GM 47/GM 48
Technical Description

Sony Ericsson

CE

The product described in this manual conforms to the Radio and Teleterminals directive 1999/5/EC with requirements covering EMC directive 89/336/EEC and Low Voltage directive 73/23/EEC.

SAR statement: This product is intended to be used with the antenna or other radiating element 20 cm far away of the any part of the human body.

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Contents

1 Introduction

1.1 Overview

The GM47/48 belong to a new generation of Sony Ericsson Mobile Communications GSM modules. This document describes the main characteristics and functionality of the GM 47/48, two dual band products for 900/ 1800 MHz and 850/1900 MHz GSM bands respectively.

They are intended to be used in both machine-to-machine applications and man-to-machine applications. The module serves its purpose when there is a need for sending and receiving data (by SMS, CSD, HSCSD, or GPRS), as well as making voice calls over the GSM network.

GM47/48 are business-to-business products. It is intended to be sold to manufacturers, system integrators, applications developers-developing solutions with wireless communication. The module is intended to be integrated by the system integrator within an application. The module and the external application will form a system for wireless communication.

A typical system is one where a micro controller in an external application communicates with the module over its serial interface. The micro controller will control the module, via the supported set of AT commands. It is assumed that the system integrators have a high technical knowledge and the ability to integrate the module into a system. For the GM47/48 modules some interesting applications are the following:

- Fleet and Asset Management
- Vending Machines
- Security and Alarm
- Other telemetry applications

1.2 Features

The module performs a set of telecom services (TS) according to GSM standard phase 2+, ETSI and ITU-T. The functions of the module are implemented by issuing AT commands over the serial interface. Supported AT commands are listed in section 5, these are defined further in GSM 7.05.

1.2.1 Type of Mobile Station

The GM 4X family are normal dual band type of MS with the following characteristics.

GM 47	GSM 900	E-GSM 900	GSM 1800
Frequency Range (MHz)	TX: 890-915	TX: 880-890	TX: 1710-1785
	RX: 935-960	RX: 925-935	RX: 1805-1880
Channel spacing	200 kHz		200 kHz
Number of channels	173 Carriers *8 (TDMA)		374 Carriers *8 (TDMA)
	GSM: Channels 1 to 124		DCS: Channels 512 to 885
	E-GSM: Channels 975 to 1023		
Modulation	GMSK		GMSK
TX Phase Accuracy	< 5º RMS Phase error (burst)		< 5º RMS Phase error (burst)
Duplex spacing	45 MHz		95 MHz
Receiver sensitivity at antenna connector	< - 102 dBm		< - 102 dBm
Transmitter output power at antenna connector	Class 4		Class 1
	2W (33 dBm)		1W (30 dBm)
Automatic hand-over between GSM 900 and GSM 1800			

GM 48	GSM 850	GSM 1900
Frequency Range (MHz)	TX: 824-849	TX: 1850-1910
	RX: 869-894	RX: 1930-1990
Channel spacing	200 kHz	200 kHz
Number of channels	123 carriers *8 (TDMA)	298 Carriers *8 (TDMA)
	GSM: Channels 128 to 251	PCS: Channels 512 to 810
Modulation	GMSK	GMSK
TX Phase Accuracy	< 5º RMS Phase error (burst)	< 5º RMS Phase error (burst)
Duplex spacing	45 MHz	80 MHz
Receiver sensitivity at antenna connector	< - 102 dBm	< - 102 dBm
Transmitter output power at antenna connector	Class 5	Class 1
	0.8 W (29 dBm)	1W (30 dBm)

Automatic hand-over between GSM 850 and GSM 1900

1.2.2 SMS

The module supports the following SMS services:

- Sending: MO, both PDU and Text mode supported.
- Receiving: MT, both PDU and Text mode supported.
- CBM is a service, in which a message is sent to all subscribers located in one or more specific cell(s) in the GSM network, for example, cell location information.
- SMS STATUS REPORT according to GSM 03.40.
- SMS COMMAND according to GSM 03.40.

The maximum length of an SMS message is 160 characters when using 7-bit encoding. For 8-bit data, the maximum length is 140 bytes.

The module does support upto 6 concatenated messages to extend this function.

1.2.3 Voice calls

The GM47/48 offers the capability of MO and MT voice calls, as well as supporting emergency calls. In addition to this multiparty, call waiting and call deflection features are available. Some of these features are operator specific.

The module offers normal analogue input/output lines, analogue audio input/ output lines in differential modes, and digital audio interface, with the possibility of accessing internal points within the digital audio lines. Moreover, the GM 47/GM48 has embedded echo canceller and noise suppresser, which provides high quality audio.

The module supports both HR, FR and EFR voice coding, provided that EFR is available in the network.

1.2.4 Data

The module supports the following data protocols:

- *General Packet Radio Service (GPRS).* The modules are Class B Terminals, which provides simultaneous activation and attach of GPRS and GSM services. The GM47/48 modules are GPRS 3+1 devices, which are capable of transmitting in one timeslot per frame (uplink), and receiving in a maximum of three timeslots per frame (downlink).
- *Circuit Switched Data (CSD).* GM47/48 modules are capable to stablish a circuit switch data communication at 9.6 kbps, V42bis compression is not supported.

- *High Speed Circuit Switched Data (HSCSD).* GM47/48 support HSCSD communication, with one timeslot per frame capacity in the uplink and two timeslots per frame capacity in the downlink (2+1).

1.2.5 SIM Card

The module supports the connection of an external SIM Card with 3V and 5 V technology, via the 60-pin system connector. The module does not have an internal SIM holder.

1.2.6 Power consumption

	Stand-by[1]	Transmit/Operation
GSM 850 & 900 MHz	20 mA	275 mA (2A peak)
GSM 1800 & 1900 MHz	20 mA	250 mA (1.75A peak)

Note! The power consumption during transmission is measured at maximum transmit power.

1.2.7 Other features

- Internet Ready Module
- 07.10 Multiplexing
- Bluetooth interoperability
- GPS interoperability
- SIM application toolkit, class 2 release 96 compliant

1.2.8 Development Kit

Sony Ericsson Mobile Communications provides the opportunity to test the module in a limited scale, before ordering a large quantity. With the development kit you can quickly get started with the module. The kit includes necessary accessories (software and hardware) that you will need for your test purposes. It also includes the following:

- GSM module GM 47 or GM 48
- Integrator's Manual
- Warranty Sheet

1 This figures are tentative data, subject to change.

The Integrator's Manual provides you with all the information you need to be able to integrate the module with your application.

1.3 Precautions

The GM47/48 should be handled like any mobile station. In the Integrators' Manual you will find more information about safety and product care. In the Technical Data chapter in this document the environmental and electrical limits are specified. Never exceed these limits to ensure the module is not damaged.

1.4 Abbreviations

Abbreviation	Explanation
BT	Bluetooth
CBS	Cell Broadcast Service
CBM	Cell Broadcast Messaging
CSD	Circuit Switch Data
DCE	Data Circuit Terminating Equipment
DTE	Data Terminal Equipment
DTMF	Dual Tone Multi Frequency
EFR	Enhanced Full Rate codec
EMC	Electro-Magnetic Compatibility
ETSI	European Telecommunications Standards Institute
FR	Full Rate codec
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile Comunication
HR	Half Rate codec
HSCSD	High Speed Circuit Switched Data
ITU-T	International Telecommunication Union – Telecommunications Standardisation Sector
ME	Mobile Equipment
MO	Mobile Originated
MS	Mobile Station
MT	Mobile Terminated
PCM	Pulse Code Modulation
PDU	Protocol Data Unit
RLP	Radio Link Protocol
RF	Radio Frequency
RTC	Real Time Clock

SDP	Service Discovery Protocol
SMS	Short Message Service
SIM	Subscriber Identity Module
TBD	To Be Defined

2 Mechanical Description

2.1 Interface Description

The picture below presents the conceptual mechanical design of the GM 47/48. The GM 47/48 are protected with AISI 304 Stainless Steel covers suitable to fulfil the environmental and EMC requirements. Dimensions, the position of the different connectors and mounting holes are shown in figure 2.2.

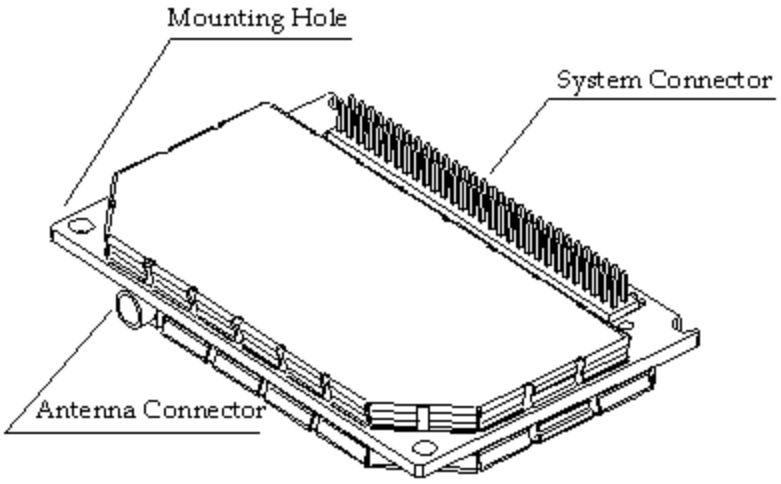

Figure 2.1 GM 47/48, view from the underside

2.2 Physical Dimensions

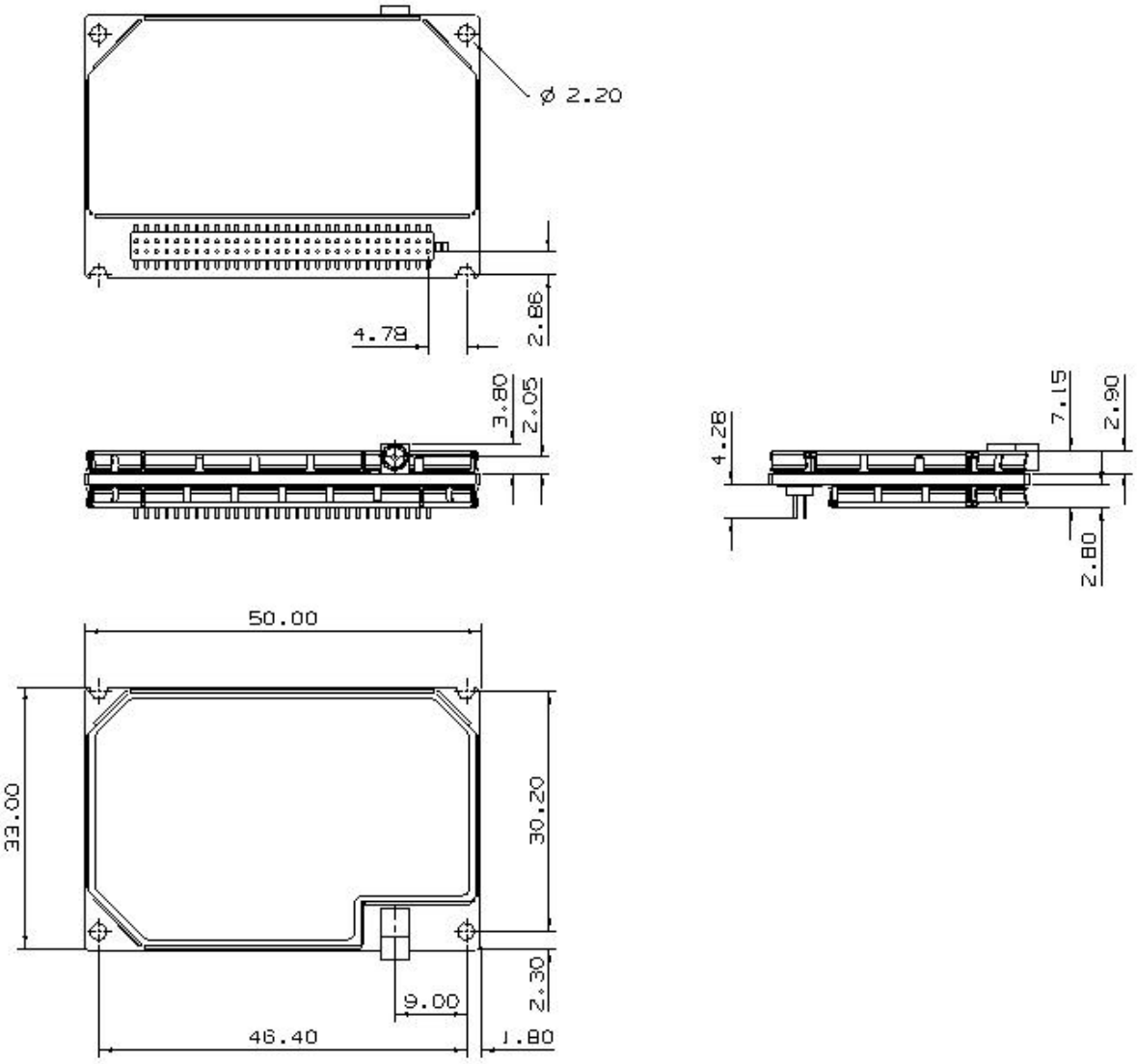

Figure 2.2 Physical dimensions of GM 47/48

The measures are given in millimetre's. See also chapter 6, Technical Data.

3 System Connector Interface

3.1 Overview

The electrical connections to the module (except the antenna), are set through the System Connector Interface.

The connector shall allow the following connections: board to board and board to cable. The table below provides the two possible mating connectors for the application system:

No	Pin	Part Number	Description
1	60	9462-9101-606	Female connector (Speed Tech). Board-Board
2	60	TBD	Female connector. Board-Cable

The figure 3.1 below indicates the pin numbering scheme.

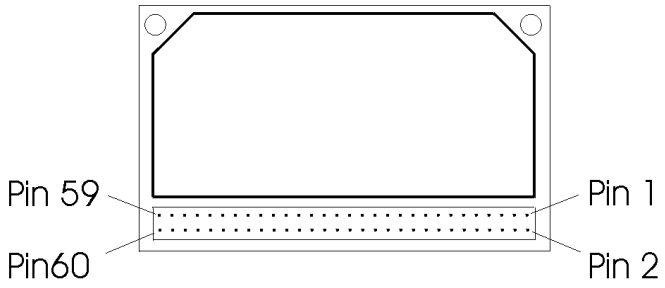

Figure 3.1 GM 47/48. View from the underside

The table on next page provides the pin assignment of the different signals in the System Connector Interface as well as a short description of them.

All signal directions are with respect to the module i.e. Direction 'O' means data being sent by the module.

Pin	*Signal Name*	*Dir*	*Signal Type*	*Description*
1.	VCC	-	Supply	Power Supply
2.	DGND	-	-	Digital Ground
3.	VCC	-	Supply	Power Supply
4.	DGND	-	-	Digital Ground
5.	VCC	-	Supply	Power Supply
6.	DGND	-	-	Digital Ground
7.	VCC	-	Supply	Power Supply
8.	DGND	-	-	Digital Ground
9.	VCC	-	Supply	Power Supply
10.	DGND	-	-	Digital Ground
11.	VCC	-	Supply	Power Supply
12.	DGND	-	-	Digital Ground
13.	Reserved for future use			
14.	ON/OFF	I	Internal pull up, open drain	Turns the module on/off Former WAKE_B
15.	SIMVCC	-	Dig. 3/5 V	SIM card power supply Power output for SIM Card from module
16.	SIMPRESENCE	I	Internal pull up, open drain	SIM Presence A "1" shall indicate that the SIM is missing; a "0" that it is inserted.
17.	SIMRST	O	Dig. 3/5 V	SIM card reset
18.	SIMDATA	I/O	Dig. 3/5 V	SIM card data
19.	SIMCLK	O	Dig. 3/5 V	SIM card clock
20.	DAC	O	Analogue	Digital to Analogue converter
21.	IO1	I/O	Digital, 2.75	General purpose input/output 1
22.	IO2	I/O	Digital, 2.75	General purpose input/output 2
23.	IO3	I/O	Digital, 2.75	General purpose input/output 3
24.	IO4	I/O	Digital, 2.75	General purpose input/output 4
25.	VRTC	I	Supply 1.8 V	Voltage for real time clock
26.	ADC1	I	Analogue	Analogue to Digital converter 1
27.	ADC2	I	Analogue	Analogue to Digital converter 2
28.	ADC3	I	Analogue	Analogue to Digital converter 3
29.	SDA	I/O	2.75, internal pullup	I^2C Data
30.	SCL	O	2.75, internal pullup	I^2C Clock
31.	BUZZER	O	Dig. 2.75	Buzzer output from module
32.	TIMESTAMP	O	Dig. 2.75	Timestamp Timestamp is reserved for future use, if A-GPS is implemented on network side.

33.	LED	O	Dig. 2.75	Flashing LED
34.	VIO	O	Power Out 2.75	Module powered indication. The VIO is a 2.75 V output that could power external devices to transmit data towards the GSM device to a 75mA max.
35.	TX_ON	O	Dig 2.75	This output shall indicate when the GSM module is going to transmit the burst.
36.	RI	O	Dig. 2.75	Ring Indicator
37.	DTR	I	Dig. 2.75	Data Terminal Ready
38.	DCD	O	Dig. 2.75	Data Carrier Detect
39.	RTS	I	Dig. 2.75	Request To Send
40.	CTS	O	Dig. 2.75	Clear To Send
41.	TD	I	Dig. 2.75	Transmitted Data Data from DTE (host) to DCE (module). [former DTMS]
42.	RD	O	Dig. 2.75	Received Data Data from DCE (module) to DTE (host). [former DFMS]
43.	TD3	I	Dig. 2.75	UART3 Transmission Data from DTE (host) to DCE (module). [former DTMS]
44.	RD3	O	Dig. 2.75	UART3 Reception Data from DTE (host) to DCE (module). [former DTMS] Data from DCE (module) to DTE (host). [former DFMS]
45.	TD2	I	Dig. 2.75	UART2 Reception Former CTMS. Used for flashing
46.	RD2	O	Dig. 2.75	UART2 Transmission Data from DCE (module) to DTE (host). [former DFMS] Former CFMS. Used for flashing
47.	PCMULD	I	Dig. 2.75	DSP PCM digital audio input
48.	PCMDLD	O	Dig. 2.75	DSP PCM digital audio output
49.	PCMO	O	Dig. 2.75	Codec PCM digital audio output
50.	PCMI	I	Dig. 2.75	Codec PCM digital audio input
51.	PCMSYNC	O	Dig. 2.75	DSP PCM frame sync
52.	PCMCLK	O	Dig. 2.75	DSP PCM clock output
53.	MICP	I	Analogue	Microphone input positive
54.	MICN	I	Analogue	Microphone input negative
55.	BEARP	O	Analogue	Speaker output positive
56.	BEARN	O	Analogue	Speaker output negative
57.	AFMS	O	Analogue	Audio output from module

58.	SERVICE	I	12V/2.7V	Flash programming voltage for the MS. Enable logger information if no flashing Former VPPFLASH
59.	ATMS	I	Analogue	Audio input to module
60.	AGND	-	-	Analogue ground

3.2 General Electrical and Logical Characteristics

Many of the signals present in the interface are high-speed CMOS logic inputs or outputs powered from 2.75 V ± 5 %. Whenever a signal is defined as Dig. 2.75 V, the following electrical characteristics shall apply.

Parameter	*Min.*	*Typ.*	*Max.*	*Output current I_o*	*Units*
High Level Output Voltage (V_{OH})	2.2		2.75	- 2 mA	Volts
Low Level Output Voltage (V_{OL})	0		0.6	2 mA	Volts
High Level Input Voltage (V_{IH})	1.93		2.75		Volts
Low Level Input voltage (V_{IL})	0		0.5		Volts

3.2.1 General Protection Requirements

All 2.75V digital inputs shall continuously withstand any voltage from -0.5V up to 3.47V (3.3V + 5%) in the power-on or power-off condition with no damage. All 2.75V digital outputs shall continuously withstand a short circuit to any voltage within the range from 0V to 3V.

The SIM output signals and the SIMVCC supply shall continuously withstand a short circuit to any voltage within the range from 0V to 4.1V.

3.3 Grounds

Pins	Name	Description
2, 4, 6, 8, 10, 12	DGND	Digital Ground
60	AGND	Analogue Ground

There are two ground signals in GM 47/48, Analogue Ground (AGND) and Digital Ground (DGND). The analogue Ground is connected to pin number 60, and the Digital Ground is connected to the System Connector Interface through pin numbers 2, 4, 6, 8, 10 and 12.

Note: All the Ground pins have to be connected to the application. The AGND is connected to the DGND in the ME, and *only* there. It is important that the AGND and the DGND are separated in the application.

3.3.1 The Analogue Ground

The AGND lead is the analogue audio reference ground. It is the return signal for Audio To Mobile Station (ATMS) and Audio From Mobile Station (AFMS).

It shall be connected to the Digital Ground (DGND) inside the module and only there. The application shall not connect DGND and AGND.

Parameter	*Limit*
I_{max}	≅12.5mA

3.3.2 The Digital Ground (DGND)

DGND is the reference for all digital signals in the System Interface. It shall also be the DC return for the power supply on VCC and SERVICE. Each DGND pin is rated at 0.5 A. All DGND pins are connected internally in the module.

Parameter	*Limit*
$I_{average}$	< 0.5 A No DGND pin can withstand over 0.5 A
I_{max}	< 600 mA (100 mA each)

3.4 Regulated Power Supply

Pins	*Name*	*Description*
1, 3, 5, 7, 9, 11	VCC	Regulated Power Supply

The regulated power supply, VCC, is connected to the pin numbers 1, 3, 5, 7, 9 and 11.

3.4.1 Power Supply (VCC)

The VCC supplies the module with external power. Any other voltage needed is generated internally.

Parameter	*Mode*	*Limit*
Voltage to be applied	Nominal	3.6 Volts
	Tolerance including ripple[2]	3.4 Volts - 4.0 Volts
	Over voltages	5.5 Volts
Current Drive capability at TX Full Power		< 600 mA (average))
		< 2 A (Peak)

GM 47/48 have not internal capacitance to supply the large current peaks during GSM transmission. Therefore on burst transmission the application DC source is responsible for providing the appropriate current.

3.5 ON/OFF and External Power Signals

Pins	*Name*	*Dir*	*Description*
14	ON/OFF	I	Square signal to turn on/off the module
34	VIO	O	External power supply

3.5.1 Module ON/OFF

The module is powered ON/OFF by earthing (pulling low) pin 14 as per figure 3.2 below. The pin should then be released as it is an internal pull up to return it to the high state.

Note: Driving with 2.75V or 3.6V is not permitted and restrict module functionality.

Parameter	*Minimum*	*Typical*	*Maximum*	*Units*
Voltage HIGH Level (FALSE)			VCC	By internal pull up only
Voltage LOW Level (TRUE)	0		0.3*VCC	Volts
Pull-up Resistance	Internal pull up		39	KΩ

2 Measured at system connector pins.

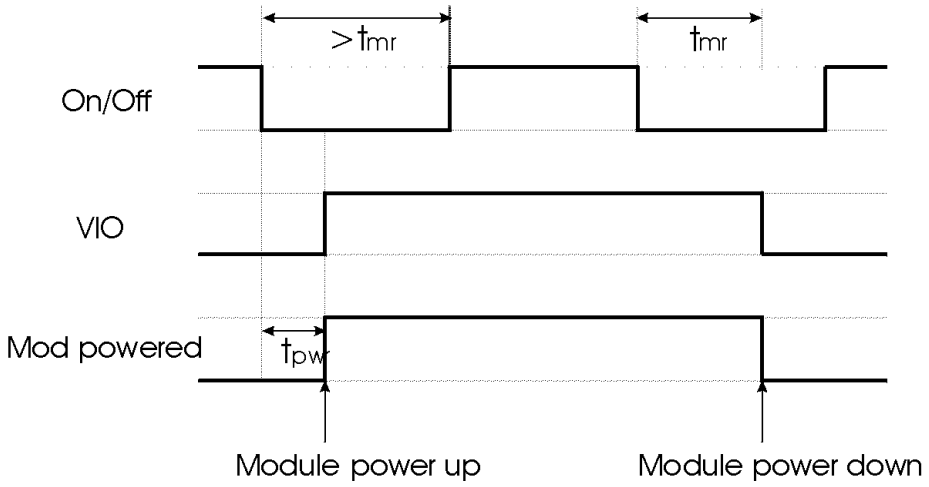

Figure 3.2ON/OFF and VIO performance

Where the times are defined as follows:

Time	*Description*	*Min*	*Typ*	*Max*	*Unit*
t_{MR}	Time to start an ON/OFF operation	1	1.5		S
t_{PWR}	Time for module start-up one ON/ OFF signal has set to TRUE	100		200	Ms

3.5.2 External 2.75 V (VIO)

The VIO has been derived from a 2.75 V regulator. It is possible to use this output as a power supply at 2.75 V with a maximum of 75mA.

It will indicate that the module is alive and it could power external devices. In this case, the external applications do not need to implement a 2.75 volt regulator to adapt the incoming (from module point of view) serial data.

Parameter	*Minimum*	*Typical*	*Maximum*	*Units*
Output Voltage (I_{load}=50 mA)	2.70	2.75	2.85	Volts
Load current			75	mA

3.6 Analogue Audio

Pins	*Name*	*Dir*	*Description*
57	AFMS	O	Audio From Mobile Station
59	ATMS	I	Audio To Mobile Station
60	AGND	-	Reference for analogue audio

ATMS and AFMS are the audio input and output for the module. The analogue audio signals can be used in two different modes, Normal and Portable Handsfree.

Handsfree
This mode is referred to as Audio To Mobile Station (ATMS) and Audio From Mobile Station (AFMS). It is used by audio accessories such as Handsets and Handsfree equipment.

Portable Handsfree
This mode activates a different amplification factor in the Mobile Equipment (ME). It also activates a microphone bias level in ATMS. This is the default mode.

3.6.1 Audio To Mobile Station (ATMS)

ATMS is the analogue audio input to the module. It connects to the audio input of the CODEC in the module. The CODEC then converts the analogue audio to digital audio, in PCM format, which is connected to the internal PCM bus in the module. The internal PCM bus connects the encoded audio to PCMO on the system connector.

ATMS is also used as the microphone input from the Portable Handsfree. If this is the case, a DC bias is provided from the ATMS.

All sources must be AC-coupled except the Portable HandsFree microphone, which shall be DC-coupled in order to supply DC current to the Portable HandsFree microphone. AC coupling prevents incorrect biasing or damage of the ATMS input. The capacitor must have a value greater than shown below to avoid attenuation of low frequencies.

The ATMS input is a passive network followed by the transmit part of the CODEC.

Parameter	*Limit*
Application driving impedance (0.3 - 3.5 kHz)	< 300 Ω
AC coupling capacitance[3]	> 1 µF
Module input impedance (0.3 - 3.5 kHz)	>50KΩ
Low frequency cut-off (- 3 dB)	300 Hz ± 50 Hz
High frequency cut-off (- 3 dB)	> 3500 Hz
Maximum allowed input level	$1.5V_{pp}$ = 530mV
Output DC bias level Handsfree mode	0 V

3 AC coupling capacitance must be supplied by the application, unless a DC coupled microphone is used.

	Portable Handsfree mode	2 V ± 0.1 V
Additional Gain in Portable Handsfree mode		28.5 dB

- Maximum input level at ATMS 245mVrms output at PCMO = 3dBm0
- The following table is with nominal PGA (Programmable Gain Settings)
- For more information see AT commands

Input	Input Volts mV_{rms}	TXAGC dB	AUXI1 Gain	PCMO dBm0
ATMS	245	0	13	3

Maximum input level at MICI 61.4mV_{rms} output at PCMO = 3dBm0

Input	Input Volts mV_{rms}	TXAGC dB	AUXI1 Gain	PCMO dBm0
MICI	61.4	0	25	3

Output at AUX02 for 3dBm0 at PCMI

Input	dBm0	RXPGA	Volume Control dB	AUX02 mV_{rms}
PCMI	3dBm0	0	0	436

Output at BEAR for 3dBm0 at PCMI

Input	dBm0	RXPGA	Volume Control dB	BEAR mV_{rms}
PCMI	3dBm0	0	0	388

3.6.2 Audio From Mobile Station (AFMS)

AFMS is the analogue audio output from the module. When it is active, the output is derived from the PCM digital audio by the decoder part of the CODEC. The PCM data comes from PCMI on the system connector. It is also used as an ear-piece driver for the Portable Hands Free accessory.

Parameter		*Limit*
Speaker impedance		64 Ω το 1KΩ
AFMS Output Capacitance		2.2 µF ±10%
Levels (THD < 5 %)	Drive capability into 5 kΩ (0.3 - 3.5 kHz)	> 2.4 Vpp [TBC]
	Drive capability into 1.5 kΩ (0.3 - 3.5 kHz)	> 2.2 Vpp [TBC]
	Drive capability into 150 Ω (at 1kHz)	> 1.3 Vpp [TBC]

3.7 Microphone Signals

Pin	*Speaker signals*	*Dir*	*Function*
53	MICP	I	Microphone Positive Input
54	MICN	I	Microphone Negative Input

MICP and MICN are the microphone-input pins. These inputs shall be compatible with an electret microphone. The microphone contains a FET buffer with open drain output, which must be supplied at least +2V relative to ground.

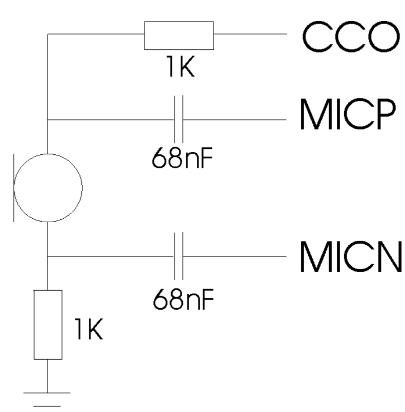

Figure 3.3 Microphone connection to module

CCO is the source voltage that will provide the necessary drive current for the microphone.

Parameter	Limit
CCO	2.0 - 2.5 V

3.8 Speaker Signals

Pin	Speaker signals	Dir	Function
55	BEARP	O	Microphone Positive Output
56	BEARN	O	Microphone Negative Output

BEARP and BEARN are the speakers output pins. These outputs are in differential mode.

3.9 Digital Audio

Pin	PCM signal	Dir	Function
52	PCMCLK	O	PCM clock
51	PCMSYNC	O	PCM frame sync
47	PCMULD	I	PCM audio input to DSP
48	PCMDLD	O	PCM audio output to DSP
50	PCMI	I	PCM audio input to Codec
49	PCMO	O	PCM audio output to Codec

The digital PCM audio signals allow the connection of a digital audio source / receiver, bypassing the analogue audio CODEC processing functions performed within the module.

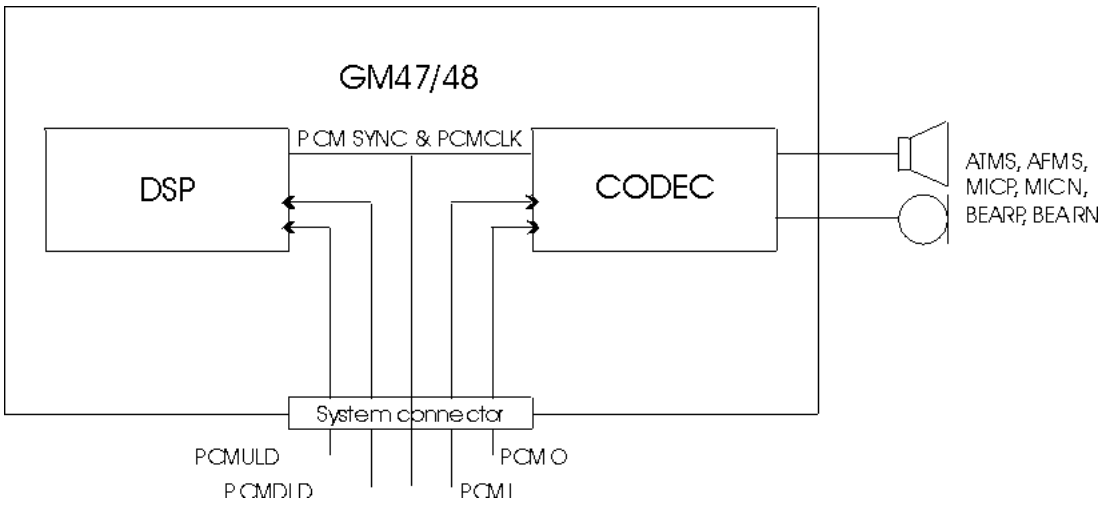

Figure 3.4 Pin connections to digital audio

In case no external audio processing is performed, then it is needed to connect

PCMDLD and PCMI
PCMULD and PCMO

Electrical characteristics
The Dig. 2.75 V CMOS Output / Input electrical characteristics shall apply, with DGND as the reference.

PCM interface format
The PCM format (for PCMULD and PCMDLD) shall follow a linear PCM data I/O format of an industry standard Texas Instrument DSP. It is the same format as the one used between the CODEC and the DSP. The DSP is the source of the bit clock PCMCLK and the frame synchronisation PCMSYNC. The data bits in PCMULD and PCMDLD shall be aligned so that the MSB in each word occurs on the same clock edge.

3.10 Serial Data

Pin	Name	Dir	Description	RS232 CCITT Nº
41	TD	I	Serial data to module	103
42	RD	O	Serial data from module	104
39	RTS	I	Request To Send	105
40	CTS	O	Clear To Send	106
37	DTR	I	Data Terminal Ready	108.2
38	DCD	O	Data Carrier Detect	109
36	RI	O	Ring Indicator	125
45	TD2	I	UART 2 Data Transmission	
46	RD2	O	UART 2 Data Reception	
43	TD3	O	UART 3 Data Transmission	
44	RD3	I	UART 3 Data Reception	

The serial channels are used as asynchronous communication links between an application system or accessory units connected to the Module. They consist of three UART's. One of them, the first and main one, shall have RS-232 functionality. The rest shall behave as general- purpose serial data lines, except for special applications (such as accessories for the UART2 and Bluetooth for UART 3).

The Dig. 2.75 V CMOS Output / Input electrical characteristics shall apply, with DGND as the reference. Extra relevant data is specified for some of the signals.

The only character format supported is 1 start bit, 8 bit data, non-parity plus 1 stop bit, in total 10 bits per character.

3.10.1 UART 1 (RS232) - RD, TD, RTS, CTS, DTR, DCD and RI

The UART1 signals form a 9 pin RS-232 (V.24) serial port, apart from the DSR (CCITT Nº 107) signal. DSR signal has been removed as it is usually connected to DTR in most systems.

The signal levels do not match the standard RS-232 (V.28) levels. The relationship between the levels is shown in the table below

RS - 232 Level	*RD, TD*	*RTS, CTS, DTR, DCD, RI*	*2.75 V CMOS Level*
< - 3 V	1	OFF	> 1.93
> + 3 V	0	ON	< 0.80 V

Conversion between the 2.75V CMOS levels and the RS232 levels can be achieved using a standard interface IC, such as the Maxim Integrated Products MAX3237.

3.10.2 Serial Data Signals - RD, TD

The default baud rate is 9.6 kbit/s, however higher bit rates up to 460 kbit/s shall be supported, and set by an AT command. The UART 1 starts at a rate of 9.6 kbit/s in standard AT mode or binary mode (First received data AT or binary will determine the operation mode).
The GSM 07.10 multiplexing protocol is supported and shall be started on command. In this case bit rates up to 460 kbits/s shall be supported.

Serial Data From Module (RD)
RD is an output used to send data on the UART 1 to the application system. This is a Dig. 2.75 CMOS Output and general characteristics are applicable.

Parameter	*Limit*
Application load resistance	< 100 kΩ
Application load capacitance	< 500 pF

Serial Data To Module (TD)
TD is input (to the module) used by the application system to send data on the UART 1 to the module. This is a Dig. 2.75 CMOS Input and general characteristics are applicable.

Parameter	*Limit*
Application driving impedance	< 100 Ω
Input capacitance	1 nF
Input resistance (pull-up)	100 kΩ to 2.75 V

3.10.3 Control Signals - RTS, CTS, DTR, DCD, RI

The control signals are active low, and hence when a standard interface IC is used (such as MAX3237), then standard RS-232 levels are obtained.

These signals together with DGND, RD and TD form a 9-pin RS-232 data port (with the exception of the voltage levels and DSR).
RTS and CTS shall be capable of transmitting at 1/10 of the data transmission speed for data rates, up to 460 kbit/s. (Byte oriented flow control mechanism).

Switching times for RTS and CTS

Parameter	*Limit*
Time from Low to High level	< 2 µs
Time from High to Low level	< 2 µs

Request to Send (RTS)
RTS is an input to the module. The signals on this circuit shall be used to condition the DCE (the module when used for data transmission purposes) for data transmission. Default level is OFF, by internal pull up.

The exact behaviour of RTS shall be defined by an AT command. Software or hardware flow control can be selected. Hardware flow control is the default.

This is a Dig. 2.75 CMOS Input and general characteristics are applicable.

It is the duty of the application to pull RTS low (logic levels) to request communications with the module. The module will respond by asserting CTS low and as such may be used as a notification as a module status ready for communication.

Parameter	*Limit*
Application driving impedance	< 100 Ω
Input capacitance	< 2 nF
Input resistance (pull-down)	100 kΩ to DGND

Clear To Send (CTS)
CTS is an output from the module. The signals on this circuit shall be used to indicate that the DCE (the module when used for data transmission purposes) is ready to transmit data. Default level is high. The exact behaviour of CTS shall be defined by an AT command. Software or hardware flow control can be selected.

This is a Dig. 2.75 CMOS Output and general characteristics are applicable.

Tip: if only software flow control is to be used it becomes necessary to assert RTS low or to connect RTS to CTS at the module.

Parameter	*Limit*
Application load capacitance	< 500 pF
Application load resistance	> 1 MΩ

Data Terminal Ready (DTR)
DTR is an input to the module. Signals from the DTE on this circuit indicate the DTE is ready to transmit and receive data. DTR also acts as a hardware 'hang-up' so that calls are terminated if DTR is OFF (high).

Default level is ON (low). The exact behaviour of DTR shall be defined by AT commands.

This is a Dig. 2.75 CMOS Input and general characteristics are applicable.

Data Carrier Detect (DCD)
DCD is an output from the module. An ON (low) signal shall indicate that a valid carrier (data signal) is being received by the DCE (module). The exact behaviour of DCD shall be defined by an AT command.

This is a Dig. 2.75 CMOS Output and general characteristics are applicable.

Ring Indicator (RI)
RI is an output from the module. An ON (low) signal shall indicate a ringing signal is being received by the DCE (module).

The functionality shall be selected by an AT command.

This is a Dig. 2.75 CMOS Output and general characteristics are applicable.

Note: DSR is considered permanently ready for a module, therefore any DGND connection may be taken as DSR functionality.

3.10.4 UART 2 - TD2, RD2

The UART 2 consists of a full duplex serial communication. This involves the transmission and reception lines.

The communication port shall work in one mode: Operation and Maintenance mode.

Operation and Maintenance mode shall work in addition with SERVICE signal. On switching the module on, if SERVICE signal is active then two events can happen. If no data is sent to the module, then the logger is activated. Otherwise, the module shall be ready to be reprogrammed.

Timing and Electrical signals characteristics equal to UART 1 TD and RD, except for maximum baud rate that could be increased to 921 KBPS.

Transmitted Data 2 (TD2)
TD2 is input (to the module) used by the application system to send data on the UART 2 to the module.

The electrical characteristics shall be the same as TD.

Received Data 2 (RD2)
RD2 is an output used to send data on the UART 2 to the application system.

The electrical characteristics shall be the same as RD.

3.10.5 UART 3 - TD3, RD3

The UART 3 consists of a full duplex serial communication. This involves the transmission and reception lines.

Timing and electrical signals characteristics equal to UART 1 TD and RD.

Transmitted Data 3 (TD3)
TD3 is input (to the module) used by the application system to send data on the UART 3 to the module.

The electrical characteristics shall be the same as TD.

Received Data 3 (RD3)
RD is an output used to send data on the UART 3 to the application system.

The electrical characteristics shall be the same as RD.

3.11 SIM Card related signals

Parameter	Mode	Signal	Min.	Typ.	Max.	Unit
SIM supply Voltage	3 V	SIMVCC	2.7	3.0	3.3	V
	5 V		4.5	5.0	5.5	V
High Level Input Voltage (V_{IH})	3 V	SIMDAT	2.1		3.0	V
	5 V		3.5		5.0	V
Low Level Input Voltage (V_{IL})	3 V	SIMDAT	0		0.9	V
	5 V		0		1.5	V
High Level Output Voltage (V_{OH})	3 V	SIMDAT	2.7		3.0	V
	5 V		4.7		5.0	V
Low Level Output Voltage (V_{OL})	3 V	SIMDAT	0		0.2	V
	5 V		0		0.2	V
High Level Output Voltage (V_{OH})	3 V	SIMCLK SIMRST	2.4		3.0	V
	5 V		4.4		5.0	V
Low Level Output Voltage (V_{OL})	3 V	SIMCLK SIMRST	0		0.35	V
	5 V		0		0.3	V

3.11.1 SIM Detection – SIM Presence

SIMDETECT is an input intended to be used to determine whether a SIM card has been inserted or removed in the external SIM card holder. It shall be normally wired to the "Card Inserted Switch" of the external SIM card holder, but different implementation could be handled.

On having High level it will mean, "SIM card missing". While pulled down to Low the module shall understand it as "SIM card inserted". SIMDETECT is Dig. 2.75 CMOS input and general characteristics are applicable.

Parameter	*Min.*	*Typ.*	*Max.*	*Units*
Pull-up resistance (at 2.75 V)	100			kΩ
Low Level Input Voltage (SIM inserted)			0.8	V
High Level Input Voltage (SIM missing)	1.93		5	V

3.12 Service/Programming

Pin	*Signal*	*Description*
58	SERVICE	Flash programming voltage

This input shall be used as a programming voltage for the Flash Memories to initiate and speed up the programming process, or a signal to indicate the module a logging process.

	SERVICE Voltage (V)			
Mode				Drive Capacity
Mode	SERVICE Voltage (V)			Drive Capacity
	Min.	Typ.	Max.	
Normal Operation			0.8	-
Service/enable programming	1.9	2.75	3.6	> 1 mA
Fast programming	11.4		12.6	> 60 mA
Absolute maximum voltage			13.5	-

The maximum accumulated time allowed with Programming voltage applied shall be 80 h. over the lifetime of the module.

3.13 Buzzer

Pin	*Signal*	*Description*
31	BUZZER	Buzzer Output from module

This is an output signal which allows the application to use pre-programmed melodies or sounds. Typical use would involve a transistor buffer with a piezoelectric sounder.

The Dig. 2.75 V CMOS Output electrical characteristics shall apply, with DGND as the reference.

3.14 LED

Pin	*Signal*	*Description*
33	LED	LED Output from module

This is an output signal which allows the use of an external LED. The LED shall indicate different states within the module.

This signal is a Dig. 2.75 V CMOS output so general characteristics are applicable. In order to connect a LED in the external application following scheme shall be followed.

The operation of the LED is hardcoded and is not controlled by the host application.

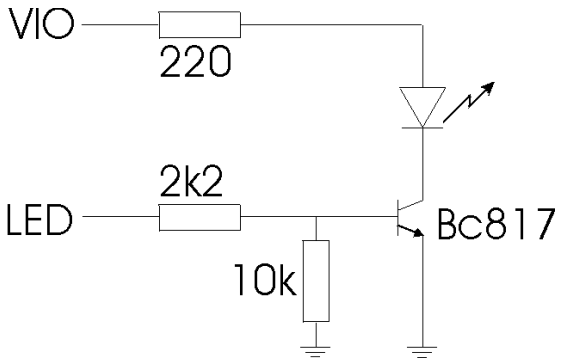

Figure 3.5 Electrical connection for led

3.15 TX_ON - Burst Transmission

Pin	*Signal*	*Dir*	*Description*
35	TX_ON	O	GSM module on transmission

The TX_ON is a digital signal output. This shall indicate that the module is going to transmit the burst. Burst transmission is the time when a GSM transceiver unit.

Dig 2.75 CMOS Output so general electrical characteristics are applicable.

3.16 Timestamp

Pin	*Signal*	*Dir*	*Description*
32	TIMESTAMP	O	Global Positioning System Timestamp

TIMESTAMP is a Dig. 2.75 V CMOS Output electrical characteristics, with DGND as the reference.

Its main purpose is the A-GPS timestamp. As it is shown this is only applicable when the Assisted GPS is implemented. In order to apply the assisted GPS performance not only MS implementation is necessary but network side as well.

3.17 Real Time Clock

The Real Time Clock provides with a time-of-day calendar with alarm and one hundred-year calendar to the main microprocessor.

The real time clock operates with a separate power supply. Therefore, two modes of operation shall be distinguished:

RTC Normal operation: This is when the MS is powered, and it does not take into account if the MS is in OFF, ON or SLEEP mode.
RTC Backup operation: This operation is performed when the MS is not powered, VCC = 0V. In this case the RTC operation is maintained by the backup power supply.

The backup power supply is a passive power supply, capacitor, golden- capacitor, battery etc., which shall be connected outside the MS to VRTC pin. During the RTC normal operation, the passive power supply is being charged; this is like charging a capacitor.

In backup operation, the backup source provides with enough voltage for RTC operations. Following table shows both voltage operations characteristics.

Parameter	*Min.*	*Typ.*	*Max.*	*Units*
Supply Voltage RTC (Normal Operation – Charging the capacitance)	1.6	1.8	2.0	V
Supply Voltage RTC (Backup Operation – Capacitance provides with voltage)	1.0	1.8	2.0	V

In Back-up operation if the voltage drop below 1.0 Volts, the RTC shall stop working. Following picture shows the RTC connection:

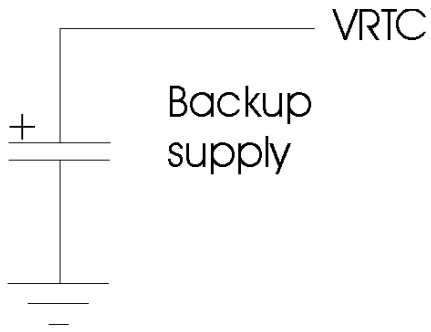

Figure 3.6 RTC connection

A typical value for this capacitor will be 0.16F, this will power the RTC for approximately 6 hours.

4 Antenna Connector

The Antenna Connector is a hub for transmission of the Radio Frequency (RF) signals from the module to the external customer-supplied antenna. It is a microminiature coaxial MMCX connector that is mounted on the surface of the module. One provider of Antenna Connectors is IMS.

This table provides the electrical characteristics at the antenna interface.

Parameter	*Limit*	*Description*
Nominal impedance	50 Ω (SWR < 2:1)	
Output Power	2 Watt peak (Class 4)	Extended GSM 900
	1 Watt peak (Class 1)	GSM 1800
Static Sensitivity	Better than - 102 dBm	Extended GSM 900
	Better than - 102 dBm	GSM 1800

5 AT Command Summary

The AT standard is a line-oriented command language. "AT" is an abbreviation of ATtention and it is always used to start sending a command line from a TE to the TA. TE stands for Terminal Equipment which is a computer of any size and TA stands for Terminal Adapter which is the modem part of the module.

The command line consists of a string of alphanumeric characters. It is sent to the modem to instruct it to perform the commands specified by the characters.

Functionality	AT commands
CONTROL AND IDENTIFICATION	
Subscriber Information	AT+CNUM, AT+CIMI, AT*ESNU
Product & Release info	AT+CGMI, AT+CGMM, AT+CGMR, AT+CGSN, AT*ESIR
Generic information & Settings	AT, AT*, AT+CLAC, AT+GCAP, ATI, AT+CSCS, AT&F, AT&W, ATZ, AT+WS46
CALL CONTROL	ATA, ATD, ATL, ATH, ATO, ATP, ATT, AT+CHUP, AT+CMOD, AT+VTS, AT+CVHU, AT+CR, AT+CRC, AT+CRLP
AUDIO CONTROL	AT*EALR, AT*EAMS, AT*EARS, AT*ELAM, AT*EMIR, AT*EMIC, AT*EXVC
NETWORK SERVICES	
Alternate Line Service (ALS)	AT*EALS, AT*ELIN, AT*ESLN
Customer Service Profile	AT*ECSP
Call forwarding	AT+CCFC, AT*EDIF, AT*EDIS
Calling/called number identification	AT+CLIP, AT+CLIR, AT*EIPS
Preferred networks	AT*EPNR, AT*EPNW
Advice of Charge	AT+CACM, AT+CAMM, AT+CAOC, AT+CPUC
Calling cards	AT*ESCN
Call hold, waiting & multiparty	AT+CCWA, AT+CHLD
Operator selection	AT+COPS
Network registration	AT+CREG
USSD	AT+CUSD, AT+ CSSN
Security & Locks	AT+CLCK, AT+ CPWD, AT+CPIN, AT*EPEE
SETTINGS	AT*EMAR, AT*ERIL, AT*ERIN, AT*ERIP, AT*ESIL, AT*ESMA, AT*ESMM, AT*ESOM,

	AT*ECPI
ME STATUS INFORMATION	AT*ECAM, AT+CSQ, AT+CBC, AT+CIND, AT+CPAS, AT+CMER
ERROR CONTROL	AT+CMEE, AT+CEER
SMS & CB	
Settings	AT*ESTL, AT+CPMS, AT+CRES, AT+CSAS, AT+CSCA, AT+CSMS, AT+CNMI, AT+CSDH, AT+CSMP, AT+CGSMS
SMS-Command	AT+CMGC
Read / write SMS	AT+CMGD, AT+CMGW, AT+CMGL, AT+CMGR
Send SMS	AT+CMGS, AT+CMSS
PHONEBOOK	
Read / write / find	AT+CPBS, AT+CPBR, AT+CPBW, AT+CPBF
Call screening	AT*ECAR, AT*ECAS, AT*ECAW
Groups	AT*EGIR, AT*ESAC, AT*ESCG, AT*ESDG, AT*ESDI, AT*ESGR
Personal Rings	AT*EPRR, AT*EPRW
Settings	AT*EPBM, AT*ESIA, AT*E2PCS
CLOCK	
Alarm	AT+CALA, AT+CALD, AT+CAPD
Time & Date	AT+CCLK, AT+CTZU, AT*EDST
WAP	
Bookmarks	AT*EWBA, AT*EWBR
Settings	AT*EWCG, AT*EWCT, AT*EWDT, AT*EWHP, AT*EWIL, AT*EWLI, AT*EWPB, AT*ENAD, AT*EWSA, AT*EWSG
Profiles	AT*EWPN, AT*EWPR
INTERFACE COMMANDS	AT&C, AT&D, AT+ICF, AT+IFC, AT+ILRR, AT+IPR, ATE, AETM, ATQ, ATS0, ATS10, ATS2, ATS3, ATS4, ATS5, ATS6, ATS7, ATS8, ATV, ATX, AT+CSCS
DATA COMPRESSION V42bis	AT+DR, AT+DS
07.10 MULTIPLEXING	AT+CMUX

HSCSD	AT+CHSR, AT+CHSU
GPRS	
PDP Context Activation	AT+CGACT
Manual PDP Context Activation	AT+CGANS
GPRS Attachment	AT+CGATT
Enter Data State	AT+CGDATA
Define PDP Context	AT+CGDCONT
GPRS Event Reporting	AT+CGEREP
Show PDP Address	AT+CGPADDR
Quality of Service Profile (MINIMUM ACCEPTABLE)	AT+CGQMIN
Quality of Service Profile (REQUESTED)	AT+CGQREQ
GPRS Network registration Status	AT+CGREG
Extension of ATD for GPRS	ATD*
NETWORK INFORMATION	
Cell information	AT*E2CD
Engineering Mode	AT*E2EMM
SIM APPLICATION TOOLKIT	
Set Up Call	AT*E2STKC
Display Text	AT*E2STKD
Get Inkey	AT*E2STKG
Get Input	AT*E2STKI
Select Item	AT*E2STKL
Set Up Menu	AT*E2STKM
Envelope (Menu Selection)	AT*E2STKN
Application Toolkit Settings	AT*E2STKS

6 Technical Data

Mechanical specifications	
Maximum length:	50 mm
Maximum width:	33 mm
Maximum thickness:	6.82 mm (without system connector pins length)
Weight:	18,5 g

Power supply voltage, normal operation	
Voltage:	3.6V Nominal
Tolerance	±0.2V
Ripple:	<100mV @ 200KHz, <20mV @>200KHz
Voltage must always stay within a normal operating range, ripple included.	
Power consumption:	Speech mode < 600 mA (< 2 A peak) Idle mode: 20 mA Switched off: < 100 µA

Radio specifications	
Frequency range:	GM 47: EGSM 900 MHz and 1800 MHz (Dual Band) GM 48: GSM 850 MHz and 1900 MHz (Dual Band)
Maximum RF output power:	2 W / 1 W
Antenna impedance:	50 Ω

SIM card	
SIM card interface:	3 V or 5 V
Support of external SIM card	

Environmental specifications	
Operating temperature range:	-25 ^{0}C to +55 ^{0}C
Storage temperature range:	-40 ^{0}C to +85 ^{0}C
Maximum relative humidity:	95% at +40 ^{0}C
Stationary vibration, sinusoidal:	Displacement: 7.5 mm Acceleration amplitude: 20 m/s^2 40 m/s^2 Frequency range: 2-8 Hz 8-200 Hz 200-500 Hz
Stationary vibration, random	Acceleration spectral density (m^2/s^2): 0.96 2.88 0.96 Frequency range: 5-10 10-200 200-500 60 min per/axis
Non-stationary vibration, including shock	Shock response spectrum I, peak acceleration: - 3 shocks in each axis and direction: 300 m/s^2, 11 ms

	Shock response spectrum II, peak acceleration: - 3 shocks in each axis and direction: 1000 m/s^2, 6 ms
Bump:	Acceleration 250 m/s^2
Free fall transportation:	1.2 m
Rolling pitching transportation:	Angle: ±35 degrees, period: 8s
Static load:	10 kPa
Low air pressure/high air pressure:	70 kPa / 106 kPa

Storage	
SMS Storage capacity	40 in ME In addition the unit can handle as many SMS as the SIM can store (SIM dependent).
Phone book capacity	100

DAC

Parameter	*Value*	*Units*
Resolution	8	bit
Output voltage swing for Code=00_{HEX}	0.138 ± 0.1	V
Output voltage swing for Code=FF_{HEX}	2.61 ± 0.2	V
Nominal Step Size	9.668 ± 0.1	mV
Linear Code Range	8-247 (8_H-$F7_H$)	LSB
Absolute Error during Linear Range	±100	mV
Conversion Speed	<100	µs

ADC

Parameter	*Value*	*Units*
Resolution	8	bit
Input voltage for Code=00_H	0.01 ± 0.01	V
Input voltage for Code=FF_H	2.75 ± 0.1	V
Nominal Step Size	10.742	mV
Accuracy	±3	LSB
Input Impedance	>1	MΩ
Conversion Time to within 0.5bit	<100	µs