Voyantic

Tagsurance 3

Manual

System version 4.x

June 8, 2026

1 Overview

The Tagsurance 3 system is a turnkey solution for testing RAIN RFID tags in tag production machines. It is optimal for chip attachment, label converting, and final personalization stages, but it is not limited to these.

Voyantic delivers the Tagsurance 3 system complete with *stations* that conduct the tag testing and encoding. The trigger signal to the system can come either from the machine or from a trigger sensor delivered by Voyantic. Depending on the use case, we strongly recommend connecting the trigger sensor to Tagsurance 3, as trigger filtering features, such as pattern filtering, are then available. Tagsurance 3 comes with its own rotary encoder for location sensing. All IO signals necessary for operating the system are handled within the system itself and do not need interfacing with the machine.

Tagsurance 3 uses its own configuration and *recipe* for a job and then initializes the stations accordingly so that they know what to do when the lane controller triggers them. The lane controller handles the triggering of all stations on the lane when tags travel past. Each station sends its result as data (Ethernet) to the Tagsurance controller server and the system then gathers the job results from this data.

Tagsurance 3 is easy to integrate into a production line or machine, as it can work independently and does not necessarily need to interface with the machine or logic controlling the production line.

Tagsurance 3 is simple and quick to configure for the machine. This lane configuration contains information on where and how the trigger sensor, Snoop Pro coupling elements, markers and other such stations are installed.

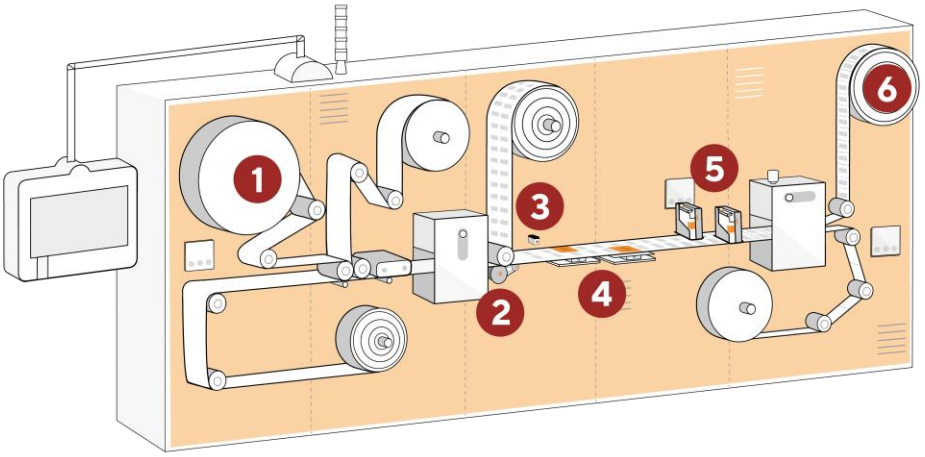
Tagsurance 3 is easy to operate with a browser-based operator UI that acts as a client on your computer connected to Tagsurance 3, and the browser pointed to Tagsurance 3's IP address:

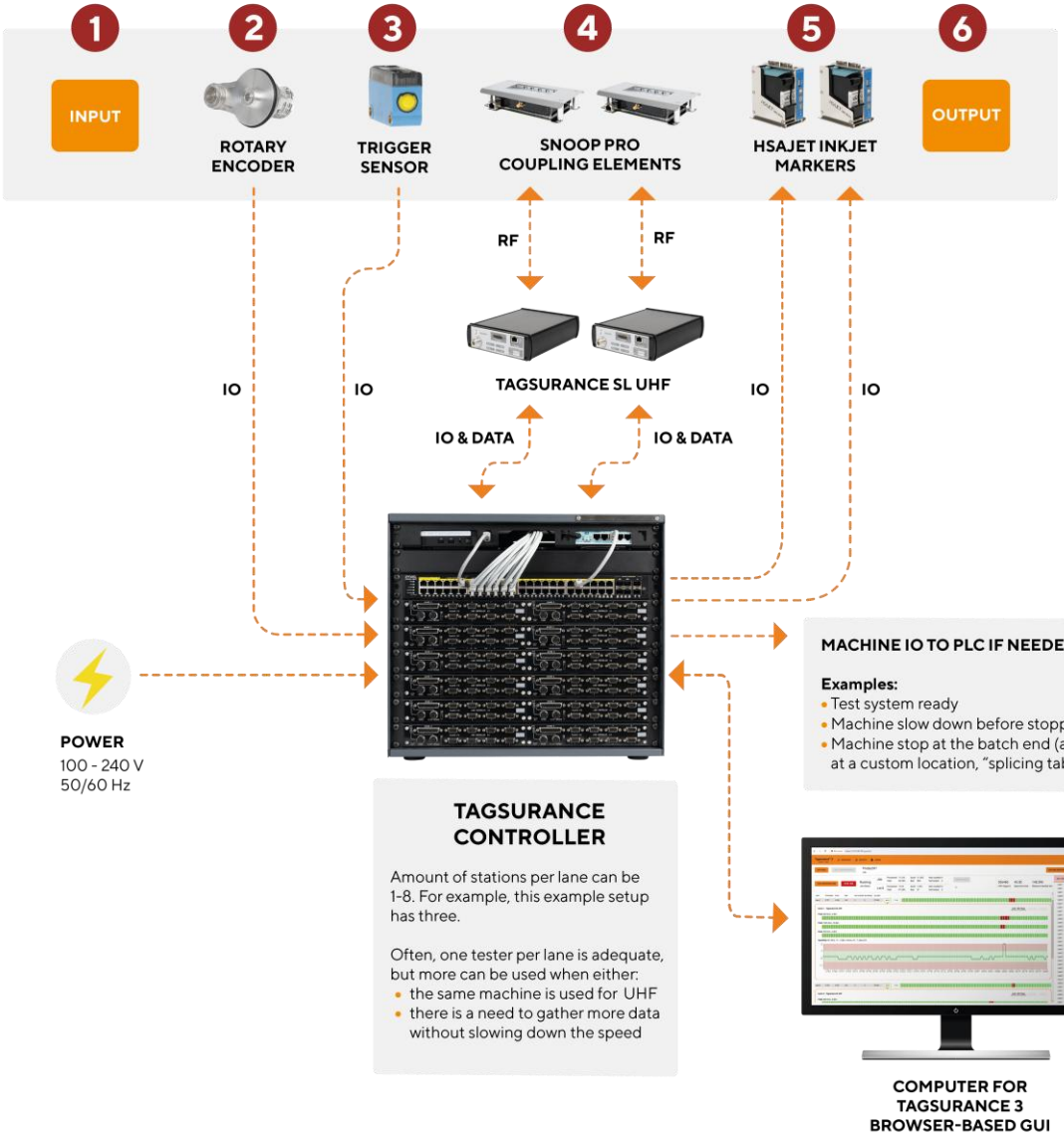
- Either via connecting Tagsurance 3 to your internal network from which it receives its IP address via DHCP
- Or as a point-to-point connection to a fixed IP in the system.

As your computer will receive an IP address in the same range via DHCP, there is usually no need to change its settings.

Tagsurance 3 also allows machine manufacturers or end users to build their own operator user interface, as the system offers a complete REST API and AsyncAPI which have the same functionality as is used by Tagsurance 3's own operator UI. Voyantic reserves the right to some limitations in special cases.

Tagsurance 3 can interface with the machine via a machine IO that can offer, for example, start and stop signals to the machine that can be connected when you want to control such operations by the Tagsurance 3 system.



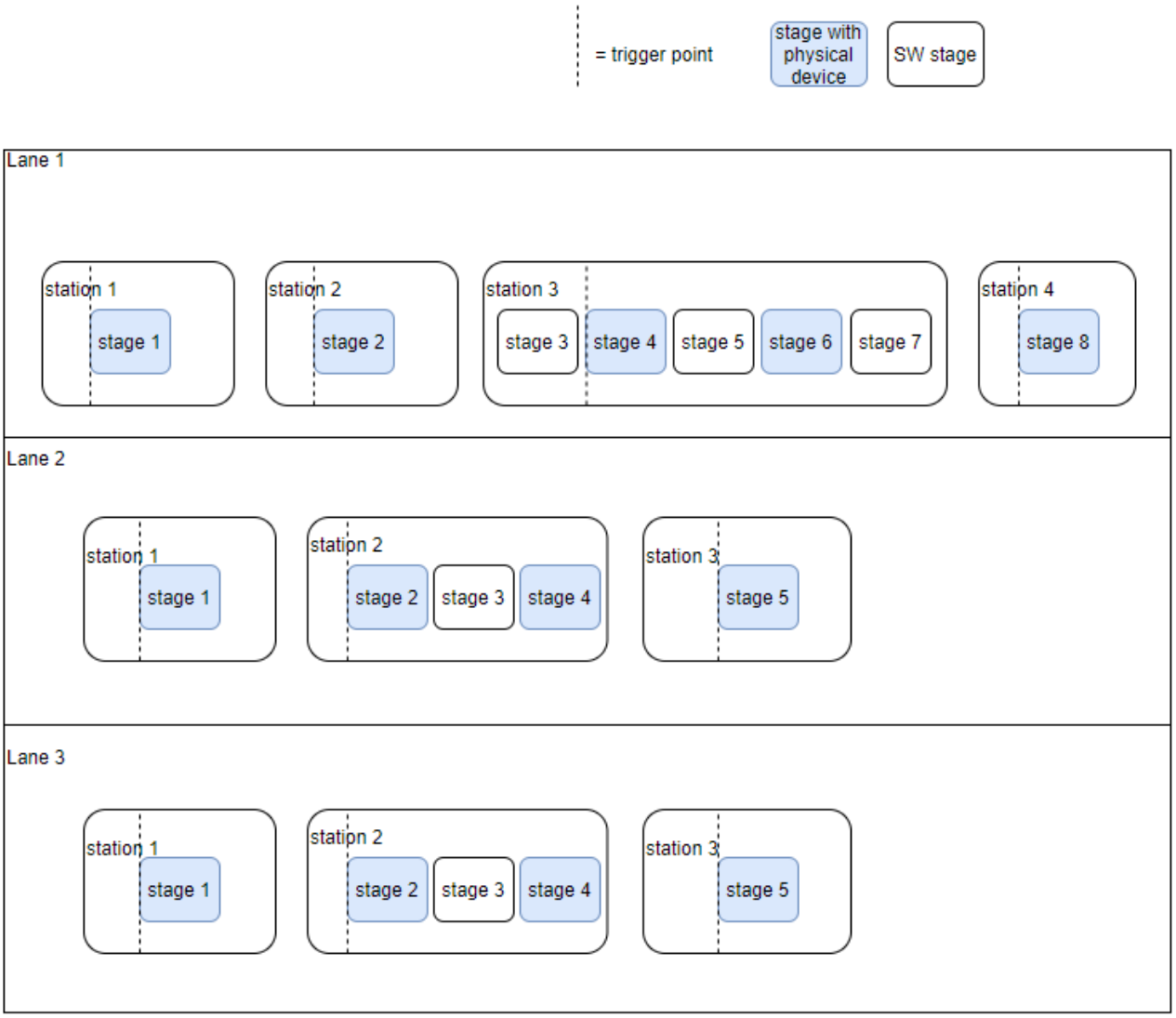


2 Terminology

Term	Meaning
Tagsurance 3	The whole system is called Tagsurance 3
Operator	Person that runs the machine in production. Does not necessarily need to know anything about the recipe, except for loading the correct one. Does not need to know anything about machine configuration, but rather needs to switch Snoop Pro coupling elements and shielding plates according to the recipe in use.
Production engineer	Plans the recipes needed for production. Distributes recipes to operators.
Job	Contains the recipe and optional information about the job, such as job label and lot size.
Recipe	Instructions for the system of what is to be done to each tag, e.g., “2 point tests and TID read” and “mark failed tags”. The recipe needed for a machine anywhere in the world to test and/or encode labels in a certain job by an operator as required by a production engineer.
Lot	The subset of a job. The lot number is automatically incremented after a predefined number of tags are processed. The lot number is included in the tag result.
Lane	In the material under process: one lane of tags going through the process one by one. In the machine: stations that process the lane of tags going through the machine. Can be the only lane in a single-lane or one of the lanes in a multilane setup.
Lane configuration	Defines which devices are on a given lane and in which order. Contains the device configuration.
Device configuration	Each device has its device specific settings configured here. The idea is to set it once for each device and these configurations are then just used as building blocks for lane configurations.
Lane controller	Device for controlling stations on a single lane, either the only lane in a single-lane setup or one of the lanes in a multilane setup.

Station	Defines a physical device on the lane. Includes 1-N stages one of which must be a physical device. Any stage in a station before the first physical device stage is executed as soon as possible and all stages after the first physical device stage are executed as soon as possible after the triggered stage is executed. There are two types of stations: • Feedback stations such as Tagsurance SL UHF, that affect the tags' pass/fail result • Silent stations such as marker and puncher, that do not affect the tags' pass/fail result, yet may affect the tag itself
Stage	Defines any operation (related to HW device or SW process) that: • takes in a tag data object • modifies it • outputs a tag data object Is always included in a station. When a stage is the first physical device within a station, it is the trigger point within a station. The stages are always executed in the order they are defined within a station, and the execution stops at each first physical device within a station until that station is triggered.
Task list	Instructions for each stage.
Tagsurance controller	The whole rack with everything that is inside.
PoE	Power over Ethernet. This is how Lane controller and Tagsurance SL UHF are powered to reduce number of cables and power bricks needed.
Trigger	Sensor that is used by Lane controller to sense when tags enter the process.
Rotary encoder	Sensor that is used by Lane controller to sense accurately how material is moving.

2.1 Visualization of the lanes, stations, and stages

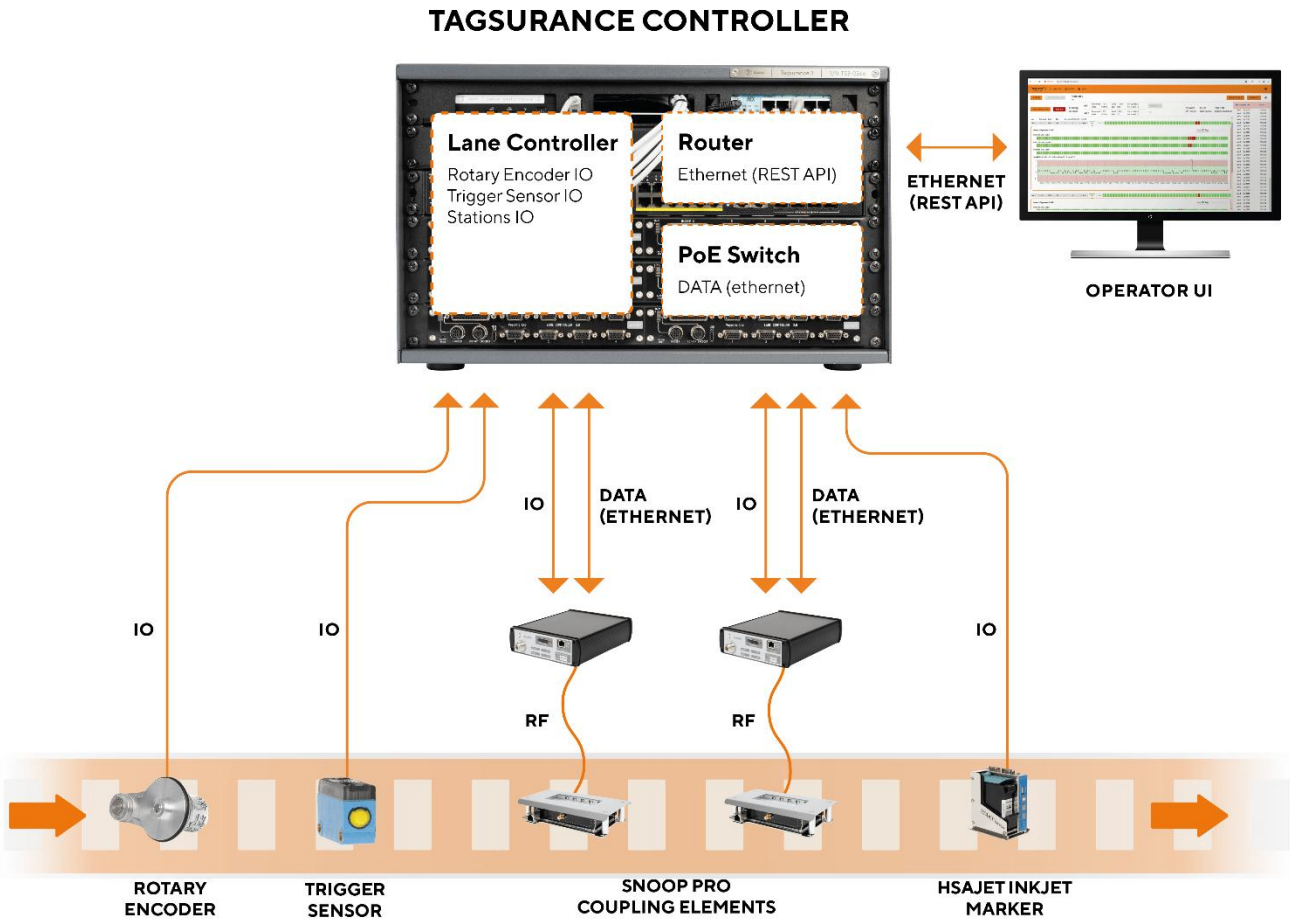


3 System Components and Installation

This section describes the system components, including installing them on a machine and connecting them to the Tagsurance controller. The installation and wiring are guided on the component level. The diagram below shows the example configuration of the Tagsurance system.

The main components of the Tagsurance 3 system:

- Tagsurance controller
  - Server
  - Router
  - PoE switch
  - Lane controller(s)
- Trigger sensor
- Rotary encoder
- Stations, devices for interacting with tags
  - Tagsurance SL UHF tester with Snoop Pro coupling element
  - IO only device
  - Marker
  - Puncher



3.1 Tagsurance controller

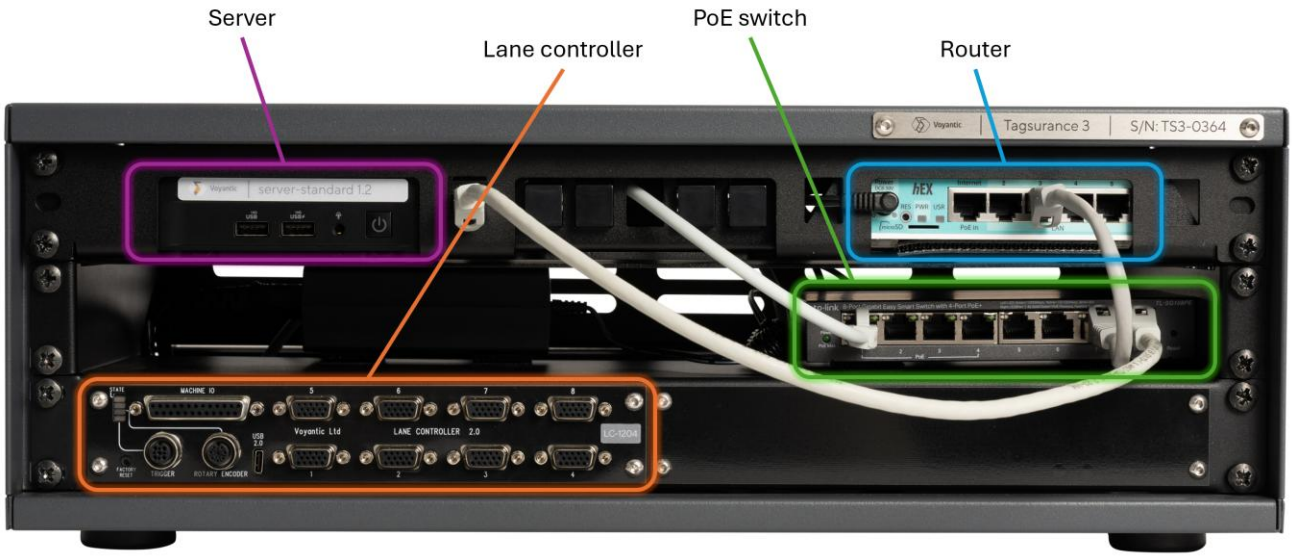
Tagsurance controller is the main unit of the Tagsurance 3 system. The Tagsurance controller:

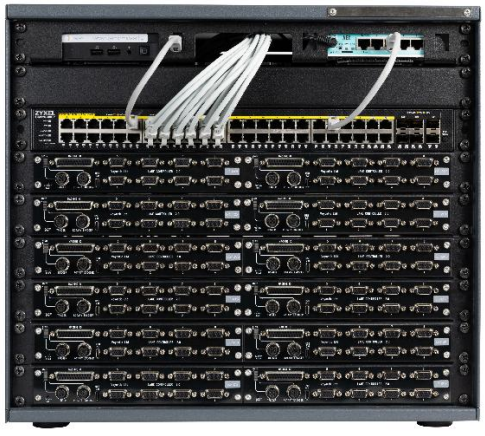
- follows the flow of tags in the process;
- triggers the testing and encoding stations when the tags are on the coupling elements;
- collects the results;
- provides interfaces to the operator and a client system to take advantage of all the data.

The Tagsurance controller consists of a few components, which are listed below. The number and configuration of components may vary according to customer requirements.

Different variants of Tagsurance 3 Controller racks:

	1 lane	1–6 lanes	1–12 lanes
Rack type	19”	19”	19”
Rack capacity	3U	6U	9U
Dimensions	See the Product catalog.		





Tagsurace 3 controllers which can handle up to 6 and up to 12 lanes

3.1.1 Server

The server is a computer that, for example, hosts APIs and the result database. Together with a router, it forms a server unit that is installed highest on the rack.

As the specifications for racks of different sizes may differ, the server can comply with higher system throughput with a higher number of lanes.

3.1.1.1 Updating the software (patching and feature updates)

Software updates are available in the Tagsurance 3 admin UI for systems connected to the internet. The downloadable versions are listed, and after downloading the locally stored version can be installed. Downloading the installer and installation is operated in Tagsurance 3 admin UI. The offline update package will be provided separately for offline systems. The offline packages are first uploaded to the Tagsurance 3 system and then installed. The package upload option is available in the admin UI. The system update updates all the system components, including the server software and device firmware. The update is a one-click process and includes the possibility for an immediate one-click rollback in case something is not working or is not satisfactory in the new version.

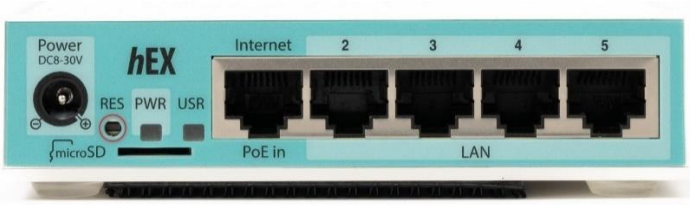
As Voyantic adheres to semver.org in versioning, do NOT expect a major version (e.g., 3.12.0 → 4.0.0) to be backward compatible. See the API specification for detailed information on backward compatibility and API version life cycle.

3.1.1.2 Security

Tagsurance 3 version 4.x systems are Linux-based, hardened, and patched by Voyantic. Voyantic recommends connecting the system to the internet to benefit from all available cloud-based features.

3.1.2 Router

The router is configured to organize the Tagsurance controller network.



Port number	Name	Description
1 (Internet)	WAN port	Port for connecting to the customer network, with or without internet connectivity. The port can receive an IP address from the DHCP service of the network, or the IP address of the port can be set as static.
2	Direct connection	Direct connection with DHCP server with network segment 10.10.10.0/24. This is meant for customers to directly connect the computer/server that obtains the IP from the Tagsurance router and can connect to the API server through this socket. See the domain where the operator UI and API server are available in section 3.11.1.
3	Tagsurance network	Tagsurance internal network with a DHCP server. It is connected to any port in the switch and is the network to which all Tagsurance devices (Tagsurance SL UHF, etc.) will be connected. The network is firewalled without any access outside, except to selected services on the Tagsurance server.
4	Not in use	Not in use
5	Management network	Router management

***Note**: The router's "RES" button must not be pressed in any circumstances.*

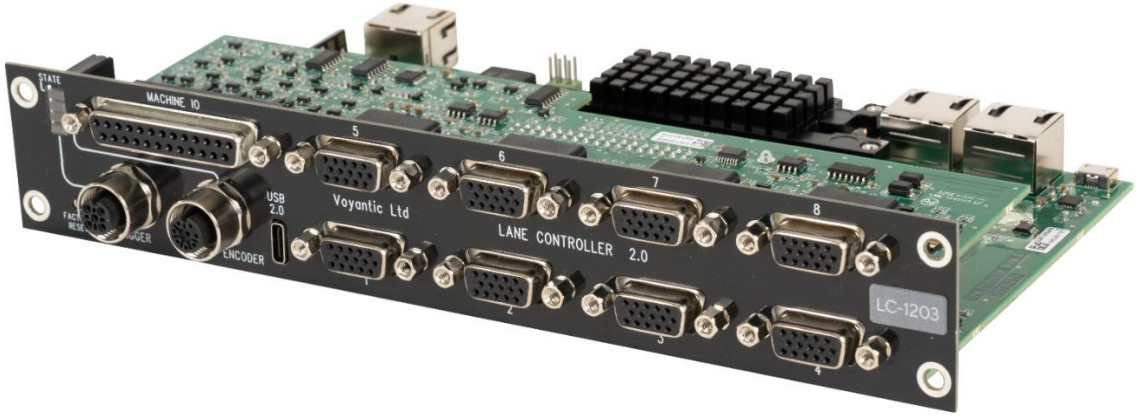
3.1.3 PoE switch

The Power over Ethernet (PoE) switch is a connection point for all Ethernet devices in the Tagsurance 3 system. The PoE switch can also be utilized as a power supply for certain devices like lane controllers. The model and power supply capacity of the PoE switch vary between Tagsurance 3 controller variants.

3.1.4 Lane controller

Lane controller is a device for controlling the stations on a single lane. The number of lane controllers in the system defines the maximum number of lanes the Tagsurance 3 system can manage. Based on the lane configuration, trigger and rotary encoder signals, the lane controller observes the web movement and triggers the stations via IO connections when a tag is on top of the coupling elements.

On the front panel, the lane controller has *DE-15* connectors for each station on the lane, *M12* connectors for the trigger sensor and a rotary encoder, and *DB-25* machine IO connector.



Lane controller 2.0

See the connectors' pinout in Section *9.1 Lane controller*.

3.1.4.1 Status LEDs

Lane controller has status LEDs for the state, trigger input signal, and rotary encoder input signals on its front panel.

- STATUS
  - Yellow when the lane controller is powered and initializing
  - Green when the lane controller is ready
- ROTARY ENCODER indicates the lane movement and direction
  - Green when the lane is moving forward
  - Yellow when the lane is moving backwards
- TRIGGER
  - Yellow when the trigger input is in an active state, i.e., the voltage level in the input is high

3.1.4.2 Factory reset

The factory reset restores the state of the lane controller and clears the system-specific settings. Lane controllers are provisioned to the system on which they are installed. For example, this pairing can be broken by a factory reset, and this is required when replacing the lane controller. After installing the new lane controller, turn the system on, push the factory reset button, and hold it for 5 seconds. Reprovisioning will happen automatically after the factory reset.

***Note**: The instructions for restoring factory settings apply only to the lane controller. The router's "RES" button must not be pressed in any circumstances. The router is described in Section 3.1.2.*

3.1.5 Connecting cables in Tagsurance controller

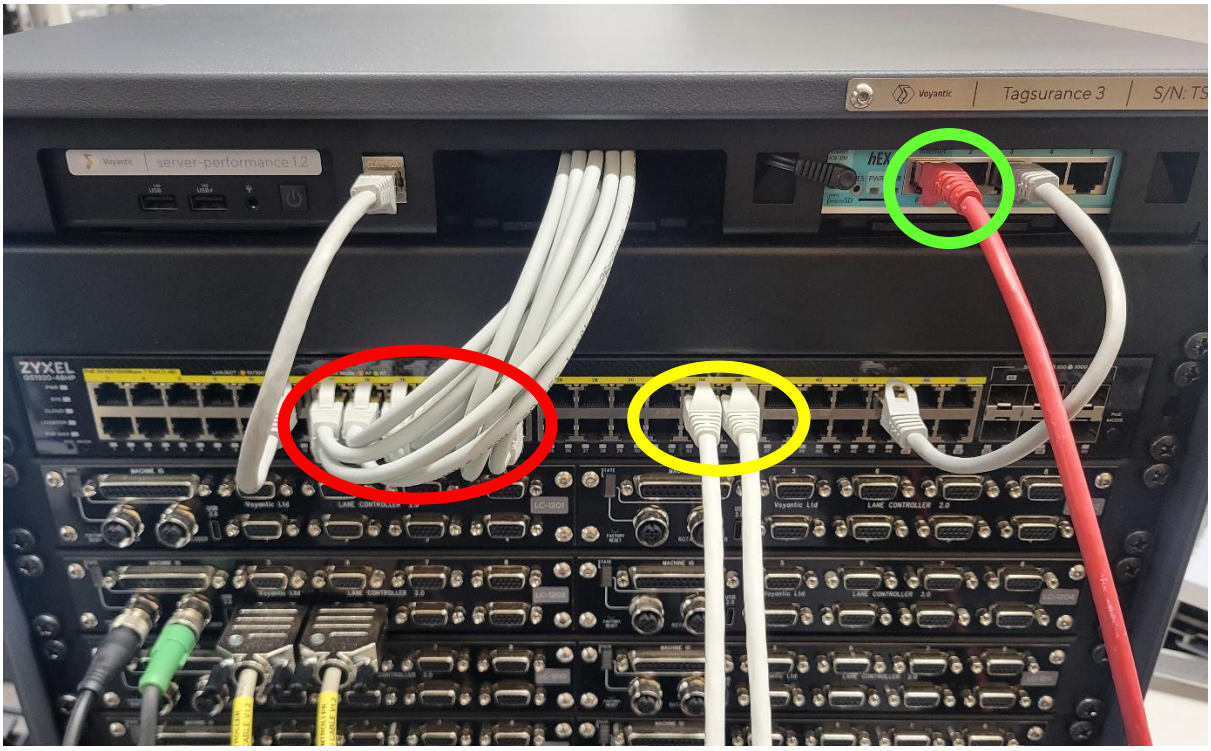
3.1.5.1 Tagsurance network

Connect Ethernet cables between the router, Ethernet switch, and Tagsurance server.

- Router port #3 → Ethernet (PoE) switch
- Ethernet switch → Tagsurance server (computer in the Tagsurance system)

Depending on the Ethernet switch model, not all ports are PoE powered, and in case you have several PoE devices, the Ethernet switch may run out of PoE ports. You can use non-PoE ports on the Ethernet switch end for the Tagsurance network connections listed above.

See the router description in Section *3.1.2 Router*.



The stations' data cables (Ethernet) are connected to the Tagsurance controller's PoE (Ethernet) switch (marked in yellow). The external network access (Internet) is connected to the router port#1 (marked in green)

3.1.5.2 Lane controllers

Connect the lane controllers' Ethernet cables (marked red in the picture above) to the PoE enabled ports of the Power-over-Ethernet (PoE) switch.

3.2 Trigger sensor

The trigger sensor is used to detect the individual labels/inlays passing through the system. The trigger signal introduces a new label to the lane controller which starts the label tracking and triggers the stations at the right time.

There are two types of trigger sensors available:

- SICK KTM-WP11172P, contrast sensor (standard delivery)
- SICK KTS-WB9114115AZZZZ, color contrast sensor

3.2.1 Installing the trigger sensor

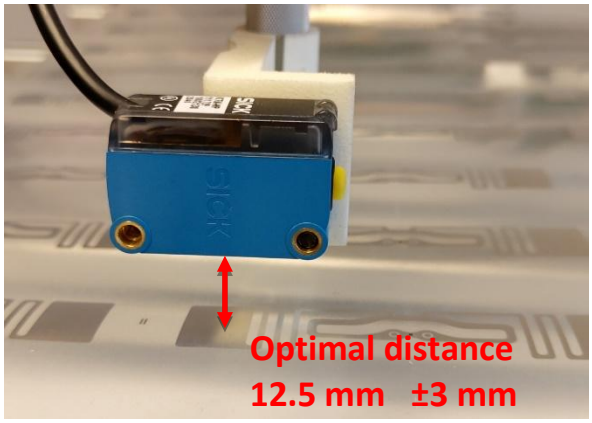
The trigger sensor must be placed before the test stations. The distance from the trigger sensor to each operating station in millimeters [mm] is set in the lane configuration.

Some features require a minimum distance from the trigger to the first station to work. See details in Section 5.2.1 Distance from trigger.

Connect the trigger sensor to the M12 connector in the lane controller, below the machine IO connector. The system can only have one trigger sensor connected, and it can be connected to any lane controller. The trigger signal is routed between all lane controllers inside the Tagsurance controller.

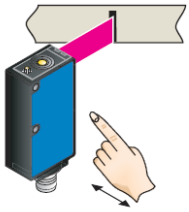
3.2.1.1 Installing and training SICK contrast sensor

- SICK KTM-WP11172P



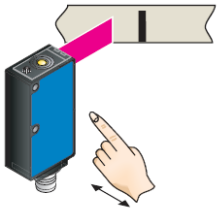
Setting the switching threshold via teach-in (static 2-point teach-in)

1. Position mark



Press and hold teach-in button > 1 s.
Yellow LED flashes slowly.

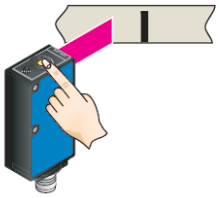
2. Position background



Press and hold teach-in button > 1 s.
Yellow LED goes out.

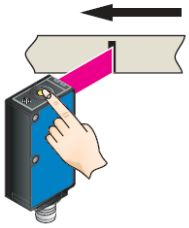
Setting the switching threshold via teach-in (dynamic)

1. Position background

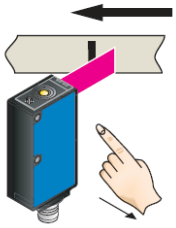


Press the teach-in button and keep it pressed.

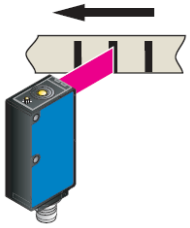
2. Move at least one mark using the light spot



Keep the teach-in button pressed.

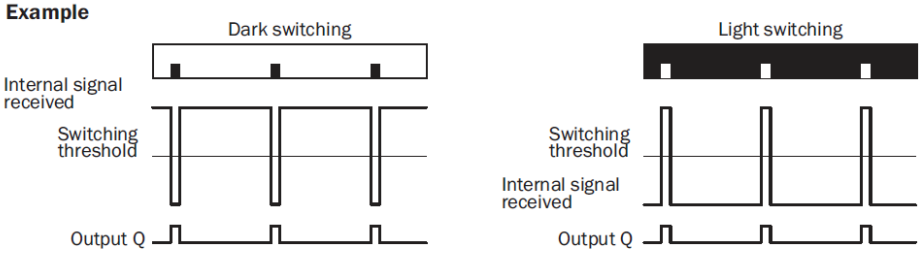


Release the teach-in button.



Yellow LED will illuminate, when emitted light is on the mark.

Example



https://www.sick.com/ch/en/contrast-sensors/ktm-prime/ktm-wp11172p/p/p455245
(Product data sheet)

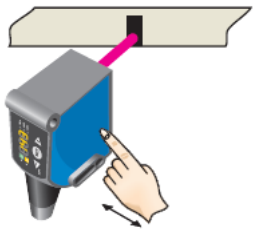
3.2.1.2 Installing and training SICK color contrast sensor

- SICK KTS-WB9114115AZZZZ

KTS/KTX Prime - setting the switching threshold (2-point teach-in)

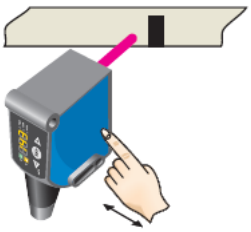
Suitable for manual positioning of the object to be detected, e.g. marks and background.

1. Position mark



When setting the contrasts to be detected, “1st” flashes.
Press set button.

2. Position background

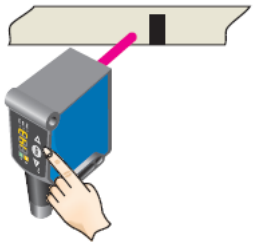


When setting the contrasts to be detected, “2nd” flashes. Press set button.
The Quality of Teach is displayed.

KTS/KTX Prime - Setting the switching threshold (teach-in dynamic)

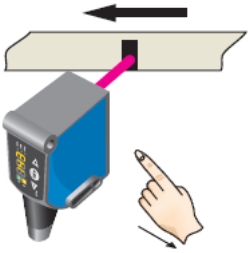
Suitable for teaching in moving objects.

1. Position background

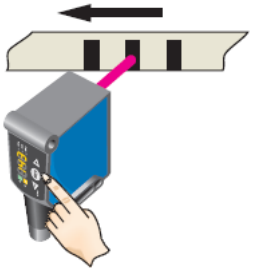


Press the Set pushbutton to start the teach-in process.

2. Move at least the mark and background using the light spot

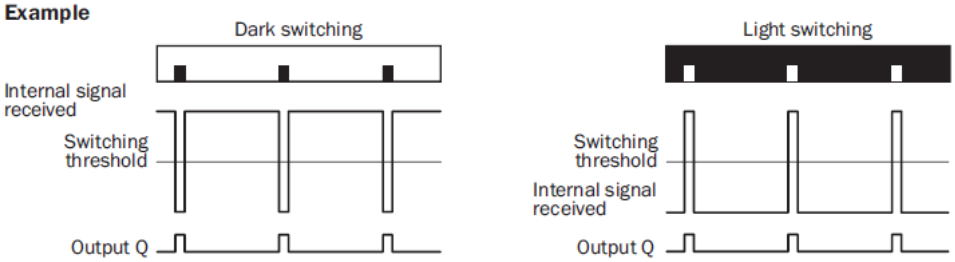


The display lights up during repeat length detection (- - -).



Press the Set pushbutton to end the teach-in process.
The Quality of Teach is displayed.

Example



https://www.sick.com/us/en/contrast-sensors/kts-prime/kts-wb9114115azzzz/p/p505059
(Product data sheet)

3.3 Rotary encoder

The rotary encoder is a sensor that measures the liner movement. During the process, the lane controller uses the movement information in label tracking.

If the material is moved backward (reversed), Tagsurance 3 will notice it, if a job is running. The processing of tags will only start after the liner has moved forward to the position from which the reversing started.

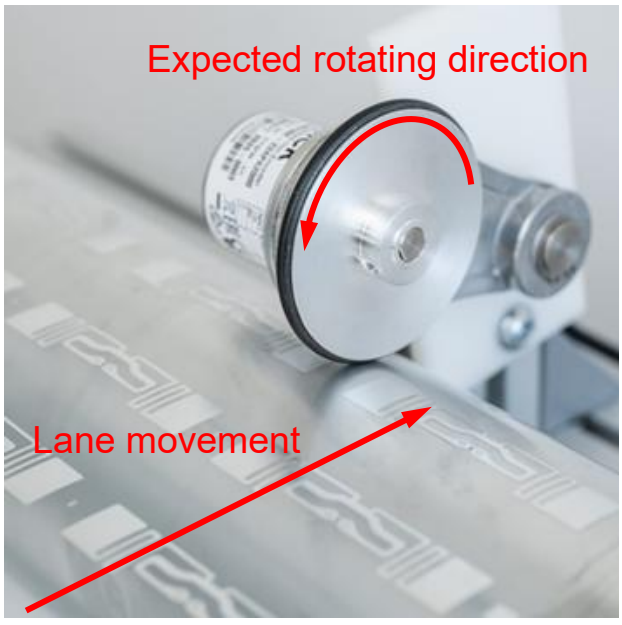
There is one type of rotary encoder available, and only its resolution is supported, 10 pulses/mm:

- SICK DBV50E-22APA2000

3.3.1 Installing the rotary encoder

Place the rotary encoder against a roll that rotates at the liner speed. Check that it does not slip against the roller.

The **expected rotating direction** is shown in the images below. In lane configuration, **this is known as the forward direction**. Depending on the rotary encoder installation, you can also configure the reverse direction in the lane configuration.



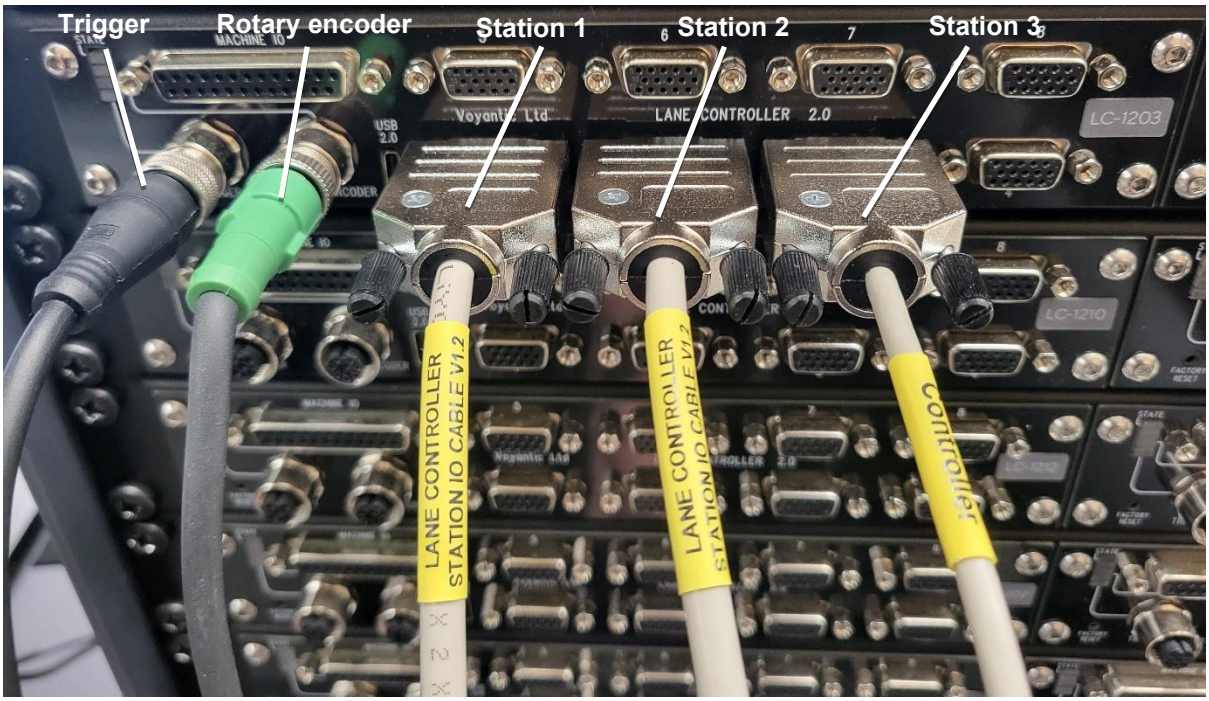
Connect the rotary encoder to the M12 connector in the lane controller, next to the station connectors. The system can only have one rotary encoder connected, and it can be connected to any lane controller. The rotary encoder signals are routed between all lane controllers inside the Tagsurance controller.

3.4 Station devices

Stations are the devices processing the RFID tag: Tagsurance SL UHF, IO-only devices, HSA Jet marker, puncher etc.

Install the stations in a separate space within or close to the machine setup so that they are in the same order as their corresponding coupling elements on the lanes. This will make it easier to work with and maintain the system. Note that the required minimum distance between stations is 50 mm.

Connect the IO cables from the lane controller's station ports (DE-15, 15 pins in 3 rows) to each station in the same order the stations are physically located on the lane. Each lane has a dedicated lane controller.



3.4.1 Tagsurance SL UHF

Tagsurance SL UHF is a new generation of UHF RFID testers Voyantic is providing. This device does performance testing like its predecessor and also the encoding which enables tag personalization. See detailed technical specifications in the *Product catalog*.

Tagsurance SL UHF has improved tag response detection, which can consider a tag as bad if the tag response is significantly weaker than the responses used to be for good tags tested by the same Tagsurance SL UHF tester. This response level detection, called backscatter strength detection, improves the test result quality, especially in multilane processes. In the multilane process, the tester's sensitive receiver may hear a tag response from the simultaneously tested neighbor tags. However, this feature prevents a weak response from being interpreted as a good tag response. The backscatter acceptance level is auto-adaptive, so weak responses can only be rejected after a few tags from the job start.

3.4.1.1 Connecting Tagsurance SL UHF

On the device's front panel, connect:

- Ethernet cable (data and power)
  - LAN/PoE port → PoE switch in Tagsurance controller
- IO cable (IO signals)
  - I/O port → Lane controller's station port
- RF cable going to the Snoop Pro coupling element. The RF connector in Tagsurance SL UHF is an N-type connector.

If you use cables other than those provided by Voyantic, you must use high-quality, low-loss cables. The RF cable length from a station must not exceed the given maximum length. See the maximum length for an RF cable in Section *9.6.2*.

As there is no compensation for cable losses, the cables should be matched to each other in length when a similar device on different lanes is in question.

3.4.2 Tagsurance HF

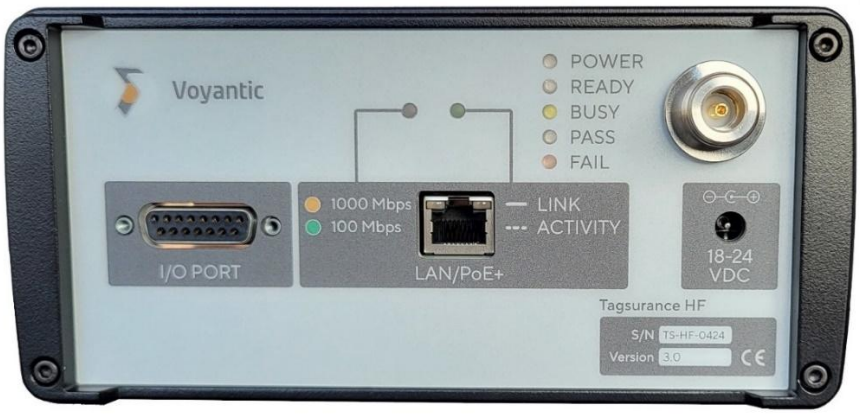
Tagsurance HF is a device for testing the performance of HF RFID tags, such as NFC labels. The most common protocols are supported, and the tests are deterministic. See detailed technical specifications in the *Product catalogue*.

3.4.2.1 Connecting Tagsurance HF

Tagsurance HF version 3.x has all the connectors on the front panel. Connect:

- Ethernet cable (data and power)
  - LAN/PoE+ port → PoE (Ethernet) switch in Tagsurance controller
- IO cable (IO signals)
  - I/O port → adapter [1)] → Lane controller's station port
- RF cable going to the Snoop Pro HF coupling element. The RF connector in Tagsurance HF is an N-type connector.

There is also an 18-24 VDC connector in Tagsurance HF version 3.x. However, it is not needed when the device is PoE powered. While not recommended, having both power supply options connected simultaneously is safe.



If you use cables other than those provided by Voyantic, you must use high-quality, low-loss cables. The RF cable length from a station must not exceed the given maximum length. See the maximum length for an RF cable in Section *9.7.2*.

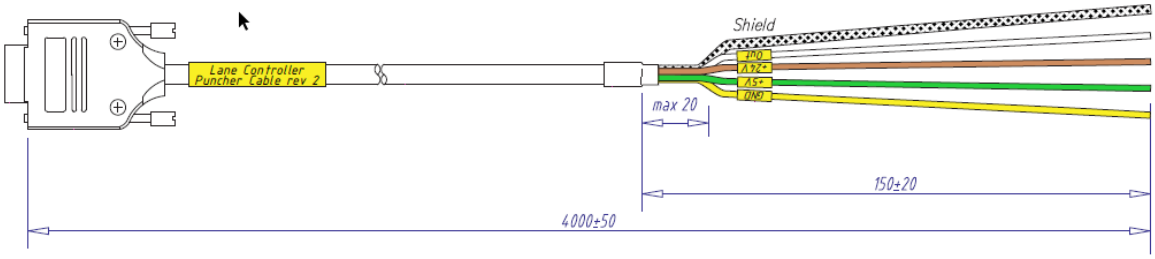
Note: Tagsurance HF versions 1.x and 2.x are not PoE devices, hence the power cable is mandatory.

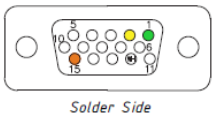
3.4.3 Puncher

Voyantic does not offer punchers but rather a signal interface to fire a puncher at the correct time to crunch a chip in a failed tag.

3.4.3.1 Connecting a puncher

The IO cable to the puncher (rev2) has 4 pins at the puncher end. The available output signal (white wire) is an NPN type trigger (active on low). The shield is grounded.





The trigger signal is not meant to drive the puncher directly but a relay in between. See the current limits for signals in Section *9.1.6 Power budget and current* limits.

3.4.4 Marker

Voyantic offers one marker model, HAS Jet Micron, as a bad tag marking station and a ready-made IO cable for triggering another marker model, Wolke M610. The marker configuration must be done using the tools provided by the marker manufacturer. Tagsurance 3 only triggers the markers at the correct moment. Feedback signals, such as a low ink level indication, are not supported.

3.4.4.1 HSA Jet Micron

HSA Jet Micron MCHP1

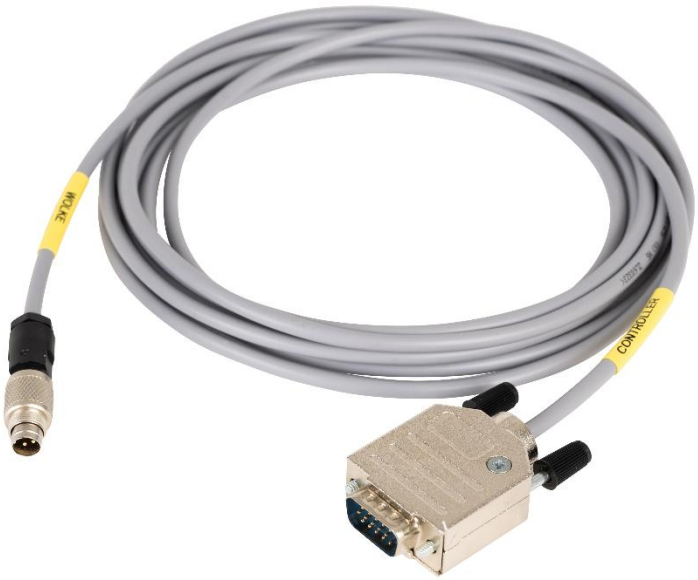
The print images can be designed by MicroDraw software.

Connect the branched IO cable from lane controller's station port to the HSA Jet Micron marker. The cable has 2 pieces of D9 connectors at the marker end, as shown in the picture below. The connectors are labeled as "I/O" and "ENC", respectively, at HSA Jet Micron marker. Connect also the power cable. Tagsurance 3 controller shares the rotary encoder signals to HSA JET Micron.

3.4.4.2 Connecting Wolke M610

Wolke M610 marker's print heads can be connected and triggered by Tagsurance 3. Lane controller will provide the trigger signal to the print head, but rotary encoder signals are not

shared. Connect the cable from the lane controller's station port (DE-15) to the Wolke print head (M9, 3-pin).



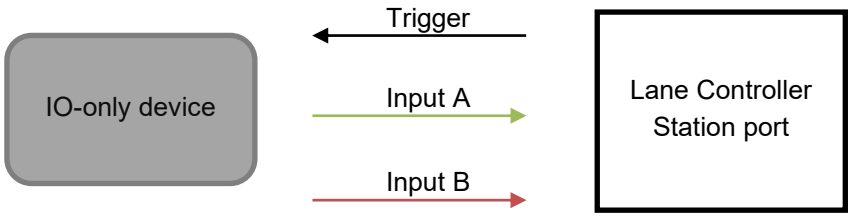
3.4.5 IO-only device

It is possible to connect devices other than those provided by Voyantic as a station to the Tagsurance 3 system. The devices must implement a specific IO signal interface that the Tagsurance 3 controller uses to trigger them when it is time to start processing the tag. The device is expected to report whether the processing was successful or not.

The pass-fail results of IO-only devices are shown in the Tagsurance 3 operator UI and added to the logged tag results. The initialization and advanced result handling of the IO-only device must be done separately from the Tagsurance 3 system, for example, by using the device's own UI.

3.4.5.1 Connecting an IO-only device

The IO-only device will be connected to the station port of the lane controller. There are three IO signals: trigger, input A (pass / fail 1), and input B (fail / fail 2). The lane controller sends the trigger pulse, the length of which is adjustable in the lane configuration. The IO-only device is expected to reply the result by sending a pulse either to lane controller's input A or input B. When the result signal is not detected in either input, the configuration defines how the station status is interpreted. It can be either pass, fail, or error and the result is shown accordingly in operator UI.



For the signals at input A and B, the minimum pulse length is 1 ms. See the signal polarities and voltage levels in Section *9.1.4 Station connector*.

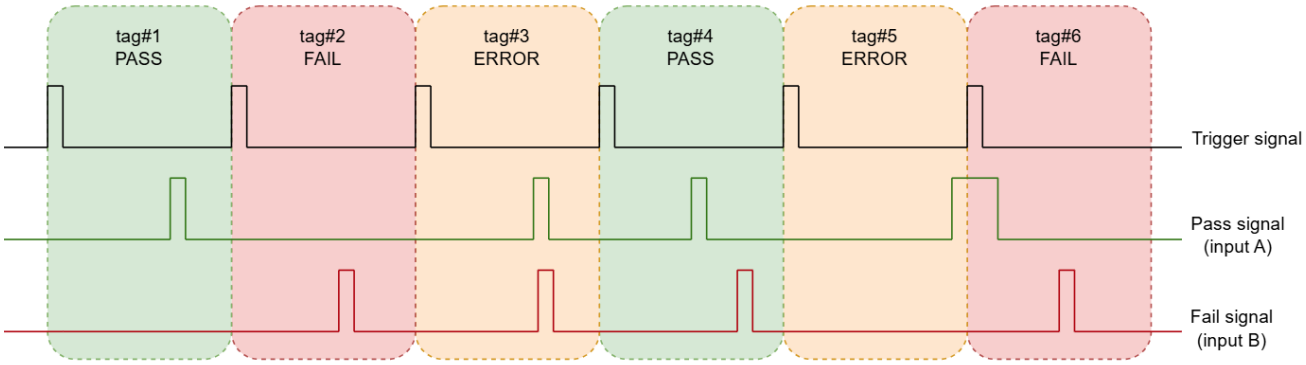
For the correct result signal interpretation, the pass or fail pulse must be sent before detection deadlines, and the result pulse must be completed before the deadline, i.e., the signal must return to passive state. There are four different modes for the result signaling: *'Pass and fail'*, *'Pass only'*, *'Fail only'*, and *'Dual fail'*. See the mode details below. The signal mode is set in the lane configuration, see Section *5.2.6 IO-only device*.

The error results are handled as fail results. The "error" tags can be marked as bad ones by a bad tag marker, and the error results represent bad tags in yield calculations.

In the following signal diagrams, the signals are PNP type, active high (> 5 VDC) and passive low (< 2 VDC). See the voltage level details in Section *9.1.4 Station connector*.

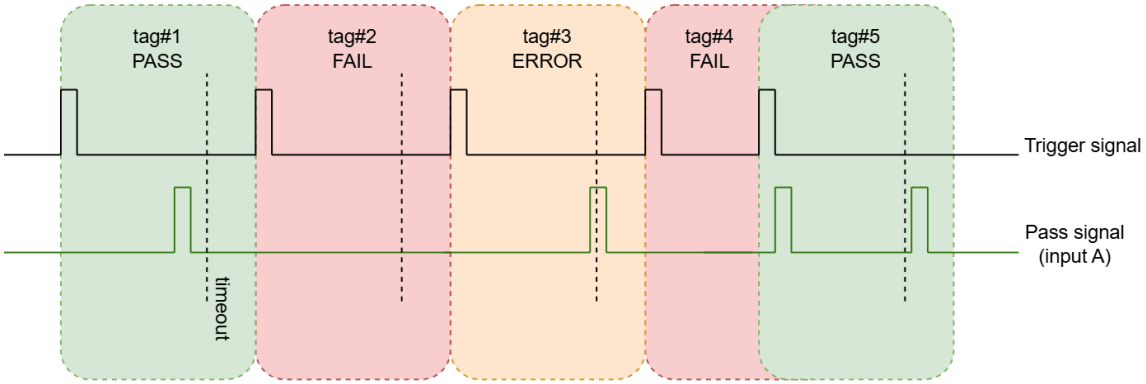
3.4.5.2 Pass and fail

Either pass or fail pulse must be sent before the next trigger. If there are both pass and fail pulses, the first pulse determines the tag status. However, if the result pulses overlap each other or the next trigger, the tag result is interpreted as an error. The tag result will be an error if neither of the result pulses is detected.



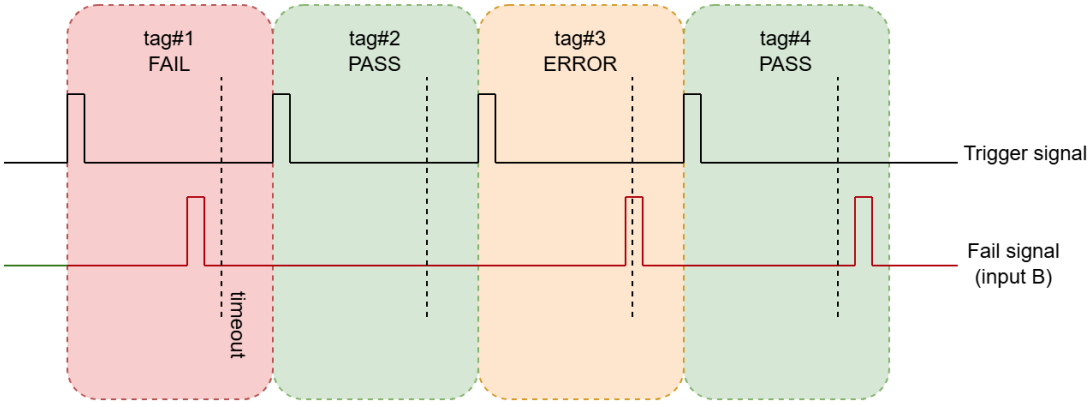
3.4.5.3 Pass only

In the *'Pass only'* mode, the deadline for the result pulse is the defined timeout value or the next trigger signal, whichever comes first, otherwise, the tag is interpreted as fail. If the result pulse overlaps the deadline, the tag status will be an error.



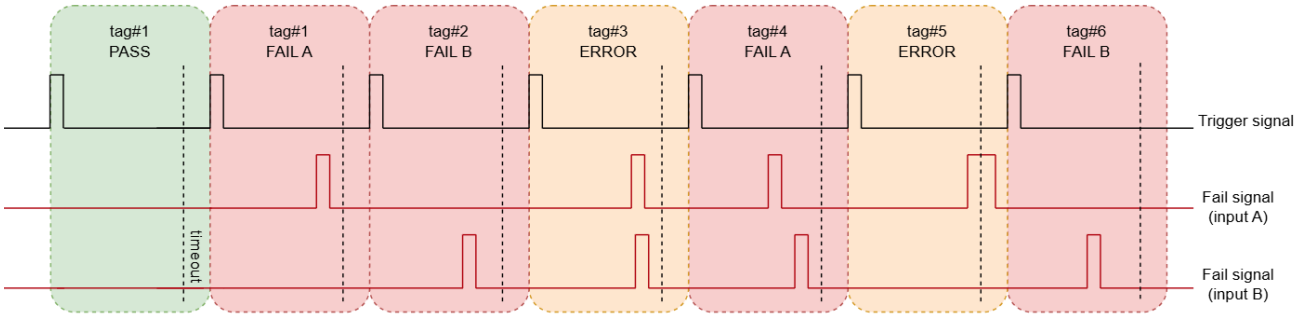
3.4.5.4 Fail only

In the *'Fail only'* mode, the deadline for the result pulse is the defined timeout value or the next trigger signal, whichever comes first, otherwise, the tag is interpreted as fail. If the result pulse overlaps the deadline, the tag status will be an error



3.4.5.5 Dual fail

The *'Dual fail'* mode enables an IO-only station to differentiate between the reasons for failures. The signaling rules in the *'Dual fail'* mode are the combination of rules in the 'Pass and fail' and 'Fail only' modes: The deadline for the result pulse is the defined timeout value or the next trigger signal, whichever comes first; otherwise, the tag is interpreted to pass. If the result pulse overlaps the deadline, the tag status will be an error. If both fail pulses occur, the first pulse determines the failure type.



3.5 Snoop Pro coupling elements

Snoop Pro is the coupling element that creates an electromagnetic field, near field, where a RFID tag is energized, and the tester can execute performance tests and encode the tag memory. Technical details and available Snoop Pro models are listed in Tagsurance 3 Catalog.

3.5.1.1 Snoop Pro 2.0

Snoop Pro 2.0 is a new version of the most used Snoop Pro model. The new version is backward compatible with the predecessor mechanically and in RF performance. New features include built-in strobe lights for tag position validation and a fail indicator. The maximum supported tag antenna dimensions are 50 x 100 mm.

3.5.1.2 Snoop Pro Mini 3.0

When small tags are processed, and the larger Snoop Pro model cannot fit in the available installation space, Snoop Pro Mini 3.0 serves the purpose with its smaller, optimized footprint. The maximum tag antenna dimensions are 50 x 65 mm. Snoop Pro Mini 3.0 has the same strobe light features as Snoop Pro 2.0.

3.5.1.3 Snoop Pro Tiny 2.0

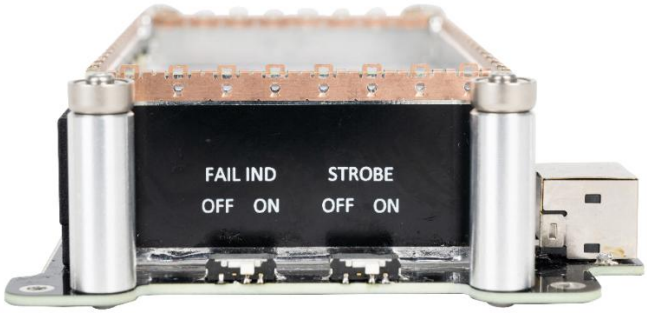
Snoop Pro Tiny is the smallest model in the Snoop Pro coupling element line designed for dipole antenna tags. The maximum supported tag antenna dimensions are 30 x 40 mm. Snoop Pro Tiny 2.0 contains the same strobe features as the larger models, but it lacks the fail indicator switch; the fail indicator is always enabled.

3.5.2 Snoop Pro built-in strobe light and fail indicator

The strobe light flashes when Tagsurance SL UHF is triggered, and the tag is illuminated for a short moment. When the lane is moving, the tags appear to remain in the position where testing starts. This feature helps the user identify, for example, if the configured triggering position is correct, tags are double-triggered due to a wrong trigger sensor configuration, or the rotary encoder is slipping. The flash duration decreases with lane speed, keeping the seen tag image sharp.

The fail indicator flashes every time the tag fails the executed test and visually indicates failures in the production line. The fail indicator is reset when the next tag result is available. The strobe light and the fail indicator can be turned on and off separately.

***Note**: The strobe light may interfere with tag ICs, and tags may behave differently with and without the strobe light. Please, read more in the Section 3.9.1 High-intensity light may interfere with tag ICs.*



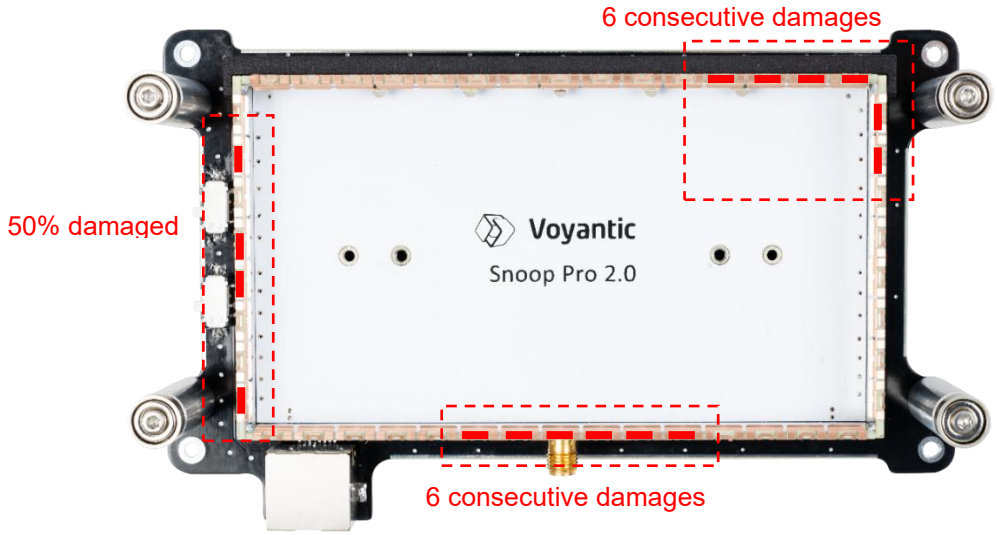
The strobe operating voltage and control signals are connected via Ethernet cable from the station IO cable's connector (see Section *3.6*) to the RJ45 connector in Snoop Pro 2.0.

Crossover Ethernet cables are not allowed; only patch Ethernet cables (“straight-through” / “normal”) can be used as strobe cables. The strobe cable can be routed with the RF cable.

3.5.3 Maintenance

When the shielding plates are changed, the copper gaskets between the Snoop Pro body and the shielding plate may become damaged. The gaskets must be replaced when 50% of all fingers in a gasket are damaged or when 6 consecutive fingers are damaged. The consecutive fingers can be on the same gasket or on two gaskets around the corner. A few missing fingers on the gasket don’t change Snoop Pro's behavior, but please monitor the condition of the Snoop Pro coupling elements.

The example below shows damage in Snoop Pro 2.0 gaskets that cause the gasket replacement. The same rules apply: 50% or 6 consecutive damages to all Snoop Pro models.



3.5.4 Installing Snoop Pro coupling elements

Install the Snoop Pro coupling elements on each lane as required, and as they fit to the machine. The liner must make contact with the shielding plate. A gap between the liner and coupling element creates a risk of cross-reading.

The center line of the inlay antenna must cross the Snoop Pro coupling element's center line.

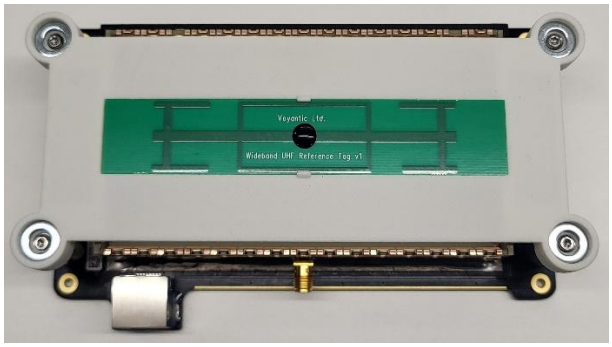
Snoop Pro has an SMA-type RF connector. Make sure to tighten it completely but not exceed 1 Nm torque.

Snoop Pro coupling elements have an RJ45 connector for the strobe light control signals. Connect an Ethernet cable from the RJ45 connector to *the station IO cable*, which supplies power and control signals. The station IO cable must be version 1.2, which has an RJ45 connector for strobe light control.

If you use cables other than those provided by Voyantic, you must use high-quality, low-loss cables. See the maximum length for an RF cable in Section *9.6.2*.

3.5.5 Verifying Snoop Pro installation (verifying RF connections)

Place a reference tag on top of the Snoop Pro coupling element. In the picture below, Voyantic Wideband UHF Reference Tag is mounted to a jig, but you can use your own tag attached to a shielding plate, for example, with tape. The most important thing is the repeatability of the installation between the measurements.



Open the **Recipe Builder**. For more information, see Section *6.*

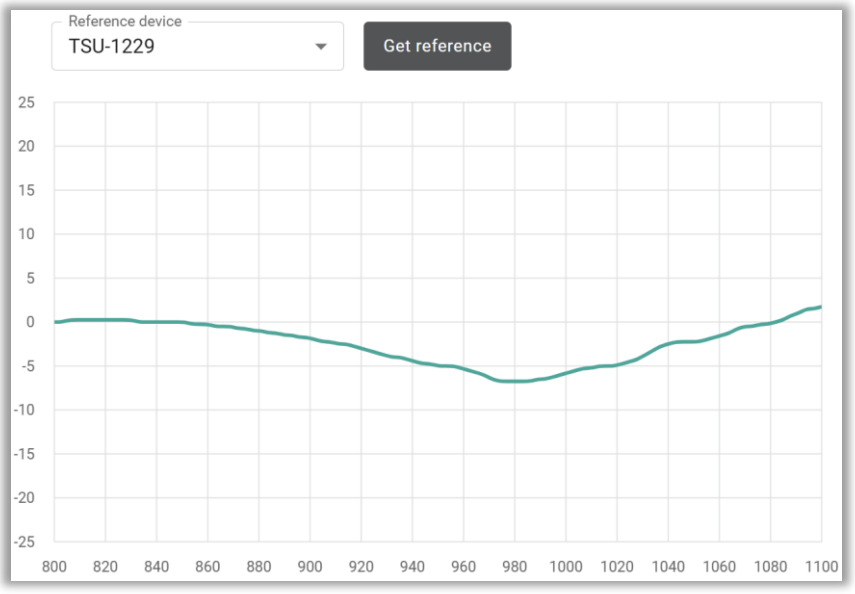
Start creating a new recipe containing Tagsurance SL UHF as a station and measure a reference sweep by selecting the device and pressing **Get Reference**.

In a good installation:

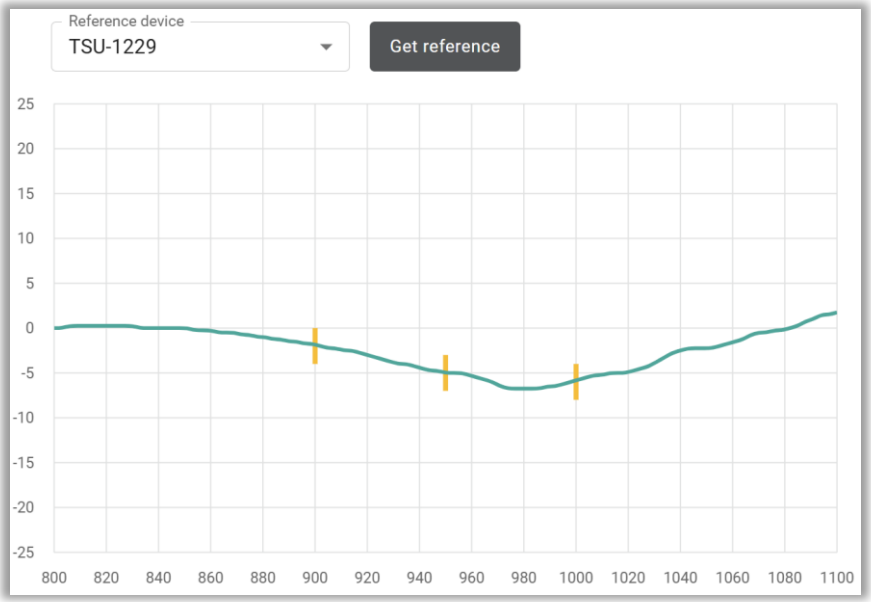
- The threshold sweep should be visible for the entire frequency range.
- In the curve, there should not be any sudden peaks or notches larger than 1 dB.

Note that the curve level may be different from installation to installation due to:

- different cable types and lengths
- Snoop Pro model and version
- Snoop Pro electrode extensions



In the recipe, set sensitivity tests around the reference curve. Set the upper limit to 2 dB above and the lower limit to 2 dB below the threshold. Save the recipe with the name such as **`ReferenceTag_NameOfStationAndLane_Date`**.



Afterward, you can use the **`ReferenceTag_NameOfStationAndLane_Date`** recipe to check that the installation has not drifted and that the cables and connections are still intact. Open the **`ReferenceTag_NameOfStationAndLane_Date`** recipe, get the reference, and check that the reference curve is still above the set sensitivity test limits. If the installation has drifted (the reference curve is not visible or it is below or above the limits),

- Check the RF cable connections and conditions.
- Clean the Snoop Pro coupling element from dust.
- Check that the coupling element configuration is correct (coupling element model and use of electrode extensions).
- Check for any potential use of an external attenuator.

3.6 IO cable for Voyantic devices

The IO signals of all Voyantic devices, Tagsurances, are connected to the lane controller using the IO cable, which has DA-15 (pins in two rows) and DE-15 (pins in three rows) connectors. Similarly, the ends are labeled as *Station* and *Lane Controller*. The IO Cable has customized connections to make Voyantic devices compatible with the lane controller's pinout.

IO cable v1.2 has an RJ45 female connector for the strobe connection in Snoop Pro 2.0. See more about the strobe connection in Section *3.5.1.1 Snoop Pro 2.0*.

3.6.1 IO cable compatibilities

There are two compatible revisions of the IO cable between the lane controller and the Voyantic device.

Lane Controller	IO cable
version 2.0	version 1.1 version 1.2

Note: An incompatible version of the IO cable exists, and it does not have a version number label. Also, the IO cable version 1.1 does not have the version label, and it is, unfortunately, easy to mix with the incompatible cable. The color of the compatible cable, version 1.1, is either black or grey, while the incompatible cable is beige. The incompatible cable version is for the previous version of the system.

3.7 Machine IO

The Tagsurance controller can be configured to communicate with the production machine (e.g., PLC) via the machine IO connector's digital signals, for example, to stop the machine when a batch is fulfilled.

All configured outputs of the machine IO have both output types: NPN and PNP. See the pinout in Section *9.1.5*. The signal configuration is described in Section *5.1.1*.

3.8 IO breakout

The IO breakout is an access point to IO signals between a lane controller and a station. The IO breakout provides the trigger, busy/ready, and pass/fail signals at both types of outputs, NPN and PNP, and these outputs are isolated from the original signals coming from the lane controller and the station.

With the help of IO breakout, for example, the station trigger signal can be safely distributed to the PLC without the risk of interference with sensitive IO signals.

The lane controller powers the IO breakout; hence, the lane controller's power budget must be considered when an IO breakout is added to the setup. See Section *9.1.7 Power consumption of accessories*.

Note: The IO breakout has only signal outputs. You cannot input the signals to the IO breakout.

3.8.1 IO breakout versions compatibility

There are different versions of IO breakouts differentiated by color and version number. Regarding the IO breakout compatibility, the most important are the version of the lane controller and the version of Tagsurance SL UHF tester unit. The hardware version of devices can be found either on the device’s front panel or back panel. The lane controllers are shown in the section *3.1.4 Lane controller*, and when connecting the devices, see also *3.6.1 IO cable compatibilities*.

IO breakout	Lane Controller	Device
version 1.0, black enclosure	version 2.0	• Tagsurance SL UHF **version 1.x only**
version 2.0, black enclosure	version 2.0	• Tagsurance SL UHF, **versions 1.x and 2.0**

3.8.2 Connecting IO breakout

Connect the IO breakout between the lane controller and the station. Connect the IO cable from the station to the IO breakout instead of the lane controller and the IO cable with DE-15 connectors at both ends (male and female) from the lane controller’s station port to the IO breakout. The latter IO cable is provided together with the IO breakout.

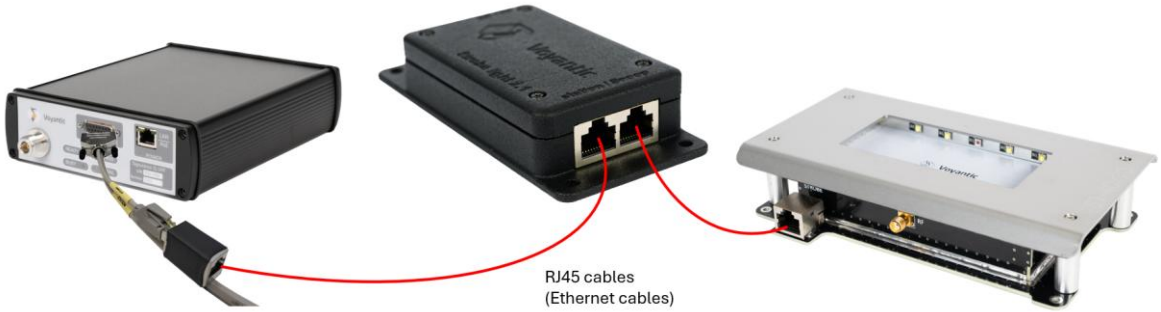
The station’s IO signals can now be connected from the IO breakout’s green connector to the PLC. Either PNP or NPN output can be chosen depending on the interface of the machine. See the pinout and details in the section *9.3*.

3.9 Strobe Light

The strobe light is an accessory that helps observe the RFID tag position when the station is triggered. The flash duration is independent of the trigger signal pulse length, and duration adjusts automatically based on the triggering interval. As a result, the tag or label appears to be standing still at the triggering location.

The lane controller powers the strobe light. Therefore, the lane controller's power budget must be considered when adding a strobe light to the setup. The strobe light is powered by the 5 VDC output of a station connector that sets the limit for the number of connected strobe lights per lane controller. See section *9.1.7 Power consumption of accessories*.

The strobe light connects to *the station IO cable*, which supplies power and control signals. The station IO cable must be version 1.2, which has an RJ45 connector for strobe light control. The strobe light has two RJ45 connectors, enabling daisy-chaining with the Snoop Pro built-in strobe lights. Strobe light version 2.1 has an on/off switch that controls only the strobe light itself and does not affect daisy-chained strobe lights.



3.9.1 High-intensity light may interfere with tag ICs

Some RFID ICs are known to be sensitive to light, and high-intensity light can interfere with their operation. The Tagsurance 3 system includes components and accessories that emit high-intensity light, which may interfere with the ICs. Strobe light exposure may increase the likelihood of failures, potentially leading to a drop in production yield. When testing or encoding tags near their sensitivity level, they are more likely to fail than with a greater power margin.

The external Strobe Light and new versions of the Snoop Pro coupling elements with a built-in strobe help users adjust the trigger location of stations. The strobe flashes when the station is triggered. As a result, humans see a stationary tag at the position where the interaction with an RFID tag begins, even if the tag is moving. The flash duration is about 500 µs, and it starts at the same time as Tagsurance SL UHF or Tagsurance HF starts transmitting the carrier waveform to an RFID tag. The light-sensitive tag ICs disturbed by the strobe light behave differently from

those that are not. Effectively, the tag's sensitivity decreases, and the tester must transmit more power before the tag powers up.

The light-sensitive ICs are not always disturbed, but it depends on how much light can penetrate to the IC. For example, details such as the distance between the Strobe Light and IC, or the web and label material between the light source and the IC.

When strobe lights are used in RFID production, and not just for lane configuration setup, light exposure must be considered in the test recipe design.

3.9.1.1 Best practices

The phenomenon is quite difficult to verify during recipe building when the reference curve measurement is the only reference for the tag behavior, and because the strobe light flashes only at the beginning of the sweep measurement.

The more margin you have between the tag threshold power level and the transmitted power level, the less likely the tag is to fail the test because of the strobe light. The strobe light affects only the first task in the recipe, so it’s better to place a task with a higher power margin first on the task list. For example, if you do a TID read with a higher power margin than the point tests, it’s worth having the TID read the first task on the task list.

When looking at a larger tag population in production, the variance in tag sensitivity becomes apparent. When the acceptance criteria for tag sensitivity are fixed, and a strobe light affects the tag sensitivity level, it is a statistical fact that the strobe light is a factor in the production yield, even if the effect is minimal and may be masked by more-determinant factors. However, the yield loss is most probably less than the benefits the strobe light can offer. To collect more accurate knowledge about the effect on your product in production, run production with and without the strobe light. If you don’t know how the strobe affects the tags in your production, and you don’t want to take any yield risk, prefer using the strobe light only during the production setup and when verifying the triggering position.

3.10 Holder Rack with Cooling Fans

Voyantic devices, such as Tagsurance SL UHF, must not be stacked due to heat management. The Holder Rack with Cooling Fans is designed to ensure adequate ventilation around the devices and to assist with device placement. The air flows through the rack from front to back

The rack contains PoE-powered fans in the rack back panel. Connect an Ethernet cable between the power module of the holder rack and the PoE switch in the Tagsurance 3 controller. The fans have three speed levels: slow (1), medium (2), and high (3). High speed is recommended for use in warm conditions. Slow speed must not be used. The speed level can be controlled by the three-state switch next to the power module’s Ethernet connector. The delivered racks have the medium speed set by default.

3.11 Connecting to the Tagsurance system

3.11.1 Direct connection

- Connect an Ethernet cable from your computer to **router port #2**.
- Browser based operator UI is available in https://10.10.30.10

You may need to allow an exception in your browser before the operator UI opens. Depending on your computer settings, you may also have to close your computer's WiFi connection before successfully establishing a connection.

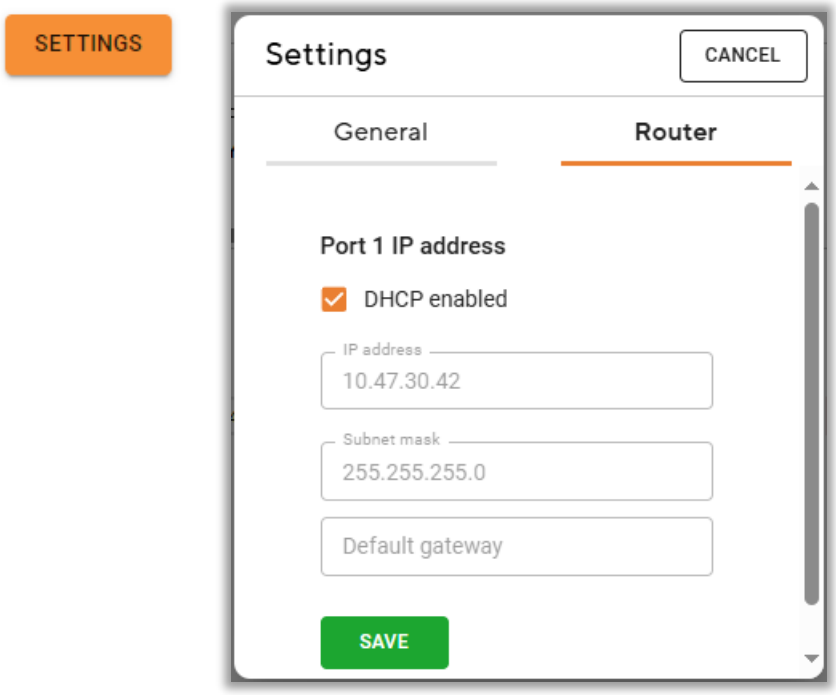
3.11.2 Network connection

Connect your ethernet network to router port #1.

- Browser-based operator UI is available in `https://[system IP address]`
  You can access the operator UI from any computer connected to the same (ethernet) network.

The router port#1 has DHCP enabled by default. To find out the system IP address in the network, You must connect your own PC to the router using a direct connection as described in Section *3.11.1* and open the operator UI in a browser window to see the IP address of Tagsurance controller. The router port#1 IP address can be seen in settings and the information view in the picture below. You can also query the current IP address from the status endpoint of the REST API by using a direct connection.

You can configure the IP address of the router port #1 in the operator UI settings.



***Note**: IP address assignment changes require a complete system reboot to prevent network issues. The system may seem to work perfectly, but without a reboot, there may be, e.g., 1% packet loss, which is not good.*
How to reboot: Press the power button on the server, and when it is shut down, cycle the power of the whole Tagsurance 3 rack and then power the server back on.

Through a network connection, the operator UI, REST API, and API documentation are available as they are through the direct connection, but the IP address is different. The IP address is either provided by the DHCP service or is a static IP defined by the user). In the example of the picture above, the operator UI is available at https://10.47.30.42.

To make the Tagsurance system always available from the same address, it is a good idea to configure your network to give the same IP address to the Tagsurance system. If your network configuration so allows, you can configure the router port #1 to have a static IP address.

Note: The IP address 10.10.30.10 and the range 169.x.x.x are not supported. Select the static address outside of this range and value.

The information view on the right in the operator UI main view shows router information including the IP address that the router has received from the network, for example WAN IP address 10.47.30.42/24. The same information, including router's MAC address, is available in the status endpoint.

3.11.3 APIs

You can integrate to the Tagsurance system via APIs. Tagsurance system offers REST API and AsyncAPI. The REST API is a call-response type of communication. With the REST API, you can, for example, save a lane configuration, start a job, finetune the station triggering location, and export data after the job is stopped.

In the AsyncAPI, you can subscribe to channels from which data is streamed. From the AsyncAPI streams, you can receive metrics such as lane speed and process yield several times per second, and tag results when they are ready, without separate requests. You can use APIs in parallel as you wish.

You can connect to APIs at the same address where the operator UI is available, which is described above. API documentation is available at the same address as operator UI. The API specifications are available in the system, and the addresses are listed in Section *9.5 APIs*.

3.12 Internet connection for cloud-based features

Tagsurance 3 has cloud-based features that users can benefit from, especially in system maintenance: new features are easy to get into use by updating to the latest available version with a few clicks, or the Tagsurance 3 system automatically keeps licenses up to date by fetching the newest license without any manual action.

For the cloud-based features, Tagsurance 3 requires an internet connection. Regarding the network and firewall configurations, only an outbound port is required. The system has no requirement of having an inbound port open, nor any port forwarding requirement.

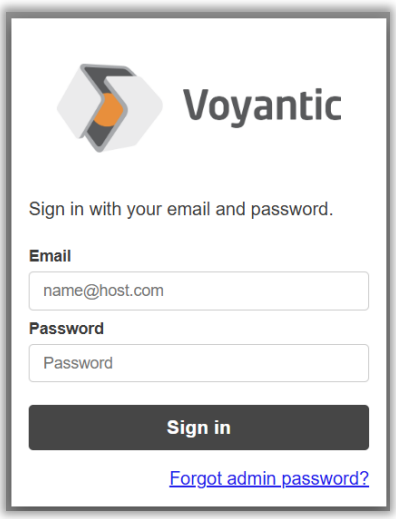
Simplistically put, the system has the same requirements as a web browser.

- Protocol: TCP/IP
- Port: 443

4 User Interface

Tagsurance 3 system has a browser-based user interface. Tagsurance 3 is a headless system and the user interface can be operated on an external computer connected to Tagsurance 3 system. The section *3.11 Connecting to the Tagsurance system* describes how to connect to the system and open the user interface.

The login credentials are required to access the user interface. The credentials are provided for the Tagsurance 3 main user for the first login. The main user can manage the credentials in the Admin UI.



Tagsurance 3 user interface consists of three sections:

- Operator UI
- Recipe service
- Admin UI

Navigation between the components is done in the title bar of the user interface. Operator UI is for operating the system in the RFID tag production: configurations, job running, result monitoring and result exporting. Operator UI is introduced in more detail in sections *5 Building Lane Configuration* and *7 Running a Job*.

Recipe service, including Recipe Builder, is for recipe management. Recipe service is introduced in the section *6 Building a Recipe*.

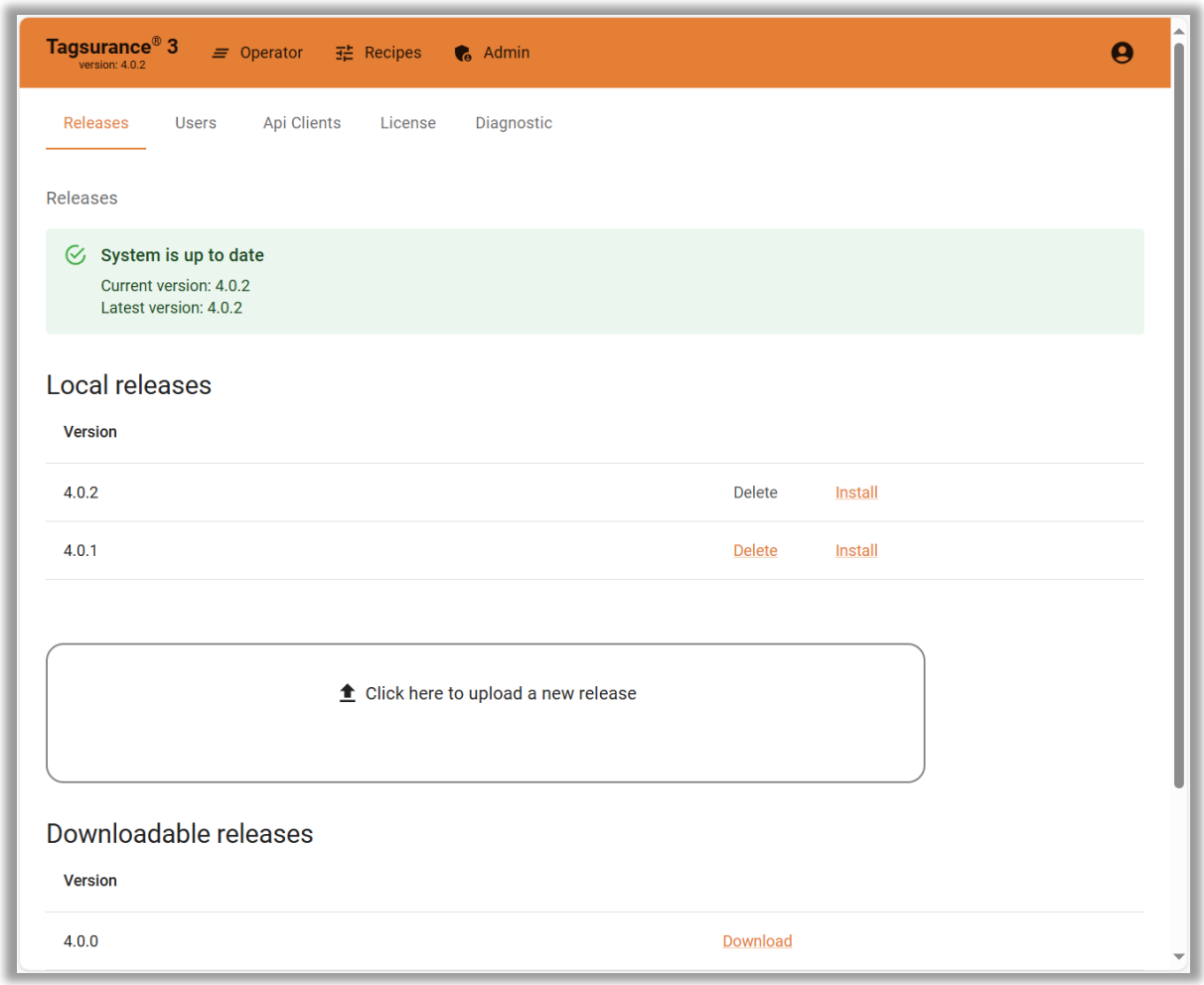
4.1 Admin UI

The Admin UI is for Tagsurance 3 system management. A user with admin rights can download and install software versions, manage system-specific user accounts, query the API client credentials, update the license, and export diagnostic data.

4.1.1 Updating the Software

Software updates: patches and feature updates, are available on the Releases tab. In the systems connected to the internet, the info banner shows the current version and the latest available version of the releases. The releases must first be downloaded locally, and then the system update is a one-click process. The system update updates all the system components, including the server software, lane controller firmware, and firmware for Voyantic station devices. The update progress is clearly indicated. Please refrain from using the system during the update.

***Note**: Lane Controller gives pulses from IO outputs during the SW / FW update. For example, marker and puncher will act if they are powered and connected. Make sure these unintentional signals will not affect the machine during the Tagsurance 3 system update.*



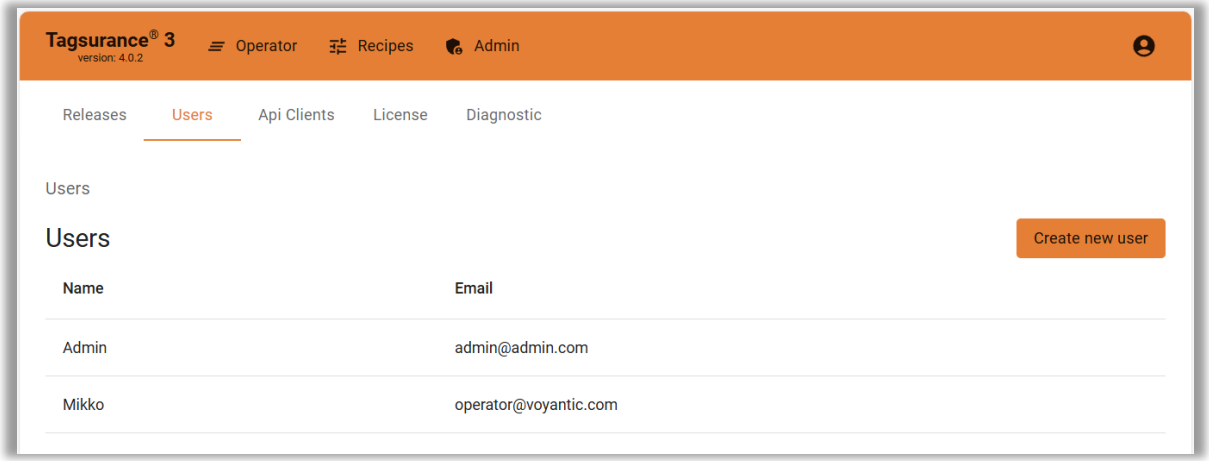
Tagsurance 3 system can store three different releases locally at the same time. A warning is shown, and admin UI instructs the user how to proceed.

The offline update is available for the systems that are not connected to the internet. The release package must first be downloaded from the Voyantic release page to the computer where admin UI is operated, and then it can be uploaded to Tagsurance 3 system as a local release.

***Note**: The update process supports Tagsurance HF firmware version 2.8.0 and later. Tagsurance HF version 3.0 devices have the correct firmware pre-installed. If earlier Tagsurance HF hardware versions are connected to Tagsurance 3 version 4.x systems, the user must ensure that firmware version 2.8.0 is installed and that DHCP is enabled in the IP settings before connecting the device to the system. Contact Voyantic support for any assistance.*

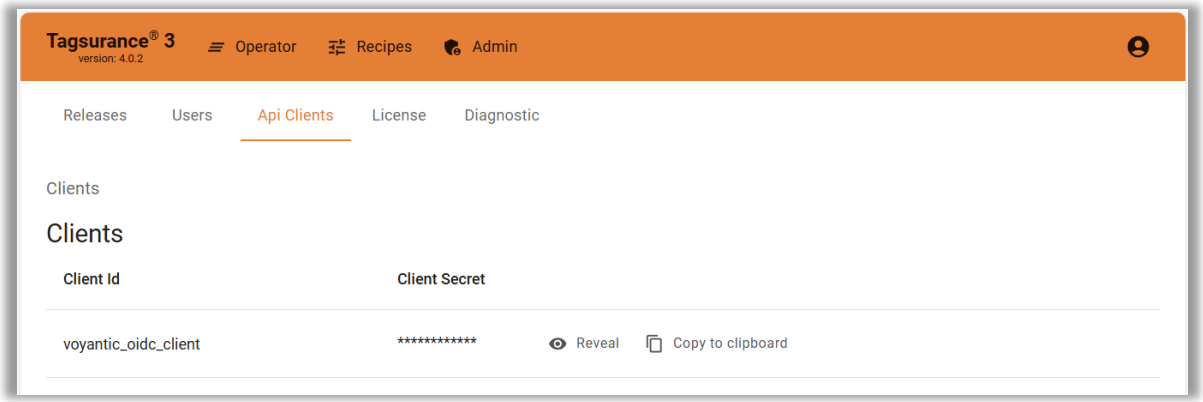
4.1.2 User management

Tagsurance 3 system has two levels of user accounts: admin and operator. Operator users have access to operator UI and recipe service only, whereas admin users also have access to admin UI. Admin users can add and remove user accounts, and reset the passwords.



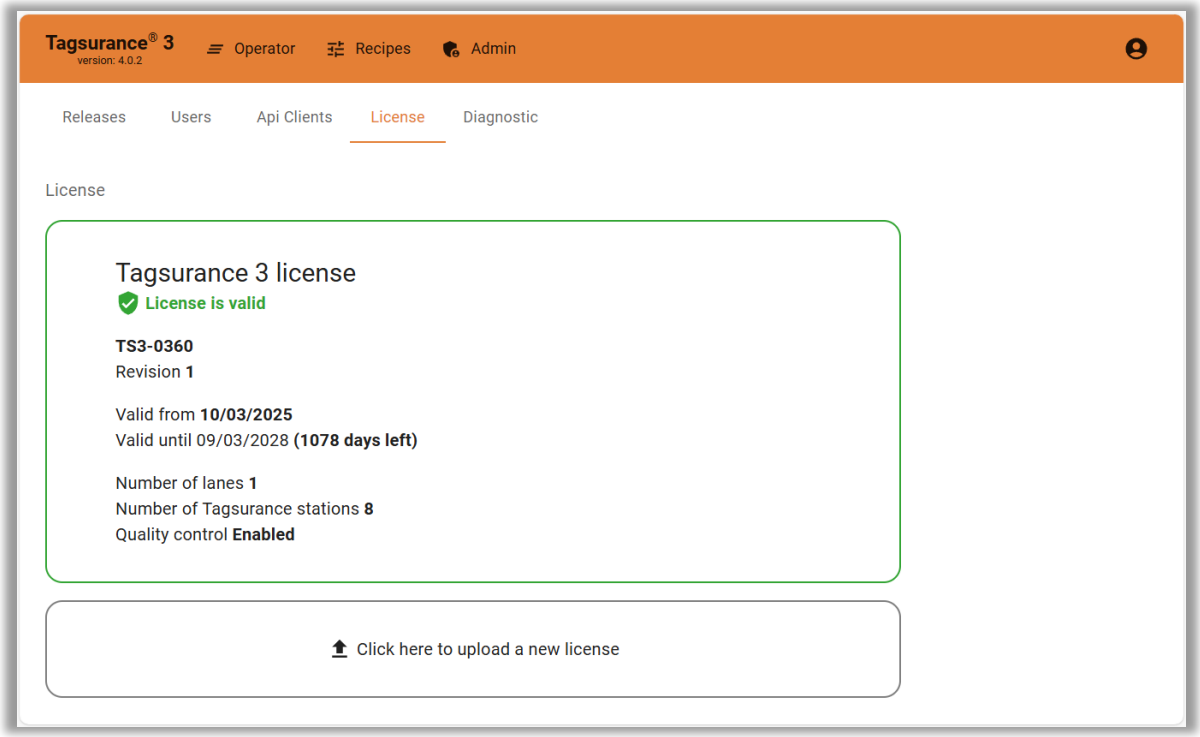
4.1.3 API client credentials

Tagsurance 3 systems of version 4 have system-specific API client credentials. The credentials are available only in admin UI.



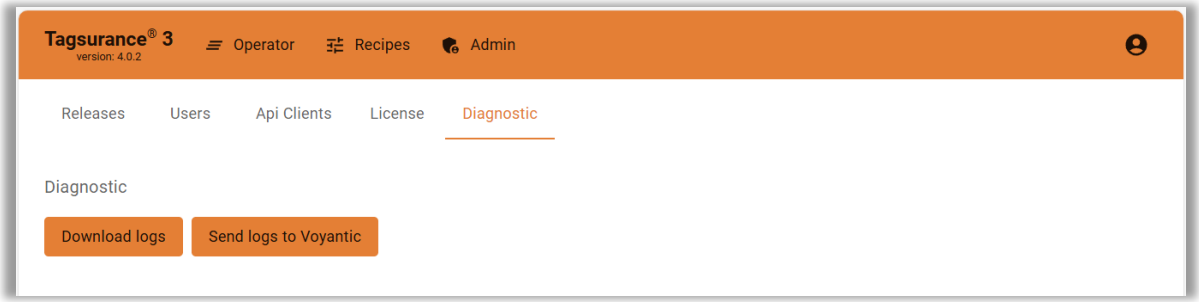
4.1.4 License

Tagsurance 3 system is updating the license information form the Voyantic cloud service automatically when the system is connected to the internet. When the license of an offline system must be updated, the main user can request the license file from Voyantic support, and upload the new license in admin UI.



4.1.5 Diagnostics

Tagsurance 3 system collects diagnostic logs from its components and internal processes. The diagnostic logs do not include any user-sensitive information, such as test results, but only diagnostic logs that help Voyantic support resolve possible issues. From the systems online, the logs can be sent to Voyantic support via Voyantic cloud service by clicking the *Send logs to Voyantic* button, or the logs can be downloaded to an external computer and e-mailed to Voyantic support.

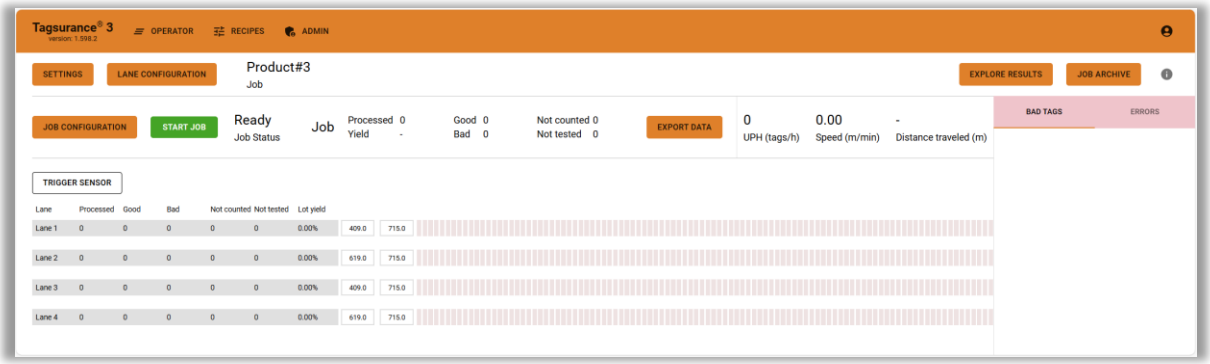


5 Building Lane Configuration

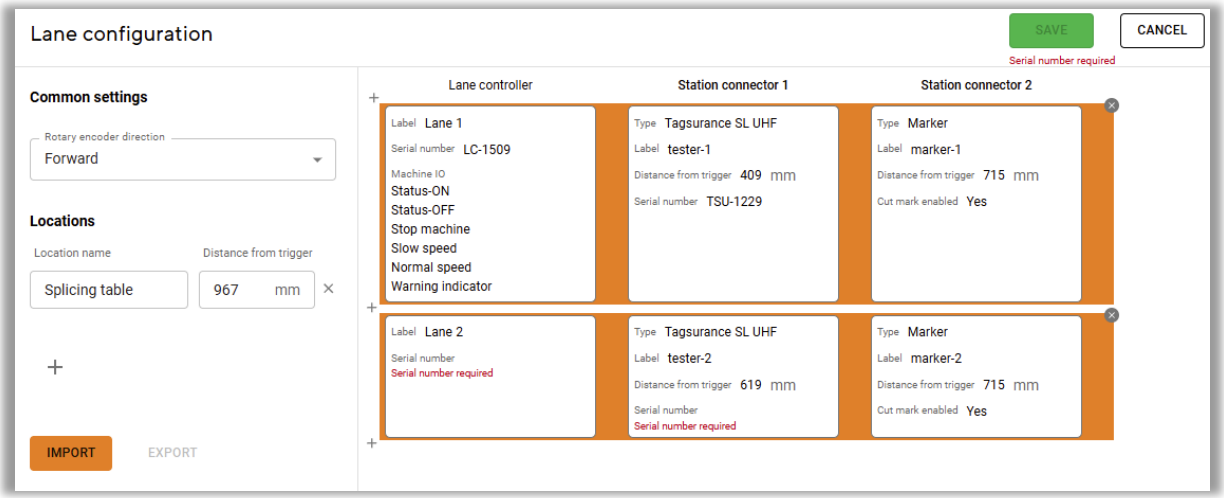
For building a lane configuration, the system needs to know:

- How many lanes are in use
- Lane controllers' serial numbers
- Which stations are connected, and what are their serial numbers
- Distance from the trigger to each station on the lane

To modify or change your lane configuration in the operator UI, click **Lane Configurator**.



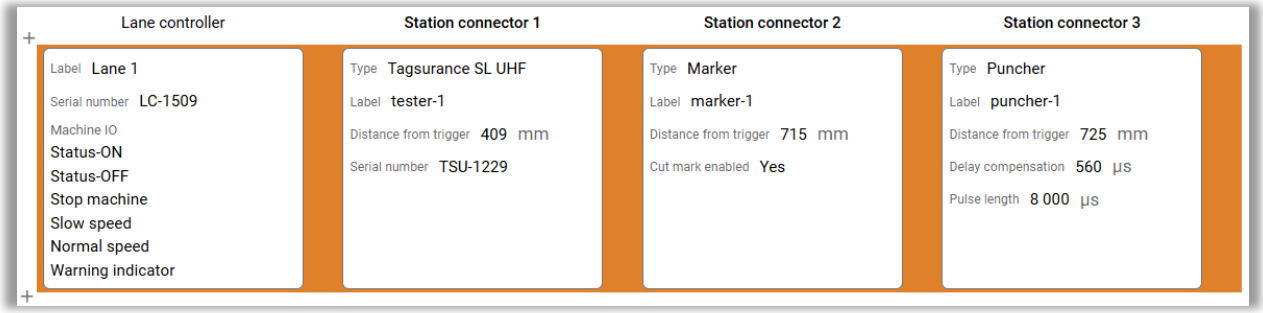
Build a lane configuration to match your machine configuration. Add as many lanes as you have on your machine, and add devices as stations in the same order they are mounted on the machine. One lane is configured horizontally, with the devices next to each other. The column header shows the station connector of the lane controller to which the device must be connected. The lanes are stacked on top of each other.



The common settings and locations for lane controllers in the left column are common to all lanes, that is, lane controllers.

You can add (**+**) a new lane at any position before or after the current lanes or remove lanes (**x**).

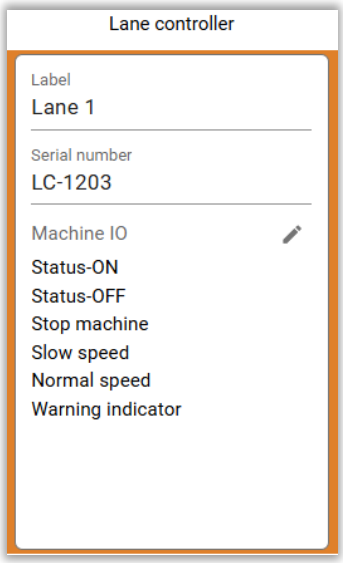
1. Click (**+**) to add a new lane, and the Lane Editor dialog opens.
2. Edit the information according to your needs.

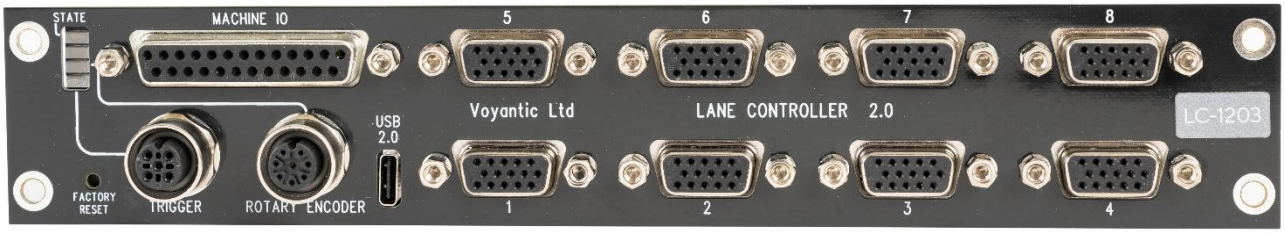


***Note**: When filling in information for your configuration, the UI will highlight a field in red if some mandatory information is missing.*

5.1 Lane controller

In the operator UI, select the lane controller that is in use and insert the correct serial number. The serial number is located on the lane controller's front panel.



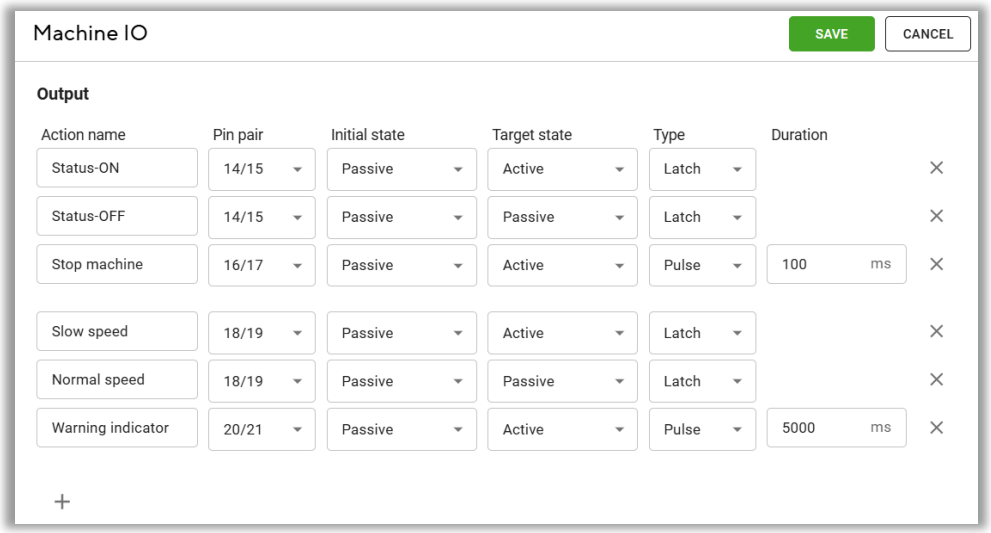


5.1.1 Machine IO

You can define machine IO settings specific to each lane controller and name the actions as you wish.

This view shows what happens when the conditions defined by action triggers are met, and the actions defined here are set to happen. Based on the definitions made, the following actions are triggered in the example below:

- When *Status-ON* action is triggered, the pin pair 14/15 is set to active state.
- When *Status-OFF* action is triggered, the pin pair 14/15 is set to passive state.
- When *Stop machine* action is triggered, the pin pair 16/17 is pulsed to active state for 100 ms.
- When *Slow speed* action is triggered, the pin pair 18/19 is set to active state.
- When *Normal speed* action is triggered, the pin pair 18/19 is set to passive state.
- When *Warning indicator* action is triggered, the pin pair 20/21 is pulsed to active state for 500 ms.



Tip: It may be good to name the actions from the machine's point of view: Where the signal is connected or what the signal state change means.

Each lane controller has its own specific machine IO. It is active during a job only if so specified in a recipe as part of a job. In other words, the actions defined in a machine IO can only be triggered if the lane controller in question is active.

Actions are triggered by using the action name, which consists of 1…64 characters. In multilane systems, where the same action name is used in the machine IO configuration of multiple different lane controllers, all the actions with the same name are triggered.

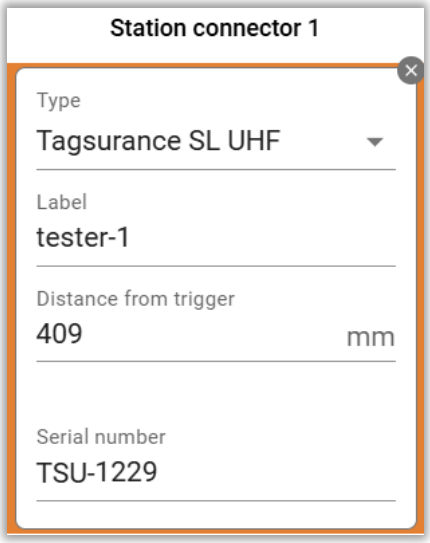
Example: Each lane controller has an action "Stop Machine" defined in the machine IO configuration. The Lot completion action trigger, defined in the job configuration, is supposed to stop the machine by triggering the "Stop Machine" actions. When the lot is completed, "Stop Machine" actions in all lane controllers are triggered simultaneously, and, e.g., a pulsed

signal is transmitted at the machine IO of each lane controller. The exception is the Station event action trigger, which can trigger actions only within the same lane controller.

5.2 Stations

You must set the stations in the same order as they appear on the machine.

1. Select the device type.
2. Set distance from the trigger [mm].
3. Fill in the device type specific configurations.



5.2.1 Distance from trigger

The distance from trigger is calculated from the location where the trigger sensor detects a tag to the location where a station operates, e.g. the location where Tagsurance SL UHF tests the tag.

When the recipe contains the tag product dimensions and has defined shielding plates for stations, the distance from trigger is measured to the center of the station location, e.g., the center line of the Snoop Pro coupling element. Section 6.2.2 describes how to add the product dimensions in the recipe, and how Tagsurance 3 uses the information.

Tip: Use the rotary encoder to measure the distance from the trigger. Move the lane to the position where the trigger sensor has just detected a new tag. Start a job in the Tagsurance 3 system and run the lane forward until the tag is at the desired station location. The travelled distance is shown in the operator UI.

The minimum required distances from trigger and between stations ensure the correct operation of all system features. See the requirements in Section *9.4 Station locations*.

5.2.1.1 External IO trigger setup

The exception to the requirements is the 0 mm distance from trigger value that sets the system to trigger the station instantly after the lane controller receives a trigger signal. The use case for this feature is in stop-and-go machines. The machine stops the lane when a tag is at the testing location and triggers the Tagsurance 3 system. From this point on, Tagsurance 3 system triggers the station, indicates to the machine when the test is done and the lane can move again, and is responsible for the bad tag marking. The distance from trigger of a marker is now measured from the testing station, that is, the location where Tagsurance 3 system receives the trigger signal. The rotary encoder's existence is mandatory for tag movement detection in case Tagsurance 3 is responsible for bad tag marking.

The external IO trigger setup supports only lane configuration, which contains one lane and one feedback station. Marker and puncher can follow the feedback station. Feedback signals for the machine are available in the machine IO connector's output pins which are configured by action triggers; see the section *7.2.7 Action trigger*.

5.2.2 Tagsurance SL UHF

Enter the serial number as written on the device's front panel. It looks like this: TSU-1234. The number always starts with "TSU—" and ends with four digits. Note that the letters are in upper case.

Set the distance from the trigger to the position on the coupling element (with the shielding plate of your choice) where the test should start when the tag passes the coupling element. Note that some 2–5 mm of clearance between the shielding plate leading edge and tag trailing edge should be left to ensure stable measurement.

5.2.3 Tagsurance HF

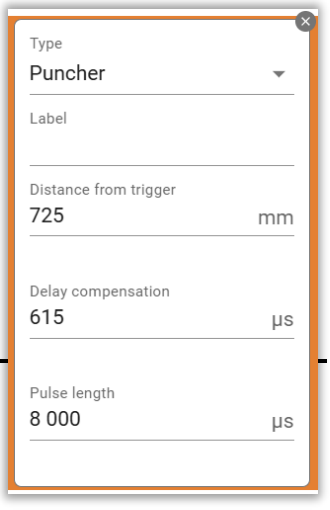
Enter the serial number as written on the device's back panel. It looks like this: TS-HF-1234, always starting with "TS-HF-" and ending with four digits. Note that the letters are in upper case.

Set the distance from the trigger to the point over the coupling element (with the shielding plate of your choice) where the test should start when the tag passes the coupling element. Note that usually some 2–5 mm of air between the shielding plate leading edge and tag trailing edge should be left to ensure stable enough measurement.

5.2.4 Puncher

For the puncher, you can set the following in the lane configuration:

- *Distance from trigger:* This parameter defines the distance from the trigger point where the puncher should activate.
- *Type:* You can define the trigger pulse length in two ways:
    - *Time-based Pulse Length:* If the pulse length type is set to time, then the corresponding Pulse length parameter should be defined in microseconds.



- *Distance-based Pulse Length:* If the pulse length type is set to distance, then the Pulse length parameter should be defined in millimeters.

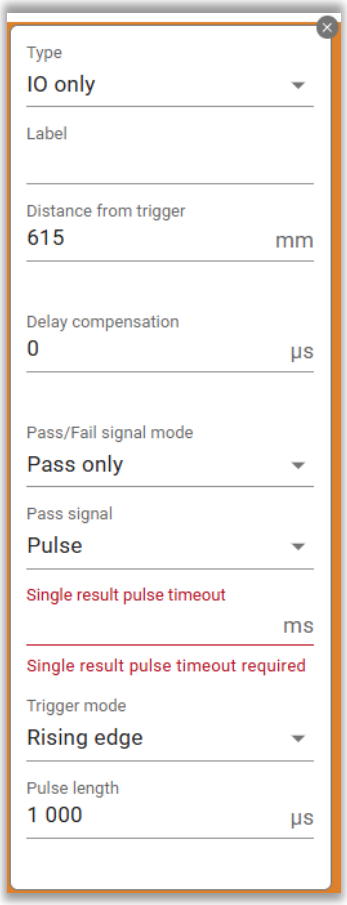
- *Delay compensation:* Due to its inherent inertia, delay compensation may be necessary to advance the triggering of the moment puncher (in time). This ensures that the puncher will activate at the correct moment, compensating for any system delays.

5.2.5 Marker

You only need to set the distance from the trigger in the system configuration for the marker.

5.2.6 IO-only device

For the IO-only device, you need to define the distance from the trigger where you want the device to be triggered. You can configure IO signal settings, such as the trigger pulse length, delay compensation, and trigger mode.



Pass/Fail signal mode must be configured to match how the connected IO-only station communicates the results. The options are *'Pass and fail'*, *'Pass only'*, *'Fail only'*, and *'Dual fail'*. When the Pass/Fail signal mode is configured to be *'Pass and fail'*, both pass and fail results, must be communicated at the IO interface. See the signal requirements in the section *3.4.5.1 Connecting an IO-only device*.

Choosing *'Pass only'* or *'Fail only'* forces the IO-only station to reply with either a pass or a fail signal. When choosing one of these options in Pass/Fail signal mode, the *Single result pulse timeout* must also be defined, specifying how long to wait for the pass or fail pulse before the result status is set. The deadline for the result pulse is the time out defined here or the next trigger for the station, whichever comes first. See more details about the signal requirements in the section *3.4.5.1*.

'Dual fail' allows you to distinguish between failure reasons. The Tagsurance 3 UI supports two reasons: '*Generic failure'* and *'Missing label'*. In this mode, there are two fail signal inputs, and the signaling rules are a combination of other modes. See more details about the signal requirements in the section *3.4.5.1*.

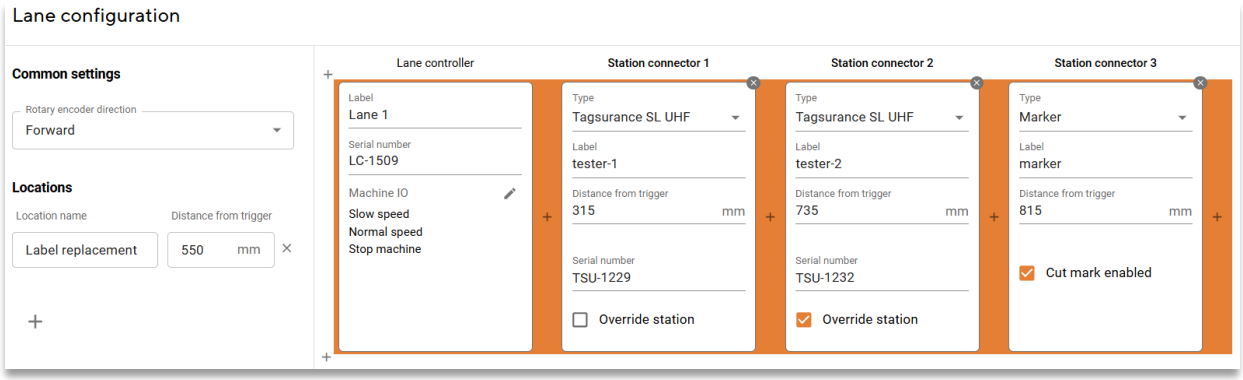
5.2.6.1 Failure reasons in the IO-only station's dual fail mode

The IO-only station will indicate only failures and can differentiate among them; e.g., one signal indicates missing labels, and another indicates other failure modes. The marker and puncher can be configured to skip marking tags that fail for a specific reason. For example, the missing labels do not need to be marked. The behavior of markers and punchers is defined in the recipe. In the action trigger configurations, the failure reason can be set to critical, triggering the action for this type of failure. For example, the *Lot failure limit* and *Consecutive failures* action triggers will occur immediately without waiting for the conditions to be met, and 'Missing label' tags can always be stopped at the replacement location.

5.3 Label replacement

In the RFID tag production process, where faulty tags are replaced with new ones, the Tagsurance 3 system can reprocess tags after the label replacement and provide results based solely on the process steps following the label replacement. This enables collecting results that match the production process output, e.g., collected TID codes and lot yield match the output tag roll.

This can be configured in the lane configuration by designating a station as an *override station*. The override station is meant to be the next station after the label replacement. All previous station results, whether they pass or fail, are ignored, and only the results from subsequent stations, including the override station, are considered.



In this example, both Tagsurance SL UHF testers could perform the same performance tests and data collection for the tags, and only the results from the last tester will affect the final tag results. Since the tag's pass/fail result is reset at the override station, the marker will only mark the tags that fail at the second tester.

All station results are stored, even if results before the override station do not impact the final tag results. When the lot management is enabled, the lot result export includes only results that affect the final tag results. This way, the lot results contain only relevant data. However, the job results contain all station results, including those that do not affect the final tag result, allowing result post-processing.

Tagsurance 3 can also control the machine to stop for label replacement. The stop signal configuration is described in Section *7.2.7.1 Stop the machine for label replacement*.

6 Building a Recipe

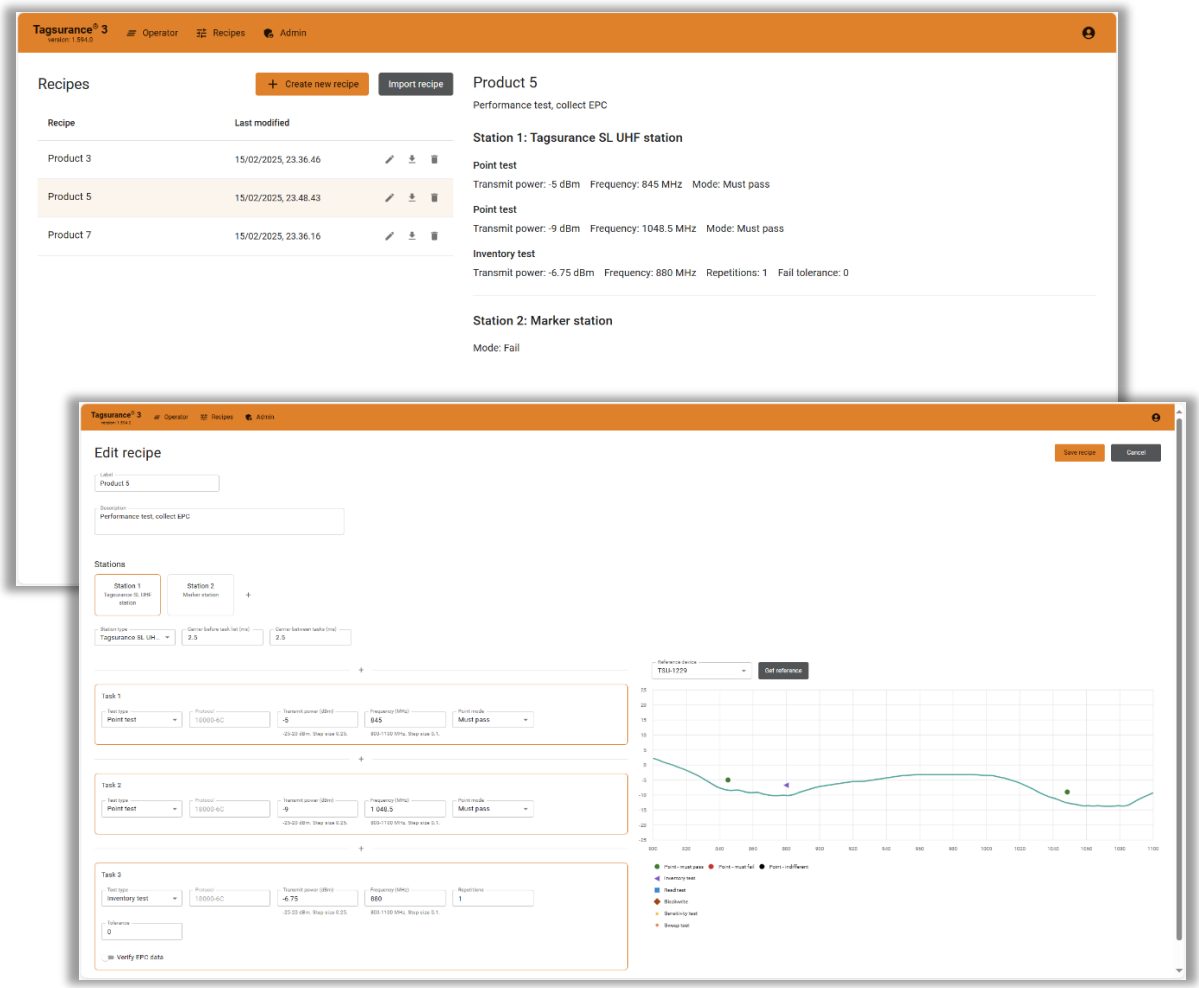
The recipe is a configuration that defines the device types to be used and the actions to be taken for RFID tags within the process. Recipes are stored locally in the Tagsurance 3 recipe service, which has a built-in Recipe builder for creating and editing recipes.

6.1 Recipe service overview

All the stored recipes are listed in the Recipe service, which is available on the Tagsurance 3 UI header: *Recipes*. Recipes can be created, edited, imported, and exported. When recipes are created or edited, the Recipe Builder view opens. A recipe is always designed for a single lane and describes what Tagsurance 3 will do for a tag on a lane.

When recipes are imported, a new recipe is always added to the list. The recipe label is not an identifier, but multiple recipes can have the same name, for example, when importing the same recipe multiple times. Multilane recipes created for the old Tagsurance 3 version can be imported. When a multilane recipe is imported, a new recipe is added based on each unique lane. Lane-specific multilane recipes are split and imported as multiple recipes.

The recipe details can easily be previewed by selecting a recipe from the list.



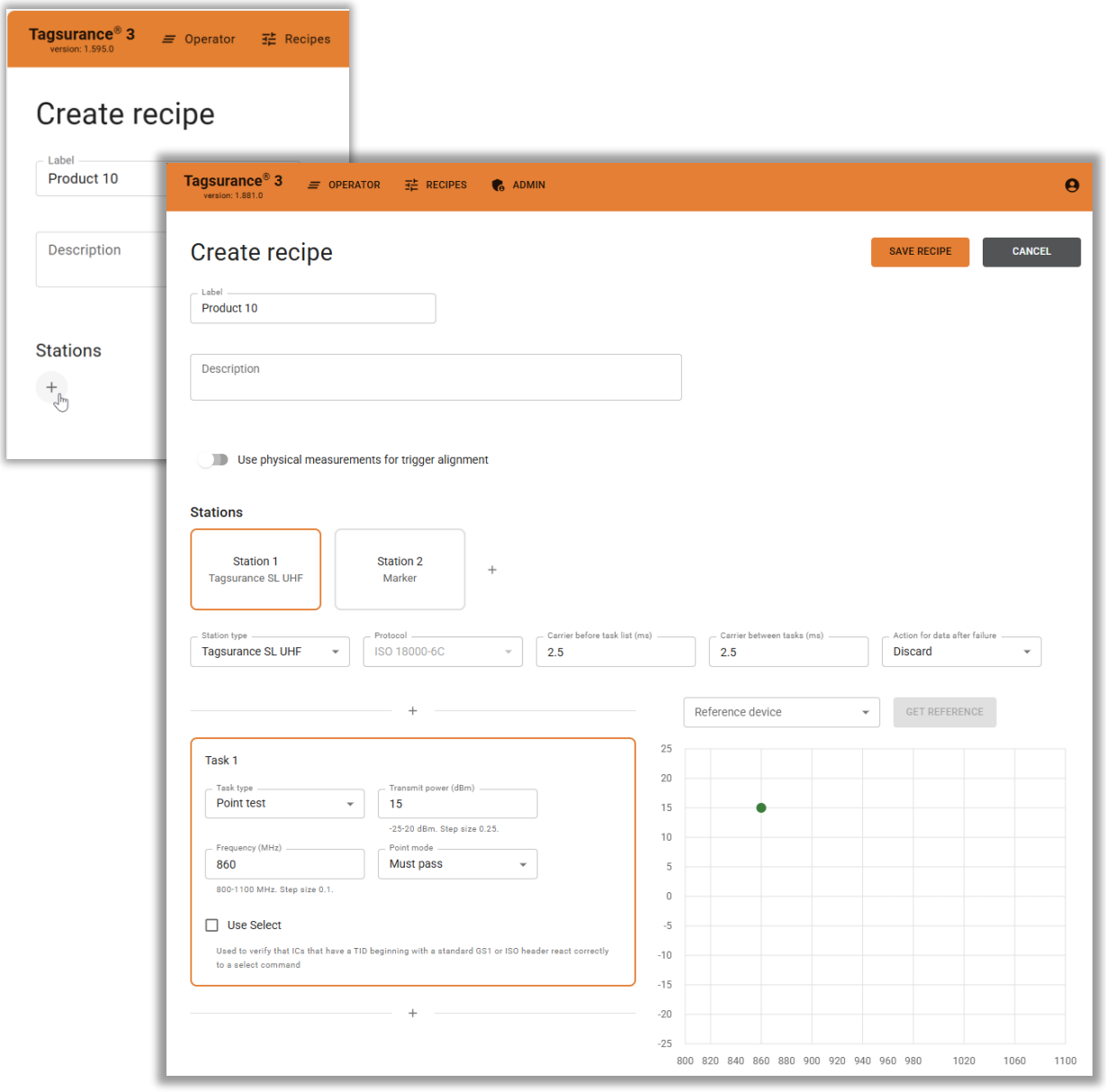
6.2 Create a new recipe

The recipe label allows the user to differentiate the recipes on the recipe list. The label doesn't identify the recipe, and duplicate labels may exist. However, recipes have a unique ID hidden from the user. In addition to the label, there is a description field for more detailed information. The description is also shown in the recipe preview view.

6.2.1 Add stations

In Recipe Builder, a physical device is defined as a station. Stations can be added (+) and deleted (x), and the order can be switched. The station type is the first parameter of the station, and the station type specific configuration is shown based on the selected station type.

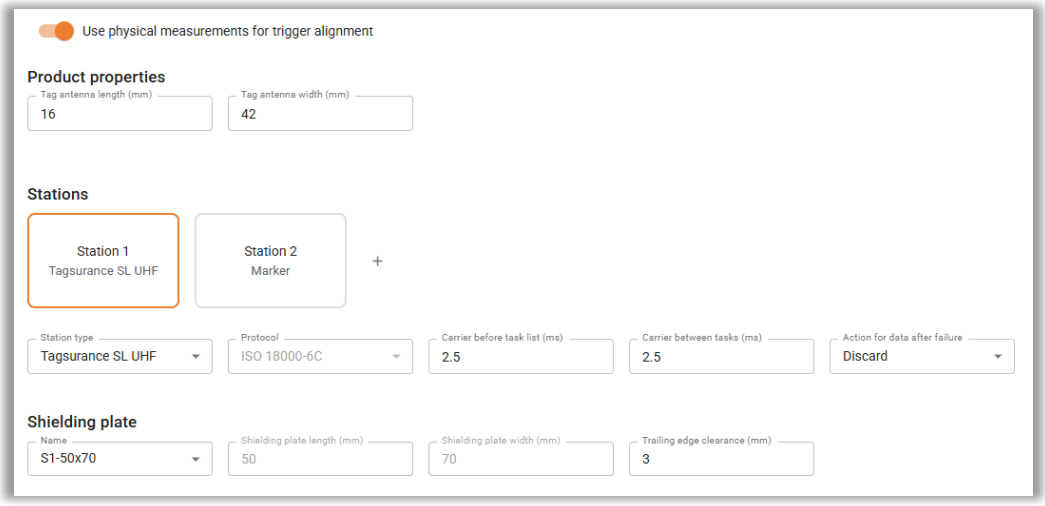
Recipe Builder validates the station configuration and allows users to save only technically valid recipes. Incorrect values are highlighted, and the user is guided to select a valid value.

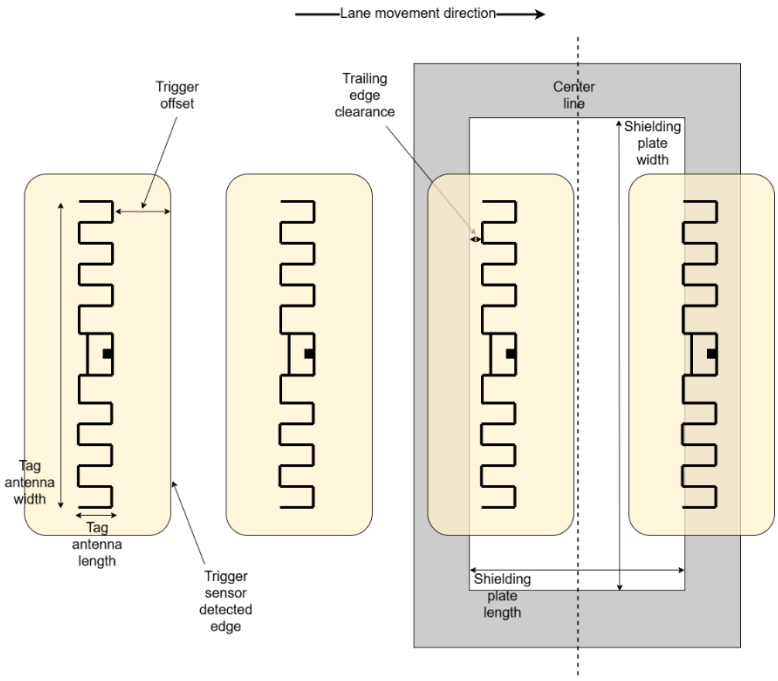


6.2.2 Define the tag product dimensions and shielding plate size

When the tag product dimensions and the shielding plate sizes are defined in a recipe, Tagsurance 3 system adjusts the triggering position of the stations accordingly, and the lane configuration can remain the same regardless of the tag or shielding plate size. This simplifies the configuration after changing the product in the production machine.

The shielding plate size is station-specific and supported in Tagsurance SL UHF, Tagsurance HF, and IO-only stations. Marker and puncher are triggered without recipe-based triggering position adjustment, and only the trigger offset in the job configuration's trigger settings adjusts the triggering position. In the case of the example drawing below, this means that a marker and puncher are triggered when the tag antenna's leading edge is at the station's location defined in the lane configuration.





Steps to isolate the lane configuration from product dimensions:

1. Lane Configuration:
   Measure the distance from the trigger sensor to the center of the station, e.g., the center line of Snoop Pro coupling element.
2. Recipe:
   Define the physical product measurements in the recipe.
3. Job Configuration:
   Define the offset between the detection point of a label or inlay and the leading edge of the RFID tag antenna. For example, the offset between the label's leading edge and the tag antenna's leading edge.

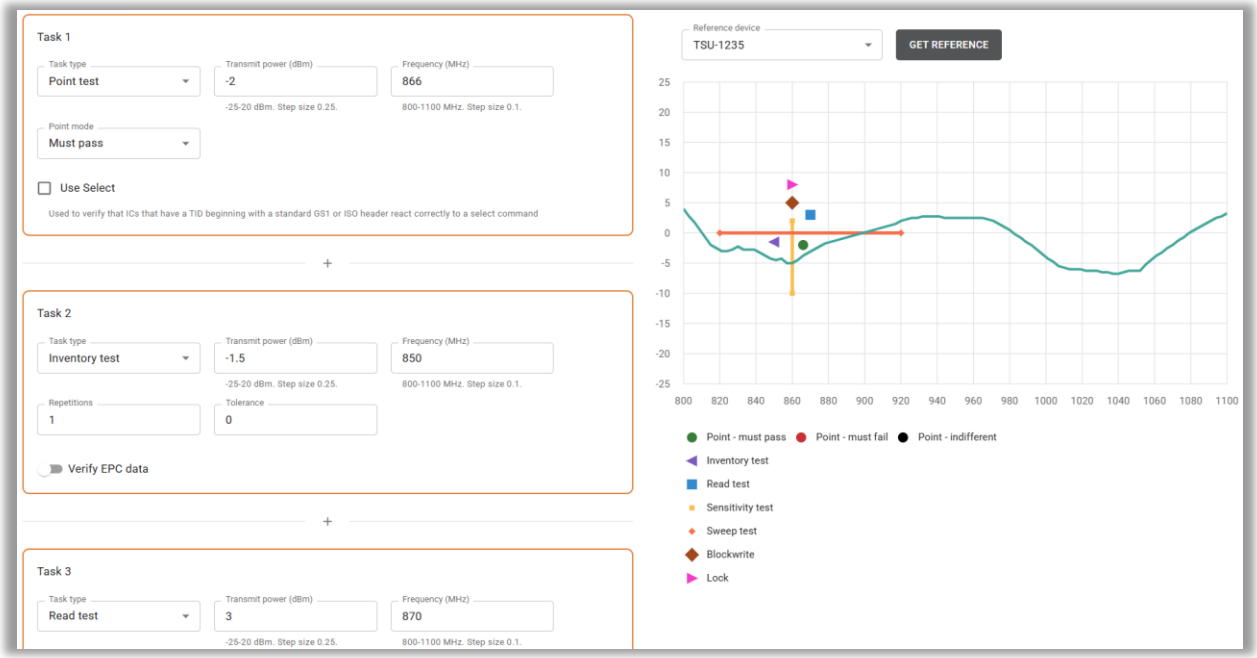
6.2.3 Define task list for Tagsurance SL UHF

Tagsurance SL UHF performs active tests for UHF RFID tags. Each test is a task on the task list that will be executed for each tag in the order specified by the task list. The primary result for a test is a pass/fail grade, and test-specific information may be included. The test-specific information could be, for example, a sensitivity level or read memory content.

The *Carrier before task list (ms)* and the *Carrier between tasks (ms)* are the control values for the carrier before command time, that is the time the tester transmits RF power before it starts modulating the command, i.e., the duration of how long the RFID tag has time to get energized before the tester starts sending the first command. Both values define the carrier before command time, but for different tasks on the task list. The *Carrier before task list (ms)* is for the first task on the list, and the *Carrier between tasks (ms)* is for all other tasks and iterations inside the task, e.g., Sweep test, and Sensitivity test. When the Sweep or Sensitivity test is the first task on the task list, the Carrier before task list (ms) will only be applied to the first iteration of the command transmission.

The default carrier before command value for Tagsurance SL UHF is 2.5 ms. However, some RFID chip models are fully functional after 1.5 ms. The carrier before command time equals T_{cp} in GS1 EPC Gen2v3 standard, which specifies a minimum value of 2.5 ms.

A reference sweep can be measured to help position the test correctly on the frequency and power axes. Any Tagsurance SL UHF device in the lane configuration can be utilized in the reference sweep measurement. In the reference sweep measurement, the *Carrier between tasks (ms)* is applied for each iteration as a carrier before command value. The user must ensure the tag is correctly positioned on the Snoop Pro coupling element.



Task type	Task description	Task parameters
Point test	A single Query command is transmitted and detected whether a tag replies or not. Before the Query command is transmitted, an optional Select command can be issued.	*Frequency (MHz)* *Transmit power (dBm)* *Point mode*: - Must pass – the test is pass only if a tag replies - Must fail – the test is pass only if a tag do not reply - Indifferent – the test is always pass Select (enabled/disabled), optional: Used to verify that ICs that have a TID beginning with a standard GS1 or ISO header respond correctly to a Select command. Specifically, when set to true, tags with bit pattern $0_b111000$ stored in TID memory address 0 are instructed to set their S0 inventoried flag to B. Query used in the Point test will subsequently target tags that have followed the instruction.
Inventory test	Perform a command sequence used for tag inventory. It detects whether a tag is inventoried or not. In successful inventory, the tag provides its EPC data which is stored as a part of the Inventory test result.	*Frequency (MHz)* *Transmit power (dBm)* *Repetitions* – Maximum number of test repetitions *Tolerance* – Maximum number of failed test repetitions allowed *Verify EPC data* – The EPC can be verified with a fixed data mask. *Mask* defines the read data to be verified on the bit level, and *Values* are the expected data.

Read test	A memory bank read is performed, and whether the read is successful is detected. The read data is included in the test result. The tag is inventoried before the read. The EPC data is received during the Inventory sequence and included in the Read test result.	*Frequency (MHz)* *Transmit power (dBm)* *Memory bank* – Reserved, EPC, TID or User *Word pointer* – the address of the first word to be read *Word count* – the number of words to be read *Repetitions* – Maximum number of test repetitions *Tolerance* – Maximum number of failed test repetitions allowed. *Verify read data* – The read data can be verified with a data mask. *Mask* defines the read data to be verified on the bit level, and *Values* are the expected data. The data can be either *Static* or dynamic, read from *CSV* data source separately for each tag. The data can also be a combination of static and dynamic.
Sensitivity test	Threshold power, the minimum transmit power to make a tag reply at a single frequency, is searched and detected if it is within control limits.	*Frequency (MHz)* *Power range low (dBm)* – Lowest test power *Power range high (dBm)* – Highest test power *Power range resolution (dB)* – The minimum difference in sensitivity level that can be detected. [1)] *Criteria low limit (dBm)* – Lowest accepted threshold power *Criteria high limit (dBm)* – Highest accepted threshold power
Sweep test	Threshold power across a frequency range is searched	*Frequency range low (MHz)* – Start frequency of the sweep *Frequency range high (MHz)* – Stop frequency of the sweep *Frequency range step (MHz)* – Frequency step size in the sweep
Blockwrite	Data is written to tag memory by BlockWrite command(s). The data is automatically split into multiple BlockWrite commands by the Tagsurance 3 system. The tag is inventoried before the first BlockWrite command and the BlockWrite commands are transmitted sequentially without carrier down between the commands. A single BlockWrite command writes one word of data to tag memory.	*Frequency (MHz)* *Transmit power (dBm)* *Response timeout (µs)* *Memory bank* – Reserved, EPC, TID or User *Word pointer* – the address of the first word to be read *Write data* – The data can be either *Static*, the same for each tag, or dynamic, read from *CSV* data source separately for each tag. The data can also be a combination of static and dynamic.
Lock	Lock the tag memories as defined in properties. The tag is inventoried before the Lock command.	*Frequency (MHz)* *Transmit power (dBm)* *Response timeout (µs)* *Lockable items* – defines an action for each lockable target: LOCK PERMANENTLY or NO ACTION

1) The sensitivity test searches the threshold level by binary tree algorithm. The actual threshold level is within $\text{Sensitivity}_{\text{result}} \pm \frac{\text{resolution}}{2}$. The power range and resolution define the number of iterations is $N_{\text{iterations}} = \text{ceil}\left(\log_2\left(\frac{P_{\text{high}} - P_{\text{low}}}{\text{resolution}}\right)\right)$The sensitivity result can be more precise than the resolution; for example, it can be 2.25 dBm even if the resolution is 1 dB.

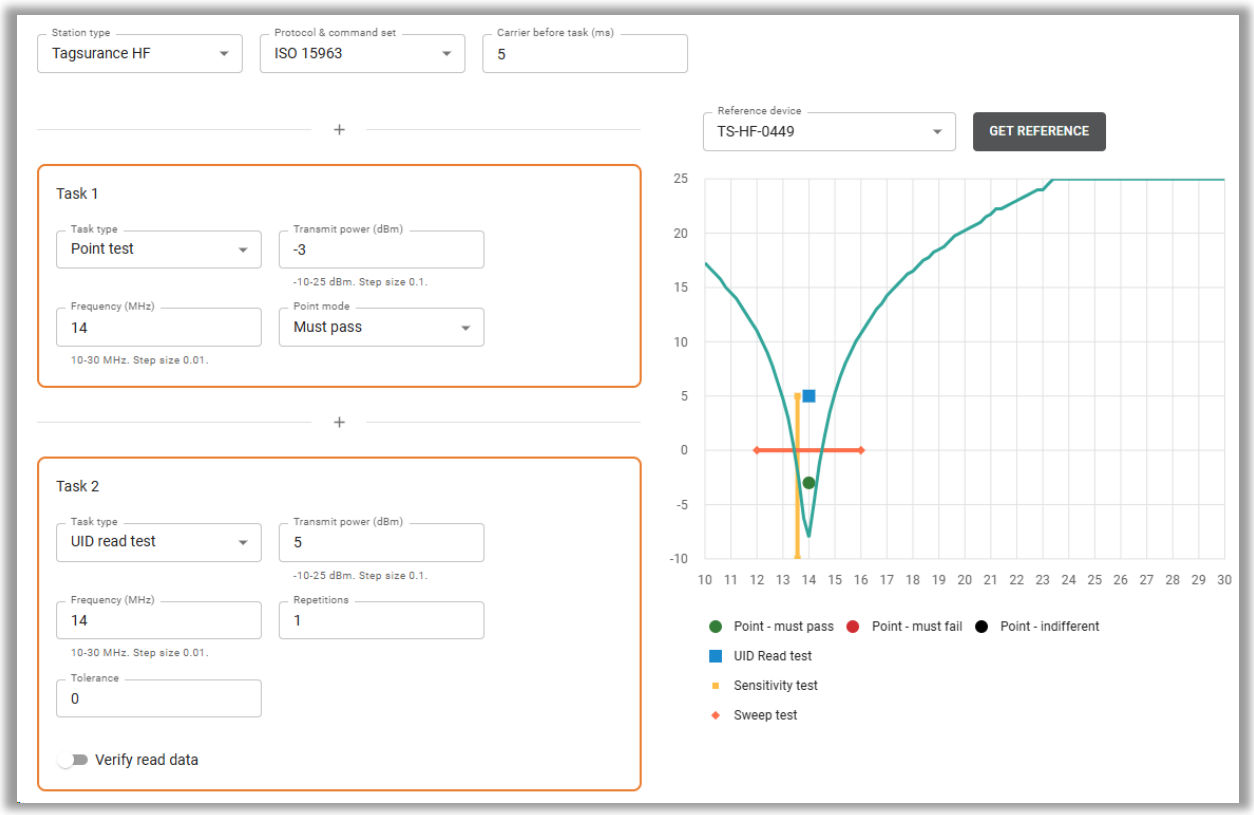
6.2.4 Define task list for Tagsurance HF

Tagsurance HF performs active tests for HF RFID tags. Each test is a task on the task list that will be performed for each tag. The primary result for a test is a grade of pass/fail, and test-specific information may be included. For example, the test-specific information could be a sensitivity level or read UID.

The selected protocol and timing settings are applied to all tasks on the task list. The supported test types depend on the selected protocol.

The *Carrier before task (ms)* is the time how long the tester transmits RF power before it starts to modulate the command, i.e., the duration how long the RFID tag has time to get energized before the tester starts sending the first command. The default value for Tagsurance HF is 5 ms

A reference sweep can be measured to help position the test correctly on the frequency and power axes. The reference sweep measurement can use any Tagsurance HF device in the lane configuration. The user must ensure the tag is correctly positioned on the Snoop Pro HF coupling element.

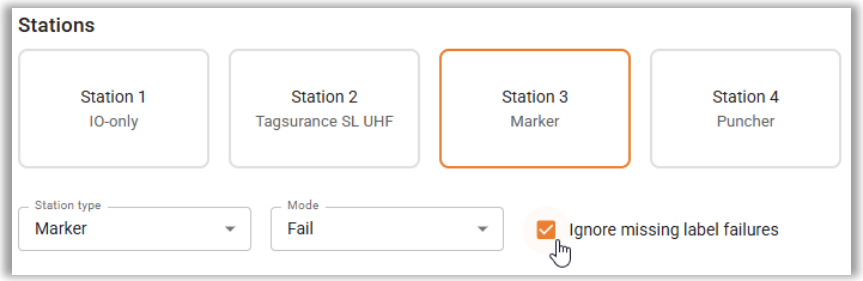


Task type	Task description	Task parameters
Point test	A single command is transmitted, and it is detected whether a tag replies or not.	*Frequency (MHz)* *Transmit power (dBm)* *Point mode*: - Must pass – the test is pass only if a tag replies - Must fail – the test is pass only if a tag do not reply - Indifferent – the test is always pass
UID read test	UID memory read is performed and it is detected if read is successful or not. The UID is included in the test result	*Frequency (MHz)* *Transmit power (dBm)* *Repetitions* – Maximum number of test repetitions *Tolerance* – Maximum number of failed test repetitions allowed *Verify read data* – The read UID can be verified with a data mask. *Mask* defines the read data to be verified on the bit level, and *Values* are the expected data. The available options for the byte count or word count are appropriate for the selected protocol.
Sensitivity test	Threshold power, the minimum transmit power to make a tag reply at a single frequency, is searched and detected if it is within the criteria.	*Frequency (MHz)* *Power range low (dBm)* – Lowest test power *Power range high (dBm)* – Highest test power *Power range resolution (dB)* – The minimum difference in sensitivity level that can be detected. [1)] *Criteria low limit (dBm)* – Lowest accepted threshold power *Criteria high limit (dBm)* – Highest accepted threshold power
Sweep test	Threshold power across a frequency range is searched	*Frequency range low (MHz)* – Start frequency of the sweep *Frequency range high (MHz)* – Stop frequency of the sweep *Frequency range step (MHz)* – Frequency step size in the sweep

1) The sensitivity test searches the threshold level by binary tree algorithm. The actual threshold level is within $\text{Sensitivity}_{\text{result}} \pm \frac{\text{resolution}}{2}$. The power range and resolution define the number of iterations is $\text{N}_{\text{iterations}} = \text{ceil}\left(\log_2\left(\frac{\text{P}_{\text{high}} - \text{P}_{\text{low}}}{\text{resolution}}\right)\right)$. The sensitivity result can be more precise than the resolution, e.g. the result can be 2.25 dBm even if the resolution is 1 dB.

6.2.5 Conditional rules for marker and puncher

Marker and puncher stations are designed for bad tag marking and are triggered only for tags that have failed at any previous station. However, the recipe defines whether the marker and puncher are triggered for all tags, only passed tags, or only failed tags, and whether certain failures are skipped. Tagsurance 3 UI supports skipping the IO-only station's missing label failures. See more about the failure reasons that can be ignored in the Sections 5.2.6.1 and 3.4.5.1.



6.3 Example cases of recipe building

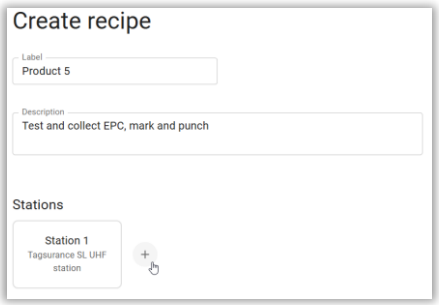
6.3.1 Performance test

The following example shows how to build a recipe for the tag manufacturing process where

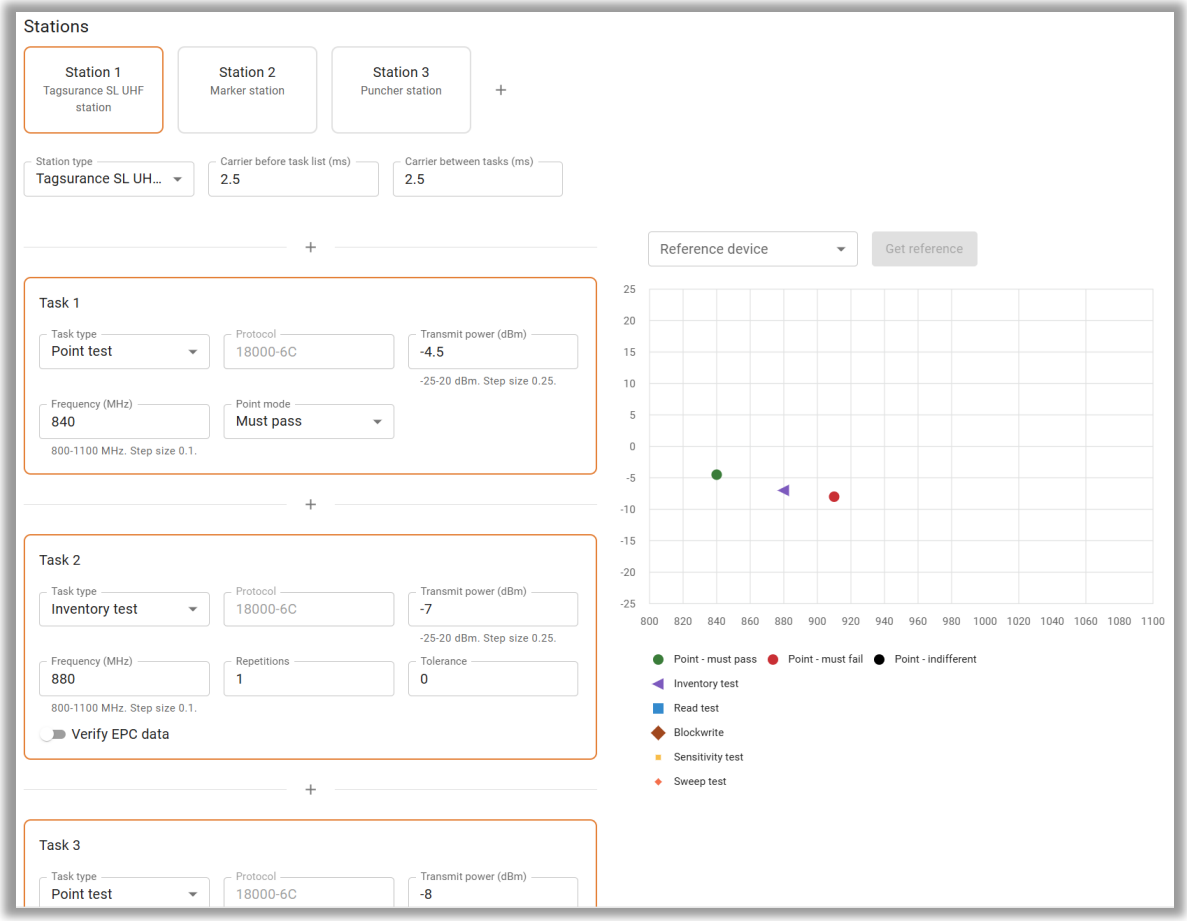
1. Tags are tested to make sure the quality is at an expected level.
2. Tags that failed the quality requirements are visually marked.
3. The chip of failed tags is punched and mechanically destroyed to prevent them from working at all.

The simplest performance test verifies if a tag responds with the known reader transmit power. The end application may require the tags to work consistently, so they are not overly sensitive.

In Tagsurance 3 Recipe Builder, you can start by labeling the recipe, writing a description, and choosing the station device types.

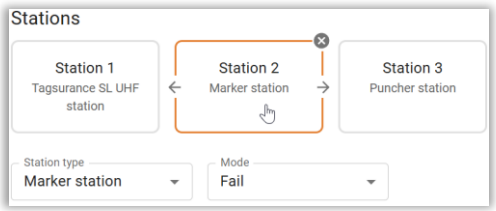


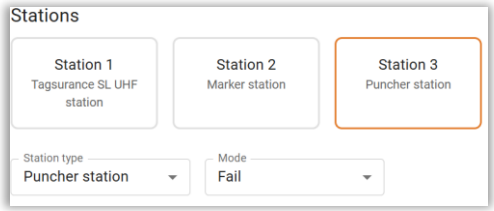
In the Tagsurance SL UHF station, you can measure a reference sweep for the tags tested. First, move a tag on the Snoop Pro coupling element to the position where the tags will be when the test execution starts. Then, select the *Reference device* on the list and press *Get reference*.



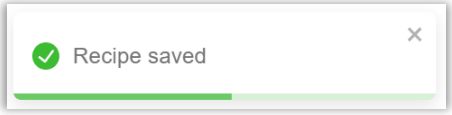
The reference curve shows the minimum transmit power level as a function of the frequency the tag requires to communicate. The tests are set so that tags with too high or too low sensitivity or tags with shifted frequency tuning (the curve will shift sideways) will fail. The Inventory test works as a performance test point and collects EPC data from the tags for production quality control documentation purposes.

The marker and the puncher are configured to mark and punch only the failed tags.





Now, all stations are configured, and the recipe can be saved. Recipe Builder saves the recipe locally to the Tagsurance 3 server, where it is available for the job configuration.



6.3.2 Encoding

The following example shows how to build a recipe for the tag personalization process where

1. EPC data is written to tags, the written data is verified by reading, and the tag is permanently locked.
2. Tags that failed the quality requirements are visually marked.
3. The chip of failed tags is punched and mechanically destroyed to prevent them from working at all.

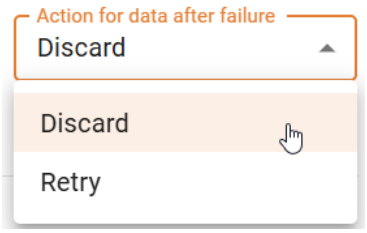
Tagsurance 3 uses Tagsurance SL UHF station for the encoding. Building an encoding recipe is not different from building a performance test recipe, but other tasks are selected for encoding purposes in the Tagsurance SL UHF task list. The task list can be a combination of any available tasks. Tasks are performed in the order of the list, so the user must pay attention to the task order: don't lock before writing. For EPC encoding, data verification, and locking the tag, the task list consists of Blockwrite, Read, and Lock tasks.

In this example, the EPC data consists of 2 static words and 4 dynamic words. The static data is the same for each tag, while the dynamic data is read from the CSV data source separately for each tag. The combination demonstrates both options and the possibility to combine the options. The same data definition model applies for both, encoding and verification.

For the dynamic data, the source data is not specified in the recipe, but the source data selection is done later in the job configuration. See the section *7.2.3 Source data selection*. The recipe is made for an RFID tag, and the source data is selected for a tag production job.

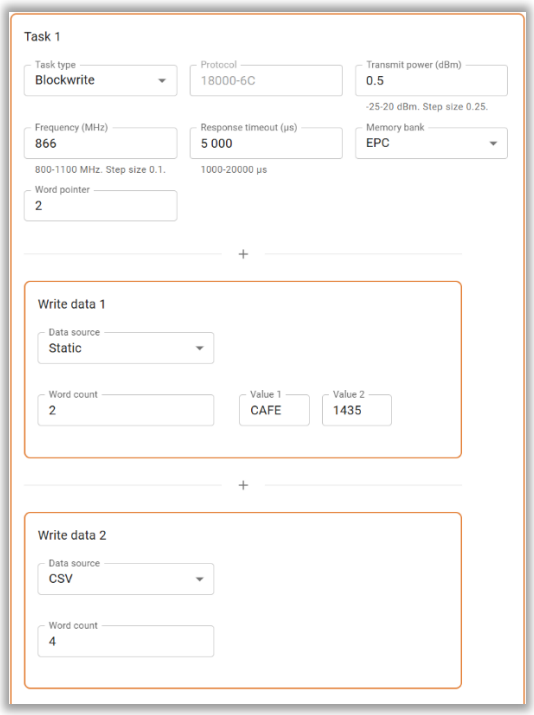
When the dynamic data, CSV data source, is defined in the task list, the user can choose how to handle the data when the task list execution fails for a tag. The task list execution fails if any of the tasks fails. The data can be either discarded or re-used for the next tag.

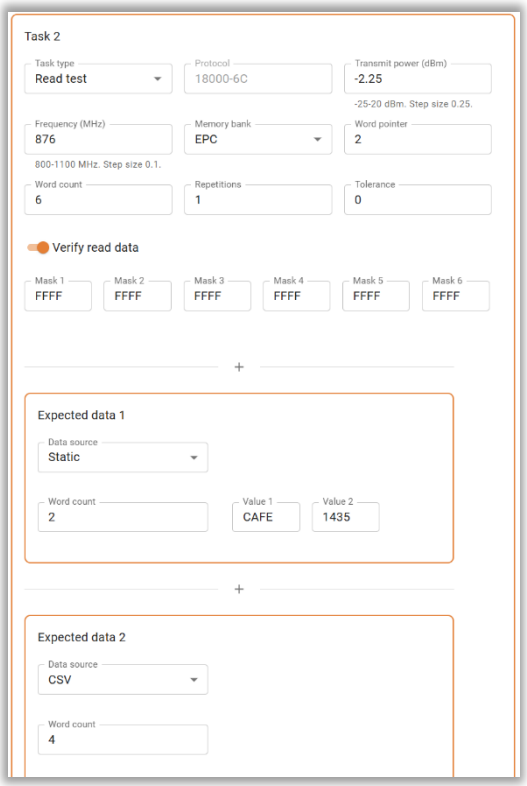
- Action for data after failure
  - *Discard*: When a tag fails in the process, the data is rejected and lost.
  - *Retry*: When a tag fails, the same data is re-assigned to the next tag. Reassignment will occur until tags stop failing and it's time to fetch new data from the buffer. The *Retry* is supported only in the single lane setup with one Tagsurance SL UHF. Additional feedback stations, i.e., Tagsurance SL UHF or IO-only stations, are not allowed. Marker and puncher may exist.



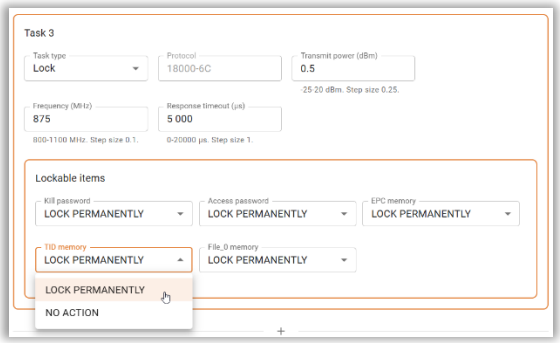
The data verification has a bit-level data mask, which is defined as HEX characters. The verification data mask defines the bits of the read data that must match the expected data for successful data verification. The amount of expected data must match the length of the data mask.

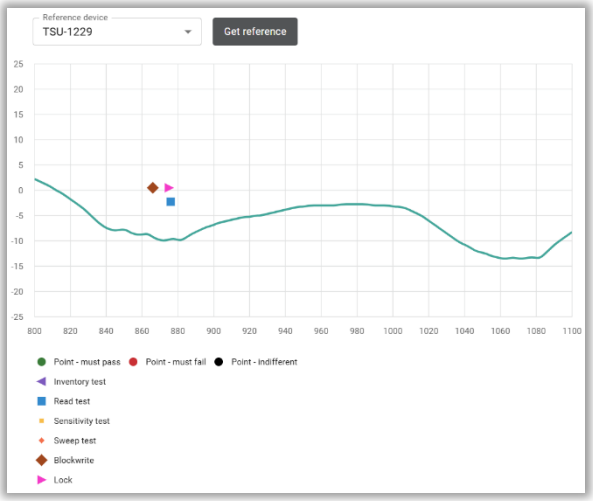
- Complete match is expected: $FFFF_h$ = $1111\ 1111\ 1111\ 1111_2$
- Data is irrelevant to the verification: 0000_h = $0000\ 0000\ 0000\ 0000_2$
- Only the MSB bit of the data word must match: 8000_h = $1000\ 0000\ 0000\ 0000_2$
- Only the LSB bit of the data word must match: 0001_h = $0000\ 0000\ 0000\ 0001_2$





The *Response timeout* is parametric for the Blockwrite and Lock tasks. The timeout defines how long Tagsurance SL UHF waits for the tag response to begin after the command is transmitted.





7 Running a Job

Prerequisites:

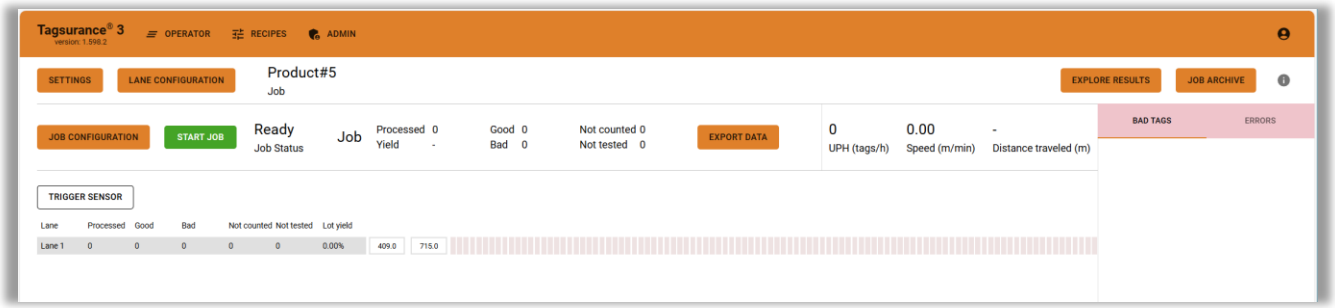
- system installation has been done, and all cables are correctly connected
- a suitable lane configuration has been uploaded to the system
- a suitable recipe has been created with *Recipe Builder*

In the operator UI, **Select Recipe** under **Job Configuration** and then **Start Job**. The job will run until you click **Stop Job**.

If there is any error when starting the job, it is indicated on the error list on the right side of the operator UI.

After a job is completed, you can click **Export Data** to download the results and the used job data (recipe and other settings).

The maximum job size is 100 million results.



7.1 Updating a lane configuration

When you open Lane Configurator in the operator UI, it will show you the current lane configuration stored in Tagsurance Controller.

You can modify or replace the existing lane configuration by importing another configuration from a JSON file. You may have formerly exported the JSON file from the operator UI to your default downloads location or created it using the older version of Lane Configurator.

Note: To save your changes in Tagsurance Controller, click **Save**.

The system will store the lane configuration until a new one is loaded. There is no need to load/update lane configuration after system restart, but rather only after mechanical changes in the system setup, such as the trigger or coupling element position, device order, device count, etc.

You can also edit the machine IO part of the lane configuration in the operator UI. Note that if you edit it in the Operator UI and then load a lane configuration, the changes made in the Operator UI will be overridden.

The lanes and devices of the loaded lane configuration are illustrated in the operator UI. The white boxes with *distanceFromTrigger* values represent stations. The distance from trigger values can be fine-tuned to adjust the tag position on the coupling element when the station is triggered.

7.2 Job configuration

7.2.1 Job type selection

The job type defines the principle by which the Tagsurance 3 system operates. A standard job is agile and works in most cases. In addition to the standard job, there are machine model specific job types.

7.2.1.1 Standard job

The standard job is for most use cases, including single- and multi-lane machines, and it supports all the features of the Tagsurance 3 system.

7.2.1.2 API trigger job

The API trigger job is like the standard job, but with a limited feature set supported and with a different trigger source. When an API trigger job is running, the stations can be triggered by sending an API trigger request to the REST API. The received API trigger request causes the lane controller to trigger the defined device by IO signal. The IO signal interface of devices is the same regardless of the job type.

The results from API-triggered devices are available only at the AsyncAPI channel *tag-event*. The *Station Result* is streamed out when the result is ready, and there is no way to retrieve it afterward – data export is not supported. Possible errors in triggering, e.g., the requested device is not active in the running job, are indicated as messages in the AsyncAPI channel *error-messages.* Refer to API documentation, see the section *9.5*.

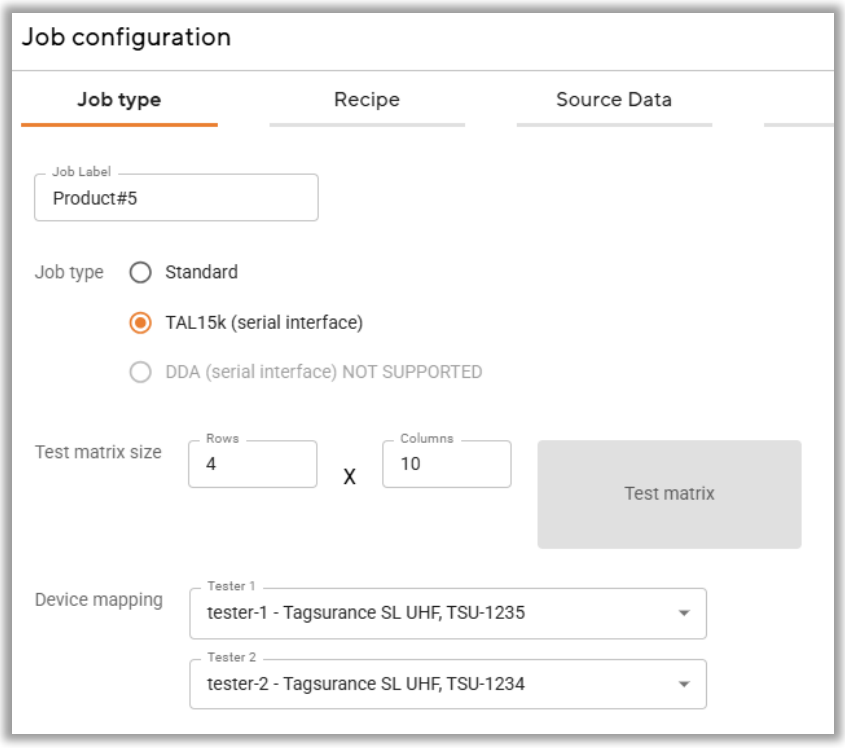
Compared to the standard job, there are restrictions in the API trigger job. Anything related to yield calculation, lot management, trigger detection (trigger sensor), and action triggers are not supported. This is simply an API trigger request followed by the streamed station result. The API trigger request is rejected when any other job type is in use. The API trigger is available only in the API, and this is not implemented in the operator UI.

Due to network and operating system processes, the latency in triggering a device by an API trigger is not deterministic. This is why the API trigger is not a feature for moving material but can only be used in stop-and-go processes or to verify the stations are working as expected before starting the production process. The magnitude of the latency is tens of milliseconds, and there is no more precise promise about its duration.

7.2.1.3 TAL15k job

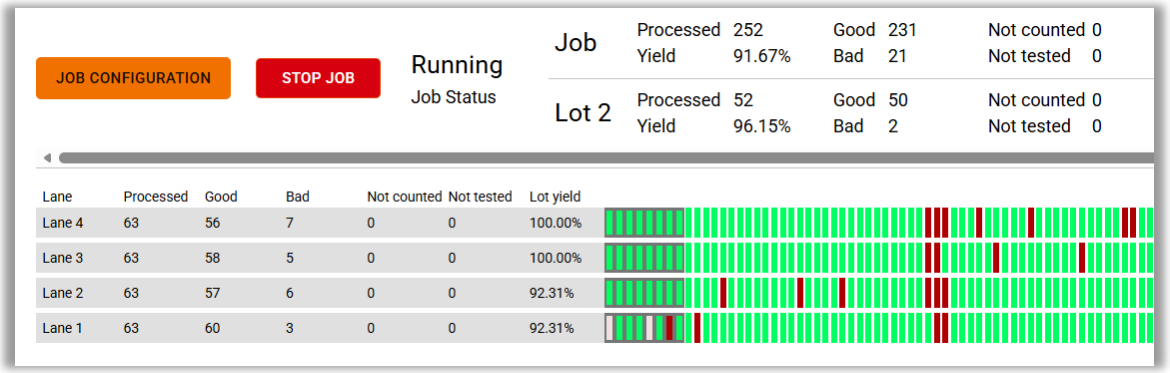
Tagsurance 3 system can be used with Mühlbauer TAL15k machine. Tagsurance 3 supports the “RS232 tester interface” of TAL15k machine, and the system works seamlessly as a part of machine. Due to the special use case, there are limitations and requirements for Tagsurance 3 configuration.

- Three device types are supported for stations controlled by Tagsurance 3
  - Tagsurance SL UHF
  - Tagsurance HF
  - IO only device
- Regardless of the number of lanes, only one lane controller is in use, and all devices, one or two, are connected to it.
- In the case of two devices, both must be the same type.
- The recipe must be made for one device. The same recipe will be assigned to both devices.
- Tagsurance 3 does not control the bad tag marking, but TAL15k does that.
- The test matrix size must be configured the same in Tagsurance 3 job configuration and in TAL15k machine settings.
- TAL15k machine must have the “RS-232 tester interface” enabled.

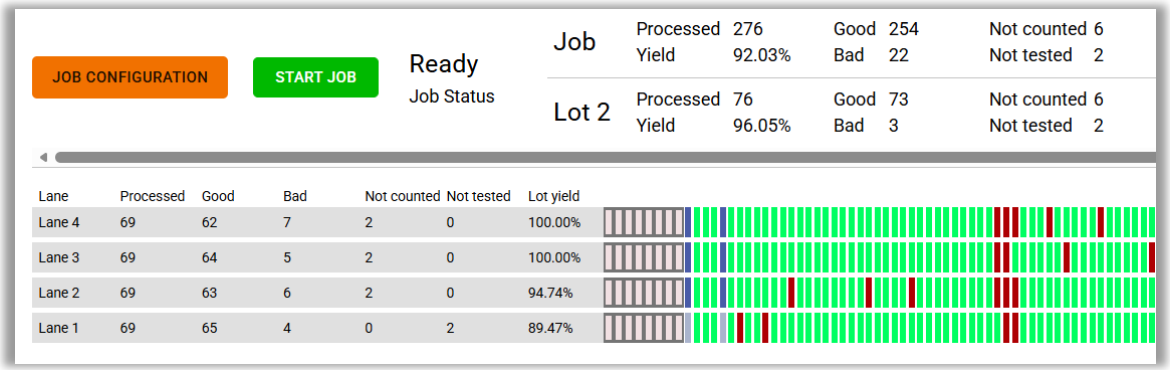


Tagsurance 3 has dedicated pins for serial communication in the lane controller’s machine IO connector, described in Section 9.1.5 Machine IO connector. In Tagsurance 3 accessories, there is the *RS232-Machine IO cable*, an adapter cable that enables connecting the DE-9 connector, “the standard serial cable”, to the lane controller’s 25-pin machine IO connector. See the details in Tagsurance 3 Catalog.

When a job is running, the results are shown in real-time in the Tagsurance 3 operator UI, and the result details are available as they are in a standard job. The tag result color coding is described in Section *7.4.1 Results in operator UI*. Tagsurance 3 also provides the pass/fail results to the TAL15k machine, and the machine's HMI shows them normally.



Tags can be retested as long as they are located in the test matrix area. When the tag exits the test matrix area, its result is finalized and published. In the TAL15k job, the column of tags is treated as a unit that must be complete to be counted in a lot or yield calculation. If one tag in a column is not tested, the statuses of other results in the same column are changed to NOT_COUNTED. When the job is stopped, all the results are finalized, and tag results are published even if the tags are on the test matrix.



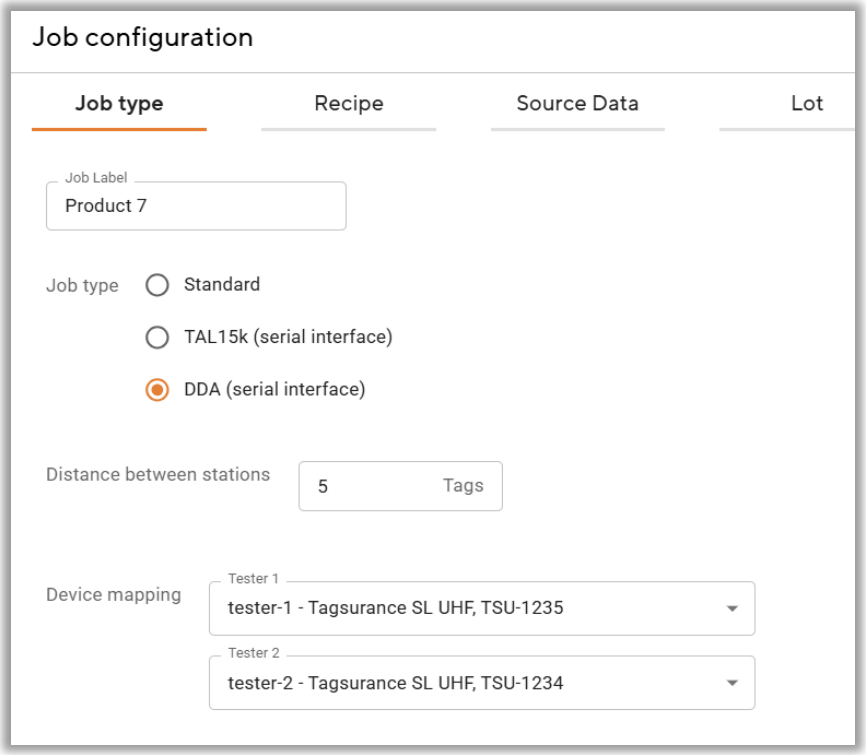
If the machine moves the lane forward without testing tags, Tagsurance 3 will recognize the number of bypassed tags next time a tag is tested and a machine provides the location information. Tagsurance 3 generates results for the bypassed tags with a status of UNTESTED. In case of a huge number of bypassed tags, a maximum of 500 columns of tag results are generated.

7.2.1.4 DDA job

Tagsurance 3 system can be used with Mühlbauer DDA machines, which support “RS232 tester interface”, e.g., DDA40k. Tagsurance 3 supports the “RS232 tester interface” of the DDA machine, and the system works seamlessly as a part of the machine. Due to the special use case, there are limitations and requirements for Tagsurance 3 configuration.

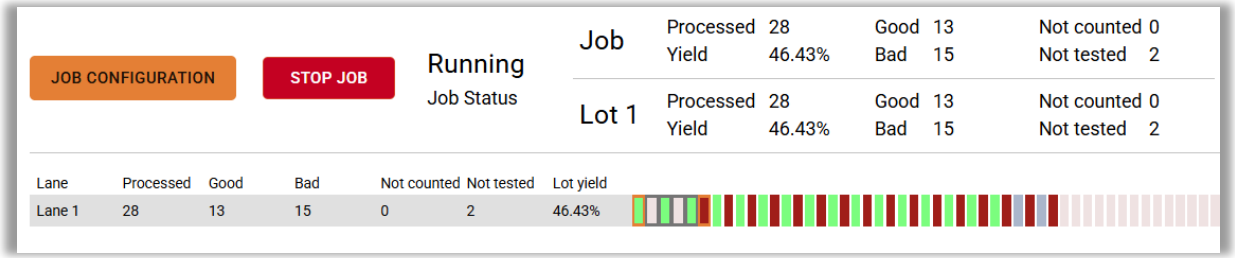
- Only three device types are supported
    - Tagsurance SL UHF

    - Tagsurance HF
    - IO only device
- One lane controller is in use and all devices, one or two, are connected to it.
- In the case of two devices, both must be the same type.
- The recipe must be made for a single lane and a single device. The same recipe will be assigned to both devices.
- Tagsurance 3 does not control the bad tag marking, but DDA does that.
- The mechanical setup, the distance between coupling elements, must be configured the same in Tagsurance 3 job configuration and in DDA machine settings. The distance is defined in terms of the number of tags, and it must be an odd number.
- DDA machine must have the “RS-232 tester interface” enabled.

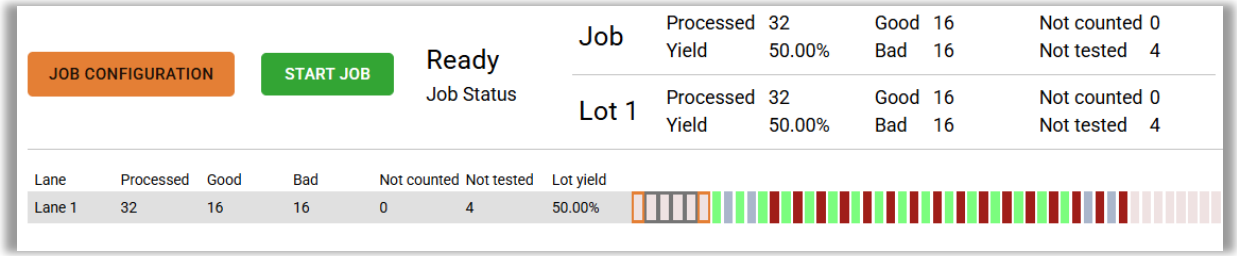


Tagsurance 3 has dedicated pins for serial communication in the lane controller’s machine IO connector, described in Section 9.1.5 Machine IO connector. In Tagsurance 3 accessories, there is the *RS232-Machine IO cable*, an adapter cable that enables connecting the DE-9 connector, “the standard serial cable”, to the lane controller’s 25-pin machine IO connector. See the details in Tagsurance 3 Catalog.

When a job is running, the results are shown in real-time in Tagsurance 3 operator UI, and the result details are available as they are in a standard job. Tagsurance 3 provides the pass/fail information of the results to the DDA machine as well, and the machine HMI shows the results normally.

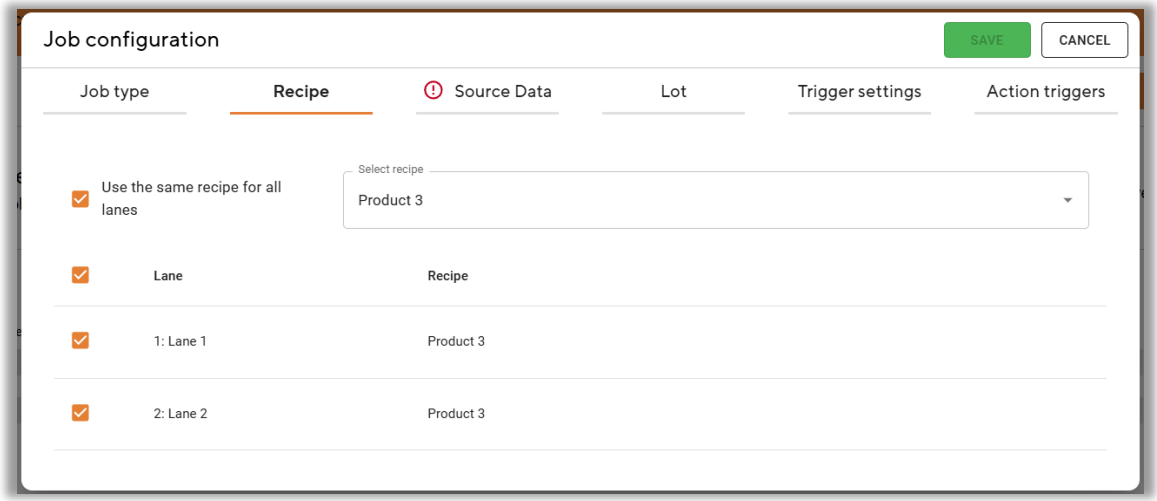


A second tester can retest a tag that the first tester has already tested. When the tag passes the last tester, the tag result is finalized and released. If no tester has tested the tag, the status of the tag result is UNTESTED. When the job is stopped, all tag results are finalized, and tag results are published even if the tags have not passed the last tester.



7.2.2 Recipe selection

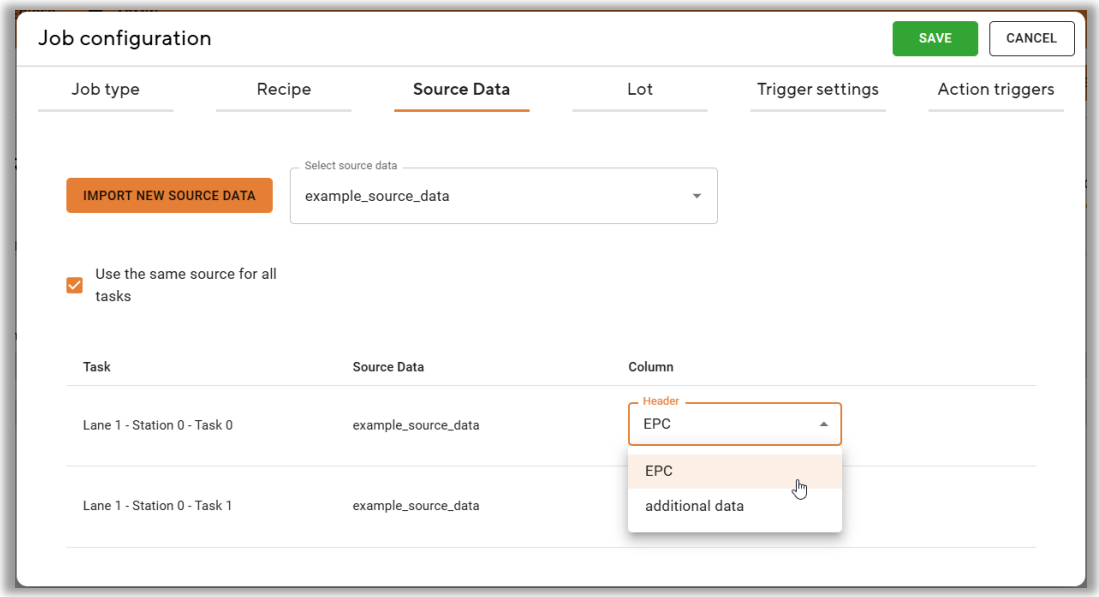
In the operator UI, click **Job Configuration.** The **Recipe tab** of the modal that opens will allow you to **select a recipe from the dropdown list**. The recipe list is populated based on the recipes saved into the Tagsurance server. You can scroll the list or find a recipe by typing its label name. You can use the same recipe for all lanes or select a recipe per lane.



When the selected recipe requires dynamic source data for the encoding task(s), the validator highlights the *Source Data* tab because of missing configuration: the source data must be selected and linked to the tasks.

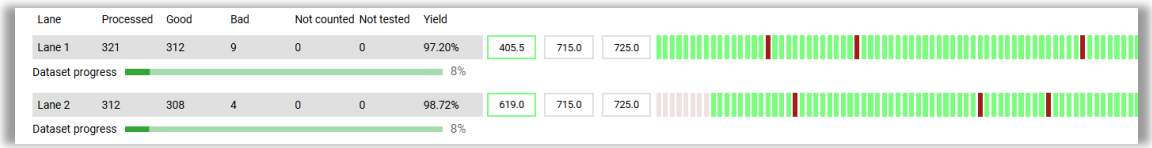
7.2.3 Source data selection

The data source is a CSV file uploaded to the Tagsurance 3 system by the user before starting the encoding job. The source data must be selected for each task with dynamic data defined in the recipe. When the CSV has header information for the data, the user can select the column by name.



When the job starts, Tagsurance 3 reads data from the data source row by row: One tag gets data from one row, and column selection defines which column the data is read in that row.

During a job, the user can monitor the progress of data consumption in the Operator UI. When the data runs out, tags won't be encoded, and tag results will fail. The task list is executed normally except for the Blockwrite tasks with dynamic data, which are skipped. If the recipe defines it, these failed tags are marked and punched as usual.



7.2.3.1 CSV data source format

- Data in the file must be in hexadecimal. Example of 2 words: "AB120034"
- CSV file character encoding must be UTF-8
- CSV files with or without a header row are supported. A user must specify this when uploading the file to Tagsurance 3
- The maximum number of rows is 100 million
- The maximum file size is 4 gigabytes

```
EPC,password
000100010001000100010001,FEE71234
000200020002000200020002,FEE85678
000300030003000300030003,FEE99012
000400040004000400040004,FEEA3456
000500050005000500050005,FEEB7890
000600060006000600060006,FEEC1234
000700070007000700070007,FEED5678
000800080008000800080008,FEEE9012
000900090009000900090009,FEEF3456
000A000A000A000A000A000A,FEF07890
000B000B000B000B000B000B,FEF11234
```

The uploaded CSV file is validated, and invalid or empty data columns are disabled. Invalid data, even one character, will cause the column to be disabled. Disabled columns cannot be used as a source for the dynamic data in a task. If the file contains only one column, which fails the validation, the whole file as a data source is disabled. The empty row at the end of the file is interpreted as empty data, which fails the validation.

Tagsurance 3 stores the last 10 data sources, i.e., CSV files, and the oldest is automatically deleted when the 11th data source is uploaded.

7.2.4 Lot settings

Tags can be marked as a lot in the results based on the lot settings. The lot change can be managed by the Tagsurance 3 system when the lot change is done after the defined number of tags are processed. When Tagsurance 3 is counting tags for a lot, the lot change position can be indicated to a machine by an IO signal.

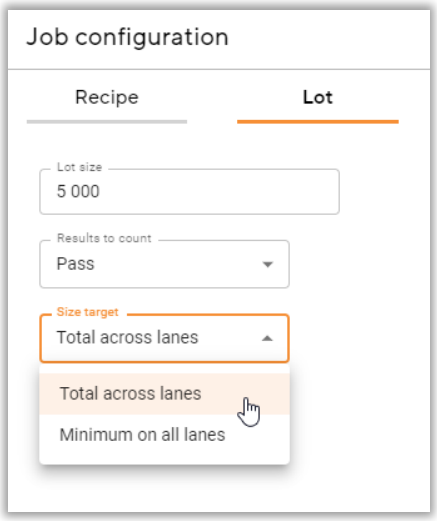
7.2.4.1 Lot control by Tagsurance 3 system

The lot control in Tagsurance 3 system can mind all/passed tags over all lanes or require a minimum number on all lanes. The lot fulfillment will not stop the job. Instead, the counter will reset, the lot number will increase, a new lot will begin, and the job keeps running uninterrupted.

The status of the lot completion can be used as a trigger for output signals in a machine IO connector.

In the exported results and in API the lot is called batch. Only the name is different.

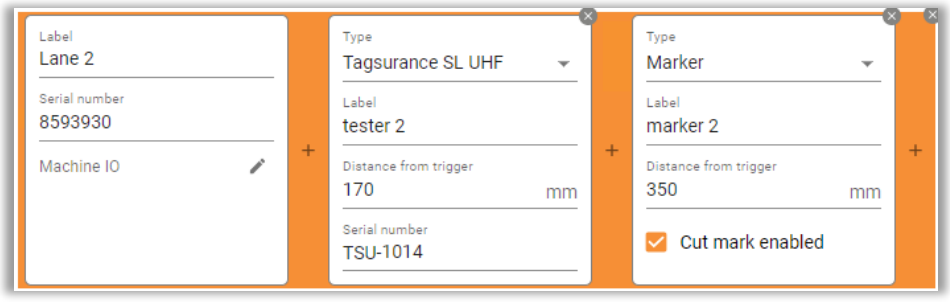
The maximum number of lots in a job is 5000. The maximum lot size is not limited but the job size is, see the section *7 Running a Job*.

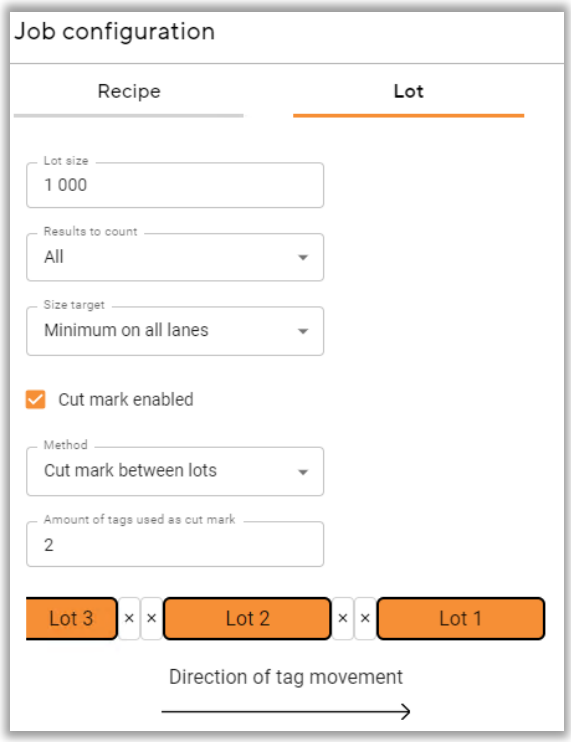


7.2.5 Cut mark

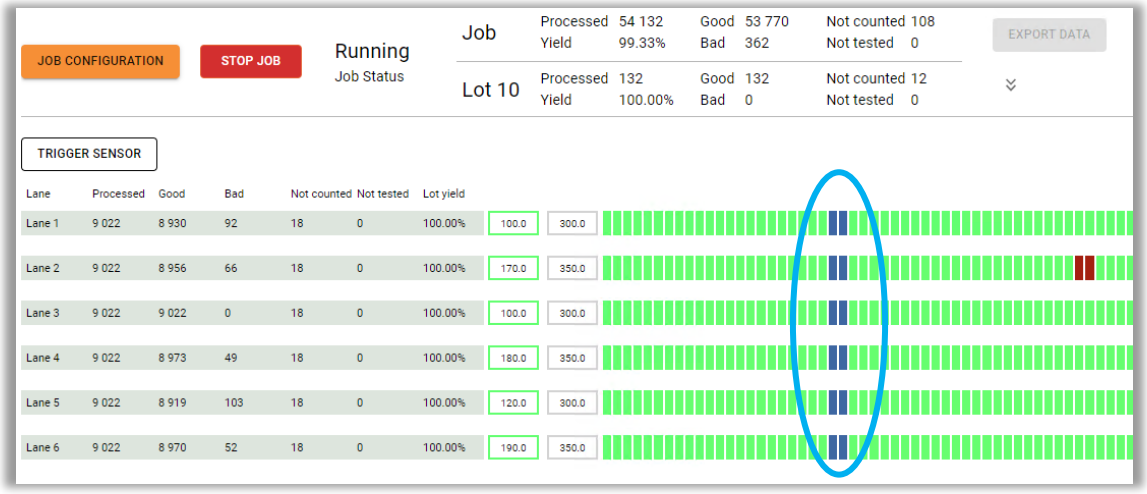
The cut mark is a defined number of marked tags between the lots. This makes it easier to differentiate the lots from each other. The cut mark feature uses the markers to mark tags, and the results of these marked tags are not counted to lots or yields, and the status of results is changed to NOT_COUNTED.

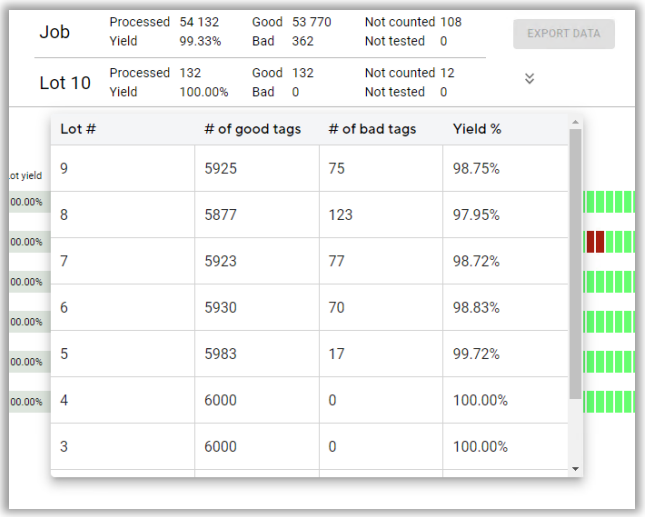
Any marker in the lane configuration on the active lane can be used for the cut mark, and at least one marker must be selected for this purpose if the cut mark is enabled. In addition to the cut mark marking, the selected markers work as the recipe defines. If a marker should be used only for cut mark marking, omit it in the recipe. In a multilane setup, the tags do not need to be marked on each lane. However, in the column where the cut mark is made to at least one tag, the status of all tag results is changed to NOT_COUNTED.





The Operator UI visualizes the cut mark in tag results. Results with the status of NOT_COUNTED are indicated in blue.





Note: The marker prints the cut mark only if the marker location is after the station where the lot completion decision is made. Tagsurance 3 makes the lot completion decision at the last feedback station, i.e., the last Tagsurance tester or IO-only station, which affects the tag result. Especially in multilane systems, it is important to pay attention to the locations because the tester can locate after the marker on the parallel lane.

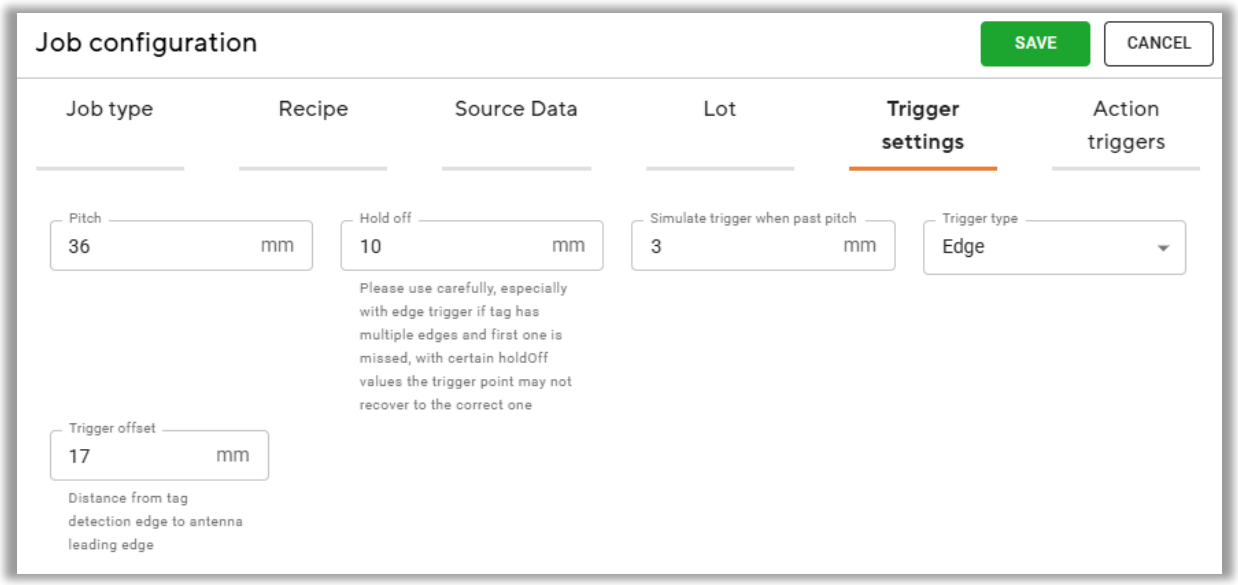
7.2.5.1 Cut mark in encoding

There is no difference in cut mark feature behavior whether the task list contains encoding tasks or performance test tasks, i.e. whether the tags are tested only or personalized by encoding. The tags are processed as usual and then marked, and the result status is changed to NOT_COUNTED. In the dynamic data encoding process, the source data is consumed for the cut mark tags and not moved to the following tags.

7.2.6 Trigger settings

The lane controller can be set up to use trigger filtering, which can be useful when dealing with tags/materials from which a single trigger per item is difficult to achieve.

Filtering can be achieved by hold-off distance with the edge trigger or by using the pattern trigger. It is also possible to use hold-off distance with the pattern trigger but it is usually not necessary. The hold-off distance has its risks especially with the edge trigger. If, for any reason, the correct edge is missed and an edge normally filtered away with hold-off is then hit, the system is stuck with an incorrect trigger position.



7.2.6.1 Trigger type – edge

Edge is a very simple solution where any rising edge in the trigger signal is detected as a trigger and treated as a tag leading edge (given that the distance from the trigger on stations is set to the leading edge of a tag).

7.2.6.2 Trigger type – pattern

A pattern can be specified so that it must be matched before a trigger is accepted. The trigger point does not need to be the beginning of the pattern.

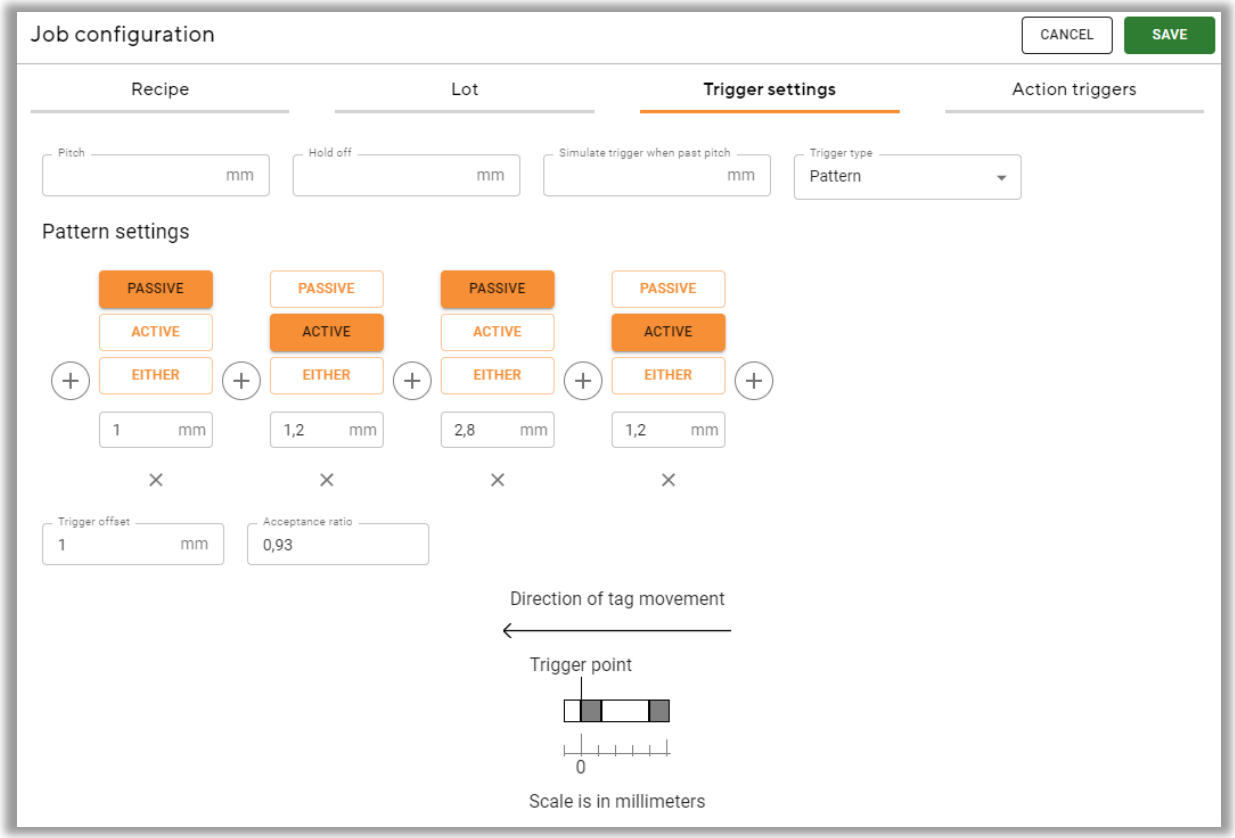
It is usually advisable to keep the pattern the simplest unique pattern found in the tag.

The maximum pattern length is 30 mm, and it can contain up to 10 areas.

The resolution for areas in a pattern is 0.2 mm.

The acceptance ratio is calculated as the correlation between the received trigger signal and the defined pattern.

Try to come up with patterns that have relatively similar amounts of ACTIVE and PASSIVE areas, and be careful with patterns that have, for example, only 0.2 ratio of ACTIVE compared to PASSIVE (or vice versa), as the acceptance ratio works over the whole pattern. For example, having an acceptance ratio of 0.9 combined with a PASSIVE/ACTIVE ratio of 0.9 would mean that no signal (PASSIVE) from the trigger for pattern length would be interpreted as a trigger.



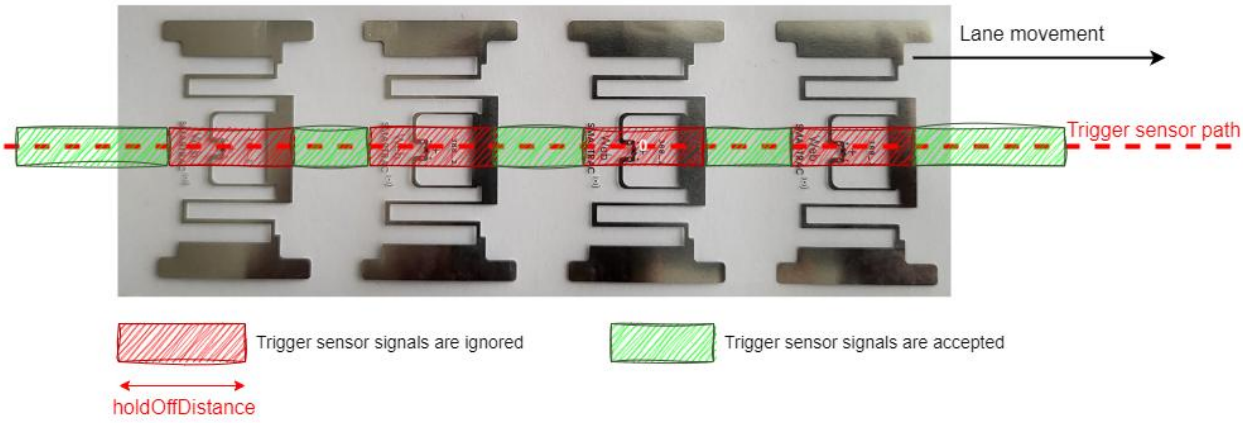
For more details about the pattern trigger, see the Appendix: How to Configure the Pattern Trigger.

7.2.6.3 Hold-off distance

See the following example of such a use case. The tags have such a design that without filtering the trigger sensor would react multiple times to each tag, resulting in unwanted triggers.

The settable multi-trigger filter *holdOffDistance* can be configured so that only the first edge of the tag would be detected, and so that the remaining edges are ignored for the remainder of the tag (see the red-striped sections in the example).

After the accepted trigger pulse, the multi-trigger filter ignores the signals from the trigger sensor at the *holdOffDistance* travel.

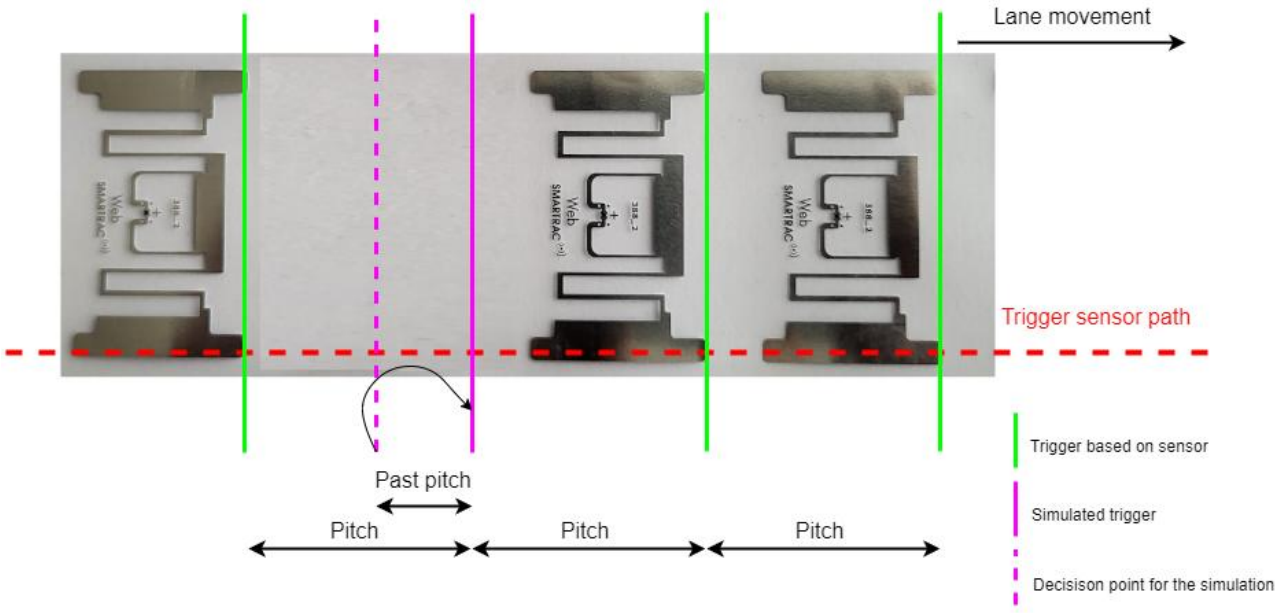


Warning!
The hold-off distance must be used carefully. Do not use longer hold-off distances than necessary. Especially with simulated trigger, there is a high risk the triggering gets completely off. Then tags are triggered at wrong location by the simulated triggers and the system may not recover to detect the tags correctly according to the trigger sensor. See sections *10.4* and *10.5*.

7.2.6.4 Simulated trigger

In case a tag is not triggered because of missing tag or sensor fails the detection, the *missingTrigger behavior* can be applied. Tagsurance 3 can simulate the trigger as if a tag had been normally detected.

After the previous trigger position, the following trigger will be simulated when the lane has travelled the distance of *pitchMm* + *simulateTriggerWhenPastPitchMm* without receiving the trigger signal from the sensor. The simulated trigger is placed on a pitch after the previous trigger position. It doesn't matter if the previous trigger is simulated or based on sensor detection. The trigger simulation is based on the *Pitch* and the *Simulate trigger when pass pitch* values defined in the job configuration.



The first trigger cannot be simulated, but once the first tag is detected by the sensor the following triggers can be simulated. Once the simulation prerequisites are full filled, all the following triggers can be simulated even if the sensor is not even connected any more.

Warning!
When the pattern trigger is defined, the *simulateTriggerWhenPastPitchMm* value must be greater than the length of the pattern, and some extra. The entire pattern of the tag features must be recognized completely before the trigger is applied based on the pattern. If the trigger is simulated before the pattern is recognized, an extra trigger is generated, and the tag will be triggered twice. See the section *10.4*.

7.2.6.5 Pitch

The pitch of the tags on material means the repetition rate in the distance between the tags. It is given at the tenth of a millimeter resolution, e.g., 23.6 mm.

7.2.7 Action trigger

The machine IO output signals are configured by:

- actions –change in the signal state
- action triggers – determine when does the action takes place

To define an action trigger:

1. Select the action trigger type.
2. Define the type-specific properties.
3. Select the actions to be triggered.

The actions defined in a lane configuration are automatically available here in the action trigger settings.

Action trigger types

- *Status change*
  When the system status changes to the defined target value

- *Lot completion*
  When the lot completion level reaches the target at the defined location. The observing location can be the last feedback station, the last station affecting the tag result status, or any designated location after that. An action can be triggered before the lot is completed by defining the *amount before* value bigger than 0 pcs, for example, 20 tags before the lot is completed.

- *Station event*
  When the defined station is ready, or its result is pass or fail. This is an internal action trigger for the lane controller. Only the results of the station connected to the lane

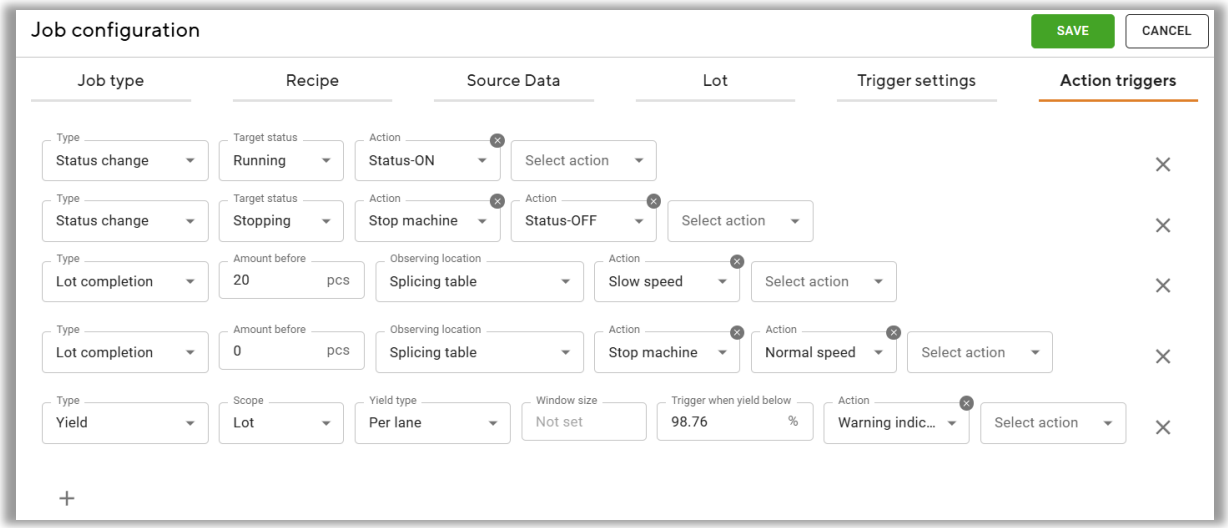
controller can trigger the action of the same lane controller (output pin state in machine IO connector). For example, the failed station result on the “Lane-2” cannot be replicated at the machine IO connector of the “Lane-1’” lane connector.

- *Yield*
  When the yield falls below the defined limit. The yield is calculated based on the tag results at the last feedback station, and it is updated every time a new tag result becomes available. All tag results are counted since either a job start or a lot start, except when the window is defined. The window determines how many of the latest results are counted since the job or lot began. The window must be filled before the action(s) are triggered. For example, the yield is calculated for the latest 10 tags since the lot change, and not before the 10 tag results are available.

- *Consecutive failures*
  When the defined number of consecutive failures is detected at the observing location. The location can exist between two feedback stations, e.g., test stations, and the tag status is determined based on the station results available at the observing location. When the number of consecutive failures is defined as 5, the fifth consecutive failure will trigger the action. The *critical failure* parameter defines the failure type that forces the action to be triggered even if the consecutive failure conditions are not met. Only the different failure types of an IO-only station are considered. The consecutive failure counter is reset after the action is triggered, i.e., for ten consecutive failures, the action is triggered two times.

- *Lot failure limit*
  For all failures after the maximum allowed number of failures has been detected at the observing location. The location can exist between two feedback stations, e.g., test stations, and the tag status is determined based on the station results available at the observing location. The maximum allowed number of failures is calculated based on the defined target lot yield. When the maximum number of failures has passed the observing location, the action is triggered every time a failed tag reaches the observing location. Suppose the override station exists on the lane after the observing location, and a failure tag is finally interpreted as a good one, for example, because of label replacement. In that case, the failure counter is revised accordingly, allowing one more failure to pass the observing location without triggering an action. This action trigger is designed to control the label replacement and ensure the target lot yield is reached. The *critical failure* parameter defines the failure type that forces the action to be triggered, i.e., a label to be replaced, even if the lot failure limit conditions are not met. Only the different failure types of an IO-only station are considered.

Example configuration:



- After a job is started and the system status has changed to *Running*, the action *Status-ON* is triggered: The machine knows Tagsurance 3 is ready for the first tag coming.
- When a job stops, and the system status turns to *Stopping*, the actions *Stop machine* and *Status-OFF* are triggered: The machine stops and knows Tagsurance 3 is not going to process tags anymore.
- When a lot is almost full, the action *Slow down* is triggered: The machine is told to slow down the lane speed and be ready to stop immediately when the stop is asked.
- When the lot is completed, and the last tag of the lot is on the *Splicing table*, the actions *Stop machine* and *Normal speed* are triggered: The machine stops, and the speed control is reset to normal speed.

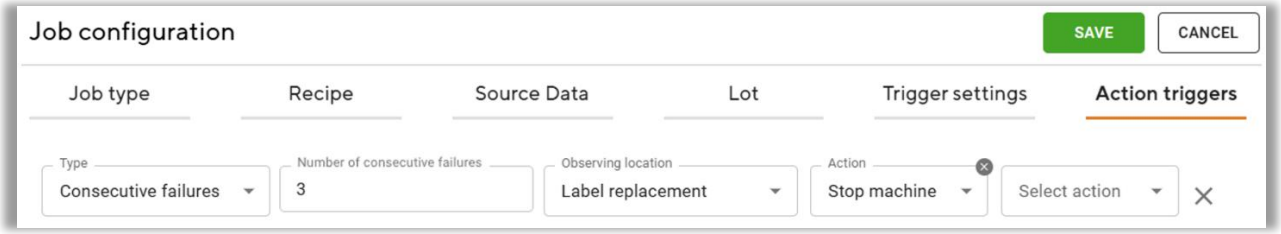
The actions and locations are defined accordingly in a lane configuration described in *Section 5 Building Lane Configuration*. For information on defining machine IO settings, see Section *5.1.1* and Section *9.1.5* for Machine IO connector.

7.2.7.1 Stop the machine for label replacement

Tagsurance 3 can stop the machine for the label replacement. The label replacement can be located between the test stations, and the final tag result doesn't need to be ready. Tagsurance 3 gives a stop signal when the stopping criteria are met based on the station results before the label replacement location.

The machine can be stopped for label replacement at each failed tag or when there is a defined number of consecutive failures. The stop signal is configured by the *Consecutive failures* type action trigger. The *"Number of consecutive failures"* property specifies the number of failures after which the last failed tag will be stopped at the defined location.

In the example below, two consecutive failures are accepted, and the third one will be stopped at the Label replacement location. This means the stop signal is given to the machine when the tag is at the location.



The consecutive counter is reset every time the action is triggered. If all tags fail, the action is triggered by every Nth failure. The example configuration stops every third tag at the Label replacement location. If there are 10 consecutive failures, three tags are stopped at the Label replacement location, and seven tags are passed through.

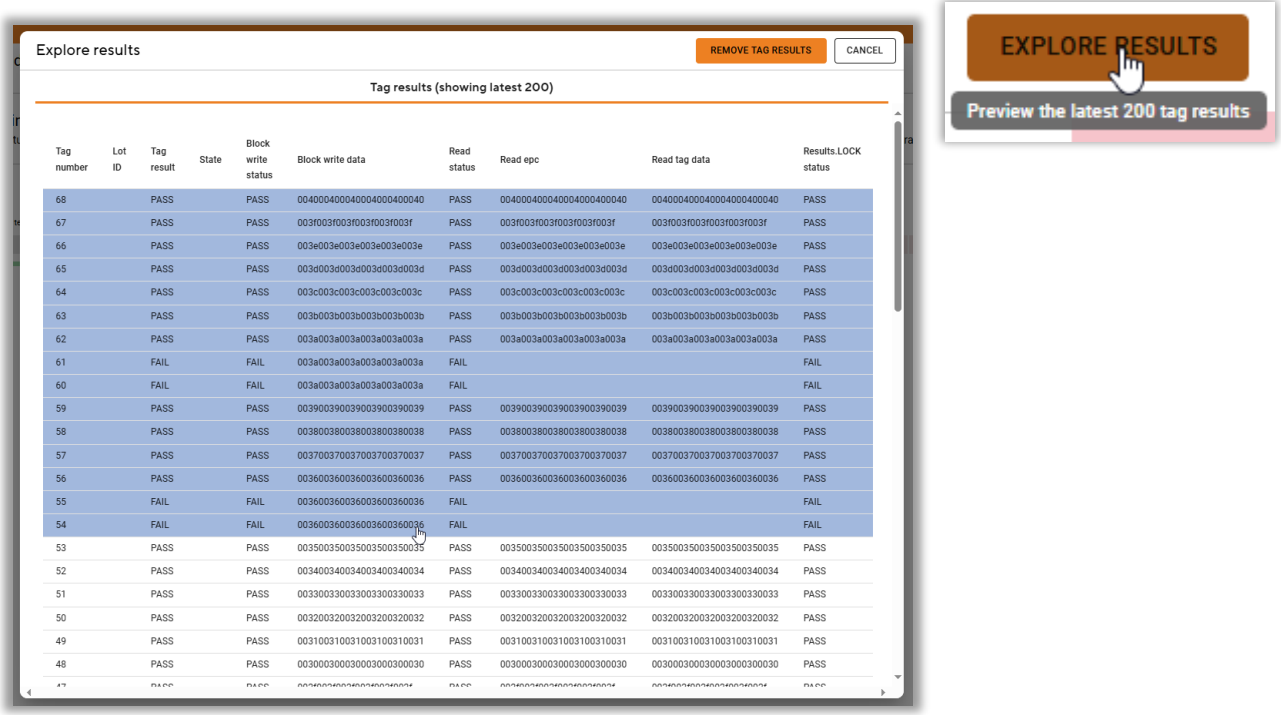
How to collect only the tag results after the label replacement, and how to do the lot management based only on the results after the label replacement, is described in Section *5.3 Label replacement*.

7.3 Source data rewinding

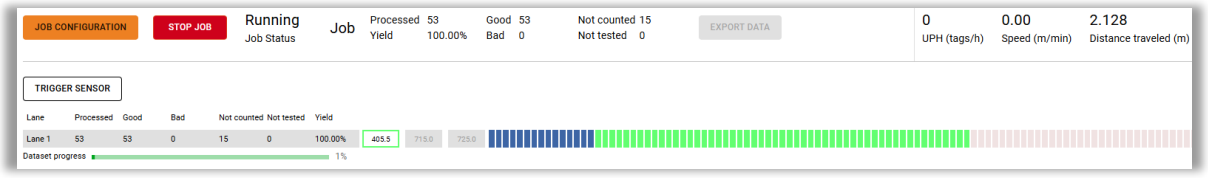
Source data rewinding is an extension of the retry mode in encoding jobs. When the retry is selected as an action for the data after a failed tag, the same data is automatically assigned to the next tag until a tag is successfully processed. The source data rewinding is a manual process in which the user defines tags that must be reproduced with the same source data. This is necessary when tags must be rejected after the Tagsurance 3 controlled process. The reason for the rejection can be, for example, a visual defect. All the tags after the defective one are expected to be rejected and reproduced.

The source data rewinding can be performed while the job is running, so the lot and statistics counters continue without interruption or reset. The user must identify the first rejected tag and select the tag result from the result exploration list. The source data can be rewound for up to 200 tags at a time.

All results from the selected one to the latest tag result are highlighted. Then, the user can press the Remove Tag Results button and accept the warning message. The on how much the source



Any results in the Tagsurance 3 system are not removed, but they are marked as REMOVED and treated as NOT_COUNTED, and therefore, not taken into account in statistics or lot management. The “removed” results are visualized in the operator UI as the NOT_COUNTED tag results. The following pictures show the state before and after the source data rewinding.



After the source data rewinding, the next encoded tag will have the same data as the first rejected tag. This can be easily verified by opening the Explore Results view.

The source data rewinding is supported only in the setups of single-lane with one-station, and when the *Action for data after failure* option is *Retry*.

7.4 Results

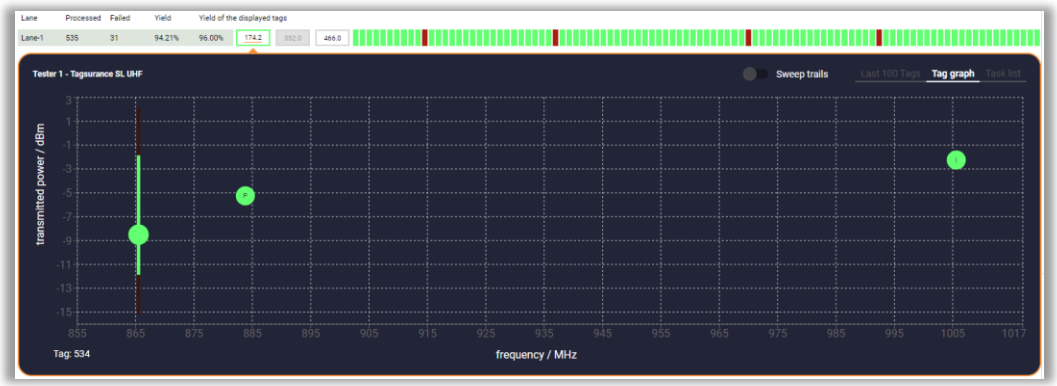
7.4.1 Results in operator UI

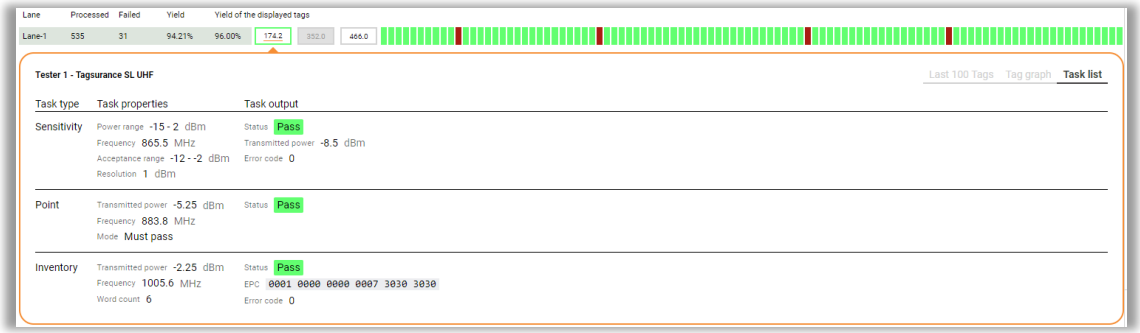
Results are shown in operator UI for each tag on the tag result level but also more detailed on the station result level. The statuses of results are shown in colors:

- PASS – green
- FAIL – red
- ERROR – orange
- NOT_COUNTED – blue
- UNTESTED – grey

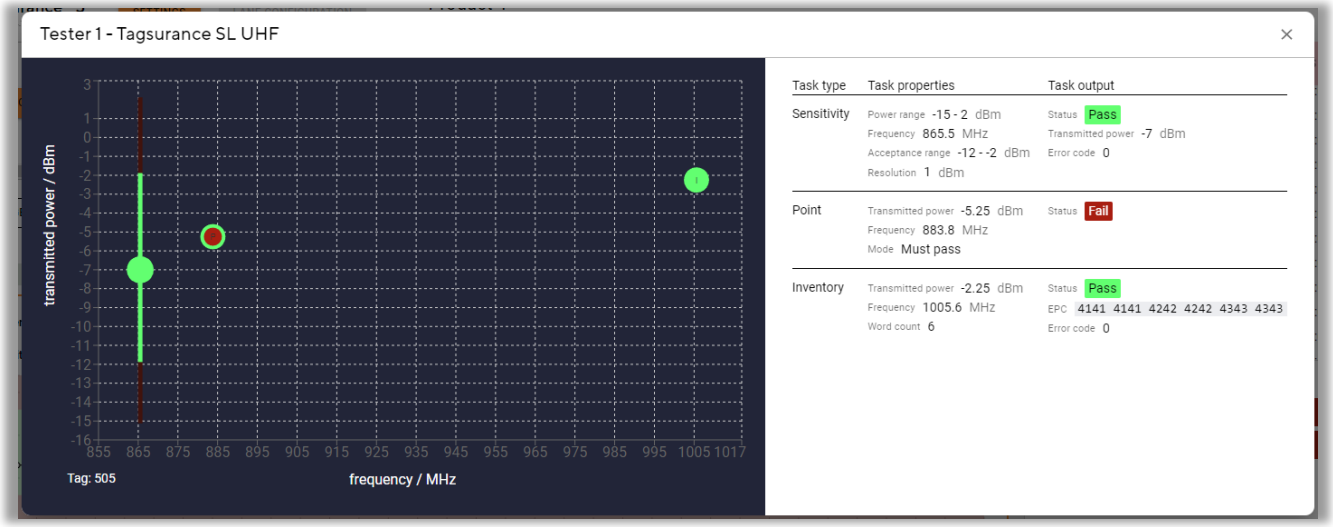
In addition to the overall tag results, you can also view more detailed station and even task-specific results by clicking the station. You can investigate the details of failed tag results on the right.

The station results are also visualized in other views: *Tag graph, Task list*.

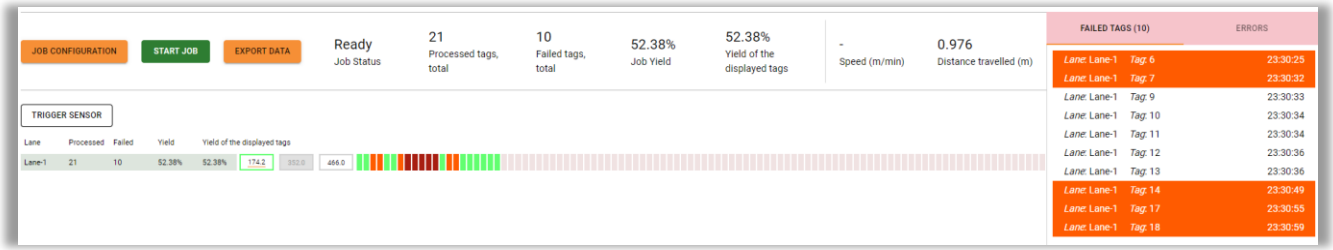




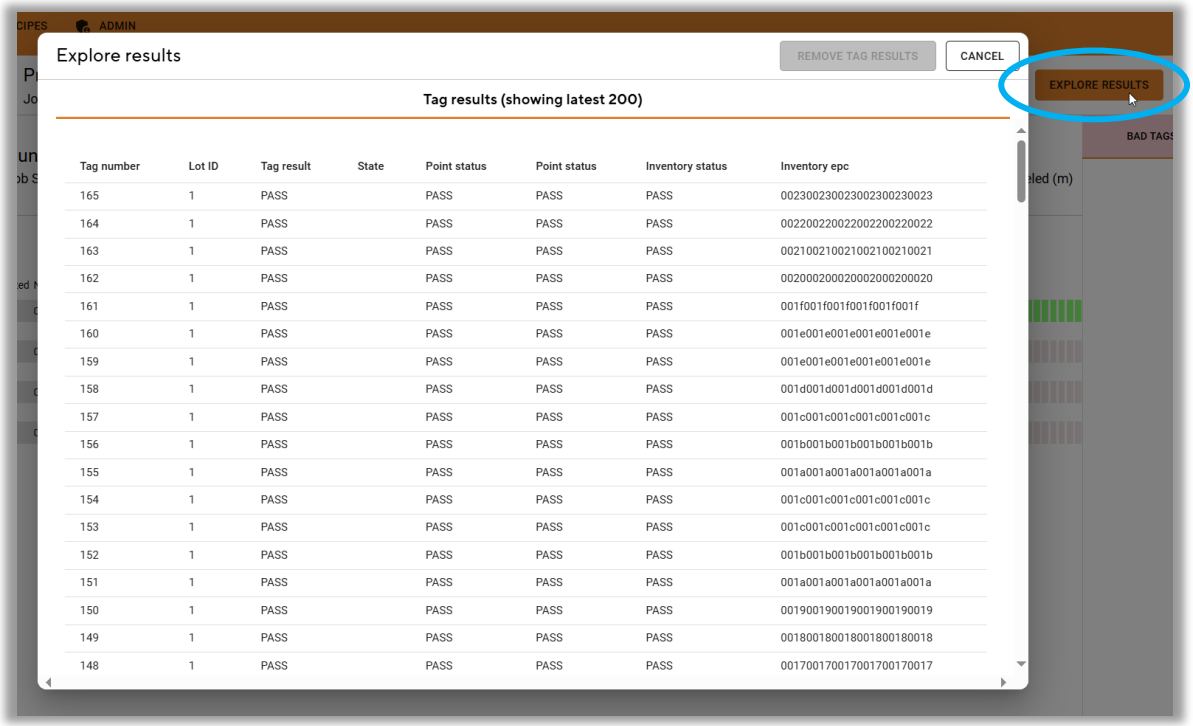
More detailed results of a failed tag can be reviewed by selecting the *Station* under the *Tag Info*.



Errors in tag results are shown in the list of *failed tags* highlighted with orange. The errors leading to this are listed in Section *7.4.4.3 Station result errors*.



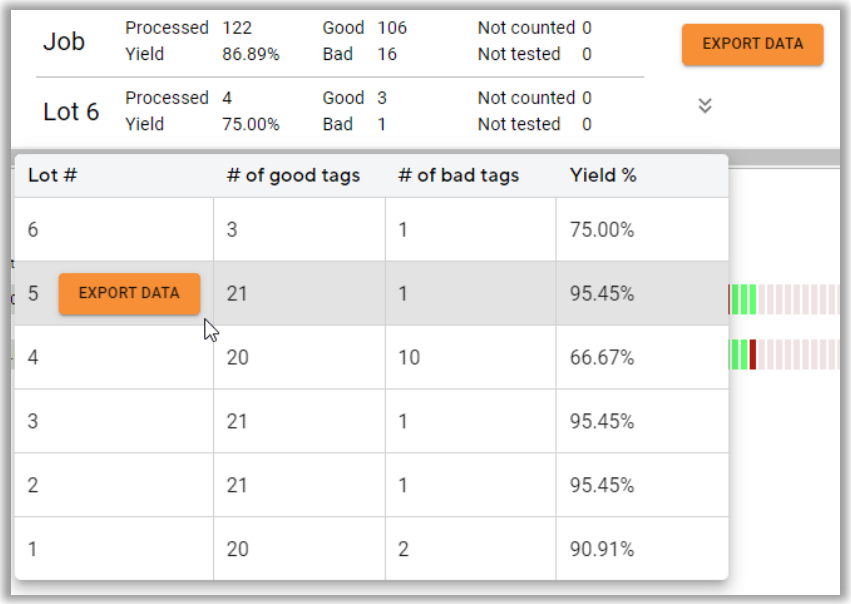
The *Explore results* button opens a list of tag results where the result data, for example, the read EPC data of the tags can be reviewed when a job is running.



7.4.2 Result saving

The results can be saved by exporting the result data from operator UI. The data export can contain either all results of a completed job or only results of a completed lot. The lot results can be exported even if the job is running, but the job results downloading is possible only when the job is stopped, and the system is in idle state.

In operator UI, the lot results can be exported only from the latest job. However, the API provides access to the lot results of any job in the system's result archive.

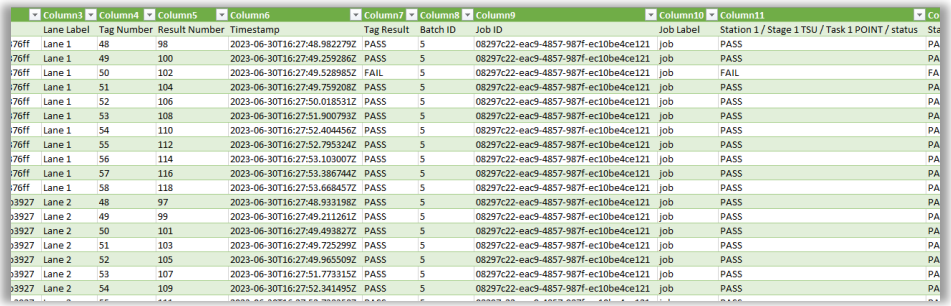


The result data is packed into a zip file, which will be downloaded and saved to the computer where the UI is running. The saving location is the browser's default downloading location.

The content of the exported result data packages is as follows.

- Job results
  - job summary (.csv)
  - job configuration (.json)
  - tag results in lane specific files (.csv)
- Lot results
  - Lot summary (.csv)
  - job configuration(.json)
  - tag results of a lot in lane specific files (.csv)

The CSV files have a header row before the data, and separator is comma (,). The job configuration files are formatted according to the API specification. The result files can be opened, and data viewed in any suitable csv viewer. For example, the results can be imported to Microsoft Excel.

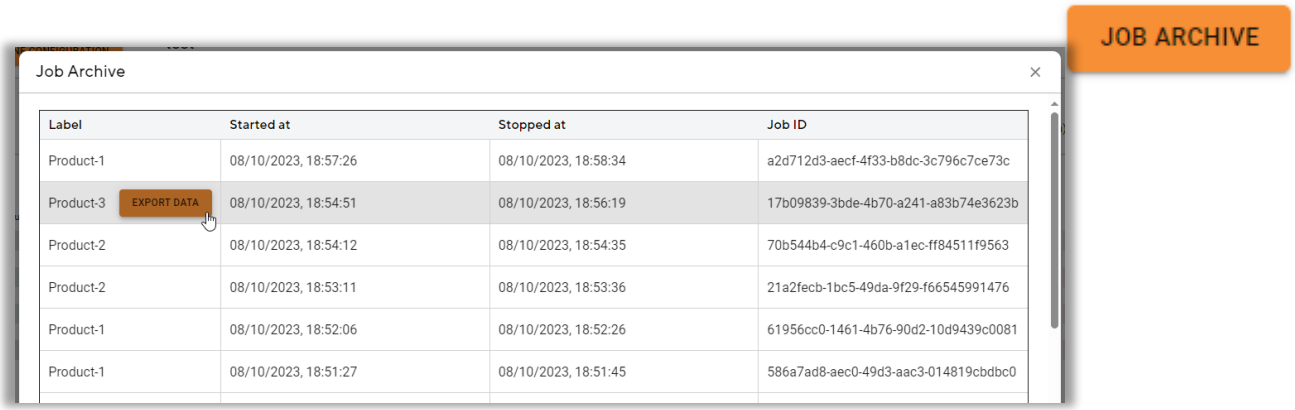


Column3	Column4	Column5	Column6	Column7	Column8	Column9	Column10	Column11	Co
Lane Label	Tag Number	Result Number	Timestamp	Tag Result	Batch ID	Job ID	Job Label	Station 1 / Stage 1 TSU / Task 1 POINT / status	Sta
76ff	Lane 1	48	98	2023-06-30T16:27:48.982279Z	PASS	5	08297c22-eac9-4857-987f-ec10be4ce121	job	PASS	PA
76ff	Lane 1	49	100	2023-06-30T16:27:49.259286Z	PASS	5	08297c22-eac9-4857-987f-ec10be4ce121	job	PASS	PA
76ff	Lane 1	50	102	2023-06-30T16:27:49.528985Z	FAIL	5	08297c22-eac9-4857-987f-ec10be4ce121	job	FAIL	FA
76ff	Lane 1	51	104	2023-06-30T16:27:49.759208Z	PASS	5	08297c22-eac9-4857-987f-ec10be4ce121	job	PASS	PA
76ff	Lane 1	52	106	2023-06-30T16:27:50.018531Z	PASS	5	08297c22-eac9-4857-987f-ec10be4ce121	job	PASS	PA
76ff	Lane 1	53	108	2023-06-30T16:27:51.900793Z	PASS	5	08297c22-eac9-4857-987f-ec10be4ce121	job	PASS	PA
76ff	Lane 1	54	110	2023-06-30T16:27:52.404456Z	PASS	5	08297c22-eac9-4857-987f-ec10be4ce121	job	PASS	PA
76ff	Lane 1	55	112	2023-06-30T16:27:52.795324Z	PASS	5	08297c22-eac9-4857-987f-ec10be4ce121	job	PASS	PA
76ff	Lane 1	56	114	2023-06-30T16:27:53.103007Z	PASS	5	08297c22-eac9-4857-987f-ec10be4ce121	job	PASS	PA
76ff	Lane 1	57	116	2023-06-30T16:27:53.386744Z	PASS	5	08297c22-eac9-4857-987f-ec10be4ce121	job	PASS	PA
76ff	Lane 1	58	118	2023-06-30T16:27:53.668457Z	PASS	5	08297c22-eac9-4857-987f-ec10be4ce121	job	PASS	PA
3927	Lane 2	48	97	2023-06-30T16:27:48.933198Z	PASS	5	08297c22-eac9-4857-987f-ec10be4ce121	job	PASS	PA
3927	Lane 2	49	99	2023-06-30T16:27:49.211261Z	PASS	5	08297c22-eac9-4857-987f-ec10be4ce121	job	PASS	PA
3927	Lane 2	50	101	2023-06-30T16:27:49.493827Z	PASS	5	08297c22-eac9-4857-987f-ec10be4ce121	job	PASS	PA
3927	Lane 2	51	103	2023-06-30T16:27:49.725299Z	PASS	5	08297c22-eac9-4857-987f-ec10be4ce121	job	PASS	PA
3927	Lane 2	52	105	2023-06-30T16:27:49.965509Z	PASS	5	08297c22-eac9-4857-987f-ec10be4ce121	job	PASS	PA
3927	Lane 2	53	107	2023-06-30T16:27:51.773315Z	PASS	5	08297c22-eac9-4857-987f-ec10be4ce121	job	PASS	PA
3927	Lane 2	54	109	2023-06-30T16:27:52.341495Z	PASS	5	08297c22-eac9-4857-987f-ec10be4ce121	job	PASS	PA

Note: When the lane configuration contains an override station, the lot results contain only the station results of the override station and the following stations. See Section *5.3 Label replacement*.

7.4.3 Result archive

Tagsurance 3 system archives the results of 50 previous jobs. The results can be exported as long as the results are in the archive. In addition to the limit of 50 jobs, the archive size is limited to 200 million tag results. When one of the constraints is met, the oldest job will be deleted.



7.4.4 Error codes

7.4.4.1 Error codes of tasks in Tagsurance SL UHF results

Error code	Name	Description
0	No error	
1	No connection	No connection to a tag. The tag did not respond to Query command.
2	Verification error	Verification error of read data. The data read from the tag does not match the verification data.
3	Signal strength too low	The signal strength check failed. The tag's signal strength was suddenly too low compared to the expected signal strength.
5	Ack error	Error during ACK command execution. The device could not receive the tag's response to the ACK command. [1)]
6	Req RN error	Error during REQ_RN command execution. The device could not receive the tag's response to REQ_RN command. [1)]
7	Command exec error	Error during command execution. The device could not execute the actual command. In the case of a read task, this error code is used if the Read command fails. In the case of a write task, this error code is used if the BlockWrite command fails.
8	Protocol error	The device does not support the command.
9	Timeout	Timeout error.
10	Out of data	The device is configured to use a dynamic data source for read or write tasks, but the data source is empty.

1) See the GS1 EPC Gen2v3 standard for details.

7.4.4.2 Tag errors

A tag can reply with an error code. According to the GS1 EPC Gen2v3 standard, the error code is translated to the error code name. The standard provides detailed error descriptions.

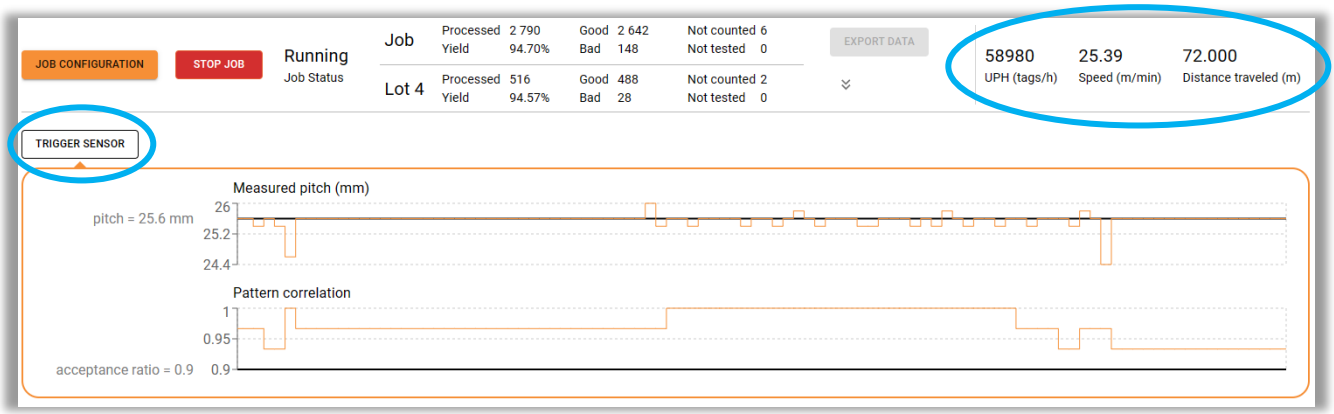
Error
OTHER_ERROR
INSUFFICIENT_PRIVILEGES
MEMORY_OVERRUN
MEMORY_LOCKED
CRYPTO_SUITE_ERROR
COMMAND_NOT_ENCAPSULATED
RESPONSE_BUFFER_OVERFLOW
SECURITY_TIMEOUT
INSUFFICIENT_POWER
NOT_SUPPORTED

7.4.4.3 Station result errors

Error	Description
GENERIC_ERROR	Unspecified error in lane controller
INVALID_TRIGGER_RESPONSE	The IO-only station does not report the pass/fail result as defined in the lane configuration. Lane controller either does not receive a result pulse in the pass pin or fail pin, or it gets both signals as a result for one tag.
LC_RESULT_MISMATCH	The result status in the station's reported result data does not match the status reported via station IO signaling.
MISSING_TRIGGER_RESPONSE	Station do not send PASS/FAIL signal before the next trigger. Possible reasons: IO cable is disconnected, or the lane speed is too high compared to the time required to complete the task list.
STATION_MISSING_DATA	The expected result data from Tagsurance SL UHF is missing. The station was triggered, the pass/fail status was detected based on IO signaling, but the station’s reported result data is missing.
STATION_NOT_READY	A new tag arrives at the station triggering position, but the station is still busy because it is still processing the previous tag.
STATION_NOT_TRIGGERED	The tag has passed the station location before the triggering occurs. Possible reasons: too short *distanceFromTrigger* for the pattern recognition, the simulated trigger is generated too late, or the lane speed is higher, or the acceleration is faster than what Tagsurance 3 supports.
TAG_MISSED_SYSTEM_TOO_FAST	The system reached the maximum length of an assembly mentioned in the catalog and cannot handle the upcoming tag.
TAG_NUMBER_MISMATCH	There is a tag count mismatch between the station and lane controller, causing the synchronization between two individual counters to be lost.
TAG_NUMBER_TIMEOUT	Tagsurance SL UHF could not add a tag sequence number to the station result.

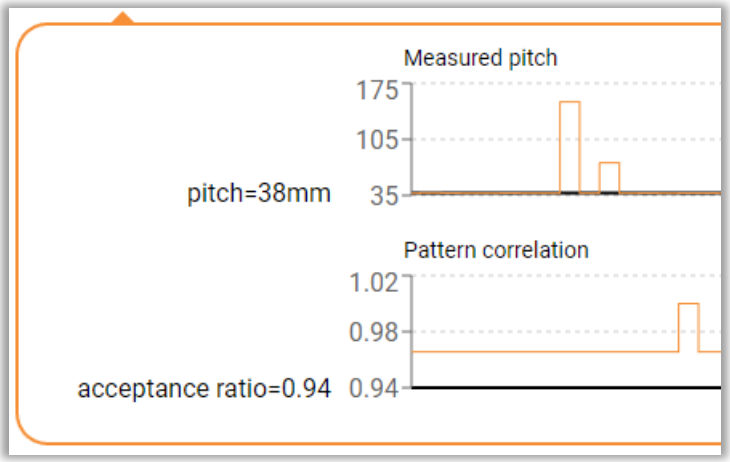
7.5 Metrics in operator UI

The system measures and calculates the movement of tags using a rotary encoder and trigger sensor. UPH, lane speed, and traveled distance are always shown, whereas the trigger metrics can be shown/hidden by the user.

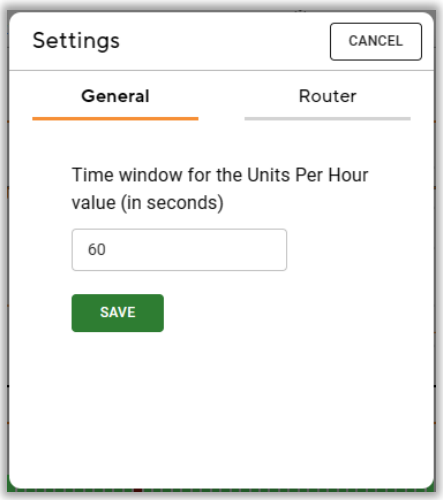


The tag pitch is always measured and shown with the pitch defined in job configuration. The pattern trigger correlation is shown only if the pattern trigger is defined in the job configuration.

If the correlation between the detected and the expected pattern remains below the acceptance ratio, the tag is not triggered and the measured pitch between triggered tags is multiplied. Non-detected or missing tags are not shown in the results unless the simulated trigger is enabled. The correlations below the acceptance ratio are not shown, and for the simulated triggers the correlation is 1.



The UPH value is calculated based on the adjustable time window. The default value is 60 seconds, in which case the presented UPH value is extrapolated based on the number of results during the past minute. Since the UPH is a value of speed, tag result types of *PASS*, *FAIL,* and *NOT_COUNTED* are taken into account in UPH calculation.



8 Hardware Maintenance

The Tagsurance controller and stations should be kept from overheating. The environmental operating temperature should be between +15°C and +35°C (59°F...95°F) for all the components.

The hardware should be kept free of excess dust.

Clean the trigger sensor lenses and rotary encoder wheel from dust and accumulated dirt as needed. Wipe the dust with a brush or wipe with a moist cloth.

Remove accumulated dust from inside Snoop Pro coupling elements (the area seen through the shielding plate opening).

Remove accumulated dust from surfaces of the Tagsurance controller. Remove accumulated dust with a gentle air blow. Remove dust with a brush as needed, and power off the hardware before brushing.

At some point, the O-ring of the rotary encoder wheel is to be replaced. The surface of a measuring wheel is subject to wear. This depends on contact pressure, acceleration behavior in the machine, traversing speed, measurement surface, mechanical alignment of the measuring wheel, temperature, and ambient conditions. We recommend you regularly check the condition of the measuring wheel and replace it as required.

Annual calibration is recommended for Tagsurance SL UHF measurement devices.

9 Technical Specifications

9.1 Lane controller

9.1.1 IO cables

The maximum length of any IO cable connected to a lane controller is 10 m (32.8 feet).

9.1.2 Trigger connector

M12, 5-pin connector (female)

PIN number	Description
1	+24 VDC, supply voltage for trigger sensor
2	N.C.
3	GND
4	TRIG, PNP input
5	N.C.

Logic levels for *TRIG* signal: V_L = 0.8 V, V_H = 2 V. Rising edge is detected as a trigger.

9.1.3 Rotary encoder connector

M12, 8-pin connector (female)

PIN number	Description
1	N.C.
2	Pulse A
3	N.C.
4	Pulse B
5	N.C.
6	N.C.
7	GND
8	+5 VDC, supply voltage for encoder

Logic levels for *Pulse A* and *Pulse B* signals: V_L = 0.8 V, V_H = 2 V

9.1.4 Station connector

In most cases it is highly recommended to use cabling provided by Voyantic. In case other cabling is used with Voyantic stations (Tagsurance SL UHF, etc.), Voyantic may not provide support when problems arise nor any warranty if the hardware is damaged due to non-Voyantic cabling.

For other uses, consult Voyantic support support@voyantic.com with specifications of what is needed and of the station to be connected. This is due to high risk of incorrect assumption of what can be done and how.

Using the station connector to drive the tag puncher, for example, is an exception to the above. For more information, see Section *5.2.4 Puncher.*

Note the *9.1.6 Power budget and current* limits

9.1.4.1 Station connector of Lane Controller 2.0

DE-15 Connector (female), in Lane Controllers with 8 station ports

PIN number	Description
1	+5 VDC
2	GND
3	INPUT A NPN (pass/fail, IO-only: pass or fail A)
4	INPUT B NPN (busy/ready, IO-only: fail or fail B)
5	INPUT A PNP (pass/fail, IO-only: pass or fail A)
6	INPUT B PNP (busy/ready, IO-only: fail or fail B)
7	RFU
8	Rotary encoder Pulse B out
9 … 10	RFU
11	PNP OUT (trigger), active state 24 V
12	NPN OUT (trigger), active state grounded
13	Rotary encoder Pulse A out
14	GND
15	+24 VDC

PNP inputs tolerate voltage levels up to 24 VDC.
The threshold level between active and passive state on the PNP inputs is about 2.4 V.

9.1.5 Machine IO connector

See the output current limits listed in Section *9.1.6 Power budget and current limits.*

9.1.5.1 Machine IO connector in Lane controller 2.0

DB-25 Connector (female)

PIN number	Description
1	GND
2	+5 VDC
3	RS232 TxD
4	RS232 RxD
5	Digital input 1 NPN (5/6)
6	Digital input 1 PNP (5/6)
7	Digital input 2 NPN (7/8)
8	Digital input 2 PNP (7/8)
9	Digital input 3 NPN (9/10)
10	Digital input 3 PNP (9/10)
11 ... 12	RFU
13	GND
14	Digital output 1 NPN (14/15)
15	Digital output 1 PNP (14/15)
16	Digital output 2 NPN (16/17)
17	Digital output 2 PNP (16/17)
18	Digital output 3 NPN (18/19)
19	Digital output 3 PNP (18/19)
20	Digital output 4 NPN (20/21)
21	Digital output 4 PNP (20/21)

22	Digital output 5 NPN (22/23)
23	Digital output 5 PNP (22/23)
24	+24 VDC
25	GND

DB-25 machine IO connector has three inputs and five outputs named according to the pin pairs. The inputs and outputs are configured by using these names.

The active state of PNP outputs is 24 V.

PNP inputs tolerate voltage levels up to 24 VDC.
The threshold level between active and passive state on the PNP inputs is about 2.4 V.

9.1.6 Power budget and current limits

The supply voltage outputs of machine I/O and station ports are designed for reference-level and control use, as well as for powering Tagsurance accessories. Third-party devices and applications are not meant to be powered by the lane controller but only controlled by it.

Description	Max value
NPN signal output (max 24 VDC)	200 mA
PNP signal output (24 VDC)	50 mA
Machine IO connector - 5 VDC supply output	200 mA
Machine IO connector – 24 VDC supply output	200 mA
Station ports 1…4 – 5 VDC supply output (combined ports 1-4)	750 mA
Station ports 1…4 – 24 VDC supply output (combined ports 1-4)	200 mA
Station ports 5…8 – 5 VDC supply output (combined ports 5-8)	750 mA
Station ports 5…8 – 24 VDC supply output (combined ports 5-8)	200 mA
Total output power of the lane controller 2.0	5 W

Note: PNP outputs on the IO breakout are powered by 24 VDC from the station port output where the IO breakout is connected.

9.1.7 Power consumption of accessories

The supply voltage outputs of machine IO and station ports are designed for signal reference and control use, and powering Tagsurance accessories. The power consumption of accessories must be considered in the total current consumption and in the power budget; see Section *9.1.6*.

Accessory / Component	Maximum current consumption
Snoop Pro 2.0 strobe feature (5 VDC)	150 mA [1)]
Snoop Pro Mini 3.0 strobe feature (5 VDC)	150 mA [1)]
Snoop Pro Tiny 2.0 strobe feature (5 VDC)	75 mA [1)]
Strobe Light 2.1 (5 VDC)	75 mA [1)]
IO breakout total (24 VDC) single PNP output (24 VDC)	150 mA [2)] 50 mA [2)]

1) Current consumption at maximum lane speed with minimum tag pitch
2) The current consumption depends on the connected device; the values shown are maximum limits. One IO breakout can fully consume the maximum current at 24 VDC per connector group.

The lane controller's output power rating should be considered when designing the system setup. It is recommended to leave some margin between the maximum load current and the lane controller's current limits.

9.1.7.1 Example of the maximum number of connected accessories

3 stations equipped with both Snoop Pro coupling elements and external strobes connected to one lane controller 2.0	
Strobe Light 2.1 (5 VDC)	3 pcs
Snoop Pro 2.0 or Snoop Pro Mini 3.0 with strobe feature (5 VDC)	3 pcs
	Total 6 pcs
Limited by the maximum current of station ports 1…4	

8 stations equipped with both Snoop Pro coupling elements connected to one lane controller 2.0	
Snoop Pro 2.0 or Snoop Pro Mini 3.0 with strobe feature (5 VDC)	6 pcs
Limited by total power consumption	

9.2 Standard Tagsurance 3 device IO port

DA-15 connector (female)
Devices such as *Tagsurance SL UHF* have this connector.

PIN number	Description
1	N.C.
2	RFU
3	GND
4	GND
5	TRIG -
6	TRIG +
7	Busy/Ready
8	Pass/Fail
9	RFU
10	RFU
11	+5 VDC [1]
12	Logic 0-level reference
13	Logic 1-level reference
14	RFU
15	RFU

1) The maximum output current is 20 mA for Tagsurance SL UHF.

The high and low levels of the output pins 7 and 8 are set by the pins 12 and 13. The voltage level of pin 13 must be higher than the voltage of pin 12.

The trigger signal is a 5-24 V differential signal between pins 5 and 6. If a unipolar signal is preferred, pin 5 can be grounded to either pin 3 or pin 4.

9.3 Digital signals of IO Breakout

10-pin terminal block header (green) MC 1,5/10-GF-3,81

All signals are outputs.
The active state for PNP outputs is 24 V.

The power for PNP outputs is taken from the lane controller's station port 24 VDC pin, and the current consumption at IO breakout's output must be considered in lane controller's power budget. See *9.1.6 Power budget and current* limits.

An example of compatible connectors is the connector with screw terminal "MC 1,5/10-STF-3,8" supplied with the IO breakout.

9.4 Station locations

Requirements for the relative station positions are set to ensure proper operation of all system features.

Minimum distance from the trigger sensor to a station [1]	Tag pitch or 60 mm, whichever is greater
Minimum distance between stations	50 mm
Minimum distance between the last station and the lot change location [2]	50 mm

1) The exception is the 0 mm distance from the trigger sensor. The 0 mm distance from trigger value sets the system to trigger the station instantly after the lane controller receives a trigger signal. See the use case in Section *5.2.1 Distance from trigger*.
2) The lot change location must be defined only when the external lot change control is enabled.

9.5 APIs

9.5.1 REST API

Documentation, versioning, and API support life cycle information can be found on the Tagsurance 3 system at: `https://[system IP address]/api-docs`

With a direct connection to Router port#2: https://10.10.30.10/api-docs

9.5.2 AsyncAPI

Documentation, versioning, and API support life cycle information can be found on the Tagsurance 3 system at: `https://[system IP address]/async-api-docs`

With a direct connection to Router port#2: https://10.10.30.10/async-api-docs

9.5.3 Recipe Service

Documentation can be found on the Tagsurance 3 system at: `https://[system IP address]/recipe/v1/api-docs`

With a direct connection to Router port#2: https://10.10.30.10/recipe/v1/api-docs/

9.5.4 Authentication API

Documentation can be found on the Tagsurance 3 system at: `https://[system IP address]/auth-api/v1/api-docs`

With a direct connection to Router port#2: https://10.10.30.10/auth-api/v1/api-docs

9.5.5 Update Service

Documentation can be found on the Tagsurance 3 system at: `https://[system IP address]/us/v1/api-docs`

With a direct connection to Router port#2: https://10.10.30.10/us/v1/api-docs

9.6 Tagsurance SL UHF

9.6.1 RF performance

See specifications in the Tagsurance 3 Product catalog.

9.6.2 RF cables

The maximum length of an RF cable between the Tagsurance unit and the Snoop Pro coupling element is 5 meters (16.4 feet).

9.6.3 Protocol parameters

9.6.3.1 ISO 18000-63

Query parameters

Parameter	Value
DR	64/3
M	1 (FM0)
TRext	use pilot tone
Sel	All
Session	S0
Target	A
Q	0

Timing parameters

Parameter	Value
BLF	320 kHz
Tari	12.5 µs
PW	0.395 * Tari
data-1 length	1.75 * Tari
RTcal	2.75 * Tari
TRcal	DR / BLF

9.7 Tagsurance HF

9.7.1 RF performance

See specifications in the Tagsurance 3 Product catalog.

9.7.2 RF cables

The maximum length of an RF cable between the Tagsurance unit and the Snoop Pro coupling element is 5 meters (16.4 feet).

9.7.3 Protocol parameters

9.7.3.1 ISO15693

- Forward link
  - ASK 100%
  - 26.48 kbps (fc/512)

- Reverse link
  - Single subcarrier + “High data rate”, 26.48 kbps (fc/512)
  - Manchester

9.7.3.2 ISO14443A

- Forward link
  - ASK 100%
  - Modified Miller, 106 kbps (fc/128)

- Reverse link
  - OOK (ASK 100%)
  - Manchester 106 kbps (fc/128)

9.7.3.3 ISO 14443B

- Forward link
  - ASK 10%
  - NRZ, 106 kbps (fc/128)

- Reverse link
  - BPSK
  - NRZ-L, 106 kbps (fc/128)

9.7.3.4 FeliCa

- Forward link
  - ASK 20%
  - Manchester, 212 kbps (fc/64)

- Reverse link
  - ASK
  - Manchester, 212 kbps (fc/64)

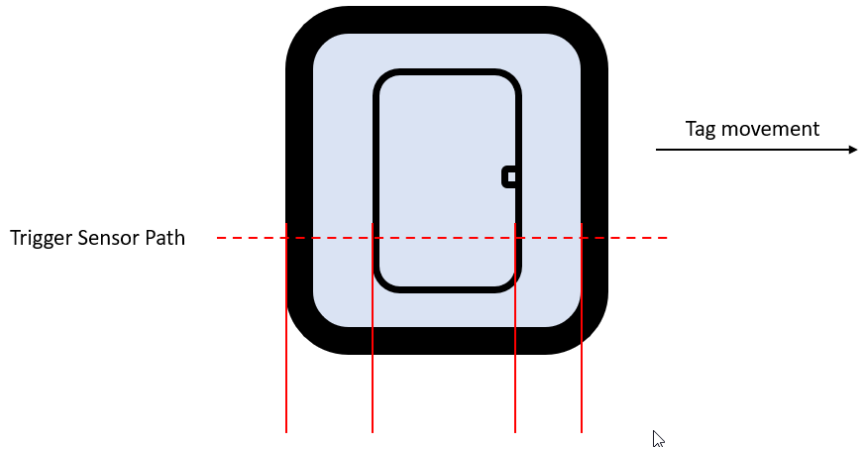
9.7.3.5 ISO 18000-3M3

- Forward link
  - ASK 15%
  - Tari: 25 µs
  - RTCal: 75 µs (3x Tari)
    - “0” length 25 µs (fc/339)
    - “1” length 50 µs (fc/678)
- Reverse link
  - ASK
  - FM0, 424 kbps (fc/32)
  - Using pilot tone

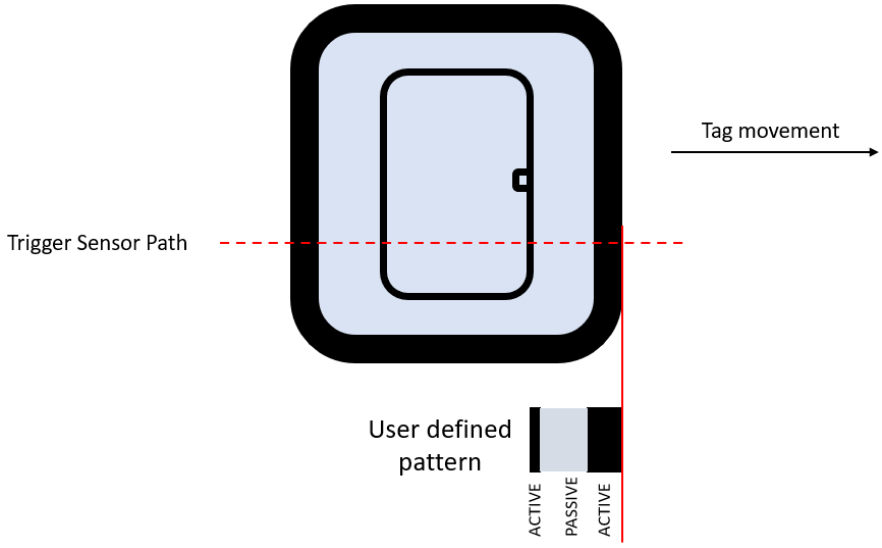
10 Appendix: How to Configure the Pattern Trigger

10.1 What is the Pattern Trigger

Instead of triggering the system every time the trigger sensor is detecting a change between passive and active area, a trigger can be made to only trigger if a predefined pattern of passive and active areas is detected.



Edge Trigger: a tag is triggered at each detected edge -> 4 triggers per tag

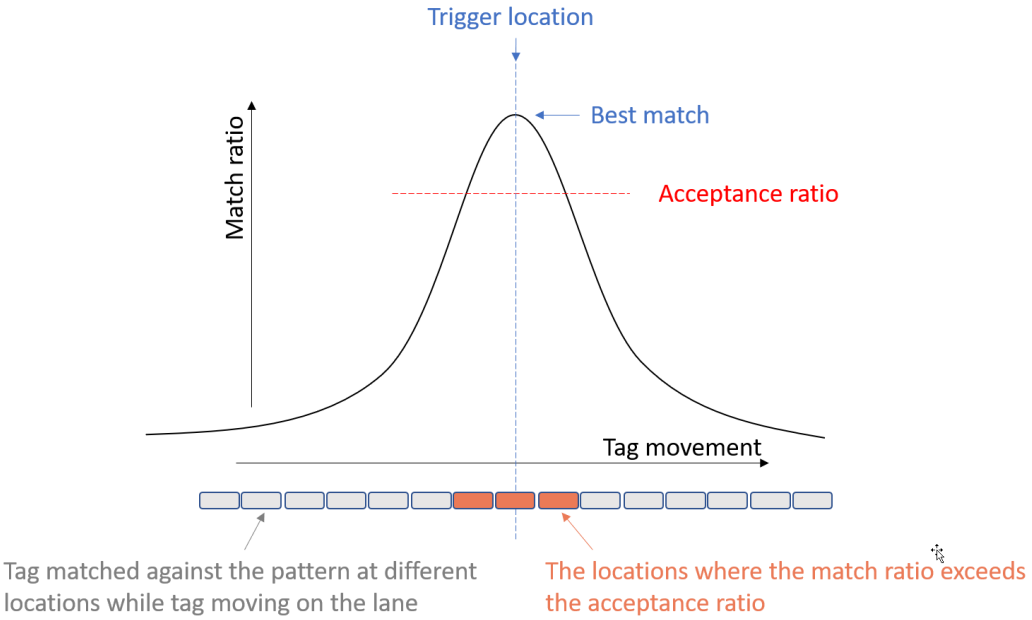


Pattern Trigger: a tag is triggered only when the pattern match is found -> 1 trigger per tag

The active and passive areas depend on the trigger sensor settings. In this document the RFID tag's antenna features are expected to be the sensor's active areas as shown in picture above.

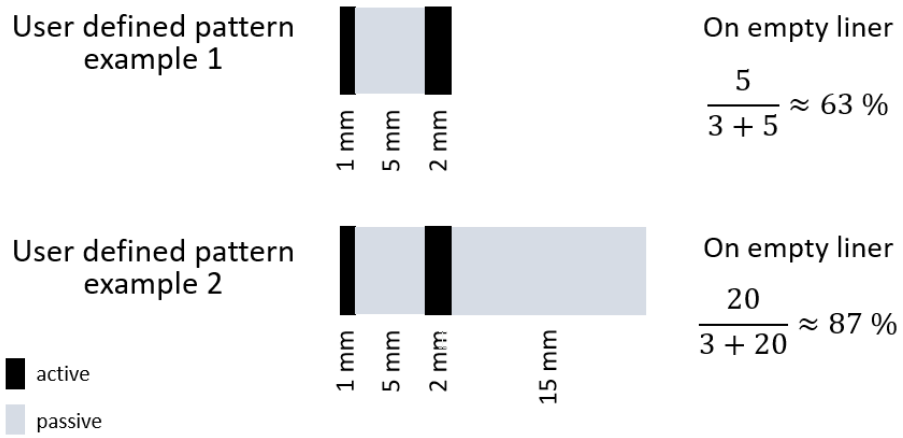
10.2 How Pattern Trigger Works

The pattern detection attempts to find the best possible match for the length of the defined *tag pattern* as long as the pattern match ratio stays above the *tag pattern acceptance ratio*. On the other words, as soon as the match ratio increases above the limit, the system keeps recording the positions of match ratios until the match ratio drops below the limit. At that time the location of the best match is determined based on the records and set as trigger location retroactively.



If the acceptance ratio has been set so low that the pattern matches above the criteria all the time, the algorithm cannot define the trigger position. After a valid match, the matching pattern ratio must decrease below the criteria limit before another match is detected.

The matching calculation takes all defined sections into account, not only the active sections. When having a lot of passive area compared to active area in the defined pattern, the matching ratio is high even on top of the empty liner.

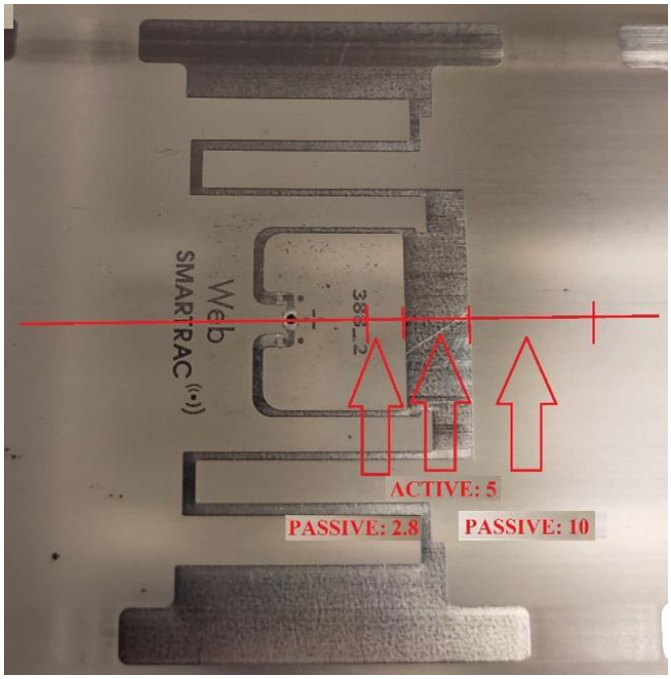


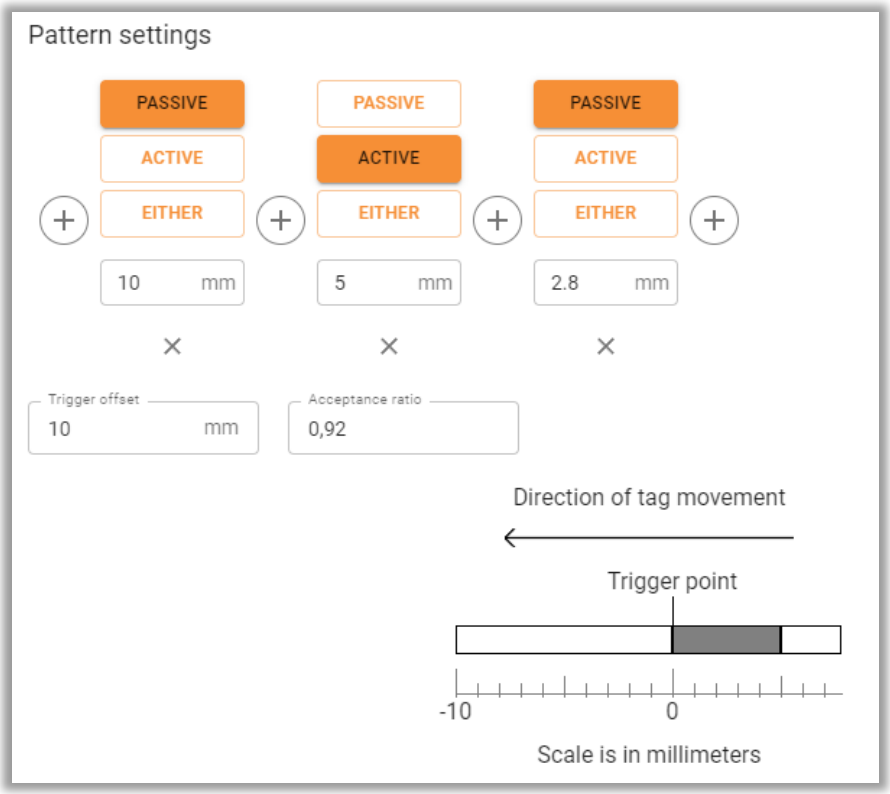
It is important to understand how the passive area in the pattern affects the ratio calculation and use passive areas in a way to help make the pattern unique but no extra.

10.3 Pattern Trigger Configuration

10.3.1 Active and Passive Sections

Configure the trigger settings according to the pattern sections the trigger sensor is detecting.





Pattern Trigger settings in Tagsurance 3 operator UI
Note: the tag movement is exceptionally from right to left

In case the tag antenna has similar features sequentially, you can make sure the first feature is found correctly by adding a long enough passive section before the first feature of the tag antenna. The first passive section presents a part of the clearance between antennas. However, the passive section must not be any longer what is really needed. The unnecessary long passive section affects the active/passive relation and the pattern detection. Low active/passive relation may cause misdetections. See the Section *10.2 How Pattern Trigger Works*.

10.3.2 Trigger Location Offset

In the example above, the pattern begins with a passive section. By default, the trigger point will be set at the beginning of the pattern. A station, e.g. Tagsurance SL UHF, is triggered when the tag's trigger point reaches the test antenna position on the lane.

With the *trigger location offset* you can move the trigger point past the passive section to the beginning of tag antenna feature. Tagsurance 3 UI shows the trigger point based on the defined offset value. See the figure above.

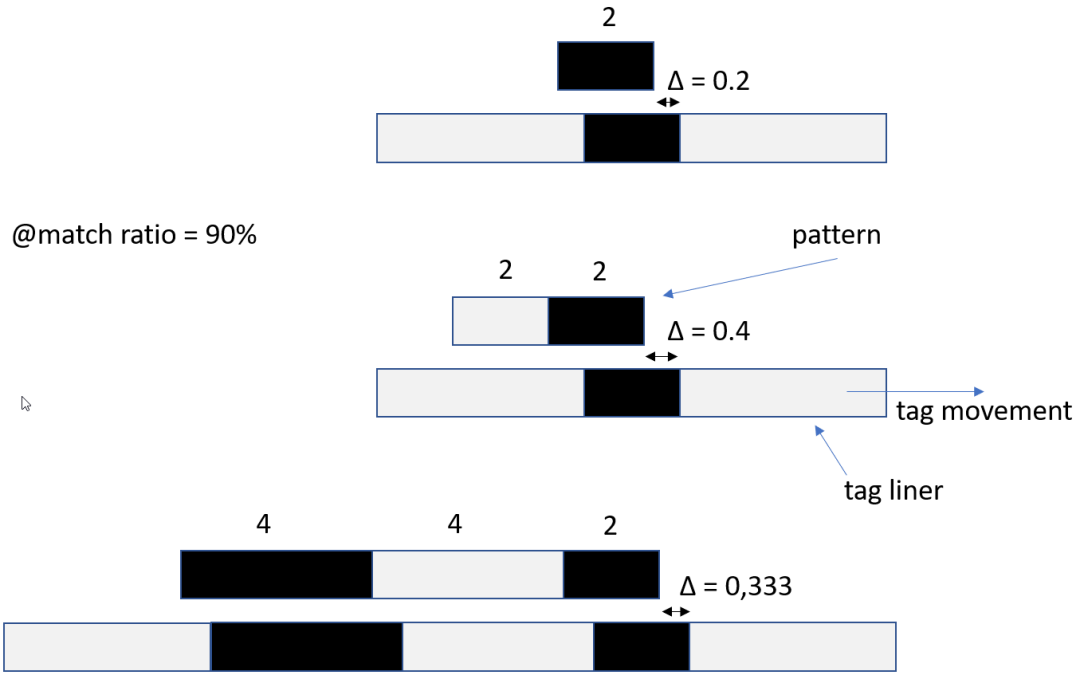
10.4 Simulated Triggers

Tagsurance 3 system has a feature to create simulated triggers when a tag is not detected because it is missing, or the sensing has failed. The simulated trigger is created after a tag pitch since the previous trigger. It does not matter if the previous trigger is based on a true detected tag or is a simulated one. The simulated trigger is created if the given travel in addition to the pitch is past since the last trigger.

10.4.1 Simulated Trigger with Pattern Trigger

When the simulated trigger is activated, its parameter *simulateTriggerWhenPastPitchMm* must be set long enough to allow the pattern trigger detection to work properly. See the section *10.2 How Pattern Trigger Works.*

The pattern trigger detection creates a trigger retroactively when the match ratio decreases below the acceptance level. That happens later than where the best match is located, so the distance between the best match and the match ratio decreasing under the acceptance level is required to be scanned before the trigger simulation is allowed to happen. This extra travel must be taken into account when defining the simulated trigger's parameter *simulateTriggerWhenPastPitchMm*.

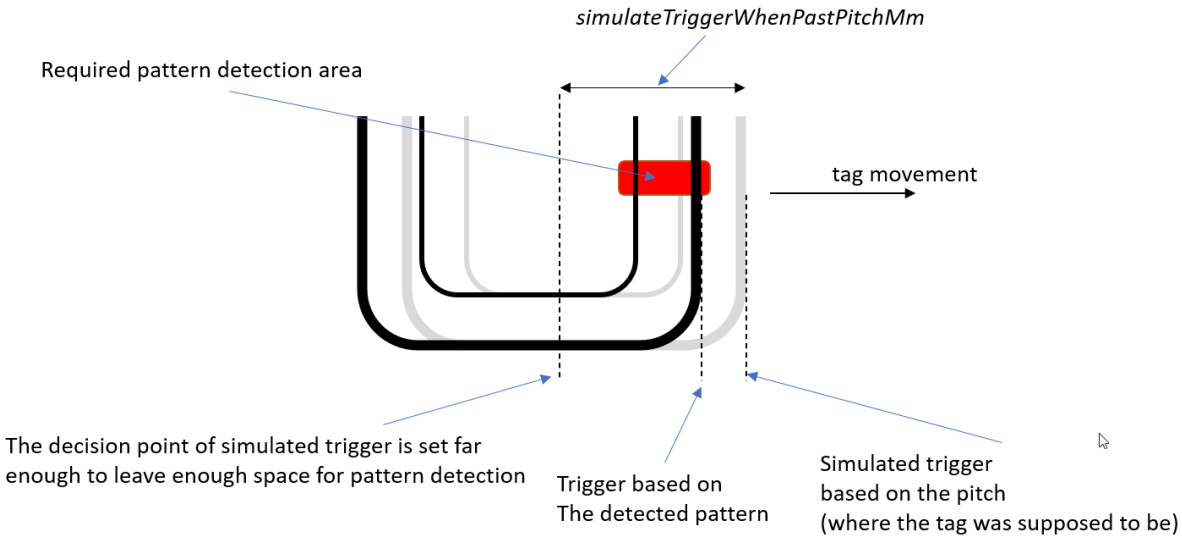


The examples of pattern offsets that reaches the acceptance ratio of 90%

Since the trigger sensor scans the liner at a static location, the entire pattern must travel past the sensor to be detected.

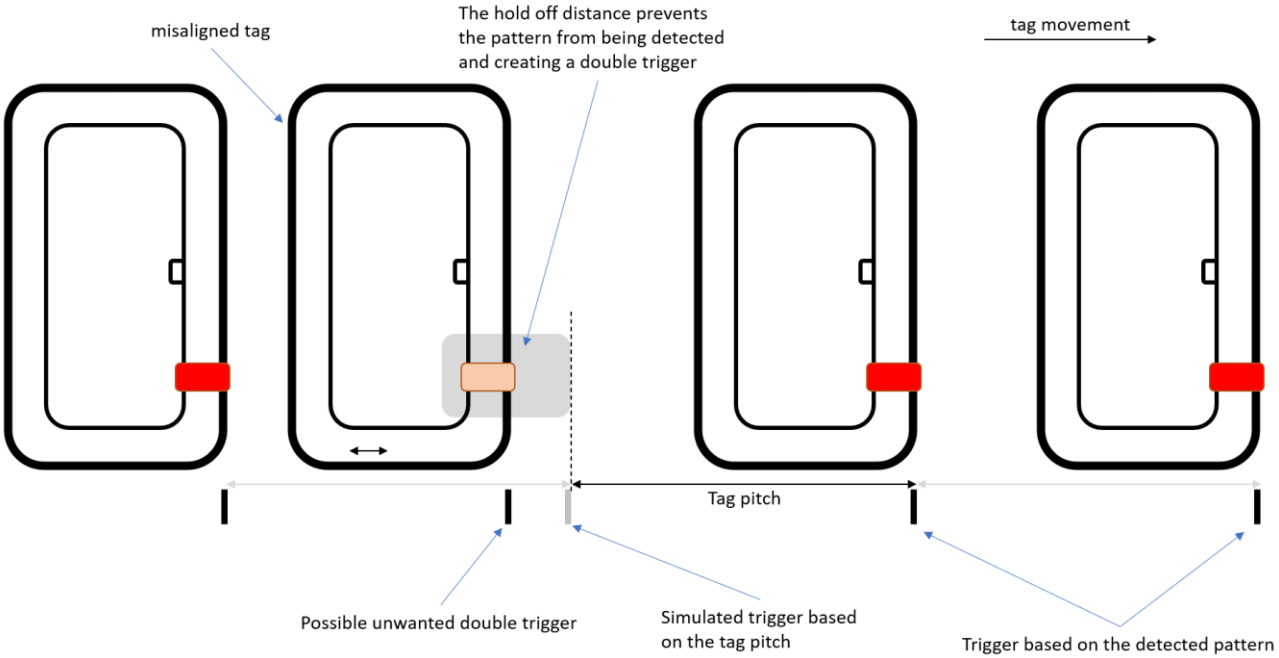
As a summary, the *simulateTriggerWhenPastPitchMm* parameter must be more than the sum of the pattern length and the required offset due to the acceptance ratio decrease. In case of the longest pattern in the picture above, the *simulateTriggerWhenPastPitchMm* must be greater than 10.4 .

In the picture below, the tag is misaligned, and the pitch is longer than expected. The *simulateTriggerWhenPastPitchMm* is set long enough, and the tag can be triggered based on the pattern. A new pitch calculation starts from the pattern-based trigger point.



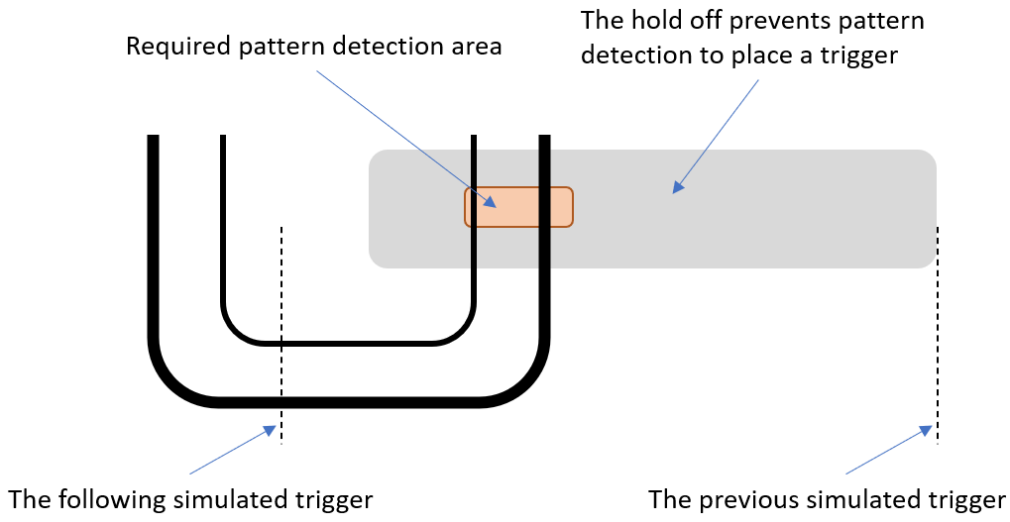
10.5 Hold Off Distance

To prevent unwanted additional triggers, the system trigger can be put on hold after each trigger point for a specified distance. During the hold off distance, the edge and the pattern-based triggers are ignored.
Note: the simulated trigger is the exception here.



The hold-off distance must be used carefully. Do not use longer hold-off distances than necessary. Especially with simulated trigger, there is a high risk the trigger point may not recover to the correct one after a one missed trigger point.

In the picture below, the simulated trigger is very off where the tag exists, and the hold off distance prevents the trigger placement based on the pattern detection. In this case, the system cannot recover to trigger the tags at correct positions, but triggers are only simulated at wrong positions.



10.6 Summary of Pattern Trigger Configuration

- What are the tag antenna features or trigger mark size the trigger sensor detects on its path.
- Define a unique pattern and use passive areas as much as really needed but no extra.
- Give enough distance for the pattern detection to complete before forcing the simulated trigger (simulateTriggerWhenPastPitchMm >> pattern length).
- Make the hold of distance only as long as really needed.
- Consider carefully whether the simulated trigger or the hold of distance are needed.