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USERS MANUAL		
Document number		Revision
1/198 17-5/FCP 101 3317 Uen		A
Date		
2005-02-17		
Remarks		
This document is managed in metaDoc.		

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EDGE Daughter Card User Manual

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Contents

Part 1 : Overview

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1   Introduction

The EDGE Daughter Card product is a custom product, developed for the host equipment customer.

The EDGE Daughter Card is a total solution designed as an add-in option for integrators of the host equipment. The Daughter Card comprises of several component parts:

- EDGE wireless modem, which is the wireless enabling circuitry integrated on to the Daughter Card PCB together with its mechanical RF shielding

- RF connector, which provides physical connectivity between the Daughter Card and the antenna which is integrated in to the notebook mechanical housing

- Voltage regulation circuitry, which converts raw unregulated power from the host battery to the core regulated voltage to the EDGE wireless components

- System connector, which provided the data, control, power and status interface between the host and the wireless modem

- SIM connector, a combined connector and retention device for the users Subscriber Identity Module (SIM) card
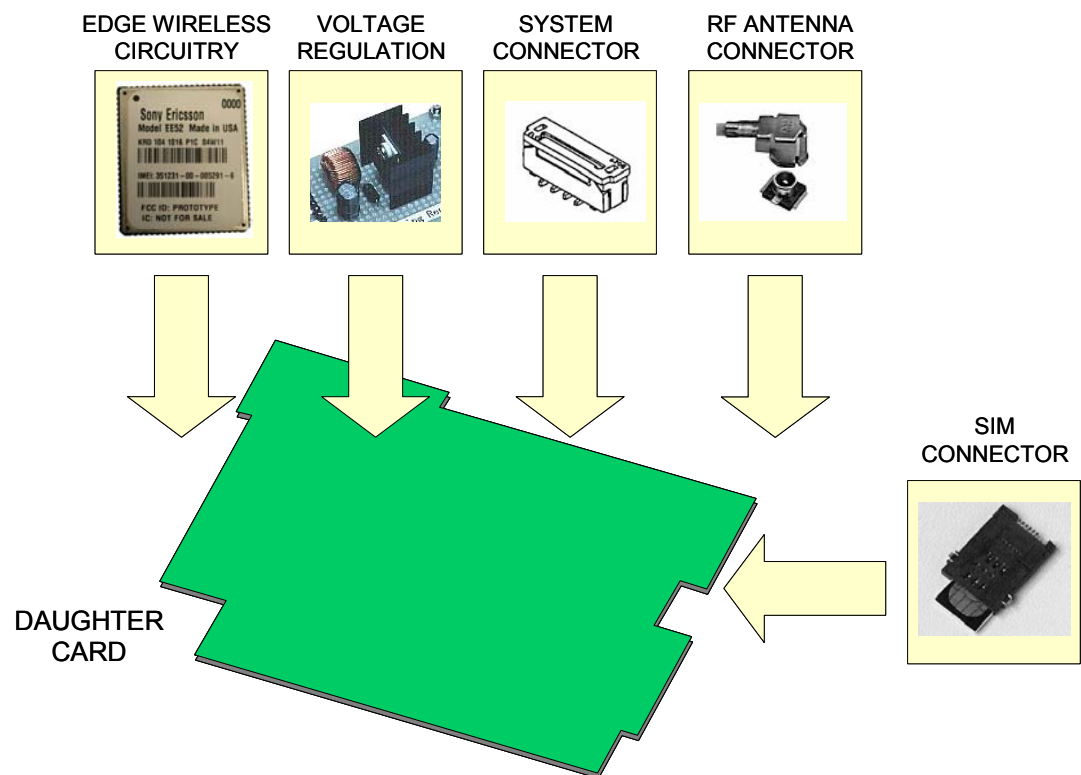
Figure 1-1 EDGE Daughter Card Component Parts

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1.1 Target Users

The EDGE Daughter Card solution is specifically for the host equipment.

1.2 Prerequisites

Integration of the EDGE Daughter Card will be performed at facilities under the host equipment customer's management. All necessary integration instruction, driver software and user documentation will be provided. No special pre-requisite knowledge is necessary.

1.3 Notation

This document describes a custom solution for the host equipment. The Daughter Card product is defined through a cooperative partnership between the host equipment customer and Sony Ericsson Mobile Communications (SEMC).

EDGE (Enhanced Data rate for GSM Evolution) is the wireless-enabling technology.

The EDGE Daughter Card is a PCB assembly with the components described on the previous page integrated on to the board. The complete assembly is reffered in this document as the the host equipment DC (*DC=Daughter Card*).

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2 EDGE Wireless Modem

2.1 EDGE Wireless Modem in a Communication System

Figure 2-1 illustrates the main blocks of a wireless communication system using the EDGE Daughter Card embedded in the host equipment device. It also shows the communication principles of the system. The definitions in the figure, as used elsewhere in this manual, are in accordance with the recommendations of GSM 07.07.

- The MS (mobile station) represents the EDGE Daughter Card modem plus SIM card.
- The modem excluding SIM card, is known as the ME (mobile equipment).
- The TE (terminal equipment) is a micro-controller and is a part of the application.

Wireless Communications System
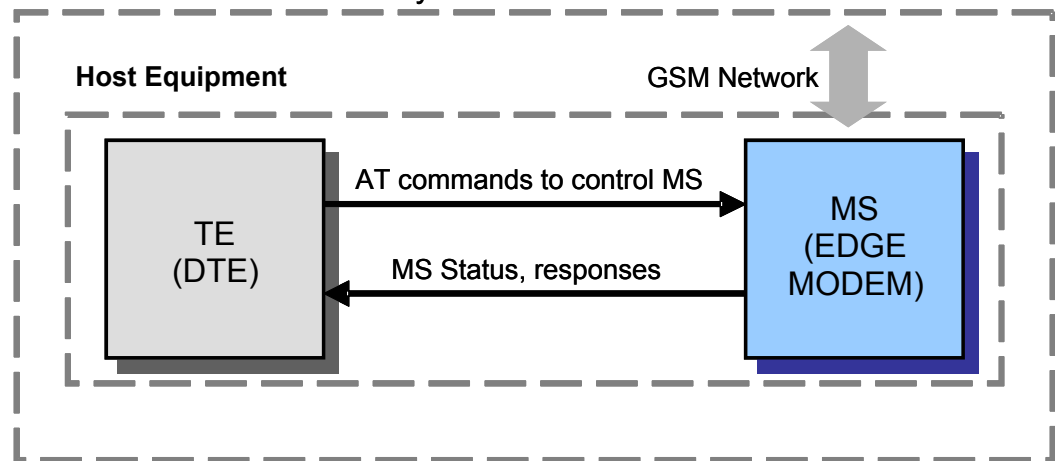
Figure 2-1 Main Blocks in a Wireless System

In accordance with the recommendations of ITU-T (International Telecommunication Union - Telecommunications Standardisation Sector) V.24, the TE communicates with the MS over a serial interface. In this case this is the Universal Serial Bus (USB).

The functions of the EDGE modem follow the recommendations provided by ETSI (European Telecommunications Standards Institute) and ITU-T.

ETSI specifies a set of AT commands for controlling the GSM/E-GSM element of the modem; these commands are supplemented by Sony Ericsson specific commands.

Figure 2-2 illustrates the interface between the Daughter Card and the the host equipment application. Each interface signal is described in Section 3.

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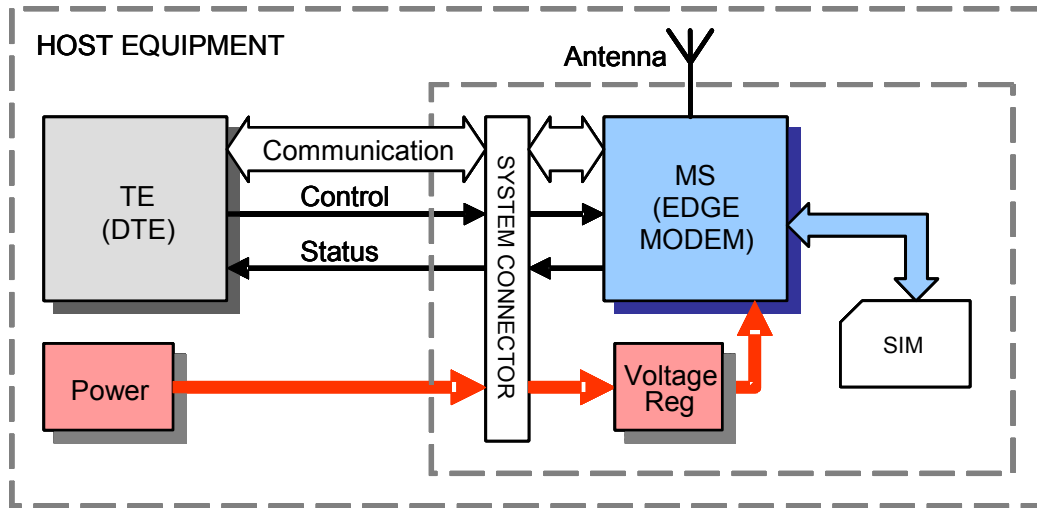
Figure 2-2Figure 2-2 Interface between Daughter Card and Application

Note that ITU-T standards define TE and TA as DTE (Data Terminal Equipment) and DCE (Data Circuit Terminating Equipment) respectively.

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2.2 Functional Block Diagram

A function representation of the EDGE duaghter card is included in the figure below.
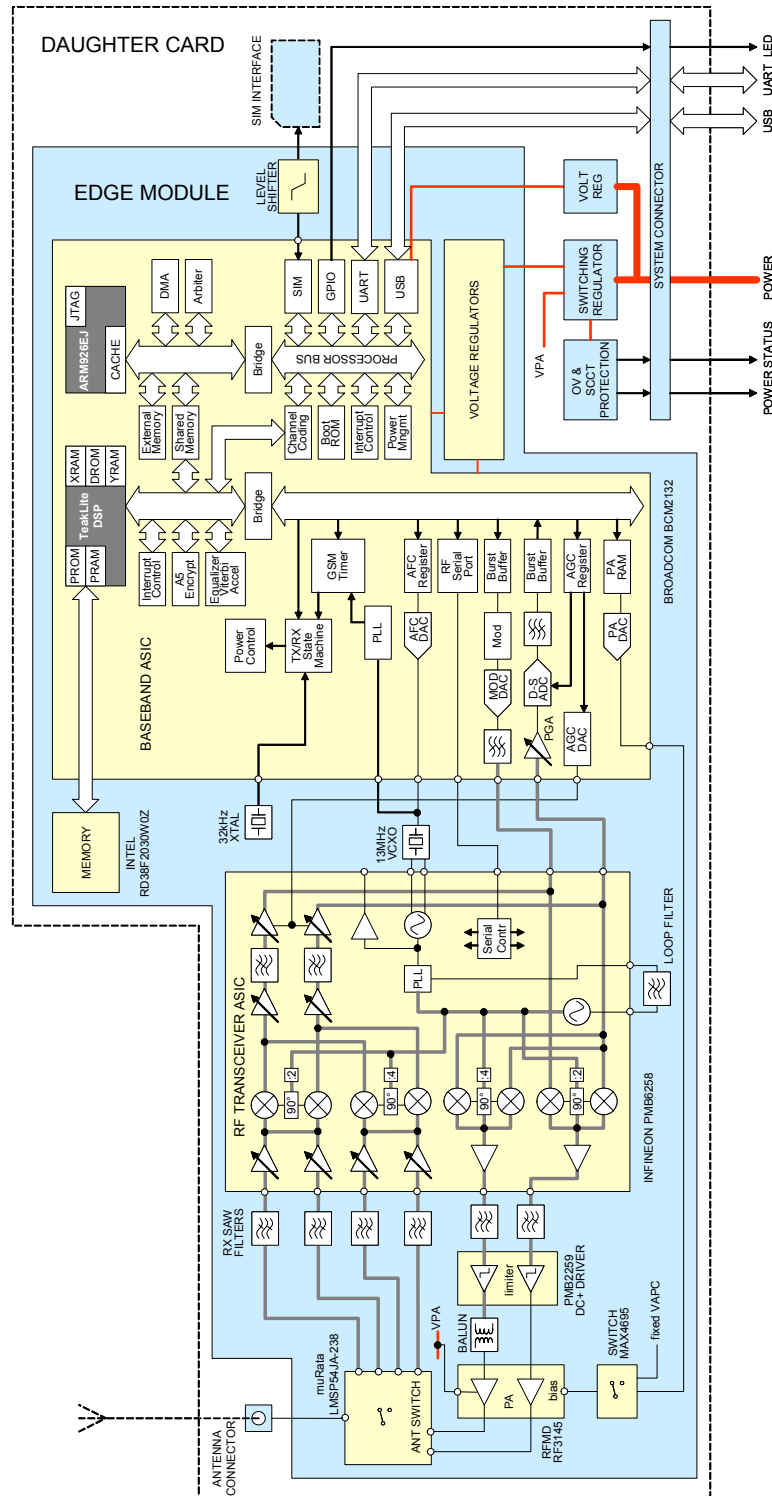
Figure 2-3 EDGE Daughter Card Functional Block Diagram

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2.3 Features

The EDGE modem performs a set of telecom services (TS) according to GSM standard phase 2+, ETSI and ITU-T. The functions of the modem are implemented by issuing AT commands over a serial interface.

2.3.1 Mobile Station Characteristics

The EDGE modem can be configured for single, dual, triple and quad band GSM functionality. The quad band characteristics of the EDGE modem are shown in the following table.

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EDGE MODEM			GSM850	E-GSM900	GSM1800	GSM1900
Frequency range (MHz)			TX: 824-849 RX: 869-894	TX: 880-915 RX: 925-960	TX: 1710-1785 RX: 1805-1880	TX: 1850-1910 RX: 1930-1990
Channel spacing				200kHz		
Number of channels			123 x 8 (TDMA)	173 x 8 (TDMA)	373 x 8 (TDMA)	298 x 8 (TDMA)
Duplex spacing				45MHz	95MHz	80MHz
Modulation	GSM/GPRS			GMSK		
	EDGE			8-PSK		
Tx phase accuracy (burst)	Nom.			TBD		
	Max.			<5° rms phase error ; <20° max peak phase error		
Tx Spectrum Due to Modulation	100KHz			<+0.5dB		
	200KHz			<-30dB		
	250KHz			<-33dB		
	400KHz			<-60dB		
Tx Spectrum Due to Switching Transients	100KHz			<-23dBm		
	200KHz			<-26dBm		
	250KHz			<-32dBm		
	400KHz			<-36dBm		
Receiver sensitivity (ANT pin)			<-102dBm	<-102dBm	<-102dBm	<-102dBm
Transmitter output power (ANT conn)	GSM	Class		Class 4	Class 1	
		Nom.		+33dBm	+30dBm	
	EDGE	Class		Class E2	Class E2	
		Nom.		+27dBm	+26dBm	
Receiver sensitivity (ANT connector)	Nom.		<-104dBm			
	Max.		<-102dBm			

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Rx Intermodulation	f_1	-49dBm	
$F_0 = 2f_1\text{-}f_2$; $|f_2\text{-}f_1| = $ 800KHz	f_2	-49dBm	
GPRS operation	Class 10		

Note that the number of frequency bands available will be dependant upon the factory configuration. The available bands will be determined by customer requirements.

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2.3.2 Environmental Conditions

The DC will support the following environmental conditions

Temperature Range (Full GSM Specification)[1]	-10°C to +55°C
Temperature Range (Operational) [2]	-20°C to +65°C
Storage Temperature Range	-20°C to +75°C

Table 2.3-1 Environmental Conditions

Notes
1. Full compliance to Type Approval and Regulatory Approval requirements between these temperature ranges
2. Design Verification Testing (DVT) and Operational compliance between these temperature ranges.

2.4 SIM Card

An external SIM card with 3V or 1.8V technology, can be connected to the modem via the SIM interface pins.

2.5 Other Features

The EDGE modem supports a number of additional features including

- 07.10 multiplexing (normal mode)
- SIM application tool kit

2.6 Precautions

The EDGE modem device is ESD protected up to 4K V contact and 8K V air discharge. It is recommended that integrators follow electronic device handling precautions when working with any electronic device system to ensure no damage occurs to the host or the radio device.

The EDGE modem is integrated on to the daughter card. When the card is mounted in the host it is the responsibility of the integrator to ensure that static discharge protection beyond the voltages specified above are designed in to the host product. If exposed, the antenna is a vulnerable contact point for ESD.

Part 2 : Daughter Card Description

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3 Mechanical Description

3.1 Physical Detail

Dimensional details given here are for reference only. For mechanical design data, please refer to the mechanical outline drawing 151 88 - KRD 104 1025/2.
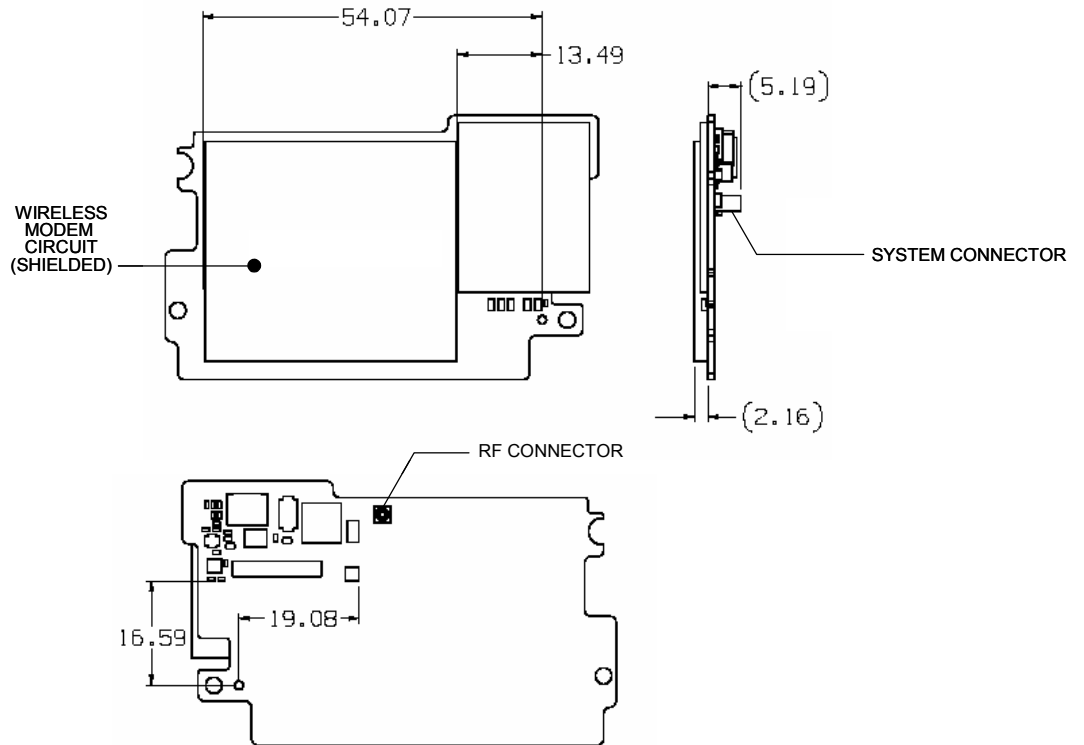
Figure 3-1 Layout Detail (reference only)
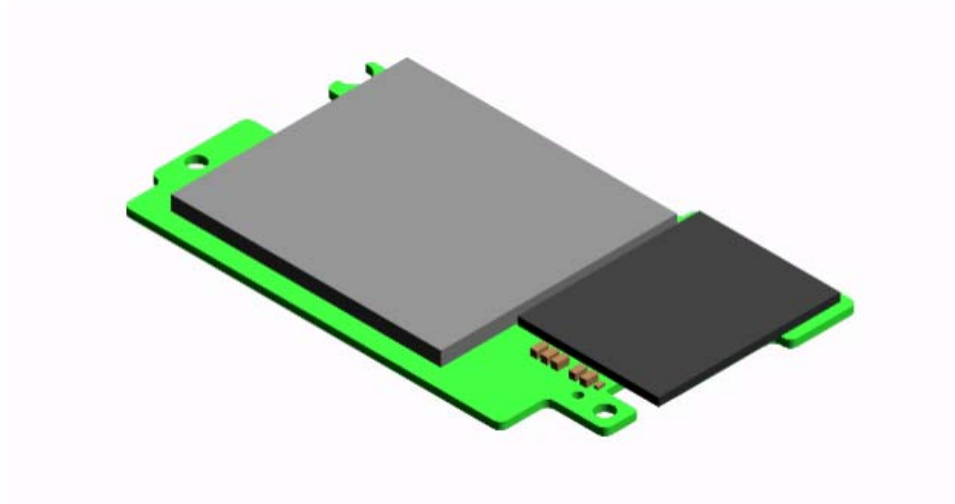
Figure 3-2 EDGE Daughter Card Primary Side View
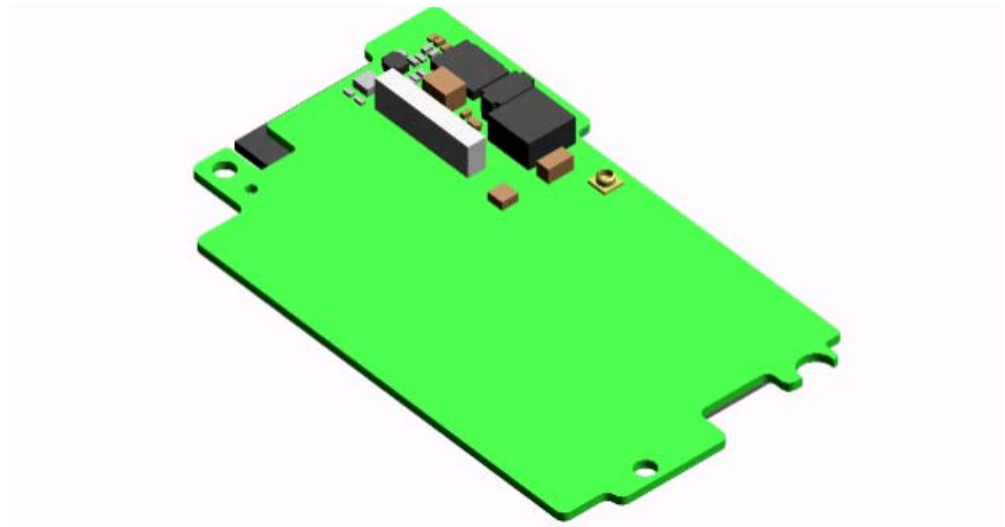
Figure 3-3 EDGE Daughter Card Underneath View

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4 System Interface

4.1 Overview

4.1.1 System Connector

All of the systems interface signals flow through a single connector; power, ground, data, cotrol, status and GPIO.

Electrical connections to the modem are made through a 24 pin low insertion force (LIF) vertical SMT mount FFC or FPC cable receptor. The connector is a single sided contact type, for example the AVX Elco part 04-6244-024-011-800.

Connector type	NON-ZIF (LIF) ST SMT
Contact	Single
Profile Height (mm)	4.10
Number of Contacts	24
Current Rating	0.4A Max.
Voltage Rating	50V Max.
Dielectric withstanding voltage	200Vrms
Contact Material	Phosphor bronze Tin-Plated
Insulator material	Heat resistant plastic
Operating temperature	40ºC~+85ºC
FFC/FPC thickness	0.3±0.05

Table 4.1-1 Connector Characteristics
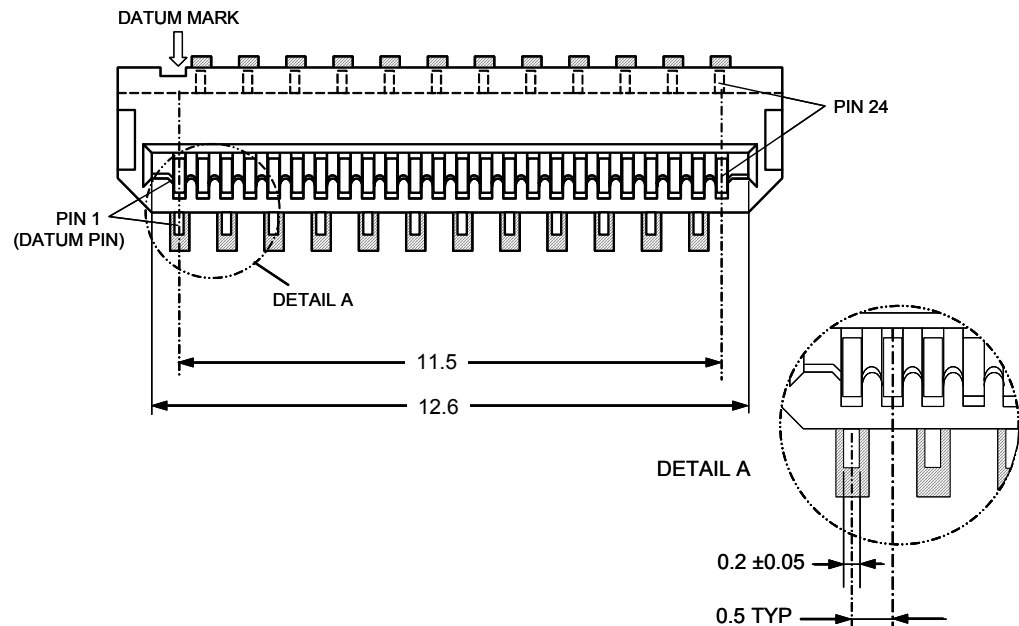
Figure 4-1 Connector Detail

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Pin	Name	Function
1	USB_DN	USB differential (-) line
2	USB_DP	USB differential (+) line
3	VREF	Modem logic voltage reference output from daughter card
4	OVP	Over voltage protection output from daughter card
5	SPARE	
6	SPARE	
7	SPARE	
8	GND	Ground
9	GND	Ground
10	GND	Ground
11	GND	Ground
12	GND	Ground
13	GND	Ground
14	VIN	Voltage input from host application
15	VIN	Voltage input from host application
16	VIN	Voltage input from host application
17	VIN	Voltage input from host application
18	VIN	Voltage input from host application
19	VIN	Voltage input from host application
20	RI	Ring Indicator output from daughter card
21	3V3	Application reference voltage input to daughter card
22	LED	Pulsing LED output from daughter card
23	UVP	Under voltage & short circuit protection output from daughter card
24	P_EN	Power ON enable input to daughter card

Table 4.1-2 Pin List

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4.2 Electrical Interface Detail Format

Details of each electrical interface is contained in paragraph 5 (beginning page 19). The description of each interface follows a common format. An example is shown below:

Interface Name

This is the name of the interface; usually this is the actual name found in the pin list; sometimes this is a collective name for a number of signals, such as the example shown here for a UART.

Function:

This identifies the basic function of the interface; some interfaces are grouped according to their functional sub-class.

Description:

The description contains a basic overview of the interface and its functional relationship with the host.

Pin Numbers:

All pin numbers associated with the interface are listed; these will not necessarily be in numerical order but may be arranged to coincide with signal name list.

Signal Names:

All sigal names associated with the interface exactly as shown in the pin list; the signal names also contain information on signal flow direction.

If not used:

This gives specific details, for each signal, of how to terminate the physical connection if it is not required by the host; failure to observe this convention may result in unstable operation of the EDGE modem. (This may not be necessary in the host application since all signals have a defined function).

5   Electrical Interface

This section describes each signal line of the electrical interface between the EDGE modem and the host equipment application. A summary of the function of each signal is provided, together with any additional relevant information.

Signals are described from the perspective of the EDGE modem and Daughter Card circuitry. Consequently signals described as input are inputs to the modem, driven by the host [host⇒modem]. Likewise, signals described as output are driven by the modem in to the host [modem⇒host]. Bi-directional signal flow (I/O) is indicated by a double-headed arrow [modem⇔host]. In some instances the [daughter card] will be identified if the modem circuitry is not directly involved, or where additional interface circuitry resides between the host and the modem.

Signals which are pulled internally are identified in parentheses beside the signal name as either (PU)=Pulled Up or (PD)=Pulled Down. Signals with no designation are not pulled either way.

5.1   Power Interfaces

This section describes the power, ground, and other signals that control or indicate power states.

- VIN
- 3V3
- VREF
- GND

5.1.1   VIN

Function: Daughter card power supply

Description: Primary voltage supply to switching regulator (5.5 to 20.0V).

Pin Numbers: 14, 15, 16, 17, 18, 19

Signal Names: VIN   [host⇒daughter card]

If not used: Required

Details:

Power provided by the host will range from 5.5V minimum to a maximum 20.0V, dependent upon the battery discharge state. The Daughter Card has on board regulation which regulates the supply range to a steady 3.6V by means of a switching regulator rated at 3A max.

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Typical Electrical Characteristics:

Parameter		Condition	Low	Mid	High	Unit
Voltage			5.5	7.4	20.0	V
Transmit mode Power Consumption (worst case)	Peak*	GSM850 2-slot TX	1880	1500	950 est	mA
	average	GSM850 2-slot TX	450	340	145 est	
Idle mode Power Consumption (worst case)	average	DRX 2	9.9	7.6	3.8 est	mA

*Peak current consumption is an instantaneous value which occurs during a TDMA transmitter burst.

Table 5.1-1: VIN Electrical Characteristics

5.1.2   3V3

Function: Daughter card reference voltage

Description: Host reference to protection circuit & USB (3.3V)

Pin Numbers: 21

Signal Names: 3V3   [host⇒daughter card]

If not used: Required

Details:

The host supplies a 3.3V regulated supply to the Daughter Card for two primary functions:
- reference supply for the undervoltage / short circuit protection circuitry
- input for the USB interface

Electrical Characteristics:

Parameter	Condition	Min	Nom	Max	Unit
Voltage			3.30		V
Ripple				100	mV

5.1.3   VREF

Function: Voltage Reference

Description: Core digital voltage reference from modem.

Pin Number: 3

Signal Name: VREF   [modem⇒host]

If not used: Required

Details:

VREF is supplied as a reference voltage from the modem. This reference is the modem's core digital supply voltage at a nominal 2.80V.

The interface is capable of sourcing 200uA and is intended primarily for situations where host interface circuitry is required to be level shifted to maintain wireless modem signal level compatibility. If more current is required by the host, a current amplifier must be implemented.

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This signal can also be used to indicate whether the wireless modem is powered on or not. A high level (2.7V to 2.9V) indicates that the modem is powered on. A low level (<0.5V) indicates that the modem is powered off.

All digital logic, except the SIM interface, is characteristic CMOS logic operating at VREF.

Electrical Characteristics:

Parameter	Condition	Min	Typ	Max	Unit
VREF output voltage	inactive		0.3	0.5	V
	active	2.70	2.80	2.90	V
VREF output current I$_{OUT}$				200	uA

Table 5.1-2: VREF Electrical Characteristics

5.1.4 GND

Function: Ground

Description: Modem common rail

Pin Numbers: 8, 9, 10, 11, 12, 13

Signal Name: GND

If not used: Required

Details:

Return path for all currents.

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5.2 Status Interfaces

Status interfaces indicate or control status features of the modem.

- UVP
- OVP
- RI
- LED
- VREF

5.2.1 UVP

Function: Under voltage protection

Description: Status indicator to host of potential malfunction in Daughter Card circuitry

Pin Number: 23

Signal Name: UVP (PD)   [daughter card⇒host]

If not used: Required

Details:

The Daughter Card has FET circuitry which uses 3V3 as a reference, driving an output to the host indicating the voltage condition of the of VBAT (the modem supply voltage). A resistive divider connected to VBATT presents a very low V_{be} to the UVP transistor. This presents a steady state low voltage output under normal VBAT conditions with external pulldown circuitry. In the event of a short circuit or high current fault condition on the Daughter Card, the voltage drop from the switching regulator will bias the UVP transistor on and present a high output to the host equipment monitoring circuit.

The UVP signal should be pulled low by the application circuit for correct function.

Electrical Characteristics:

Parameter	Condition	Min	Typ	Max	Unit
UVP output voltage	Normal			0.5	V
	Fault		3.3		V

Table 5.2-1: UVP Electrical Characteristics

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5.2.2 **OVP**

Function: Over voltage protection

Description: Status indicator to host of potential malfunction in Daughter Card circuitry

Pin Number: 4

Signal Name: OVP (PU) [daughter card⇒host]

If not used: Required

Details:

The OVP signal is simply an output from the main onboard regulator. In it's operational state under normal functional conditions this will output 3.6V nominal

Parameter	Condition	Min	Typ	Max	Unit
UVP output voltage	Normal		3.6		V
	Fault	3.7			V

Table 5.2-2: OVP Electrical Characteristics

5.2.3 **RI**

Function: Ring Indicator

Description: Alert signal from the modem to indicate an incoming SMS, or unmasked unsolicited response

Pin Number: 20

Signal Name: RI [modem⇒host]

If not used: Leave open

Details:

Ring Indicator is essentially a wake-up call from the modem to the host application to signal one of two events:

- an in-coming message (SMS).
- an unmasked unsolicited response/result code.

For the EDGE modem the Ring Indicator is implemented as a GPIO interface within the EDGE baseband device.

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A falling edge indicates an alert or message. The signal remains low for a period of time before going high. An SMS-page or unsolicited response/result code generates one pulse (the length is configurable using an AT command)[TBC].

The ring indicator is implemented on the daughter card as an open collector transistor output to allow the host the convenience of driving the host equipment circuitry.

5.2.4   LED

Function: LED

Description: LED-signal indicating a status change

Pin Number: 22

Signal Name: LED   [modem⇒host]

If not used: Leave open

Details:

The LED is implemented on the Daughter Card as an open collector transistor output which providesa driver level interface to an LED acting as a status indicator for the user. The LED output can be made to blink at a rate pre-determined by modem software.

5.2.5   VREF

The function of VREF is already described in 5.1.3. This interface can be used as a status indicator to the host that the modem is still powered. VREF is present whilst the modem is powered and is removed upon the completion of the modem power down. This feature can be useful in the event of a communications lock-up between the host and the daughter card.

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5.3 Data Communication and Control Interfaces

The serial data and control interfaces consist of the following :

- USB
- P_EN

5.3.1 USB Interface

Function: USB data communication port

Description: USB transmit and receive port for data communication between modem and host.

Pin Numbers: 1, 2

Signal Names: USB_DP (2) [modem⇔host]
USB_DN (1) [modem⇔host]

If not used: Required

Details:

Power to the USB interface is provided by the 3V3 input from the host.

5.3.2 P_EN

Function: Power Enable

Description: Modem power enable control from host

Pin Numbers: 24

Signal Names: P_EN   [host⇒daughter card]

If not used: Required

Details:

The power enable signal is provided from the host application and is routed to the switching regulator shutdown input and also to the REG_EN (regulator enable) pin on the modem. Assertion of this pin will initiate power up. The P_EN pin is active high and has to be maintained continually in order to keep the modem powered.

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5.4 ANTENNA CONNECTOR

Function: Antenna connector

Description: 50 ohm wireless antenna connection.

Pin Numbers: N/A

Signal Names: ANTENNA

If not used: Required

Details:

The antenna interface to the modem is routed to a low profile coaxial connector on the daughter card.   The antenna connector has a nominal impedance of 50 ohms and a maximum frequency rating of 2.5GHz.

IMPORTANT NOTE:
FCC Radiation Exposure Statement:
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance of 20cm between the radiator and your body.
This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

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6 Rudimentary Circuit Functions

This section contains some rudimentary circuit functions for the sequencing of powering the modem up and down.

6.1 Power On Sequence

This sequence illustrates the power on procedure.
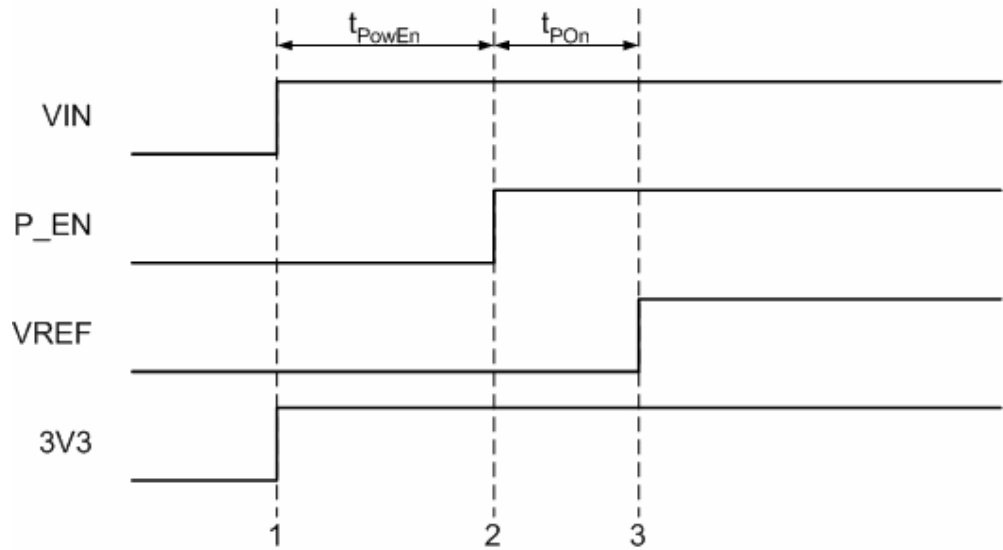
Figure 6-1 Power On Sequence

Sequence Detail:

1   VIN and 3V3 are supplied to the modem by the host. These two voltages can be supplied simultaneously when the Daughter Card is required to be powered on. Both voltages must be present before the power on sequence is initiated for the Daughter Card to function correctly.

2   Once VIN and 3V3 voltages are applied the host can enable power up by asserting power enable signal P_EN. The power up process will begin.

3   VREF may be used as an indicator that the modems regulators are powered. t_{POn} is typically less than 70 ms

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6.2 Power Off Sequence

This sequence illustrates the power off procedure.

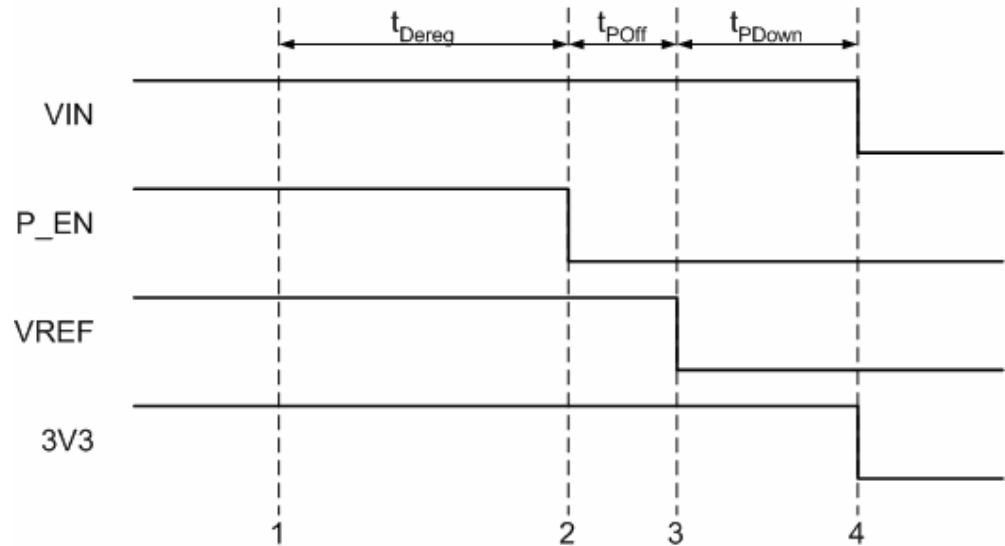Figure 6-2 Power Off Sequence

Sequence Detail:

1 The "AT+CFUN=4" instruction is sent from the host application to the modem in order to initiate a deregistration sequence.

2 The modem responds to the request with an 'OK' to indicate that deregistration is completed. Deregistration from the network can take from 3-30 seconds. After de-registration has been acknowledged the host application may remove P_EN.

3 The switching regulator output capacitor will gradually discharge until the modem regulators threshold is exceeded. and power down will be complete. VREF may be used as indicator of complete shut down.

4 When the modem has successful shutdown, and VREF has fallen bellow 0.5V then the host may safely remove VIN and 3V3 at any time. However the supplies can remain active without increasing current consumption (typically <25uA).

6.3 USB communications timing

This sequence illustrates USB initialization.

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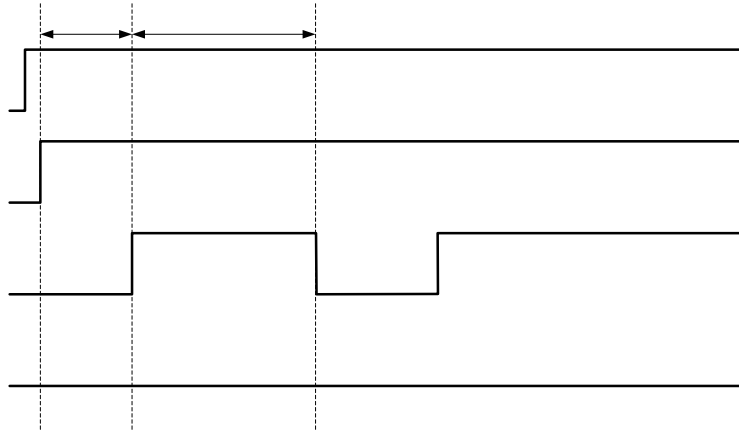
1. The startup sequence begins with the completion of the power up ramping of the VREF signal as described in Power On Sequence.

2. The D+ signal is brought high with the power up of the USB block in the baseband circuitry. This produces the J state indicating to the USB host that a device is attaching.

3. A host initiated SE0 begins the USB protocol transactions. A power up summary of USB transactions is shown for example.

```
Transactions by Device:
                      #Transactns      Acknowledgement            Bytes
  Addr    Endp    Type   Total   Error    ACK   NAK   None   Attempt   Success
    0       0   SETUP      4       0       4     0     0       32        32
    0       0   IN         4       0       4     0     0       36        36
    0       0   OUT        2       0       2     0     0        0         0

    3       0   SETUP      7       0       7     0     0       56        56
    3       0   IN         7       0       7     0     0      132       132
    3       0   OUT        6       0       6     0     0        0         0

    4       0   SETUP      3       0       3     0     0       24        24
    4       0   IN         3       0       3     0     0       27        27
    4       0   OUT        2       0       2     0     0        0         0

    4       2   IN      7164       0       3  7161     0       63        63
    4       2   OUT        2       0       2     0     0       39        39


Control Transfers by Device:
  Addr   Endp   Packet#   Dir    Type      Recipient   Request              Value   Index   Length
    0      0      336     D->H   Standard   Device     GET_DESCRIPTOR        256     0       64
    0      0      426     H->D   Standard   Device     SET_ADDRESS             3     0        0
    0      0      874     D->H   Standard   Device     GET_DESCRIPTOR        256     0       64
    0      0      904     H->D   Standard   Device     SET_ADDRESS             4     0        0

    3      0      472     D->H   Standard   Device     GET_DESCRIPTOR        256     0       18
    3      0      481     D->H   Standard   Device     GET_DESCRIPTOR        512     0        9
    3      0      490     D->H   Standard   Device     GET_DESCRIPTOR        512     0      255
    3      0      670     D->H   Standard   Device     GET_DESCRIPTOR        256     0       18
    3      0      679     D->H   Standard   Device     GET_DESCRIPTOR        512     0        9
    3      0      688     D->H   Standard   Device     GET_DESCRIPTOR        512     0       38
    3      0      697     H->D   Standard   Device     SET_CONFIGURATION       1     0        0

    4      0      950     D->H   Standard   Device     GET_DESCRIPTOR        256     0       18
    4      0      959     D->H   Standard   Device     GET_DESCRIPTOR        512     0        9
    4      0      968     H->D   Standard   Device     SET_CONFIGURATION       1     0        0
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Eye Diagram for Full Speed USB signaling.