



**Lat-Lon Solar Tracking Unit (STU)  
With Sensor Options**

**User's Guide and Installation Instructions**

**Version 1.1 (A)**

**X13000**

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Part No. X13000

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

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

This equipment has been verified to comply with the limits for a class B computing device, pursuant to FCC Rules. In order to maintain compliance with FCC regulations, shielded cables must be used with this

equipment. Operation with non-approved equipment or unshielded cables is likely to result in interference to radio and TV reception.

The user is cautioned that changes and modifications made to the equipment without the approval of manufacturer could void the user's authority to operate this equipment.

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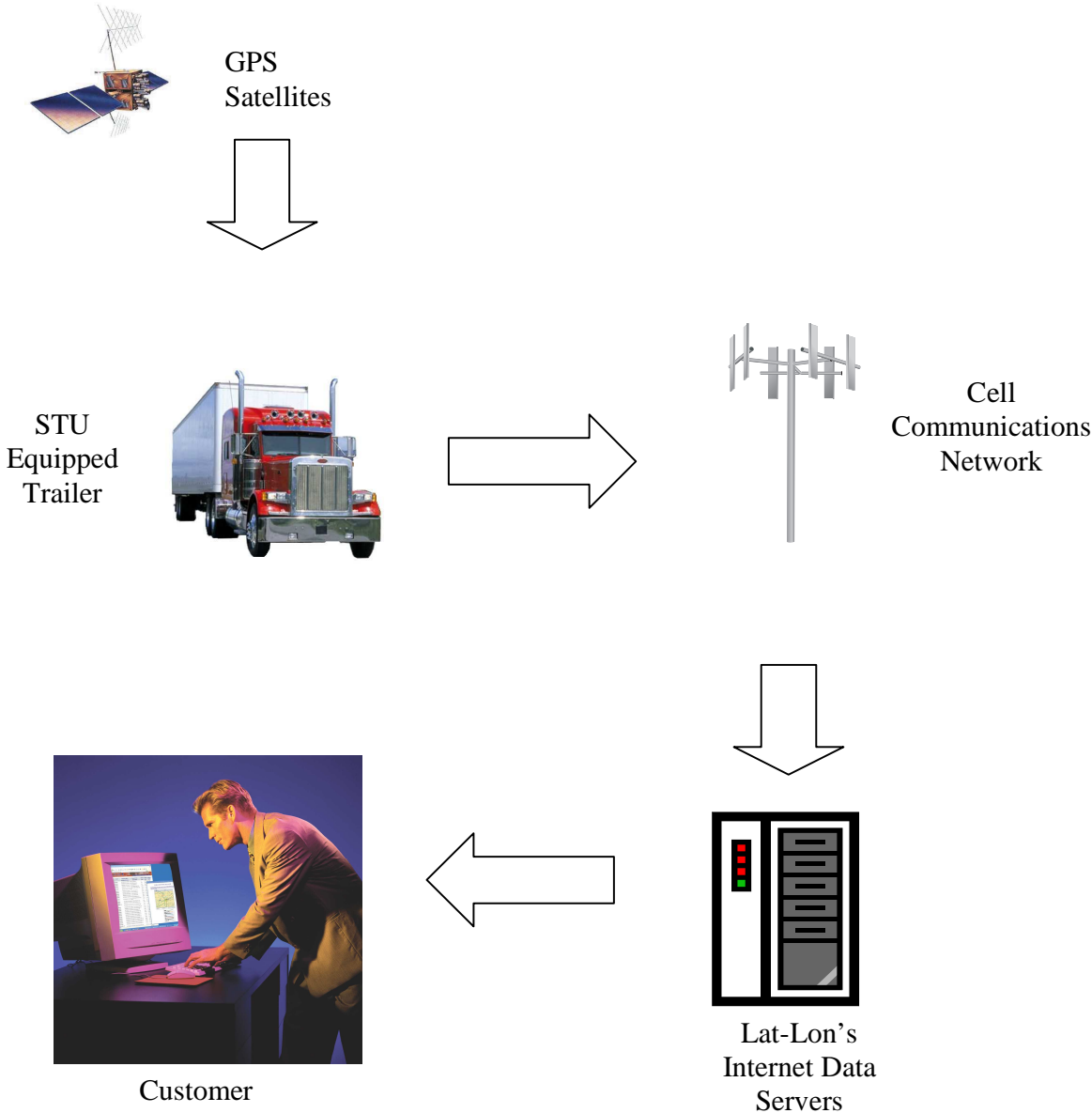
Size: 9" x 7.25" x 4.25"

# STU BASIC INFORMATION

## SYSTEM OVERVIEW

The Lat-Lon Solar Tracking Unit (STU) is a wireless data system that monitors several parameters on a trailer, railcar, locomotive or any other equipment including GPS data, and sends that data from most any location world wide to Lat-Lon's database and website. The radio communicates via the GSM digital cellular network. The STU is configured to transmit on a near real-time basis.

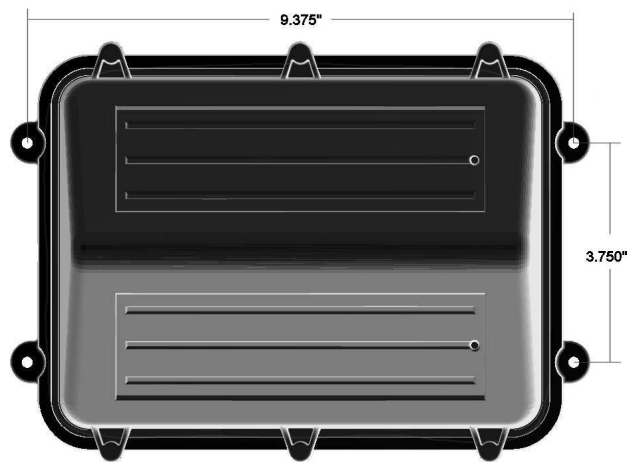
Notes on GPS: GPS receivers such as the STU use the GPS satellite system to get their latitude and longitude (position) as well as exact time. GPS satellites transmit data to GPS receivers on earth. GPS satellites do not receive any information from GPS receivers. GPS receivers must have a clear, unobstructed view of the sky in order to see satellites to get location and time information. Satellites must be in "line of site" of the unit. Nearby obstructions like buildings and trees or tunnels can obstruct the sky view and degrade or prevent GPS reception.



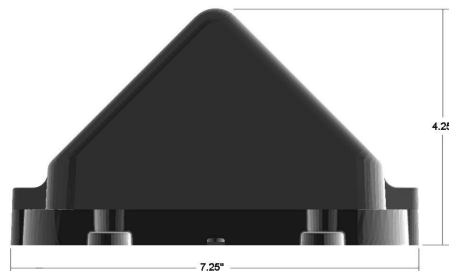
## HARDWARE

### Included Hardware

The STU unit (triangular box 9.75" x 7.25" x 4.25") is a self contained unit that includes everything that is required to track an asset. The unit contains an internal GPS and data communication antenna, a GPS receiver, a data communications radio, a rechargeable hybrid battery, and a processor board.



*STU top view*



*STU end view*

## **BACKGROUND INFORMATION**

### **STU Operation**

The STU is designed to be outside on a trailer, railcar or locomotive in a vertical orientation either on the end of the asset or horizontal on the top. The STU has an internal GPS antenna that must have a clear view of the sky. Both the GPS and data communications antennas are in the apex of the enclosure and must be positioned to optimize the signal outward away from the asset and have access to as much sky as possible.

The unit gets its power to operate from the sun. Solar power is used to keep the internal batteries and power system charged. The ideal position is one that optimizes the chance of getting direct sunlight sometime during the day. Indirect sunlight provides enough power to run the unit, but does not significantly charge the batteries.

Once the unit is installed (or put outside in the sun) it should start reporting within an hour or two. It will report up to every 10 minutes while moving (Moving Timed) and every 2 hours while stopped (Timed). The Moving Timed reports are over the air programmable but can never be set lower than every 10 minutes while moving. The Timed Reports are in intervals of 2 hours. This means that it will start reporting every 2 hours from the hour/minute that it wakes up. If the unit can not get out a message, then the unit will store the message and try to send it out at the next report time. The two possible reasons that a message will not be sent immediately are:

1. The unit can not communicate with a cell tower
2. The power of the unit has dropped below its normal operation threshold

Communication requires sufficient proximity to a cell tower for adequate signal strength and the ability of the unit to reach the Lat-Lon web-site (via the internet) for validation that the message was received.

### **STU Power**

During shipping, the STU internal battery rapidly drains because the unit tries to get a GPS fix and cannot, and tries to establish cellular communications and cannot. Therefore, the STU will most likely have a depleted battery when you receive it. To initialize the unit's power, place the unit outdoors where it can get a GPS fix with a good sky view. Placing the STU where direct sun is hitting the solar panels is the quickest way to charge the internal battery.

The power level of the STU is reported in each message as bus voltage. The user can see how much power the STU has as it operates from day to day by building a voltage history report or by adding the bus voltage field to other reports. Some critical voltages are listed in the table below:

Minimum voltage to power GPS (to build a message)	6.8V
Minimum voltage to power the GSM radio to transmit a report	7.0V
Max voltage – charging batteries with 100mA	12.5V
Charging batteries with at least 60mA	12.0V
Minimal battery charging	10.0V

The STU can achieve different qualities of location fix. It reports this quality level by reporting how many satellites were used in the solution. The more satellites used, the better the location precision. If six or more satellites are used in the solution, then it will be accurate to 10 meters 95% of the time. Solutions with less than six satellites may be less accurate and solutions with only three satellites may have degraded location and/or speed precision.

### **STU Reporting Types**

The STU will report 5 ways as follows:

1. Timed report (ever 2 hours when not moving)
2. Move Begin or Move End messages
3. Move Timed (default=every 60 min for STU/I and every 15 min for all others).  
Can configure up to every 10 minutes.
4. Sensor Alarms (dependent on if any sensors purchased)

***Timed Reports*** – A message to update the location of the STU and asset to which it is attached when stationary.

***Move Begin Reports*** – A message to update the location of the STU and to report that the STU has started moving.

***Move End Report*** – A message to update the location of the STU and to report that the STU has stopped moving.

***Move Timed Report*** – A message to update the location of the STU while it is moving.

***Sensor Alarms*** – A message to alert you of a sensor alarm. Messages include: Impact Alarm, RF Trigger, Digital 1 Alarm, Digital 2 Alarm, Temperature Alarm

### **STU Data**

The STU will report the data listed below. More information on the data can be seen in the website/administration manual. Additional information will be reported if sensors were purchased.

1. Message origination date/time (time stamp from the STU for the event)
2. Unit/Asset name
3. Message type
4. Latitude and longitude
5. Speed
6. Max Speed
7. Course
8. Nearest Town, state/province, country (Geography)
9. System voltage
10. Messages in queue
11. Odometer
12. Firmware version



### **STU LED Blink Codes (LED only installed on units with magnetic mount)**

1 blink per 10 seconds = normal

1 blink per minute = low power (not able to create message)

1 blink per second = excess power

Steady on for 5 – 10 seconds = packet transmitting

## **STU (no sensors, no impact detection) MOUNTING INSTRUCTIONS**

### **Items Provided**

STU unit (triangular box 9" x 7.25" x 4.25")

### **Items Needed**

Lift, ramp or other approved system able to reach mounting location

### **Installation Procedure**

1. Remove STU from its delivery box
2. We **HIGHLY RECOMMEND** putting the STU outside in direct sun as soon as received to allow for solar charging of the batteries (even if you are not installing right away). If the internal batteries are completely dead then the STU will require at least 1 to 3 hours in the sun to start reporting and 24 to 48 hours of sun to charge its internal batteries fully.

NOTE: if your unit has magnetic mount then it also has a choice for a 9volt battery installation on the back of the unit. This will help boost the unit's initial power but is not enough power to run the unit.

3. Determine mounting location on asset. A suitable mounting location has the following:
  - A. Provides exposure to the sun.
  - B. Provides a relatively flat surface for attaching system.
  - C. Is high enough so that the unit is out of reach.
  - D. Due to transmission of RF signal we suggest installing the STU with a clear view in front of it. However, we understand this is not always possible therefore, a good rule of thumb would be to have at least 6 feet of clearance in front of the STU in order to avoid reception problems.
  - E. Unit can be placed lying down on top of the asset or placed on the front, back or side of the asset. Note the "top" sticker if placing the unit on the front, back or side of the asset.
4. Using standard safety procedures, access mounting location with a lift or ladder and attach unit with #10 self drilling screws or bolts. If attaching to the top of a fiberglass trailer, it is recommended to through bolt the unit. (Bolting on the unit is only needed if magnetic mount was not purchased).

**If your unit is magnetically mounted, please do not screw through mounting tabs. This could cause damage to the mounting tabs because the magnets prevent the tabs from being flush with the mounting surface.**

## **STU ELECTRICAL SPECIFICATIONS:**

GSM quad band 850/1900 MHz and 900/1800 MHz  
GPRS Class 10  
GPS receiver sensitivity: -160 dBm  
600 mA-hour NiMH rechargeable battery  
2F super-capacitor rapid charge energy storage  
Dual 0.9 Watt 24-cell solar panels

## **MECHANICAL SPECIFICATIONS:**

STU

Size: 9.2" x 6.8" x 4.25"

Weight: 2 lbs.

Screw Mounting: 4 - #10 x ¾ self drilling screws

## **STU FUNCTIONAL SPECIFICATIONS:**

Reporting frequency

Timed every 2 hours, Move Timed up to every 10 minutes

Cellular Coverage

Better than 97% (message sent without delay)

GPS location accuracy

< 30 feet 95% of the time

GPS speed accuracy

+/- (1 MPH)

## OPTIONAL SENSORS:

### STU IMPACT DETECTION

#### Overview

The STU/I is equipped with a 35G accelerometer and is programmed with a 10Hz and 100Hz level filter.

Standard impact thresholds are:

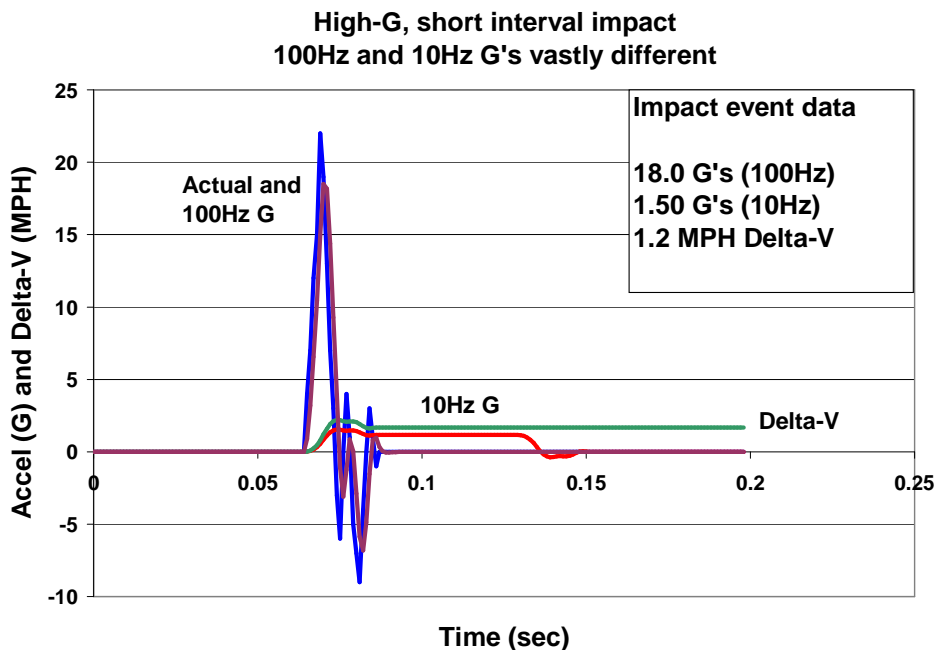
1G 10Hz

5G 100Hz

5DV (delta velocity)

These thresholds can be changed over the air via the Lat-Lon website (see the Website Manual for more information)

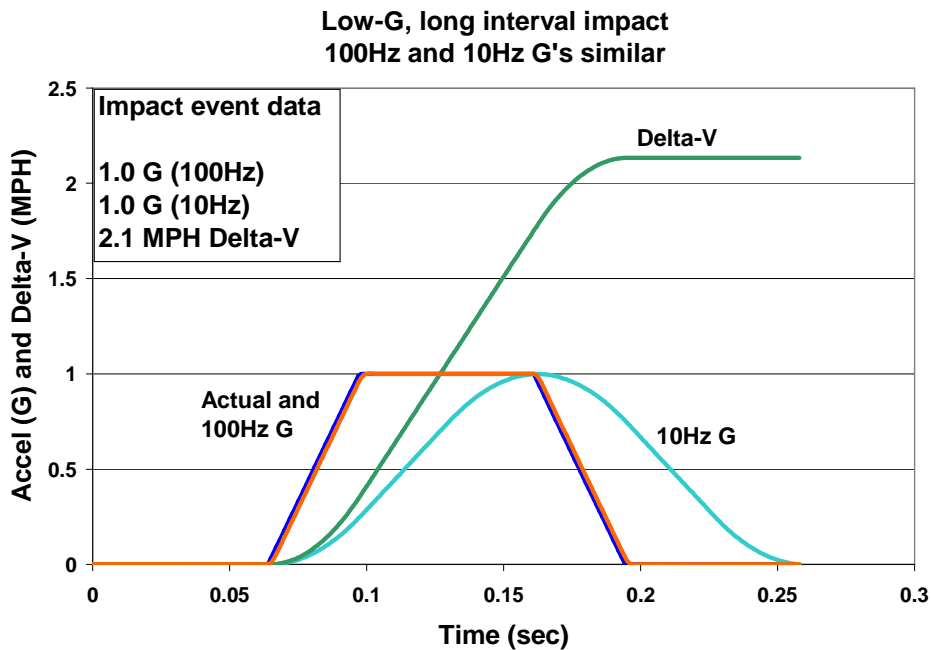
Below is a chart of a high G force, short interval impact. The force measured at 100Hz was 18.0G's and the force measured at 10Hz was 1.5G's. Because of the short interval the 10Hz filtering (1/10 of a second) averages out the large spike of data. The difference between the two filters will be large during this type of impact.



Delta-Velocity (or DV) is the sum of the accelerations during the impact event. More technically, it is the integral of the acceleration over time. The DV measures the net change in speed associated with the impact event. For a railcar coupling to another railcar, the DV will be approximately the approach speed between the two cars. This becomes less true if the car being hit moves after being hit. In this case the change in speed is less than the approach speed because the approaching car did not come to a stop, but only slowed down during the impact.

When handling the STU/I, DV can become large quickly because one G of acceleration acts for up to half a second giving 11 MPH's change in speed.

In the chart below the impact is a low G force, long interval impact. The force measured at 100Hz was 1.0G and the force measured at 10Hz was also 1.0G. Because of the long interval of time during the impact, both filters measured the same G force and the DV rises smoothly to the net change in speed.



**Alarm Event**

An impact ALARM can be sent to your email address, or text message cell phone (contact your Lat-Lon representative to have this set up).

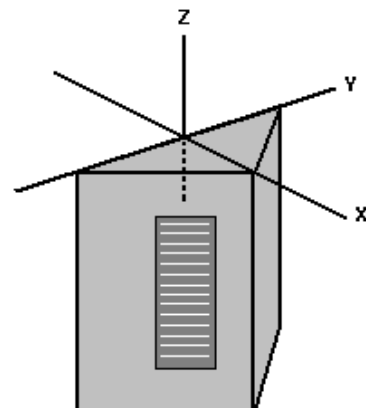
The ALARM event will give you the following information:

- Time of the event
- GPS coordinates, including nearest town
- X axis G force and DV (in 10Hz and 100Hz filtering)
- Y axis G force and DV (in 10Hz and 100Hz filtering)
- Z axis G force and DV (in 10Hz and 100Hz filtering)

(The direction of the impact occurs by seeing which axes shows a higher value)

**Impact Coordinates**

Lat-Lon's STU/I uses the following coordinate system to report its impacts. When mounted on the end of a car, the coordinates are co-aligned with the car's coordinates. (X= longitudinal, Y= lateral, Z= vertical)



## STU/I MOUNTING INSTRUCTIONS

### Items Provided

STU unit (triangular box 9" x 7.25" x 4.25")

### Items Needed

Lift, ramp or other approved system able to reach mounting location

### Installation Procedure

5. Remove STU from its delivery box
6. We **HIGHLY RECOMMEND** putting the STU outside in direct sun as soon as received to allow for solar charging of the batteries (even if you are not installing right away). If the internal batteries are completely dead then the STU will require at least 1 to 3 hours in the sun to start reporting and 24 to 48 hours of sun to charge its internal batteries fully.  
NOTE: if your unit has magnetic mount then it also has a choice for a 9volt battery installation on the back of the unit. This will help boost the unit's initial power but is not enough power to run the unit.
7. Determine mounting location on asset. A suitable mounting location has the following:
  - F. Provides exposure to the sun.
  - G. Provides a relatively flat surface for attaching system.
  - H. Is high enough so that the unit is out of reach.
  - I. Due to transmission of RF signal we suggest installing the STU with a clear view in front of it. However, we understand this is not always possible therefore, a good rule of thumb would be to have at least 6 feet of clearance in front of the STU in order to avoid reception problems.
  - J. Is a structurally rigged and solid part of the railcar or asset. This is highly important. *The accuracy of impact results from the STU/I will be affected if they are mounted on sheet metal, or other areas that vibrate and "ring" during impact.***
  - K. Unit can be placed lying down on top of the asset or car but it is important to notate the orientation of the unit so that the impact axis for longitudinal, vertical and lateral can be determined. Orientation can be determined by notating which direction the "top" sticker on the STU is facing. For example, is the "top" sticker facing to the side of the car/asset or to the front/back of the car/asset?
  - L. The STU/I can also be placed on the front, back or side of an asset (make sure that the unit gets sun and has nothing directly above it). It is not recommended to install the unit on the front or back of a non-cushioned railcar due to the possibility
8. Using standard safety procedures, access mounting location with a lift or ladder and attach unit with #10 self drilling screws or bolts. If attaching to the top of a fiberglass trailer, it is recommended to through bolt the unit. (Bolting on the unit is only needed if magnetic mount was not purchased).

**If your unit is magnetically mounted, please do not screw through mounting tabs. This could cause damage to the mounting tabs because the magnets prevent the tabs from being flush with the mounting surface.**

## **STU RF WIRELESS SENSORS**

Up to 10 RF wireless sensors are available for each STU. Each RF wireless sensor can measure:

1. Tilt in two different axis
2. Door/hatch open and close via magnetic reed switch
3. Temperature
4. Its own battery voltage



The RF sender is an event based sensor. It will send data to the STU upon a triggered event (such as open door/hatch). The sender does not send any periodic transmissions to the STU.

The STU can be set to send out a report on the receipt of each RF message (over the air configurable). The STU can also be set to take a picture on the receipt of a digital change of state/RF message being received.

### **Tilt Sensor:**

Measures an analog value of the tilt reading and also a digital that the tilt changed by more than X (X is programmed here at Lat-Lon when we make the unit). The tilt also creates a digital value of 1 when it's at the high-end of its range and 0 when it's at the low end of its analog range. This is useful for loaded/empty or hatch open/closed where orientations change from one zone to another.

### **Digital Reed Switch:**

The digital reed switch reports a change of state as well whether the door/hatch was opened or closed since the last timed report. Note that 1 end of the sensor says "Reed Switch".

**Temperature Sensor:**

The temperature sensor takes readings every 10 minutes. High and low temperature alarms can be set (see additional information in the Website Manual).

If the sensor is being used for a temperature sensor, the temperature probe is on the opposite side of label towards to antenna end.

**Battery Voltage for RF Sender:**

There is a low voltage digital when the unit detects its battery is near end of life. 1 = low voltage, 0 = good voltage

**RF WIRELESS SENSOR INSTALLATION**

RF sensors should be mounted as close as possible to the STU/RF. The maximum range is about 60 feet.

RF sensors have a serial number and are keyed to a STU/RF. Make sure you mount the correct RF sensors with the correct STU/RF.

**RF sensors and the STU/RF should be mounted on the same end of asset if possible. RF sensors can be mounted in several ways. The recommended way is to use silicone and wire ties. Clean the area that the sensor will attach to. Apply Dow Chemical 995 Structural Silicone to back side of the sensor and press on. Then wire tie sensor to keep it in place while silicone dries.**

Installation for the RF Wireless Sensor depends on the application you will be using it on. (Please call Lat-Lon, LLC at 1-877-300-6566 for additional installation information)



## STU CAMERA

Camera resolutions available:

640x480

320x240

160x128

The picture is a JPG color image.

The user can select the resolution (via our website) and also the time to white-balance prior to capturing the picture.

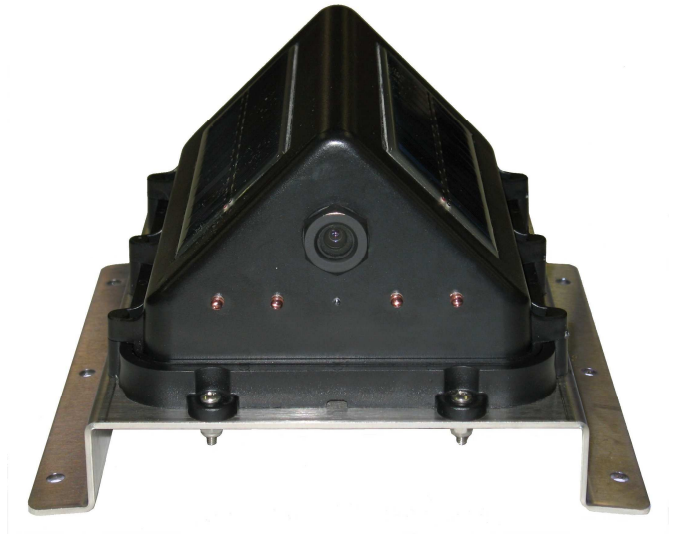
Triggers for pictures are:

1. Paging the unit
2. Impact thresholds
3. RF digital change of state (example: door open)

Camera/STU Infrared LED info:

- The STU can illuminate a night shot up to about 20 feet away
- Cannot be seen by a human when on
- Only come on during the process of taking the picture and turn off as soon as it is taken
- Only come on if it is dark outside
- They draw 100mA so we are careful about how long they are on. They have a circuit that ensures they have the same illumination regardless of our system voltage (unless the STU is less than 6V)





## STU CAMERA INSTALLATION

### Items Provided

STU unit (triangular box 9" x 7.25" x 4.25")

### Mounting Options

Magnetic Mount

Saddle Mount (pictured to right)

Bolt-on Mounting Plate

### Items Needed

Lift, ramp or other approved system able to reach mounting location

### Installation Procedure

9. Remove STU from its delivery box
10. We **HIGHLY RECOMMEND** putting the STU outside in direct sun as soon as received to allow for solar charging of the batteries (even if you are not installing right away). If the internal batteries are completely dead then the STU will require at least 1 to 3 hours in the sun to start reporting and 24 to 48 hours of sun to charge its internal batteries fully.

NOTE: if your unit has magnetic mount then it also has a choice for a 9volt battery installation on the back of the unit. This will help boost the unit's initial power but is not enough power to run the unit.

11. Determine mounting location on asset. A suitable mounting location has the following:
  - M. Provides exposure to the sun.
  - N. Provides a relatively flat surface for attaching system.
  - O. Is high enough so that the unit is out of reach.

- P. Due to transmission of RF signal we suggest installing the STU with a clear view in front of it. However, we understand this is not always possible therefore, a good rule of thumb would be to have at least 6 feet of clearance in front of the STU in order to avoid reception problems.
- Q. It is important to have the camera lens pointing in the correct direction as well as the correct level to insure a good picture.

**If your unit is magnetically mounted, please do not screw through mounting tabs. This could cause damage to the mounting tabs because the magnets prevent the tabs from being flush with the mounting surface.**