FALCOM
WIRELESS COMMUNICATIONS GMBH

Description

Embedded GSM/GPS–Module A2D–JP

Contents

List of figures

Versions

Version number	Author	Changes
V 1.00	M. Menz	Initial version
V 1.01	G. Buch	Chip set of RAM/Flash changed (GPS)
V 1.02	G. Buch	Reset chip changed (GPS)
V 1.03	G. Buch	Layout of L2/R35/C2/D13/C27 changed Ground GSM-antenna changed

1 Introduction

1.1 General

This manual is focussed on the embedded GSM/GPS-module of the FALCOM A2D-JP series from FALCOM GmbH. It contains some information about the FALCOM GSM module and the FALCOM GPS-module based on the CONEXANT Zodiac 2000 chip set.

Information furnished herein by FALCOM GmbH is believed to be accurate and reliable. However, no responsibility is assumed for its use. Also the information contained herein is subject to change without notice.

Users are advised to proceed quickly to the „Security“ chapter and read the hints carefully.

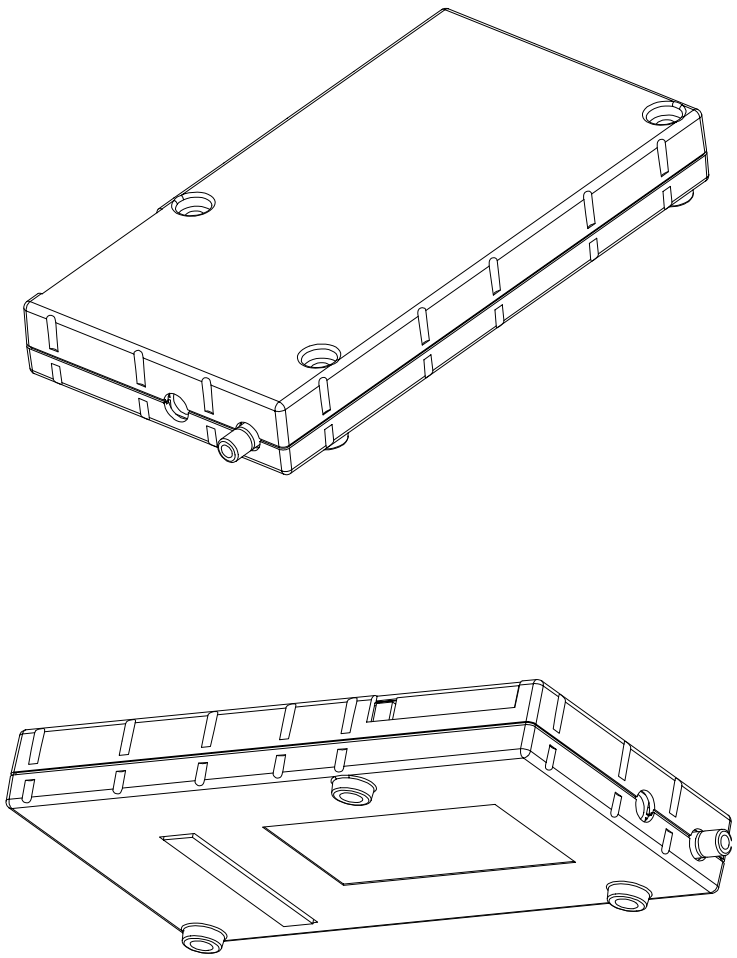

Figure 1: Drawing of A2D–JP

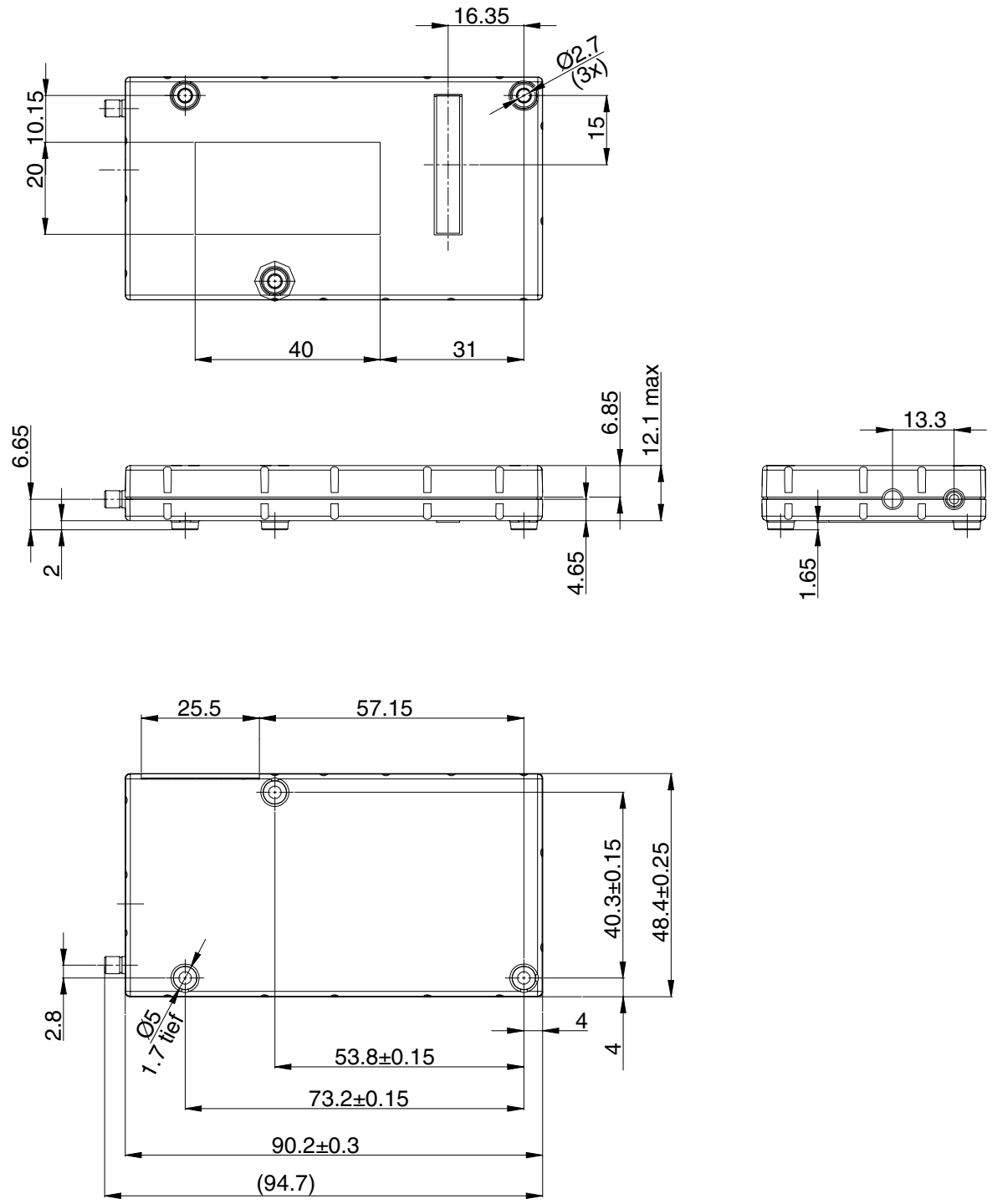

Figure 2: Technical drawing of A2D–JP

1.2 Used abbreviations

Abbreviation	Meaning
CTS	Clear To Send signal from Dent
DGPS	Differential GPS
DOP	Dilution of Precision
ECEF	Earth-Centred Earth-Fixed Coordinate system
EEPROM	Memory for parameter
ETSI	European Telecommunications Standards Institute
GSM	Global System for Mobile communications
GPS	Global Positioning System
GGA	GPS Fixed Data
HDOP	Horizontal DOP
IMEI	International Mobile station Equipment Identity
ME	Mobile Equipment
NMEA	National Maritime Electronics Association
PIN	Personal Identification Number
PLMN	Public Land Mobile Network
PRN	Pseudorandom Noise Number–The Identity of GPS satellites
PUK	Personal Unblocking Key
RP	Receive Protocol
RTC	Real Time Clock
RTCM	Radio Technical Commission for Maritime Services
RXD	Data input
RXQUAL	Received Signal Quality
SIM	Subscriber Identity Module
SMS	Short Message Service
SMS/PP	Short Message Service/Point-to-Point
SRAM	Static Random Access Memory
TA	Terminal Adapter
TE	Terminal Equipment
TP	Transmit Protocol
TTFF	Time To First Fix
TXD	Data output

Table 1: Abbreviations

1.3 Related documents

[1]	ETSI GSM 07.05	"Use of Data Terminal Equipment - Data Circuit terminating Equipment interface for Short Message Service and Cell Broadcast Service"
[2]	ETSI GSM 07.07	"AT command set for GSM Mobile Equipment"
[3]	ITU-T V.25ter	"Serial asynchronous automatic dialling and control"
[4]	Zodiac GPS receiver Family Designers' Guide	http://www.falcom.de/service/downloads
[5]	GPS Chipset-Zodiac 2000	http://www.falcom.de/service/downloads
[6]	Serial Data I/O Interface	see chapter 5 of [4]

1.4 Alert symbols used

Alerts the user to potential safety risks.

Indicates important information and tips.

2 Security

IMPORTANT FOR THE EFFICIENT AND SAFE OPERATION OF YOUR GSM–MODEM, READ THIS INFORMATION BEFORE USE!

Your embedded GSM/GPS–modem is one of the most exciting and innovative electronic products ever developed. With it you can stay in contact with your office, your home, emergency services, and others, wherever service is provided.

This chapter contains important information for the safe and reliable use of the GPS receiver. Please read this chapter carefully before starting to use the GPS receiver.

2.1 General information

Your modem utilises the GSM standard for cellular technology. GSM is a newer radio frequency („RF“) technology than the current FM technology that has been used for radio communications for decades. The GSM standard has been established for use in the European community and elsewhere.

Your modem is actually a low power radio transmitter and receiver. It sends out and receives radio frequency energy. When you use your modem, the cellular system handling your calls controls both the radio frequency and the power level of your cellular modem.

The Global Positioning System uses satellite navigation, an entirely new concept in navigation. GPS has become established in many areas, for example, in civil aviation or deep-sea shipping. It is making deep inroads in vehicle manufacturing, and long before everyone of us will use it in one way or another.

The GPS system is operated by the government of the United States of America, which also has sole responsibility for the accuracy and maintenance of the system. The system is constantly being improved and may entail modifications effecting the accuracy and performance of the GPS equipment.

2.2 Exposure to RF energy

There has been some public concern about possible health effects of using GSM modem. Although research on health effects from RF energy has focused for many years on the current RF technology, scientists have begun research regarding newer radio technologies, such as GSM. After existing research had been reviewed, and after compliance to all applicable safety standards had been tested, it has been concluded that the product is fit for use.

If you are concerned about exposure to RF energy there are things you can do to minimise exposure. Obviously, limiting the duration of your calls will reduce your exposure to RF energy. In addition, you can reduce RF exposure by operating your cellular modem efficiently by following the guidelines below.

2.3 Efficient modem operation

In order to operate your modem at the lowest power level, consistent with satisfactory call quality please take note of the following hints. If your modem has an extendible antenna, extend it fully. Some models allow you to place a call with the antenna retracted. However your modem operates more efficiently with the antenna fully extended.

Do not hold the antenna when the modem is „IN USE“. Holding the antenna affects call quality and may cause the modem to operate at a higher power level than needed.

2.4 Antenna care and replacement

Do not use the modem with a damaged antenna. If a damaged antenna comes into contact with the skin, a minor burn may result. Replace a damaged antenna immediately. Consult your manual to see if you may change the antenna yourself. If so, use only a manufacturer-approved antenna. Otherwise, have your antenna repaired by a qualified technician.

Use only the supplied or approved antenna. Unauthorised antennas, modifications or attachments could damage the modem and may contravene local RF emission regulations or invalidate type approval.

Operate the GPS receiver with a connected antenna and make sure that there is no obstruction between the receiver and the satellite.

Make absolutely sure that the antenna socket or antenna cable is not shorted as this would render the GPS receiver dysfunctional.

Do not use the receiver with a damaged antenna. Replace a damaged antenna without delay. Use only a manufacturer-approved antenna. Use only the supplied or an approved antenna with your GPS receiver. Antennas from other manufacturers which are not authorized by the supplier can damage the GPS receiver. Technical modifications and additions may contravene local radio-frequency emission regulations or invalidate the type approval.

Authorized GPS antennas:
FALCOM ANT 006 (active)

2.5 Driving

Check the laws and regulations on the use of cellular devices in the area where you drive. Always obey them. Also, when using your modem while driving, please pay full attention to driving, pull off the road and park before making or answering a call if driving conditions so require. When applications are prepared for mobile use they should fulfil road-safety instructions of the current law!

2.6 Electronic devices

Most electronic equipment, for example in hospitals and motor vehicles is shielded from RF energy. However RF energy may affect some malfunctioning or improperly shielded electronic equipment.

2.7 Vehicle electronic equipment

Check your vehicle manufacturer's representative to determine if any on board electronic equipment is adequately shielded from RF energy.

2.8 Medical electronic equipment

Consult the manufacturer of any personal medical devices (such as pacemakers, hearing aids, etc...) to determine if they are adequately shielded from external RF energy.
Turn your modem OFF in health care facilities when any regulations posted in the area instruct you to do so. Hospitals or health care facilities may be using RF monitoring equipment.

2.9 Aircraft

Turn your modem OFF before boarding any aircraft.
Use it on the ground only with crew permission.
Do not use it in the air.
To prevent possible interference with aircraft systems, Federal Aviation Administration (FAA) regulations require you to have permission from a crew member to use your modem while the plane is on the ground. To prevent interference with cellular systems, local RF regulations prohibit using your modem whilst airborne.

2.10 Children

Do not allow children to play with your modem. It is not a toy. Children could hurt themselves or others (by poking themselves or others in the eye with the antenna, for example). Children could damage the modem, or make calls that increase your modem bills.

2.11 Blasting areas

To avoid interfering with blasting operations, turn your unit OFF when in a "blasting area" or in areas posted : „turn off two-way radio“. Construction crew often use remote control RF devices to set off explosives.

2.12 Potentially explosive atmospheres

Turn your modem **OFF** when in any area with a potentially explosive atmosphere. It is rare, but your modem or its accessories could generate sparks. Sparks in such areas could cause an explosion or fire resulting in bodily injury or even death.

Areas with a potentially explosive atmosphere are often, but not always, clearly marked. They include fuelling areas such as petrol stations; below decks on boats; fuel or chemical transfer or storage facilities; and areas where the air contains chemicals or particles, such as grain, dust, or metal powders.

Do not transport or store flammable gas, liquid, or explosives, in the compartment of your vehicle which contains your modem or accessories.

Before using your modem in a vehicle powered by liquefied petroleum gas (such as propane or butane) ensure that the vehicle complies with the relevant fire and safety regulations of the country in which the vehicle is to be used.

2.13 Non-ionising radiation

As with other mobile radio transmitting equipment users are advised that for satisfactory operation and for the safety of personnel, it is recommended that no part of the human body be allowed to come too close to the antenna during operation of the equipment.

The radio equipment shall be connected to the antenna via a non-radiating 50Ohm coaxial cable.

The antenna shall be mounted in such a position that no part of the human body will normally rest close to any part of the antenna. It is also recommended to use the equipment not close to medical devices as for example hearing aids and pacemakers.

3 Safety standards

This GSM/GPS-modem complies with all applicable RF safety standards.

The embedded GMS/GPS-modem meets the safety standards for RF receivers and the standards and recommendations for the protection of public exposure to RF electromagnetic energy established by government bodies and professional organizations, such as directives of the European Community, Directorate General V in matters of radio frequency electromagnetic energy.

4 Technical data

General specifications	
Dimensions	95 mm x 50 mm x 15 mm (B x W x H)
Weight	60 g

Table 2: General specifications

Power supply		
GPS	VC3 3.3 V DC ±5 % Max. 190 mA Operate VBAT 3 V DC ±0,25 V Max. 40 µA for „Keep Alive“ Preamp. Power 3,3 V DC – 6 V DC ±5 % Max. 50 mA	
GSM	VC5 5,0 V DC ± 5 %	
	Average current (in mA at 5V nominal):	
	0,015	in OFF mode 2 (EN pulled to LOW, the internal regulator is switched off)
	17*	in OFF mode 1 (AT+CPOF was issued and SOFT_ON was set to LOW, the internal regulator is still working)
	30*	in idle mode (base station sends at -85 dBm)
	260*	in transmit mode at power level 7
	350*	in transmit mode at power level 5 (Maximum)
		* Serial interface is applied and working.

Table 3: Power supply

Temperature limits	
Operation	-20 °C to +55 °C
Transportation	-40 °C to +70 °C
Storage	-25 °C to +70 °C

Table 4: Temperature limits

Interface specifications	
Interface A	60pin connector AMP 177984-2
Interface B	GPS 50 Ω MCX female, for active 3 V GPS antenna
Interface C	GSM 50 Ω, SMB male
Interface D	SIM card reader for small SIM cards (3V)

Table 5: Interface specifications

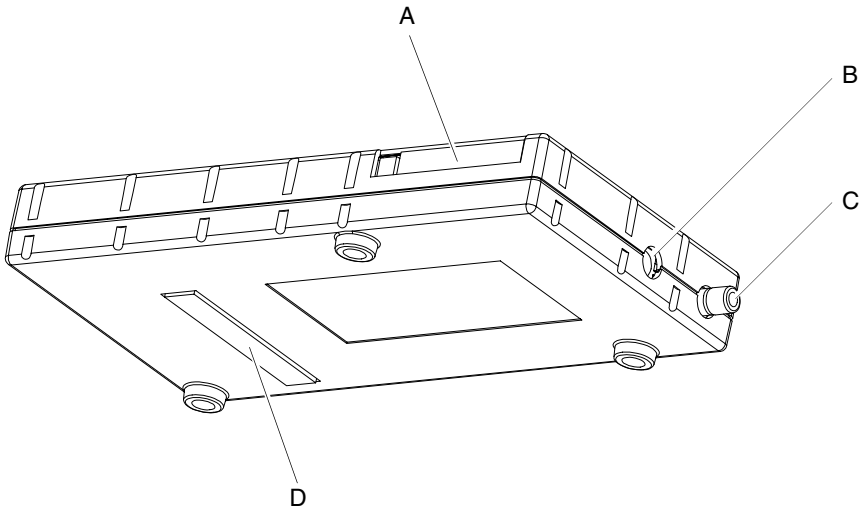

Figure 3: Interface connections

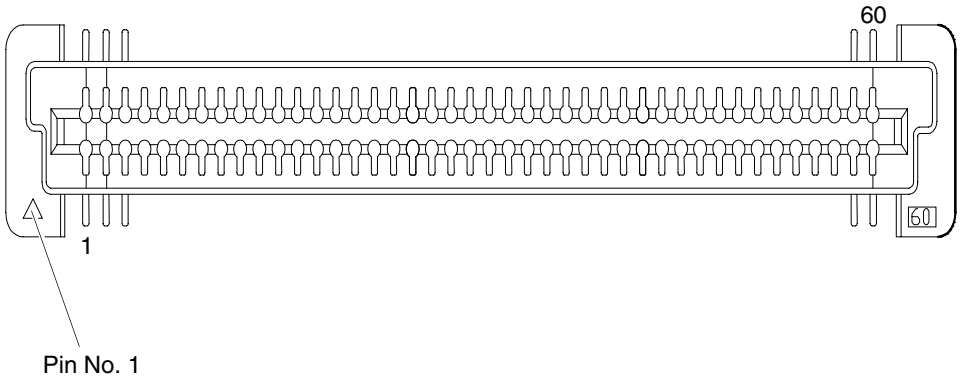

Figure 4: Interface A: 60pin connector AMP 177984-2

Correction Pin configuration AMP 177984-2

Pin	GSM–modem	Description	Level
1	MIC P15	Microphone 1 positive	differential inp.
2	MIC N15	Microphone 1 negative	differential inp.
3	SPK P2	Speaker 1 positive	differential out.
4	SPK N2	Speaker 1 negative	differential out.
5	DTR	RS-232 Data Term. Ready	CMOS 2,8 V inp.
6	CTS	RS-232 Clear To Send	CMOS 2,8 V out.
7	DSR	RS-232 Data Set Ready	CMOS 2,8 V out.
8	RTS	RS-232 Ready To Send	CMOS 2,8 V inp.
9	RI	RS-232 Ring Indicator	CMOS 2,8 V out.
10	DCD	RS-232 Data Carrier Detect	CMOS 2,8 V out.
11	SOFT ON	Turn phone on	CMOS 2,8 V inp.
12	RING PWM	Ringer Interface	CMOS 2,8 V out.
13	TX	RS-232 Transmit Data	CMOS 2,8 V out.
14	RX	RS-232 Receive Data	CMOS 2,8 V inp.
15	Free		
16	RESET GSM	Reset-Active Low	SCHMITT
17	Free		
18	VCCRTC	RTC back-up batt. Supply	inp.
19	Free		
20	Free		
21	Free		
22	Free		
23	VC5	Power supply	5 V DC
24	VC5	Power supply	5 V DC
25	VC5	Power supply	5 V DC
26	VC5	Power supply	5 V DC
27	GPIO1	General purpose in/out	CMOS 2,8 V
28	VC5	Power supply	5 V DC
29	Free		
30	EN	Internal Power enable	CMOS 2,8 V inp.
31	GROUND		
32	GROUND		
33	GROUND		

Table 1: Pin configuration AMP 177984-2, GSM-modem

Pin	GSM–modem	Description	Level
34	GROUND		
35	SIMPREK	SIM present for external card	CMOS 2,8 V inp.
36	GROUND		
37	SIMDATA	SIM Data	inp./out.
38	SIMVCC	SIM Card power supply	3 V DC
39	SIMRST	SIM Reset	inp.
40	SIMCLK	SIM Clock	out.

Table 1: Pin configuration AMP 177984-2, GSM-modem

Pin	GPS receiver	Description	Level
41	TMARK	1 PPS time Mark Output	CMOS 3,3 V out.
42	10 KHZ UTC	10 kHz Clock	CMOS 3,3 V out.
43	GROUND		
44	GROUND		
45	SDI 2	Serial 2 Data Input	CMOS 3,3 V inp.
46	GROUND		
47	GROUND		
48	SDO 2	Serial 2 Data Output	CMOS 3,3 V out.
49	SDO 1	Serial 1 Data Output	CMOS 3,3 V inp.
50	SDI 1	Serial 1 Data Input	CMOS 3,3 V out.
51	WHEEL_TICK	Reserved for Wheel in	
52	GROUND		
53	DIRECTION	NMEA Protocol select	Low
54	DSP_GPIO 3	ROM default select	Low
55	M-RST	Master Reset Input	Low
56	GYRO_IN	Reserved for Gyro_in	
57	VBATT_RTC	Battery Backup Input	3 V DC
58	3,3 VDC	Primary DC Power	3,3 V DC
59	PREAMP_POWER	Preamplifier Power	3,3 V DC – 6 V DC
60	3,3 VDC	Primary DC Power	3,3 V DC

Table 2: Pin configuration AMP 177984-2, GPS receiver

5 GSM–modem

5.1 General

5.1.1 GSM capability

E-GSM and DCS (GSM ETSI Phase I and II)

5.1.2 GSM data services

300 … 14400 BPS, asynchronous, transparent and non-transparent (V.21, V.22, V.23, V.22bis, V.26ter, V.32, V.34, V.110)

5.1.3 RF characteristics

Receiver	
EGSM Sensitivity	< –104 dBm
DCS Sensitivity	< –100 dBm
Selectivity @ 200 kHz	> +9 dBc
Selectivity @ 400 kHz	> +41 dBc
Dynamic range	62 dB
Intermodulation	> -43 dBm
Co-channel rejection	≥ 9 dBc

Table 8: Receiver

Transmitter	
Maximum output power (EGSM)	33 dBm ±2 dB
Maximum output power (DCS)	30 dBm ±2 dB
Minimum output power (EGSM)	5 dBm ±5 dB
Minimum output power (DCS)	0 dBm ±5 dB
H2 level	≤ 30 dBm
H3 level	≤ 30 dBm
Noise in 925 - 935 MHz	≤ 67 dBm
Noise in 935 - 960 MHz	≤ 79 dBm
Noise in 1805 - 1880 MHz	≤ 71 dBm
Phase error at peak power	< 5 ° RMS
Frequency error	±0.1ppm max

Table 9: Transmitter

5.1.4 SIM card reader

Internal, for small SIM cards (3 V)
External, 10 … 15 cm maximum cable length

5.1.5 RS 232

RS 232	
2.8 V	RX, TX, RTS, CTS, DTR, DSR, DCD, RI
300..115200	Baud rates for serial link (2400 … 19200 with auto-bauding)

Table 10: RS 232

5.1.6 Possible external devices

Audio	
2 KΩ differential	Microphone 1 impedance
2 V	Microphone 1 bias voltage
0,5 mA	Microphone 1 input current
2 KΩ differential	Microphone 2 impedance
2 V	Microphone 2 bias voltage
0,5 mA	Microphone 2 input current
> 50 Ω (<1nF)	Speaker 1 impedance
> 50 Ω (<1nF)	Speaker 2 impedance

Table 11: Audio

5.2 Special functionality pins

Table 6 and Tabl e7 show the pin-configuration of the AMP 177984-2.

In these tables CMOS means 2.8 V. You may use a 3 V or 3.3 V CMOS level logic (never 5 V) on the 2.8 V I/O's. However, it is required to add serial resistance on all the lines you will use (typical value: from 4.7 to 10 KΩ).

There are a few pins needed for the operation of the module. The handling of that pins is described as follows.

Pin 30 (EN)

This signal is an input of the internal voltage regulator.

- Pull to LOW to switch the voltage regulator off (for minimum current consumption).
- Pull to HIGH or leave the signal open if EN is not used.

Pin 27 (GPIO 1 → Flash_LED)

This signal can be used to show the current status of the module:

- If GPIO 1 is LOW then the module is off.
- If it is continuously HIGH then module is on, but not registered into a network.
- If GPIO 1 is flashing in a 2sec period then the module is on and registered into a network.
- If it flashes in a 1sec period then the module is on and a call is in progress (incoming or outgoing).

GPIO 1 can be an input into a controller (here it needs to be driven by an open collector circuit) or used together with a LED (see picture below):

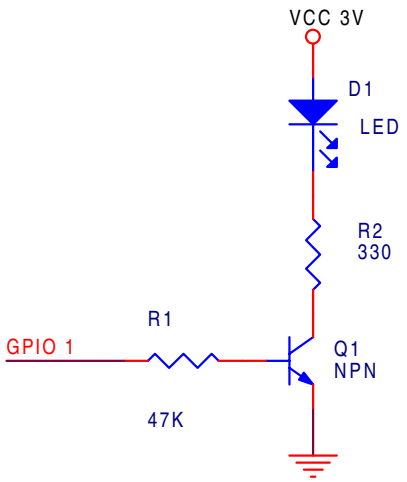

Figure 5: GPIO 1 → Flash_LED

Pin 35 (SIMPREK)

This signal needs to be driven by an open collector circuit. It is used by the module's firmware to detect a SIM card exchange when the module is online. A high to low transition means SIM card is inserted and the module will be able to accept the AT+CPIN command. A low to high transition means SIM card has been removed, the mo-dule will de-register from the network and show the unsolicited error code CME ERROR: 10.

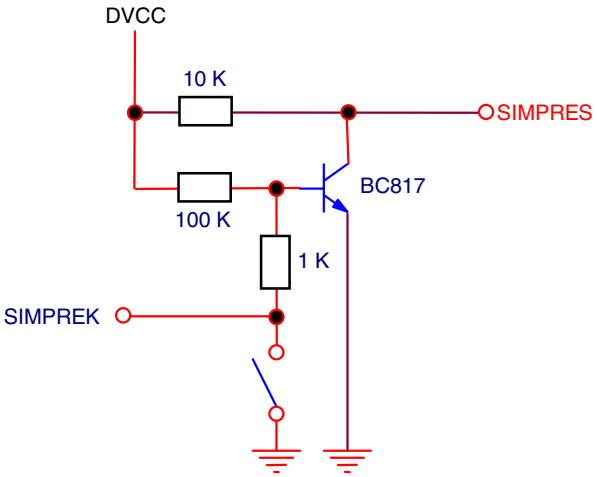

Figure 6: Sample-application SIMPREK

Pin 16 (RESET GSM)

This signal needs to be driven by an external open collector circuit.

- ❒ To issue a hardware reset pull the signal to LOW for a minimum of 100 ms.
- ❒ Pull the signal to HIGH or leave it open for normal operation.

Pin 11 (SOFT_ON)

This signal needs to be driven by an external open collector circuit.

- ❒ For switching the module on (external power must be connected!) set the SOFT_ON signal to HIGH for approx. 3 sec. The signal can be left HIGH until module shall be switched off.
- ❒ For switching the module off the commands AT+CPOF or AT+CFUN=0 have to be issued.

  – If SOFT_ON is HIGH then only the RF part of the module is off, but the AT command set is still working (AT+CFUN=1 can be used to wake up the RF part again) → the Flash_LED stays HIGH.

  – If SOFT_ON is LOW then the complete GSM engine goes OFF → the Flash_LED goes LOW. Some small power consumption will be still there, use the EN pin to avoid that.

It is not recommended to switch the module on and off by means of the power supply (e. g. by tying the SOFT_ON constantly to HIGH). The module will so have no possibility to de-register correctly from the network and this will cause problems at the next attempt to register.

Pin 18 (VCCRTC)

This is the Pin for a +3 V DC back-up battery supply for the real-time-clock.

5.2.1 Firmware download procedure

The download procedure will be documented together with the firmware release on the FALCOM homepage (http://www.falcom.de).

5.2.2 Resetting the GSM–module by AT+CFUN=1,1

If the GSM software is still running, while the user feels the need to reset the module, AT+CFUN=1,1 can be used. This will de-register the modem from the network and bring it into the state before the PIN could be entered.
The Flash_LED pin will shortly toggle to OFF and back to ON again to show the progress.

5.3 GSM 07.05. and 07.07. commands

The GSM-modem of the FALCOM A2D-JP is controlled by an advanced set of AT-commands. In the following list there is a short overview of these commands. For further information it is recommended to read the ETSI GSM recommendation or have a look at the FALCOM A2(D) user manual which can be downloaded from the homepage of FALCOM http://www.falcom.de/service/downloads (document: a2dman.pdf).

5.3.1 General AT commands

Command	Meaning	Command	Meaning
+++	Switch to command mode when connected	AT&C1	DCD matches state of the remote modem's data carrier
ATA	Answer call	AT&D0	Ignore DTR signal
ATDx	Dial data number „x“	AT&D1	At DTR-> OFF: Switches from data to command mode
ATDx;	Dial voice number „x“	AT&D2	At DTR-> OFF: Clear down the call
ATE0	Disable command echo	AT&W	Store current configuration
ATE1	Enable command echo	AT+IPR	Select the modem's data rate
ATH	Disconnect existing connection	AT+IFC	Select the modem's local flow control setting
ATO	Return to data mode	AT+VGR	Tune the receive gain
ATS0=n	Go off-hook after n-th ringing signal (n = „1“- „5“)	AT+VGT	Tune the transmit gain
ATS0=0	No automatic answering of calls	AT+VTD	Define DTMF tone duration
ATZ	Load stored profile	AT+VTS	Send DTMF tone
AT&C0	DCD always ON		

Table 12: General AT commands

5.3.2 SMS AT commands (GSM 07.05)

Command	Meaning	Command	Meaning
AT+CSCA	Service centre address	AT+CMGR	Read message
AT+CSCS	Select TE character set	AT+CMGS	Send message
AT+CSDH	Show text mode parameter	AT+CMGD	Delete message
AT+CSMP	Select text mode parameter	AT+CMGL	List messages
AT+CSMS	Select message service	AT+CNMI	New message indication
AT+CPMS	Preferred message storage	AT+CSAS	Save SMS Settings
AT+CMGF	Text mode / PDU Mode	AT+CRES	Restore SMS Settings

Table 13: SMS AT commands

5.3.3 GSM AT commands (GSM 07.07)

Command	Meaning	Command	Meaning
AT+CBST	Select the bearer type	AT+CPIN	Enter PIN and query blocks
AT+CCFC	Control the call forwarding supplementary service	AT+CPWD	Change PIN or the supplementary password
AT+CCWA	Control the call waiting supplementary service	AT+CSQ	Display signal quality information
AT+CFUN	Select the functionality level in the modem	AT+CR	Select connection service report
AT+CGMI	Display manufacturer ID	AT+CRC	Select call service report
AT+CGMM	Display model ID	AT+CLIP	Calling line identification presentation
AT+CGMR	Display version of GSM module	AT+CLIR	Control the calling line identification presentation
AT+CGSN	Display serial number (IMEI)	AT+COLP	Control the connected line identification presentation
AT+CLCK	Change the PIN state or the call barring supplementary service	AT+GCAP	Display the complete capability list
AT+CREG	Display network registration status	AT+CMEE	Report mobile equipment errors
AT+COPS	Commands relating to network operator selection	AT+CEER	Extend error report
AT+CPAS	Display the activity state of the mobile		

Table 14: GSM AT commands

6 GPS receiver

6.1 General

This description is focussed on the GPS receiver of the FALCOM JP2 series from FALCOM GmbH. It contains some short information about purpose and use of the GPS receiver. The GPS receiver is a single-board 12 parallel channel receiver intended as a component for OEM Products. The GPS receiver continuously tracks all satellites in view, thus providing accurate satellite position data. The highly in-tegrated digital GPS receiver uses the Zodiac 2000 chip set compo-sed of two custom CONEXANT devices together with suitable memory devices.
Please consult CONEXANT for special information about the GPS Zodiac 2000 chip set.

Signal acquisition performance					
		Initial ERROR uncertainties			maximum ephemeris age
Satellite acquisition state	TTFF 90 % probable (minutes)	position (km)	velocity (m/sec)	time (min.)	hours
Warm	0,40	100	75	5	4
Initialised	1,00	100	75	5	4
Cold	2,30	N/A*	N/A	N/A	N/A
Frozen	N/A	N/A	N/A	N/A	N/A

Table 15: Signal acquisition performance

* Signal acquisition performance N/A = Not available

Accuracy					
	Position (meter)				velocity (meter/sec)
	horizontal		3-D	vertical	
	CEP	(2 dRMS)			
SA off	25	50	93	78	0.1
SA on	50	100 (95 %)	200 (95 %)	173 (95 %)	

Table 16: Accuracy

6.2 Product overview

The GPS receiver requires conditioned 3,3 V DC power and a GPS signal from a passive or active antenna.

The 12 channel architecture provides rapid Time-To-First-Fix (TTFF) under all start-up conditions. As long as visible satellites are not obscured, acquisition is guaranteed under all initialisation conditions.

To minimise TTFF when main power is removed from the GPS receiver SRAM with external DC supply voltage and EEPROM are used to archive RTC time and prior position data.

Communication with the GPS receiver is established through two asynchronous serial I/O ports. The GPS receiver's primary serial port outputs navigation data and accepts commands from OEM application in NMEA-0183 format or CONEXANT binary format.

The secondary port is configured to accept differential GPS (DGPS) corrections in the RTCM SC-104 format.

6.2.1 GPS receiver architecture

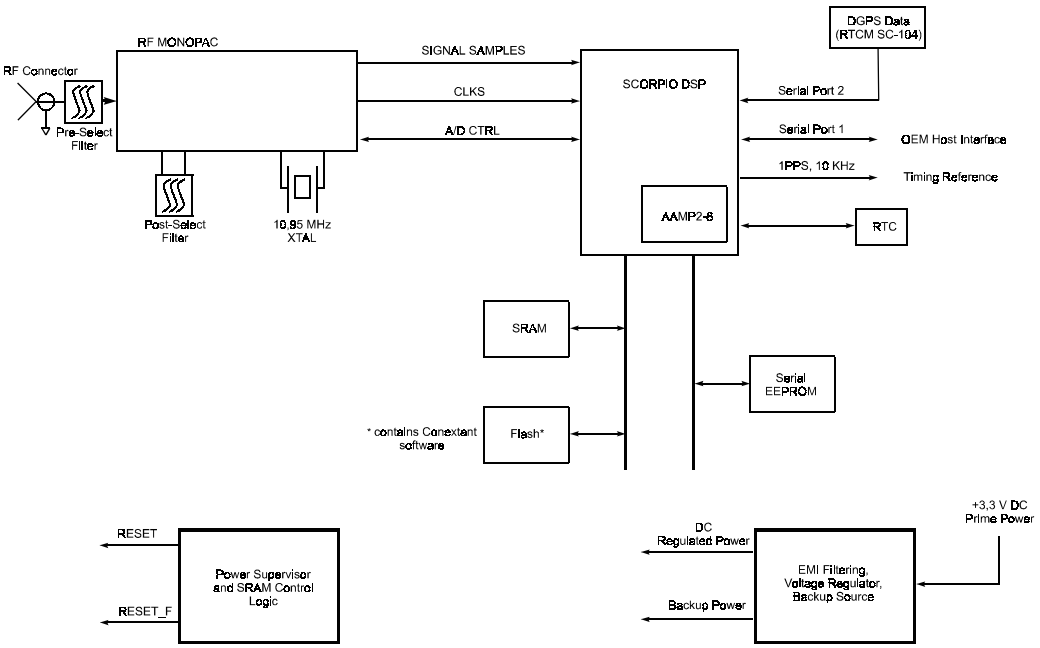

Figure 7: GPS receiver architecture

The functional architecture of the GPS receiver is shown in Figure 7. The GPS receiver design is based on the Conexant Zodiac chip set, the RF-Monopac and the Scorpio DSP, which contain the required GPS functionality. The RF-Monopac contains all the RF down-conversion and amplification circuitry, and presents the In-Phase (I) and Quadrature-Phase (Q) Intermediate.

Frequency (IF) sampled data to the Scorpio device. The Scorpio device contains an integral microprocessor and all the required GPS-specific signal processing hardware. Memory and other external supporting components configure the GPS receiver into a complete navigation system.

6.2.2 Product applications

- ❒ Automotive applications
- ❒ Marine navigation applications
- ❒ Aviation applications
- ❒ Timing applications

6.3 Technical description

6.3.1 General information

Since the GPS receiver determines its position by ranging signals from four or more GPS satellites orbiting the Earth, its antenna must have reasonable visibility of the sky.

Navigation modes

The GPS receiver supports three types of navigation mode operations.

- ❒ **Three dimensional navigation (3D):** The GPS receiver defaults to 3-D navigation whenever at least four GPS satellites are being tracked In 3-D navigation, the GPS receiver computes latitude, longitude, altitude and time information from satellites measurements.
- ❒ **Two dimension navigation (2D):** When less than four GPS satellite signals are available or when a fixed value of altitude can be used to produce an acceptable navigation solution, the GPS receiver will enter the 2-D navigation mode. Forced operating in 2-D mode can be commanded by the OEM.
- ❒ **DGPS navigation:** The GPS receiver processes DGPS corrections through its Auxiliary serial port. These corrections must be compliant with the RTCM recommended standards RTMC-104.

Satellites acquisition

The TTFF of the GPS receiver depends from start conditions. Start condition means if old satellites data are available and how old they are. The conditions are:

- ❒ **Warm start:** results from an short (few minutes) interrupt by continuous navigation. Data are available in SRAM.

- **Initialised start:** is if last known position (in EEPROM) and time are available. Satellite data validity has expired.
- **Cold start:** means only almanac information is used.
- **Frozen start:** no valid internal data source available.

Built in test (BIT) mode

A BIT is available on command from the application software using binary Message 1300. The BIT is used to provide a health status of the GPS receiver functions. Results of the BIT are available in binary Message 1100. A BIT command is possible in NMEA protocol, too.

Power modes and power sequencing requirements

The GPS receiver have three power modes: Off, Operate, and „Keep-Alive“.
The Off mode assumes that neither main power is available.
In the Operate mode the GPS receiver's components are full supplied at 3,3 VDC. The M_RST control signal is at a "high" logic level.
From Operate mode, the GPS receiver will enter a "Keep Alive" mode when supply voltage is available at the VBATT signal input and VC3 voltage is removed. VBATT provides power for SRAM and RTC.

6.3.2 Hardware interface

The following paragraphs describe the basic functions allocated to the various pins on the AMP interface connector. These functions are divided into three groups: Configuration and timing signals, serial communication signals, and DC input signals.

6.3.2.1 Configuration and timing signals

Pin 55: Master reset (M_RST)

This signal allows the OEM to generate a system hardware reset to the GPS receiver. This signal is capable of being driven directly by an external microprocessor or by external logic without the need for any external pull-up or pull-down resistors. The OEM can generate a system reset to the GPS receiver by pulling the M_RST control signal low to ground.

The M_RST signal must be pulled to a CMOS logic „high“ level coincident with, or after, the application of prime DC power for the receiver to enter its Operate mode. The M_RST must be held at ground level for a minimum of 150 nanoseconds to assure proper generation of a hardware reset to the receiver.

This signal can also be used to provide control of the GPS receiver's Operate mode without removing prime input power from the GPS receiver. When M_RST is pulled to ground, the GPS receiver will enter a low power state for as long as the M_RST signal is asserted low.

In this state, a portion of the GPS receiver's RF circuitry is de-energized, the SRAMs are transitioned into their low power data retention state, and the RTC device is maintained. When the GPS receiver is placed into this low power state through the use of the M_RST control signal, the GPS receiver will continue to draw current from the primary input power (PWRIN) but at a reduced level.

When the M_RST signal is subsequently asserted high by the OEM, RF power is re-applied, a system reset is generated, and the GPS receiver will return to its normal Operate mode.

Pins 56, 53, 54 and 51: General Purpose I/O (GPIO1, GPIO2, GPIO3 and GPIO4)

The GPS receiver provides four General Purpose Input/Output (GPIO) connections that are available for use by the OEM. These GPIO connections are digital interfaces that are OEM software programmable as inputs or outputs.

Pin 41: UTC Time Mark Pulse (TMARK)

The Time Mark output provides a one pulse-per-second (1 pps) signal to the OEM application processor. When the GPS receiver provides a valid navigation solution, the rising edge of each TMARK pulse is synchronized with the UTC one second epochs to within ±300 nsec.

Pin 42: 10 kHz UTC synchronized clock

This is a 10 kHz clock waveform that is synchronized to the UTC TMARK pulse.
This clock signal is a positive logic, buffered CMOS level output.

6.3.3 Serial communication signals

Both the configuration and timing signals, described in the previous section, and the serial communication signals described below must be applied according to the limits shown in table 17.

Symbol	Parameter	Limits (*)	Units
PWRIN 3	Main power input to the JP2 (+3,3 V DC)	3,135 to 3,465	volts
VIH (min)	Minimum high-level input voltage	0.7 x PWRIN	volts
VIH (max)	Maximum high-level input voltage	PWRIN	volts
VIL (min)	Minimum low-level input voltage	- 0,3	volts
VIL (max)	Maximum low-level input voltage	0,3 x PWRIN	volts
VOH (min)	Minimum high-level output voltage	0,8 x PWRIN	volts
VOH (max)	Maximum high-level output voltage	PWRIN	volts

Table 17: Digital signal requirements

Symbol	Parameter	Limits (*)	Units
VOL (min)	Minimum low-level output voltage	0	volts
VOL (max)	Maximum low-level output voltage	0,2 x PWRIN	volts
tr, tf	Input rise and fall time	50	nanoseconds
C out	Maximum output load capacitance	25	picofarads
(*) PWRIN refers to a + 3,3 V DC power input (PWRIN-3)			

Table 17: Digital signal requirements

Pins 49 and 50: host port serial data input and output (SDO1 and SDI1)

The host port consists of a full-duplex asynchronous serial data interface. Both binary and NMEA initialization and configuration data messages are transmitted and received across this port.

The default ROM settings for the host serial data port are binary message format, 9600 baud, no parity, 8 data bits, and 1 stop bit. The default may be modified using custom OEM software.
The serial port settings may also be changed to a new configuration using binary serial message 1330. The new serial port settings are stored in SRAM and serial EEPROM. The next time the GPS receiver is powered on or a master reset is initiated, the serial port configuration parameters are accessed in the following priority:

1. If SRAM checksums are valid, the communication parameters and initialization data parameters will be read from SRAM.
2. If SRAM checksums are invalid and EEPROM checksums are valid, the communication parameters and initialization data parameters will be read from EEPROM.
3. If SRAM checksums are invalid and EEPROM checksums are invalid, the default values in ROM will be used.

The OEM application must provide any Line Driver/Line Receiver (LD/LR) circuitry to extend the range of the interface.
Port Idle is nominally a CMOS logical high (+ 3,3 V DC).

Pin 45 and 48: Auxiliary port serial data (SDI2 and SDO2)

The auxiliary port consists of a second half-duplex asynchronous serial data interface. This port is configured to receive RTCM DGPS correction data messages.
The default ROM settings for the Auxiliary Serial Data Port are 9600 baud, no parity, 8 data bits, and 1 stop bit. The default may be modified using custom OEM software.

The serial port settings may also be changed to a new configuration using binary serial message 1330. The new serial port settings are stored in SRAM and serial EEPROM. The next time the GPS receiver is powered on or a master reset is initiated, the serial port configuration parameters are accessed in the following priority:
1. If SRAM checksums are valid, the communication parameters and initialization data parameters will be read from SRAM.

2. If SRAM checksums are invalid and EEPROM checksums are valid, the communication parameters and initialization data parameters will be read from EEPROM.
3. If SRAM checksums are invalid and EEPROM checksums are invalid, the default values in ROM will be used.

The OEM application must provide any LD/LR circuitry to extend the range of the interface. Port Idle is nominally a CMOS logical high (+ 3,3 V DC).

6.3.4 DC input signals

Do not apply power to a passive antenna or damage to the receiver will occur.

Pin 59: Preamp power input (PREAMP)

The OEM may optionally supply power to a preamplifier using the antenna cable center conductor. The maximum voltage is +12 V DC and the current must not exceed 100 mA.

Pins 58 and 60: Power input (PWRIN 3)

This signal is the main power input to the GPS receiver. Regulated DC power requirements are shown in table 2.

Pin 57: Battery backup power input (VBATT)

This signal is used to provide a DC power input to the SRAM and RTC devices only. The GPS receiver automatically switches to the VBATT input signal when primary DC power (PWRIN) is removed from the board.

This feature is intended to provide the GPS receiver with a "warm start" capability by maintaining an accurate time source and using position and satellite data stored in SRAM after prime input power (PWRIN) has been removed from the GPS receiver.

Pins 43, 44, 46, 47 and 52: Ground (GND)

DC grounds for the board. All grounds are tied together through the GPS receiver's printed wiring board (PWB) ground plane and should all be grounded externally to the GPS receiver.

6.3.5 Software interface

The host serial I/O port of the GPS receiver serial data interface supports full duplex communication between the GPS receiver and the OEM application. Data messages can be in the Conexant binary format or NMEA-01 83 format. The GPS receiver also contains an auxiliary port dedicated to direct processing of the RTCM SC-104 messages for DGPS corrections.

6.3.5.1 Binary data message

If you wish to use binary data message you get detailed information in [6]. Binary data have more information but are difficult to use.

Output message name	Default messages	Message ID
Geodetic position status	Position, ground speed, course over ground, climb rate, map, datum and validity	1000
Channel summary	Signal tracking information per satellite	1002
Visible satellites	Their corresponding elevation and azimuth best possible DOP	1003
Differential GPS status	Corrections status of satellite	1005
Channel measurement		1007
ECEF position	Per channel	1009
Receiver ID	Send by power up	1011
User-settings		1012
Built in test results	For the hardware parts	1100
UTC time mark pulse		1108
Frequency standard	Parameter in use	1110
Power management	Duty cycle in use	1117
Serial port communication	Parameters in use	1130
EEPROM update	Show data ID for the last write	1135
EEPROM status	Show failure and status information	1136
Frequency standard table		1160
Boot status		1180
Status/Error	By firmware	1190
Geodetic position and velocity initialisation	Position, ground speed, course, over ground, climb rate	1200
User defined datum definition	To transform the position solution	1210
Map datum select	For 1210	1211
Satellite elevation mask control	Set the elevation mask angle	1212
Satellites candidate select		1213
Differential GPS control		1214
Cold start control	Disable cold start	1216
Solution validity criteria	Position validity status	1217
User entered altitude input	Define altitude for 2D navigation	1219
Application platform control	Means special using	1220
Nav configuration	Control features by navigation	1221

Table 18: Binary data message

Output message name	Default messages	Message ID
Perform built in test		1300
Restart command	With different start condition	1303
Frequency standard Input parameters	Is used by GPS without non-volatile storage	1310
Power management control		1317
Serial port communication parameter		1330
Message protocol control		1331
Factory calibration input	For oscillator	1350
Raw DGPS RTCM SC-104 data	In lieu of the auxiliary port	1351
Frequency standard table input data		1360
Flash reprogram	For flash update	1380

Table 18: Binary data message

6.3.5.2 NMEA data message

Detailed information shown in [6].

Output message name	Default messages	Message ID
Conexant proprietary Built In test	Test results for devices	BIT
Conexant proprietary Error/status		ERR
GPS Fix Data	Time, position, HDOP	GGA
GPS DOP and active satellites	Operating mode, DOP per coordinate, satellite number	GSA
GPS satellites in view	Position an SNR per satellite. Max four satellites per sentence	GSV
Conexant proprietary Receiver ID	Channels, software version	RID
Recommended minimum specific GPS Data (*)	Time, date, position, course and speed	RMC
Track made good and ground Speed	Course and speed	VTG
Conexant proprietary Zodiac channel status (*)	PRN, status	ZCH
Input message name	**Default messages**	**Message ID**
Conexant proprietary built in test command		IBIT
Conexant proprietary log control message	Controls the output of the NMEA messages	ILOG
Conexant proprietary receiver initialisation	Initialisation with specified parameters	INIT
Conexant proprietary protocol message	Set the message format to BIN	IPRO
Standard query message	Request a NMEA message	Q

Table 19: NMEA data message

7 A2D-JP evaluation board

The quickest way to get first results with the embedded GSM/GPS module is the activation by the A2D-JP evaluation board by means of a terminal program.

Figure 8: The A2D-JP evaluation board

Figure 8 shows the A2D-JP evaluation board in complete packaging i. e.

- A2D-JP evaluation board
- A2D-JP module
- power supply FRIWO type FW 3299 (12 VDC/580 mA)
- GPS antenna ANT-006
- RS232 combined cable KA08
- headset with RJ45 plug

The evaluation board transfers data from GSM module and GPS receiver to two separate serial RS232 interfaces.
For voice communication by the GSM module there is a headset

available.
So the data of both modules can be processed by your PC at the same time.

Thus the evaluation board offers an excellent possibility for development and testing (trials) of your own application on the base of the embedded GSM/GPS modules A2D-JP.