MOTOROLA

Technical Information

Motorola H24 Developer's Guide

Module Hardware Description

MAY 15, 2009
6802986C38-B

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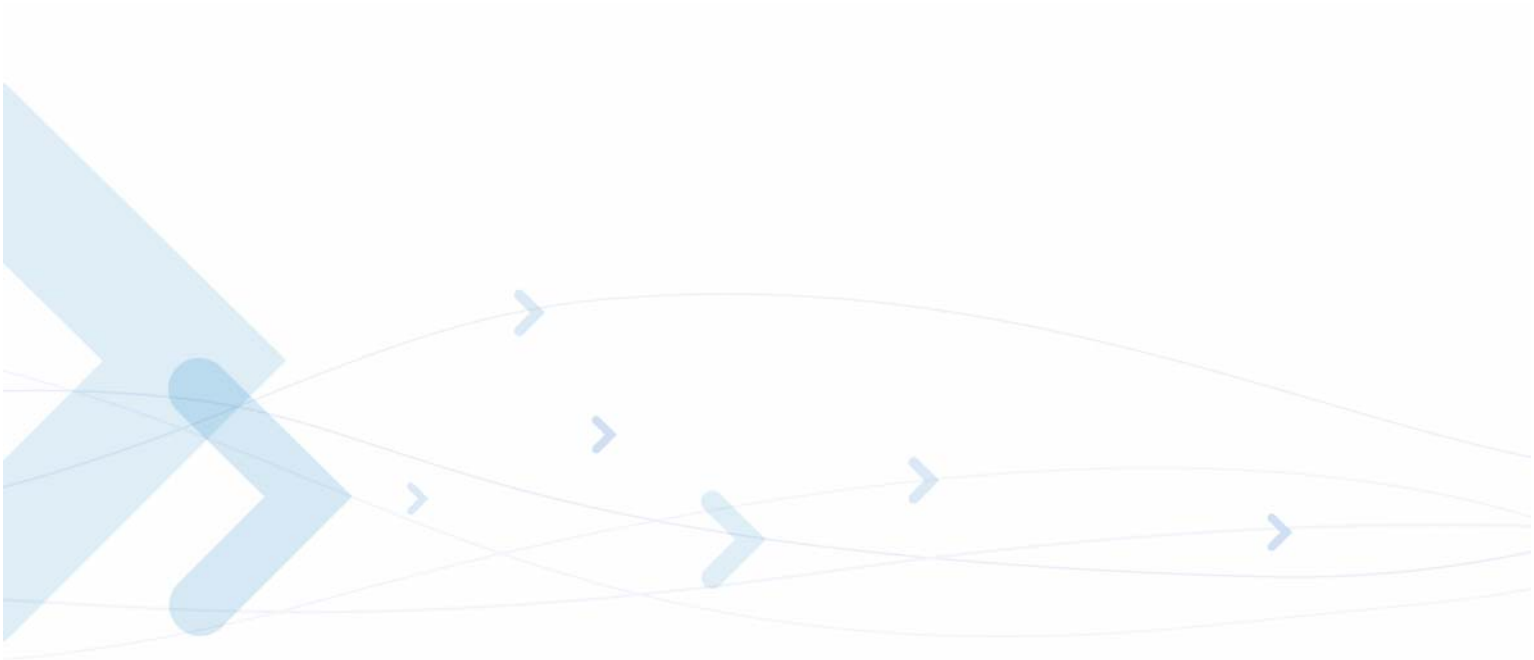

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Preface

Manual Scope

This manual provides the electrical, mechanical and environmental requirements for properly integrating the H24 module in a host application.

This manual gives a complete set of hardware features and functions that may be provided by H24. The availability of any feature or function, which is described in this manual, depends on the hardware revision and software version of a specific H24 model.

The parameters and values provided in this manual are defined under typical conditions. These values may vary when subject to different conditions, such as SW version, network status, application settings and environmental conditions.

Target Audience

This manual is intended for all members of the integration team who are responsible for integrating the H24 module into the host OEM device, including representatives from hardware, software and RF engineering disciplines.

Manual Organization

This manual contains the following chapters:

- **Chapter 1**—introduces the H24 unit and provides important safety instructions.
- **Chapter 2**—provides a detailed hardware description of the blocks and components comprising the H24.
- **Chapter 3**—describes the pin assignments for H24 connectors.
- **Chapter 4**—describes H24 mechanical specifications and requirements.
- **Chapter 5**—provides contact information for Motorola Service Support and Customer Assistance.

Applicable Documents

- H24/G24 Developer's Kit - 6802986C39
- H24 AT Commands - 6802986C37

Regulatory Requirements

The Federal Communications Commission (FCC) requires application for certification of digital devices in accordance with CFR Title 47, Part 2 and Part 15. This includes MPE calculation. As the H24 modem is not a standalone transceiver but is an integrated module, the H24 cannot be tested by itself for EME certification. It is, however, the integrator's responsibility to have the completed device tested for EME certification.

Caution: Unauthorized repairs or modifications could result in permanent damage to the equipment and void your warranty and your authority to operate this device under Part 15 of the FCC Rules.

Regulatory Statement (Safety)

The following safety precautions must be observed during all phases of the operation, usage, service or repair of any cellular terminal or mobile incorporating the H24 module. 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. Motorola assumes no liability for customer failure to comply with these precautions.

- The H24 should not be assembled when voltage is supplied to the 70 pin connector
- The H24 must be operated at the voltages described in the technical documentation
- The H24 must not be mechanically nor electrically changed. Use of connectors should follow the guidance of the technical documentation
- The H24 is designed to meet the EMC requirements of ETS 300342
- When integrating the H24 into a system, Motorola recommends testing the system to ETS300342-1
- You must not remove any label from the H24
- Systems using the H24 are subject to mandatory EMC testing under directive 89/336/EEC (to://www.newapproach.org/Directives/). Other directives, such as the LVD directive 73/23/EE, may also apply to a system using the H24 module

FCC Notice to Users

Motorola has not approved any changes or modifications to this device by the user. Any changes or modifications could void the user's authority to operate the equipment. See 47 CFR Sec. 15.21. This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. See 47 CFR Sec. 15.19(3).

If your mobile device or accessory has a USB connector, or is otherwise considered a computer peripheral device whereby it can be connected to a computer for purposes of transferring data, then it is considered a Class B device and the following statement applies:

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can

radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

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

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference.

(2) This device must accept any interference received, including interference that may cause undesired operation.

Precautions

Interface connector and some of the module circuits are not shielded. Be sure to take appropriate precautionary measures in order to avoid ESD while handling the module. ESD can damage the H24 modules. Integrators need to design ESD protection on all external interfaces.

Antenna and Transmission Safety Precautions

User Operation

Do not operate your unit when a person is within 8 inches (20 centimeters) of the antenna. A person or object within 8 inches (20 centimeters) of the antenna could impair call quality and may cause the phone to operate at a higher power level than necessary.

Important: The unit must be installed in a manner that provides a minimum separation distance of 20 cm or more between the antenna and persons and must not be co-located or operate in conjunction with any other antenna or transmitter to satisfy FCC RF exposure requirements for mobile transmitting devices.

Important: To comply with the FCC RF exposure limits and satisfy the categorical exclusion requirements for mobile transmitters, the requirements described in the following section, “Antenna Installation” , must be met.

Antenna Installation

- The antenna installation must provide a minimum separation distance of 20 cm from users and nearby persons and must not be co-located or operating in conjunction with any other antenna or transmitter.
- Antenna installation should be done by a professional installer and should meet all FCC requirement as given in FCC part 15.
- The combined cable loss and antenna gain must not exceed +4.3 dBi (850 band). The combined cable loss and antenna gain must not exceed +2.55 dBi and total system output must not exceed 2.0W EIRP in the PCS (1900) band in order to comply with the EIRP limit of 24.232 (b). OEM installers must be provided with antenna installation instruction and transmitter operating conditions for satisfying RF exposure compliance.

Section 15.203 - Antenna Requirements

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to de-vices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

Standards

Electromagnetic Compatibility: Principles and Applications by David A Weston, published by Marcel Dekker, Inc., 270 Madison Avenue, New York, NY 10016 USA.

GSM 07.07 - prETS 300 916, Digital cellular telecommunication system (Phase 2+); AT command set for GSM Mobile Equipment (ME), Version 5.2.0 or higher, Reference RE/SMG-040707QR1.

GSM 07.05, Digital cellular telecommunication system (Phase 2+); Use of Data Terminal Equipment - Data Circuit terminating; Equipment (DTE-DCE) interface for Short Message Service (SMS) and Cell Broadcast Service (CBS), Version 5.3.0, August, 1997, Reference TS/SMG-040705QR2.

GSM 03.40, Digital cellular telecommunication system (Phase 2+); Technical realization of the Short Message Service (SMS) Point-to-Point (PP), Version 5.3.0, July 1996, Reference TS/SMG-040340QR2.

GSM 04.11 Digital cellular telecommunication system (Phase 2+); Point-to-Point (PP) Short Message Service (SMS) support on mobile radio interface, Version 5.1.0, March 1996, Reference TS/SMG-030411QR.

GSM 03.38, Digital cellular telecommunication system (Phase 2+); Alphabets and language-specific information, Version 5.3.0, July 1996, Reference TS/SMG-040338QR2.

GSM 11.10-1, Digital cellular telecommunication system (Phase 2); Mobile Station (MS) Conformance specification; Part 1: Conformance specification. Draft pr ETS 300 607-1, March 1998, Reference RE/SMG-071110PR6-1.

GSM Specifications are orderable from Global Engineering Documents, 15 Inverness Way East, Englewood, Colorado 80112-5704 USA 303-792-2181 800-624-3974.

ETSI Standard PCS - *11.10-1*.

GSM 02.30 Supplementary services.

GSM 03.90 USSD stage 2.

GSM 11.14 SIM toolkit.

ITU-T *V.25ter*

GSM Data Adapter for Motorola Handsets, AT command reference, Rev 2, June 9 1997.

ETSI standard SMG31.

GSM 05.02.

ETSI 07.60.

ETSI 0.7.07 Ver. 7.5.0.

Contact Us

We at Motorola want to make this guide as helpful as possible. Keep us informed of your comments and suggestions for improvements.

For general contact, technical support, report documentation errors and to order manuals, use this email address:
M2M.CustomerCare@motorola.com

Motorola appreciates feedback from the users of our information.

Text Conventions

The following special paragraphs are used in this guide to point out information that must be read. This information may be set-off from the surrounding text, but is always preceded by a bold title in capital letters:

Note

Note: Presents additional, helpful, noncritical information that you can use.

Warning

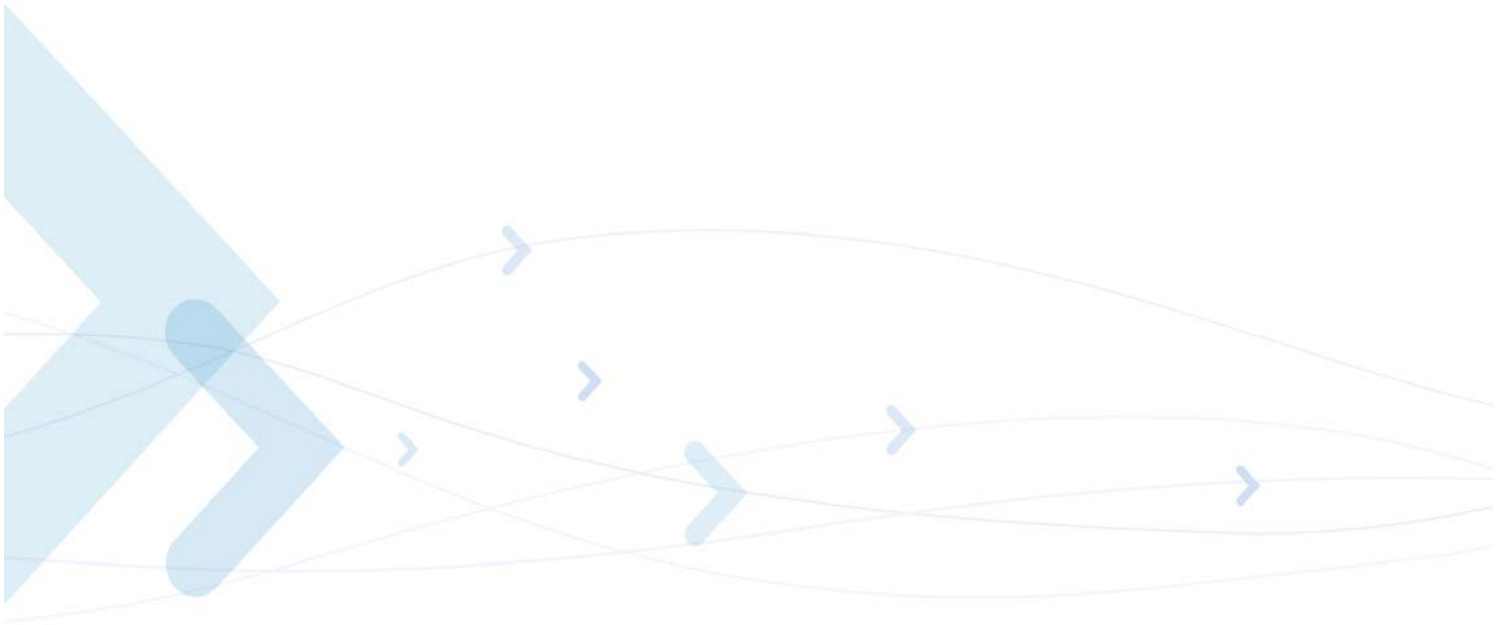
Warning: Presents information to warn you of a potentially hazardous situation in which there is a possibility of personal injury.

Important

Important:	Presents information to help you avoid an undesirable situation or provides additional information to help you understand a topic or concept.

Caution

Caution:	Presents information to identify a situation in which damage to software, stored data, or equipment could occur, thus avoiding the damage.



Field Service

For Field Service requests, use this email address:
n2csfs01@motorola.com

General Safety

Remember!. . . safety depends on you!

The following general safety precautions must be observed during all phases of operation, service, and repair of the equipment described in this manual. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the equipment. Motorola, Inc. assumes no liability for the customer's failure to comply with these requirements. The safety precautions listed below represent warnings of certain dangers of which we are aware. You, as the user of this product, should follow these warnings and all other safety precautions necessary for the safe operation of the equipment in your operating environment.

Ground the instrument

To minimize shock hazard, the equipment chassis and enclosure must be connected to an electrical ground. If the equipment is supplied with a three-conductor AC power cable, the power cable must be either plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter. The three-contact to two-contact adapter must have the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable must meet International Electrotechnical Commission (IEC) safety standards.

Note: Refer to *"Grounding Guideline for Cellular Radio Installations"*–Motorola part no. *68P081150E62*.

Do not operate in an explosive atmosphere

Do not operate the equipment in the presence of flammable gases or fumes. Operation of any electrical equipment in such an environment constitutes a definite safety hazard.

Do not service or adjust alone

Do not attempt internal service or adjustment unless another person, capable of rendering first aid is present.

Keep away from live circuits

Operating personnel must:

- not remove equipment covers. Only Factory Authorized Service Personnel or other qualified maintenance personnel may remove equipment covers for internal subassembly, or component replacement, or any internal adjustment

- not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed
- always disconnect power and discharge circuits before touching them

Do not substitute parts or modify equipment

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification of equipment. Contact Motorola Warranty and Repair for service and repair to ensure that safety features are maintained.

Dangerous procedure warnings

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed. You should also employ all other safety precautions that you deem necessary for the operation of the equipment in your operating environment.

Warning example:

Warning: Dangerous voltages, capable of causing death, are present in this equipment. Use extreme caution when handling, testing, and adjusting.

Caring for the Environment

The following information is provided to enable regulatory compliance with the European Union (EU) Directive 2002/96/EC Waste Electrical and Electronic Equipment (WEEE) when using Motorola equipment in EU countries.

Disposal of Motorola equipment in EU countries

Please do not dispose of Motorola equipment in landfill sites.

In the EU, Motorola in conjunction with a recycling partner will ensure that equipment is collected and recycled according to the requirements of EU environmental law.

Please contact the Customer Network Resolution Center (CNRC) for assistance. The 24 hour telephone numbers are listed at
http://mynetworksupport.motorola.com
Select **Customer Network Resolution Center contact information**.

Alternatively if you do not have access to CNRC or the internet, contact the Local Motorola Office.

Disposal of Motorola equipment in non-EU countries

In non-EU countries, dispose of Motorola equipment in accordance with national and regional regulations.

Turkey

Article 7 of the *European Union (EU) Directive 2002/96/EC Waste Electrical and Electronic Equipment (WEEE)*

The Government of Turkey requests a statement of conformity with the EEE regulation be provided with this equipment. This statement of EEE conformity (in Turkish) is: **EEE Yönetmeliğine Uygundur**.

Limitation of Liability

The Products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body; in other applications intended to support or sustain life; for the planning, construction, maintenance, operation or use of any nuclear facility; for the flight, navigation, communication of aircraft or ground support equipment; or in any other application in which the failure of the Product could create a situation where personal injury or death may occur. If CUSTOMER should use any Product or provide any Product to a third party for any such use, CUSTOMER hereby agrees that MOTOROLA is not liable, in whole or in part, for any claims or damages arising from such use, and further agrees to indemnify and hold MOTOROLA harmless from any claim, loss, cost or damage arising from such use.

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Motorola guarantees to you, the original purchaser, the OEM module and accessories which you have purchased from an authorized Motorola dealer (the "Products"), to be in conformance with the applicable Motorola specifications current at the time of manufacture for a term of [1] year from date of purchase of the Product(s) (Warranty Term).

You must inform Motorola of the lack of conformity to the applicable specifications of any of the Products within a period of two (2) months from the date on which you detect a defect in material, workmanship or lack of conformity and in any event within a term not to exceed the Warranty Term, and must immediately submit the Product for service to Motorola's Authorized Repair or Service Center. Motorola shall not be bound by Product related statements not directly made by Motorola nor any warranty obligations applicable to the seller.

A list of the Motorola Call Center numbers is enclosed with this Product.

During the Warranty term, Motorola will, at its discretion and without extra charge, as your exclusive remedy, repair or replace your Product which does not comply with this warranty; or failing this, to reimburse the price of the Product but reduced to take into account the use you have had of the Product since it was delivered. This warranty will expire at the end of the Warranty Term.

This is the complete and exclusive warranty for a Motorola OEM module and accessories and in lieu of all other warranties, terms and conditions, whether express or implied.

Where you purchase the product other than as a consumer, Motorola disclaims all other warranties, terms and conditions express or implied, such as fitness for purpose and satisfactory quality.

In no event shall Motorola be liable for damages nor loss of data in excess of the purchase price nor for any incidental special or consequential damages* arising out of the use or inability to use the Product, to the full extent such may be disclaimed by law.

This Warranty does not affect any statutory rights that you may have if you are a consumer, such as a warranty of satisfactory quality and fit for the purpose for which products of the same type are normally used under normal use and service, nor any rights against the seller of the Products arising from your purchase and sales contract.

(*)including without limitation loss of use, loss of time, loss of data, inconvenience, commercial loss, lost profits or savings.

How to Get Warranty Service?

In most cases the authorized Motorola dealer which sold and/or installed your Motorola OEM module and original accessories will honor a warranty claim and/or provide warranty service. Alternatively, for further information on how to get warranty service please contact either the customer service department of your service provider or Motorola's service centers, listed in Chapter 5.

Claiming

In order to claim the warranty service you must return the OEM module and/or accessories in question to Motorola's Authorized Repair or Service Center in the original configuration and packaging as supplied by Motorola. Please avoid leaving any supplementary items like SIM cards. The Product should also be accompanied by a label with your name, address, and telephone number; name of operator and a description of the problem.

In order to be eligible to receive warranty service, you must present your receipt of purchase or a comparable substitute proof of purchase bearing the date of purchase. The phone should also clearly display the original compatible electronic serial number (IMEI) and mechanic serial number [MSN]. Such information is contained with the Product.

You must ensure that all and any repairs or servicing is handled at all times by a Motorola Authorized Service Center in accordance with the Motorola Service requirements

In some cases, you may be requested to provide additional information concerning the maintenance of the Products by Motorola Authorized Service Centers only, therefore it is important to keep a record of any previous repairs, and make them available if questions arise concerning maintenance.

Conditions

This warranty will not apply if the type or serial numbers on the Product has been altered, deleted, duplicated, removed, or made illegible. Motorola reserves the right to refuse free-of-charge warranty service if the requested documentation can not be presented or if the information is incomplete, illegible or incompatible with the factory records.

Repair, at Motorola's option, may include reflashing of software, the replacement of parts or boards with functionally equivalent, reconditioned or new parts or boards. Replaced parts, accessories, batteries, or boards are warranted for the balance of the original warranty time period. The Warranty Term will not be extended. All original accessories, batteries, parts, and OEM module equipment that have been replaced shall become the property of Motorola. Motorola does not warrant the installation, maintenance or service of the products, accessories, batteries or parts.

Motorola will not be responsible in any way for problems or damage caused by any ancillary equipment not furnished by Motorola which is attached to or used in connection with the Products, or for operation of Motorola equipment with any ancillary equipment and all such equipment is expressly excluded from this warranty.

When the Product is used in conjunction with ancillary or peripheral equipment not supplied by Motorola, Motorola does not warrant the operation of the Product/peripheral combination and Motorola will not honor any warranty claim where the Product is used in such a combination and it is determined by Motorola that there is no fault with the Product. Motorola specifically disclaims any responsibility for any damage, whether or not to Motorola equipment, caused in any way by the use of the OEM module, accessories, software applications and peripherals (specific examples include, but are not limited to: batteries, chargers, adapters, and power supplies) when such accessories, software applications and peripherals are not manufactured and supplied by Motorola.

What is Not Covered by the Warranty

This warranty is not valid if the defects are due to damage, misuse, tampering, neglect or lack of care and in case of alterations or repair carried out by unauthorized persons.

The following are examples of defects or damage not covered by this product warranty

1. Defects or damage resulting from use of the Product in other than its normal and customary manner.
2. Defects or damage from misuse, access to incompatible sources, accident or neglect.
3. Defects or damage from improper testing, operation, maintenance, installation, adjustment, unauthorized software applications or any alteration or modification of any kind.
4. Breakage or damage to antennas unless caused directly by defects in material or workmanship.

5. Products disassembled or repaired other than by Motorola in such a manner as to adversely affect performance or prevent adequate inspection and testing to verify any warranty claim.
6. Defects or damage due to range, coverage, availability, grade of service, or operation of the cellular system by the cellular operator.
7. Defects or damage due to moist, liquid or spills of food.
8. Control unit coil cords in the Product that are stretched or have the modular tab broken.
9. All plastic surfaces and all other externally exposed parts that are scratched or damaged due to customer normal use.

Depending on operating conditions and your usage habits, wear and tear might take place of components including mechanical problems related to Product housing, paint, assembly, sub-assemblies, displays and keyboards and any accessories which are not part of the Product's in-box configuration. The rectification of faults generated through wear and tear and the use of consumable items like batteries beyond their Optimum Performance Time as indicated in the product manual is considered to be your responsibility and therefore Motorola will not provide the free Warranty repair service for these items

Installed Data

Please make and retain a note of all data you have inserted into your Product for example names, addresses, phone numbers, user and access codes, notes etc. before submitting your Product for a Warranty service as such data may be deleted or erased as part of the repair or service process.

Please note if you have downloaded material onto your product, these may be deleted or erased as part of the repair process or testing process. Motorola shall not be responsible for such matters. The repair or testing process should not affect any such material that was installed by Motorola on your Product as a standard feature.

Out of Warranty Repairs

If you request Motorola to repair your Product any time after the Warranty term or where this warranty does not apply due to the nature of the defect or fault, then Motorola may in its discretion carry out such repairs subject to you paying Motorola its fees for such a repair or it may refer you to an authorized third party to carry out such repairs.

Revision History

Manual Number

6802986C38-B

Manual Title

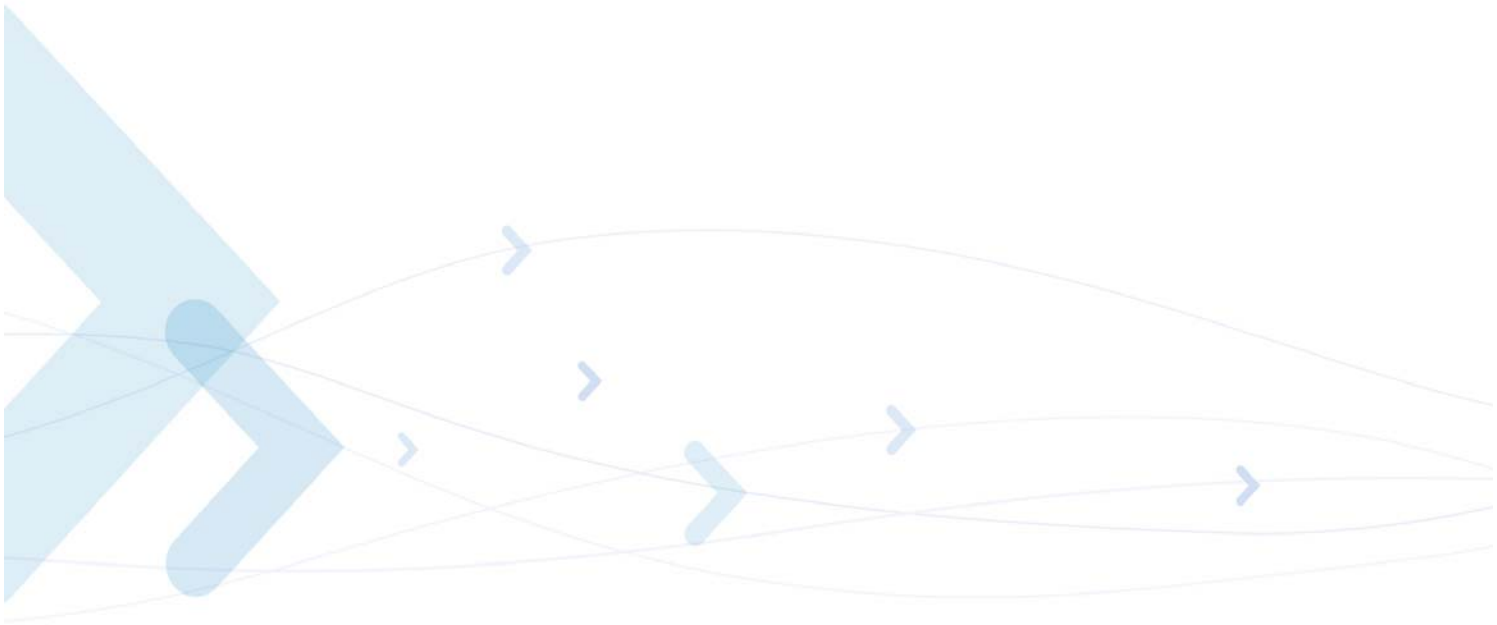
H24 - Module Hardware Description

Version Information

The following table lists the manual version, date of version, and remarks about the version.

Revision History

Version	Date Issue	Remarks
A	January 15, 2009	Initial Release
B	May 15, 2009	Minor updates throughout the manual



Chapter 1: Introduction

The H24 is the newest member of Motorola's embedded cellular modules family.

Designed with Tri bands WCDMA & quad band GSM capabilities, which supports WCDMA bands: B1-2100, B2-1900, B5 -850 with HSDPA capability and four GSM bands - 850/900/1800/1900 MHz, with GPRS/EGPRS multislot class 12. H24 can operate on any GSM/GPRS/EGPRS/WCDMA/HSDPA network to provide voice and data communications.

The H24 is similar to a condensed cellular phone core, which can be integrated into any system or product that needs to transfer voice or data information over a cellular network. Thus, it significantly enhances the system's capabilities, transforming it from a standalone, isolated product to a powerful high-performance system with global communications capabilities.

The H24 is designed as a complete GSM/WCDMA communications solution with all the controls, interfaces and features to support a broad range of applications:

- A powerful audio interface
- A large set of indicators and control signals
- Several advanced power-saving modes
- A variety of serial communications solutions.

All these features and interfaces are easily controlled and configured using a versatile AT command interface that provides full control over the H24 operation.

The H24 control and indication interface extends its capabilities beyond GSM communications. This includes an A/D and GPIO interface, and a regulated output voltage for supplying external circuits. With these interfaces, the H24 can operate and control external applications and receive feedback from external environment and circuits.

The H24 interface design, using a single 70 pin board-to-board connector, through which all application interfaces are managed, facilitates fast and easy integration. It significantly shortens the development process, and minimizes the product's time to market.

The H24 is extremely compact in size with a slim mechanical design, which makes it space saving on the application board and easily fitted into any board design.

The advanced power supply management significantly reduces power consumption to a necessary minimum and prolongs battery life.

Product Specifications

Important: For safety regulations and requirements, see “Regulatory Requirements” on page viii, “Regulatory Statement (Safety)” on page viii and “Antenna and Transmission Safety Precautions” on page ix in “Preface” .

Note: Motorola reserves the right to change the specifications without prior notice.

Table 1-1: Product Specifications

Product Features	
Operating systems:	GSM: GSM 850/GSM 900 DCS 1800/PCS 1900 WCDMA: B1- 2100 B2 - 1900 B5 - 850
Physical Characteristics	
Size (with 3 mm connector):	45.2 x 24.4 x 5.4 mm
Mounting:	Two Ø2.4 mm holes
Weight:	10 grams

Table 1-1: Product Specifications (Cont.)

Environmental	
Operational temperature:	-30°C to +85°C
Storage temperature:	-40°C to +85°C
Performance	
Operating voltage:	3.3 - 4.2 V
Current consumption:	In AT mode: TBD mA @ DRX9 (Sleep mode)
Maximum Tx output power:	GSM 850/GSM 900: Power class 4 (33 ± 2dBm) DCS 1800/PCS 1900: Power class 1 (30 ± 2 dBm) GSM 850/GSM 900: GPRS 4 slot up (28 ± 2 dBm) DCS 1800/PCS 1900: GPRS 4 slot up (25 ± 2 dBm) GSM 850/GSM 900: EGPRS 4 slot up (22 ± 2 dBm) DCS 1800/PCS 1900: EGPRS 4 slot up (21 ± 2 dBm) WCDMA/HSDPA B1, B2, B5: Power class 3 (24 dBm+ 1 /-3 dB)
Interfaces	
Connectors:	Single 70-pin, board-to-board RF MMCX RF UFL Connectors (Diversity , GPS)
SIM Card:	External USIM connectivity 1.8V/3.0 V
Serial Ports:	UART: BR up to 4M bps (Using DM) and up to 230K bps for Data Services USB: USB High-Speed device specifications, Rev. 2.0 I2C
Data Features	
GPRS:	Multi-slot class 12 (4 Rx/4 Tx/5 Sum) Max air Downlink BR 80 kbps Coding scheme CS1-CS4 Class B
EGPRS (model dependant):	Multi-slot class 12 Max air Downlink BR 236 kbps Coding scheme MCS1-MCS9 Class B
CSD:	Max BR 14.4 kbps
SMS:	MO/MT Text and PDU modes Cell broadcast
Voice Features	
Telephony	
Digital audio	
Differential analog audio lines	
Vocoders	EFR/HR/FR/AMR

Table 1-1: Product Specifications (Cont.)

DTMF support	
Audio control:	Echo suppression, noise suppression, side tone and gain control

Table 1-1: Product Specifications (Cont.)

GSM Supplementary Service
USSD Phase II
Call forwarding
Call hold, waiting and multiparty
Call diverting
Missed-call indicator
AOC
Call barring
Character Set
UTF8
UCS2
ASCII
GSM
8859-1
Control/Status Indicators
GSM/GPRS/EGPRS coverage
Wakeup
TX enable
Reset
Antenna Detect
Features over RS232
Embedded TCP/IP stack
AT Command Set
GSM 07.05
GSM 07.07
Motorola proprietary AT commands
Accessories
Firmware data loader
Data logger
Developer Kit

Regulatory Approvals

The H24 module has been tested and approved under the standards and regulations listed below:

- FCC
- DOC
- R&TTE
- PTCRB
- IC
- CTIA
- FTA
- EMC

Important: The following paragraphs must be addressed by the integrator to ensure their host is in compliance to the H24 FCC grant and/or the FCC grant of the host device.

CFR 47 Part 15.19 specifies label requirements

The following text may be on the product, user's manual, or container.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

CFR 47 Part 15.21 Information to user

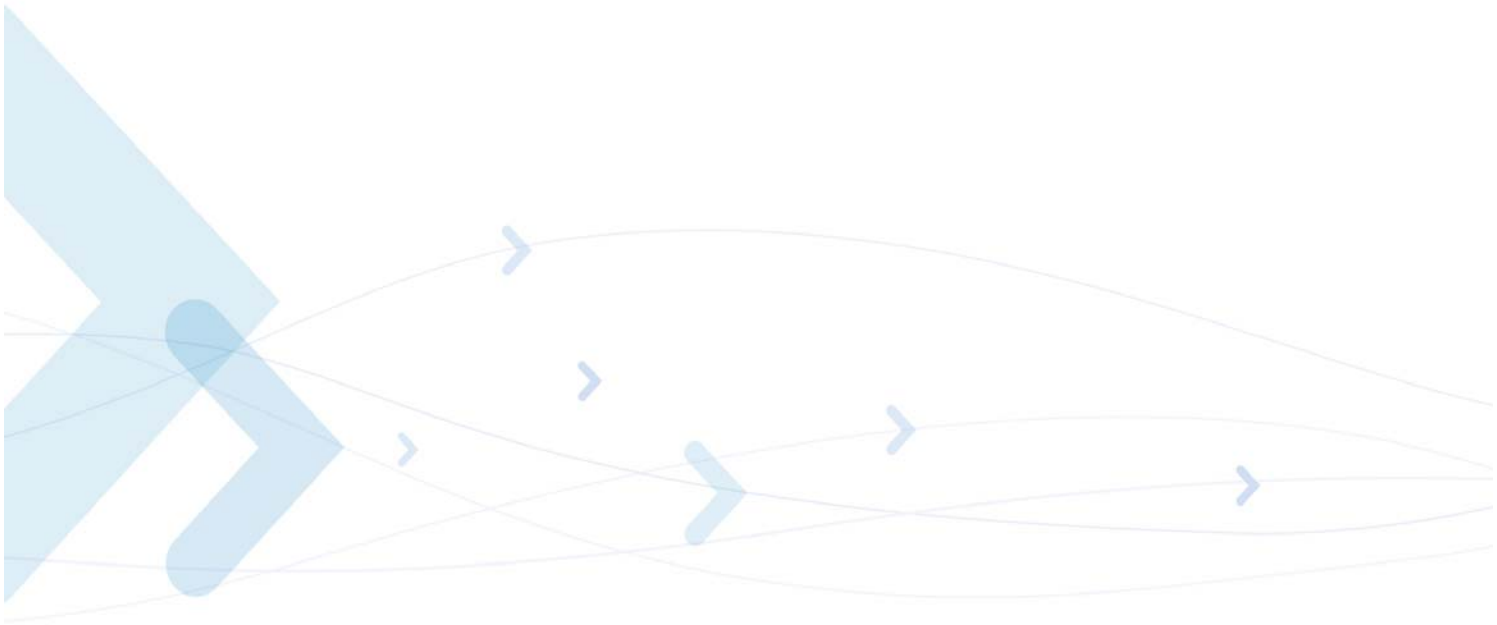
The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. In cases where the manual is provided only in a form other than paper, such as on a computer disk or over the Internet, the information required by this section may be included in the manual in that alternative form, provided the user can reasonably be expected to have the capability to access information in that form.

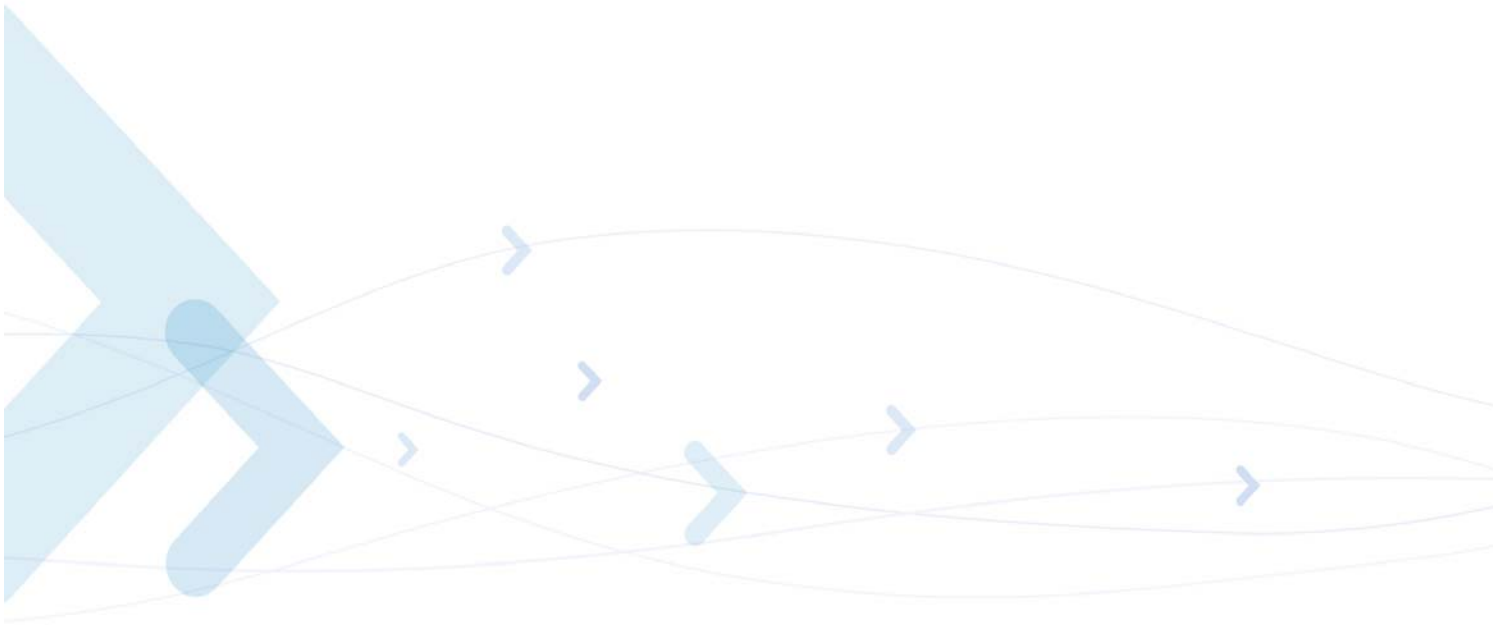
CFR 47 Part 15.105 Information to the user

(b) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

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

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





Chapter 2: Hardware Interface Description

The following paragraphs describe in details the hardware requirements for properly interfacing and operating the H24 module.

Architecture Overview

Figure 2-1 below illustrates the primary functional components of the H24.

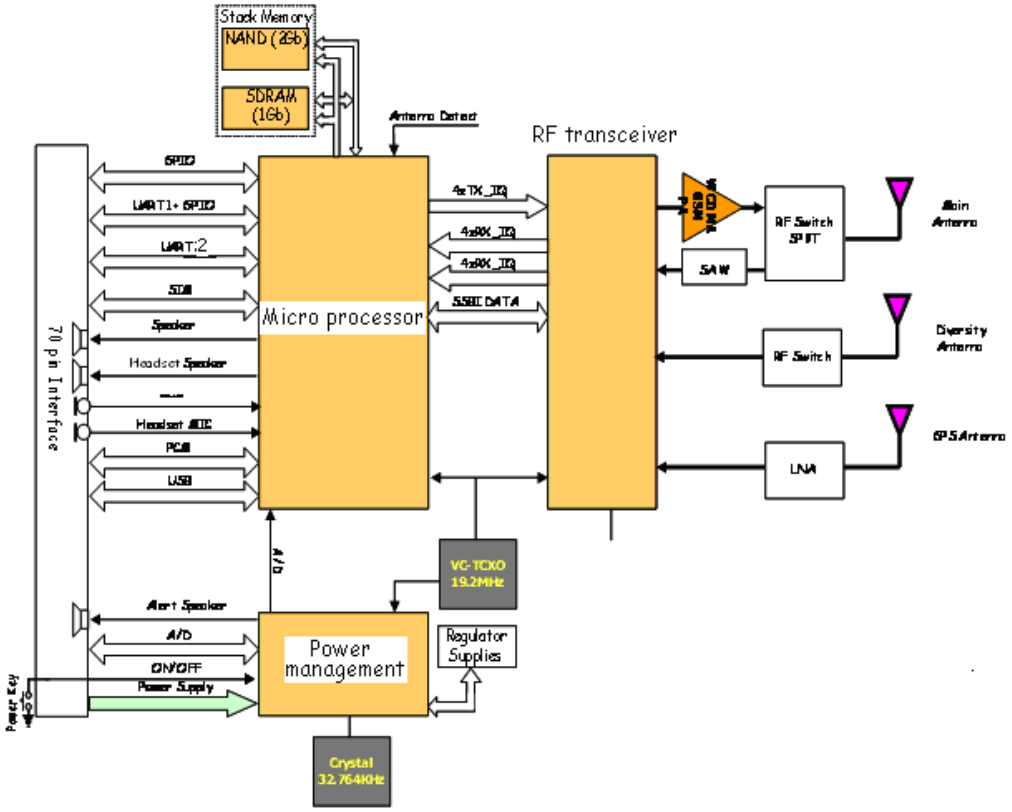


Figure 2-1: H24 Block Diagram

The H24 consists of the following blocks:

Digital Block

- Micro-controller Unit (MCU) for system and user code execution.
- Digital Signal Processor (DSP) for voice and data processing.
- Serial communications interfaces.
  - USB driver interface
  - UART1
  - UART2
  - I2C
  - SIM card
- Digital audio (PCM) bus interface.
- General purpose IO signals.

Analog Block

- Power Management IC (PMIC).
  - Internal regulators
  - 1 external regulator for customer use
- Analog audio interface management.
  - Speaker, microphone
  - Alert speaker
  - Headset
- General purpose and dedicated A/D signals.
  - A/D
  - Voltage sensor
  - Temperature sensor
- Real Time Clock (RTC) subsystem.

RF Transceiver Block

Figure 2-2 is a detailed RF block diagram.

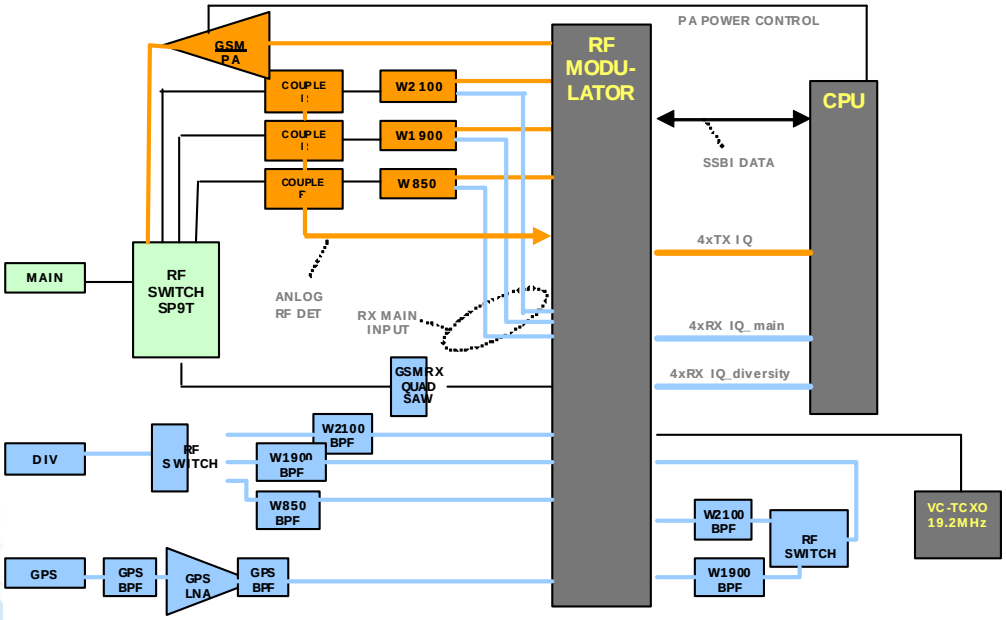


Figure 2-2: RF Block Diagram

WCDMA Transceiver

- RTR6285 includes: modulator, receiver, LNAs, Mixers, VCOs, I/Q outputs and buffers for all WCDMA bands.
- Three RF Power Amplifiers for B1-2100, B2-1900 & B5 - 850.
- Three couplers for feedback into the Modulator for each band.
- RF Switch SP9T for selecting corrected path to and from main MMCX connector.
- Receive path is inside PA via internal duplexer into the RTR.
- Internal LNAs for all WCDMA bands inside RTR
- External switch, RF SPDT, from WB1900 & WB2100 LNA's output into one receiver's differential input.
- Diversity path: From Diversity UFL connector via SP3T into SAW filter for WB2100, WB1900 & WB850 fed into secondary receivers inputs inside the RTR.

GPS

- External LNA for improved GPS performances.

GSM Transceiver Block

- RF power amplifier.
  - 2 gain ranges for the low (850/900) and high (1800/1900) GSM bands.
- RF transceiver, which includes LNAs, Mixers, VCOs, I/Q outputs and buffers.
- Signal processing IC for transmit and receive GSM data processing.
- FEM - Front End Module.
  - Includes a harmonic filter and antenna switch
- Filters - Two dual-band SAW filter that selects the required receive band and selects band filter for low band PA input.

Operating Modes

H24 incorporates several operating modes. Each operating mode is different in the active features and interfaces.

Table 2-1 summarizes the general characteristics of the H24 operating modes and provides general guidelines for operation.

Table 2-1: H24 Operating Modes

Mode	Description	Features
Not Powered	VCC supply is disconnected.	The H24 is Off. Any signals connected to the interface connector must be set low or tri-state.
Off Mode	Valid VCC supply. RESET_N signal is enabled (low).	The H24 Interfaces are Off. Only the internal RTC timer is operating. Any signals connected to the interface connector must be set low or tri-stated.
Idle Mode	RESET_N signal is disabled (high). CTS_N and DSR_N signals are enabled (low).	The H24 is fully active, registered to the GSM network and ready to communicate. This is the default power-up mode.
Sleep Mode	RESET_N signal is high. CTS_N signal is disabled.	The H24 is in low power mode. The application interfaces are disabled, but, H24 continues to monitor the GSM network.
CSD call or GPRS/EGPRS data	RESET_N signal is high. TXEN_N signal is toggling.	A GSM voice or data call is in progress.When the call terminates, H24 returns to the last operating state (Idle or Sleep).
CSD call or WCDMA/HSDPA data	RESET_N signal is high. TXEN_N signal is toggling.	A GSM voice or data call is in progress. When the call terminates, H24 returns to the last operating state (Idle or Sleep).

Power Supply

The H24 power supply must be a single external DC voltage source of 3.3V to 4.2V. The power supply must be able to sustain the voltage level during a GSM transmit burst current surge, which may reach 2.0A.

The H24 interface connector has 8 contacts for the main power supply, as described in Table 2-2. All these contacts must be used for proper operation.

Table 2-2: Power Supply Signals

Pin #	Signal Name	Description
1-4	GND	Main ground connection for H24 module.
5-8	VCC	DC supply input for H24 module. V_{IN} = 3.3 V to 4.2 V I_{MAX} = 2 A during transmit bursts Maximum rise time: 8mS AC ripple: +/-3%

Power Supply Design

Special care must be taken when designing the power supply of the H24. The single external DC power source indirectly supplies all the digital and analog interfaces, but also directly supplies the RF power amplifier (PA). Therefore, any degradation in the power supply performance, due to losses, noises or transients, will directly affect the H24 performance.

The burst-mode operation of the GSM transmission and reception, draws instantaneous current surges from the power supply, which causes temporary voltage drops of the power supply level. The transmission bursts consume the most instantaneous current, and therefore cause the largest voltage drop. If the voltage drops are not minimized, the frequent voltage fluctuations may degrade the H24 performance.

Figure 2-3 illustrates the power supply behavior during GSM transmission.

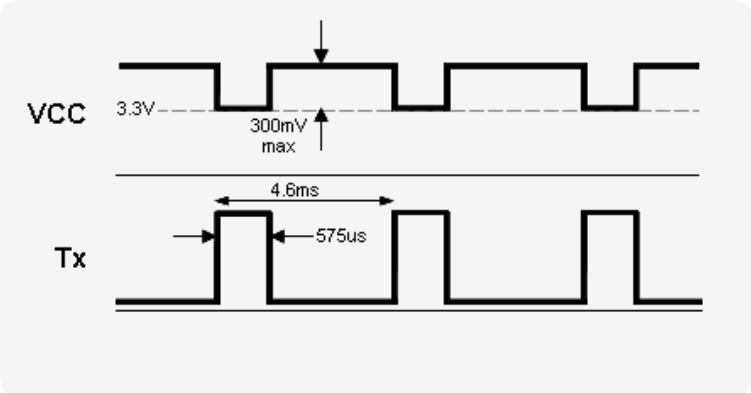


Figure 2-3: Transmission Power Drops

Note: 1 TX slot is shown.

It is recommended that the voltage drops during a transmit burst will not exceed 300mV, measured on the H24 interface connector. In any case, the H24 supply input must not drop below the minimum operating level during a transmit burst. Dropping below the minimum operating level may result in a low voltage detection, which will initiate an automatic power-off.

To minimize the losses and transients on the power supply lines, it is recommended to follow these guidelines:

- Use a 1000 uF, or greater, low ESR capacitor on the H24 supply inputs. The capacitor should be located as near to the H24 interface connector as possible.
- Use low impedance power source, cabling and board routing.
- Use cabling and routing as short as possible.
- Filter the H24 supply lines using filtering capacitors, as described in Table 2-3.

Table 2-3: Recommended Power Supply Filtering

Capacitor	Usage	Description
1000 uF	GSM Transmit current serge	Minimizes power supply losses during transmit bursts- no more than 200mV. Use maximum possible value.
10 nF, 100 nF	Digital switching noise	Filters digital logic noises from clocks and data sources.
8.2 pF, 10 pF	1800/1900/2100 MHz bands	Filters transmission EMI.
33 pF, 39 pF	850/900 MHz bands	Filters transmission EMI.

Current Consumption

The tables below specify typical H24 current consumption ratings in various operating modes. The current ratings refer to the overall H24 current consumption over the VCC supply.

Table 2-4: H24 Operation Mode Current Consumption -GSM

Operating Mode	Supply Voltage VIN[V]	Total Current [mA]
		25°C
Powered OFF	3.2	80uA
	3.8	100uA
	4.2	110uA
SLEEP	3.2	NA
	3.8	NA
	4.2	NA
IDLE	3.2	33.03
	3.8	30.74
	4.2	28.8
Full Power TX	3.7	294
	4.2	291

Note: WCDMA@24.3dbm

Table 2-5: WCDMA current draw

Supply Voltage [V]	Total Current [mA]	Remarks
3.7	754	
4.2	737	

Note: HSDPA@0dbm

Table 2-6: HSDPA current draw

Supply Voltage [V]	Total Current [mA]	Remarks
3.7	290	
4.2	262	

Power On/Off Operation

The H24 power on and off process includes two primary phases, which are indicated at the interface connector by the hardware output signals RESET_N and CTS_N.

The RESET_N signal indicates whether H24 is powered on or off.

When this signal is enabled (low), H24 is powered-off. When it is disabled (high), H24 is powered-on.

The CTS_N signal indicates the serial communications interface (UART) status. When this signal is high, the H24 serial interface is disabled. When it is low, the serial interface is enabled, and H24 is ready to communicate.

These same conditions apply to the CTS2_N signal with regards to the second serial interface (UART2).

Important: Do not operate the H24 out of its electrical or environmental limits. Refer to the specifications chapter for details of these limits.

Turning the H24 On

When the H24 power supply is stable above the minimum operating level and H24 is powered off, only the internal RTC timer is active.

When H24 is turned on, by any of the methods described below, it will first perform an automatic internal system-test, during which basic functions are verified. The system-test duration is typically TBD milliseconds. When the system-test has completed H24 resumes normal operation.

During the internal system-test process H24 may toggle several interface signals, which are visible to the application. These signals do not represent any valid state or data, and should be ignored by the customer application until the system-test has completed.

Power Supply Turn-on

When connecting the power supply for the first time, or when reconnecting it after a power supply loss, H24 will power-on. The H24 is turned-on automatically when external power is applied above the minimum operating level.

The H24 will power-off automatically, in case it is not powered-on by the ON_N or IGN signals, after the internal system-test period (typically TBD) is completed.

If the ON_N or IGN signals are asserted during that period, H24 will respond accordingly and continue to power-up normally.

The ON_N and IGN signals will be active and responding only after the power supply to the H24 is stable above the minimum operating level. Therefore, the ON_N and IGN signals must not be used for at least 100 milliseconds after applying power to H24.

Figure 2-4 illustrates the H24 power on and off upon application of a power supply, during which the ON_N or IGN signals are not asserted.

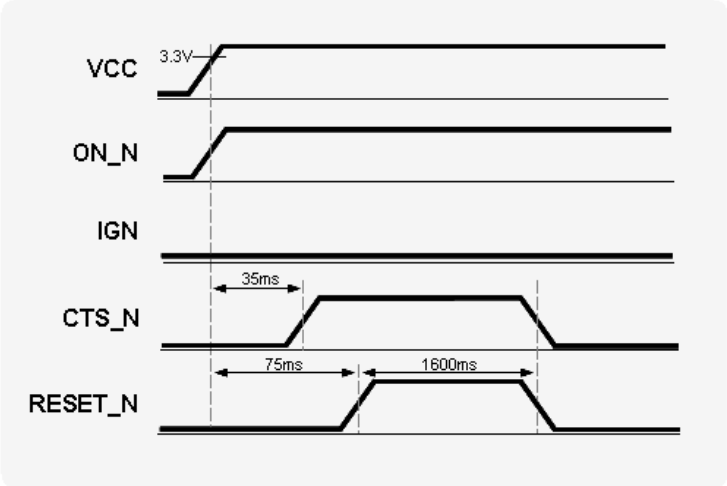


Figure 2-4: Power Supply Turn-on and Off

Turning the H24 On Using ON_N

The ON_N input signal is set high by an internal pull-up resistor whenever a power supply is applied to H24. Therefore, it is recommended to operate this signal using an open collector/drain circuit connection.

Asserting the ON_N signal low for a minimum of 500 milliseconds (0.5 seconds) and a maximum of 1.5 seconds will cause the H24 to turn-on.

Asserting the ON_N signal low for more than 1.5 seconds may cause the H24 to interpret the signal as a power-off command, and turn off immediately after turning on.

Turning the H24 On Using IGN

The IGN input signal must be set low when not used. To turn on H24, this signal must be asserted high. The IGN signal must remain high for the duration of the H24 operation. H24 powers down when the IGN signal is returned to its low state.

Turning the H24 Off

There are several ways to turn the H24 off:

- Asserting the ON_N signal low for a minimum of 2 seconds.
- Setting the IGN signal low.
- Low power automatic shut down.
- AT command.

Turning the H24 Off Using ON_N

The ON_N signal is set high using an internal pull up resistor when power is applied to H24. Asserting the ON_N signal low for a minimum of 2 seconds will turn H24 off. This will initiate a normal power-off process, which includes disabling of all applications interfaces (UART, SIM card, audio, etc.) and closing the network connection.

Turning the H24 Off Using IGN

The IGN signal may be used to power off H24 only if it was also used to power it on. When the IGN signal is set low, H24 will turn off. This will initiate a normal power-off process, which includes disabling of all applications interfaces (UART, SIM card, audio, etc.) and closing the network connection.

The IGN signal will not power off H24 before 30 seconds have elapsed since H24 was powered-on. This delay mechanism is implemented to protect H24 from unexpected transients on the IGN line during power up, particularly when applying vehicle cranking waveforms.

Power Loss shut down

A low power shut down occurs when H24 senses the external power supply is below the minimal operating limit. The module will respond by powering down automatically without notice.

This form of power-down is not recommended for regular use since the unexpected power loss may result in loss of data.

Turning the H24 Off Using AT+MPWRDN

The AT+MPWRDN command initiates a H24 power down. This command emulates the ON_N signal operation for power off.

Low Power Mode

The H24 incorporates an optional low power mode, called Sleep Mode, in which it operates in minimum functionality, and therefore draws significantly less current. During low power mode the H24 network connection is not lost. H24 continues to monitor the GSM network constantly for any incoming calls or data.

During low power mode, all of the H24 interface signals are inactive and are kept in their previous state, prior to activating low power mode. To save power, all the H24 internal clocks and circuits are shut down, and therefore serial communications is limited.

Activating Low Power Mode

UART:

By default, the H24 powers on in Idle mode. In this mode the H24 interfaces and features are functional and the module is fully active.

Low power mode is controlled by the AT+MSLEEP & ATS24 commands.

The command AT+MSLEEP=1 enable Sleep Mode (AT+MSLEEP=0 disable Sleep Mode).

The value of S24 command determines the inactive state duration required by H24, in seconds, after which H24 will enter sleep mode.

For example:

ATS24 = 1 activates low power mode after 1 second of inactivity.

ATS24 = 5 activates low power mode after 5 seconds of inactivity.

Note: ATS24=0 will not disable sleep mode at H24.

AT+MSLEEP = 0 disables low power mode (default).

Important: H24 will not enter low power mode in any case when there is data present on the serial interface.Also when any network (GSM/UMTS) activity (e.g. incoming voice call, data session) or an internal system task is running. Only when processing of any external or internal system task has completed, if AT+MSLEEP=1 and H24 UARTis inactive for the duration of ATS24, H24 will enter low power mode.

Important: H24 will not enter low power mode when USB is operating. Connecting USB to the H24 will disable the low power mode operation.

USB:

Any transaction to the USB will wake up the h24 provided the user USB stack supports suspend/resume mechanism. In case such mechanism is not supported the user will have to wake up the H24 with the wakeup in line prior to any transaction.

In case of resume event the SW will be responsible to all the needed configurations (endpoints etc.) to maintain the link. In case the host USB protocols stack doesn't support resume suspend mechanism the USB module in the H24 will not go to sleep hence the entire H24 will remain active as long as the USB cable is connected.

Remote wake up is supported.

If USB is connected the CTS signal state will not be change when enter to Sleep Mode.

Serial Interface During Low Power Mode

During low power mode the H24 serial interfaces are disabled. This is indicated by the CTS_N signal high state (if hardware flow control is set by AT+IFC=1,1 (or AT&K4) and CTS control is set by AT+MSCTS=1 command).

The H24 wakes up periodically from low power mode to listen to page channel of the GSM network for any incoming calls or data. After this short paging is completed, H24 returns to low power mode. During this short awake period, the serial interfaces are enabled and communications with the module is possible (if AT+IFC=1,1 (or AT&K4) & AT+MSCTS=1 commands are in use).

The CTS_N signal is alternately enabled and disabled synchronously with the network paging cycle. CTS_N is enabled whenever H24 awakes to page the network. This indicates the H24 serial interfaces are active (see Figure 2-5).

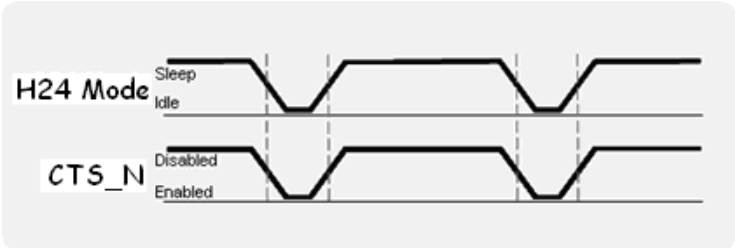


Figure 2-5: CTS Signal During Sleep Mode

The periodical enabling and disabling of the CTS_N signal during low power mode can be controlled by the AT+MSCTS command.

Setting AT+MSCTS=1 permanently disables the serial interface during low power mode, even during a network page by H24. The CTS_N signal is disabled, and therefore the serial interfaces are blocked.

Terminating Low Power Mode

Terminating the low power mode, or wake-up, is defined as the transition of the H24 operating state from Sleep mode to Idle mode. There are several ways (using UART CTS_N signal, WKUPI_N line or UART RX line interrupt) to wake-up H24 from low power mode as described below.

Important: During power saving mode the H24 internal clocks and circuits are disabled, in order to minimize power consumption. When terminating the power saving mode, and switching to Idle mode, H24 requires a minimal delay time to reactivate and stabilize its internal circuits before it can respond to application data.
This delay is typically of TBD milliseconds, and is also indicated by the CTS_N signal inactive (high) state. The delay guarantees that data on the serial interface is not lost or misinterpreted.

Temporary Termination of Low Power Mode

The WKUPI_N signal is an active low input that is set high by default. By asserting this signal low the application can wake-up H24 from low power mode and switch to idle mode.

Low power mode may be terminated temporarily by several sources, some of which are user initiated and others are initiated by the system.

Using the WKUPI_N signal to wake UART from Sleep Mode

The WKUPI_N signal is an active low input, that is set high by default. By asserting this signal low the application can wake-up H24 from low power mode and switch to Idle mode.

H24 will remain in idle mode, awake and fully active, as long as WKUPI_N signal remains low. When this signal is disabled and set high again, H24 will return to Sleep mode automatically, according to the ATS24 settings (see Figure 2-6).

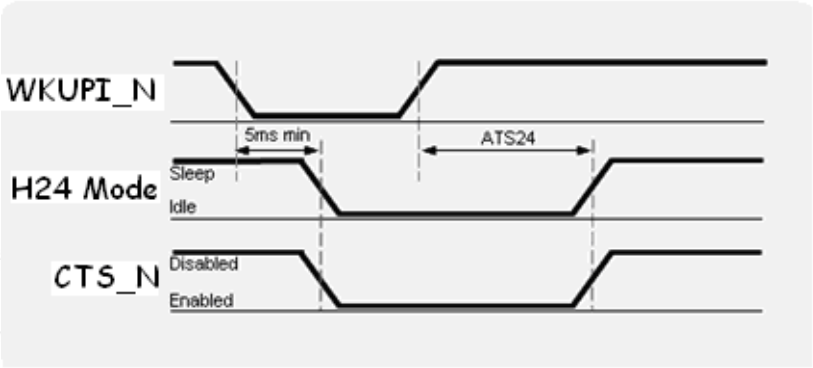


Figure 2-6: WKUPI_N Signal Operation

The WKUPI_N signal is the **recommended** method to temporarily wake-up H24 from low power mode. It provides the application full control of the H24 operating mode and guarantees that data on the serial interface will not be lost or misinterpreted.

The WKUPI_N signal can be used to wake up H24 from low power mode. If the serial interface has been controlled by the AT+IFC=1,1 (or AT&K4) command, the application can work in Hardware Flow Control accumulate the data in its buffer and send it to the module when the CTS is Enabled. (Note: this method of operation works without using AT+MSCTS=1 command).

Incoming Network Data

During low power mode, H24 continues monitoring the network (GSM or UMTS) for any incoming data, message or voice calls.

When H24 receives an indication from the network that an incoming voice call, message or data is available, it automatically wakes up from low power mode to alert the application. When H24 has completed to process all the tasks related to the incoming data, it will automatically return to low power mode according to the ATS24 settings.

Depending on the type of network indication and the application settings, H24 may operate in several methods, which are configurable by AT commands, to alert the application of the incoming data:

- Enable the WKUPO_N signal to wake-up the application from low power.
- Send data to the application over the serial interface.

- Enable the serial interface's Ring Indicator (RI_N) signal.

Data on the Serial interface

While H24 is temporarily awake in Idle mode, data may be transmitted on the serial interface. In case data is being transmitted in any direction, H24 will not return to low power mode. This is regardless of the original wake-up reason or source. H24 will remain awake while data is transferred.

Only when the serial interface transfer is completed and the data has been processed, H24 will return to low power mode automatically, according to the ATS24 settings (see Figure 2-7).

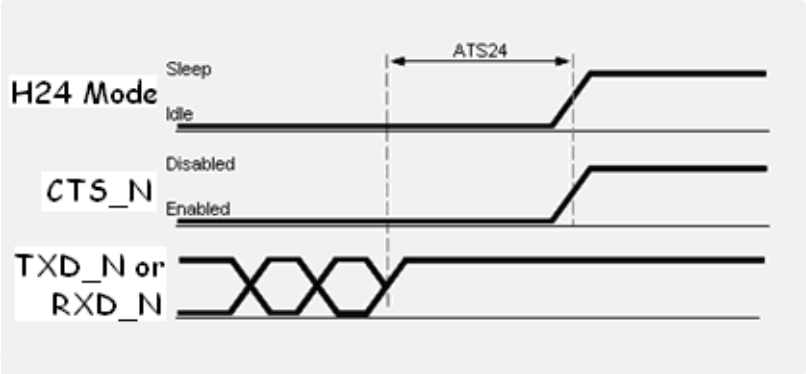


Figure 2-7: Serial Interface Data

UART Exiting of Low Power Mode

The H24 low power mode is enabled and disabled by the ATS24 command.

To permanently terminate the H24 low power mode, the +MSLEEP=0 command must be used. Setting AT+MSLEEP=0 disables the currently active low power mode and switches H24 to Idle mode.

H24 will not return to low power mode until an AT+MSLEEP=1 commands is set again.

This command can be sent only when the serial interface is active.

In case the serial interface is disabled, Hardware Flow control is OFF and WKUP_I is not used, it must first be activated before sending this command. To reactivate the serial interface, a temporary termination of the low power mode is required, by sending "A" (or any other AT command) that will catch by the RX line interrupt service rotiine and will use to wake up the module for S24 [second] (The execution of the first command after exit Sleep Mode is not guarantied and can happened if the module was already waked by the RF paging channel).

Real Time Clock

H24 incorporates a Real Time Clock (RTC) mechanism that performs many internal functions, one of which is keeping time. The RTC subsystem is embedded in the PMIC and operates in all of the H24 operating modes (Off, Idle, Sleep), as long as power is supplied above the minimum operating level.

The H24 time and date can be set using the following methods:

- Automatically retrieved from the GSM network.
  In case H24 is operated in a GSM network that supports automatic time zone updating, it will update the RTC with the local time and date upon connection to the network. The RTC will continue to keep the time from that point.
- Using the AT+CCLK command.
  Setting the time and date manually by this AT commands overrides the automatic network update.
  Once the time and date are manually updated, the RTC timer will keep the time and date synchronized regardless of the H24 operating state.

When the power supply is disconnected from H24, the RTC timer will reset and the current time and date will be lost. On the next H24 power-up the time and date will need to be set again automatically or manually.

Nevertheless, there is ability to keep the RTC working while main power supply is off.

This can be done by supplying the RTC an external power of 3V to a dedicated pin in the microprocessor.

This dedicated pin is called Vcoin.

When the main power supply is off and Vcoin is active, the RTC is still working.

The default state is that in this case (main power supply is off and Vcoin is active) the RTC will work only for 2 sec, and will turn "off". This period can be changed by SW according to costumer’s request.

Serial Interfaces

H24 includes three completely independent serial communications interfaces, which may be used by the application for several purposes.

Primary UART (UART1)

The H24 primary UART is a standard 8-signal bus. The primary UART is used for all the communications with H24 - AT commands interface, GPRS/EGPRS data and CSD data, programming and software upgrades.

The UART signals are active low CMOS level signals. For standard RS232 communications with a PC, an external transceiver is required.

H24 is defined as a DCE device, and the user application is defined as the DTE device. These definitions apply for the UART signals naming conventions, and the direction of data flow, as described in Figure 2-8.

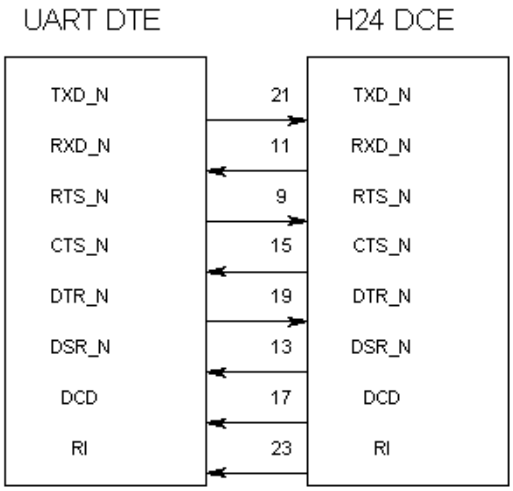


Figure 2-8: UART1 Interface Signals

The H24 primary UART supports maximum data rate of up to 4 Mbps using the UART1DM data mover interface and up to 230 kbps for data services using the UART1 interface.

All flow control handshakes are supported: hardware, software, or none.

Parity bit and Stop bit definitions are also supported.

The UART default port configuration is 8 data bits, 1 stop bit and no parity, with hardware flow control and auto baud rate detect enabled.

Secondary UART (UART2)

The secondary UART is a 4-signal interface, which only provides data and flow control signals. The secondary UART is designed, but not limited, to enhance the H24 capabilities by providing connectivity to external devices or applications that require serial communications, such as GPS receivers or Bluetooth wireless devices.

The secondary UART may also be used for standard serial communications, like the primary UART.

The UART signals are active low CMOS level signals. For standard RS232 communications with a PC, an external transceiver is required.

H24 is defined as a DCE device, and the user application is defined as the DTE device. These definitions apply for the UART signals naming conventions, and the direction of data flow, as described in Figure 2-9.

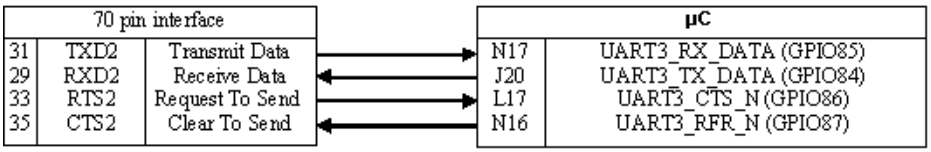


Figure 2-9: UART2 Interface Signals

USB Interface

H24 incorporates a standard Universal Serial Bus (USB) interface.

The H24 USB electrical interface and protocol conform to the USB 2.0 full-speed specifications. H24 is defined as a USB device on the USB bus and does not support hub or host functionality.

USB may be used for standard communications with H24, as done through the UART interface.

The USB interface signals are shown in Figure 2-10.

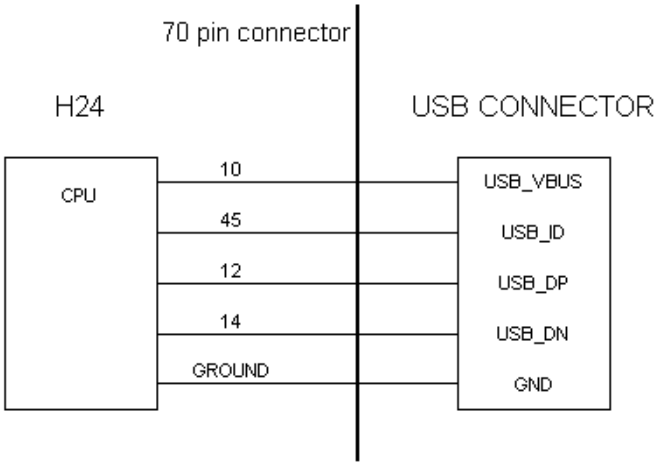


Figure 2-10: USB Interface Signals

UID determines the USB mode configuration: Host or Client.

SIM Interface

The H24 incorporates a SIM interface, which conforms to the GSM 11.11 and GSM 11.12 standards, that are based on the ISO/IEC 7816 standard. These standards define the electrical, signaling and protocol specifications of a GSM SIM card.

H24 does not incorporate an on-board SIM card tray for SIM placement. The SIM must be located on the user application board, external to the H24. The H24 SIM interface includes all the necessary signals, which are routed to the interface connector, for a direct and complete connection to an external SIM.

H24 supports dynamic detection of the SIM card, through a dedicated SIM detection signal. H24 will detect a SIM card insertion or removal upon power up or during operation by the transitions on the SIM_PD_N signal.

SIM Connection

Table 2-7 details the SIM interface signals.

Table 2-7: SIM Interface Signals

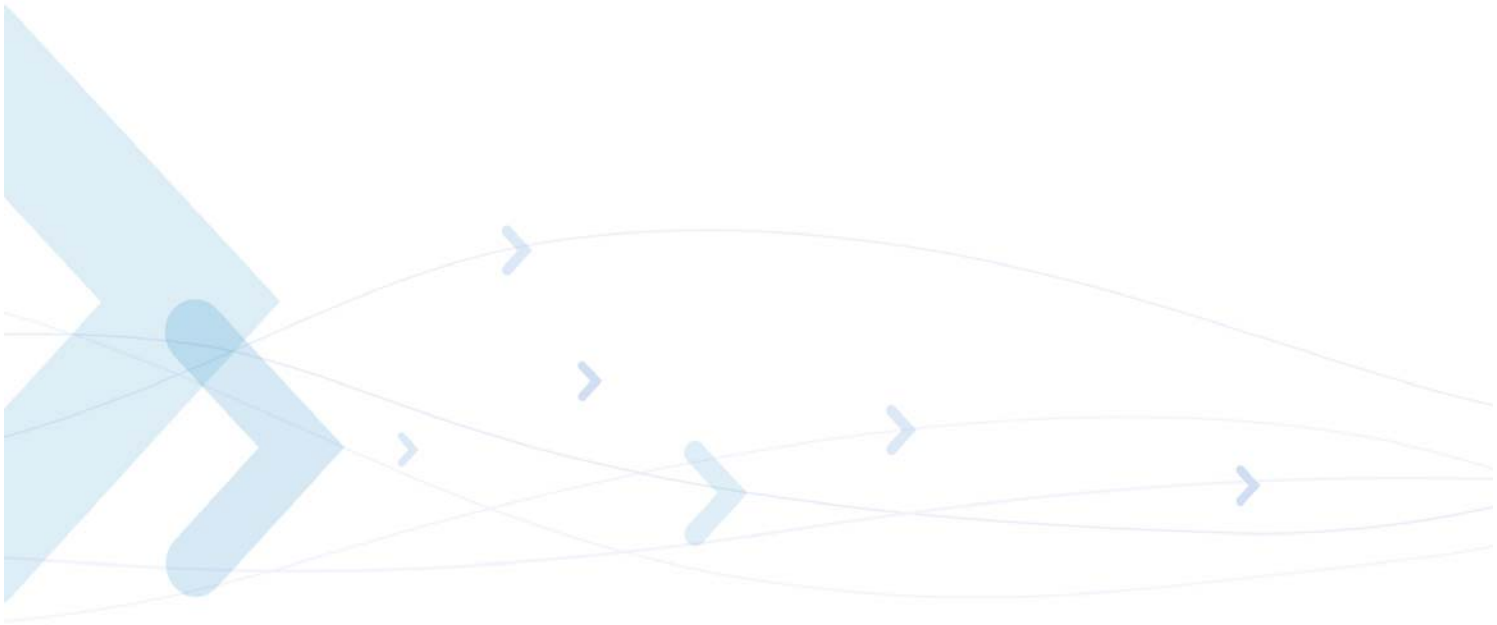
Connected to 70 pin	H24	Interruptible
44	SIM_RST_N	N
46	SIM_CLK	N
48	SIM_VCC	N
50	SIM_PD_N	Y
52	SIM_DIO	N

SIM Design Guidelines

The SIM interface and signals design is extremely important for proper operation of H24 and the SIM card. There are several design guidelines that must be followed to achieve a robust and stable design that meets the required standards and regulations.

- Using the SIM detection signal, SIM_PD_N, is mandatory in case the SIM card is accessible to the user and may be removed during H24 operation. To avoid any damage to the SIM or H24, the SIM interface signals must be deactivated before the SIM card contacts are mechanically removed from the SIM tray contacts. Therefore, the SIM_PD_N detection signal must be disabled before the SIM is removed from its tray.
- The SIM should be located, and its signals should be routed, away from any possible EMI sources, such as the RF antenna and digital switching signals.
- The SIM interface signals length should not exceed 100 mm between the H24 interface connector and the SIM tray. This is to meet with EMC regulations and improve signal integrity.
- To avoid crosstalk between the SIM clock and data signals (SIM_CLK and SIM_DIO), it is recommended to rout them separately on the application board, and preferably isolated by a surrounding ground plane.

- The SIM card signals should be protected from ESD using very low capacitance protective elements (zener diodes, etc.).
- The H24 interface does not support SIM programming through the VPP signal. This signal should not be connected to H24.
- SIM voltage level will not drop below 2.7V (1.6V for 1.8V SIM card) during hot insertion.



Audio Interface

The H24 audio interface supports several audio devices and operating modes.

The audio interface's operating modes, active devices, amplification levels and speech processing algorithms are fully controlled by the host application, through advanced programming options and a versatile AT commands set.

The H24 supports the following audio devices:

- Two single-ended/ Differential and biased mono analog microphone inputs for use in a variety of modes.
- Differential mono analog speaker output.
- Differential mono analog alert output. (Amplified to 1W)
- Single-ended mono analog headset output.
- A digital serial interface using PCM coding.

All the above analog audio paths with the interface to the 70 pin connector are shown in Figure 2-11.

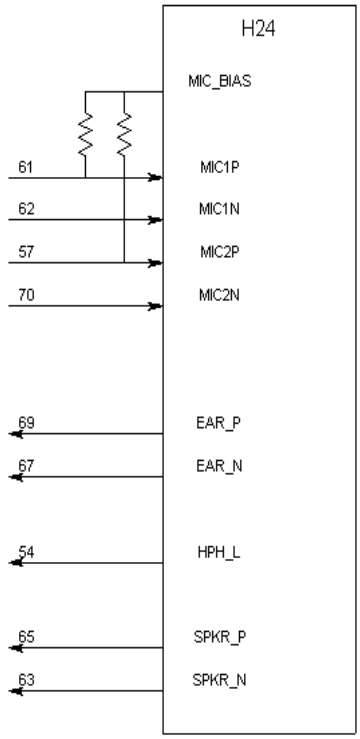


Figure 2-11: H24 Audio Interface

Handset Interface

Typical handset interfaces are shown in Figure 2-12. The earphone output pins are connected directly to the handset's earphone with 2 bypass capacitors connected to ground. The capacitance is selected de-pending on the design, typically less than 100 pF.

The output power for the differential EAR1 output is typically 70 mW for a full-scale +3 dBm0 sine wave into a 32Ω speaker.

Both microphone pins require 2.2 k bias resistors and 0.1µF AC-coupling capacitors.

The positive microphone terminal is connected to the µC MICBIAS pin through one of the 2.2 kΩ resistors; this 1.8 V output provides 1 mA of bias current for the Microphone.

MICBIAS supports multiple microphones simultaneously up to 1 mA.

In case the user connect single-ended mic, he must connect it to pin 61 and short circuit pin 62 to ground.

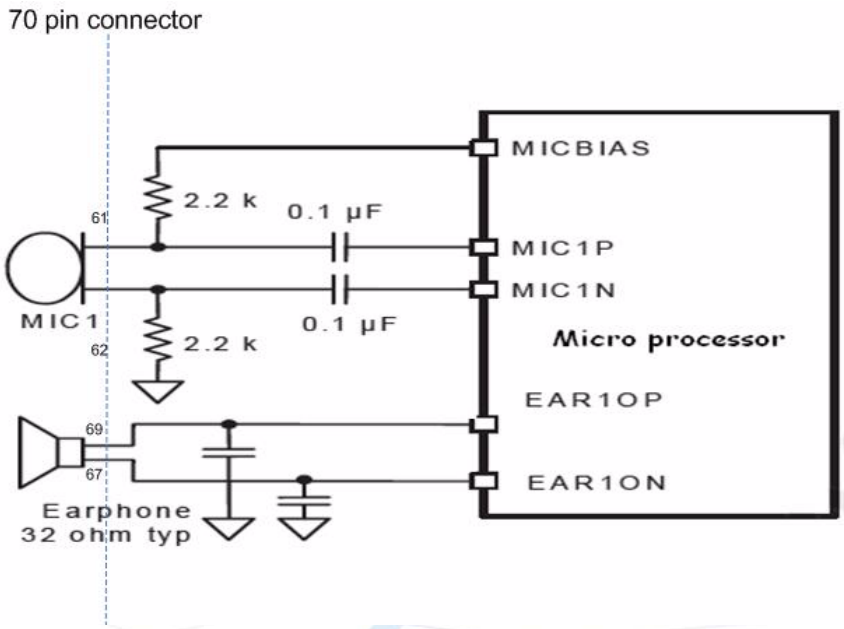


Figure 2-12: Handset Interface

Headset Interface

The most basic handset configuration is shown in Figure 2-13. This configuration uses an AC-coupled mono earphone interface and a standard single-ended microphone interface.

The output power for the single-ended HPH_L/HPH_R output is typically 21.6 mW per side for a full-scale +3 dBm0 sine wave into a 15Ω speaker.

Few alternative earphone configurations are given in the following paragraphs. If the load capacitance is greater than 100 pF due to earphones with different capacitive load used, a RC

shunt network (0.22µF and 22Ω) is recommended to prevent oscillations as shown in Figure 2-13.

Note: In case a differential mic is used, the negative node should be connected to pin 70.

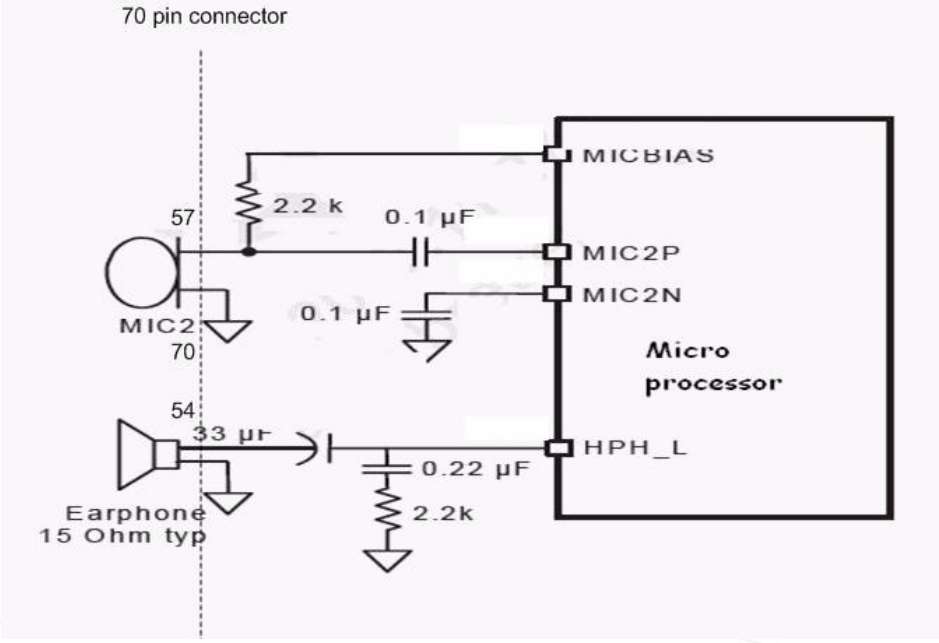


Figure 2-13: Headset Interface

Interface to an External Speaker Amplifier

The power management device can also be used as a speaker amplifier. The power management speaker driver output power is rated at 500 mW. To use this feature as an amplifier of an audio output, be sure to set the appropriate speaker driver analog and digital gains, and set the analog high-pass filter corner at the resonant frequency of the far-field speaker transducer (see Figure 2-14).

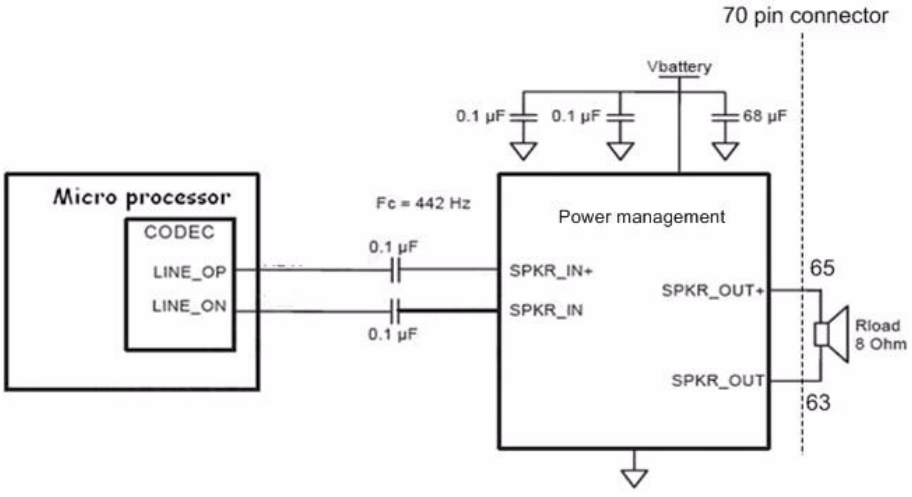


Figure 2-14: External Speaker

Audio Design

The audio quality delivered by H24 is highly affected by the application audio design, particularly when using the analog audio interface. Therefore, special care must be taken when designing the H24 audio interface. Improper design and implementation of the audio interface will result in poor audio quality.

Poor audio quality is a result of electrical interferences, or noises, from circuits surrounding the audio interface. There are several possible sources for the audio noise:

- Transients and losses on the power supply
- EMI from antenna radiations
- Digital logic switching noise

Most of the audio noise originates from the GSM transmit burst current surges (217 Hz TDMA buzz), which appear on the main power supply lines and antenna, but also indirectly penetrate the internal application's supplies and signals. The noises are transferred into the H24's audio circuits through the microphone input signals and then are amplified by the H24's internal audio amplifiers.

To minimize the audio noise and improve the audio performance the microphone and speaker signals must be designed with sufficient protection from surrounding noises.

The following guidelines should be followed to achieve best audio performance:

- Reference the microphone input circuits to the H24 AGND interface signal.
- If using single-ended audio outputs, they should be referenced to the H24 AGND interface signal.
- Keep the audio circuits away from the antenna.
- Use RF filtering capacitors on the audio signals, as described in Table 2-3.
- The audio signals should not be routed adjacent to digital signals.
- Isolate the audio signals by a surrounding ground plane or shields.
- Filter internal supplies and signals that may indirectly affect the audio circuits, from noises and voltage drops.

Analog Ground

The H24 interface incorporates a dedicated analog ground contact, AGND pin 59, which is internally connected to the H24's ground. The AGND signal is intended to provide a separate ground connection for the application's external audio devices and circuits.

This signal provides an isolated ground connection directly from H24, which is separated from the noisy digital ground of the application. It is recommended to connect this signal to analog audio devices and circuits used by the application. Using a separate analog ground minimizes audio noises and improves the audio circuit's immunity from external interferences.

Digital Audio Interface

The H24 digital audio interface is a serial Pulse Code Modulation (PCM) bus, which uses linear 2's compliment coding. H24 is the PCM bus master, supplying the clock and sync signals to the application.

The H24 digital interface is a 4 signal PCM bus, which includes a bit clock output signal for the bus timing, a frame sync output signal for audio sampling timing, and serial data input and output signals.

Important: The PCM bus signals are shared internally by the analog audio interface and the digital audio interface. Therefore, when using the analog audio interface the PCM bus signals must be tri-stated or disconnected at the interface connector.

The digital audio interface supports 4 types of audio data formats, which define the PCM bus configuration and data rates:

- Voice band audio - Intended for speech during voice calls and for mono rings and alerts.
- Stereo audio - Includes 3 audio formats that support high quality stereo ring tones and alerts.

The PCM bus configuration is defined by the audio data format that is sounded through the digital audio path, as described in Table 2-8.

Table 2-8: Digital Audio modes

Audio Mode	Frame Sync Sampling	Bit Clock	AT+CRTT Tones
Voice			
Mono tones			
Stereo low tones			
Stereo high tones			

Voiceband Audio

This digital voice audio format is used for speech during voice calls and for mono rings and alerts.

The PCM bus signal's configuration for voiceband audio is:

- PCM_CLK - 2048 kHz serial clock
- PCM_FS - 8 kHz bit-wide frame-sync
- PCM_DOUT - 13-bit linear audio data output
- PCM_DIN - 13-bit linear audio data input

The analog audio is sampled at an 8 kHz rate and converted to linear 13-bit serial PCM audio data. The serial data is transferred on the PCM bus in 16-bit word format, which includes 13 sampled data bits, and 3 added zero value bits.

The 16-bit serial data is transferred in both directions after each sync signal's falling edge. The sync signal pulse duration is one clock period, after which the serial data is transferred in both directions for 16 consecutive clock periods.

Following the 16-bit data transfer, the serial input and output data signals inactivate until the next sync pulse, which occurs every 125 µS (8 kHz). It is recommended the serial data signals will be High-Z during the inactive period.

Important: In digital audio mode the input and output gains cannot be controlled by AT commands.

Figure 2-15 illustrates the PCM bus format of the voiceband audio configuration.

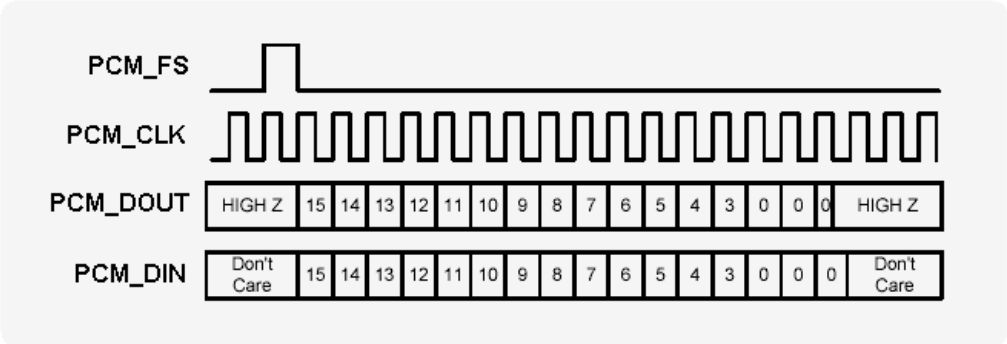


Figure 2-15: Voiceband Mode PCM Bus Coding Format

A/D Interface

The H24 includes 5 Analog to Digital Converter (ADC) signals with 10-bit resolution, for environmental and electrical measurements. The ADC signals measure an analog DC voltage level on their inputs which is converted to a 10-bit digital value for further processing by H24 or the user application.

The A/D signals operation and reporting mechanism is defined by the AT+MMAD command. Each A/D can be defined to provide several reports:

- A single measurement.
  A single A/D measurement will take place and will be reported upon activation of the AT command.
- An automatic periodical measurement.
  The A/D measures its input signal at a rate that is defined by the user application. Every measurement will generate an unsolicited message over the serial interface.
- An automatic periodical measurement with predefined limits.
  The A/D measures its input signal at a rate that is defined by the user. The user also defines upper and/or lower limits for the A/D measurements. Each measurement is compared to these limits, and an unsolicited message is generated only if these limits are exceeded.

Important: In case the defined periodical measurement rate is equal to, or shorter than, the defined sleep mode delay settings (ATS24), H24 will not enter low power mode.

Table 2-9 below, lists the internal and external A/D signals provided by H24.

Table 2-9: A/D Signals

ADC Name	Description	Pin #	ADC #	Min	Max	Unit
ADC3	GPAD 3	47		0	2.6	V
ADC2	GPAD 2	43		0	2.6	V
ADC1	GPAD 1	37		0	2.6	V

Temperature A/D

The H24 incorporates an internal temperature sensor circuit, which is used to monitor the operating temperature. The temperature is constantly monitored by H24 through a dedicated A/D signal, which is not accessible at the interface connector. Figure 2-16 shows the temperature A/D characteristics.

TBD

Figure 2-16: Temperature A/D Characteristics

The measured temperature level can be monitored by the user application through the TBD command, which returns a digital decimal value that represents the measured temperature level.

The temperature is measured by thermistors at the power management, and at the RF section of the H24.

General Purpose A/D

The H24 provides 3 general purpose A/D (GPAD) signals for customer application use. Each A/D signal can monitor a separate external voltage and report its measured level independently to the application, through the AT command interface.

The GPAD signals measure a DC voltage level of 0 - 2.6 V, which is converted internally to a 8-bit digital value. The user application can monitor the A/D voltage level through the TBD command.

Controls and Indicators Interface

The H24 incorporates several interface signals for controlling and monitoring the module's operation. The following paragraphs describes these signals and their operation.

Table 2-10 gives a description of the controls and indicators signals.

Table 2-10: Controls and Indicators

Connector Pin	Signal Name	Description
25	RESET_N	H24 system reset output indicator. When high, H24 is operating.
27	VREF	2.85V regulated output. Supplies external circuits up to 150mA.
16	WKUPO_N	Host application wake-up signal indicator.
41	ANT_DET	Antenna physical connection detect indicator (For main antenna only).
49	GPRS/GSM/ WCDMA	Network status indicator.
39	TXEN_N	Transmission burst indication.
28, 30, 32, 34, 36, 38, 40, 42	GPIO 1-8	General purpose IO signals for customer use.

Reset

The RESET_N output signal indicates the H24's operating status. This signal is set high after power up, when H24 is operating. It is set low when H24 is powered off.

When the RESET_N signal is low, the H24 interface signals are disabled and do not represent any valid data or state. Furthermore, any input signals connected to the H24 interface must be disabled (tri-state) or set low when RESET_N is low.

VREF Reference Regulator

The H24 incorporates a regulated voltage output, VREF. The regulator provides a 2.85V output for use by the customer application. This regulator can source up to TBD mA of current to power any external digital circuits.

Important: The VREF regulator is powered from the H24's main power supply, and therefore any current sourced through this regulator originates from the H24 VCC supply. The overall VCC current consumed by H24 is directly affected by the VREF operation. The H24 current consumption rises with respect to the current sourced through VREF.

The VREF regulator incorporates 3 operating modes that are controlled by the AT+MVREF command. These modes define the regulator operating state relative to the H24's operating mode.

OFF Mode

In this mode the VREF regulator is disabled and its output drops to 0V, regardless of the H24 operating state.

Standby Mode

The Standby operating mode is the default mode when H24 powers on. In this mode VREF follows the H24's operating state.

When the H24 is in low power mode, Sleep mode, the VREF regulator is also in a low power state. In this state the VREF regulated output is limited to providing only TBD mA of current maximum, while maintaining the 2.75V output level.

When H24 is in Idle mode, or wakes up temporarily from low power mode, the VREF regulator returns to full operation, supplying up to TBD mA.

Active Mode

In this mode the VREF regulator is always fully active while H24 is operating, regardless of the H24 operating mode.

Table 2-11 gives the VREF specifications.

Table 2-11: VREF Specifications

Parameter	Conditions	Min	Typ	Max	Unit
V_{OUT}		-3%	2.85	+3%	V
I_{OUT}				150	mA
Load regulation					mV/mA
Line regulation					mV
PSRR					dB

Wakeup Out

Some applications incorporate their own power saving mode, in which they operate with minimal functionality, including disabling of interfaces and serial communications.

The wakeup-out (WKUPO_N) signal is an active low output, which is designed to support a low power mode feature in the host application. This signal is used by H24 to indicate that it requires to communicate with the host application through the serial interface, due to an incoming call or data, or an unsolicited event. Applications that incorporate a low power mode should use this

signal as an indication to switch from low power mode to normal operation, and activate the serial interface.

The wakeup-out mechanism, using the WKUPO_N signal, is controlled by 2 AT commands (see Figure 2-17):

- ATS102 - Defines the delay time in milliseconds that H24 will wait, after asserting the WKUPO_N signal low, before sending data on the serial interface. This delay is required to allow the application enough time to reactivate from low power mode and switch to normal mode.
  If ATS102=0, which is the default value, the WKUPO_N signal and mechanism is disabled. In case the serial interface incorporates hardware flow control signals, the data will be sent according to their state, after the ATS102 delay time has expired.

- ATS100 - Defines the application minimal wakeup duration, in seconds, for a single wakeup event. This time definition is required to avoid frequent unnecessary wakeup events and consequent ATS102 delays.
  The application may return to low power mode after the serial interface has been inactive for the duration set by ATS100. This duration is measured from the last data sent or received on the serial interface.

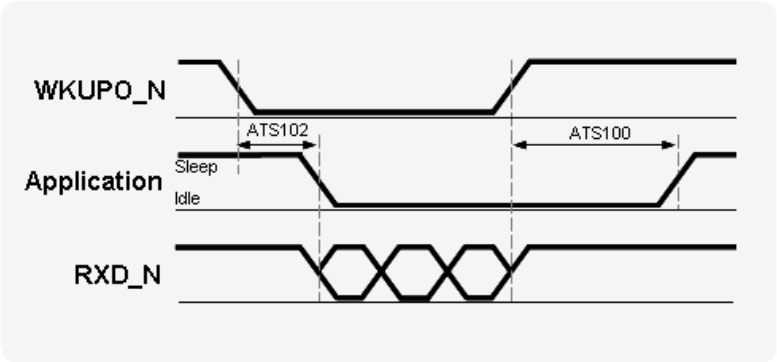


Figure 2-17: WKUPO_N Operation

The following guidelines apply to the wakeup-out mechanism:

- H24 will set the WKUPO_N signal low to indicate that in has data to send through the serial interface.
- H24 will start sending the data to the application after the delay defined by ATS102.
- The WKUPO_N signal will remain low while data is being sent to the host application.
- The host application should keep its serial interface active, and not switch to low power mode, while the WKUPO_N signal is low.
- H24 will set the WKUPO_N signal high when it has completed sending the data.
- The application serial interface must stay active, and not switch to low power mode, for the duration set by ATS100, after WKUPO_N is set high.
- H24 will not set the WKUPO_N signal low if it needs to send additional data during the ATS100 delay time.
- The application may switch to low power mode after the WKUPO_N signal is set high and the serial interface has been inactive for the duration set by ATS100.

Antenna Detection

The H24 incorporates an internal antenna detection circuit, which senses the physical connection and removal of the main antenna or antenna circuit on the H24 antenna connector. The antenna detection state is reported to the application through the ANT_DET output signal, and may also be queried by the ATS97 command.

The detection circuit senses DC resistance to ground on the H24 antenna connector.

A DC resistance below 100kohm (±10%) is defined as a valid antenna connection, and the ANT_DET output signal is set high.

GPRS/EGPRS - WCDMA/HSDPA Detection

The GPRS output signal (Pin 49) indicates the network GPRS/EGPRS connection status. When H24 is connected to a network, this signal is enabled. When H24 is not connected to the GPRS/EGPRS network this signal is disabled.

Transmission Indicator

The TXEN_N output signal indicates when H24 is transmitting over the GSM network. This signal follows the H24 GSM transmit bursts. This signal is set low during transmission burst, and set high when no transmission is in progress.

Figure 2-18 shows the TXEN_N operation.

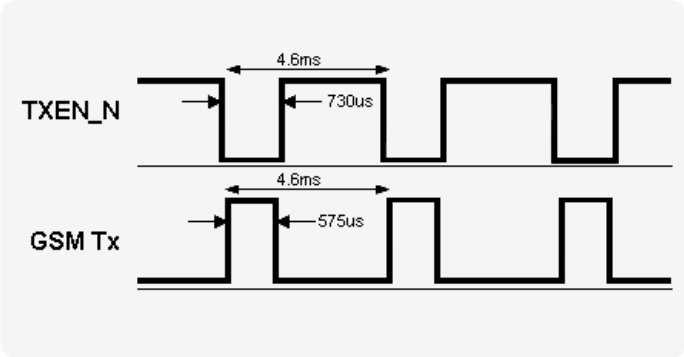


Figure 2-18: TXEN_N Operation

General Purpose I/O

The H24 incorporates 8 general purpose IO signals for the user application. Each GPIO signal may be configured and controlled by AT command. These signals may be used to control or set external application circuits, or to receive indications from the external application.

Antenna Interface

The H24 antenna connector is the RF interface to the GSM/WCDMA network.

The antenna interface is terminated by an MMCX connector type, which is 50Ω impedance matched at the relevant GSM frequencies.

The antenna or antenna application must be installed properly to achieve best performance.

Table 2-12 gives the antenna interface specifications.

Table 2-12: Antenna Interface Specifications

Parameter	Conditions	Specifications
GSM 850	TX	824 - 849 MHz
	RX	869 - 894 MHz
GSM 900	TX	880 - 915 MHz
	RX	925 - 960 MHz
DCS 1800	TX	1710 - 1785 MHz
	RX	1805 - 1880 MHz
PCS 1900	TX	1850 - 1910 MHz
	RX	1930 - 1990 MHz
Gain		TBD dBi (unity) gain max
Impedance		50Ω
VSWR		Less than: 2.5:1
WCDMA B1 2100	TX	1920-1980 MHz
	RX	2110 - 2170 MHz
WCDMA B2 1900	TX	1850-1910 MHz
	RX	1930-1990 MHz
WCDMA B5 850	TX	824 - 849 MHz
	RX	869 - 894 MHz

It is the Integrator's responsibility to design the antenna or antenna assembly used with the H24. This will highly affect the RF performance of the H24 (dropped calls, battery consumption etc.). The following guidelines should be followed:

- Make sure that the antenna or antenna assembly matches the Antenna Interface Specifications.
- Use low loss RF cable and connectors keeping cable runs to a minimum.

It is highly recommended to test the application in which the H24 is installed for minimum radiated RF performance based on the tables below:

		Band	
		850/900	1800/1900
GSM/GPRS	TRP [dBm]	TBD	TBD
	TIS [dBm]	TBD	TBD
EGPRS	TRP [dBm]	TBD	TBD
	TIS [dBm]	TBD	TBD

		Band		
		B1-2100	B2-1900	B5-850
WCDMA	TRP [dBm]	TBD	TBD	TBD
	TIS [dBm]	TBD	TBD	TBD
HSDPA	TRP [dBm]	TBD	TBD	TBD
	TIS [dBm]	TBD	TBD	TBD

Chapter 3: Electrical and Environmental Specifications

Absolute Maximum Ratings

Table 3-1 gives the maximum electrical characteristics of the H24 interface signals.

Caution: Exceeding the values may result in permanent damage to the module.

Table 3-1: Maximum Ratings

Parameter	Conditions	Min	Max	Unit
VCC Supply		-0.2	4.2	V
Digital Input Signals (Except for IGN, VBUS, USB_DP, USB_DN)	H24 powered on	-0.2	2.6	V
Analog Input Signals (Audio, A/D inter-faces)	H24 powered on	-0.2	2.6	V
All Input Signals (Except for IGN, VBUS, USB_DP, USB_DN)	H24 powered off	-0.2	0.2	V
IGN signal		-0.2	16	V
VBUS signal		-0.2	5	V
USB_DP, USB_DN		-0.2	5	V

Caution: It is not recommended to connect the ignition pin directly to the car's ignition wire without adequate protection.

Environmental Specifications

Table 3-2 gives the environmental operating conditions of the H24 module.

Caution: Exceeding the values may result in permanent damage to the module.

Table 3-2: Environmental Ratings

Parameter	Conditions	Min	Max	Unit
Ambient Operating Temperature		-30	85	°C
Storage Temperature		-40	85	°C
ESD	At antenna connector Contact Air At interface connector		 ± 8 ± 15 ± 1	KV

Application Interface Specifications

Table 3-3 summarizes the DC electrical specifications of the application interface connector signals.

Important: Interface signals that are not used by the customer application must be left unconnected. H24 incorporates the necessary internal circuitry to keep unconnected signal in their default state. Do not connect any components to, or apply any voltage on, signals that are not used by the application.

Important: It is recommended to place a pull-down resistor in the customer application, on the IGN signal. A 100 kohm resistor, or less, is acceptable.

Important: Signals that are defined as "Do Not Use", or DNU, must remain externally unconnected in any case. These signals are reserved for future use.

The following table gives a brief description of the 70 pins connector for quick integration.

GND	1	2	GND
GND	3	4	GND
VCC	5	6	VCC
VCC	7	8	VCC
RTS_N	9	10	USB_VBUS
RXD_N	11	12	USB_DP
DSR_N	13	14	USB_DN
CTS_N	15	16	WKUPI_N
DCD_N	17	18	PCM_DIN
DTR_N	19	20	PCM_DOUT
TXD_N	21	22	PCM_CLK
RI_N	23	24	PCM_FS
RESET_N	25	26	WKUPO_N
VREF	27	28	GPIO1
RXD2	29	30	GPIO2
TXD2	31	32	GPIO3
RTS2	33	34	GPIO4
CTS2	35	36	GPIO5
ADC1	37	38	GPIO6
TXEN_N	39	40	GPIO7
ANT_DET	41	42	GPIO8
ADC2	43	44	SIM_RST_N
USB_ID	45	46	SIM_CLK
ADC3	47	48	SIM_VCC
GPRS	49	50	SIM_PD_N
IGN	51	52	SIM_DIO
ON_N	53	54	HEADSET_P
HDST_INT_N	55	56	NC
MIC2_P	57	58	GPS_PWR
AGND	59	60	MDDI_MSP
MIC1_P	61	62	MIC1_N
ALRT_N	63	64	I2C_SCL
ALRT_P	65	66	I2C_SDA
SPKR_N	67	68	Coin Cell
SPKR_P	69	70	MIC2_N

Table 3-3: Interface Specifications

Pin #	Signal Name	Description	I/O	Active H/L	Internal PU/PD	Parameter	Conditions	Level			
								Min	Typ	Max	Units
Power:											
1	GND	Ground									
2											
3											
4											
5	VCC	DC power supply	I			V_{IN} I_{MAX} I_{OFF}	VCC = 3.6 V	3.3	3.6	4.2	V
6											
7											
8											
68	COIN CELL		I					1.8		3	V
56	NC										
58	GPS ANT POWER		I								V
27	VREF	Reference regulator output	O						2.85		V
Control:											
16	WKUPI_N	H24 wakeup input	I						2.6		V
26	WKUPO_N	Host wakeup output	O						2.6		V
25	RESET_N	Reset signal output	O						2.6		V
53	ON_N	On/Off switch	I								
51	IGN	Ignition input	I				V_{IL} V_{IH}	0 3.3		0.4 16	V
39	TXEN_N	Transmit indicator	O						2.6		V
41	ANT_DET	Antenna presence indicator	O						2.6		V

Table 3-3: Interface Specifications (Cont.)

Pin #	Signal Name	Description	I/O	Active H/L	Internal PU/PD	Parameter	Conditions	Level			
								Min	Typ	Max	Units
49	GPRS	GPRS/ EGPRS coverage indicator	O						2.6		V
UART1:											
21	TXD_N	UART1 TXD	I						2.6		V
11	RXD_N	UART1 RXD	O								
9	RTS_N	UART1 RTS	I								
15	CTS_N	UART1 CTS	O								
19	DTR_N	UART1 DTR	I								
13	DSR_N	UART1 DSR	O								
17	DCD_N	UART1 DCD	O								
23	RI_N	UART1 RI	O								
UART2:											
29	RXD2_N	UART2 RXD	O						2.6		V
31	TXD2_N	UART2 TXD	I								
33	RTS2_N	UART2 RTS	I								
35	CTS2_N	UART2 CTS	O								
USB:											
10	USB_VBUS	USB bus power	O						5		V
12	USB_DP	USB bus serial data	I/O								
14	USB_DN	USB bus serial data	I/O								
45	USB_ID	USB bus serial data	I								
SIM Card:											
50	SIM_PD_N	SIM presence detect	I								
48	SIM_VCC	SIM supply	O						3/1.8		V
44	SIM_RST_N	SIM reset	O						3/1.8		V
52	SIM_DIO	SIM serial data	I/O								
46	SIM_CLK	SIM clock	O								

Table 3-3: Interface Specifications (Cont.)

Pin #	Signal Name	Description	I/O	Active H/L	Internal PU/PD	Parameter	Conditions	Level			
								Min	Typ	Max	Units
Digital Audio:											
18	PCM_ DIN	Digital audio receive	I						2.6		V
20	PCM_ DOUT	Digital audio transmit	O								
22	PCM_CLK	Digital audio clock	O								
24	PCM_FS	Digital audio frame sync.	O								

Table 3-3: Interface Specifications (Cont.)

Pin #	Signal Name	Description	I/O	Active H/L	Internal PU/PD	Parameter	Conditions	Level			
								Min	Typ	Max	Units
GPIO:											
28	GPIO1	General purpose I/O	I/O						2.6		V
30	GPIO2	General purpose I/O	I/O								
32	GPIO3	General purpose I/O	I/O								
34	GPIO4	General purpose I/O	I/O								
36	GPIO5	General purpose I/O	I/O								
38	GPIO6	General purpose I/O	I/O								
40	GPIO7	General purpose I/O	I/O								
42	GPIO8	General purpose I/O	I/O								
Audio:											
67	SPKR_N	Speaker inverted	O								
69	SPKR_P	Speaker	O								
63	ALRT_N	Alert speaker inverted	O								
65	ALRT_P	Alert speaker	O								
61	MIC1_P	Microphone 1 positive	I								
62	MIC1_N	Microphone 1 negative	I								
59	AGND	Audio ground									
57	MIC2_P	Microphone 2 positive	I								
70	MIC2_N	Microphone 2 negative	I								
54	HPH_L	Headset detect interrupt	O								
55	HDST_INT_N	Headset detect interrupt	I								

Table 3-3: Interface Specifications (Cont.)

Pin #	Signal Name	Description	I/O	Active H/L	Internal PU/PD	Parameter	Conditions	Level			
								Min	Typ	Max	Units
A/D:											
37	ADC1	General purpose A/D	I					0		2.6	V
43	ADC2	General purpose A/D	I					0		2.6	V
47	ADC3	General purpose A/D	I					0		2.6	V
Display:											
60	Special mode	Leave this pin disconnected	I								
I2C:											
64	I2C_SCL		O							2.6	V
66	I2C_SDA		I/O								

Note 1: Per USB Specifications Rev 2.0.

Note 2: Per ISO 7816-3 IC specifications.

Chapter 4: Mechanical Specifications

Board Dimensions

Figure 4-1 describes the H24 mechanical characteristics.

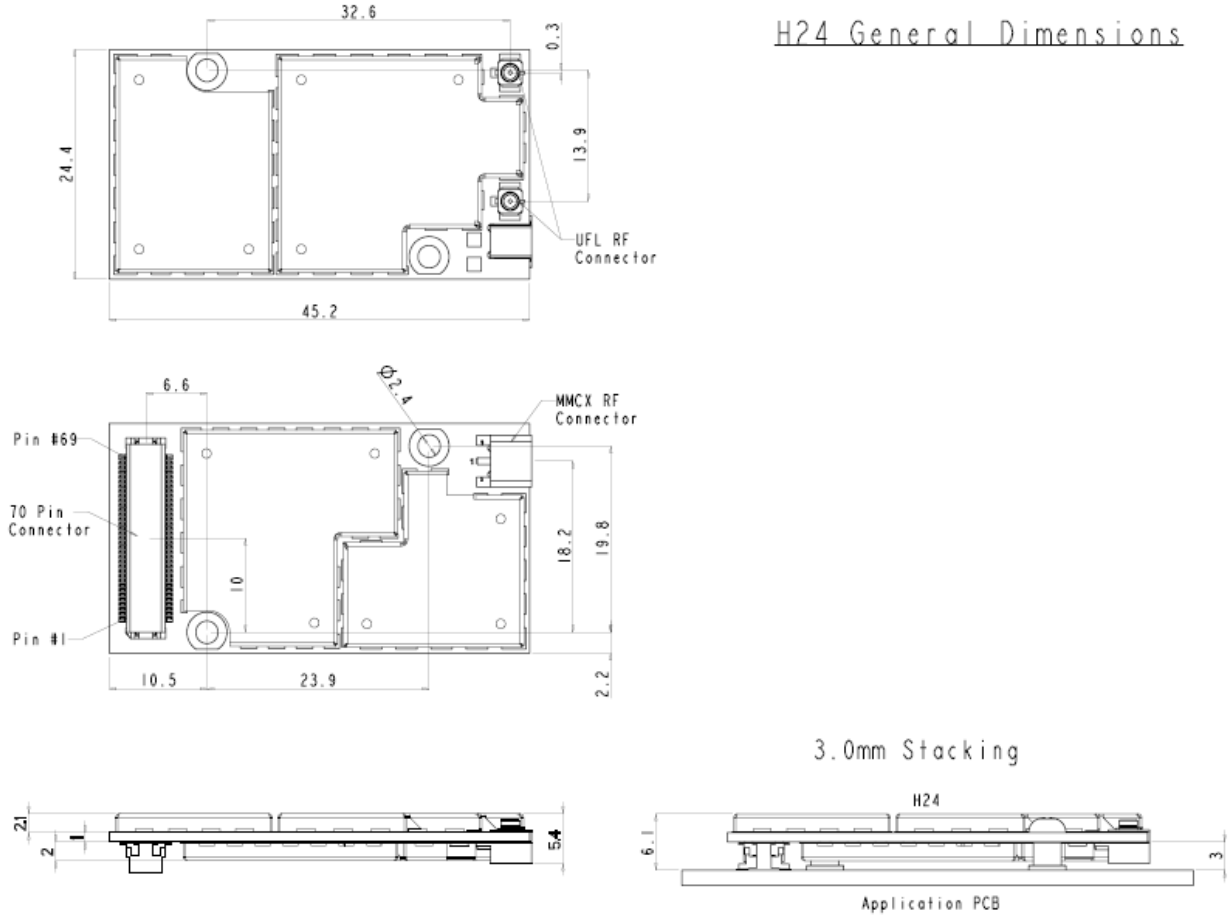


Figure 4-1: H24 Mechanical Characteristics

Interface Connector Specifications

The H24 uses a single 70-pin, 0.5 mm pitch, board to board connector for the application interface, as described in Table 4-1.

Table 4-1: H24 interface connector options

H24 Connector	Mating Connector	Stacking Height
Molex 53748-0708	Molex 52991-0708	3.0 mm

Figure 4-2 shows the H24 interface connectors.

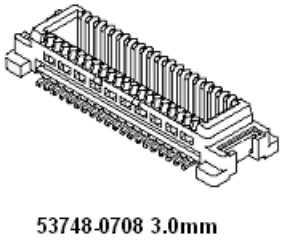


Figure 4-2: H24 Interface Connectors

Table 4-2 describes the H24 interface connector characteristics.

Table 4-2: Interface Connector Specifications

Parameter	53748 (3.0 mm)
Contacts	70
Rows	2
Pitch	0.5 mm
Maximum Current	500 mA
Maximum Voltage	50 V
Contact Resistance	50 mΩ maximum
Insulation Resistance	100 MΩ minimum
Durability	50 mated cycles maximum
Stacking Height	3.0 mm
Mates with	Molex 52991-0708

Mating Connector

The mating connector incorporates the same electrical and mechanical characteristics as the corresponding H24 interface connector, and is described in Table 4-2.

Figure 4-3 provides a reference drawing of the mating connector mechanical dimensions.

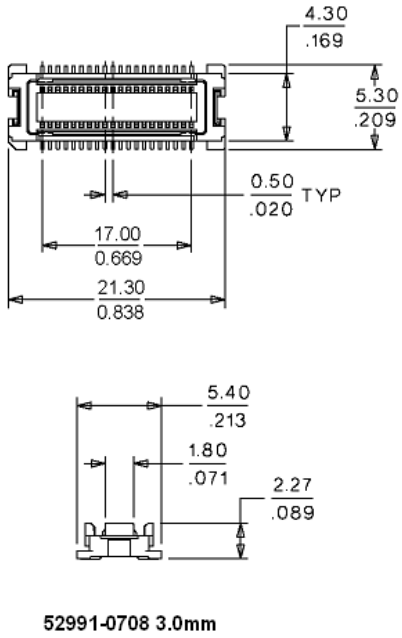


Figure 4-3: Mating Connector Dimensions

For more information on the H24 mating connector, please refer to the Molex web site at TBD.

MMCX Connector Specifications

The H24 uses a standard MMCX receptacle connector for the radio interface.

Figure 4-4 shows the MMCX connector dimensions.

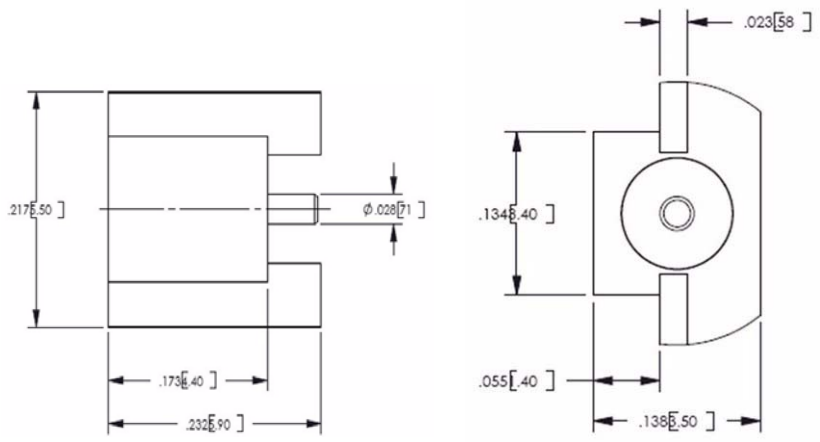


Figure 4-4: MMCX Connector Dimensions

Table 4-3 describes H24 RF connector characteristics.

Table 4-3: RF Connector Specifications

Parameter	Specifications
Rated Voltage	335 V_{RMS}
Impedance	50 Ω
Contact Resistance	5 mΩ center contact 2.5 mΩ outer contact
Insulation Resistance	1000 MΩ
Insertion Force	3.4 lbs maximum
Withdrawal Force	4.5 lbs maximum
Contact Retention Force	4 lbs maximum
Durability	500 mated cycles maximum

Mating Connector

The RF mating connector should be a standard MMCX plug connector or cable assembly, which corresponds to the H24 MMCX connector specifications.

Any standard MMCX connector or application from different manufacturers may be mated with H24.

Such a cable assembly example is the Huber-Suhner PN 11_MMCX-50-1-2/111_OH, which is illustrated in Figure 4-5.

Item description	11_MMCX-50-1-1/111_OH	
Connector Description	Straight cable plug for flexible cable	
Series / Pattern Highlights	• MMCX – Type / **Pattern 11** • SUHNER full crimp cable attachement	
Item number	22651666	
Data sheet	**11_MMCX-50-1-1/111_O**	
Outline drawing	**11_MMCX-50-1-1/111_O**	
Catalogue drawing	**11_MMCX-50-1-1/111_O**	
Related documents	**Assembly Instruction**	
2002/95/EC (RoHS)	compliant	
Interface Standards	SUHNER-MMCX	
Mechanical data		Jump to [Top]
Cable Entry Centre Contact		crimped
Cable Entry Outer Contact		crimped
Engangement Force max		15 N
Disengangement F. min		6 N
Disengangement F. max		15 N
Dielectric Size		1
Electrical data		Jump to [Top]
Impedance		50 Ω
Interface Freq max		≤6 GHz
Environmental and general data		Jump to [Top]
Operating Temp min		-55 °C
Operating Temp max		155 °C
Weight		0.0009 kg
Number of Matings		500

Figure 4-5: Optional MMCX Cable Assembly

U.FL Connector Specifications

The H24 uses a standard U.FL receptacle connector for the radio interface.

Figure 4-6 shows the U.FL connector dimensions.

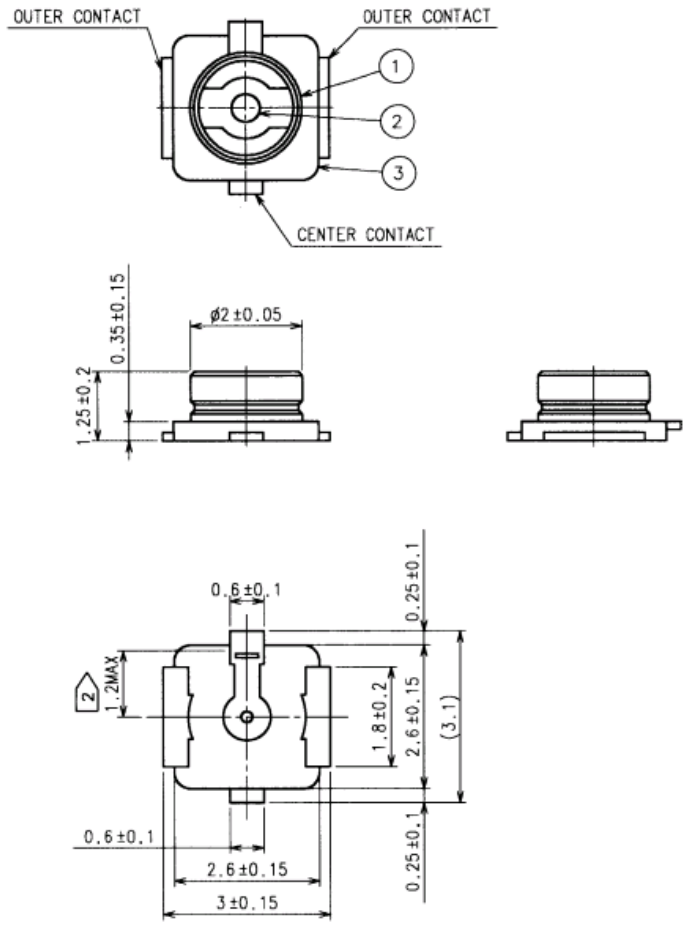


Figure 4-6: U.FL Connector Dimensions

Table 4-4 describes the U.FL connector characteristics.

Table 4-4: U.FL Connector Specifications

Parameter	Specifications
Characteristic Impedance	50 Ohms
Frequency Range	DC to 6 GHz
VSWR (mated pair)	1.30 max DC to 3 GHz 1.40 max 3 to 6 GHz (cable dependent)
Insertion Loss (connectors only)	0.24 dB max DC to 6 GHz

Table 4-4: U.FL Connector Specifications (Cont.)

Parameter	Specifications
Rated voltage	60 VAC (rms) - standard recept (Styles A, B)
Dielectric Withstanding Voltage	200 VAC, 50 Hz for 1 min (at sea level)
Insulation Resistance	500 Megohms min
Contact Resistance (connectors only)	20 milliohms max (Center) 10 milliohms max (Outer, Plug) 10 milliohms max (Outer, Receptacle)
Durability	30 cycles - standard recept (Styles A, B)
Disengagement Force	2N min perpendicular 4N min orthogonal
Center Contact Retention force	0.15N min
Tape/Reel Packaging (receptacle)	12mm carrier per EIA-481
Operating Temperature	40°C to + 90°C

Mating Connector

The RF mating connector should be a standard U.FL plug connector or cable assembly, which corresponds to the H24 U.FL connector specifications.

Any standard U.FL connector or application from different manufacturers may be mated with H24.

Such a cable assembly example is the Hirose U.FL-LP-040 is U.FL-R-SMT, which is illustrated in Figure 4-7.

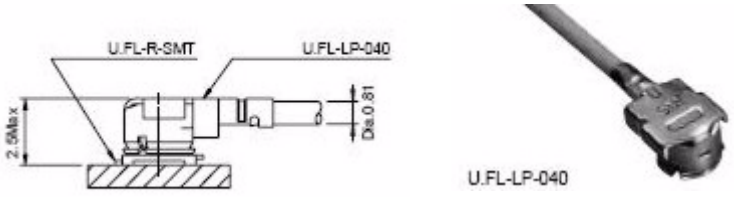


Figure 4-7: U.FL Mating Connector

The following table describes U.FL Mating Connector characteristics.

Product Specifications

Ratings	Nominal characteristic impedance Rated voltage Rated frequency	50Ω 60 V AC (rms) DC to 6 GHz	Operating temperature range Operating humidity	-40°C to +90°C 90% max.

Item	Specification		Conditions
1. Contact resistance	Center: 20 mΩ max. Outside: 10 mΩ max.		Measured at 10 mA max.
2. Insulation resistance	500 MΩ min.		Measured at 100 V DC
3. Withstand voltage	No line or insulation breakdown		200 V AC for 1 minute
4. V.S.W.R.*	1.3 max.		DC to 3 GHz
	Dia.0.81Cable	1.35	3 to 6 GHz
	Dia.1.13Cable	1.4	
	Dia.1.32Cable	1.5	
5. Female contact holding force	0.15 N min.		Measured with a ϕ 0.475 pin gauge
6. Repetitive operation	Contact resistance 25 mΩ max. (Center) 15 mΩ max. (Outside)		30 cycles of insertion and disengagement
7. Vibration	No momentary disconnections of 1 μs min. No damage, cracks, or parts looseness min.		Frequency of 10 to 100 Hz, single amplitude of 1.5 mm, acceleration of 59 m/s², for 5 cyles in the direction of each of the 3 axes
8. Shock	No momentary disconnections of 1 μs min. No damage, cracks, or parts looseness		Acceleration of 735 m/s², 11 ms duration, sine half-wave waveform, for 6 cycles in the direction of each of the 3 axes
9. Humidity resistance (Steady state)	No damage, cracks, or parts looseness Insulation resistance 100 MΩ min.(High temperature) Insulation resistance 500 MΩ min.(Pry)		Temperature of 40°C, humidity of 95%, let stand for 96 hours
10. Temperature cycle	No damage, cracks, or parts looseness Contact resistance 25 mΩ max. (Center) 15 mΩ max. (Outside)		Temperature: +40°C → 5 to 35°C → +90°C → 5 to 35°C Time: 30 min. → Within 5 min. → 30 min. → Within 5 min. Cycles: 5
11. Salt spray test	No excessive corrosion		48 hours continuous exposure to 5% salt water

H24 Mounting

The H24 incorporates 2 mechanical holes for installing the module onto the application board. The holes are 2.4 millimeters in diameter, which accommodates several types of mechanical elements.

Several mechanical approaches may be applied to mount and fasten H24 to the application board. Using M2 screws with suitable washers to mount the module onto spacers, a bracket or chassis is a recommended design.

Special attention must be paid to the area surrounding the H24 mounting holes. A grounding pad of 4.4 milimeters in diameter surrounds these holes. The diameter and area of this pad must not be exceeded by any mechanical or electrical element. Several electrical components, which are not shielded, are located near the holes. These components must not be in contact with the mounting elements or with other parts of the application board, and care must be taken to avoid any damage.

Figure 4-8 depicts the H24 mounting area.

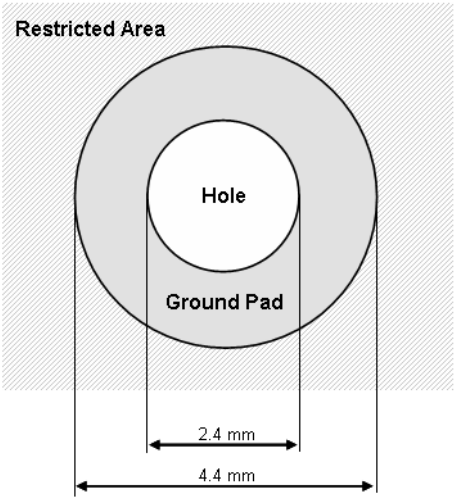


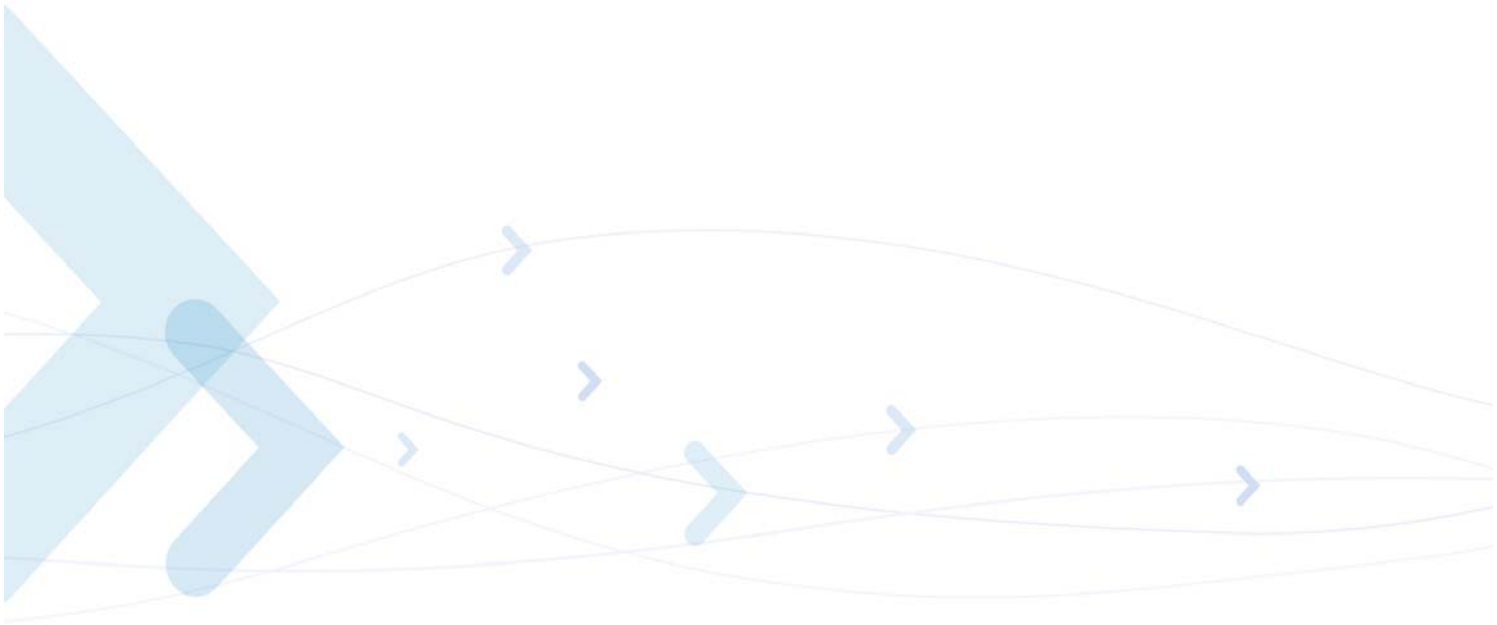
Figure 4-8: H24 Mounting Area

The holes are used for mechanical mounting of H24 to the application board but also for grounding support. Using conductive elements to install H24, significantly improves the overall grounding of the module and therefore improves the H24 performance and stability.

It is required to use screws or other mechanical elements to fasten H24 to the application board, but it is highly recommended to use conductive elements to improve the module's performance.

The preferred mounting screw head types are:

- "Allen" head with a champer - the best choice.
- "Star" head - good.
- "Philips" head - may cause damage to nearby components.



Chapter 5: Service and Testing

Service

This section provides contact information for any possible queries that may arise, for example:

- Have questions?
- Having trouble getting the Developer Board set up?
- Technical questions?
- Configuration questions/problems?
- Technical operating problems?
- Need documentation?

Who to Contact?

Direct Customer. Use this following email address to contact customer assistance: **M2M.CustomerCare@motorola.com**

Indirect Customer. Send requests to your distributor and not to Motorola help desk.

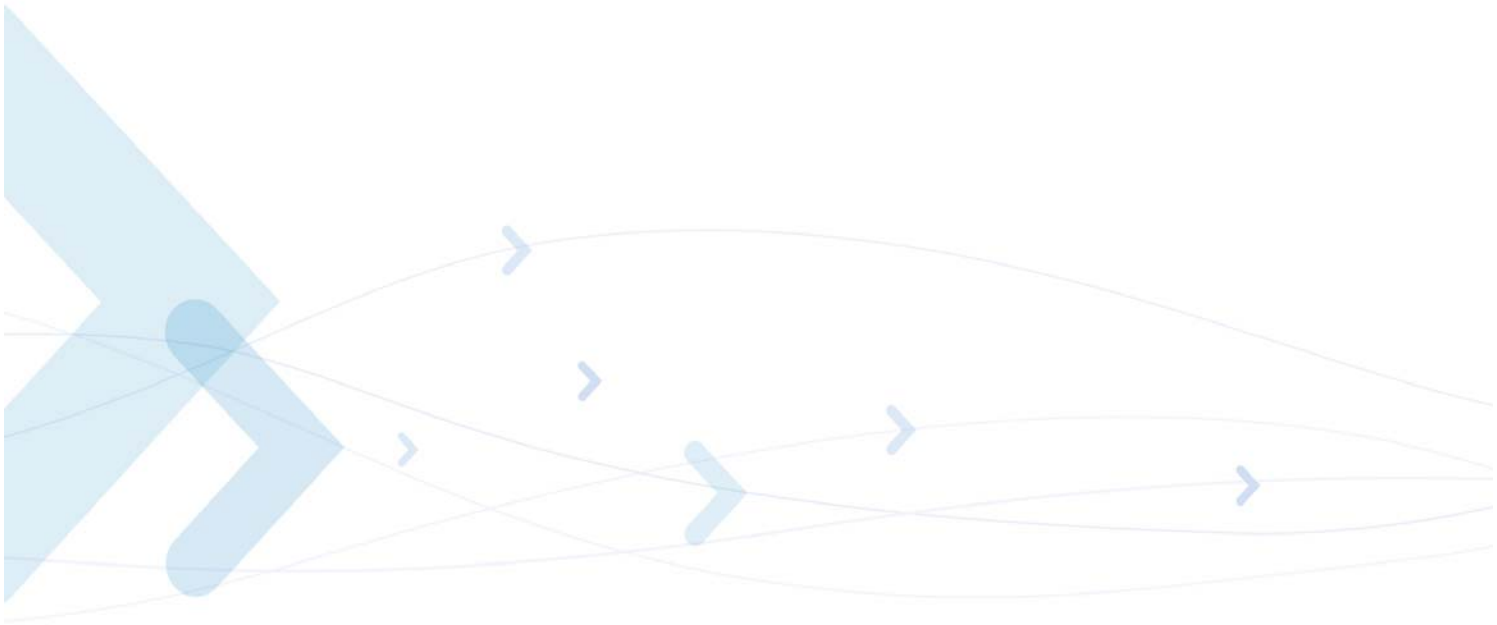
Required Query Information

Every new call/problem report, directly from a Direct Customer or from a distributor, should be directed to the help desk email address noted above in "Who to Contact?" . It is recommended to report each individual issue in a separate email. The following information is required when reporting a problem:

- Customer name and address
- Customer contact information for this request, including:
  - Name
  - Telephone
  - Fax number
  - Mobile number
  - Email address
- Product name (H24)
- Software version of the unit (ATI8i9 command) or model number
- PCB version (located on the PCB near the RF connector) TBD

In addition to the information requested above, send the following AT commands and the HyperTerminal log with the responses:

- **AT+CMEE=2 //** to get textual error message
- **AT+CPIN? //** to get SIM card status
- **AT+CREG? //** to see if the TXVR is registered to the network
- **AT+CSQ //** to get the signal strength (RX level)
- **AT+CGSN //** to read the IMEI number of the unit
- **AT\S //** to get the setting of basic AT commands
- **AT+CMER=0,0,1,1 //** to get messages and indicators from the handset display to the DTE



Acronyms and Abbreviations

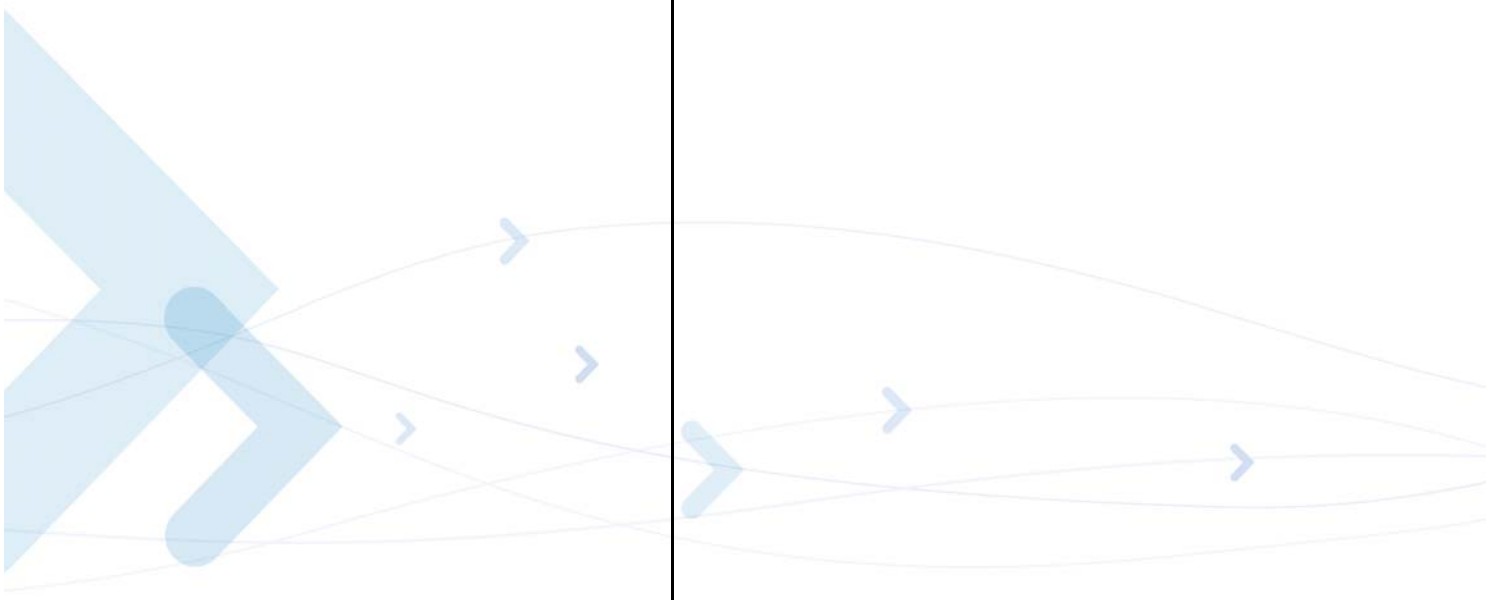
Abbreviation	Full Name
A	
AMR	Adaptive Multi Rate
AOC	Advice of Charge
B	
BR	Baud Rate
bps	Bits Per Second
C	
CSD	Circuit Switched Data
CTS	Clear to Send
D	
DCD	Data Carrier Detect
DCE	Data Communication Equipment (such as modems)
DCS	Digital Cellular System (GSM in the 1800MHz band)
DOC	Department of Communications (Canada)
DRX	Discontinuos Reception
DSP	Digital Signal Processor
DSR	Data Set Ready
DTE	Data Terminal Equipment (such as terminals, PCs and so on)
DTMF	Dual Tone MultiFrequency
DTR	Data Terminal Ready
DTX	Discontinuos Transmission
E	
EFR	Enhanced Full Rate
EGPRS	Enhanced General Packet Radio Service
EGSM	Extended Global System for Mobile Communications
EIRP	Effective Isotropic Radiated Power

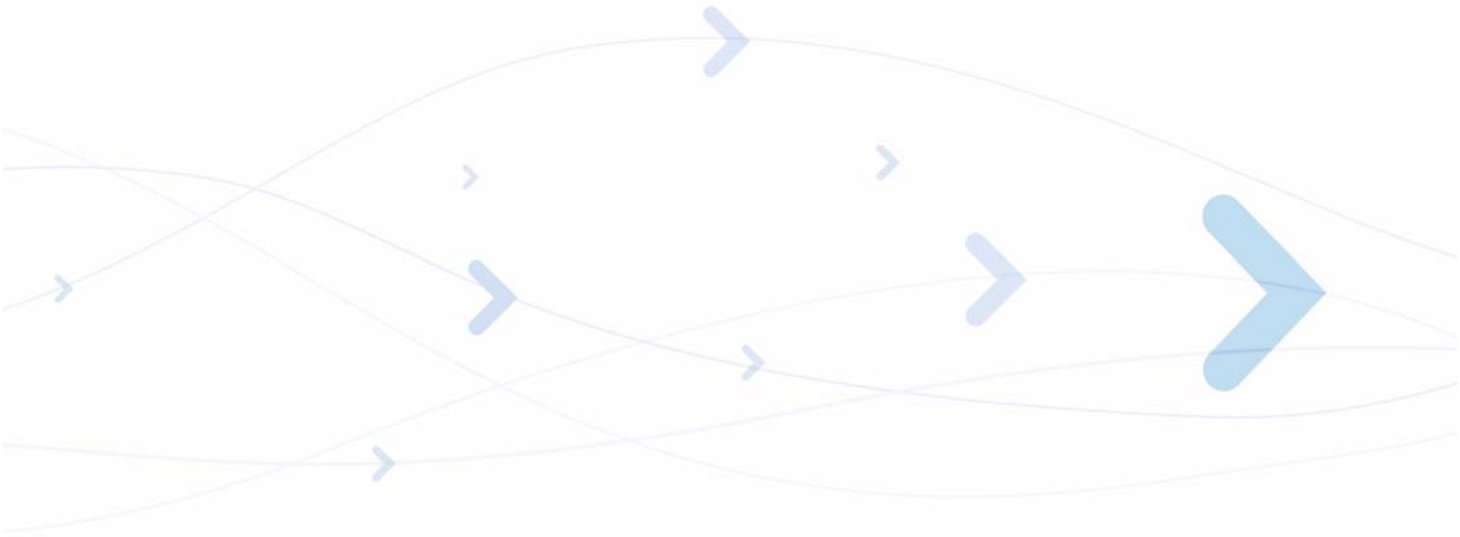
Abbreviation	Full Name
EMC	Electromagnetic Compatibility
EOTD	Enhanced Observed Time Difference
EPOS	Electronic Point of Sale
ERP	Effective Radiated Power
ESD	Electrostatic Discharge
ETSI	European Telecommunication Standards Institute
F	
FCC	Federal Communications Commission (U.S.)
FR	Full Rate
FTA	Full Type Approval
G	
GCF	GSM Certification Forum
GPIO	General Purpose Input/Output
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
H	
HR	Half Rate
HSDPA	High-Speed Downlink Packet Access
I	
IC	Integrated Circuit
L	
LNA	Low-noise Amplifier
M	
MMCX	Miniature Micro Coax
MO	Mobile Originated
MT	Mobile Terminated
O	
OEM	Original Equipment Manufacturer
P	
PCB	Printed Circuit Board
PCL	Power Class Level
PCM	Pulse Code Modulation
PCS	Personal Communication System (also known as GSM 1900)
PD	Pull Down

Abbreviation	Full Name
PDA	Personal Data Assistant
PDU	Packet Data Unit
PLL	Phase-locked Loop
PTCRB	PCS-1900 Type Certification Review Board (GSM North America)
PU	Pull Up
R	
R&TTE	Radio and Telecommunications Terminal Equipment
RMS	Root Mean Square
RI	Ring Indicator
RTS	Request To Send
S	
SAR	Specific Absorption Rate
SIM	Subscriber Identity Module
SMS	Short Message Service
SPI	Serial Peripheral Interface
T	
TDMA	Time Division Multiple Access
TIS	Transmitter Isotropic Sensitivity
TRP	Transmitter Radiated Power

Abbreviation	Full Name
U	
UART	Universal Asynchronous Receiver Transmitter
USB	Universal Serial Bus
USSD	Unstructured Supplementary Services Data
V	
VCC	Voltage Common Collector
VSWR	Voltage Standing Wave Ratio
W	
WCDMA	Wideband Code Division Multiple Access

Index





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