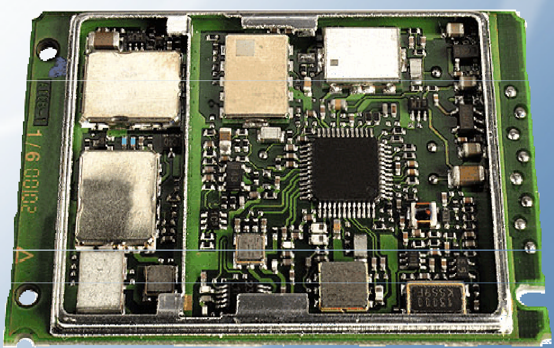
SIEMENS

TC35

Cellular Engine



Hardware Interface Description

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Wireless Modules

Information and Communications

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0 Version history

This chapter reports modifications and improvements over previous versions of the document.

"Hardware Interface Description" Version **02.00 => 02.10**

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4.2.3	20	Figure 5: RTC supply from battery added
4.6.2.2	27	Further information on LED mode of SYNC pin added
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1 Introduction

This document describes the hardware interface of the GSM Engine TC35 that connects to the cellular device application and the air interface. As TC35 is intended to integrate with a wide range of application platforms, all functional components are described in great detail.

So this documentation is a guidance that covers all information you need to know to design and set up cellular applications incorporating the TC35 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.

Specifications are subject to change without notice. This product is an original Siemens product protected by US, European and other patents.

1.1 Standards

This product will be approved as complying with the following directives and standards.

(1) GSM Recommendation Phase II (GSM 11.20; ETS 300607 - 11.10)
(2) ETSI GSM Phase 2 / Phase 2+ Technical Standards (including Multiband; except GPRS / HSCSD)
(3) ETS 300 342-1 EMC for Cellular Phones (GSM 900MHz and DCS 1800MHz)
(4) CE 89 336 EWG
(5) 11 73 23 EWG
(6) EN 55022 (Limits and Measuring Methods for Radio Interference)
(7) CISPR Pub. No. I 16-1
(8) Telecommunications Terminals Guideline R&TTE 99/5/EC (valid from 04-08-2000)
(9) EN 60950 Product Safety
(10) 92 / 59 / EEC Product Safety
(11) Cellular Telecommunication Systems (GSM 900MHz and DCS 1800MHz)
(12) ENV 50166 -2 1995 Human Exposure to Electromagnetic Fields, High Frequency (10KHz to 300GHz)
(13) GSM MoU TWG Technical Notes
(14) ETS 300 342-1 ESD
(15) ETS 300 019-1-0 / ETS 300 019-2-7 (Environmental Requirements)
(16) ETR 051 (Human Factors Basic Requirements) and ETR 166 (Evaluation Method)
(17) IEC 68 ff (Vibration and Shock test)
(18) CE at Directive 98/13/ EC
(19) DIN 40050 (Climatic Conditions & Protections)
(20) DIN 0848 (Draft) Part 2, (Protection against Radiation)
(21) DIN / VDE 0879 Part 2, Draft 8/94 (pr EN55025)
(22) DIN 54840 (Typical Plastic Parts)
(23) Low Voltage Directions 73/23 EWG (changed to 93/68 EWG)
(24) Internal Auxiliary Specification for VHF Broadcasting Range (-82dBm)
(25) EN 40140 Basic Immunity Standard Radiated; Radio Frequency; Electromagnetic Fields;
(26) CENELEC WGMTE Safety Consideration for Human Exposure to EMFs from Mobile Telecommunications Equipment
(27) (MTE) in the Frequency Range 30MHz - 6GHz

1.2 References

Directive 73/23/EEC (Low Voltage Directive)
Directive 89/336/EEC (EMC Directive)
Directive 1999/5/EC (R&TTE Directive)
Directive 91/263/EEC (TTE Directive)

1.3 Terms and abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
AFC	Automatic Frequency Correction
AGC	Automatic Gain Control
ARP	Antenna Reference Point
ASIC	Application Specific Integrated Circuit
ATC	AT Cellular
BiCMOS	Bipolar CMOS
BTS	Base Transceiver Station
CB	Cell Broadcast
CODEC	Coder-Decoder
CPU	Central Processing Unit
CTR 31	Common Technical Regulation
CTR 32	Common Technical Regulation
DAI	Digital Analog Interface
dBm0	digital level, 3.14dBm0 corresponds to full scale, see ITU G.711, A-law
DCE	Data Circuit-terminating Equipment
DSB	Development Support Box
DSP	Digital Signal Processor
DSR	Data Set Ready
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
FFS	For further studies
FR	Full rate
GaAs	Gallium Arsenide
G.C.F.	GSM Conformity Forum
GFSK	Gaussian Frequency Shift Keying
GSM	Global Standard for Mobile Communication
HF	Hands-free
HR	Half rate

Abbreviation	Description
HW	Hardware
IC	Integrated Circuit
IEEE	Institute of Electrical and Electronics Engineers
IF	Intermediate Frequency
IMEI	International Mobile Equipment Identifier
I/O	Input/ Output
IGT	Ignition
ISO	International Standards Organization
ITU	International Telecommunications Union
kbps	kbits per second
Li-Ion	Lithium-Ion
LNA	Low Noise Amplifier
LPC	Linear Prediction Coding
LVD	Low voltage Directive
Mbps	Mbits per second
MCU	Microcomputer Unit
MMI	Machine Machine Interface
MO	Mobile Originated
MS	Mobile Station
MT	Mobile Terminated
NTC	Negative Temperature Coefficient
PA	Power Amplifier
PCB	Printed Circuit Board
PCM	Pulse Code Modulation
PCS	Personal Communication System
PD	Power Down
PDU	Protocol Data Unit
PGC	Programmable Gain-Controlled Amplifier
PLL	Phase Locked Loop
R&TTE	Radio and Telecommunication Terminal Equipment
RAM	Random Access Memory
RF	Radio frequency
RI	Ring Indication
ROM	Read -Only Memory
RPE-LTP	Regular-Pulse Excited LPC with a Long-Term Predictor
RSSI	Radio Signal Strength Indicator
Rx	Receive direction

Abbreviation	Description
SAW	Surface Acoustical Wave Filter
SIM	Subscriber Identification Module
SMS	Short Message Service
SRAM	Static Random Access Memory
SW	Software
TBR	Technical Based Regulation
TBD	To Be Defined
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
Tx	Transmit direction
UART	Universal Asynchronous Receiver and Transmitter
VCO	Voltage Controlled Oscillator
VAD	Voice Activity Detection
ZIF	Zero Insertion Force

2 Overview

TC35 is a Siemens GSM Engine designed to easily provide radio connection for voice and data transmission. The complete RF part is incorporated and the GSM protocol runs autonomously on a GSM baseband processor. TC35 is ideally suited to develop and build a GSM cellular device with minimum effort. The cellular device application forms the Man-Machine Interface (MMI). Access to the TC35 is enabled by a serial interface (RS232).

TC35 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 GSM Engine is similar to an electronic component. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates a TC35 module.

3 Functions

3.1 Block diagram

Figure 1 shows a block diagram of the GSM Engine TC35. The main functional blocks

- GSM baseband processor
- GSM Radio
- Power Supply ASIC
- Flash

are outlined in the following chapters.

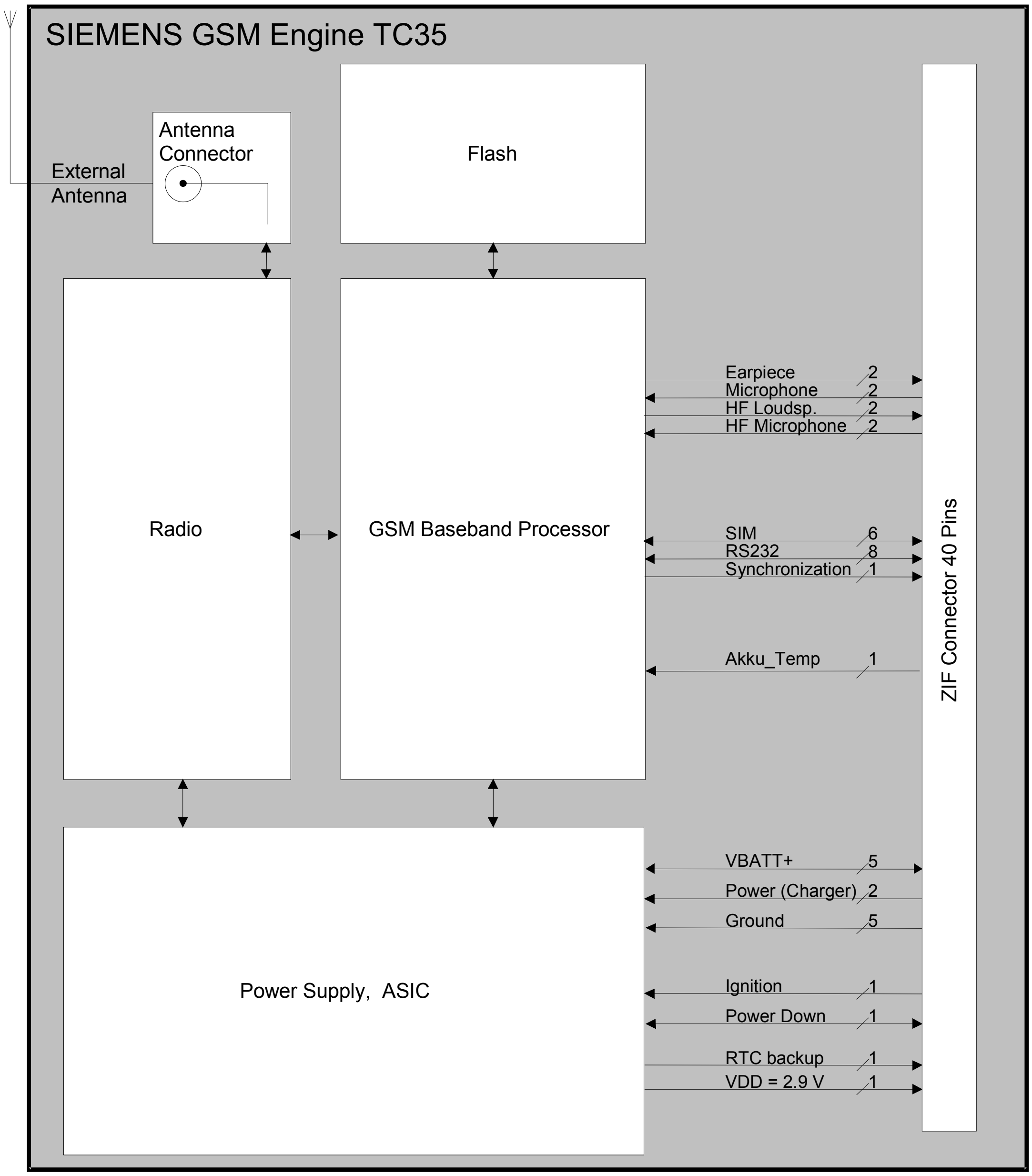


Figure 1: TC35 block diagram

3.2 Features at glance

The following table provides an overview of the TC35 key features.

Table 1: TC35 key features

Feature	Implementation
Transmission	Voice and data
Power supply	Single supply voltage 3.3V – 5.5V;
Frequency bands	Dual Band EGSM900 and GSM1800 (GSM Phase 2+)
GSM class	Small MS
Transmit power	Class 4 (2W) for EGSM900 Class 1 (1W) for GSM1800
SIM card reader	External – connected via interface connector Note: The SIM card reader is not part of the TC35
External antenna	Connected via antenna connector
Temperature range see Table 13	-20°C to +55°C (normal operation) +55°C to +70°C (restricted operation) -40°C to +85°C (storage)
Current consumption see Table 14	TALK mode (peak): 1.8A (typ.) TALK mode: 300mA (typ.) IDLE mode: 10mA (typ.) SLEEP mode: 3mA (typ.) Power Down mode: 50µA (typ.)
Speech codec	Triple rate codec: Half Rate (ETS 06.20) Full Rate (ETS 06.10) Enhanced Full Rate (ETS 06.50 / 06.60 / 06.80)
SMS	MT, MO, CB, Text and PDU mode
DATA	2.4, 4.8, 9.6 Kbps, nontransparent
FAX	Group 3 : Class 1, Class 2
Size	54.5 x 36 x 6.85mm (approx.)
Audio interface	Analog (Microphone, Earpiece, Handsfree)
Interfaces	RS232 (CMOS level) bi-directional bus for commands / data using AT commands
Supported SIM card	3V/1.8V (Please note that 1.8V support requires to be separately tested and validated according to GSM 11.10)
Phonebooks	Implemented via SIM
Reset of GSM Engine TC35	Reset via AT command or Power Down Signal
Selectable baud rate	300bps...115kbps (AT Interface)
Auto bauding range	1.2kbps...115kbps (AT Interface)
Software download	Via RS232 interface, SIM Interface
Real time clock	Implemented (clock frequency 32.768kHz)
Timer function	Programmable via AT command

3.3 GSM baseband processor

The GSM baseband processor handles all the processing for audio, signal and data 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 processor 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.

The GSM baseband processor has the following key 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 and battery technology
- GMSK Modulator
- Viterbi Hardware Accelerator
- A51/A52 Cipher Unit
- Comprehensive static and dynamic power management

4 Application Interface

The module is equipped with a 40-pin 0.5mm pitch ZIF connector which is 2mm in height (AVX ordering number 04 6240 040 00 3800). It connects TC35 to the cellular device application. The following interfaces are incorporated.

4.1 Power supply

The power supply of the GSM Engine TC35 has to be a single voltage source of VBatt+ = 3.3V...5.5V providing a peak current of about 2A during the uplink transmission (exact values of the uplink currents see later on in the RF part). The uplink bursts cause strong ripple on the VBatt+ line.

The safety status of the power supply has to be SELV (as defined by EN60950).

An ASIC power supply stabilizes the supply voltages for the GSM base-band processor and for the RF part using linear voltage regulators. In addition, the ASIC power supply provides the regulated voltage 2.9V/70mA for the external application. The RF power amplifier is driven directly from VBatt+.

The input voltage VBatt+ must not drop below its minimum value on the TC35 board in any circumstances, not even during the uplink current bursts. This has some influence on the minimum open circuit voltage of VBatt+ because the standard connection (FFC 200mm in length) over ZIF-FFC-ZIF has a maximum resistance of 50mΩ in the VBatt+ line and 50mΩ in the GND line. So 2A bursts cause an overall voltage drop of 200mV.

In addition to this line resistance, the resistance of the applications power supply should be taken into account.

4.2 Battery pack

For some applications the use of a battery pack may be required. TC35 supports charging from a special Li-Ion battery pack (3.8V / 0.85Ah / maximum charge voltage: 4.2V.

To ensure reliable operation and proper charging take care that the battery pack you want to integrate into your TC35 application meets the following requirements:

- Ensure that the battery pack incorporates a protection circuit. To detect overtemperature and undertemperature on the battery, the circuit must include an NTC resistor connected between AKKU_TEMP and GND. Required NTC characteristics are: *10kΩ @ 25°C, B=3370 Kelvin ±3%*. Please note that the NTC is indispensabe for proper charging.
- Furthermore, the protection circuit must be capable of detecting overvoltage (against overcharging), undervoltage (against deep discharging) and overcurrent. The circuit must be insensitive to pulse loading (see Chapter 4.2.1).
- On the TC35 module, a built-in measuring circuit constantly monitors the charge voltage. In the event of undervoltage, it causes TC35 to power down and automatically starts up charging to protect the cell from damage. Undervoltage thresholds during the IDLE or TALK mode 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 the TC35 and of the application circuit.
- The battery cell must be insensitive to rupture, fire and gasing under extreme conditions of temperature and charging (voltage, current).

Figure 2 shows the circuit diagram of a typical battery pack design that includes the protection elements described above.

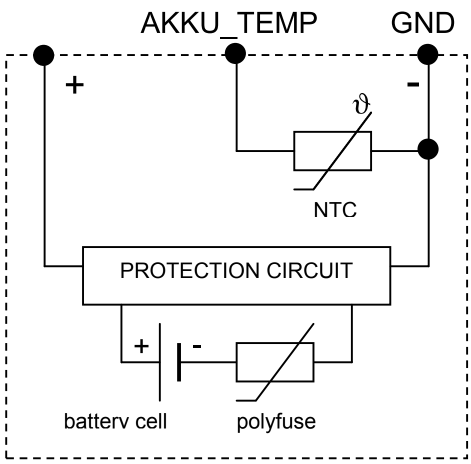


Figure 2: Battery pack

4.2.1 Charging process

Charging is accomplished only in the temperature range from 0°C to +45°C. The battery will be charged with a constant current until the voltage reaches 4.2V. Then the duty-cycle is reduced to prevent overshooting beyond 4.2V. After the pulse width has decreased to its minimum duration of 100ms it is kept at a constant level. From this moment, the battery voltage is regulated by the open-circuit voltage. In this state of operation the voltage will not exceed the level of 4.3V for 100ms. Charging is completed if the pulse width does not change within 2 min.

Note: The battery manufacturer must guarantee that this charging process does not damage the battery.
Please refer to the Application notes"Battery Pack" and "Charging of Battery Pack" for further details.

4.2.2 Charger

The charging process begins once the charger is connected to the POWER pin of the ZIF connector, no matter whether the GSM engine is in Power Down, IDLE or TALK mode. While charging is in progress the normal mode software is active.

If the battery is deeply discharged, the charger goes into trickle charge mode. When the battery voltage gets over 3.2V within 60 minutes, software controlled charging will be automatically started in parallel. If the voltage does not reach 3.2V before 60 minutes ±10% or IGT is connected to ground in the event of undervoltage, while trickle charging is in progress, software controlled charging must be started manually by reconnecting POWER (see also Table 6 for details on to Power on and down scenarios).

Note: Do not connect the charger to the VBatt+ line. Only the POWER line is intended as input for charging!

The charger must be designed to meet the following requirements:

a) Simple transformer power plug
- Output voltage: 5.5V...15V
- The charge current must be limited to 500mA
- At an output voltage of 2.8V the current must never exceed 1A.
- 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
- Output voltage: 5.5V...8V
- Current limit: 500mA
- When current is switched off a voltage peak of 12V maximum is allowed, though it must not exceed 10V for more than 1ms
- When current is switched on a spike of 1.6A for 1ms is allowed

Note: *To to detect extreme thermal conditions while charging is in progress, connect a NTC (10kΩ @ 25°C, B=3370 Kelvin ±3%) from AKKU_TEMP to GND.*

4.2.3 RTC backup

Via pin no. 30 of the ZIF connector you can backup the internal RTC of the TC35 with an external capacitor or battery. The capacitor is charged by V_{Batt+} over a diode from the module. If the voltage supply at V_{Batt+} is disconnected the RTC is powered by the capacitor (for example with C=100µF typically for 30 seconds).
A serial resistor R will be needed to limit the input current of an empty capacitor. 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 7 for the parameters required.

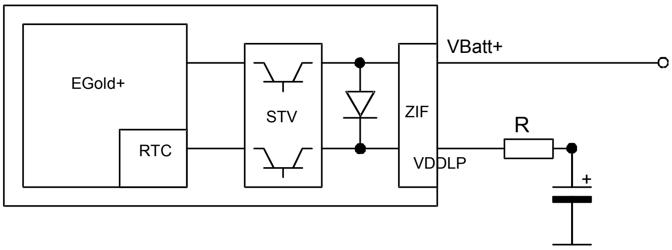


Figure 3: RTC supply from capacitor

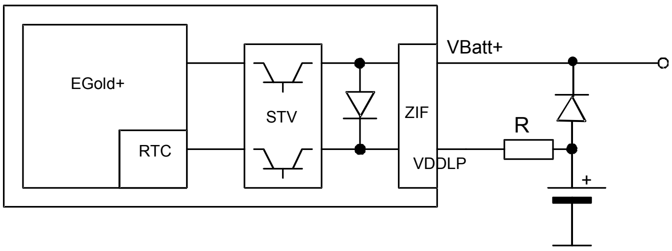


Figure 4: RTC supply from accumulator

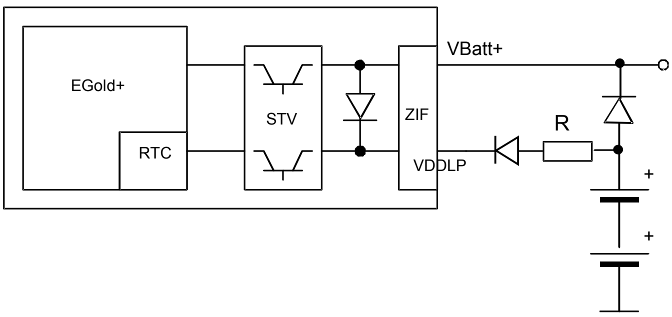


Figure 5: RTC supply from battery

4.3 Data interface

This chapter describes the data interface of the TC35 GSM Engine. The data interface operates at CMOS level (2.65V).

Note: The GSM Engine TC35 will be connected like a DCE:
TxD TC35 connected to TxD Application
RxD TC35 connected to RxD Application

All RS232 signals on the ZIF connector are low active!

An overview of the data interface signals is given in *Figure 6.*

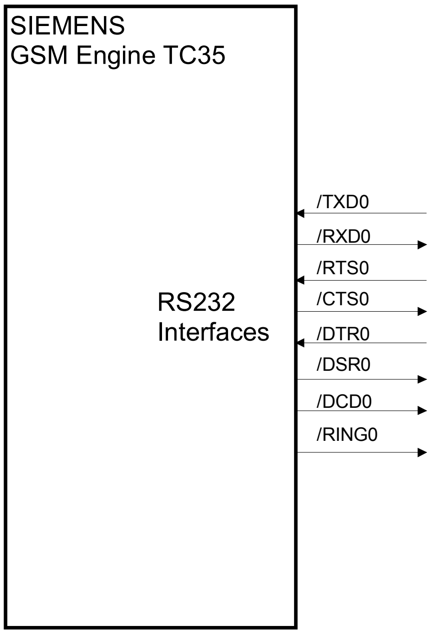


Figure 6: RS232 interface

The data interface is implemented as a serial asynchronous transmitter and receiver conforming to ITU-T RS232 Interchange Circuits DCE. It has fixed parameters of 8 data bits, no parity and 1 stop bit, and can be selected in the range of 4.8kbps up to 115kbps for autobauding and in the range of 300baud to 115kbps for manual settings. HW handshake using signals RTS0 / CTS0 and SW flow control via XON/XOFF are supported.

In addition, the modem control signals DTR0[*)], DSR0, DCD0 and RING0 are available. The modem control signal RING0 (Ring Indication) is supported to indicate an incoming call to the cellular device application. There are different modes of operation, which are software-selectable (AT commands).

*) The DTR signal will only be polled once per second from the internal Firmware of the TC35 !

4.4 Audio interface

TC35 comprises two audio interfaces. The first interface is intended for an analog microphone input and an analog earpiece output. An additional analog input for a microphone and an analog output for an earpiece is available e.g. for handsfree applications. The microphone inputs and the earpiece / hands-free outputs are balanced.

For electret microphones a supply source can be switched on. The selected input and output, the on/off-state of the microphone supply, the gains for sending and receiving and the sidetone volume depend on the current audio mode.

In particular audio modes, the gain in the microphone, earpiece and sidetone paths can be adjusted from the cellular device application (you can set various volume steps by using AT commands). See Table 21 for the characteristics of the audio modes. A block diagram of the audio interface is given in Figure 7.

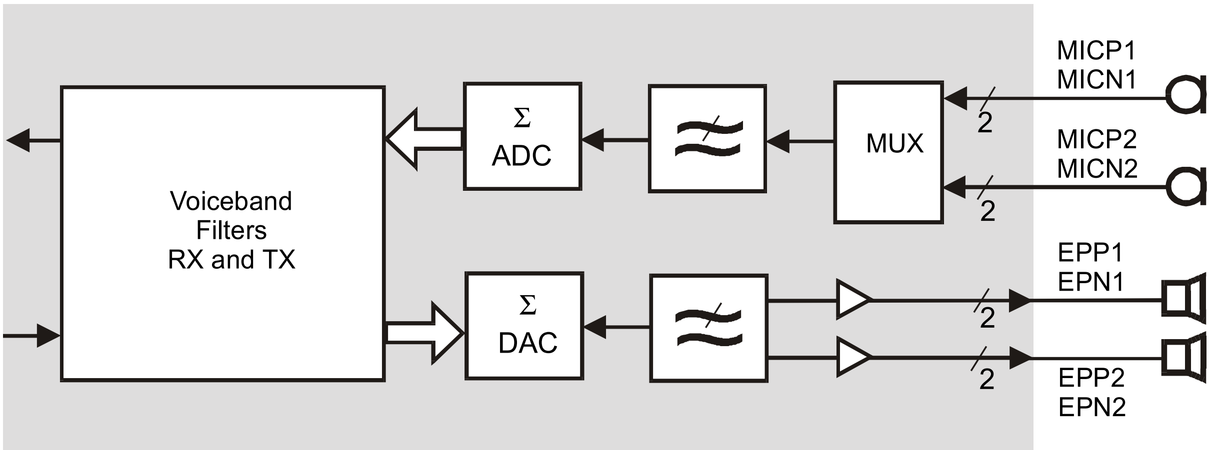


Figure 7: Audio block diagram

4.4.1 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 handset 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.

4.5 SIM interface

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 inserted into the card holder. To take advantage of this feature, an appropriate contact is required on the card holder. For example, this is true for the model supplied by Molex Deutschland GmbH, which was tested within the Siemens reference configuration (Molex ordering number 91228-0001). The default level of CCIN is low (internal pull down resistor, no card inserted). It goes high when the card is inserted.

See also "TC35-AN-01-V0100_SIM_interface.pdf" for recommendations on designing a SIM interface for your GSM application.

Note: Before removing the SIM card be sure that the GSM engine has been powered down as described in Chapter 4.7. Failure to do so would seriously affect the serviceability of your GSM application, though no damage would be caused to the SIM card itself.

4.5.1 Updating firmware over SIM interface

TC35 offers two different solutions for updating firmware. To download the software onto the module, you can either use the SIM interface or, if available on your application platform, the RS232 interface of the ZIF connector. To avail of the SIM option, you will need to purchase a special adapter named B35 BootBox. Click http://www.siemens.com/wm for further details and ordering information.

4.6 Control signals

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

4.6.1 Inputs

Table 2: Input control signals of the TC35 module

Function	Pin	Status	Description
Ignition	**IGT**	= falling edge	Power on TC35
		= 1	No operation
	Active Low ≥ 100ms (Open drain/collector driver required in cellular device application) Note: If a charger and a battery is connected to the customer application the IGT signal must not be less than 1s.		
Power down	**PD**	= 0	Power down GSM Engine TC35
		= 1	No operation
	Active Low ≥ 3.2s (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 7).		

4.6.2 Outputs

4.6.2.1 Synchronisation signal

The synchronisation 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 "AT Command Set".

To generate the synchronisation signal the pin needs to be configured to mode 0 (= default). This setting is recommended if you want your application to use the synchronisation signal for better power supply control. Your platform design must be such that the incoming signal accomodates sufficient power supply to the TC35 module if required. This can be achieved by lowering the current drawn from other components installed in your application. The characteristics of the synchronisation signal are explained below.

Table 3: TC35 synchronisation signal (if SYNC pin is set to mode 0 via AT^SSYNC)

Function	Pin	Status	Description
Synchronization	**SYNC**	= 0	No operation
		= 1	Indicates increased power consumption during transmission.

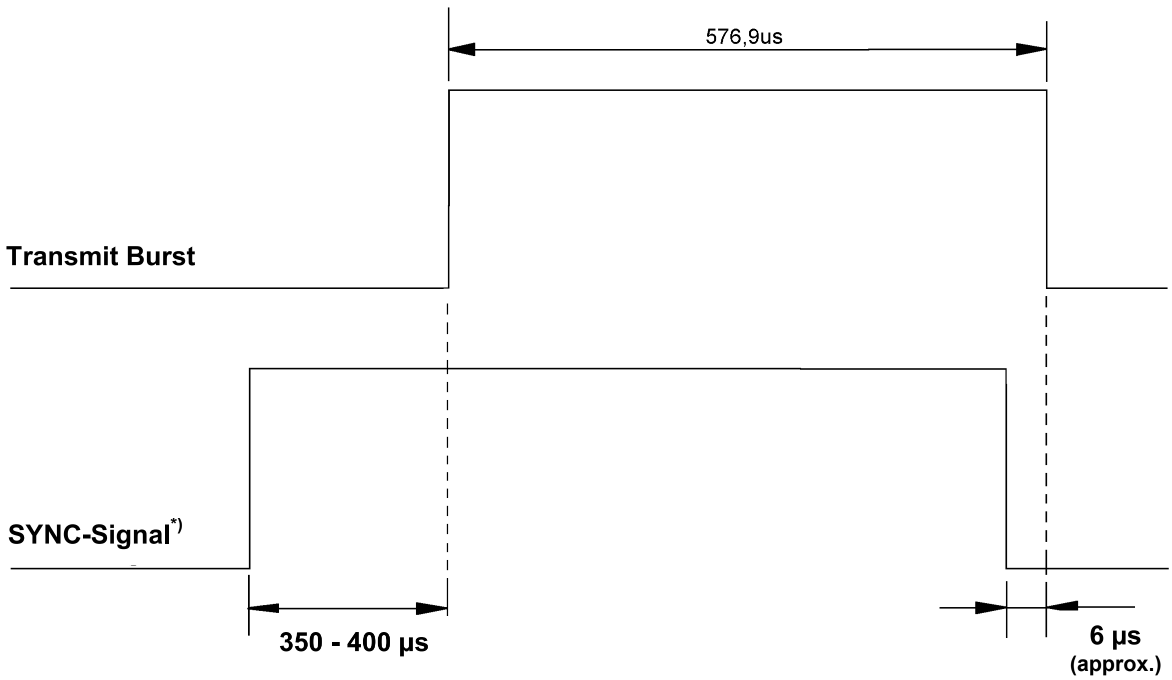


Figure 8: TC35 output control signals

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

4.6.2.2 Using the SYNC pin to control a status LED

As an alternative to generating the synchronisation 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 following functions:

Table 4: Modes of the LED and associated functions

LED mode	Function
Off *)	TC35 is off or in Sleep 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
75ms On / 3s Off *)	Logged to network (monitoring control channels and user interactions). No call in progress.
On	Depending on type of call: *Voice call:* Connected to remote party. *Data call:* Connected to remote party or exchange of parameters while setting up or disconnecting a call.

*) LED Off = SYNC pin low. LED On = SYNC pin high

To operate the LED a transistor or gatter must be included in your application. A sample configuration can be gathered from Figure 9. Power consumption in the LED mode is the same as for the synchronisation signal mode. For details see Table 7, pin number 32.

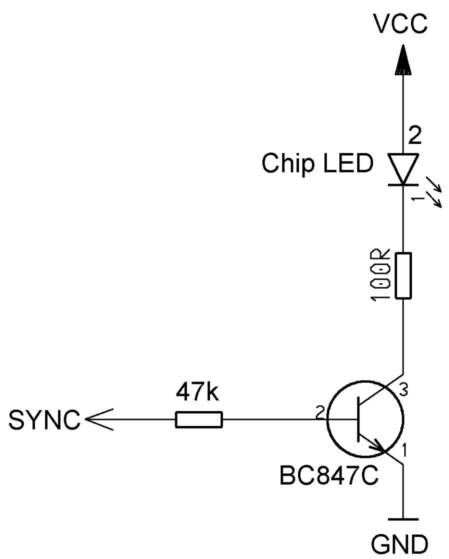


Figure 9: LED Circuit (Example)

4.6.2.3 Behavior of the RING0 line

The behavior of the RING0 line depends on the type of the call received.

- When a *voice call* comes in the RING0 line goes active low for 1s and inactive high for another 4s. Every 5 seconds, on the falling edge of RING0, the ring string is generated and sent over the RXD line.
  If there is a call in progress and call waiting is activated for a connected handset or handsfree device, the RING0 pin switches to zero on every falling edge in order to generate acoustic signals that indicate the waiting call.

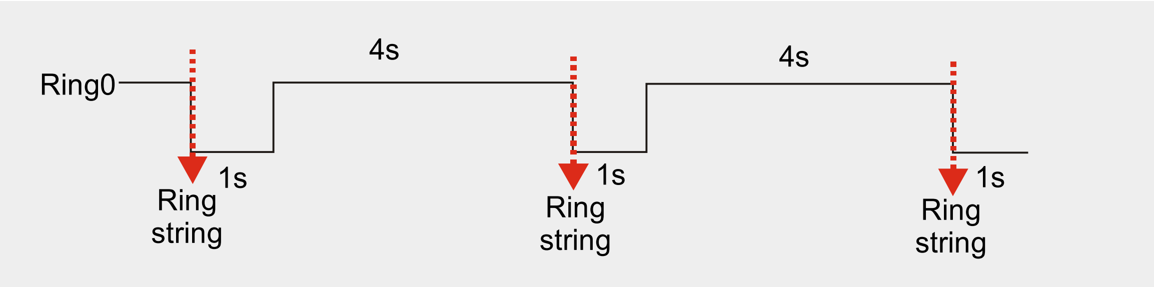


Figure 10: Incoming voice call

- Likewise, when a *data call* is received, RING0 goes active low. However, in contrast to voice calls, the line remains active low. Every 5 seconds, on the falling edge of RING0, the ring string is generated and sent over the RXD line.

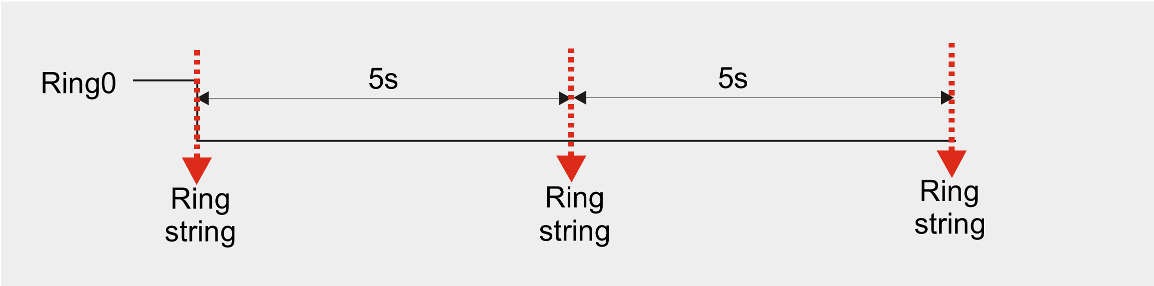


Figure 11: Incoming data call

Table 5: TC35 ring signal

Function	Pin	Status	Description
Ring indication	**RING0**	= 0	Indicates an incoming call. Wakeup of cellular device application.
		= 1	No operation

4.7 Power on / down scenarios

Power on:
To switch the GSM Engine TC35 on the IGT (Ignition) signal needs to be driven to ground level for at least 100ms. This must be accomplished with an open drain/collector driver to avoid current flowing into this pin.

Note: If a charger and a battery connects to the customer application the duration of the IGT signal must be 1s minimum.

Power down:
The TC35 module can be powered down via RS232 application interface using an AT command or exceptionally by driving the PD (Power down) signal to ground level. The PD signal is available on the ZIF connector and must be driven with an open drain/collector driver.

Caution:
Use the PD signal (pin) only if the TC35 module fails to shut down properly. Pushing this signal causes the loss of all information stored in the non volatile memory.

4.7.1 Timing of the ignition process

When designing your application platform take into account that powering up TC35 requires the following steps.

- The ignition line cannot be operated until V_{Batt+} passes the level of 3.3V.
- After V_{Batt+} has reached 3.3V the ignition line can be switched low. Duration of the falling edge must not exceed 1ms.
- Another 100ms are required to power up TC35.
- Ensure that V_{Batt+} does not fall below 3.3V while the ignition line is driven. Otherwise TC35 cannot be activated.

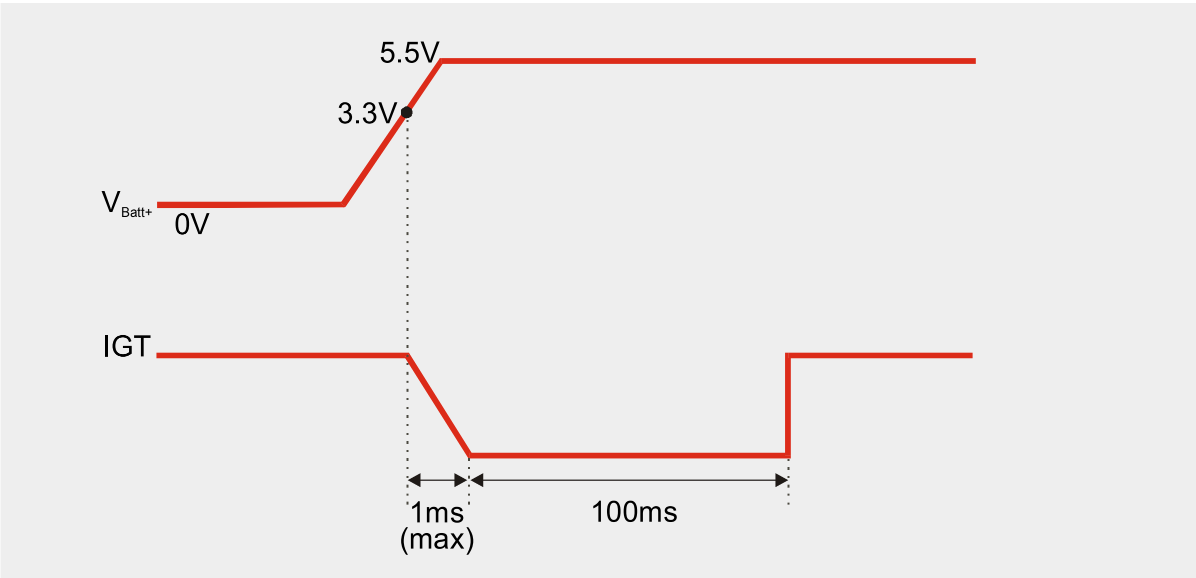


Figure 12: Timing of Power on process

4.7.2 Options of activating Power Down / Power On

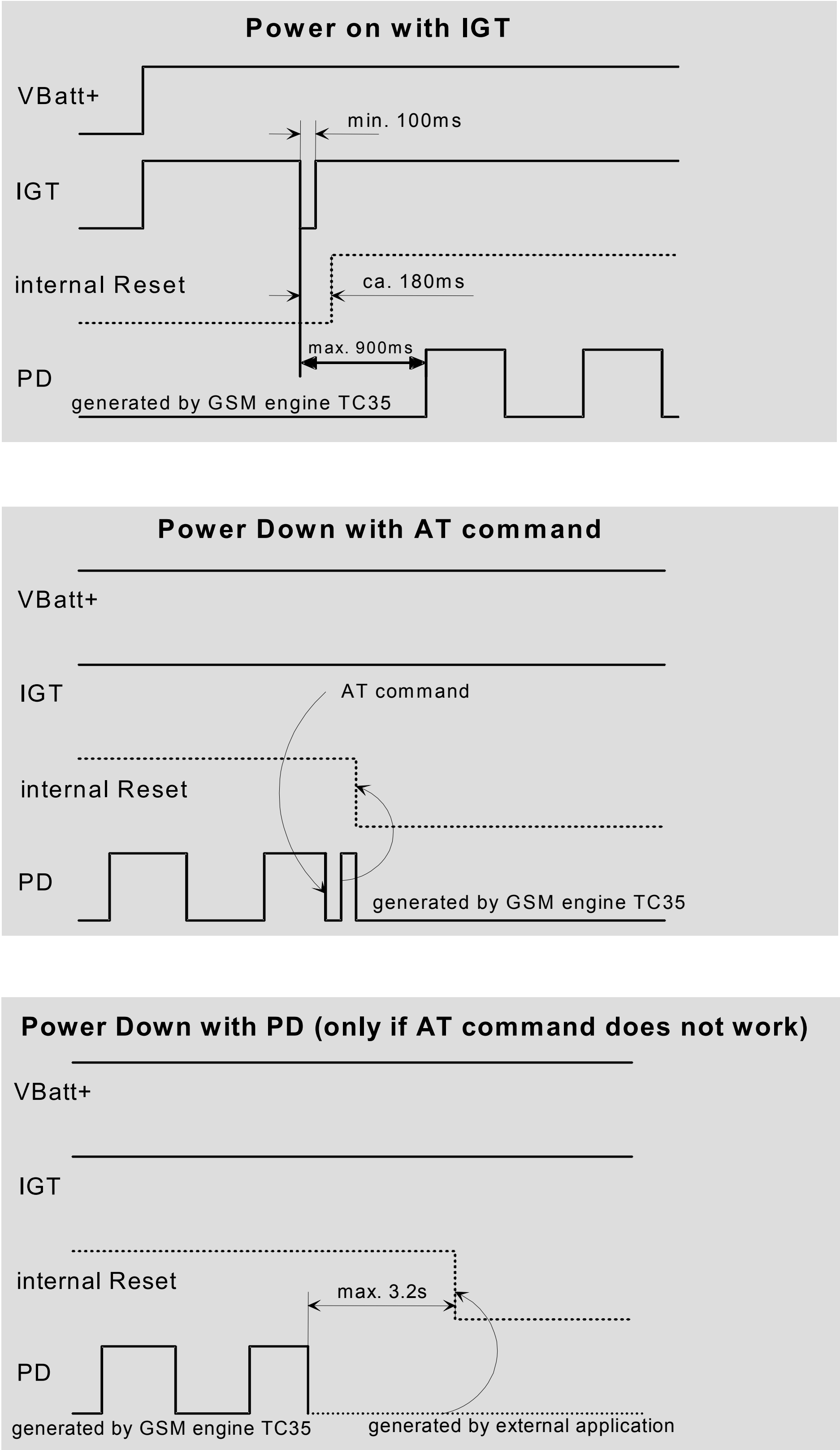


Figure 13: Power on / Power down

Table 6: State transitions TC35 (IGT, POWER (charger), AT-command, PD)

Further mod / Present mode	Power down	Normal mode**)	Charge only mode *)	Charging in normal mode*) **)
Power down mode without charger	---	IGT > 100ms at low-level	connect charger to POWER (high-level at POWER)	no direct transition, but via “Charge only mode” or “Normal mode”
Power down mode with charger (high-level at POWER)	---	no direct transition, but via “Power down mode without charger)	100ms < IGT < 500ms at low-level	IGT > 1s at low-level
Normal mode)**	AT-command or exceptionally PD > 3,2s at low-level	---	no direct transition, but via “Power down”	connect charger to POWER (high-level at POWER)
Charge only mode *)	disconnect charger (POWER at low-level) or exceptionally PD > 3,2s at low-level	no direct transition, but via “Charge in Normal mode”	---	IGT > 1s at low-level
Charging in normal mode*) **)	via “Charge only mode” or exceptionally PD > 3,2s at low-level	disconnect charger from POWER	AT command	---

*) See Chapter 4.2 for details on the charging mode.
**) Normal mode covers TALK, IDLE and SLEEP modes

4.8 Pin assignment

Please note that the reference voltages listed below are the values measured directly on the TC35 module. They do not apply to the accessories connected.

Table 7: Pin assignment

Function	Signal Name	Pin No.	I/O	Signal Level	Comment
Power supply	Batt+	1	I/(O)	*Input:*	Usage is mandatory Five power supply pins have to be connected in parallel due to peak current up to 2A
		2		V_{in} = 3.3V...5.5V	
		3		I_{max} ≤ 2.0A with a return loss better than ≥ 6dB (see Figure 1 and Figure 29)	
		4		I_{max} is valid only during uplink transmission timeslot (e.g. TALK mode: I_{max} for 577µs every 4.616ms)	
		5		*Output:* only valid when charging	
	GND	6	-	Ground (0V)	
		7			
		8			
		9			
		10			
Charger	POWER	11	I	V_{in} = 5.5V...15V transformer plug	If unused keep pin open
		12		V_{in} = 5.5V...8V regulated plug I_{min} = 350mA I_{max} = 550mA internal Pull Down (100kΩ)	
Supply voltage for external application	VDD	13	O	IDLE/TALK mode: V_{out} = 2.9V ±3% @ 70mA I_{max} = 70mA Power Down mode: V_{out} = 0V	If unused keep pin open
Battery temperature	AKKU_TEMP	14	I/O	External NTC: R_{NTC} = 10kΩ @ 25°C B = 3370 Kelvin ±3% connected to GND IDLE/ TALK mode: $V_{out,MEAS}(R_{NTC}$=10kΩ)=1.15V Power Down mode: V_{out} = 0V (internal Pull Down)	If unused keep pin open, else external NTC, which must be installed in the battery pack enables the charging algorithm and delivers temperature values
Ignition	IGT	15	I	IDLE/ TALK/ Power-Down mode: V_{out} = 2.0V R_{out} = 200kΩ $V_{low,max}$ = 0.45V @ I_{out} = 10µA t_{low} ≥ 100ms *(see Chapter 4.7!)* Signal: falling edge and hold for t_{low}	Usage is mandatory Open drain/collector driver or a simple switch is required to pull down this pin to power on the GSM Engine Signal is low active.

Function	Signal Name	Pin No.	I/O	Signal Level	Comment
RS232	DSR0	16	O	IDLE/ TALK mode: *Output* R_{out} = 1kΩ $V_{out,low,max}$ = 0.2V @ I = 0.1mA $V_{out,high,min}$ = 2.25V @ I = -0.1mA $V_{out,high,max}$ = 2.76V *Input* $R_i \geq$ 1MΩ (1kΩ serial resistor) $V_{in,low,min}$ = -0.3V, $V_{i,l,max}$ = 0.5V $V_{in,high,min}$ = 1.95V, $V_{i,h,max}$=3.3V Power Down mode: • Signals are low active. • Be aware of backward supply effects at the *inputs* and *outputs*	Application interface to control TC35 via AT commands If unused keep output pins open and connect input pins to GND via 10kΩ. 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 4.6.2.3. DCD0 and DTR0 lines are connected via internal clamp diodes to 2.65V and GND
	RING0	17	O		
	RxD0	18	O		
	TxD0	19	I		
	CTS0	20	O		
	RTS0	21	I		
	DTR0	22	I		
	DCD0	23	O		
SIM	CCIN	24	I	IDLE / TALK mode: SIM contact (active high) R_{PD} = 100kΩ (internal Pull Down resistor to GND) R_i = 10kΩ (serial resistor) $V_{in,low,max}$ = 0.4V @ I_{OUT} = 0.1mA $V_{in,high,min}$ = 1.95V, $V_{i,h,max}$ = 3.3V Power Down mode: 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 If a card is inserted CCIN has to be at high-level If not used connect to CCVCC
	CCRST	25	O	External C = 1nF to CCGND required	Usage is mandatory
	CCIO	26	I/O		Signal levels according to GSM Rec. (2) Wire must not exceed 200mm to meet the timing requirements of GSM Rec. 11.10
	CCCLK	27	O		
	CCVCC	28	O	$CCVCC_{min}$ = 2.84V $CCVCC_{max}$ = 2.96V I_{max} = 20mA External C $\geq$ 200nF to CCGND required	Usage is mandatory
	CCGND	29	-	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	O I	IDLE/TALK/Power Down mode if VBatt+ connected: V_{out} = VBatt+ - 0.6V $I_{out,max}$ = 100mA PD if VBatt+ disconnected: V_{in} = 2.0V...5.5V $I_{in,max}$ = 30µA $t_{RTC,on}$ ≈ 30s @ 100µF (typically)	If unused keep pin open (see chapter *0)*
Power down	PD	31	I/O	IDLE/ TALK mode: *Input:* R_i = 1kΩ; $V_{in,low,max}$ = 0.45V @ I = 0.1mA input signal ˜˜˜|_______|˜˜˜ active low ≥ 3.5s *Watchdog Output:* R_{out} = 22kΩ $V_{out,low}$ = 0.35V @ 0.01mA $V_{out,high}$ = 2.30V @ -0.01mA f_{out} = 0.5...2.0Hz Power Down mode: R_i ≈ 23kΩ	If unused keep pin open Open drain/collector driver or simple switch to GND required. PD switches TC35 off. A subsequent low pulse at pin IGT causes a reset of GSM Engine TC35 and the restart of the system.
Synchronization	SYNC	32	O	IDLE/ TALK mode: R_o = 1kΩ $V_{out,low,max}$ = 0.2V @ 0.1mA $V_{out,high,min}$ = 2.25V @ -0.1mA $V_{out,high,max}$ = 2.76V Power Down mode: be aware of backward supply	If unused keep pin open Indication of increased current consumption during uplink transmission burst

Function	Signal Name	Pin No.	I/O	Signal Level	Comment
Audio Interface	EPP2	33	O	R_i = 15Ω, (30kΩ if not active) V_{omax} = 3.7V_{pp}, no load, @ 3.14 dBm0, f = 1024Hz, audio mode = 6, outBbcGain = 0, outCalibrate = 32767	If unused keep pin open Differential output, e.g. for external loud-speaker amplifier for handsfree operation
	EPN2	34	O		
	EPP1	35	O	R_i = 15Ω, (30kΩ if not active) V_{omax} = 3.7V_{pp}, no load, @ 3.14 dBm0, f = 1024Hz, audio mode = 5, outBbcGain = 0, outCalibrate = 32767	If unused keep pin open Differential output, e.g. for internal ear-piece
	EPN1	36	O		
	MICP1	37	I	Z_i = 2kΩ V_{imax} = 1.03V_{pp} V_{supply} = 2.65V (0V if off), R_i = 4kΩ	Keep unused inter-face open Balanced input with switchable micro-phone supply source, e.g. for internal micro-phone
	MICN1	38	I		
	MICP2	39	I	Z_i = 2kΩ V_{imax} = 1.03V_{pp} V_{supply} = 2.65V (0V if off), R_i = 4kΩ	Keep unused inter-face open Balanced input with switchable micro-phone supply source, e.g. for external microphone for handsfree operation
	MICN2	40			

5 Radio interface

5.1 Overview

The RF part of the GSM Engine TC35 is based on the Transceiver Chip SMARTi. The transceiver consists of a heterodyne receiver part, an upconversion modulation loop transmitter, a RF PLL and fully integrated IF synthesizer.

5.2 Receiver

The receiver section of RF part provides the following features:

- Two low noise RF mixers for optimal dual band architectures
- Programmable Gain IF/Baseband amplifier strip by steps of 2dB
- Quadrature IF demodulator
- Differential I and Q outputs
- Programmable output DC level
- Automatic DC offset compensation

The signal received from the antenna first passes a gain programmable discrete low noise amplifier (LNA) in the receiver chain. After external filtering the double balanced RF signal is down converted to an intermediate frequency (IF) by a first mixer. The IF signal is passed through an external Surface Acoustic Wave (SAW) filter, which performs a rough channel selection. After that the signal is fed again into the receiver circuit to pass a digitally programmable gain-controlled amplifier (PGC). Finally the amplified IF signal is demodulated to baseband by a IQ demodulator. A differential offset introduced by the IQ demodulator is compensated by a sample-and-hold circuit. The resulting differential I and Q baseband signals are converted independently from analog to digital forming two 6.5Mbit/s data streams.

5.3 Transmitter

- Differential I and Q inputs
- IF quadrature modulator
- Integrated IF filters and down conversion mixer
- Digital 250MHz Phase Frequency Detector
- Programmable Charge pump current and phase detector polarity

The digital 10-bit I and Q baseband components (GMSK modulated and 8-times oversampled) provided by GSM baseband processor are converted in parallel from digital to analog. The resulting analog differential baseband signal is fed to the input of a quadrature amplitude modulator followed by the up-conversion loop. This up-conversion loop configuration converts the IF-band signal to the desired radio frequency in the 900MHz or 1.8GHz band. Finally a RF power module (Dual band) amplifies the RF signal to the required power. Ramping of the power amplifier is performed software controlled by 10-bit control values.

5.4 Antenna connector (antenna reference point – ARP)

An external antenna or application has to be connected to the antenna connector type GSC from Murata (for more detailed information refer to chapter 6.4).
The system impedance is 50Ω.

Table 8: Return loss

State of the module	Return loss of the module	Required return loss of application
receive	8dB min	10dB min
transmit	Not applicable	10dB min
idle	5dBmax	Not applicable

In every case, for good RF performance the return loss of the customer application should be better than 10dB (VSWR < 2). See also *chapter 8.4.2.*

The module will withstand a total mismatch at this connector when transmitting with power control level for maximum RF Power

6 Mechanical characteristics

6.1 ZIF connector

The 40-pin ZIF connector and the Flat Flexible Cable (FFC) used to connect the TC35 module to the cellular device application are illustrated below. For further details on the ZIF connector refer *to Figure 15 and Table 9.*

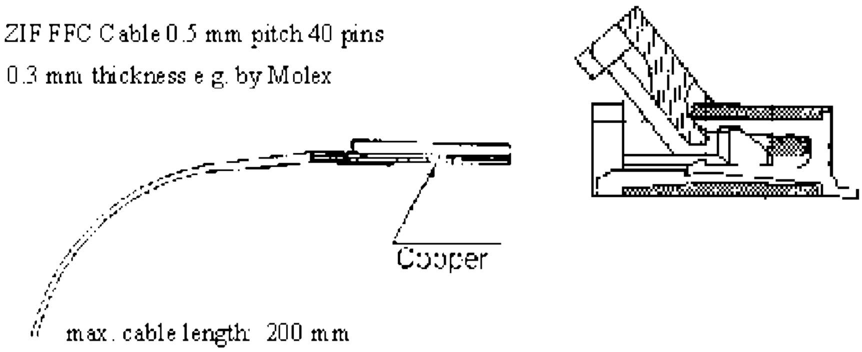


Figure 14: Detail drawing of ZIF connector

6.2 Mechanical dimensions of ZIF connector

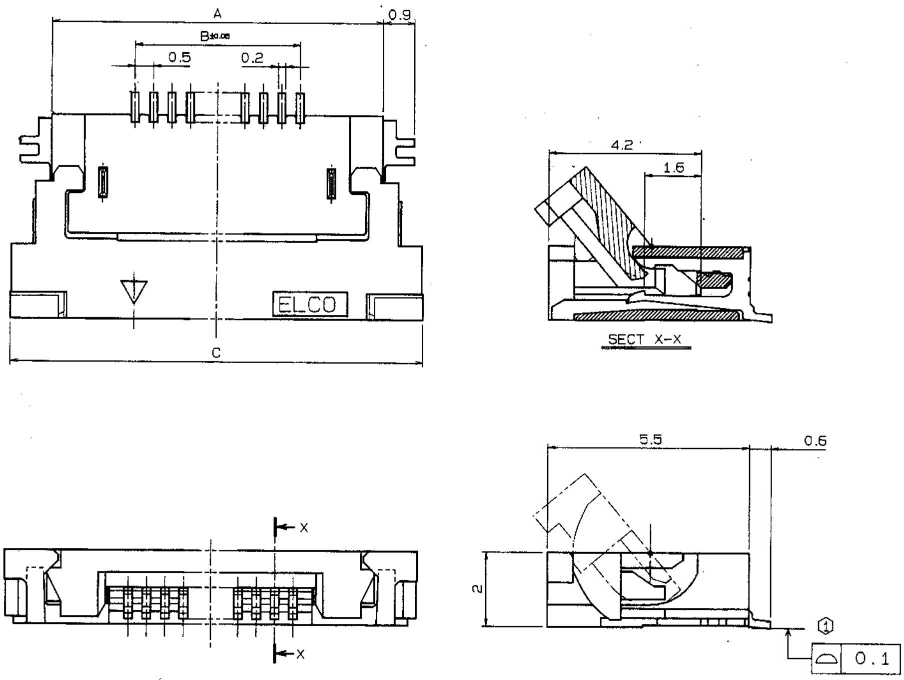


Figure 15: Mechanical dimensions of ZIF connector

6.3 PCB description of the ZIF connector

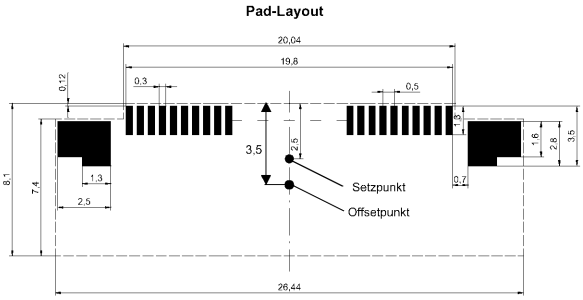


Figure 16: PCB ZIF connector

Table 9: Specification of ZIF connector

Parameter	Value (40 pin ZIF connector)
Number of Contacts	40
Quantity delivered	2000 Connectors per Tape & Reel
Voltage	50V
Current Rating	0.4A max
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

6.4 Antenna connector

The RF connection between the module and the customer application is made by the Murata coaxial connector type GSC.

- Part number of male connector mounted on the module: MM9329-2700
- Part numbers of further female connectors suited for cable assembly:
  - MXTK88xxxx (flexible cable)
  - MXTK92xxxx (flexible cable)
  - MXTK91xxxx (semirigid cable), for detailed information contact Murata

The physical dimensions and maximum mechanical stress limits can be gathered from the table and the figures below.

Table 10: Specification of antenna connector GSC type

Parameter	Value	Notes
Connector Durability	100 cycles of mating and withdrawal with a jig at 12 cycles/minute maximum	It is recommended to use a tool as shown in Figure 20.
Engage Force	30N max	
Disengage Force	3N min, 30N max	
Limit angle of engagement	15 degree max	See Figure 18. To fasten or remove the antenna cable it is recommended to use a tool as shown in Figure 20.
Mechanical stress to the connector	Stress to the housing: A and B 4.9N max	Figure 19
	Stress to outer sleeve: C: 2.94N max D: 1.96N max	Figure 19
	Cable pull strength: E: 4.9N max	Figure 19

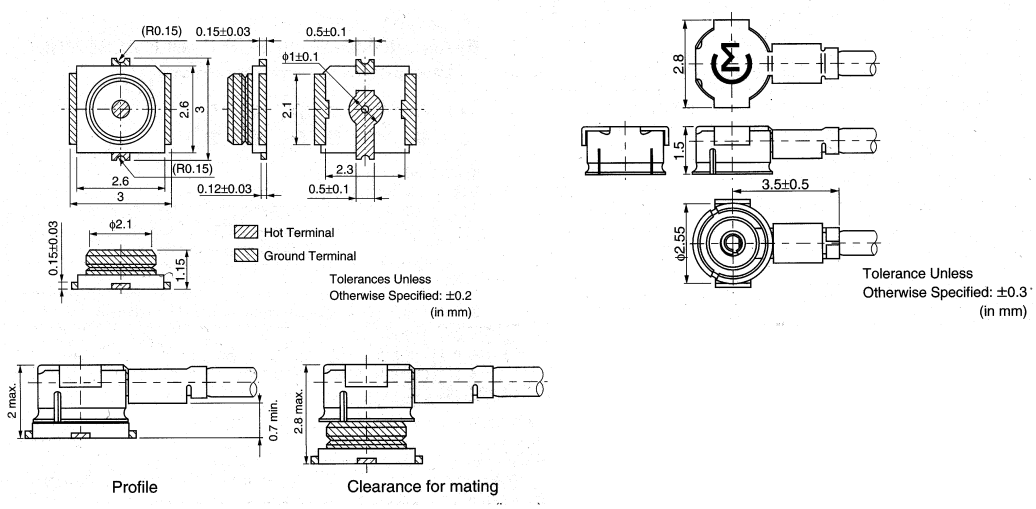


Figure 17: Mechanical dimensions

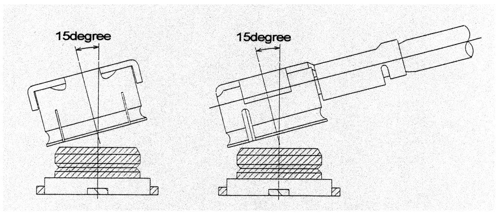


Figure 18: Limit angle of engagement (only)

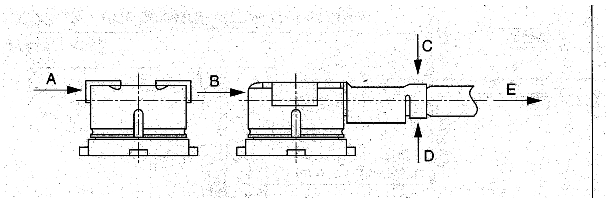


Figure 19: Maximum mechanical stress to the connector

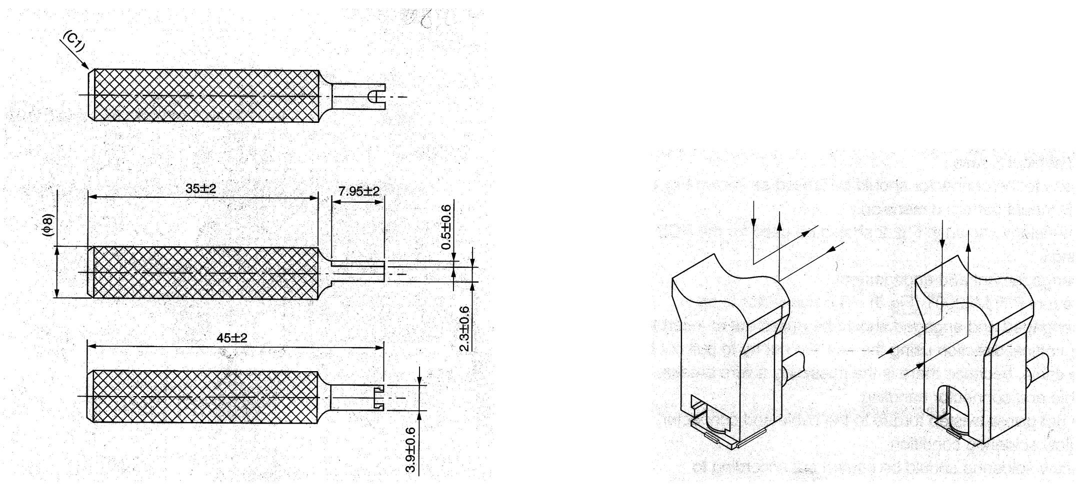


Figure 20: Engagement and disengagement tool, recommended by Murata

6.5 Exploded diagram

An exploded diagram of GSM Engine TC35 is given in *Figure 21.*

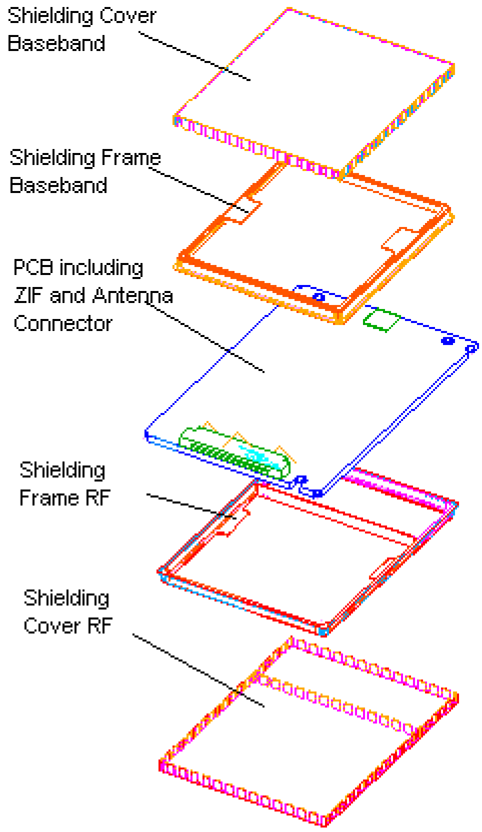


Figure 21: Exploded diagram of GSM Engine TC35

6.6 Weight of GSM Engine TC35

Approx. 11g (FFS).

6.7 Mechanical dimensions of the PCB of TC35

The PCB dimensions of GSM Engine TC35 can be gathered from *Figure 22.* The overall physical dimensions of the GSM Engine TC35 are 54.5 x 36 x 6.85mm (typically). The height of the antenna connector and the location of the ZIFF connector are not included.

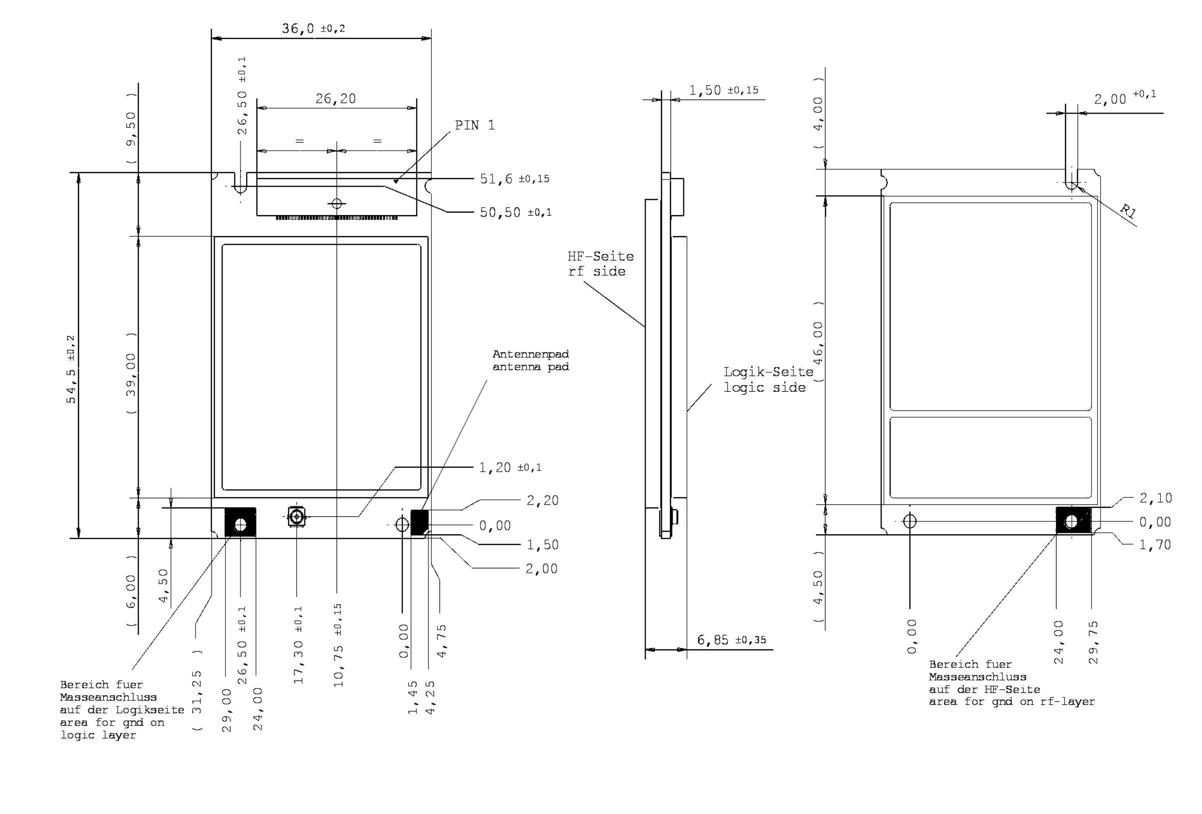


Figure 22: Mechanical dimensions of the PCB of TC35

7 Labeling

The label on the TC35 is placed onto the RF shielding of the TC35 as shown in *Figure 23.*
It has the same dimensions as the RF shielding cover and consists of two sections with identical content.
The label on the top can be placed onto the customer application. The second label must be placed on the TC35.

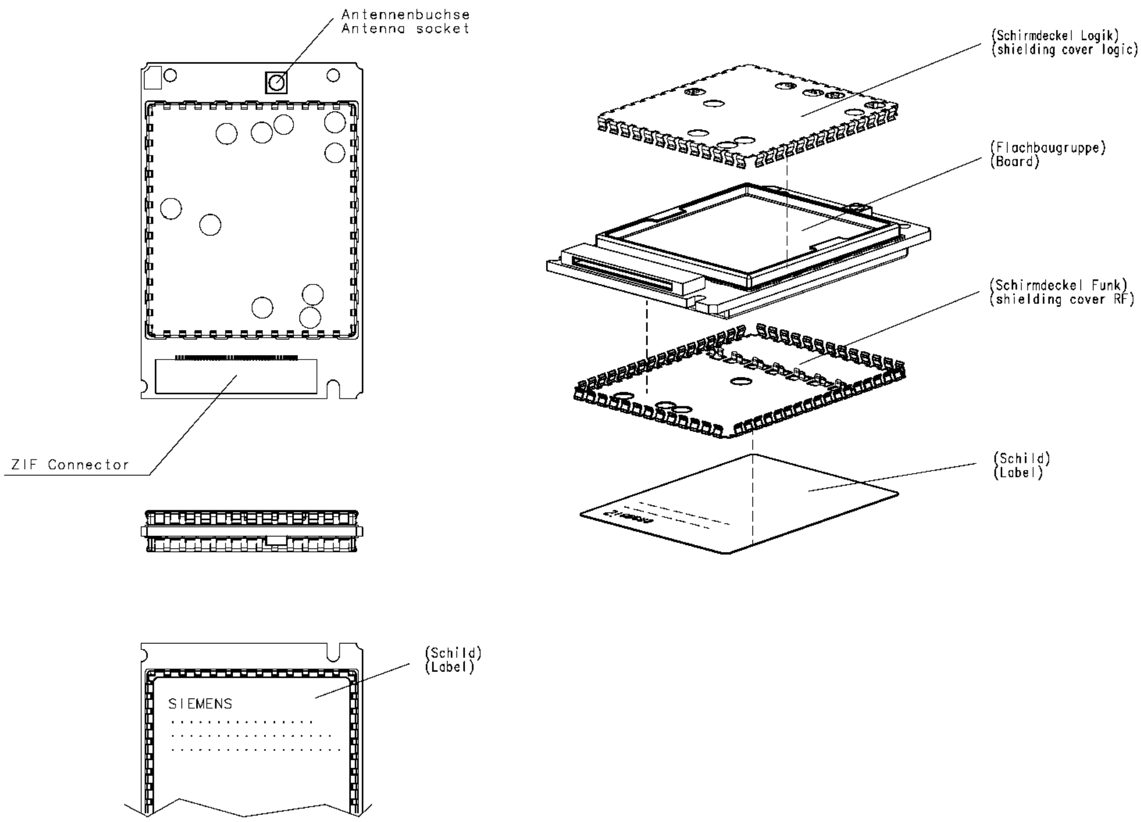


Figure 23: Label placing

7.1 Label dimensions

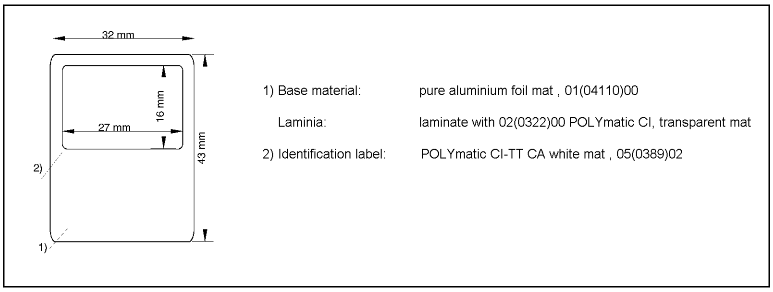
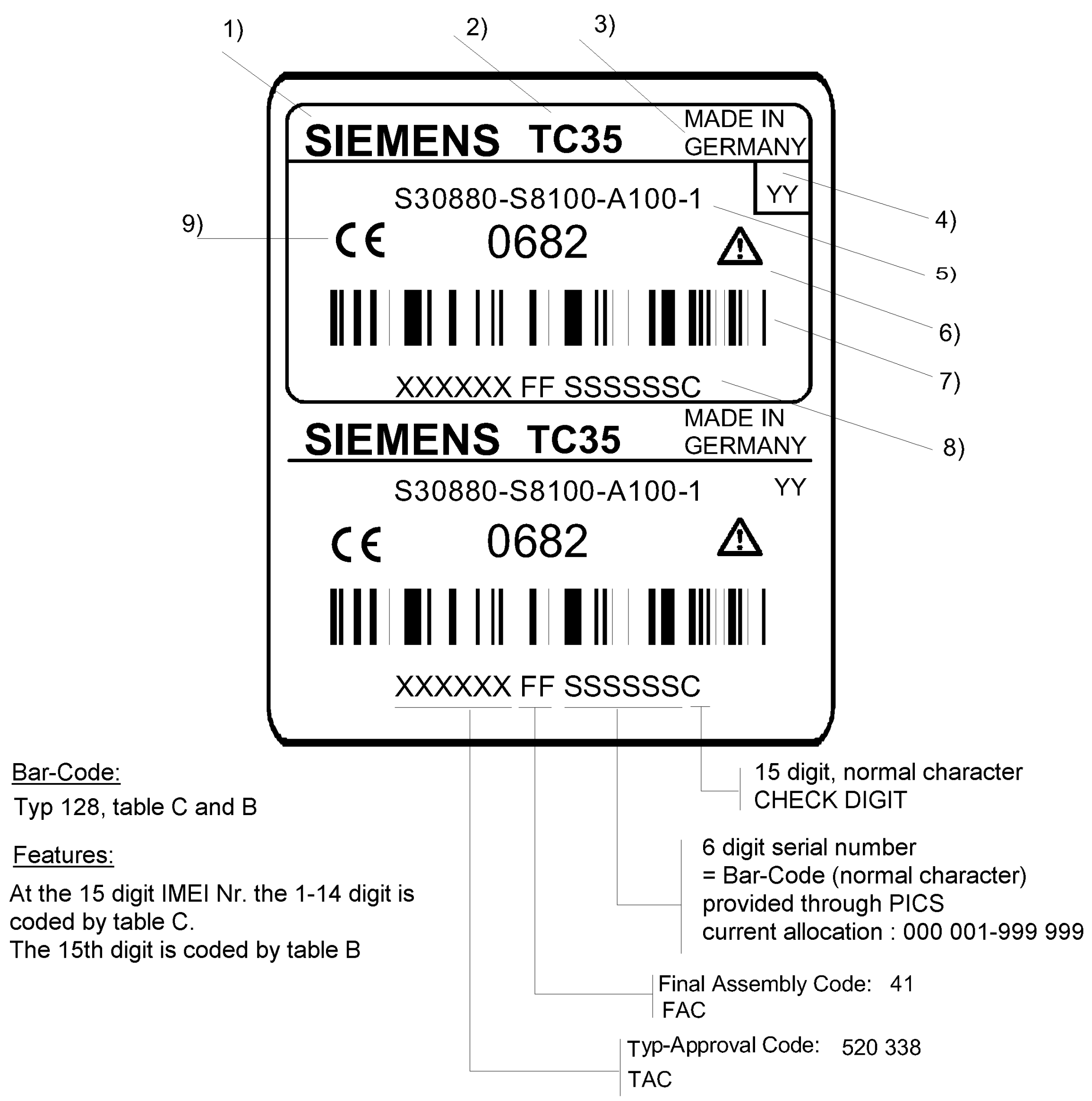


Figure 24: Label dimensions

7.2 Label marking

Label made of aluminium foil with 1 removable white label with black characters



1) Company name
2) Product name
3) Made in Germany
4) Date code
5) Code number
6) Note triangle
7) Barcode IMEI number
8) Normal character IMEI number
9) CE-Sign

Figure 25: TC35 Label

8 Electrical, temperature and radio characteristics

8.1 Absolute maximum ratings

Absolute maximum ratings for supply voltage and voltages on digital and analog pins of GSM Engine TC35 are listed in *Table 11*. Exceeding these values will cause permanent damage to the GSM Engine TC35.
The safety status of the power supply has to be SELV (as defined by EN60950). The supply current must be limited according to *Table 11*.

Table 11: Absolute maximum ratings

Parameter	Min	Max	Unit
Supply voltage V_{Batt+}	0	5.5	V
Peak current of power supply	0	4.0	A
RMS current of power supply (during one TDMA-frame)	0	0.5	A
Voltage on digital pins *)	-0.3	3.3	V
Voltage on analog pins *)	-0.3	3.0	V
Storage temperature	-40	+85	°C

*)Valid only in IDLE and TALK mode, if in Power Down mode absolute maximum ratings are ± 0.25 V.

8.2 Operating conditions

Table 12: Operating conditions

Parameter	Min	Typ	Max	Unit
Ambient temperature	-20	25	55	°C
Supply voltage V_{Batt+}	3.3	4.2	5.5	V

8.3 Temperature conditions

Table 13: Temperature conditions

Parameter	Min	Typ	Max	Unit
Ambient temperature (regarding GSM 11.10)	-20	25	55	°C
Restricted operation *)		55	70	°C
Automatic switch off			70**)	°C
Storage temperature ***)	-40		+85	°C

*) The TC35 works, but deviations from the GSM specification may occur.
**) Operating voltage: $Vbat_{max} \leq 4.0V$ when PCL5 is required at $Tamb_{max}$ = 70° (still air)
***) Storage temperature over the max. temperature can damage or destroy the TC35

8.4 Power supply

Table 14: Power supply

Parameter	Description	Conditions	Min	Typ	Max	Unit
V_{BATT+}	Supply voltage	Reference point on the module (TP301), voltage must stay in the min/max values, including voltage drop, ripple, spikes	3.3	4.2	5.5	V
	Voltage drop during transmit burst	Normal condition, power control level for Pout max			400	mV
I_{BATT+}	Average supply current	Power Down mode		50	100	µA
		SLEEP mode		3	3.5	mA
		IDLE mode		10	20	mA
		TALK mode		300	400	mA
	Peak supply current (during 577µs transmission slot every 4.6ms)	Power control level for P_{out} max		See Table 17 and Table 18		mA
I_{CHARGE}	Charging current	Li-Ion battery pack	350		550	mA
	Trickle charging				9.0	mA

8.4.1 Typical current vs power control level

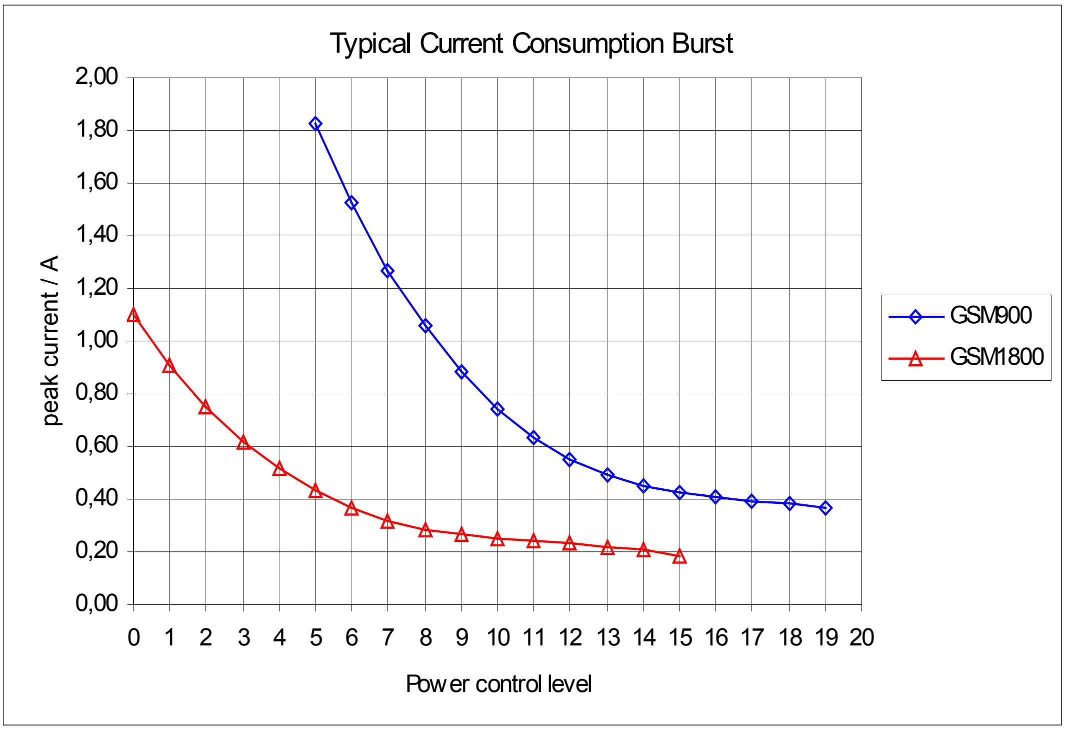


Figure 26: Typical current (peak) vs power control level

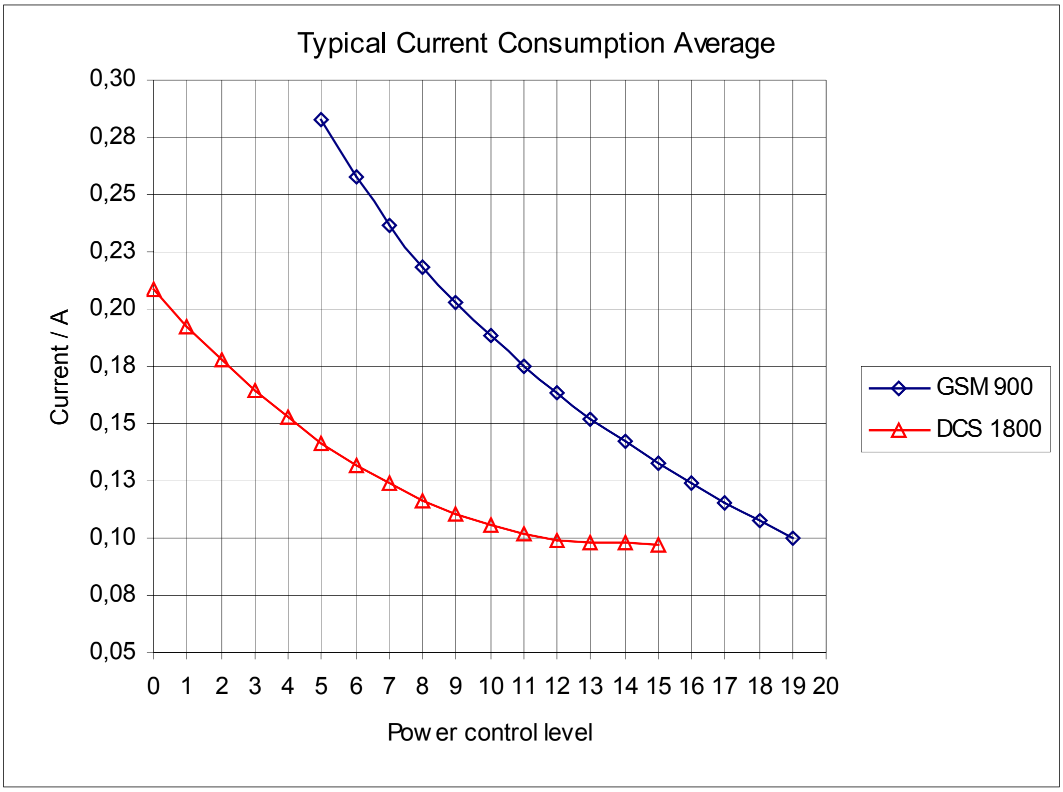


Figure 27: Typical current (average) vs power control level

Table 15: Power control levels GSM 900, power class 4

Power control level	Transmitter output power	Tolerances according to GSM 05.05	
	dBm	normal	extreme
5	33	+/- 2dB	+/-2,5dB
6	31	+/- 3dB	+/-4dB
7	29	+/- 3dB	+/-4dB
8	27	+/- 3dB	+/-4dB
9	25	+/- 3dB	+/-4dB
10	23	+/- 3dB	+/-4dB
11	21	+/- 3dB	+/-4dB
12	29	+/- 3dB	+/-4dB
13	17	+/- 3dB	+/-4dB
14	15	+/- 3dB	+/-4dB
15	13	+/- 3dB	+/-4dB
16	11	+/- 5dB	+/- 6dB
17	9	+/- 5dB	+/- 6dB
18	7	+/- 5dB	+/- 6dB
19	5	+/- 5dB	+/- 6dB

Table 16: Power control levels DCS 1800, power class 1

Power control level	Transmitter output power	Tolerances according to GSM 05.05	
	dBm	normal	extreme
0	30	+/- 2dB	+/-2,5dB
1	28	+/- 3dB	+/-4dB
2	26	+/- 3dB	+/-4dB
3	24	+/- 3dB	+/-4dB
4	22	+/- 3dB	+/-4dB
5	20	+/- 3dB	+/-4dB
6	18	+/- 3dB	+/-4dB
7	16	+/- 3dB	+/-4dB
8	14	+/- 3dB	+/-4dB
9	12	+/- 4dB	+/-5dB
10	10	+/- 4dB	+/-5dB
11	8	+/- 4dB	+/- 5dB
12	6	+/- 4dB	+/- 5dB
13	4	+/- 4dB	+/- 5dB
14	2	+/- 5dB	+/- 6dB
15	0	+/- 5dB	+/- 6dB

8.4.2 Peak current in dependency of the load mismatch

The following figures show the typical peak current in dependency of load mismatch during a transmit burst with the power control level for maximum RF power.

For a good performance the return loss of the customer application should be better than 10dB.

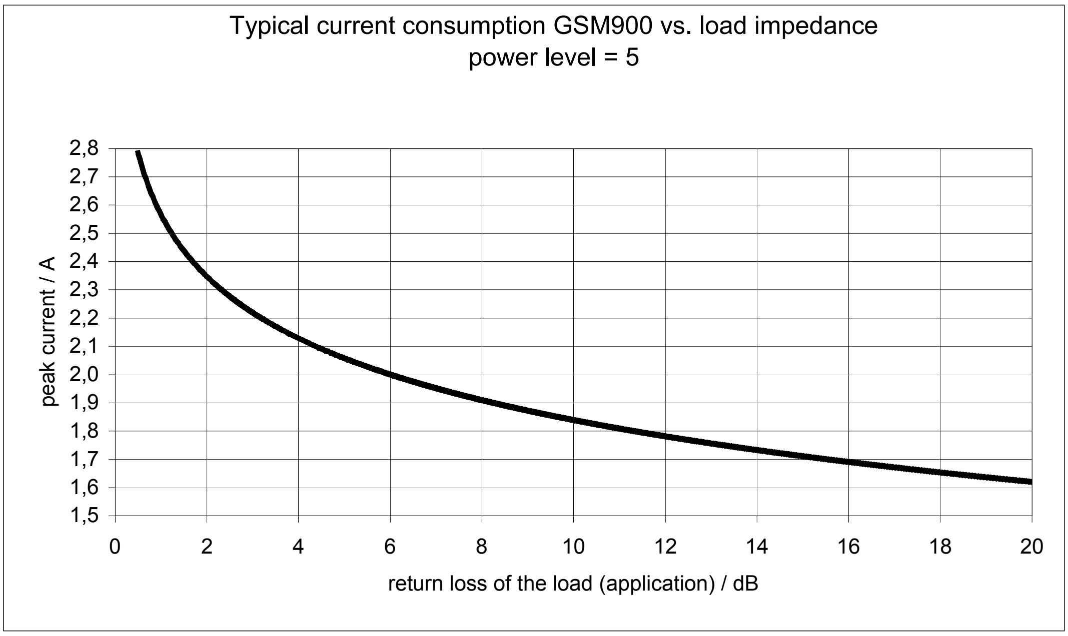


Figure 28: Typical current consumption for GSM 900, power level = 5

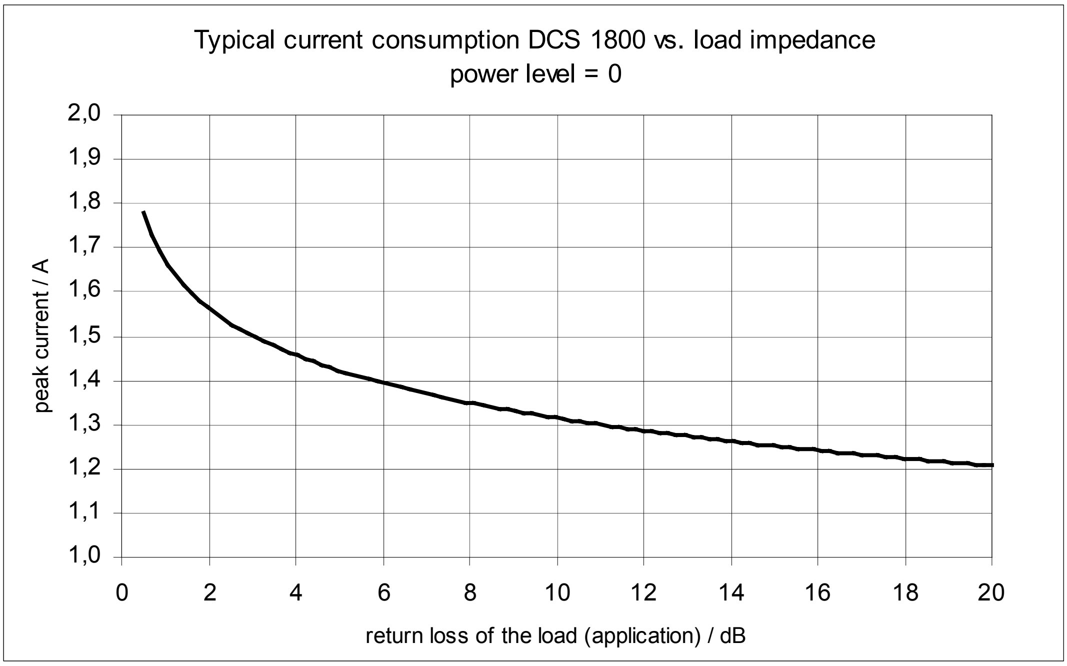


Figure 29: Typical current consumption for DCS1800, power level = 0

8.4.3 Typical peak current values for antenna load matching

Peak current during transmit burst at max. power level. Values for current and return loss refer to Figure 28 and Figure 29.

Table 17: GSM 900, power level 5

Typ	Return loss	VSWR (approx.)
1600 mA	20 dB	1.20
1800 mA	11 dB	1.75
2000 mA	6 dB *)	3.00
2300 mA	2.5 dB **)	9.00

Table 18: GSM 1800, power level 0

Typ	Return loss	VSWR (approx.)
1200 mA	20 dB	1.20
1300 mA	11 dB	1.75
1400 mA	6 dB *)	3.00
1500 mA	2.5 dB **)	9.00

The typical value of a dual band antenna is in the range of VSWR < 2.
*) mismatched antenna e.g. caused by bad dielectric or a mistuned antenna
**) short circuit at the GSC connector or broken (destroyed) antenna

8.5 Digital I/Os

Table 19: Digital I/Os

Parameter	Description	Conditions	Min	Typ	Max*)	Unit
V_{IL}	Logical 0 input level				0.6	V
V_{ICH}	Logical 1 input level		2.0	2.65	3.3	V
I_{in}	Input current	V_{in} = 3V			10	µA
		V_{in}=GND			-100	µA
V_{OL}	Logical 0 output level	I_{out} = 0.1mA	0	0.20	0.40	V
V_{OH}	Logical 1 output level	I_{out} = -0.1mA	2.30	2.45	2.76	V
R_{out}	Output Resistance				1.1	kΩ
t_{OR}	Output Rise time	$C_{LOAD} \leq$ 10p			100	ns
t_{OF}	Output Fall time				100	ns
t_{IR}	Permitted Input Rise time	$C_{LOAD} \leq$ 20p			500	ns
t_{IF}	Permitted Input Fall time				500	ns

*) The output values listed under Max are maximum values that are not applicable to each pin. For example, V_{OH} of the Power Down pin does not exceed 2,3V. Refer to Table 7 for details.

8.6 Electrical characteristics of the voiceband part

8.6.1 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 20: 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 present for each volume step[n]	0...32767	-∞...+6dB	20 * log (2 * outCalibrate[n]/ 32768)
sideTone	digital attenuation of sidetone is corrected internally by outBbcGain to obtain a constant sidetone independent of output volume	0...32767	-∞...0dB	20 * log (sideTone/ 32768)

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

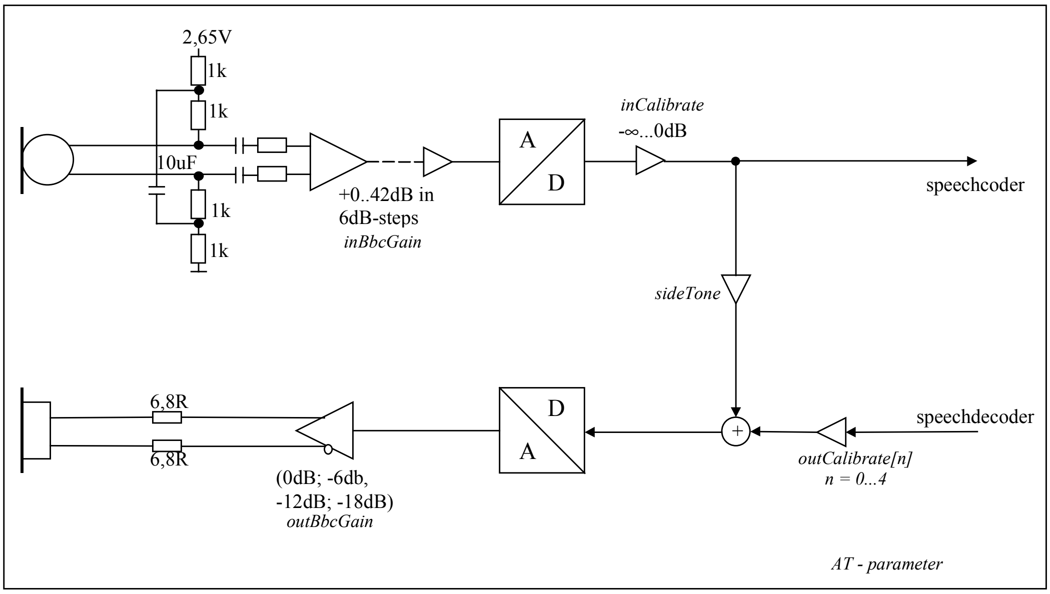


Figure 30: AT audio programming model

8.6.2 Characteristics of audio modes

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

Table 21: Voiceband characteristics

Mode No AT^SNFS=	**1**	**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 handset from customer	direct access to speech coder	direct access to speech coder
Gain setting via AT command	NO	YES	YES	YES	YES	YES
MICPn/MICNn EPPn/EPNn	n=1	n=2	n=2	n=1	n=1	n=2
Supply	ON	ON	ON	ON	OFF	OFF
Sidetone	YES	NO	YES	YES	YES	YES
Volume control	NO	YES	YES	YES	YES	YES
Limiter (receive)	YES	YES	YES	YES	NO	NO
Compressor (receive)	NO	YES *)	NO	NO	NO	NO
AGC (send)	NO	NO	YES	NO	NO	NO
Echo control (send)	Suppression	Cancellation + Suppression	NO	Suppression	NO	NO
Noise suppression	NO	YES	YES	NO	NO	NO
MIC input signal for 0dBm0 @ 1024 Hz (default gain)	11.54 mV	91.9 mV	n/a due to AGC	11.54 mV	308.5 mV	308.5 mV
EP output signal in mV eff. @ 0dBm0, 1024 Hz, no load (default gain); @ 3.14 dBm0	397.5 mV	561.4 mV default @ max volume	288 mV default @ max volume	397.5 mV default @ max volume	931.8 mV 3.7 Vpp	931.8 mV 3.7 Vpp
Sidetone gain at default settings	22 dB	n/a	n/a due to AGC	22 dB	-∞ dB	-∞ dB

All values are preliminary.
*) Adaptive, receive volume increases with higher ambient noise level.

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.

8.6.3 Voiceband receive path

The values specified below were tested to 1kHz and 0dB gain stage, unless otherwise stated.

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 22: 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 *gs* = 0dB @ 3.14 dBm0
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 VDD, temperature and life time
Attenuation distortion			1	dB	for 300...3900Hz, @ EPPx/EPNx (333Hz) / @ 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

8.6.4 Voiceband transmit path

The values specified below were tested to 1kHz and 0dB gain stage, unless otherwise stated.

Audio mode = 5 for MICP1 to MICN1 and 6 for MICP2 to MICN2, inBbcGain= 0, inCalibrate = 32767, outBbcGain = 0, OutCalibrate = 16384, sideTone = 0

Table 23: Voiceband transmit path

Parameter	Min	Typ	Max	Unit	Test condition/Remark
Input voltage (peak to peak) 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 Ri = 4kΩ	2.57 2.17 1.77	2.65 2.25 1.85	2.73 2.33 1.93	V V V	no supply current @ 100µA @ 200µA
Microphone supply voltage OFF ; Ri = 4kΩ		0		V	
Microphone supply in power down mode					see Figure 31

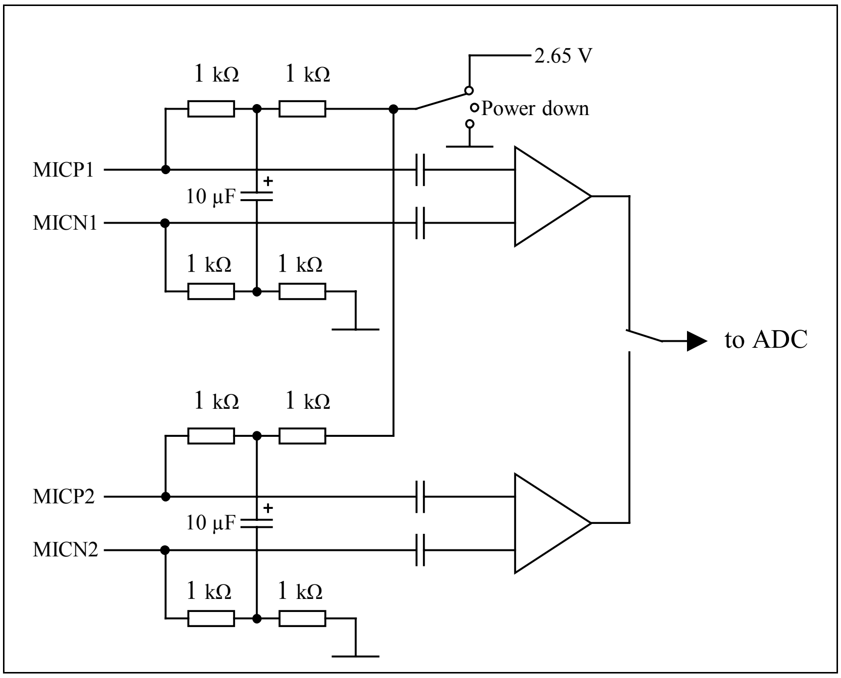


Figure 31: Structure of audio inputs

8.7 Air interface

Table 24: 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	33	35	dBm
	GSM 1800	28	30	32	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		
Time slots usable RX / TX			1 / 1		
Frame duration			4.615		ms
Time slot duration			577		µs
Modulation		GMSK			
Receiver input sensitivity @ ARP	E-GSM 900	- 102	-105		dBm
BER Class II < 2.4%	GSM 1800	- 102	-105		dBm

8.8 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.
Despite of this, the antenna port, the SIM interface, the Akku_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 over the application platform that incorporates the GSM engine.

Table 25: Measured electrostatic values

PIN No.	Signal name	Contact discharge (environment)	Air discharge (direct to TC35)
1 - 5	Batt+	>4kV	1.5kV
6 - 10	GND	>4kV	15kV
11 - 12	POWER	>4kV	15kV
13	VDD	>4kV	1.5kV
14	Akku_Temp	>4kV	15kV
15	IGT	>4kV	1.5kV
16 - 23	RS232-signals	>4kV	1.5kV
24 - 29	SIM-signals	>4kV	15kV
30	VDDLP	>4kV	1.5kV
31	PD	>4kV	1.5kV
32	SYNC	>4kV	1.5kV
33 - 40	Audio	>4kV	1.5kV
Antenna	HF-signal	>4kV	15kV
Antenna	HF-GND	>4kV	15kV

9 Reference Approval

9.1 Reference Equipment

The Siemens TC35 GSM engine has been approved for a reference configuration that satisfies all the requirements of GSM Phase 2/2+ (CTR 31, CTR 32).

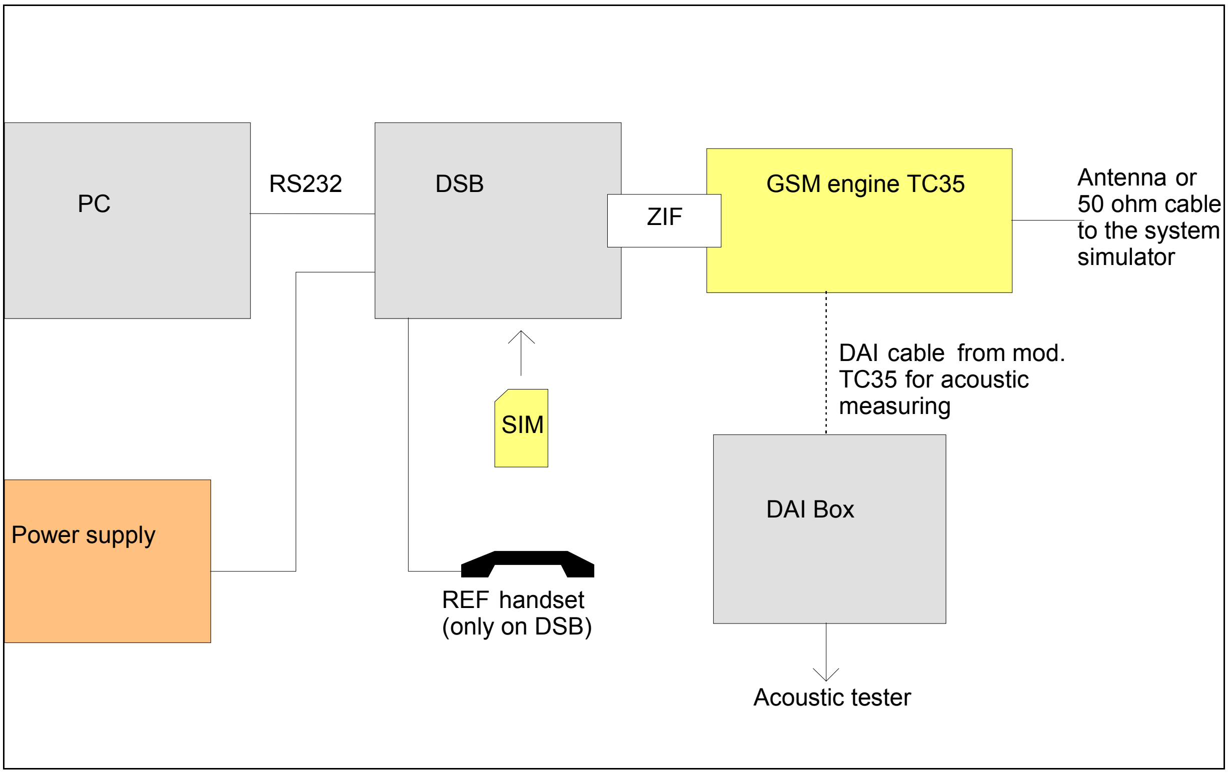


Figure 32: Reference Equipment for Approval

Referred to as "GSM terminal equipment" the reference configuration consists of the following components:
- Siemens TC35 GSM Engine
- Development Support Box (DSB)
- SIM card reader integrated on the DSB
- Handset Votronic standard handset type HH-V0-30.1
- PC as MMI

For the Siemens TC35, 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 the Siemens TC35 module.

Approved Siemens TC35 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.

9.2 CE Conformity

The TC35 module meets the requirements of EU directives listed below and is labeled with the CE conformity mark.

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

9.3 G.C.F. Conformity

The TC35 is approved under GCF-CCV and CCR, v. 3.20.

10 Accessory list for TC35

Table 26: List of accessories

Description	Supplier	Parts number (supplier)
Card colder SIM **Ejector Type SIM**	Molex	91228 91236
ZIF connector	AVX	04 6240 040 003 800
Flat cable for ZIF connector (cable 160 mm) (cable 80 mm)	Axon	 FFC 0.50 A 40 / 0160 K4.0-4.0-08.0-08.0SABB FFC 0.50 A 40 / 0080 K4.0-4.0-08.0-08.0SABB
RF cable GSC-GSC (cable 50 mm) (cable 100 mm)	Murata	 MXTK 88 TK 0500 MXTK 88 TK 1000
GSC connector	Murata	MM9329-2700 TB2
Handset	Votronic	HH-SI-30.3/V1.1/0