DTAG-4 Configuration Options

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DTAG-4 devices have a wide array of options for controlling when they record in keeping with the longer duration and wide range of species for which these tags are intended as compared to DTAG-3. The purpose of this document is to explain the configuration options available and provide examples of how to configure the tag for different applications.

1. Operating states of the DTAG

To understand the configuration options it is helpful to know what kind of operating states the tag can be in and how it switches between these. D4 devices are always in one of five states:

HOST: Whenever a powered USB cable is plugged into the tag, the tag is ready to communicate with a host. The tag stops recording and all timed events (e.g., the release) are cancelled. If the tag was recording when the USB cable was plugged, the recording will be stopped instantly and the final few milliseconds may be lost. Operating power is taken from the USB port and the tag battery will be recharged if it is rechargeable. The HOST state ends when the USB is unplugged. The next state is either SLEEP (if the tag is unarmed) or WAIT (if the tag is armed).

SLEEP: The tag enters the SLEEP state when USB is unplugged and the tag is unarmed. In this state the tag is completely shutdown and no VHF tracking signals are produced (if this feature is available). The tag should be in this state when stored, shipped or taken on an aeroplane. Current consumption in the SLEEP state is negligible. The only way to exit from the SLEEP state is to plug in a powered USB cable, forcing the tag into the HOST state.

WAIT: The tag enters the WAIT state when USB is unplugged and the tag is armed. In this state, the tag continually looks for a start condition as outlined below. While in this state, the Armed LED will flash once every 4 s (or more often when some start conditions are detected) if the LED_ENABLE configuration is set to ON. If the tag has a VHF beacon, it will produce a pair of fast pulses every 2 s. The WAIT state is also entered whenever the tag stops recording because of one of the stop conditions outlined below. The WAIT state ends when: (i) a low battery is detected (change to RECOVERY state), (ii) a powered USB cable is plugged (change to HOST state) or (iii) a valid start condition is detected (change to RECORD state). A start condition can be refused if the battery is temporarily too low to power the tag for recording. In this case, the tag will revert to the WAIT state and look for another start condition. This can continue until a final low battery condition is detected and the tag enters the RECOVERY state. Average current consumption in the WAIT state is of order 15 uA and so can be neglected in most cases. If the TEST mode is enabled in the configuration menu, the tag will automatically switch to RECORD state 10s after entering WAIT state from HOST state and will record for 30s before reverting to WAIT state to wait for a configured start condition.

RECORD: The tag enters the RECORD state from the WAIT state when a valid start condition is detected. In this state, the digital signal processor in the tag is powered and the application code is run. Current consumption in the RECORD state varies depending on the application, sensors and sampling rate but is typically of order 5-10 mA. The VHF beacon will transmit at 1 pulse per second in the RECORD state if the application allows it. Applications can hold off VHF transmissions for up to 2 hours and this is done to avoid generating any interference with sound recordings during long dives, or with GPS captures when the animal surfaces. The RECORD state ends when (i) a valid stop condition is detected (change back to the WAIT state), (ii) a final low
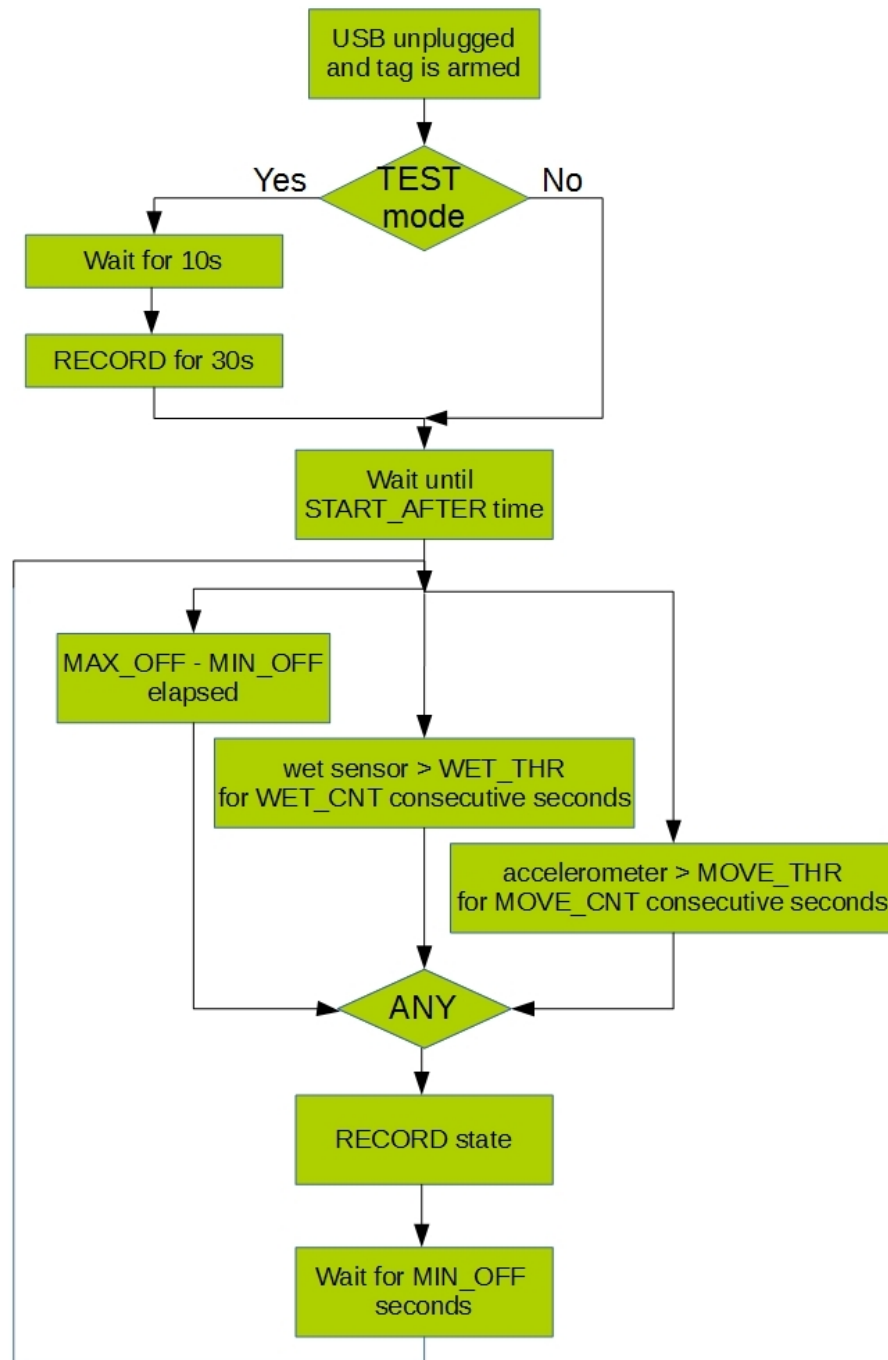
battery is detected (change to the RECOVERY state) or (iii) a powered USB cable is plugged (change to the HOST state).

RECOVERY: The tag enters the RECOVERY state whenever the tag would otherwise be in the WAIT or RECORD states but recording cannot take place either because the battery is too low or the memory is full. In this state, the tag no longer tests for start conditions but continues to run the VHF tracking beacon if this is available. The beacon rate is 1 pulse per 2 seconds. For tags without a VHF beacon, the RECOVERY state is identical to the SLEEP state. RECOVERY mode is only exited by plugging in a powered USB cable, forcing the tag into the HOST state.

2. Start conditions

The tag can check up to three conditions to determine if it should start recording: (i) time, (ii) water immersion, and (iii) movement. A number of parameters control which of these start conditions are active. The parameter START_AFTER defines the earliest absolute time at which the tag can start. Set this parameter to 0 to disable any initial start delay. The tag does not check for start conditions until the START_AFTER time is passed. Following that time, a start condition will be detected if either the tag is immersed in sufficiently conductive water for WET_CNT consecutive seconds or if sufficient movement is detected by the accelerometer for MOVE_CNT consecutive seconds. Alternatively, immersion and movement sensing can be turned off by selecting ALWAYS_START as YES. When ALWAYS_START is NO, the parameters WET_THR and MOVE_THR determine the thresholds for detecting immersion and movement. The immersion threshold is expressed as a saltiness percentage with 0% being fresh and 100% being extremely salty. Using a WET_THRESH of 1% will ensure that immersion is always detected irrespective of whether the tag is wet or dry. A WET_THRESH of 100% will result in the tag almost never detecting immersion. A value of 30% is appropriate for most water but testing is advised. When the tag is in the WAIT state and detects immersion, the Armed LED will flash twice rapidly every second if LED_ENABLE is ON and this can be used to check sensitivity. The MOVE_THRESH is defined in the same way with a threshold of 1% allowing almost any movement to trigger a start while a threshold of 100% requires continual extremely vigorous movement. Again, test this feature before relying on it. Note that movement activated recording is not currently enabled and will be introduced after further testing.

Two other timed events can be configured to control when recordings happen: the MIN_OFF and MAX_OFF times. The MIN_OFF time sets the minimum time that the tag must be in the WAIT state before looking for a start condition. This parameter is only active after the first recording in a deployment, i.e., after the tag has already passed through one RECORD state. This is to avoid conflict between the MIN_OFF and START_AFTER parameters. The MAX_OFF time is the maximum time that the tag is allowed to search for a start condition. If this time expires, a recording is automatically started. If no MAX_OFF time is required (i.e., the tag should look for a start condition indefinitely), use a MAX_OFF value of 0. Although the MIN_OFF event is inactive before the first recording, the MAX_OFF event is active but it is set in this one case to the difference between the requested MAX_OFF and MIN_OFF parameters. See the flowchart below for a graphical view of how these parameters control the startup behaviour of the tag.

```
                    ┌─────────────────┐
                    │  USB unplugged  │
                    │ and tag is armed│
                    └────────┬────────┘
                             │
                    ◇─────────────◇
            Yes    ◇    TEST      ◇    No
          ┌────────◇    mode      ◇────────┐
          │         ◇─────────────◇         │
    ┌─────────────┐                         │
    │ Wait for 10s│                         │
    └──────┬──────┘                         │
    ┌─────────────┐                         │
    │RECORD for 30s│                        │
    └──────┬──────┘                         │
           └──────────────┬─────────────────┘
                  ┌─────────────────┐
                  │   Wait until    │
                  │ START_AFTER time│
                  └────────┬────────┘
```

Flowchart:

- USB unplugged and tag is armed
- TEST mode?
  - Yes → Wait for 10s → RECORD for 30s
  - No
- Wait until START_AFTER time
- MAX_OFF - MIN_OFF elapsed
- wet sensor > WET_THR for WET_CNT consecutive seconds
- accelerometer > MOVE_THR for MOVE_CNT consecutive seconds
- ANY
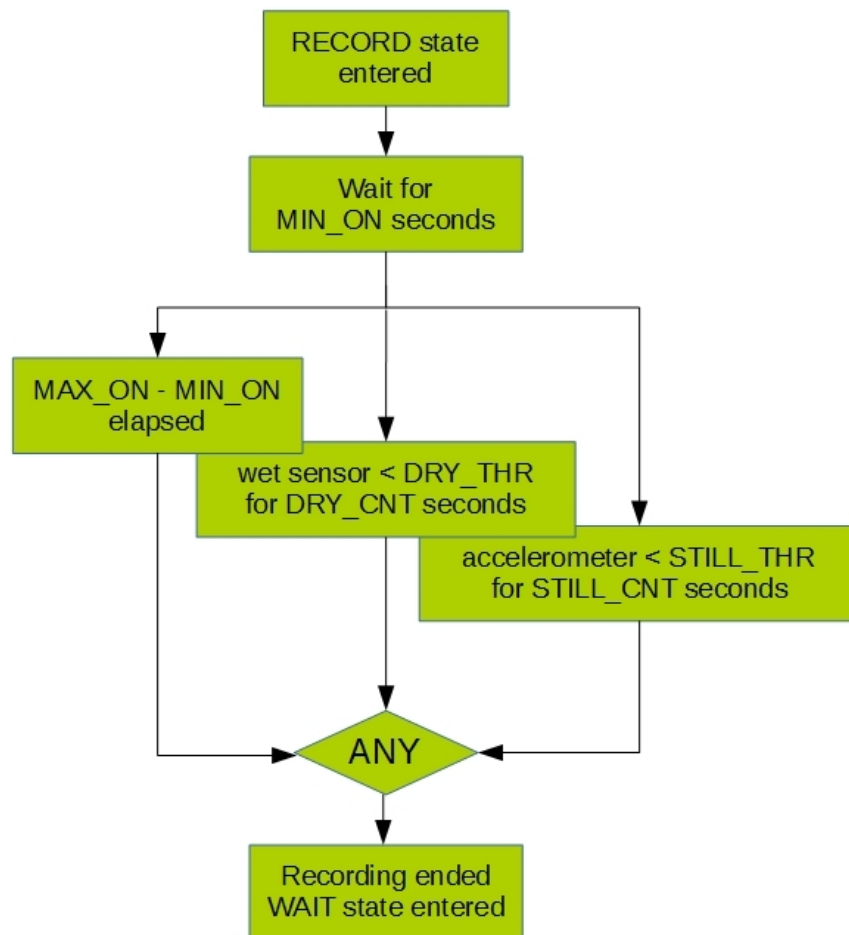- RECORD state
- Wait for MIN_OFF seconds

3. Stop conditions

The tag checks three kinds of stop conditions continuously while it is recording in a similar way to the start behaviour. The MIN_ON parameter determines the shortest possible recording time. After this time has elapsed, the tag looks for a dry condition (i.e., the immersion sensor is < DRY_THRESH for DRY_CNT consecutive seconds) and for a still condition (i.e., the high-pass filtered accelerometer is < STILL_THRESH for STILL_CNT consecutive seconds). To disable either of these parameters, set the respective threshold to zero. A MAX_ON condition can also be set that limits the recording duration irrespective of the other stop conditions. To disable the MAX_ON condition, set it to 0. A graphical view of the stop conditions is given below.

4. Release

The release can be programmed to start either at an absolute time (RLS_AT) or at a time relative to the first entry to the RECORD state (RLS_IN, i.e., the time after the first valid start condition is detected). The active duration of the release can also be set with the RLS_DUR parameter. The release can become active when the tag is in the WAIT or RECORD states and it has no effect on these states. To disable the release set both the RLS_AT and RLS_IN configurations to 0. Note that the release capability is not used in all tags or may be used to control a function other than a physical release. Always test that the duration of the release is adequate for the water temperature and salinity.

```
                    ┌─────────────────┐
                    │  RECORD state   │
                    │    entered      │
                    └────────┬────────┘
                             │
                    ┌────────▼────────┐
                    │    Wait for     │
                    │ MIN_ON seconds  │
                    └────────┬────────┘
                             │
        ┌────────────────────┼────────────────────┐
        │                    │                     │
┌───────▼─────────┐          │                     │
│ MAX_ON - MIN_ON │          │                     │
│    elapsed      │          │                     │
└───────┬─────────┘  ┌───────▼──────────┐          │
        │            │ wet sensor < DRY_THR │      │
        │            │ for DRY_CNT seconds  │      │
        │            └───────┬──────────┘  ┌───────▼──────────────┐
        │                    │             │ accelerometer < STILL_THR │
        │                    │             │ for STILL_CNT seconds     │
        │                    │             └───────┬──────────────┘
        │                    │                     │
        │            ┌───────▼──────┐              │
        └───────────►│     ANY      │◄─────────────┘
                     └───────┬──────┘
                             │
                    ┌────────▼────────┐
                    │ Recording ended │
                    │ WAIT state entered │
                    └─────────────────┘
```

5. Recording configurations

A number of additional parameters can be set in the configuration menu to control how the tag shows what it is doing and how it records sound and movement when it turns on. These are described below.

ARMED LED (ON/OFF)
A red led flashes every 5 s whenever the tag is armed. This is useful for whale tags that can fall in the water and start accidently. However, light flashes may not be desirable in a tag on a seal during a haul out. Select OFF to disable the LED. Note that it will then no longer be possible to know what state the tag is in by looking at it.

TEST MODE (ENABLED/DISABLED)
If TEST mode is enabled, the tag will automatically start recording 10s after being unplugged from the USB. This will happen whenever the USB is plugged irrespective of whether the driver is installed on the PC. The tag will record for 30s and then go back to WAIT state.

GAIN (12 dB or 0 dB)
Gain of the audio preamplifier. Select 12 dB if you need to capture weak sounds at the risk of occasionally clipping on strong sounds.

BASE SAMPLING RATE (192 kHz or 576 kHz)
Selects the raw audio sampling rate of the tag. This should be chosen according to the anti-alias filter fitted in the tag. Use 576 kHz on HF tags (160 kHz anti-alias filter) and 192 kHz on MF tags (<= 70 kHz anti-alias filter). A warning will appear if you have selected a sampling rate that is too low for the filter frequency.

AUDIO DECIMATION FACTOR (1-8)
Determines the sampling rate of the audio stream that is actually stored to memory. The output sampling rate will be the base sampling rate divided by the decimation factor. An appropriate decimation filter is automatically selected to perform the decimation if the factor is >1.

ACCELERATION DECIMATION FACTOR (1, 2, 4, 5, or 10)
The accelerometer is sampled at 1 kHz per axis but data is not usually required at this high sampling rate. Select a decimation factor to reduce the sampling rate that is stored in memory. A decimation filter is automatically selected to perform the decimation. The output sampling rate will be 1kHz divided by the decimation factor.

ACCELERATION FULL SCALE (2 g, 4 g, 8 g)
Controls the full scale range of the accelerometer. A wide range is useful to track rapid movements, e.g., foraging strikes, or on small animals, but the sensor noise floor will be correspondingly higher. For large animals or fine resolution, use the lowest settings.

PRESSURE FULL SCALE (100 m or 200 m / 1000 m or 2000 m depending on sensor)
Selects the full scale pressure according to the maximum depth that the animal could reach at the deployment site. This will not change the destruction depth of the sensor (which is about 400m or 4000m for the high pressure sensor) but will change the clipping level of depth. If in doubt, use the highest setting. The lowest setting will give the finest depth resolution.

GPS GRAB COUNT (0, 1, 2, 3)
This sets the number of GPS grabs that are performed rapidly in sequence whenever the tag recognizes that it is at the surface. Use a value of 0 to disable the GPS. Not every grab will capture enough satellites to decode a position. A higher grab count increases the chance of getting a GPS position at each surfacing but uses proportionally more memory.

GPS DRY THRESH (0-100 %)
Determines the sensitivity of the wet/dry sensor used to time GPS grabs. This feature is currently under development and the threshold is very sensitive. Only use the value recommended when receiving the tags.

GPS MIN GAP (0-32000 seconds)
Sets the minimum time gap between GPS grabs (or sets of grabs if the grab count is greater than 1). The actual gap between grabs will depend on when the animal surfaces but will not be less than the MIN GAP.

6. Example settings
The flexible control configurations enable several functional modes for the tag. Examples are given below.

Whale-style continuous recording: The tag starts recording when wet and continues recording until memory is full.

Menu	Parameter	Setting
a	START AFTER	0 (to disable)
z	START_ALWAYS	NO
s	WET_THR	30 (set for conditions)
c	WET_CNT	5
i	DRY_THR	0 (to disable)
b	RELEASE AT	Enter absolute time of release (0 if not needed)
r	RELEASE IN	Enter relative time of release (0 if not needed)
t	BURN TIME	Enter duration of release
m	MIN ON	1 (minimum value)
n	MAX ON	0 (to disable)
o	MIN OFF	1 (minimum value)
p	MAX OFF	0 (to disable)
l	LED_ENABLE	ON
h	TEST	DISABLED
g	GAIN	12 (or 0 for a loud animal)
f	FS	192kHz if MF tag or 576kHz for a HF tag
d	DF	1 (or greater if some decimation is required)
k	ADF	4, 5, or 10 (depending on study and animal size)
u	AFS	4g or 8g (depending on study and animal size)
v	PFS	Choose according to study area and tag capabilities
w	GPS_CNT	3
x	GPS_THR	30
y	GPS_MINGAP	180

Haul-out controlled recording for seals: The tag records whenever it is wet.

Menu	Parameter	Setting
a	START AFTER	0 (to disable)
z	START_ALWAYS	NO
s	WET_THR	30 (set for conditions)
c	WET_CNT	10
i	DRY_THR	40 (should be greater than wet threshold)
j	DRY_CNT	60 (tag must be dry for at least a minute to stop)
b	RELEASE AT	Enter absolute time of release (0 if not needed)
r	RELEASE IN	Enter relative time of release (0 if not needed)
t	BURN TIME	Enter release duration remembering to include maximum haul out time as release must be in water to corrode.
m	MIN ON	5 0 (minimum on time of 5 mins)
n	MAX ON	12 0 0 (maximum on time of 12 hours)
o	MIN OFF	5 0 (minimum off time of 5 mins)
p	MAX OFF	12 0 0 (maximum off time of 12 hours)
l	LED_ENABLE	OFF
h	TEST	ENABLED (allows testing of tags in the field)
g	GAIN	12
f	FS	192kHz
d	DF	4 (for 48kHz recording)
k	ADF	10 (100Hz acceleration data)

Menu	Parameter	Setting
u	AFS	8g
v	PFS	Choose according to study area and tag capabilities
w	GPS_CNT	3
x	GPS_THR	30
y	GPS_MINGAP	180

Duty-cycle recording (e.g., for manatees): The tag always records for MAX_ON seconds and then waits for MAX_OFF seconds. No immersion or movement sensing is performed.

Menu	Parameter	Setting
a	START AFTER	Time and date of the first recording
z	START_ALWAYS	YES
b	RELEASE AT	Enter absolute time of release (0 if not needed)
r	RELEASE IN	Enter relative time of release (0 if not needed)
t	BURN TIME	Enter release duration
m	MIN ON	On time of recordings
n	MAX ON	Same as MIN_ON
o	MIN OFF	Off time between recordings
p	MAX OFF	Same as MIN_OFF
l	LED_ENABLE	OFF
h	TEST	ENABLED (allows testing of tags in the field)
g	GAIN	12
f	FS	192kHz
d	DF	6 (for 32kHz recording)
k	ADF	10 (100Hz acceleration data)
u	AFS	2g
v	PFS	Choose according to study area and tag capabilities
w	GPS_CNT	3
x	GPS_THR	30
y	GPS_MINGAP	180

VERY IMPORTANT: Remember to select q to quit the configuration menu when you have completed changing the settings otherwise the new settings will not be saved. You will be asked whether you want to arm the tag y/n. Type y for the tag to be ready to use. Type n to disable the tag and put it in a low power state for storage or shipping. In this mode the VHF beacon (if installed) will not pulse making it safe for carrying on a plane.

7. Summary of configuration options

START CONFIGURATION
a start after (START_AFTER), unit = 6 digit time (year, month, day, hour, minute, second) or 0 for bypass.
z then always start (ALWAYS_START), options = YES, NO.
o min off time (MIN_OFF), unit = 3 digit time duration (hour, minute, second).
s wet turn-on threshold (WET_THR), unit = % (100=least sensitive, i.e., tag has to be very wet before turning on). Hidden if ALWAYS_START=YES.
c wet turn-on count (WET_CNT), unit = seconds. Hidden if ALWAYS_START=YES.
p max off time (MAX_OFF), unit = 3 digit time duration (hour, minute, second). Hidden if ALWAYS_START=YES.

STOP CONFIGURATION
i dry turn-off threshold (DRY_THR), unit = % (0=disable i.e., tag is never stopped for being dry,

100% is least sensitive i.e., tag has to be very dry before turning off).

j   dry turn-off count (DRY_CNT), unit = seconds. Hidden if DRY_THR = 0.

m min on time (MIN_ON), unit = 3 digit time duration (hour, minute, second).

n   max on time (MAX_ON), unit = 3 digit time duration (hour, minute, second).

RELEASE CONFIGURATION

b   release at time (RLS_AT), units = 6 digit time (year, month, day, hour, minute, second) or 0 for disable.

r   release in (RLS_IN), unit = 3 digit time delay (day, hour, minute) or 0 for disable.

t   burn time (RLS_DUR), unit = 3 digit time duration (hour, minute, second). Hidden if RLS_AT=0 and RLS_IN=0.

APPLICATION CONFIGURATION

l   Armed LED (LED_ENABLE), options = ON, OFF.

h   Test mode (TEST), options = ENABLED, DISABLED.

g   Gain (GAIN), options = 0dB, 12dB.

f   Base sampling rate (FS), options = 192kHz, 576kHz.

d   Audio decimation factor (DF), unit = relative to base sampling rate

k   Accelerometer decimation factor (ADF), options = 1, 2, 4, 5, 10 relative to 1kHz.

u   Accelerometer full scale (AFS), options = 2g, 4g, 8g.

v   Pressure full scale (PFS), options = 100m, 200m or 1000m, 2000m.

w   GPS grab count (GPS_CNT), options = 0 (DISABLED), 1, 2 or 3.

x   GPS dry thresh (GPS_THR), unit = % (100 is least sensitive, i.e., tag has to be very dry before triggering GPS). Hidden if GPS_CNT=0.

y   GPS min gap (GPS_MINGAP), unit = seconds. Hidden if GPS_CNT=0.