SIEMENS

TC35 Terminal

Siemens Cellular Engine

Hardware Interface Description

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Wireless Modules

Information and Communications

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1 Introduction

This document is a supplement to the "User Guide" supplied with your TC35 Terminal. The purpose of the document is to provide additional technical details on the hardware platform and the external interfaces of the TC35 Terminal.

The information are 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 TC35T. It specifies standards pertaining to wireless applications and outlines requirements that must be adhered to for successful product design.

For basic information on TC35T, a feature overview, installing instructions and safety precautions please refer to the "User Guide".

1.1 References

/1/ TC35 Hardware Interface Description
/2/ User GuideTC35 Terminal
/3/ Migration TC35 GSM Engine to TC35 Terminal
/4/ Migration M20T to TC35T
/5/ AT Command Set for TC35, TC37 and TC35 Terminal

Further information on Siemens cellular engines and a list of distributors can be found at the following Internet addesses:

English: http://siemens.de/gsm_e
German: http://siemens.de/gsm

1.2 Key features of TC35 Terminal

Feature	Implementation
Transmission	Voice and data
Power supply	Single supply voltage 8V to 30V
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	internal
External antenna	Connected via antenna FME connector
Ambient temperature range	-20°C to +55°C (normal operation) -40°C to +85°C (storage)
Current consumption @12V see Table 8	TALK mode (peak) 1,5A (pulsed 577ms at T=4,615ms) TALK mode: 160mA (typ.) IDLE mode: 35mA (typ.) SLEEP mode: 25mA (typ.) Power Down mode: 560µA (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, 14.4 Kbps, non-transparent
FAX	Group 3 : Class 1, Class 2
USSD	
Size	65x74x33 mm (approx.)
Weight	130g
Audio interface	Analog (Microphone, Earpiece)
Interfaces	RS232 for commands / data using AT commands
Supported SIM card	3V
Phonebooks	Implemented via SIM
Reset of TC35 Terminal	Reset via AT command or Power Down Signal
Selectable baud rate	300bps...115kbps (AT Interface)
Auto bauding range	1.2kbps...115kbps (AT Interface)
Firmware download	Via RS232 interface, SIM interface
Real time clock	Implemented (clock frequency 32.768kHz)
Timer function	Programmable via AT command

1.3 Standards

This product has been approved to comply with the following directives and standards.

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
89/336/EC	Directive on electromagnetic compatibility
73/23/EC	Directive on electrical equipment designed for use within certain voltage limits (Low Voltage Directive)
99/519/EC	Specific absorption rate (SAR) (recommendation)

Standards of type approval

ETS 300 607-1	Digital cellular telecommunications system (Phase 2); Mobile Station (MS) conformance specification; (equal GSM 11.10-1=>equal 3GPP51.010-1)
EN 301 419-1	v.4.1.1 (4-2000) Global System for Mobile communications (GSM); Harmonized standard for mobile stations in the GSM 900 and 1800 Bands covering essential requirements under article 3.2 of the R&TTE Directive (1999/5EC)(GSM 13.11)
ETS 300 342-1	Radio Equipment and Systems(RES); Electro Magnetic Compatibility (EMC) for European digital cellular telecommunications system (GSM 900 MHz and DCS 1 800 MHz) Part 1: Mobile and portable radio and ancillary equipment (for equipment for fixed and vehicular use)
EN 60 950	Safety of information technology equipment
ES 59005/ANSI C95.1	Considerations for evaluation of human exposure to Electromagnetic Fields (EMFs) from Mobile Telecommunication Equipment (MTE)in the frequency range 30MHz-6GHz (relevant for applications)

Requirements of quality

IEC 60068	Environmental testing
DIN EN 60529	IP - codes
DIN EN ISO 11469	Typical Plastic Parts

1.4 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

Abbreviation	Description
HR	Half rate
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

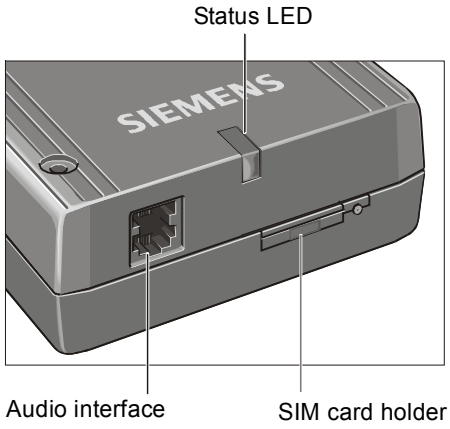
Abbreviation	Description
Rx	Receive direction
SAW	Surface Acoustical Wave Filter
SIM	Subscriber Identification Module
SMS	Short Message Service
SRAM	Static Random Access Memory
SW	Software
TBR	Technical Based Regulation
TBD	To Be Defined
TC35	Short for TC35 GSM Engine
TC35T	Short for TC35 Terminal
TDD	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

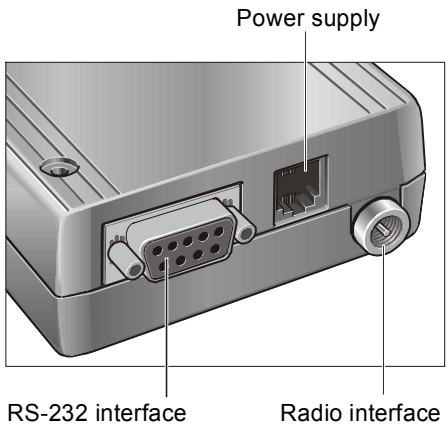
2 Interface description

2.1 Overview

TC35 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





2.2 Block diagram of a GSM application

Figure 1 shows a block diagram of a sample configuration that incorporates a TC35 Terminal and typical accessories.

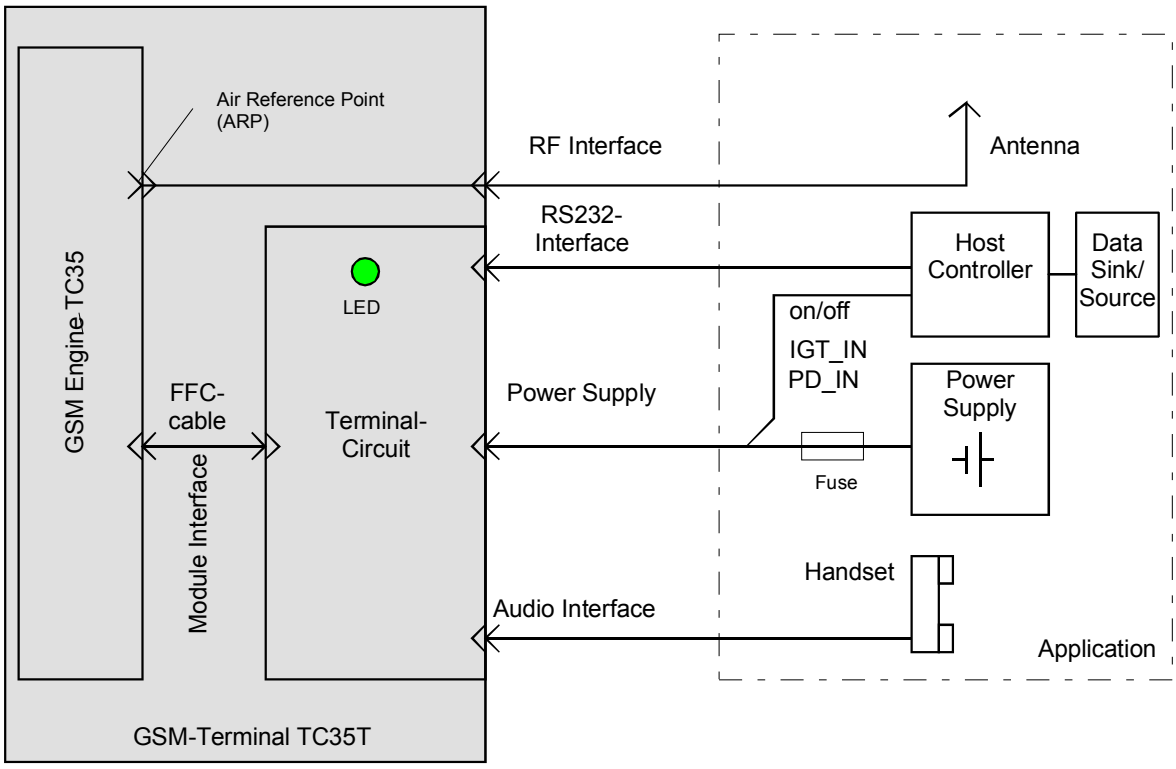


Figure 1: Block diagram of a TC35 Terminal application (example)

2.3 The TC35 GSM Engine

The TC35 GSM Engine is a major functional component of the TC35 Terminal that 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 Terminal Circuit.

A GSM baseband processor contains 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.

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 a fully integrated IF synthesizer.

The internal antenna cable connects to the connector type GSC from Murata with a 50Ω impedance. This GSC connector is the ARP (Air Reference Point) for type approval measurements.

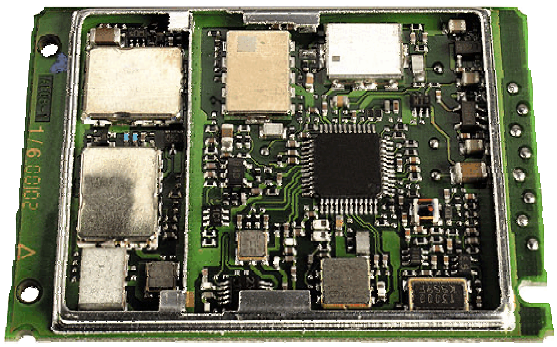


Figure 2: TC35 GSM Engine

2.4 Terminal circuit

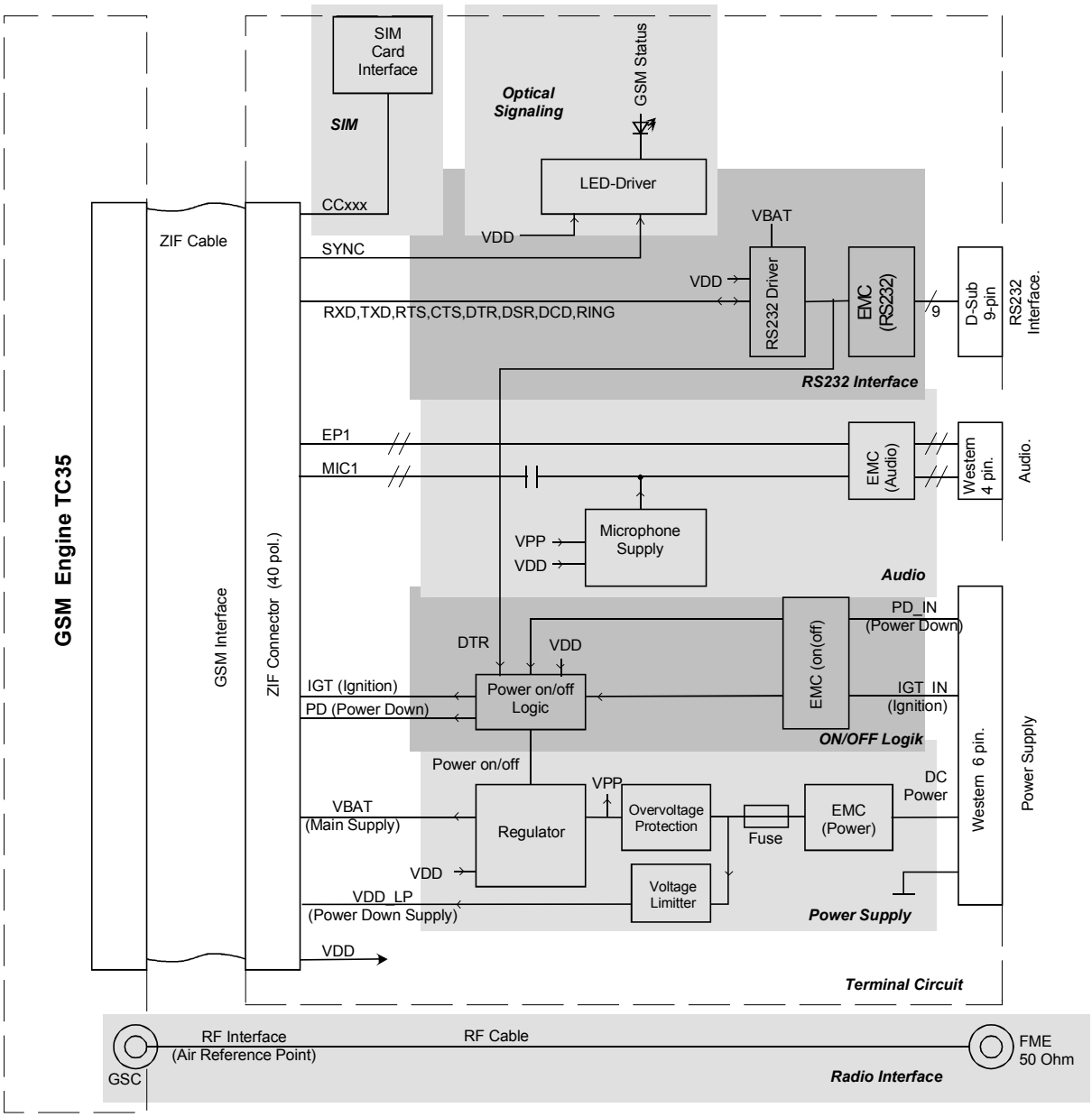
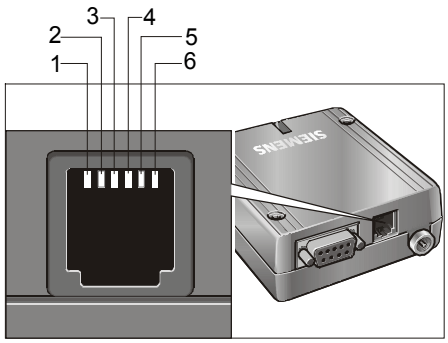


Figure 3: TC35 Terminal Circuit block diagram

2.4.1 Power supply and On-Off control

- 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 limiter supplies the real time clock in the TC35 GSM Engine.
- The Terminal is protected from supply voltage reversal and overvoltage.
- The internal fuse is not removable, it is only for electrical safety according to EN60950.
- EMC immunity complies with the vehicular environment requirements according ETS 300 342-1.



Pin assignment:

1 +
2 free
3 PD_IN
4 IGT_IN
5 free
6 GND

Figure 4: Female 6-pole Western plug for power supply, ignition, power down

Mains adapter:

It is recommended to use the adapter of the type approval reference configuration. Ordering information can be found in /2/. This 12V mains adapter comes with a 6 pole Western plug and features an internal connection between IGT_IN pin and PLUS pin for auto ignition (power up).

Table 1: Female 6-pole Western plug for power supply, ignition, power down

Pin	Signal Name	Use	Parameters
1	PLUS	Power supply (see Note 1)	8V - 30V DC, max. 33V for 1 min
2	Free	---	---
3	PD_IN	Signal for power down mode (see Note 2)	$U_{IH} \geq$5V for t > 3,5s U_{IL} <2V
4	IGT_IN	Ignition (see Note 3)	$U_{IH} \geq$5V Ignition $\geq$ 5V for more than 200ms switches the terminal on
5	Free	---	---
6	GND	Ground	0V

Note 1:

- To protect the device from high voltages (>30V) a 1.25A quick-break fuse on pin 1 of the 6-pole Western plug shall be used. For use with power packs and batteries observe the EN60950 guidelines. Installation and start-up may only be performed by authorised persons.
- The power supply of the TC35 Terminal has to be a single voltage source of V_{PLUS}+ = 8V...30V providing a peak current (pulsed 577ms at T=4,615ms) of about 1,5A at 12V during the active transmission. The uplink bursts cause strong ripple (drops) on the power lines. The drop voltage should not exceed 1V, but the absolute minimum voltage during drops must be >7,6V.
- The safety status of the power supply has to be SELV (as defined by EN60950).
- When power fails for >1ms, TC35T resets or switches off.
  When power fails for >7s, the real time clock will be reset.

Note 2:

- Power off exception handling: In the event of software hang-ups etc. the TC35T can be switched off by applying a voltage >5V to Pin 3 for more than 3,5s.
  To switch on again you have two options: Apply a voltage >5V to the ignition pin (IGT_IN Pin 4) or switch on the RS-232 DTR line, while applying a voltage <2V to PD_IN Pin 3.
- The PD_IN signal switches the terminal off. All internal supply voltages are off, except the power down voltage, which still supplies the real-time clock (RTC). The option of powering on the TC35 Terminal via the RTC alarm as described in /1/ cannot be used during power down mode.
- For all other operating modes the PD_IN signal must be Low (<2V).

  CAUTION: Use the PD_IN signal (pin) only as a last resort if the TC35 reacts no other way. Be aware, that no information will be stored in the non-volatile memory when you push this signal.

Note 3:

- The ignition is activated only by a rising edge. The rise time has to be <20ms.
- The IGT_IN signal switches the terminal on (it changes from power down state to the net searching state).

2.4.2 RS-232 interface

Via RS-232 Interface, the host controller controls the TC35 Terminal and transports data.

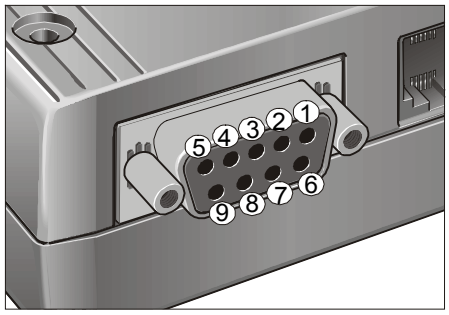


Figure 5: Pin assignment RS-232 (D-Sub 9 pole female)

EMC immunity applicabilities comply with the vehicular environment requirements according to ETS 300 342-1

Table 2: 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 TC35 Terminal is activated via a rising edge of high potential (+5 ... +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

The current of all signals is limited by serial resistors:
Outputs: 510 Ohm
Inputs: 1kOhm

Note : The TC35 Terminal will be connected like a DCE:
TxD TC35T connected to TxD Application
RxD TC35T connected to RxD Application

The RS-232 interface is implemented as a serial asynchronous transmitter and receiver conforming to ITU-T RS-232 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. Hardware handshake using signals RTS / CTS and software flow control via XON/XOFF are supported.

In addition, the modem control signals DTR*), DSR, DCD and RING 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).

*) **Note that the DTR signal is polled from the internal Firmware once per second only!**

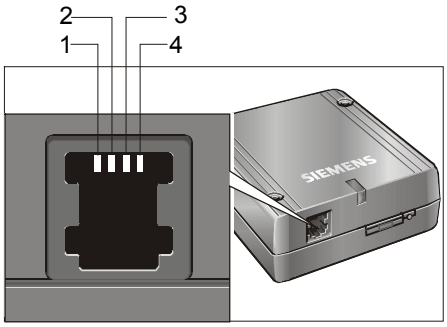
2.4.3 Audio interface

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 handset. (Votronic HH-SI-30.3/V1.1/0. For ordering Information see /2/).
- This handset used has been used as the reference handset for type approval. 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 applicabilities comply with the vehicular environment requirements according to ETS 300 342-1.



Pin assignment:

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

Figure 6: Audio Western plug (4 pole female)

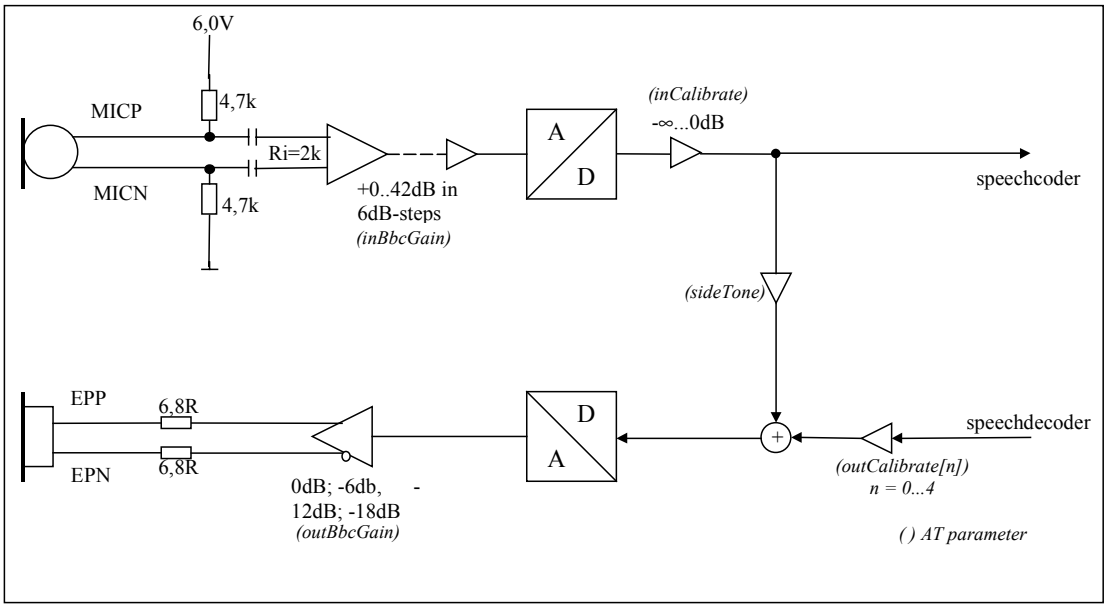


Figure 7: Audio block diagram

The audio interface can be configured by AT commands. For detailed instructions on using AT commands please refer to /5/.

The electrical characteristics of the voiceband part vary with the audio mode. To suit several types of audio equipment, there are three modes available which can be selected by the AT command AT^SNFS. In audio mode 4 and 5, the gain in the microphone, earpiece and the sidetone path can be adjusted from the cellular device application (different volume steps can be selected by AT commands). See *Table 12: AT adjustable parameters* for the characteristics of the audio modes.

Table 3: Audio Modes

Mode No AT^SNFS=	**1**	**4**	**5**
Name	Default Handset	User Handset	Plain Codec 1
Purpose	DSB with M20T Handset	DSB with user provided handset	Direct access to speech coder
Gains programmable via AT command	NO	YES	YES
Supply	ON	ON	OFF
Sidetone	YES	YES	YES
Volume control	NO	YES	YES
Limiter (receive)	YES	YES	NO
Compressor (receive)	NO	NO	NO
Echo control (send)	Suppression	Suppression	NO
Noise suppresion	NO	NO	NO
MIC input signal for 0dBm0 @ 1024 Hz (at default gain settings)	11.54 mV	11.54 mV	308.5 mV
EP output signal in mV eff. @ 0dBm0, 1024 Hz, no load (at default gain settings); @ 3.14 dBm0	397.5 mV	397.5 mV default @ max volume	931.8 mV 3.7 Vpp
Sidetone gain (at default settings)	22 dB	22 dB	-∞ dB

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.

2.4.4 Radio interface

An internal antenna cable adapts the Air Reference Point (ARP) (antenna connector type GSC from Murata) to the FME (male) connector.

- Cable loss
  <0,7dB @ 900MHz
  <1,4dB @ 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).
- TC35 Terminal withstands a total mismatch at this connector when transmitting with power control level for maximum RF Power.

EMC immunity applicabilities comply with the vehicular environment requirements according to ETS 300 342-1.

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

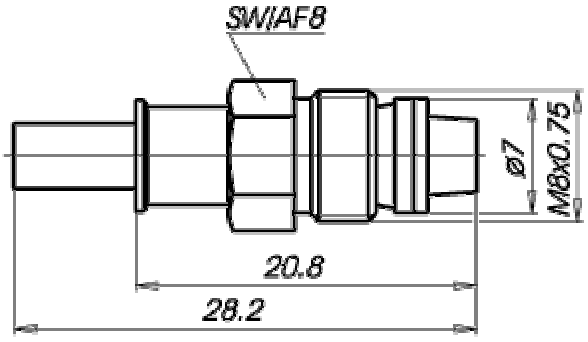
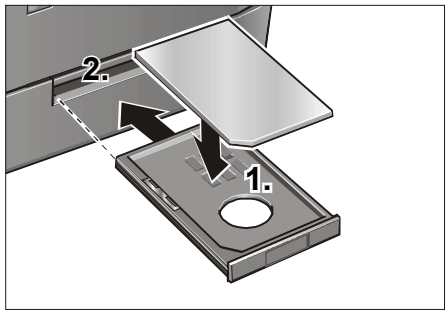


Figure 8: Recommended Antenna Connector

2.4.5 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 elctrostatic discharge with spark gaps to GND and clamp diodes to 2.9V and GND.

Note: Do not remove the SIM card while voltage is applied to TC35 Terminal. Before removing the card be sure TC35 Terminal is in Power Down mode. Failure to do so may seriously affect the serviceability of your GSM application.

TC35 Terminal offers two different solutions for updating firmware. In most cases, you can download the firmware from the RS-232 interface. However, if your application does not allow access to the serial interface you can use the SIM interface instead. 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.

2.4.6 Status LED

A green LED displays the operating status of the terminal:

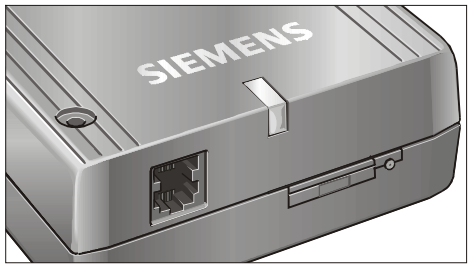


Table 4: Coding of the green status LED

Operating status	LED
Power Down	off
Not registered to the net (missing SIM, PIN, net)	fast blinking
Standby (registered to the net)	slow flash (75ms On / 3s Off)
Sleep mode (Power save mode, registered to the net)	off
Talk mode	on

3 Mechanical characteristics

Table 5: Mechanical characteristics

Weight	130 g
Dimensions (max) LxWxH =	65x74x33mm
Temperature range	-20°C – 55 °C
Protection class	IP40 (Avoid exposing TC35 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...98% (non condensing)
Class of flammability	UL94 HB
Casing material	PC/ABS Cycoloy 1200 HF grey 96444

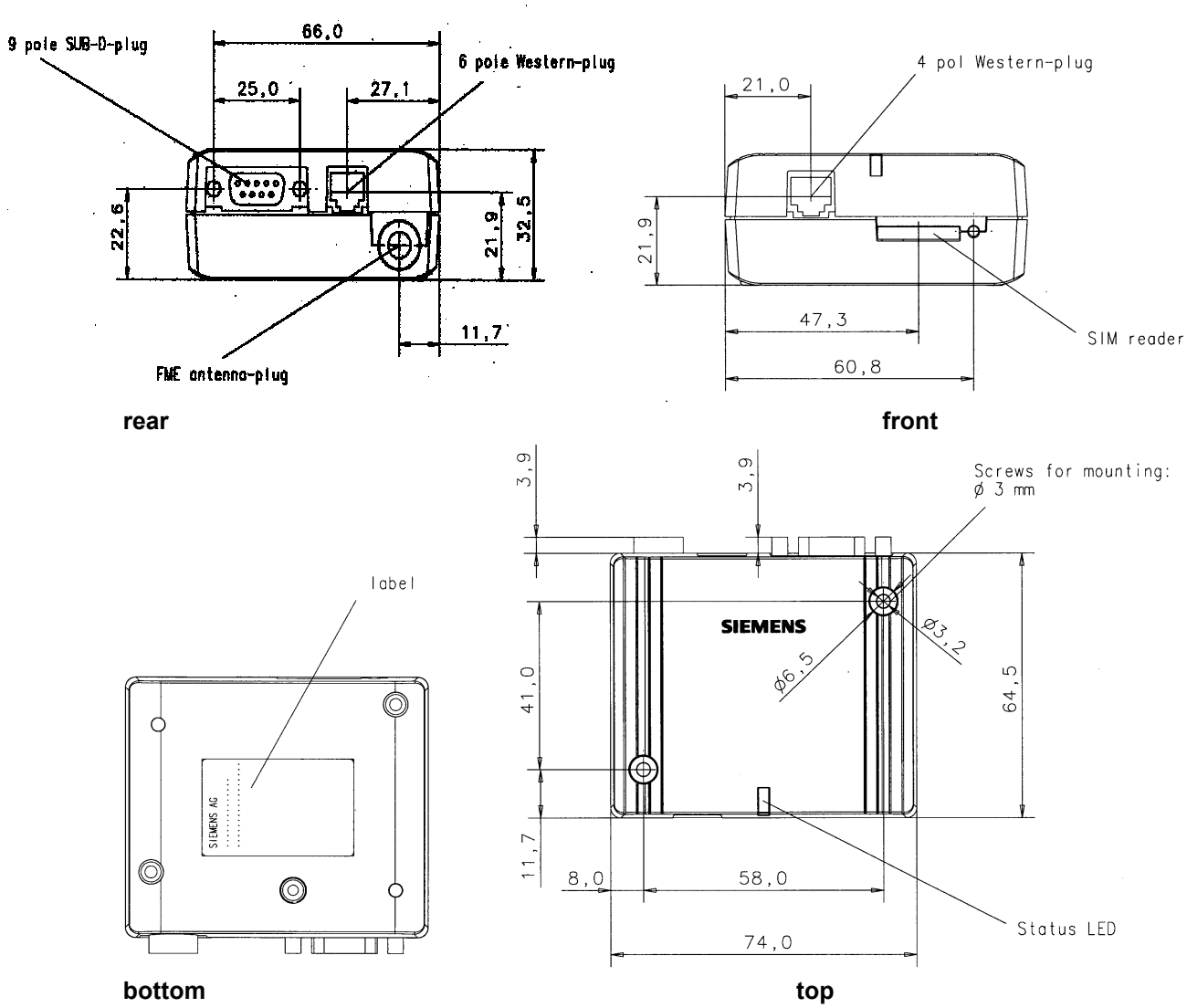


Figure 9: Design drawing

3.1 Label marking

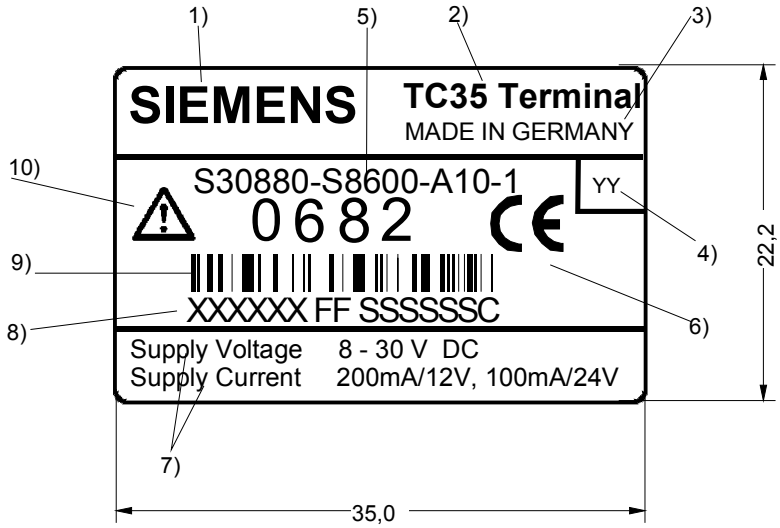


Figure 10: Label marking

1) Company Name
2) Product Name
3) Made in Germany
4) Date code
5) Code number
6) CE-Sign
7) Supply Voltage Operating Conditions
   Max. Supply Current (Average)
8) Normal character IMEI number
   - XXXXXX Type Approval Code:
   - FF Final Assembly Code:41
   - SSSSSS 6 digit serial number = Bar Code (normal character) provided through PICS
   - C Check Digit
9) Barcode IMEI Number
10) Note triangle

4 Electrical and environmental characteristics

Table 6: Absolute maximum ratings

Parameter	Port / Description	Min.	Max.	Unit
Supply voltage	PLUS	-63	30	V
Overvoltage	PLUS / for 1h		33	V
RMS current of external power supply	PLUS		2,5	A
Input voltage for on/off Control lines	IIGT_IN, PD_IN	-5	30	V
RS-232 line voltage	TXD, DTR, RTS	-0,3	+5,3	V
	RXD,CTS,DSR,DCD,RING	-20	+20	
Microphone line voltage	MICP, MICN	-0,3	+10	V
Earpiece voltage	EPP, EPN	-0,3	+3,3	V
Storage temperature		-40	+90	°C
Electro static air discharge immunity against distortion	all connectors (lines)	-15	+15	kV
Air humidity	no condensed		98	%
Protection Class	IP40 (avoid exposing TC35 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 7: Operating conditions

Parameter	Min	Typ	Max	Unit
Ambient temperature	-20	25	55	°C
Supply voltage PLUS measured at (6 pole) western jack pin (1 to 6)	7,6 lowest voltage (minimum peak) incl. all ripple and drops	12	30	V

Table 8: Characteristics Power supply

Parameter	Description	Conditions		Min	Typ	Max	Unit
V_{PLUS}	Allowed voltage ripple (peak-peak), drop during transmit burst peak current	[1] Talk Mode, power control level for P_{out} max				1	V
I_{PLUS}	Average supply current	Power Down mode	@8V		380	450	µA
			@12V		560	600	
			@30V		1500	1600	
		SLEEP mode	@8V		35	40	mA
			@12V		25	30	
			@30V		15	20	
		NET Searching mode	@8V		80	120	mA
			@12V		45	75	
			@30V		30	35	
		STANDBY mode	@8V		50	60	mA
			@12V		35	45	
			@30V		20	30	
		TALK mode	@8V		260	300	mA
			@12V		160	190	
			@30V		70	80	
	Peak supply current (during 577µs transmission slot every 4.6ms)	Power control level for Pout max	@8V			1.5	A
			@12V		1	1.1	
			@30V			0.4	
$t_{PLUS-Fail}$	Allowed powerfail time without terminal reset or power down	After this time the 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% @100mA				20	ms
LE_{Cable}	Length of supply cable					3	m

1) lowest voltage (minimum peak) incl. all ripple and drops >7,6V, measured at western jack (6 pole) pin (1 to 6)

Table 9: Characteristics (Requirements) On/Off Control lines

Parameter	Description	Conditions	Min	Typ	Max	Unit
V_{high}	Input voltage	active high	5			V
V_{low}	IGT_IN, PD_IN, RTS				2	V
R_{IN}	Input resistance of IGT_IN, PD_IN		47			kOhm
R_{IN}	Input resistance of RTS		4	6	8	kOhm
t_{D_IGT}	Duration of active high IGT_IN		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 RTS for power up	0% to 100%			20	ms
$t_{D\_passive}$	Duration passive (low) of IGT_IN, DTR before restart	after power down	1			s

Table 10: Characteristics (Requirements) RS-232 Interface

Parameter	Description	Conditions	Min	Typ	Max	Unit
V_{OUT}	Transmitter Output Voltage for RXD,CTS,DSR,DCD, RING	@ 5kOhm load	±5	6	7	V
R_{OUT}	Transmitter Output Resistance RXD,CTS,DSR,DCD, RING		810			Ohm
R_{IN}	Receiver Input Resistance TXD,RTS,DTR		4	6	8	kOhm
V_{RIHYS}	Input Hysteresis		0.2	0.5	1	V
V_{Ilow}	Input Threshold Low		1,0	1,8		V
V_{Ihigh}	Input Threshold High			2,4	3	
Baudrate		Autobauding	4,8		115	kbps
		Fixed range	0,300		115	kbps
LE_{Cable}	Length of RS-232 cable			1.8	2	m

Table 11: Characteristics (Requirements) Audio Interface

Parameter		Min.	Typ.	Max.	Unit
Microphone MICP,MICN	DC (no load) at MICP	5,4	6,0	6,6	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)		2k		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	4,07V	V_{PP}
	Gain range	-18		0	dB
	Gain accuracy			0,8dB	
	Frequency area	300		3400	Hz
	DC Offset (balanced)			100	mV
	Attenuation distortion for 300...3900Hz			1	dB
	Out-of-band discrimination	60			dB
LE_{Audio}	Length of Audio (Handset) cable			3	m

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.

Audio Modes:
The electrical characteristics of the voiceband part depend on the current audio mode selected by the AT command AT^SNFS. See Table 3: Audio Modes.

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

Table 12: AT adjustable parameters

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)

Table 13: Characteristics 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	Class 4			
	GSM 1800	Class 1			
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	- 104			dBm
	GSM 1800	- 102			dBm
Length of antenna cable				3	m

5 Full type approval

The TC35 Terminal has been approved for a reference configuration that complies with the requirements of GSM Phase 2/2+

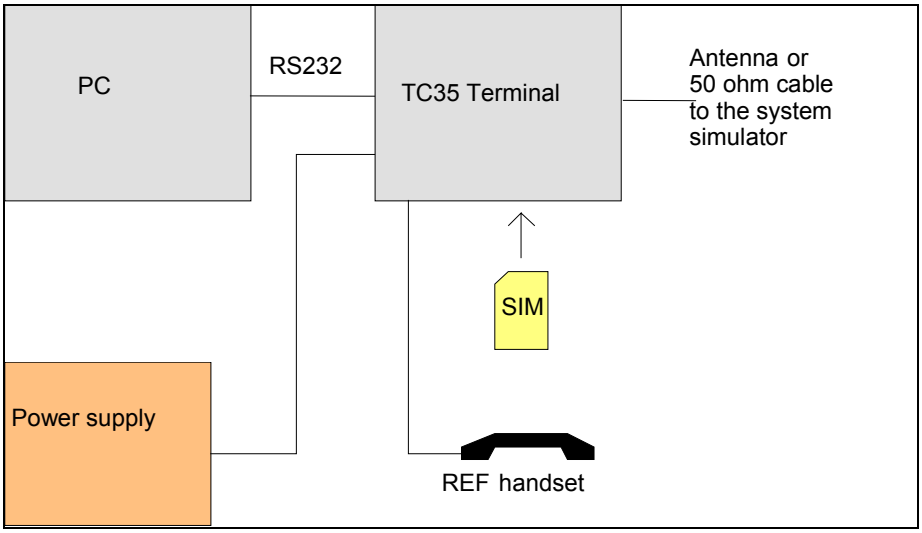


Figure 11: Reference equipment for approval

Referred to as "GSM terminal equipment" the reference configuration consists of the following components:

- TC35T with approved GSM Engine TC35
- Handset Votronic standard handset type HH-SI-30.3V1.1/0
- PC as MMI
- Power Supply: Mains adapter Sphere Design Type FW7207/12

For the Siemens GSM Engine 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 TC35 Terminal.

Approved Siemens TC35 configurations are recorded in the approval documentation.

5.1 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. The relevant test applications for supplementary approvals should be agreed upon with Siemens.

- No further approvals are required for customer applications that comply with the approved TC35 Terminal configuration.
- Extra approval must be obtained for applications using other accessories than those included in the approved TC35 Terminal configuration (handset, MMI implementation supported by AT commands). Information about certified configurations and accessories approved for use with the TC35 Terminal can be obtained in the appendix to EC TYPE EXAMINATION CERTIFICATE or from your local distributor.
- Applications using the "DATA ONLY" capabilities (data, SMS, fax) of the TC35 Terminal need no extra approval.

5.2 CE Conformity

The TC35 Terminal meets the requirements of the 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

5.3 EMC

The TC35 Terminal meets ETS 300 342-1 requirements of equipment for vehicular and fixed use.
(Note :V_{PLUS} power fail time>1ms resets the terminal)