SIEMENS

MC75
Siemens Cellular Engine

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Hardware Interface Description

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New document: "MC75 Hardware Interface Description" Version **00.190a**

Chapter	What is new
2.3	Updated Figure 2
8.2	Added notes regarding FCC regulations

Preceding document: "MC75 Hardware Interface Description" Version 00.111
New document: "MC75 Hardware Interface Description" Version 00.190

Chapter	What is new
3.4.5	Described effect of AT^SMSO during Charge-only mode.
3.12.2	Corrected several parameters in figures.
3.13	More detailed description of AT^SSYNC command.
8.2	Changed antenna gain and FCC identifier.

Preceding document: "MC75 Hardware Interface Description" Version 00.02
New document: "MC75 Hardware Interface Description" Version 00.111

Chapter	What is new
3.1.2 / 3.1.3	Added description of how to measure V_{BATT+}.
3.2.3.5	Orderly shutdown in case of overvoltage (description is preliminary)
3.4.1 / 3.4.2 9.3	Updated battery requirements. Added description of VARTA batteries. Added data sheets of VARTA batteries.
3.9.1	Added info about usbser.sys file.
3.12.2	Added filter in microphone circuit figures.
3.12.3	Added figures "Differential loudspeaker configuration" and "Single ended loudspeaker configuration".
3.10	More detailed description of how to connect the I^2C interface.
5.1	Updated Table 14: Absolute maximum ratings.
6.1	Updated Figure 36.

Preceding document: "MC75 Hardware Interface Description" Version 00.02
New document: "MC75 Hardware Interface Description" Version 00.65

Chapter	What is new
---	Deleted section about limitations of MC75 Preview Release.
Throughout manual	Supply voltage range now 3.2V – 4.3V (instead of 3.2V – 4.2V)
2.1 / 5.3	Operating temperature specified.
3.2.2.2	Added section Leakage Current in Power Down Mode.
3.4	Added Lithium Polymer batteries. Updated recommended battery specifications. More detailed description of trickle charging.
3.6	Use CCGND as separate ground line for the SIM interface.
3.9	Corrected description and figure of USB interface. Described driver installation.
3.12.4 / 5.3	USC4 pin marked as input.
5.3	Added specifications of USB interface.
5.4	Table 17: Added electrostatic values of USB and SD card interfaces.
6.1	Updated Figure 36.

Preceding document: "MC75 Hardware Interface Description" Version 00.02
New document: "MC75 Hardware Interface Description" Version 00.30

Chapter	What is new
Completely revised and updated all chapters and technical specifications. Added new chapters and appendix.	

Preceding document: "MC75 Hardware Interface Description" Version 00.01
New document: "MC75 Hardware Interface Description" Version 00.02

Chapter	What is new
5	Changed description of VEXT pin. Changed description of pin 55 and renamed pin from EMERGOFF to EMERG_RST.
3.11	Corrected Figure 17: SD card interface.
7	Changed sample application.

1 Introduction

This document describes the hardware of the Siemens MC75 module that connects to the cellular device application and the air interface. It helps you quickly retrieve interface specifications, electrical and mechanical details and information on the requirements to be considered for integrating further components.

1.1 Related Documents

[1]   MC75 AT Command Set
[2]   MC75 Release Notes 00.190
[3]   DSB75 Support Box - Evaluation Kit for Siemens Cellular Engines
[4]   Application 07: Rechargeable Lithium Batteries in GSM Applications (not yet available)
[5]   Multiplexer User's Guide (not yet available)

1.2 Terms and Abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
AGC	Automatic Gain Control
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 MC75
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
dBm0	Digital level, 3.14dBm0 corresponds to full scale, see ITU G.711, A-law
DCE	Data Communication Equipment (typically modems, e.g. Siemens GSM engine)
DCS 1800	Digital Cellular System, also referred to as PCN
DRX	Discontinuous Reception
DSB	Development Support Box
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
EDGE	Enhanced Data Rates for Global Evolution
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
EGPRS	Enhanced General Packet Radio Service
EMC	Electromagnetic Compatibility

Abbreviation	Description
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
FCC	Federal Communications Commission (U.S.)
FDMA	Frequency Division Multiple Access
FR	Full Rate
GMSK	Gaussian Minimum Shift Keying
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
HiZ	High Impedance
HR	Half Rate
I/O	Input/Output
IC	Integrated Circuit
IMEI	International Mobile Equipment Identity
ISO	International Standards Organization
ITU	International Telecommunications Union
kbps	kbits per second
LED	Light Emitting Diode
Li-Ion / Li+	Lithium-Ion
Li battery	Rechargeable Lithium Ion or Lithium Polymer battery
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
MT	Mobile Terminated
NTC	Negative Temperature Coefficient
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

Abbreviation	Description
PSK	Phase Shift Keying
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
RTC	Real Time Clock
RTS	Request to Send
Rx	Receive Direction
SAR	Specific Absorption Rate
SD	Secure Digital
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
USB	Universal Serial Bus
USSD	Unstructured Supplementary Service Data
VSWR	Voltage Standing Wave Ratio
Phonebook abbreviations	
FD	SIM fixdialing 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

1.3   Type Approval

MC75 is designed to comply with the directives and standards listed below. Please note that the product is still in a pre-release state and, therefore, type approval and testing procedures have not yet been completed.

European directives

99/05/EC	"Directive of the European Parliament and of the council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity", in short referred to as R&TTE Directive 1999/5/EC
89/336/EC	Directive on electromagnetic compatibility
73/23/EC	Directive on electrical equipment designed for use within certain voltage limits (Low Voltage Directive)

Standards of North American Type Approval

CFR Title 47	"Code of Federal Regulations, Part 22 and Part 24 (Telecommuni-cations, PCS)"; US Equipment Authorization FCC
UL 60 950	"Product Safety Certification" (Safety requirements)
NAPRD.03	"Overview of PCS Type certification review board Mobile Equipment Type Certification and IMEI control" PCS Type Certification Review board (PTCRB), Version 3.1.0
RSS133 (Issue2)	Canadian Standard

Standards of European Type Approval

3GPP TS 51.010-1	"Digital cellular telecommunications system (Phase 2); Mobile Station (MS) conformance specification"
ETSI EN 301 511	"V7.0.1 (2000-12) Candidate Harmonized European Standard (Telecommunications series) Global System for Mobile communications (GSM); Harmonized standard for mobile stations in the GSM 900 and DCS 1800 bands covering essential requirements under article 3.2 of the R&TTE directive (1999/5/EC) (GSM 13.11 version 7.0.1 Release 1998)"
GCF-CC	"Global Certification Forum - Certification Criteria" V3.16.0
ETSI EN 301 489-1	"V1.2.1 Candidate Harmonized European Standard (Telecommunications series) Electro Magnetic Compatibility and Radio spectrum Matters (ERM); Electro Magnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common Technical Requirements"
ETSI EN 301 489-7	"V1.1.1 Candidate Harmonized European Standard (Telecommunications series) Electro Magnetic Compatibility and Radio spectrum Matters (ERM); Electro Magnetic Compatibility (EMC) standard for radio equipment and services; Part 7: Specific conditions for mobile and portable radio and ancillary equipment of digital cellular radio telecommunications systems (GSM and DCS)"
EN 60 950	Safety of information technology equipment (2000)

Requirements of quality

IEC 60068   Environmental testing

DIN EN 60529   IP codes

Compliance with international rules and regulations

Manufacturers of mobile or fixed devices incorporating MC75 modules are advised to have their completed product tested and approved for compliance with all applicable national and international regulations. As a quad-band GSM/GPRS engine designed for use on any GSM network in the world, MC75 is required to pass all approvals relevant to operation on the European and North American markets. For the North American market this includes the Rules and Regulations of the Federal Communications Commission (FCC) and PTCRB, for the European market the R&TTE Directives and GCF Certification Criteria must be fully satisfied.

The FCC Equipment Authorization granted to the MC75 Siemens reference application is valid *only* for the equipment described in Section 8.1.

SAR requirements specific to portable mobiles

Mobile phones, PDAs or other portable transmitters and receivers incorporating a GSM module must be in accordance with the guidelines for human exposure to radio frequency energy. This requires the Specific Absorption Rate (SAR) of portable MC75 based applications to be evaluated and approved for compliance with national and/or international regulations.

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

Products intended for sale on US markets
ES 59005/ANSI C95.1   Considerations for evaluation of human exposure to Electromagnetic Fields (EMFs) from Mobile Telecommunication Equipment (MTE) in the frequency range 30MHz - 6GHz

Products intended for sale on European markets
EN 50360   Product standard to demonstrate the compliance of mobile phones with the basic restrictions related to human exposure to electromagnetic fields (300 MHz - 3 GHz)

Note: Usage of MC75 in a fixed, mobile or portable application is not allowed without a new FCC certification.

1.4   Safety Precautions

The following safety precautions must be observed during all phases of the operation, usage, service or repair of any cellular terminal or mobile incorporating MC75. Manufacturers of the cellular terminal are advised to convey the following safety information to users and operating personnel and to incorporate these guidelines into all manuals supplied with the product. Failure to comply with these precautions violates safety standards of design, manufacture and intended use of the product. Siemens AG assumes no liability for customer's failure to comply with these precautions.

When in a hospital or other health care facility, observe the restrictions on the use of mobiles. Switch the cellular terminal or mobile off, if instructed to do so by the guidelines posted in sensitive areas. Medical equipment may be sensitive to RF energy.

The operation of cardiac pacemakers, other implanted medical equipment and hearing aids can be affected by interference from cellular terminals or mobiles placed close to the device. If in doubt about potential danger, contact the physician or the manufacturer of the device to verify that the equipment is properly shielded. Pacemaker patients are advised to keep their hand-held mobile away from the pacemaker, while it is on.

Switch off the cellular terminal or mobile before boarding an aircraft. Make sure it cannot be switched on inadvertently. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communications systems. Failure to observe these instructions may lead to the suspension or denial of cellular services to the offender, legal action, or both.

Do not operate the cellular terminal or mobile in the presence of flammable gases or fumes. Switch off the cellular terminal when you are near petrol stations, fuel depots, chemical plants or where blasting operations are in progress. Operation of any electrical equipment in potentially explosive atmospheres can constitute a safety hazard.

Your cellular terminal or mobile receives and transmits radio frequency energy while switched on. Remember that interference can occur if it is used close to TV sets, radios, computers or inadequately shielded equipment. Follow any special regulations and always switch off the cellular terminal or mobile wherever forbidden, or when you suspect that it may cause interference or danger.

Road safety comes first! Do not use a hand-held cellular terminal or mobile when driving a vehicle, unless it is securely mounted in a holder for speakerphone operation. Before making a call with a hand-held terminal or mobile, park the vehicle.

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

SOS

IMPORTANT!
Cellular terminals or mobiles operate using radio signals and cellular networks. Because of this, connection cannot be guaranteed at all times under all conditions. Therefore, you should never rely solely upon any wireless device for essential communications, for example emergency calls.

Remember, in order to make or receive calls, the cellular terminal or mobile must be switched on and in a service area with adequate cellular signal strength.

Some networks do not allow for emergency calls if certain network services or phone features are in use (e.g. lock functions, fixed dialing etc.). You may need to deactivate those features before you can make an emergency call.

Some networks require that a valid SIM card be properly inserted in the cellular terminal or mobile.

2 Product Concept

2.1 Key Features at a Glance

Feature	Implementation
General	
Frequency bands	Quad band: GSM 850/900/1800/1900 MHz
GSM class	Small MS
Output power (according to Release 99, V5)	Class 4 (+33 dBm ±2 dB) for EGSM850 Class 4 (+33 dBm ±2 dB) for EGSM900 Class 1 (+30 dBm ±2 dB) for GSM1800 Class 1 (+30 dBm ±2 dB) for GSM1900 Class E2 (+27 dBm ± 3 dB) for GSM 850 8-PSK Class E2 (+27 dBm ± 3 dB) for GSM 900 8-PSK Class E2 (+26 dBm +3 /-4 dB) for GSM 1800 8-PSK Class E2 (+26 dBm +3 /-4 dB) for GSM 1900 8-PSK The values stated above are maximum limits. According to Release 99, Version 5, the maximum output power in a multislot configuration may be lower. The nominal reduction of maximum output power varies with the number of uplink timeslots used and amounts to 3.0 dB for 2 Tx, 4.8 dB for 3 Tx and 6.0 dB for 4 Tx.
Power supply	3.2V to 4.3V
Power consumption	Sleep mode: max. TBD Power down mode: typically 50µA
Operating temperature	-30°C to +65°C ambient temperature Auto switch-off at +90°C board temperature (preliminary)
Physical	Dimensions: 33.9mm x 44.6mm x max. 3.5mm Weight: approx. 10g
GSM / GPRS/ EGPRS features	
Data transfer	GPRS • Multislot Class 12 • Full PBCCH support • Mobile Station Class B • Coding Scheme 1 – 4 EGPRS • Multislot Class 10 • Mobile Station Class B • Modulation and Coding Scheme MCS 1 – 9

Feature	Implementation
	CSD • V.110, RLP, non-transparent • 2.4, 4.8, 9.6, 14.4 kbps • USSD PPP-stack for GPRS data transfer
SMS	• Point-to-point MT and MO • Cell broadcast • Text and PDU mode • Storage: SIM card plus 25 SMS locations in mobile equipment • Transmission of SMS alternatively over CSD or GPRS. Preferred mode can be user defined.
Fax	Group 3; Class 1
Audio	Speech codecs: • Half rate HR (ETS 06.20) • Full rate FR (ETS 06.10) • Enhanced full rate EFR (ETS 06.50/06.60/06.80) • Adaptive Multi Rate AMR Speakerphone operation Echo cancellation, noise suppression DTMF 7 ringing tones
Software	
AT commands	AT-Hayes GSM 07.05 and 07.07, Siemens AT commands for RIL compatibility (NDIS/RIL)
Microsoft™ compatibility	RIL / NDIS for Pocket PC and Smartphone
SIM Application Toolkit	SAT Release 99
TCP/IP stack	Access by AT commands
IP adresses	IP version 6
Firmware update	Download over serial interface ASC0 Download over SIM interface Download over USB
Interfaces	
2 serial interfaces	ASC0 • 8-wire modem interface with status and control lines, unbalanced, asynchronous • 1.2 kbps to 460 kbps • Autobauding TBD • Supports RTS0/CTS0 hardware handshake and software XON/XOFF flow control. • Multiplex ability according to GSM 07.10 Multiplexer Protocol.

Feature	Implementation
	ASC1 • 4-wire, unbalanced asynchronous interface • 1.2 kbps to 460 kbps • Autobauding TBD • Supports RTS1/CTS1 hardware handshake and software XON/XOFF flow control
USB	Supports a USB 2.0 Full Speed (12 Mbit/s) slave interface.
I²C	I²C bus for transmission rates up to 400 kbps
SD card interface	Interface for SD memory card or multimedia card
Audio	• 2 analog interfaces • 1 digital interface (PCM)
SIM interface	Supported SIM cards: 3V, 1.8V
Antenna	50 Ohms. External antenna can be connected via antenna connector or solderable pad.
Module interface	80-pin board-to-board connector
Power on/off, Reset	
Power on/off	• Switch-on by hardware pin IGT • Switch-off by AT command (AT^SMSO) • Automatic switch-off in case of critical temperature and voltage conditions.
Reset	• Orderly shutdown and reset by AT command • Emergency reset by hardware pin EMERG_RST
Special features	
Charging	Supports management of rechargeable Lithium Ion and Lithium Polymer batteries
Real time clock	Timer functions via AT commands
Phonebook	SIM and phone
Evaluation kit	
DSB75	DSB75 Evaluation Board designed to test and type approve Siemens cellular engines and provide a sample configuration for application engineering.

2.2   MC75 System Overview
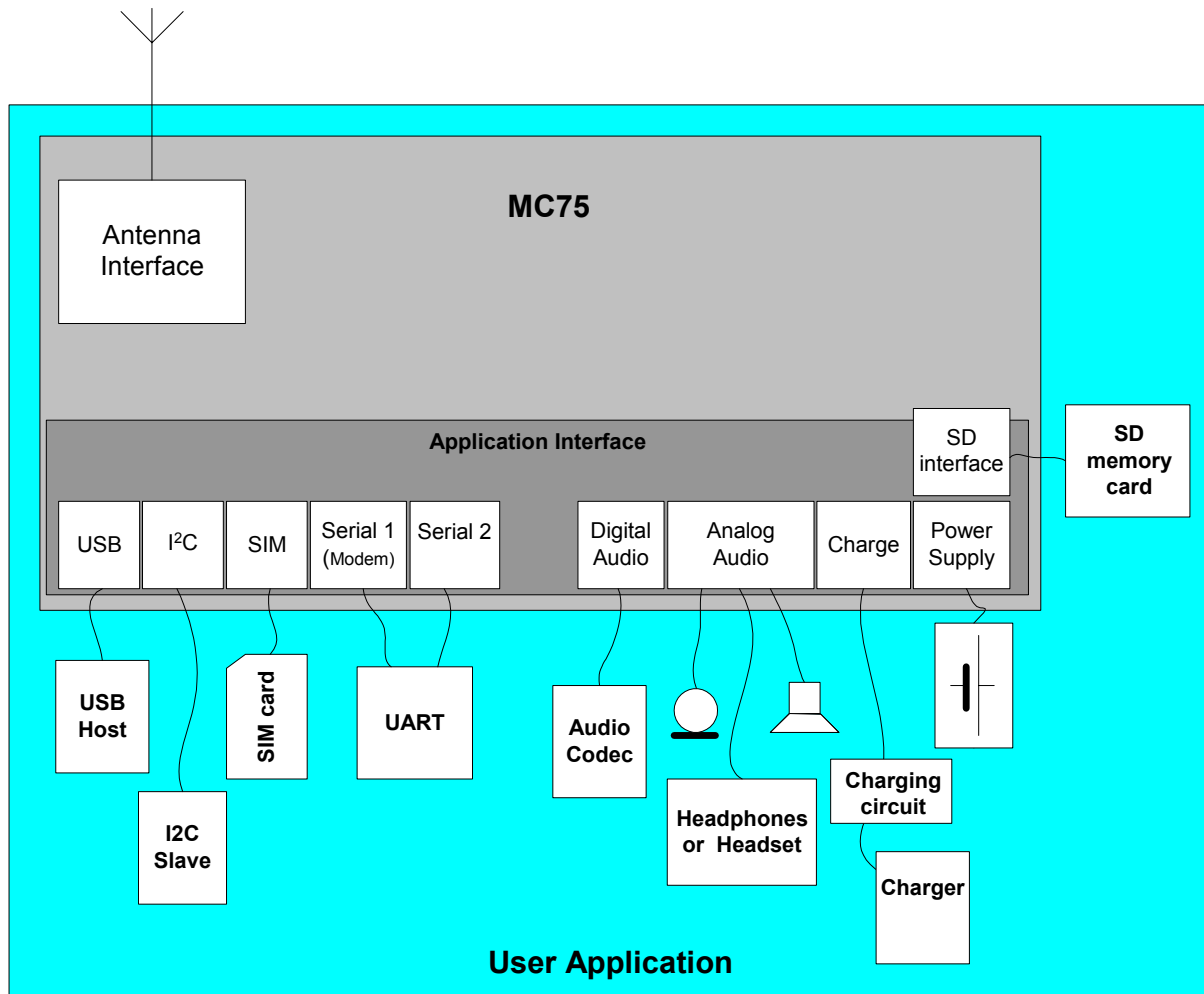
Figure 1: MC75 system overview

2.3 Circuit Concept

Figure 2 shows a block diagram of the MC75 module and illustrates the major functional components:

Baseband Block:
- Digital baseband processor with DSP
- Analog processor with power supply unit (PSU)
- Flash / SRAM (stacked)
- Application interface (board-to-board connector)

RF section:
- RF transceiver
- RF power amplifier
- RF front end
- Antenna connector
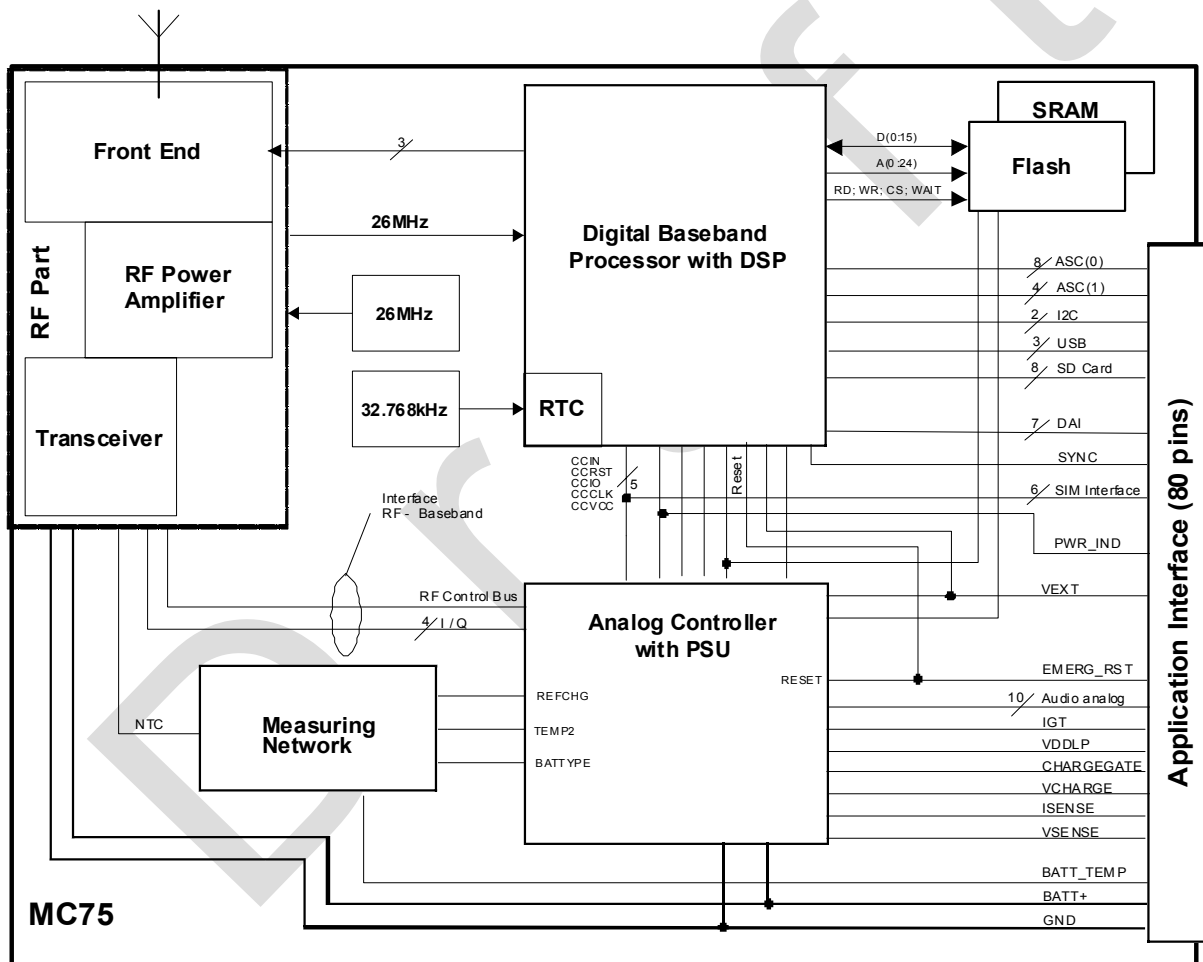
Figure 2: MC75 block diagram

3   Application Interface

MC75 is equipped with an 80-pin board-to-board connector that connects to the external application. The host interface incorporates several sub-interfaces described in the following chapters:

- Power supply - see Section 3.1
- Charger interface – Section 3.4
- SIM interface - see Section 3.6
- Serial interface ASC0 - see Section 3.7
- Serial interface ASC1 - see Section 3.8
- Serial interface USB - see Section 3.9.
- Serial interface I²C - see Section 3.10
- SD card interface - see Section 3.11
- Two analog audio interfaces - see Section 3.12
- Digital audio interface (DAI) - see Section 3.12 and 3.12.4
- Status and control lines: IGT, EMERG_RST, PWR_IND, SYNC - see Table 16

3.1 Power Supply

MC75 needs to be connected to a power supply at the B2B connector (5 pins each BATT+ and GND).

The power supply of MC75 has to be a single voltage source at BATT+. It must be able to provide the peak current during the uplink transmission.

All the key functions for supplying power to the device are handled by the power management section of the analog controller. This IC provides the following features:

- Stabilizes the supply voltages for the GSM baseband using low drop linear voltage regulators.
- Switches the module's power voltages for the power up and down procedures.
- Delivers, across the VEXT pin, a regulated voltage for an external application. This voltage is not available in Power-down mode.
- SIM switch to provide SIM power supply.

3.1.1 Minimizing Power Losses

When designing the power supply for your application please pay specific attention to power losses. Ensure that the input voltage V_{BATT+} never drops below 3.2 V on the MC75 board, not even in a transmit burst where current consumption can rise to typical peaks of 2A. It should be noted that MC75 switches off when exceeding these limits. Any voltage drops that may occur in a transmit burst should not exceed 400mV.

The best approach to reducing voltage drops is to use a board-to-board connection as recommended, and a low impedance power source. The resistance of the power supply lines on the host board and of a battery pack should also be considered.

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

Example: If the length of the flex cable reaches the maximum length of 100mm, this connection may cause, for example, a resistance of 30mΩ in the BATT+ line and 30mΩ in the GND line. As a result, a 2A transmit burst would add up to a total voltage drop of 120mV. Plus, if a battery pack is involved, further losses may occur due to the resistance across the battery lines and the internal resistance of the battery including its protection circuit.
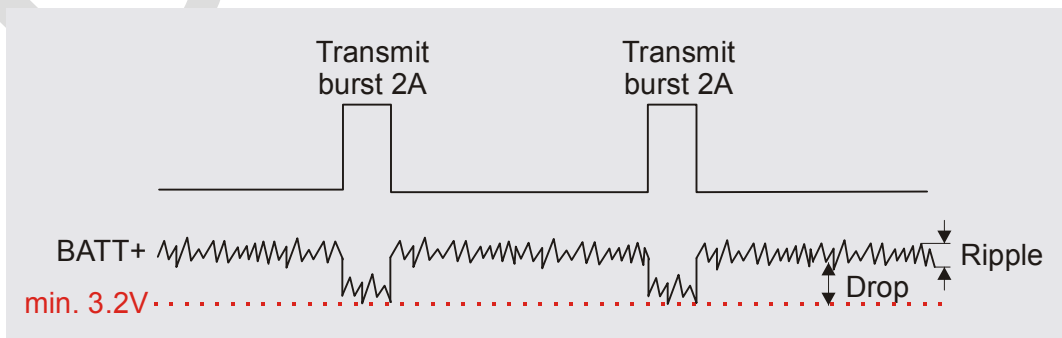
Figure 3: Power supply limits during transmit burst

3.1.2 Measuring the Supply Voltage V$_{BATT+}$

The reference points for measuring the supply voltage V$_{BATT+}$ on the module are BATT+ and GND, both accessible at a capacitor located close to the board-to-board connector of the module.
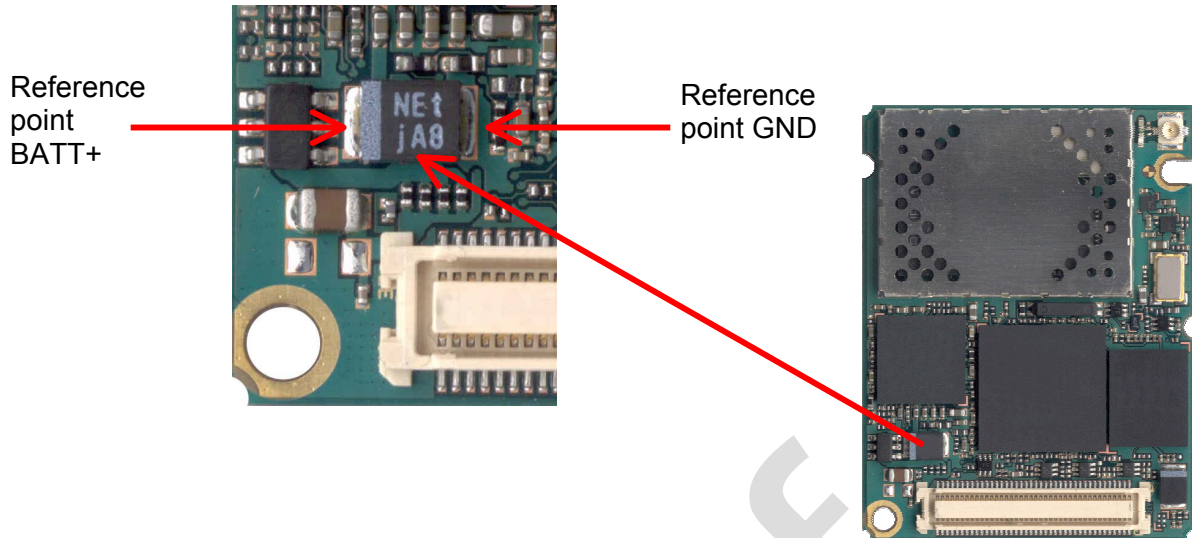
Figure 4: Position of the reference points BATT+ and GND

3.1.3 Monitoring Power Supply by AT Command

To monitor the supply voltage you can also use the AT^SBV command which returns the value related to the reference points BATT+ and GND.

The module continuously measures the voltage at intervals depending on the operating mode of the RF interface. The duration of measuring ranges from 0.5s in TALK/DATA mode to 50s when MC75 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.

3.2   Power Up / Power Down Scenarios

In general, be sure not to turn on MC75 while it is beyond the safety limits of voltage and temperature stated in Chapter 5. MC75 would immediately switch off after having started and detected these inappropriate conditions. In extreme cases this can cause permanent damage to the module.

3.2.1   Turn on MC75

MC75 can be started in a variety of ways as described in the following sections:
- Hardware driven start-up by IGT line: starts normal operating state (see Section 3.2.1.1)
- Software controlled reset by AT+CFUN command: starts normal operating state (see Section 3.2.1.3)
- Hardware driven start-up by VCHARGE line: starts charging algorithm and charge-only mode (see Section 3.2.1.2)
- Wake-up from Power-down mode by using RTC interrupt: starts Alarm mode

3.2.1.1 Turn on MC75 Using Ignition Line IGT

When the MC75 module is in Power-down mode, it can be started to normal operation by driving the IGT (ignition) line to ground. This must be accomplished with an open drain/collector driver to avoid current flowing into this pin.

The module will start up when both of the following two conditions are met:
- The supply voltage applied at BATT+ must be in the operating range.
- The IGT line needs to be driven low for at least 300ms.

Considering different strategies of host application design the figures below show two approaches to meet this requirement: The example in Figure 5 assumes that IGT is activated after BATT+ has already been applied. The example in Figure 6 assumes that IGT is held low before BATT+ is switched on. In either case, to power on the module, ensure that low state of IGT takes at least 300ms from the moment the voltage at BATT+ is available.

If configured to a fix baud rate (AT+IPR≠0), the module will send the URC "^SYSSTART" to notify that it is ready to operate. If autobauding is enabled (AT+IPR=0) there will be no notification.
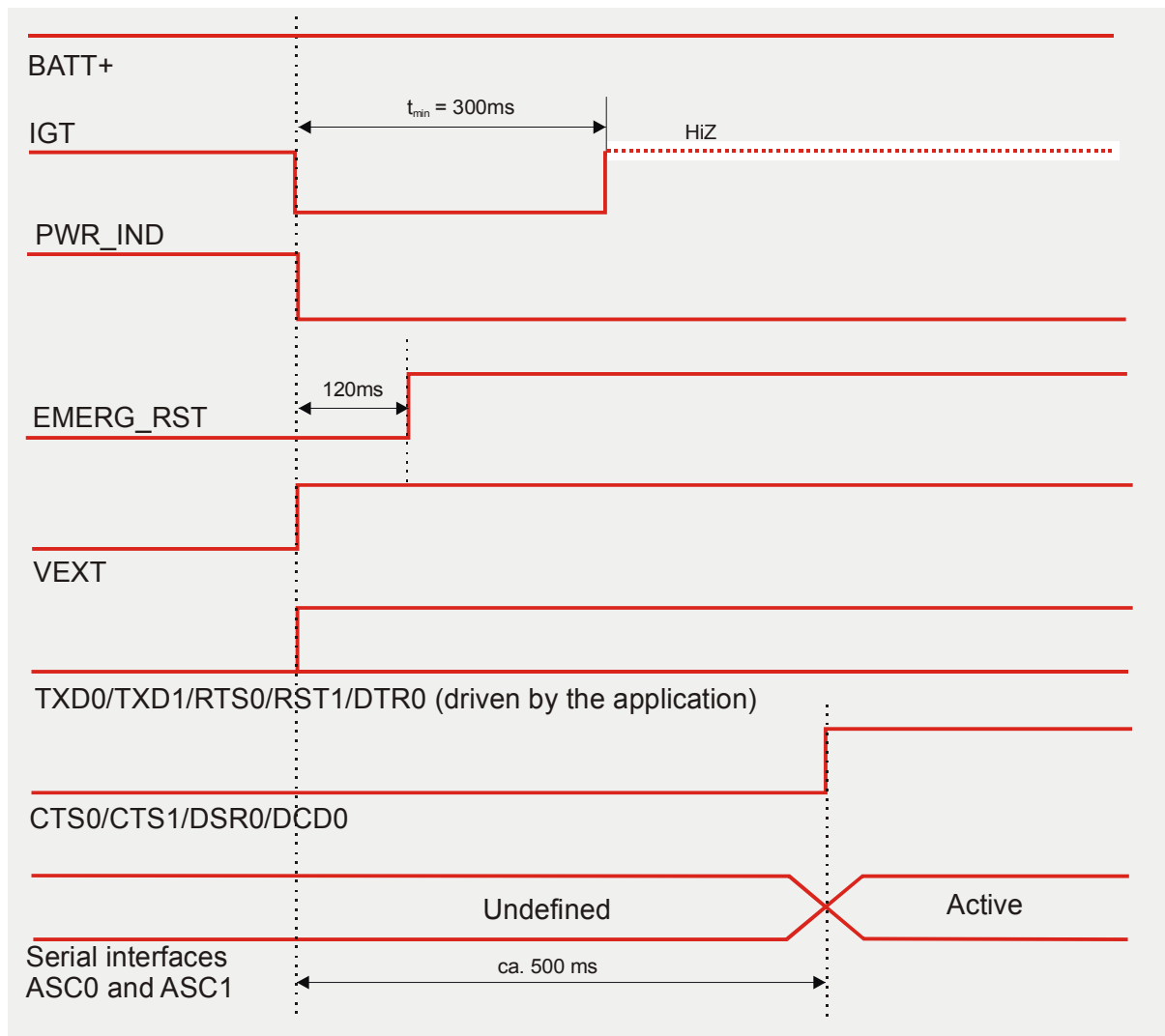
Figure 5: Power-on with operating voltage at BATT+ applied before activating IGT
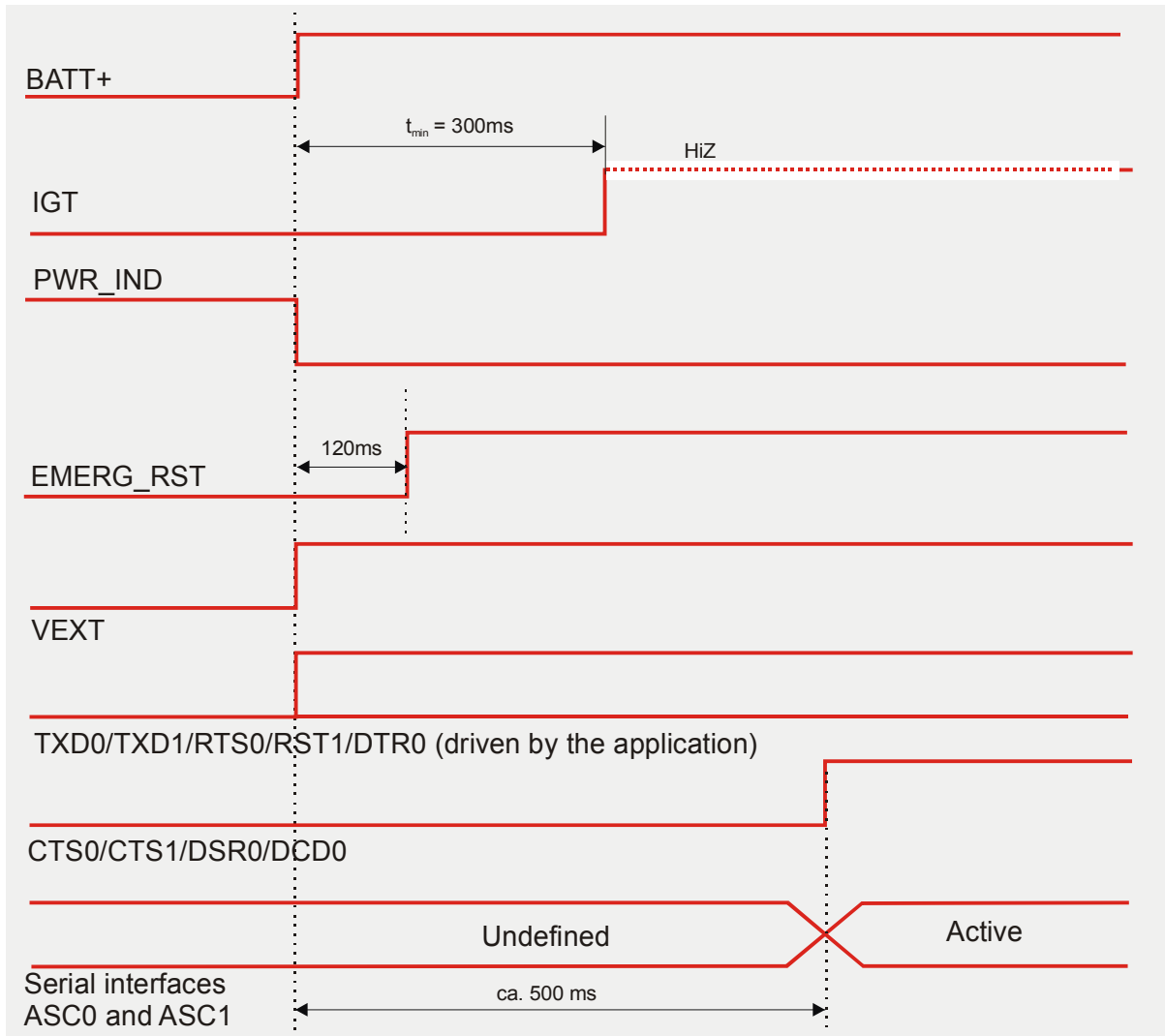
Figure 6: Power-on with IGT held low before switching on operating voltage at BATT+

3.2.1.2 Turn on MC75 Using the VCHARGE Signal

As detailed in Section 3.4.5, the charging adapter can be connected regardless of the module's operating mode.

If the charger is connected to the charger input of the external charging circuit and the module's VCHARGE pin while MC75 is off, and the battery voltage is above the undervoltage lockout threshold, processor controlled fast charging starts (see Section 3.4.4). MC75 enters a restricted mode, referred to as Charge-only mode where only the charging algorithm will be launched.

During the Charge-only mode MC75 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 IGT line needs to be activated as described in Section 3.2.1.

3.2.1.3 Reset MC75 via AT+CFUN Command

To reset and restart the MC75 module use the command AT+CFUN. You can enter AT+CFUN=,1 or AT+CFUN=x,1, where x may be in the range from 0 to 9. See [1] for details.

If configured to a fix baud rate (AT+IPR≠0), the module will send the URC "^SYSSTART" to notify that it is ready to operate. If autobauding is enabled (AT+IPR=0) there will be no notification. To register to the network SIM PIN authentication is necessary after restart.

3.2.1.4 Reset MC75 in Case of Emergency via EMERG_RST

Caution: Use the EMERG_RST pin only when, due to serious problems, the software is not responding for more than 5 seconds. Pulling the EMERG_RST pin causes the loss of all information stored in the volatile memory since the processor restarts immediately. Therefore, this procedure is intended only for use in case of emergency, e.g. if MC75 does not respond, if reset or shutdown via AT command fails.

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

To actually reset the MC75 module, the EMERG_RST line must be pulled to ground for ≥10ms. After releasing the line MC75 will start again.

After hardware driven restart, notification via "^SYSSTART" URC is the same as in case of restart by IGT or AT command. To register to the network SIM PIN authentication is necessary after restart.

3.2.2   Turn off MC75

MC75 can be turned off as follows:

*   Normal shutdown: Software controlled by AT^SMSO command
*   Automatic shutdown: Takes effect if board or battery temperature is out of range or if undervoltage or overvoltage conditions occur.

3.2.2.1   Turn off MC75 Using AT Command

The best and safest approach to powering down MC75 is to issue the AT^SMSO command. This procedure lets MC75 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 PWR_IND pin. High state of PWR_IND definitely indicates that the module is switched off.

Be sure not to disconnect the supply voltage V_{BATT+} before the URC "^SHUTDOWN" has been issued and the PWR_IND signal has gone high. Otherwise you run the risk of losing data. Signal states during turn-off are shown in Figure 7.

While MC75 is in Power-down mode the application interface is switched off and must not be fed from any other source. Therefore, your application must be designed to avoid any current flow into any digital pins of the application interface, especially of the serial interfaces. No special care is required for the USB interface which is protected from reverse current.
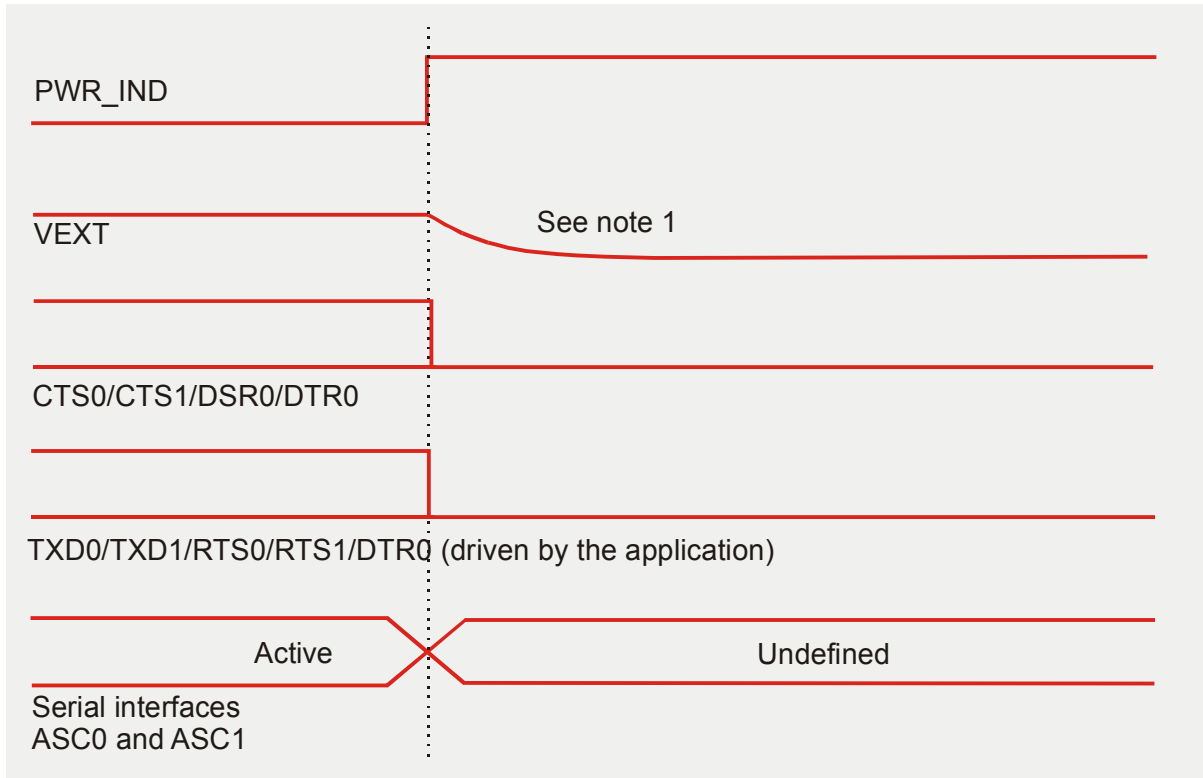
Figure 7: Signal states during turn-off procedure

Note 1: Depending on capacitance load from host application

3.2.2.2 Leakage Current in Power Down Mode

The leakage current in Power Down mode varies depending on the following conditions:
- If the supply voltage at BATT+ was disconnected and then applied again without starting up the MC75 module, the leakage current ranges between 90µA and 100µA.
- If the MC75 module is started and afterwards powered down with AT^SMSO, then the leakage current is only 50µA.

Therefore, in order to minimize the leakage current take care to start up the module at least once before it is powered down.

3.2.3 Automatic Shutdown

Automatic shutdown takes effect if
* the MC75 board is exceeding the critical limits of overtemperature or undertemperature
* the battery is exceeding the critical limits of overtemperature or undertemperature
* undervoltage or overvoltage is detected

The automatic shutdown procedure is equivalent to the Power-down initiated with the AT^SMSO command, i.e. MC75 logs off from the network and the software enters a secure state avoiding loss of data.

Alert messages transmitted before the device switches off are implemented as Unsolicited Result Codes (URCs). The presentation of these URCs can be enabled or disabled with the two AT commands AT^SBC and AT^SCTM. The URC presentation mode varies with the condition, please see Chapters 3.2.3.1 to 3.2.3.4 for details. For further instructions on AT commands refer to [1].

3.2.3.1 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 3.4.1 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, MC75 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 MC75. 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 Table 15. Refer to Table 1 for the associated URCs. All statements are based on test conditions according to IEC 60068-2-2 (still air).

Table 1: Temperature dependent behavior

Sending temperature alert (15 s after MC75 start-up, otherwise only if URC presentation enabled)	
^SCTM_A: 1	Caution: T_{amb} of battery close to overtemperature limit.
^SCTM_B: 1	Caution: T_{amb} of board close to overtemperature limit.
^SCTM_A: -1	Caution: T_{amb} of battery close to undertemperature limit.
^SCTM_B: -1	Caution: T_{amb} of board close to undertemperature limit.
^SCTM_A: 0	Battery back to uncritical temperature range.
^SCTM_B: 0	Board back to uncritical temperature range.
Automatic shutdown (URC appears no matter whether or not presentation was enabled)	
^SCTM_A: 2	Alert: T_{amb} of battery equal or beyond overtemperature limit. MC75 switches off.
^SCTM_B: 2	Alert: T_{amb} of board equal or beyond overtemperature limit. MC75 switches off.
^SCTM_A: -2	Alert: T_{amb} of battery equal or below undertemperature limit. MC75 switches off.
^SCTM_B: -2	Alert: T_{amb} of board equal or below undertemperature limit. MC75 switches off.

3.2.3.2 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).

3.2.3.3 Undervoltage Shutdown if Battery NTC is Present

In applications where the module's charging technique 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: Undervoltage.

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 current consumption of your host application. Step by step instructions are provided in [1].

3.2.3.4   Undervoltage Shutdown if no Battery NTC is Present

The undervoltage 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 MC75 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 TBD.) the URC
     ^SBC: Undervoltage
appears several times before the module switches off.

3.2.3.5   Overvoltage Shutdown

In the event of the voltage rising above the maximum voltage (see Table TBD) the module sends a URC and then performs an orderly shutdown. Further details: TBD

Keep in mind that several MC75 components are directly linked to BATT+ and, therefore, the supply voltage remains applied at major parts of MC75, even if the module is switched off. Especially the power amplifier is very sensitive to high voltage and might even be destroyed.

3.3 Automatic EGPRS/GPRS Multislot Class Change

Temperature control is also effective for operation in EGPRS Multislot Class 10 and GPRS Multislot Class 12. If the board temperature increases to the limit specified for restricted operation[1] while data are transmitted over EGPRS or GPRS, the module automatically reverts

- from EGPRS Multislot Class 10 (2 Tx slots) to EGPRS Multislot Class 8 (1Tx),
- from GPRS Multislot Class 12 (4 Tx slots) to GPRS Multislot Class 8 (1Tx),
- from GPRS Multislot Class 10 (2 Tx slots) to GPRS Multislot Class 8 (1Tx)

This reduces the power consumption and, consequently, causes the board's temperature to decrease. Once the temperature drops to a value of 5 degrees below the limit of restricted operation, MC75 returns to the higher Multislot Class. If the temperature stays at the critical level or even continues to rise, MC75 will not switch back to the higher class.

After a transition from EGPRS Multislot Class 10 to EGPRS Multislot Class 8 a possible switchback to EGPRS Multislot Class 10 is blocked for one minute. The same applies when a transition occurs from GPRS Multislot Class 12 or 10 to GPRS Multislot Class 8.

Please note that there is not one single cause of switching over to a lower 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 Section 3.2.3.1.

[1] See Table 15 for temperature limits known as restricted operation.

3.4   Charging Control

MC75 integrates a charging management for rechargeable Lithium Ion and Lithium Polymer batteries. You can skip this chapter if charging is not your concern, or if you are not using the implemented charging algorithm.

MC75 has no on-board charging circuit. To benefit from the implemented charging management you are required to install a charging circuit within your application according to the Figure 39.

The following sections contain an overview of charging and battery specifications. Please refer to [4] for greater detail, especially regarding requirements for batteries and chargers, appropriate charging circuits, recommended batteries and an analysis of operational issues typical of battery powered GSM/GPRS applications.

3.4.1   Battery Pack Requirements

The charging algorithm has been optimized for rechargeable Lithium batteries that meet the characteristics listed below and in Table 2. It is recommended that the battery pack you want to integrate into your MC75 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 [1] for details). Failure to comply with these specifications might cause AT^SBC to deliver incorrect battery capacity values.

- Li-Ion or Lithium Polymer battery pack specified for a maximum charging voltage of 4.2 V and a recommended capacity of 1000 to 1200 mAh.
- 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.
  The B value of the NTC should be in the range: *10 kΩ +5% @ 25°C, $B_{25/85}$* = 3423K to B =3435K ± 3% (alternatively acceptable: *10 kΩ +2% @ 25°C, $B_{25/50}$ = 3370K +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 overvoltage (protection against overcharging), undervoltage (protection against deep discharging) and overcurrent. Due to the discharge current profile typical of GSM applications, the circuit must be insensitive to pulsed current.
- On the MC75 module, a built-in measuring circuit constantly monitors the supply voltage. In the event of undervoltage, it causes MC75 to power down. Undervoltage thresholds are specific to the battery pack and must be evaluated for the intended model. When you evaluate undervoltage thresholds, consider both the current consumption of MC75 <u>and</u> 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 150mΩ, 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.
- It is recommended that the battery pack be approved to satisfy the requirements of CE conformity.

Figure 8 shows the circuit diagram of a typical battery pack design that includes the protection elements described above.
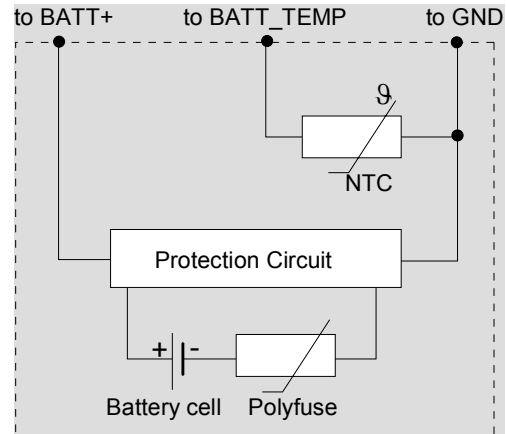
Figure 8: Battery pack circuit diagram

Table 2: Specifications of battery packs suitable for use with MC75

Battery type	Rechargeable Lithium Ion or Lithium Polymer battery
Nominal voltage	3.6V / 3.7V
Capacity	Recommended: 1000mAh to 1200mAh Minimum: 500mAh
NTC	10kΩ ± 5% @ 25°C B value range: B (25/85)=3423K to B =3435K ± 3%
Overcharge detection voltage	4.325 ± 0.025V
Overdischarge detection voltage	2.5 ± 0.05V
Overcurrent detection	3 ± 0.5A
Overcurrent detection delay time	4ms
Short detection delay time	50µs
Internal resistance	<130mΩ Note: A maximum internal resistance of 150mΩ should not be exceeded even after 500 cycles and under extreme conditions.

3.4.2   Batteries Recommended for Use with MC75

When you choose a battery for your MC75 application you can take advantage of one of the following two batteries offered by VARTA Microbattery GmbH. Both batteries meet all requirements listed above. They have been thoroughly tested by Siemens and proved to be equally suited for MC75.

- LIP 633450A1B PCM.STB, type Lithium Ion
  This battery is listed in the standard product range of VARTA. Incorporated in a shrink sleeve, the battery is CE approved. Therefore it has been chosen for integration into the reference setup submitted for Type Approval of Siemens GSM modules.

- LPP 503759CA PCM.NTC.LT50, type Lithium Polymer
  This battery has been especially designed by VARTA for use with Siemens GSM modules. It has the same properties as the above Li-Ion battery, except that it is type Polymer, is smaller, comes without casing and is not CE approved.

Specifications, construction drawings and sales contacts for both VARTA batteries can be found in Section 9.3.

3.4.3 Charger Requirements

For using the implemented charging algorithm and the reference charging circuit recommended in [4] and in Figure 39, the charger has to meet the following requirements:

Output voltage: 5.2Volts ±0.2V (stabilized voltage)
Output current: 500mA

Chargers with a higher output current are acceptable, but please consider that only 500mA will be applied when a 0.3 Ohms shunt resistor is connected between VSENSE and ISENSE. See [4] for further details.

3.4.4 Implemented Charging Technique

If the external charging circuit of your application and the charger meet the requirements listed above, charging is enabled in various stages depending on the battery condition:

Trickle charging:
- Trickle charge current flows over the VCHARGE line.
- Trickle charging is done when a charger is present (connected to VCHARGE) and the battery is deeply discharged or has undervoltage. If deeply discharged (Deep Discharge Lockout at V_{BATT+}= 0…2.5V) the battery is charged with 5mA, in case of undervoltage (Undervoltage Lockout at V_{BATT+}= 2.5…3.2V) it is charged with 25mA

Software controlled charging:
- Controlled over the CHARGEGATE.
- Temperature conditions: 0°C to 45°C
- Software controlled charging is done when the charger is present (connected to VCHARGE) and the battery voltage is at least above the undervoltage threshold. Software controlled charging passes the following stages:
  - Power ramp: Depending on the discharge level of the battery (i.e. the measured battery voltage V_{BATT+}) the software adjusts the maximum charge current for charging the battery. The duration of power ramp charging is very short (less than 30 seconds).
  - Fast charging: Battery is charged with constant current (approx. 500mA) until the battery voltage reaches 4.2V (approx. 70% of the battery capacity).
  - Top-up charging: The battery is charged with constant voltage of 4.2V at stepwise reducing charge current until full battery capacity is reached.
- The duration of software controlled charging depends on the battery capacity and the level of discharge.

3.4.5   Operating Modes during Charging

Of course, the battery can be charged regardless of the engine's operating mode. When the GSM module 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 module's VCHARGE pin while MC75 is in Power-down mode, MC75 goes into *Charge-only* mode.

Table 3: Comparison Charge-only and Charge mode

<table>
<tr><th></th><th>How to activate mode</th><th>Description of mode</th></tr>
<tr>
<td>Charge mode</td>
<td>Connect charger to charger input of host application charging circuit and module's VCHARGE pin while MC75 is
• operating, e.g. in IDLE or TALK mode
• in SLEEP mode</td>
<td>• Battery can be charged while GSM module remains operational and registered to the GSM network.
• In IDLE and TALK mode, the serial interfaces are accessible. All AT commands can be used to full extent.
NOTE: If the module operates at maximum power level (PCL5) and GPRS Class 12 at the same time current consumption is higher than the current supplied by the charger.</td>
</tr>
<tr>
<td>Charge-only mode</td>
<td>Connect charger to charger input of host application charging circuit and module's VCHARGE pin while MC75 is
• in Power-down mode
• in Normal mode: Connect charger to the VCHARGE pin, then enter AT^SMSO.

NOTE: While trickle charging is in progress, be sure that the host 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.</td>
<td>• 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.</td>
</tr>
</table>

Table 4: AT commands available in Charge-only mode

AT command	Use
AT+CALA	Set alarm time
AT+CCLK	Set date and time of RTC
AT^SBC	Query status of charger connection. Enable / disable "^SBC" URCs.
AT^SCTM	Query temperature range, enable/disable URCs to report critical temperature ranges
AT^SMSO	AT^SMSO shuts down the module, but if the charger remains connected the module will automatically restart into Charge-only mode.

3.5 RTC Backup

The internal Real Time Clock of MC75 is supplied from a separate voltage regulator in the analog controller which is also active when MC75 is in POWER DOWN status. An alarm function is provided that allows to wake up MC75 without logging on to the GSM network.

In addition, you can use the VDDLP pin on the board-to-board connector to backup the RTC from an external capacitor or a battery (rechargeable or non-chargeable). The capacitor is charged by the BATT+ line of MC75. If the voltage supply at BATT+ is disconnected the RTC can be powered by the capacitor. The size of the capacitor determines the duration of buffering when no voltage is applied to MC75, i.e. the larger the capacitor the longer MC75 will save the date and time.

A serial 1kΩ resistor placed on the board next to VDDLP limits the charge current of an empty capacitor or battery.

The following figures show various sample configurations. Please refer to Table 16 for the parameters required.
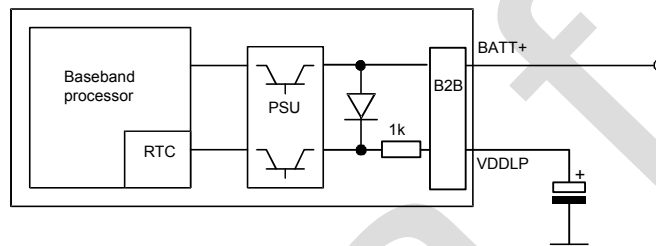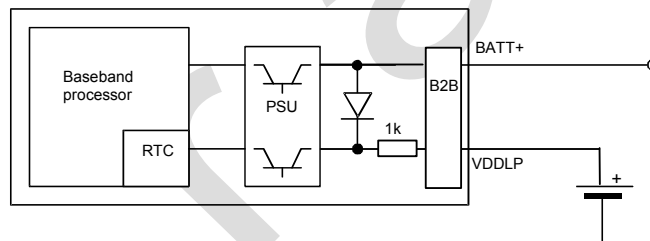
Figure 9: RTC supply from capacitor

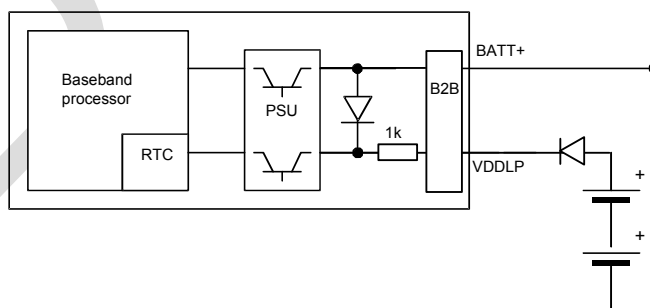Figure 10: RTC supply from rechargeable battery

Figure 11: RTC supply from non-chargeable battery

3.6   SIM Interface

The baseband 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 SIM interface supports 3V and 1.8V SIM cards. Please refer to Table 16 for electrical specifications of the SIM interface lines depending on whether a 3V or 1.8V SIM card is used.

The CCIN pin serves to detect whether a tray (with SIM card) is present in the card holder. Using the CCIN pin is mandatory for compliance with the GSM 11.11 recommendation if the mechanical design of the host application allows the user to remove the SIM card during operation. To take advantage of this feature, an appropriate SIM card detect switch is required on the card holder. For example, this is true for the model supplied by Molex, which has been tested to operate with MC75 and is part of the Siemens reference equipment submitted for type approval. See Chapter 8 for Molex ordering numbers.

Table 5: Signals of the SIM interface (board-to-board connector)

Signal	Description
CCGND	Separate ground connection for SIM card to improve EMC. Be sure to use this ground line for the SIM interface rather than any other ground pin or plane on the module. A design example for grounding the SIM interface is shown in Figure 39.
CCCLK	Chipcard clock, various clock rates can be set in the baseband processor.
CCVCC	SIM supply voltage.
CCIO	Serial data line, input and output.
CCRST	Chipcard reset, provided by baseband processor.
CCIN	Input on the baseband processor for detecting a SIM card tray in the holder. If the SIM is removed during operation the SIM interface is shut down immediately to prevent destruction of the SIM. The CCIN pin is mandatory for applications that allow the user to remove the SIM card during operation. The CCIN pin is solely intended for use with a SIM card. It must not be used for any other purposes. Failure to comply with this requirement may invalidate the type approval of MC75.

The total cable length between the board-to-board connector pins on MC75 and the pins of the external SIM card holder must not exceed 100 mm in order to meet the specifications of 3GPP TS 51.010-1 and to satisfy the requirements of EMC compliance.

To avoid possible cross-talk from the CCCLK signal to the CCIO signal be careful that both lines are not placed closely next to each other. A useful approach is using the CCGND line to shield the CCIO line from the CCCLK line.

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 MC75.

3.7   Serial Interface ASC0

MC75 offers an 8-wire unbalanced, asynchronous modem interface ASC0 conforming to ITU-T V.24 protocol DCE signalling. The electrical characteristics do not comply with ITU-T V.28. The significant levels are 0V (for low data bit or active state) and 2.9V (for high data bit or inactive state). For electrical characteristics please refer to Table 16.

MC75 is designed for use as a DCE. Based on the conventions for DCE-DTE connections it communicates with the customer application (DTE) using the following signals:
- Port TXD @ application sends data to the module's TXD0 signal line
- Port RXD @ application receives data from the module's RXD0 signal line
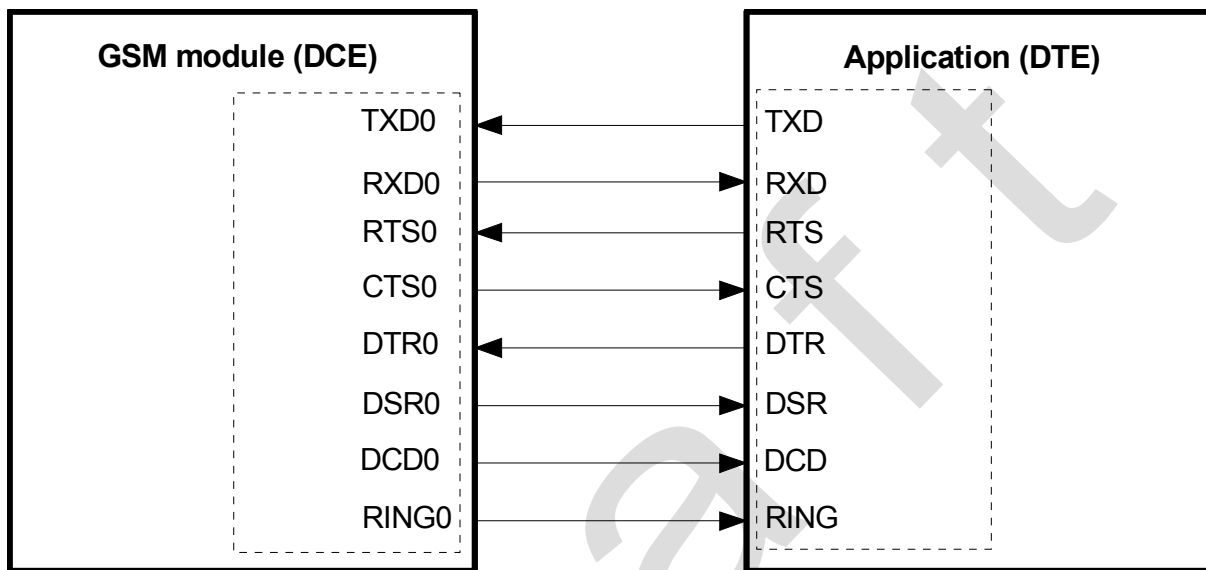
Figure 12: Serial interface ASC0

Features
- Includes the data lines TXD0 and RXD0, the status lines RTS0 and CTS0 and, in addition, the modem control lines DTR0, DSR0, DCD0 and RING0.
- ASC0 is primarily designed for controlling voice calls, transferring CSD, fax and GPRS data 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 details on Multiplex mode see [5].
- The DTR0 signal will only be polled once per second from the internal firmware of MC75.
- The RING0 signal serves to indicate incoming calls and other types of URCs (Unsolicited Result Code). It can also be used to send pulses to the host application, for example to wake up the application from power saving state. See [1] for details on how to configure the RING0 line by AT^SCFG.
- By default, configured for 8 data bits, no parity and 1 stop bit. The setting can be changed using the AT command AT+ICF and, if required, AT^STPB. For details see [1].
- ASC0 can be operated at bit rates from 300bps to 460800 bps.
- Autobauding supports the following bit rates: TBD.
- Autobauding is not compatible with multiplex mode.
- Supports RTS0/CTS0 hardware flow control and XON/XOFF software flow control.

Table 6: DCE-DTE wiring of ASC0

V.24 circuit	DCE		DTE	
	Pin function	**Signal direction**	**Pin function**	**Signal direction**
103	TXD0	Input	TXD	Output
104	RXD0	Output	RXD	Input
105	RTS0	Input	RTS	Output
106	CTS0	Output	CTS	Input
108/2	DTR0	Input	DTR	Output
107	DSR0	Output	DSR	Input
109	DCD0	Output	DCD	Input
125	RING0	Output	/RING	Input

3.8   Serial Interface ASC1

MC75 offers a 4-wire unbalanced, asynchronous modem interface ASC1 conforming to ITU-T V.24 protocol DCE signalling. The electrical characteristics do not comply with ITU-T V.28. The significant levels are 0V (for low data bit or active state) and 2.9V (for high data bit or inactive state). For electrical characteristics please refer to Table 16.

MC75 is designed for use as a DCE. Based on the conventions for DCE-DTE connections it communicates with the customer application (DTE) using the following signals:
- Port TXD @ application sends data to module's TXD1 signal line
- Port RXD @ application receives data from the module's RXD1 signal line
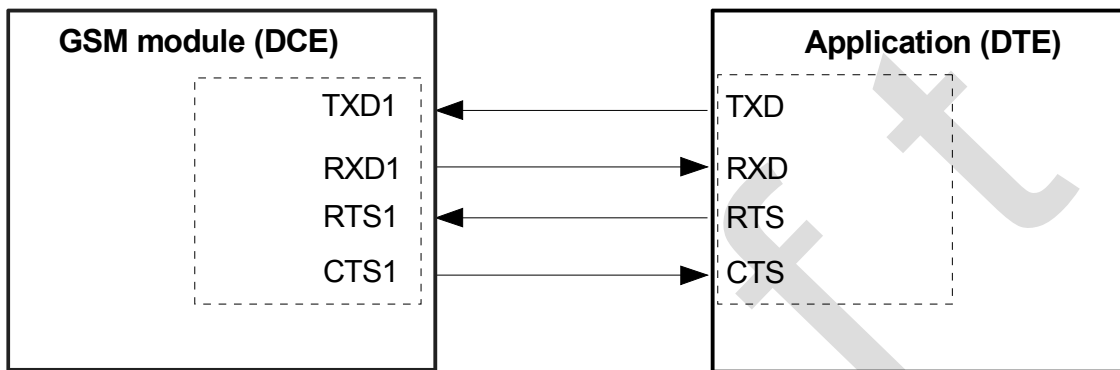
Figure 13: Serial interface ASC1

Features
- Includes only the data lines TXD1 and RXD1 plus RTS1 and CTS1 for hardware handshake.
- On ASC1 no 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 [1].
- Configured for 8 data bits, no parity and 1 or 2 stop bits.
- ASC1 can be operated at bit rates from 300bps to 460800 bps.
- Autobauding TBD.
- Supports RTS1/CTS1 hardware flow control and XON/XOFF software flow control.

Table 7: DCE-DTE wiring of ASC1

V.24 circuit	DCE		DTE	
	Pin function	Signal direction	Pin function	Signal direction
103	TXD1	Input	TXD	Output
104	RXD1	Output	RXD	Input
105	RTS1	Input	RTS	Output
106	CTS1	Output	CTS	Input

3.9   USB Interface

MC75 supports a USB 2.0 Full Speed (12 Mbit/s) device interface. It is primarily intended for use as command and data interface and for downloading firmware.

The USB I/O-pins are capable of driving the signal at min 3.0V. They are 5V I/O compliant.

To properly connect the module's USB interface to the host a USB 2.0 compatible connector is required. Furthermore, the USB modem driver delivered with MC75 must be installed as described below.

The USB host is responsible for supplying, across the VUSB_IN line, power to the module's USB interface, but not to other MC75 interfaces. This is because MC75 is designed as a self-powered device compliant with the "Universal Serial Bus Specification Revision 2.0"[1].
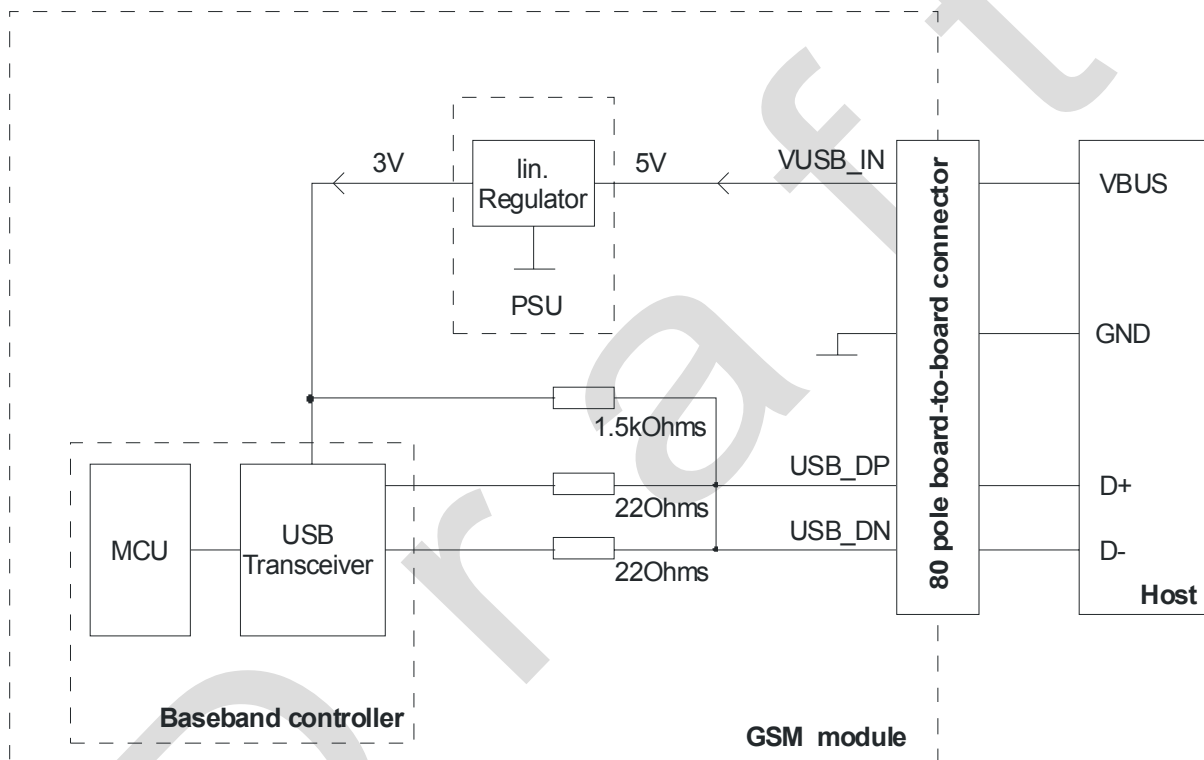
Figure 14: USB circuit

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

3.9.1   Installing the USB Modem Driver

This section assumes you are familiar with installing and configuring a modem under Windows 2000 and Windows XP. As both operating systems use multiple methods to access modem settings this section provides only a brief summary of the most important steps.

Take care that the "usbmodem.inf" file delivered with MC75 is at hand. Connect the USB cable to the MC75 host application (for example the evaluation board DSB75) and the PC. Windows detects MC75 as a new USB modem, opens the *Found New Hardware Wizard* and reports that it is searching for the "Siemens AG WM USB Modem" driver. Follow the instructions on the screen and specify the path where the "usbmodem.inf" file is located. Windows will copy the required software to your computer and configure the modem by assigning a free COM port. If you are already using more than one COM port then the next free one will be allocated. Click *Finish* to complete the installation.

Notes for Windows 2000 only:
- During the installation procedure you will be prompted for the "usbser.sys" driver. Make sure the file is present before you start installing the above inf file.
  The "usbser.sys" file is not delivered as a single file, but must be extracted from a Windows 2000 cabinet file. This is either the file "driver.cab" located in the "I386" folder of the original Windows 2000 CD or a later cabinet file inside the Service Pack. SP4 for example includes the "sp4.cab" file which can be found in its "I386" folder. The "usbser.sys" driver from the Service Pack has priority over one provided with the standard Windows 2000 install CD.
- It is necessary to restart Windows 2000 to make the changes take effect.
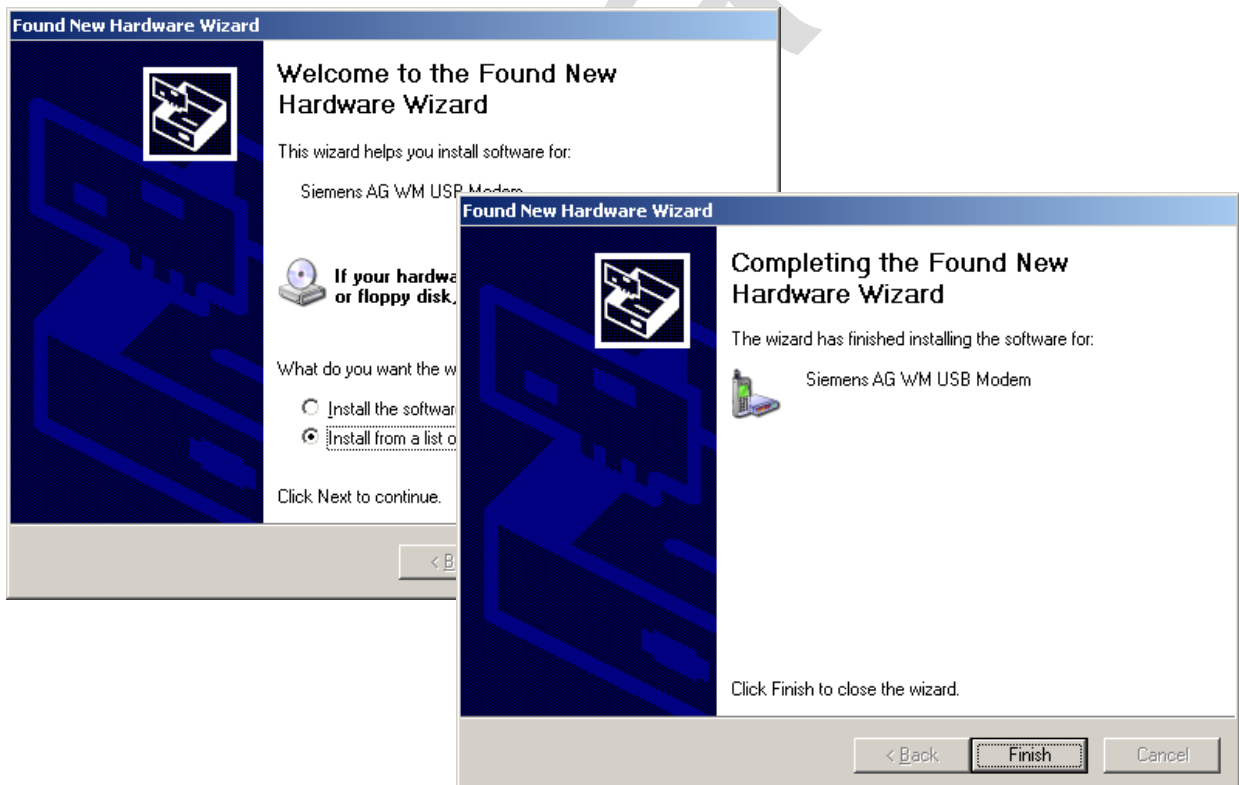
You can find the "Siemens AG WM USB Modem" listed under *Control Panel | Phone and Modem Options | Modems.*
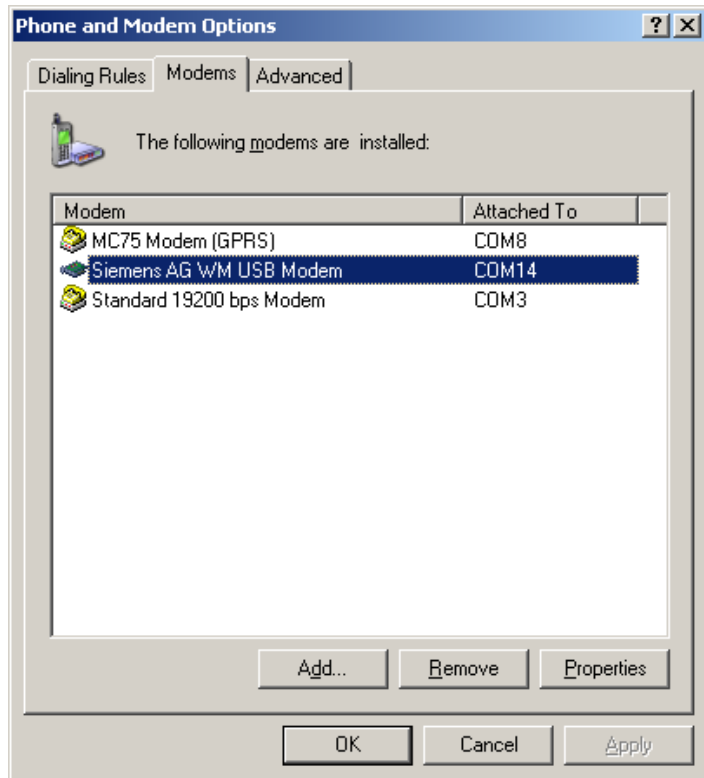
Troubleshooting for installation problems

If Windows fails to assign the next free COM port to MC75 and, for example, allocates a COM port already used by another modem you can manually select a free port as follows:

Open the Windows *Device Manager*, select the installed "Siemens AG WM USB Modem", click *Properties*, select the *Advanced* tab and click *Advanced Port settings*. From the listbox *COM Port Number* choose a free port. To make the changes take effect disconnect and re-connect the USB cable. If not yet successful, also restart Windows.
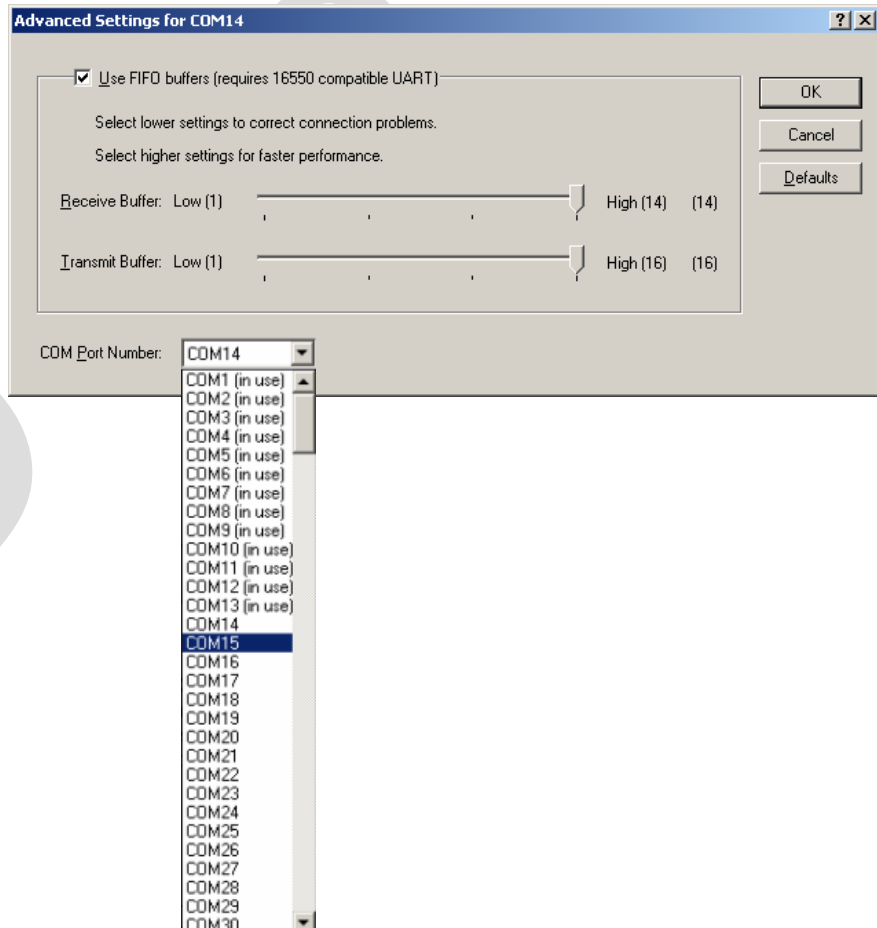
3.10 I²C Interface

I²C is a serial, 8-bit oriented data transfer bus for bit rates up to 400 kbps in Fast mode. It consists of two lines, the serial data line I2CDAT and the serial clock line I2CCLK.

The MC75 module acts as a single master device, e.g. the clock I2CCLK is driven by module. I2CDAT is a bi-directional line.

Each device connected to the bus is software addressable by a unique address, and simple master/slave relationships exist at all times. The module operates as master-transmitter or as master-receiver. The customer application transmits or receives data only on request of the module. To configure and activate the I²C interface use the AT^SSPI command described in [1].

The I²C interface can be powered from an external supply or via the VEXT line of MC75. If connected to the VEXT line the I²C interface will be properly shut down when the module enters the Power-down mode. If you prefer to connect the I²C interface to an external power supply, take care that VCC of the application is in the range of V_{VEXT} and that the interface is shut down when the PWR_IND signal goes high. See figures below as well as Section 7 and Figure 39.

In the application I2CDAT and I2CCLK lines need to be connected to a positive supply voltage via a pull-up resistor.

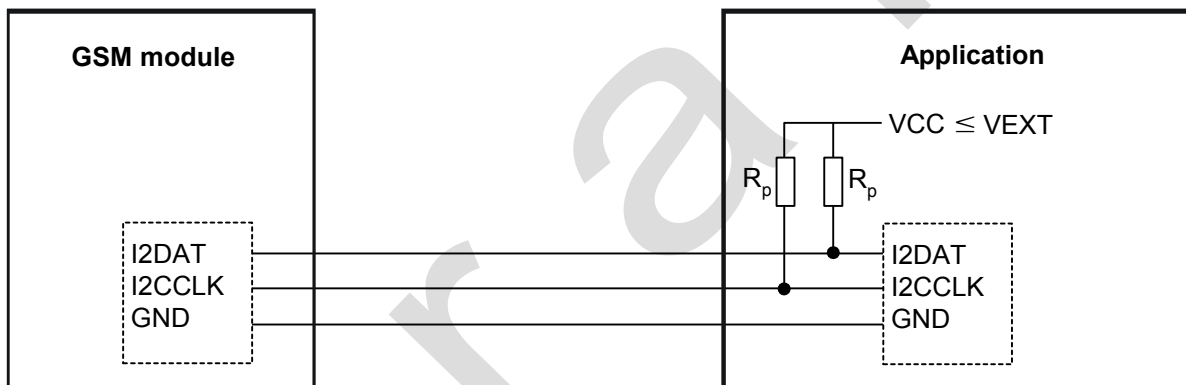For electrical characteristics please refer to Table 16.

Figure 15: I²C interface connected to VCC of application
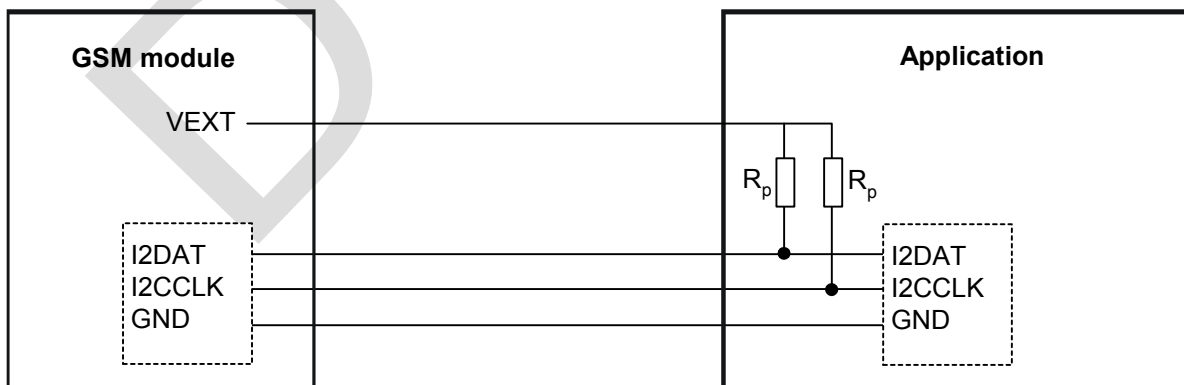

Figure 16: I²C interface connected to VEXT line of MC75

Note: Good care should be taken when creating the PCB layout of the host application: The traces of I2CCLK and I2CDAT should be equal in length and as short as possible.

3.11   SD Memory Card Interface

The SD card interface is compliant with the "SD Memory Card Specifications / Part 1 Physical Layer Specification, Version 1.01".

The interface supports the following features:
- Data rates up to 3250 kByte/s.
- The read/write data rate depends on the clock rate.
- SD card insertion detection (at SD_D3-line) or via SD_DET line as option (CD switch in SD card holder required)
- Write protect detection via SD_WP line is optional (WP switch in SD card holder required)
- Maximum capacity of SD cards compliant with the above SD Memory Card Specification is 4 GByte.

The SD memory card interface can be powered from an external supply or via the VEXT line of MC75. If connected to the VEXT line the SD memory card interface will be properly shut down when the module enters the Power-down mode. If you prefer to connect the SD card interface to an external power supply, take care that the interface is shut down when the PWR_IND signal goes high. See also Section 7 and Figure 39.

Note: No guarantee can be given, nor any liability accepted, if loss of data is encountered after removing the SD memory card during operation.

Table 8: SD card interface

Signal	I/O	Description	Remark
SD_D0	I/O	4 bit data bus	---
SD_D1	I/O		---
SD_D2	I/O		---
SD_D3	I/O		Card detect at power on: 0 or open = Card removed 1 or 50k pullup = Card inserted Note: This is no removal detection during card operation!
SD_CMD	O	Command / Response	
SD_CLK	O	Clock	25.4kHz …13MHz Clock rise and fall time: max. 10ns
SD_WP	I	Write protect detection	0= unlocked 1= locked (External pull-up resistor required)
SD_DET	I	Card detection (optional)	0= card inserted 1= card removed
Power supply from external source or from VEXT line			Required power supply: min. 2.7V, max. 3.6V.

Note: Good care should be taken when creating the PCB layout of the host application: The traces of SD_CLK, SD_CMD, and SD_D(0..3) should be equal in length and as short as possible.
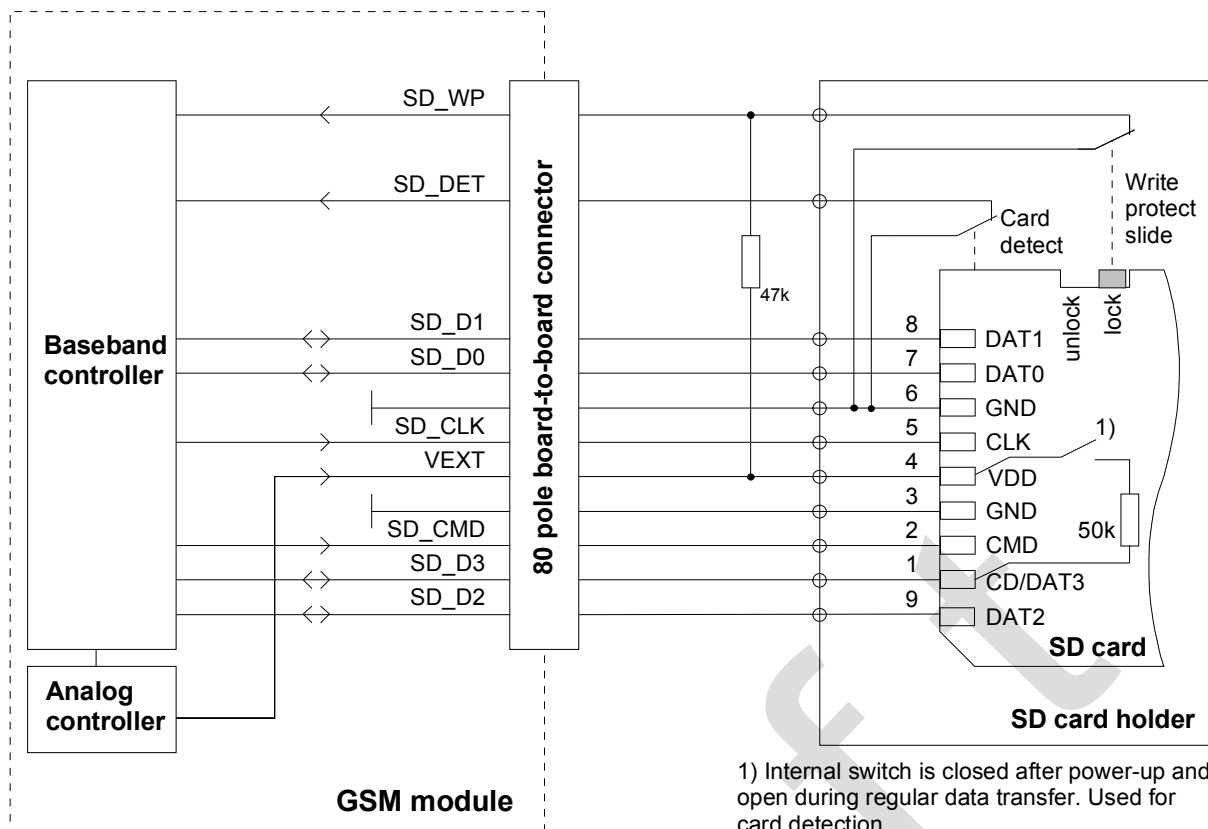
Figure 17: SD card interface (example with power supply from module's VEXT line)

3.12 Audio Interfaces

MC75 comprises three audio interfaces available on the board-to-board connector:
- Two analog audio interfaces, both with balanced or single-ended inputs/outputs.
- Serial digital audio interface (DAI) designed for PCM (Pulse Code Modulation).

This means you can connect up to three different audio devices, although only one interface can be operated at a time. Using the AT^SAIC command you can easily switch back and forth.
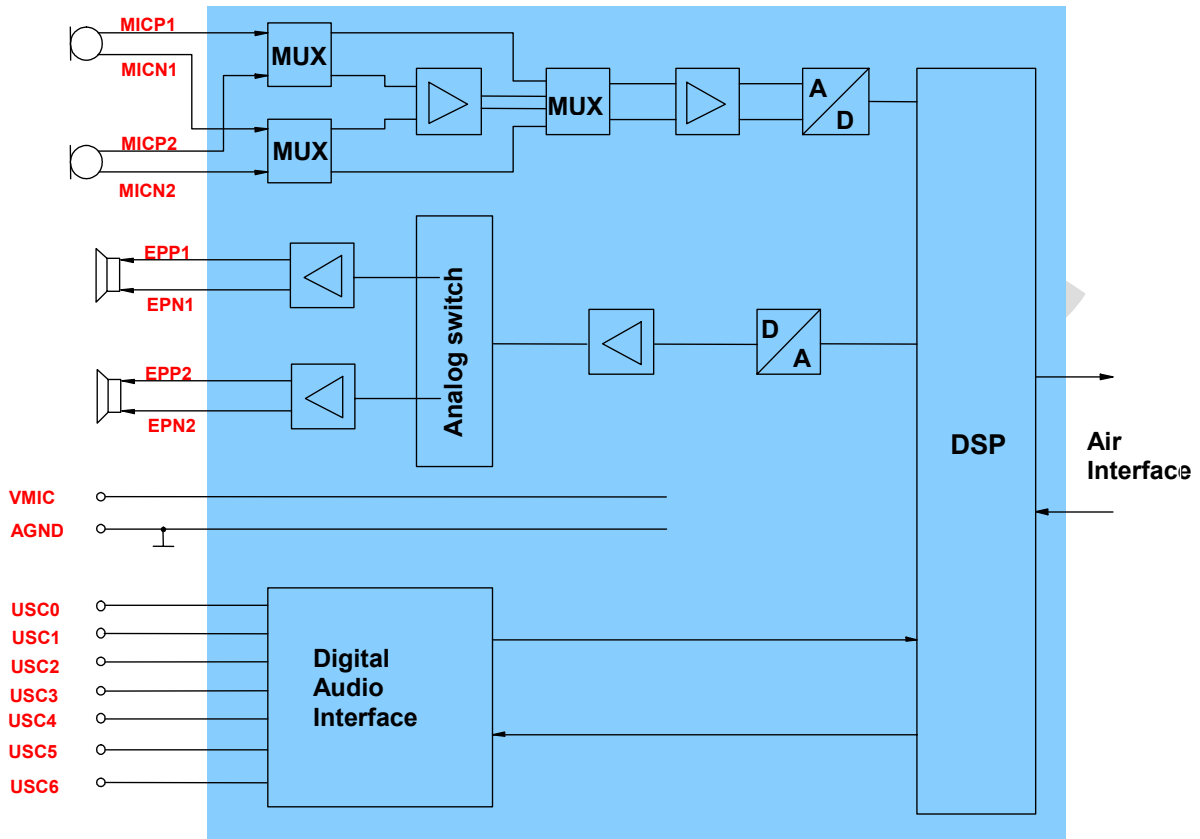
Figure 18: Audio block diagram

To suit different types of accessories the audio interfaces can be configured for different audio modes via the AT^SNFS command. The electrical characteristics of the voiceband part vary with the audio mode. For example, sending and receiving amplification, sidetone paths, noise suppression etc. depend on the selected mode and can be altered with AT commands (except for mode 1).

Both analog audio interfaces can be used to connect headsets with microphones or speakerphones. Headsets can be operated in audio mode 3, speakerphones in audio mode 2. Audio mode 5 can be used for a speech coder without signal pre or post processing.

When shipped from factory, all audio parameters of MC75 are set to interface 1 and audio mode 1. This is the default configuration optimized for the Votronic HH-SI-30.3/V1.1/0 handset and used for type approving the Siemens reference configuration. Audio mode 1 has fix parameters which cannot be modified. To adjust the settings of the Votronic handset simply change to another audio mode.

3.12.1   Speech Processing

The speech samples from the ADC or DAI are handled by the DSP of the baseband controller to calculate e.g. amplifications, sidetone, 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 sidetone 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 baseband processor.

3.12.2   Microphone Circuit

MC75 has two identical analog microphone inputs. There is no on-board microphone supply circuit, except for the internal voltage supply VMIC and the dedicated audio ground line AGND. Both lines are well suited to feed a balanced audio application or a single-ended audio application.

The AGND line on the MC75 board is especially provided to achieve best grounding conditions for your audio application. As there is less current flowing than through other GND lines of the module or the application, this solution will avoid hum and buzz problems.

3.12.2.1   Single-ended Microphone Input

Figure 19 as well as Figure 39 show an example of how to integrate a single-ended microphone input.

R_A = typ. 2k
R_B = typ. 5k
R_{VMIC} = typ. 470Ohm

C_k = typ. 100nF
C_F = typ. 22µF

V_{MIC} = typ. 2.5V

V_{bias} = 1.0V … 1.6V, typ. 1.5V
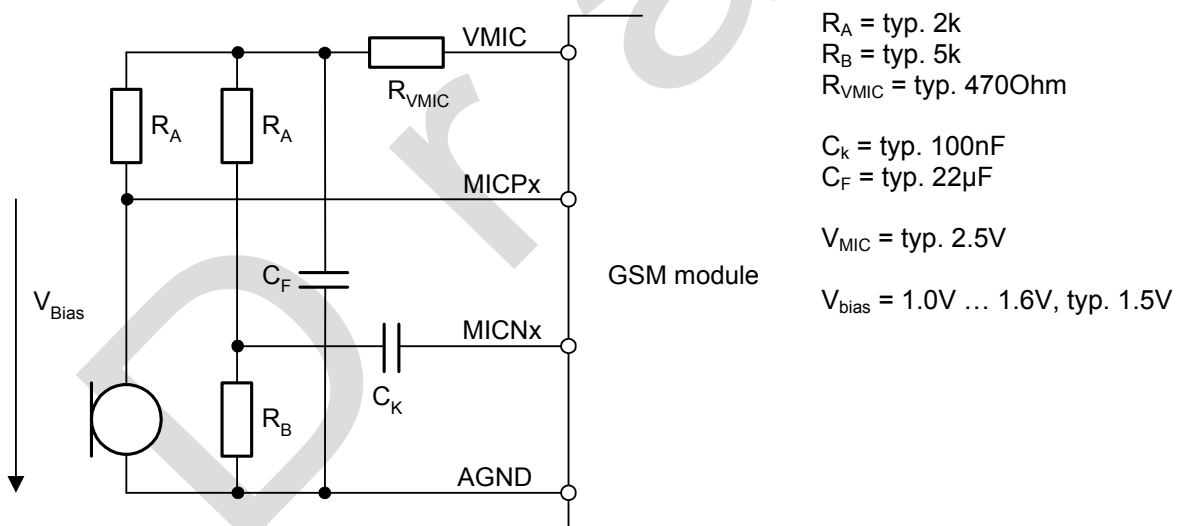
Figure 19: Single ended microphone input

R_A has to be chosen so that the DC voltage across the microphone falls into the bias voltage range of 1.0V to 1.6V and the microphone feeding current meets its specification.

The MICNx input is automatically self biased to the MICPx DC level. It is AC coupled via C_K to a resistive divider which is used to optimize supply noise cancellation by the differential microphone amplifier in the module.

The VMIC voltage should be filtered if gains larger than 20dB are used. The filter can be attached as a simple first order RC-network (R_{VMIC} and C_F).

This circuit is well suited if the distance between microphone and module is kept short. Due to good grounding the microphone can be easily ESD protected as its housing usually connects to the negative terminal.

3.12.2.2   Differential Microphone Input

Figure 20 shows a differential solution for connecting an electret microphone.

R_A = typ. 1k
R_{VMIC} = 470Ohm

C_K = typ. 100nF
C_F = typ. 22µF

V_{MIC} = typ. 2.5V

V_{bias} = 1.0V … 1.6V, typ. 1.5V
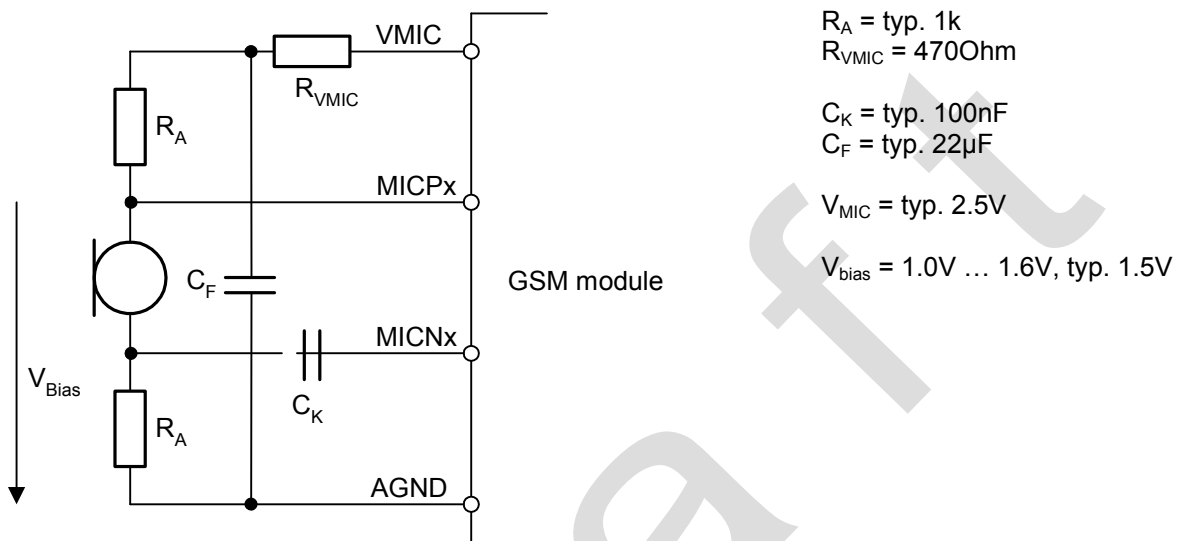
Figure 20: Differential microphone input

The resulting DC voltage between MICPx and AGND should be in the range of 1.0V to 1.6V to bias the input amplifier. MICNx is automatically self biased to the MICPx DC level. The resulting AC differential voltage is then amplified in the GSM module.

The VMIC voltage should be filtered if gains larger than 20dB are used. The filter can be attached as a simple first order RC-network (R_{VMIC} and C_F).

The advantage of this circuit is that it can be used if the application involves longer lines between microphone and module.

3.12.2.3   Line Input Configuration with OpAmp

Figure 21 shows an example of how to connect an opamp into the microphone circuit.

R_A = typ. 47k
R_{VMIC} = 470Ohm

C_k = typ. 100nF
C_F = typ. 22µF

V_{MIC} = typ. 2.5V

V_{bias} = typ. ½ V_{MIC} = 1.25V
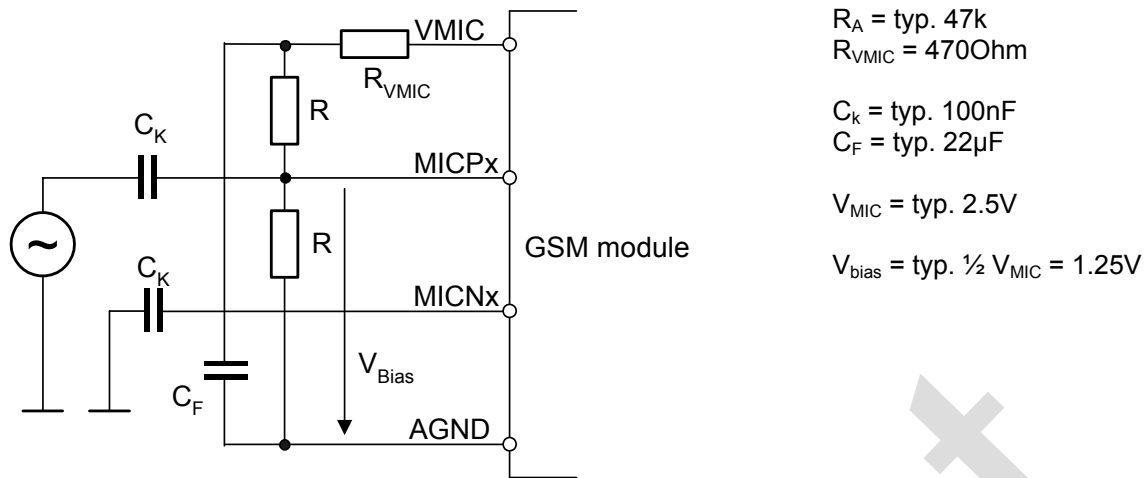
Figure 21: Line input configuration with OpAmp

The AC source (e.g. an opamp) and its reference potential have to be AC coupled to the MICPx resp. MICNx input terminals. The voltage divider between VMIC and AGND is necessary to bias the input amplifier. MICNx is automatically self biased to the MICPx DC level.

The VMIC voltage should be filtered if gains larger than 20dB are used. The filter can be attached as a simple first order RC-network (R_{VMIC} and C_F). If a high input level and a lower gain are applied the filter is not necessary.

If desired, MICNx via C_K can also be connected to the inverse output of the AC source instead of connecting it to the reference potential for differential line input.

3.12.3 Loudspeaker Circuit

The GSM module comprises two analog speaker outputs: EP1 and EP2. Output EP1 is able to drive a load of 8Ohms while the output EP2 can drive a load of 32Ohms. Each interface can be connected in differential and in single ended configuration. See examples in Figure 22 and Figure 23.

Loudspeaker impedance

EPP1/EPN1
Z_L = typ. 8Ohm

EPP2/EPN2
Z_L = typ. 32Ohm
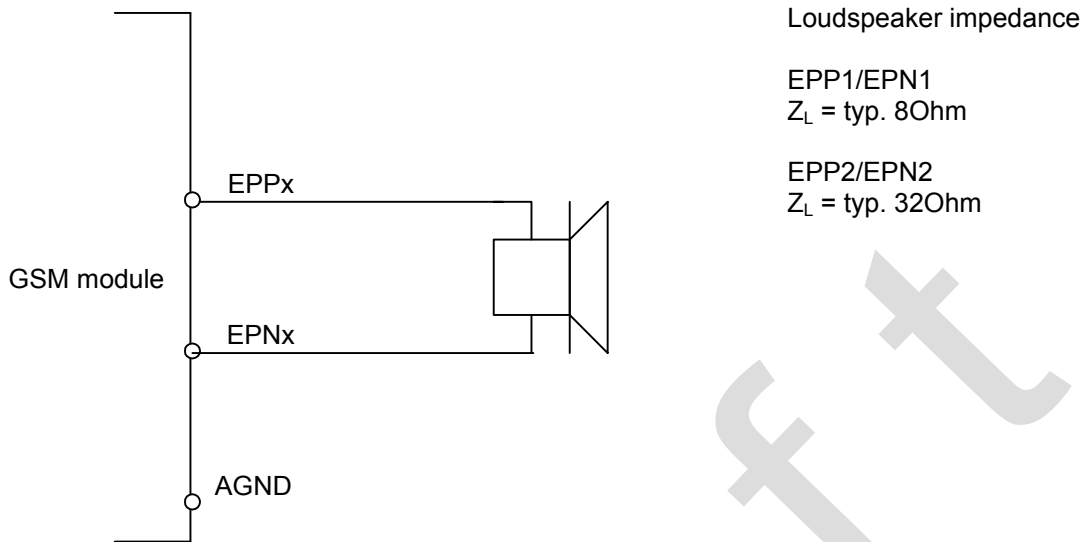
Figure 22: Differential loudspeaker configuration

Loudspeaker impedance

EPP1/EPN1
Z_L = typ. 8Ohm
C_k = 220µF

EPP2/EPN2
Z_L = typ. 32Ohm
C_k = 47µF
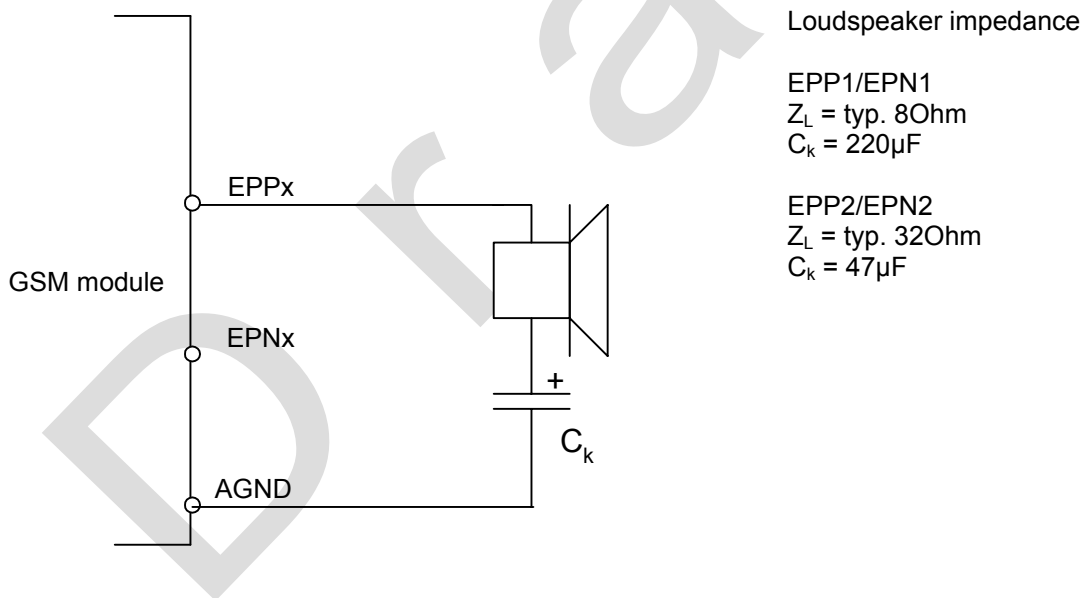
Figure 23: Single ended loudspeaker configuration

3.12.4   Digital Audio Interface DAI

The DAI can be used to connect audio devices capable of PCM (Pulse Code Modulation), for example a codec.

Table 9: Overview of USC pin functions

Signal name on B2B connector	Function for PCM Interface	Input/Output
USC0 (DAI0)	REF_CLK_13M	O
USC1 (DAI1)	Reserved for future use	I
USC2 (DAI2)	REF_CLK_8K (Bit clock slave)	O
USC3 (DAI3)	BITCLK	I
USC4 (DAI4)	FS_IN (Frame sync slave)	I
USC5 (DAI5)	RXDAI	I
USC6 (DAI6)	TXDAI	O

To clock input and output PCM samples the PCM interface requires a clock (BITCLK) which is synchronous to the 26 MHz system clock. The customer application must be designed to generate this bit clock by a PLL circuit or a divider controlled by one of the two following reference clock signals:
- REF_CLK_13M that is equal to the system clock of 13 MHz.
- REF_CLK_8K that is an 8 kHz signal divided from the system clock.

The frequency of the bit clock can vary from 256 kHz to 2048 kHz. The PCM interface is slave for the bit clock and the frame sync signals generated by the external codec.
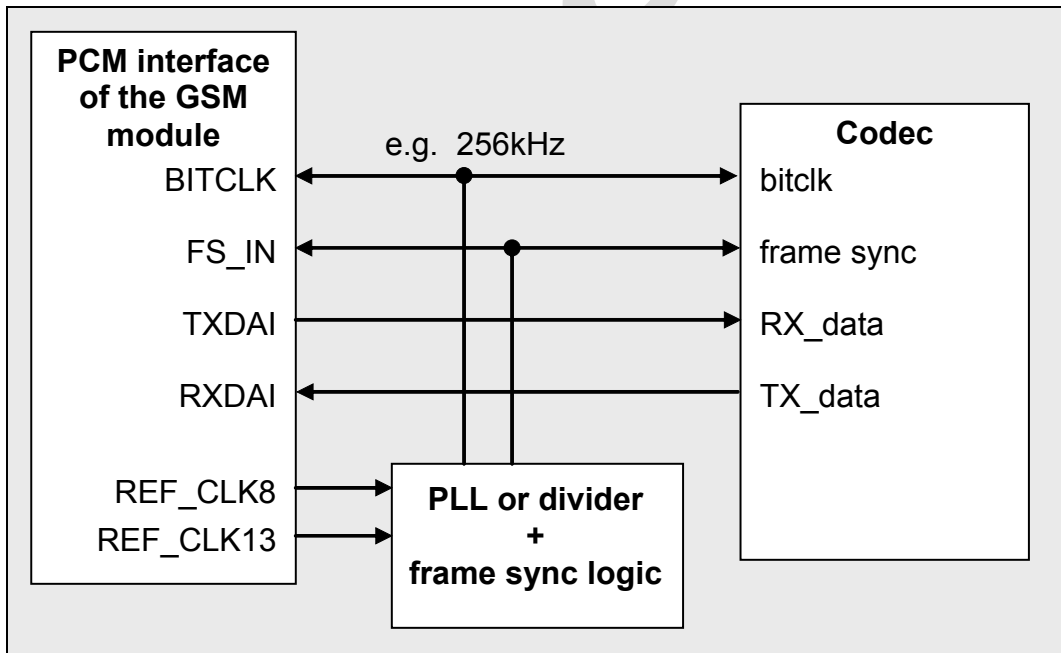
Figure 24: PCM interface application

The timing of a PCM short frame is shown in Figure 25. In PCM mode, 16-bit data are transferred in both directions at the same time. The duration of a frame sync pulse is one BITCLK period, starting at the rising edge of BITCLK. TXDAI data is shifted out at the next rising edge of BITCLK. The most significant bit is transferred first. Data transmitted from RXDAI of the internal application is sampled at the falling edge of BITCLK.
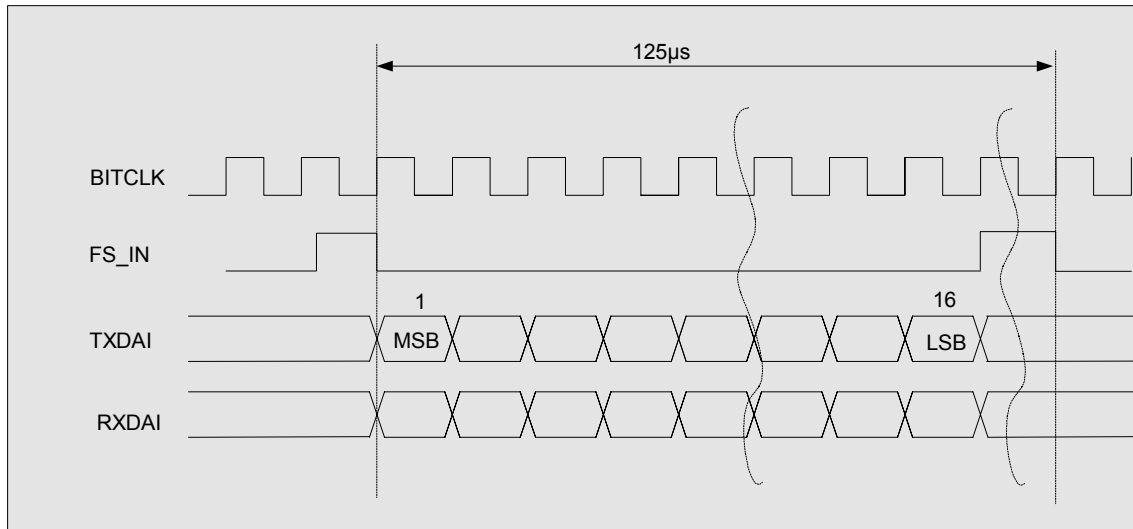
Figure 25: PCM timing

3.13   Control Signals

3.13.1   Synchronization Signal

The synchronization signal serves to indicate growing power consumption during the transmit burst. The signal is generated by the SYNC pin (pin number 32). Please note that this pin can adopt three different operating modes which you can select by using the AT^SSYNC command: the mode AT^SSYNC=0 described below, and the two LED modes AT^SSYNC=1 or AT^SSYNC=2 described in [1] and Section 3.13.2.

The first function (factory default AT^SSYNC=0) 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 MC75 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 SYNC pin indicates increased power consumption during transmission.
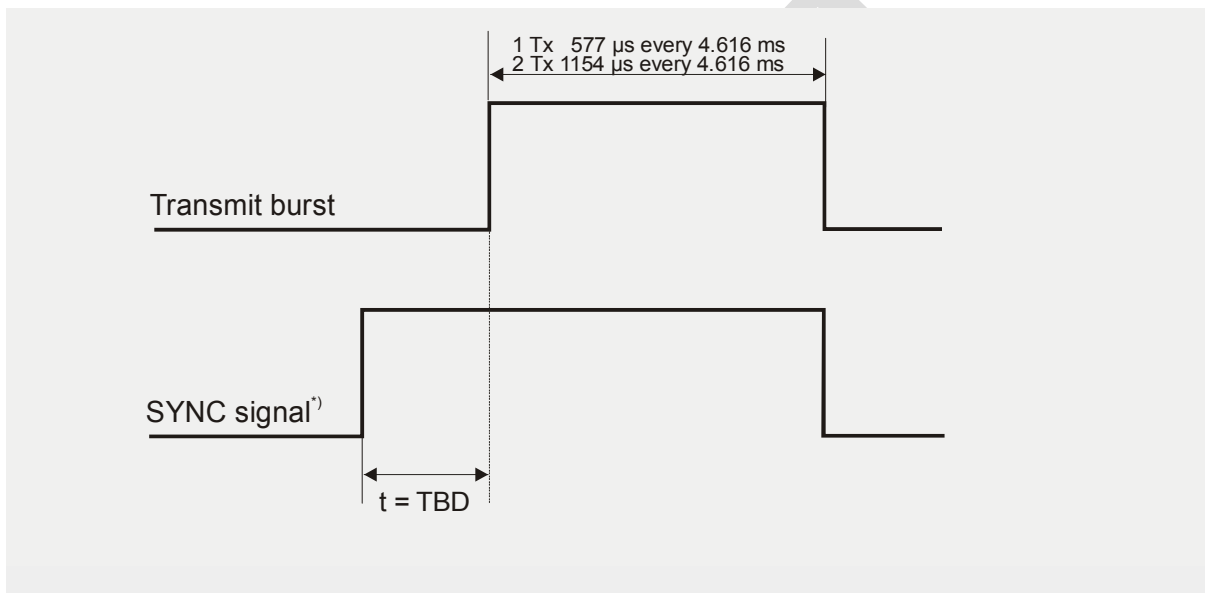
Figure 26: SYNC signal during transmit burst

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

3.13.2   Using the SYNC Pin to Control a Status LED

As an alternative to generating the synchronization signal, the SYNC pin can be configured to drive a status LED that indicates different operating modes of the MC75 module. To take advantage of this function the LED mode must be activated with the AT^SSYNC command and the LED must be connected to the host application. The connected LED can be operated in two different display modes (AT^SSYNC=1 or AT^SSYNC=2). For details please refer to [1].

Especially in the development and test phase of an application, system integrators are advised to use the LED mode of the SYNC pin in order to evaluate their product design and identify the source of errors.

To operate the LED a buffer, e.g. a transistor or gate, must be included in your application. A sample cicuit is shown in Figure 27. Power consumption in the LED mode is the same as for the synchronization signal mode. For details see Table 16, SYNC pin.

Figure 27: LED Circuit (Example)

4 Antenna Interface

The RF interface has an impedance of 50Ω. MC75 is capable of sustaining a total mismatch at the antenna connector or pad without any damage, even when transmitting at maximum RF power.

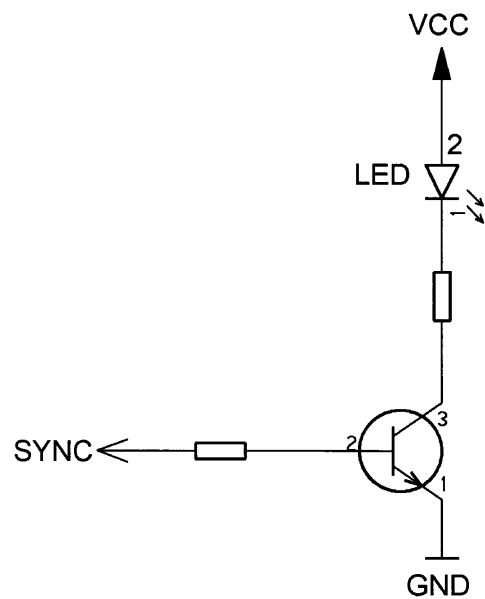The external antenna must be matched properly to achieve best performance regarding radiated power, DC-power consumption, modulation accuracy and harmonic suppression. Matching networks are not included on the MC75 PCB and should be placed in the host application.

Regarding the return loss MC75 provides the following values in the active band:

Table 10: Return loss in the active band

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

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

4.1 Antenna Installation

To suit the physical design of individual applications MC75 offers two alternative approaches to connecting the antenna:
- Recommended approach: U.FL-R-SMT antenna connector from Hirose assembled on the component side of the PCB (top view on MC75). See Section 4.3 for details.
- Antenna pad and grounding plane placed on the bottom side. See Section 4.2.

The U.FL-R-SMT connector has been chosen as antenna reference point (ARP) for the Siemens reference equipment submitted to type approve MC75. All RF data specified throughout this manual are related to the ARP. For compliance with the test results of the Siemens type approval you are advised to give priority to the connector, rather than using the antenna pad.

IMPORTANT: Both solutions can only be applied alternatively. This means, whenever an antenna is plugged to the Hirose connector, the pad must not be used. Vice versa, if the antenna is connected to the pad, then the Hirose connector must be left empty.
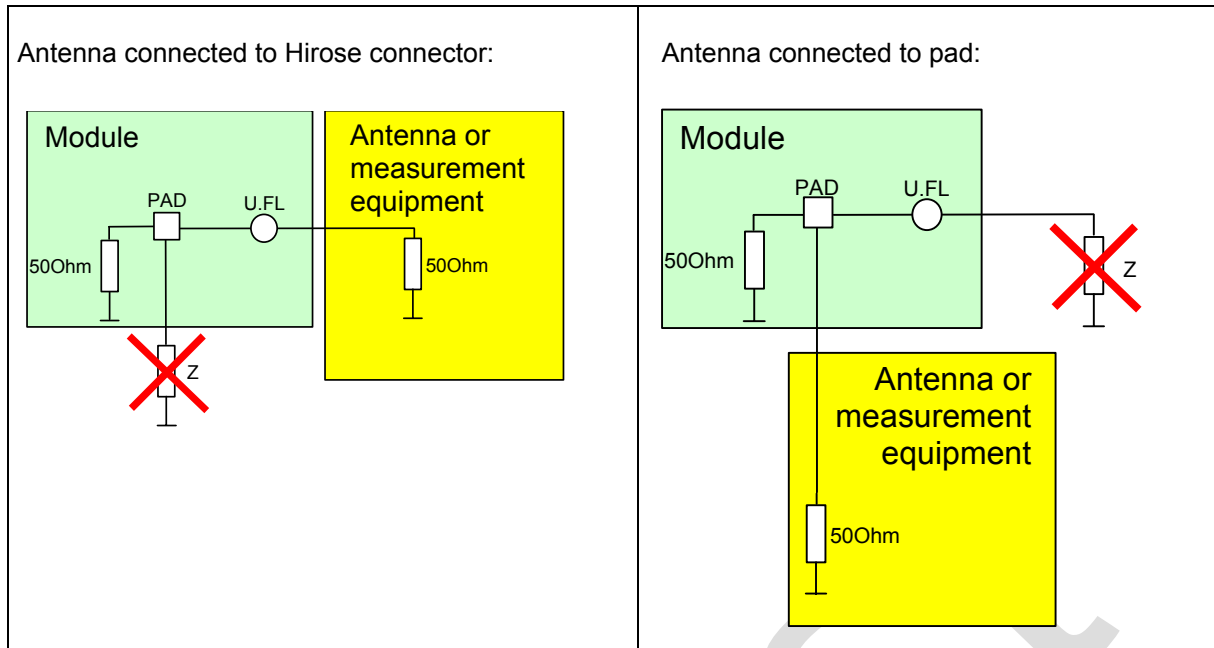
Figure 28: Never use antenna connector and antenna pad at the same time

No matter which option you choose, ensure that the antenna pad does not come into contact with the holding device or any other components of the host application. It needs to be surrounded by a restricted area filled with air, which must also be reserved 0.8 mm in height.
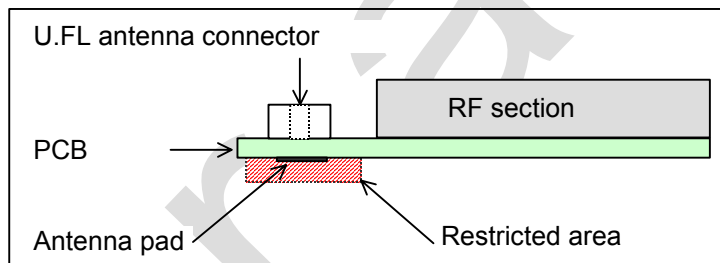
Figure 29: Restricted area around antenna pad

4.2   Antenna Pad

The antenna can be soldered to the pad, or attached via contact springs. For proper grounding connect the antenna to the ground plane on the bottom of MC75 which must be connected to the ground plane of the application.

When you decide to use the antenna pad take into account that the pad has not been intended as antenna reference point (ARP) for the Siemens MC75 type approval. 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.

Also, consider that according to the GSM recommendations TS 45.005 and TS 51.010-01 a 50Ω connector is mandatory for type approval measurements. This requires GSM devices with an integral antenna to be temporarily equipped with a suitable connector or a low loss RF cable with adapter.

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.

MC75 material properties:
MC75 PCB: FR4
Antenna pad: Gold plated pad

4.2.1   Suitable Cable Types

For direct solder attachment, we suggest to use the following cable types:
- RG316/U 50 Ohm coaxial cable
- 1671A 50 Ohm coaxial cable

Suitable cables are offered, for example, by IMS Connector Systems. For further details and other cable types please contact http://www.imscs.com.

4.3 Antenna Connector

MC75 uses an ultra-miniature SMT antenna connector supplied from Hirose Ltd. The product name is:

U.FL-R-SMT

The position of the antenna connector on the MC75 board can be seen in Figure 30.
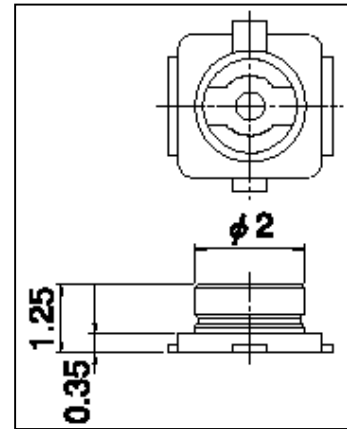
Figure 30: Mechanical dimensions of U.FL-R-SMT connector

Table 11: Product specifications of U.FL-R-SMT connector

Item	Specification	Conditions
Ratings		
Nominal impedance	50 Ω	Operating temp:-40°c to + 90°C
Rated frequency	DC to 3 GHz	Operating humidity: max. 90%
Mechanical characteristics		
Female contact holding force	0.15 N min	Measured with a ∅ 0.475 pin gauge
Repetitive operation	Contact resistance: Center 25 mΩ Outside 15mΩ	30 cycles of insertion and disengagement
Vibration	No momentary disconnections of 1 µs; No damage, cracks and looseness of parts	Frequency of 10 to 100 Hz, single amplitude of 1.5 mm, acceleration of 59 m/s^2, for 5 cycles in the direction of each of the 3 axes
Shock	No momentary disconnections of 1 µs. No damage, cracks and looseness of parts.	Acceleration of 735 m/s^2, 11 ms duration for 6 cycles in the direction of each of the 3 axes
Environmental characteristics		
Humidity resistance	No damage, cracks and looseness of parts. Insulation resistance: 100 MΩ min. at high humidity 500 MΩ min when dry	Exposure to 40°C, humidity of 95% for a total of 96 hours
Temperature cycle	No damage, cracks and looseness of parts. Contact resistance: Center 25 mΩ Outside 15mΩ	Temperature: +40°C → 5 to 35°C → +90°C → 5 to 35°C Time: 30 min. → within 5 min. → 30 min. within 5 min
Salt spray test	No excessive corrosion	48 hours continuous exposure to 5% salt water

Table 12: Material and finish of U.FL-R-SMT connector and recommended plugs

Part	Material		Finish
Shell	Phosphor bronze		Silver plating
Male center contact	Brass		Gold plating
Female center contact	Phosphor bronze		Gold plating
Insulator	Plug:	PBT	Black
	Receptacle:	LCP	Beige

Mating plugs and cables can be chosen from the Hirose U.FL Series. Examples are shown below and listed in Table 13. For latest product information please contact your Hirose dealer or visit the Hirose home page, for example http://www.hirose.com.
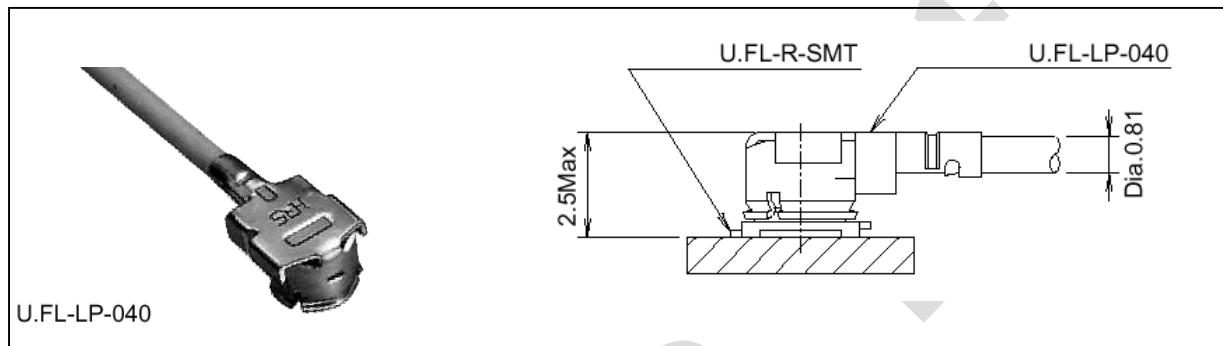
Figure 31: U.FL-R-SMT connector with U.FL-LP-040 plug
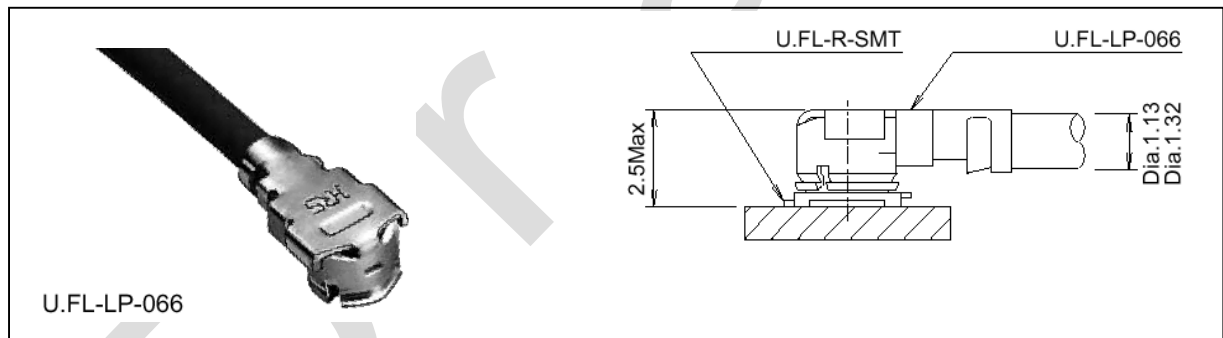
Figure 32: U.FL-R-SMT connector with U.FL-LP-066 plug

In addition to the connectors illustrated above, the U.FL-LP-(V)-040(01) version is offered as an extremely space saving solution. This plug is intended for use with extra fine cable (up to $\varnothing$ 0.81 mm) and minimizes the mating height to 2 mm. See Figure 33 which shows the Hirose datasheet.
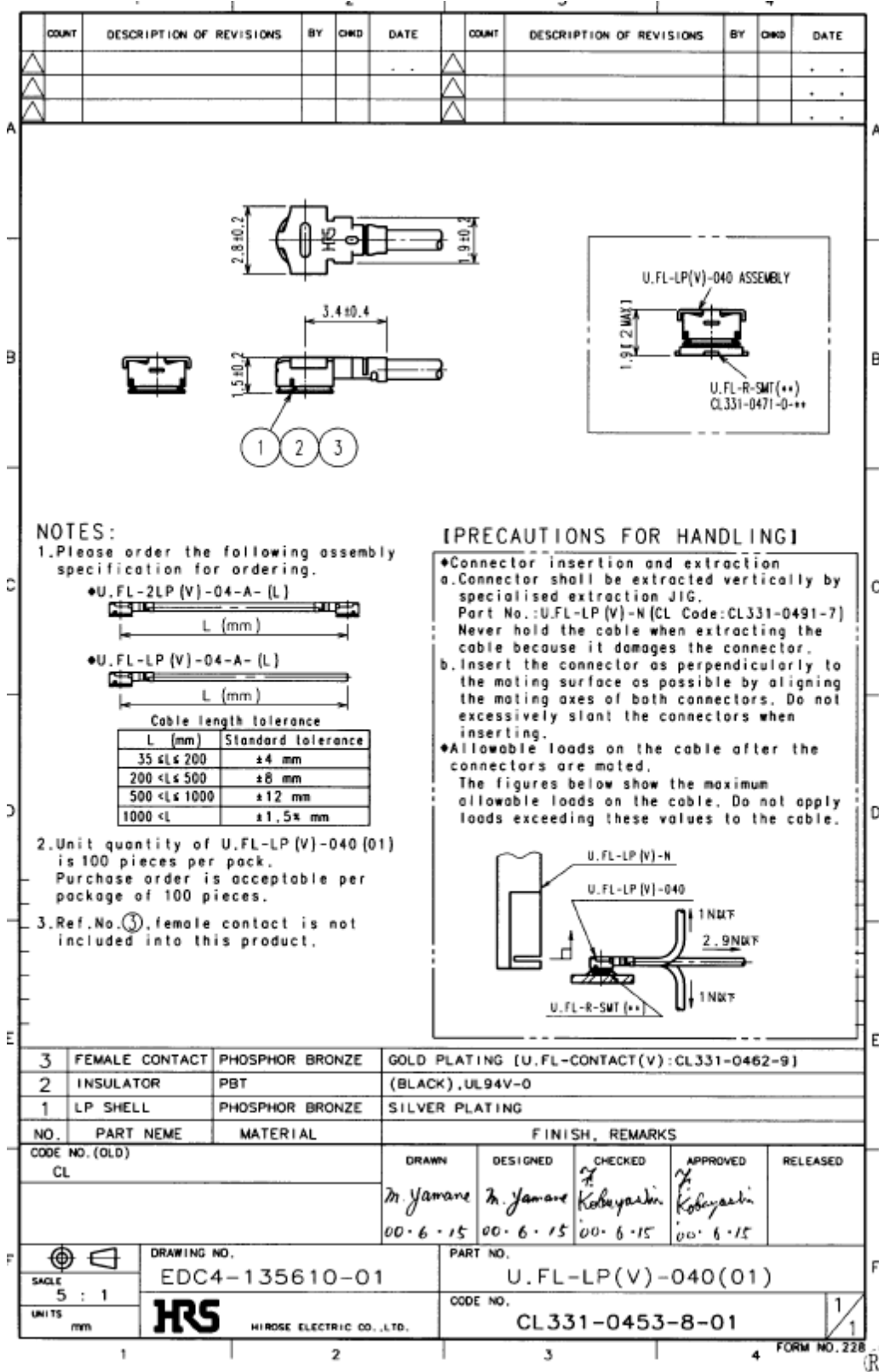
Figure 33: Specifications of U.FL-LP-(V)-040(01) plug

Table 13: Ordering information for Hirose U.FL Series

Item	Part number	HRS number
Connector on MC75	U.FL-R-SMT	CL331-0471-0-10
Right-angle plug shell for $\varnothing$ 0.81 mm cable	U.FL-LP-040	CL331-0451-2
Right-angle plug for $\varnothing$ 0.81 mm cable	U.FL-LP(V)-040 (01)	CL331-053-8-01
Right-angle plug for $\varnothing$ 1.13 mm cable	U.FL-LP-068	CL331-0452-5
Right-angle plug for $\varnothing$ 1.32 mm cable	U.FL-LP-066	CL331-0452-5
Extraction jig	E.FL-LP-N	CL331-04441-9

5 Electrical, Reliability and Radio Characteristics

5.1 Absolute Maximum Ratings

The absolute maximum ratings stated in Table 14 are stress ratings. Stresses beyond any of these limits will cause permanent damage to MC75.

Table 14: Absolute maximum ratings

Parameter	Min	Max	Unit
Supply voltage BATT+	-0.3	5.5	V
Voltage at digital pins	-0.3	3.05	V
Voltage at analog pins	-0.3	3.0	V
Voltage at digital / analog pins in Power-down mode	TBD	TBD	V
Voltage at VCHARGE pin	-0.3	5.5	V
Voltage at CHARGEGATE pin	-0.3	5.5	V
VUSB_IN	-0.3	5.5	V
VSENSE		5.5	V
ISENSE		5.5	V

5.2 Operating Temperatures

Test conditions were specified in accordance with IEC 60068-2 (still air). The values stated below are in compliance with GSM recommendation TS 51.010-01.

Table 15: Operating temperatures

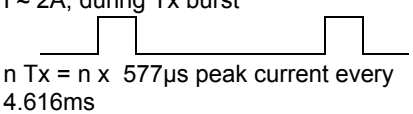| Parameter	Min	Typ	Max	Unit
Ambient temperature (according to GSM 11.10)	-30	+25	+65	°C

Automatic shutdown
        MC75 board temperature
        Battery temperature
	-30
	-20
		--- 	
		--- 	
			+90
			+60
				°C

Ambient temperature for charging (software controlled fast charging)	0	---	+45	°C

5.3 Pin Assignment and Signal Description

The Molex board-to-board connector on MC75 is an 80-pin double-row receptacle. The names and the positions of the pins can be seen from Figure 1 which shows the top view of MC75.
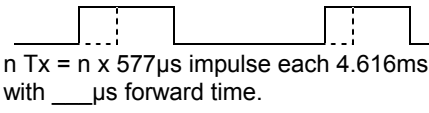
1	GND	GND	80
2	*nc*	*Do not use*	79
3	*nc*	PWR_IND	78
4	GND	*Do not use*	77
5	*Do not use*	*Do not use*	76
6	SD_WP	*Do not use*	75
7	*Do not use*	SD_D3	74
8	SD_DETECT	SD_D2	73
9	SD_CMD	SD_D1	72
10	SD_CLK	SD_D0	71
11	I2CCLK	I2CDAT	70
12	VUSB_IN	USB_DP	69
13	USC5	USB_DN	68
14	ISENSE	VSENSE	67
15	USC6	VMIC	66
16	CCCLK	EPN2	65
17	CCVCC	EPP2	64
18	CCIO	EPP1	63
19	CCRST	EPN1	62
20	CCIN	MICN2	61
21	CCGND	MICP2	60
22	USC4	MICP1	59
23	USC3	MICN1	58
24	USC2	AGND	57
25	USC1	IGT	56
26	USC0	EMERG_RST	55
27	BATT_TEMP	DCD0	54
28	SYNC	CTS1	53
29	RXD1	CTS0	52
30	RXD0	RTS1	51
31	TXD1	DTR0	50
32	TXD0	RTS0	49
33	VDDLP	DSR0	48
34	VCHARGE	RING0	47
35	CHARGEGATE	VEXT	46
36	GND	BATT+	45
37	GND	BATT+	44
38	GND	BATT+	43
39	GND	BATT+	42
40	GND	BATT+	41

Figure 34: Pin assignment (component side of MC75)

Please note that the reference voltages listed in Table 16 are the values measured directly on the MC75 module. They do not apply to the accessories connected.

Table 16: Signal description

Function	Signal name	IO	Signal form and level	Comment
Power supply	BATT+	I	$V_I max = 4.3V$ $V_I typ = 3.8V$ $V_I min = 3.2V$ during Tx burst on board $I \approx 2A$, during Tx burst n Tx = n x 577µs peak current every 4.616ms	Five pins of BATT+ and GND must be connected in parallel for supply purposes because higher peak currents may occur. Minimum voltage must not fall below 3.2V including drop, ripple, spikes.
Power supply	GND		Ground	Application Ground
Charge Interface	VCHARGE	I	$V_I min = 1.015 * V_{BATT+}$ $V_I max = 5.45V$	This line signalizes to the processor that the charger is connected. If unused keep pin open.
	BATT_TEMP	I	Connect NTC with $R_{NTC} \approx 10k\Omega$ @ 25°C to ground. See Section 3.4.1 for B value of NTC.	Battery temperature measurement via NTC resistance. NTC should be installed inside or near battery pack to enable proper charging and deliver temperature values. If unused keep pin open.
	ISENSE	I	$V_I max = 4.65V$ $\Delta V_I max$ to V_{BATT+} = +0.3V at normal condition	ISENSE is required for measuring the charge current. For this purpose, a shunt resistor for current measurement needs to be connected between ISENSE and VSENSE. If unused connect pin to VSENSE.
	VSENSE	I	$V_I max = 4.5V$	VSENSE must be directly connected to BATT+ at battery connector or external power supply.
	CHARGEGATE	O	$V_O max = 5.5V$ $I_O max = 1mA$	Control line to the gate of charge FET If unused keep pin open.
External supply voltage	VEXT	O	Normal mode: $V_O min = 2.75V$ $V_O typ = 2.93V$ $V_O max = 3.05V$ $I_O max = -50mA$	VEXT may be used for application circuits, for example to supply power for an SD Card. If unused keep pin open. Not available in Power-down mode. The external digital logic must not cause any spikes or glitches on voltage VEXT.

Function	Signal name	IO	Signal form and level	Comment
Power indicator	PWR_IND [SE10]	O	$V_{IH}max = 10V$ $V_{OL}max = 0.4V$ at Imax = 2mA	PWR_IND (Power Indicator) notifies the module's on/off state. PWR_IND is an open collector that needs to be connected to an external pull-up resistor. Low state of the open collector indicates that the module is on. Vice versa, high level notifies the Power-down mode. Therefore, the pin may be used to enable external voltage regulators which supply an external logic for communication with the module, e.g. level converters.
Ignition	IGT	I	$R_I \approx 30k\Omega$, $C_I \approx 10nF$ $V_{IL}max = 0.8V$ at Imax = -150µA $V_{OH}max = 4.5V$ (V_{BATT+}) ON ˜˜˜|____|˜˜˜ Active Low $\geq$ 300ms	This signal switches the mobile on. This line must be driven low by an open drain or open collector driver.
Emergency reset	EMERG_RST	I	$R_I \approx 5k\Omega$ $V_{IL}max = 0.2V$ at Imax = -0.5mA $V_{OH}min = 1.75V$ $V_{OH}max = 3.05V$ Signal ˜˜˜|_____|˜˜˜ Pull down $\geq$ 10ms Falling edge resets module.	Reset function in case of emergency: Pull down and release EMERG_RST. Falling edge will reset the module. Data stored in the volatile memory will be lost. For orderly software controlled reset rather use the AT+CFUN command (e.g. AT+CFUN=,1). This line must be driven by open drain or open collector. If unused keep pin open.
Synchroni-zation	SYNC	O	$V_{OL}max = 0.3V$ at I = 0.1mA $V_{OH}min = 2.3V$ at I = -0.1mA $V_{OH}max = 0.05V$ n Tx = n x 577µs impulse each 4.616ms, with ___µs forward time.	There are two alternative options for using the SYNC pin: a) Indicating increased current consumption during uplink transmission burst. Note that the timing of the signal is different during handover. b) Driving a status LED to indicate different operating modes of MC75. The LED must be installed in the host application. If unused keep pin open.
RTC backup	VDDLP	I/O	$R_I \approx 1k\Omega$ $V_Omax = 4.5V$ $V_{BATT+} = 4.3V$: $V_O = 3.2V$ at I_O = -500µA $V_{BATT+} = 0V$: $V_I = 2.7V…4.5V$ at I_{max}= 15µA	If unused keep pin open.

Function	Signal name	IO	Signal form and level	Comment
SIM interface specified for use with 3V SIM card	CCIN	I	$R_I \approx 100k\Omega$ $V_{IL}max = 0.6V$ at $I = -25\mu A$ $V_{IH}min = 2.1V$ at $I = -10\mu A$, $V_Omax = 3.05V$	CCIN = Low, SIM card holder closed
	CCRST	O	$R_O \approx 47\Omega$ $V_{OL}max = 0.25V$ at $I = +1mA$ $V_{OH}min = 2.5V$ at $I = -0.5mA$ $V_{OH}max = 2.95V$	Maximum cable length or copper track 100mm to SIM card holder.
	CCIO	I/O	$R_I \approx 4.7k\Omega$ $V_{IL}max = 0.75V$ $V_{IL}min = -0.3V$ $V_{IH}min = 2.1V$ $V_{IH}max = CCVCCmin + 0.3V = 3.05V$ $R_O \approx 100\Omega$ $V_{OL}max = 0.3V$ at $I = +1mA$ $V_{OH}min = 2.5V$ at $I = -0.5mA$ $V_{OH}max = 2.95V$	All signals of SIM interface are protected against ESD with a special diode array. Usage of CCGND is mandatory.
	CCCLK	O	$R_O \approx 100\Omega$ $V_{OL}max = 0.3V$ at $I = +1mA$ $V_{OH}min = 2.5V$ at $I = -0.5mA$ $V_{OH}max = 2.95V$	
	CCVCC	O	$V_Omin = 2.75V$, $V_Otyp = 2.85V$ $V_Omax = 2.95V$ $I_Omax = -20mA$	
	CCGND		Ground	
SIM interface specified for use with 1.8V SIM card	CCIN	I	$R_I \approx 100k\Omega$ $V_{IL}max = 0.6V$ at $I = -25\mu A$ $V_{IH}min = 2.1V$ at $I = -10\mu A$, $V_Omax = 3.05V$	CCIN = Low, SIM card holder closed
	CCRST	O	$R_O \approx 47\Omega$ $V_{OL}max = 0.25V$ at $I = +1mA$ $V_{OH}min = 1.45V$ at $I = -0.5mA$ $V_{OH}max = 1.90V$	Maximum cable length or copper track 100mm to SIM card holder.
	CCIO	I/O	$R_I \approx 4.7k\Omega$ $V_{IL}max = 0.45V$ $V_{IH}min = 1.35V$ $V_{IH}max = CCVCCmin + 0.3V = 2.00V$ $R_O \approx 100\Omega$ $V_{OL}max = 0.3V$ at $I = +1mA$ $V_{OH}min = 1.45V$ at $I = -0.5mA$ $V_{OH}max = 1.90V$	All signals of SIM interface are protected against ESD with a special diode array. Usage of CCGND is mandatory.
	CCCLK	O	$R_O \approx 100\Omega$ $V_{OL}max = 0.3V$ at $I = +1mA$ $V_{OH}min = 1.45V$ at $I = -0.5mA$ $V_{OH}max = 1.90V$	
	CCVCC	O	$V_Omin = 1.70V$, $V_Otyp = 1.80V$ $V_Omax = 1.90V$ $I_Omax = -20mA$	
	CCGND		Ground	
ASC0 Serial interface	RXD0 TXD0 CTS0 RTS0 DTR0 DCD0 DSR0 RING0	O I O I I O O IO	$V_{OL}max = 0.2V$ at $I = 2mA$ $V_{OH}min = 2.55V$ at $I = -0.5mA$ $V_{OH}max = 3.05V$ $V_{IL}max = 0.8V$ $V_{IH}min = 2.0V$, $V_{IH}max = VEXTmin + 0.3V = 3.05V$	Serial interface for AT commands or data stream. If lines are unused keep pins open.

Function	Signal name	IO	Signal form and level	Comment
ASC1 Serial interface	RXD1 TXD1 CTS1 RTS1	O I O I	$V_{OL}max = 0.2V$ at $I = 2mA$ $V_{OH}min = 2.55V$ at $I = -0.5mA$ $V_{OH}max = 3.05V$ $V_{IL}max = 0.8V$ $V_{IH}min = 2.0V$ $V_{IH}max = VEXTmin + 0.3V = 3.05V$	Serial interface for AT commands or data stream. If lines are unused keep pins open.
I^{2}C interface	I2CCLK	O	$V_{OL}max = 0.2V$ at $I = 2mA$ $V_{OH}min = 2.55V$ at $I = -0.5mA$ $V_{OH}max = 3.05V$	I2CDAT is configured as Open Drain and needs a pull-up resistor in the host application. According to the I2C Bus Specification Version 2.1 for the fast mode a rise time of max. 300ns is permitted. There is also a maximum $V_{OL}=0.4V$ at 3mA specified. The value of the pull-up depends on the capacitive load of the whole system (I2C Slave + lines). The maximum sink current of I2CDAT and I2CCLK is 4mA. If lines are unused keep pins open.
	I2CDAT	I/O	$V_{OL}max = 0.2V$ at $I = 2mA$ $V_{IL}max = 0.8V$ $V_{IH}min = 2.0V$ $V_{IH}max = VEXTmin + 0.3V = 3.05V$	
USB	VUSB_IN	I	$V_{IN}min = 4.0V$ $V_{IN}max = 5.25V$	If lines are unused keep pins open.
	USB_DN	I/O	Differential Output Crossover voltage Range $V_{CRS}min = 1.5V$, $V_{CRS}max = 2.0V$ Driver Output Resistance $Z_{DRV}typ = 32$ Ohm	
	USB_DP	I/O		
SD card interface	SD_D0 SD_D1 SD_D2 SD_D3	I/O	$V_{OL}max = 0.2V$ at $I = 2mA$ $V_{OH}min = 2.55V$ at $I = -0.5mA$ $V_{OH}max = 3.05V$ $V_{IL}max = 0.8V$ $V_{IH}min = 2.0V$ $V_{IH}max = VEXTmin + 0.3V = 3.05V$	SD card interface can be connected to VEXT of MC75 or to external power supply. Rise and fall time of SD_CLK signal: max. 10ns. If lines are unused keep pins open.
	SD_CLK	O		
	SD_WP	I		
	SD_CMD	O		
	SD_DETECT	I		
Digital Audio interface	USC0 (DAI0)	O	$V_{OL}max = 0.2V$ at $I = 2mA$ $V_{OH}min = 2.55V$ at $I = -0.5mA$ $V_{OH}max = 3.05V$ $V_{IL}max = 0.8V$ $V_{IH}min = 2.0V$ $V_{IH}max = VEXTmin + 0.3V = 3.05V$	See Table 9 for details. If unused keep pins open.
	USC1 (DAI1)	I		
	USC2 (DAI2)	O		
	USC3 (DAI3)	I		
	USC4 (DAI4)	I		
	USC5 (DAI5)	I		
	USC6 (DAI6)	O		