

**Integration Guide:
LPP0108IG001**

Enfora Enabler LPP G Integration Guide

Version: Preliminary

Enfora, Inc.
www.enfora.com

Document Title:	Enfora Enabler LPP G Integration Guide
Version:	Preliminary
Date:	06/20/2008
Status:	Preliminary
Document Control ID:	LPP0108IG001

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1. Safety Precautions

1.1. Important Safety Information

The following information applies to the devices described in this manual. Always observe all standard and accepted safety precautions and guidelines when handling any electrical device.

- Save this manual: it contains important safety information and operating instructions.
- Do not expose the Enfora Enabler LPP G product to open flames.
- Ensure that liquids do not spill onto the devices.
- Do not attempt to disassemble the product: Doing so will void the warranty. With the exception of the Subscriber Identification Module (SIM), this product does not contain consumer-serviceable components.

2. Regulatory Compliance FCC

2.1. Integration Considerations and Installation Requirements

The Enabler LPP G module is designed for use in a variety of host units, "enabling" the host platform to perform wireless data communications. However, there are certain criteria relative to integrating the Enabler LPP G module into a host platform such as a PC, laptop, handheld or PocketPC[®], monitor and control unit, etc. that must be considered to ensure continued compliance with FCC compliance requirements.

- Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.
- In order to use the Enabler LPP G module without additional FCC certification approvals, the installation must meet the following conditions:

Maximum RF output power and antenna gain to meet Maximum Permissible Exposure Requirements: GSM850 mode: Power at antenna port is +33 dBm. The maximum gain is 1.4 dBi. GSM1900 mode: Power at antenna port is 30 dBm. The maximum gain is 7 dBi in order to meet the requirements of maximum 2 watts EIRP for mobile transmitters. If RF power and/or antenna gain is desired, a separate FCC certification is required.

- If used in a "portable" application such as a handheld or body worn device with the antenna less than 20 cm (7.9 in.) from the human body when the device is operating, then the integrator is responsible for passing additional "as installed" testing and the device will require its own FCC ID:
 - SAR (Specific Absorption Rate) testing, with results submitted to the FCC for approval prior to selling the integrated unit. If unable to meet SAR requirements, then the host unit must be restricted to "mobile" use (see below).
 - Unintentional emissions, FCC Part 15; results do not have to be submitted to the FCC unless requested, although the test provides substantiation for required labeling (see below).

- ERP and EIRP measurements for FCC Parts 22 and 24, alternatively a full retest on FCC Parts 22 and 24 can be performed.
- If used in a "mobile" application where the antenna is normally separated at least 20 cm (7.9 in) from the human body during device operation, then an appropriate warning label must be placed on the host unit adjacent to the antenna. The label should contain a statement such as the following:

WARNING
RF exposure. Keep at least 20 cm (7.9 in) separation distance from the antenna and the human body.

- Host unit user manuals and other documentation must also include appropriate caution and warning statements and information.
- If the FCCID for the Enabler LPP G module is not visible when installed in the host platform, then a permanently attached or marked label must be displayed on the host unit referring to the enclosed module.

For example, the label should contain wording such as:

Contains GSM/GPRS modem transmitter module
 FCC ID: MIVLPP0108
 This device complies with Part 15 of the FCC Rules.
 Operation is subject to the following two conditions: (1)
 This device may not cause harmful interference, and (2)
 This device must accept any interference received,
 including interference that may cause undesired
 operation.

OR

Contains FCC ID: MIVLPP0108
 This device complies with Part 15 of the FCC Rules.
 Operation is subject to the following two conditions: (1)
 This device may not cause harmful interference, and (2)
 This device must accept any interference received,
 including interference that may cause undesired
 operation.

- Any antenna used with the Enabler LPP G module must be approved by the FCC or as a Class II Permissive Change (including MPEL or SAR data as applicable). The "professional installation" provision of FCC Part 15.203 does not apply.

- The transmitter and antenna must not be co-located or operating in conjunction with any other antenna or transmitter. Violation of this would allow a user to plug another transmitter in to the product and potentially create an RF exposure condition.

WARNING
The transmitter and antenna must not be collocated or operating in conjunction with any other antenna or transmitter. Failure to observe this warning could produce an RF exposure condition.

2.2. Disclaimer

The information and instructions contained within this publication comply with all FCC, GCF, PTCRB, R&TTE, IMEI and other applicable codes that are in effect at the time of publication. Enfora disclaims all responsibility for any act or omissions, or for breach of law, code or regulation, including local or state codes, performed by a third party.

Enfora strongly recommends that all installations, hookups, transmissions, etc., be performed by persons who are experienced in the fields of radio frequency technologies. Enfora 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 Enfora shall not be responsible for installations or transmissions that fall outside of the parameters set forth in this publication.

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The Enabler LPP G platform is designed with features to support a robust connection. There are instances where the module performance is beyond the control of the intended design. Integrated designs that require 24 by 7 operation must implement power control via an external circuit or by implementing power management as specified within this design guide.

3. Manual Overview

This document describes the available hardware interface of the Enabler LPP G module. The purpose of this document is to define the electrical, mechanical and software interfaces while providing detailed technical information in order to streamline the process of hardware and system integration.

3.1. Revision History

Date	Rev	Author	Description
06/20/08	1.00	Chuck Todd	Preliminary

3.2. References

3.2.1. Enfora Enabler LPP G Product Documentation

Manuals

- LPP0108AT001 - Enfora Enabler LPP G AT Command Set Reference
- GSM0308UG001 - Enfora GSM-GPRS Family API Reference
- LPP0108PR001 – Enfora Enabler LPP G Programming Reference
- LPP0108SD001 – Enfora Enabler LPP G SDK Reference
- LPP0108UG001 – Enfora Enabler LPP G Power Management Developer Tool Guide

3.2.2. GSM Device Specifications

- 3GPP TS 51010-1 (850, 900, 1800, 1900 MHz devices)

To view the latest release, go to:

<http://www.3gpp.org/ftp/Specs/html-info/51010-1.htm>

3.2.3. US Government

3.2.4. Federal Communications Commission (FCC)

Internet: <http://www.fcc.gov/>

- FCC Rules, Part 24
 - 47 CFR Subpart E--Broadband PCS
 - 47 CFR § 24.52, sections 1.1307(b), 2.1091, and 2.1093
- FCC Rules, Part 22 for GSM 850
- FCC Rules, Part 15
- FCC Rules, Part 2
 - Subpart J--Equipment Authorization Procedures
 - Section 2.925

3.2.5. FCC Office of Engineering and Technology (OET)

Internet: <http://www.fcc.gov/oet/>

- Bulletin Number 65 "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields"
- Supplement C "Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Exposure to Radio Frequency Emissions"

3.2.6. Industry Canada

- RSS-132
- RSS-133
- ICES-003

3.2.7.Environmental Regulations

- National Environmental Policy Act (NEPA) of 1969 (Part 1, Subpart 1)
- RoHS Compliant

3.2.8.Mechanical Specifications

- ASTM D999
- ASTM D775
- IEC 68-2-27
- Bellcore Gr-63-CORE
- ETS 300 019-1-1 Class 1.2
- ETS 300 019-1-2 Class 2.1
- ETS 300 019-1-3 Class 3.1

3.2.9.RF and EMI Specifications

- ETSI Standards
- EN 61000-4-6
- EN 61000-4-3
- 3GPP TS 51.010-1, Section 12.2

4. Introduction

4.1. Product Overview

The Enfora Enabler LPP G module is a compact, wireless OEM module that utilizes the Global System for Mobile Communications (GSM) and General Packet Radio Services (GPRS) international communications standard to provide two-way wireless capabilities via GSM services. This GSM/GPRS module is combined with a Global Positioning System (GPS) chipset to provide physical location, a host processor to ensure very low power standby configurations, and vibration sensor to detect movement of the module. The Enfora Enabler LPP G module is a fully Type-approved GSM/GPRS device, enabling application-specific, two-way communication and control.

The small size of the Enfora Enabler LPP G module allows it to be integrated easily into the application and packaging.

4.2. Key Features of the Enabler LPP G Module

The following table summarizes the main features of the Enfora Enabler LPP G Radio Module.

Interface	Data input/output interface	50 position 1.27mm pitch
	Primary serial port	3.3V levels, '2-wire' UART implementation
	Secondary serial Port	Single TX from GPS, NMEA data only.
	USB port	USB Debug and Configuration
	Audio	Digital audio
	Command protocol	Enfora Packet API, GSM AT command set, Enfora MCP
	Subscriber Identification Module (SIM)	USIM port with SIM detect, Optional embedded SIM.
Battery Charger	Lithium Ion battery charger, temperature and battery ID analog inputs	
Power	Electrical power	3.3 to 4.5 Vdc (vbat)
	Peak currents and average power dissipation	Refer to the Operating Power table in the Technical Specifications for peak currents and average power dissipation for various modes of operation.
Radio Features	Frequency bands	EGSM 900, GSM1800, GSM 850 and GSM 1900 capability.
	GSM/GPRS features supported	Provides for all GSM/GPRS authentication, encryption, and frequency hopping algorithms. GPRS Coding Schemes CS1-CS4 supported. Multi-Slot Class 10 (4RX/2TX, Max 5 Slots).
Regulatory	Agency approvals	<ul style="list-style-type: none"> • GCF Type Approval • PTCRB Type Approval • FCC Certification • RTTE • CE (European Community Certification) • IC (Industry Canada) Approval
GSM/GPRS Functionality		<ul style="list-style-type: none"> • 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 • Voice (EFR, FR, HR, AMR) • Supports Unstructured Supplementary Service Data (USSD) • Multi-Slot Class 10 Supported (4Rx/2TX), (5 Slot Max) PBCCH/PCCCH Supported

Audio Features	<ul style="list-style-type: none"> • Handset Microphone biasing, internal • Handset microphone input (MICIN, MICIP pins)
Outputs	<ul style="list-style-type: none"> • Handset earphone outputs (EARP, EARN pins)
SIM	<ul style="list-style-type: none"> • 1.8/3 V Mini-Subscriber Identity Module (SIM) compatible
Software	<ul style="list-style-type: none"> • Free RTOS included

Table 1 - Enabler LPP G Key Features

Preliminary

4.3. Providing Multi-Band Operation

The Enfora Enabler LPP G module provides 4 frequency bands for compatibility with worldwide frequency standards. 850/1900 frequency bands are primarily used in North and South America, while 900/1800 bands are used throughout the world. The Enabler LPP G offers all four bands for use worldwide.

4.4. Summary of Features for the Enabler LPP G Module

The following summarizes the main features of the Enfora Enabler LPP G Module.

Mechanical

Dimensions..... 38.5 mm x 33.6 mm x 4.19 mm
Weight 8.6g

Packet Data Transfer:

Protocol.....GPRS Release 97
Coding Schemes.....CS1-CS4
Multi-Slot Capability: (Demonstrated @MS10).....MS10 (4RX/2TX) (Max 5 Slots)
Packet Channel SupportPBCCH/PCCCH

Short Message Services:

GSM SMS MO, MT, CB, Text and PDU Modes
GPRS SMS MO, MT, CB, Text and PDU Modes

Voice Capability:

Speech Codec..... EFR, FR, HR, AMR

GSM/GPRS Radio Performance Multi-Band:

LPP0108 Radio Frequencies 850 MHz, 900 MHz, 1800 MHz, and 1900 MHz
Sensitivity <-106 dBm (Typical GPRS CS1)
850 & 900 MHz Transmit Power .. Class 4 (2 W)
1800 & 1900 MHz Transmit PowerClass 1 (1 W)

System Requirements:

Host Interface Serial Interface
DC Voltage 3.3 to 4.5 Vdc

Application Interface:

Host Protocol MCP Protocol, AT Commands, OTA Enfora Packet API and USB.
Internal Protocols UDP stack and TCP/IP stack
Physical Interface 2 serial (primary - Default rate 115,200 baud; secondary - rate 19,200 baud), 1 USB (debug)
Audio Interface Handset microphone input (MICIN, MICIP pins), Handset earphone outputs (EARP, EARN pins).

SIM Interface:

Remote SIM 1.8/3-Volt SIM Capability

Environmental:

Compliant Operating Temp. -20 °C to 60 °C (Fully GSM Spec Compliant)
Operating Temperature -30 °C to 70 °C (Not fully GSM Spec Compliant)
Storage Temperature -40 °C to 85 °C
Humidity 5 to 95% non-condensing

EMC:

Emissions FCC Parts 15,22 & 24, Class B
3GPP TS 51010-1, Section 12.2
EN 55022 Class B

Operating Power (TYPICAL):

NOTE: UART disabled during testing; data average taken for 5 minutes; Vbat = 3.7V.

Function Block	State		Min Current	Average Current	Peak Current
MSP	Idle	2.2V	TBD	<2uA	22uA
		3.3V	TBD	<2.5uA	25uA
	Motion sensor on (no movement)	2.2V	TBD	<7uA	40uA
		3.3V	TBD	3.5uA	21.5uA
	Motion sensor with movement	2.2V	TBD	14uA	2250uA
		3.3V	TBD	25.5uA	3750uA
GSM only	Power on to modem register		TBD	TBD	TBD
	Idle		TBD	TBD	TBD
GPS only	GPS enable to first 3D fix - 130dbm (~45sec)		TBD	56.6mA	247.5mA
	Acquisition		TBD	76mA	80mA
	Tracking (@ -155dbm)		TBD	72mA	78mA
GSM & GPS	Shutdown		TBD	TBD	TBD
	Acquisition		TBD	TBD	TBD
	Tracking		TBD	TBD	TBD

Table 2: Typical Operating Power

GSM Transmit Power

1800/1900 MHz..... GSM Power Class 1 (30 dBm \pm 2 dB @ antenna connection)
850/900 MHz..... GSM Power Class 4 (33 dBm \pm 2 dB @ antenna connection)

GSM/GPRS Receiver Sensitivity (Typical)

1800/1900 MHz..... <-106 dBm, GPRS Coding Scheme 1 (CS1)
850/900 MHz..... <-106 dBm, GPRS Coding Scheme 1 (CS1)

4.5. General design guidelines for utilizing Enfora GSM modules

The following guidelines are provided in an effort to allow Enabler LPP G module users to successfully implement their PCB layout to obtain the best performance. This includes the lowest possible EMI emissions, maximum thermal conduction, mechanical integrity, and voice quality. The Enabler LPP G module is a very compact, high performance design, yet it is easy to interface into the final product. In order to realize its full potential, designers should pay close attention to ground structures, the routing of RF and Digital traces, and the size of the power supply lines.



These design tips are strictly guidelines and are not meant to be a complete list of items that guarantee actual performance. Each application is different and may require variation from these guidelines; however, care should be given to utilize these sound engineering principles whenever possible.

4.5.1. Advanced tips for an RF friendly layout

4.5.1.1. Ground Plane

To ensure the lowest possible EMI emissions and maximum thermal conductivity, it is recommended that all metal tabs on the GSM module shield must be soldered down onto a continuous ground plane that runs under the entire module. Ample ground vias should be provided to create a low impedance ground. It is recommended to minimize the number of I/O and power traces under the GSM module to allow for as much ground plane as possible. An example of a good ground structure and pad layout is shown below in Figure 1 - Example of good ground plane for GSM modules.

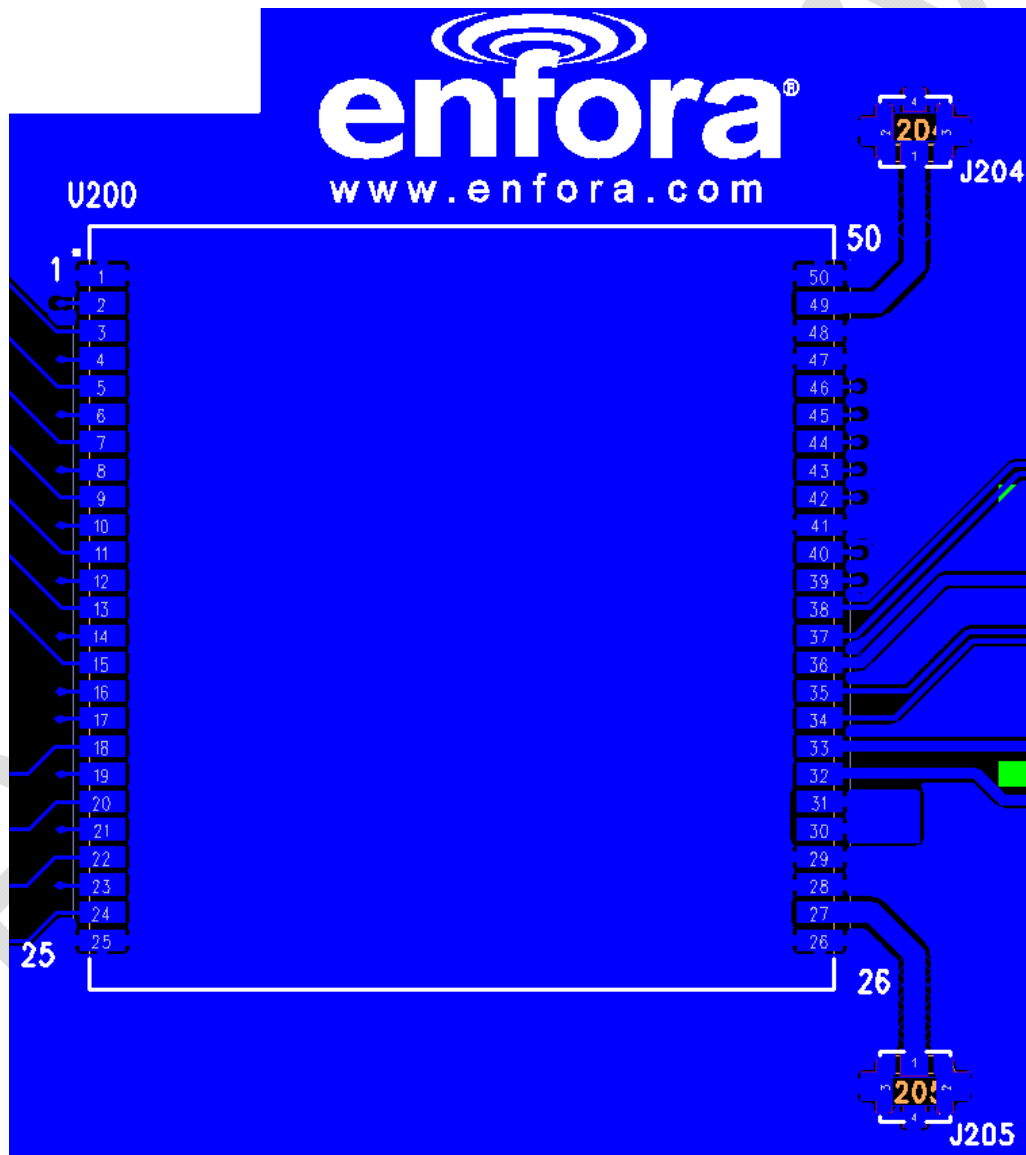


Figure 1 - Example of good ground plane for GSM modules

4.5.1.2. Thermal Relief

Because the ground plane acts as a large heat sink, it can affect the solderability of components. A common method to reduce this effect is to use thermal relief around the pad in question. However, great care must be taken when using thermal relief for high current or high frequency applications

For example, a large thermal relief like the one shown in Figure 2 can serve the purpose for general applications such as low current, low speed data lines, DC connections and audio frequency applications. However, such thermal relief structures should be avoided for applications where high current and/or high frequency is involved, such as those using the Enabler Module. Depending on the frequency of operation, the long narrow thermal relief traces between the pad and the ground plane act like an RF choke. These RF chokes become higher impedance at harmonics of the fundamental frequency making it problematic for high frequency suppression. This can make it difficult to pass type approval testing.

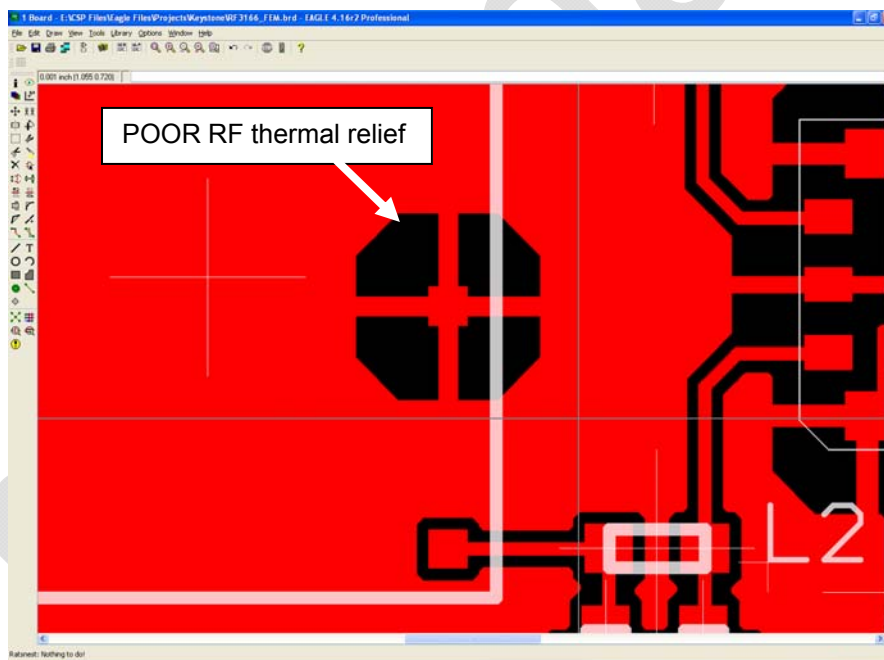


Figure 2 - Example of a POOR RF Thermal Relief

If thermal relief is necessary, it is recommended that you use short, fat traces similar to those shown in Figure 3. This will still provide a solderable connection, while providing a better RF connection. Making them shorter also allows for a more continuous ground plane due to less copper being removed from the area. It is also recommended to have ground vias around all thermal relief of critical ground pins.

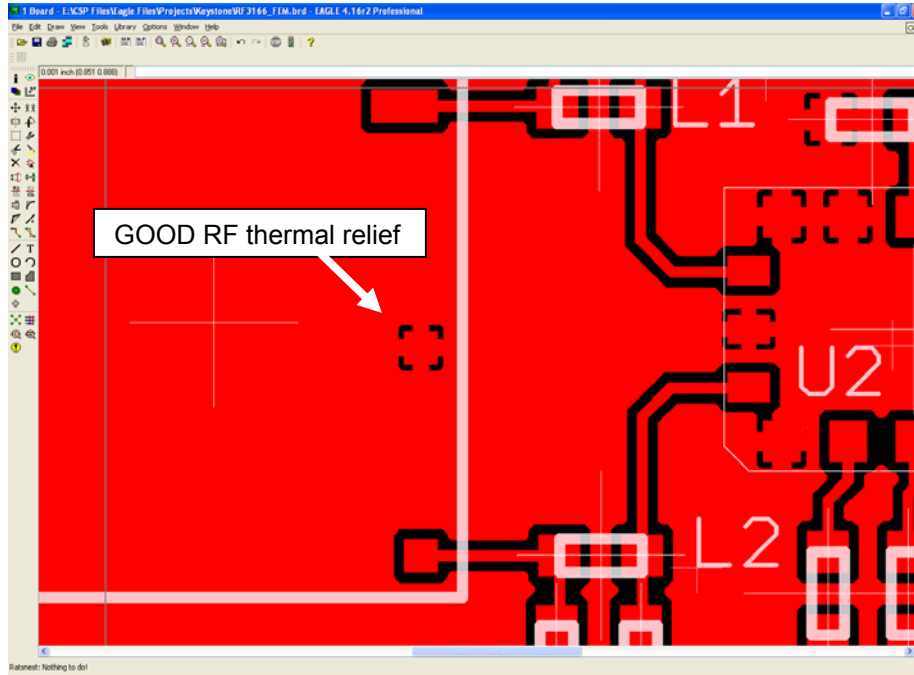


Figure 3 - Example of a GOOD RF Thermal Relief

4.5.1.3. Antenna and RF Signal Trace

The PCB trace that feeds the RF output port must be designed for a 50 ohm characteristic impedance, coplanar, or routed into internal layers to keep the top layer continuous around and underneath the Enabler module. Ample ground vias should be provided around the RF contacts, the RF trace and launch pad. If possible, keep I/O and power traces away from the RF port. This includes traces running parallel or orthogonal to it. Thermal relief should not be used on the antenna output port ground pads. The designer must pay close attention to the size of the pad and thickness of the dielectric beneath the signal pad and trace. Most PCB manufacturers can adjust the trace width to maintain 50 ohms impedance if the traces are identified and instructions are included on the FAB drawing. This service is typically provided at no or minimal additional cost.

For minimum RF emissions due to the fundamental frequency of operation, the Enabler module works best with an antenna load that has a VSWR of 1.5:1 or better. The antenna should not have gain at the harmonic frequencies, otherwise, the conducted harmonics could get amplified to a point where the product no longer passes type approval. However, for applications where antenna quality is less than ideal, it is recommended to have a low pass filter (Pi structure with N=3) in the RF path to the antenna. This is a secondary plan should there be a need to lower harmonic levels at frequencies above the PCS band. The pad structure may also be used to match the antenna load impedance, if required. If it is not needed, a capacitor of low reactance may be used to bridge the Pi structure.

The RF cable going between the Enable module and the antenna is very lossy, therefore, the length of this cable should be kept as short as possible.

4.5.1.4. Vbat Input

The Enabler Vbat input can have a relative high current draw that can fluctuate rapidly, especially when transmitting at max power and burst mode. The Vbat interface must be designed to provide the required instantaneous voltage and current with minimal voltage droop. This includes both sufficient bulk decoupling capacitance as well as adequate layout provisions.

Similar to the discussion on thermal relief, the use of narrow traces to connect the Vbat pins to the source voltage can act like a high impedance and cause a significant voltage droop when higher currents are required as shown in Figure 4. If the Vbat drops too low, the Enabler modules will reset. To minimize the trace loss, it is suggested to use a larger trace that spans several pins. The layout should provide sufficient trace width over the entire trace from the Enabler module all the way to the source of the Vbat voltage. Any transitions between layers for this trace should utilize multiple vias.

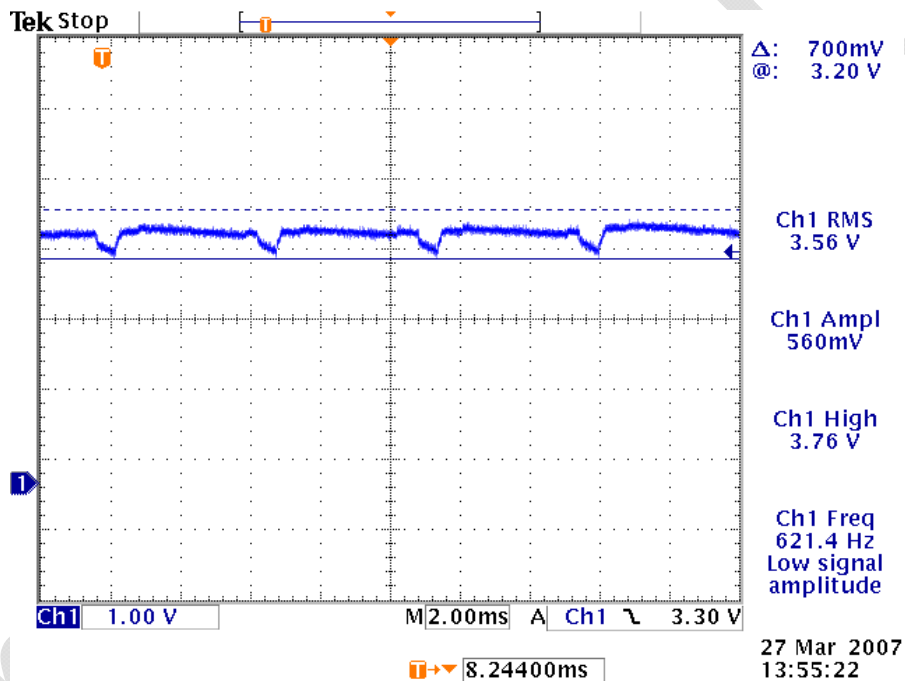


Figure 4 - Example of Vbat Voltage Droop

Two 470 uF, low ESR, tantalum capacitors are included in the design to provide decoupling of Vbat input voltage. Bulk decoupling capacitance is not required at the Vbat input external to the Enabler module.

4.5.2. Audio Reference Design

The audio quality is very dependent on the circuit design and layout. As an aid to obtaining good audio quality, a reference design has been included below. It has been proven to provide good performance on the SDK module.

4.5.2.1. Audio Schematics

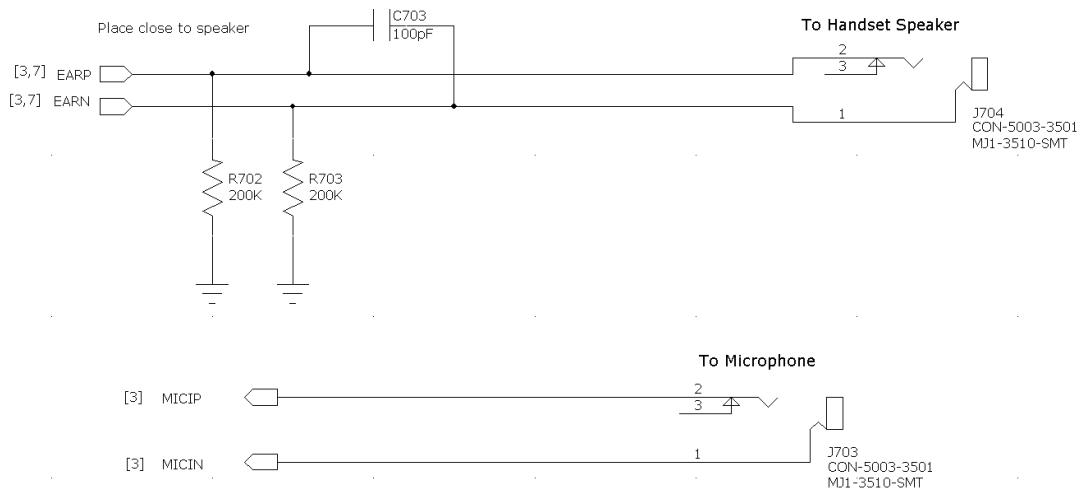


Figure 5 - Audio Reference Design Schematic

4.5.2.2. Audio Layout

Layout plots for the audio section of the SDK are available upon request.

4.6. Handling and Soldering Guidelines

The guidelines presented in IPC/JEDEC J-STD-020C for handling, preparation, and reflow of lead-free devices should be applied to the Enabler LPP G module. Care should be taken to minimize module moisture exposure before reflow. The module is classified as a Type 3 MSL (moisture sensitivity level).

Additional information forthcoming

5. Technical Specifications

5.1. Enabler LPP G Module Block Diagram

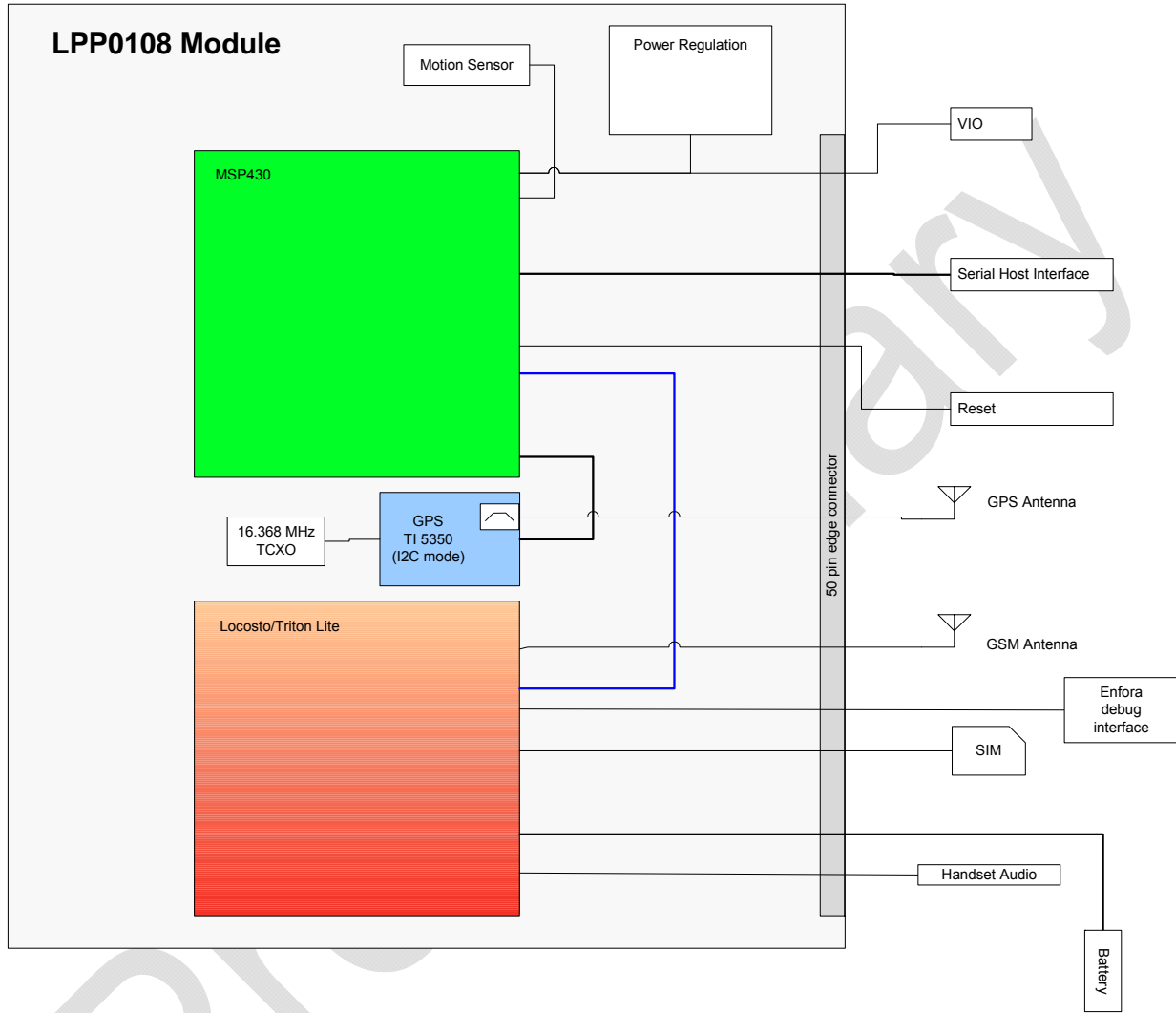


Figure 6 - Enabler LPP G Module Block Diagram

5.2. Detailed Product Specifications

Physical Dimensions and Weight	
Size (L x W x H)	38.5 mm x 33.6 mm x 4.19 mm
Weight	< 8.6 grams

Climatic: Operational	
GSM Compliant temperature Operating temperature	-20°C to +60°C -30°C to +70°C
Relative humidity	5 - 95%
Air pressure (altitude)	70 kPa to 106 kPa (-400 m to 3000 m)

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

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

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

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

Electromagnetic Emissions	
Radiated spurious	FCC Part 22 & 24 / Part 15 Class \ B 3GPP TS 51.010-1 Section 12.2 EN 55022 Class B

5.3. Operating Power

The Enfora Enabler LPP G module requires an input voltage of 3.3 Vdc to 4.5 Vdc.

5.3.1. Typical Input Current

Test Conditions:

- Typical Results @ 3.8V, 20 deg C, terminated into a 50Ω load.

GSM Operation		Input Current			
Band	Mode	Low	Nom/Avg	High/Peak	Units
1900	1 RX/1 TX, Full Power	21	240	1180	mA
1800		21	245	1280	mA
900		21	287	1600	mA
850		21	265	1600	mA
ALL	Idle		6.5		

GPRS Operation		Input Current			
Band	Mode	Low	Nom/Avg	High/Peak	Units
1900	4 RX/1TX, Full Power	15	269	1180	mA
	2 RX/2TX, Full Power	15	375	1180	mA
	1 RX/1TX, Full Power	15	227	1180	mA
1800	4 RX/1TX, Full Power	15	271	1280	mA
	2 RX/2TX, Full Power	15	381	1280	mA
	1 RX/1TX, Full Power	15	230	1280	mA
900	4 RX/1TX, Full Power	15	313	1600	mA
	2 RX/2TX, Full Power	15	473	1600	mA
	1 RX/1TX, Full Power	15	274	1600	mA
850	4 RX/1TX, Full Power	15	300	1600	mA
	2 RX/2TX, Full Power	15	455	1600	mA
	1 RX/1TX, Full Power	15	264	1600	mA
ALL	Idle		7.3		mA

5.3.2. GSM Transmit Power

Enfora Enabler LPP G module	Power Class	Transmit Power
1900 MHz 1800 MHz	GSM Power Class 1	1-W conducted power maximum (30 dBm +/- 2 dB), measured at the antenna port
850 MHz 900 MHz	GSM Power Class 4	2-W conducted power maximum (33 dBm +/- 2 dB), measured at the antenna port

5.3.3.GSM Receiver Sensitivity

Enfora Enabler LPP G module	Sensitivity	Mode
1900 MHz 1800 MHz	-106 dBm (typical)	GPRS Coding Scheme 1 (CS1)
900 MHz 850 MHz	-106 dBm (typical)	GPRS Coding Scheme 1 (CS1)

6. Physical Interfaces

(Dimensions are in millimeters.)

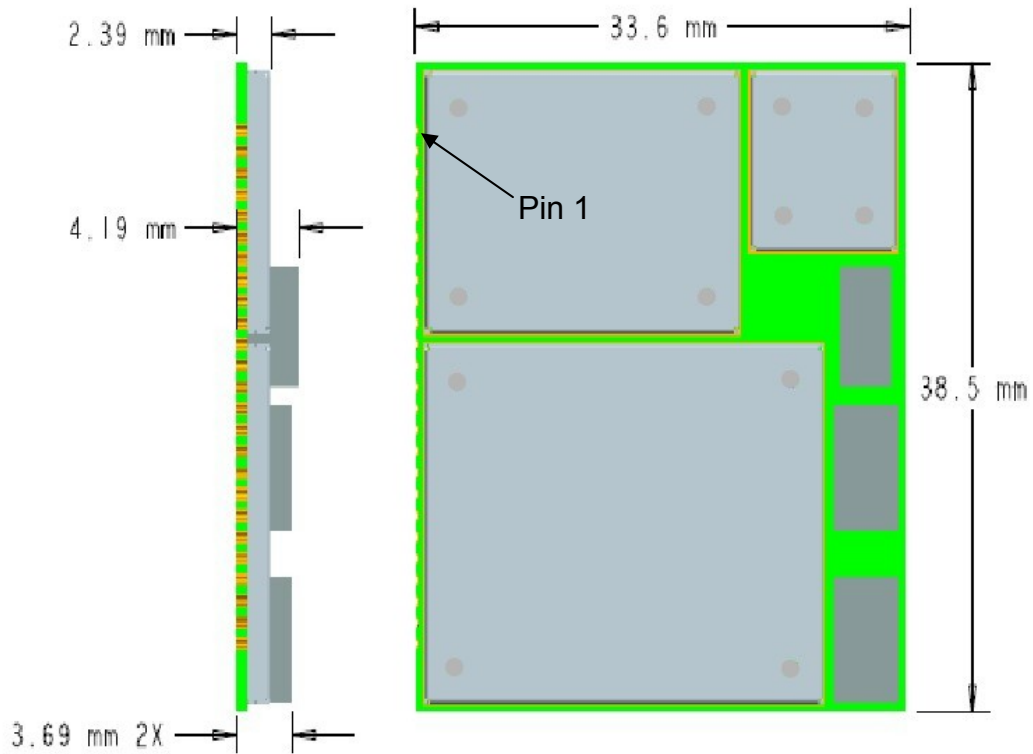


Figure 7 – Side and Front of Module with Pin 1 reference

6.1. Module Mounting to Host Board (Reference)

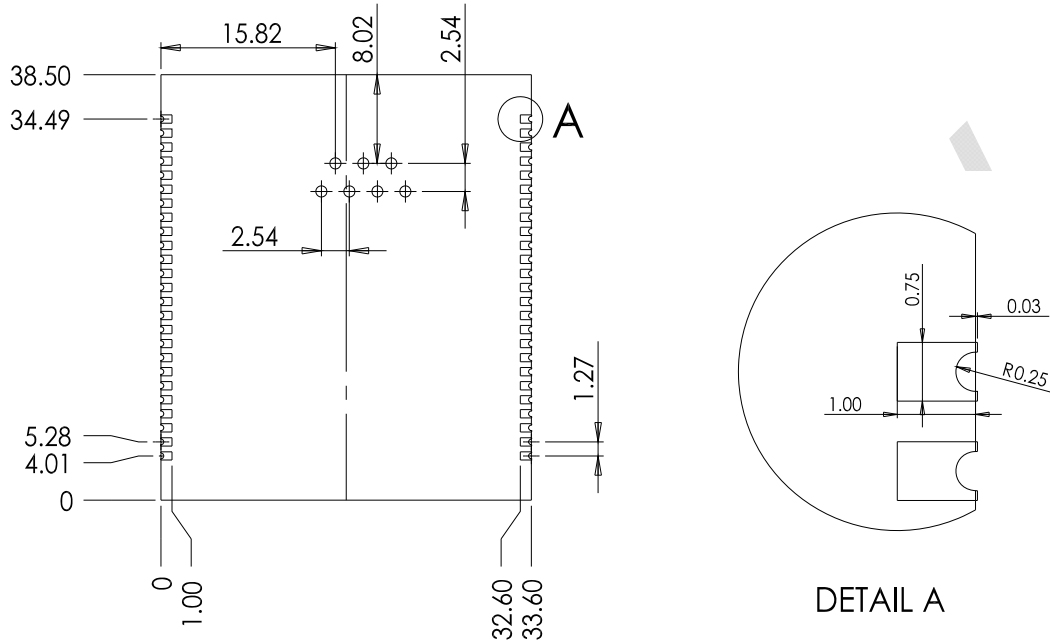


Figure 8 - Module Footprint

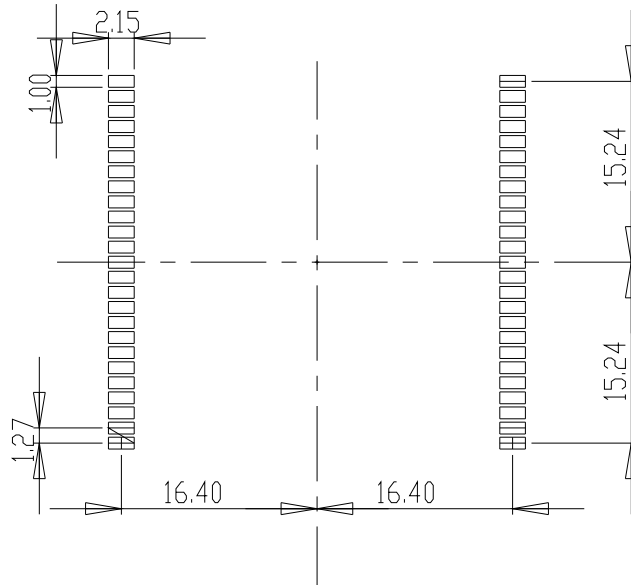


Figure 9 - Copper PADS (Recommended)

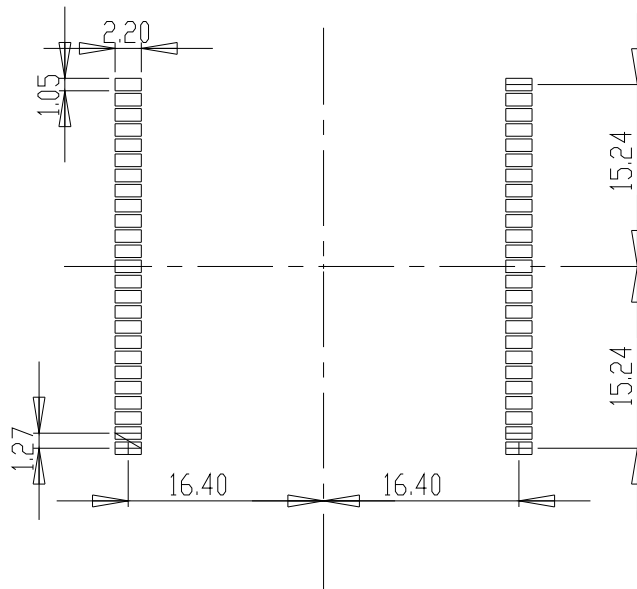


Figure 10 - Solder Mask (Recommended)

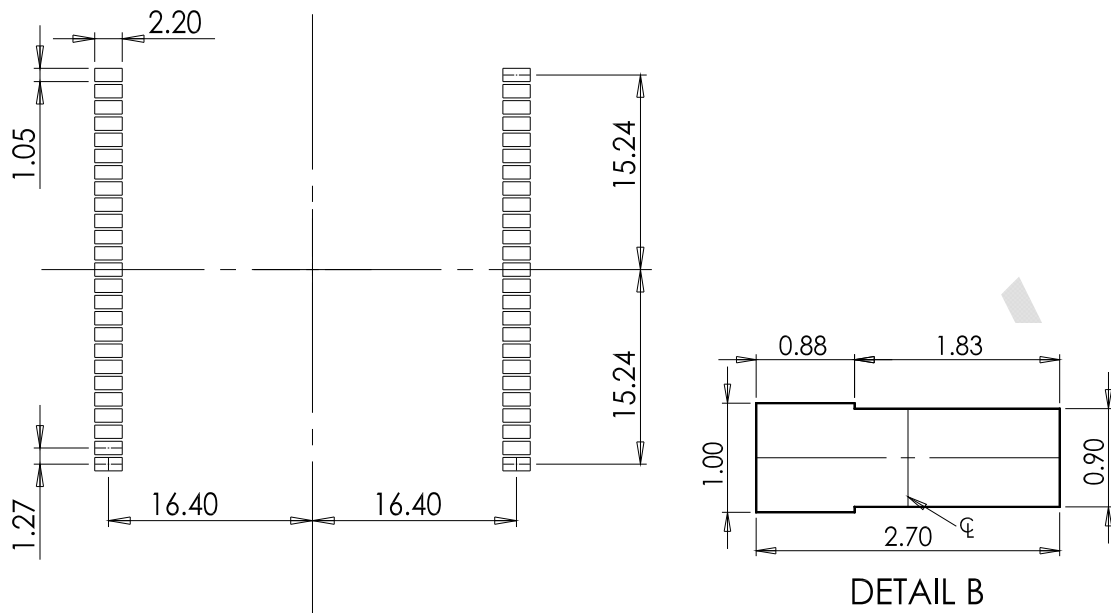


Figure 11 - Paste Mask (Reccomended) based on 0.004" stencil.

6.2. I/O Pin Assignments

The following table shows the pin assignments for the input/output connector.

Pin #	I/O	Enabler LPP G	Description/Comments (Default Function / Secondary Function)
1	P	GND	System Ground
2	R	BATT_TEMP	Battery Temperature Input
3	P	BATT_ID	Battery Identification Input
4	I	POWER ON/OFF	Power ON/OFF control Input
5	O	STATUS	Power ON/OFF status Output
6		Reserved	
7		Reserved	
8		Reserved	
9		Reserved	
10	I	GPI1	General Purpose INPUT 1
11	I	GPI2	General Purpose INPUT 2
12	O	GPO1	General Purpose OUTPUT 1
13	O	GPO2	General Purpose OUTPUT 2
14		Reserved	
15		Reserved	
16		Reserved	
17	O	MSP_UART_TX	UART Serial Data Output From Module
18	I	MSP_UART_RX	UART Serial Data Input To Module
19	O	GPS_TX	UART Serial Data Output (NMEA data only)
20		Reserved	
21		Reserved	
22		Reserved	
23		Reserved	
24	I	MSP_RESET	Reset Input
25	R	GND	System Ground
26	R	GND	System Ground
27	O	GSM_RF_ANT	GSM RF Output
28	R	GND	System Ground
29	R	GND	System Ground
30	P	VBAT_GSM	Power for GSM radio
31	P	VBAT	Power for non-GSM systems
32	PWR	VIN	Battery Charger input power supply
33	O	VIO	2.2 / 3.3 VDC Output
34	I/O	USB_D-	USB Data Bus (negative Terminal)
35	I/O	USB_D+	USB Data Bus (Positive Terminal)
36	I	USB_VBUS	USB Power Supply Line
37	O	EAR+	Earphone amplifier positive output
38	O	EAR-	Earphone amplifier negative output
39	I	MIC+	Microphone amplifier positive input (Handset)
40	I	MIC-	Microphone amplifier negative input (Handset)
41	R	GND	System Ground
42	O	SIM_RESET	SIM Card Reset
43	I/O	SIM_CLK	SIM Card Reference Clock
44	I/O	SIM_IO	SIM Card I/O Data
45	PWR	SIM_VDD	SIM Output Voltage 1.8 V / 2.85 V
46	I	SIM_DETECT	SIM Card Detect
47	R	GND	System Ground
48	R	GND	System Ground
49	O	GPS_RF_ANT	GPS RF Output
50	R	GND	System Ground

Table 3 - Enabler LPP G Pin Assignments

I = Input into Module
O = Output from Module

P = Power Input to Module
R = Power Return from Module

I/O = Input/Output to/from Module
PWR = Other Power

6.3. Circuit Protection

Other than very low level ESD protection within the module's integrated circuits, the module does not have any protection against ESD events or other excursions that exceed the specified operating parameters.

Generally, ESD protection (typically TVS/Transorb devices) should be added to all signals that leave the host board. This includes V_{BAT}/V_{CC} .

Series resistors (typically 47Ω) can also be added in series with data lines to limit the peak current during a voltage excursion.

NOTE: DO NOT ADD SERIES RESISTANCE TO THE SIM ELECTRICAL LINES.

Minimum ESD Protection Levels		ESD/Input Voltage	
Pin #'s	ESD Test Method	High/ Peak	Units
Pins 4-16, 17, 18, 19, 34, 35	Human Body Model EIA/JEDEC22-A114-A	500	V
	Charge Device Model EIA/JEDEC22-C101-A	200	V
Pins (all VBUS/PWR), 37, 38, 42, 43, 44, 46	Human Body Model EIA/JEDEC22-A114-A	2000	V
	Charge Device Model EIA/JEDEC22-C101-A	500	V
RF Antenna	IEC 61000-4-2	8000	V

Table 4: ESD Protection Levels



Caution – It is the Integrator's responsibility to protect the Enabler LPP G module from electrical disturbances and excursions, which exceed the specified operating parameters.

6.4. Power Button and Status LED

The power button is polled once per second. Once the power button press is detected, the signal is debounced using Timer A. The button must be held for three (3) seconds to deactivate the device. Once sufficient button press and hold occurs, the status LED is enabled for three (3) seconds. If the modem is on at the time of deactivation, the status LED on-time is extended until the modem turns off. Next the system enters LPM4 mode and the unit is deactivated.

The MSP exits LPM4 mode when the button is pressed again. The button signal is debounced again using Timer A. The button must be held for three (3) seconds to activate the device. If the button is not held long enough, the system re-enters LPM4. Once sufficient button press and hold occurs, the status LED blinks (four times per second) for three seconds. The system is now activated.

6.5. Antenna

The LPP0108 module has two RF antenna connections. One connection is for the GSM section of the module and the other for GPS. Please be sure to follow proper RF design practices when designing the antennas.

6.5.1. GSM

A GSM antenna should be designed from proper RF design practices.

6.5.2. GPS

The GPS_ANT is the RF connection from the GPS antenna; no external LNA is required. The LPP0108 can support both passive and active GPS antenna. However, external power supply and circuitry is required for an active GPS antenna. See Figure 12 - GPS Antenna Sample Schematic

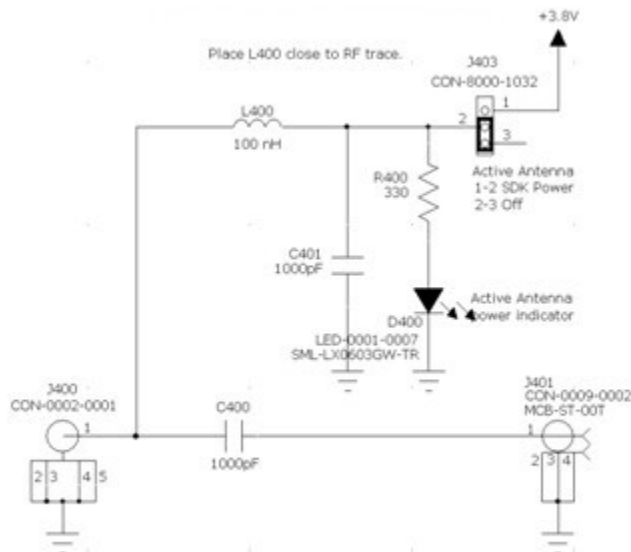


Figure 12 - GPS Antenna Sample Schematic

Active antenna is enabled by placing a jumper on J403 in the sample schematic between pins 1 and 2.

Passive antenna is enabled by placing a jumper on J403 in the sample schematic between pins 2 and 3.

Preliminary

6.6. Control Connector Signal Descriptions and Functions



Please note that the following descriptions are intended to provide hardware-level definitions. In some cases, specific lines will have no firmware functionality implemented. Information for each hardware-specific feature will be noted in the appropriate section.

6.6.1. Module Power (Pins 30, 31)

The Enfora Enabler LPP G module uses a single voltage source of $V_{CC}=+3.3V$ to $4.5V$. (The exact values of the uplink currents are shown in the tables in section 5.3.1.)

V_{BAT}	Parameter/Conditions	Min	Typ	Max	Units
Main Battery Supply	Voltage In Regulation	3.3		4.5	Vdc
Peak Current	970 μF (2 x 470 μF) on Host at Module Connector				mA

The uplink burst will cause strong ripple on the voltage lines and should be effectively filtered.

External capacitance is not typically required by low current or extended life applications. However, if capacitance is added, then current leakage of the capacitor needs to be taken into consideration for these types of applications.



It should be noted that the input voltage level should not drop below the minimum voltage rating under any circumstances, especially during the uplink burst period.

6.6.2. On/Off Signal (Pin 4)

The module may be set into a low power 'off' mode by pulling the pin low for a minimum of 3 seconds. This will shutdown any active functions including GPS and GSM, and stop the processor. This is the lowest power mode of the module, it can be ideally used when storing or shipping units and the controller is not to be enabled.

Once the module is in the 'off' state, it can be turned 'on' by holding the pin low for a minimum of 3 seconds. This will start the processor, once booted the controller will be enabled and run as per the saved settings.

The module will normally start in the 'on' state and enable the controller logic when power is applied.

6.6.3. On/Off Status (Pin 5)

When the On/Off pin is used to put the modem into an 'off' state or to turn it 'on', the status pin will indicate when it has successfully entered either state.

When turning off the unit, the status signal is set high after the On/Off signal is sufficiently held low (3 seconds). The status signal is held high for normally 3 seconds but can stay enabled for up to 5-6 seconds if the system is waiting for the GSM modem to shut down.

When turning on the unit, the status line blinks for 3 seconds at a frequency of 4Hz.

6.6.1. General Purpose Input Signals (Pins 10, 11)

Two input pins are available for input and are configured in conjunction with the event engine of the GSM modem. The voltage level of the signal must be in reference to the selected VIO voltage (Pin 33).

6.6.1. General Purpose Output Signals (Pins 12, 13)

Two input pins are available for output signals and are configured in conjunction with the event engine of the GSM modem.

The voltage level of the signal must be in reference to the selected VIO voltage (Pin 33).

6.6.2. Reset Signal (Pin 24)

The Reset signal is used to force the micro-controller to start at a known state. When the Reset is pulled low the micro-controller will immediately suspend any function and will not exit the reset state until the reset signal is released to be pulled high. Once the transition from low to high is complete, the micro-controller will boot. The Reset signal is falling edge triggered, so the reset function is set immediately when the signal is pulled low.

When using Reset, it will immediately lose the connection to the GSM network, this is not considered ideal. Typically during a normal shutdown, the module will issue a detach request to the network to indicate that it is being removed.

Parameter	Parameter/Conditions	Vcc	MIN	TYP	MAX	UNIT
V _{IL}	Input Voltage – Low or float	2.2V/3 V	V _{ss}		V _{ss} +0.6	Vdc
V _{IH}	Input Voltage – High	2.2V/3 V	0.8*V _{cc}		V _{cc}	Vdc
Reset Pulse Duration			2			μS

6.6.3.USB (Pins 34, 35, 36)

This is for Enfora Debug only

Pin Name	Pin Number	Signal Direction	Description
USB_VBUS	36	In	5 V tolerant power Supply VBUS line; Used only as a USB sense, not for powering the module. (optional connection)
USB_DP	35	Analog I/O	5 V tolerant data plus pin in USB
USB_DM	34	Analog I/O	5 V tolerant data minus pin in USB

5V Tolerant Transceiver

USB	Parameter/Conditions	Min	Typ	Max	Units
Input Voltage		4.4	4.65	5.25	V
Output voltage	High (Driven)	2.8	3.3	3.6	Vdc
	Low	0.0	0.1	0.3	Vdc
Transceiver D+/- Leakage Current		-2		2	μA

6.6.4. Serial Interfaces

6.6.4.1. Main Serial Interface (Pins 17, 18)

The pin naming for TX/RX is referenced as a DTE. The DTE device should match their input pins to the Enfora outputs and vice-versa.

9 way D Connector Pin Number	Signal	Signal Direction	Enfora Pin Number	Enfora Module Signal Direction
1	N/A			
2	Receive Data (RD)	from DCE	18	Input
3	Transmit Data (TD)	from DTE	17	Output
4	N/A			
5	Signal Ground	both		
6	N/A			
7	N/A			
8	N/A			
9	N/A			

The key features of the UART in the Enabler LPP G module mode are as follows:

- 16C550 compatibility
- Baud rate 115200 Kbits/s
- Data format:
 - Data bit: 8 bits
 - Parity bit: none
 - Stop bit: 1bit
 - Flow Control: None

6.6.4.2. GPS Serial Interface (Pin 19)

It is optional as to whether something should be connected to the RS232 GPS DEBUG OUT. If streaming NMEA messages are needed for external processing, above and beyond the NMEA sent to the server, then a serial cable can be connected between this serial connector and a PC. The baud rate is fixed at 19200.

9 way D Connector Pin Number	Signal	Enfora Pin Number	Enfora Module Signal Direction
1	N/A		
2	Transmit Data (TD)	19	Output
3	N/A		
4	N/A		
5	Signal Ground		
6	N/A		
7	N/A		
8	N/A		
9	N/A		

The key features of the UART in the Enabler LPP G module mode are as follows:

- Baud rate 19200 Kbits/s
- Data format:
 - Data bit: 8 bits
 - Parity bit: none
 - Stop bit: 1bit

6.6.5. Handset Microphone Input (Pins 39, 40)

The handset differential inputs MICIP and MICIN can be amplified by the differential handset microphone amplifier. This amplifier has a gain of 25.6 dB.

Handset Mic Input	Parameter/Conditions	Min	Typ	Max	Units
Maximum Input Range – Mic(+) to Mic(-)	Inputs 3 dBm0 (Max. digital sample amplitude when PGA gain set to 0 dB)			32.5	mV _{RMS}
Nominal Ref. Level – Mic(+) to Mic(-)	Differential MIC		-10		dBm0
Differential Input Resistance – Mic(+) to Mic(-)	Differential MIC, MICAMP gain = 25.6 dB (INMODE = 0001)		36		kΩ
Microphone Pre-Amplifier Gain	Differential MIC		25.6		dB

6.6.6. Handset Speaker Output (Pins 37, 38)

Pin Name	Pin Number	Signal Direction	Description
EARP	37	O	Earphone positive output
EARN	38	O	Earphone negative output

The earphone amplifier provides a full differential signal on the terminals EARP and EARN (Earphone).

Handset Spkr Output	Parameter/Conditions	Min	Typ	Max	Units
Maximum Differential Resistive Load	Output Swing 3.9 V _{PP}		120		Ω
	Output Swing 1.5 V _{PP}		33		Ω
Maximum Differential Capacitive Load				100	pF
Common Mode Minimum Resistive Load	At Internal Speaker (+) or (-)		200		kΩ
Common Mode Maximum Capacitive Load	At Internal Speaker (+) or (-)			50	pF
Amplifier Gain	EARG = 1		1		DB
	EARG = 0		-11		dB

Parameter	Test Conditions	Min	Typ	Max	Units
Earphone output swing at EARP-EARN	Distortion \leq 2% and 120 Ω , VSP input level = +3 dBm0, amp gain = -11 dB		0.98		V_{P-P}
	Distortion \leq 2% and 33 Ω , VSP input level = -5.34 dBm0, amp gain = -11 dB		0.38		
	Distortion \leq 2% and 120 Ω , I2S input level = +3 dBm0, amp gain = -11 dB		0.93		
	Distortion \leq 2% and 120 Ω , VSP input level = +3 dBm0, amp gain = 1 dB	3.1	3.92		
	Distortion \leq 2% and 33 Ω , VSP input level = -5.34 dBm0, amp gain = 1 dB	1.2	1.5		
	Distortion \leq 2% and 120 Ω , I2S input level = +3 dBm0, amp gain = 1 dB	2.96	3.7		
Earphone amplifier state in power down			High Z		
Earphone amplifier power supply rejection	1 kHz, 100 mVp-p		50		dB

An external audio amplifier should be used for loads of less than 16 Ω or if volume is inadequate.

6.7. Subscriber Identity Module (SIM) (Pins 42, 43, 44, 45, 46)

The SIM, an integral part of any GSM terminal device, is a "smart card" that is programmed with subscriber information:

- The user information consists of an International Mobile Subscriber Identity (IMSI) number, which is registered with the GSM provider, and an encryption Ki (pronounced "key"). This information consists of a microprocessor and memory installed on a plastic card.

Note: The SIM is not provided with the Enfora Enabler LPP G module. The SIM must be obtained from the GSM service provider and must be provisioned by the operator for data and/or voice. Always take care to protect the SIM: the GSM terminal will not operate without the SIM installed.

The SIM provides the IMSI for 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 SMS messages, storing the message for transmission until a radio link is available and buffering received messages until retrieved.

6.7.1. Using a Remote SIM with the Enfora Enabler LPP G Module (Pins 42, 43, 44, 45, 46)

The Enabler LPP G module does not include an on-board SIM carrier.

The module supports the use of 1.8 V and 3 V SIM cards. The module includes a hardware interface module dedicated to Universal Subscriber Identity Module (USIM). All baud-rates defined in ISO 7816-3 standard are supported for high-speed transmission.

- The integrator must provide a suitable SIM connector.
- The maximum distance from the module to the remote SIM connector must not exceed 25.4 cm (10 inches).
- It is recommended to have Zero resistance between the SIM connector and the module.
- External ESD Protection is Required;
 - 15 kV Air Discharge;
 - 8 kV Contact Discharge;

The transorb must have a low junction capacitance (typically < 10 pf) such as the following part:

Manufacturer: On Semi
Manufacturer PN: NSQA6V8AW5T2G

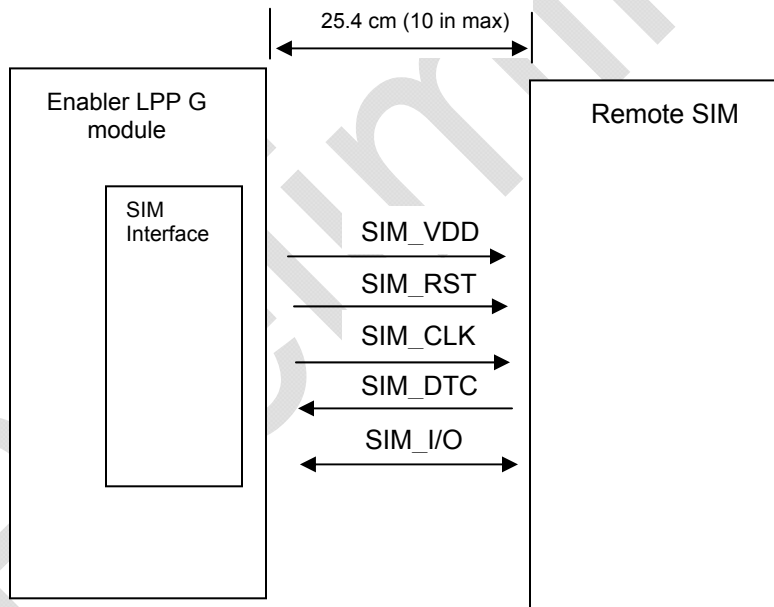


Figure 13 - Remote SIM Interface

Pin Name	Pin Number	Signal Direction	Description
SIM_VDD	45	O	SIM VDD
SIM_CLK	43	O	Card Reference Clock
SIM_RST	42	O	Card Reset
SIM_I/O	44	I/O	Card I/O Data
SIMDTC	46	I	Card detect

The module provides the regulated supply voltage for the SIM-card and the circuitry to detect the insertion or extraction of the SIM-Card in or from the mobile.

The SIMDTC is disabled by default (see AT\$SIMDTC in the EIII AT Command Manual for settings). When enabled, the SIMDTC pin has an internal pull up to Vcc and can be configured to detect a SIM insertion when the SIMDTC is either pulled to ground or left floating.

It can be configured to detect either just a SIM removal or both removal and insertion.

When the module detects a SIM removal, it will de-register from the network. When the module is configured to and detects a SIM insertion, it will reset the module and re-register on the network.

The SIM-card presence detection logic is active even when the system is in idle mode.

USIM	Parameter/Conditions	Min	Typ	Max	Units
VDD	SIM VDD voltage	1.8V	1.8	1.96	V
		3.3V	2.7	2.85	2.95
VIH	High level input voltage	1.15			V
VIL	Low level input voltage			0.61	V
VOH	High level output voltage, IO = 4 mA	Vdd-0.45			V
VOL	Low level output voltage, IO = 1 mA			0.4	V
Ii	Input leakage current			±1	µA
Iout	Output current		4		mA
PU	PU resistance		32		kΩ
PD	PD resistance		30		kΩ
Iz	Leakage current			± 30	µA
Card Detect	Debouncing time (SIM-card insertion)		0.5		mS
	Debouncing time (SIM-card extraction)		15		mS
	Pull-up resistor (resistor + resistive switch)		475		kΩ

6.7.1.1. Remote SIM Component Information

Any compatible SIM carrier can be used in conjunction with the Enabler LPP G module. For example:

Lumberg P/N 8840_A_21.

or

Suyin P/N: 254016MA006G103ZL

7. Battery Charging Calibration and Configuration

7.1. Objective

The objective of this document is to outline how to configure the Enabler LPP G based battery charger for specific batteries and chargers.

7.2. Supported Devices

- Enabler LPP G

7.3. References

- LPM0108AT001- Enabler LPP G AT Command Set

7.4. List of battery charging commands

The following is a list of Locosto/Triton-Lite battery charger AT commands, and who is responsible for setting their parameters.

Enfora should set the default parameters so the overall charging scheme will work “out-of-the-box”. However, it is the customer’s responsibility to configure the charging scheme to conform to their particular battery(-ies) and charger(-s).

Command	Information	Calibrated by Enfora	Calibrated by Customer	Set by Enfora	Set by Customer
AT\$BAT	X				
AT\$BCIDBG	X				
AT\$BCIMNI	X				
AT\$BCIN4A	X (internal only)				
AT\$BCIVSF		X	Opt.		
AT\$BCIISF		X			
AT\$BCIAVG				X	Opt.
AT\$BCIMAP# (1,2,3,4,5)				X	X
AT\$BCIPCT# (1,2,3,4,5)				X	Opt.
AT\$BCICHG# (1,2,3,4,5)					X
AT\$BCIBAT# (1,2,3,4,5)					X
AT\$BCITMP# (1,2,3,4,5)					X
AT\$BCIDEL					X
AT\$BCIOFF					X

7.4.1. Setting BCIVSF parameters

BCIVSF sets the scaling factor so the battery voltage reported by the Triton-Lite matches the real battery voltage on the Vbat pin. This one-time calibration should be done at module production.

7.4.2. Equipment required

- Programmable power supply with <10mV resolution and voltage sense lines.
- A notebook or desktop computer with any version of Microsoft Windows that has the HyperTerminal communications program. If this hardware is not available, the user could use a DOS terminal emulation program.

7.4.3. Procedure

This procedure assumes an appropriate test fixture is used.

1. Disconnect battery (if connected), and connect power supply to Vbat test point.
2. Perform the following procedure:

	Action	Command	Power supply	Calculation
1	Set power supply		On, Voltage = 3700mV	
2	Establish serial communications with device			
3	Fill in default values. This reads in the parameters without changing their values.	AT\$BCIAVG=, AT\$BCIVSF=, AT\$BCIISF=,		
4	Set voltage averaging to 0. Note original value for later.	AT\$BCIAVG= 0 ,5,10,10000		
5	Preset voltage scaling to <num>=1700 and <offset>=0.	AT\$BCIVSF = 1700,0		
6	Disable charging.	AT\$BCIOFF= 1		
7	Ensure State=3(SUP).	AT\$BCIDBG= 2,0		
8	Read Vbat (mV) after trace update.	Vbat(mV)= xxxx		
9	Calculate <new_num>			<new_num> = 1700*3700 / Vbat(mV)
10	Set voltage scaling factor	AT\$BCIVSF = <new_num>,0		
11	Verify results after trace update.			Vbat(mV)=3700 +/-10mV
12	Restore settings	AT\$BCIAVG= <previous> ,5,10,10000 AT\$BCIOFF= 0 AT\$BCIDBG= 0,0	Off	

Note: The values that are red indicate the values that will need to be set.

7.4.4. Setting BCISF Parameters

The charging current calibration requires measuring the current at 2 levels and determining the `adc_num` and `adc_offset` based on the physical currents (I_{phy}) and reported charging currents ($I_{chg_avg_mA}$). Two points are required to get accurate calibrations at both the high and low current levels.

7.4.5. Scope

This calibration does not need to be done as part of a factory level production test on every device, default values can be used to get ballpark readings. Customer level calibration is required if the battery charge current and end-of-charge current are critical.

7.4.6.2 Equipment required

1. Battery simulator, or mostly discharged battery.
2. Power supply with capability to measure current, 5-12V, 1A, to emulate wall charger. Agilent
3. A notebook or desktop computer with any version of Microsoft Windows that has the HyperTerminal communications program. If this hardware is not available, the user could use a DOS terminal emulation program.

7.4.7.6.3 Calibration procedure

Step	Action	Command	Power supply	Calculation
1	Turn off automatic registration	AT+CFUN=0 AT\$AREG=0	$V_{PS}=3.700V$ $V_{BATSIM}=5.000V$	
2	Normalize slope and offset.	AT\$BCIISF=800,0		
3	Set voltage averaging to 0. Note original value for later.	AT\$BCIAVG=5,5,0,10000		
4	Verify charging state 4(LCI) and charger #.	AT\$BAT= 40,1,#,4,3956,839 Note: # must be 2,3,4, or 5. Assumed 2 for the remainder of this procedure		
5	Set charging current, low	AT\$BCICHG2= 1,32,7450,4725,5725 ^{3,4}		
6	Cycle charging so charge current will take effect.	AT\$BCIOFF=1 AT\$BCIOFF=0		
7	Measure power supply current		Read I_{BATSIM} current.	I_{phy1}
8	Record reported I_{chg} , after update.	AT\$BAT= 40,1,2,4,3956,< I_{chg1} >		I_{chg1}
9	Set charging current, high	AT\$BCICHG2= 1,250,6050,4725,5725 ^{3,4}		
10	Cycle	AT\$BCIOFF=1		

	charging so charge current will take effect.	AT\$BCIOFF=0		
11	Measure power supply current		Read I _{BATSIM} current.	Iphy2
12	Record reported Ichg, after update.	AT\$BAT= 40,1,2,4,3956, <Ichg2>		Ichg2
13	Calculate <adc_num>, <adc_offset>			Note 1 Note 2
14	Set scaling factors	AT\$BCIISF=<adc_num>, <adc_offset>		
15	Verify results.	AT\$BCICHG2= 1,32,6050,4725,5725		
		AT\$BCIOFF=1, AT\$BCIOFF=0		
		AT\$BAT= 40,1,2,4,3956, <Ichg1>	Read I _{BATSIM} current.	Iphy1=Ichg1
16	Verify results.	AT\$BCICHG2= 1,250,6050,4725,5725		
		AT\$BCIOFF=1, AT\$BCIOFF=0		
		AT\$BAT= 40,1,2,4,3956, <Ichg2>	Read I _{BATSIM} current.	Iphy2=Ichg2
17	Set final value	AT\$BCICHG2= 1,x,6050,4725,5725		
18	Restore settings	AT\$BCIAVG=x,x, <previous> AT+CFUN=1 AT\$AREG=1 AT\$RESET		

Notes:

1. $\langle adc_num \rangle = \frac{(I_{phy1} - I_{phy2}) \cdot 800}{(I_{chg1} - I_{chg2})}$
2. $\langle adc_offset \rangle = I_{phy1} - \frac{\langle adc_num \rangle}{800} \cdot I_{chg1}$
3. The strategy for production level calibration is to set an arbitrary low and high charge currents that will optimize accurate Ichg readings in most charging applications.
4. The strategy for customers in setting the low and high charging currents is to calibrate at the two most important points in the charge process, <ci_chgireg> and <I_{EOC}>, thus ensuring the state transitions are accurate. <ci_chgireg> and <I_{EOC}> are determined once as a system-level design. <ci_chgireg> = [0 to 255] such that the Ichg = Isys + 1*C (800mA max.). <I_{EOC}> = Isys + C/20. For example, if the battery capacity is 1980mAh and the system current is 50mA, Ichg = 50+1980 = 2030mA => 800mA. <chgireg1>=255. <I_{EOC}> = Isys + C/20 = 50+1980/20 = 149mA.

Note: In the above example you will receive 2030mA as the answer. The physical limitation is 800mA.

7.5. Setting BCI AVG parameters

Averaging of the voltage, temperature, and current readings is used to reduce noise or spikes that could otherwise trigger ill-timed state changes or inaccurate readings. It is up to the user's comfort level what values should be set. Setting any $\alpha=0$ may give readings that are too noisy, especially in the case of current readings. Setting α to a very large number will cause state transitions to occur later than desired while the averaging "catches-up".

7.6. Setting BCIMAP# parameters

The BCIMAP# command sets the maps battery voltage and charge current to battery capacity while the battery is charging. Each battery n may be given a unique BCIMAP n , depending on the battery ID (if required). Battery capacity is reported as a percentage in 10% steps, no interpolation is given.

When the battery is not charging, BCIPCT# maps battery voltage to battery capacity.

7.6.1. Scope

Default values are intended to be sufficient for general-purpose applications. However, if the battery capacity mapping needs adjustment for per customer specification, this procedure is one empirical approach to determining new values.

Production-level calibration not required.

7.6.2. Procedure

The following summary outlines a procedure that requires one complete battery charge and discharge to determine the battery capacity mappings.

- Choose the BCIMAP# index.
- Set the desired CI charge current <ci_chgireg> for the designated charger.
- Determine the BCIMAP# values up to the <#_ci_elements>.
- Determine the BCIPCT# that corresponds to the BCIMAP index.
- Calculate the BCIMAP# values for the parameters above the index.
- Discharge the battery, determine the remaining BCIPCT# parameters.
- Repeat for each battery and charger.

7.6.3. Choose the BCIMAP# index

Select a BCIMAP# index, <#_ci_elements>, that gives good resolution of capacities in the CI and CV stages of the charge cycle. If the index is too low, the CI stage will have fewer, disproportionately large capacity steps, and the CV stage will have more, smaller capacity steps. If the index is too high, the CI stage will have more, disproportionately small capacity steps, and the CV stage will have fewer, larger capacity steps. From empirical analysis,

$$\langle \#_ci_elements \rangle = 7 \pm 1$$

is a good balance giving proportional intervals between the capacity steps in both the CI and CV stages.

7.6.4. Set the desired CI charge current for the designated charger.

Determining the charge current for the constant-current charging stage now will make the BCIMAP# <%> parameters more accurate. Typical limiting values are listed in the following table:

Charger	Max. charge current	<ci_chgireg> [0-255]
USB charger	500mA	160
Wall charger	Limited by Triton-Lite maximum	255
Triton-Lite	800mA	255
Customer charger	X	Calculate ¹

Note: <ci_chgireg> = [0.22 * (CI + ISYS) * 10 + 0] * 255 / 1750.
Max value is 255.

Determine the charger # and <ci_chgireg> for that charger.

Charger 1=BCICHG1 is dedicated for USB charging.

Chargers 2-5=BCICHG(2-5) are for any general purpose charger. Set with:

AT\$BCICHG#=<type>,<ci_chgireg>,<ov_thr>,<id_low>,<id_high>

Reset or cycle charging with AT\$BCIOFF to make new <ci_chgireg> take effect.

Example:

Suppose it is desired to have a USB charge at 100mA when it is the charging source and a wall charger charge at 800mA when it is the charging source. The system nominal current Isys=50mA.

<ci_chgireg1> = [0.22 * (100 + 50) * 10 + 0] * 255 / 1750 = 48

<ci_chgireg2> = [0.22 * (800 + 50) * 10 + 0] * 255 / 1750 = 272 => 255

AT\$BCICHG1=<type>,48,<ov_thr>,<id_low>,<id_high>

AT\$BCICHG2=<type>,255,<ov_thr>,<id_low>,<id_high>

7.6.5. Charge empty battery in constant current with target <ci_chgireg>.

Up to 5 different batteries can be independently defined with capacities using the BCIMAP# and BCIPCT#.

1. Completely discharge the battery *n* that will be associated with the BCIMAP*n* and BCIPCT*n*.
2. Plug in a charger.
3. When Vbat=3.2V, the Locosto powers on and the modem enumerates a port through USB. Start logging a text file while the charge state is still precharge 1(PRE).
4. Type the following commands:

Command	Detail
AT\$BCIDBG=2,0	Start debug traces
AT\$STOATEV=10,AT\$BCIOFF=1 AT\$STOATEV=11,AT\$BCIDBG=2,0 AT\$EVENT=10,0,85,6,6 AT\$EVENT=10,3,44,10,0 AT\$EVENT=10,3,44,11,0	Script to stop charging and report Vbat when the CI-CV transition occurs.

5. Let the battery charge to the CI-CV transition and stop charging.
6. Stop the log file.

7.6.6. Note the first Vbat(mA) that occurred after the charge stopped and went to 3(SUP).

Parameter	Value (mV)
Vbat(mA)_at transition	

Note the start and stop times of State 4(CCI). Calculate the time interval given the <#_ci_elements> chosen earlier:

Parameter	Value (hh:mm:ss)
T _{CI START}	
T _{CI STOP}	
Calculation	Value (sec)
(T _{CI STOP} - T _{CI START})/<#_ci_elements>	T _{STEP}

Determine the BCIMAP_n percentage parameters from the log file at the calculated times, given the interval T_{STEP}:

BCIMAP _n Parameter ¹	Time (hh:mm:ss) ¹	Vbat (mV) ¹
<10%>	T _{CI START} + 1* T _{STEP} =	
<20%>	T _{CI START} + 2* T _{STEP} =	
<30%>	T _{CI START} + 3* T _{STEP} =	
<40%>	T _{CI START} + 4* T _{STEP} =	
<50%>	T _{CI START} + 5* T _{STEP} =	
<60%>	T _{CI START} + 6* T _{STEP} =	
<70%>	T _{CI START} + 7* T _{STEP} =	4200 ²

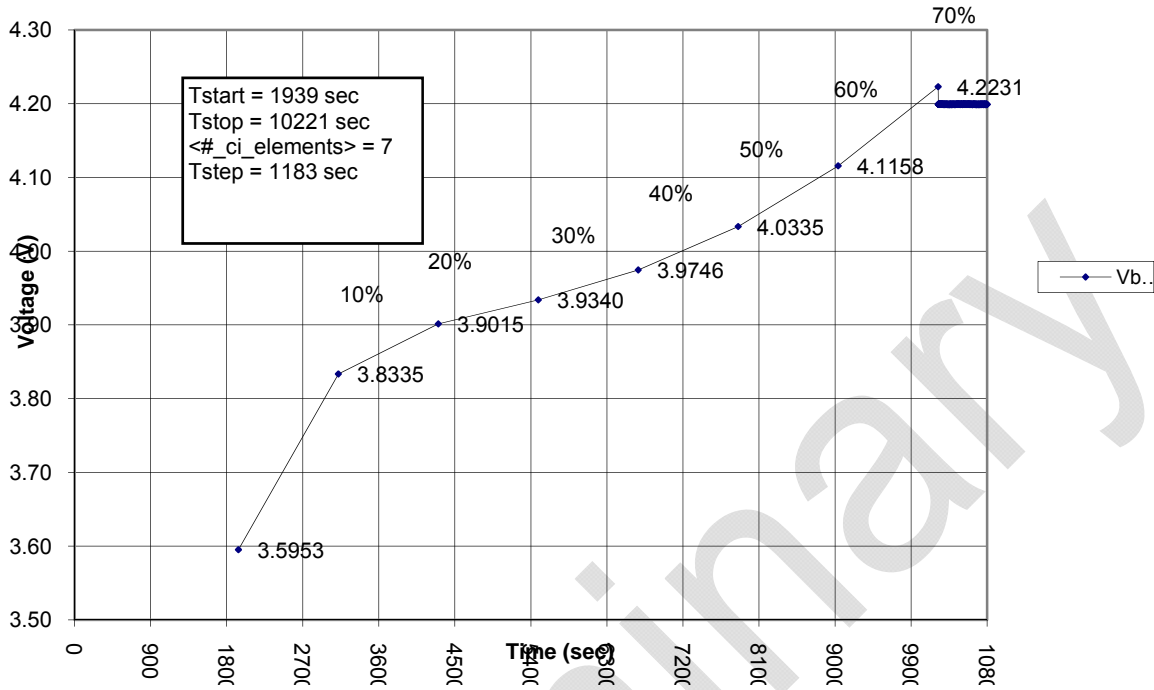
Note: Assuming the <#_ci_elements>=7. Customer may choose different value from section 7.6.3 above, and will have to adjust this table accordingly.

Note: End of CI charge should always be 4200mV for Li-Ion batteries.

Example:

The following graph shows what the resulting battery charge profile looks like, with the BCIMAP capacity percentages determined from Vbat in the log file.

**Battery Charge
Constant Current Stage 4(CCI)**



7.6.7. Calculate the BCIMAP# values for the parameters above the index.

The remaining parameters are capacities determined from the Ichg current, since the battery voltage is fixed at 4.200V and is no longer an indication of capacity.

BCIMAP# Parameter ¹	Calculation	Ichg (mA) ¹
<80%>	$[(CI - I_{EOC}) * 2/3] + I_{sys}^2$	
<90%>	$[(CI - I_{EOC}) * 1/3] + I_{sys}^2$	
<100%>	$I_{sys} + C/20 =$	

Note: Assuming the <#_ci_elements>=7. Customer may choose different value from 8.2.1 above, and will have to adjust this table accordingly.

Note: Linear interpolation will introduce a slight error in the capacity.

7.6.8. Discharge the battery, determine the remaining BCIPCT# parameters.

Determination of BCIPCT:

1. Start with a fully charged battery.
2. Monitor battery voltage over the full discharge cycle. This can done in-circuit or with a load. In-circuit is preferred because it will give a better representation of the CI-CV transition point, and the data can be logged to a text file. Discharging through a load will require a data-logger to record the discharge voltage, and may not give a clear indication of the CI-CV transition.
3. Note the start and stop times of State 4(CCI). Calculate the time interval given the <#_ci_elements> chosen earlier:

Parameter	Value (hh:mm:ss)
T _{DIS START}	
T _{DIS 70%}	
T _{DIS STOP (when Vbat=3200mV)}	
Calculation	Value (sec)
$(T_{DIS STOP} - T_{DIS 70\%}) / \langle \#_ci_elements \rangle$	T _{STEP LOW}
$(T_{DIS 70\%} - T_{DIS START}) / (10 - \langle \#_ci_elements \rangle)$	T _{STEP HIGH}

4. Determine the BCIPCT_n percentage parameters from the logged data.

BCIPCT _n Parameter ¹	Time (hh:mm:ss) ¹	Vbat (mV) ¹
<100%>	T _{DIS START}	
<90%>	T _{DIS START} + 1 * T _{STEP HIGH} =	
<80%>	T _{DIS START} + 2 * T _{STEP HIGH} =	
<70%> ¹		Vbat(mA)_at transition
<60%>	T _{DIS 70%} + 1 * T _{STEP LOW} =	
<50%>	T _{DIS 70%} + 2 * T _{STEP LOW} =	
<40%>	T _{DIS 70%} + 3 * T _{STEP LOW} =	
<30%>	T _{DIS 70%} + 4 * T _{STEP LOW} =	
<20%>	T _{DIS 70%} + 5 * T _{STEP LOW} =	
<10%>	T _{DIS 70%} + 6 * T _{STEP LOW} =	

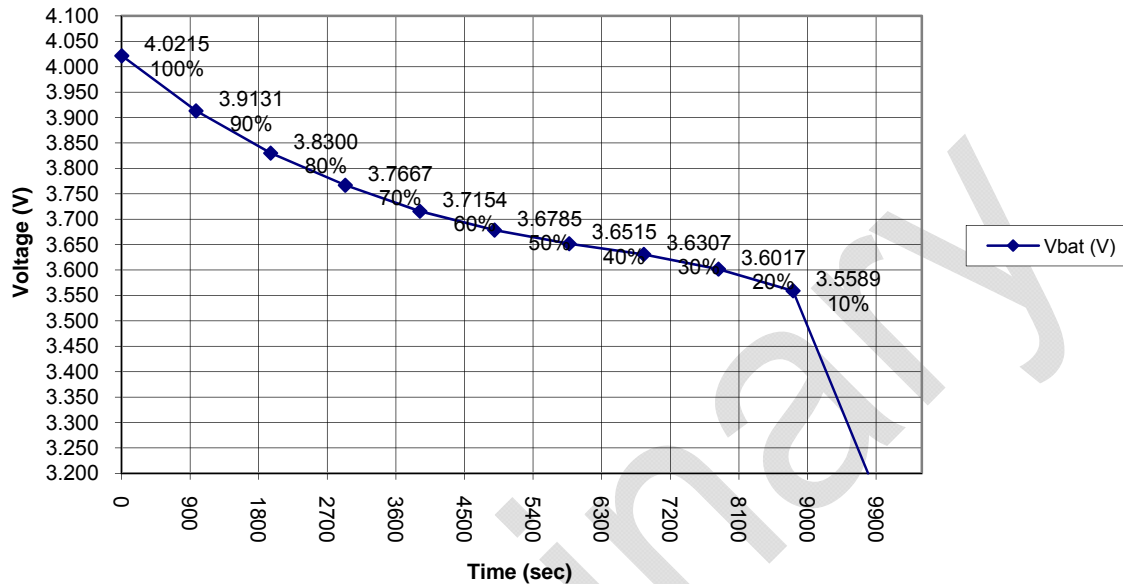
Note: Assuming the $\langle \#_ci_elements \rangle = 7$. Customer may choose different value from section 7.6.3 above, and will have to adjust this table accordingly.

5. Set AT\$BCIPCT5= <10%>, <20%>, <30%>, <40%>, <50%>, <60%>, <70%>, <80%>, <90%>, <100%>

Example:

The following graph shows what the resulting battery discharge profile looks like discharging through a constant load. BCIPCT capacity percentages determined from Vbat readings spaced equally in time.

Battery Discharge
w/constant load
Determination of BCIPCT# parameters



Repeat for each battery (if multiple batteries of different capacities are to be used in the design).

7.7. Setting BCIBAT# parameters

7.7.1. Procedure to set the battery ID

1. Choose the bat_ID resistor (ohms) = RID from a table that maps battery capacity range to a resistance.
2. Calculate the expected ADC reading. $ADC4 = RID \cdot 0.01 \cdot 1023 / 1750$.
3. Calculate $\langle id_low \rangle = (1023 / 1837.5) \times (0.99 \times RID) \times 0.008 - 2$; 0 if none
4. Calculate $\langle id_high \rangle = (1023 / 1662.5) \times (1.01 \times RID) \times 0.012 + 2$; 1023 if none
5. Enter AT\$BCIBAT#: $\langle \rangle, \langle \rangle, \langle \rangle, \langle \rangle, \langle \rangle, \langle \rangle, \langle id_low \rangle, \langle id_high \rangle$.
6. Enter AT\$RESET: Reset the device, so changed parameters will take effect.
7. Read AT\$BAT $\langle \rangle, \langle bat_id \rangle$.
8. Verify bat_id = # of the BCIBAT# corresponding to the range: $\langle id_low \rangle - \langle id_high \rangle$.

7.8. Setting BCITMP# parameters

7.8.1. Scope

Setting the BCITMP# parameters needs to be done by the customer, for each battery with a thermistor installed. If no thermistor is installed in a battery, set all nine adc parameters to 0.

AT\$BCITMP#=-20,60,0,0,0,0,0,0,0,30

This is a one-time system level design, no factory-level production test or calibration is required.

7.8.2. Equipment required

- Temperature chamber
- Mostly discharged battery or battery simulator.
- A notebook or desktop computer with any version of Microsoft Windows that has the HyperTerminal communications program. If this hardware is not available, the user could use a DOS terminal emulation program.

7.8.3. Procedure

This is a procedure for setting the AT\$BCITMP# parameters, assuming a 10kohm NTC temperature sense resistor is used.

Step	Action	Command	Equip. Setting	Calculation
1	Set temperature averaging.	AT\$BCIAVG=<alfaV>,0,<alfa>,<sampling> (Note original value for later.)		
2	Set current to 30uA	AT\$BCITMP#=-20,60,x,x,x,x,x,x,x,x,x,x,30		
3	Reset the modem	AT\$RESET		
4	Start debug traces	AT\$BCIDBG=2,0.		
5	Cycle charger off, on.	AT\$BCIOFF=1, AT\$BCIOFF=0		
6	Ensure battery is charging	4(CCI) mode or 6(CVI) mode	V _{BAT} < 4.2V	
7	Set temp. (Note: This Tbat is a hex value (Tbat) ₁₆).	Read Tbat=xxxx	T _{CH} =-20C	<adc@-20> = (Tbat) ₁₀
			T _{CH} =-10C	<adc@-10> = (Tbat) ₁₀
			T _{CH} =0C	<adc@0> = (Tbat) ₁₀
			T _{CH} =10C	<adc@+10> = (Tbat) ₁₀
			T _{CH} =20C	<adc@+20> = (Tbat) ₁₀
			T _{CH} =30C	<adc@+30> = (Tbat) ₁₀
			T _{CH} =40C	<adc@+40> = (Tbat) ₁₀
			T _{CH} =50C	<adc@+50> = (Tbat) ₁₀
			T _{CH} =60C	<adc@+60> = (Tbat) ₁₀
8	Set temperature parameters	AT\$BCITMP#=-20,60,<adc@-20>,<adc@-10>,<adc@0>,<adc@+10>,<adc@+20>,<adc@+30>,<adc@+40>,<adc@+50>,<adc@+60>,30		
9	Restore averaging	AT\$BCIAVG=<alfaV>,<alfaT>,<alfa>,<sampling>		
10	Reset the modem	AT\$RESET		
11	Verify temperature readings	AT\$BAT=<pct>,<bat_id>,<chg_id>,<state>,<Vbat>,<lchg>,<Tbat> (Note: This Tbat is a decimal value (Tbat) ₁₀).	T _{CH} =-20C	Tbat = T _{CH} +/- 5C
			T _{CH} =25C	Tbat = T _{CH} +/- 5C
			T _{CH} =60C	Tbat = T _{CH} +/- 5C

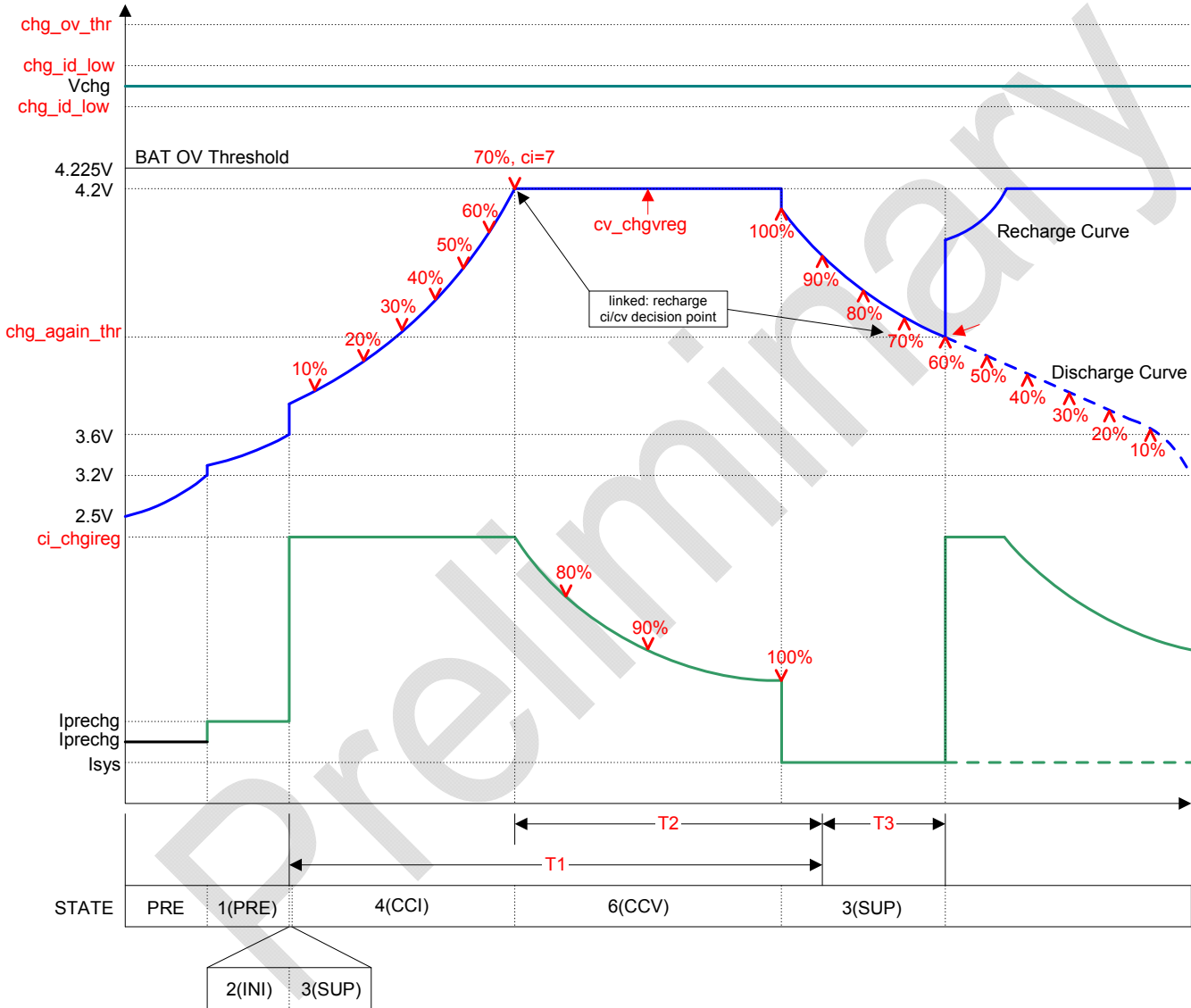
Repeat procedure for AT\$BCITMP2-AT\$BCITMP5, as required.

7.9. Setting BCIDEL parameters

Self-explanatory. Customer may choose to delete chargers or batteries from the list.

7.10. Setting BCIOFF parameters

Self-explanatory. Customer may choose enable/disable the charging at any time.



7.11. Battery Charging Calibration and Configuration - Appendix 1

Summary of all BCI commands and their parameters

General charging commands:

- AT\$BAT=<pct>,<bat_id>,<chg_id>,<state>,<Vbat>,<lchg>,<Tbat>
- AT\$BCIAVG=<alfaV>,<alfaT>,<alfal>,<sampling>
- AT\$BCIDBG=<level>,<dest>
- AT\$BCIDEL=<cmd>,<id>
- AT\$BCIISF=<adc_num>,<adc_offset>,<pre_chgireg>
- AT\$BCIMMI=<repetition>
- AT\$BCIN4A=<cmd>
- AT\$BCIOFF=<flag>
- AT\$BCIVSF=<num>,<offset>

Specific to Battery 1:

- AT\$BCIBAT1=<type>,<T1>,<T2>,<T3>,<chg_again_thr>,<cv_chgvgreg>,<id_low>,<id_high>
- AT\$BCIMAP1=<#_ci_elements>,<10%>,<20%>,<30%>,<40%>,<50%>,<60%>,<70%>,<80%>,<90%>,<100%>
- AT\$BCIPCT1=<10%>,<20%>,<30%>,<40%>,<50%>,<60%>,<70%>,<80%>,<90%>,<100%>
- AT\$BCITMP1=<tbat_min>,<tbat_max>,<adc@-20>,<adc@-10>,<adc@0>,<adc@+10>,<adc@+20>,<adc@+30>,<adc@+40>,<adc@+50>,<adc@+60>,<i_meas>

Specific to Battery 2:

- AT\$BCIBAT2=<type>,<T1>,<T2>,<T3>,<chg_again_thr>,<cv_chgvgreg>,<id_low>,<id_high>
- AT\$BCIMAP2=<#_ci_elements>,<10%>,<20%>,<30%>,<40%>,<50%>,<60%>,<70%>,<80%>,<90%>,<100%>
- AT\$BCIPCT2=<10%>,<20%>,<30%>,<40%>,<50%>,<60%>,<70%>,<80%>,<90%>,<100%>
- AT\$BCITMP2=<tbat_min>,<tbat_max>,<adc@-20>,<adc@-10>,<adc@0>,<adc@+10>,<adc@+20>,<adc@+30>,<adc@+40>,<adc@+50>,<adc@+60>,<i_meas>

Specific to Battery 3:

- AT\$BCIBAT3=<type>,<T1>,<T2>,<T3>,<chg_again_thr>,<cv_chgvgreg>,<id_low>,<id_high>
- AT\$BCIMAP3=<#_ci_elements>,10%>,<20%>,<30%>,<40%>,<50%>,<60%>,<70%>,<80%>,<90%>,<100%>
- AT\$BCIPCT3=<10%>,<20%>,<30%>,<40%>,<50%>,<60%>,<70%>,<80%>,<90%>,<100%>
- AT\$BCITMP3=<tbat_min>,<tbat_max>,<adc@-20>,<adc@-10>,<adc@0>,<adc@+10>,<adc@+20>,<adc@+30>,<adc@+40>,<adc@+50>,<adc@+60>,<i_meas>

Specific to Battery 4:

- AT\$BCIBAT4=<type>,<T1>,<T2>,<T3>,<chg_again_thr>,<cv_chgvgreg>,<id_low>,<id_high>
- AT\$BCIMAP4=<#_ci_elements>,10%>,<20%>,<30%>,<40%>,<50%>,<60%>,<70%>,<80%>,<90%>,<100%>
- AT\$BCIPCT4=<10%>,<20%>,<30%>,<40%>,<50%>,<60%>,<70%>,<80%>,<90%>,<100%>
- AT\$BCITMP4=<tbat_min>,<tbat_max>,<adc@-20>,<adc@-10>,<adc@0>,<adc@+10>,<adc@+20>,<adc@+30>,<adc@+40>,<adc@+50>,<adc@+60>,<i_meas>

Specific to Battery 5:

- AT\$BCIBAT5=<type>,<T1>,<T2>,<T3>,<chg_again_thr>,<cv_chgvgreg>,<id_low>,<id_high>
- AT\$BCIMAP5=<#_ci_elements>,10%>,<20%>,<30%>,<40%>,<50%>,<60%>,<70%>,<80%>,<90%>,<100%>
- AT\$BCIPCT5=<10%>,<20%>,<30%>,<40%>,<50%>,<60%>,<70%>,<80%>,<90%>,<100%>
- AT\$BCITMP5=<tbat_min>,<tbat_max>,<adc@-20>,<adc@-10>,<adc@0>,<adc@+10>,<adc@+20>,<adc@+30>,<adc@+40>,<adc@+50>,<adc@+60>,<i_meas>

Specific to Chargers:

- AT\$BCICHG1=<type>,<ci_chgireg>,<ov_thr>,<id_low>,<id_high>
- AT\$BCICHG2=<type>,<ci_chgireg>,<ov_thr>,<id_low>,<id_high>
- AT\$BCICHG3=<type>,<ci_chgireg>,<ov_thr>,<id_low>,<id_high>
- AT\$BCICHG4=<type>,<ci_chgireg>,<ov_thr>,<id_low>,<id_high>
- AT\$BCICHG5=<type>,<ci_chgireg>,<ov_thr>,<id_low>,<id_high>

7.12. BCI Command Parameters - Appendix 2

Table of BCI command parameters relating to per-unit calibration and system-level configuration.

- Calibration is required on every module.
- Configuration is required once and all modules configured likewise.
- Recommend leave all other parameters at default values.

Command	Parameter	Factory Production Calibration	Customer Calibration	Factory Configuration	Customer Battery Configuration	Customer Charger Configuration
AT\$BCIVSF	<num>	X	Opt.			
	<offset>	X	Opt.			
AT\$BCIISF	<adc_num>	X	Opt.			
	<adc_offset>	X	Opt.			
	<pre_chgireg>	X	Opt.			
AT\$BCIAVG	<alfaV>			X	Opt.	
	<alfaT>			X	Opt.	
	<alfal>			X	Opt.	
	<sampling>			X	Opt.	
AT\$BCIDEL	<cmd>				Opt.	Opt.
	<id>				Opt.	Opt.
AT\$BCIOFF	<flag>				Opt.	Opt.
AT\$BCICHG#	<type>			X		
	<ci_chgireg>					X
	<ov_thr>					X
	<id_low>					X
	<id_high>					X
AT\$BCIBAT#	<type>			X		Opt.
	<T1>					X
	<T2>					X
	<T3>			X		Opt.
	<chg_again_thr>					X
	<cv_chgireg>			X		Opt.
	<id_low>					X
	<id_high>					X
AT\$BCIMAP#	<#_ci_elements>			X	Opt.	
	<10%>			X	Opt.	
	<20%>			X	Opt.	
	<30%>			X	Opt.	
	<40%>			X	Opt.	
	<50%>			X	Opt.	
	<60%>			X	Opt.	
	<70%>			X	Opt.	
	<80%>				X	
	<90%>				X	
	<100%>				X	
AT\$BCIPCT#	<10%>			X	Opt.	
	<20%>			X	Opt.	
	<30%>			X	Opt.	
	<40%>			X	Opt.	
	<50%>			X	Opt.	
	<60%>			X	Opt.	
	<70%>			X	Opt.	

	<80%>			X	Opt.		
	<90%>			X	Opt.		
	<100%>			X	Opt.		
AT\$BCITMP#	<tbat_min>			X	Opt.		
	<tbat_max>			X	Opt.		
	<adc@-20>				X		
	<adc@-10>				X		
	<adc@0>				X		
	<adc@+10>				X		
	<adc@+20>				X		
	<adc@+30>				X		
	<adc@+40>				X		
	<adc@+50>				X		
	<adc@+60>				X		
	<i_meas>				X	Opt.	

Table of BCI commands that report information and debug parameters.

Command	Parameter	Information	Debug
AT\$BAT	<pct>	X	
	<bat_id>	X	
	<chg_id>	X	
	<state>	X	
	<Vbat>	X	
	<lchg>	X	
	<Tbat>	X	
AT\$BCIMMI	<repetition>	X	
AT\$BCIDBG	<level>		X
	<dest>		X

7.13. Set BCI parameters for an ActiveKey2 - Appendix 3

Example 1: Set BCI parameters for an ActiveKey2, 230mAh Li-Ion battery, and 5V regulated wall charger.

Step 1 - Given:

Variable	Value	Description
I _{SYS}	50mA	AKII idle current
V _{MAX}	6.050 V	AKII max. voltage on charger input
C ₁ R _{ID} Temp_max Temp_min	230mAh 4.7kohm +60C -20C	Battery1 capacity (Nitro battery), ID, and temp. specs.
C ₂	-	Battery2 capacity
C ₃	-	Battery3 capacity
C ₄	-	Battery4 capacity
C ₅	-	Battery5 capacity
Vchg1	5.00V Vchg1_Max = 5.725V Vchg1_Min = 4.725V	Charger1 (USB charger)
Vchg2	5.00V Vchg2_Max = 5.05V Vchg2_Min = 4.95V	Charger2 (Regulated wall supply)
Charger3	-	Charger3
Charger4	-	Charger4
Charger5	-	Charger5

Step 2 - Calculate system parameters:

Variable	Value	Description
CI	CI = 1 x C ₁ = 230mA	Constant current (800mA max.)
Iprechg	C ₁ /10 = 23mA	Precharge current (Locosto on)
I _{EOC}	C ₁ /20 = 12mA	EOC current
T _{CI_CHG}	(<#_ci_elements> / 10) x (C ₁ / CI) x 60 = 0.7 x 60 = 42min	CI charge time (min)
T _{CV_CHG}	(1-<#_ci_elements> / 10) x C ₁ x 60 / (0.5 x (CI - I _{EOC}) + I _{SYS}) = 0.3 x 230 x 60 / (0.5 x (230 - 12) + 50) = 26 min	CV charge time (min)

Step 3 - Calculate BCI parameters:

Variable ₂	Formula	Result
AT\$BCICHG2 <ci_chgireg>	$[0.22 \times (CI + I_{SYS}) \times 10 + 0] \times 255 / 1750$	90
AT\$BCICHG2 <ov_thr>	$\text{<ov_thr>} = V_{MAX} \times 1000$	6050
AT\$BCICHG2 <id_low>	$\text{<id_low>} = V_{chg2_Min} \times 1000$	4725
AT\$BCICHG2 <id_high>	$\text{<id_high>} = V_{chg2_Max} \times 1000$	5725
AT\$BCIISF <pre_chgireg>	$[0.22 \times (I_{PRECHG} + I_{SYS}) \times 10 + 0] \times 255 / 1750$	23
AT\$BCIBAT1 <T1>	By design, $> (T_{CI_CHG} + T_{CI_CHG}) \times 60 \times 1000$	4800000
AT\$BCIBAT1 <T2>	By design, $> T_{CV_CHG} \times 60 \times 1000$	1800000
AT\$BCIBAT1 <chg_again_thr>	By design	90 %
AT\$BCIBAT1 <id_low>	$(1023/1837.5) \times (0.99 \times R_{ID}) \times 0.008 - 2$	19
AT\$BCIBAT1 <id_high>	$(1023/1662.5) \times (1.01 \times R_{ID}) \times 0.012 + 2$	37
AT\$BCIMAP1 <80%> ¹	$[(ci_chgireg - I_{EOC}) \times 2/3] + I_{sys}$	102 mA
AT\$BCIMAP1 <90%> ¹	$[(ci_chgireg - I_{EOC}) \times 1/3] + I_{sys}$	76 mA
AT\$BCIMAP1 <100%> ¹	$I_{EOC} + I_{SYS}$	62 mA
AT\$BCITMP1 <tbat_min>	By design, or Temp_min	-20 C
AT\$BCITMP1 <tbat_max>	By design, or Temp_max	60 C
AT\$BCITMP1 <adc@-20>	Set temp to -20C. <adc@-20>= dec(Tbat)	Measure
AT\$BCITMP1 <adc@-10>	Set temp to -10C. <adc@-10>= dec(Tbat)	Measure
AT\$BCITMP1 <adc@0>	Set temp to 0C. <adc@0>= dec(Tbat)	Measure
AT\$BCITMP1 <adc@+10>	Set temp to +10C. <adc@10>= dec(Tbat)	Measure
AT\$BCITMP1 <adc@+20>	Set temp to +20C. <adc@20>= dec(Tbat)	Measure
AT\$BCITMP1 <adc@+30>	Set temp to +30C. <adc@30>= dec(Tbat)	Measure
AT\$BCITMP1 <adc@+40>	Set temp to +40C. <adc@40>= dec(Tbat)	Measure
AT\$BCITMP1 <adc@+50>	Set temp to +50C. <adc@50>= dec(Tbat)	Measure
AT\$BCITMP1 <adc@+60>	Set temp to +60C. <adc@60>= dec(Tbat)	Measure

Note 1: Assuming the index is 7. If a different index is used, the CV capacities must be calculated differently.

Note 2: This table is for a regulated wall-charger Charger2, and Battery1. Follow similar calculations for additional chargers and batteries.

8. GPS Performance

Specification	Parameter/Conditions	Min	Typ	Max	Units
Maximum Update Rate			1		Hz
Accuracy	-130 dBm, Autonomous CEP (50%)		1	3	m
	-140 dBm, Autonomous CEP (50%)		1.5	5	m
	-150 dBm, Autonomous CEP (50%)		7	10	m
	-155 dBm, Autonomous CEP (50%)		18	25	m
	-130 dBm, Autonomous CEP (95%)		2.5	5	m
	-140 dBm, Autonomous CEP (95%)		3	7	m
	-150 dBm, Autonomous CEP (95%)		15	25	m
	-155 dBm, Autonomous CEP (95%)		40	50	m
Acquisition Times -130 dBm, 25 °C	Cold Start TTFF	27	35	49	S
	Reacquisition		3	5	S
Sensitivity	Tracking		-157.5	-160	dBm
	Reacquisition		-157		dBm
	Cold Start		-144		dBm

- CEP (50%): The radius of a horizontal circle centered at the antenna's true position that contains 50% of the fixes.
- CEP (95%): The radius of a horizontal circle centered at the antenna's true position that contains 95% of the fixes.
- TTFF (Time To First Fix (seconds)): The number of seconds to provide a position fix (latitude & longitude).
- Cold Start: The GPS receiver does not have valid almanac or time data.
- Assisted Cold Start: The modem supplies the GPS receiver any valid time, ephemeris, almanac, and position data, that the modem might have stored.
- Reacquisition: The GPS receiver has valid ephemeris, almanac and time data.

9. GSM/GPRS Modes of Operation

GSM/GPRS supports many optional services and modes. The Enfora Enabler LPP G module supports the following GSM/GPRS services:

- Short-Message Services (SMS)
- Class B GPRS Functionality
- Voice communication

9.1. Enabling the Transmission Modes for the GSM/GPRS Services

Each of the GSM/GPRS services has two modes that can be enabled separately:

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

Note: Contact your local GSM operator to ensure that the services and modes have been provisioned for the SIM.

9.2. Voice Communication

The Enfora Enabler LPP G module has voice capabilities, provided the necessary connections have been made for the speaker and microphone pins. The Enfora **Enabler-LPP G AT Command Set Reference – LPP0108AT001** has the entire list of commands that can be used to control the voice functionality.

The Enfora Enabler LPP G module supports four vocoder compression algorithms for voice communication: Full-Rate (FR), Enhanced Full-Rate (EFR), Half-rate (HR) and Adaptive Multi-rate (AMR).

9.3. SMS: Short Message Services

- Short Message Services (SMS) is a feature-rich GSM service. The Enfora Enabler LPP G module can perform the following tasks:
- Sending and receiving binary messages of up to 160 characters (7-bit characters)
- Sending and receiving text messages of up to 140 bytes (8-bit data)
- Submitting a SMS Protocol Data Unit (PDU) to a SMSC (Short Message Service Center) and storing a copy of the PDU until either a report arrives from the network or a timer expires
- Receiving a SMS PDU from a SMSC
- Returning a delivery report to the network for a previously received message
- Receiving a report from the network
- Notifying the network when the module has sufficient memory capacity available to receive one or more SMS messages (after the module had previously rejected a message because its memory capacity was exceeded)

9.4. SIM Operation

9.4.1. Provisioning the SIM

The SIM can support optional features or services. Most 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 circuit switched and GPRS data are also additional services that may be required 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)
- The GSM SIM can have multiple telephone numbers.

It is imperative for the Enfora Enabler LPP G module that the SIM be configured for the optional services that are required for the application.

9.5. GPRS Services Supported by the Enfora Enabler LPP G Module

The Enfora Enabler LPP G module supports the following GPRS (modes of operation) that must be enabled by the operator:

- GPRS Packet Connectivity (MO and MT) with Both Dynamic and Static IP option
- GPRS SMS (MO and MT): uses the IP (Dynamic or Static) set by the operator
- Multiple APN Setting
- Quality of Service Options

- Up to Multi-slot 10 Class of Service

9.6. Selecting the GSM Modes of Operation

When provisioning the SIM for the Enfora Enabler LPP G module, 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)

Voice	SMS	GPRS	Function
MO/MT	MT		Voice calls, receive SMS
MO/MT	MO/MT		Voice calls, receive / send SMS
MO/MT	MO/MT		Voice calls, receive / send SMS

10. Software Interface

10.1. Software Interface

The application sends commands to the Enfora Enabler LPP G module via the 50-pin I/O signal connector. These commands use the Enabler LPP G Menu System, Enfora AT Command Set and/or Enfora GSM-GPRS Family API.

The Enfora Enabler LPP G module operates in one of the following modes:

- Command Menu mode: Used for configuring the Enfora Enabler LPP G module. It uses menu based commands via the serial port for communication. See ***LPP0108PR001 - Enfora Enabler LPP G Programming Reference*** for more details on specific commands.
- Modem Pass-Thru mode: Used to communicate directly with the modem. It uses the AT command set via the serial port for communication. Entry to this mode is available via a menu mode command.

10.2. Format for the AT Commands

The general format of the command line is: **<prefix> <command> <CR>**

<prefix>	AT
<command>	See AT Command Manual
<CR>	0X0D

The prefix AT obtains synchronization, identifies the character parameters, and indicates that a command may be in the following characters.

AT commands are not case sensitive; use either capital letters or lower-case letters for the AT command.

Note: Some AT Command parameter values **ARE** case sensitive and are documented in the ***Enfora Enabler-LPP G AT Command Set Reference – LPP0108AT001***.

10.3. Enfora AT Command Set

For a full description of the AT commands, refer to the ***Enfora Enabler-LPP G AT Command Set Reference – LPP0108AT001***.

Note: A command description that includes an *asterisk denotes that the GSM service provider must enable supplementary services functionality before the command is available.

11. Integration and Testing

TBD

Preliminary

12. APPENDIX A - LIMITED WARRANTY

12.1. Scope

Enfora warrants to the original purchaser of the product that, for a period of one (1) year from the date of product purchase, the product hardware, when used in conjunction with any associated software (including any firmware and applications) supplied by Enfora, will be free from defects in material or workmanship under normal operation. Enfora further warrants to such original purchaser that, for a period of ninety (90) days from the date of product purchase, any software associated with the product will perform substantially in accordance with the user documentation provided by Enfora, and any software media provided with the product will be free from defects in material or workmanship under normal operation. Enfora does not warrant that (a) the product hardware or any associated software will meet the purchaser's requirements, (b) that the operation of the product hardware or software will be uninterrupted or error-free, or (c) the product, when integrated in, or combined with, other products or software not supplied by Enfora, will continue to perform substantially in accordance with the user documentation. This limited warranty is only for the benefit of the original purchaser and is not transferable. No other party may act on behalf of such purchaser for the purpose of claiming or exercising any rights or benefits under or in connection with this limited warranty except as may be provided in a written agreement between Enfora and such other party.

12.2. Hardware

During the warranty period applicable to the product hardware, Enfora, at its expense and in its sole discretion, will repair or replace the product if it is determined to have a covered hardware defect, provided that the purchaser first notifies Enfora of any such defect, furnishes Enfora with a proof of purchase, requests and obtains a return merchandise authorization (RMA) number from Enfora, and returns the product, shipping charges prepaid, to Enfora under that RMA. If, upon reasonable examination of the returned product, Enfora does not substantiate the defect claimed by purchaser, or determines that the defect is not covered under this limited warranty, Enfora will not be required to repair or replace the product, but may instead reship the product to the purchaser, in which case purchaser shall be responsible for paying Enfora's usual charges for unpacking, testing, and repacking the product for reshipment to purchaser. Purchaser shall bear the risk of loss or damage in transit to any product returned by purchaser to Enfora, or any returned product not found to be defective or covered under this warranty and reshipped by Enfora to purchaser. In the event Enfora repairs or replaces a defective product, the repaired or replacement product will be covered under this limited warranty for the remainder of the original warranty period on the defective product. If Enfora is unable to repair or replace a defective product, the purchaser's exclusive remedy shall be a refund of the original purchase price. Any returned and replaced product, or any product for which Enfora has refunded the original purchase price, becomes the property of Enfora.

12.3. Software

During the warranty period applicable to the software or its media, Enfora, at its expense, will replace any defective software or media if purchaser gives written notification of the defect to the technical support department at Enfora during the applicable warranty period. Enfora will ship or otherwise transmit the replacement software or media to purchaser, and purchaser shall be responsible for incorporating any replacement software in the product. Enfora shall not have any obligation to provide any software bug fixes, upgrades or new releases except as may be necessary to correct any covered defect of which purchaser notifies Enfora in writing during the applicable warranty period. Enfora, from time to time and in its sole discretion, may make available for download on its website (www.enfora.com) certain software bug fixes, upgrades or new releases for the product. The purchaser should periodically visit such website to determine whether any such bug fixes, upgrades or new releases have become available. Download and use of any such bug fixes, upgrades or new

releases is subject to all of the applicable terms and conditions of Enfora's technical support policy as posted and updated on its website.

Exceptions and Disclaimers

Enfora shall have no obligation under this limited warranty for (a) normal wear and tear, (b) the cost of procurement of substitute products or (c) any defect that is (i) discovered by purchaser during the warranty period but purchaser does not notify or request an RMA number from Enfora, as required above, until after the end of the warranty period, (ii) caused by any accident, misuse, abuse, improper installation, handling or testing, or unauthorized repair or modification of the product, (iii) caused by use of any software other than any software supplied by Enfora, or by use of the product other than in accordance with its documentation or (iv) the result of electrostatic discharge, electrical surge, fire, flood or similar causes. Unless otherwise provided in a written agreement between the purchaser and Enfora, the purchaser shall be solely responsible for the proper configuration, testing and verification of the product prior to deployment in the field.

ENFORA'S SOLE RESPONSIBILITY AND PURCHASER'S SOLE REMEDY UNDER THIS LIMITED WARRANTY SHALL BE TO REPAIR OR REPLACE THE PRODUCT HARDWARE, SOFTWARE OR SOFTWARE MEDIA (OR IF REPAIR OR REPLACEMENT IS NOT POSSIBLE, OBTAIN A REFUND OF THE PURCHASE PRICE) AS PROVIDED ABOVE. ENFORA EXPRESSLY DISCLAIMS ALL OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY, SATISFACTORY PERFORMANCE AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL ENFORA BE LIABLE FOR ANY INDIRECT, SPECIAL, EXEMPLARY, INCIDENTAL OR CONSEQUENTIAL DAMAGES (INCLUDING WITHOUT LIMITATION LOSS OR INTERRUPTION OF USE, DATA, REVENUES OR PROFITS) RESULTING FROM A BREACH OF THIS WARRANTY OR BASED ON ANY OTHER LEGAL THEORY, EVEN IF ENFORA HAS BEEN ADVISED OF THE POSSIBILITY OR LIKELIHOOD OF SUCH DAMAGES.

12.4. Other Considerations

Some jurisdictions may require a longer warranty period than specified above and, accordingly, for products sold in those jurisdictions the applicable warranty period shall be extended as required under the laws of those jurisdictions. Furthermore, some jurisdictions may not allow the disclaimer of implied warranties or the exclusion or limitation of incidental or consequential damages, so the above disclaimer, limitation or exclusion may not apply to products sold in those jurisdictions. This limited warranty gives the purchaser specific legal rights and the purchaser may have other legal rights that vary from jurisdiction to jurisdiction.

In some instances, certain aspects of the product warranty may also be covered in a separate written agreement between Enfora and the distributor or reseller, if any, from whom purchaser purchased the product. That agreement may provide, for example, a different product return procedure that may also be available to purchaser (e.g., the product may be returned to Enfora through that distributor or reseller).

Governing Law

This limited warranty shall be governed by the laws of the State of Texas, United States of America, without regard to conflict of laws principles. This limited warranty shall not be governed in any respect by the United Nations Convention on Contracts for the International Sale of Goods.

13. APPENDIX B - Regulations and Compliance

This section summarizes the responsibilities and actions required of manufacturers and integrators who incorporate OEM versions of the Enfora Enabler LPP G module into their products. In certain situations and applications, these products will require additional FCC, CE, GCF, PTCRB or other regulatory approvals prior to sale or operation. Appropriate instructions, documentation and labels are required for all products. For more information concerning regulatory requirements, please contact Enfora.

13.1. GCF/PTCRB Approval (Formerly FTA)

The Enfora Enabler LPP G module is type approved in accordance with the requirements of and through the procedures set forth by the GSM industry association. The relevant conformance specification is 3GPP TS 51010-1. Any OEM changes in the SIM interface, antenna port, software or the physical makeup of the unit may require an incremental FTA to ensure continued compliance with the above-mentioned standard. For more information concerning type approval, please contact Enfora.

13.2. Electromagnetic Compatibility (EMC) and Safety Requirements

The Enfora Enabler LPP G module has been tested and approved for application in the United States of America (US) and the European Union (EU). The compliance details for each of these markets follow. For other markets, additional or alternative regulatory approvals may be required. Always ensure that all rules and regulations are complied with in every country that the OEM application is to be operated. Regardless of the country or market, the OEM must comply with all applicable regulatory requirements.

13.3. EMC/Safety Requirements for the USA

Compliance to the US rules and regulations falls under two categories:

- Radio approvals: Federal Communications Commission (FCC)
- Transmitter: FCC Rules, Part 22 & 24
- Unintentional emission: FCC Rules, Part 15

Although the Enfora Enabler LPP G module has been authorized by the FCC and listed as a component by an NRTL, products and applications that incorporate the Enfora Enabler LPP G module will require final verification of EM emission and product safety approval.

Note: Particular attention should be made to the following statements regarding RF Exposure:

13.4. Human Exposure Compliance Statement

LPP0108 GSM/GPRS Module

Enfora certifies that the Enfora Enabler LPP G 850/900/1800/1900 MHz GSM Radio Module (FCC ID: MIVLPP0108) complies with the RF hazard requirements applicable to broadband PCS equipment operating under the authority of 47 CFR Part 24, Subpart E and Part 22 of the FCC Rules and Regulations. This certification is contingent upon installation, operation and use of the Enfora Enabler LPP G module and its host product in accordance with all instructions provided to both the OEM and end user. When installed and operated in a manner consistent with the instructions provided, the Enfora Enabler LPP G module meets the maximum permissible exposure (MPE) limits for general population / uncontrolled exposure as defined in Section 1.1310 of the FCC Rules and Regulations.

Note: Installation and operation of this equipment must comply with all applicable FCC Rules and Regulations, including those that implement the National Environmental Policy Act of 1969 (Part 1, Subpart I), with specific regard to antenna siting and human exposure to radio frequency radiation. For further guidance, consult the FCC Rules, a certified FCC test house, or Enfora.

13.5. Compliance with FCC Regulations

The Federal Communications Commission (FCC) is the agency of the Federal Government that oversees all non-governmental radio frequency transmitters that operate within the United States. Unintentional emissions from digital devices are regulated by Part 15 of the FCC Rules and Regulations, which distinguishes between the environments in which these devices may operate. Intentional radiators operating as a GSM-1900 radio transmitter are regulated under Part 22 & 24, Subpart E—Broadband PCS of the FCC Rules and Regulations.

13.6. Unintentional Radiators, Part 15

Equipment designated as Class A is intended for use in a commercial, industrial or business environment. The Enfora Enabler LPP G module has been tested and found to comply with the limits for a Class A digital device and can be integrated into equipment or applications intended for use in commercial, industrial or business environments.

The following statement must be included in the user manual for such products:

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Equipment intended for use in a residential environment (notwithstanding use in commercial, industrial or business environments) is designated as Class B. The Enfora Enabler LPP G module has been tested and found to comply with the limits for a Class B digital device and can be integrated into equipment or applications intended for use in residential environments.

The following statement must be included in the user manual for such products:

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

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

13.7. Intentional Radiators, Part 22 & 24

Products incorporating the Enfora Enabler LPP G transceiver operate as Personal Communications Services (PCS) devices under the authority of Part 22 & Part 24, Subpart E—Broadband PCS, of the FCC Rules and Regulations. All such transmitters must be authorized by the FCC through its Certification process, as detailed in Part 2, Subpart J - Equipment Authorization Procedures. Through the Certification process, the FCC verifies that the product complies with all applicable regulatory and technical requirements, including those that address human exposure to radio frequency radiation. In general, radio frequency transmitters cannot be sold or operated in the US prior to FCC approval.

13.8. Instructions to the Original Equipment Manufacturer (OEM)

To comply with the requirements of the National Environmental Policy Act (NEPA) of 1969, operation of an FCC-regulated transmitter may not result in human exposure to radio frequency radiation in excess of the applicable health and safety guidelines established by the FCC. Further information on RF exposure issues may be found in the FCC's Office of Engineering and Technology (OET) Bulletin Number 65, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields" and Supplement C, "Additional Information for Evaluating Compliance of Mobile and Portable devices with FCC Limits for Human Exposure to Radio Frequency Emissions." Both of these documents are available via the Internet at the OET web site: <http://www.fcc.gov/oet>

The Enfora Enabler LPP G products are GSM radio transceivers, which operate under the authority of 47 CFR Part 24, Subpart E and Part 22 of the FCC Rules and Regulations. When installed and operated in accordance with the instructions provided in this manual, these devices comply with current FCC regulations regarding human exposure to radio frequency radiation.

The following installation and operation restrictions apply to all Enfora Enabler LPP G products:

- This device may only be used in fixed and mobile applications.
- Portable applications, as defined by the FCC, are prohibited.
- The use of this device for desktop and other applications where the antenna can easily be relocated are considered by the FCC to be mobile applications.
- A separation distance of at least 20 cm (7.87 inches) between the antenna and the body of the user and other persons must be maintained at all times
- In FIXED applications, *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, *antenna gain* is limited to a maximum of 2 dBi, with a corresponding EIRP of 33 dBm / 2 W.
- End products must provide instructions to ensure compliance with radio frequency radiation exposure requirements.
- A warning label visible to all persons exposed to the antenna and identical to that described in this manual must be displayed on or next to the antenna.
- Separate FCC approval for RF exposure compliance is required for end products that do not meet these conditions.

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 Enfora Enabler LPP G 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.

Depending upon the application and type of product into which the Enfora Enabler LPP G module has been incorporated, specific OEM actions and responsibilities required to meet these conditions vary. However, in all cases the primary concern is to ensure compliance with current FCC guidelines and regulations that limit human exposure to radio frequency radiation.

Definitions

For the purpose of determining compliance with current FCC rules addressing human exposure to radio frequency radiation, the FCC has established the following three categories of transmitting devices:

- Portable Devices – devices where the antenna is located within 20 cm (7.87 inches) of any person, including the user, if applicable. Portable devices operating under the authority of Part 22 or 24 (broadband PCS) are limited to a maximum of 2 W EIRP.
- Mobile Devices – devices designed to be used in other than fixed locations and generally such that the antenna is located at a minimum of 20 cm (7.87 inches) from any person, including the user, if applicable. Mobile devices operating under the authority of Part 22 or 24 (broadband PCS) are limited to a maximum of 2 W EIRP.
- Fixed devices – devices in which the antenna, either integral to the product or remotely located, is physically secured at one location and is not able to be easily moved to another location. The antenna for a fixed device is mounted on an outdoor permanent structure with a minimum separation distance of 2 meters (79 inches)

13.8.1. OEM Responsibilities for All Products Containing the Enabler LPP G module

In addition to any other regulatory requirements, OEMs and integrators must include or provide the following information, instructions, warnings and labels with any device or product into which the Enfora Enabler LPP G GSM1900 GSM transceiver has been incorporated:

Information	Description	
Detailed Operating Instructions for ensuring compliance with current FCC guidelines which limit human exposure to radio frequency radiation	<p>The OEM must provide an operating/installation manual with the final product which clearly indicates that these operating conditions and restrictions must be observed at all times to ensure compliance with current FCC guidelines which limit human exposure to radio frequency radiation.</p> <p>20 cm (7.87 inch) separation distance between the antenna and all persons must be maintained at all times for all fixed and mobile products and applications</p> <p>Portable devices and applications are prohibited unless such devices and products are specifically authorized by the FCC</p> <p>Maximum antenna gain is limited to 2 dBi* in mobile products and applications</p> <p>For fixed applications (2 meter separation) the antenna gain can be as much as 26 dBi.</p> <p>Modifications and/or additions to the Enfora Enabler LPP G GSM transceiver, including use of antennas with higher gain than those authorized by the FCC, are prohibited</p> <p>*dBi = antenna gain in dB relative to an isotropic radiator</p>	
Antenna Avoidance Label	Attach the following warning label directly to or displayed next to the antenna. Furthermore, this label must be visible to and easily readable by all persons in the immediate vicinity of the antenna	WARNING To comply with FCC RF exposure requirements, a separation distance of 20 cm (7.87") or more must be maintained between this antenna and all persons
Human Exposure Compliance Statement	Include the following statement in the instruction / operation manual.	Enfora certifies that the Enfora Enabler LPP G™ MHz GSM Radio Module (FCC ID: MIVLPP0108) complies with the RF hazard requirements applicable to broadband PCS equipment operating under the authority of 47 CFR Part 22 or Part 24, Subpart E of the FCC Rules and Regulations. This certification is contingent upon installation, operation and use of the Enfora Enabler LPP G module and its host product in accordance with all instructions provided to both the OEM and end user. When installed and operated in a manner consistent with the instructions provided, the Enfora Enabler LPP G module meets the maximum permissible exposure (MPE) limits for general population / uncontrolled exposure as defined in Section 1.1310 of the FCC Rules and Regulations.

13.8.2. Specific OEM Responsibilities for Portable Products and Applications

Each device or product, into which the Enfora Enabler LPP G PCS-1900 GSM transceiver has been incorporated, and which is intended to be used in an application that meets the definition of "portable" MUST be separately authorized by the FCC for the purposes of determining compliance with current FCC guidelines limiting human exposure to radio frequency radiation.

Portable devices must be evaluated for RF exposure based on Specific Absorption Rate (SAR) limits; further information on such evaluations are available from the FCC via the Internet.

13.8.3. Specific OEM Responsibilities for Mobile Products and Applications

Separate or additional FCC approvals are NOT required for devices or products, into which the Enfora Enabler LPP G PCS-1900 GSM transceiver has been incorporated, that are used in applications that meet the definition of "mobile."

For all end products, the OEM or integrator must provide instructions, warnings and labels to ensure that the product complies with current FCC guidelines limiting human exposure to radio frequency radiation.

Current FCC regulations limit the EIRP of mobile devices to 2 W. Because the nominal RF output power of the Enfora Enabler LPP G GSM1900 GSM transceiver is 1.0 W (31 dBm), antenna gain for mobile products and applications cannot exceed 2 dBi.

13.8.4. Specific OEM Responsibilities for Fixed Products and Applications

Separate or additional FCC approvals are not required for devices or products, into which the Enfora Enabler LPP G GSM transceiver has been incorporated, that are used in applications that meet the definition of "fixed."

For all end products, the OEM or integrator must provide the instructions, warnings and labels to ensure that the product complies with current FCC guidelines limiting human exposure to radio frequency radiation.

Separate or additional FCC approvals are required for devices or end products used in fixed applications where antenna gain in excess of 7dBi is desired.

13.9. EMC/Safety Requirements for the Countries of the European Union (EU)

The European Union (EU) is comprised of fifteen countries that follow a harmonized set of standards, utilizing the CE mark as a uniform mark of acceptance. The member countries are:

- Austria
- Belgium
- Cyprus
- Czech Republic
- Denmark
- Estonia
- Finland
- France
- Germany
- Greece
- Hungary
- Ireland
- Italy
- Latvia
- Lithuania
- Luxembourg
- The Netherlands
- Poland
- Portugal
- Slovakia
- Slovenia
- Spain
- Sweden
- United Kingdom

13.10. EMC/Safety Requirements for Other Countries

In most other countries that have not been listed above there are similar rules and regulations that must be met for importing the Enfora Enabler LPP G module. Each may require a different mark of approval (for example, the CB Scheme) as an acceptance requirement. For each of these cases the country should be identified, and the appropriate steps should be taken to meet the requirements set forth in the intended market.

14. APPENDIX C - Glossary and Acronyms

API	Application Programming Interface.
App Application	Refers to the Application which sends or receives commands/responses from the Enfora Enabler LPP G Module
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.
BER Bit Error Rate	Bit Error Rate
CEP Circular Error Probable	
CMUX	Multiplexer protocol that operates between an MS and a TE and allows a number of simultaneous sessions over a normal serial asynchronous interface
CPE Customer Premise Equipment	A terminal in fixed location on the customer's premises.
CSD Circuit Switched Data	Data link from a terminal through the network allowing real-time, duplex connectivity at 9600 bytes/second.
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 algorithms which offer 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.
EMC Electromagnetic Compatibility	The ability of a device to function satisfactorily in its electromagnetic environment without inducing intolerable disturbance to that environment (or to other devices)
ESD Electrostatic Discharge	Static electricity that can damage electronic equipment.
EU European Union	An organization of 15 European states whose purpose is to organize relations between the Member States and between their peoples.
FTA Full Type Approval	GSM Full Type Approval
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.
GPS	Global Positioning System

HLR Home Location Register	Stores the identity and user data for all subscribers belonging to the area of the related MSC.
IMEI International Mobile Equipment Identity	A unique number for each GSM Terminal tracked by the GSM operators in their Equipment Identity Register (EIR) database.
IMSI International Mobile Subscriber Identification	A unique number identifying the subscriber stored in the SIM card. Number is used in conjunction with the network for call routing.
Ki	A secret code used in authentication and encryption by the terminal.
LPP Low Power Platform	
MCP	
MO Mobile Originated	Any GSM/GPRS service originated at the mobile terminal.
MT Mobile Terminated	Any GSM/GPRS service originated from or routed through the network and sent to the mobile terminal.
MSC Mobile Switching Center	The central switch of the GSM network. Performs call routing, collects call detail records for billing, and supervises system operations.
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.
PA	Power Amplifier.
Packet	A collection of data transmitted over a digital network in a burst.
PCS	Personal Communication Services.
PDA	Personal Digital Assistant.
PDU	Packet Data Unit.
PPP	Point-To-Point Protocol.
RTC Real Time Clock	
SIM	Subscriber Identity Module.
SMS	Short Message Service.
SMSC	Short Message Service Center.
SUPL	Secure User Plane Location
TCP Transfer Control Protocol	
UDP	User Datagram Protocol.

15. APPENDIX D – Tables and Figures

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16. APPENDIX E - Contacting Enfora

For technical support and customer service dealing with the modem itself, contact the company where you purchased the product. If you purchased the product directly from Enfora, visit the SUPPORT page on the Enfora website: http://www.enfora.com/support_newissue.asp

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