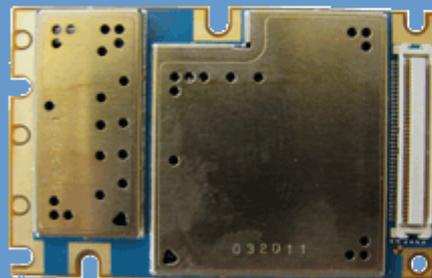




**CINTERION**  
a Gemalto company

## AH3-US

Version: 01.000  
DocId: AH3-US\_HD\_v01.000



# Hardware Interface Overview

Document Name: **AH3-US Hardware Interface Overview**

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# Contents

<b>1</b>	<b>Introduction .....</b>	<b>6</b>
1.1	Related Documents .....	6
1.2	Terms and Abbreviations .....	6
1.3	Regulatory and Type Approval Information .....	9
1.3.1	Directives and Standards .....	9
1.3.2	SAR requirements specific to portable mobiles .....	12
1.3.3	SELV Requirements .....	13
1.3.4	Safety Precautions .....	13
<b>2</b>	<b>Product Concept .....</b>	<b>15</b>
2.1	Key Features at a Glance .....	15
2.2	AH3-US System Overview .....	18
<b>3</b>	<b>Application Interface.....</b>	<b>19</b>
3.1	Operating Modes .....	20
3.2	Power Supply .....	21
3.3	USB Interface.....	22
3.4	Serial Interface ASC0 .....	23
3.5	UICC/SIM/USIM Interface .....	25
3.6	Analog Audio Interface.....	27
3.7	Pulse Code Modulation Interface (PCM) .....	27
3.8	Analog-to-Digital Converter (ADC).....	27
3.9	GPIO Interface .....	27
<b>4</b>	<b>GPS Receiver.....</b>	<b>28</b>
<b>5</b>	<b>Antenna Interfaces .....</b>	<b>29</b>
5.1	GSM/UMTS Antenna Interface .....	29
5.1.1	RF Antenna Pad .....	29
5.1.1.1	Pogo Pins.....	30
5.2	GPS Antenna Interface .....	32
<b>6</b>	<b>Mechanics.....</b>	<b>33</b>
6.1	Mechanical Dimensions of AH3-US .....	33
6.2	Mounting AH3-US to the Application Platform .....	35
6.3	Board-to-Board Application Connector .....	35
<b>7</b>	<b>Reference Approval .....</b>	<b>39</b>
7.1	Reference Equipment for Type Approval .....	39
7.2	Compliance with FCC and IC Rules and Regulations .....	40
<b>8</b>	<b>Appendix.....</b>	<b>41</b>
8.1	List of Parts and Accessories.....	41

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## Tables

Table 1:	Directives .....	9
Table 2:	Standards of North American type approval .....	9
Table 3:	Standards of European type approval.....	9
Table 4:	Requirements of quality .....	10
Table 5:	Standards of the Ministry of Information Industry of the People’s Republic of China .....	10
Table 6:	Toxic or hazardous substances or elements with defined concentration limits .....	11
Table 7:	Overview of operating modes .....	20
Table 8:	DCE-DTE wiring of ASC0 .....	24
Table 9:	Signals of the SIM interface (board-to-board connector) .....	25
Table 10:	Return loss in the active band.....	29
Table 11:	Pogo pins characteristics .....	30
Table 12:	Technical specifications of Molex board-to-board connector .....	36
Table 13:	List of parts and accessories.....	41
Table 14:	Molex sales contacts (subject to change) .....	42

# Figures

Figure 1: AH3-US system overview ..... 18

Figure 2: USB circuit ..... 22

Figure 3: Serial interface ASC0..... 23

Figure 4: UICC/SIM/USIM interface ..... 26

Figure 5: RF antenna pad size ..... 29

Figure 6: Pogo pins dimensions ..... 30

Figure 7: Exploded view of module’s antenna pads mounted on Pogo pins..... 31

Figure 8: AH3-US – top view..... 33

Figure 9: Dimensions of AH3-US (all dimensions in mm) ..... 34

Figure 10: Mating board-to-board connector 53748-0808 on application ..... 36

Figure 11: Molex board-to-board connector 52991-0808 on AH3-US..... 37

Figure 12: Mating board-to-board connector 53748-0808 on application ..... 38

Figure 13: Reference equipment for type approval ..... 39

# 1 Introduction

The document<sup>1</sup> describes the hardware of the AH3-US 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] AH3-US AT Command Set
- [2] AH3-US Release Notes

## 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

<sup>1</sup> 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.

<b>Abbreviation</b>	<b>Description</b>
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

<b>Abbreviation</b>	<b>Description</b>
PS	Packet Switched
PDU	Protocol Data Unit
PSK	Phase Shift Keying
QAM	Quadrature Amplitude Modulation
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
SMPL	Sudden momentary power loss
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

AH3-US has been 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 "AH3-US Hardware Interface Description".<sup>1</sup>

**Table 1:** Directives

99/05/EC	Directive of the European Parliament and of the council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (in short referred to as R&TTE Directive 1999/5/EC). The product is labeled with the CE conformity mark 
ECE-R 10	Economic Commission for Europe (ECE) Regulation No. 10: Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility
2002/95/EC	Directive of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS) 

**Table 2:** Standards of North American type approval

CFR Title 47	Code of Federal Regulations, Part 22, Part 24 and Part 27; US Equipment Authorization FCC
OET Bulletin 65 (Edition 97-01)	Evaluating Compliance with FCC Guidelines for Human Exposure to Radio-frequency Electromagnetic Fields
UL 60 950-1	Product Safety Certification (Safety requirements) 
NAPRD.03 V5.9	Overview of PCS Type certification review board Mobile Equipment Type Certification and IMEI control PCS Type Certification Review board (PTCRB)
RSS132, RSS133, RSS139	Canadian Standard

**Table 3:** Standards of European type approval

3GPP TS 51.010-1	Digital cellular telecommunications system (Release 7); Mobile Station (MS) conformance specification;
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)
GCF-CC V3.43.1	Global Certification Forum - Certification Criteria

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

**Table 3:** Standards of European type approval

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 portableradio 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
ETSI EN 301 908-01 V4.2.1	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
ETSI EN 301 908-02 V4.2.1	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
EN 62311:2008	Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz)
IEC/EN 60950-1:2006	Safety of information technology equipment

**Table 4:** Requirements of quality

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

**Table 5:** Standards of the Ministry of Information Industry of the People’s Republic of China

SJ/T 11363-2006	“Requirements for Concentration Limits for Certain Hazardous Substances in Electronic Information Products” (2006-06).
SJ/T 11364-2006	<p>“Marking for Control of Pollution Caused by Electronic Information Products” (2006-06).</p> <p>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.</p> <p>Please see <a href="#">Table 6</a> 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.</p> 

**Table 6:** Toxic or hazardous substances or elements with defined concentration limits

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

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 AH3-US based applications to be evaluated and approved for compliance with national and/or international regulations.

Since the SAR value varies significantly with the individual product design manufacturers are advised to submit their product for approval if designed for portable use. For European and US-markets the relevant directives are mentioned below. It is the responsibility of the manufacturer of the final product to verify whether or not further standards, recommendations or directives are in force outside these areas.

*Products intended for sale on US markets*

ES 59005/ANSI C95.1 Considerations for evaluation of human exposure to electromagnetic fields (EMFs) from mobile telecommunication equipment (MTE) in the frequency range 30MHz - 6GHz

*Products intended for sale on European markets*

EN 50360 Product standard to demonstrate the compliance of mobile phones with the basic restrictions related to human exposure to electromagnetic fields (300MHz - 3GHz)

**IMPORTANT:**

Manufacturers of portable applications based on AH3-US modules are required to have their final product certified and apply for their own FCC Grant and Industry Canada Certificate related to the specific portable mobile. See also [Section 7.2](#).

### 1.3.3 SELV Requirements

The power supply connected to the AH3-US 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 AH3-US. 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.

	<p>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.</p> <p>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.</p>
	<p>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.</p>
	<p>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.</p>
	<p>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.</p>
	<p>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.</p> <p>Speakerphones must be installed by qualified personnel. Faulty installation or operation can constitute a safety hazard.</p>

	<p><b>IMPORTANT!</b> 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.</p> <p>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.</p> <p>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.</p> <p>Some networks require that a valid SIM card be properly inserted in the cellular terminal or mobile.</p>
	<p>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.</p>

## 2 Product Concept

### 2.1 Key Features at a Glance

Feature	Implementation
<i>General</i>	
Frequency bands	GSM/GPRS/EDGE: Quad band, 850/900/1800/1900MHz UMTS/HSPA+: Triple band, 850/AWS/1900MHz UMTS diversity: Triple band, 850/AWS/1900MHz
GSM class	Small MS
Output power (according to Release 99)	Class 4 (+33dBm ±2dB) for EGSM850 Class 4 (+33dBm ±2dB) for EGSM900 Class 1 (+30dBm ±2dB) for GSM1800 Class 1 (+30dBm ±2dB) for GSM1900 Class E2 (+27dBm ± 3dB) for GSM 850 8-PSK Class E2 (+27dBm ± 3dB) for GSM 900 8-PSK Class E2 (+26dBm +3 /-4dB) for GSM 1800 8-PSK Class E2 (+26dBm +3 /-4dB) for GSM 1900 8-PSK Class 3 (+24dBm +1/-3dB) for UMTS 1900,WCDMA FDD BdII Class 3 (+24dBm +1/-3dB) for UMTS 1700AWS, WCDMA FDD BdIV Class 3 (+24dBm +1/-3dB) for UMTS 850, WCDMA FDD BdV
Power supply	$3.3V < V_{BATT+} < 4.2V$
Operating temperature (board temperature)	Normal operation: -30°C to +85°C Restricted operation: -40°C to +95°C
Physical	Dimensions: 53mm x 33.9mm x 3.1mm (length x width x height) Weight: approx. 10g
RoHS	All hardware components fully compliant with EU RoHS Directive
<i>HSPA features</i>	
3GPP Release 6, 7	DL 14.4Mbps, UL 5.7Mbps UE CAT. 1-12 supported Compressed mode (CM) supported according to 3GPP TS25.212
<i>UMTS features</i>	
3GPP Release 4	PS data rate – 384 kbps DL / 384 kbps UL CS data rate – 64 kbps DL / 64 kbps UL

Feature	Implementation
<i>GSM / GPRS / EGPRS features</i>	
Data transfer	<p>GPRS:</p> <ul style="list-style-type: none"> <li>• Multislot Class 12</li> <li>• Full PBCCH support</li> <li>• Mobile Station Class B</li> <li>• Coding Scheme 1 – 4</li> </ul> <p>EGPRS:</p> <ul style="list-style-type: none"> <li>• Multislot Class 12</li> <li>• EDGE E2 power class for 8 PSK</li> <li>• Downlink coding schemes – CS 1-4, MCS 1-9</li> <li>• Uplink coding schemes – CS 1-4, MCS 1-9</li> <li>• SRB loopback and test mode B</li> <li>• 8-bit, 11-bit RACH, PBCCH support</li> <li>• 1 phase/2 phase access procedures</li> <li>• Link adaptation and IR</li> <li>• NACC, extended UL TBF</li> <li>• Mobile Station Class B</li> </ul> <p>CSD:</p> <ul style="list-style-type: none"> <li>• V.110, RLP, non-transparent</li> <li>• 14.4kbps</li> <li>• USSD</li> </ul>
SMS	<p>Point-to-point MT and MO</p> <p>Cell broadcast</p> <p>Text and PDU mode</p>
<i>GPS Features</i>	
Protocol	NMEA
Modes	<p>Standalone GPS</p> <p>Assisted GPS</p> <ul style="list-style-type: none"> <li>- Control plane - E911</li> <li>- User plane - gpsOneXTRA™</li> </ul>
General	<p>Power saving modes</p> <p>Power supply for active antenna</p>
<i>Software</i>	
Remote SIM Access	<p>AH3-US supports Remote SIM Access. RSA enables AH3-US to use a remote SIM card via its serial interface and an external application, in addition to the SIM card locally attached to the dedicated lines of the application interface. The connection between the external application and the remote SIM card can be a Bluetooth wireless link or a serial link.</p> <p>The necessary protocols and procedures are implemented according to the “SIM Access Profile Interoperability Specification of the Bluetooth Special Interest Group”.</p>
AT commands	Hayes, 3GPP TS 27.007 and 27.005, and proprietary Cinterion Wireless Modules commands
SIM Application Toolkit	SAT Release 99
Audio	<p>Audio speech codecs</p> <p>GSM: AMR, EFR, FR, HR</p> <p>3GPP: AMR</p> <p>Speakerphone operation (VDA), echo cancellation, noise suppression, 9 ringing tones, TTY support</p>

Feature	Implementation
Firmware update	Generic update from host application over ASC0 or USB
<i>Interfaces</i>	
Module interface	80-pin board-to-board connector
Antenna	Antenna pads for contact springs. Main GSM/UMTS antenna, diversity antenna, (active/passive) GPS antenna
USB	USB 2.0 High Speed (480Mbit/s) device interface, Full Speed (12Mbit/s) compliant
Serial interface	ASC0: <ul style="list-style-type: none"> <li>• 8-wire modem interface with status and control lines, unbalanced, asynchronous</li> <li>• Adjustable baud rates from 9,600bps up to 921,600bps</li> <li>• Supports autobauding</li> <li>• Supports RTS0/CTS0 hardware flow control</li> <li>• Multiplex ability according to GSM 07.10 Multiplexer Protocol</li> </ul>
UICC interface	Supported chip cards: UICC/SIM/USIM 3V, 1.8V
Status	Signal pin to indicate network connectivity state
Audio	1 analog interface with microphone feeding 1 digital interface (PCM)
<i>Power on/off, Reset</i>	
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-off	Emergency-off by hardware pin EMERG_OFF if IGT is not active.
<i>Special Features</i>	
Phonebook	SIM and phone
TTY/CTM support	Integrated CTM modem
GPIO	10 I/O pins of the application interface programmable as GPIO. Programming is done via AT commands. GPIO5 and GPIO7 can be configured for antenna diagnosis, GPIO 4 as host wakeup line and GPIO6 as low current indicator
ADC inputs	Analog-to-Digital Converter with two unbalanced analog inputs for (external) antenna diagnosis.
European Emergency Call	eCall 3GPP Release 8 compliant
RLS Monitoring	Jamming Detection
Antenna	SAIC (Single Antenna Interference Cancellation) / DARP (Downlink Advanced Receiver Performance) RX diversity (receiver type 3i - 16-QAM)
<i>Evaluation kit</i>	
DSB75	DSB75 Development Support 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 AH3-US System Overview

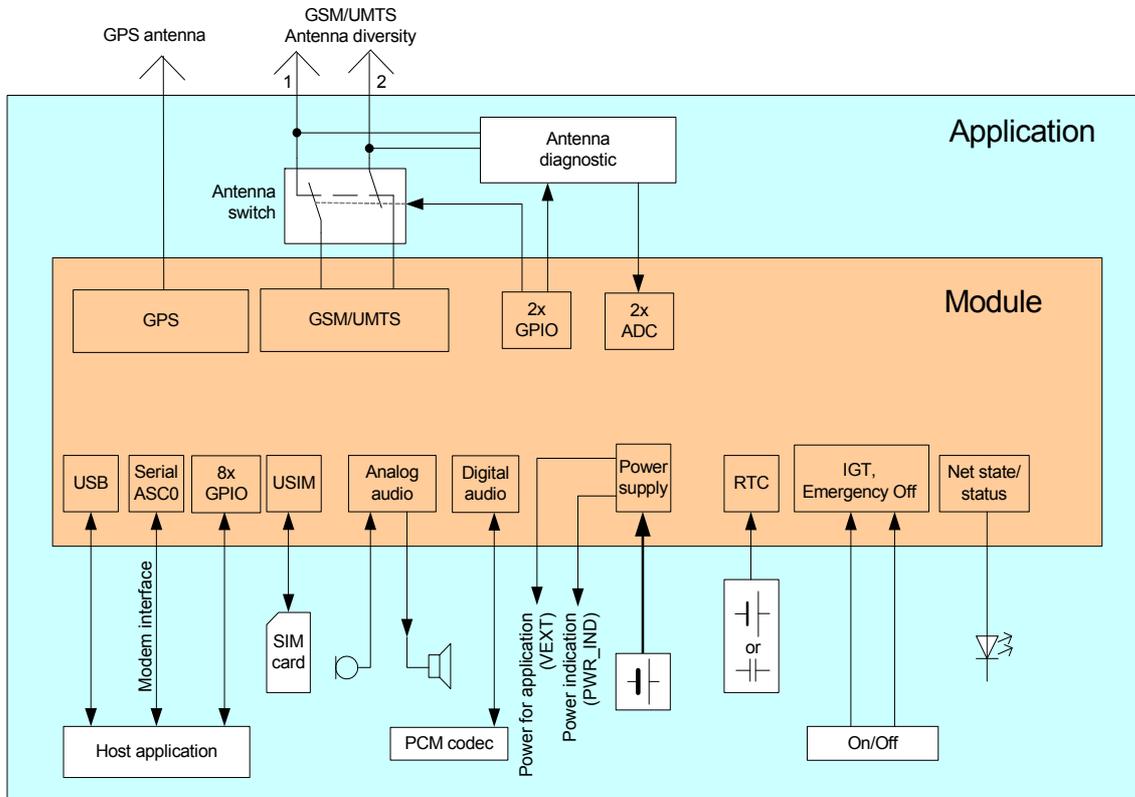


Figure 1: AH3-US system overview

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## 3 Application Interface

AH3-US 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](#)
- Serial interface USB - see [Section 3.3](#)
- Serial interface ASC0 - [Section 3.4](#)
- UICC/SIM/USIM interface - see [Section 3.5](#)
- Analog audio interface - see [Section 3.6](#)
- Pulse Code Modulation interface (PCM) - see [Section 3.7](#)
- Analog-to-Digital Converter (ADC) - see [Section 3.8](#)
- GPIO lines - see [Section 3.9](#)
- Status and control lines: IGT, EMERG\_OFF, PWR\_IND, STATUS - see [Table 27](#)

### 3.1 Operating Modes

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

**Table 7:** Overview of operating modes

Mode	Function	
Normal operation	GSM / GPRS / UMTS / HSPA SLEEP	Power saving 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. Also, the GPS active antenna mode has to be turned off or set to "auto".
	GSM / GPRS / UMTS / HSPA IDLE	Power saving disabled (see [1]: AT^SCFG "MEopMode/PwrSave", <PwrSaveMode>), but no call in progress.
	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.
	HSPA DATA	HSPA 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.	
Airplane mode	Airplane mode shuts down the radio part of the module, causes the module to log off from the GSM/GPRS network and disables all AT commands whose execution requires a radio connection. Airplane mode can be controlled by AT command (see [1]).	

## 3.2 Power Supply

AH3-US needs to be connected to a power supply at the board-to-board connector - 5 lines each BATT+ and GND.

The power supply of AH3-US has to be a single voltage source at BATT+. It must be able to provide the peak current during the uplink transmission.

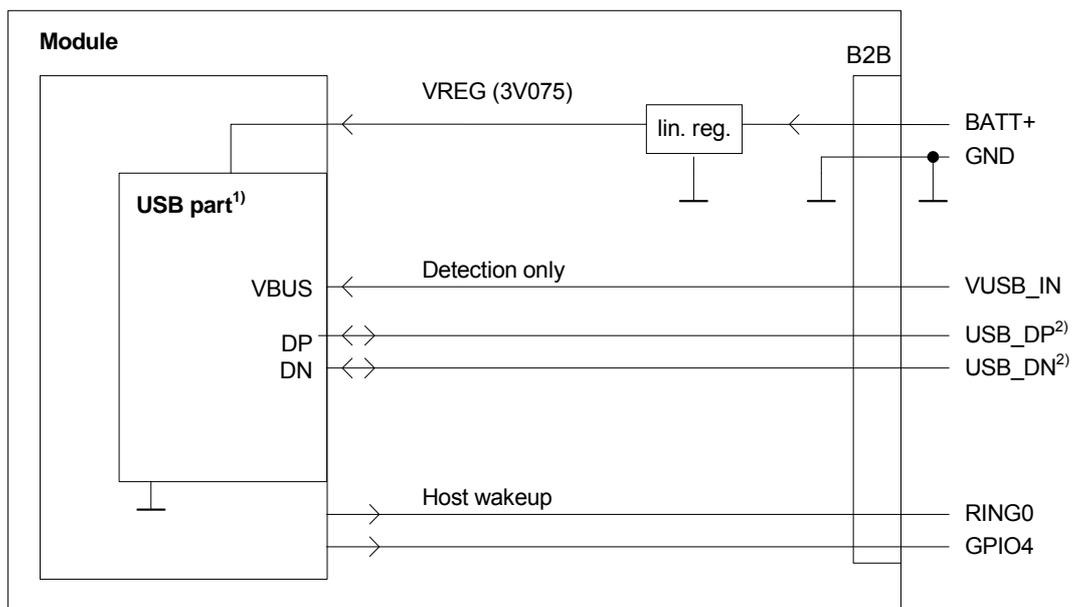
All key functions for supplying power to the device are handled by the power management IC. It provides the following features:

- 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 and can be reduced via AT command to save power.
- SIM switch to provide SIM power supply.

### 3.3 USB Interface

AH3-US supports a USB 2.0 High Speed (480Mbit/s) device interface that is Full Speed (12Mbit/s) compliant. The USB interface is primarily intended for use as command and data interface and for downloading firmware.

The USB host is responsible for supplying the VUSB\_IN line. This line is for voltage detection only. The USB part (driver and transceiver) is supplied by means of BATT+. This is because AH3-US is designed as a self-powered device compliant with the “Universal Serial Bus Specification Revision 2.0”<sup>1</sup>.



<sup>1</sup>) All serial and pull-up resistors for data lines are implemented.

<sup>2</sup>) If the USB interface is operated in High Speed mode (480MHz), it is recommended to take special care routing the data lines USB\_DP and USB\_DN. Application layout should in this case implement a differential impedance of 90Ohm for proper signal integrity.

**Figure 2:** 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 27](#). Furthermore, the USB modem driver distributed with AH3-US needs to be installed.

While the USB connection is active, the module will not change into SLEEP Mode. To enable switching into SLEEP mode the USB host must bring its USB interface into Suspend state. Also, VUSB\_IN should always be kept enabled for this functionality. See “Universal Serial Bus Specification Revision 2.0”<sup>1</sup> for a description of the Suspend state. On incoming calls AH3-US will then generate a remote wake up request to resume the USB connection (active low).

As an alternative to the regular USB remote wakeup mechanism it is possible to employ the RING0 or GPIO4 line to wake up the host application. The benefit is that the RING0 or GPIO4 lines can wake up the host application in case of incoming calls or other events signaled by URCs while the USB interface is suspended or shut down.

<sup>1</sup>. The specification is ready for download on <http://www.usb.org/developers/docs/>

### 3.4 Serial Interface ASC0

AH3-US 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 1.8V (for high data bit or inactive state). For electrical characteristics please refer to [Table 27](#).

AH3-US is designed for use as a DCE. Based on the conventions for DCE-DTE connections it communicates with the customer application (DTE) using the following signals:

- Port TXD @ application sends data to the module's TXD0 signal line
- Port RXD @ application receives data from the module's RXD0 signal line

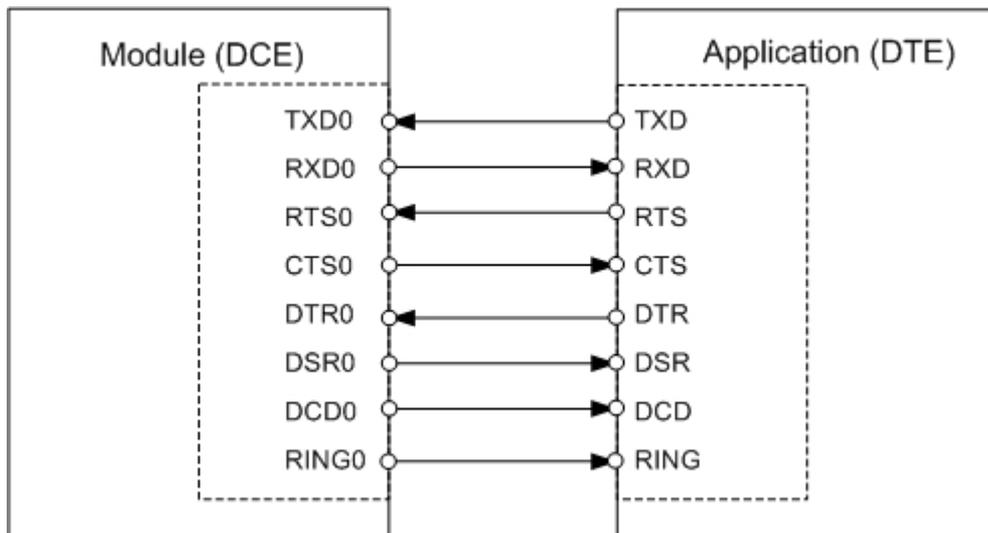


Figure 3: Serial interface ASC0

#### Features:

- Includes the data lines TXD0 and RXD0, the status lines RTS0 and CTS0 and, in addition, the modem control lines DTR0, DSR0, DCD0 and RING0.
- ASC0 is 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 9600bps up to 921600bps.
- Autobauding is supported.
- Autobauding is not compatible with multiplex mode.
- Supports RTS0/CTS0 hardware flow control.
- Wake up from SLEEP mode by RTS0 activation (high to low transition).

Note. If the ASC0 serial interface is the application's only interface, it is suggested to connect test points on the USB signal lines as a potential tracing possibility.

**Table 8:** 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

### 3.5 UICC/SIM/USIM Interface

AH3-US has an integrated UICC/SIM/USIM interface compatible with the 3GPP 31.102 and ETSI 102 221. This is wired to the host interface 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/USIM interface supports 3V and 1.8V SIM cards. Please refer to [Table 27](#) for electrical specifications of the UICC/SIM/USIM 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 AH3-US and is part of the Cinterion reference equipment submitted for type approval. See [Chapter 8](#) for Molex ordering numbers.

**Table 9:** 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 line 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 AH3-US.

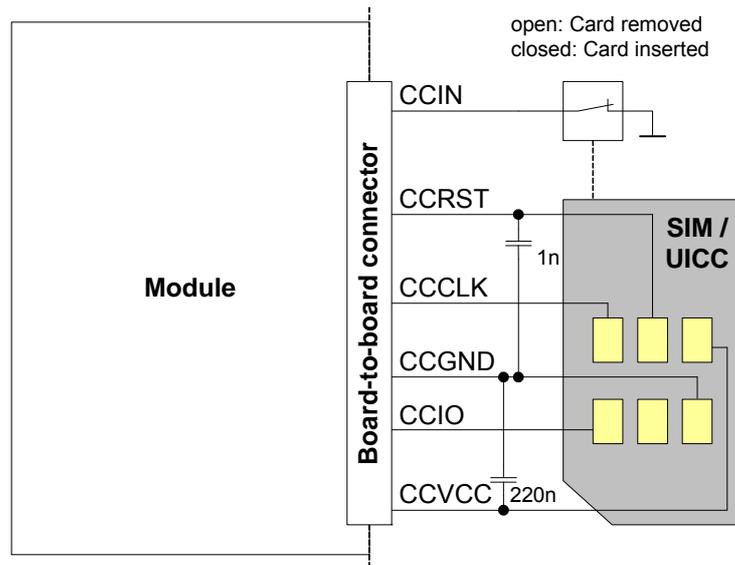


Figure 4: UICC/SIM/USIM interface

The total cable length between the board-to-board connector pins on AH3-US 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.

## 3.6 Analog Audio Interface

AH3-US has an analog audio interface with a balanced analog microphone input and a balanced analog earpiece output. A supply voltage and an analog ground connection are provided at dedicated pins.

AH3-US offers six audio modes which can be selected with the AT<sup>^</sup>SNFS command. The electrical characteristics of the voiceband part vary with the audio mode. For example, sending and receiving amplification, sidetone paths, noise suppression etc. depend on the selected mode and can be altered with AT commands (except for mode 1).

When shipped from factory, all audio parameters of AH3-US are set to audio mode 1. This is the default configuration optimised for the Votronic HH-SI-30.3/V1.1/0 handset and used for type approving the Cinterion Wireless Modules reference configuration. Audio mode 1 has fix parameters which cannot be modified. To adjust the settings of the Votronic handset simply change to another audio mode.

## 3.7 Pulse Code Modulation Interface (PCM)

AH3-US's PCM interface can be used to connect audio devices capable of pulse code modulation. The PCM functionality allows the use of a codec like the Freescale MC145483.

## 3.8 Analog-to-Digital Converter (ADC)

ADC is used for antenna diagnosis only.

## 3.9 GPIO Interface

The AH3-US has 10 GPIOs for external hardware devices. Each GPIO can be configured for use as input or output. All settings are AT command controlled. The IO port driver has to be open before using and configuring GPIOs. Before changing the configuration of a GPIO pin (e.g. input to output) the pin has to be closed. If the GPIO pins are not configured or the pins/driver were closed, the GPIO pins are high-Z with pull down resistor. If a GPIO is configured to input, the pin has high-Z without pull resistor.

## 4 GPS Receiver

AH3-US integrates a GPS receiver that offers the full performance of GPS technology. The GPS receiver is able to continuously track all satellites in view, thus providing accurate satellite position data.

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

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

By default, the GPS receiver is switched off. It has to be switched on and configured using AT commands. For more information on how to control the GPS interface via the AT command AT^SGPSC see [1].

## 5 Antenna Interfaces

### 5.1 GSM/UMTS Antenna Interface

The AH3-US RF antenna interface comprises a main GSM/UMTS antenna as well as an optional UMTS Rx diversity antenna to improve signal reliability and quality<sup>1</sup>. The RF interface has an impedance of 50Ω. AH3-US is capable of sustaining a total mismatch at the antenna pad without any damage, even when transmitting at maximum RF power.

The external antenna must be matched properly to achieve best performance regarding radiated power, DC-power consumption, modulation accuracy and harmonic suppression. Antenna matching networks are not included on the AH3-US module and should be placed in the host application.

Regarding the return loss AH3-US provides the following values in the active band:

**Table 10:** Return loss in the active band

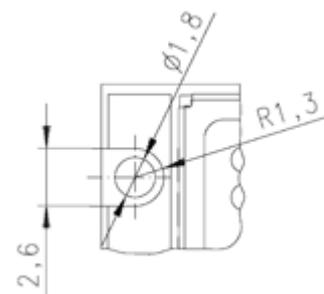
State of module	Return loss of module	Recommended return loss of application
Receive	≥ 8dB	≥ 12dB
Transmit not	applicable	≥ 12dB
Idle	≤ 5dB	not applicable

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

#### 5.1.1 RF Antenna Pad

The RF antenna can be attached to the antenna pad via contact springs such as the Rosenberger pogo pin series (Figure 5 shows the module's RF antenna pad size; for more information on the Pogo pin series see Section 5.1.1.1).

Note: The antenna pad resp. an SMA antenna connector soldered to the antenna pad has been chosen as antenna reference point (ARP) for the Cinterion module AH3-US type approval.



**Figure 5:** RF antenna pad size

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.

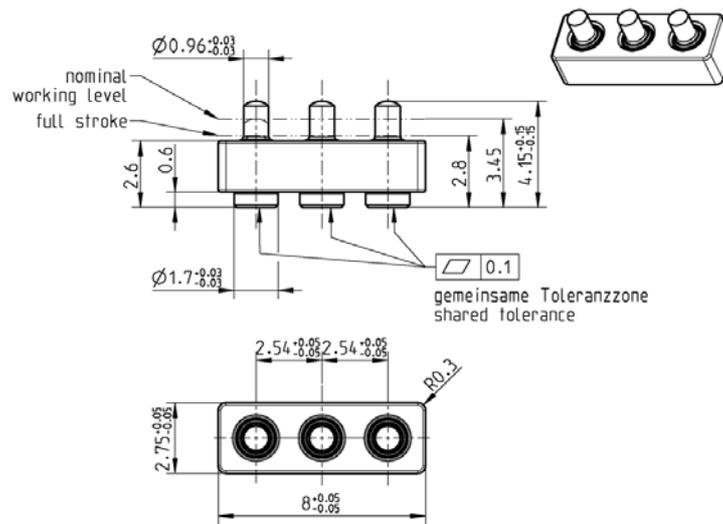
Please note that the GSM antenna must be isolated for ESD (to withstand a voltage resistance up to 8kV air discharge).

<sup>1</sup>. By delivery default the optional UMTS Rx diversity antenna is configured as available for the module. Please refer to [1] for details on how to configure antenna settings.

### 5.1.1.1 Pogo Pins

The Rosenberger pogo pins have been qualified by Cinterion for applications with a 3mm board-to-board connector stacking height. To ensure a reliable connection the module should therefore be fixed at an equidistance of 3mm from the external application's PCB. For details on board-to-board connectors and stacking heights see [Section 6.3](#). For ordering information on the pogo pins see [Section 8.1](#).

[Figure 6](#) and [Table 11](#) show the dimensions of the Pogo pins as well as some basic characteristics. For further details and a test report please contact Rosenberger.

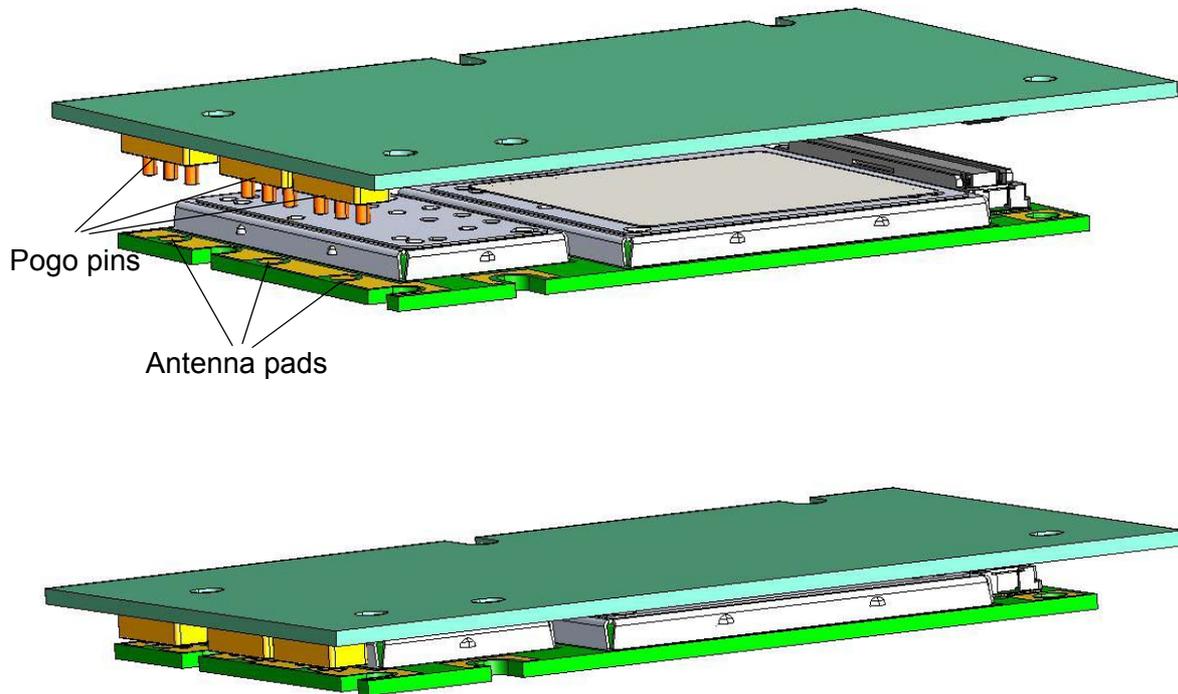


**Figure 6:** Pogo pins dimensions

**Table 11:** Pogo pins characteristics

Parameter	Specification
Material and plating	
Connector parts:	
Piston	Material: Brass; Plating: Gold, 0.5µm over chemical Nickel
Ferrule	Material: Brass; Plating: min. Gold, 0.15µm over chemical Nickel
Spring	N/A
Isolator	PPS
Electrical data	
Insulation resistance	$\geq 5 \times 10^3 \text{ M}\Omega$
Contact resistance	$\leq 25\text{m}\Omega$ initial; after 5 cycles operational stroke
Working voltage	4V
Max. current	1.5A per pin
Mechanical data	
Durability	> 5000
Max. pin travel	1.6mm
Nominal height	4.15mm
Travel vs Force	Initial: $F_0 = 0.2\text{N} \pm 0.1\text{N}$ ; at 3.45mm: $F_1 = 0.7\text{N} \pm 0.15\text{N}$

Figure 7 shows how the module's antenna pads may be mounted onto the Rosenberger Pogo pins on an external application.



Module connected to application (antenna pads and board-to-board connector)

**Figure 7:** Exploded view of module's antenna pads mounted on Pogo pins

## 5.2 GPS Antenna Interface

In addition to the RF antenna interface AH3-US also has a GPS antenna interface. See [Section 6.1](#) to find out where the GPS antenna pad is located. The GPS pad is the same as for the RF antenna interface (see [Section 5.1.1](#)).

It is possible to connect active or passive GPS antennas. In either case they must have 50 Ohm impedance. The simultaneous operation of GSM and GPS has been implemented. For electrical characteristics see [Section 6.8](#).

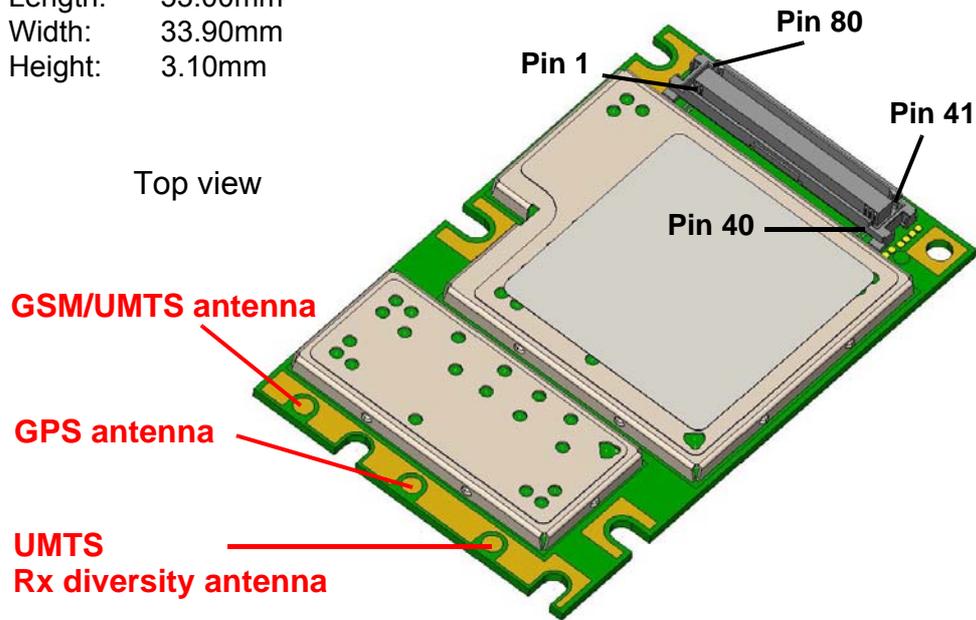
Active 3V GPS antennas can be supplied via the GPS antenna interface, if the supply voltage is switched on. This is done by AT command: `AT^SGPSC="Power/Antenna"` to configure the use of an active GPS antenna and `AT^SGPSC="Engine"` to start the GPS receiver (for command details see [\[1\]](#)). The available current is limited to prevent short circuits.

## 6 Mechanics

### 6.1 Mechanical Dimensions of AH3-US

Figure 8 shows a 3D view<sup>1</sup> of AH3-US and provides an overview of the board's mechanical dimensions. For further details see Figure 9.

Length: 53.00mm  
 Width: 33.90mm  
 Height: 3.10mm



Alternate top view  
 Shieldings may have no perforations and varying colors  
 Electrical characteristics and module dimensions remain unchanged

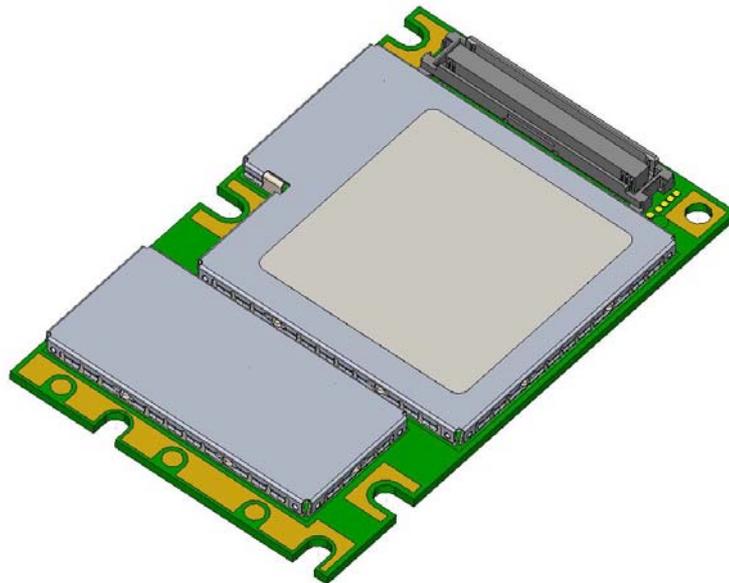
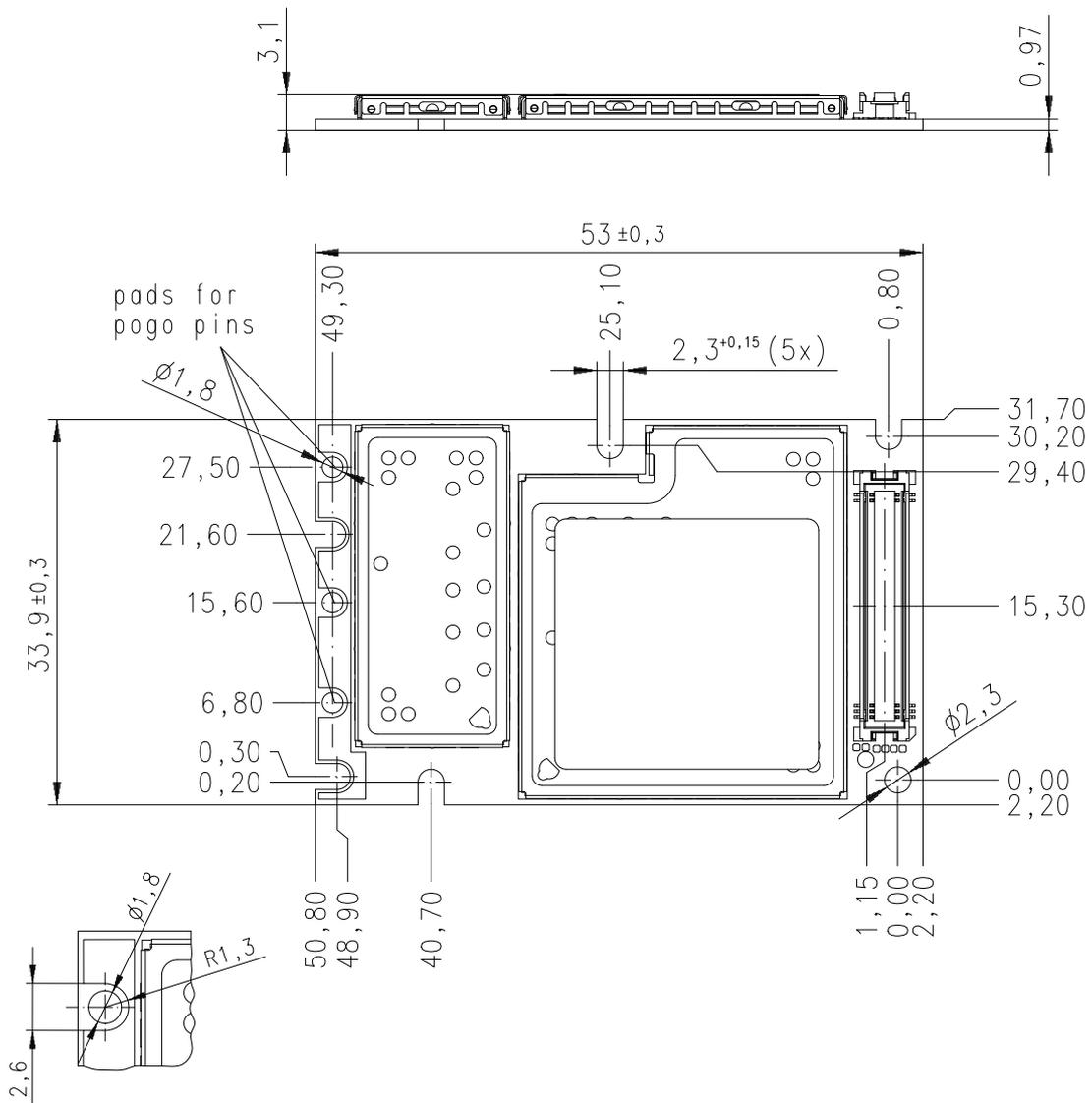


Figure 8: AH3-US – top view

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



**Figure 9:** Dimensions of AH3-US (all dimensions in mm)

## 6.2 Mounting AH3-US to the Application Platform

There are many ways to properly install AH3-US in the host device. An efficient approach is to mount the AH3-US 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.

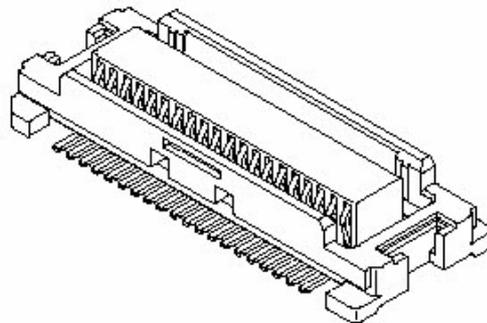
For proper grounding it is strongly recommended to use large ground plane on the bottom of board in addition to the five GND pins of the board-to-board connector. The ground plane may also be used to attach cooling elements, e.g. a heat sink or thermally conductive tape.

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

## 6.3 Board-to-Board Application Connector

This section provides the specifications of the 80-pin board-to-board connector used to connect AH3-US to the external application.

Connector mounted on the AH3-US module:



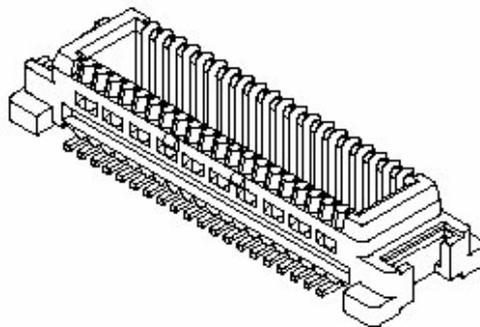
Type: 52991-0808 SlimStack Receptacle 80 pins, 0.50mm pitch, for stacking heights of 3.0 or 4.0mm, see [Figure 11](#) for details.

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

**Table 12:** Technical specifications of Molex board-to-board connector

Parameter	Specification (80-pin B2B connector)
<i>Electrical</i>	
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)
<i>Physical</i>	
Insulator material (housing)	White glass-filled LCP plastic, flammability UL 94V 0
Contact material	Plating: Gold over nickel
Insertion force 1 <sup>st</sup>	< 74.4N
Insertion force 30 <sup>th</sup>	< 65.6N
Withdrawal force 1 <sup>st</sup>	> 10.8N
Maximum connection cycles	30 (@ 70mΩ max per contact)

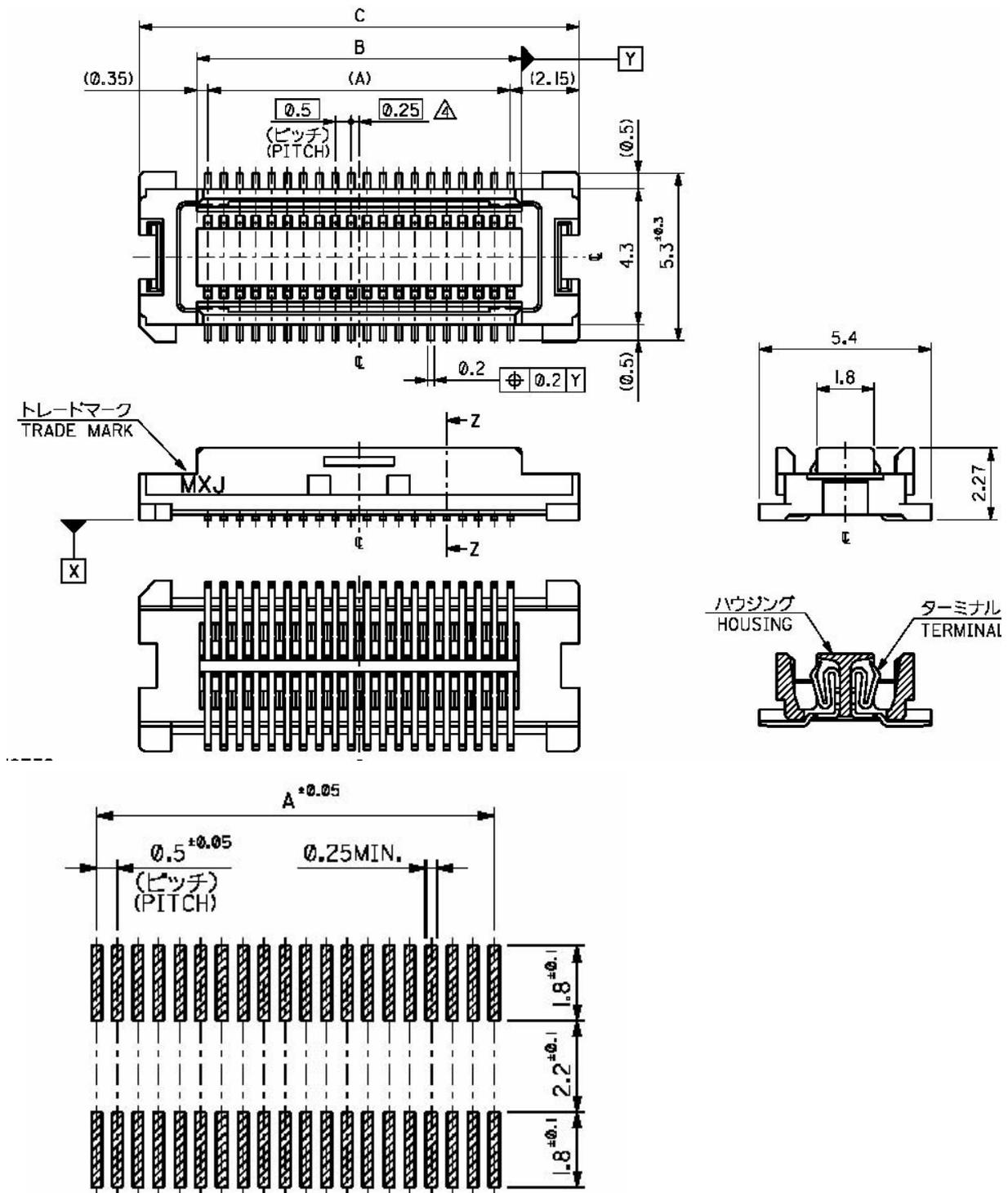
Mating connector types for the customer's application offered by Molex:



**Figure 10:** Mating board-to-board connector 53748-0808 on application

- 53748-0808 SlimStack Plug, 3mm stacking height, see [Figure 12](#) 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 6.5](#), pin locations are shown in [Figure 8](#).*



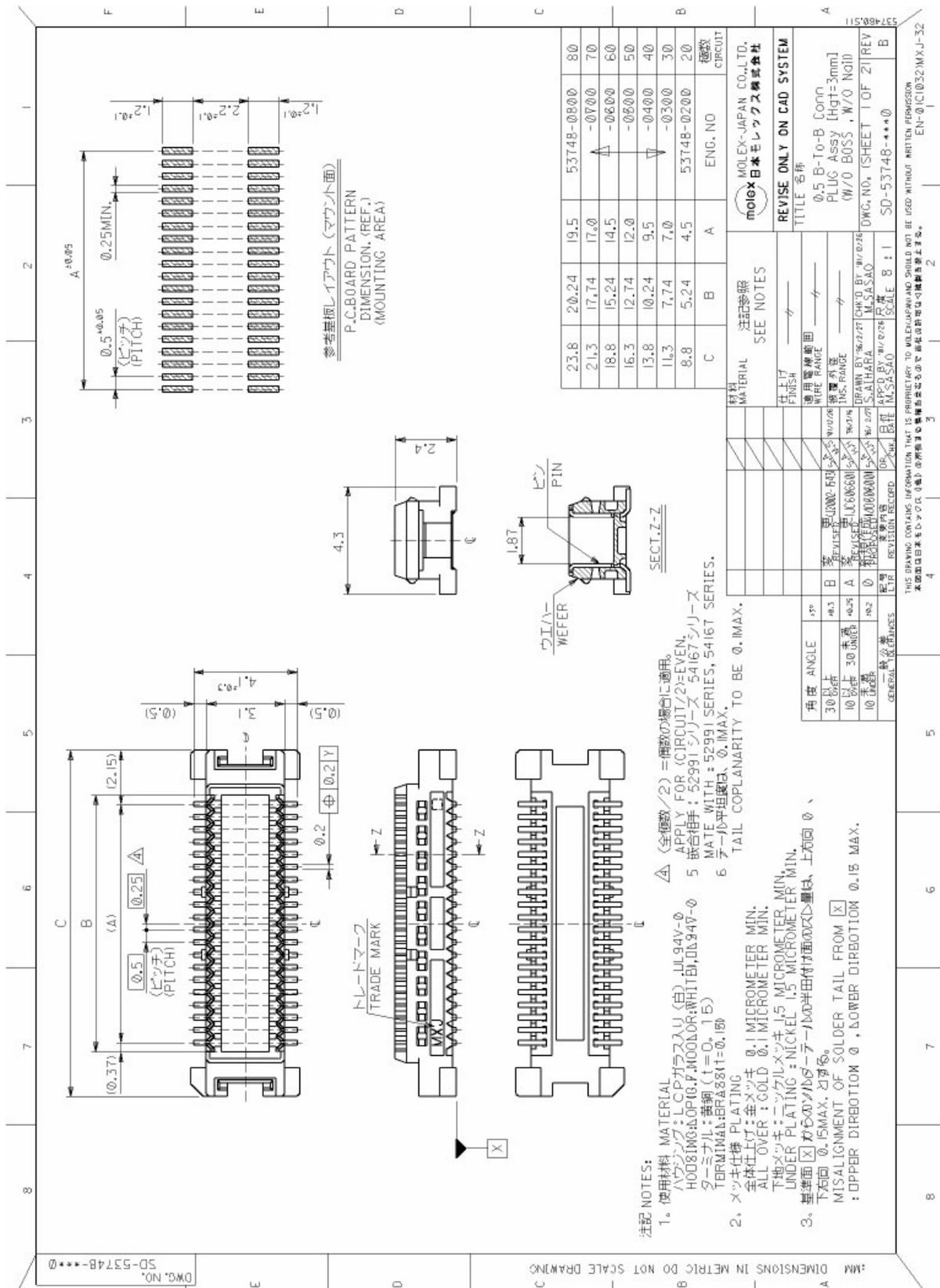


Figure 12: Mating board-to-board connector 53748-0808 on application

## 7 Reference Approval

### 7.1 Reference Equipment for Type Approval

The Cinterion Wireless Modules reference setup submitted to type approve AH3-US is shown in the following figure<sup>1</sup>. The module is connected to the DSB75 via a special adapter and either mounted directly onto the adapter or connected using a flex cable:

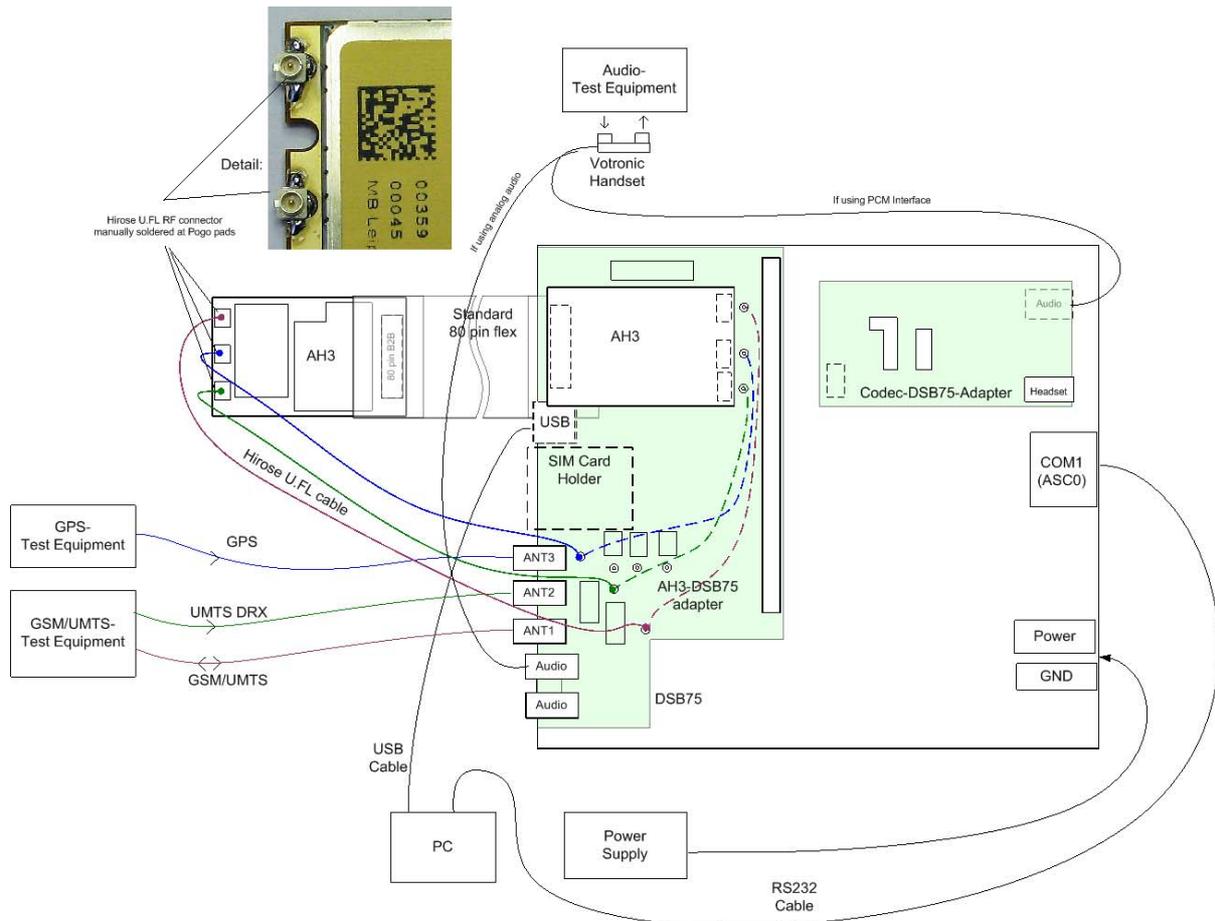


Figure 13: Reference equipment for type approval

1. For RF performance tests a mini-SMT/U.FL to SMA adapter with attached 6dB coaxial attenuator is chosen to connect the module directly to the GSM/UMTS/GPS test equipment instead of employing the SMA antenna connectors on the AH3-US-DSB75 adapter as shown in Figure 13. The following products are recommended:

Hirose SMA-Jack/U.FL-Plug conversion adapter HRMJ-U.FLP(40)

(for details see see <http://www.hirose-connectors.com/> or <http://www.farnell.com/>)

Aeroflex Weinschel Fixed Coaxial Attenuator Model 3T/4T

(for details see <http://www.aeroflex.com/ams/weinschel/pdfs/wmod3&4T.pdf>)

## 7.2 Compliance with FCC and IC Rules and Regulations

The Equipment Authorization Certification for the Cinterion Wireless Modules reference application described in [Section 7.1](#) will be registered under the following identifiers:

*FCC Identifier QIPAH3-US*

*Industry Canada Certification Number: 7830A-AH3US*

*Granted to Cinterion Wireless Modules GmbH*

Manufacturers of mobile or fixed devices incorporating AH3-US modules are authorized to use the FCC Grants and Industry Canada Certificates of the AH3-US modules for their own final products according to the conditions referenced in these documents. In this case, the FCC label of the module shall be visible from the outside, or the host device shall bear a second label stating "Contains FCC ID QIPAH3-US", and accordingly "Contains IC 7830A-AH3US". The integration is limited to fixed or mobile categorised host devices, where a separation distance between the antenna and any person of min. 20cm can be assured during normal operating conditions. For mobile and fixed operation configurations the antenna gain, including cable loss, must not exceed the limits 4,32 dBi (850 MHz), -3.39 dBi (1700 MHz) and 0,9 dBi (1900 MHz).

### IMPORTANT:

Manufacturers of portable applications incorporating AH3-US modules are required to have their final product certified and apply for their own FCC Grant and Industry Canada Certificate related to the specific portable mobile. This is mandatory to meet the SAR requirements for portable mobiles (see [Section 1.3.2](#) for detail).

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

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

## 8 Appendix

### 8.1 List of Parts and Accessories

**Table 13:** List of parts and accessories

Description	Supplier	Ordering information
AH3-US	Cinterion	Standard module Cinterion Wireless Modules IMEI: Ordering number: L30960-N2350-A100
DSB75 Support Box	Cinterion	Ordering number: L36880-N8811-A100
DSB75-Adapter for mounting the AH3-US module	Cinterion	Ordering number: L30960-N2301-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: <a href="mailto:contact@votronic.com">contact@votronic.com</a>
SIM card holder incl. push button ejector and slide-in tray	Molex	Ordering numbers: 91228 91236 Sales contacts are listed in <a href="#">Table 14</a> .
Board-to-board connector	Molex	Sales contacts are listed in <a href="#">Table 14</a> .
Pogo pin series	Rosenberger	Rosenberger Hochfrequenztechnik GmbH & Co. POB 1260 84526 Tittmoning Germany <a href="http://www.rosenberger.de">http://www.rosenberger.de</a>  Ordering number: 99P307-041Z

**Table 14:** Molex sales contacts (subject to change)

<p>Molex For further information please click: <a href="http://www.molex.com">http://www.molex.com</a></p>	<p>Molex Deutschland GmbH Otto-Hahn-Str. 1b 69190 Walldorf Germany Phone: +49-6227-3091-0 Fax: +49-6227-3091-8100 Email: <a href="mailto:mxgermany@molex.com">mxgermany@molex.com</a></p>	<p>American Headquarters Lisle, Illinois 60532 U.S.A. Phone: +1-800-78MOLEX Fax: +1-630-969-1352</p>
<p>Molex China Distributors Beijing, Room 1311, Tower B, COFCO Plaza No. 8, Jian Guo Men Nei Street, 100005 Beijing P.R. China Phone: +86-10-6526-9628 Fax: +86-10-6526-9730</p>	<p>Molex Singapore Pte. Ltd. 110, International Road Jurong Town, Singapore 629174  Phone: +65-6-268-6868 Fax: +65-6-265-6044</p>	<p>Molex Japan Co. Ltd. 1-5-4 Fukami-Higashi, Yamato-City, Kanagawa, 242-8585 Japan  Phone: +81-46-265-2325 Fax: +81-46-265-2365</p>