

# miniSURT

miniature  
**Submersible  
Ultrasonic  
Receiver  
Transmitter**

## Operation Manual



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## miniSURT miniature Submersible Ultrasonic Receiver/Transmitter

The miniSURT is a miniature submersible ultrasonic receiver and (optional) transmitter designed to detect and log to flash memory the presence and telemetry of an animal tagged with Sonotronics ultrasonic transmitters. The miniSURT is a stand-alone device consisting of a battery system, microprocessor, flash memory, real time clock, hydrophone, ultrasonic receiver, and Bluetooth Low Energy (BLE) radio.

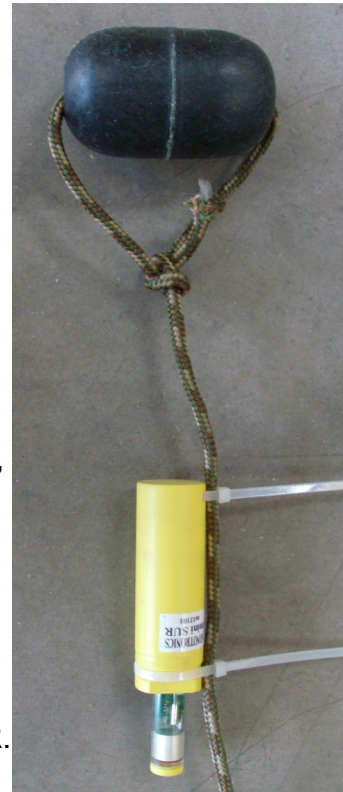
### Specifications:

**Weight:** 130g  
**Sensitivity:** >35dB (S+N)/N with 10uV input  
**Length:** 145mm  
**Diameter:** 33mm base, 16mm hydrophone  
**Memory:** 2 Megabyte—Over 200000 detections  
**Lifetime:** >2 months, TL5903 AA Li  
**Battery:** Tadiran TL5903  
**Optional:** 18650 re-chargeable Li-ion (button top)

### Basic Operation:

A key advantages the miniSURT brings to fisheries studies are its small size and simple deployment methods. In most cases, the miniSURT may be attached to 1/4 inch rope using wire ties, and buoyed with a small rope float, and anchored with a small mushroom anchor or rock sack. Covert deployments are possible by burying a small rope tied to the anchor, or by using a grapple to snag the small float.

The miniSURT scans up to 5 different frequency “ranges”, measuring and recording the intervals between successive pings from individual transmitters. This allows multiple ‘continuous pinging’ transmitters to be used by both passive receivers, like the SUR, as well as active tracking receivers found in the MANTRAK and diver receivers, such as the UDR. The miniSURT employs proprietary techniques to reduce the effects of environmental noise, and adjustable gain to allow maximum flexibility whether deployed in marine, lake or riverine systems. While the miniSURT is highly configurable, factory default settings are suitable for most studies: generally the user needs only verify the correct current time and date before deployment.



### Anatomy of a miniSURT:

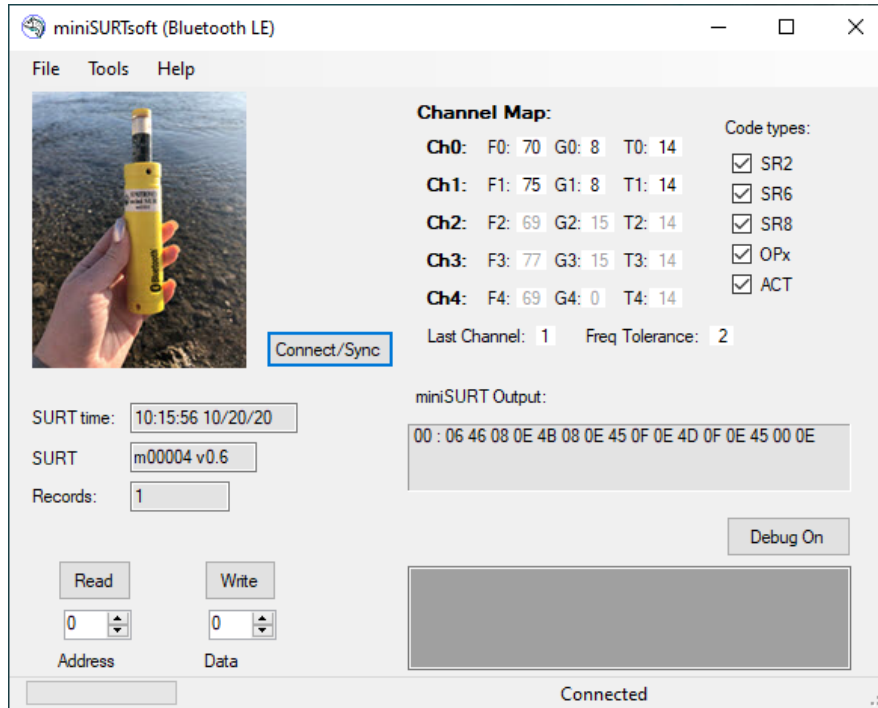


### Initial Power On Sequence:

The miniSURT must first have a battery installed: insert a small diameter screwdriver into the 3/16" hole at the PVC cover which is the bottom of the miniSURT and carefully turn counter-clockwise, this will uncover the battery access. Using a large blade screwdriver or flat metal object like a small coin, turn the battery access cover counter-clockwise to open access to the battery compartment. Insert a new lithium battery (Tadiran TL5903 or 14500 Li-ion) button end first into the battery compartment, and re-install the battery access and PVC cover in reverse order, once installed, the LED will blink rapidly indicating successful power up, and that it is now ready to communicate via BLE (it is helpful to write the current date and time on the battery as a guide for future re-charging, also remove battery prior to storage for longer than 30 days). **NOTE:** It is necessary to set the onboard time and date prior to deployment. If no time and date is set, this will default to 05/28/00, 17:00:00. If the current date and time is noted prior to deployment, it is possible to correct logged data entries after a download if the date and time are noted on the battery as suggested above.

## **miniSURTsoft Interface software:**

miniSURTsoft is a Microsoft Windows application that allows the user to download data from the miniSURT, erase memory, program frequency window to scan, and configure several operating parameters. SURsoftDPC is a separate application used to post process retrieved data: identifying particular transmitters, decoding telemetry, and providing for several types of data presentation.



## **Pre-Deployment:**

Prior to deployment, miniSURTsoft should be installed on the 'field' computer that will later be used to recover field data using either the included device or from the Sonotronics website. Optionally, an additional 'lab' computer may also be designated, allowing an installation of an additional instance of miniSURTsoft and SURsoftDPC. Use of a lab PC in a controlled environment is a good practice to ensure the security of the downloaded data. As the miniSURT communicates via a Bluetooth "BLE" connection, it is necessary for the field computer to have a Bluetooth radio, version 4.0 or higher installed and operating. To ensure good communication between the miniSURT and field PC, it is necessary to have fresh, or recently charged batteries. Place a magnet next to the magnetic sensor of the miniSURT until the onboard LED starts flashing, then locate the miniSURT to within 12 inches of the Bluetooth radio of the field PC. While the LED is continually blinking, launch miniSURTsoft, and begin communication with the miniSURT by clicking the "Connect" button, and choosing the correct miniSURT identified as "sono\_XXXX" where "XXXX" is the unit serial number shown on the white label.

**Pre-Deployment (continued):**

Current time and download options are available, and additional operating parameters such as multiple scanning modes, and transmitter detection preferences are shown on this screen. Please refer to the embedded Help command for current configuration options for the miniSURT.

The factory default setting for the miniSURT allows for detections of tags from 69kHz to 83kHz, with medium gain and 1 second scanning. The following table shows some important values that may be modified by using the Read and Write functions

Address	Value	Comments (values are in hexadecimal)
01	4A	F0 detection window (74kHz +/- 2 kHz)
02	08	F0 gain setting (mid range)
03	0E	F0 listening time 14*5 seconds = 60 seconds
10	00	Ping detect character
13	18	24*0.25hr=6 hr temperature update
1A	00	Flags register
18	01	Last channel
1A	00	Flags register
1D		Flash memory page and record count
1E		
1F		

A bench test may be performed in air to verify proper operation: verify the test transmitter frequency is within the detection window, and place the transmitter with a few inches of the hydrophone. Connect the miniSURT as before, and click on “Debug On” and observe the highlighted window for real-time information from the selected miniSURT and transmitter. Once testing is finished, click the button, now labeled “Debug Off”, which ends the testing session. Note that maintaining a Bluetooth connection rapidly depletes the miniSURT batteries, to it is best to keep this testing brief.



### **Deployment/Mounting:**

The most common deployment configuration is shown in the earlier diagram: using tie wraps to attach the miniSURT to a rope, using a small rope float for buoyancy and small mushroom anchor or rock sack to anchor the miniSURT. This method allows for simple selection of the depth of the miniSURT. If this is near shore, a rope may be connected to the anchor and hid near shore, and retrieval is possible by simply dragging the anchor and miniSURT.

Attaching the miniSURT to a fixed object, such as a dock piling or post, is accomplished using wire ties and stainless steel hose clamps. It is recommended to acoustically isolate the miniSURT body from a solid structure such as a piling by wrapping it in neoprene or other closed cell foam.

In addition, in areas where barnacles accumulate, use a simple nylon stocking as a sacrificial membrane by covering the entire miniSURT, and replacing the stocking during each deployment. This method may also be helpful in rivers with high sediment flow.

The main body of the miniSURT is slightly smaller in diameter than 1 inch PVC, and as a result it is possible to use standard couplers by applying a layer or 2 of electrical tape around the body of the miniSURT for a friction fit, alternatively the miniSURT will fit inside of 1 1/4 inch sch 40 PVC allowing many low cost and novel deployment platforms.



### **Replacing Batteries:**

To replace the battery in a miniSURT, follow these steps:

1. Slide a screwdriver or rod into the 3/16" thru hole at the base of the miniSURT and turn counter-clockwise.
2. Access the internal battery holder by using a large blade straight screwdriver or thin flat metallic object like a coin into the visible slot and turn counter-clockwise.



3. Insert a new or freshly charged battery into this compartment, button end first.
4. All the settings for frequency, gain, and scanning as well as the logged detection records are stored in protected memory and are unaffected by power loss. **HOWEVER THE CLOCK MUST BE RESET EACH TIME** the battery is changed. If field conditions require the change of batteries without the presence of computer to set the time, be sure to note the exact time and date on the batteries as this value may be used to correct the stored date and time after the data is retrieved from the miniSURT.
5. When reassembling the unit, it should be observed that the LED will blink rapidly for several minutes when the unit is powered on.
6. **IMPORTANT!!** Inspect the O-ring while screwing the PVC end back into the unit. If the O-ring is not seated properly, the units will not be waterproof. Tighten securely: occasionally use silicon grease to increase the useable life of the O-ring.

**Note:** It is good practice to write the date on the batteries prior to deployment, providing a helpful reminder when the next replacement should occur.

### ***Ranging and Testing miniSURT:***

The actual range achievable with a miniSURT is the result of a number of factors: Transmitter power level, receiver sensitivity and SNR (signal to noise ratio), and a variety of factors in the environment. The factors in the environment are always the most difficult to characterize. This section is a simple guide to give the user some idea of what kind of range to expect, as well as techniques for quantifying the range more closely.

Here is a preliminary table of information:

Depth is one of the main environmental influences that determines range. A quick way to adjust the table above is to halve the range if the depth is less than 60 feet. If you were in a deep open water environment, the ranges listed above would increase.

<b>Range</b>	<b>Transmitter Type</b>	<b>Depth</b>
150-200m	High Power: DT, CHP, AST	>60 feet depth
100-150m	Medium Power: CT, CTT	>60 feet depth
75-100m	Low Power: IBT, PT	>60 feet depth

Some other factors that compromise range:

1. Any form of trapped air between pinger and receiver: Vegetation containing air, air mixed in water, air trapped in a log or other object.
2. Objects not containing air between pinger and hydrophone can cause scattering and reflection of signals.
3. Acoustic noise: Machinery, spill over (dam or any other source), depth finders, sonars, snapping shrimp, or any other source of noise in the water.
4. Thermal or salinity stratification in the water.
5. Turbidity caused by suspended sediments.

**Test:** Determining miniSURT range

- Setting up the miniSURT: set to factory defaults to ensure only one detection window is used. Be sure to set the time and date in the miniSURT and make sure you have a watch or clock with the same time.



### ***Ranging and Testing miniSURT continued:***

- Deploy the miniSURT in its actual location, and move away from the miniSURT periodically placing the transmitter in the water for a couple of minutes at important sample points (i.e., 50m, 100m, 150m, 200m ...). A GPS is the easiest tool for determining your range from the receiver. It is important to note the times at each distance so you can correlate it with the data in the miniSURT. Alternatively it is possible to fix the test transmitter(s), and to move the miniSURT away, noting the time and location each time the receiver is lowered in the water.
- The final step is to correlate the data with the times at each range. You will see which range the miniSURT begins to have difficulty in picking up transmitters.

### **Range Scanning:** Using miniSURT to estimate range

- It is possible to perform tests to allow the miniSURT to estimate ranges between the miniSURT and a group of transmitters. For the success of such a test, it is vital to know the actual measured output power of the transmitters (Source Level) or to have the transmitters on hand before tagging. The miniSURT has fine gain control that may be cycled as part of a scanning protocol, and the value of this gain is saved with the logged data. By locating transmitters within a 10-50 meters of the a miniSURT, then selecting constant detection windows, but decreasing gain per scan selection, it is possible to note cutoff values for detection ranges. As a result detections that occur with a low gain setting must be within the minimum range as tested, and this may be helpful to prove the existing of small home ranges, spawning areas, or to clarify social behavior. Please feel free to contact Sonotronics for more details concerning techniques for ascertaining fixed detection areas.

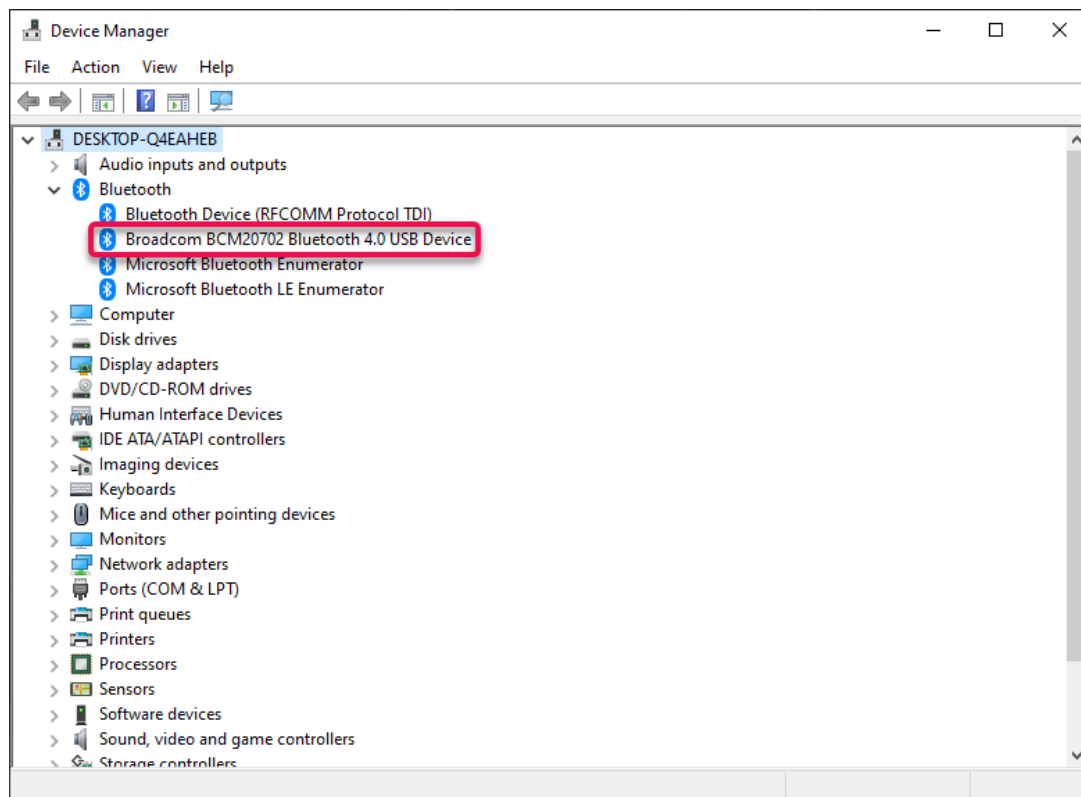
### ***Using SURsoftDPC to analyze miniSURT data sets:***

Data logged to the miniSURT is recovered by using miniSURTsoft: a Bluetooth (BLE) connection is established as before, and once connected, select *File->Download Data* to retrieve the stored data. Only after a satisfactory inspection of the raw data file should the option to erase the data be performed. The raw data file is processed using a special taglist that contains mapping codes between the detection window values, and the actual frequencies of the transmitters used in a study. SURsoftDPC uses the embedded serial number to identify the collected data source as a miniSURT, and performs the necessary translations of detection window to tag frequency. The resultant processed data set is compatible with other data collected from Sonotronics USR14 active tracking receivers and SUR passive logging receivers.

## Using Bluetooth Low Energy enabled receivers

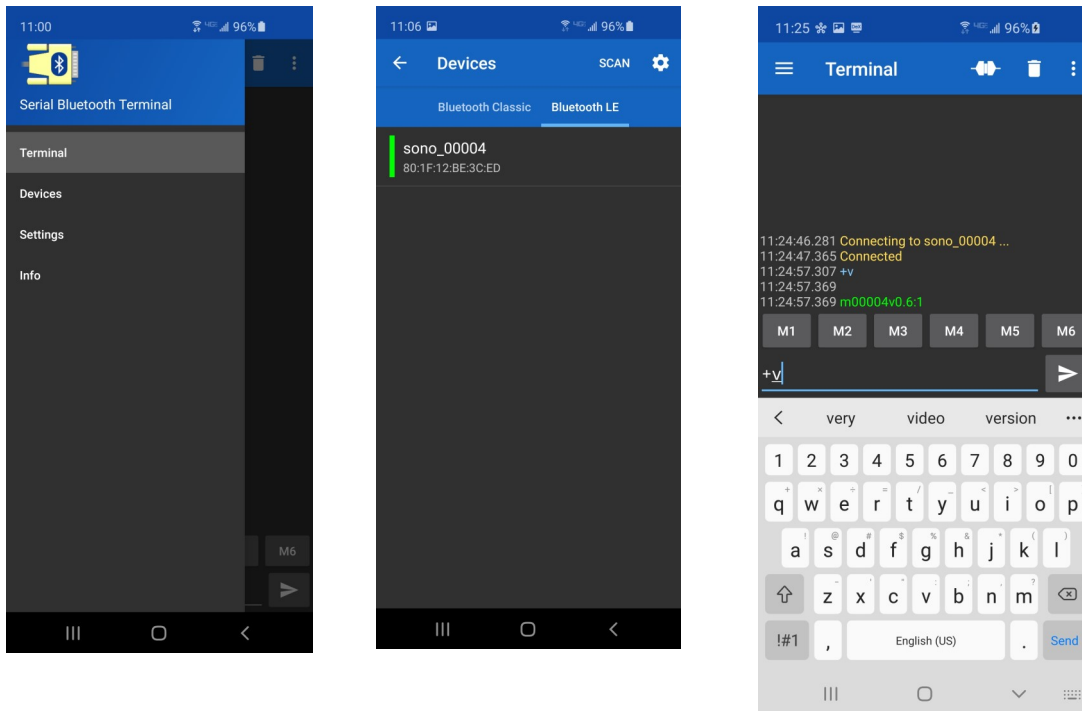
### Overview:

The Sonotronics' miniSURT is a Bluetooth Low Energy (BLE) enabled unit, allowing wireless configuration and downloads. The miniSURT uses a Microchip RN4870 BLE modem, and specifically a GATT service named "Transparent UART", enabling the use of standard BLE interfaces found in many PCs, laptops, and android devices that support Bluetooth version 4.0 and higher. Verifying that a Windows 10 device has a compatible interface may be accomplished by starting Device Manager (WIN+X, then click on Device Manager), expanding the Bluetooth tab to observe the characteristics of the installed interface:



With a compatible NT interface installed, miniSURTsoft will be empowered to scan and connect with compatible Sonotronics receivers.

A useful tool for Android devices is “Serial Bluetooth Terminal”, available on the play store, that allows for scanning and connecting to Sonotronics BLE receivers:



Data may be exchanged with receivers using this app, in the example above, typing “+v” and pressing the send icon causes a miniSURT to respond with its serial number, firmware version number, and number of detections saved into internal EEPROM. The following are a few interesting commands that may be sent using this method, note these are all case sensitive:

- “+e1” obtains the most recent detection record
- “+p” resets the miniSURT
- “+z1” sets miniSURT into debug mode
- “+z0” clears debug mode

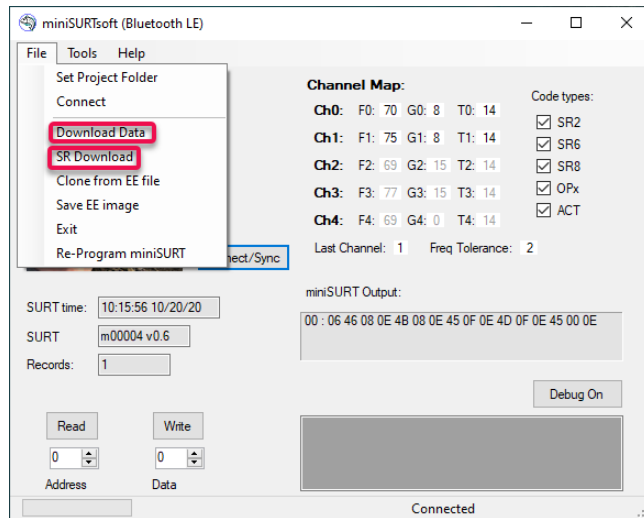
## Data Format

The miniSURT transfers data in a compact but readable form. An example of a native 26 character data record is:

01090120081620452000000002

The first 2 characters from a record sequence number, followed by 12 characters for time and date, 2 characters representing the detected frequency, 2 characters for the detection type, and 8 characters for the data sent obtained from the detected transmitter.

Fortunately, miniSURTsoft provides methods to convert this raw data into useable form, either by selecting “Download Data” to make use of integration with SURsoftDPC, or by selecting “SR Download” which prepares a .csv file immediately readable by Excel.



## NOTES:

miniSURT supplied with a high resolution 32 bit timer, identified as version 0.c, should use the “SR Download” option when retrieving logged data. The additional 32 bit timer value is shown in the last position without a named header for the data field. This number is a value of a 32 bit counter updated every 0.5556mS.

	A	B	C	D	E	F	G	H	I	J
1	Receiver	Rec#	Time	Date	Freq	Type	ID	Telemetry	Gain	
2	mE0005	0	15:28:58	9/30/2020	0	0	1004	27	0	
3	mE0005	1	15:29:06	9/30/2020	69	5	44		8	12456
4	mE0005	2	15:29:24	9/30/2020	69	5	44		8	30455

Fin this case, the time between the 2 detection events is  $(30455-12456)*0.5556\text{mS} = 10000.2 \text{ mS}$ . Using the time and data and ID, data from multiple receivers may be normalized to provide a precise time difference for detection among multiple receivers.