EXHIBIT 12
OPERATIONAL DESCRIPTION

U.S.TELEMATICS PROJECT

LoCate™

Product Specification

Document: DOC/TEL/003
Date: 05.21.2001
Issue: 4.6
Author: I.M. Fairman
Editor: CSI-Wireless

TABLE OF CONTENTS

Acronyms and Abbreviations

bps	Bits per Second
ADDR	Address (Data)
AMPS	American Mobile Phone System
ASP	Application Service Provider
CVDM	Cellular Voice Data Modem
DAC	Digital to Analog Converter
DGPS	Differential Global Positioning System
DSP	Digital Signal Processor
DUT	Device Under Test
EEPROM	Electronic Erasable Programmable Read Only Memory
EMC	Electro-Magnetic Compatibility
ESD	Electrostatic Discharge
ESN	Electronic Serial Number
FCC	Federal Communications Commission (USA)
FLASH	Type of computer memory
FCP	Function Control Processor
FOCC	Forward Control Channel
GUI	Graphical User Interface
GPS	Global Positioning System
ID	Identification (Numeric or alpha value)
I/O	Inputs and/or outputs
LJU	LoJack Unit
LCC	LoJack Call Center
mA	Milliamp (1000^{th} of an Ampere)
mSec	Millisecond (1000^{th} of a second)
mW	Milliwatt (1000^{th} of a Watt)
MIN	Mobile Identification Number
PCB	Printed Circuit Board
PPM	Parts per Million
RAM	Random Access Memory
RECC	Return Control Channel
RF	Radio Frequency
RSSI	Received Signal Strength Indicator
RTC	Real Time Clock
RX	Receiver or Receive
SAE	Society of Automotive Engineers
SID	System Identification Number
SMC	Sub-Minature Connector
TNC	Type of RF Connector

VSWR	Voltage Standing Wave Ratio

Definitions

Action	A programmed response to an exception.
Aeris	Company that invented and operates the MicroBurst network in North and South America.
Almanac	A subset of orbital parameters from the GPS satellite ephemeris used to calculate approximate satellite positions and velocities.
Baud	A unit of measurement specifying the signaling rate (Signals/Sec).
Concierge	Like a Concierge in a hotel, but offering help via cellular telephone
Control Channel	A specific cellular communications channel designated for use by the cellular system to set up a voice telephone call between the PSTN and a cellular user, and to control handover.
Ephemeris	A set of GPS satellite parameters used to calculate precise satellite positions and velocities.
Exception	A predefined event or condition that causes a programmed response (Action).
Geo-Fence	An electronically created boundary or enclosed area comprising of a number of latitude and longitude coordinates.
Host	The LoCate central software and protocol server applications that control and monitor all messages sent between the Locate devices in the field and the user interfaces.
Immobilizer	Type of vehicle security alarm that has the capability to immobilize the vehicle by interrupting the fuel line or ignition.
Intermodulation	Interference created when two discrete radio signals combine to create a third interfering radio signal.
MicroBurst	Data communications specification using telephone signaling protocol of the Analog Cellular Telephone system
PSTN	Public Switched Telephone Network (the copper wire telephone system)
System Timing	A set of rules and actions which determine how and when the product makes decisions

Telematics New technology description of Electronic Vehicle information, communications, positioning and security services

Typical Expected value under normal operating conditions

1.0 INTRODUCTION

1.1 Product Overview

The LoCate™ device is designed to be installed into a wide range of vehicles to provide Telematics services. The device provides a specific set of features for safety, security and tracking through the integration of Cellular Control Channel data communications, Global Positioning System (GPS) technology, and an intelligent power management capability. Command and control of the LoCate unit is managed via an Application Service Provider (ASP) Web browser interface provided through the user's Personal Computer, or via the LoJack Call Center operator.

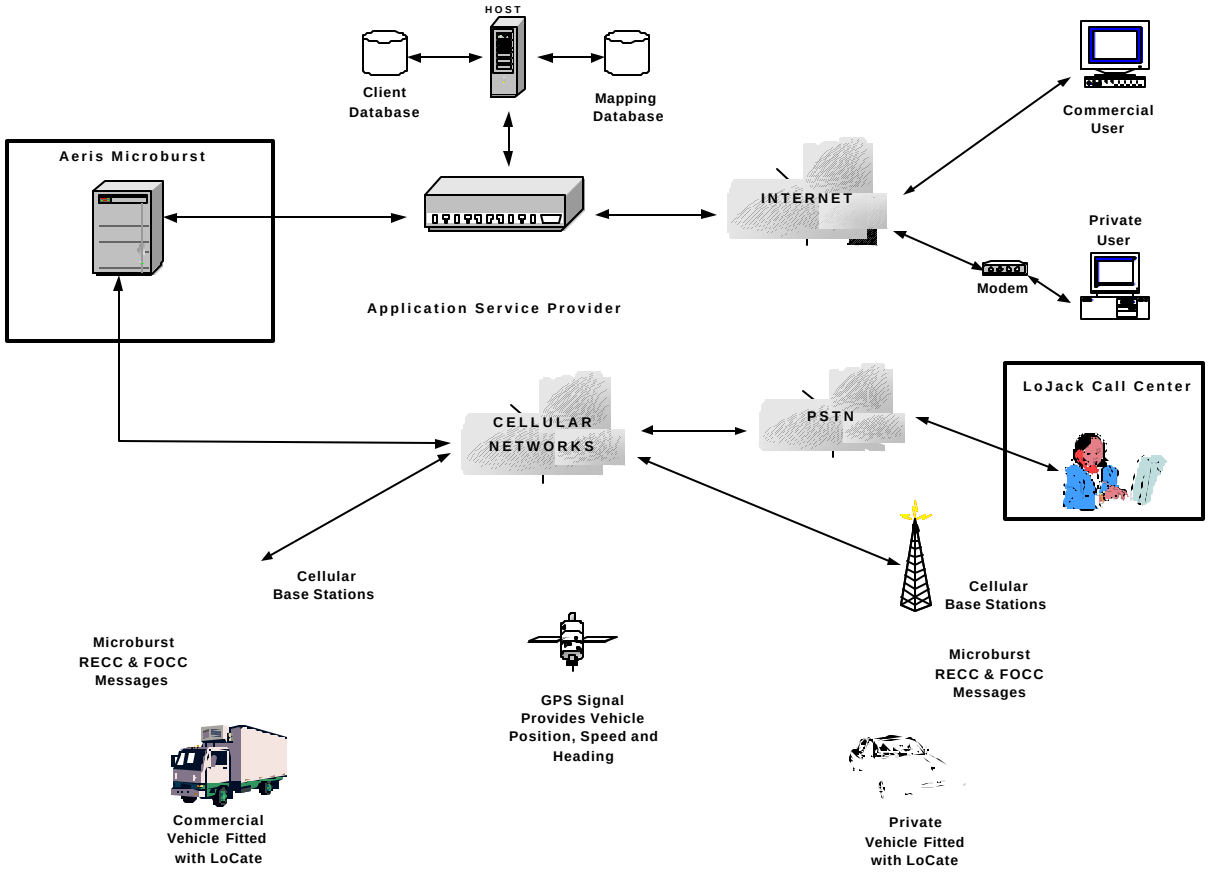


Figure 1 – LoCate by LoJack Operational Overview

1.2 Product Features

The LoCate™ device incorporates the following major features:

i. Integrated Microburst control channel radio, GPS receiver and power management modules.

ii. Real Time Clock for scheduling events and power management.

iii. Low power mode.

iv. Automatic Crash Notification.

v. Event schedules & triggers.

vi. Protected automotive power supply.

1.3 Product Components

Figure 3 is a block diagram of the LoCate™ vehicle unit depicting the major components and interfaces.

The LoCate™ Product consists of the following major components:

i. Twelve Channel GPS Receiver.
ii. 600 mW Cellular Voice & Data Modem (CVDM).
iii. Highly Integrated Function Control Processor (FCP) firmware.
iv. Power Management Unit.
v. One analogue input.
vi. Two digital inputs for connection to the external crash sensor.
vii. Two digital outputs for interface to a vehicle security system, immobilizer or other external devices.
viii. Two relay driver outputs for control of door unlock and starter disable relays.
ix. GPS and cellular antennas, supplied separately.

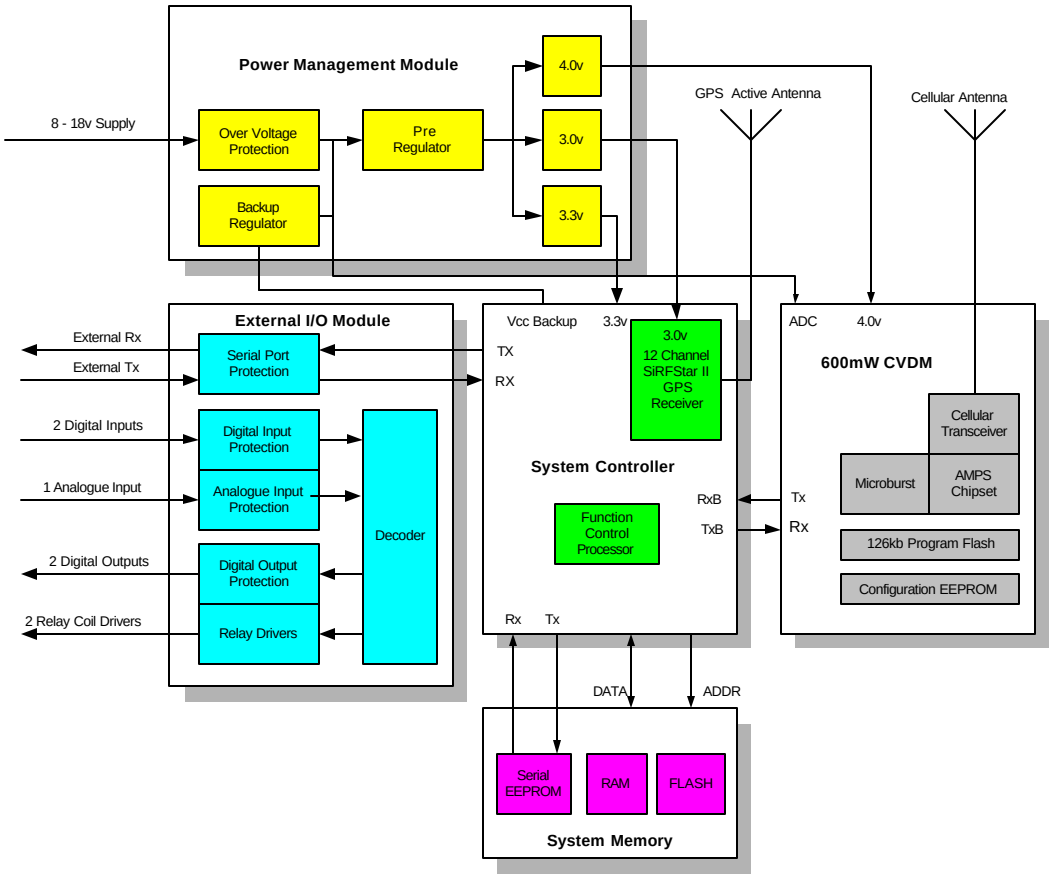


Figure 2 - LoCate Device Block Diagram

1.4 Operating Modes

The LoCate™ device incorporates three distinct operating modes:

1. Engine Running Mode
2. Power Management Mode
3. Complete Shutdown Mode

In the Engine Running mode the device remains in a fully operational state. In the Power Management mode the device assumes that the engine is not running and utilizes 3 states that are designed to conserve vehicle battery power, while allowing the device to remain operational. The device is designed to remain in the Power Management mode for 72 hours, or until the vehicle battery voltage drops below +8 volts.

In this mode the device transitions between 3 distinct states:

1) Power Off State

2) Armed State

3) Active State

Transition between the 3 states is determined by the following:

I. Expiry of an allocated state time slot.

II. Activity on the Analog I/O # 1input, either of the two Digital I/O # 2 & 3 inputs.

III. Reception of an FOCC message from the host.

In the Complete Shutdown mode the device is non-functional due to either the vehicle battery supply dropping below +8 volts, or expiry of the 72 hour Power Management period. In this mode the device will only switch on when the vehicle battery supply voltage is + 12.8 volts, where it will automatically switch to the Engine Running Mode.

2.0 DETAILED PRODUCT DESCRIPTION

This section provides a detailed description of the LoCate product.

2.1 Twelve Channel GPS Receiver

The LoCate™ unit incorporates an integrated twelve-channel GPS receiver based on the SiRFStar II chipset. The SiRFStar II architecture includes acquisition accelerator and multi path mitigation hardware.

2.1.1 GPS Position/Velocity Fix

The GPS receiver establishes a position fix as shown in Table 2.

Time for Fix	Certainty	Conditions
< 1min.	90%	GPS receiver powered on 6 –24 hrs. without a current almanac, satellite ephemeris, initial position or time.
< 30 sec.	90%	"Warm Start", GPS receiver powered on 1 – 6 hrs. with a current almanac, satellite ephemeris, initial position and time.
< 10 sec.	90%	"Hot Start", GPS receiver powered off for less than 60 minutes with a valid almanac, satellite ephemeris, position and time.

Table 1 - Establishment of Position Fix

During the Active State the GPS remains fully operational, continuously updates the almanac, and is attempting position fixes.

The GPS receiver can be configured during the Armed state to specify the "maximum time to fix" interval allowed for the receiver to obtain a fix before powering off. This is necessary in situations where the GPS antenna is completely hidden from the sky and cannot get an updated position fix during its 'wake-up/status check' cycle.

During the Armed state the GPS receiver is immediately powered off after getting a valid fix and determining that the vehicle has not moved.

2.1.2 Geo-Fences

The LoCate™ device will be factory programmed with 4 Geo-fence settings. The default setting will be "OFF". The radii of the 3 other settings are as follows:

1. Geofence # 1: 0 to 1 mile radius
2. Geofence # 2: 0 to 25 miles radius
3. Geofence # 3: 0 to 50 miles radius

Users can change these settings via their web page interface or by contacting the LCC, where FOCC commands are sent to the device instructing it to select the required radius. A geo-fence defines a boundary or a geographic area calculated as a radius from a central point.

Only one geo-fence can be enabled at a time. The LoCate device will send a RECC Status message to the host in the event that the vehicle crosses the fence or boundary (exception).

The four settings are selected following receipt of an FOCC message containing one of four secondary MIN's from the host. These MIN's are allocated as follows:

1) Secondary MIN # 5 selects Geo-fence # 1, 0 to 1 mile radius.
2) Secondary MIN # 6 selects Ge0fence # 2, 0 to 25 miles radius.
3) Secondary MIN # 7 selects Geo-fence # 3, 0 to 50 miles radius.
4) Secondary MIN # 9 switches the Geo-fence feature off.

The current GPS position of the vehicle is used to calculate the Geo-fence's radius center point, known as the "Home Origin". Once a Geo-fence setting has been selected, the LoCate device will transmit a RECC message to the host in the form of a "Status Message" when either of the following exceptions arise:

I. The vehicle crosses or exits the geo-fence,
II. The LoCate device powers up outside the geo-fence.

2.1.3 Home Origin

One Latitude-Longitude position, referred to as Home Origin, can be entered in the FCP EEPROM configuration memory when any of the three Geo-fence settings are selected. This position is used to calculate the radius of the selected geo-fence, and subsequently the distance from the center of the circle.

2.1.4 Differential GPS

The LoCate™ device described in this document does not support DGPS computations.

2.2 Function Control Processor (FCP)

The FCP performs the following functions:

1) Monitors the vehicle battery voltage.
2) Controls the Operating modes and states.
3) Monitors and controls external I/O port signals (both digital and analog).
4) Controls the CVDM module.
5) Controls the GPS receiver.
6) Manages the non-volatile configuration memory in serial EEPROM.
7) Schedules event processing.
8) Performs exception handling (such as input signal and Geo-fence exceptions).
9) Maintains the Real Time Clock (RTC).
10) Supports FCP FLASH program code updates through the asynchronous RS-232 serial communications interface.

2.3 Power Management Unit

The Power Manager Unit (PMU) provides for:

1) The conditioning of an external +8 to +18 volt power source.
2) + 3.6/+ 3.3 volt regulation.
3) Power management of the Cellular Control Channel Transceiver and the GPS receiver.

2.3.1 Power Input Special Protection

The power input lines will have suitable protection to meet the requirements as specified in Section 3.6 of this specification.

2.4 System Timing

Accurate system timing is derived from two sources, the GPS satellite timing information, and the internal Real Time Clock (RTC). When the GPS receiver is active and can see at least one satellite, the RTC becomes synchronized with the GPS timing information.

In the event that the GPS receiver looses contact with the GPS satellites, the system timing is maintained by the RTC. The timing information is used to control and manage the following:

1. Transition timing between the Power Off, Armed and Active states.
2. The length of time the device remains in each state.
3. Control of the Wake-up timer.
4. Control of the Power Management Mode 72 hour cycle.

2.5 External I/O Module

The external I/O module performs the following functions:

1. Manages the external I/O signal configuration.
2. Monitors the external digital and analog input exceptions
3. Manages the digital output conditions.

2.5.1 I/O Ports

Seven I/O ports are provided for connecting external devices and are defined as follows:

1. Three inputs, two digital and one analog. Polled once per second, as an interrupt to wake up the unit when in the Armed state.
2. Two digital outputs.
3. Two relay driver outputs designed to control Bosch Automotive relay, type VF4-45F11-S01, or electrical equivalent.

2.5.2 I/O Port Functions

The seven I/O ports of the LoCate device are configured as follows:

Port #	Designation	Type	Function	Signal Characteristics
1	Output	Relay Driver	Doors Unlock Relay	Pulse active LOW, 1 sec maximum
2	Output	Relay Driver	Starter Enable/disable Relay	Level, remains HIGH or LOW as determined by MIN 3 or MIN 4
3	Input	Digital	Crash Sensor, Low Impact	Active LOW, 1 sec Minimum. Rise time less than 150 µsecs
4	Input	Digital	Crash Sensor, High Impact	Active LOW, 1 sec Minimum. Rise time less than 150 µsecs
5	Output	Digital	Future Assignment	
6	Output	Digital	Future Assignment	
7	Input	Analogue	Future Assignment	

Table 2 – I/O Port Configuration

2.6 Event Monitor and Exception Handler

The LoCate™ device is programmed to recognize a number of events as exceptions and use these to trigger an RECC Status Message. Some examples of these events are:

1. Excessive speed. (Not currently supported)
2. Door lock open/close, as defined by monitoring of a LoCate digital input. (Not currently supported)
3. Geo-fence violation.
4. The GPS antenna disconnected.
5. Vehicle alarm violated, as defined by monitoring of a LoCate digital input. (Not currently supported)

2.7 Action Scheduler (Not currently supported)

The LoCate™ unit allows as many as four independent schedules to be used to schedule a number of actions. Actions can be scheduled singularly or in groups with the action group type.

A schedule contains a list of up to 21 discrete times of the week that is used to schedule an activity at absolute times of the week such as 8:00 A.M. on Monday and 5:00 P.M. on Friday.

An example of a contiguous schedule would be as follows:

1. Disable an exception condition configured to be an alarm at 8:00 A.M. on Monday.

2. Enable an exception condition configured as an alarm at 5:00 P.M. on Monday.
3. Repeat (1) and (2) for each remaining weekday until finally enabling the alarm exception at 5:00 P.M. on Friday for the weekend until Monday at 8:00 A.M. when the schedule repeats.

2.8 On-Board Diagnostics

The LoCate™ device incorporates on board diagnostics and troubleshooting support accessible via the RS232 serial port. The device is automatically switched to the Diagnostic Mode when the serial port detects connection of the Asset Vision Link test software. This application provides the following information:

1. GPS fix attained (Yes/No)
2. GPS Antenna Status (Connected/disconnected)
3. CVDM RSSI
4. Asset voltage
5. Asset ID
6. Internal phone number (MIN)
7. System Identification (SID)
8. ESN

2.9 Power Consumption Profile

The table below details power consumption figures in the 3 states:

State	Time In State	Typical Current	Details
Power Off	2 to 63 sec	65uA	The unit has a programmable power off state duration from 2 to 63 sec. At the end of this interval the unit switches to the Armed state. The unit will switch to the Active state if triggered by either of the digital inputs, the analog input or the serial input.
Armed	60 msec	23mA	The unit switches to the Armed state from the Power Off state for 60 msec to: i. Check for FOCC messages ii. Check for I/O port activity iii. Check vehicle battery voltage iv. Check 72 hour timer If any of the above are TRUE, LoCate switches to the Active state, if none are TRUE, LoCate switches back to the Power Off state.
Active	150 msec minimum	20mA (diagnostic)	The unit will enter the Active state from the Armed state, or from the Power Off state if triggered by either of the digital inputs, the analog input or the

		550mA (All modules ON)	serial input. Length of time in the Active state is dependant on the task to be performed, and external system influences.

Table 3 – Power Off Mode Consumption

Table 5 below lists the power consumption for each of the hardware modules that are controlled by exceptions, schedules, configuration or remote actions. The current drain requirement is determined by adding the individual module consumption to the FCP minimum of 30 mA.

Module	Time in State	Typical Current	Details
CVDM Min	As long as LCP is active	20 mA	FCP diagnostic state that is entered into whenever the LCP is active
CVDM Standby	Programmable	100 mA	This mode allows the LoCate device to receive a message (FOCC), a diagnostic command or exception action.
CVDM Transmit	Controlled by Cellular Network	290 to 400 mA	The 600 mW transmitter is ON. Current depends on power level setting controlled by the cellular base station.
GPS Receiver	Time to get a fix	15mA including active antenna consumption	The GPS receiver is ON and attempting a position fix. The CVDM receiver is switched ON by the GPS fix action.

Table 4 – LoCate Hardware Module Consumption

3.0 POWER MANAGEMENT FEATURE DESCRIPTION

The objective of the Power management feature is to provide the vehicle owner or operator with access to the Locate Telematics features when the engine is not running and the vehicle battery is being discharged. It is important that the current draw of the device does not adversely contribute to the overall battery drain when the vehicle is left standing for extended periods.

The Locate device is designed to remain functional for up to 72 hours[1] when the vehicle engine is not running, and the vehicle battery is not being charged. To achieve this the device transitions between three operating modes and three states in order to retain functionality, but reduce battery drain. The rules governing these modes and states are described below.

3.1 Engine Running Mode

In this mode the device detects that the vehicle battery voltage is greater than +12.8 volts[2], and continually operates in the **Active** state. In this mode it is assumed that the engine is running and charging the vehicle battery. When the device input voltage drops below +12.8 volts the device will automatically switch to the Power Management Mode. In the Engine Running mode all modules are powered and the analogue and digital input ports are scanned every 1 second. The device will not transition to either the Armed or Power Off states whilst in this mode.

When the device transitions from a Complete Shutdown Mode to Engine Running Mode, a RECC Status message is sent to the host advising that the device has re-registered on the Microburst network. This message is used by the host to clear any “Shutdown” flag previously created by the host when the device shutdown after expiry of the 72 hour Power Management mode period.

3.2 Power Management Mode

The Power Management mode is designed to allow the LoCate device to operate normally, whilst limiting vehicle battery consumption. It does this by transitioning between three states at pre-determined intervals, and remaining in each state for a pre-determined period to carry out certain “housekeeping” functions.

The device will remain in this mode for a minimum period of 72 hours, or until the battery voltage drops below +8 Volts, and then transition to the Complete Shutdown Mode. Prior to switching off the device will transmit a RECC status message informing the host of it’s pending shutdown. This message allows the host to raise a flag on the users web page, advising that no further FOCC messages can be successfully sent to the device.

[1] This period will be configurable, and may alter following extended field testing.
[2] This voltage level will be configurable, and may alter following extended field testing.

3.2.1 Power Off State

This is the lowest power consumption state where only the wake-up timer and the RTC are operating, and the analogue I/O port # 7, and digital I/O ports # 3 & 4, are monitored. The length of time the LoCate device remains in this mode is programmable from 2 to 63 seconds, after which time the device will automatically enter the **Armed** state. In the Power Off state if any of the monitored inputs are triggered, then the device switches to the **Active** state.

If during this state the 72 hour timer expires, or the vehicle battery voltage drops below +8 volts, the device will enter the Complete Shutdown mode and send a RECC status message to the host advising of imminent shutdown.

During this state neither the GPS receiver or the CVDM modules are operational.

3.2.2 Armed State

The LoCate device automatically enters the **Armed** state for 63 milli-seconds provided the input voltage range is +8 to +11.5 volts. During this period the device carries out the following:

1. Checks for any FOCC messages from the host. These are any messages containing secondary MIN's 1 – 9[3]. If any of these messages are received the device will transition to the **Active** state.
2. Checks for any valid triggers on the analogue I/O port # 7, or valid triggers on any of the two digital I/O ports # 3 & 4. If any of these valid triggers are present, the device will transition to the **Active** state.
3. Checks vehicle battery voltage is greater than + 8 volts and less than + 11.5 volts. If the voltage is below +8 volts then the device will send an RECC Status message, and transition to the Complete Shutdown Mode. If the vehicle battery voltage is greater than +12.8 volts the device will transition to the Engine Running Mode.
4. Checks the status of the 72 hour timer. If this period has expired the device will generate a RECC Status Message, and transition to the Complete Shutdown Mode.

During this state the GPS receiver module is powered and able to obtain a position fix and a system timing update from the satellites. The CVDM module switches to the standby mode where it can receive and process any incoming FOCC messages from the host.

3.2.3 Active State

The device will enter the **Active** state, or highest consumption mode, when triggered by either events occurring in the **Power Off** or the **Armed** states. These conditions are described in 3.2.1 and 3.2.2 above.

[3] FOCC commands from the host are not acknowledged.

The length of time the device remains in this state is dependant on the tasks it is required to perform, but will typically be a minimum of 150 milli-seconds.

During this state all modules are powered up and the CVDM module can transmit any RECC messages to the host.

3.3 Complete Shutdown Mode

In this mode the Locate device is completely non-functional and has shutdown, as a result of the following:

1. The vehicle battery voltage is less than +8 volts.
2. The device has transitioned from the Power Management Mode to the Complete Shutdown mode following expiry of the 72 hour timer.

Prior to entering this mode the device will transmit a RECC Status message to the host advising of it's impending shutdown. The device will only enter the Engine Running Mode once the vehicle battery voltage has reached + 12.8 volts[4] (engine running), and become fully operational.

At this instance the device will re-register on the Microburst network and transmit a RECC status message to the host, which in turn will clear any shutdown advisory flag at the users web page interface. The host will differentiate between this RECC status message, and the previous RECC status message, using bit stuffing allocations in the message field of the RECC0 message.

[4] This is precautionary to prevent the device trying to transmit on a possible flat battery.

4.0 PERFORMANCE SPECIFICATIONS

4.1 CVDM

The LoCate cellular transceiver comprises of the following components:

1) AMPS radio
2) AMPS Chipset
3) Microburst firmware
4) 128 KB Program FLASH Memory
5) Configuration EEPROM

Parameter	Specification	Units
Frequency Range (Tx)	824.010 – 848.970	MHz
Frequency Range (Rx)	869.010 – 893.970	MHz
Channel Spacing	30	KHz
Deviation	± 12	KHz Max.
Number of Channels	832	
Antenna Impedance	50	Ohms
Receiver Sensitivity	-116	dBm typical
Adjacent Channel Rejection	-16	dBm minimum
Alternate Channel Rejection	-60	dBm minimum
Intermodulation Rejection	-65	dBm minimum
Transmitter Power Output	0.6	Watts nominal
Peak Deviation	+/- 8	KHz
Frequency Stability	+/- 2.5	ppm maximum
Carrier Switching Time	2	ms
Channel Switching Time	40	ms maximum

Table 5– CVDM Performance Characteristics

4.2 GPS Receiver

The LoCate GPS receiver comprises of the following components:

1) SiRFStar II chipset.
2) AMPS cellular chipset
3) Memory

The major specifications are as follows:

Parameter	Specification
Receiver	L1, C/A code
Channels	12
Max Solution Update rate	10/second (1/second standard)
Satellite Reacquisition Time	100 ms

Snap Start	< 2 seconds
Hot Start	< 8 seconds
Warm Start	< 38 seconds
Cold Start	< 45 seconds
Minimum Signal Tracked	-175 dBW
Maximum Velocity	< 1,000 knots
Consumption	150 mA
Voltage	3.15 to 5.5 VDC
Protocols	NMEA v2.2, SiRF Binary
Position Accuracy	100 meter 2d RMS SA On 10 meter 2d RMS

Table 6 – GPS Receiver Specifications

4.3 LoCate Antenna Specifications

The LoCate unit requires two separate antennas, or a dual band cellular and GPS antenna to provide communications with the Aeris Microburst network and the GPS satellites.

4.3.1 CVDM Antenna Specifications

The CVDM antenna maybe one of either two types:

1. External mounted whip antenna.
2. Internal Stub antenna.

Parameter	Specification
Frequency	824 – 894 MHz
Gain	3dBd
VSWR	Max 2:1 over range
Max Power	2 watts
Nominal Impedance	50 Ohms
Connector	TNC
Cable (If required)	15 feet RG-174U

Table 7 – CVDM Antenna Specification

4.3.2 GPS Antenna Specifications

Parameter	Specification
Type	Low Noise with Active Amplifier
Frequency	1,575.42 MHz, ±2 MHz
Gain	5 dBiC antenna, 24 dB active amp

Noise Figure	1.5 dB Max
Operating Temp	-30 to + 60 C
Nominal Impedance	50 ohms
Amplifier Bias Voltage	3.3 VDC, ±10%
Connector	SMA
Cable	15 feet RG-174U
Antenna Current	20 mA max.

Table 8 – GPS Antenna Specification

4.4 MicroBurst Communications Requirements

The LoCate™ device will comply with the current EIA and Aeris Microburst specifications:

1) EIA-553 Tower to Mobile Signaling Protocol
2) IS-19 Analog Cellular Standard
3) MicroBurst RF Module Requirements
4) MicroBurst Application Requirements
5) MicroBurst Data Delivery Technical Description
6) MicroBurst Page Delivery Technical Description
7) Aeris Standard Date & Time Format Specification
8) MicroBurst Coverage Determination Application Note

4.5 Environmental Requirements

4.5.1 Temperature and Humidity

Parameter	Minimum	Maximum
Operating Temperature Range	-30 °C	+60 °C
Storage Temperature Range	-30 °C	+60 °C
Operating Humidity @ -30°C to +60 °C, %RH non condensing	0 %	95 %

Table 9 – Temperature & Humidity Specification

4.5.2 Vibration

The LoCate device shall perform normally before, during and after exposure to the operating swept sine vibration profile defined for cab mounted equipment shown in figure A1 of SAE J1455, shown below. Test duration is 180 minutes for each axis.

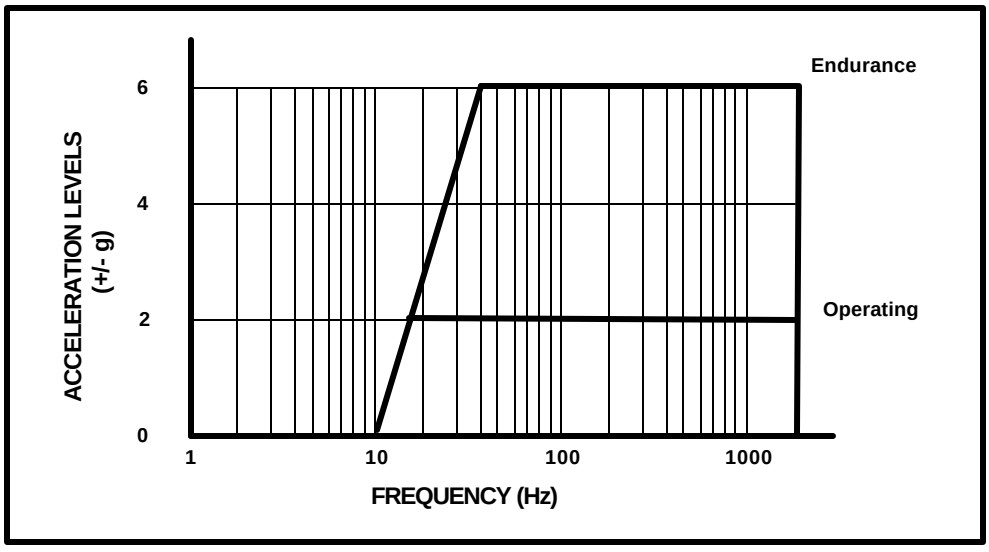


Figure 3 - SAE J1455 Vibration Profile

Only the operating profile in this figure will be performed, per the following acceleration levels:

1. 0 grams for frequencies less than 10Hz

2. Linearly increasing from 0 grams at 10Hz to 2 grams at 18Hz
3. Constant 2 grams from 18 Hz to 1000 Hz

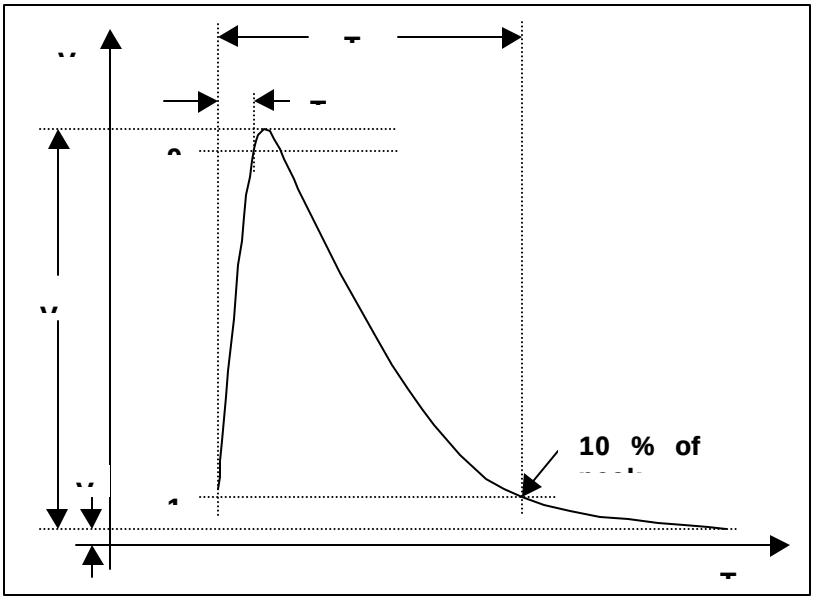
4.5.3 Drop Test

The LoCate™ device shall be dropped from a height of 1 meter onto a concrete surface, once on each face and corner. If the device exhibits obvious physical damage after the drop, this will not be considered a failure. The device will fail the drop test if the unit does not function properly and exhibits hidden damage, which cannot be seen or heard.

4.6 Electrical Stress Requirements

4.6.1 Load Dump

The LoCate™ device shall be subjected to the waveform shown in Figure 4[5]. A total of ten (10) load dump pulses will be applied to the units at a rate of 1 pulse every 10 seconds. After completion of the test, the LoCate™ must pass a room temperature functional test.



[5] The load dump test is only applicable to the power lines, not the I/O lines.

Figure 4 – Load Dump Pulse Test

Open Circuit Characteristics	$13.6 + 80e^{-t/0.18}$Volts
Vs: 93.6 Vpeak	
T: 400mS	
Tr: <10mS	
Rs: 2Ω	

Table 10 – Load Dump Characteristics

4.6.2 Reverse Voltage

The LoCate™ shall be subjected to the following reverse voltage conditions and must pass a room temperature functional test after the reverse voltage test is complete.

-24vdc for 5 minutes

4.6.3 Over voltage

The LoCate™ shall be subjected to the following over voltage conditions and must pass a room temperature functional test after the over voltage test is complete.

+24vdc for 5 minutes

4.6.4 ESD

The LoCate™ shall be subjected to ESD tests as +25°C ambient and <30% RH. Each unit will be subjected to 5 discharges to each external wire, 5 discharges to each antenna, and 5 discharges to housing starting at 1Kv, increasing at 1Kv intervals until a maximum of ±15Kv is reached. The discharge network will be 150pf/150ohm. The LoCate™ must pass a room temperature functional test at the completion of each KV interval.

4.6.5 EMC Requirements

The LoCate™ shall meet the following EMC requirements:

1. Radiated emissions per FCC 47 CFR Part 15 subpart B, section 109 with the transmitter off.
2. Radiated emissions per FCC 47 CFR Part 15 subpart C, section 209 with the transmitter on.
3. Radiated emissions per FCC 47 CFR Part 22 subpart H, sections 22.905, 22.913 and 22.917 with the transmitter on.
4. Conducted emissions per FCC 47 Part 15 subpart B, section 107 and 111 with the transmitter off.

5. Conducted emissions per FCC 47 Part 15 subpart C, section 207 with the transmitter on.
6. Radiated susceptibility of 50Volts/Metre, using stripline, 20KHz-1GHz, DUT and Harnesses.
7. Conducted susceptibility;
    1) Power Lead (3Vpp, 20Hz-10KHz sine wave) No Malfunction
    2) Signal Lead (0.5 Vpp, 20Hz-10KHz). No malfunction
    3) Power & I/O Lead pulse (+10V, 10uS, 5-350pps for 10 secs). No Malfunction
    4) Power & I/O Lead pulse (-10V, 10uS, 5-350pps for 10 secs). No malfunction

4.7 I/O PORTS

4.7.1 Serial Data Port

The LoCate unit has a serial data port for general purpose use, unit configuration and diagnostics. The port is a 9600 baud, full duplex, no parity, asynchronous serial RS232 interface. The electrical characteristics are as follows:

Parameter	Min	Max
Input Voltage High	-3.5V	+5.5 V
Input Voltage Low	-0.6V	+1.0V
Output Voltage High	+4.0 V	+5.5 V
Output Voltage Low	-0.6 V	+0.6 V
Input Impedance	40 Kohm	75 Kohm
Output Impedance	1.5 Kohm	4.0 Kohm

Table 11 – Serial Data Port Specifications

4.7.2 Special Protection

The serial port includes protection from over-voltage faults due to wiring errors. Both transmit and receive lines are protected against voltages of ±36 V DC. A Zener diode on each line protects against transients and ESD.

4.7.3 Analogue & Digital I/O Ports

The LoCate device has seven I/O ports, two digital inputs, two digital outputs, one analogue input and two relay driver outputs. The electrical characteristics are as follows:

Parameter	Min	Max
GENERAL:		
Input Impedance	40 KOhm	75 KOhm
Output Impedance	1.5 KOhm	4.0 Kohm
DIGITAL:		
Input Logic High	+3.5 V	+5.5V
Input Logic Low	-0.6 V	+0.6V
Output Logic High	+4.0 V	+5.5 V

Output Logic Low	-0.6 V	+0.6 V
ANALOGUE:		
Input Impedance	20 KOhm	40 KOhm
Input High Voltage	+6.5V	+7.5V
Input Low Voltage	-0.3V	-0.6V
RELAY DRIVER:		
Output Impedance	0 3hm	3 ohm
Input High Voltage less than 1mA draw	0V	+32V
Reverse Voltage at 1mA draw	OV	-2V

Table 12 – Analogue & Digital Ports Specifications

4.7.4 External Connector Pin Assignments

The external I/O connector shall be a Molex type 53259-1310 or equivalent. The mating connector shall be Molex type 51067-1300 or equivalent connected to the vehicle using a LoJack custom supplied cable harness. The pin assignments for the connector are as follows:

Pin	Description	Notes
1[6]	I/O Port # 1 Relay Driver 1	Connects relay coil to ground, other side of relay coil goes to supply positive.
2	I/O Port # 2 Relay Driver 2	Connects relay coil to ground, other side of relay coil goes to supply positive.
3	I/O Port # 3 Digital Input1	0 and 5 volt logic signal with 2 KOhm series impedance driven from LoCate
4	I/O Port # 4 Digital Input 2	0 and 5 volt logic signal with 2 KOhm series impedance driven from LoCate
5	I/O Port # 5 Digital output 1	0 and 5 volt logic signal with 300 KOhms to ground as input to LoCate
6	I/O Port # 6 Digital output 2	0 and 5 volt logic signal with 300 KOhms to ground as input to LoCate
7	I/O Port # 7 Analog Input	Input for measurement, -3 volts to +7 volts
8	Ground	Connects to chassis of LoCate
9	Serial Output	Signal from LoCate to Computer
10	Serial Input	Signal from Computer to LoCate
11	Spare	No connection
12	5 Volt Reference	5 volts with 2 Kohm series impedance, for reference

[6] Pin 1 is located next to the TNC CVDM connector

		use
13[7]	Battery Voltage	For measurement only, 0 to 20 volts range.

Table 13 - External Signal Connector

4.7.5 External Connector Harness Assignments

The Locate external connector wiring harness assignments are as follows:

External Connector Pin #	Wire Color	Function
1	Green	I/O Port # 1 - Connects to ground side of external door unlock relay
2	Yellow	I/O Port # 2 - Connects to ground side of external starter enable/disable relay
3	Blue	I/O Port # 3 - Connects to Low Sense connection point of Crash Sensor
4	Brown	I/O Port # 4 - Connects to High Sense connection point of Crash Sensor
5	White	I/O Port # 5 - Future digital output connection for external device
6	Grey	I/O Port # 6 - Future digital output connection for external device
7	Violet	I/O Port # 7 - Future analog input connection for external device
8	Black	LoCate device extended ground.
9	Red/White	Serial data 1 output
10	Red/Yellow	Serial data 2 input

Table 14 – External Connector Wiring Harness Assigments

4.7.6 Power Lead Assignments

The LoCate power lead assignments are as follows:

Color	Designation	Notes
Black	Supply Battery Voltage Negative	Power input to Locate, battery negative with protection for current to chassis, connected to chassis with low impedance.
Red	Supply Battery Voltage Positive	Power input to Locate, +8 to +18 volts, 2 amp fused externally, internally protected.

Table 15 - Power Supply Lead Assignments.

[7] Pin 13 is located next to the SMA GPS connector

5.0 MECHNAICAL & PHYSICAL REQUIREMENTS

5.1 Housing Requirements

The LoCate™ shall consist of a PCB contained inside a housing. The approximate size of the LoCate™ shall be 140mm(L) x 76.2mm (W) x 25.4mm (H), not including mounting tabs.

The housing shall meet the following minimum requirements;

1) The housing will be made of Aluminium. The finish shall be pebbled Pentone Process black with a finish equivalent to EDM VDI/36.
2) Three holed mounting tabs will allow for the use of a No.10 sheet metal screw when the unit is installed.
3) The color of the housing shall be black.

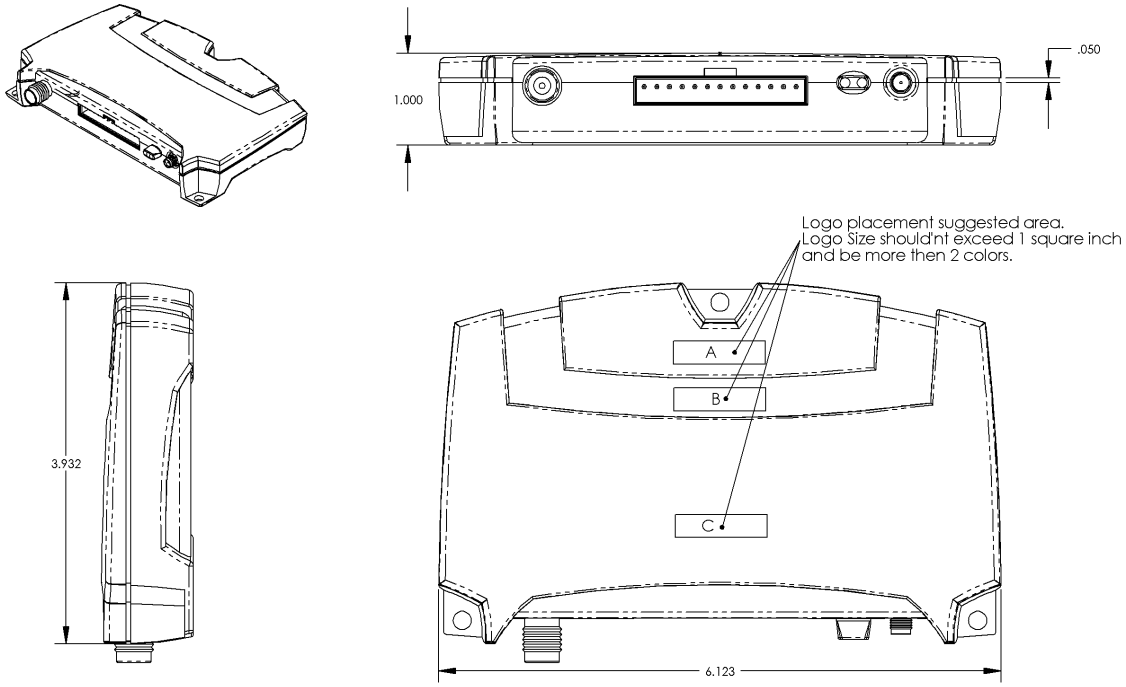


Figure 5 – LoCate Housing Layout

5.2 Connection & Identification Requirements

The LoCate unit shall be supplied with the following;

1) 18 AWG twisted power (red) wire end stripped and tinned, and the ground (black) wire terminated with a No. 10 ring terminal. Length from cable grommet is approximately 11.5 inches (292mm). This connection is to be

brought out of the housing separately from the I/O and RF connectors, through an appropriately size rubber grommet.

2) The I/O lines will terminate using a Molex multi-pin connector mounted on the housing.

3) Two silver labels shall be fixed to the underside of the LoCate housing during manufacture. The top label shall include the Barcode information as detailed in paragraph 4.3 below. The label below shall contain the FCC certification information. Refer to Figure 5 in paragraph 4.1.

4) No over pack box will be provided.

5) A label containing the LoJack Corporation company logo shall be pad printed in the top left-hand corner of the upper side of the LoCate housing. Refer to Figure 5 in paragraph 4.1.

5.3 ESN Barcode Specifications

The LoCate device ESN barcode specifications are as follows:

1) Code 39 Bar Code Label.

2) One(1) label permanently attached to locate device, two(2) "peel and stick" labels attached to locate device, 1 label permanently attached to the box the locate device is packed in.

3) Labels should contain:
4) Code 39 bar code
5) Printed ESN(Serial Number)
6) Printed model number
7) Printed date of manufacture or code representing date of manufacture
8) Printed code for manufacturing facility

9) Minimum size (size of current LJU label): **50mm x 12mm**(label) **27mm x 7mm**(bar code)

10) Maximum size (size of older LJU label, preferred over smaller label): **67mm x 23mm**(label) **56mm x 11mm**(bar code)

11) ESN should consist only of alpha-numeric characters, excluding the letters **I**, **O** and **Q**

12) Check Digit Calculation: Use a Mod 11 calculation method and add the check digit to the bar code and the printed ESN:

13) Assign each character of the ESN a value:

Character	Value
A	1
B	2

C	3
D	4
E	5
F	6
G	7
H	8
J	1
K	2
L	3
M	4
N	5
P	7
R	9
S	2
T	3
U	4
V	5
W	6
X	7
Y	8
Z	9
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
0	0

14) Assign each position of the ESN a multiplier. Assuming an 11 character ESN, the multipliers would be:

Position	Value
1	8
2	7
3	6
4	5
5	4
6	3
7	2
8	10
9	9
10	8
11	7

15) Multiply the number value of the characters in each position by the multiplier. Add the resulting products together and divide by **11**. Use the remainder of this division as the check digit if it is a single digit number. If the remainder is **10**, use the letter **A** as the check digit. If there is no remainder, use the number **0** as the check digit.

16) Example: ESN = 23602018698

POSITION	1	2	3	4	5	6	7	8	9	10	11	TOTAL
ESN	2	3	6	0	2	0	1	8	6	9	8	
Value	2	3	6	0	2	0	1	8	6	9	8	
Multiplier	8	7	6	5	4	3	2	10	9	8	7	
Product	16	21	36	0	8	0	2	80	54	72	56	345

Divide the total by 11:

345/11 = 31, remainder = 4 = Check Digit
ESN with Check Digit = 236020186984

6.0 MIN ALLOCATION STRATEGY

The LoCate device features will be controlled by one Primary and 9 Secondary MIN's. Each secondary MIN is allocated a specific function as indicated in the table below:

MIN #	Feature	Description	Message Types	Remarks
0	Primary MIN	Used for transmitting Microburst messages, not for receiving pages	FOCC	
1	Secondary MIN # 1 **Send Position**	Instructs the device to send it's current GPS position.	FOCC & RECC0	This message only contains position and whether or not the fix is current.
2	Secondary MIN # 2 **Doors Unlock**	Command to instruct I/O Port # 1 to unlock vehicle doors	FOCC	Requires external relay. No acknowledgement.
3	Secondary MIN # 3 **Starter Disable**	Command to instruct I/O Port # 2 to disable vehicle starter circuit	FOCC	Requires external relay. No acknowledgement.
4	Secondary MIN # 4 **Starter Enable**	Command to instruct I/O Port #2 to enable vehicle starter circuit	FOCC	Requires external relay. No acknowledgement.
5	Secondary MIN # 5 **Set Geofence # 1**	Instructs the device to select Geofence No.1 (0-1 mile radius)	FOCC	No acknowledgement.
6	Secondary MIN # 6 **Set Geofence # 2**	Instructs the device to select Geofence No.1 (0-25 miles radius)	FOCC	No acknowledgement.
7	Secondary MIN # 7 **Set Geofence # 3**	Instructs the device to select Geofence No.1 (0-50 milse radius)	FOCC	No acknowledgement.
8	Secondary MIN # 8 **Request Status**	Instructs the device to send Status Message	FOCC & RECC1	
9	Secondary MIN # 9 **Geofence Off**	Switches the Geo-fences OFF	FOCC	No acknowledgement.
	Crash Sensor Low Impact Sense	The Crash Sensor Module will trigger I/O port # 3 .	RECC0	
	Crash Sensor High Impact Sense	The Crash Sensor Module will trigger I/O port # 3 .	RECC0	
	Installation Test	Installer will disconnect GPS antenna that will send a "Status" message. Host will reply with secondary MIN # 2 "Doors Unlock".	RECC1 & FOCC	
	Power Management	The device will apply full power when ignition is "ON" and go into Power Management mode when ignition is "OFF" and remain		Uses 1 exception.

		in this mode for 72 hours or until the battery voltage drops below +8V.		

Table 16 - MIN Allocation Table

Each of the Microburst RECC messages contain a total of 45 bits. A single bit is allocated to Message I.D. to enable the host to identify between a RECC0 (Send Position) and RECC1 (Status) message.

6.1 Send Position RECC0 Message

RECC0 is generated by the device in response to the host sending a Microburst FOCC message containing secondary MIN # 1, to the device in question. This option will be available on the GUI and titled **" REQUEST POSITION"**. A diagnostic message will be generated by the host after a reply window has expired. This window should be based on the maximum expected end-to-end delay period from GUI to host to device to host to GUI, and include any Microburst and Cellular network latency figures.

Of importance with the bit allocations for this message is the resolution accuracy required for the latitude and longitude coordinates, that they match those of the actual GPS receiver. Using 21 bits for latitude and 22 bits for longitude a resolution of **± 9.5 metres**[8] can be achieved.

This allows, 1 bit for the RECC message ID, and a final bit for Current fix. The Current Fix bit says whether or not the position received is a new, current fix. Providing the Microburst message arrives at the host within a short period of time following initiation by the device, it can be assumed that this fix is relatively new.

Bit Allocation	Parameter Description	Resolution
1	RECC Message ID	Full
21	Latitude	9.5 metres
22	Longitude	9.5 metres
1	Current Fix	Full

Table 17 - Send Position RECC0 Message Bit Allocation

6.2 Doors Unlock (Secondary MIN # 2)

This command would be instituted upon receipt from the host of an FOCC message containing secondary MIN # 2 information. This option will be available on the GUI and titled ' **DOORS UNLOCK**". The LoCate device will drive I/O Port

[8] This resolution exceeds attainable GPS accuracy

1 **HIGH** (pulse, 5 seconds) causing the externally mounted automotive relay to unlock the doors.

6.3 Starter Disable (Secondary MIN # 3)

The LoCate device would institute this command following receipt of an FOCC message containing secondary MIN # 3 information from the host. This option will be available on the GUI and titled " **STARTER DISABLE**". The LoCate device will drive I/O Port # 2 **LOW** (no pulse, latched)causing the externally mounted automotive relay to disconnect the vehicle starter circuit.

6.4 Starter Enable (Secondary MIN # 4)

The LoCate device would institute this command following receipt of an FOCC message containing secondary MIN # 4 information from the host. This option will be available on the GUI and titled " **STARTER ENABLE**". The LoCate device will drive I/O Port # 2 **HIGH** (no pulse, latched) causing the externally mounted automotive relay to re-connect the vehicle starter circuit.

6.5 Set Geo-Fence 1 (Secondary MIN # 5)

This MIN sets Geo-fence number 1 (0-1 mile) active, and sets origin to current vehicle position. This feature will be available on the GUI and titled " **SET GEOFENCE 0-1 MILE".**

6.6 Set Geo-Fence 2 (Secondary MIN # 6)

This MIN sets Geo-fence number 2 (0-25 miles) active, and sets origin to current vehicle position. This feature will be available on the GUI and titled " **SET GEOFENCE 0-25 MILES".**

Set Geo-Fence 3 (Secondary MIN # 7)

This MIN sets Geo-fence number 3 (0-50 miles) active, and sets origin to current vehicle position. This feature will be available on the GUI and titled " **SET GEOFENCE 0-50 MILES".**

6.6 Status Message (Secondary MIN # 8)

The purpose of the Status message is to provide the user, or the call center with a tool to check the operability and current status of the LoCate device. This is achieved by selecting the **"SEND STATUS"** feature from within the web page. The device responds with a RECC1 message with the following bit allocations:

Bit Allocation	Parameter Description	Resolution
1	RECC Message ID	Full
8	Vehicle battery voltage	Full
8	RSSI	Full
6	Speed	Resolution to 183 mph, LSB = 2.86 mph
11	Age of Fix	Resolution to 36.4 hours, LSB = 64 seconds
3	GPS status	Full

3	Meter # 9 value (Geo-fence set flag)	Full
1	Constraint region 49 (Geo-fence violation flag)	Full
1	Constraint region 0 (Remote Door Unlock Flag)	Full
1	Constraint region 1 (starter flag)	Full
1	Input 2 Low Impact Sense	Full
1	Input 3 High Impact Sense	Full

Table 18 - Status Message RECC1 Bit Allocation

6.7 Geo-Fence OFF (Secondary MIN # 9)

Turns the Geo-fence mode OFF. This feature will be available on the GUI and titled " **GEOFENCE OFF".**

7.0 INSTALLATION TEST

The installation test for a LoCate installation will consist of the following;

1) Following installation of the LoCate device, relays and combination AMPS/GPS antenna the installer will connect vehicle power and wait for 15 minutes.
2) After this period he will disconnect the GPS antenna for about 30 seconds, then re-connect.
3) This action will cause the device to send a RECC1 **Status Message** to the host.
4) Following receipt of this message the host will check that through bit interrogation of the Status message, a GPS position message has been received and that the other parameters of the status message (RSSI and Vehicle Supply Voltage) are correct.
5) Following this evaluation the host will send a **Secondary MIN # 2 Door Unlock** message to the device.
6) When the device receives this command and unlocks the doors, this will indicate to the installer that he can sign the installation off.
7) If the installer does not see the doors unlock, he will need to contact the LoJack Call Center to assist in diagnosing the problem before he leaves the vehicle.

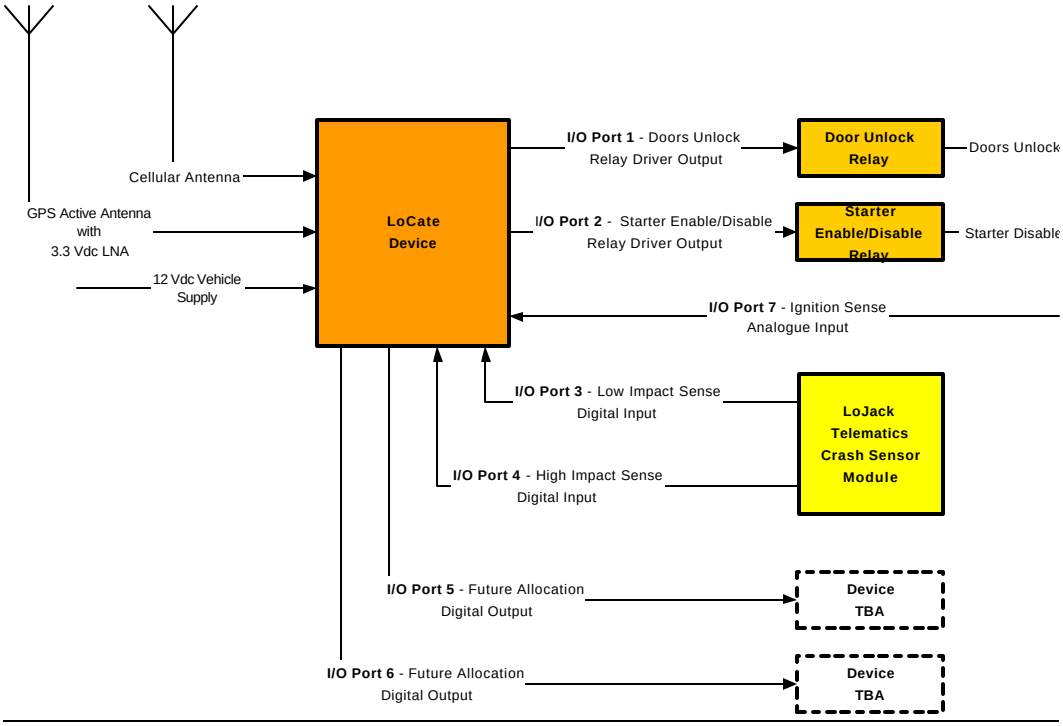


Figure 6 – LoCate Installation Layout