CINTERION
WIRELESS MODULES

Hardware Interface Description

EU3-E

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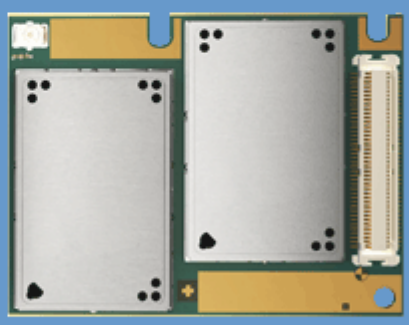

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Contents

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0 Document History

Preceding document: "EU3-E Hardware Interface Description" Version 00.295
New document: "EU3-E Hardware Interface Description" Version **01.000**

Chapter	What is new
Throughout document	STATUS0 and STATUS1 lines have been replaced by SYNC pin. Appropriate sections, figures and tables were modified accordingly.
1.3.1	Updated Table 2 listing standards of type approval.
3.3.1.3	Added remark that EMERG_OFF should only be used in case of serious problems.
3.3.2	Revised defined states for GPIO lines.
3.4.4	Added figure showing timing of CTS0 line during power saving.
3.10.1	Added section describing behavior of RING0 line.
5.3, 5.4	Renamed all IEC 68-* standards to IEC 60068-*.
5.5	Revised Figure 27 and added characteristics for signal lines marked as "Do not use". Adapted Table 21 accordingly.
5.8	Added values for RF power@ARP and Pout@ARP.
5.2	Added operating temperature values.
5.6	Added power supply ratings.

Preceding document: "EU3-E Hardware Interface Description" Version 00.125
New document: "EU3-E Hardware Interface Description" Version 00.295

Chapter	What is new
2.1	Updated frequency bands.
3.1	Changed brief description of operating modes.
3.3.3.1	Removed "^SHUTDOWN" URC.
5.6	Updated Table 22.

Preceding document: "EU3-E Hardware Interface Description" Version 00.001
New document: "EU3-E Hardware Interface Description" Version 00.125

Chapter	What is new
2.1	Added module weight.
3.3.1.3	Modified use of EMERG_OFF line: EMERG_OFF can also be used to reset module.
3.3.2	Revised table listing signal states after startup.
3.9	Replaced Figure 17.

5.5	Added VSENSE signal - pin 67 (see also 5.6, 5.9). Revised pin assignment shown in Figure 27. Revised electrical characteristics for the following signals described in Table 21: VEXT, IGT, EMERG_OFF, CCIO, ASC0, GPIO, EPP, EPN, MICP, MICN. Replaced "32 Load" with "No load" for EPP/EPN in Table 21.
5.7.5	Revised first two lines of Table 26.
7	New chapter "Sample Application".
9.1	Added ordering numbers for customer IMEI module variant as well as DSB75 adapter.

New document: "EU3-E Hardware Interface Description" Version 00.001

Chapter	What is new
--	Initial document setup.

1 Introduction

The document[1] describes the hardware of the EU3-E module, 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.

1.1 Related Documents

[1] EU3-E AT Command Set
[2] EU3-E Release Notes
[3] Application Note 39: USB Interface Description

1.2 Terms and Abbreviations

Abbreviation	Description
ANSI	American National Standards Institute
AMR	Adaptive Multirate
ARP	Antenna Reference Point
B2B	Board-to-board connector
BB	Baseband
BEP	Bit Error Probability
BTS	Base Transceiver Station
CB or CBM	Cell Broadcast Message
CE	Conformité Européene (European Conformity)
CS	Coding Scheme
CS	Circuit Switched
CSD	Circuit Switched Data
DAC	Digital-to-Analog Converter
DCS	Digital Cellular System
DL	Download
DRX	Discontinuous Reception
DSB	Development Support Board
DSP	Digital Signal Processor
DTMF	Dual Tone Multi Frequency

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

Abbreviation	Description
DTX	Discontinuous Transmission
EDGE	Enhanced Data rates for GSM Evolution
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
EMC	Electromagnetic Compatibility
ERP	Effective Radiated Power
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission (U.S.)
FDD	Frequency Division Duplex
FDMA	Frequency Division Multiple Access
FR	Full Rate
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
HiZ	High Impedance
HSDPA	High Speed Downlink Packed Access
HR	Half Rate
I/O	Input/Output
IF	Intermediate Frequency
IMEI	International Mobile Equipment Identity
ISO	International Standards Organization
ITU	International Telecommunications Union
kbps	kbits per second
LED	Light Emitting Diode
Mbps	Mbits per second
MCS	Modulation and Coding Scheme
MO	Mobile Originated
MS	Mobile Station, also referred to as TE
MT	Mobile Terminated
NTC	Negative Temperature Coefficient
PBCCH	Packet Switched Broadcast Control Channel
PCB	Printed Circuit Board
PCL	Power Control Level
PCM	Pulse Code Modulation
PCS	Personal Communication System, also referred to as GSM 1900

Abbreviation	Description
PS	Packet Switched
PDU	Protocol Data Unit
PSK	Phase Shift Keying
R&TTE	Radio and Telecommunication Terminal Equipment
RACH	Random Access Channel
RF	Radio Frequency
RTC	Real Time Clock
Rx	Receive Direction
SAR	Specific Absorption Rate
SELV	Safety Extra Low Voltage
SIM	Subscriber Identification Module
SLIC	Subscriber Line Interface Circuit
SMS	Short Message Service
SRAM	Static Random Access Memory
SRB	Signalling Radio Bearer
TA	Terminal adapter (e.g. GSM module)
TDMA	Time Division Multiple Access
TE	Terminal Equipment
TS	Technical Specification
Tx	Transmit Direction
UL	Upload
UMTS	Universal Mobile Telecommunications System
URC	Unsolicited Result Code
USB	Universal Serial Bus
UICC	USIM Integrated Circuit Card
USIM	UMTS Subscriber Identification Module
WCDMA	Wideband Code Division Multiple Access

1.3 Regulatory and Type Approval Information

1.3.1 Directives and Standards

EU3-E will be designed to comply with the directives and standards listed below.

It is the responsibility of the application manufacturer to ensure compliance of the final product with all provisions of the applicable directives and standards as well as with the technical specifications provided in the "EU3-E Hardware Interface Description".

Table 1: Directives

1999/05/EC	Directive of the European Parliament and of the council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (in short referred to as R&TTE Directive 1999/5/EC). The product is labeled with the CE conformity mark CE 0682
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 type approval

ETSI EN 301 511 V9.0.2	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)
ETSI EN 301 489-01 V1.8.1	Electromagnetic Compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common Technical Requirements
ETSI EN 301 489-07 V1.3.1	Electromagnetic Compatibility and Radio spectrum Matters (ERM); Electromagnetic 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)
ETSI EN 301 489-24 V1.4.1	Electromagnetic Compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 24: Specific conditions for IMT-2000 CDMA Direct Spread (UTRA) for Mobile and portable (UE) radio and ancillary equipment
EN 301 908-01 V3.2.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Base Stations (BS) and User Equipment (UE) for IMT-2000 Third Generation cellular networks; Part 1: Harmonized EN for IMT-2000, introduction and common requirements of article 3.2 of the R&TTE Directive
EN 301 908-02 V3.2.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Base Stations (BS) and User Equipment (UE) for IMT-2000 Third Generation cellular networks; Part 2: Harmonized EN for IMT-2000, CDMA Direct Spread (UTRA FDD) (UE) covering essential requirements of article 3.2 of the R&TTE Directive
3GPP TS 34.124	Electromagnetic Compatibility (EMC) for mobile terminals and ancillary equipment.
GCF-CC V3.36.0	Global Certification Forum - Certification Criteria

Table 2: Standards of type approval

3GPP TS 51.010-1	Digital cellular telecommunications system (Release 7); Mobile Station (MS) conformance specification;
3GPP TS 34.121	Technical Specification Group Radio Access Network; Terminal conformance specification; Radio transmission and reception (FDD)
3GPP TS 34.123-1	User Equipment (UE) conformance specification; Part 1: Protocol conformance specification.
3GPP TS 34.123-3	User Equipment (UE) conformance specification; Part 3: Abstract Test Suites.
IEC/EN 60950-1:2001	Safety of information technology equipment (2000)
EN 62311:2008	Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz)
1999/519/EC	Council Recommendation 1999/519/EC of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (Official Journal L 197 of 30 July 1999)
AS/NZS 2772.1:1998	Radiofrequency fields Part 1: Maximum exposure limits - 3 kHz to 300 GHz.
IEEE Std C95.1-1999	IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz

Table 3: Requirements of quality

IEC 60068	Environmental testing
DIN EN 60529	IP codes

Table 4: Standards of the Ministry of Information Industry of the People's Republic of China

SJ/T 11363-2006	"Requirements for Concentration Limits for Certain Hazardous Substances in Electronic Information Products" (2006-06).
SJ/T 11364-2006	"Marking for Control of Pollution Caused by Electronic Information Products" (2006-06).  According to the "Chinese Administration on the Control of Pollution caused by Electronic Information Products" (ACPEIP) the EPUP, i.e., Environmental Protection Use Period, of this product is 20 years as per the symbol shown here, unless otherwise marked. The EPUP is valid only as long as the product is operated within the operating limits described in the Cinterion Hardware Interface Description. Please see Table 5 for an overview of toxic or hazardous substances or elements that might be contained in product parts in concentrations above the limits defined by SJ/T 11363-2006.

Table 5: Toxic or hazardous substances or elements with defined concentration limits

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

O:
表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T11363-2006 标准规定的限量要求以下。
Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in SJ/T11363-2006.

X:
表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T11363-2006标准规定的限量要求。
Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part *might exceed* the limit requirement in SJ/T11363-2006.

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 EU3-E based applications to be evaluated and approved for compliance with national and/or international regulations.

Since the SAR value varies significantly with the individual product design manufacturers are advised to submit their product for approval if designed for portable use. For European 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 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)

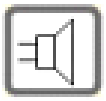
1.3.3 SELV Requirements

The power supply connected to the EU3-E module shall be in compliance with the SELV requirements defined in EN 60950-1.

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 EU3-E. Manufacturers of the cellular terminal are advised to convey the following safety information to users and operating personnel and to incorporate these guidelines into all manuals supplied with the product. Failure to comply with these precautions violates safety standards of design, manufacture and intended use of the product. Cinterion Wireless Modules 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	UMTS/HSDPA: Dual band, 900/2100MHz GSM/GPRS/EDGE: Dual band, 900/1800MHz
GSM class	Small MS
Output power (according to Release 99)	Class 4 (+33dBm ±2dB) for EGSM900 Class 1 (+30dBm ±2dB) for GSM1800 Class E2 (+27dBm ± 3dB) for GSM 900 8-PSK Class E2 (+26dBm +3 /-4dB) for GSM 1800 8-PSK Class 3 (+24dBm +1/-3dB) for UMTS 2100, WCDMA FDD BdI Class 3 (+24dBm +1/-3dB) for UMTS 900,WCDMA FDD BdVIII
Power supply	3.3V < V_{BATT+} < 4.2V
Ambient operating temperature according to IEC 60068-2	Normal operation: -30°C to +85°C Restricted operation: -30°C to -40°C and +85°C to +90°C
Physical	Dimensions: 33.9mm x 44.6mm x 5.0mm Weight: approx. 10g
RoHS	All hardware components fully compliant with EU RoHS Directive
HSDPA features	
3GPP Release 5	3.6 Mbps, UL 384 kbps UE CAT. [1-6], 11, 12 supported Compressed mode (CM) supported according to 3GPP TS25.212
UMTS features	
3GPP Release 4	PS data rate – 384 kbps DL / 384 kbps UL CS data rate – 64 kbps DL / 64 kbps UL

Feature	Implementation
GSM / GPRS / EGPRS features	
Data transfer	GPRS: • Multislot Class 10 • Full PBCCH support • Mobile Station Class B • Coding Scheme 1 – 4 EGPRS: • Multislot Class 10 • EDGE E2 power class for 8 PSK • Downlink coding schemes – CS 1-4, MCS 1-9 • Uplink coding schemes – CS 1-4, MCS 1-9 • BEP reporting • SRB loopback and test mode B • 8-bit, 11-bit RACH • PBCCH support • 1 phase/2 phase access procedures • Link adaptation and IR • NACC, extended UL TBF • Mobile Station Class B CSD: • V.110, RLP, non-transparent • 9.6 kbps
SMS	Point-to-point MT and MO Cell broadcast Text and PDU mode
Fax	Group 3; Class 1
Software	
AT commands	Hayes, 3GPP TS 27.007 and 27.005, and propriatary Cinterion Wireless Modules commands
SIM Application Toolkit	SAT Release 99
TCP/IP stack	Access by AT commands
Audio	Audio speech codecs GSM: AMR, EFR, FR, HR 3GPP: AMR DTMF supported 9 ringing melodies supported with volume control CEPT and ANSI supervisory tones supported
Firmware update	Generic update from host application over ASC0 and USB.

Feature	Implementation
Interfaces	
USB	USB 2.0 High Speed (480Mbit/s) device interface.
Serial interface	8-wire modem interface (ASC0) with status and control lines, unbalanced, asynchronous.
Status	Signal pin to indicate network connectivity state.
Audio	1 analog interface
UICC interface	Supported chip cards: SIM / UICC 3V, 1.8V.
Antenna	50Ohms. External antenna can be connected via antenna connector or solderable pad.
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 or voltage conditions.
Reset	Orderly shutdown and reset by AT command Emergency reset by hardware pin EMERG_OFF and IGT.
Emergency off	Emergency off by hardware pin EMERG_OFF if IGT is not active.
Special features	
Real time clock	Timer functions via AT commands
Phonebook	SIM and phone
Evaluation kit	
DSB75	DSB75 Evaluation Board designed to test and type approve Cinterion Wireless Modules and provide a sample configuration for application engineering. A special adapter is required to connect the module to the DSB75.

2.2 EU3-E System Overview

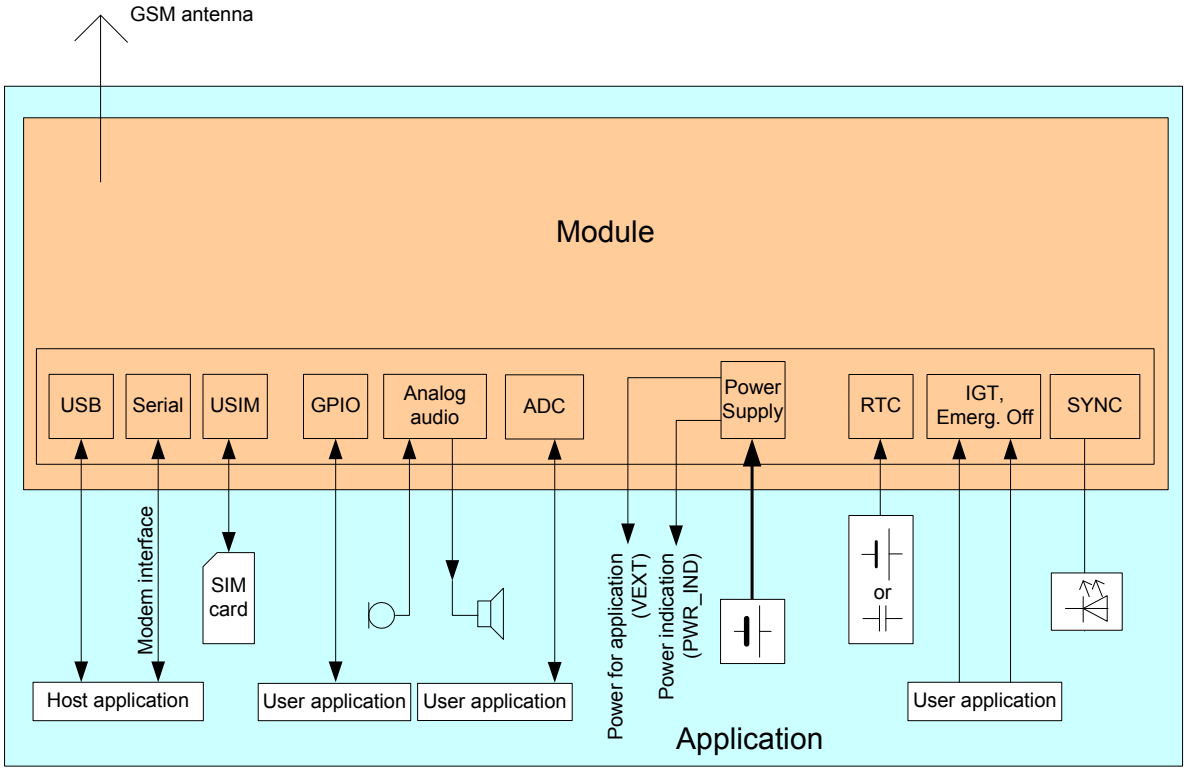


Figure 1: EU3-E system overview

2.3 Circuit Concept

Figure 2 shows a block diagram of the EU3-E module and illustrates the major functional components:

Baseband block:
- Digital baseband processor with DSPs
- Power management
- NAND Flash
- SDRAM
- Application interface (board-to-board connector)

RF section:
- GSM/UMTS transceiver
- GSM/WCDMA power amplifier, front end
- Antenna connector

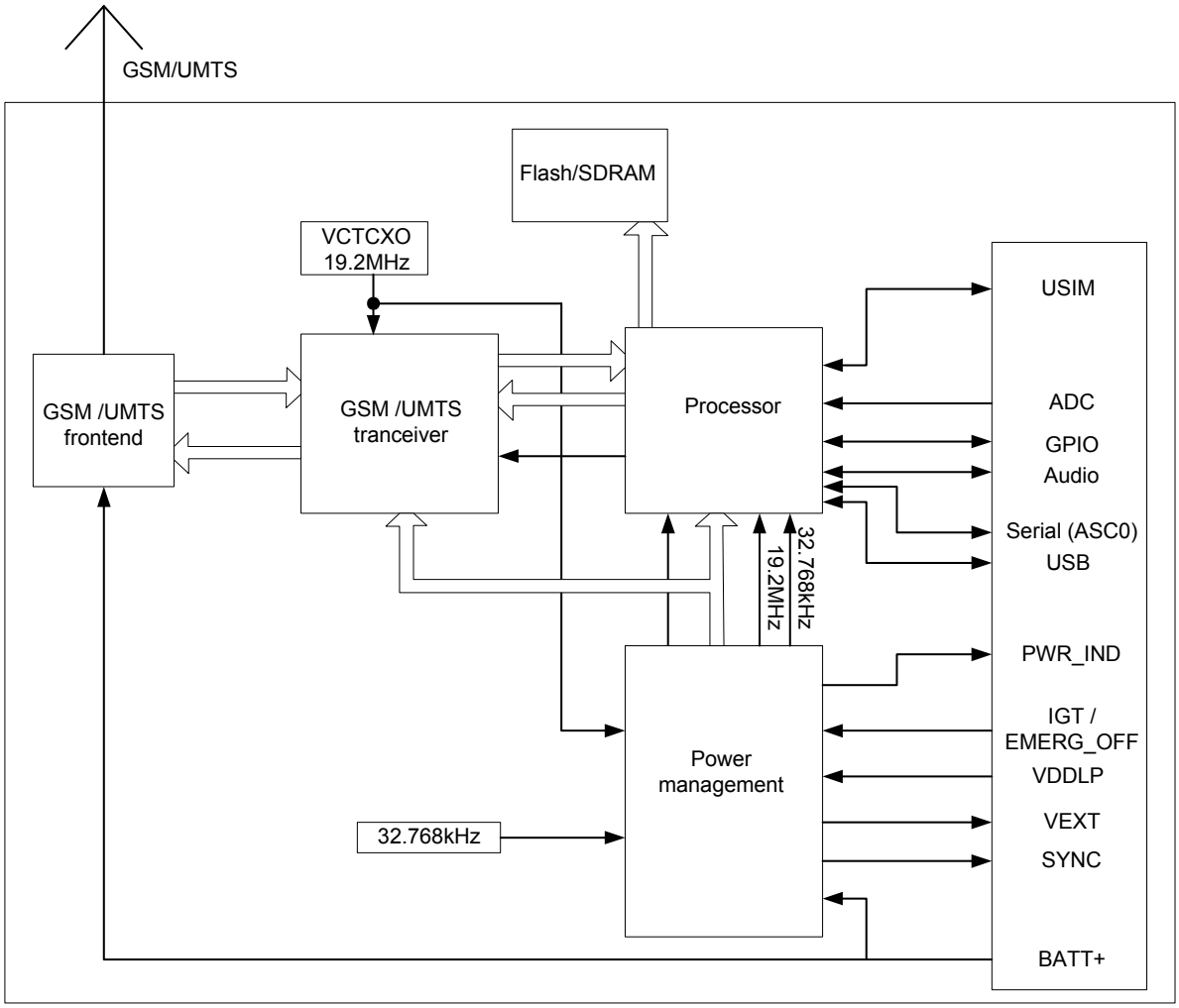


Figure 2: EU3-E block diagram

3 Application Interface

EU3-E 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 sections:

- Operating modes - see Section 3.1
- Power supply - see Section 3.2
- RTC backup - see Section 3.5
- Serial interface ASC0 - see Section 3.6
- Serial interface USB - see Section 3.7
- SIM interface - see Section 3.8
- Analog audio interface - see Section 3.9
- Status and control lines: IGT, EMERG_OFF, PWR_IND - see Table 21

3.1 Operating Modes

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

Table 6: Overview of operating modes

Mode	Function	
Normal operation	GSM / GPRS / UMTS / HSDPA SLEEP	Power saving mode set automatically when no call is in progress and the USB connection is suspended by host or not present and no active communication via ASC0.
	GSM TALK/ GSM DATA	Connection between two subscribers is in progress. Power consumption depends on the GSM network coverage and several connection settings (e.g. DTX off/on, FR/EFR/HR, hopping sequences and antenna connection). The following applies when power is to be measured in TALK_GSM mode: DTX off, FR and no frequency hopping.
	GPRS DATA	GPRS data transfer in progress. Power consumption depends on network settings (e.g. power control level), uplink / downlink data rates and GPRS configuration (e.g. used multislot settings).
	EGPRS DATA	EGPRS data transfer in progress. Power consumption depends on network settings (e.g. power control level), uplink / downlink data rates and EGPRS configuration (e.g. used multislot settings).
	UMTS TALK/ UMTS DATA	UMTS data transfer in progress. Power consumption depends on network settings (e.g. TPC Pattern) and data transfer rate.
	HSDPA DATA	HSDPA data transfer in progress. Power consumption depends on network settings (e.g. TPC Pattern) and data transfer rate.
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.	

3.2 Power Supply

EU3-E needs to be connected to a power supply at the B2B connector (5 pins each BATT+ and GND).

The power supply of EU3-E 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 baseband controller. It provides the following features:

- Stabilizes the supply voltages for the baseband using switching regulators and 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 EU3-E board, not even in a GSM transmit burst where current consumption can rise (for peak values see the power supply ratings listed in Section 5.6). It should be noted that EU3-E switches off when exceeding these limits. Any voltage drops that may occur in a transmit burst should not exceed 400mV.

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.

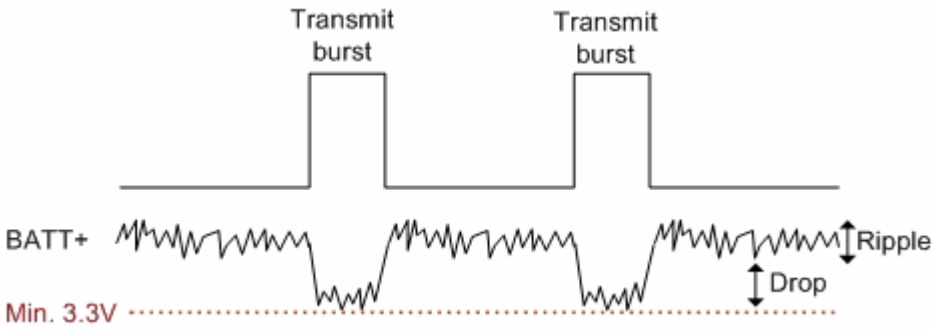


Figure 3: Power supply limits during transmit burst

3.2.2 Monitoring Power Supply by AT Command

To monitor the supply voltage you can use the AT^SBV command which returns the averaged 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 EU3-E is in 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 EU3-E while it is beyond the safety limits of voltage and temperature stated in Section 5.1. EU3-E 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 EU3-E

When the EU3-E module is in Power-down mode, it can be started to Normal 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 line.

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 300ms in Power-down mode.

Considering different strategies of host application design the figures below show two approaches to meet this requirement: The example in Figure 4 assumes that IGT is activated after BATT+ has already been applied. The example in Figure 5 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 300ms (Power-down mode) from the moment the voltage at BATT+ is available.

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+IFC (see [1] for details). The default setting of EU3-E 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 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 Section 3.3.2 "Signal States after Startup".

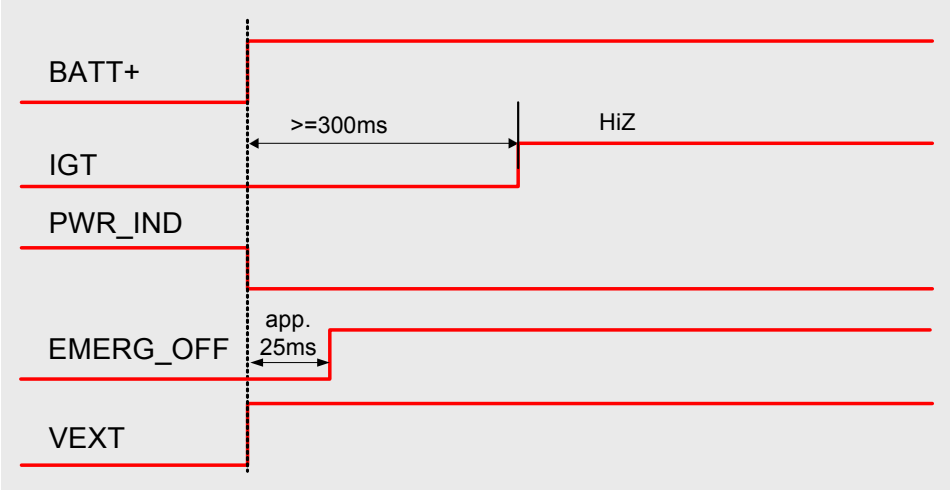


Figure 4: Power-on with IGT held low before switching on operating voltage at BATT+

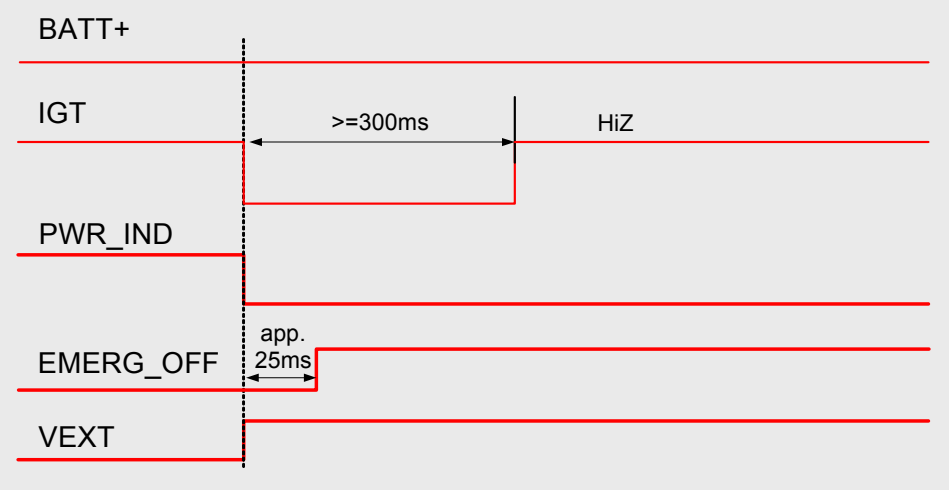


Figure 5: Power-on with operating voltage at BATT+ applied before activating IGT

Note: After power up IGT should remain high.

The module is ready to receive AT commands as soon as CTS0 turns active (low), i.e., after approximately 5 seconds. With a USB connection the USB host may take more than 5 seconds to set up the virtual COM port connection.

3.3.1.1 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 EU3-E.
OK                                             IGT works as described in Section 3.3.1.
```

To configure IGT for use as ON/OFF switch:

```
at^scfg=meshutdown/onignition                  # Enable the ON/OFF switch mode of IGT.
^SCFG: "MEShutdown/OnIgnition","on"            # IGT can be used to switch on and off EU3-E.
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 EU3-E is off, the IGT line must be asserted for at least 300ms before being released.

Switch-off condition: If the EU3-E is on, the IGT line must be asserted for at least 2s 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 5 seconds after startup.

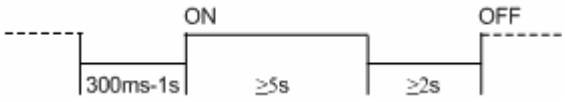


Figure 6: Timing of IGT if used as ON/OFF switch

3.3.1.2 Reset EU3-E via AT+CFUN Command

To reset and restart the EU3-E module use the command AT+CFUN. You can enter AT+CFUN=,1 or AT+CFUN=x,1, where x may be either 0, 1 or 4. See [1] for details.

To register to the network SIM PIN authentication is necessary after restart.

3.3.1.3 Reset (or Turn off) EU3-E in Case of Emergency

Caution: Use the EMERG_OFF line only when, due to serious problems, the software is not responding for more than 5 seconds. Pulling the EMERG_OFF line 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 EU3-E *does not respond, if reset or shutdown via AT command fails.*

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

The EMERG_OFF line can be used to switch off or to reset the module in case of serious problems. If pulled to ground for any period of time between 10ms and 2500ms and then released, the module resets itself. If pulled to ground for more than 2500ms and then released, the module shuts down. In addition, it is also possible to reset the module if the IGT line is held low for more then 300ms after releasing the EMERG_OFF line.

To register to the network SIM PIN authentication is necessary after restart.

3.3.2 Signal States after Startup

Table 7 describes the various states each interface signal passes through after startup and during operation.

Signals are in an undefined state while the module is initializing. Once the startup initialization has completed, i.e. when the software is running, all signals are in defined state. The state of several signals will change again once the respective interface is activated or configured by AT command.

Table 7: Signal states

Signal name	Undefined state during startup	Defined state after startup initialization	Active state GPIO
CCIN	PU	I, PU(100k)	
CCRST	PD	O, L	
CCIO	PD	O, L	
CCCLK	PD	O, L	
CCVCC	Off	1.8V/2.85V	
RXD0	I, PU	O, H	
TXD0	PD	I, PD(330k)	
CTS0	PD	O, L[1]	
RTS0	PD	I, PD(330k)	
DTR0	PU	I	
DCD0	PU	O, H	
DSR0	PU	O, L[1]	
RING0	PU	O, H	
GPIO1	PD	I, PD	IO
GPIO2	PD	I, PD	IO
GPIO3	PD	I, PD	IO
GPIO4	PD	I, PD	IO
GPIO5	PD	I, PD	IO
GPIO6	PD	I, PD	IO
GPIO7	PD	I, PD	IO
GPIO8	PD	I, PD	IO
GPIO9	PU	I, PD	IO
GPIO10	PU	I, PD	IO

1. Before reaching the defined state the signal has the intermediate state O, H for about 5s.

L = Low level H = High level I = Input O = Output	PD = Pull down with max. +30µA PD(…k) = Fix pull down resistor PU = Pull up with max. -30µA PU(…k) = Fix pull up resistor

3.3.3 Turn off EU3-E

EU3-E 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 EU3-E Using AT Command

The best and safest approach to powering down EU3-E is to issue the AT^SMSO command. This procedure lets EU3-E 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 Powerdown mode. In this mode, only the RTC stays active.

After sending AT^SMSO do not enter any other AT commands. There are two ways to verify that the module turns off:
- Wait for the ”OK” – response. It indicates that data has been stored non-volatile and that the module turns off after about 1 second.
- Also, you can monitor the PWR_IND pin. A high state of the PWR_IND pin definitely indicates that the module is switched off.

Be sure not to disconnect the supply voltage V_{BATT+} before the module has been switched of 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 7.

While EU3-E 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.

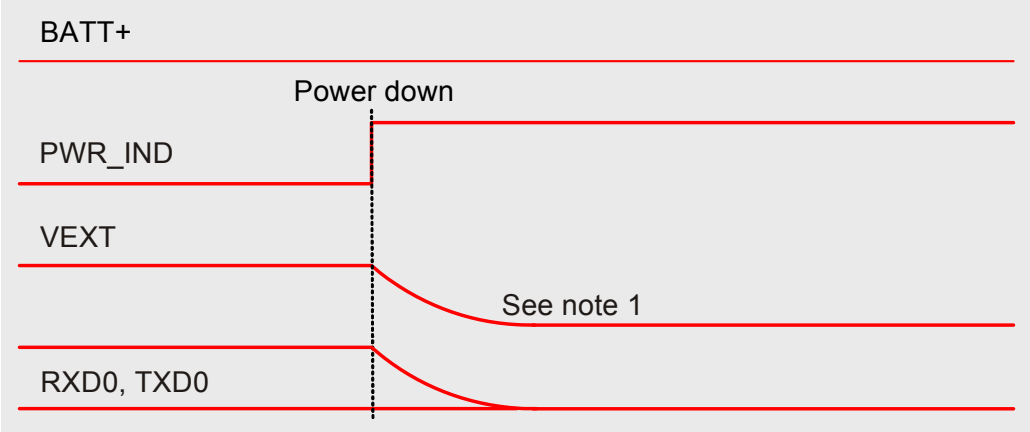


Figure 7: Signal states during turn-off procedure

Note 1: Depending on capacitance load from host application

Note 2: After module shutdown by means of AT command, please allow for a time period of at least 1s before restarting the module.

3.3.3.2 Turn on/off EU3-E Applications with Integrated USB

In a Microsoft® Windows™ environment, the USB COM port emulation causes the USB port of EU3-E 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 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 ensure that the host application or Terminal program on the USB VCOM port is 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 EU3-E board is exceeding the critical limits of overtemperature or undertemperature
- Undervoltage or overvoltage is detected

The automatic shutdown procedure is equivalent to the Power-down initiated with the AT^SMSO command, i.e. EU3-E 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 presentation of these URCs can be enabled or disabled with the two AT commands AT^SBC and AT^SCTM. The URC presentation mode varies with the condition, please see Section 3.3.4.1 to Section 3.3.4.2 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 values detected by the NTC resistor are measured directly on the board and therefore, are not fully identical with the ambient temperature.

Each time the board temperature goes out of range or back to normal, EU3-E 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 during the 2 minute guard period after start-up of EU3-E. After expiry of the 2 minute guard period, the presentation will be disabled, i.e. no URCs with alert levels "1" or "-1" will 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 Section 5.2. Refer to Table 8 for the associated URCs.

Table 8: Temperature dependent behavior

Sending temperature alert (2min after EU3-E start-up, otherwise only if URC presentation enabled)	
^SCTM_B: 1	Caution: Board close to overtemperature limit, i.e., board is 5°C below overtemperature limit.
^SCTM_B: -1	Caution: Board close to undertemperature limit, i.e., board is 5°C above undertemperature limit.
^SCTM_B: 0	Board back to uncritical temperature range, i.e., board is 6°C below its over- or above its undertemperature limit.
Automatic shutdown (URC appears no matter whether or not presentation was enabled)	
^SCTM_B: 2	Alert: Board equal or beyond overtemperature limit. EU3-E switches off.
^SCTM_B: -2	Alert: Board equal or below undertemperature limit. EU3-E switches off.

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.

3.3.4.2 Undervoltage Shutdown

If the measured supply 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 3.3V and further power loss is caused during the transmit burst. In an idle state, the shutdown threshold is the sum of the module's minimum supply voltage (3.3V) and the value of the maximum voltage drop resulting from earlier calls. This means that in an idle state the actual shutdown threshold may be higher than 3.3V. Therefore, to properly calculate the actual shutdown threshold application manufacturers are advised to measure the maximum voltage drops that may occur during transmit bursts.

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

3.3.4.3 Overvoltage Shutdown

The overvoltage shutdown threshold is 100mV above the maximum supply voltage V_{BATT+} specified in Table 21.

When the supply voltage approaches the overvoltage shutdown threshold the module will send the following URC:

^SBC: Overvoltage warning

This alert is sent once.

When the overvoltage shutdown threshold is exceeded the module will send the following 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 EU3-E components are directly linked to BATT+ and, therefore, the supply voltage remains applied at major parts of EU3-E, even if the module is switched off. Especially the power amplifier is very sensitive to high voltage and might even be destroyed.

3.4 Power Saving

EU3-E is able to reduce its functionality to a minimum (during the so-called SLEEP mode) in order to minimize its current consumption. The following sections explain the module's network dependant power saving behavior.[2]

The implementation of the USB host interface also influences the module's power saving behavior and therefore its current consumption. For more information see Section 3.7.

3.4.1 Power Saving while Attached to GSM Networks

The power saving possibilities while attached to a GSM network depend on the paging timing cycle of the base station. The duration of a power saving interval can be calculated using 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 between 0.47 and 2.12 seconds. The DRX value of the base station is assigned by the GSM network operator.

In the pauses between listening to paging messages, the module resumes power saving, as shown in Figure 8.

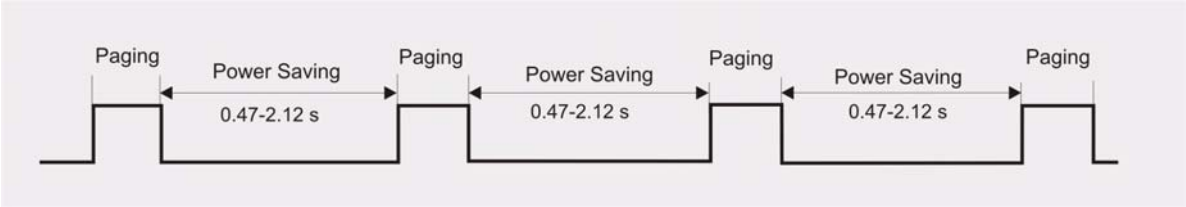


Figure 8: Power saving and paging in GSM networks

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

Generally, power saving depends on the module's application scenario and may differ from the above mentioned normal operation. The power saving interval may be shorter than 0.47 seconds or longer than 2.12 seconds (see also Section 3.4.3).

2. **Note:** If not regularly woken up from power saving, the module might enter an unintentional operating state. Therefore, the power save period recommended for the AT^SCFG "MEopMode/PwrSave" parameter ensures that the ME regularly wakes up from its power saving state (SLEEP mode), especially under following conditions: The module is configured for minimum functionality (i.e., AT+CFUN=0 or 4), connected via serial interface (i.e., AT^SDPORT=2) and controlled by an external application without direct access to its RTS line (e.g., an application using standard Windows/Linux serial device drivers). For more information on power saving and the AT^SCFG parameter "MEopMode/PwrSave" see [1].

3.4.2 Power Saving while Attached to WCDMA Networks

The power saving possibilities while attached to a WCDMA network depend on the paging timing cycle of the base station.

During normal WCDMA operation, i.e., the module is connected to a WCDMA network, the duration of a power saving period varies. It may be calculated using the following formula:

$t = 2^{DRX\ value} * 10$ ms (WCDMA frame duration).

DRX (Discontinuous Reception) in WCDMA networks is a value between 6 and 9, thus resulting in power saving intervals between 0.64 and 5.12 seconds. The DRX value of the base station is assigned by the WCDMA network operator.

In the pauses between listening to paging messages, the mod7le resumes power saving, as shown in Figure 9.

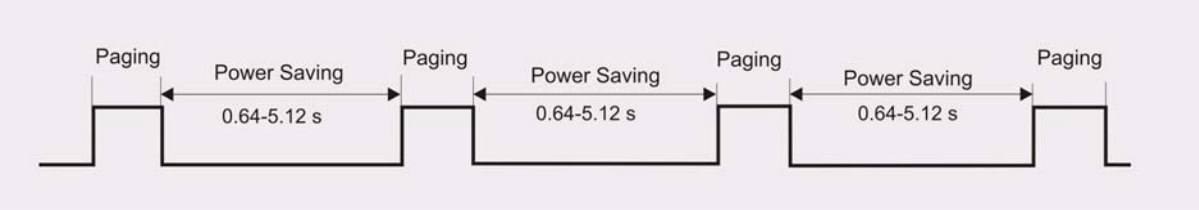


Figure 9: Power saving and paging in WCDMA networks

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

Generally, power saving depends on the module's application scenario and may differ from the above mentioned normal operation. The power saving interval may be shorter than 0.64 seconds or longer than 5.12 seconds (see also Section 3.4.3).

3.4.3 Power Saving during Network Search, GSM/WCDMA

The power saving interval during network search depends on the network registration mode configured for EU3-E. This mode can be specified with the AT^SCFG command parameter MEopMode/RM:

- In "Fast" mode, the power saving interval may last for up to 5 seconds.
- In "Normal" mode, the power saving interval may last for up to 40 seconds.

For details on how to configure the AT^SCFG parameter MEopMode/RM see [1].

3.4.4 Timing of the CTS0 Signal, GSM/WCDMA

As long as EU3-E is operated via the ASC0 interface and not in power saving mode, the CTS0 line is always active. This means that while attached to a network the CTS0 signal will be temporarily active during each paging.

After a concluding activity on the serial interface ASC0 - and depending on the module's other activities - it takes at least 5 seconds before CTS0 goes inactive (again) and power saving starts (as described in Section 3.4.1 and Section 3.4.2).

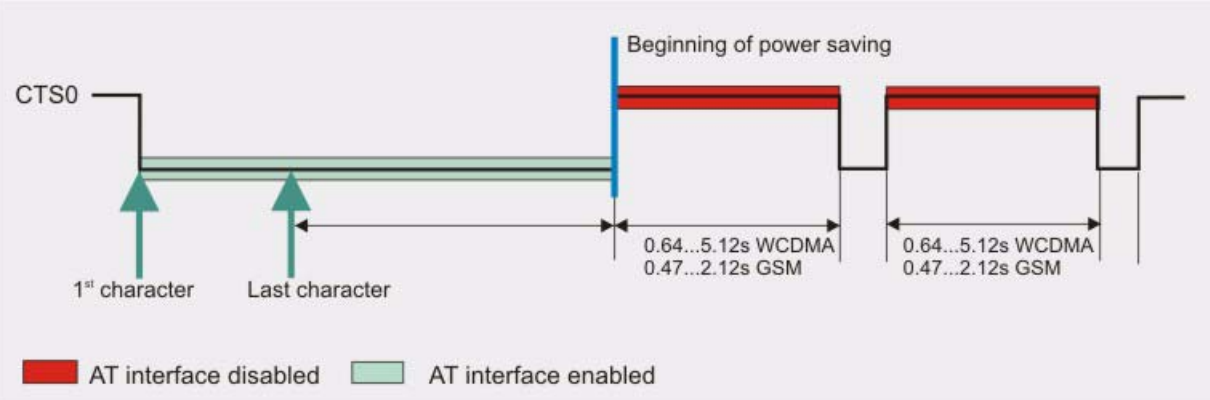


Figure 10: Timing of CTS0 signal

With regard to programming or using timeouts, the UART must take the varying CTS0 inactivity periods into account.

Note: Hardware handshaking is mandatory if employing EU3-E's ASC0 interface. Thus AT commands are only recognized by the module while CTS0 is active.

3.5 RTC Backup

The internal Real Time Clock of EU3-E is supplied from a separate voltage regulator in the analog controller which is also active when EU3-E is in POWER DOWN status.

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 EU3-E. 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 EU3-E, i.e. the larger the capacitor the longer EU3-E 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. The following figures show various sample configurations. Please refer to Table 21 for the parameters required.

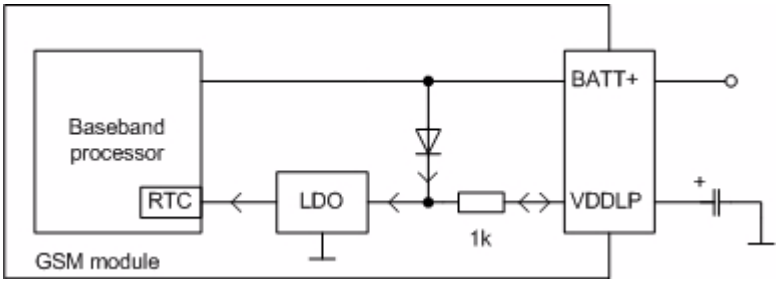


Figure 11: RTC supply from capacitor

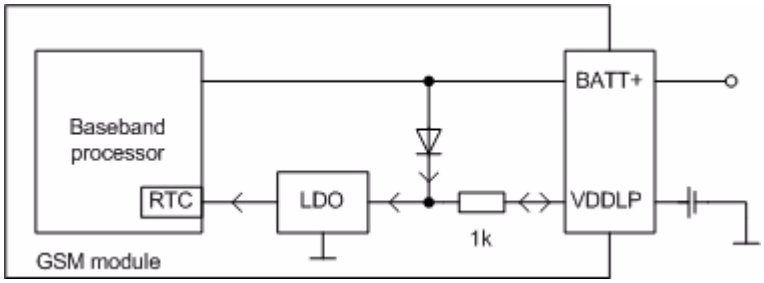


Figure 12: RTC supply from rechargeable battery

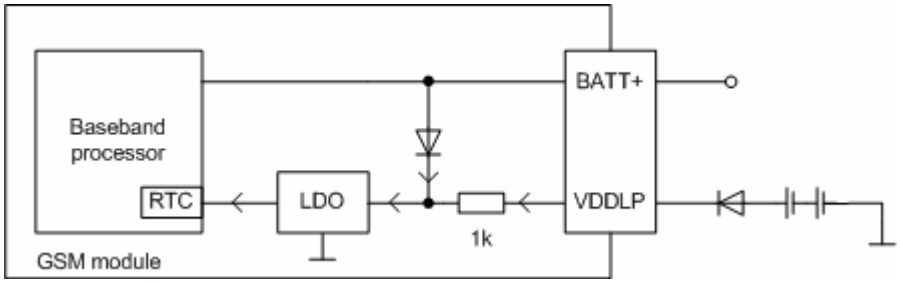


Figure 13: RTC supply from non-chargeable battery

3.6 Serial Interface ASC0

EU3-E offers an 8-wire unbalanced, asynchronous modem interface ASC0 conforming to ITU-T V.24 protocol DCE signalling. The electrical characteristics do not comply with ITU-T V.28. The significant levels are 0V (for low data bit or active state) and 2.6V (for high data bit or inactive state). For electrical characteristics please refer to Table 21. Note that ASC0 and USB operation are mutually exclusive. The type of interface to employ will have to be configured via AT command.

EU3-E is designed for use as a DCE. Based on the conventions for DCE-DTE connections it communicates with the customer application (DTE) using the following signals:
- Port TXD @ application sends data to the module's TXD0 signal line
- Port RXD @ application receives data from the module's RXD0 signal line

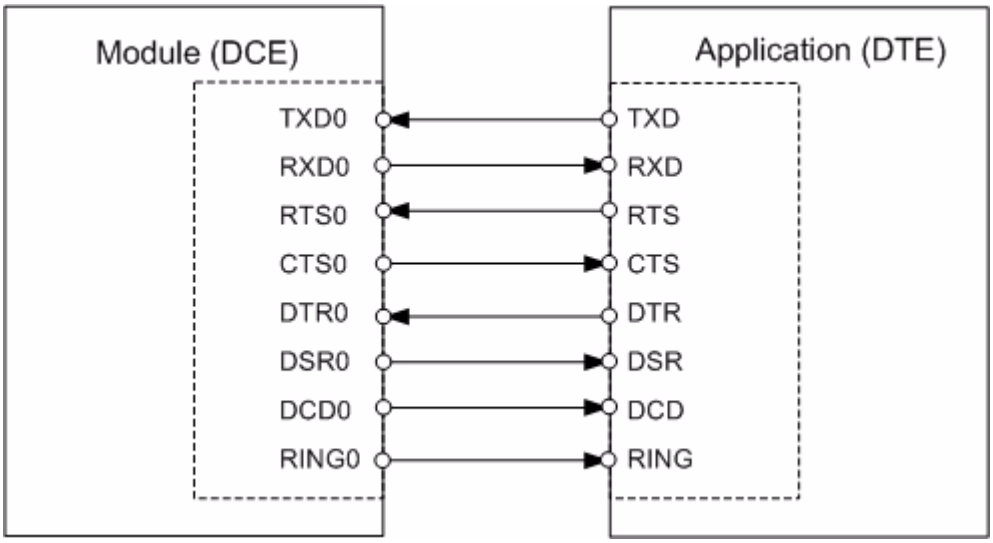


Figure 14: Serial interface ASC0

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 designed for controlling GSM/UMTS voice calls, transferring data and for controlling the module with AT commands.
- Full multiplexing capability allows the interface to be partitioned into virtual channels.
- The RING0 signal serves to indicate incoming calls and other types of URCs (Unsolicited Result Code). It can also be used to send pulses to the host application, for example to wake up the application from power saving state. See [1] for details on how to configure the RING0 line by AT^SCFG.
- Configured for 8 data bits, no parity and 1 stop bit.
- ASC0 can be operated at fixed bit rates from 1200 bps to 460800 bps.
- Autobauding is supported.
- Autobauding is not compatible with multiplex mode.
- Supports RTS0/CTS0 hardware flow control and XON/XOFF software flow control.

Table 9: DCE-DTE wiring of ASC0

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

3.7 USB Interface

EU3-E supports a USB 2.0 High Speed (480Mbit/s) device interface. The USB interface is primarily intended for use as command and data interface and for downloading firmware. The USB I/O-lines 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 EU3-E interfaces. This is because EU3-E is designed as a self-powered device compliant with the "Universal Serial Bus Specification Revision 2.0"[3].

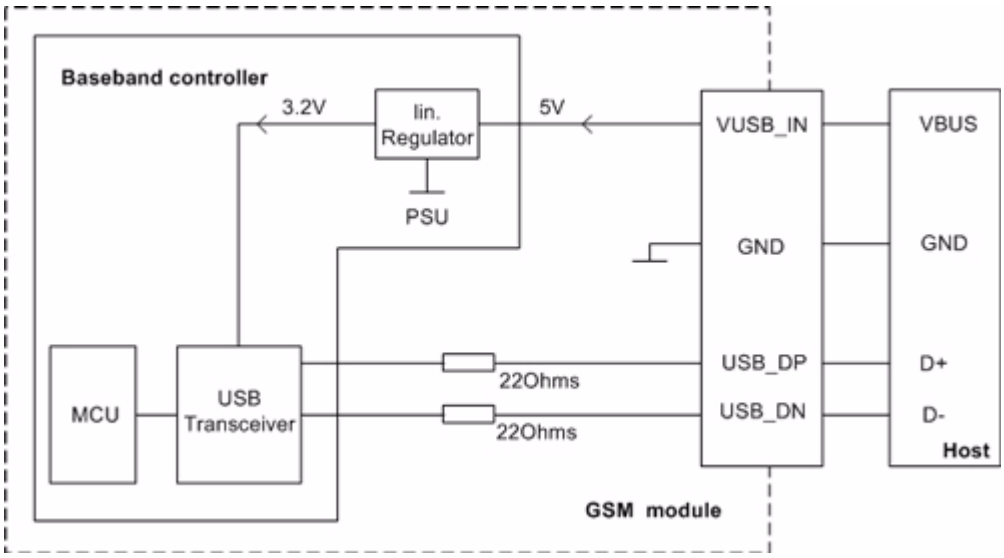


Figure 15: USB circuit

To properly connect the module's USB interface to the host a USB 2.0 compatible connector is required. For more information on the USB related pins see Table 21. Note that USB and ASC0 operation are mutually exclusive. The type of interface to employ will have to be configured via AT command. For a detailed description of the USB interface see [3].

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

3.8 SIM Interface

EU3-E has an integrated UICC/USIM interface compatible with the 3GPP 31.102 and ETSI 102 221; additionally EU3-E supports U-SAT as specified in 3GPP 31.124. 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 UICC/SIM interface supports 3V and 1.8V SIM cards. Please refer to Table 21 for electrical specifications of the UICC/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 EU3-E and is part of the Cinterion reference equipment submitted for type approval. See Chapter 9 for Molex ordering numbers.

Table 10: 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.
CCCLK	Chipcard clock
CCVCC	SIM supply voltage.
CCIO	Serial data line, input and output.
CCRST	Chipcard reset
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 EU3-E.

Note: No guarantee can be given, nor any liability accepted, if loss of data is encountered after removing the SIM card during operation. Also, no guarantee can be given for properly initializing any SIM card that the user inserts after having removed the SIM card during operation. In this case, the application must restart EU3-E.

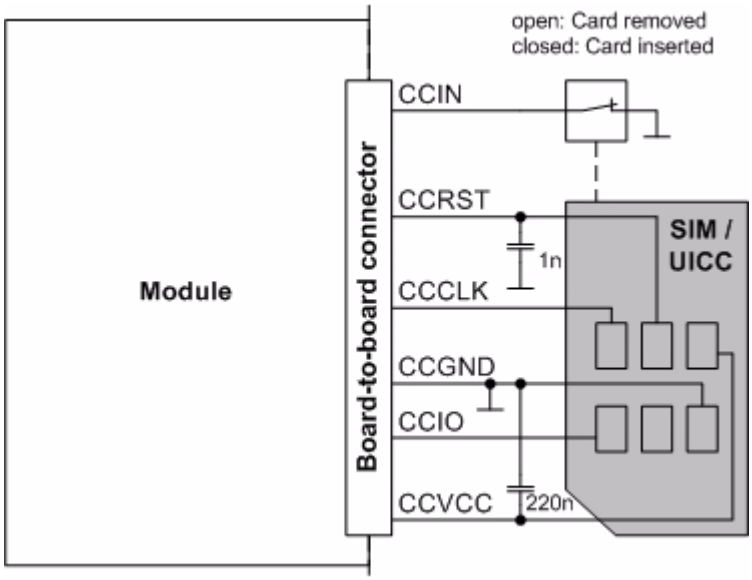


Figure 16: UICC/SIM external interface

The total cable length between the board-to-board connector pins on EU3-E 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.

3.9 Audio Interface

EU3-E supports an analog audio interface with a balanced microphone input and a balanced loudspeaker output. The following picture shows a simplified block diagram:

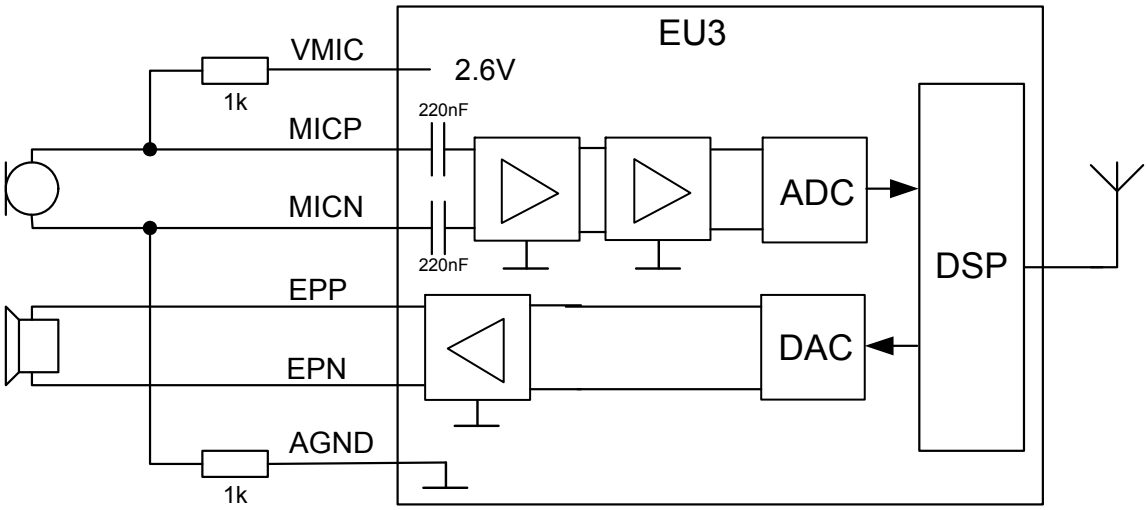


Figure 17: Audio block diagram

A power supply for electret microphones is available via VMIC at the board-to-board connector. VMIC is capable to drive a current of 1mA at a voltage of typically 2.6V. The microphone should be fed symmetrically between VMIC and AGND. AGND provides for an extra connection to the modules ground potential to avoid disturbing the microphone by high power supply current ripple. Coupling capacitors for the pins MICP and MICN are implemented on the module.

Microphone signals are fed via the MICP and MICN pins to an analog-to-digital converter (ADC) and the DSP. The DSP application core calculates e.g. digital gains, sidetone, echo cancellation or noise suppression depending on the current configuration of the audio path. The processed speech samples are passed to the speech encoder.

Received samples from the speech decoder are passed to the digital-to-analog converter (DAC) after post processing (frequency response correction, adding sidetone etc.). The loudspeaker signal is routed via EPP and EPN pins. No gain setting is available in the earphone amplifier. The volume is controlled in the digital data stream by the DSP only.

In order to support different types of equipment, the audio interface can be configured with 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 set with AT commands. The default audio mode (AT^SNFS=1) is intended to be used with the audio interface. This default configuration is optimized for the Votronic HH-SI-30.3/V1.1/0 handset and used for type approving the Cinterion reference configuration. Audio mode 1 has fixed parameters that cannot be modified (see also Section 5.7).

Detailed instructions on using AT commands to configure audio modes are to be found in Section 5.7 and [1].

3.10 Control Signals

3.10.1 Behavior o fthe RING0 Line (ASC0 Interface only)

The RING0 line is available on the first serial interface ASC0 (see also Section 3.9). The signal serves to indicate incoming calls.

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.

When a voice/fax/data call comes in the RING0 line goes low for 5.9s and high for another 0.1s. Every 6 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.

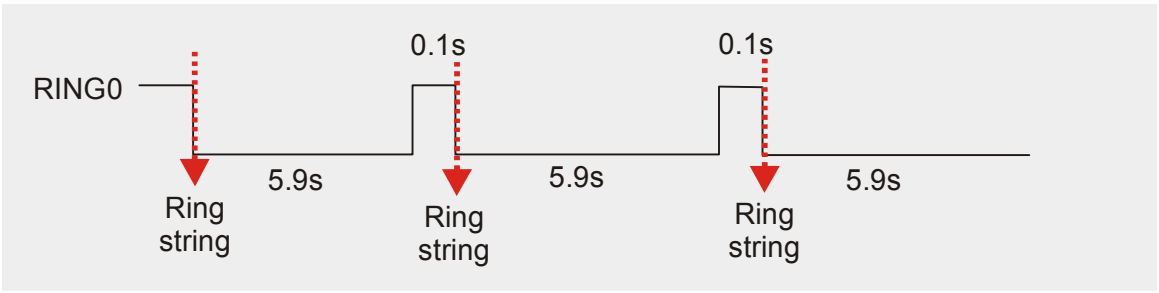


Figure 18: Incoming voice/fax/data call

3.10.2 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.

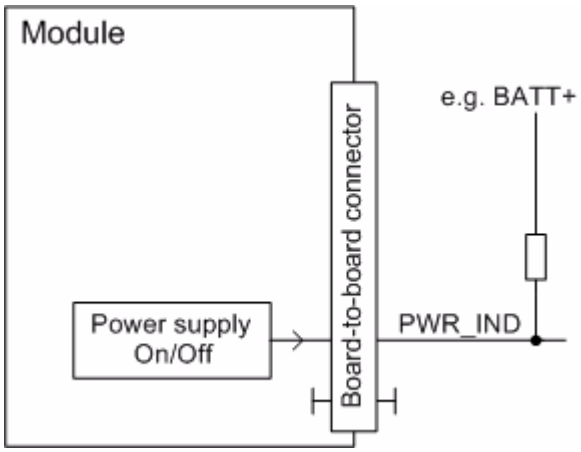


Figure 19: PWR_IND signal

3.10.3 Network Connectivity Signal

The SYNC line serves to indicate the module's network connectivity state and can be used to control an externally connected LED as shown in Figure 20. To operate the LED a buffer, e.g. a transistor or gate, must be included in the external application.

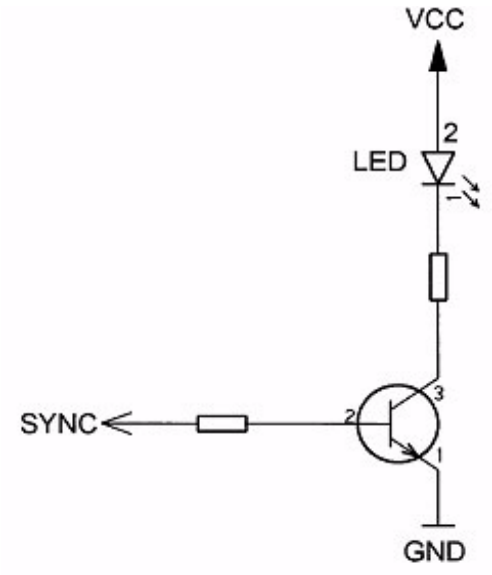


Figure 20: LED Circuit (Example)

For electrical characteristics of the SYNC line see Table 21. The network connectivity signal function has to be activated with AT^SLED. For details on the command see [1].

4 Antenna Interface

The RF interface has an impedance of 50Ω. EU3-E is capable of sustaining a total mismatch at the antenna interface 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 EU3-E module and should be placed in the host application.

Regarding the return loss EU3-E provides the following values in the active band:

Table 11: Return loss in the active band

State of module	Return loss of module	Recommended return loss of application
Receive	≥ 8dB	≥ 12dB
Transmit	not applicable	≥ 12dB
Idle	≤ 5dB	not applicable

The connection of the antenna or other equipment must be decoupled from DC voltage. This is necessary because the antenna connector is DC coupled to ground via an inductor for ESD protection.

4.1 Antenna Installation

To suit the physical design of individual applications EU3-E offers two alternative approaches to connecting the antenna:

- Recommended approach: U.FL antenna connector from Hirose/Molex assembled on the component side of the PCB (top view on EU3-E). See Section 4.3 for details.
- Antenna pad and grounding plane placed on the bottom side. See Section 4.2.

The U.FL connector has been chosen as antenna reference point (ARP) for the Cinterion Wireless Modules reference equipment submitted to type approve EU3-E. All RF data specified throughout this manual are related to the ARP. For compliance with the test results of the Cinterion Wireless Modules 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/Molex connector, the pad must not be used. Vice versa, if the antenna is connected to the pad, then the Hirose/Molex connector must be left empty.

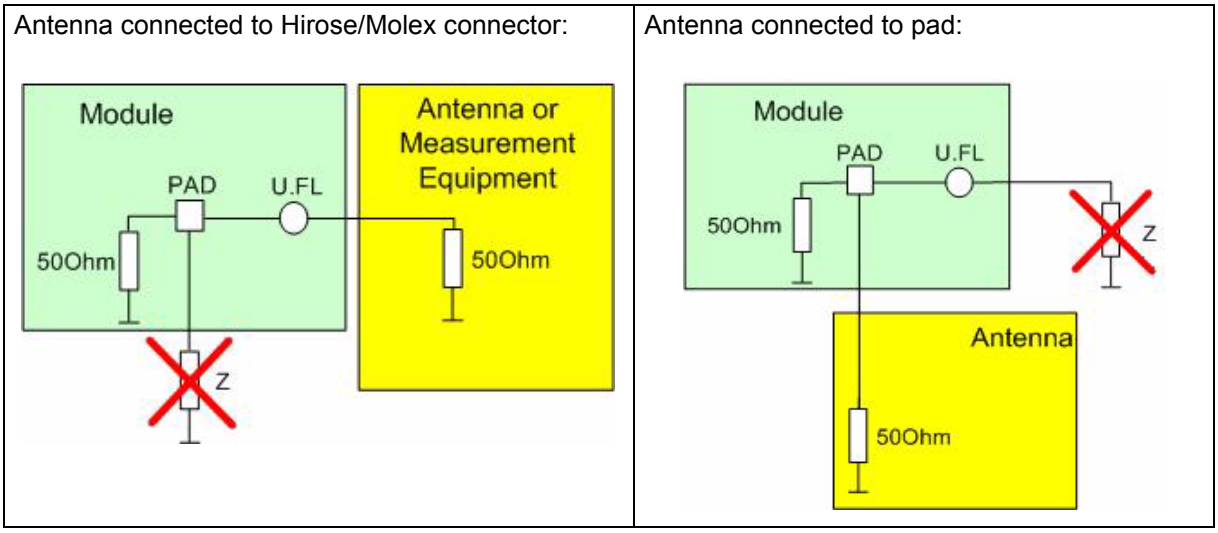


Figure 21: Never use antenna connector and antenna pad at the same time

No matter which option you choose, 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 empty area, i.e., free space which must also be reserved 0.8mm in height.

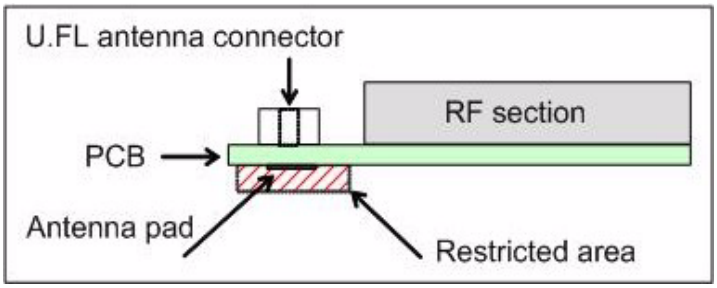


Figure 22: Restricted area around antenna pad

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 EU3-E which must be connected to the ground plane of the application.

When you decide to use the antenna pad take into account that the pad has not been intended as antenna reference point (ARP) for the Cinterion Wireless Module EU3-E type approval. The antenna pad is provided only as an alternative option which can be used, for example, if the recommended Hirose/Molex connection does not fit into your antenna design.

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.

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.

EU3-E material properties:
EU3-E 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 50Ω coaxial cable
- 1671A 50Ω 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.

4.3 Antenna Connector

EU3-E uses either an ultra-miniature SMT antenna connector from Hirose Ltd: U.FL-R-SMT, or the Molex 07341201 U.FL antenna connector. Both connectors have identical mechanical dimensions (see Figure 23). Minor differences in product specifications are mentioned in Table 12. The position of the antenna connector on the EU3-E board can be seen in Figure 29.

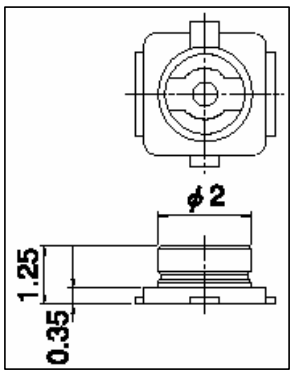


Figure 23: Mechanical dimensions of EU3-E antenna connectors

Table 12: Product specifications of EU3-E antenna connectors

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		
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
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 13: Material and finish of EU3-E antenna connectors and recommended plugs

Part	Material	Finish
Shell	Phosphor bronze	Hirose: Silver plating Molex: Gold plating
Male center contact	Brass	Gold plating
Female center contact	Phosphor bronze	Gold plating
Insulator	Receptacle: LCP	Hirose: Beige, Molex: Ivory

Mating plugs and cables can be chosen from the Hirose U.FL Series or from other antenna equipment manufacturers like Molex or IMS. Examples from the Hirose U.FL Series are shown below and listed in Table 14. For latest product information please contact your respective antenna equipment manufacturer.

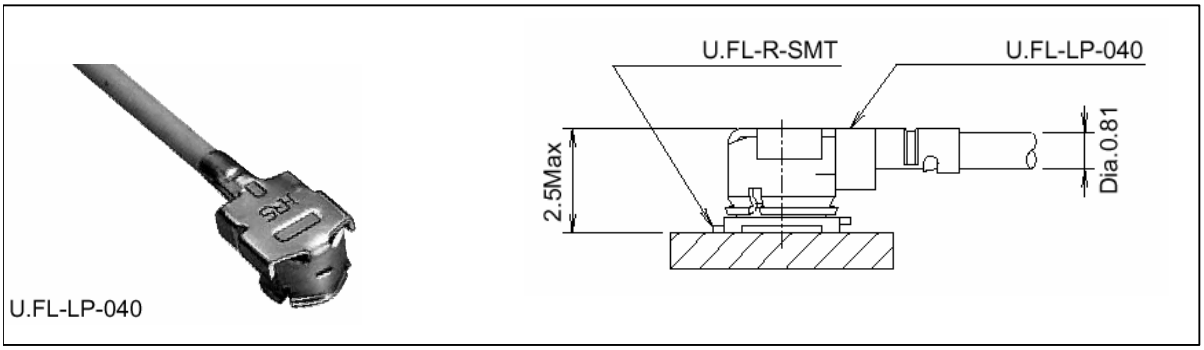


Figure 24: U.FL-R-SMT connector with U.FL-LP-040 plug

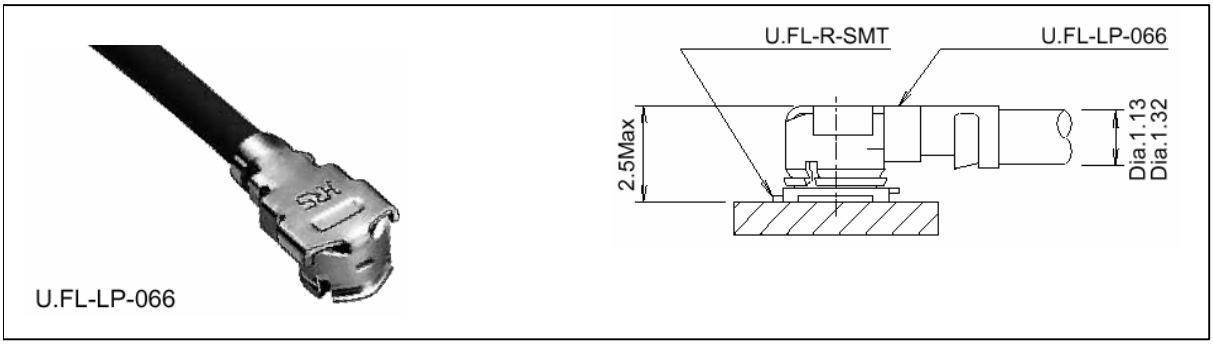


Figure 25: U.FL-R-SMT connector with U.FL-LP-066 plug

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 Ø 0.81mm) and minimizes the mating height to 2mm. See Figure 26 which shows the Hirose data sheet.

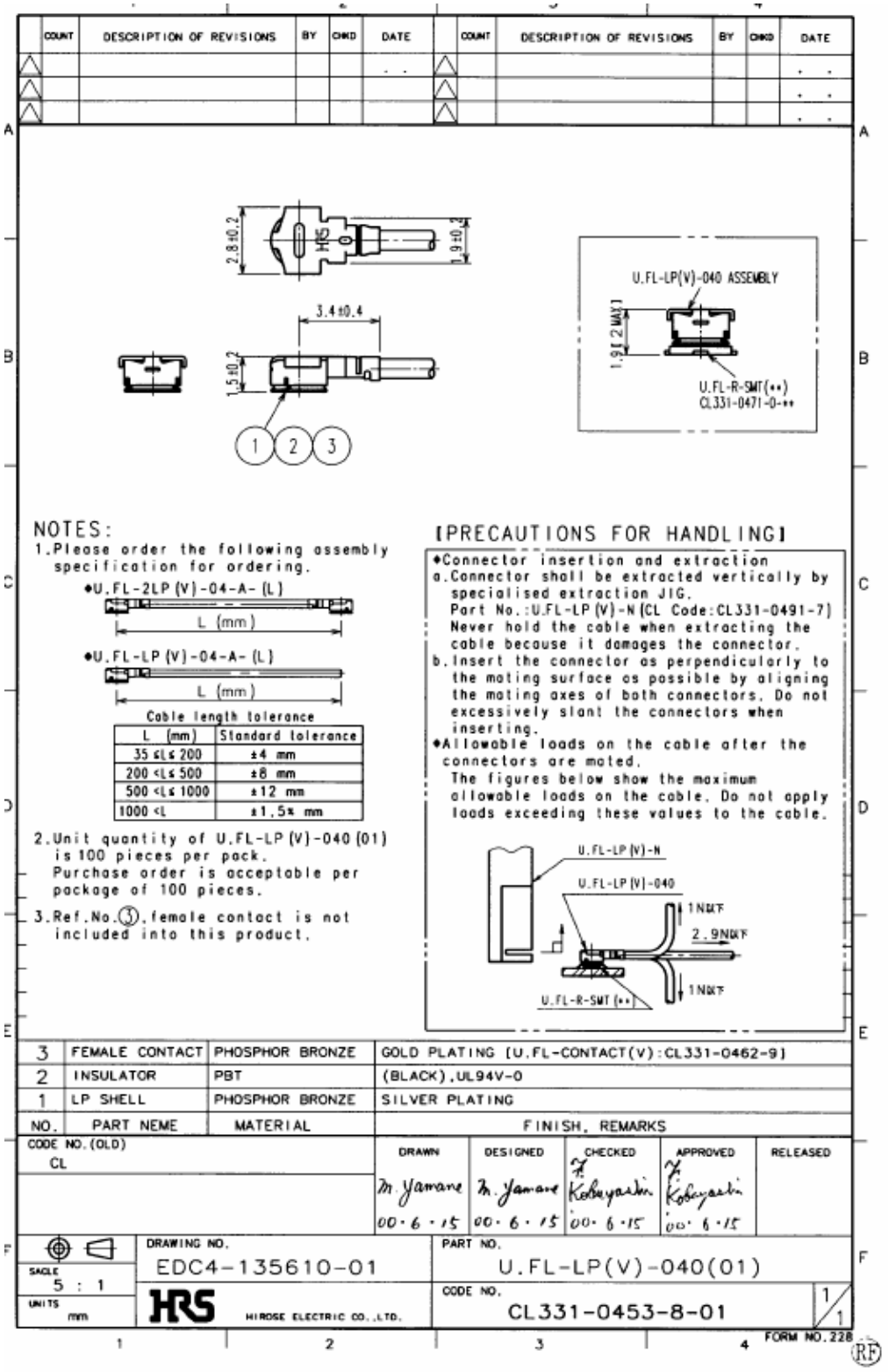


Figure 26: Specifications of U.FL-LP-(V)-040(01) plug

Table 14: Ordering information for Hirose U.FL Series

Item	Part number	HRS number
Connector on EU3-E	U.FL-R-SMT	CL331-0471-0-10
Right-angle plug shell for Ø 0.81mm cable	U.FL-LP-040	CL331-0451-2
Right-angle plug for Ø 0.81mm cable	U.FL-LP(V)-040 (01)	CL331-053-8-01
Right-angle plug for Ø 1.13mm cable	U.FL-LP-068	CL331-0452-5
Right-angle plug for Ø 1.32mm cable	U.FL-LP-066	CL331-0452-5
Extraction jig	E.FL-LP-N	CL331-04441-9

5 Electrical, Reliability and Radio Characteristics

5.1 Absolute Maximum Ratings

The absolute maximum ratings stated in Table 15 are stress ratings under any conditions. Stresses beyond any of these limits will cause permanent damage to EU3-E.

Table 15: Absolute maximum ratings

Parameter	Min	Max	Unit
Supply voltage BATT+	-0.3	4.5	V
Voltage at digital pins in POWER DOWN mode	-0.3	0.3	V
Voltage at digital pins in normal operation	-0.3	2.8	V
Voltage at analog pins in POWER DOWN mode	-0.3	0.3	V
Voltage at analog pins in normal operation	-0.3	2.5	V
VUSB_IN	-0.3	7.5	V
USB_DP, USB_DN	-0.3	7.5	V
PWR_IND	-0.3	10	V
VDDLP	-0.3	3.25	V

5.2 Operating Temperatures

Table 16: Board temperature

Parameter	Min	Typ	Max	Unit
Operating temperature range	-30	+25	+85	°C
Restricted temperature range	-40		+90	°C
Automatic shutdown[1] Temperature measured on EU3-E board	<-40	---	>+90	°C

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.

The maximum allowable ambient temperature that causes the module to shut down depends on various conditions. The following Table 17 and Table 18 show sample lab environment conditions. Please be aware that the maximum ambient temperature as well as the operating duration may vary significally for your application.

Table 17: Sample operating conditions without forced air circulation (according to IEC 60068-2)

Mode	Ambient Temperature	Voltage	RF Power	Operating Duration
GSM, GPRS/EDGE Class 8	+70°C	$V_{BATT+} \leq 4.2V$	Max.	∞
GRPS/EDGE Class10	+70°C	$V_{BATT+} \leq 3.8V$	Max.	∞
WCDMA	+60°C	$V_{BATT+} \leq 3.8V$	Max.	∞
WCDMA	+65°C	$V_{BATT+} \leq 3.8V$	≤ 10dBm	∞
WCDMA	+75°C	$V_{BATT+} \leq 3.8V$	≤ 0dBm	∞
WCDMA	+65°C	$V_{BATT+} \leq 3.8V$	Max.	≤ 5min

Table 18: Sample operating conditions with forced air circulation (air speed 0.9m/s)

Mode	Ambient Temperature	Voltage	RF Power	Operating Duration
GSM, GPRS/EDGE Class 8	+80°C	$V_{BATT+} \leq 4.2V$	Max.	∞
GRPS/EDGE Class 10	+80°C	$V_{BATT+} \leq 3.8V$	Max.	∞
WCDMA	+75°C	$V_{BATT+} \leq 3.8V$	Max.	∞
WCDMA	+80°C	$V_{BATT+} \leq 3.8V$	≤ 10dBm	∞
WCDMA	+80°C	$V_{BATT+} \leq 3.8V$	≤ 0dBm	∞

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 19: Storage conditions

Type	Condition	Unit	Reference
Air temperature: Low High	-40 +85	°C	ETS 300 019-2-1: T1.2, IEC 60068-2-1 Ab ETS 300 019-2-1: T1.2, IEC 60068-2-2 Bb
Humidity relative: Low High Condens.	10 90 at 30°C 90-100 at 30°C	%	--- ETS 300 019-2-1: T1.2, IEC 60068-2-56 Cb ETS 300 019-2-1: T1.2, IEC 60068-2-30 Db
Air pressure: Low High	70 106	kPa	IEC TR 60271-3-1: 1K4 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 Heat	1120 600	W/m^2	ETS 300 019-2-1: T1.2, IEC 60068-2-2 Bb ETS 300 019-2-1: T1.2, IEC 60068-2-2 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: Displacement Acceleration Frequency range	 1.5 5 2-9 9-200	 mm m/s^2 Hz	IEC TR 60271-3-1: 1M2
Shocks: Shock spectrum Duration Acceleration	 semi-sinusoidal 1 50	 ms m/s^2	IEC 60068-2-27 Ea

5.4 Reliability Characteristics

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

Table 20: 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 60068-2-6
Shock half-sinus	Acceleration: 500g Shock duration: 1msec 1 shock per axis 6 positions (± x, y and z)	DIN IEC 60068-2-27
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 60068-2-14 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 60068-2-30 Db ETS 300 019-2-5
Cold (constant exposure)	Temperature: -40 ±2°C Test duration: 16h	DIN IEC 60068-2-1

5.5 Pin Assignment and Signal Description

The Molex board-to-board connector on EU3-E is an 80-pin double-row receptacle. The position of the pins can be seen in Figure 29 that shows the top view of EU3-E.

1	GND	GND	80
2	ADC1_IN	Do not use (Output, low)	79
3	ADC2_IN	PWR_IND	78
4	GND	Not connected	77
5	GPIO10	GPIO9	76
6	GPIO8	Not connected	75
7	Not connected	GPIO4	74
8	GPIO7	GPIO3	73
9	GPIO6	GPIO2	72
10	GPIO5	GPIO1	71
11	Do not use (Input, PD, Vin,max = 2.6V)	Do not use (Input, PD, Vin,max = 2.6V)	70
12	VUSB_IN	USB_DP	69
13	Do not use (Input, PD, Vin,max = 2.6V)	USB_DN	68
14	Not connected	VSENSE	67
15	Do not use (Input, PD, Vin,max = 2.6V)	VMIC	66
16	CCCLK	Do not use (100pF to GND)	65
17	CCVCC	Do not use (100pF to GND)	64
18	CCIO	EPP	63
19	CCRST	EPN	62
20	CCIN	Not connected	61
21	CCGND	Not connected	60
22	Do not use (Input, PD, Vin,max = 2.6V)	MICP	59
23	Do not use (Input, PD, Vin,max = 2.6V)	MICN	58
24	Do not use (Input, PD, Vin,max = 2.6V)	AGND	57
25	Do not use (Input, PD, Vin,max = 2.6V)	IGT	56
26	Do not use (Input, PD, Vin,max = 2.6V)	EMERG_OFF	55
27	Not connected	DCD0	54
28	SYNC	Do not use (Tristate, Vin,max = BATT+)	53
29	Do not use (Tristate, Vin,max = BATT+)	CTS0	52
30	RXD0	Not connected	51
31	Not connected	DTR0	50
32	TXD0	RTS0	49
33	VDDLP	DSR0	48
34	Not connected	RING0	47
35	Not connected	VEXT	46
36	GND	BATT+	45
37	GND	BATT+	44
38	GND	BATT+	43
39	GND	BATT+	42
40	GND	BATT+	41

Figure 27: Pin assignment

PD=Pull Down

Please note that the reference voltages listed in Table 21 are the values measured directly on the EU3-E module. They do not apply to the accessories connected.

Table 21: Signal description

Function	Signal name	IO	Signal form and level	Comment
Power supply	BATT+	I	$V_I$max = 4.2V $V_I$typ = 3.8V $V_I$min = 3.3V during Tx burst on board I ≈ 2A, during Tx burst (GSM)  n Tx = n x 577µs peak current every 4.616ms	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
External supply voltage	VEXT	O	$V_O$typ = 2.6V ±2% $I_O$max = 0.5mA	VEXT may be used for application circuits. 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.
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 ≈ 250kΩ, C_I ≈ 1nF V_{IL}max = 0.8V at Imax = -20µA V_{OH}max = V_{BATT+} IGT as ON switch: ~~~|____|~~~ Active Low ≥ 300ms	This signal switches the mobile on. This line must be driven low by an open drain or open collector driver.

Table 21: Signal description

Function	Signal name	IO	Signal form and level	Comment
Emer-gency off	EMERG_OFF	I	Internal pull-up: $R_I \approx 6.6k\Omega$ V_{IL}max = 0.6V at Imax = -40µA V_{OH}min = 2.0V V_{OH}max = 2.65V For emergency off (power down): Signal ˜˜|____|˜˜ Power down ≥2.5s	This line must be driven by open drain or open collector. If unused keep pin open.
Synchro-nization	SYNC	O	V_{OL}max = 0.45V at I = 2mA V_{OH}min = 2.45V at I = -0.5mA V_{OH}min = 2.15V at I = -2mA V_{OH}max = 2.65V	Connectivity status, driving a status LED to indicate net-work connectivity status. The LED circuit must be imple-mented by the external appli-cation (for more information see Section 3.10.3). If unused keep line open.
RTC backup	VDDLP	I/O	$V_O$max = 3.2V while BATT+ =>3.35V V_I = 1.5V…3.25V at I_{max}= 3 µA while V_{BATT+} = 0V	For details see Section 3.5. If unused keep pin open.
	VSENSE	I	$V_I$max = 4.2V	Connect VSENSE directly to BATT+
SIM interface specified for use with 3V SIM card	CCIN	I	$R_I \approx 110k\Omega$ V_{IL}max = 0.5V at I = -25µA V_{IH}min = 2.2V at I = -5µA V_{OH}max = V_{IH}max = 2.85V	CCIN = Low, SIM card holder closed. If unused, connect to GND. Maximum cable length or copper track 200mm to SIM card holder. All signals of SIM interface are protected against ESD with a special diode array. Usage of CCGND is manda-tory.
	CCRST	O	V_{OL}max = 0.25V at I = +1mA V_{OH}min = 2.6V at I = -1mA V_{OH}max = 3.10V	
	CCIO	I/O	$R_I \approx 4.7k\Omega$ V_{IL}max = 0.8V V_{IL}min = -0.3V V_{IH}min = 2.05V V_{IH}max = 3.10V V_{OL}max = 0.25V at I = +1mA V_{OH}min = 2.4V at I = -0.1mA V_{OH}max = 3.10V	
	CCCLK	O	V_{OL}max = 0.25V at I = +1mA V_{OH}min = 2.6V at I = -1mA V_{OH}max = 3.10V	
	CCVCC	O	$V_O$min = 2.9V $V_O$typ = 3.00V $V_O$max = 3.10V $I_O$max = -50mA	
	CCGND		Ground	

Table 21: Signal description

Function	Signal name	IO	Signal form and level	Comment
SIM interface specified for use with 1.8V SIM card	CCIN	I	$R_I \approx 110k\Omega$ V_{IL}max = 0.5V at I = -25µA V_{IH}min = 2.2V at I = -5µA V_{OH}max = V_{IH}max = 2.85V	CCIN = Low, SIM card holder closed. If unused, connect to GND. 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	V_{OL}max = 0.25V at I = +1mA V_{OH}min = 1.50V at I = -1mA V_{OH}max = 1.85V	
	CCIO	I/O	$R_I \approx 4.7k\Omega$ V_{IL}max = 0.50V V_{IL}min = -0.30V V_{IH}min = 1.20V V_{IH}max = 1.85V V_{OL}max = 0.25V at I = +1mA V_{OH}min = 1.25V at I = -1mA V_{OH}max = 1.85V	
	CCCLK	O	V_{OL}max = 0.25V at I = +1mA V_{OH}min = 1.50V at I = -1mA V_{OH}max = 1.85V	
	CCVCC	O	$V_O$min = 1.75V, $V_O$typ = 1.80V $V_O$max = 1.85V $I_O$max = -50mA	
	CCGND		Ground	
USB	VUSB_IN	I	V_{IN}min = 4.5V V_{IN}max = 5.25V Active current $I_I$typ = 2.5mA $I_I$max = 10mA Suspend current $I_I$typ = 450µA	All electrical characteristics according to USB Implementers' Forum, USB 2.0 Full Speed Specification. If lines are unused keep pins open.
	USB_DN	I/O	Input sensitivity (Diff), |D+ - D-|, V_{IN} = 0.8V to 2.5V: 0.2V min Common mode range (Diff) V_{IN} = 0.8V to 2.5V Receiver threshold (single-end) $V_{threshold}$min = 0.8V $V_{threshold}$max = 2.0V Receiver hysteresis, V_{hys}typ = 200mV	
	USB_DP	I/O		

Table 21: Signal description

Function	Signal name	IO	Signal form and level	Comment
ASC0 Serial interface	RXD0	O	V_{OL}max = 0.45V at I = 2mA V_{OH}min = 2.45V at I = -0.5mA V_{OH}min = 2.15V at I = -2mA V_{OH}max = 2.7V V_{IL}max = 0.8V V_{IH}min = 1.80V V_{IH}max = 2.80V	Serial interface for AT commands or data stream. If unused keep pins open.
	TXD0	I		
	CTS0	O		
	RTS0	I		
	DTR0	I		
	DCD0	O		
	DSR0	O		
	RING0	O		
GPIO Interface	GPIO1	IO	V_{OL}max = 0.45V at I = 2mA V_{OH}min = 2.45V at I = -0.5mA V_{OH}min = 2.15V at I = -2mA V_{OH}max = 2.65V V_{IL}max = 0.8V V_{IH}min = 1.80V V_{IH}max = 2.80V	If unused keep pins open.
	GPIO2	IO		
	GPIO3	IO		
	GPIO4	IO		
	GPIO5	IO		
	GPIO6	IO		
	GPIO7	IO		
	GPIO8	IO		
	GPIO9	IO		
	GPIO10	IO		
ADC	ADC1_IN	I	$R_I \approx 1k\Omega$ $C_I \approx 1nF$ V_{IL}max = 0V V_{IH}max = 2.5V Resolution = 8Bit DNL = ±1.5LSB INL = ±0.75LSB offset = ±3LSB Gain Error = ±2.5% Channel Isolation typ 50dB at DC	If unused keep pins open.
	ADC2_IN	I		

Table 21: Signal description

Function	Signal name	IO	Signal form and level	Comment
Analog Audio interface	VMIC	O	$V_O$min = 2.52V $V_O$typ = 2.60V $V_O$max = 2.68V I_{max} = 3mA	Microphone supply for customer feeding circuits If unused keep line open.
	EPP	O	3.0 Vpp (differential) typical @ 0dBm0 4.24 Vpp differential maximal @ 3.14dBm0 Measurement conditions: Audio mode: **6** Outstep 33 No load Output common mode voltage 1.25V ± 0.125V Minimum differential load 25.6 Ohms	Balanced output for earphone or balance output for line out If unused keep pin open.
	EPN	O		
	MICP	I	External bias not necessary Input DC offset voltage range: +3V…-3V Full Scale Input Voltage: 3.66 Vpp 0dBm0 Input Voltage: 2.6 Vpp Measurement conditions: Audio mode: **6** ^SNFI: 0,4,16384 => PGA = 0dB ZImin = 16k ZItyp = 20k ZImax = 24k	Balanced differential microphone with external feeding circuit (using VMIC and AGND) or balanced differential line input. If unused keep pins open.
	MICN	I		
	AGND		Analog Ground	GND level for external audio circuits

5.6 Power Supply Ratings

Table 22: Power supply ratings

	Description	Conditions	Min	Typ	Max	Unit
BATT+	Supply voltage	Directly measured at Module Voltage must stay within the min/max values, including voltage drop, ripple, spikes.	3.3	3.8	4.2	V
	Maximum allowed 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≤250kHz @ f>250kHz			 80 12	 mV mV
I_{BATT+}	OFF State supply current	POWER DOWN		30		µA
	Average GSM / GPRS supply current[1]	SLEEP (USB Suspend) @DRX=9		2.2		mA
		SLEEP (USB Suspend) @DRX=5		2.7		mA
		SLEEP (USB Suspend) @DRX=2		3.9		mA
		Voice Call GSM900; PCL=5		290		mA
		GPRS Data transfer GSM900; PCL=5; 1Tx/4Rx		310		mA
		GPRS Data transfer GSM900; PCL=5; 2Tx/3Rx		410		mA
		EDGE Data transfer GSM900; PCL=5; 1Tx/4Rx		250		mA
		EDGE Data transfer GSM900; PCL=5; 2Tx/3Rx		300		mA
		Voice Call GSM1800; PCL=0		240		mA
		GPRS Data transfer GSM1800; PCL=0; 1Tx/4Rx		270		mA
		GPRS Data transfer GSM1800; PCL=0; 2Tx/3Rx		340		mA
		EDGE Data transfer GSM1800; PCL=0; 1Tx/4Rx		230		mA
		EDGE Data transfer GSM1800; PCL=0; 2Tx/3Rx		280		mA

Table 22: Power supply ratings

	Description	Conditions	Min	Typ	Max	Unit
I_{BATT+}	Peak current during GSM transmit burst	VOICE Call GSM900; PCL=5		1.95	2.7	A
		VOICE Call GSM1800; PCL=0		1.2	2.1	A
	Average WCDMA supply current	SLEEP (USB Suspend) @DRX=9		2.0		mA
		SLEEP (USB Suspend) @DRX=8		2.4		mA
		SLEEP (USB Suspend) @DRX=6		3.7		mA
		UMTS Data transfer Band I @+23dBm		650	750	mA
		HSDPA Data transfer Band I @+23dBm		610		mA
		UMTS Data transfer Band VIII @+23dBm		630		mA
		HSDPA Data transfer Band VIII @+23dBm		640	740	mA

1. With an impedance of Z_{LOAD}=50Ohm at the antenna connector

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 temporarily adjusted according to the AT command parameters listed in the table below. The audio parameters are set with the AT commands AT^SNFI as well as AT^SNFO and they are reset to their default values when the audio mode is changed by AT^SNFS (see [1]). For an model of how the parameters influence the audio signal path see Section 5.7.2.

Table 23: Audio parameters adjustable by AT command

Parameter	Influence to	Range	Gain range	Calculation
micAmp1	MICP/MICN first analogue amplifier gain of before ADC	0,1	0 or 24dB	1 step
micAmp2	MICP/MICN second analogue amplifier gain of before ADC	0…22	-6…25.5dB	1.5 dB steps
micTxVol	Digital gain of input signal after ADC	0, 1...65535	Mute, -84...+12dB	20 * log (micTXVol/ 16384)
cdcRXGain	Digital gain of output signal after summation of sidetone	0, 1...65535	Mute, -84...+12dB	20 * log (cdcRxGain/ 16384)
rxVol	Digital Volume of output signal after speech decoder, before summation of sidetone and DAC	0, 1…41	Mute, -48...+12dB	1.5 dB steps
stGain	Digital attenuation of sidetone	0, 1...65535	Mute, -96...0dB	20 * log (stGain/ 16384) -12

5.7.2 Audio Programming Model

The audio programming model shows how the signal path can be influenced by varying AT command parameters: AT^SNFI allows to set the parameters <micAmp1>, <micAmp2> and <micTxVol>, whereas the parameters <cdcRxGain>, <stGain> and <rxVol> can be adjusted with AT^SNFO. For more information on the AT commands and parameters see Section 5.7.1 and [1].

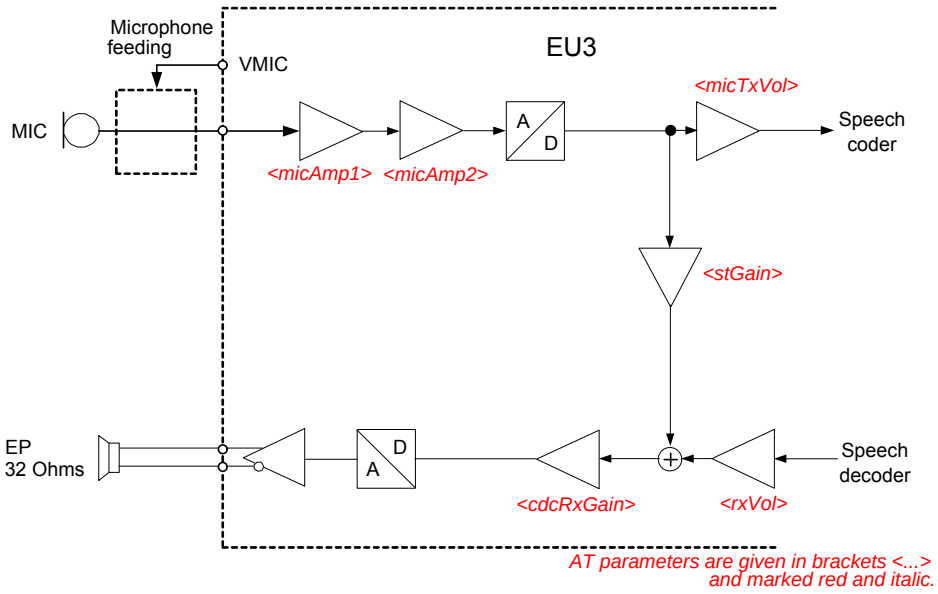


Figure 28: Audio programming model

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 24: Voiceband characteristics (typical)

Audio mode no. AT^SNFS=	**1**	**2**	**3**	**4**	**5**	**6**
Name	Default Handset	Router	User Handset	Headset	Speaker phone	Transpar-ent
Purpose	DSB with Votronic handset	Analogue phone inter-face		Mono Headset	Handheld speaker-phone	Direct access to speech coder
TX-Filters	Adjusted	Flat	Adjusted	Flat	Flat	Flat

Table 24: Voiceband characteristics (typical)

Audio mode no. AT^SNFS=	**1**	**2**	**3**	**4**	**5**	**6**
RX-Filters	Adjusted to fit artificial ear type 3.2 low leakage	Flat	Adjusted to fit artificial ear type 3.2 low leakage	Flat	500 Hz HP	Flat
Gain setting:	Fix	Adjustable	Adjustable	Adjustable	Adjustable	Adjustable
Default SNFI Parameters	1,11,16384	0,6,25000	1,11,16384	1,19,16384	1,19,16384	0,4,16384
Default SNFO Parameters	29136,33, 6942	7978,33,0	29136,33, 6942	7732,33, 12288	15465,33,0	16384,33, 0
Power supply VMIC	ON during call	ON during call	ON during call	ON during call	ON during call	ON during call
Sidetone	Fix	Adjustable	Adjustable	Adjustable	Adjustable	Adjustable
Volume control	Fix	Adjustable	Adjustable	Adjustable	Adjustable	Adjustable
Echo canceller Behaviour optimized for	ON Low echo	ON Low echo	ON Low echo	ON Moderate echo	ON High echo	OFF
Non Linear Processor with Comfort Noise Generator	ON	ON	ON	ON	ON	OFF
Noise Reduction (Tx)	OFF	OFF	OFF	-12dB	-12dB	OFF
MIC input signal for 0dBm0, [1] f = 1024 Hz	17.5mV	665mV	17.5mV	5mV	5mV	1036mV
EP output signal in mV rms. @ 0dBm0, 1024 Hz, no load (default gain) / @ 3.14 dBm0	508mV 2.1Vpp	516mV 2.1Vpp	508mV 2.1Vpp	407mV 1.68Vpp	1220mV 4.5Vpp	1060mV 4.3Vpp
Sidetone gain at default settings	23.6dB	-∞ dB	23.6dB	25.3 dB	-∞ dB	-∞ dB

1. All values measured before the noise reduction attenuates the sine wave after a few seconds.

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.

5.7.4 Voiceband Receive Path

Test conditions:
- The values specified below were tested to 1024Hz with default settings in audio mode 6 during a GSM EFR voice call unless otherwise stated.

Table 25: Voiceband receive path

Parameter	Min	Typ	Max	Unit	Test condition / remark
Maximum differential output voltage (peak to peak) EPP to EPN	- 8	4.0 4.3		V V	32Ω, No load, @ 3.14 dBm0 (Full Scale)
Nominal differential output voltage (peak to peak) EPP to EPN		2.8 3.0		V V	32Ω, No load, @ 0 dBm0 (Nominal level)
Output bias voltage		1.24		V	From EPP or EPN to AGND
Fine scaling by DSP (cdcRxGain)	-84		+12	dB	Set with AT^SNFO
Differential output load resistance	25.6	32		Ω	From EPP to EPN
Differential output load capacitance			300	pF	From EPP to EPN

5.7.5 Voiceband Transmit Path

Test conditions:
- The values specified below were tested to 1024Hz and default settings in audio mode 6 during a GSM EFR unless otherwise stated.

Table 26: Voiceband transmit path

Parameter	Min	Typ	Max	Unit	Test condition / Remark
Full scale input voltage (peak to peak) for 3.14dBm0 MICP to MICN		3.66		V	Balanced
Nominal input voltage (rms) for 0dBm0 MICP to MICN		0.92		V	Balanced
Input amplifier 1 gain (micAmp1)	0		24	dB	Set with AT^SNFI
Input amplifier 2 gain in 1.5dB steps (micAmp2)	-6		25.5	dB	Set with AT^SNFI
Fine scaling by DSP (micTxVol)	-84		+12	dB	Set with AT^SNFI
Microphone supply voltage VMIC	2.52	2.60	2.68	V	No load
Microphone supply voltage VMIC	2.05			V	@ 3mA
VMIC current			3	mA	
Input DC common mode voltage	-3		+3	V	

5.8 Air Interface

Table 27: Air interface GSM / UMTS

Parameter	Conditions	Min.	Typical	Max.	Unit
UMTS connectivity	Band I, VIII				
	UMTS 900 Band VIII	880		915	MHz
	UMTS 2100 Band I	1920		1980	MHz
	UMTS 900 Band VIII	925		960	MHz
	UMTS 2100 Band I	2110		2170	MHz
	UMTS 900 Band VIII		-108		dBm
	UMTS 2100 Band I		-108		dBm
	UMTS 900 Band VIII	+21	+23	+25	dBm
	UMTS 2100 Band I	+21	+23	+25	dBm
GPRS coding schemes	Class 10, CS1 to CS4				
EGPRS	Class 10, MCS1 to MCS9				
GSM Class	Small MS				
GSM Frequency range Uplink (MS to BTS)	E-GSM 900	880		915	MHz
	GSM 1800	1710		1785	MHz
GSM Frequency range Downlink (BTS to MS)	E-GSM 900	925		960	MHz
	GSM 1800	1805		1880	MHz
Static Receiver input Sensitivity @ ARP	E-GSM 900	-102	-108		dBm
	GSM 1800	-102	-108		dBm
Pout @ ARP	E-GSM 900	31	32	35	dBm
	GSM 1800	28	29	32	dBm

5.9 Electrostatic Discharge

The module 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 EU3-E module.

Special ESD protection provided on EU3-E*:*
SIM interface: clamp diodes for protection against overvoltage.

The remaining interfaces of EU3-E are not accessible to the user of the final product (since they are installed within the device) and are therefore only protected according to the JEDEC JESD22-A114D requirements.

EU3-E has been tested according to the following standards. The measured values can be gathered from the following table.

Table 28: Measured electrostatic values

Specification / Requirements	Contact discharge	Air discharge
JEDEC JESD22-A114D		
All other board-to-board interfaces	± 1kV Human Body Model	± 1kV Human Body Model
VSENSE	± 250V Human Body Model	± 250V Human Body Model
ETSI EN 300 342-1		
SIM interface	± 4kV	± 8kV

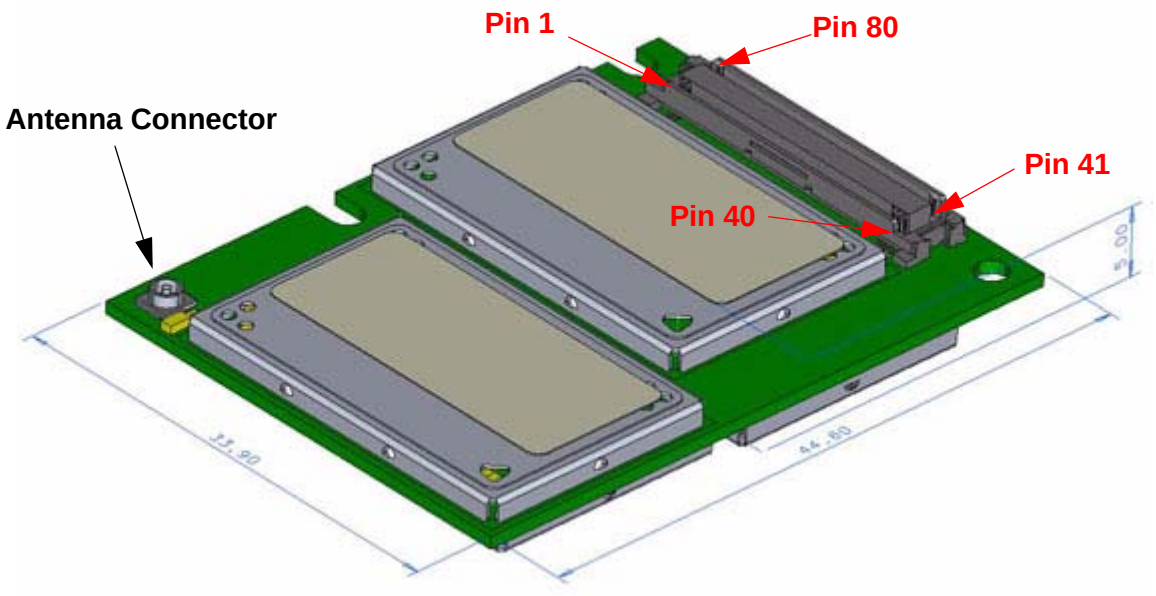
Note: Please note that the values may vary with the individual application design. For example, it matters whether or not the application platform is grounded over external devices like a computer or other equipment, such as the Cinterion Wireless Modules reference application described in Chapter 8.

6 Mechanics

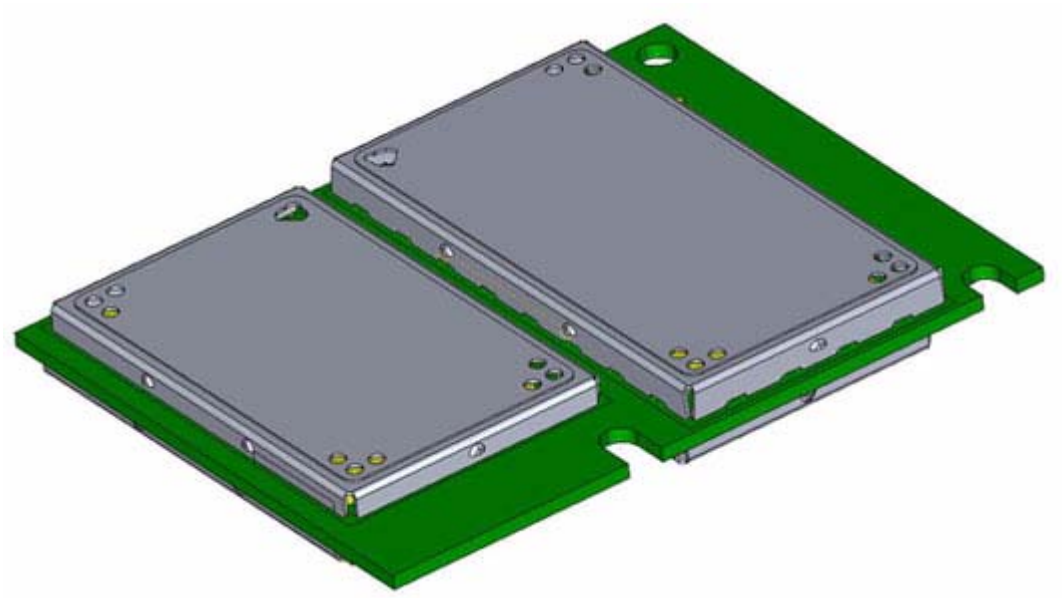
6.1 Mechanical Dimensions of EU3-E

Figure 29 shows the top view of EU3-E and provides an overview of the board's mechanical dimensions. For further details see Figure 30.

Length: 44.60mm
Width: 33.90mm
Height: 5mm



Top side



Bottom side

Figure 29: EU3-E – top view

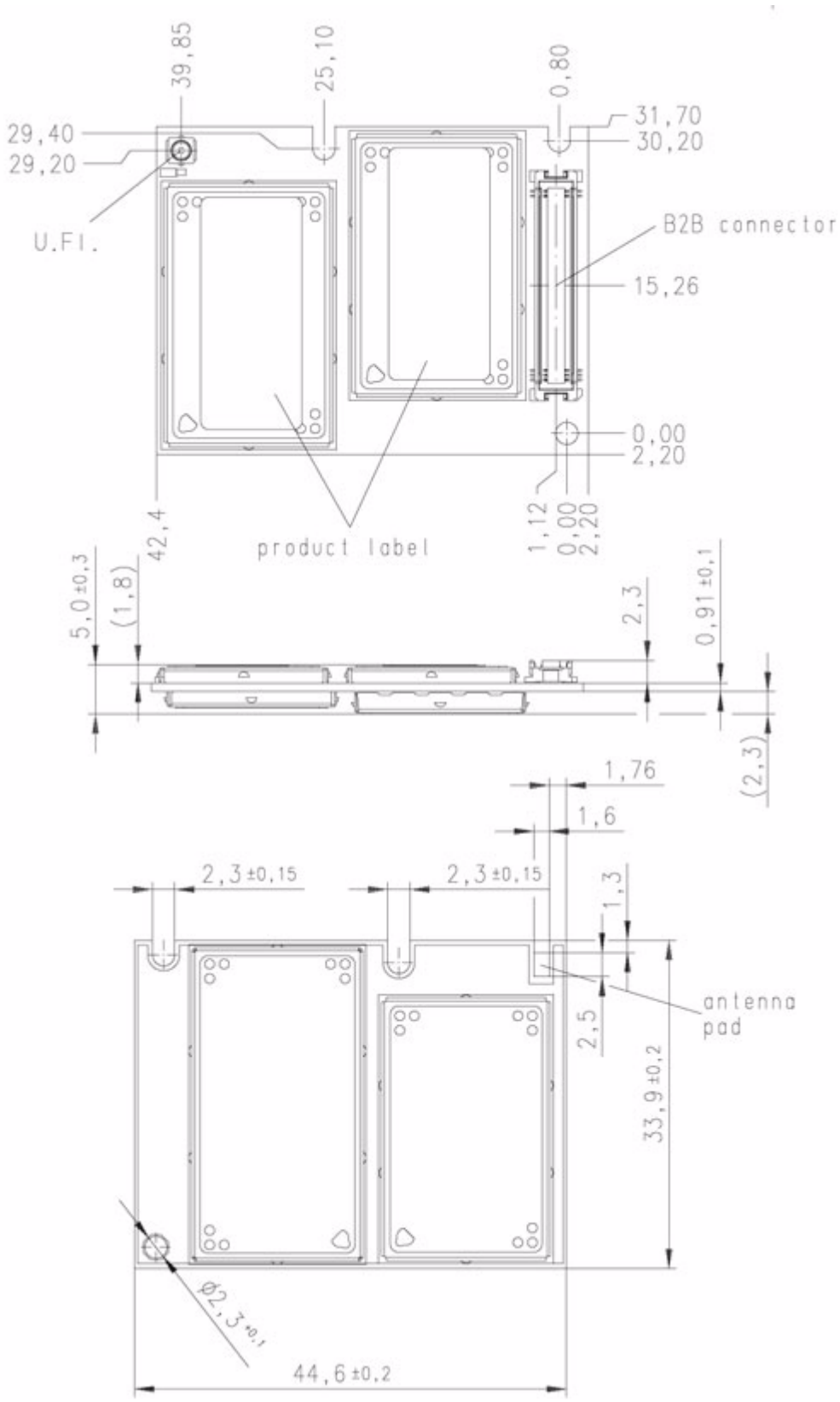


Figure 30: Dimensions of EU3-E (all dimensions in mm)

6.2 Mounting EU3-E to the Application Platform

There are many ways to properly install EU3-E in the host device. An efficient approach is to mount the EU3-E 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.

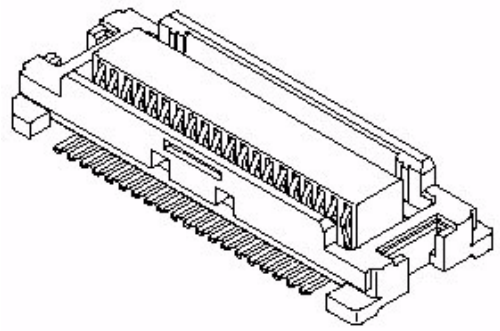
For proper grounding it is strongly recommended to use large ground plane on the bottom of board in addition to the five GND pins of the board-to-board connector. The ground plane may also be used to attach cooling elements, e.g. a heat sink or thermally conductive tape.

To prevent mechanical damage, be careful not to force, bend or twist the module. Be sure it is positioned flat against the host device. See also Section 9.3 with mounting advice sheet.

6.3 Board-to-Board Application Connector

This section provides the specifications of the 80-pin board-to-board connector used to connect EU3-E to the external application.

Connector mounted on the EU3-E module:



Type: 52991-0808 SlimStack Receptacle 80 pins, 0.50mm pitch, for stacking heights of 3.0 or 4.0mm, see Figure 32 for details.
Supplier: Molex, http//www.molex.com

Table 29: 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:

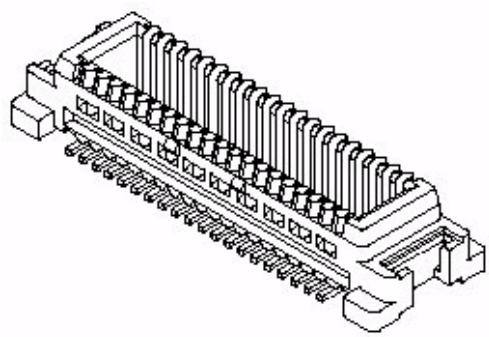


Figure 31: Mating board-to-board connector 53748-0808 on application

- 53748-0808 SlimStack Plug, 3mm stacking height,
  see Figure 33 for details.
- 53916-0808 SlimStack Plug, 4mm stacking height

Note: There is no inverse polarity protection for the board-to-board connector. It is therefore very important that the board-to-board connector is connected correctly to the host application, i.e., pin1 must be connected to pin1, pin2 to pin 2, etc. Pin assignments are listed in Section 5.5, pin locations are shown in Figure 29.

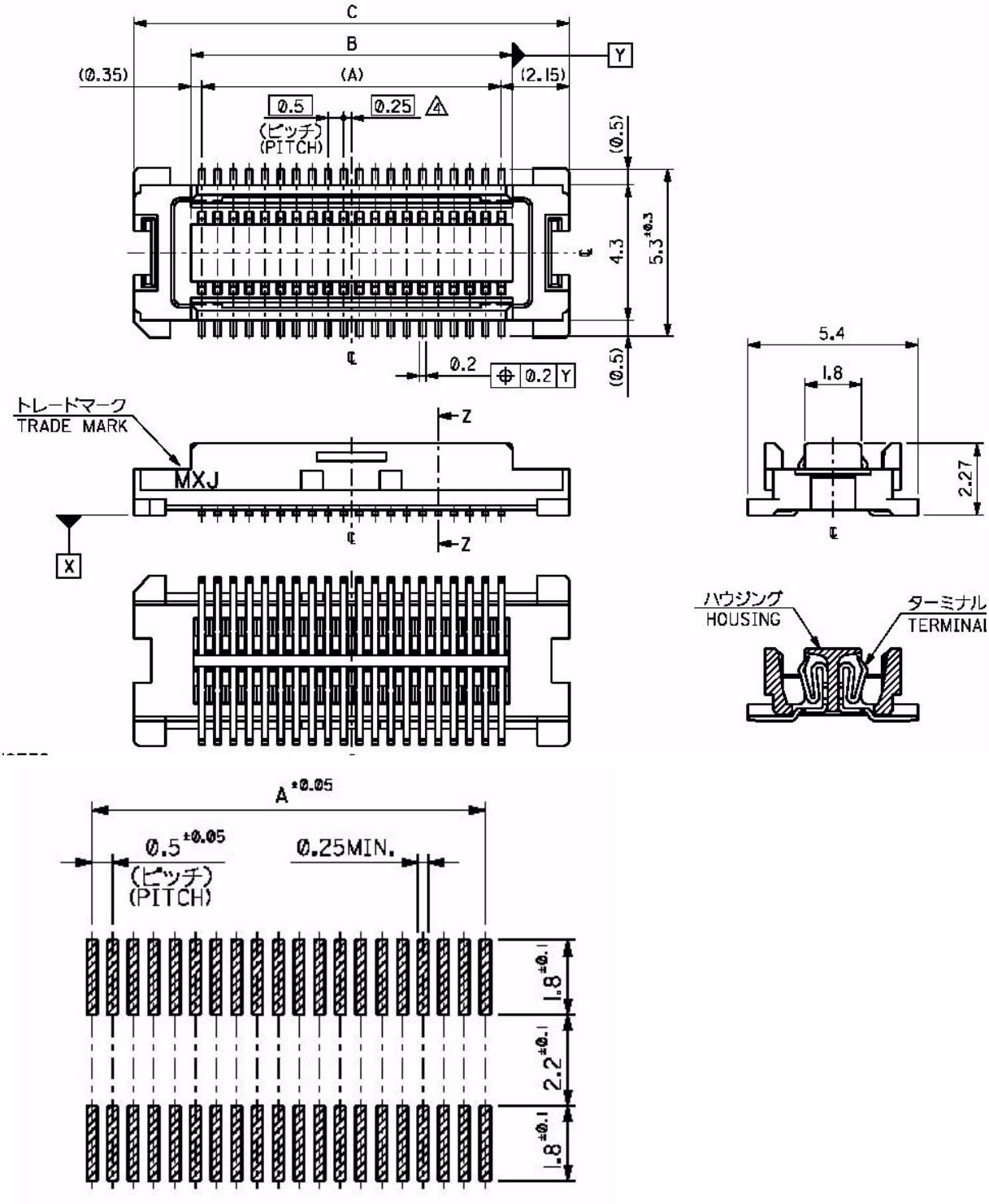


Figure 32: Molex board-to-board connector 52991-0808 on EU3-E

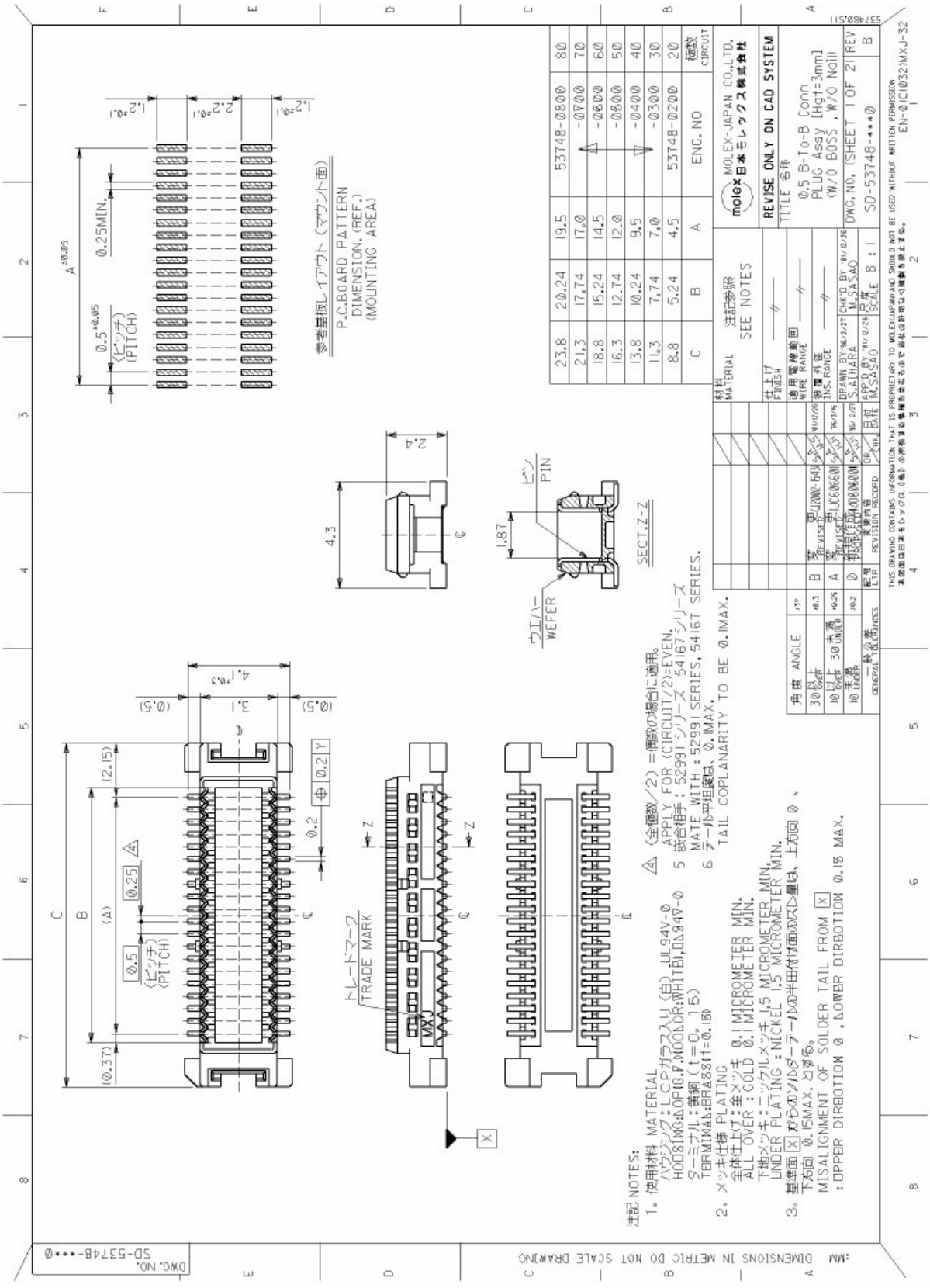


Figure 33: Mating board-to-board connector 53748-0808 on application

7 Sample Application

Figure 34 shows a typical example of how to integrate an EU3-E module with an application.

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

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 EU3-E 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 an external level controller is required, this can be done by using for example a 5V I/O tolerant buffer/driver like an LCX244 with $\overline{OE}$ (Output Enable) controlled by PWR_IND.

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

Disclaimer:
No warranty, either stated or implied, is provided on the sample schematic diagram shown in Figure 34 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 EU3-E modules.

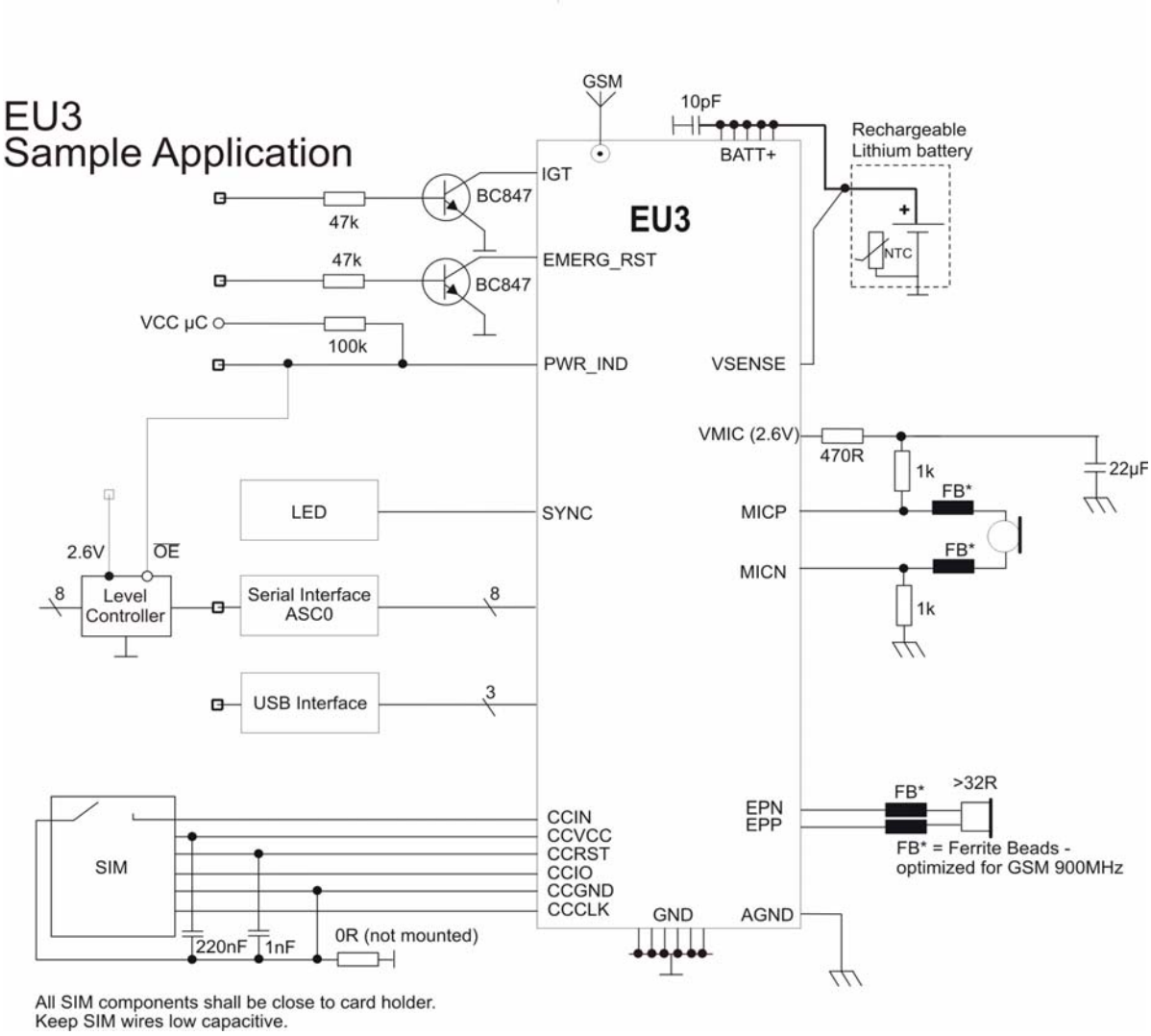


Figure 34: EU3-E sample application

8 Reference Approval

8.1 Reference Equipment for Type Approval

The Cinterion Wireless Modules reference setup submitted to type approve EU3-E is shown in the following figure:

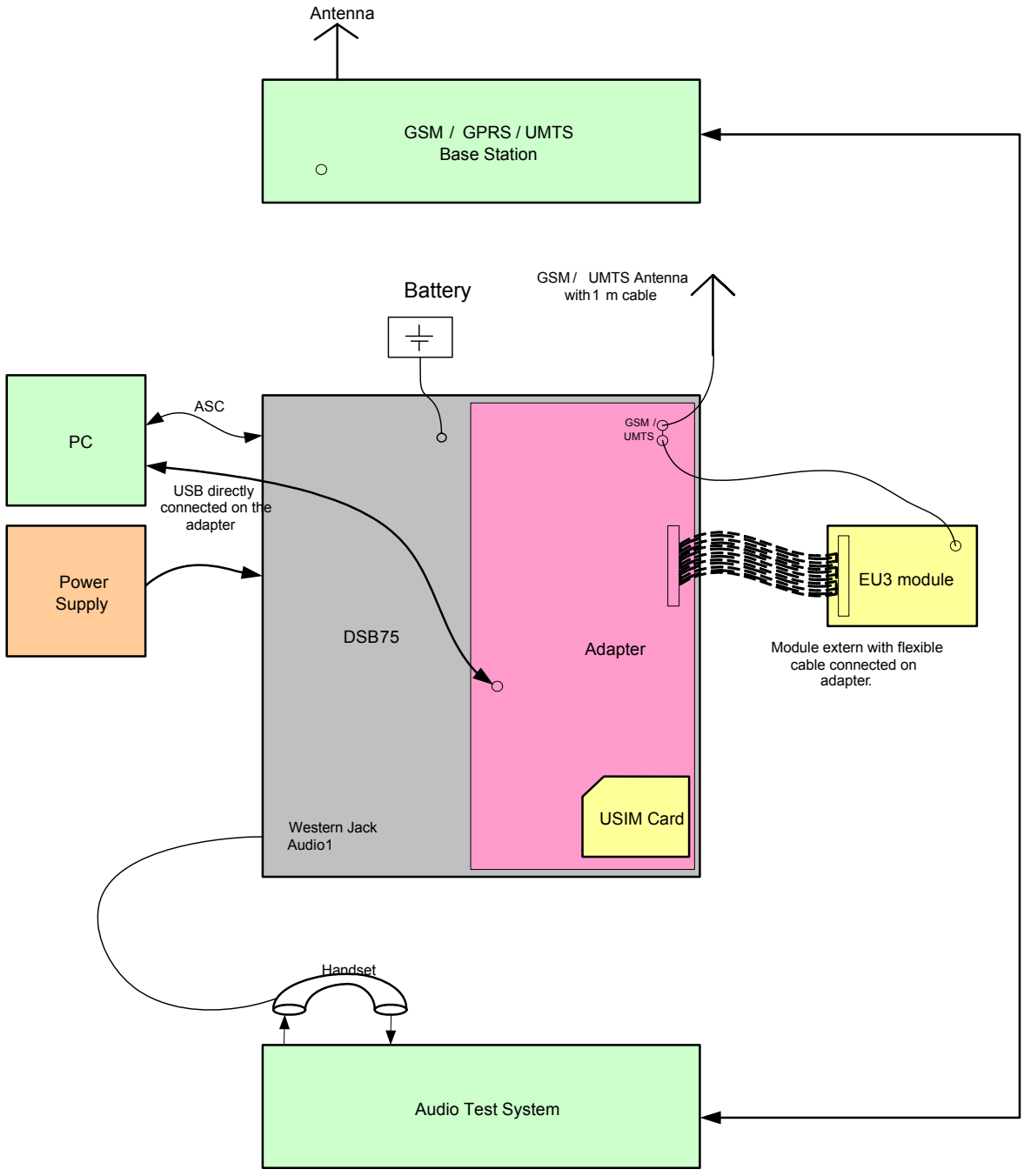


Figure 35: Reference equipment for Type Approval

9 Appendix

9.1 List of Parts and Accessories

Table 30: List of parts and accessories

Description	Supplier	Ordering information
EU3-E	Cinterion	Standard module Cinterion Wireless Modules IMEI: Ordering number: L30960-N1700-A100 Customer IMEI mode: Ordering number: L30960-N1705-A100
DSB75 Support Box	Cinterion	Ordering number: L36880-N8811-A100
DSB75-Adapter for mounting the EU3-E module	Cinterion	Ordering number: L30960-N1701-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 Email: contact@votronic.com
SIM card holder incl. push button ejector and slide-in tray	Molex	Ordering numbers: 91228 91236 Sales contacts are listed in Table 31.
Board-to-board connector	Molex	Sales contacts are listed in Table 31.
U.FL antenna connector	Hirose or Molex	Sales contacts are listed in Table 31 and Table 32.

Table 31: 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 32: 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 Herzog-Carl-Strasse 4 73760 Ostfildern Germany Phone: +49-711-456002-1 Fax: +49-711-456002-299 Email: 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 Branche 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

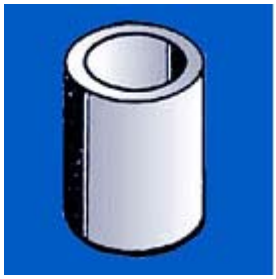
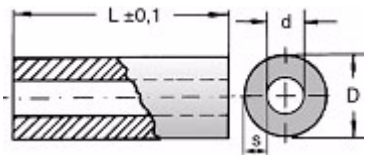
This section provides a list of suppliers and manufacturers offering fasteners and fixings for electronic equipment and PCB mounting. The content of this section is designed to offer basic guidance to various mounting solutions with no warranty on the accuracy and sufficiency of the information supplied.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

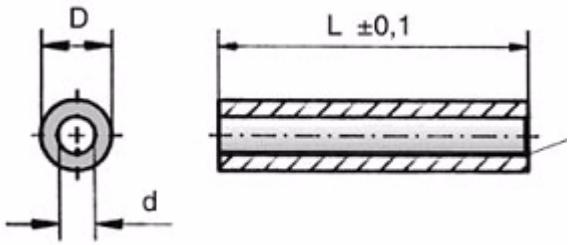
9.2.1 Fasteners from German Supplier ETTINGER GmbH

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

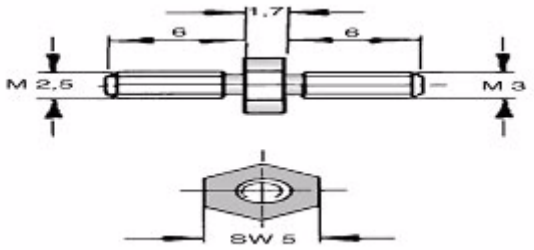
The following tables contain only article numbers and basic parameters of the listed components. For further detail and ordering information please contact Ettinger GmbH.

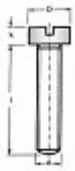
Please note that some of the listed screws, spacers and nuts are delivered with the DSB75 Support Board. See comments below.

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
	

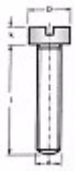
Article number: 07.51.403	Insulating Spacer for M2 Self-gripping[1]
Length	3.0mm
Material	Polyamide 6.6
Surface	Black
Internal diameter	2.2mm
External diameter	4.0mm
Flammability rating	UL94-HB
	

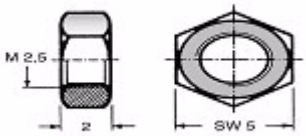
1. 2 spacers are delivered with DSB75 Support Board

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 / Ø	4
Thickness / L	1.6mm
Type	Nut DIN/UNC, DIN934
	

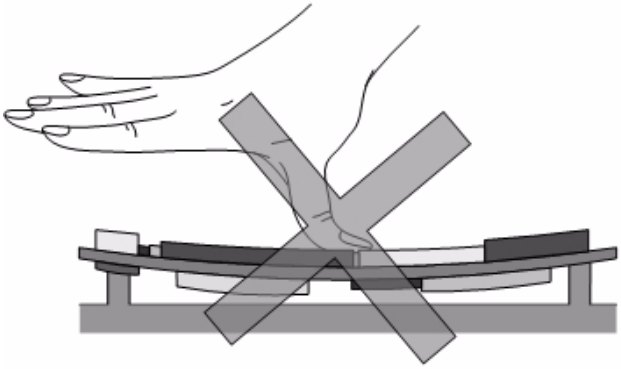
1. 2 nuts are delivered with DSB75 Support Board

9.3 Mounting Advice Sheet

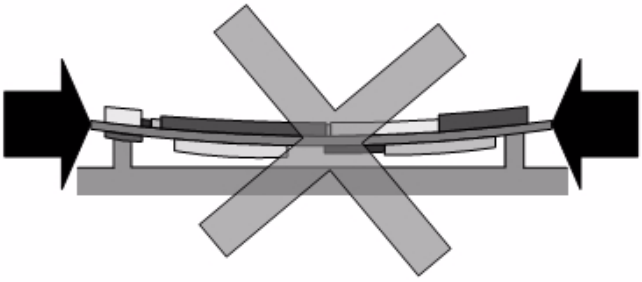
To prevent mechanical damage, be careful not to force, bend or twist the module. Be sure it is positioned flat against the host device (see also Section 6.2). The advice sheet on the next page shows a number of examples for the kind of bending that may lead to mechanical damage of the module.

Mounting Advice

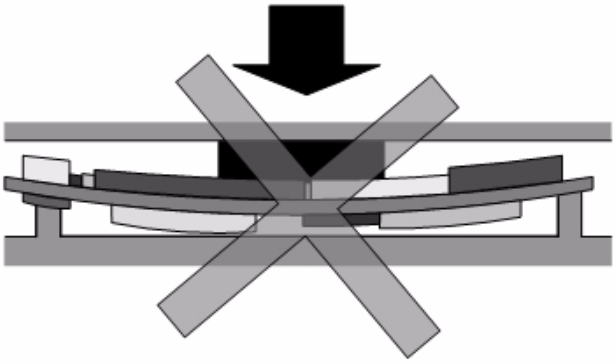
Do NOT BEND the Module



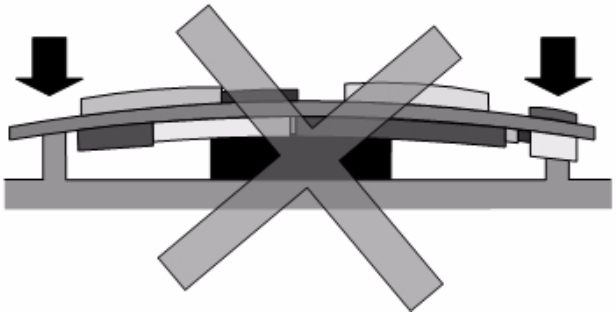
- By pressing from above



- By mounting under pressure



- By putting objects on top



- By putting objects below