

# **CH32GGT – 232/485 GSM Terminal: Hardware Description**

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## 1 Introduction

This document describes Cermetek Microelectronics, Inc. CH32GGT-232/485 Terminal electronics, hardware configuration and mounting options. The CH32GGT Terminal is provided in two versions:

- CH32GGT-RS232. This variant implements a V.24 / V.28 RS-232 interface with a D-sub 9-pole female socket and a 6-pole Western jack as plug-in power supply connector.
- CH32GGT-RS485. This variant implements a 6-pin header for the RS-485 interface including power supply and ignition line.

Wherever necessary and appropriate this document distinguishes between these two variants. The scope of this document includes interface specifications, electrical issues and mechanical characteristics of CH32GGT. It specifies standards pertaining to wireless applications and outlines requirements that must be adhered to for successful product design. The CH32GGT is a compact GSM modem for the transfer of data in GSM networks. Industrial standard interfaces and an integrated SIM card reader allow easy usage of the CH32GGT as a quad band GSM/GPRS terminal.

### 1.1 Related Documents

[1] 613-0011, CH32GGT AT Commands

Please use the following link to visit the Cermetek Website to download the above documents:  
<http://www.Cermetek.com>

## 1.2 Terms and Abbreviations

**Table 1: Terms and abbreviations**

Abbreviation	Description
ARP	Antenna Reference Point
ATC	AT Command
BTS	Base Transceiver Station
CB	Cell Broadcast
CODEC	Coder-Decoder
DCE	Data Circuit terminating Equipment
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
G.C.F.	GSM Conformity Forum
GSM	Global Standard for Mobile Communication
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
LVD	Low voltage Directive
Mbps	Mbits per second
MMI	Machine to Machine Interface
MO	Mobile Originated
MS	Mobile Station
MT	Mobile Terminated
NC	Not Connected
NTC	Negative Temperature Coefficient

**Table 1: Terms and abbreviations (continued)**


Abbreviation	Description
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
RF	Radio frequency
RI	Ring Indication
RX	Receive direction
SIM	Subscriber Identification Module
SMS	Short Message Service
SW	Software
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
TX	Transmit direction
UART	Universal Asynchronous Receiver and Transmitter

### 1.3 Regulatory and Type Approval Information

#### 1.3.1 Directives and Standards

CH32GGT has been designed to comply with the directives and standards listed in Tables 2-6 below.

**Table 2: Directives**

99/05/EC	<p>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&amp;TTE Directive 1999/5/EC).</p> <p>The product is labeled with the CE conformity mark <b>CE 0682</b></p>
2002/95/EC	<p>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)</p> 
2002/96/EC	<p>Directive of the European Parliament and of the Council on waste electrical and electronic equipment (WEEE)</p>
2003/108/EC	<p>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)</p>

**Table 3: Standards of North American type approval**

CFR Title 47	<p>“Code of Federal Regulations, Part 15 B, Part 22 and Part 24 (Telecommunications, PCS)”; US Equipment Authorization FCC</p>
NAPRD.03 V5.6	<p>“Overview of PCS Type certification review board Mobile Equipment Type Certification and IMEI control” PCS Type Certification Review board (PTCRB)</p>
RSS133 (Issue 2)	<p>Canadian Standard</p>
IEEE Std. C95.1-1999	<p>IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz</p>

**Table 4: Standards of European type approval**

3GPP TS 51.010-1	<p>“Digital cellular telecommunications system (Phase 2); Mobile Station (MS) conformance specification”</p>
ETSI EN 301 511 V9.0.2	<p>Candidate Harmonized European Standard (Telecommunications series) Global System for Mobile communications (GSM); Harmonized standard for mobile stations in the GSM 900 and DCS 1800 bands covering essential requirements under article 3.2 of the R&amp;TTE directive (1999/5/EC) (GSM 13.11 version 7.0.1 Release 1998)</p>
GCF-CC V3.40.0	<p>Global Certification Forum - Certification Criteria</p>
ETSI EN 301 489-1 V1.8.1	<p>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</p>


**Table 4: Standards of European type approval (continued)**

ETSI EN 301 489-7 V1.3.1	Candidate Harmonized European Standard (Telecommunications series) Electro Magnetic Compatibility and Radio spectrum Matters (ERM); Electro Magnetic Compatibility (EMC) standard for radio equipment and services; Part 7: Specific conditions for mobile and portable radio and ancillary equipment of digital cellular radio telecommunications systems (GSM and DCS).
EN 62311-2008	Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz).
EN 60950-1 (2006)	Safety of information technology equipment.

**Table 5: Requirements of Quality**

IEC 60068	Environmental testing.
DIN EN 60529	IP codes.

**Table 6: 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	<p>"Marking for Control of Pollution Caused by Electronic Information Products" (2006-06).</p> <p>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 Hardware Interface Description.</p> <p>Please see Table 1.3.2 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.</p>



### CH32GGT Hardware Interface Description

Table 7: 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)	○	○	○	○	○	○
电路模块 (Circuit Modules)	X	○	○	○	○	○
电缆及电缆组件 (Cables and Cable Assemblies)	○	○	○	○	○	○
塑料和聚合物部件 (Plastic and Polymeric parts)	○	○	○	○	○	○


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.

### 1.3.2 Safety Precautions

The following safety precautions must be observed during all phases of the operation, usage, service or repair of any product incorporating the CH32GGT. Manufacturers are advised to convey the following safety information to users and operating personnel and incorporate these guidelines into all manuals supplied with any product containing the CH32GGT. Failure to comply with these precautions violates safety standards of design, manufacture and intended use of the CH32GGT. Cermetek Microelectronics, Inc. assumes no liability for customer's failure to comply with these precautions.

	<p>When in hospitals or other health care facilities, observe the restrictions on the use of mobiles. Switch off the cellular terminal or mobile if instructed to do so by the guidelines posted in sensitive areas. Medical equipment may be sensitive to RF energy.</p> <p>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.</p>
	<p>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.</p> <p>Check the local laws regarding the use of the CH32GGT on aircraft.</p>
	<p>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 fueling 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.</p>
	<p>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.</p>
	<p>Road safety comes first! Do not use a hand-held cellular terminal or mobile while driving a vehicle unless it is securely mounted in a holder for speakerphone operation. Before making a call with a hand-held terminal or mobile park the vehicle. Speakerphones must be installed by qualified personnel. Faulty installation or operation can constitute a safety hazard.</p> <p>Check the local laws before operating the CH32GGT while driving.</p>
	<p><b>IMPORTANT!</b></p> <p>Cellular terminals or mobiles operate using radio signals and cellular networks. Connections cannot be guaranteed at all times under all conditions. Therefore, you should never rely solely upon any wireless device for essential communications, such as emergency calls.</p> <p>Remember, in order to make calls or receive calls the cellular terminal or mobile must be switched on in a service area with adequate cellular signal strength.</p> <p>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.</p> <p>Some networks require a valid SIM card to be properly inserted in the cellular terminal.</p>
	<p>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 3 meters.</p>

	<p>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 20 cm away from human bodies.</p>
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## 1.4 Product Label

**Table 8: CH32GGT label information**

No.	Information
1	Cermetek logo
2	Product name
3	Product variant
4	Marking "Made in Germany"
5	Product ordering number
6	Barcode (Code128)
7	Product IMEI
8	Date code
9	CE logo with fixed number 0682 (may be replaced for samples with "Not for sale")
10	WEEE symbol (see Table 2).
11	Chinese RoHS symbol (see Table 6).
12	UL logo
13	FCC ID
14	IC ID
15	Manufacturer code
16	Power supply unit ratings
17	Manufacturer code

## 2 Key Features at a Glance

Feature	Implementation
General	
Incorporates CH32GGT Terminal	The CH32GGT Terminal handles all signal and data processing within the CH32GGT. Internal software runs the application interface and the complete GSM/GPRS protocol stack.
Frequency bands	Quad band: GSM 850/900/1800/1900MHz
GSM class	Small MS
Output power (according to Release 99, V5)	Class 4 (+33dBm ±2dB) for EGSM850 Class 4 (+33dBm ±2dB) for EGSM900 Class 1 (+30dBm ±2dB) for GSM1800 Class 1 (+30dBm ±2dB) for GSM1900  The values stated above are maximum limits. According to Release 99, the maximum output power in a multislot configuration may be lower. The nominal reduction of maximum output power varies with the number of uplink timeslots used and amounts to 3.0dB for 2Tx.
Power supply	Single supply voltage 8V to 30V
Operating temperature (CH32GGT Terminal)	Normal operation: -30°C to +85°C Restricted operation: -40°C to -30°C and +85°C to +90°C
Physical	Dimensions: 80mm x 55mm x 23mm (excluding antenna and serial interface connectors) Weight: 65g (approx.)
RoHS, WEEE	All hardware components are fully compliant with the EU RoHS and WEEE Directives
GSM / GPRS features	
Data transfer	GPRS: <ul style="list-style-type: none"> <li>• Multislot Class 10</li> <li>• Full PBCCH support</li> <li>• Mobile Station Class B</li> <li>• Coding Scheme 1 – 4</li> </ul> CSD: <ul style="list-style-type: none"> <li>• V.110, RLP, non-transparent</li> <li>• 2.4, 4.8, 9.6, 14.4kbps</li> <li>• USSD</li> </ul> PPP-stack for GPRS data transfer
SMS	<ul style="list-style-type: none"> <li>• Point-to-point MT and MO</li> <li>• Cell broadcast</li> <li>• Text and PDU mode</li> </ul>
Fax	Group 3; Class 2 and Class 1
Software	
AT commands	Hayes 3GPP TS 27.007, TS 27.005, Cermetek AT commands
SIM Application Toolkit	SAT Release 99

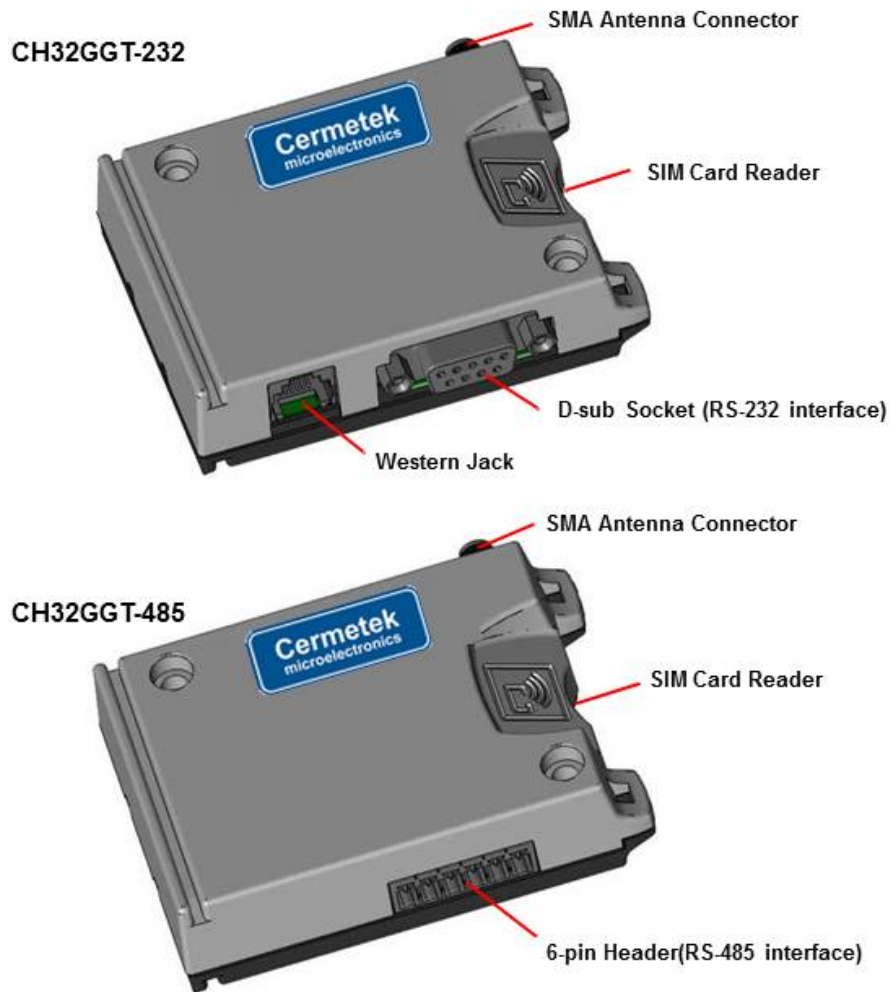
Feature	Implementation
TCP/IP stack	Protocols: TCP server/client, UDP, HTTP, FTP, SMTP, POP3 Access by AT commands
Firmware update	Upgradeable via serial interface
<b>Interfaces</b>	
Serial interface	CH32GGT-232: <ul style="list-style-type: none"> <li>• RS-232 interface for AT commands and data</li> <li>• Supports RTS/CTS hardware handshake</li> <li>• Supports software XON/XOFF flow control</li> <li>• Multiplex ability according to GSM 07.10 Multiplexer protocol</li> <li>• Baud rates from 1200bps to 230400bps</li> </ul> CH32GGT-485: <ul style="list-style-type: none"> <li>• RS-485 interface for AT commands and data</li> <li>• Baud rates from 1200bps to 115200bps</li> </ul> Both variants: <ul style="list-style-type: none"> <li>• Autobauding supported</li> </ul>
SIM card reader	Supported SIM cards: 3V, 1.8V
Antenna	Antenna connected via female SMA connector
<b>Power on/off, Reset</b>	
Power on	CH32GGT-232: <ul style="list-style-type: none"> <li>• DTR line at RS-232 interface or IGT_IN line at power connector</li> </ul> CH32GGT-485: <ul style="list-style-type: none"> <li>• IGT_IN line at RS-485 interface</li> </ul>
Power off	Normal switch-off by AT^SMSO or external On/Off push button Automatic switch-off in case of critical temperature and voltage conditions
Reset	Orderly shutdown and reset by AT command Emergency restart via RST_IN line at power connector (CH32GGT-232 only)
<b>Special features</b>	
Real time clock	Timer functions via AT commands
Phonebook	SIM card and terminal

### 3 Interface Description

#### 3.1 Overview

CH32GGT provides the following interfaces for power supply, antenna, SIM card and data transfer:

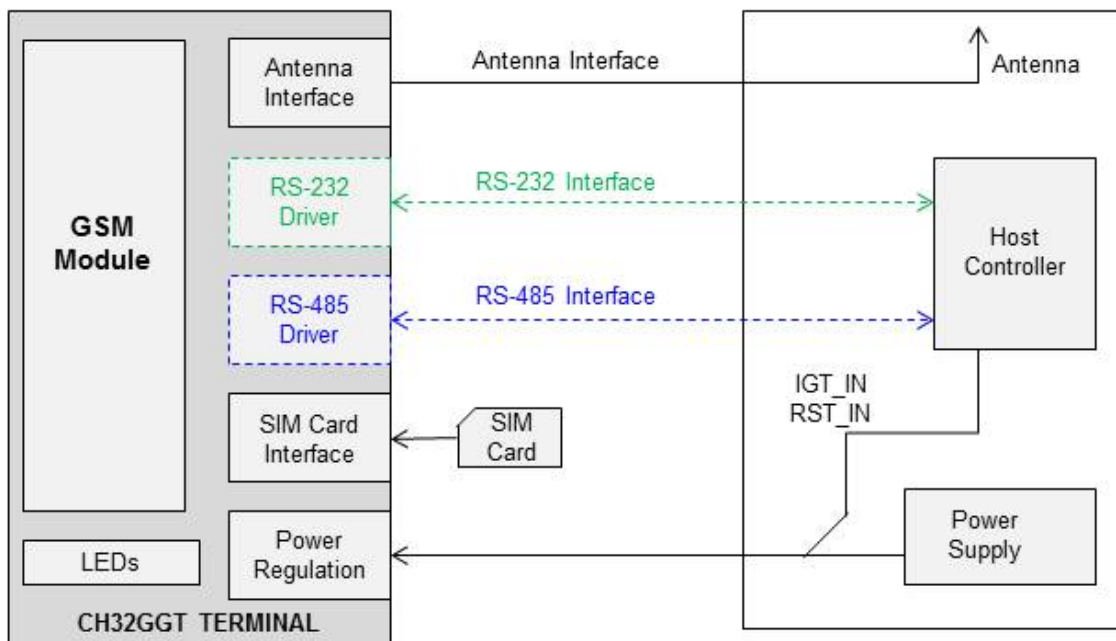
- 6-pole Western connector (female) for power supply, ignition, power down signal (CH32GGT-232 only)
- SMA antenna connector (female)
- SIM card reader
- 9-pole (female) D-sub connector for CH32GGT-232 or 6-pin (female) connector for CH32GGT-485



**Figure 1: CH32GGT-232 and CH32GGT-485 3D images.**

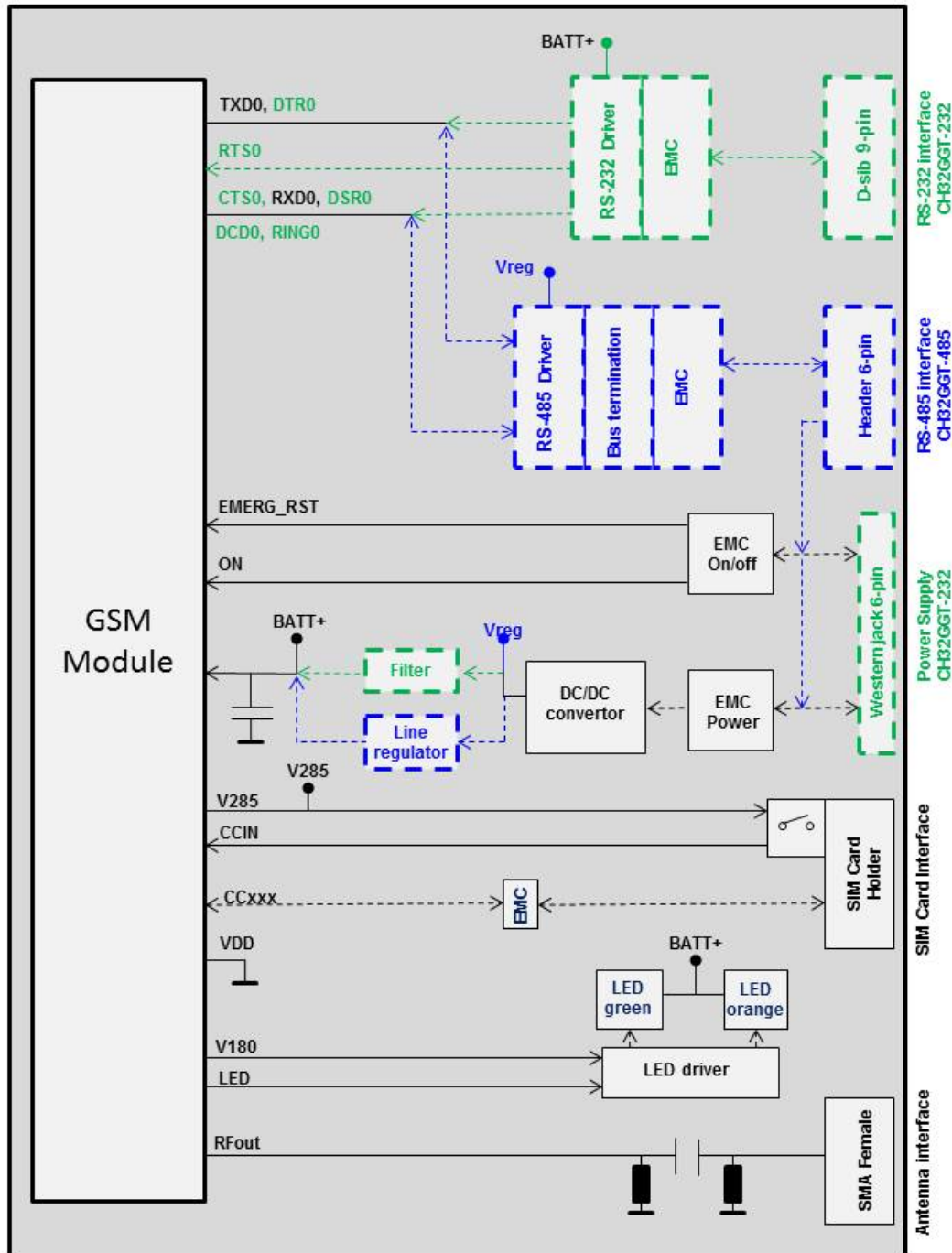
### 3.2 Block Diagram

Figure 2 contains a block diagram of a sample configuration that incorporates a CH32GGT and typical accessories.



**Figure 2: CH32GGT Block diagram**

**3.3 Terminal Circuit**



**Figure 3: CH32GGT internal circuit diagram**

The CH32GGT-232 contains separate connectors for data interface and power supply (D-sub RS-232 socket and Western jack). The CH32GGT-485 contains a single connector for the RS485 interface (6-pin header socket).



### 3.4 Operating Modes

Table 9 below briefly summarizes the various operating modes referred to in the following chapters.

**Table 9: Overview of operating modes**

Normal operation	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	Terminal is ready for GPRS data transfer, but no data is currently sent or received. Power consumption depends on network settings and GPRS configuration (e.g. multislot settings).
	GPRS DATA	GPRS data transfer in progress. Power consumption depends on network settings (e.g. power control level), uplink / downlink data rates, GPRS configuration (e.g. used multislot settings) and reduction of maximum out- put power.
POWER DOWN	Normal shutdown after sending the AT^SMSO command. The RTC works continuously, but the software is not active. Interfaces are not accessible.	

### 3.5 CH32GGT-232 (RS-232 Interface) Variant

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 1200bps to 230kbps. Autobauding supports bit rates from 1.2kbps to 230kbps.

For more information see also Section 3.5.1 and Section 3.5.2.

#### 3.5.1 Power Supply

The CH32GGT-232 power supply must be a single voltage source of  $V_{PLUS}=8V - 30V$  capable of providing a peak current (pulsed  $2 \times 577ms$  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 CH32GGT is protected from supply voltage reversal. An external fast acting fuse  $\geq 0.4A$  with melting integral  $I^2t$  (0.15 - 0.25) $A^2s$  is necessary to use the CH32GGT at a 12V or 24V unlimited power supply system.

The power supply must be compliant with the EN60950 guidelines. A switching regulator regulates the input voltage for the internal supply.

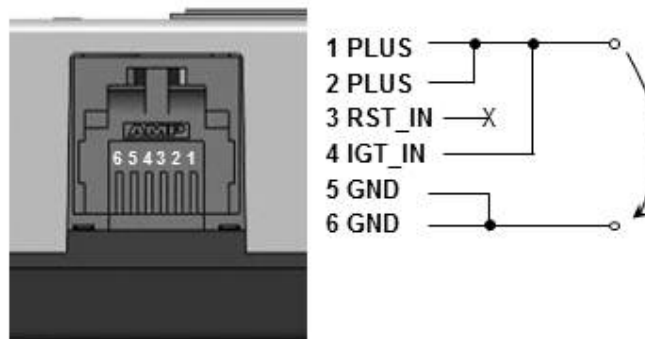
When power fails for  $>1ms$ , CH32GGT resets or switches off. When power fails for  $>15s$  the RTC will be

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	PLUS	Power supply	8V – 30V DC, max. 33V for 1 min
3	RST_IN	Signal for module reset	$U_{IH} \geq 8V$ for $t > 10ms$ resets the terminal. $U_{IL} < 2V$ and low level for normal operation.
4	IGT_IN	Ignition	$U_{IH} \geq 8V$ Ignition $\geq 8V$ for more than 200ms switches the CH32GGT on. Ignition is activated only by a rising edge. The rise time is $< 20ms$
5	GND	Ground	0V
6	GND	Ground	0V

**Pin Assignment and Typical Connection:**



**Figure 4: 6-pole Western jack for power supply, ignition, reset, typical connection.**

Mains adapter: If it fits into the design of your GSM application we recommend the plug-in supply unit used with the type approved and indicated in the Cermetek 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 CH32GGT on

CH32GGT is turned on by plugging an appropriate power supply unit between PLUS and GND of the 6-pole Western jack.

While the RST\_IN pin (pin4) is not active (voltage  $< 2V$ ) you can start the CH32GGT by activating the RS-232 DTR line if in POWER DOWN mode.

The IGT\_IN signal (pin3) may be used to switch on CH32GGT if in POWER DOWN mode.

After startup of the CH32GGT the RS-232 lines are in an undefined state for approx. 900ms. This may cause undefined characters to be transmitted over the RS-232 lines during this period.

### 3.5.1.2 Reset CH32GGT

An easy way to reset the CH32GGT is entering the command AT+CFUN=x,1. For details concerning this or other AT Commands, see Cermetek document, 613-0011, CH32GGT AT Commands.

As an alternative, shut down the CH32GGT as described in Section 3.5.1.3 and then re- start it as described in Section 3.5.1.1.

### 3.5.1.3 Turn CH32GGT off

Normal shutdown:

- To turn off the CH32GGT use the AT^SMSO command, rather than disconnecting the mains adapter.

This procedure lets the CH32GGT 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 CH32GGT returns the following result codes:

```
^SMSO: MS OFF OK
^SHUTDOWN
```

The "**^SHUTDOWN**" result code indicates that the CH32GGT turns off in less than 1 second. After the shutdown procedure is complete the CH32GGT enters the POWER DOWN mode. The orange LED stops flashing (see Section 3.10 for a detailed LED description). The RTC is still fed from the voltage regulator in the power supply ASIC. Please note that if there is an auto ignition connection between PLUS and IGT\_IN the module will restart automatically after a normal shutdown.

#### RECOMMENDATION

**Emergency Restart.** In the event of software hang-ups etc, the CH32GGT can be restarted by applying a voltage >8V to the RST\_IN pin (pin 3) for more than 10ms. The RST\_IN signal restarts the CH32GGT.

#### CAUTION

Use the RST\_IN pin only when the software is not responding for more than 5 seconds. Pulling the RST\_IN pin HIGH 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 the case of an emergency, e.g., if CH32GGT fails to respond or shut down properly.

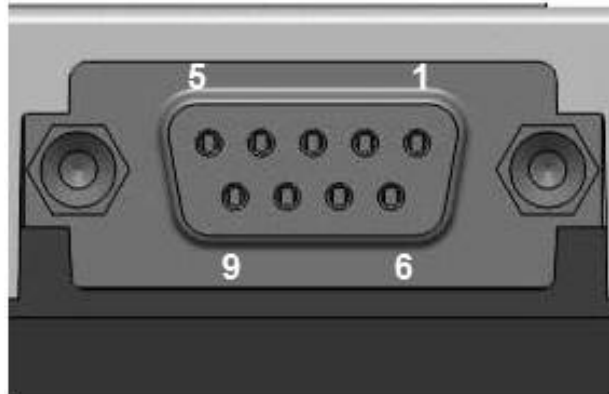
When the CH32GGT enters the POWER DOWN mode, e.g. after issuance of the AT^SMSO command or activated with the RST\_IN signal, all RS-232 interface lines are active for a period of 50ms to max. 3.5s. This may cause undefined characters to be transmitted on the RS-232 lines which can be ignored.

### 3.5.1.4 Disconnecting power supply

Before disconnecting the power supply from the PLUS pin, make sure that the CH32GGT is in a safe condition. The best way is to wait 1s after the "**^SHUTDOWN**" result code has been indicated.

### 3.5.2 9-Pole D-sub Connector

Via RS-232 interface, the host system controls the CH32GGT 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 CH32GGT 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	RING	O	Ring Indication

CH32GGT 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 CH32GGT
- Port RxD @ application receives data from RXD of CH32GGT

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 CH32GGT.

### 3.6 RS-485 Interface Variant

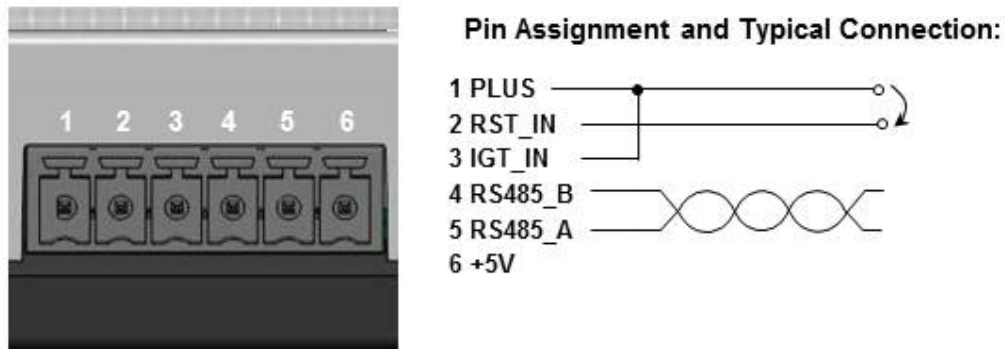
The RS-485 interface is based on the TIA/EIA-485 standard defining electrical characteristics of drivers and receivers for use in balanced multidrop communication systems. RS-485 is used in a lot of different fieldbus systems like Profibus, Interbus, Modbus and P-net.

RS-485 uses a shielded twisted pair cable where the shield is used as ground return, and the inner pairs are used for balanced communication. The two conductors in each pair are called A and B. RS-485 is usually half-duplex.

Data transmission speed depends on the length of the RS-485 bus cable and may be up to 115kbps.

#### 3.6.1 6-Pin Header and Power Supply

Via RS-485 interface, the host controller controls CH32GGT RS485 including power supply and data transmission.



**Figure 6: Pin assignment RS-485 (6-pin header female), typical connection**

**Table 12: 6-pin header pin assignment**

1	PLUS	Power supply	8V-30V DC
2	GND	Ground	0V
3	IGT_IN	Ignition	$U_{IH} \geq 8V$ Ignition $\geq 8V$ for more than 200ms switches the CH32GGT on. Ignition is activated only by a rising edge. The rise time is <20ms
4	RS485-B	Data transmission	Receive and transmit data for conductor B
5	RS485-A	Data transmission	Receive and transmit data for conductor A
6	+5V	Power output	Output: +5V, max. TBD. A

The power supply of the CH32GGT has to be a single voltage source of  $V_{PLUS}=8V - 30V$  capable of providing a peak current (pulsed  $2 \times 577ms$  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 CH32GGT is protected from supply voltage reversal. An external fast acting fuse  $\geq 0.4A$  with melting integral  $I^2t$  (0.15 - 0.25) $A^2s$  is necessary to use the CH32GGT at a 12V or 24V unlimited power supply system.

The power supply must be compliant with the EN60950 guidelines. A switching regulator regulates the input voltage for the internal supply. It is recommended that the power supply provides an internal connection between IGT\_IN pin and PLUS pin for auto ignition (power up).

When power fails for >1ms, CH32GGT resets or switches off. When power fails for >15s the RTC will be reset.

### 3.6.1.1 Turn CH32GGT on

Before switching CH32GGT on the SIM should be inserted. Now, CH32GGT is turned on by connecting an appropriate power supply between PLUS and GND of the 6-pin header.

The IGT\_IN signal (pin3) may be used to switch on CH32GGT if in POWER DOWN mode.

After startup of the CH32GGT the RS-485 lines are in an undefined state for approx. 900ms. This may cause undefined characters to be transmitted over the RS-485 lines during this period.

### 3.6.1.2 Reset CH32GGT

As an alternative, CH32GGT can be shut down as described in Section 3.5.1.3 and then restarted as described in Section 3.5.1.1.

### 3.6.1.3 Turn CH32GGT off

Normal shutdown:

- To turn off the CH32GGT use the AT^SMSO command, rather than disconnecting the mains adapter.

This procedure lets the CH32GGT 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 CH32GGT returns the following result codes:

```
^SMSO: MS OFF OK
^SHUTDOWN
```

The "SHUTDOWN" result code indicates that the CH32GGT turns off in less than 1 second. After the shutdown procedure is complete the CH32GGT enters the POWER DOWN mode. The orange LED stops flashing (see Section 3.10 for a detailed LED description). The RTC is still fed from the voltage regulator in the power supply ASIC. Please note that if there is an auto ignition connection between PLUS and IGT\_IN the module will restart automatically after a normal shutdown.

When the CH32GGT enters the POWER DOWN mode, e.g. after you have issued the AT^SMSO command or after emergency shutdown, all data transmission lines are active for a period of 50ms to max. 3.5s. This may cause undefined characters to be transmitted on the data transmission lines which can be ignored.

### 3.6.1.4 Disconnecting power supply

Before disconnecting the power supply lines, make sure that the CH32GGT is in a safe condition. The best way is to wait 1s after the "SHUTDOWN" result code has been indicated.

## 3.7 Automatic thermal shutdown

An on-board NTC measures the temperature of the built-in BGS2 module. If over- or under temperature is detected on the module the CH32GGT automatically shuts down to avoid thermal damage to the system.

Table 16 specifies the ambient temperature threshold for the CH32GGT.

The automatic shutdown procedure is equivalent to the power-down initiated with the AT^SMSO command, i.e. CH32GGT 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 CH32GGT switches off are implemented as Unsolicited Result codes (URCs). For details see the description of AT^SCTM command as described in 613-0010, CH32GGT AT Commands.

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.

### 3.8 RTC

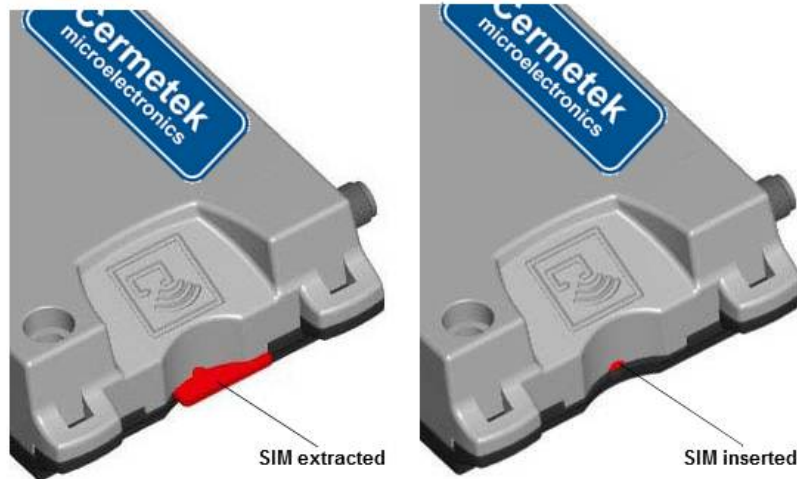
The internal Real Time Clock (RTC) of the CH32GGT retains the time and date and handles the alarm (reminder) function. The AT+CCLK command serves to set the time and date, and AT+CALA specifies a reminder message. See 613-0011, CH32GGT AT Commands, for details.

A dedicated voltage regulator backs up the RTC even in POWER DOWN mode and enables CH32GGT to keep track of time and date.

However, DO NOT attempt to set the Alarm mode via command AT+CALA. The AT+CALA command can only be used to set a reminder message, and not to configure the CH32GGT 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 CH32GGT by AT^SMSO or RST\_IN signal (CH32GGT RS232 variant).

### 3.9 SIM Interface

The SIM interface is intended for 1.8V and 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.



**Figure 7: SIM interface**

The SIM - with the circuit side facing towards the Cermetek logo - is inserted by gently pushing it into the SIM card holder until it snaps hold. It is now protected from accidental removal. The SIM can be removed from the card holder by using a flat object such as a screwdriver to carefully press the inserted SIM until it snaps out again.

All signals of the SIM interface are protected from electrostatic discharge with spark gaps to GND and clamp diodes to 1.8V resp. 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 CH32GGT.

#### **NOTE**

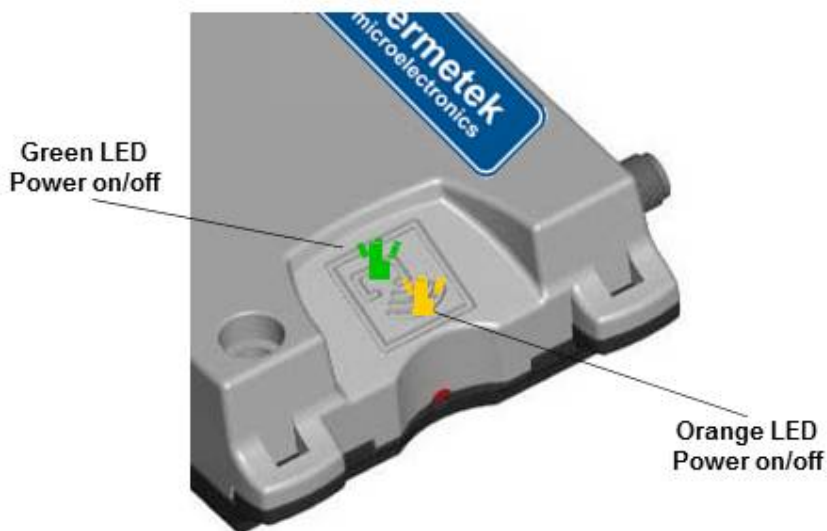
No guarantee can be given, nor any liability accepted, if loss of data is encountered after removing the SIM card during operation. Also, no guarantee can be given for properly initializing any SIM card that the user inserts after having removed a SIM card during operation. In this case, the application must restart the CH32GGT.



### 3.10 Status LEDs

CH32GGT has two LEDs indicating its operating states through the semitransparent casing:

- A green LED indicates whether the CH32GGT is ready to operate.
- An orange LED indicates the various operating states of the terminal.



**Figure 8: Status LED**

The orange LED is driven by a line of the integrated BGS2 module which can be configured by using the AT<sup>^</sup>SSYNC command. For the purpose of the CH32GGT it is recommended to retain the default setting of AT<sup>^</sup>SSYNC=1 (AT<sup>^</sup>SSYNC=0 is not applicable).

The following table lists the possible LED patterns and describes the operating status of the CH32GGT indicated by each pattern if AT<sup>^</sup>SSYNC=1.

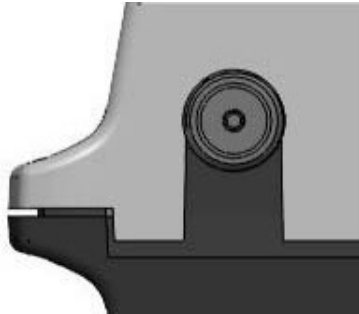
During the transition from one LED pattern to another the "on" and/or "off" periods of the LED may vary in length. This is because an event that triggers the change may occur any time and, thus, truncate the current LED pattern at any point.

**Table 13: Coding of the orange status LED**

LED mode	Operating status of CH32GGT
Permanently off	CH32GGT is in POWER DOWN mode
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	Connected to remote party or exchange of parameters while setting up or disconnecting a call.

### 3.11 Antenna Interface

An external antenna is connected via the terminal's female SMA connector that is also the antenna reference point (ARP).



**Figure 9: Antenna connector**

The system impedance is 50Ω. In any case, for good RF performance, the return loss of the customer application's antenna should be better than 10dB (VSWR < 2). CH32GGT withstands a total mismatch at this connector when transmitting with power control level for maximum RF power.

Inside the CH32GGT module an inductor to ground provides additional ESD protection to the antenna connector. To protect the inductor from damage no DC voltage must be applied to the antenna circuit.

For the application it is recommended to use an antenna with an SMA (male) connector: Please note that the terminal should be installed and operated with a minimum distance of 20cm between the antenna connected to the terminal and any human bodies. Also, the transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. The allowed maximum antenna gain for stand-alone situation is 7.24dBi (<1GHz) and 3.30dBi for the high bands (>1.7GHz).

## 4 Electrical and Environmental Characteristics

### 4.1 Absolute Maximum Ratings

**Table 14: Absolute maximum ratings**

Parameter	Port / Description	Min.	Max.	Unit
Supply voltage	PLUS	-50	30	V
Overtoltage	PLUS / for 1min		33	V
Input voltage for on/off control lines	IGT_IN, RST_IN	-5	30	V
RS-232 input voltage range	TXD, DTR, RTS	-25	+25	V
RS-232 output voltage range	RXD, CTS, DSR, DCD, RING	-0.3	+4.3	V
RS-485 input voltage range	RS485-A, RS485-B	-8	+13	V
Immunity against discharge of static electricity	All interfaces (lines) Contact discharge Human body model	-8 -15	+8 +15	kV kV
Protection Class	TBD. (avoid exposing CH32GGT to liquid or moisture, for example do not use it in a shower or bath)		TBD.	
Mechanical vibrations amplitude	@ 5-200Hz		TBD.	mm
Mechanical pulse-acceleration	@ 18 ms duration		TBD.	g

**Table 15: Operating supply voltage for CH32GGT**

Parameter	Min	Typ	Max	Unit
Supply voltage PLUS measured at (6-pole) western jack plug (1 to 6)	5.5 lowest voltage (minimum peak) incl. all ripple and drops	12	30	V
Supply voltage PLUS for RS-485 at 6-pin header	7.6 lowest voltage (minimum peak) incl. all ripple and drops	12	30	V

### 4.2 Operating Temperatures

**Table 16: Board temperature of CH32GGT module**

Parameter	Min	Max	Unit
Normal operation	-30	+85	°C
Restricted operation <sup>1</sup>	-40 to -30	+85 to +90	°C
Automatic thermal shutdown <sup>2</sup>	<-40	>+90	°C

<sup>1</sup> 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."

<sup>2</sup> Due to temperature measurement uncertainty, a tolerance of  $\pm 3^{\circ}\text{C}$  on these switching thresholds may occur.

If the CH32GGT Terminal temperature rises close to the limit specified for normal operation, while data is transmitted over GPRS, the module automatically reverts from GPRS Multislot Class 10 (2Tx slots) to GPRS Multislot Class 8 (1Tx). This reduces the power consumption and, consequently, causes the board's temperature to decrease. Once the temperature drops by 5 degrees, the module returns to the higher Multislot Class.

### 4.3 Storage Conditions

**Table 17: Storage conditions**

Type	Condition	Unit	Reference
Air temperature: Low High	-30 +75	°C	ETS 300 019-2-1: T1.2, IEC 60068-2-1 Ab ETS 300 019-2-1: T1.2, IEC 60068-2-2 Bb
Humidity relative: Low High Condens .	10 90 at 30°C 90-100 at 30°C	%	--- ETS 300 019-2-1: T1.2, IEC 60068-2-56 Cb ETS 300 019-2-1: T1.2, IEC 60068-2-30 Db
Air pressure: Low High	70 106	kPa	IEC TR 60271-3-1: 1K4 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 Heat	1120 600	W/m <sup>2</sup>	ETS 300 019-2-1: T1.2, IEC 60068-2-2 Bb ETS 300 019-2-1: T1.2, IEC 60068-2-2 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: Displacement Acceleration Frequency	1.5 5 2-9 9-200	mm m/s <sup>2</sup> Hz	IEC TR 60271-3-1: 1M2
Shocks: Shock spectrum Duration Acceleration	semi-sinusoidal 1 50	ms m/s <sup>2</sup>	IEC 60068-2-27 Ea

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.

### 4.4 Electrical Specifications of the Application Interface

#### 4.4.1 On/Off Control (CH32GGT-232)

**Table 18: RS-232 On/Off control line specifications (requirements)**

Parameter	Description	Conditions	Min.	Typ	Max.	Unit
$V_{high}$	Input voltage IGT_IN, RST_IN	active high	5			V
$V_{low}$					2	V
$V_{high}$	Input voltage DTR	active high	3		+15	V
$V_{low}$					1.2	V
$R_{IN}$	Input resistance of IGT_IN, RST_IN		1			M $\Omega$
$R_{IN}$	Input resistance of DTR		3	5	7	k $\Omega$

#### 4.4.2 On/Off Control (CH32GGT-485)

**Table 19: RS-485 On/Off control line specifications (requirements)**

Parameter	Description	Conditions	Min.	Typ	Max.	Unit
$V_{high}$	Input voltage IGT_IN	active high	5			V
$V_{low}$						2
$R_{IN}$	Input resistance of IGT_IN		1			M $\Omega$

#### 4.4.3 RS-232 Interface

**Table 20: RS-232 interface specifications (requirements)**

Parameter	Description	Conditions	Min.	Typ	Max.	Unit
$V_{OUT}$	Transmitter output voltage for RXD, CTS, DSR, DCD, RING	@ 3k $\Omega$ load	$\pm 5$	$\pm 6$	$\pm 7$	V
$R_{OUT}$	Transmitter output resistance RXD, CTS, DSR, DCD, RING		300			$\Omega$
$R_{IN}$	Resistance TXD, RTS, DTR		3	5	7	k $\Omega$
$V_{In}$	Receiver input voltage range TXD, RTS, DTR		-25		+25	V
$V_{RIHYS}$	Input hysteresis			0.5		V
$V_{llow}$	Input threshold low		0.6	1.2		V
$V_{Ihigh}$	Input threshold high			1.5	2.4	V
Baudrate		Autobauding	1.2		230	kbps
		Fixed range	1.2		230	kbps
$LE_{Cable}$	Length of RS-232 cable			1.8	2	m

### 4.4.4 RS-485 Interface

**Table 21: RS-485 interface specifications (requirements)**

Parameter	Description	Conditions	Min.	Typ	Max.	Unit
$V_{OUT}$	Transmitter output voltage for RS485-A, -B	$R_{Diff} = 100\Omega$	2		5	V
$R_{IN}$	Resistance RS485-A, -B			48		$k\Omega$
$V_{in}$	Receiver input voltage range RS485-A, -B		-7		+12	V
$V_{RIHYS}$	Input hysteresis			25		mV
Threshold voltage	Receiver diff. threshold voltage		-200		+200	mV
Bus termination				120		$\Omega$
Baudrate		Autobauding	1.2		230	kbps
		Fixed range	1.2		230	kbps
$LE_{Cable}$	Length of RS-485 indoor cable				10	m

## 4.5 Power Supply Ratings

**Table 22: Power supply specifications**

Parameter	Description	Conditions	Min.	Typ	Max.	Unit
V <sub>PLUS</sub>	Allowed voltage ripple (peak-peak), drop during transmit burst peak current	TALK mode, power control level for P <sub>out</sub> max <sup>1</sup>			1	V
I <sub>PLUS</sub> <sup>2</sup>	Average supply current (average time 3 min.)	Power Down mode	@8V	9		mA
			@30V	3,7		
		IDLE mode (GSM/GPRS, 850/900MHz, 1800/1900MHz)	@8V	25		mA
			@30V	10		
		GSM TALK mode, 850/900MHz	@8V	135		mA
			@30V	40		
		GSM TALK mode, 1800/1900MHz	@8V	100		mA
			@30V	35		
		GPRS DATA mode(1 Tx, 4 Rx, 850/900MHz)	@8V	125		mA
			@30V	35		
		GPRS DATA mode(1 Tx, 4 Rx, 1800/1900MHz)	@8V	90		mA
			@30V	30		
		GPRS DATA mode(2 Tx, 3 Rx, 850/900MHz)	@8V	215		mA
			@30V	60		
GPRS DATA mode(2 Tx, 3 Rx, 1800/1900MHz)	@8V	150		mA		
	@30V	45				
Peak supply current (during 577µs transmission slot every 4.6ms)	Power control level for P <sub>out</sub> max (850/900MHz)	@8V	810		mA	
		@30V	200			
	Power control level for P <sub>out</sub> max (1800/1900MHz)	@8V	490		mA	
		@30V	130			

<sup>1</sup> Lowest voltage (minimum peak) incl. all ripple and drops >7.6V including voltage drop, ripple and spikes, measured at western jack (6-pole) pins (CH32GGT-232) and 6-pin header (CH32GGT-485).

<sup>2</sup> Typical values measured with antenna impedance = 50 Ohm (return loss >20dB).

### 4.6 Antenna Interface

**Table 23: Antenna interface characteristics**

Parameter		Min	Typ	Max	Unit
Frequency range Uplink (MS → BTS)	GSM 850	824		849	MHz
	E-GSM 900	880		915	MHz
	GSM 1800	1710		1785	MHz
	GSM 1900	1850		1910	MHz
Frequency range Downlink (BTS → MS)	GSM 850	869		894	MHz
	E-GSM 900	925		960	MHz
	GSM 1800	1805		1880	MHz
	GSM 1900	1930		1990	MHz
RF power @ ARP with 50Ω load	GSM 850 <sup>1</sup>	31		35	dBm
	E-GSM 900 <sup>1</sup>	31		35	dBm
	GSM 1800 <sup>2</sup>	28		32	dBm
	GSM 1900 <sup>2</sup>	28		32	dBm
Number of carriers	GSM 850		124		
	E-GSM 900		174		
	GSM 1800		374		
	GSM 1900		299		
Duplex spacing	GSM 850		45		MHz
	E-GSM 900		45		MHz
	GSM 1800		95		MHz
	GSM 1900		80		MHz
Carrier spacing			200		kHz
Multiplex, Duplex	TDMA / FDMA, FDD				
Time slots per TDMA frame	8				
Frame duration	4.615				ms
Time slot duration	577				μs
Modulation	GMSK				
Receiver input sensitivity @ ARP BER Class II < 2.4% (static input level)	GSM 850	-107 <sup>4</sup>			dBm
	E-GSM 900	-107 <sup>4</sup>			dBm
	GSM 1800	-107 <sup>4</sup>			dBm
	GSM 1900	-107 <sup>4</sup>			dBm

1. Power control level PCL 5
2. Power control level PCL 0
3. Under fading conditions
4. Typical value is at least -107dBm.



## **5 Mechanics, Mounting and Packaging**

### **5.1 Mechanical Dimensions**

Figure 10 shows a 3 dimensional view of the CH32GGT and provides an overview of the mechanical dimensions.

Length: 80mm (including fixtures for cable straps)  
Width: 55mm (excluding antenna and serial interface connectors) Height 23mm  
Weight: 65g



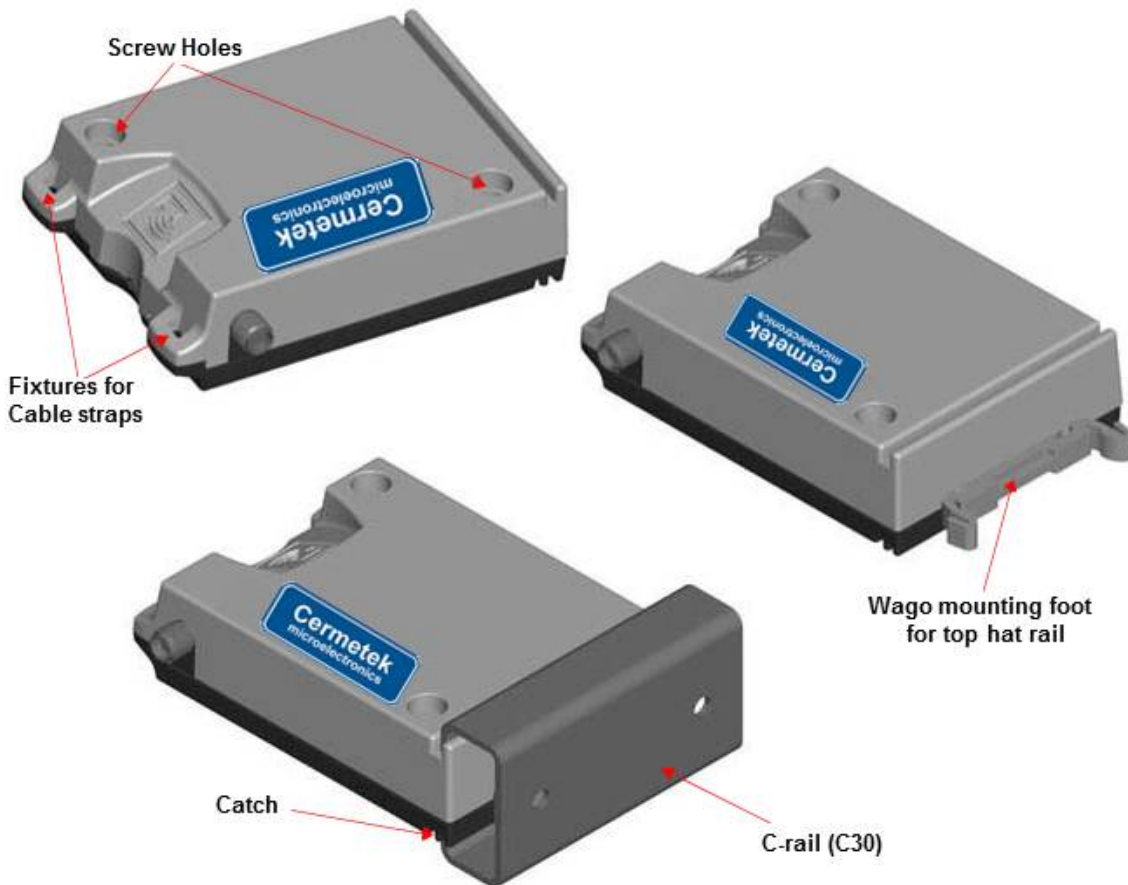
**Figure 10: Mechanical dimensions.**

### 5.2 Mounting the CH32GGT

There are a number of ways to mount the CH32GGT:

- CH32GGT can be attached to a rail installation or other surface using the two provided screw holes.
- CH32GGT can be fastened to a rack or holding using the two provided fixtures for cable straps.
- CH32GGT can be slid onto a specific DIN rail made according to DIN EN 60715 - C section, C30 format. A catch at the terminal's bottom side will have to be removed to slide multiple terminals onto a single rail.
- Using a Wago 209-188 mounting foot for terminal blocks the CH32GGT can be fitted onto another special type of DIN rail made according to DIN EN 60715 - Top hat section, 35mm (e.g., Wago 210-113 steel carrier rail).

The following figure (figure 11) shows the options for mounting the CH32GGT.



**Figure 11: Mounting the CH32GGT**

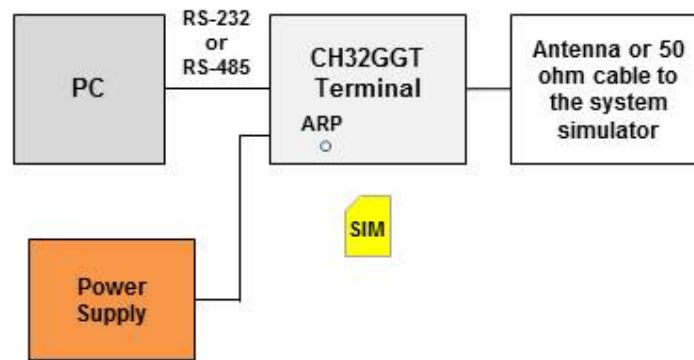
The various ways to mount the CH32GGT may be combined where appropriate. It is for example possible to slide the terminal onto a DIN rail and in addition use cable straps to fasten it to a holding.

## 6 Full Type Approval

### 6.1 Cermetek Reference Setup

The Cermetek reference setup submitted to type approval for the CH32GGT consists of the following components:

- CH32GGT with approved GSM module (CH32GGT RS232 or CH32GGT RS485)
- PC as MMI
- Power Supply



**Figure 12: Reference equipment for approval**

For ordering information please refer to Chapter 7

### 6.2 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 CH32GGT configuration.
- Extra approval must be obtained for applications using other accessories than those included in the approved CH32GGT configuration (power supply, MMI implementation supported by AT commands).

### 6.3 CE Conformity

The CH32GGT meets the requirements of the EU directives listed below:

- R&TTE Directive 1999/5/EC

### 6.4 EMC

The CH32GGT complies with the equipment requirements specified in EN 301489-1, -7 and is covered by the R&TTE Directive.

### 6.5 Compliance with FCC Rules and Regulations

As an integrated product, the CH32GGT is fully compliant with the grant of the FCC Equipment Authorization issued for the built-in CH32GGT terminal, and therefore, bears the label “Contains FCC ID QIPBGS2”.

The Equipment Authorization Certification for the CH32GGT module is listed under the following identifiers:

*FCC Identifier: QIPBGS2*

*Industry Canada Certification Number: 7830A-BGS2*

Radiofrequency radiation exposure Information:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance of 20 cm between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

**Note:** This terminal equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

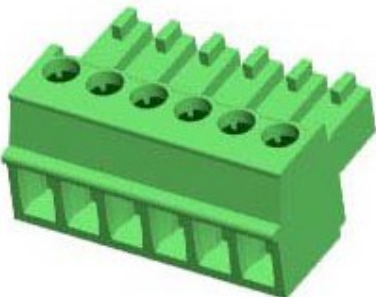
Changes or modifications made to this equipment not expressly approved by Cermetek may void the FCC authorization to operate this equipment.

This device contains GSM and GPRS Class10 functions in the 900 and 1800MHz Band which are not operational in U.S. Territories. This device is to be used only for mobile and fixed applications.

Users and installers must be provided with antenna installation instructions and transmitter operating conditions for satisfying RF exposure compliance.

### 7 List of Parts and Accessories

**Table 24: List of parts and accessories**

Description	Supplier	Ordering information
CH32GGT	Cermetek	Ordering number CH32GGT-232 CH32GGT-485
Power supply unit	Cermetek	Terminal Power Supply Ordering number: CH32GGP (Specify country of installation)
Mounting foot (209-188) Top hat rail, i.e., 35mm DIN rail (210-113) 	Wago	WAGO Kontakttechnik GmbH & Co. KG Hansastr. 27 32423 Minden Phone: +49-571-887-0 Fax: +49-571-887-169  Email: <a href="mailto:info@wago.com">info@wago.com</a> Web: <a href="http://www.wago.com/">http://www.wago.com/</a>
Antenna - SMARTEQ-MiniMAG Dualband, 0dBd, 2.6m RG174, SMA (m)	KÖBEL Mobile Communication	Ordering number: 1140.26 with crimped SMA connector KÖBEL Mobile Communication Sesamstrasse 12 D-24632 Lentföhrden
RS-232 cable with 9-pin D-sub connector (male)	Tecline	Ordering number: 300574 Tecline GmbH Behrener Straße 8 D-66117 Saarbrücken Phone: +49-681-926-78-70 Fax: +49-681-926-78-555 Web: <a href="http://www.tecline-edv.de/">http://www.tecline-edv.de/</a>
6-pin header connector (male) for RS-485 interface	PHOENIX CONTACT	Ordering number: 1803617 PHOENIX CONTACT Deutschland GmbH Flachsmarktstr. 8 D-32825 Blomberg  Phone: +49 52 35/3-1 20 00 Fax: +49 52 35/3-1 29 99  Email: <a href="mailto:iinfo@phoenixcontact.de">iinfo@phoenixcontact.de</a> Web: <a href="http://www.phoenixcontact.com">http://www.phoenixcontact.com</a>

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