CINTERION
WIRELESS MODULES

Hardware Interface Description

MC35i Terminal

Version: 02.00a
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Tables

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0 Document history

Preceding document: "MC35i Terminal Hardware Interface Description" Version 02.00
New document: "MC35i Terminal Hardware Interface Description" Version **02.00a**

Chapter	What is new
1.2	Added MII standards to list of directives and standards (Table 4 and Table 5).

Preceding document: "MC35i Terminal Hardware Interface Description" Version 01.03
New document: "MC35i Terminal Hardware Interface Description" Version 02.00

Chapter	What is new
1.2	Added European Directive related to RoHS and WEEE. Updated list of directives and standards.
2	Further notes on firmware upgrade, therefore deleted extra chapter on same topic.
3.5	Updated Figure 3: MC35i Terminal circuit block diagram
3.5.1	More detailed description of external fuse.
3.5.2	Deleted info on EMC and resistors. Modified DTR description.
3.5.1.5	New chapter: Automatic thermal shutdown.
3.5.3.1	More detailed description of audio modes. Updated Figure 7: Audio block diagram.
5	More detailed description of operating conditions (added Table 16, Table 17, Table 18). Added Table 19: Storage conditions. Updated values in Table 15, Table 20, Table 21, Table 22.
3.5.6	Added notes on AT^SSYNC command and LED patterns.
6.3	More detailed description of EMC.
7	New ordering number for MC35i Terminal and power supply unit.
---	Deleted chapter "Maximum number of turn on/off cycles".

Preceding document: "MC35i Terminal Hardware Interface Description" Version 01.02a
New document: "MC35i Terminal Hardware Interface Description" Version 01.03

Chapter	What is new
2	Further notes on firmware upgrade, therefore deleted extra chapter on same topic.
3.5.1	Revised entire chapter.
3.5.6	More detailed description of LED patterns.
3.5.3	Revised chapter.

Preceding document: "MC35i Terminal Hardware Interface Description" Version 01.02
New document: "MC35i Terminal Hardware Interface Description" Version 01.02a

Chapter	What is new
1.1	Added Application Note 24: Application Developers' Guide
1.2, 6	MC35i Terminal now fully type approved and labeled with CE mark

1 Introduction

This document describes the hardware of the Cinterion MC35i Terminal. The information is intended for users, developers or manufacturers who design and build cellular applications beyond the standard setup. The scope of this document includes interface specifications, electrical issues and mechanical characteristics of MC35i Terminal. It specifies standards pertaining to wireless applications and outlines requirements that must be adhered to for successful product design. The MC35i Terminal is a compact GSM modem for the transfer of data, voice, SMS and faxes in GSM networks. Industrial standard interfaces and an integrated SIM card reader allow using MC35i Terminal easily as a dual band GSM terminal. The functionality of the Terminal corresponds to the features of the MC35i module.

1.1 References

[1]   MC35i AT Command Set for MC35i and MC35i Terminal, Version 02.00
[2]   Release Note, Version 02.00
[3]   Application Note 16: Upgrading MC35i Firmware
[4]   Application Note 24: Application Developers' Guide
[5]   Remote Sat User's Guide
[6]   GPRS Startup User's Guide
[7]   Multiplexer User's Guide
[8]   Multiplexer Driver Developer's Guide for Windows 2000 and Windows XP
[9]   Multiplexer Driver Installation Guide for Windows 2000 and Windows XP

Prior to using the GSM engine carefully read the latest product information provided in the Release Notes.

For further information visit the Cinterion Website:
http://www.cinterion.com

1.2 Directives and Standards

MC35i Terminal has been approved to comply with the directives and standards listed below.

Table 1: 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). The product is labeled with the CE conformity mark C E 0682	
89/336/EC	Directive on electromagnetic compatibility	
73/23/EC	Directive on electrical equipment designed for use within certain voltage limits (Low Voltage Directive)	
72/245/EC	Automotive EMC Directive	
2004/104/EC	Automotive EMC Directive	
2002/95/EC	Directive of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)	RoHS & WEEE compliant
2002/96/EC	Directive of the European Parliament and of the Council on waste electrical and electronic equipment (WEEE)	
2003/108/EC	Directive of the European Parliament and of the Council of 8 December 2003 amending directive 2002/96/ec on waste electrical and electronic equipment (WEEE)	

Table 2: Standards of type approval

3GPP TS 51.010-1	Digital cellular telecommunications system (Phase 2); Mobile Station (MS) conformance specification
EN 301 511 V9.0.2	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)
GCF-CC V3.18.0	Global Certification Forum - Certification Criteria
EN 301 489-1 V1.4.1	Candidate Harmonized European Standard (Telecommunications series) Electro Magnetic Compatibility and Radio spectrum Matters (ERM); Electro Magnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common Technical Requirements
EN 301 489-07 V1.2.1	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)

Table 3: Requirements of quality

IEC 60068	Environmental testing
DIN EN 60529	IP codes

Table 4: Standards of the Ministry of Information Industry of the People's Republic of China

SJ/T 11363-2006	"Requirements for Concentration Limits for Certain Hazardous Substances in Electronic Information Products" (2006-06).
SJ/T 11364-2006	"Marking for Control of Pollution Caused by Electronic Information Products" (2006-06). According to the "Chinese Administration on the Control of Pollution caused by Electronic Information Products" (ACPEIP) the EPUP, i.e., Environmental Protection Use Period, of this product is 20 years as per the symbol shown here, unless otherwise marked. The EPUP is valid only as long as the product is operated within the operating limits described in the Cinterion Hardware Interface Description. Please see Table 5 for an overview of toxic or hazardous substances or elements that might be contained in product parts in concentrations above the limits defined by SJ/T 11363-2006.

Table 5: Toxic or hazardous substances or elements with defined concentration limits

部件名称 Name of the part	有毒有害物质或元素 Hazardous substances					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
金属部件 (Metal parts)	O	O	O	O	O	O
电路模块 (Circuit modules)	X	O	O	O	O	O
电缆及电缆组件 (Cables and cable assemblies)	O	O	O	O	O	O
塑料和聚合物部件 (Plastic and polymeric parts)	O	O	O	O	O	O
O: 表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T11363-2006 标准规定的限量要求以下。 Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in SJ/T11363-2006. X: 表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T11363-2006标准规定的限量要求。 Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part *might exceed* the limit requirement in SJ/T11363-2006.						

1.3   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 MC35i Terminal. 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. Cinterion Wireless Modules GmbH 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.

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 dialing etc.). You may need to deactivate those features before you can make an emergency call.

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

If a power supply unit is used to supply the device, it must meet the demands placed on SELV circuits in accordance with EN60950. The maximum permissible connection length between the device and the supply source should not exceed 3m.

According to the guidelines for human exposure to radio frequency energy, an antenna connected to the FME jack of the device should be placed at least 20cm away from human bodies.

1.4 Terms and abbreviations

Table 6: Terms and abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
ARP	Antenna Reference Point
ASIC	Application Specific Integrated Circuit
ATC	AT Cellular
BTS	Base Transceiver Station
CB	Cell Broadcast
CODEC	Coder-Decoder
CPU	Central Processing Unit
DCE	Data Circuit terminating Equipment
DSP	Digital Signal Processor
DSR	Data Set Ready
DTR	Data Terminal Ready
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
FDMA	Frequency Division Multiple Access
FR	Full rate
G.C.F.	GSM Conformity Forum
GSM	Global Standard for Mobile Communication
HF	Hands-free
HR	Half rate
HW	Hardware
IC	Integrated Circuit
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
LVD	Low voltage Directive

Abbreviation	Description
Mbps	Mbits per second
MMI	Machine Machine Interface
MO	Mobile Originated
MS	Mobile Station
MT	Mobile Terminated
NC	Not Connected
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
R&TTE	Radio and Telecommunication Terminal Equipment
RAM	Random Access Memory
RF	Radio frequency
RI	Ring Indication
ROM	Read Only Memory
RX	Receive direction
SIM	Subscriber Identification Module
SMS	Short Message Service
SRAM	Static Random Access Memory
SW	Software
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
TX	Transmit direction
UART	Universal Asynchronous Receiver and Transmitter
VAD	Voice Activity Detection
ZIF	Zero Insertion Force

2   Key features of MC35i Terminal

Table 7: Key features

Feature	Implementation
Transmission	Voice, Data, SMS, Fax
Power supply	Single supply voltage 8V to 30V
GSM class	Small MS
Frequency bands	Dual Band E-GSM 900 and GSM 1800 Compliant to GSM Phase 2/2+
Transmit power	Class 4 (2W) for EGSM900 Class 1 (1W) for GSM1800
GPRS connectivity	GPRS multi-slot class 8 GPRS mobile station class B
SIM card reader	Internal
Supported SIM card	3V
External antenna	Connected via antenna FME connector
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 *GPRS:* *CSD:*	• GPRS data downlink transfer: max. 85.6 kbps (see Table 8) • GPRS data uplink transfer: max. 21.4 kbps (see Table 8) • Coding scheme: CS-1, CS-2, CS-3 and CS-4 • MC35i Terminal supports the two protocols PAP (Password Authentication Protocol) and CHAP (Challenge Handshake Authentication Protocol) commonly used for PPP connections. • Support of Packet Switched Broadcast Control Channel (PBCCH) allows you to benefit from enhanced GPRS performance when offered by the network operators. • CSD transmission rates: 2.4, 4.8, 9.6, 14.4 kbps, non-transparent, V.110 • Unstructured Supplementary Services Data (USSD) support
FAX	Group 3: Class 1, Class 2
Audio interface	Analog (Microphone, Earpiece)
Serial interface	• RS-232 interface, bi-directional bus for AT commands and data • Multiplex ability according to GSM 07.10 Multiplexer protocol • Baud rates from 300bps to 115200bps • Autobauding supports: 1200, 2400, 4800, 9600, 19200, 38.400, 57600 and 115200bps
Phonebook management	Supported phonebook types: SM, FD, LD, MC, RC, ON, ME

Feature	Implementation
Reset of MC35i Terminal	Reset via AT command or Power Down signal
Firmware upgrade	Upgradable via serial interface. Instructions for the firmware download can be found in [3].
Real time clock	Implemented (clock frequency 32.768kHz)
RoHS, WEEE	All hardware components are fully compliant with the EU RoHS and WEEE Directives
Ambient operating temperature	-20°C to +55°C Thermal shutdown protection
Humidity	max. 80 % relative humidity
Size	65x74x33 mm (approx.)
Weight	130g

Table 8: Coding schemes and maximum 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

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

3 Interface description

3.1 Overview

MC35i Terminal provides the following connectors for power supply, interfacing and antenna:

- 6-pole Western plug (female) for power supply, ignition, power down signal
- 4-pole Western plug (female) for audio accessory, such as a handset
- 9-pole (female) SUB-D plug for RS-232 serial interface
- FME Jack (male) for antenna (Radio Interface)
- SIM card holder

Status LED

Power supply

Audio interface   SIM card holder   RS-232 interface   Radio interface
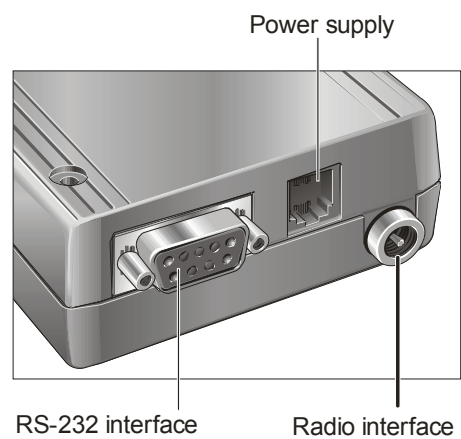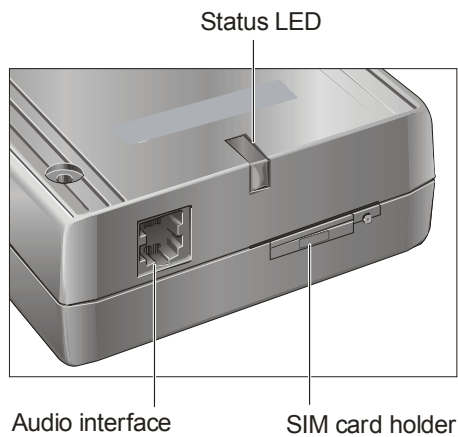
3.2 Block diagram of a GSM application

Figure 1 shows a block diagram of a sample configuration that incorporates a MC35i Terminal and typical accessories.
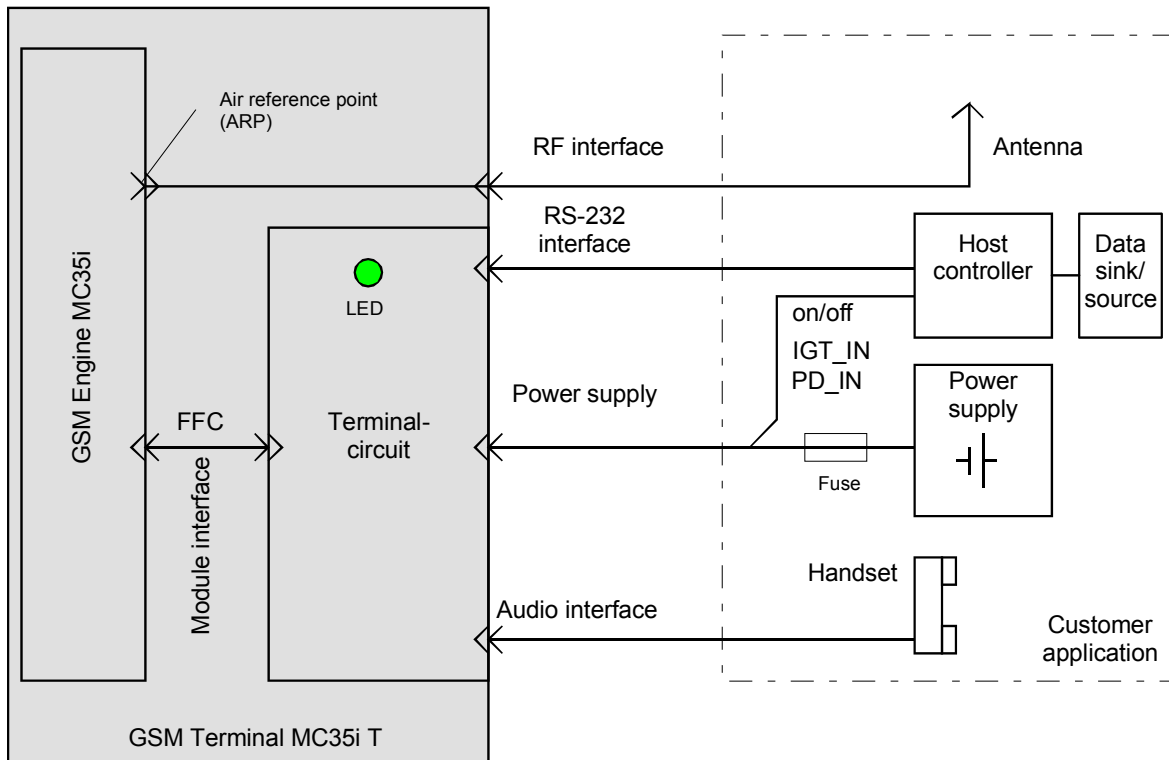
Figure 1: Block diagram of a MC35i Terminal application (example)

3.3   The MC35i GSM/GPRS engine

The MC35i GSM/GPRS engine is a major functional component of the MC35i Terminal that handles all the processing for audio, signal and data within a GSM/GPRS cellular device. Internal software runs the application interface and the whole GSM and GPRS protocol stack. A UART forms the interface to the Terminal Circuit.

Designed to easily provide radio connection for voice and data transmissions 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.

MC35i Terminal supports GPRS multislot class 8 (4 Rx, 1 Tx time slot) and 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.

A GSM baseband processor contains all analog and digital functionality of a cellular radio. Designed to meet the increasing demands of the GSM/PCS/GPRS cellular subscriber market, it supports FR, HR and EFR speech and channel coding without the need for external hardware.

The RF part of the GSM engine MC35i is based on a highly integrated single transceiver chip solution.

The internal antenna cable connects to the connector type GSC from Murata with a 50Ω impedance. This GSC connector is the ARP (Antenna Reference Point) for type approval measurements as well as for electrical characteristics.
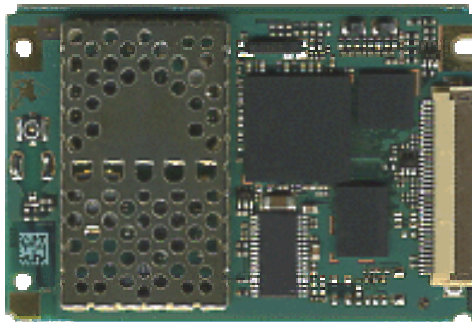
Figure 2: MC35i GSM engine

3.4 Operating modes

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

Table 9: Overview of operating modes

Mode	Function	
Normal operation	SLEEP	Various power saving modes set by AT+CFUN command. Software is active to minimum extent. If the Terminal was registered to the GSM network in IDLE mode, it remains, in SLEEP mode, registered and pageable from the BTS. Power saving can be chosen at different levels. The NON-CYCLIC SLEEP mode (AT+CFUN=0) disables the AT interface. The CYCLIC SLEEP mode AT+CFUN=5, 6, 7 and 8 alternatingly activate and deactivate the AT interface to allow permanent access to all AT commands.
	GSM IDLE	Software is active. Once registered to the GSM network, paging with BTS is carried out. The Terminal 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. DRX 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).
Power Down	Operating voltage 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.	

3.5　Terminal circuit
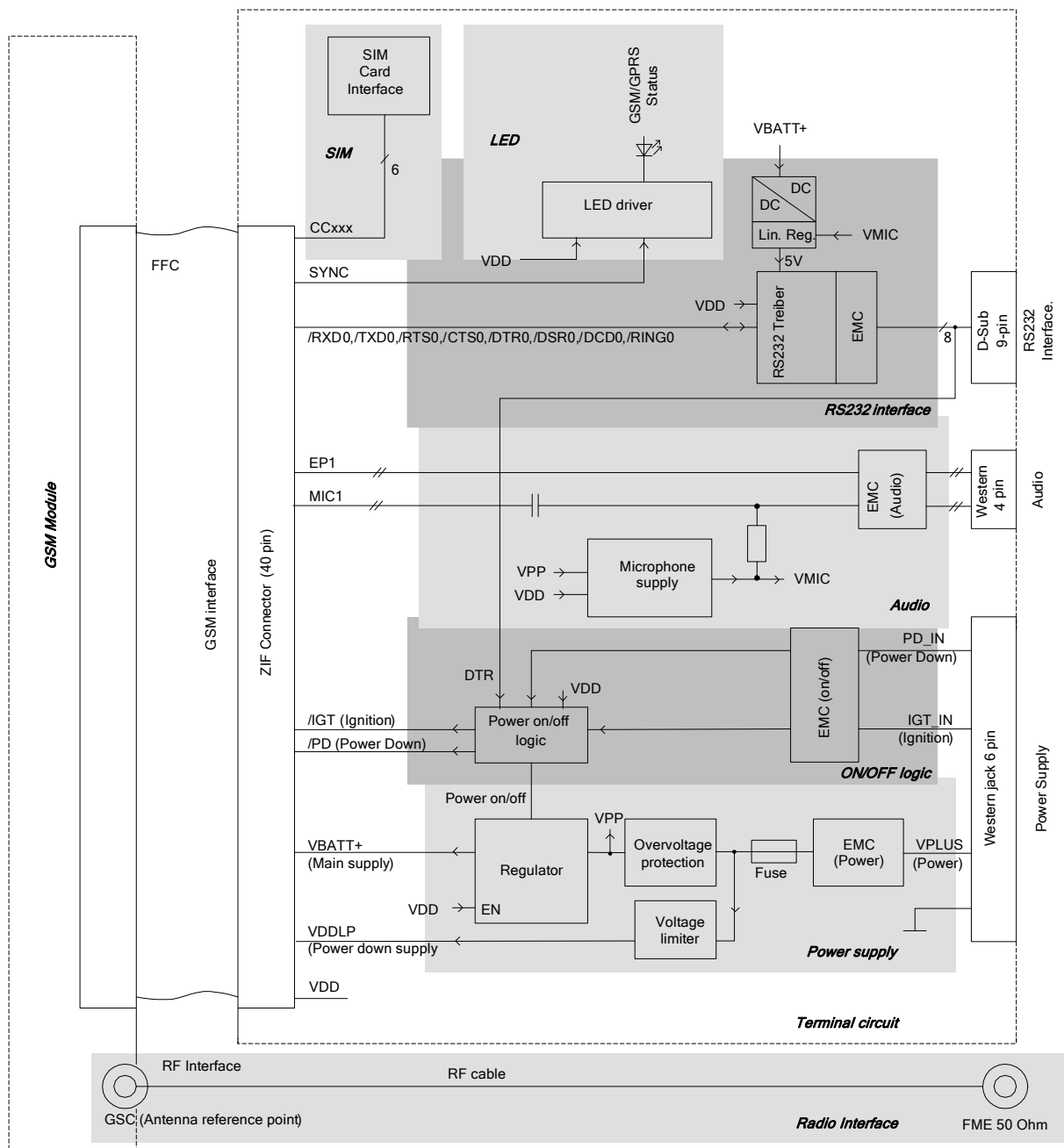
Figure 3: MC35i Terminal circuit block diagram

3.5.1   Power supply and On/Off control

The power supply of the MC35i Terminal has to be a single voltage source of V_{PLUS}=8V…30V capable of providing a peak current (pulsed 577ms at T=4.615ms) of about 1.2A at 12V during an active transmission. The uplink burst causes strong ripple (drop) on the power lines. The drop voltage should not exceed 1V, but the absolute minimum voltage during drops must be >7.6V.

The MC35i Terminal is protected from supply voltage reversal and overvoltage. An internal fuse that is not removable is intended for electrical safety according to EN60950. An external fast acting fuse ≥0.4A with melting integral I²t (0.15 … 0.25)A²s is necessary to use the MC35i Terminal at a 12V or 24V power supply system for vehicles.

The power supply must be compliant with the EN60950 guidelines.

A switching regulator regulates the input voltage for the internal supply. In POWER DOWN mode the switching regulator is turned off by the On/Off logic. A separate voltage regulator supplies the real time clock (RTC) in the GSM engine.

When power fails for >1ms, MC35i Terminal resets or switches off. When power fails for >7s the RTC will be reset.

Table 10: Female 6-pole Western plug for power supply, ignition, power down

Pin	Signal name	Use	Parameters
1	PLUS	Power supply	8V – 30V DC, max. 33V for 1 min
2	free	---	---
3	PD_IN	Signal for POWER DOWN mode	U_{IH} ≥5V for t>3.5s turns the terminal off. U_{IL} <2V and low level for normal operation.
4	IGT_IN	Ignition[*)]	U_{IH} ≥5V Ignition ≥5V for more than 200ms switches the MC35i Terminal on. Ignition is activated only by a rising edge. The rise time is <20ms
5	free	---	---
6	GND	Ground	0V

Pin assignment:

1 +
2 free
3 PD_IN
4 IGT_IN
5 free
6 GND
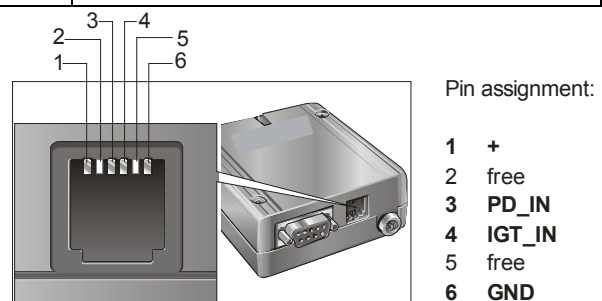
Figure 4: 6-pole Western jack for power supply, ignition, power down

Mains adapter: If it fits into the design of your GSM application we recommend the plug-in supply unit used with the type approved Cinterion reference setup. Ordering information can be found in Chapter 7. This 12V mains adapter comes with a 6-pole Western plug and provides an internal connection between IGT_IN pin and PLUS pin for auto ignition (power up).

3.5.1.1   Turn MC35i Terminal on

The IGT_IN signal (pin 4) switches the MC35i Terminal on. After start-up, the MC35i Terminal enters the net searching state. The IGT_IN signal is activated when an appropriate power supply unit is plugged to the 6-pole Western jack.

While the PD_IN pin (pin3) is not active (voltage <2V) you can start the MC35i Terminal by activating the RS-232 DTR line.

3.5.1.2   Reset MC35i Terminal

An easy way to reset the MC35i Terminal is entering the command AT+CFUN=x,1. For details on AT+CFUN please see [1].

As an alternative, you can shut down the MC35i Terminal as described in Section 3.5.1.3 and then restart it as described in Section 3.5.1.1.

3.5.1.3   Turn MC35i Terminal off

Normal shutdown:
- To turn off the MC35i Terminal use the AT^SMSO command, rather than disconnecting the mains adapter.
  This procedure lets the MC35i Terminal log off from the network and allows the software to enter a secure state and save data before disconnecting the power supply. After AT^SMSO has been entered the MC35i Terminal returns the following result codes:
      ^SMSO: MS OFF
      OK
      ^SHUTDOWN

  The "^SHUTDOWN" result code indicates that the MC35i Terminal turns off in less than 1 second. After the shutdown procedure is complete the MC35i Terminal enters the POWER DOWN mode. The green status LED stops flashing (see Section 3.5.6 for a detailed LED description). The RTC is still fed from the voltage regulator in the power supply ASIC.

Emergency shutdown:
- In the event of software hang-ups etc. the MC35i Terminal can be switched off by applying a voltage >5V to the PD_IN pin (pin 3) for more than 3.5s.
  The PD_IN signal switches the MC35i Terminal off. All internal supply voltages are off, except for the power down voltage, which still feeds the real-time clock (RTC).

  Caution: Use the PD_IN 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 MC35i Terminal fails to shut down properly.

When the MC35i Terminal enters the POWER DOWN mode, e.g. after you have issued the AT^SMSO command or activated the PD_IN signal, all RS-232 interface lines are active for a period of 50ms to max. 3.5s. This may cause undefined characters to be transmitted on the RS-232 lines which can be ignored.

3.5.1.4   Disconnecting power supply

Before disconnecting the power supply from the PLUS pin, make sure that the MC35i Terminal is in a safe condition. The best way is to wait 1s after the "^SHUTDOWN" result code has been indicated.

3.5.1.5   Automatic thermal shutdown

An on-board NTC measures the temperature of the built-in MC35i module. If over- or undertemperature is detected on the module the MC35i Terminal automatically shuts down to avoid thermal damage to the system. Table 17 and Table 18 specify the ambient temperature thresholds for the MC35i Terminal and the equivalent thresholds of the MC35i module.

The automatic shutdown procedure is equivalent to the power-down initiated with the AT^SMSO command, i.e. MC35i Terminal logs off from the network and the software enters a secure state avoiding loss of data. In IDLE mode it takes typically one minute to deregister from the network and to switch off.

Alert messages transmitted before the MC35i Terminal switches off are implemented as Unsolicited Result codes (URCs). For details see the description of AT^SCTM command provided in [1].

Thermal shutdown will be deferred if a critical temperature limit is exceeded, while an emergency call or a call to a predefined phone number is in progress, or during a two minute guard period after power up. See [1] for details.

3.5.1.6   RTC

The internal Real Time Clock (RTC) of the MC35i Terminal retains the time and date and handles the alarm (reminder) function. The AT+CCLK command serves to set the time and date, and AT+CALA specifies a reminder message. See [1] for details.

A dedicated voltage regulator backs up the RTC even in POWER DOWN mode and enables MC35i Terminal to keep track of time and date.

However, please note that the Alarm mode described in [1], Section AT+CALA, is not intended for the MC35i Terminal. The AT+CALA command can only be used to set a reminder message, but not to configure the mobile to wake up from POWER DOWN mode into Alarm mode. Therefore, after setting a timer with AT+CALA be sure not to shut down the MC35i Terminal by AT^SMSO or PD_IN signal.

3.5.2   RS-232 interface

Via RS-232 interface, the host controller controls the MC35i Terminal and transports data.
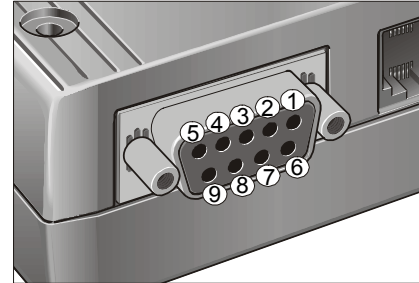
Figure 5: Pin assignment RS-232 (D-Sub 9-pole female)

Table 11: 9-pole D-Sub (female) RS-232

Pin no.	Signal name	I/O	Function
1	/DCD	O	Data Carrier Detected
2	/RXD	O	Receive Data
3	/TXD	I	Transmit Data
4	/DTR	I	Data Terminal Ready Attention: The ignition of MC35i Terminal is activated via a rising edge of high potential (+3 ... +15 V)
5	GND	-	Ground
6	/DSR	O	Data Set Ready
7	/RTS	I	Request To Send
8	/CTS	O	Clear To Send
9	/RI	O	Ring Indication

MC35i Terminal 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 TXD of MC35i Terminal
- Port RxD @ application receives data from RXD of MC35i Terminal

The RS-232 interface is implemented as a serial asynchronous transmitter and receiver conforming to ITU-T V.24 Interchange Circuits DCE. It 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 bit rates from 4.8kbps to 115kbps. Hardware handshake using the /RTS and /CTS signals and XON/XOFF software flow control are supported.

In addition, the modem control signals /DTR[*], /DSR, /DCD and /RING are available. The modem control signal RING (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.

[*]   *Note: The /DTR signal will only be polled once per second from the internal firmware of MC35i.*

3.5.3 Audio interface

The audio interface provides an analog input for a microphone and an analog output for an earpiece.

- The microphone input and the earpiece output are balanced.
- For electret microphones a supply source is implemented.
- The microphone supply characteristics are optimized for the recommended Votronic handset. This handset has been used as the reference handset for type approval (see chapters 6 and 7). An extra approval must be obtained for integrating other handsets or amplifiers.

The amplification of sending direction, receiving direction and sidetone depend on the current audio mode.

EMC immunity complies with the vehicular environment requirements according to EN 301 489-7.

Pin assignment:

1	**MICN (Microphone -)**
2	**EPN (Earpiece)**
3	**EPP (Earpiece)**
4	**MICP**

(Microphone +)
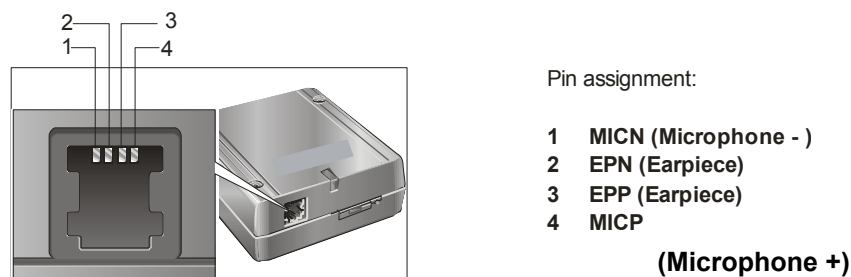
Figure 6: Audio Western plug (4-pole female)
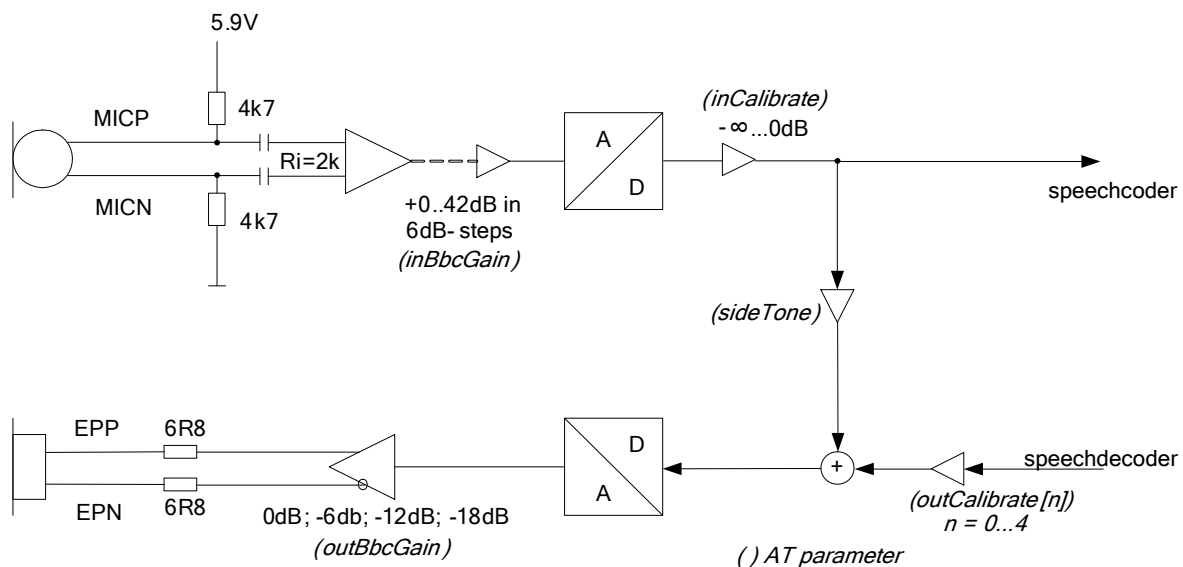
Figure 7: Audio block diagram

3.5.3.1 Supported audio modes

The audio interface can be configured by AT commands. Refer to [1] for details.

The electrical characteristics of the voiceband part vary with the audio mode. Specifications are listed in Table 24. To suit several types of audio equipment, three audio modes given by default can be selected by the AT command AT^SNFS.

Regarding audio performance, compliance with the TS 51010-1 specification and GCF recommendations has been certified for the parameters provided by audio mode 1 and audio interface 1. The settings are optimized for the reference handset (type Votronic) connected to the MC35i Terminal. To ensure that the reference parameters are always within the limits demanded by the standards they cannot be changed by AT command. Furthermore, the reference parameters are set as factory default.

In audio mode 4 and 5, the gain in the microphone, earpiece and the sidetone path can be adjusted from the cellular device application by using further AT commands.

Please note that the 2nd audio interface of the MC35i module is not connected in the MC35i Terminal. Audio modes 2, 3 and 6 can be selected by setting AT^SAIC=2,1,1, for further details refer to [1].

Table 12: Audio modes

Audio mode number: AT^SNFS=	1 (Default settings, not adjustable)	4	5
Audio mode name	Default Handset	User Handset	Plain Codec 1
Purpose	Recommended handset (see chapter 6)	User provided handset	Direct access to speech coder
Gain programmable via AT command	NO	YES	YES
Sidetone	YES	YES	YES
Volume control	NO	YES	YES
Limiter (receive)	YES	YES	NO
Echo control (send)	Suppression	Suppression	NO
MIC input signal for 0dBm0 @ 1024 Hz (at default gain settings)	12.5 mV	12.5 mV	315 mV
Earpiece output signal in mV eff. @ 0dBm0, 1024 Hz, no load (at default gain settings); @ 3.14 dBm0	275 mV	275 mV default @ max volume	880 mV 3.7 Vpp
Sidetone gain (at default settings)	27.7 dB	27.7 dB	-∞ dB

3.5.3.2   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.

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

3.5.4   Radio interface

An internal antenna cable adapts the antenna reference point (antenna connector type GSC from Murata) to the FME (male) connector. The position of the antenna reference point can be seen in Figure 1.

- Cable loss of the internal cable
    <0.4dB @ 900MHz
    <0.6dB @ 1800MHz
- The system impedance is 50Ω.
- In every case, for good RF performance the return loss of the customer application should be better than 10dB (VSWR < 2).
- MC35i Terminal withstands a total mismatch at this connector when transmitting with power control level for maximum RF power.

Inside the MC35i module a 27nH inductor to ground provides additional ESD protection to the antenna connector. For details see Figure 8. To protect the inductor from damage no DC voltage must be applied to the antenna circuit.
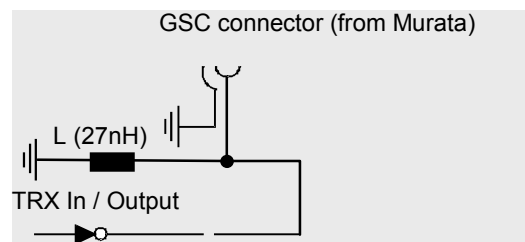
Figure 8: Antenna connector circuit on MC35i module

EMC immunity complies with the vehicular environment requirements according to EN 301 489-7.

For the application it is recommended to use an antenna with the following FME (female) connector:
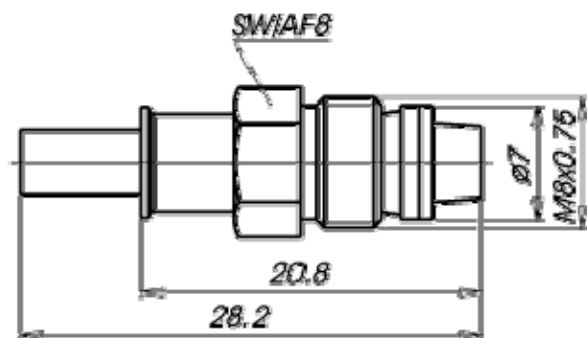
Figure 9: Recommended antenna connector

3.5.5   SIM interface

The SIM interface is intended for 3V SIM cards in accordance with GSM 11.12 Phase 2. The card holder is a five wire interface according to GSM 11.11. A sixth pin has been added to detect whether or not a SIM card is inserted.

All signals of the SIM interface are protected from electrostatic discharge with spark gaps to GND and clamp diodes to 2.9V and GND.
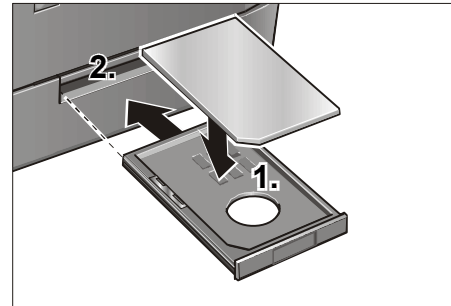
Removing and inserting the SIM card during operation requires the software to be reinitialized. Therefore, after reinserting the SIM card it is necessary to restart MC35i Terminal.

Note: No guarantee can be given, nor any liability accepted, if loss of data is encountered after removing the SIM card during operation.
Also, no guarantee can be given for properly initializing any SIM card that the user inserts after having removed a SIM card during operation. In this case, the application must restart MC35i Terminal.

3.5.6 Status LED

A green LED displays the operating status of the terminal:
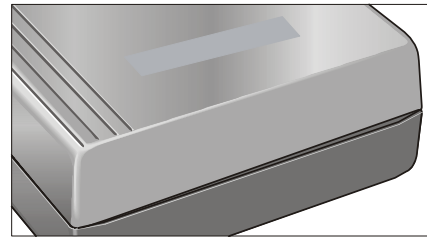
The LED is driven by the SYNC line of the integrated MC35i module which can be configured by using the AT^SSYNC command. For the purpose of the MC35i Terminal it is recommended to retain the default setting of AT^SSYNC=1 (AT^SSYNC=0 switches the LED off).

The following table lists the possible LED patterns and describes the operating status of the MC35i Terminal indicated by each pattern if AT^SSYNC=1.

During the transition from one LED pattern to another the "on" and/or "off" periods of the LED may vary in length. This is because an event that triggers the change may occur any time and, thus, truncate the current LED pattern at any point.

Table 13: Coding of the green status LED

LED mode	Operating status of MC35i Terminal
Permanently off	MC35i Terminal is in one of the following modes: • POWER DOWN mode • ALARM mode • NON-CYCLIC SLEEP mode • CYCLIC SLEEP mode with no temporary wake-up event[1] in progress.
600 ms on / 600 ms off	Limited Network Service: 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	IDLE mode: The mobile is logged to the 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.
500 ms on / 25 ms off	Packet switched data transfer in progress.
Permanently on	Depending on type of call: *Voice call:* Connected to remote party. *CSD call:* Connected to remote party or exchange of parameters while setting up or disconnecting a call.

---

[1] When a temporary wake-up event (for example URC, call, packet switched transfer) occurs in CYCLIC SLEEP mode the LED flashes. See Chapter AT+CFUN provided in [1] for details on the various SLEEP modes and wake-up events.

4 Mechanical characteristics and mounting advice

Table 14: Mechanical characteristics

Weight	130 g
Dimensions (max) LxWxH =	65x74x33mm
Temperature range	-20°C to +55 °C
Protection class	IP40 (Avoid exposing MC35i Terminal to liquid or moisture, for example do not use it in a shower or bath.)
Mechanical vibrations Amplitude	7.5 mm at 5-200 Hz sinus
Max. pulse acceleration	30g pulse with 18 ms duration time
Air humidity	5...80% (non condensing)
Class of flammability	UL94 HB
Casing material	PC/ABS Cycoloy 1200 HF grey 96444
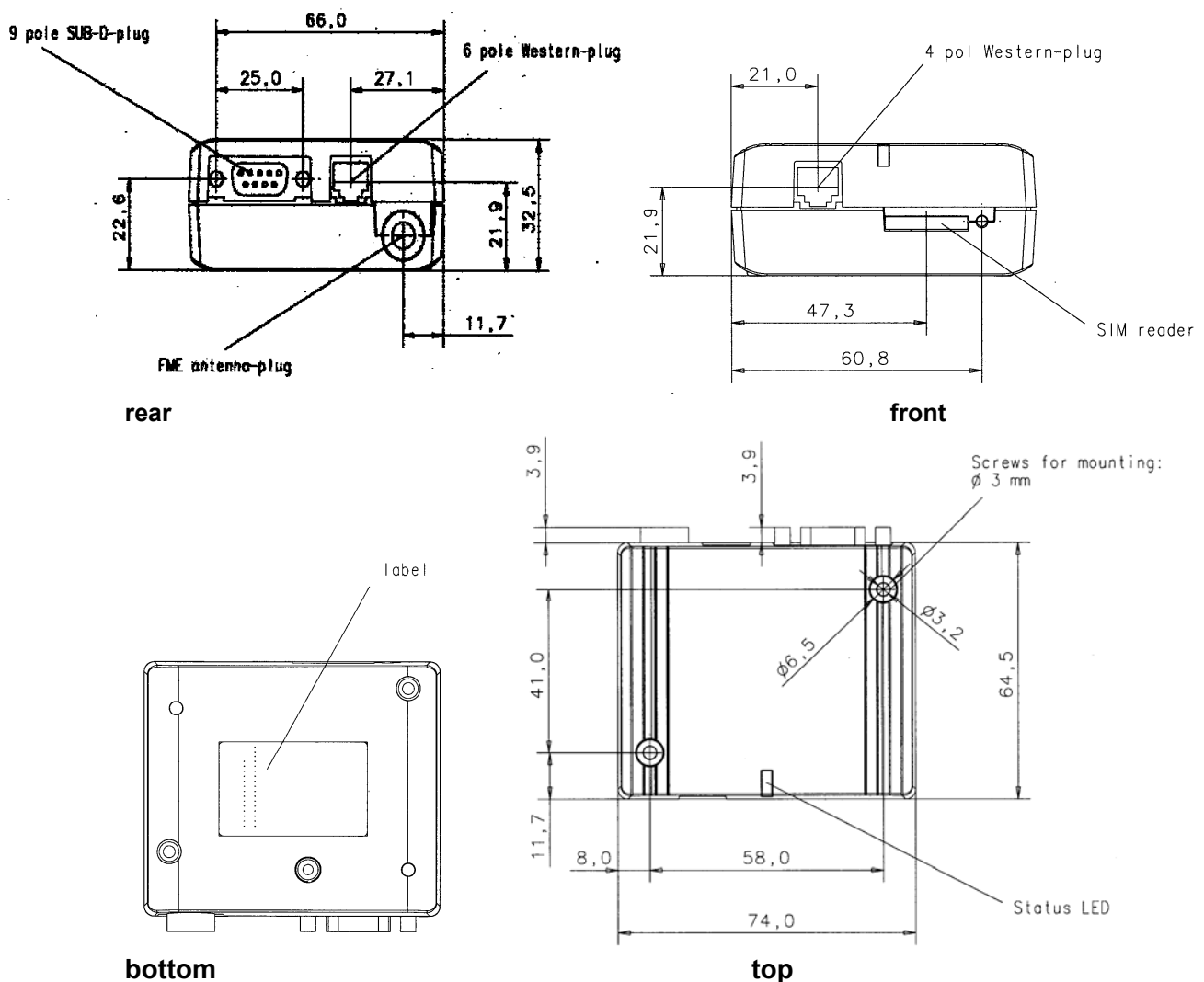
Figure 10: Design drawing

4.1 Mounting example

The MC35i Terminal can be attached e.g. to a 35mm top-hat rail installation using two M3 x 50mm screws and an additional fixture element, see Figure 12. In case you wish to order the recommended mounting kit, please refer to Chapter 7 for detailed information.
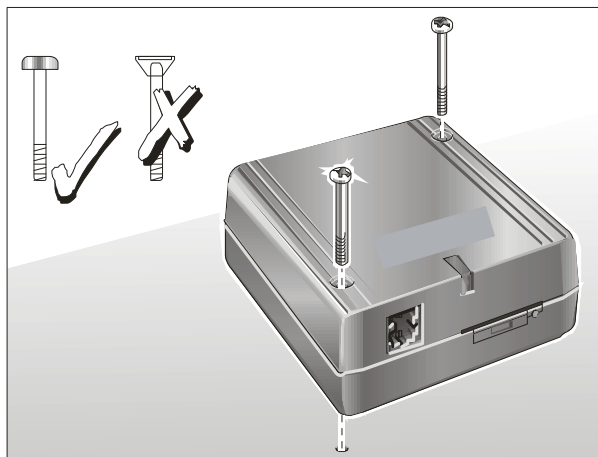
Figure 11: Recommended screws

Figure 12: Attaching MC35i Terminal to a top-hat rail

5 Electrical and environmental characteristics

Table 15: Absolute maximum ratings

Parameter	Port / Description	Min.	Max.	Unit
Supply voltage	PLUS	-50	30	V
Overvoltage	PLUS / for 1min		33	V
Input voltage for on/off Control lines	/IGT_IN, /PD_IN	-5	30	V
RS-232 input voltage range	/TXD, /DTR, /RTS	-20	+20	V
	/RXD, /CTS, /DSR, /DCD, /RING	-0.3	+5.3	V
Microphone input line voltage	MICP, MICN	-0.3	+10	V
Earpiece input voltage	EPP, EPN	-0.3	+3.3	V
Immunity against discharge of static electricity	all connectors (lines)	-8	+8	kV
Protection Class	IP40 (avoid exposing MC35i Terminal to liquid or moisture, for example do not use it in a shower or bath)		IP 40	
Mechanical vibrations amplitude	@ 5-200Hz		7.5	mm
Mechanical pulse-acceleration	@ 18 ms duration		30	g

Table 16: Operating supply voltage for MC35i Terminal

Parameter	Min	Typ	Max	Unit
Supply voltage PLUS measured at (6-pole) western jack plug (1 to 6)	7.6 lowest voltage (minimum peak) incl. all ripple and drops	12	30	V

Table 17: On-board operating temperature of built-in MC35i module

Parameter	Min	Typ	Max	Unit
Normal operation	-20	+25	+70	°C
Automatic thermal shutdown[1)2)]	-25	---	>+80	°C

Table 18: Ambient operating temperature of MC35i Terminal according to IEC 60068-2 (without forced air circulation)

Parameter	Min	Typ	Max	Unit
Normal operation	-20	+25	+55	°C
Restricted operation[3)]	-25 to -20	---	+55 to +60	°C
Automatic thermal shutdown[1)2)]	-25	---	≥+60	°C

---

[1]   When an emergency call is in progress automatic thermal shutdown is deferred. See also Chapter 3.5.1.5.

[2]   Due to temperature measurement uncertainty, a tolerance of ±3°C on these switching thresholds may occur.

[3]   Restricted operation according to 3GPP TS 45.005 V6.7.0 (2004-11), Annex D, D.2.1, Temperature (GSM 400, GSM 900 and DCS 1 800): "Outside this temperature range the MS, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the MS exceed the transmitted levels as defined in 3GPP TS 45.005 for extreme operation."

Table 19: Storage conditions

Type		Condition	Unit	Reference
Air temperature:	Low	-30	°C	ETS 300 019-2-1: T1.2, IEC 68-2-1 Ab
	High	+70		ETS 300 019-2-1: T1.2, IEC 68-2-2 Bb
Humidity relative:	Low	10	%	---
	High	90 at 30°C		ETS 300 019-2-1: T1.2, IEC 68-2-56 Cb
	Condens.	90-100 at 30°C		ETS 300 019-2-1: T1.2, IEC 68-2-30 Db
Air pressure:	Low	70	kPa	IEC TR 60271-3-1: 1K4
	High	106		IEC TR 60271-3-1: 1K4
Movement of surrounding air		1.0	m/s	IEC TR 60271-3-1: 1K4
Water: rain, dripping, icing and frosting		Not allowed	---	---
Radiation:	Solar	1120	W/m^2	ETS 300 019-2-1: T1.2, IEC 68-2-2 Bb
	Heat	600		ETS 300 019-2-1: T1.2, IEC 68-2-2 Bb
Chemically active substances		Not recommended		IEC TR 60271-3-1: 1C1L
Mechanically active substances		Not recommended		IEC TR 60271-3-1: 1S1
Vibration sinusoidal:				IEC TR 60271-3-1: 1M2
	Displacement	1.5	mm	
	Acceleration	5	m/s^2	
	Frequency range	2-9 9-200	Hz	
Shocks:				IEC 68-2-27 Ea
	Shock spectrum	semi-sinusoidal		
	Duration	1	ms	
	Acceleration	50	m/s^2	

The conditions stated above are only valid for devices in their original packed state in weather protected, non-temperature-controlled storage locations. Normal storage time under these conditions is 12 months maximum.

Table 20: Power supply specifications

Parameter	Description	Conditions		Min.	Typ	Max.	Unit
V_{PLUS}	Allowed voltage ripple (peak-peak), drop during transmit burst peak current	TALK mode, power control level for P_{out} max [1]				1	V
I_{PLUS} [2]	Average supply current (average time 3 min.)	Power Down mode	@8V		480	550	µA
			@12V		700	800	
			@30V		1750	1850	
		SLEEP mode (GSM/GPRS)	@8V		45		mA
			@12V		30		
			@30V		17		
		Net searching mode (no net)	@8V		70		mA
			@12V		50		
			@30V		30		
		IDLE mode (GSM/GPRS)	@8V		60		mA
			@12V		45		
			@30V		25		
		GSM TALK mode	@8V		270	400	mA
			@12V		170	240	
			@30V		72	100	
		GPRS DATA mode(1 Tx, 4 RX)	@8V		290	420	mA
			@12V		180	250	
			@30V		77	105	
	Peak supply current (during 577µs transmission slot every 4.6ms)	Power control level for Pout max	@8V		1,7	2.1	A
			@12V		1.2	1.6	
			@30V		0.7	1.0	
$t_{PLUS-Fail}$	Allowed powerfail time without terminal reset or power down	After this time the MC35i Terminal will be reset or switched off				1	ms
	Allowed powerfail time without RTC (real time clock) reset	After this time the RTC will be reset				7	s
t_{R_PLUS}	Allowed rise time of V_{PLUS}	0% to 100%				20	ms

[1] Lowest voltage (minimum peak) incl. all ripple and drops >7.6V including voltage drop, ripple and spikes, measured at western jack (6-pole) pin (1 to 6)

[2] Typical values measured with antenna impedance = 50 Ohm (return loss >20dB)
Maximum values measured with mismatched antenna

Table 21: On/Off control line specifications (requirements)

Parameter	Description	Conditions	Min.	Typ	Max.	Unit
V_{high}	Input voltage /IGT_IN, /PD_IN	active high	5			V
V_{low}					2	V
V_{high}	Input voltage /DTR	active high	3		+15	V
V_{low}			-15		1.2	V
R_{IN}	Input resistance of /IGT_IN, /PD_IN		47			kOhm
R_{IN}	Input resistance of /DTR		4	6	8	kOhm
t_{D_IGT}	Duration of active high /IGT_IN, /DTR		200			ms
t_{D_PD}	Duration of active high /PD_IN		3.5			s
t_{R_IGT}	Rise time /IGT_IN for power up	0% to 100%			20	ms
t_{R_RTS}	Rise time /DTR for power up	0% to 100%			20	ms
$t_{D\_passive}$	Duration passive (low) of /IGT_IN, /DTR before restart	after power down	500			ms

Table 22: RS-232 interface specifications (requirements)

Parameter	Description	Conditions	Min.	Typ	Max.	Unit
V_{OUT}	Transmitter output voltage for /RXD, /CTS, /DSR, /DCD, /RING	@ 3kOhm load	±5	±6	±7	V
R_{OUT}	Transmitter output resistance /RXD, /CTS, /DSR, /DCD, /RING		300			Ohm
R_{IN}	Resistance /TXD, /RTS, /DTR		3	5	7	kOhm
V_{In}	Receiver input voltage range /TXD, /RTS, /DTR		-15		+15	V
V_{RIHYS}	Input hysteresis		0.2	0.5	1	V
V_{Ilow}	Input threshold low		0.8	1.2		V
V_{Ihigh}	Input threshold high			1.7	2.8	V
Baudrate		Autobauding	4.8		115	kbps
		Fixed range	0.300		115	kbps
LE_{Cable}	Length of RS-232 cable			1.8	2	m

Table 23: Audio interface specifications (requirements)

Parameter		Min.	Typ.	Max.	Unit
Microphone MICP, MICN	DC (no load) at MICP	5.6	5.9	6.2	V
	DC at MICP in POWER DOWN		0		V
	DC (no load) at MICN		0		V
	DC resistance differential MICN, MICP (balanced)	9.3	9.4	9.5	kOhm
	Impedance Z_i (balanced)	1.4	1.5	1.7	kOhm
	Input level U_{imax}			1.03	V_{PP}
	Gain range 6 dB steps	0		42	dB
	Frequency range	300		3400	Hz
Earpiece EPP, EPN	fine scaling by DSP (inCalibrate)	-∞		0	dB
	Impedance (audio not active)		30		kOhm
	Impedance (balanced)		15		Ohm
	AC output level U_O *Gain* = 0dB @ 3.14 dBm0 no load audio mode = 5, outBbcGain = 0, outCalibrate = 32767	3.3	3.7	4.07	V_{PP}
	Gain range	-18		0	dB
	Gain accuracy			0.8	dB
	Frequency area	300		3400	Hz
	DC Offset (balanced)			100	mV
	Attenuation distortion for 300...3900Hz			1	dB
	Out-of-band discrimination	60			dB

Unless otherwise stated, all specified values are valid for gain setting (*gs*) 0dB and 1kHz test signal.

gs = 0dB means audio mode = 5 for EPP to EPN, inBbcGain= 0, inCalibrate = 32767, outBbcGain = 0, OutCalibrate = 16384, sideTone = 0.

The electrical characteristics of the voiceband part depend on the current audio mode selected by the AT command AT^SNFS. See Table 12: Audio modes.

The audio modes 4 and 5 can be adjusted by parameters. Each audio mode is assigned a separate parameter set.

Table 24: Audio parameters adjustable by AT commands

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 independently to output volume	0...32767	-∞...0dB	20 * log (sideTone/ 32768)

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

Table 25: Air interface

Parameter		Min	Typ	Max	Unit
Frequency range Uplink (MS → BTS)	E-GSM 900	880		915	MHz
	GSM 1800	1710		1785	MHz
Frequency range Downlink (BTS → MS)	E-GSM 900	925		960	MHz
	GSM 1800	1805		1880	MHz
RF power @ ARP at 50Ω load	E-GSM 900	30.5	33	35	dBm
	GSM 1800	27.5	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 Under all propagation conditions according to GSM specification	E-GSM 900	- 102			dBm
	GSM 1800	- 102			dBm
Receiver input sensitivity @ ARP BER Class II < 2.4% @ static input level (no fading)	E-GSM 900		-107		dBm
	GSM 1800		-106		dBm

6 Full type approval

The Cinterion reference setup submitted to type approve MC35i Terminal consists of the following components:

- MC35i Terminal with approved GSM Engine MC35i
- Votronic Handset type
- PC as MMI
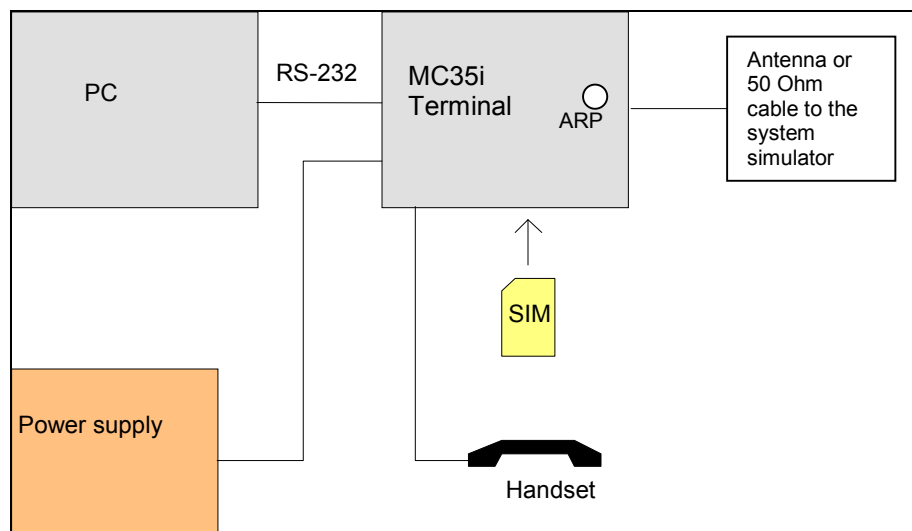- Power Supply: Mains adapter Sphere Design Type FW75550/12

Figure 13: Reference equipment for approval

For ordering information please refer to Chapter 7.

6.1 Restrictions

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.

- No further approvals are required for customer applications that comply with the approved MC35i Terminal configuration.
- Extra approval must be obtained for applications using other accessories than those included in the approved MC35i Terminal configuration (handset, power supply, MMI implementation supported by AT commands).

6.2 CE Conformity

The MC35i Terminal meets the requirements of the EU directives listed below.

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

6.3 EMC

The MC35i Terminal meets the EN 301489-7 requirements of equipment for vehicular and fixed use and the 2004/104/EC Directive.

The MC35i Terminal does not resist to test pulse 5 according ISO 7637-2 (load dump at vehicles 12V (≥ level3) and 24V (≥ level2) supply voltage). In case of failure, the internal slow acting unremovable fuse would be damaged. For load dump protection, it is recommended to use an external fast acting fuse ≥0.4A with melting integral I^2t (0.15…0.25)A^2s.

Note: V_{PLUS} power fail time>1ms resets the MC35i Terminal.

7   List of parts and recommended accessories

Description	Supplier	Ordering information
MC35i Terminal	Cinterion	Ordering number L36880-N8665-A100
Mounting kit for top/hat rail installation	Sphere Design	Ordering number: 20100 Sphere Design Saarpfalz-Park 17 D-66450 Bexbach / Saar Phone: +49-6826-5200-0 Fax: +49-6826-5200-25 E-Mail: info@spheredesign.de http://www.spheredesign.de
Power supply unit	Sphere Design	Type FW75550/12 Ordering number: 39020 Sphere Design Saarpfalz-Park 17 D-66450 Bexbach / Saar Phone: +49-6826-5200-0 Fax: +49-6826-5200-25 E-Mail: info@spheredesign.de http://www.spheredesign.de
Handset	Votronic	Ordering number: HH-SI-30.3/V1.1/0 Votronic GmbH Saarbrücker Str. 8 D-86386 St. Ingbert Phone: +49-6894-9255-44 Fax: +49-6894-9255-88 E-Mail: contact@votronic.com http://www.votronic.com/
Antenna (900 – 1800 MHz)	MC Technologies	Ordering number: various types available MC Technologies GmbH Ahrensburger Straße 8 D-30659 Hannover Phone: +49-511-67-69 99-0 Fax: +49-511-67-69-99-150 E-Mail: info@mc-technologies.net
RS-232 cable (9 pin D-Sub)	Tecline	Ordering number: 300574 Tecline GmbH Behrener Straße 8 D-66117 Saarbrücken Phone: +49-681-926-78-70 Fax: +49-681-926-78-555 http://www.tecline-edv.de/