

UserManual

LN-L

Lioness-L Tracking Device

May 21, 2018



R1.0

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1 Introduction

The LN-L is a self-contained vehicle tracking device that combines GPS location with LTE CAT1/3G fallback cellular connectivity. It is primarily a location reporting device that responds to requests (user, server) and events (timers, geo-fences). Data reports consist of a single record that contains all location data and system status.

The device comes pre-configured from the factory. It is ready to use. The LN-L appears to a user or a server application as an endpoint device. It can be queried, updated and configured either through a serial connection, an over-the-air IP connection, or through SMS messaging. The LN-L presents itself over these connections as an enhanced cellular modem with attached functional elements. These elements include:

- GPS location engine
- Accelerometer
- Input/outputs dedicated for ignition, relay, buzzer, and general purpose
- Serial UART port
- Timers
- Watchdog lockup protection
- Power management
- Event reporting
- Voltage monitoring

Access to these elements and general purpose interfaces is done through an extended AT command set. Configuration parameters are stored to flash memory and are automatically used on the next power up event. For more details, please reference the AT Command document.

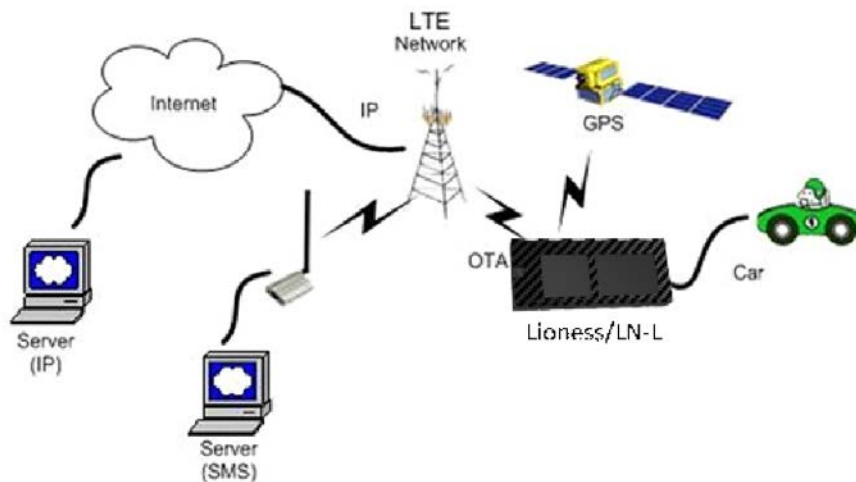


Figure 1

This product is designed based on the Quectel EC21-A (4G LTE CAT 1/3G fallback) baseband module.
Antennas for cellular and GPS are internal to the device.

2 Hardware Design

2.1 Basic Hardware

Items	Requirement
Cellular Modem	Based on Quectel EC21-A baseband module.
Cellular Network Interface	Support for LTE B12, B4, B2 WCDMA B2, B4, B5
Frequency	B2(MHZ): TX(1850-1910) RX(1930-1990) B4(MHZ): TX(1710-1755) RX(2110-2155) B12(MHZ): TX(699-716) RX(729-746) B5 (MHZ): TX (824-849) RX (869-894)
Cellular Antenna	Internal single antenna
GPS Antenna	Dedicate high performance ceramic antenna
UIM Requirement	Support: 3FF SIM Interrupt Mode No Support: Hot Plug/Unplug
Battery Monitor	Internal analog input
Build in battery manager	Yes
Interface	Debug UART
	Application UART
	USB
	12V DC Input (1A current) , Ground
	Relay Drive (Open Drain ,500mA current)
	Dedicated Output for buzzer control
	Ignition Input
	GPIO
Dedicate Timers	Yes
Watchdog	External HW via MCU
Motion Detect	Supported (GPS/G-Sensor)
LED	2 LED Supported 1- RED; 1- Green
Battery	Build in battery (80MAH Lion)
Working Time	4 hours
Power switch	No
Power Cable color	8 colors
Power Cable connector type	8-pin connector
Power Consumption	< 5Watts

The LN- provides support for specialized hardware features through extended AT commands. The features supported include the following:

GPS

GPS location functionality is provided by the device GPS receiver. NMEA GPS records can be extracted in real time from the unit via the UART connection using special debug commands that are outside the scope of this document.

GPIO

One dedicated input, two dedicated outputs, and one general purpose IO are presented to the external environment on the main connector. They are capable of providing system interrupt to generate a report or drive logic levels to external devices. These lines are 2.8V logic level and are 16V tolerant. These pins default to input and are pulled down representing 0 when disconnected. They should be asserted to a known value if used.

LED's

Two LED status indicators are provided to verify correct installation and operation. The status LEDs are color coded and directly convey the status of the cellular and GPS subsystems as described in the table below. Their valid operation also indicates operational status and power.

LED	Function	Status
Red	GPS	On: GPS satellites acquired and Locked Flash Slow: GPS satellite search is in progress Off: No power or GPS subsystem fault
Green	Cellular Connection	On: Indicates LTE connection is made Flash Slow: LTE subsystem initialization in progress Flash Fast: LTE initialization but no data connection available Off: No power or LTE subsystem fault

The LN-L provides user control allowing the LED to be extinguished once installation is verified. This feature reduces power and further conceals the LN-L Tracker from untrained parties wishing to defeat its operation.

UART

There is one UART's provided. A debug UART port is provided for AT commands, data interaction and optionally for application specific control.

USB

The USB port is provided for provisioning or debug available only if the case is open.

Relay Driver

A 500mA sink capable output pin is provided. This pin is meant to drive a relay coil intended to interrupt the starter solenoid relay for the ignition circuit to a car.

Power and Battery

The battery monitor is an internal analog input scaled such that the DC value of the power input pin to the LN-L system is measured. This value is scaled to span the most significant 8 bits of the A/D and consequently covers a scale from 0 to 28 Volts.

Timers

Timers resident on the baseband chip generate periodic interrupts for power down wakeup, watchdog support, periodic report generation and other timer related functions.

Watchdog

Quectel EC21-A chip set provides internal software Watchdog. Also the LN-L includes an MCU that acts as a fail safe external watchdog. The MCU power cycles the system, if no activity is detected for 1 hour.

Accelerometer

The accelerometer can be used for motion detection and driver behavior monitoring.

2.2 Basic RF Performance

Items	Requirements	Remark
TRP free space	LTE B2: channel 650: 20.7dBm channel 900: 20.38dBm channel 1150: 20.76dBm LTE B4: channel 200: 20.7dBm channel 2175: 20.53dBm channel 2350: 20.53dBm LTE B12: channel 5060: 20.3dBm channel 5095: 20.1dBm channel 5130: 20.3dBm	TRP free space
TIS free space	Main: LTE B2 : -94.47dBm LTE B4: -94.4dBm LTE B12: -94.8dBm DIV: DNP	TIS free space

Antenna loss	LTE B2: channel 650: -3.1dBm channel 900 : -3.2dBm channel 1150: -3.1dBm LTE B4: channel 200: -3.2dBm channel 2175 : -3.1dBm channel 2350: -3.2dBm LTE B12: channel 5060: -4.3dBm channel 5095: -4dBm channel 5130: -3.7dBm	TRP-TX Power Conducted
Antenna Loss	Main: LTE B2 : -5.5dBm LTE B4: -5.5dBm LTE B12: -5.2dBm DIV: DNP	RXreceivesensitivityconducted– TIS

BoardRFSpecification			
LTE_B4RX			
B4Frequencyrange	2110-2155MHZ		
Sensitivity	-99.5dBm(10MHZ_50RB_Downlink)		
Dynamicrange	-23 ~ -99.5dBm		
LTE_B4TX			
B4Frequencyrange	1710MHz ~ 1755MHz		
MaximumFrequencyerror	±10Hz		
Maximumoutputpower	23dBm		
Minimumcontrol output power	<-40dBm		
ACLR	UTRA2:46.48 UTRA2:43.87	UTRA1: 41.21 UTRA1: 40.51	E-UTRA1:39.23 E-UTRA2:38.05
OBW	8.87MHZ(10MHZ Nominal)		
IQOFFSET	<-55.6dbc		
EVM	<3%		
LTE_B12_RX			
Frequency range	728MHz~ 746MHz		
Sensitivity	-100dBm(10MHZ_50RB_Downlink)		
Dynamicrange	-23~ -100dBm		
LTE_B12_TX			
Frequency range	698MHz~ 716MHz		
MaximumFrequency error	±10Hz		
Maximumoutputpower	23dBm		
Minimumcontrol output power	<-40dBm		
ACLR	UTRA2:45.48 UTRA2:44.87	UTRA1: 41.41 UTRA1: 41.51	E-UTRA1:39.43 E-UTRA2:38.25
OBW	8.87MHZ(10MHZ Nominal)		
IQOFFSET	<-54.7dbc		

EVM	<3%
LTE_B2_RX	
Frequency range	(1930-1990)MHZ
Sensitivity	-100dBm(10MHZ_50RB_Downlink)
Dynamicrange	-23~ -100dBm
LTE_B2_TX	
Frequency range	(1850-1910) MHZ
MaximumFrequency error	±10Hz
Maximumoutputpower	23dBm
Minimumcontrol output power	<-40dBm
ACLR	UTRA2:46.48 UTRA1: 41.51 E-UTRA1:39.49 UTRA2:44.45 UTRA1: 42.51 E-UTRA2:38.29
OBW	8.87MHZ(10MHZ Nominal)
IQOFFSET	<-54.9dbc
EVM	<3%

GPS	
Frequency Support	L1-band(1.57542GHz) Channels: 210PRN, 66Search, 22Simultaneous tracking
Sensitivity	Sensitivity(UHS): Tracking:-156dBm Reacquisition:-153dBm Acquisition:-144dBm
TrackingTime Requirement	Acquisitiontime: Hot:<2s Warm:<15s Cold:<60s Reacquisition:2s-10sDependsonsignallevel

2.3 Certification andSafety

Items	Requirement
Drop Design	1.2meter 6direction standard drop test
Temperature Range	-20to40°C Operation -50to +100°C Storage
Humidity:	20% to90% Operation 10% to95%Storage
Altitude:	-500 to +18,000m
VehicleISOTest	ISO7637-2-2004;ISO7637-3-2007;ISO10605-2008; ISO16750-2-2010
FCC Certification	FCC 47 CFRPart 15 and Part 18
OtherCertifications	Industry Canada(optional)
ESD Requirement	10KVnon-Conductive
OperatorCertifications	PTCRB / AT&T

3 SoftwareFeatures

3.1 Basic Software

Items	Requirement
Network Interface	LTE B2, B4, B12 WCDMA B2, B4, B5
IPStack	IPV4/IPV6
UpgradeMethod	Remoteupdate/PCtool
RemoteUpdate	Supported – including OMA DM
PowerModes	Supported
ATCommands	Supported
Report	Supported: 3000records
Drivers	GPIO, LED, GPS, UART, USB Accelerometer
GPIOs	InterruptforIgnitionStatus, Buzzer, Relay
LEDs	GPSStatus,NetworkStatus
WatchDog	Supported
Reset	Softreset,hardreset, GPS reset, RF reset
StartupBanner	Supported

3.2 Remote Update

TheLN-LsupportsOTAfieldupgradesoftheresidentapplication.An overthearTFTP(TrivialFileTransferProtocol)connectionismadeoveran IPconnection. Areplacementfileisthentransferred fromaservertotheLN-Landthatfilereplaces thepreviousapplicationimage.

3.3 PowerModes

TheLN-L devicesupportsseveralpowermodesthataresetbyAT commands. InfullpowermodetheGPSisactiveandthecellularsubsystem willmaintaina persistentcellularconnectionwhenever serviceisavailable.IPconnection ismaintained accordingto theconfigurationofthedevice.

Thedevicecanbeputinlowpowermodewheneveritrusonabackupbatteryoriftheexternal batteryis loworifitis notmoving.InlowpowermodetheGPSisnot runningand theLED's areoff.Thedevicewouldreturntofull powerwheneveraneventoccursthattriggersareport. Thoseeventsinclude:

- Periodic report
- GPIO change
- IP change
- Battery threshold
- Heartbeat
- Watchdog

- Power-up
- Ignition
- Trip start and stop

Any hardware or software reset will return the device to full power mode.

3.4 AT Commands

Extended AT commands are specific to the LN-L device. They are closely based on commands that are as similar as possible to industry common devices and are essentially subsets of standard LN-L commands. Native AT commands supported by the Quectel EC21-A modules are also available via the serial and USB interfaces.

3.5 Ack'ed Mode

UDP is not a 100% reliable connection and occasional reports or command/responses may be lost. Since all commands have responses, the server can repeat any command to which there is no response. In order to assure reliable reception of reports, LN-L devices can be configured either in Normal or Ack'ed mode to send the reports. In the Normal mode the reports are simply sent "as is" with no acknowledgment from the server. In the Ack'ed mode every report sent is expected to be acknowledged by the server by sending back an ACK message back. If acknowledgment is not received within the specified timeout, the report is re-sent. If the report is not acknowledged after the specified number of attempts, it is queued. If acknowledgment is received after the report is queued (i.e. past timeout of the last attempt), it is ignored.

Report is not considered "complete" until its acknowledgment is received. Thus, if report X is sent and report X+1 is triggered while waiting for acknowledgment of X, report X+1 will be queued until such acknowledgment is received and only then sent. The LN-L will attempt to re-send queued report(s) every time a new report is triggered. If there is more than one report queued, the reports will attempt to be sent in the order of triggering and only once the report is acknowledged, the next report is attempted. This assures that reports are sent and received in order.

Ack'ed mode assures that all reports are received, but adds overhead in time and data. Report that is not acknowledged is sent again and eventually will be queued and sent again. The number and frequency of re-tries is configurable via the Report Acknowledgement command.

3.6 Event Report Format

Reports are encoded as binary hex. It is also echoed to the debug UART in ASCII format.

3.7 Reset

There are a number of resets available on the device. Soft reset only restarts the software running on the device. Hard reset is caused by resetting the whole baseband module via a reset

pin. There is also an option to reset the GPS and the cellular sub-systems individually.

3.7.1 Context Preservation

When a self-initiated reset is performed due to Network Watchdog or by the Reset command (modes 0, 1), the context of the system is being preserved and is restored after the reset. The context includes all the periodic timers, the report queue, the odometer, etc. This allows to reset the unit as a troubleshooting or preventive measure without losing reports that are already in the queue or are pending on running timers. Note that the reset process may cause 1-2 min of inaccuracy in the timers and should not be considered as very precise.

3.8 Startup Banner

After a reset a startup banner is printed through the UART only.

4 TestMethod

4.1 Hardware

Test Item	Description
Baseband FunctionTest	• Power InputTest • Power Consumption and CurrentTest • Heat DissipationTest • UARTStabilityTest • GPIOLevelTest • LED StabilityTest • DropDownTest • ESDTest • High/LowTemperatureTest • HumidityTest
RFTest	• RF PerformanceTest • GPS PerformanceTest • Antenna PerformanceTest

4.2 Software Test

TestEnvironmentConstruct

☐ MessageTestenvironment

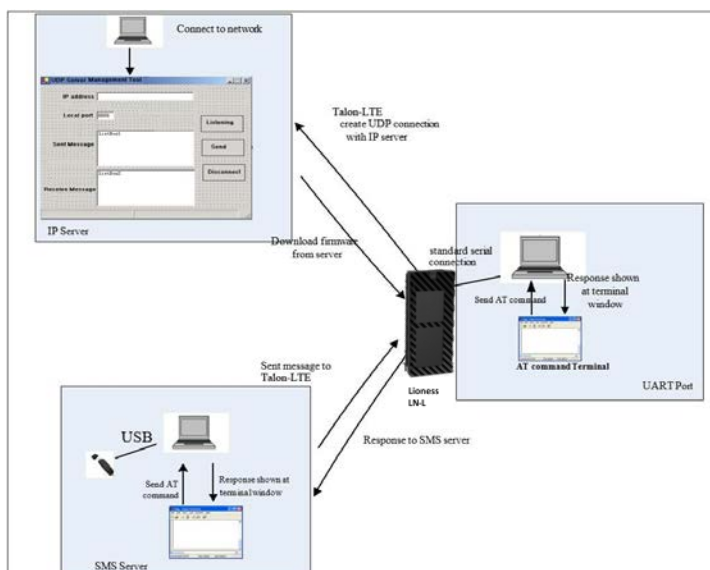
- 1.USBdongleandPCasmessageserver
- 2.SendmessagetoLN-L

☐ UDPTestenvironment

- 1.ConnectdongletoPCandcreatedialupasipserver
- 2.LN-LcreateIPconnectiontoserver

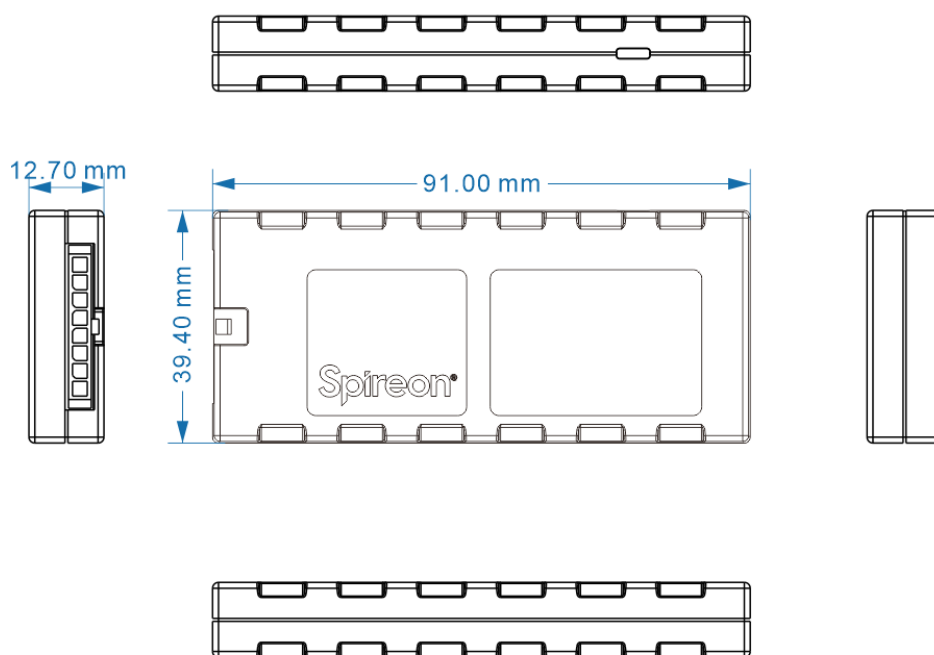
☐ UARTTestenvironment

- 1.ConnectLN-LtoPCwithcomserialcable
- 2.OpenTerminaltoolandsendatcommand
- 3.Responsecanbeshownatterminalwindow



批注 [GE1]: Needs update

MechanicalStructure (mm)



FCC Statement

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 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.

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.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

RF Exposure Warning Statements:

The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons during the normal operations.

IC STATEMENT

This device complies with Industry Canada license-exempt RSS standard(s). 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.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

In order to avoid the possibility of exceeding the IC radio frequency exposure limits, human proximity to the antenna shall not be less than 20 cm (8 inches) during normal operation.

Afin d'éviter la possibilité de dépasser les limites d'exposition aux fréquences radio de la IC NR102,

la proximité humaine à l'antenne ne doit pas être inférieure à 20 cm (8 pouces) pendant le fonctionnement normal.