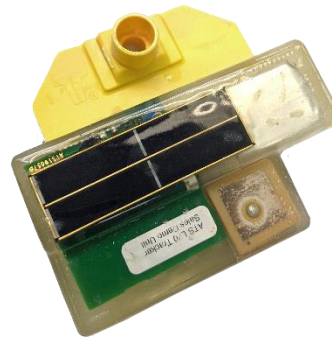


## L20 Solar-Cell Tracker

# *User's Manual*

**IMPORTANT:** Your L20's SIM card has been activated for a 5-year period of service. After this period, ATS will contact the customer to determine if the data period should be renewed.

**Trackers ARE NOT refurbishable. Do not return trackers for refurbishment service or disposal.**



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## **Section 1 Introduction**

The L20 Solar-Cell Tracker is a lightweight, solar rechargeable, LTE-M Cellular enabled GPS tracking device. With very long life due to rechargeability, the L20 is well-suited for use in multiple longer studies.

Tracker configuration and data download is done via web browser. Login information will be sent by ATS sales when tracker is shipped.

**IMPORTANT: Your tracker IS NOT RUNNING until the attached magnet is removed. More details in Section 4.**

**Data service HAS BEEN activated for all shipped L20 models.**

## **Section 2 Theory of Operation**

### **Quick Reference**

- Data offload/programming is done solely over LTE-M (CAT-M1) networks over several cellular carriers. Contact ATS to check coverage in your area.
- The trackers can recover from a drained battery. When low on battery in hibernation/low light conditions, the tracker will stop collecting data and wait to recharge. It will restart and transmit when charged.
- All collected data is retained in flash memory. If low on battery, or out of cell service the unit will continue to collect data and save it. Data will be sent out when the tracker finds cell networks during a scheduled transmission.
- Schedules can be changed post-deployment. Configuration is done via a web interface. Login information is sent to users after ordering.

The L20 Solar-Cell Tracker's main function is to take GPS locations with an onboard modem, then transmit those GPS locations over LTE-M cellular networks to a cloud database.

Data access and device configuration are both done within a web browser by the user.

## **Section 3 Using the Web Interface**

All configuration and data downloads for L20 trackers are done via a simple browser web interface. This interface changes values within a cloud that the trackers connect to on each scheduled LTE session.

### **Logging in**

To reach the online dashboard, navigate to the URL given in the email/QR code upon purchasing an L20. A login page will show, where users will enter their username / password, which is delivered via email when first purchasing any L20 model.

### **Selecting a Tracker**

The top of the webpage has a dropdown menu that gives access to all trackers that are available to the user. Clicking on one of the choices in the menu populates current settings into the interface. The user is then able to select one of the three views for the tracker:

### **Configuring a Tracker**

By default, after logging in, the user is brought to the tracker configuration page. This view is for changing schedule settings for the L20. The first slider changes how frequently the tracker tries to get a GPS fix. The second slider changes the interval between LTE data sessions, where the tracker sends its data and looks in the cloud for new schedule configurations.

The **Adaptive fix** switch changes the GPS fix schedule to be variable, based on battery voltage trends. The L20 will learn how quickly the battery is draining/charging over the course of several days and adjust the fix schedule to maintain a charge of approximately 90%. This mode allows faster GPS fixes than a programmed schedule, but the exact rate of data collected will be variable based on sunlight. **The L20 ignores all user GPS settings when Adaptive Fix mode is enabled.** Internal algorithms will work to keep the L20 operating with minimal downtime in low-light conditions.

**IMPORTANT: the user MUST click the "Save New Configuration" button for schedule changes to take effect.**

## Downloading Data

By clicking “Tracker data”, the user is brought to a page which gives data download options. A date range can be chosen to only retrieve data within a specific time period, or all data from the tracker can be fetched. GPS data points may be retrieved in hhmmss format, or decimal.

## Viewing Recent Transmissions

The final view that may be selected shows the recent LTE sessions and some statistics about the tracker at each event. The data shown is as follows:

- Date/time
- Number of GPS fixes sent by tracker
- Firmware version
- Battery voltage

## Section 4 Interacting with the Tracker

The L20 is sealed with water/splash-proofing material, and the only physical user interaction is with an onboard magnetic switch.

### Forcing the L20 to enter sleep mode

A magnet may be attached to the L20 over its switch to place it in an ultra-low-power sleep mode. This area is marked with two dots on the tracker. Magnets that are weaker than the one shipped with the L20 may not activate the switch, so only use the provided magnet.

In sleep mode, the L20’s data collection schedule will be paused until the magnet is removed.

After attaching the magnet, the L20’s LED will blink to confirm that it has gone to sleep. Check table 1 for LED blink patterns. Normally, confirmation will take a few seconds, but may take up to 3 minutes if the L20 is attempting a GPS fix or connecting to LTE.

### Taking the L20 out of sleep mode

Removing the magnet from the tracker will take the L20 out of sleep. The onboard LED will blink to confirm this. Check Table 1 for a reference on LED blink patterns. **On wakeup, the L20 will always attempt to connect to LTE to upload data and update settings** (provided the battery is charged enough to attempt a transmission).

## LED Blink Pattern Table

There are a number of events on the L20 that are indicated by flashes of color from the onboard RGB LED.

Interaction	LED pattern	Meaning
Place magnet on Tracker	3 x Blink PURPLE	Tracker is now in Sleep Mode
Remove magnet from Tracker	5 x Blink PURPLE	Tracker has left Sleep Mode
-	1Hz Blinking BLUE	Tracker is searching for LTE towers
-	1Hz Blinking GREEN	Tracker is searching for GPS
-	Single YELLOW Blink	Battery is too low for LTE/GPS
-	Single RED Blink	Hardware error

*Table 1: LED Blink Patterns*

## Section 5 Tracker Functionality

### GPS Operation

A GPS attempt may last as long 120 seconds but may also be shorter depending on the tracker's view of the sky. In the case where a fix was not successfully found, the failure reason and other metrics will be recorded for users to view.

The GPS receiver specifications are shown in table 2:

Symbol	Description	Value	Unit
Sensitivity, cold	Acquisition sensitivity, cold start	-142	dBm
Sensitivity, hot	Acquisition sensitivity, hot start	-145	dBm
Sensitivity, tracking	Tracking sensitivity	-151	dBm
TTFF, cold	Acquisition time (time to first fix (TTFF)), cold start, open sky, typical	36	s
TTFF, hot	Acquisition time (TTFF), hot start, open sky, typical	1.3	s
Accuracy, periodic	Positioning accuracy (CEP50), periodic tracking	5	m
Accuracy, continuous	Positioning accuracy (CEP50), continuous tracking	3	m

*Table 2: GPS receiver specifications*

## LTE-M Transmission Operation

The L20 has an embedded Global IoT SIM card which allows it to communicate with LTE networks in most parts of the world.

During an LTE transmission, the data stored in flash is sent over cell networks, and once the data is confirmed as received, it is deleted from the tracker's internal memory.

On connection to the LTE network, the tracker also reads the current configuration from the cloud that is populated by the website. Internal timers are updated in the case of a schedule change since the last connection.

## Solar charging Operation

The L20 has an onboard solar charging circuit that is able to charge the battery in both high and low-light scenarios. There are separate battery thresholds for different events within the L20, as when battery drops too low, activity is kept at a minimum in order to charge.

Cloudy conditions and dense cover may impact the number of LTE transmissions or GPS data points. Very sunny conditions can yield upwards of 48 fixes a day, where consistently low light conditions may only allow for 1 fix per day. The Adaptive Fix option on the web dashboard is recommended to keep the tracker operational under changing light levels.

In the case of very long periods of time with little light, like hibernation, the battery will be completely cut off from the microprocessor. All sensor data is held in flash, and will be retained over the power-out period. When the tracker is in sufficient sunlight and the battery reaches a set level, the circuit will power on again and resume its schedule.

Rechargeable battery management is difficult in cold climates, where lithium-ion batteries can have issues when under load. Below freezing temperatures, the tracker is set to not attempt an LTE connection unless it is near a full charge. This is done in order to improve reliability and keep the battery from being damaged in cold temperatures.

**If a faster fix schedule is set than sunlight levels allow, gaps in data may occur. The tracker will charge up from low battery conditions, but it may take a considerable amount of time for it to start transmitting again. This is why ATS recommends using Adaptive Fix mode in most use cases.**

## VHF Operation

The L20 has an onboard VHF beacon, for locating the animal precisely for recapture or other purposes. The beacon is initialized by default, but users can change VHF settings to their needs over the web dashboard.

## **Water Sensing**

Water is great at attenuating high-frequency signals. As such, both GPS and LTE-M cellular signals cannot penetrate very far into bodies of water. For animals that spend a significant amount of time in the water, the L20 has an optional conductivity sensor which allows it to sense when it is submerged in water. This allows it to skip GPS and LTE activity when in the water, saving battery power. If a scheduled fix is attempted in water, the tracker keeps record of that fix time, skips that GPS data point, and will check the conductivity sensor frequently. When the L20 sees that the animal is out of the water, it will take a GPS fix, and return to its normal GPS schedule. This results in large amounts of power saving for the tracker, especially when attached to amphibians.

## **Section 6 Attaching the Tracker**

The method of attaching the L20 to an animal varies on the exact model that was ordered.

### **Glue-on Attachment**

The Glue-on configuration is up to the customer, when it comes to choosing adhesives and location on the animal. To ensure proper operation, do not cover the solar panel, even with a clear material. Also, when testing the L20 in your deployment area of interest, do not place the tracker near (within 6”) of metal objects. This may cause detuning for the antennae in the tracker.

For trackers with a whip antenna, it is possible to bend the antenna (say around the perimeter of a turtle shell, less than 90° from original angle), but expect some slight reduction in cell signal.

### **Backpack Attachment**

The backpack configuration has through-holes for feeding wire through, creating loops to go around an animal's limbs. ATS leaves the wire loop attachment to the researcher.

### **Ear tag Attachment**

Use a standard tag applicator, and the provided stud with the tag to affix the ear tag to the ear of the animal.

## **Collar Attachment**

Your Collar(s) has been optimized according to the collar dimensions specified during ordering. The size of the collar is determined by the collar adjustment bracket and the main collar holes. To adjust the collar and/or attach the collar to an animal, the procedure is as follows (some differences may exist between models):

1. First remove the collar adjustment bracket nuts and plate from the collar adjustment bracket and remove the collar adjustment bracket from the main collar.
2. Wrap the collar around the animal's neck so that the extra length (if any) of the main collar is tucked inside the main collar end with the solar panels. The extra length can also be cut if desired.
3. Observe where the set of holes on the solar panel end of the main collar line up with the holes on the other end of the main collar such as to maintain a desired tension level on the animal's neck.
4. Place the collar attachment bracket through both sets of holes and through the brass bracket and tighten the collar adjustment bracket nuts using the provided nut driver. Do not over-tighten as this may damage the collar adjustment bracket.
5. Finally ensure that the case nuts have been tightened before releasing the animal.

## **Section 7 Warranty and Service**

The model Collar(s) series collars are warranted for one year from the time of shipment.

**NOTE: Collars ARE NOT refurbishable. Do not return collars for refurbishment or disposal.**

Should you encounter any difficulty during configuration or operation of your trackers, please contact ATS Sales and Service at 763.444.9267 during normal business hours. This and other ATS User Manuals, as well as software, are available for download from the ATS website, at [www.atstrack.com](http://www.atstrack.com).



## **Section 8 Changelog**

2021-11-06 – Initial Release

2023-06-02 – Added RGB indication, more details on solar charging scheme

2024-02-21 – Simplified Theory of Operation, more Adaptive Fix details