

Stomach Temperature Pill 3 (STP3) User Guide

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General Information and New STP3 Features

The Stomach Temperature Pill 3 (STP3) is the third generation of Wildlife Computers STP. New features include:

- Individual transmitted messages encode the temperature. With the older STPs, temperature was conveyed by the timing between two consecutive pulses.
- The STP3 measures 0 to 50C, with a resolution of 0.1C, and accuracy of approximately $\pm 0.3C$.
- Can be used in conjunction with an MK10-L or MK10-AL.

Overview of Functionality

The STP3 is designed to give insight as to when an animal feeds by detecting temperature changes associated with ingesting cold prey. It therefore must be inserted into, and remain within, the stomach of a warm-blooded study animal throughout the study. The temperature of the STP is measured using four thermistors, and the coldest measured temperature is relayed to an associated Wildlife Computers MK10-L or MK10-AL data recorder. A sudden drop in the measured temperature may be an indication that the study animal ingested cold prey. The STP3 must be within approximately 2m of the MK10-L or MK10-AL for the temperature to be received.

The STP3 measures and transmits temperatures from 0 to 50C (with a resolution of 0.1C, and accuracy of approximately $\pm 0.3C$) at a user-specified transmission interval of 10, 20, or 30 seconds. Limited battery capacity means that messages spaced 10 seconds apart will yield approximately 22 days of life, 20 seconds apart will yield approximately 45 days, and 30 seconds apart will yield approximately 69 days.

The components are cast in an epoxy tube which measures 63mm in length and 21.5mm in diameter. The temperature sensors are attached to the inside of a titanium ring to minimize the temperature response time. The STP3 is turned on (Deployed) and off (Shutdown) with a magnet. An LED flashes in response to confirm whether the STP3 is “on” or “off.”



How It Works

Once enabled with a magnet, the STP3 transmits encoded messages at pre-defined intervals. These messages encode temperature over the range 0 to 50C. Temperatures below 0C will be encoded as 0C and temperatures above 50C will be encoded as 50C. Normally the STP is inserted into the stomach of an animal and the encoded messages are received by an MK10-L or MK10-AL tag mounted on the outside of the animal, no more than 2m from the STP. The MK10 synchronizes itself to receive the encoded messages and saves the temperatures into the data archive. MK10-AL tags also encode the temperatures into messages that are relayed back to the investigator by the Argos satellite system. Ideally stomach temperature should be measured in the middle of the stomach and not against the stomach wall, where the temperature may not be affected by ingested cold prey. Given that we cannot be sure that the STP isn't against the stomach wall, four temperature sensors, spaced equally around a titanium ring, record temperature. We assume that the coldest temperature measured best reflects the temperature in the middle of the stomach.

Operational Mode(s)

The STP3 was developed to have 3 different transmission modes. While all three are described here, at the present time ONLY the first mode, Coldest Temperature, is currently available. Once the additional modes are available, the user will be able to specify which mode is desired for the current research project at the time the order is placed.

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There are two variables that need to be specified for the production of the STP3. They are transmission mode and ping-interval:

Transmission modes:

1. **Coldest Temperature.** In this mode, the coldest of the four thermistors will be used to determine the temperature. This is the default mode, and the only mode currently available for purchase.
2. **Sequence.** All four thermistors will be sampled, and the results transmitted in sequence.
3. **Fixed Message.** In this mode, the user will be able to define a fixed value that will always be transmitted (0-4095). This mode is not used to determine stomach temperature, as in the first two modes listed, but as a proximity monitor. An STP3 is attached to each study animal, with a different fixed message to distinguish among them. This will allow the researcher to identify when an individual animal is near one or more stationary receivers.

Ping Intervals:

Three ping intervals are available for any of the transmission modes: 10, 20 and 30 seconds.

Interpreting Temperature Readings when STP3 is used in conjunction with an MK10-AL

When the STP3 is used in conjunction with an MK10-AL, the MK10-AL can generate three message types to be relayed back the user via the Argos satellite system. Some of these message types are triggered by an “ingestion event”. An ingestion event is defined as starting with the detection of a rapid drop in stomach temperature (ST) and ending when the ST returns to within 0.5C of pre-ingestion temperatures or when the event exceeds a maximum duration. You preset values to fine-tune the ingestion event detection. The message types are:

- **Ingestion event message.** This message is created as an ingestion event finishes and contains the following parameters:
 - The time and date of the ingestion event
 - The ST immediately before the ingestion event started
 - The first ST of the ingestion event
 - The depth immediately before the ingestion event started
 - Whether the tag was ascending or descending when the ingestion event started
 - The deepest depth measured during the ingestion event
 - The seawater temperature at this deepest depth
 - The time of this deepest depth
 - The overall duration of the feeding event
 - The last ST of the feeding event
 - The lowest ST recorded
 - The time of the lowest ST recorded
- **Fine-scale ST message.** During a recognized ingestion event, the ST readings will be saved as a time-series at 1-min intervals. Temperature resolution is 0.1C.
- **Course-scale ST message.** This is the default method of encoding ST readings as a time-series. Data are stored at 2-min intervals, but small changes in temperature ($< \pm 0.5C$) will be reported as “no change”. This allows much greater compression of data.

These message types can be selected independently. Selecting or deselecting the “ingestion events records” just affects the generation of such messages, not the recognition of ingestion events. Thus you can deselect “Ingestion events records” and select “fine-scale ST...” and fine-scale messages will still be generated during an ingestion event. The table below shows how the fine- and coarse-scale messages interact.

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	Fine-scale disabled	Fine-scale enabled
Coarse-scale disabled	No time-series messages are generated.	No time-series messages will be generated unless an ingestion event is underway.
Coarse-scale enabled	Coarse-scale messages will be generated throughout the deployment. No special action will take place during an ingestion event.	Coarse-scale messages will be generated between ingestion events, and fine-scale messages will be generated during ingestion events.

Ingestion event messages will always be generated if enabled, regardless of the settings for Fine- and Coarse-scale ST messages.

Understanding STP3 LED Flashes

The STP3 incorporates Wildlife Computers Smart On/Off Protocol. To toggle the tag from Deploy (on) to Shutdown (off), and vice versa, requires 2 properly timed magnet swipes. After the first swipe from the bottom of the serial number label to the bottom of the penguin label, the LED will flash indicating the current state of the pill (Shutdown or Deploy).

- Shutdown: Two rapid blinks (75ms on, 75ms off), then off for 2 seconds. Two more rapid blinks (75ms on, 75ms off), then off for 2 more seconds, for a total time of 6.5 seconds.
- Deploy: Ten rapid blinks (200ms on, 50ms off) for a total of 2.5 seconds.

After current state flash sequence, the LED will be on solid for 2 seconds. During this period a second magnet swipe from the bottom of the serial number label to the bottom of the penguin label will toggle the state of the STP3. If you keep the magnet away from the STP3 during this long LED flash, the STP3 will stay in its current mode. If the state has been toggled during the long LED flash, the blinking sequence will start over.

LED Flash Sequence – Once the pill is Deployed, the LED will flash for the first 50 messages. A single short LED flash indicates that all is operating as it should. Any other flash sequence, e.g., a double short flash or no flash at all, indicates there is a problem with the pill and it should not be deployed in an animal. If the LED has ceased flashing after the 50 messages, a single swipe with the magnet will reset the internal counter and LED will flash for 50 more messages.

Set-up Tips and Other Advice

- You can test the functionality of the STP3 when the MK10-L or MK10-AL is connected to MK10Host. More details are provided in the MK10 Manual.
- In Shutdown mode, the STP3 can be stored for years. For long storage, the STP3 should be kept in a cool environment, preferably at +5C in a refrigerator or in a non-commercial freezer, to help prevent battery passivation.
- Other researchers have found that the animal may regurgitate objects if too large or pass them if too small. We were unable to make these “pills” any smaller. If, however, you feel the pill is too small and want to add more epoxy or other inert material, ensure that the metal ring is still exposed.