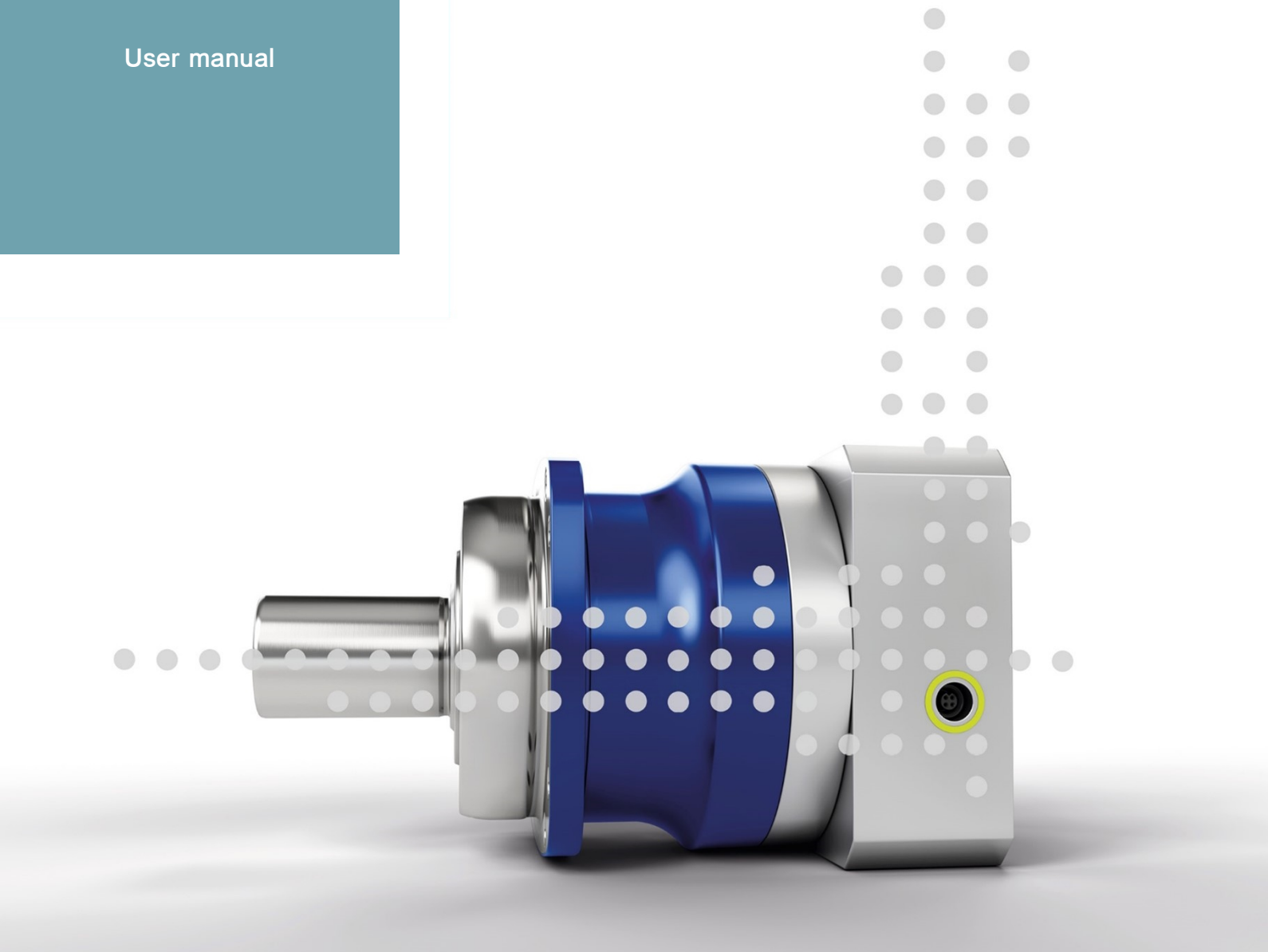
WITTENSTEIN

User manual

Smart Service
cynapse® Analyze



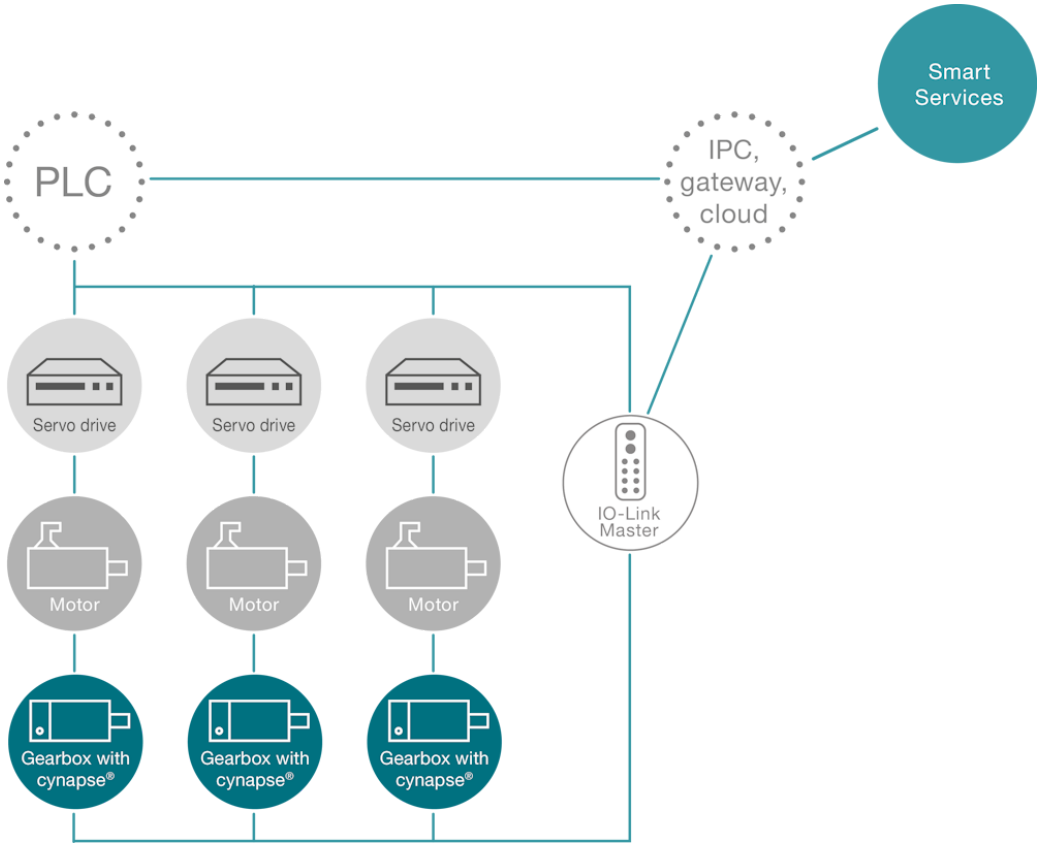
This document describes the features of the Smart Service **cynapse®** **Analyze** in the version **2.0.0**.

For older versions, please contact cybertronic-support@wittenstein.de

System requirements

The WITTENSTEIN Smart Services are based on the hardware abstraction via the container virtualization and support various daten sources and manufacturers.

We recommend a system setup with an IPC as a Docker host or the use of the Bosch Rexroth ctrlX CORE as well as systems with ctrlX OS in combination with cynapse® sensor cubes as data sources and an IO-Link master as part of the infrastructure.



Using this system as an example, the gearboxes with cynapse® are connected to an IPC/gateway via an IO-Link master in addition to the PLC via a separate network connection. This IPC serves as a Docker host and offers the option of integrating additional machine data from the PLC or sending data to the cloud using WITTENSTEIN's Smart Services.

Data sources

The following sources are supported for communication between WITTENSTEIN Smart Services and the cynapse® Sensor Cube:

- IO-Link master with integrated OPC-UA server according to Companion Specification "OPC-UA for IO-Link"
- ifm IO-Link master (e.g.: AL13xx, AL19xx)
- Pepperl+Fuchs or Comtrol with integrated OPC-UA server (e.g.: IEC2-8IOL or IEC3-8IOL)

Furthermore, OPC-UA servers (e.g.: SIMATIC S7-1500 OPC-UA server) are supported as a data source to integrate machine data.

Host

- IPC for running Smart Services using Docker from version 2.5.0.1.
- Bosch Rexroth ctrlX CORE or systems with ctrlX OS.

The requirements for running WITTENSTEIN Smart Services using Docker are:

- 64-bit kernel and CPU support for virtualization
- KVM virtualization
- QEMU in version 5.2 or later
- systemd init system
- At least 4 GB of RAM

(Source: https://docs.docker.com/desktop/install/linux-install/)

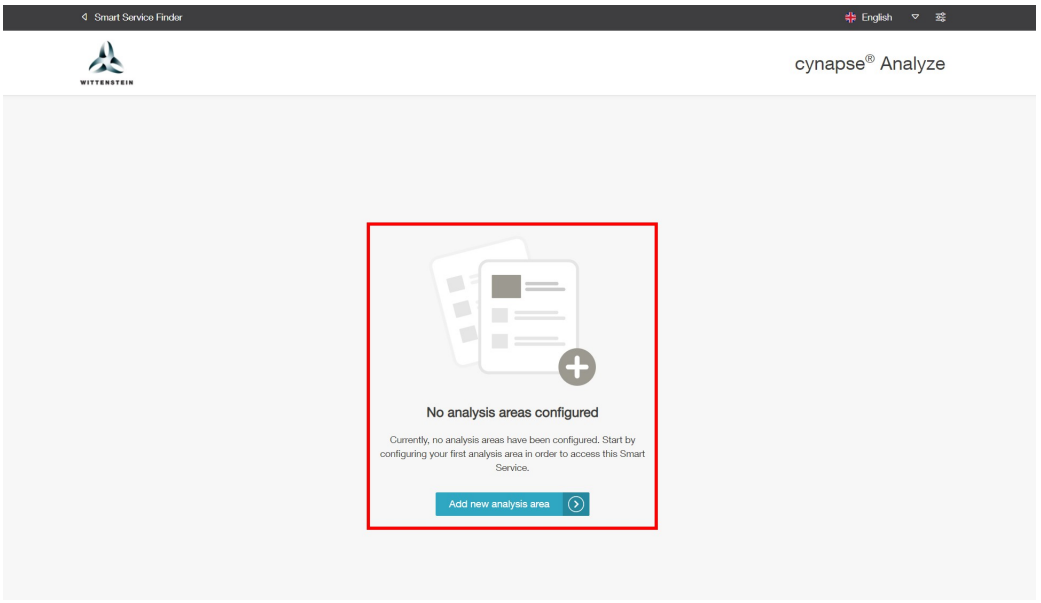
This user manual explains the functionalities and setup instructions of the WITTENSTEIN smart service **cynapse® Analyze**.

cynapse® Analyze consists of several **analysis areas**, each of which can be activated and configured separately. Each analysis area provides analysis and interpretation functionality regarding a certain aspect of your machine's condition and health using data from cynapse® Sensor Cube and external data sources.

Overview and Setup

All analysis areas perform their analyses on a per-drive-train level. Therefore, you must configure at least one drive train in cynapse® Connect in order to fully leverage the abilities of cynapse® Analyze and its analysis areas. The specific requirements to the drive trains are different depending upon the analysis area and are described in the following chapters.

After installing cynapse® Analyze, you will be welcomed by the following view:

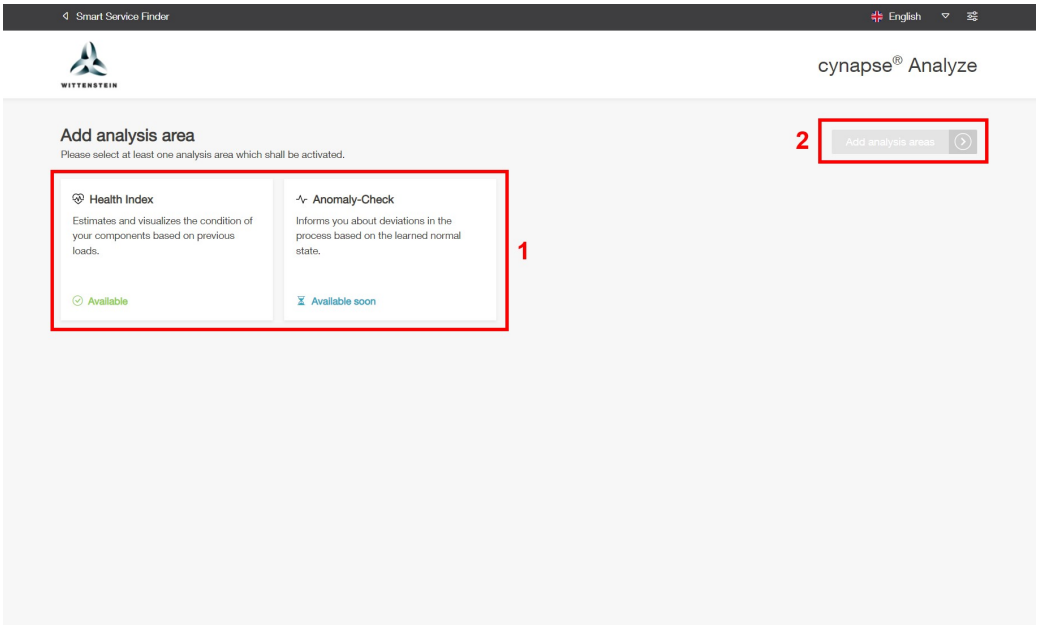


First, click the *Add new analysis area* button in order to activate the analysis areas you want to use.

All analysis areas are presented in the following chapters of this manual.

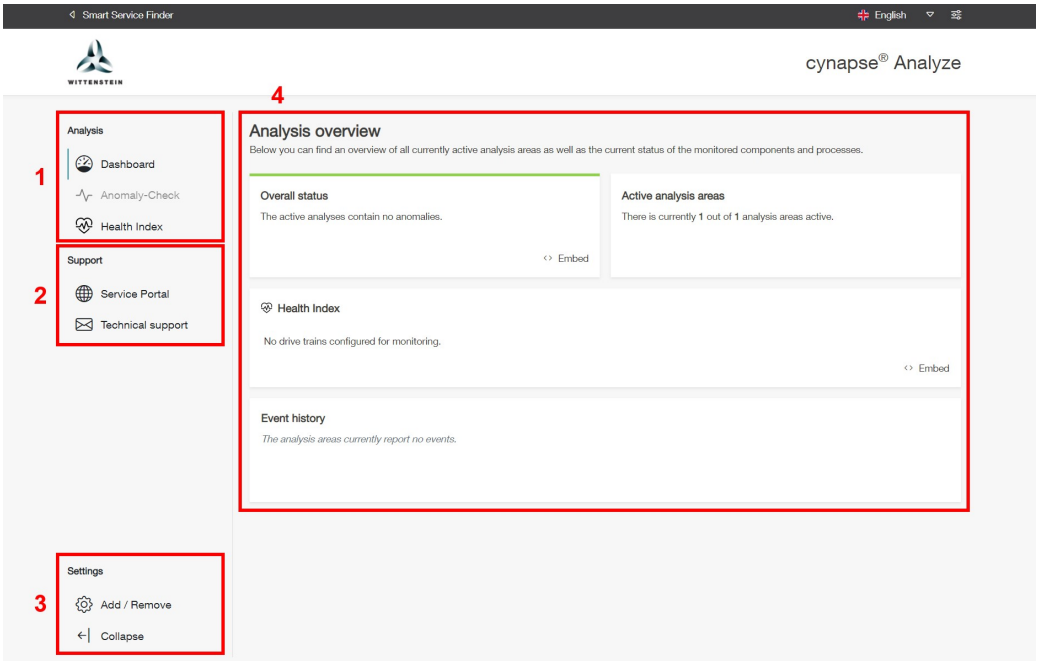
> ***Note**: You can only activate analysis areas which are included in the license you purchased. If you have any questions regarding licensing, please contact our support.*

1. Select one or more analysis areas you wish to enable initially. The detailed configuration of the analysis areas is done independently of the initial selection.
2. After selecting at least one analysis area, the button for applying your changes will be unlocked.



After the initial activation of the wanted analysis areas, you will see the following page:

1. Switch between the dashboard and the individual analysis areas. Note that deactivated analysis areas will be grayed out.
2. Contact WITTENSTEIN. The available contact methods are explained in the section below.
3. The *Settings* section allows you to enable and disable analysis areas after the initial setup. To do this, open the *Add / Remove* page. Also, you can collapse and expand the sidebar.
4. To the right of the menu bar, you will see the dashboard or the analysis area UI. The main dashboard presents to you the following information:
    - **Overall status** | Shows the combined status of all analysis areas. This value can also be queried using the REST API which is described through the *Embed* option.
    - **Active analysis areas** | The number of enabled analysis areas out of the total number of available analysis areas.
    - Next, each analysis area displays its own overall status in a separate tile. These statuses can also be queried using the REST API. Alternatively, the entire tile can be embedded in any arbitrary HTML page. Both options are described through the *Embed* option.
    - **Event history** | Displays significant events which are reported by the analysis areas.



Contact and Support

Within the Smart Service cynapse® Analyze, we offer the following contact channels, which can be found in the menu bar in the **Support** section:

- **Service Portal** | Displays all assets which are currently connected to your cynapse® Connect instance. The information presented contains the serial number, ordering code as well as a direct link to our WITTENSTEIN Service Portal. There, you can find further information and documentation for the corresponding product such as technical documentation, manuals, tutorial videos and firmware files.
- **Technical support** | Consider this option when have an individual support inquiry:
  - *Customer support*: Contact our customer support via telephone or E-Mail when you have any questions regarding our standard products.
    - +49 7931 493-10900
    - service@wittenstein.de
  - *Data export*: Use this option to download a file containing all analysis-related data stored in the Smart Service. You can send this file to our *cybertronic Support* (cybertronic-support@wittenstein.de). Our support engineers are happy to analyze and evaluate the data to help you diagnose issues and improve your application.

Analysis Areas

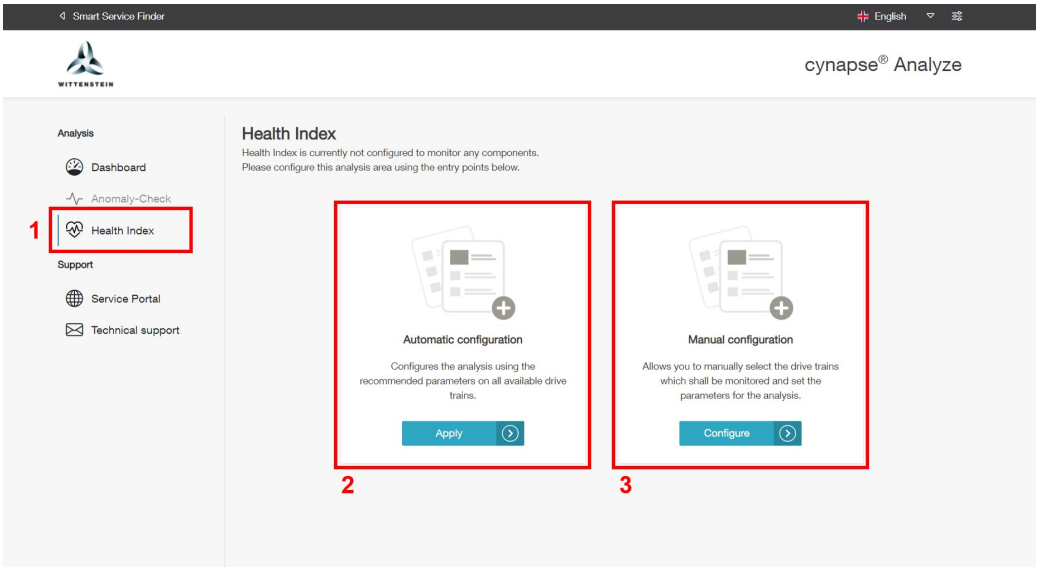
In the following sections, all available analysis areas are described in detail.

Analysis Area: Health Index

Health Index uses sensor data from your machine in order to compute an estimation of the current health status of your gearboxes, allowing you to detect unexpectedly high wear and maintain or replace your gearboxes before they break down.

In order to use the Health Index (`1`), you need to set up at least on drive train in the Smart Service cynapse® Connect. If done properly, you can use the automatic configuration (`2`) which activates monitoring for all compatible drive trains. If an automatic set up is not available, you can refer to the manual configuration page (`3`) to find out what issues cause the automatic configuration to fail. Also, you can use the manual configuration if you wish to select, which drive trains shall be monitored by Health Index.

> ***Hint**: The required steps to achieve an example drive train configuration, which can be used for the Health Index, is presented in a subsequent section.**



As soon as you elect at least one drive train for monitoring, you can see the Health Index dashboard which is described in the following section.

Monitored Drive Train Overview

This overview displays detailed information about the current health status of all drive trains which are currently monitored. In the following, all components of this page are described.

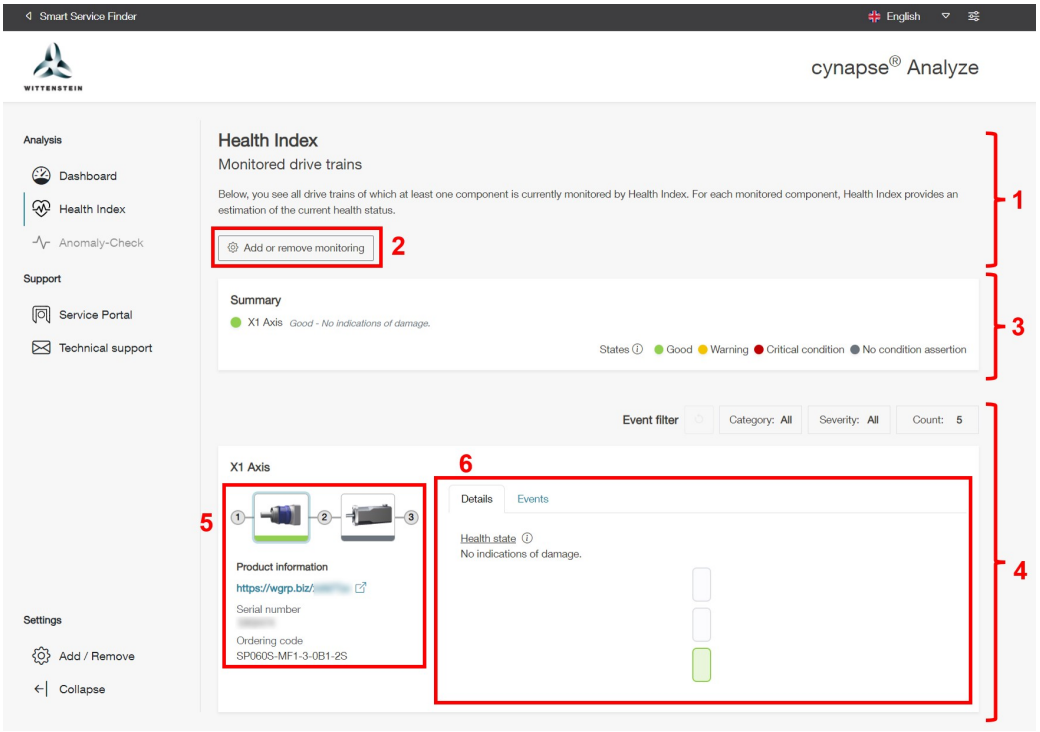
1. The header displays general information.
2. By clicking the *Add or remove monitoring* button, you can retroactively disable or enable the monitoring of drive trains which are currently (not) monitored.
3. The upper tile shows a summary of all monitored drive trains as well as a legend depicting the meaning of the used color code. Further information about this tile is given in the section *Overview Tile*.
4. The area below shows the available filter options for events and one tile for each monitored drive train.
5. On the left hand side, each component of the drive train is displayed along with its current status. The status is indicated using the color code described in `1` . Additionally, the colored bar is displayed hatched in the case that the monitoring is currently paused, for example due to interrupted input data.

   > ***Note**: With supported gearboxes, the drive train illustration will show the correct gearbox type.*

   You can click on the individual components of the drive train to view component-specific information such as asset ID, serial number or ordering code as well as the details and events.
6. On the right side, you see details of the selected component's status as well as a list of events related to the monitoring of this drive train:
   - **Threshold exceeded events** | This event type symbolizes that the total accumulated damage to a certain component exceeded a specific threshold which caused the status color code to change.
   - **Interrupted events** | Events of this type are generated whenever the monitoring of any component is temporarily paused to external influences. The events are decorated with further information that aims to help debug the issue and possible causes can be the following:

- Missing data: One or more of the required data points was not received for a duration of 20 seconds or longer. This forces the model execution to halt until new data points are received.
- Service shutdown: The Smart Service cynapse® Analyze was shut down for a duration of 20 seconds or longer. This is expected during an update of the Smart Service.

The event history also offers basic search functionality which allows you to filter for certain types of events and limit the number of displayed entries.

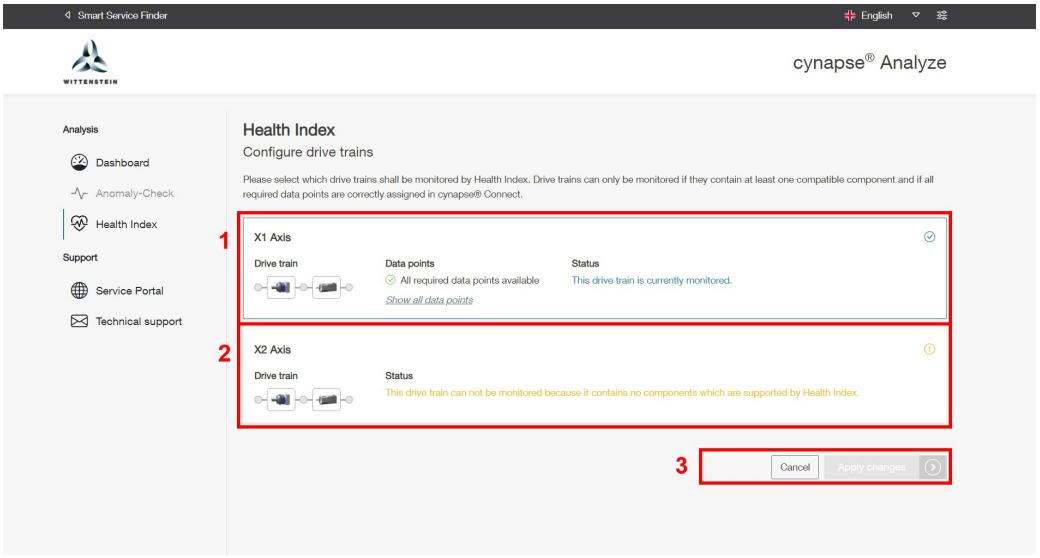


Manual Configuration

The manual configuration page displays all drive trains which are currently configured in cynapse® Connect, regardless of their current monitoring state. In addition, you can see, which of those drive trains are supported by Health Index and which ones not. Also, for the latter, it is shown, what causes the incompatibility.

1. An example drive train which contains a compatible gearbox and all data points required for monitoring are correctly configured in cynapse® Connect.
2. Another drive train that, unlike the first one, cannot currently be activated.
3. When one of the above drive trains is selected or deselected, the button for applying the changes becomes available.

> ***Note**: If the underlying configuration of a currently monitored drive train changes in such a way that makes the drive train incompatible with Health Index, applying the changes will **always** disable monitoring of that drive train.*



Data Points

For each drive train with a compatible asset, Health Index also displays the necessary data points for monitoring that drive train.

1. All required data points are available. For brevity, only a short notice is displayed. However, you can expand the list and view a list of all data points (see `2`).

2. All required data points are available and the full list was expanded. Each data point is listed along with its physical quantity, location (component input/output) and unit.

   - A *calculator* symbol means that the data point can be calculated using one or multiple of the other available data points.
   - A *person with checkmark* symbol means that the data point is a user defined constant which was configured in cynapse® Connect.

   > ***Note**: Internally, Health Index also uses additional data points which are not displayed in this view. These data points are gearbox-specific constants which can not be changed by the user.*

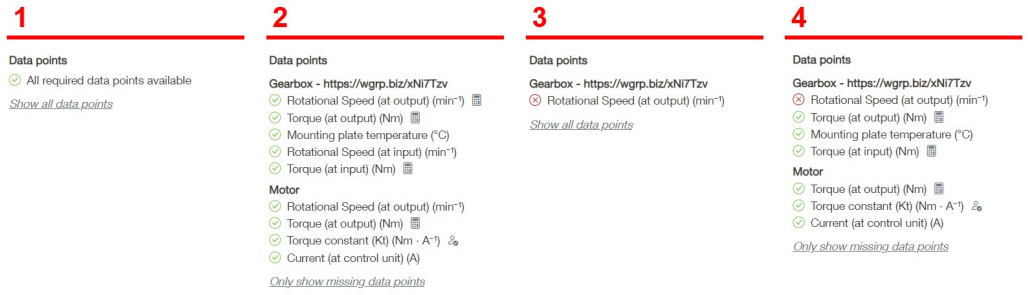
   You can switch back to the original view (`1`) using the link below the list.

3. In this case, at least one data point which is required for monitoring the drive train is missing. For brevity, only the missing data points are displayed. However, you can expand the list and view a list of all data points including all available and missing ones (see `4`).

4. At least on data point is missing and the full list was expanded. Similar to `2`, the expanded list shows all data points required for monitoring. The data point description and the symbols next to the data points follow the same pattern as described above.
   Missing data points are indicated using a red cross instead of the green check mark. In order to activate the monitoring of the drive train, you must first update the drive train configuration such that all missing data points are available by:

   - assigning the data point manually in cynapse® Connect
   - assigning related data points which can be used in order to calculate the missing data point

   You can switch back to the original view (`3`) using the link below the list.

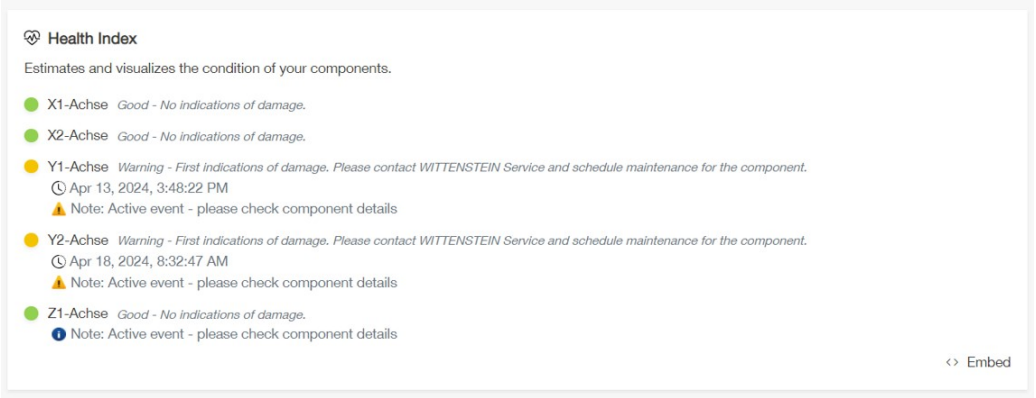


Overview Tile

On the cynapse® Analyze home page and on the monitoring overview of the Health Index, there is a tile which presents the current state of all monitored drive trains. This tile can be embedded into your customer specific application using the *Embed* feature.

> ***Hinweis**: Embedding can be done using an HTML-* `<iframe>` *or the service's REST API.*

An overview tile of a fully configured Health Index installation might look like the following:



Compatible Gearboxes

The following gearboxes are currently supported by Health Index:

- Oil-lubricated gearboxes with the type codes **SP** and **TP** from *alpha Advanced Line* with the exceptions of TP2000S and TP4000S.
- Oil-lubricated gearboxes with the type codes **XP** and **RP** from *alpha Premium Line*.
- Hypoid gearboxes with type codes **HG+**, **SK+**, **SPK+**, **TK+** and **TPK+** from *alpha Advanced Line*.
- Hypoid gearboxes with type codes **XPK+** and **RPK+** der *alpha Premium Line*.
- Bevel gearboxes with type codes **SC+**, **SPC+** and **TPC+** from *alpha Advanced Line*.
- Bevel gearboxes with type codes **XPC+** and **RPX+** from *alpha Premium Line*.

Data Point Calculations

The following calculations can be done within Health Index:

Input value	Output value	User defined constants	Reverse possible?	Notes
Current (Motor)	Torque (Motor output)	k_t factor	**No**	

Rotational Speed (Gearbox input)	Rotational Speed (Gearbox output)	*None*	**Yes**	
Torque (Gearbox input)	Torque (Gearbox output)	*None*	**Yes**	To maximize accuracy, rotational speed should be available at gearbox input or output.

Example Configuration in cynapse® Connect

In order to use Health Index with all its capabilities, the following data points must either be explicitly assigned or computable using the calculation formulas described above:

- Temperature of the gearbox adapter plate. By default, this value is provided by the cynapse® Sensor Cube mounted to your adapter plate.
- Rotational speed of the gearbox output. Alternatively, you can provide the gearbox input speed and Health Index calculates the output speed using the known gearbox parameters.
- Torque at the gearbox output. Alternatively, you can provide the gearbox input torque and Health Index calculates the output torque using the known gearbox parameters. Gearbox input torque can either be provided directly or you can specify the motor current and its k_t factor.

An example cynapse® Connect configuration can be created by following these steps:

1. Make sure there exists a machine configuration with at least one drive train in cynapse® Connect.
2. Assign one of the connected assets by clicking on the gearbox icon and selecting from the dropdown.
3. Assign rotational speed of the gearbox input or output to the corresponding connector `1` *or* `2`.
4. Choose one of the following two alternatives:
    1. Assign torque at the gearbox input or output to the corresponding connector `1` *or* `2`.
    2. Assign motor current at the connector `3` *and* specify the motor's k_t factor by clicking on the motor icon and entering the value.

> ***Note**: The required data points must be configured in an external data source such as an OPC-UA server.*

Handling of Changed cynapse® Connect Configuration

If you retrospectively change the drive train configuration or asset assignment in cynapse® Connect, Health Index will automatically be informed about the changes and will react accordingly as described in the following.

- If you delete a drive train, no recorded data will be deleted in cynapse® Analyze. Health Index will always store damage-related data on a per asset level instead of per drive train.
- If you create a new drive train, the monitoring by Health Index will not be started automatically. You must manually enable monitoring of new drive trains.
- If you change the assignments of assets to drive trains, Health Index will attempt to monitor the same drive trains as before, rather than the same assets. Therefore, changing the asset assignments may cause drive trains which have previously been monitored to become suspended due to missing data points or asset incompatibility. If this is the case, Health Index will display a warning on the dashboard which prompts you to fix the configuration.

Analysis Area: Anomaly Check

The analysis area *Anomaly Check* is still under development and will be available in a later version of cynapse® Analyze.

Data Export

The data export contains all stored data which is generated in the context of the *Health Index* analysis area.

> ***Note**: The data export is protected such that only our WITTENSTEIN cybertronic support can read the contents.*