LMU-1300

CalAmp LMU-1300 Training Guide

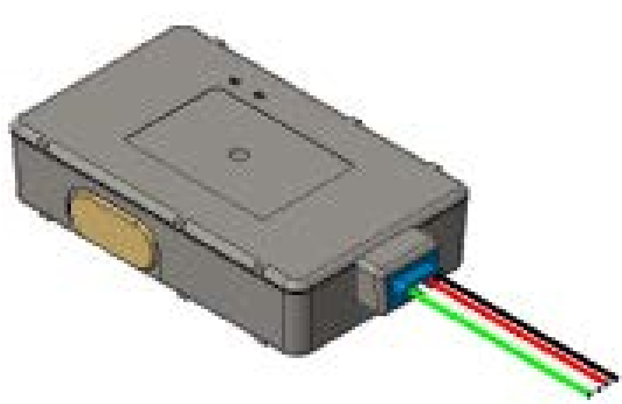

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Table of Contents

1. Scope

This document provides an overview of CalAmp's Telematics EdgeCore platform, referred as EdgeCore hereafter, the associated products, its highlights and major features. It also serves as a training manual on 'how-to' get started with an EdgeCore device (e.g. LMU-1300). Lastly, this document serves to describe the major differences between EdgeCore and the LMU32 predecessor platforms.

1.1 Platform Introduction

CalAmp's next-generation EdgeCore platform features a new embedded architecture and revamped hardware featuring significant advanced capability, reliability, and security. EdgeCore is agnostic to operating system (OS) and Hardware underneath. This section highlights the major features and benefits of the new platform.

1.2 Highlights and Features

- A new embedded architecture & framework designed to be adapted on new technologies, hardware chipsets, and operating systems
- Support of Next-Generation PEG2 scripting environment
- Power Management down to sub-milliamp levels during sleep
- BLE Asset Tag scanner and aggregator
- 3 axis - Accelerometer (MEMS) and 3 axis Gyroscope
- Extensive RAM/Flash memory space to avoid code space constraints.
- Delta file upgrade capability

1.3 Embedded Software Architecture

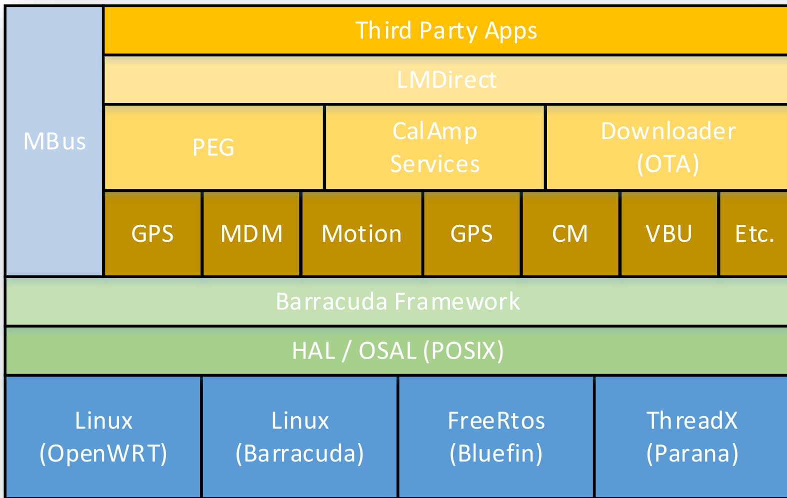
The new software architecture deployed on the EdgeCore platform moves the CalAmp LMU application functionality into a multi-threaded/multi-tasking environment. While the initial deployment for this architecture is in a Linux environment, the architecture is specifically designed to be portable across many other multi-tasking environments.

The fundamental goal of this architecture is to not only achieve a powerful and extensible software platform, but also a platform that easily supports for scalability across other hardware designs in order to meet different market segments. This is achieved by re-using common code built on a common framework that can be ported onto different operating systems and hardware chipsets by leveraging the use of abstraction layers.

The design and architecture of this software platform achieve the intended benefits by following these principles:

1. Modularity and compactness of system. One module envelops one concept and/or task.
2. Commonality across modules to allow more efficient methods to understand code across different platforms and developers.
3. Adaptability to allow for easier changes within the product or platform, with the goal that one module is applicable to other modules.

4. Portability that allows for streamlined ports of application code base on different operating systems and hardware chipsets using both OS and Hardware abstraction layers.



2. LMU-1300 Hardware Specifications

Cellular/Network

Global Variant:

LTE Cat M1: 2100 (B1)/1900 (B2)/1800 (B3)AWS 1700 (B4)/850 (B5/B26)/900 (B8)/700 (B12/B13/B28)/800 (B18/B19/B20) MHz

GSM/GPRS: 850/900/1800/1900 MHz

Data Support

SMS, UDP Packet Data

Satellite Location (GNSS)

Constellation Support: GPS/GLONASS/BeiDou/Galileo/QZSS

Tracking Sensitivity: -163 dBm

Acquisition Sensitivity: -156 dBm (hot start) -148 dBm (cold start)

Location Accuracy: ~2.0m CEP Open Sky (GPS SBAS 24 hours static)

Location Update Rate: Up to 5 Hz

Comprehensive I/O

Digital Inputs: 1 (high/low selectable 0-32 VDC)

Digital Outputs: 1 (open collector relay 150mA)

Serial Interface: 1 USB Port

Status LEDs: 2 (Cellular, GPS)

Sensors: Gyroscope: Triple-axis, tilt, yaw, roll detection

Accelerometer: Triple-axis, impact, motion sense

Certifications:

Industry Certifications: FCC, IC, PTCRB, CE/RED/CE SAFETY Applicable Carriers

Device Management

PULS™: Monitor, manage, upgrade firmware, configure and troubleshoot devices remotely

Embedded Intelligence Engine

PEGII™: Behavioral scripting (PEG2 on RTOS)

Geo-Fences: 32 built-in

Buffered Messages: 20,000

Electrical

Operating Voltage: 12-24 VDC Vehicle Systems

9-30 VDC (start-up, operating)

7-32 VDC (momentary)

Power Consumption: Typical <500uA @ 12V (low power sleep)

Typical <1mA @ 12 V (sleep)

Typical <15mA @ 12 V (radio-active sleep)

Typical <60mA @ 12 V (GPS tracking and cell idle)

Battery

Battery Capacity: 180 mAH

Battery Technology: Lithium-Ion

Charging Temperature: 0° to +45° C

Certifications: IEEE 1725-2011, UL 1624, UN 38.3

Environmental:

Temperature: -30° to +60° C (connected to primary power)

-20° to +60° C (operating on internal battery)

-10° to +25° C ≤ 6 months (long term storage with battery)

Humidity: 90% RH @ 50° C non-condensing

Shock and Vibration: U.S. Military Standards 202G, 810F SAEJ1455

ESD: IEC 61000-4-2 (4KV Test)

Ingress Protection: IP65 (CalAmp Assembled)

Physical/Design

Dimensions: 3.50 x 1.97 x 0.75" (89 x 50.1 x 19.2 mm)

Weight: 3.53 oz. (100g)

Connectors/SIM Access

GPS Antenna Internal

Cellular Antenna Internal

SIM Access Internal (4FF SIM)

BLE Antenna Internal

3. LMU-1300™ Connectors

3.1 Primary Connector

The LMU-1300 equips a 4-wire captive harness to receive power, ground and supply input and output signals.

Wire	Color	Description	Input or Output	AWG
1	Red	VCC	Power	22
2	Black	Ground	Ground	22
3	White	(Selectable Bias)	Input	22
4	Green	Output_0	Output	22

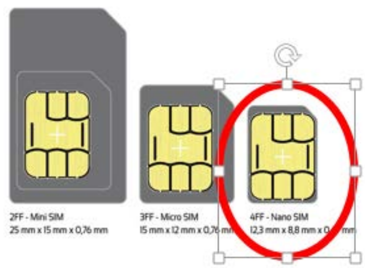
4. Getting Started

With any new platform, there are some changes in the form, fit, and function when compared to the predecessor product line. This section highlights pertinent changes compared to the LMU32 platform to help users get started with an EdgeCore device:

4.1 The Basics

4.1.1 SIM Card

EdgeCore products (including LMU-1300, LMU-3040, and LMU-3240) use a 4FF (nano) SIM card, which is smaller than the 2FF (mini) SIM card commonly used in prior LMUs.



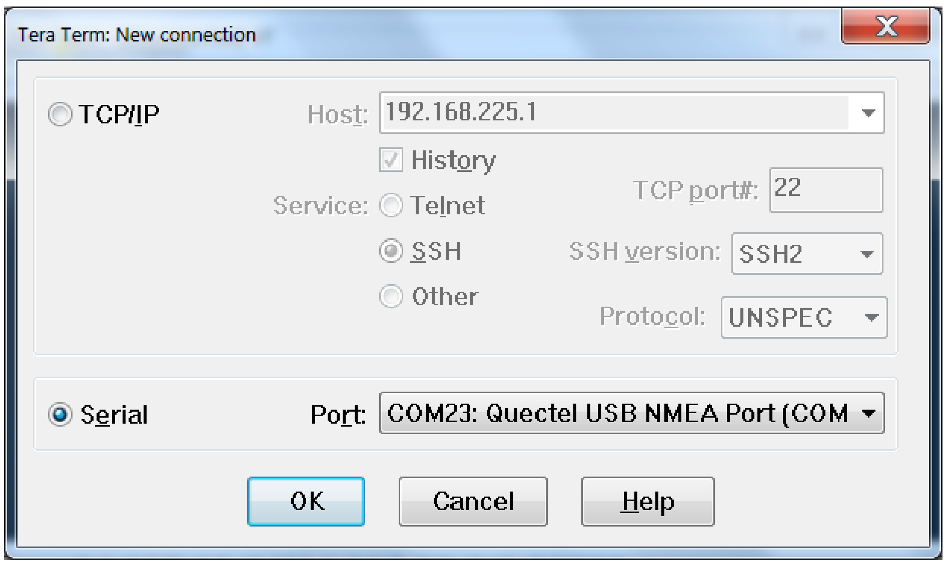
4.1.2 USB Cable

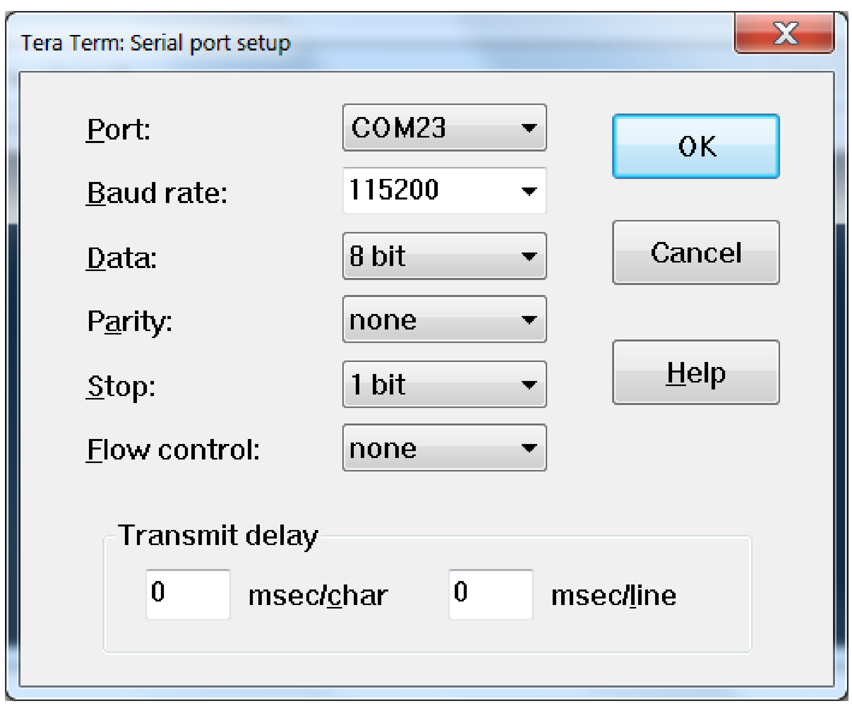
LMU-1300 does not require a serial adapter cable, but rather a stand-alone USB cable. The required cable type is a MICRO USB B cable (male). Example: *StarTech P/N: UUSBHAUB3*

4.1.3 Accessing Serial Port

After installing the quectel drivers, you would see 2 ports in device manager.

To access the serial port customer should chose NMEA port, Serial port settings 115200,8,N,1,none





4.5 Log File

Engineering and LMU logs can be found in the Linux file system. You can find the most recent log file in a specific **/var/log/** directory, in a file named **messages**

If you would like to view new information that is written to this log file, Linux offers a way to do this through the command line.

- Enter: **tail –F /var/log/messages**

This command will open the messages file and display the latest written lines of the file. It will continue to display the most updated lines you quit.

Helpful Tip: Linux allows the option to create multiple instances of SSH windows so you can have one SSH session viewing a log while the other is being used to send AT commands. Other Linux options such as parsing specific debug using a grep command can also be utilized. For example, the command: **tail –F /var/log/messages | grep VBU** will display lines in the log that have VBU in the string.

Important Note: The log file stored in 'messages' gets overwritten on every device wake-up.

4.6 Backup Logs

There is a method to store a current log file into a backup directory. This can be programmed in the PEG Script by using **PEG Action 144**.

- PEG Action 144 modifier 1 will save the current log into the /data/backup/ folder
- PEG Action 144 modifier 2 will save the current log and also send it to the set remote debug server defined in param 2328.

Important Note: Only one backup file can be stored at a time

4.7 File Components

Devices have several components on the EdgeCore platform that are provisioned at the factory. These components are described below:

File	Description	~Size
LMU Delta Image	This image includes Modem and GPS software in addition to Application software.	12-18Mb
PEG2 Script	This file controls and defines all the business logic and configuration settings on the device. PEG2 script file sizes will vary from application to application	50-150Kb (avg)

All file sizes are subject to change.

Important Note: Data plans may be impacted due to the larger size of FW delta files.

4.8 Software & Script Updates

All of these files can be updated Over-The-Air if subscribed to Calamp's Device Management Service (PULS).

These files can also be updated with physical access to the device as well. Below are the steps and options below:

1. Transfer Firmware/Script (e.g. WINScp, ADB Push) to **/data/configs/files** directory.

First, change directory to /data/configs/files directory.

Enter command: **cd /data/configs/files/**

a) PEG2: **dnld_cli prog_file 0 22 <*PEG2 File>.pg2***

b) LMU: **dnld_cli prog_file 0 0 >*LMU Binary>.bin***

c) VBU: **dnld_cli prog_file 25 0 <*VBU Binary File>.bin***

d) BLE: **dnld_cli prog_file 26 0 <*BLE Binary File>.bin***

2. Option 2: Using AT Console: Change the file name to update to "**ota_file.bin"**

a) PEG2: **at$app fprog 0 22**

b) LMU: **at$app fprog 0 0**

c) VBU: **at$app fprog 25 0**

d) BLE: **at$app fprog 26 0**

5. PEG2

PEG2 is the next-generation scripting environment with enhancements that allow you to build more efficient scripts with easier maintenance and unrestricted feature growth. These benefits are made possible by features such as:

- Multiple Triggers, Conditions and Actions per line
- Expanded modifier fields
- Complex boolean Condition logic
- Labels for Jumps and Calls (i.e. PEG line indexing will not change no matter where a line is added)
- In-line comments

5.2 PEG2 File

In next generation devices supporting PEG2, the file containing the PEG script and the configurations parameters has an updated format. The new file has the following characteristics:

- Format
  - Header - Time/Date, Signature, ID

   - Configuration Parameters - same format as existing Config Param file (File Type 1)
   - PEG2 Script - ASCII Text Lines delimited with <CR><LF>
   - End-Of-File marker
   - CRC - Usual 2-byte CRC is appended to the file by PULS or file generation tool
- Configuration Parameter section (if present) is merged with configuration parameters on target device
- Script section (if present) overwrites script on target device.
- New File Type: 22
- File Extension: 'PG2'

The sections 5.1.1 through 5.1.4 below describe the content of each file section. Tags are used to identify the start of each section.

5.2.1 Header

TAG Definition	Example
!TD: UTC Date and Time the file was generated or uploaded to the maintenance server (PULS) !SIG: File Signature is a MD-5 Hash generated from the file contents (anything after the signature). This is generated by LMU Manager and PULS during upload. !ID: User defined identification field. Up to 60 characters allowed. This field is displayed on PULS.	!TD:10:47:38 12-27-2018 !SIG:2a944f7d34857d99e4b39ce50069dcf0 !ID:v10.41_12_27_18_FAEPilot

5.2.2 Configuration Parameters

TAG Definition	Example
!CP: Following this tag, this is where all the Config Parameters start until the PEG2 script section starts or the EOF is detected. Important Notes: • Config Parameters use the same format as in a PEG1 file • Config Parameters are still a union of the file contents and what already resides on the target device	!CP: 256,0,00 256,1,01 256,2,00 256,3,00 257,0,15D4 259,3,00 260,0,00 260,1,00 ....

5.2.3 Script Section

TAG Definition	Example
!SCR: Script Section starts here. This section must immediately follow the Configuration Parameter (!CP) section. • PEG Lines are no longer parameterized. • !SCR will overwrite the entire PEG2 script on the device (no longer a union of PEG lines) • You can delete the PEG2 script on the target device by including the !SCR tag without any lines following. • The generic line number references can be replaced with custom names or named sub-routines	!SCR: L512000;T1,0;A51,512225 L512001;T2,0;A51,512225 L512002;T3,0;C39,7;A51,512185 L512003;T5,2;A51,512185 L512004;T11,0;C17,15;A31,15 L512005;T18,5;C17,15;A31,15 L512006;T48,0;C16,15;^C17,16;A31,16 L512007;T5,2;C8,0;^C16,16;A32,16 L512008;T12,0;A124,28 L512009;T12,0;A125,29 LCustomLabel;T5,2;!C44,0;A51,512195

5.2.4 End of File (EOF) and CRC

TAG Definition	Example
!EOF: End-of-file marker (this tag) must be included **!CRC:** Following EOF marker, a 2-byte binary CRC value must be appended to validate integrity of file during transit. This is needed for OTA and Serial transfers **Important Note:** If !SIG or !CRC is incorrect, PULS will re-calculate upon upload. However, this means while the file has been corrected for OTA, your original file will not be valid or usable for serial updates until fixed.	... L514014;T18,35;A112,0,0 L514015;T15,0;A112,0,0 L514250;T0,0;A0,0 !EOF: %P

5.3 PEG2 TAG Definitions

Definitions of the PEG2 Tag Characters with examples are listed below:

Tag Char	Name	Description	Example
L	Label	Defines a unique label to be used as a “virtual line”. Used as reference for Jump & Call PEG Actions	L514013
T	Trigger	Define one or more Triggers on the same line. T<TrigCode>,<Mod0>,T<TrigCode>,<Mod0>	T18,0;T17;A8,4
C	Condition	Define one or more Conditions on the same line. C<CondCode>,<Mod0>, C<CondCode>,<Mod0>	T13;C16,11;^C16,10;!+!C16,12;A1,24
A	Action	Defines one or more PEG Actions. Actions executed in order of appearance. A<ActionCode>,<Mod0>,A<ActionCode>,<Mod0>	T13;C16,11;^C16,10;!+!C16,12;A1,24
:	Comment	The comment tag ‘:’ is immediately followed by free text and is only terminated by the end-of-line delimiter (<CR>)	T18,0;T17;A8,4;:This is a comment
+	OR	Boolean operator that combines result with next Condition results using ‘OR’ operation	
^	AND	Boolean operator that combines result with next Condition results using ‘AND’ operation	
!	NOT	Boolean operator that inverts results of following Condition or previous Boolean state depending on placement.	

5.4 Multiple Modifiers

PEG2 offers the ability to use multiple modifiers for specific Triggers, Conditions or Actions. This makes it easier to use some existing PEG actions where there was a need to bit mask one modifier, or use two PEG actions to satisfy one function (like copy accumulator). See below for a few examples of how multiple modifiers can be utilized in a PEG2 script.

Trigger/Cond/Action	Definition	Modifier 0	Modifier 1
Update End Trigger (Code 61)	An update has completed. PEG1 single modifier mapping: Bits 0-3=File Type, bits 4-7 = Device Type	Device Type	File Type
Zone State Condition (Code 40)	True when current location is inside (0) or outside (1) the Zone identified by Zone# and the Zone is enabled. PEG1 single modifier mapping: Inside (bit7 of is 0), Outside (bit7 is 1), Zone Identifier (bits 0-6).	Current Location (inside/outside Zone)	Zone#
Copy Accumulator Action (103)	Copies value in Accum Source into Accum Destination PEG1 single modifier mapping: Upper 4 bits = Source, Lower 4 bits = Destination	Source Accum	Destination Accum

Example: *"I want to copy Accumulator 10 into Accumulator 22 every second"*

PEG1	PEG2 Example
Not possible using PEG Action 103 (Copy Accum). Limited to 4 bits (accum 0-15)	Possible with this PEG2 line: T18,5;A103,10,22
Using PEG Action 124 (Select Dest.) & 125 (Copy to Dest.): 120500007C160000 120500007D0A0000	Possible with one PEG2 line: T18,5;A103,10,22

5.5 PEG1 -> PEG2 Conversion

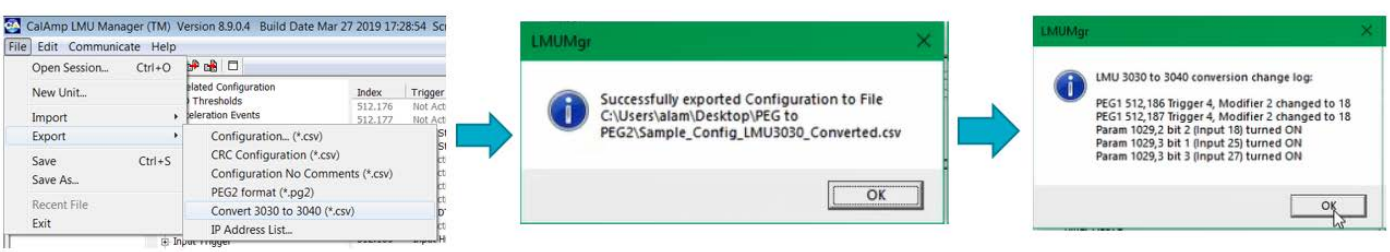
The latest version of LMU Manager offers a PEG1-PEG2 conversion export feature so that an existing PEG1 script can be easily converted into a PEG2 script to avoid the need of re-writing an existing script.

Note: A PEG1->PEG2 conversation does not optimize how PEG resources would be used if the script were to be written natively in PEG2. For example, the ability to have a complex set of conditions on one PEG2 line is not able to be leveraged unless done manually by the script writer. As a result, no PEG lines are being saved during the conversion.

Converting from PEG1 to PEG2, it is a two-step process.

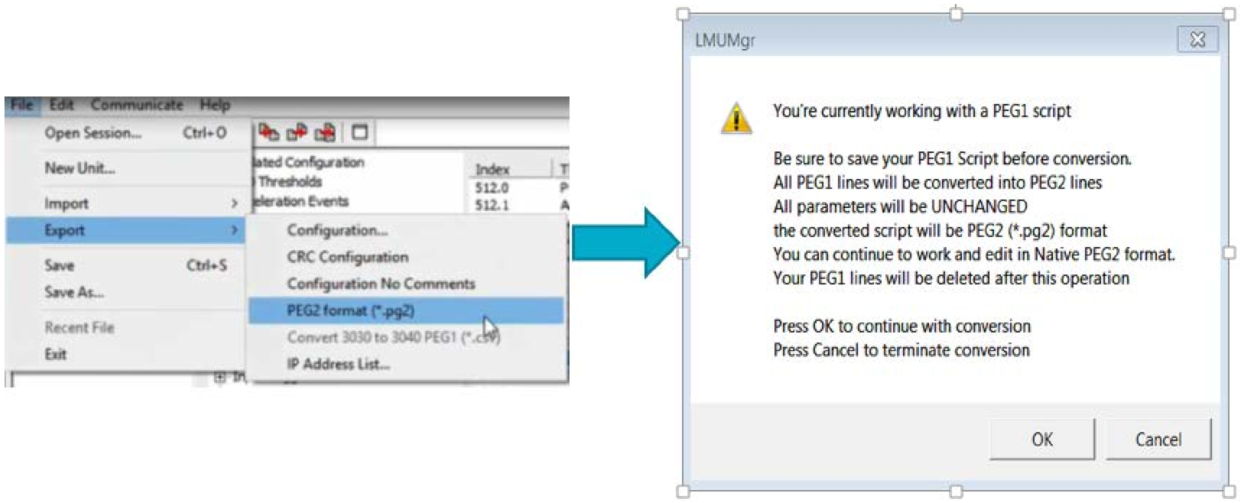
Step1: Convert PEG1 script file to an LMU 8-Bit PEG1 script file:

- Load PEG1 Script to Convert
- Select "Export" -> "Convert (*.csv)" selection
- Press OK on dialog boxes and Save File as CSV



Step2: Convert a PEG1 script file into an PEG2 script file

- Load PEG1 script to convert (from Step 1)
- Select "Export" -> "PEG2 format (*.pg2)" selection
- Press OK and Save File



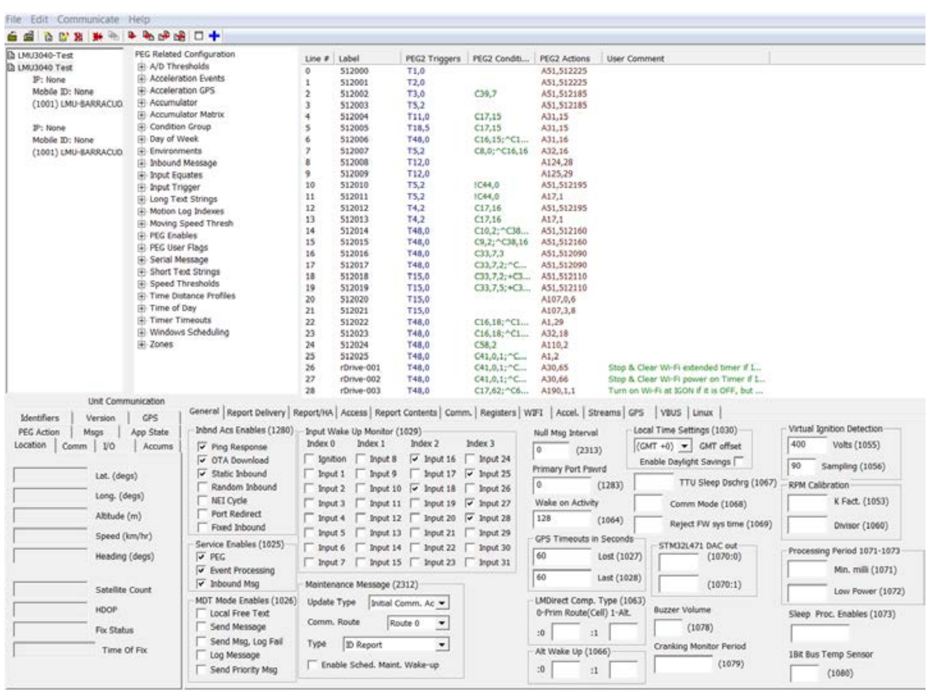
Note: A more detailed step-by-step PEG1->PEG2 conversion user guide can be made available

5.6 PEG2 Native Editor

The latest LMU Manager also offers a way to create or edit PEG2 files natively, without requiring a PEG1 to PEG2 conversion. High level features are introduced below:

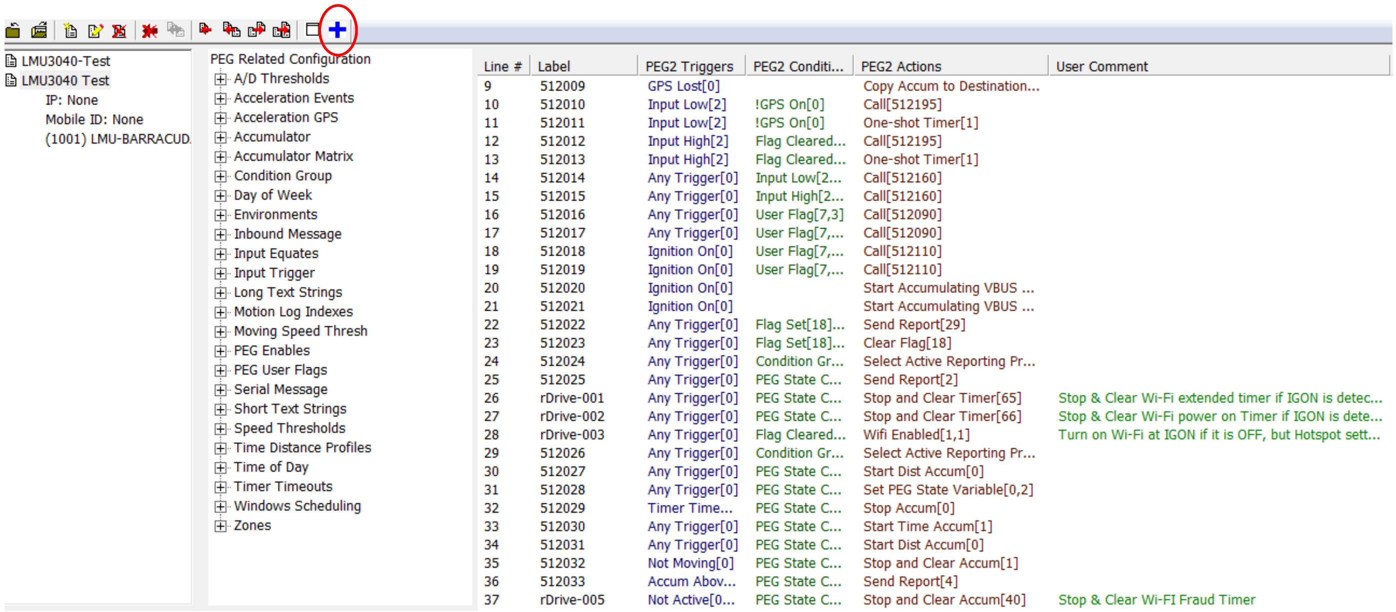
5.6.1 Load PEG2 file:

In LMU Manager, go to **FILE -> IMPORT - > PEG2 (.pg2)** or start from a blank script with any App ID that supports PEG2 (e.g. 1001, 1002, 1011, 1012):



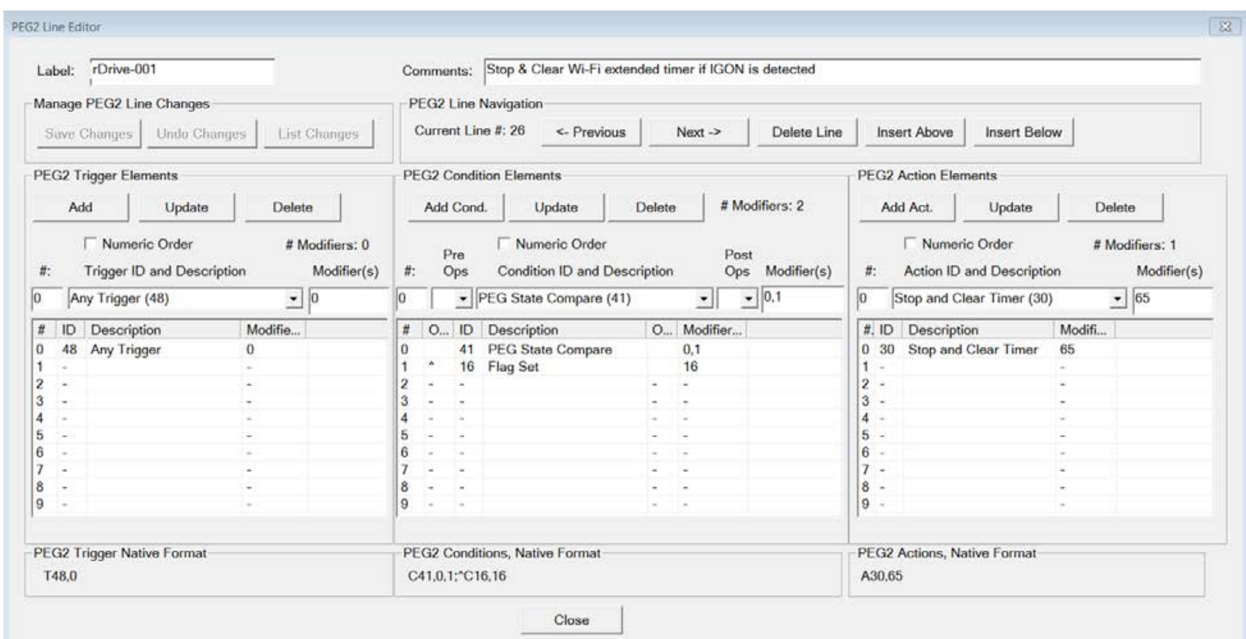
5.6.2 PEG2 Readable Text

To switch from PEG2 ASCII to readable text, you can toggle the blue cross bar icon on top left.



5.6.3 Single Line Editor

Double click on any line to open the Single Line Editor screen to add, edit, delete or insert a PEG2



6. LMU32 vs EdgeCore Platform Differences

I/O Mapping

I/O	LMU 8-Bit	LMU-1300
Input-0	Ignition	Ignition
Input-1	Motion Wake	Motion
Input-2	Pwr State Wake	Pwr State
Input-3	Vbatt Low Wake	Vbatt Low
Input-4	Batt Virt Ign	Batt Virt Ign
Input-5		
Input-6		
Input-5		
Input-6		
Input-7		
Input-8		
Input-9		
Input-10		
Input-11		
Input-12		
Input-13		
Input-14	Pure Virt Ign	Pure Virt Ign
Input-15		
Input-16	N/A	Motion Wake
Input-17		
Input-18	N/A	Power State Wake
Input-19		
Input-20		
Input-21		
Input-22		
Input-23	N/A	Radio Active Wake
Input-24	N/A	BLE Wake
Input-25	N/A	N/A
Input-26		
Input-27	N/A	Crank Detect Wake
Input-28	N/A	RTC Wake

6.2.1 3-Axis Accelerometer + 3-Axis Gyroscope

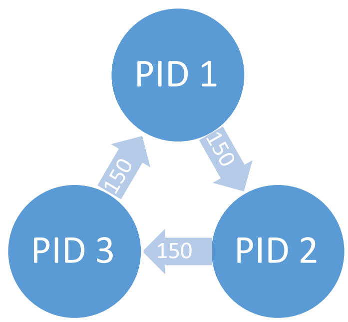
The LMU-1300™ supports an internal 3 Axis Precision Accelerometer as one of its discreet inputs. When the LMU is moved in any direction, the associated input will be in the High state. If the LMU's accelerometer does not detect motion, then the input will be in the Low state. No external connections are required for this functionality to be operational.

Accelerometer	Gyroscope
Acquisition rate: >1600Hz	Acquisition rate: >1600Hz
Sampling rate - output data rate: 100, 200, 400 Hz	Sampling rate - output data rate: 100, 200, 400 Hz
Resolution: <= 0.01G	Resolution: <= 0.01G
Full Scale: 15-24G	Full Scale: 15-24G

6.3 Vehicle Bus PID Polling Rate

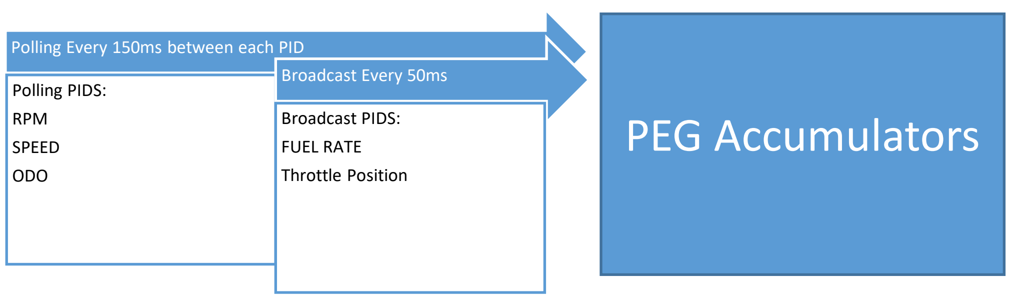
Unlike on the LMU-3030, the polling rate between each PID is a fixed. It is set to 150ms.

Additionally, the LMU-1300 no longer gives priority polling precedence to Speed and RPM PIDs. For example, if there are three registered non-broadcast parameters, each individual parameter is polled every 450ms



The LMU-1300 is different in that in-between each registered (non-broadcast) PID, the device polls for SPEED and RPM, increasing the polling interval between each polled PID by a factor of three.

On the LMU-1300, Broadcast PIDs, if available and registered on the specific YMME installed, do not add to the polling interval. Below is an illustration of this;



6.4 PEG2 “Lines”

PEG2 lines are no longer considered “parameters”. A PEG2 “line” is only a virtual line, but in reality they are not enumerated the same way as in a PEG1 script.

The Script (!SCR) section of a PEG2 file is one whole section that requires either deleting or updating the whole section at once. No individual “line” can be updated.

The following differences should be noted from the LMU32/PEG1 environment:

- Individual PEG "lines" cannot be updated via Param Write or SMS.
- When updating a PEG2 script section, you must provide the complete script.

Note: Configuration Parameters (!CP section) can still be updated as individual parameters via Param Write or SMS.

6.5 Event Index Field

The LMDirect protocol defines the Event Index field as the PEG1 Config Parameter index number of the event that generated the report.

Since this field is limited to 1-byte in the LMDirect protocol and the LMU-1300 uses PEG2 which can have an indefinite amount of PEG "Lines", this field has a slightly new definition. The table below indicates the differences:

PEG1 Event Index	PEG2 Event Index
• Values should range from 0-249. • 255 representing a Real Time PEG Action request.	• Values should range from 0-253. • 254 representing any PEG line number exceeding 253. • 255 still representing a Real Time PEG Action request

6.6 Remote Debug PEG Action

Unlike the LMU32 platforms, EdgeCore (LMU-1300) is always logging at a default level. There is no need to "start capturing" data using Peg Action 144, Modifier 1. To use this PEG Action on the EdgeCore there is a different definition of the modifiers as shown in the following table.

LMU 8 Bit: PEG Action 144 Definition	LMU-1300: PEG Action 144 Definition
Peg Action 144 0 - Stop capturing the LMU debug in SPI Flash **Peg Action 144 1** - Start capturing the LMU debug into SPI Flash. **Peg Action 144 2** - Stop capturing and send the debug captured so far as a file to the server	**Peg Action 144 0** - Save log files in a tar ball in /data/backup/. This is useful for someone at the AT Console to save logs when desired. **Peg Action 144 1** - Upload the existing saved log if the URL specified by Param 2328 is present. **Peg Action 144 2** - Save log files in a tar ball in /data/backup/ and upload the file. This is good for timer or event based log saving.

6.7 Modem/GPS Reset

The LMU-1300 hardware architecture does not support rebooting the modem and/or GPS, since both are on the same chip, they both use the same power rail. A complete system reboot is required to reboot either function.

6.8 SIM Form Factor

All previous legacy Calamp devices utilize a 2FF Micro SIM. The LMU-1300 device uses a 4ff nano SIM.

6.9 Boot Reason

There are some boot reasons that are no longer supported on the EdgeCore platform and some new ones that are only supported on EdgeCore. The table below defines the boot reasons supported on each product type:

Boot Reason	LMU 8-Bit	LMU-1300
Boot Reason 0 (Cold Boot/Normal Power Up)	Yes	Yes
Boot Reason 1 (Power On - Factory Boot)	Yes	No
Boot Reason 2 (Reset Due to OTA Download Complete)	Yes	Yes
Boot Reason 3 (Reset Due to Radio Power Up	Yes	No
Boot Reason 4 (Wake Due to I/O Activity)	Yes	Yes
Boot Reason 5 (Wake Due To Timer)	Yes	Yes
Boot Reason 6 (Wake Due to An Incoming SMS Message)	Yes	Yes
Boot Reason 7 (Wake Due to Application Restart)	Yes	Yes
Boot Reason 11 (Reset Due to Hosted App OTA Download Complete)	N/A	No
Boot Reason 12 (Wakeup from receive line activity on serial port)	N/A	No
Boot Reason 14 (BOOT_WDOG - lmu watchdog reboot)	No	Yes
Boot Reason 16 (BOOT_LMU_HARD_RESET - linux hard crash/kernel panic)	No	Yes

6.10 Peg Resources

The LMU-1300 offers a significant amount of PEG resources for PEG2 scripting and accumulator storage. The table below highlights the PEG resource differences between the product types.

	LMU 8-Bit	LMU-1300
PEG Accumulators	32	254
PEG Timers	32	254
PEG Condition Groups	8	32
PEG TimeDate Masks	8	10
PEG Event Lines/Pages	500/2	Peg2 Script
PEG Zones	32	32

6.11 GPS

Some of the notable differences between GPS operation are indicated in the following table.

	LMU 8-Bit	LMU-1300
GPS Sample Rate	1hz	5hz
Differential GPS	Available	Not Available
SBAS	Available	Available

Assisted GPS	Available (UBLOX)	Available (QCOM) URL: http://xtrapath1.izatcloud.net/xtra3grc.bin

Important Note: If you are using private data plans, it is important to open a tunnel to ensure the GPS Assist URLs can be resolved.

6.12 Motion Logs (1hz vs 5hz GPS Sample Rate)

Since there is a difference in the GPS update rate (1Hz vs. 5Hz) between the LMU8 and EdgeCore products, there is an impact on the sampling in some of the pre-defined motion logs.

On an EdgeCore platform the Short Motion Log types 0-4 samples at a fixed interval of 200mS while on the LMU 8-Bit the sample interval is 250mS. This causes the motion log buffer to fill up faster.

The Short Motion Logs Types are defined on Calamp's wiki site:
https://puls.calamp.com/wiki/Accelerometer_App_Note#Long_Type_0_.28Record_Type_1.29

6.13 Time Sync Precedence

The possible time sources for syncing the system clock is slightly different between the product types. Both are listed below in order of precedence.

LMU 8-Bit	LMU-1300
GPS 3D Fix (highest priority)	GPS 3D Fix (highest priority)
Real Time Clock (RTC)	Real Time Clock (RTC)
GPS Fix (2D-Fix)	N/A
Time Server	N/A
Network Time	Network Time
No Time Sync Available	No Time Sync Available

6.14 Version String in ID Reports

The EdgeCore platform sends and displays the version string in a different format.

6.14.1 ID Reports:

The firmware version of the LMU-1300, can be obtained from the LMDirect ID Report, Extension String field. In that field, there is a new Key-Value pair in the "LMUAPP" extension string. See the definition below.

LMU Application Info

LMUAPP:< DeviceID>,< HW-ID>,< SerialNumber>[,< FileType>,< Version>[,< FileType>,< Version>[,…]]]

Example:

LMUAPP:0,Rev11,,0,1.5.0.2.0.2aaf159,22,,11,,18, Highlighted above is an example of file type '0' which denotes the firmware file paired with the version string. In this example the version of firmware file type is '1.5.0.2.2aaf159'. The version string is 1.5.0.2 and the rest of the string ('2aaf159') is a build number. Please note, other files can be loaded in this field as an array of FileType, Version key-pair values.

6.15 Firmware Revision Convention

The Firmware Revision Convention is defined as follows: MAJOR.MINOR.RELEASE.CANDIDATE.REVISION.HASH[M]
Below is the breakdown:

a) MAJOR.MINOR.RELEASE is the external facing official Version. (e.g. 1.5.4)
b) CANDIDATE is used to address bugs and minor changes. Also external facing (1.5.4.9)
c) REVISION number displays the amount of commits and is used by the development team. Customers can ignore this field.
d) HASH is used by the development team. Customers can ignore this field.

6.16 Status LEDs

The LMU-1300 has 2 status LEDs, green and amber, to indicate GPS/Cell status.

6.16.1 Status LED Behavior

Please note that there are PEG configuration parameters that can change the factory default behavior of all LEDs. LED behavior detail can be reviewed in the table below:

LED Definitions and Behavior

LED #1 (Comm LED – Orange or Amber) Definitions

Condition	LED 1
Modem Off	Off
Comm On - Searching	Slow Blinking
Network Available	Fast Blinking
Registered but no Inbound Acknowledgement	Alternates from Solid to Fast Blink every 1s
Registered and Received Inbound Acknowledgement	Solid

LED #2 (GPS LED – Green or Yellow) Definitions

Condition	LED 2
GPS Off	Off
GPS On	Slow Blinking
GPS Time Sync	Fast Blinking
GPS Fix	Solid

6.17 Version Reports (App Message 111)

Since the firmware versions strings are quite different between the LMU32 and EdgeCore platforms, it is possible that the processing of LMDirect App Message 111 (Version Reports) would require updating in order to properly parse the firmware version.

7. Preparing for Installation

Be sure you have received all the LMU components you need. This must include:

- The LMU to be installed
- Optional Components:
- Input and output cables
- Relays
- LMU peripherals (i.e. Serial adapter, jPOD, TetheredLocator)
- Host serial devices (e.g. PDAs, laptops, other serial devices)

7.1 Plan the Installation

Verify Power, Ground and Ignition. Be sure to check each source (power, ground and ignition) to ensure that the proper signaling exists. This is typically accomplished with a multi-meter.

Before drilling any holes or running any wires, decide where each hardware component will be located (LMU, antennas, peripherals, etc.). Be sure that the cables to the LMU are not bent or constricted in any way. Also make sure that the LMU is kept free from direct exposure to the elements (sun, heat, rain, moisture etc...).

Be advised that an installation that violates the environmental specifications of the LMU will void the warranty.

The best way to ensure a trouble-free installation is to consider your options and make some decisions before you start. Take a look at the vehicle and determine how to best install the LMU for the following purposes:

- Accurate data gathering and simulation of how customers actually use your solution
- Ongoing monitoring and maintenance of LMU equipment
- Accidental or intentional alteration of the equipment or cable connections
- The following sections cover some of the issues to consider when planning your LMU installation.

7.2 Size and Placement of LMU unit

The dimensions of the LMU should be taken into account, particularly when installing in a vehicle:

Whether you intend to place the LMU under a seat or into a cavity behind the vehicle's interior molded trim, be sure the LMU will fit before drilling any holes or running cable

Be certain that the cables running to the LMU will not be bent or constricted. Damage to the cables may impede the LMU's performance.

Be certain that the installation point will not violate any of the LMU's environmental specification (temperature, moisture, etc…) as improper installation of the LMU may void the warranty.

See the LMU Environmental Specifications for the exact measurements and specifications of the LMU-1300™.

Typical installations will place the LMU under the vehicle dash board, or in the trunk. Make sure you can get access to the unit afterwards as under some circumstances it may be necessary to add additional wiring or connections to the LMU.

7.2.1 Protection from Hear

It is best not to place the LMU unit in an unusually warm location such as directly near heater vents, near hot engine components or in direct sunlight. The maximum temperature that can be tolerated by the LMU is described in the LMU Environmental Specifications section.

7.2.2 Visibility of Diagnostic LEDs

Status LED lights on the front of the LMU unit can provide valuable information about the operation of the LMU. When feasible, attempt to install the LMU in such a way that these lights can be seen with reasonable ease.

You may find it useful to be able to view the LEDs periodically to make sure that the LMU is operating properly. If at any time you should encounter a problem with the LMU, you may need to read the LEDs in order to troubleshoot the problem. If you cannot fix the LMU yourself, you will need to provide the LED information to CalAmp customer support.

For information about how to interpret the LEDs, see the Status LED Behavior section.

7.2.3 Cable Length

Do not cut cables. Instead, coil any excess length, making sure not to crimp or flatten any cable.

7.2.4 Moisture and Weather Protection

The LMU unit must be located where it will not be exposed to moisture or water. In a typical installation inside a vehicle this is not commonly thought to be a concern; however, it might be best to avoid locating the LMU below a car’s cup holders, or where rain might easily splash into the compartment when a door is opened.

7.2.5 Preventing Accidental of Unauthorized Modification

If you anticipate that fleet drivers or others might interfere with the LMUs once they are installed, take steps to be sure that it is not easy to remove the LMU from its power source, or disrupt internal antenna interference.

Two common methods are the use of Tamper Proof Sealant or creation of PEG Script to detect power loss or GPS antenna disconnections.

7.3 Installing the LMU in a Vehicle

This section provides instructions for installing an LMU in a vehicle.

Be sure to consider the design decisions described in the previous sections. When you are ready to begin installing the LMU, follow these steps:

7.3.1 Place the LMU in the Vehicle

The LMU-1300 contains an internal battery, and thus should be oriented with the label facing upwards towards the sky. LMUs with internal antennas should be placed directly under a thick panel to maximize their performance and protect from external elements. A typical location includes under the dash close to the front wind-shield.

Attach the LMU to the solid body of the vehicle, not to plastic panels. The LMU can be placed out of sight by removing interior trim and molding to expose available space, then replacing the trim once the LMU is in place.

7.3.2 Connect Power, Ignition, and Ground

The power input (red wire) must be connected to a constant (un-switched) +12 VDC or +24 VDC supply; preferably, connected directly to the vehicle battery terminal or as close to it as possible. This connection point should be fuse protected to not more than 5 Amps for 12VDC or 2.5 Amps for 24VDC.

The ignition input (white wire) must be connected to the vehicle ignition or another appropriate key operated line, such as ACCESSORY, ensuring that power to the ignition wire is available only when the vehicle ignition is on.

The ground line (black wire) must be connected to chassis ground.

Failure to connect these lines in the manner described may result in discharge of the vehicle battery.

For best results, it is strongly recommended that the LMU connection be on its own circuit. Connect the power input directly to the vehicle battery if possible and protect the circuit with an inline fuse, as noted above. If you must connect through the fuse box, use standard commercial wiring practices to create a permanent installation rather than using press-in fuse clips or other temporary measures.

DO NOT connect the power cable to the LMU at this time.

7.3.3 Typical Connection Sequence

Connect any peripherals to the LMU

Plug in the power harness.

The physical installation of the LMU hardware is now complete.

8. Installation Verification

In many cases it is desirable to verify that an installed LMU-1300™ is working properly. That is, installers should verify that the GPS and communications functions of the LMU-1300™ are working properly before departing the installation site. In more robust cases, some key configuration settings such as the Inbound Address and URL should also be verified.

Note that these processes are all based on issuing AT Commands to the LMU-1300™. It is expected that installers will have access to a serial port expansion cable and a laptop or PDA capable of a terminal connection. Alternatively, an SMS message can be sent to an LMU-1300™ to obtain its current status.

8.1 Comm Verification

Installers should first verify that the LMU-1300™ has been acquired and has registered to the wireless network.

Comm may be verified using an AT Command: ATIC

Depending on the wireless network being used something similar to what is shown below will be displayed. It is important to verify that 'Yes' values are displayed at the top for Data and Network registration and the correct APN is displayed.

Radio Access : LTE

GSM Registered : Yes, Home

GPRS Registered : No, Searching

Connection : Yes

RSRP : -98 dBm

BER : 0

Channel : 0

Cell ID : 960049202

Base Station ID : 209924879

Local Area Code : 0

NetworkCode : 410

Country Code : 310

IMEI (Modem S/N): 864475040099839

IMSI (SIM ID) : 310170845788488884883

ICC-ID (SIM S/N): 89011703278457884883

Phone Number :

GPRS APN : LOJACK03.COM.ATTZ

Maint. Server : 216.177.93.236(216.177.93.236):20500

Inbound Server : 34.227.33.84(34.227.33.84):20500

Primary Service : srvc(0) log(0) radio(0) inbnd_index(0) mode(0)

If any of the responses return Not-Acquired or Not-Registered (and the APN is correct), the wireless network operator should be contacted for further troubleshooting.

Please note that it may take several seconds (or longer) for the LMU-1300™ to communicate with the modem and acquire the wireless network.

8.2 GPS Verification

The next step is to verify that the GPS receiver is seeing enough satellites to obtain a valid GPS position. Again, installers have two choices on how to perform this verification. First, like the Comm Verification, there is a GPS status LED (i.e., the one closest to the SMA connector). If this LED is solid, then the LMU has found GPS service.

If the LED is not visible then GPS service may be verified using an AT Command:

```
AT$APP GPS?
```

The response should be similar to:

```
Lat=3304713, Lon=-11727730, Alt=0
Hdg=113 Spd=0 3D-RTIME HDOP=130 nSats=7
```

Installers are looking for the 3D-RTIME setting along with a valid Lat, Long pair (i.e. something other than 0). If the GPS receiver does not have a valid lock within 2-3 minutes, for further troubleshooting, installers should contact CalAmp Support (productsupport@CalAmp.com)

8.3 Inbound Verification

The last item to verify is that the LMU-1300™ is sending data to the correct server. In general, this is a two-step process that will need the aid of an observer on the back end. That is, a technician will have to be logged in so they can monitor data coming into the backend mapping/vehicle management application.

First, verify that the LMU-1300™ is using the correct Inbound IP address by using:

```
ATIS
```

The response should be similar to:

```
PUBLIC SERVICES 4
srvc(0)  log(0:0)  radio(0)   mode(0:0) inb(0)  ddd.ddd.ddd.ddd:<ppppp>
srvc(1)  log(1:0)  radio(0)   mode(0:0) inb(1)  0.0.0.0:20500
srvc(2)  log(2:0)  radio(0)   mode(0:0) inb(2)  0.0.0.0:20500
srvc(3)  log(3:0)  radio(0)   mode(0:0) inb(3)  0.0.0.0:20500
```

```
PRIVATE SERVICES 1
srvc(0)  log(0:0)  radio(0)   mode(0:0) inb(0)  0.0.0.0:20500

OK
```

The installer will need to verify with a backend technician that the IP address (ddd.ddd.ddd.ddd) and port (<ppppp>) are correct.

The second step is to verify that the LMU-1300™ is sending data. The best way to do this is to force the LMU-1300™ to send in an unacknowledged Event Report (i.e., its current GPS location) with the following command:

AT$APP PEG ACTION 44 255

The LMU-1300™ will respond with: OK

The backend monitor must then be contacted to confirm that they received an Event Report with Event Code 255.

Assuming that all three sections have passed, the installation can be considered to be complete.

8.4 Verification via SMS

The current Comm, GPS and Inbound status of a LMU can be obtained via SMS provided you have access to an SMS capable phone or PDA.

Using your handset, send the following SMS Message to the LMU:

```
!R0
```

Within a few minutes, the LMU should return a response in the following format:

```
APP: <App ID> <Firmware Version>
COM:<RSSI> [./d/D][./a/A][./L][IP address] [<APN>]
GPS:[Antenna <Short/Open/Off>] | [No Time Sync] | [<FixStatus> <Sat
Count>]
INP:<inputs states> <vehicle voltage>
MID:<mobile ID> <mobile ID type>
INB:<inbound IP address>:<inbound port> <Inbound Protocol (LMD/LMX)>
```

□

APP: o

<App ID>:

The Application ID value of the LMU indicating the host platform and the wireless networking technology of the LMU.

o <Firmware Version>:

The current firmware version in use by the LMU

□ COM:

o <RSSI>:

This is the signal strength the wireless modem sees from the network. In general the LMU is at least scanning for the network if the RSSI is not -113.

o [./d/D]:

If the character 'D' is present, it indicates the LMU had a data session established when it responded to the status request. For the 8-Bit product line an upper case 'D' indicates both the Inbound and Maintenance sockets are ready. The lower case 'd' indicates that only the Maintenance socket is ready. A '.' indicates no sockets are ready.

o [./a/A]:

This field indicates if the LMU has received an Acknowledgement from the Inbound server. This field will be empty if the LMU has never received an ACK. The lower case 'a' will be present if it has received an ACK since the last cold boot (i.e. power cycle) but not the last warm boot (App Restart or Sleep). The upper case 'A' will be present if the LMU has received an ACK since the last warm boot. A '.' Indicates no acknowledgement has been received.

o [./L]:

This field indicates if the LMU's log is currently active. An 'L' indicates that the log is currently in use (i.e. one or more records have been stored) where a '.' indicates the log is inactive.

o [IP Address]:

This is an optional field if and is only present if the LMU has established a valid data session. This field will contain the current IP address of the LMU as assigned by the wireless network. Note that if you see a value of 192.168.0.0, this is an indication that the LMU has not been able to establish a data session.

o [<APN>]

The current Access Point Name in use by a GSM LMU.

- GPS:
    - o [Antenna <Short/Open/Off>]:

This field, if present, indicates a problem with the LMU's GPS antenna. A value of Short indicates that the antenna cable has likely been crushed. A value of Open indicates that the antenna cable is either cut or disconnected. A value of Off indicates that the LMU' GPS receiver is off.

- o [No Time Sync]:

If this field is present, it indicates that the LMU's GPS receiver has not been able to find even a single GPS satellite. This would likely been seen in conjunction with the above antenna error, or if the LMU GPS antenna is otherwise blocked.

- o [<FixStatus> <Sat Count>]:

If these fields are present it indicates that the LMU has, or had a valid GPS solution. The <Sat Count> field indicates how many GPS satellites are currently in use by the LMU. The <FixStatus> field indicates the type of fix. The Fix Status types are detailed in the LM Direct Reference Guide.

- INP:
    - o <input states>:

This field details the current state of each of the LMU's discreet inputs. This field is always 8 characters long. The left most character represents the state of input 7 where the right most represents the state of input 0 (i.e. the ignition). A value of 1 indicates the input is currently in the high state. A value of 0 indicates it is currently in the low state.

- o <vehicle voltage>:

This field will contain the current reading of the LMU's internal A/D. This will be the supply voltage provided to the LMU in mV.

- MID:
    - o <mobile ID>:

This will be the current mobile ID in use by the LMU.

- o <mobile ID type>:

This will be the type of Mobile ID in use by the LMU. The available types are, Off, ESN, IMEI, IMSI, USER, MIN and IP ADDRESS.

- INB:
    - o <inbound IP address>:

This is the current IP address in use by the LMU. This value should match the IP address of your LM Direct™ server.

o <inbound port>:

This is the current UDP port the LMU will use to deliver its LM Direct™ data. This value should match UDP port you are using on your LM Direct™ server. It is typically 20500.

o <Inbound Protocol (LMD/LMX)>:

This is the current UDP/IP messaging protocol in use by the LMU. In general it should be LMD.

Example Response

```
APP:1001 10a
COM:0
GPS:No Time Sync
INP:11100111 13.7V
MID:4141000100 ESN
INB:207.7.101.227:20500 LMD
```

9. Certification

FCC CFR 47 15.19

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.

FCC CFR 47 15.21

Caution: any changes or modifications to this device not expressly approved by CalAmp could void the user's authority to operate the equipment.

FCC CFR 47 15.105 Information to the User

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

Note: This equipment has been tested and found to comply with the limits for a Class 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.

FCC Radiation Exposure Statement:

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

ISED statements

This device contains license-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada’s licence exempt RSS(s). Operation is subject to the following two conditions:

(1) This device may not cause interference.
(2) This device must accept any interference, including interference that may cause undesired operation of the device.

Ce dispositif contient les émetteurs/récepteurs autoriser-exempts qui sont conformes au permis RSS exempt du Canada d'innovation, de la Science et de développement économique. L'opération est sujette aux deux conditions suivantes:

(1) Ce dispositif peut ne pas causer l'interférence.
(2) Ce dispositif doit accepter n'importe quelle interférence, y compris l'interférence qui peut causer le fonctionnement peu désiré du dispositif.

CAN ICES-3 (A) / NMB-3 (A)

Radiation Exposure Statement: ISED

This equipment complies with ISED radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with greater than 20cm between the radiator & your body.

Déclaration d’exposition aux radiations:

Cet équipement est conforme aux limites d’exposition aux rayonnements ISED établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé à plus de 20 cm entre le radiateur et votre corps.

Innovation, Science and Economic Development Canada ICES 003 Compliance Label: CAN ICES-3 (A)/NMB-3(A)

10. Version History

Change Description	Version	Author	Date
Initial draft – General Updates	0.8	L. Gomon	09/22/2020