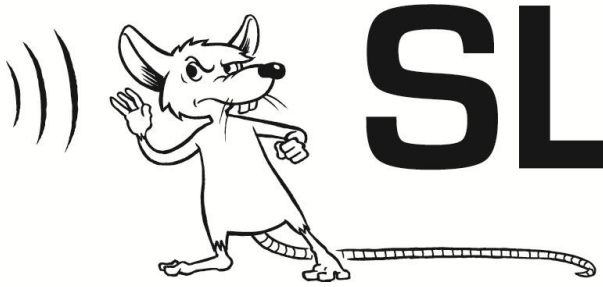
InfoSense, Inc
Innovating Acoustic Inspection Technology™



SL-RAT™

Sewer Line Rapid Assessment Tool User Manual

SL-RAT User Manual

1/13/2013

MADE IN U. S. A.

Produced Under License from the University of North Carolina at Charlotte

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Introduction

Thank you for purchasing the Sewer Line Rapid Assessment Tool or SL-RAT™ device from InfoSense. The device you have purchased uses a patented technology to quickly provide an assessment of overall blockage in gravity fed sewer lines. Our device relies on the fact that air flowing through the free space in a pipe acts very similarly to water. The SL-RAT™ transmitter component or TX introduces a known sound into the pipe typically through a manhole. The SL-RAT™ receiver component or RX listens at an adjacent manhole. Using a sophisticated algorithm to measure the sound energy it hears, the RX is able to make a blockage assessment that is immediately displayed to the user and also provides the ability to transfer that data to a computer file that can be further manipulated and analyzed by the SL-RAT™ user.

Overview

Features

- Low Operational Cost
- Rapid Results – Typically Under 3 minutes/segment
- Safe - No Flow Contact
- Field Tested –Ruggedized Design
- Easy to Use – Train Operators In Minutes
- Onsite Results – Easy to Interpret
- Portable – Transmitter and Receiver Combined Weight Less Than 30 lbs
- GIS Integration - GPS Enabled

Applications

- Focus Cleaning Crews On Dirty Pipes
- Perform Quick & Low Cost "Pre-maintenance" Basin Assessments
- Avoid Downstream Overflows Caused By Upstream Cleaning Activity
- Avoid Repeat Overflows – Identify Hot Spots After Spill Events
- Post-Cleaning – Quality Assurance

Identify Parts and Controls

The SL-RAT™ device is composed of two primary parts the TX or transmitter component contains a heavy duty marine grade speaker. It can be readily identified due to its bulkier speaker housing and relatively heavier weight, Figure 1. The RX or receiver component contains a high quality microphone and is easily identifiable by its smaller sensor housing and lighter weight, Figure 2. Each component is also labeled graphically with a "TX" or "RX".

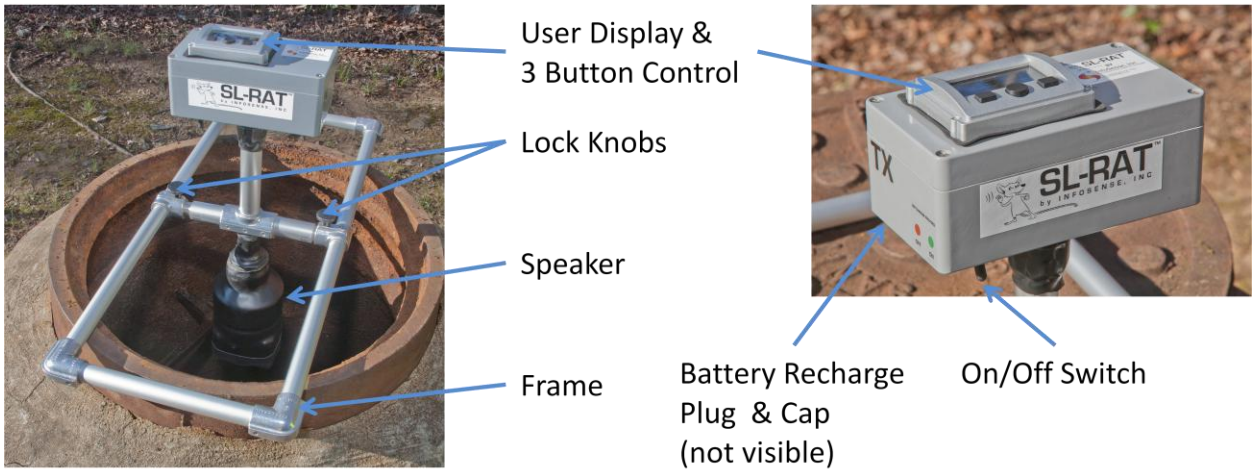

Figure 1 Major sub-components of the SL-RAT™ device's Transmitter (TX) Component

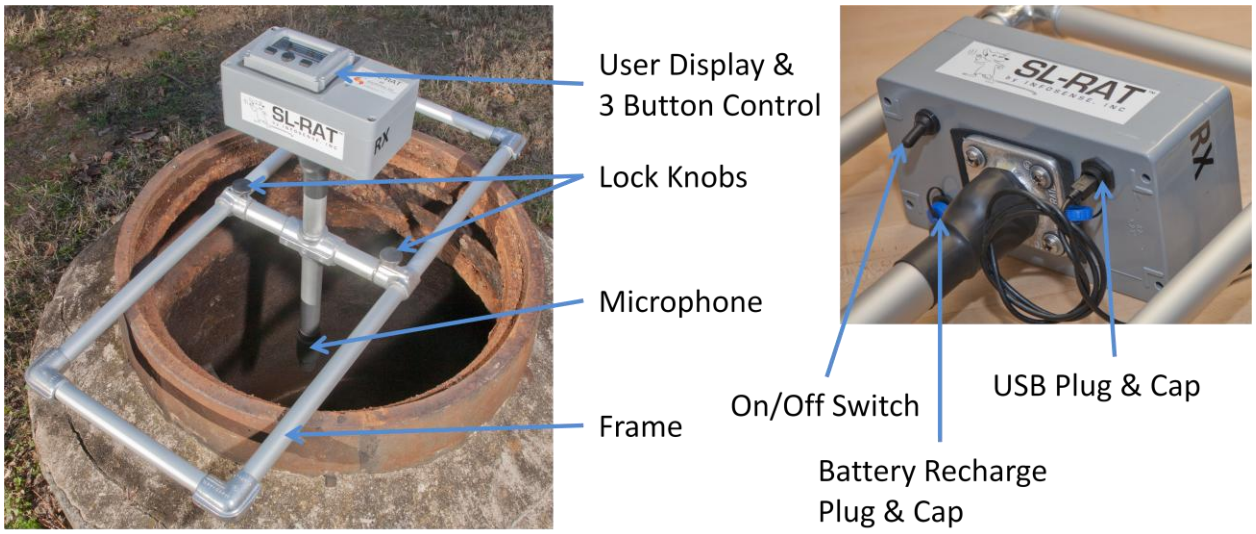

Figure 2 Major sub-components of the SL-RAT™ device's Receiver (RX) Component

- **User Display & 3 Button Control**: (TX & RX) Provides the user interface for making acoustic measurements and obtaining status information from the RX & TX components.
- **ON/OFF Switch**: (TX & RX) Turn on by moving the toggle switch forward. This provides battery power to the component. When in the on position (Forward), the User display & 3 Button Control will be operational. If you are not planning on using the RX and TX components for an extended period of time (more than one hour) - Turn off the power by moving the toggle switch back.
- **Battery Recharge Plug & Cap:** (TX & RX) The battery is recharged by connecting the provided AC adapter's Battery Recharge Jack into the plug. To comply with the SL-RAT™ warranty, only use the provided Battery Recharger which has been specifically engineered to support the SL-RAT™ device. When not being charged the Battery Recharge Plug Cover must be securely fastened to prevent moisture & dirt from entering the RX & TX components and to comply with the SL-RAT™ warranty.

- **Speaker:** (TX Only) Is a rugged heavy duty marine-grade speaker used for generating the sound signal received by the RX component. It needs to be inserted below the plane of the manhole during acoustic measurements.
- **Microphone:** (RX Only) Is a rugged harsh environment microphone used for detecting the sound waves generated by the TX component. It needs to be inserted below the plane of the manhole during acoustic measurements.
- **Lock Knobs:** (TX & RX) Two lock knobs per RX & TX component which allow the TX speaker or RX microphone to be transitioned from the open/measurement position to the closed/transport position.
- **Frame:** (TX & RX) Used to support the RX & TX component during measurements. Provides limited protection to the electronics case and speaker or microphone during transportation when Transporting directions are correctly followed.
- **USB Plug & Cap:** (RX Only) Allows acoustic measurements conducted in the field to be uploaded for historical archive and additional analysis via USB cable. When not being used the USB Plug Cover must be securely fastened to prevent moisture & dirt from entering the RX component and to comply with the SL-RAT™ warranty.

Transporting

Transporting by Foot

When transporting the SL-RAT™ TX & RX components by foot, follow the procedures in this section to reduce the possibility of damage.

1. Place TX & RX in closed/transport position (see Figure 3)
2. Securely tighten the two Lock Knobs on both the TX & RX (see Figure 3)
3. When transporting the SL-RAT™ TX & RX components by Foot over long distances, it is recommended the components are transported in SL-RAT™ carrying case as required when transporting by vehicle.

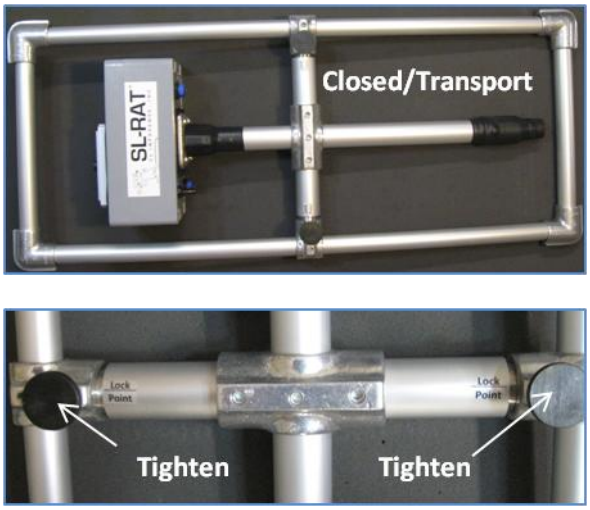

Figure 3 Transporting SL-RAT by Foot

Transporting by Vehicle

When transporting the SL-RAT™ TX & RX components by vehicle the procedures in this section are required to reduce the possibility of damaging the TX & RX components and to comply with the SL-RAT™ warranty.

1. Place TX & RX in closed/transport position (see Figure 3)
2. Securely tighten the two Lock Knobs on both the TX & RX (see Figure 3)
3. Place TX in the carrying case on top of first Foam Insert (see Figure 4)
4. Place second Foam Insert on top of TX
5. Place RX in the carrying case on top of second Foam Insert (see Figure 4)
6. Place third Foam Insert on top of RX
7. Securely Close the carrying case (see Figure 4)

We recommend wiping down the components prior to placing in the carrying case. This will reduce fouling of the Foam Inserts and extend the service life of the carrying case. Additionally, it is a good habit to inspect the components prior to transport for damage, for battery charge level, and for dirt or other foreign material that may have become lodged in the microphone or speaker housings.

Figure 4 Transporting SL-RAT by Vehicle

Conducting Acoustic Measurement

A test is conducted by deploying the SL-RAT™ TX and the SL-RAT™ RX at adjacent manholes, see Figure 5. With both components turned on, the test is conducted by the following sequence:

1. Setting up the test parameters on the SL-RAT™ Receiver
2. Starting the SL-RAT™ Transmitter
3. Starting the SL-RAT™ Receiver
4. Test results displayed on SL-RAT™ Receiver
5. Stopping the SL-RAT™ Transmission

Once started, the test is automated. The SL-RAT™ RX displays real time graphics indicating both the test's progress and the performance. The SL-RAT™ TX displays real time graphics indicating the number of tone sequences completed.

Figure 5 SL-RAT deployment for acoustic measurement of the pipe segment between the two manholes

The SL-RAT™ RX & TX control and operation are performed through a series of screens on the User Display and through the 3 Button Control.

Deploying Transmitter & Receiver

An acoustic measurement for a pipe segment is typically conducted by deploying the TX and RX components in adjacent manholes. When deploying the components the following guidelines should be followed with Figures 6 and 7 illustrating typical deployments:

1. Care should be used when deploying and removing the components from the manhole to prevent damaging the speaker/microphone.
2. Deploy the RX & TX by setting the component on an open manhole in the Open/Measurement position. The frame should rest securely on the frame/manhole cover when deployed.
3. Speaker/microphone should be approximately one foot below the plane of the manhole.
4. Speaker/microphone should be approximately centered within the manhole entrance. The area below the

Figure 6 SL-RAT RX deployment with microphone centered and 1' below plane of manhole. Manhole cover removed for the measurement.

speaker/microphone should have at least one foot clearance from any obstruction within the manhole.

5. If the distance between adjacent manholes is less than 20', then the acoustic measurement for the short segment should be coupled together with the next adjacent segment. As an example, for two adjacent pipe segments with lengths of 200' and 18'. Two measurements should be conducted: first between the adjacent manholes for the 200' segment and seconded, between the manholes for the combined 218' where the center manhole for the two segments is skipped.
6. Measurements can be conducted with or without the manhole cover fully removed, as illustrated in the Figures 6 and 7.
7. Once the acoustic measurement is completed, carefully remove the components and return them to their Closed/Transport position.

Figure 7 SL-RAT RX deployment with microphone approximately centered and 1' below plane of manhole. Manhole cover only partially removed for the measurement.

Transmitter Acoustic Measurement Operation

During an acoustic inspection for a pipe segment, the TX transmits a sequence of tones and this sequence is repeated up to 12 times over the duration of the measurement. The TX needs to be started prior to starting the RX and needs to be ended after the RX has reported to the RX operator the measurement has been completed. After correctly deploying the TX, the steps for operating the TX are as follows:

1. RX operator signals the start of the acoustic measurement test, typically via either hand signal or walkie talkie/cell phone
2. From the Main Menu, Start the TX Acoustic Measurement Operation by pressing the center button, see Figure 8.a
3. Confirm the start of the test by pressing the Right Button as in Figure 8.b
4. TX tone sequence begins shortly and the display changes to the one shown in Figure 8.c
5. RX operator signals the end of the acoustic measurement test. If the pipe segment is sufficiently clean, this typically occurs prior to the 7^{th} sequence.
6. End the TX signal transmission by pressing the center button
7. Terminated test screen is displayed, Figure 8.d. Return to the Main Menu by pressing the center button. The terminated test screen displays how the test was terminated (User, RX via RF interface or Normal). The screen also provides the GPS status and the number of satellites used

to estimate the TX location. GPS status: 0 – no estimate; 1 – normal; 2- differential; other values indicate various tracking modes, typically with limited or no satellites in view.

8. If the TX completes 12 tone sequences prior to the TX operator terminating the TX signal transmission, then the TX automatically ends the transmission.
9. If the TX and the RX are within wireless communication range, the TX signal transmission may be automatically ended by the RX.

The TX component uses more energy than the RX component when in operation. We recommend minimizing the number of extra tones generated while in field operation to maximize battery life.

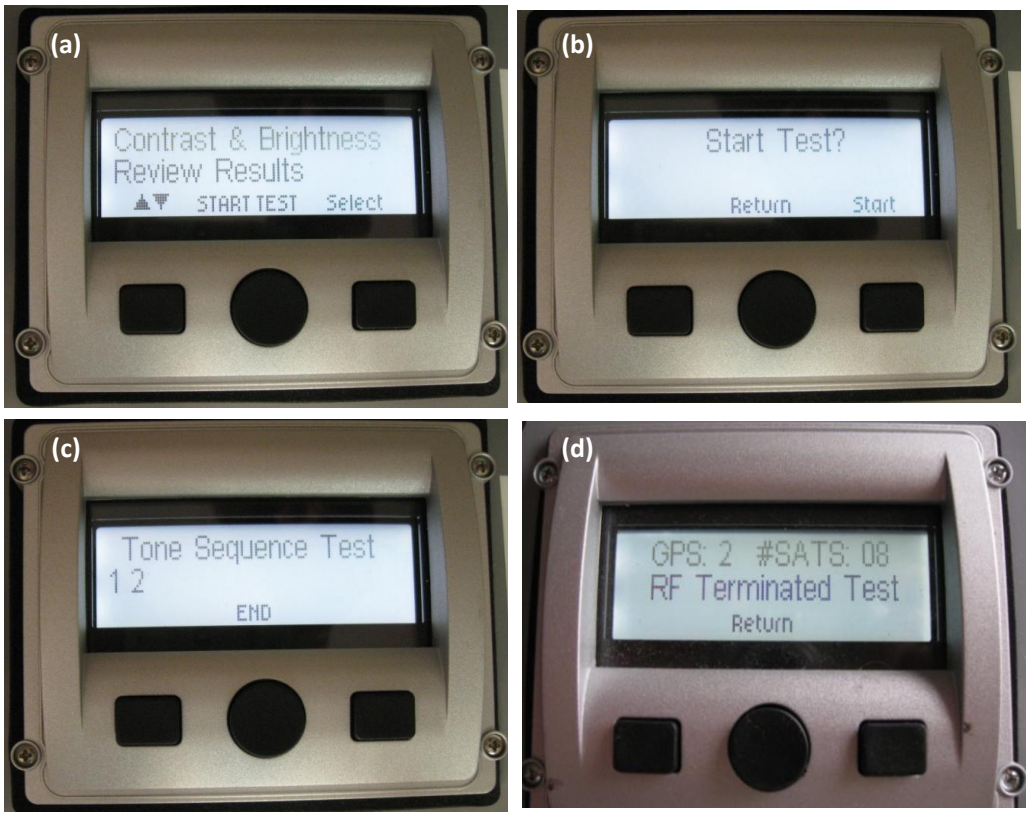

Figure 8 Menu Sequence for TX acoustic measurement operation. (a) Main Menu - Center Button; (b) Confirm start test - Right Button; (c) TX Measurement Display - count updated after each tone sequence. To end test - Center Button; (d) Return to Main Menu – Center Button.

Receiver Acoustic Measurement Operation

During an acoustic inspection for a pipe segment, the RX component receives the sound signal generated by the TX component. Based on the characteristics of the received signal, it assesses the condition of the pipe segment between the TX location and the RX location. After correctly deploying the RX, the steps for operating the RX are as follows:

1. From the Main Menu, Start the RX Acoustic Measurement Operation by pressing the center button. see Figure 9.a.

2. Pipe Length Menu - the first menu requests the RX Operator to enter the pipe segment length between the SL-RAT™ TX and the SL-RAT™ RX. The range of values for the pipe length estimate is from 50 feet to 750 feet in 100 foot increments. The values can be changed by pressing the right key to cycle through the available values. Pressing the left key returns to the Main Menu and pressing the center key continues to the Start Test Instruction Menu. If the RX and TX are sufficiently close to each other, then the distance between the components is estimated based on GPS. The initial pipe length displayed on the screen will indicate if it is a GPS Est. (GPS Estimate) or the Default value (350 feet). See Figure 9.b.
3. Start Test Instruction Menu – At this time the RX operator signals the start of the acoustic measurement test to the TX operator. Once the TX operator starts the TX signal transmission, the RX operator should immediately start the RX operation by pressing the center button – Start RX. The left button will return to the Pipe Length Menu. See Figure 9.c.
4. RX Real Time Display - Once the SL-RAT™ receiver enters the test mode, the display provides real time graphics which indicates the status of the measurement. The Status bar on the right of the display is incremented at one second intervals. After 16 seconds a graphical display appears which provides measurement status for individual components used in assessing the pipes status. See Figure 9.d.
5. Pipe Segment Classification - The Pipe Segment Classification is displayed first after the test. The classification is based on the Pipe Segment Assessment, a numeric value from 0 to 10. The classification can be one of the following five possibilities: GOOD (Pipe Segment Assessment from 7 to 10), FAIR (4 to 7), POOR (1 to 4), BLOCK (0 to 1) and NOISE. NOISE – indicates that the noise impairment was sufficient to cause the status of the pipe to be unknown. If this occurs, it may be possible to either repeat the test and/or to swap the locations of the SL-RAT™ transmitter and the SL-RAT™ receiver. See Figure 9.e.
6. RX operator signals the end of the acoustic measurement test to the TX operator when the Pipe Segment Classification Screen Appears.
7. Pipe Segment Assessment - The data used in evaluating the Pipe Segment Assessment is provided in the next screen, Figure 9.f. This display provides Measurement ID (a unique ID number for the SL-RAT™ RX) and the numeric result from 0 to 10. The screen also provides the GPS status and the number of satellites used to estimate the TX location. The format is {GPS Status}:{Number of Satellites} where GPS status: 0 – no estimate; 1 – normal; 2- differential; other values indicate various tracking modes, typically with limited or no satellites in view. The RX operator can select to save the data as being a valid test by pressing the right button or REJECT the data by pressing the left key. Rejecting the data still saves the measurement, but flags the data as being rejected by the RX operator. See Figure 9.f.

Table 1 Pipe Segment Assessment - General Interpretation

Assessment	Typical Condition / Interpretation
10	No significant obstructions within the pipe
7-9	Minor impediments within the pipe such as joint offsets, partial sags, protruding laterals, debris, minor grease, and/or minor root fibers.
4-6	Impediments within the pipe such as joint offsets, partial sags, protruding laterals, debris, grease, and/or root fibers. Single or multiple occurrences.
1-3	Significant impediments within the pipe such as multiple joint offsets, near full pipe sag, multiple protruding laterals, significant debris, significant grease, significant root fibers and/or root balls. Single or multiple occurrences.
0	Full pipe sag; single or multiple obstructions within the pipe reaching or nearly reaching the flow.

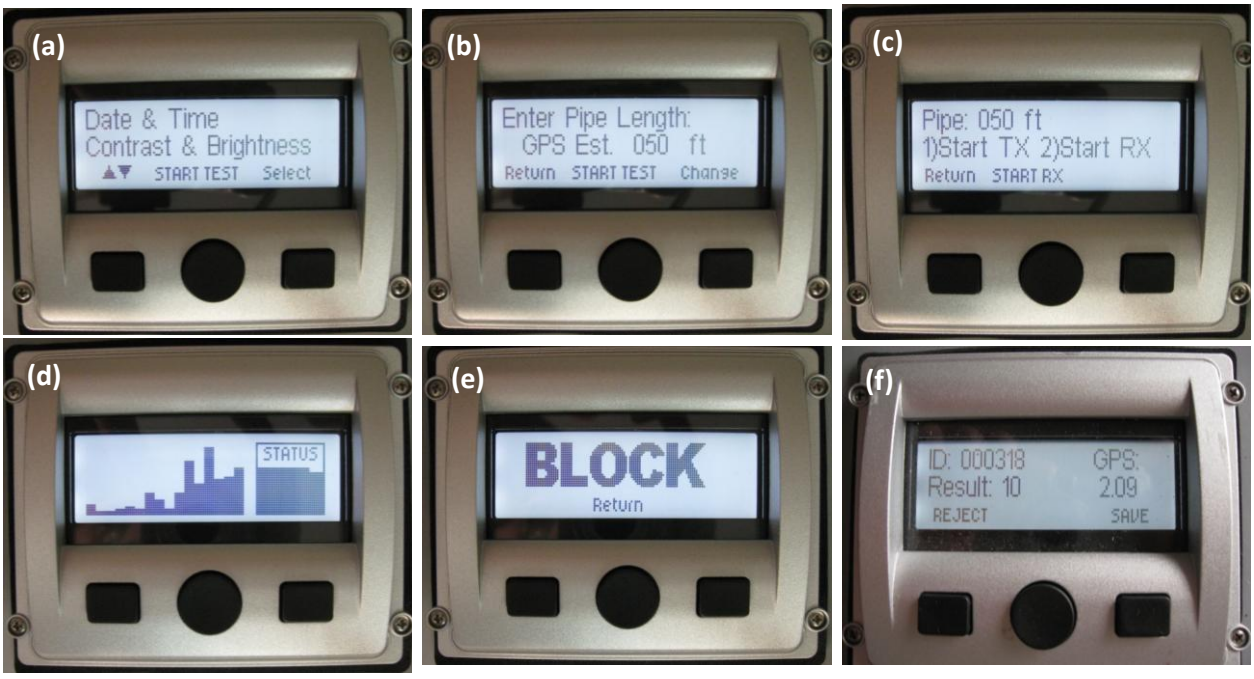

Figure 9 Menu Sequence for RX acoustic measurement operation. (a) Main Menu; (b) Pipe Length Menu; (c) Start Test Instruction Menu; (d) RX Real Time Display; (e) Pipe Segment Assessment; (f) Pipe Segment Evaluation.

Synchronizing Transmitter Data with Receiver

Data is stored on both the SL-RAT™ RX and the SL-RAT™ TX when a measurement is made. In order to validate the measurement and archive the measurement data for later upload through the SL-RAT™ RX's USB port, the TX data needs to be transferred to the RX. This is accomplished using a wireless interface built into each component. To begin the transfer and synchronization of the TX data with the RX measurements, the Data Synch option is selected from the RX Main Menu, Figure 10.a. The Data Synch operation should only be conducted when the RX and TX components are close to each other (less than 50' and free of obstructions between) and should remain close while the transfer takes place. Once the transfer is completed, Figure 10.b, both displays will automatically return to the Main Menu. The time required for data synchronization depends on the number of measurements conducted since the last synchronization. We recommend Data Synch to be conducted at least once every 10 measurements. Synchronization allows measurements to be validated. Table 2 lists the possible outcomes for the measurement validation process and the measurement condition which causes the outcome.

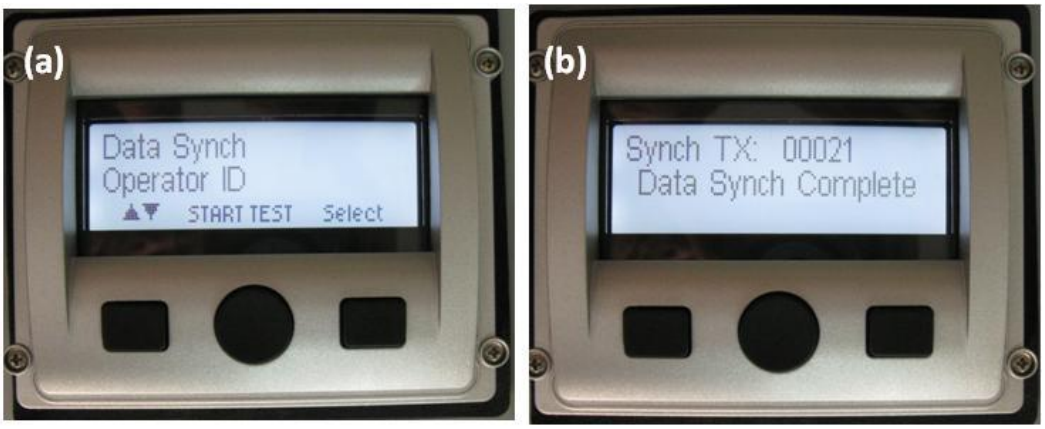

Figure 10 (a) Initiate Data Synchronization from the RX Main Menu when the RX and TX are within 50'. (b) Keep RX and TX within 50' until Data Synchronization is complete.

Table 2 Outcomes for the Measurement Validation Process

Measurement Status	Condition
Valid	No anomalies in the measurement conditions were detected
Early	The SL-RAT transmitter unit (TX) was stopped prior to the SL-RAT receiving unit (RX) completed its processing. The Pipe assessment may be corrupted.
Late	The SL-RAT transmitter unit (TX) was started after the SL-RAT receiving unit (RX). The Pipe assessment may be corrupted.
No TX	The SL-RAT transmitter unit (TX) was not turned on during SL-RAT receiving unit (RX) measurement. **The Pipe assessment is corrupted.**

General Operations

Start Up

The SL-RAT™ TX and RX components are provided as a pair. They are factory calibrated to operate as a single device when performing an acoustic measurement. The following automated Start Up procedure is required when either or both SL-RAT™ RX and TX components are powered on (Toggle Switch is turned to the on position).

1. Turn TX and RX components off - Toggle Switch is turned to the off position
2. Position the TX and RX components close to each other (less than 50')
3. Turn TX and RX components on - Toggle Switch is turned to the on position
4. Automated Start Up Procedure
    a. TX and RX synchronize wireless communication interface (Association Screen)
    b. TX and RX Data Synchronization (Data Synchronization Screen)
    c. TX and RX Acquire GPS (Acquiring GPS Screen)
5. Operator ID – Operator is requested to enter their ID.

Menu Operations

The SL-RAT™ control and operation is performed through a series of screens on the User Display and by the 3 Button Control. The Main Menu is displayed in Figure 11. The left key is used to scroll through the user selectable options. The option at the top of the screen is selected by pressing the right key. A test can be started by pressing the center key. Each option is described below.

Figure 11 SL-RAT Main Menu - Left Button scrolls the menu; Right Button selects the Top Option.

- **Date & Time**: (TX & RX) Current date and time are provided based on GPS. The center button returns to the Main Menu.
- **Contrast & Brightness**: (TX & RX) User display's contrast & brightness can be set in order to improve the ability to view the display. Each value ranges from 0 to 255 in unit steps. At power up, the display returns to the default settings - 128. Care should be used in changing the Contrast setting. Deviating too far from the default can cause the screen to blank or saturate. The brightness controls an LED backlight for illuminating the LCD display. This is necessary in a reduced light setting, e.g., indoors or at night. If the SL-RAT™ is being used outdoors during the day, typically the brightness setting can be reduced (turning down the LED). This will improve the battery performance. The button on the left is used to cycle between fields within the contrast & brightness. The button on the right is used to change the selected field. The center button returns to the Main Menu.
- **Review Results**: (TX & RX) Previous measurements can be reviewed. The SL-RAT™ RX & TX components can store up to 200 measurements. Once 200 measurements are reached, a new

measurement over writes the oldest measurement (FIFO data storage). The button on the left and right provide up and down scroll directions, respectfully. Center button returns to the Main Menu.

RX Display: Unique ID, Measurement Classification, Measurement Status (Synch – if the TX & RX have not been synchronized), Measurement's Date & Time, Pipe Length, Measurement Assessment.

TX Display: Unique ID, Temperature, Measurement's Date & Time, Measurement Duration, Termination Condition (User Terminated, Normal, Low Battery).

- **Power Save**: (TX & RX) Allows the operator to place the RX & TX component in power save mode when selected. In addtion, the RX & TX components will automatically enter power save mode if left idle for approximately 2 minutes. When in power save mode, a screen will periodically be displayed to remind the operator the RX or TX component is still turned on. To exit Power Save mode – press the center key. Reminder - if the SL-RAT™ is not being used for an extended period of time (more than one hour), then the RX & TX component should be turned off by the operator.
- **System Info**: (TX & RX) System information can be viewed through multiple screens. The button on the left and right provide up and down scroll directions, respectfully. Center button returns to the Main Menu.

  RX Display: Battery Level, RX Operator ID, Number Measurement Conducted on the RX, RX component serial number (Corresponds to the Face Plate SN), TX component serial number, Number of test requiring synchronization between the RX and TX, RX Firmware Version Number, RX Hardware Version Number, RX Build Date.

  TX Display: Battery Level, TX Operator ID, Number Measurement Conducted on the TX, TX component serial number (Corresponds to the Face Plate SN), TX Firmware Version Number, TX Hardware Version Number, TX Build Date.
- **GPS Monitor**: (TX & RX) Provides the current GPS location data for the component. The GPS location is updated at 15 second intervals.

  RX Display: RX Latitude & Longitude specified in degrees, minutes, Estimated distance to TX; RX and TX GPS status indicating both the type of GPS tracking and the number of satellites.

  TX Display: TX Latitude & Longitude specified in degrees, minutes, TX GPS status indicating type of GPS tracking and the number of satellites.
- **Data Synch**: (RX Only) When selected it initiates Data Synchronization between the TX and RX, if they are in communication range of each other.
- **Operator ID**: (TX & RX) Allows the operator to select/change the Operator ID recorded for each measurement. Operator ID values range from 01 to 30. The button on the left and right provide up and down scroll directions to change the Operator ID value.. Center button returns to the Main Menu and selects the current value displayed as the Operator ID.
- **Verify Operation**: (TX & RX) Provides method for verifying the TX and RX functional operation. The test is conductied with the TX tone sequence at a lower sound pressure level (-16 dB from normal test). To conduct a Verify Operation Test – the TX and RX should be located within 1 to 3 feet of each other. To start the test select Verify Operations on first the TX and then the RX .

- **Low Battery Warning**: (TX & RX) This screen occurs when the battery can no longer support additional measurements without being recharged. When a low battery warning occurs, the component should be turned off and recharged. Failure to do so can cause damage to both the battery and the components' electronics.

Battery

The SL-RAT™ RX and TX are powered by a 11.1v Li-Ion battery pack rated at 44.4 Wh, 10A rate. The following directions are essential for correct operation and to avoid damage or loss caused by misuse.

1. Maintain batteries at above 50% battery status as reported in the SL-RAT™ RX & TX System Info Screen. Continued operation of the component at low battery levels can result in damage. We recommend recharging the TX after each daily use and recharging the RX at least once per week.
2. Prior to using the SL-RAT™ RX and TX components in the field, verify the Battery levels are sufficient for the day's planed number of acoustic measurements.
3. A Low Battery Warning occurs when the battery can no longer support additional measurements without being recharged. When a low battery warning occurs, the component should be turned off and recharged. Failure to do so can cause damage to both the battery and the component's electronics.
4. Only use the battery charger provided to recharge the units. Failure to do so can result in battery pack overheating and potentially catching fire.
5. The battery recharger jack is keyed to the plug on the RX & TX components. Make sure the keys are correctly aligned and do not force the connection. Failure to do so can result in battery pack overheating and potentially catching fire.
6. Prior to using the battery recharger visually inspect the wires for any damage. If damage is observed do not use, contact manufacture for a replacement battery recharger. Failure to do so can result in battery pack overheating and potentially catching fire.
7. Battery Recharger is for indoor use only. Do not expose the battery recharger to moisture or water.
8. Do not recharge battery while RX & TX are in the SL-RAT™ carrying case.
9. Do not open the cover of the battery recharger – High Voltage inside the charger can cause serious injury.
10. Do not operate the SL-RAT™ RX or TX while recharging their battery.
11. Do not use the battery charger to charge any other battery or battery pack.
12. Do not charge batteries unattended. When charging Li-ion batteries you should always remain in constant observation to monitor the charging process and react to potential problems that may occur.
13. If at any time you witness smoke, discontinue charging process immediately, disconnect the battery charger and observe the component in a safe place for approximately 15 minutes. Smoke maybe an indication of battery failure, and the reaction with air may cause the chemicals to ignite, resulting in fire.

14. Since delayed chemical reaction can occur, it is best to observe the battery as a safety precaution. Observation should occur in a safe area outside of any building or vehicle and away from any combustible material.
15. Never store or charge battery pack inside your car in extreme temperatures, since extreme temperature could lead to overheating of the battery and potential cause a fire. When transporting or temporarily storing in a vehicle, temperature range should be greater than 20 degrees F but no more than 150 degrees F.
16. Store battery at room temperature between 40 and 80 degrees F for best results.
17. Storing battery at temperatures greater than 170 degrees F for extended periods of time (more than 2 hours) may cause damage to battery and possible fire.

Sewer Line Data Organizer (SL-DOG™)

The Sewer Line Data Organizer is the backend data processing and analysis tool that allows the end-user of the SL-RAT™ to access their data in a convenient electronic format. The SL-DOG™ software is composed of a local installation on the end-user's PC that facilitates communication between the SL-RAT™ RX component and a backend online SQL database that is supported by InfoSense.

Client Installation

The local installation software is provided via a CD enclosed in the shipment with the SL-RAT™ device. The local software requires an Internet connection to work and is configured for use with Windows XP and Windows 7 operating systems.

Installation Troubleshooting: Under certain circumstances the SL-RAT™ USB device driver fails to load. If this occurs, reload the device driver provided with the SL-DOG™ installation CD.

The external database can be accessed at www.infosenseinc.com

Operation Overview

The SL-DOG™ software (SL-DOG™ Client) operating on the user's computer provides an interface for downloading the measurement stored on the SL-RAT™ to the InfoSense Inc. Website for archival storage. Once the data download is complete, the user can then generate a local file containing the acoustic measurement data from the SL-RAT™ device. Once the SL-DOG™ Client is installed on the user's PC, the following steps are used to download the data and generate a user's measurement data file.

1. Verify the SL-RAT™ RX and TX are data synchronized. This must be done prior to downloading data to the PC. The SL-RAT™ RX will not initiate the USB interface unless all measurement records have been synchronized.
2. Verify the PC is connected to the Internet. An internet connection is required to

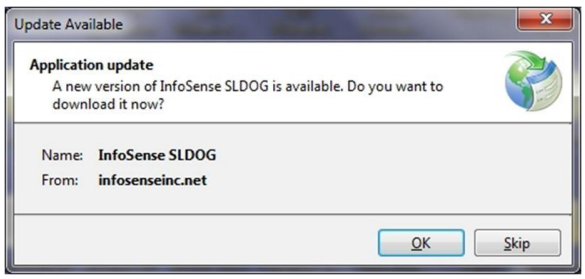

Figure 12 SL-DOG Checking for Software Update.

successfully perform the download operation and to generate the user's measurement data file.

3. Double click on the InfoSense SLDOG Icon on the Desk Top (or select from the Start Menu). This initiates the program.
4. The SL-DOG™ Client checks to see if there is a software update, see Figure 12. If there is an update to the client software, it is recommended that you update the client software by selecting OK.
5. The SL-DOG™ Client main window opens. This may take up to 1 minute.
6. Step 1 – Establish and Verify a communication (COM) port connection between the SL-RAT™ and the PC.
    a. Examine the current COM ports in use by the PC by viewing the Select Port pull down menu
    b. Turn on the SL-RAT™ RX device
    c. Connect the USB cable provided between the PC and the SL-RAT™. Only use a high quality USB cable such as the USB cable provided with the SL-RAT™. Low-grade USB cables can damage the SL-RAT™ RX USB port requiring replacement of the USB port.
    d. Once the USB cable is securely connected, wait approximately 5 to 30 seconds for the PC and SL-RAT to recognize the new USB connection.
    e. On the SL-RAT™ screen the following message is displayed "Transfer Data to PC/Follow Directions on PC."
    f. On the SL-DOG™ Client press the Refresh Port List button
    g. Reexamine the Select Port list and highlight the new COM Port.
    h. Press the Connect button to establish and verify the connection
    i. This process is illustrated in Figure 13(a) and (b). In Figure 13(a) the COM ports in use prior to inserting the USB cable between the PC and SL-RAT™ are displayed and Figure 3(b) is after the USB cable is connected. Communication port 21 is selected by highlighting COM21 and then pressing Connect button.
    j. When the correct communication port is selected, the SL-RAT™ RX device ID and measurement IDs to be downloaded are displayed.
7. Step 2 – Download the Data from the SL-RAT RX Component to the InfoSense Archive
    a. Once the COM port is successfully established, Figure 13(c), press the Download Data button. This will initiate downloading the data to the InfoSense archive.
    b. The status bar will be updated as the download progresses. Depending on the number of records to be downloaded this operation can take from 1 minute to over 10 minutes to complete.
8. Step 3 – Export User Measurement Data File stored on the local PC
    a. Once the download is completed, Figure 13(d), press the Create CSV File button in order to create the User's measurement data file.
    b. A new window will open allowing the user to specify the location and filename for the measurement data file. It is highly recommended that the ".csv" file extension be used in specifying the file type.

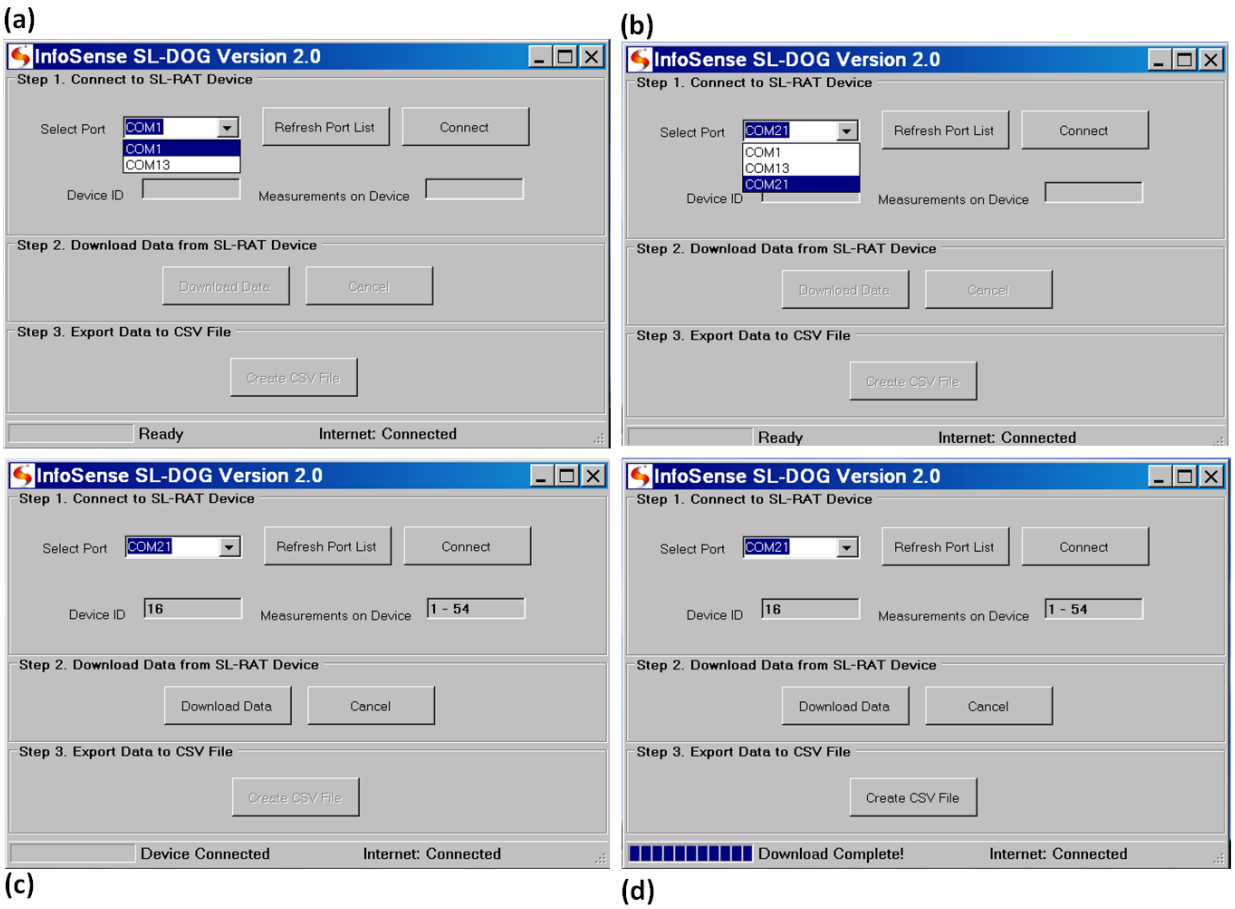

Figure 13 SL-DOG Operation overview. (a) & (b) COM port selection for connecting SL-RAT to SL-DOG; (c) Connection verified and ready to download data; (d) Download complete and ready to create user's measurement data file.

Sample Report from CSV –File

The user data file generated from the SL-DOG™ is in standard format with coma separated fields for each record, i.e., CSV file. The file can be viewed directly using Microsoft Office Excel® and/or imported into a Microsoft Office Word® report template as illustrated in Table 3. The CSV file format can also be used to import the acoustic measurement data into the user's Graphic Information System (GIS) allowing integration with user's current GIS system.

Table 3 Sample Report from SL-DOG Generated CSV File

Meas. ID	RX Oper. ID	RX HW ID	TX Oper. ID	TX HW ID	Date & Time	Meas. Duration (sec)	Oper. Pipe Length (ft)	Eval. Pipe Length (ft)	Meas. Status	Assessment (0-Blocked; 10-Clean)	Pipe Status	RX Latitude (dec. deg.)	RX Longitude (dec. deg.)	TX Latitude (dec. deg.)	TX Longitude (dec. deg.)
31	3	6	15	7	12/16/11 3:12 PM	79	150	184	Valid	5	Fair	35.31480	-80.74676	35.31506	-80.74623
30	3	6	15	7	12/16/11 3:01 PM	79	350	333	Valid	7	Good	35.31557	-80.74715	35.31506	-80.74623
29	3	6	15	7	12/16/11 2:51 PM	96	150	60	Valid	4	Fair	35.31533	-80.74724	35.31549	-80.74729
28	3	6	15	7	12/16/11 2:41 PM	80	250	242	Valid	9	Good	35.31533	-80.74724	35.31480	-80.74676
27	3	6	15	7	12/16/11 2:33 PM	192	250	209	Valid	0	Block	35.31488	-80.74745	35.31480	-80.74676
26	3	6	15	7	12/16/11 2:25 PM	80	150	115	Valid	9	Good	35.31488	-80.74745	35.31517	-80.74758
25	3	6	15	7	12/16/11 2:14 PM	79	250	232	Valid	8	Good	35.31559	-80.74816	35.31517	-80.74758
24	3	6	15	7	12/16/11 2:04 PM	160	150	107	Valid	2	Poor	35.31559	-80.74816	35.31582	-80.74794
23	3	6	15	7	12/16/11 1:58 PM	79	50	83	Valid	6	Fair	35.31559	-80.74816	35.31581	-80.74823
22	3	6	15	7	12/16/11 1:49 PM	79	250	223	Valid	9	Good	35.31633	-80.74863	35.31581	-80.74823

Definition for Sample Report illustrated in Table 3:

TX – SL-RAT™ transmitting unit.

RX – SL-RAT™ receiving unit.

Meas. ID - (Measurement ID) Unique identification number for each SL-RAT™ receiving unit (RX).

RX Oper. ID – (Receiver Operator ID) Operator ID assigned to the operator by the SL-DOG system administrator and entered by the operator when login into the SL-RAT™ receiving unit (RX).

RX HW ID – (Receiver Hardware ID) Unique serial number assigned by InfoSense to the SL-RAT™ receiving unit (RX); RX serial numbers are even.

TX Oper. ID - (Transmitter Operator ID) Operator ID assigned to the operator by the SL-DOG system administrator and entered by the operator when login into the SL-RAT™ transmitting unit (TX).

TX HW ID - (Transmitter Hardware ID) Unique serial number assigned by InfoSense to the SL-RAT™ transmit unit (TX); TX serial numbers are odd.

Date & Time – Date and time of the SL-RAT™ measurement in UTC (Coordinated Universal Time).

Meas. Duration – (Measurement Duration) Duration of the measurement as recorded by the SL-RAT™ receiver (RX). Measurement duration is in seconds.

Oper. Pipe Length – (Operator Pipe Length) Pipe length as entered by the SL-RAT™ receiver operator. This value is used in the pipe segment assessment. Pipe length is in feet.

Eval. Pipe Length – (Evaluated Pipe Length) Pipe length estimated by the SL-RAT™ unit.

Meas. Status –(Measurement Status) the SL-RAT™ receiving unit (RX) evaluates the conditions under which the pipe assessment is conducted and provides a warning concerning possible limitations in the measurement as follows:

Measurement Status	Condition
Valid	No anomalies in the measurement conditions were detected
Early	The SL-RAT transmitter unit (TX) was stopped prior to the SL-RAT receiving unit (RX) completed its processing. The Pipe assessment maybe corrupted.
Late	The SL-RAT transmitter unit (TX) was started after the SL-RAT receiving unit (RX). The Pipe assessment maybe corrupted.
No TX	The SL-RAT transmitter unit (TX) was not turned on during SL-RAT receiving unit (RX) measurement. **The Pipe assessment is corrupted.**

Assessment – Pipe assessment scaled from 0 to 10 with the following general interpretation:

Assessment	Typical Condition / Interpretation
10	No significant obstructions within the pipe
7-9	Minor impediments within the pipe such as joint offsets, partial sags, protruding laterals, debris, minor grease, and/or minor root fibers.
4-6	Impediments within the pipe such as joint offsets, partial sags, protruding laterals, debris, grease, and/or root fibers. Single or multiple occurrences.
1-3	Significant impediments within the pipe such as multiple joint offsets, near full pipe sag, multiple protruding laterals, significant debris, significant grease, significant root fibers and/or root balls. Single or multiple occurrences.
0	Full pipe sag; single or multiple obstructions within the pipe reaching or nearly reaching the flow.

Pipe Status - The Pipe Segment classification based on the Pipe Segment Assessment. It is also used to report the test type and condition. The Pipe Status can be one of the following eight possibilities:

Pipe Status	Condition
GOOD	Pipe Segment Assessment from 7 to 10
FAIR	Pipe Segment Assessment from 4 to 7
POOR	Pipe Segment Assessment from 1 to 4
BLOCK	Pipe Segment Assessment from 0 to 1
CLOSE	The SL-RAT transmitter unit (TX) and the SL-RAT receiving unit (RX) were too close during the measurement. The Pipe assessment maybe corrupted.
NOISE	The SL-RAT receiver (RX) detected noise conditions which may impact the measurement. The Pipe assessment maybe corrupted
VERIFY	Verify SL-RAT RX & SL-RAT TX Operational Test
REJECT	Indicates the RX operator rejected the measurement

RX Latitude – Global position system (GPS) latitude at the SL-RAT receiver (RX) unit at the time of the measurement; GPS RX measurement is in decimal degrees.

RX Longitude - Global position system (GPS) longitude at the SL-RAT receiver (RX) unit at the time of the measurement; GPS RX measurement is in decimal degrees.

TX Latitude - Global position system (GPS) latitude at the SL-RAT transmitter (TX) unit at the time of the measurement; GPS TX measurement is in decimal degrees.

TX Longitude - Global position system (GPS) longitude at the SL-RAT transmitter (TX) unit at the time of the measurement; GPS TX measurement is in decimal degrees.

Additional Information

Wireless Device

Contains FCC ID: OUR-XBEE/OUR-XBEEPRO

The enclosed device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (i.) this device may not cause harmful interference and (ii.) this device must accept any interference received, including interference that may cause undesired operation.

Maintenance

General Cleaning Recommendation

Under recommended operation of the SL-RAT™ device, maintenance should be minimal. It is recommended to clean the exterior of the SL-RAT™ device with a mild disinfecting wipe or a mild general purpose cleaner after each daily use. Do not use harsh chemicals on the exterior. Do not open Electronic Case, remove TX Speaker and/or remove RX Microphone in order to perform maintenance - cleaning or otherwise.

TX Speaker & RX Microphone

User maintenance is required if the TX Speaker or RX Microphone are fouled with debris, dirt or have been exposed to harsh chemicals airborne or otherwise. Under any of these conditions, they are required to be cleaned.

Cleaning - DO NOT USE CLEANERS OR CHEMICALS. Use a mild liquid dish soap and water mixture on a clean rag to clean the exterior of the TX Speaker or RX Microphone.

If the SL-RAT™ device is regularly exposed to harsh environments, then the SL-RAT™ TX and RX should be returned to the factory at least one time per year to provide more extensive cleaning, inspection of seals, cables, and electronics.

Opening the electronics' case will void the warranty. All repairs requiring opening of the electronics' case, should only be performed by factory trained technicians.

Lock Knob Maintenance

The two lock knobs (Figures 1 & 2) on both the SL-RAT™ RX and TX should be oiled at least once per year more often if the device is regularly exposed to wet weather, wet environments and/or harsh environments.

Battery

The rechargeable Li-ion battery is not customer replaceable. Please return the RX or TX component to the Manufacturer for battery replacement.

Specification

General

- Dimensions: 33” x 14” x 5.5”
- Weight: TX 18 lbs; RX 11 lbs
- Operating Temperature: 0 to +60 degrees Celsius
- Storage Temperature: -20 to +60 degrees Celsius; For best results store between +5 to +27 degrees Celsius
- Environmental Resistance: Components used are at least NEMA 4x compliant
- Number of Measurements Prior to Overwrite: 200 measurements with FIFO data storage

Power

- Battery LiMNNi 11.1v 4Ah
- Battery Cycle Life: 80% of initial capacity at 1000 charge cycles
- Time to charge battery: 3.5hrs
- Temperature range for charging: -10 to +40 degrees Celsius
- Number of TX Measurements starting with fully charged battery: approximately 40
- Number of RX Measurements starting with fully charged battery: greater than 80

Operational

- Recommended Minimum Pipe Segment Length: 20 ft.
- Recommended Maximum Pipe Segment Length: 800 ft.
- Recommended Pipe Flow Levels: Typically less than 50%; Measurements in higher flow levels may also work, but are likely to produce lower pipe assessments.
- Pipe Diameters: 6” to 30”; Measurements in larger & smaller diameter pipes may also work, but have not been explicitly included in the current blockage assessment algorithms.
- Pipe Material: PVC, HDPE, Ductile Iron, Concrete, Vitrified Clay; and others.

Document Revision History

Document Number	Date	Revision List
6-12	6/14/2012	Original Document
8-12	8/7/2012	1. Corrected Measurement Status Table 2. Test classifications added to the Pipe Status: Close & Verify 3. Pipe Status Table added 4. New Menu option Verify Operation 5. TX Measurement termination through RX wireless signal
	8/28/2012	6. General Cleaning Recommendation
1-13	1/3/2013	7. Lock Knob Maintenance 8. USB Cable (SL-DOG Operation Overview 6.c) 9. Reinstalling USB device driver 10. Augmenting Measurement Test Screens with GPS Status