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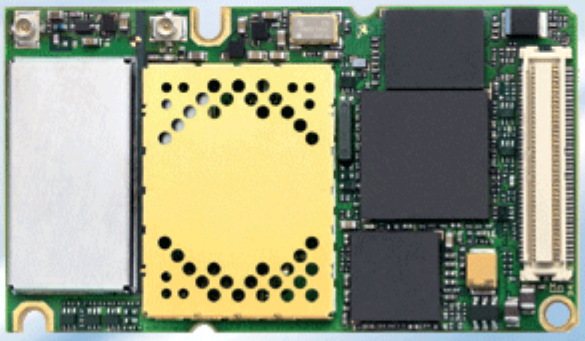

Hardware Interface Overview

XT65/XT75
Siemens Cellular Engine

Version:	00.130
DocId:	XT65_XT75_HO_v00.130
Supported Products:	XT65, XT75

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1 Introduction

This document applies to the following Siemens products:

- XT65 Module
- XT75 Module

The document describes the hardware of the XT65 and XT75 modules, 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 the XT75 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 XT65/XT75.

1.1 Related Documents

[1] XT65 AT Command Set 00.130
XT75 AT Command Set 00.130
[2] XT65/XT75 Release Notes 00.130
[3] DSB75 Support Box - Evaluation Kit for Siemens Cellular Engines
[4] Application Note 02: Audio Interface Design for GSM Applications
[5] Application Note 07: Rechargeable Lithium Batteries in GSM Applications
[6] Application Note 16: Upgrading Firmware
[7] Application Note 17: Over-The-Air Firmware Update
[8] Application Note 22: Using TTY / CTM Equipment
[9] Application Note 24: Application Developer's Guide
[10] Application Note 26: Power Supply Design for GSM Applications
[11] Application Note 32: Integrating USB into GSM 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
[16] Java User's Guide
[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	Asynchronous Controller. Abbreviations used for the serial interface of XT65/XT75
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

Abbreviation	Description
PLL	Phase Locked Loop
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 Regulatory and Type Approval Information

1.3.1 Directives and Standards

XT65/XT75 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.

It is the responsibility of the application manufacturer to ensure compliance of the final product with all provisions of the applicable directives and standards as well as with the technical specifications provided in the "XT65/XT75 Hardware Interface Description".[1]

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)

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

Table 3: Standards of European type approval

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

1.3.2 SAR requirements specific to portable mobiles

Mobile phones, PDAs or other portable transmitters and receivers incorporating a GSM module must be in accordance with the guidelines for human exposure to radio frequency energy. This requires the Specific Absorption Rate (SAR) of portable XT65/XT75 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 XT65/XT75 modules are required to have their final product certified and apply for their own FCC Grant and Industry Canada Certificate related to the specific portable mobile. See also Section 8.2.

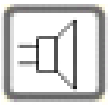
1.3.3 SELV Requirements

The power supply connected to the XT65/XT75 module shall be in compliance with the SELV requirements defined in EN 60950-1. See also Section 6.1 for further detail.

1.3.4 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 XT65/XT75. 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 XT75 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, 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 +65°C Restricted operation:-30°C / +85°C
Physical	Dimensions: 34mm x 59mm x 3.5mm Weight: < 10g
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 (XT75 only): Multislot Class 10 Mobile Station Class B Modulation and Coding Scheme MCS 1 – 9 CSD: V.110, RLP, non-transparent 2.4, 4.8, 9.6, 14.4kbps USSD PPP-stack for GPRS data transfer

Feature	Implementation
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, echo cancellation, noise suppression, DTMF, 7 ringing tones
GPS Features	
Supported Protocol	NMEA-0183, RTCM v2.2, UBX binary protocol
GPS modes	GPS, Assisted GPS (AGPS), Differential GSP (DGPS), Satellite Based Augmentation Systems (SBAS)
Position accuracy	10-15m, with DGPS/SBAS 1-3m
Start-up times	Hot start < 3.5s Warm start 33s, average Cold start 34s, average
Sensitivity	Active antenna: Aquisition sensitivity: -141dBm Tracking sensitivity: -158dBm At antenna connector: Aquisition sensitivity: -139dBm Tracking sensitivity: -156dBm
General	Receiver 16 channel, L1 1575.42 MHz, GPS part controlled by GSM baseband controller, Java engine or via application (ASC0)
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 1.2 MB in the flash file system and around 400kB RAM. Application code and data share the space in the flash file system and in RAM.

Feature	Implementation
SIM Application Toolkit	SAT Release 99
TCP/IP stack	Access by AT commands
IP addresses	IP version 4
Remote SIM Access	XT65/XT75 supports Remote SIM Access. RSA enables XT65/XT75 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”.
Firmware update	Generic update from host application over ASC0 or USB. Over-the-air (OTA) firmware update is possible via SPI interface.
Interfaces	
Serial interface (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.
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 GSM antenna can be connected via antenna connector. • 50Ohms. External GPS antenna can be connected via antenna connector.
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.

Feature	Implementation
Special features	
Charging	Supports management of rechargeable Lithium Ion and Lithium Polymer batteries
Real time clock	Timer functions via AT commands
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.

3 Application Interface

XT65/XT75 is equipped with an 80-pin board-to-board connector that connects to the external application and incorporates several sub-interfaces: power supply, charger interface, SIM interface, serial interface ASC0, serial interface USB, serial interface I²C/SPI, two analog audio interfaces, digital audio interface (DAI), 10 lines GPIO interface, as well as status and control lines: IGT, EMERG_RST, PWR_IND, SYNC (for details see Chapter 2 and Section 6.5).

3.1 Operating Modes

The table below briefly summarizes the various operating modes available for the module.

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.	

4 GSM Antenna Interface

The GSM interface has an impedance of 50Ω. XT65/XT75 is capable of sustaining a total mismatch at the antenna connector without any damage, even when transmitting at maximum RF power. DC electric strength is given (see Table 11).

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 XT65/XT75 PCB and should be placed in the host application.

Regarding the return loss XT65/XT75 provides the following values in the active band:

Table 6: 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 Installation

To suit the physical design of individual applications XT65/XT75 offers two alternative approaches to connecting the antenna:

- Recommended approach: U.FL-R-SMT antenna connector from Hirose assembled on the component side of the PCB.

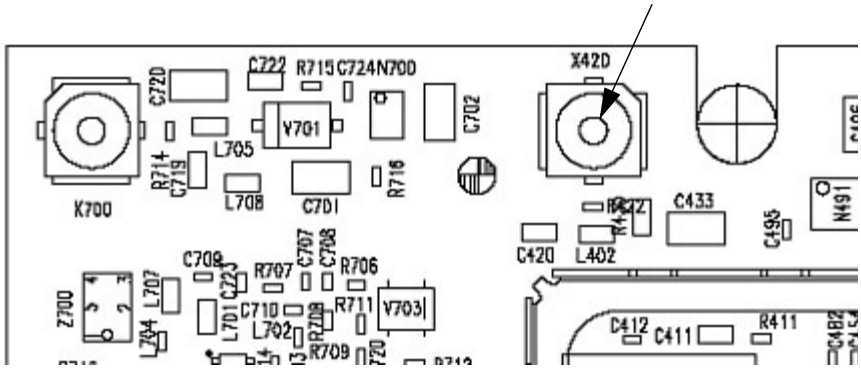


Figure 1: GSM antenna connector placement

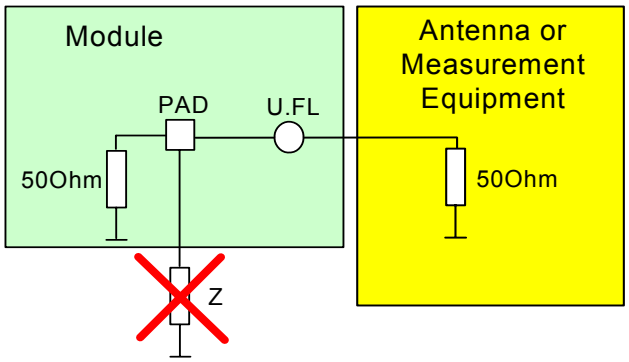
See Section 4.3 for connector details.

- Antenna pad and grounding plane placed on the bottom side. See Section 4.2.

The U.FL-R-SMT connector has been chosen as antenna reference point (ARP) for the Siemens reference equipment submitted to type approve XT65/XT75. All RF data specified throughout this manual are related to the ARP. For compliance with the test results of the Siemens type approval you are advised to give priority to the connector, rather than using the antenna pad.

IMPORTANT: Both solutions can only be applied alternatively. This means, whenever an antenna is plugged to the Hirose connector, the pad must not be used. Vice versa, if the antenna is connected to the pad, then the Hirose connector must be left empty.

Antenna connected to Hirose connector:



Antenna connected to pad:

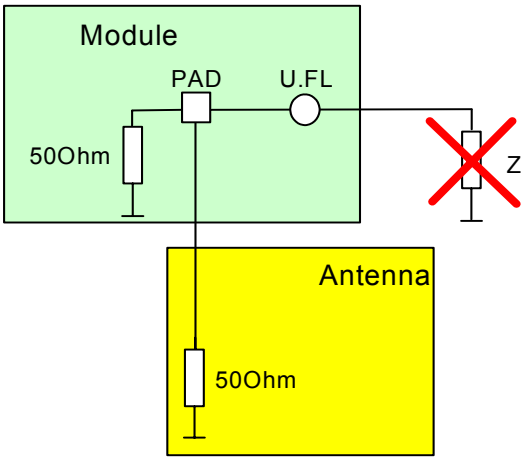


Figure 40: Never use antenna connector and antenna pad at the same time

4.2 Antenna Pad

The antenna can be soldered to the pad, or attached via contact springs. For proper grounding connect the antenna to the ground plane on the bottom of XT65/XT75 which must be connected to the ground plane of the application.

If you decide to use the antenna pad take into account that the pad has not been intended as antenna reference point (ARP) for the Siemens XT65/XT75 type approval. The antenna pad is provided only as an alternative option which can be used, for example, if the recommended Hirose connection does not fit into your antenna design.

Please ensure that the antenna pad does not come into contact with the holding device or any other components of the host application. It needs to be surrounded by a restricted area filled with air, which must also be reserved 0.8mm in height.

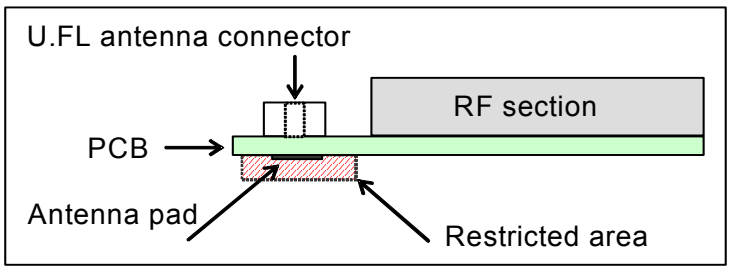


Figure 2: Figure 41: Restricted area around antenna pad

Also, consider that according to the GSM recommendations TS 45.005 and TS 51.010-01 a 50Ω connector is mandatory for type approval measurements. This requires GSM devices with an integral antenna to be temporarily equipped with a suitable connector or a low loss RF cable with adapter.

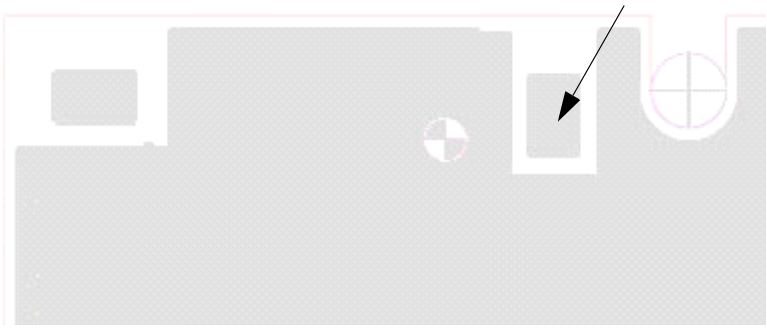


Figure 3: GSM antenna pad placement

Notes on soldering:

- To prevent damage to the module and to obtain long-term solder joint properties you are advised to maintain the standards of good engineering practice for soldering.
- Be sure to solder the antenna core to the pad and the shielding of the coax cable to the ground plane of the module next to the antenna pad. The direction of the cable is not relevant from the electrical point of view.

XT65/XT75 material properties:

XT65/XT75 PCB: FR4

Antenna pad: Gold plated pad

4.2.1 Suitable Cable Types

For direct solder attachment, we suggest to use the following cable types:

- RG316/U 50Ohm coaxial cable
- 1671A 50Ohm coaxial cable

Suitable cables are offered, for example, by IMS Connector Systems. For further details and other cable types please contact http://www.imscs.com.

Please note that the GSM antenna must be isolated for ESD and SAR protection (to withstand a voltage resistance up to 8kV air discharge).

4.3 Antenna Connector

For GSM and GPS, XT65/XT75 uses an ultra-miniature SMT antenna connector supplied from Hirose Ltd. The product name is:

- U.FL-R-SMT

The position of the antenna connector on the XT65/XT75 board can be seen in Section 4.1.

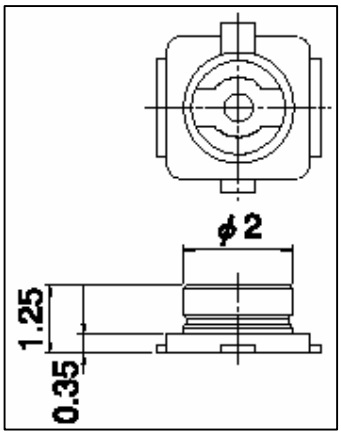


Figure 4: Mechanical dimensions of U.FL-R-SMT connector

Table 7: Product specifications of U.FL-R-SMT connector

Item	Specification	Conditions
Ratings		
Nominal impedance	50Ω	Operating temp:-40°C to + 90°C Operating humidity: max. 90%
Rated frequency	DC to 3GHz	
Mechanical characteristics		
Female contact holding force	0.15N min	Measured with a ∅ 0.475 pin gauge
Repetitive operation	Contact resistance: Center 25mΩ Outside 15mΩ	30 cycles of insertion and disengagement
Vibration	No momentary disconnections of 1µs; No damage, cracks and looseness of parts	Frequency of 10 to 100Hz, single amplitude of 1.5mm, acceleration of 59m/s^2, for 5 cycles in the direction of each of the 3 axes
Shock	No momentary disconnections of 1µs. No damage, cracks and looseness of parts.	Acceleration of 735m/s^2, 11ms duration for 6 cycles in the direction of each of the 3 axes
Environmental characteristics		
Humidity resistance	No damage, cracks and looseness of parts. Insulation resistance: 100MΩ min. at high humidity 500MΩ min. when dry	Exposure to 40°C, humidity of 95% for a total of 96 hours

Table 7: Product specifications of U.FL-R-SMT connector

Item	Specification	Conditions
Temperature cycle	No damage, cracks and looseness of parts. Contact resistance: Center 25mΩ Outside 15mΩ	Temperature: +40°C → 5 to 35°C → +90°C → 5 to 35°C Time: 30min → within 5min → 30min within 5min
Salt spray test	No excessive corrosion	48 hours continuous exposure to 5% salt water

Table 8: Material and finish of U.FL-R-SMT connector and recommended plugs

Part	Material	Finish
Shell	Phosphor bronze	Silver plating
Male center contact	Brass	Gold plating
Female center contact	Phosphor bronze	Gold plating
Insulator	Plug: PBT Receptacle: LCP	Black Beige

Mating plugs and cables can be chosen from the Hirose U.FL Series. Examples are shown below and listed in Table 19. For latest product information please contact your Hirose dealer or visit the Hirose home page, for example http://www.hirose.com.

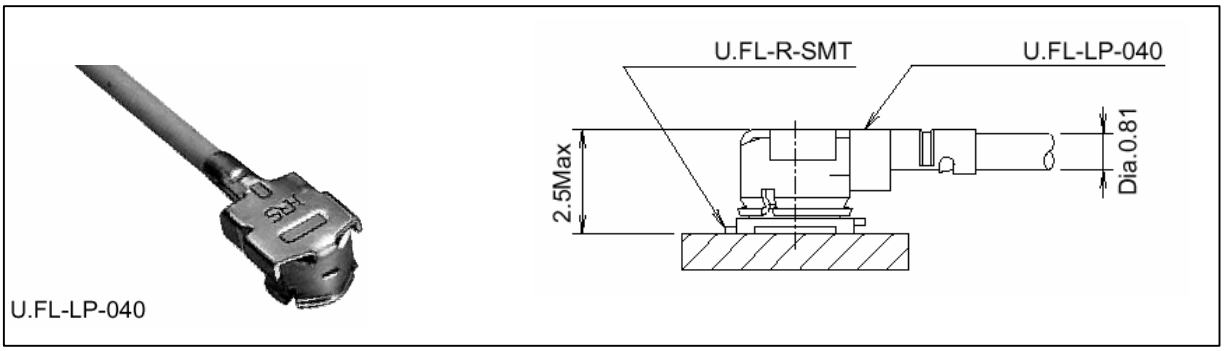


Figure 5: U.FL-R-SMT connector with U.FL-LP-040 plug

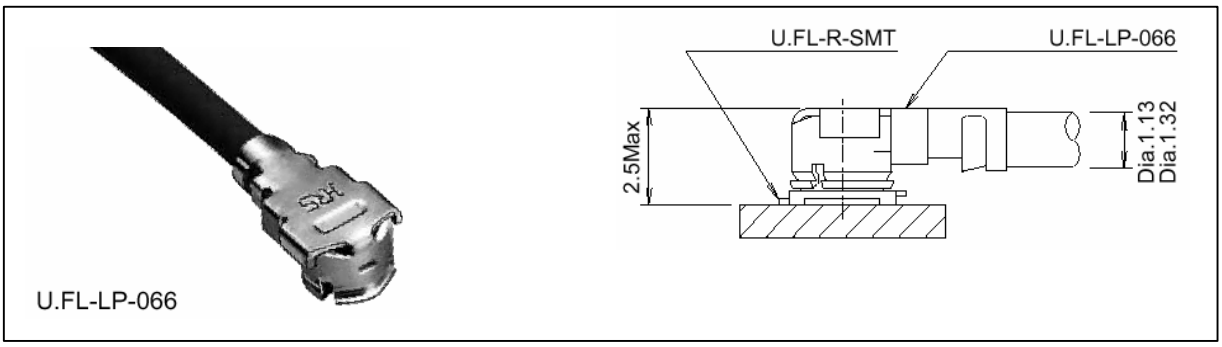


Figure 6: U.FL-R-SMT connector with U.FL-LP-066 plug

In addition to the connectors illustrated above, the U.FL-LP-(V)-040(01) version is offered as an extremely space saving solution. This plug is intended for use with extra fine cable (up to ∅ 0.81mm) and minimizes the mating height to 2mm. See Figure 46 which shows the Hirose datasheet.

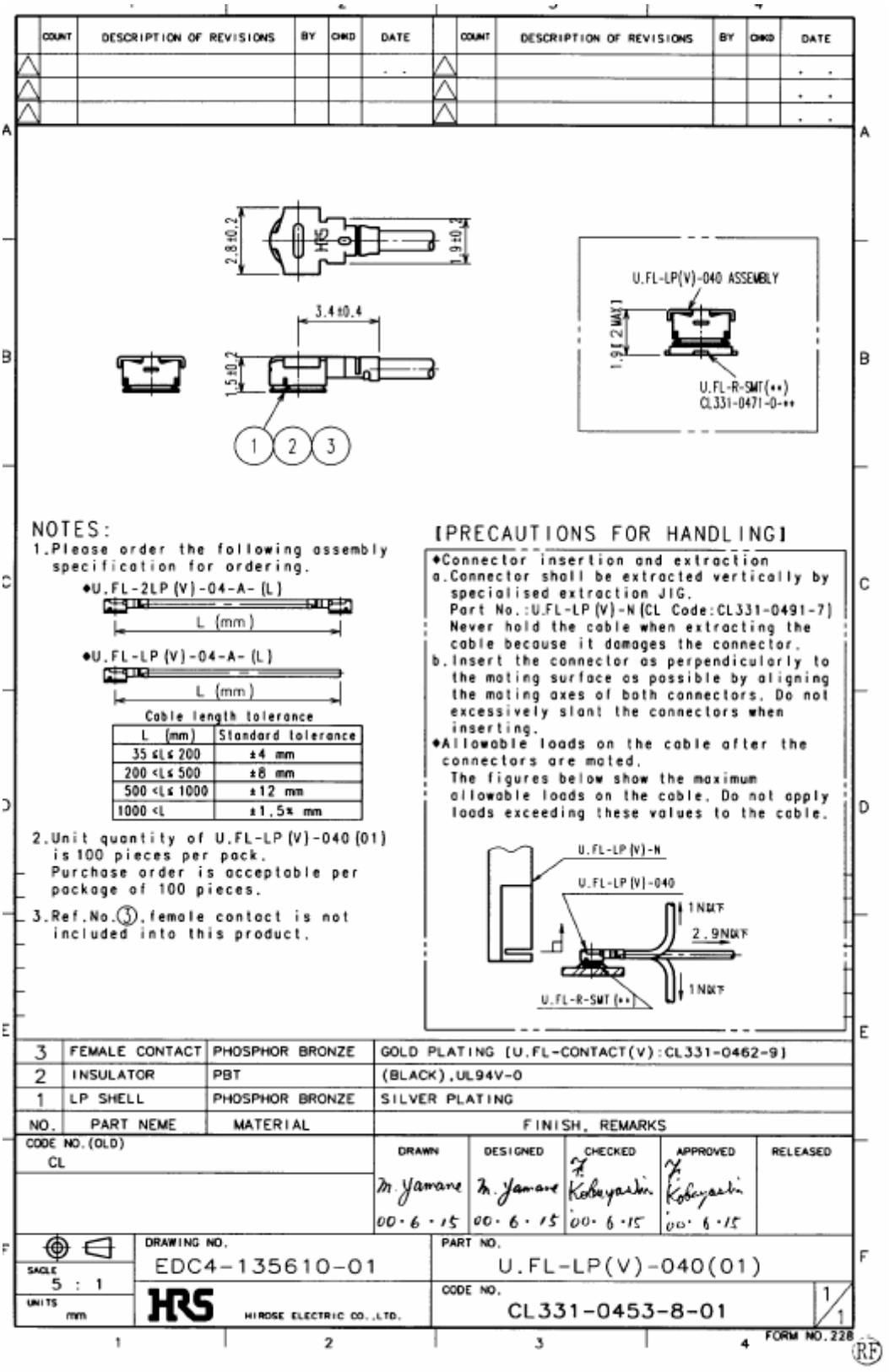


Figure 7: Specifications of U.FL-LP-(V)-040(01) plug

Table 9: Ordering information for Hirose U.FL Series

Item	Part number	HRS number
Connector on XT65/XT75	U.FL-R-SMT	CL331-0471-0-10
Right-angle plug shell for ∅ 0.81mm cable	U.FL-LP-040	CL331-0451-2
Right-angle plug for ∅ 0.81mm cable	U.FL-LP(V)-040 (01)	CL331-053-8-01
Right-angle plug for ∅ 1.13mm cable	U.FL-LP-068	CL331-0452-5
Right-angle plug for ∅ 1.32mm cable	U.FL-LP-066	CL331-0452-5
Extraction jig	E.FL-LP-N	CL331-04441-9

5 GPS Antenna Interface

In order to receive satellite signals an additional GPS antenna must be connected to the GPS part of the XT65/ XT75 module.

5.1 Antenna Installation

To suit the physical design of individual applications XT65/XT75 offers two alternative approaches to connecting the antenna:

- Recommended approach: U.FL-R-SMT antenna connector from Hirose assembled on the component side of the PCB. The GPS antenna connector is the same as for the GSM antenna connector. For details see Section 5.3.

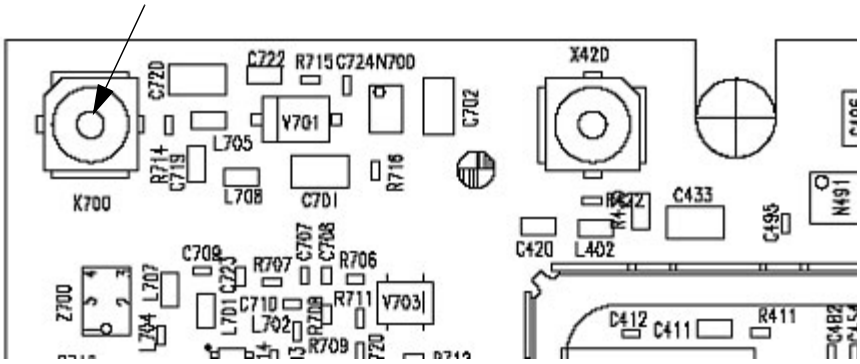


Figure 8: GPS antenna connector placement

- Antenna pad and grounding plane placed on the bottom side of the PCB. For some notes on soldering the antenna to the pad see Section 5.2.

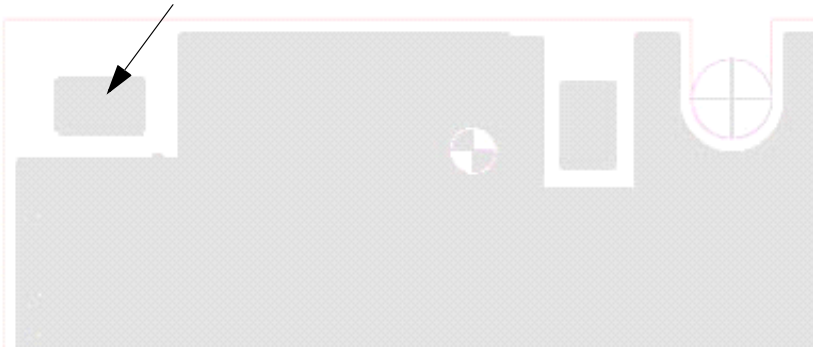


Figure 9: GPS antenna pad placement

Note that it is not possible to employ both alternatives at the same time.

5.2 GPS Antenna

It is possible to connect active or passive GPS antennas. In either case they must have 50 Ohm impedance. The application should be designed in a way to achieve a minimum of 6dB decoupling between the GSM/DCS/PCS antenna path and the GPS antenna path. Please note that the GPS antenna must be isolated for ESD protection (to withstand a voltage resistance up to 8kV air discharge).

Active versus Passive Antennas

Passive antennas contain only the radiating element, e.g. the ceramic patch or the quadrifilar dipole structure. Sometimes they also contain a passive matching network to match the electrical connection to 50 Ohms impedance. Note: Passive antenna need not have a DC connection to ground.

Active antennas have an integrated low-noise amplifier (in some cases an additional GPS band pass filter). This is beneficial in two respects: First, the losses of the cable do no longer influence the overall noise figure of the GPS receiver system. Secondly, even the receiver noise figure can be higher without sacrificing performance. Active antennas need a power supply that will contribute to GPS system power consumption, typically in the region of 5 to 20 mA. The supply voltage is fed to the antenna through the coaxial RF cable.

Inside the antenna, the DC component on the inner conductor will be separated from the RF signal and routed to the supply pin of the LNA.

The use of an active antenna is always advisable, if the RF-cable length between receiver and antenna exceeds about 10 cm.

Table 10: GPS antenna: Active versus Passive

Active Antenna	Passive Antenna
Active antenna connected to the GPS module.	Passive patch antennas or quadrifilar dipole antennas connected with a microcoax to the GPS module
• A wide range of active patch or quadrifilar dipole antennas is available in the market. They differ in size, sensitivity, selectivity and power consumption • Less sensitive to jamming than a passive antenna, as the placement of the active antenna is usually some distance away of other noise or signal radiating devices. • Needs more power than a passive antenna • Easier and less sensitive to jamming. • More freedom to place the antenna[1]	• Passive patch antennas or helical antennas are available in different form factors and sensitivity • Antenna must be connected with a low insertion loss line to the GPS module to ensure a good GPS sensitivity. • The PCB design with a passive antenna must consider the sensitivity of the GPS antenna to other radiating circuits or general signal jamming. • Due to the proximity of the GPS antenna to other electronic circuits, in-band jamming may become a critical issue. • Only suitable for RF experts! • Needs more experience in RF design. • Requires more effort to optimise the circuit design to minimize jamming into the antenna and the antenna signal routing.

1. Some cars for instance have a metallic coating on the windshield. GPS reception may not be possible in such a car. There is usually a small section, typically behind the rear view mirror without the coating for mobile phone and GPS antennas. The antenna has to be placed with optimal sky visibility. An external antenna (e.g. with a magnetic base) is easier to use and usually allows a better positioning.

Note: If you are not an expert in RF designs, you should implement an active antenna setup and place the antenna away from any emitting circuits.

6 Electrical, Reliability and Radio Characteristics

6.1 Absolute Maximum Ratings

The absolute maximum ratings stated in Table 11 are stress ratings under any conditions. Stresses beyond any of these limits will cause permanent damage to XT65/XT75.

The power supply connected to the XT65/XT75 module shall be compliant with the SELV requirements defined in EN60950. Above all, the peak current of the power supply shall be limited according to Table 11.

Table 11: Absolute maximum ratings

Parameter	Min	Max	Unit
Peak current of power supply		3.2	A
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[1]	-0.3	2.75	V
Voltage at analog pins, VMIC off[1]	-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	510	V
VDDLP	-0.3	5.5	V
GSM antenna	-36	36	V
GPS antenna	-0.3	V_{BATT+}+0.3	V

1. 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.

6.2 Operating Temperatures

Table 12: Board temperature

Parameter	Min	Typ	Max	Unit
Automatic shutdown[1]				
Temperature measured on XT65/XT75 board	-30	---	>+80	°C
Temperature measured at battery NTC	-20	---	+60	

1. 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.

Table 13: Ambient temperature according to IEC 60068-2 (without forced air circulation)

Parameter	Min	Typ	Max	Unit
Operating temperature range	-30	+25	+65	°C
Restricted operation (with VBATT ≤ 3,8V)			+70	°C
Restricted operation[1]		---	+70 to +85	°C

1. Restricted operation allows normal mode speech calls or data transmission for limited time until automatic thermal shutdown takes effect. For operating the XT75/65 above an expected ambient temperatures of 75°C please contact Siemens Application Engineering. The duration of emergency calls is unlimited because automatic thermal shutdown is deferred until hang up.

Table 14: Charging temperature

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

6.3 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 15: 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 recom-mended		IEC TR 60271-3-1: 1C1L
Mechanically active substances	Not recom-mended		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	

6.4 Reliability Characteristics

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

Table 16: 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

6.5 Pin Assignment and Signal Description

The Molex board-to-board connector on XT65/XT75 is an 80-pin double-row receptacle. The position of the board-to-board connector can be seen in Figure 11 that shows the top view of XT65/XT75.

1	GND	GND	80
2	ADC1_IN	DAC_OUT	79
3	ADC2_IN	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	not connected	53
29	not connected	CTS0	52
30	RXD0	Pull up	51
31	Pull up	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 10: Pin assignment (component side of XT65/XT75)

Please note that the reference voltages listed in Table 17 are the values measured directly on the XT65/XT75 module. They do not apply to the accessories connected.

Table 17: Signal description

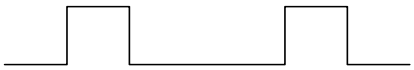
Function	Signal name	IO	Signal form and level	Comment
Power supply	BATT+	I	V_I = 3.3V to 4.5V $V_I$typ = 3.8V I ≈ 2A, during Tx burst  n Tx = n x 577µs peak current every 4.616ms	Five pins of BATT+ and GND must be connected in parallel for supply purposes because higher peak currents may occur.
Power supply	GND		Ground	Application Ground
Charge Interface	VCHARGE	I	$V_I$min = 3.1 V $V_I$max = 5.25V	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.	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	Connect ISENSE directly at the shunt for current measurement. 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	$V_I$max = 5.5V $I_I$max = 0.6mA (for fast charging)	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 $C_{load,max,extern}$ = 1µF	VEXT may be used for application circuits, for example to supply power for an I^2C. 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.

Table 17: Signal description

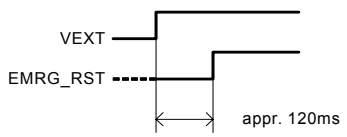
Function	Signal name	IO	Signal form and level	Comment
Power indicator	PWR_IND	O	V_{IH}max = 10V V_{OL}max = 0.4V at Imax = 2mA	PWR_IND (Power Indicator) notifies the module's on/off state. PWR_IND is an open collector that needs to be connected to an external pull-up resistor. Low state of the open collector 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 = V_{BATT+} ON ˜˜˜|____|˜˜˜ Active Low ≥ 300ms	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 shut down in case of emergency: Pull down and release EMERG_RST. Then, activating IGT for 400ms will reset XT65/XT75. If IGT is not activated for 400ms, XT65/XT75 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:  	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.

Table 17: Signal description

Function	Signal name	IO	Signal form and level	Comment
Synchronization	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 XT65/XT75. 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	$R_I \approx 1k\Omega$ $V_O$max = 4.5V V_{BATT+} = 4.2V: V_O = 3.3V at I_O = -500µA V_{BATT+} = 0V: VI = 2.4V…4.5V at Imax = 25µA	If unused keep pin open.
ASC0 Serial interface	RXD0	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	Serial interface for AT commands or data stream. If lines are unused keep pins open.
	TXD0	I		
	CTS0	O		
	RTS0	I		
	DTR0	I		
	DCD0	O		
	DSR0	O		
	RING0	O		

Table 17: Signal description

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 = -25µA $V_{IH}min = 2.1V$ at I = -10µA $V_Omax = 3.05V$	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	

Table 17: Signal description

Function	Signal name	IO	Signal form and level	Comment
SIM interface specified for use with 1.8V SIM card	CCIN	I	$R_I \approx 100k\Omega$ V_{IL}max = 0.6V at I = -25µA V_{IH}min = 2.1V at I = -10µA $V_O$max = 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	$V_O$min = 1.70V, $V_O$typ = 1.80V $V_O$max = 1.90V $I_O$max = -20mA	
	CCGND		Ground	
I^2C interface	I2CCLK _SPICLK	O	V_{OL}max = 0.2V at I = 2mA V_{OH}min = 2.55V at I = -0.5mA V_{OH}max = 3.05V	I^2C interface is only available if the two pins are not used as SPI interface. I2CDAT is configured as Open Drain and needs a pull-up resistor in the host application. According to the I^2C 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 (I^2C Slave + lines). The maximum sink current of I2CDAT and I2CCLK is 4mA. If lines are unused keep pins open.
	I2CDAT_SPIDO	I/O	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	

Table 17: Signal description

Function	Signal name	IO	Signal form and level	Comment
SPI Serial Peripheral Interface	SPIDI	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	If the Serial Peripheral Interface is active the I^2C interface is not available. If lines are unused keep pins open.
	I2CDAT_SPIDO	O		
	I2CCLK_SPICLK	O		
	SPICS	O		
USB	VUSB_IN	I	V_{IN}min = 4.0V V_{IN}max = 5.25V	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.
	USB_DN	I/O	Differential Output Crossover voltage Range V_{CRS}min = 1.5V, V_{CRS}max = 2.0V Driver Output Resistance Z_{DRVtyp} = 32Ohm	
	USB_DP	I/O		
Digital Audio interface	DAI0 (USC0)	I/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	DAI0…DAI6 are configurable as PCM interface
	DAI1 (USC1)	I/O		
	DAI2 (USC2)	I/O		
	DAI3 (USC3)	I/O		
	DAI4 (USC4)	I/O		
	DAI5 (USC5)	I/O		
	DAI6 (USC6)	I/O		
General Purpose Input/Output	GPIO1	I/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	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. Alternatively, the GPIO10 pin can be configured as a pulse counter for pulse rates from 0 to 1000 pulses per second.
	GPIO2	I/O		
	GPIO3	I/O		
	GPIO4	I/O		
	GPIO5	I/O		
	GPIO6	I/O		
	GPIO7	I/O		
	GPIO8	I/O		
	GPIO9	I/O		
	GPIO10	I/O		

Table 17: Signal description

Function	Signal name	IO	Signal form and level	Comment
Analog Digital Converter	ADC1_IN	I	Input voltage: VImin = 0V, VImax = 2.4V Ri ≈ 750kOhms Measurement interval: 100ms - 30s selectable by AT command Sensitivity, accuracy: 2400 steps (1step = 1mv) Cut-off frequency: 30 Hz Underflow: ≥ -25mV Overflow: ≥ +2425 mV Accuracy: ± 0.5mV Linear error: ± 0.5mV Temperature error: ± 0.5mV Burst error: ± 0.5mV	Inputs used for measuring external voltages. In the range of 0mV to 2400mV. Use the command AT^SRADC to select analog inputs ADC1_IN or ADC2_IN, to set the measurement mode and read out the results. The values are indicated in mV. ADC1_IN and ADC2_IN are internally multiplexed through analog switch. Important: For restrictions during SLEEP mode see [1].
	ADC2_IN	I		
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.

Table 17: Signal description

Function	Signal name	IO	Signal form and level	Comment
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 4.2Vpp differential maximal @ 3.14dBm0 Measurement conditions: Audio mode: 6 Outstep 3 No load Minimum differential resp. single ended load 27Ohms	The audio output can directly operate a 32-Ohm-loudspeaker. If unused keep pins open.
	EPN2	O		
	EPP1	O	4.2Vpp (differential) typical @ 0dBm0 6.0Vpp differential maximal @ 3.14dBm0 Measurement conditions: Audio mode: 5 Outstep 4 No load Minimum differential resp. single ended load 7.5Ohms	The audio output can directly operate an 8-Ohm-loudspeaker. If unused keep pins open.
	EPN1	O		
	MICP1	I	Differential Line Input Configuration. Apply external bias of 1.5V at MICN1 Full Scale Input Voltage: 1.6 Vpp 0dBm0 Input Voltage: 1.1 Vpp Measurement conditions: Audio mode: 5 ^SNFI: 0,32767 => PGA = 0dB Ri = 100 kOhm (typical)	Balanced or single ended microphone or line input with external feeding circuit (using VMIC and AGND). If unused keep pins open.
	MICN1	I		
	MICP2	I	Differential Line Input Configuration. Apply external bias of 1.5V at MICN2 Full Scale Input Voltage1.6 Vpp 0dBm0 Input Voltage1.1 Vpp Measurement conditions: Audio mode: 6 ^SNFI: 0,32767 => PGA = 0dB Ri = 100 kOhm (typical)	Balanced or single ended microphone or line input with external feeding circuit (using VMIC and AGND) and accessory detection circuit. If unused keep pins open.
	MICN2	I		
	AGND		Analog Ground	GND level for external audio circuits

[1] **Restrictions during SLEEP mode:**
During SLEEP Mode the ADC is shut down temporarily (per default). Please make sure that during SLEEP Mode shutdown the ADCx_IN input voltage does not exceed ±0.3V. The input current (reverse feeding) may reach 3mA!
If SLEEP Mode is activated there are three protection possibilities:
- Use an RC combination for current limitation.
Advantages: Lowest current consumption at SLEEP Mode, small component count, high input resistance
Disadvantages: Lower input resistance at Sleep Mode (100k only).
- Use the AT^SNFM=,1 command to enable the ADC supply continuously .
Advantages: No additional component components needed.
Disadvantages: Higher current consumption in SLEEP (about 2mA)
- Detect presence of VMIC-voltage. If VMIC is off, make sure that ADCx_IN input voltages does not exceed ±0.3V
Advantages: Lowest current, high input resistance.
Disadvantages: Effort for SLEEP Mode (VMIC) detection.

6.6 Power Supply Ratings

Table 18: Power supply ratings

Parameter	Description	Conditions	Min	Typ	Max	Unit
BATT+	Supply voltage	Directly measured at reference point TP BATT+ and TP GND. 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 @ f>200kHz			 50 2	 mV mV
I_{VDDLP}	OFF State supply current	RTC Backup @ BATT+ = 0V		40		µA
I_{BATT+}		POWER DOWN mode[1]		60	120	µA
	Average standby supply current[2] **(GPS off)**	SLEEP mode @ DRX = 9		3.7[3]		mA
		SLEEP mode @ DRX = 5		4.6[3]		mA
		SLEEP mode @ DRX = 2		7.0[3]		mA
		IDLE mode @ DRX = 2		28[4]		mA
	Average supply current for GPS part **(GSM in IDLE mode, w/o active GPS antenna)**	Satellite acquisition (no position found)		68		mA
		Tracking mode[5]		70		mA
		Sleep state		32		mA
		Shut down mode		28		mA

1. 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.
2. 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
3. Stated value applies to operation without autobauding (AT+IPR≠0).
4. 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.
5. 1 fix/s, tracking on 6 channels, depends on FXN configuration settings

7 Mechanics

7.1 Mechanical Dimensions of XT65/XT75

Figure 11 shows the top view of XT65/XT75 and provides an overview of the board's mechanical dimensions. For further details see Figure 12.

Length: 55.00mm

Width: 33.90mm

Height: 3.15mm

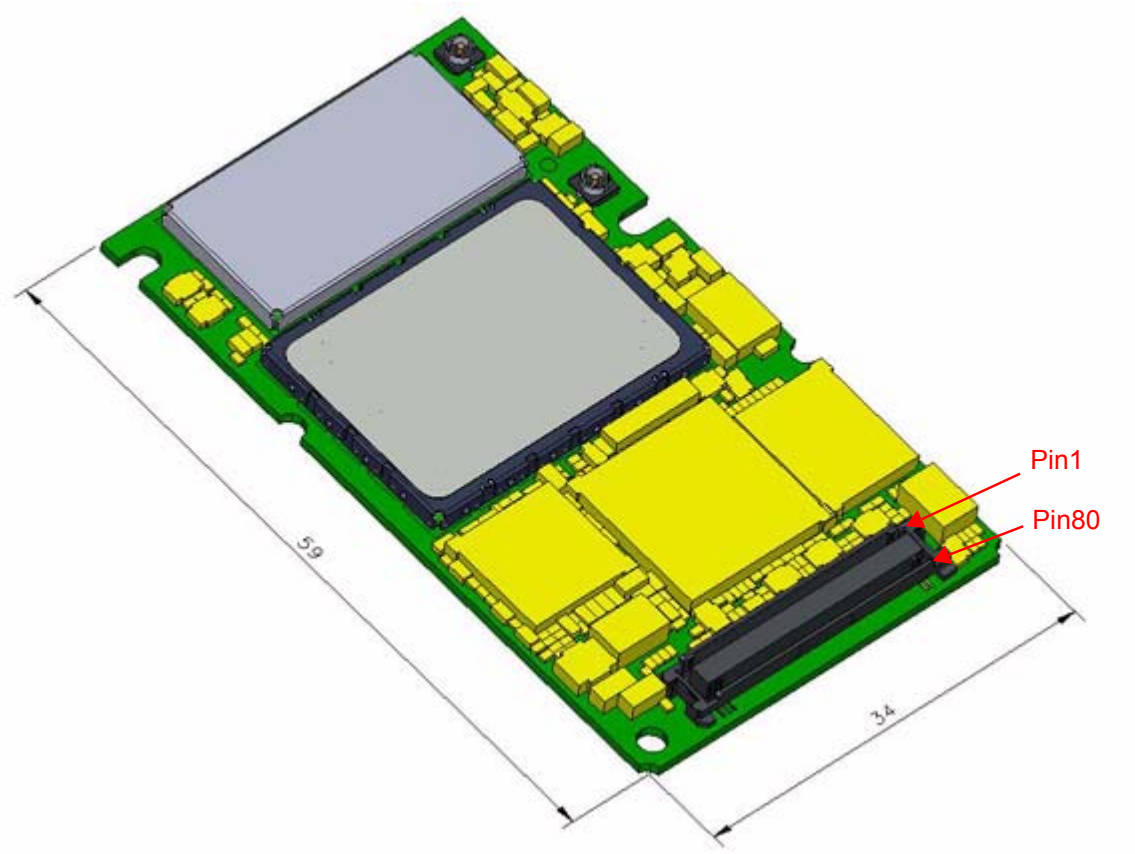


Figure 11: XT65/XT75– top view

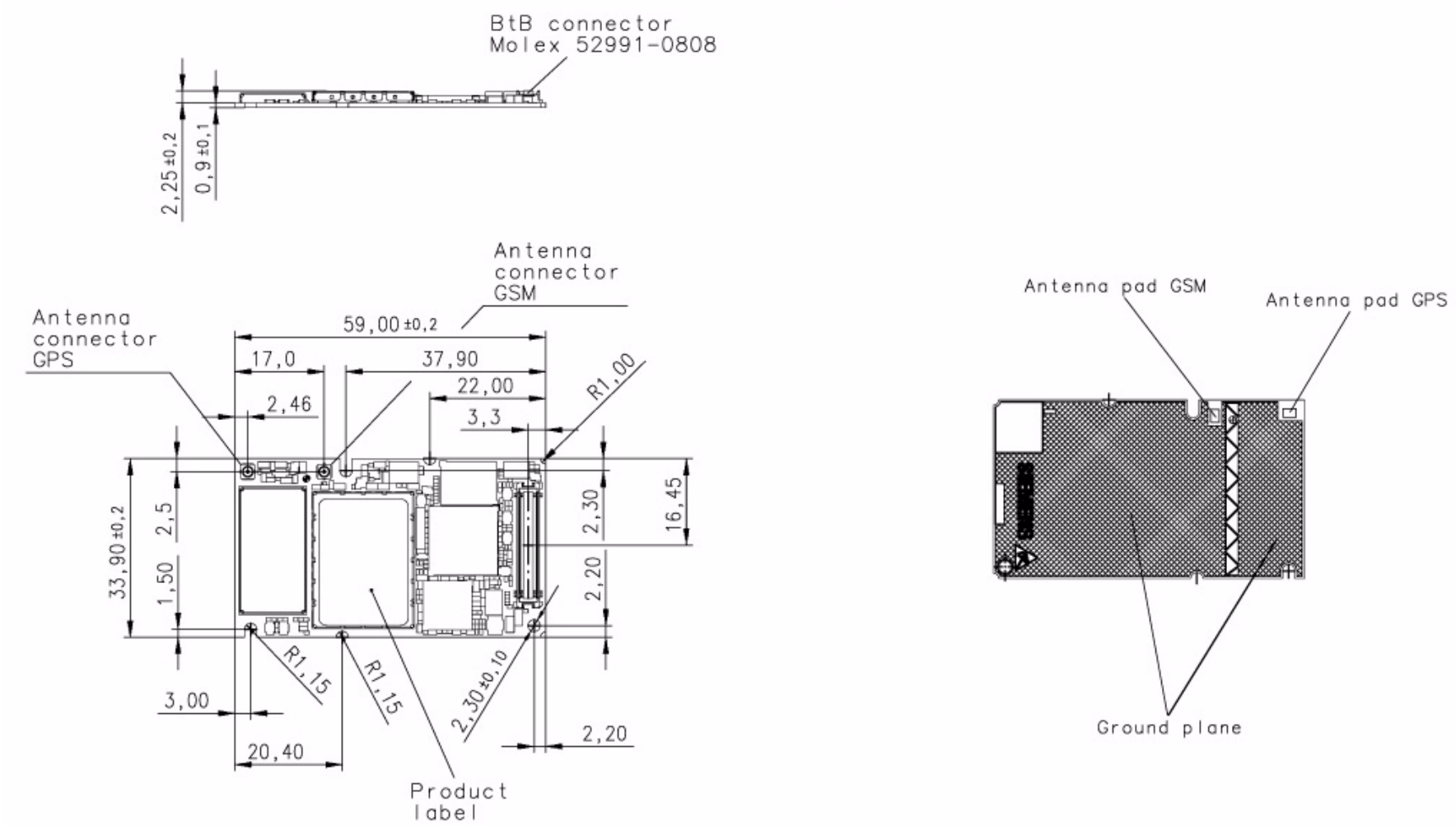


Figure 12: Dimensions of XT65/XT75 (all dimensions in mm)

7.2 Mounting XT65/XT75 to the Application Platform

There are many ways to properly install XT65/XT75 in the host device. An efficient approach is to mount the XT65/XT75 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 Section 9.2.

When using the two small holes take care that the screws are inserted with the screw head on the bottom of the XT65/XT75 PCB. Screws for the large holes can be inserted from top or bottom.

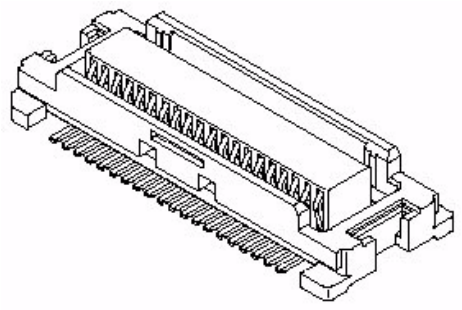
For proper grounding it is strongly recommended to use large ground plane on the bottom of board in addition to the five GND pins of the board-to-board connector. The ground plane may also be used to attach cooling elements, e.g. a heat sink or thermally conductive tape. Please take care that attached cooling elements do not touch the antenna pads on the module's bottom side, as this may lead a short-circuit.

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

7.3 Board-to-Board Application Connector

This section provides the specifications of the 80-pin board-to-board connector used to connect XT65/XT75 to the external application.

Connector mounted on the XT65/XT75 module:



Type: 52991-0808 SlimStack Receptacle 80 pins, 0.50mm pitch, for stacking heights from 3.0 to 4.0mm, see Figure 14 for details.

Supplier: Molex, http//www.molex.com

Table 19: 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:

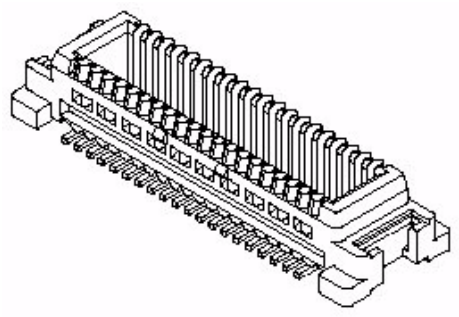


Figure 13: Mating board-to-board connector 53748-0808 on application

- 53748-0808 SlimStack Plug, 3mm stacking height,
  see Figure 15 for details.
- 53916-0808 SlimStack Plug, 4mm stacking height

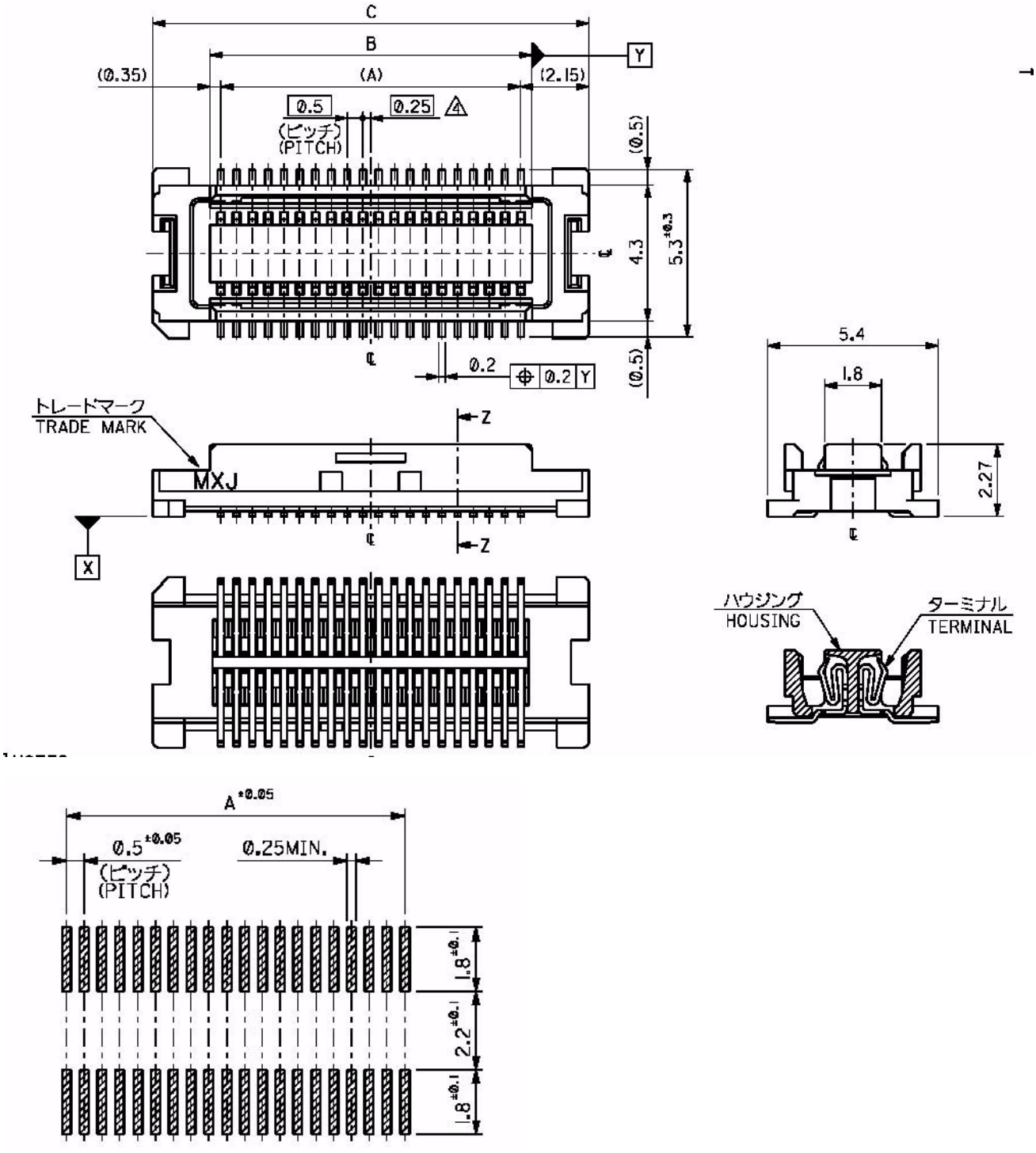


Figure 14: Molex board-to-board connector 52991-0808 on XT65/XT75

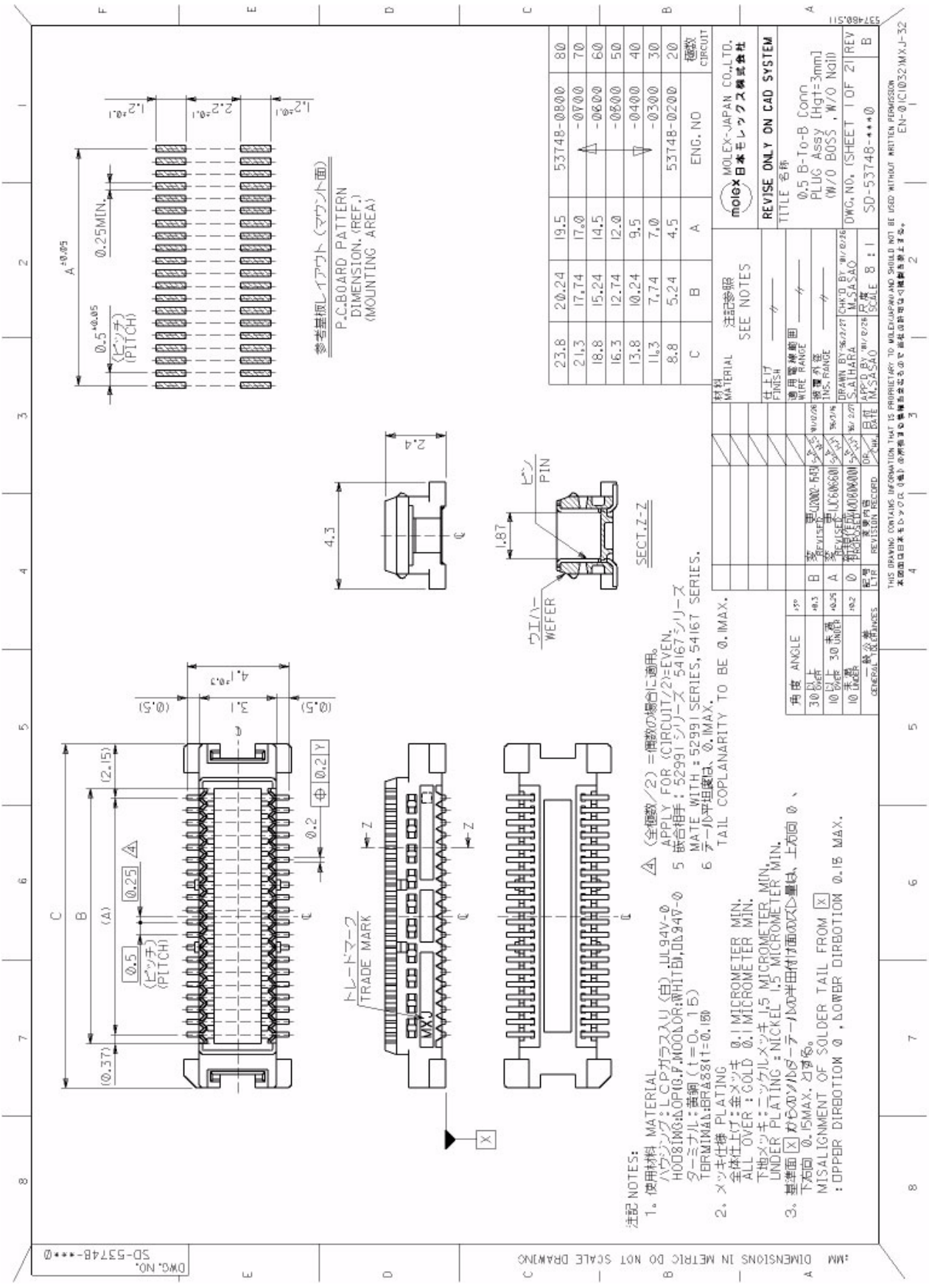


Figure 15: Mating board-to-board connector 53748-0808 on application

8 Reference Approval

8.1 Reference Equipment for Type Approval

The Siemens reference setup submitted to type approve XT65/XT75 consists of the following components:

- Siemens XT65/XT75 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

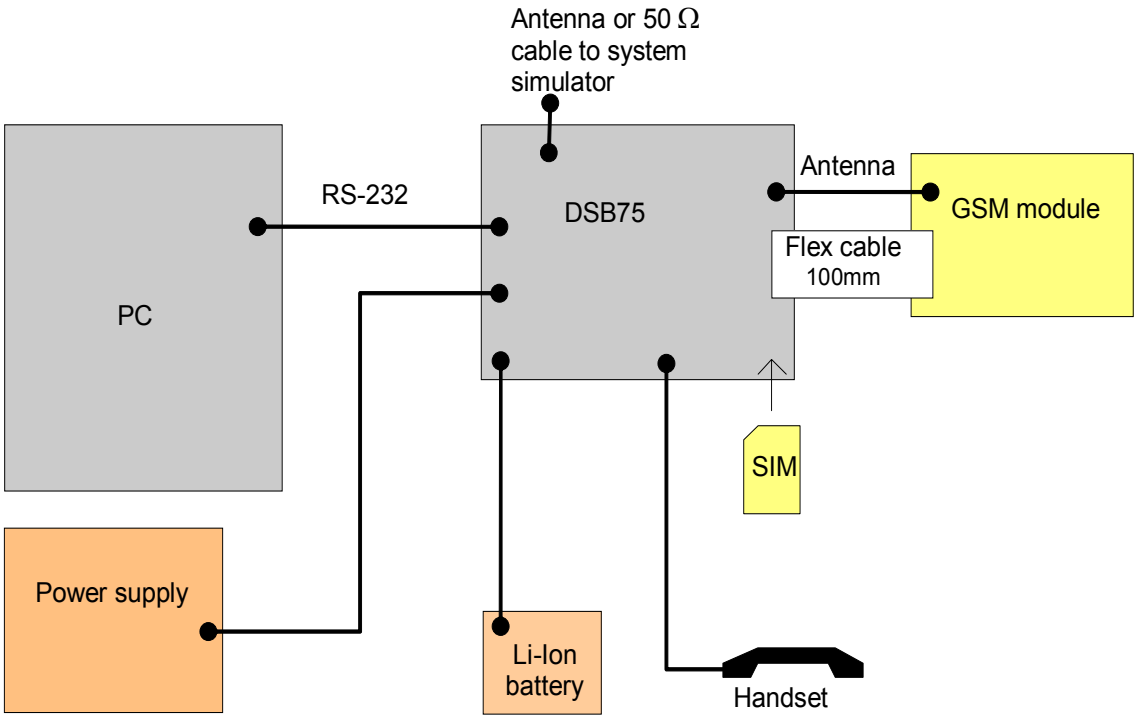


Figure 16: Reference equipment for Type Approval

8.2 Compliance with FCC Rules and Regulations

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

FCC Identifier: QIPXT65
Industry Canada Certification Number: 267W-XT65
Granted to Siemens AG

FCC Identifier QIPXT75
Industry Canada Certification Number: 267W-XT75
Granted to Siemens AG

Manufacturers of mobile or fixed devices incorporating XT65/XT75 modules are authorized to use the FCC Grants and Industry Canada Certificates of the XT65/XT75 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 XT65" resp. "Contains FCC ID QIP XT75".

IMPORTANT:
Manufacturers of portable applications incorporating XT65/XT75 modules are required to have their final product certified and apply for their own FCC Grant and Industry Canada Certificate related to the specific portable mobile. This is mandatory to meet the SAR requirements for portable mobiles (see Section 1.3.2 for detail).

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

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 20: List of parts and accessories

Description	Supplier	Ordering information
XT65	Siemens	Standard module (Siemens IMEI) Siemens ordering number: L36880-N8835-A100 Customer IMEI mode: Siemens Ordering number: L36880-N8836-A100
XT75	Siemens	Standard module (Siemens IMEI) Siemens ordering number: L36880-N8830-A100 Customer IMEI mode: Siemens Ordering number: L36880-N8831-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 21.
Board-to-board connector	Molex	Sales contacts are listed in Table 21.

Table 21: 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

Table 22: Hirose sales contacts (subject to change)

Hirose Ltd. For further information please click: http://www.hirose.com	Hirose Electric (U.S.A.) Inc 2688 Westhills Court Simi Valley, CA 93065 U.S.A. Phone: +1-805-522-7958 Fax: +1-805-522-3217	Hirose Electric GmbH Zeppelinstrasse 42 73760 Ostfildern Kemnat 4 Germany Phone: +49-711-4560-021 Fax +49-711-4560-729 E-mail info@hirose.de
Hirose Electric UK, Ltd Crownhill Business Centre 22 Vincent Avenue, Crownhill Milton Keynes, MK8 OAB Great Britain Phone: +44-1908-305400 Fax: +44-1908-305401	Hirose Electric Co., Ltd. 5-23, Osaki 5 Chome, Shinagawa-Ku Tokyo 141 Japan Phone: +81-03-3491-9741 Fax: +81-03-3493-2933	Hirose Electric Co., Ltd. European Branch First class Building 4F Beechavenue 46 1119PV Schiphol-Rijk Netherlands Phone: +31-20-6557-460 Fax: +31-20-6557-469

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

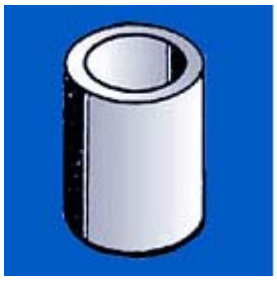
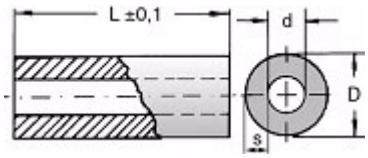
http://www.ettinger.de/main.cfm

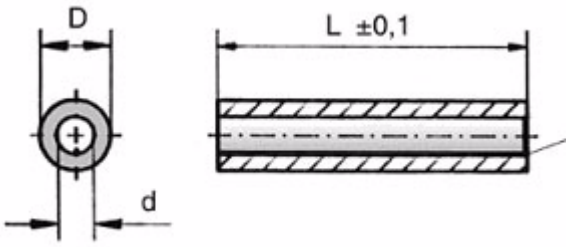
Phone: +4981 04 66 23 – 0

Fax: +4981 04 66 23 – 0

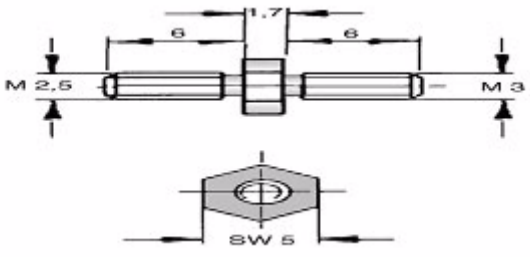
The following tables contain only article numbers and basic parameters of the listed components. For further detail and ordering information please contact Ettinger GmbH.

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[1]
Length	3.0mm
Material	Polyamide 6.6
Surface	Black
Internal diameter	2.2mm
External diameter	4.0mm
Flammability rating	UL94-HB
	

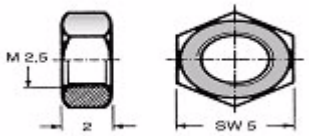
[1] 2 spacers are delivered with DSB75 Support Board

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[1] 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
	

1. 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[1] DIN 934 - ISO 4032
Material	Steel 4.8
Surface	Zinced A2K
Thread	M2
Wrench size / ∅	4
Thickness / L	1.6mm
Type	Nut DIN/UNC, DIN934
	

1. 2 nuts are delivered with DSB75 Support Board