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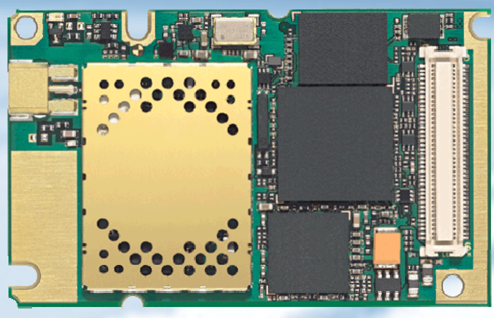

Hardware Interface Description

AC65/AC75
Siemens Cellular Engines

Version: 00.372
DocID: AC65/AC75_hd_v00.372

Document Name:	**AC65/AC75 Hardware Interface Description**
Version:	**00.372**
Date:	**August 03, 2006**
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Contents

Tables

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0 Document History

Preceding document: "AC75 Hardware Interface Description" Version 00.251
New document: "AC65/AC75 Hardware Interface Description" Version **00.372**

Chapter	What is new
Throughout document	Added new product: AC65 module
1	Added AC65 and general statement on difference between AC65 and AC75.
1.3	Updated list of standards.
1.3.1	Every portable mobile shall have an FCC Grant and IC Certificate of its own.
1.4	Added note on audio safety precautions.
3.5, 9	Removed all information related to specific types of batteries and specific vendors.
3.9	Removed note on required restart of module after removing and reinserting a SIM card during operation.
3.12	Removed section describing USB modem installation. For installation details see [11].
3.15.4.1	Corrected description of master PCM timing with long or short frame selected.
3.15.4.2	Updated timing for slave mode of PCM interface (Figure 32 and Figure 33).
5.1	Added remark on SELV compliance.
5.5	Table 26: Modified RTC input voltage values (RTC Backup VDDLP).
5.6	Table 27: Different current consumption depending on whether autobauding enabled / disabled.
8.2	Added FCC and IC identifiers for AC65. Changed notes on mobile and fixed devices, added note on portable mobiles.
9.1	Added AC65 incl. Siemens ordering numbers.

Preceding document: "AC75 Hardware Interface Description" Version 00.202
New document: "AC75 Hardware Interface Description" Version 00.251

Chapter	What is new
3.3.4.2	Corrected description of deferred shutdown.
3.3.4.4 to 3.3.4.6	Alert URCs for undervoltage and overvoltage do not need to enabled by the user.
3.5.3	Added overdischarge release voltage 2.6V
9.1	Specified Siemens ordering numbers for AC75.

Preceding document: "AC75 Hardware Interface Description" Version 00.020
New document: "AC75 Hardware Interface Description" Version 00.202

Chapter	What is new
3.3.2	New chapter: Signal States after Startup.
3.3.1.1	More detailed description of IGT timing depending on Power-down or Charge-only mode. Added further details on timing after power-up. Added alert message “SHUTDOWN after Illegal PowerUp”

Chapter	What is new
3.3.1.2	New chapter: Configuring the IGT Line for Use as ON/OFF Switch
3.3.4.1	Revised Table 7: Temperature dependent behavior.
3.3.4.2, 3.3.4.3	Changed description. Added new section.
3.4	Minor text change.
3.3.1.3, 3.5.6, 3.7	To change from Charge-only mode to Normal mode the IGT line must be pulled low for at least 1s and then released. High state of IGT lets AC75 enter Normal mode.
3.5.6, 3.7	Added transition from Charge-only to Normal mode by switching off Airplane mode.
3.6	Added chapter on power saving.
3.12	AC75 does not support generic USB 2.0 High Speed hubs.
3.15.2.2	Added remarks on VMIC behaviour.
3.15.2.3	Replaced remark on VMIC behaviour.
3.15.4	Added Table 15: Configuration combinations for the PCM interface
5.1	New maximum values for voltage at analog pins with VMIC on/off.
5.2	Specified operating board temperature. Table 22: Temperature specified for charging is battery temperature (not ambient)
5.5	Specified internal pull-down resistors 330kΩ at TXD0, RXD0, TXD1, RXD1. Changed all V_{IH}min values from 2.0 to 2.15V. Corrected overview table: USB_DP was listed in wrong row.
5.7	New chapter: Electrical Characteristics of the Voiceband Part
7	Modified description for Java “System.out” in sample application.
9	New datasheet for recommended VARTA PoLiFlex® Lithium polymer battery.

1 Introduction

This document applies to the following Siemens products:

- AC65 Module
- AC75 Module

The document describes the hardware of the AC65 and the AC75, both designed to connect to a 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.

The difference between both modules is that AC75 additionally features EGPRS. Please note that except for EGPRS specific statements, all information provided below applies to both module types.

Throughout the document, both modules are generally referred to as AC65/AC75.

1.1 Related Documents

[1] AC65 AT Command Set 00.372
AC75 AT Command Set 00.372
[2] AC65/AC75 Release Notes 00.372
[3] DSB75 Support Box - Evaluation Kit for Siemens Cellular Engines
[4] Application Note 02: Audio Interface Design for GSM Applications (AC65, AC75)
[5] Application Note 07: Rechargeable Lithium Batteries in GSM Applications
[6] Application Note 16: Upgrading Firmware on MC75, TC6x, AC65, AC75
[7] Application Note 17: Over-The-Air Firmware Update for TC65, AC65, AC75
[8] Application Note 22: Using TTY / CTM Equipment
[9] Application Note 26: Power Supply Design for GSM Applications
[10] Application Note 24: Application Developer's Guide
[11] Application Note 32: Integrating USB into MC75, TC6x, AC65, AC75 Applications
[12] Multiplexer User's Guide
[13] Multiplex Driver Developer's Guide for Windows 2000 and Windows XP
[14] Multiplex Driver Installation Guide for Windows 2000 and Windows XP
[15] Remote SAT User's Guide for MC75, TC6x, AC65, AC75
[16] Java User's Guide for TC65, AC65, AC75
[17] Java doc \wtk\doc\html\index.html

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 AC65/AC75
B	Thermistor Constant
B2B	Board-to-board connector
BER	Bit Error Rate
BTS	Base Transceiver Station
CB or CBM	Cell Broadcast Message
CE	Conformité Européene (European Conformity)
CHAP	Challenge Handshake Authentication Protocol
CPU	Central Processing Unit
CS	Coding Scheme
CSD	Circuit Switched Data
CTS	Clear to Send
DAC	Digital-to-Analog Converter
DAI	Digital Audio Interface
dBm0	Digital level, 3.14dBm0 corresponds to full scale, see ITU G.711, A-law
DCE	Data Communication Equipment (typically modems, e.g. Siemens GSM engine)
DCS 1800	Digital Cellular System, also referred to as PCN
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

Abbreviation	Description
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
FCC	Federal Communications Commission (U.S.)
FDMA	Frequency Division Multiple Access
FR	Full Rate
GMSK	Gaussian Minimum Shift Keying
GPIO	General Purpose Input/Output
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
HiZ	High Impedance
HR	Half Rate
I/O	Input/Output
IC	Integrated Circuit
IMEI	International Mobile Equipment Identity
ISO	International Standards Organization
ITU	International Telecommunications Union
kbps	kbits per second
LED	Light Emitting Diode
Li-Ion / Li+	Lithium-Ion
Li battery	Rechargeable Lithium Ion or Lithium Polymer battery
Mbps	Mbits per second
MMI	Man Machine Interface
MO	Mobile Originated
MS	Mobile Station (GSM engine), 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
PLL	Phase Locked Loop

Abbreviation	Description
PPP	Point-to-point protocol
PSK	Phase Shift Keying
PSU	Power Supply Unit
R&TTE	Radio and Telecommunication Terminal Equipment
RAM	Random Access Memory
RF	Radio Frequency
RMS	Root Mean Square (value)
ROM	Read-only Memory
RTC	Real Time Clock
RTS	Request to Send
Rx	Receive Direction
SAR	Specific Absorption Rate
SELV	Safety Extra Low Voltage
SIM	Subscriber Identification Module
SMS	Short Message Service
SPI	Serial Peripheral Interface
SRAM	Static Random Access Memory
TA	Terminal adapter (e.g. GSM engine)
TDMA	Time Division Multiple Access
TE	Terminal Equipment, also referred to as DTE
Tx	Transmit Direction
UART	Universal asynchronous receiver-transmitter
URC	Unsolicited Result Code
USB	Universal Serial Bus
USSD	Unstructured Supplementary Service Data
VSWR	Voltage Standing Wave Ratio
Phonebook abbreviations	
FD	SIM fixdialing phonebook
LD	SIM last dialing phonebook (list of numbers most recently dialed)
MC	Mobile Equipment list of unanswered MT calls (missed calls)
ME	Mobile Equipment phonebook
ON	Own numbers (MSISDNs) stored on SIM or ME
RC	Mobile Equipment list of received calls
SM	SIM phonebook

1.3 Type Approval

AC65/AC75 is designed to comply with the directives and standards listed below. Please note that the product is still in a pre-release state and, therefore, type approval and testing procedures have not yet been completed.

Table 1: Directives

99/05/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
89/336/EC	Directive on electromagnetic compatibility
73/23/EC	Directive on electrical equipment designed for use within certain voltage limits (Low Voltage Directive)
95/94/EC	Automotive EMC directive
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	Product Safety Certification (Safety requirements)
NAPRD.03 V3.6.1	Overview of PCS Type certification review board Mobile Equipment Type Certification and IMEI control PCS Type Certification Review board (PTCRB)
RSS133 (Issue2)	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 V3.21.0	Global Certification Forum - Certification Criteria
ETSI EN 301 489-1 V1.4.1	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 V1.2.1 (2000-09)	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)
IEC/EN 60950-1 (2001)	Safety of information technology equipment (2000)

Table 4: Requirements of quality

IEC 60068	Environmental testing
DIN EN 60529	IP codes

1.3.1 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 AC65/AC75 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 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

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 AC65/AC75 modules are required to have their final product certified and apply for their own FCC Grant and IC Certificate related to the specific portable mobile. See also Chapter 8.2.

1.4 Safety Precautions

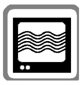
The following safety precautions must be observed during all phases of the operation, usage, service or repair of any cellular terminal or mobile incorporating AC65/AC75. Manufacturers of the cellular terminal are advised to convey the following safety information to users and operating personnel and 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. Siemens AG 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.

Bear in mind that exposure to excessive levels of noise can cause physical damage to users! With regard to acoustic shock, the cellular application must be designed to avoid unintentional increase of amplification, e.g. for a highly sensitive earpiece. A protection circuit should be implemented in the cellular application.

2 Product Concept

2.1 Key Features at a Glance

Feature	Implementation
General	
Frequency bands	Quad band: GSM 850/900/1800/1900MHz
GSM class	Small MS
Output power (according to Release 99, V5)	Class 4 (+33dBm ±2dB) for EGSM850 Class 4 (+33dBm ±2dB) for EGSM900 Class 1 (+30dBm ±2dB) for GSM1800 Class 1 (+30dBm ±2dB) for GSM1900 AC75 only: Class E2 (+27dBm ± 3dB) for GSM 850 8-PSK Class E2 (+27dBm ± 3dB) for GSM 900 8-PSK Class E2 (+26dBm +3 /-4dB) for GSM 1800 8-PSK Class E2 (+26dBm +3 /-4dB) for GSM 1900 8-PSK The values stated above are maximum limits. According to Release 99, Version 5, the maximum output power in a multislot configuration may be lower. The nominal reduction of maximum output power varies with the number of uplink timeslots used and amounts to 3.0dB for 2Tx, 4.8dB for 3Tx and 6.0dB for 4Tx.
Power supply	3.3V to 4.5V
Ambient operating temperature according to IEC 60068-2	Normal operation -30°C to +75°C Restricted operation -30°C / +85°C
Physical	Dimensions: 33.9mm x 55mm x max. 4mm Weight: approx. 8.5g
RoHS	All hardware components fully compliant with EU RoHS Directive
GSM / GPRS / EGPRS features	
Data transfer	GPRS • Multislot Class 12 • Full PBCCH support • Mobile Station Class B • Coding Scheme 1 – 4 EGPRS (AC75 only) • Multislot Class 10 • Mobile Station Class B • Modulation and Coding Scheme MCS 1 – 9

Feature	Implementation
	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.
Fax	Group 3; Class 1
Audio	Speech codecs: • Half rate HR (ETS 06.20) • Full rate FR (ETS 06.10) • Enhanced full rate EFR (ETS 06.50/06.60/06.80) • Adaptive Multi Rate AMR Speakerphone operation (VDA), echo cancellation, noise suppression, DTMF, 7 ringing tones
Software	
AT commands	AT-Hayes GSM 07.05 and 07.07, Siemens AT commands for RIL compatibility (NDIS/RIL)
Microsoft™ compatibility	RIL / NDIS for Pocket PC and Smartphone
Java platform JDK Version: 1.4.2_09	Java Virtual Machine with APIs for AT Parser, Serial Interface, FlashFileSystem and TCP/IP Stack. Major benefits: seamless integration into Java applications, ease of programming, no need for application microcontroller, extremely cost-efficient hardware and software design – ideal platform for industrial GSM applications. The memory space available for Java programs is around 1.7 MB in the flash file system and around 400k RAM. Application code and data share the space in the flash file system and in RAM.
SIM Application Toolkit	SAT Release 99
TCP/IP stack	Access by AT commands
IP addresses	IP version 6
Remote SIM Access	AC65/AC75 supports Remote SIM Access. RSA enables AC65/AC75 to use a remote SIM card via its serial interface and an external application, in addition to the SIM card locally attached to the dedicated lines of the application interface. The connection between the external application and the remote SIM card can be a Bluetooth wireless link or a serial link. The necessary protocols and procedures are implemented according to the “SIM Access Profile Interoperability Specification of the Bluetooth Special Interest Group”.

Feature	Implementation
Firmware update	Generic update from host application over ASC0, ASC1 or USB. Over-the-air (OTA) firmware update is possible via SPI interface.
Interfaces	
2 serial interfaces	ASC0: • 8-wire modem interface with status and control lines, unbalanced, asynchronous • Fixed bit rates: 300 bps to 460,800 bps • Autobauding: 1,200 bps to 460,800 bps • RTS0/CTS0 and XON/XOFF flow control. • Multiplex ability according to GSM 07.10 Multiplexer Protocol. ASC1: • 4-wire, unbalanced asynchronous interface • Fixed bit rates: 300 bps to 460,800 bps • RTS1/CTS1 and software XON/XOFF flow control
USB	Supports a USB 2.0 Full Speed (12Mbit/s) slave interface.
I^2C	I^2C bus for 7-bit addressing and transmission rates up to 400kbps. Programmable with AT^SSPI command. Alternatively, all pins of the I²C interface are configurable as SPI.
SPI	Serial Peripheral Interface for transmission rates up to 6.5 Mbps. Programmable with AT^SSPI command. If the SPI is active the I²C interface is not available.
Audio	• 2 analog interfaces (2 microphone inputs and 2 headphone outputs with microphone power supply) • 1 digital interface (PCM)
SIM interface	Supported SIM cards: 3V, 1.8V
Antenna	• 50Ohms. External antenna can be connected via antenna connector. • Antenna diagnostic
Module interface	80-pin board-to-board connector
Power on/off, Reset	
Power on/off	• Switch-on by hardware pin 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 • Emergency reset by hardware pin EMERG_RST and IGT.
Special features	
Charging	Supports management of rechargeable Lithium Ion and Lithium Polymer batteries
Real time clock	Timer functions via AT commands

Feature	Implementation
GPIO	10 I/O pins of the application interface programmable as GPIO. Programming is done via AT commands. Alternatively, GPIO pin10 is configurable as pulse counter.
Pulse counter	Pulse counter for measuring pulse rates from 0 to 1000 pulses per second. If the pulse counter is active the GPIO10 pin is not available.
DAC output	Digital-to-Analog Converter which can provide a PWM signal.
Phonebook	SIM and phone
Evaluation kit	
DSB75	DSB75 Evaluation Board designed to test and type approve Siemens cellular engines and provide a sample configuration for application engineering.

2.2 AC65/AC75 System Overview

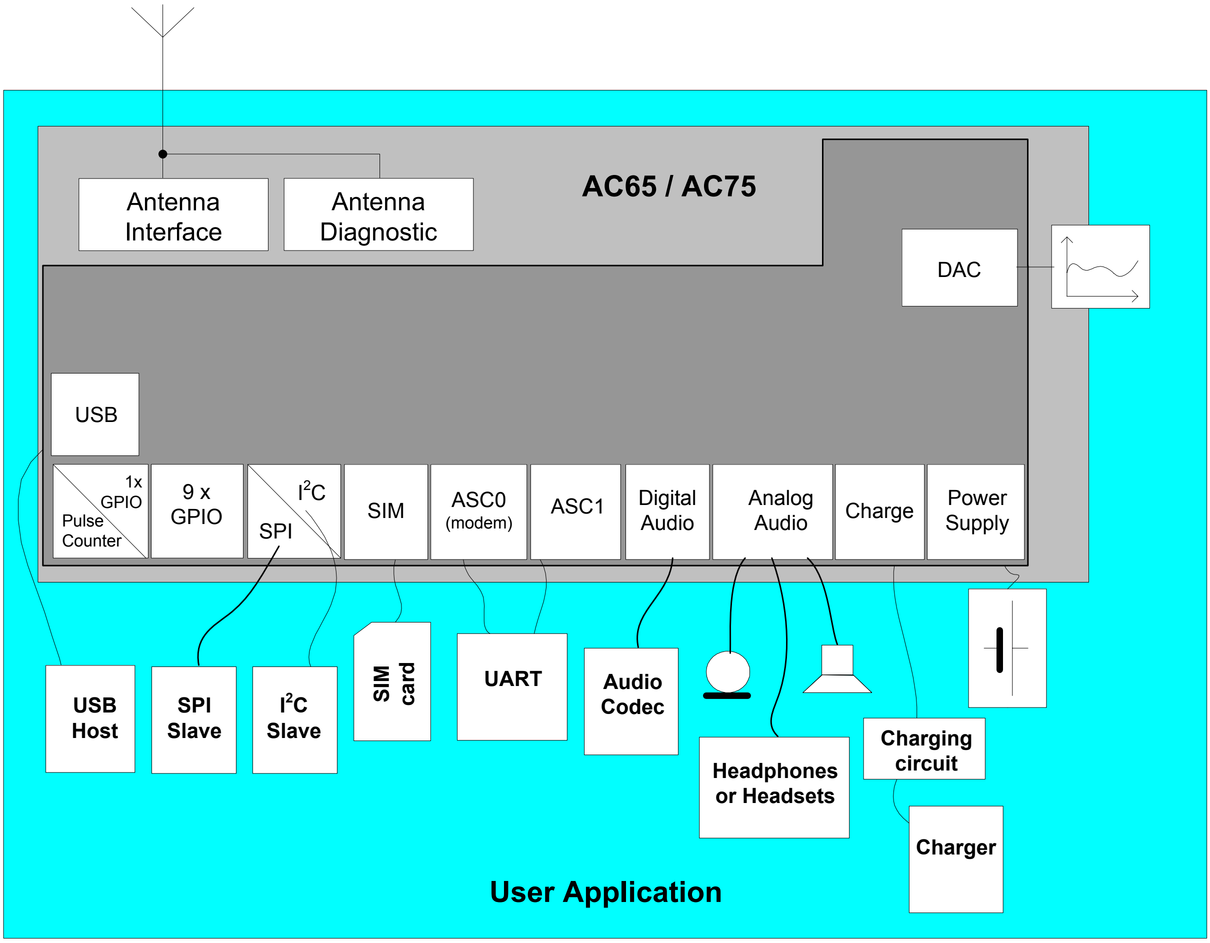


Figure 1: AC65/AC75 system overview

2.3 Circuit Concept

Figure 1 shows a block diagram of the AC65/AC75 module and illustrates the major functional components:

Baseband block:
- Digital baseband processor with DSP
- Analog processor with power supply unit (PSU)
- Flash / SRAM (stacked)
- Application interface (board-to-board connector)
- Antenna diagnostic

RF section:
- RF transceiver
- RF power amplifier
- RF front end
- Antenna connector

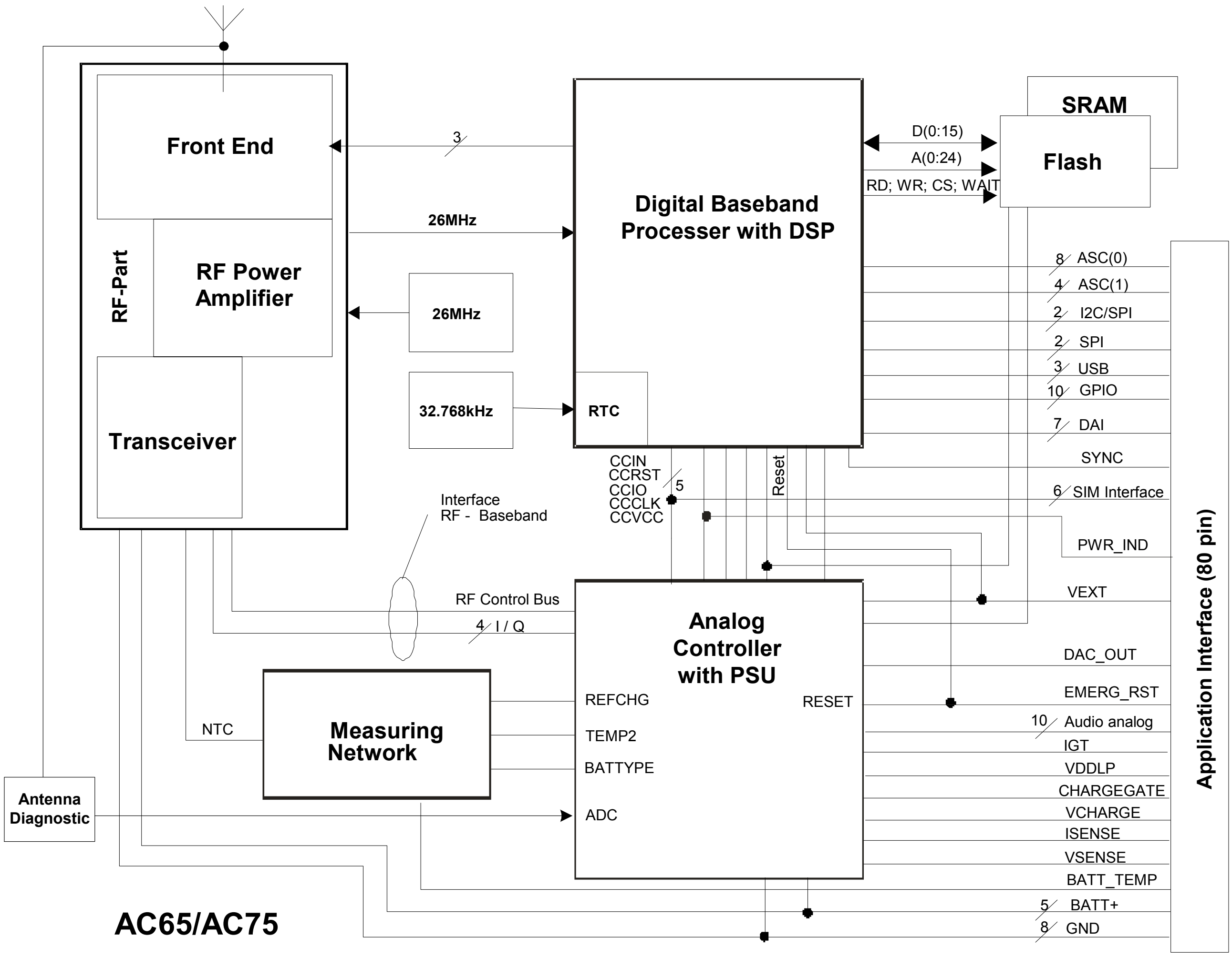


Figure 2: AC65/AC75 block diagram

3 Application Interface

AC65/AC75 is equipped with an 80-pin board-to-board connector that connects to the external application. The host interface incorporates several sub-interfaces described in the following chapters:

- Power supply - see Chapter 3.1
- Charger interface – see Chapter 3.5
- SIM interface - see Chapter 3.9
- Serial interface ASC0 - see Chapter 3.10
- Serial interface ASC1 - see Chapter 3.11
- Serial interface USB - see Chapter 3.12
- Serial interface I²C/SPI - see Chapter 3.13 and 3.14
- Two analog audio interfaces - see Chapter 3.15
- Digital audio interface (DAI) - see Chapter 3.15 and 3.15.4
- 10 lines GPIO interface – see Chapter 3.16
- Status and control lines: IGT, EMERG_RST, PWR_IND, SYNC - see Table 26

3.1 Operating Modes

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

Table 5: 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 alternatingly 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 EGPRS IDLE	Module is ready for GPRS/EGPRS data transfer, but no data is currently sent or received. Power consumption depends on network settings and GPRS/EGPRS configuration (e.g. multislot settings).
	GPRS DATA EGPRS DATA	GPRS/EGPRS 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.
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.	

Airplane mode	Airplane mode shuts down the radio part of the module, causes the module to log off from the GSM/GPRS network and disables all AT commands whose execution requires a radio connection. Airplane mode can be controlled by using the AT commands AT^SCFG and AT+CALA: • With AT^SCFG=MEopMode/Airplane/OnStart the module can be configured to enter the Airplane mode each time when switched on or reset. • The parameter AT^SCFG=MEopMode/Airplane can be used to switch back and forth between Normal mode and Airplane mode any time during operation. • Setting an alarm time with AT+CALA followed by AT^SMSO wakes the module up into Airplane mode at the scheduled time.
Charge-only mode	Limited operation for battery powered applications. Enables charging while module is detached from GSM network. Limited number of AT commands is accessible. Charge-only mode applies when the charger is connected if the module was powered down with AT^SMSO.
Charge mode during normal operation	Normal operation (SLEEP, IDLE, TALK, GPRS/EGPRS IDLE, GPRS/EGPRS DATA) and charging running in parallel. Charge mode changes to Charge-only mode when the module is powered down before charging has been completed.

See Table 11 for the various options proceeding from one mode to another.

3.2 Power Supply

AC65/AC75 needs to be connected to a power supply at the B2B connector (5 pins each BATT+ and GND).

The power supply of AC65/AC75 has to be a single voltage source at BATT+. 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.
- Switches the module's power voltages for the power-up and -down procedures.
- Delivers, across the VEXT pin, a regulated voltage for an external application. This voltage is not available in Power-down mode.
- SIM switch to provide SIM power supply.

3.2.1 Minimizing Power Losses

When designing the power supply for your application please pay specific attention to power losses. Ensure that the input voltage V_{BATT+} never drops below 3.3V on the AC65/AC75 board, not even in a transmit burst where current consumption can rise to typical peaks of 2A. It should be noted that AC65/AC75 switches off when exceeding these limits. Any voltage drops that may occur in a transmit burst should not exceed 400mV.

The measurement network monitors outburst and inburst values. The drop is the difference of both values. The maximum drop (Dmax) since the last start of the module will be saved. In IDLE and SLEEP mode, the module switches off if the minimum battery voltage (V_{batt}min) is reached.

Example:
$V_I$min = 3.3V
Dmax = 0.4V

V_{batt}min = $V_I$min + Dmax
V_{batt}min = 3.3V + 0.4V = 3.7V

The best approach to reducing voltage drops is to use a board-to-board connection as recommended, and a low impedance power source. The resistance of the power supply lines on the host board and of a battery pack should also be considered.

Note: If the application design requires an adapter cable between both board-to-board connectors, use a flex cable as short as possible in order to minimize power losses.

Example: If the length of the flex cable reaches the maximum length of 100mm, this connection may cause, for example, a resistance of 30mΩ in the BATT+ line and 30mΩ in the GND line. As a result, a 2A transmit burst would add up to a total voltage drop of 120mV. Plus, if a battery pack is involved, further losses may occur due to the resistance across the battery lines and the internal resistance of the battery including its protection circuit.

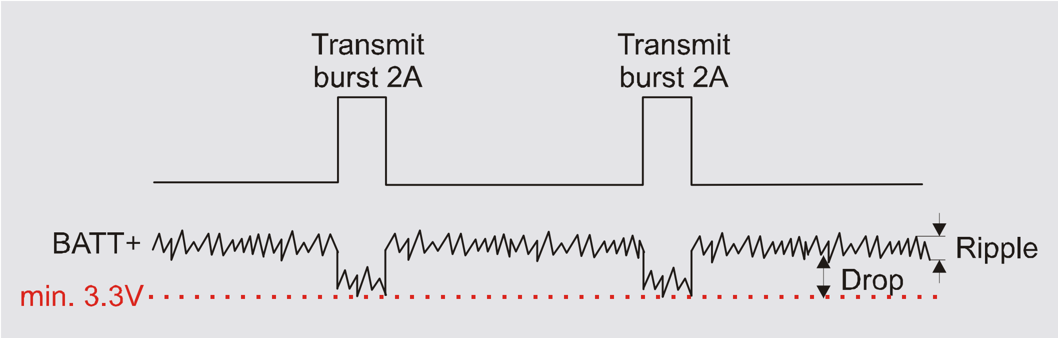


Figure 3: Power supply limits during transmit burst

3.2.2 Measuring the Supply Voltage V_{BATT+}

The reference points for measuring the supply voltage V_{BATT+} on the module are BATT+ and GND, both accessible at a capacitor located close to the board-to-board connector of the module.

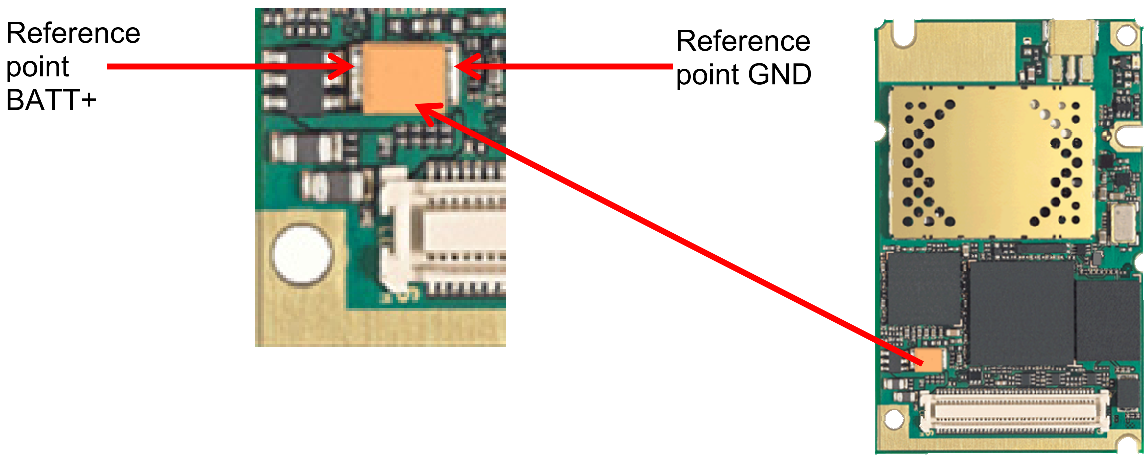


Figure 4: Position of the reference points BATT+ and GND

3.2.3 Monitoring Power Supply by AT Command

To monitor the supply voltage you can also use the AT^SBV command which returns the value related to the reference points BATT+ and GND.

The module continuously measures the voltage at intervals depending on the operating mode of the RF interface. The duration of measuring ranges from 0.5s in TALK/DATA mode to 50s when AC65/AC75 is in IDLE mode or Limited Service (deregistered). The displayed voltage (in mV) is averaged over the last measuring period before the AT^SBV command was executed.

3.3 Power-Up / Power-Down Scenarios

In general, be sure not to turn on AC65/AC75 while it is beyond the safety limits of voltage and temperature stated in Chapter 5.1. AC65/AC75 would immediately switch off after having started and detected these inappropriate conditions. In extreme cases this can cause permanent damage to the module.

3.3.1 Turn on AC65/AC75

AC65/AC75 can be started in a variety of ways as described in the following sections:
- Hardware driven start-up by IGT line: starts Normal mode or Airplane mode (see Section 3.3.1.1)
- Software controlled reset by AT+CFUN command: starts Normal mode or Airplane mode (see Section 3.3.1.4)
- Hardware driven start-up by VCHARGE line: starts charging algorithm and Charge-only mode (see Section 3.3.1.3)
- Wake-up from Power-down mode by using RTC interrupt: starts Airplane mode

The option whether to start into Normal mode or Airplane mode depends on the settings made with the AT^SCFG command or AT+CALA. With AT+CALA, followed by AT^SMSO the module can be configured to restart into Airplane mode at a scheduled alarm time. Switching back and forth between Normal mode and Airplane mode is possible any time during operation by using the AT^SCFG command.

After startup or mode change the following URCs indicate the module's ready state:
- "SYSSTART" indicates that the module has entered Normal mode.
- "^SYSSTART AIRPLANE MODE" indicates that the module has entered Airplane mode.
- "^SYSSTART CHARGE ONLY MODE" indicates that the module has entered the Charge-only mode.

These URCs are indicated only if the module is set to a fixed bit rate, i.e. they do not appear if autobauding is enabled (AT+IPR≠0).

Detailed explanations on AT^SCFG, AT+CFUN, AT+CALA, Airplane mode and AT+IPR can be found in [1].

3.3.1.1 Turn on AC65/AC75 Using Ignition Line IGT

When AC65/AC75 is in Power-down mode or Charge-only mode, it can be started to Normal mode or Airplane mode by driving the IGT (ignition) line to ground. This must be accomplished with an open drain/collector driver to avoid current flowing into this pin.
The module will start up when both of the following two conditions are met:
- The supply voltage applied at BATT+ must be in the operating range.
- The IGT line needs to be driven low for at least 400ms in Power-down mode or at least 2s in Charge-only mode. When released IGT goes high and causes the module to start.

Considering different strategies of host application design the figures below show two approaches to meet this requirement: The example in Figure 5 assumes that IGT is activated after BATT+ has already been applied. The example in Figure 6 assumes that IGT is held low before BATT+ is switched on. In either case, to power on the module, ensure that low state of IGT takes at least 400ms (Power-down mode) or 2s (Charge-only mode) from the moment the voltage at BATT+ is available. For Charge-only mode see also Chapter 3.5.6.

Assertion of CTS indicates that the module is ready to receive data from the host application. In addition, if configured to a fixed bit rate (AT+IPR≠0), the module will send the URC "^SYSSTART" or "^SYSSTART AIRPLANE MODE" which notifies the host application that the first AT command can be sent to the module. The duration until this URC is output varies with the SIM card and may take a couple of seconds.

Please note that no "^SYSSTART" or "^SYSSTART AIRPLANE MODE" URC will be generated if autobauding (AT+IPR=0) is enabled.

To allow the application to detect the ready state of the module we recommend using hardware flow control which can be set with AT\Q or AT+ICF (see [1] for details). The default setting of AC65/AC75 is AT\Q0 (no flow control) which shall be altered to AT\Q3 (RTS/CTS handshake). If the application design does not integrate RTS/CTS lines the host application shall wait at least for the "^SYSSTART" or "^SYSSTART AIRPLANE MODE" URC. However, if the URCs are neither used (due to autobauding) then the only way of checking the module's ready state is polling. To do so, try to send characters (e.g. "at") until the module is responding.

See also Chapter 3.3.2 "Signal States after Startup"

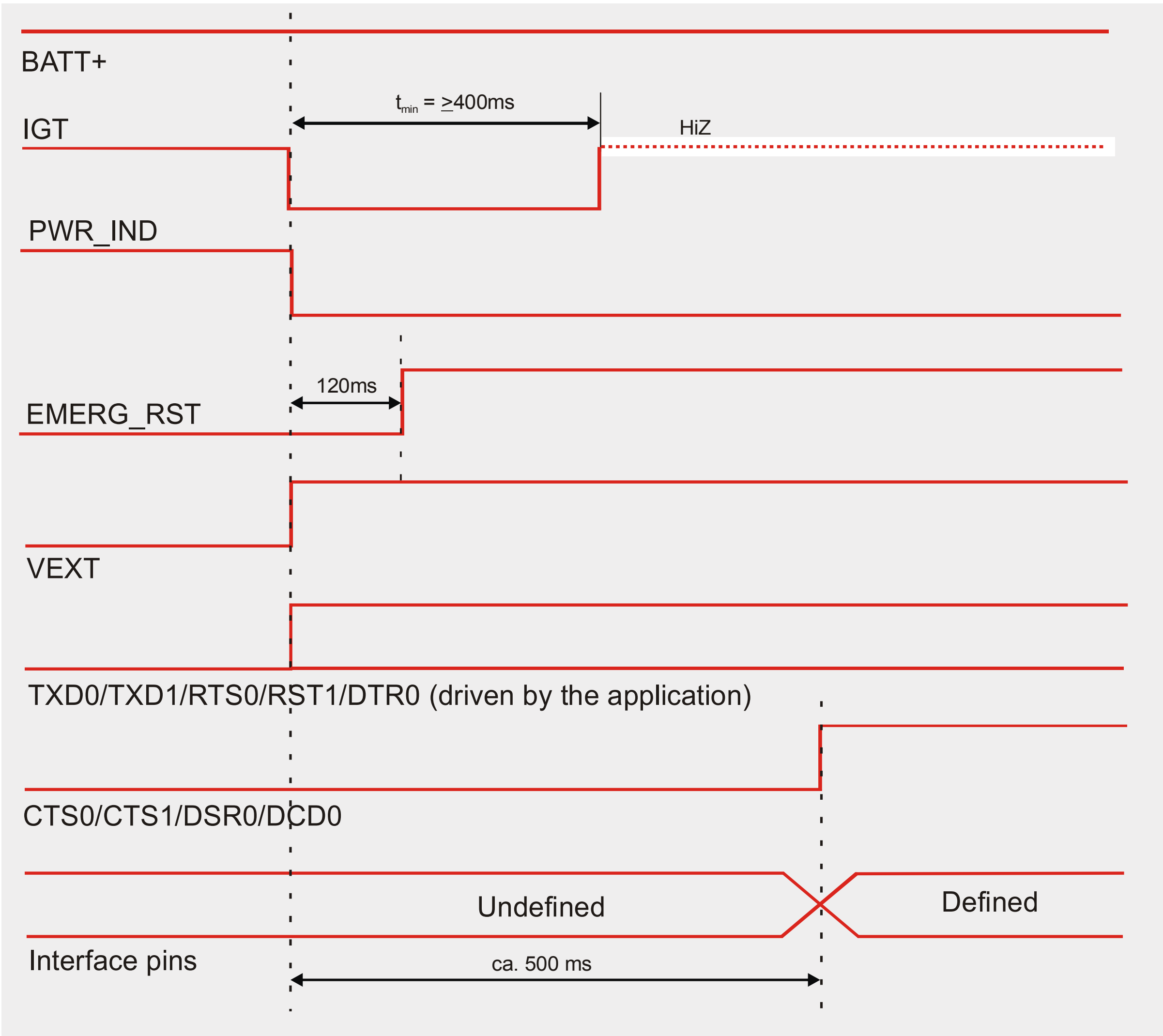


Figure 5: Power-on with operating voltage at BATT+ applied before activating IGT

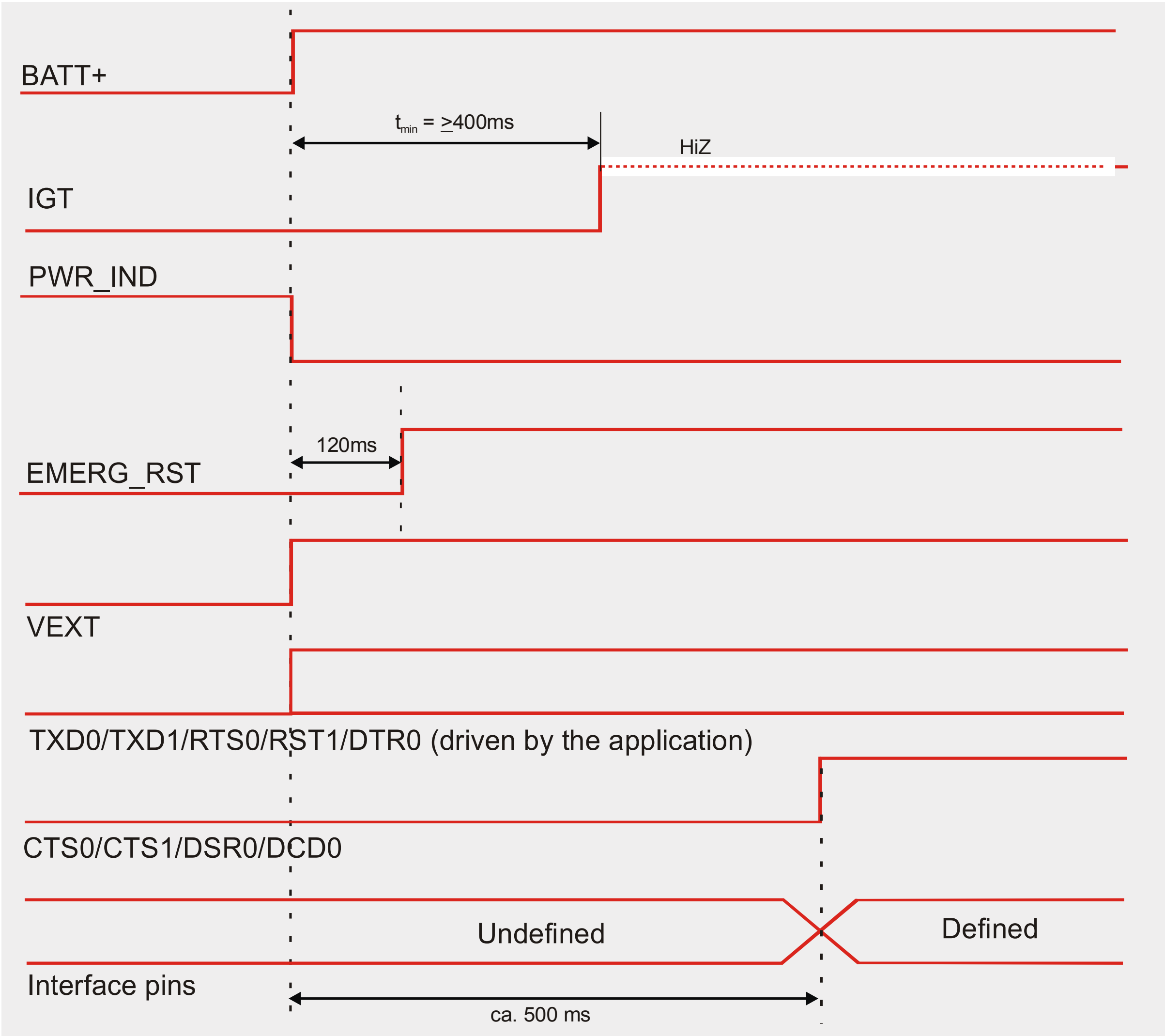


Figure 6: Power-on with IGT held low before switching on operating voltage at BATT+

If the IGT line is driven low for less than 400ms the module will, instead of starting up, send only the alert message "SHUTDOWN after Illegal PowerUp" to the host application. The alert message appears on the serial interfaces ASC0 and ASC1 at a fixed bit rate of 115200bps. If other fixed bit rates or autobauding are set, the URC delivers only undefined characters. The message will not be indicated on the USB interface.

3.3.1.2 Configuring the IGT Line for Use as ON/OFF Switch

The IGT line can be configured for use in two different switching modes: You can set the IGT line to switch on the module only, or to switch it on and off. The switching mode is determined by the parameter “MEShutdown/OnIgnition” of the AT^SCFG command. This approach is useful for application manufacturers who wish to have an ON/OFF switch installed on the host device.

By factory default, the ON/OFF switch mode of IGT is disabled:

at^scfg=meshutdown/onignition	# Query the current status of IGT.
^SCFG: "MEShutdown/OnIgnition","off"	# IGT can be used only to switch on AC65/AC75.
OK	IGT works as described in Section 3.3.1.1.

To configure IGT for use as ON/OFF switch:

at^scfg=meshutdown/onignition,on	# Enable the ON/OFF switch mode of IGT.
^SCFG: "MEShutdown/OnIgnition","on"	# IGT can be used to switch on and off AC65/AC75.
OK	

We strongly recommend taking great care before changing the switching mode of the IGT line. To ensure that the IGT line works properly as ON/OFF switch it is of vital importance that the following conditions are met.

Switch-on condition: If the AC65/AC75 is off, the IGT line must be asserted for at least 400ms before being released. The module switches on after 400ms.

Switch-off condition: If the AC65/AC75 is on, the IGT line must be asserted for at least 1s before being released. The module switches off after the line is released.
The switch-off routine is identical with the procedure initiated by AT^SMSO, i.e. the software performs an orderly shutdown as described in Section 3.3.3.1.
Before switching off the module wait at least 2 seconds after startup.

```
                 ON                        OFF
~~~~|__________|~~~~~~~~~~~~~|__________|~~~~
    |   0.4s   |    ≥ 2s     |  ≥ 1s     |
```

Figure 7: Timing of IGT if used as ON/OFF switch

3.3.1.3 Turn on AC65/AC75 Using the VCHARGE Signal

As detailed in Section 3.5.6, the charging adapter can be connected regardless of the module's operating mode.

If the charger is connected to the charger input of the external charging circuit and the module's VCHARGE pin while AC65/AC75 is off, and the battery voltage is above the undervoltage lockout threshold, processor controlled fast charging starts (see Section 3.5.5). AC65/AC75 enters a restricted mode, referred to as Charge-only mode where only the charging algorithm will be launched.

During the Charge-only mode AC65/AC75 is neither logged on to the GSM network nor are the serial interfaces fully accessible. To switch from Charge-only mode to Normal mode the ignition line (IGT) must be pulled low for at least 2 seconds. When released, the IGT line goes high and causes the module to enter the Normal mode. See also Section 3.5.6.

3.3.1.4 Reset AC65/AC75 via AT+CFUN Command

To reset and restart the AC65/AC75 module use the command AT+CFUN. You can enter AT+CFUN=,1 or AT+CFUN=x,1, where x may be in the range from 0 to 9. See [1] for details.

If configured to a fix baud rate (AT+IPR≠0), the module will send the URC "^SYSSTART" or "^SYSSTART AIRPLANE MODE" to notify that it is ready to operate. If autobauding is enabled (AT+IPR=0) there will be no notification. To register to the network SIM PIN authentication is necessary after restart.

3.3.1.5 Reset or Turn off AC65/AC75 in Case of Emergency

Caution: Use the EMERG_RST pin only when, due to serious problems, the software is not responding for more than 5 seconds. Pulling the EMERG_RST pin causes the loss of all information stored in the volatile memory. Therefore, this procedure is intended only for use in case of emergency, e.g. if AC65/AC75 does not respond, if reset or shutdown via AT command fails.

The EMERG_RST signal is available on the application interface. To control the EMERG_RST line it is recommended to use an open drain / collector driver.

The EMERG_RST line can be used to switch off or to reset the module. In any case the EMERG_RST line must be pulled to ground for ≥10ms. Then, after releasing the EMERG_RST line the module restarts if IGT is held low for at least 400ms. Otherwise, if IGT is not low the module switches off. In this case, it can be restarted any time as described in Section 3.3.1.1.

After hardware driven restart, notification via “^SYSSTART” or “^SYSSTART AIRPLANE” URC is the same as in case of restart by IGT or AT command. To register to the network SIM PIN authentication is necessary after restart.

3.3.1.6 Using EMERG_RST to Reset Application(s) or External Device(s)

When the module starts up, while IGT is held low for 400ms, the EMERG_RST signal goes low for 120ms as shown in Figure 5 and Figure 6. During this 120ms period, EMERG_RST becomes an output which can be used to reset application(s) or external device(s) connected to the module.

After the 120ms period, i.e. during operation of the module, the EMERG_RST is an input.

Specifications of the input and output mode of EMERG_RST can be found in Table 26.

3.3.2 Signal States after Startup

Table 6 describes the various states each interface pin passes through after startup and during operation.

As shown in Figure 5 and Figure 6 the pins are in undefined state while the module is initializing. Once the startup initialization has completed, i.e. when CTS is high and the software is running, all pins are in defined state. The state of several pins will change again once the respective interface is activated or configured by AT command.

Table 6: Signal states

Signal name	Undefined state during startup	Defined state after initialization	Active state after configuration by AT command			
			GPIO	SPI	I^2C	DAI
SYNC	L	O				
CCIN	I, PU(100k)	I, PU(100k)				
CCRST	L	O				
CCIO	L	O				
CCCLK	L	O				
CCVCC	L	2.9V				
RXD0	I, PU	O				
TXD0	I, PU	I, PD(330k)				
CTS0	L	O				
RTS0	I, PU	I, PD(330k)				
DTR0	I, PU	I				
DCD0	L	O				
DSR0	L	O				
RING0	I, PU	O				
RXD1	H	O				
TXD1	I, PD(330k)	I, PD(330k)				
CTS1	L	O				
RTS1	I, PD(330k)	I, PD(330k)				
SPIDI	I	Tristate		I	Tristate	
SPICS	I	Tristate		O	Tristate	
I2CDAT_SPIDO	I	O		O	IO	
I2CCLK_SPICLK	I	O		O	O	
GPIO1	I, PU	Tristate	IO			
GPIO2	I, PU	Tristate	IO			
GPIO3	I, PU	Tristate	IO			
GPIO4	I, PD	Tristate	IO			
GPIO5	L	Tristate	IO			
GPIO6	I	Tristate	IO			
GPIO7	I, PU	Tristate	IO			
GPIO8	L	Tristate	IO			
GPIO9	I	Tristate	IO			
GPIO10	I	Tristate	IO			
DAC_OUT	L	O				
DAI0	I	Tristate				O
DAI1	I	Tristate				I
DAI2	I	Tristate				O
DAI3	I	Tristate				O
DAI4	I	Tristate				I
DAI5	I	Tristate				I
DAI6	I	Tristate				I

For abbreviations, see below.

Abbreviations used in Table 6:

L = Low output level	PD = Pull down with min +15µA and max. +100µA
H = High output level	PD(…k) = Fix pull down resistor
I = Input	PU = Pull up with min -15µA and max. -100µA
O = Output	PU(…k) = Fix pull up resistor

3.3.3 Turn off AC65/AC75

AC65/AC75 can be turned off as follows:

- Normal shutdown: Software controlled by AT^SMSO command
- Automatic shutdown: Takes effect if board or battery temperature is out of range or if undervoltage or overvoltage conditions occur.

3.3.3.1 Turn off AC65/AC75 Using AT Command

The best and safest approach to powering down AC65/AC75 is to issue the AT^SMSO command. This procedure lets AC65/AC75 log off from the network and allows the software to enter into a secure state and safe data before disconnecting the power supply. The mode is referred to as Power-down mode. In this mode, only the RTC stays active.

Before switching off the device sends the following response:

```
^SMSO: MS OFF

OK
^SHUTDOWN
```

After sending AT^SMSO do not enter any other AT commands. There are two ways to verify when the module turns off:

- Wait for the URC "^SHUTDOWN". It indicates that data have been stored non-volatile and the module turns off in less than 1 second.
- Also, you can monitor the PWR_IND pin. High state of PWR_IND definitely indicates that the module is switched off.

Be sure not to disconnect the supply voltage V_{BATT+} before the URC "^SHUTDOWN" has been issued and the PWR_IND signal has gone high. Otherwise you run the risk of losing data. Signal states during turn-off are shown in Figure 8.

While AC65/AC75 is in Power-down mode the application interface is switched off and must not be fed from any other source. Therefore, your application must be designed to avoid any current flow into any digital pins of the application interface, especially of the serial interfaces. No special care is required for the USB interface which is protected from reverse current.

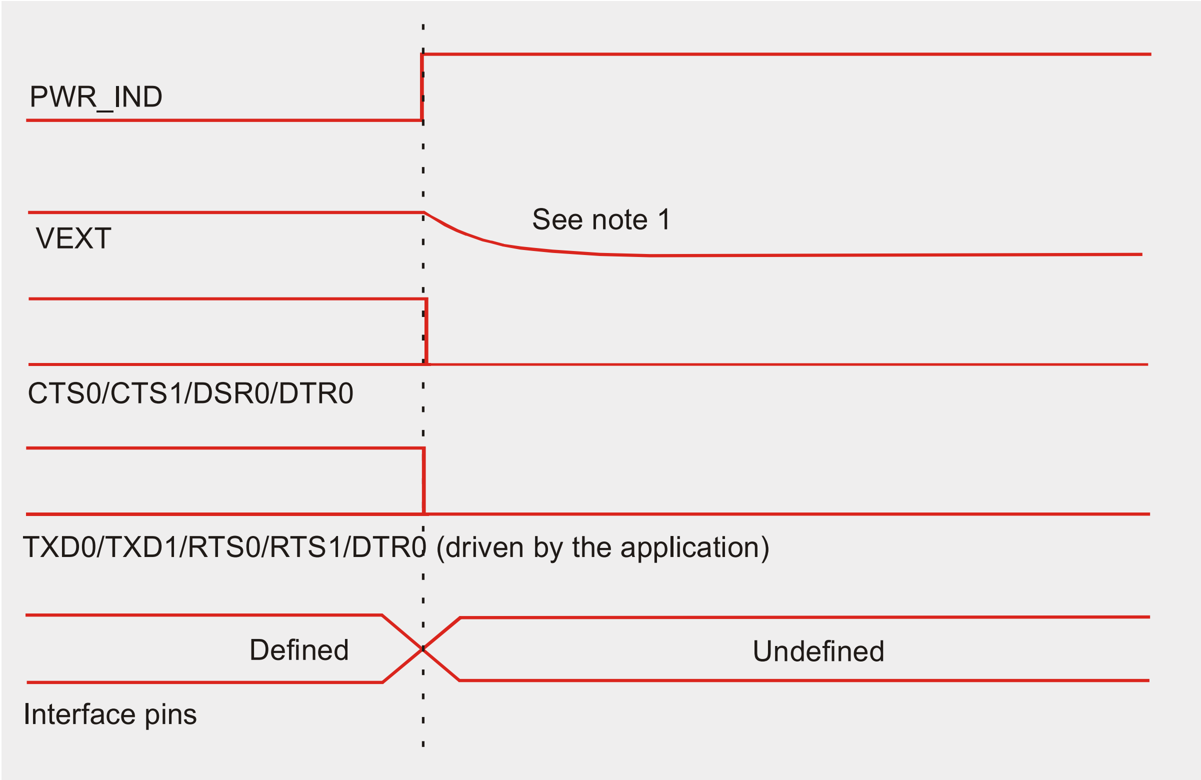


Figure 8: Signal states during turn-off procedure

Note 1: Depending on capacitance load from host application

3.3.3.2 Leakage Current in Power-Down Mode

The leakage current in Power-down mode varies depending on the following conditions:

- If the supply voltage at BATT+ was disconnected and then applied again without starting up the AC65/AC75 module, the leakage current ranges between 90µA and 100µA.
- If the AC65/AC75 module is started and afterwards powered down with AT^SMSO, then the leakage current is only 50µA.

Therefore, in order to minimize the leakage current take care to start up the module at least once before it is powered down.

3.3.3.3 Turn on/off AC65/AC75 Applications with Integrated USB

In a Windows environment, the USB COM port emulation causes the USB port of AC65/AC75 to appear as a virtual COM port (VCOM port). The VCOM port emulation is only present when Windows can communicate with the module, and is lost when the module shuts down. Therefore, the host application or Terminal program must be disconnected from the USB VCOM port each time the module is restarted.

Restart after shutdown with AT^SMSO:
After entering the power-down command AT^SMSO on one of the interfaces (ASC0, ASC1, USB) the host application or Terminal program used on the USB VCOM port must be closed before the module is restarted by activating the IGT line.

Software reset with AT+CFUN=x,1:
Likewise, when using the reset command AT+CFUN=x,1 on one of the interfaces (ASC0, ASC1, USB) ensure that the host application or Terminal program on the USB VCOM port be closed down before the module restarts.
Note that if AT+CFUN=x,1 is entered on the USB interface the application or Terminal program on the USB VCOM port must be closed immediately after the response OK is returned.

3.3.4 Automatic Shutdown

Automatic shutdown takes effect if:

- the AC65/AC75 board is exceeding the critical limits of overtemperature or undertemperature
- the battery is exceeding the critical limits of overtemperature or undertemperature
- undervoltage or overvoltage is detected

See Charge-only mode described in Section 3.5.6 for exceptions.

The automatic shutdown procedure is equivalent to the Power-down initiated with the AT^SMSO command, i.e. AC65/AC75 logs off from the network and the software enters a secure state avoiding loss of data.

Alert messages transmitted before the device switches off are implemented as Unsolicited Result Codes (URCs). The URC presentation mode varies with the condition, please see Chapters 3.3.4.1 to 3.3.4.5 for details. For further instructions on AT commands refer to [1].

3.3.4.1 Thermal Shutdown

The board temperature is constantly monitored by an internal NTC resistor located on the PCB. The NTC that detects the battery temperature must be part of the battery pack circuit as described in 3.5.3 The values detected by either NTC resistor are measured directly on the board or the battery and therefore, are not fully identical with the ambient temperature.

Each time the board or battery temperature goes out of range or back to normal, AC65/AC75 instantly displays an alert (if enabled).

- URCs indicating the level "1" or "-1" allow the user to take appropriate precautions, such as protecting the module from exposure to extreme conditions. The presentation of the URCs depends on the settings selected with the AT^SCTM write command:
  AT^SCTM=1: Presentation of URCs is always enabled.
  AT^SCTM=0 (default): Presentation of URCs is enabled for 15 seconds time after start-up of AC65/AC75. After 15 seconds operation, the presentation will be disabled, i.e. no alert messages can be generated.
- URCs indicating the level "2" or "-2" are instantly followed by an orderly shutdown. The presentation of these URCs is always enabled, i.e. they will be output even though the factory setting AT^SCTM=0 was never changed.

The maximum temperature ratings are stated in Chapter 5.2. Refer to Table 7 for the associated URCs.

Table 7: Temperature dependent behavior

Sending temperature alert (2min after AC65/AC75 start-up, otherwise only if URC presentation enabled)	
^SCTM_A: 1	Caution: Battery close to overtemperature limit.
^SCTM_B: 1	Caution: Bboard close to overtemperature limit.
^SCTM_A: -1	Caution: Battery close to undertemperature limit.
^SCTM_B: -1	Caution: Board close to undertemperature limit.
^SCTM_A: 0	Battery back to uncritical temperature range.
^SCTM_B: 0	Board back to uncritical temperature range.
Automatic shutdown (URC appears no matter whether or not presentation was enabled)	
^SCTM_A: 2	Alert: Battery equal or beyond overtemperature limit. AC65/AC75 switches off.
^SCTM_B: 2	Alert: Board equal or beyond overtemperature limit. AC65/AC75 switches off.
^SCTM_A: -2	Alert: Battery equal or below undertemperature limit. AC65/AC75 switches off.
^SCTM_B: -2	Alert: Board equal or below undertemperature limit. AC65/AC75 switches off.

3.3.4.2 Deferred Shutdown at Extreme Temperature Conditions

In the following cases, shutdown will be deferred if a critical temperature limit is exceeded:

- while an emergency call is in progress
- during a two minute guard period after power-up. This guard period has been introduced in order to allow the user to make an emergency call. The start of an emergency call extends the guard period until the end of the call. Any other network activity may be terminated by shutdown upon expiry of the guard time. The guard period starts again when the module registers to the GSM network the first time after power-up.

If the temperature is still out of range after the guard period expires or the call ends, the module switches off immediately (without another alert message).

CAUTION! Automatic shutdown is a safety feature intended to prevent damage to the module. Extended usage of the deferred shutdown functionality may result in damage to the module, and possibly other severe consequences.

3.3.4.3 Monitoring the Board Temperature of AC65/AC75

The AT^SCTM command can also be used to check the present status of the board. Depending on the selected mode, the read command returns the current board temperature in degrees Celsius or only a value that indicates whether the board is within the safe or critical temperature range. See [1] for further instructions.

3.3.4.4 Undervoltage Shutdown if Battery NTC is Present

In applications where the module's charging technique is used and an NTC is connected to the BATT_TEMP terminal, the software constantly monitors the applied voltage. If the measured battery voltage is no more sufficient to set up a call the following URC will be presented:

^SBC: Undervoltage.

The message will be reported, for example, when you attempt to make a call while the voltage is close to the shutdown threshold of 3.2V and further power loss is caused during the transmit burst. In IDLE mode, the shutdown threshold is the sum of the module's minimum supply voltage (3.2V) and the value of the maximum voltage drop resulting from earlier calls. This means that in IDLE mode the actual shutdown threshold may be higher than 3.2V. Therefore, to properly calculate the actual shutdown threshold application manufacturers are advised to measure the maximum voltage drops that may occur during transmit bursts.

To remind you that the battery needs to be charged soon, the URC appears several times before the module switches off.

This type of URC does not need to be activated by the user. It will be output automatically when fault conditions occur.

3.3.4.5 Undervoltage Shutdown if no Battery NTC is Present

The undervoltage protection is also effective in applications, where no NTC connects to the BATT_TEMP terminal. Thus, you can take advantage of this feature even though the application handles the charging process or AC65/AC75 is fed by a fixed supply voltage.

Whenever the supply voltage falls below the value of 3.2V the URC
^SBC: Undervoltage
appears several times before the module switches off.

This type of URC does not need to be activated by the user. It will be output automatically when fault conditions occur.

3.3.4.6 Overvoltage Shutdown

The overvoltage shutdown threshold is 100mV above the maximum supply voltage V_{BATT+} specified in Table 27.

When the supply voltage approaches the overvoltage shutdown threshold the module will send the URC
^SBC: Overvoltage warning.
This alert is sent once.

When the overvoltage shutdown threshold is exceeded the module will send the URC
^SBC: Overvoltage shutdown,
before it shuts down cleanly.

This type of URC does not need to be activated by the user. It will be output automatically when fault conditions occur.

Keep in mind that several AC65/AC75 components are directly linked to BATT+ and, therefore, the supply voltage remains applied at major parts of AC65/AC75, even if the module is switched off. Especially the power amplifier is very sensitive to high voltage and might even be destroyed.

3.4 Automatic EGPRS/GPRS Multislot Class Change

Temperature control is also effective for operation in EGPRS Multislot Class 10 (AC75 only), GPRS Multislot Class 10 and GPRS Multislot Class 12. If the board temperature rises close to the limit specified for normal operation[1] while data are transmitted over EGPRS or GPRS, the module automatically reverts

- from EGPRS Multislot Class 10 (2Tx slots) to EGPRS Multislot Class 8 (1Tx),
- from GPRS Multislot Class 12 (4Tx slots) to GPRS Multislot Class 8 (1Tx),
- from GPRS Multislot Class 10 (2Tx slots) to GPRS Multislot Class 8 (1Tx)

This reduces the power consumption and, consequently, causes the board's temperature to decrease. Once the temperature drops by 5 degrees, AC65/AC75 returns to the higher Multislot Class. If the temperature stays at the critical level or even continues to rise, AC65/AC75 will not switch back to the higher class.

After a transition from EGPRS Multislot Class 10 to EGPRS Multislot Class 8 a possible switchback to EGPRS Multislot Class 10 is blocked for one minute. The same applies when a transition occurs from GPRS Multislot Class 12 or 10 to GPRS Multislot Class 8.

Please note that there is not one single cause of switching over to a lower Multislot Class. Rather it is the result of an interaction of several factors, such as the board temperature that depends largely on the ambient temperature, the operating mode and the transmit power. Furthermore, take into account that there is a delay until the network proceeds to a lower or, accordingly, higher Multislot Class. The delay time is network dependent. In extreme cases, if it takes too much time for the network and the temperature cannot drop due to this delay, the module may even switch off as described in Section 3.3.4.1.

[1] See Chapter 5.2 for temperature limits.

3.5 Charging Control

AC65/AC75 integrates a charging management for rechargeable Lithium Ion and Lithium Polymer batteries. You can skip this chapter if charging is not your concern, or if you are not using the implemented charging algorithm.

The following sections contain an overview of charging and battery specifications. Please refer to [4] for greater detail, especially regarding requirements for batteries and chargers, appropriate charging circuits, recommended batteries and an analysis of operational issues typical of battery powered GSM/GPRS applications.

3.5.1 Hardware Requirements

AC65/AC75 has no on-board charging circuit. To benefit from the implemented charging management you are required to install a charging circuit within your application according to the Figure 46.

3.5.2 Software Requirements

Use the command AT^SBC, parameter <current>, to enter the current consumption of the host application. This information enables the AC65/AC75 module to correctly determine the end of charging and terminate charging automatically when the battery is fully charged. If the <current> value is inaccurate and the application draws a current higher than the final charge current, either charging will not be terminated or the battery fails to reach its maximum voltage. Therefore, the termination condition is defined as: current consumption dependent on the operating mode of the ME plus current consumption of the external application. If used the current flowing over the VEXT pin of the application interface must be added, too.

The parameter <current> is volatile, meaning that the factory default (0mA) is restored each time the module is powered down or reset. Therefore, for better control of charging, it is recommended to enter the value every time the module is started.

See [1] for details on AT^SBC.

3.5.3 Battery Pack Requirements

The charging algorithm has been optimized for rechargeable Lithium batteries that meet the characteristics listed below and in Table 8. It is recommended that the battery pack you want to integrate into your AC65/AC75 application is compliant with these specifications. This ensures reliable operation, proper charging and, particularly, allows you to monitor the battery capacity using the AT^SBC command. Failure to comply with these specifications might cause AT^SBC to deliver incorrect battery capacity values.

- Li-Ion or Lithium Polymer battery pack specified for a maximum charging voltage of 4.2V and a recommended capacity of 1000 to 1200mAh.
- Since charging and discharging largely depend on the battery temperature, the battery pack should include an NTC resistor. If the NTC is not inside the battery it must be in thermal contact with the battery. The NTC resistor must be connected between BATT_TEMP and GND.
  The B value of the NTC should be in the range: *10kΩ ±5% @ 25°C,* $B_{25/85}$ = 3423K to B =3435K ± 3% (alternatively acceptable: *10kΩ ±2% @ 25°C,* $B_{25/50}$ *= 3370K ±3%)*. Please note that the NTC is indispensable for proper charging, i.e. the charging process will not start if no NTC is present.
- Ensure that the pack incorporates a protection circuit capable of detecting overvoltage (protection against overcharging), undervoltage (protection against deep discharging) and overcurrent. Due to the discharge current profile typical of GSM applications, the circuit must be insensitive to pulsed current.
- On the AC65/AC75 module, a built-in measuring circuit constantly monitors the supply voltage. In the event of undervoltage, it causes AC65/AC75 to power down. Undervoltage thresholds are specific to the battery pack and must be evaluated for the intended model. When you evaluate undervoltage thresholds, consider both the current consumption of AC65/AC75 and of the application circuit.
- The internal resistance of the battery and the protection should be as low as possible. It is recommended not to exceed 150mΩ, even in extreme conditions at low temperature. The battery cell must be insensitive to rupture, fire and gassing under extreme conditions of temperature and charging (voltage, current).
- The battery pack must be protected from reverse pole connection. For example, the casing should be designed to prevent the user from mounting the battery in reverse orientation.
- It is recommended that the battery pack be approved to satisfy the requirements of CE conformity.

Figure 9 shows the circuit diagram of a typical battery pack design that includes the protection elements described above.

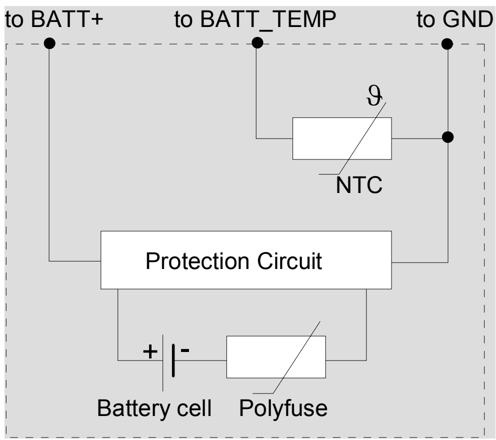


Figure 9: Battery pack circuit diagram

Table 8: Specifications of battery packs suitable for use with AC65/AC75

Battery type	Rechargeable Lithium Ion or Lithium Polymer battery
Nominal voltage	3.6V / 3.7V
Capacity	Recommended: 1000mAh to 1200mAh Minimum: 500mAh
NTC	10kΩ ± 5% @ 25°C approx. 5kΩ @ 45°C approx. 26.2kΩ @ 0°C B value range: B (25/85)=3423K to B =3435K ± 3%
Overcharge detection voltage	4.325 ± 0.025V
Overdischarge detection voltage	2.5V
Overdischarge release voltage	2.6V
Overcurrent detection	3 ± 0.5A
Overcurrent detection delay time	4 ~ 16ms
Short detection delay time	50µs
Internal resistance	<130mΩ Note: A maximum internal resistance of 150mΩ should not be exceeded even after 500 cycles and under extreme conditions.

3.5.4 Charger Requirements

For using the implemented charging algorithm and the reference charging circuit recommended in [4] and in Figure 46, the charger has to meet the following requirements:

Output voltage: 5.2Volts ±0.2V (stabilized voltage)

Output current: 500mA
Chargers with a higher output current are acceptable, but please consider that only 500mA will be applied when a 0.3Ohms shunt resistor is connected between VSENSE and ISENSE. See [4] for further details.

3.5.5 Implemented Charging Technique

If all requirements listed above are met (appropriate external charging circuit of application, battery pack, charger, AT^SBC settings) then charging is enabled in various stages depending on the battery condition:

Trickle charging:

- Trickle charge current flows over the VCHARGE line.
- Trickle charging is done when a charger is present (connected to VCHARGE) and the battery is deeply discharged or has undervoltage. If deeply discharged (Deep Discharge Lockout at V_{BATT+}= <2.5V) the battery is charged with 5mA, in case of undervoltage (Undervoltage Lockout at V_{BATT+}= 2.5…3.2V) it is charged with 30mA.

Software controlled charging:

- Controlled over the CHARGEGATE.
- Temperature conditions: 0°C to 45°C
- Software controlled charging is done when the charger is present (connected to VCHARGE) and the battery voltage is at least above the undervoltage threshold. Software controlled charging passes the following stages:
  - Power ramp: Depending on the discharge level of the battery (i.e. the measured battery voltage V_{BATT+}) the software adjusts the maximum charge current for charging the battery. The duration of power ramp charging is very short (less than 30 seconds).
  - Fast charging: Battery is charged with constant current (approx. 500mA) until the battery voltage reaches 4.2V (approx. 80% of the battery capacity).
  - Top-up charging: The battery is charged with constant voltage of 4.2V at stepwise reducing charge current until full battery capacity is reached.

Duration of charging:

- AC65/AC75 provides two charging timers: a software controlled timer set to 4 hours and a hardware controlled timer set to 4.66 hours.
  - The duration of software controlled charging depends on the battery capacity and the level of discharge. Normally, charging stops when the battery is fully charged or, at the latest, when the software timer expires after 4 hours.
  - The hardware timer is provided to prevent runaway charging and to stop charging if the software is not responding. The hardware timer will start each time the charger is plugged to the VCHARGE line.

3.5.6 Operating Modes during Charging

Of course, the battery can be charged regardless of the engine's operating mode. When the GSM module is in Normal mode (SLEEP, IDLE, TALK, GPRS IDLE or GPRS DATA mode), it remains operational while charging is in progress (provided that sufficient voltage is applied). The charging process during the Normal mode is referred to as *Charge mode*.

If the charger is connected to the charger input of the external charging circuit and the module's VCHARGE pin while AC65/AC75 is in Power-down mode, AC65/AC75 goes into *Charge-only* mode.

While the charger remains connected it is not possible to switch the module off by using the AT^SMSO command or the automatic shutdown mechanism. Instead the following applies:

- If the module is in Normal mode and the charger is connected (Charge mode) the AT^SMSO command causes the module to shut down shortly and then start into the Charge-only mode.
- In Charge-only mode the AT^SMSO command is not usable.
- In Charge-only mode the module neither switches off when the battery or the module exceeds the critical limits of overtemperature or undertemperature.

In these cases you can only switch the module off by disconnecting the charger.

To proceed from Charge-only mode to another operating mode you have the following options, provided that the battery voltage is at least above the undervoltage threshold.

- To switch from Charge-only mode to Normal mode you have two ways:
  - Hardware driven: The ignition line (IGT) must be pulled low for at least 2 seconds. When released, the IGT line goes high and causes the module to enter the Normal mode.
  - AT command driven: Set the command *AT^SCFG=MEopMode/Airplane,off* (please do so although the current status of Airplane mode is already “off”). The module will enter the Normal mode, indicated by the “^SYSSTART” URC.
- To switch from Charge-only mode to Airplane mode set the command *AT^SCFG=MEopMode/Airplane,on*. The mode is indicated by the URC “^SYSSTART AIRPLANE MODE”.
- If *AT^SCFG=MEopMode/Airplane/OnStart,on* is set, driving the ignition line (IGT) activates the Airplane mode. The mode is indicated by the URC “^SYSSTART AIRPLANE MODE”.

Table 9: AT commands available in Charge-only mode

AT command	Use
AT+CALA	Set alarm time, configure Airplane mode.
AT+CCLK	Set date and time of RTC.
AT^SBC	Query status of charger connection.
AT^SBV	Monitor supply voltage.
AT^SCTM	Query temperature range, enable/disable URCs to report critical temperature ranges
AT^SCFG	Enable/disable parameters MEopMode/Airplane or MEopMode/Airplane/OnStart

Table 10: Comparison Charge-only and Charge mode

	How to activate mode	Description of mode
Charge mode	Connect charger to charger input of host application charging circuit and module's VCHARGE pin while AC65/AC75 is • operating, e.g. in IDLE or TALK mode • in SLEEP mode	• Battery can be charged while GSM module remains operational and registered to the GSM network. • In IDLE and TALK mode, the serial interfaces are accessible. All AT commands can be used to full extent. NOTE: If the module operates at maximum power level (PCL5) and GPRS Class 12 at the same time the current consumption is higher than the current supplied by the charger.
Charge-only mode	Connect charger to charger input of host application charging circuit and module's VCHARGE pin while AC65/AC75 is • in Power-down mode • in Normal mode: Connect charger to the VCHARGE pin, then enter AT^SMSO. NOTE: While trickle charging is in progress, be sure that the host application is switched off. If the application is fed from the trickle charge current the module might be prevented from proceeding to software controlled charging since the current would not be sufficient.	• Battery can be charged while GSM engine is deregistered from GSM network. • Charging runs smoothly due to constant current consumption. • The AT interface is accessible and allows to use the commands listed below.

3.6 Power Saving

Intended for power saving, SLEEP mode reduces the functionality of the AC65/AC75 to a minimum and thus minimizes the current consumption. Settings can be made using the AT+CFUN command. For details see [1]. SLEEP mode falls in two categories:

- NON-CYCLIC SLEEP mode: AT+CFUN = 0
- CYCLIC SLEEP modes, AT+CFUN = 7 or 9.

The functionality level AT+CFUN=1 is where power saving is switched off. This is the default after startup.

NON-CYCLIC SLEEP mode permanently blocks the serial interface. The benefit of the CYCLIC SLEEP mode is that the serial interface remains accessible and that, in intermittent wake-up periods, characters can be sent or received without terminating the selected mode. This allows the AC65/AC75 to wake up for the duration of an event and, afterwards, to resume power saving. Please refer to [1] for a summary of all SLEEP modes and the different ways of waking up the module.

For CYCLIC SLEEP mode both the AC65/AC75 and the application must be configured to use hardware flow control. This is necessary since the CTSx signal is set/reset every 0.9-2.7 seconds in order to indicate to the application when the UART is active. Please refer to [1] for details on how to configure hardware flow control for the AC65/AC75.

Note: Although not explicitly stated, all explanations given in this section refer equally to ASC0 and ASC1, and accordingly to CTS0 and CTS1 or RTS0 and RTS1.

3.6.1 Network Dependency of SLEEP Modes

The power saving possibilities of SLEEP modes depend on the network the module is registered in. The paging timing cycle varies with the base station. The duration of a paging interval can be calculated from the following formula:

*t = 4.615 ms (TDMA frame duration) * 51 (number of frames) * DRX value*.

DRX (Discontinuous Reception) is a value from 2 to 9, resulting in paging intervals from 0.47-2.12 seconds. The DRX value of the base station is assigned by the network operator.

In the pauses between listening to paging messages, the module resumes power saving, as shown in Figure 10.

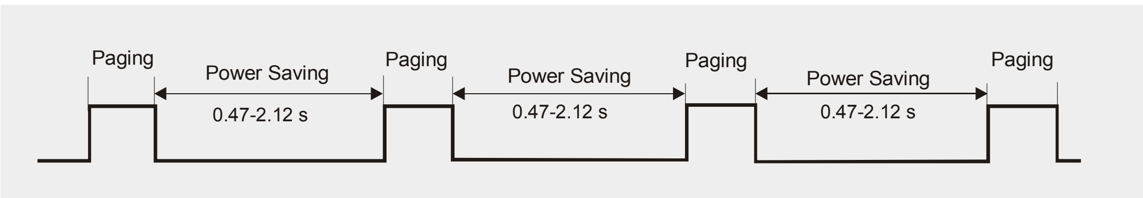


Figure 10: Power saving and paging

The varying pauses explain the different potential for power saving. The longer the pause the less power is consumed.

3.6.2 Timing of the CTSx Signal in CYCLIC SLEEP Mode 7

Figure 11 illustrates the CTSx signal timing in CYCLIC SLEEP mode 7 (CFUN=7).

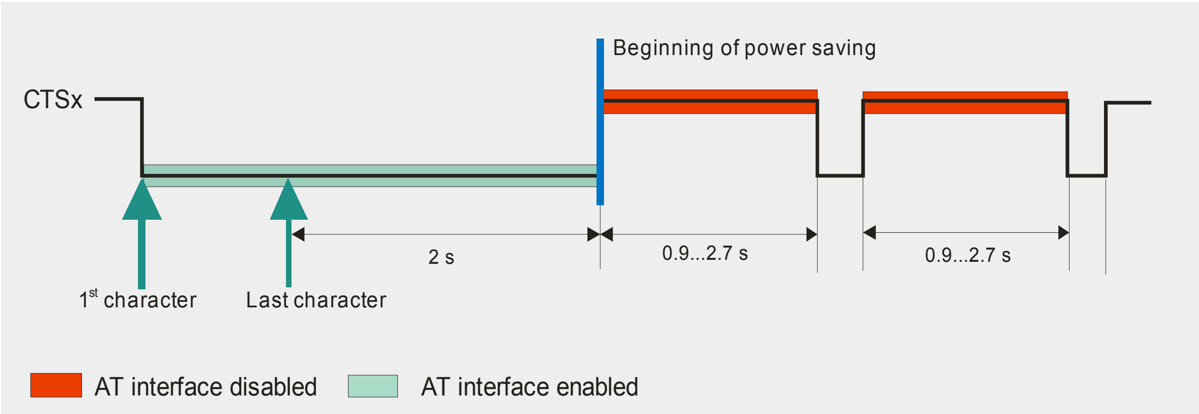


Figure 11: Timing of CTSx signal (if CFUN= 7)

With regard to programming or using timeouts, the UART must take the varying CTS inactivity periods into account.

3.6.3 Timing of the RTSx Signal in CYCLIC SLEEP Mode 9

In SLEEP mode 9 the falling edge of RTSx can be used to temporarily wake up the ME. In this case the activity time is at least the time set with AT^SCFG="PowerSaver/Mode9/Timeout",<psm9to> (default 2 seconds). RTSx has to be asserted for at least a dedicated debounce time in order to wake up the ME. The debounce time specifies the minimum time period an RTSx signal has to remain asserted for the signal to be recognized as wake up signal and being processed. The debounce time is defined as 8*4.615 ms (TDMA frame duration) and is used to prevent bouncing or other fluctuations from being recognized as signals. Toggling RTSx while the ME is awake has no effect on the AT interface state, the regular hardware flow control via CTS/RTS is unaffected by this RTSx behaviour.

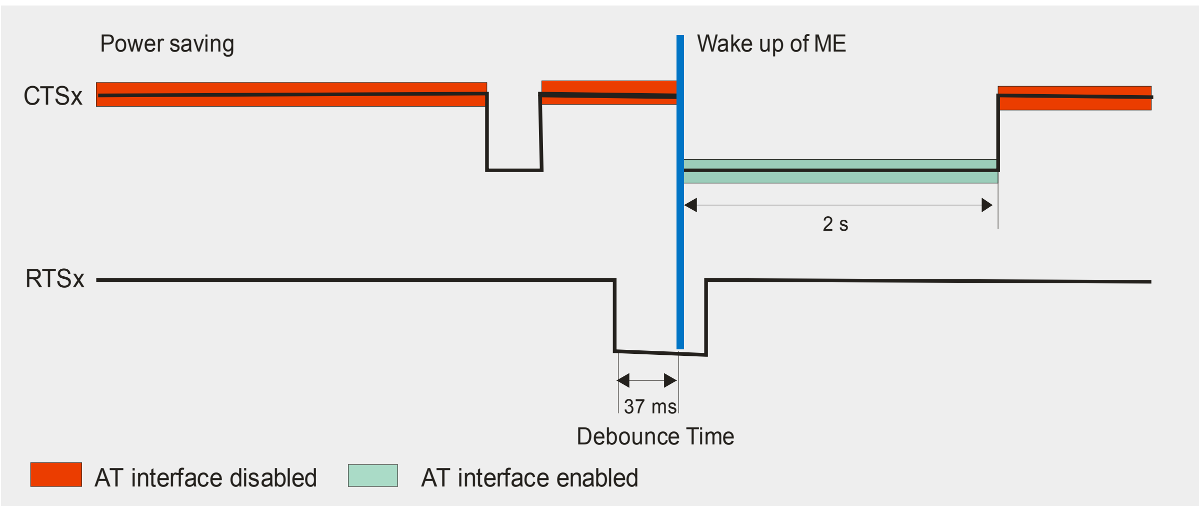


Figure 12: Timing of RTSx signal (if CFUN = 9)

3.7 Summary of State Transitions (Except SLEEP Mode)

Table 11: State transitions of AC65/AC75 (except SLEEP mode)
The table shows how to proceed from one mode to another (grey column = present mode, white columns = intended modes)

Further mode →→→ Present mode	POWER DOWN	Normal mode**)	Charge-only mode*)	Airplane mode
POWER DOWN mode	---	If AT^SCFG=MeOpMode/ Airplane/OnStart,off: IGT >400 ms at low level, then release IGT	Connect charger to VCHARGE	If AT^SCFG=MeOpMode/ Airplane/OnStart,on: IGT >400 ms at low level, then release IGT. Regardless of AT^SCFG configuration: scheduled wake-up set with AT+CALA.
Normal mode**)	AT^SMSO	---	AT^SMSO if charger is connected	AT^SCFG=MeOpMode/ Airplane,on. If AT^SCFG=MeOpMode/ Airplane/OnStart,on: AT+CFUN=x,1 or EMERG_RST + IGT >400 ms.
Charge-only mode *)	Disconnect charger	Hardware driven: If AT^SCFG= MeOpMode/Airplane/OnStart,off: IGT >2s at low level, then release IGT AT command driven: AT^SCFG= MeOpMode/Airplane,off	---	AT^SCFG=MeOpMode/ Airplane,on. If AT^SCFG=MeOpMode/ Airplane/OnStart,on: IGT >2s at low level
Airplane mode	AT^SMSO	AT^SCFG=MeOpMode/ Airplane,off	AT^SMSO if charger is connected	---

*) See Section 3.5.6 for details on the charging mode

**) Normal mode covers TALK, DATA, GPRS/EGPRS, IDLE and SLEEP modes

3.8 RTC Backup

The internal Real Time Clock of AC65/AC75 is supplied from a separate voltage regulator in the analog controller which is also active when AC65/AC75 is in POWER DOWN status. An alarm function is provided to wake up AC65/AC75 to Airplane mode without logging on to the GSM network.

In addition, you can use the VDDLP pin on the board-to-board connector to backup the RTC from an external capacitor or a battery (rechargeable or non-chargeable). The capacitor is charged by the BATT+ line of AC65/AC75. If the voltage supply at BATT+ is disconnected the RTC can be powered by the capacitor. The size of the capacitor determines the duration of buffering when no voltage is applied to AC65/AC75, i.e. the larger the capacitor the longer AC65/AC75 will save the date and time.

A serial 1kΩ resistor placed on the board next to VDDLP limits the charge current of an empty capacitor or battery.

The following figures show various sample configurations. Please refer to Table 26 for the parameters required.

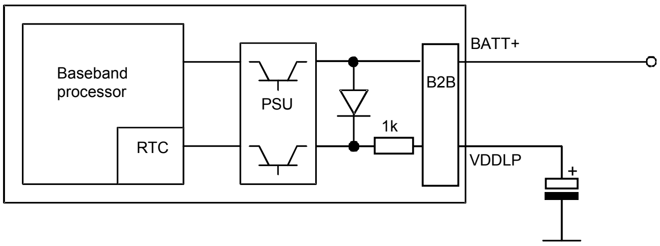


Figure 13: RTC supply from capacitor

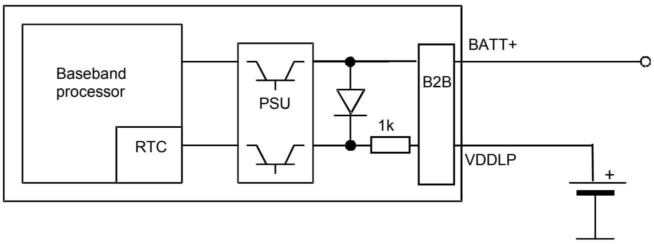


Figure 14: RTC supply from rechargeable battery

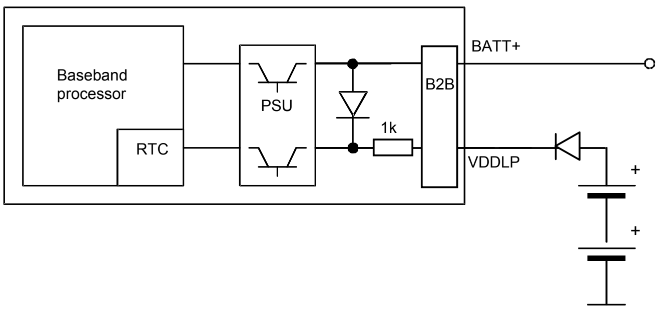


Figure 15: RTC supply from non-chargeable battery

3.9 SIM Interface

The baseband processor has an integrated SIM interface compatible with the ISO 7816 IC Card standard. This is wired to the host interface (board-to-board connector) in order to be connected to an external SIM card holder. Six pins on the board-to-board connector are reserved for the SIM interface.

The SIM interface supports 3V and 1.8V SIM cards. Please refer to Table 26 for electrical specifications of the SIM interface lines depending on whether a 3V or 1.8V SIM card is used.

The CCIN pin serves to detect whether a tray (with SIM card) is present in the card holder. Using the CCIN pin 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 AC65/AC75 and is part of the Siemens reference equipment submitted for type approval. See Chapter 8 for Molex ordering numbers.

Table 12: Signals of the SIM interface (board-to-board connector)

Signal	Description
CCGND	Separate ground connection for SIM card to improve EMC. Be sure to use this ground line for the SIM interface rather than any other ground pin or plane on the module. A design example for grounding the SIM interface is shown in Figure 46.
CCCLK	Chipcard clock, various clock rates can be set in the baseband processor.
CCVCC	SIM supply voltage.
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. If the SIM is removed during operation the SIM interface is shut down immediately to prevent destruction of the SIM. The CCIN pin is active low. The CCIN pin is mandatory for applications that allow the user to remove the SIM card during operation. The CCIN pin 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 AC65/AC75.

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 a SIM card during operation.

3.9.1 Installation Advice

The total cable length between the board-to-board connector pins on AC65/AC75 and the pins 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 is using the CCGND line to shield the CCIO line from the CCCLK line.

To meet EMC requirements it is strongly recommended to add several capacitors as shown in Figure 46. Take care to place the capacitors close to the SIM card holder.

3.10 Serial Interface ASC0

AC65/AC75 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 significant levels are 0V (for low data bit or active state) and 2.9V (for high data bit or inactive state). For electrical characteristics please refer to Table 26.

AC65/AC75 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

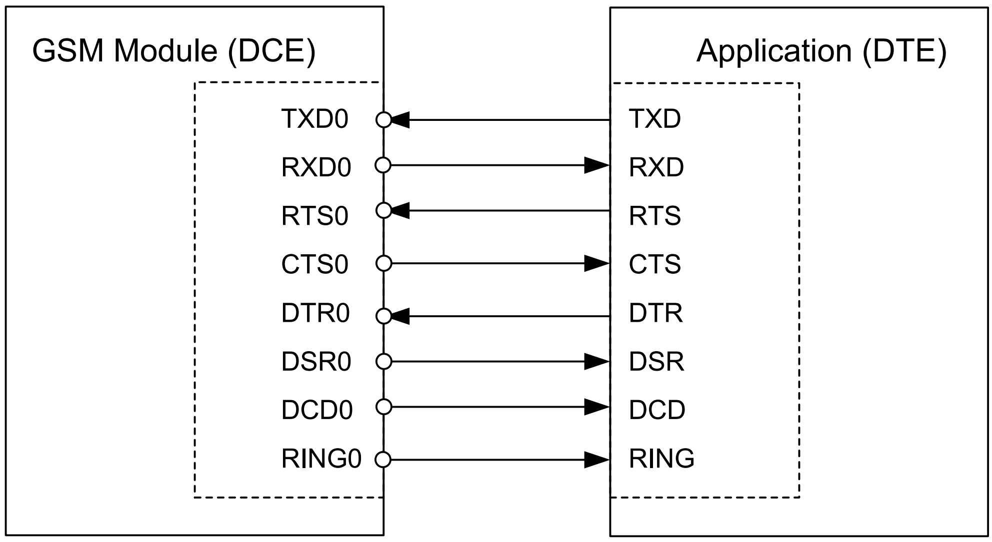


Figure 16: Serial interface ASC0

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 engine with AT commands.
- Full Multiplex capability allows the interface to be partitioned into three virtual channels, yet with CSD and fax services only available on the first logical channel. Please note that when the ASC0 interface runs in Multiplex mode, ASC1 cannot be used. For more details on Multiplex mode see [10].
- The DTR0 signal will only be polled once per second from the internal firmware of AC65/AC75.
- 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.
- By default, configured for 8 data bits, no parity and 1 stop bit. The setting can be changed using the AT command AT+ICF and, if required, AT^STPB. For details see [1].
- ASC0 can be operated at fixed bit rates from 300 bps to 460,800 bps.
- Autobauding supports bit rates from 1,200 to 460,800 bps.
- Autobauding is not compatible with multiplex mode.
- Supports RTS0/CTS0 hardware flow control and XON/XOFF software flow control.

Table 13: DCE-DTE wiring of ASC0

V.24 circuit	DCE		DTE	
	Pin function	**Signal direction**	**Pin 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

3.11 Serial Interface ASC1

The ASC1 interface is available as a 4-wire unbalanced, asynchronous modem interface ASC1 conforming to ITU-T V.24 protocol DCE signalling. The electrical characteristics do not comply with ITU-T V.28. The significant levels are 0V (for low data bit or active state) and 2.9V (for high data bit or inactive state). For electrical characteristics please refer to Table 26.

AC65/AC75 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

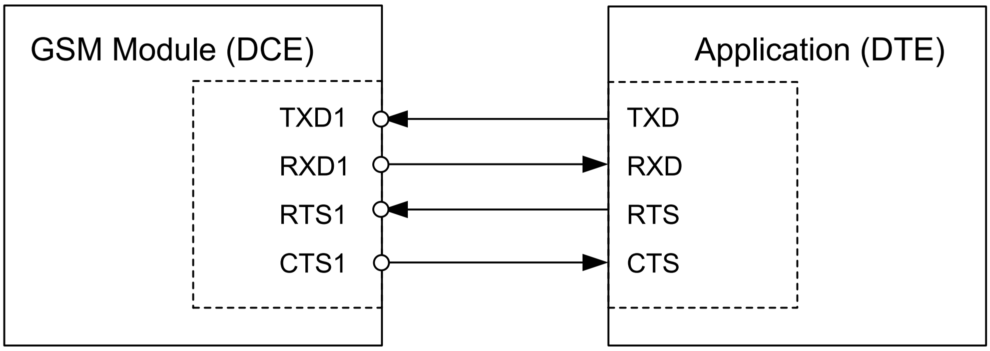


Figure 17: Serial interface ASC1

Features

- Includes only the data lines TXD1 and RXD1 plus RTS1 and CTS1 for hardware handshake.
- On ASC1 no RING line is available. The indication of URCs on the second interface depends on the settings made with the AT^SCFG command. For details refer to [1].
- Configured for 8 data bits, no parity and 1 or 2 stop bits.
- ASC1 can be operated at fixed bit rates from 300 bps to 460,800 bps. Autobauding is not supported on ASC1.
- Supports RTS1/CTS1 hardware flow control and XON/XOFF software flow control.

Table 14: DCE-DTE wiring of ASC1

V.24 circuit	DCE		DTE	
	Pin function	Signal direction	Pin function	Signal direction
103	TXD1	Input	TXD	Output
104	RXD1	Output	RXD	Input
105	RTS1	Input	RTS	Output
106	CTS1	Output	CTS	Input

3.12 USB Interface

AC65/AC75 supports a USB 2.0 Full Speed (12Mbit/s) device interface. It can be operated on a USB 2.0 Full Speed or High Speed root hub (a PC host), but not on a generic USB 2.0 High Speed hub which translates High Speed (480 Mbit/s/) to Full Speed (12 Mbit/s).

The USB port has different functions depending on whether or not Java is running. Under Java, the lines may be used for debugging purposes (see [16] for further detail). If Java is not used, the USB interface is available as a command and data interface and for downloading firmware.

The USB I/O-pins are capable of driving the signal at min 3.0V. They are 5V I/O compliant.

The USB host is responsible for supplying, across the VUSB_IN line, power to the module's USB interface, but not to other AC65/AC75 interfaces. This is because AC65/AC75 is designed as a self-powered device compliant with the "Universal Serial Bus Specification Revision 2.0"[2].

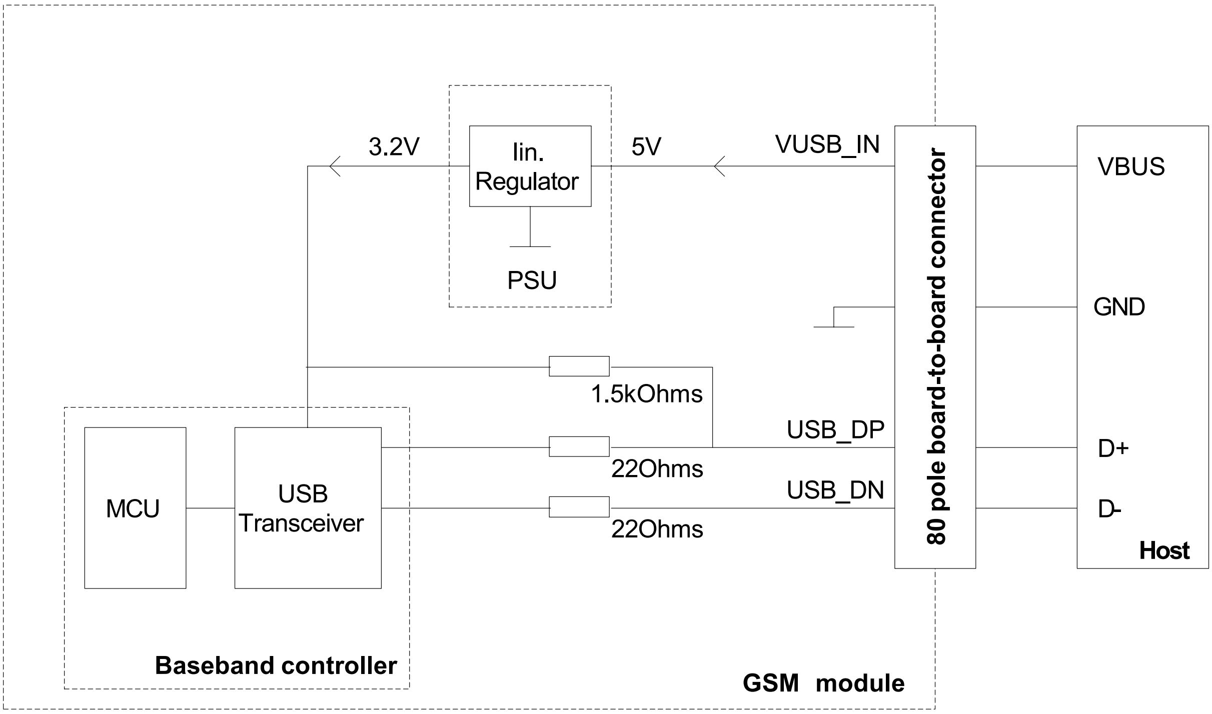


Figure 18: USB circuit

To properly connect the module's USB interface to the host a USB 2.0 compatible connector is required. For more information on how to install a USB modem driver and on how to integrate USB into AC65/AC75 applications see [11].

[2] The specification is ready for download on http://www.usb.org/developers/docs/

3.13 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 AC65/AC75 module acts as a single master device, e.g. the clock I2CCLK is driven by 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.

To configure and activate the I²C bus use the AT^SSPI command. If the I²C bus is active the two lines I2CCLK and I2DAT are locked for use as SPI lines. Vice versa, the activation of the SPI locks both lines for I²C. Detailed information on the AT^SSPI command as well explanations on the protocol and syntax required for data transmission can be found in [1].

The I²C interface can be powered from an external supply or via the VEXT line of AC65/AC75. If connected to the VEXT line the I²C interface will be properly shut down when the module enters the Power-down mode. If you prefer to connect the I²C interface to an external power supply, take care that VCC of the application is in the range of V_{VEXT} and that the interface is shut down when the PWR_IND signal goes high. See figures below as well as Section 7 and Figure 46.

In the application I2CDAT and I2CCLK lines need to be connected to a positive supply voltage via a pull-up resistor.

For electrical characteristics please refer to Table 26.

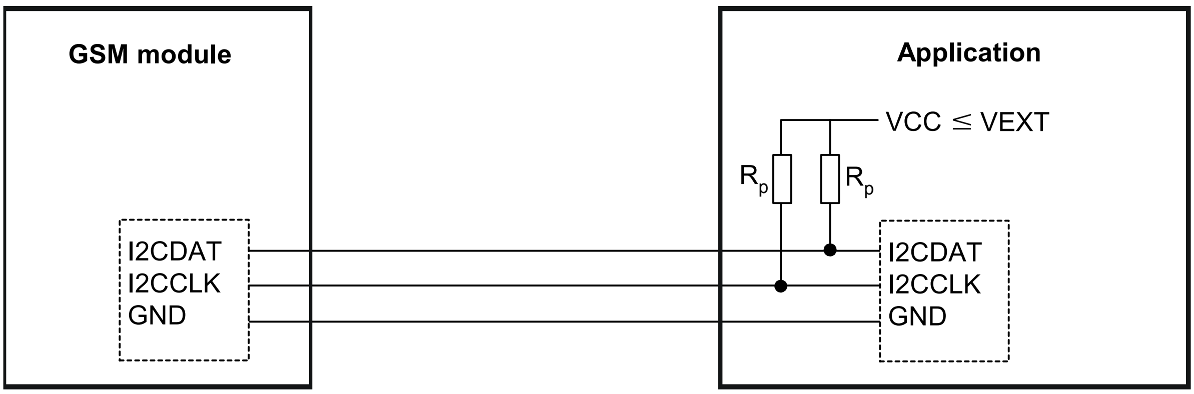


Figure 19: I²C interface connected to VCC of application

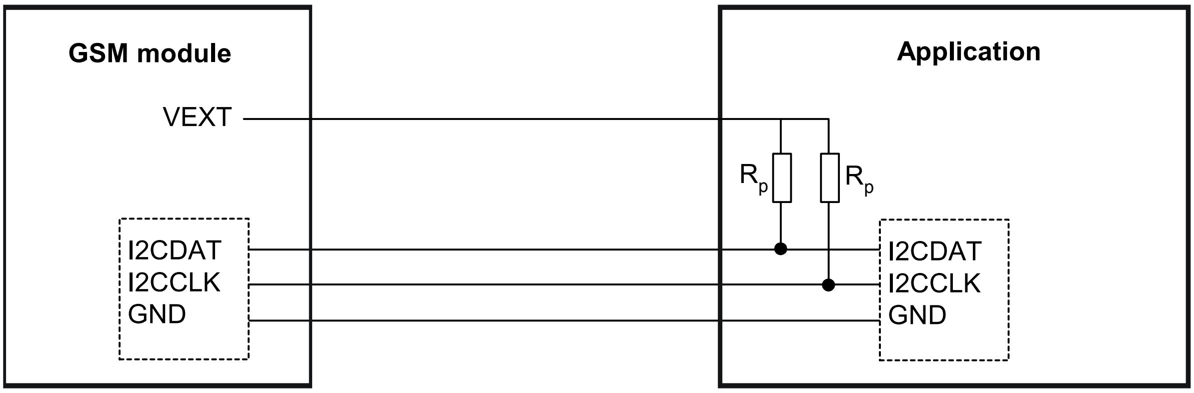


Figure 20: I^2C interface connected to VEXT line of AC65/AC75

Note: Good care should be taken when creating the PCB layout of the host application: The traces of I2CCLK and I2CDAT should be equal in length and as short as possible.

3.14 SPI Interface

The SPI (serial peripheral interface) is a synchronous serial interface for control and data transfer between the AC65/AC75 module and the connected application. Only one application can be connected to the module's SPI. The interface supports transmission rates up to 6.5Mbit/s. It consists of four lines, the two data lines SPIDI/SPIDO, the clock line SPICLK and the chip select line SPICS.

The AC65/AC75 module acts as a single master device, e.g. the clock SPICLK is driven by module. Whenever the SPICS pin is in a low state, the SPI bus is activated and data can be transferred from the module and vice versa. The SPI interface uses two independent lines for data input (SPIDI) and data output (SPIDO).

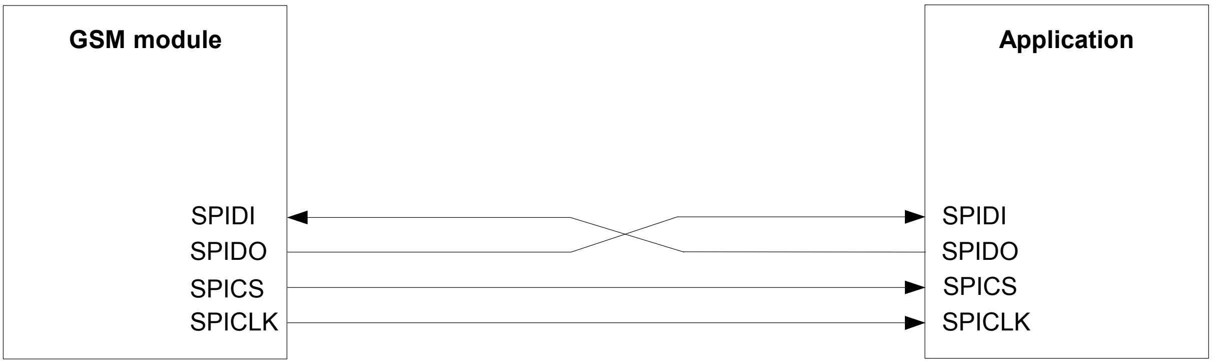


Figure 21: SPI interface

To configure and activate the SPI bus use the AT^SSPI command. If the SPI bus is active the two lines I2CCLK and I2DAT are locked for use as I^2C lines. Detailed information on the AT^SSPI command as well explanations on the SPI modes required for data transmission can be found in [1].

In general, SPI supports four operation modes. The modes are different in clock phase and clock polarity. The module's SPI mode can be configured by using the AT command AT^SSPI. Make sure the module and the connected slave device works with the same SPI mode.

Figure 22 shows the characteristics of the four SPI modes. The SPI modes 0 and 3 are the most common used modes.

For electrical characteristics please refer to Table 26.

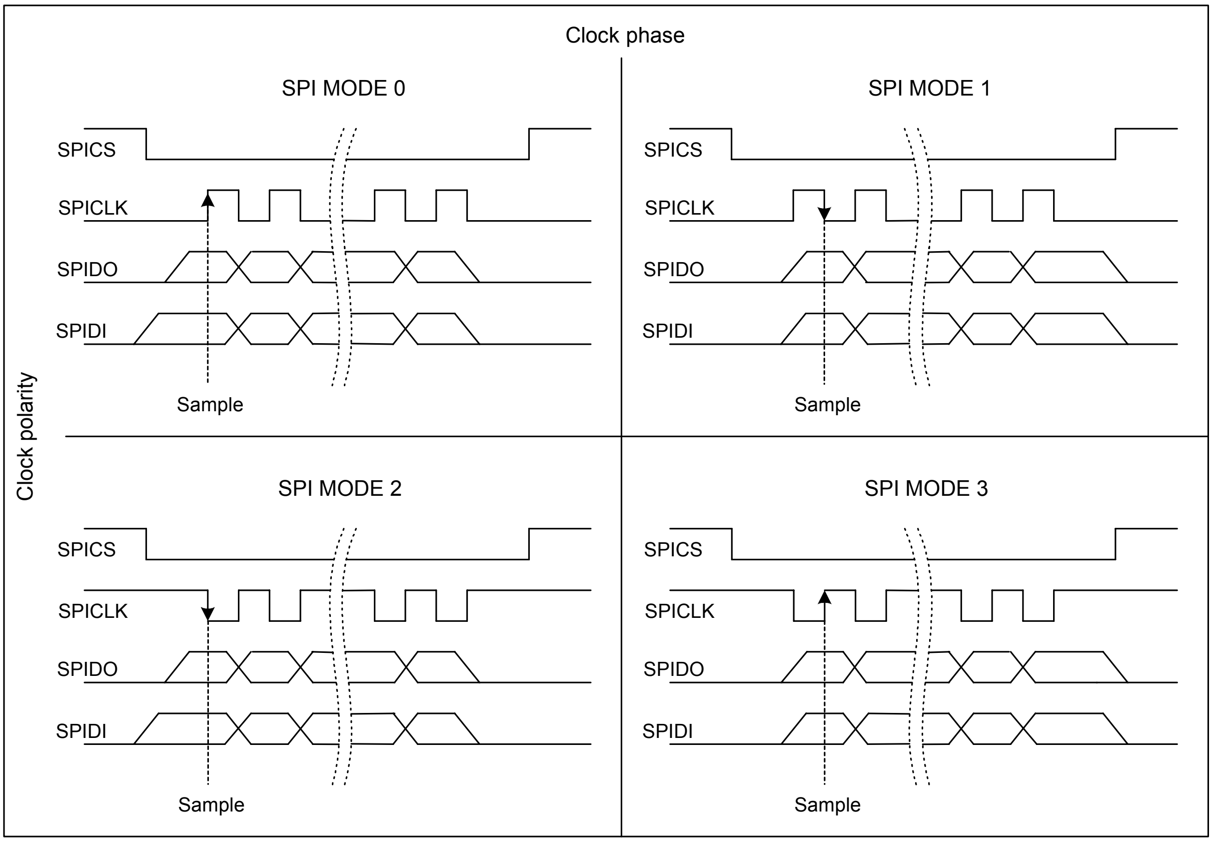


Figure 22: Characteristics of SPI modes

3.15 Audio Interfaces

AC65/AC75 comprises three audio interfaces available on the board-to-board connector:

- Two analog audio interfaces, both with balanced or single-ended inputs/outputs.
- Serial digital audio interface (DAI) designed for PCM (Pulse Code Modulation).

This means you can connect up to three different audio devices, although only one interface can be operated at a time. Using the AT^SAIC command you can easily switch back and forth.

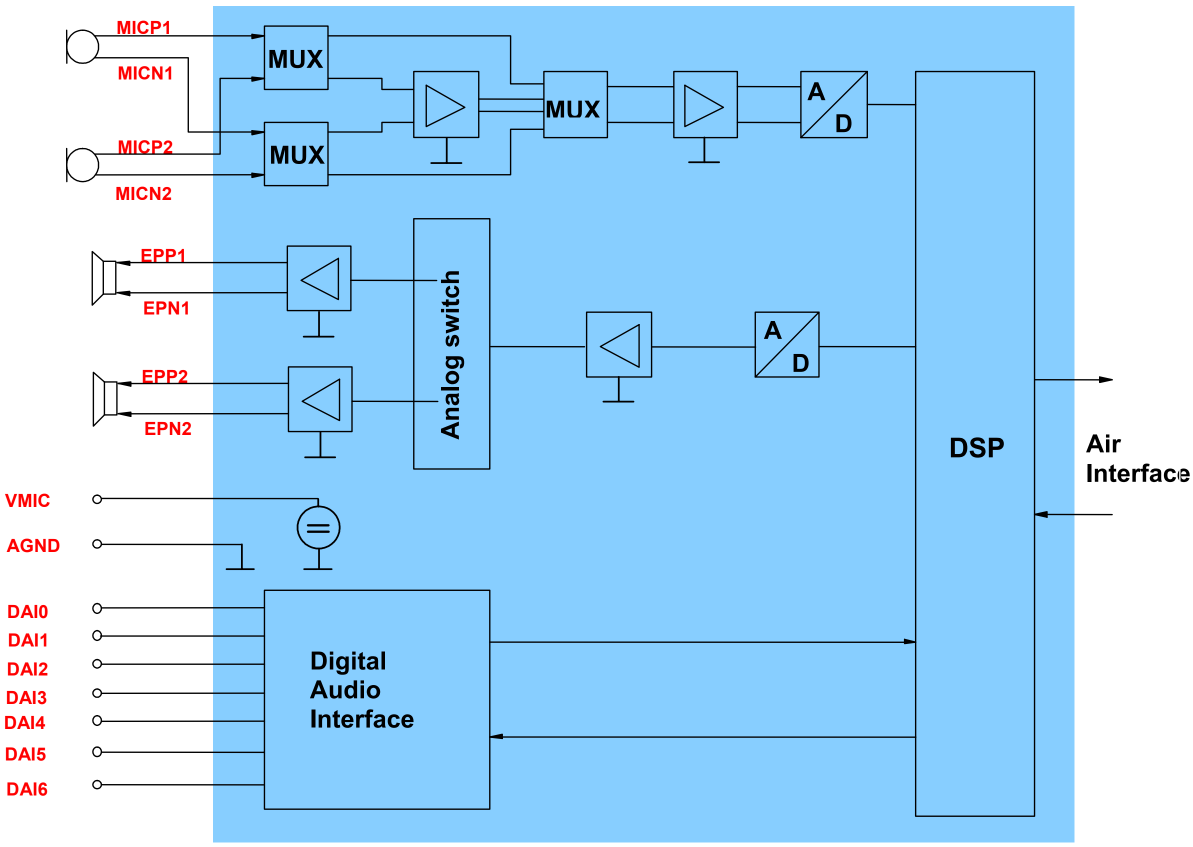


Figure 23: Audio block diagram

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

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

When shipped from factory, all audio parameters of AC65/AC75 are set to interface 1 and audio mode 1. This is the default configuration optimized for the Votronic HH-SI-30.3/V1.1/0 handset and used for type approving the Siemens 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.

3.15.1 Speech Processing

The speech samples from the ADC or DAI are handled by the DSP of the baseband controller to calculate e.g. amplifications, sidetone, echo cancellation or noise suppression depending on the configuration of the active audio mode. These processed samples are passed to the speech encoder. Received samples from the speech decoder are passed to the DAC or DAI after post processing (frequency response correction, adding sidetone etc.).

Full rate, half rate, enhanced full rate, adaptive multi rate (AMR), speech and channel encoding including voice activity detection (VAD) and discontinuous transmission (DTX) and digital GMSK modulation are also performed on the GSM baseband processor.

3.15.2 Microphone Circuit

AC65/AC75 has two identical analog microphone inputs. There is no on-board microphone supply circuit, except for the internal voltage supply VMIC and the dedicated audio ground line AGND. Both lines are well suited to feed a balanced audio application or a single-ended audio application.

The AGND line on the AC65/AC75 board is especially provided to achieve best grounding conditions for your audio application. As there is less current flowing than through other GND lines of the module or the application, this solution will avoid hum and buzz problems.

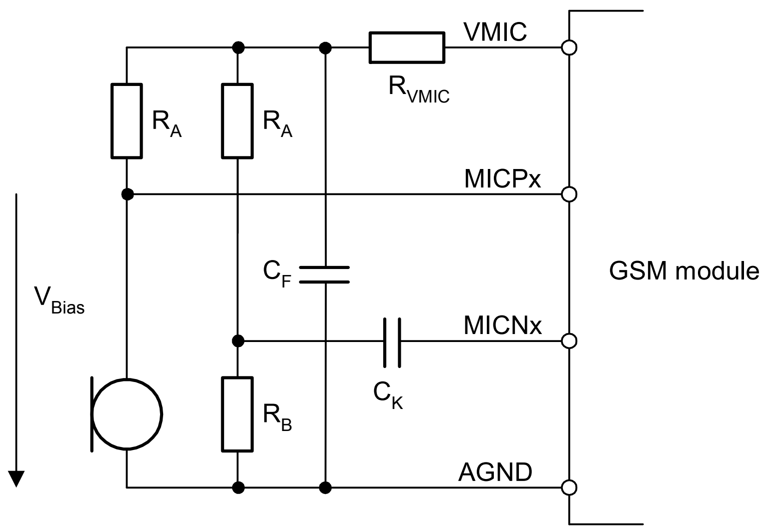
While AC65/AC75 is in Power-down mode, the input voltage at any MIC pin must not exceed ±0.3V relative to AGND (see also Chapter 5.1). In any other operating state the voltage applied to any MIC pin must be in the range of +2.7V to -0.3V, otherwise undervoltage shutdown may be caused.

If VMIC is used to generate the MICP-pin bias voltage as shown in the following examples consider that VMIC is switched off (0V) outside a call. Audio signals applied to MICP in this case must not fall below -0.3V.

If higher input levels are used especially in the line input configuration the signal level must be limited to $600mV_{pp}$ outside a call, or AT^SNFM=,1 should be used to switch on VMIC permanently.

3.15.2.1 Single-ended Microphone Input

Figure 24 as well as Figure 46 show an example of how to integrate a single-ended microphone input.



R_A = typ. 2k
R_B = typ. 5k
R_{VMIC} = typ. 470Ohm

C_k = typ. 100nF
C_F = typ. 22µF

V_{MIC} = typ. 2.5V

V_{bias} = 1.0V … 1.6V, typ. 1.5V

Figure 24: Single ended microphone input

R_A has to be chosen so that the DC voltage across the microphone falls into the bias voltage range of 1.0V to 1.6V and the microphone feeding current meets its specification.

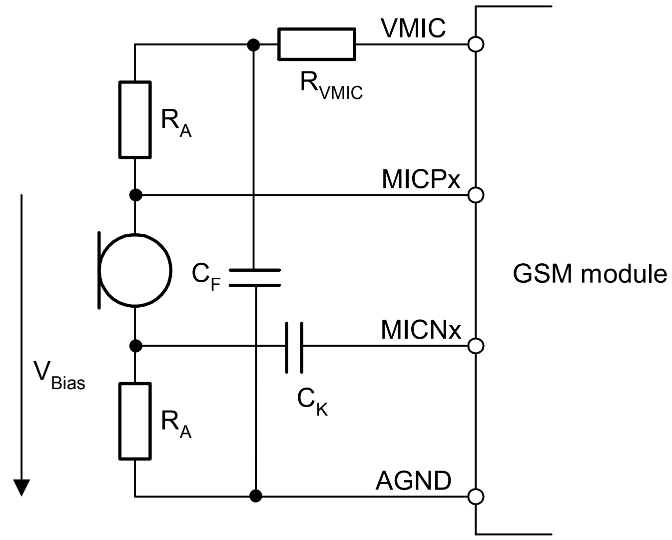
The MICNx input is automatically self biased to the MICPx DC level. It is AC coupled via C_K to a resistive divider which is used to optimize supply noise cancellation by the differential microphone amplifier in the module.

The VMIC voltage should be filtered if gains larger than 20dB are used. The filter can be attached as a simple first order RC-network (R_{VMIC} and C_F).

This circuit is well suited if the distance between microphone and module is kept short. Due to good grounding the microphone can be easily ESD protected as its housing usually connects to the negative terminal.

3.15.2.2 Differential Microphone Input

Figure 25 shows a differential solution for connecting an electret microphone.



R_A = typ. 1k
R_{VMIC} = 470Ohm

C_K = typ. 100nF
C_F = typ. 22µF

V_{MIC} = typ. 2.5V

V_{bias} = 1.0V … 1.6V, typ. 1.5V

Figure 25: Differential microphone input

The advantage of this circuit is that it can be used if the application involves longer lines between microphone and module.

While VMIC is switched off, the input voltage at any MIC pin should not exceed ±0.25V relative to AGND (see also Chapter 5.1). In this case no bias voltage has to be supplied from the customer circuit to the MIC pin and any signal voltage should be smaller than Vpp = 0.5V.

VMIC can be used to generate the MICP-pin bias voltage as shown below. In this case the bias voltage is only applied if VMIC is switched on.

Only if VMIC is switched on, can the voltage applied to any MIC pin be in the range of 2.4V to 0V. If these limits are exceeded undervoltage shutdown may be caused.

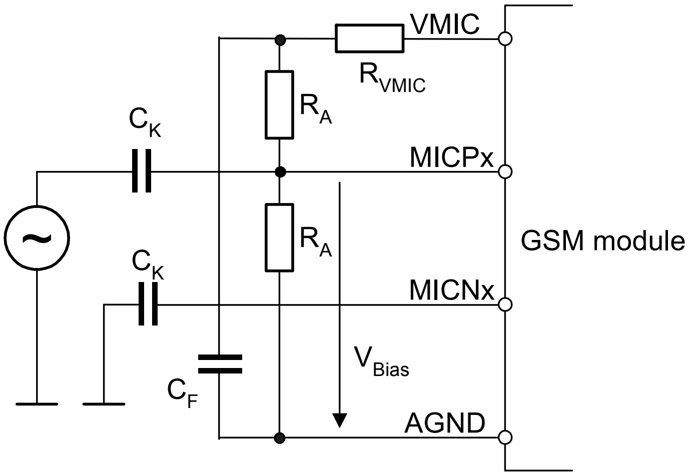
Consider that the maximum full scale input voltage is Vpp = 1.6V.

The behavior of VMIC can be controlled with the parameter micVccCtl of the AT command AT^SNFM (see [1]):

- micVccCtl=2 (default). VMIC is controlled automatically by the module. VMIC is always switched on while the internal audio circuits of the module are active (e.g., during a call). VMIC can be used as indicator for active audio in the module.
- micVccCtl=1. VMIC is switched on continuously. This setting can be used to supply the microphone in order to use the signal in other customer circuits as well. However, this setting leads to a higher current consumption in SLEEP modes.
- micVccCtl=0. VMIC is permanently switched off.

3.15.2.3 Line Input Configuration with OpAmp

Figure 26 shows an example of how to connect an opamp into the microphone circuit.



R_A = typ. 47k
R_{VMIC} = 470Ohm

C_k = typ. 100nF
C_F = typ. 22µF

V_{MIC} = typ. 2.5V

V_{bias} = typ. ½ V_{MIC} = 1.25V

Figure 26: Line input configuration with OpAmp

The AC source (e.g. an opamp) and its reference potential have to be AC coupled to the MICPx resp. MICNx input terminals. The voltage divider between VMIC and AGND is necessary to bias the input amplifier. MICNx is automatically self biased to the MICPx DC level.

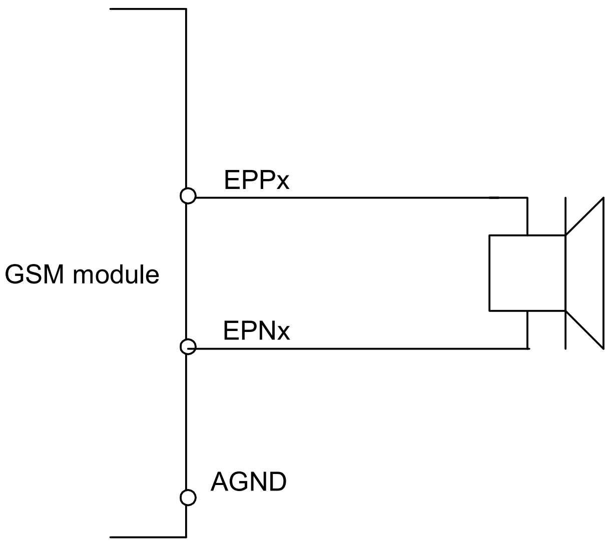
The VMIC voltage should be filtered if gains larger than 20dB are used. The filter can be attached as a simple first order RC-network (R_{VMIC} and C_F). If a high input level and a lower gain are applied the filter is not necessary.

Consider that if VMIC is switched off, the signal voltage should be limited to Vpp = 0.5V and any bias voltage must not be applied. Otherwise VMIC can be switched on permanently by using AT^SNFM=,1. In this case the current consumption in SLEEP modes is higher.

If desired, MICNx via C_K can also be connected to the inverse output of the AC source instead of connecting it to the reference potential for differential line input.

3.15.3 Loudspeaker Circuit

The GSM module comprises two analog speaker outputs: EP1 and EP2. Output EP1 is able to drive a load of 8Ohms while the output EP2 can drive a load of 32Ohms. Each interface can be connected in differential and in single ended configuration. Figure 27 shows an example of a differential loudspeaker configuration.



Loudspeaker impedance

EPP1/EPN1
Z_L = typ. 8Ohm

EPP2/EPN2
Z_L = typ. 32Ohm

Figure 27: Differential loudspeaker configuration

3.15.4 Digital Audio Interface (DAI)

The DAI can be used to connect audio devices capable of PCM (Pulse Code Modulation) or for type approval. The following chapters describe the PCM interface functionality.

The PCM functionality allows the use of a codec like for example the MC145483. This codec replaces the analog audio inputs and outputs during a call, if digital audio is selected by AT^SAIC.

The PCM interface is configurable with the AT^SAIC command (see [1]) and supports the following features:

- Master and slave mode
- Short frame and long frame synchronization
- 256 kHz or 512 kHz bit clock frequency

For the PCM interface configuration the parameters <clock>, <mode> and <framemode> of the AT^SAIC command are used. The following table lists possible combinations:

Table 15: Configuration combinations for the PCM interface

Configuration	<clock>	<mode>	<framemode>
Master, 256kHz, short frame	0	0	0
Master, 256kHz, long frame	0	0	1
Master, 512kHz, short frame	1	0	0
Master, 512kHz, long frame	1	0	1
Slave, 256kHz, short frame	0 or 1[3]	1	0
Slave, 256kHz, long frame	0 or 1	1	1
Slave, 512kHz, short frame	0 or 1	1	0
Slave, 512kHz, long frame	0 or 1	1	1

In all configurations the PCM interface has the following common features:

- 16 Bit linear
- 8 kHz sample rate
- the most significant bit MSB is transferred first
- 125 µs frame duration
- common frame sync signal for transmit and receive

[3] In slave mode the BCLKIN signal is directly used for data shifting. Therefore, the clock frequency setting is not evaluated and may be either 0 or 1.

Table 16 shows the assignment of the DAI0…6 pins to the PCM interface signals. To avoid hardware conflicts different pins are used as inputs and outputs for frame sync and clock signals in master or slave operation. The table shows also which pin is used for master or slave. The data pins (TXDAI and RXDAI) however are used in both modes. Unused inputs have to be tied to GND, unused outputs must be left open.

Table 16: Overview of DAI pin functions

Signal name on B2B connector	Function for PCM Interface		Input/Output
DAI0	TXDAI	Master/Slave	O
DAI1	RXDAI	Master/Slave	I
DAI2	FS (Frame sync)	Master	O
DAI3	BITCLK	Master	O
DAI4	FSIN	Slave	I
DAI5	BCLKIN	Slave	I
DAI6	nc		I

3.15.4.1 Master Mode

To clock input and output PCM samples the PCM interface delivers a bit clock (BITCLK) which is synchronous to the GSM system clock. The frequency of the bit clock is 256kHz or 512kHz. Any edge of this clock deviates less than ±100ns (Jitter) from an ideal 256-kHz clock respective 512-kHz-clock.

The frame sync signal (FS) has a frequency of 8 kHz and is high for one BITCLK period before the data transmission starts if short frame is configured. If long frame is selected the frame sync signal (FS) is high during the whole transfer of the 16 data bits. Each frame has a duration of 125µs and contains 32 respectively 64 clock cycles.

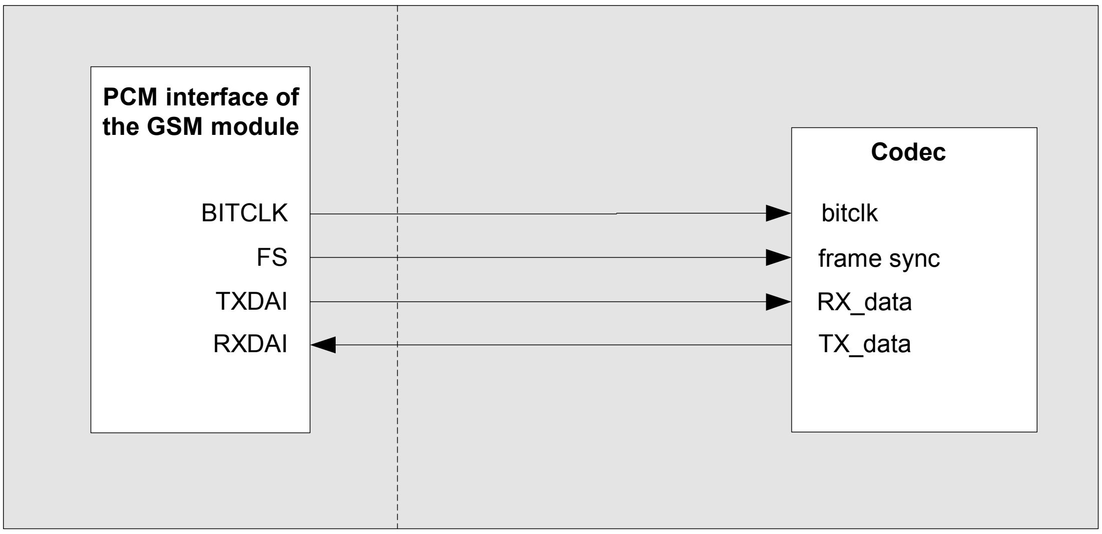


Figure 28: Master PCM interface Application

The timing of a PCM **short frame** is shown in Figure 29. The 16-bit TXDAI and RXDAI data are transferred simultaneously in both directions during the first 16 clock cycles after the frame sync pulse. The duration of a frame sync pulse is one BITCLK period, starting at the rising edge of BITCLK. TXDAI data is shifted out at the next rising edge of BITCLK. RXDAI data (i.e. data transmitted from the host application to the module's RXDAI line) is sampled at the falling edge of BITCLK.

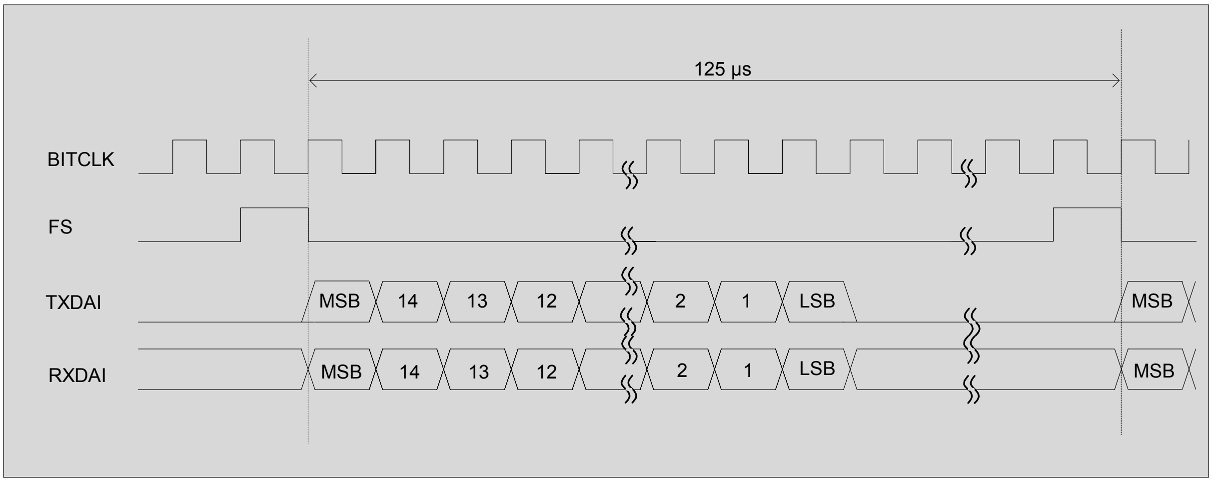


Figure 29: Master PCM timing, short frame selected

The timing of a PCM **long frame** is shown in Figure 30. The 16-bit TXDAI and RXDAI data are transferred simultaneously in both directions while the frame sync pulse FS is high. For this reason the duration of a frame sync pulse is 16 BITCLK periods, starting at the rising edge of BITCLK. TXDAI data is shifted out at the same rising edge of BITCLK. RXDAI data (i.e. data transmitted from the host application to the module's RXDAI line) is sampled at the falling edge of BITCLK.

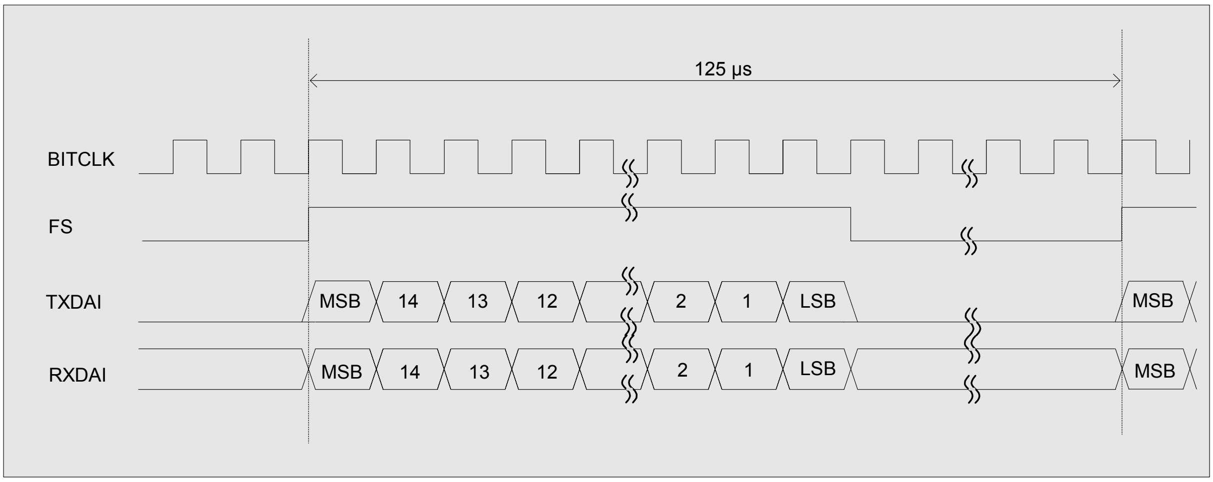


Figure 30: Master PCM timing, long frame selected

3.15.4.2 Slave Mode

In slave mode the PCM interface is controlled by an external bit clock and an external frame sync signal applied to the BCLKIN and FSIN pins and delivered either by the connected codec or another source. The bit clock frequency has to be in the range of 256kHz -125ppm to 512kHz +125ppm.

Data transfer starts at the falling edge of FSIN if the short frame format is selected, and at the rising edge of FSIN if long frame format is selected. With this edge control the frame sync signal is independent of the frame sync pulse length.

TXDAI data is shifted out at the rising edge of BCLKIN. RXDAI data (i.e. data transmitted from the host application to the module's RXDAI line) is sampled at the falling edge of BCLKIN.

The deviation of the external frame rate from the internal frame rate must not exceed ±125ppm. The internal frame rate of nominal 8kHz is synchronized to the GSM network.
The difference between the internal and the external frame rate is equalized by doubling or skipping samples. This happens for example every second, if the difference is 125ppm.
The resulting distortion can be neglected in speech signals.

The pins BITCLK and FS remain low in slave mode.

Figure 31 shows the typical slave configuration. The external codec delivers the bit clock and the frame sync signal. If the codec itself is not able to run in master mode as for example the MC145483, a third party has to generate the clock and the frame sync signal.

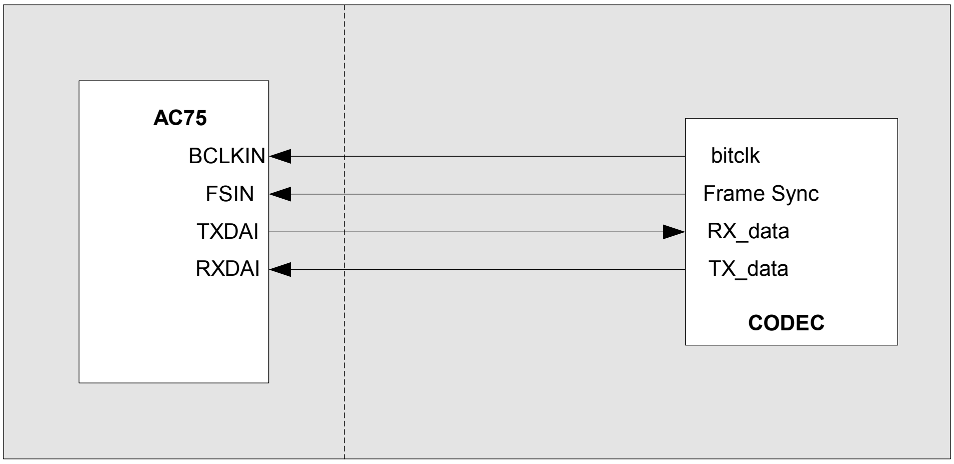


Figure 31: Slave PCM interface application

The following figures show the slave short and long frame timings. Because these are edge controlled, frame sync signals may deviate from the ideal form as shown with the dotted lines.

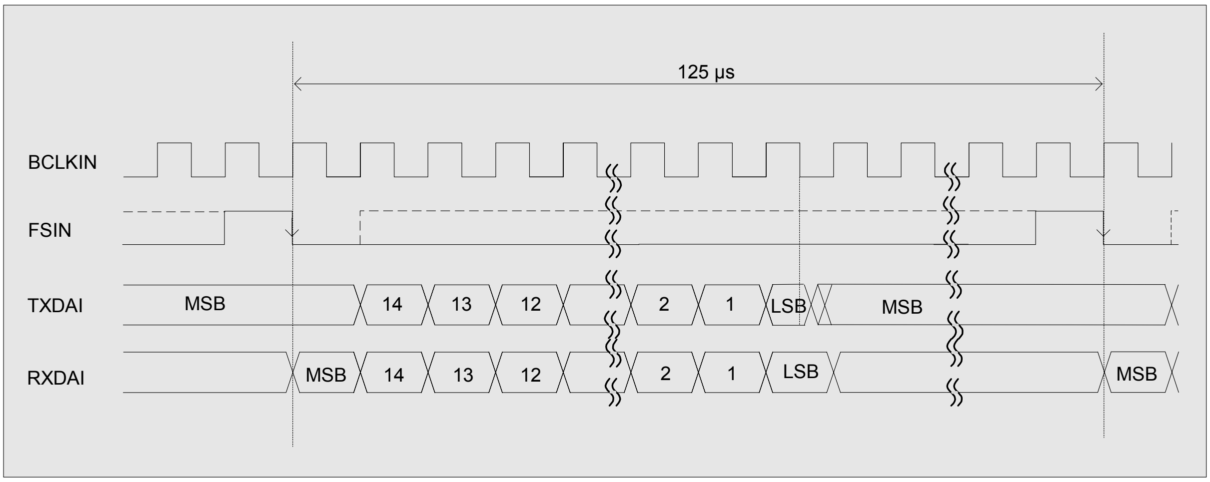


Figure 32: Slave PCM timing, short frame selected

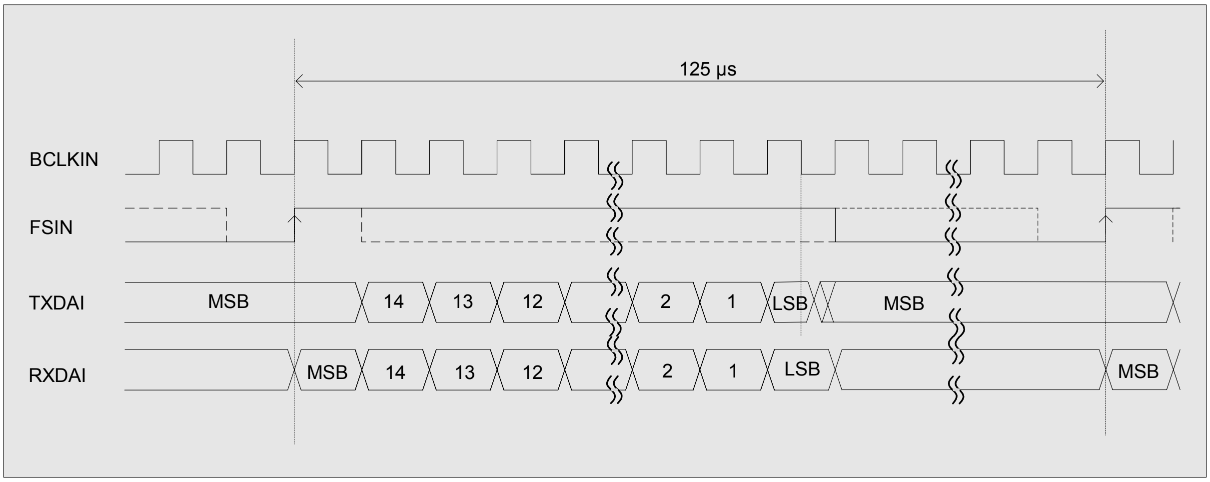


Figure 33: Slave PCM timing, long frame selected

3.16 GPIO Interface

The AC65/AC75 has 10 GPIOs for external hardware devices. Each GPIO can be configured for use as input or output. All settings are AT command controlled.

The GIPO related AT commands are the following: AT^SPIO, AT^SCPIN, AT^SCPOL, AT^SCPORT, AT^SDPORT, AT^SGIO, AT^SSIO. A detailed description can be found in [1].

3.16.1 Using the GPIO10 Pin as Pulse Counter

The GPIO10 pin can be assigned two different functions selectable by AT command:

- The AT^SCPIN command configures the pin for use as GPIO.
- With AT^SCCNT and AT^SSCNT the pin can be configured and operated as pulse counter.

Both functions exclude each other. The pulse counter disables the GPIO functionality, and vice versa, the GPIO functionality disables the pulse counter. Detailed AT command descriptions can be found in [1].

The pulse counter is designed to measure signals from 0 to 1000 pulses per second. It can be operated either in Limit counter mode or Start-Stop mode. Depending on the selected mode the counted value is either the number of pulses or the time (in milliseconds) taken to generate a number of pulses specified with AT^SCCNT.

In Limit counter mode, the displayed measurement result (URC “^SSCNT: <count>”) implies an inaccuracy <5ms. In Start-Stop mode, you can achieve 100% accuracy if you take care that no pulses are transmitted before starting the pulse counter (AT^SSCNT=0 or 1) and after closing the pulse counter (AT^SSCNT=3).

3.17 Control Signals

3.17.1 Synchronization Signal

The synchronization signal serves to indicate growing power consumption during the transmit burst. The signal is generated by the SYNC pin. Please note that this pin can adopt three different operating modes which you can select by using the AT^SSYNC command: the mode AT^SSYNC=0 described below, and the two LED modes AT^SSYNC=1 or AT^SSYNC=2 described in [1] and Section 3.17.2.

The first function (factory default AT^SSYNC=0) is recommended if you want your application to use the synchronization signal for better power supply control. Your platform design must be such that the incoming signal accommodates sufficient power supply to the AC65/AC75 module if required. This can be achieved by lowering the current drawn from other components installed in your application.

The timing of the synchronization signal is shown below. High level of the SYNC pin indicates increased power consumption during transmission.

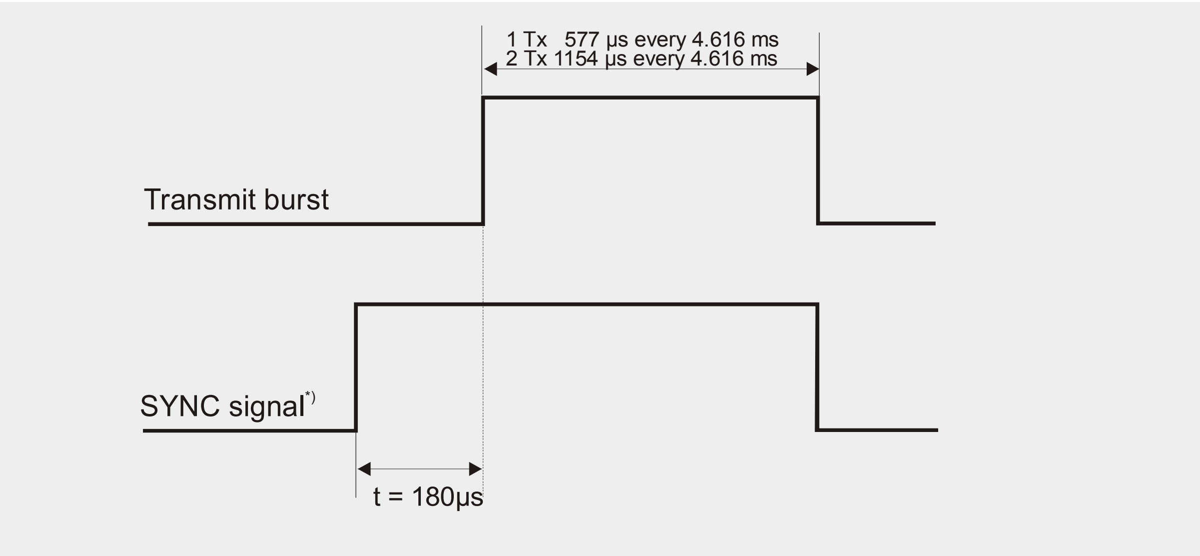


Figure 34: SYNC signal during transmit burst

*) The duration of the SYNC signal is always equal, no matter whether the traffic or the access burst are active.

3.17.2 Using the SYNC Pin to Control a Status LED

As an alternative to generating the synchronization signal, the SYNC pin can be configured to drive a status LED that indicates different operating modes of the AC65/AC75 module. To take advantage of this function the LED mode must be activated with the AT^SSYNC command and the LED must be connected to the host application. The connected LED can be operated in two different display modes (AT^SSYNC=1 or AT^SSYNC=2). For details please refer to [1].

Especially in the development and test phase of an application, system integrators are advised to use the LED mode of the SYNC pin in order to evaluate their product design and identify the source of errors.

To operate the LED a buffer, e.g. a transistor or gate, must be included in your application. A sample circuit is shown in Figure 35. Power consumption in the LED mode is the same as for the synchronization signal mode. For details see Table 26, SYNC pin.

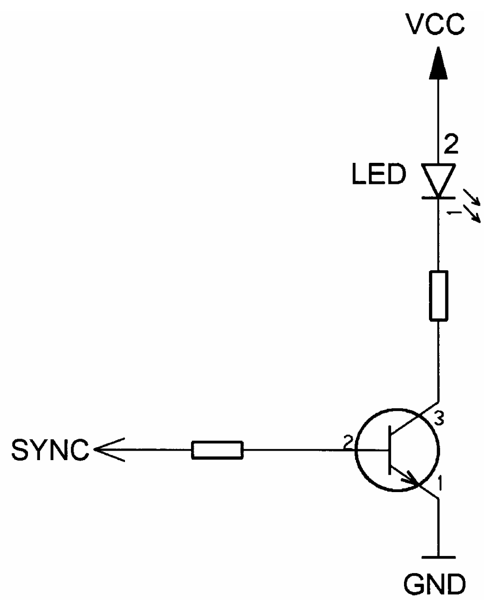


Figure 35: LED Circuit (Example)

3.17.3 Behavior of the RING0 Line (ASC0 Interface only)

The RING0 line is available on the first serial interface ASC0 (see also Chapter 3.10). The signal serves to indicate incoming calls and other types of URCs (Unsolicited Result Code).

Although not mandatory for use in a host application, it is strongly suggested that you connect the RING0 line to an interrupt line of your application. In this case, the application can be designed to receive an interrupt when a falling edge on RING0 occurs. This solution is most effective, particularly, for waking up an application from power saving. Note that if the RING0 line is not wired, the application would be required to permanently poll the data and status lines of the serial interface at the expense of a higher current consumption. Therefore, utilizing the RING0 line provides an option to significantly reduce the overall current consumption of your application.

The behavior of the RING0 line varies with the type of event:

- When a voice/fax/data call comes in the RING0 line goes low for 1s and high for another 4s. Every 5 seconds the ring string is generated and sent over the /RXD0 line.
  If there is a call in progress and call waiting is activated for a connected handset or handsfree device, the RING0 line switches to ground in order to generate acoustic signals that indicate the waiting call.

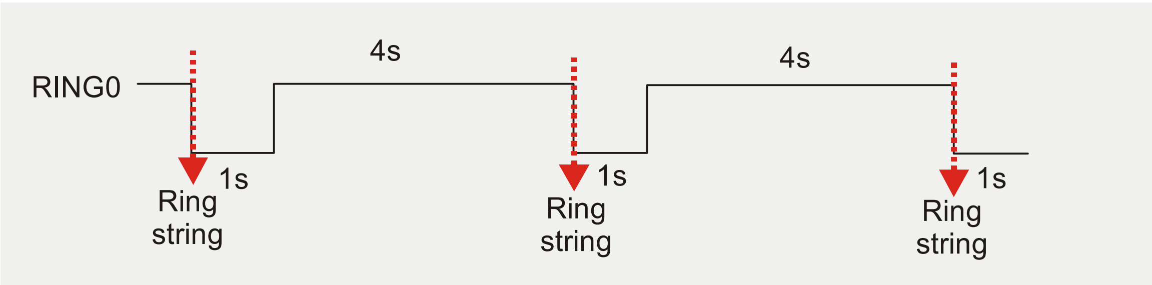


Figure 36: Incoming voice/fax/data call

- All other types of Unsolicited Result Codes (URCs) also cause the RING0 line to go low, however for 1 second only.

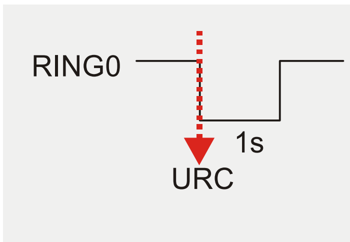


Figure 37: URC transmission

3.17.4 PWR_IND Signal

PWR_IND notifies the on/off state of the module. High state of PWR_IND indicates that the module is switched off. The state of PWR_IND immediately changes to low when IGT is pulled low. For state detection an external pull-up resistor is required.

4 Antenna Interface

The RF interface has an impedance of 50Ω. AC65/AC75 is capable of sustaining a total mismatch at the antenna connector without any damage, even when transmitting at maximum RF power.

The external antenna must be matched properly to achieve best performance regarding radiated power, DC-power consumption, modulation accuracy and harmonic suppression. Antenna matching networks are not included on the AC65/AC75 PCB and should be placed in the host application.

Regarding the return loss AC65/AC75 provides the following values in the active band:

Table 17: Return loss in the active band

State of module	Return loss of module	Recommended return loss of application
Receive	≥ 8dB	≥ 12dB
Transmit	not applicable	≥ 12dB

4.1 Antenna Diagnostic

The antenna diagnostic allows the customer to check the presence and the connection status of the antenna by using the AT^SAD command. A description of the AT^SAD command can be found in [1].

To properly detect the antenna and verify its connection status the antenna feed point must have a DC resistance R_{ANT} of 9kΩ (±3kΩ). Any lower or higher resistance from 1kΩ to 6kΩ or 12kΩ to 40kΩ gives an undefined result.

A positive or negative voltage drop (referred to as $V_{disturb}$) on the ground line may occur without having any impact on the measuring procedure and the measuring result. A peak deviation ($V_{disturb}$) of ≤ 0.8V from ground is acceptable.

$V_{disturb}$ (peak) = ± 0.8V (maximum); $f_{disturb}$ = 0Hz … 5kHz
Waveform: DC, sinus, square-pulse, peak-pulse (width = 100µs)
$R_{disturb}$ = 5Ω

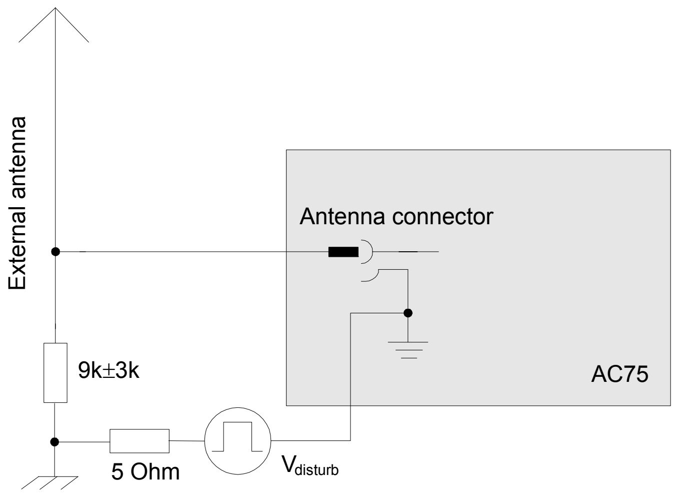


Figure 38: Resistor measurement used for antenna detection

Table 18: Values of the AT^SAD parameter <diag> and their meaning

Antenna connection status indicated by AT^SAD	<diag>	Equivalent ranges
Normal operation, antenna connected (resistance at feed point as required)	<diag>=0	R_{ANT} = 6kΩ…12kΩ
Antenna connector short-circuited to GND	<diag>=1	R_{ANT} = 0...1kΩ
Antenna connector is short-circuited to the supply voltage of the host application, for example the vehicle's on-board power supply voltage	<diag>=2	max. 36V
Antenna not properly connected, or resistance at antenna feed point wrong or not present	<diag>=3	R_{ANT} = 40kΩ...∞Ω

4.2 Antenna Connector

AC65/AC75 uses a subminiature coaxial antenna connector type SMP MIL-Std 348-A supplied from Rosenberger.

Table 19: Product specifications of Rosenberger SMP connector

Item	Specification	Conditions
Material and finish		
Center contact	Brass 0.8 µm gold plating over 2-4 µm NiP plating	
Outer contact	Brass 0.8 µm gold plating over 2-4 µm NiP plating	
Dielectric	PTFE	
Electrical ratings		
Nominal Impedance	50 Ω	
Operating frequency	DC – 2 GHz	
VSWR	1.10	DC to 2 GHz
Insertion loss	≤ 0.1 dB x √ f/GHz	
Center contact resistance	max. 6 mΩ	
Outer contact resistance	max. 2 mΩ	
Insulation resistance	5 GΩ	
Working voltage	335 V rms	at sea level
Dielectric withstanding voltage	500 V rms	at sea level
Mechanical ratings		
Durability	30 mating cycles	
Engagement force	20-35 N	
Disengagement force	30-50 N	
Center contact captivation Axial retention force	7 N min.	
Environmental ratings		
Operating temperature	-65°C to +155°C	
Manufacturer		
Rosenberger Hochfrequenztechnik GmbH & Co. POB 1260 D-84526 Tittmoning http://www.rosenberger.de		

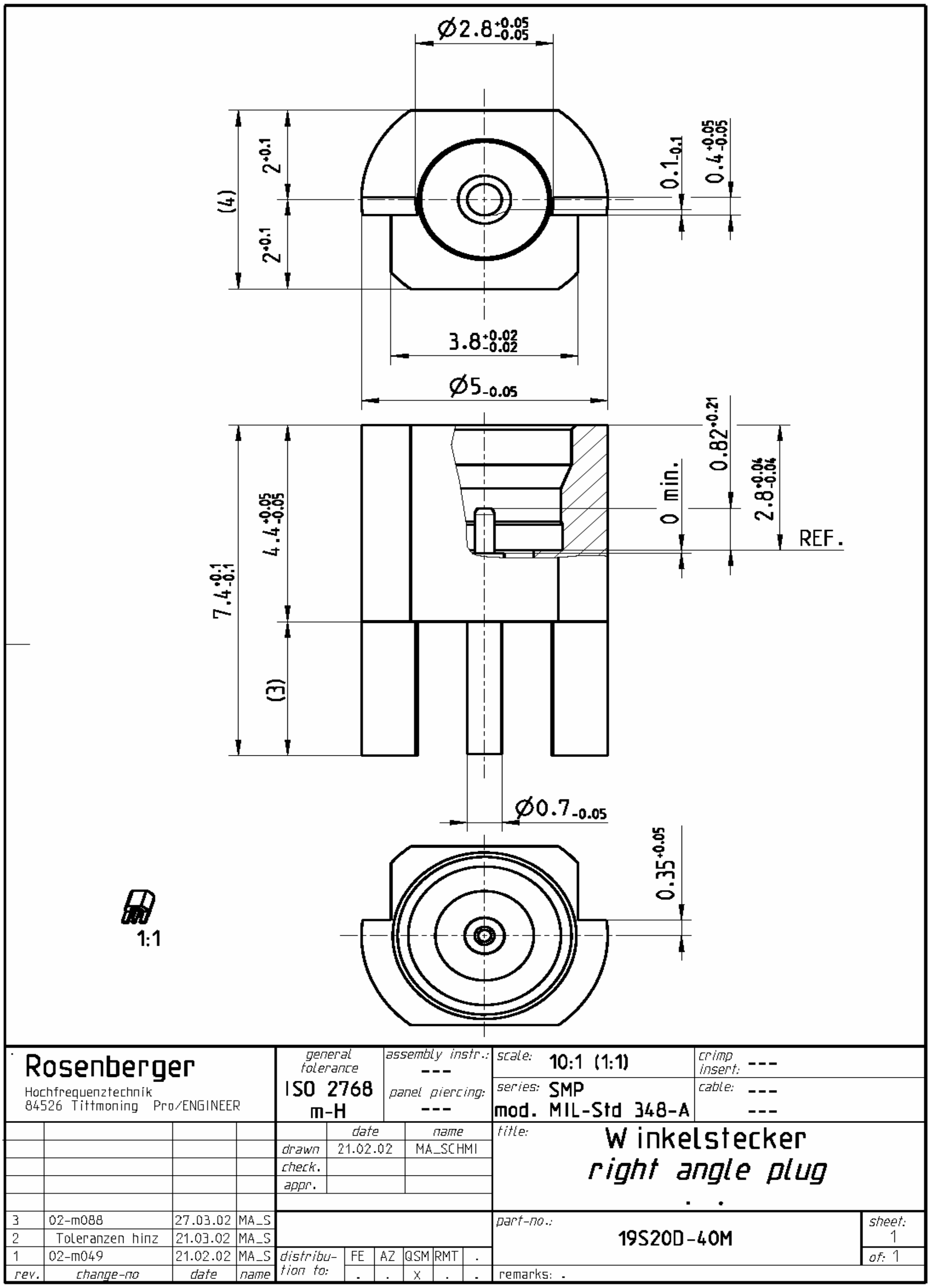


Figure 39: Datasheet of Rosenberger SMP MIL-Std 348-A connector

5 Electrical, Reliability and Radio Characteristics

5.1 Absolute Maximum Ratings

The absolute maximum ratings stated in Table 20 are stress ratings under any conditions. Stresses beyond any of these limits will cause permanent damage to AC65/AC75. The power supply shall be compliant with the SELV safety standard defined in EN60950. The supply voltage must be limited according to Table 20.

Table 20: Absolute maximum ratings

Parameter	**Min**	**Max**	**Unit**
Supply voltage BATT+	-0.3	5.5	V
Voltage at digital pins in POWER DOWN mode	-0.3	0.3	V
Voltage at digital pins in normal operation	-0.3	3.05 or VEXT+0.3	V
Voltage at analog pins in POWER DOWN mode	-0.3	0.3	V
Voltage at analog pins, VMIC on[4]	-0.3	2.75	V
Voltage at analog pins, VMIC off[4]	-0.3	0.3	V
Voltage at VCHARGE pin	-0.3	5.5	V
Voltage at CHARGEGATE pin	-0.3	5.5	V
VUSB_IN	-0.3	5.5	V
USB_DP, USB_DN	-0.3	3.5	V
VSENSE		5.5	V
ISENSE		5.5	V
PWR_IND	-0.3	10	V
VDDLP	-0.3	5.5	V

4 For normal operation the voltage at analog pins with *VMIC on* should be within the range of 0V to 2.4V and with *VMIC off* within the range of -0.25V to 0.25V.

5.2 Operating Temperatures

Table 21: Board temperature

Parameter	Min	Typ	Max	Unit
Operating temperature range	-30		+85	°C
Automatic shutdown[5] Temperature measured on AC65/AC75 board Temperature measured at battery NTC	 -30 -20	 --- ---	 +90 +60	°C

Table 22: Ambient temperature according to IEC 60068-2 (without forced air circulation)

Parameter	Min	Typ	Max	Unit
Operating temperature range	-30	+25	+75	°C
Restricted operation[6]		---	+75 to +85	°C

Table 23: Charging temperature

Parameter	Min	Typ	Max	Unit
Battery temperature for software controlled fast charging (measured at battery NTC)	0	---	+45	°C

Note:
- See Chapter 3.3.4 for further information about the NTCs for on-board and battery temperature measurement, automatic thermal shutdown and alert messages.
- When data are transmitted over EGPRS or GPRS the AC65/AC75 automatically reverts to a lower Multislot Class if the temperature increases to the limit specified for normal operation and, vice versa, returns to the higher Multislot Class if the temperature is back to normal. For details see Chapter 3.4 “Automatic EGPRS/GPRS Multislot Class Change”.

[5] Due to temperature measurement uncertainty, a tolerance on the stated shutdown thresholds may occur. The possible deviation is in the range of ± 3°C at the overtemperature limit and ± 5°C at the undertemperature limit.
[6] Restricted operation allows normal mode speech calls or data transmission for limited time until automatic thermal shutdown takes effect. The duration of emergency calls is unlimited because automatic thermal shutdown is deferred until hang up.

5.3 Storage Conditions

The conditions stated below are only valid for modules in their original packed state in weather protected, non-temperature-controlled storage locations. Normal storage time under these conditions is 12 months maximum.

Table 24: Storage conditions

Type		Condition	Unit	Reference
Air temperature:	Low	-40	°C	ETS 300 019-2-1: T1.2, IEC 68-2-1 Ab
	High	+85		ETS 300 019-2-1: T1.2, IEC 68-2-2 Bb
Humidity relative:	Low	10	%	---
	High	90 at 30°C		ETS 300 019-2-1: T1.2, IEC 68-2-56 Cb
	Condens.	90-100 at 30°C		ETS 300 019-2-1: T1.2, IEC 68-2-30 Db
Air pressure:	Low	70	kPa	IEC TR 60271-3-1: 1K4
	High	106		IEC TR 60271-3-1: 1K4
Movement of surrounding air		1.0	m/s	IEC TR 60271-3-1: 1K4
Water: rain, dripping, icing and frosting		Not allowed	---	---
Radiation:	Solar	1120	W/m^2	ETS 300 019-2-1: T1.2, IEC 68-2-2 Bb
	Heat	600		ETS 300 019-2-1: T1.2, IEC 68-2-2 Bb
Chemically active substances		Not recommended		IEC TR 60271-3-1: 1C1L
Mechanically active substances		Not recommended		IEC TR 60271-3-1: 1S1
Vibration sinusoidal:				IEC TR 60271-3-1: 1M2
	Displacement	1.5	mm	
	Acceleration	5	m/s^2	
	Frequency range	2-9 9-200	Hz	
Shocks:				IEC 68-2-27 Ea
	Shock spectrum	semi-sinusoidal		
	Duration	1	ms	
	Acceleration	50	m/s^2	

5.4 Reliability Characteristics

The test conditions stated below are an extract of the complete test specifications.

Table 25: Summary of reliability test conditions

Type of test	**Conditions**	**Standard**
Vibration	Frequency range: 10-20Hz; acceleration: 3.1mm amplitude Frequency range: 20-500Hz; acceleration: 5g Duration: 2h per axis = 10 cycles; 3 axes	DIN IEC 68-2-6
Shock half-sinus	Acceleration: 500g Shock duration: 1msec 1 shock per axis 6 positions (± x, y and z)	DIN IEC 68-2-27
Dry heat	Temperature: +70 ±2°C Test duration: 16h Humidity in the test chamber: < 50%	EN 60068-2-2 Bb ETS 300 019-2-7
Temperature change (shock)	Low temperature: -40°C ±2°C High temperature: +85°C ±2°C Changeover time: < 30s (dual chamber system) Test duration: 1h Number of repetitions: 100	DIN IEC 68-2-14 Na ETS 300 019-2-7
Damp heat cyclic	High temperature: +55°C ±2°C Low temperature: +25°C ±2°C Humidity: 93% ±3% Number of repetitions: 6 Test duration: 12h + 12h	DIN IEC 68-2-30 Db ETS 300 019-2-5
Cold (constant exposure)	Temperature: -40 ±2°C Test duration: 16h	DIN IEC 68-2-1

5.5 Pin Assignment and Signal Description

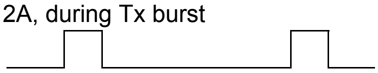
The Molex board-to-board connector on AC65/AC75 is an 80-pin double-row receptacle. The names and the positions of the pins can be seen from Figure 1 which shows the top view of AC65/AC75.

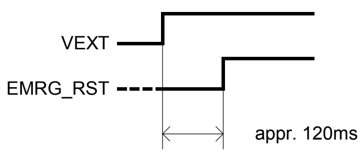
1	GND	GND	80
2	Not connected	DAC_OUT	79
3	Not connected	PWR_IND	78
4	GND	*Do not use*	77
5	GPIO10	GPIO9	76
6	GPIO8	SPICS	75
7	SPIDI	GPIO4	74
8	GPIO7	GPIO3	73
9	GPIO6	GPIO2	72
10	GPIO5	GPIO1	71
11	I2CCLK_SPICLK	I2CDAT_SPIDO	70
12	VUSB_IN	USB_DP	69
13	DAI5	USB_DN	68
14	ISENSE	VSENSE	67
15	DAI6	VMIC	66
16	CCCLK	EPN2	65
17	CCVCC	EPP2	64
18	CCIO	EPP1	63
19	CCRST	EPN1	62
20	CCIN	MICN2	61
21	CCGND	MICP2	60
22	DAI4	MICP1	59
23	DAI3	MICN1	58
24	DAI2	AGND	57
25	DAI1	IGT	56
26	DAI0	EMERG_RST	55
27	BATT_TEMP	DCD0	54
28	SYNC	CTS1	53
29	RXD1	CTS0	52
30	RXD0	RTS1	51
31	TXD1	DTR0	50
32	TXD0	RTS0	49
33	VDDLP	DSR0	48
34	VCHARGE	RING0	47
35	CHARGEGATE	VEXT	46
36	GND	BATT+	45
37	GND	BATT+	44
38	GND	BATT+	43
39	GND	BATT+	42
40	GND	BATT+	41

Figure 40: Pin assignment (component side of AC65/AC75)

Please note that the reference voltages listed in Table 26 are the values measured directly on the AC65/AC75 module. They do not apply to the accessories connected.

Table 26: Signal description

Function	Signal name	IO	Signal form and level	Comment
Power supply	BATT+	I	$V_I$max = 4.5V $V_I$typ = 3.8V $V_I$min = 3.3V during Tx burst on board I ≈ 2A, during Tx burst  n Tx = n x 577µs peak current every 4.616ms	Five pins of BATT+ and GND must be connected in parallel for supply purposes because higher peak currents may occur. Minimum voltage must not fall below 3.3V including drop, ripple, spikes.
Power supply	GND		Ground	Application Ground
Charge Interface	VCHARGE	I	$V_I$min = 1.015 * V_{BATT+} $V_I$max = 5.45V	This line signalizes to the processor that the charger is connected. If unused keep pin open.
	BATT_TEMP	I	Connect NTC with R_{NTC} ≈ 10kΩ @ 25°C to ground. See Section 3.5.3 for B value of NTC.	Battery temperature measurement via NTC resistance. NTC should be installed inside or near battery pack to enable proper charging and deliver temperature values. If unused keep pin open.
	ISENSE	I	$V_I$max = 4.65V ΔV_Imax to V_{BATT+} = +0.3V at normal condition	ISENSE is required for measuring the charge current. For this purpose, a shunt resistor for current measurement needs to be connected between ISENSE and VSENSE. If unused connect pin to VSENSE.
	VSENSE	I	$V_I$max = 4.5V	VSENSE must be directly connected to BATT+ at battery connector or external power supply.
	CHARGEGATE	O	$V_O$max = 5.5V $I_O$max = 0.6mA	Control line to the gate of charge FET If unused keep pin open.
External supply voltage	VEXT	O	Normal mode: $V_O$min = 2.75V $V_O$typ = 2.93V $V_O$max = 3.05V $I_O$max = -50mA	VEXT may be used for application circuits, for example to supply power for an I2C If unused keep pin open. Not available in Power-down mode. The external digital logic must not cause any spikes or glitches on voltage VEXT.

Function	Signal name	IO	Signal form and level	Comment
Power indicator	PWR_IND	O	V_{IH}max = 10V V_{OL}max = 0.4V at Imax = 2mA	PWR_IND (Power Indicator) notifies the module's on/off state. PWR_IND is an open collector that needs to be connected to an external pull-up resistor. Low state of the open collector indicates that the module is on. Vice versa, high level notifies the Power-down mode. Therefore, the pin may be used to enable external voltage regulators which supply an external logic for communication with the module, e.g. level converters.
Ignition	IGT	I	Internal pull-up: $R_I \approx 30k\Omega$, $C_I \approx 10nF$ V_{IL}max = 0.8V at Imax = -150µA V_{OH}max = 4.5V (V_{BATT+}) ON ˜˜˜|____|˜˜˜ Active Low ≥ 400ms	This signal switches the mobile on. This line must be driven low by an open drain or open collector driver.
Emergency reset	EMERG_RST	I	Internal pull-up: $R_I \approx 5k\Omega$ V_{IL}max = 0.2V at Imax = -0.5mA V_{OH}min = 1.75V V_{OH}max = 3.05V Signal ˜˜˜|______|˜˜˜ Pull down ≥ 10ms	Reset or turn-off in case of emergency: Pull down and release EMERG_RST. Then, activating IGT for 400ms will reset AC65/AC75. If IGT is not activated for 400ms, AC65/AC75 switches off. Data stored in the volatile memory will be lost. For orderly software controlled reset rather use the AT+CFUN command (e.g. AT+CFUN=x,1). This line must be driven by open drain or open collector. If unused keep pin open.
Power-on reset		O	Internal pull-up: $R_I \approx 5k\Omega$ V_{OL}max = 0.2V at I = 2mA V_{OH}min = 1.75V V_{OH}max = 3.05V Reset signal driven by the module:  (see also Figure 5 and Figure 6)	Reset signal driven by the module which can be used to reset any application or device connected to the module. Only effective for 120ms during the assertion of IGT when the module is about to start.

Function	Signal name	IO	Signal form and level	Comment
Synchroni-zation	SYNC	O	V_{OL}max = 0.3V at I = 0.1mA V_{OH}min = 2.3V at I = -0.1mA V_{OH}max = 3.05V  n Tx = n x 577µs impulse each 4.616ms, with 180µs forward time.	There are two alternative options for using the SYNC pin: a) Indicating increased current consumption during uplink transmission burst. Note that the timing of the signal is different during handover. b) Driving a status LED to indicate different operating modes of AC65/AC75. The LED must be installed in the host application. To select a) or b) use the AT^SSYNC command. If unused keep pin open.
RTC backup	VDDLP	I/O	R_I ≈ 1kΩ $V_O$max = 4.5V V_{BATT+} = 4.3V: V_O = 3.2V at I_O = -500µA V_{BATT+} = 0V: V_I = 2.4V…4.5V at I_{max} = 25µA	If unused keep pin open.
ASC0 Serial interface	RXD0 TXD0 CTS0 RTS0 DTR0 DCD0 DSR0 RING0	O I O I I O O O	V_{OL}max = 0.2V at I = 2mA V_{OH}min = 2.55V at I = -0.5mA V_{OH}max = 3.05V V_{IL}max = 0.8V V_{IH}min = 2.15V V_{IH}max = VEXTmin + 0.3V = 3.05V Internal pull-down at TXD0: R_I =330kΩ Internal pull-down at RTS0: R_I =330kΩ	Serial interface for AT commands or data stream. If lines are unused keep pins open.
ASC1 Serial interface	RXD1 TXD1 CTS1 RTS1	O I O I	V_{OL}max = 0.2V at I = 2mA V_{OH}min = 2.55V at I = -0.5mA V_{OH}max = 3.05V V_{IL}max = 0.8V V_{IH}min = 2.15V V_{IH}max = VEXTmin + 0.3V = 3.05V Internal pull-down at TXD1: R_I =330kΩ Internal pull-down at RTS1: R_I =330kΩ	4-wire serial interface for AT commands or data stream. If lines are unused keep pins open.

Function	Signal name	IO	Signal form and level	Comment
SIM interface specified for use with 3V SIM card	CCIN	I	$R_I \approx 100k\Omega$ $V_{IL}max = 0.6V$ at $I = -25\mu A$ $V_{IH}min = 2.1V$ at $I = -10\mu A$ $V_Omax = 3.05V$	CCIN = Low, SIM card holder closed Maximum cable length or copper track 100mm to SIM card holder. All signals of SIM interface are protected against ESD with a special diode array. Usage of CCGND is mandatory.
	CCRST	O	$R_O \approx 47\Omega$ $V_{OL}max = 0.25V$ at $I = +1mA$ $V_{OH}min = 2.5V$ at $I = -0.5mA$ $V_{OH}max = 2.95V$	
	CCIO	I/O	$R_I \approx 4.7k\Omega$ $V_{IL}max = 0.75V$ $V_{IL}min = -0.3V$ $V_{IH}min = 2.1V$ $V_{IH}max = CCVCCmin + 0.3V = 3.05V$ $R_O \approx 100\Omega$ $V_{OL}max = 0.3V$ at $I = +1mA$ $V_{OH}min = 2.5V$ at $I = -0.5mA$ $V_{OH}max = 2.95V$	
	CCCLK	O	$R_O \approx 100\Omega$ $V_{OL}max = 0.3V$ at $I = +1mA$ $V_{OH}min = 2.5V$ at $I = -0.5mA$ $V_{OH}max = 2.95V$	
	CCVCC	O	$V_Omin = 2.75V$ $V_Otyp = 2.85V$ $V_Omax = 2.95V$ $I_Omax = -20mA$	
	CCGND		Ground	
SIM interface specified for use with 1.8V SIM card	CCIN	I	$R_I \approx 100k\Omega$ $V_{IL}max = 0.6V$ at $I = -25\mu A$ $V_{IH}min = 2.1V$ at $I = -10\mu A$ $V_Omax = 3.05V$	CCIN = Low, SIM card holder closed Maximum cable length or copper track 100mm to SIM card holder. All signals of SIM interface are protected against ESD with a special diode array. Usage of CCGND is mandatory.
	CCRST	O	$R_O \approx 47\Omega$ $V_{OL}max = 0.25V$ at $I = +1mA$ $V_{OH}min = 1.45V$ at $I = -0.5mA$ $V_{OH}max = 1.90V$	
	CCIO	I/O	$R_I \approx 4.7k\Omega$ $V_{IL}max = 0.45V$ $V_{IH}min = 1.35V$ $V_{IH}max = CCVCCmin + 0.3V = 2.00V$ $R_O \approx 100\Omega$ $V_{OL}max = 0.3V$ at $I = +1mA$ $V_{OH}min = 1.45V$ at $I = -0.5mA$ $V_{OH}max = 1.90V$	
	CCCLK	O	$R_O \approx 100\Omega$ $V_{OL}max = 0.3V$ at $I = +1mA$ $V_{OH}min = 1.45V$ at $I = -0.5mA$ $V_{OH}max = 1.90V$	
	CCVCC	O	$V_Omin = 1.70V$, $V_Otyp = 1.80V$ $V_Omax = 1.90V$ $I_Omax = -20mA$	
	CCGND		Ground	
SPI Serial Peripheral Interface	SPIDI I2CDAT_SPIDO I2CCLK_SPICLK SPICS	I O O O	$V_{OL}max = 0.2V$ at $I = 2mA$ $V_{OH}min = 2.55V$ at $I = -0.5mA$ $V_{OH}max = 3.05V$ $V_{IL}max = 0.8V$ $V_{IH}min = 2.15V$, $V_{IH}max = VEXTmin + 0.3V = 3.05V$	If the Serial Peripheral Interface is active the I^2C interface is not available. If lines are unused keep pins open.

<table>
<tr><th>Function</th><th>Signal name</th><th>IO</th><th>Signal form and level</th><th>Comment</th></tr>
<tr><td rowspan="2">I^2C interface</td><td>I2CCLK _SPICLK</td><td>O</td><td>V_{OL}max = 0.2V at I = 2mA
V_{OH}min = 2.55V at I = -0.5mA
V_{OH}max = 3.05V</td><td>I^2C interface is only available if the two pins are not used as SPI interface.</td></tr>
<tr><td>I2CDAT_SPIDO</td><td>I/O</td><td>V_{OL}max = 0.2V at I = 2mA
V_{IL}max = 0.8V
V_{IH}min = 2.15V
V_{IH}max = VEXTmin + 0.3V = 3.05V</td><td>I2CDAT is configured as Open Drain and needs a pull-up resistor in the host application.
According to the I2C Bus Specification Version 2.1 for the fast mode a rise time of max. 300ns is permitted. There is also a maximum VOL=0.4V at 3mA specified.
The value of the pull-up depends on the capacitive load of the whole system (I2C Slave + lines). The maximum sink current of I2CDAT and I2CCLK is 4mA.
If lines are unused keep pins open.</td></tr>
<tr><td rowspan="3">USB</td><td>VUSB_IN</td><td>I</td><td>V_{IN}min = 4.0V
V_{IN}max = 5.25V</td><td rowspan="3">All electrical characteristics according to USB Implementers' Forum, USB 2.0 Full Speed Specification.

Without Java: USB port
Under Java: Debug interface for development purposes.
If lines are unused keep pins open.</td></tr>
<tr><td>USB_DN</td><td>I/O</td><td rowspan="2">Differential Output Crossover voltage Range
V_{CRS}min = 1.5V, V_{CRS}max = 2.0V

Line to GND:
V_{OH}max = 3.6V
V_{OH}typ = 3.2V
V_{OH}min = 3.0V at I=-0.5mA
V_{OL}max = 0.2V at I=2mA
V_{IH}min = 2.24V
V_{IL}max = 0.96V
Driver Output Resistance
Z_{typ} = 32Ohm

Pullup at USB_DP R_{typ}=1.5kOhm</td></tr>
<tr><td>USB_DP</td><td>I/O</td></tr>
<tr><td rowspan="10">General Purpose Input/Output</td><td>GPIO1</td><td>I/O</td><td rowspan="9">V_{OL}max = 0.2V at I = 2mA
V_{OH}min = 2.55V at I = -0.5mA
V_{OH}max = 3.05V

V_{IL}max = 0.8V
V_{IH}min = 2.15V,
V_{IH}max = VEXTmin + 0.3V = 3.05V</td><td rowspan="8">All pins which are configured as input must be connected to a pull-up or pull-down resistor.
If lines are unused (not configured) keep pins open.</td></tr>
<tr><td>GPIO2</td><td>I/O</td></tr>
<tr><td>GPIO3</td><td>I/O</td></tr>
<tr><td>GPIO4</td><td>I/O</td></tr>
<tr><td>GPIO5</td><td>I/O</td></tr>
<tr><td>GPIO6</td><td>I/O</td></tr>
<tr><td>GPIO7</td><td>I/O</td></tr>
<tr><td>GPIO8</td><td>I/O</td></tr>
<tr><td>GPIO9</td><td>I/O</td><td rowspan="2">Alternatively, the GPIO10 pin can be configured as a pulse counter for pulse rates from 0 to 1000 pulses per second.</td></tr>
<tr><td>GPIO10</td><td>I/O</td><td>Pulse counter:
pulse
~|________|~~~~~~~~~~~~|________|~~~
| ≥ 450µs | ≥ 450µs |

Slew rate ≤ 1µs
Pulse rate: max. 1000 pulses per second</td></tr>
</table>

Function	Signal name	IO	Signal form and level	Comment
Digital Analog Converter	DAC_OUT	O	$V_{OL}max$ = 0.2V at I = 2mA $V_{OH}min$ = 2.55V at I = -0.5mA $V_{OH}max$ = 3.05V	PWM signal which can be smoothed by an external filter. Use the AT^SWDAC command to open and configure the DAC_OUT output.
Digital Audio interface	DAI0	O	$V_{OL}max$ = 0.2V at I = 2mA $V_{OH}min$ = 2.55V at I = -0.5mA $V_{OH}max$ = 3.05V $V_{IL}max$ = 0.8V $V_{IH}min$ = 2.15V $V_{IH}max$ = VEXTmin + 0.3V = 3.05V	See Table 16 for details. If unused keep pins open.
	DAI1	I		
	DAI2	O		
	DAI3	O		
	DAI4	I		
	DAI5	I		
	DAI6	I		
Analog Audio interface	VMIC	O	$V_{O}min$ = 2.4V $V_{O}typ$ = 2.5V $V_{O}max$ = 2.6V I_{max} = 2mA	Microphone supply for customer feeding circuits
	EPP2	O	3.0Vpp differential typical @ 0dBm0	The audio output can directly operate a 32-Ohm-loudspeaker. If unused keep pins open.
	EPN2	O	4.2Vpp differential maximal @ 3.14dBm0 Measurement conditions: Audio mode: 6 Outstep 3 No load Minimum differential resp. single ended load 27Ohms	
	EPP1	O	4.2Vpp (differential) typical @ 0dBm0	The audio output can directly operate an 8-Ohm-loudspeaker. If unused keep pins open.
	EPN1	O	6.0Vpp differential maximal @ 3.14dBm0 Measurement conditions: Audio mode: 5 Outstep 4 No load Minimum differential resp. single ended load 7.5Ohms	
	MICP1	I	Full Scale Input Voltage 1.6Vpp	Balanced or single ended microphone or line input with external feeding circuit (using VMIC and AGND). If unused keep pins open.
	MICN1	I	0dBm0 Input Voltage 1.1Vpp At MICN1, apply external bias from 1.0V to 1.6V. Measurement conditions: Audio mode: 5	
	MICP2	I	Full Scale Input Voltage 1.6Vpp	Balanced or single ended microphone or line input with external feeding circuit (using VMIC and AGND). If unused keep pins open.
	MICN2	I	0dBm0 Input Voltage 1.1Vpp At MICN2, apply external bias from 1.0V to 1.6V. Measurement conditions: Audio mode: 6	
	AGND		Analog Ground	GND level for external audio circuits

5.6 Power Supply Ratings

Table 27: Power supply ratings

Parameter	Description	Conditions	Min	Typ	Max	Unit
BATT+	Supply voltage	Directly measured at reference point TP BATT+ and TP GND, see chapter 3.2.2 Voltage must stay within the min/max values, including voltage drop, ripple, spikes.	3.3	3.8	4.5	V
	Voltage drop during transmit burst	Normal condition, power control level for $P_{out\ max}$			400	mV
	Voltage ripple	Normal condition, power control level for $P_{out\ max}$				
		@ f<200kHz			50	mV
		@ f>200kHz			2	mV
I_{VDDLP}	OFF State supply current	RTC Backup @ BATT+ = 0V		25		µA
I_{BATT+}		POWER DOWN mode[7]		50	100	µA
	Average standby supply current[8]	SLEEP mode @ DRX = 9		3.7 [9]		mA
		SLEEP mode @ DRX = 5		4.6 [9]		mA
		SLEEP mode @ DRX = 2		7.0 [9]		mA
		IDLE mode @ DRX = 2		28 [10]		mA

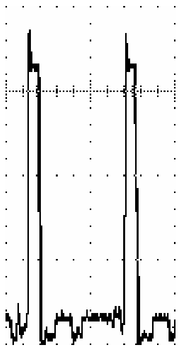
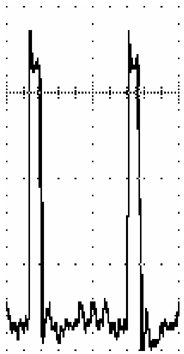
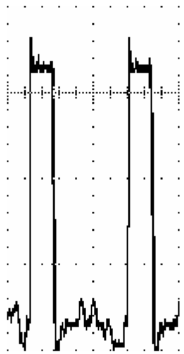
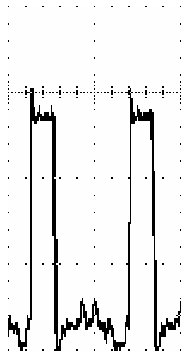
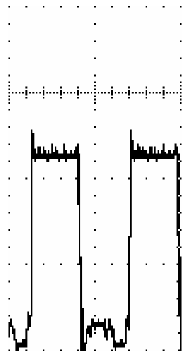
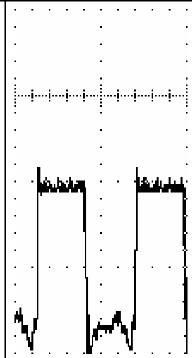
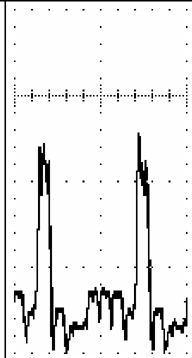
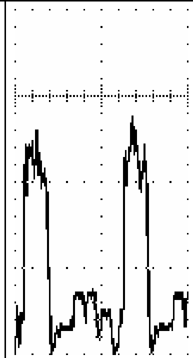
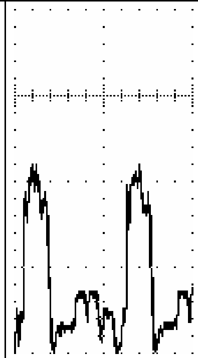
[7] Measured after module INIT (switch ON the module and following switch OFF); applied voltage on BATT+ (w/o INIT) show increased POWER DOWN supply current.

[8] Additional conditions:
- SLEEP and IDLE mode measurements started 5 minutes after switching ON the module or after mode transition
- Averaging times: SLEEP mode - 3 minutes; IDLE mode - 1.5 minutes
- Communication tester settings: no neighbor cells, no cell reselection
- USB interface disabled

[9] Stated value applies to operation without autobauding (AT+IPR≠0).

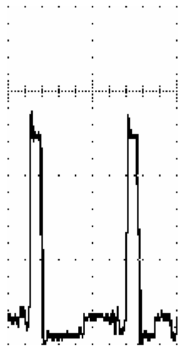
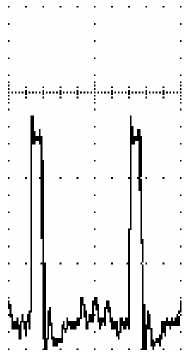
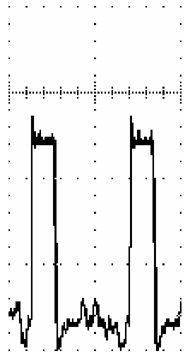
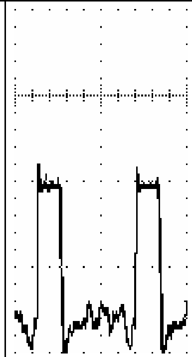
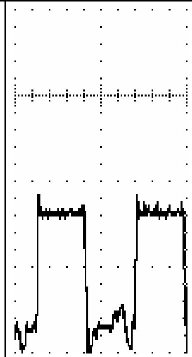
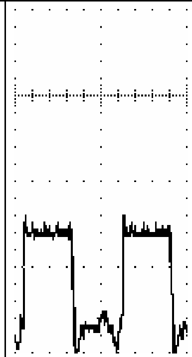
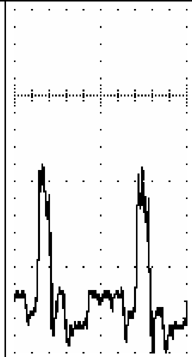
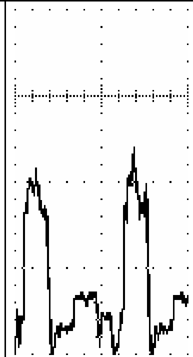
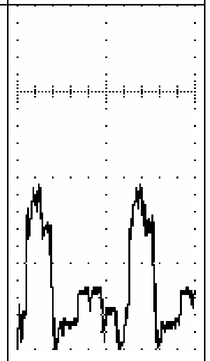
[10] Stated value applies to operation without autobauding (AT+IPR≠0). If autobauding is enabled (AT+IPR=0) average current consumption in IDLE mode is up to 43mA.

Table 28: Current consumption during Tx burst for GSM 850MHz and GSM 900MHz

Mode	**GSM call**	**GPRS Class 8**	**GPRS Class10**		**GPRS Class 12**		**EGPRS Class 8**	**EGPRS Class 10**	
Timeslot configuration	1Tx / 1Rx	1Tx / 4Rx	2Tx / 3Rx		4Tx / 1Rx		1Tx / 4Rx	2Tx / 3Rx	
RF power nominal	2W (33dBm)	2W (33dBm)	2W (33dBm)	1W (30dBm)	1W (30dBm)	0.5W (27dBm)	0.5W (27dBm)	0.5W (27dBm)	0.25W (24dBm)
Radio output power reduction with AT^SCFG, parameter *<ropr>*	*<ropr>* = 1 ... 3	<ropr> = 1 ... 3	<ropr> = 1	<ropr> = 2 or 3	*<ropr>* = 1	*<ropr>* = 2 or 3	*<ropr>* = 1 ... 3	*<ropr>* = 1 or 2	*<ropr>* = 3
Current characteristics									
Burst current @ 50Ω antenna (typ.)	1.75A	1.75A	1.75A	1.48A	1.26A	1.1A	1.4A peak 1.2A plateau	1.4A peak 1.2A plateau	1.1A peak 1.0A plateau
Burst current @ total mismatch	3.2A	3.2A	3.2A	2.7A	2.3A	1.9A	1.8A peak 1.5A plateau	1.8A peak 1.5A plateau	1.4A peak 1.2A plateau
Average current @ 50Ω antenna (typ.)	330mA	360mA	540mA	475mA	680mA	600mA	370mA	450mA	400mA
Average current @ total mismatch	510mA	540mA	905mA	780mA	1200mA	1000mA	395mA	525mA	450mA

AT parameters are given in brackets <...> and marked *italic*.
Statements on EGPRS apply to AC75 only.

Table 29: Current consumption during Tx burst for GSM 1800MHz and GSM 1900MHz

Mode	GSM call	GPRS Class 8	GPRS Class10		GPRS Class 12		EGPRS Class 8	EGPRS Class 10	
Timeslot configuration	1Tx / 1Rx	1Tx / 4Rx	2Tx / 3Rx		4Tx / 1Rx		1Tx / 4Rx	2Tx / 3Rx	
RF power nominal	1W (30dBm)	1W (30dBm)	1W (30dBm)	0.5W (27dBm)	0.5W (27dBm)	0.25W (24dBm)	0.4W (26dBm)	0.4W (26dBm)	0.2W (23dBm)
Radio output power reduction with AT^SCFG, parameter *<ropr>*	*<ropr>* = 1 ... 3	*<ropr>* = 1 ... 3	*<ropr>* = 1	*<ropr>* = 2 or 3	*<ropr>* = 1	*<ropr>* = 2 or 3	*<ropr>* = 1 ... 3	*<ropr>* = 1 or 2	*<ropr>* = 3
Current characteristics									
Burst current @ 50Ω antenna (typ.)	1.3A	1.3A	1.3A	1.1A	0.95A	0.85A	1.0A peak 0.9A plateau	1.0A peak 0.9A plateau	0.9A peak 0.75A plateau
Burst current @ total mismatch	2.2A	2.2A	2.2A	1.75A	1.5A	1.25A	1.3A peak 1.0A plateau	1.3A peak 1.0A plateau	1.1A peak 0.95A plateau
Average current @ 50Ω antenna (typ.)	295mA	330mA	430mA	380mA	520mA	470mA	360mA	445mA	420mA
Average current @ total mismatch	360mA	395mA	650mA	540mA	800mA	670mA	410mA	545mA	470mA

AT parameters are given in brackets <...> and marked *italic*.
Statements on EGPRS apply to AC75 only.

5.7 Electrical Characteristics of the Voiceband Part

5.7.1 Setting Audio Parameters by AT Commands

The audio modes 2 to 6 can be adjusted according to the parameters listed below. Each audio mode is assigned a separate set of parameters.

Table 30: Audio parameters adjustable by AT command

Parameter	Influence to	Range	Gain range	Calculation
inBbcGain	MICP/MICN analogue amplifier gain of baseband controller before ADC	0...7	0...42dB	6dB steps
inCalibrate	Digital attenuation of input signal after ADC	0...32767	-∞...0dB	20 * log (inCalibrate/ 32768)
outBbcGain	EPP/EPN analogue output gain of baseband controller after DAC	0...3	0...-18dB	6dB steps
outCalibrate[n] n = 0...4	Digital attenuation of output signal after speech decoder, before summation of sidetone and DAC Present for each volume step[n]	0...32767	-∞...+6dB	20 * log (2 * outCalibrate[n]/ 32768)
sideTone	Digital attenuation of sidetone Is corrected internally by outBbcGain to obtain a constant sidetone independent of output volume	0...32767	-∞...0dB	20 * log (sideTone/ 32768)

Note: The parameters outCalibrate and sideTone accept also values from 32768 to 65535. These values are internally truncated to 32767.

5.7.2 Audio Programming Model

The audio programming model shows how the signal path can be influenced by varying the AT command parameters. The parameters inBbcGain and inCalibrate can be set with AT^SNFI. All the other parameters are adjusted with AT^SNFO.

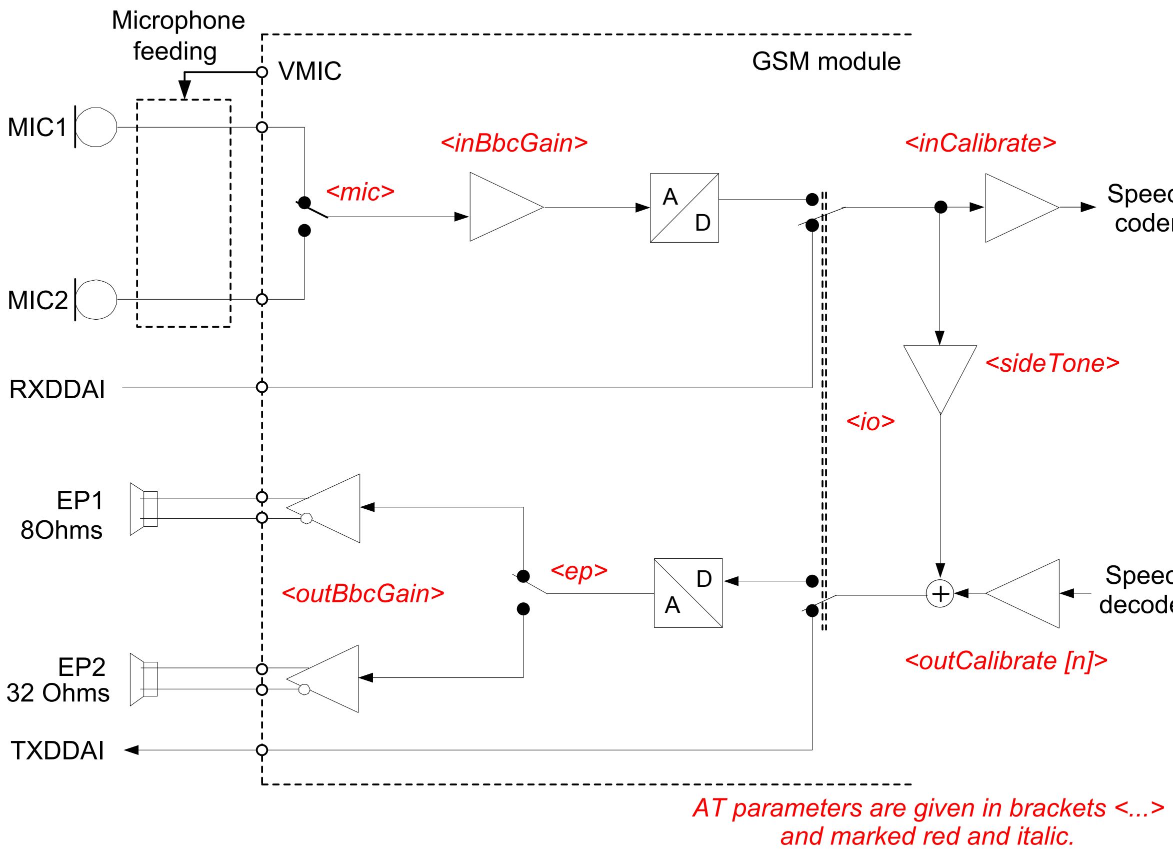


Figure 41: Audio programming model

5.7.3 Characteristics of Audio Modes

The electrical characteristics of the voiceband part depend on the current audio mode set with the AT^SNFS command. All values are noted for default gains e.g. all parameters of AT^SNFI and AT^SNFO are left unchanged.

Table 31: Voiceband characteristics (typical)

Audio mode no. AT^SNFS=	**1 (Default settings, not adjustable)**	**2**	**3**	**4**	**5**	**6**
Name	Default Handset	Basic Handsfree	Headset	User Handset	Plain Codec 1	Plain Codec 2
Purpose	DSB with Votronic handset	Siemens Car Kit Portable	Siemens Headset	DSB with individual handset	Direct access to speech coder	Direct access to speech coder
Gain setting via AT command. Defaults: inBbcGain outBbcGain	Fix 5 (30dB) 1 (-6dB)	Adjustable 2 (12dB) 2 (-12dB)	Adjustable 5 (30dB) 1 (-6dB)	Adjustable 5 (30dB) 1 (-6dB)	Adjustable 0 (0dB) 0 (0dB)	Adjustable 0 (0dB) 0 (0dB)
Default audio interface	1	2	2	1	1	2 [11]
Power supply VMIC	ON	ON	ON	ON	ON	ON
Sidetone	Fix	---	Adjustable	Adjustable	Adjustable	Adjustable
Volume control	Fix	Adjustable	Adjustable	Adjustable	Adjustable	Adjustable
Echo control						
Echo canceller	ON	ON	ON	ON	OFF	OFF
Loss controller idle/full attenuation	3dB / 6dB	4dB / 50dB	9dB / 18dB	3dB / 6dB	OFF	OFF
Comfort noise generator	ON	ON	ON	ON	OFF	OFF
Non linear processor	ON	ON	ON	ON	OFF	OFF
MIC input signal for 0dBm0 -10dBm0 f=1024 Hz	18mV 5.8mV	---[12] 95mV	---[12] 14mV	18mV 5.8mV	400mV 126mV	400mV 126mV
EP output signal in mV rms. @ 0dBm0, 1024 Hz, no load (default gain) / @ 3.14 dBm0	475mV	70mV default @ max volume	270mV default @ max volume	475mV default @ max volume	1.47V Vpp = 6.2 V	1.47V
Sidetone gain at default settings	21.9dB	-∞ dB	10.0dB	21.9dB	-∞ dB	-∞ dB

NOTE: With regard to acoustic shock, the cellular application must be designed to avoid sending false AT commands that might increase amplification, e.g. for a highly sensitive earpiece. A protection circuit should be implemented in the cellular application.

[11] Audio mode 5 and 6 are identical. AT^SAIC can be used to switch mode 5 to the second interface. Audio mode 6 is therefore kept mainly for compatibility to earlier Siemens GSM products.

[12] In audio modes with an active loss controller a continuous sine signal is attenuated by the idle attenuation after a few seconds. All input voltages are noted for the idle attenuation. If the idle attenuation is higher than 3 dB, 0dBm0 cannot be reached without clipping. In this case only the value for -10dBm0 is noted.

5.7.4 Voiceband Receive Path

Test conditions:

- The values specified below were tested to 1kHz with default audio mode settings, unless otherwise stated.
- Default audio mode settings are: mode=5 for EPP1 to EPN1 and mode=6 for EPP2 to EPN2, inBbcGain=0, inCalibrate=32767, outBbcGain=0, OutCalibrate=16384 (volume=4) or OutCalibrate=11585 (volume=3), sideTone=0.

Table 32: Voiceband receive path

Parameter	Min	Typ	Max	Unit	Test condition / remark
Maximum differential output voltage (peak to peak) EPP1 to EPN1		6.0 6.2		V V	8 Ω, no load, Audio Mode 5, Volume 4 @ 3.14 dBm0 (Full Scale) Batt+ = 3.6V
Maximum differential output voltage (peak to peak) EPP2 to EPN2		4.0 4.2		V V	32 Ω, no load Audio Mode 6, Volume 3[13] @ 3.14 dBm0 (Full Scale)
Nominal differential output voltage (peak to peak) EPP1 to EPN1		4.2 4.3		V V	8 Ω, no load, Audio Mode 5, Volume 4 @ 0 dBm0 (Nominal level)
Nominal differential output voltage (peak to peak) EPP1 to EPN1		2.8 2.9		V V	32 Ω, no load Audio Mode 6, Volume 3[13] @ 0 dBm0 (Nominal level)
Output bias voltage		Batt+/2		V	from EPP1 or EPN1 to AGND
Output bias voltage		1.2		V	from EPP2 or EPN2 to AGND
Differential output gain settings (gs) at 6dB stages (outBbcGain)	-18		0	dB	Set with AT^SNFO
Fine scaling by DSP (outCalibrate)	-∞		0	dB	Set with AT^SNFO
Differential output load resistance	7.5	8		Ω	From EPP1 to EPN1
Differential output load resistance	27	32		Ω	From EPP2 to EPN2
Single ended output load resistance	7.5	8		Ω	From EPP1 or EPN1 to AGND
Single ended output load resistance	27	32		Ω	From EPP2 or EPN2 to AGND
Absolute gain error	-0.1		0.1	dB	outBbcGain=2
Idle channel noise[14]		-83	-75	dBm0p	outBbcGain=2
Signal to noise and distortion[15]	47			dB	outBbcGain=2

[13] Full scale of EPP2/EPN2 is lower than full scale of EPP1/EPN1 but the default gain is the same. 3.14dBm0 will lead to clipping if the default gain is used.
[14] The idle channel noise was measured with digital zero signal fed to decoder. This can be realized by setting outCalibrate and sideTone to 0 during a call.
[15] The test signal is a 1 kHz, 0 dbm0 sine wave.

Parameter	Min	Typ	Max	Unit	Test condition / remark
Frequency Response[16] 0Hz - 100Hz 200Hz 300Hz - 3350Hz 3400Hz 4000Hz ≥4400Hz	 -0.2	 -1.1 -0.7 -39	 -34 0.1 -75	 dB	

gs = gain setting

5.7.5 Voiceband Transmit Path

Test conditions:

- The values specified below were tested to 1kHz and default settings of audio modes, unless otherwise stated.
- Parameter setup: Audio mode=5 for MICP1 to MICN1 and 6 for MICP2 to MICN2, inBbcGain=0, inCalibrate=32767, outBbcGain=0, OutCalibrate=16384, sideTone=0

Table 33: Voiceband transmit path

Parameter	Min	Typ	Max	Unit	Test condition / Remark
Full scale input voltage (peak to peak) for 3.14dBm0 MICP1 to MICN1 or AGND, MICP2 to MICN2 or AGND		1.6		V	MICPx must be biased with 1.25V (VMIC/2)
Nominal input voltage (peak to peak) for 0dBm0 MICP1 to MICN1 or AGND, MICP2 to MICN2 or AGND		1.1		V	MICPx must be biased with 1.25V (VMIC/2)
Input amplifier gain in 6dB steps (inBbcGain)	0		42	dB	Set with AT^SNFI
Fine scaling by DSP (inCalibrate)	-∞		0	dB	Set with AT^SNFI
Microphone supply voltage VMIC	2.4	2.5	2.6	V	
VMIC current			2	mA	
Idle channel noise		-82	-76	dBm0p	
Signal to noise and distortion	70	77		dB	
Frequency response[16] 0Hz - 100Hz 200Hz 300Hz - 3350Hz 3400Hz 4000Hz ≥4400Hz	 -0.2	 -1.1 -0.7 -39	 -34 0.1 -75	 dB	

[16] This is the frequency response from a highpass and lowpass filter combination in the DAC of the baseband chip set. If the PCM interface is used, this filter is not involved in the audio path. Audio mode 1 to 4 incorporate additional frequency response correction filters in the digital signal processing unit and are adjusted to their dedicated audio devices (see Table 31).

5.8 Air Interface

Test conditions: All measurements have been performed at T_{amb}= 25°C, $V_{BATT+\ nom}$ = 4.0V. The reference points used on AC65/AC75 are the BATT+ and GND contacts (test points are shown in Figure 4).

Table 34: Air Interface

Parameter		Min	Typ	Max	Unit
Frequency range Uplink (MS → BTS)	GSM 850	824		849	MHz
	E-GSM 900	880		915	MHz
	GSM 1800	1710		1785	MHz
	GSM 1900	1850		1910	MHz
Frequency range Downlink (BTS → MS)	GSM 850	869		894	MHz
	E-GSM 900	925		960	MHz
	GSM 1800	1805		1880	MHz
	GSM 1900	1930		1990	MHz
RF power @ ARP with 50Ω load	GSM 850	31	33	35	dBm
	E-GSM 900[17]	31	33	35	dBm
	GSM 1800[18]	28	30	32	dBm
	GSM 1900	28	30	32	dBm
Number of carriers	GSM 850		124		
	E-GSM 900		174		
	GSM 1800		374		
	GSM 1900		299		
Duplex spacing	GSM 850		45		MHz
	E-GSM 900		45		MHz
	GSM 1800		95		MHz
	GSM 1900		80		MHz
Carrier spacing			200		kHz
Multiplex, Duplex		TDMA / FDMA, FDD			
Time slots per TDMA frame			8		
Frame duration			4.615		ms
Time slot duration			577		µs
Modulation		GMSK			
Receiver input sensitivity @ ARP BER Class II < 2.4% (static input level)	GSM 850	-102	-108		dBm
	E-GSM 900	-102	-108		dBm
	GSM 1800	-102	-107		dBm
	GSM 1900	-102	-107		dBm

[17] Power control level PCL 5
[18] Power control level PCL 0

5.9 Electrostatic Discharge

The GSM engine is not protected against Electrostatic Discharge (ESD) in general. Consequently, it is subject to ESD handling precautions that typically apply to ESD sensitive components. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates a AC65/AC75 module.

Special ESD protection provided on AC65/AC75:
Antenna interface: one spark discharge line (spark gap)
SIM interface: clamp diodes for protection against overvoltage.
The remaining ports of AC65/AC75 are not accessible to the user of the final product (since they are installed within the device) and therefore, are only protected according to the "Human Body Model" requirements.

AC65/AC75 has been tested according to the EN 61000-4-2 standard. The measured values can be gathered from the following table.

Table 35: Measured electrostatic values

Specification / Requirements	Contact discharge	Air discharge
ETSI EN 301 489-7		
ESD at SIM port	± 4kV	± 8kV
ESD at antenna port	± 4kV	± 8kV
Human Body Model (Test conditions: 1.5kΩ, 100pF)		
ESD at all other interfaces	± 1kV	± 1kV

Note: Please note that the values may vary with the individual application design. For example, it matters whether or not the application platform is grounded over external devices like a computer or other equipment, such as the Siemens reference application described in Chapter 8.

6 Mechanics

6.1 Mechanical Dimensions of AC65/AC75

Figure 42 shows the top view of AC65/AC75 and provides an overview of the board's mechanical dimensions. For further details see Figure 43.

Length: 55.00mm
Width: 33.90mm
Height: 3.15mm

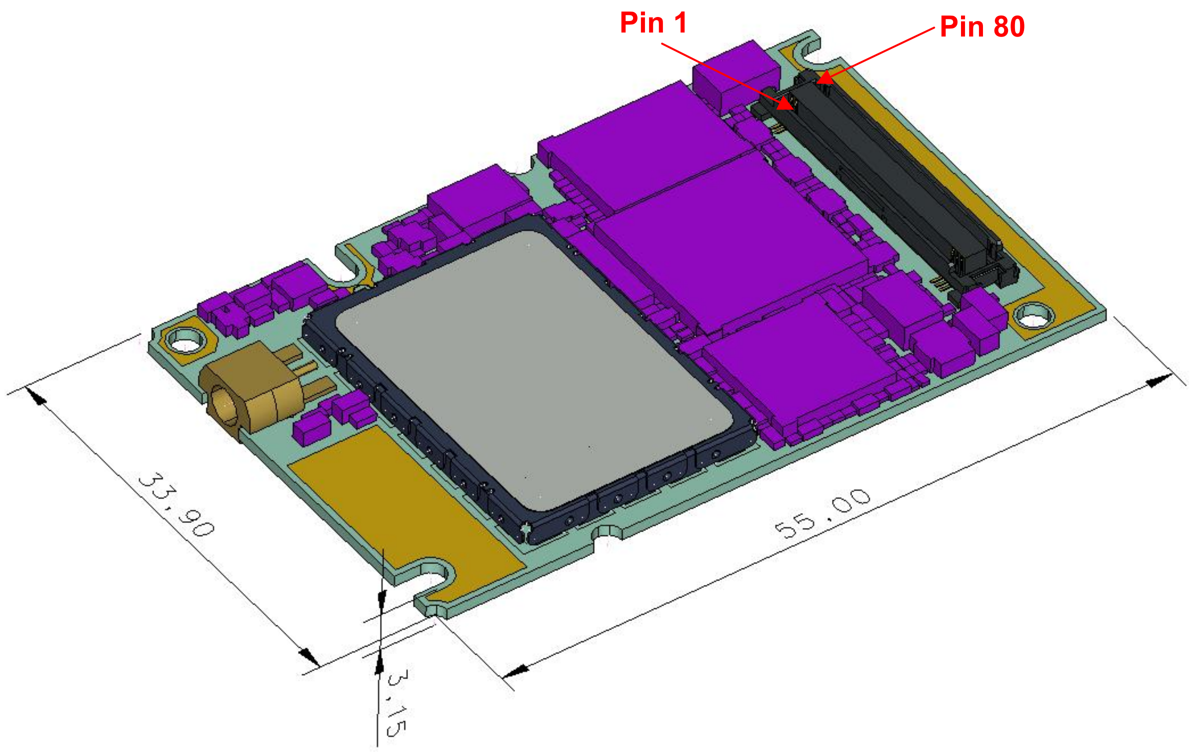
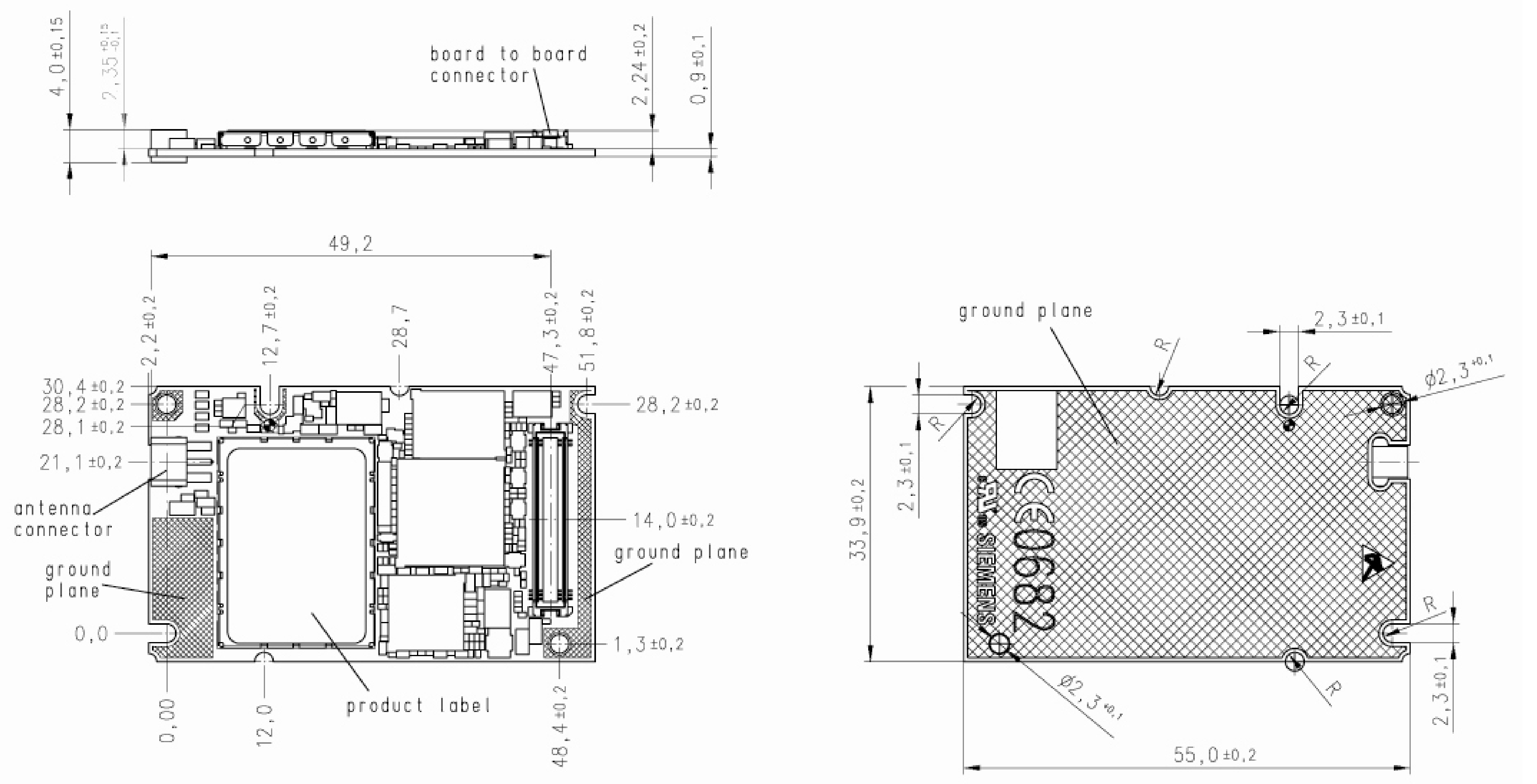


Figure 42: AC65/AC75 – top view



All dimensions in mm

Figure 43: Dimensions of AC65/AC75

6.2 Mounting AC65/AC75 to the Application Platform

There are many ways to properly install AC65/AC75 in the host device. An efficient approach is to mount the AC65/AC75 PCB to a frame, plate, rack or chassis.

Fasteners can be M2 screws plus suitable washers, circuit board spacers, or customized screws, clamps, or brackets. In addition, the board-to-board connection can also be utilized to achieve better support. To help you find appropriate spacers a list of selected screws and distance sleeves for 3mm stacking height can be found in Chapter 9.2.

When using the two small holes take care that the screws are inserted with the screw head on the bottom of the AC65/AC75 PCB. Screws for the large holes can be inserted from top or bottom.

For proper grounding it is strongly recommended to use large ground plane on the bottom of board in addition to the five GND pins of the board-to-board connector. The ground plane may also be used to attach cooling elements, e.g. a heat sink or thermally conductive tape.

To prevent mechanical damage, be careful not to force, bend or twist the module. Be sure it is positioned flat against the host device.

6.3 Board-to-Board Application Connector

This section provides the specifications of the 80-pin board-to-board connector used to connect AC65/AC75 to the external application.

Connector mounted on the AC65/AC75 module:
Type: 52991-0808 SlimStack Receptacle
80 pins, 0.50mm pitch,
for stacking heights from 3.0 to 4.0mm,
see Figure 44 for details.
Supplier: Molex
www.molex.com

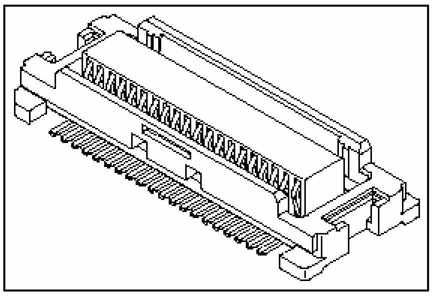
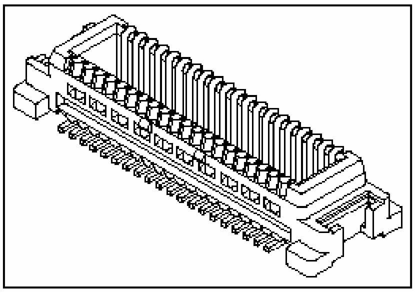


Table 36: Technical specifications of Molex board-to-board connector

Parameter	**Specification (80-pin B2B connector)**
Electrical	
Number of Contacts	80
Contact spacing	0.5mm (.020")
Voltage	50V
Rated current	0.5A max per contact
Contact resistance	50mΩ max per contact
Insulation resistance	> 100MΩ
Dielectric Withstanding Voltage	500V AC (for 1 minute)
Physical	
Insulator material (housing)	White glass-filled LCP plastic, flammability UL 94V 0
Contact material	Plating: Gold over nickel
Insertion force 1st	< 74.4N
Insertion force 30th	< 65.6N
Withdrawal force 1st	> 10.8N
Maximum connection cycles	30 (@ 70mΩ max per contact)

Mating connector types for the customer's application offered by Molex:

- 53748-0808 SlimStack Plug, 3mm stacking height, see Figure 45 for details.
- 53916-0808 SlimStack Plug, 4mm stacking height



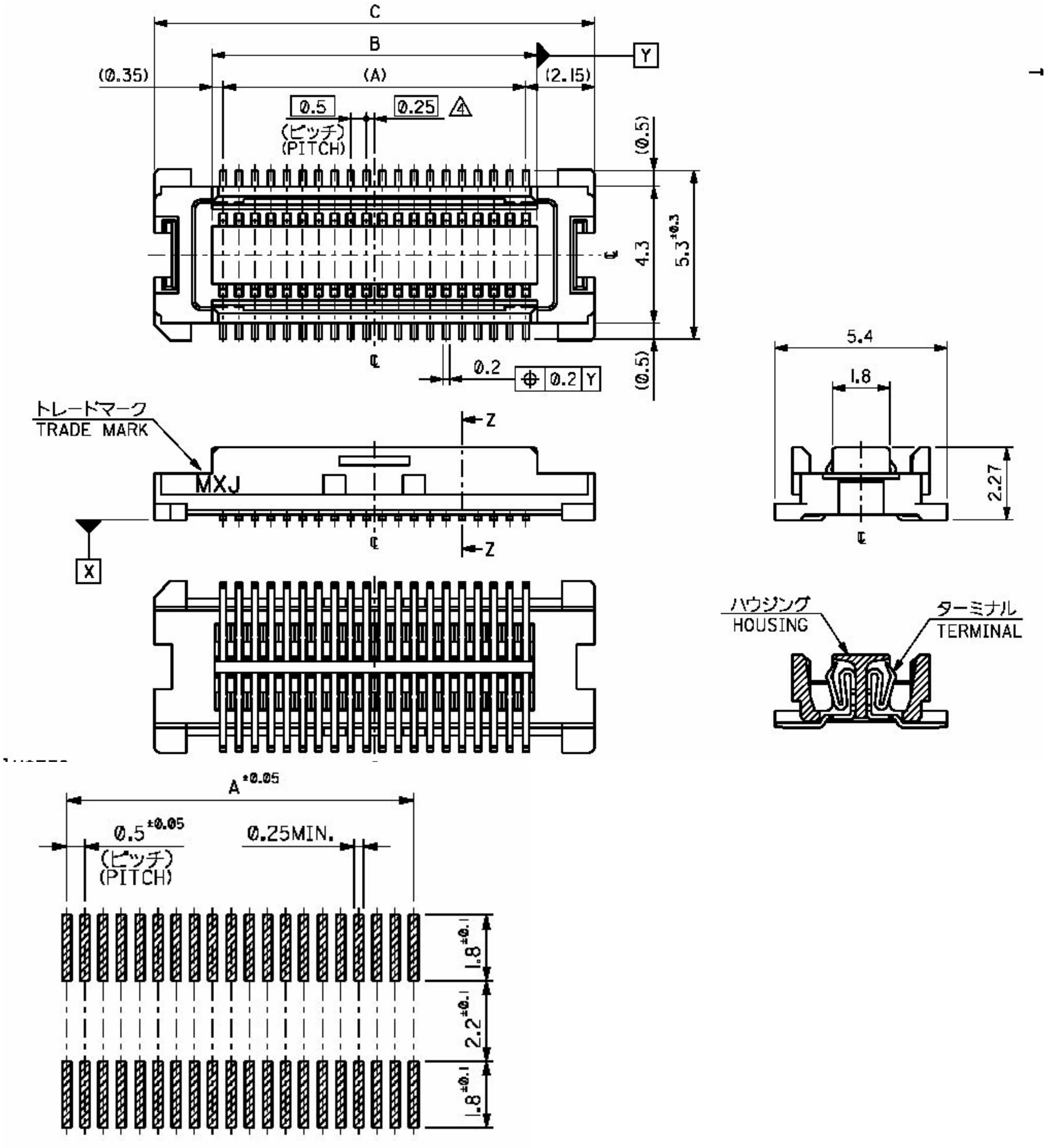


Figure 44: Molex board-to-board connector 52991-0808 on AC65/AC75

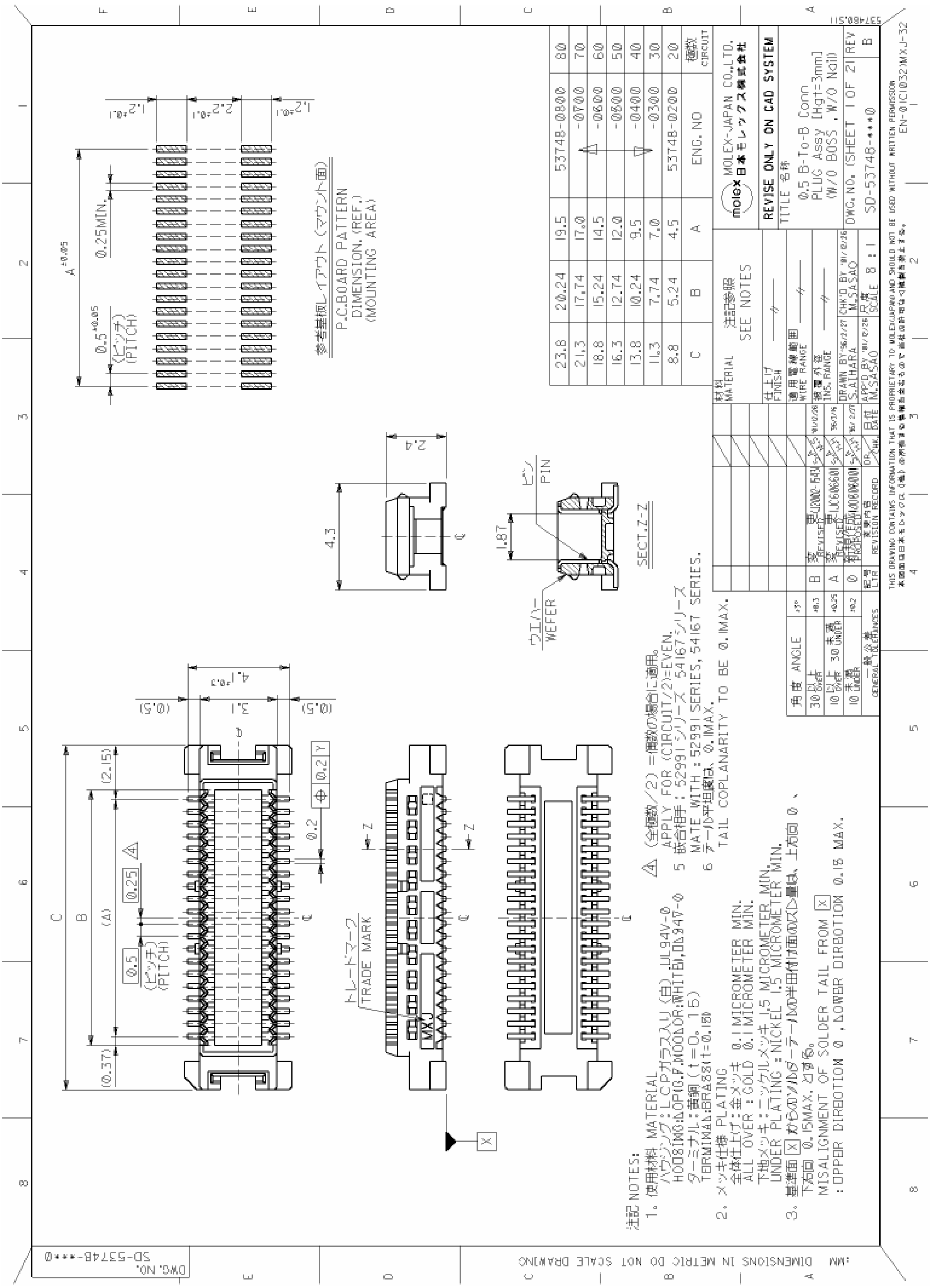


Figure 45: Mating board-to-board connector 53748-0808 on application

7 Sample Application

Figure 46 shows a typical example of how to integrate a AC65/AC75 module with a Java application. Usage of the various host interfaces depends on the desired features of the application.

Audio interface 1 demonstrates the balanced connection of microphone and earpiece. This solution is particularly well suited for internal transducers. Audio interface 2 uses an unbalanced microphone and earpiece connection typically found in headset applications.

The charging circuit is optimized for the charging stages (trickle charging and software controlled charging) as well as the battery and charger specifications described in Chapter 3.5.

The PWR_IND line is an open collector that needs an external pull-up resistor which connects to the voltage supply VCC µC of the microcontroller. Low state of the open collector pulls the PWR_IND signal low and indicates that the AC65/AC75 module is active, high level notifies the Power-down mode.

If the module is in Power-down mode avoid current flowing from any other source into the module circuit, for example reverse current from high state external control lines. Therefore, the controlling application must be designed to prevent reverse flow.

If the I^2C bus is active the two lines I2CCLK and I2DAT are locked for use as SPI lines. Vice versa, the activation of the SPI locks both lines for I^2C. Settings for either interface are made by using the AT^SSPI command.

The internal pull-up resistors (Rp) of the I^2C interface can be connected to an external power supply or to the VEXT line of AC65/AC75. The advantage of using VEXT is that when the module enters the Power-down mode, the I^2CI interface is shut down as well. If you prefer to connect the resistors to an external power supply, take care that the interface is shut down when the PWR_IND signal goes high in Power-down mode.

The interfaces ASC0, ASC1 and USB have different functions depending on whether or not Java is running. Without Java, all of them are used as AT interfaces. When a Java application is started, ASC0 and ASC1 can be used for CommConnection or/and System.out, and the USB lines can be used for debugging or System.out.

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. However, when connecting cables to the module's interfaces it is strongly recommended to add appropriate ferrite beads for reducing RF radiation.

<u>Disclaimer</u>
No warranty, either stated or implied, is provided on the sample schematic diagram shown in Figure 46 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 AC65/AC75 modules.

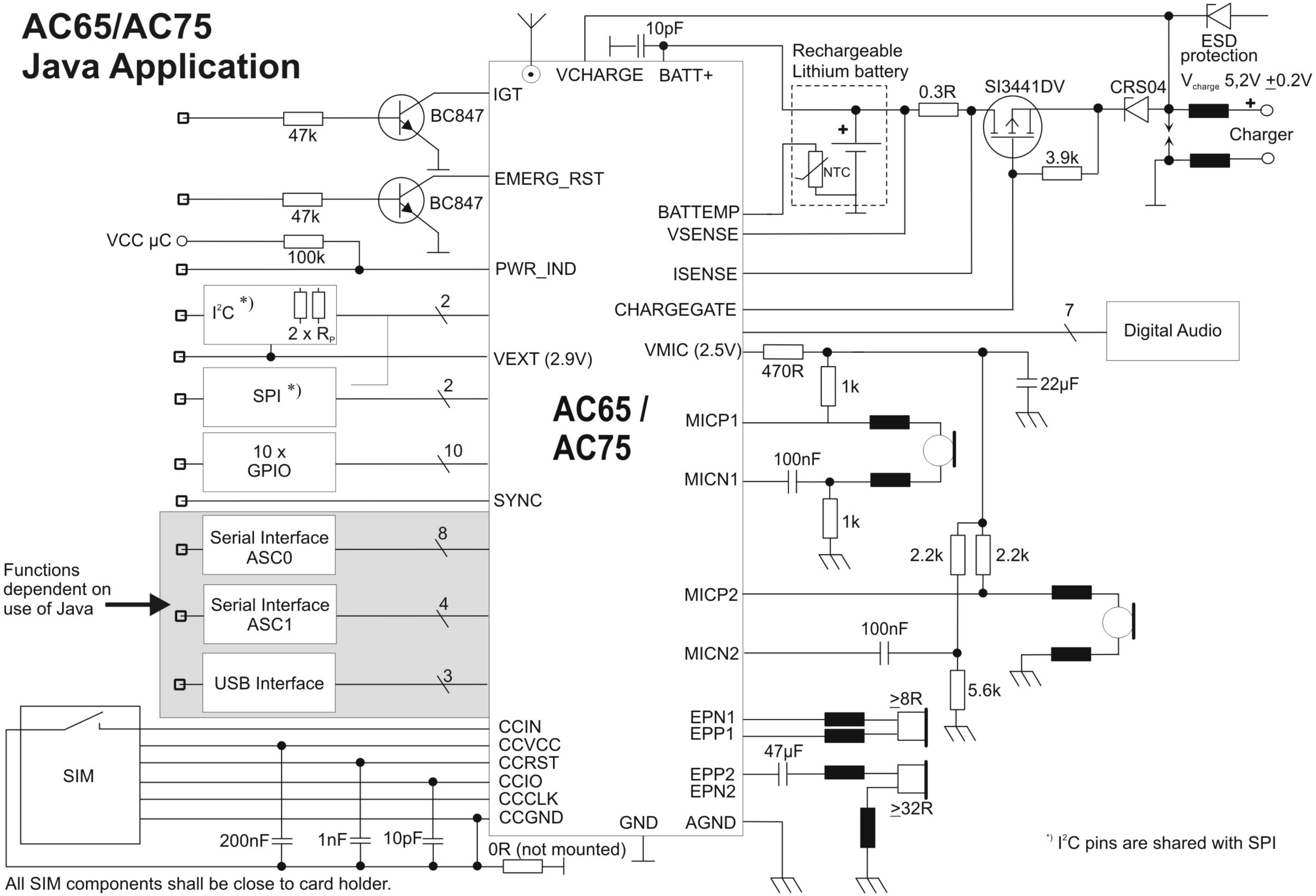


Figure 46: AC65/AC75 sample application for Java

8 Reference Approval

8.1 Reference Equipment for Type Approval

The Siemens reference setup submitted to type approve AC65/AC75 consists of the following components:

- Siemens AC65/AC75 cellular engine
- Development Support Box DSB75
- SIM card reader integrated on DSB75
- U.FL-R-SMT antenna connector and U.FL-LP antenna cable
- Handset type Votronic HH-SI-30.3/V1.1/0
- Li-Ion battery
- PC as MMI

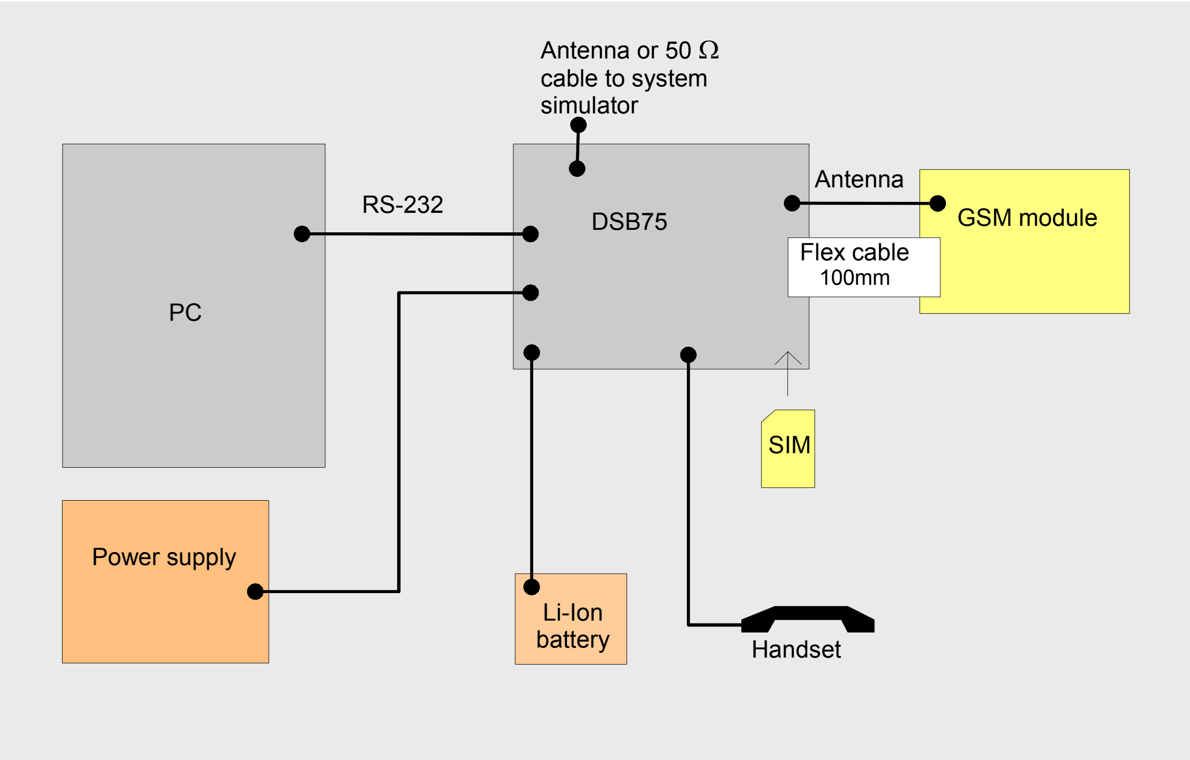


Figure 47: Reference equipment for Type Approval

8.2 Compliance with FCC Rules and Regulations

The FCC Equipment Authorization Certification for the Siemens reference application described in Chapter 8.1 will be registered under the following identifiers:

FCC identifier QIPAC65
IC: 267W-AC65
granted to Siemens AG

and

FCC identifier QIPAC75
IC: 267W-AC75
granted to Siemens AG.

Manufacturers of mobile or fixed devices incorporating AC65/AC75 modules are authorized to use the FCC Grants and IC Certificates of the AC65/AC75 modules for their own final products according to the conditions referenced in these documents. In this case, the FCC label of the module shall be visible from the outside, or the host device shall bear a second label stating "Contains FCC ID QIP AC65" resp. "Contains FCC ID QIPAC75".

IMPORTANT:
Manufacturers of portable applications incorporating AC65/AC75 modules are required to have their final product certified and apply for their own FCC Grant and IC Certificate related to the specific portable mobile. This is mandatory to meet the SAR requirements for portable mobiles (see Chapter 1.3.1 for detail).

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

If the final product is not approved for use in U.S. territories the application manufacturer shall take care that the 850 MHz and 1900 MHz frequency bands be deactivated and that band settings be inaccessible to end users. If these demands are not met (e.g. if the AT interface is accessible to end users), it is the responsibility of the application manufacturer to always ensure that the application be FCC approved regardless of the country it is marketed in. The frequency bands can be set using the command

AT^SCFG="Radio/Band"[,<rbp>][, <rba>].

A detailed command description can be found in [1].

9 Appendix

9.1 List of Parts and Accessories

Table 37: List of parts and accessories

Description	Supplier	Ordering information
AC65	Siemens	Standard module (Siemens IMEI) Siemens ordering number: L36880-N8335-A100 Customer IMEI mode: Siemens Ordering number: L36880-N8336-A100
AC75	Siemens	Standard module (Siemens IMEI) Siemens ordering number: L36880-N8330-A100 Customer IMEI mode: Siemens Ordering number: L36880-N8331-A100
Siemens Car Kit Portable	Siemens	Siemens ordering number: L36880-N3015-A117
DSB75 Support Box	Siemens	Siemens ordering number: L36880-N8811-A100
Votronic Handset	VOTRONIC	Votronic 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 e-mail: 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 38.
Board-to-board connector	Molex	Sales contacts are listed in Table 38.
SMP Rosenberger antenna connector	Hirose	Rosenberger Hochfrequenztechnik GmbH & Co. POB 1260 84526 Tittmoning Germany http://www.rosenberger.de

Table 38: Molex sales contacts (subject to change)

Molex For further information please click: http://www.molex.com/	Molex Deutschland GmbH Felix-Wankel-Str. 11 4078 Heilbronn-Biberach Germany Phone: +49-7066-9555 0 Fax: +49-7066-9555 29 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 1319, Tower B, COFCO Plaza No. 8, Jian Guo Men Nei Street, 100005 Beijing P.R. China Phone: +86-10-6526-9628 Phone: +86-10-6526-9728 Phone: +86-10-6526-9731 Fax: +86-10-6526-9730	Molex Singapore Pte. Ltd. Jurong, Singapore Phone: +65-268-6868 Fax: +65-265-6044	Molex Japan Co. Ltd. Yamato, Kanagawa, Japan Phone: +81-462-65-2324 Fax: +81-462-65-2366

9.2 Fasteners and Fixings for Electronic Equipment

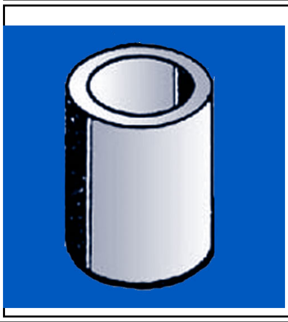
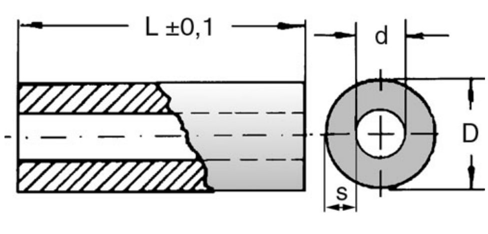
This section provides a list of suppliers and manufacturers offering fasteners and fixings for electronic equipment and PCB mounting. The content of this section is designed to offer basic guidance to various mounting solutions with no warranty on the accuracy and sufficiency of the information supplied. Please note that the list remains preliminary although it is going to be updated in later versions of this document.

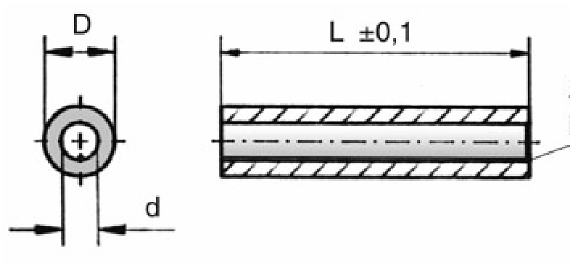
9.2.1 Fasteners from German Supplier ETTINGER GmbH

Sales contact: ETTINGER GmbH
http://www.ettinger.de/main.cfm
Phone: +4981 04 66 23 – 0
Fax: +4981 04 66 23 – 0

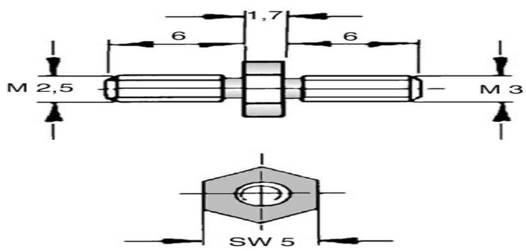
The following tables contain only article numbers and basic parameters of the listed components. For further detail and ordering information please contact Ettinger GmbH.

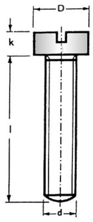
Please note that some of the listed screws, spacers and nuts are delivered with the DSB75 Support Board. See comments below.

Article number: 05.71.038	**Spacer - Aluminum / Wall thickness = 0.8mm**
Length	3.0mm
Material	AlMgSi-0,5
For internal diameter	M2=2.0-2.3
Internal diameter	d = 2.4mm
External diameter	4.0mm
Vogt AG No.	x40030080.10
	

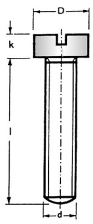
Article number: 07.51.403	**Insulating Spacer for M2 Self-gripping** *)
Length	3.0mm
Material	Polyamide 6.6
Surface	Black
Internal diameter	2.2mm
External diameter	4.0mm
Flammability rating	UL94-HB
	

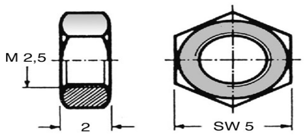
*) 2 spacers are delivered with DSB75 Support Board

Article number: 05.11.209	**Threaded Stud M2.5 - M2 Type E / External thread at both ends**
Length	3.0mm
Material	Stainless steel X12CrMoS17
Thread 1 / Length	M2.5 / 6.0mm
Thread 2 / Length	M2 / 8.0mm
Width across flats	5
Recess	yes
Type	External / External
	

Article number: 01.14.131	**Screw M2** *) **DIN 84 - ISO 1207**
Length	8.0mm
Material	Steel 4.8
Surface	Zinced A2K
Thread	M2
Head diameter	D = 3.8mm
Head height	1.30mm
Type	Slotted cheese head screw
	

*) 2 screws are delivered with DSB75 Support Board

Article number: 01.14.141	**Screw M2** **DIN 84 - ISO 1207**
Length	10.0mm
Material	Steel 4.8
Surface	Zinced A2K
Thread	M2
Head diameter	D = 3.8mm
Head height	1.30mm
Type	Slotted cheese head screw
	

Article number: 02.10.011	**Hexagon Nut** *) **DIN 934 - ISO 4032**
Material	Steel 4.8
Surface	Zinced A2K
Thread	M2
Wrench size / Ø	4
Thickness / L	1.6mm
Type	Nut DIN/UNC, DIN934
	

*) 2 nuts are delivered with DSB75 Support Board