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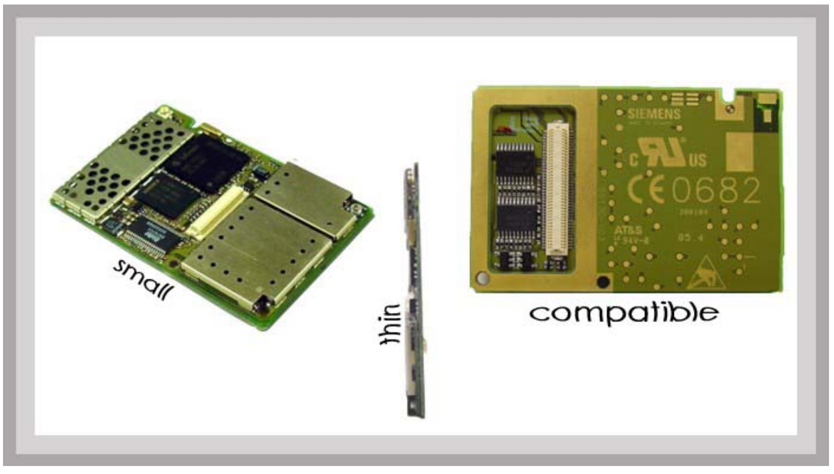
XF55-AVL

Hardware description

Preliminary



Version 0.01

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Version history:

Version number	Author	Changes
0.00	Fadil Beqiri	Initial version
0.01	Fadil Beqiri	Chapter 5.6.4 corrected. Chapter "Type approval" removed Power consumption (**Table 2**) updated.

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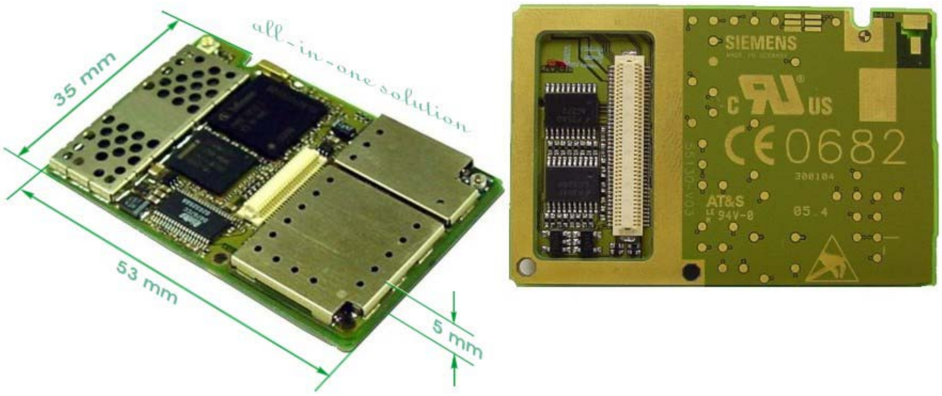
0 Introduction

0.1 General

This description is focused on the GSM/GPRS and GPS module XF55-AVL from FALCOM GmbH. It contains short information about purpose and use of the XF55-AVL concept. This guide completes information needed to prepare and build applications incorporating the XF55-AVL module.
In order quickly to start and immediately and comprehensive to use all functions and to avoid any mistakes of XF55-AVL module on your utilization, we recommend to read the following references and suggestions for using your new XF55-AVL module.
The XF55-AVL is designed to be used on any GSM network. This single and very small (35 x 53 x 5 mm) compact device is Tri-band GSM/GPRS engine that works on the three frequencies GSM 900MHz, GSM 1800 MHz and GSM 1900 MHz, it supports also state-of-art GPS technology for satellite navigation. XF55-AVL features GPRS multislot class 10 and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. The XF55-AVL is combined GSM/GPRS and GPS device. Figure 1 shows the front and backside of the XF55-AVL module.



a) top view b) bottom view

Figure 1: Top and bottom view of XF55-AVL module

The compact design of the XF55-AVL module makes it easy to integrate GSM/GPRS and GPS as an all-in-one solution. The XF55-AVL is designed for application that prefers to use board-to-board connection to the main PCB application platform. Due to its summit form factor it offers a high-performance combination between small form factor and improved flexibility for smaller and medium-sized projects. The combination of these two technologies in such a small form-factor device will make many new asset tracking applications possible, particularly in the fields of transportation, logistics and security. This combination concept builds perfect basis for the design tracking solutions for applications such as fleet management, vehicle tracking, navigation, emergency calling, location-based services and others. It saves significantly both time and cost for integration of additional hardware components.

The integrated GPS module provides more then enough precise location information using satellite signals to enable users to determine where they are anywhere in the world. The XF55-AVL module has also an integrated TCXO that allows the support for high sensitivity SiRFXTrac2 software.
An integrated Combo-Memory into the XF55-AVL module of GPS part, combination Flash and SRAM is high-performance memory solution that significantly improves the system performance. It saves the XF55-AVL software in its flash memory section and static RAM section provides the additional storage capacity.
A compact "stacked FLASH/SRAM" device stores the XF55-AVL software in the flash memory section of GSM/GPRS part, and static RAM section provides the additional storage capacity required by GPRS connectivity.
The physical interface to the module application is made through board-to-board connector. This is required for controlling the unit, receiving GPS location data, transferring data and audio signals and providing power supply lines. XF55-AVL provides two serial GSM interfaces (ASC0-provided on the 80-pin connector and ASC1 provided on the 50-pin connector) and two serial GPS interfaces (Serial data 1 and Serial data 2) giving you maximum flexibility for easy integration with the Man-Machine Interface (MMI). For battery powered applications, XF55-AVL features a charging control which can be used to charge a Li-Ion battery. The charging circuit must be implemented external the module on your application platform.

0.2 Circuit concept

The XF55-AVL architecture includes the following major functional components (*see figure 2*):

- ❖ Architecture integrates:
  - ✓ high-performance Tri Band GSM/GPRS core (operating at 26MHz)
  - ✓ 12 parallel channel low-power GPS core (operating at L1 1575.42 MHz and C/A code 1,023 MHz chip rate)
  - ✓ ARM7TDMI Processor (at speed 25MHz) that controls all functions of the system
  - ✓ Power Control circuitry
  - ✓ 2 x Audio channels
  - ✓ Interface circuitry
  - ✓ Combo-Memory (2MB - 512KB) for loading software.
- ❖ Physical interfaces:
  - ✓ 80-pin board-to-board connector (Type Hirose DF12C) serves as physical interface to the host application.
  - ✓ 50-pin board-to-board connector (Type Hirose DF12C) serves as physical interface for GSM/GPRS part to the host application.
  - ✓ provided pins for an external SIM card reader.
  - ✓ an ultra-miniature SMT GSM/GPRS antenna connector (Type **U.FL-R-SMT**) supplied from Hirose Ltd.

- ✓ an ultra-miniature SMT GPS antenna connector (Type **U.FL-R-SMT)** supplied from Hirose Ltd.

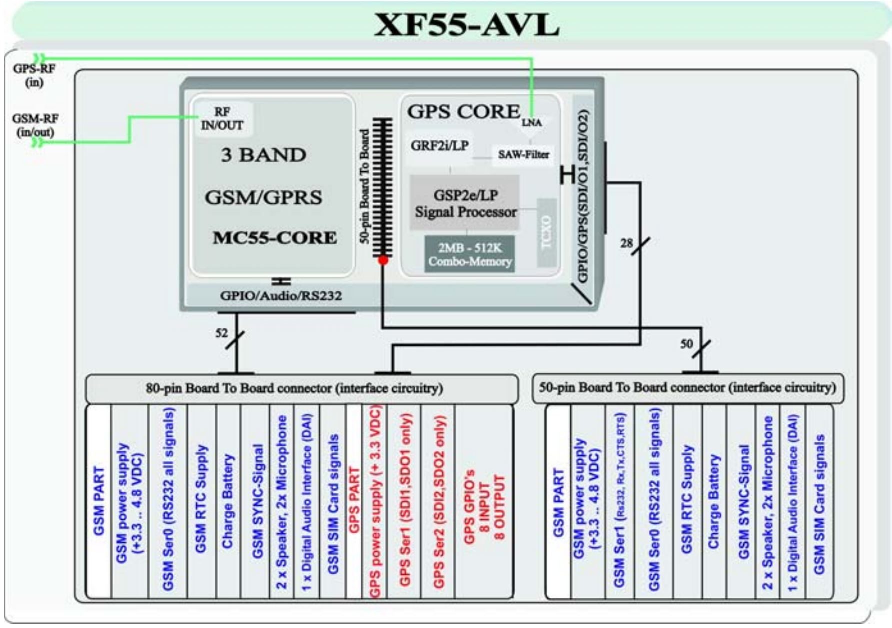


Figure 2: Architecture of the XF55-AVL module

Please note that the GPS part of XF55-AVL operates with SiRF GSW2, version 2.32. There is no AVL software included in the delivery pack.

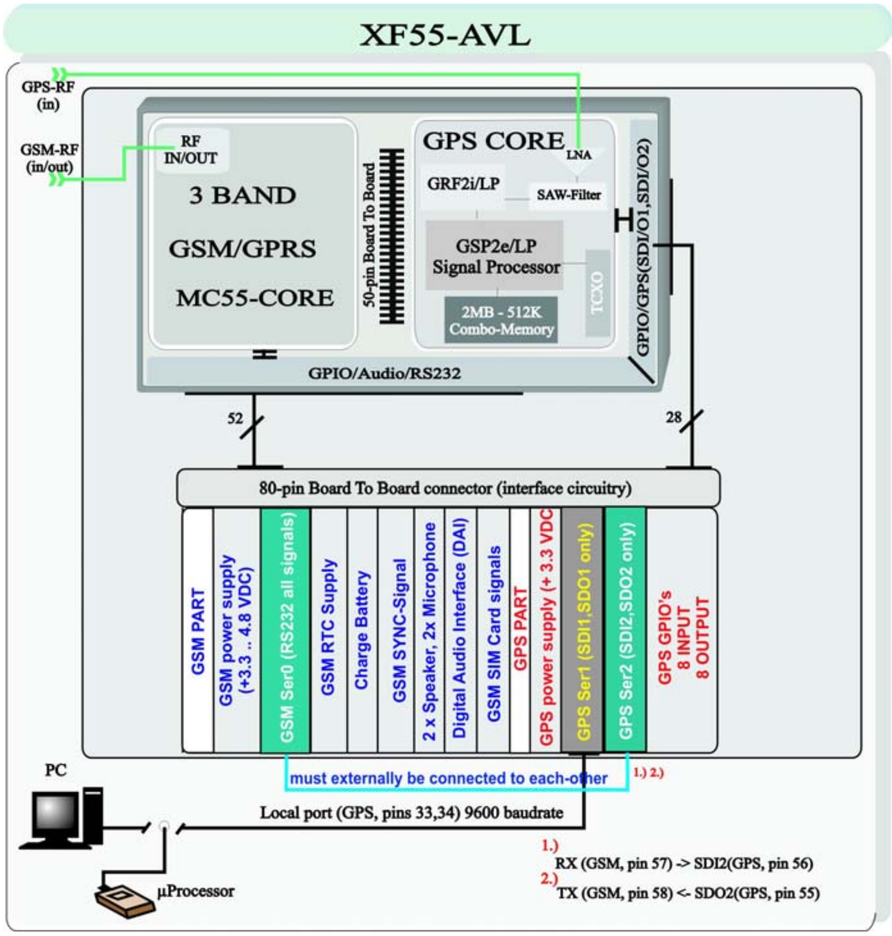


Figure 3: Architecture of the XF55-AVL module operating with AVL or TCP/IP software application (optional)

0.3 Used abbreviations

Abbreviation	Description
AD	Analog/Digita
ADC	Analog-to-Digital Converter
AFC	Automatic Frequency Control
AGC	Automatic Gain Control
AMP	Advanced Power Management
ANSI	American National Standards Institute
ARFCN	Absolute Radio Frequency Channel Number
ARP	Antenna Reference Point
ASC0/ASC1	Asynchronous Controller. Abbreviations used for first and second serial interface of XF55-AVL
ASIC	Application Specific Integrated Circuit
B	Thermistor Constant
B2B	Board-to-board connector
BER	Bit Error Rate
BTS	Base Transceiver Station
CB or CBM	Cell Broadcast Message
CE	Conformité Européene (European Conformity)
CHAP	Challenge Handshake Authentication Protocol
CPU	Central Processing Unit
CS	Coding Scheme
CSD	Circuit Switched Data
CTS	Clear to Send
DAC	Digital-to-Analog Converter
DAI	Digital Audio Interface
dBW	Decibel per Watt
dBm0	Digital level, 3.14 dBm0 corresponds to full scale, see ITU G.711, A-law
DCE	Data Communication Equipment (typically modems, e.g. XF55-AVL GSM engine)
DCS 1800	Digital Cellular System, also referred to as PCN
DGPS	Differential GPS
DOP	Dilution of Precision
DRX	Discontinuous Reception
DSP	Digital Signal Processor
DSR	Data Set Ready
DTE	Data Terminal Equipment (typically computer, terminal, printer or, for example, GSM application)
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
FCC	Federal Communications Commission (U.S.)
FDMA	Frequency Division Multiple Access

Abbreviation	Description
FR	Full Rate
GGA	GPS Fixed Data
GMSK	Gaussian Minimum Shift Keying
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global Standard for Mobile Communications
HiZ	High Impedance
HR	Half Rate
I/O	Input/Output
IC	Integrated Circuit
IF	Intermediate Frequency
IMEI	International Mobile Equipment Identity
ISO	International Standards Organization
ITU	International Telecommunications Union
kbps	kbits per second
LED	Light Emitting Diode
Li-Ion	Lithium-Ion
LNA	Low Noise Amplifier
Mbps	Mbits per second
MMI	Man Machine Interface
MO	Mobile Originated
MS	Mobile Station (GSM engine), also referred to as TE
MSISDN	Mobile Station International ISDN number
MSK	Minimum Shift Key
MT	Mobile Terminated
NTC	Negative Temperature Coefficient
NMEA	National Maritime Electronics Association
OEM	Original Equipment Manufacturer
PA	Power Amplifier
PAP	Password Authentication Protocol
PBCCH	Packet Switched Broadcast Control Channel
PCB	Printed Circuit Board
PCL	Power Control Level
PCM	Pulse Code Modulation
PCN	Personal Communications Network, also referred to as DCS 1800
PCS	Personal Communication System, also referred to as GSM 1900
PDU	Protocol Data Unit
PLL	Phase Locked Loop
PPP	Point-to-point protocol
PRN	Pseudo-Random Noise Number. The identity of GPS satellites
PSU	Power Supply Unit
R&TTE	Radio and Telecommunication Terminal Equipment
RAM	Random Access Memory
RF	Radio Frequency
RMS	Root Mean Square (value)
ROM	Read-only Memory
RP	Receive Protocol
RTC	Real Time Clock

Abbreviation	Description
RTCM	Radio Technical Commission for Maritime Services
Rx	Receive Direction
SA	Selective Availability
SAR	Specific Absorption Rate
SELV	Safety Extra Low Voltage
SIM	Subscriber Identification Module
SMS	Short Message Service
SRAM	Static Random Access Memory
TA	Terminal adapter (e.g. GSM engine)
TDMA	Time Division Multiple Access
TE	Terminal Equipment, also referred to as DTE
Tx	Transmit Direction
UART	Universal asynchronous receiver-transmitter
URC	Unsolicited Result Code
USSD	Unstructured Supplementary Service Data
VSWR	Voltage Standing Wave Ratio
WAAS	Wide Area Augmentation System
FD	SIM fix dialing phonebook
LD	SIM last dialing phonebook (list of numbers most recently dialed)
MC	Mobile Equipment list of unanswered MT calls (missed calls)
ME	Mobile Equipment phonebook
ON	Own numbers (MSISDNs) stored on SIM or ME
RC	Mobile Equipment list of received calls
SM	SIM phonebook

Table 1: Used abbreviations

0.4 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. xf55_at_command_set.pdf
5. gprs_startup_user_guide.pdf
6. SiRF binary and NMEA protocol specification; www.falcom.de/download/manuals/SiRF
7. xf55-avl_using_stepp_II_1.6.2_sw.pdf
8. xf55_avl_tcp_ip_software_manual.pdf
9. Multiplexer User's Guide (in preparation)
10. Application Note 14: Audio and Battery Parameter Download (in preparation)
11. Application Note 02: Audio Interface Design (in preparation)
12. falcom_eCos_SDK_user_guide.pdf
13. universal_evaluation_board_manual.pdf
14. xf55_avl_getting_started.pdf
15. xf55_avl_using_V2.0RC1_sw.pdf
16. Application Note 01: Interrupt control

1 Security

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

Your cellular engine XF55-AVL 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 XF55-AVL module. Please read this chapter carefully before starting to use the cellular engine XF55-AVL.

1.1 General information

Your XF55-AVL device utilize the GSM/GPS 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 XF55-AVL 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.

1.2 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 minimize 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.

1.3 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.

1.4 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 antenna. Otherwise, have your antenna repaired by a qualified technician.
Use only the supplied (if there is one) or approved antenna. Unauthorized antennas, modifications or attachments could damage the modem and may contravene local RF emission regulations.

1.5 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!

1.6 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.

1.7 Vehicle electronic equipment

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

1.8 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 XF55-AVL device 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.

1.9 Aircraft

Turn your XF55-AVL 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.

1.10 Children

Do not allow children to play with your XF55-AVL device. 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.

1.11 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 uses remote control RF devices to set off explosives.

1.12 Potentially explosive atmospheres

Turn your XF55-AVL device **OFF** when in any area with a potentially explosive atmosphere. It is rare, but your modems or their 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.

1.13 Non-ionizing 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 50 Ohm 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.

2 Safety standards

Your GSM/GPS module complies with all applicable RF safety standards.
The embedded GMS/GPS module meet 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.

3 Technical data

3.1 General specifications of module XF55-AVL

- ***Power supply:***
  - Supply voltage 3.3 V...4.8 V for the GSM/GPRS module
  - Separate power supply source: 3.3 V ± 5 % for the GPS device
- ***Power saving (GSM):***
  - Minimizes power consumption in SLEEP mode to 3 mA
- ***Power saving (GPS)***
  - TricklePower mode reduces power to <60 mW
- ***Charging***
  - Supports charging control for Li-Ion battery for the GSM/GPRS part of the module
- ***Temperature range:***
  - Normal operation: -20 °C to +55 °C (see chapter 7.2 for further details)
- ***Evaluation kit***
  - The XF55-AVL Evaluation Kit is designed to tests and types approve the FALCOM devices and provide a sample configuration for application engineering.
- ***Physical characteristics:***
  - Size: 35.0 ± 0.15 mm x 53.0 ± 0.15 mm x 5.1 ± 0.15 mm
  - Weight: 12 g
- ***Firmware upgrade***
  - ***XF55-AVL*** firmware upgradeable over serial interface

3.1.1 Power consumption

POWER CONSUMPTION					
	Min	**Typ**	**Max**	**Unit**	**Description**
GSM/GPRS engine					
Supply voltage	3.3	4.5	4.8	V	Voltage must stay within the min/max values, including voltage drop, ripple and spikes.

Average supply current						
		50	100	µA	POWER DOWN mode	
GSM		3		mA	SLEEP mode @ DRX = 6	
					MODE	***BAND***
		15		mA	IDLE mode	EGSM 900
		15				GSM 1800/1900
		260		mA	TALK mode	EGSM 900*)
		180				GSM 1800/1900**)
GPRS		15		mA	IDLE GPRS	EGSM 900
		15				GSM 1800/1900
		300		mA	DATA mode GPRS, (4 Rx, 1 Tx)	EGSM 900*)
		230				GSM 1800/1900**)
		450		mA	DATA mode GPRS, (3 Rx, 2 Tx)	EGSM 900*)
		320				GSM 1800/1900**)
Peak supply current.		1.6		A	Power control level*) During transmission slot every 4.6 ms.	
GPS engine						
Supply voltage	3.14	3.3	3.46	V	Voltage must stay within the min/max values, including voltage drop, ripple, and spikes.	
Antenna voltage		3		V	**GPS_VCC_RF** pin connected to **GPS_VANT** pin. The current consumption of connected active GPS is 3 mA.	
					Power mode description	
2.32 firmware	60		74	mA	During signal receiving in continuous mode (GPS fix is already obtained)	
	0.65	13	69		During signal receiving in TricklePower mode (GPS fix is obtained) TricklePower Mode settings: **Total period = 2000 ms** **Tracking State = 240 ms** **CPU mode = 630 ms** **Trickle State = 1130 ms**	
	0.65		69		During signal receiving in Push-To-Fix mode (GPS fix is already obtained)	
XTrac firmware	71		84	mA	During signal receiving in continuous mode (GPS fix is already obtained)	
	68		88		During signal receiving in APM mode APM Mode settings: **AMP enable = True** **Num AMP cycle before sleep = 0** **Time between fixes = 30 sec** **Power Duty cycle = 50 %** **Timing priority preference = Tbf***)** **Accuracy Priority preference = no preference**	

Table 2: Power consumption of GSM/GPRS and GPS parts

*) in transmit/receive mode at maximum power level (5)
**) in transmit/receive mode at maximum power level (0)
***) Time between fixes

3.2 Technical specifications of GSM/GPRS engine

- ***Frequency bands***:
  - Tri band: EGSM 900, GSM 1800, GSM 1900
  - Compliant to GSM Phase 2/2+
- ***GSM class:***
  - Small MS
- ***Transmit power:***
  - Class 4 (2 W) at EGSM900
  - Class 1 (1 W) at GSM1800 and GSM 1900
- ***GPRS connectivity:***
  - GPRS multi-slot class 10
  - GPRS mobile station class B
- ***DATA***:

  GPRS ⇒
  - GPRS data downlink transfer: max. 85.6 kbps (see table 3).
  - GPRS data uplink transfer: max. 42.8 kbps (see table 3).
  - Coding scheme: CS-1, CS-2, CS-3 and CS-4.
  - XF55-AVL supports two protocols PAP (Password Authentication Protocol) and CHAP (Challenge Handshake Authentication Protocol) commonly used for PPP connections.
  - Supports of Packet Switched Broadcast Control Channel (PBCCH) allows you to benefit from enhanced GPRS performance when offered by the network operators.

  CSD ⇒
  - CSD transmission rates: 2.4, 4.8, 9.6, 14.4 kbps, non-transparent, V.110.
  - Unstructured Supplementary Services Data (USSD) support.

  WAP ⇒
  - WAP compliant.
- ***SMS:***
  - MT, MO, CB, Text and PDU mode
  - SMS storage: SIM card plus 25 SMS locations in the mobile equipment
  - Transmission of SMS alternatively over CSD or GPRS. Preferred mode can be user-defined.
- ***MMS:***
  - MMS compliant

- ***FAX:***
  - Group 3: class 1, class 2
- ***SIM interface:***
  - Supported SIM card: 3 V
  - External SIM card reader has to be connected via interface connector (note that card reader is not part of module XF55-AVL)
- ***Casing:***
  - Fully shield
- ***Temperature control and auto switch-off:***
  - Constant temperature control prevents damage to module XF55-AVL when the specified temperature is exceeded. When an emergency call is in progress the automatic temperature shutdown functionality is deactivated. (see chapter 7.2 for further details)
- ***External antenna:***
  - Connected via 50 Ohm antenna connector or antenna pad.
- ***Audio interfaces:***
  - Two analogue audio interfaces, one digital audio interface (DAI)
- ***Audio features:***

  Speech codec modes:
  - Half Rate (ETS 06.20)
  - Full Rate (ETS 06.10)
  - Enhanced Full Rate (ETS 06.50/06.60/06.80)
  - Adaptive Multi Rate (AMR)

  Handsfree operation
  - Echo cancellation
  - Noise reduction
- ***Two serial interfaces (ASC0, ASC1):***
  - 2.65V level, bi-directional bus for AT commands and data
  - ASC0↔full-featured 8-wire serial interface. Supports RTS0/CTS0 hardware handshake and software XON/XOFF flow control. Multiplex ability according to GSM 07.10 Multiplexer Protocol.
  - ASC1↔4-wire serial interface. Supports RTS1/CTS1 hardware handshake and software XON/XOFF flow control.
  - Baud rate: 300 bps ... 230 kbps on ASC0 and ASC1

- Autobauding (on ASC0 only) detects 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400 bps

❖ ***Phonebook management:***

- Supported phonebook types: SM, FD, LD, MC, RC, ON, ME

❖ ***SIM Application Toolkit:***

- Supports SAT class 3, GSM 11.14 Release 98

❖ ***Ringing tones:***

- Offers a choice of 7 different ringing tones/melodies, easily selectable with AT command

❖ ***Real time clock:***

- Implemented

❖ ***Timer function:***

- Programmable via AT command

❖ ***Internal memory:***

- Stacked Flash/SRAM

❖ ***Support of TTY/CTM:***

- To benefit from TTY communication via GSM, CTM equipment can be connected to one of the three audio interfaces.

Coding scheme	1 Timeslot	2 Timeslots	4 Timeslots
CS-1:	9.05 kbps	18.1 kbps	36.2 kbps
CS-2:	13.4 kbps	26.8 kbps	53.6 kbps
CS-3:	15.6 kbps	31.2 kbps	62.4 kbps
CS-4:	21.4 kbps	42.8 kbps	85.6 kbps

Table 3: Coding schemes and maximum net data rates over air interface

Please note that the values listed above are the maximum ratings which, in practice, are influenced by a great variety of factors, primarily, for example, traffic variations and network coverage.

3.3 Technical specifications of GPS receiver

❖ ***GPS features:***

- OEM single board 12 channel GPS receiver, L1 1575.42 MHz, C/A code 1,023 MHz chip rate.
- GPS receiver with SiRFstarIIe/LP chip set
- Processor type ARM7/TDMI
- SiRF GSW2, version 2.32

❖ ***Accuracy:***

- Position 10 meters CEP without SA.

- ***V***elocity 0.1 meters/second, without SA
- ***T***ime 1 microsecond synchronized to GPS time

- ***DGPS Accuracy:***
  - ***P***osition 1 to 5 meters, typical.
  - ***V***elocity 0.05 meters/second, typical
- ***Datum:***
  - ***W***GS-84.
- ***Sensitivity*:***
  - ***T***racking 16 dBHz.
  - ***H***ot Start 23 dBHz
  - ***W***arm Start 28 dBHz
  - ***C***old Start 32 dBHz

* The sensitivity value is specified at the correlator. On a GPS Evaluation Receiver using SiRFXTrac2 firmware with the supplied antenna, 32 dBHz is equivalent to -142 dBm or -172 dBW. Other board and antenna characteristics will vary.

- ***Acquisition Rate:***
  - ***C***old start <45 sec, average
- ***Dynamic Conditions:***
  - ***A***ltitude 18,000 meters (60,000 feet) max.
  - ***V***elocity <515 meters/second (1000 knots) max.
  - ***A***cceleration 4 g, max.
  - ***J***erk 20 meters/second^3, max.
- ***Backup battery power:***
  - ***S***upply +3 V DC ±5 %.
- ***Casing:***
  - ***F***ully shield
- ***Time – 1 PPS Pulse:***
  - ***L***evel CMOS.
  - ***P***ulse duration 100 ms
  - ***T***ime reference At the pulse positive edge
  - ***M***easurements Aligned to GPS second, ± µs
- ***Supported protocols:***
  - ***N***MEA Msg.: GLL, GGA, RMC, VTG, GSV, GSA
  - ***S***iRF binary: position, velocity, altitude, status and control.
  - ***R***TCM SC-104
- ***Serial Interface Settings (SD1, SD2):***
  - ***T***wo full duplex serial communication, CMOS level

- ***B***aud rate: 4800 bps on the GPS_SD1 port, 9600 bps on the GPS_SD2 port (see chapter 11.5.1.1 for SiRFXTrac2 software settings).
- 8 data bits, no parity, 1 stop bit

❖ ***Crystal oscillator (TCXO) specification:***

Typical phase noise density	1 Hz offset	-57.0 dBc/Hz
Typical phase noise density	10 Hz offset	-88.0 dBc/Hz
Typical phase noise density	100 Hz offset	-112.0 dBc/Hz
Typical phase noise density	1 kHz offset	-130.0 dBc/Hz
Typical phase noise density	10 kHz offset	-140.0 dBc/Hz
Load sensitivity	± 10 % load change	0.2 ± ppm
Long term stability	Frequency drift over 1 year	0.5 to 2.0 ± ppm

❖ ***External antenna:***

- ***S***eparate GPS antenna connector. See figure 37 for details

❖ ***Memory:***

- ***C***ombo-Memory (**2 MB Flash–512 KB SRAM**)

❖ ***Additional software options (can be obtained separately):***

- ***A***VL: The integration of AVL software into the on-board Memory allows the module XF55-AVL a wide range of tracking solutions in applications that can locally and remotely be configured. The concept of the device is based on a simple implementation for a wide range of applications with low costs and high flexibility (see related documents [7 and 15])
- ***T***CP/IP: The integration of TCP/IP stack into the XF55-AVL converts it to a stand-alone client that can be connected to the internet through any GSM 900/1800/1900 network. The module can also send and receive data by GSM and GPRS network using TCP/IP stack. It supports SMS, DATA and FAX calls. The **XF55-AVL** using module TCP/IP can be easily controlled by using AT or IP commands (see related document [8])
- ***S***iRFXTrac2 (high sensitivity stand alone software) see section **11.5.1**

4 GSM/GPRS application interface

4.1 Description of operating modes

The chapter below briefly summarizes the various operating modes referred to in the following chapters. GPS operating modes are also described in chapter 5.2.

Definition of the GPRS class B mode of operation:

The definition of GPRS class B mode is, the MS can be attached to both GPRS and other GSM services, but the MS can only operate one set of services at a time. Class B enables making or receiving a voice call, or sending/receiving an SMS during a GPRS connection. During voice calls or SMS, GPRS services are suspended and then resumed automatically after the call or SMS session has ended.

4.1.1 Normal mode operation

4.1.1.1 GSM/GPRS SLEEP

Various power save modes set with `AT+CFUN` command. Software is active to minimum extent. If the module was registered to the GSM network in IDLE mode, it is registered and paging with the BTS in SLEEP mode, too. Power saving can be chosen at different levels: The NON-CYCLIC SLEEP mode (`AT+CFUN=0`) disables the AT interface. The CYCLIC SLEEP modes `AT+CFUN=5,6,7,8` and `9` alternatively activate and deactivate the AT interfaces to allow permanent access to all AT commands.

4.1.1.2 GSM IDLE

Software is active. Once registered to the GSM network, paging with BTS is carried out. The module is ready to send and receive.

4.1.1.3 GSM TALK

Connection between two subscribers is in progress. Power consumption depends on network coverage individual settings, such as DTX off/on, FR/EFR/HR, hopping sequences, antenna.

4.1.1.4 GPRS IDLE

Module is ready for GPRS data transfer, but no data is currently sent or received. Power consumption depends on network settings and GPRS configuration (e.g. multislot settings).

4.1.1.5 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).

4.1.2 Power down

Normal shutdown after sending the AT^SMSO command. The Power Supply ASIC (PSU-ASIC) disconnects the supply voltage from the base band part of the circuit. Only a voltage regulator in the PSU-ASIC is active for powering the RTC. Software is not active. The serial interfaces are not accessible. Operating voltage (connected to GSM_BATT+) remains applied.

4.1.3 Alarm mode

Alarm mode restricted operation launched by RTC alert function while the module is in POWER DOWN mode. Module will not be registered to GSM network. Limited number of AT commands is accessible.

4.1.4 Charge-only mode

Limited operation for battery powered applications. Enables charging while module is detached from GSM network. Limited number of AT commands is accessible. There are several ways to launch Charge-only mode:

- From POWER DOWN mode: Connect charger to the charger input pin of the external charging circuit and the GSM_POWER pin of module when XF55-AVL was powered down by AT^SMSO.
- From Normal mode: Connect charger to the charger input pin of the external charging circuit and the GSM_POWER pin of module, then enter AT^SMSO.

4.1.5 Charge mode during normal operation

Normal operation (SLEEP, IDLE, TALK, GPRS IDLE, and GPRS DATA) and charging are running in parallel. Charge mode changes to Charge-only mode when the module is powered down before charging has been completed.

4.2 Description of the 80-pin double-row connector

Please note that the reference voltages listed in table 4 are the values measured directly on the XF55-AVL module. They do not apply to the accessories connected. If an input pin is specified for V_{IHmax} = 3.3V, be sure never to exceed the stated voltage. The value 3.3 V is an absolute maximum rating. The Hirose DF12C board-to-board connector on XF55-AVL is a 80-pin double-row receptacle. The names and the position of the pins can be seen from figure 4 below which shows the top view of XF55-AVL.

Please note that, both application interfaces (80- and 50-pin connectors) of the XF55-AVL module could not concurrently be used. The second application interface (ASC1) is not included on the 80-pin connector, it is available on the 50-pin connector for user applications.

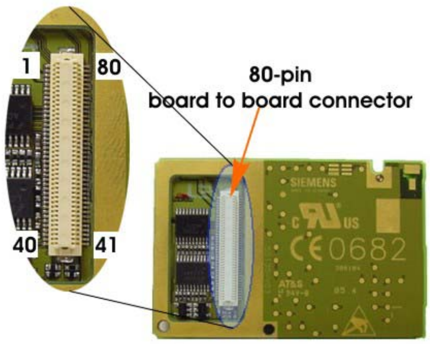


Figure 4: Pin assignment on the 80-pin connector (bottom view on XF55-AVL)

PIN	NAME	I/O	DISCRIPTION	LEVEL
1	GPS_VANT	I	Power supply for an active antenna. See chapter 5.5	Up to +12 V DC/max. 25 mA
2	GPS_VCC_RF	O	Supply voltage of RF section. See chapter 5.5	+ 3.0 V DC/max. 25 mA
3	GPS_VCC	I	Main power supply. See chapter 5.5	+ 3.3 V DC ±5 %/max: 100 mA
4	GPS_VCC			
5	GSM_RXDDAI	I	Digital audio interface If not used leave all pins open.	$V_{OL}max$ = 0.2 V at I = 1 mA $V_{OH}min$ = 2.35 V at I = -1 mA $V_{OH}max$ = 2.73 V $V_{IL}max$ = 0.5 V $V_{IH}min$ = 1.95 V, $V_{IH}max$ = 3.3 V $I_{I}max$ = 330 µA at VIN = 3.3 V
6	GSM_TFSDAI	O		
7	GSM_SCLK	I		
8	GSM_TXDDAI	O		
9	GSM_RFSDAI	I		
10	GPS_OUT_A1	O	General propose outputs See chapter 5.6.4	Output 3.3 V DC/50 mA
11	GPS_OUT_A2			
12	GPS_OUT_A3			
13	GPS_OUT_A4			
14	GPS_OUT_A5			
15	GPS_OUT_A6			
16	GPS_OUT_A7			
17	GPS_OUT_A8			
18	GPS_IN_1	I	General propose inputs See chapter 5.6.3	Are configured as active low level
19	GPS_IN_2			
20	GPS_IN_3			
21	GPS_IN_4			
22	GPS_IN_5			
23	GPS_IN_6			
24	GPS_IN_7			
25	GPS_IN_8			
26	GPS_GPIO15	I/O	See chapter 5.6.2	CMOS 3.3 V DC
27	GPS_GPIO10			
28	GPS_GPIO7			
29	GPS_GPIO6			
30	GPS_GPIO5			
31	GPS_GPIO1			
32	GPS_GPIO0			
33	GPS_SDI1	I	Serial Data Input A (first receive line). See chapter 5.6.1	CMOS 3.3V DC level
34	GPS_SDO1	O	Serial Data Output A (first transmit line). See chapter 5.6.1	CMOS 3.3V DC level
35	GPS_TMARK	O	1 PPS Time Mark Output. See chapter 5.6	CMOS 3.3 V DC

36	**GPS_BOOTSEL**	**I**	**Boots in update mode, if high. See chapter 5.6**	**CMOS 3.3 V DC**
37	**GPS_RFPC1**	**O**	**Control output for Trickle-Power Mode. See chapter 5.6**	**+ 2.85 V DC / max. 25 mA**
38	**GPS_M-RST**	**I**	**Reset the unit if Active Low. See chapter 5.6**	**CMOS**
39	**GSM_VDD**	**O**	**Supply voltage, e.g. for an external LED or level shifter. The external digital logic must not cause any spikes or glitches on voltage VDD. Not available in POWER DOWN mode. VDD signalizes the "ON" state of the module. If unused keep it open.**	**V_{DDmin} = 2.84 V, V_{DDmax} = 2.96 V Imax = -10 mA C_{Lmax} = 1 µF**
40	**GSM_VDDLP**	**I/O**	**Supplies the RTC with power via an external capacitor or buffer battery if no VBATT+ is applied. If not used leave it open.**	**R_I =1 kΩ V_{Omax} 4.0 V (output) V_{Imin} = 2.2 V, V_{Imax} = 5.5 V (input) I_{Ityp} = 10 µA at BATT+ = 0 V Mobile in POWER DOWN mode: V_{Imin} = 1.2V**
41	**GSM_GND**	**-**	**Negative operating voltage (grounds).**	**0 V**
42	**GSM_GND**			
43	**GSM_GND**			
44	**GSM_GND**			
45	**GSM_GND**			
46	**GSM_VBATT**	**I**	**Power supply input. 5 BATT+ pins to be connected in parallel. 5 GND pins to be connected in parallel. The power supply must be able to meet the requirements of current consumption in a Tx burst (up to 3 A). Sending with two timeslots doubles the duration of current pulses to 1154 µs (every 4.616 ms)! These pins are also linked to the GPS part, which power the RTC and SRAM of GPS receiver.**	**VI = 3.3 V to 4.8 V VInorm = 4.1 V Imax < 2 A (during Tx burst) 1 x Tx, peak current 577 µs every 4.616 ms 2 x Tx, peak current 1154 µs every 4.616 ms**
47	**GSM_VBATT**			
48	**GSM_VBATT**			
49	**GSM_VBATT**			
50	**GSM_VBATT**			
51	**GSM_SYNC**	**O**	**Indicates increased current consumption during uplink transmission burst. Note that timing is different during handover. Alternatively used to control status LED (see chapter 4.11.2.2). If not used leave it open.**	**V_{OLmax} = 0.2 V at I = 1 mA V_{OHmin} = 2.35 V at I = -1 mA V_{OHmax} = 2.73 V 1 Tx, 877 µs impulse each 4.616 ms and 2 Tx, 1454 µs impulse each 4.616 ms, with 300 µs forward time.**
52	**GSM_BATT_ TEMP**	**I**	**Input to measure the battery temperature over NTC resistor. NTC should be installed inside or near battery pack to enable the charging algorithm and deliver temperature values.**	**Connect NTC with R_{NTC} ≈ 10 kΩ @ 25 °C to ground.**

			If not used leave it open.	
53	GSM_POWER	I	This line signals to the processor that the charger is connected. If not used leave it open	VImin = 3.0 V VImax = 15 V
54	GSM_CHARGE	O	This line is a current source for the charge FET with a 10 kΩ resistance between gate and source. If not used leave it open.	$I_{GSM\ CHARGE}$ = -300 µA ... –600 µA @ 3 V < $V_{GSM\ CHARGE}$ < V_{LOAD}
55	GPS_SDO2	O	Serial Data Output B (second transmit line). See chapter 5.6.1	CMOS 3.3 V DC level
56	GPS_SDI2	I	Serial Data Input B (second receive line). See chapter 5.6.1	CMOS 3.3 V DC level
57	GSM_RXDO	O	First serial interface (ASC0) for AT commands or data stream. To avoid floating if output pins are high-impedance, use pull-up resistors tied to GSM_VDD or pull-down resistors tied to GND. See chapter 4.3.3.1. If not used leave it open.	V_{OL}max = 0.2 V at I = 1 mA V_{OH}min = 2.35 V at I = -1 mA V_{OH}max = 2.73 V V_{IL}max = 0.5 V V_{IH}min = 1.95 V, V_{IH}max=3.3 V GSM_DTR0, GSM_RTS0: Imax = -90 µA at V_{IN} = 0 V GSM_TXD0: Imax = -30 µA at VIN = 0 V
58	GSM_TXDO	I		
59	GSM_DSRO	O		
60	GSM_RINGO	O		
61	GSM_RTSO	I		
62	GSM_DTRO	I		
63	GSM_CTSO	O		
64	GSM_DCDO	O		
65	GSM_EMERG OFF	I	This line must be driven by an Open Drain or Open Collector driver. Emergency shutdown deactivates the power supply to the module. The module can be reset if /IGT is activated after emergency shutdown. To switch the mobile off use the AT^SMSO command. To avoid floating if pin is high impedance, use pull-down resistor tied to GND. See chapter 4.3.3.1. /EMERGOFF also indicates the internal watchdog function. If not used leave it open.	RI 22 kΩ V_{IL}max = 0.5 V at Imax = -100 µA Vopenmax = 2.73 V Signal ¯¯|______|¯¯ Active Low ≥ 3.2 s Watchdog: V_{OL}max = 0.35 V at I = 10 µA V_{OH}min= 2.25 V at I = -10 µA fomin = 0.16 Hz fomax = 1.55 Hz
66	GSM_IGT	I	Input to switch the mobile ON. The line must be driven low by an Open Drain or Open Collector driver.	R_I ≈ 100 kΩ, C_I ≈1 nF V_{ILmax} = 0.5 V at Imax = -20 µA $V_{Openmax}$ = 2.3 V ON ¯¯|____|¯¯ Active Low ≥100 ms
67	GSM_CCGND	-	<u>SIM interface</u>	0 V (Ground)
68	GSM_CCIN	I	GSM_CCIN = high, SIM card holder closed (no card recognition) Maximum cable length 200 mm to SIM card holder. All signals of SIM interface are protected against ESD	R_I ≈ 100 kΩ V_{IL}max = 0.5 V V_{IH}min = 2.15 V at I = 20 µA, V_{IH}max = 3.3 V at I = 30 µA
69	GSM_CCRST	O		R_O ≈ 47 Ω V_{OL}max = 0.25 V at I = 1 mA V_{OH}min = 2.3 V at I = -1 mA V_{OH}max = 2.73 V

70	GSM_CCDATA	I/O	with a special diode array. Usage of GSM_CCGND is mandatory.	R_I ≈ 10 kΩ $V_{IL}max$ = 0.5 V $V_{IH}min$ = 1.95 V, $V_{IH}max$ = 3.3 V R_O ≈ 220 Ω $V_{OL}max$ = 0.4 V at I = 1 mA $V_{OH}min$ = 2.15 V at I = -1 mA $V_{OH}min$ = 2.55 V at I = -20 µA $V_{OH}max$ = 2.96 V
71	GSM_CCCLK	O		R_O ≈ 220 Ω $V_{OL}max$ = 0.4 V at I = 1 mA $V_{OH}min$ = 2.15 V at I = -1 mA $V_{OH}max$ = 2.73 V
72	GSM_CCVCC	O		$R_O max$ = 5 Ω GSM_CCVCCmin = 2.84 V, GSM_CCVCCmax = 2.96 V Imax = -20 mA
73	GSM_MICN1	I(-)	Balanced microphone input. To be decoupled with 2 capacitors (CK = 100 nF), if connected to a microphone or another device. If not used leave both pins open.	R_I ≈ 50k Ω differential $V_I max$ = 1.03 Vpp See also Table 30.
74	GSM_MICP1	I(+)		
75	GSM_MICP2	I(+)	Balanced microphone input. Can be used to directly feed an active microphone. If used for another signal source, e.g. op amp, to be decoupled with capacitors. If not used leave both pins open.	R_I = 2 kΩ differential $V_I max$ = 1.03 Vpp See also Table 30.
76	GSM_MICN2	I(-)		
77	GSM_EPN1	O(-)	Analog audio interfaces. Balanced audio output. Can be used to directly operate an earpiece. If not used leave both pins open.	$V_O max$ = 3.7 Vpp See also Table 29.
78	GSM_EPP1	O(+)		
79	GSM_EPP2	O(+)	Analog audio interfaces. The audio output is balanced and can directly operate an earpiece. If not used leave both pins open.	$V_O max$ = 3.7 Vpp See also Table 29.
80	GSM_EPN2	O(-)		

Table 4: Pin description of 80-pin board-to-board connector (primary application interface)

CMOS 3.3 V level:
Input High = 2.0 - 3.3 V DC; I_leakage = 2 µA
Input Low = 0 - 0.8 V DC, I_leakage = 2 µA
Output High = min. 2.4 V DC, Ioh = 2 mA
Output Low = max 0.4 V DC, Ioh = 2 mA

4.3 Description of the 50-pin double-row connector

The Hirose DF12C board-to-board connector on XF55-AVL is a 50-pin double-row receptacle. The names and the positions of the pins can be seen from figure 5 below which shows the top view of XF55-AVL.

Please note that, both interfaces (80- and 50-pin connectors) could not concurrently be used. The second application interface (ASC1) included on this interface is not provided on the 80-pin connector. So, it is always usable for controlling the GSM/GPRS applications. In order to use it connect corresponded lines to the host interface.

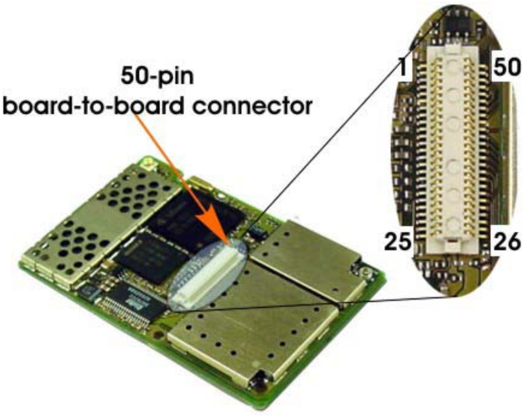


Figure 5: Pin assignment (top view on XF55-AVL)

PIN	NAME	I/O	DISCRIPTION	LEVEL
1	**GSM_CCCLK**	**O**	**SIM interface** **GSM_CCIN = high, SIM card holder closed (no card recognition) Maximum cable length 200 mm to SIM card holder.** **All signals of SIM interface are protected against ESD with a special diode array.** **Usage of GSM_CCGND is mandatory.**	**$R_O \approx 220\ \Omega$** **$V_{OL}max = 0.4$ V at I = 1 mA** **$V_{OH}min = 2.15$ V at I = -1 mA** **$V_{OH}max = 2.73$ V**
2	**GSM_CCVCC**	**O**		**$R_O max = 5\ \Omega$** **GSM_CCVCCmin = 2.84 V,** **GSM_CCVCCmax = 2.96 V** **Imax = -20 mA**
3	**GSM_CCDATA**	**I/O**		**$R_I \approx 10$ kΩ** **$V_{IL}max = 0.5$ V** **$V_{IH}min = 1.95$ V, $V_{IH}max$=3.3 V** **$R_O \approx 220\ \Omega$** **$V_{OL}max = 0.4$ V at I = 1 mA** **$V_{OH}min = 2.15$ V at I = -1 mA** **$V_{OH}min = 2.55$ V at I = -20 µA** **$V_{OH}max = 2.96$ V**
4	**GSM_CCRST**	**O**		**$R_O \approx 47\ \Omega$** **$V_{OL}max = 0.25$ V at I = 1 mA** **$V_{OH}min = 2.3$ V at I = -1 mA** **$V_{OH}max = 2.73$ V**
5	**GSM_CCIN**	**I**		**$R_I \approx 100$ kΩ** **$V_{IL}max = 0.5$ V** **$V_{IH}min = 2.15$ V at I = 20 µA,** **$V_{IH}max = 3.3$ V at I = 30 µA**
6	**GSM_CCGND**			**0 V (Ground)**
7	**GSM_RXDDAI**	**I**	**Digital audio interface** **If unused keep all pins open.**	**$V_{OL}max = 0.2$ V at I = 1 mA** **$V_{OH}min = 2.35$ V at I = -1 mA** **$V_{OH}max = 2.73$ V** **$V_{IL}max = 0.5$ V** **$V_{IH}min = 1.95$ V, $V_{IH}max$=3.3 V** **$I_I max = 330$ µA at $V_{IN} = 3.3$ V**
8	**GSM_TFSDAI**	**O**		
9	**GSM_SCLK**	**I**		
10	**GSM_TXDDAI**	**O**		
11	**GSM_RFSDAI**	**I**		
12	**GSM_BATT_ TEMP**	**I**	**Input to measure the battery temperature over NTC resistor. NTC should be installed inside or near battery pack to enable the**	**Connect NTC with $R_{NTC} \approx 10$ kΩ @ 25 °C to ground.**

			charging algorithm and deliver temperature values. If not used leave it open.	
13	GSM_SYNC	O	Indicates increased current consumption during uplink transmission burst. Note that timing is different during handover. Alternatively used to control status LED (see chapter 4.11.2.2). If not used leave it open.	$V_{OL}max$ = 0.2 V at I = 1 mA $V_{OH}min$ = 2.35 V at I = -1 mA $V_{OH}max$ = 2.73 V 1 Tx, 877 µs impulse each 4.616 ms and 2 Tx, 1454 µs impulse each 4.616 ms, with 300 µs forward time.
15	GSM_RXDO	O	First serial interface (ASC0) for AT commands or data stream. To avoid floating if output pins are high-impedance, use pull-up resistors tied to GSM_VDD or pull-down resistors tied to GND. See chapter 4.3.2.2. If not used leave it open.	$V_{OL}max$ = 0.2 V at I = 1 mA $V_{OH}min$ = 2.35 V at I = -1 mA $V_{OH}max$ = 2.73 V $V_{IL}max$ = 0.5 V $V_{IH}min$ = 1.95 V, $V_{IH}max$ = 3.3 V GSM_DTR0, GSM_RTS0: Imax = -90µA at V_{IN} = 0 V GSM_TXD0: Imax = -30 µA at V_{IN} = 0 V
17	GSM_TXDO	I		
59	GSM_DSRO	O		
32	GSM_RINGO	O		
34	GSM_RTSO	I		
35	GSM_DTRO	I		
37	GSM_CTSO	O		
39	GSM_DCDO	O		
14	GSM_RXD1	O	Second serial interface for AT commands. To avoid floating if output pins are high-impedance, use pull-up resistors tied to GSM_VDD or pull-down resistors tied to GND. See chapter 4.3.2.2. If not used leave it open.	$V_{OL}max$ = 0.2 V at I = 1 mA $V_{OH}min$ = 2.35 V at I = -1 mA $V_{OH}max$ = 2.73 V $V_{IL}max$ = 0.5 V $V_{IH}min$ = 1.95 V, $V_{IH}max$ = 3.3 V Imax = -90 µA at V_{IN} = 0 V
16	GSM_TXD1	I		
36	GSM_RTS1	I		
38	GSM_CTS1	O		
18	GSM_VDDLP	I/O	Supplies the RTC with power via an external capacitor or buffer battery if no VBATT+ is applied. If not used leave it open.	R_I = 1 kΩ $V_O max$ = 4.0 V (output) $V_I min$ = 2.2V, $V_I max$ = 5.5 V (input) $I_I typ$ = 10 µA at BATT+ = 0 V Mobile in POWER DOWN mode: $V_I min$ = 1.2 V
19	GSM_POWER	I	This line signals to the processor that the charger is connected. If not used leave it open	$V_I min$ = 3.0 V $V_I max$ = 15 V
20	GSM_CHARGE	O	This line is a current source for the charge FET with a 10 kΩ resistance between gate and source. If not used leave it open.	$I_{GSM\ CHARGE}$ = -300 µA ... –600 µA @ 3V < $V_{GSM\ CHARGE}$ < V_{LOAD}
21	GSM_GND	-	Negative operating voltage (grounds).	0 V
22	GSM_GND			
23	GSM_GND			
24	GSM_GND			
25	GSM_GND			
42	GSM_GND			
26	GSM_VBATT	I	Power supply input. 5 BATT+ pins to be connected in parallel. 5 GND pins to be connected in parallel.	V_I = 3.3 V to 4.8 V $V_I norm$ = 4.1V Imax < 2 A (during Tx burst) 1 x Tx, peak current 577 µs every 4.616 ms
27	GSM_VBATT			

28	**GSM_VBATT**		**able to meet the requirements of current consumption in a Tx burst (up to 3 A). Sending with two timeslots doubles the duration of current pulses to 1154 µs (every 4.616 ms)!**	**2 x Tx, peak current 1154 µs every 4.616 ms**
29	**GSM_VBATT**			
30	**GSM_VBATT**			
31	**GSM_VDD**	**O**	**Supply voltage, e.g. for an external LED or level shifter. The external digital logic must not cause any spikes or glitches on voltage VDD. Not available in POWER DOWN mode. VDD signalizes the "ON" state of the module. If unused VDD keep pin open.**	**V_{DD}min = 2.84 V, V_{DD}max = 2.96 V Imax = -10 mA $C_L$max = 1 µF**
40	**GSM_EMERG OFF**	**I**	**This line must be driven by an Open Drain or Open Collector driver. Emergency shutdown deactivates the power supply to the module. The module can be reset if /IGT is activated after emergency shutdown. To switch the mobile off use the AT^SMSO command. To avoid floating if pin is high impedance, use pull-down resistor tied to GND. See chapter 4.3.3.1. /EMERGOFF also indicates the internal watchdog function. If not used leave it open.**	**R_I = 22 kΩ V_{IL}max = 0.5 V at Imax = -100 µA Vopenmax = 2.73 V Signal ¯¯¯|_______|¯¯¯ Active Low ≥ 3.2 s Watchdog: V_{OL}max = 0.35 V at I = 10 µA V_{OH}min = 2.25 V at I = -10 µA fomin = 0.16 Hz fomax = 1.55 Hz**
41	**GSM_IGT**	**I**	**Input to switch the mobile ON. The line must be driven low by an Open Drain or Open Collector driver.**	**R_I ≈ 100 kΩ, C_I ≈ 1 nF V_{ILmax} = 0.5 V at Imax = -20 µA $V_{Openmax}$ = 2.3 V ON ¯¯¯|_____|¯¯¯ Active Low ≥ 100ms**
43	**GSM_MICN1**	**I(-)**	**Balanced microphone input. To be decoupled with 2 capacitors (CK = 100 nF), if connected to a microphone or another device. If not used leave both pins open.**	**R_I ≈ 50 kΩ differential $V_I$max = 1.03 Vpp See also Table 30.**
44	**GSM_MICP1**	**I(+)**		
45	**GSM_MICP2**	**I(+)**	**Balanced microphone input. Can be used to directly feed an active microphone. If used for another signal source, e.g. op amp, to be decoupled with capacitors. If not used leave both pins open.**	**R_I = 2 kΩ differential $V_I$max = 1.03 Vpp See also Table 30.**
46	**GSM_MICN2**	**I(-)**		

47	GSM_EPN1	O(-)	**Analog audio interfaces Balanced audio output. Can be used to directly operate an earpiece. If not used leave both pins open.**	**Vomax = 3.7 Vpp See also Table 29.**
48	GSM_EPP1	O(+)		
49	GSM_EPP2	O(+)	**Analog audio interfaces. The audio output is balanced and can directly operate an earpiece. If not used leave both pins open.**	**Vomax = 3.7 Vpp See also Table 29.**
50	GSM_EPN2	O(-)		

Table 5: Pin description of 50-pin board-to-board connector (second application interface)

4.3.1 Special pin description

4.3.1.1 Power supply

The power supply for the GSM/GPRS part of the XF55-AVL module has to be a single voltage source of V_{GSM_BATT+} = 3.3 V...4.8 V. It must be able to provide sufficient current in a transmit burst which typically rises to 1.6 A.
All the key functions for supplying power to the device are handled by an ASIC power supply. The ASIC provides the following features:

- Stabilizes the supply voltages for the GSM base band using low drop linear voltage regulators.
- Controls the module's power up and power down procedures.
- A watchdog logic implemented in the base band processor periodically sends signals to the ASIC, allowing it to maintain the supply voltage for all digital XF55-AVL components. Whenever the watchdog pulses fail to arrive constantly, the module is turned off.
- Delivers, across the GSM_VDD pin, a regulated voltage of 2.9 V. The output voltage GSM_VDD may be used to supply, for example, an external LED or a level shifter. However, the external circuitry must not cause any spikes or glitches on voltage GSM_VDD. This voltage is not available in POWER DOWN mode. Therefore, the GSM_VDD pin can be used to indicate whether or not GSM/GPRS part of the XF55-AVL module is in POWER DOWN mode.
- Provides power to the SIM interface.

The RF power amplifier is driven directly from GSM_BATT+.

4.3.1.2 Power supply pins (41…50, 53, and 54) on the board-to-board connectors

Five GSM_BATT+ pins of the board-to-board connector are dedicated to connect the supply voltage, five GND pins are recommended for grounding.
The values stated below must be measured directly at the reference points on the XF55-AVL board (TP GSM_BATT+ and TP GND illustrated in **Figure 43**).
The GSM_POWER and GSM_CHARGE pins serve as control signals for charging a Li-Ion battery. GSM_VDDLP can be used to back up the RTC.

Signal name	I/O	Parameter	Description
GSM_BATT+	I/O	3.3 V...4.8 V, $I_{typ} \leq$ 1.6 A during transmit burst. The minimum	Positive operating voltage Reference

		operating voltage must not fall below 3.3 V, not even in case of voltage drop.	points are the test points.
GND	-	0 V	Ground
GSM_POWER	I		This line signals to the processor that the charger is connected
GSM_CHARGE	O		Control signal for external charging transistor
GSM_VDDLP	I/O	$U_{OUT,max} < V_{GSM\ BATT+}$ U_{IN} = 2.0 V...5.5 V Ri = 1 kΩ Iin,max = 30 µA	Can be used to back up the RTC when $V_{GSM\ BATT+}$ is not applied. See chapter 4.8

Table 6: Pin description of 50-pin board-to-board connector (secondary application interface)

4.3.1.3 Minimizing power losses

When designing the power supply for your application please pay specific attention to power losses. Ensure that the input voltage V_{GSM_BATT+} never drops below 3.3 V on the GSM/GPRS part of the XF55-AVL board, not even in a transmit burst where current consumption can rise to typical peaks of 1.6 A. It should be noted that the GSM/GPRS part of the XF55-AVL module switches off when exceeding these limits. Any voltage drops that may occur in a transmit burst should not exceed 400 mV. For further details see **Table 2**. The best approach to reducing voltage drops is to use a board-to-board connection as recommended, and a low impedance power source. The resistance of the power supply lines on the host board and of a battery pack should also be considered.

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

Example: If the length of the cable reaches the maximum length of 200 mm, this connection may cause, for example, a resistance of 50 mΩ in the GSM_BATT+ line and 50 mΩ in the GND line. As a result, a 1.6 A transmit burst would add up to a total voltage drop of 160mV. Plus, if a battery packs is involved, further losses may occur due to the resistance across the battery lines and the internal resistance of the battery including its protective circuit.

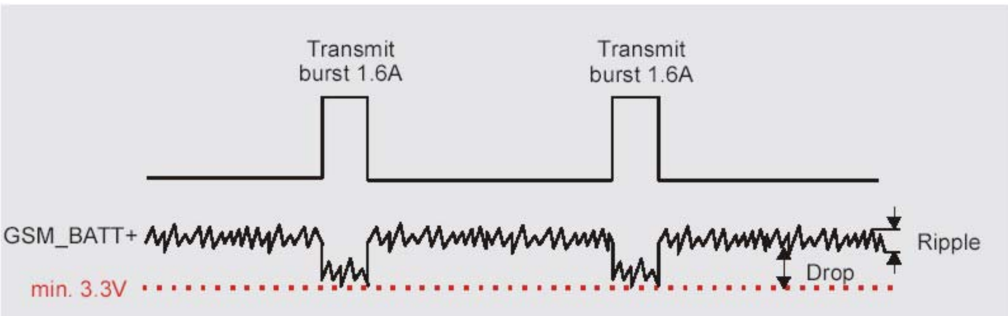


Figure 6: Power supply limits during transmit burst

The input voltage V_{GSM_BATT+} must be measured directly at the test points on the XF55-AVL board (TP GSM_BATT+ and TP GND illustrated in **Figure 43**).

4.3.1.4 Monitoring power supply

To help you monitor the supply voltage you can use the `AT^SBV` command which returns the voltage measured at TP GSM_BATT+ and GND.
The voltage is continuously measured at intervals depending on the operating mode on the RF interface. The duration of measuring ranges from 0.5 s in TALK/DATA mode up to 50 s when the GSM/GPRS part of the XF55-AVL is in IDLE mode or Limited Service (deregistered).
The displayed voltage (in mV) is averaged over the last measuring period before the `AT^SBV` command was executed. For details please refer to [4].

4.3.2 Power up/down scenarios

In general, be sure not to turn on GSM/GPRS part of the XF55-AVL module while it is out of the operating range of voltage and temperature stated in chapters 4.2, 4.3 and 7.2. The GSM/GPRS part of the XF55-AVL would immediately switch off after having started and detected these inappropriate conditions.

4.3.2.1 Turn on the GSM/GPRS part of XF55-AVL

The GSM/GPRS part of the XF55-AVL can be activated in a variety of ways, which are described in the following chapters:

- via ignition line GSM_IGT: starts normal operating state (see chapters 4.3.2.2 and 4.3.2.3)
- via GSM_POWER line: starts charging algorithm (see chapters 4.5.4 and 4.3.2.4)
- via RTC interrupt: starts Alarm mode (see chapter 4.3.2.5)

4.3.2.2 Turn on the GSM/GPRS part of XF55-AVL using the ignition line GSM_IGT (Power on)

To switch on the XF55-AVL GSM/GPRS part the GSM_IGT (Ignition) signal needs to be driven to ground level for at least 100 ms and not earlier than 10 ms after the last falling edge of GSM_VDD. This can be accomplished using an open drain/collector driver in order to avoid current flowing into this pin.

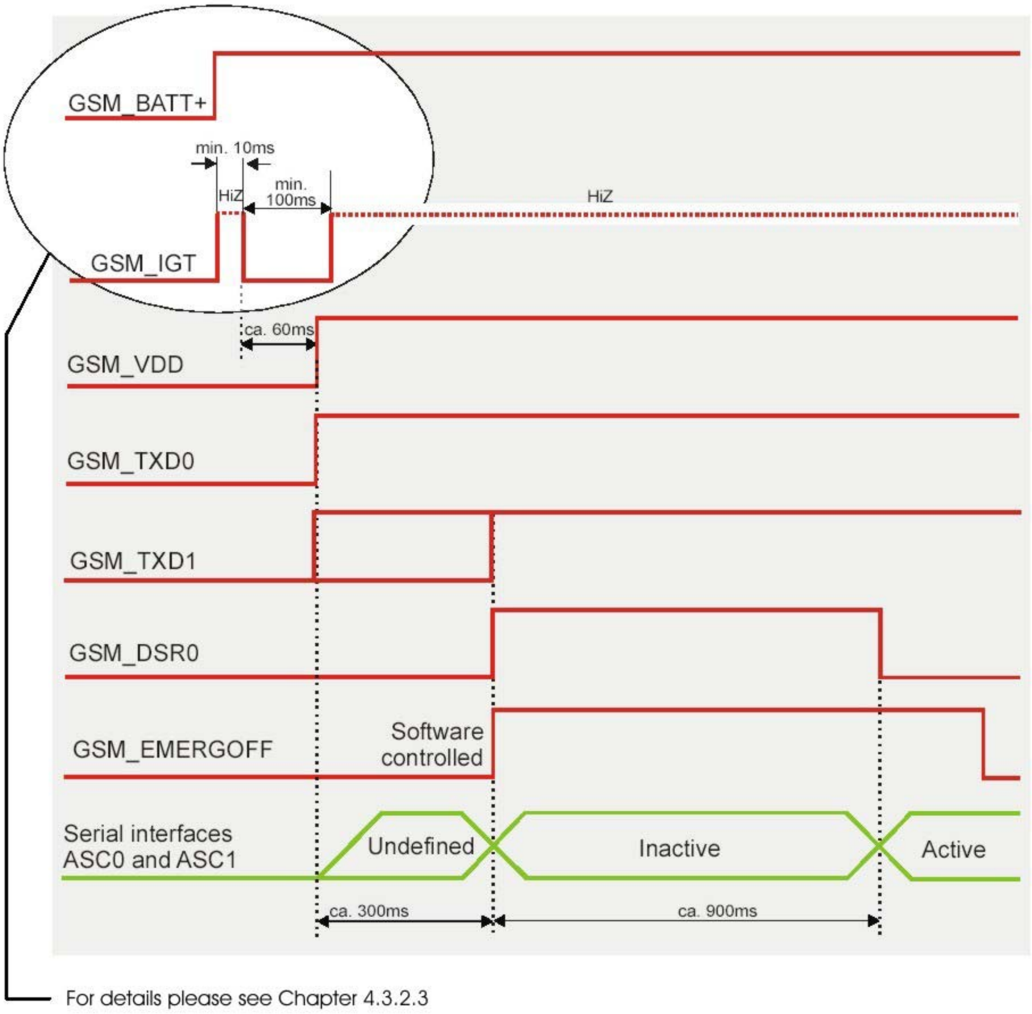


Figure 7: Power-on by ignition signal

If the module is configured to a fix baud rate, the GSM/GPRS part of the XF55-AVL will send the result code ^SYSSTART to indicate that it is ready to operate. This result code does not appear when autobauding is active. See chapter `AT+IPR` in [4].

In a battery operated XF55-AVL application, the duration of the GSM_IGT signal must be 1 s minimum when the charger is connected and you may want to go from Charge only mode to Normal mode. For details please see the next chapter.

4.3.2.3 Timing of the ignition process

When designing your application platform take into account that powering up the GSM/GPRS part of the XF55-AVL module requires the following steps.

- The ignition line cannot be operated until V_{GSM_BATT+} passes the level of 3.0 V.
- The ignition line shall not be operated earlier than 10 ms after the last falling edge of GSM_VDD.
- 10 ms after V_{GSM_BATT+} has reached 3.0 V the ignition line can be switched low. The duration of the falling edge must not exceed 1 ms.
- Another 100 ms are required to power up the module.
- Ensure that V_{GSM_BATT+} does not fall below 3.0 V while the ignition line is driven. Otherwise the module cannot be activated.

❖ If the GSM_VDDLP line is fed from an external power supply as explained in chapter 4.8, the GSM_IGT line is HiZ before the rising edge of GSM_BATT+.

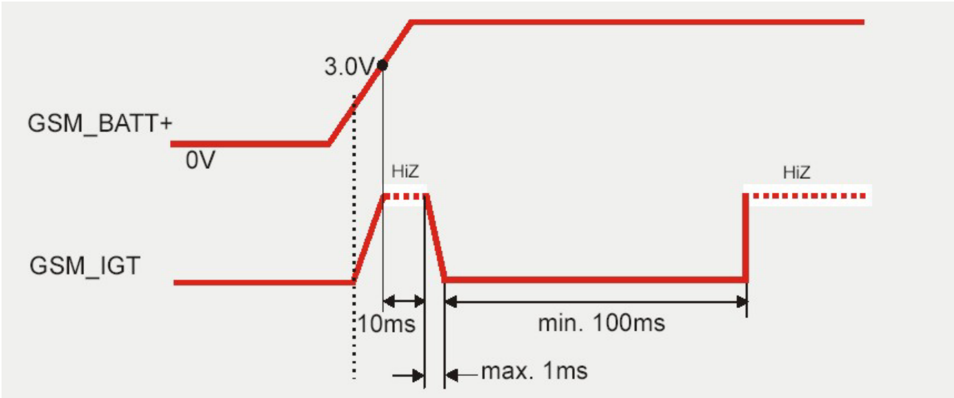


Figure 8: Timing of power-on process if GSM_VDDLP is not used

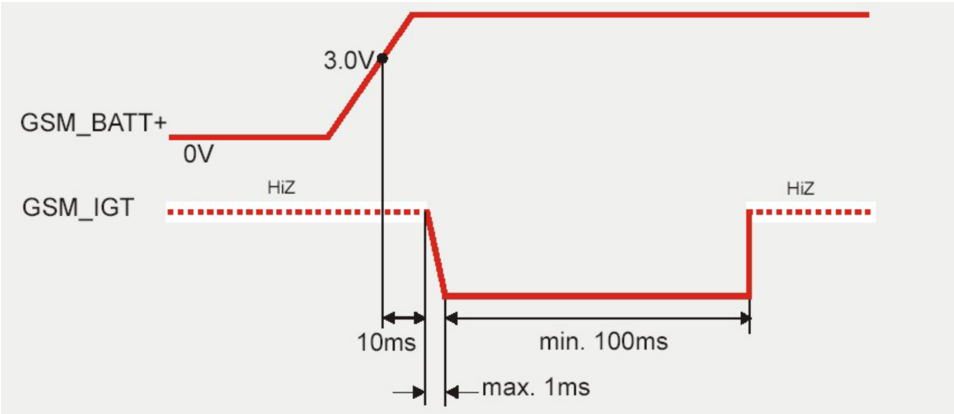


Figure 9: Timing of power-on process if GSM_VDDLP is fed from external source

4.3.2.4 Turn on the GSM/GPRS part of XF55-AVL using the GSM_POWER signal

As detailed in chapter 4.5.4, the charging adapter can be connected regardless of the module's operating mode (except for Alarm mode).
If the charger is connected to the charger input of the external charging circuit and the module's GSM_POWER pin while XF55-AVL is off, processor controlled fast charging starts (see chapter 4.5.3). The GSM/GPRS part of XF55-AVL enters a restricted mode, referred to as Charge-only mode where only the charging algorithm will be launched. During the Charge-only mode XF55-AVL is neither logged on to the GSM network nor are the serial interfaces fully accessible. To switch to normal operation and log on to the GSM network, the GSM_IGT line needs to be activated.

4.3.2.5 Turn on the GSM/GPRS part of XF55-AVL using the RTC (Alarm mode)

Another power-on approach is to use the RTC, which is constantly supplied with power from a separate voltage regulator in the power supply ASIC. The RTC provides an alert function, which allows the GSM/GPRS part of the XF55-AVL to wake up whilst the internal voltage regulators are off. To prevent the engine from unintentionally logging into the GSM network, this procedure only enables restricted operation, referred to as Alarm mode. It must

not be confused with a wake-up or alarm call that can be activated by using the same AT command, but without switching off power.
Use the AT+CALA command to set the alarm time. The RTC retains the alarm time if the GSM/GPRS part of XF55-AVL was powered down by AT^SMSO. Once the alarm is timed out and executed, XF55-AVL enters the Alarm mode. This is indicated by an Unsolicited Result Code (URC) which reads:

^SYSSTART ALARM MODE

Note that this URC is the only indication of the Alarm mode and will not appear when autobauding was activated (due to the missing synchronization between DTE and DCE upon start-up). Therefore, it is recommended to select a fixed baud rate before using the Alarm mode. In Alarm mode only a limited number of AT commands is available. For further instructions refer to the AT Command Set.

AT command	Function
AT+CALA	Set alarm time
AT+CCLK	Set date and time of RTC
AT^SBC	In Alarm mode, you can only query the present current consumption and check whether or not a charger is connected. The battery capacity is returned as 0, regardless of the actual voltage (since the values measured directly on the cell are not delivered to the module).
AT^SCTM	Query temperature range, enable/disable URCs to report critical temperature ranges
AT^SMSO	Power down GSM engine

Table 7: AT commands available in Alarm mode

For the GSM engine to change from the Alarm mode to full operation (normal operating mode) it is necessary to drive the ignition line to ground. This must be implemented in your host application as described in chapter 4.3.2.2.
If the charger is connected to the GSM_POWER line when GSM/GPRS part of the XF55-AVL is in ALARM mode charging will start, while XF55-AVL stays in ALARM mode. See also chapter 4.7 which summarizes the various options of changing the mode of operation.
If your host application uses the GSM_SYNC pin to control a status LED as described in chapter 4.11.2.2, please note that the LED is off while the GSM engine is in Alarm mode.

4.3.3 Turn off the GSM/GPRS part of XF55-AVL

To switch the module off the following procedures may be used:

- *Normal shutdown procedure*: Software controlled by sending the AT^SMSO command over the serial application interface. See chapter 4.3.3.1.
- *Emergency shutdown*: Hardware driven by switching the GSM_EMERGOFF line of the board-to-board-connector to ground = immediate shutdown of supply voltages, only applicable if the software controlled procedure fails! See chapter 4.3.4.3.
- *Automatic shutdown*: See chapter 4.3.4
  - a) Takes effect if under voltage is detected.
  - b) Takes effect if XF55-AVL board temperature exceeds critical limit.

4.3.3.1 Turn off GSM/GPRS part of the XF55-AVL module using AT command

The best and safest approach to powering down the XF55-AVL GSM/GPRS part is to issue the `AT^SMSO` command. This procedure lets GSM engine log off from the network and allows the software to enter into a secure state and safe data before disconnecting the power supply. The mode is referred to as POWER DOWN mode. In this mode, only the RTC stays active.
Before switching off the device sends the following response:

```
^SMSO: MS OFF

OK
^SHUTDOWN
```

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

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

Be sure not to disconnect the operating voltage V_{GSM_BATT+} before the URC "SHUTDOWN" has been issued and the GSM_VDD signal has gone low. Otherwise you run the risk of losing data.
While the GSM engine is in POWER DOWN mode the application interface is switched off and must not be fed from any other source. Therefore, your application must be designed to avoid any current flow into any digital pins of the application interface.

Note: In POWER DOWN mode, the GSM_EMERGOFF pin, the output pins of the ASC0 interface GSM_RXD0, GSM_CTS0, GSM_DCD0, GSM_DSR0, GSM_RING0 and the output pins of the ASC1 interface GSM_RXD1 and GSM_CTS1 are switched to high impedance state.
If this causes the associated input pins of your application to float, you are advised to integrate an additional resistor (100 kΩ, 1 MΩ) at each line. In the case of the GSM_EMERGOFF pin use a pull-down resistor tied to GND. In the case of the serial interface pins you can either connect pull-up resistors to the GSM_VDD line, or pull down resistors to GND.

4.3.3.2 Maximum number of turn-on/turn-off cycles

Each time the module is shut down, data will be written from volatile memory to flash memory. The guaranteed maximum number of write cycles is limited to 100.000.

4.3.3.3 Emergency shutdown using GSM_EMERGOFF pin

!!!Caution: *Use the GSM_EMERGOFF pin only when, due to serious problems, the software is not responding for more than 5 seconds. Pulling the GSM_EMERGOFF pin causes the loss of all information stored in the volatile memory since power is cut off immediately. Therefore, this procedure is intended only for use in case of emergency, e.g. if XF55-AVL fails to shut down properly.*

The GSM_EMERGOFF signal is available on the board-to-board connectors. To control the GSM_EMERGOFF line it is recommended to use an open drain/collector driver. To turn the GSM engine off, the GSM_EMERGOFF line has to be driven to ground for ≥ 3.2 s.

4.3.3.3.1 How does it work?

a) Voltage V_{GSM_BATT+} is permanently applied to the module.
b) The module is active while the internal reset signal is kept at high level. During operation of XF55-AVL the base band controller generates watchdog pulses at regular intervals. Once the GSM_EMERGOFF pin is grounded these watchdog pulses are cut off from the power supply ASIC. The power supply ASIC shuts down the internal supply voltages of XF55-AVL after max. 3.2 s and the module turns off. Consequently, the output voltage at GSM_VDD is switched off.

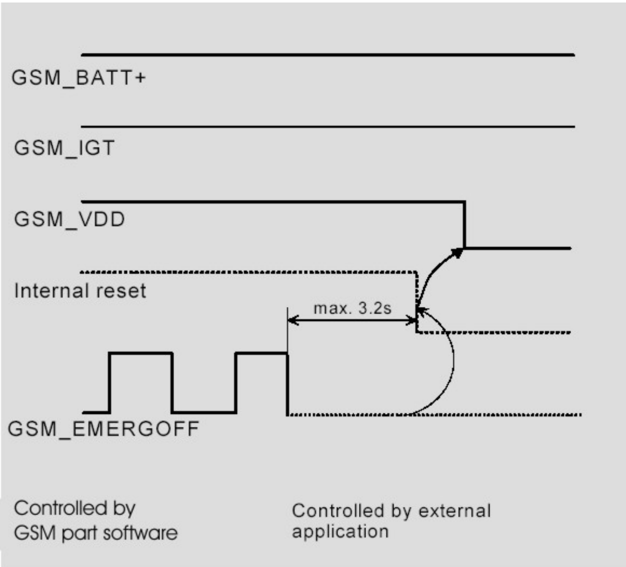


Figure 10: Deactivating GSM engine by GSM_EMERGOFF signal

4.3.4 Automatic shutdown

Automatic shutdown takes effect if

- ❖ the XF55-AVL board is exceeding the critical limits of over temperature or under temperature.
- ❖ the battery is exceeding the critical limits of over temperature or under temperature.
- ❖ under voltage is detected.

The automatic shutdown procedure is equivalent to the power-down initiated with the `AT^SMSO` command, i.e. XF55-AVL logs off from the network and the software enters a secure state avoiding loss of data.

NOTE: This does not apply if over voltage conditions or unrecoverable hardware or software errors occur (see below for details).

Alert messages transmitted before the device switches off are implemented as Unsolicited Result Codes (URCs). The presentation of these URCs can be enabled or disabled with the two AT commands `AT^SBC` and `AT^SCTM`. The URC presentation mode varies with the condition, please see chapters 4.3.4.1 to 4.3.4.3 for details. For further instructions on AT commands refer to [4].

4.3.4.1 Temperature dependent shutdown

The board temperature is constantly monitored by an internal NTC resistor located on the PCB. The NTC that detects the battery temperature must be part of the battery pack circuit as described in chapter 4.5. The values detected by either NTC resistor are measured directly on the board or the battery and therefore, are not fully identical with the ambient temperature.
Each time the board or battery temperature goes out of range or back to normal, XF55-AVL instantly displays an alert (if enabled).

- URCs indicating the level "1" or "-1" allow the user to take appropriate precautions, such as protecting the module from exposure to extreme conditions. The presentation of the URCs depends on the settings selected with the `AT^SCTM` write command:

`AT^SCTM=1`:	Presentation of URCs is always enabled.
`AT^SCTM=0` (default):	Presentation of URCs is enabled for 15 seconds time after start-up of C55. After 15 seconds operation, the presentation will be disabled, i.e. no alert messages can be generated.

- URCs indicating the level "2" or "-2" are instantly followed by an orderly shutdown. The presentation of these URCs is always enabled, i.e. they will be output even though the factory setting `AT^SCTM=0` was never changed.

The maximum temperature ratings are stated in chapter 7.2. Refer to tables 8 and 9 below for the associated URCs. All statements are based on test conditions according to IEC 60068-2-2 (still air).
Sending temperature alert (15 s after start-up, otherwise only if URC presentation enabled).

^SCTM_A: 1	Caution: T_{amb} of battery close to over temperature limit.
^SCTM_B: 1	Caution: T_{amb} of board close to over temperature limit.
^SCTM_A: -1	Caution: T_{amb} of battery close to under temperature limit.
^SCTM_B: -1	Caution: T_{amb} of board close to under temperature limit.
^SCTM_A: 0	Battery back to uncritical temperature range.
^SCTM_B: 0	Board back to uncritical temperature range.

Table 8: Temperature dependent behaviour

Automatic shutdown (URC appears no matter whether or not presentation was enabled).

^SCTM_A: 2	Alert: T_{amb} of battery equal or beyond over temperature limit. XF55-AVL switches off.
^SCTM_B: 2	Alert: T_{amb} of board equal or beyond over temperature limit. XF55-AVL switches off.
^SCTM_A: -2	Alert: T_{amb} of battery equal or below under temperature limit. XF55-AVL switches off.

	AVL switches off.
^SCTM_B: -2	Alert: T_{amb} of board equal or below under temperature limit. XF55-AVL switches off.

Table 9: Automatic shutdown

4.3.4.2 Temperature control during emergency call

If the temperature limit is exceeded while an emergency call is in progress the engine continues to measure the temperature, but deactivates the shutdown functionality. If the temperature is still out of range when the call ends, the module switches off immediately (without another alert message).

4.3.4.3 Under voltage shutdown if battery NTC is present

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

^SBC: Under voltage.

The message will be reported, for example, when you attempt to make a call while the voltage is close to the critical limit and further power loss is caused during the transmit burst. To remind you that the battery needs to be charged soon, the URC appears several times before the module switches off. To enable or disable the URC use the `AT^SBC` command. The URC will be enabled when you enter the write command and specify the power consumption of your GSM application. Step by step instructions are provided in [4].

4.3.4.4 Under voltage shutdown if no battery NTC is present

The under voltage protection is also effective in applications, where no NTC connects to the BATT_TEMP terminal. Thus, you can take advantage of this feature even though the application handles the charging process or XF55-AVL is fed by a fixed supply voltage. All you need to do is executing the write command `AT^SBC=<current>` which automatically enables the presentation of URCs. You do not need to specify <current>.

Whenever the supply voltage falls below the specified value (see **Table 2**) the URC

^SBC: Under voltage

appears several times before the module switches off.

4.3.4.5 Over voltage shutdown

For over voltage conditions, no software controlled shutdown is implemented. If the supply voltage exceeds the maximum value specified in **Table 2**, loss of data and even unrecoverable hardware damage can occur.

Keep in mind that several XF55-AVL components are directly linked to GSM_VBATT+ and, therefore, the supply voltage remains applied at major parts of XF55-AVL. Especially the power amplifier is very sensitive to high voltage and might even be destroyed.

4.4 Automatic GPRS Multislot Class change

Temperature control is also effective for operation in GPRS Multislot class 10. If the board temperature increases to the limit specified for restricted operation (*see 7.2 for temperature limits known as restricted operating*) while data are transmitted over GPRS, the module automatically reverts from GPRS Multislot class 10 (3 RX x 2 TX) to class 8 (4 RX x 1 TX). This reduces the power consumption and, consequently, causes the temperature of board to decrease. Once the temperature drops to a value of 5 degrees below the limit of restricted operation, XF55-AVL returns to the higher Multislot class. If the temperature stays at the critical level or even continues to rise, XF55-AVL will not switch back to the higher class. After a transition from Multislot class 10 to Multislot class 8 a possible switchback to Multislot class 10 is blocked for one minute. Please note that there is not one single cause of switching over to a lower GPRS Multislot class. Rather it is the result of an interaction of several factors, such as the board temperature that depends largely on the ambient temperature, the operating mode and the transmit power. Furthermore, take into account that there is a delay until the network proceeds to a lower or, accordingly, higher Multislot class. The delay time is network dependent. In extreme cases, if it takes too much time for the network and the temperature cannot drop due to this delay, the module may even switch off as described in chapter 4.3.4.1.

4.5 GSM charging control

The GSM/GPRS part of the XF55-AVL module integrates a charging management for Li-Ion batteries. You can skip this chapter if charging is not your concern, or if you are not using the implemented charging algorithm.
XF55-AVL has no on-board charging circuit. To benefit from the implemented charging management you are required to install a charging circuit within your application. In this case, XF55-AVL needs to be powered from a Li-Ion battery pack, e.g. as specified in chapter 4.5.2.

Note: *The charging control described in this chapter is optimized for the GSM/GPRS part of XF55-AVL only and does not cover the GPS part. To include the GPS part you need to change components illustrated in figure 11 below , especially those of the trickle charging path (470R, 4V3, 1SS355).*

The module only delivers, via its POWER line and CHARGE line, the control signals needed to start and stop the charging process. The charging circuit should include a transistor and should be designed as illustrated in figure 11. A list of parts recommended for the external circuit is given in table 10 below.

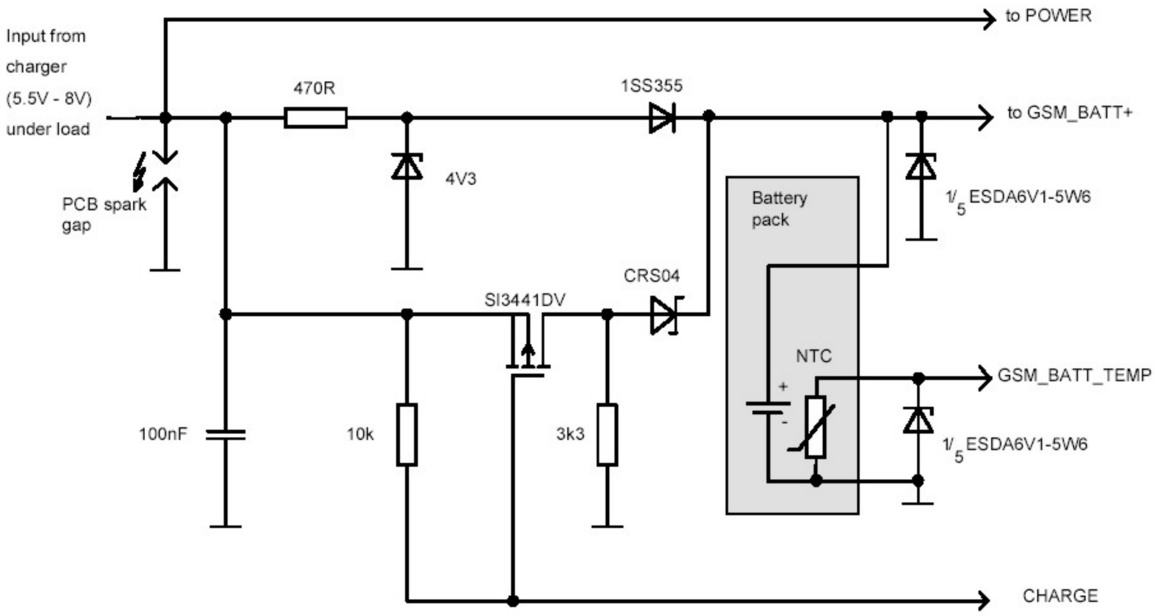


Figure 11: Schematic of approved charging transistor, trickle charging and ESD protection

Part	Description	First supplier	Second supplier
SI3441DV	p-chan 2.5 V (G-S) MOSFET (TSOP-6)	VISHAY: SI3441DV-T1	NEC: UPA1911TE-T1
1SS355	100 mA Si-diode (UMD2)	ROHM: 1SS355TE-18	Toshiba: 1SS352TPH3
CRS04	1 A Schottky diode	Toshiba: CRS04	--
4V3	250 mW; 200 mA; 4.3 V Z-Diode (SOD323)	Philips: PDZ4.3B	ROHM: UDZS4.3B UDZ4.3B
ESDA6V1-5W6	ESD protection TRANSIL. array	STM: ESDA6V1-5W6	--
470R, 3k3, 10k	Resistor, e.g. 0805 or 0603	--	--
100nF	Ceramic capacitor 50 V	--	--
PCB spark gap	0.2 mm spark gap on PCB	--	--

Table 10: A list of parts recommended for the external circuit

4.5.1 Battery pack characteristics

The charging algorithm has been optimized for a Li-Ion battery pack that meets the characteristics listed below. It is recommended that the battery pack you want to integrate into your XF55-AVL application is compliant with these specifications. This ensures reliable operation, proper charging and, particularly, allows you to monitor the battery capacity using the AT^SBC command (see [4] for details). Failure to comply with these specifications might cause AT^SBC to deliver incorrect battery capacity values. A battery pack especially designed to operate with XF55-AVL module is specified in chapter 4.5.2.

- Li-Ion battery pack specified for a maximum charging voltage of 4.2 V and a capacity of 800 mAh. Battery packs with a capacity down to 600 mAh or more than 800 mAh are allowed, too.
- Since charging and discharging largely depend on the battery temperature, the battery pack should include an NTC resistor. If the NTC is not inside the battery it must be in thermal contact with the battery. The NTC resistor must be connected between BATT_TEMP and GND. Required NTC characteristics are: *10 kΩ + 5 % @ 25 °C, B25/85 = 3435 K + 3 %* (alternatively acceptable: *10 kΩ + 2 % @ 25 °C, B25/50 = 3370 K + 3 %).*
- Please note that the NTC is indispensable for proper charging, i.e. the charging process will not start if no NTC is present.
- Ensure that the pack incorporates a protection circuit capable of detecting over voltage (protection against overcharging), under voltage (protection against deep discharging) and over current. The circuit must be insensitive to pulsed current.
- On the XF55-AVL module, a built-in measuring circuit constantly monitors the supply voltage. In the event of under voltage, it causes XF55-AVL to power down. Under voltage thresholds are specific to the battery pack and must be evaluated for the intended model. When you evaluate under voltage thresholds, consider both the current consumption of XF55-AVL and of the application circuit.
- The internal resistance of the battery and the protection should be as low as possible. It is recommended not to exceed 150 mΩ, even in extreme conditions at low temperature. The battery cell must be insensitive to rupture, fire and gassing under extreme conditions of temperature and charging (voltage, current).
- The battery pack must be protected from reverse pole connection. For example, the casing should be designed to prevent the user from mounting the battery in reverse orientation.
- The battery pack must be approved to satisfy the requirements of CE conformity.

Figure 12 below shows the circuit diagram of a typical battery pack design that includes the protection elements described above.

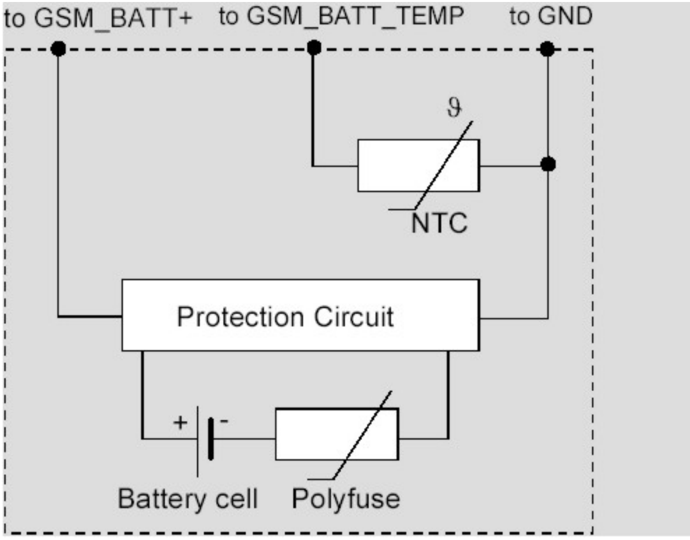


Figure 12: Battery pack circuit diagram

4.5.2 Recommended battery pack specification

Nominal voltage	3.6 V
Capacity	800 mAh
NTC	10 kΩ ± 5 % @ 25 °C, B (25/85) = 3435K ± 3 %
Overcharge detection voltage	4.325 ± 0.025 V
Overcharge release voltage	4.075 ± 0.025 V
Over discharge detection voltage	2.5 ± 0.05 V
Over discharge release voltage	2.9 ± 0.5 V
Over correct detection	3 ± 0.5 A
Nominal working current	<5 µA
Current of low voltage detection	0.5 µA
Over current detection delay time	8 ~ 16 ms
Short detection delay time	50 µs
Over discharge detection delay time	31 ~ 125 ms
Overcharge detection delay time	1 s
Internal resistance	<130 mΩ

Table 11: Battery pack specifications

4.5.3 Implemented charging technique

If the external charging circuit follows the recommendation of Figure 11, the charging process consists of trickle charging and processor controlled fast charging. For this solution, the fast charging current provided by the charger or any other external source must be limited to 500 mA.

4.5.3.1 Trickle charging

- Trickle charging starts when the charger is connected to the charger input of the external charging circuit and the module's POWER pin. The charging current depends on the voltage difference between the charger input of the external charging circuit and GSM_VBATT+ of the module.
- Trickle charging stops when the battery voltage reaches 3.6 V.

4.5.3.2 *Fast charging*

- ❖ After trickle charging has raised the battery voltage to 3.2 V within 60 minutes ±10 % from connecting the charger, the power ASIC turns on and wakes up the base band processor. Now, processor controlled fast charging begins. If the battery voltage was already above 3.2 V, processor controlled fast charging starts just after the charger was connected to the charger input of the external charging circuit and the POWER pin of module. If the GSM/GPRS part of the XF55-AVL was in POWER DOWN mode, it turns on and enters the Charge-only mode along with fast charging (see also chapter 4.3.2.4).
- ❖ Fast charging delivers a constant current until the battery voltage reaches 4.2 V and then proceeds with varying charge pulses. As shown in **Figure 7**, the pulse duty cycle is reduced to adjust the charging procedure and prevent the voltage from overshooting beyond 4.2 V. Once the pulse width reaches the minimum of 100 ms and the duty cycle does not change for 2 minutes, fast charging is completed.
- ❖ Fast charging can only be accomplished in a temperature range from 0 °C to +45 °C.

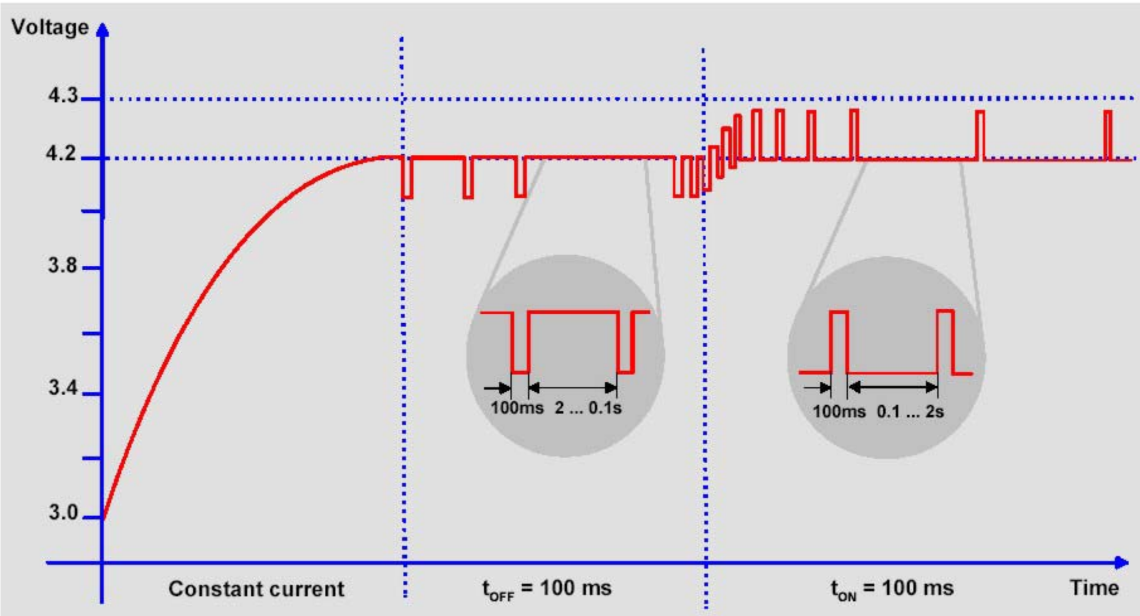


Figure 13: Charging process

Note: Do not connect the charger to the VC+ lines. Only the charger input of the external charging circuit is intended as input for charging current! The POWER pin of XF55-AVL is the input only for indicating a connected charger! The battery manufacturer must guarantee that the battery complies with the described charging technique.

<u>What to do if software controlled charging does not start up?</u>

If trickle charging fails to raise the battery voltage to 3.2 V within 60 minutes +10 %, processor controlled charging does not begin. To start fast charging you can do one of the following:

- ❖ Once the voltage has risen above its minimum of 3 V, you can try to start software controlled charging by pulling the SOFT_ON line to HIGH.

- ❖ If the voltage is still below 3 V, driving the SOFT_ON line to HIGH switches the timer off.
- ❖ Without the timer running, the GSM/GPRS part of the XF55-AVL module will not proceed to software controlled charging. To restart the timer you are required to shortly disconnect and reconnect the charger.

4.5.4 Operating modes during charging

Of course, the battery can be charged regardless of the engine's operating mode. When the GSM engine is in Normal mode (SLEEP, IDLE, TALK, GPRS IDLE or GPRS DATA mode), it remains operational while charging is in progress (provided that sufficient voltage is applied). The charging process during the Normal mode is referred to as *Charge mode*. If the charger is connected to the charger input of the external charging circuit and the POWER pin of module while GSM/GPRS part of XF55-AVL is in POWER DOWN mode, the GSM/GPRS part of the XF55-AVL goes into *Charge-only* mode.

4.5.4.1 Comparison Charge-only and Charge mode

4.5.4.1.1 Charge mode

In order to activate the charge mode, connect charger to charger input of external charging circuit and the POWER pin of module while the GSM/GPRS part of the XF55-AVL is in the following modes:

- ✓ operating, e.g. in IDLE or TALK mode
- ✓ in SLEEP mode

The features while the charge mode is:

- ➢ Battery can be charged while GSM engine remains operational and registered to the GSM network.
- ➢ In IDLE and TALK mode, the serial interfaces are accessible. AT command set can be used to full extent.
- ➢ In the NON-CYCLIC SLEEP mode, the serial interfaces are not accessible at all. During the CYCLIC SLEEP mode they can be used as described in chapter 4.6.3.

4.5.4.1.2 Charge-only mode

In order to activate the charge-only mode, connect charger to charger input of external charging circuit and the POWER pin of module while the GSM/GPRS part of the XF55-AVL is:

- ✓ in POWER DOWN mode
- ✓ in Normal mode: Connect charger to the POWER pin, then enter AT^SMSO.

IMPORTANT: While trickle charging is in progress, be sure that the application is switched off. If the application is fed from the trickle charge current the module might be prevented from proceeding to software controlled charging since the current would not be sufficient.

The features while the charge-only mode is:

- ➢ Battery can be charged while GSM engine is deregistered from GSM network.
- ➢ Charging runs smoothly due to constant current consumption.

- The AT interface is accessible and allows to use the commands listed below.

Features of Charge-only mode

Once the GSM engine enters the Charge-only mode, the AT command interface presents an Unsolicited Result Code (URC) which reads:

^SYSSTART CHARGE-ONLY MODE

Note that this URC will not appear when autobauding was activated (due to the missing synchronization between DTE and DCE upon start-up). Therefore, it is recommended to select a fixed baud rate before using the Charge-only mode. While the Charge-only mode is in progress, you can only use the AT commands listed in table 12 below. For further instructions refer to the AT Command Set supplied with your GSM engine.

AT command	Function
AT+CALA	Set alarm time
AT+CCLK	Set date and time of RTC
AT^SBC	Monitor charging process Note: While charging is in progress, no battery capacity value is available. To query the battery capacity disconnects the charger. If the charger connects *externally* to the host device no charging parameters are transferred to the module. In this case, the command cannot be used.
AT^SCTM	Query temperature range, enable/disable URCs to report critical temperature ranges
AT^SMSO	Power down GSM engine

Table 12: AT commands for charge-only

To proceed from Charge-only mode to normal operation, it is necessary to drive the ignition line to ground. This must be implemented in your host application as described in chapter 4.3.2.4. See also chapter 4.7 which summarizes the various options of changing the mode of operation.

If your host application uses the SYNC pin to control a status LED as described in chapter 4.11.2.2, please note that the LED is off while the GSM engine is in Charge-only mode.

4.5.5 Charger requirements

If you are using the implemented charging technique and the charging circuit recommended in **Figure 11**, the charger must be designed to meet the following requirements:

a) *Simple transformer power plug*
   - Output voltage: 5.5 V...8 V (under load)
   - The charge current must be limited to 500 mA.
   - Voltage spikes that may occur while you connect or disconnect the charger must be limited.
   - There must not be any capacitor on the secondary side of the power plug (avoidance of current spikes at the beginning of charging).

b) *Supplementary requirements for a) to ensure a regulated power supply*

- When current is switched off a voltage peak of 10 V is allowed for a maximum 1 ms.
- When current is switched on a spike of 1.6.A for 1.ms is allowed.

4.6 Power saving

SLEEP mode reduces the functionality of the GSM/GPRS part of the XF55-AVL module to a minimum and, thus, minimizes the current consumption to the lowest level. Settings can be made using the `AT+CFUN` command. For details see below and [4]. SLEEP mode falls into two categories:

- ✓ NON-CYCLIC SLEEP mode `AT+CFUN=0`
- ✓ CYCLIC SLEEP modes, selectable with `AT+CFUN=5,6,7,8` or `9`.

IMPORTANT: Please keep in mind that power saving works properly only when PIN authentication has been done. If you attempt to activate power saving while the SIM card is not inserted or the PIN not correctly entered, the selected <fun> level will be set, though power saving does not take effect. For the same reason, power saving cannot be used if the GSM/GPRS part of the XF55-AVL operates in Alarm mode.

To check whether power saving is on, you can query the status of `AT+CFUN` if you have chosen CYCLIC SLEEP mode. If available, you can take advantage of the status LED controlled by the SYNC pin (see chapter 4.11.2.2). The LED stops flashing once the module starts power saving. The wake-up procedures are quite different depending on the selected SLEEP mode. **Table 13** compares the wake-up events that can occur in NON-CYCLIC and CYCLIC SLEEP modes.

4.6.1 No power saving (AT+CFUN=1)

The functionality level <fun>=1 is where power saving is switched off. This is the default after start-up.

4.6.2 NON-CYCLIC SLEEP mode (AT+CFUN=0)

If level 0 has been selected (`AT+CFUN=0`), the serial interface is blocked. The module shortly deactivates power saving to listen to a paging message sent from the base station and then immediately resumes power saving. Level 0 is called NON-CYCLIC SLEEP mode, since the serial interface is not alternatingly made accessible as in CYCLIC SLEEP mode.

The first wake-up event fully activates the module, enables the serial interface and terminates the power saving mode. In short, it takes the GSM/GPRS part of the XF55-AVL back to the highest level of functionality <fun>=1. GSM_RTS0 or GSM_RTS1 are not used for flow control, but to wake up the module.

4.6.3 CYCLIC SLEEP mode (AT+CFUN=5, 6, 7, 8)

The major benefit over the NON-CYCLIC SLEEP mode is that the serial interface is not permanently blocked and that packet switched calls may go on without terminating the selected CYCLIC SLEEP mode. This allows the GSM/GPRS part of the XF55-AVL to become active, for example to perform a

GPRS data transfer, and to resume power saving after the GPRS data transfer is completed.

The CYCLIC SLEEP modes give you greater flexibility regarding the wake-up procedures:
For example, in all CYCLIC SLEEP modes, you can enter `AT+CFUN=1` to permanently wake up the module. In modes CFUN=7 and 8, the GSM/GPRS part of the XF55-AVL automatically resumes power saving, after you have sent or received a short message or made a call. CFUN=5 and 6 do not offer this feature, and therefore, are only supported for compatibility with earlier releases. Please refer to **Table 13** for a summary of all modes.

The CYCLIC SLEEP mode is a dynamic process which alternatingly enables and disables the serial interface. By setting/resetting the CTS_0 signal, the module indicates to the application whether or not the UART is active. The timing of CTS_0 is described below.

Both the application and the module must be configured to use hardware flow control (RTS/CTS handshake). The default setting of the GSM/GPRS part of the XF55-AVL is AT\Q0 (no flow control) which must be altered to AT\Q3. See [4] for details.

Note: If both serial interfaces ASC0 and ASC1 are connected, both are synchronized. This means that SLEEP mode takes effect on both, no matter on which interface the AT command was issued. Although not explicitly stated, all explanations given in this chapter refer equally to ASC0 and ASC1, and accordingly to GSM_CTS0 and GSM_CTS1.

4.6.4 CYCLIC SLEEP mode AT+CFUN=9

Mode `AT+CFUN=9` is similar to `AT+CFUN=7` or `8`, but provides two additional features:

- ❖ GSM_RTS0 and GSM_RTS1 are not intended for flow control (as in modes `AT+CFUN=5,6,7` or `8`), but can be used to temporarily wake up the module. This way, the module can quickly wake up and resume power saving, regardless of the GSM_CTS timing controlled by the paging cycle.
- ❖ The time the module stays active after GSM_RTS was asserted or after the last character was sent or received, can be configured individually using the command `AT^SCFG`. Default setting is 2 seconds like in `AT+CFUN=7`. The entire range is from 0.5 seconds to 1 hour, selectable in tenths of seconds. For details see [4].

4.6.5 Timing of the GSM_CTS signal in CYCLIC SLEEP modes

The GSM_CTS signal is enabled in synchrony with the paging cycle of module. It goes active low each time when the module starts listening to a paging message block from the base station. The timing of the paging cycle varies with the base station. The duration of a paging interval can be calculated from the following formula:
*4.615 ms (TDMA frame duration) * 51 (number of frames) * DRX value.*
DRX (Discontinuous Reception) is a value from 2 to 9, resulting in paging intervals from 0.47 to 2.12 seconds. The DRX value of the base station is assigned by the network operator. Each listening period causes the GSM_CTS

signal to go active low: If DRX is 2, the GSM_CTS signal is activated every 0.47 seconds, if DRX is 3, the GSM_CTS signal is activated every 0.71 seconds and if DRX is 9, the GSM_CTS signal is activated every 2.1 seconds. The GSM_CTS signal is active low for 4.6 ms. This is followed by another 4.6 ms UART activity. If the start bit of a received character is detected within these 9.2 ms, GSM_CTS will be activated and the proper reception of the character will be guaranteed.
GSM_CTS will also be activated if any character is to be sent.
After the last character was sent or received the interface will remain active for:

- ✓ another 2 seconds, if `AT+CFUN=5` or `7`,
- ✓ another 10 minutes, if `AT+CFUN=6` or `8`,
- ✓ or for an individual time defined with `AT^SCFG`, if `AT+CFUN=9`. Assertion of GSM_RTS has the same effect.

In the pauses between listening to paging messages, while GSM_CTS is high, the module resumes power saving and the AT interface is not accessible. See figure 14 and figure 15.

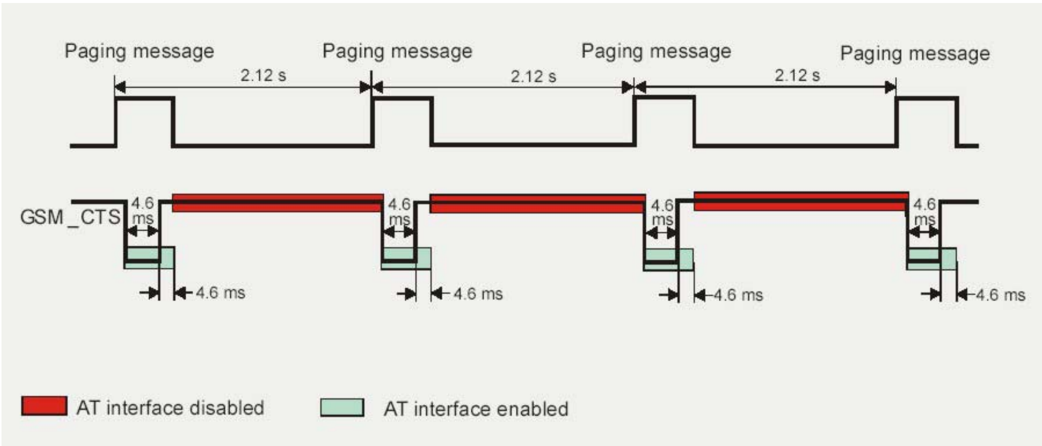


Figure 14: Timing of CTS signal (example for a 2.12 s paging cycle)

Figure 15 illustrates the CFUN=5 and CFUN=7 modes, which reset the GSM_CTS signal 2 seconds after the last character was sent or received.

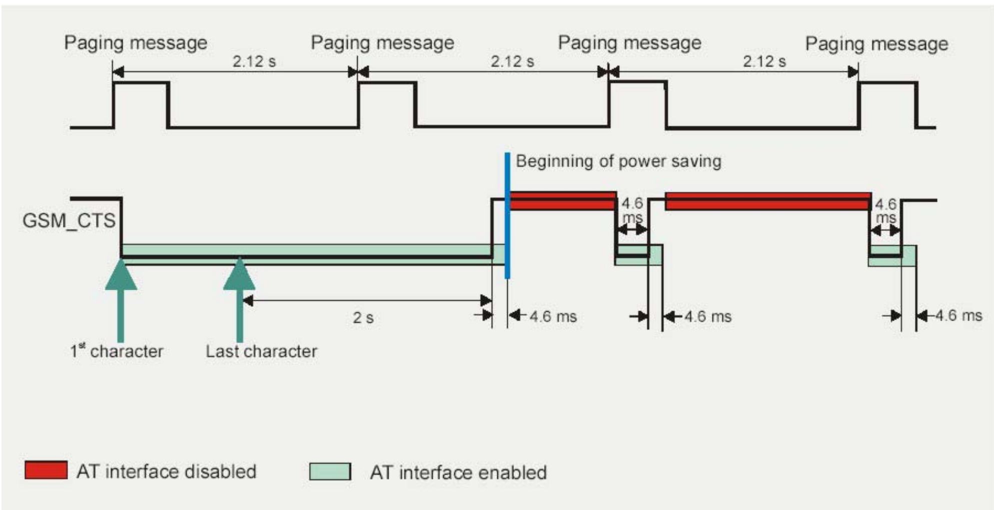


Figure 15: Beginning of power saving if CFUN=5 or 7

4.6.6 Wake up XF55-AVL from SLEEP mode

A wake-up event is any event that causes the module to draw current. Depending on the selected mode the wake-up event either switches SLEEP mode off and takes XF55-AVL back to `AT+CFUN=1`, or activates XF55-AVL temporarily without leaving the current SLEEP mode.
Definitions of the state transitions described in table 13 below:

Quit = XF55-AVL exits SLEEP mode and returns to `AT+CFUN=1`.

Temporary = XF55-AVL becomes active temporarily for the duration of the event and the mode-specific follow-up time after the last character was sent or received on the serial interface.

No effect: = Event is not relevant in the selected SLEEP mode. XF55-AVL does not wake up.

Event	Selected mode AT+CFUN=0	Selected mode AT+CFUN=5 or 6	Selected mode AT+CFUN=7,8,9
Ignition line	No effect	No effect	No effect
GSM_RTS0 or GSM_RTS1[1)] (falling edge)	Quit	No effect (GSM_RTS is only used for flow control)	Mode 7 and 8: No effect (GSM_RTS is only used for flow control) Mode 9: Temporary
Unsolicited Result Code (URC)	Quit	Quit	Temporary
Incoming voice or data call	Quit	Quit	Temporary
Any AT command (incl. outgoing voice or data call, outgoing SMS)	Not possible (UART disabled)	Temporary	Temporary
Incoming SMS depending on mode selected by AT+CNMI: AT+CNMI=0,0 (= default, no indication of received SMS) AT+CNMI=1,1 (= displays URC upon receipt of SMS)	No effect Quit	No effect Quit	No effect Temporary
GPRS data transfer	Not possible (UART disabled)	Temporary	Temporary
RTC alarm[2)]	Quit	Quit	Temporary
AT+CFUN=1	Not possible (UART disabled)	Quit	Quit

Table 13: Wake-up events in NON-CYCLIC and CYCLIC SLEEP modes

[1)] During the CYCLIC SLEEP modes 5, 6, 7, and 8, GSM_RTS0 and GSM_RTS1 are conventionally used for flow control: The assertion of GSM_RTS0 or GSM_RTS1 signals that the application is ready to receive data - without waking up the module. If the module is in CFUN=0 mode the assertion of GSM_RTS0 and GSM_RTS1 serves as a wake-up event, giving the application the possibility to intentionally terminate power saving. If the module is in CFUN=9 mode, the assertion of GSM_RTS0 or GSM_RTS1 can be used to temporarily wake up XF55-AVL for the time specified with the AT^SCFG command (default = 2 s).

2) Recommendation: In NON-CYCLIC SLEEP mode, you can set an RTC alarm to wake up XF55-AVL and return to full functionality. This is a useful approach because, in this mode, the AT interface is not accessible.

4.7 Summary of state transitions (except SLEEP mode)

Further mode / Present mode	POWER DOWN	Normal mode**)	Charge-only mode*)	Charging in normal mode*)**)	Alarm mode
POWER DOWN mode without charger	--	**GSM_IGT >100 ms at low level**	**Connect charger to input of ext. charging circuit and GSM_POWER pin (high level at GSM_POWER)**	**No direct transition, but via "Charge-only mode" or "Normal mode"**	**Wake-up from POWER DOWN mode (if activated with** `AT+CALA`**)**
POWER DOWN mode with charger (high level at GSM_POWER pin of XF55-AVL)	--	**GSM_IGT >1 s at low level, if battery is fully charged**	**100 ms < GSM_IGT < 500 ms at low level**	**GSM_IGT >1 s at low level**	**Wake-up from POWER DOWN mode (if activated with** `AT+CALA`**)**
Normal mode)**	**AT^SMSO or exceptionally GSM_EMERGOFF pin > 3.2 s at low level**	--	**No automatic transition, but via "POWER DOWN"**	**Connect charger to GSM_POWER pin at XF55-AVL (high level at GSM_POWER)**	`AT+CALA` **followed by** `AT^SMSO`**. XF55-AVL enters Alarm mode when specified time is reached**
Charge-only mode*)	**Charge-only mode *) Disconnect charger (XF55-AVL GSM_POWER pin at low level) or** `AT^SMSO` **or exceptionally GSM_EMERGOFF pin >3.2 s at low level**	**No automatic transition, but via "Charge in Normal Mode"**	---	**GSM_IGT >1 s at low level**	`AT+CALA` **followed by** `AT^SMSO`**. XF55-AVL enters Alarm mode when specified time is reached and $V_{GSM\ BATT+}$>3.2 V**
Charging in normal mode*))**	`AT^SMSO` **"Charge-only mode", again** `AT^SMSO` **or exceptionally GSM_EMERGOFF pin >3.2 s at low level**	**Disconnect charger from input of ext. charging circuit and module's GSM_POWER pin**	**AT^SMSO**	--	**No direct transition**
Alarm mode	**Alarm mode** `AT^SMSO` **or exceptionally**	**GSM_IGT >100 ms at low level**	`AT^SMSO` **if charger is connected**	**GSM_IGT >100 ms at low level**	--

	GSM_EMERGOFF pin >3.2 s at low level				

Table 14: Summary of state transitions

*) See chapter 4.5.4 for details on the charging mode
**) Normal mode covers TALK, DATA, GPRS, IDLE and SLEEP modes

4.8 RTC backup for GSM/GPRS part of XF55-AVL

The internal Real Time Clock of the XF55-AVL GSM/GPRS part is supplied from a separate voltage regulator in the power supply ASIC which is also active when the GSM/GPRS part of the XF55-AVL is in POWER DOWN status. An alarm function is provided that allows to wake up XF55-AVL without logging on to the GSM network.
In addition, you can use the GSM_VDDLP pin on the board-to-board connector to backup the RTC from an external capacitor or a battery (rechargeable or non-chargeable). The capacitor is charged by the GSM_BATT+ line of XF55-AVL. If the voltage supply at GSM_BATT+ is disconnected the RTC can be powered by the capacitor. The size of the capacitor determines the duration of buffering when no voltage is applied to the GSM/GPRS part of the XF55-AVL, i.e. the greater capacitor the longer the GSM/GPRS part of the XF55-AVL will save the date and time.
The following figures show various sample configurations. The voltage applied at GSM_VDDLP can be in the range from 2 to 5.5 V. Please refer to **Table 4** and **Table 5** for the parameters required.

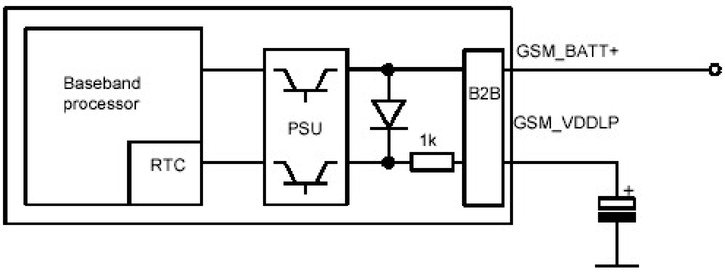


Figure 16: RTC supply from capacitor

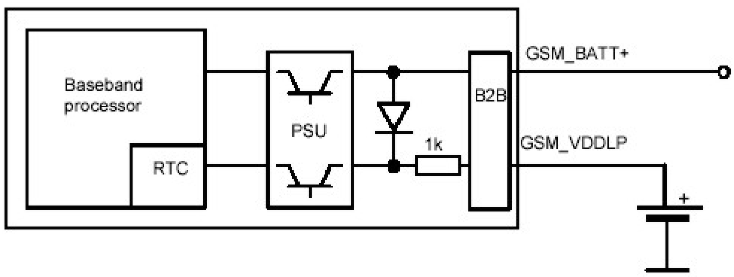


Figure 17: RTC supply from rechargeable battery

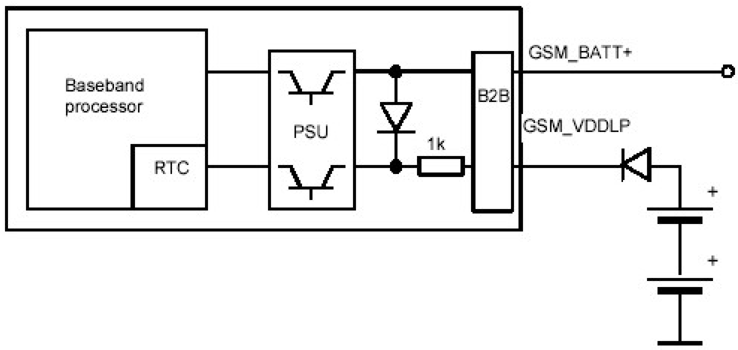


Figure 18: RTC supply from non-chargeable battery

4.9 Features supported on the serial interface of GSM/GPRS part

The GSM/GPRS part of the XF55-AVL module offers two unbalanced, asynchronous serial interfaces conforming to ITU-T V.24 protocol DCE signaling. The electrical characteristics do not comply with ITU-T V.28. The significant levels are 0 V (for low data bit or ON condition) and 2.65 V (for high data bit or OFF condition). For electrical characteristics please refer to **Table 3** and **Table 3**. See chapter 6.1 to determinate the DTE-DCE connection.

ASC0:

- 8-wire serial interface
- Includes the data lines GSM_TXD0 and GSM_RXD0, the status lines GSM_RTS0 and GSM_CTS0 and, in addition, the modem control lines GSM_DTR0, GSM_DSR0, GSM_DCD0 and GSM_RING0.
- It is primarily designed for voice calls, CSD calls, fax calls and GPRS services and for controlling the GSM engine with AT commands. Full Multiplex capability allows the interface to be partitioned into three virtual channels, yet with CSD and fax services only available on the first logical channel. Please note that when the ASC0 interface runs in Multiplex mode, ASC1 cannot be used. For more detailed characteristics see [9].
- The GSM_DTR0 signal will only be polled once per second from the internal firmware of XF55-AVL.
- The GSM_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. For further details see chapter 4.11.2.3.
- Autobauding is only selectable on ASC0 and supports the following bit rates: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400 bps.
- Autobauding is not compatible with multiplex mode, see [9].
- ASC0 interface is intended for firmware upgrade of the GSM/GPRS part.

ASC1:

- 4-wire serial interface
- Includes only the data lines GSM_TXD1 and GSM_RXD1 plus GSM_RTS1 and GSM_CTS1 for hardware handshake. This interface is intended for voice calls, GPRS services and for controlling the GSM

engine with AT commands. It is not suited for CSD calls, fax calls and Multiplex mode.

↔ On ASC1 no GSM_RING line is available. The indication of URCs on the second interface depends on the settings made with the AT^SCFG command. For details refer to [4].

ASC0 and ASC1 configuration:

❖ Both interfaces are configured for 8 data bits, no parity and 1 stop bit, and can be operated at bit rates from 300 bps to 230400 bps.
❖ XON/XOFF software flow control can be used on both interfaces (except if power saving is active).

4.10 Audio interfaces

XF55-AVL comprises three audio interfaces available on the board-to-board connector:

❖ Two analog audio interfaces, each with a balanced analog microphone input and a balanced analog earpiece output. The second analog interface provides a supply circuit to feed an active microphone.
❖ Serial digital audio interface (DAI) using PCM (Pulse Code Modulation) to encode analog voice signals into digital bit streams.

This means you can connect up to three audio devices in any combination, although analog and digital audio cannot be operated at the same time. Using the AT^SAIC command you can easily switch back and forth.

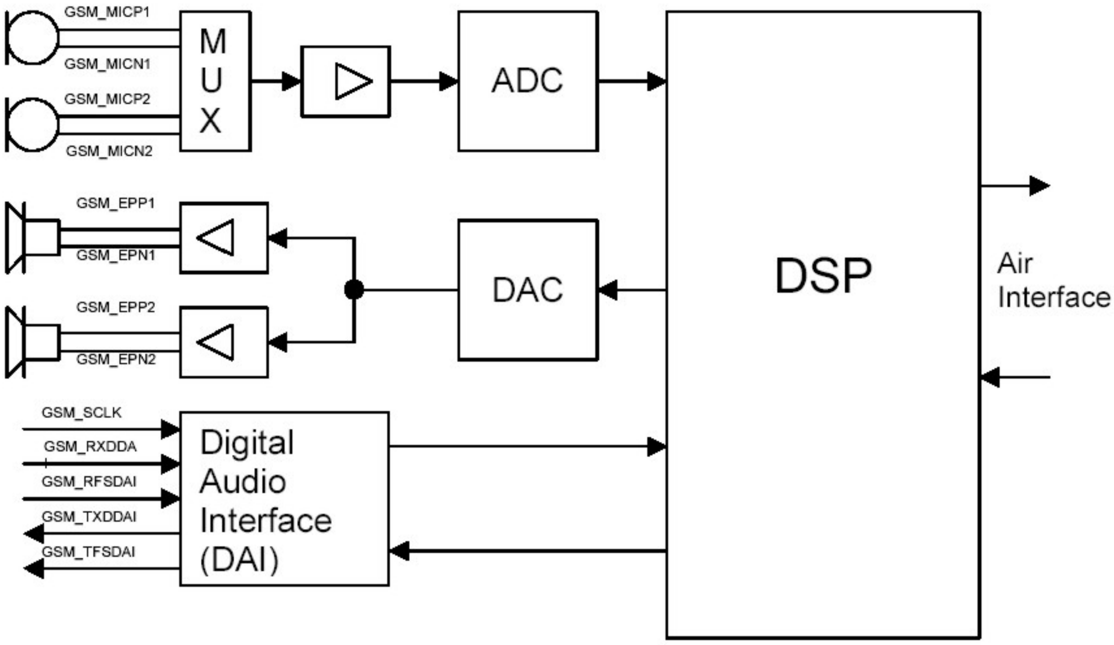


Figure 19: Audio block diagram

XF55-AVL offers six audio modes which can be selected with the AT^SNFS command, no matter which of the three interfaces is currently active. The electrical characteristics of the voice band part vary with the audio mode. For example, sending and receiving amplification, side tone paths, noise suppression etc. depend on the selected mode and can be altered with AT commands (except for mode 1).

On each audio interface you can use all audio AT commands specified in [4] to alter parameters. The only exception are the DAC and ADC gain amplifier attenuation <outBbcGain> and <inBbcGain> which cannot be modified when the digital audio interface is used, since in this case the DAC and ADC are switched off. Please refer to chapter 4.10 for specifications of the audio interface and an overview of the audio parameters. Detailed instructions on using AT commands are presented in [4]. **Table 28** summarizes the characteristics of the various audio modes and shows what parameters are supported in each mode.

When shipped from factory, all audio parameters of XF55-AVL are set to interface 1 and audio mode 1. Audio mode 1 has fix parameters which cannot be modified. In transmit direction, all audio modes contain internal scaling factors (digital amplification) that are not accessible by the user. To avoid saturation with a full scale digital input signal on the DAI, and to obtain a one-to-one digital access to the speech coder in audio mode 5 and 6, it is recommended to set the parameter <inCalibrate> of the selected audio mode as follows:

Audio mode 1 and 4: 23196
Audio mode 2: 17396
Audio mode 3: 21901
Audio mode 5 and 6: 21402

4.10.1 Microphone circuit

Interface 1

This interface has no microphone supply circuit and therefore, has an impedance of 50 kΩ. When connecting a microphone or another signal source to interface 1 you are required to add two 100 nF capacitors, one to each line.

Interface 2

This interface comes with a microphone supply circuit and can be used to feed an active microphone. It has an impedance of 2 kΩ. If you do not use it or if you want to connect another type of signal source, for example, an op amp or a dynamic microphone, it needs to be decoupled with capacitors. The power supply can be switched off and on by using the command `AT^SNFM`. For details see [4].

Figure 20 shows the microphone inputs at both analog interfaces of XF55-AVL.

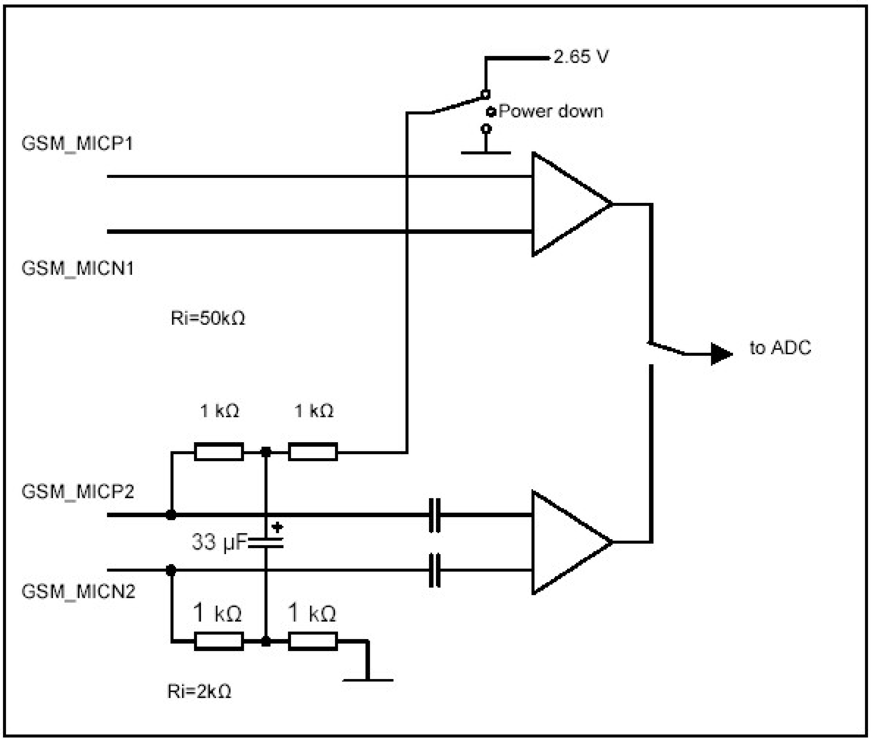


Figure 20: Schematic of microphone inputs

4.10.2 Speech processing

The speech samples from the ADC or DAI are handled by the DSP of the base band controller to calculate e.g. amplifications, side tone, echo cancellation or noise suppression depending on the configuration of the active audio mode. These processed samples are passed to the speech encoder. Received samples from the speech decoder are passed to the DAC or DAI after post processing (frequency response correction, adding side tone etc.).
Full rate, half rate, enhanced full rate, adaptive multi rate (AMR), speech and channel encoding including voice activity detection (VAD) and discontinuous transmission (DTX) and digital GMSK modulation are also performed on the GSM base band processor.

4.10.3 DAI timing

To support the DAI function, XF55-AVL integrates a simple five-line serial interface with one input data clock line (GSM_SCLK) and input/output data and frame lines (GSM_TXDDAI, GSM_TFSDAI, GSM_RXDDAI, GSM_RFSDAI). The serial interface is always active if the external input data clock GSM_SLCK is present, i.e. the serial interface is not clocked by the DSP of the XF55-AVL base band processor. GSM_SLCK must be supplied from the application and can be in a frequency range between 0.2 and 10 MHz. Serial transfer of 16-bit words is done in both directions. Data transfer to the application is initiated by the module via a short pulse of GSM_TFSDAI. The duration of the GSM_TFSDAI pulse is one GSM_SCLK period, starting at the rising edge of SLCK. During the following 16 SLCK cycles, the 16-bit sample will be transferred on the GSM_TXDDAI line. The next outgoing sample will be transferred after the next GSM_TFSDAI pulse which occurs every 125 µs.

The GSM_TFSDAI pulse is the master clock of the sample transfer. From the rising edge of the GSM_TFSDAI pulse, the application has 100 µs to transfer the 16-bit input sample on the GSM_RXDDAI line. The rising edge of the GSM_RFSDAI pulse (supplied by the application) may coincide with the falling edge of GSM_TFSDAI or occur slightly later - it is only significant that, in any case, the transfer of the LSB input sample will be completed within the specified duration of 100 µs.
Audio samples are transferred from the module to the application in an average of 125 µs.
This is determined by the 8 kHz sampling rate, which is derived from and synchronized to the GSM network. As SLCK is independent of the GSM network, the distance between two succeeding sample transfers may vary about + 1 SLCK period.
The application is required to adapt its sampling rate to the GSM_TFSDAI rate. Failure to synchronize the timing between the module and the application may cause audible pops and clicks in a conversation. The timing characteristics of both data transfer directions are shown in figure 21 and figure 22 below.

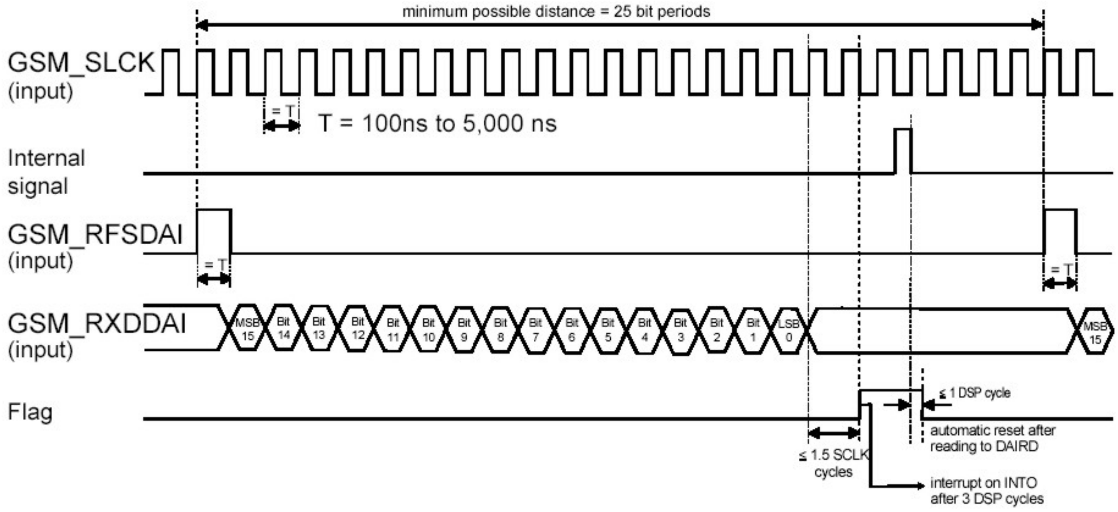


Figure 21: DAI timing on transmit path

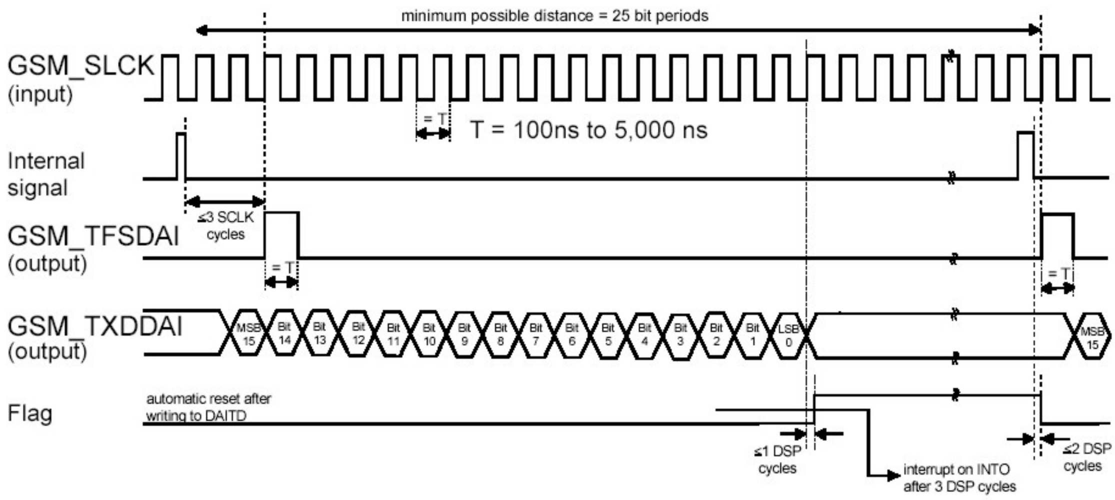


Figure 22: DAI timing on receive path

4.10.4 SIM interface

The base band processor has an integrated SIM interface compatible with the ISO 7816 IC card standard. This is wired to the host interface (board-to-board connector) in order to be connected to an external SIM card holder. Six pins on the board-to-board connector are reserved for the SIM interface. The GSM_CCIN pin serves to detect whether a tray (with SIM card) is present in the card holder. Using the GSM_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. See chapter 4.10.4.1 for details. It is recommended that the total cable length between the board-to-board connector pins on XF55-AVL and the pins of the SIM card holder does not exceed 200 mm in order to meet the specifications of 3GPP TS 51.010-1 and to satisfy the requirements of EMC compliance.

Signal	Description
GSM_CCGND	Separate ground connection for SIM card to improve EMC
GSM_CCCLK	Chip card clock, various clock rates can be set in the base band processor
GSM_CCVCC	SIM supply voltage from PSU-ASIC
GSM_CCIO	Serial data line, input and output
GSM_CCRST	Chip card reset, provided by base band processor
GSM_CCIN	Input on the base band processor for detecting a SIM card tray in the holder. The GSM_CCIN pin is mandatory for applications that allow the user to remove the SIM card during operation. The GSM_CCIN pin is solely intended for use with a SIM card. It must not be used for any other purposes.

Table 15: Signals of the SIM interface (board-to-board connector).

4.10.4.1 Requirements for using the GSM_CCIN pin

According to ISO/IEC 7816-3 the SIM interface must be immediately shut down once the SIM card is removed during operation. Therefore, the signal at the GSM_CCIN pin must go low *before* the SIM card contacts are mechanically detached from the SIM interface contacts. This shut-down procedure is particularly required to protect the SIM card as well as the SIM interface of XF55-AVL from damage. 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 XF55-AVL. Molex ordering number is 91228-0001.

The start-up procedure of module involves a SIM card initialization performed within 1 second after getting started. An important issue is whether the initialization procedure ends up with a high or low level of the GSM_CCIN signal:

a) If, during start-up of XF55-AVL, the GSM_CCIN signal on the SIM interface is high, then the status of the SIM card holder can be recognized each time the card is inserted or ejected. A low level of GSM_CCIN indicates that no SIM card tray is inserted into the holder. In this case, the module keeps searching, at regular intervals, for the SIM card. Once the

SIM card tray with a SIM card is inserted, GSM_CCIN is taken high again.

b) If, during start-up of XF55-AVL, the GSM_CCIN signal is low, the module will also attempt to initialize the SIM card. In this case, the initialization will only be successful when the card is present. If the SIM card initialization has been done, but the card is no more operational or removed, then the module will never search again for a SIM card and only emergency calls can be made. Removing and inserting the SIM card during operation requires the software to be reinitialized. Therefore, after reinserting the SIM card it is necessary to restart XF55-AVL. It is strongly recommended to connect the contacts of the SIM card detect switch to the GSM_CCIN input and to the GSM_CCVCC output of the module as illustrated in the sample diagram in figure 23 below.

Note: *No guarantee can be given, nor any liability accepted, if loss of data is encountered after removing the SIM card during operation. Also, no guarantee can be given for properly initializing any SIM card that the user inserts after having removed a SIM card during operation. In this case, the application must restart XF55-AVL.*

4.10.4.2 Design considerations for SIM card holder

The schematic below is a sample configuration that illustrates the Molex SIM card holder located on the evaluation kit used for test of the XF55-AVL reference setup. X503 is the designation used for the SIM card holder.

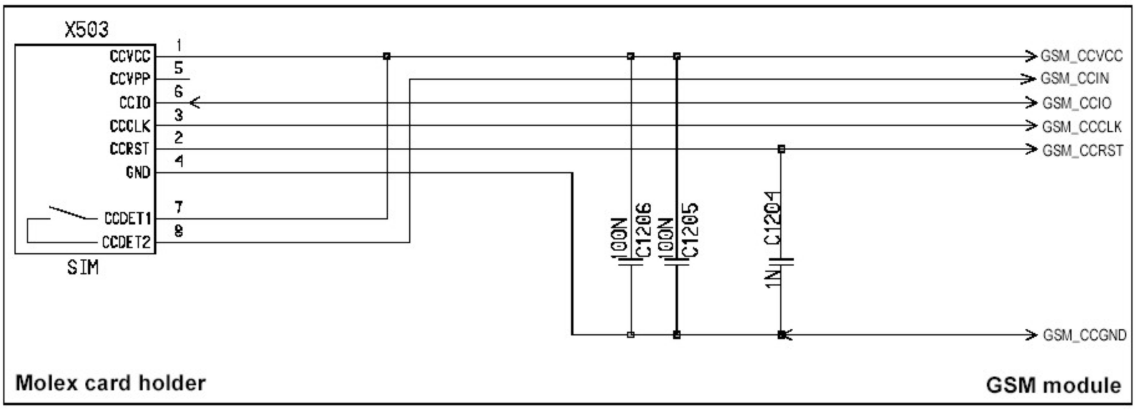


Figure 23: SIM card holder

Pin	Signal name	I/O	Function
1	CCVCC	I	Supply voltage for SIM card, generated by the GSM engine
2	CCRST	I	Chip card reset, prompted by the GSM engine
3	CCCLK	I	Chip card clock
4	CCGND	-	Individual ground line for the SIM card to improve EMC
5	CCVPP	-	Not connected
6	CCIO	I/O	Serial data line, bi-directional
7	CCDET1	-	Connect to GSM_CCVCC
8	CCDET2	-	Connects to the GSM_CCIN input of the GSM engine. Serves to recognize whether a SIM card is in the holder.

Table 16: Pin assignment of Molex SIM card holder

Pins 1 through 8 (except for 5) are the minimum requirement according to the GSM recommendations, where pins 7 and 8 are needed for SIM card tray detection through the GSM_CCIN pin. Place the capacitors C1205 and C1206 (or instead one capacitor of 200 nF) as close as possible to the pins 1 (CCVCC) and 4 (GND) of the card holder. Connect the capacitors to the pins via low resistance tracks.

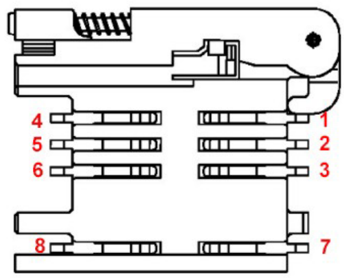


Figure 23: Pin numbers of Molex SIM card holder

4.11 Control signals

4.11.1 Inputs

Signal	Pin	Pin status	Function	Remarks
Ignition	**GSM_IGT**	Falling edge	Power up XF55-AVL	Active low ≥ 100 ms (Open drain/collector driver to GND required in cellular device application). Note: If a charger and a battery is connected to the customer application the GSM_IGT signal must be 1 s minimum.
		Left open or HiZ	No operation	
Emergency shutdown	**GSM_ EMERG OFF**	Low	Power down XF55-AVL	Active low ≥ 3.2 s (Open drain/collector driver required in cellular device application). At the signal the watchdog signal of the GSM engine can be traced (see description in **Table 4** or **Table 5**).
		Left open or HiZ	No operation	

Table 17: Input control signals of the GSM/GPRS part of the XF55-AVL module

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(HiZ = high impedance)

4.11.2 Outputs

4.11.2.1 Synchronization signal

The synchronization signal serves to indicate growing power consumption during the transmit burst. The signal is generated by the GSM_SYNC pin. Please note that this pin can adopt two different operating modes which you can select by using the `AT^SSYNC` command (mode 0 and 1). For details refer to the following chapter and to [4]. To generate the synchronization signal the pin needs to be configured to mode 0 (= default). This setting is recommended if you want your application to use the synchronization signal for better power supply control. Your platform design must be such that the incoming signal accommodates sufficient power supply to the XF55-AVL module if required. This can be achieved by lowering the current drawn from other components installed in your application. The timing of the synchronization signal is shown below. High level of the GSM_SYNC pin indicates increased power consumption during transmission.

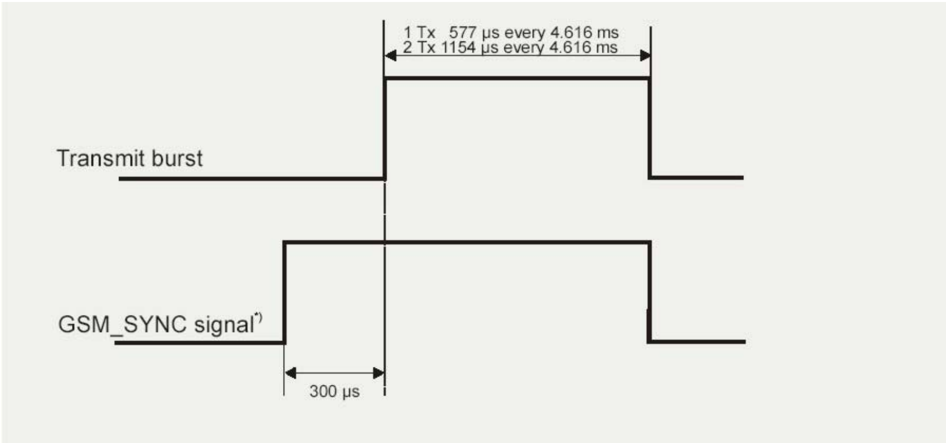


Figure 24: GSM_SYNC signal during transmit burst

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

4.11.2.2 Using the GSM_SYNC pin to control a status LED

As an alternative to generating the synchronization signal, the GSM_SYNC pin can be used to control a status LED on your application platform.
To avail of this feature you need to set the GSM_SYNC pin to mode 1 by using the `AT^SSYNC` command. For details see [4].
When controlled from the GSM_SYNC pin the LED can display the functions listed in table 18 below.

LED mode	Operating status
Off	XF55-AVL is off or run in SLEEP, Alarm or Charge-only mode
600 ms On/ 600ms	Off No SIM card inserted or no PIN entered, or network search in progress, or ongoing user authentication, or network login in progress.
75 ms On/3 s	Off Logged to network (monitoring control channels and user interactions). No call in progress.
75 ms on/75 ms Off/75 ms On/3 s Off	One or more GPRS contexts activated.
Flashing	Indicates GPRS data transfer: When a GPRS transfer is in progress, the LED goes on within 1 second after data packets were exchanged. Flash duration is approximately 0.5 s.
On	Depending on type of call: *Voice call:* Connected to remote party. *Data call:* Connected to remote party or exchange of parameters while setting up or disconnecting a call

Table 18: Coding of the status LED

LED Off = GSM_SYNC pin low.
LED On = GSM_SYNC pin high (if LED is connected as illustrated in figure 25)

To operate the LED a buffer, e.g. a transistor or gate, must be included in your application. A sample configuration can be gathered from figure 25. Power consumption in the LED mode is the same as for the synchronization signal mode. For details see **Table 4** or **Table 5**, GSM_SYNC pin.

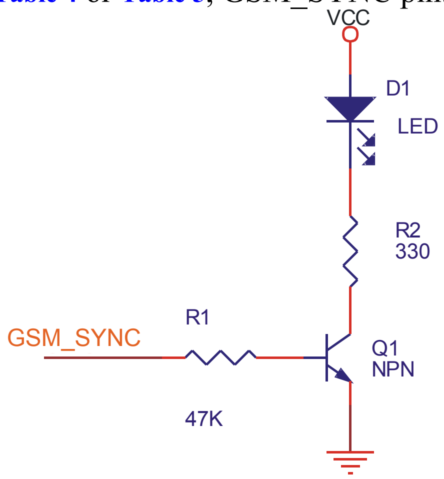


Figure 25: LED Circuit (Example)

4.11.2.3 Behaviour of the GSM_RING0 line (ASC0 interface only)

The GSM_RING0 line is available on the first serial interface (ASC0). The signal serves to indicate incoming calls and other types of URCs (Unsolicited Result Code). Although not mandatory for use in a host application, it is strongly suggested that you connect the GSM_RING0 line to an interrupt line of your application. In this case, the application can be designed to receive an interrupt when a falling edge on GSM_RING0 occurs. This solution is most effective, particularly, for waking up an application from power saving. Note that if the GSM_RING0 line is not wired, the application would be required to permanently poll the data and status lines of the serial interface at the expense of a higher current consumption. Therefore, utilizing the GSM_RING0 line provides an option to significantly reduce the overall current consumption of your application.
The behaviour of the GSM_RING0 line varies with the type of event:

- ✓ When a *voice call* comes in the GSM_RING0 line goes low for 1 s and high for another 4 s. Every 5 seconds the ring string is generated and sent over the GSM_RXD0 line. If there is a call in progress and call waiting is activated for a connected handset or handsfree device, the GSM_RING0 line switches to ground in order to generate acoustic signals that indicate the waiting call.

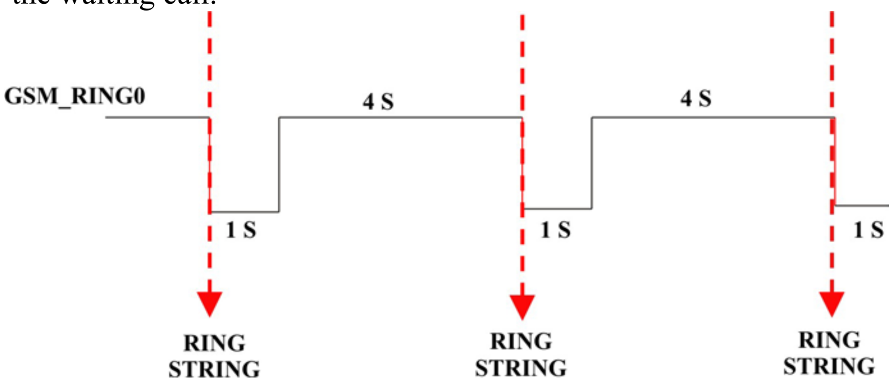


Figure 26: Incoming voice call

✓ Likewise, when a *fax* or *data call* is received, GSM_RING0 goes low. However, in contrast to voice calls, the line remains low. Every 5 seconds the ring string is generated and sent over the GSM_RXD0 line.

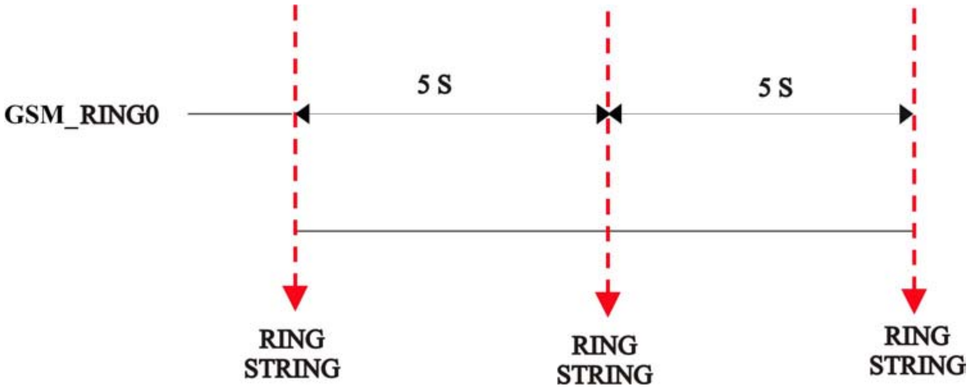


Figure 27: Incoming data call

✓ All types of Unsolicited Result Codes (URCs) also cause the GSM_RING0 line to go low, however for 1 second only. For example, XF55-AVL may be configured to output a URC upon the receipt of an SMS. As a result, if this URC type was activated with `AT+CNMI=1,1`, each incoming SMS causes the GSM_RING0 line to go low. See [4] for detailed information on URCs.

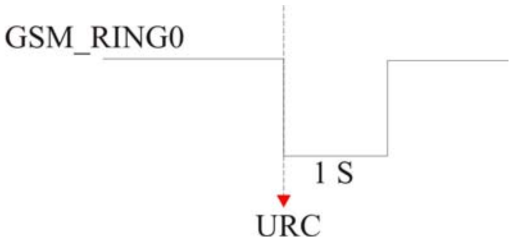


Figure 28: URC transmission

Function	Pin	Status	Description
Ring indication	GSM_RING0	0	SLEEP mode CFUN=0 or CYCLIC SLEEP mode CFUN=5 or 6, the module is caused to wake up to full functionality. If CFUN=7 or 8, power saving is resumed after URC transmission or end of call.
		1	No operation

Table 19: ASC0 ring signal

5 GPS application interface

The XF55-AVL module integrates a GPS receiver which offers the full performance of GPS technology. If the GPS receiver is fully powered it continuously tracks all satellites in view, thus providing accurate satellite position data. The computed data solution is sent on a serial port for high level applications to use or process it locally. Integrated GPS receiver offers also applications for highly visible LEDs (the LED circuit must be implemented external the module on your application platform) which provide immediate indication of the receiver operation, while two configurable serial ports allow operation in either SiRF Binary or NMEA protocols. The embedded GPS receiver is an independent part on the XF55-AVL module. All required interfaces have to be connected to this part in order to make it works. Additionally, the GPS part can also be used even if the XF55-AVL module is deregistered from the GSM network.

5.1 Signal Processing Operation of GPS receiver

The GPS receiver is designed to use L1 Frequency (C/A Code). The module is separated into four major parts: **(1) RF frequency down-converter**, **(2) digital base band demodulation**, **(3) embedded ARM microprocessor** and **(4) internal GPS software** stored on-board (2 MB - 512 K) Combo-Memory. The RF frequency conversion and the base band demodulation are executed by hardware while the embedded ARM processor computes the GPS position, velocity and time solution employing the internal GPS software.

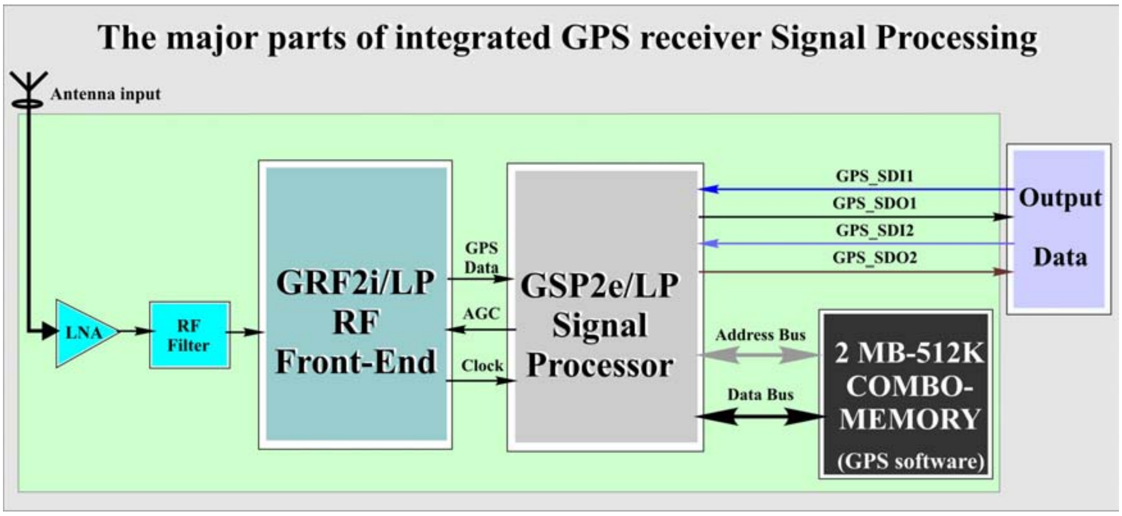


Figure 29: Signal processing of GPS receiver

The signal processing is described as follow:

- The purpose of the RF circuitry is to reinforce the very weak (-130 dBm nominal) GPS signal, filters it and down-converts it to an Intermediate Frequency (IF) of 9.45 MHz for digital processing. The GPS receiver architecture relies on the high level of integration in the RF part to significantly reduce part count and circuit complexity. The IF filter is built-in as well.

- The digital base band demodulator takes the quantified GPS signal and detects the individual satellites serial data bit stream, along with the associated pseudo range. This action consists of removing spread spectrum and Doppler frequency components of the signal to obtain the serial data messages.
- The embedded ARM processor monitors channel allocation, extracts the raw satellite tracking data, computes the position and time solution and sends it on a serial port for high level applications to use or process it locally. Support functions for the microprocessor include real-time clock and reset pulse generator circuits.
- The internal GPS software monitors and allocate channels, computes the position, velocity and time using the pseudo-range of the satellites and reformat the data to be output at the serial interface or used locally. The internal GPS software is a tasking based architecture driven by the 100 ms interrupt generated by GSP2e internal hardware.

5.2 Description of operating modes

There are three basic operating in which the GPS receiver operates during use. Each mode is used to accomplish a different task during the process of acquiring and maintaining the GPS information. The integrated GPS receiver designs include all the functionality necessary to implement the three different modes of operation. The default mode of GPS receiver is normal mode (continuous mode). Three different operating modes are described below. Additionally, two of them are designed as low-power modes consumption such as the Trickle Power mode and Push-To-Fix mode. In order to allow the integrated GPS receiver to perform internally the warm and hot start it is advisable to use an external backup battery (refer to **Table 4,** pins 46..50. See also section **4.5**). The lines which power the RTC and SRAM of the GPS part are linked directly to GSM power supply pins.

5.2.1 Normal Operation

In this default implementation of normal mode the GPS receiver is fully powered and performs the function of signal search, acquisition, measurement and satellite tracking. The amount of time spent in the initial full power is dependent on the start condition that applies the number of satellites for which the ephemeris must be collected and the time to calibrate the RTC as well as the location of the GPS antenna (which it must have an unobstructed view to the sky in order to receive the satellite radio transmissions). When the GPS receiver has been locked-on to at least four satellites, the receiver is able to calculate its current positions. In this mode the GPS receiver is fully powered and satellite searching, initial acquisition, initial position calculation and tracking measurements functions are always performed.

5.2.2 Trickle Power Operation

Please note that the integrated GPS receiver does not support this mode when it operates with SiRFXTrac2 software, see section 11.5.1. In the Trickle Power mode, power is still applied to the GPS receiver, but the GPS engine is shut off and RF circuits are powered down. The Trickle Power mode provides a method of operating the GPS receiver in a user programmable duty cycle, consisting of a receiver measurement on time tracking and an interval of position update, thereby reducing the average power consumption over a period of time. The transition into the Trickle Power mode of GPS receiver can be implemented and configured by using the SiRFdemo software. Between two on time tracking periods the GPS receiver sets itself in the sleep phase in other word into the low power consumption. The transition from sleep mode of GPS receiver back to the on time tracking is generated through the internal RTC which transmits a wakeup signal to the GPS engine to switch it on as well the RF circuit is powered on. The GPS receiver is waked up and begins to acquire the on view satellites. If the receiver fails to acquire satellites within a given period of time (approx. 150 sec), the receiver sets itself into the sleep phase. The duration of this sleep phase is approx. 30 sec. After that, the receiver wakes up, reset itself and tries to acquire satellites which are in view. This procedure repeats itself until the initial position computation of GPS receiver is completed. For further details refer to related manuals.[6]

As above, the GPS receiver can be set into the Trickle Power Mode via input command message (for more details refer to the chapter 5.3). Please note that, the Trickle Power Mode is not supported on the integrated GPS receiver operating with SiRFXTrac2 software. The SiRFXTrac2 software supports so-called AMP-mode. See chapter 11.5.1.2 for more details.

The GPS receiver enters the trickle power mode corresponding to figure 30 (**800 ms OFF Time and 200 ms ON Time**) as soon as valid GPS data are available. As a result the average power consumption is reduced by approximately 80 % (approximately 150 mW). The settings for the trickle power mode can be modified by using the SiRFstar demo software. For example if the GPS receiver is configured to enter the OnTime mode each 10 s for a duration of 200 ms the average power consumption can be reduced up to approx. 95 % (approx. 15 mW, ca. 4,8 mA at Vcc=3.3 V).

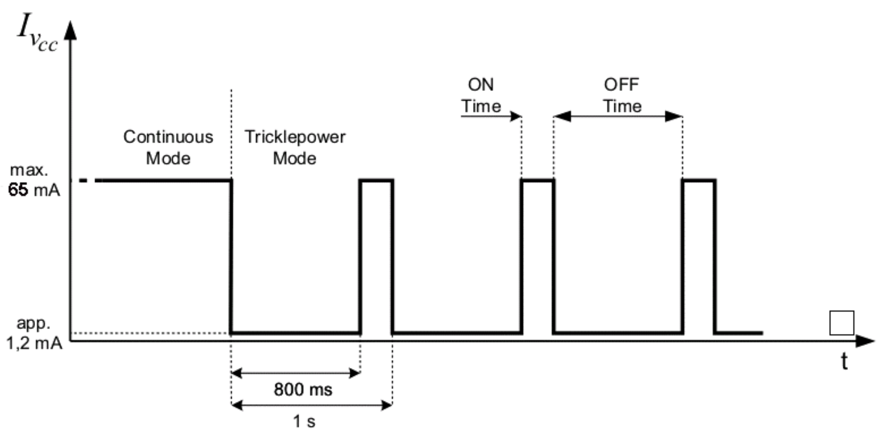


Figure 30: Example for the trickle power mode of GPS receiver

Hint: After initial turn on or system reset, the GPS receiver will remain in the full power tracking until a series of Kalman filter navigation solution is obtained, all ephemeris data is collected and the RTC is calibrated prior to transitioning to the low power duty cycle mode.

5.2.3 Push-to-Fix Mode

Please note that the integrated GPS receiver does not support this mode when it operates with SiRFXTrac2 software, see section 11.5.1. The Push-to-Fix mode puts the GPS receiver into a background duty cycle which provides a periodic refresh of position, receiver time, ephemeris data and RTC calibration every 30 minutes. The Push-to-Fix mode is similar but executive from Trickle Power mode, meaning that only one mode can be set at a time. In this mode the receiver sets itself into the sleep phase for 29.5 minutes and a full tracking phase for 30 seconds. During the tracking phase the GPS receiver acquires satellites, computes position and updates ephemeris data as well the RTC is being calibrated.
The transition into the Push-to-Fix mode of GPS receiver can be implemented and configured by using the SiRFdemo software. During the subsequent background cycles or when a user requests a position update (the GPS_M-RST has to be used) a reset is generated and a hot start will be typically performed which may take up to a maximum of 8 seconds. The receiver wakes up, computes its position fix and goes back to the previous sleep phase again.

5.3 NMEA input message for Trickle Power Mode

The input command message below sets the GPS receiver into the Trickle Power Mode or Push-To-Fix Mode. Details to configure Trickle Power Mode and Push-To-Fix Modes are described below.
The receiver accepts the input message with following format:

$PSRF107,<parameter>, <parameter> ,<parameter><* Checksum><CR> <LF>.

COMAND SYNTAX	DESCRIPTION
$PSRF10 7, ptf, dc, msot *XX <CR><LF>	**Parameters description:** ptf *// numeric, performs the receiver in one of two pre-defined modes* **Possible values:** **0: Set the receiver in Trickle Power mode** **1: Set the receiver in Push-To-Fix mode** dc *// numeric, Duty Cycle in percent (%)* **Possible value:** **max 1000: Set the time which will be spent for tracking (dc% / 10)** msot *// numeric, the on Time in milliseconds* **Possible value** **200.. 900: Set the time duration of each tracking period** *XX *// Checksum has to be calculated in hexadecimal.* Example: `$PSRF107,0,200,200*3D` *The receiver will be set in Trickle Power mode where 20% of time it will spend for tracking and the tracking period will takes 200 msec.*

Table 20: Example of Trickle Power Mode Control

Note:
If the receiver is set into the Trickle Power Mode, the high data rate transmission is recommend as suitable.

Computation of Duty Cycle and On Time

The Duty Cycle is the desired time, which will be spent for tracking. The On Time is the duration of each tracking period (range is 200 - 900 msec). To calculate the Trickle Power update rate as a function of Duty Cycle and On Time, use the following formula:

$$\textbf{Off Time} = \frac{\textbf{On Time} - (\textbf{Duty Cycle} * \textbf{On Time})}{\textbf{Duty Cycle}}$$

Update rate = Off Time + On Time

Hint:

It is not possible to enter an On Time > 900 msec

Following are some examples of selections:

Mode	On Time (msec)	Duty Cycle (%)	Update Rate (1/Hz)
Continuous	1000	100	1
Trickle Power	200	20	1
Trickle Power	200	10	2
Trickle Power	300	10	3
Trickle Power	500	5	10

Table 21: Example of Selections for Trickle Power Mode of Operation

	Update Rates (seconds)									
On Time (msec)	1	2	3	4	5	6	7	8	9	10
200	√	√	√	√	√	√	√	√	√	√
300	√	√	√	√	√	√	√	√	√	√
400	√	√	√	√	√	√	√	√	√	√
500	√	√	√	√	√	√	√	√	√	√
600	√	√	√	√	√	√	√	√	√	√
700		√	√	√	√	√	√	√	√	√
800		√	√	√	√	√	√	√	√	√
900		√	√	√	√	√	√	√	√	√

Table 22: Trickle Power supported Modes

Push-To-Fix

In this mode the receiver will turn on every 30 minutes to perform a system update consisting of a RTC calibration and satellite ephemeris data collection if required (i.e., a new satellite has become visible) as well as all software tasks to support SnapStart in the event of an NMEA. Ephemeris collection time in general takes 18 to 30 seconds. If ephemeris data is not required then the system will re-calibrate and shut down. In either case, the amount of time the receiver remains off will be in proportion to how long it stayed on:

$$\textbf{Off period} = \frac{\textbf{On Period} * \textbf{(1-Duty Cycle)}}{\textbf{Duty Cycle}}$$

The off period has a possible range between 10 and 7200 seconds. The default is 1800 seconds.

Comparison

A comparison of the Trickle Power and Push-to-Fix modes is shown in figure 31 below. This diagram shows that for position update intervals less than approximately 600 seconds (i.e. rates faster than one fix per 10 minutes), the Trickle Power mode at an update interval of 10 seconds offers a lower power solution. The user would then be required to filter the output position data to use only the data points corresponding to the desired update interval. For example, if the desired position output is at 60 second intervals, then the user would only need one out of every six position outputs at a 10 second Trickle Power update interval. Alternatively, the user could perform smoothing or averaging of the position data and provide an output at the desired rate.

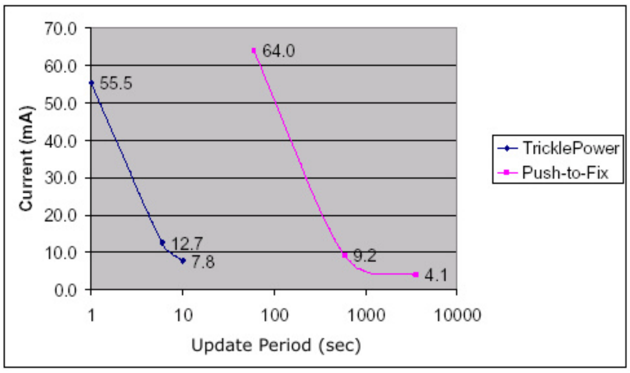


Figure 31: comparison of the Trickle Power and Push-to-Fix modes

5.4 Integrated GPS Receiver Architecture

The GPS receiver OEM GPS receiver from FALCOM is new OEM GPS receiver product that features the SiRFstarII-Low Power chipset. This completes 12 channel, WAAS-enabled GPS receiver provides a vastly superior position accuracy performance in a much smaller package. The SiRFstarII architecture builds on the high-performance SiRFstarI core, adding an acquisition accelerator, differential GPS processor, multipath mitigation hardware and satellite-tracking engine. The GPS receiver delivers major advancements in GPS performance, accuracy, integration, computing power and flexibility. Figure 31 above shows the block diagram of the GPS receiver architecture.

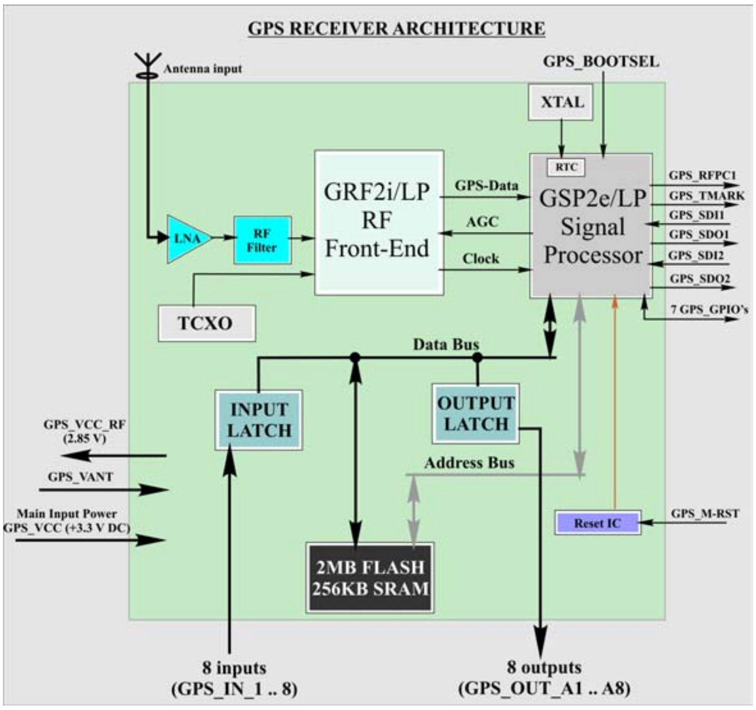


Figure 32: Architecture of the integrated GPS receiver as stand alone part of XF55-AVL

As shown in the figure above the integrated GPS receiver into XF55-AVL module demonstrate a device concept which builds perfect basis for the design in sufficient application fields of high-sensitive, low-power, compact and cost efficient state-of-the-art GPS enabled system solutions like hand-held devices, navigation, tracking and security systems and many others.

5.4.1 Description of GPS receiving signals

When the GPS receiver is initially turned on, it begins to determinate its current positions, velocity and time. In order to perform a successful start it must have a current almanac, a reasonable expectation of its current location and a reasonable idea of the current time. When the Ephemeris data are completely collected, then satellite signals are tracked continuously and the position is calculated from time to time.
While the receiver trying to obtain a position fix, it needs to be locked-on to at least four satellites. The receiver uses the satellite signals to calculate its exact current location by calculating the receiver distance from the satellites. The position data within the receiver is then converted into latitude and longitude coordinates, which are usually provided in the geodetic datum on which the GPS is based (WGS84).

5.5 GPS input signals

GPS_VCC

The input power is very important as far as the minimum and maximum voltage is concerned. The power supply of GPS part has to be a single voltage source of GPS_VCC at 3.3 V DC, typically. The power supply has to be able to provide a sufficient current which typically rises to 200 mA.

Please, connect GND pins to ground, and connect the line which supply the GPS_VCC pin to +3.3 V, properly. If they are correctly connected, the board is full powered and the unit begins obtaining its position fix.

GPS_VANT

This pin is an input and reserved for an external DC power supply for an active antenna.
The antenna bias for an external active antenna can be provided in two way to pin **V_ANT**. In order to use a 5 V active GPS antenna, the **GPS_VANT** has to be externally connected to +5 V power supply.
Other possibility is supported when you connect the **GPS_VCC_RF** output (which provides +3.0 V) to **GPS_VANT**, so that an active GPS antenna with +3.0 V supply voltage can be used.

Hint: The input voltage on the **GPS_VANT** should be chosen in according to the antenna to be used.

Note: The current of connected active GPS antenna must not exceed 25 mA.

GPS_VCC_RF

This pin is an output which provides +2.85 V DC, and can be connected to the **GPS_VANT**, to supply the connected GPS antenna. In Trickle Operation and Push-To-Fix operation, **GPS_VCC_RF** is switched off when the receiver sets itself into the sleep mode. When the receiver wakes up the **GPS_VCC_RF** is switched on.

5.6 Configuration and timing signals

GPS_M-RST

This pin provides an active-low reset input to the board. It causes the board to reset and to start searching for satellites. By pulling down M-RST for at least 1 µs, the integrated GPS receiver can externally be reset. The M-RST signal is also needed in Push-to-Fix mode to wake up the module from sleep mode, when a position is needed. If not used, it may be left open.

GPS_TMARK

This pin provides 1 pulse per second output from the board, which is synchronized to within 1 microsecond of GPS time. The output is a CMOS level signal. Please note that the SiRFXTrac2 software does not support this output.

GPS_BOOTSEL

Set this Pin to high (+3.3 V DC) for reprogramming the flash of the GPS receiver (for instance updating a new firmware for the GPS receiver).

GPS_RFPC1

GPS_RFPC1 pin is also provided on the GPS receiver signal lines which is available on the 80-pin board-to-board connector. This pin is a control output for the Trickle-Power Mode. A possible external circuit is shown in figure 33 below. If the LED lights permanently the GPS receiver is searching satellites. Is the GPS receiver in Trickle-Power Mode, the LED flashes in rhythm, i.e. the GPS receiver receives valid positions data (see also figure 6).

Note: By switched off Trickle power the LED will flash permanently. The reception of satellites data can be checked by using the T-Mark, however, can not be evaluated.

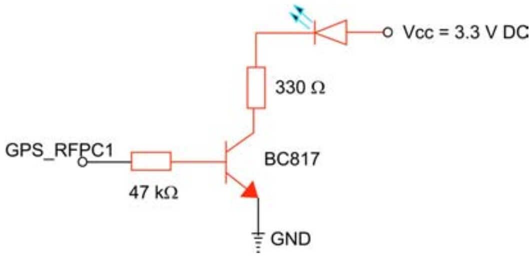


Figure 33: The control output for Trickle-Power Mode.

5.6.1 Serial communication signals

The physical interface to the integrated GPS receiver is performed through available lines on the 80-pin board-to-board connector. The GPS part supports two full duplex serial channels. Each interface is provided with two-wire the SDI1, SDO1 supports line and ground for the first serial interface (port A) and SDI2, SDO2 supports line and ground for the second serial interface (port B). These pins are 3.3 V CMOS level. In order to use different voltage levels, a appropriate level shifters has to be used.
E.g. in order to provide RS232 compatible levels use the 3 V compatible MAX3232 transceiver from Maxim or others based on the required levels. If a RS232 compatible serial level is obtained, then you can directly communicate with a host device serial port. The GPS data will be transmitted through port A (first serial port) to the host interface, if an active antenna is connected, which has to be located in a place with a good view to sky (no obstacle).

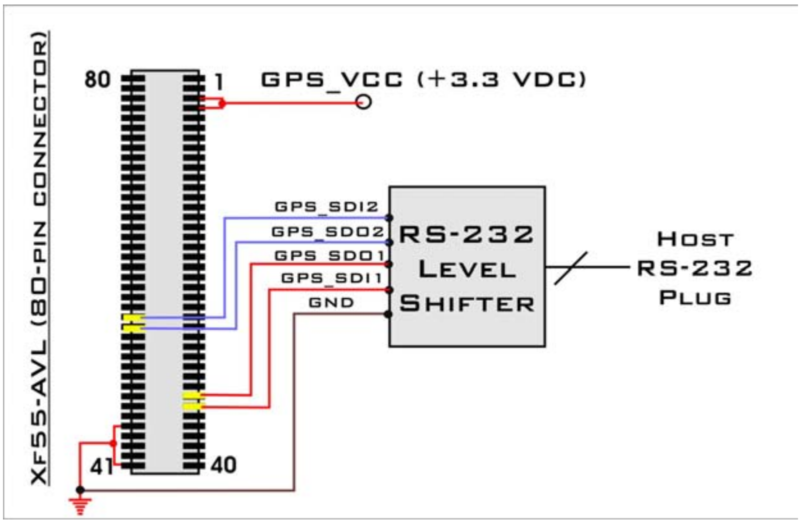


Figure 34: Using a RS-232 level shifter for GPS application

For increasing the accuracy, the GPS receiver is DGPS ready - being able to use DGPS corrections data in the RTCM SC-104 format. The port B (second serial port) can be used to feed in DGPS correction data. Connect pull-up resistor (by 100 kΩ) to the unused SDI inputs.

All supported variable baud rates can be controlled from the appropriate screens in SiRFdemo software. The GPS part has to be supplied by using externally +3.3 V DC at the GPS_VCC lines and GND's.

GPS_SDI1

This is the main receiving channel and is used to receive software commands to the board from SiRFdemo software or from user written software.

GPS_SDI2

This is the auxiliary receiving channel and is used to input differential corrections to the board to enable DGPS navigation.

GPS_SDO1

This is the main transmitting channel and is used to output navigation and measurement data to SiRFdemo or user written software.

GPS_SDO2

For user's application.

5.6.2 General purpose input/output

Several I/O's (GPIO0, GPIO1, GPIO5, GPIO6, GPIO7, GPIO10, GPIO15) of the CPU are connected to the hardware interface 80-pin connector of the XF55-AVL. They are reserved for customer specific applications.
For example:

- for realization a SPI-Bus
- for realization an Antenna-indication

These pins are not supported by the current GPS firmware.

5.6.3 General purpose input

All inputs provided on the 80-pin board-to-board connector can be used for user application. However, note that all inputs are not supported by using the standard (current) software. Their functionality is supported only by using AVL software which is an option of delivery or by writing your own developed software which has to be updated into the combo-memory device. These inputs can be used to trigger an alarm or sending an SMS to the control centre. All inputs reserved for customer specific applications can be configured as shown below:

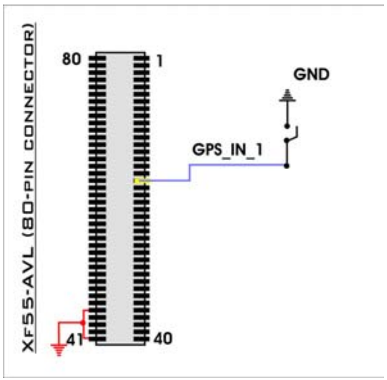


Figure 35: The possible schematic for input configuration.

5.6.4 General purpose Output

All outputs provided on the 80-pin board-to-board connector can be used for user proposed application. However, note that all outputs are not supported by using the standard (current) software. Their functionality is supported only by using AVL software which is an option of delivery or they can be supported by writing your own software. The outputs can be used to switch on/off something from remote. All outputs reserved for customer specific applications can be configured as shown below:

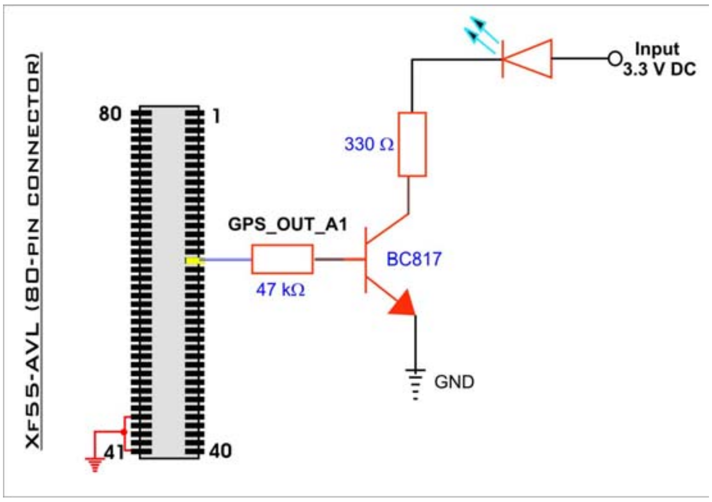


Figure 36: The possible schematic for output configuration

6 Hardware Interfaces

6.1 Determining the External Equipment Type

Before you connect one of provided serial ports on the XF55-AVL board to board connectors to external host application, you need to determine if its external hardware serial ports are configured as DTE or DCE.
The terms DTE (Data Terminal Equipment) and DCE (Data Communications Equipment) are typically used to describe serial ports on devices. Computers (PCs) generally use DTE connectors and communication devices such as modems and DSU/CSU devices generally use DCE connectors. As a general rule, DTE ports connect to DCE ports via straight through pinned cables. In other words, a DTE port never connects directly to another DTE port. In a similar manner, a DCE port never connects directly to another DCE port. The signalling definitions were written from the perspective of the DTE device; therefore, a Receive Data signal becomes an input to DTE but an output from DCE.

The Falcom XF55-AVL is designed for use as a DCE. Based on the aforementioned conventions for DCE-DTE connections it communicates with the customer application (DTE) using the following signals:

XF55-AVL (DCE)	to	Application (DTE)
GSM_TXD0(1)	◄----------------------	TXD
GSM_RXD0(1)	----------------------►	RXD
GSM_RTS0(1)	◄----------------------	RTS
GSM_CTS0(1)	----------------------►	CTS
GSM_DTR0	◄----------------------	DTR
GSM_DSR0	----------------------►	DSR
GSM_DCD0	----------------------►	DCD
GSM_RING0	----------------------►	RING

Table 23: Definitions between DTE and DCE ports

6.2 Interfaces overview

This chapter describes several interfaces incorporated into the XF55-AVL module:

- Application interface (80-pin board-to-board connector)
- Application interface (50-pin board-to-board connector, GSM/GPRS applications, only)
- RF interface
- Electrical and mechanical characteristics
- Mounting holes

Interface specifications	
Interface A	80-pin board-to-board connector (GSM/GPRS and GPS signals)
Interface B	50-pin board-to-board connector (GSM/GPRS signals, only)
Interface C	GSM RF Connector
Interface D	GPS RF connector
Interface E	Mounting holes

Table 24: Interface specifications

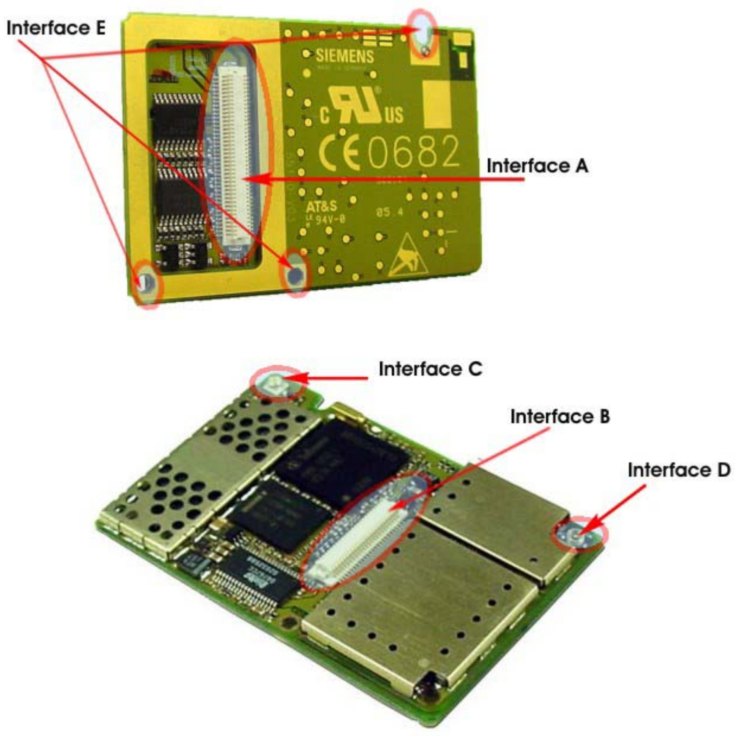


Figure 37: Interface of XF55-AVL module

6.2.1 Interface A (80-pin board to board connector)

The primary physical interface to the GSM/GPRS and GPS applications is through the 80-pin board-to-board connector. The receptacle assembled on the XF55-AVL is type Hirose DF12C. This connector offers one serial GSM interface (ASC0) and two serial GPS interfaces as well as all control pins which giving you maximum flexibility for easy integration with the Man-Machine Interface (MMI). The positions of the pins can be seen from figure below which shows the bottom view of XF55-AVL. Mating headers can be chosen from the Hirose DF12C series.

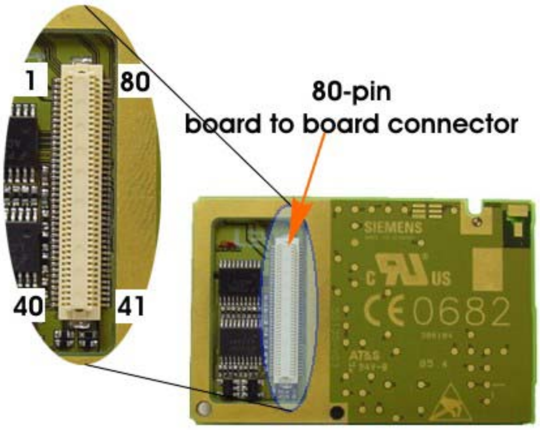


Figure 38: View of the 80-pin board-to-board connector

6.2.2 Interface B (50-pin board to board connector)

The secondary physical interface to the GSM/GPRS applications is through the 50-pin board-to-board connector. The receptacle assembled on the XF55-AVL is also type Hirose DF12C. This connector offers two serial GSM interface (ASC0 and ASC1) as well as all control pins which giving you maximum flexibility for easy integration with the Man-Machine Interface (MMI). The positions of the pins can be seen from figure below which shows the top view of XF55-AVL. Mating headers can be chosen from the Hirose DF12C series.

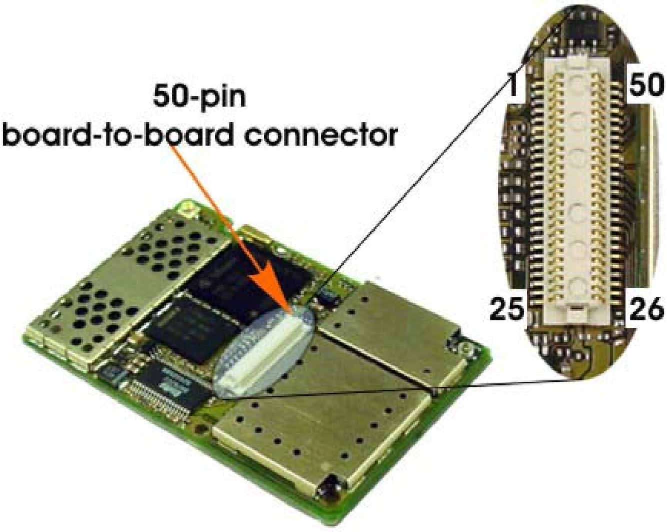


Figure 39: View of the 50-pin board-to-board connector

6.2.3 Interface C (GSM antenna installation)

The RF interface has an impedance of 50Ω. XF55-AVL is capable of sustaining a total mismatch at the antenna connector or 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 and harmonic suppression. Matching networks are not included on the XF55-AVL PCB and should be placed in the host application.
Regarding the return loss XF55-AVL provides the following values:

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.

6.2.3.1 GSM antenna connector

The XF55-AVL uses two ultra-miniature SMT antenna connector supplied from Hirose Ltd. One of them see attached image below, is provided for GSM RF connection. The GSM RF connector has impedance 50 Ω. A GSM antenna can be directly connected to this connector. Figure below show the position of GPS antenna connector as well as its general mechanical dimensions. Mating plugs and cables can be chosen from the Hirose U.FL series. (see chapter appendix, too).

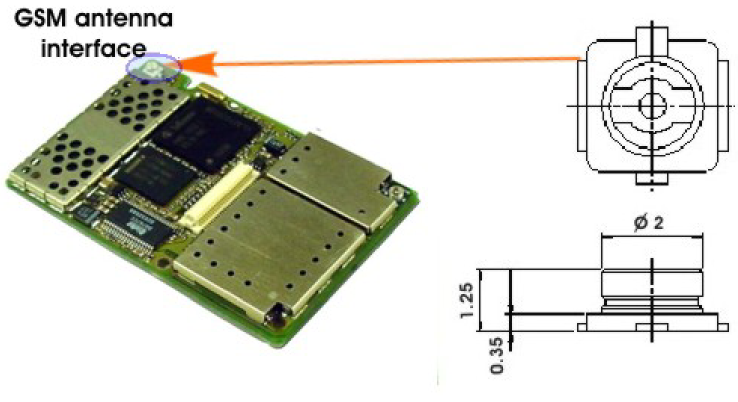


Figure 40: View of the GSM antenna connector

The XF55-AVL module offers another possibility for connecting a GSM antenna to the XF55-AVL. On the bottom side of module is placed an antenna pad and grounding plane for user application. Refer to the **Figure 43** for a view of antenna pads.

6.2.4 Interface D (GPS antenna interface)

The XF55-AVL uses two ultra-miniature SMT antenna connector supplied from Hirose Ltd. The GPS RF connector see attached image below has impedance 50 Ω. The SMT connector is provided for a GPS active antenna connection. Active antennas have an integrated low-noise amplifier. They can be directly connected to this connector. If an active antenna is connected to this connector, the integrated low-noise amplifier of the antenna needs to be supplied with the correct voltage through pin **GPS_VANT (**see chapter 5.5). Figure below show the position of GPS antenna connector as well as its general mechanical dimensions. Mating plugs and cables can be chosen from the Hirose U.FL series. (see chapter Appendix 11.3, too).

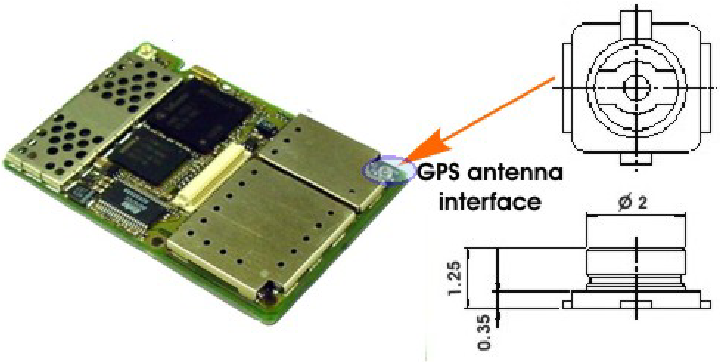


Figure 41: View of the GSM antenna connector

Caution: Do not connect or disconnect the antenna when the XF55-AVL is running.

Caution: The RF connector is always fed from the input voltage on the GPS_VANT pin. Do not use any input voltage on this connector.

6.2.5 Interface E (Mounting holes)

The XF55-AVL compact device provides also 3 holes for attaching into a host device. As a reference for mounting holes use figure 42 attached below on this section.

An efficient approach is to mount the XF55-AVL PCB to a frame, plate, rack or chassis. In order to avoid any damage during mounting the module is required to choose properly the attachment screws. Fasteners can be M1.6 or M1.8 screws plus suitable washers, circuit board spacers, or customized screws, clamps, or brackets. Screws must be inserted with the screw head on the bottom of the XF55-AVL PCB. If the bottom of XF55-AVL faces the holding device, only use the ground pads for the connection. To avoid short circuits ensure that the remaining sections of the XF55-AVL PCB do not come into contact with the host device since there are a number of test points. The largest ground pad in the middle of the board can also be used to attach cooling elements, e.g. a heat sink or thermally conductive tape.

Figure 42: View of the mounting holes

Figure below shows the bottom view of XF55-AVL and marks the test points and pads for GSM antenna connection. See also chapter 11.4

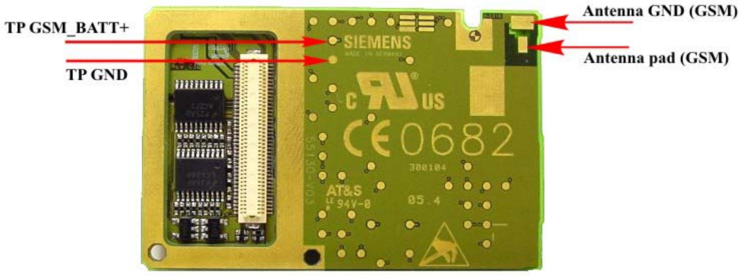


Figure 43: XF55-AVL bottom view

7 Electrical, reliability and radio characteristics

7.1 Absolute maximum ratings

Absolute maximum ratings for supply voltage and voltages on digital and analog pins of XF55-AVL are listed in table 24. Exceeding these values will cause permanent damage to XF55-AVL .

Parameter	Min	Max	Unit
Voltage GSM_BATT+	-0.3	4.8	V
Voltage at digital pins	-0.3	3.3	V
Voltage at analog pins	-0.3	3.0	V
Voltage at digital/analog pins in POWER DOWN mode	-0.25	+0.25 V	
Voltage at GSM_POWER pin		-15	V
Voltage at GSM_CHARGE pin		-15	V
Differential load resistance between EPNx and EPPx	15		Ω

Table 24: Absolute maximum ratings (GSM/GPRS part)

Parameter	Min	Max	Unit
Voltage at GPS_VCC	3.14	3.64	V
Current at GPS_VCC_RF		25	mA

Table 25: Absolute maximum rating (GPS part)

7.2 Operating temperatures

Parameter	Min	Typ	Max	Unit
Ambient temperature (according to GSM 11.10)	-20	25	50	°C
Restricted operation *)	-25 to -20		55 to 70	°C
Automatic shutdown XF55-AVL board temperature Battery temperature	 -29°C -18°C		 >70**) >60	 °C
Charging temperature (software controlled fast charging)	0°C		+45	°C

Table 26: Operating temperature

*) XF55-AVL works, but deviations from the GSM specification may occur.

**) Consider the ratio of output power, supply voltage and operating temperature: To achieve Tamb max = 70 °C and, for example, GSM 900 PCL5 the supply voltage must not be higher than 4.0 V.

7.3 Electrical characteristics of the voice band part

7.3.1 Setting audio parameters by AT commands

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

Parameter	Influence to	Range	Gain range	Calculation
inBbcGain	MICP/MICN analogue amplifier gain of base band controller before ADC	0...7	0...42 dB	6d B steps
inCalibrate	digital attenuation of input signal after ADC	0...327 67	-∞...0 dB	20 * log (inCalibrate/ 32768)
outBbcGain	EPP/EPN analog output gain of base band controller after DAC	0...3	0...-18 dB	6 dB steps
outCalibrate[n] n = 0...4	digital attenuation of output signal after speech decoder, before summation of sidetone and DAC present for each volume step [n]	0...327 67	-∞...+6 dB	20 * log (2 * outCalibrate[n]/ 32768)
sideTone	digital attenuation of sidetone is corrected internally by outBbcGain to obtain a constant sidetone independent of output volume	0...327 67	-∞...0dB	20 * log (sideTone/ 32768)

Table 27: Setting audio parameters by AT commands

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

7.3.2 Audio programming model

The audio programming model shows how the signal path can be influenced by varying the AT command parameters. The model is the same for all three interfaces, except for the parameters <outBbcGain> and <inBbcGain> which cannot be modified if the digital audio interface is being used, since in this case the DAC is switched off.
The parameters inBbcGain and inCalibrate can be set with `AT^SNFI`. All the other parameters are adjusted with `AT^SNFO`.

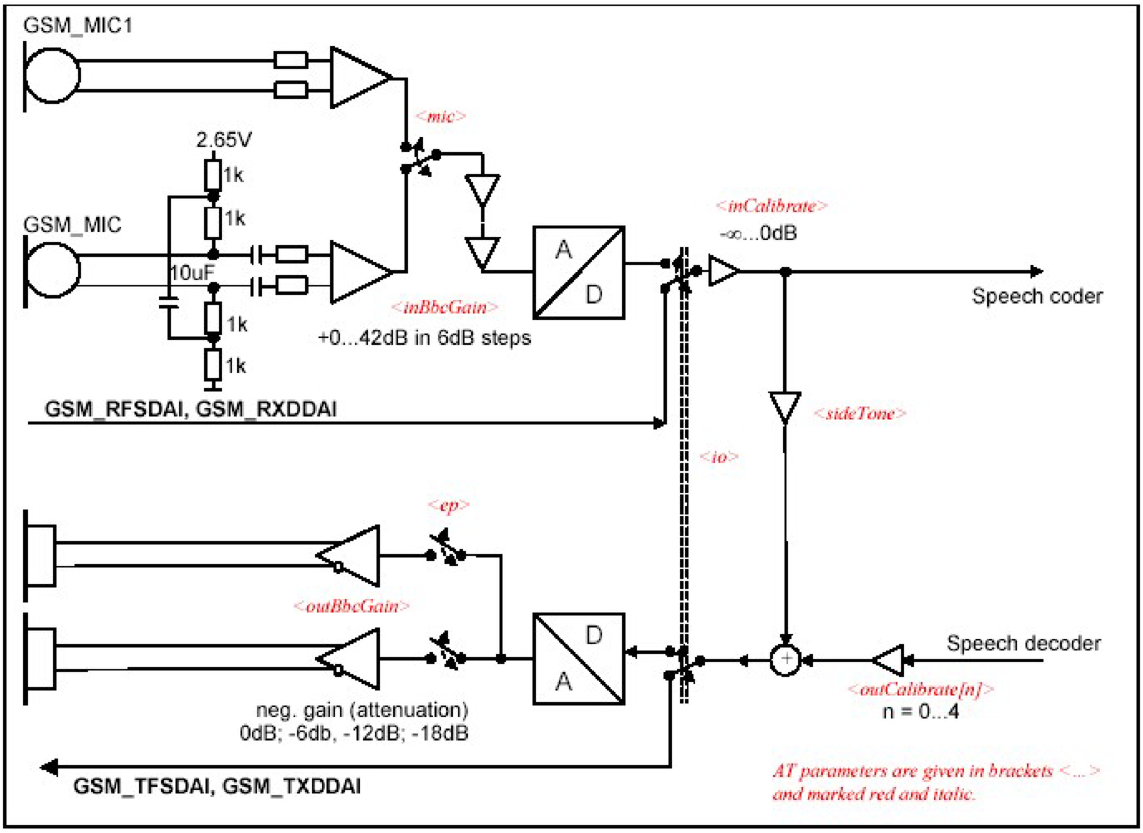


Figure 44: AT audio programming model

7.3.3 Characteristics of audio modes

The electrical characteristics of the voice band part depend on the current audio mode set with the AT^SNFS command.

Audio mode no. AT^SNFS=	**1 (Default settings, not adjustable)**	**2**	**3**	**4**	**5**	**6**
Name	**Default Handset**	**Basic Handsfree**	**Headset**	**User Handset**	**Plain Codec 1**	**Plain Codec 2**
Gain setting via AT command. Defaults: inBbcGain outBbcGain	**Fix 4 (24 dB) 1 (-6 dB)**	**Adjustable 2 (12 dB) 1 (-6 dB)**	**Adjustable 5 (30 dB) 2 (-12 dB)**	**Adjustable 4 (24 dB) 1 (-6 dB)**	**Adjustabl e 0 (0 dB) 0 (0 dB)**	**Adjustabl e 0 (0 dB) 0 (0 dB)**
Default audio interface	**1**	**2**	**2**	**1**	**1**	**2[4)]**
Power supply	**ON(2.65 V)**	**ON(2.65 V)**	**ON(2.65 V)**	**ON(2.65 V)**	**OFF(GND)**	**OFF(GND)**
Sidetone	**ON**	**---**	**Adjustable**	**Adjustable**	**Adjustabl e**	**Adjustabl e**
Volume control	**OFF**	**Adjustable**	**Adjustable**	**Adjustable**	**Adjustabl e**	**Adjustabl e**
Limiter (receive)	**ON**	**ON**	**ON**	**ON**	**---**	**---**
Compressor (receive)	**---**	**OFF[1)]**	**---**	**---**	**---**	**---**
AGC (send)	**---**	**---**	**ON**	**---**	**---**	**---**
Echo control (send)	**Suppression**	**Cancellatio n + suppression**	**---**	**Suppression**	**---**	**---**
Noise suppression[2)]	**---**	**up to 10dB**	**10dB**	**---**	**---**	**---**
MIC input signal for	**23 mV**	**58 mV**	**7.5 mV @**	**23 mV**	**315 mV**	**315 mV**

0dBm0 @ 1024 Hz (default gain)			**-3dBm0 due to AGC**			
EP output signal in mV rms. @ 0dBm0, 1024 Hz, no load (default gain); @ 3.14 dBm0	**284 mV**	**120 mV default @ max volume**	**300 mV default @ max volume**	**284 mV default @ max volume**	**895 mV 3.7 Vpp**	**895 mV 3.7 Vpp**
Side tone gain at default settings	**22.8 dB**	**-∞ dB**	**Affected by AGC, 13 dB @ 7.5 mV (MIC)**	**22.8 dB**	**-2.5 dB @ sideTone = 8192[3]**	**-2.5 dB @ sideTone = 8192[3]**

Table 28: Voice-band characteristics (typical)

1) Adaptive, receive volume increases with higher ambient noise level. The compressor can be activated by loading an application specific audio parameter set (see [10]).

2) In audio modes with noise reduction, the microphone input signal for 0dBm0 shall be measured with a sine burst signal for a tone duration of 5 seconds and a pause of 2 sec. The sine signal appears as noise and, after approx. 12 sec, is attenuated by the noise reduction by up to 10 dB.

3) See AT^SNFO command in [4].

4) Audio mode 5 and 6 are identical. With `AT^SAIC`, you can easily switch mode 5 to the second interface.

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

7.3.4 Voice band receive path

Test conditions:

- The values specified below were tested to 1 kHz and 0 dB gain stage, unless otherwise stated.
- Parameter setup: gs = 0 dB means audio mode = 5 for GSM_EPP1 to GSM_EPN1 and 6 for GSM_EPP2 to GSM_EPN2, inBbcGain= 0, inCalibrate = 32767, outBbcGain = 0, OutCalibrate = 16384, sideTone = 0.

Parameter	Min	Typ	Max	Unit	Test condition / remark
Differential output voltage (peak to peak)	**3.33**	**3.7**	**4.07**	**V**	**from GSM_EPPx to GSM_EPNx *gs* = 0 dB @ 3.14 dBm0 no load**
Differential output gain settings (*gs*) at 6 dB stages (outBbcGain)	**-18**		**0**	**dB**	**Set with AT^SNFO**
Fine scaling by DSP (outCalibrate)	**-∞**		**0**	**dB**	**Set with AT^SNFO**
Output differential DC offset			**100**	**mV**	***gs* = 0dB, outBbcGain = 0 and –6 dB**
Differential output resistance		**2**		**Ω**	**from GSM_EPPx to GSM_EPNx**
Differential load capacitance			**1000**	**pF**	**from GSM_EPPx to GSM_EPNx**
Absolute gain accuracy			**0.8**	**dB**	**Variation due to change in temperature and life time**
Attenuation distortion			**1**	**dB**	**for 300...3900Hz, @ GSM_EPPx/ GSM_EPNx (333Hz) / @ GSM_EPPx/ GSM_EPNx (3.66kHz)**
Out-of-band discrimination	**60**			**dB**	**for *f* > 4kHz with in-band test signal@ 1 kHz and 1 kHz RBW**

Table 29: Voice band receive path

---

gs = gain setting

7.3.5 Voice band transmit path

Test conditions:

- ❖ The values specified below were tested to 1 kHz and 0 dB gain stage, unless otherwise stated.
- ❖ Parameter setup: Audio mode = 5 for GSM_MICP1 to GSM_MICN1 and 6 for GSM_MICP2 to GSM_MICN2, inBbcGain= 0, inCalibrate = 32767, outBbcGain = 0, OutCalibrate = 16384, sideTone = 0

Parameter	Min	Typ	Max	Unit	Test condition/remark
Input voltage (peak to peak) GSM_MICP1 to GSM_MICN1, GSM_MICP2 to GSM_MICN2			1.03	V	
Input amplifier gain in 6 dB steps (inBbcGain)	0		42	dB	Set with AT^SNFI
Fine scaling by DSP (inCalibrate)	-∞		0	dB	Set with AT^SNFI
Input impedance GSM_MIC1		50		kΩ	
Input impedance GSM_MIC2		2.0		kΩ	
Microphone supply voltage ON Ri = 4 kΩ (GSM_MIC2 only)	2.57 2.17 1.77	2.65 2.25 1.85	2.73 2.33 1.93	V V V	no supply current @ 100 µA @ 200 µA
Microphone supply voltage OFF; Ri = 4 kΩ (GSM_MIC2 only)		0		V	
Microphone supply in POWER DOWN mode					See figure 20

Table 30: Voice band transmit path

7.4 Air interface of the XF55-AVL GSM/GPRS part

Test conditions:

All measurements have been performed at T_{amb}= 25 °C, V_{GSM_BATT+} nom = 4.1 V. The reference points used on XF55-AVL are the GSM_BATT+ and GND contacts (test points are shown in figure 52).

Parameter		Min	Typ	Max	Unit
Frequency range Uplink (MS → BTS)	E-GSM 900	880		915	MHz
	GSM 900	1710		1785	MHz
Frequency range Downlink (BTS → MS)	GSM 1800	1850		1910	MHz
	E-GSM 1900	925		960	MHz
	GSM 1800	1805		1880	MHz

	GSM 1900	1930		1990	MHz
RF power @ ARP with 50 Ω load	E-GSM 900	31	33	35	dBm
	GSM 1800	28	30	32	dBm
	GSM 1900	28	30	32	dBm
	E-GSM 900		174		
	GSM 1800		374		
	GSM 1900		299		dBm
Duplex spacing	E-GSM 900		45		MHz
	GSM 1800		95		MHz
	GSM 1900		80		MHz
Carrier spacing			200		kHz
Multiplex, Duplex		TDMA/FTDMA, FDD			
Time slots per TDMA frame			8		
Frame duration			4.615		ms
Time slot duration			577		µs
Modulation		GMSK			
Receiver input sensitivity @ ARP BER Class II < 2.4 %	E-GSM 900	-102	-107		dBm
	GSM 1800	-102	-106		dBm
	GSM 1900	-102	-106		dBm

Table 31: Air Interface

7.5 Electrostatic discharge

The GSM engine is not protected against Electrostatic Discharge (ESD) in general. Consequently, it is subject to ESD handling precautions that typically apply to ESD sensitive components. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates a XF55-AVL module.
Special ESD protection provided on XF55-AVL:
Antenna interface: one spark discharge line (spark gap)
SIM interface: clamp diodes for protection against over voltage.
The remaining ports of XF55-AVL are not accessible to the user of the final product (since they are installed within the device) and therefore, are only protected according to the “Human Body Model” requirements.
XF55-AVL has been tested according to the EN 61000-4-2 standard. The measured values can be gathered from the following table.

Specification/Requirements	**Contact discharge**	**Air discharge**
ETSI EN 301 489-7		
ESD at SIM port (GSM)	± 4 kV	± 8 kV
ESD at GSM antenna port	± 4 kV	± 8 kV
Indirect ESD to GSM/GPRS part	± 4 kV	-
Indirect ESD to GPS part	± 4 kV	-
Human Body Model (Test conditions: 1.5 kΩ, 100 pF)		
ESD at GPS antenna port	± 1 kV	
ESD at all other ports	± 1 kV	
Please note that the values may vary with the individual application design. For example, it matters whether or not the application platform is grounded over external devices like a computer or other equipment, such as the Falcom reference application described in chapter 9.		

Table 32: Measured electrostatic values

7.6 Reliability characteristics

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

Type of test	**Conditions**	**Standard**
Vibration	Frequency range: 10-20 Hz; acceleration: 3.1 mm amplitude Frequency range: 20-500 Hz; acceleration: 5 g Duration: 2h per axis = 10 cycles; 3 axes	DIN IEC 68-2-6
Shock half-sinus	Acceleration: 500 g Shock duration: 1 msec 1 shock per axis 6 positions (± x, y and z)	DIN IEC 68-2-27
Dry heat	Temperature: +70 ±2 °C Test duration: 16 h Humidity in the test chamber: < 50 %	EN 60068-2-2 Bb ETS 300019-2-7
Temperature change (shock)	Low temperature: -40 °C ±2 °C High temperature: +85 °C ±2 °C Changeover time: < 30 s (dual chamber system) Test duration: 1 h Number of repetitions: 100	DIN IEC 68-2-14 Na ETS 300019-2-7
Damp heat cyclic	High temperature: +55 °C ±2 °C Low temperature: +25 °C ±2 °C Humidity: 93 % ±3 % Number of repetitions: 6 Test duration: 12 h + 12 h	DIN IEC 68-2-30 Db ETS 300019-2-5
Cold (constant exposure)	Temperature: -40 ±2°C Test duration: 16 h	DIN IEC 68-2-1

Table 33: Summary of reliability test conditions

8 Housing

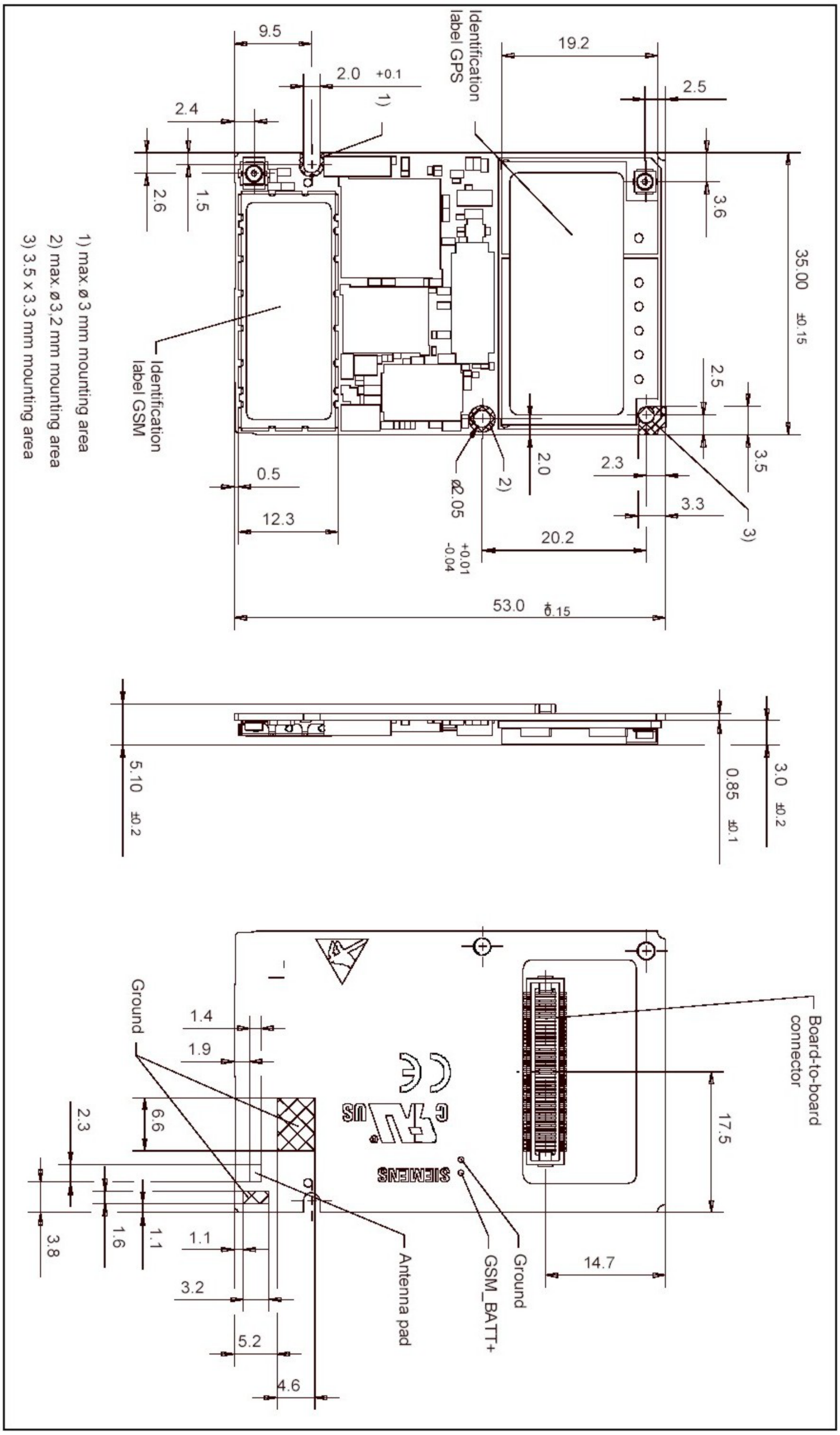


Figure 45: Housing of the XF55-AVL

9 Reference equipment for test

The Falcom reference set-up to test XF55-AVL consists of the following components:

- ✓ Falcom XF55-AVL cellular engine
- ✓ Evaluation Board
- ✓ Flex cable (160 mm) from Hirose DF12C receptacle on XF55-AVL to Hirose DF12 connector on Evaluation Board. Please note that this cable is not included in the scope of delivery of Evaluation Board.
- ✓ SIM card reader integrated on Evaluation Board
- ✓ Handset
- ✓ PC as MMI

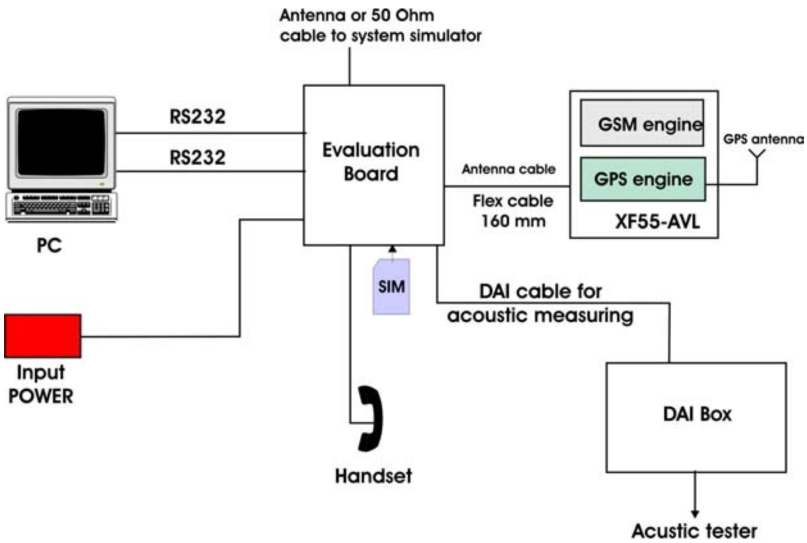


Figure 46: Reference equipment for test

10 List of parts and accessories

Description	Supplier	Ordering information
XF55-AVL module	**Falcom**	**Falcom ordering number: XF55-AVL**
GSM/GPS combined antenna with FME and SMA connectors (for XF55-AVL module)	**Falcom**	**Falcom ordering number: FAL-ANT-2**
GSM antenna (for XF55-AVL module)	**Falcom**	**Falcom ordering number: ANT-001**
GPS antenna (for XF55-AVL module)	**Falcom**	**Falcom ordering number: FAL-ANT-3 or FAL-ANT-4**
GSM antenna cable (U.FL FME) (for XF55-AVL module)	**Falcom**	**Falcom ordering number: KA17**
GPS antenna cable (U.FL SMA) (for XF55-AVL module)	**Falcom**	**Falcom ordering number: KA16**
XF55-AVL Evaluation Kit	**Falcom**	**Falcom ordering number: XF55-EVALKIT**
Votronic Handset	**VOTRONIC**	**Votronic HH-SI-30.3/V1.1/0 VOTRONIC Entwicklungs- und Produktionsgesellschaft fur elektronische Geräte GmbH Saarbrücker Str. 8 66386 St. Ingbert Germany Phone: +49-(0)6 89 4 / 92 55-0 Fax: +49-(0)6 89 4 / 92 55-88 e-mail: contact@votronic.com**
SIM card holder incl. push button ejector and slide-in tray	**Molex**	**Ordering numbers: 91228 91236 Sales contacts are listed in Table 35.**
DF12C board-to-board connector	**Hirose**	**See Appendix for details on receptacle on XF55-AVL and mating headers. Sales contacts are listed in Table 36.**
U.FL-R-SMT antenna connector	**Hirose**	**See Appendix for details on U.FL-R-SMT connector, mating plugs and cables. Sales contacts are listed in Table 36.**

Table 34: List of parts and accessories

Molex For further information please click: http://www.molex.com/	**Molex Deutschland GmbH Felix-Wankel-Str. 11 4078 Heilbronn-Biberach Germany Phone: +49-7066-9555 0 Fax: +49-7066-9555 29 Email: mxgermany@molex.com**	**American Headquarters Lisle, Illinois 60532 U.S.A. Phone: +1-800-78MOLEX Fax: +1-630-969-1352**
Molex China Distributors Molex Singapore Pte. Ltd. Beijing, Room 1319, Tower B, COFCO Plaza No. 8, Jian Guo Men Nei Street, 100005 Beijing P.R. China Phone: +86-10-6526-9628 Phone: +86-10-6526-9728 Phone: +86-10-6526-9731 Fax: +86-10-6526-9730	**Molex Japan Co. Ltd. Jurong, Singapore Phone: +65-268-6868 Fax: +65-265-6044**	**Yamato, Kanagawa, Japan Phone: +81-462-65-2324 Fax: +81-462-65-2366**

Table 35: Molex sales contacts (subject to change)

Hirose Ltd. For further information please click- U.S.A. http://www.hirose.com Fax: +1-805-522-3217 Fax +49-711-4560-729 E-mail info@hirose.de	**Hirose Electric (U.S.A.) Inc 2688 Westhills Court Simi Valley CA 93065 Kemnat4 Phone: +1-805-522-7958 Phone: +49-711-4560-021**	**Hirose Electric GmbH Zeppelinstrasse 42 73760 Ostfildern Germany**
Hirose Electric UK, Ltd Crownhill Business Centre 5-23, Osaki 5 Chome, 22 Vincent Avenue, Crownhill Milton Keynes, MK8 OAB Japan Great Britain Phone:+44-1908-305400 Fax: +81-03-3493-2933	**Hirose Electric Co., Ltd. European Branch Shinagawa-Ku Tokyo 141 1119PV Schiphol-Rijk Phone: +81-03-3491-9741 Phone: +31-20-6557-460**	**Hirose Electric Co., Ltd. First class Building 4F Beechavenue 46 Netherlands**

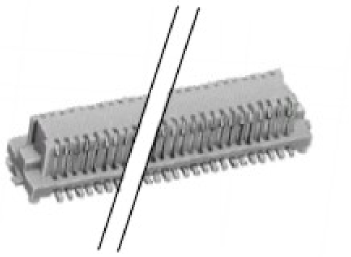
Table 36: Hirose sales contacts (subject to change)

11 Appendix

11.1 80-pin board-to-board connector

This chapter provides specifications for the 80-pin board-to-board connector which serves as physical interface to the host application. The receptacle assembled on the XF55-AVL is type Hirose DF12C, Part number: **DF12C(3.0)-80DS-0.5V(81)**. Mating headers from Hirose are available in different stacking heights:

Parts numbers of 80-pin headers by Hirose Ltd: **DF12D(3.0)-80DP-0.5V(81)**
DF12E(3.0)-80DP-0.5V(81)



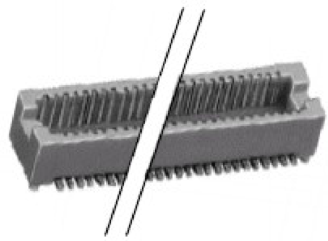


Figure 47.a: Hirose DF12C receptacle on XF55-AVL **Figure 47.b:** Header Hirose DF12C

Figure below shows the mechanical dimensions of Hirose DF12C 80-pin board to board receptacle on XF55-AVL.

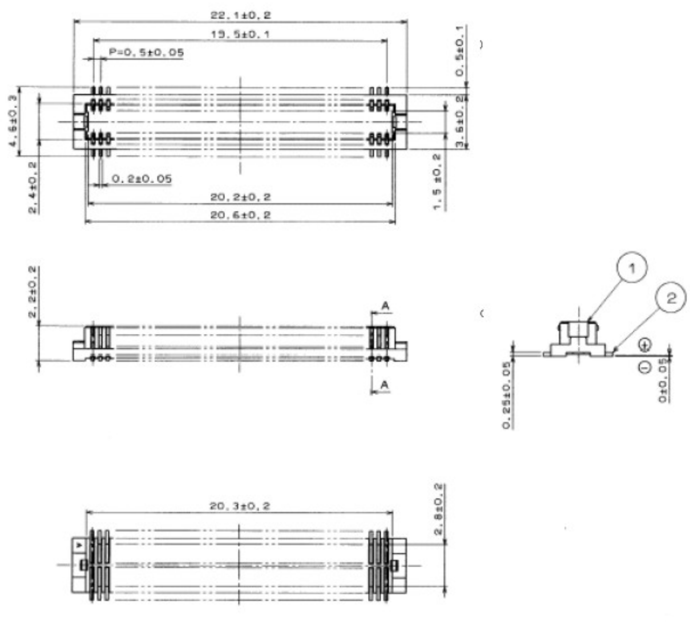


Figure 48: Mechanical dimensions of Hirose DF12C 80-pin receptacle

Parameter	Specification (80 pin board-to-board connector)
Number of contacts	80
Voltage	50 V
Rated current	0.3 A max per contact
Resistance	0.05 Ohm per contact
Dielectric withstanding voltage	500 V RMS min

Operating temperature	-45 °C...+125 °C
Contact material	phosphor bronze (surface: gold plated)
Insulator material	PA, beige natural
Stacking height	3.0 mm
Insertion force	21.8 N
Withdrawal force 1st	10 N
Withdrawal force 50th	10 N
Maximum connection cycles	50

Table 37: Electrical and mechanical characteristics of the Hirose DF12C 80-pin connector

11.2 50-pin board-to-board connector

This chapter provides specifications for the 50-pin board-to-board connector which serves as physical interface to the host application. The receptacle assembled on the XF55-AVL is type Hirose DF12C, Part number: **DF12C(3.0)-50DS-0.5V(81)**. Mating headers from Hirose are available in different stacking heights.

Parts numbers of 50-pin headers by Hirose Ltd: **DF12D(3.0)-80DP-0.5V(81)**
DF12E(3.0)-80DP-0.5V(81)

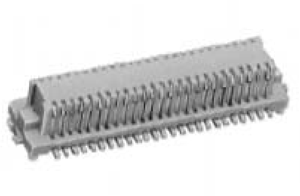


Figure 49.a: Hirose DF12C receptacle on XF55-AVL **Figure 49.b:** Header Hirose DF12C

Figure below shows the mechanical dimensions of Hirose DF12C 50-pin board to board receptacle on XF55-AVL.

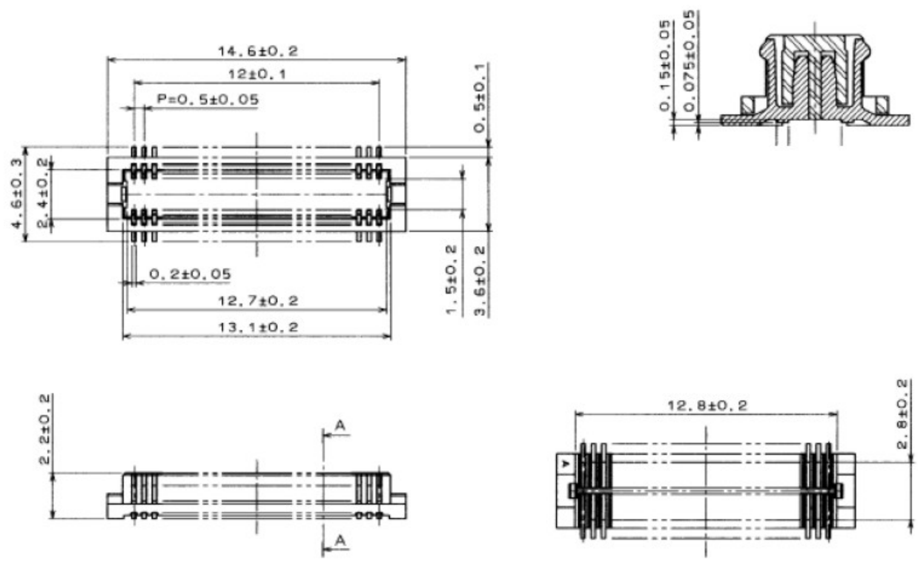


Figure 50: Mechanical dimensions of Hirose DF12C 50-pin receptacle

Parameter	Specification (50 pin board-to-board connector)
Number of contacts	50
Voltage	50 V
Rated current	0.3 A max per contact
Resistance	0.05 Ohm per contact
Dielectric withstanding voltage	500 V RMS min
Operating temperature	-45 °C...+125 °C
Contact material	phosphor bronze (surface: gold plated)
Insulator material	PA, beige natural
Stacking height	3.0 mm; 3.5 mm; 4.0 mm; 5.0 mm
Insertion force	21.8 N
Withdrawal force 1st	10 N
Withdrawal force 50th	10 N
Maximum connection cycles	50

Table 38: Electrical and mechanical characteristics of the Hirose DF12C 50-pin connector

11.3 GSM and GPS antenna connectors

The XF55-AVL uses an ultra-miniature SMT antenna connector supplied from Hirose Ltd.
Mating plugs and cables can be chosen from the Hirose U.FL series. Examples are shown in figure below. For latest product information please contact your Hirose dealer or visit the Hirose home page, for example http://www.hirose.com.

Figure 51: Mechanical dimensions of U.FL-R-SMT connector with U.FL-LP-040 plug

Item	Specification
Nominal impedance	50 Ω
Rated frequency	DC to 6 GHz
Female contact holding force	0.15 N min
Repetitive operation	Contact resistance: Centre 25 mΩ Outside 15 mΩ
Vibration	No momentary disconnections of 1 µs; No damage, cracks and looseness of parts
Shock	No momentary disconnections of 1 µs. No damage, cracks and looseness of parts.
Humidity resistance	No damage, cracks and looseness of parts.

	Insulation resistance: 100 MΩ min. at high humidity 500 MΩ min when dry
Temperature cycle	No damage, cracks and looseness of parts. Contact resistance: Centre 25 mΩ Outside 15 mΩ
Salt spray test	No excessive corrosion

Table 39: Electrical and mechanical characteristics of the Hirose U.FL-R-SMT connector

11.4 GSM antenna pad

The antenna can be soldered to the pad, or attached via contact springs. To help you ground the antenna, XF55-AVL comes with a grounding plane located close to the antenna pad. The positions of both pads can be seen from figure 43.
When you decide to use the antenna pad take into account that the pad has not been intended as antenna reference point (ARP) for the Falcom XF55-AVL test. The antenna pad is provided only as an alternative option which can be used, for example, if the recommended Hirose connection does not fit into your antenna design.
To prevent damage to the module and to obtain long-term solder joint properties you are advised to maintain the standards of good engineering practice for soldering.
XF55-AVL material properties:
XF55-AVL PCB: FR4
Antenna pad: Gold plated pad
Suitable cable types:
For direct solder attachment, we suggest to use the following cable types:
- ✓ RG316/U 50 Ohm coaxial cable
- ✓ 1671A 50 Ohm coaxial cable

11.5 Firmware Interface

The table below shows supported SiRF firmware versions into the XF55-AVL device.

Device Name	Supported SiRF internal firmware version			
	2.20	2.32	SiRFXTrac2	eCos SDK
XF55-AVL	X	X	X	X

Table 40: Supported SiRF firmware on the XF55-AVL integrated GPS receiver.

11.5.1 XTrac firmware description

The XF55-AVL using SiRFXTrac2 software offers high position accuracy and fast Time-To-First-Fix (TTFF) than is currently possible with other autonomous GPS solution. This means that the XF55-AVL will continue to determinate its positions or obtain an initial fix in places where previously not possible. When the GPS receiver loaded with SiRFXTrac2 is initially turned

on, it begins to determinate its current positions, velocity and time which will be calculated from tracking the GPS signals an extremely small level by 16 dBHz. While trying to calculate a position fix, the receiver needs to be locked-on to at least four satellites. Your position can be extremely quick fixed within 4 seconds instead of within 8 seconds using other GPS software from a "hot-start" state, and within 45 seconds from a "cold-start" state.
As a general note, the SiRFdemo v3.61 supports the additional functionality and configuration of SiRFXTrac2.
This software is now available on the FALCOM's Website for free download:
➔ www.falcom.de/downloads/manual/SiRF/SiRFdemo3.61.zip

11.5.1.1 SiRFXTrac2 firmware default settings

The XF55-AVL which use the SiRFXTrac2 firmware version has following settings on GPS serial interfaces (GPS_SD1):
GPS_SDI1/GPS_SDO1 (first serial port):
NMEA 38400 baud, Msg.: GLL, GGA, RMC, VTG, GSV, GSA
8 data bits, no parity, 1 stop bit
GPS_SDI2/GPS_SDO2 (second serial port):
RTCM, 38400 baud

11.5.1.2 Advanced Power Management (AMP)

APM is a software-based power management solution that provides the ability to decrease the overall power consumption of the receiver. Fundamentally, the receiver will power down all unnecessary systems and then power up long enough to obtain a fix and then power down again. The on and off times are dependant on the chosen operating modes – either time-between-fix priority, or duty cycle priority, and the operating environment. The AMP is available on the GPS receiver with SiRFXTrac2 software, only.