3-2000733

GSM/GPRS Data Module

User Manual

TABLE OF CONTENTS

1 Document Mission

The User Manual provides all information necessary for a successful integration of 3-2000733 module into the application of the customer. Additionally, the User Manual contains all product functions for application.

2 Glossary

Abbreviation / Term	Explanation / Definition
ADC	Analog-to-Digital Converter
ADN	Abbreviated Dialling Numbers
AFC	Automatic Frequency Correction
AND	Abbreviated Dialing Number
AMR	Adaptive Multi Rate
API	Application Programming Interface
ASC	Asynchronous Serial Interface Controller
BCCH	Broadcast Control Channel
BDN	Barred Dialing Number
CB	Cell Broadcast
CBCH	Cell Broadcast Channel
CCCH	Common Control Channel
CD	Carrier Detect
CGU	Clock Generation Unit
CLI	Calling Line Identifcation
CSD	Circuit Switched Data
DAI	Digital Audio Interface
DCE	Data Communication Equipment
DCS	Digital Cellular System (1800 MHz)
DCXO	Digital Controlled Crystal Oscillator
DL	Reception
DSP	Digital Signal Processor
DSR	Data Set Ready
DTE	Data Terminal Equipment
DTMF	Dual Tone Multi Frequency
DTR	Data Transmit Receive
EBU	External Bus Interface Unit
EFR	Enhanced Full Rate
EGSM	Extended - Global System for Mobile Communication
EMS	Enhanced Messaging Service

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Abbreviation / Term	Explanation / Definition
ESD	Electro Static Discharge
ETSI	European Telecommunications Standards Institute
FDN	Fixed Dialing Number
FFS	Flash File System
FR	Full Rate
GPIO	General Purpose Input/Output
GPP	3rd Generation Partnership Project
GPRS	General Packet Radio System
GSM	Global System for Mobile Communication
HR	Half Rate
HW	Hardware
IC	Integrated Circuit
I2C	Inter-Integrated Circuit
IIR	Infinite Impulsive Response
IMEI	International Mobile Equipment Identity
JTAG	Joint Test Action Group
LDN	Last Dialing Number
M2M	Machine-to-Machine
ME	Mobile Equipment
MIDI	Musical Instrument Digital Interface
MS	Mobile Station
MSC	Multi-Slot Class
N-AMR	Narrow-AMR
NOM	Network Operating Mode
NV	Non Volatile
PA	Power Amplifier
PC	Personal Computer
PBCCH	Packet Broadcast Control Channel
PCCCH	Packet Common Control Channel
PDP	Packet Data Protocol
PDU	Protocol Data Unit
PLMN	Public Land Mobile Network
PPS	Protocol and Parameter Selection
PST	Protocol Stack

Abbreviation / Term	Explanation / Definition
PWM	Pulse Width Modulation
RF	Radio Frequency
RTC	Real Time Clock
RX	Receiver
SAW	Surface Acoustic(al) Wave
SDN	Service Dialing Number
SIM	Subscriber Identity Module
SMA	SubMiniature version A connector
SMS	Short Message Service
SMS MO	Short Message Service Mobile-Originated
SMS MT	Short Message Service Mobile-Terminated
SPMidi	Scalable Polyphony MIDI
SPI	Serial Peripheral Interface
SSC	Serial Synchronous Interface Controller
STK	SIM Toolkit
SW	Software
TCH	Traffic Channel
TX	Transmitter
UART	Universal Asynchronous Receiver-Transmitter
UL	Transmission

3 Scope of Product

3-2000733 is a small, light weight and low power consumption module that enables digital communications services on GSM/GPRS networks for machine to machine or user to machine wireless applications.

3-2000733 modules are developed in compliance with internal and normative certification requirements. In particular, they are certified by CE approval report and Radio & Tele Terminal Equipment Directive (R&TTED) report. Requirements for lead-free components are imposed and satisfied.

The product implements a dual-band MS able to operate in the frequency bands EGSM 900 MHz and DCS 1800 MHz; the dynamic behavior can be configured dynamically by disabling/enabling a specific band e.g. through AT commands. Eventually, the module can be configured either dual-band or tri-band or quad-band.

The supported power classes for both voice and data services will be:

- Class 4 (2W) for GSM band;
- Class 1 (1W) for DCS bands.

The product implements a Class B Mobile Station, offering simultaneous access to GSM and GPRS services. Network operation modes I to III are supported, with user-definable preferred service between GSM and GPRS.

The main buildings blocks of the module are E-GOLDlite (GSM/GPRS Baseband System, Infineon PMB7860) and E-POWERlite (Power Management, Infineon PMB6814). It's possible connecting SIM card either with an on-board connector or with an external SIM connector. The core of the module is represented by the modem, constituted from E-GOLDlite, a power amplifier (TriQuint TQM7M4006), a transceiver (Infineon SMARTISD2 PMB6271) and a front-end (EPCOS DGM081M03).

4 Product environment

3-2000733 module is composed from the following blocks:
- Modem;
- Memory;
- Power Management;
- Interface;
- Miscellanous features.

4.1 Modem

- Infineon E-GOLDlite PMB7860 GSM/GPRS Baseband System;
- Infineon SMARTISD2 PMB6271 V1.1 GSM 850/900/1800/1900 MHz Voice and Data Quad-Band/Multi-Slot Transceiver;
- TriQuint TQM7M4006 3V Quad-Band GSM850/900/DCS/PCS Power Amplifier Module with integrated power controller;
- Epcos DGM081M03 Quad Band Antenna Switch Module with integrated SAW filters for GSM850/900/1800/1900 Receiver.

4.2 Memory

- Intel Multi-Chip Package 64Mbits 1.8V Flash and 16Mbits RAM RD38F2030W0YTQ0.

4.3 Power Management

- Infineon E-POWERlite PMB6814. All the modem power rails are supplied by E-POWERlite;
- Battery connector.

4.4 Interface

- SIM card holder supporting 1.8 V and 3 V card type via E-POWERlite (Suyin 254038MA006G505ZL);
- MMCX Interface connector for RF output (50 Ohm connector MMCX Edge Mount SMD J01341A0081 (Telegartner));
- 60 pin board-to-board connector (MOLEX 54167-0608): Audio (2x analog, 1x digital), I2C bus, SPI bus, 2x ADC, 2x analog out (PWM), 10 GPIOs;
- 2 UART serial ports: one with HW handshake signals and the other one with SW flow control;
- Debug testpoints (JTAG) for C166 and for TEAKlite debug tools.

4.5 Miscellanous features

- 40 tones polyphonic ring tones support.

A block diagram and an overview of the module with the listed components are reported in the following pages.
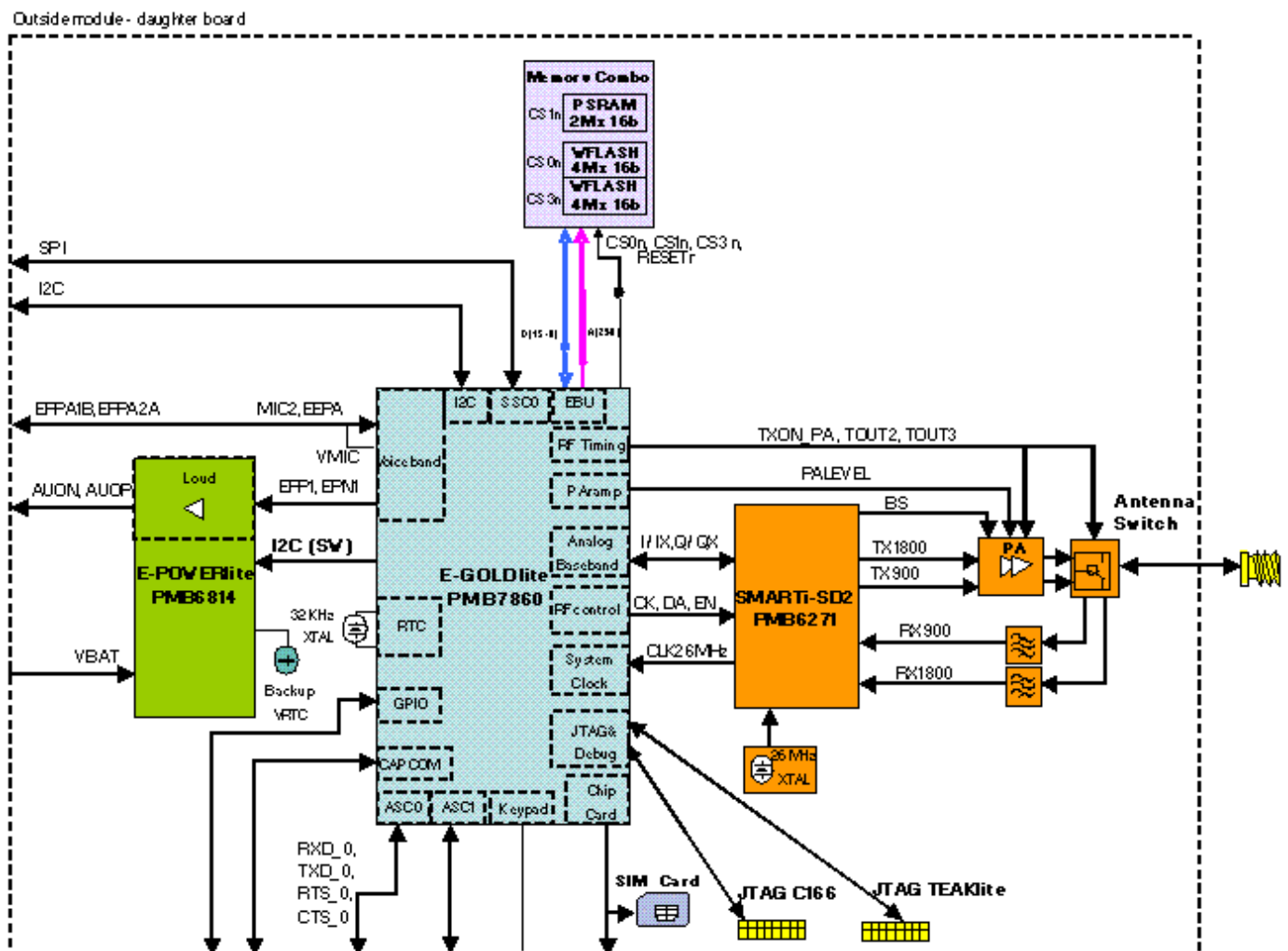
Image 1: 3-2000733 block diagram

Mipot reserves the right to change specifications without notice.

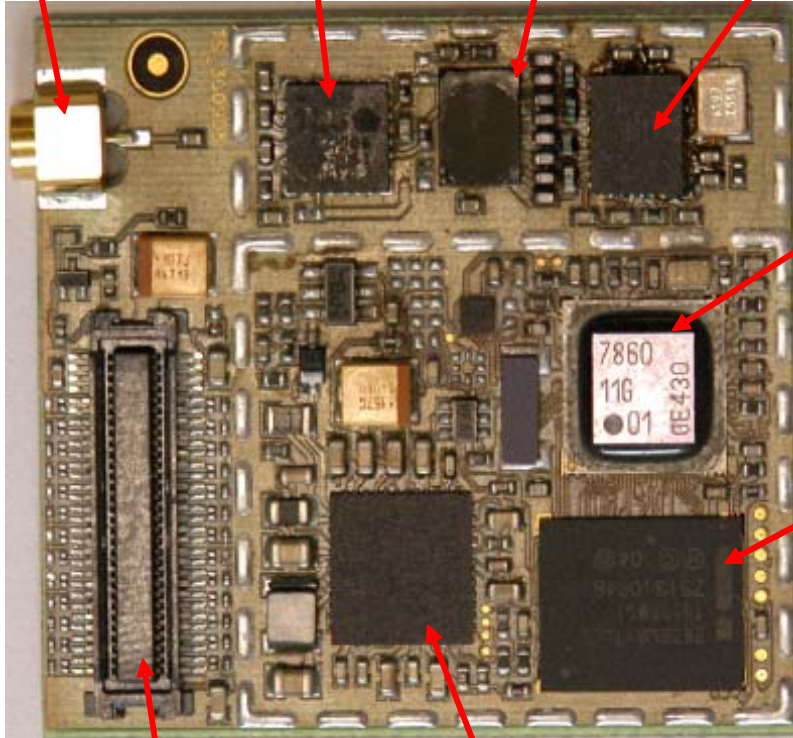**Interface connector for RF output Telegartner J01341A0081**

Triquint Power Amplifier 7M4006

Epcos Antenna Switch DGM081M03

Infineon Radio Transceiver SMARTi SD2 PMB6271

Infineon Micro Processor EGOLDlite PMB7860

Intel Memory 8 MB Flash 2 MB RAM RD38F2030W0YTQ0

Board-to-Board Connector Molex 54167-0608

Infineon Power Management EPOWERlite PMB6814

Image 2: 3-2000733 overview module

5 Product functions

5.1 System Features

A comprehensive list of 3-2000733's features is presented in the following table and further detailed in the following paragraphs. The features can be shared in the following sections:

- Generic features;
- GSM/GPRS modem functionalities;
- Mechanical and Electronics features;
- Software features;
- Accessory support ;
- Host SW tools.

Set of features	Description
Type approval	CE approval report available
	Radio & Tele Terminal Equipment Directive (R&TTED) report available
Environmental constraints	Requirements for lead-free components
Security	Platform security concept description available
	Secure IMEI management
	Secure flashing environment
	Secure memory area
Service software API functionality	Software update
	Software update using system connector
	Module testing SW
	Rewrite IMEI
	Manage SIM locks
	Backup and restore user data
	Defect logger to analyze memory trace
Manufacturing requirements	Flashing throughput (for 8 Mbytes memory) : 400 kbps
GSM standard compliancy	ETSI GSM Phase 2+ (R99)
Frequency Bands	EGSM 900 MHz
	DCS 1800 MHz
	Disable band/Manual band selection
GSM/GPRS Data Services	GPRS multi-slot class (MSC) 10 (4+1, 3+2)
	GPRS PBCCH/PCCCH support
	CBCH reception when on PBCCH supported
	GPRS Class B and CC
	Coding scheme CS-1, CS-2, CS-3, CS-4
	Network operation mode I, II, III
	CSD up to 9.6kbps (V.32, V.110)
	FAX G3, Class 2.0
SMS Short message service	Short Message Service Mobile-Terminated (SMS MT)

Set of features	Description
	Short Message Service Mobile-Originated (SMS MO)
	SMS-CB Cell Broadcast (SMS CB)
	Concatenated SMS
	Via GSM or GPRS
SIM Functionality	Abbreviated Dialling Numbers (ADN)
	Fixed Dialling Numbers (FDN)
	Last Dialled Numbers (LDN)
	Service Dialling Numbers (SDN)
	SIM Lock protection
	SIM Toolkit
SIM Locks	Network
	Network subset
	Service provider
	Corporate
	Operator
Basic Mobile Station features	Display of Called Number
	Indication of Call Progress Signals
	Country/PLMN Indication
	Short Message Indication and Acknowledgement
	International Access Function
	Service Indicator
	Dual Tone Multi Frequency (DTMF)
	Subscription Identity Management
	On/Off Switch
	Service Provider Indication
GSM Supplementary services	Call Hold (CH)
	Call Waiting (CW)
	Multi-Party (MTPY)
	Call Forwarding (CF)
	Explicit Call Transfer (ECT)
	Call Barring (CB)
	Calling Line Identification Presentation (CLIP)
	Calling Line Identification Restriction (CLIR)
	Connected Line Identification Presentation (COLP)
	Connected Line Identification Restriction (COLR)
	Unstructured Supplementary Services Data (USSD)
Audio Codecs	Speech codecs FR (Full rate) / EFR (Enhanced Full Rate) / HR (Half Rate)

Set of features	Description
Encryption algorithms	Encryption algorithms A5/1
	Encryption algorithms A5/2
Mechanical features	Number of RF shield required = 1
	Number of PIN's used for SW flashing = 3 (RX/TX and Ground)
Connector	RF connector
	Board to board connector
	SIM holder
RTC	Real Time Clock (RTC) supported with alarm capabilities
SIM	SIM connector on-board or external
	SIM voltage: 1.8 and 3 V
	High-speed interface
	External SIM ESD protection required.
	External SIM connector support
Flash Memory	Largest capacity single memory chip 16MB
	Maximum FFS data write rate 20 Kbytes/s
RAM	Largest capacity single memory chip 4 MB
	Memory providers supported: Intel
	Page mode support
Battery	Protection circuitry integrated on the platform
	Charging of deeply discharged battery must be possible.
	Charging during phone call
	Maximum charging current of battery :1100 mA
Audio features	Handsfree and headset operation
Audio filter types supported	Echo canceller
	Noise reduction
I/O Interfaces	Number of GPIO-interfaces 6
	Number of UART's 2
	Number of free UART's for user : 1
	One UART with complete 9-pin UART 1
	Max speed UART (AT commands) 115.2 kbps
	One UART with RX/TX 1
Power on	Power on time (sec) 3 sec
Call Handling	Redial missed and/or received calls (CLI)
	Abbreviated Dialling
Call phone	Full duplex
	Ringtones
	Polyphonic ringtones

Set of features	Description
Audio formats integrated with the hardware	HR, FR, EFR, AMR
	MIDI 1.0
	iMelody
	Number of simultaneous polyphonic tones (without extra HW) 40
Accessory support	Audio headset
	Charger
SW development tools	Tracing tools available
	Audio tools available
	PC application development tools available
Manufacturing tools	Flashing tools available
	RF tuning tools available

5.2   Modem

The modem part provides with minimal component's list all functionality necessary for voice and data transmission over GSM and GPRS network.

The modem is divided in two separated areas surrounded by traces on which metal boxes can be soldered. The first area encloses the RF High power components and the remaining passive components of the transceiver; the second area groups baseband processor, memory, crystals and power management unit. The modem is designed as a four-band transceiver, i.e. GSM850/900/1800/1900.

The modem is composed from the following components:

- o   Infineon E-GOLDlite PMB7860 GSM/GPRS Baseband System;
- o   Infineon SMARTISD2 PMB6271 V1.1 GSM 850/900/1800/1900 MHz Voice and Data Quad-Band/Multi-Slot Transceiver;
- o   Epcos DGM081M03 Quad Band Antenna Switch Module with integrated SAW filters for GSM850/900/1800/1900 MHz Receiver;
- o   Infineon E-POWERlite PMB6814. All the modem power rails are supplied by E-POWERlite;
- o   Intel Multi-Chip Package 64Mbits 1.8V Wireless Flash and 16Mbits RAM RD38F2030W0YTQ0.

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Confidential

RF High Power
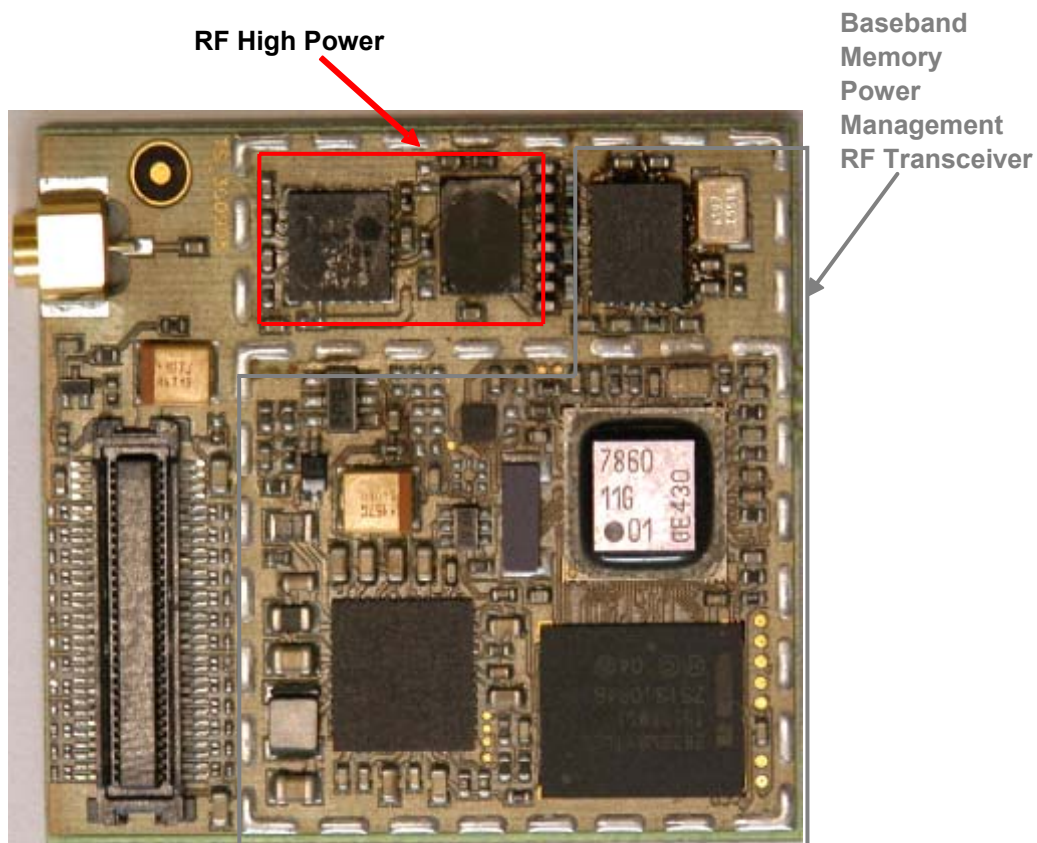
Baseband
Memory
Power
Management
RF Transceiver

Image 3: Overview of main parts of 3-2000733 module

5.3 RF High POWER

Core of RF part is the SMARTiSD2 transceiver which performs modulation and up-conversion of I/Q signal as well as down-conversion and demodulation of the RF received signals.

The interface between E-GOLDlite and SMARTiSD2 is balanced I/Q analog signal, time shared by transmitter and receiver.

Programming of SMARTiSD2 transceiver is done through dedicated 3-wires interface of E-GOLDlite. Timing are provided by the built-in GSM Timer Unit of E-GOLDlite; the antenna switch and PA are commanded via trigger signal TOUT0, TOUT[2..3].

SMARTiSD2 provides two different RF TX outputs respectively for 850/900 and 1800/1900 bands. TriQuint TQM7M4006 PA amplifies these signals maintaining two separate paths.

The PA is directly connected to the VBAT supply. The power ramp control is provided by E-GOLDlite to the PA module, which has a built-in power controller.

Quad Band Epcos antenna switch integrates SAW filters and matching for all the RX paths. It is directly connected to the RX inputs of SMARTiSD2.

The RF I/O signal is by default provided to 50ohm SMA connector. Printed antenna is selectable as RF I/O interface by soldering some matching components.
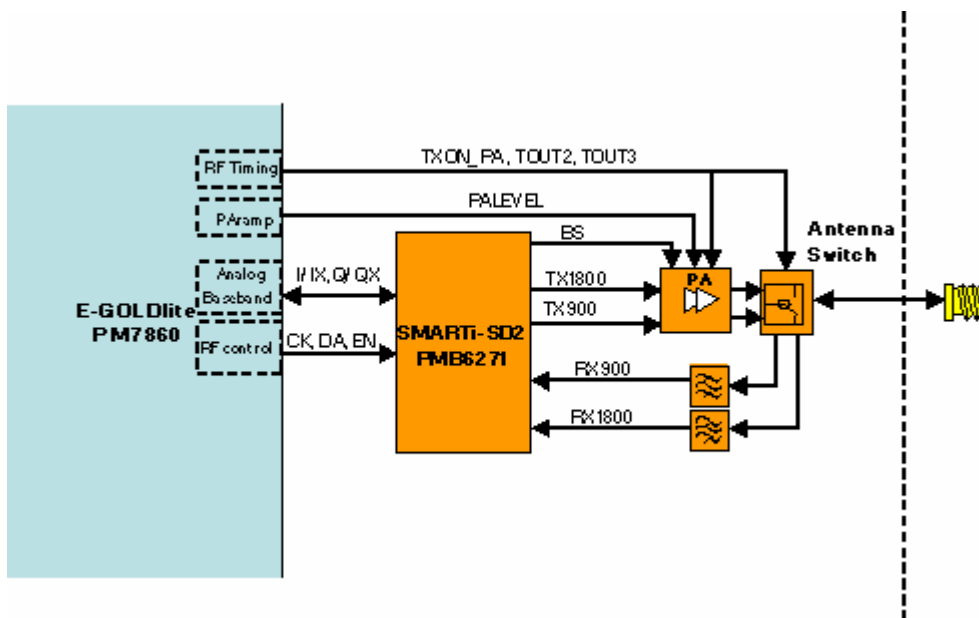

Image 4: 3-2000733 RF High Power block diagram

5.4 Baseband

3-2000733 baseband system provides all necessary interfaces for design a realistic phone and additional interface for hardware/software designing and debugging.

Phone design includes the following interfaces:

- SIM card holder supporting 1.8 and 3V card type.
- System connector on phone with serial data I/O with handshake signals.

Outside phone design there are the following interfaces:

- 2 UART: ASC0 with hardware handshake signals and ASC1 without flow control. Both of them are accessible on Molex board-to-board connector and supports high speed dataflow.
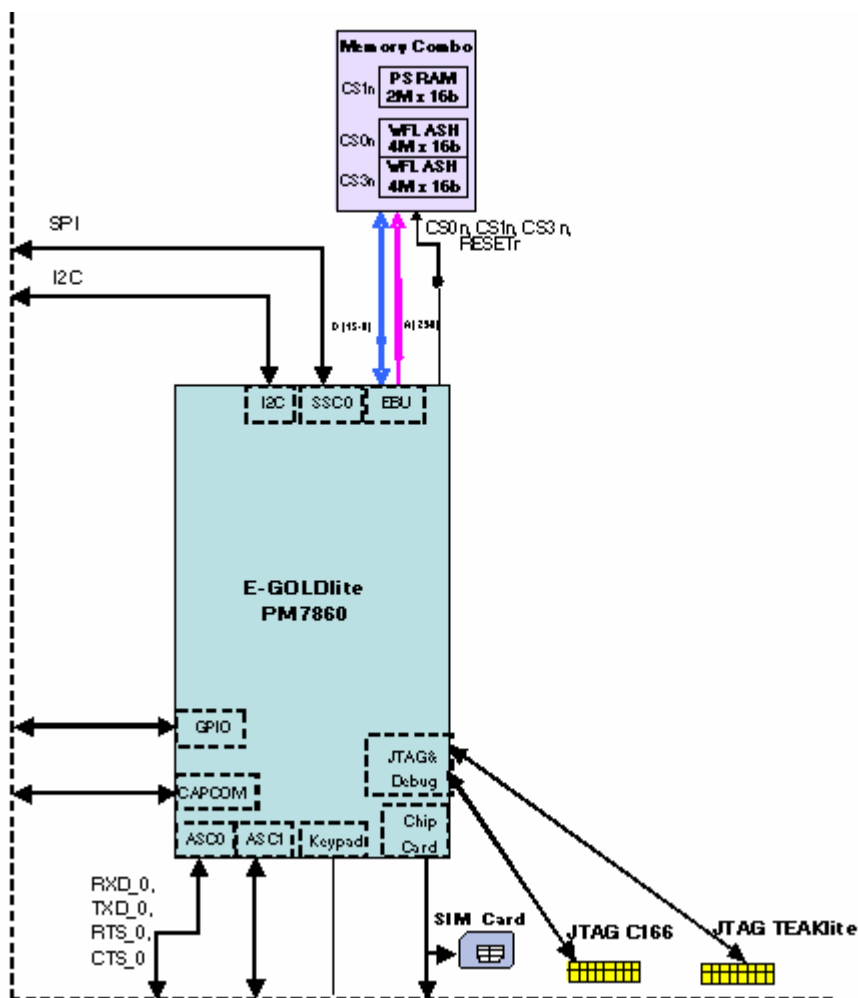- Debug connectors (JTAG) for C166 and for TEAKlite debug tools.

Image 5: 3-2000733 Baseband block diagram

5.5 Memory

GSM modem is equipped with Intel RD38F2030W0YTQ0 Multi-Chip–Memory combo:

- 64 Mbits 1.8V Flash;
- 16 Mbits RAM;
- ROM footprint amount to ca 4MB;
- A max of 2MB is provided to a file system service of customizable size;

- The maximum storable file size is 1 MB.
- The maximum FFS data write rate is 20 Kbytes/s.

Page mode is supported for enhanced system performance.

5.6 Clock

The 26MHz master clock is generated by SMARTiSD2 with a fully integrate digital controlled crystal oscillator (DCXO), whose signal is used as a reference frequency for the radio synthesizer and also provided to the baseband IC, after a buffer amplifier. The only external component needed for oscillator is a quartz crystal.

The oscillator and buffer are supplied by VRF2: powering it up activates the 26MHz clock.

The baseband provide Automatic Frequency Correction (AFC) to SMARTiSD2 with control words sent on the 3-wires interface to guarantee the GSM frequency stability requirements.

E-GOLDlite has built-in Clock Generation Unit (CGU) that generates and distributes the suitable clock signals to all the baseband sections.

The Real Time Clock (RTC) is implemented with a 32 KHz quartz crystal for E-GOLDlite internal oscillator.
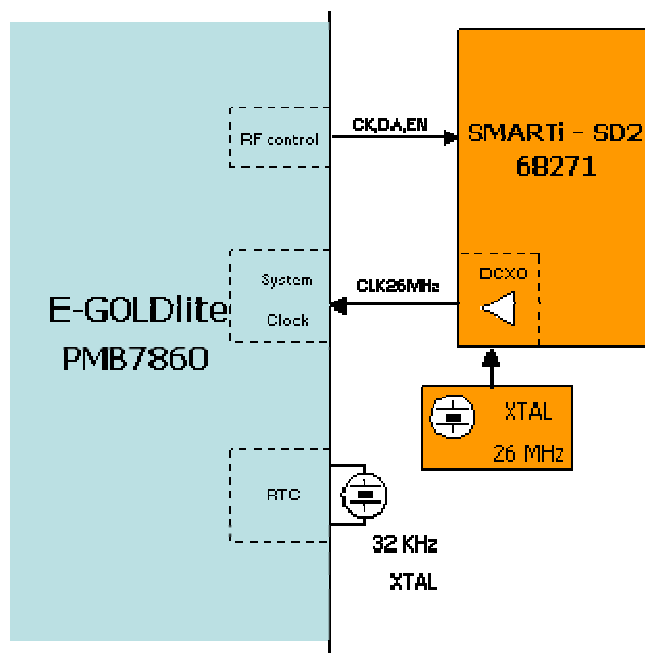
Image 6: Block diagram of 3-2000733 clock system

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5.7 Voiceband

5.7.1 Handset Mode

The normal voiceband functional mode of the phone is completely handled by E-GOLDlite:
- Microphone bias current is provided by internal regulator VMIC;
- Microphone signal is directly connected to input MICP1/MICN1;
- Earpiece is directly driven by EPPAx outputs and it's connected by pass-through wires on the top of the display module;
- Additional HandSet Plug is located outside phone design.

5.7.2 Hands-Free

In hands-free mode several hardware connections allow multiple mode of operation.

In standard mode, the microphone signal comes from the external stereo head-set device and is connected to MICP2/MICN2 inputs of E-GOLDlite. Voice output from E-GOLDlite EPP1 is connected to the Stereo Audio Amplifier (in mono), and then to the external audio device.

In viva voice mode of operation, the output signal of EPP1/EPN1 is amplified by the built-in Audio amplifier of E-POWERlite, and then applied to the Loudspeaker output.

Loudspeaker (mechanical assembled with earpiece) is connected by pass-through wires on the top of the display module.

5.7.3 Ringer Mode

The ringer tones are generated by E-GOLDlite built-in generator and then they are amplified by E-POWERlite amplifier before being applied to loudspeaker.

Otherwise, the generated ringer signal might be applied to the Stereo audio amplifier that serves the head-set external device.
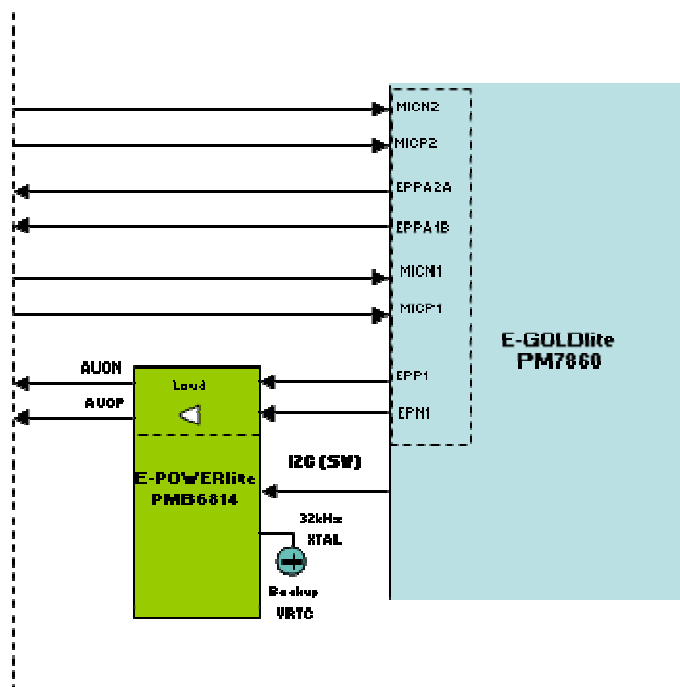
Image 7: 3-2000733 audio interface block diagram

5.8 Mechanical characteristics

The Number of RF shield required is 1. For mechanical characteristics of GSM/GPRS module refer to the following images:
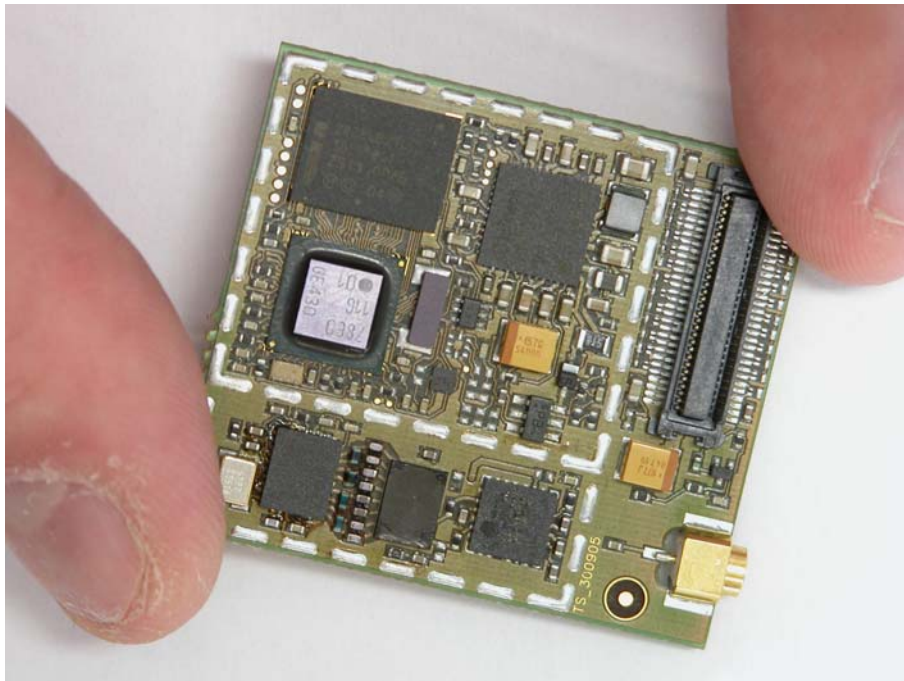
Image 8: 3-2000733 3D representation

Mechanical and environment	Value
Size	33 x 38 x 5.6 mm
Weight	< 10 g
Operating temperature range	From -20°C to +55°C

5.9 Power supply

The on board power supply is derived by Molex connector that provides a voltage value VBAT on pins 1, 3, 5, 7. The range of VBAT is between 3.3 V and 4.3 V, while typically its value is 3.8 V.

Description	Min	Typ	Max
Supply voltage	3.5 V	3.8 V	4.2 V

The modem starting from this VBAT voltage derives all the needed voltage levels to supply the different circuit parts by the power management IC Infineon E-POWERlite PMB6814.
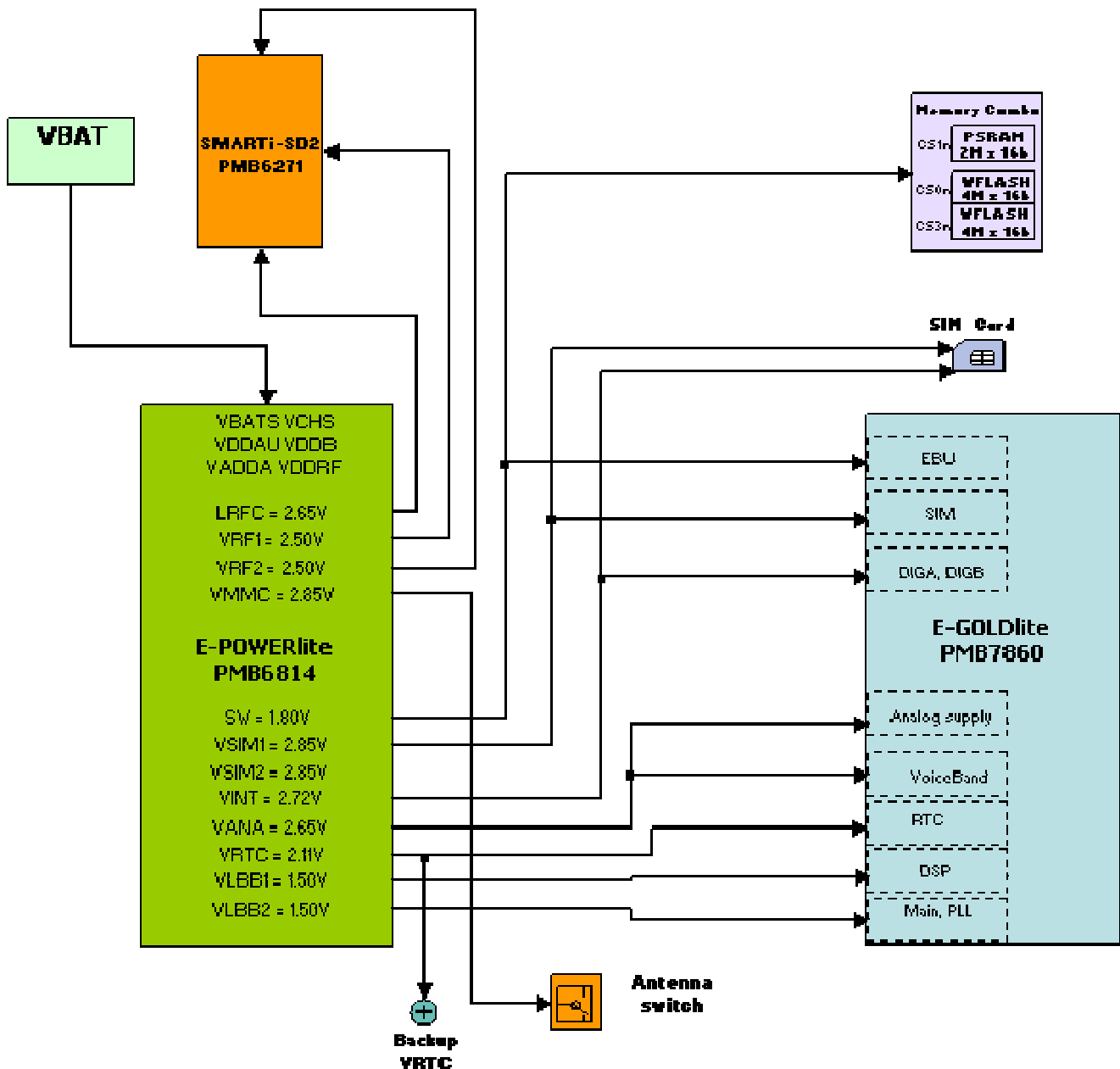
Image 9: Power supply block diagram

The supply domain might have different setting and they are programmed via a dedicated EP_I2C bus (implemented with SW driver) by E-GOLDlite at startup. All the other programming of the E-POWERlite are performed in the same way. Please refer to the Infineon datasheets for detailed specifications.

E-POWERlite should be pin-to-pin compatible with S/M-POWER PMB6811.

| Supply name	Supply domain	Voltage level	Supply device remarks
SDBB	V_SD	1.92 V 1.86 V **1.80 V** 1.50 V	Step-Down converter: E-GOLDlite core (Input for LBB1 and LBB2 baseband supply) + External Bus Unit of E-GOLDlite + Memories
LBB1	VBB1	**1.50 V** 1.65 V	E-GOLDlite DSP (TEAKlite) supply (supplied by SDBB)
LBB2	VBB2	**1.50 V** 1.65 V	E-GOLDlite core supply including C166 (supplied by SDBB), Main, PLL power supply
LANA	VANA	**2.65 V**	Analog Supply of E-GOLDlite
LINT	VINT	**2.72 V**	DIGA, DIGB and external SIM holder
LSIM1	VSIM	**2.85 V** 1.8 V	External and internal SIM interface
LSIM2	2V85	**2.85 V**	N. A.
LRTC	VRTC	**2.11 V**	Ultra-low zero-load current for Real Time Clock supply
LRFC	VRF0	**1.5 V**	SMARTi-SD2 Core *(supplied by SDBB via VDDC input)*
LRF1	VRF1	**2.5 V**	SMARTi-SD2 main supply
LRF2	VRF2	**2.5 V**	SMARTi-SD2
LMMC	VMMC	**2.85 V**	Antenna switch

The voltage levels written in bold are the output voltage values after start-up.

The PA is directly supply by VBAT. Two hot spots can be considered: the PA, and the E-POWERlite. The heat dissipation is based on the thermal resistance reduction around these two components by using a large number of vias in those regions.

5.9.1 Current consumptions

Current consumptions of the module are reported in the following pages. All measurements have been performed at the following conditions:

Power OFF current: < 30 µA.

BAND: GSM900

TEST SETTINGS:
DRX: 5
BA LIST arfcn: 1 9 17 26 34 42 50 58 67 75 83 91 99 108 116 124
PCL: 5
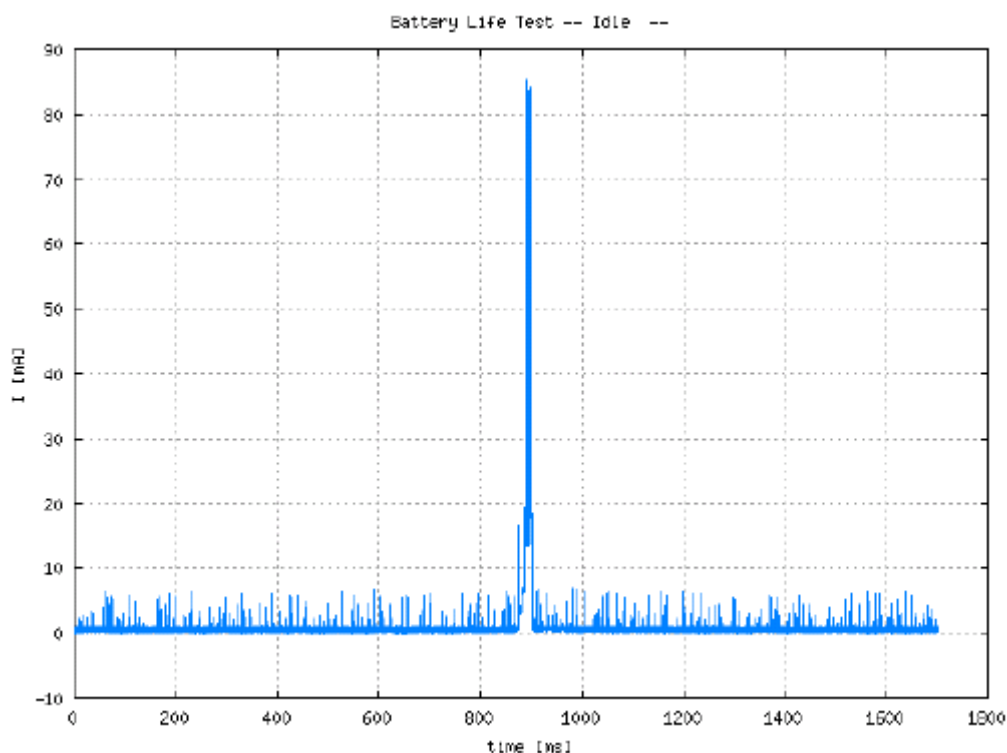
GSM900

Idle mode

Average current:
1.16 mA
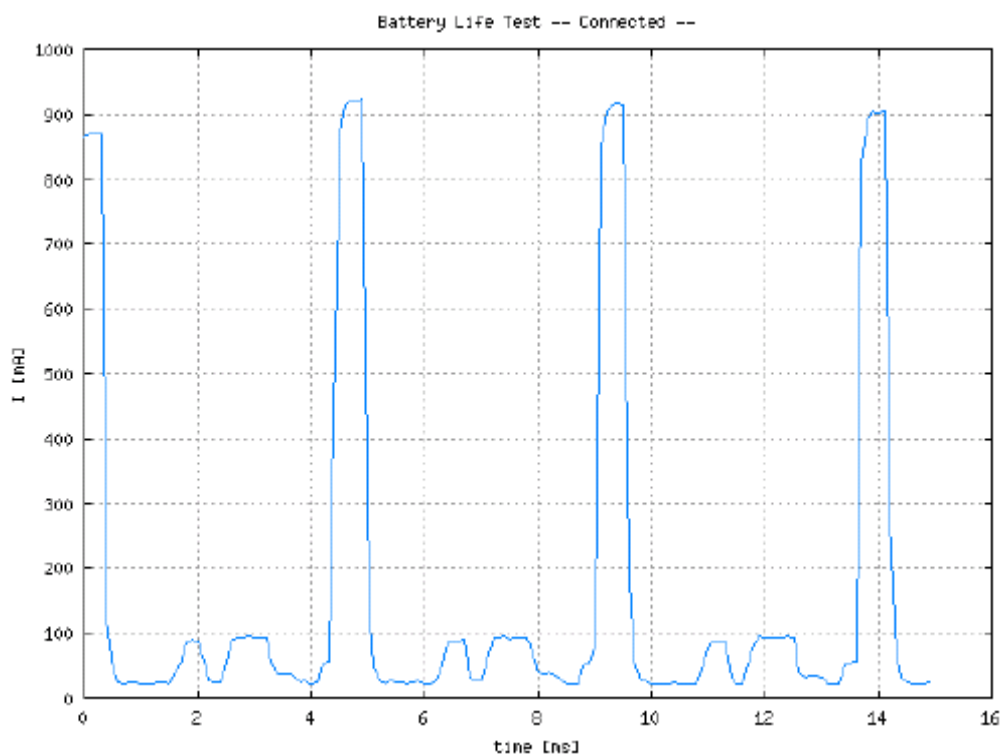
GSM900

Allocated mode

Average current:
144.92 mA

Image 10: Current consumption at 900 MHz

BAND: GSM1800

TEST SETTINGS:
DRX: 5
BA LIST arfcn: 512 530 560 580 610 640 670 700 720 740 760 790 810 840 860
PCL: 0
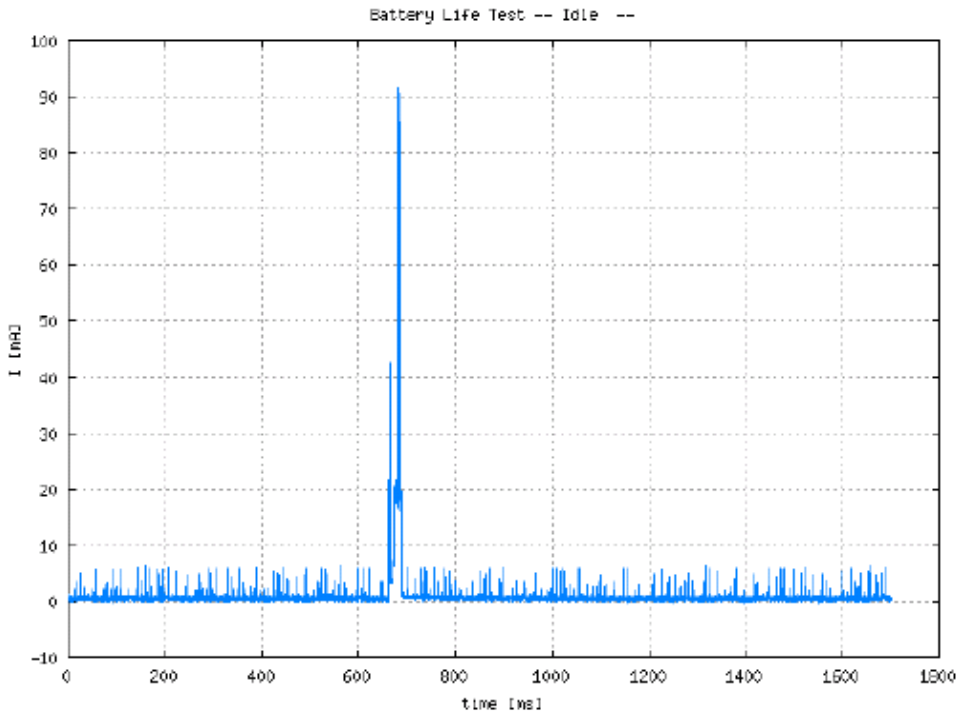
GSM1800

Idle mode

Average current:
1.13 mA
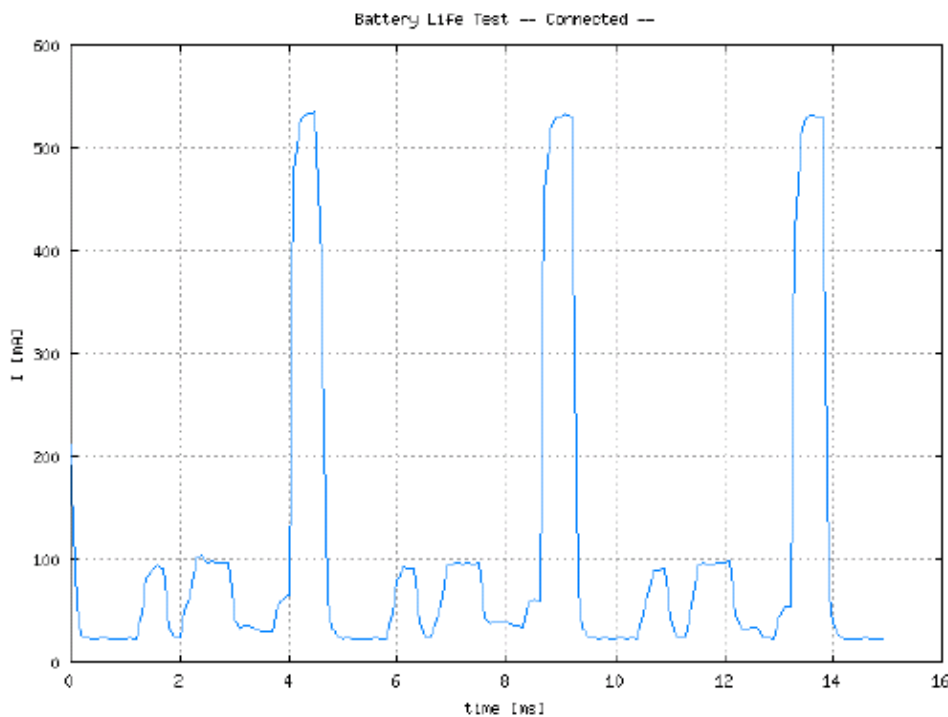
GSM1800

Allocated mode

Average current:
105.63 mA

Image 11: Current Consumptions at 1800 MHz

5.10 Power Saving

Power saving is a special function that allows the reducing of power consumption during the idle time. If the clock increases, required power increases too. Therefore a solution for minimizing the power is the reducing of the master clock frequency when there aren't activities. In this period the system doesn't work with a clock of 26 MHz ("fast clock") but with a clock of 32 KHz (RTC clock or "slow clock"). This switching between 26 MHz and 32 KHz clock is performed by SCCU (Standby Clock Control Unit).

Main priorities of power saving are the following:
1. Reduce base (min) current consumption;
2. Minimize full-speed running periods, minimize power saving on/off switching;
3. Reduce max current consumption.

These points are reported in the following figure:
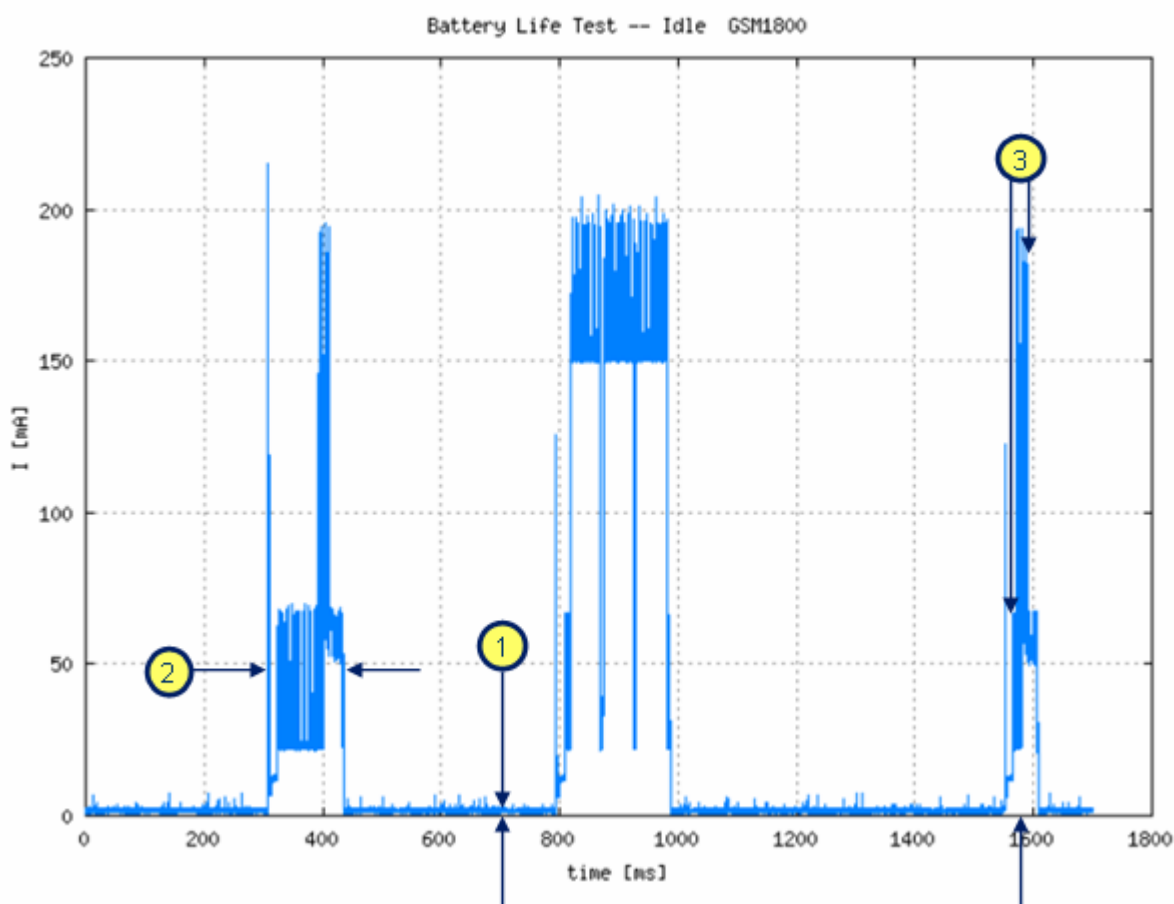
Image 12: Power saving priorities

5.10.1 E-POWERlite

If the voltage decreases, the power decreases too. VCXO_en control voltage is applied to E-POWERlite to selectively shutdown supply voltage lines LRF0, LRF1 and LRF2 for radio frequency part.
VCXO_en control voltage is used in PWM ⇔ PFM StepDown converter, since PFM mode requires less switching (less power) than PWM on light loads.
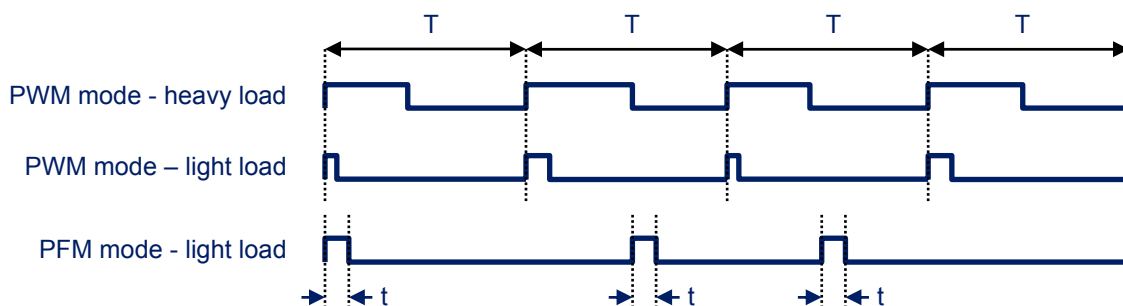
Image 13: E-POWERlite comportament during Power Saving

E-POWERlite built-in audio amplifier shall also shut down when unused via proper I2C messages.

5.10.2 SMARTi

SMARTi and BaseBand are linked via a 3-wire bus (Clock, Data, and Enable). Since Enable is active low (and inactive high), it is forced low before enter power saving, else SMARTi will be pseudo supplied via Enable input junctions. This may be very harmful for relevant BaseBand output port HW and consumes power.

Enable is restored high when power saving exits. Moreover SMARTi has also to be reinitialized, just like the first power up (stealth telegrams).
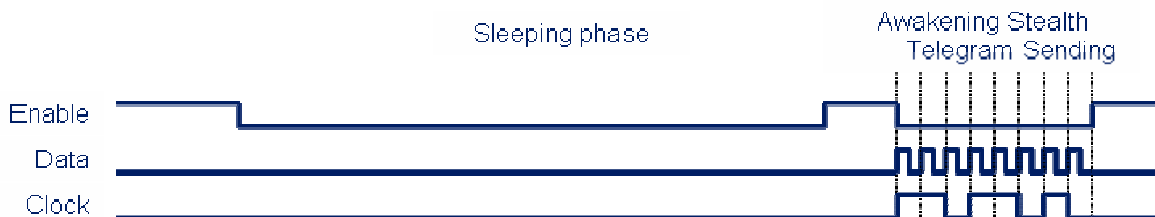
Image 14: SMARTi comportament during Power Saving

5.10.3 Serial ports

It is impossible to receive and send on Asynchronous Serial Communication (ASC) ports at standard speeds in power saving.
DCE serial port relies on hardware flow control logic. DTE shall cache serial data flow if it senses CTS inactive (high logic). CTS is set inactive while power saving and set active while running at full speed and ready to receive. Since power saving exits at least every 2 seconds, DTE shall be capable to cache up to 2 seconds of information flow (host polling mode). System waits on a software timer for 5000 frames (23.077 sec) after the last valid character received, allowing immediate response, before re-enter power saving.
Hardware flow control is currently supported only on ASC0, not on ASC1.

5.11 Security

3-2000733 supports a security module that prevents uncontrolled installation/updates of software on delivered products.
The IMEI (International Mobile Equipment Identity) cannot not be changed after the ME's final production process: the protection of the IMEI shall resist tampering, i.e. manipulation and change by any means (e.g. physical, electrical and software). The security module provides the required measures to fulfill these IMEI protection requirements.
For protection against flash tampering, the system uses a unique Chip Identification Number for encryption and authentication of valid flash memory images.

A secure flashing environment is provided: in order to restrict communication with the ME only to authorized PC tools (e.g. production test equipment), the security module implements an authentication handshake with the PC tools that are provided with a suitable HW dongle.

5.12 GSM/GPRS modem functionalities

3-2000733 GSM/GPRS module integrates a full-featured R99 GSM-GPRS Protocol Stack, whose main characteristics are listed in the following. Refer to the PICS/PIXIT documentation for a detailed description of the Stack features.

The module can be configured either dual-band or tri-band or quad-band.

The product implements a dual-band MS able to operate in the frequency bands EGSM 900 MHz and DCS 1800 MHz; the dynamic behavior can be configured dynamically by disabling/enabling a specific band e.g. through AT commands.

The supported power classes for both voice and data services will be:
- Class 4 for GSM band;
- Class 1 for DCS bands.

The product implements a Class B Mobile Station, offering simultaneous access to GSM and GPRS services. Network operation modes I to III are supported, with user-definable preferred service between GSM and GPRS.

Optionally paging messages for GSM calls can be monitored during GPRS data transfer in not-coordinating network operation mode NOM II-III.

PBCCH/PCCCH logical channels are supported, as well as CBCH reception.

GPRS multislot 10 is implemented, implying a maximum of 4 slots in DL (reception) and 2 slots in UL (transmission) and 5 slots on the whole.

Finally the GSM/GPRS module supported:
- All coding schemes from CS1 to CS4;
- As for the circuit switched services, speech channel modes HR and FR version 1, 2 and 3 (FR, HR, EFR, N-AMR) are supported;
- Encryption algorithms A5/1 and A5/2 for GSM for GPRS are supported;
- CS Data calls are supported in transparent/non transparent mode up to 9.6 kbps;
- Bearer service fax Group 3 Class 2.0 is supported.

Among access interfaces to DTE, both V.32 and V.110 are provided.

5.12.1 Supplementary services

The following supplementary services are provided:
- Call Hold (CH);
- Call Waiting (CW);
- Multi-Party (MTPY);
- Call Forwarding (CF);
- Explicit Call Transfer (ECT);
- Call Barring (CB);
- Calling Line Identification Presentation (CLIP);
- Calling Line Identification Restriction (CLIR);
- Connected Line Identification Presentation (COLP);
- Connected Line Identification Restriction (COLR);
- Unstructured Supplementary Services Data (USSD).

5.12.2 Short Message Service

Mobile-originated as well as mobile-terminated SMS are supported. Text and PDU mode are supported.
Reception of SMS during circuit-switched calls is supported. Reception of SMS via GPRS is also supported.
SMS SIM storage is provided.

5.12.3 SIM Functionality

Among SIM functionalities, the following services of the SIM are supported:
- Abbreviated Dialing Numbers (ADN);
- Fixed Dialing Numbers (FDN);
- Last Dialed Numbers (LDN);
- Service Dialing Numbers (SDN);
- ME Personalization (SIM Lock).

ME Personalization handling is a mechanism to tie the ME operation to one specific SIM card or to a limited range of SIM cards from a given Network Operator or Service Provider. The ME will only accept the SIM if there is a positive match between the personalization code group(s) stored in the ME and the code group(s) belonging to the inserted SIM.

The SIM Lock feature supported by the GSM/GPRS module enables ME personalization through the following personalization categories:
- Network lock;
- Network subset lock;
- Service provider lock;
- Corporate lock;
- Operator lock.

SIM Toolkit R 99 is supported. For a detailed description of the STK features, refer to the PICS/Pixit documentation.

5.12.4 AT-command support

The modem functionalities and services are provided through a rich serial AT-command interface. All supported standard as well as proprietary AT commands are detailed in the table of SW interface.

5.12.5 Other basic features

Within the scope of the M2M or user interface, the following indications and functionalities are supported:
- Display of Called Number;
- Indication of Call Progress Signals;
- Country/PLMN Indication;
- Short Message Indication and Acknowledgement;
- International Access Function;
- Service Indicator;
- Dual Tone Multi Frequency (DTMF);
- Subscription Identity Management;
- Service Provider Indication;
- Abbreviated Dialing;
- Power on (external input).

5.13 Software tools

The GSM/GPRS module supports a development tool suite that caters for trace, programming target flash, calibration and production testing.

5.13.1 SW development tools

A trace tool is supported to debug the software behavior through serial communication port 2 (UART1).
Almost all supported AT commands can be entered on the trace port itself for sake of usability.

5.13.2 Manufacturing tools

Manufacturing/llaboratory tools comprise:
- **Flashtool**, a multithreaded application to handle the download of software to target (up to 8 target concurrently), conceived to be used in manufacturing sites and hardware key protected;

- **Phonetool**, an application to handle the target software's functionalities, giving access to several driver functionalities such RF, Audio, FFS, EEPROM, power management, etc.

In particular, Phonetool provides support for:

- the generation of EEPROM maps used to access the target EEPROM from host;
- the generation of EEPROM structures defaults;
- the FFS formatting of the file system binary image file;
- RF calibration;
- Audio filters measurements and tuning.

5.14 Lay-up and Shielding

3-2000733 GSM/GPRS modem is placed and routed on a single face of 6 layers build up printed circuit board. Electronics parts are placed on both sides. The RF connections traces dimensions are calculated to achieve the wanted characteristic impedance and are placed on Layer4. Layer 3 is full ground. Layer5 is also mostly RF ground under sensible RF parts, with suitable clearance over components pads. The VBATT track is routed on Layer2 and Layer5. Quad band printed antenna elements are on Layer6 and Layer1.

The following picture shows the lay-up main dimensions.
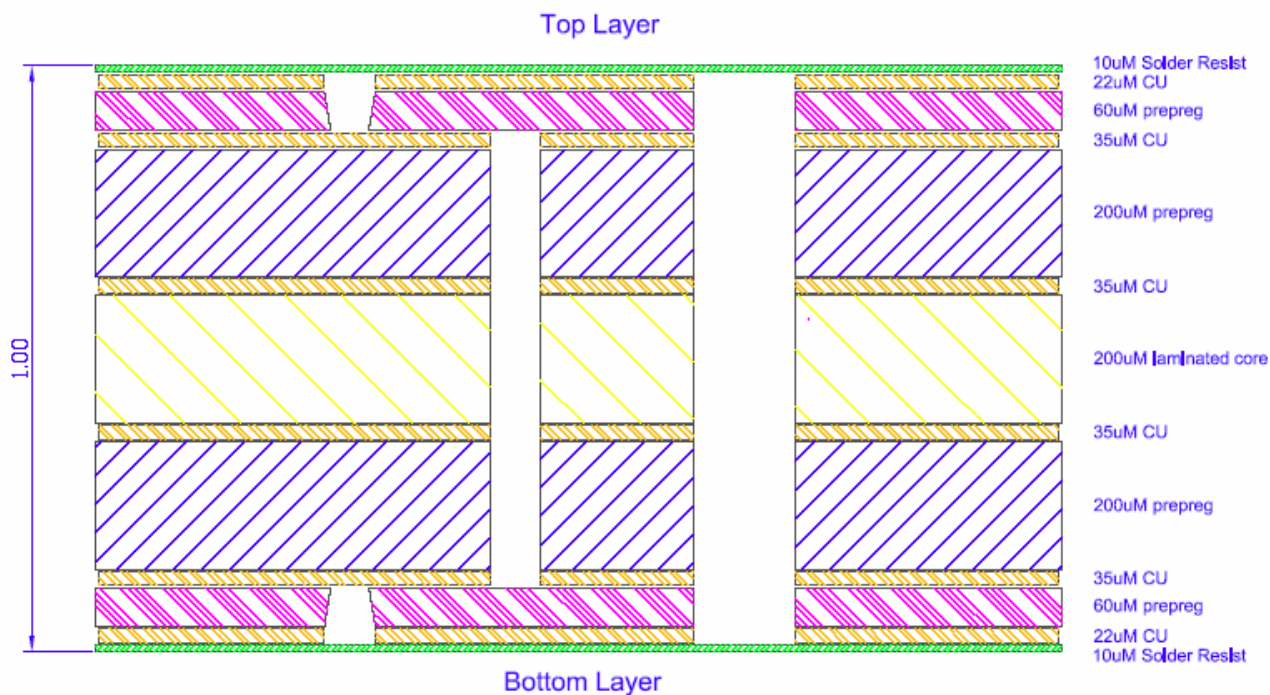
Image 15: Lay-up main dimensions (Surface Finishing: Chemical Gold Plate Ni 5 uM / Au 0.1 uM)

6 User Interfaces

6.1 PIN OUT description

A 60-pin connector is provided to interface of 3-2000733 module for the power supply, SIM interface, audio interface (2 x analog, 1x digital), I2C bus, SPI bus, 2 x analog in (ADC), 2 x analog out (PWM), 2 UART serial ports, and 10 GPIOs.

PIN #	Name	I/O	Function	I/O type	Description
1	VBAT	PWR	GSM Power Supply	From 3.3 to 4.3 V (Typ: 3.8 V)	Should be connected with pins 3, 5, 7
2	GND	PWR	GSM Power Supply	Ground	Should be connected with pins 4, 6, 8
3	VBAT	PWR	GSM Power Supply	From 3.3 to 4.3 V (Typ: 3.8 V)	Should be connected with pins 1, 5, 7
4	GND	PWR	GSM Power Supply	Ground	Should be connected with pins 2, 6, 8
5	VBAT	PWR	GSM Power Supply	From 3.3 to 4.3 V (Typ: 3.8 V)	Should be connected with pins 1, 3, 7
6	GND	PWR	GSM Power Supply	Ground	Should be connected with pins 2, 4, 8
7	VBAT	PWR	GSM Power Supply	From 3.3 to 4.3 V (Typ: 3.8 V)	Should be connected with pins 1, 3, 5
8	GND	PWR	GSM Power Supply	Ground	Should be connected with pins 2, 4, 6
9	VCHARGE	PWR	GSM Power Supply	0 - 12V (Typ: 6V) Current limited to 600 mA	Should be connected with pin 11
10	DCD	O	Asynchronous Serial Interface 0	CMOS 3.3V compatible	Data Carrier Detect
11	VCHARGE	PWR	GSM Power Supply	0 - 12V (Typ: 6V) Current limited to 600 mA	Should be connected with pin 9
12	DTR	I	Asynchronous Serial Interface 0	CMOS 3.3V compatible	Data Terminal Ready
13	SIM_VCC	I/O	SIM interface	Supply 1.8V-3.3V	SIM power supply
14	CTS_0	I	Asynchronous Serial Interface 0	CMOS 3.3V compatible	Clear To Send
15	SIM_IO	I/O	SIM interface	CMOS 3.3V compatible	SIM I/O serial data
16	RTS_0	O	Asynchronous Serial Interface 0	CMOS 3.3V compatible	Request to Send
17	SIM_CLK	O	SIM interface	CMOS 3.3V compatible	SIM clock signal
18	RXD_0	I	Asynchronous Serial Interface 0	CMOS 3.3V compatible	Receive Serial Data
19	SIM_RST	O	SIM interface	CMOS 3.3V compatible	SIM reset signal
20	TXD_0	O	Asynchronous Serial Interface 0	CMOS 3.3V compatible	Transmit Serial Data
21	MRST0/GPIO	I/O	Synchronous Serial Interface (SPI compatible)	CMOS 3.3V compatible	Master Receive Slave Transmit
22	RI	O	Asynchronous Serial Interface 0	CMOS 3.3V compatible	Ring Indicator

PIN #	Name	I/O	Function	I/O type	Description
23	MTSR0/GPIO	I/O	Synchronous Serial Interface (SPI compatible)	CMOS 3.3V compatible	Master Transmit Slave Receive
24	DSR	O	Asynchronous Serial Interface 0	CMOS 3.3V compatible	Data Set Ready
25	SCLK0/GPIO	I/O	Synchronous Serial Interface (SPI compatible)	CMOS 3.3V compatible	Shift Clock
26	RXD_1	I	Asynchronous Serial Interface 1	CMOS 3.3V compatible	Receive Serial Data
27	SCL/GPIO	O	I2C bus interface	CMOS 3.3V compatible	Serial Clock Line
28	TXD_1	O	Asynchronous Serial Interface 1	CMOS 3.3V compatible	Transmit Serial Data
29	SDA/GPIO	I/O	I2C bus interface	CMOS 3.3V compatible	Serial Data Line
30	KEYOUT0/GPIO	I/O	Keypad interface / GPIO	CMOS 3.3V compatible	Keypad output pin 0 / GPIO 00
31	CLK0_DAI/GPIO	I/O	Digital Audio Interface	CMOS 3.3V compatible	DAI Clock
32	KEYOUT1/GPIO	I/O	Keypad interface / GPIO	CMOS 3.3V compatible	Keypad output pin 1 / GPIO 50
33	RXD_DAI/GPIO	I	Digital Audio Interface	CMOS 3.3V compatible	DAI Receive
34	KEYOUT2/GPIO	I/O	Keypad interface / GPIO	CMOS 3.3V compatible	Keypad output pin 2 / GPIO 01
35	TXD_DAI/GPIO	O	Digital Audio Interface	CMOS 3.3V compatible	DAI Transmit
36	KEYOUT3/GPIO	I/O	Keypad interface / GPIO	CMOS 3.3V compatible	Keypad output pin 3 / GPIO 02
37	WA0_DAI/GPIO	I/O	Digital Audio Interface	CMOS 3.3V compatible	DAI Reset
38	KEYOUT4/GPIO	I/O	Keypad interface / GPIO	CMOS 3.3V compatible	Keypad output pin 4 / GPIO 03
39	EXTRSTn	I	External reset	CMOS 3.3V compatible	External HW reset
40	KEYOUT5/GPIO	I/O	Keypad interface / GPIO	CMOS 3.3V compatible	Keypad output pin 5 / GPIO 04
41	MICP1	I	Audio Interface	Analog	Handset microphone reference
42	KEYIN0/GPIO	I/O	Keypad interface / GPIO	CMOS 3.3V compatible	Keypad input pin 0 / GPIO 05
43	MICN1	I	Audio Interface	Analog	Handset microphone bias
44	KEYIN1/GPIO	I/O	Keypad interface / GPIO	CMOS 3.3V compatible	Keypad input pin 1 / GPIO 06
45	EPPA1B	O	Audio Interface	Analog	Balanced audio out
46	KEYIN2/ON	I/O	Keypad interface / Power on	CMOS 3.3V compatible	Keypad input pin 2 / Power on button /GPIO 07
47	EPPA2A	O	Audio Interface	Analog	Balanced audio out
48	KEYIN3/GPIO	I/O	Keypad interface / GPIO	CMOS 3.3V compatible	Keypad input pin 3 / GPIO 08
49	MICP2	I	Audio Interface	Analog	Handset microphone

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PIN #	Name	I/O	Function	I/O type	Description
					reference
50	CAP19/GPIO	I/O	Capture Compare / GPIO	CMOS 3.3V compatible	Capture Compare 19 / GPIO 47
51	MICN2	I	Audio Interface	Analog	Handset microphone bias
52	CAP02/GPIO	I/O	Capture Compare / GPIO	CMOS 3.3V compatible	Capture Compare 02 / GPIO 57
53	AUOP	O	Audio Interface	Analog	Balanced power audio out
54	CAP05/GPIO	I/O	Capture Compare / GPIO	CMOS 3.3V compatible	Capture Compare 05 / GPIO 28
55	AUON	O	Audio Interface	Analog	Balanced power audio out
56	CAP06/GPIO	I/O	Capture Compare / GPIO	CMOS 3.3V compatible	Capture Compare 06 / GPIO 30
57	ADC1	I	Measurement interface	ADC 12bits 0-2.5V	Analog to Digital Converter
58	CAP00_EX5IN/GPIO	I/O	Capture Compare / GPIO / External Interrupt	CMOS 3.3V compatible	Capture Compare 00 / GPIO 30 / Ext Int 5B
59	ADC2	I	Measurement interface	ADC 12bits 0-2.5V	Analog to Digital Converter
60	CAP22_EX3IN/GPIO	I/O	Capture Compare / GPIO / External Interrupt	CMOS 3.3V compatible	Capture Compare 22 / GPIO 55 / Ext Int 3
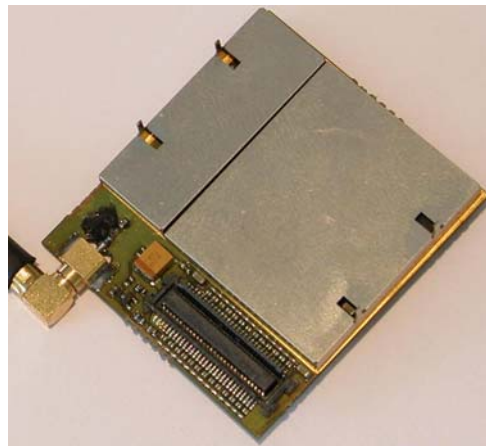
Image 16: Board-to-Board connector overwiew

6.2   SIM Interface

3-2000733 module can be equipped with an on-board SIM connector or an external SIM connector. High-speed SIM/ME interface is implemented.

Both 1.8V and 3V SIM type will be supported (1.8/3V ME); activation and deactivation with automatic voltage switch from 1.8V to 3V are implemented, according to ISO-IEC 78-16-e Specifications. The SIM driver supports the PPS (Protocol and Parameter Selection) procedure for baud-rate selection, according to the values proposed by the SIM Card. Clock stop is supported at both high and low level.

Finally, external SIM ESD protection is required.

Name	PIN #	I/O	I/O type	Description
SIM_VCC	13	I/O	Supply 1.8V 3.3V	SIM Power Supply
SIM_IO	15	I/O	CMOS 3.3V compatible	SIM I/O Serial Data

Name	PIN #	I/O	I/O type	Description
SIM_CLK	17	O	CMOS 3.3V compatible	SIM Clock Signal
SIM_RST	19	O	CMOS 3.3V compatible	SIM Reset Signal

6.3 Battery

The supported type for the battery shall be Li-Ion rechargeable only; default system will support 650mAh nominal. Protection circuitry is integrated on the module.

The Battery/Charger functionality provides:

- battery charging control, i.e. constant voltage charging and trickling of charging in order to maintain the full capacity of the battery;
- pulse charge mode, to improve capacity estimation accuracy;
- capacity estimation during charging, no charging, ongoing calls, etc., constantly considering the different load parameters of the phone;
- Measurements of battery voltage, RF and battery temperature, equipment status, etc.

Charging of deeply discharged battery as well as charging during phone call is possible.

The module has a current consumption lower than 3mA during idle mode reception, lower than 300 mA in connected mode on GSM band and lower than 180mA in connected mode on DCS band (measurements are performed following the GSM Association Battery Life Measurement Technique Document).

The charging battery range goes from 400 to 1100 mA with a step of 100 mA.

Name	PIN #	I/O	I/O type	Description
VBAT	1	PWR	From 3.3 to 4.3 V (Typ: 3.8 V)	Should be connected with pins 3, 5, 7
GND	2	PWR	Ground	Should be connected with pins 4, 6, 8
VBAT	3	PWR	From 3.3 to 4.3 V (Typ: 3.8 V)	Should be connected with pins 1, 5, 7
GND	4	PWR	Ground	Should be connected with pins 2, 6, 8
VBAT	5	PWR	From 3.3 to 4.3 V (Typ: 3.8 V)	Should be connected with pins 1, 5, 7
GND	6	PWR	Ground	Should be connected with pins 2, 4, 8
VBAT	7	PWR	From 3.3 to 4.3 V (Typ: 3.8 V)	Should be connected with pins 1, 5, 7
GND	8	PWR	Ground	Should be connected with pins 2, 4, 6
VCHARGE	9	PWR	From 0 to 12 V (Typ: 6V) Current limited to 600 mA	Should be connected with pin 11
VCHARGE	11	PWR	From 0 to 12 V (Typ: 6V) Current limited to 600 mA	Should be connected with pin 9

6.4 Antenna interface

A 50 Ohm SMA connector is provided as antenna connector for GSM functionality.

6.5 Asynchronous Serial interface

Two serial ports (ASC0 UART and ASC1 UART) are supported working at the selected baud rate (default 115.2 kbps): on ASC0 complete 9 pin serial port is supported and power saving wakeup is available. This interface is fully RS232 9-pin logical compliant and support full HW flow control. Default UART configuration implies ASC0 devoted to AT interface, ASC1 available for debug/tracing (only RX/TX lines).

These serial interfaces are available complying with V.24 protocol and the signals are:

- TX Data (TXD_0);
- RX Data (RXD_0);
- Request to Send (RTS_0);
- Clear to Send (CTS_0);
- Data Terminal Ready (DTR);
- Data Set Ready (DSR).

To avoid floating if output pins are high-impedance, use pull-up resistors tied to GSM_VDD or pull-down resistors tied to GND. The first 6 pin reported in the table refer at the first serial interface, while the last two refer at the second serial interface.

Name	PIN #	I/O	I/O type	Description	Serial interface #
DCD	10	O	CMOS 3.3V compatible	Data Carrier Detect	Asynchronous Serial Interface 0
DTR	12	I	CMOS 3.3V compatible	Data Terminal Ready	
CTS_0	14	I	CMOS 3.3V compatible	Clear To Send	
RTS_0	16	O	CMOS 3.3V compatible	Request to Send	
RXD_0	18	I	CMOS 3.3V compatible	Receive Serial Data	
TXD_0	20	O	CMOS 3.3V compatible	Transmit Serial Data	
RI	22	O	CMOS 3.3V compatible	Ring Indicator	
DSR	24	O	CMOS 3.3V compatible	Data Set Ready	
RXD_1	26	I	CMOS 3.3V compatible	Receive Serial Data	Asynchronous Serial Interface 1
TXD_1	28	O	CMOS 3.3V compatible	Transmit Serial Data	

6.6   GPIO

All General Purpose I/O (GPIOs) shall be initialized to proper direction / output logic level as soon as possible. If supply is removed from external device, relevant GPIOs should be placed at low logic level, or decoupled.

Name	PIN #	I/O	I/O type	Description
GPIO 0	30	I/O	CMOS 3.3V compatible	GPIO 00
GPIO 1	32	I/O	CMOS 3.3V compatible	GPIO 50
GPIO 2	34	I/O	CMOS 3.3V compatible	GPIO 01
GPIO 3	36	I/O	CMOS 3.3V compatible	GPIO 02
GPIO 4	38	I/O	CMOS 3.3V compatible	GPIO 03
GPIO 5	40	I/O	CMOS 3.3V compatible	GPIO 04
GPIO 6	42	I/O	CMOS 3.3V compatible	GPIO 05
GPIO 7	44	I/O	CMOS 3.3V compatible	GPIO 06
KEYIN2/ON	46	I/O	CMOS 3.3V compatible	Power on button/GPIO 07
GPIO 8	48	I/O	CMOS 3.3V compatible	GPIO 08

6.7   Real Time Clock

Real Time Clock (RTC) is integrated within the module and is implemented with a quartz crystal of 32 KHz and an E-GOLDlite internal oscillator.

The RTC time and alarm settings are retained also with battery removed; the system uses a capacitor based system with a backup time of 20 sec.

6.8 SW interfaces

The AT-command interface provides the service and the functionalities of GSM/GPRS modem. It is possible observe the AT commands of 3-2000733 module in the following table.

Name	Command description
General Commands	
+CGMI	Manufacturer identification
+CGMM	Request model identification
+CGMR	Request revision identification
+CGSN	Request product serial number identification
+CSCS	Set TE character set
+CIMI	Request international mobile subscriber identification
+CCID	Card identification
+GCAP	Request complete capability list
A/	Repeat last command
Mobile equipment control and status commands	
+CPAS	Phone activity status
+CPWROFF	Switch off the MS
+CFUN	Set phone functionality
+CBC	Battery charge
+CIND	Indicator control
+CMER	Mobile termination event reporting
+CCLK	Clock
+CALA	Alarm
+CRSM	Restricted SIM access
+CALM	Alert sound mode
+CRSL	Ringer sound level
+CLVL	Loudspeaker volume level
+CMUT	Mute control
+CCWE	Call meter maximum event
+CSGT	Set greeting text
+CALD	Delete alarm
+CTZU	Automatic Time Zone Update
+CTZR	Time Zone Reporting
+CLAC	List all available AT commands
+CMEE	Report mobile termination error
Call control commands	
+CSTA	Select type of address
D	Dial command (full support of modifiers: ;,>,I,G)
T	Select tone dialing
P	Select pulse dialing

Name	Command description
A	Call answer
H	Hook control
M	Monitor speaker mode
L	Monitor speaker loudness
+CMOD	Call mode
+CHUP	Hang up call
+CEER	Extended error report
+VTD	Tone duration
+VTS	DTMF and tone generation
DL	Redial last telephone number
S0	Automatic answer
Network service commands	
+CNUM	Subscriber number
+CSQ	Signal quality
+COPS	Operator selection
+CREG	Network registration
+CPOL	Preferred operator list
+COPN	Read operator names
Security commands	
+CPIN	Enter PIN
+CLCK	Facility lock
+CPWD	Change password
Phonebook commands	
+CPBS	Select phonebook memory storage
+CPBR	Read phonebook entries
+CPBF	Find phonebook entries
+CPBW	Write phonebook entry
Short message commands	
+CSMS	Select message service
+CPMS	Preferred message storage
+CMGF	Preferred message format
+CSAS	Save settings
+CRES	Restore settings
+CSDH	Show text mode parameters
+CNMI	New message indication
+CMGR	Read message
+CNMA	New message acknowledgement to ME/TA
+CMGL	List message
+CMGS	Send message
+CMGW	Write message to memory
+CMSS	Send message from storage
+CSMP	Set text mode parameters
+CMGD	Delete SMS

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Name	Command description
+CSCA	Service center address
+CSCB	Select cell broadcast message types
Supplementary services commands	
+CCFC	Call forwarding
+CCWA	Call waiting
+CLIR	Calling line identification restriction
+CLIP	Calling line identification presentation
+COLP	Connected line identification presentation
+COLR	Connected line identification restriction
+CAOC	Advise of charge
+CACM	Accumulated call meter
+CAMM	Accumulated call meter maximum
+CPUC	Price per unit and currency table
+CHLD	Call related supplementary services
+CTFR	Call deflection
+CLCC	List current list calls
+CSSN	Supplementary service notifications
+CUSD	Unstructured supplementary service data
+CCUG	Closed user group
+CNAP	Calling name presentation
Data commands	
+CBST	Select bearer service type
+FCLASS	Service class selection and identification
+CR	Service reporting control
+CRC	Cellular result codes
+CRLP	Radio link protocol
FAX class 2.0 commands	
+FDT	Transmit data
+FDR	Receive data
+FIP	Initialize facsimile parameters
+FKS	Session termination
+FK	Session termination
+FAA	Adaptive answer
+FAP	Address & polling capabilities
+FBS	Buffer size
+FBO	Data bit order
+FBU	HDLC frame reporting
+FCC	DS capabilities parameters
+FCQ	Copy quality checking
+FCR	Capability to receive data
+FCS	Current session results
+FCT	DTE phase C response timeout
+FEA	Phase C received EOL alignment

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Name	Command description
+FFC	Format conversion
+FHS	Call termination status
+FIE	Procedure interrupt enable
+FIS	Current session parameters
+FIT	Inactivity timeout
+FLI	Local ID string
+FLO	Set flow control
+FLP	Indicate document to poll
+FMI	Request manufacturer identification
+FMM	Request model identification
+FMR	Request revision identification
+FMS	Minimum phase C speed
+FNR	Negotiation reporting
+FNS	Non-standard frame FIF octet string
+FND	NSF message data indication
+FPA	Selective polling address
+FPI	Local polling ID string
+FPP	Packet protocol control
+FPS	Page status
+FPW	Password parameter
+FRQ	Receive quality thresholds
+FRY	Error correction mode retry count
+FSA	Sub Address parameter
+FSP	Request to poll
V.24 control and V.25ter commands	
Z	Reset to default configuration
&F	Set to factory defined configuration
&C	Circuit 109 (CD) behavior
&D	Circuit 108/2 (DTR) behavior
&S	DSR override
&K	Flow control
&W	Store current configuration
&V	Display current configuration
&Y	Designate a default reset profile
I	Request identification information
+GMI	Request manufacturer identification
+GMM	Request model identification
+GSN	Request product serial number identification
+GMR	Request revision identification
+ICF	DTE-DCE character framing
+IFC	DTE-DCE local flow control
\Q	Set flow control
+IPR	Fixed DTE rate
O	Return to on-line data state

Name	Command description
S2	Escape character
S3	Command line termination character
S4	Response formatting character
S5	Command line editing character
S6	Pause before blind dialing
S7	Connection completion timeout
S8	Command dial modifier time
S10	Automatic disconnect delay
S12	Escape prompt delay (EPD)
E	Command echo
Q	Result code suppression
V	DCE response format
X	Result code selection and call progress monitoring control
Specific AT commands	
#	Production test command
+CGED	GPRS cell environment description
+TRACE	Switch on/off trace
+XBANDSEL	Select band
+XCALLSTAT	Set reporting call status
+XGENDATA	Display generation and SW version
+XGCNTRD	Read counters of sent or received GPRS data
+XGCNTSET	Set/reset counter of sent or received GPRS data
+XHANDSFREE	Set hands free mode
+XL1SET	Call the L1-specific function
+XSIO	Configuration trace and modem (AT) interfaces
SIM toolkit	
+STKPRO	SIM-APPL-TK proactive commands
+STKTR	SIM-APPL-TK terminal response
+STKENV	SIM-APPL-TK envelope
+STKPROF	SIM-APPL-TK terminal profile
+STKCC	SIM-APPL-TK call control commands
+STKCNF	SIM-APPL-TK proactive session status
GPRS AT commands	
+CGDCONT	Define PDP context
+CGEREP	GPRS event reporting
+CGQREQ	Quality of service profile (requested)
+CGQMIN	Quality of service profile (minimum acceptable)
+CGATT	GPRS attach or detach
+CGACT	PDP context activate or deactivate
+CGDATA	Enter data state
+CGAUTO	Automatic response to a network request for PDP context activation
+CGPADDR	Show PDP address
+CGCLASS	GPRS mobile station class

Name	Command description
+CGREG	GPRS network registration status
+CGSMS	Select service for MO SMS messages

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6.9 Audio interface

6.9.1 Audio codecs

The following speech codecs are supported in firmware on the DSP:
- GSM Half Rate (TCH/HS);
- GSM Full Rate (TCH/FS);
- GSM Enhanced Full Rate (TCH/EFR);
- 3GPP Adaptive Multi Rate (AMR) (TCH/AFS+TCH/AHS).

6.9.2 Echo canceller/Noise Reduction

For better handling of speech calls and audio functionalities, the product supports algorithms for echo cancellation, noise suppression and automatic gain control.

6.9.3 DAI Mode

For certification testing of audio and vocoder functions the mobile phone has to be connected to the system simulator. The Digital Audio Interface between the system simulator and the MS is supported as described in GSM 04.14 specifications.
Supported modalities are:
- Normal mode;
- Vocoder test;
- Acoustic test;
- Voiceband test.

The table below shows the PIN number related to the DAI signals.

Name	PIN #	I/O	Type	Description
CLK0_DAI	31	I/O	CMOS 3.3V compatible	DAI clock
RXD_DAI	33	I	CMOS 3.3V compatible	DAI receive
TXD_DAI	35	O	CMOS 3.3V compatible	DAI Transmit
WA0_DAI	37	I/O	CMOS 3.3V compatible	DAI Reset

6.9.4 Audio devices

Handset
A standard handset is supported for normal handset operation on the default audio path.

Headset
Two earpiece headsets are supported and may be used for voice during calls.
The audio path switching from handset to headset and back is automatic when the headset jack is inserted or removed.
In headset mode uplink audio path is switched to the headset microphone and headset button works for call accept/release.

Microphone
The uplink path can be switched between the handset and the headset microphone. The path switching is driven automatically by the headset jack.
The uplink path can be muted.

Hands-free
A true hands-free functionality is implemented using high power loudspeaker, MS microphone and appropriate DSP algorithms for voice band handling (Echo canceller and Automatic Gain control).
The product is equipped with a power audio amplifier that can drive an external 8 ohm speaker with 400mW peak.

The audio power amplifier can be used as a voice amplifier for the handsfree functionality and as a melody player amplifier for ringer functionality. The melody player could be the Midi synthesizer or the tone generator.
In order to minimize the clipping of the audio signal, the polarization voltage can be adapted to the voltage supply (battery voltage).
The audio signal on the loudspeaker is a mono signal.

6.9.5 Circuit Description

The output signal of EPP1/EPN1 is amplified by the built-in Audio amplifier of E-POWERlite, and then applied to the Molex Connector:
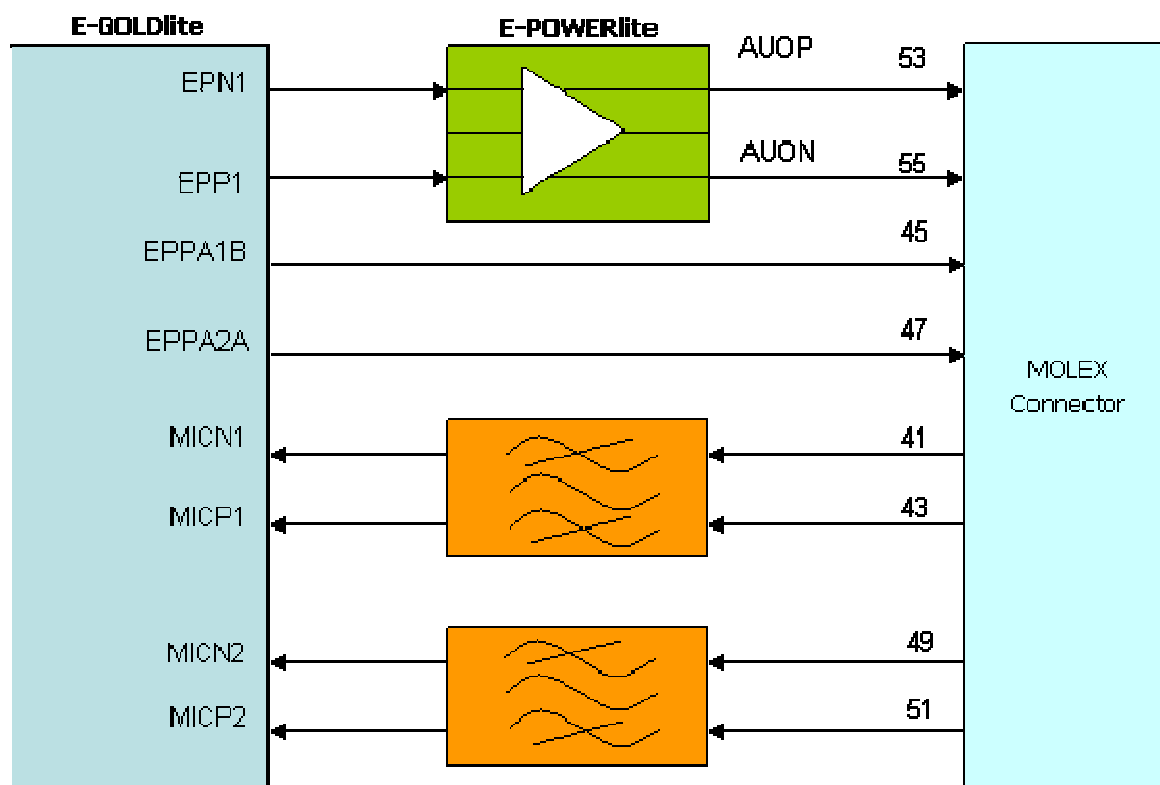

Image 17: Linking between E-GOLDlite and connector for audio interface

The table below shows the PIN number related to the analog audio signals.

Name	PIN #	I/O	I/O type	Description
MICP1	41	I	Analog	Handset microphone reference
MICN1	43	I	Analog	Handset microphone bias
EPPA1B	45	O	Analog	Balanced audio out
EPPA2A	47	O	Analog	Balanced audio out
MICP2	49	I	Analog	Handset microphone reference
MICN2	51	I	Analog	Handset microphone bias
AUOP	53	O	Analog	Balanced power audio out
AUON	55	O	Analog	Balanced power audio out

6.9.6 Polyphonic ringer

Polyphonic ring-tones can be generated by an internal MIDI synthesizer, which runs at 16 or 32 KHz sample frequency and can sum up to 40 voices at 16 kHz sampling rate.

The synthesizer output is only mono and cannot be mixed with TCH voice path (the two are mutually exclusive). To perform in-band alerting during TCH with voice path open, only Tone Generator can be used.

The output samples of the synthesizer are post processed by two modules:

- High Frequency Shelving Filter: This module is implemented as a first order IIR Filter, which is mainly used for high frequency boost in audio signals. Its transfer function can be controlled by 4 filter coefficients.
- Audio Compressor: The audio compressor is a device for manipulating the dynamic range of mono or stereo audio signals. The audio compressor can be controlled by 14 configuration parameters.

Polyphonic standard format supported.

The MIDI driver can play:

- MIDI files conforming to:
    - General Midi Level 1.0 with file-format 0 and 1;
    - General Midi Lite 1.0.
- SPMidi (Scalable Polyphony MIDI) files conforming to:
    - SPMidi 1.0.
- iMelody files conforming to:
    - iMelody v.1.2 specifications.

6.10 ADC interface / Measurement interface

2 inputs for Analog-to-Digital Converter are supported. The resolution of these converters is of 12-bit with a range of 0-2.5 Volt.

Name	PIN #	I/O	I/O type	Description
ADC1	57	I	ADC 12bits 0-2.5V	Analog to Digital Converter
ADC2	59	I	ADC 12bits 0-2.5V	Analog to Digital Converter

6.11 SPI

The SPI bus includes a clock signal, and two signals for the transmissions of the master and the slave.

Name	PIN #	I/O	I/O type	Description
MRST0/GPIO	21	I/O	CMOS 3.3V compatible	Master Receive Slave Transmit
MTSR0/GPIO	23	I/O	CMOS 3.3V compatible	Master Transmit Slave Receive
SCLK0/GPIO	25	I/O	CMOS 3.3V compatible	Shift Clock

6.12 I2C bus interface

The I2C bus interface includes a serial clock and a serial data line.

Name	PIN #	I/O	I/O type	Description
SCL/GPIO	27	O	CMOS 3.3V compatible	Serial Clock Line
SDA/GPIO	29	I/O	CMOS 3.3V compatible	Serial Data Line

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