



Core Engine GSM/GPRS Wireless Terminal

Developer Guide

(Preliminary Draft – 7/6/2001)

Confidential

1 REVISION HISTORY

Date	Revision	Description
3/20/01	001	Initial revision (preliminary).
7/6/01	002	Added <i>Core Engine</i> RF antenna connector information. Added information on antenna design considerations. Added <i>Core Engine</i> 60-pin I/O connector pin-out information. Updated Carrier Board section for Rev B carrier board. Updated information in Detailed Specifications section. Removed reference to dual-band 900/1800 version. Added the following new sections: - Power (requirements; management; etc.). - Serial communications (single vs dual ports, XGAP, etc.). - Audio (mic & speaker interface; audio path selection; cabling; etc.). - Updating the <i>Core Engine</i> firmware.

2 SAFETY PRECAUTIONS

2.1 Important Safety Information

Some of the following information may not apply to all devices described in this manual. However, precautions should be observed when handling any electrical device.

- ❑ Save this manual, it contains important safety information and operating instructions.
- ❑ Do not expose the *Core Engine* product to open flames.
- ❑ Care should be taken so that liquids do not spill into the devices.
- ❑ A qualified electrician should perform all primary connections to AC power.
- ❑ Do not attempt to disassemble the product. Doing so will void the warranty. With the exception of Subscriber Identification Modules (SIM), this product does not contain consumer serviceable components.

2.2 Guidelines for Limiting RF Exposure

The *Core Engine* products are GSM radio transceivers.

The following installation and operation restrictions apply to the all *Core Engine* products:

- ❑ A separation distance of at least 20 cm (7 7/8) inches between the antenna and body of the user and other persons must be maintained at all times
- ❑ In FIXED applications using a 1900Mhz *Core Engine* antenna gain* is limited to a maximum of 7 dBi, with a corresponding equivalent isotropic radiated power (EIRP) of 37 dBm / 5 W
- ❑ In MOBILE applications using a 1900Mhz *Core Engine* antenna gain* is limited to a maximum of 3 dBi, with a corresponding equivalent isotropic radiated power (EIRP) of 33 dBm / 3 W
- ❑ Desktop and other uses of these devices where the antenna can easily be relocated are considered by the FCC to be mobile applications.

* Antenna gain is defined as gain in dBi (dB referenced to an isotropic radiator) minus cabling loss.

NOTE: Additional care must be taken by the installer and/or user of the *Core Engine* products to ensure proper antenna selection and installation. Adherence to the above conditions is necessary to comply with FCC requirements for safe operation regarding exposure to RF radiation.

2.3 Disclaimer

The information and instructions contained within this publication comply with all FCC, NRTL, IMEI and other applicable codes in effect at the time of publication. Xircom, Inc. disclaims all responsibility for any act, or breach of law, code or regulation, including local or state codes, performed by a third party.

Xircom, Inc., an Intel company (hereafter “Xircom”) strongly recommends that all installations, hookups, transmissions, etc. be performed by persons who are experienced in the fields of radio frequency technologies. Xircom acknowledges that the installation, setup and transmission guidelines contained within this publication are guidelines, and that each installation may have variables outside of the guidelines contained herein. Said variables must be taken into consideration when installing or using the product, and Xircom, Inc. shall not be responsible for installations or transmissions that fall outside of the parameters set forth in this publication.

Xircom shall not be liable for consequential or incidental damages, injury to any person or property, anticipated or lost profits, loss of time, or other losses incurred by Customer or any third party in connection with the installation of the Products or Customer's failure to comply with the information and instructions contained herein.

2.4 Beta Release Notes

The information in this document is preliminary and subject to change by Xircom.

2.4.1 Data Services

The current software release does not support USSD or Group 3 Fax. These services will be added in subsequent versions.

2.4.2 AT Commands

The current software version may not support all AT commands listed in this document. Please reference the *Core Engine Programmer Reference* document for details of the software AT command implementation.

2.4.3 PUK Procedure

The PUK procedure outlined in this document will be changing.

TABLE OF CONTENTS

1 REVISION HISTORY	2
2 SAFETY PRECAUTIONS	3
2.1 Important Safety Information	3
2.2 Guidelines for Limiting RF Exposure	3
2.3 Disclaimer	3
2.4 Beta Release Notes	4
2.4.1 Data Services	4
2.4.2 AT Commands	4
2.4.3 PUK Procedure	4
3 PRODUCT OVERVIEW	9
3.1 GSM Overview	9
3.2 Model Variation	9
3.3 General Description	9
3.4 Summary of the Features for the Core Engine modem	10
3.5 Programmer Reference	10
3.6 Backward Compatibility	10
3.7 Modes of Operation	11
3.7.1 Circuit Switched Data	11
3.7.2 Transparent and Non Transparent Transmissions	11
3.7.3 Short Message Service	11
3.7.4 Voice	12
3.7.5 General Packet Radio Service (GPRS)	12
4 CARRIER BOARD	13
4.1 Core Engine Modem I/O Interface [P4]	13
4.2 Core Engine I/O Signal Header [J4]	17
4.3 Ground Points [J2, J9]	17
4.4 RF Antenna Connector [J5, J6]	17
4.5 Power [J7, J8, J10]	17
4.6 Primary Serial Interface [P3]	18

4.7 Secondary Serial Interface [P2]	18
4.8 Primary Audio Interface [P1]	19
4.9 Secondary Audio Interface [J1]	20
4.10 Audio Interface Select [JP2]	20
4.11 Subscriber Interface Module [J3]	20
4.12 Status Indication [DS1]	20
5 POWER.....	22
5.1 Power Up Sequence	22
5.2 Power Management.....	22
5.2.1 Power Modes	22
5.2.2 Hardware Signals.....	24
5.2.3 Software Commands.....	24
5.3 Transmit Power	25
6 SERIAL COMMUNICATIONS	26
6.1 Supported Serial Port Configurations.....	26
6.1.1 Single Port Configuration	26
6.1.2 Dual Port Configuration	27
7 AUDIO.....	29
7.1 Audio Path Selection	29
7.1.1 Hardware Selection of Audio Path.....	29
7.1.2 Software Selection of Audio Path	29
7.2 Microphone Input.....	29
7.3 Speaker Output	30
7.4 Audio Circuit Implementation	31
7.4.1 Example Single-Ended Microphone Circuit	31
7.4.2 Example Differential Microphone Circuit.....	32
7.5 Microphone Cable Considerations	32
8 RF ANTENNA.....	33
8.1 Antenna Connector.....	33
8.2 Antenna Selection.....	33
8.3 Antenna Performance Guidelines	33
8.3.1 Antenna Impedance Match	33
8.3.2 Antenna Pattern and Gain.....	34
8.3.3 Antenna Beam Width	34

8.3.4 Antenna Polarization	35
8.4 Antenna Location and Network Communication	35
9 PROVISIONING THE SIM	36
9.1 GSM Services Supported by the <i>Core Engine</i> modem.....	36
9.2 Selecting the Modes of Operation.....	36
10 INSTALLATION & INITIALIZATION.....	37
10.1 Installation and Verification	37
10.1.1 Installation.....	37
10.1.2 Verification	38
10.2 SMS Message Verification	41
10.2.1 Modem Sent SMS (Text).....	41
10.2.2 Modem RECEIVE SMS (Text).....	44
10.2.3 SIM Data Provisioning Verification (Optional)	44
10.2.4 Match Modem Serial port to CPE	44
10.2.5 Verify Setup	44
10.2.6 Connect Primary Serial Port Cable	44
10.3 Final Verification	45
10.3.1 SMS Verification.....	45
11 DETAILED SPECIFICATIONS	46
11.1 Physical Dimensions and Weight.....	46
11.2 Operating Power	46
11.2.1 Transmit Power	46
11.2.2 Receiver Sensitivity.....	47
11.3 Care and Maintenance.....	47
12 ENVIRONMENTAL SPECIFICATIONS	48
12.1 Climatic.....	48
12.1.1 Climatic: Operational	48
12.1.2 Climatic: Storage and Transportation	48
12.2 Mechanical	48
12.2.1 Mechanical: Operational.....	48
12.2.2 Mechanical: Storage and Transportation.....	48
12.2.3 Mechanical: Proposed Standards.....	49
12.3 Electromagnetic.....	49
12.3.1 Electromagnetic Emissions	49
12.3.2 Electromagnetic Immunity	49
13 GLOSSARY AND ACRONYMS	50

14 UPDATING THE CORE ENGINE FIRMWARE.....53

14.1 Required Files53

14.2 Download Utility53

14.3 Download Procedure54

15 INSTALLING A REMOTE ANTENNA56

15.1 Antenna Coaxial Cable and Connectors56

15.2 Outdoor Antenna Grounding56

15.3 Coaxial Cable Routing56

15.4 Coaxial Cable Losses and Lengths.....57

15.5 Formula Examples.....59

15.5.1 Example 1:59

15.5.2 Example 2:59

15.5.3 Example 3:59

3 PRODUCT OVERVIEW

The *Core Engine* modem is a compact, wireless modem that utilizes the international standard Global System for Mobile communications (GSM). The device enables low-cost, application-specific, two-way communication and control. It takes full advantage of GSM capabilities such as Subscriber Identity Modules (SIM), which are "smart cards" that provides numerous advantages.

Over-the-air communication lets the *Core Engine* accomplish tasks that previously required on-site visits and offers innovative new service capabilities never before available. In addition, terminal authentication and data encryption ensures a more confidential communication link between the terminal user and the data recipient.

3.1 GSM Overview

The GSM communications standard, already widely deployed in Europe, Asia, and North America, overcomes many of the drawbacks found in other wireless telemetry approaches. The GSM communications network was designed from the ground up, for reliable and inexpensive digital data transfers.

The GSM network employs integrated data and data-friendly capabilities such as short message services, circuit switched data and, soon, GPRS, which brings the best of wireless and packet data into harmony and will make new services even more practical and affordable. In many countries around the world, especially in Western Europe, GSM-based networks are the only digital networks deployed.

The *Core Engine* modem leverages *existing* public GSM networks, as opposed to other systems that require the utility to build, operate, and maintain expensive private wireless networks.

3.2 Model Variation

The *Core Engine* modem supports GSM *Short message service* (SMS), *voice*, and *circuit switched data* (transparent and non-transparent mode) up to 9.6 Kbps. This modem also is GPRS hardware ready. It provides *GPRS packet data* up to and including Class 10, in addition to *Short Message Service* (SMS), *voice*, and *circuit switched data* (transparent and non-transparent mode) up to 9.6 Kbps.

- ❑ *Core Engine* modems are available in the following configuration:
 - ❑ 1900 MHz: Part # 4200-1100

3.3 General Description

The *Core Engine* Carrier Board assembly provides DC to DC conversion and standard interface connections with drivers for two serial interfaces, a voice interface, and DC power.

The modem operates under a wide range of DC input power. Communication is through an RS-232 physical interface, using the GSM - AT command set.

3.4 Summary of the Features for the Core Engine modem

Interface	Primary serial port	V.24 protocol, 3V levels.
	Secondary serial port	Secondary 3V serial port (currently restricted to debug use).
	Voice	Supports two (2) vocoder modes: full-rate, and enhanced full-rate (EFR).
	Antenna	On-board microminiature coaxial connector for RF antenna.
	Command protocol	AT command set.
	Subscriber Identification Module (SIM)	3V mini-SIM carrier and interface on carrier board.
Power	Electrical power	Fixed DC voltage 3.7V +/-0.3V
	Peak currents and average power dissipation	Refer to the Operating Power table in the Technical Specifications section for peak currents and average power dissipation for various modes of operation.
Radio Features	Frequency bands	PCS 1900 capability.
	GSM features supported	Provides for all GSM authentication, encryption, and frequency hopping algorithms.
Regulatory	Agency approvals	▪ GSM Type Approval – <i>planned</i> ▪ FCC Certification (Part 24) – <i>planned</i> ▪ CE (European Community Certification) – <i>planned</i> ▪ IC (Industry Canada) – <i>planned</i>
GSM Functionality	▪ Mobile-originated and mobile-terminated SMS messages: up to 140 bytes or up to 160 GSM 7-bit ASCII characters. ▪ Reception of Cell Broadcast Message. ▪ SMS Receipt acknowledgement. ▪ Circuit Switched Data (Transparent & Non-transparent programmable from 4.8 to 9.6 Kbps). ▪ Voice. ▪ Supports GSM Phase 2+.	
GPRS Functionality	GPRS software will be available at a later date.	

Table 1: Core Engine Summary of Features

3.5 Programmer Reference

For greater flexibility that enhances the usability of the *Core Engine* modems, Xircom provides a *Core Engine Programmer Reference*. This document goes into greater detail, in an easy to read format, on the enhanced programming capabilities specific to the *Core Engine* modem, including details of supported AT commands.

3.6 Backward Compatibility

GSM functionality is forever evolving. Subsequently, in order to maintain the highest standards, the *Core Engine* modems will be backward compatible with new GSM functionality such as General Packet Radio Service (GPRS). Applications supported with

early current versions of the modem will continue to be supported, as GSM technology evolves to GPRS, and then on to third generation technologies, which are now in the process of standardization and development.

3.7 Modes of Operation

Core Engine offers several modes of operation to address a variety of application requirements.

3.7.1 Circuit Switched Data

Circuit switched data is the most widespread and traditional means of data and voice transmission available today. A circuit switched connection occupies one network line for the entire length of data transmission and during this time, no other user may access this network line. A circuit switched connection is the optimal means for transmitting any continuous amount of data, such as video transmission or voice.

A common example of a circuit switched network is the public telephone system. When person A picks up the telephone and dials the number of person B, the network determines and assigns a path for that transmission. The signal travels through each assigned circuit switch to complete the connection.

Once the signal has reached person B, a continuous two-way transmission path has been established. On a long distance call, for example, many circuits would need to be connected together to make the call possible. These circuits are dedicated to the call for the duration of the transmission and cannot be shared by other users. This requires substantial network resources to be allocated per user.

3.7.2 Transparent and Non Transparent Transmissions

GSM provides two connection modes of transmission: transparent and non-transparent. All *Core Engine* models support both modes. The *transparent data mode* delivers a service with a variable error rate, with a guaranteed throughput and delay, whereas the *non-transparent mode* delivers a constantly low forward error correction rate, but with a non-guaranteed throughput or delay.

Not all networks support transparent services.

The non-transparent service delivers the most reliable performance and is closest to using a modem over a fixed telephone line.

3.7.3 Short Message Service

To accommodate smaller messages, GSM uses short message service (SMS) for efficient and timely data transmission and data retrieval. SMS is a point-to-point, storage and forwarding, message service that is used in data transmissions such as paging, notification, news flashes, and information retrieval.

Short messages can carry up to 140 8-bit characters. (160, 7-bit characters available – refer to the *Core Engine Programmer Reference* for configuration)

Short Messages can be sent and received simultaneously with a voice or data call and are sent above the voice or data in the overhead-signaling path (Traffic & Bearer).

Although similar in concept to traditional paging, the primary difference is that SMS is not geographically restricted as paging systems are. Moreover, the GSM network stores and resends the message if the receiver's handset is turned off (In some cases, if a pager is turned off, the message is simply lost).

Listed below are the essential characteristics and assumptions regarding the form of SMS supported by the *Core Engine* modem.

- ❑ Support of both mobile originated and mobile terminated SMS.
- ❑ 8-bit data in PDU mode
- ❑ Message Class 1
- ❑ Up to 140 ASCII characters per message using 8-bit data mode. (160 characters if 7bit GSM ASCII used)
- ❑ Notify the network when it has memory capacity available to receive one or more SMS messages after it has previously rejected a message because its memory capacity was exceeded

3.7.4 Voice

The *Core Engine* modem has full voice capabilities, provided the necessary connections have been made for the speaker and microphone pins on the 60-pin I/O connector. The AT commands and their responses allow the user to enter and receive information from the *Core Engine* modem. These functions include the ability for dialing, for providing on-hook or off-hook, and for controlling other aspects of the voice call interface.

The *Core Engine* modem supports two (2) vocoder compression algorithms for voice communication: full-rate and enhanced full-rate (EFR)

3.7.5 General Packet Radio Service (GPRS)

GPRS is the next step in GSM data services: a fully packet-based protocol service with direct access to the Internet. By bringing the best features of messaging, circuit-switched services, and packet data into harmony, GPRS promises to make new applications even more practical and affordable. Future releases of the *Core Engine* modem will support GPRS mode. Currently, the *Core Engine* modem is hardware-ready for GPRS.

4 CARRIER BOARD

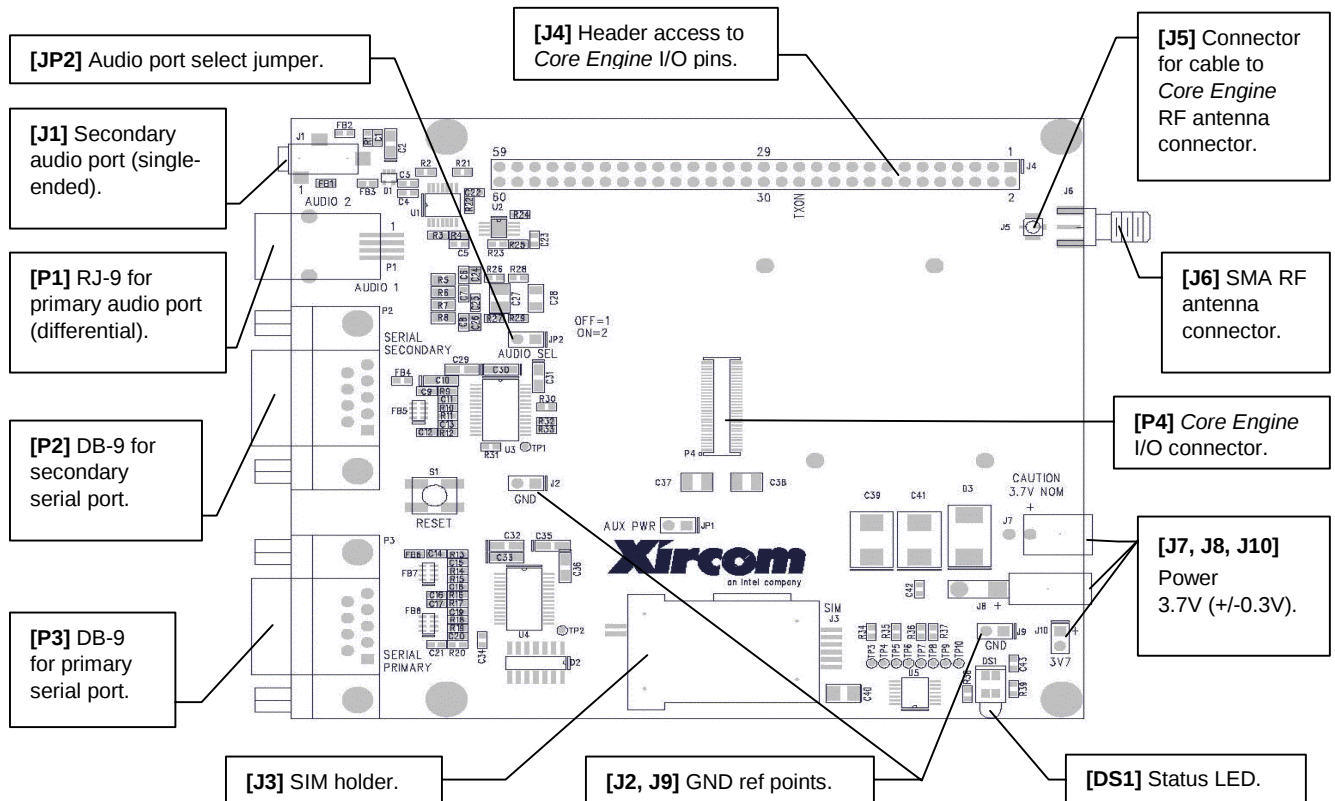


Figure 1: Core Engine Carrier Board (Rev B)

NOTE: The carrier board is intended for development only, and is not suitable for performing RF qualification.

4.1 Core Engine Modem I/O Interface [P4]

The Core Engine modem connects to the carrier board using a 60-pin connector (connector P4 on the carrier board). The I/O interface signals are described in Table 2.

Pin	Signal Name	I/O	Functionality	Parameters
1	VCC	*	0.5A per contact maximum current per contact.	Vin= 3.7 +/- 0.3 Volt
2	VCC	*	0.5A per contact maximum current per contact.	Vin= 3.7 +/- 0.3 Volt

Pin	Signal Name	I/O	Functionality	Parameters
3	VCC	*	0.5A per contact maximum current per contact.	Vin= 3.7 +/- 0.3 Volt
4	VCC	*	0.5A per contact maximum current per contact.	Vin= 3.7 +/- 0.3 Volt
5	VCC	*	0.5A per contact maximum current per contact.	Vin= 3.7 +/- 0.3 Volt
6	VCC	*	0.5A per contact maximum current per contact.	Vin= 3.7 +/- 0.3 Volt
7	GND	*		(0V)
8	GND	*		(0V)
9	SPK_N1	O	- Differential output - Speaker 1 (primary)	- Differential output voltage typ. 3.7V - Output differential max. DC offset 100mV - Differential output load resistance min. 15 Ohm - Output load capacitance max. 4700pF
10	BATT_LOW	O	Active low when BATT voltage is <= 3.4V	- Vol min = 0V Vol max = 0.2V - Voh min = 2.28V Voh max = 2.53V
11	GND	*		(0V)
12	CTS_2	O	- Flow control 2nd port (DCE) - Clear to Send	- Vol min = 0V Vol max = 0.2V - Voh min = 2.28V Voh max = 2.53V
13	SPK_P1	O	- Differential output - Speaker 1 (primary)	- Differential output voltage typ. 3.7V - Output differential max. DC offset 100mV - Differential output load resistance min. 15 Ohm - Output load capacitance max. 4700pF
14	GPIO0	IO	GPIO	- Vil min = -0.3V Vil max = 0.496V - Vih min = 1.771V Vih max = 3.3V - Vol min = 0V Vol max = 0.2V - Voh min = 2.28V Vol max = 2.53V
15	GND	*		(0V)
16	RTS_2	I	- Flow control. 2nd port (DCE) - Request to Send	- Vol min = 0V Vol max = 0.2V - Voh min = 2.28V Voh max = 2.53V
17	VMIC	O	Bias voltage output for Mic(s)	- Vmic Typ = 1.8V, min. = 1.6V - Current 2mA
18	RESET_B	I	- Reset Baseband - Active Low	- Vil min = -0.3V Vil max = 0.496V - Vih min = 1.771V Vih max = 3.3V
19	GND	*		(0V)
20	RINGER	O	External ringer function	- Vol min = 0V Vol max = 0.2V - Voh min = 2.28V Voh max = 2.53V
21	MIC_N1	I	- Differential input - MIC 1 (primary)	- Input voltage differential 1.03Vpp - Differential input resistance typ. 50Kohm

Pin	Signal Name	I/O	Functionality	Parameters
				Input capacitance typ. 5pF
22	PWR_DWN	I	Active low input bring the unit down like CPWROFF	- Vil min = -0.3V Vil max = 0.496V - Vih min = 1.771V Vih max = 3.3V
23	GND	*		(0V)
24	GND	*		(0V)
25	MIC_P1	I	- Differential input - MIC 1 (primary)	- Input voltage differential 1.03 Vpp - Differential input resistance typ. 50Kohm - Input capacitance typ. 5pF
26	TXON	O	- Transmitter on - Active High	- Vol min = 0V Vol max = 0.2V - Voh min = 2.28V Voh max = 2.53V
27	GND	*		
28	GPIO1	IO	GPIO	- Vil min = -0.3V Vil max = 0.496V - Vih min = 1.771V Vih max = 3.3V - Vol min = 0V Vol max = 0.2V - Voh min = 2.28V Voh max = 2.53V
29	RX_2	O	- Check your Rx/Tx direction - Core Engine is DCE	- Vol min = 0V Vol max = 0.2V - Voh min = 2.28V Voh max = 2.53V
30	AUDIO_EN	O	- Active high when audio circuit should be enabled - Can be used by a customer to go into power savings mode on their audio circuit.	- Vol min = 0V Vol max = 0.2V - Voh min = 2.28V Voh max = 2.53V
31	TX_2	I	- Check your Rx/Tx direction - Core is DCE	- Vil min = -0.3V Vil max = 0.496V - Vih min = 1.771V Vih max = 3.3V
32	SLEEP	O	- Indication when RF section is asleep - Active Low	- Vol min = 0V Vol max = 0.2V - Voh min = 2.28V Voh max = 2.53V
33	GND	*		(0V)
34	AUDIO_SEL	I	- Selection between Primary/Secondary audio port - Active low - High=Primary, Low=Secondary	- Vil min = -0.3V Vil max = 0.496V - Vih min = 1.771V Vih max = 3.3V
35	LED0_RMT	O	- Used for driving LED (Red) - Active High	- Vol min = 0V Vol max = 0.2V - Voh min = 2.28V Voh max = 2.53V
36	SPK_N2	O	- Differential output - Speaker 2 (secondary)	- Differential output voltage typ. 3.7V - Output differential max. DC offset 100mV - Differential output load resistance min. 15 Ohm - Output load capacitance max. 4700pF.
37	LED1_RMT	O	- Used for driving LED (Green) - Active High	- Vol min = 0V Vol max = 0.2V - Voh min = 2.28V Voh max = 2.53V
38	SPK_P2	O	Differential output	Differential output voltage typ. 3.7V

Pin	Signal Name	I/O	Functionality	Parameters
			Speaker 2 (secondary)	- Output differential max. DC offset 100mV - Differential output load resistance min. 15 Ohm - Output load capacitance max. 4700pF.
39	WAKE_UP	I	- Wake up request if baseband is asleep - Active Low	- Vil min = -0.3V Vil max = 0.496V - Vih min = 1.771V Vih max = 3.3V
40	MIC_N2	I	- Differential input - MIC 2 (secondary)	- Input voltage differential 1.03Vpp - Differential input resistance typ. 50Kohm - Input capacitance typ. 5pF
41	GND	*		(0V)
42	MIC_P2	I	- Differential input - MIC 2 (secondary)	- Input voltage differential 1.03 Vpp - Differential input resistance typ. 50Kohm - Input capacitance typ. 5pF
43	RX_1	O	- Check your Rx/Tx direction 1st port - Core is DCE	- Vol min = 0V Vol max = 0.2V - Voh min = 2.28V Voh max = 2.53V
44	GND	*		(0V)
45	DSR_1	O	- Core is DCE - Data Set Ready (DSR)	- Vol min = 0V Vol max = 0.2V - Voh min = 2.28V Voh max = 2.53V
46	TBAT	I	Thermistor voltage divider input (NTC)	T.B.D.
47	DCD_1	O	- Core is DCE - Data Carrier Detect (DCD)	- Vol min = 0V Vol max = 0.2V - Voh min = 2.28V Voh max = 2.53V
48	SIM_CLK	O	SIM	T.B.D.
49	RI_1	O	- Core is DCE - Ring Indicator (RI) - Indicates incoming circuit switched data or voice call.	- Vol min = 0V Vol max = 0.2V - Voh min = 2.28V Voh max = 2.53V
50	GND	*		(0V)
51	TX_1	I	- Check your Rx/Tx direction 1st port - Core is DCE	- Vil min = -0.3V Vil max = 0.496V - Vih min = 1.771V Vih max = 3.3V
52	SIM_IO	IO	SIM	T.B.D.
53	RTS_1	I	- Flow control 1st port (DCE) - Request To Send (RTS)	- Vil min = -0.3V Vil max = 0.496V - Vih min = 1.771V Vih max = 3.3V
54	SIM_RST	O	SIM	T.B.D.
55	CTS_1	O	- Flow control 1st port (DCE) - Clear To Send (CTS)	- Vol min = 0V Vol max = 0.2V - Voh min = 2.28V Voh max = 2.53V

Pin	Signal Name	I/O	Functionality	Parameters
56	SIM_GND	O	SIM	GND
57	DTR_1	I	- Core is DCE - Data Terminal Ready (DTR)	- Vil min = -0.3V Vil max = 0.496V - Vih min = 1.771V Vih max = 3.3V
58	SIM_VCC	O	SIM	T.B.D.
59	GND	*		(0V)
60	GND	*		(0V)

Table 2: Core Engine I/O Connector Pin Out

4.2 Core Engine I/O Signal Header [J4]

The Core Engine I/O signals can be accessed externally at a 60-pin header (connector J4 on the carrier board). The I/O interface signals are described in Table 2.

4.3 Ground Points [J2, J9]

Two ground points are provided (J2 and J9 on the carrier board) which can be used for any probe hookup, for example to an oscilloscope.

4.4 RF Antenna Connector [J5, J6]

The RF antenna may be connected to the Core Engine modem directly, or to the carrier board (at connector J6). When connecting the RF antenna to the carrier board, a cable must also be connected from the carrier board (at connector J5) to the RF connector on the Core Engine board.

The Core Engine board uses a muRata Microminiature SMT Coaxial Connector (muRata p/n "MM9329-2700") for RF antenna connection.

The carrier board uses an SMA connector for connection to an antenna, and a muRata Microminiature SMT Coaxial Connector (muRata p/n "MM9329-2700") for connection to the Core Engine board RF connector.

The Core Engine modem is designed to support interchangeable antenna types, provided that each antenna has 50-ohm impedance and has been tuned to the frequency band intended.

4.5 Power [J7, J8, J10]

The Core Engine carrier board requires an input voltage of 3.7 VDC +/- 0.3V (connectors J7, J8 & J10 on the carrier board).

CAUTION: The carrier board powers the Core Engine board directly, and so must be used with a 3.7V (+/- 0.3V) power supply only.

4.6 Primary Serial Interface [P3]

The primary serial I/O interface (connector P3 on the carrier board) implements RS-232 using a DB-9 connector and supports auto baud capability from 2400 bps to 115200 bps with hardware handshake flow control.

Pin Number	Signal Name	Direction	Functionality
1	DCD0_DS	To CPE	Data Carrier Detect 0. DCE Output signal. Active low. Main serial interface data carrier detect signal. Connects to a DTE, CD, Carrier Detect pin.
2	RX0_DS	To CPE	Receive data 0. DCE Output signal. Main serial interface transmit data signal. During idle or reset, signal will be a logic 1. Connects to a DTE, RX, receive data pin.
3	TX0_DS	From CPE	Transmit data 0. DCE Input signal. Active low. Main serial interface receive data signal. During idle or reset, signal will be a logic 1. Connects to a DTE, TX, transmit data pin.
4	DTR0_DS	From CPE	Data Terminal Ready 0. DCE Input signal. Active low. Main serial interface data terminal ready signal. Connects to a DTE, DTR, Data Terminal Ready pin.
5	GND_IN	From CPE	Electrical power return for digital and analog grounds.
6	DSR0_DS	To CPE	Data Set Ready 0. DCE Output signal. Active low. Main serial interface data set ready signal. Connects to a DTE, DSR, Data Set Ready pin.
7	RTS0_DS	From CPE	Request-To-Send 0. DCE Input signal. Active low. Main serial interface request to send signal. Connects to a DTE, RTS, Request-To-Send pin.
8	CTS0_DS	To CPE	Clear-To-Send 0. DCE Output signal. Active low. Main serial interface clear to send signal. Connects to a DTE, CTS, Clear to send pin.
9	RI0_DS	To CPE	Ring Indicator 0. DCE Output signal. Active low. Main serial interface ring indicator signal. Connects to a DTE, RI, Ring Indicator pin.

Table 3: Carrier Board Primary Serial Connector Pin Out

NOTE: The maximum length for the Primary Serial cable is 25 feet.

4.7 Secondary Serial Interface [P2]

The secondary serial I/O interface (connector P2 on the carrier board) implements RS-232 using a DB-9 connector and supports auto baud capability from 2400 bps to 115200 bps with hardware handshake flow control.

Pin Number	Signal Name	Direction	Functionality
------------	-------------	-----------	---------------

Pin Number	Signal Name	Direction	Functionality
2	RX0_DS	To CPE	Receive data 0. DCE Output signal. Main serial interface transmit data signal. During idle or reset, signal will be a logic 1. Connects to a DTE, RX, receive data pin.
3	TX0_DS	From CPE	Transmit data 0. DCE Input signal. Active low. Main serial interface receive data signal. During idle or reset, signal will be a logic 1. Connects to a DTE, TX, transmit data pin.
7	RTS0_DS	From CPE	Request-To-Send 0. DCE Input signal. Active low. Main serial interface request to send signal. Connects to a DTE, RTS, Request-To-Send pin.
8	CTS0_DS	To CPE	Clear-To-Send 0. DCE Output signal. Active low. Main serial interface clear to send signal. Connects to a DTE, CTS, Clear to send pin.

Table 4: Carrier Board Secondary Serial Connector Pin Out

NOTE: The maximum length for the Secondary Serial cable is 25 feet.

4.8 Primary Audio Interface [P1]

The primary audio interface (connector P1 on the carrier board) uses an RJ-9 connector and provides differential microphone input and speaker output.

Pin Number	Signal Name	Direction	Functionality
1	MIC0N	From CPE	Microphone Negative. Negative input pin from an electret-type microphone. Nominal microphone differential voltage should be 2.0 volts. Impedance not less than 900 ohms. Leave signal disconnected if function is not used.
2	SPK0N	To CPE	Speaker Negative. Negative output pin. Low side of a push-pull amplifier. Speaker impedance 15 ohms, minimum. Speaker capacitance of 700 pF, maximum. Driver voltage is 3.7V peak-to-peak. Leave signal disconnected if function is not used.
3	SPK0P	To CPE	Speaker Positive. Positive output pin. High side of a push-pull amplifier. Speaker impedance 15 ohms, minimum. Speaker capacitance of 700 pF, maximum. Driver voltage is 3.7V peak-to-peak. Leave signal disconnected if function is not used.
4	MIC0P	From CPE	Microphone Positive. Positive input pin from an electret-type microphone. Nominal microphone differential voltage should be 2.0 volts. Impedance not less than 900 ohms. Leave signal disconnected if function is not used.

Table 5: Carrier Board Primary Audio Port Connector Pin Out

4.9 Secondary Audio Interface [J1]

The secondary audio interface (connector J1 on the carrier board) provides single-ended microphone input and speaker output.

4.10 Audio Interface Select [JP2]

Selection of which audio interface is active is controlled by a jumper (jumper JP2 on the carrier board). If the jumper is removed, the primary audio interface is active; if the jumper is installed, the secondary audio interface is active.

This jumper is in parallel with the audio select pin ('AUDIO_SEL') on the *Core Engine* I/O connector.

4.11 Subscriber Interface Module [J3]

The SIM, an integral part of any GSM terminal device, is programmed with subscriber information. The SIM is not provided with the *Core Engine* unit and must be provided by the GSM service subscriber. Care must be taken to protect the SIM. A GSM terminal will not operate without the SIM installed.

The user information consists of an identity (IMSI number) registered with the GSM provider, and an encryption Ki (pronounced key). The SIM consists of a microprocessor chip and memory, installed on a plastic card. *Core Engine* uses the "mini-SIM" or plug in configuration. The SIM, which is removable, installs in a holder (connector J3) on the carrier board.

The SIM card performs authentication. To gain access to the GSM network, the network must recognize the IMSI number and the terminal must be able to properly decrypt the data sent by the network. The SIM also serves as a buffer for Incoming and Stored SMS messages, or when a radio link is not available, store an outgoing message until a network link is established.

NOTE: Power must be off when installing or removing a SIM card.

4.12 Status Indication [DS1]

The *Core Engine* carrier board provides a multi-color LED (DS1 on the carrier board) that indicates the current link status and signal quality.

NOTE: The LED illuminates any time power is applied to the carrier board.

LED Color	Link Status
Green	Modem is attached to the network
Flashing Orange	Modem is registered on the network but is rejected
Flashing Red	Modem is in Start-up mode or is not attached to the network

Table 6: Carrier Board LED Colors

NOTE: When the carrier board is not used, then to implement the LED status indication using the I/O interface pins directly on the *Core Engine* modem using a dual color LED requires two pins: "LED0_RMT" and LED1_RMT". LED0 is red and LED1 is green. To get the status indications, an inverter can be placed in between the buffer output and the cathode, and the anode can be tied to 3V through a 220Ohm resistor. To achieve the status indications shown in the table, either LED0 will pulse on and off, or both LED0 and LED1 will pulse on and off together (giving orange), or LED1 will be on steady. Otherwise the LEDs are not driven.

5 POWER

5.1 Power Up Sequence

To power up the *Core Engine*, apply Vbat 3.7 Volts (+/- 0.3 Volts) to *Core Engine* I/O interface pins 1-6 for VCC(+) and pins 7, 8, 11, 15, 19, 23, 24, 27, 33, 41, 44, 50, 59, 60 for GND(-).

The *Core Engine* will power up and will register on the network if an RF link is available.

5.2 Power Management

For maximum power savings some cooperation is required from the host device and controlling software that interfaces to the *Core Engine* module. Mechanisms are provided to allow the host to go to sleep and the *Core Engine* to wake the host, as well as for the host to awaken the *Core Engine*.

Several power management levels (or power modes) are implemented in the *Core Engine*.

5.2.1 Power Modes

5.2.1.1 "READY" Mode

The READY mode is characterized as follows:

- ❑ AT+CFUN=1
- ❑ The *Core Engine* is attached to the network.
- ❑ PDP Context is activated.
- ❑ Packet data transfer is in progress or imminent.
- ❑ Full GSM operation for voice, data and SMS is possible.
- ❑ The SLEEP signal on the *Core Engine* I/O interface is High.

5.2.1.2 "STANDBY" Mode

The STANDBY mode is characterized as follows:

- ❑ AT+CFUN=1
- ❑ The *Core Engine* is attached to the network.
- ❑ Will transition to READY mode when an incoming message from the network is detected.
- ❑ Will transition to READY mode when an outgoing call is setup by the host.
- ❑ The SLEEP signal on the *Core Engine* I/O interface is High.
- ❑ Lower power than READY mode.
- ❑ Reduced clock speed.

5.2.1.3 “RF DISABLED” Mode

The RF DISABLED mode is characterized as follows:

- ❑ AT+CFUN=4
- ❑ The *Core Engine* is not attached to the network.
- ❑ The RF section of *Core Engine* is powered down.
- ❑ Limited functionality is available with the digital section (AT changes, phone book entries, etc. are possible).
- ❑ The SLEEP signal on the *Core Engine* I/O interface is Low.
- ❑ Will transition to READY mode when the WAKEP_UP signal on the *Core Engine* I/O interface is asserted.

5.2.1.4 “SLEEP” Mode

The SLEEP mode is characterized as follows:

- ❑ AT+CFUN=0
- ❑ The *Core Engine* is not attached to the network.
- ❑ Reduced clock speed.
- ❑ Minimal digital functionality.
- ❑ The SLEEP signal on the *Core Engine* I/O interface is Low.
- ❑ Will transition to READY mode when the WAKEP_UP signal on the *Core Engine* I/O interface is asserted.
- ❑ Will transition to READY mode when an “AT+CFUN=1” command is received.
- ❑ Minimal power draw.

5.2.1.5 “DORMANT” Mode

The DORMANT mode is characterized as follows:

- ❑ AT+CPWROFF
- ❑ The *Core Engine* is not attached to the network.
- ❑ The RF section of *Core Engine* is disabled.
- ❑ The baseband section of *Core Engine* is stopped.
- ❑ AT command interface is disabled.
- ❑ The SLEEP signal on the *Core Engine* I/O interface is Low.
- ❑ Will transition to READY mode when the WAKEP_UP signal on the *Core Engine* I/O interface is asserted.
- ❑ Will transition to READY mode when the RESET_B signal on the *Core Engine* I/O interface is asserted.
- ❑ Will transition to READY mode when a hardware reset (cycle power) is performed.

5.2.2 Hardware Signals

5.2.2.1 “SLEEP” Signal

The SLEEP signal indicates whether or not the *Core Engine* RF section is active. When the RF section is shutdown, the SLEEP signal will be Low. The SLEEP output is provided if a host application wants to use it, but it is not necessary to use this pin. Usage would depend on the host device and application. Some examples of when the SLEEP signal may be useful are as follows:

- ❑ *Power down other host elements when the Core Engine radio is inactive:* Monitoring the SLEEP signal allows the host to detect when the radio is asleep so that other elements of the host device may be powered down while there is no radio activity, and so saving power.
- ❑ *Avoid multiple elements transmitting simultaneously:* If the host device incorporates another transmitting device (such as Bluetooth or 802.11) then the host may monitor the SLEEP signal to confirm the *Core Engine* is not active before transmitting on one of the other devices - it may be desirable to limit the implementation only one technology or device is active or transmitting at once.

5.2.2.2 “PWR_DWN” Signal

The PWR_DWN signal triggers the software power down sequence (the same as the AT+CPWROFF software command). The *Core Engine* will be released from the network and the RF section will be shutdown. At this time the SLEEP signal will be Low. The *Core Engine* will transition to “DORMANT” mode. The WAKE_UP signal or RESET_B signal can be used to make the *Core Engine* re-activate and register on the network.

5.2.2.3 “WAKE_UP” Signal

The WAKE_UP signal will transition the *Core Engine* to the “READY” mode from the “RF DISABLED”, “SLEEP” or “DORMANT” modes. The WAKE_UP signal (active Low) must be held active for at least 10 microseconds.

5.2.2.4 “RESET_B” Signal

The RESET_B signal can be used to perform a complete restart the *Core Engine*, similar to cycling power to the *Core Engine*. The RESET_B signal (active Low) must be held active for at least 10 microseconds.

5.2.3 Software Commands

5.2.3.1 AT+CPWROFF

The “AT+CPWROFF” command will perform a graceful shutdown and transition the *Core Engine* to the “DORMANT” mode. No subsequent AT commands will be recognized by the *Core Engine* until it is reset, either by cycling power or by either a WAKE_UP or a RESET_B hardware signal.

5.2.3.2 AT+CFUN

The “AT+CFUN” command can be used to instruct the *Core Engine* to enter the “RF DISABLED”, “SLEEP” or “DORMANT” mode, or to return to the “READY” mode. Unlike the AT+CPWROFF command, the AT+CFUN command does not disable the *Core Engine* AT command interface.

NOTE: Refer to the *Core Engine Programmer Reference* documentation for the syntax of how to use these software commands.

5.3 Transmit Power

The duration of a single transmit burst is 577 microseconds (uS). In Multislot Class 10 operation, two transmit slots may be concatenated, for a total of $(577 \text{ uS} \times 2 =) 1.154 \text{ mS}$. The current required during the transmit burst is somewhat less than 2 Amps. This is when running the full transmit power (30 dBm for PCS). The current required is substantially less at the lower power levels.

A good way to estimate the current required at each power control level is to calculate the current required to provide the transmit power to the antenna with a typical power amplifier efficiency of 50%. For instance, to achieve 33 dBm transmit power to the antenna, add about 2 dB to account for losses in the transmit filters and switches, so 35 dBm is required from the power amplifier output. Add another 3 dB to account for the (typically) 50% power amplifier efficiency, so the power that must be delivered to the power amplifier is 38 dBm. This is equal to 6.3 Watts. This requires about 1.7 amps at 3.7 Volts. This is the current required for the power amplifier stage only. The remainder of the transmitter requires an additional 200 mA during the transmit burst (regardless of transmit power level), for a total requirement of 1.9 Amps.

The capacitance required to sustain the transmit burst current can be estimated by subtracting the current available from the power supply from the total burst current required, and determining a suitable voltage droop during the burst. For instance, if 500 mA is available from the power supply, the capacitor will have to supply $(1.9 - 0.5) = 1.4$ Amps during the transmit burst time. If 300 mV is an acceptable voltage droop during the transmit burst, the capacitance required would be $C = (i \cdot t) / V$ which would be $(1.4 \cdot 0.00154) / 0.3 = 7.2 \text{ milliFarad } (7,200 \text{ uF})$.

Capacitor ESR must also be considered. Since the ESR multiplied by the current produces a voltage step that increases the droop during the transmit burst, the lower the ESR the better; 50 milliohms or less is preferred. Some of the "supercap" solutions on the market may have unacceptably high ESR values.

These values are conservative estimates, and depending on the application, less capacitance may give satisfactory performance. Dropping to a single transmit slot operation (for example, Multislot Class 8 which uses 1 transmit and 4 receive slots) cuts the capacitance required by half.

6 SERIAL COMMUNICATIONS

The *Core Engine* includes support for two (2) serial interfaces, Primary and Secondary, which provide the means for the host to issue commands to and exchange data with the *Core Engine* module. The host may utilize both serial ports of the *Core Engine*, or only one, depending on the host requirements.

6.1 Supported Serial Port Configurations

6.1.1 Single Port Configuration

When only one serial port is used, that must be the Primary serial port; the Secondary serial port is not used.

6.1.1.1 Single Port – Control and Packet Data

In a single port configuration, the Primary serial port can be used for the following:

- ☐ AT commands
- ☐ Voice control
- ☐ SMS control
- ☐ Circuit switched data
- ☐ GPRS packet data

6.1.1.2 Single Port - Standard Protocol Support

Using the standard AT command interface to communicate with the *Core Engine*, AT commands and traditional GSM operations (SMS, voice calls, circuit switched data) can be performed on the Primary serial port, but these operations must be ended before the port can be used for GPRS operations. This configuration facilitates “dial-up” type applications, where a GPRS connection can be established, but must be terminated in order to perform AT commands and GSM operations (including the notification or receipt of incoming circuit switched calls and SMS messages).

NOTE: For full details of the AT commands supported refer to the separate document *Core Engine Programmer Reference*, part number 07100027.

6.1.1.3 Single Port - Enhanced Protocol Support Using “XGAP”

In addition to the standard AT command interface, the *Core Engine* supports a proprietary protocol that allows multiplexing of certain types of information on a single serial port. This protocol, known as the Xircom GPRS Asynchronous Protocol (XGAP) provides the capability to split the communications traffic on the single physical serial port into four (4) distinct virtual channels.

Using XGAP each virtual channel is used for one of the following types of communications:

- ☐ Command channel from host to baseband controller
- ☐ Event channel from baseband controller to host
- ☐ Packet data channel from host to baseband controller
- ☐ Packet data channel from baseband controller to host

NOTE: For full details of the XGAP protocol implementation refer to the separate document: *Xircom GPRS Asynchronous Protocol (XGAP) Specification*, part number 07300416.

Switching between the standard AT command interface and the XGAP interface is accomplished using an AT command to select the desired interface.

NOTE: For full details of the AT commands supported refer to the separate document: *Core Engine Programmer Reference*, part number 07100027.

6.1.2 Dual Port Configuration

When two serial ports are used, the Primary port can be used for AT commands and traditional GSM operations (SMS, voice calls, circuit switched data), and the Secondary port for packet data and GPRS operations. This configuration facilitates “always on” applications, where a GPRS connection can be established and remain connected on the Secondary port, while AT commands and GSM operations can be performed on the Primary port.

NOTE: In a dual port configuration, communications on the Secondary serial port must use the proprietary XGAP protocol. The documentation in this section assumes XGAP is implemented on the Secondary serial port. For full details of the XGAP protocol implementation refer to the separate document *Xircom GPRS Asynchronous Protocol (XGAP) Specification*, part number 07300416.

6.1.2.1 Dual Port - Primary Port: Control & Circuit Switched Data

In a dual port configuration, the Primary serial port can be used for the following:

- ☐ AT commands.
- ☐ Voice control.
- ☐ SMS control.
- ☐ Circuit switched data.

NOTE: In a dual port configuration, there is no GPRS packet data capability on the Primary serial port.

6.1.2.2 Dual Port - Secondary Port: Packet Data Using “XGAP”

In a dual port configuration, the Secondary serial port using the Xircom GPRS Asynchronous Protocol (XGAP) can be used for the following:

- ❑ AT commands.
- ❑ Voice control.
- ❑ SMS control.
- ❑ GPRS Packet Data.

NOTE: Since circuit switched data is streaming rather than packet based, in a dual port configuration there is no circuit switched data capability on the Secondary serial port.

XGAP provides the capability to split the communications traffic on the single physical serial port into four (4) distinct virtual channels. Each virtual channel is used for one of the following types of communications:

- ❑ Command channel from host to baseband controller
- ❑ Event channel from baseband controller to host
- ❑ Packet data channel from host to baseband controller
- ❑ Packet data channel from baseband controller to host

NOTE: For full details of the XGAP protocol implementation refer to the separate document: *Xircom GPRS Asynchronous Protocol (XGAP) Specification*, part number 07300416.

7 AUDIO

The *Core Engine* includes two (2) audio interfaces, each with support for one (1) microphone and one (1) speaker.

7.1 Audio Path Selection

Selection of which mic/speaker pair should be active is achieved either by hardware, using a designated signal on the *Core Engine* I/O connector, or by software, using an AT command.

7.1.1 Hardware Selection of Audio Path

The *AUDIO_SEL* signal on the (pin 34 of the *Core Engine* I/O interface) can be used to select whether the Primary or Secondary mic/speaker should be active.

7.1.2 Software Selection of Audio Path

The “AT+SPEAKER” software command can be used to select whether the Primary or Secondary mic/speaker should be active.

NOTE: Refer to the *Core Engine Programmer Reference* documentation for the syntax of how to use this software command.

7.2 Microphone Input

The Core Engine microphone (input) interface specification is shown in Table 8:

Input voltage differential	1.03Vpp
Differential input resistance	50Kohm
Input capacitance	5pF

Table 7: *Core Engine* microphone interface specification.

Each microphone circuit should have its own RC filtering on the bias supply. Microphone characteristics vary and exact biasing values may need some experimentation. The microphone inputs are multiplexed (not summed) into the voiceband receive circuit.

7.3 Speaker Output

The Core Engine speaker (output) interface specification is shown in Table 9:

Differential output voltage typical	3.7V
Output differential maximum DC offset	100mV
Differential output load resistance minimum	15ohm
Output load capacitance maximum	4700pF

Table 8: Core Engine speaker interface specification.

The baseband is powered at 2.5V in the audio circuit design. The minimum load is 15 ohms.

The 3.7V peak-to-peak specification is a differential measurement with the reference of *SPK_N1* or *SPK_N2* (pins 9 and 36 respectively of the *Core Engine* I/O interface). Each *SPK_xx* positive/negative pair can swing approximately 1.85V peak, with respect to ground. The 3.7V peak-to-peak is obtainable because the *SPK_Px* positive is 180 degrees out of phase with the negative. Since this occurs simultaneously, the differential measurement is ($2 * 1.85V$), or 3.7V peak-to-peak.

There is no audio power amp component in our design. The signals are driven directly by the baseband processor.

7.4 Audio Circuit Implementation

7.4.1 Example Single-Ended Microphone Circuit

Figure 3 shows an example of how to implement a single ended microphone circuit compatible with the *Core Engine*.

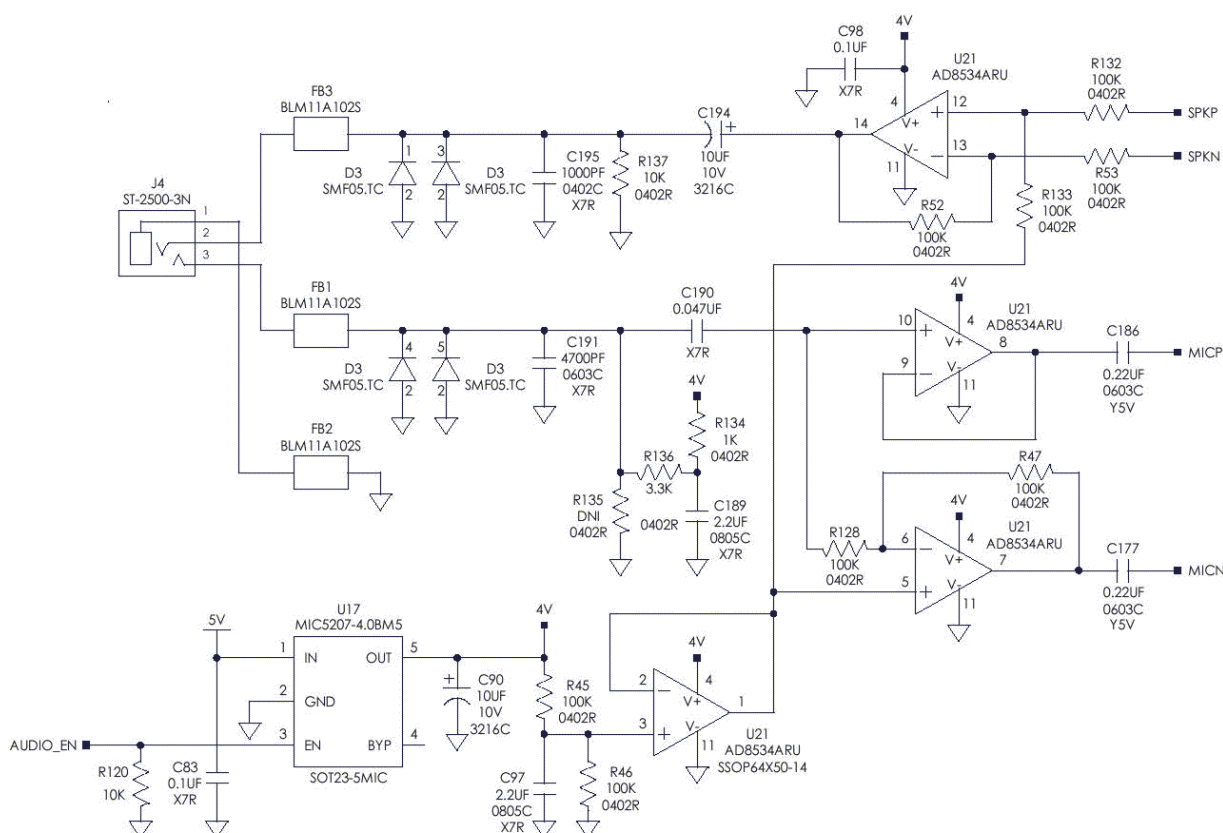


Figure 2: Single-Ended Microphone Circuit (Example)

NOTE: The *FB1*, *FB2* and *FB3* components are ferrite beads to suppress any energy on to the headset cord. Component *D3* is a transient surge suppressor to protect against ESD.

7.4.2 Example Differential Microphone Circuit

Figure 4 shows an example of how to implement a differential microphone circuit compatible with the *Core Engine*.

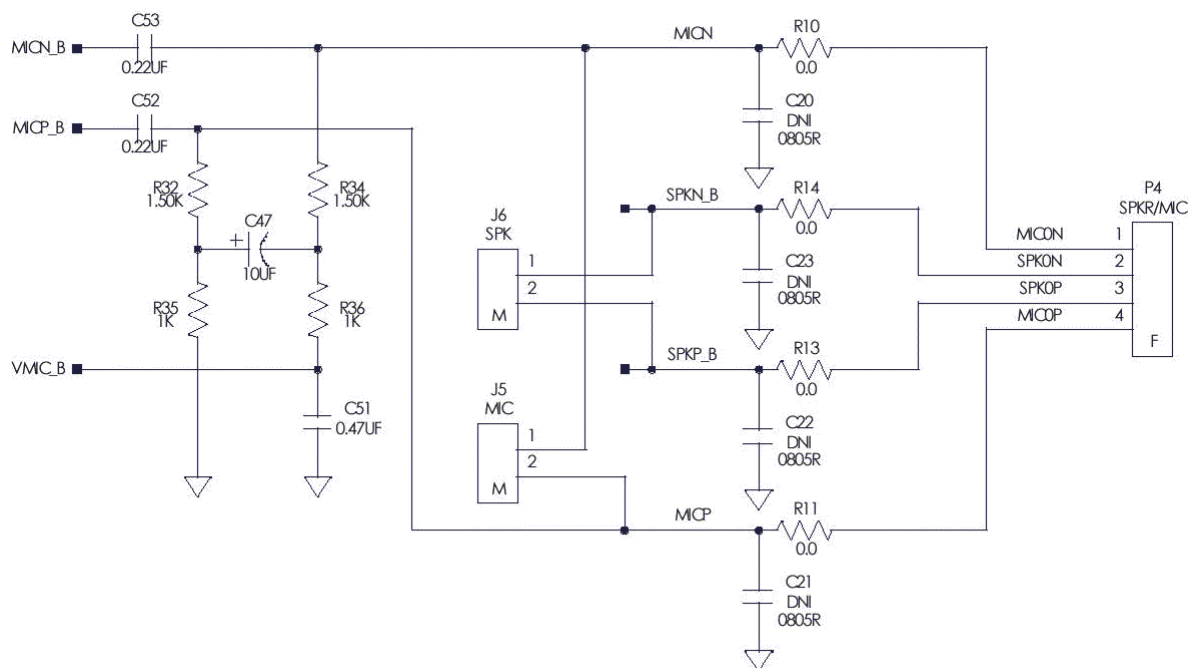


Figure 3: Differential Microphone Circuit (Example)

7.5 Microphone Cable Considerations

The differential circuit design in the *Core Engine* baseband processor has excellent common mode voltage rejection for noise signals.

If the microphone is located reasonably close to the *Core Engine* module, it should be OK to use unshielded cable. However, this also depends on where the cable is routed. Slight TDMA framing noises may be noticed if the cable is close to the antenna.

It is recommended that a twisted pair cable be used from the *Core Engine* microphone connector to the microphone element. If problems arise, then a shielded cable (i.e. termination of the shield) may be used.

8 RF ANTENNA

8.1 Antenna Connector

The *Core Engine* modem includes an on-board RF antenna connector. The modem is designed to support interchangeable antenna types provided they have impedance of 50 ohms.

The *Core Engine* on-board RF antenna connector is a MuRata Microminiature SMT Coaxial Connector (muRata p/n "MM9329-2700").

8.2 Antenna Selection

The selection of an antenna for use with any radio or radio system, whether integrated or remote, is a process that cannot be taken lightly. To simplify the process and identify a few key performance metrics is difficult to do since antennas are extremely sensitive to the environment in which they are placed. If the antenna is integrated into a plastic cover that will be used in a handheld device, then all antenna performance measurements should be made with the integrated solution held in a hand, or hand simulator. Similar measurement criteria should be used for units used near the head, on a tabletop, wall, etc. In this way, the antenna can be tuned for best performance while operating in the environment that it will be expected to operate in when used by the customer.

As a result, the following criteria assumes that, as a minimum, the antenna is being measured as it will be used in the final product, i.e. either integrated with the radio or in free space.

8.3 Antenna Performance Guidelines

8.3.1 Antenna Impedance Match

The antenna impedance within the operating bands of interest should match the impedance of the radio RF port for maximum power transfer.

Almost universally the antenna port impedance is 50 ohms. The metric used to determine how well the antenna is matched to 50 ohms is called the return loss or VSWR. These values can be used to calculate the mismatch loss, which in turn can be used directly as a loss in the overall system link budget. For a mismatch loss of 1 dB or less, the return loss must be less than -7 dB (VSWR less than 2.6:1) across all bands of operation. A return loss of -9.5 dB (VSWR = 2.0:1) results in a mismatch loss of -0.5 dB.

It should be noted that a large impedance mismatch at the antenna port could lead to more severe losses in radio performance than those calculated here. This is due to the fact that the radio power amplifier/low noise amplifier and filtering circuits are tuned for peak performance with a 50 ohm load. Any deviation from this matching impedance will cause a load line deviation for these devices, which if very large (VSWR > 2:1), can cause serious degradation to the power output, noise figure, or filter frequency response of the radio.

8.3.2 Antenna Pattern and Gain

The antenna pattern shape should be consistent for all frequencies of operation. The radiation pattern shape and maximum gain should be consistent with the radio link performance objectives and the anticipated deployment configurations. This combination of factors will determine if a directional or omni-directional antenna pattern shape is desired. In general, for a portable device the antenna pattern shape should be omni-directional with a peak gain that is less than 2dBi and an average total field gain (vertical and horizontal polarization combined response) that is -4dBi or greater.

Directional antennas can be used for wall mount applications. These antennas should have a directional radiation pattern with a peak gain broadside to the antenna. For most applications, these antennas should have a 10 dB front-to-back ratio as a minimum. The peak gain will be a function of the system performance requirements and regulatory allowances.

FCC requirements limit the amount of antenna gain permissible. The combination of antenna and cable loss (if any) must be selected to maximize path gain within the FCC requirements (maximum of 3dBi for mobile and 7dBi for fixed applications).

8.3.3 Antenna Beam Width

For mobile applications, the installer should select an omni-directional antenna with good elevation beam width. With an omni-directional antenna, you trade some **gain** (azimuth) for an increased **elevation beam width** (elevation). Good omni-directional antennas with 2-3dBi gain, and a good elevation beam width are readily available.

Fixed applications could use any type of antenna because there is more flexibility in gain, but unless the installation site is on the outer fringes, or in a deep fade area, (major obstructions) gain is the most important thing. Again, you trade gain for beam width (azimuth and elevation).

The Installer should keep in mind that networks and site environments change. For example, new cell sites are added to expand existing coverage and/or capacity. With this growth, new obstructions are added as well, which could change the signal quality for fixed applications (e.g. a newly constructed building).

Therefore, it is recommended that the installer **not** install highly directional antennas attempting to pinpoint the link to a serving base station. Due to the FCC restrictions, the installer should be able to find a good performing antenna, which provides decent gain, and good beam width performance.

In order to accomplish "seeing" as much of the network as possible, the installer is advised to use as broad of a beam width as possible (and reasonable given any particular installation).

Installation using these guideline, avoid potential problems such as:

- ☐ New base station sites, installed closer to site but which cannot be "seen" by the network.
- ☐ Serving cell taken out of service temporarily, but the network lacks the ability to jump to other cell sites
- ☐ Newly constructed obstructions, resulting in a change to the RF environmental characteristics.

8.3.4 Antenna Polarization

Antenna polarization is normally defined as vertical, horizontal, slant left, slant right, or circular. For portable devices, polarization purity is not required nor desired. Due to the random positions that a portable device can be used in, and due to the fact that a significant de-polarization of the predominantly linear polarization of the serving base station will occur in most user environments, it is important that a portable device have an antenna that will respond well to all polarizations. This is generally known as “dirty” polarization and can be described as a polarization ellipse with an axial ratio (ratio of the maximum to minimum response of the polarization ellipse) of 7 to 9 dB.

8.4 Antenna Location and Network Communication

The antenna location for modem installation is dependent on the individual site conditions. As a rule, the antenna should be positioned so that a reliable radio connection can be made with the GSM network. The following guidelines will assist the installer in making this determination.

- ❑ Where the reliability of the signal strength would be in question, one or more base stations would enhance quality of the signal.
- ❑ Where possible, the modem location should be selected so that the antenna has an unobstructed line of sight to the selected base-station(s)
- ❑ The antenna should be located to maximize the signal strength and quality received from the selected base-station(s).
- ❑ It is recommended that the installer obtain GSM Network coverage maps from the GSM operator indicating that the installation site is in a covered area. It is also recommended that coverage and signal quality be verified prior to installation, using a GSM handset.
- ❑ If possible, the modem and its associated antenna should be deployed inside an environmentally controlled protected structure (such as an office building).

9 PROVISIONING THE SIM

The GSM SIM can support optional features or services. Most GSM operators typically configure the SIM to send/receive voice calls and to receive SMS; however, some may require an additional tariff to enable the SIM to send SMS. The transmission of data and fax are also additional services that may require tariffs and additional provisioning. Each of these services has two separate modes that must be enabled to allow the service:

- ☐ Mobile-originated (MO): allows making a service request (such as, making a call or sending an SMS)
- ☐ Mobile-terminated (MT): allows receiving a service request (such as, receiving a phone call or an SMS)

It is imperative for the *Core Engine* modem that the SIM be configured for the optional services that are required for the application.

9.1 GSM Services Supported by the *Core Engine* modem

The *Core Engine* modem supports three (3) GSM services (modes of operation) that must be enabled by the operator:

- ☐ Voice calls (MO and MT): requires a telephone number
- ☐ SMS (MO and MT): uses the telephone number for Voice
- ☐ Circuit-switched data calls (MO and MT): requires a telephone number

The GSM SIM can have multiple telephone numbers: one number for voice calls and SMS and one number for data calls.

9.2 Selecting the Modes of Operation

When provisioning the SIM for the *Core Engine* modem, enable the following modes of operation:

- ☐ Voice calls: configure the SIM for both MO and MT service (to send and receive)
- ☐ SMS: configure the SIM either for MT alone (to receive) or for both MO and MT (to send and receive)
- ☐ Data: configure the SIM either for MO alone (to send) or for both MO and MT (to send and receive)

Voice	SMS	Data	Function
MO/MT	MT	MO	Voice calls, receive SMS, make data calls
MO/MT	MT/MO	MO	Voice calls, receive/send SMS, make data calls
MO/MT	MT/MO	MO/MT	Voice calls, receive/send SMS, make/receive data calls (requires an additional data telephone number)

10 INSTALLATION & INITIALIZATION

10.1 Installation and Verification

10.1.1 Installation

10.1.1.1 Install SIM card.

NOTE: The SIM card is supplied by the service provider, and is not supplied by Xircom. The *Core Engine* unit will not operate without a properly coded SIM card installed.

- ❑ **Disconnect all power to the unit before installing the SIM card.**
- ❑ Install the SIM card in the SIM card slot (connector J7) on the *Core Engine* carrier board.

10.1.1.2 Terminal Connect & Setup

Connect the Terminal to the Primary Serial Port (DB-9) connector (P5 on the carrier board) using a standard (straight thru) modem cable. The diagnostic terminal can be a laptop PC, with a serial port connection, running a program such as ProComm™ or other communication application.

Set up the diagnostic serial communication to the *Core Engine* default values:

Baud Rate	9.6 Kbps	Stop Bits	1
Data	8 bits	Parity	No
Duplex	Full		

Table 9: *Core Engine* default serial interface values.

10.1.1.3 Connect Power Supply Cable

Install the power supply per manufacturer's recommended procedures. Plug the power supply cable plug into the modem power connector (J17 or J18). The connector is keyed so it can only be installed one way. The connector also has an automatic locking feature that will engage when the connector pair is fully mated and is easily releasable with finger pressure.

10.1.1.4 Verify all Terminal Connections

Check that all *Core Engine* connections have been installed per the instructions in this manual, and that the power cable (or cord) is secured with no exposed wires.

10.1.1.5 Apply Power

10.1.2 Verification

10.1.2.1 Using AT Commands

In the GSM vocabulary, a call from GSM mobile to the PSTN is called a "mobile-originated call" or "outgoing call." A call from the fixed network to a GSM mobile is called a "mobile-terminated call" or "incoming call."

In the following examples, "App" refers to the application. The following convention describes the direction of the data exchange:

- ❑ The data exchange from the customer application to the *Core Engine* modem is designated as: **App > Modem**
- ❑ The data exchange from the *Core Engine* modem to the customer application is designated as: **Modem > App**

NOTE: With the exception of the +++ command (Online Escape Sequence), all commands must be preceded by the AT attention code (or command prefix) and terminated by pressing the <CR> character.

In the following examples, the <CR> and <CR><LF> are intentionally omitted for clarity and space.

10.1.2.2 Initial Response to the AT Command

After power is applied to the *Core Engine*, the modem performs a power-up self-test. When queried with the AT command, the *Core Engine* modem responds with one of the following result codes:

- ❑ OK signifies that the *Core Engine* modem is ready, that it correctly interprets the AT command, and that it can execute the command.
- ❑ ERROR signifies that the *Core Engine* modem does not understand the command or that the command is invalid.

App > Modem	AT	
Modem > App	OK	Command valid: modem is ready

The *Core Engine* modem must be in Command mode when any command is entered (with the exception of the online escape sequence +++). Commands entered when the modem is in Online mode are treated as data, and are transmitted as such to the receiving modem.

10.1.2.3 Modem Initialization

The following example provides the sample AT commands and responses for the following initialization tasks:

- ❑ Disable character echo
- ❑ Set the modem to Verbose mode (to display result codes as words)

- ❑ Set the DCD to ON
- ❑ Monitor the DTR

App > Modem	ATE0Q0V1&C1&D0	Initialization string
Modem > App	OK	Command is valid
App > Modem	ATS0=1	Auto answer on 1st ring
Modem > App	OK	Command is valid

10.1.2.4 SIM PIN Status

The following example provides the AT command and response for querying the PIN status and entering the SIM PIN number if required.

App > Modem	AT+CPIN?	Query the SIM PIN status
Modem > App	+CPIN: Ready	GSM terminal is not waiting for any password
	OK	+CPIN: SIM PIN terminal is waiting for PIN
		+CPIN: SIM PUK terminal is waiting for PUK
		ERROR SIM is not installed

If the response is +CPIN:Ready, then skip the remainder of this paragraph. If the response is +CPIN:SIM PIN then proceed with the remainder of this paragraph to enable the terminal by entering the SIM PIN.

CAUTION: Use care when entering the SIM PIN. If it is entered incorrectly three times in a row, the GSM terminal will lock and a SIM PUK is required to unlock the SIM.

App > Modem	AT+CPIN="1234"	Enter the PIN number
Modem > App	OK	Command is valid
App > Modem	AT+CPIN?	Query the SIM PIN status
Modem > App	+CPIN: Ready	GSM terminal is not waiting for any password
	OK	+CPIN: SIM PIN terminal is waiting PIN

If the response is +CPIN:Ready, then skip the remainder of this paragraph. If the response is +CPIN:SIM PIN then carefully verify that you have the correct SIM PIN and repeat the SIM PIN entry.

10.1.2.5 Data Call Setup (modem origination)

The following example provides the AT command and response for setting the Core Engine modem for 9600 baud, non-transparent mode.

App > Modem	AT+CBST=7,0,1	9600 baud, non-transparent mode
Modem > App	OK	Command is valid

10.1.2.6 Modem Status Commands

The following examples provide the AT commands and responses for querying the status of the unit.

- The following command checks to determine if the *Core Engine* modem has successfully registered with the GSM network.

App > Modem	AT+CREG?	Get the registration status
Modem > App	+CREG: 0,1* OK	Registered with home network +CREG=0,2 registration in progress +CREG=0,5 registered as roaming

*First character can be "0" or "1": "0" for manual response, "1" for auto response.

- The following command queries the strength of the RF coverage. This command provides information about the RF coverage for the *Core Engine* modem.

App > Modem	AT+CSQ	Get the signal strength (for this command, do not enter "?")
Modem > App	+CSQ: 20,99 OK	Receive signal strength = 20, -74 +/- 1 dBm RXQUAL =99, unknown

Value	RSSI (dBm) +/- 1 dBm	Value	RSSI (dBm)
0	< -110	16	-82
1	-110	17	-80
2	-109	18	-78
3	-108	19	-76
4	-106	20	-74
5	-104	21	-72
6	-102	22	-70
7	-100	23	-68
8	-98	24	-66
9	-96	25	-64
10	-94	26	-62

11	-92	27	-60
12	-90	28	-58
13	-88	29	-56
14	-86	30	-54
15	-84	31	-52

Table 10: RSSI vs. Received Signal Power

Value	RSSI (dBm)
0	BER < 0.2%
1	0.2% < BER < 0.4%
2	0.4% < BER < 0.8%
3	0.8% < BER < 1.6%
4	1.6% < BER < 3.2%
5	3.2% < BER < 6.4%
6	6.4% < BER < 12.8%
7	12.8% < BER

Table 11: RXQUAL vs. Bit Error Rate

- ❑ The following command requests the current Public Land Mobile Network (PLMN). DeTeMobil is used as an example, the PLMN may be different.

App > Modem	AT+COPS?	Request current PLMN
Modem > App	+COPS: 0,0,"DeTeMobil"	PLMN is DeTeMobil
	OK	

10.2 SMS Message Verification

10.2.1 Modem Sent SMS (Text)

To be able to send SMS text messages, the *Core Engine* modem must be initialized with the proper SMS mode. The following examples provide the AT commands and responses for initializing the SMS mode.

- ❑ The following command initializes the *Core Engine* modem by setting the text mode parameters.

App > Modem	AT+CSMP=17,167,0,0	Set text mode parameters: ▪ 17: Sets reply pat, user data header, status report request, validity period format, reject duplicates and message type ▪ 167: Sets validity period ▪ 0: Higher layer protocol indicator ▪ 0: Information encode format
Modem > App	OK	Command is correct

- ❑ After initializing the modem with the proper SMS mode, select the proper service center. The service center is the Public Land Mobile Network (PLMN) to which the SME telephone number belongs. The following command selects the service center. Voicestream is used as an example, the users home PLMN may be different.

App > Modem	AT+CSCA="+491710760000"	Service center initialization: D1 – Germany
Modem > App	OK	

- ❑ The following command selects TEXT mode for SMS messages.

App > Modem	AT+CMGF=1	Set message format to TEXT mode
Modem > App	OK	Command is correct

- The following command sets the indicators for the message.

App > Modem	AT+CNMI=1,1,0,0,0	Set the new message indicators AT+CNMI=<mode>,<mt>,<bm>,<ds>,<bfr> ▪ <mode>=1, discard unsolicited result codes indication ▪ <mt>=1, SMS-DELIVERs are routed using unsolicited code ▪ <bm>=0, no CBM indications are routed to the TE ▪ <ds>=0, no SMS-STATUS-REPORTs are routed ▪ <bfr>=0, TA buffer of unsolicited result codes defined within this command is flushed to the TE
Modem > App	OK	Successful command

- The following command saves the SMS settings. Once the SMS commands have been saved, the initialization commands do not need to be sent again until they are changed.

App > Modem	AT+CSAS	Save SMS settings
Modem > App	OK	Successful transmission

- After the *Core Engine* modem has been initialized, the following commands and sample responses provide the telephone number and the message to be transmitted.

App > Modem	AT+CMGS="12017572673"	Send a message to the telephone number (insert user modem phone number as the value in parenthesis)
Modem > App	>	Ready to send message
App > Modem	Hello, how are you?^Z	Enter the text message. End the message with Control Z.
Modem > App	+CMGS: 1 OK	Successful transmission

10.2.2 Modem RECEIVE SMS (Text)

The following example provides the AT command for requesting that the *Core Engine* modem list received SMS messages. This string requests that the modem send (over the RS232 interface) all of the messages that have been received.

App > Modem	AT+CMGL="ALL"	Read ALL messages received, including status, originator, message number and message content (if messages are present)
Modem > App	+CMGL: 1, "REC UNREAD", "12017572673" Hello, how are you? OK	

10.2.3 SIM Data Provisioning Verification (Optional)

At this time the user has the option of verifying the data communications function from the users system application to the modem prior to connection to the CPE. To check this path, have the user's system application send a data stream to the modem and observe the data stream on the diagnostic terminal for verification of correct performance.

10.2.4 Match Modem Serial port to CPE

The modem is now ready to be interfaced with the CPE. The serial port settings, data type, and flow control between the modem and the CPE need to be matched. Reference Table 9 for the *Core Engine* modem initialization defaults.

1. Match the bearer type selection (transparent deviation on different sheet or non-transparent data).
2. Match the flow control.
3. Match the serial interface parameters (baud rate, 8 data bits, 1 stop bit, no parity).
4. Set up the terminal serial interface parameters to match the modem (if modem has changed).
5. Save parameters to non-volatile memory. (AT&W command, AT+CSAS)

10.2.5 Verify Setup

1. Power down the unit
2. Wait 5 seconds and then re-apply power to verify commands were saved properly
3. Power down again.

10.2.6 Connect Primary Serial Port Cable

Plug the RS232 cable from the CPE into the Primary Serial Port connector (DB-9) on the *Core Engine* carrier board. The connectors are keyed so it can only be installed one way.

10.3 Final Verification

10.3.1 SMS Verification

Repeat the *SMS Message Verification* section.

11 DETAILED SPECIFICATIONS

11.1 Physical Dimensions and Weight

Size (L x W x H) including connectors	53.09 mm x 34.80 mm x 5.66 mm (2.09" x 1.37" x 0.22")
Weight	15 g (0.5 oz.)

Table 12: Core Engine Size and Weight

11.2 Operating Power

The Core Engine carrier board requires an input voltage of 3.7 VDC +/- 0.3 VDC. The input source voltage ripple should be less than 20% of the average supply voltage peak-to-peak under normal operating conditions.

Core Engine modem			Average Current (Amps)	Peak Current (Amps)
PCS 1900	Ready Mode (GSM)	1 TX, 1 RX	TBD	TBD
		1 RX	TBD	TBD
	Ready Mode (GPRS Class 10)	1 TX, 4 RX	TBD	TBD
		2 TX, 3 RX	TBD	TBD
	Standby Mode	N/a	TBD	N/a
	RF Disabled Mode	N/a	TBD	N/a
	Sleep Mode	N/a	TBD	N/a
	Dormant Mode	N/a	< 100uA	N/a

Table 13: Core Engine Power Modes & Current Requirements

11.2.1 Transmit Power

Core Engine modem	Power Class	Transmit Power
1900 MHz	GSM Power Class 1	1-W conducted power maximum (30 dBm +/- 2 dB), measured at the antenna port

Table 14: Core Engine Transmitted Output Power

11.2.2 Receiver Sensitivity

The receiver sensitivity measured at the antenna port is -106 dB (typical) and -104 dB (minimum).

11.3 Care and Maintenance

The *Core Engine* modem should be used in a protected environment. The internal components of the modem must remain dry and free of moisture. Avoid installations in extremely cold or hot locations, and avoid extreme temperature changes during use.

There are no external or internal maintenance requirements.

12 ENVIRONMENTAL SPECIFICATIONS

12.1 Climatic

Internal circuitry provides automatic shutdown control to prevent the unit from operating above or below the specified operating temperature range.

12.1.1 Climatic: Operational

Operating temperature	-20°C to +55°C NOTE: Upper temperature range can be extended under certain operating conditions.
Relative humidity	5 - 95%
Solar radiation	Not Applicable
Air pressure (altitude)	70 kPa to 106 kPa (-400 m to 3000 m)

12.1.2 Climatic: Storage and Transportation

Duration	24 months
Ambient temperature	-40°C to +85°C
Relative humidity	5% to 95%, non condensing (at 40°C)
Thermal shock	-50°C to +23°C, +70°C to +23°C; < 5 min
Altitude	-400 m to 15,000 m

12.2 Mechanical

12.2.1 Mechanical: Operational

Operational vibration, sinusoidal	3.0 mm disp, 2 to 9 Hz; 1 m/s ² , 9 to 350 Hz
Operational vibration, random	0.1 m ² /s ³ , 2 to 200 Hz

12.2.2 Mechanical: Storage and Transportation

Transportation vibration, packaged	ASTM D999
Drop, packaged	ASTM D775 method A, 10 drops
Shock, un-packaged	150 m/s ² , 11 ms, half-sine per IEC 68-2-27

Drop, un-packaged	4-inch drop per Bellcore GR-63-CORE
-------------------	-------------------------------------

12.2.3 Mechanical: Proposed Standards

Transportation	ETSI Standard ETS 300 019-1-2 Class 2.3 Transportation
Operational	ETSI Standard ETS 300 019-1-3 Class 3.1 Operational
Storage	ETSI Standard ETS 300 019-1-1 Class 1.2 Storage

12.3 Electromagnetic

12.3.1 Electromagnetic Emissions

Radiated spurious	FCC part 24 / Part 15 Class \ B GSM 11.10 Section 12.2 EN 55022 Class B
-------------------	---

12.3.2 Electromagnetic Immunity

TBD	
-----	--

13 GLOSSARY AND ACRONYMS

App Application	Refers to the Application which sends or receives commands/responses from the <i>Core Engine</i> modem
AT Command Set	Commands issued by intelligent device to a modem to perform functions, such as to initiate call, to answer call, or to transmit data.
CSD Circuit Switched Data	Data link from a terminal through the network allowing real-time, duplex connectivity up to 9600 bytes/second.
CE European Community Certification	
CPE Customer Premise Equipment	A terminal in fixed location on the customer's premises.
Dbi	Decibels referenced to an isotropic radiator
DCE Data Communications Equipment	Data Communications Equipment
DCS Digital Cellular System	A collection of services and capabilities providing flexibility of access and mobility through a combination of wireless and wire-line networks, utilizing the 1800 MHz bandwidth.
DTE Data Terminal Equipment	Data Terminal Equipment
EFR Enhanced Full Rate	Voice (vocoder) compression algorithm which offers the highest quality voice communication.
EIR Equipment Identity Register	A database used to store International Mobile Equipment Identity (IMEI) of a locally issued terminal.
EIRP Equivalent Isotropic Radiated Power	In a given direction, the gain of a transmitting antenna multiplied by the net power accepted by the antenna from the connected transmitter.
ESD Electrostatic Discharge	Static electricity that can damage electronic equipment.
FTA Full Type Approval	GSM Full Type Approval

FCC Federal Communications Commission	US Government body that defines requirements for emission level of equipment in the United States.
GPRS General Packet Radio Service	Standard for packet communications utilizing Global Standard for Mobility (GSM) infrastructure.
GSM Global System for Mobile Communications	Standard for digital communications. Allows consistent communications in various parts of the world despite variations in RF spectrum allocations. Transferring the SIM (see below) permits users to roam by changing terminal equipment.
IMEI International Mobile Equipment Identity	A unique number for each GSM Terminal tracked by the GSM operators in their Equipment Identity Register (EIR) database.
Ki	A secret code used in authentication and encryption by the terminal.
LED Light Emitting Diode	Light Emitting Diode
MMS More Messages to Send	More Messages to Send
MO Mobile Originated	A voice or data call originated at the mobile terminal.
MT Mobile Terminated	A voice or data call originated from the network and sent to the mobile terminal.
Non-Transparent Mode	Delivers a constantly low error rate but with a non-guaranteed throughput or delay. The Non-Transparent service provides a performance that is closest to using a modem over a fixed PSTN line.
NRTL Nationally Recognized Test Laboratory	OSHA-approved Nationally Recognized Testing Laboratory
OEM	Original Equipment Manufacturer
Packet	A collection of data transmitted over a digital network in a burst.
PCS Personal Communications Service	A collection of services and capabilities providing flexibility of access and mobility through a combination of wireless and wireline networks.
PDU Protocol Data Unit	Data packet defined by protocol layer of SMS interface.
PLMN	Public Land Mobile Network
PSTN	Public Switched Telephone Network

RF Radio Frequency	A frequency at which electromagnetic radiation may be detected and amplified as an electric current at the wave frequency.
Rx	Receive
Short Message	An alphanumeric message of up to 160 characters that can be sent to or from a GSM terminal.
SIM Subscriber Identification Module	“Smart Card” technology that contains user information and has four main functions: ▪ Authentication ▪ Storage of data ▪ Assist in encryption process ▪ Subscriber protection
SMS Short Message Services	Services provided by GSM network allowing the transmission and receipt of short messages.
SMSC Short Message Service Center	Location of SMS store and forward message server.
TBD	To Be Determined
Transparent Mode	Delivers a service with a variable error rate, with a guaranteed throughput and delay.
Tx	Transmit
Type Approval	Rigorous testing required by GSM operators to ensure terminals operating on network does not degrade performance, capacity, or functionality of GSM network.
UL Underwriters Laboratory	Testing agency chartered with ensuring safety of electrical devices.
USSD	Unstructured Supplementary Service Data
V.24 Serial Interface	The ITU-T standard defining interchange circuits between DTE and DCE. V.24 is the ITU-T equivalent of EIA standard RS-232, with the exception of voltage levels.

14 UPDATING THE CORE ENGINE FIRMWARE

The *Core Engine* firmware may be downloaded from a host computer to the *Core Engine* through the *Core Engine* primary serial port. The host computer that holds the firmware update utilities and the new files that are to be downloaded to the *Core Engine* must be connected to the *Core Engine* primary serial port **before** the *Core Engine* is powered up.

When the *Core Engine* is powered up, it will look for a specific signal on the primary port. If none is detected, then the *Core Engine* will boot normally. If a special signal is detected on the primary serial port at the start of the boot sequence, then the *Core Engine* will stop the normal boot sequence and instead it will start the firmware update process.

In addition to the firmware image file to be downloaded to the *Core Engine*, there are a number of utility programs required in order to perform the download.

14.1 Required Files

To download a new firmware image, the following files are required:

- ❑ serload.exe
- ❑ flash.hex
- ❑ egload.hex
- ❑ newstack.hex

14.2 Download Utility

The software utility used to perform the firmware download is called "serload.exe".

The download utility works with Windows 95, 98, 2000, and NT, and can be run from a command line prompt within Windows.

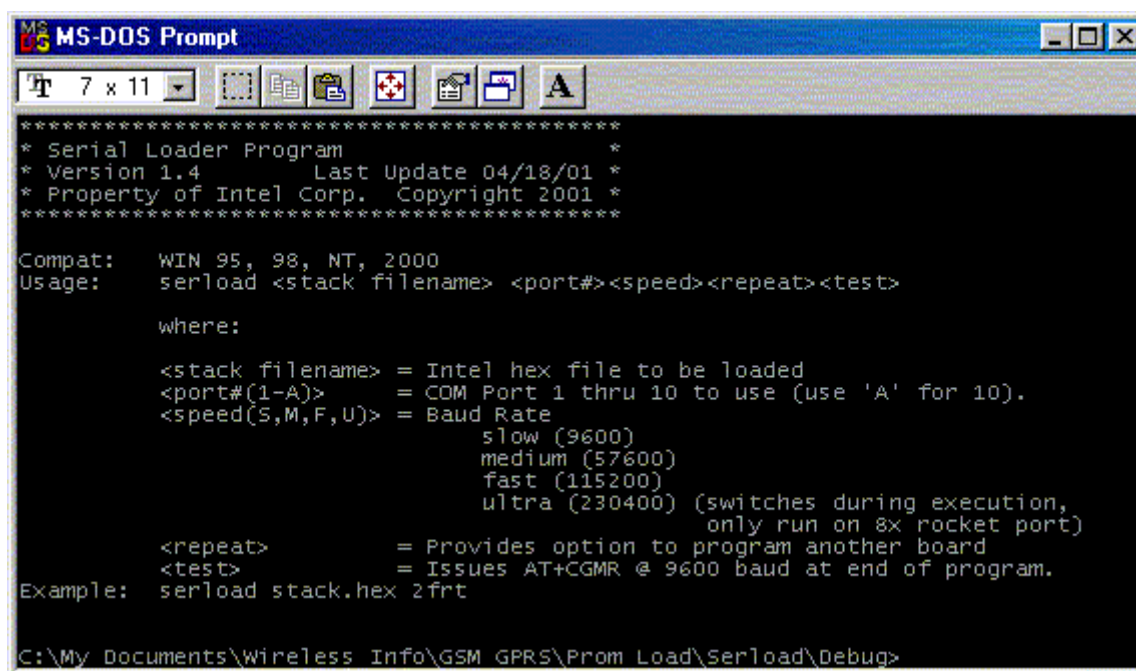
The utility accepts several command line parameters, which determine the host serial port to use as well as the communications speed to use for the download. Information about the supported command line parameters can be displayed by issuing a command to run the utility without any command line parameters.

The command line for information is: **serload**

where:

serload is the download utility program name

Figure 5 shows the display of information on supported command line parameters.



```
MS-DOS Prompt
7 x 11
*****
* Serial Loader Program
* Version 1.4      Last Update 04/18/01 *
* Property of Intel Corp.  Copyright 2001 *
*****

Compat:  WIN 95, 98, NT, 2000
Usage:   serload <stack filename> <port#><speed><repeat><test>

where:

<stack filename> = Intel hex file to be loaded
<port#(1-A)>     = COM Port 1 thru 10 to use (use 'A' for 10).
<speed(S,M,F,U)> = Baud Rate
                  slow (9600)
                  medium (57600)
                  fast (115200)
                  ultra (230400) (switches during execution,
                                only run on 8x rocket port)
<repeat>        = Provides option to program another board
<test>          = Issues AT+CGMR @ 9600 baud at end of program.
Example: serload stack.hex 2f

C:\My Documents\Wireless Info\GSM GPRS\Prom Load\Serload\Debug>
```

Figure 6: Serial Loader Session (Example)

14.3 Download Procedure

IMPORTANT: The Core Engine should be powered off before starting the download utility.

The command line to perform a download is: **serload newstack.hex 1f**

where:

- serload** is the download utility program name
- newstack.hex** is the firmware image file (Note: the actual filename may vary)
- 1f** is the host computer Com port (e.g. Com1) and speed (**f** for fast)

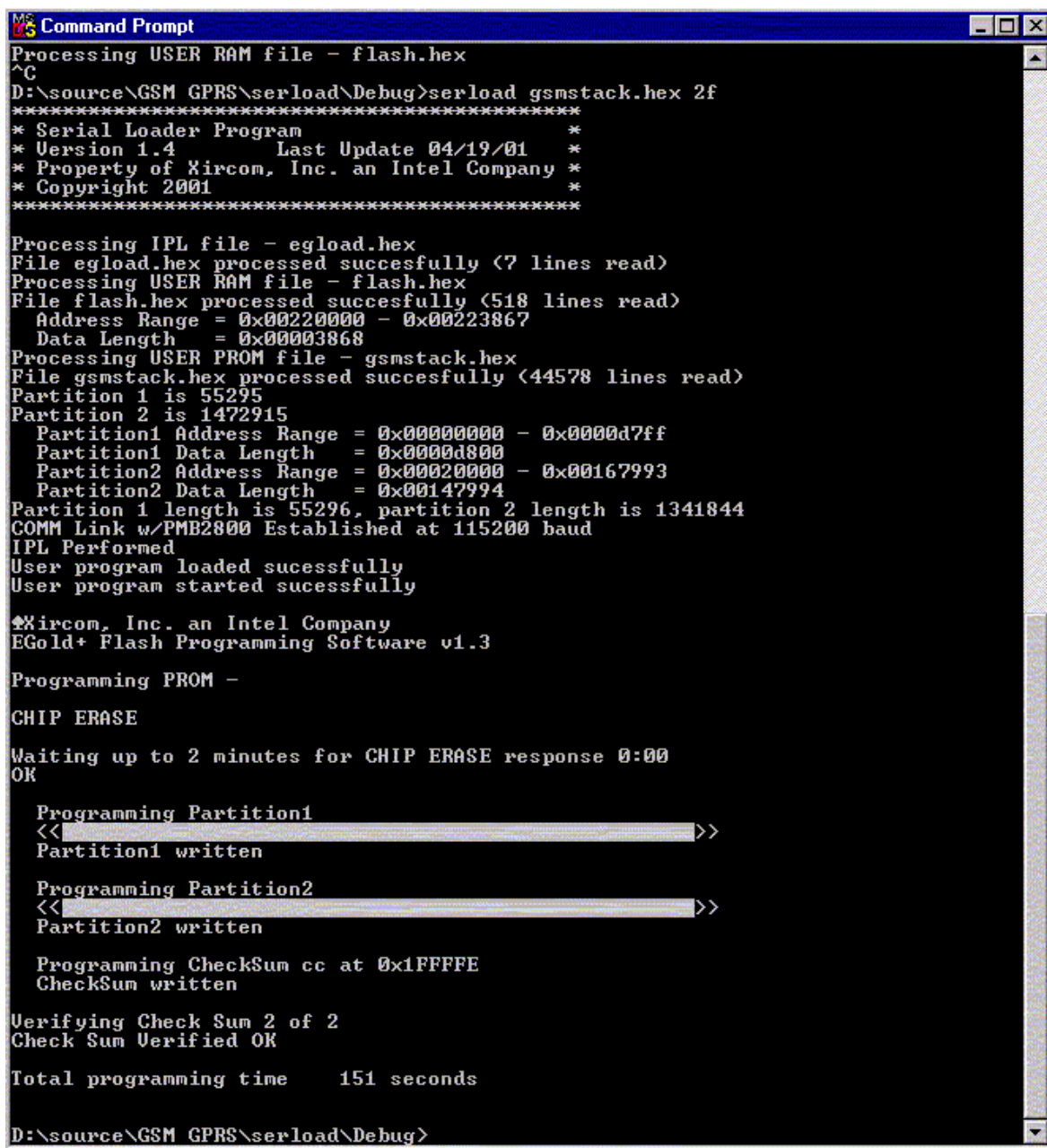
The download utility will display several lines of information, then it will pause after displaying the length of Partition 1 and Partition 2, and a spinning line prompt will appear indicating the utility is ready to communicate with the *Core Engine*. Once this prompt appears the *Core Engine* can be powered up.

IMPORTANT: Wait for the spinning prompt in the lower left hand corner before applying power to the *Core Engine*.

Once power is applied to the *Core Engine* the utility will display a confirmation that a communications link has been established, then it will proceed with the download.

The download should take about 4-5 minutes to complete. A successful download will be indicated by a checksum verification message.

Figure 6 shows an example of a firmware download session.



```
Command Prompt
Processing USER RAM file - flash.hex
^C
D:\source\GSM GPRS\serload\Debug>serload gsmstack.hex 2f
*****
* Serial Loader Program *
* Version 1.4 Last Update 04/19/01 *
* Property of Xircom, Inc. an Intel Company *
* Copyright 2001 *
*****

Processing IPL file - egload.hex
File egload.hex processed successfully <7 lines read>
Processing USER RAM file - flash.hex
File flash.hex processed successfully <518 lines read>
Address Range = 0x00220000 - 0x00223867
Data Length = 0x00003868
Processing USER PROM file - gsmstack.hex
File gsmstack.hex processed successfully <44578 lines read>
Partition 1 is 55295
Partition 2 is 1472915
Partition1 Address Range = 0x00000000 - 0x0000d7ff
Partition1 Data Length = 0x0000d800
Partition2 Address Range = 0x00020000 - 0x00167993
Partition2 Data Length = 0x00147994
Partition 1 length is 55296, partition 2 length is 1341844
COMM Link w/PMB2800 Established at 115200 baud
IPL Performed
User program loaded successfully
User program started successfully

Xircom, Inc. an Intel Company
EGold+ Flash Programming Software v1.3

Programming PROM -
CHIP ERASE
Waiting up to 2 minutes for CHIP ERASE response 0:00
OK

Programming Partition1
<< [Progress Bar] >>
Partition1 written

Programming Partition2
<< [Progress Bar] >>
Partition2 written

Programming CheckSum cc at 0x1FFFFE
Checksum written

Verifying Check Sum 2 of 2
Check Sum Verified OK

Total programming time 151 seconds

D:\source\GSM GPRS\serload\Debug>
```

Figure 6: Serial Loader Session (Example)

NOTE: After the download is complete you must reset the *Core Engine* to start the new firmware.

15 INSTALLING A REMOTE ANTENNA

There are a number of antennas designed for use with the *Core Engine* modem. If coverage is poor then the use of a remote antenna may be required. Ideally, the external antenna is mounted on a rooftop, or on the side of a building where optimal signal strength can be obtained.

15.1 Antenna Coaxial Cable and Connectors

In most cases RG223 50 ohms or similar small diameter cable can be used. For outdoor installations, the coaxial cable must be rated for outdoor exposure.

For either fixed or mobile applications, if the antenna has less than a 3 dB gain and a separation distance of greater than 20 cm (7 7/8 inches) from the body of the antenna, and any nearby person(s), then the installation will comply with current FCC requirements addressing human exposure to radio frequency electromagnetic fields.

NOTE: The installer is responsible for assuring that the proper antenna is installed so that the above limits are not exceeded.

15.2 Outdoor Antenna Grounding

Any outdoor antenna used to transmit or receive RF signals and the antenna connecting cables must be properly grounded to comply with the National Electrical Code (NEC) - specifically, but not limited to, articles 250, 800, 810, 820.

Codes require proper grounding of the cables at the point where they enter a building. Local building codes may also be applicable. For clarification on either local or national grounding requirements, contact the state or county inspection officials in your location.

15.3 Coaxial Cable Routing

When surveying a site for external antenna installation, verify that there is a suitable path for the antenna cable from the antenna to the RF antenna connector on the modem. The coaxial cable must be supported along its path, and protected to assure that damage does not occur.

NOTE: All cables require routing to be free from any obstacles or any other type of interference that may cause the cable to be damaged or undergo later damage to the shielding or cable casing.

Installation of the cables should be in accordance with the manufacturer's instructions, the National Electrical Code, applicable building codes, and general industry standards and

practices. Emphasis on freedom from obstacles, and the aesthetic guidelines required by site management should be taken into consideration during the install.

NOTE: Coaxial cables must be professionally installed. Coaxial cables must be routed and installed in a manner that insures that the jacket, dielectric and outer shield are not crushed, kinked, cut, scraped or otherwise damaged.

15.4 Coaxial Cable Losses and Lengths

There are some important factors to consider concerning coaxial cable length. The FCC requires that for **mobile** applications, the maximum output power can be **no more than 2 W (+33 dBm) EIRP**, and for **fixed** applications, **no more than 5W (+37dBm)**. When using a directional gain antenna and short coaxial cable connections, it is possible to exceed either FCC requirement. In such cases, additional attenuation must be added into the path gain. This can be achieved with either in line attenuators, or by adding more cable length.

To determine the amount of loss needed between the modem and the antenna, the following formula can be used.

$$\text{Attenuation needed} = g - p$$

where

$$g = \text{antenna gain (in dB)}$$

g = maximum path gain allowed by FCC based on the modem maximum output power of +30 dBm, and where **p** = 3 dB for mobile applications, or **p** = 7 dB for fixed applications

To determine the proper minimum cable length the following formula can be used.

$$L = (g - p) / a$$

where

$$L = \text{required minimum cable length}$$

$$g = \text{antenna gain (in dB; per antenna manufacturers specifications).}$$

p = maximum path gain allowed by FCC based on the modem maximum output power of +30 dBm, **p** = 3 dB for mobile applications, or **p** = 7 dB for fixed applications

$$a = \text{attenuation per foot of cable (in dB; per cable manufacturers specifications).}$$

As long as installation and operating restrictions previously provided are observed, and antenna gain is limited to 7 dBi for fixed, or 3 dBi for mobile applications, there is no need to introduce RF loss between the modem and antenna in order to comply with FCC MPE limits.

NOTE: Cable loss beyond that required to meet the FCC requirements, with the given antenna, will decrease the signal strength reaching the modem. This will negatively impact the ability of the modem to communicate with the network.

For more details and guidelines, please see Table 15 and Table 16 and the following examples.

FIXED APPLICATIONS		MINIMUM CABLE LENGTH (feet)		
ANTENNA GAIN (dBi)	REQUIRED PATH LOSS (dB)	RG 58 (0.33 db/ft)	RG 223 (0.29 db/ft)	RG 8 (0.15 db/ft)
0	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	1	3.0	3.4	6.7
9	2	6.0	6.9	13.3
10	3	9.0	10.3	20.0

Table 15: Cable Loss & Length - Fixed Applications

MOBILE APPLICATIONS		MINIMUM CABLE LENGTH (feet)		
ANTENNA GAIN (dBi)	REQUIRED PATH LOSS (dB)	RG 58 (0.33 db/ft)	RG 223 (0.29 db/ft)	RG 8 (0.15 db/ft)
0	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	1	3.0	3.4	6.7
5	2	6.0	6.9	13.3
6	3	9.0	10.3	20.0
7*		* = not recommended		
8*				
9*				
10*				

Table 16: Cable Loss & Length - Mobile Applications

15.5 Formula Examples

15.5.1 Example 1:

The installer has a nominal 7dB gain antenna, is using RG-223 cable, and is using the modem in a fixed application.

$$G = 7 \text{ dB}$$

$$p = 7 \text{ dB}$$

$$a = 0.29 \text{ dB/ft}$$

$$\text{then Attenuation needed} = 7 - 7 = 0 \text{ dB}$$

$$\text{and } L = (7 - 7) / 0.29 = 0 \text{ ft}$$

In this example, the length of cable the installer must use does not matter because he does not need any loss in the line to meet the FCC requirements.

15.5.2 Example 2:

The installer has a nominal 7 dB gain antenna, is using RG-223 cable, and is using the modem in a mobile application.

$$G = 7 \text{ dB}$$

$$p = 3 \text{ dB}$$

$$a = 0.29 \text{ dB/ft}$$

$$\text{then Attenuation needed} = 7 - 3 = 4 \text{ dB}$$

$$\text{and } L = (7 - 3) / 0.29 = 13.8 \text{ ft}$$

In this example, the installer must use at least 13.8 feet of cable or use a 4 dB “in line attenuator”, or a combination of the two.

15.5.3 Example 3:

The installer has a 10 dB nominal gain antenna, using RG-223 cable, and the modem is in a fixed application.

$$G = 10 \text{ dB}$$

$$P = 7 \text{ dB}$$

$$a = 0.29 \text{ dB/ft}$$

$$\text{then Attenuation needed} = 10 - 7 = 3 \text{ dB}$$

$$\text{and } L = (10 - 7) / 0.29 = 10.3 \text{ ft}$$

In this example, the installer must use at least 10.3 feet of cable, or use a 3 dB in line attenuator, or a combination of the two.

NOTE: The installer is responsible for assuring that the proper antenna, cable length, and / or attenuation, is installed correctly, so that the limits of FCC §15.203 are not exceeded.