

SmartSpace®

Grenade Tag Support

For version 3.5.7829 and above

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Contents

- Overview of Grenade tag support** 1
- Application-level overview of tag behavior** 2
- How to configure the sensors** 4
 - Configuring Countdown Ack Threshold 4
 - Configuring Mode and Value 0 5
- Example output using the tracing options** 7
 - Tracing options 7
 - Simple test setup 7
 - Sensor (mis)configuration 7
 - Test traces 8
 - Test 1: Multiple failed attempts to ack a tag (due to misconfiguration) 8
 - Test 2: Successful ack of the tag 10
 - Test 3: Successful ack of two tags simultaneously 10

Overview of Grenade tag support

This guide describes the behavior of a tag attached to a grenade: how it is controlled by using tag status message acknowledgment via 2.4 GHz wireless, and how its status is pushed to the server-side schemas to make it available to application-level code. An example configuration and test results are provided.

Application-level overview of tag behavior

The following describes the behavior of a tag attached to a grenade:

1. *Initial state.* Initially the tag is not armed and does not transmit anything.
2. *When the grenade is armed.* At some point the grenade's pin is pulled so that it is armed; the tag wakes up and transmits at rate 2 Hz, sending the data message 0x0660 (with data payload 0x0000). This status will be pushed to the TagStatus schema in an expedited way (i.e. we do not use the normal TagStatus batching for these messages). This allows client application code to be notified and take some action when a grenade is armed.
3. *When the grenade is thrown.* When the grenade spoon is released (i.e. when the grenade is thrown) the tag transmits at 10 Hz, sending the status message 0x0666, for a period of 5 seconds before it 'explodes' and ceases transmissions. The data payload of the status message is:
 - **MSB:** 'ack count', the number of 2.4 GHz ack messages received (i.e. initially zero)
 - **LSB:** 'message count', the number of transmissions since the spoon was released
4. *Tracking the grenade and updating its status during countdown.* If the tag transmissions are picked up by a sensor group, they will be forwarded (in the usual way) to a master sensor for the tag in that group. The master sensor will update the TagStatus schema as soon as it receives a message for which there is a valid location sighting and thereafter every second (i.e. after 10, 20, 30, 40, 50 messages) if it has managed to generate a location for the tag in the previous second or if the count of received ack messages is greater than zero, effectively giving a 4, 3, 2, 1, 0 countdown for tags which are receiving or have received good sightings. There are no special mechanisms to deal with 'dropped' tag transmissions because they are highly unlikely in the context (the tag has to get located by the master sensor so each transmission will be received by a few sensors). This notification mechanism allows client application code to be notified and take action in response to the tag countdown.
5. *Acknowledging tag transmissions.* The sensor software will send ack messages to the tag if it has a good position for the tag sufficiently close to the time when the grenade explodes. The purpose of the ack messages is solely to disable the third-party hardware mechanism for weapons effects. The timing of the ack is determined by the **Countdown Ack Threshold** parameter which should be set to some value T, where $0 \leq T < 50$, such that an ack will be

sent for the tag if:

1. The tag has just been located in this measurement, and
2. The message count in this measurement is greater than T, and
3. The ack count in this measurement is zero

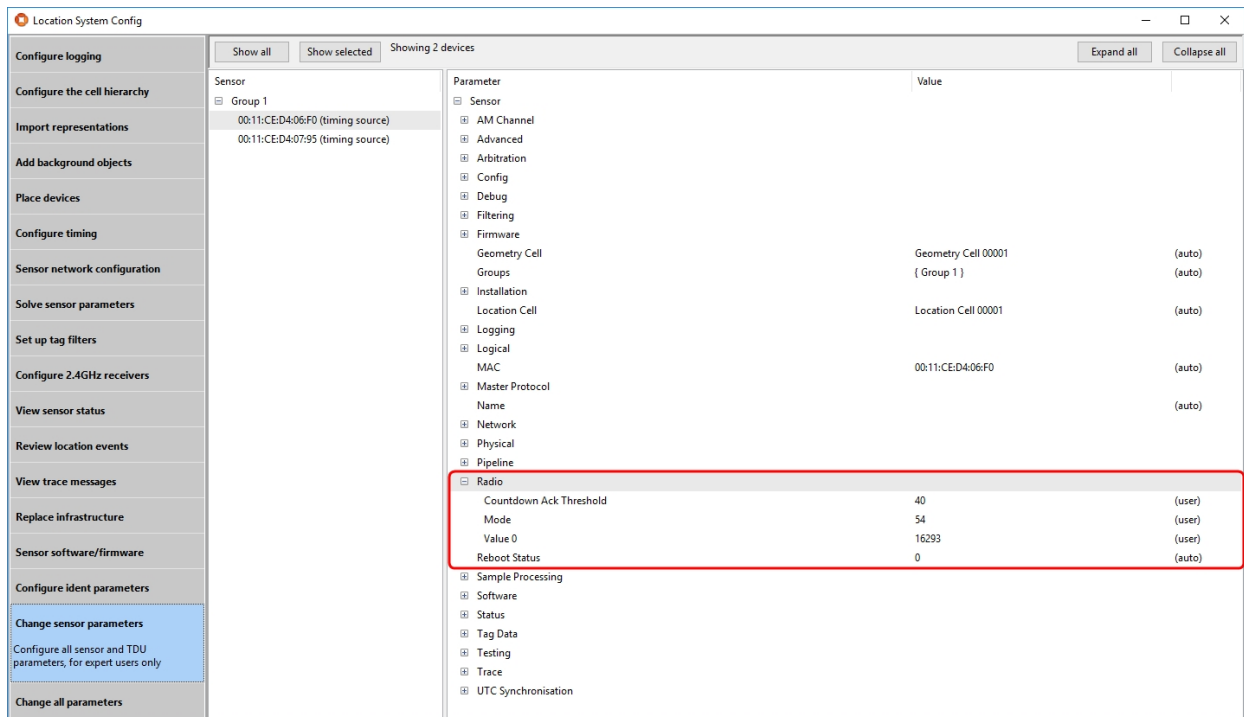
Thus the **Countdown Ack Threshold** setting allows the user to control how long to wait before the tag is acknowledged. The default value of **Countdown Ack Threshold** is **0**, meaning that the tag will be acked as soon as it is thrown. But in practice it may be preferable to set the threshold higher, because effective calculation of area weapons effects requires that we know the position of the grenade at the time that it detonated. If the grenade is thrown into an area where it cannot be tracked then we are better off using the third-party area weapons mechanism, so we should not ack the tag. However it is not possible to leave it too long before acking the tag because we would not have time to get the ack message to the tag before the third-party mechanism was triggered. The example traces shown later in the document show the behavior when **Countdown Ack Threshold** is set to **40**.

6. *Grenade explosion.* The grenade will explode 5 seconds (i.e. fifty transmissions) after the spoon was released. When the grenade explodes the tag ceases transmitting and communicates its ack status to the third-party hardware. If no acks have been received then the third-party hardware kicks off some appropriate area weapons effect evaluation. When the tag status has message count of **50**, the grenade has detonated: this allows application-level client code to be notified of the grenade detonation.
7. *Evaluating area weapons effects.* The area weapons effects software should operate whenever any tag (for a grenade) has status **0x0666** with data **0xXX32**, i.e. where **XX** is the ack count and **0x32** (decimal 50) is the message count.
 - If **XX == 0** then the third-party hardware mechanism will be operating, so the area weapons software must make some arbitration decision (e.g. leave the weapons effects to the third-party hardware, override the hardware in some way).
 - If **XX > 0** then the third-party hardware mechanism will have been disabled, in which case there will also be a valid location available for the tag with the location at which it was seen shortly before the explosion. By using the tag location, together with the locations of other players at the same time, the area weapons effects of the grenade detonation may be calculated.

How to configure the sensors

The sensors each require three parameters to be set in order to control the acknowledgment functions.

The parameters are configured in Location System Config in the **Radio** section of the **Change sensor parameters** configuration screen.



The screenshot shows the 'Location System Config' window. The left sidebar contains various configuration categories, with 'Change sensor parameters' selected. The main area displays a table of parameters for two sensors. The 'Radio' section is highlighted with a red box, showing the following parameters:

| Parameter | Value | Setting |
|-------------------------|-------|---------|
| Countdown Ack Threshold | 40 | (user) |
| Mode | 54 | (user) |
| Value 0 | 16293 | (user) |
| Reboot Status | 0 | (auto) |

Their values must be configured according to the following guidelines:

Configuring Countdown Ack Threshold

As previously discussed, **Countdown Ack Threshold** should be set fairly close to the value of the tag message count when the grenade detonates but low enough such that the sensors have time to acknowledge the tag. A good compromise is to set the value to the value of the message count one second before detonation, so if the tag's location is calculated one second before detonation an ack will be sent. In the current implementation this corresponds to a value of **40**.

Configuring Mode and Value 0

The radio **Mode** parameter must be configured to the value **54**. This sets up the radio in the sensor and starts it running. If the radio mode is not configured to the value **54** then a warning message will be generated by the sensor if it receives a request to send an ack to the tag. By default this value is set to zero, which ensures that the sensor will not transmit on the 2.4 GHz channel (this is required in some installations).

The radio **Value 0** parameter must be configured in order to set a suitable transmit power and transmission 'on-time' for each radio transmission. When a sensor transmits an ack to a tag it actually transmits a repeated sequence of messages over a period of 40 ms, where each message is about 1 ms duration, and where the sensor can choose randomly whether or not to transmit each message in the sequence. The **Value 0** parameter combines two values:

- The 'on time', which represents the probability of transmitting each message, and
- The 'power setting' which controls the transmit power of the radio.

The parameters are combined into the single **Value 0** parameter using this table:

| Approximate Range: | | 100% | 75% | 50% | 25% | 10% |
|---------------------------|---------------------|--------------------------|------------|------------|------------|------------|
| Power setting: | | 255 | 210 | 165 | 138 | 129 |
| Power Byte: | | 0xFF | 0xD2 | 0xA5 | 0x8A | 0x81 |
| On-Time | On-Time Byte | Decimal "Value 0" | | | | |
| 0% * | 0x0000 | 255 | 210 | 165 | 138 | 129 |
| 5% | 0x0C00 | 3327 | 3282 | 3237 | 3210 | 3201 |
| 10% | 0x1900 | 6655 | 6610 | 6565 | 6538 | 6529 |
| 15% | 0x2600 | 9983 | 9938 | 9893 | 9866 | 9857 |
| 20% | 0x3300 | 13311 | 13266 | 13221 | 13194 | 13185 |
| 25% | 0x3F00 | 16383 | 16338 | 16293 | 16266 | 16257 |
| 30% | 0x4C00 | 19711 | 19666 | 19621 | 19594 | 19585 |
| 35% | 0x5900 | 23039 | 22994 | 22949 | 22922 | 22913 |
| 40% | 0x6600 | 26367 | 26322 | 26277 | 26250 | 26241 |
| 45% | 0x7200 | 29439 | 29394 | 29349 | 29322 | 29313 |

| | | | | | | |
|------|--------|-------|-------|-------|-------|-------|
| 50% | 0x7F00 | 32767 | 32722 | 32677 | 32650 | 32641 |
| 55% | 0x8C00 | 36095 | 36050 | 36005 | 35978 | 35969 |
| 60% | 0x9900 | 39423 | 39378 | 39333 | 39306 | 39297 |
| 65% | 0xA500 | 42495 | 42450 | 42405 | 42378 | 42369 |
| 70% | 0xB200 | 45823 | 45778 | 45733 | 45706 | 45697 |
| 75% | 0xBF00 | 49151 | 49106 | 49061 | 49034 | 49025 |
| 80% | 0xCC00 | 52479 | 52434 | 52389 | 52362 | 52353 |
| 85% | 0xD800 | 55551 | 55506 | 55461 | 55434 | 55425 |
| 90% | 0xE500 | 58879 | 58834 | 58789 | 58762 | 58753 |
| 95% | 0xF200 | 62207 | 62162 | 62117 | 62090 | 62081 |
| 100% | 0xFF00 | 65535 | 65490 | 65445 | 65418 | 65409 |

* Note: The 0% setting actually corresponds to 1/256, or 0.4%.

A suitable recommended value for the **Value 0** parameter is **16293**, corresponding to a 25% duty cycle and 50% power setting. This should permit the acknowledgment of large numbers of grenade tags simultaneously thrown into the same building. This is the value used in the [example configurations](#).

Example output using the tracing options

Tracing options

In order to simplify user setup, a tracing option is provided. In normal use this option would be disabled, but it provides a 'running commentary' on the sensors' response to tag events which can be helpful if the user is trying to understand the operation of their particular configuration.

To enable the tracing option, set the **platform_monitor** global configuration parameter to contain the string **tag_countdown**, before rebooting the sensors.

For example, execute the command:

```
ubisense_configuration_client set platform_monitor tag_countdown
```

and then reboot the sensors.

Simple test setup

The traces below show some sample output for a simple test setup using a two sensor system; both sensors can see UWB from the tag(s). Up to four tags are used, all with the tag filter initially set to **Always succeed** to ensure that we get a location event for each tag.

Sensor (mis)configuration

Tests 1 and 2 purposefully contain a misconfiguration: the radio has only been configured on one of the two sensors. This is shown on line 2 of the table below. Line 3 shows the correct configuration as used in test 3.

| Sensor | Countdown Ack Threshold | Radio Mode | Radio Value 0 | Test |
|-------------------|-------------------------|------------|---------------|---------------|
| 00:11:CE:D4:01:08 | 40 | 54 | 16293 | all tests |
| 00:11:CE:D4:02:38 | 40 | 0 | 0 | tests 1 and 2 |
| 00:11:CE:D4:02:38 | 40 | 54 | 16293 | test 3 |

Test traces

Test 1: Multiple failed attempts to ack a tag (due to misconfiguration)

This test shows the tag being processed by 02:38. Both sensors 'see' the tag UWB and there is a random choice between them to determine the ack-ing sensor. This comes out for 02:38 all four times. Each of these ack attempts (msg count = 40, 43, 46, 49) causes a warning message to be generated because the 02:38 radio has not been configured (and the attempt fails). The tag has not received any acknowledgement at msg count = 50 and therefore the status 50 gets sent to the tag status service.

Tag 4 powered up, button pressed, tracked, acknowledged, but ack not received

```
[29/03/2021 11:23:42] [Source 10.0.0.3:36114] tag_countdown: 00:11:CE:D4:02:38: 00:11:CE:D4:02:38 initializes new tag countdown state for 00:11:CE:00:00:00:04
[29/03/2021 11:23:42] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:00:04 countdown_armed_flag
[29/03/2021 11:23:47] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:00:04 countdown_value = 1
[29/03/2021 11:23:48] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:00:04 countdown_value = 10
[29/03/2021 11:23:49] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:00:04 countdown_value = 20
[29/03/2021 11:23:50] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:00:04 countdown_value = 30
[29/03/2021 11:23:51] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:00:04 countdown_value = 40
[29/03/2021 11:23:51] [Source 10.0.0.3:36114] tag_countdown: 00:11:CE:D4:02:38: 00:11:CE:D4:02:38 sends countdown ack to 00:11:CE:00:00:00:00:04
[29/03/2021 11:23:51] [Source 10.0.0.3:36114] sensor_warning: 00:11:CE:D4:02:38: attempt to send radio ack message with power/duty cycle unset
[29/03/2021 11:23:52] [Source 10.0.0.3:36114] tag_countdown: 00:11:CE:D4:02:38: 00:11:CE:D4:02:38 sends countdown ack to 00:11:CE:00:00:00:00:04
[29/03/2021 11:23:52] [Source 10.0.0.3:36114] sensor_warning: 00:11:CE:D4:02:38: attempt to send radio ack message with power/duty cycle unset
[29/03/2021 11:23:52] [Source 10.0.0.3:36114] tag_countdown: 00:11:CE:D4:02:38: 00:11:CE:D4:02:38 sends countdown ack to 00:11:CE:00:00:00:00:04
[29/03/2021 11:23:52] [Source 10.0.0.3:36114] sensor_warning: 00:11:CE:D4:02:38: attempt to send radio ack message with power/duty cycle unset
[29/03/2021 11:23:52] [Source 10.0.0.3:36114] tag_countdown: 00:11:CE:D4:02:38: 00:11:CE:D4:02:38 sends countdown ack to 00:11:CE:00:00:00:00:04
[29/03/2021 11:23:52] [Source 10.0.0.3:36114] sensor_warning: 00:11:CE:D4:02:38: attempt to send radio ack message with power/duty cycle unset
[29/03/2021 11:23:52] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:00:04 countdown_value = 50
[29/03/2021 11:24:22] [Source 10.0.1.1:55506] tag_countdown: tag status server ages out old entry for 00:11:CE:00:00:00:00:04 countdown_armed_flag
[29/03/2021 11:24:22] [Source 10.0.1.1:55506] tag_countdown: tag status server ages out old entry for 00:11:CE:00:00:00:00:04 countdown_value
```

Test 2: Successful ack of the tag

This is the same configuration as (1) but in this case the sensor 01:08 is selected for the first ack attempt and the tag is successfully ack-ed.

Tag 4 powered up, button pressed, tracked, acknowledged, ack received

```
[29/03/2021 11:19:10] [Source 10.0.0.3:36114] tag_countdown: 00:11:CE:D4:02:38: 00:11:CE:D4:02:38 initializes new tag countdown state for 00:11:CE:00:00:00:04
[29/03/2021 11:19:10] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:04 countdown_armed_flag
[29/03/2021 11:19:15] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:04 countdown_value = 1
[29/03/2021 11:19:16] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:04 countdown_value = 10
[29/03/2021 11:19:17] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:04 countdown_value = 20
[29/03/2021 11:19:18] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:04 countdown_value = 30
[29/03/2021 11:19:19] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:04 countdown_value = 40
[29/03/2021 11:19:19] [Source 10.0.0.3:36114] tag_countdown: 00:11:CE:D4:02:38: 00:11:CE:D4:02:38 forwards acknowledgement request for 00:11:CE:00:00:00:04 to 00:11:CE:D4:01:08 at 10.0.0.1:53536
[29/03/2021 11:19:19] [Source 10.0.0.1:37349] tag_countdown: 00:11:CE:D4:01:08: 00:11:CE:D4:01:08 sends countdown ack to 00:11:CE:00:00:00:04
[29/03/2021 11:19:19] [Source 10.0.0.3:36114] tag_countdown: 00:11:CE:D4:02:38: 00:11:CE:D4:02:38 receives 00:11:CE:00:00:00:04 confirmation that it has received an ack message
[29/03/2021 11:19:20] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:04 countdown_value = 306
[29/03/2021 11:19:52] [Source 10.0.1.1:55506] tag_countdown: tag status server ages out old entry for 00:11:CE:00:00:00:04 countdown_armed_flag
[29/03/2021 11:19:52] [Source 10.0.1.1:55506] tag_countdown: tag status server ages out old entry for 00:11:CE:00:00:00:04 countdown_value
```

Test 3: Successful ack of two tags simultaneously

Using the correct radio configuration for both sensors (to improve radio reliability) we show two tags being ack-ed simultaneously. Note that both final values are 306 which is 1 ack + 50 messages, demonstrating that each tag only heard one ack message (the one destined for it).

Tag 1 and 4 powered up, button pressed, tracked, acknowledged, but ack not received

```
[29/03/2021 12:23:02] [Source 10.0.0.3:36114] tag_countdown: 00:11:CE:D4:02:38: 00:11:CE:D4:02:38 initializes new tag countdown state for 00:11:CE:00:00:00:01
[29/03/2021 12:23:02] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:00:01 countdown_armed_flag
[29/03/2021 12:23:02] [Source 10.0.0.3:36114] tag_countdown: 00:11:CE:D4:02:38: 00:11:CE:D4:02:38 initializes new tag countdown state for 00:11:CE:00:00:00:04
[29/03/2021 12:23:02] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:00:04 countdown_armed_flag
[29/03/2021 12:23:07] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:00:01 countdown_value = 1
[29/03/2021 12:23:08] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:00:04 countdown_value = 1
[29/03/2021 12:23:08] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:00:01 countdown_value = 10
[29/03/2021 12:23:09] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:00:04 countdown_value = 10
[29/03/2021 12:23:09] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:00:01 countdown_value = 20
[29/03/2021 12:23:10] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:00:04 countdown_value = 20
[29/03/2021 12:23:10] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:00:01 countdown_value = 30
[29/03/2021 12:23:11] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:00:04 countdown_value = 30
[29/03/2021 12:23:11] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:00:01 countdown_value = 40
[29/03/2021 12:23:11] [Source 10.0.0.3:36114] tag_countdown: 00:11:CE:D4:02:38: 00:11:CE:D4:02:38 forwards acknowledgement request for 00:11:CE:00:00:00:00:01 to 00:11:CE:D4:01:08 at 10.0.0.1:53536
[29/03/2021 12:23:11] [Source 10.0.0.1:37349] tag_countdown: 00:11:CE:D4:01:08: 00:11:CE:D4:01:08 sends countdown ack to 00:11:CE:00:00:00:00:01
[29/03/2021 12:23:11] [Source 10.0.0.3:36114] tag_countdown: 00:11:CE:D4:02:38: 00:11:CE:D4:02:38 receives 00:11:CE:00:00:00:00:01 confirmation that it has received an ack message
[29/03/2021 12:23:12] [Source 10.0.0.3:36114] tag_countdown: 00:11:CE:D4:02:38: 00:11:CE:D4:02:38 receives 00:11:CE:00:00:00:00:04 confirmation that it has received an ack message
[29/03/2021 12:23:12] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:00:04 countdown_value = 296
[29/03/2021 12:23:12] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:00:01 countdown_value = 306
[29/03/2021 12:23:13] [Source 10.0.1.1:55506] tag_countdown: tag status server asserts 00:11:CE:00:00:00:00:04 countdown_value =
```