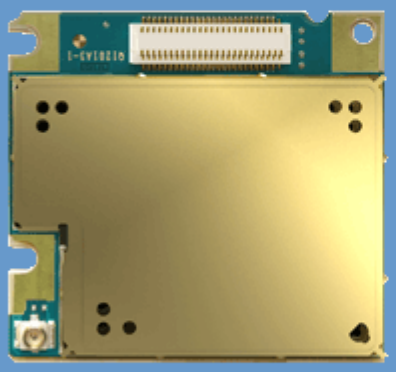
CINTERION
a Gemalto company

Hardware Interface Description

MC52iR3



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0 Document History

New document: "MC52iR3 Hardware Interface Description" Version **00.100**

Chapter	What is new
---	Initial document setup.

1 Introduction

This document[1] describes the hardware of the MC52iR3 module that connects to the cellular device application and the air interface. It helps you quickly retrieve interface specifications, electrical and mechanical details and information on the requirements to be considered for integrating further components.

1.1 Related documents

[1] MC52iR3 AT Command Set
[2] MC52iR3 Release Notes

Prior to using the MC52iR3 modules or upgrading to a new firmware release, please carefully read the latest product information.

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

[1] The document is effective only if listed in the appropriate Release Notes as part of the technical documentation delivered with your Cinterion Wireless Modules product.

1.2 Terms and Abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
AFC	Automatic Frequency Control
AGC	Automatic Gain Control
ANSI	American National Standards Institute
ARFCN	Absolute Radio Frequency Channel Number
ARP	Antenna Reference Point
ASC0 / ASC1	Asynchronous Serial Controller. Abbreviations used for first and second serial interface of MC52iR3
ASIC	Application Specific Integrated Circuit
B	Thermistor Constant
B2B	Board-to-board connector
BER	Bit Error Rate
BTS	Base Transceiver Station
CB or CBM	Cell Broadcast Message
CE	Conformité Européene (European Conformity)
CHAP	Challenge Handshake Authentication Protocol
CPU	Central Processing Unit
CS	Coding Scheme
CSD	Circuit Switched Data
CTS	Clear to Send
DAC	Digital-to-Analog Converter
DAI	Digital Audio Interface
dBm0	Digital level, 3.14dBm0 corresponds to full scale, see ITU G.711, A-law
DCE	Data Communication Equipment (typically modems, e.g. GSM module)
DCS 1800	Digital Cellular System, also referred to as PCN
DRX	Discontinuous Reception
DSB	Development Support Box
DSP	Digital Signal Processor
DSR	Data Set Ready
DTE	Data Terminal Equipment (typically computer, terminal, printer or, for example, GSM application)
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EFR	Enhanced Full Rate
EGSM	Enhanced GSM

Abbreviation	Description
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
FDMA	Frequency Division Multiple Access
FR	Full Rate
GMSK	Gaussian Minimum Shift Keying
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
HiZ	High Impedance
HR	Half Rate
I/O	Input/Output
IC	Integrated Circuit
IMEI	International Mobile Equipment Identity
ISO	International Standards Organization
ITU	International Telecommunications Union
kbps	kbits per second
LED	Light Emitting Diode
Li-Ion	Lithium-Ion
Mbps	Mbits per second
MMI	Man Machine Interface
MO	Mobile Originated
MS	Mobile Station (GSM module), also referred to as TE
MSISDN	Mobile Station International ISDN number
MT	Mobile Terminated
MTTF	Mean time to failure
NTC	Negative Temperature Coefficient
OEM	Original Equipment Manufacturer
PA	Power Amplifier
PAP	Password Authentication Protocol
PBCCH	Packet Switched Broadcast Control Channel
PCB	Printed Circuit Board
PCL	Power Control Level
PCM	Pulse Code Modulation
PCN	Personal Communications Network, also referred to as DCS 1800
PDU	Protocol Data Unit
PLL	Phase Locked Loop

Abbreviation	Description
PPP	Point-to-point protocol
PSU	Power Supply Unit
R&TTE	Radio and Telecommunication Terminal Equipment
RAM	Random Access Memory
RF	Radio Frequency
RMS	Root Mean Square (value)
ROM	Read-only Memory
RTC	Real Time Clock
Rx	Receive Direction
SAR	Specific Absorption Rate
SELV	Safety Extra Low Voltage
SIM	Subscriber Identification Module
SMS	Short Message Service
SRAM	Static Random Access Memory
TA	Terminal adapter (e.g. GSM module)
TDMA	Time Division Multiple Access
TE	Terminal Equipment, also referred to as DTE
Tx	Transmit Direction
UART	Universal asynchronous receiver-transmitter
URC	Unsolicited Result Code
USSD	Unstructured Supplementary Service Data
VSWR	Voltage Standing Wave Ratio
Phonebook abbreviations	
FD	SIM fixdialing phonebook
LD	SIM last dialling phonebook (list of numbers most recently dialled)
MC	Mobile Equipment list of unanswered MT calls (missed calls)
ME	Mobile Equipment phonebook
ON	Own numbers (MSISDNs) stored on SIM or ME
RC	Mobile Equipment list of received calls
SM	SIM phonebook

1.3 Regulatory and Type Approval Information

1.3.1 Directives and Standards

MC52iR3 has been designed to comply with the directives and standards listed below. It is the responsibility of the application manufacturer to ensure compliance of the final product with all provisions of the applicable directives and standards as well as with the technical specifications provided in the "MC52iR3 Hardware Interface Description".

Table 1: Directives

99/05/EC	Directive of the European Parliament and of the council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (in short referred to as R&TTE Directive 1999/5/EC). The product is labeled with the CE conformity mark CE 0682
2002/95/EC	Directive of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)

Table 2: Standards of European type approval

3GPP TS 51.010-1	Digital cellular telecommunications system (Phase 2); Mobile Station (MS) conformance specification
ETSI EN 301 511 V9.0.2	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&TTE directive (1999/5/EC) (GSM 13.11 version 7.0.1 Release 1998)
GCF-CC V3.40	Global Certification Forum - Certification Criteria
ETSI EN 301 489-1 V1.8.1	Candidate Harmonized European Standard (Telecommunications series) Electro Magnetic Compatibility and Radio spectrum Matters (ERM); Electro Magnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common Technical Requirements
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 60950-1:2006	Safety of information technology equipment

Table 3: Requirements of quality

IEC 60068	Environmental testing
DIN EN 60529	IP codes

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

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

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

部件名称 Name of the part	有毒有害物质或元素 Hazardous substances					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
金属部件 (Metal Parts)	O	O	O	O	O	O
电路模块 (Circuit Modules)	X	O	O	O	O	O
电缆及电缆组件 (Cables and Cable Assemblies)	O	O	O	O	O	O
塑料和聚合物部件 (Plastic and Polymeric parts)	O	O	O	O	O	O

O:
表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T11363-2006 标准规定的限量要求以下。
Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in SJ/T11363-2006.

X:
表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T11363-2006标准规定的限量要求。
Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part *might exceed* the limit requirement in SJ/T11363-2006.

1.3.2 SAR Requirements Specific to Portable Mobiles

Mobile phones, PDAs or other portable transmitters and receivers incorporating a GSM module must be in accordance with the guidelines for human exposure to radio frequency energy. This requires the Specific Absorption Rate (SAR) of portable MC52iR3 based applications to be evaluated and approved for compliance with national and/or international regulations.

Since the SAR value varies significantly with the individual product design manufacturers are advised to submit their product for approval if designed for portable use. For European markets the relevant directives are mentioned below. It is the responsibility of the manufacturer of the final product to verify whether or not further standards, recommendations or directives are in force outside these areas.

Products intended for sale on European markets

EN 50360:	Product standard to demonstrate the compliance of mobile phones with the basic restrictions related to human exposure to electro-magnetic fields (300MHz - 3GHz)

1.3.3 Safety Precautions

The following safety precautions must be observed during all phases of the operation, usage, service or repair of any cellular terminal or mobile incorporating MC52iR3. Manufacturers of the cellular terminal are advised to convey the following safety information to users and operating personnel and to incorporate these guidelines into all manuals supplied with the product. Failure to comply with these precautions violates safety standards of design, manufacture and intended use of the product. Cinterion Wireless Modules GmbH assumes no liability for customer failure to comply with these precautions.

	When in a hospital or other health care facility, observe the restrictions on the use of mobiles. Switch the cellular terminal or mobile off, if instructed to do so by the guidelines posted in sensitive areas. Medical equipment may be sensitive to RF energy. The operation of cardiac pacemakers, other implanted medical equipment and hearing aids can be affected by interference from cellular terminals or mobiles placed close to the device. If in doubt about potential danger, contact the physician or the manufacturer of the device to verify that the equipment is properly shielded. Pacemaker patients are advised to keep their hand-held mobile away from the pacemaker, while it is on.
	Switch off the cellular terminal or mobile before boarding an aircraft. Make sure it cannot be switched on inadvertently. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communications systems. Failure to observe these instructions may lead to the suspension or denial of cellular services to the offender, legal action, or both.
	Do not operate the cellular terminal or mobile in the presence of flammable gases or fumes. Switch off the cellular terminal when you are near petrol stations, fuel depots, chemical plants or where blasting operations are in progress. Operation of any electrical equipment in potentially explosive atmospheres can constitute a safety hazard.
	Your cellular terminal or mobile receives and transmits radio frequency energy while switched on. Remember that interference can occur if it is used close to TV sets, radios, computers or inadequately shielded equipment. Follow any special regulations and always switch off the cellular terminal or mobile wherever forbidden, or when you suspect that it may cause interference or danger.
	Road safety comes first! Do not use a hand-held cellular terminal or mobile when driving a vehicle, unless it is securely mounted in a holder for handsfree operation. Before making a call with a hand-held terminal or mobile, park the vehicle. Handsfree devices must be installed by qualified personnel. Faulty installation or operation can constitute a safety hazard.
	IMPORTANT! Cellular terminals or mobiles operate using radio signals and cellular networks. Because of this, connection cannot be guaranteed at all times under all conditions. Therefore, you should never rely solely upon any wireless device for essential communications, for example emergency calls. Remember, in order to make or receive calls, the cellular terminal or mobile must be switched on and in a service area with adequate cellular signal strength. Some networks do not allow for emergency calls if certain network services or phone features are in use (e.g. lock functions, fixed dialling etc.). You may need to deactivate those features before you can make an emergency call. Some networks require that a valid SIM card be properly inserted in the cellular terminal or mobile.

2 Product Concept

2.1 MC52iR3 Key Features at a Glance

Feature	Implementation
General	
Frequency bands	Dual band: GSM 900/1800MHz
GSM class	Small MS
Output power (according to Release 99, V5)	Class 4 (+33dBm ±2dB) for EGSM900 Class 1 (+30dBm ±2dB) for GSM1800
Power supply	$3.3V \leq V_{BATT+} \leq 4.8V$
Operating temperature (board temperature)	Normal operation: -30°C to +85°C Restricted operation: -40°C to -30°C and +85°C to +90°C
Physical	Dimensions: 32.5mm x 35mm x max. 3.1mm Weight: approx. 6g
RoHS	All hardware components fully compliant with EU RoHS Directive
GSM / GPRS features	
Data transfer	GPRS: • Multislot Class 10 • Full PBCCH support • Mobile Station Class B • Coding Scheme 1 – 4 CSD: • V.110, RLP, non-transparent • 2.4, 4.8, 9.6, 14.4kbps • USSD PPP-stack for GPRS data transfer
SMS	Point-to-point MT and MO Cell broadcast Text and PDU mode Storage: SIM card plus 25 SMS locations in mobile equipment Transmission of SMS alternatively over CSD or GPRS. Preferred mode can be user defined.
Fax	Group 3; Class 2
Audio	Speech codecs: • Half Rate (ETS 06.20) • Full Rate (ETS 06.10) • Enhanced Full Rate (ETS 06.50 / 06.60 / 06.80) • Adaptive Multi Rate AMR Handsfree operation, echo cancellation, noise reduction, 7 different ringing tones / melodies

Feature	Implementation
Software	
AT commands	Hayes 3GPP TS 27.007, TS 27.005, Cinterion Wireless Modules AT commands for RIL compatibility
SIM Application Toolkit	Supports SAT class 3, GSM 11.14 Release 99, support of letter class “c”
TCP/IP stack	Protocols: TCP, UDP, HTTP, FTP, SMTP, POP3 Access by AT commands
Firmware update	Windows executable for update over serial interface ASC0
Interfaces	
2 serial interfaces	ASC0: • 8-wire modem interface with status and control lines, unbalanced, asynchronous • Fixed bit rates: 300bps to 230,000bps • Autobauding: 1,200bps to 230,000bps • Supports RTS0/CTS0 hardware handshake and software XON/XOFF flow control. • Multiplex ability according to GSM 07.10 Multiplexer Protocol. ASC1: • 4-wire, unbalanced asynchronous interface • Fixed bit rates: 300bps to 230,000bps • Supports RTS1/CTS1 hardware handshake and software XON/XOFF flow control
Audio	1 analog interface 1 digital interface (PCM)
SIM interface	Supported SIM cards: 3V, 1.8V External SIM card reader has to be connected via interface connector (note that card reader is not part of MC52iR3)
Antenna	50Ω. External antenna can be connected via antenna connector or solderable pad.
Module interface	50-pin board-to-board connector
Power on/off, Reset	
Power on/off	Switch-on by hardware pin IGT Switch-off by AT command (AT^SMSO) Automatic switch-off in case of critical temperature and voltage conditions
Reset	Orderly shutdown and reset by AT command
Special features	
Real time clock	Timer functions via AT commands
Phonebook	SIM and phone
TTY/CTM support	Integrated CTM modem
Evaluation kit	
DSB75	DSB75 Evaluation board designed to test and type approve Cinterion Wireless Module and provide a sample configuration for application engineering. A special adapter is required to connect the module to the DSB75.

2.2 MC52iR3 System Overview

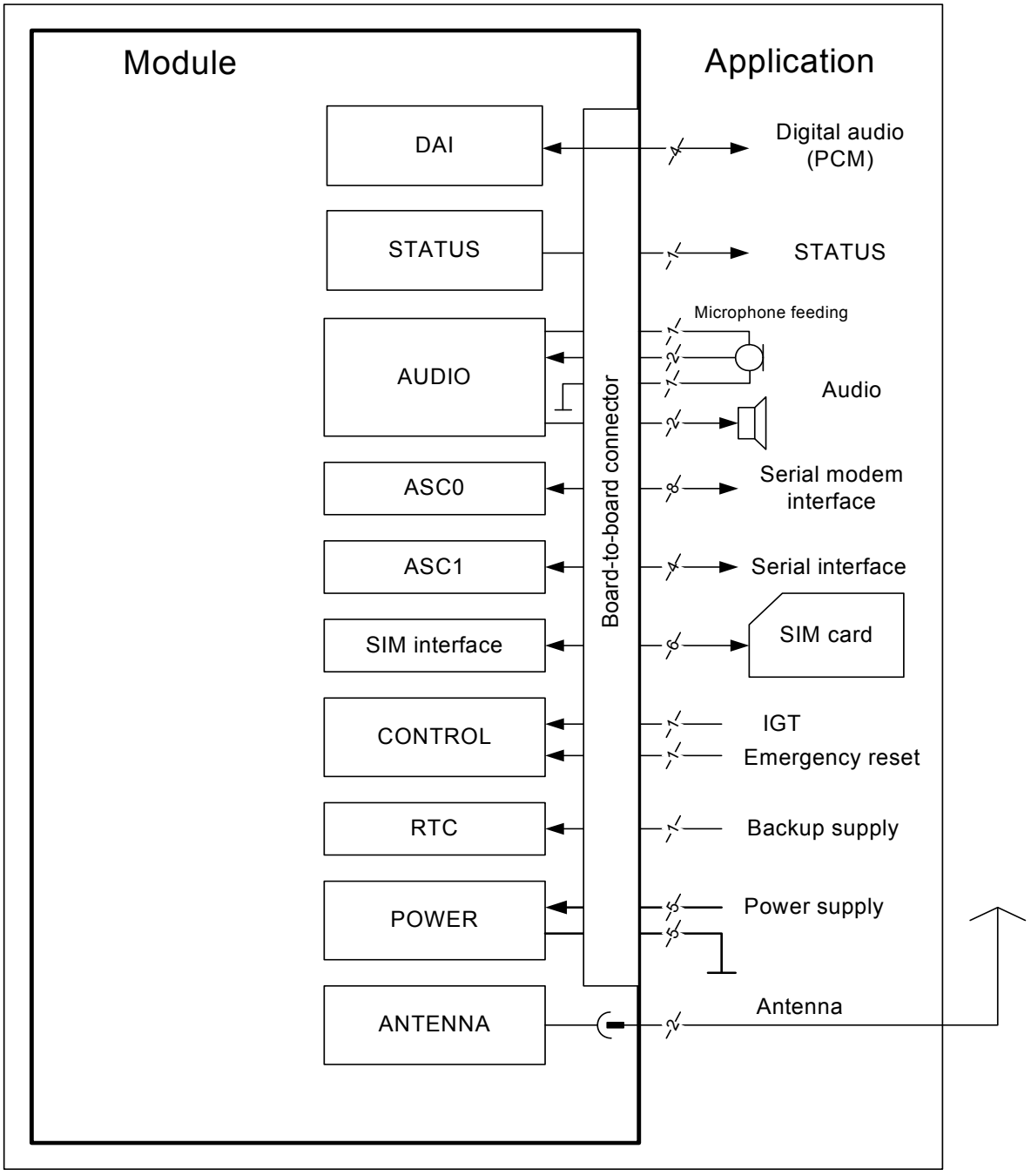


Figure 1: MC52iR3 system overview

2.3 Circuit Concept

Figure 2 shows a block diagram of the MC52iR3 module and illustrates the major functional components:

The baseband consists of the following parts:
- GSM baseband processor and power management
- Stacked flash / SRAM memory
- Application interface (50-pin board-to-board connector)

GSM RF block:
- RF transceiver (part of baseband connector)
- RF power amplifier / front-end module inc. harmonics filtering
- Receive SAW filters

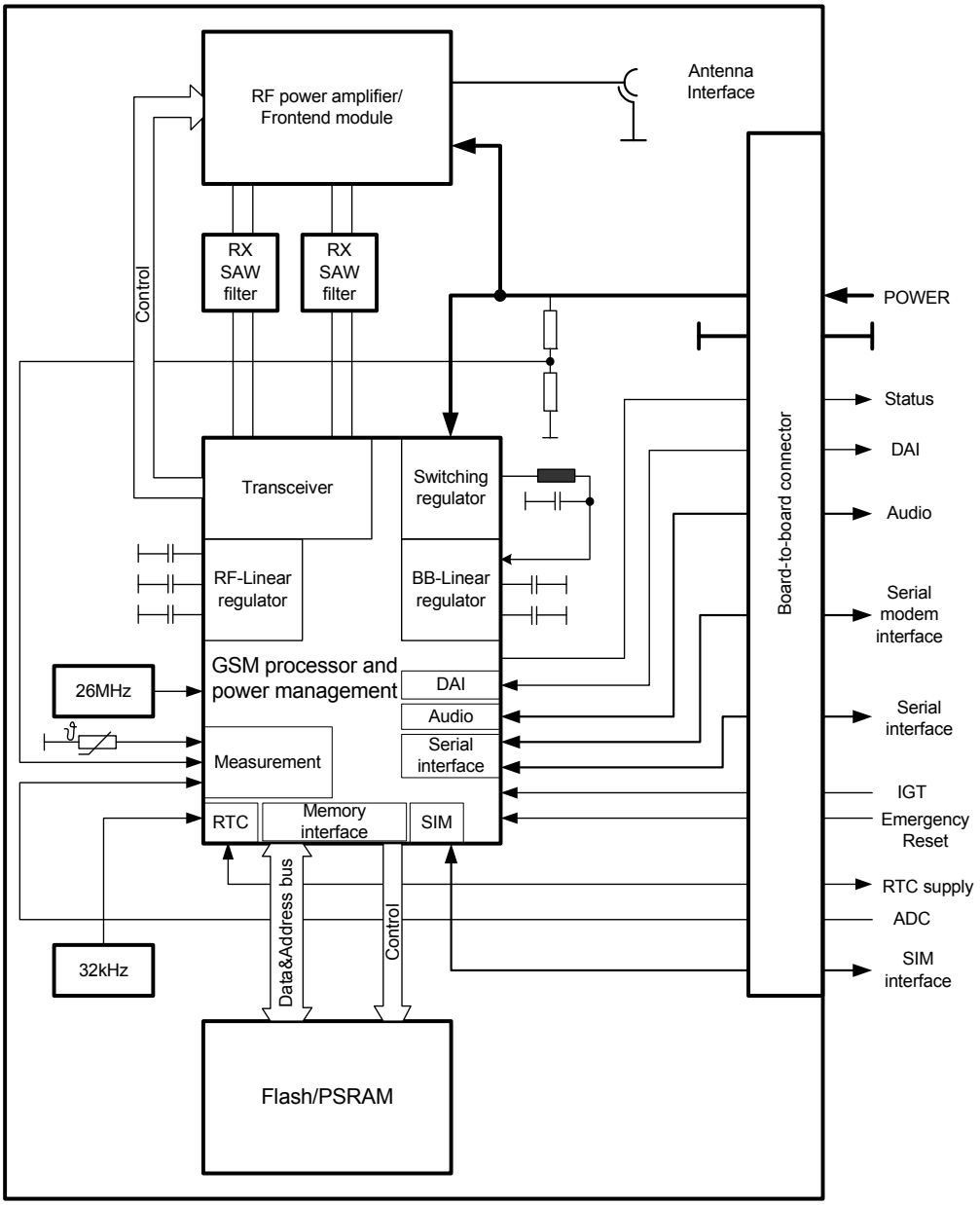


Figure 2: MC52iR3 block diagram

3 Application Interface

MC52iR3 is equipped with a 50-pin board-to-board connector that connects to the external application. The host interface incorporates several sub-interfaces described in the following sections:

- Power supply - see Section 3.2
- RTC backup - see Section 3.8
- SIM interface - see Section 3.9
- Serial interface ASC0 - see Section 3.10
- Serial interface ASC1 - see Section 3.11
- Analog audio interface - see Section 3.12
- Digital audio interface (PCM) - see Section 3.13
- Status LED - see Section 3.14

Electrical and mechanical characteristics of the board-to-board connector are specified in Section 6.3. Ordering information for mating connectors and cables are included.

3.1 Operating Modes

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

Table 6: Overview of operating modes

Mode	Function	
Normal operation	GSM / GPRS SLEEP	Various powersave modes set with AT+CFUN command. Software is active to minimum extent. If the module was registered to the GSM network in IDLE mode, it is registered and paging with the BTS in SLEEP mode, too. Power saving can be chosen at different levels: The NON-CYCLIC SLEEP mode (AT+CFUN=0) disables the AT interface. The CYCLIC SLEEP modes AT+CFUN= 7 and 9 alternatingly activate and deactivate the AT interfaces to allow permanent access to all AT commands.
	GSM IDLE	Software is active. Once registered to the GSM network, paging with BTS is carried out. The module is ready to send and receive.
	GSM TALK	Connection between two subscribers is in progress. Power consumption depends on network coverage individual settings, such as DTX off/on, FR/EFR/HR, hopping sequences, antenna.
	GPRS IDLE	Module is ready for GPRS data transfer, but no data is currently sent or received. Power consumption depends on network settings and GPRS configuration (e.g. multislot settings).
	GPRS DATA	GPRS data transfer in progress. Power consumption depends on network settings (e.g. power control level), uplink / downlink data rates and GPRS configuration (e.g. used multislot settings).
Power Down	Normal shutdown after sending the AT^SMSO command. Only a voltage regulator is active for powering the RTC. Software is not active. Interfaces are not accessible. Operating voltage (connected to BATT+) remains applied.	
Alarm mode	Restricted operation launched by RTC alert function while the module is in Power Down mode. Module will not be registered to GSM network. Limited number of AT commands is accessible.	

See the following sections for the various options of waking up MC52iR3 and proceeding from one mode to another.

3.2 Power Supply

MC52iR3 needs to be connected to a power supply at the board-to-board connector (5 pins each BATT+ and GND).

The power supply of MC52iR3 has to be a single voltage source at BATT+. It must be able to provide the peak current during the uplink transmission.

All the key functions for supplying power to the device are handled by an ASIC power supply. The ASIC provides the following features:

- Stabilizes the supply voltages for the GSM baseband using low drop linear voltage regulators.
- Switches the module's power voltages for the power-up and -down procedures.
- Delivers, across the VDD pin, a regulated voltage for an external application. This voltage is not available in Power-down mode.
- SIM switch to provide SIM power supply.

3.2.1 Minimizing Power Losses

When designing the power supply for your application please pay specific attention to power losses. Ensure that the input voltage V_{BATT+} never drops below 3.3V on the MC52iR3 board, not even in a transmit burst where current consumption can rise (for peak values see the power supply ratings listed in Section 5.6). It should be noted that MC52iR3 switches off when exceeding these limits. Any voltage drops that may occur in a transmit burst should not exceed 400mV.

The module switches off if the minimum supply voltage ($V_{BattMin}$) is reached.

Example:
$V_{BattLowLimit}$ = 3.3V
$V_{DropMax}$ = 0.4V

$V_{BattMin} = V_{BattLowLimit} + V_{DropMax}$
$V_{BattMin}$ = 3.3V + 0.4V = 3.7V

The best approach to reducing voltage drops is to use a board-to-board connection as recommended, and a low impedance power source. The resistance of the power supply lines on the host board and of a battery pack should also be considered.

Note: If the application design requires an adapter cable between both board-to-board connectors, use a cable as short as possible in order to minimize power losses.

If the length of the cable reaches the maximum length of 100mm, this connection may cause, for example, a resistance of 30mΩ in the BATT+ line and 30mΩ in the GND line. As a result, a 1.6A transmit burst would add up to a total voltage drop of 96mV. Plus, if a battery pack is involved, further losses may occur due to the resistance across the battery lines and the internal resistance of the battery including its protective circuit.

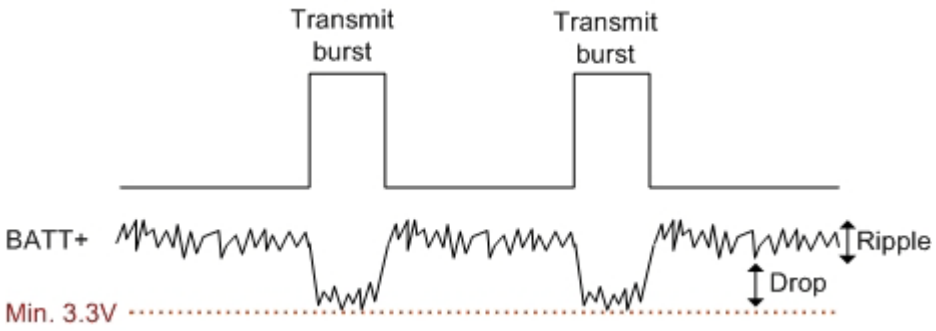


Figure 3: Power supply limits during transmit burst

3.2.2 Measuring the Supply Voltage (V_{BATT+})

Figure 4 shows reference test points for measuring the supply voltage V_{BATT+} on the module: TP BATT+ and TP GND. The test point for BATT+ is located above the board-to-board connector of the module. The test point for GND can be the module shielding.

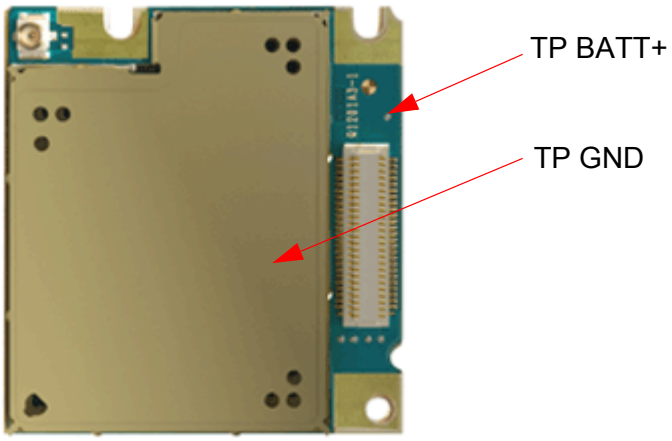


Figure 4: Position of the reference test points TP BATT+ and TP GND

3.2.3 Monitoring Power Supply

To help you monitor the supply voltage you can use the AT^SBV command which returns the voltage related to the test points TP BATT+ and TP GND.

The voltage is continuously measured at intervals depending on the operating mode on the RF interface. The duration of measuring ranges from 0.5s in TALK/DATA mode up to 50s when MC52iR3 is in IDLE mode or Limited Service (deregistered). The displayed voltage (in mV) is averaged over the last measuring period before the AT^SBV command was executed.

3.3 Power Up / Power Down Scenarios

In general, be sure not to turn on MC52iR3 while it is out of the operating range of voltage and temperature stated in Section 5.2 and Section 5.6. MC52iR3 would immediately switch off after having started and detected these inappropriate conditions. In extreme cases this can cause permanent damage to the module.

3.3.1 Turn on MC52iR3

MC52iR3 can be started as described in the following sections:

- Hardware driven switch on by IGT line: Starts Normal mode (see Section 3.3.1.1 and Section).
- Wake-up from Power Down mode by using RTC interrupt: Starts Alarm mode (see Section 3.3.1.2).

3.3.1.1 Switch on MC52iR3 using IGT Signal

When the operating voltage BATT+ is applied, MC52iR3 can be switched on by means of the IGT signal.

If the operating voltage BATT+ is applied while the IGT signal is present, MC52iR3 will be switched on automatically. Please note that if the rise time for the operating voltage BATT+ is longer than 12ms, the module startup will be delayed by about 1 second.

Please also note that if there is no IGT signal present right after applying BATT+, MC52iR3 will instead of switching on perform a very short switch on/off sequence (approx. 120ms) that cannot be avoided.

The IGT signal is a low active signal and only allows the input voltage level of the VDDLP signal. The following Figure 5 shows an example for a switch-on circuit.

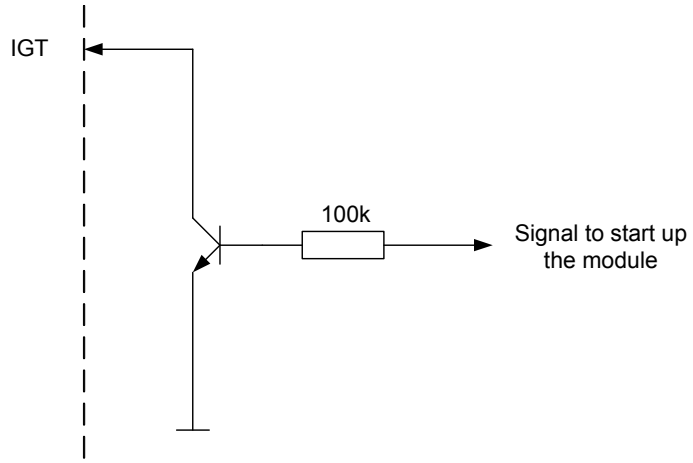


Figure 5: IGT circuit sample

Please also note that if the state of the IGT signal is coupled to the state of the VDDLP line or that if the IGT signal otherwise remains active low after switch on, it is no longer possible to switch off MC52iR3 using the AT command AT^SMSO. Using this command will instead automatically restart the module.

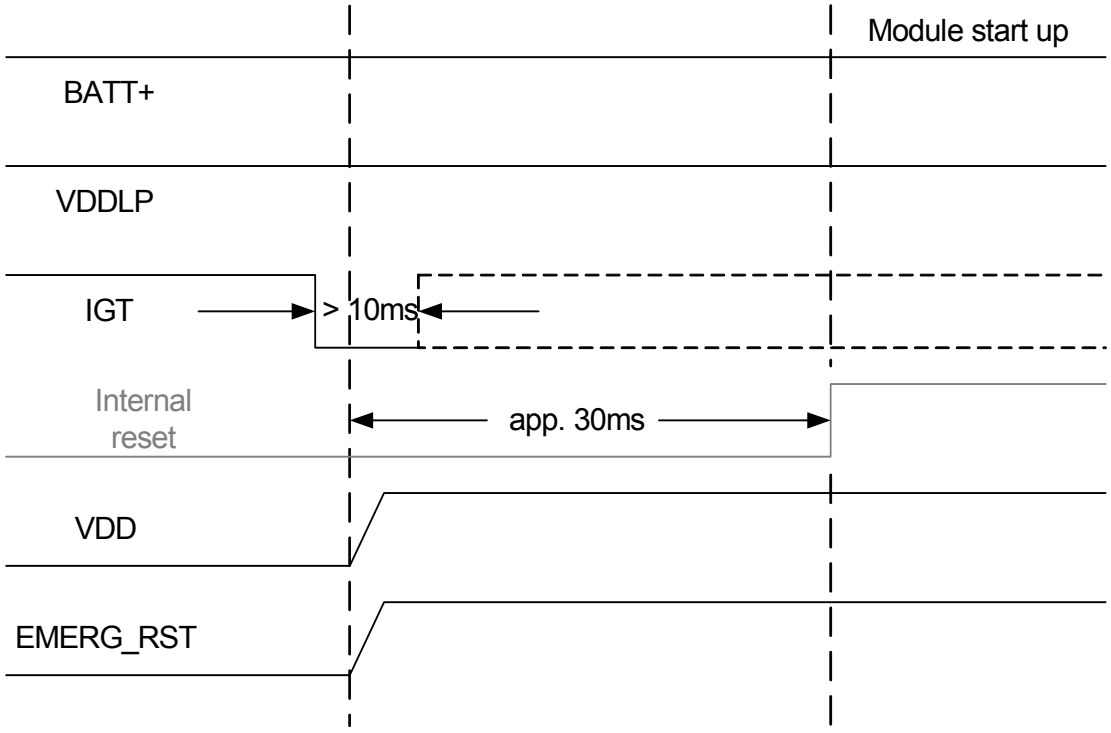


Figure 6: Power-on by ignition signal

If configured to a fixed bit rate (AT+IPR≠0), the module will send the URC "^SYSSTART" which notifies the host application that the first AT command can be sent to the module. The duration until this URC is output varies with the SIM card and may take a couple of seconds, particularly if the request for the SIM PIN is deactivated on the SIM card.

Please note that no "^SYSSTART" URC will be generated if autobauding (AT+IPR=0) is enabled.

To allow the application to detect the ready state of the module we recommend using hardware flow control which can be set with AT\Q (see [1] for details). The default setting is AT\Q0 (no flow control) which shall be altered to AT\Q3 (RTS/CTS handshake). If the application design does not integrate RTS/CTS lines the host application shall wait at least for the "^SYSSTART" URC. However, if the URC is not available (due to autobauding), you will simply have to wait for a period of time (at least 2 seconds) before assuming the module to be in ready state and before entering any data.

Please note that no data must be sent over the ASC0 interface before the interface is active and ready to receive data.

3.3.1.2 Turn on MC52iR3 using the RTC (Alarm Mode)

Another power-on approach is to use the RTC, which is constantly supplied with power from a separate voltage regulator in the power supply ASIC. The RTC provides an alert function, which allows the MC52iR3 to wake up whilst the internal voltage regulators are off. To prevent the module from unintentionally logging into the GSM network, this procedure only enables restricted operation, referred to as Alarm mode. It must not be confused with a wake-up or alarm call that can be activated by using the same AT command, but without switching off power.

Use the AT+CALA command to set the alarm time. The RTC retains the alarm time if MC52iR3 was powered down by AT^SMSO. Once the alarm is timed out and executed, MC52iR3 enters the Alarm mode. This is indicated by an Unsolicited Result Code (URC) which reads:

^SYSSTART ALARM MODE

Note that this URC is the only indication of the Alarm mode and will not appear when autobauding was activated (due to the missing synchronization between DTE and DCE upon start-up). Therefore, it is recommended to select a fixed baudrate before using the Alarm mode.

In Alarm mode the module is deregistered from the GSM network and only a limited number of AT commands is available. For a table showing the availability of AT commands depending on the module‘s operating mode please refer to [1].

For the module to change from Alarm mode to full operation (normal operating mode) it is possible to use the AT+CFUN command or to drive the ignition line to ground. The latter must be implemented in your host application as described in Section 3.3.1.1.

If your host application uses the STATUS pin to control a status LED as described in Section 3.14, please note that the LED is off while the GSM module is in Alarm mode.

3.3.2 Restart MC52iR3

After startup MC52iR3 can be re-started as described in the following sections:
- Software controlled reset by AT+CFUN command: Starts Normal mode (see Section 3.3.2.1).
- Hardware controlled reset by EMERG_RST line: Starts Normal mode (see Section 3.3.2.2)

3.3.2.1 Restart MC52iR3 via AT+CFUN Command

To reset and restart the MC52iR3 module use the command AT+CFUN. You can enter the command AT+CFUN=,1 or 1,1 or 7,1 or 9,1. See [1] for details.

If configured to a fix baud rate (AT+IPR≠0), the module will send the URC "^SYSSTART" to notify that it is ready to operate. If autobauding is enabled (AT+IPR=0) there will be no notification. To register to the network SIM PIN authentication is necessary after restart.

3.3.2.2 Restart MC52iR3 Using EMERG_RST

The EMERG_RST signal is internally connected to the central GSM processor. A low level for more than 10ms sets the processor and with it all the other signal pads to their respective reset state. The reset state is mentioned in Section 3.4 as well as in the figures showing the startup behavior of the serial interfaces.

After releasing the EMERG-RST line, i.e., with a change of the signal level from low to high, the module restarts. The other signals continue from their reset state as if the module was switched on by the ON signal (see Figure 7).

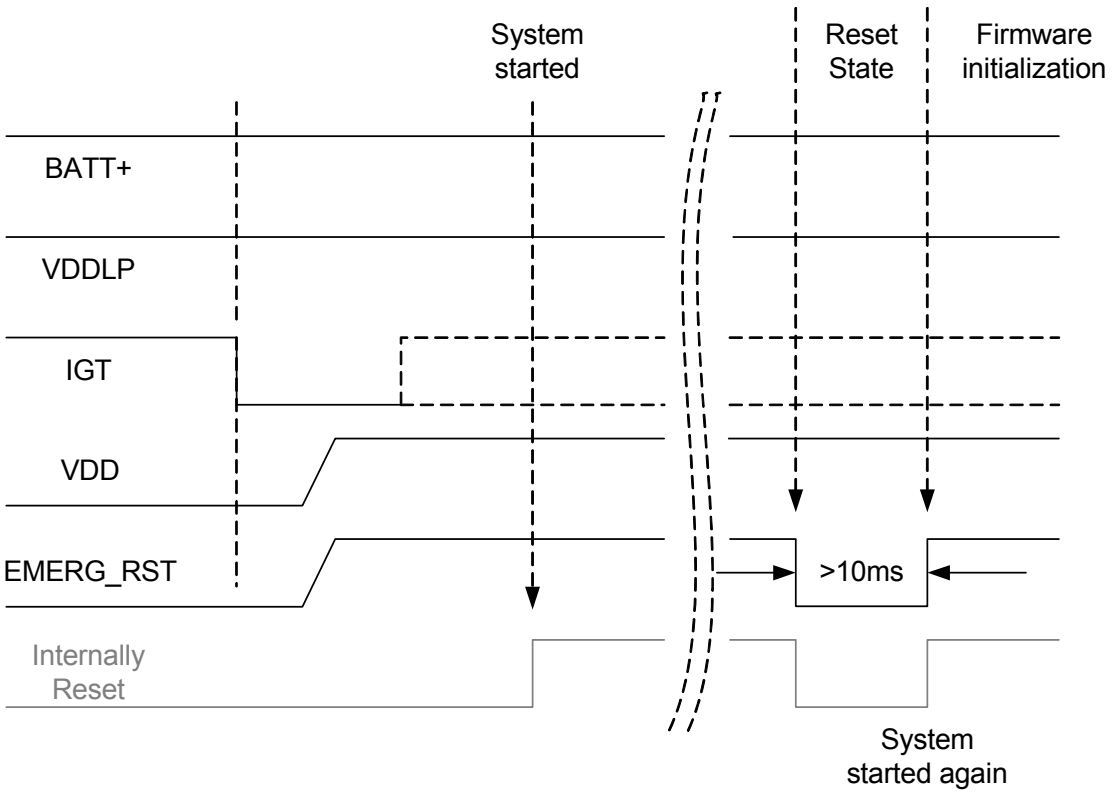


Figure 7: Emergency restart timing

It is recommended to control this EMERG_RST line with an open collector transistor or an open drain field-effect transistor. The following figure shows a sample for such a control circuit.

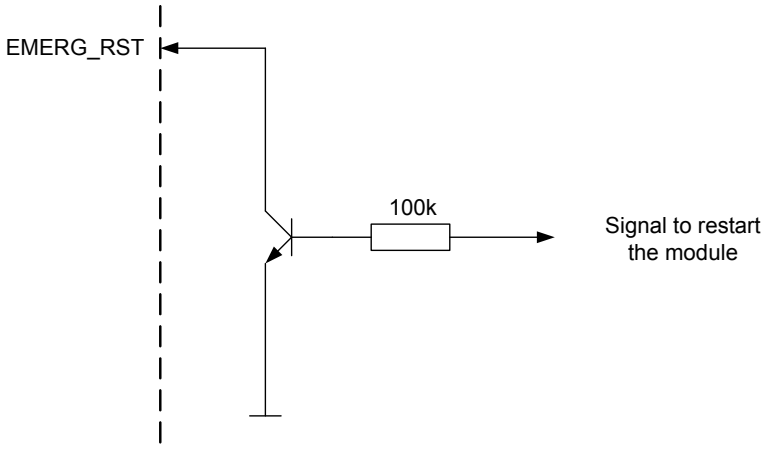


Figure 8: EMERG_RST circuit

Caution: Use the EMERG_RST line only when, due to serious problems, the software is not responding for more than 5 seconds. Pulling the EMERG_RST line causes the loss of all information stored in the volatile memory. Therefore, this procedure is intended only for use in case of emergency, e.g. if MC52iR3 does not respond, if reset or shutdown via AT command fails.

3.4 Signal States after Startup

Table 7 lists states the interface signals pass through during reset and firmware initialization.

The reset state is reached with the rising edge of the EMERG_RST signal - either after a normal module startup (see Section 3.3.1) or after a reset (see Section 3.3.2). After the reset state has been reached the firmware initialization state begins. The firmware initialization is completed as soon as the ASC0 interface lines CTS0, DSR0 and RING0 as well as the ASC1 interface line CTS1 have turned low (see Section 3.10 and Section 3.11). Now, the module is ready to receive and transmit data.

Table 7: Signal states

Signal name	Reset state	Firmware initialization
CCIN	T / 100k PD	I / 100k PD
CCRST	L	O / L
CCIO	L	O / L
CCCLK	L	O / L
RXD0	T / 2 x PU_A	O / H
TXD0	T / 2 x PU_A	I
CTS0	PD_B	O / H
RTS0	T / 10k PU	I / 10k PU
RING0	T / 10k PU	O / H, 10k PU
DTR0	T / 10k PU	I / 10k PU
DCD0	T / 10k PU	O / H, 10k PU
DSR0	T / 5k PU	O / H, 5k PU
RXD1	T / 10k PU	O / H, 10k PU
TXD1	T / 2.2k PU	I / 2.2k PU
CTS1	T / 10k PU	O / H, 10k PU
RTS1	T / 10k PU	I / 10k PU
RXDDAI	T / PD_B	I / PD_B
SCLK	T / PU_B	O / H
TFSDAI	T / PD_B	O / L
TXDDAI	T / PD_B	O / L
RFSDAI	10k PD	10k PD
STATUS	T / 10k PU	O / H, 10k PU

Abbreviations used in above Table 7:

L = Low level H = High level L/H = Low or high level T = Tristate I = Input O = Output	OD = Open Drain PD_A = Pull down, 103µA at 1.75V PD_B = Pull down, 51µA at 1.75V PD_C = Pull down, 27µA at 1.75V PU_A = Pull up -102µA at 0.05V PU_B = Pull up -55µA at 0.05V PU_C = Pull up -31µA at 0.05V

3.4.1 Turn off MC52iR3

To switch the module off the following procedures may be used:
- *Normal shutdown procedure*: Software controlled by sending the AT^SMSO command over the serial application interface. See Section 3.4.1.1.
- *Automatic shutdown*: See Section 3.4.2
  - Takes effect if under- or overvoltage is detected.
  - Takes effect if MC52iR3 board temperature exceeds a critical limit.

3.4.1.1 Switch off MC52iR3 using AT Command

The best and safest approach to powering down MC52iR3 is to issue the AT^SMSO command. This procedure lets MC52iR3 log off from the network and allows the software to enter into a secure state and safe data before disconnecting the power supply. The mode is referred to as Power Down mode. In this mode, only the RTC stays active.

Before switching off the device sends the following response:

```
^SMSO: MS OFF

OK
^SHUTDOWN
```

After sending AT^SMSO do not enter any other AT commands. There are two ways to verify when the module turns off:
- Wait for the URC “^SHUTDOWN”. It indicates that data have been stored non-volatile and the module turns off in less than 1 second.
- Also, you can monitor the VDD pin. The low state of VDD definitely indicates that the module is switched off.

Be sure not to disconnect the operating voltage V_{BATT+} before the URC “^SHUTDOWN” has been issued and the VDD signal has gone low. Otherwise you run the risk of losing data.

While MC52iR3 is in Power Down mode the application interface is switched off and must not be fed from any other source. Therefore, your application must be designed to avoid any current flow into any digital pins of the application interface.

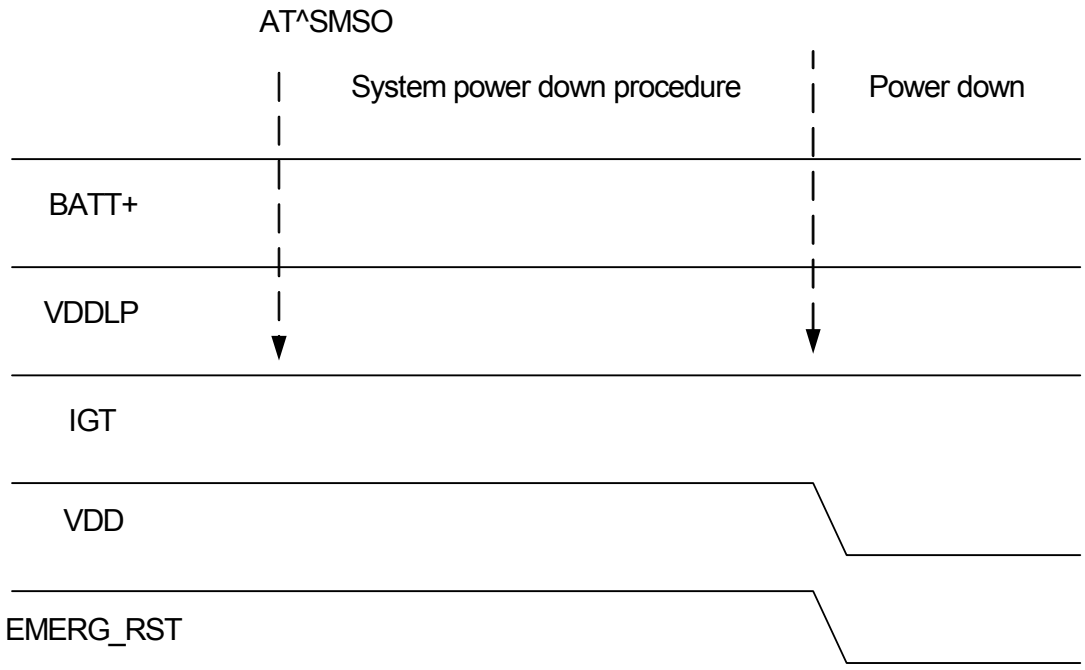


Figure 9: Switch off behavior

3.4.2 Automatic Shutdown

Automatic shutdown takes effect if
- the MC52iR3 board exceeds the critical limits of overtemperature or undertemperature
- Undervoltage or overvoltage is detected

The automatic shutdown procedure is equivalent to the power-down initiated with the AT^SMSO command, i.e. MC52iR3 logs off from the network and the software enters a secure state avoiding loss of data.

3.4.2.1 Thermal Shutdown

The board temperature is constantly monitored by an internal NTC resistor located on the PCB. The values detected by either NTC resistor are measured directly on the board or the battery and therefore, are not fully identical with the ambient temperature.

Each time the board temperature goes out of range or back to normal, MC52iR3 instantly displays an alert (if enabled).
- URCs indicating the level "1" or "-1" allow the user to take appropriate precautions, such as protecting the module from exposure to extreme conditions. The presentation of the URCs depends on the settings selected with the AT^SCTM write command (for details see [1]):
  AT^SCTM=1: Presentation of URCs is always enabled.
  AT^SCTM=0 (default): Presentation of URCs is enabled during the 2 minute guard period after start-up of MC52iR3. After expiry of the 2 minute guard period, the presentation will be disabled, i.e. no URCs with alert levels "1" or "-1" will be generated.
- URCs indicating the level "2" or "-2" are instantly followed by an orderly shutdown, except in cases described in Section 3.4.2.2. The presentation of these URCs is always enabled, i.e. they will be output even though the factory setting AT^SCTM=0 was never changed.

The maximum temperature ratings are stated in Section 5.2. Refer to Table 8 for the associated URCs.

Table 8: Temperature dependent behavior

Sending temperature alert (2min after start-up, otherwise only if URC presentation enabled)	
^SCTM_B: 1	Board close to overtemperature limit.
^SCTM_B: -1	Board close to undertemperature limit.
^SCTM_B: 0	Board back to non-critical temperature range.
Automatic shutdown (URC appears no matter whether or not presentation was enabled)	
^SCTM_B: 2	Alert: Board equal or beyond overtemperature limit. MC52iR3 switches off.
^SCTM_B: -2	Alert: Board equal or below undertemperature limit. MC52iR3 switches off.

3.4.2.2 Deferred Shutdown at Extreme Temperature Conditions

In the following cases, automatic shutdown will be deferred if a critical temperature limit is exceeded:

- While an emergency call is in progress.
- During a two minute guard period after power-up. This guard period has been introduced in order to allow for the user to make an emergency call. The start of any one of these calls extends the guard period until the end of the call. Any other network activity may be terminated by shutdown upon expiry of the guard time.

While in a "deferred shutdown" situation, MC52iR3 continues to measure the temperature and to deliver alert messages, but deactivates the shutdown functionality. Once the 2 minute guard period is expired or the call is terminated, full temperature control will be resumed. If the temperature is still out of range, MC52iR3 switches off immediately (without another alert message).

CAUTION! Automatic shutdown is a safety feature intended to prevent damage to the module. Extended usage of the deferred shutdown facilities provided may result in damage to the module, and possibly other severe consequences.

3.4.2.3 Undervoltage Shutdown

The undervoltage threshold is 100mV below the minimum supply voltage V_{BATT+} specified in Table 26. When the supply voltage approaches the undervoltage shutdown threshold the module will send the following URC:

^SBC: Undervoltage.

This alert is sent once. When the overvoltage shutdown threshold is exceeded the module will shut down cleanly.

This type of URC does not need to be activated by the user. It will be output automatically when fault conditions occur.

3.4.2.4 Overvoltage Shutdown

The overvoltage shutdown threshold is 100mV above the maximum supply voltage V_{BATT+} specified in Table 26. When the supply voltage approaches the overvoltage shutdown threshold the module will send the following URC:

^SBC: Overvoltage.

This alert is sent once. When the overvoltage shutdown threshold is exceeded the module will shut down cleanly.

This type of URC does not need to be activated by the user. It will be output automatically when fault conditions occur.

Keep in mind that several MC52iR3 components are directly linked to BATT+ and, therefore, the supply voltage remains applied at major parts of MC52iR3. Especially the power amplifier is very sensitive to high voltage and might even be destroyed.

3.5 Automatic GPRS Multislot Class Change

Temperature control is also effective for operation in GPRS Multislot Class 10. If the board temperature increases to the limit specified for restricted operation (see Section 5.2 for temperature limits) while data is transmitted over GPRS, the module automatically reverts from GPRS Multislot Class 10 (2Tx) to Class 8 (1Tx). This reduces the power consumption and, consequently, causes the board's temperature to decrease. Once the temperature drops to a value of 5 degrees below the limit of restricted operation, MC52iR3 returns to the higher Multislot Class. If the temperature stays at the critical level or even continues to rise, MC52iR3 will not switch back to the higher class.

After a transition from Multislot Class 10 to Multislot 8 a possible switchback to Multislot Class 10 is blocked for one minute.

Please note that there is not one single cause of switching over to a lower GPRS Multislot Class. Rather it is the result of an interaction of several factors, such as the board temperature that depends largely on the ambient temperature, the operating mode and the transmit power. Furthermore, take into account that there is a delay until the network proceeds to a lower or, accordingly, higher Multislot Class. The delay time is network dependent. In extreme cases, if it takes too much time for the network and the temperature cannot drop due to this delay, the module may even switch off as described in Section 3.4.2.1.

3.6 Power Saving

SLEEP mode reduces the functionality of the MC52iR3 module to a minimum and, thus, minimizes the current consumption to the lowest level. Settings can be made using the AT+CFUN command. For details see below and [1]. SLEEP mode falls into two categories:

- NON-CYCLIC SLEEP mode AT+CFUN=0
- CYCLIC SLEEP modes, selectable with AT+CFUN=7 or 9.

IMPORTANT: Please keep in mind that power saving works properly only when PIN authentication has been done. If you attempt to activate power saving while the SIM card is not inserted or the PIN not correctly entered (Limited Service), the selected <fun> level will be set, though power saving does not take effect. For the same reason, power saving cannot be used if MC52iR3 operates in Alarm mode.

To check whether power saving is on, you can query the status of AT+CFUN if you have chosen CYCLIC SLEEP mode.

The wake-up procedures are quite different depending on the selected SLEEP mode. Table 9 compares the wake-up events that can occur in NON-CYCLIC and CYCLIC SLEEP modes.

3.6.1 No Power Saving (AT+CFUN=1)

The functionality level <fun>=1 is where power saving is switched off. This is the default after startup.

3.6.2 NON-CYCLIC SLEEP Mode (AT+CFUN=0)

If level 0 has been selected (AT+CFUN=0), the serial interface is blocked. The module shortly deactivates power saving to listen to a paging message sent from the base station and then immediately resumes power saving. Level 0 is called NON-CYCLIC SLEEP mode, since the serial interface is not alternatingly made accessible as in CYCLIC SLEEP mode.

The first wake-up event fully activates the module, enables the serial interface and terminates the power saving mode. In short, it takes MC52iR3 back to the highest level of functionality <fun>=1.

In NON-CYCLIC mode, the falling edge of the RTS0 or RTS1 lines wakes up the module to <fun>=1. To efficiently use this feature it is recommended to enable hardware flow control (RTS/CTS handshake) as in this case the CTS line notifies the application when the module is ready to send or receive characters. See Section 3.6.6.1 for details.

3.6.3 CYCLIC SLEEP Mode (AT+CFUN=7)

The functionality level AT+CFUN=7 is referred to as CYCLIC SLEEP mode. The major benefit of all CYCLIC SLEEP modes is that the serial interface remains accessible, and that, in intermittent wake-up periods, characters can be sent or received without terminating the selected mode.

The CYCLIC SLEEP modes give you greater flexibility regarding the wake-up procedures: For example, in all CYCLIC SLEEP modes, you can enter AT+CFUN=1 to permanently wake up the module. In mode CFUN=7, MC52iR3 automatically resumes power saving, after you have sent or received a short message, made a call or completed a GPRS transfer. Please refer to Table 9 for a summary of all modes.

The CYCLIC SLEEP mode is a dynamic process which alternatingly enables and disables the serial interface. By setting/resetting the CTS signal, the module indicates to the application whether or not the UART is active. The timing of CTS is described below.

Both the application and the module must be configured to use hardware flow control (RTS/CTS handshake). The default setting of MC52iR3 is AT\Q0 (no flow control) which must be altered to AT\Q3. See [1] for details.

Note: If both serial interfaces ASC0 and ASC1 are connected, both are synchronized. This means that SLEEP mode takes effect on both, no matter on which interface the AT command was issued. Although not explicitly stated, all explanations given in this section refer equally to ASC0 and ASC1, and accordingly to CTS0 and CTS1.

3.6.4 CYCLIC SLEEP Mode AT+CFUN=9

Mode AT+CFUN=9 is similar to AT+CFUN=7, but provides two additional features:

- The time the module stays active after RTS was asserted or after the last character was sent or received, can be configured individually using the command AT^SCFG. Default setting is 2 seconds like in AT+CFUN=7. The entire range is from 0.5 seconds to 1 hour, selectable in tenths of seconds. For details see [1].
- RTS0 and RTS1 are not only used for flow control (as in mode AT+CFUN=7), but also cause the module to wake up temporarily. See Section 3.6.6.1 for details.

3.6.5 Timing of the CTS Signal in CYCLIC SLEEP Modes

The CTS signal is enabled in synchrony with the module's paging cycle. It goes active low each time when the module starts listening to a paging message block from the base station. The timing of the paging cycle varies with the base station. The duration of a paging interval can be calculated from the following formula:
*4.615 ms (TDMA frame duration) * 51 (number of frames) * DRX value*.

DRX (Discontinuous Reception) is a value from 2 to 9, resulting in paging intervals from 0.47 to 2.12 seconds. The DRX value of the base station is assigned by the network operator.

Each listening period causes the CTS signal to go active low: If DRX is 2, the CTS signal is activated every 0.47 seconds, if DRX is 3, the CTS signal is activated every 0.71 seconds and if DRX is 9, the CTS signal is activated every 2.1 seconds.

The CTS signal is active low for 4.6 ms. This is followed by another 4.6 ms UART activity. If the start bit of a received character is detected within these 9.2 ms, CTS will be activated and the proper reception of the character will be guaranteed. CTS will also be activated if any character is to be sent.

After the last character was sent or received the interface will remain active for

- another 2 seconds, if AT+CFUN=7
- or for an individual time defined with AT^SCFG, if AT+CFUN=9. Assertion of RTS has the same effect.

In the pauses between listening to paging messages, while CTS is high, the module resumes power saving and the AT interface is not accessible. See Figure 10 and Figure 11.

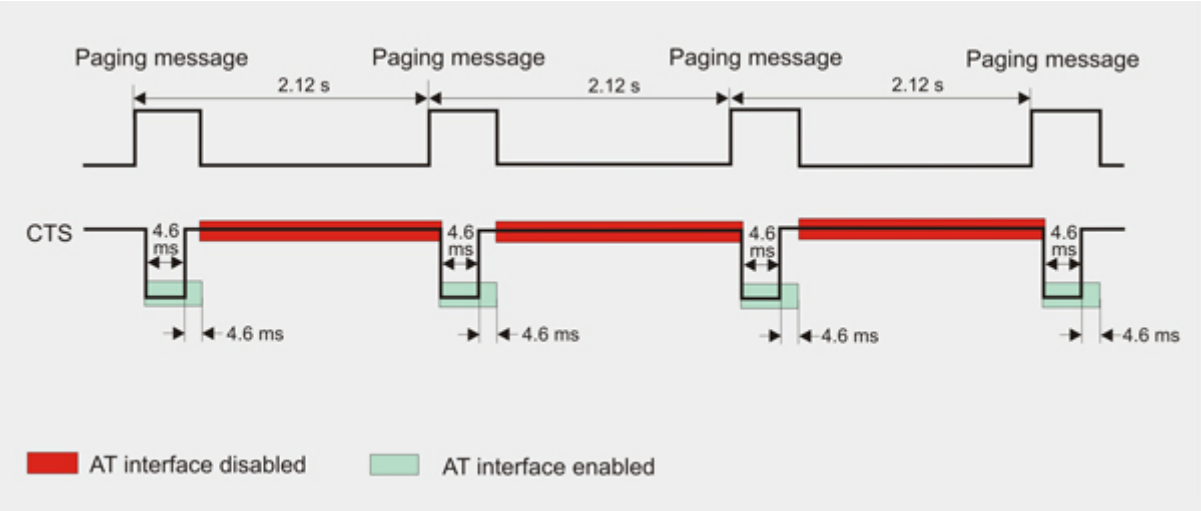


Figure 10: Timing of CTS signal (example for a 2.12 s paging cycle)

Figure 11 illustrates the CFUN=7 mode, which reset the CTS signal 2 seconds after the last character was sent or received.

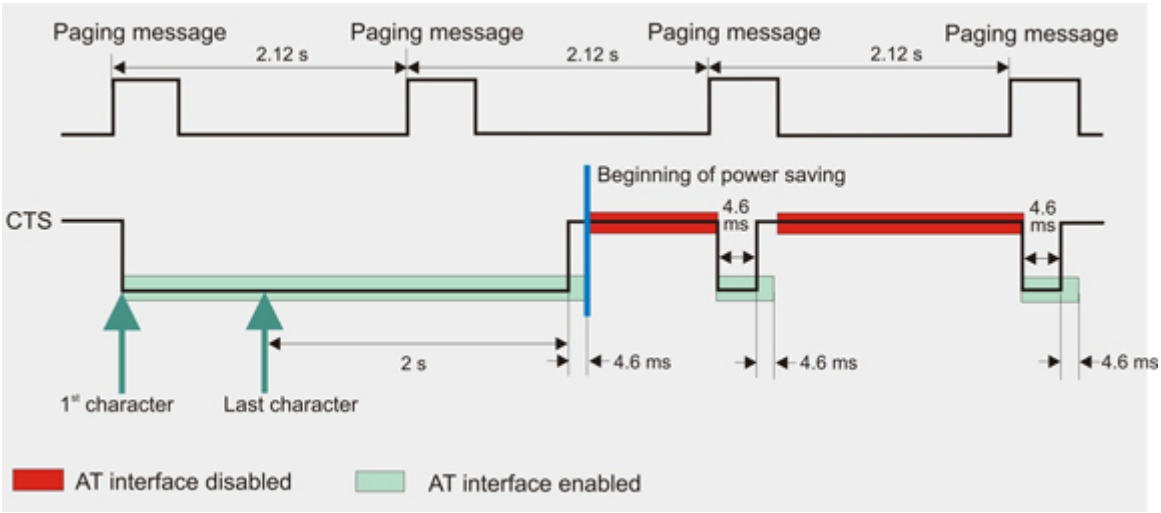


Figure 11: Beginning of power saving if CFUN=7

3.6.6 Wake up MC52iR3 from SLEEP Mode

A wake-up event is any event that causes the module to draw current. Depending on the selected mode the wake-up event either switches SLEEP mode off and takes MC52iR3 back to AT+CFUN=1, or activates MC52iR3 temporarily without leaving the current SLEEP mode.

Definitions of the state transitions described in Table 9:

Quit = MC52iR3 exits SLEEP mode and returns to AT+CFUN=1.

Temporary = MC52iR3 becomes active temporarily for the duration of the event and the mode specific follow-up time after the last character was sent or received on the serial interface.

No effect = Event is not relevant in the selected SLEEP mode. MC52iR3 does not wake up.

Table 9: Wake-up events in NON-CYCLIC and CYCLIC SLEEP modes

Event	Selected mode AT+CFUN=0	Selected mode AT+CFUN=7 or 9
Ignition line	No effect	No effect
RTS0 or RTS1[1)] (falling edge)	Quit + flow control	Mode 7: No effect, RTS is only used for flow control Mode 9: Temporary + flow control
Unsolicited Result Code (URC)	Quit	Temporary
Incoming voice or data call	Quit	Temporary
Any AT command (incl. outgoing voice or data call, outgoing SMS)	Not possible (UART disabled)	Temporary
Incoming SMS depending on mode selected by AT+CNMI: AT+CNMI=0,0 (= default, no indication of received SMS) AT+CNMI=1,1 (= displays URC upon receipt of SMS)	 No effect Quit	 No effect Temporary
GPRS data transfer	Not possible (UART disabled)	Temporary
RTC alarm[2]	Quit	Temporary
AT+CFUN=1	Not possible (UART disabled)	Quit

1. See Section 3.6.6.1 on wake-up via RTS.
2. Recommendation: In NON-CYCLIC SLEEP mode, you can set an RTC alarm to wake up MC52iR3 and return to full functionality. This is a useful approach because, in this mode, the AT interface is not accessible.

3.6.6.1 Wake-up via RTS0 and RTS1 (if AT+CFUN=0 or AT+CFUN=9)

During the CYCLIC SLEEP mode 7, the RTS0 and RTS1 lines are conventionally used for flow control: The assertion of RTS0 or RTS1 indicates that the application is ready to receive data - without waking up the module.

If the module is in CFUN=0 mode the assertion of RTS0 and RTS1 serves as a wake-up event, giving the application the possibility to intentionally terminate power saving. If the module is in CFUN=9 mode, the assertion of RTS0 or RTS1 can be used to temporarily wake up MC52iR3 for the time specified with the AT^SCFG command (default = 2s). In both cases, if RTS0 or RTS1 is asserted while AT+CFUN=0 or AT+CFUN=9 is set, there may be a short delay until the module is able to receive data again. This delay depends on the current module activities (e.g. paging cycle) and may be up to 60ms. The ability to receive data is signalized by CTS0 and CTS1. It is therefore recommended to enable RTS/CTS flow control, not only in CYCLIC SLEEP mode, but also in NON-CYCLIC SLEEP mode.

3.7 Summary of State Transitions (except SLEEP Mode)

The table shows how to proceed from one mode to another (grey column = present mode, white columns = intended modes)

Table 10: State transitions of MC52iR3 (except SLEEP mode)

Further mode →→ Present mode	**Power Down**	**Normal mode**	**Alarm mode**
Power Down mode	---	IGT >10ms at low level	Wake-up from Power Down mode (if activated with AT+CALA)
Normal mode	AT^SMSO	EMERG_RST > 10ms	AT+CALA followed by AT^SMSO. MC52iR3 enters Alarm mode when specified time is reached.
Alarm mode	AT^SMSO	AT+CFUN=x,1	---

3.8 RTC Backup

The internal Real Time Clock of MC52iR3 is supplied from a separate voltage regulator in the power supply component which is also active when MC52iR3 is in Power Down mode and BATT+ is available. An alarm function is provided that allows to wake up MC52iR3 without logging on to the GSM network.

In addition, you can use the VDDLP pin on the board-to-board connector to backup the RTC from an external capacitor. The capacitor is charged from the internal LDO of MC52iR3. If the voltage supply at BATT+ is disconnected the RTC can be powered by the capacitor. The size of the capacitor determines the duration of buffering when no voltage is applied to MC52iR3, i.e. the greater the capacitor the longer MC52iR3 will save the date and time. A serial 1kOhm resistor has to be placed on the application next to VDDLP. It limits the input current of an empty capacitor. The RTC can also be supplied from an external battery (rechargeable or non-chargeable). In this case the electrical specification of the VDDLP pin (see Section 5.5) has to be taken in to account.

Figure 12 shows an RTC backup configuration.

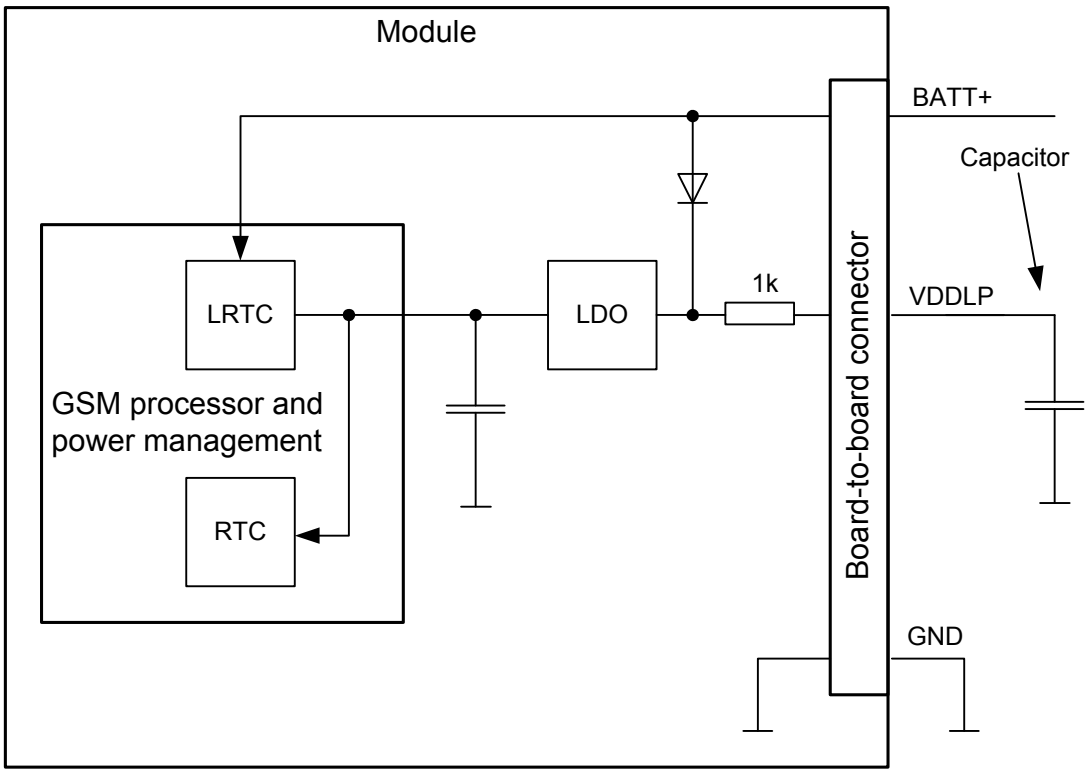


Figure 12: RTC supply variant

3.9 SIM Interface

The baseband processor has an integrated SIM card interface compatible with the ISO 7816 IC Card standard. This is wired to the host interface (board-to-board connector) in order to be connected to an external SIM card holder. Five pins on the board-to-board connector are reserved for the SIM interface. MC52iR3 supports and automatically detects 3.0V as well as 1.8V SIM cards.

The CCIN pin serves to detect whether a tray is present in the card holder. Using the CCIN pin is mandatory for compliance with the 3GPP TS 11.11 (Rel.99) recommendation if the mechanical design of the host application allows the user to remove the SIM card during operation.

Table 11: Signals of the SIM interface (board-to-board connector)

Signal	Description
CCCLK	Chipcard clock, various clock rates can be set in the baseband processor.
CCVCC	SIM supply voltage from PSU-ASIC
CCIO	Serial data line, input and output.
CCRST	Chipcard reset, provided by baseband processor
CCIN	Input on the baseband processor for detecting a SIM card tray in the holder.The default level of CCIN is low (internal pull down resistor, no card inserted). It will change to high level when the card is inserted. To take advantage of this feature, an appropriate contact is required on the cardholder. Ensure that the cardholder on your application platform is wired to output a high signal when the SIM card is present. The CCIN pin is mandatory for applications that allow the user to remove the SIM card during operation. The CCIN pin is solely intended for use with a SIM card. It must not be used for any other purposes. Failure to comply with this requirement may invalidate the type approval of MC52iR3.

The figure below shows a circuit to connect an external SIM card holder.

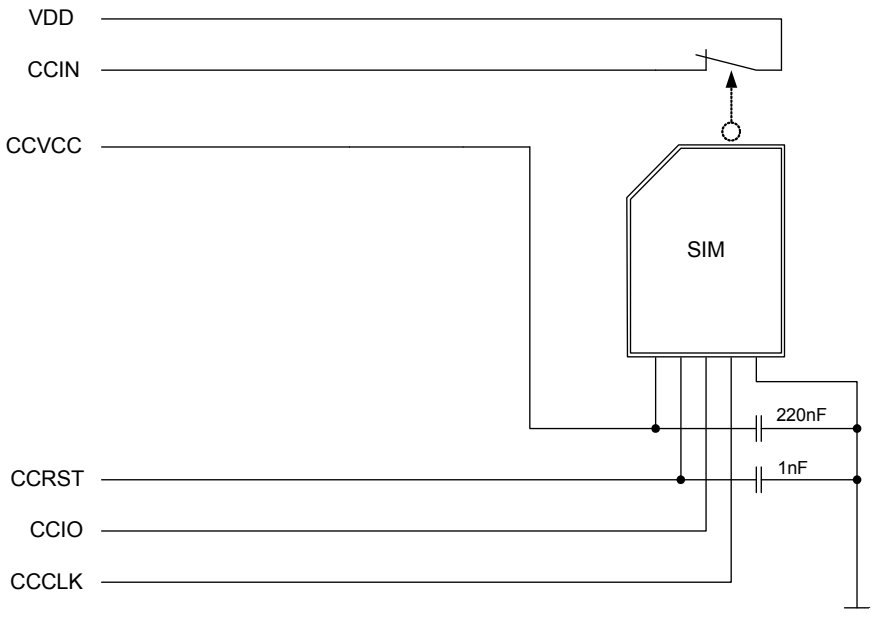


Figure 13: External SIM card holder circuit

It is recommended that the total cable length between the board-to-board connector pins on MC52iR3 and the pins of the SIM card holder does not exceed 100mm in order to meet the specifications of 3GPP TS 51.010-1 and to satisfy the requirements of EMC compliance.

To avoid possible cross-talk from the CCCLK signal to the CCIO signal be careful that both lines are not placed closely next to each other. A useful approach would be to use a separate SIM card ground connection to shield the CCIO line from the CCCLK line. A GND line (pin 2) may be employed for such a case.

Notes: 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 initialising any SIM card that the user inserts after having removed a SIM card during operation. In this case, the application must restart MC52iR3.
If using a SIM card holder without detecting contact please be sure to switch off the module before removing the SIM Card or inserting a new one.

3.10 Serial Interface ASC0

MC52iR3 offers an 8-wire unbalanced, asynchronous modem interface ASC0 conforming to ITU-T V.24 protocol DCE signalling. The voltage level of the ASC0 interface is configured to 2.85V. For electrical characteristics please refer to Table 25.

MC52iR3 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 the module's TXD0 signal line
- Port RXD @ application receives data from the module's RXD0 signal line

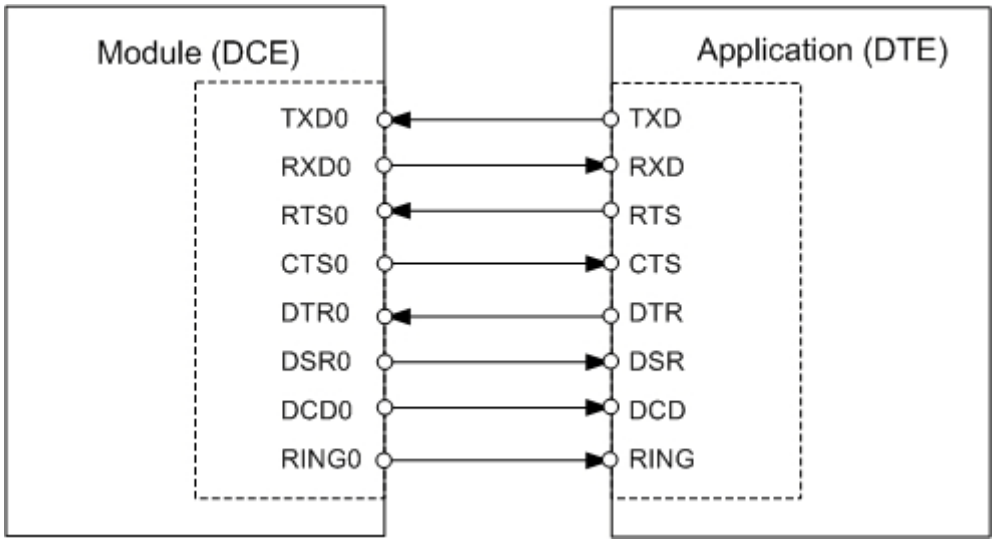


Figure 14: Serial interface ASC0

Features:

- Includes the data lines TXD0 and RXD0, the status lines RTS0 and CTS0 and, in addition, the modem control lines DTR0, DSR0, DCD0 and RING0.
- ASC0 is primarily designed for controlling voice calls, transferring CSD, fax and GPRS data and for controlling the GSM module with AT commands.
- The DTR0 signal will only be polled once per second from the internal firmware of MC52iR3.
- The RING0 signal serves to indicate incoming calls and other types of URCs (Unsolicited Result Code). It can also be used to send pulses to the host application, for example to wake up the application from power saving state. See [1] for details on how to configure the RING0 line by AT^SCFG.
- Configured for 8 data bits, no parity and 1 stop bit.
- ASC0 can be operated at fixed bit rates from 300 bps to 230400 bps.
- Autobauding supports bit rates from 1200 to 230400 bps.
- Supports RTS0/CTS0 hardware flow control and XON/XOFF software flow control.

Table 12: DCE-DTE wiring of ASC0

V.24 circuit	DCE		DTE	
	Pin function	**Signal direction**	**Pin function**	**Signal direction**
103	TXD0	Input	TXD	Output
104	RXD0	Output	RXD	Input
105	RTS0	Input	RTS	Output
106	CTS0	Output	CTS	Input
108/2	DTR0	Input	DTR	Output
107	DSR0	Output	DSR	Input
109	DCD0	Output	DCD	Input
125	RING0	Output	RING	Input

The following figure shows the startup behavior of the asynchronous serial interface ASC0.

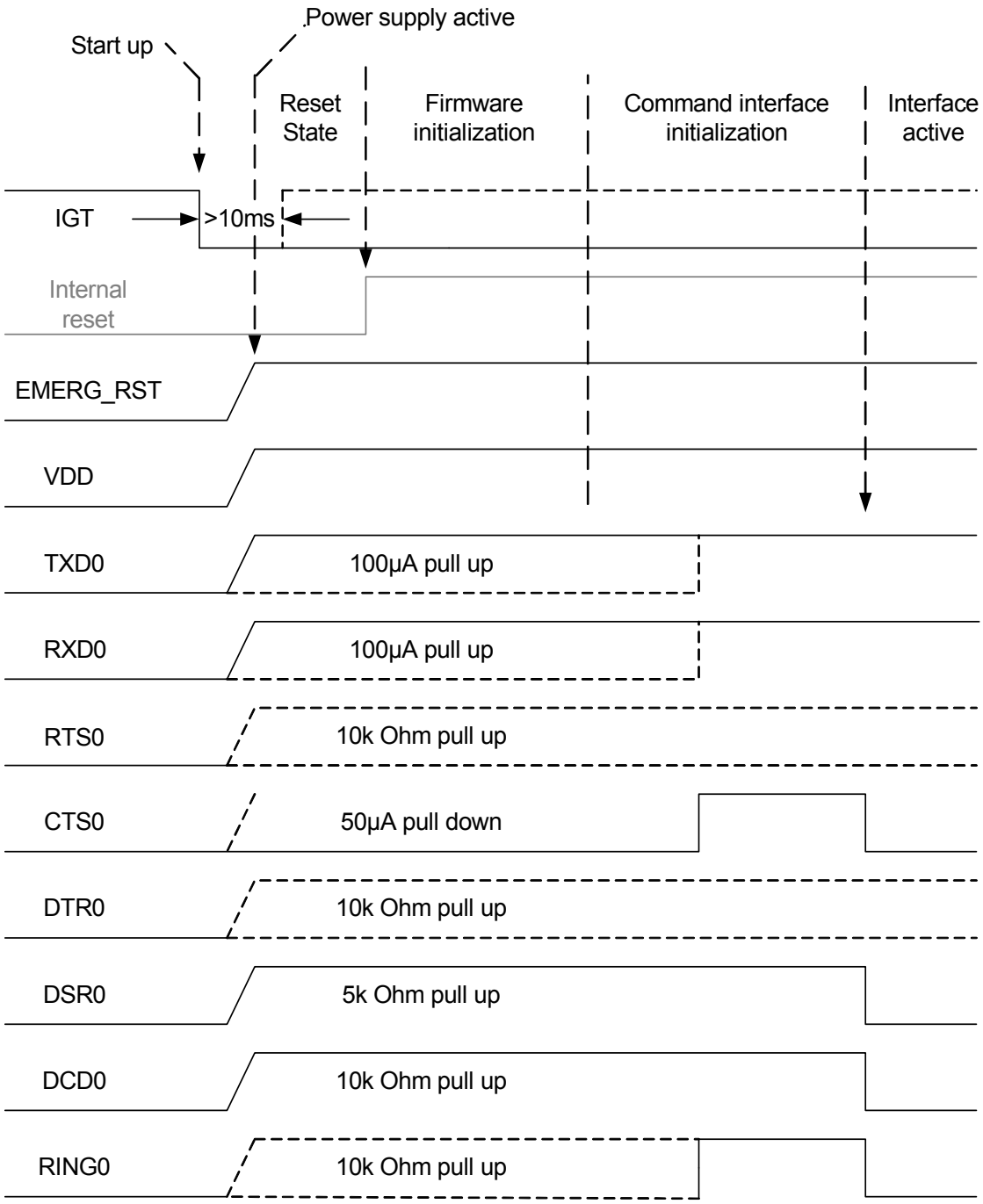


Figure 15: ASC0 startup behavior

Please note that no data must be sent over the ASC0 interface before the interface is active and ready to receive data (see Section 3.3.1.1).

3.11 Serial Interface ASC1

MC52iR3 offers a 4-wire unbalanced, asynchronous modem interface ASC1 conforming to ITU-T V.24 protocol DCE signalling. The electrical characteristics do not comply with ITU-T V.28. The voltage level of the ASC0 interface is configured to 2.85V. For electrical characteristics please refer to Table 25.

MC52iR3 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 module's TXD1 signal line
- Port RXD @ application receives data from the module's RXD1 signal line

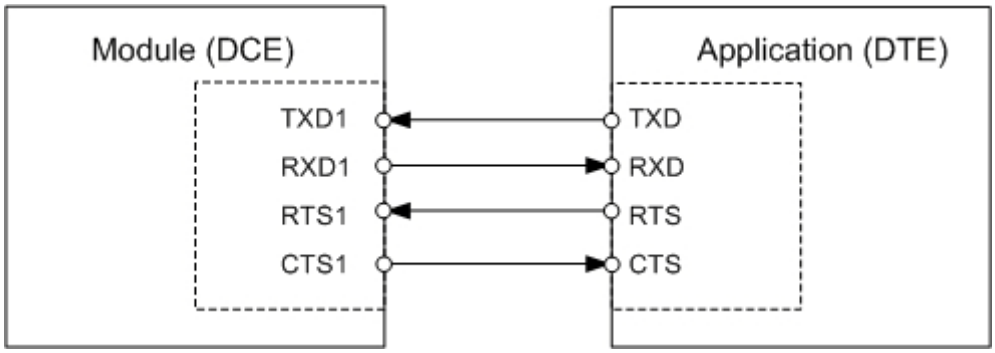


Figure 16: Serial interface ASC1

Features
- Includes only the data lines TXD1 and RXD1 plus RTS1 and CTS1 for hardware handshake.
- On ASC1 no RING line is available. The indication of URCs on the second interface depends on the settings made with the AT^SCFG command. For details refer to [1].
- Configured for 8 data bits, no parity and 1 or 2 stop bits.
- ASC1 can be operated at fixed bit rates from 300 bps to 230400 bps. Autobauding is not supported on ASC1.
- Supports RTS1/CTS1 hardware flow control and XON/XOFF software flow control.

Table 13: DCE-DTE wiring of ASC1

V.24 circuit	DCE		DTE	
	Pin function	Signal direction	Pin function	Signal direction
103	TXD1	Input	TXD	Output
104	RXD1	Output	RXD	Input
105	RTS1	Input	RTS	Output
106	CTS1	Output	CTS	Input

The following figure shows the startup behavior of the asynchronous serial interface ASC0.

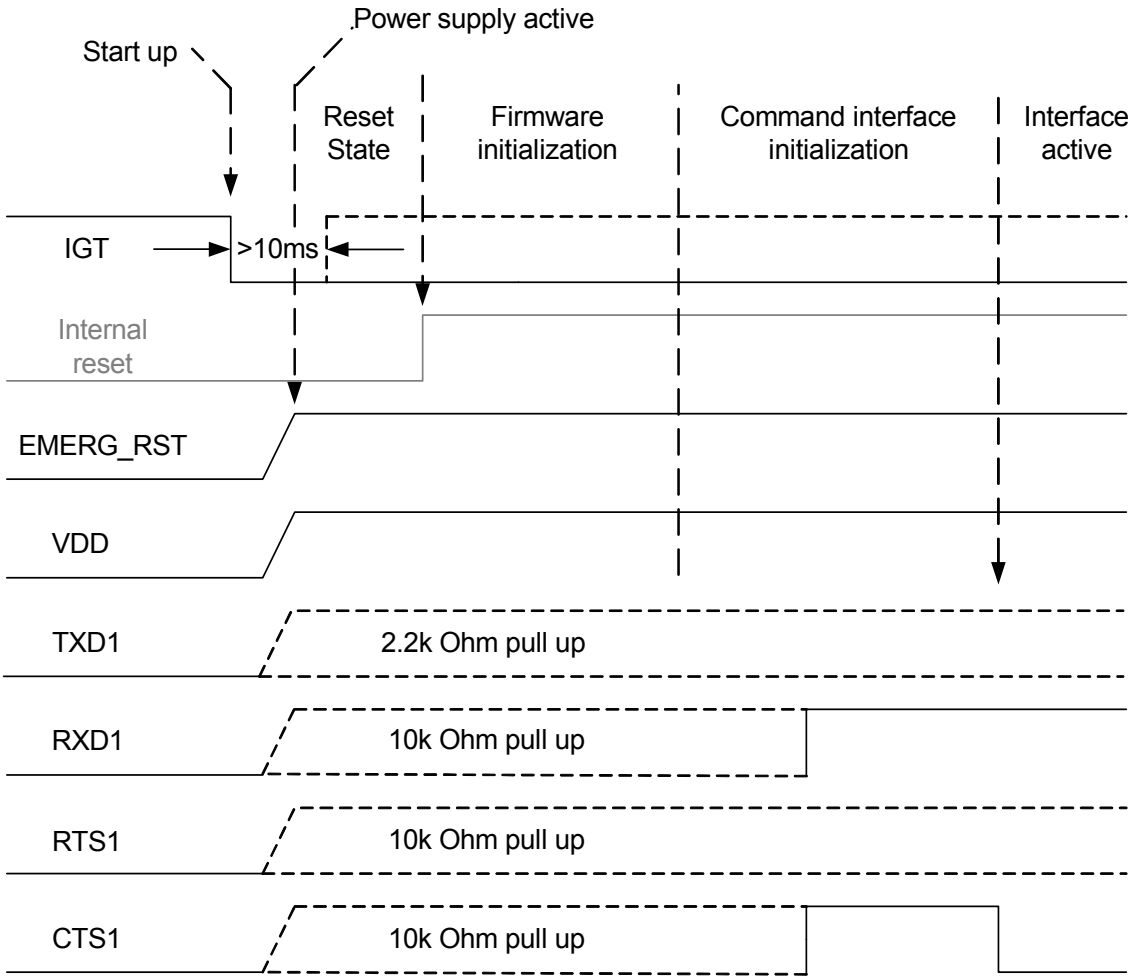


Figure 17: ASC1 startup behavior

3.12 Audio interface

MC52iR3 has an analog audio interface with a balanced analog microphone input and a balanced analog earpiece output. A supply voltage and an analog ground connection are provided at dedicated pins.

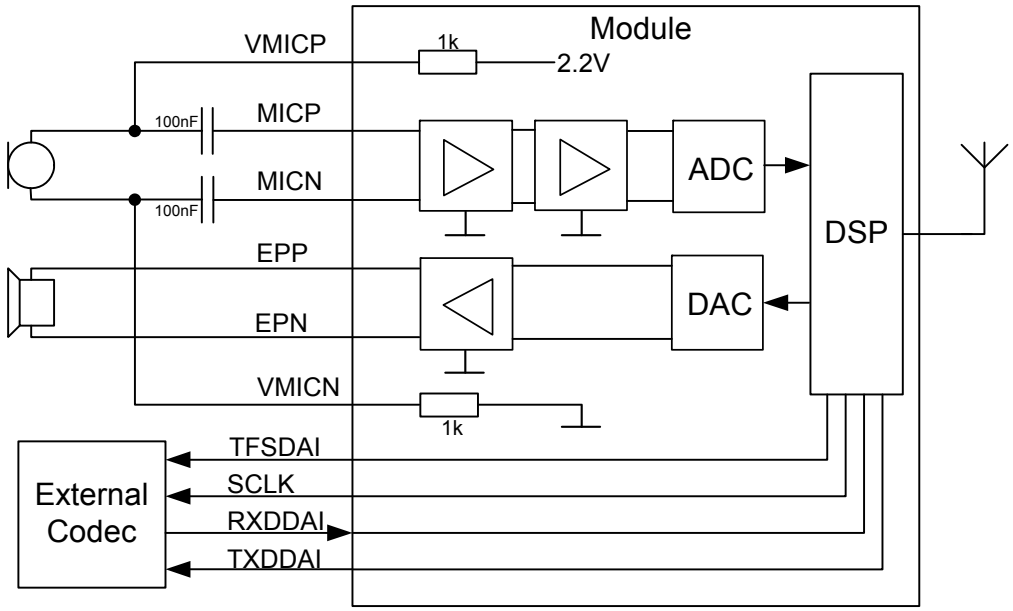


Figure 18: Audio block diagram

MC52iR3 offers six audio modes which can be selected with the AT^SNFS command, no matter which of the three interfaces is currently active. The electrical characteristics of the voiceband part vary with the audio mode. For example, sending and receiving amplification, sidetone paths, noise suppression etc. depend on the selected mode and can be altered with AT commands (except for mode 1).

On the audio interface you can use all audio AT commands specified in [1] to alter parameters. The only exception are the DAC and ADC gain amplifier attenuation <outBbcGain> and <inBbcGain> which cannot be modified when the pulse code modulation interface is used, since in this case the DAC and ADC are switched off.

Please refer to Section 3.12 for specifications of the audio interface and an overview of the audio parameters. Detailed instructions on using AT commands are presented in [1]. Table 28 summarizes the characteristics of the various audio modes and shows what parameters are supported in each mode.

When shipped from factory, all audio parameters of MC52iR3 are set to interface 1 and audio mode 1. This is the default configuration optimised for the Votronic HH-SI-30.3/V1.1/0 handset and used for type approving the Cinterion Wireless Modules reference configuration. Audio mode 1 has fix parameters which cannot be modified. To adjust the settings of the Votronic handset simply change to another audio mode.

In transmit direction, all audio modes contain internal scaling factors (digital amplification) that are not accessible. In case of digital signal input via the DAI, these scaling factors are set to 0dB, so that no further correction using the AT^SNFI parameter <inCalibrate> is required. <inCalibrate> can be left at its default value (=32767).

3.12.1 Microphone Circuit

The differential microphone inputs MICP and MICN present an impedance of 50kOhm and must be decoupled by capacitors (typical 100nF). A regulated power supply for electret microphones is available at VMICP. The voltage at VMICP is rated at 2.2V and available while audio is active (e.g., during a call). It can also be controlled by AT^SNFM. It is recommended to use an additional RC-filter if a high microphone gain is necessary. It is also recommended to use the VMICN line for grounding the microphone circuit. VMICN provides for the same module ground potential the analog circuits of the module refer to. VMICN must not be connected to the system GND anywhere. Otherwise high GSM burst peak currents will flow across the VMICN line causing GSM humming in the uplink audio signal.

The following figures show possible microphone and line connections.

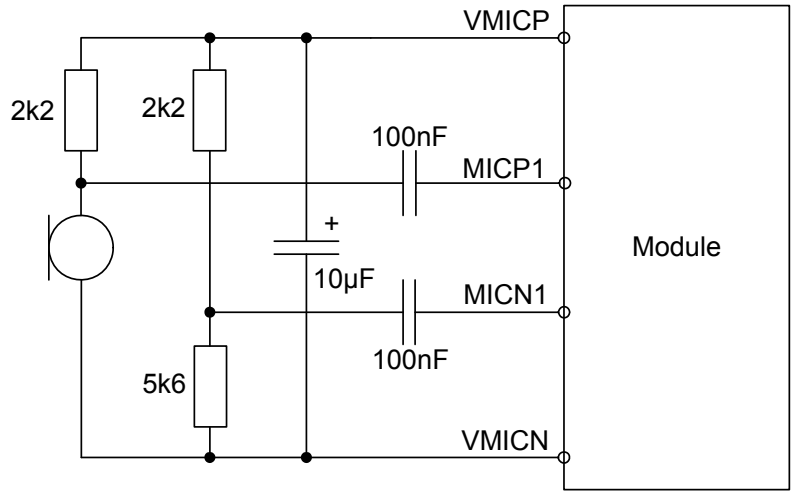


Figure 19: Single ended microphone connection

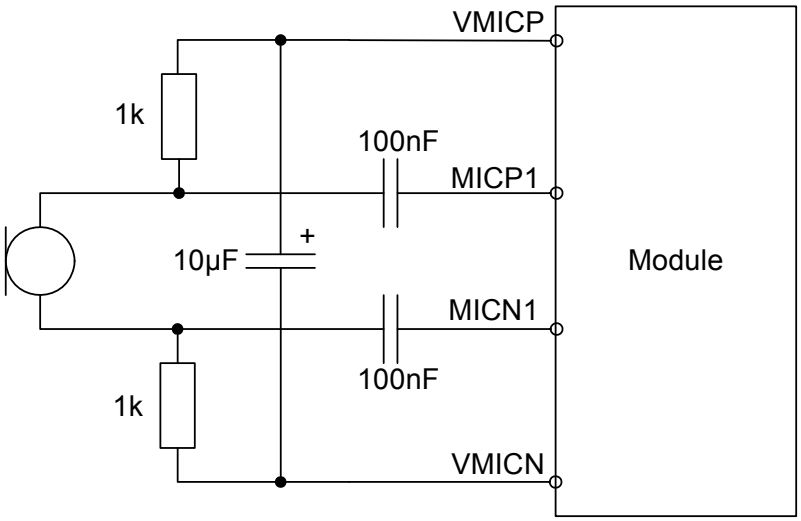


Figure 20: Differential microphone connection

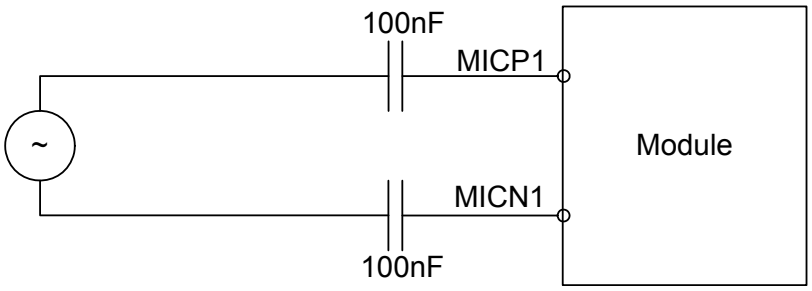


Figure 21: Line input

3.12.2 Loudspeaker Output

MC52iR3 provides a differential loudspeaker output EPP/EPN. The output is able to deliver a voltage of 3.2Vpp at a load resistance of 16Ohm. If it is used as line output (see Figure 23), the application should provide a capacitor decoupled differential input to eliminate GSM humming. A single ended connection to a speaker or a line input should not be realized.

The following figures show the typical output configurations.

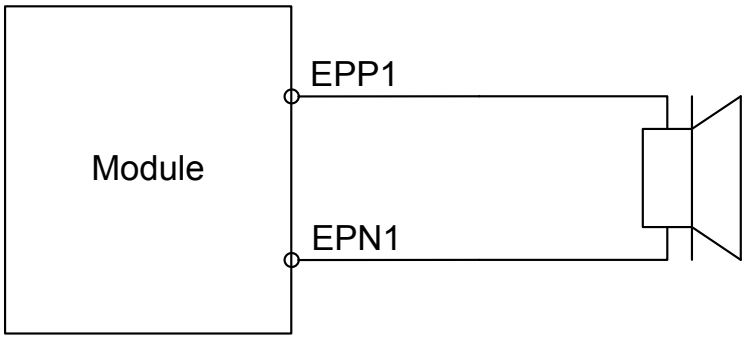


Figure 22: Differential loudspeaker connection

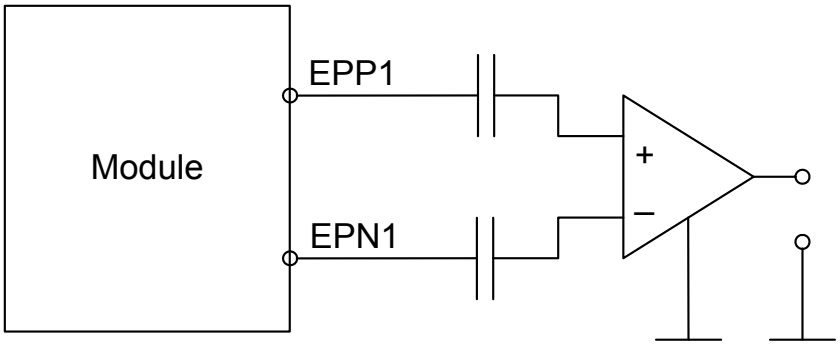


Figure 23: Line output connection

3.13 Digital Audio Interface

MC52iR3's digital audio interface (DAI) can be used to connect audio devices capable of pulse code modulation (PCM). The PCM functionality allows for the use of an external codec like the MC145483. Using the AT^SAIC command you can activate the DAI interface (see [1]).

The DAI interface supports a 256kHz, long frame synchronization master mode with the following features:

- 16 Bit linear
- 8kHz sample rate
- The most significant bit MSB is transferred first
- 125µs frame duration
- Common frame sync signal for transmit and receive

Table 14 describes the available DAI pins at the digital audio interface. For electrical details see Section 5.5.

Table 14: Overview of DAI pins

Signal name on B2B connector	Pin direction	Input/Output
TXDDAI	O	PCM data from MC52iR3 to external codec.
RXDDAI	I	PCM data from external codec to MC52iR3.
TFSDAI	O	Frame synchronization signal to external codec: Long frame @ 256kHz
SCLK	O	Bit clock to external codec: 256kHz
RFSDAI		Reserved for future use

Figure 24 shows the PCM timing for the master mode available with MC52iR3.

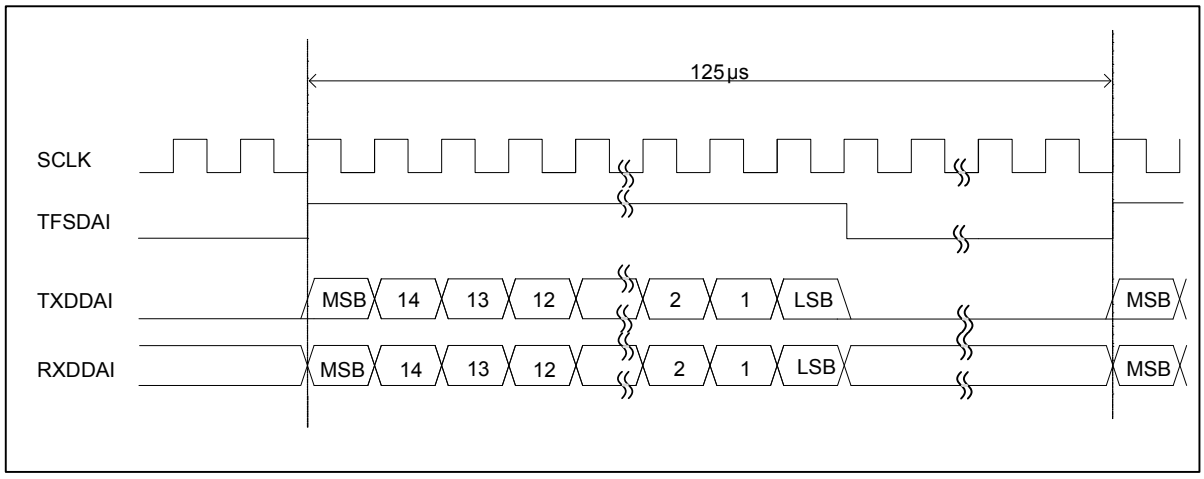


Figure 24: Long frame PCM timing, 256kHz

The following figure shows the start up behaviour of the DAI interface. It is possible to set the startup configuration of the DAI interface via AT command (see [1]). The start up configuration of functions will be activated after the software initialization of the command interface. With an active state of RING0, CTS0 or CTS1 (low level) the initialization of the DAI interface is finished.

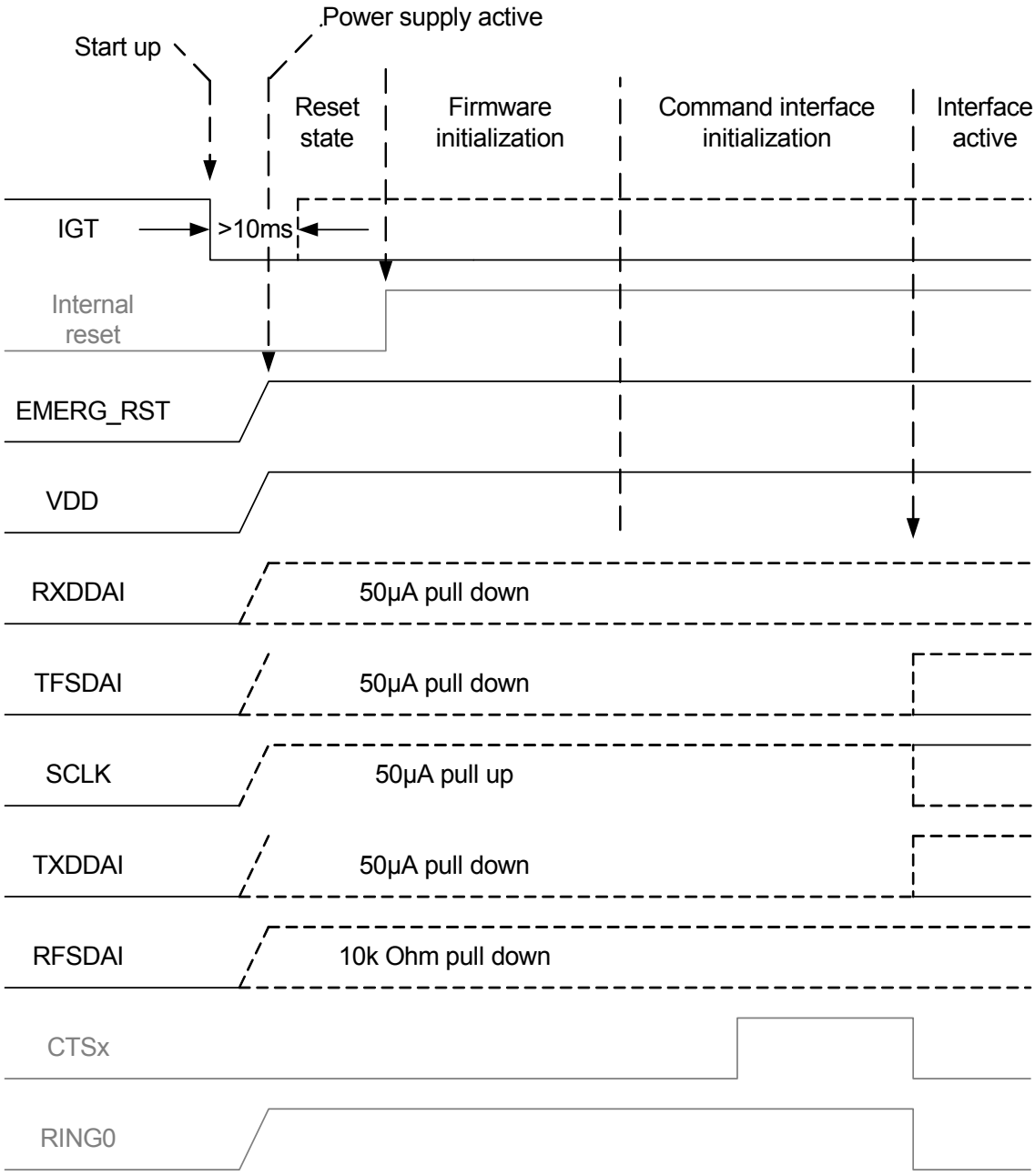


Figure 25: DAI startup timing

3.14 Status LED

The STATUS line of the board-to-board connector can be configured to drive a status LED that indicates different operating modes of the module.

To take advantage of this function connect an LED to the STATUS line as shown in Figure 26. The LED can be enabled/disabled by AT command. For details refer to [1]: AT^SSYNC.

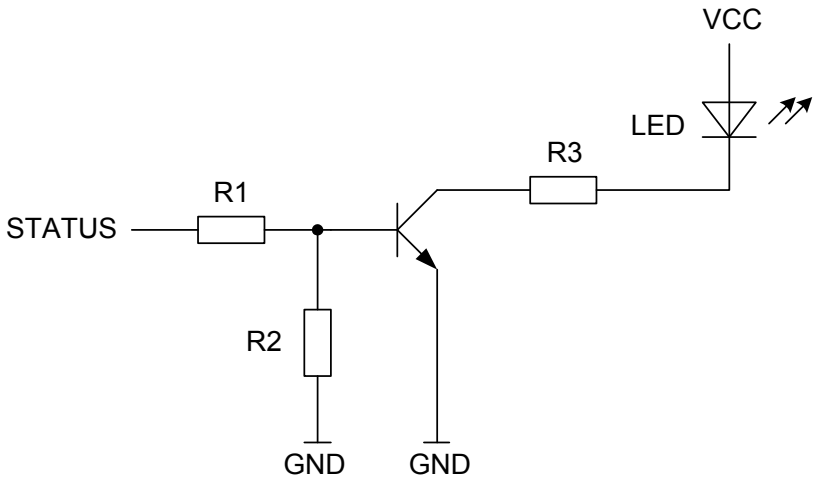


Figure 26: Status signalling with LED driver

3.15 Behavior of the RING0 Line (ASC0 Interface only)

The RING0 line is available on the first serial interface (ASC0). The signal serves to indicate incoming calls and other types of URCs (Unsolicited Result Code).

Although not mandatory for use in a host application, it is strongly suggested that you connect the RING0 line to an interrupt line of your application. In this case, the application can be designed to receive an interrupt when a falling edge on RING0 occurs. This solution is most effective, particularly, for waking up an application from power saving. Note that if the RING0 line is not wired, the application would be required to permanently poll the data and status lines of the serial interface at the expense of a higher current consumption. Therefore, utilizing the RING0 line provides an option to significantly reduce the overall current consumption of your application.

The behavior of the RING0 line varies with the type of event:

- When a voice/fax/data call comes in the RING0 line goes low for 1s and high for another 4s. Every 5 seconds the ring string is generated and sent over the RXD0 line.
  If there is a call in progress and call waiting is activated for a connected handset or hands-free device, the RING0 line switches to ground in order to generate acoustic signals that indicate the waiting call.

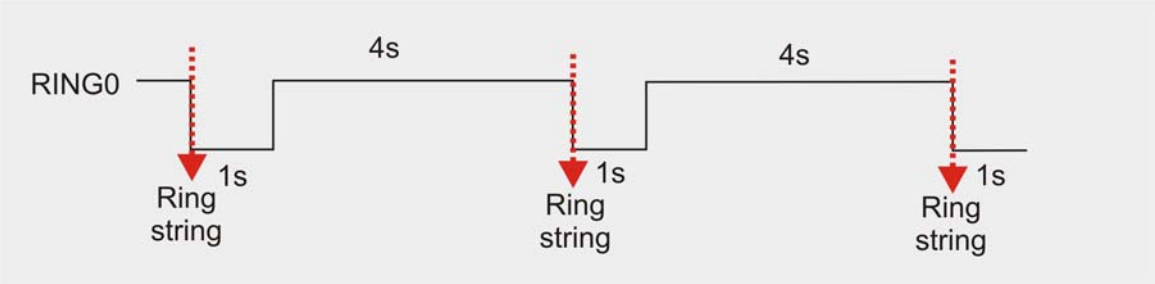


Figure 27: Incoming voice call

- All other types of Unsolicited Result Codes (URCs) also cause the RING0 line to go low, however for 1 second only.

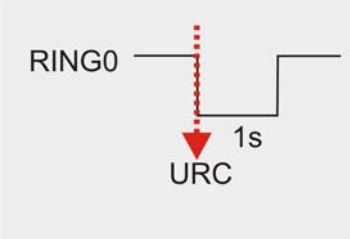


Figure 28: URC transmission

4 Antenna Interface

The RF interface has an impedance of 50Ω. MC52iR3 is capable of sustaining a total mismatch at the antenna connector or pad without any damage, even when transmitting at maximum RF power.

The external antenna must be matched properly to achieve best performance regarding radiated power, DC-power consumption and harmonic suppression. Matching networks are not included on the MC52iR3 PCB and should be placed in the host application.

Regarding the return loss MC52iR3 provides the following values:

Table 15: Return loss

State of module	Return loss of module	Recommended return loss of application
Receive	≥ 8dB	≥ 12dB
Transmit	not applicable	≥ 12dB
Idle	≤ 5dB	not applicable

The connection of the antenna or other equipment must be decoupled from DC voltage. This is necessary because the antenna connector is DC coupled to ground via an inductor for ESD protection.

4.1 Antenna Installation

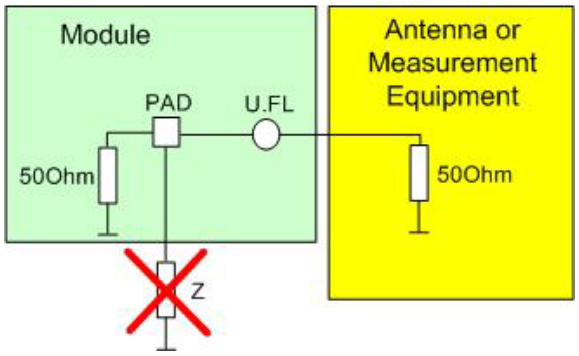
To suit the physical design of individual applications MC52iR3 offers two alternative approaches to connecting the antenna:

- Recommended approach: U.FL antenna connector from Hirose/Molex assembled on the component side of the PCB (top view on MC52iR3). See Section 4.1.2 for details.
- Antenna pad and grounding plane placed on the bottom side. See Section 4.1.1.

The U.FL connector has been chosen as antenna reference point (ARP) for the Cinterion Wireless Modules reference equipment submitted to type approve MC52iR3. All RF data specified throughout this manual are related to the ARP. For compliance with the test results of the Cinterion Wireless Modules type approval you are advised to give priority to the connector, rather than using the antenna pad.

IMPORTANT: Both solutions can only be applied alternatively. This means, whenever an antenna is plugged to the Hirose/Molex connector, the pad must not be used. Vice versa, if the antenna is connected to the pad, then the Hirose/Molex connector must be left empty.

Antenna connected to Hirose/Molex connector:



Antenna connected to pad:

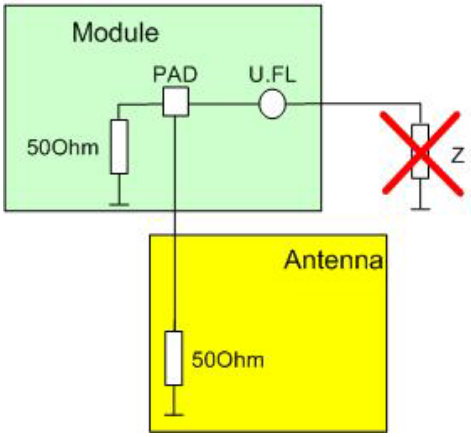


Figure 29: Never use antenna connector and antenna pad at the same time

No matter which option you choose, ensure that the antenna pad does not come into contact with the holding device or any other components of the host application. It needs to be surrounded by a restricted area filled with air, which must also be reserved 0.8 mm in height.

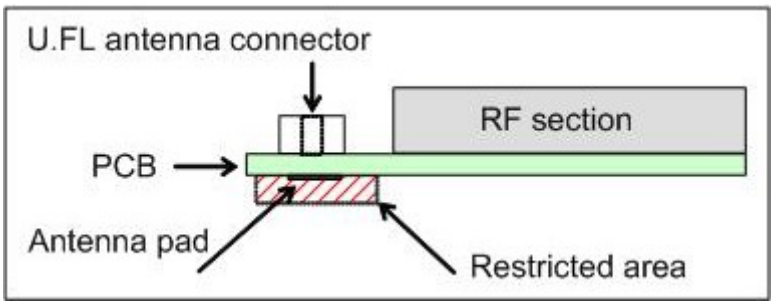


Figure 30: Restricted area around antenna pad

4.1.1 Antenna Pad

The antenna can be soldered to the pad, or attached via contact springs. To help you ground the antenna, MC52iR3 comes with a grounding plane located close to the antenna pad.

When you decide to use the antenna pad take into account that the pad has not been intended as antenna reference point (ARP) for the MC52iR3 type approval. The antenna pad is provided only as an alternative option which can be used, for example, if the recommended Hirose/Molex connection does not fit into your antenna design.

Also, consider that according to the GSM recommendations TS 45.005 and TS 51.010-01 a 50Ω connector is mandatory for type approval measurements. This requires GSM devices with an integral antenna to be temporarily equipped with a suitable connector or a low loss RF cable with adapter.

To prevent damage to the module and to obtain long-term solder joint properties you are advised to maintain the standards of good engineering practice for soldering.

MC52iR3 material properties:
MC52iR3 PCB: FR4
Antenna pad: Gold plated pad

4.1.1.1 Suitable Cable Types

For direct solder attachment, we suggest to use the following cable types:
RG316/U 50Ω coaxial cable
1671A 50Ω coaxial cable

Suitable cables are offered, for example, by IMS Connector Systems. For further details and other cable types please contact http://www.imscs.com.

4.1.2 Antenna Connector

MC52iR3 uses either an ultra-miniature SMT antenna connector from Hirose Ltd: U.FL-R-SMT, or the Molex 07341201 U.FL antenna connector. Both connectors have identical mechanical dimensions (see Figure 31). Minor differences in product specifications are mentioned in Table 17. The position of the antenna connector on the MC52iR3 board can be seen in Figure 37.

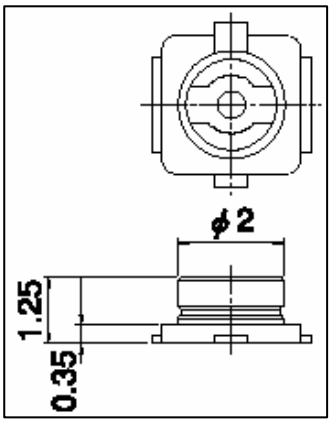


Figure 31: Mechanical dimensions of MC52iR3 antenna connectors

Table 16: Product specifications of MC52iR3 antenna connectors

Item	Specification	Conditions
Ratings		
Nominal impedance	50Ω	Operating temp:-40°C to + 90°C Operating humidity: max. 90%
Rated frequency	DC to 3GHz	
Mechanical characteristics		
Repetitive operation	Contact resistance: Center 25mΩ Outside 15mΩ	30 cycles of insertion and disengagement
Vibration	No momentary disconnections of 1µs. No damage, cracks and looseness of parts.	Frequency of 10 to 100Hz, single amplitude of 1.5mm, acceleration of 59m/s^2, for 5 cycles in the direction of each of the 3 axes
Shock	No momentary disconnections of 1µs. No damage, cracks and looseness of parts.	Acceleration of 735m/s^2, 11ms duration for 6 cycles in the direction of each of the 3 axes
Environmental characteristics		
Humidity resistance	No damage, cracks and looseness of parts. Insulation resistance: 100MΩ min. at high humidity 500MΩ min. when dry	Exposure to 40°C, humidity of 95% for a total of 96 hours
Temperature cycle	No damage, cracks and looseness of parts. Contact resistance: Center 25mΩ Outside 15mΩ	Temperature: +40°C → 5 to 35°C → +90°C → 5 to 35°C Time: 30min → within 5min → 30min within 5min
Salt spray test	No excessive corrosion	48 hours continuous exposure to 5% salt water

Table 17: Material and finish of MC52iR3 antenna connectors and recommended plugs

Part	Material	Finish
Shell	Phosphor bronze	Hirose: Silver plating Molex: Gold plating
Male center contact	Brass	Gold plating
Female center contact	Phosphor bronze	Gold plating
Insulator	Receptacle: LCP	Hirose: Beige, Molex: Ivory

Mating plugs and cables can be chosen from the Hirose U.FL Series or from other antenna equipment manufacturers like Molex or IMS. Examples from the Hirose U.FL Series are shown below and listed in Table 18. For latest product information please contact your respective antenna equipment manufacturer.

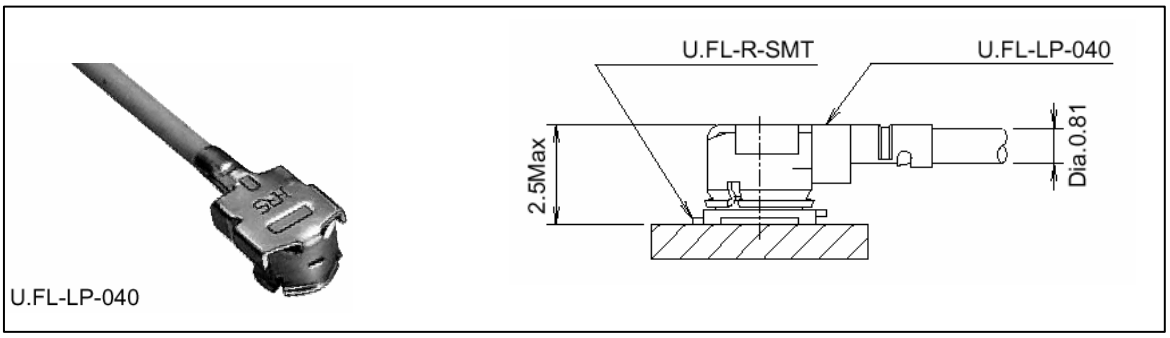


Figure 32: U.FL-R-SMT connector with U.FL-LP-040 plug

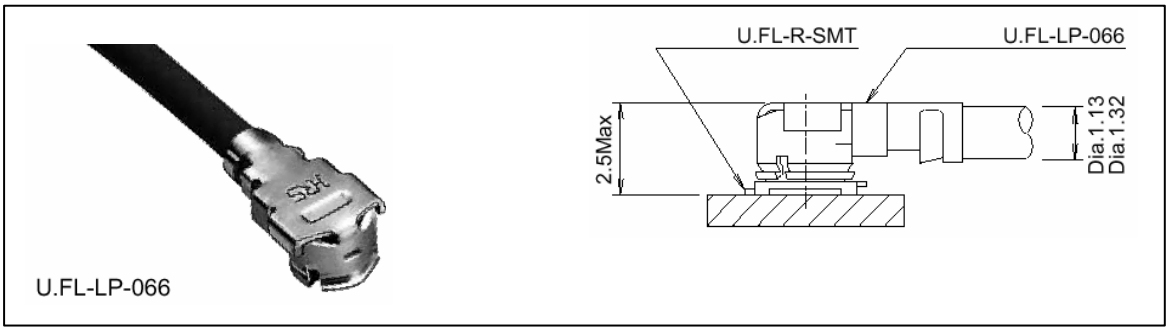


Figure 33: U.FL-R-SMT connector with U.FL-LP-066 plug

In addition to the connectors illustrated above, the U.FL-LP-(V)-040(01) version is offered as an extremely space saving solution. This plug is intended for use with extra fine cable (up to ∅ 0.81 mm) and minimizes the mating height to 2 mm. See Figure 34 which shows the Hirose datasheet.

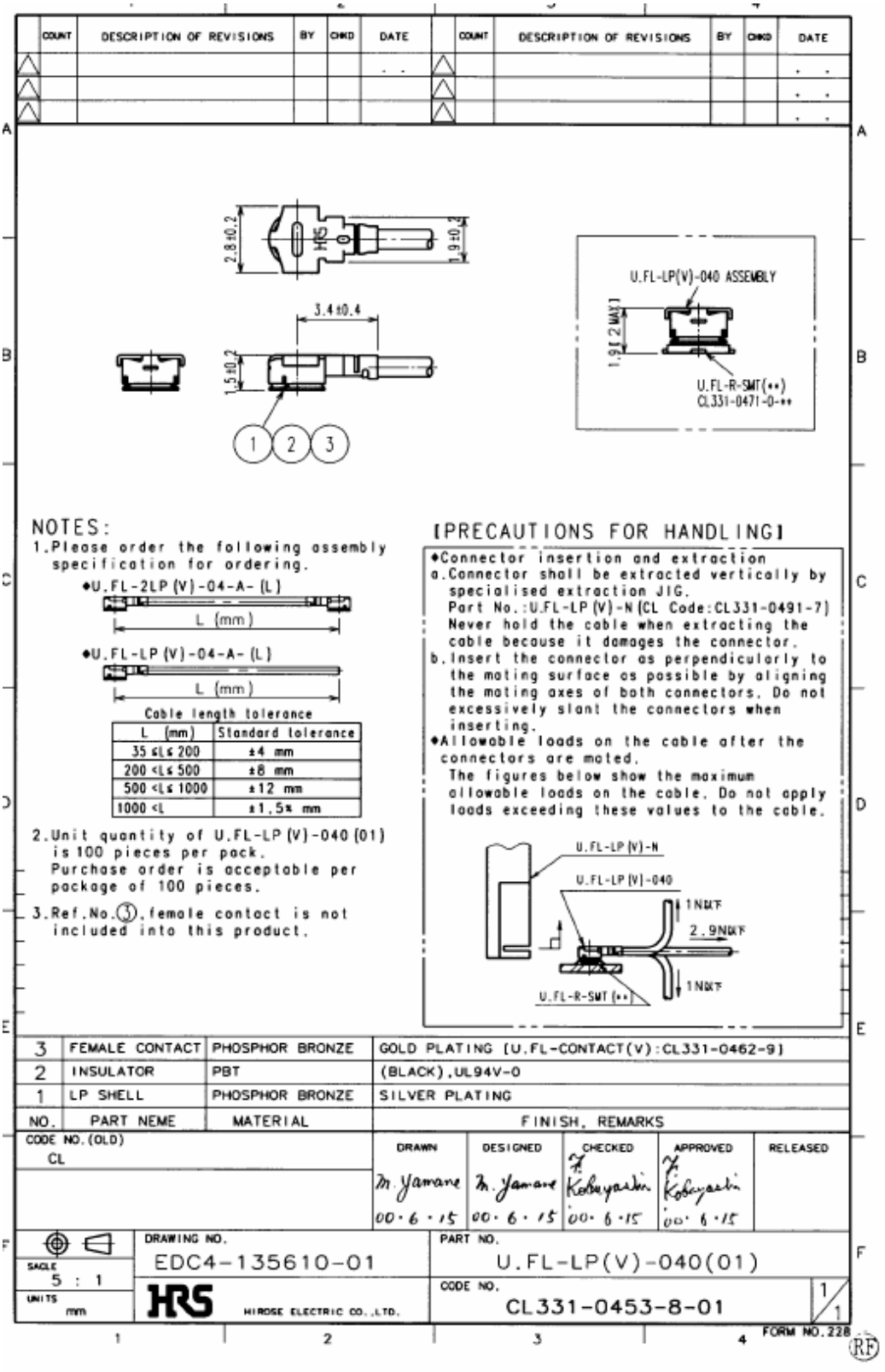


Figure 34: Specifications of U.FL-LP-(V)-040(01) plug

Table 18: Ordering information for Hirose U.FL Series

Item	Part number	HRS number
Connector on MC52iR3	U.FL-R-SMT	CL331-0471-0-10
Right-angle plug shell for ∅ 0.81 mm cable	U.FL-LP-040	CL331-0451-2
Right-angle plug for ∅ 0.81 mm cable	U.FL-LP(V)-040 (01)	CL331-053-8-01
Right-angle plug for ∅ 1.13 mm cable	U.FL-LP-066	CL331-0452-5
Right-angle plug for ∅ 1.32 mm cable	U.FL-LP-066	CL331-0452-5
Extraction jig	E.FL-LP-N	CL331-0441-9

5 Electrical, Reliability and Radio Characteristics

5.1 Absolute Maximum Ratings

Absolute maximum ratings for supply voltage and voltages on digital and analog pins of MC52iR3 are listed in Table 19. Exceeding these values will cause permanent damage to MC52iR3.

Table 19: Absolute maximum ratings

Parameter	Min	Max	Unit
Supply voltage BATT+	-0.3	+6.0	V
Voltage at digital pins in normal operation	-0.3	+3.3	V
Voltage at all digital pins in Power Down mode	-0.3	+0.3	V
Voltage at SIM interface, CCVCC 1.8V in normal Operation	-0.3	+2.2	V
Voltage at SIM interface, CCVCC 2.85V in normal Operation	-0.3	+3.3	V
Voltage at analogue pins in normal operation	-0.3	+3.0	V
Voltage at analogue pins in Power Down mode	-0.3	+0.3	V
VDDLP	-0.3	+2.5	V

5.2 Operating Temperatures

Please note that the module's lifetime, i.e., the MTTF (mean time to failure) may be reduced, if operated outside the restriced temperature range. A special URC reports whether the module enters or leaves the restriced temperature range (see [1]; AT^SCTM).

Table 20: Board temperature

Parameter	Min	Typ	Max	Unit
Normal operation	-30	+25	+85	°C
Restricted operation	-40 to -30		+85 to +90	°C
Automatic shutdown[1] Temperature measured on MC52iR3 board	<-40	---	>+90	°C

1. Due to temperature measurement uncertainty, a tolerance of ±3°C on the thresholds may occur.

Table 21: Ambient temperature according to IEC 60068-2 (w/o forced air circulation)

Parameter	Min	Typ	Max	Unit
GSM Call @ max. RF-Power	-40		+75	°C
GPRS Class 8 @ max. RF-Power	-40		+75	°C
GPRS Class 10 @ max. RF-Power (quad band only)	-40		+60	°C

Table 22: Ambient temperature with forced air circulation (air speed 0.9m/s)

Parameter	Min	Typ	Max	Unit
GSM Call @ max. RF-Power	-40		+80	°C
GPRS Class 8 @ max. RF-Power	-40		+80	°C
GPRS Class 10 @ max. RF-Power (quad band only)	-40		+70	°C

See also Section 3.3.5.1 for information about the NTC for on-board temperature measurement, automatic thermal shutdown and alert messages.

Note that within the specified operating temperature ranges the board temperature may vary to a great extent depending on operating mode, used frequency band, radio output power and current supply voltage.

When data are transmitted over GPRS the quad band module variant automatically reverts to a lower Multislot Class if the temperature rises to the limit specified for normal operation and, vice versa, returns to the higher Multislot Class if the temperature is back to normal. For details see Section 3.4.

5.3 Storage Conditions

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

Table 23: Storage conditions

Type	Condition	Unit	Reference
Air temperature: Low High	 -40 +85	 °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^2	 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 recom-mended		IEC TR 60271-3-1: 1C1L
Mechanically active substances	Not recom-mended		IEC TR 60271-3-1: 1S1
Vibration sinusoidal: Displacement Acceleration Frequency range	 1.5 5 2-9 9-200	 mm m/s^2 Hz	IEC TR 60271-3-1: 1M2
Shocks: Shock spectrum Duration Acceleration	 semi-sinusoidal 1 50	 ms m/s^2	IEC 60068-2-27 Ea

5.4 Reliability Characteristics

The test conditions stated below are an extract of the complete test specifications.

Table 24: Summary of reliability test conditions

Type of test	Conditions	Standard
Vibration	Frequency range: 10-20 Hz; acceleration: 3.1mm amplitude Frequency range: 20-500 Hz; acceleration: 5g Duration: 2h per axis = 10 cycles; 3 axes	DIN IEC 60068-2-6
Shock half-sinus	Acceleration: 500g Shock duration: 1msec 1 shock per axis 6 positions (± x, y and z)	DIN IEC 60068-2-27
Dry heat	Temperature: +70 ±2°C Test duration: 16 h Humidity in the test chamber: < 50%	EN 60068-2-2 Bb ETS 300019-2-7
Temperature change (shock)	Low temperature: -40°C ±2°C High temperature: +85°C ±2°C Changeover time: < 30s (dual chamber system) Test duration: 1 h Number of repetitions: 100	DIN IEC 60068-2-14 Na ETS 300019-2-7
Damp heat cyclic	High temperature: +55°C ±2°C Low temperature: +25°C ±2°C Humidity: 93% ±3% Number of repetitions: 6 Test duration: 12h + 12h	DIN IEC 60068-2-30 Db ETS 300019-2-5
Cold (constant exposure)	Temperature: -40 ±2°C Test duration: 16 h	DIN IEC 60068-2-1

5.5 Electrical Specifications of the Application Interface

Please note that the reference voltages listed in Table 25 are the values measured directly on the MC52iR3 module. They do not apply to the accessories connected.

If an input pin is specified for $V_{i,h,max}$ = 3.3V, be sure never to exceed the stated voltage. The value 3.3V is an absolute maximum rating.

The Hirose DF12C board-to-board connector on MC52iR3 is a 50-pin double-row receptacle. The names and the positions of the pins can be seen from Figure 37 which shows the top view of MC52iR3.

1	CCCLK	Not connected	50
2	CCVCC	Not connected	49
3	CCIO	EPP	48
4	CCRST	EPN	47
5	CCIN	VMICN	46
6	CCGND	VMICP	45
7	RXDDAI	MICP	44
8	TFSDAI	MICN	43
9	SCLK	GND	42
10	TXDDAI	IGT	41
11	RFSDAI	EMERG_RST	40
12	(ADC)	DCD0	39
13	STATUS	CTS1	38
14	RXD1	CTS0	37
15	RXD0	RTS1	36
16	TXD1	DTR0	35
17	TXD0	RTS0	34
18	VDDLP	DSR0	33
19	Not connected	RING0	32
20	Not connected	VDD	31
21	GND	BATT+	30
22	GND	BATT+	29
23	GND	BATT+	28
24	GND	BATT+	27
25	GND	BATT+	26

Figure 35: Pin assignment

Table 25: Signal description

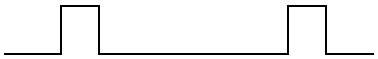
Function	Signal name	IO	Signal form and level	Comment
Power supply	BATT+	I	$V_I$max = 4.8V $V_I$norm = 4.2V $V_I$min = 3.3V during Tx burst on board I ≈ 1.2A, during Tx burst (GSM)  n Tx = n x 577µs peak current every 4.616ms	Pins of BATT+ and GND must be connected in parallel for supply purposes because higher peak currents may occur. Minimum voltage must not fall below 3.3V including drop, ripple, spikes.
	GND		Ground	Application Ground
External supply voltage	VDD	O	$V_O$norm = 2.85V +1.5%, -2% $I_O$max = -10mA CLmax = 100nF	VDD may be used for application circuits. If unused keep pin open. Not available in Power-down mode. The external digital logic must not cause any spikes or glitches.
Ignition	IGT	I	R_I ≈ 100kΩ V_{IL}max = (BATT+) -1V at I = -5µA V_{IL}min = 0V at Imax = -45µA V_{Open}max = 4.8V IGT ˜˜˜|____|˜˜˜ Active Low ≥ 10ms	This signal switches the module on. This line must be driven high by an open drain or open collector driver to ground.
Emergency Restart	EMERG_RST	I	R_I ≈ 1kΩ, C_I ≈ 1nF V_{OH}max = 1.9V V_{IH}min = 1.35V V_{IL}max = 0.3V at ~200µA ˜˜˜˜|___|˜˜˜˜ low impulse width > 10ms	This line must be driven low by an open drain or open collector driver connected to ground. If unused keep pin open.
RTC back up	VDDLP	I/O	R_I =1kΩ $V_O$max ≈ 4.3V (output) $V_I$min = 2.2V, $V_I$max = 5.5V (input) $I_I$typ = 6µA at BATT+ = 0V Mobile in POWER DOWN mode: $V_I$min = 1.2V	If unused keep pin open.
Status	STATUS	O	V_{OL}max = 0.4V at I = 1mA V_{OH}min = 2.40V at I = -40µA V_{OH}max = 2.9V	If unused keep pin open.
SIM Card detection	CCIN	I	R_I ≈ 100kΩ V_{IH}min = 1.45V at I = 15µA, V_{IH}max= 3.3V V_{IL}max = 0.3V	CCIN = High, SIM card inserted. CCIN is protected against ESD with a special diode array. If unused keep pin open.

Table 25: Signal description

Function	Signal name	IO	Signal form and level	Comment
3V SIM Card Interface	CCRST	O	V_{OL}max = 0.20V at I = 1mA V_{OH}min = 2.40V at I = -1mA V_{OH}max = 2.90V	Maximum cable length or copper track to the SIM card holder should not exceed 100mm.. The signals CCRST, CCIO, CCCLK and CCVCC are protected against ESD with a special diode array.
	CCIO	I/O	V_{IL}max = 0.60V V_{IH}min = 1.95V V_{IH}max = 2.90V V_{OL}max = 0.20V at I = 1mA V_{OH}min = 2.40V at I = -1mA V_{OH}max = 2.90V	
	CCCLK	O	V_{OL}max = 0.20V at I = 1mA V_{OH}min = 2.40V at I = -1mA V_{OH}max = 2.90V	
	CCVCC	O	$V_O$min = 2.80V $V_O$typ = 2.85V $V_O$max = 2.90V $I_O$max = -30mA	
	CCGND		Ground	
1.8V SIM Card Interface	CCRST	O	V_{OL}max = 0.20V at I = 1mA V_{OH}min = 1.50V at I = -1mA V_{OH}max = 1.90V	
	CCIO	I/O	V_{IL}max = 0.37V V_{IH}min = 1.22V V_{IH}max = 1.90V V_{OL}max = 0.20V at I = 1mA V_{OH}min = 1.50V at I = -1mA V_{OH}max = 1.90V	
	CCCLK	O	V_{OL}max = 0.20V at I = 1mA V_{OH}min = 1.50V at I = -1mA V_{OH}max = 1.90V	
	CCVCC	O	$V_O$min = 1.75V $V_O$typ = 1.80V $V_O$max = 1.85V $I_O$max = -30mA	
	CCGND		Ground	

Table 25: Signal description

Function	Signal name	IO	Signal form and level	Comment
Serial Modem Interface ASC0	RXD0	O	V_{OL}max = 0.20V at I = 1mA V_{OH}min = 2.40V at I = -1mA V_{OH}max = 2.90V	If unused keep pin open.
	TXD0	I	V_{IL}max = 0.56V V_{IH}min = 2.05V V_{IH}max = 2.90V	
	CTS0	O		
	RTS0	I	V_{IL}max = 0.30V at I = -180µA V_{IH}min = 2.00V at I = -10µA V_{IH}max = 2.90V	
	DTR0	I		
	RING0	O	V_{OL}max = 0.40V at I = 1mA V_{OH}min = 2.40V at I = -40µA V_{OH}max = 2.90V	
	DSR0	O	Open Drain Output R_I ≈ 5kOhm (internal Pull up) V_{OL}min = 0.2V at I = -1mA V_{OH}min = 2.4V at I = -80µA V_{OH}max = 2.90V	
	DCD0	O	Open Drain Output R_I ≈ 10kOhm (internal Pull up) V_{OL}min = 0.2V at I = -1mA V_{OH}min = 2.4V at I = -40µA V_{OH}max = 2.90V	
Serial Interface ASC1	RXD1	O	V_{OL}max = 0.40V at I = 1mA V_{OH}min = 2.40V at I = -180µA V_{OH}max = 2.90V	If unused keep pin open.
	CTS1	O	V_{OL}max = 0.40V at I = 1mA V_{OH}min = 2.40V at I = -40µA V_{OH}max = 2.90V	
	TXD1	I	V_{IL}max = 0.30V at I = -180µA V_{IH}min = 2.00V at I = -10µA V_{IH}max = 2.90V	
	RTS1	I		
Digital audio interface (PCM)	RXDDAI	I	V_{OL}max = 0.20V at I = 1mA V_{OH}min = 2.40V at I = -1mA V_{OH}max = 2.90V	The RFSDAI pin is reserved for future use. If unused keep pin open.
	TFSDAI	O		
	SCLK	O	V_{IL}max = 0.56V V_{IH}min = 2.05V V_{IH}max = 2.90V	
	TXDDAI	O		
	RFSDAI			

Table 25: Signal description

Function	Signal name	IO	Signal form and level	Comment
Analog audio interface	VMICP	O	R_I ~ 1kOmh $V_O$max = 2.2V $V_O$min = 1.2V at I_{max} = 300µA connected to VMICN	Microphone supply for customer feeding circuits If unused keep pin open.
	EPP	O	Differential, typ. 3.2Vpp at 16Ω load typ. 4.1Vpp at no load PCM level = +3dBm0, 1.02 kHz sine wave	Balanced output for earphone or balance output for line out If unused keep pin open.
	EPN	O		
	MICP	I	$Z_I$typ = 50kΩ $V_I$max = 0.8Vpp (for 3dBm0 @ 0dB gain)	Balanced differential microphone with external feeding circuit (using VMICP and VMICN) or balanced differential line input. Use coupling capacitors. If unused keep pin open.
	MICN	I		
	VMICN		R_I ~1kOhm analog ground	Ground level for external audio circuits
(ADC)		I	R_I = 1MOhm V_I = 0V … 1.2V (valid range) V_{IH} max = 3.3V	Do not use this pin, keep pin open.

5.6 Power Supply Ratings

Table 26: Power supply ratings

Parame-ter	Description	Conditions	Min	Typ	Max	Unit
BATT+	Supply voltage	Voltage must stay within the min/ max values, including voltage drop, ripple and spikes.	3.3	4.0	4.8	V
	Voltage drop during transmit burst	Normal condition, power control level for $P_{out\ max}$			400	mV
	Voltage ripple	Normal condition, power control level for $P_{out\ max}$ @ f<200kHz @ f>200kHz			 50 2	mV
I_{VDDLP}	OFF state supply current	RTC backup @ BATT+ = 0V		6		µA
I_{BATT+}		POWER DOWN mode		34		µA
	Average supply cur-rent	SLEEP mode[1] @ DRX = 2 @ DRX = 5 @ DRX = 9		 3.0 2.3 2.1		mA
		IDLE mode[1] @ DRX = 2 EGSM 900 GSM 1800		 12 12		mA
		TALK mode EGSM 900[2 3] GSM 1800[4 3]		 180 135		mA
		DATA mode GPRS,(4 Rx, 1 Tx) EGSM 900[2 3] GSM 1800[4 3]		 170 130		mA
		DATA mode GPRS,(3 Rx, 2 Tx) EGSM 900[2 3] GSM 1800[4 3]		 310 230		mA
	Peak supply current (during transmission slot every 4.6ms)	Power Control Level[2]		TBD.		A

1. Measurements start 6 minutes after switching on the module,
Averaging times: SLEEP mode - 3 minutes; IDLE mode - 1.5 minutes,
Communication tester settings: no neighbour cells, no cell reselection etc.
2. Power control level PCL 5
3. Test conditions for the typical values: 50Ω antenna
4. Power control level PCL 0

5.7 Electrical Characteristics of the Voiceband Part

5.7.1 Setting Audio Parameters by AT Commands

The audio modes 2 to 6 can be adjusted according to the parameters listed below. Each audio mode is assigned a separate set of parameters.

Table 27: Audio parameters adjustable by AT command

Parameter	Influence to	Range	Gain range	Calculation
inBbcGain	MICP/MICN analog amplifier gain of baseband controller before ADC	0...7	0...42dB	6dB steps
inCalibrate	Digital attenuation of input signal after ADC	0...32767	-∞...0dB	20 * log (inCalibrate/ 32768)
outBbcGain	EPP/EPN analog output gain of baseband controller after DAC	0...3	0...-18dB	6dB steps
outCalibrate[n] n = 0...4	Digital attenuation of output signal after speech decoder, before summation of sidetone and DAC present for each volume step[n]	0...32767	-∞...+6dB	20 * log (2 * outCalibrate[n]/ 32768)
sideTone	Digital attenuation of sidetone is corrected internally by outBbcGain to obtain a constant sidetone independent of output volume	0...32767	-∞...0dB	20 * log (sideTone/ 32768)

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

5.7.2 Audio Programming Model

The audio programming model shows how the signal path can be influenced by varying the AT command parameters. The model is the same for all three interfaces, except for the parameters <outBbcGain> and <inBbcGain> which cannot be modified if the digital audio interface is being used, since in this case the DAC is switched off.

The parameters <inBbcGain> and <inCalibrate> can be set with AT^SNFI. All the other parameters are adjusted with AT^SNFO and AT^SAIC.

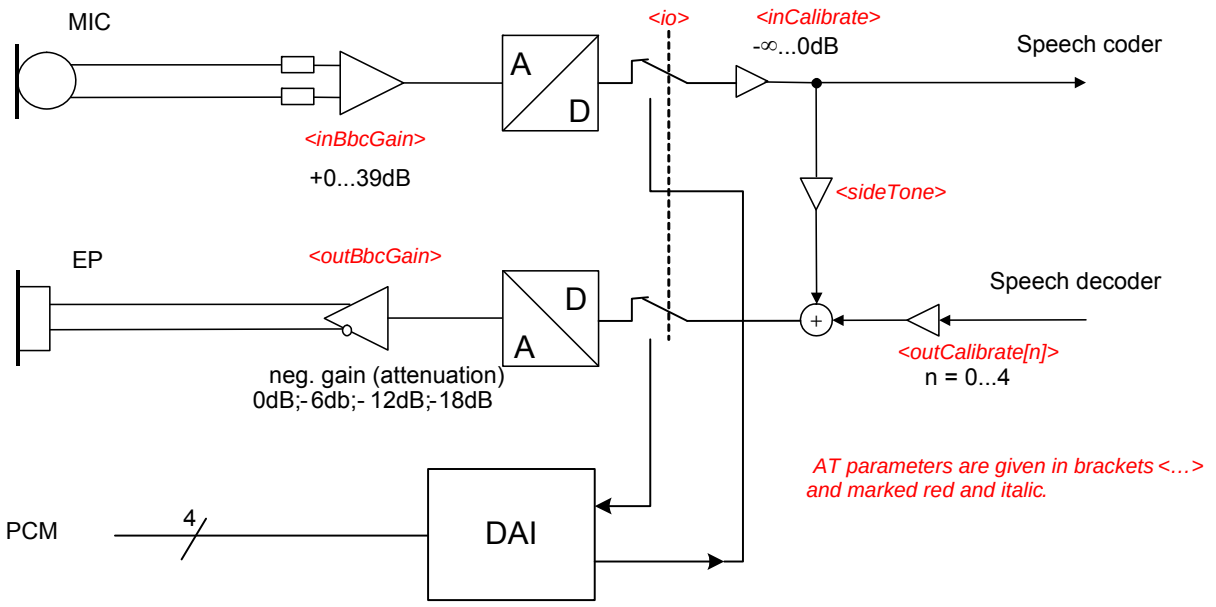


Figure 36: Audio programming model

5.7.3 Characteristics of Audio Modes

The electrical characteristics of the voiceband part depend on the current audio mode set with the AT^SNFS command.

Table 28: Voiceband characteristics (typical)

Audio mode no. AT^SNFS=	**1** (Default settings, not adjustable)	**2**	**3**	**4**	**5**	**6**
Name	Default Handset	Basic Handsfree	Headset	User Handset	Plain Codec 1	Plain Codec 2
Purpose	DSB with Votronic handset	Car Kit	Headset	DSB with individual handset	Direct access to speech coder	Direct access to speech coder
Gain setting via AT command. Defaults: inBbcGain outBbcGain	Fix 4 (24dB) 0 (0dB)	Adjustable 1 (6dB) 2 (-12dB)	Adjustable 6 (36dB) 2 (-12dB)	Adjustable 4 (24dB) 0 (0dB)	Adjustable 0 (0dB) 0 (0dB)	Adjustable 0 (0dB) 0 (0dB)
Power supply	ON (2.2V)	ON (2.2V)	ON (2.2V)	ON (2.2V)	ON (2.2V)	ON (2.2V)
Sidetone	ON	--	Adjustable	Adjustable	Adjustable	Adjustable
Volume control	OFF	Adjustable	Adjustable	Adjustable	Adjustable	Adjustable
Echo control (send)	Cancella-tion	Cancella-tion	Cancella-tion	Cancella-tion	Cancella-tion	Cancella-tion
Noise suppression[1]	12dB	12dB	12dB	12dB	--	--
MIC input signal for 0dBm0 @ 1024 Hz (default gain)	16mV	130mV	7.5mV[2]	16mV	275mV	275mV
EP output signal in mV rms. @ 0dBm0, 1024 Hz, no load (default gain); @ 3.14 dBm0	500mV	160mV	230mV	500mV	1160mV 4.5Vpp	1160mV 4.5Vpp
Sidetone gain at default settings	20dB	-∞	17dB	20dB	-∞	-∞

1. In audio modes with noise reduction, the microphone input signal for 0dBm0 shall be measured with a sine burst signal for a tone duration of 5 seconds and a pause of 2 sec. The sine signal appears as noise and, after approx. 12 sec, is attenuated by the noise reduction by up to 12dB.
2. Signal for -2dBm0 (due to attenuation of uplink filter at 1kHz)

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

5.7.4 Voiceband Receive Path

Test conditions:

- The values specified below were tested to 1kHz and 0dB gain stage, unless otherwise stated.
- Parameter setup: gs = 0dB means audio mode = 5 for EPP to EPN, inBbcGain= 0, inCalibrate = 32767, outBbcGain = 0, OutCalibrate = 16384, sideTone = 0.

Table 29: Voiceband receive path

Parameter	Min	Typ	Max	Unit	Test condition/remark
Differential output voltage (peak to peak)		3.4 4.5		Vpp	16Ohm, no load, from EPPx to EPNx *gs* = 0dB @ 3.14dBm0
Differential output gain settings (*gs*) at 6dB stages (outBbcGain)	-18		0	dB	Set with AT^SNFO
Fine scaling by DSP (outCalibrate)	-∞		+6	dB	Set with AT^SNFO
Output differential DC offset	-50		+50	mV	*gs* = 0dB, outBbcGain = 0 and -6dB
Differential output load resistance	14			Ω	from EPP to EPN
Allowed single ended load capacitance			150	pF	from EPP or EPN to VMICN
Absolute gain drift	-5		+5	%	Variation due to change in temperature and life time
Passband ripple			0.5	dB	for f < 3600 Hz
Stopband attenuation	50			dB	for f > 4600 Hz

gs = gain setting

5.7.5 Voiceband Transmit Path

Test conditions:

- The values specified below were tested to 1kHz and 0dB gain stage, unless otherwise stated.
- Parameter setup: Audio mode = 5 for MICP to MICN, inBbcGain= 0, inCalibrate = 32767, outBbcGain = 0, OutCalibrate = 16384, sideTone = 0

Table 30: Voiceband transmit path

Parameter	Min	Typ	Max	Unit	Test condition/Remark
Input voltage (peak to peak) MICP to MICN			0.8	V	
Input amplifier gain in 6dB steps (inBbcGain)[1]	0		39	dB	Set with AT^SNFI
Fine scaling by DSP (inCalibrate)	-∞		0	dB	Set with AT^SNFI
Input impedance MIC		50		kΩ	
Microphone supply voltage		2.2		V	
Microphone supply current			1.1	mA	

1. 3dB step between inBbcGain 6 and 7.

5.8 Air Interface

Test conditions: All measurements have been performed at T_{amb}= 25°C, $V_{BATT+\ nom}$ = 4.1V.

Table 31: Air Interface

Parameter		Min	Typ	Max	Unit
Frequency range	E-GSM 900	880		915	MHz
Uplink (MS → BTS)	GSM 1800	1710		1785	MHz
Frequency range	E-GSM 900	925		960	MHz
Downlink (BTS → MS)	GSM 1800	1805		1880	MHz
RF power @ ARP with 50Ω load	E-GSM 900 [1]	31	33	35	dBm
	GSM 1800 [2]	28	30	32	dBm
Number of carriers	E-GSM 900		174		
	GSM 1800		374		
Duplex spacing	E-GSM 900		45		MHz
	GSM 1800		95		MHz
Carrier spacing			200		kHz
Multiplex, Duplex		TDMA / FDMA, FDD			
Time slots per TDMA frame			8		
Frame duration			4.615		ms
Time slot duration			577		µs
Modulation		GMSK			
Receiver input sensitivity @ ARP BER Class II < 2.4% (static input level)	E-GSM 900	-102[3]	-107[4]		dBm
	GSM 1800	-102[3]	-107[4]		dBm

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

5.9 Electrostatic Discharge

The GSM module is not protected against Electrostatic Discharge (ESD) in general. Consequently, it is subject to ESD handling precautions that typically apply to ESD sensitive components. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates a MC52iR3 module.

Special ESD protection provided on MC52iR3:
- SIM interface: Clamp diodes for protection against overvoltage.
- Antenna port: RF choke to ground.
- The remaining ports of MC52iR3 are not accessible to the user of the final product (since they are installed within the device) and therefore, are only protected according to the "Human Body Model" requirements.

MC52iR3 has been tested according to group standard ETSI EN 301 489-1 (see Table 2) and test standard EN 61000-4-2. The measured values can be gathered from the following table.

Table 32: Measured electrostatic values

Specification / Requirements	Contact discharge	Air discharge
EN 61000-4-2		
SIM interface	± 4kV	± 8kV
Antenna interface	± 4kV	± 8kV
JEDEC JESD22-A114D (Human Body Model, Test conditions: 1.5 kΩ, 100 pF)		
ESD at the module	± 1kV	n.a.

Note: Please note that the values may vary with the individual application design. For example, it matters whether or not the application platform is grounded over external devices like a computer or other equipment, such as the Cinterion Wireless Modules reference application described in Chapter 7.

6 Mechanics

The following sections describe the mechanical dimensions of MC52iR3 and give recommendations for integrating MC52iR3 into the host application.

6.1 Mechanical Dimensions of MC52iR3

Figure 37 shows the top view on MC52iR3 and provides an overview of the mechanical dimensions of the board. For further details see Figure 38.

Length: 35mm
Width: 32.5mm
Height: 3.1mm (including board-to-board connector), 2.9mm (excluding connector)

Weight: 6g

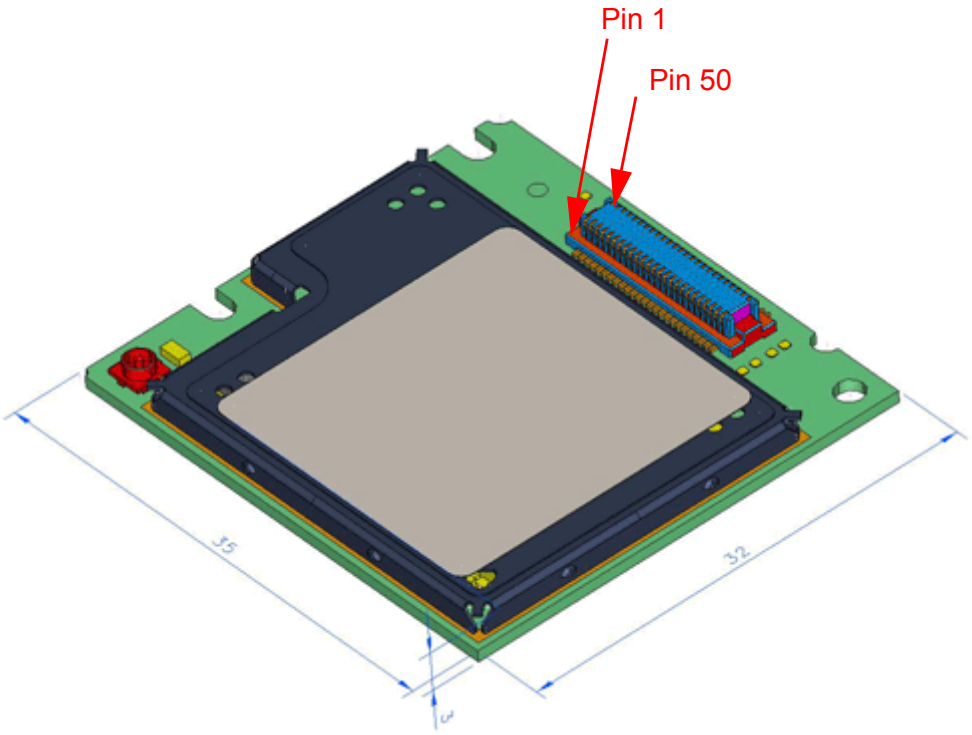


Figure 37: MC52iR3 – top view

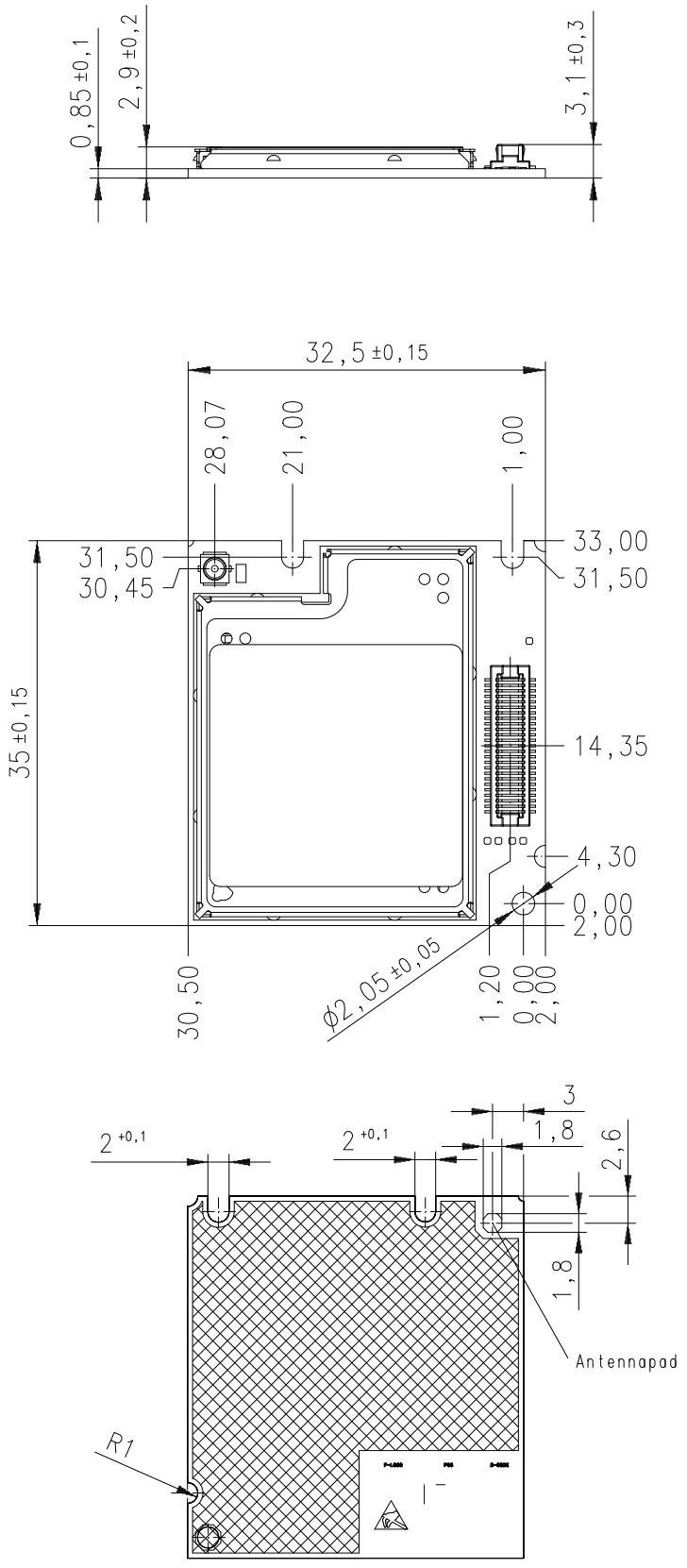


Figure 38: Mechanical dimensions of MC52iR3 (all dimensions in millimeters)

6.2 Mounting MC52iR3 onto the Application Platform

There are many ways to properly install MC52iR3 in the host device. An efficient approach is to mount the MC52iR3 PCB to a frame, plate, rack or chassis.

Fasteners can be M1.6 or M1.8 screws plus suitable washers, circuit board spacers, or customized screws, clamps, or brackets. Screws must be inserted with the screw head on the bottom of the MC52iR3 PCB. In addition, the board-to-board connection can also be utilized to achieve better support. There is also a mounting clip available (see Section 9.2).

For proper grounding it is strongly recommended to use the ground plane on the back side in addition to the five GND pins of the board-to-board connector. To avoid short circuits ensure that the remaining sections of the MC52iR3 PCB do not come into contact with the host device.

To prevent mechanical damage, be careful not to force, bend or twist the module. Be sure it is positioned flat against the host device. See also Section 9.3 with mounting advice sheet.

All the information you need to install an antenna is summarized in Section 4.1. Note that the antenna pad on the bottom of the MC52iR3 PCB must not be influenced by any other PCBs, components or by the housing of the host device. It needs to be surrounded by a restricted space as described in Section 4.1.

6.3 Board-to-Board Connector

This section provides specifications for the 50-pin board-to-board connector which serves as physical interface to the host application. The receptacle assembled on the MC52iR3 PCB is type Hirose DF12C. Mating headers from Hirose are available in different stacking heights.

Figure 39: Hirose DF12C receptacle on MC52iR3

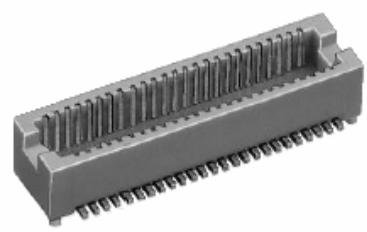


Figure 40: Header Hirose DF12 series

Table 33: Ordering information DF12 series

Item	Part number	Stacking height (mm)	HRS number
Receptacle on MC52iR3	DF12C(3.0)-50DS-0.5V(81)	3 - 5	537-0694-9-81
Headers DF12 series	DF12E(3.0)-50DP-0.5V(81) DF12E(3.5)-50DP-0.5V(81) DF12E(4.0)-50DP-0.5V(81) DF12E(5.0)-50DP-0.5V(81)	3.0 3.5 4.0 5.0	537-0834-6-** 537-0534-2-** 537-0559-3-** 537-0584-0-**

Note: The headers listed above are without boss and metal fitting. Please contact Hirose for details on other types of mating headers. Asterixed HRS numbers denote different types of packaging.

Table 34: Electrical and mechanical characteristics of the Hirose DF12C connector

Parameter	Specification (50 pin board-to-board connector)
Number of contacts	50
Quantity delivered	2000 connectors per tape & reel
Voltage	50V
Rated current	0.3A max per contact
Resistance	0.05 Ω per contact
Dielectric withstanding voltage	500V RMS min
Operating temperature	-45°C...+125°C
Contact material	phosphor bronze (surface: gold plated)
Insulator material	PA , beige natural
Stacking height	3.0 mm ; 3.5 mm ; 4.0 mm ; 5.0 mm
Insertion force	21.8N
Withdrawal force 1st	10N
Withdrawal force 50th	10N
Maximum connection cycles	50

6.3.1 Mechanical Dimensions of the Hirose DF12 Connector

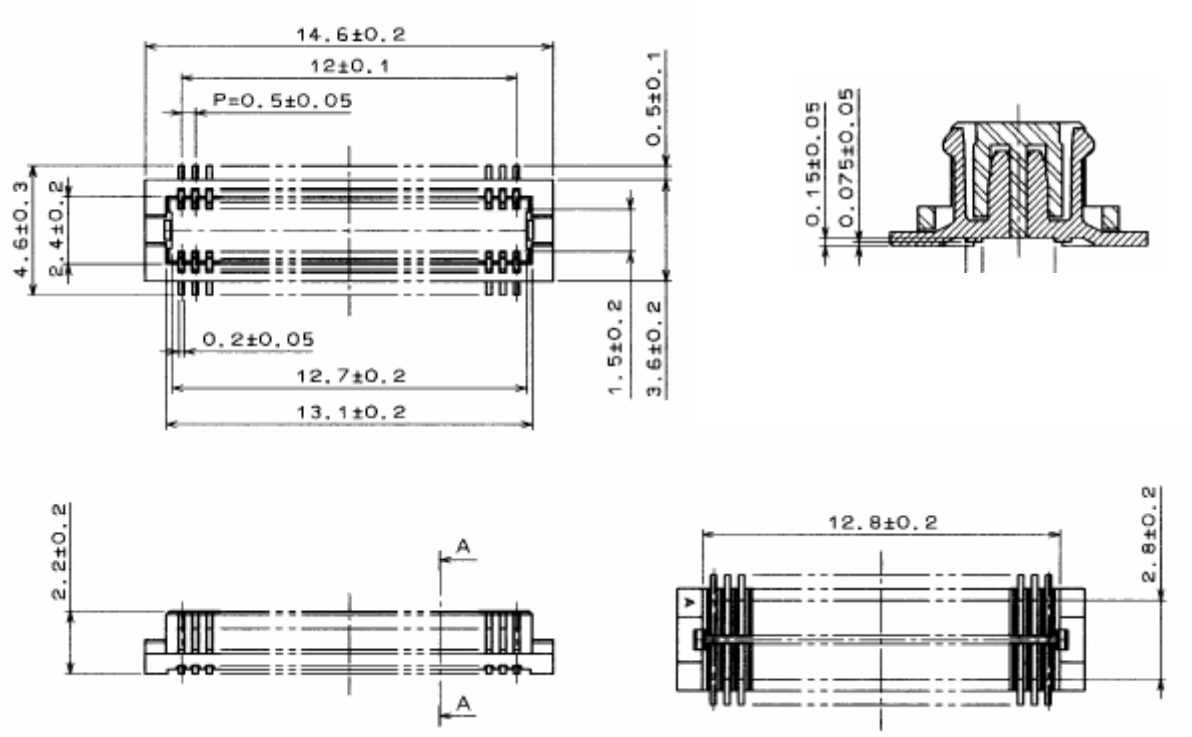


Figure 41: Mechanical dimensions of Hirose DF12 connector

7 Reference Approval

7.1 Reference Equipment for Type Approval

The Cinterion Wireless Modules reference setup submitted to type approve MC52iR3 consists of the following components:

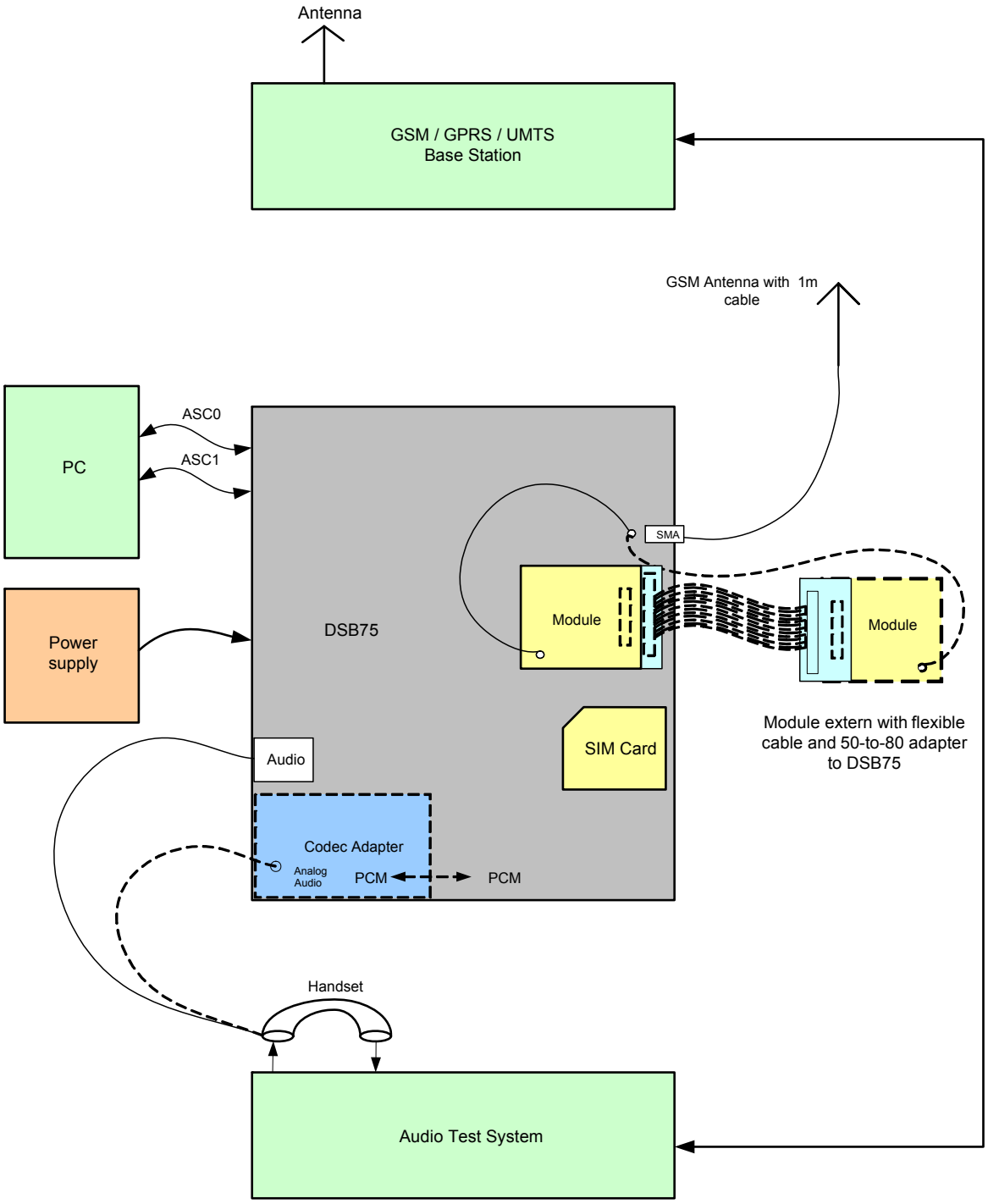


Figure 42: Reference equipment for approval

8 Sample Application

Figure 43 shows a typical example of how to integrate an MC52iR3 module with an application.

The audio interface demonstrates the balanced connection of microphone and earpiece. This solution is particularly well suited for internal transducers.

If the module is in Power down mode avoid current flowing from any other source into the module circuit, for example reverse current from high state external control lines. Therefore, the controlling application must be designed to prevent reverse flow.

The EMC measures are best practice recommendations. In fact, an adequate EMC strategy for an individual application is very much determined by the overall layout and, especially, the position of components. For example, when connecting cables to the module's interfaces it is strongly recommended to add appropriate ferrite beads for reducing RF radiation.

Disclaimer:
No warranty, either stated or implied, is provided on the sample schematic diagram shown in Figure 43 and the information detailed in this section. As functionality and compliance with national regulations depend to a great amount on the used electronic components and the individual application layout manufacturers are required to ensure adequate design and operating safeguards for their products using MC52iR3 modules.

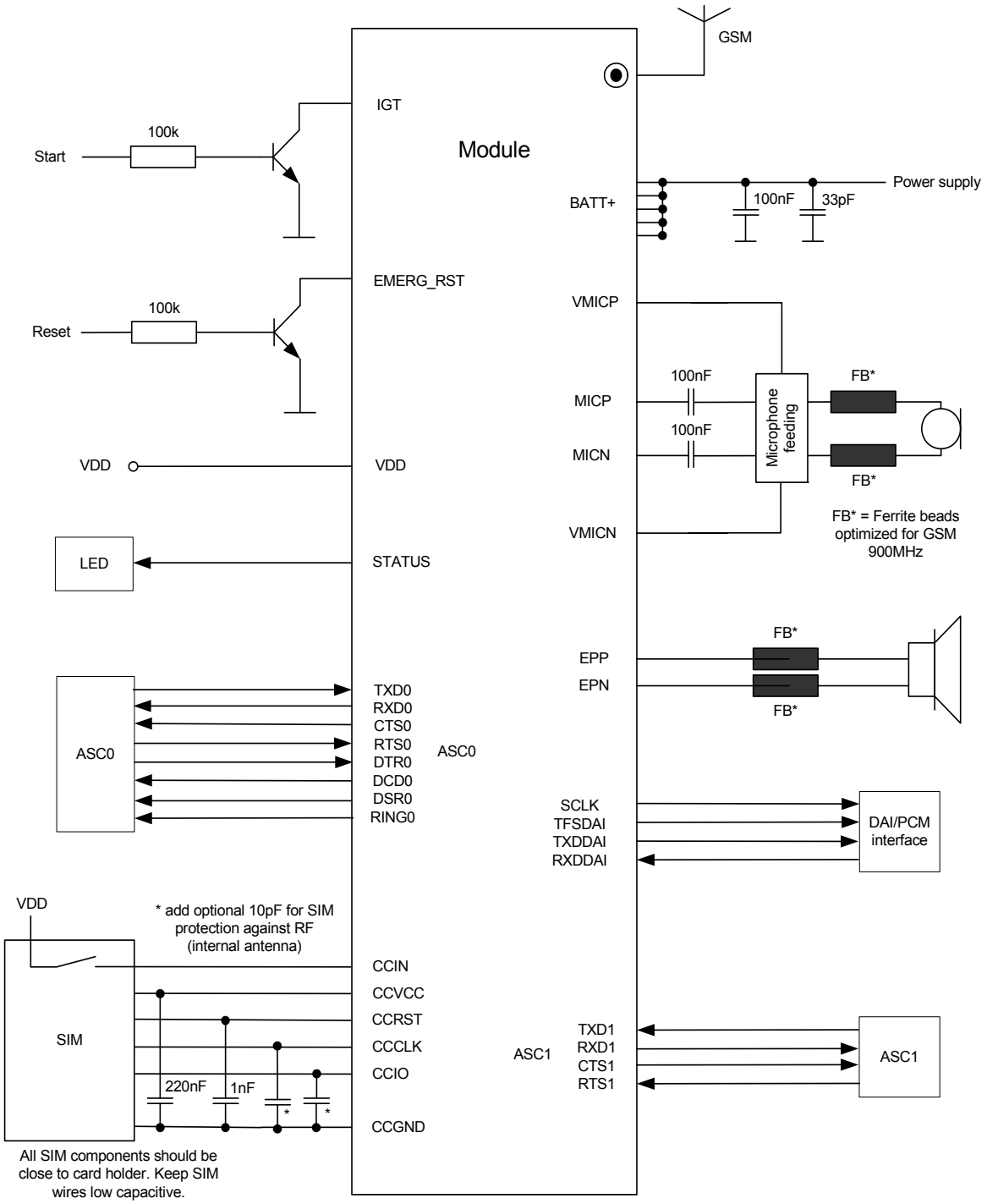


Figure 43: Schematic diagram of MC52iR3 sample application

9 Appendix

9.1 List of Parts and Accessories

Table 35: List of parts and accessories

Description	Supplier	Ordering information
MC52iR3	Cinterion	Standard module Cinterion Wireless Modules IMEI: L30960-N1221-A300
DSB75 Support Box	Cinterion	Ordering number: L36880-N8811-A100
DSB75-Adapter for mounting the MC52iR3 module	Cinterion	Ordering number: TBD.
Votronic Handset	VOTRONIC	Votronic HH-SI-30.3/V1.1/0 VOTRONIC Entwicklungs- und Produktionsgesellschaft für elektronische Geräte mbH Saarbrücker Str. 8 66386 St. Ingbert Germany Phone: +49-(0)6 89 4 / 92 55-0 Fax: +49-(0)6 89 4 / 92 55-88 Email: contact@votronic.com
SIM card holder incl. push button ejector and slide-in tray	Molex	Ordering numbers: 91228 91236 Sales contacts are listed in Table 36.
Board-to-board connector	Hirose	Sales contacts are listed in Table 37.
U.FL antenna connector	Hirose or Molex	Sales contacts are listed in Table 36 and Table 37.

Table 36: Molex sales contacts (subject to change)

Molex For further information please click: http://www.molex.com	Molex Deutschland GmbH Felix-Wankel-Str. 11 4078 Heilbronn-Biberach Germany Phone: +49-7066-9555 0 Fax: +49-7066-9555 29 Email: mxgermany@molex.com	American Headquarters Lisle, Illinois 60532 U.S.A. Phone: +1-800-78MOLEX Fax: +1-630-969-1352
Molex China Distributors Beijing, Room 1319, Tower B, COFCO Plaza No. 8, Jian Guo Men Nei Street, 100005 Beijing P.R. China Phone: +86-10-6526-9628 Phone: +86-10-6526-972 Phone: +86-10-6526-9731 Fax: +86-10-6526-9730	Molex Singapore Pte. Ltd. Jurong, Singapore Phone: +65-268-6868 Fax: +65-265-6044	Molex Japan Co. Ltd. Yamato, Kanagawa, Japan Phone: +81-462-65-2324 Fax: +81-462-65-2366

Table 37: Hirose sales contacts (subject to change)

Hirose Ltd. For further information please click: http://www.hirose.com	Hirose Electric (U.S.A.) Inc 2688 Westhills Court Simi Valley, CA 93065 U.S.A. Phone: +1-805-522-7958 Fax: +1-805-522-3217	Hirose Electric GmbH Herzog-Carl-Strasse 4 73760 Ostfildern Germany Phone: +49-711-456002-1 Fax: +49-711-456002-299 Email: info@hirose.de
Hirose Electric UK, Ltd Crownhill Business Centre 22 Vincent Avenue, Crownhill Milton Keynes, MK8 OAB Great Britain Phone: +44-1908-305400 Fax: +44-1908-305401	Hirose Electric Co., Ltd. 5-23, Osaki 5 Chome, Shinagawa-Ku Tokyo 141 Japan Phone: +81-03-3491-9741 Fax: +81-03-3493-2933	Hirose Electric Co., Ltd. European Branch First class Building 4F Beechavenue 46 1119PV Schiphol-Rijk Netherlands Phone: +31-20-6557-460 Fax: +31-20-6557-469

9.2 Mounting Clip

An optional mounting clip is available to connect MC52iR3 to an external application. The mounting clip provides for an easy module exchange or replacement.

Mounting Clip for Cinterion MC55i module

GTT Europe P/N : GT-MC55i-CLIP **V1.3 Release 06th July 2009**

PCB Mounting Clip Design for Cinterion Wireless Module : MC55i

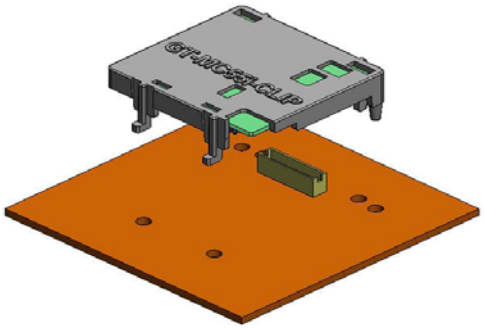
Web: www.gtteurope.co.uk
Email: enquiries@gtteurope.co.uk
Phone: + 44 (0) 1780 758 530

FEATURES AND APPLICATION

Board to Board connector information
Cinterion module board side header : Hirose DF12C(3.0)-50DS-0.5V(86)
PCB mating board side receptable : Hirose DF12E(5.0)-50DP-0.5V(86)
Size : 50 pins
Stacking height : 5.0mm

PCB mating board thickness : 1.6mm
Pulling force (Module Clip on PCB) : Minimum 10N
Maximum 150N

Reference information
Packaging information : 25clips/bag , 1350clips/carton



CLIP SPECIFICATIONS

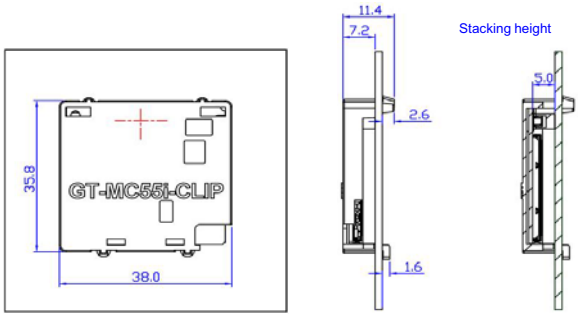
Physical

Clip material :
- PC-940A (Flame retardant PC ,UL 94V-0)
- Color : Black
- RoHS compliant

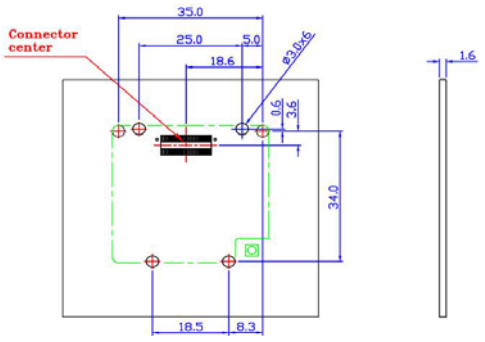
Operating Temperature : -40°C ~ +100°C

Weight : 2.35 g

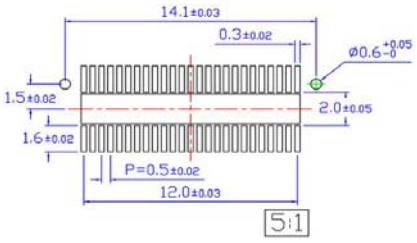
Assembled dimensions *(in millimeters)*



MODULE CLIP PCB FOOTPRINT AND CONNECTOR RECEPTACLE DIMENSIONS



Module Clip PCB Footprint



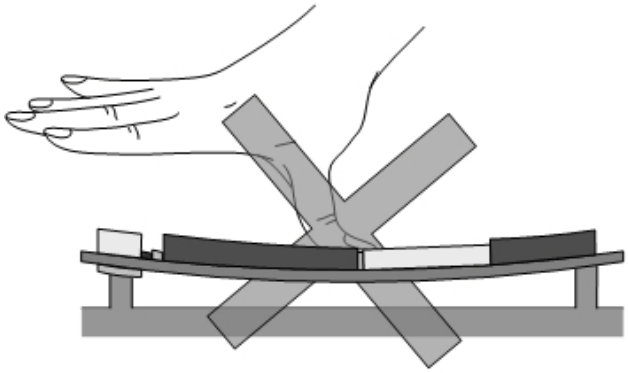
PCB Connector Receptable dimensions

9.3 Mounting Advice Sheet

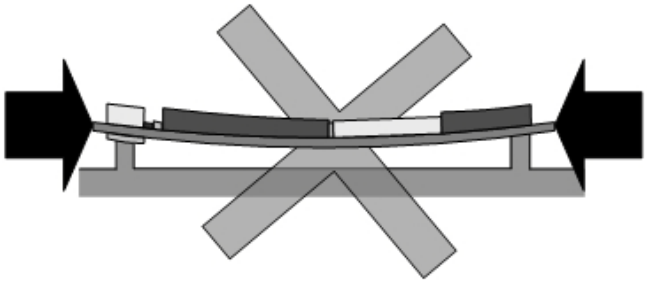
To prevent mechanical damage, be careful not to force, bend or twist the module. Be sure it is positioned flat against the host device (see also Section 6.2). The advice sheet on the next page shows a number of examples for the kind of bending that may lead to mechanical damage of the module.

Mounting Advice

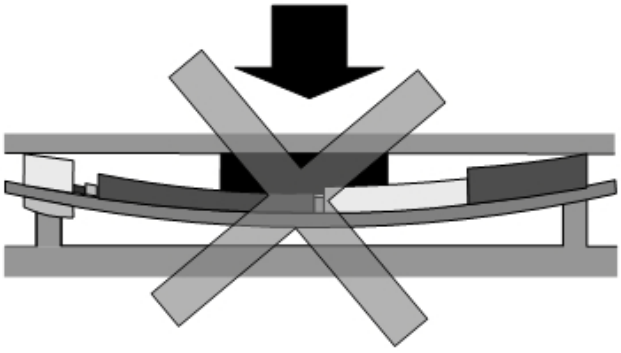
Do NOT BEND the Module



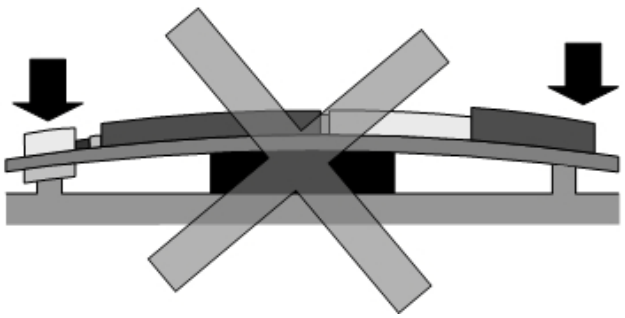
- By pressing from above



- By mounting under pressure



- By putting objects on top



- By putting objects below