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MOTOROLA

g20 Cellular Engine Module Description

Developer's Guide

98-08901C66-O

REVISION HISTORY

Revision	Date	Purpose

MOTOROLA

g20 Cellular Engine Module Description

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PREFACE

1.1 SCOPE OF THIS MANUAL

This manual introduces the g20 embedded module and describes the technical details required by the data terminal equipment (DTE) team to successfully integrate the Motorola g20 cellular engine into an original equipment manufacturer (OEM) wireless host device.

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

You can reach us by Email at: GSM support-BSH015@email.mot.com.

1.2 WHO SHOULD USE THIS MANUAL

This manual is intended for all members of the DTE OEM integration team who are responsible for integrating the c18 module into the host OEM device, including representatives from hardware, software and RF engineering disciplines.

1.3 APPLICABLE DOCUMENTS

PLEASE PROVIDE DETAILS FOR THIS SECTION.

1.3.1 Documents

g20 Developer's Kit - 9808901C67-O

g20 AT Commands - 9808901C68-O

1.3.2 Standards

PLEASE PROVIDE DETAILS FOR THIS SECTION.

1.4 HOW THIS MANUAL IS ORGANIZED

This manual contains the following chapters:

- **Chapter 1** contains this Preface.
- **Chapter 2** introduces the g20 unit and provides important safety instructions.
- **Chapter 3** provides a detailed hardware description of the blocks and components comprising the g20.
- **Chapter 4** describes the pin assignments for g20 connectors.
- **Chapter 5** describes mechanical requirements for the g20 unit.
- **Chapter 6** provides contact information for Motorola Service Support and Customer Assistance, as well as valuable troubleshooting and programming information.

INTRODUCTION

2.1 GENERAL DESCRIPTION

The g20 is Motorola's newest family of embedded cellular products. Motorola continues its tradition of excellence by introducing this new cellular engine family for GSM/GPRS communications, consisting of the d10, the d15 and the g18.

The new module is similar to a condensed cellular phone core, and can be integrated in any system or product that needs to transfer voice or data information. Thus, it significantly enhances the system's capabilities, transforming it from a standalone, isolated product to a powerful component connected to communication nets.

The new g20 is extremely small in dimensions, yet packed with a host of highly-advanced features designed to facilitate fast and easy integration with OEM user products. It significantly shortens the development process for OEM developers, thanks to its wide range of built-in applications, and minimizes the product's time to market.

The g20 module is ideally suited for the automotive, telemetry, security, insurance and EPOS industries, for delivery and handheld terminals, and for PDA markets.

2.2 TERMS AND ABBREVIATIONS

This section provides definitions for terms and acronyms used in this document.

Table 1. Terms and Abbreviations

Acronym/Term	Definition/Description
AOC	Automatic Output Control
BABT	British Approval Board - Telecommunications
CSD	Circuit-switched Data
DCE	Data Communication Equipment (such as modems)
DCS	Digital Cellular System (GSM in the 1800MHz band)
DOC	Department of Communications (Canada)
DSP	Digital Signal Processor
DTE	Data Terminal Equipment (such as terminals, PCs and so on)
DTMF	Dual-Tone Multi-Frequency
EGSM	Extended Global System for Mobile Communications
EIRP	Effective Isotropic Radiated Power
EMC	***WHAT DOES THIS STAND FOR?***
EOTD	Enhanced Observed Time Difference
EPOS	Electronic Point of Sale
ERP	Effective Radiated Power
ESD	Electrostatic Discharge
FCC	Federal Communications Commission (U.S.)
FTA	Foreign Telecommunication Administration

Table 1. Terms and Abbreviations *(Continued)*

Acronym/Term	Definition/Description
GCF	***WHAT DOES THIS STAND FOR?***
GPIO	General Purpose Input/Output
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
IC	Integrated Circuit
LNA	Low-noise Amplifier
MMCX	Multimedia Communications Exchange
MO	Mobile Originated
MT	Mobile Terminated
OEM	Original Equipment Manufacturer
PCB	Printed Circuit Board
PCM	Pulse Code Modulation
PCS	Personal Communication System (also known as CDMA 1900)
PDA	Personal Data Assistant
PDU	Packet Data Unit
PLL	Phase-locked Loop
PTCRB	PCS-1900 Type Certification Review Board (GSM North America)
R&TTE	Radio and Telecommunications Terminal Equipment
RMS	Root Mean Square
RTS	Request To Send
SAR	Segmentation and Reassembly
SIM	Subscriber Identity Module
SMS	Short Message Service
SPI	Serial Peripheral Interface
TDMA	Time Division Multiple Access
UART	Universal Asynchronous Receiver Transmitter
USB	Universal Serial Bus
USSD	Unstructured Supplementary Services Data
VCC	Voltage Common Collector
VSWR	Voltage Standing Wave Ratio

2.3 PRODUCT SPECIFICATIONS

Table 2. Product Specifications

Product Features	
Operating systems:	EGSM: 900/1800 MHz GSM: 850/1900 MHz
Physical Characteristics	
Size:	Size: 24.4 x 48.2 x 6.0 mm
Mounting:	Two 2.2 mm holes
Weight:	11.9 grams
Environmental	
Operational temperature:	-20°C +60°C
Functional temperature:	-20°C +70°C
Storage temperature:	-40°C +85°C
Performance	
Operating voltage:	Voltage: 3.0 - 4.2 V
Current consumption:	< 2.5 mA @ DRX9 (Idle mode)
Tx power:	• 0.6 W, 850 MHz • 2 W, 900 MHz • 1 W, 1800/1900 MHz
Interfaces	
Connectors:	• Single 70-pin, board-to-board • RF MMCX
SIM Card:	• Local SIM connectivity • 32K SIM • 1.8/3.0 V

Serial:	• RS232:
	  • BR from 300 bps to 115 Kbps
	  • Auto BR from 300 bps to 115 Kbps
	• USB
	  • 12 Mbps USB specifications, Rev. 1.1

Data Features	
GPRS:	• Multi-slot class 8 (4 down; 1 up) • Max BR 85.6 Kbps • Class B GSM 07.10 multiplexing protocol • Coding scheme CS1-CS4
CSD:	Max BR 14.4 Kbps
SMS:	• MO/MT Text and PDU modes • Cell broadcast
FAX Class 1	
Voice Features	
Telephony	
Digital audio	
Differential analog audio lines	

Table 2. Product Specifications *(Continued)*

Voice Features (Continued)
Vocoders EFR/ER/FR/AMR
DTMF support
Audio control: echo cancellation, noise suppression, side tone and gain control
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
Control/Status Indicators
GPRS coverage
Wakeup
Antenna detect
TX enable
Reset
Entertainment mute
Features over RS232
Embedded TCP/IP stack
STK Class II
User Application
Application Programming Interface (API)
12 GPIO lines
2 A/D lines
Emergency and Location
FCC E911 Phase II Location Mandate using EOTD
AT Command Set
GSM 07.05
GSM 07.07
Motorola proprietary AT commands
Accessories
Firmware data loader
Data logger
Developer Kit

Note

Specifications are subject to change without prior notice.

2.4 MODELS DESCRIPTION

Table 3 lists the available g20 models.

Table 3. g20 Models

Model	Operating Bands	Interface Connectors	Serial Interface
F3001	GSM 850/1900	• 70-pin 0.5 mm pitch • MMCX RF connector	RS232
F3002	EGSM 900/1800	• 70-pin 0.5 mm pitch • MMCX RF connector	RS232
F3003	GSM 850/1900	• 70-pin 0.5 mm pitch • MMCX RF connector	USB
F3004	EGSM 900/1800	• 70-pin 0.5 mm pitch • MMCX RF connector	USB

2.5 REGULATORY APPROVALS

The following regulatory approvals apply for the g20 module:

- FTA, FCC, DOC, PTCRB
- R&TTE
- GCF
- EMC
- BABT
- QS9000 manufacturing

2.6 REGULATORY STATEMENT

WE NEED SOURCE MATERIAL FOR THIS SECTION.

2.7 SAFETY PRECAUTIONS

2.7.1 User Operation

Do not operate your telephone 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 telephone must be installed in a manner that provides a minimum separation distance of 20 cm or more between the antenna and persons 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 following requirements must be met:

2.7.2 Antenna Installation

- A minimum separation distance of 20 cm needs to be maintained between the antenna and all persons, otherwise a SAR test will be required.
- The transmitter effective radiated power must be less than 1.5 Watts ERP (2.45 Watts or 33.9 dBm EIRP). This requires that the combination of antenna gain and feed line loss does not exceed 11 dBi.

3.1 G20 BLOCK DIAGRAM DESCRIPTION AND OPERATION OVERVIEW

This chapter describes the basic blocks comprising the g20 module and the connectivity options for the module.

3.1.1 g20 Block Diagram

Figure 1 shows a block diagram for the g20 module:

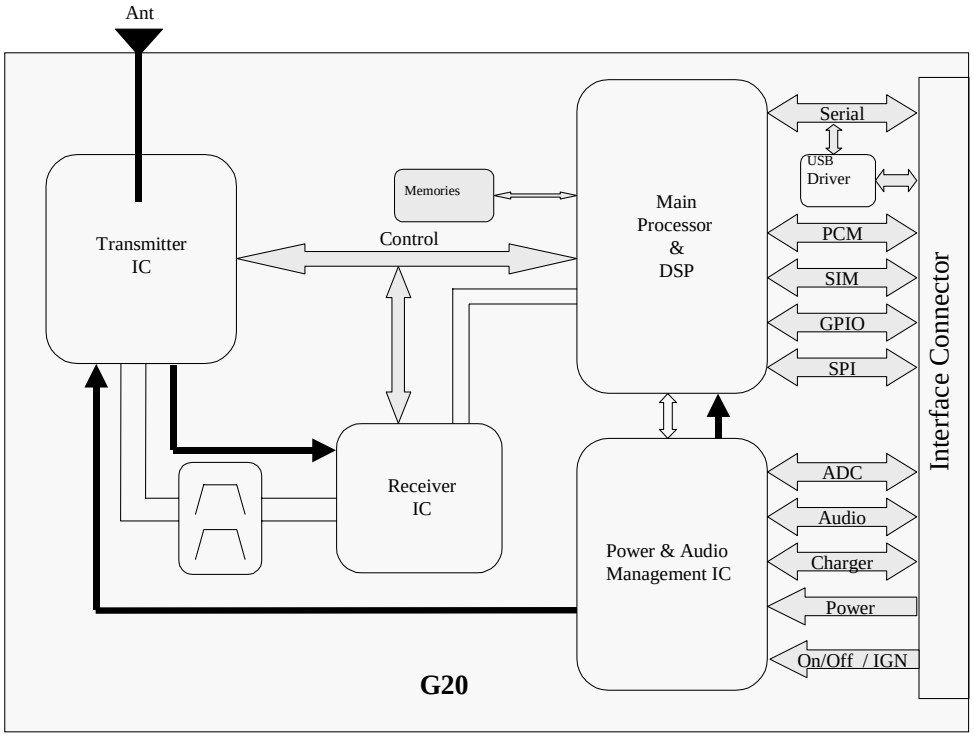

Figure 1. g20 Block Diagram

The g20 consists of the following blocks:

- **Power and Audio Management IC:** This block is responsible for the power on/off process, analog audio drivers, internal regulators, realtime clock activities, and the battery charging process. When an On command is received, this IC wakes up the internal regulators and controls the reset process. This activity turns the unit on. When an Off command is received, this IC sends the request to the main processor, which in turn shuts down the unit in an orderly fashion. During shutdown, the unit is disconnected from the network, all tasks are terminated and the regulators are shut down. The on/off inputs (On/Off and Ignition) are always on, even when the unit is off.

- **Main Processor and DSP:** This block is responsible for all the main tasks in the unit. This block contains the following components:
  - Main processor
  - DSP for controlling speech options
  - UART
  - USB block
  - Digital audio driver
  - SIM card
  - Two SPI buses (one internal and one externally accessible)
  - Main clock (26 MHz)
  - Address/data buses
  - RF PLL
  - Controller to the RF ICs, which is the heart of the unit

  This module provides the following connectivity:

  - Address/data bus
  - UART to the user connector
  - USB via an optional USB driver to the user connector
  - Digital audio (PCM) to the user connector
  - SIM card interface
  - SPI to the user connector
  - SPI to control the RF ICs
  - Control signals to the power amplifier IC
  - Handshake with the Power and Audio Management IC
  - General I/O to the user connector
- **Receiver Block:** This block is an RF block that contains all the receiver channels. It contains the following components:
  - Front filters
  - LNAs
  - Mixers
  - VCOs
  - I/Q outputs
  - Control signals
- **Transmitter Block:** This is an RF block that contains all the transmitter channels. It contains the following components:
  - Power amplifiers
  - Power control loop
  - Antenna switch
  - Harmonic filter
  - Input buffers
  - Control signals
  - Antenna connection

3.1.2 Basic RS232 and Analog Audio Connectivity

The following basic g20 connectivity requirements apply for UART (RS232) and analog audio connections (see Figure 2 for reference):

- The RS232 is connected via eight pins to the g20.
- The SIM card is connected via five pins to the SIM driver of the g20.
- The microphone is connected via two pins to the g20 (Mic and Mic Ground).
- The Speaker is connected via two differential lines to the g20.
- The power supply is connected via eight pins (four VCC and four Ground) to the g20.
- The On/Off or Ignition pin is connected.

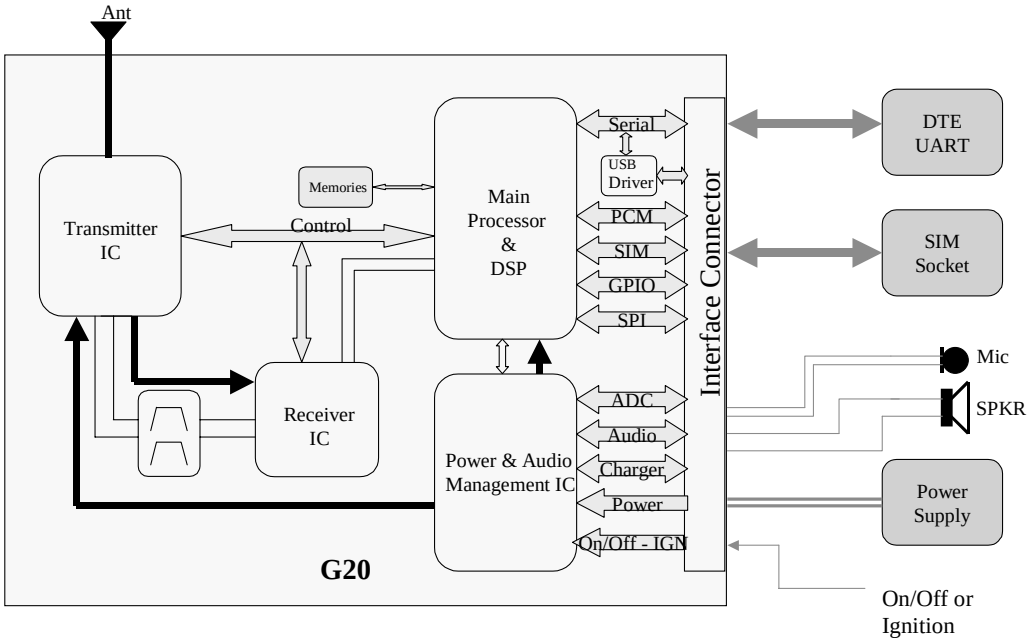

Figure 2. Basic RS232 and Analog Audio Connectivity

3.1.3 Basic RS232 and Digital Audio Connectivity

The following basic g20 connectivity requirements apply for UART (RS232) and digital audio connections (see Figure 3 for reference):

- The RS232 is connected via eight pins to the g20.
- The SIM card socket is connected via five pins to the SIM driver of the g20.
- The DTE DSP is connected via five pins to the g20 (PCM).
- The power supply is connected via eight pins (four VCC and four Ground) to the g20.
- The On/Off or Ignition pin is connected.

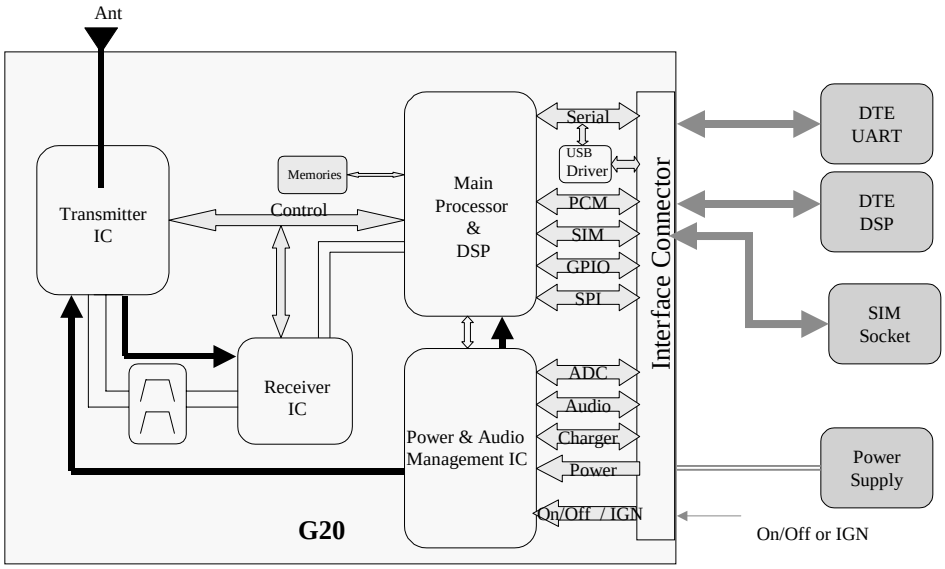

Figure 3. Basic RS232 and Digital Audio Connectivity

3.1.4 Additional Recommended Connections

Additional g20 connectivity options are described below (see Figure 4 for reference):

- A USB connector that is connected via three lines to the g20. In this case, when USB is used, the DTE UART should be in tri-state (high impedance).
- A USB connector that is connected via a USB driver to the g20 (in g20 models without a USB driver). When USB is used, the DTE UART should be in tri-state (high impedance).
- An SPI block that is connected via four pins to the g20 (for debug accessibility).

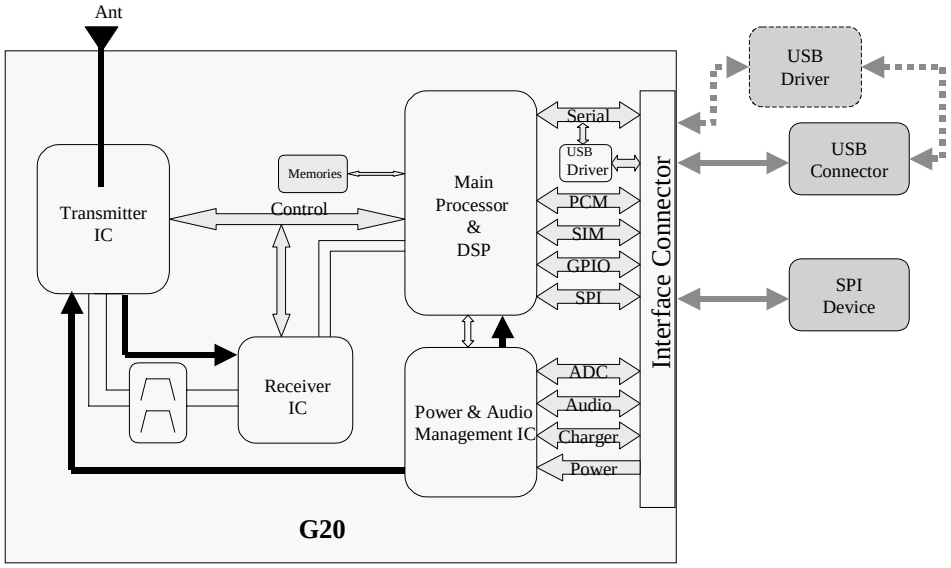

Figure 4. Additional g20 Connectivity

3.1.5 G20 for Handset Configuration

g20 connectivity when using the g20 as a cellular phone engine is described below (see Figure 5 for reference):

- The display is connected via five pins to the g20.
- The keypad is connected via eight pins to the g20.
- The SIM card socket is connected via five pins to the g20 SIM driver.
- The charger is connected via six pins (Interface to National LM3652) to the g20.
- The microphone is connected via two pins (Mic and Mic Ground) to the g20.
- The speaker is connected via two differential lines to the g20.
- The alert device is connected via two differential lines to the g20.
- The vibrator is connected via one pin to the g20.
- The battery is connected to the charger, and the charger is connected to the VCC and Ground pins.

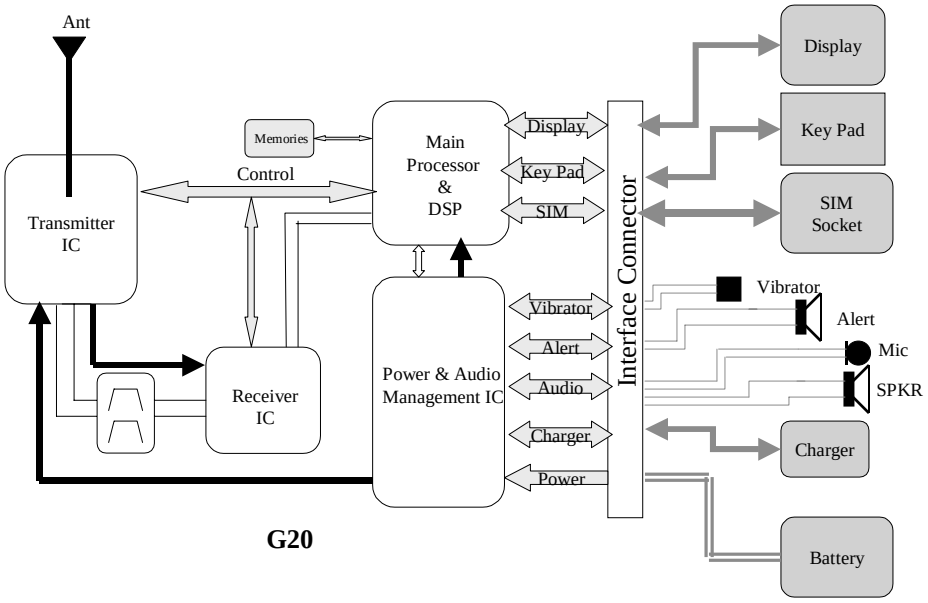

Figure 5. g20 for Handset Configuration

3.2 POWER SUPPLY AND CURRENT CONSUMPTION

This section describes the following power-related considerations for the g20:

- Power supply design
- g20 current consumption
- Turning the unit on/off
- Sleep mode options

3.2.1 Power Supply Design

The following power supply design considerations apply to the g20:

- The g20 is designed to operate between 3.0 V to 4.2 V on the g20 input (after all losses). In order to reduce battery power consumption, it is important to verify power supply line and regulator losses in the PCB.
- The g20 is a GSM/GPRS phone that transmits in 0.5 ms pulses every 4.6 ms. The peak current is approximately 2.0 A.

- When the power supply is lower than 2.85 V, the g20 software determines that the battery is low and disconnects the unit.
- When the voltage is greater than 4.25 V, the g20 software detects an over voltage condition and does not allow the unit to establish a call.
- The VCC line typically drops during TX periods.

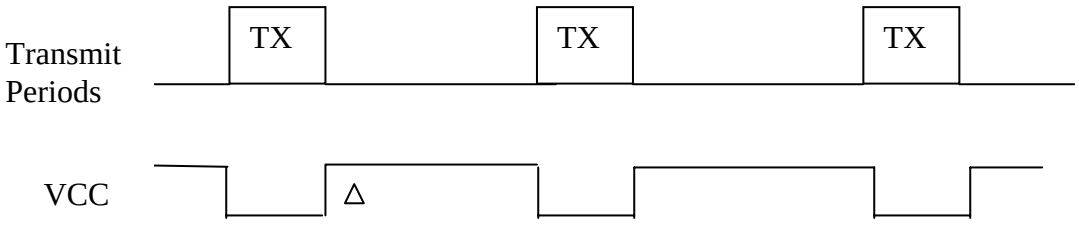

Figure 6. VCC Signal During TX Periods

To minimize the Δ, it is recommended to use lines that are as short as possible, and to place a 1000uF capacitor (or the maximum possible) in the g20 VCC input. (When a battery is used, there is no need for a large capacitor.)

It is recommended to keep the Δ less than 0.3 V.

Note

The power supply should be able to drive at least 2.5 A.

3.2.1.1 Power Supply RF Filtering

It is recommended to add RF filtering to the DC lines.

Use 100nF, 39pF, 22pF or 8.2pF capacitors in parallel to the power supply lines (close to the g20 connector). ***MUST ALL THESE CAPACITORS BE USED IN PARALLEL? OR SOME COMBINATION?***

3.2.2 G20 Current Consumption

In order to design the power supply correctly and to calculate the battery life, you should take into account the current consumption of the g20 when operating in different modes.

Table 4. g20 Current Consumption

Mode	Current Consumption (mA RMS)
g20 in Sleep mode (camped and Sleep-mode enabled)	< 2.5 mA, RMS @ DRX9, Typical 2.2 mA < 4.5 mA, RMS @ DRX2, Typical 3.5 mA
g20 during search time	< 40 mA, RMS, Typical 25 mA, RMS
g20 off	< 100 uA – Typical 25 uA
g20 during a call	
GSM 900	@ Power level #5 < 350 mA, Typical 270 mA @ Power level #10, Typical 160 mA @ Power level #19, Typical 135 mA

Table 4. g20 Current Consumption *(Continued)*

Mode	Current Consumption (mA RMS)
GSM 850	@ Power level #7 < 250 mA, Typical 185 mA @ Power level #10, Typical 160 mA @ Power level #19, Typical 135 mA
DCS 1800	@ Power level #0 < 300 mA, Typical 220 mA @ Power level #10, Typical 160 mA @ Power level #19, Typical 135 mA
PCS 1900	@ Power level #5 < 300 mA, Typical 240 mA @ Power level #10, Typical 160 mA @ Power level #19, Typical 135 mA

Note

DRX2/9 is the rate used by the base station to query the mobile station. The network operator sets this parameter.

3.2.3 Turning the Unit On/Off

Two different mechanisms are available to turn the g20 on and off:

- On/Off signal (Pin 53)
- Ignition line (Pin 51)

3.2.3.1 On/Off Signal

After power is applied to the g20, the on/off signal is pulled high to the VCC by a 200kΩ resistor.

To turn the g20 on, the on/off signal should be pulled low for a minimum of 700 ms.

After the g20 is turned on, the line should be pulled low for a minimum of 1.1 seconds to turn it off. The unit can be turned off only if at least seven seconds have elapsed since turning it on.

Figure 7 shows the timing diagram for the on/off signal.

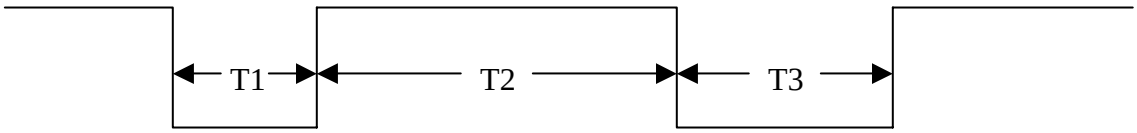

Figure 7. On/Off Signal Timing Diagram

In Figure 7, the following timing requirements apply:

- T1 minimum = 0.7 seconds.
- T2 minimum = 7 seconds.
- T3 minimum = 1.1 seconds.

3.2.3.2 Ignition Line

When the g20 ignition line is held at a high level, the g20 is turned on. When this line is pulled low, the g20 is turned off. In order to protect the line from voltage bounces, the g20 is tuned off only if the line is held low for at least 500 ms.

The high input to the ignition line must be greater than 2.75 V. The line can tolerate up to 40 V.

After the g20 is turned on, the application should wait for DSR before sending data to the g20. The DSR becomes active low eight seconds after the start of T1, or after the ignition line is pulled high. DSR is only valid with UART, and is not valid with USB.

3.2.4 Sleep Mode Options

This section describes how the g20 can be awakened by the DTE and vice-versa.

The DCE (g20) and the DTE can incorporate a sleep mechanism in their application in order to conserve battery life.

Sleep mode enables the g20 to be awakened when the DTE wants to communicate with it. Conversely, it also enables the DTE to be awakened by the g20 when the g20 wants to communicate with it.

3.2.4.1 General

- The g20 Sleep Mode option can be enabled or disabled using ATS24.
- Sleep mode is activated by sending ATS24 = n, where n = 1, 2, 3 or 4 seconds. (To disable Sleep mode, send ATS24=0.)
- The g20 drops the CTS (h/w Flow Control) when it is in Sleep mode.
- The g20 does not enter Sleep mode when data is present on TXD or RXD lines.
- At the end of the TXD (meaning, the TXD buffer is empty), the g20 waits n seconds (as defined in ATS24 = n) before entering Sleep mode.
- The DTE uses CTS to send data only when the g20 is awake. The DTE waits when the g20 is in Sleep mode.
- The DTE should drop RTS during the sleep period in order to prevent the loss of data sent by the g20.

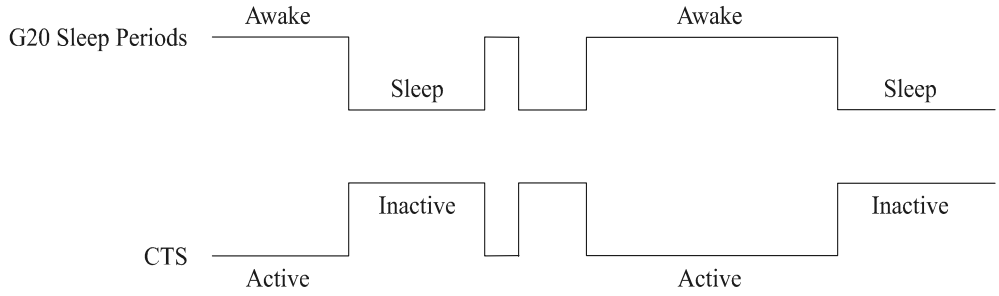

Figure 8. CTS Sleep Mode Timing

3.2.4.2 DCE/DTE Connectivity

Figure 9 shows DCE/DTE connectivity:

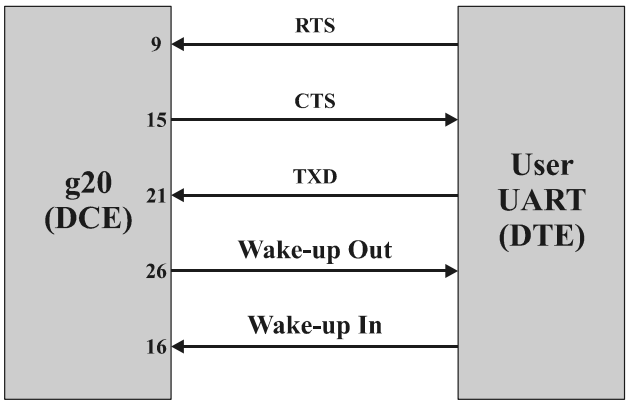

Figure 9. DCE/DTE Connectivity

Waking Up the DCE:

The following apply when waking up the DCE:

- The Wake-up In line is used to awaken the g20. This input is routed into an Interrupt in the g20.
- Whenever the Wake-up In line is at logic “low”, the g20 remains in an awake state.
- When the DTE needs to send data, it should activate this line, wait 30 ms (the wake time required for the g20), and then start sending the data.
- While the DTE is sending data, the wake-up line should remain low, so that the g20 does not enter Sleep mode.

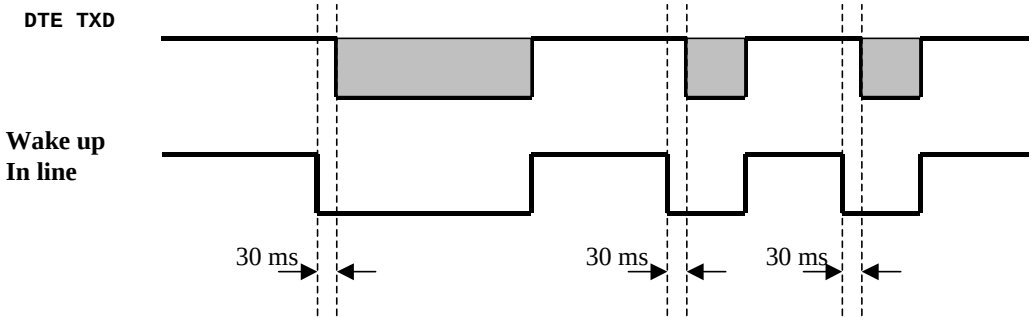

Figure 10. Waking Up the g20 when the DTE Wants to Send Data

Waking Up the DTE:

The following apply when waking up the DTE:

- The g20 uses the Wake-up Out line to indicate to the DTE that data is present.
- The DTE should not enter Sleep mode when the Wake-up Out line is low.
- When the g20 has data to send to the DTE, it drops the Wake-up Out line to low.
- The g20 will send the Wake-up Out line #ms to low, as indicated by S10x in Figure 11.

- While the g20 is sending data, the Wake-up Out line remains low.
- After the sending of data is completed, the g20 brings the Wake-up Out line to high.
- The DTE should keep RTS off during this sleep period in order to avoid sending data when it is not ready.

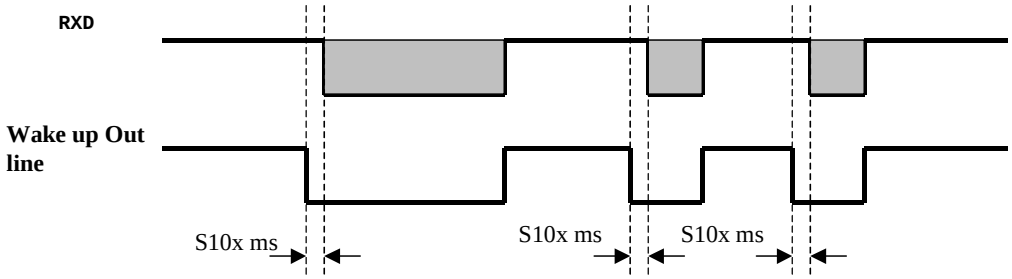

Figure 11. Waking Up the DTE when the g20 Wants to Send Data

3.3 COMMUNICATION INTERFACES

This section describes the following four interfaces that are available in the g20:

- RS232
- USB
- SIM
- SPI

3.3.1 RS232

The following apply when using the RS2332 interface of the g20:

- The g20 supports full hardware flow control (9 pins), software flow control (Xon/Xoff) and non-flow control.
- The g20 UART is connected directly to the interface connector.
- The g20 is a DCE device. Applicable line terminology is shown in Figure 12.

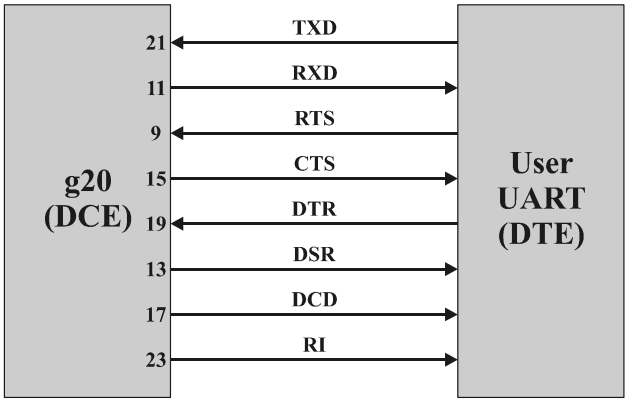

Figure 12. g20 RS232 Interface

3.3.1.1 RS232 Levels

RS232 levels are as follows:

- Vih = 1.95 V minimum, 3.0 V maximum
- Vil = 0.8 V maximum
- Voh = 2.56 V minimum @ 100 uA
- Vol = 0.2 V maximum @ 100 uA

Note

A buffer is required whenever DTE levels do not match g20 levels.

3.3.1.2 RS232 Connection

Figure 13 shows an RS232 connection diagram:

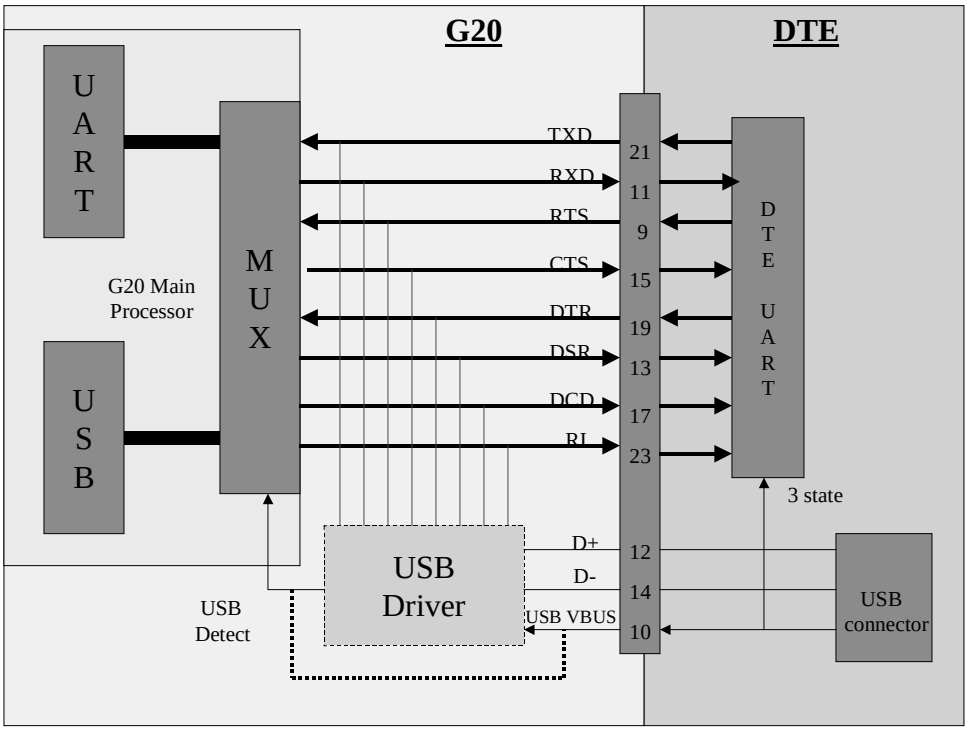

Figure 13. RS232 Connection

The following apply for g20 RS232 connections:

- The g20 can use both UART and USB connectors, but cannot use them both simultaneously.
- When USB is detected (by sensing the USB VBUS signal), the UART is disconnected from the g20 main processor pins and USB functionality is added instead.
- The DTE should unload the RS232 lines when USB is used in order for the USB to function properly.
- RS232 signals are routed directly from the main processor to the connector.

Note

In g20 models without a USB driver (F3001and F3002 models), RS232 signals can be used to connect an external USB driver.

3.3.2 USB

The following apply for g20 USB connections:

- The g20 can use a USB port to communicate with a DTE device.
- The USB port is also used to load software into the g20. It is recommended to include connectivity to this port in the user application.
- The g20 supports USB1.1 at a baud rate of 12 Mbps.
- The g20 supports two basic types, one with a USB driver (models F3003 and F3004), and one with the USB driver removed (models F3001 and F3002).

3.3.2.1 USB Connection

Figure 14 shows g20 connection for g20 models with a USB driver:

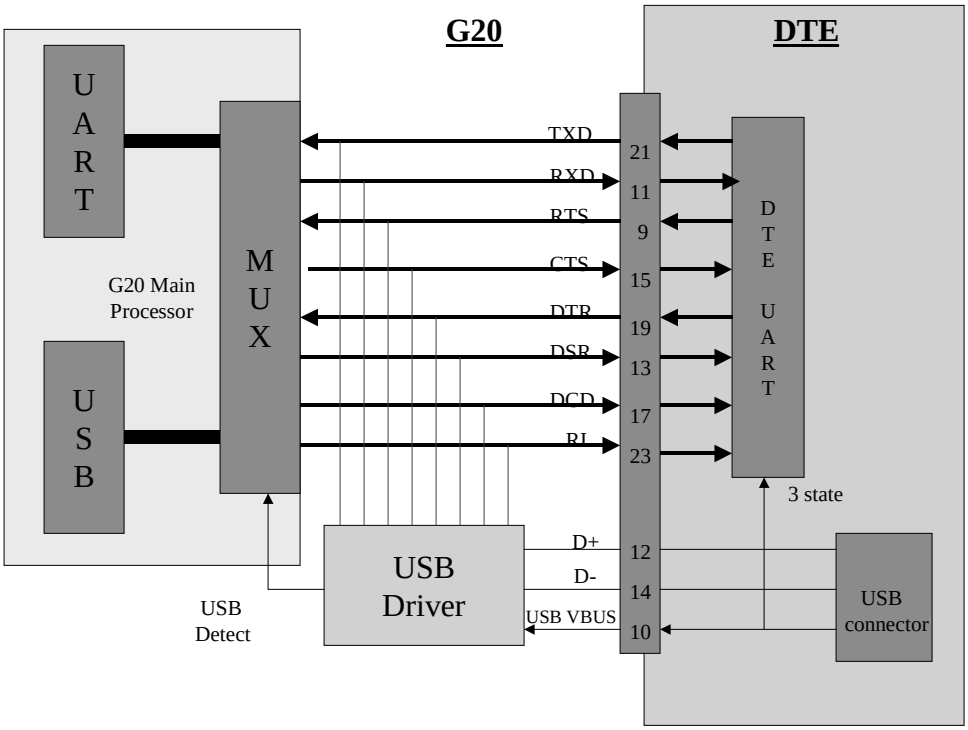

Figure 14. g20 USB Connection for g20 Models with a USB Driver

As shown in Figure 14, the g20 USB is connected via three lines to the USB connector in the user application: D+, D- and USB VBUS. When USB VBUS is applied, the g20 detects it and switches the main processor to USB mode.

Note

The DTE UART loads the USB driver/main processor lines. Therefore, the UART should be kept in tri-state.

Figure 15 shows g20 USB connection for g20 models without a USB driver, using an external USB driver connection. The circuit shown in this figure can be used by the user application in cases where a USB driver is needed.

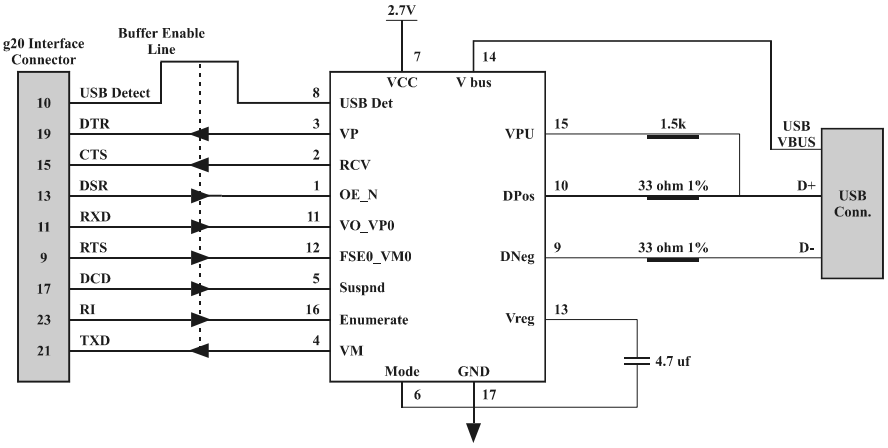

Figure 15. g20 USB Connection for g20 Models without a USB Driver

3.3.3 SIM

The g20 includes a SIM card driver, however, it does not contain a SIM socket. SIM signals are routed to the interface connector and include all the functionality required for SIM card operation.

3.3.3.1 SIM Connection

Figure 16 shows a g20 SIM connection:

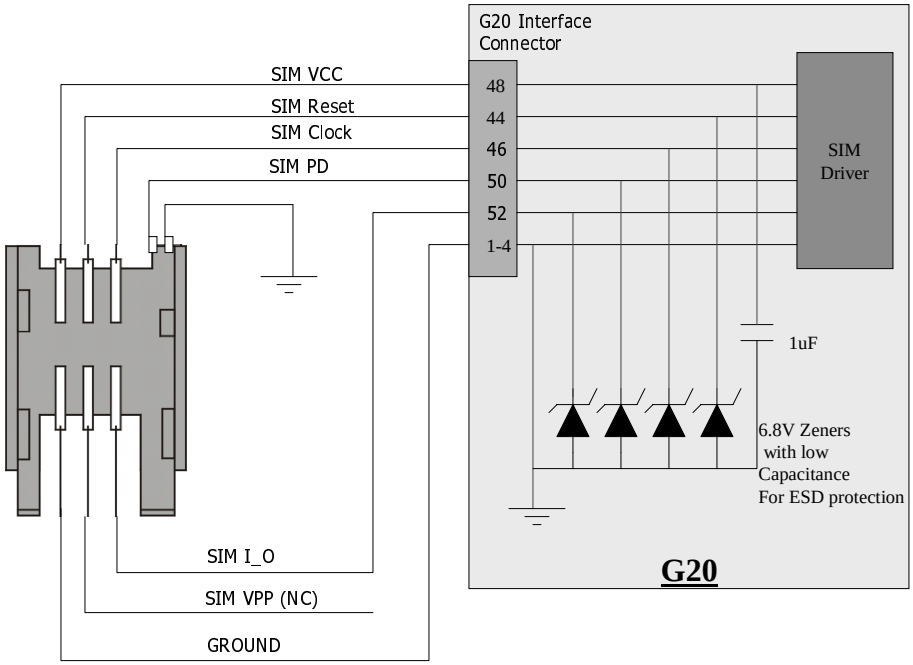

Figure 16. g20 SIM Connection

The following apply for g20 SIM connections:

- The g20 passes all SIM ETSI tests when an external socket is connected to the g20 with lines shorter than 10 cm.
- Longer connections require SIM testing to be performed in the user application.
- The g20 can work with 1.8 V or 3 V SIM cards.
- The g20 provides ESD protection for the SIM lines (6.8V Zener diodes with low capacitance), and for 1uF capacitors to the SIM VCC.
- The SIM_PD (SIM Present Detect) signal is active when it is pulled low.

3.3.4 SPI

The SPI is a standard microprocessor bus used as a g20 debugging port. This port activates a debug option that enables logs to be taken from the g20 while it is operating. It is recommended that this bus be accessible in the user application. In the g20 Developer's Kit, the SPI is driven to an SPI/RS232 interface. The SPI is then converted and uses the RS232 port for debugging. In the g20 Developer's Kit, the SPI bus is converted to an RS232 protocol using a special interface circuit. It then uses the standard RS232 port for debugging. Table 5 shows the pins available on the SPI bus.

3.3.4.1 SPI Connection

Table 5. SPI Pinout

Pin #	Name	Function	Input/Output
70	SPI_CS	SPI chip-select	Output
62	SPI_IRQ	SPI Interrupt	Input
64	SPI_DIN	SPI MISO input	Input
68	SPI_DOUT	SPI MOSI output	Output
66	SPI_CLK	SPI clock	Output

3.3.5 Unique g20 Interfaces

The g20 features certain unique functions (pins) that may be required by selected user applications, such as TX_EN, Antenna Detect, GPRS Detect and Entertainment Mute. Each of these functions is described in the sections that follow.

3.3.5.1 Transmit Enable

This pin indicates when the g20 is transmitting RF in the antenna.

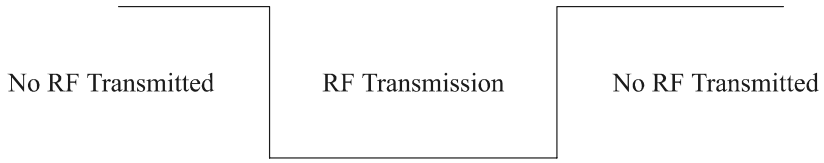

Figure 17. TX_EN Transmission

3.3.5.2 Antenna Detect

This pin indicates whether or not the antenna is inserted. This option was requested by a specific customer and was prepared specifically for their board layout. Thus, this option is not supported by the basic g20 models.

The antenna-detect circuit detects whether the impedance of the antenna is 100 KΩ or lower. The antenna must have a resistance to ground of less than 100 KΩ. in order to be detected.

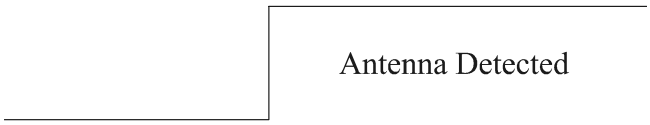

Figure 18. Antenna-detect Circuit

3.3.5.3 GPRS-detect Coverage Indication

This pin indicates whether or not the g20 is located in an area with GPRS network coverage. This pin can be used to indicate the GPRS coverage status before GPRS section activation has occurred, or before a switch to circuit-switched data is made.

Figure 19. GPRS-detect Coverage Indication

3.3.5.4 Entertainment Mute

This pin is reserved for future use. It will be dedicated to automotive applications in which there is a need to mute the entertainment radio when there is a cellular call.

3.4 AUDIO INTERFACES

The g20 has an analog audio interface and a digital audio interface. Both of these interfaces are described in the sections that follow.

3.4.1 Analog Audio Interfaces

The g20 supports microphone input, headset microphone input, differential speaker output, and a differential alert speaker.

3.4.1.1 Analog Input

The g20 has two analog inputs that are referenced to the microphone ground (pin 59):

- **Headset microphone:** Pin 57 is the headset microphone input. Input to this line can be directly from a headset microphone. In order for the headset microphone to be active, the headset interrupt signal (pin 55) must be pulled low. The maximum input to the g20 headset microphone before there is a distortion of the signal in the network is 12 mV RMS.
- **Hands-free microphone:** Pin 61 is the microphone input to the g20. The microphone is active when the headset interrupt signal is not pulled low. The maximum input to the g20 microphone before there is a distortion of the signal in the network is 32 mV RMS.

3.4.1.2 Analog Output

The g20 has a differential speaker output and an alert output:

- **Speaker output:** When headset mode is used, the headset speaker should be connected to the SPKR_N signal of the g20. When a differential amplifier is used, both lines should be connected. An 8-ohm speaker can be connected directly to the speaker lines.
- **Alert:** The g20 supports a direct connection for an alert transducer, in order to build a handset from the g20. All the sounds that are transmitted to the alert can be routed to the speaker using the appropriate AT command.

Table 6 shows the SPKR_N output in headset mode for different network signal levels when the g20 is set to the maximum volume level and the headset interrupt is pulled low.

Table 6. SPKR_N Output when g20 Set to Maximum Volume Level and Headset Interrupt is Low

dBm0	mV RMS	SPKR_N
3.14	1111.9	94
0	774.6	67
-5	435.6	38
-10	244.9	22
-15.5	130	12.5
-16	122.8	12
-17	109.4	11
-20	77.5	8.5
-25	43.6	6.5
-30	24.5	5.5
	3000	250

The measurements shown in Table 6 apply in the following configuration:

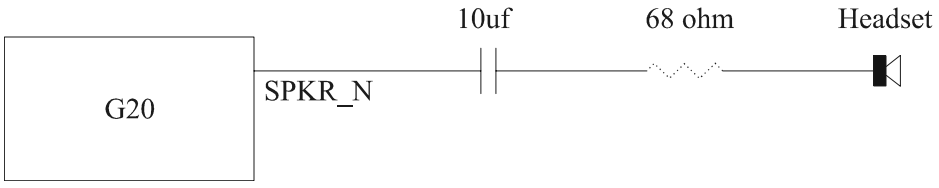

Figure 20. SPKR_N Output Configuration

Table 7 shows the output of the SPKR_N signal for different network signal levels when the g20 is set at the maximum volume level and the headset interrupt is not pulled low.

Table 7. SPKR_N Output when g20 Set to Maximum Volume Level and Headset Interrupt is Not Low

dBm0	mV RMS	SPKR_N
3.14	1111.9	335
0	774.6	242
-5	435.6	134
-10	244.9	76
-15.5	130	41
-16	122.8	39
-17	109.4	34
-20	77.5	24
-25	43.6	14
-30	24.5	8
max	2900	900

Table 8 shows the SPKR_N output at different volume levels, when a 500mV RMS signal is transmitted from the network.

Table 8. SPKR_N Output when a 500mV RMS Signal is Transmitted

Handset Volume	SPKR_N
0 (lowest gain)	15
1	20
2	28
3	39
4	55
5	78
6	110
7 (highest gain)	155

Table 9 shows the typical keypad tone levels generated by the g20. These measurements taken with the g20 in handset mode (meaning the headset-detect signal is not pulled low).

Table 9. SPKR_N Output when g20 is in Handset Mode

Handset Volume	SPKR_N
0	0
1	122
2	172
3	244
4	342
5	482
6	678
7	954

Table 10 shows the keypad tone levels generated by the g20 when in headset mode (meaning the handset-detect signal is pulled low).

Table 10. SPKR_N Output when g20 is in Headset Mode

Handset Volume	SPKR_N
0	0
1	4
2	5.5
3	7.5
4	10.5
5	14
6	19.5
7	27.5

Table 11 shows the levels of the alert transducer measured on the ALERT_P signal at different ring volumes.

Table 11. Alert Transducer Levels for the ALERT_P Signal

Handset Volume	ALRT_P
0	107
1	153
2	206
3	305
4	424
5	600
6	850
7	1200

3.4.1.3 Audio Circuit Design Considerations

In order to design an audio circuit that produces clear audio, without being affected by the GSM transmission, the following guidelines should be considered when designing the circuit:

- The audio input to the g20 should be referenced to the MIC_GND line of the g20.
- The microphone bias of the g20 for both the microphone and headset is 2.2 V. If a microphone with a different voltage is used, the bias should be as clean as possible, and referenced to MIC_GND. Because most GSM buzz (217Hz TDMA noise) is generated from the microphone path, if a different bias is created, it should be filtered to supply DC only.
- The MIC_GND and GND are connected inside the g20 and should not be connected to the application board.
- Keep the lines of the microphone inputs as short as possible. To filter the lines from RF emission, 39pF capacitors can be used.
- The g20 GND should be connected on all four pins, with two mounting screws to the application ground.
- If possible, the RF cable ground from the g20 should be connected to the GND of the g20.
- The digital lines of the application should never be referenced to the MIC_GND.

3.4.2 Digital Audio Interface

The g20 digital audio interface is a full-duplex SAP (serial audio port) comprised of four signals:

- **PCM_FS:** This pin is used for frame sync output provided by the g20.
- **PCM_CLK:** This pin is used for the clock output provided by the g20.
- **PCM_DIN:** This pin is the serial input to the g20 SAP.
- **PCM_DOUT:** This pin is the serial output of the g20 SAP.

The following conditions apply to the digital audio interface of the g20:

- The g20 SAP works in network mode, with four slots in each frame. Each slot consists of 16-bit data.
- The frame sync rate is 8 KHz, and the clock rate is 512 KHz.
- The g20 is the master in the SAP network. Therefore, the connected DSP should be configured as the host.

3.5 ANTENNA

The g20 has two models, one for North America Frequency bands (850/1900 MHz), and one for European Bands (900/1800 MHz). The following connection requirements apply for the g20 antenna:

- The g20 is terminated with an MMCX connector, and with 50-ohm impedance in the relevant frequencies.
- The g20 can be connected to any antenna with 50-ohm impedance in the relevant frequency bands.
- The g20 is designed to work on VSWR, up to 3:1 The antenna should meet this requirement.

3.5.1 Antenna Performance Recommendations

Table 12 lists the performance recommendations for the g20 antenna.

Table 12. Antenna Performance Recommendations

Frequencies:		
GSM 850	TX	824 – 849 MHz
	RX	869 – 893 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:	0 dBi (unity) gain or greater	
Impedance:	50 Ohm	
VSWR:	Typical: 1.5:1 Worst case: 2.5:1	

3.6 CHARGER INTERFACE

g20 software supports charging circuitry for 3.6 V Lithium Ion batteries on some g20 models. The software interface is designed to work with a charging IC from National Semiconductor, model LM3652. Refer to the schematics chapter in the g20 Developer's Kit for more details about the design of the charging circuitry.

3.7 DISPLAY INTERFACE

The g20 supports a four-level gray-scale display with 96 x 65 pixels. The following five lines should be connected to the display:

- LCD_CS
- LCD_RS
- LCD_DATA
- LCD_CLK
- RESET_N

Use the BL_SINK line for backlighting (display and keypad) when using the display. The backlight sink can provide current up to 100 mA, and can be used as an open drain output for more than 100 mA.

3.8 ESD PROTECTION

In general, the g20 does not include embedded ESD protection circuits. This type of protection should be implemented in the customer application. Partial ESD protection is provided, as follows:

- SIM lines are protected up to 3 KV with 6.8 V Zener Diodes.
- VCC input is protected with a 2.2 uF capacitor.
- Ignition input is protected with a 100 nF capacitor.

CONNECTOR PIN ASSIGNMENTS

4.1 CONNECTORS

The g20 has two connectors: the g20 interface connector and the g20 RF connector. Each is described below.

g20 Interface Connector	Mating Connector	Stacking Height
70-pin, 0.5mm pitch, Molex 53748-0708	Molex 52991-0708	3.0 mm

g20 RF Connector	Mating Connector
Standard MMCX female	Standard MMCX male (connector for cable)

4.2 PIN ASSIGNMENTS

The g20 interface is provided via a 70-pin connector. Table 13 describes the pin assignments for the g20 interface connector.

Table 13. g20 Interface Connector Pin Assignments

Pin #	Signal Name	Description	I/O	Signal	Level				Models with USB Driver/ Alternate Function
					Min	Typ	Max	Units	
Power:									
1	GND	Ground		GND					
2	GND	Ground		GND					
3	GND	Ground		GND					
4	GND	Ground		GND					
5	VCC	Power supply	I	DC	3.0	3.6	4.2	V	
6	VCC	Power supply	I	DC	3.0	3.6	4.2	V	

Table 13. g20 Interface Connector Pin Assignments *(Continued)*

Pin #	Signal Name	Description	I/O	Signal	Level				Models with USB Driver/ Alternate Function
					Min	Typ	Max	Units	
7	VCC	Power supply	I	DC	3.0	3.6	4.2	V	
8	VCC	Power supply	I	DC	3.0	3.6	4.2	V	
GPIO:									
16	WAKEUP_IN	Wakeup input	I	Logic		2.775		V	
26	WAKEUP_ OUT	Wakeup output	O	Logic		2.775		V	
25	RESET	Reset signal output	O	Logic		2.775		V	
53	ON_OFF	On/off switch	I	DC	3.0	3.6	4.2	V	
51	IGN	Ignition input	I	Logic	2.775	3.6	16	V	
39	TX_EN	GSM transmit indicator	O	Logic		2.775		V	
41	ANT_DET	Antenna-presence detect	O	Logic		2.775		V	
49	GPRS_DET	GPRS coverage indicator	O	Logic		2.775		V	
37	ENT_MUTE	Entertainment mute	O	Logic		2.775		V	
UART:									
21	TXD	RS232 TXD	I	Logic		2.775		V	USB VMIN
11	RXD	RS232 RXD	O	Logic		2.775		V	USB VPOUT
9	RTS	RS232 RTS	I	Logic		2.775		V	USB XRXD
15	CTS	RS232 CTS	O	Logic		2.775		V	USB VMOUT
19	DTR	RS232 DTR	I	Logic		2.775		V	USB VPIN

Table 13. g20 Interface Connector Pin Assignments *(Continued)*

Pin #	Signal Name	Description	I/O	Signal	Level				Models with USB Driver/ Alternate Function
					Min	Typ	Max	Units	
13	DSR	RS232 DSR	O	Logic		2.775		V	USB TXENB
17	DCD	RS232 DCD	O	Logic		2.775		V	USB SUSPEND
23	RI	RS232 RI	O	Logic		2.775		V	USB SOFTCON
USB:									
10	USB_DET	USB-connection detect	I	DC	4.4	5	5.25	V	USB_ VBUS
12	Not connected								USB_D+
14	Not connected								USB_D-
SPI:									
70	SPI_CS	SPI chip-select	O	Logic		2.775		V	
62	SPI_IRQ	SPI interrupt	I	Logic		2.775		V	
64	SPI_DIN	SPI MISO input	I	Logic		2.775		V	
68	SPI_DOUT	SPI MOSI output	O	Logic		2.775		V	
66	SPI_CLK	SPI clock	O	Logic		2.775		V	
SIM Card:									
50	SIM_PD	SIM-presence detect	I	Logic		2.775		V	
48	SIM_VCC	SIM VCC	O	DC	1.8		3	V	
44	SIM_RST	SIM reset	O	Logic	1.8		3	V	

Table 13. g20 Interface Connector Pin Assignments *(Continued)*

Pin #	Signal Name	Description	I/O	Signal	Level				Models with USB Driver/ Alternate Function
					Min	Typ	Max	Units	
52	SIM_DIO	SIM serial data	I/O	Logic	1.8		3	V	
46	SIM_CLK	SIM clock	O	Logic	1.8		3	V	
PCM Audio:									
18	PCM_DIN	Digital audio receive	I	Logic		2.775		V	
20	PCM_DOUT	Digital audio transmit	O	Logic		2.775		V	
22	PCM_CLK	Digital audio clock	O	Logic		2.775		V	
24	PCM_FS	Digital audio frame sync	O	Logic		2.775		V	
Display:									
54	LCD_CS	Display chip-select	O	Logic		2.775		V	
60	LCD_RS	Display register-select	O	Logic		2.775		V	
56	LCD_DATA	Display serial data	O	Logic		2.775		V	
58	LCD_CLK	Display serial clock	O	Logic		2.775		V	
Keypad:									
30	KBC0	Keypad column 0	I	Logic		2.775		V	
28	KBC1	Keypad column 1	I	Logic		2.775		V	
32	KBR0	Keypad row 0	I	Logic		2.775		V	
34	KBR1	Keypad row 1	I	Logic		2.775		V	
36	KBR2	Keypad row 2	I	Logic		2.775		V	

Table 13. g20 Interface Connector Pin Assignments *(Continued)*

Pin #	Signal Name	Description	I/O	Signal	Level				Models with USB Driver/ Alternate Function
					Min	Typ	Max	Units	
38	KBR3	Keypad row 3	I	Logic		2.775		V	
40	KBR4	Keypad row 4	I	Logic		2.775		V	
42	KBR5	Keypad row 5	I	Logic		2.775		V	
Audio:									
67	SPKR_N	Speaker inverted	O	Audio				V	
69	SPKR_P	Speaker	O	Audio				V	
63	ALRT_N	Alert speaker inverted	O	Logic				V	
65	ALRT_P	Alert speaker	O	Audio				V	
61	MIC	Microphone input	I	Audio				V	
59	MIC_GND	Microphone ground ***What goes in I/O column for this pin?***		GND				V	
57	HDST_MIC	Headset microphone	I	Audio				V	
55	HDST_INT	Headset-detect interrupt	I	Logic		2.775		V	
Charger:									
35	CHRG_DET	Charger-presence detect	I	Logic		2.775		V	
33	CHRG_ STATE	Charger rate indicator	I	Logic		2.775		V	
31	CHRG_SW	Accessory current control	O	Logic		2.775		V	

Table 13. g20 Interface Connector Pin Assignments *(Continued)*

Pin #	Signal Name	Description	I/O	Signal	Level				Models with USB Driver/ Alternate Function
					Min	Typ	Max	Units	
29	CHRG_DIS	Charger disable	O	Logic		2.775		V	
ADC:									
45	CHRG_TYP	Accessory-type detect	I	Logic	0		2.775	V	
47	THERM	Temperature measurement	I	Logic	0		2.775	V	
Miscellaneous:									
27	BL_SINK	Backlight current sink	I	DC		80	100	mA	
43	VIB_OUT	Vibrator regulator	O	DC		1.3		V	

MECHANICAL DESCRIPTION

5.1 MECHANICAL DETAILS

This section describes the mechanical details for the g20:

Size: 45.2x24.4x6 mm

Mounting: Two 2.4 mmØ holes are provided that accommodate M2 screws or #1-64 UNC 2A machine screws. Torque to 2 inches per pound. Refer to Figure 21 below for mounting requirements.

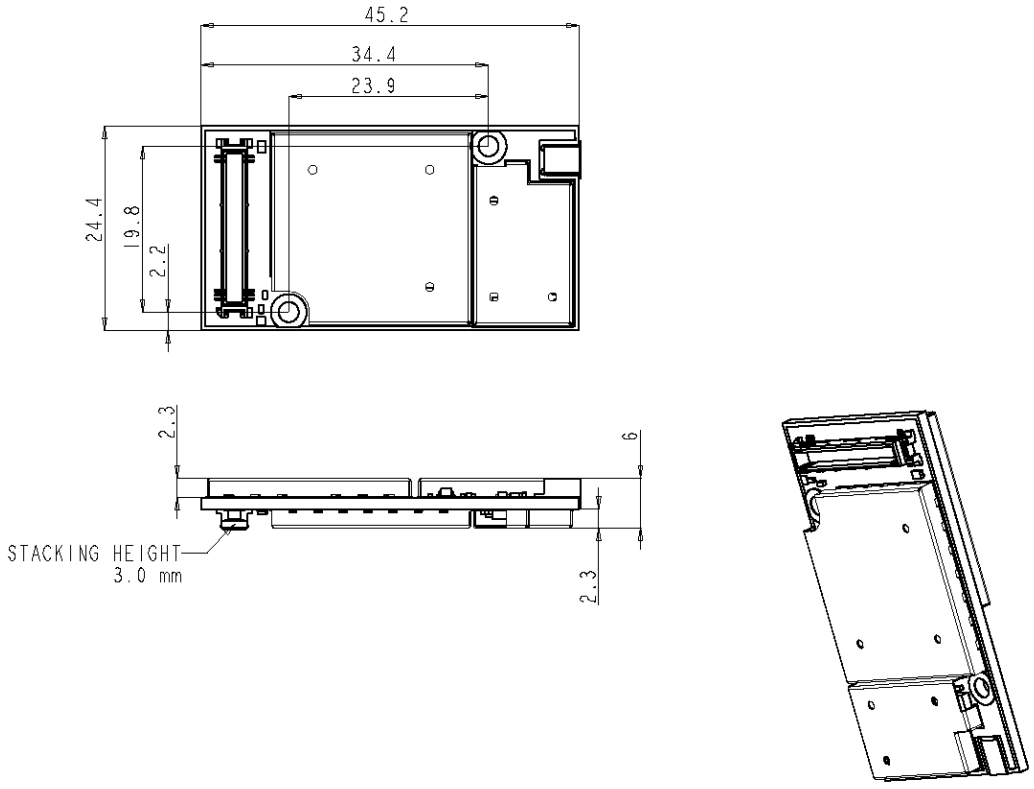

Figure 21. Mechanical Mounting Requirements

SERVICE SUPPORT

6.1 CUSTOMER ASSISTANCE

For customer assistance, contact us as directed below:

Helpdesk email: n2cshd@motorola.com

Helpdesk telephone: +972-3-568-4040

6.2 TESTING A STANDALONE UNIT

PLEASE PROVIDE DETAILS FOR THIS SECTION.

6.3 TROUBLESHOOTING

PLEASE PROVIDE DETAILS FOR THIS SECTION.

6.4 PROGRAMMING

PLEASE PROVIDE DETAILS FOR THIS SECTION.

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