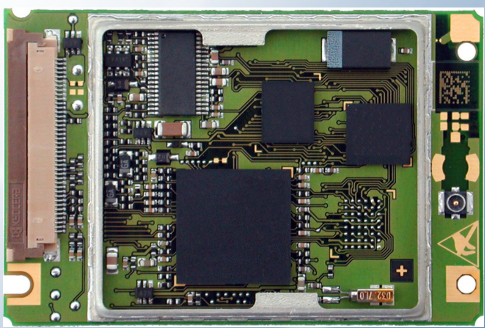
SIEMENS

# MC35

## Siemens Cellular Engine



# Hardware Interface Description

Version: 04.00
DocID: MC35_HD_01_V04.00

Wireless Modules

Document Name: **MC35 Hardware Interface Description**

Version: **04.00**
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**General notes**

With respect to any damages arising in connection with the described product or this document, Siemens shall be liable according to the General Conditions on which the delivery of the described product and this document are based.
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Applications incorporating the described product must be designed to be in accordance with the technical specifications provided in these guidelines. Failure to comply with any of the required procedures can result in malfunctions or serious discrepancies in results.
Furthermore, all safety instructions regarding the use of mobile technical systems, including GSM products, which also apply to cellular phones must be followed.
Handheld applications such as mobile phones or PDAs incorporating the described product must be in accordance with the guidelines for human exposure to radio frequency energy. The Specific Absorption Rate (SAR) of the application must be evaluated and approved to be compliant with national and international safety standards or directives.

Subject to change without notice at any time.

# Contents

## Figures



## Tables

# 0 Version history

This chapter reports modifications and improvements over previous versions of the document.
Preceding document: "MC35 Hardware Interface Description" Version **03.02**
New document: "MC35 Hardware Interface Description" Version **04.00**

| Chapter | Page | What is new |
|---|---|---|
| 3.2.4 | 29 | Recommendation regarding low internal resistance of battery added. |
| 3.3.5.1 | 41 | Presentation of Table 11 modified (temperature values have not changed!) |
| 5.3 | 67 | Note added: Do not exert pressure or apply solder joints to the covers. |

Preceding document: "MC35 Hardware Interface Description" Version **02.00**
New document: "MC35 Hardware Interface Description" Version **03.02**

| Chapter | Page | What is new |
|---|---|---|
| 1.3 | 13f | Recommendations regarding SAR approval |
| 2.1 | 18ff | SMS storage on SIM card and mobile equipment. Transmission of SMS over CSD and GPRS<br>New feature: PPP authentication now over PAP and CHAP<br>Release class of SIM Application Toolkit added<br>Weight updated from 17 g to 16 g |
| 3.2.3 | 28 | Parameters of ACCU_Temp (pin 14) corrected: $V_{out,MEAS}$ = 1.16 V |
| 3.2.4<br>3.2.4.1 | 29<br>30 | Nominal voltage and capacity of recommended battery specified.<br>Reference battery pack added. |
| 3.3.1.1 | 34 | Description of result code ^SYSSTART added. |
| 3.3.2 | 37 | SLEEP mode described in greater detail. Timing of CTS signal needed for CYCLIC SLEEP mode added. |
| 3.3.4.1 | 40 | Description of result code ^SMSO added. |
| 3.3.4.1 | 40 | Description of Power Down procedure revised. |
| 3.3.5 | 41 | Chapter revised due to improved presentation of temperature shutdown URCs. |
| 3.7 | 50 | Note regarding risk of damage when SIM card is inserted or removed during operation.<br>CCIN pin only for use with SIM cards, not with for other purposes.<br>Design recommendations for connecting CCIN added. |
| 3.8.2.2 | 56 | Status LED now capable of indicating GPRS transfer |
| 3.9 | 58ff | Pins 1 to 10: no fuse provided on MC35<br>ACCU_Temp (pin 14): $V_{out,MEAS}$ = 1.16 V<br>Note added behind Table 20: If an input pin is specified for $V_{i,h,max}$ = 3.3V, be sure never to exceed the stated voltage. |
| 4.1 | 63 | VSWR changed from to $\leq$ 2 to $\leq$ 1.3 |
| 8 | 89 | Sidetone values different over TC35 |
| 11 | 94 | Reference battery pack added |

# 1 Introduction

This document describes the hardware interface of the Siemens MC35 module that connects to the cellular device application and the air interface. As MC35 is intended to integrate with a wide range of application platforms, all functional components are described in great detail.

So this guide covers all information you need to design and set up cellular applications incorporating the MC35 module. It helps you quickly retrieve interface specifications, electrical and mechanical details and, last but not least, information on the requirements to be considered for integrating further components.

## 1.1 Scope of the document and related documents

Please note that this hardware interface description is intended for the following MC35 release:

- Hardware: PCB number Q8500-A1-6
- Software: Version 04.00

*Related documents*

[1] AT Command Set for MC35 and MC35 Terminal, Version 04.00
[2] Release Notes: MC35, Version 04.00
[3] MC35 GPRS Startup User's Guide
[4] MC35 Remote-SAT User's Guide, Version 04.00
[5] Application Note 16: Updating MC35 Firmware, as of Version 02.00
[6] DSB35 Support Box - Evaluation Kit for Siemens Cellular Engines
[7] MC35 Multiplexer User's Guide, as of Version 02.00
[8] Application Note 02: Audio Interface Design
[9] Application Note 14: Audio and Battery Parameter Download
[10] Multiplex Driver Developer's Guide for Windows 2000 and Windows XP
[11] Multiplex Driver Installation Guide for Windows 2000 and Windows XP

*Prior to using the MC35 engines or upgrading to a new firmware release, be sure to carefully read and understand the latest product information provided in the Release Notes.*

To visit the Siemens Website you can use the following link:
http://www.siemens.com/wm

## 1.2 Terms and abbreviations

| Abbreviation | Description |
|---|---|
| ADC | Analog-to-Digital Converter |
| AFC | Automatic Frequency Control |
| AGC | Automatic Gain Control |
| ARFCN | Absolute Radio Frequency Channel Number |
| ARP | Antenna Reference Point |
| ASIC | Application Specific Integrated Circuit |
| B | Thermistor Constant |
| 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 |
| 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 |
| EFR | Enhanced Full Rate |
| EGSM | Enhanced GSM |
| EMC | Electromagnetic Compatibility |
| ESD | Electrostatic Discharge |
| ETS | European Telecommunication Standard |
| FDMA | Frequency Division Multiple Access |
| FFC | Flat Flexible Cable |

| Abbreviation | Description |
|---|---|
| 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 | Lithium-Ion |
| 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 |
| PAP | Password Authentication Protocol |
| PBCCH | Packet Switched Broadcast Control Channel |
| PCB | Printed Circuit Board |
| PCL | Power Control Level |
| PCN | Personal Communications Network, also referred to as DCS 1800 |
| PCS | Personal Communication System |
| PDU | Protocol Data Unit |
| PLL | Phase Locked Loop |
| PPP | Point-to-point protocol |
| 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 |

| Abbreviation | Description |
| --- | --- |
| Rx | Receive Direction |
| SAR | Specific Absorption Rate |
| SELV | Safety Extra Low Voltage |
| SIM | Subscriber Identification Module |
| SMS | Short Message Service |
| SRAM | Static Random Access Memory |
| TA | Terminal adapter (e.g. GSM engine) |
| TDMA | Time Division Multiple Access |
| TE | Terminal Equipment, also referred to as DTE |
| Tx | Transmit Direction |
| UART | Universal asynchronous receiver-transmitter |
| URC | Unsolicited Result Code |
| USSD | Unstructured Supplementary Service Data |
| VSWR | Voltage Standing Wave Ratio |
| ZIF | Zero Insertion Force |
| *Phonebook abbreviations* | |
| FD | SIM fixdialling phonebook |
| LD | SIM last dialling phonebook (list of numbers most recently dialled) |
| 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 Standards

This product has been approved to comply with the directives and standards listed below and is labeled with the CE conformity mark.

### 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 type approval

| | |
|---|---|
| ETS 300 607-1 | Digital cellular telecommunications system (Phase 2);<br>Mobile Station (MS) conformance specification;<br>(equal GSM 11.10-1=>equal 3GPP51.010-1) |
| 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) |
| ETSI EN 301 489-7 | V1.1.1 (2000-09) 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 |

## SAR requirements specific to handheld mobiles

Mobile phones, PDAs or other handheld 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 handheld MC35 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 handheld operation. 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 of 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) |

## 1.4 Safety precautions

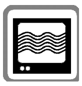
The following safety precautions must be observed during all phases of the operation, usage, service or repair of any cellular terminal or mobile incorporating MC35. Manufacturers of the cellular terminal are advised to convey the following safety information to users and operating personnel and to incorporate 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 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 handsfree operation. Before making a call with a hand-held terminal or mobile, park the vehicle.

Handsfree devices 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 cannot be guaranteed to connect in 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 dialling 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 Functions

MC35 is a product variant of the well-proven TC35 dual band GSM engine. It supports all the features of TC35 and, on top, offers the advantages of the fast GPRS technology. Designed to easily provide radio connection for voice and data transmission it integrates seamlessly with a wide range of GSM/GPRS application platforms and is ideally suited to design and set up innovative cellular solutions with minimum effort.

MC35 supports GPRS multislot class 8 (4 Rx, 1 Tx timeslot) and the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. It operates in the frequency bands GSM 900 MHz and GSM 1800 MHz.

The complete RF part is incorporated and the GSM protocol runs autonomously on a GSM baseband processor. MC35 uses a single 40-pin ZIF connector that connects to the cellular device application. The ZIF connector establishes the application interface for control data, audio signals and power supply lines.

The cellular device application forms the Man-Machine Interface (MMI). Access to the MC35 is enabled by a serial interface (RS-232).

*Note: Compared with pure GSM operation, the GPRS technology involves the use of different chipsets for RF and baseband and another EMC approach. As a result, you are required to obtain a new approval according to R&TTE when you upgrade existing TC3x applications to MC35. See also Chapter 8.*

## 2.1 MC35 key features at a glance

Table 1: MC35 key features

| Feature | Implementation |
|---|---|
| Transmission | Voice, Data, SMS, Fax |
| Power supply | Single supply voltage 3.3V – 4.8V<br>Please refer to Chapter 6.4 for more detailed information |
| Frequency bands | Dual Band EGSM 900 and GSM1800 (GSM Phase 2+) |
| PBCCH support | Support of Packet Switched Broadcast Control Channel allows you to benefit from future GPRS broadcast services when offered by the network operators. No need for later hardware modifications. |
| GSM class | Small MS |
| Transmit power | Class 4 (2W) for EGSM900<br>Class 1 (1W) for GSM1800 |
| GPRS connectivity | GPRS multi-slot class 8<br>GPRS mobile station class B<br>• Note: GPRS data transfer is suspended upon incoming or outgoing voice call and resumed when voice call hangs up. Concurrent GPRS data transfer and CSD / fax call are not supported. |
| SIM card reader | External SIM card reader has to be connected via interface connector (note that card reader is not part of MC35) |
| External antenna | Connected via 50 Ohm antenna connector |
| Temperature range | Normal operation: -25°C to +55°C<br>Restricted operation: -29°C to -25°C and +55°C to +70°C<br>Storage: -40°C to +85°C |
| Current consumption (typical) | Depending on operating mode<br>• TALK mode (during TX burst) at EGSM 900 / GSM 1800: 2A<br>• TALK mode (average) at EGSM 900 / GSM 1800: 300mA / 270mA<br>• IDLE mode at EGSM 900 / GSM 1800: 15mA / 15mA<br>• IDLE GPRS mode at EGSM 900 / GSM 1800: 15mA / 15mA<br>• DATA GPRS mode at EGSM 900, multi-slot class 8: 360mA<br>at GSM 1800, multi-slot class 8: 330mA<br>• SLEEP mode (depending on network configuration): 3mA<br>• Power Down mode: 50µA |

| Feature | Implementation |
|---|---|
| Speech codec | Triple rate codec:<br>• Half Rate (ETS 06.20)<br>• Full Rate (ETS 06.10)<br>• Enhanced Full Rate (ETS 06.50 / 06.60 / 06.80) |
| SMS | MT, MO, CB, Text and PDU mode<br>SMS storage: SIM card plus space for 25 SMS location in the mobile equipment<br>Transmission of SMS alternatively over CSD or GPRS connections. Preferred mode can be user-defined. |
| DATA *GPRS:* | GPRS data downlink transfer: max. 85.6 kbps (see Table 2)<br>GPRS data uplink transfer: max. 21.4 kbps (see Table 2)<br>Coding scheme: CS-1, CS-2, CS-3 and CS-4<br>MC35 supports the two protocols PAP (Password Authentication Protocol) and CHAP (Challenge Handshake Authentication Protocol) commonly used for PPP connections. |
| *CSD:* | CSD transmission rates: 2.4, 4.8, 9.6, 14.4 kbps, non-transparent<br>Unstructured Supplementary Services Data (USSD) support |
| FAX | Group 3: Class 1, Class 2 |
| Audio interface | Analog voice:<br>• Microphone<br>• Earpiece<br>• Handsfree (supports echo cancellation and noise reduction) |
| Serial interface | RS-232 (CMOS level) bi-directional bus for commands / data using AT commands<br>MC35 supports Multiplex mode according to the GSM 07.10 Multiplexer Protocol and enables one physical serial interface to be partitioned into three virtual channels. This allows you to take advantage of up to 3 simultaneous sessions on the serial interface. For example, you can transfer data over one channel while two further channels are free to control the GSM engine with AT commands. |
| Supported SIM card | 3V |
| Phonebook management | Supported phonebook types:<br>SM, FD, LD, MC, RC, ON, ME |
| SIM Application Toolkit | Supported per GSM 11.14, Release class 98 |

| Feature | Implementation |
|---|---|
| Selectable baud rate | 300bps ... 115kbps (AT interface) |
| Autobauding range | Supported baud rates:<br>1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps |
| Firmware upgrade | Firmware upgradable via RS-232 interface or SIM interface |
| Real time clock | Implemented |
| Timer function | Programmable via AT command |
| Physical characteristics | Size: 54.5 x 36 x 6.65mm<br>Weight: 16g |

Table 2: Coding schemes and net data rates over air interface

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

## 2.2 Block diagram of a GSM/GPRS application

MC35 connects to the application platform over the host interface, which takes the form of a ZIF connector. This is a data, control, audio and power supply interface. In addition, power can be supplied via contact pads located on the RF part of the MC35 PCB.

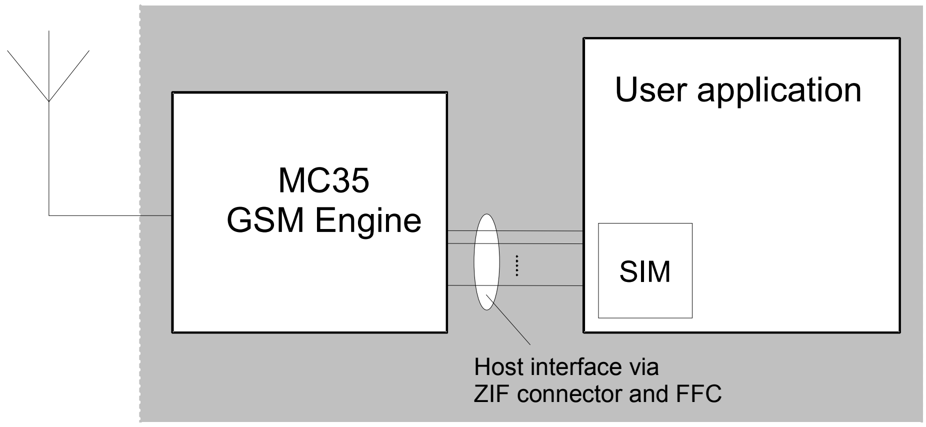
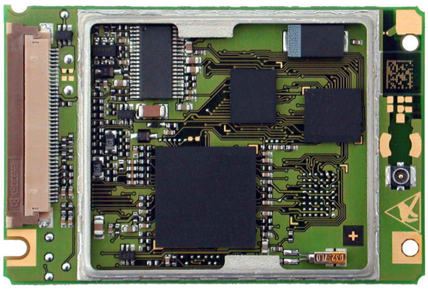



Figure 1: Product concept

## 2.3 Block diagram of MC35

Figure 2 shows a block diagram of the MC35 module and illustrates the major functional components:

- GSM baseband processor
- GSM radio
- Power supply (ASIC)
- Flash
- SRAM
- ZIF connector
- Antenna connector



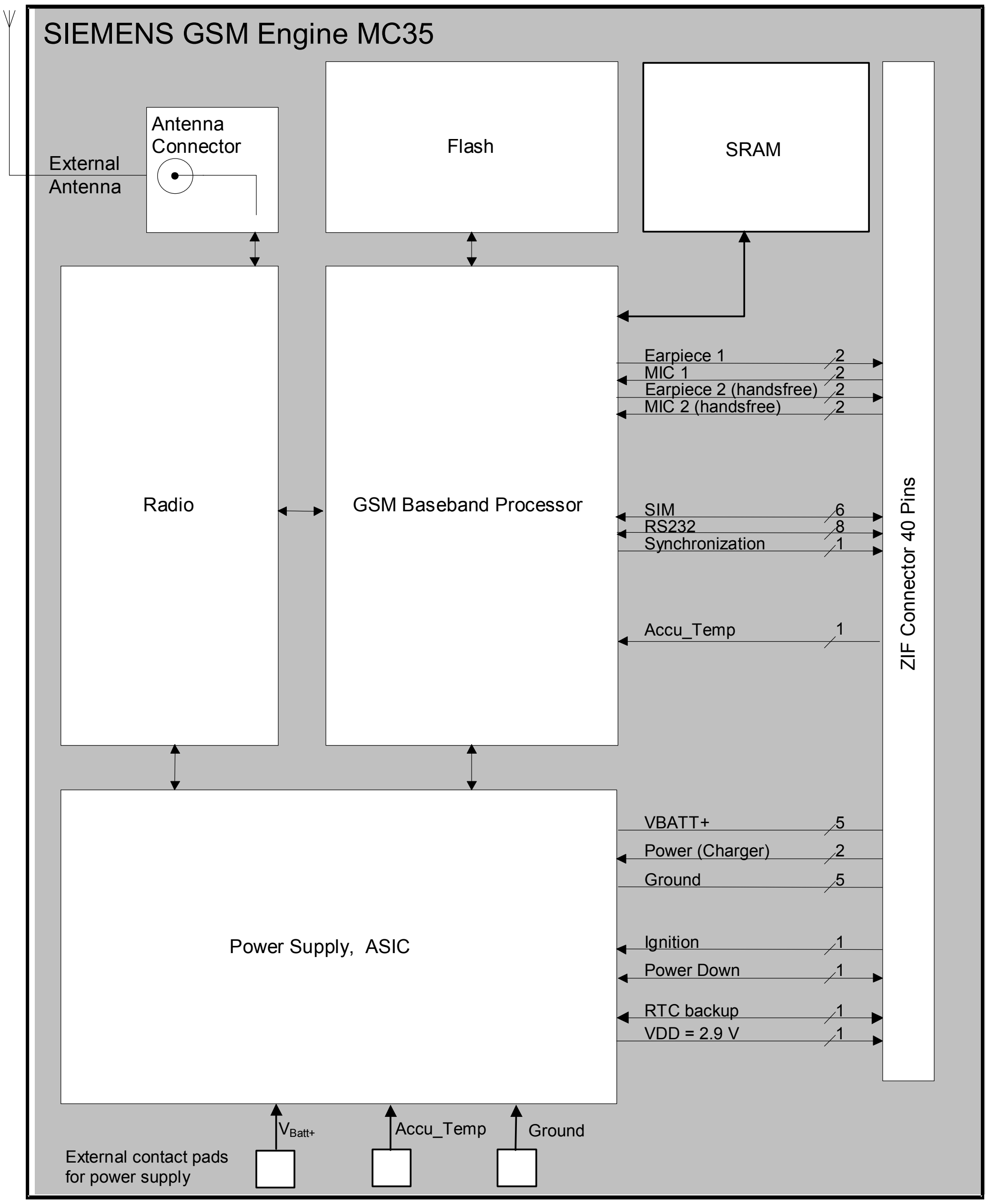



Figure 2: Block diagram of MC35

## 2.4 GSM baseband processor

The GSM baseband processor handles all the processing for audio, signaling and data transfer within a GSM cellular device. Internal software runs the application interface and the whole GSM protocol stack. A UART forms the interface to the cellular device application.

The GSM baseband processor is a single chip mixed signal baseband IC, containing all analog and digital functionality of a cellular radio. Designed to meet the increasing demands of the GSM/PCS cellular subscriber market, it supports FR, HR and EFR speech and channel coding without the need for external hardware.

Its high level of integration reduces system complexity, board dimensions and the number of components. In combination with the RF solution a complete two-chip GSM system solution is achieved, which results in extremely compact implementation, very low power consumption and cost effective system performance. Due to its very flexible interfaces the baseband controller can easily be set up to control a wide variety of RF architectures. The baseband processor is powered by a C166 CPU and a DSP core. Integrating these high performance processor cores with on-chip memory, a TDMA timer module and GSM specific peripherals provides a compelling single chip cellular baseband processor.

### 2.4.1 Features of the GSM baseband processor

The baseband processor includes the following major features:

- C166 MCU processor core
- Digital Signal Processing core
- On-chip MCU Program ROM / SRAM flexibly configurable as program or data RAM
- DSP Program ROM / RAM
- DSP Data ROM / RAM
- Programmable PLL for system clock generation
- GSM Timer Module that off-loads the MCU from radio channel timing
- MCU and DSP Timers
- Pulse Carry Modulation output for Automatic Frequency Correction (AFC)
- Serial RF Control Interface
- ISO 7816 compatible SIM card interface
- Digital and analog voiceband and baseband filters including digital-to-analog and analog-to-digital converters
- RF power ramping functions
- Measurement of battery voltage, battery and environment temperature
- GMSK Modulator
- Viterbi Hardware Accelerator
- A51/A52 Cipher Unit
- Comprehensive static and dynamic power management

# 3 Application Interface

MC35 is equipped with a 40-pin 0.5mm pitch ZIF connector that connects to the cellular application platform. The host interface incorporates several sub-interfaces described in the following chapters:

- Power supply and charging (see Chapters 3.2 and 3.3)
- Serial interface (see Chapter 3.5)
- Two audio interfaces (see Chapter 3.6)
- SIM interface (see Chapter 3.7)

Electrical and mechanical characteristics of the ZIF connector are specified in Chapter 5.4. Ordering information for the ZIF connector and the required cables are listed in Chapter 11.

## 3.1 Operating modes

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

Table 3: Overview of operating modes

| Mode | Function | |
|---|---|---|
| Power Down | Operating voltage is applied. Only a voltage regulator in the Power Supply ASIC is active for powering the RTC. Software is not active. The RS-232 interface is not accessible. | |
| Normal operation | GSM / GPRS SLEEP | Powersave modes set with AT+CFUN command. Software is active to minimum extent. If the module was registered to the GSM network in IDLE mode, it is registered and paging with the BTS in SLEEP mode, too. Power saving can be chosen at different levels: The NON-CYCLIC SLEEP mode (AT+CFUN=0) disables the AT interface. The two CYCLIC SLEEP modes AT+CFUN=5 or 6 alternatingly activate and deactivate the AT interface to allow permanent access to all AT commands. See Chapters 3.3.2 and 0. |
| | GSM IDLE | Software is active. Once registered to the GSM network, paging with BTS is carried out. The module is ready to send and receive. |
| | GSM TALK | Connection between two subscribers is in progress. Power consumption depends on network coverage individual settings, such as DTX off/on, FR/EFR/HR, hopping sequences, antenna. |
| | GPRS IDLE | Module is ready for GPRS data transfer, but no data is currently sent or received. Power consumption depends on network settings and GPRS configuration (e.g. multislot settings). |
| | GPRS DATA | GPRS data transfer in progress. Power consumption depends on network settings (e.g. power control level), uplink / downlink data rates and GPRS configuration (e.g. used multislot settings). |
| Alarm mode | Restricted operation launched by RTC alert function while the module is in Power Down mode. Module will not be registered to GSM network. Limited number of AT commands is accessible.<br>If application is battery powered: No charging functionality in Alarm mode. | |
| Charge-only mode | Limited operation for battery powered applications. Enables charging while module is detached from GSM network. Limited number of AT commands is accessible. There are several ways to launch Charge-only mode:<br>• From Power Down mode: Connect charger to POWER lines when engine was powered down by AT^SMSO.<br>• From Normal mode: Connect charger to POWER lines, then enter AT^SMSO. | |
| Charge mode during normal operation | Normal operation (SLEEP, IDLE, TALK, GPRS IDLE, GPRS DATA) and charging running in parallel. Charge mode changes to Charge-only mode when the module is powered down before charging has been completed. | |

See Table 10 and Table 12 for the various options of waking up MC35 and proceeding from one mode to another.

## 3.2 Power supply

The power supply of the GSM Engine MC35 has to be a single voltage source of $V_{BATT+}$= 3.3V...4.8V. It must be able to provide a peak current of about 2A during the uplink transmission and account for drops on the VBATT+ line that may be caused in transmit bursts.

All the key functions for supplying power to the device are handled by an ASIC power supply. The ASIC provides the following features:

- Stabilizes the supply voltages for the GSM baseband using linear voltage regulators.
- Controls the module's power up and power down procedures.
  A watchdog logic implemented in the baseband processor periodically sends signals to the ASIC, allowing it to maintain the supply voltage for all MC35 components. Whenever the watchdog pulses fail to arrive constantly, the module is turned off.
- Delivers, across the VDD pin, a regulated voltage of 2.9V for the external application.

The RF power amplifier is driven directly from VBATT+.

MC35 offers two options of connecting the power supply to your application platform:

- the ZIF connector (see Chapter 3.2.2)
- or the contact pads located on the MC35 PCB (see Chapter 3.2.3).

Both options can be used in parallel.

### 3.2.1 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 3.3 V on the MC35 board, not even during transmit bursts. Also, make sure that any voltage drops that may occur during transmit bursts never exceed 400mV. It should be noted that MC35 switches off in the event of exceeding these limits. For further details see Chapter 6.4.

Note: In order to minimize power losses, use an FFC as short as possible. The resistance of the power supply lines on the host board and of a battery pack should also be considered.

Example: The ZIF-FFC-ZIF connection causes a resistance of 50mΩ in the VBATT+ line and 50mΩ in the GND line, if the FFC reaches the maximum length of 200mm. As a result, a 2A transmit burst would add up to a total voltage drop of 200mV. 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.

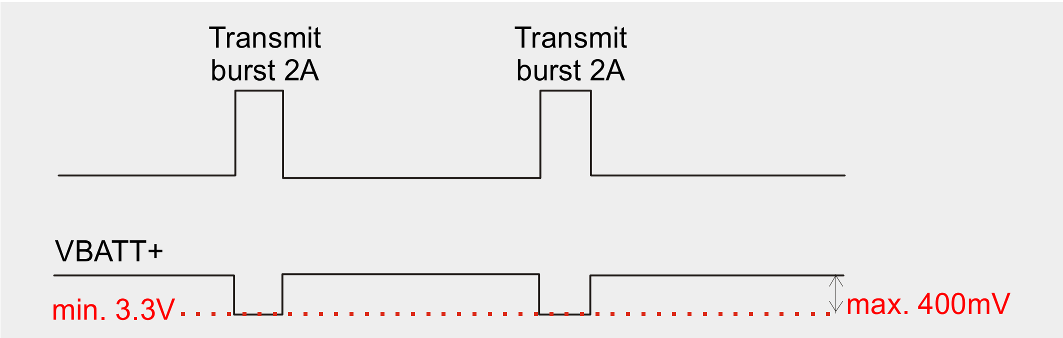



Figure 3: Power supply limits during transmit burst

### 3.2.2 Power supply across ZIF connector

10 pins of the ZIF connector are dedicated to connect the supply voltage (VBATT+) and ground (GND).

Table 4: Power supply pins of ZIF connector

| Signal name | Pin | I/O | Description | Parameter |
|---|---|---|---|---|
| VBATT+ | 1-5 | I/O | Positive operating voltage | 3.3 V...4.8 V, $I_{typ} \leq 2$ A during transmit burst<br>The minimum operating voltage must not fall below 3.3 V, not even in case of voltage drop. |
| GND | 6-10 | - | Ground | 0 V |
| POWER | 11-12 | I | Positive charging voltage | $I_{max}$ = 500 mA<br>U = 5.5...8 V<br>internal Pull Down R=100kΩ |
| VDDLP | 30 | I/O | Buffering of RTC (see Chapter 3.4) | $U_{OUT,max} < V_{BATT+}$<br>$U_{IN}$ = 2.0 V...5.5 V<br>$R_i$ = 1kΩ<br>$I_{in,max}$ = 30µA |

### 3.2.3 Power supply across contact pads

In addition, MC35 can be powered from the contact pads located on the RF part of the PCB.

In order to connect the contact pads to your application platform it is recommended to use contact springs. A soldering connection to any of the contact pads VBATT+, GND or ACCU_TEMP may damage MC35 and is not permitted. The position of the power pads is shown in Figure 27. See also Chapter 5.4.

Table 5: Parameters of power supply contact pads

| Signal name | I/O | Description | Parameter |
|---|---|---|---|
| VBATT+ | I/O | Positive operating voltage | 3.3 V...4.8 V, $I_{max} \leq 2$ A during transmit burst<br>The minimum operating voltage must not fall below 3.3 V, not even in case of voltage ripple. |
| GND | - | Ground | 0 V |
| ACCU_ TEMP | I/O | Input for temperature measurement with NTC 10 kΩ @ 25°C to GND, $B_{25/50}$ = 3370 Kelvin ± 3% | $V_{out,MEAS}$ = 1.16V<br>Note: Voltage is applied only while temperature is measured. |

### 3.2.4 Battery pack

For some applications the use of a battery pack may be required. MC35 can be powered from a Li-Ion battery pack which must be specified for a typical nominal voltage of 3.6 V and a maximum charging voltage of 4.2 V. The capacity may be 600 mAh to 800 mAh.

The charging algorithm has been optimized for a battery pack that meets the characteristics listed below. It is strongly recommended that the battery pack you want to integrate into your MC35 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. A battery pack especially designed to operate with MC35 modules is specified in Chapter 3.2.4.1.

*Battery pack characteristics*

- 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 pack it must be placed nearby. The NTC resistor must be connected between ACCU_TEMP and GND. Required NTC characteristics are: *10 kΩ ±5% @ 25°C,* $B_{25/85}$ *= 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. The circuit must be insensitive to pulsed current.
- On the MC35 module, a built-in measuring circuit constantly monitors the supply voltage. In the event of undervoltage, it causes MC35 to power down and automatically starts up trickle charging to protect the cell from damage. 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 MC35 and of the application circuit.
- The internal resistance of the battery and the protection should be as low as possible. It is recommended not to exceed 150mΩ, even in extreme conditions at low temperature. The battery cell must be insensitive to rupture, fire and gasing under extreme conditions of temperature and charging (voltage, current).
- The battery pack must be protected from reverse pole connection. For example, the casing should be designed to prevent the user from mounting the battery in reverse orientation.
- The battery pack must be approved to satisfy the requirements of CE conformity.

Figure 4 shows the circuit diagram of a typical battery pack design that includes the protection elements described above.

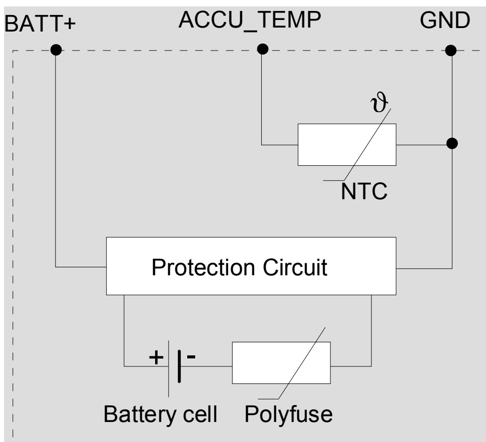



Figure 4: Battery pack circuit diagram

#### 3.2.4.1 Recommended battery pack

The following battery pack has been especially designed for use with MC35 modules.

Table 6: Specifications of XWDTC35PL battery pack

| | |
|---|---|
| Product name, type | XWDTC35PL, Li-Ion, 3.6V, 800mAh |
| Vendor<br>To place orders or obtain more information please contact: | Shenzhen Xwoda Electronic Co., Ltd<br>Linda Yang<br>Unit 3003, Yingjingyuan,Zhongdian Garden,<br>Shenzhen 518032<br>P.R.China<br>Phone: +86-755-7633789 ext. 33<br>Fax: +86-755-7632078<br>Email: xwda@public.szptt.net.cn |
| Nominal voltage | 3.6V |
| Capacity | 800mAh |
| NTC | 10kΩ ± 5% @ 25°C, B (25/85)=3435K ± 3% |
| Overcharge detection voltage | 4.325 ± 0.025V |
| Overcharge release voltage | 4.075 ± 0.025V |
| Overdischarge detection voltage | 2.5 ± 0.05V |
| Overdischarge release voltage | 2.9 ± 0.5V |
| Overcurrent detection | 3 ± 0.5A |
| Nominal working current | <5µA |
| Current of low voltage detection | 0.5µA |
| Overcurrent detection delay time | 8~16ms |
| Short detection delay time | 50µs |
| Overdischarge detection delay time | 31~125ms |
| Overcharge detection delay time | 1s |
| Internal resistance | <130mΩ |

#### 3.2.4.2 Supported charging technique

Charging can be accomplished in a temperature range from 0°C to +45°C. The charging process supports trickle charging and processor controlled fast charging. In trickle mode, the battery is charged with a current of less than 10mA. The fast charging current provided by the charger or any other external source must be limited to 500mA. See also Table 29.

The charge cycle begins once the charger is tied to the two POWER pins of the ZIF connector. First, the charging process goes into trickle charge mode, no matter whether the battery was deeply or partially discharged. When the battery voltage reaches 3.2V within 60 minutes ±10%, the Power ASIC turns on and wakes up the baseband processor.

Once activated, the baseband processor enables fast charging, in parallel to trickle charging. Fast charging delivers a constant current until the battery voltage reaches 4.2V and then proceeds with varying charge pulses. As shown in Figure 5, the pulse duty cycle is reduced to adjust the charging procedure and prevent the voltage from overshooting beyond 4.2V. Once the pulse width reaches the minimum of 100ms and the duty cycle does not change for 2 minutes, fast charging is completed.

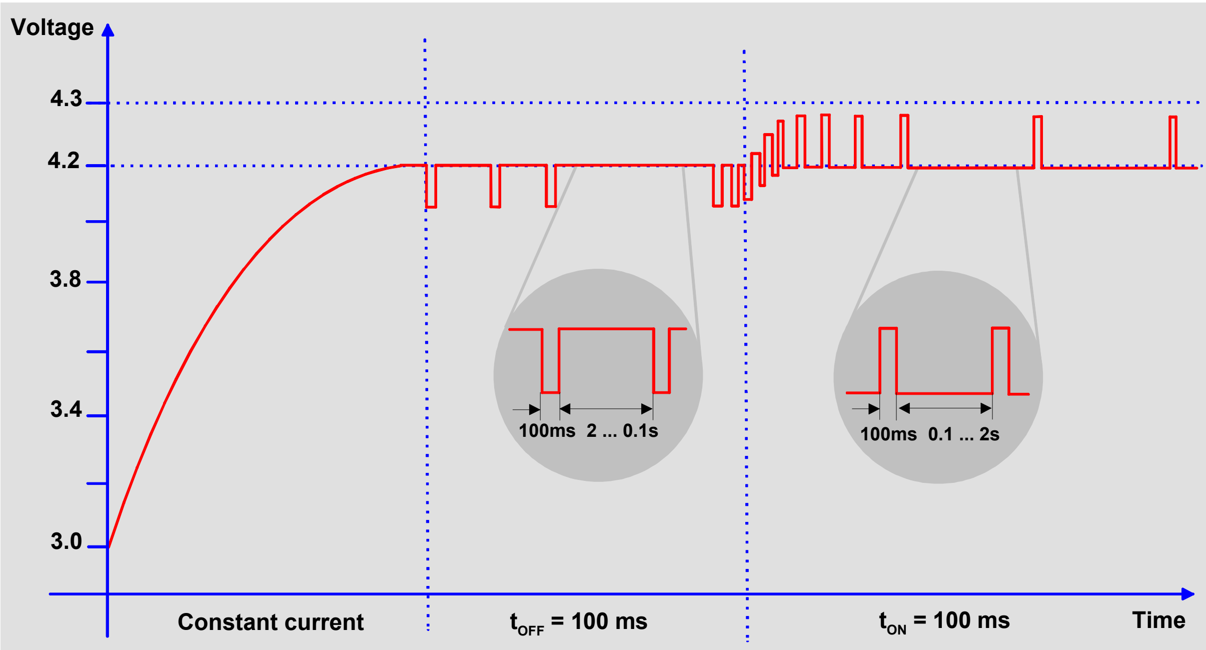



Figure 5: Charging process

*Note: Do <u>not</u> connect the charger to the VBATT+ lines. Only the POWER lines are intended as input for charging!*

*The battery manufacturer must guarantee that the battery complies with the described charging technique. Please refer to the application notes "Battery Pack" and "Charging the Battery Pack" for a detailed description of the charging characteristics.*

*What to do if software controlled charging does not start up?*
If the battery voltage fails to pass the 3.2V level when the 60 minutes timer expires, processor controlled charging does not begin. To solve the problem you can do one of the following:

- Once the voltage has reached its minimum of 3V, you can try to start software controlled charging by pulling the /IGT line to ground.
- If the voltage is still below 3V, driving the /IGT line to ground switches the timer off and, thus, prevents the system from proceeding to software controlled charging. Instead, you are required to shortly disconnect and reconnect the charger. This turns on the timer and starts anew the entire process.

Apart from this, trickle charging continues whenever the charger connects to the POWER lines.

#### 3.2.4.3 Operating modes during charging

Of course, the battery can be charged regardless of the engine's operating mode. When the GSM engine is in Normal mode (SLEEP, IDLE, TALK GPRS IDLE or GPRS DATA mode), it remains operational while charging is in progress (provided that sufficient voltage is applied). The charging process during the Normal mode is referred to as *Charge mode*.

If the charger is connected to the POWER lines while the engine is in Power Down mode (caused by AT^SMSO), the GSM engine goes into *Charge-only mode*.

Table 7: Comparison Charge-only and Charge mode

| | How to activate mode | Features |
|---|---|---|
| **Charge mode** | Connecting charger to the POWER lines while GSM engine is<br>• operating, e.g. in IDLE or TALK mode<br>• in SLEEP mode | • Battery can be charged while GSM engine remains operational and registered to the GSM network.<br>• In IDLE and TALK mode, the RS-232 interface is accessible. AT command set can be used to full extent.<br>• In the NON-CYCLIC SLEEP mode, the RS-232 interface is not accessible at all. During the CYCLIC SLEEP mode it can be used as described in Chapter 3.3.2.2. |
| **Charge-only mode** | Connecting charger to the POWER lines while GSM engine is<br>• in Power Down mode (powered down by AT^SMSO)<br>• in Normal mode: Connect charger to POWER lines, then enter AT^SMSO.<br><br>IMPORTANT: While trickle charging is in progress, be sure that the application is switched off. If the application is fed from the trickle charge current the module might be prevented from proceeding to software controlled charging since the current would not be sufficient. | • Battery can be charged while GSM engine is deregistered from GSM network.<br>• Charging runs smoothly due to constant current consumption.<br>• The AT interface is accessible and allows to use the commands listed below. |

*Features of Charge-only mode*

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

^SYSSTART CHARGE-ONLY MODE

Note that this URC will not appear when autobauding was activated (due to the missing synchronization between DTE and DCE upon start-up). Therefore, it is recommended to select a fixed baudrate before using the Charge-only mode.

While the Charge-only mode is in progress, you can take advantage of the AT commands listed in Table 8. For further instructions refer to the AT Command Set supplied with your GSM engine.

Table 8: 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 | Monitor charging process<br>Note: While charging is in progress, no battery parameters are available. To query the battery capacity disconnect the charger.<br>If the charger connects *externally* to the host device no charging parameters are transferred to the module. In this case, the command cannot be used. |
| AT^SCTM | Query temperature range, enable/disable URCs to report critical temperature ranges |
| AT^SMSO | Power down GSM engine |

To proceed from Charge-only mode to normal operation, it is necessary to drive the ignition line to ground. This must be implemented in your host application as described in Chapter 3.3.1.1. When the engine is in Alarm mode there is no direct way to start charging, i.e. charging will not begin even though the charger connects to the POWER lines. See also Chapter 3.3.6 which summarizes the various options of changing the mode of operation.

If your host application uses the SYNC pin to control a status LED as described in Chapter 3.8.2.2, please note that the LED is off while the GSM engine is in Charge-only mode.

### 3.2.4.4 Charger requirements

The charger must be designed to meet the following requirements:

*a) Simple transformer power plug*

- Output voltage: 5.5V...8V (under load)
- The charge current must be limited to 500mA
- Voltage spikes that may occur while you connect or disconnect the charger must be limited to a maximum of 25V and must not exceed 1ms
- There must not be any capacitor on the secondary side of the power plug (avoidance of current spikes at the beginning of charging)

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

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

*Note: To detect extreme thermal conditions while charging is in progress, connect an NTC (10kΩ±5% @ 25°C, B=3435 Kelvin ±3%) from ACCU_TEMP to GND.*

# 3.3 Power up / down scenarios

## 3.3.1 Turn on the GSM engine

MC35 can be activated in a variety of ways, which are described in the following chapters:

- via ignition line /IGT: starts normal operating state (see Chapters 3.3.1.1 and 3.3.1.2)
- via POWER lines: starts charging algorithm (see Chapters 3.2.4.3 and 3.3.1.3)
- via RTC interrupt: starts Alarm mode (see Chapter 3.3.1.4)

### 3.3.1.1 Turn on GSM engine using the ignition line /IGT (Power on)

To switch on MC35 the /IGT (Ignition) signal needs to be driven to ground level for at least 100ms. This can be accomplished using an open drain/collector driver in order to avoid current flowing into this pin.

If configured to a fix baud rate, MC35 will send the result code ^SYSSTART to indicate that it is ready to operate. This result code does not appear when autobauding is active. See Chapter AT+IPR in [1].

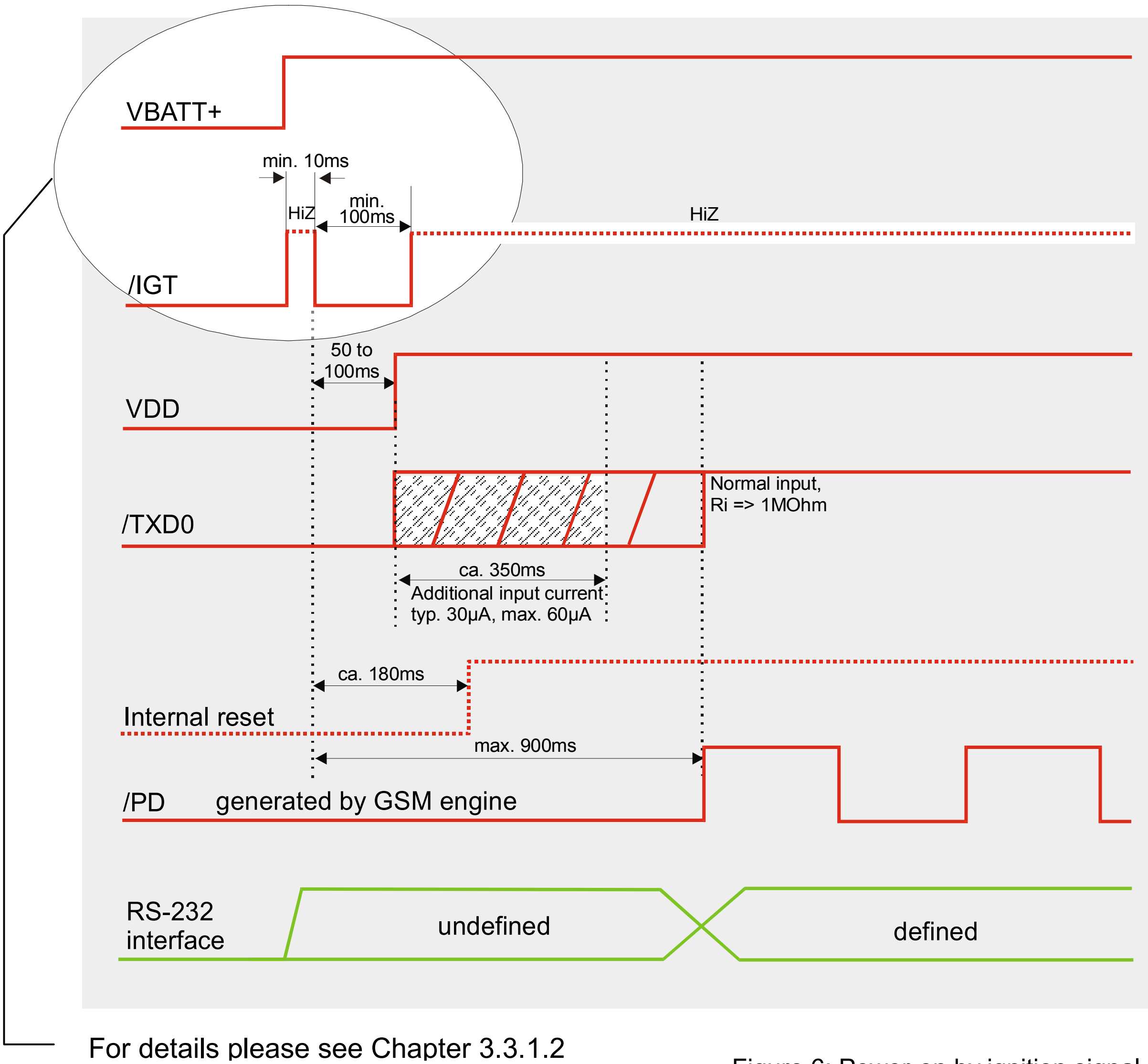



Figure 6: Power-on by ignition signal

When the TXD0 line is driven to high level initially, a current increase of up to 60µA occurs at the TXD0 input for 350ms after the rising edge of the MC35 output voltage line VDD. After that, TXD0 has an input impedance greater than 1MΩ.

In a battery operated MC35 application, the duration of the /IGT signal must be 1s minimum when the charger is connected and you may want to go from charging to Normal mode.

### 3.3.1.2 Timing of the ignition process

When designing your application platform take into account that powering up MC35 requires the following steps.

- The ignition line cannot be operated until $V_{BATT+}$ passes the level of 3.0V.
- 10ms after $V_{BATT+}$ has reached 3.0V the ignition line can be switched low. The duration of the falling edge must not exceed 1ms.
- Another 100ms are required to power up the module.
- Ensure that $V_{BATT+}$ does not fall below 3.0V while the ignition line is driven. Otherwise the module cannot be activated.
- If the VDDLP line is fed from an external power supply as explained in Chapter 3.4, the /IGT line is HiZ before the rising edge of VBATT+.

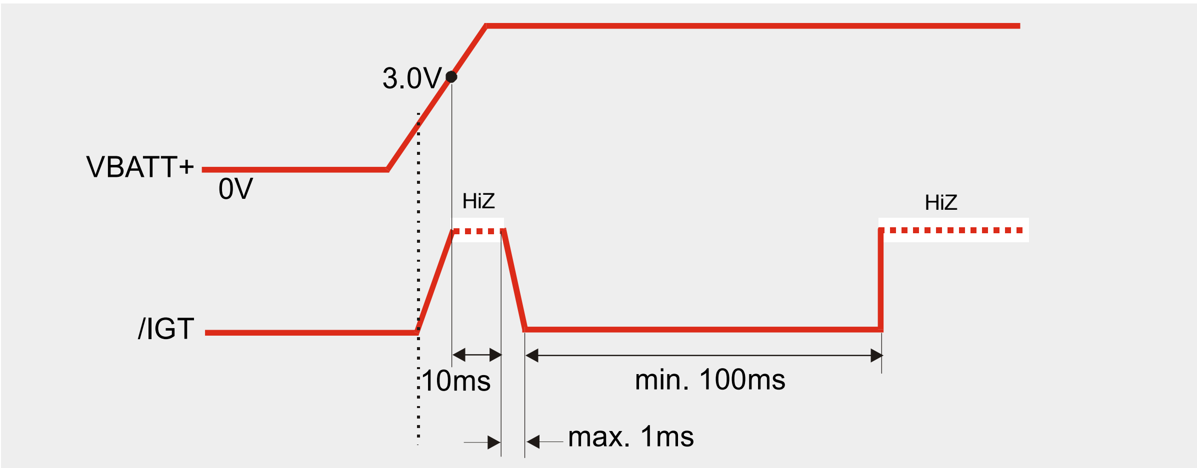



Figure 7: Timing of power-on process if VDDLP is not used

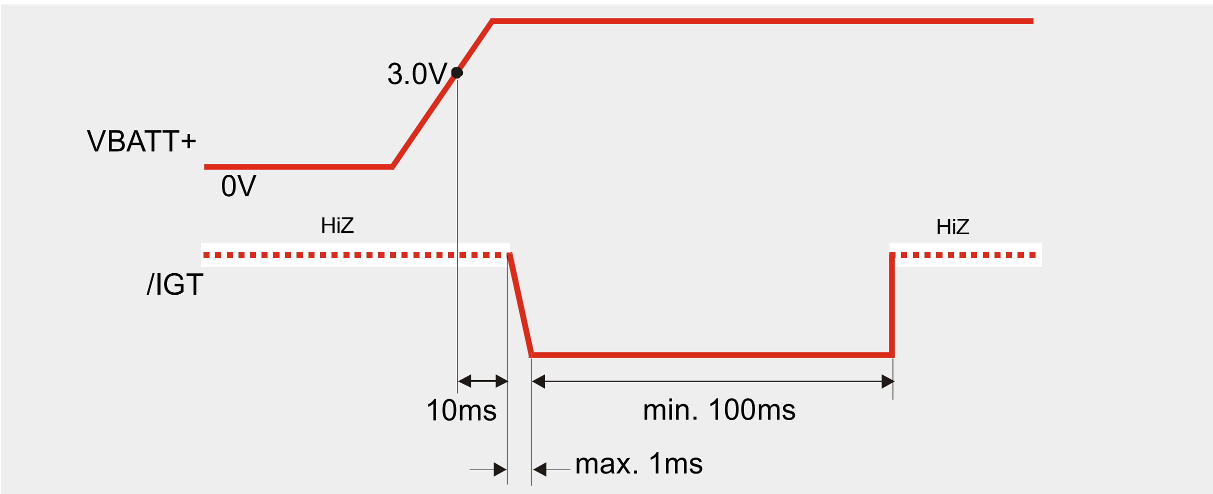



Figure 8: Timing of power-on process if VDDLP is fed from external source

#### 3.3.1.3 Turn on GSM engine using the POWER lines

As detailed in Chapter 3.2.4.3, the charging adapter can be connected regardless of the GSM engine's operating mode (except for Alarm mode).

If the charger is connected to the POWER lines while the GSM engine is off, only the charging algorithm will be launched. The GSM engine runs in a restricted mode, referred to as Charge-only mode.

During the Charge-only mode the GSM engine is neither logged on to the GSM network nor is the RS-232 interface fully accessible. When the minimum voltage of 3.2V is achieved within 60 minutes the charging process proceeds to software controlled charging. To switch to normal operation and log on to the GSM network, the /IGT line needs to be activated.

#### 3.3.1.4 Turn on GSM engine using the RTC (Alarm mode)

Another power-on approach is to use the RTC, which is constantly supplied with power from a separate voltage regulator in the power supply ASIC. The RTC provides an alert function which allows to wake up the GSM engine while power is off. To prevent the engine from unintentionally logging into the GSM network, this procedure only enables restricted operation, referred to as Alarm mode. It must not be confused with a wake-up or alarm call that can be activated by using the same AT command, but without switching off power.

Use the *AT+CALA* command to set the alarm time. The RTC retains the alarm time if the GSM engine was powered down by AT^SMSO. Once the alarm is timed out and executed, the GSM engine enters into the Alarm mode. This is indicated by an Unsolicited Result Code (URC) which reads:

^SYSSTART ALARM MODE

In Alarm mode only a limited number of AT commands is available. For further instructions refer to the AT Command Set.

Table 9: AT commands available in Alarm mode

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

For the GSM engine to change from the Alarm mode to full operation (normal operating mode) it is necessary to drive the ignition line to ground. This must be implemented in your host application as described in Chapter 3.3.1.1. If your application is battery powered note that charging cannot be started while the engine is in Alarm mode, i.e. charging will not begin even though the charger connects to the POWER lines. See also Chapter 3.3.6 which summarizes the various options of changing the mode of operation.

If your host application uses the SYNC pin to control a status LED as described in Chapter 3.8.2.2, please note that the LED is off while the GSM engine is in Alarm mode.

### 3.3.2 Power saving

SLEEP mode reduces the functionality of the MC35 module to a minimum and, thus, minimizes the current consumption to the lowest level. SLEEP mode is set with the AT+CFUN command and can be selected in the three levels <fun>=0, 5 or 6.

IMPORTANT: The AT+CFUN command can be executed before or after entering PIN1. Nevertheless, please keep in mind *that power saving works only while the module is registered to the GSM network*. If you attempt to activate power saving while the module is detached, the selected <fun> level will be set, though power saving does not take effect.

To check whether power saving is on, it is recommended to measure the supply current. If available, you can take advantage of the status LED controlled by the SYNC pin (see Chapter 3.8.2.2). The LED stops flashing once the module starts power saving.

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

If level 0 has been selected, the serial interface is blocked. The module shortly wakes up to listen to a paging message block sent from the base station and immediately returns to the power saving mode.

The first wake-up event fully activates the module, enables the serial interface and terminates power saving. Level 0 is called NON-CYCLIC SLEEP mode.

#### 3.3.2.2 CYCLIC SLEEP mode (AT+CFUN=5 or 6)

These two options are referred to as CYCLIC SLEEP modes. The major benefit over the NON-CYCLIC SLEEP mode is that the serial interface is not permanently blocked and that packet switched calls may go on without terminating the power saving mode. This allows you to take advantage of power saving, for example, while the GSM engine remains attached to the GPRS and even performs a GPRS data transfer.

The CYCLIC SLEEP mode is a dynamic process which alternatingly enables and disables the serial interface. The application must be configured to use hardware flow control. By setting/resetting the CTS signal, the module indicates to the application when the UART is active. The application must wait until CTS is set (i.e. is active low) on the physical UART before data can be sent to the module.

The module starts or resumes power saving two seconds (AT+CFUN=5) or ten minutes (AT+CFUN=6) after the last sent or received character. The module resets the CTS signal, and after additional 5ms it physically deactivates the UART to save power. See Figure 10.

Wake-up procedures are the same as in the NON-CYCLIC SLEEP mode. The first wake-up event fully activates the module, enables the serial interface and terminates power saving. As an additional option, you can set AT+CFUN=1 to wake up the module.

#### 3.3.2.3 Timing of the CTS signal in CYCLIC SLEEP modes

The CTS signal is enabled in synchrony with the module's paging cycle. It goes active low each time when the module starts listening to a paging message block from the base station.

The timing of the paging cycle varies with the base station and can be determined by the following formula:

*4.615 ms (TDMA frame duration) * 51 (number of frames) * DRX value.*

DRX (Discontinuous Reception) is a value from 2 to 9, resulting in paging intervals from 0.47 to 2.12 seconds. The precise DRX value of the base station can be requested from the network operator.

If DRX $\geq$ 3, i.e. if paging is performed at intervals from 0.71 to 2.12 seconds, each listening period causes the CTS signal to go active low. If DRX is 2, i.e. if paging is done every 0.47 seconds, the CTS signal is activated with every 2nd listening period.

The CTS signal stays active low for 20 ms. This is followed by another 5 ms UART activity. Thus, once the CTS signal goes active low, you have 25 ms to enter characters. In the pauses between listening to paging message blocks, while CTS is high, the module resumes power saving and the AT interface is not accessible. See Figure 9.

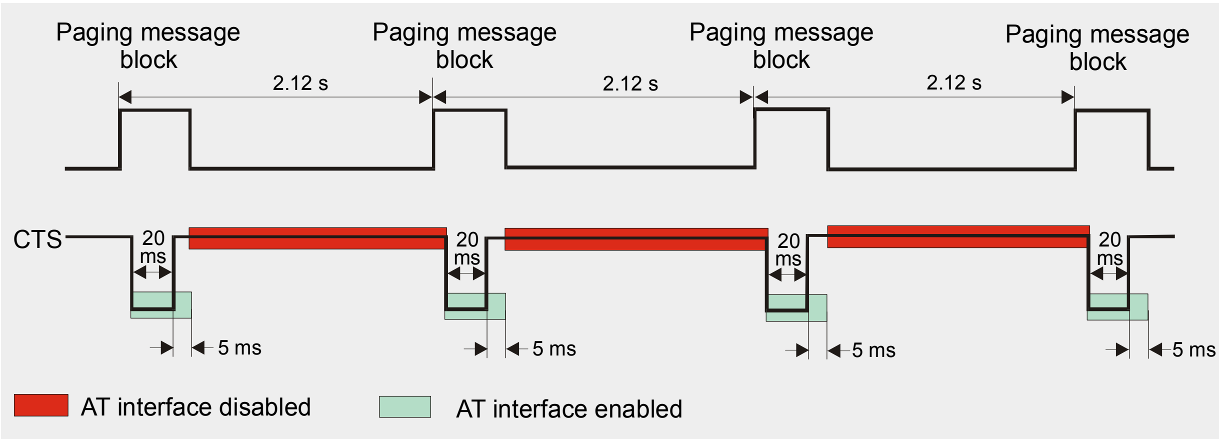



Figure 9: Timing of CTS signal (example for a 2.12 s paging cycle)

Figure 10 illustrates the CFUN=5 mode, which resets the CTS signal 2 seconds after the last character was sent or received. The UART is kept active for another 5 ms before power saving begins.

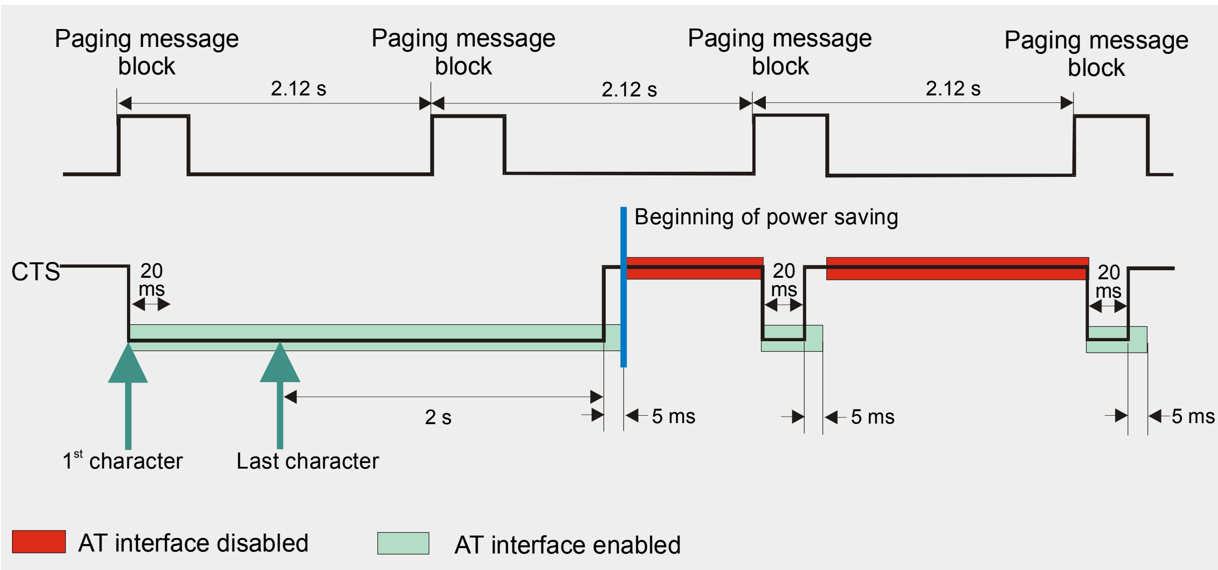



Figure 10: Beginning of power saving if CFUN=5

### 3.3.3 Wake up GSM engine

The following table summarizes the options of waking up the GSM engine from SLEEP or Power Down mode. See also Table 12 for further information.

Table 10: Wake-up events

| GSM engine is registered to GSM network | | |
|---|---|---|
| How to wake up | From SLEEP mode AT+CFUN=0 | From SLEEP mode AT+CFUN=5 or 6 |
| Ignition line | No | No |
| RTS (falling edge) | Yes | No |
| Unsolicited Result Code (URC) | Yes | Yes |
| Incoming call | Yes | Yes |
| Incoming SMS depending on mode selected by AT+CNMI: | | |
| AT+CNMI=0,0 (= default, no indication upon receipt of SMS) | No | No |
| AT+CNMI=1,1 (= displays URC upon receipt of SMS) | Yes | Yes |
| RTC alarm | Yes | Yes |
| AT+CFUN=1 | No (UART disabled) | Yes |

| GSM engine is detached from GSM network | |
|---|---|
| How to wake up | From Power Down mode |
| Ignition line | Yes (see Chapter 3.3.1.1) |
| RTS (falling edge) | No |
| Unsolicited Result Code | No |
| Incoming call | No |
| RTC alarm | Yes, but only wake-up into Alarm mode (see Chapter 3.3.1.4) |
| Connecting charger to POWER lines | Yes, but only wake-up into Charge-only mode (see Chapter 3.2.4.3) |

### 3.3.4 Turn off the GSM engine

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

- *Normal procedure*: Software controlled by sending an AT command over the RS-232 application interface. See Chapter 3.3.4.1.
- *Emergency shutdown*: Hardware driven by switching the /PD (Power Down) line of the ZIF connector to ground = immediate shutdown of supply voltages, only applicable if the software controlled procedure fails! See Chapter 3.3.4.2.
- *Automatic shutdown*: Takes effect if undervoltage / overvoltage is detected or if battery or board (engine) temperature exceeds critical limit. See Chapter 3.3.5.

#### 3.3.4.1 Turn off GSM engine using AT command

The best and safest approach to powering down MC35 is to issue the *AT^SMSO* command. This procedure lets MC35 log off from the network and allows the software to enter into a secure state and safe data before disconnecting the power supply.
Before switching off the device sends the result code

*^SMSO: MS is OFF*

From this moment on, no further AT commands can be executed. Only the RTC is still active. The mode is referred to as Power Down mode.

#### 3.3.4.2 Emergency shutdown using /PD pin

*Caution: Use the /PD pin only when, due to serious problems, the software is not responding for more than 5 seconds. Pulling the /PD pin causes the loss of all information stored in the volatile memory since power is cut off immediately. Therefore, this procedure is intended only for use in case of emergency, e.g. if MC35 fails to shut down properly.*

The /PD signal is available on the ZIF connector. To control the /PD line it is recommended to use an open drain / collector driver. To turn the GSM engine off, the /PD line has to be driven to ground for ≥ 3.5 s.

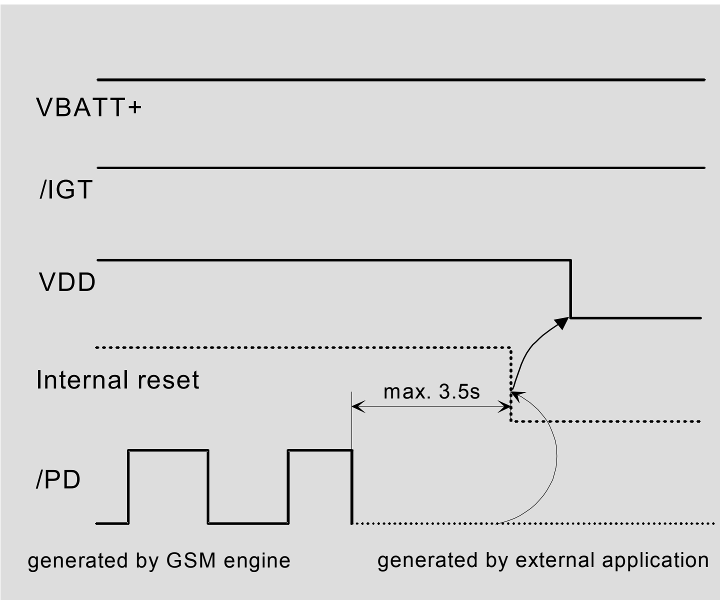



Figure 11: Deactivating GSM engine by Power Down signal

How does it work:

- Voltage VBATT+ is permanently applied to the module.
- The module is active while the internal reset signal is kept at high potential.
  During operation of MC35 the baseband controller generates watchdog pulses at regular intervals.
  Once the /PD pin is grounded these watchdog pulses are cut off from the power supply ASIC. The power suppy ASIC shuts down the internal supply voltages of MC35 after max. 3.5s and the module turns off. Consequently output voltage at VDD goes low.

### 3.3.5 Automatic shutdown

To ensure proper operation of all assemblies under varying conditions, such as temperature, input voltage, transmission power etc., MC35 features protection elements for automatic shutdown.

Automatic shutdown takes effect if
- the MC35 PCB is exceeding the critical limits of overtemperature or undertemperature
- the battery is exceeding the critical limits of overtemperature or undertemperature
- undervoltage is detected
- overvoltage is detected.

The automatic shutdown procedure is equivalent to the power-down initiated with the AT^SMSO command, i.e. MC35 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 3.3.5.1 to 3.3.5.4 for details. For further instructions on AT commands refer to [1].

#### 3.3.5.1 Temperature dependent shutdown

The board temperature is constantly monitored by an internal NTC resistor located on the PCB. The NTC that detects the battery temperature must be part of the battery pack circuit as described in Chapter 3.2.4. 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.

Proceeding from the measured temperature, MC35 sends an alert in the form of a URC and switches off when exceeding the critical limits:
- URCs indicating the alert level "1" or "-1" allow you to take appropriate precautions, such as protect the module or battery from exposure to extreme conditions, or save or back up data etc. 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 MC35. After 15 seconds operation, the presentation will be disabled, i.e. no alert messages can be generated.
- URCs indicating the alert level "2" or "-2" are followed by immediate shutdown. The presentation of these URCs is always enabled, i.e. they will be output even though the factory setting AT^SCTMC=0 was never changed.
- When the temperature is back to normal, again a message will be delivered. In this case, the URC indicates level “0”.

Table 11 summarizes the maximum ratings and the associated URCs.

Table 11: Temperature dependent behaviour

| | |
|---|---|
| Sending temperature alert (15 s after start-up, otherwise only if URC presentation enabled) | |
| ^SCTM_A: 1 | Caution: $T_{amb}$ of battery is between +56°C and +60°C. |
| ^SCTM_B: 1 | Caution: $T_{amb}$ of board is between +55°C and +70°C. |
| ^SCTM_A: -1 | Caution: $T_{amb}$ of battery is between –14°C and –18°C |
| ^SCTM_B: -1 | Caution: $T_{amb}$ of board is between –25°C and –29°C. |
| ^SBCTM_A: 0 | Battery back to uncritical temperature range. |
| ^SBCTM_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 ≥ 60°C. MC35 switches off. |
| ^SCTM_B: 2 | Alert: $T_{amb}$ of board ≥70°C. MC35 switches off. |
| ^SCTM_A: -2 | Alert: $T_{amb}$ of battery < -18°C. MC35 switches off. |
| ^SCTM_B: -2 | Alert: $T_{amb}$ of board ≤-29°C. MC35 switches off. |

The values stated in Table 11 are based on test conditions according to IEC 60068-2-2 (still air).

### 3.3.5.2 Undervoltage shutdown if battery NTC is present

In applications where the module's charging technique is used and an NTC is connected to the ACCU_TEMP terminal, the software constantly monitors the applied voltage to check that the battery voltage is sufficient to set up a call. When the battery voltage decreases to $V_{batt+}$<3.3V, the following URC will be presented:

^SBC: Undervoltage

To enable or disable the URC use the AT^SBC command. The URC will be enabled when you enter the write command and specify the power consumption of your GSM application. Step by step instructions are provided in [1].

The message will be reported, for example, when you attempt to set up 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.

### 3.3.5.3 Undervoltage shutdown if no battery NTC is present

The undervoltage protection is also effective in applications, where no NTC connects to the ACCU_TEMP terminal. Thus, you can take advantage of this feature even though the application handles the charging process or MC35 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>.

Please note, that in contrast to applications with an NTC connected to ACCU_TEMP, the module will present the URC

^SBC: Undervoltage

only once and will then switch off without sending any further messages.

#### 3.3.5.4 Shutdown in the event of overvoltage

Overvoltage protection is implemented in the PSU-ASIC. If the supply voltage raises to $V_{batt+}$ > 5.8V MC35 switches off automatically. In contrast to undervoltage shutdown

- there is no URC function available
- and the module turns off immediately, i.e. loss of data cannot be avoided.

### 3.3.6 Summary of state transitions

Table 12: State transitions of MC35

The table shows how to proceed from one mode to another (gray column = present mode, white columns = intended modes)

| Further mode →→→<br>Present mode | Power Down | Normal mode**) | Charge-only mode*) | Charging in normal mode*)**) | Alarm mode |
|---|---|---|---|---|---|
| Power Down mode without charger | --- | /IGT >100 ms at low level | Connect charger to POWER (high level at POWER) | No direct transition, but via "Charge-only mode" or "Normal mode" | Wake-up from Power Down mode (if activated with AT+CALA) |
| Power Down mode with charger (high level at POWER pins) | --- | /IGT (if supply voltage is above 3.0V). No automatic transition, but via Power Down mode without charger | 100ms < /IGT < 500ms at low level | /IGT >1 s at low level | Wake-up from Power Down mode (if activated with AT+CALA) |
| Normal mode**) | AT^SMSO<br>or<br>exceptionally /PD pin > 3.5 s at low level | --- | No automatic transition, but via "Power Down" | Connect charger to POWER (high level at POWER) | AT+CALA followed by AT^SMSO. MC35 enters Alarm mode when specified time is reached. |
| Charge-only mode *) | Disconnect charger (POWER at low level) or AT^SMSO or exceptionally /PD pin >3.5 s at low level | No automatic transition, but via "Charge in Normal mode" | --- | /IGT >1 s at low level | AT+CALA followed by AT^SMSO. MC35 enters Alarm mode when specified time is reached and $V_{BATT+} \leq 3.3V$ |
| Charging in normal mode*) **) | Via "Charge-only mode" or exceptionally /PD pin > 3.5 s at low level | Disconnect charger from POWER | AT^SMSO | --- | No direct transition |
| Alarm mode | AT^SMSO or exceptionally /PD pin > 3.5 s at low level | /IGT >100 ms at low level | No transition | /IGT >100 ms at low level | --- |

*) See Chapter 3.2.4.3 for details on the charging mode

**) Normal mode covers TALK, DATA, GPRS, IDLE and SLEEP modes

## 3.4 RTC backup

The internal Real Time Clock of MC35 is supplied from a voltage regulator of the power supply ASIC which is also active when MC35 is powered down. An alarm function is provided for activating and deactivating MC35.

In addition, you can use the VDDLP pin on the ZIF connector (pin no. 30) to backup the RTC from an external capacitor or a battery (rechargeable or non-chargeable). The capacitor is charged by the VBATT+ line of MC35. If the voltage supply at VBATT+ 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 MC35, i.e. the greater capacitor the longer MC35 will save the date and time.

A serial resistor placed on the board next to VDDLP limits the input current of an empty capacitor. This eliminates the need of adding a resistor as required on TC35 or TC37 applications. If you integrate MC35 into an existing TC3x application please note the recommendations provided in Chapter 8.

The following figures show various sample configurations. The voltage applied at VDDLP can be in the range from 2 to 5.5V. Please refer to Table 20 for the parameters required.

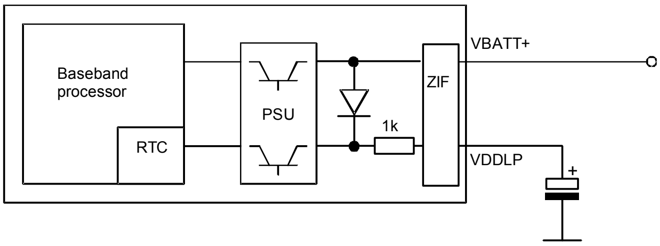



Figure 12: RTC supply from capacitor

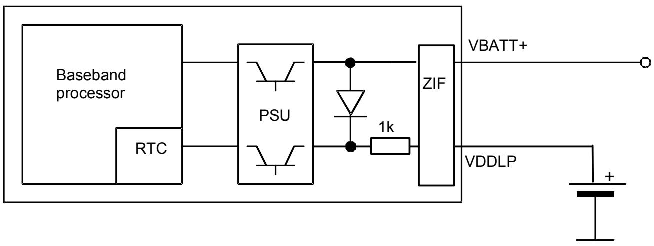



Figure 13: RTC supply from rechargeable battery (accumulator)

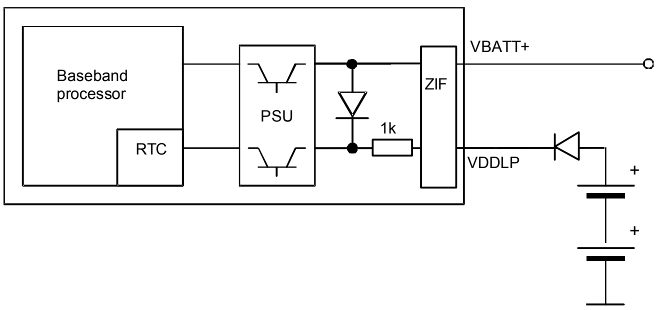



Figure 14: RTC supply from non-chargeable battery

## 3.5 Serial interface

The data interface is implemented as a serial asynchronous transmitter and receiver conforming to ITU-T RS-232 Interchange Circuits DCE. It operates at CMOS level (2.65V). All RS-232 signals on the ZIF connector are low active.

The GSM engine 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 /TxD0 of the GSM engine
- Port /RxD @ application receives data from /RXD0 of the GSM engine

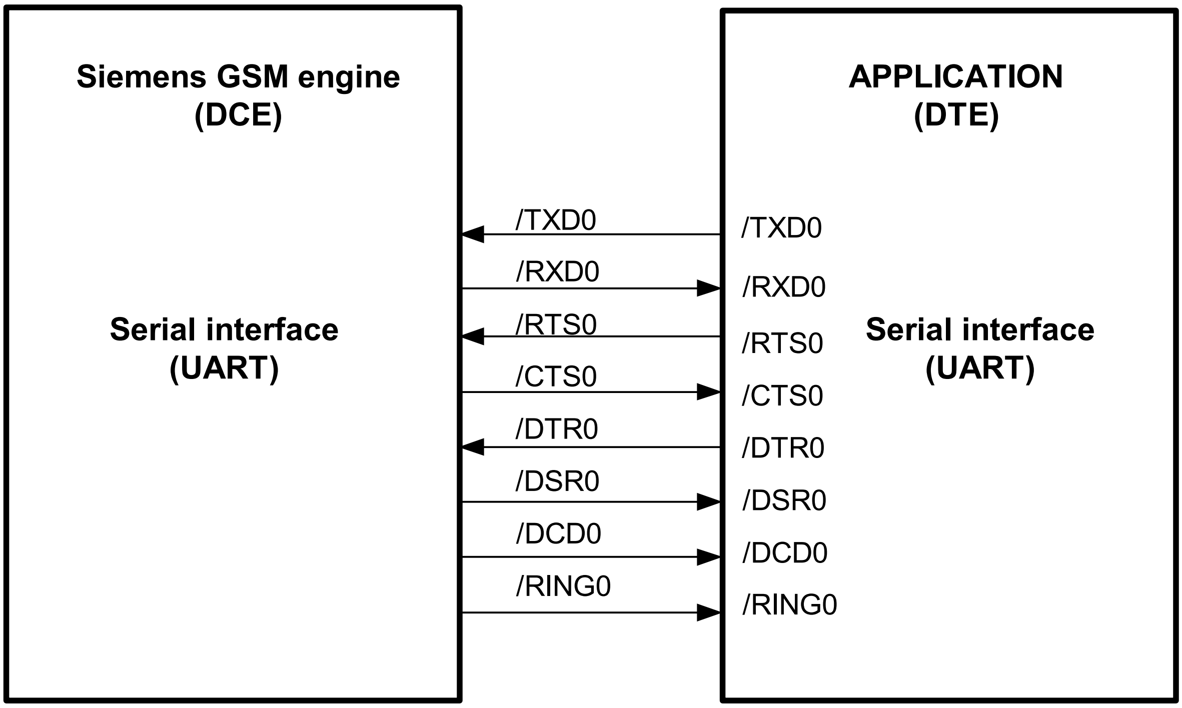



Figure 15: RS-232 interface

Table 13: DCE-DTE wiring

| DCE | | | DTE | |
|---|---|---|---|---|
| Pin no*). | Pin function | Signal direction | Pin function | Signal direction |
| 19 | /TxD0 | Input | /TxD0 | Output |
| 18 | /RxD0 | Output | /RxD0 | Input |
| 21 | /RTS0 | Input | /RTS0 | Output |
| 20 | /CTS0 | Output | /CTS0 | Input |
| 22 | /DTR0 | Input | /DTR0 | Output |
| 16 | /DSR0 | Output | /DSR0 | Input |
| 23 | /DCD0 | Output | /DCD0 | Input |
| 17 | /RING0 | Output | /RING0 | Input |

*) pin numbers on ZIF connector of GSM engine

The data interface is configured for 8 data bits, no parity and 1 stop bit, and can be operated at bit rates from 300bps to 115kbps. Autobauding supports the following bit rates: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps. Hardware handshake using the /RTS0 and /CTS0 signals and XON/XOFF software flow control are supported.

In addition, the modem control signals /DTR0*), /DSR0, /DCD0 and /RING0 are available. The modem control signal /RING0 (Ring Indication) can be used to indicate, to the cellular device application, that a call or Unsolicited Result Code (URC) is received. There are different modes of operation, which can be set with AT commands.

*) **The /DTR0 signal will only be polled once per second from the internal firmware of MC35.**

## 3.6 Audio interface

MC35 comprises two audio interfaces, each with an analog microphone input and an analog earpiece output (see block diagram below).

To suit several types of equipment, there are six audio modes available which can be selected with 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 set with AT commands (except for mode 1).

Please refer to Chapter 6.5 for specifications of the audio interface and an overview of the audio parameters. Detailed instructions on using AT commands are presented in the "MC35 AT Command Set". Table 31 on page 81 summarizes the characteristics of the various audio modes and shows what parameters are supported in each mode.

The first audio interface can be set to the audio modes 1 (default), 4 and 5. The default configuration is 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. In audio mode 4, you can avail of AT commands to adjust the Votronic handset as well as any individual handset.

The second audio interface is especially intended for headsets and can be configured to the audio modes 2, 3 or 6. In order to integrate a handsfree application you can take advantage of the Siemens Car Kit Portable and connect it to the second interface.

All microphone inputs and the earpiece / headset outputs are balanced. A power supply for electret microphones is implemented and can be used with in audio modes 1 to 4. If not needed, it has to be decoupled with capacitors.

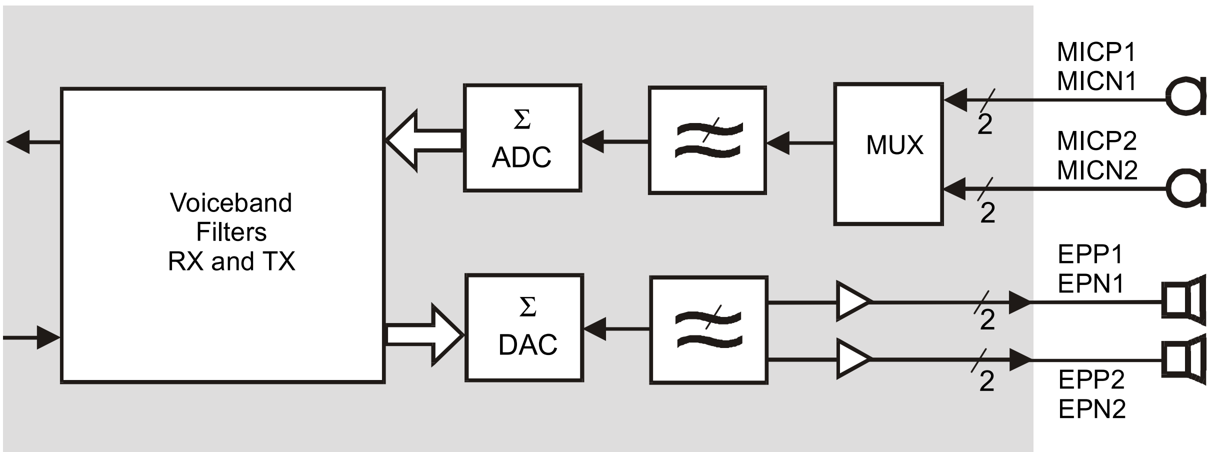



Figure 16: Audio block diagram

### 3.6.1 Speech processing

The voiceband filter includes a digital interpolation low-pass filter for received voiceband signals with digital noise shaping and a digital decimation low-pass filter for voiceband signals to be transmitted.

After voiceband (interpolation) filtering the resulting 2Mbit/s data stream is digital-to-analog converted and amplified by a programmable gain stage in the voiceband processing part. The output signal can directly be connected to the earpiece of the GSM cellular device or to an external headset earpiece (via I/O connector). In the opposite direction the input signal from the microphone is first amplified by a programmable amplifier. After analog-to-digital conversion a 2Mbit/s data stream is generated and voiceband (decimation) filtering is performed.

The resulting speech samples from the voiceband filters are handled by the DSP of the baseband controller to calculate e.g. amplifications, sidetone, echo cancellation or noise suppression.

Full rate, half rate and enhanced full rate, 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.

## 3.7 SIM interface

The baseband processor has an integrated SIM interface compatible with the ISO 7816-3 IC Card standard. This is wired to the host interface (ZIF connector) in order to be adapted to an external SIM card holder. Six pins on the ZIF connector are reserved for the SIM interface. Further to the five wire SIM interface according to GSM 11.11, the CCIN pin has been added. The CCIN pin serves to detect mechanically whether or not a card is present in the card holder.

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 Deutschland GmbH, which has been tested to operate with MC35 and is part of the Siemens reference setup for type approval (Molex ordering number 91228-0001).

It is recommended that the total cable length between the ZIF connector pins on MC35 and the pins of the card holder does not exceed 200 mm in order to meet the specifications of GSM Recommendations 11.10 and to satisfy the requirements of EMC compliance.

*Note: Before removing the SIM card or inserting a new one be sure that the GSM engine has been powered down as described in Chapter 3.3.4.1. Otherwise, you run the risk of causing damage to the card, or losing data stored on the card.*

Table 14: Signals of the SIM interface (ZIF connector)

| **Signal** | **Pin no.** | **Description** |
|---|---|---|
| CCRST | 25 | Chipcard reset, provided by baseband processor. |
| CCCLK | 27 | Chipcard clock, various clock rates can be set in the baseband processor. |
| CCIO | 26 | Serial data line, input and output. |
| CCIN | 24 | Input on the baseband processor for detecting the SIM card in the holder; if the SIM card is removed during operation the SIM interface shuts down immediately. This function is implemented to prevent destruction of the SIM card. Nevertheless, inserting or removing the SIM card during operation should be avoided (see Note above).<br><br>IMPORTANT: 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 MC35. |
| CCVCC | 28 | SIM supply voltage. |
| CCGND | 29 | Separate ground connection for SIM card to improve EMC. |

### 3.7.1 Requirements for using the CCIN pin

The module's startup procedure involves a SIM card initialization performed within 1 second after getting started. A most important issue for reliable operation is whether the initialization procedure ends up with a high or low level of the CCIN signal:

a) If, during startup of MC35, the CCIN signal on the SIM interface is high, then the status of the SIM card holder can be recognized each time the card is inserted or ejected. This can be easily achieved when the card holder comprises a card detect switch. The switch causes CCIN to go and stay high when the card is present.
   A low level of CCIN indicates that the holder is empty. In this case, the module keeps searching, at regular intervals, for the SIM card. Once the card is inserted, CCIN is taken high again.
b) If, during startup of MC35, the CCIN signal is low, the module will also attempt to initialize the SIM card. In this case, the initialization will only be successful when the card is present.
   If the SIM card initialization has been done, but the card is no more operational or removed, then the module will never search again for a SIM card and only emergency calls can be made.

It is strongly recommended to connect the contacts of the SIM card detect switch to the CCIN input and to the CCVCC output of the module as illustrated in the sample diagram in Figure 17. The additional switch in the CCIN line shown in Figure 17 is intended for debugging purposes only and is, normally, not required in your application.

In special cases, the CCIN signal might be controlled by the host application. If so, be sure that the CCIN signal is low while the output voltage VDD is low, too. In particular, no voltage may be applied at the CCIN input, when MC35 is in Power Down mode. Otherwise, proper operation of MC35 may be affected due to an electric leakage current flowing through the CCIN pin into the module.

### 3.7.2 Design considerations for SIM card holder

The schematic below is a sample configuration that illustrates the Molex SIM card holder located on the DSB35 Support Box (evaluation kit used for type approval of the Siemens MC35 reference setup, see [6] and Chapter 7 for technical details). X1201 is the designation used for the SIM card holder in Figure 40 on page 87 and in [6].

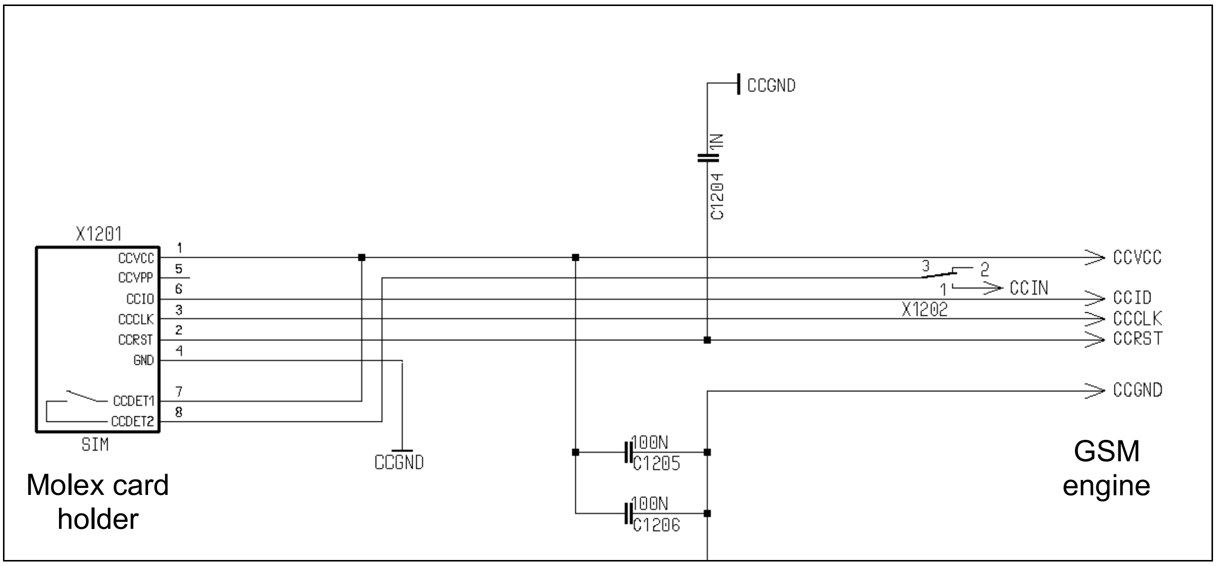



Figure 17: SIM card holder of DSB35 Support Box

Table 15 : Pin assignment of Molex SIM card holder on DSB35 Support Box

| Pin no. | Signal name | I/O | Function |
|---|---|---|---|
| 1 | CCVCC | I | Supply voltage for SIM card, generated by the GSM engine |
| 2 | CCRST | I | Chip card reset, prompted by the GSM engine |
| 3 | CCCLK | I | Chip card clock |
| 4 | CCGND | - | Individual ground line for the SIM card to improve EMC |
| 5 | CCVPP | - | Not connected |
| 6 | CCIO | I/O | Serial data line, bi-directional |
| 7 | CCDET1 | - | Connect to CCVCC |
| 8 | CCDET2 | | Connects to the CCIN input of the GSM engine. Serves to recognize whether a SIM card is in the holder. Removing the SIM card during operation will immediately stop further transmission of signals to the card to protect the card from damage. |

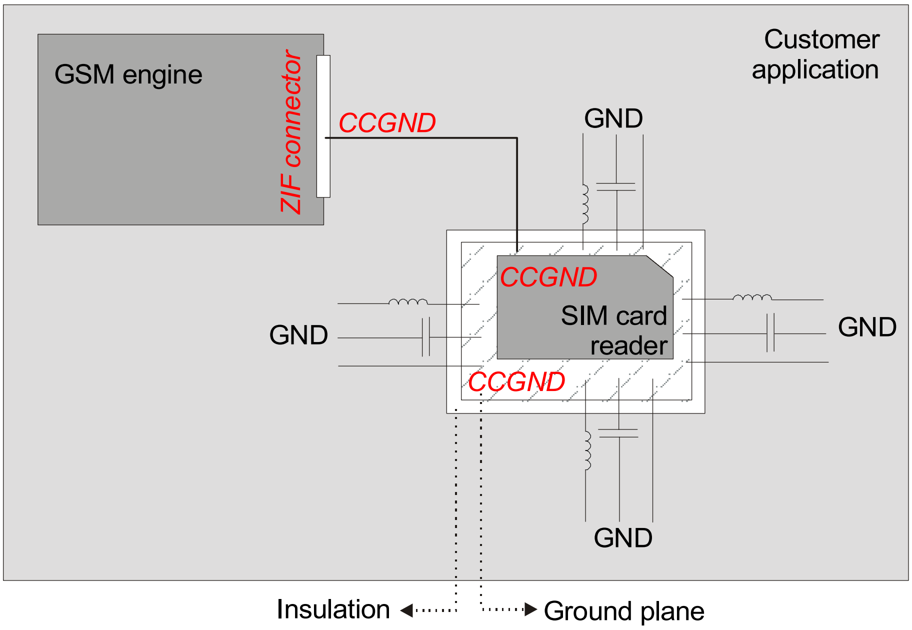
Pins 1 through 6 are the minimum requirement according to the GSM Recommendations, while 7 and 8 are needed for the CCIN pin.
The X1202 switch is not mandatory, but may be added to help the system integrator control the CCIN signal, e.g. for designing and testing purposes. When the switch is pushed open (3 is switched to 2), the line simulates an empty SIM card holder although the SIM is inserted. When closed (3 switched to 1), the line simulates that the SIM card is present.

### 3.7.3 Grounding the SIM interface

To ground the SIM interface you can proceed from several approaches, depending on your individual application design. The following information is just one of several options you can apply:

Potential equalization can best be achieved by applying a separate ground for the SIM interface. For example, the PCB of your application platform may be designed to include an extra ground plane for the SIM card reader, rather than connecting the CCGND pin of the ZIF connector to the central ground on your application platform. For the SIM card ground plane, you can choose a capacitive or inductive coupling or a zero Ohm bridge. Often, a combination of capacitive and inductive coupling will yield best results. It depends on your actual layout where to place these lines. For ease of planning and designing, you can simply place the required footprints at each side of the ground plane and then decide which of them to use when you test your equipment for ESD and EMC protection.

An example can be gathered from the figure below.




Note: This figure is only a simplified diagram to give you an idea where to place the lines.

Figure 18: Connecting a separate ground for SIM interface

## 3.8 Control signals

The following control signals are available (2.65V CMOS level).

### 3.8.1 Inputs

Table 16: Input control signals of the MC35 module

| Signal | Pin | Pin status | Function | Remarks |
|---|---|---|---|---|
| **Ignition** | /IGT | Falling edge | Power up GSM engine | Active low ≥ 100ms (Open drain/collector driver to GND required in cellular device application).<br>Note: If a charger and a battery is connected to the customer application the /IGT signal must be 1s minimum. |
| | | Left open or HiZ | No operation | |
| **Power Down** | /PD | Low | Power down GSM engine | Active low ≥ 3.5s (Open drain/collector driver required in cellular device application). At the /PD signal the watchdog signal of the GSM Engine can be traced (see description in Table 20). |
| | | Left open or HiZ | No operation | |

(HiZ = high impedance)

## 3.8.2 Outputs

### 3.8.2.1 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 two different operating modes which you can select by using the AT^SSYNC command (mode 0 and 1). For details refer to the following chapter and to the "AT Command Set".

To generate the synchronization signal the pin needs to be configured to mode 0 (= default). This setting is recommended if you want your application to use the synchronization signal for better power supply control. Your platform design must be such that the incoming signal accomodates sufficient power supply to the MC35 module if required. This can be achieved by lowering the current drawn from other components installed in your application. The characteristics of the synchronization signal are explained below.

Table 17: MC35 synchronization signal (if SYNC pin is set to mode 0 via AT^SSYNC)

| Function | Pin | Pin status | Description |
|---|---|---|---|
| Synchronization | SYNC | Low | No operation |
| | | High | Indicates increased power consumption during transmission. |

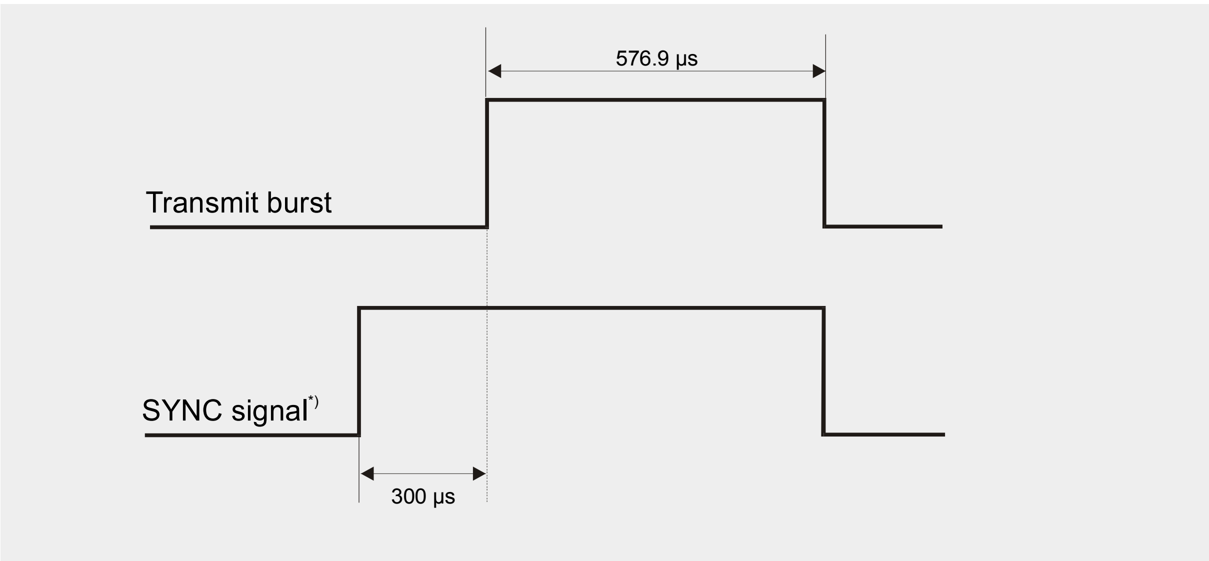



Figure 19: SYNC signal during transmit burst

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

### 3.8.2.2 Using the SYNC pin to control a status LED

As an alternative to generating the synchronization signal, the SYNC pin can be used to control a status LED on your application platform.

To avail of this feature you need to set the SYNC pin to mode 1 by using the AT^SSYNC command. For details see the "AT Command Set".

When controlled from the SYNC pin the LED can display the functions listed in Table 18.

Table 18: Coding of the status LED

| LED mode | Operating status |
|---|---|
| Off | MC35 is off or run in SLEEP, Alarm or Charge-only mode |
| 600 ms On / 600ms Off | No SIM card inserted or no PIN entered, or network search in progress, or ongoing user authentication, or network login in progress. |
| 75 ms On / 3 s Off | Logged to network (monitoring control channels and user interactions). No call in progress. |
| 75 ms on / 75 ms Off / 75 ms On / 3 s Off | One or more GPRS contexts activated. |
| Flashing | Indicates GPRS data transfer: When a GPRS transfer is in progress, the LED goes on within 1 second after data packets were exchanged. Flash duration is approximately 0.5 s. |
| On | Depending on type of call:<br>*Voice call:* Connected to remote party.<br>*Data call:* Connected to remote party or exchange of parameters while setting up or disconnecting a call. |

LED Off = SYNC pin low. LED On = SYNC pin high (if LED is connected as illustrated in Figure 20)

To operate the LED a buffer, e.g. a transistor or gate, must be included in your application. A sample configuration can be gathered from Figure 20. Power consumption in the LED mode is the same as for the synchronization signal mode. For details see Table 20, pin number 32.

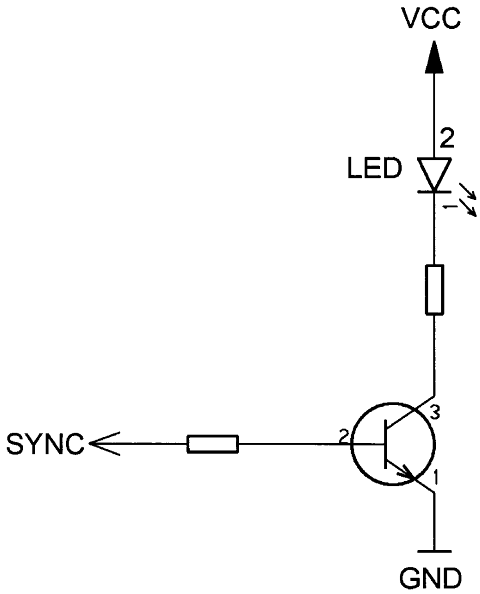



Figure 20: LED Circuit (Example)

### 3.8.2.3 Behaviour of the /RING0 line

The behaviour of the /RING0 line depends on the type of the call received.

- When a *voice call* comes in the /RING0 line goes low for 1s and high for another 4s. Every 5 seconds the ring string is generated and sent over the RXD0 line.
  If there is a call in progress and call waiting is activated for a connected handset or handsfree device, the /RING0 line switches to ground in order to generate acoustic signals that indicate the waiting call.

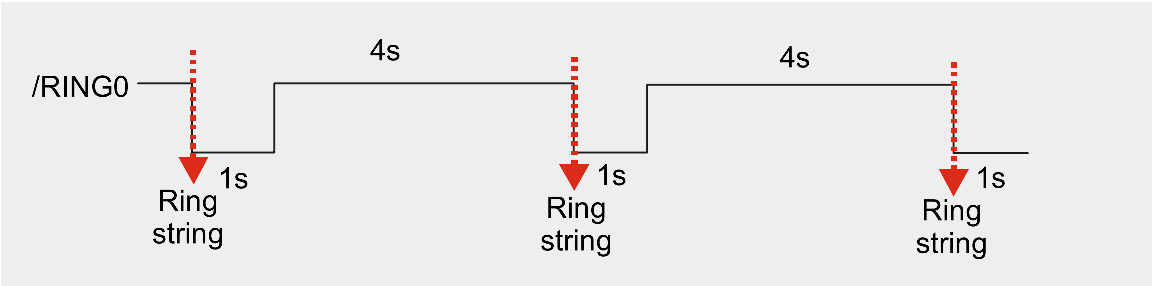



Figure 21: Incoming voice call

- Likewise, when a *Fax* or *data call* is received, /RING0 goes low. However, in contrast to voice calls, the line remains low. Every 5 seconds the ring string is generated and sent over the RXD0 line.

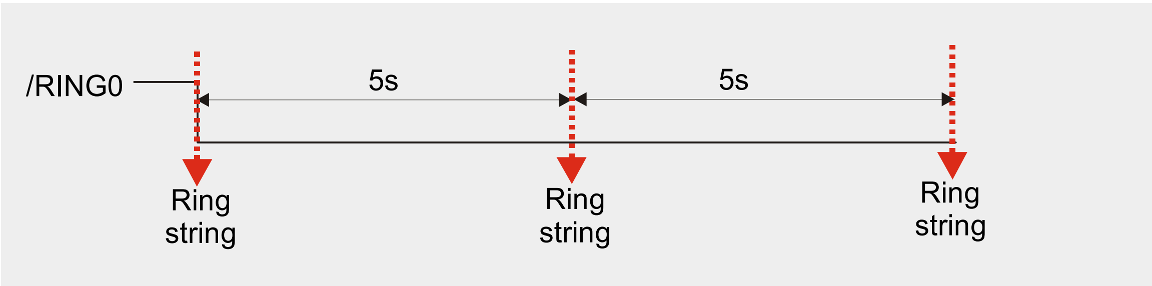



Figure 22: Incoming data call

- All types of unsolicited result codes (URCs) also cause the /RING0 line to go low, however for 1 second only.
  For example, the GSM engine may be configured to output a URC upon the receipt of an SMS. As a result, if this URC type was activated with *AT+CNMI=1,1*, each incoming SMS causes the /RING0 line to go low.
  For more detailed information on URCs please refer the "MC35 AT Command Set".

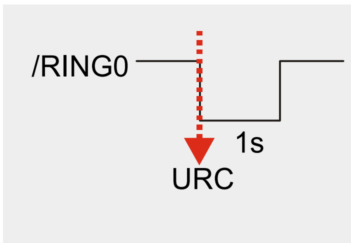



Table 19: MC35 ring signal

| Function | Pin | Status | Description |
|---|---|---|---|
| Ring indication | /RING0 | 0 | Indicates an incoming call or URC. If in SLEEP mode, the cellular device application is caused to wake up. |
| | | 1 | No operation |

## 3.9 Pin assignment

Please note that the reference voltages listed below are the values measured directly on the MC35 module. They do not apply to the accessories connected.

Table 20: Pin assignment

| Function | Signal Name | Pin No. | I/O | Signal Level | Comment |
|---|---|---|---|---|---|
| Power supply | VBATT+ | 1<br>2<br>3<br>4<br>5 | I/O | Input:<br>$V_{in}$ = 3.3V...4.8V<br>$V_{in\ nominal}$ = 4.2V<br>$I_{typ} \leq$ 2 A during uplink transmission timeslot, i.e. for 577µs every 4.616ms (TALK mode)<br>Output: only valid when charging | Usage is mandatory<br>Five power supply pins have to be connected in parallel due to peak current up to 2A<br>Voltage must stay within the min/max values, including voltage drop, ripple, spikes. See also Table 29.<br>There are no fuses connected to these lines. |
| | GND | 6<br>7<br>8<br>9<br>10 | - | Ground (0V) | |
| Charger | POWER | 11<br>12 | I | $V_{in}$ = 5.5V...8V<br>$I_{max}$ = 500mA<br>Internal Pull Down (100kΩ) | If unused keep pins open. If used be sure that both pins are connected in parallel. |
| Supply voltage for external application | VDD | 13 | O | IDLE / TALK mode:<br>$V_{out}$ = 2.9V ±3% @ 70mA, $V_{Batt}$ = 4.2V and $T_{amb\ typ}$ = 25°C<br>$V_{out}$ = 2.9V ±3% @ 20mA, $V_{Batt}$ = 4.8V and $T_{amb\ typ}$ = 25°C<br>$I_{max}$ = 70mA<br>Power Down mode: $V_{out}$ = 0V<br>$C_{load\ max,extern}$ = 1µF | Can be used, for example, to connect a level converter or a pull-up resistor. Not recommended for components operated by pulse current.<br>If unused keep pins open.<br>Voltage is applied 60ms – 100ms after /IGT was driven low. |
| Battery temperature | ACCU_TEMP | 14 | I/O | External NTC: $R_{NTC}$ = 10kΩ @ 25°C ±3% connected to GND<br>IDLE / TALK mode:<br>$V_{out,MEAS}(R_{NTC}$=10kΩ)=1.16V<br>Power Down mode:<br>$V_{out}$ = 0V (internal Pull Down) | If unused keep pin open.<br>If used: external NTC should be installed inside or near battery.<br>The NTC enables the charging algorithm and delivers temperature values. |

| Function | Signal Name | Pin No. | I/O | Signal Level | Comment |
|---|---|---|---|---|---|
| Ignition | /IGT | 15 | I | IDLE / TALK / Power Down mode:<br>$R_{pullup}$ = 200kΩ<br>$V_{low,max}$ = 0.45V @ $I_{out}$ = 10µA<br>$t_{low}$ ≥ 100ms (see Chapter 3.3)<br>Signal: falling edge and hold for $t_{low}$ | Usage is mandatory.<br>Open drain/collector driver is required to pull down this pin to ground in order to turn on MC35.<br>Signal is low active. |
| RS-232 | /DSR0 | 16 | O | IDLE / TALK mode:<br>Output:<br>$R_i$ = 1kΩ (serial resistor)<br>$V_{out,low,max}$ = 0.2V @ I = 0.1mA<br>$V_{out,high,min}$ = 2.25V @ I = -0.1mA<br>$V_{out,high,max}$ = 2.76V<br>Input:<br>$R_i$ ≥ 1MΩ<br>$V_{in,low,min}$ = -0.3V, $V_{i,l,max}$ = 0.5V<br>$V_{in,high,min}$ = 1.95V, $V_{i,h,max}$=3.3V<br>Power Down mode:<br>• Signals are not defined.<br>• Be aware of backward supply effects at the *inputs* and *outputs* | Application interface to control MC35 via AT commands<br>If unused keep output pins open and connect input pins to VDD via 10kΩ.<br>When a voice call comes in /RING0 goes active low for 1s and inactive high for another 4s (alternating). An incoming data call also causes /RING0 to go active low, but without changing to inactive high. See Chapter 3.8.2.3. |
| | /RING0 | 17 | O | | |
| | /RXD0 | 18 | O | | |
| | /CTS0 | 20 | O | | |
| | /RTS0 | 21 | I | | |
| | /DTR0 | 22 | I | | |
| | /DCD0 | 23 | O | | |
| | /TXD0 | 19 | I | $V_{in,low,min}$ = -0.3V, $V_{i,l,max}$ = 0.5V<br>$V_{in,high,min}$ = 2,01V @ additional consumption of 60µA for 350ms<br>$V_{i,h,max}$=3.3V | Please note that the /TXD0 pin draws, for 350ms, an additional current of max. 60µA when the GSM engine is activated. See timing characteristics in Figure 6. |

| Function | Signal Name | Pin No. | I/O | Signal Level | Comment |
|---|---|---|---|---|---|
| SIM | CCIN | 24 | I | IDLE / TALK mode:<br>SIM contact (active high)<br>$R_{PD}$ = 100kΩ (internal Pull Down resistor to GND)<br>$R_i$ = 10kΩ (serial resistor)<br>$V_{in,low,max}$ = 0.4V<br>$V_{in,high,min}$ = 2.15V, $V_{i,h,max}$ = 3.3V<br><br>Power Down mode:<br>Be aware of backward supply | All signals of the SIM interface are protected from electrostatic discharge with spark gaps to GND and clamp diodes to 2.9V and GND<br>If a card is inserted CCIN has to be at high level<br>If not used connect to CCVCC |
| | CCRST | 25 | O | $R_i$ ~ 47 Ω<br>External C = 1nF to CCGND required. This capacitor must be located close to the SIM card reader. | Usage is mandatory<br>Signal levels according to GSM Rec. 11.11<br>FFC must not exceed 200mm to meet the timing requirements of GSM Rec. 11.10 |
| | CCIO | 26 | I/O | Output:<br>$R_i$ ~ 220 Ω (serial resistor)<br>$V_{OLmax}$ = 0.2 V at I = 0.1 mA<br>$V_{OHmin}$ = 2.25 V at I = -0.1 mA<br>$V_{OH}$ = 2.76 V<br><br>Input:<br>$R_i$ ~ 10 kΩ<br>$V_{ILmin}$=-0.3 V, $V_{ILmax}$ = 0.5 V<br>$V_{IHmin}$ = 1.95 V, $V_{Ihmax}$ =3.3 V | |
| | CCCLK | 27 | O | Output:<br>$R_i$ ~ 220 Ω (serial resistor)<br>$V_{OLmax}$ = 0.2 V at I = 0.1 mA<br>$V_{OHmin}$ = 2.25 V at I = -0.1 mA<br>$V_{OH}$ = 2.76 V | |
| | CCVCC | 28 | O | $CCVCC_{min}$ = 2.84V<br>$CCVCC_{max}$ = 2.96V<br>$I_{max}$ = 20mA<br>External C ≥ 200nF to CCGND is required. This capacitor must be located close to the SIM card reader. | Usage is mandatory |
| | CCGND | 29 | O | Ground (0V) | Usage is mandatory. See application note SIM Interface for details on grounding. |

| Function | Signal Name | Pin No. | I/O | Signal Level | Comment |
|---|---|---|---|---|---|
| RTC backup | VDDLP | 30 | I/O<br>I | IDLE / TALK / DATA / Power Down mode if VBATT+ connected:<br>$V_{out} < V_{BATT+}$<br>$R_i$ = 1kΩ (serial resistor)<br><br>PD mode if VBATT+ disconnected:<br>$V_{in}$ = 2.0V...5.5V<br>$I_{in,max}$ = 30µA | If unused keep pin open (see chapter 3.4) |
| Power down<br><br>(only for emer-gency) | /PD | 31 | I/O | IDLE / TALK / DATA mode input:<br>$V_{in,low,max}$ = 0.45V @ I = 0.1mA<br>input signal ˜˜˜\|______\|˜˜˜ active low ≥ 3.5s<br><br>Watchdog output:<br>$V_{out,low}$ = 0.35V @ 0.01mA<br>$V_{out,high}$ = 2.30V @ -0.01mA<br>$f_{out,\ min\ =}$ = 0.16 Hz<br>$f_{out,\ max\ =}$ = 1.53 Hz | If unused keep pin open<br>Open drain/collector driver to GND required.<br>/PD switches MC35 off. A low pulse at pin /IGT resets MC35 and restarts the system.<br>The /PD pin also indicates the internal watchdog function. |
| Synchroni-zation | SYNC | 32 | O | IDLE / TALK / DATA mode:<br>$R_i$ = 1kΩ (serial resistor)<br>$V_{out,low,max}$ = 0.2V @ 0.1mA<br>$V_{out,high,min}$ = 2.25V @ -0.1mA<br>$V_{out,high,max}$ = 2.76V<br><br>Power Down mode:<br>be aware of backward supply | If unused keep pin open<br>Indication of in-creased current con-sumption during uplink transmission burst. Alternatively used to control status LED. |

| Function | Signal Name | Pin No. | I/O | Signal Level | Comment |
|---|---|---|---|---|---|
| Audio Interface | EPP2 | 33 | O | $R_i$ = 15Ω, (30kΩ if not active)<br>$V_{omax}$ = 3.7$V_{pp}$, no load,<br>@ 3.14 dBm0:<br>f = 1024Hz,<br>audio mode = 6,<br>outBbcGain = 0,<br>outCalibrate = 16384 | If unused keep pins open<br>Differential output, e.g. for a loudspeaker amplifier used in a handsfree kit |
| | EPN2 | 34 | O | | |
| | EPP1 | 35 | O | $R_i$ = 15Ω, (30kΩ if not active)<br>$V_{omax}$ = 3.7$V_{pp}$, no load,<br>@ 3.14 dBm0:<br>f = 1024Hz,<br>audio mode = 5,<br>outBbcGain = 0,<br>outCalibrate = 16384 | If unused keep pins open<br>Differential output, e.g. for earpiece |
| | EPN1 | 36 | O | | |
| | MICP1 | 37 | I | $Z_i$ = 2kΩ<br>$V_{imax}$ = 1.03$V_{pp}$<br>$V_{supply}$ = 2.65V ( 0V if off ), $R_{DC}$ = 4kΩ | Keep unused interface open<br>Balanced input with switchable microphone supply source, e.g. for microphone |
| | MICN1 | 38 | I | | |
| | MICP2 | 39 | I | $Z_i$ = 2kΩ<br>$V_{imax}$ = 1.03$V_{pp}$<br>$V_{supply}$ = 2.65V ( 0V if off ), $R_{DC}$ = 4kΩ | Keep unused interface open<br>Balanced input with switchable microphone supply source, e.g. for a microphone used in a handsfree kit |
| | MICN2 | 40 | I | | |

Explanation of signal names:
P = positive
N = negative

*Note: If an input pin is specified for $V_{i,h,max}$ = 3.3V, be sure never to exceed the stated voltage. The value 3.3V is an absolute maximum rating.*

# 4 Radio interface

In transmit mode, the radio frequency part converts the I/Q baseband signals supplied by the baseband into a RF signal with characteristics as described by the GSM recommendation and which are then radiated by the antenna. In case of the receiving mode the radio part converts the RF signals supplied by the antenna into I/Q baseband signals which can then be further processed by the baseband.

The radio part is designed for dual band operation and can therefore serve the frequency bands GSM900 (including EGSM) and GSM1800. The following definitions have been made:

- The radio part can never transmit in both bands simultaneously.
- The radio part can never receive in both bands simultaneously.
- The monitor time slot can be selected independently of the frequency band.
- The transmitter and receiver never operate simultaneously.

## 4.1 Antenna interface (antenna reference point – ARP)

In order to connect the antenna MC35 uses a GSC connector. The interface is specified for an impedance of 50Ω with a VSWR ≤ 1.3. MC35 is capable of withstanding a total mismatch at the antenna connector when transmitting at maximum RF power.

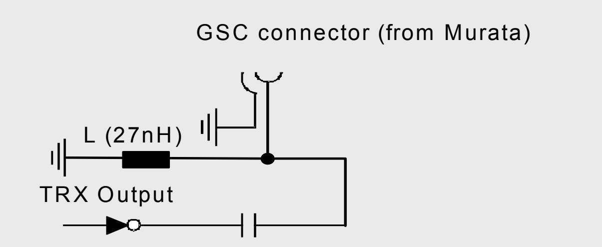



Figure 23: GSC connector circuit

To help you choose an appropriate antenna, Chapters 5.6 and 11 provide technical specifications and ordering information.

Table 21: Return loss

| State of module | Return loss of module | Recommended return loss of application |
|---|---|---|
| Receive | 8dB min | higher than 12dB min |
| Transmit | not applicable | higher than 12dB min |
| Idle | 5dB max | not applicable |

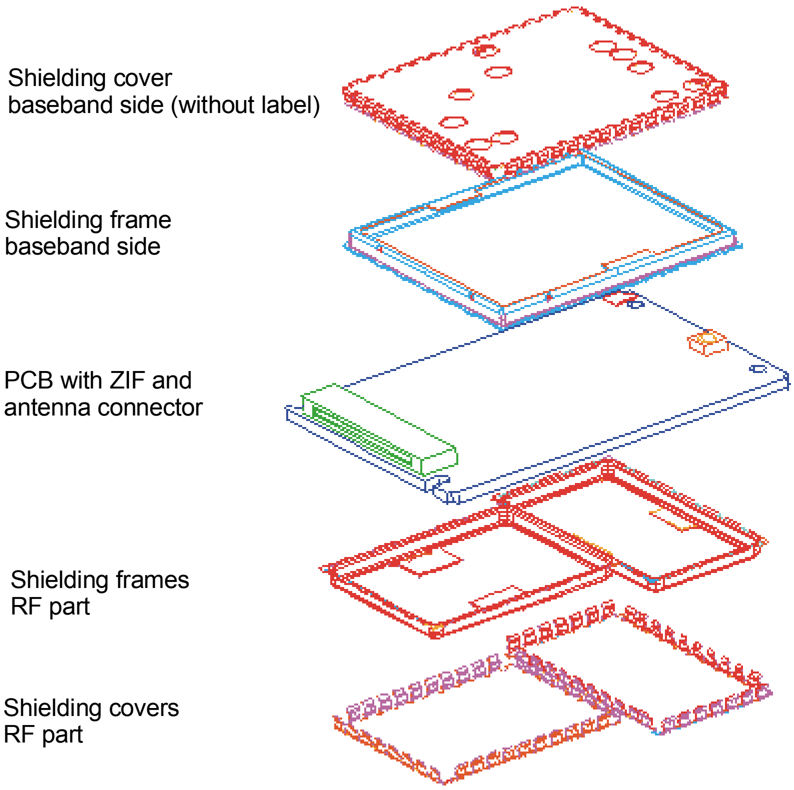
Table 22: Signals of GSC RF jack

| Signal name | Pin | I/O | Description | Parameter |
|---|---|---|---|---|
| RF | Internal | I/O | RF input and output | Z = 50 Ω |
| GND | External | X | Ground connection | |

# 5 Physical characteristics

## 5.1 Exploded diagram

Figure 24 shows an exploded assembly drawing of the MC35 module. Figure 25 presents a top and bottom view of the PCB with the shielding covers removed.



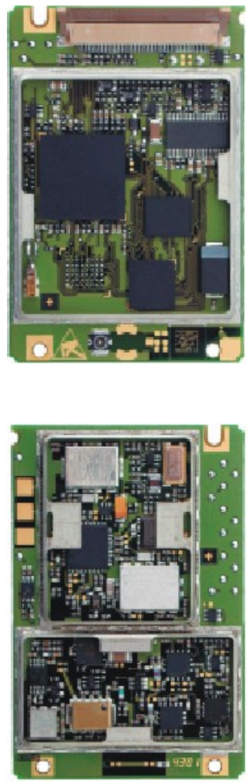



Figure 24: Exploded diagram of MC35

Figure 25: PCB of MC35 (top - baseband side, bottom - RF side)

## 5.2 Mechanical dimensions of MC35

Figure 26 shows the RF part of MC35 and provides an overview of the mechanical dimensions of the board. For further details see Figure 27.

Size: 54.5±0.2 x 36±0.2 x 6.65±0.35 mm
Weight: 16g

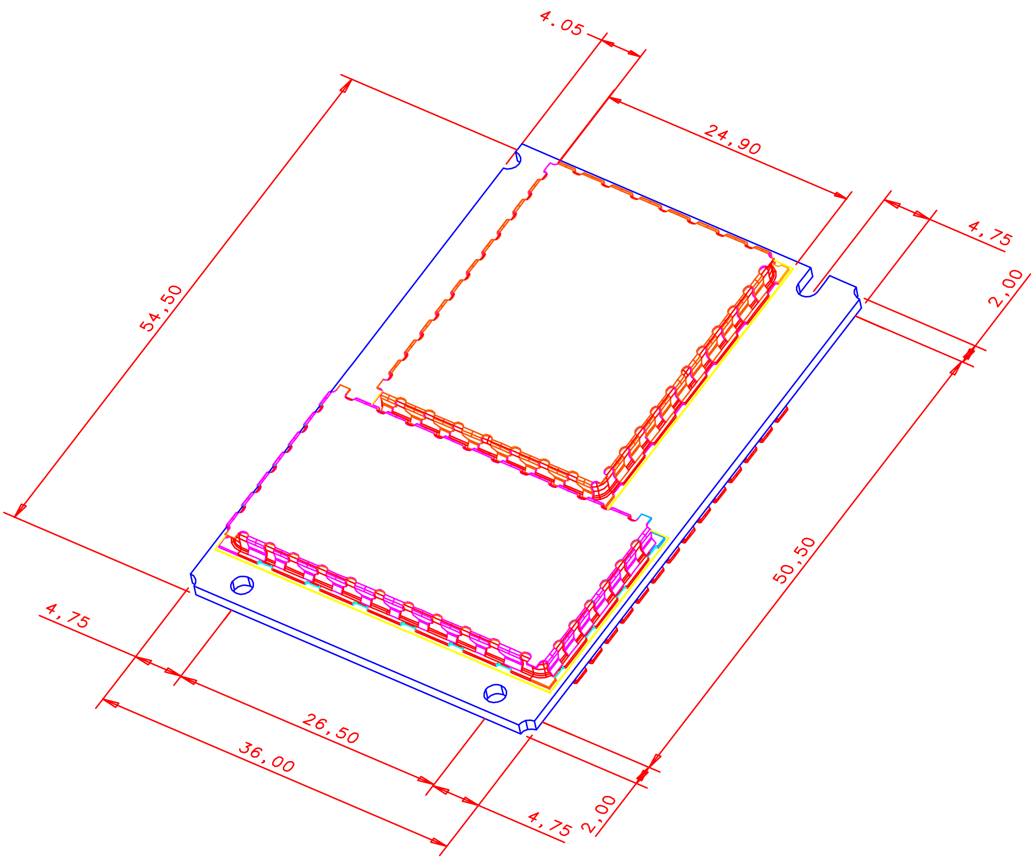
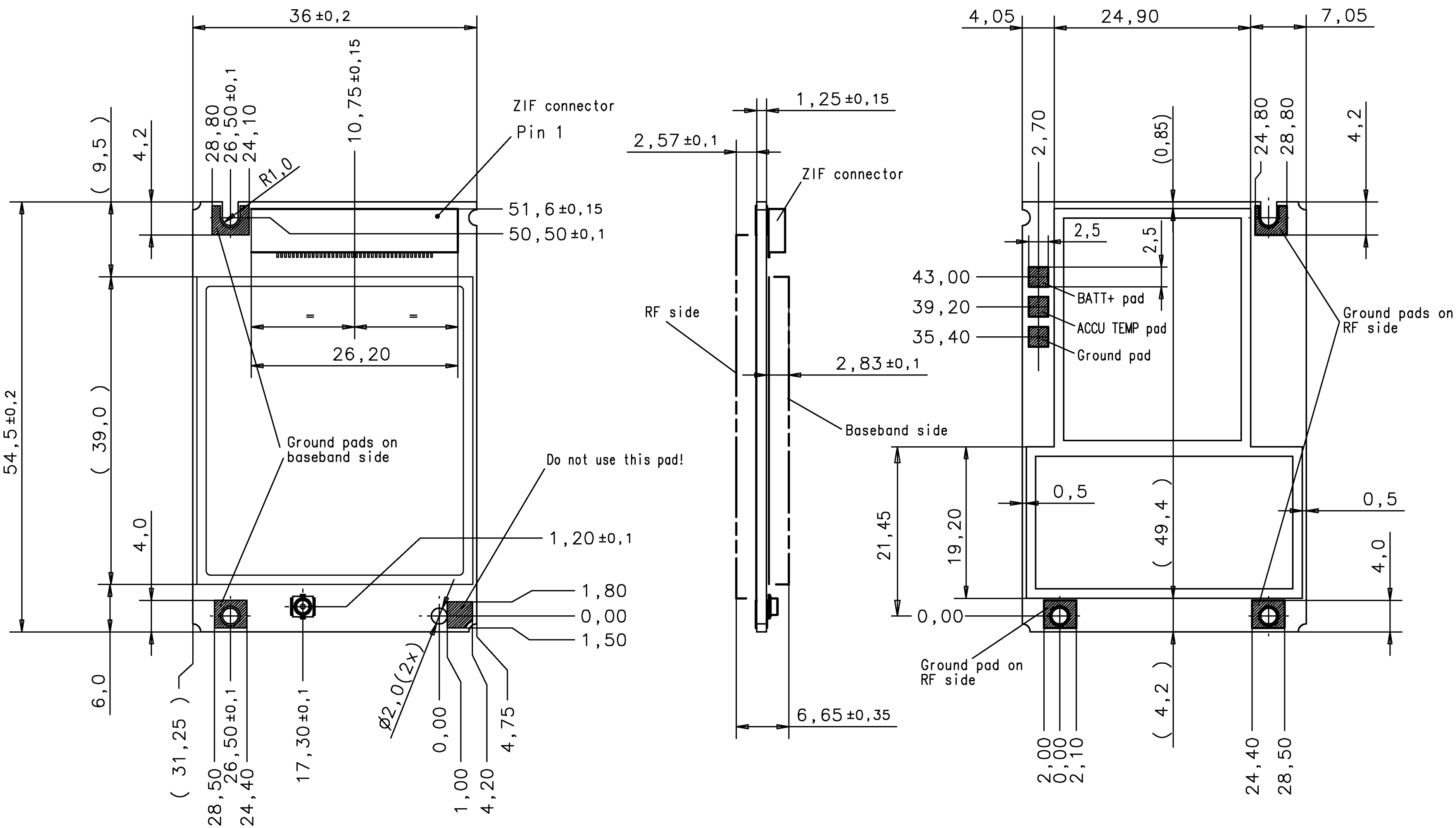



Figure 26: MC35 – view of RF side




0,00 = Reference point

All dimensions in millimeter

Figure 27: Mechanical dimensions of MC35

## 5.3 Mounting MC35 onto the application platform

For the cellular application to operate reliably it is essential that the MC35 module is securely attached to the host housing.

The MC35 board provides three mounting holes. To properly mount it to the host device you can use M1.6 or M1.8 screws plus suitable washers. The maximum diameter of the screw head incl. the washer must not exceed 4 mm.

Avoid placing the MC35 board tightly to the host device. Instead, it is recommended to set spacers between the MC35 module and the host device. If your design approach does not allow for spacers make sure the host device provides an opening for the RF part.

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

Avoid exerting any pressure on the shielding covers. Contact springs or other components must not be fastened to the covers. In extreme conditions, you run the risk of short-circuit if the cover was damaged or distorted due to pressure. Furthermore, the covers must not be used to apply any solder joints.

For ease of migration from TC35 or TC37 GSM engines, MC35 features the same dimensions. The ZIF connector, the RF connector and the mounting holes are located at the same coordinates.

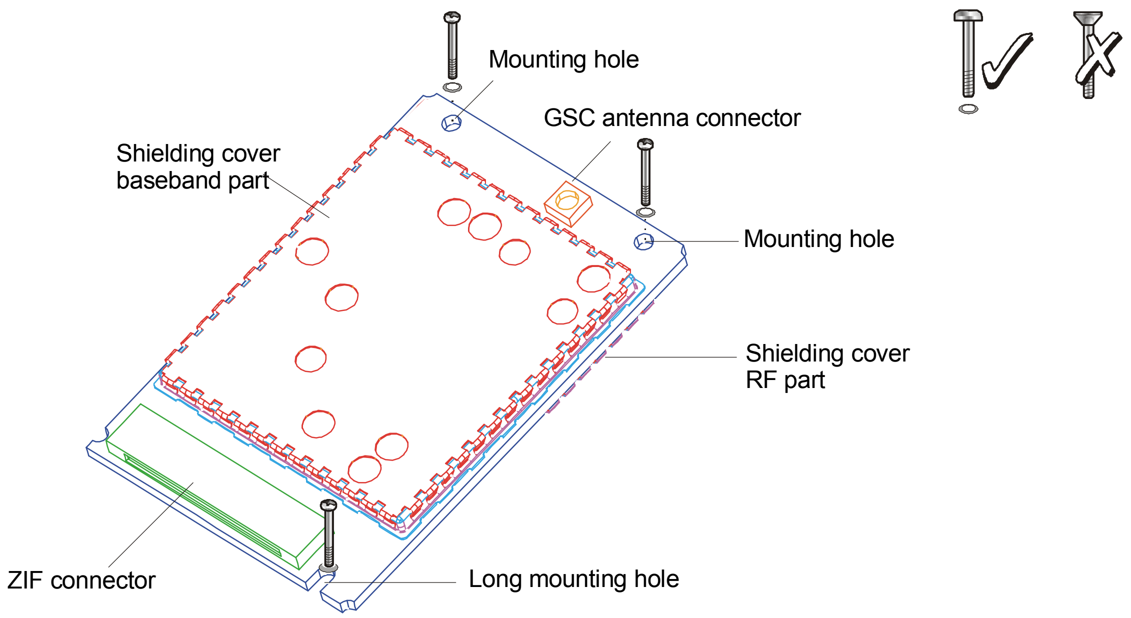



Figure 28: Mounting MC35 – view on baseband side

## 5.4 Power pads

As described in Chapter 3.2.3, MC35 can be powered across the ZIF connector and, in addition, from three contact pads. The power contact pads are placed on the RF part of the MC35 PCB. The position and the dimensions can be gathered from Figure 27.

The power pads are nickel gold plated (Ni Au). To ensure long life and a high level of reliability follow these precautions:

- Use gold contact springs only.
- To prevent damage from the pad soldering must be strictly avoided.
- Keep the contact surface clean.

## 5.5 ZIF connector

This chapter provides specifications and handling instructions for the 40-pin ZIF connector and the Flat Flexible Cable (FFC) used to connect the GSM engine to the host application.

The ZIF (zero insertion force) design allows to easily fasten or remove the cable without the need for special tools. Simply insert the FFC cable into the open socket without using any pressure. Then carefully close the socket lid until the contacts of the socket grip the cable contacts.

Table 23: Electrical and mechanical characteristics of the ZIF connector

| Parameter | Specification (40 pin ZIF connector) |
|---|---|
| Number of Contacts | 40 |
| Quantity delivered | 2000 connectors per tape & reel |
| Voltage | 50V |
| Current Rating | 0.4A max per contact |
| Resistance | 0.05 Ohm per contact |
| Dielectric Withstanding Voltage | 200V RMS min |
| Operating Temperature | -40°C...+85°C |
| Contact Material | Phosphor bronze (tin-lead plated) |
| Insulator Material | PPS, natural color |
| Slider Material | PPS, natural color |
| FFC/FPC Thickness | 0.3mm ±0.05mm (0.012" ±0.002") |
| Profile Height | 2.00mm |
| Dimension A | 24 |
| Dimension B | 19.5 |
| Dimension C | 26.2 |
| Maximum connection cycles | 50 |
| Cable | FFC (Flat Flexible Cable), max. length 200mm from SIM interface |

### 5.5.1 Mechanical dimensions of the ZIF connector

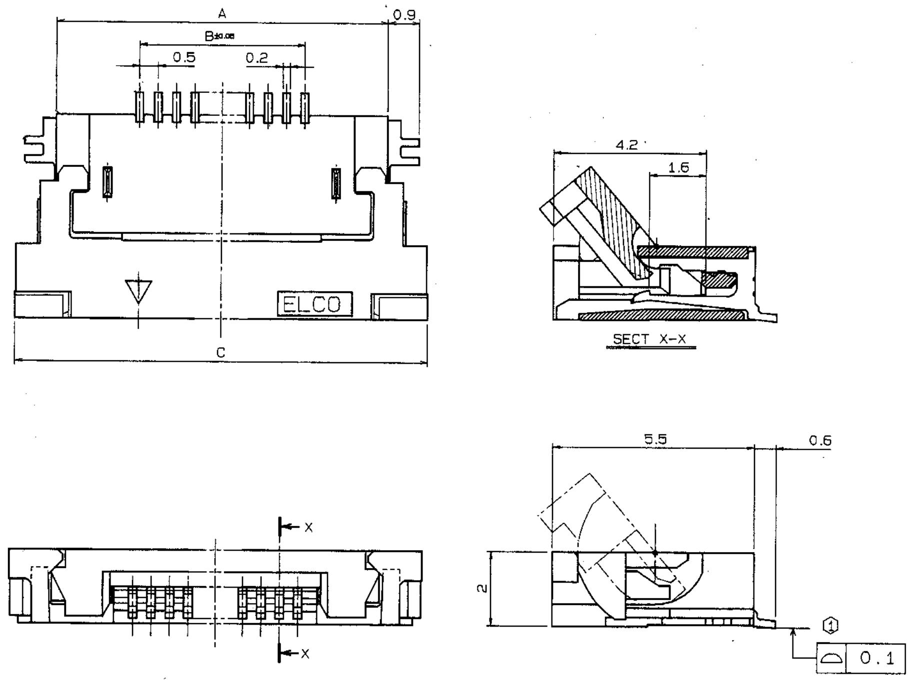



Figure 29: Mechanical dimensions of ZIF connector

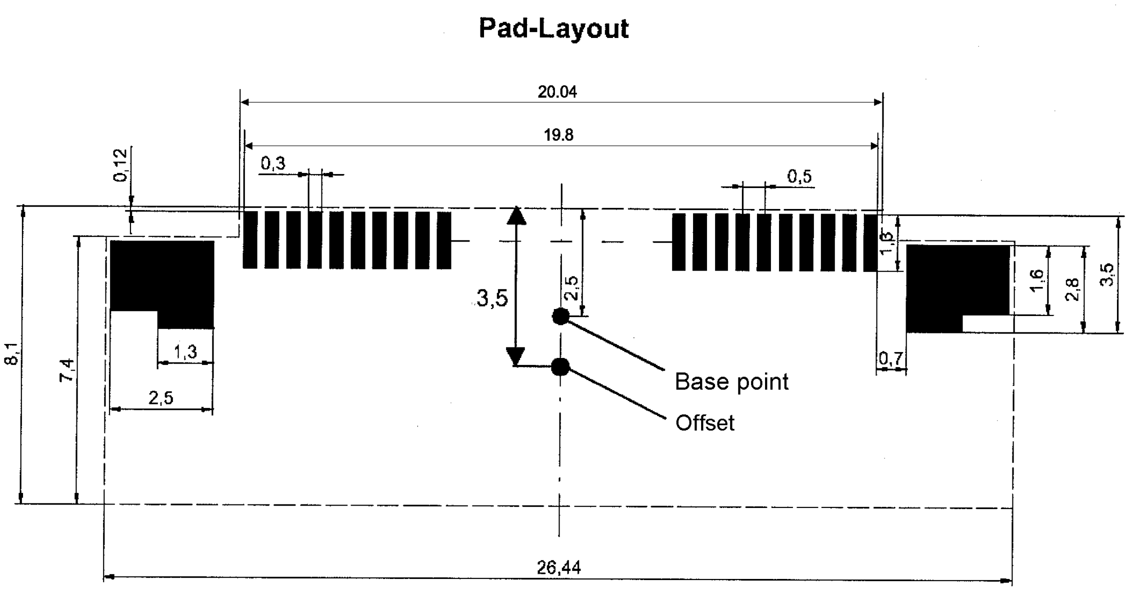



Figure 30: PCB ZIF connector

## 5.6 GSC antenna connector

MC35 uses a GSC antenna connector. Below please find brief ordering information to help you retrieve further details from the manufacturer MuRata, e.g. under http://www.murata.com.

| Description | MuRata part number |
|---|---|
| Male connector mounted on MC35 | MM9329-2700 |
| Matching female connectors suited for individual cable assembly<br>• Right-angle flexible cable<br>• Right-angle flexible cable<br>• Right-angle semirigid cable | <br>MXTK88xxxx<br>MXTK92xxxx<br>MXTK91xxxx |
| Engagement/disengagement tool type P/N M22001 | Please use product name for your order: P/N M22001 |

The physical dimensions and maximum mechanical stress limits can be gathered from the table and the figures below. To securely fasten or remove the antenna cable MuRata recommends to use the P/N M22001 engagement/disengagement tool.

Table 24: Ratings and characteristics of the GSC antenna connector

| Item | Specification | |
|---|---|---|
| Frequency range | DC to 6GHz | |
| VSWR | 1.2 max. (DC to 3 GHz), 1.3 max. (3GHz to 6GHz) | |
| Nominal impedance | 50Ω | |
| Temperature range | -40°C to +90°C | |
| Contact resistance | 15mΩ max. | |
| Insulation resistance | 500MΩ min. | |
| Material and finish | Material: | Finish: |
| • Center contact: | Copper alloy | Gold plated |
| • Outer contact: | Copper alloy | Silver plated |
| • Insulator: | Engineering plastic | None |

*Note: Be sure that all peripherals are applied according to the manufacturer's antenna specifications. For internal antenna equipment you are advised to use the services of a consultant or full-service house.*

*A 27nH inductor to ground provides additional ESD protection for the antenna connector. To protect the inductor from damage no DC voltage must be applied to the antenna circuit.*

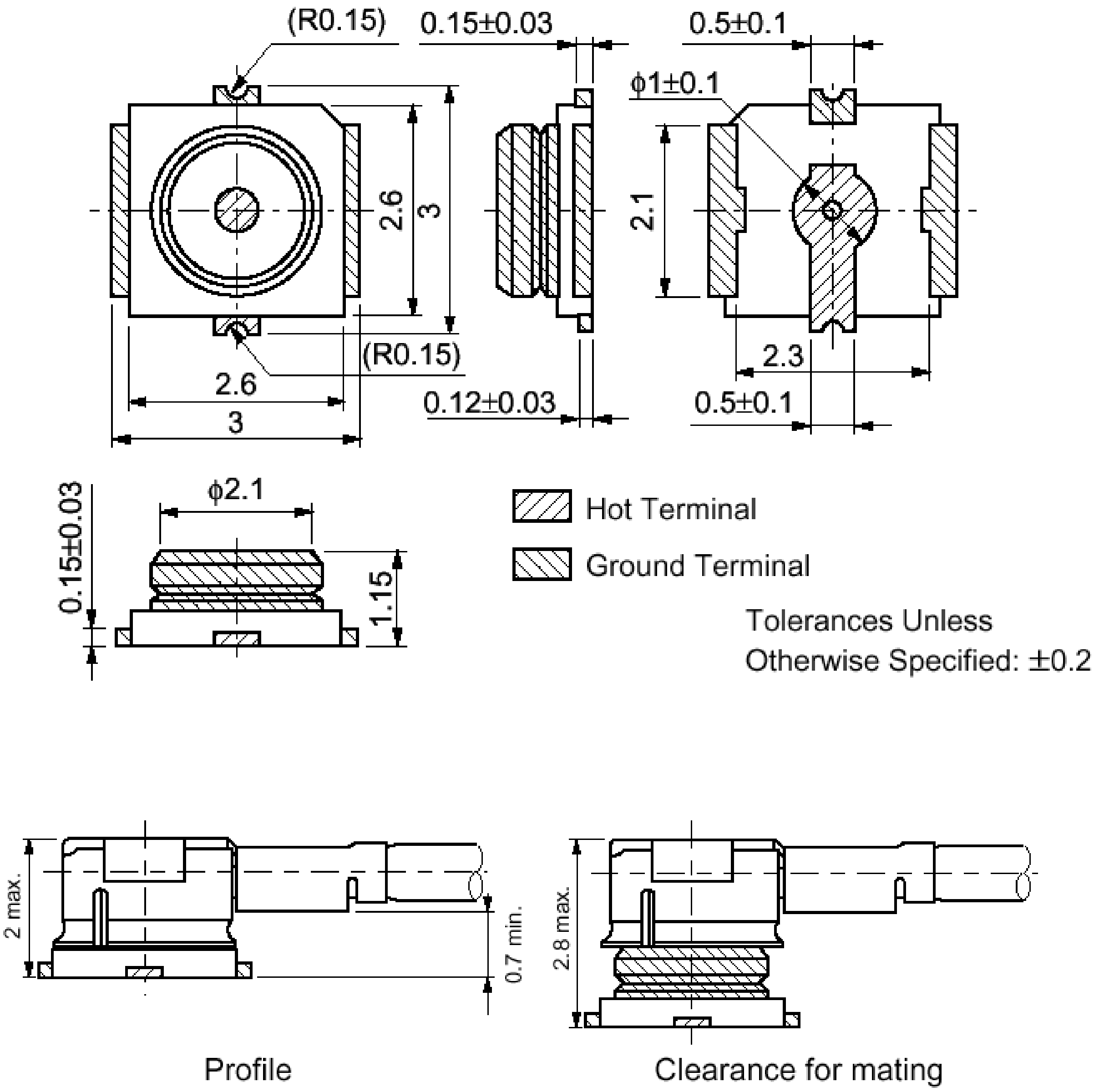



Figure 31: Mechanical dimensions of MuRata GSC connector (in mm)

Table 25: Stress characteristics of the GSC antenna connector

| Parameter | Specification |
|---|---|
| Connector durability | 100 cycles of mating and withdrawal with a jig at 12 cycles/minute maximum |
| Engage force | 30N max |
| Disengage force | 3N min, 30N max |
| Angle of engagement | 15 degree max |
| Mechanical stress to connector<br>• Stress to the housing:<br>• Stress to outer sleeve:<br>• Cable pull strength: | See Figure 32 for details<br>A and B: 4.9N max.<br>C: 2.94N max and D: 1.96N max<br>E: 4.9N max |

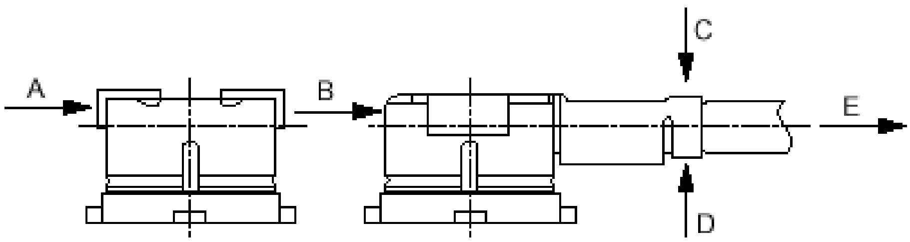



Figure 32: Maximum mechanical stress to the connector

The following figure illustrates the engagement/disengagement tool type P/N M22001 recommended by MuRata and provides instructions for proper use.

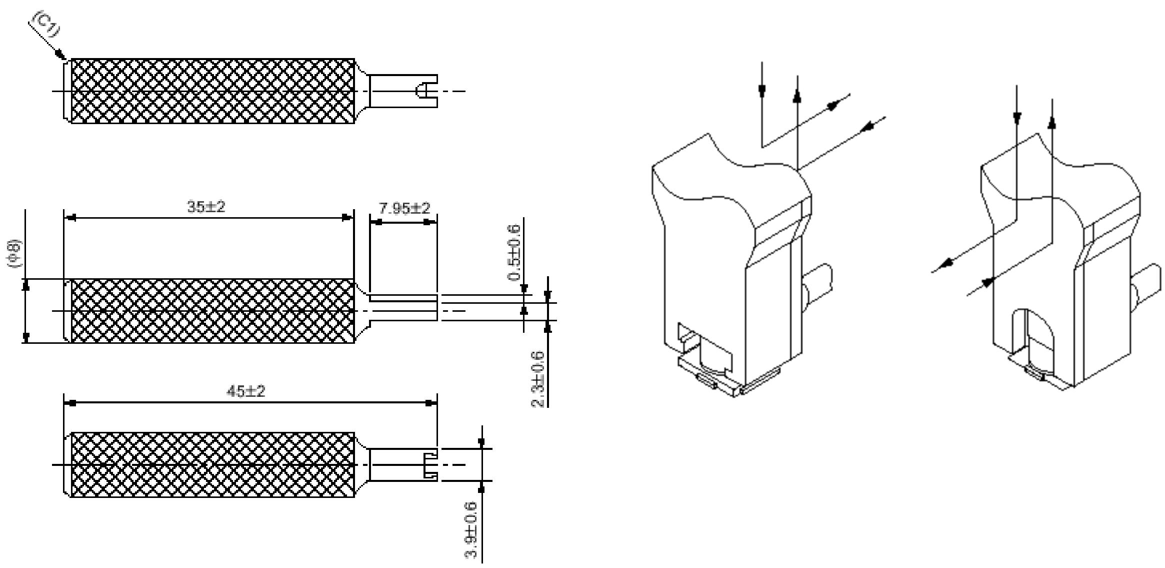



Figure 33: How to use MuRata tool

### 5.6.1 Using antenna cable from other manufacturers

For your product to meet individual design or technical requirements, you may decide to choose antenna equipment from suppliers other than MuRata.

When selecting a suitable antenna your considerations should also include the requirements of electromechanical valence. To achieve best performance it is essential to minimize the valence potential delta levels of dissimilar metal mating surfaces. Therefore the material of the antenna cable plug must be compatible with the material of the GSC receptacle on the GSM engine, i.e. it should belong to the same group in the electromechanical series. The material of the GSC connector on MC35 is specified in Table 24.

# 6 Electrical, temperature and radio characteristics

## 6.1 Absolute maximum ratings

Absolute maximum ratings for supply voltage and voltages on digital and analog pins of GSM Engine MC35 are listed in Table 26. Exceeding these values will cause permanent damage to the GSM Engine MC35.
The power supply shall be compliant with the SELV safety standard defined in EN60950. The supply current must be limited according to Table 26.

Table 26: Absolute maximum ratings

| Parameter | Min | Max | Unit |
|---|---|---|---|
| Peak current of power supply | 0 | 4.0 | A |
| RMS current of power supply (during one TDMA-frame) | 0 | 0.7 | A |
| Voltage on digital pins (IDLE, TALK or DATA mode) | -0.3 | 3.3 | V |
| Voltage on analog pins (IDLE, TALK or DATA mode) | -0.3 | 3.0 | V |
| Voltage on digital / analog pins in Power Down mode | -0.25 | +0.25 | V |

## 6.2 Operating conditions

Table 27: Operating conditions

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| Ambient temperature | -20 | 25 | 55 | °C |
| Supply voltage $V_{BATT+}$ | 3.3 | 4.2 | 4.8 | V |

## 6.3 Temperature conditions

Test conditions were specified in accordance with IEC 60068-2 (still air).

Table 28: Temperature conditions

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| Ambient temperature (according to GSM 11.10) | -25 | 25 | 55 | °C |
| Restricted operation *) | -29 to -25 | | 55 to 70 | °C |
| Automatic shutdown: if application is not battery powered<br>if application is battery powered | -29<br>-18 | | $\geq$70 **)<br>$\geq$60 **) | °C<br>°C |
| Storage temperature | -40 | | +85 | °C |
| Charging temperature (software controlled fast charging) | 0 | | +45 | °C |

*) MC35 works, but deviations from the GSM specification may occur.
**) Limited performance if $V_{BATT+\ max} \leq 4.0V$ and PCL5 is required at $T_{amb\ max}$ = 70°C

## 6.4 Power supply ratings

Table 29: Power supply ratings

| Parameter | Description | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{BATT+}$ | Supply voltage | Reference point on VBATT+ contact pad<br>Voltage must stay within the min/max values, including voltage drop, ripple, spikes. | | 3.3 | 4.2 | 4.8 | V |
| | Voltage drop during transmit burst | Normal condition, power control level for $P_{out\,max}$ | | | | 400 | mV |
| | Voltage ripple | Normal condition, power control level for $P_{out\,max}$ | | | | | mV |
| | | @ f<200kHz | | | | 50 | |
| | | @ f>200kHz | | | | 2 | |
| $I_{BATT+}$ | Average supply current[3] | Power Down mode | | | 50 | 100 | µA |
| | | SLEEP mode | @ DRX = 6 | | 3 | | mA |
| | | IDLE mode | EGSM 900 | | 15 | | mA |
| | | | GSM 1800 | | 15 | | |
| | | TALK mode | EGSM 900[1] | | 300 | 400 | mA |
| | | | GSM 1800[2] | | 270 | | |
| | | IDLE mode GPRS | EGSM 900 | | 15 | | mA |
| | | | GSM 1800 | | 15 | | |
| | | DATA mode GPRS, multi-slot class 8 | EGSM 900[1] | | 360 | 460 | mA |
| | | | GSM 1800[2] | | 330 | | |
| | Peak supply current (during 577µs transmission slot every 4.6ms) | Power level [1] | | | 2 | | A |
| $I_{CHARGE}$ | Charging current | Li-Ion battery pack | | | | 500 | mA |
| | Trickle charging | $U_{battery}$ 0...3.6V | | | | 9.0 | mA |

1) Power control level PCL 5

2) Power control level PCL 0

3) All average supply current values @ $I_{VDD}$ = 0mA

### 6.4.1 Drop definition

During the transmission burst the supply voltage of MC35 can drop considerably, depending on the internal resistance of the external power supply. As specified, the supply voltage $V_{BATT+}$ must not fall below 3.3 V at any time, thus requiring an appropriate higher open-circuit voltage at MC35.

The drop of the supply voltage, generated by the serial resistance of the supply voltage connection, is not negligible. Peak currents of I = 2 A during the GSM transmission burst cause a supply voltage drop.

If your application incorporates a battery pack it is recommended to use the ZIF connector and the power contact pads in parallel. By connecting the battery power lines to the contact pads you can reduce the total voltage drop caused across the ZIF-FFC-ZIF connection during transmit bursts. Note that the minimum supply voltage measured at the VBATT+ contact pad during TX bursts must not fall below 3.3 V, while the voltage drop must not exceed 400 mV. The power pads are located on the RF part of the PCB. See Chapters 3.2.1 and 5.4 for further details.

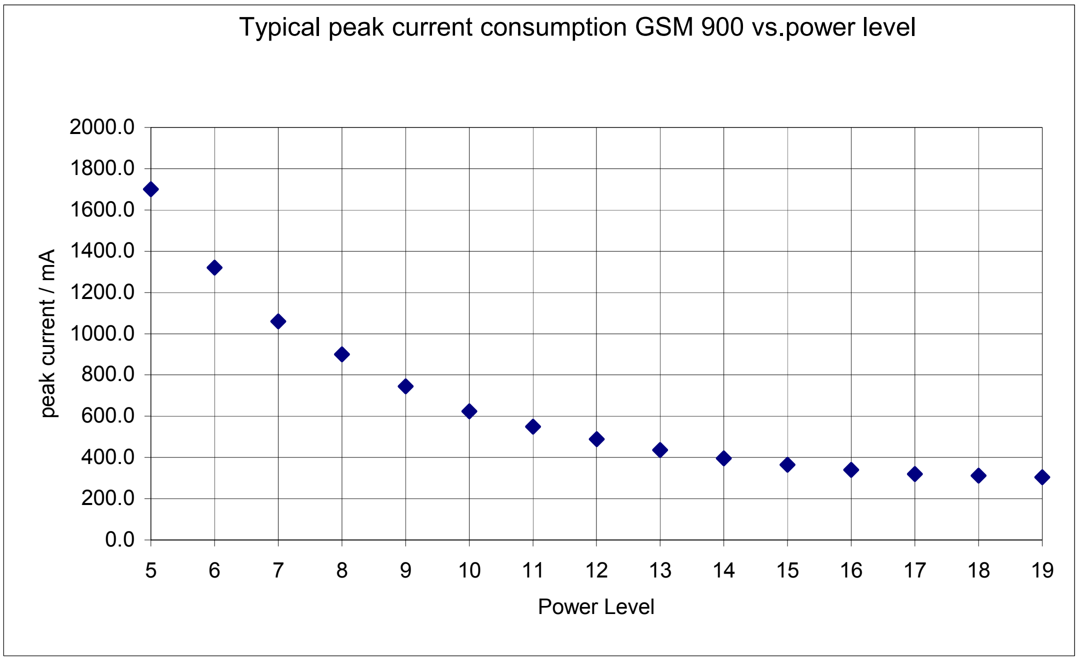
*Note: In order to reduce voltage drops during transmission choose cables (FFC) as short as possible and apply a low impedance power supply. The use of the ground pads further minimizes power losses.*

## 6.4.2 Current consumption during transmit burst

The diagrams provided in Figure 34 through Figure 37 illustrate the peak current consumption of the application caused during a transmit burst. The peak current is shown vs. the power level for GSM900/1800 and vs. the return loss of the antenna.

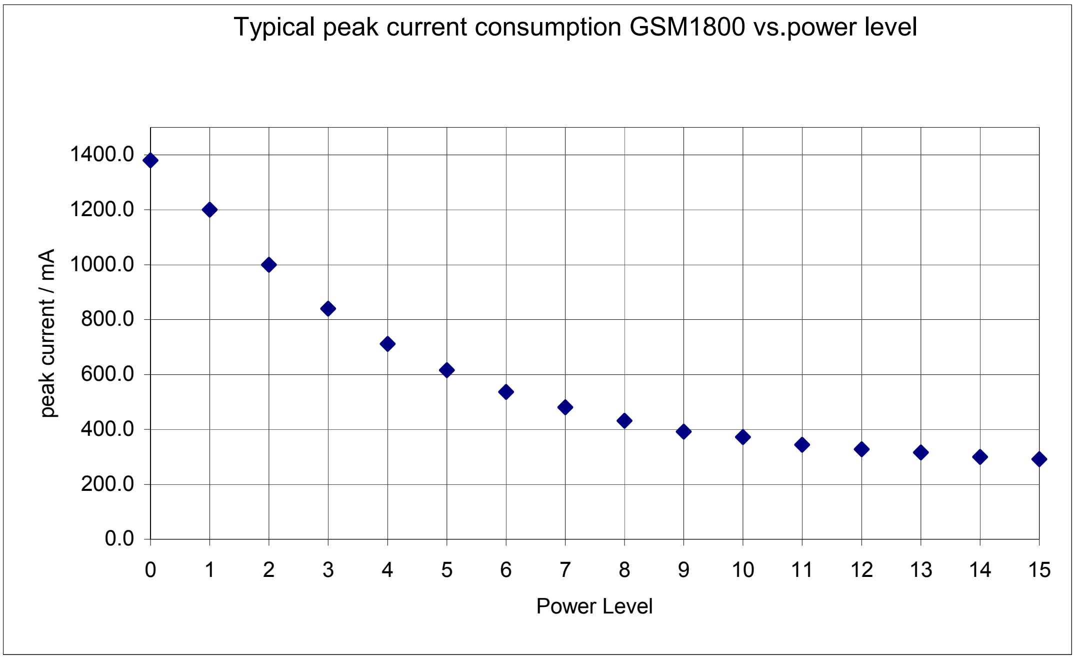
All measurements have been performed at 25°C and 4.2V (reference points used on MC35: power pads on the RF side). Changing the conditions, e.g. in terms of temperature or voltage, will cause different results. The current will be maximized when the maximum supply voltage is used together with a total reflection at the RF interface.

Using a supply voltage higher than 4.3V at PCL5 GSM 900 lets the peak current rise by about 150mA, due to higher RF output power.



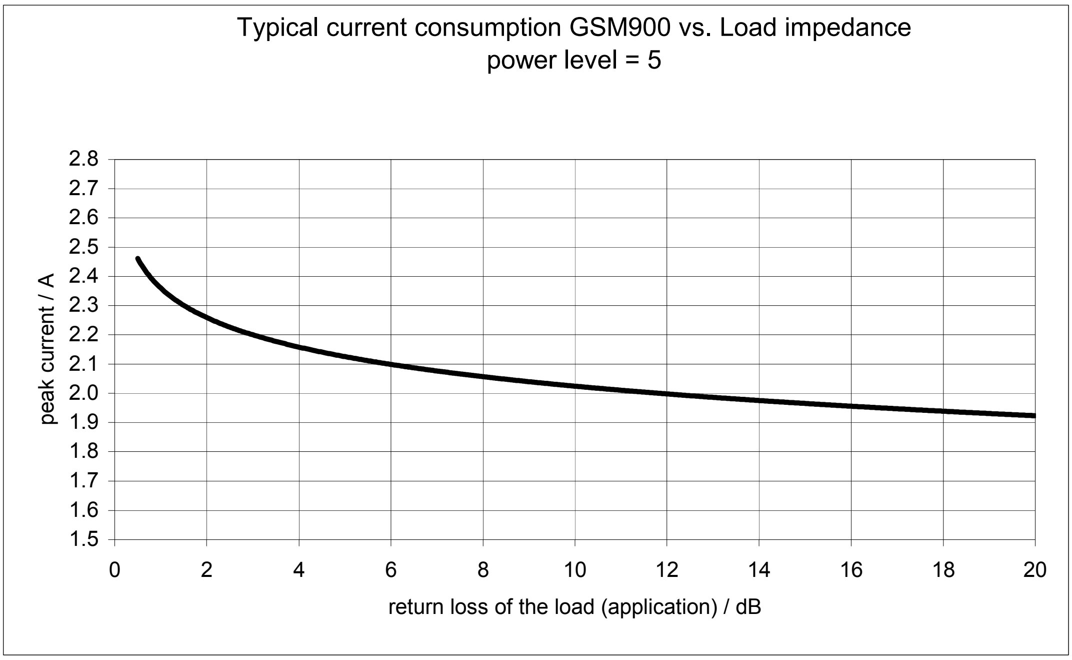

Conditions: $V_{BATT+}$ = 4.2V; $T_{amb}$ = 25°C ; ARFCN 40

Figure 34: Typical current vs. power level EGSM 900



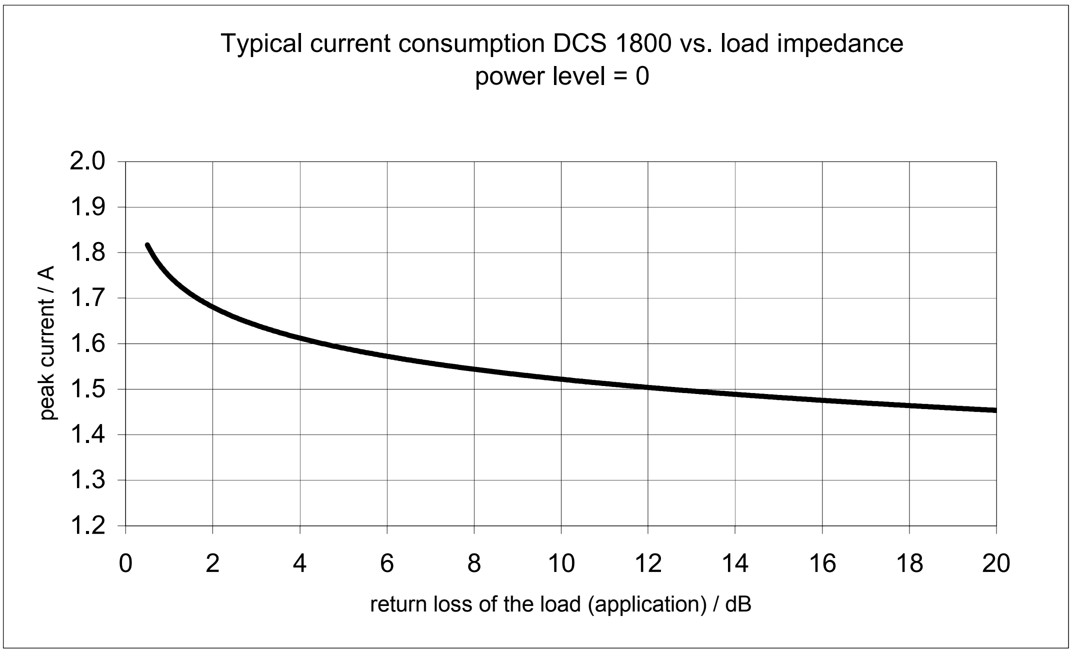

Conditions: $V_{BATT+}$= 4.2V; $T_{amb}$ = 25°C ; ARFCN = 700

Figure 35: Typical current vs. power level GSM 1800




Conditions: $V_{BATT+}$ = 4.2V; $T_{amb}$ = 25°C ; ARFCN = 975

Figure 36: Peak current vs. return loss EGSM 900




Conditions: $V_{BATT+}$ = 4.3V; $T_{amb}$ = 25°C ; ARFCN = 512

Figure 37: Peak current vs. return loss GSM 1800

# 6.5 Electrical characteristics of the voiceband part

## 6.5.1 Setting audio parameters by AT commands

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

Table 30: Audio parameters adjustable by AT command

| Parameter | Influence to | Range | Gain range | Calculation |
|---|---|---|---|---|
| inBbcGain | MICP/MICN analogue amplifier gain of baseband controller before ADC | 0...7 | 0...42dB | 6dB steps |
| inCalibrate | digital attenuation of input signal after ADC | 0...32767 | -∞...0dB | 20 * log (inCalibrate/ 32768) |
| outBbcGain | EPP/EPN analogue output gain of baseband controller after DAC | 0...3 | 0...-18dB | 6dB steps |
| outCalibrate[n] n = 0...4 | digital attenuation of output signal after speech decoder, before summation of sidetone and DAC<br><br>present for each volume step[n] | 0...32767 | -∞...+6dB | 20 * log (2 * outCalibrate[n]/ 32768) |
| sideTone | digital attenuation of sidetone<br><br>is corrected internally by outBbcGain to obtain a constant sidetone independent of output volume | 0...32767 | -∞...0dB | 20 * log (sideTone/ 32768) |

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

The following figure illustrates how the signal path can be influenced by varying the AT command parameters.

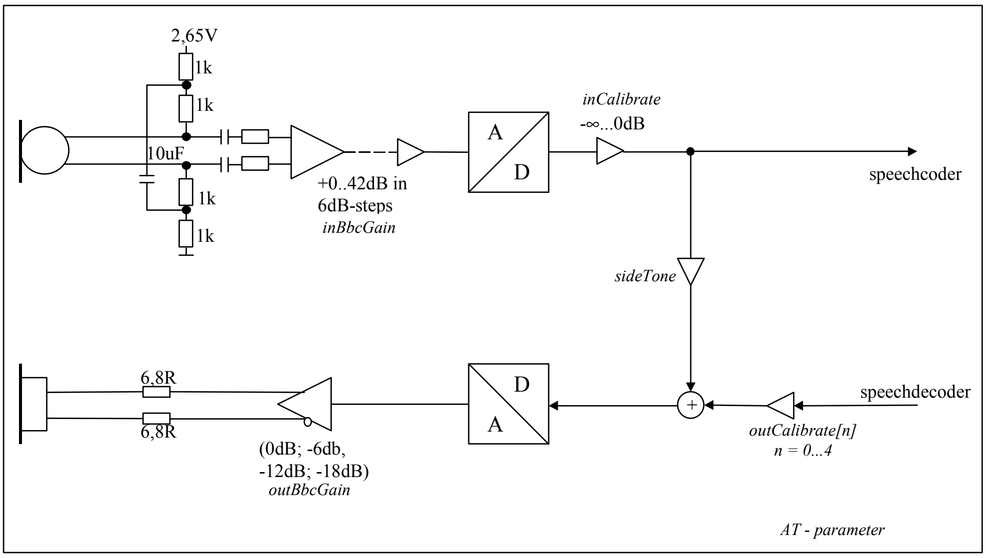



Figure 38: AT audio programming model

## 6.5.2 Characteristics of audio modes

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

Table 31: Voiceband characteristics (typical), all values preliminary

| **Audio mode no. AT^SNFS=** | **1** (Default settings, not adjustable) | **2** | **3** | **4** | **5** | **6** |
|---|---|---|---|---|---|---|
| Name | Default Handset | Basic Handsfree | Headset | User Handset | Plain Codec 1 | Plain Codec 2 |
| Purpose | DSB with M20T handset | Siemens Car Kit Portable | Siemens Headset | DSB with individual handset | Direct access to speech coder | Direct access to speech coder |
| Gain settting via AT command. Defaults: | Fix | Adjustable | Adjustable | Adjustable | Adjustable | Adjustable |
| inBbcGain | 5 (30dB) | 2 (12dB) | 4 (24dB) | 5 (30dB) | 0 (0dB) | 0 (0dB) |
| outBbcGain | 1 (-6dB) | 1 (-6dB) | 2 (-12dB) | 1 (-6dB) | 0 (0dB) | 0 (0dB) |
| MICPn/MICNn EPPn/EPNn | n=1 | n=2 | n=2 | n=1 | n=1 | n=2 |
| Power supply | ON | ON | ON | ON | OFF | OFF |
| Sidetone | ON | --- | Adjustable | Adjustable | Adjustable | Adjustable |
| Volume control | OFF | Adjustable | Adjustable | Adjustable | Adjustable | Adjustable |
| Limiter (receive) | ON | ON | ON | ON | --- | --- |
| Compressor (receive) | --- | ON[1] | --- | --- | --- | --- |
| AGC (send) | OFF | --- | ON | --- | --- | --- |
| Echo control (send) | Suppression | Cancellation + suppression | --- | Suppres-sion | --- | --- |
| Noise suppression[2] | up to 10dB | up to 10dB | 10dB | up to 10dB | --- | --- |
| MIC input signal for 0dBm0 @ 1024 Hz (default gain) | 12.5mV | 48mV | 11mV @ -3dBm0 due to AGC | 12.5mV | 315mV | 315mV |
| EP output signal in mV rms. @ 0dBm0, 1024 Hz, no load (default gain); @ 3.14 dBm0 | 275mV | 120 mV default @ max volume | 270mV default @ max volume | 275 mV default @ max volume | 880mV<br>3.7 Vpp | 880mV<br>3.7 Vpp |
| Sidetone gain at default settings | 27.7dB | -∞ dB | Affected by AGC, 9.3dB @ 11mV (MIC) | 27.7 dB | -2.7dB @ sideTone = 8192[3] | -2.7dB @ sideTone = 8192[3] |

1) Adaptive, receive volume increases with higher ambient noise level.
2) In audio modes with noise reduction, the microphone input signal for 0dBm0 shall be measured with a sine burst signal for a tone duration of 5 seconds and a pause of 2 sec. The sine signal appears as noise and, after approx. 12 sec, is attenuated by the noise reduction by up to 10dB.
3) See AT^SNFO command in [1].

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

## 6.5.3 Voiceband receive path

*Test conditions:*

- The values specified below were tested to 1kHz and 0dB gain stage, unless otherwise stated.
- Parameter setup: gs = 0dB means audio mode = 5 for EPP1 to EPN1 and 6 for EPP2 to EPN2, inBbcGain= 0, inCalibrate = 32767, outBbcGain = 0, OutCalibrate = 16384, sideTone = 0.

Table 32: Voiceband receive path

| **Parameter** | **Min** | **Typ** | **Max** | **Unit** | **Test condition / remark** |
|---|---|---|---|---|---|
| Differential output voltage (peak to peak) | 3.33 | 3.7 | 4.07 | V | from EPPx to EPNx<br>*gs* = 0dB @ 3.14 dBm0<br>no load |
| Differential output gain settings (*gs*) at 6dB stages (outBbcGain) | -18 | | 0 | dB | |
| Fine scaling by DSP (outCalibrate) | -∞ | | 0 | dB | |
| Output differential DC offset | | | 100 | mV | *gs* = 0dB, outBbcGain = 0 and -6dB |
| Differential output resistance | 13 | 15 | | Ω | from EPPx to EPNx |
| Absolute gain accuracy | | | 0.8 | dB | Variation due to change in temperature and life time |
| Attenuation distortion | | | 1 | dB | for 300...3900Hz,<br>@ EPPx/EPNx (333Hz) /<br>@ EPPx/EPNx (3.66kHz) |
| Out-of-band discrimination | 60 | | | dB | for *f* > 4kHz with in-band test signal@ 1kHz and 1kHz RBW |

gs = gain setting

## 6.5.4 Voiceband transmit path

*Test conditions:*

- The values specified below were tested to 1kHz and 0dB gain stage, unless otherwise stated.
- Parameter setup: Audio mode = 5 for MICP1 to MICN1 and 6 for MICP2 to MICN2, inBbcGain= 0, inCalibrate = 32767, outBbcGain = 0, OutCalibrate = 16384, sideTone = 0

Table 33: Voiceband transmit path

| Parameter | Min | Typ | Max | Unit | Test condition/Remark |
|---|---|---|---|---|---|
| Input voltage (peak to peak)<br>MICP1 to MICN1, MICP2 to MICN2 | | | 1.03 | V | |
| Input amplifier gain in 6dB steps (inBbcGain) | 0 | | 42 | dB | |
| fine scaling by DSP (inCalibrate) | -∞ | | 0 | dB | |
| Input impedance | | 2.0 | | kΩ | |
| Microphone supply voltage ON<br>Ri = 4kΩ | 2.57<br>2.17<br>1.77 | 2.65<br>2.25<br>1.85 | 2.73<br>2.33<br>1.93 | V<br>V<br>V | no supply current<br>@ 100µA<br>@ 200µA |
| Microphone supply voltage OFF ; Ri = 4kΩ | | 0 | | V | |
| Microphone supply in power down mode | | | | | see Figure 39 |

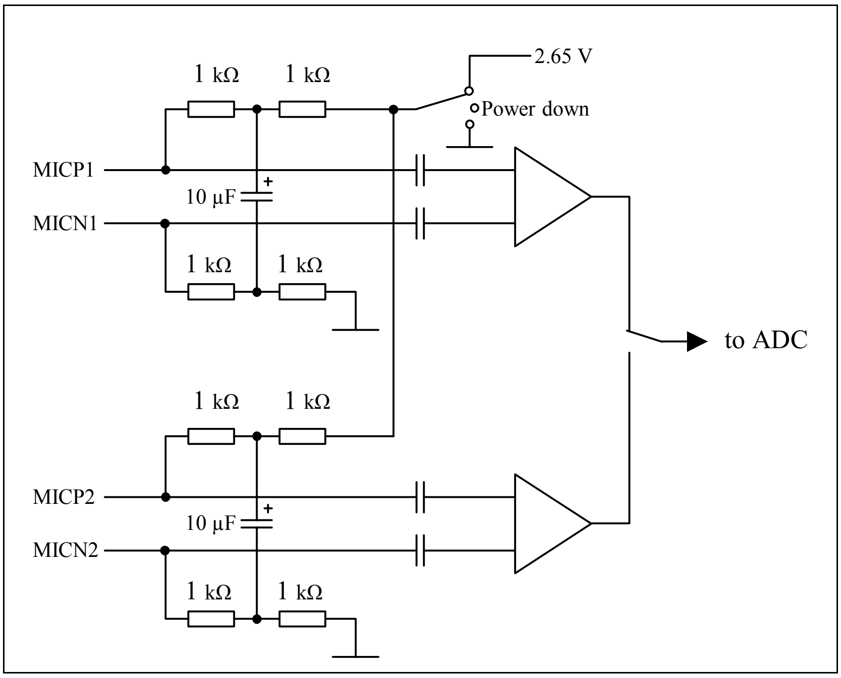



Figure 39: Structure of audio inputs

## 6.6 Air interface

Table 34: Air Interface

| Parameter | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Frequency range | E-GSM 900 | 880 | | 915 | MHz |
| Uplink (MS → BTS) | GSM 1800 | 1710 | | 1785 | MHz |
| Frequency range | E-GSM 900 | 925 | | 960 | MHz |
| Downlink (BTS → MS) | GSM 1800 | 1805 | | 1880 | MHz |
| RF power @ ARP with 50Ω load | E-GSM 900 | 31 | 32.5 | | dBm |
| | GSM 1800 | 28 | 30 | | dBm |
| Number of carriers | E-GSM 900 | | 174 | | |
| | GSM 1800 | | 374 | | |
| Duplex spacing | E-GSM 900 | | 45 | | MHz |
| | GSM 1800 | | 95 | | MHz |
| Carrier spacing | | | 200 | | kHz |
| Multiplex, Duplex | | TDMA / FDMA, FDD | | | |
| Time slots per TDMA frame | | | 8 | | |
| Frame duration | | | 4.615 | | ms |
| Time slot duration | | | 577 | | µs |
| Modulation | | GMSK | | | |
| Receiver input sensitivity @ ARP | E-GSM 900 | -102 | -106.5 | -107.5 | dBm |
| BER Class II < 2.4% | GSM 1800 | -102 | -105.5 | -106.5 | dBm |

## 6.7 Electrostatic discharge

The GSM engine is not protected against Electrostatic Discharge (ESD) in general. Consequently, it is subject to ESD handling precautions that typically apply to ESD sensitive components. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates a MC35 module.

Despite of this, the antenna port, the SIM interface, the ACCU_TEMP port, the POWER port and the battery lines are equipped with spark gaps and clamp diodes to protect these lines from overvoltage. For all the other ports, ESD protection must be implemented on the application platform that incorporates the GSM engine.

MC35 has been tested and found to comply with the EN 61000-4-2 directive. The measured values can be gathered from the following table.

Table 35: Measured electrostatic values

| Pin No. | Signal name | Indirect discharge (environment) | Direct discharge (air discharge to MC35) |
|---|---|---|---|
| 1 - 5 | VBATT+ | >4kV | 8kV |
| 6 - 10 | GND | >4kV | 8kV |
| 11 - 12 | POWER | >4kV | 8kV |
| 13 | VDD | >4kV | 1kV |
| 14 | ACCU_TEMP | >4kV | 8kV |
| 15 | /IGT | >4kV | 1kV |
| 16 - 23 | RS-232 signals | >4kV | 1kV |
| 24 - 29 | SIM signals | >4kV | 8kV |
| 30 | VDDLP | >4kV | 1kV |
| 31 | /PD | >4kV | 1kV |
| 32 | SYNC | >4kV | 1kV |
| 33 - 40 | Audio | >4kV | 1kV |
| Antenna | RF GND | >4kV | 8kV |

*Note: Please note that the values may vary with the individual application design. For example, it matters whether or not the application platform is grounded over external devices like a computer or other equipment, such as the Siemens reference application described in Chapter 10.*

*The antenna connector is ESD protected by a 27nH inductor to ground. Therefore, no DC voltage must be applied to the antenna circuit in order to protect the inductor from damage (see Chapters 4.1 and 5.6).*

# 7 Using MC35 in conjunction with DSB35 Support Box

The DSB35 Support Box is an evaluation kit designed to test and type approve Siemens cellular engines and provide a sample configuration for application engineering.

To take advantage of the evaluation kit please consider the following requirements specific to MC35. For further operating instructions and a detailed hardware interface description refer to the manual supplied with the DSB35 Support Box.

If you would like to purchase the DSB35 Support Box contact your local Siemens dealer. See Chapter 11 for ordering information.

## 7.1 Type approval requirements

Old versions of the DSB35 Support Box (e.g. supplied for TC35 evaluation) can be used to test and evaluate MC35 applications, but are not suited for type approval.

*Note:*

*If a configuration submitted for type approval includes a DSB35 Support Box, ensure that you use a model as per the new serial number. The number is printed on a label on the back of the DSB35 Support Box casing.*

| | |
|---|---|
| Old DSB35 version (not for MC35 type approval) | S30880-S8101-A10-1<br>S30880-S8101-A10-2 |
| New DSB35 version (suited for MC35 type approval) | S30880-S8101-A10-3 |

## 7.2 Power supply requirements

### 7.2.1 Power supply sources

Applications that incorporate MC35 and a DSB35 Support Box must be powered from a *laboratory power supply*, regardless of the operating mode. The laboratory PSU is specified in the DSB35 manual (supply voltage 10V ±1V, maximum current 1A, compliant with EN 60950). The *plug-in PSU* delivered with DSB35 is intended only to test and evaluate the charging procedures of the battery pack. See also Chapter 7.3.

*Note:*
*The laboratory PSU connects to the 4mm X1404 and X1405 jacks illustrated in Figure 40.*

- *To ensure that DSB35 and MC35 are powered from the laboratory PSU (normal operation, i.e. no battery charge and discharge test) set the X1300 toggle switch to "down" position.*
- *To evaluate charging and discharging characteristics turn the X1300 toggle switch "up". In this case the laboratory PSU supplies only the DSB35 board.*

*The length of the DC connection wires between DSB35 and your power supply sources must not exceed 3m.*

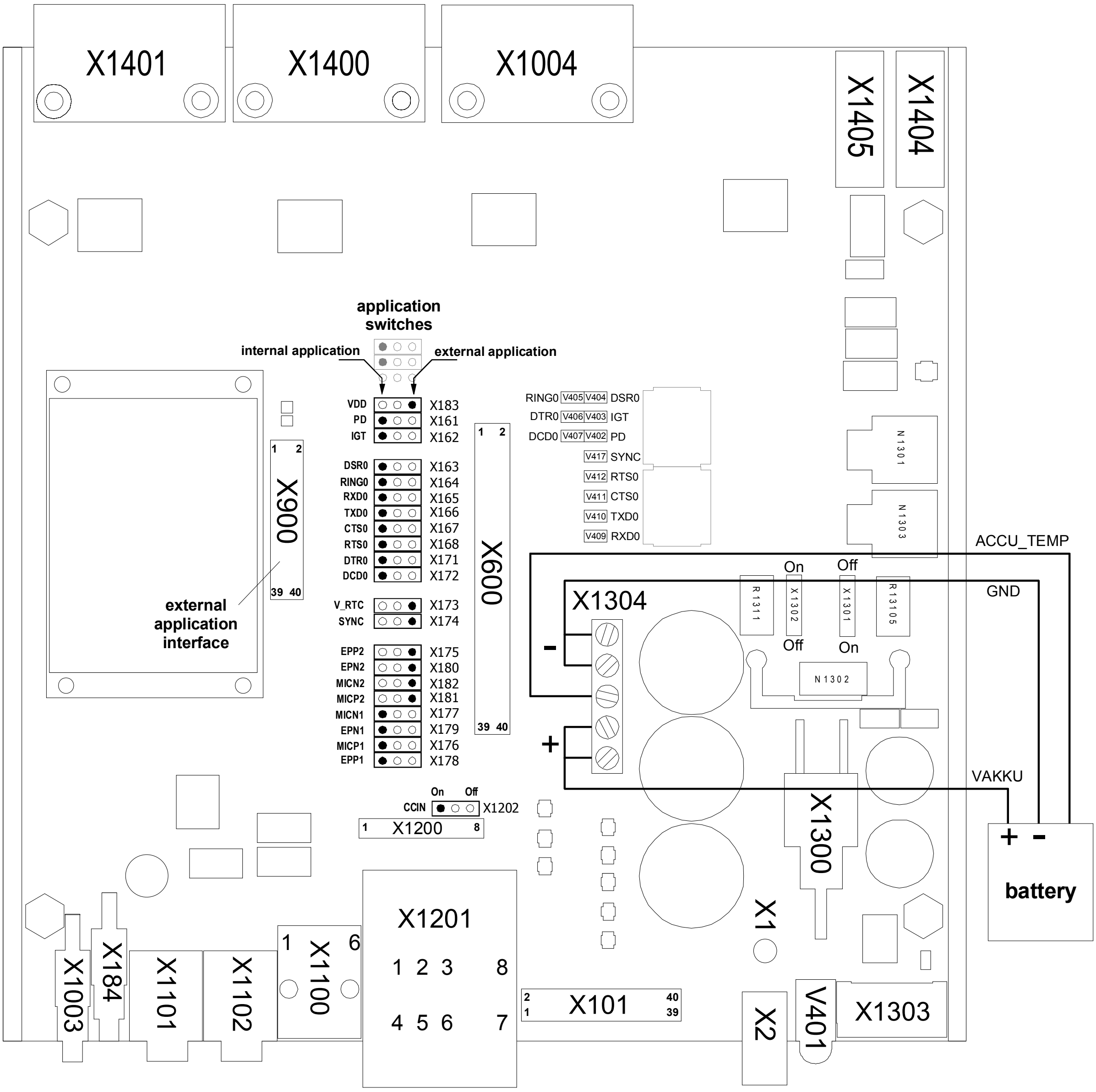



Figure 40: DSB35 board interfaces

## 7.2.2 Adjusting supply voltage

The DSB35 Support Box supplies a voltage ($V_{BATT+}$) of up to 5.75V. To operate MC35 the voltage generated by the DSB board must be limited to 4.8V.

To vary the supply voltage the DSB board uses the two R1311 and R1305 potentiometers. Both can be easily adjusted with the X1301 and X1302 slide switches and a screw on each potentiometer. The position of the switches and the potentiometers can be gathered from Figure 40. For further details on the slide switches and the generated supply voltage please refer to the DSB35 manual.
The factory setting of the slide switches is intended for a typical supply voltage of 4.2V: X1301 = OFF and X1302 = ON

*Note:*

*Follow these steps to adjust the supply voltage required for MC35.*

1. *Set the slide switches: X1301 = OFF and X1302 = OFF. This is equivalent to $V_{BATT+}$ 5.5V.*
2. *To reduce the supply voltage from 5.5V to 4.8V use a screw driver and turn the screw of R1311 until the supply voltage is 4.8V. Use the test points of the X600 connector to measure the generated voltage.*

## 7.3 Verifying charge and discharge time

The plug-in PSU supplied with the DSB35 board can be used to charge lithium-ion batteries.

*Note:*

*The internal electronic of the DSB35 Board affects the duration of charging and discharging. Your most effective approach to testing and verifying the charge and discharge time is, therefore, to make the measurements directly on your application platform, excluding the DSB35 board.*

# 8 Migrating from TC35 to MC35

This chapter is intended for system integrators who are upgrading earlier TC35 applications to MC35.

Designed to offer the same GSM functionality as TC35 and to meet the requirements of GPRS connectivity, MC35 relies on a different baseband and RF chipset. Because of this basic advantage over TC35 there are some electrical differences you need to be aware when integrating MC35. Also, please take into account that GPRS performance requires a higher current consumption while data transfer is in progress (see Table 1 and Table 29).

The table below summarizes the major differences between the two products and provides recommendations to enable a smooth transition to MC35.

Table 36: Summary of hardware differences

| Function | TC35 | MC35 |
|---|---|---|
| **ZIF interface** | | |
| Power supply<br>Pin 1 - 5 | Input: 3.3V ... 5.5V | Input: 3.3V ... 4.8V |
| RS232<br>Pin 19, /TXD0 | Input: $R_i \geq 1M\Omega$ | Input: max. 60µA for 350ms after activation of MC35, then $R_i \geq 1M\Omega$ |
| RTC backup<br>Pin 30, VDDLP | Needs an external serial resistor between VDDLP and capacitor / battery to limit input current.<br><br>If application is battery powered additional diode(s) are suggested between VDDLP and VBATT+ (see Chapter "RTC backup" in your "TC3x Hardware Interface Description"). | Includes 1kΩ resistor on VDDLP line between ZIF connector and PSU. No external resistor required.<br><br>If used in earlier TC35 application, remove additional diode(s) between VDDLP and VBATT+ line. |
| Synchronization<br>SYNC pin 32 | SYNC signal starts 350µs – 400µs before rising edge of transmit burst | SYNC signal starts 300µs before rising edge of transmit burst |
| **Audio performance** | | |
| Handsfree<br>(audio mode 2) | Basic handsfree operation<br>MIC input signal: 98mV<br>Gain setting: inBbcGain 1 (6dB) | Improved handsfree operation<br>MIC input signal: 48mV<br>Gain setting: inBbcGain 2 (12dB) |
| Noise suppression | Not supported for default handset (audio mode 2) and user handset (audio mode 4) | Noise suppression available for default handset (audio mode 2) and user handset (audio mode 4) |
| Sidetone<br><br>(audio modes 1, 3 and 4) | Audio mode 1: 4096<br>Audio mode 3: 1365<br>Audio mode 4: 4096 | Audio mode 1: 8192<br>Audio mode 3: 682<br>Audio mode 4: 8192<br><br>Sidetone values (see AT^SNFO command) are changed, the resulting sidetone gains are equal to TC35 |

| Function | TC35 | MC35 |
|---|---|---|
| **Other functions** | | |
| Power supply | No additional power pads available. | Provides 3 additional nickel gold plated copper power pads (Ni Au) on the RF side: VBATT+, GND, ACCU_TEMP.<br>The use of these pads is optional. |
| Ground pads | Provides 3 separate ground pads. | Provides 5 separate ground pads. Benefit: Better grounding of application. |
| Dimensions | Single shielding cover on RF side | Two shielding covers on RF side. See Figure 26 and Figure 27. |

## 8.1 EMC and RF characteristics

Due to the new baseband and RF concept of MC35, the EMC and RF characteristics have changed over TC35. This requires you to take the following precautions when integrating MC35 into an existing TC35 application.

For your application to achieve best EMC and RF performance use as many grounding options as possible. MC35 offers the following solutions:

- Pin 6 – 10 of the ZIF connector
- Shielding covers on the baseband and RF sides: For better stability, avoid using the central sections of the covers and contact the edges only. This is especially true for the baseband side where the product labels are placed.
- Ground pads:
  - 5 ground pads around the mounting holes (see Figure 27). Please note that the ground pads are not through-plated holes. There are two ground pads on the baseband side and three on the RF side, each to be contacted separately.
  - 1 ground pad as part of the power pads located on the RF side.

It is strongly recommended to obtain a new approval according R&TTE to ensure that your MC35 application meets the requirements of the relevant directives.

**Grounding options on baseband side:**

**Grounding options and power pads on RF side:**

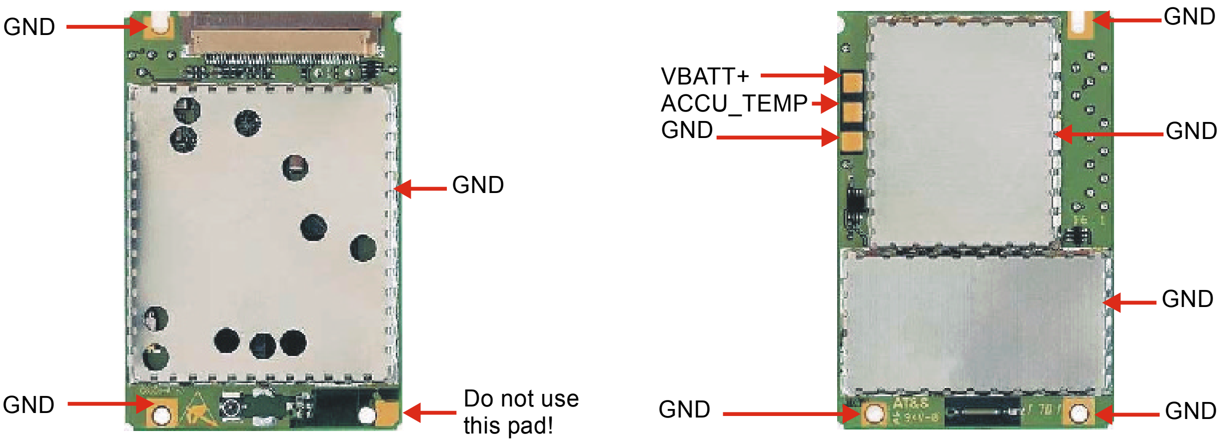



Figure 41: Position of ground and power pads and shield covers on MC35

# 9 Updating Firmware

The MC35 firmware is stored in a flash memory. This gives you the flexibility to easily upgrade to the latest firmware releases. The firmware is supplied as a Windows executable that can be downloaded onto the GSM engine using the serial interface of its ZIF connector or the SIM interface.

To meet the requirements of various application platforms there are a number of ways to perform the update. This chapter summarizes the options currently available. For detailed information, step-by-step instructions and possibly implied modifications to the hardware design please refer to the Application Note 16 "Updating MC35 Firmware" [5].

*Updating the firmware over the serial interface*

- The download procedure uses the TXD0, RXD0 and IGT lines of the ZIF connector and the TXD, RXD and DTR lines of the host application (MMI) or the PC's serial port. The approach to set up the serial link depends very much on the individual design of the host application. The "Firmware Updating User's Guide" recommends the following methods:
  1. Download over DSB35 Support Box (evaluation kit).
  2. Download over service interface and service connector with the download being supported by firmware executable.
  3. Download controlled by the processor of the host application (MMI processor).

*Updating the firmware over the SIM interface*

- This solution is recommended when your GSM application has no direct access to a serial interface. To transfer the software to the device you will need the BB35 Bootbox. It comes with a specific adapter that connects the SIM card reader of your MC35 application to your computer's serial port.
- IMPORTANT: Please note that this solution is only applicable to MC35 modules as of firmware release 02.00. Earlier releases shipped as engineering or working samples until firmware version 01.01 must be updated over the serial interface first, and are then ready for further updates over the SIM interface.

In either case, the firmware executable runs on any computer under Windows 98, Windows NT 4.0, Windows 2000, Windows ME, Windows XP (except for Windows 95 which supports only the serial interface operation).

# 10 Reference Approval

## 10.1 Reference Equipment

MC35 has been approved to satisfy the essential requirements of Directive 99/5/EC (R&TTE Directive).

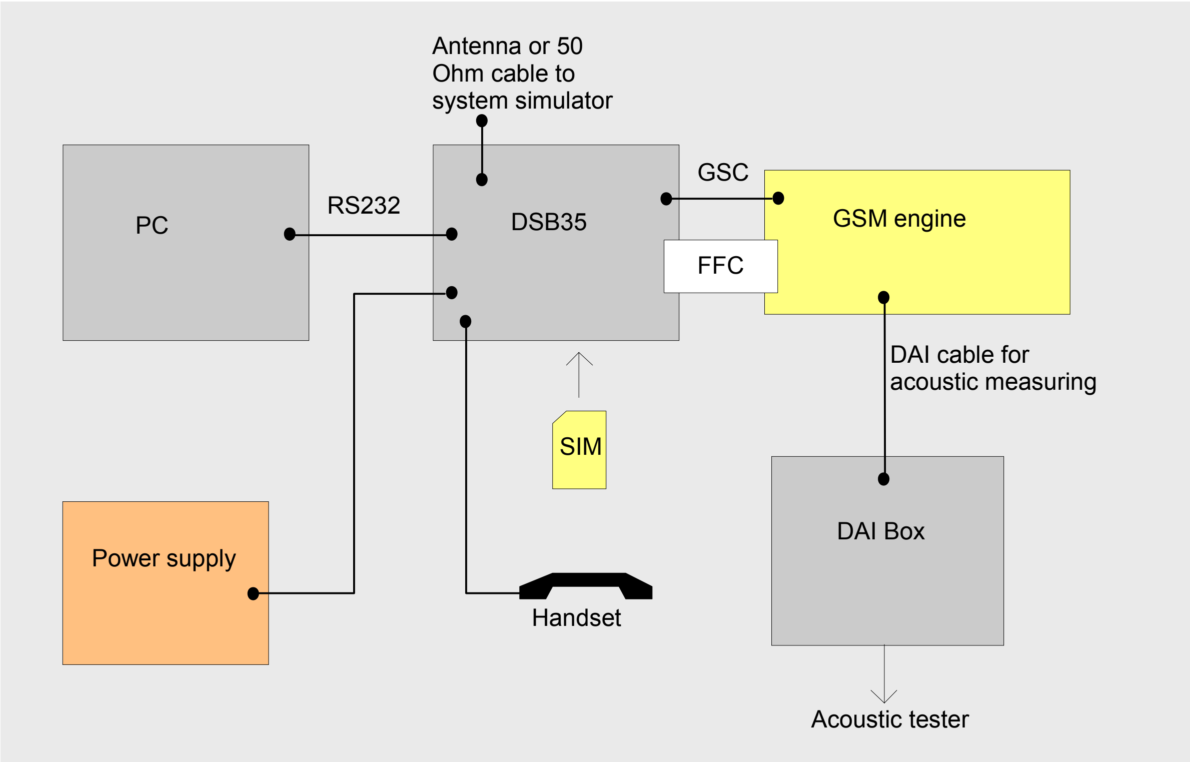



Figure 42: Reference equipment for approval

Referred to as "GSM terminal equipment" the reference configuration consists of the following components:
- Siemens MC35 cellular engine
- Development Support Box (DSB)
- SIM card reader integrated on the DSB
- Handset type Votronic HH-SI-30.3/V1.1/0
- PC as MMI

For Siemens MC35, an IMEI number contingent has been reserved for the basic approval of the reference configuration. It will also apply to later approvals of customer configurations incorporating MC35 modules.

Approved Siemens MC35 configurations are recorded in the approval documentation. Later enhancements and modifications beyond the certified configuration require extra approvals. Each supplementary approval process includes submittal of the technical documentation as well as testing of the changes made. The relevant test applications for supplementary approvals should be agreed upon with Siemens.

## 10.2 CE Conformity

Mc35 meets the requirements of EU directives listed below and is labeled with the CE conformity mark.

- R&TTE Directive 1999/5/EC
- LVD 73/23/EC
- EMC conformity in accordance with Directive 89/336/EC

## 10.3 G.C.F. Conformity

MC35 has been approved to comply with the quality assurance requirements according to GCF-CCV 3.1.0.

# 11 List of parts and accessories

Table 37: List of parts and accessories

| Description | Supplier | Ordering information |
|---|---|---|
| MC35 engine | Siemens | Siemens ordering number<br>L36880-N8500-B100 |
| SIM card holder incl. push button ejector and slide-in tray | Molex | Ordering numbers: 91228<br>91236<br>Molex Deutschland GmbH<br>Felix-Wankel-Str. 11<br>D-74078 Heilbronn-Biberach<br>Phone: +49(7066)9555 0<br>Fax: +49(7066)9555 29<br>Email: mxgermany@molex.com<br>Web site: http://www.molex.com/<br>American Headquarters<br>Lisle, Illinois 60532 U.S.A.<br>Phone: 1-800-78MOLEX<br>Fax: 630-969-1352<br>Far East Headquarters<br>Yamato, Kanagawa, Japan<br>Phone: 81-462-65-2324<br>Fax: 81-462<br>Far East Headquarters<br>Jurong, Singapore<br>Phone: 65-268-6868<br>Fax: 65-265-6044 |
| ZIF connector | AVX | Ordering number: 04 6240 040 003 800 |
| Flat cable for ZIF connector<br>cable 160 mm<br>cable 80 mm | Axon | Ordering numbers:<br>FFC 0.50 A 40 / 0160 K4.0-4.0-08.0-08.0SABB<br>FFC 0.50 A 40 / 0080 K4.0-4.0-08.0-08.0SABB |
| RF cable GSC-GSC<br>cable 50 mm<br>cable 100 mm | MuRata | Ordering numbers:<br>MXTK 88 TK 0500<br>MXTK 88 TK 1000 |
| GSC connector | MuRata | MM9329-2700 TB2 |
| P/N M22001 tool (recommended for GSC antenna installation) | MuRata | Please use product name:<br>P/N M22001 |

| Description | Supplier | Ordering information |
| --- | --- | --- |
| Battery cell XWDTC35PL | Shenzhen Xwoda Electronic Co., Ltd | To place orders or obtain more information please contact:<br>Shenzhen Xwoda Electronic Co., Ltd<br>Linda Yang<br>Unit 3003, Yingjingyuan,Zhongdian Garden,<br>Shenzhen 518032<br>P.R.China<br>Phone: +86-755-7633789 ext. 33<br>Fax: +86-755-7632078<br>Email: xwda@public.szptt.net.cn |
| Siemens Car Kit Portable | Siemens | Siemens ordering number: L36880-N3015-A117 |
| DSB35 Support Box | Siemens | Siemens ordering number: L36880-N8101-A100-3 |
| BB35 Bootbox | Siemens | Siemens ordering number: L36880-N8102-A100-1 |