

Neo_M590

Hardware Design Manual

Version 1.1


有无线，方精彩

Let's enjoy the wireless life!

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Clarification

This specification applies to the M590.

This specification is for system engineers, research engineers and test engineers.

This specification is, without prior notice, subject to changes and updates as deemed necessary by Neoway to suit enhancements or changes to the module.

All statements, information and suggestions in this manual do not constitute any express or implied guarantees.

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Contents

1. OVERVIEW	5
2. CONFIGURATION	5
3. DESIGN DIAGRAM	5
4. FEATURES	6
5. PIN DEFINITION	6
6. INTERFACE DESIGN REFERENCE	8
6.1 POWER SUPPLY & AND RESET INTERFACE	8
6.1.1 Power Supply	8
6.1.2 Power on/off Sequencing	12
6.1.3 Pin Description	13
6.1.4 Module Abnormality Recovery	14
6.1.5 VCCIO Pin Description	16
6.2 SERIAL INTERFACE	16
6.3 SIM CARD INTERFACE	19
6.4 INDICATOR LIGHT (LED)	21
6.5 RF CONNECTOR	21
6.6 SIGNAL CONNECTOR AND PCB PACKING	22
7. ASSEMBLY	26
8. PACKAGING	26
9. ABBREVIATIONS	27
10. APPENDIX 1.DESRIPTION OF THE M590 SLEEP MODE	28


Revision History		
Version	Content Revised	Effective time
V1.0	Initial version	201004
V1.1	Revised version,improved the design following customers feedback	201108

1. Overview

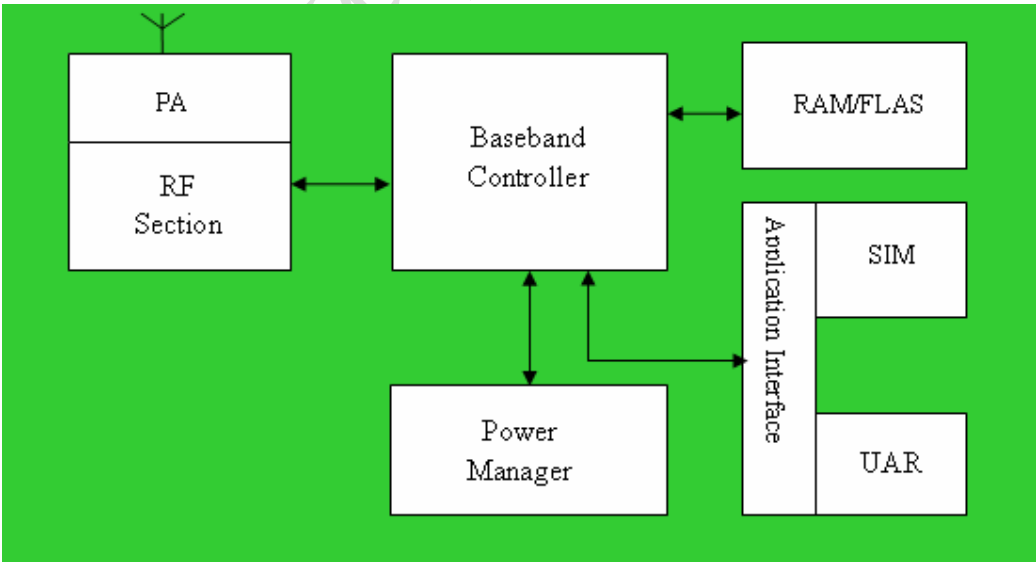
M590 pure-data Communication Module is an ultra compact GSM/GPRS industrial wireless module, optional Dual-band or Quad-band. It provides a high-quality SMS, GPRS data connection for use in industrial and commercial fields.

2. Configuration

Table 1 Shape of M590

Specifications	Description
Dimensions	27.6mm*21.6mm*2.6mm (length*width*height)
Weight	5g
Overview	

3. Design Diagram



4. Features

Table 2 Main Specifications of M590

Specification	Description
Frequency bands	EGSM900/DCS1800 Dual-band, or GSM850/1900 or Quad-band
Sensitivity	-107dBm
Maximum Transmission Power	EGSM900 Class4(2W) DCS1800 Class1(1W)
Instantaneous Current	Max 2A
Operating Current	210mA
Sleep mode Current	2.5mA
Working Temperature	-40℃~+85℃
Operating Voltage	3.3V~4.5V (The recommend value is 3.9V)
Protocol	Compatible with GSM/GPRS Phase2/2+, increased TCP/IP, FTP, UDP etc.
AT	GSM07.07 Extended command sets
Connector	20 pins LLC, 20 pin DIL form factor Murata GSC RF connector, or pad on board
SMS	TEXT/PDU Point to point/cell broadcast
Grouped Data	GPRS CLASS 10 Coding mode: CS1, CS2, CS3, CS4
Circuit Switched Data	Supports CSD data service Supports USSD

5. Pin Definition

Table 3 Pin Definition of M590

Pin	Signal Name	I/O	Description of functions	Remark
1	GND	PWR	Ground	
2-3	VBAT	PWR	VCC_MAIN input	
4	GND	PWR	Ground	
5	LED	O	Indicating working status	
6	VCCIO	O	2.85V interface level output	IO reference Level, load capacity<3mA
7	RXD	I	Receiving Data	Maximum level is < 3.3V

8	TXD	O	Sending Data	High level 2.85V output
9	DTR	I	User Circuit Ready	
10	RING	O	Ring	High level 2.85V output
11	SIMIO	I/O	SIM card data	Need to pull up to SIMVCC by external resistance 10K
12	SIMCLK	O	SIM card clock	
13	SIMRST	O	SIM card reset	
14	SIMVCC	PWR	SIM card power output	
15	GND	PWR	Ground	
16	DCD	O	Data Carrier Detect	Not supported, 0V output
17	DSR	O	The module ready	Not supported, 2.85V output
18	EMERGOFF	I/O	Emergency power OFF	Internally pulled up to VCCRTC, do not apply voltage over 2.0V
19	ON/OFF	I	ON/OFF control	Active low. For more instruction please refer to ON/OFF/RESET instruction.
20	GND	PWR	Ground	
21	RF_ANT	I/O	RF input/output	
Other pads are test pads, please keep corresponding area clear of copper, to prevent short circuit when mounting.				

Notice:

Because the module uses a **2.85V** IO power system, maximum input voltage of all IO interfaces can not exceed **3.3V**, otherwise the IO may be damaged. IO interfaces with a 3.3V power supply may for various reasons output at 3.3V or higher. In this event, this voltage on the I/O signal interface will connect to the IO of the 2.85V module and damage the IO ports. Resistors in series with these ports should be used, as well as capacitors and filters. For further details refer to item 6.2.

6. Interface Design Reference

6.1 Power Supply & and Reset Interface

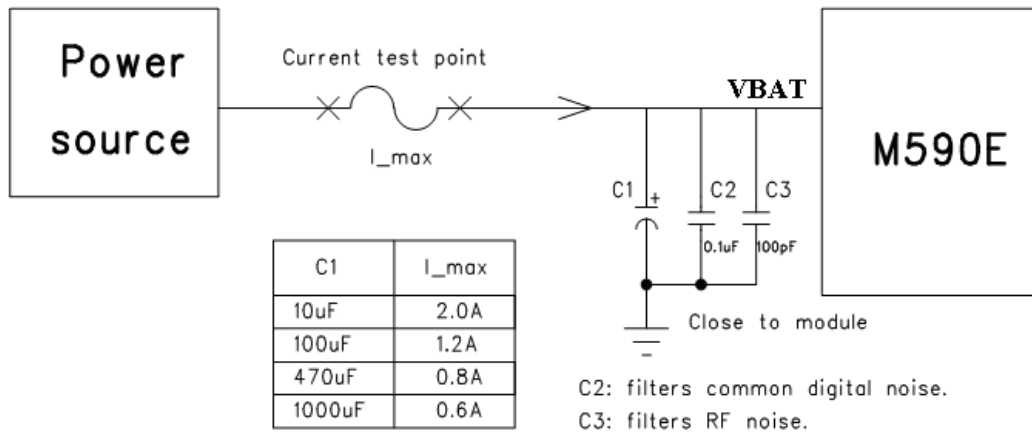
Table 4 Power Supply & and Reset Interface

Pin	Signal Name	I/O	Description of Functions	Remark
1,4,15,20	GND	PWR	Ground	
2,3	VBAT	PWR	VCC_MAIN input	
6	VCCIO	O	2.85V interface level output	IO reference Level, load capacity<3mA
18	EMERGOFF	I/O	Emergency Power OFF	Active low, 10us
19	ON/OFF	I	ON/OFF control	Active low, 300ms

6.1.1 Power Supply

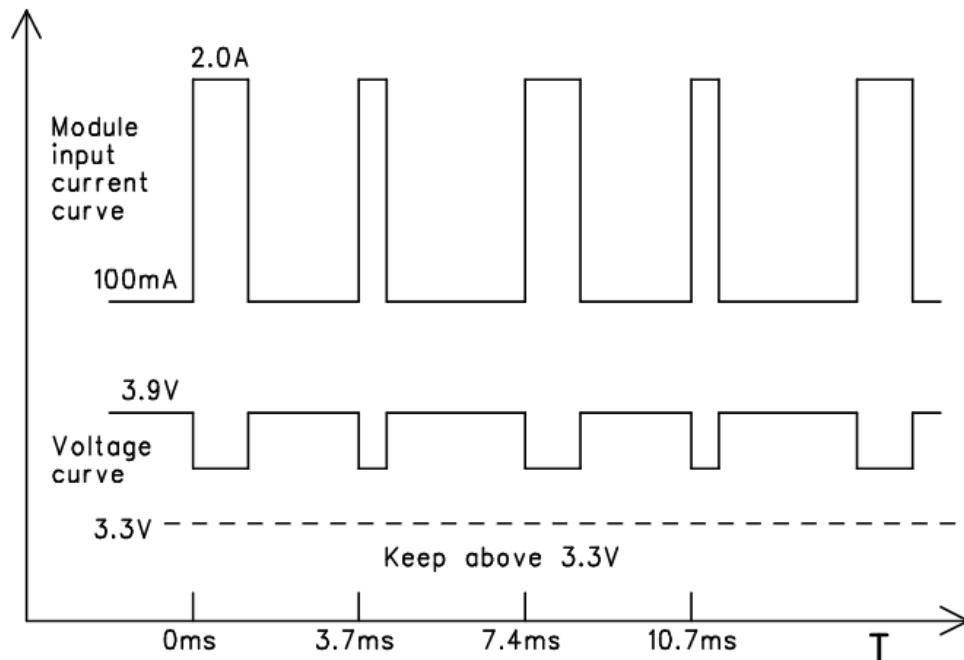
Power supply design and good PCB design techniques are crucial for ideal performance of the module. The power source not only powers the digital and analog circuit, but also the RF power amplifier which draws high peak currents. It is necessary to include low ESR electrolytic capacitors and/or tantalum capacitors, close to the VBAT supply inputs (Pin2 and Pin3). Further to this, filtering capacitors in the range of 0.1uF, 100pF and 33pF should also be included for higher frequency interference reduction.

VBAT (Pin2 and 3) is the main power supply of the module, with input range of 3.3V to 4.8V, with the recommended voltage of 3.9V. Maximum instantaneous current input to the module is 2A. USE HIGH VALUE, LOW ESR CAPACITORS, CLOSE TO THE MODULE. The use of larger capacitors to supply peak/instantaneous currents of the PA, allows for selection of a power supply with a lower continuous current output. Should high value capacitors not be used, ensure the Power Supply is designed to meet the instantaneous current demand.



1000uF low ESR aluminum electrolytic capacitors are recommended for C1. Should volume or space be limited, **470uF** tantalum capacitors may be used. If the power source is connected to lithium batteries, a lower value capacitor (100uF tantalum) may be used as the batteries are able to supply the peak instantaneous current.

Maximum current draw will occur during the process of calling or data transmission in weak signal environments. Typical current-voltage curves are shown in the diagram below.



Ensure that the instantaneous voltage does not drop lower than 3.3V during operation, otherwise the module will power off for self protection.

On the PCB, keep the power source far away from the RF section, and ensure that 2A of current can be delivered safely, with no obvious circuit to drop it. Routing width for VBAT track should be approximately 2mm.

Each digital IO including serial port SIGNAL/LIGHT, and SIM card signal has integrated ESD over-voltage protection, or an input level clamping circuit. For details see Diagram 1.

Should power be removed during operation, with signals still present on any IO, the ports have internal clamping diodes to VBAT.

Refer the red path in Diagram 1. As a result of the IO clamping diodes there may be 2.3V to 2.8V voltage on VBAT/VCCIO. This situation won't damage the module, but may lead to the external CPU IO exposed to current overload, and affect the module's normal boot.

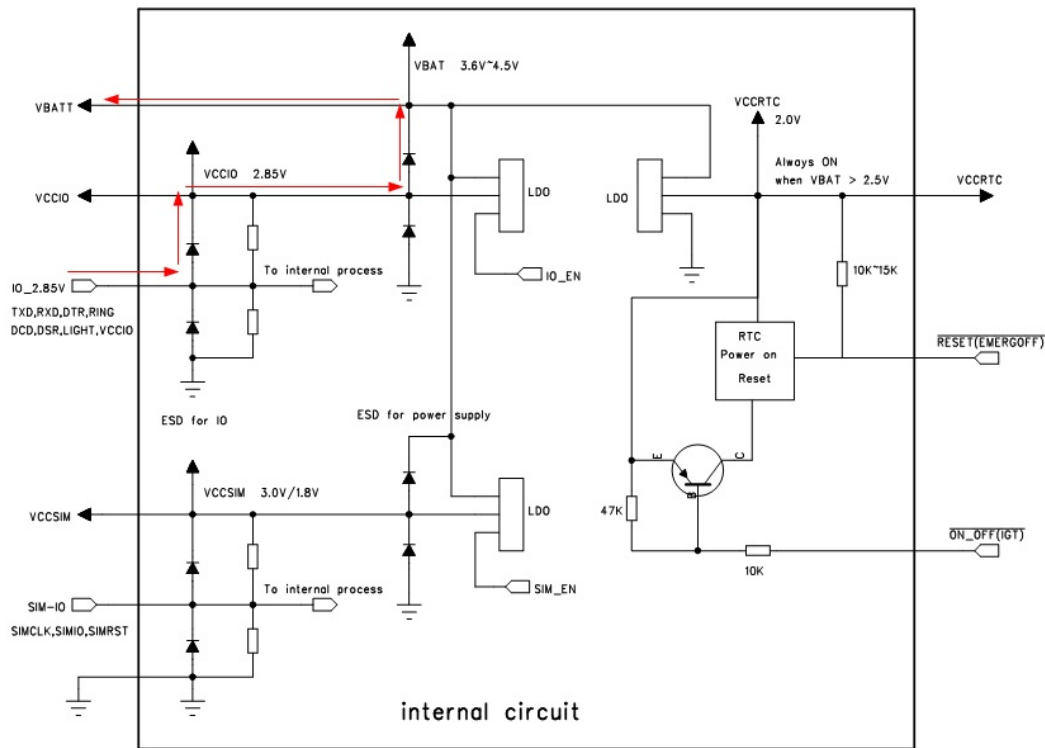


Diagram 1 IO current feedback to VBAT or other IO's

The solution to this problem is to ensure that ports on the MCU are configured low or to high impedance when power is removed.

Reset signal of the module. **Pin 22** is emergency power off pin. Its function is similar to a hardware reset signal on a MCU. The minimum reset pulse width is 1ms.

VCCRTC is RTC power source. If VBATT is higher than 2.5V, VCCRTC will output a voltage of 2.5V continuously, irrespective of if module is in startup or shutdown or dormant.

Notice:

The main power source should not exceed **4.8V**. Over-voltage will damage the module. The most common failure in this event will be VBATT to Ground short internally in the module.

Failure at low temperature (**-40C**) is usually caused by power supply design, and choice of components not suited to this environment. When selecting capacitors for the power supply, make sure they specified to operate without significant reduction in capacity in the intended design over the operating temperature range. Failure of these capacitors to maintain their capacity at temperature extremes may cause the supply voltage to drop below 3.3V and will result in the modem shutting down. Exercise caution in the power supply design.

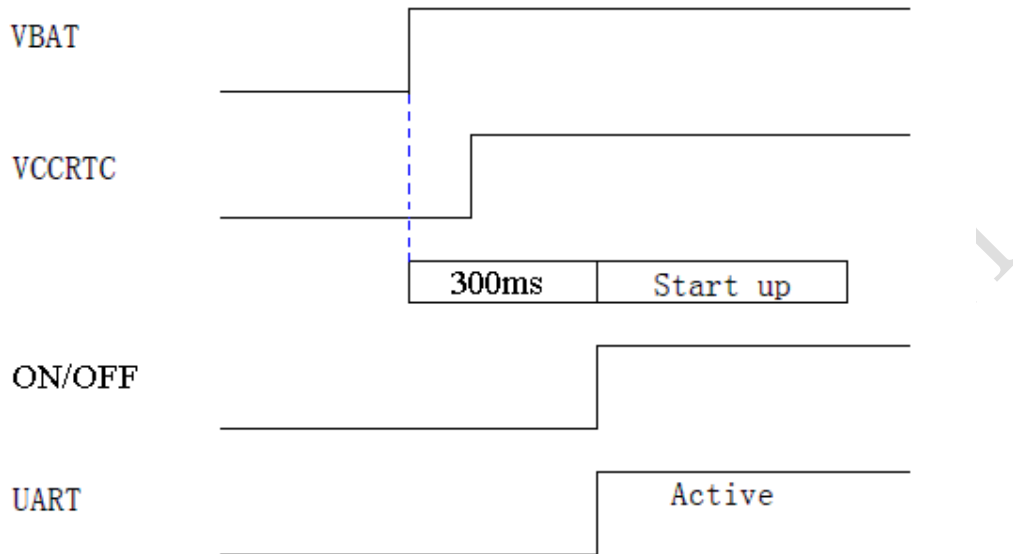
When supplying power to the module, DO NOT USE SERIES diodes to directly step-down the voltage. Voltage drop across diodes varies greatly depending on current, and may result in an unstable supply and may cause operation issues with the module.

When doing static testing or surge testing, please ensure the stability of the power source. Power, ground, inputs and outputs should be designed to consider EMC and interference to prevent glitches and spikes. Ceramic capacitors are recommended for filtering.

Avoid long tracks on the On/off control (**Pin 19**) and use filtering techniques described to reduce interference and risk of accidental power on or off.

6.1.2 Power on/off Sequencing

Power on 时序



Power off 时序

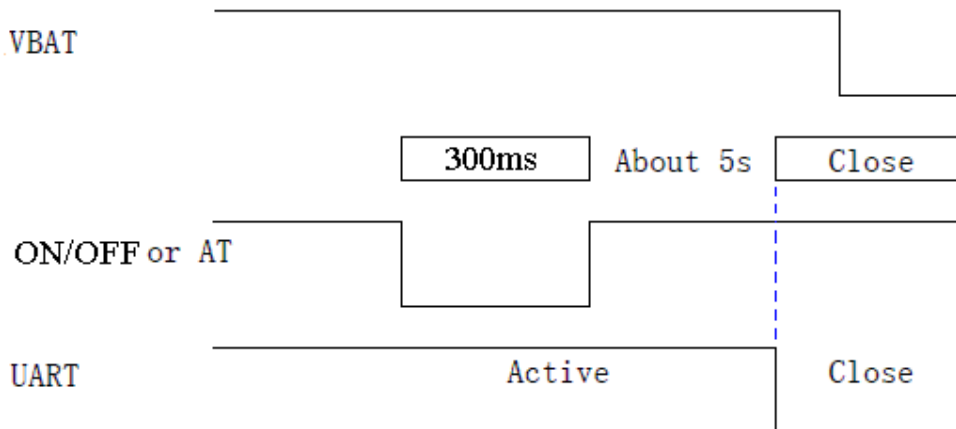


Diagram 2 Power on / off process

Supply power to MCU first, then supply power to the main power source of the module, to prevent incorrect operation in the event of unstable levels on the IO. Ensure the MCU is operating stably, prior to supplying supply power to the module ON/OFF.

6.1.3 Pin Description

Pin19 ON/OFF is an input pin. The startup and shutdown of the module can be controlled externally by this pin – active low. and effective on low level. There is a weak internal pull-up for ON/OFF in the module.

Power on process:

- 1) Apply power to the module (Pin 2 and Pin 3)
- 2) Pull down the ON/OFF control (Pin 19) for more than **300ms** (500mS minimum recommended)
- 3) The Modem will automatically generate “**Modem Startup**” on the serial port and the LED will flash for 1 second.
- 4) VCCIO will output **2.85V** continuously

Note that the ON/OFF control pin (Pin 19) can be connected permanently to ground in which case the module will power up automatically when power is applied

Power off process:

- 1) If the ON/OFF Pin is high (Pin 19) it should be pulled low and kept low for a minimum of 300ms. Alternatively the Module may be powered down by an AT command. Refer the AT command manual.
- 2) The Module will automatically begin the power down routine and log off the network. The power down routine takes approximately 5 seconds.
- 3) Turn the main power source off (Pin 2 and Pin 3)

Inverting the logic for start-up and shutdown can be achieved using a single transistor as shown in diagram 3.

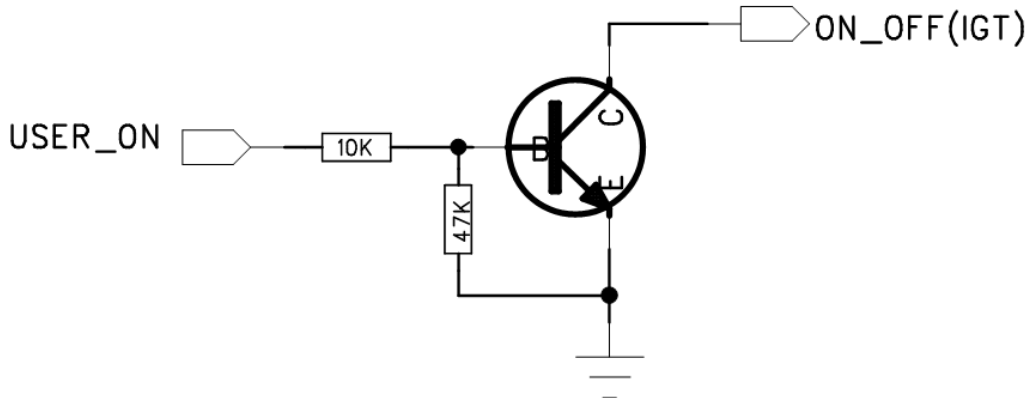


Diagram 3 Recommended circuit for high level startup for M590

Notice:

The **ON/OFF** pin is a control signal which will switch the modem between the on and off state. Do not send more than one “on” command or one “off” command when powering up or power down the module as each instruction will toggle the Modem between the on and off state. Further to this, sending two pulses may result in the module being off, and it may be possible that the I/O has information from the MCU which results in current flowing as indicated in Diagram 1. This may cause start up failure. Follow the correct power up and power down procedure.

If the module doesn't work normally, the module can't be shutdown normally.

6.1.4 Module Abnormality Recovery

Because of the complex nature of the product and the network, as well as the harsh environment the unit may operate in for extended periods of time, it is possible that the module may “crash” or lose connection to the network. Therefore it may be necessary to restore the connection in the application design. We recommend two methods:

- 1) Through the module main power source. Turn off the main power source for long enough for the supply voltage to decay through 3.0V and then supply voltage again observing the correct start up procedure. For devices that are inaccessible or remotely positioned this is the most reliable solution.

- 2) Pull the EMERGOFF (emergency shutdown) pin (Pin 18) low for 100ms in order to hard shutdown the module. This is similar to a processor hard reset and is typically used in hand held devices. If the module cannot recover in this way it is necessary to use the power off method described above..

Prior to power removal or reset, regardless whether the module responds, follow the suggested power down sequence and wait at least 5 seconds Prior to rebooting. This is important to prevent corruption and possible program damage in the event of the module performing write instructions to FLASH, when power is removed or the unit is hard reset.

Pull up **EMERGOFF** pin on the module to VCCRTC, this moment external can't enter a higher level, or may cause an exception when power on. EMERGOFF module internal connection diagrams please refer to figure 1. When supplying power to reset, EMERGOFF will output a low level, whose pulse width is 22ms.

Emergency shutdown circuit design recommendations:

- 1) EMERGOFF should be OC output, as shown in Figure 4.

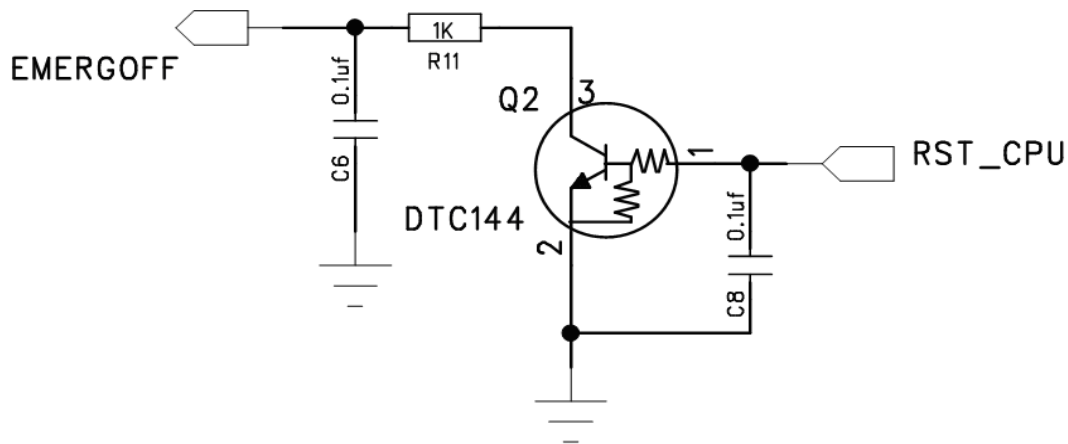


Diagram 4 EMERGOFF OC Control(C6、R11 should close to the module pin)

- 2) The effective emergency shutdown pulse width of EMERGOFF should be at least 1ms. Effective low level can't be more than **0.4V**.
- 3) If there is no need, EMERGOFF can be suspended.

6.1.5 VCCIO Pin Description

Pin 6 VCCIO is the reference voltage the module supplies, with an amplitude of 2.85V, and a loading capacity of 3mA. Its suggested use is for switching interface level only. When power off, VCCIO output shutdown.

Moreover, this pin can be used to indicate the running status of the module. When it's running normally or sleeping, this output is high, and when the power module is powered down the pin is low.

Notice:

If the module is powered on, this can be confirmed by the VCCIO pin and LED pin. When the VCCIO pin is high (**2.85V**) and a high and low level pulse on the LED pin, this confirms that the module is powered on. The serial port should also function in this instance, if not check that:

The RX/TX are not reversed, that the level converting circuit is correct, and that soldering is correct. Check the waveforms are square, and that the filter capacitors on the serial port are not too large.

6.2 Serial Interface

Table 5 Serial Interface Description

Pin	Signal Name	I/O	Function Description	Remark
17	DSR	O	The module is ready	Not supported
10	RING	O	Ring	
8	TXD	O	The module is sending data	
7	RXD	I	The module is receiving data	
9	DTR	I	The user's circuit is ready	
16	DCD	O	Data Carrier Detect	Not supported

As the Module is the DCE device and the terminal is a DTE device connect the devices as shown in Diagram 5

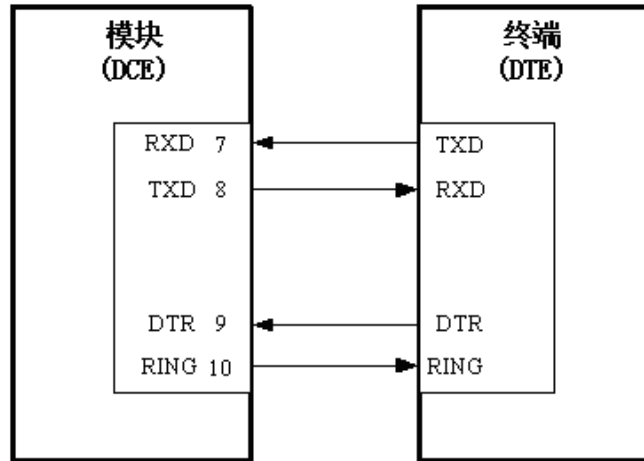


Diagram 5 DCE and DTE signal connection diagram

The CMOS interface signal level is 2.85V, and should not exceed 3.3V. Data rates supported are 1200,2400,4800,9600,19200,38400,57600,115200bps. The default rate is 115200bps.

When designing the serial communication interface circuit, a series resistor should be used should the external MCU be operating on a higher voltage – a 200 Ohm resistor should be used if the external MCU is operating on 3.3V. The resistor should be placed near the signal source. Refer Diagram 6 below.

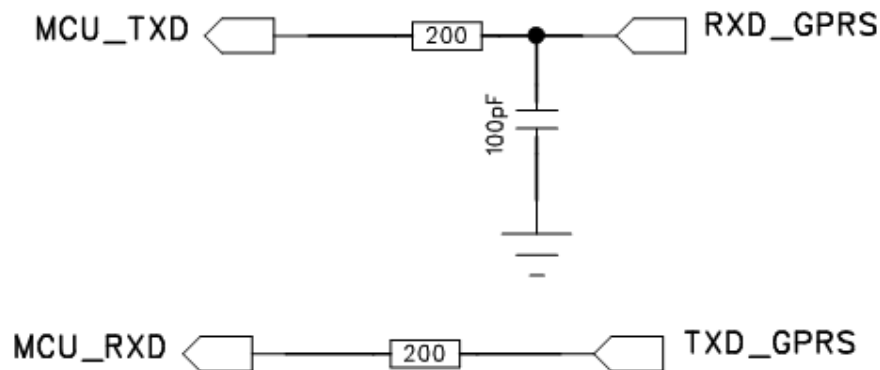


Diagram 6 3.3V MCU and module serial communication recommended circuit

Should the external MCU be operating on a higher voltage a level switching circuit is recommended. Refer Diagram 7. When the MCU voltage is 5.0V, module reception should be performed level switch (Note that this level converting circuit don't support module

software upgrade, please choose the options as needed). Reference circuit is as follows:

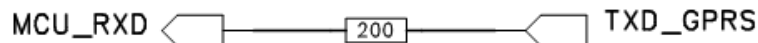
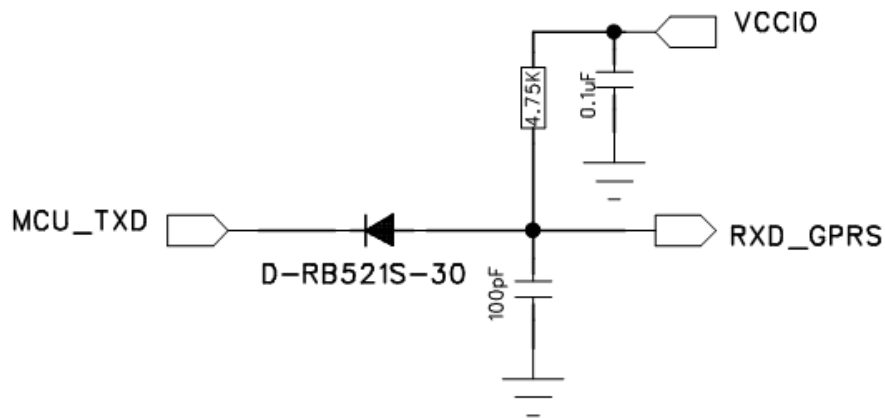


Diagram 7 5.0V MCU and module serial communication recommended circuit

A filter capacitor of 100pF should be placed near the module receive pin in Diagram 6 and 7. The capacitor should not exceed 470pF

Notice:

On power up of the module ensure no serial data generation is present, and delay any data for at least 2 seconds after successful power up to ensure no errors.

Serial ports are typically used via AT commands, data services, upgrading the module software etc. Be aware that the module does not at present provide at DCD/DSR functionality

Table 6 Digital IO (without SIM card) input / output characteristics

Digital IO input / output characteristics description					
IO input/output characteristics	Symbol	Minimum	Max.	Unit	Condition
Low level input range	VIL	-0.2	0.57	V	
High level input range	VIH	2.0	3.3	V	
Low level output range	VOL		0.2	V	load-current <2mA
High level output range	VOH	2.5	2.85	V	

DTR is the low power control pin, and if not required can remain unconnected if there is no need, it can be suspended. For low-power usage, please see the AT commands.

RING signal indication:

- 1) Call: In response to a call RING will cycle **5 seconds** of low pulses of **30ms** duration. Upon connection of the call Ring will return its state to high level. When there is a call, it will output a low pulse which cycle is 5s and width is 30ms. When the call is connected, it will restore to be high level.
- 2) SMS: In response to an SMS Ring will pulse low for **35ms**.

Notice:

If not used the DTR pin and Ring pins may be short circuit.

Serial filter capacitors cannot be greater than **470pF**, otherwise that will cause distortion of serial waveforms, resulting in the disconnection of the serial port. In the event of the serial port not functioning correctly remove the filter capacitors to confirm operation. Recommended value for filter capacitors is **100-220pF**.

The resistance of the connection between the CPU and the Modem, the lower the achievable baud rate, be aware of this when designing the PCB. Also take care of crosstalk between the TXD and RXD line by keeping them apart with a spacing of at least 3 times the track width. Avoid running the lines parallel to each other for long distances, and where possible run a ground plane close to these lines to avoid interference. Use through holes to link the ground planes on the various layers.

6.3 SIM card Interface

Table 7 SIM card interface

Pin	Signal Name	I/O	Function Description	Remark
11	SIMIO	I/O	SIM card data	External 10K pull up required to SIMVCC to read all SIM's
12	SIMCLK	O	SIM card clock	Junction Capacitance <20pF
13	SIMRST	O	SIM card reset	
14	SIMVCC	PWR	SIM card	

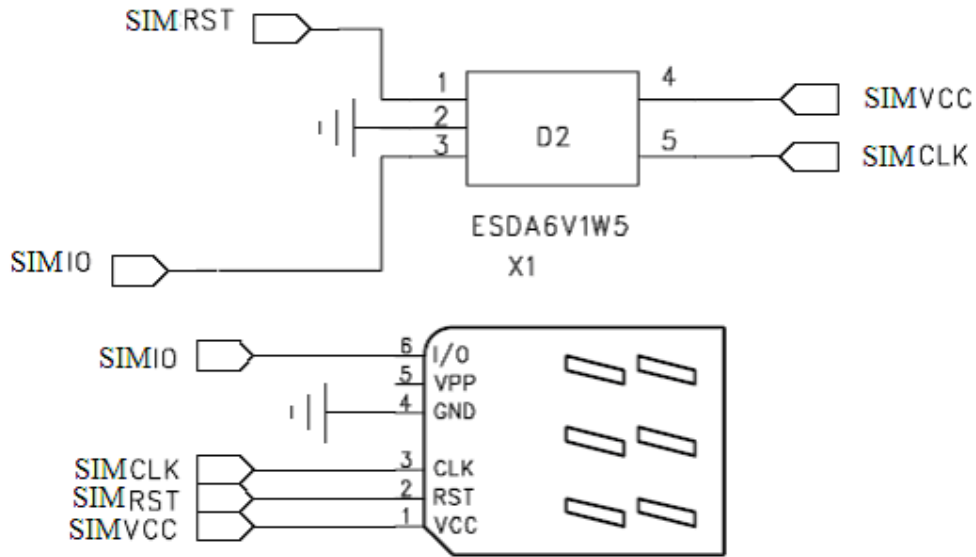


Diagram 8 SIM card interface design reference

The module supports 3V and 1.8V SIM card with adaptive functions.

Pin23 SIMVCC is the power supply of SIM card, **2.85V** and load capacity of **30mA**. This pin outputs power t only when operating the SIM card.

Pin24 SIMIO need an external resistor pull up to SIMVCC, size of the pull-up resistor can be selected based on the SIM card routing, but typically **10K**.

Pin25 SIMCLK is the clock line of SIM card, typically 3.25MHz. This track should be kept thin, short and direct. It should be surrounded by ground plane, and routed well away from the antenna and RF section. Total distributed capacitance on this track cannot exceed **100pF**.

The SIM card connector should be placed near the corresponding connections on the module. Avoid long PCB tracks and place filter capacitors in the **27-39F** range on the tracks. Close proximity to the radio frequency radiation (particularly with internal or rubber rod antennas) may result in reading abnormalities and corruption. Alternatively close proximity of the SIM to the antenna may result in decreased sensitivity.

6.4 Indicator Light (LED)

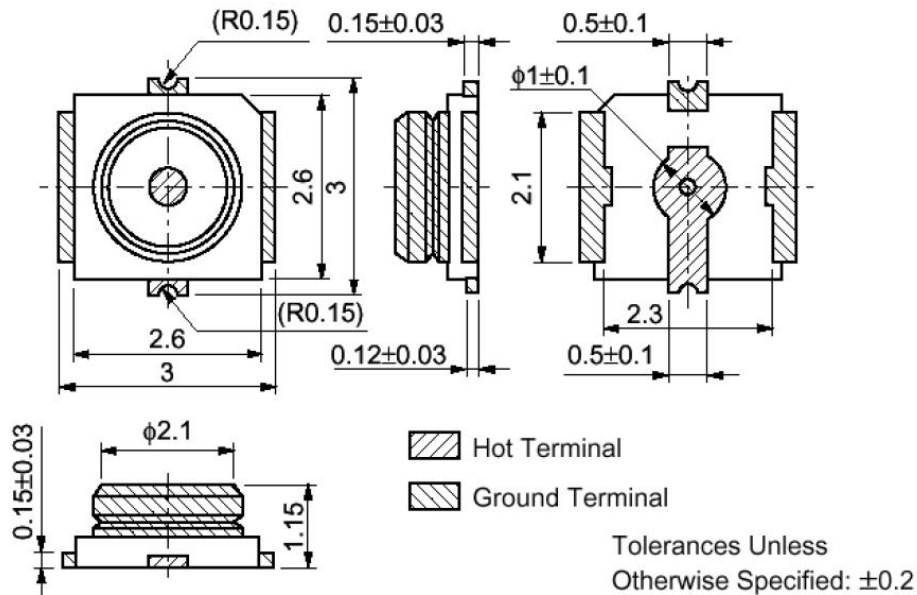
Table 8 Indicator Light Interface

Pin	Signal Name	I/O	Function Description	Remark
5	LIGHT	O	Indicates working state	

When the module is operating, the indicator light will flash once a second irrespective of a SIM card inserted or signal strength. To change the LIGHT status indication refer to the AT commands. When the module goes into sleep mode, the LIGHT will stop flashing.

6.5 RF connector

The M590 antenna interface uses a Murata GSC RF connector, Part Number MM9329-2700RA1. The external antenna's connection is through an RF cable. For packing information please refer to the following picture.



The impedance of the RF interface is 50 Ω , the antenna portion of the module should take necessary measures to avoid useful band interfere signals. There should have good shielding between the external antenna and RF connector. Moreover, the external RF cable should be kept far away from all interfere sources, especially the high-speed data signal and ON/OFF power.

The antenna used in the module should be in accordance with the standard of mobile devices. VSWR should be between 1.1 and 1.5, input impedance 50Ω . When using multi-port antennas, the separation between each port should be more than 30dB.

6.6 Signal Connector and PCB packing

The signal connectors of the M590 are half circular through hole plated on a 2.54mm pitch. The recommended layout is shown in Diagram 9.

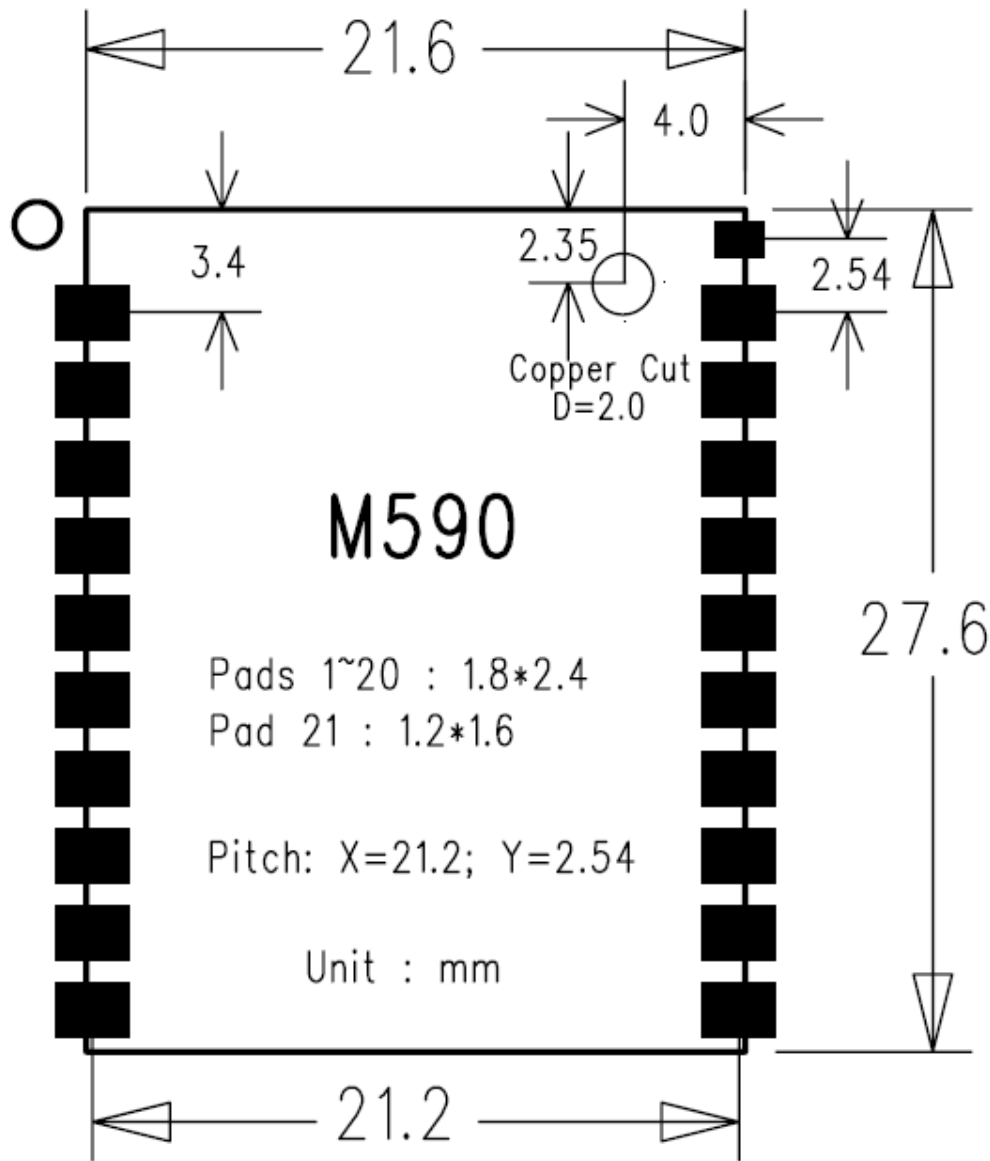


Diagram 9 Recommended PCB Packing Diagram (topview)

If RF pad pin21 is not used, then the corresponding area on the PCB should be cleared of copper. If the PAD is used, keep the track as short as possible and maintain 50 Ohm impedance.

On a double sided PCB where the impedance cannot be well controlled the recommended routing is as follows:

The RF track width should be 0.8mm to 1.0mm. The spacing between the track and the surrounding ground plane should be 0.8mm to 1.0mm. The RF line should be completely surrounded by ground plane, and ensure there are a significant number of through holes connecting the bottom layer ground plane to the top layer ground plane. The RF line should be no longer than 15mm, it should be smooth, and have tears when connecting to pads. Avoid any angular routing which may result in reflections. The layer opposite the RF track should be kept clear of copper or tracks. See Diagram 10 for suggested double-side board design, the module's RF signals connection with SMA RF connectors and then antennas recommended routing.

Module RF test points must have a clearance in the corresponding PCB position of approximately 2mm in diameter. Ensure these pads are encircled by ground plane. Pin 21 should also be cleared if its not used, with a ground plane running as shown in Diagram 9. Pin 20 of the module should be fully grounded, be sure to include through holes linking top and bottom ground planes close to the pad. Grounding is important for satisfactory operation. Keep in mind that this Module has an RF power amplifier, and it may generate interference with other signal lines. Route the PCB with care to avoid pick up risk and associated possible corruption.

20pin grounded on both sides completely, cannot allow half ground conditions.

The clearance for the RF region should be completely circled by ground

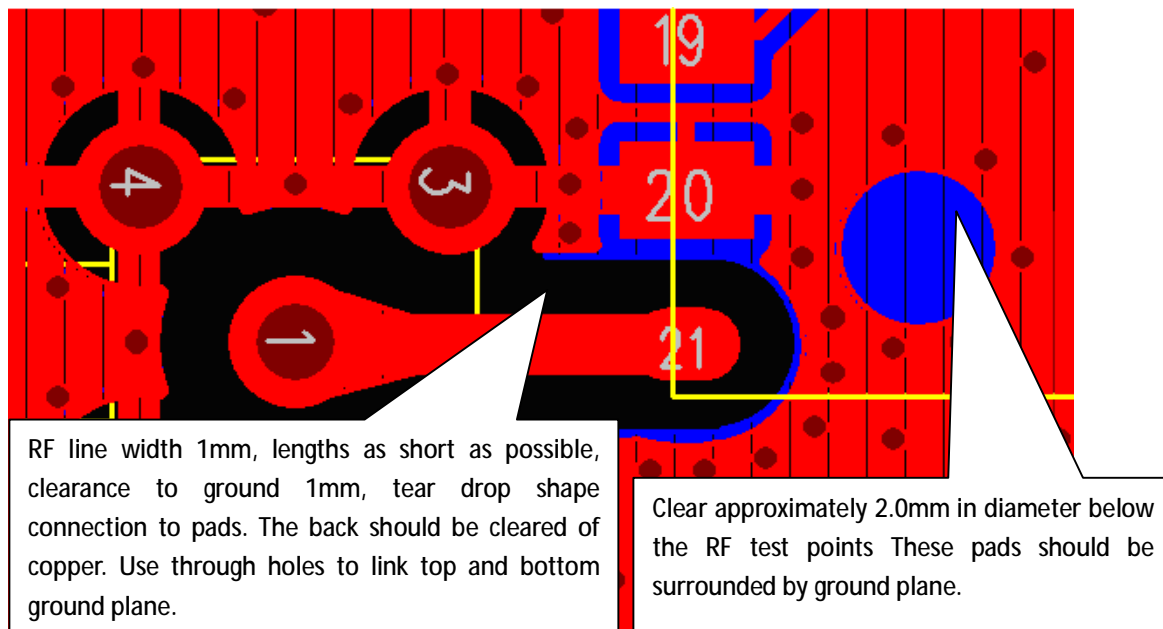


Diagram 10 Recommended PCB Layout Diagram

Should the RF feed (Pin 21) not be used, the corresponding copper on the PCB should be cleared. Refer to Diagram 11.

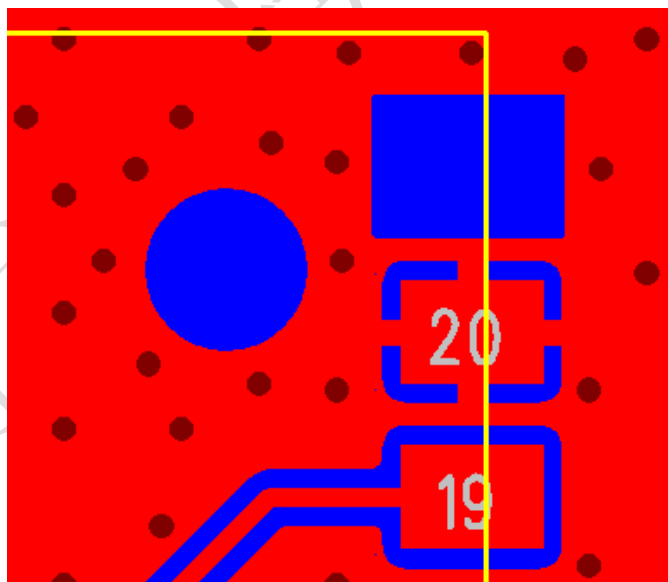


Diagram 11 Module design of the 21 pin when not in reference

Notice:

Keep the RF module layout away from high-speed circuits, switching power supplies,

power transformers, large capacitance, and single-chip clock circuit etc.

7. Assembly

The connection of M590 is using SMD soldering connection to pads on the side of the module.

8. Packaging

The M590 is intended to be reflow soldered, it is therefore necessary to prevent any moisture ingress prior to assembly. The M590 is supplied in moisture proof containers and vacuum sealed in aluminum foil bags with humidity indicator cards to ensure reliability and extends shelf life.



In order to facilitate the SMT process, pallets are used to load products. For further information on M590 storage and soldering instructions refer to Neoway M590 SMT reflow

production proposal_V1.0



9. Abbreviations

ADC	Analog-Digital Converter
AFC	Automatic Frequency Control
AGC	Automatic Gain Control
AMR	Acknowledged multi rate (speech coder)
CSD	Circuit Switched Data
CPU	Central Processing Unit
DAI	Digital Audio interface
DAC	Digital-to-Analog Converter
DCE	Data Communication Equipment
DSP	Digital Signal Processor
DTE	Data Terminal Equipment
DTMF	Dual Tone Multi-Frequency
DTR	Data Terminal Ready
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
EMC	Electromagnetic Compatibility
EMI	Electro Magnetic Interference
ESD	Electronic Static Discharge
ETS	European Telecommunication Standard
FDMA	Frequency Division Multiple Access
FR	Full Rate
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
HR	Half Rate
IC	Integrated Circuit
IMEI	International Mobile Equipment Identity

LCD	Liquid Crystal Display
LED	Light Emitting Diode
MS	Mobile Station
PCB	Printed Circuit Board
PCS	Personal Communication System
RAM	Random Access Memory
RF	Radio Frequency
ROM	Read-only Memory
RMS	Root Mean Square
RTC	Real Time Clock
SIM	Subscriber Identification Module
SMS	Short Message Service
SRAM	Static Random Access Memory
TA	Terminal adapter
TDMA	Time Division Multiple Access
UART	Universal asynchronous receiver-transmitter
VSWR	Voltage Standing Wave Ratio

10. Appendix 1.Description of the M590 Sleep mode

Operating current of M590 when connected during data transmission is 220mA. When not connected average current is about 25mA. In sleep mode (low-power state) current draw is **2.5-2.8mA**.

In sleep mode, the module will promptly respond to system calls, SMS and data services. The external MCU can also control modules out of sleep mode through hardware IO(DTR).

Process for entering sleep mode:

- 1) Keep the module DTR input high by setting the AT command to allow entering sleep mode, refer command: `at+enpwrsave`. In this mode, the run light stops flashing.
- 2) Pull the DTR input low, using external. Typically the module enter sleep mode in about 2 seconds. In sleep mode, the serial port of the module is disabled and will not respond to data. The module will only go into sleep mode, if there is data present on the serial port the module will wait for data transfer to end before entering sleep mode.

- 3) If the serial port has data the MCU can place DTR high. The module will immediately exit sleep mode within 50ms to normal mode, and the serial port will respond to AT commands. After the completion of the calling service, the external MCU may pull DTR low, the module goes into sleep mode.
- 4) In sleep mode, if the module receives calls, messages or data from the server, the module will immediately exit sleep mode and output call information through the serial port. After the external MCU detects information on the serial port, set DTR high, to process calls, data etc. When processing is complete, the module will go into sleep mode after setting DTR low. If there are calls, and DTR is not set high, and the serial port receives no data, the module will automatically enter into sleep mode in approximately 2 seconds.
- 5) In sleep mode, if the module serial port receives data, the module will exit sleep mode. In sleep mode the data/commands processed should not exceed 30 characters.

In the event of a call the RING PIN cycles 30mS low pulses for 5 seconds.

With SMS,, after using the AT+CNMI command to set the SMS reminders, when text messages are received, the RING pin will output a low pulse of 25ms.

In the data service calls, RING PIN does not change, it remains high.

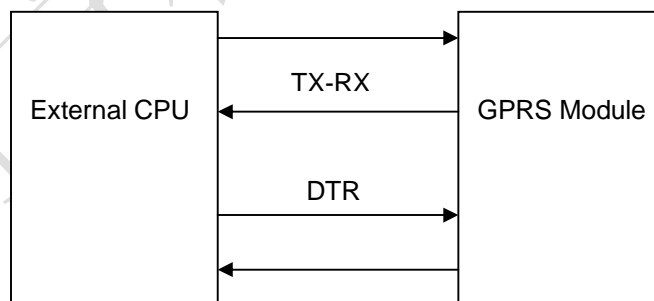


Diagram of Control Signal Connecting