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GTC01                    PRELIMINARY                    Issue 1, 28 August 2010

## GSM Telemetry Controller

*GTC01 is a self contained GSM / GPRS platform supporting the Cinterion M2M Evolution range of GSM modems.*

*GTC01 includes a watchdog, SIM holder and user interfaces. It can be directly added to any application requiring GSM connectivity.*

### Features

- Supports Cinterion MC75i, TC65i, or TC63i GSM modules
- Java platform using TC65i
- Worldwide communication potential
- Programmable Watchdog function
- SIM holder
- RS232 compliant serial interfaces
- On-board supply regulation
- DIL module form factor

*Figure 1: GTC01*

### Applications

- GSM communications interface for any product
- Remote management and instrumentation
- Remote imaging
- Emails
- SMS
- TCP/IP
- Remote web-site

## General Description

GTC01 is a complete GSM / GPRS modem communications processor solution in an easy to use plug-in module form factor.  Essential references for the developer are the hardware and software documents for the GSM module to be used.  Useful third-party documents and the contact details for Cinterion are listed at the end of this datasheet under **References**.

*This document:*

1. States the physical dimensions and pin-arrangement
2. Details the hardware connection of the Cinterion GSM device
3. Specifies the power supply requirements
4. Describes how the watchdog controller is typically used in a system

Figures 2 and 3 illustrate the outline shape and physical connections to the GTC01 PCB.

The antenna connection is 50 Ohms impedance and is via a Hirose U.FL connection directly to the GSM unit rather than to the GTC board.  Typically the part number of the connector will be U.FL-LP-0xx, where "xx" varies according to the type of coaxial cable used.  Extremely thin cable is commonly used (1.2 – 1.4mm diameter) and as both the connectors and cable require specialist tools it is often convenient to source a pre-assembled loom or loom and antenna combined.

It is easier to connect the RF loom to the GSM unit before mating the GSM unit to the rest of the module since the RF connection becomes inverted once the GSM unit is installed.  The very small size of U.FL connectors means that care must be taken when handling the RF connection.
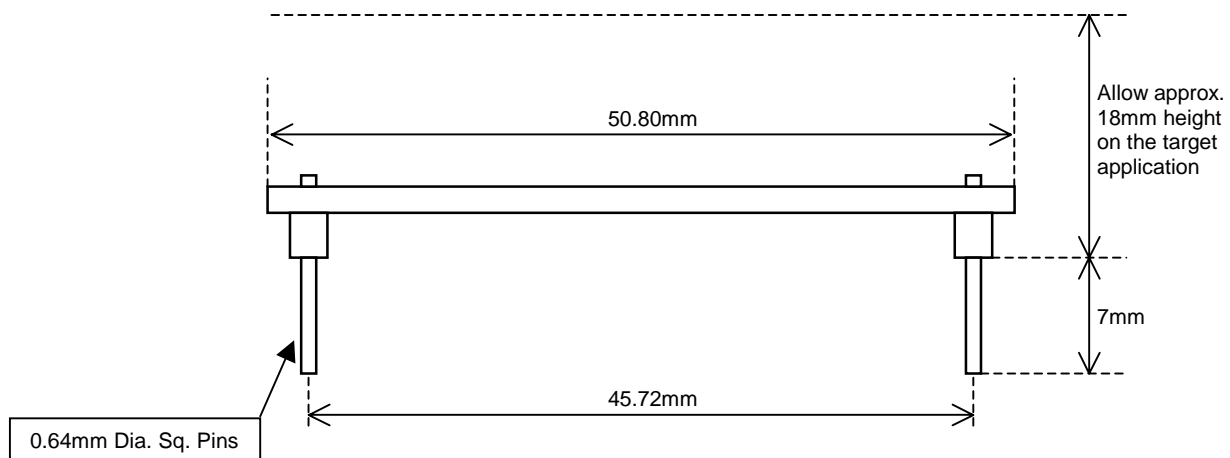
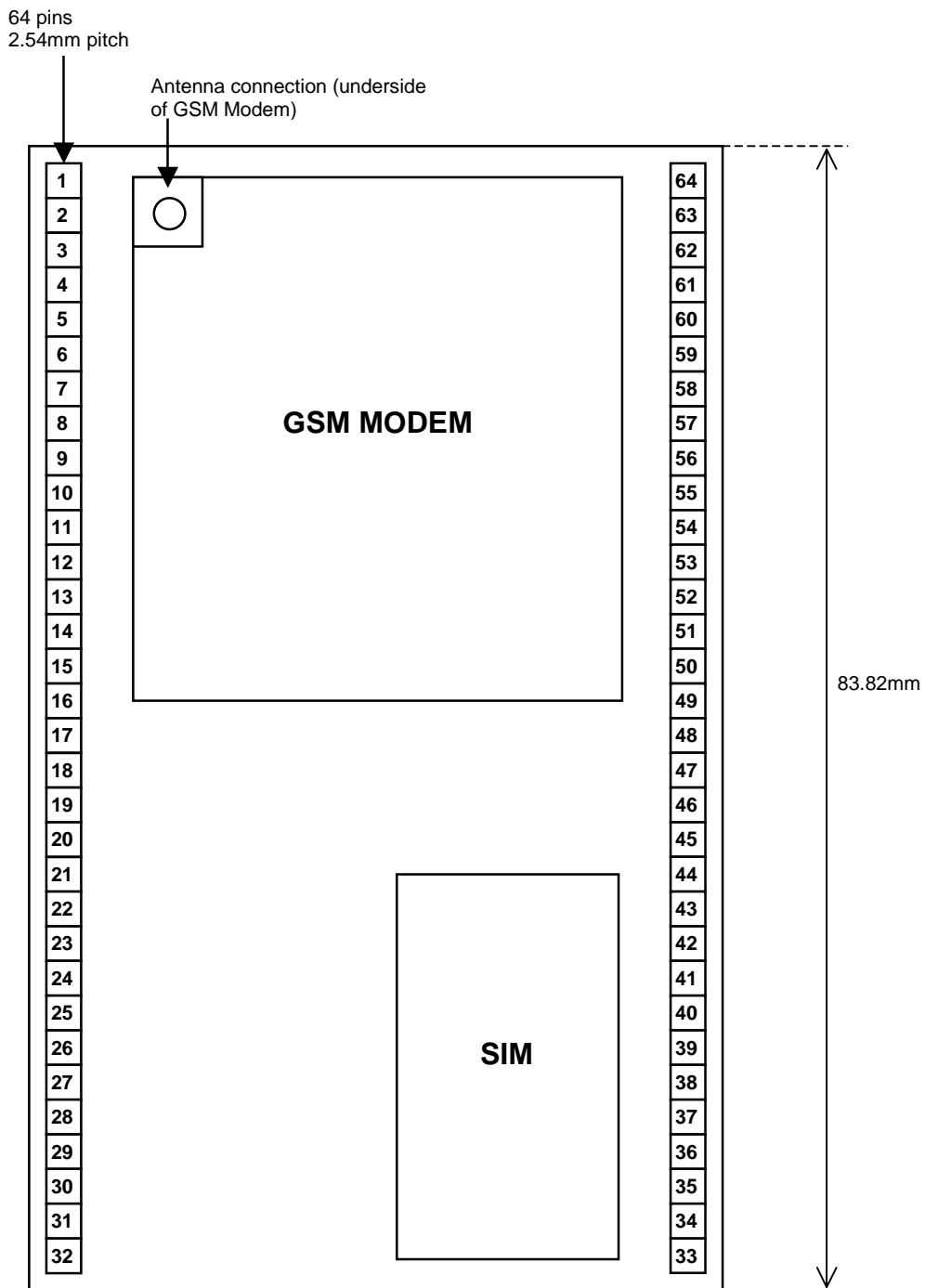*Figure 2: GTC01 Dimensions – end view*

64 pins
2.54mm pitch

Antenna connection (underside
of GSM Modem)

| | | |
|---|---|---|
| 1 | | 64 |
| 2 | | 63 |
| 3 | | 62 |
| 4 | | 61 |
| 5 | | 60 |
| 6 | | 59 |
| 7 | | 58 |
| 8 | GSM MODEM | 57 |
| 9 | | 56 |
| 10 | | 55 |
| 11 | | 54 |
| 12 | | 53 |
| 13 | | 52 |
| 14 | | 51 |
| 15 | | 50 |
| 16 | | 49 |
| 17 | | 48 |
| 18 | | 47 |
| 19 | | 46 |
| 20 | | 45 |
| 21 | | 44 |
| 22 | | 43 |
| 23 | | 42 |
| 24 | | 41 |
| 25 | | 40 |
| 26 | SIM | 39 |
| 27 | | 38 |
| 28 | | 37 |
| 29 | | 36 |
| 30 | | 35 |
| 31 | | 34 |
| 32 | | 33 |

83.82mm

*Figure 3: GTC01 Dimensions – plan view*

## GTC01 PIN DESCRIPTION

| Pin | Name | GSM unit Pin No. or PIC Pin descriptor | Function and Notes - where "GSM" is referenced please refer to the Hardware Interface Description document pertaining to the GSM unit installed |
|---|---|---|---|
| 1 | ENable | | Enables the on-board regulator when taken high – typically this pin is tied to one of the +V supply pins |
| 2 | ASC0-RI | | RS232 Ring Indicator output from GSM ASC0 |
| 3 | ASC0-DSR | | RS232 Data Set Ready output from GSM ASC0 |
| 4 | ASC0-CTS | | RS232 Clear To Send output from GSM ASC0 |
| 5 | ASC0-RTS | | RS232 Request To Send input to GSM ASC0 |
| 6 | ASC0-DTR | | RS232 Data Terminal Ready input to GSM ASC0 |
| 7 | ASC0-DCD | | RS232 Data Carrier Detect output from GSM ASC0 |
| 8 | ASC0-TD | | RS232 Data input to GSM ASC0 |
| 9 | ASC0-RD | | RS232 Data output from GSM ASC0 |
| 10 | SPIDI | GSM: 7 | GSM SPI Digital Input |
| 11 | GPIO8 | GSM: 6 | GSM General Purpose Input/Output |
| 12 | GPIO10 | GSM: 5 | GSM General Purpose Input/Output and Pulse Counter |
| 13 | ADC2_IN | GSM: 3 | GSM Analogue to Digital conversion input. +2.4V FS.  Do not drive beyond 0.3V when GSM unit is shut down |
| 14 | ADC1_IN | GSM: 2 | GSM Analogue to Digital conversion input. +2.4V FS.  Do not drive beyond 0.3V when GSM unit is shut down |
| 15 | +V Supply | | +5.00 to +13.8V supply to the module: typically 6V – see specifications for more information |
| 16 | +V Supply | | Connected to pins 15, 47, 48 |
| 17 | GND | GSM: 1, 4, 36-40, 80<br><br>PIC: VSS | Ground (0V) of the module |
| 18 | GND | | Connected to pins 17, 33, 49, 50 |
| 19 | DAC_OUT | GSM: 79 | GSM Pulse-Width Modulator output (use an external filter to achieve an analogue output) |
| 20 | GPIO9 | GSM: 76 | GSM General Purpose Input/Output |
| 21 | SPICS | GSM: 75 | GSM SPI Chip Select (output) |
| 22 | GPIO4 | GSM: 74 | GSM General Purpose Input/Output |
| 23 | GPIO3 | GSM: 73 | GSM General Purpose Input/Output |
| 24 | GPIO7 | GSM: 8 | GSM General Purpose Input/Output |
| 25 | GPIO6 | GSM: 9 | GSM General Purpose Input/Output |
| 26 | GPIO5 | GSM: 10 | GSM General Purpose Input/Output |
| 27 | I2CCLK_SPICLK | GSM: 11 | GSM I2C or SPI Clock Output |
| 28 | DAI5 | GSM: 13 | GSM: PCM Audio input – 100k pull-down on board |
| 29 | I2CDAT_SPIDO | GSM: 70 | GSM: I2C Data in/out or SPI Data output |
| 30 | VMIC | GSM: 66 | GSM: external microphone supply 2.5V output, 2mA max current capability. |
| 31 | EPN2 | GSM: 65 | GSM: external speaker connection (32 ohm) |
| 32 | EPP2 | GSM: 64 | GSM: external speaker connection (32 ohm) |
| 33 | GND | | Connected to pins 17, 18, 49, 50 |
| 34 | DAI4 | GSM: 22 | GSM: PCM Audio input – 100k pull-down on board |
| 35 | DAI3 | GSM: 23 | GSM: PCM Audio output |
| 36 | EPP1 | GSM: 63 | GSM: external speaker connection (8 ohm) |
| 37 | EPN1 | GSM: 62 | GSM: external speaker connection (8 ohm) |
| 38 | MICP1 | GSM: 59 | GSM: external microphone input |
| 39 | MICN1 | GSM: 58 | GSM: external microphone input |
| 40 | AGND | GSM: 57 | GSM: analogue ground |
| 41 | DAI2 | GSM: 24 | GSM: PCM Audio output |
| 42 | DAI1 | GSM: 25 | GSM: PCM Audio input – 100k pull-down on board |
| 43 | DAI0 | GSM: 26 | GSM: PCM Audio output |
| 44 | SYNC | GSM: 28 | GSM: Synchronization Signal – useful indicator for monitoring GSM activity (500uA max output) |
| 45 | VRTC | | GSM Real Time Clock backup supply input: connected to VDDLP (GSM: 33) via a schottky diode – the diode may be |

| | | | bypassed with a solder link in order to use a capacitor as the RTC backup supply but should be left untouched when using a battery.  Vin: 2.7V - 3.6V (max) |
|----|----|----|----|
| 46 | ASC1-CTS | | RS232 Clear To Send output from GSM ASC1 |
| 47 | +V Supply | | Connected to pins 15, 16, 48 |
| 48 | +V Supply | | Connected to pins 15, 16, 47 |
| 49 | GND | | Connected to pins 17, 18, 33, 50 |
| 50 | GND | | Connected to pins 17, 18, 33, 49 |
| 51 | ASC1-TD | | RS232 Data input to GSM ASC1 |
| 52 | ASC1-RTS | | RS232 Request To Send input to GSM ASC1 |
| 53 | ASC1-RD | | RS232 Data output from GSM ASC1 |
| 54 | ASC0-SHDN | PIC: RB4 | Output: goes high to indicate that ASC0 RS232 traffic is inhibited: if the PIC is required to make a call for some reason it needs to take over the ASC0 interface to the GSM unit.  It achieves this by making the on-board RS232 drivers for ASC0 high impedance. |
| 55 | PIC-RB5 | PIC: RB5 | PIC General Purpose Input / Output |
| 56 | PIC-PGC | PIC: RB6 | PIC General Purpose Input / Output – also used for In-Circuit Serial Programming (ICSP) of the PIC |
| 57 | PIC-PGD | PIC: RB7 | PIC General Purpose Input / Output – also used for ICSP |
| 58 | PIC-Vdd-2V7 | PIC: VDD | PIC +V supply:  Supplied from the on-board +3V regulator via a schottky diode.  This can be used as a general low current supply (<50mA).  Example: connect to pull-up resistors for use with GSM GPIO as inputs. |
| 59 | PIC-RA0 | PIC: RA0/AN0 | PIC General Purpose Input / Output |
| 60 | PIC-RA1 | PIC: RA1/AN1 | PIC General Purpose Input / Output |
| 61 | ON-OFF | PIC: RB0/INT | PIC General Purpose Input / Output but suggested use is to provide an ON/OFF input function for the GSM unit. |
| 62 | PIC-RA2 | PIC: RA2/AN2 | PIC General Purpose Input / Output |
| 63 | PWR_IND | GSM: 78

PIC: RA3 | PWR_IND (Power Indicator): the GSM unit on/off status – open collector pulled up via 100k to PIC-Vdd-2V7 so logic '0' indicates that the GSM unit is 'on'. |
| 64 | PIC-Vpp | PIC: /MCLR | PIC /MCLR is pulled up via 10k to PIC-Vdd-2V7.  This pin is used during ICSP.  Holding this pin low will hold the PIC in reset. |

## Notes on the Module Pin description table

Not all of the GSM pins are "brought out" and some of the PIC pins are similarly unavailable.  Please refer to the next table for a description of the on-board permanent connections between the PIC watchdog and the GSM unit.  The PIC will normally be programmed – even if its only function is to turn the GSM unit on or off.

In all cases of interfacing peripherals to the GSM device please refer to the relevant Hardware description documents for the type of GSM device being used.

### CAUTION!
Take care that inputs to GSM GPIO lines never exceed 3.00V – it is recommended to use the PIC-Vdd-2V7 (pin 58) as a Logic '1' reference for all digital inputs to the GTC01.  Standard RS232 bus transceivers can be used for serial interfacing.  Analogue inputs to the GSM unit should not be present whilst the unit is shut down (PWR_IND = high) and should not exceed 2.4V in any case.

## PIC Watchdog

The on-board 16LF628A PIC is able to provide support for the GTC01 in the following ways:

- Control of IGT and EMERG_OFF on the GSM unit – turn GSM unit on/off
- Initiate software shutdown (e.g. of a Java application) via GPIO
- AT commands via the ASC0 interface (e.g. make calls)

PIC pin description is given in the table below – pre-determined functions are highlighted:

| GTC Pin | PIC Name | GSM unit Pin No. | Function and Notes |
|---|---|---|---|
| 59 | RA0/AN0 | | Digital I/O or analogue input |
| 60 | RA1/AN1 | | Digital I/O or analogue input |
| 62 | RA2/AN2/VREF | | Digital I/O or analogue input |
| 63 | RA3 | 78 | PWR_IND (Power Indicator – input to the PIC): the GSM unit on/off status is open collector pulled up via 100k to PIC-Vdd-2V7, so logic '0' indicates that the GSM unit is 'on'. |
| | RA4 | 71 | Connected directly to GPIO1 on the GSM unit, RA4 is an open-drain pulled up via 100k to PIC-Vdd-2V7. Intended for use as a control output from the PIC to the GSM unit. |
| 64 | /MCLR /VPP | | PIC /MCLR is pulled up via 10k to PIC-Vdd-2V7. This pin is used during **ICSP**. Pull low to reset. |
| | RA6 | (56) | Connected to GSM IGT (pin 56) via a transistor (open collector). This is able to turn the GSM unit on/off. |
| | RA7 | (55) | Connected to GSM EMERG_OFF (pin 55) via a transistor (open collector). This is able to turn the GSM unit off. |
| 58 | VDD | | PIC-Vdd-2V7: supply to the PIC is from the +3V supply on-board the GTC01 via schottky diode. Note that the +3V supply is not available externally but the PIC supply can be used as a general-purpose low-current source for interfacing with the rest of the module. This pin can be driven to +5V during **ICSP** (whilst main module supply is disconnected). |
| 17 18 33 49 50 | VSS | | Connected to the GND (0V) pins of GTC01. Also used during **ICSP**. |
| 61 | RB0/INT | | Intended for use as the ON/OFF request user input. Normally pulled high within the PIC by software (PORT B "weak pull-up" should be enabled in the program code). |
| | RB1/RX | 30 | Connected to RXD0 on the GSM unit: serial data from GSM unit to PIC using ASC0. Never make RB1 an output. |
| | RB2/TX | 32 | Connected to TXD0 on the GSM unit: serial data from PIC to GSM unit using ASC0. Note that the PIC program should ensure that that RB2 is always configured as an input and that the TXEN bit of the TXSTA register is '0' whenever RB4 is low (i.e. when ASC0 is available for external use). |
| | RB3 | 72 | Connected directly to GPIO2 on the GSM unit, RB3 is intended for use as a status / response signal input from the GSM unit. Use PORT B "weak pull-up enable". |
| 54 | RB4 | | ASC0-SHDN: set High to inhibit external ASC0 RS232 traffic: if the PIC is required to communicate serially with the GSM unit it should have control over the ASC0 interface. This is achieved by making the GTC01 RS232 drivers for ASC0 high impedance (tri-state). RB4 should always be configured as an output in the PIC program and driven low or high as required by the application. |
| 55 | RB5 | | General Purpose Input/Output – weak pull-up. |
| 56 | RB6/PGC | | PIC-PGC: General Purpose Input/Output – weak pull-up. Also used as programming clock during **ICSP** of the PIC. |
| 57 | RB7/PGD | | PIC-PGD: General Purpose Input/Output – weak pull-up. Also used as the data input during **ICSP** of the PIC. |

## PIC Watchdog notes

The on-board PIC uses the 4MHz oscillator contained within the PIC.

The on-board PIC of the GTC01 as supplied will contain a short program allowing a GSM unit to be turned on/off.  When power is first applied (EN = High) the PIC will attempt to start the GSM unit via the IGT line.  After this, taking the GTC ON/OFF pin low for approx. 500ms will cause the PIC to attempt switching the GSM unit off using the IGT line – the success of this action will depend upon how the GSM unit is set-up.  Taking the ON/OFF pin low for >2s then releasing it will cause the PIC to force the GSM unit off via the EMERG_OFF line.

If the GSM unit is turned off it can be turned on again by taking the ON/OFF pin low for approx. 500ms, causing the PIC activate the IGT line again.

Because the PIC has direct control over the GSM unit it is also possible to write applications for the PIC and use the GSM unit as a straightforward modem.  However as the GSM device contains a far more powerful processor (32-bit) and has more resources and capabilities it is anticipated that the PIC will normally be used in a supporting role with some useful additional I/O capability.

Note: if the GSM unit were set to auto-start then it would be possible to operate the GSM unit with no program contained within the PIC.  The watchdog function may be temporarily disabled by taking pin 64 low.


## A PIC Watchdog example

The application within the GSM unit would regularly signal its status via GPIO2 (active low).  Short activation of GPIO2 could refresh a watchdog timer.  Long activation could signal a request to the PIC to make a standard telephone call using ASC0 (for example: to maintain the network acceptance of a PAYG SIM in an application that rarely uses a GSM connection e.g. alarms).

The PIC is able to restart a "hung" application, having control of both IGT and EMERG_OFF lines.  It could also request an action of the GSM unit via GPIO1 – e.g. halt a Java application.


## PIC programming

The PIC may be programmed using a suitable in-circuit programming device.  A Microchip$^{TM}$ programmer is recommended.  Note that both the Low-Voltage Programming Enable bit (LVP) and the Brown-out Reset Enable bit (BOREN) of the configuration word should be disabled (set to '0').  Oscillator Selection bits (FOSC<2:0>) should be set to '100' corresponding to selection of the internal oscillator with RA6 and RA7 available for use as general purpose I/O.


## CAUTION!

Due to the possibility for damage to be done to the GSM unit whilst in-circuit programming the PIC device with an external supply Radiometrix does not recommend in-circuit programming of the PIC with a GSM unit fitted to the board.

In-circuit programming can be achieved using the GTC01 on-board PIC supply (PIC-Vdd-2V7) but if code protection is enabled in the configuration word you may find that re-programming cannot be achieved without an external +5V supply to the PIC.  For this reason it is recommended not to enable code protection during development of PIC programs for GTC01.  If it is necessary to program the PIC using an external supply please bear in mind that several PIC port pins are connected directly to GSM I/O pins.  Disconnect the power supply to the module (or inhibit the supply by connecting pin 1 to 0V).

When programming with a +5V supply the in-circuit programming device default configuration should be set to hold the PIC in reset whilst connected, so that the PIC program is not run whilst the +5V supply is connected.  With the main module supply either disconnected or inhibited as described above, the PIC may be programmed with a +5V supply connected to pin 58.

## Operating Specifications

| | |
|---|---|
| Compatible GSM units: | Cinterion MC75i, TC65i and TC63i |
| Operating temperature[1] | -25°C to +65°C |
| Storage temperature | -40°C to +85°C |
| | |
| DC supply (pins 15, 16, 47, 48)[2] | +5.00V to +13.8V |
| Supply current | |
| (typical quiescent – GSM PA not active) | 30 – 40mA |
| (typical average allowance during GPRS activity)[3] | 600mA |
| ENable pin (Enables module supply)[4] | +1V to 13.8V (0V = module off) |
| Digital I/O logic '1' level[5] | +2.5V to +2.9V |
| Analogue inputs (GSM)[6] | +2.4V max. |
| Analogue inputs (PIC) | (up to) PIC VDD |

### Notes:

1) GSM devices can become hot during periods of GSM activity. When intending to use in applications involving long periods of GSM data transfer consideration should be given to extra heat-sinking of the GSM unit and / or extra ventilation. Please refer to the GSM device datasheet.

2) 5.00V is the absolute minimum and is measured at the supply pins of the module – no dip from this voltage is permissible during use. Because of the relatively high peak currents involved careful consideration should be given to the supply. It is recommended to use all the supply pins.

With regard to higher supply voltages 13.8V is a nominal figure and the on-board regulator will handle up to 20V for very short periods of GSM activity but when used in an application requiring long periods of GSM activity the supply voltage should be maintained at approx. 5.5V maximum otherwise the module may overheat and will shut down. However, many applications use GSM for short periods only.

In electrically noisy environments it is recommended to use transient voltage suppression (e.g. TVS clamp diode). The module is not reverse polarity protected.

3) For specific supply currents pertaining to the GSM device being used please refer to the datasheet of the device. Peak current during GSM activity can exceed 2A. Therefore a generic 5V 1A supply is not sufficient, whereas a 6V 1A supply with a 10,000uF bulk storage capacitor would be acceptable. Wide PCB traces to the module supply pins are recommended.

4) ENable is a logic-level input to a switch for the main power supply: do not apply voltages between +0.2V and +1V to the ENable pin as this may result in damage to the module. The upper value of 13.8V is a nominal figure (see Note 2 above).

5) +3.00V is the absolute maximum. No voltage should be present with the GSM device (or PIC) un-powered. Please refer to the datasheet for the GSM unit to be used.

6) Make sure that no analogue input is present when the GSM unit is shutdown. MIC inputs should not be present when VMIC is not enabled. Please refer to the GSM datasheet.

## Installing a GSM modem

There are three options when attaching a GSM unit to GTC01:

- Plastic clip
- Soldered pillars (threaded) and screws
- Plain spacers with screws, washers and nuts

Whichever method is chosen a 4mm stack height is required.  When using pillars / spacers note that the GSM unit uses a three-point mounting.  Please state your preferred choice of fitting kit when ordering or use the part numbers and supplier references given below.

**PLASTIC CLIP**

| | |
|---|---|
| Manufacturer: | GTT Europe |
| Website: | http://www.gtteurope.co.uk/ |
| | http://www.gtteurope.co.uk/cinterionwirelessmodule/integrationclips.php |
| Distribution: | Farnell |
| Manufacturer Part: | GT-MC75I-CLIP-F |

A datasheet is available illustrating how to use the mounting clip.

**SOLDERABLE PILLAR and LOCKING SCREW**

| | |
|---|---|
| Manufacturer: | GTT Europe |
| Website: | http://www.gtteurope.co.uk/ |
| | http://www.gtteurope.co.uk/cinterionwirelessmodule/pillars.php |
| Distribution: | Farnell |
| Manufacturer Part: | R-15-0075-F (pillar) |
| | R-14-0067-F (screw) |

**PLAIN SPACER**

| | |
|---|---|
| Manufacturer: | RICHCO International Co Ltd |
| Website: | http://www.richco-inc.com/ |
| Part number: | RRSB-2240-04 |

Note that M2 x 10mm screws with nuts and washers are also required when using plain spacers.


## Ordering information

Radiometrix part number:

**GTC01**

GSM Modems can be supplied with the GTC01.  Please ask for details.  To start using GSM a SIM card is also required (not supplied by Radiometrix).


## Carrier Boards

The GTC01 can be evaluated on common 0.1" stripboard or incorporated straight into the design of the customer but Radiometrix also offer a complete system with ready-to use interfaces etc.
There are two types available:

1. **GTC-DEV**

Offers a ready to use development and evaluation platform: the GTC-DEV has a Power supply socket, DB9 serial connectors, USB - UART bridge, DIP switches, buttons, LED's and a RJ12 ICSP connector.  All GTC01 connections are made available via breakout socket and through-hole solder pads.  This board can also be supplied in a "bare bones" configuration where only the Power supply connection and GTC01 breakout sockets are fitted.

2. **GTC-APP**

Aimed at a light industrial / control environment: screw terminal connections for serial data, volt-free clean-contact outputs and isolated digital inputs.  As with GTC-DEV there is breakout connection and through-hole solder pads for all of the GTC01 pins.

## References

**For Cinterion GSM products:**

Cinterion Wireless Modules GmbH
St.-Martin-Str. 53
81669 Munich
GERMANY

Switchboard: +49 89 21029 9000
Web:    http://www.cinterion.com/
        http://www.cinterion.com/m2m-evolution.html

Documentation (the documents listed here are not necessarily the latest versions):

**TC63i**
TC63i Hardware Interface Description:   TC63i_HD_v01.100a
TC63i AT Command Set:                               TC63i_ATC_V01.100

**TC65i**
TC65i Hardware Interface Description:   TC65i_HD_v01.100b
TC65i AT Command Set:                               TC65i_ATC_V01.000
Java User's Guide:                                      wm_java_usersguide_v14

**MC75i**
MC75i Hardware Interface Description:   MC75i_HD_v01.100a
MC75i AT Command Set:                               MC75i_ATC_V01.100

**PIC16LF628A**
PIC16F627A/628A/648A Data Sheet:     DS40044G

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The Intrastat commodity code for all our modules is: 8542 6000

## R&TTE Directive

After 7 April 2001 the manufacturer can only place finished product on the market under the provisions of the R&TTE Directive. Equipment within the scope of the R&TTE Directive may demonstrate compliance to the essential requirements specified in Article 3 of the Directive, as appropriate to the particular equipment.

Further details are available on The Office of Communications (Ofcom) web site:

   ***http://www.ofcom.org.uk/***

| | |
|---|---|
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