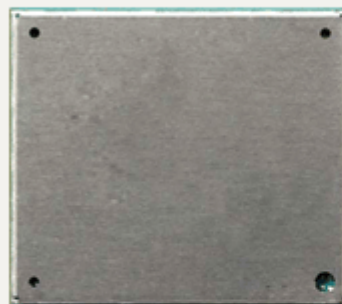


Cinterion[®] AGS2-E

Hardware Interface Overview

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1 Introduction

This document¹ describes the hardware of the Gemalto M2M Cinterion® AGS2-E module that connects to the cellular device application and the air interface. It helps you quickly retrieve interface specifications, electrical and mechanical details and information on the requirements to be considered for integrating further components.

1.1 Related Documents

- [1] Cinterion® AGS2-E AT Command Set
- [2] Application Note 48: SMT Module Integration for AGS2-E
- [3] AGS2-E MPE calculation - Test report (Maximum Permissible Exposure)

1.2 Terms and 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 AGS2-E
B	Thermistor Constant
BER	Bit Error Rate
BTS	Base Transceiver Station
CB or CBM	Cell Broadcast Message
CE	Conformité Européenne (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

-
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.

1.2 Terms and Abbreviations

Abbreviation	Description
DRX	Discontinuous Reception
DSB	Development Support Box
DSP	Digital Signal Processor
DSR	Data Set Ready
DTE	Data Terminal Equipment (typically computer, terminal, printer or, for example, GSM application)
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
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
FCC	Federal Communications Commission (U.S.)
FDMA	Frequency Division Multiple Access
FR	Full Rate
GASDL	Global Automotive Declarable Substance List
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
I/O	Input/Output
IC	Integrated Circuit
IMDS	International Material Data System
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
Mbps	Mbits per second
MMI	Man Machine Interface
MO	Mobile Originated

1.2 Terms and Abbreviations

Abbreviation	Description
MS	Mobile Station (GSM module), also referred to as TE
MSISDN	Mobile Station International ISDN number
MT	Mobile Terminated
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
PDU	Protocol Data Unit
PPM	Parts per million
PLL	Phase Locked Loop
PPP	Point-to-point protocol
PSK	Phase Shift Keying
PSU	Power Supply Unit
PWM	Pulse Width 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

1.2 Terms and Abbreviations

Abbreviation	Description
SRAM	Static Random Access Memory
TA	Terminal adapter (e.g. GSM module)
TDMA	Time Division Multiple Access
TE	Terminal Equipment, also referred to as DTE
TLS	Transport Layer Security
Tx	Transmit Direction
UART	Universal asynchronous receiver-transmitter
URC	Unsolicited Result Code
USSD	Unstructured Supplementary Service Data
VSWR	Voltage Standing Wave Ratio

1.3 Regulatory and Type Approval Information

1.3.1 Directives and Standards

AGS2-E 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 "AGS2-E Hardware Interface Description".¹

Table 1: 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 CE 0682
ECE-R 10	Economic Commission for Europe (ECE) Regulation No. 10: Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility
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) 

Table 2: 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 V5.17	Overview of PCS Type certification review board Mobile Equipment Type Certification and IMEI control PCS Type Certification Review board (PTCRB)
RSS132 (Issue2) RSS133 (Issue5)	Canadian Standard

Table 3: Standards of European type approval

3GPP TS 51.010-1	Digital cellular telecommunications system (Phase 2); Mobile Station (MS) conformance specification
ETSI EN 301 511 V9.0.2	Candidate Harmonized European Standard (Telecommunications series) 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)
GCF-CC V3.52	Global Certification Forum - Certification Criteria

1. Manufacturers of applications which can be used in the US shall ensure that their applications have a PTCRB approval. For this purpose they can refer to the PTCRB approval of the respective module.

1.3 Regulatory and Type Approval Information

Table 3: Standards of European type approval

ETSI EN 301 489-1 V1.8.1	Candidate Harmonized European Standard (Telecommunications series) 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	Candidate Harmonized European Standard (Telecommunications series) Electro Magnetic Compatibility and Radio spectrum Matters (ERM); Electro Magnetic 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)
EN 60950-1:2006/ A11:2009	Safety of information technology equipment

Table 4: Requirements of quality

IEC 60068	Environmental testing
DIN EN 60529	IP codes
VDA Hands-free	VDA Specification for Car Hands-free Terminals, Draft, December 2004, v1.5, double talk performance category 2a

Table 5: 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 6 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. 

1.3 Regulatory and Type Approval Information

Table 6: 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 <i>might exceed</i> the limit requirement in SJ/T11363-2006.						

1.3.2 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 AGS2-E 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 and 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 markets¹

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

Products intended for sale on 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)

IMPORTANT:

Manufacturers of portable applications based on AGS2-E modules are required to have their final product certified and apply for their own FCC Grant and Industry Canada Certificate related to the specific portable mobile (see also [Section 8.2](#)).

1. Applies for the quad band module variant AGS2-E only.

1.3 Regulatory and Type Approval Information

1.3.3 Safety Precautions

The following safety precautions must be observed during all phases of the operation, usage, service or repair of any cellular terminal or mobile incorporating AGS2-E. 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.
	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.

2 Product Concept

2.1 Key Features at a Glance

Feature	Implementation
<i>General</i>	
Frequency bands	Quad band (AGS2-E): GSM 850/900/1800/1900MHz
GSM class	Small MS
Output power (according to 3GPP specifications Release 99)	Class 4 (+33dBm $\pm$ 2dB) for EGSM850 Class 4 (+33dBm $\pm$ 2dB) for EGSM900 Class 1 (+30dBm $\pm$ 2dB) for GSM1800 Class 1 (+30dBm $\pm$ 2dB) for GSM1900
Power supply	3.3V to 4.5V
Operating temperature (board temperature)	Normal operation: -30°C to +85°C Extended operation: -40°C to -30°C, +85°C to +90°C
Physical	Dimensions: 33mm x 29mm x 2.2mm Weight: approx. 5g
RoHS	All hardware components fully compliant with EU RoHS Directive
<i>GSM/GPRS features</i>	
Data transfer	GPRS: • Multislot Class10 • Full PBCCH support • Mobile Station Class B • Coding Scheme 1 – 4 CSD: • V.110, RLP, non-transparent • 2.4, 4.8, 9.6, 14.4kbps • 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. Transmission of SMS over GSM.
Fax	Group 3; Class 1

2.1 Key Features at a Glance

Feature	Implementation
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 Multi Rate AMR Handsfree operation (VDA), echo cancellation, noise suppression, 7 different ringing tones/melodies Voice prompts
GNSS Features	
Protocol	NMEA
Modes	Standalone GNSS
General	Power saving modes Power supply for an active antenna
GPS 1pps clock	1 pulse per second synchronized with GPS time
Software	
AT commands	Hayes 3GPP TS 27.007, TS 27.005, Gemalto M2M AT commands for RIL compatibility
Microsoft™ compatibility	RIL for Pocket PC and Smartphone
SIM Application Toolkit	SAT Release 99
TCP/IP stack	Access by AT commands
Firmware update	Generic update from host application over ASC0.
Interfaces	
Module interface	Surface mount device with solderable connection pads (SMT application interface). Land grid array (LGA) technology ensures high solder joint reliability and provides the possibility to use an optional module mounting socket. For more information on how to integrate SMT modules see also [2] . This application note comprises chapters on module mounting and application layout issues as well as on additional SMT application development equipment.
1 serial interfaces	ASC0: • 8-wire modem interface with status and control lines, unbalanced, asynchronous • Adjustable baud rates: 300bps to 230,400bps • Autobauding: 1,200bps to 230,400bps • Supports RTS0/CTS0 hardware handshake and software XON/XOFF flow control. • Multiplex ability according to GSM 07.10 Multiplexer Protocol.
Audio	1 analog interface (with microphone feeding) 1 digital interface (PCM)
UICC interface	Supported SIM/USIM cards: 3V, 1.8V External SIM card reader has to be connected via interface connector (note that card reader is not part of AGS2-E)

2.1 Key Features at a Glance

Feature	Implementation
GPIO interface	GPIO interface with 4 GPIO lines. The GPIO interface is shared with a PWM functionality as well as a fast shutdown signal, an antenna detection line and a jamming indicator
I ² C interface	Supports I ² C serial interface
GPS 1pps clock	High accuracy 1pps output (one pulse per second) signal
Antenna	50Ω
<i>Power on/off, Reset</i>	
Power on/off	Switch-on by hardware signal IGT Switch-off by AT command (AT^SMSO) Automatic switch-off in case of critical temperature and voltage conditions.
Reset	Orderly shutdown and reset by AT command
<i>Special features</i>	
Real time clock	Timer functions via AT commands
Phonebook	SIM and phone
TTY/CTM support	Integrated CTM modem
TLS security	Transport layer security
eCall	EU eCall prepared
RLS monitoring	Jamming detection
Miscellaneous	Prepared for under-fill Automotive grade service levels Automotive test specification No repair E-marking
<i>Evaluation kit</i>	
Evaluation module	AGS2-E 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 setup is required to connect the evaluation module to the DSB75.

2.2 AGS2-E System Overview

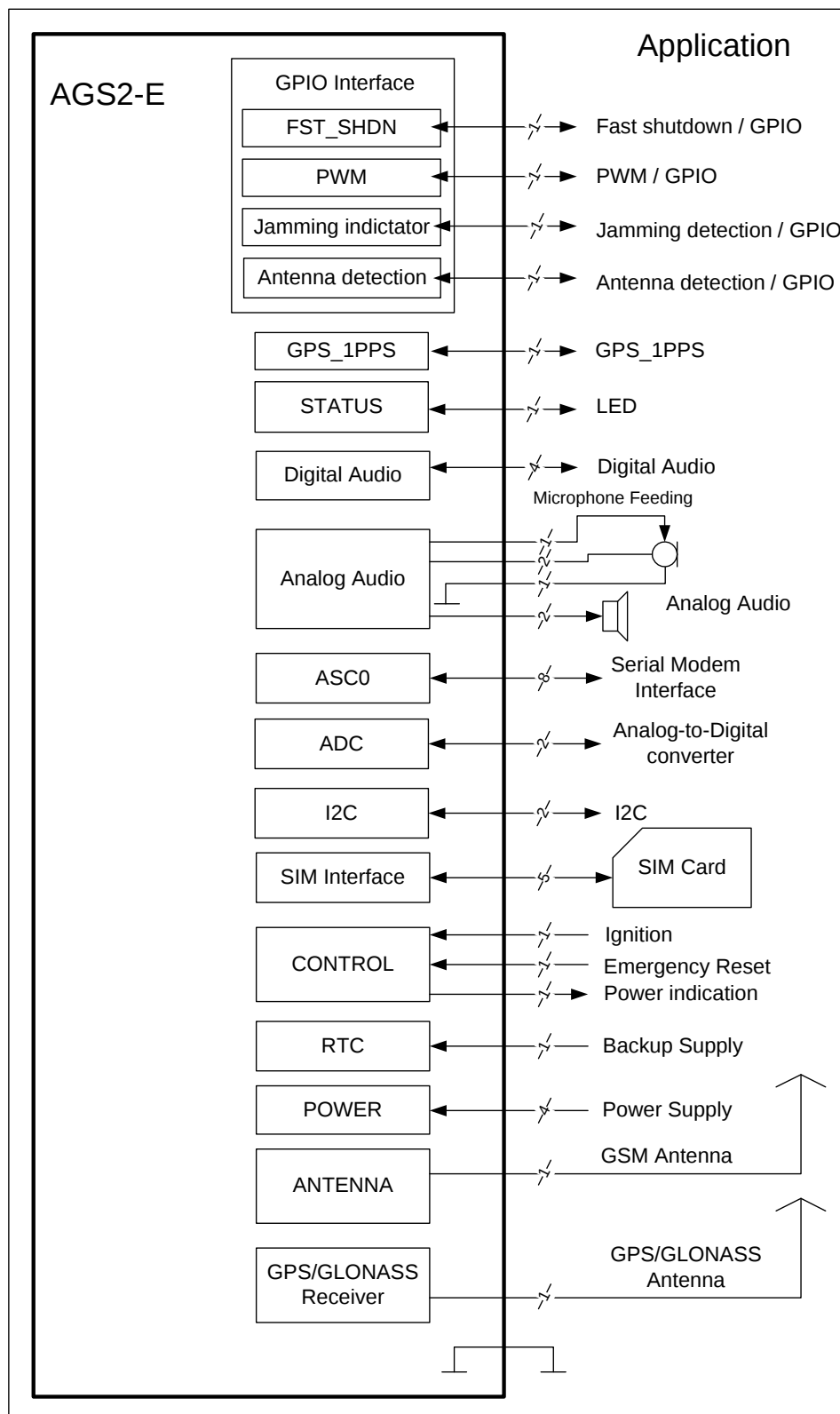


Figure 1: AGS2-E system overview

3 Application Interface

AGS2-E is equipped with an SMT application interface that connects to the external application. The host interface incorporates several sub-interfaces described in the following sections:

- Power supply - see [Section 3.2](#)
- RTC backup – see [Section 3.3](#)
- SIM/USIM interface - see [Section 3.4](#)
- Serial interface ASC0 - see [Section 3.5](#)
- Analog audio interface - see [Section 3.6](#)
- Digital audio interface (PCM) - see [Section 3.7](#)
- ADC interface - see [Section 3.8](#)
- GPIO interface - see [Section 3.9](#)
- I²C interface - [Section 3.10](#)
- Status Control - LED: [Section 3.11](#), PWR_IND: [Section 3.12](#)

3.1 Operating Modes

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

Table 7: Overview of operating modes

Normal operation	GSM/GPRS SLEEP	Various power save modes set with AT+CFUN command. Software is active to minimum extent. If the module 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 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 module is ready to send and receive.
	GSM TALK	Connection between two subscribers is in progress. Power consumption depends on network coverage individual settings, such as DTX off/on, FR/EFR/HR, hopping sequences, antenna.
	GPRS IDLE	Module 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. multislot settings).
	GPRS DATA	GPRS data transfer in progress. Power consumption depends on network settings (e.g. power control level), uplink/downlink data rates, GPRS configuration (e.g. used multislot settings) and reduction of maximum output power.
	GNSS	The GNSS NMEA data stream is internally routed to the ASC0 interface, while the baseband processor in the idle or active state. NMEA data streams are not available while the base band processor is in the SLEEP mode.
Power Down	Normal shutdown after sending the AT^SMSO command. Only a voltage regulator is active for powering the RTC. Software is not active. Interfaces are not accessible. Operating voltage (connected to BATT+) remains applied.	
Alarm mode	Restricted operation launched by RTC alert function while the module is in Power Down mode. Module will not be registered to GSM network. Limited number of AT commands is accessible.	

See the following sections for the various options of waking up AGS2-E and proceeding from one mode to another.

3.2 Power Supply

AGS2-E needs to be connected to a power supply at the SMT application interface - 4 lines BATT+, and GND. There are two separate voltage domains for BATT+:

- BATT+ with 2 lines for the general power management.
- BATT+_GSM with 2 lines for the GSM power amplifier supply.

The power supply of AGS2-E has to be a single voltage source at BATT+ and BATT+_GSM. It must be able to provide the peak current during the uplink transmission.

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 GSM 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.

3.3 RTC Backup

The internal Real Time Clocks of AGS2-E are supplied from a separate voltage regulator in the power supply component which is also active when AGS2-E is in Power Down mode and BATT+ is available. In addition, it is possible to backup the RTCs from an external capacitor.

3.4 SIM/USIM Interface

The baseband processor has an integrated SIM/USIM card interface compatible with the ISO/IEC 7816 IC Card standard. This is wired to the host interface in order to be connected to an external SIM card holder. Five pads are reserved for the SIM interface. AGS2-E supports and automatically detects 3.0V as well as 1.8V SIM cards.

The CCIN pad serves to detect whether a tray is present in the card holder. Using the CCIN pad is mandatory for compliance with the 3GPP TS 11.11 (Rel.99) 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 AGS2-E and is part of the Gemalto M2M reference equipment submitted for type approval. See [Chapter 9](#) for Molex ordering numbers.

Table 8: Signals of the SIM interface (SMT application interface)

Signal	Description
CCCLK	Chipcard clock, various clock rates can be set in the baseband processor.
CCVCC	SIM supply voltage from PSU-ASIC
CCIO	Serial data line, input and output.
CCRST	Chipcard reset, provided by baseband processor
CCIN	Input on the baseband processor for detecting a SIM card tray in the holder. The default level of CCIN is low (internal pull down resistor, no card inserted). It will change to high level when the card is inserted. To take advantage of this feature, an appropriate contact is required on the cardholder. Ensure that the cardholder on your application platform is wired to output a high signal when the SIM card is present. The CCIN pad is mandatory for applications that allow the user to remove the SIM card during operation. The CCIN pad 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 AGS2-E.

3.4 SIM/USIM Interface

The figure below shows a circuit to connect an external SIM card holder including enhanced ESD protection for the SIM interface lines.

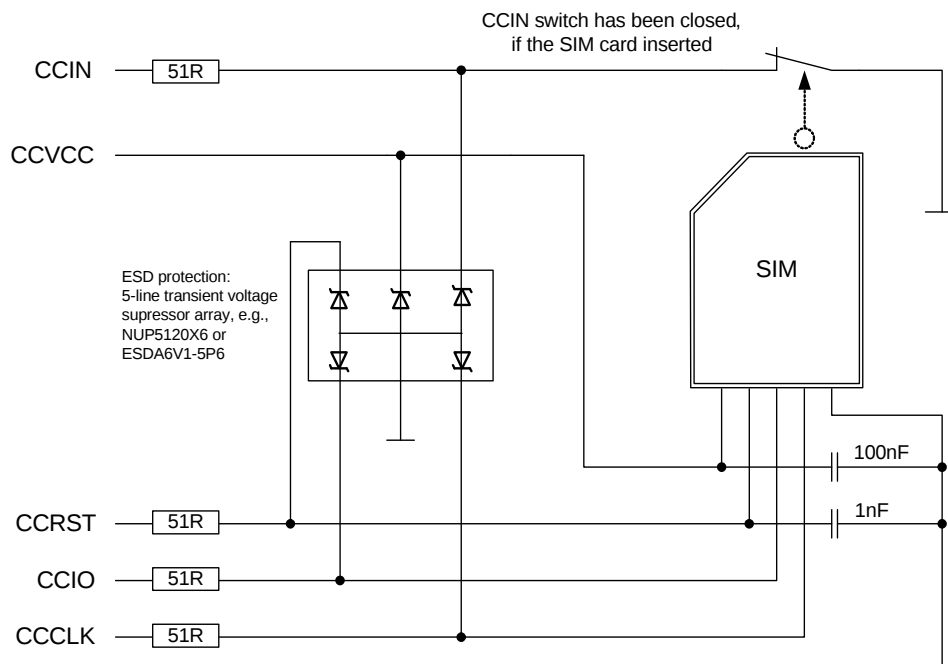


Figure 2: External SIM card holder circuit

It is recommended that the total cable length between SMT application interface pads on AGS2-E and the connector 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 CCCLK signal to the CCIO signal be careful that both lines are not placed closely next to each other. A useful approach would be to use a separate SIM card ground connection to shield the CCIO line from the CCCLK line. A GND line may be employed for such a case.

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 initialising any SIM card that the user inserts after having removed a SIM card during operation. In this case, the application must restart AGS2-E. If using a SIM card holder without detecting contact please be sure to switch off the module before removing the SIM Card or inserting a new one.

3.5 Serial Interface ASC0

AGS2-E offers an 8-wire unbalanced, asynchronous modem interface ASC0 conforming to ITU-T V.24 protocol DCE signalling. The electrical characteristics do not comply with ITU-T V.28. The voltage level of the ASC0 interface is configured to 1.8V.

AGS2-E 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

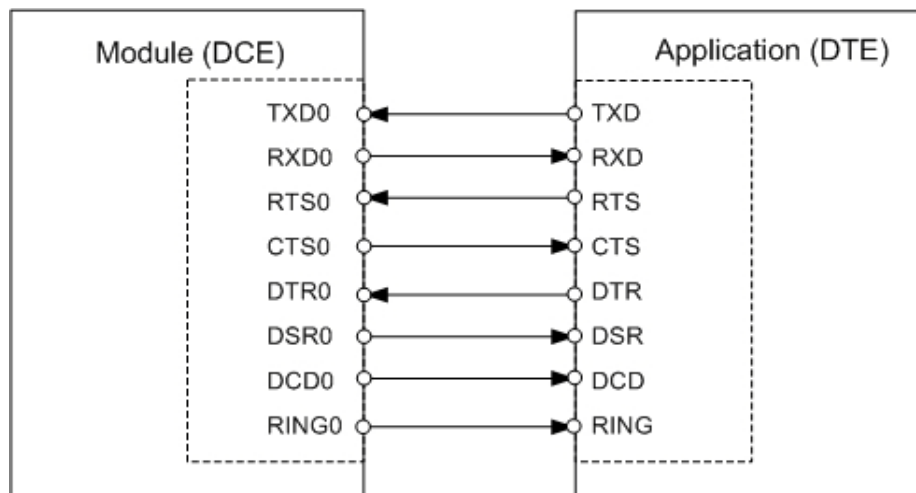


Figure 3: Serial interface ASC0

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.
- ASC0 is primarily designed for controlling voice calls, transferring CSD, fax and GPRS data and for controlling the GSM module with AT commands. Also, the GNSS NMEA data stream is internally routed to the ASC0 interface.
- The DTR0 signal will only be polled once per second from the internal firmware of AGS2-E.
- 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 up the application from power saving state. See [\[1\]](#) for details on how to configure the RING0 line by AT^SCFG.
- Configured for 8 data bits, no parity and 1 stop bit.
- ASC0 can be operated at fixed bit rates from 300bps to 230,400bps.
- Autobauding supports bit rates from 1,200bps to 230,400bps.
- Supports RTS0/CTS0 hardware flow control and XON/XOFF software flow control.

3.6 Analog Audio Interface

Table 9: DCE-DTE wiring of ASC0

V.24 circuit	DCE		DTE	
	Pad function	Signal direction	Pad function	Signal direction
103	TXD0	Input	TXD	Output
104	RXD0	Output	RXD	Input
105	RTS0	Input	RTS	Output
106	CTS0	Output	CTS	Input
108/2	DTR0	Input	DTR	Output
107	DSR0	Output	DSR	Input
109	DCD0	Output	DCD	Input
125	RING0	Output	RING	Input

3.6 Analog Audio Interface

AGS2-E has an analog audio interface with a balanced analog microphone input and a balanced analog earpiece output. A supply voltage and an analog ground connection are provided at dedicated pads.

AGS2-E offers six audio modes which can be selected with AT 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).

When shipped from factory, all audio parameters of AGS2-E are set to audio mode 1. This is the default configuration optimised for the Votronic HH-SI-30.3/V1.1/0 handset and used for type approving the Gemalto M2M reference configuration. Audio mode 1 has fix parameters which cannot be modified. To adjust the settings of the Votronic handset simply change to another audio mode.

3.7 Digital Audio Interface

AGS2-E's digital audio interface (DAI) can be used to connect audio devices capable of pulse code modulation (PCM). The PCM functionality allows for the use of an external codec like the W681360. Using an AT command you can activate the DAI interface.

3.8 Analog-to-Digital Converter (ADC)

The ADC lines are used for antenna diagnosis and general purpose voltage measurements. The lines can be configured and read by the AT command.

3.9 GPIO Interface

AGS2-E offers a GPIO interface with 4 GPIO lines. The GPIO lines are shared with other interfaces, such as the fast shutdown functionality, the PWM functionality, jamming indicator or antenna detection. All functions are controlled by dedicated AT commands.

The following table shows the configuration variants of the GPIO pads. All variants are mutually exclusive, i.e. a pad configured as GPIO is locked for alternative use.

Table 10: GPIO assignment

GPIO	FST_SHTDN	PWM	Jamming indicator	Antenna Detection
GPIO4	Yes			
GPIO5				Yes
GPIO6			Yes	
GPIO7		Yes		Yes

Each GPIO line can be configured for use as input or output.

3.10 I²C Interface

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 module acts as a single master device, e.g. the clock I2CCLK is driven by the module. I2CDAT is a bi-directional line. Each device connected to the bus is software addressable by a unique 7-bit address, and simple master/slave relationships exist at all times. The module operates as master-transmitter or as master-receiver. The customer application transmits or receives data only on request of the module.

3.11 Status LED

One line at the SMT application interface can be configured to drive a status LED which indicates different operating modes of the module.

The STATUS indicator can be enabled/disabled by AT command.

3.12 PWR_IND Signal

The PWR_IND signal notifies the on/off state of the module.

4 GNSS Receiver

AGS2-E integrates a GPS receiver that offers the full performance of GPS technology. The GPS receiver is able to continuously track all satellites in view, thus providing accurate satellite position data.

The integrated GPS receiver supports the NMEA protocol via ASC0 interface. NMEA is a combined electrical and data specification for communication between various (marine) electronic devices including GPS receivers. It has been defined and controlled by the US based National Marine Electronics Association. For more information on the NMEA Standard please refer to <http://www.nmea.org>.

Depending on the receiver's knowledge of last position, current time and ephemeris data, the receiver's startup time (i.e., TTFF = Time-To-First-Fix) may vary: If the receiver has no knowledge of its last position or time, a startup takes considerably longer than if the receiver has still knowledge of its last position, time and almanac or has still access to valid ephemeris data and the precise time.

By default, the GPS receiver is switched off. It has to be switched on and configured using AT commands (AT^SGPSC; see [1]).

GPS 1pps Clock:

AGS2-E provides a high accuracy 1pps output (one pulse per second) signal, synchronized with the GPS time.

The 1pps output can be used by an external application as a reference to generate accurate high-frequency clocks. A specific design however has to address the short-term jitter affecting the 1pps signal. As a general rule, the divided system clock is synchronized with the GPS 1pps for the long-term accuracy. The deviation is less than 50ns.

The 1pps signal is based on the almost-perfect timing of the satellite. But as the satellite moves, the distance to it will increase or decrease. This change in distance will produce a change in the 1pps signal, because the light has to travel a different distance each time.

To compensate for this effect the GNSS (Global Navigation Satellite System) has to know its position. Then it is able to correct signal effects (mainly distance but there are more). Therefore, at least three satellites are required (better four).

5 Antenna Interfaces

5.1 GSM Antenna Interface

The RF interface has an impedance of 50Ω . AGS2-E is capable of sustaining a total mismatch at the antenna pad without any damage, even when transmitting at maximum RF power.

The external antenna must be matched properly to achieve best performance regarding radiated power, modulation accuracy and harmonic suppression. Antenna matching networks are not included on the AGS2-E module and should be placed in the host application.

Regarding the return loss AGS2-E provides the following values in the active band:

Table 11: Return loss in the active band

State of module	Return loss of module	Recommended return loss of application
Receive	$\geq 8\text{dB}$	$\geq 12\text{dB}$
Transmit	Not applicable	$\geq 12\text{dB}$
Idle	$\leq 5\text{dB}$	Not applicable

5.1.1 Antenna Installation

The antenna is connected by soldering the antenna pad (ANT_GSM) and their neighboring ground pads directly to the application's PCB.

The distance between the antenna pads and their neighboring GND pads has been optimized for best possible impedance. To prevent mismatch, special attention should be paid to these pads on the application' PCB.

The wiring of the antenna connection, starting from the antenna pad to the application's antenna should result in a 50Ω line impedance. Line width and distance to the GND plane need 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 external application PCB, it is recommended to realize the antenna connection line using embedded Stripline rather than Micro-Stripline technology.

For type approval purposes, the use of a 50Ω coaxial antenna connector (U.FL-R-SMT) might be necessary. In this case the U.FL-R-SMT connector should be placed as close as possible to AGS2-E's antenna pad.

5.2 GNSS Antenna Interface

In addition to the RF antenna interface AGS2-E also has a GNSS antenna interface. The GNSS antenna installation is the same as for the RF antenna interface (see [Section 5.1.1](#)).

It is possible to connect active or passive GNSS antennas. In either case they must have 50Ω impedance. The simultaneous operation of GSM and GNSS has been implemented.

AGS2-E provides the supply voltage VGNSS for the GNSS active antenna (3.05V). It has to be enabled by software when the GNSS receiver shall become active, otherwise VGNSS should be off (power saving). VGNSS is not short circuit protected. This will have to be provided for by an external application. The DC voltage should be fed back via ANT_GNSS_DC for coupling into the GNSS antenna path. [Figure 4](#) shows the flexibility in realizing the power supply for an active GNSS antenna by giving two sample circuits realizing the supply voltage for an active GNSS antenna - one with short circuit protection and one with an external LDO employed.

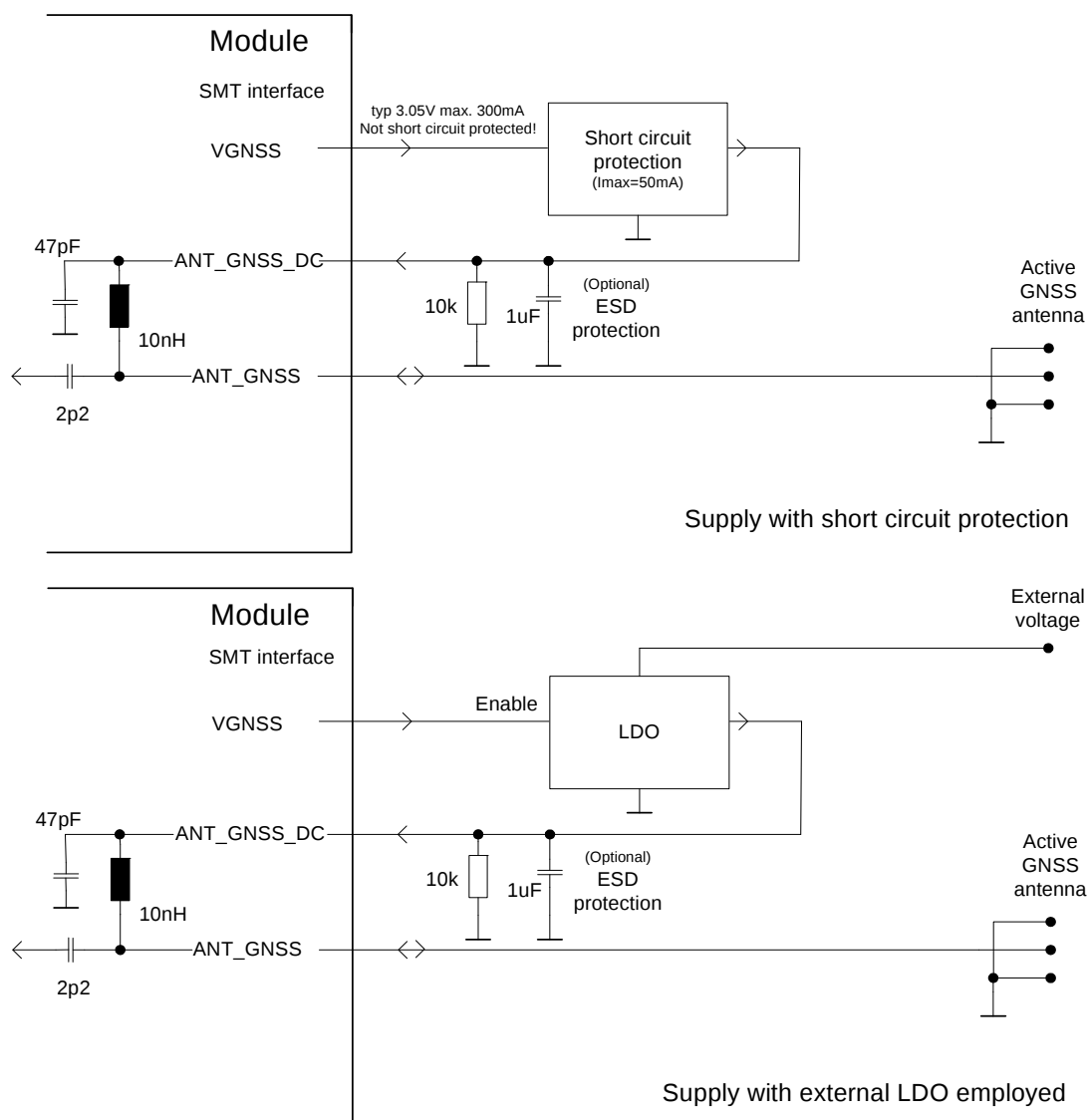


Figure 4: Supply voltage for active GNSS antenna

5.2 GNSS Antenna Interface

Figure 5 shows sample circuits realizing ESD protection for a passive GNSS antenna.

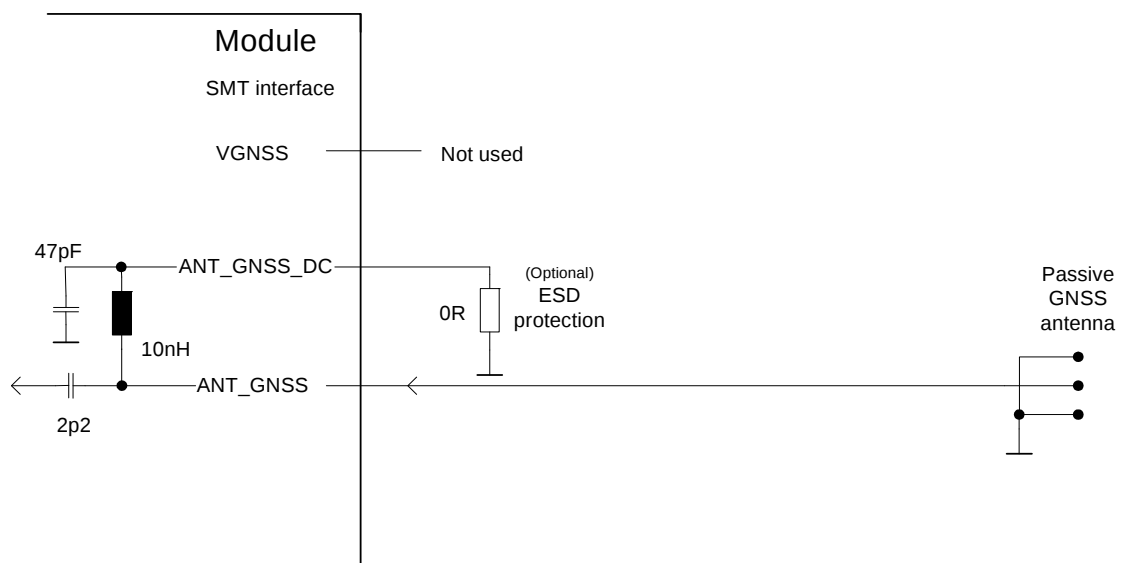


Figure 5: ESD protection for passive GNSS antenna

6 Mechanics, Mounting and Packaging

6.1 Mechanical Dimensions of AGS2-E

Figure 6 shows the top and bottom view¹ of AGS2-E and provides an overview of the board's mechanical dimensions. For further details see Figure 7.

Length: 33mm
Width: 29mm
Height: 2.2mm;
not yet finally specified

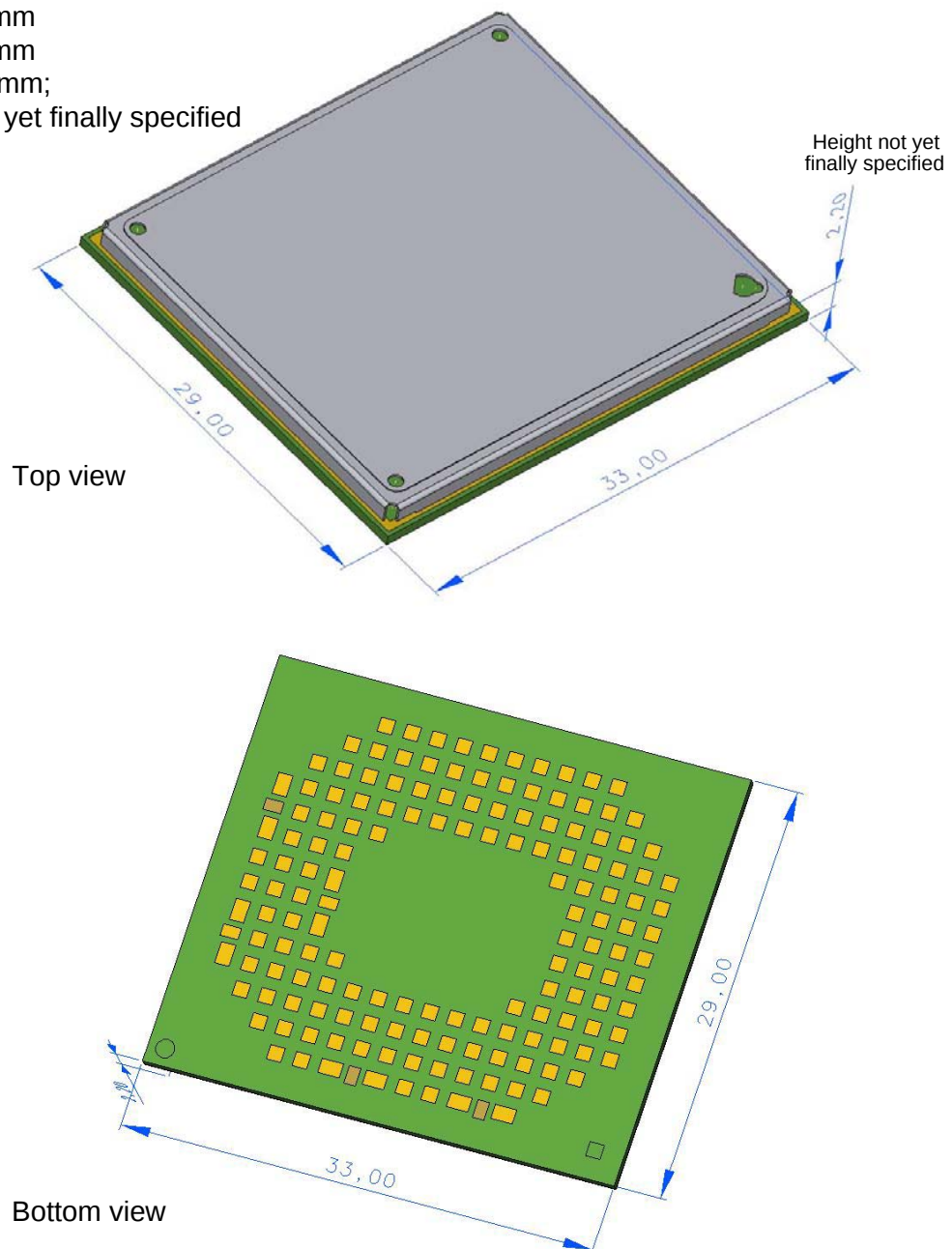


Figure 6: AGS2-E— top and bottom view

1. The coloring of the 3D view does not reflect the module's real color.

6.1 Mechanical Dimensions of AGS2-E

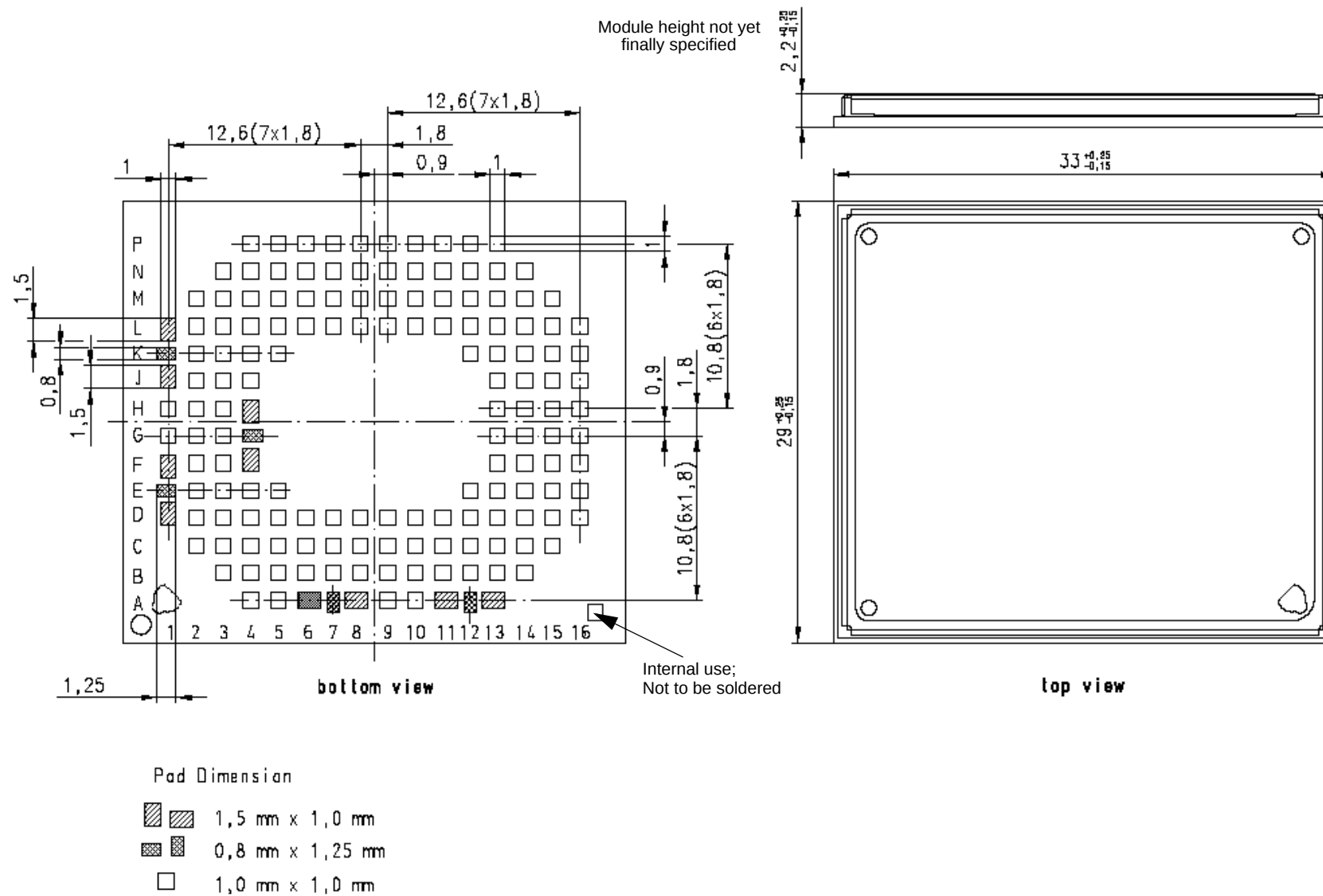


Figure 7: Dimensions of AGS2-E (all dimensions in mm)

7 Sample Application

Figure 8 shows a typical example of how to integrate a AGS2-E module with an application. Usage of the various host interfaces depends on the desired features of the application.

The analog audio interface demonstrates the balanced connection of microphone and ear-piece. This solution is particularly well suited for internal transducers.

Because of the very low power consumption design, current flowing from any other source into the module circuit must be avoided, for example reverse current from high state external control lines. Therefore, the controlling application must be designed to prevent reverse current flow. Otherwise there is the risk of undefined states of the module during startup and shutdown or even of damaging the module.

Because of the high RF field density inside the module, it cannot be guaranteed that no self interference might occur, depending on frequency and the applications grounding concept. excluded that in some applications dependant on the grounding concept of the customer. The potential interferers may be minimized by placing small capacitors (47pF) at suspected lines (e.g. RXD0, PCM_CLK, VDDL, and IGT).

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 [2].

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. For example, mounting the internal acoustic transducers directly on the PCB eliminates the need to use the ferrite beads shown in the sample schematic.

Please note that AGS2-E 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 8 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 AGS2-E modules.

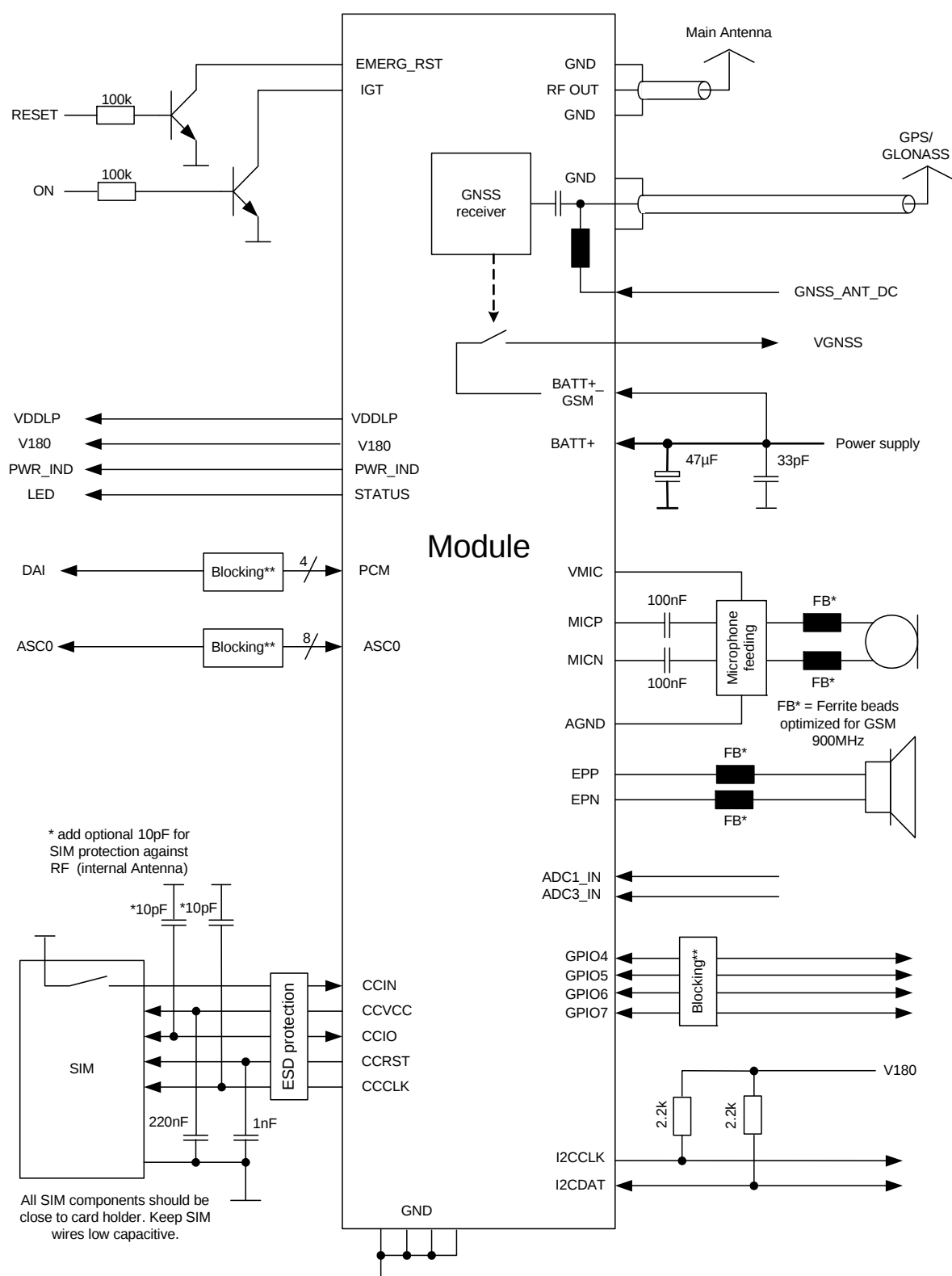


Figure 8: Schematic diagram of AGS2-E sample application

8.2 Compliance with FCC and IC Rules and Regulations

The Equipment Authorization Certification for the Gemalto M2M reference application described in [Section 8.1](#) will be registered under the following identifiers:

FCC Identifier: QIPAGS2-E

Industry Canada Certification Number: 7830A-AGS2E

Granted to Gemalto M2M GmbH

Manufacturers of mobile or fixed devices incorporating AGS2-E modules are authorized to use the FCC Grants and Industry Canada Certificates of the AGS2-E modules for their own final products according to the conditions referenced in these documents. In this case, an FCC/ IC label of the module shall be visible from the outside, or the host device shall bear a second label stating "Contains FCC ID QIPAGS2-E", and accordingly "Contains IC 7830A-AGS2E".

The integration is limited to fixed or mobile categorised 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 6.71dBi (850 MHz) and 2.23dBi (1900 MHz). See [\[3\]](#).

IMPORTANT:

Manufacturers of portable applications incorporating AGS2-E modules are required to have their final product certified and apply for their own FCC Grant and Industry Canada Certificate related to the specific portable mobile. This is mandatory to meet the SAR requirements for portable mobiles (see [Section 1.3.2](#) 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:

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.

The manufacturer is responsible for ensuring that after the module is installed and operational the host continues to be compliant with the Part 15B unintentional radiator requirements.

9 Appendix

9.1 List of Parts and Accessories

Table 12: List of parts and accessories

Description	Supplier	Ordering information
AGS2-E	Gemalto M2M	Standard module Gemalto M2M IMEI: Packaging unit (ordering) number: L30960-N3600-A100 Module label number: S30960-S3600-A100-1
AGS2-E Evaluation Module	Gemalto M2M	Ordering number: L30960-N3601-A100
DSB75 Evaluation Kit	Gemalto M2M	Ordering number: L36880-N8811-A100
DSB75-Adapter for mounting the AGS2-E evaluation module	Gemalto M2M	Ordering number: L30960-N2301-A100
Votronic Handset	Gemalto M2M, Votronic	Gemalto M2M ordering number: L36880-N8301-A107 Votronic ordering number: HH-SI-30.3/V1.1/0 Votronic Entwicklungs- und Produktionsgesellschaft für elektronische Geräte mbH Saarbrücker Str. 8 66386 St. Ingbert Germany Phone: +49-(0)6 89 4 / 92 55-0 Fax: +49-(0)6 89 4 / 92 55-88 Email: contact@votronic.com
SIM card holder incl. push button ejector and slide-in tray	Molex	Ordering numbers: 91228 91236 Sales contacts are listed in Table 13 .

9.1 List of Parts and Accessories

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

Gemalto (Euronext NL0000400653 GTO) is the world leader in digital security with 2011 annual revenues of €2 billion and more than 10,000 employees operating out of 74 offices and 14 Research & Development centers, located in 43 countries.

We are at the heart of the rapidly evolving digital society. Billions of people worldwide increasingly want the freedom to communicate, travel, shop, bank, entertain and work - anytime, everywhere - in ways that are enjoyable and safe. Gemalto delivers on their expanding needs for personal mobile services, payment security, authenticated cloud access, identity and privacy protection, eHealthcare and eGovernment efficiency, convenient ticketing and dependable machine-to-machine (M2M) applications.

Gemalto develops secure embedded software and secure products which we design and personalize. Our platforms and services manage these secure products, the confidential data they contain and the trusted end-user services they enable. Our innovations enable our clients to offer trusted and convenient digital services to billions of individuals.

Gemalto thrives with the growing number of people using its solutions to interact with the digital and wireless world.

For more information please visit

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Gemalto M2M GmbH
St.-Martin-Str. 60
81541 Munich
Germany