ENGINEERING
TOMORROW

Programming Guide

VLT® Condition-based Monitoring

VLT® FC 102 HVAC Drive, VLT® FC 103 Refrigeration Drive, VLT® FC 202 AQUA Drive, VLT® FC 302 AutomationDrive

drives.danfoss.com | VLT®

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10 Alarms and Warnings

1 Introduction

1.1 Purpose of the Guide

This guide provides information on working with condition-based monitoring parameters on VLT® FC series drives.

The guide provides an overview of parameters and value ranges for operating the drive. Installation and operating instructions are not in scope for this guide.

1.2 Intended Audience

The intended audience of this guide is trained personnel, automation engineers, and programmers with experience in operating with parameters, and with basic knowledge of Danfoss AC drives.

1.3 Safety Symbols

The following symbols are used in this guide:

DANGER

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

Indicates information considered important, but not hazard-related (for example, messages relating to property damage).

1.4 Additional Resources

Additional resources are available for better understanding of related information.

Technical documentation for various product options is available at www.danfoss.com.

1.5 Reading the Parameter Table

This programming guide includes parameter and options tables. These descriptions explain how to read the parameter and options tables.

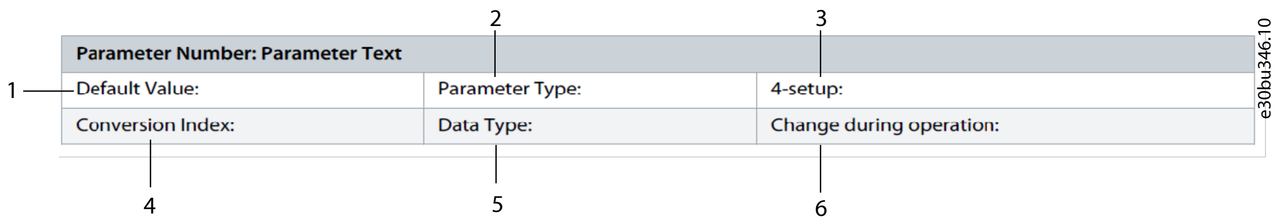


Figure 1: Parameter Table Overview

1	Indicates the factory setting	**2**	Indicates whether the parameter type is option or range.
3	Indicates the manner of parameter setups. *All setups* means that the parameter can be set individually in each of the 4 setups. For example, 1 single parameter can have 4 different data values. *1 setup* indicates that the data value is the same in all setups.	**4**	Reference to the conversion index. Parameter values are transferred as whole numbers only. Conversion factors are therefore used to transfer decimals. If a value is transferred as 100 and a conversion index of -1, the real value is 10.0. See Table 1 for more details.
5	Indicates the different data types for the parameters.	**6**	Indicates whether the parameter value can be changed while the drive is in operation. *False* indicates that the drive must be stopped before a change can be made.

Table 1: Conversion Table

Conversion index	Conversion factor
100	1
75	3600000
74	3600
70	60
67	1/60
6	1000000
5	100000
4	10000
3	1000
2	100
1	10
0	1
-1	0.1
-2	0.01
-3	0.001
-4	0.0001
-5	0.00001
-6	0.000001

Table 2: Data type

Data type	Description	Type
2	Integer 8	Int8
3	Integer 16	Int16
4	Integer 32	Int32
5	Unsigned 8	Uint8
6	Unsigned 16	Uint16
7	Unsigned 32	Uint32
9	Visible string	VisStr
33	Normalized value 2 bytes	N2

Table 2: Data type - (continued)

Data type	Description	Type
35	Bit sequence of 16 boolean variables	V2
54	Time difference w/o date	TimD

2 Introduction to Condition-based Monitoring

2.1 System Requirements and Compatibility

To enable condition-based monitoring and have the monitoring functioning efficiently, verify the following software compatibility and system requirements.

NOTE: Be sure to download the latest version of the condition-based monitoring software to make sure that the new updates are included. Also, ensure to update VLT® Motion Control Tool MCT 10 and the condition-based monitoring plug-in for efficient commissioning and monitoring.

VLT® products and software compatibility for condition-based monitoring

Table 3: Compatible Products and Software Versions

VLT® product	Minimum software version
VLT® HVAC Drive FC 102	6.01
VLT® Refrigeration Drive FC 103	2.X0
VLT® AQUA Drive FC 202	3.80
VLT® AutomationDrive FC 302	8.X0
VLT® Motion Control Tool MCT 10	5.21

Control card compatibility for condition-based monitoring

Control card version	Compatibility	Identification of control card version	Production Identification
MKII	Yes	White USB	CW18 Y2018 or later
MKI	No	Black USB	CW17 Y 2018 or earlier
MI	No	Black USB	N/A

MKII control card is required to enable the license code functions.

Contact a local Danfoss sales partner to determine the possibility of upgrading a VLT® product with a new control card to activate the license code function.

Stator winding monitoring compatibilities

Table 4: Control Mode for Stator Winding Monitoring Function

Control mode	Compatibility
VVC+	Yes
U/f	No
Flux	Yes

Table 5: Motor Types for Stator Winding Monitoring Function

Motor type	Compatibility
Induction	Yes
PM, non-salient SPM	Yes
PM, salient IPM	Yes

Table 5: Motor Types for Stator Winding Monitoring Function - (continued)

Motor type	Compatibility
SynRM	No
PMaSynRM	No

Filters for stator winding monitoring function

Table 6: Compatible Filters for Stator Winding Function

Filter name	Compatibility	Description
VLT® dU/dt Filter MCC 102	Yes	Baseline must be run with the filter. If the filter is installed later, make sure that a new baseline is generated.
VLT® Sine-Wave Filter MCC 101	Yes	
VLT® All-Mode Filter MCC 201	Yes	

Sensor configurations and additional analog inputs

Condition-based monitoring uses external sensors to obtain data. These external sensors are connected to the AC drive via analog inputs (AI).

The feature supports 4 sensor inputs and the basic hardware only includes 2 AIs. Request an options module to obtain the full value of condition-based sensor monitoring.

To facilitate the addition of more sensors, or when embedded analog inputs are used, configure the following options to extend the analog inputs.

Table 7: Options and Analog Input Configurations

Option type	Number of AI	Name of AI on the board
VLT® General Purpose I/O MCB 101	2	30/11, 30/12
VLT® Analog I/O MCB109	3	42/1, 42/3, 42/5
VLT® Sensor Input MCB 114	1	48/2
VLT® Programmable I/O MCB 115	3	X49/7+8, X49/9+10, X49/11+12

Fieldbus support in condition-based monitoring

Table 8: Fieldbus and Product Compatibility for Condition-based Monitoring

Option name	Status of condition-based monitoring support	Slot	FC 102	FC 103	FC 202	FC 302	FCD 302
Modbus RTU	Yes	RS-485	x	x	x	x	x
BACnet MS/TP	Yes	RS-485	x	–	–	–	–
Metasys N2	Yes	RS-485	x	–	–	–	–
VLT® PROFIBUS DP MCA 101	Yes, with basic PCD value exchange.	A	x	x	x	x	x
VLT® DeviceNet MCA 104	Yes, with basic PCD value exchange.	A	x	–	x	x	–
VLT® CANopen MCA 105	Yes, with basic PCD value exchange.	A	–	–	–	x	–

Table 8: Fieldbus and Product Compatibility for Condition-based Monitoring - (continued)

Option name	Status of condition-based monitoring support	Slot	FC 102	FC 103	FC 202	FC 302	FCD 302
AK-LonWorks MCA 107 for ADAP-Kool	No	A	–	x	–	–	–
LonWorks MCA 108	No	A	x	x	–	–	–
VLT® BACnet MCA 109	No	A	x	–	–	–	–
VLT® PROFINET MCA 120	Yes, with basic PCD value exchange.	A	x	x	x	x	x
VLT® EtherNet/IP MCA 121	Yes	A	x	x	x	x	x
VLT® Modbus TCP MCA 122	Yes	A	x	–	x	x	x
VLT® POWERLINK MCA 123	No	A	–	–	–	x	x
VLT® EtherCAT MCA 124	Yes	A	–	–	–	x	x
VLT® BACnet/IP MCA 125	Yes	A	x	–	–	–	–

In the preceding table:

- x indicates that the VLT® product supports the fieldbus protocol.
- - indicates that the VLT® product does not support the fieldbus protocol.

  For more information on fieldbus integration with condition-based monitoring, see *Fieldbus Integration for Condition-based Monitoring*.

For more information on the slots, see the VLT® product design guide.

2.2 Overview of Condition-based Monitoring

Condition-based monitoring in Danfoss VLT® drives enables continuous checking of the condition and performance of the application to detect potential mechanical, motor, or application failures before an actual failure occurs. Furthermore, it enables planning of service and maintenance when needed.

Benefits of installing the condition-based monitoring firmware:

- Reduces unexpected downtime.
- Eliminates unexpected halts in production.
- Optimizes maintenance.
- Reduces the spare part stock inventory.
- Optimizes production processes.

Condition-based monitoring functions

There are 5 functions in condition-based monitoring. All the functions can be enabled at the same time for monitoring functions performed by the drive.

- **Motor stator winding monitoring:** For this type of monitoring capability, an additional equipment is not required. The motor current signature (inter-turn short circuit or unbalance in motor winding) is detected in the drive. Damage caused by motor stator winding isolation occurs over a period. When more winding turns are impacted, the overcurrent protection is activated due to extensive heating and stops the motor
- **Load envelope:** For this type of monitoring capability, an additional equipment is not required. Mechanical load of an application is monitored by comparing the current load curve with the expected load curve based on data gathered during commissioning. During monitoring, overload and underload deviations, which occur in applications, are detected.
- **Sensor monitoring:** For this type of monitoring capability, install sensors. Sensors improve the monitoring quality by including the relation to the speed of the machine/application. Although any type of sensor can be selected, vibration sensors are typically used to monitor unbalanced misalignments, looseness, or resonance problems via RMS sensors, or bearing problems via peak-peak sensors.
- **Cavitation monitoring:** For this type of monitoring capability, an additional equipment is not required. Cavitation produces turbulence, which creates a distinctive signature in the motor current. The algorithm compares the actual cavitation signature against user-defined threshold levels. If the values exceed the set thresholds for a predefined time, the event is flagged as cavitation. For more details on cavitation, refer to chapter *6 Condition-based Monitoring of Cavitation*.
- **Sine-wave filter monitoring:** For this type of monitoring capability, an additional equipment is not needed. The advanced control generates a specific excitation and reads the resulting signature from the current and voltage signals. By using this method, the drive determines changes in capacitance by comparing the present value to a baseline value recorded during the initial operational life, and triggers warnings based on user-defined thresholds. For more details on sine-wave filter monitoring, refer to chapter *7 Condition-based Monitoring of Sine-wave Filters*.

NOTE: The ISO 10816 standard provides guidance for evaluating vibration severity for machines operating within 10–200 Hz of frequency range. The standard shall be complied with before commissioning of vibration monitoring functions.

2.3 Condition-based Monitoring Workflow

2.3.1 Commissioning Condition-based Monitoring

Before starting the commissioning of condition-based monitoring, ensure that the system is configured (installed and commissioned) for normal operation of the drive.

Next, generate the baseline operation of the application. The drive records the baseline to understand how the application operates in the different monitoring functions and speed ranges.

After the baseline recording, the drive generates the thresholds levels for future monitoring of the selected functions. If the thresholds are already known by the installers, these levels can be programmed directly into the drive. This excludes the stator winding which needs a baseline to operate correctly. The installers define the baseline recording period. Depending on the complexity of the application, it can take from 2 h to 6 months.

Figure 2 depicts the 2 ways to commission condition-based monitoring in a drive.

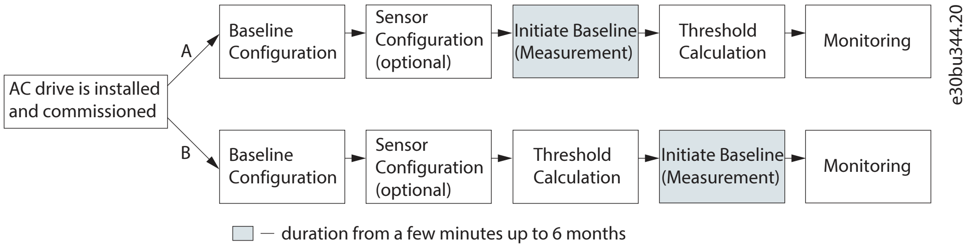


Figure 2: Condition-based Monitoring Workflow Overview

2.3.2 Step 1: Baseline Configuration

When commissioning a drive for condition-based monitoring, first configure the baseline, which is essential for the commissioning. A baseline signature is required to determine any deterioration in the stator winding, load operating point, or vibration/sensor level of the application. A baseline is recorded for each of the CBM functions, regardless of enabling the function.

There are 3 ways to generate a baseline:

- **Baseline Run:** The drive takes control of the motor speed as defined and measures the recorded signal values. This baseline generation is only applicable for applications operating from minimum to maximum speed, independent of the connected elements in the application. Depending on the load conditions, it is not always possible to execute the baseline run, for example, when the load does not allow it.
- **Online Baseline:** In this method, the baseline is created by the operation of the application. The signal values, which the drive uses, and the condition-based monitoring records, form the baseline. The operation of the application defines the operation speeds and is successful to collect values for all speed intervals. The baseline information is collected independently of the operating mode (manual or automatic) and stops when reaching the defined window, or at user-interruption.

As illustrated in the graph below, a baseline is split into 20 speed intervals, where each of the application data are recorded. Starting with the user-defined minimum and ending with the maximum speed. 20 speed points define each time a new speed interval starts and end with the maximum speed.

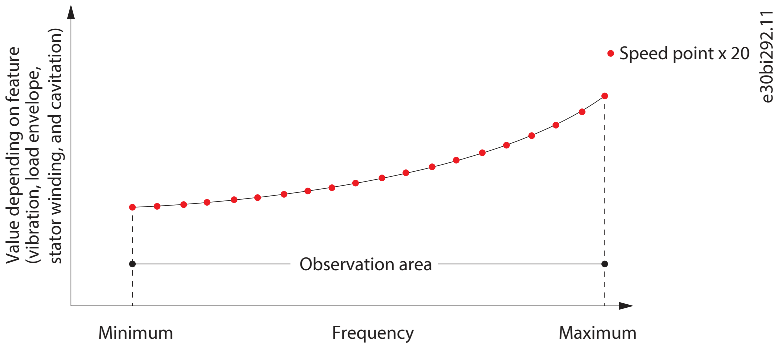


Figure 3: Baseline Curve with Speed Points

2.3.3 Step 2: Sensor Configuration

Vibration monitoring requires installation of an external vibration transmitter. The sensor is connected via an analog input using, for example, terminal 53 or terminal 54. When using these terminals, make sure to scale correctly. For AI53 S201 to ON = mA and for AI54 switch S202 to ON = mA.

Condition-based monitoring allows including any sensor type which can provide an analog input for monitoring, where speed variation also plays a role in the monitoring. Currently, it is possible to use vibration, flow, and pressure as signal types in condition-based monitoring. Typically, vibration sensors are installed in most applications where condition-based monitoring is introduced, and therefore, this guide focuses more on vibration sensors.

Make sure to configure the correct scaling by using the parameters in parameter group ***6-1* Analog Input 1***.

For example, when terminal AI53 is used, configure the following:

Parameter ID and name	Example values
Parameter ***6-12 Terminal 53 Low Current***	4 mA
Parameter ***6-13 High Current***	20 mA

If these terminals are in use for other equipment, it is possible to extend the analog input with extension options. For information on extension options, see the selection guide.

2.3.4 Step 3: Threshold Generation

Defining or setting the threshold values

Thresholds for warnings and alarms are typically created on the recorded baseline values because condition-based monitoring should provide early information on changes over time to secure maximum uptime. To ensure a correct and stable operation, the selection of threshold values is evaluated against the collected baseline values, as the baseline may indicate an unstable operation of the application. Such unstable operation may cause warnings shortly after enabling condition-based monitoring.

NOTE: Thresholds are also generated manually based on earlier conclusions or standards in vibration applications. **Stator winding monitoring** is considered as a special scenario because of the following reasons:

- AMA must be performed before starting a baseline recording.
- The condition-based monitoring default threshold generation and selection of parameters must not be changed.

All other selections of threshold values depend on the application. Therefore, user-knowledge is needed for setting up the CBM monitoring correctly.

There are 4 methods of threshold generation.

- **Absolute:** This method is the most common method when the equipment values are already known. The threshold has a fixed value irrespective of the measured baseline value. For example, when the operator knows the absolute limit for the equipment, an absolute value is set for the alarm threshold. If vibration monitoring occurs, the limit values described in standards such as ISO 10816/20816 can be used for the alarm threshold as an absolute value. Absolute values also mean manual configuration of the thresholds values when the values are directly entered into the thresholds parameters.
- **Offset:** This method of setting threshold values requires understanding of the application and baseline values. The threshold depends on the baseline value to which a user-defined offset is considered in the threshold configuration. Setting a very low or high value leading to false positives is a risk when using this method. False settings can cause irresponsive monitoring, even if faults occur.
- **Factor:** This method is easier to use compared to offset because it does not require in-depth application knowledge. The threshold depends on the baseline value which is multiplied by a factor. For example, the threshold value may be 150% of the baseline. Setting a very high threshold is a risk when using this method of threshold calculation.
- **Manual configuration:** In this method, baseline values are configured manually into the drive. This method is relevant when the baseline values are defined based on previous experience, and the values are configured in the drive.

NOTE: For new installations, ISO 20816 recommends a wear-in period before taking a baseline measurement.

2.3.5 Step 4: Alarms and Warnings

In condition-based monitoring, it is possible to define activation stages for warnings and alarms for each feature. The interpretation of faults and warning color codes are as follows:

Green: Condition-based monitoring did not observe operation conditions where actual values have crossed defined thresholds levels. There are no alarms or warnings.

Yellow: First indication of warning-stage 1 is visible, and Stage 1 warning is also shown as *Stage 1 Warning (S1)*. The Stage 1 warning is a notification to plan for maintenance operations. In this stage, condition-based monitoring operations continue.

Orange: Clear indication of warning-stage 2 is visible and is also shown as *Stage 2 Warning (S2)*. The Stage 2 warning is a notification to act as soon as possible before the warning becomes critical.

Red: A critical fault has occurred and stopped the drive. Condition-based monitoring still continues.

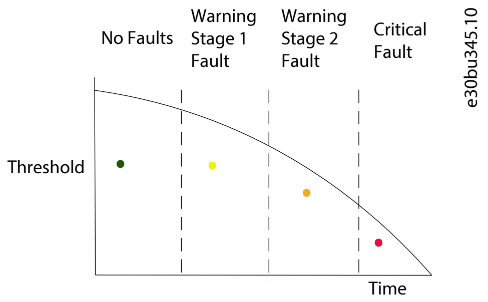


Figure 4: Alarm and Warning Stages

For more information, see *Appendix*.

2.4 Ordering Condition-based Monitoring in Drives

2.4.1 Activation of Condition-based Monitoring

Condition-based monitoring can be activated at the factory when a new drive is ordered. It is also possible to activate condition-based monitoring on existing VLT® products using a license code.

When a license code is activated, it can be seen in the parameters in parameter groups ***45-** Condition-based Monitoring***, ***46-** CBM Adv. Thresholds***, ***47-** CBM Baseline Data***, and ***48-** CBM Applications***. These parameters are visible in the LCP, in VLT® Motion Control Tool MCT 10, or in the fieldbus when the license code is activated. For further information on specific license codes for each VLT® product, refer to the product-specific selection guide.

Identifying license code information

Use parameter group ***15-** Drive Information*** to identify license code information.

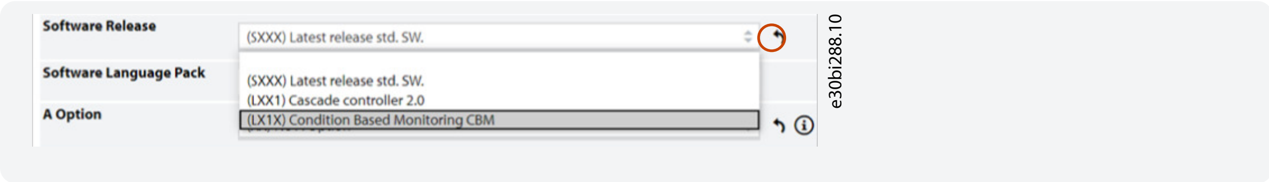
Parameter number and name	License enabled at the factory	License activated by customer (retrofit)
Parameter ***15-44 Ordered Typecode String***	LX1X	SXXX
Parameter ***15-45 Actual Typecode String***	LX1X	LX1X
Parameter ***50-00 License Installed***	CBM	CBM

2.4.2 Ordering Condition-based Monitoring License from Factory

For the license code to be activated at the factory, the information has to be entered during product selection in the configurator.

Procedure

1. Go to the configurator in Danfoss Product Store.
2. Click the symbol corresponding to *Software Release* to open software release selections.



3. Select *LX1X Condition Based Monitoring CBM*.

2.4.3 Ordering Condition-based Monitoring of Sine-wave Filter Capacitors

Provide a license to enable CBM of sine-wave filter capacitors. This license differs from the standard CBM license, LX1X. Licenses can be installed either as standalone or over an existing license. The result is cumulative. For example, installing LX2X over an existing LX1X license enables both features.

Enter the license code in parameter ***50-01 License***.

License code	Code number	License name	CBM standard	CBM sine-wave filter
LX2X	130S0013 (≤7.5 kW) 130S0014 (11–90 kW) 130S0015 (>90 kW)	VLT Sinewave Filter Monitoring	–	✓
LX3X	130S0017 (≤7.5 kW) 130S0018 (11–90 kW) 130S0019 (>90 kW)	VLT Condition Based Monitoring and Sinewave Filter Monitoring	✓	✓

2.4.4 License for Condition-based Monitoring of Cavitation

The cavitation function is part of the CBM standard package which requires a license. The standard package also contains functions such as:

- Stator winding
- Load
- Sensors

Both licenses LX1X and LX3X enable the cavitation function. The CBM license can be installed either as a standalone or over an existing license. The result is cumulative.

Enter the license code in parameter ***50-01 License***.

License code	Code number	License name	CBM standard	CBM cavitation	CBM sine-wave filter
LX1X	130S0001 (≤7.5 kW) 130S0002 (11–90 kW) 130S0003 (>90 kW)	VLT Condition Based Monitoring, stator winding, vibration, load envelope, and cavitation	✓	✓	–
LX11	130S0005 (≤7.5 kW) 130S0007 (11–90 kW) 130R0008 (>90 kW)	VLT Condition Based Monitoring and Cascade Control for FC 202	✓	✓	–

License code	Code number	License name	CBM standard	CBM cavitation	CBM sine-wave filter
LX12	130S0001 (≤7.5 kW) 130S0002 (11–90 kW) 130S0003 (>90 kW)	VLT Condition Based Monitoring, stator winding, vibration, load envelope, and cavitation for VLT® AutomationDrive FC 302 with IMC.	✓	✓	–
LX3X	130S0017 (≤7.5 kW) 130S0018 (11–90 kW) 130S0019 (>90 kW)	VLT Condition Based Monitoring and Sine-wave Filter Monitoring	✓	✓	✓

2.4.5 Activating Condition-based Monitoring in Existing VLT® Drive Using MCT 10

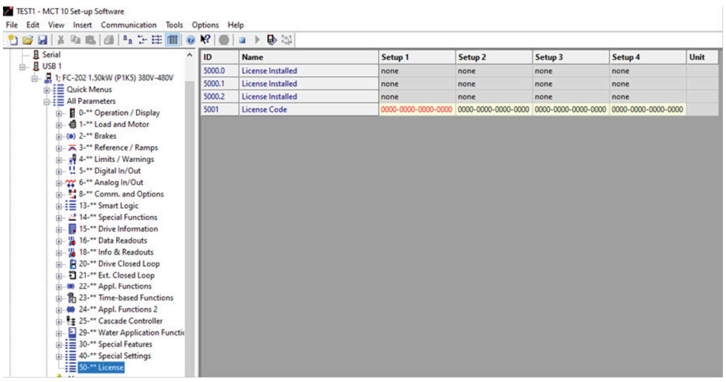
For retrofit, licenses can be ordered from the regional sales office. See Table 3.

NOTE: License codes are unique to a single drive. The license code cannot be used on multiple drives.

The license code contains 16 alphanumeric characters in the format (XXXX-XXXX-XXXX-XXXX).

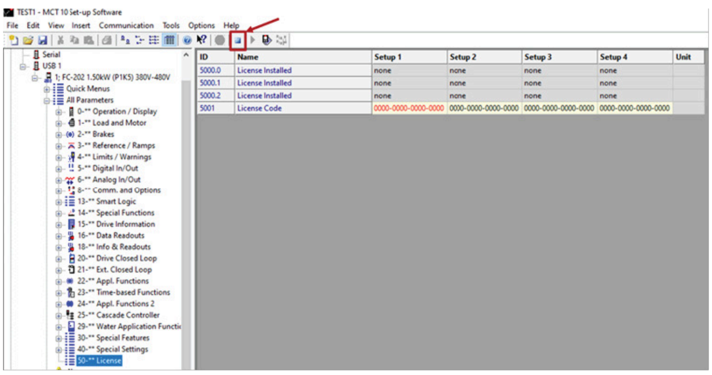
Procedure After receiving the license code, perform the following steps:

1. Go to parameter group ***50-** License***.



e30bi438.10

2. Stop polling. Press the button as shown in the figure.

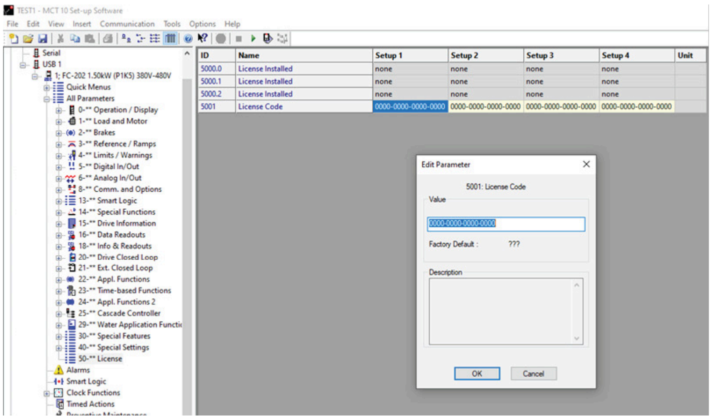


e30bi439.10

Figure 5: Stop Polling

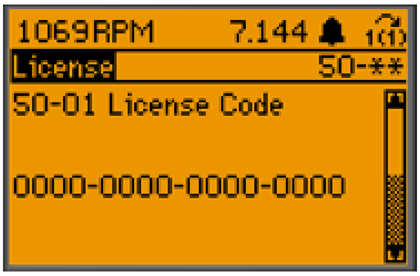
3. Go to parameter ***50-01 License Code*** using the LCP or VLT® Motion Control Tool MCT 10.

4. Enter the license code in parameter ***50-01 License Code***, instead of 0000-0000-0000-0000.



e30bi440.10

After entering the license code using the LCP, parameter ***50-01 License Code*** shows the following information.



e30bi287.10

When the license is accepted by the drive, the LCP shows a confirmation.

e30bi286.10

5. Restart the drive and MCT 10 to activate the features.

The parameter groups ***45-** Condition-based Monitoring***, ***46 CBM Adv. Thresholds***, ***47-** CBM Baseline Data***, and ***48-** CBM Applications*** are now available in LCP and in MCT 10.

2.4.6 Enabling Condition-based Monitoring Features

This recommendation considers enabling condition-based monitoring with a single sensor installed on the drive.

NOTE: Danfoss recommends using VLT® Motion Control Tool MCT 10 with condition-based monitoring plug-in to easily enable condition-based monitoring. The control panel is preferred for minor adjustments or fine-tuning of the parameters.

NOTICE

Make sure to configure parameter ***45-00 Function*** to generate ***[1] Warnings*** or ***[2] Warnings & Alarms***, for proper functioning of condition-based monitoring features.

- The recommendation is to set ***[1] Warnings*** in parameter ***45-00 Function***. Setting ***[2] Warnings & Alarms*** in the parameter can cause the AC drive to trip as alarms stop the drive.

Procedure

1. Go to parameter group ***45 -** Condition-based Monitoring***.
2. Set the values to raise warnings for condition-based monitoring features, as described in the table.

ID	Name	Value	Description
45-00.0	Function	***[1] Warning***	Set the value for enabling stator monitoring.
45-00.1	Function	***[1] Warning***	Set the value for enabling load envelope.
45-00.2	Function	***[1] Warning***	Set the option for enabling sensor 1.
45-00.3	Function	***[0] Off***	Set the option for enabling sensor 2.
45-00.4	Function	***[0] Off***	Set the option for enabling sensor 3.
45-00.5	Function	***[0] Off***	Set the option for enabling sensor 4.
45-00.6	Function	***[1] Warning***	Set the option for enabling cavitation.

3 Examples of Condition-based Monitoring Functions

3.1 Example 1: Motor Stator Winding Monitoring

The drive provides variable magnitude of voltage and frequency to the stator terminal of connected 3-phase induction motors. During healthy conditions of the motor with good stator winding insulation between inter-turn, the electrical signature shows consistency on the measurement. The electrical signature repeats the baseline value for repeated measurement.

However, if a weakened insulation or inter-turn short-circuit condition occurs, the electrical signatures deviate from their original baseline values. The function withstands a false positive if there is an AC mains imbalance.

NOTE: Ensure to perform AMA before baseline configuration to secure accurate motor data for monitoring.

NOTE: The motor stator winding monitoring is a purely technical function. The default Danfoss thresholds should not be changed as these settings are not related to application-related operations.

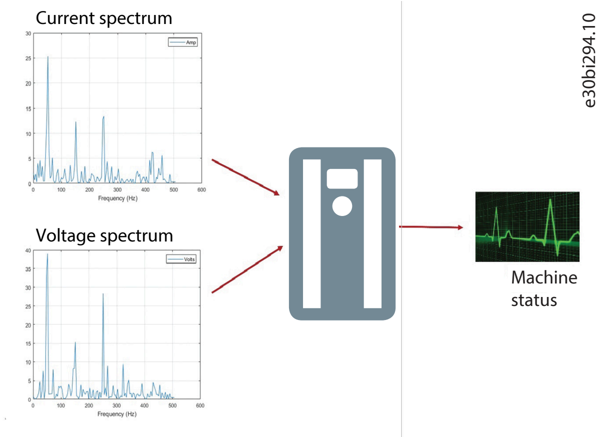


Figure 6: Example of Motor Stator Winding Monitoring

3.2 Example 2: Load Envelope

The function monitors the torque and speed profiles of the application which is measured during the baseline measurement. The threshold configuration works similar to the other functions. Condition-based monitoring can detect underload and overload situations. Hence, there are 2 warning stages for high side (overload scenario) and 2 warning stages for underload scenarios.

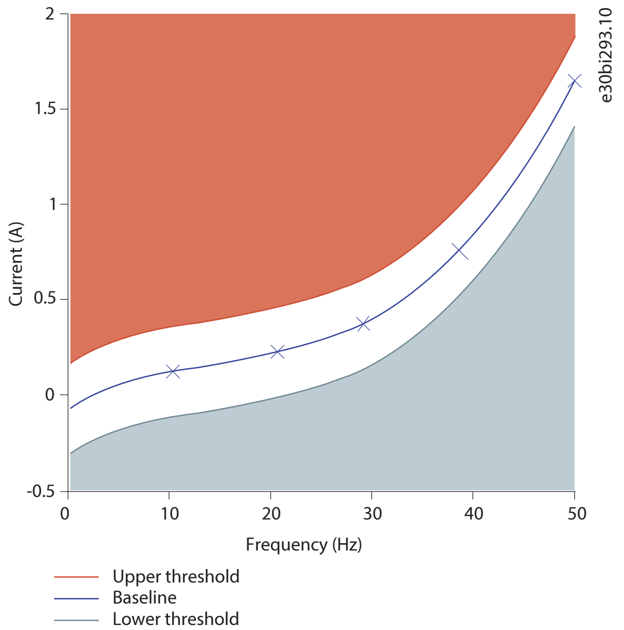


Figure 7: Load Envelope Example

NOTE: Each application has its own baseline. The baseline of an application depends on the process or production for which it is operating.

NOTE: The load envelope monitoring include application-related influence where the default Danfoss threshold settings have to be changed to avoid wrong detection related to special application-related operations.

3.3 Example 3: Vibration Monitoring

The standard ISO 10816/20816 states the recommendation for vibration monitoring. With VLT® condition-based monitoring, the speed reference relates to the vibration level instead of an absolute level. The absolute level can mislead in lower levels of the speed reference.

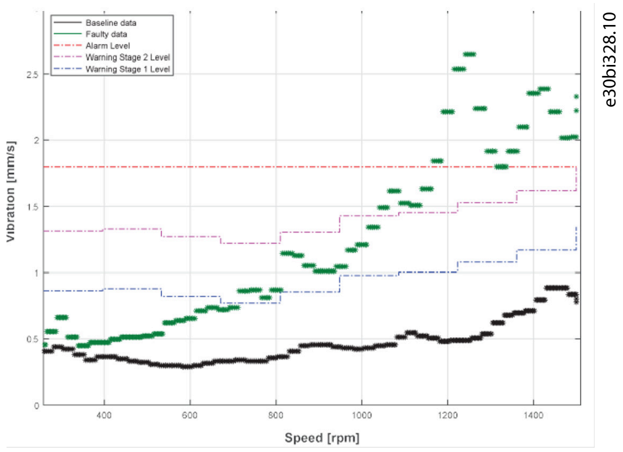


Figure 8: Vibration Monitoring Example

NOTE: The vibration/bearing/lubrication sensor monitoring includes application-related influence where the default Danfoss threshold settings need to be changed to avoid wrong detection related to special application-related operations.

3.4 Example 4: Cavitation Monitoring

The turbulence of the pump, that is the cavitation signature, is mapped during baseline for a pump running at different speeds in normal operating conditions. During monitoring, the cavitation signature increases heavily when cavitation occurs. In this example, cavitation starts from a speed higher than 3000 RPM. As soon as the signature level crosses the imposed thresholds, an event is generated as warning.

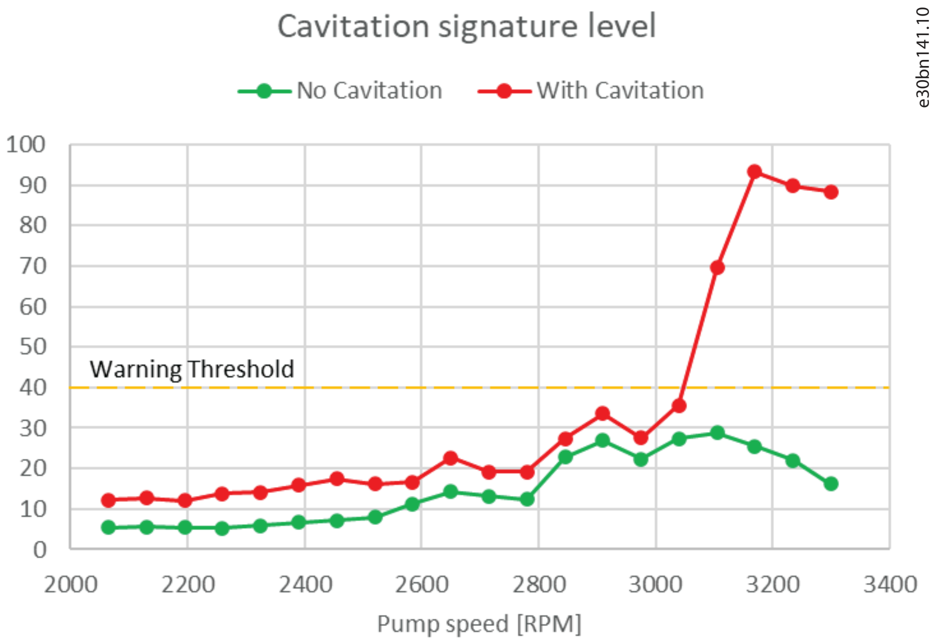


Figure 9: Cavitation Signature Level

4 Commissioning of Condition-based Monitoring

4.1 Commissioning Overview

This chapter describes the commissioning of condition-based monitoring from baseline creation to monitoring the system. Before performing any commissioning steps, the prerequisites are that the drive is installed, and the license code for condition-based monitoring is activated in the drive.

Danfoss Drives recommends using the VLT® Motion Control Tool MCT 10 condition-based monitoring plug-in for commissioning of condition-based monitoring. It is also possible to perform the commissioning using the LCP. The following sections in this chapter contain the following:

- Commissioning using MCT 10 condition-based monitoring plug-in.
- Commissioning using LCP.
- Threshold configuration guidelines.

Based on the MCT 10 version and activated license code, the plug-in is shown.

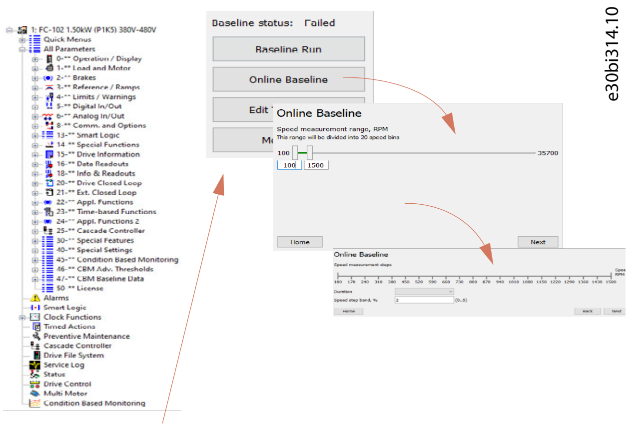


Figure 10: Condition-based Monitoring Plug-in

Tips to consider for a successful baseline.

- During the time specified for the online baseline to be completed, the quality of the recorded value is evaluated.
- If the online baseline has recorded values within each of the 20 speed intervals, the baseline is successful.
- If auto generation of threshold is interrupted and the values are not recorded correctly, make a final evaluation of the baseline data and threshold values.
- A quality counter defines the numbers of recorded data which is needed to successfully auto generate threshold values. To avoid wrong information during monitoring, speed intervals that do not reach quality levels are automatically set to minimum and maximum threshold values.

4.2 Commissioning with MCT 10 Condition-based Monitoring Plug-in

Prerequisites:

- Ensure that the latest version of VLT® Motion Control Tool MCT 10 is installed.
- Ensure that the computer is connected to a powered-on AC drive that has an activated license code.

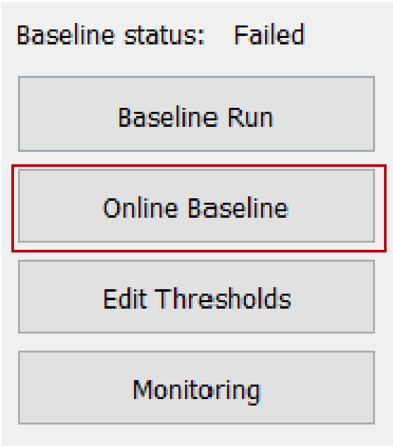
NOTE: The red highlights in the figure correspond to Danfoss recommended selections, and the blue highlights in the figure correspond to application values. These values can vary based on the application.

NOTE: It is recommended to perform a short baseline run to ensure that the baseline generation is working as expected, such as correct recording of sensor signals when online baseline starts.

Perform the following steps to set up condition-based monitoring in the drive.

Procedure:

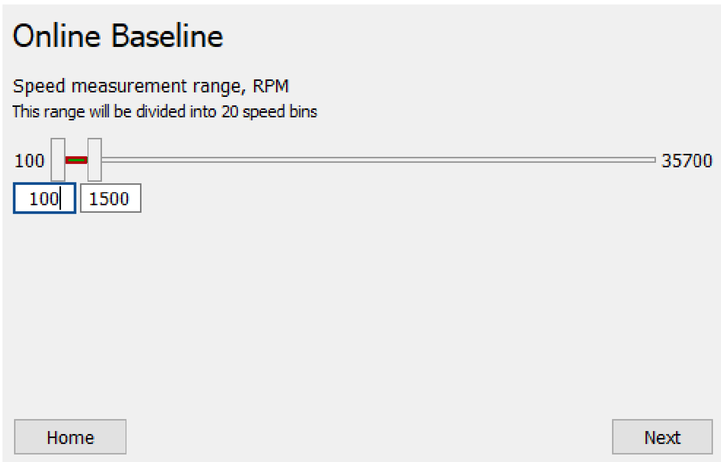
1. Select *Online Baseline*.



e30bi315.10

2. Select minimum and maximum speed range using the slider or specify values in the textboxes.

   The recommendation is to configure a speed window which relates to motor limitations. The motor speed is configured in parameter ***4-11 Motor Speed Low Limit [RPM]*** and parameter ***4-13 Motor Speed High Limit [RPM]***.

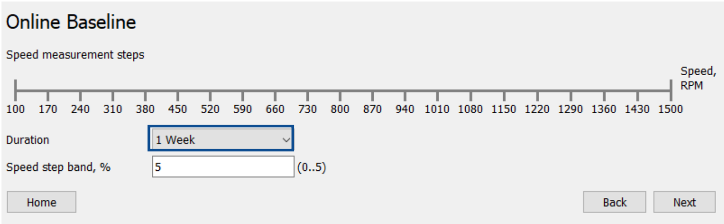


e30bi316.10

NOTE: For advanced baseline settings, the minimum speed can be set as 30% of nominal speed as failures in low speed measurement ranges are difficult to detect.

3. Specify the duration to capture baseline in the *Duration* field.

   It is recommended to specify at least *1 Week* or more in the *Duration* field.



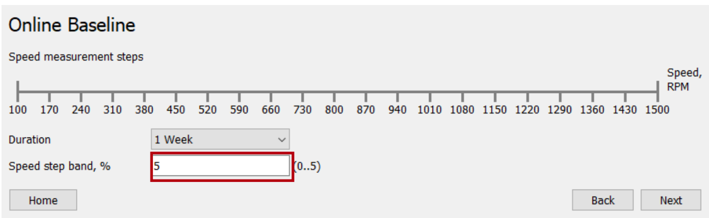
e30bi317.10

Some of the duration options and corresponding baseline run values are specified in :

Online baseline	Baseline run
2 Hours	1 Minute
4 Hours	2 Minutes
8 Hours	4 Minutes
1 Day	10 Minutes
2 Days	30 Minutes
5 Days	1 Hour
1 Week	2 Hours
2 Weeks	
1 Month	
2 Months	
4 Months	
6 Months	

4. Specify the speed band in the *Speed step band, %* field.

> **NOTE:** Do not set the speed band to 0%. 0% is for niche applications.



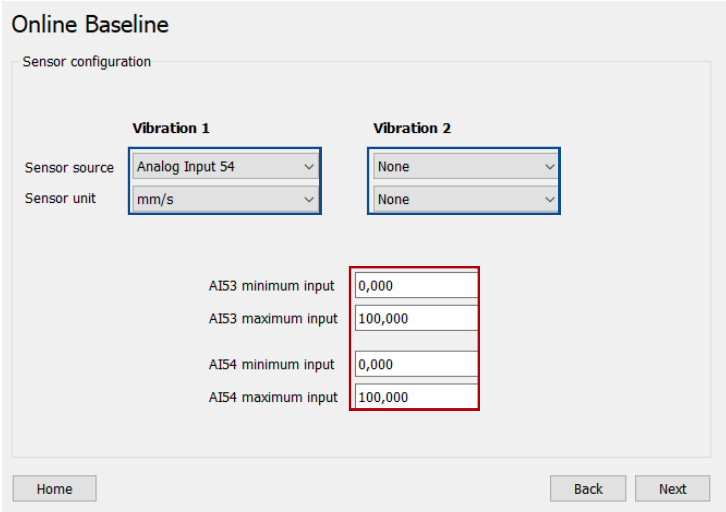
e30bi318.10

5. Configure vibration sensor information in the *Sensor source* and *Sensor unit* fields.

   By default, no value is selected in the fields. If vibration sensors are not configured, press *Next*.

6. Configure the minimum and maximum reference values in *AI53 minimum input*, *AI53 maximum input*, *AI54 minimum input*, and *AI54 maximum input*. Press *Next*.

   The recommended minimum and maximum values are 0 and 100, respectively, providing a reference of 0–100%.

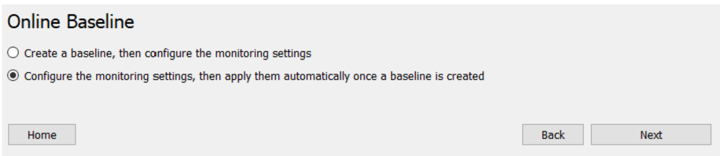


e30bi319.10

Make sure to provide the correct scaling either 0–20 mA or 4–20 mA. See *Sensor Configuration* (optional).

7. Select an option to set the method of baseline configuration. Click *Next*.

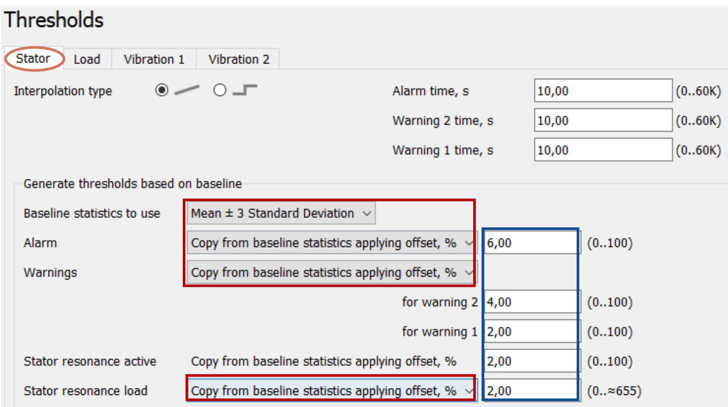
> **NOTE:**
>
> - The duration to finish online baseline execution can be within a period of 2 hours, 6 months, or 1 week.
> - Creating a baseline before configuring monitoring settings requires an additional on-site visit to configure the threshold settings.



e30bi320.10

8. To configure stator thresholds, configure settings in the *Stator* tab.
9. Select the Danfoss recommended options (highlight in red).
10. Specify application values in the *Alarm* and *Warnings* fields (highlight in blue).

> **NOTE:** The values in the figure do not imply specific application values. Ensure to enter values which suit the application. Following are the recommended application specific values for monitoring motor stator winding. See 4.4.1 Application-specific Input for Monitoring Motor Stator Winding.

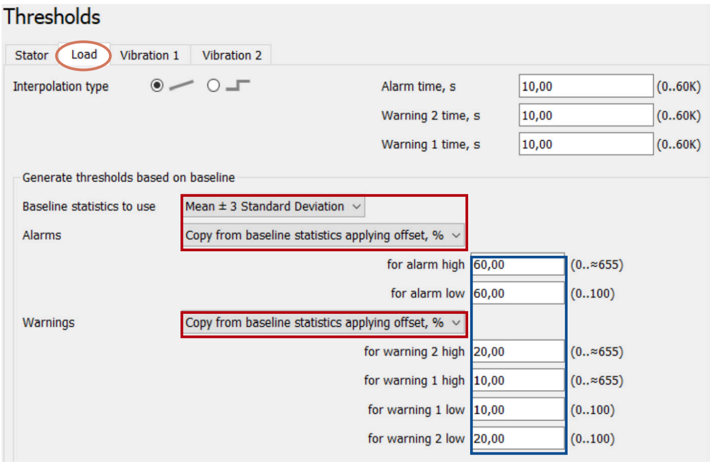


e30bi321.10

11. To configure load envelope threshold settings, click the *Load* tab.

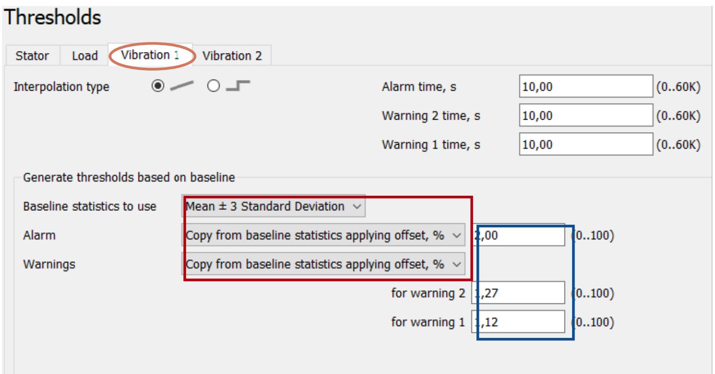
12. Select the Danfoss recommended options (highlight in red).
13. Specify the application-specific values in the *Alarms* and *Warnings* fields (highlight in blue).

NOTE: The values in the figure do not imply specific application values. Ensure to enter values which suit the application.



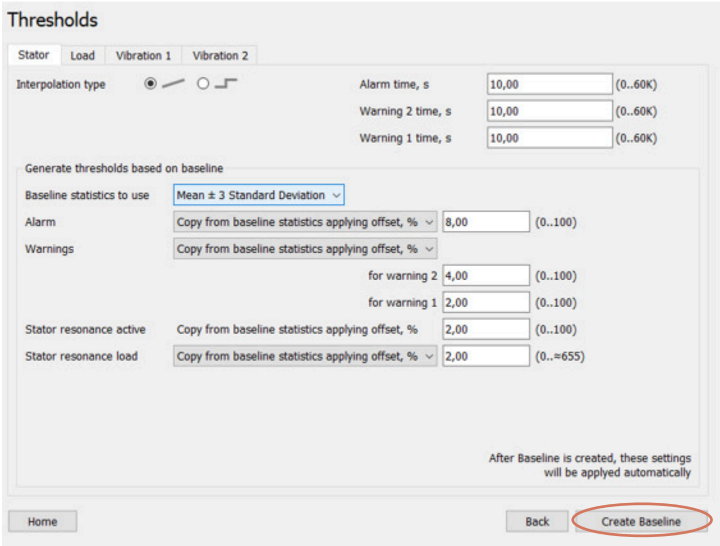
e30bi322.10

14. To configure vibration monitoring threshold configurations, click the *Vibration 1* tab.
15. Select Danfoss recommended options (highlight in red).
16. Specify application-specific values in the *Alarm* and *Warnings* fields (highlight in blue).



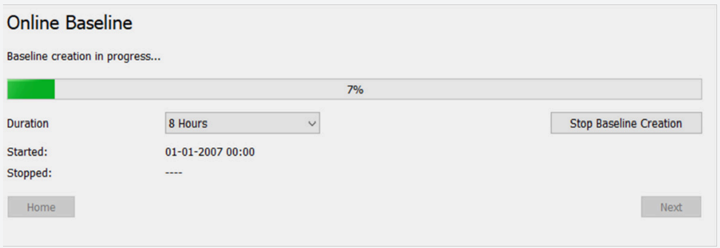
e30bi323.10

17. Click *Create Baseline*.



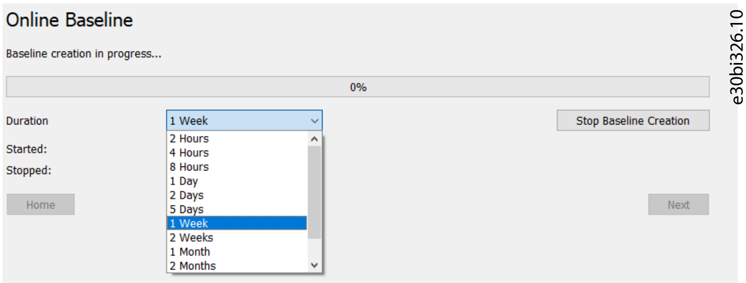
e30bi324.10

The progress bar indicates the remaining time for completion.



e30bi325.10

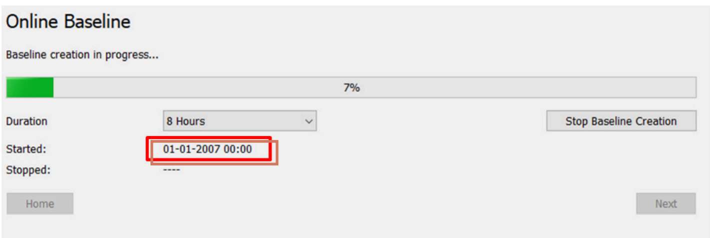
18. To modify the duration during baseline creation, select the required timeline from the *Duration* field.



e30bi326.10

19. To stop the baseline creation, click *Stop Baseline Creation*.

A timestamp is shown in the *Started* and *Stopped* fields, when parameter ***0-70 Date and Time*** is configured.



e30bi327.10

NOTE: In online baseline, the data is recorded continually and stored in the baseline database to ensure that data is not lost when interrupting the online baseline, or in cases when power is lost before online baseline is finished.

4.3 Recommended Parameter Setup using LCP or MCT 10

4.3.1 Step 1: Baseline Configuration

ID	Name	Value
Parameter ***45-00.0***	Function (Stator Winding Monitoring)	Select ***[1] Warning*** to configure a warning for stator winding monitoring.
Parameter ***45-00.1***	Function (Load Envelope)	Select ***[1] Warning*** to configure a warning for load envelope.
Parameter ***45-00.2***	Function (Sensor 1)	Select ***[1] Warning*** to configure a warning for vibration monitoring.
Parameter ***45-00.3***	Function (Sensor 2)	Select ***[0] Off*** to disable warnings or alarms for vibration sensor 2.
Parameter ***45-00.4***	Function (Sensor 3)	Select ***[0] Off*** to disable warnings or alarms for sensor 3.
Parameter ***45-00.5***	Function (Sensor 4)	Select ***[0] Off*** to disable warnings or alarms for sensor 4.
Parameter ***45-00.6***	Cavitation	Select ***[1] Warning*** to configure a warning for cavitation monitoring.
Parameter ***45-24***	Duration	Select ***[36] 1 week***. Base this selection on the application.
Parameter ***45-25***	Online Speed Band	Select *5*. This selection is application specific.
Parameter ***45-26***	Minimum Speed	Configure the same value as specified in parameter ***4-11 Motor Speed Low Limit [RPM]***
Parameter ***45-27***	Maximum Speed	Configure the same value as specified in parameter ***4-13 Motor Speed High Limit [RPM]***
Parameter ***45-20***	Type	Select ***[2] Online Baseline***.

Result:

- Parameter ***45-21 Status*** shows the baseline status.
- Parameter ***45-22 Progress*** shows the baseline progress.

4.3.2 Step 2: Threshold Configuration for Stator Winding Monitoring

To configure warnings, set parameter ***45-00.0*** to ***[1] Warning***.

Parameter number	Parameter name	Description and setting
Parameter ***45-30.0***	Baseline Statistics	Set ***[3] Mean +/-3 Standard Deviation***
Parameter ***45-31.0***	Warning mode	***[1] Offset***
Parameter ***45-34.0***	Warning S2	• For motor sizes <22 kW, specify 4.00. • For motor sizes >22 kW, specify 2.00
Parameter ***45-35.0***	Warning S1	• For motor sizes <22 kW, specify 2.00. • For motor sizes >22 kW, specify 1.00

Parameter number	Parameter name	Description and setting
Parameter ***46-11.0***	Warning S2 time	Specify 10.00
Parameter ***46-12.0***	Warning S1 time	Specify 10.00
Parameter ***45-60***	Active Threshold	Specify 0.05
Parameter ***45-61***	Load Mode	For constant torque, specify ***[0] Absolute***. For variable torque, specify ***[1] Offset***.
Parameter ***46-62***	Load Threshold	For constant torque, specify 160. For variable torque, specify 2.

To configure alarms, set parameter ***45-0.0*** to ***[2] Alarm & Warning***.

Parameter number	Parameter name	Description and setting
Parameter ***45-32.0***	Alarm Mode	Set ***[1] Offset***.
Parameter ***45-33.0***	Alarm High	• For motor sizes <22 kW, specify 6.00. • For motor sizes 22 kW – <90 kW, specify 4.00. • For motor sizes ≥90 kW, specify 3.00.
Parameter ***46-10.0***	Alarm time	Specify 10.00

4.3.3 Step 3: Threshold Configuration for Load Envelope

To configure warnings, set parameter ***45-00.1 Function*** to ***[1] Warning***. Following are the recommended settings.

Parameter number	Parameter name	Description and setting
Parameter ***45-30.1***	Baseline Statistics	Set ***[3] Mean +/-3 Standard Deviation***
Parameter ***45-31.1***	Warning mode	***[1] Offset***
Parameter ***45-34.1***	Warning S2 High	Specify 30. The value in this parameter is based on the application.
Parameter ***45-35.1***	Warning S1 High	Specify 20. The value in this parameter is based on the application.
Parameter ***45-36.1***	Warning S1 Low	Specify 20. The value in this parameter is based on the application.
Parameter ***45-37.1***	Warning S2 Low	Specify 30. The value in this parameter is based on the application.
Parameter ***46-11.1***	Warning S2 Time	Specify 10.00.
Parameter ***46-12.1***	Warning S1 Time	Specify 10.00.
Parameter ***46-13.1***	Interpolation Type	Specify ***[0] Linear***.

To configure alarm, set parameter ***45-00.1 Function*** to ***[2] Alarm & Warnings***. Following are the recommended settings. When alarms are raised, the system operation is stopped.

Parameter number	Parameter name	Description and setting
Parameter ***45-00.1***	Function (Load Envelope)	Set ***[2] Alarm & Warning***
Parameter ***45-32.1***	Alarm mode	***[1] Offset***
Parameter ***45-33.1***	Alarm high	Specify 60.

Parameter number	Parameter name	Description and setting
Parameter ***45-38.1***	Alarm low	Specify 60.
Parameter ***46-10.1***	Alarm time	Specify 10.00.

4.3.4 Step 4: Vibration Threshold Configuration

Parameter number	Parameter name	Description and setting
Parameter ***45-30.2***	Baseline Statistics	Set ***[3] Mean+/- Standard Deviation***
Parameter ***45-31.2***	Warning mode	***[1] Offset***
Parameter ***45-34.2***	Warning S2 High	Specify 1.52.
Parameter ***45-35.2***	Warning S1 High	Specify 1.12.
Parameter ***46-11.2***	Warning S2 time	Specify 10.00.
Parameter ***46-12.2***	Warning S1 time	Specify 10.00.
Parameter ***46-13.2***	Interpolation Type	Set ***[1] Linear***.

When parameter ***45-00.1 Function*** is set to ***[2] Alarm & Warnings***, following are the recommended settings. When alarms are raised, the system operation is stopped.

Parameter number	Parameter name	Description and setting
Parameter ***45-00.2***	Function (Load Envelope)	Set ***[2] Alarm & Warning***
Parameter ***45-32.2***	Alarm mode	***[1] Offset***
Parameter ***45-33.2***	Alarm high	Specify 60.
Parameter ***45-38.2***	Alarm low	Specify 0.
Parameter ***46-10.2***	Alarm time	Specify 10.00.

4.3.5 Step 5: Cavitation Threshold Configuration

Parameter number	Parameter name	Description and setting
Parameter ***45-30.6***	Baseline Statistics	Set ***[3] Mean+/- Standard Deviation***
Parameter ***45-31.6***	Warning mode	***[1] Offset***
Parameter ***45-34.6***	Warning S2 High	Specify 4, adjusted based on the application.
Parameter ***45-35.6***	Warning S1 High	Specify 2, adjusted based on the application.
Parameter ***46-11.6***	Warning S2 time	Specify 10, adjusted based on the application.
Parameter ***46-12.6***	Warning S1 time	Specify 10, adjusted based on the application.
Parameter ***46-13.6***	Interpolation Type	Set ***[1] Linear***.

When parameter ***45-00.1 Function***is set to ***[2] Alarm & Warnings***, following are the recommended settings. When alarms are raised, the system operation is stopped.

Parameter number	Parameter name	Description and setting
Parameter ***45-00.6***	Function (Load Envelope)	Set ***[2] Alarm & Warning***
Parameter ***45-32.6***	Alarm mode	***[1] Offset***
Parameter ***45-33.6***	Alarm high	Specify 20, adjusted based on the application.
Parameter ***46-10.6***	Alarm time	Specify 10, adjusted based on the application.

4.4 Threshold Configuration Guidelines

4.4.1 Application-specific Input for Monitoring Motor Stator Winding

Table 9: Recommended Configurations for Monitoring Motor Stator Winding

Parameter	Alarm or Warning	Motor Size < 22 kW	Motor Size 22 kW to <90 kW	Motor Size 90 kW to <355 kW	Motor Size 355 kW and higher
45-33.0 Alarm High	Alarm(1)	6.00	4.00	3.00	3.00
45-34.0 Warning S2 High	Warning 2	4.00	2.00	2.00	2.00
45-35.0 Warning S1 High	Warning 1	2.00	1.00	1.00	1.00

1) By default, the setting should be disabled, as it stops system operation when the event occurs.

4.4.2 Application-specific Input for Vibration Monitoring

The following are the recommendation configurations for vibration monitoring.

Table 10: Recommendation for Vibration Monitoring

Zone	Part 3 (Industrial Machines >15 kW)				Part 7 (Pumps)				Part 1 (Rest)	
	Rigid		Flexible		Category 1 (critical)		Category 2 (less critical)		Small/ Rigid	Large/ Flexible
	<300 kW	>300 kW	<300 kW	>300 kW	<200 kW	>200 kW	<200 kW	>200 kW		
Zone C limit (mm/s)	4.5	7.1	7.1	11	6.6	7.6	8.5	9.5	4.5	14.7
Zone B limit (mm/s)	2.8	4.5	4.5	7.1	4.0	5.0	5.1	6.1	1.8	9.3
Zone A limit (mm/s)	1.4	2.3	2.3	3.5	2.5	3.5	3.2	4.2	0.71	4.5

Table 10: Recommendation for Vibration Monitoring - (continued)

Zone	Part 3 (Industrial Machines >15 kW)				Part 7 (Pumps)				Part 1 (Rest)	
	Rigid		Flexible		Category 1 (critical)		Category 2 (less critical)		Small/ Rigid	Large/ Flexible
	<300 kW	>300 kW	<300 kW	>300 kW	<200 kW	>200 kW	<200 kW	>200 kW		
Vibration Warning Offset (mm/2)	0.7	1.125	1.125	1.775	1.0	1.25	1.275	1.525	0.45	2.325
Off-set % for level 1 Example(1)	2.8	4.5	4.5	7.1	4.0	5.0	5.1	6.1	1.8	9.3

1) *Sensor range 25 mm/s.*

5 Fieldbus Integration for Condition-based Monitoring

5.1 Fieldbus Integration - Options and Parameters

Parameter ***16-03 Status Word*** indicates the overall alarm or warning which is triggered due to condition-based monitoring. Specific alarms and warnings are configured using parameter ***16-97 Alarm Word 3*** and parameter ***16-98 Warning Word 3***. To make sure that the fieldbus is integrated for viewing the alarms and warnings in condition-based monitoring, configure the warning and alarm bits as described in the next sections.

5.2 Alarm and Warning Numbers with Associated Bits

The bit for each alarm and warning number is configured in parameter ***18-55 Active Alarm Number***, parameter ***18-56 Active Warning Numbers***, parameter ***16-97 Alarm Word 3***, and parameter ***16-98 Warning Word 3***, as shown in the table. The alarm and warning number is shown in the LCP.

For alarm and warning numbers for cavitation and sine-wave filters, refer to 6.5.8 Alarm and Warning Words - CBM Cavitation and 7.2.9 Alarm and Warning Words - CBM SWF, respectively.

Table 11: Bits for Configuring Alarm and Warning Number

Alarm or warning overview	Alarm number (Parameter 18-55)	Warning number (Parameter 18-56)	Alarm word 3 (Parameter 16-97)	Warning word 3 (Parameter 16-98)	Description
Stator					
Alarm	510	–	31	–	
Warning S2	–	500	–	30	
Warning S1	–	510	–	31	
Max/min thresholds exceed	520	–	–	19	Configure the bit to show the alarm when the maximum or minimum threshold value is exceeded during automatic generation or manual change.
Load envelope					
Alarm high	511	–	30	–	Configure the bit to show load envelope high alarm.
Warning S2 high	–	501	–	28	Configure the bit to show load envelope high stage 2 warning.
Warning S1 high	–	511	–	29	Configure the bit to show load envelope high stage 1 warning.
Warning S1 low	–	516	–	19	Configure the bit to show load envelope low stage 1 warning.

Table 11: Bits for Configuring Alarm and Warning Number - (continued)

Alarm or warning overview	Alarm number (Parameter 18-55)	Warning number (Parameter 18-56)	Alarm word 3 (Parameter 16-97)	Warning word 3 (Parameter 16-98)	Description
Warning S2 low	–	506	–	18	Configure the bit to show load envelope low stage 2 warning.
Alarm Low	511	–	30	–	Configure the bit to show low alarm.
Max/min thresholds exceed	521	–	–	17	Configure the bit to show an alarm when the minimum or maximum threshold value is exceeded during automatic generation or manual change.
Sensor 1					
Alarm	512	–	29	–	Configure the bit to show an alarm for sensor 1.
Warning S2	–	502	–	26	Configure the bit to show a warning stage 2 for sensor 1.
Warning S1	–	512	–	27	Configure the bit to show a warning stage 1 for sensor 1.
Max/min thresholds exceed	522	–	–	17	Configure the bit to show an alarm when the maximum or minimum threshold value is exceeded during automatic generation or manual change.
Sensor 2					
Alarm	513	–	28	–	Configure the bit to show an alarm for sensor 2.
Warning S2	–	503	–	24	Configure the bit to show a warning stage 2 for sensor 2.
Warning S1	–	513	–	25	Configure the bit to show a warning stage 1 for sensor 2.

Table 11: Bits for Configuring Alarm and Warning Number - (continued)

Alarm or warning overview	Alarm number (Parameter 18-55)	Warning number (Parameter 18-56)	Alarm word 3 (Parameter 16-97)	Warning word 3 (Parameter 16-98)	Description
Max/min thresholds exceed	–	523	–	17	Configure the bit to show a warning when the maximum or minimum threshold value is exceeded during automatic generation or manual change.
Sensor 3					
Alarm	514	–	27	–	Configure the bit to show an alarm for sensor 3.
Warning S2	–	504	–	22	Configure the bit to show a warning stage 2 for sensor 3.
Warning S1	–	514	–	23	Configure the bit to show a warning stage 1 for sensor 3.
Max/min thresholds exceed	524	–	–	17	Configure the bit to show an alarm when the maximum or minimum threshold value is exceeded during automatic generation or manual change.
Sensor 4					
Alarm	515	–	26	–	Configure the bit to show an alarm for sensor 4.
Warning S2	–	505	–	20	Configure the bit to show a warning stage 2 for sensor 4.
Warning S1	–	515	–	21	Configure the bit to show a warning stage 1 for sensor 4.
Max/min thresholds exceed	–	525	–	17	Configure the bit to show an alarm when the maximum or minimum threshold value is exceeded during automatic generation or manual change.

5.3 Alarm and Warning Conversion

In the following table, the conversion for bit, hexadecimal, and decimal are listed for parameter ***16-97 Alarm Word 3*** and parameter ***16-98 Warning Word 3***.

For alarm and warning conversion for cavitation and sine-wave filter, refer to 6.5.8 Alarm and Warning Words - CBM Cavitation and 7.2.9 Alarm and Warning Words - CBM SWF, respectively.

Table 12: Alarm and Warning Conversion Table

Bit	Hex	Dec	Alarm Word 3 in parameter 16-97 Alarm Word 3	Warning Word 3 in parameter 16-98 Warning Word 3
0	1	1	Temperature input error	Temperature input error
1	2	2	Memory module fault	–
2	4	4	Internal fan error	Internal fan warning
3	8	8	Sync. fault	–
4	10	16	ORM fault	–
5	20	32	–	Test MOC function
6	40	64	PROFIBUS Converter Invalid	PROFIBUS Converter time warning
7	80	128	–	–
8	100	256	–	–
9	200	512	–	–
10	400	1024	–	–
11	800	2048	–	–
12	1000	4096	–	–
13	2000	8192	–	–
14	4000	16384	–	–
15	8000	32768	–	–
16	10000	65536	–	–
17	20000	131072	–	–
18	40000	262144	–	CBM Load Envelope Low S2
19	80000	524288	–	CBM Load Envelope Low S1
20	100000	1048576	–	Sensor 4 S2
21	200000	2097152	–	Sensor 4 S1
22	400000	4194304	–	Sensor 3 S2
23	800000	8388608	–	Sensor 3 S1
24	1000000	16777216	–	Sensor 2 S2
25	2000000	33554432	CBM Load Low Alarm	Sensor 2 S1
26	4000000	67108864	CBM Sensor 4 Alarm	Sensor 1 S2
27	8000000	134217728	CBM Sensor 3 Alarm	Sensor 1 S1

Table 12: Alarm and Warning Conversion Table - (continued)

Bit	Hex	Dec	Alarm Word 3 in parameter 16-97 Alarm Word 3	Warning Word 3 in parameter 16-98 Warning Word 3
28	10000000	268435456	CBM Sensor 2 Alarm	CBM Load Envelope High S2
29	20000000	536870912	CBM Sensor 1 Alarm	CBM Load Envelope High S1
30	40000000	1073741824	CBM Load High Alarm	CBM Motor Stator Winding S2
31	80000000	2147483648	CBM Motor Stator Winding Alarm	CBM Motor Stator Winding S1

5.4 PCD Parameters

This section describes the parameters relevant for configuring the different fieldbus options. Within the array index of the parameter, make sure to configure the option to set up condition-based monitoring via fieldbus.

Table 13: Fieldbus Option using Parameter *8-43 PCD Read Configuration*

Parameter 8-43 PCD Read Configuration	Parameter 8-43.0 PCD Read Configuration	Parameter 8-43.2 PCD Read Configuration	Parameter 8-43.3 PCD Read Configuration
FC	[1603] Status word	[1697] Alarm Word 3	[1698] Warning Word 3
Modbus RTU			
Metasys N2			

Table 14: Fieldbus Option using Parameter *9-16 PCD Read Configuration*

Parameter 9-16 PCD Read Configuration	Parameter 9-16.0 PCD Read Configuration	Parameter 9-16.2 PCD Read Configuration	Parameter 9-16.3 PCD Read Configuration
VLT PROFIBUS DP MCA 101	[1603] Status word	[1697] Alarm Word 3	[1698] Warning Word 3
VLT PROFINET MCA 120			

Table 15: Fieldbus Option using Parameter *10-12 Process Data Config Read*

Parameter 10-12 Process Data Config Read	Parameter 10-12.0 Process Data Config Read	Parameter 10-12.2 Process Data Config Read	Parameter 10-12.3 Process Data Config Read
VLT DeviceNet MCA 104	[1603] Status word	[1697] Alarm Word 3	[1698] Warning Word 3

Table 16: Fieldbus Option using Parameter *10-51 Process Data Config Read*

Parameter 10-51 Process Data Config Read	Parameter 10-51.0 Process Data Config Read	Parameter 10-51.2 Process Data Config Read	Parameter 10-51.3 Process Data Config Read
VLT CANopen MCA 105	[1603] Status word	[1697] Alarm Word 3	[1698] Warning Word 3

Table 17: Fieldbus Option using Parameter *12-22 Process Data Config Read*

Parameter 12-22 Process Data Config Read	Parameter 12-22.0 Process Data Config Read	Parameter 12-22.2 Process Data Config Read	Parameter 12-22.3 Process Data Config Read
VLT EtherNet/IP MCA 121	[1603] Status word	[1697] Alarm Word 3	[1698] Warning Word 3
VLT Modbus TCP MCA 122			
VLT POWERLINK MCA 123			

6 Condition-based Monitoring of Cavitation

6.1 Introduction

6.1.1 Overview

This chapter describes how to use the software for testing the condition-based monitoring of the cavitation function. The chapter also provides information about the associated hardware and how to conduct measurements.

6.1.2 Functionalities

The software provides 2 functionalities:

- **Cavitation detection:**

  This function provides detection of cavitation based on the CBM concept and infrastructure of using baseline, threshold, monitoring, and warning/alarm logic. Cavitation detection provides the following functions:

  - Estimates the level of cavitation or pump turbulence.
  - Provides warnings/alarms based on user-defined thresholds.
  - Provides status of the function in different stages of execution.
  - Can be accessed via LCP, PC tool VLT® Motion Control Tool MCT 10, digital I/Os, relay, and fieldbus communication.
- **Cavitation control:**

  Cavitation control is an add-on functionality as an application, which provides active control of the pump speed to avoid cavitation. Cavitation control uses the information fed back by the cavitation detection function and adjusts the pump setpoint accordingly. Cavitation control provides the following functions:

  - Adjusts the pump speed to avoid cavitation.
  - Provides status of the function in different stages of execution.
  - Can be accessed via LCP, PC tool VLT® Motion Control Tool MCT 10, and fieldbus communication.

6.1.3 Operating Conditions

The condition-based monitoring of cavitation operates under the following conditions:

FC drive series	FC 102, FC 103, FC 202, FC 302
Control type	VVC+/Flux
Speed sensor	Open-loop speed/closed-loop speed
Motor type	Induction motors (asynchronous) Permanent magnet motors
Speed range	Entire speed range (positive speed only in CBM)
Loading range	Entire loading range
Power size	All power sizes
Power flow	Motoring (positive speed only in CBM)
Dynamics	Steady state and soft dynamics
Torque characteristics	Constant torque, variable torque, AEO

6.1.4 Limitations

Monitoring can only detect cavitation with a proper baseline. Perform the baseline while the pump operates in normal healthy conditions, without the presence of cavitation or excessive turbulence.

6.2 Background Information

6.2.1 Generics of Cavitation

Cavitation happens when rapid changes of pressure in a liquid medium form vapor bubbles. These bubbles can collapse under high pressure, generating shock waves that create micropits in the pump impeller. This leads to accelerated wear-out and erosion of the rotating blades. Also, the collapse of bubbles generates extra noise, knocking, and vibration, which further reduces pump efficiency by distorting the flow pattern.

It is important to note that cavitation can also impact other system components in contact with high-velocity moving fluids, including piping systems, pump components, engine housing, cylinder sleeves, HEX components, and hydro-turbine components. With early detection of cavitation in the pump, along with fast remedial action, the lifespan of a whole system of components can be protected and expanded.

The local collapsing of cavitation bubbles can also alter the chemical property of the liquid, producing free radicals, oxidation, and degradation of chemical compounds. Although these effects are small, it still means a change in product quality.

6.2.2 Detection Method

Cavitation detection can be achieved using current signature analysis in the drive, thereby eliminating the need for external sensors. Cavitation produces turbulence, which creates audible noise and a distinctive signature in the motor current.

By analyzing the variation of the motor current, condition-based monitoring algorithms can identify the presence of cavitation. The algorithm compares the actual cavitation signature against user-defined threshold levels. If the values exceed the set thresholds for a predefined time, the event is flagged as cavitation.

6.3 Hardware Setup

6.3.1 MKII Control Card

Being part of CBM, the cavitation function requires an MKII control card (with a white USB connector). If the drive has another control card, either replace the control card or order a new drive, which is compatible with CBM.

6.4 Software Interface

6.4.1 Software Upgrade

The CBM cavitation function software can be installed as a software upgrade.

There are a few possible interfaces to use for the software upgrade:

- VLT® Motion Control Tool MCT 10 via USB connection: This is the preferred method as it provides a fast upgrade and visible LCP and LED info. If a communication option card is installed, it is recommended to remove it while the upgrade is running.
- VLT® Motion Control Tool MCT 10 via serial RS-485: This method is slower than via USB connection, however, it is more robust to EMI noise.
- Fieldbus communication: This method is convenient for larger plants.

6.4.2 PC Tool VLT® Motion Control Tool MCT 10

Cavitation features are supported in MCT 10 in a similar way as other CBM channels, via text parameters, and graphical GUI plug-in pages. MCT 10 must be at least version 6.10 to fully support the GUI plug-in for cavitation features.

6.4.3 Preliminary Settings

The following preliminary settings must be in place before launching the cavitation function:

- Update the drive clock to show the timestamp correctly. The timestamp is used when performing baseline, generating new sets of thresholds, and enabling or disabling the monitoring.
- For drives that have the Real-time Clock option card installed, the time is saved automatically. If the option card is not installed, the time must be updated manually after each power cycle. This update is done via the clock functions in the drive.
- A warning feature can be used to verify if the time is set after each power cycle. Set parameter ***0-79 Clock Fault*** to ***[1] Enabled***. It shows a warning on the LCP after each power cycle and stays on the screen until the drive clock is updated or synchronized.

6.5 Commissioning of CBM Cavitation

6.5.1 Practical Aspects in Cavitation Commissioning

Multiple liquids

In the Food & Beverage industry, it is common that the production process changes due to a change in production need. This means that the liquid being processed may change between

- different carbonated drinks
- still water
- beverages
- cleaning agents for sanitizing the installation.

With such change in production, consider the following:

- **Multiple baseline**

  As turbulence depends on the viscosity of the liquid, the best practice is to have individual baselines separately for each group of liquids sharing the same characteristics. Sometimes, a new baseline is required when changes appear in the production line.
- **Threshold generation**

  When generating thresholds for a new baseline, it is important to generate only for cavitation and not to generate for all. To generate threshold for cavitation, select ***[11] Gen. Now - Cavitation*** in parameter ***45-45 Thresholds Generation***. This selection can also be made in the GUI plugin by clicking *Generate only for Cavitation* on the tab *Cavitation* on the *Thresholds* page.

  Avoid generating thresholds for all monitorings as it also updates all other CBM variables, overwriting all existing data acquired at the last commissioning. For example, the data of a healthy stator winding fault would be overwritten, thus losing the degradation that occurred since commissioning.
- **Multiple datasets for thresholds**

  When multiple fluids exist, a practical way of handling this is to store the thresholds in a PLC or PC and to update them to the drive via fieldbus communication protocols. Before the new production begins, the drive is updated with the corresponding thresholds that match the fluid to be used.

Consistent use of parameters

As the cavitation signature is calculated from the motor current, it is important that the drive parameters used during baseline are kept the same, also during monitoring. Changing the parameters later causes a risk of getting false-positive warnings of cavitation. Do not change the settings of the following parameters after baseline:

- Parameter ***1-01 Motor Control Principle***
- Parameter ***1-00 Configuration Mode***
- Parameter ***1-03 Torque Characteristics***

- Parameter ***1-62 Slip Compensation***
- Parameter group ***1-2* Motor Data***
- Parameter group ***1-3* Adv. Motor Data***
- Parameter group ***14-0* Inverter Switching***

6.5.2 Introduction to Monitoring of Cavitation

There are 3 steps in monitoring cavitation:

1. Baseline
2. Threshold generation
3. Monitoring

Prerequisites before testing:

- Drive and motor are successfully commissioned.
- The pump operates in normal conditions within the proper operation point, following the operation area as specified in the pump and motor datasheet, for example, inlet pressure, pump speed, and motor current.

6.5.3 Baseline

During normal run, pumps exhibit a certain level of internal turbulence, depending on their operating point. They are designed to create a laminar flow of the liquid passing through impellers, which ensures a smooth operation with a minimum level of mechanical vibrations. Smooth operation is important for ensuring an extended lifetime of all mechanical parts, motor bearings, and sealings.

Cavitation baseline measures the level of pump turbulence over different speeds and maps it for later use during monitoring. It is important that the pump operates in normal, healthy conditions with sufficient inlet pressure to overcome the required net positive suction head (NPSH). The NPSH is a pump indicator that measures the minimum required head [meter] that avoids cavitation. The NPSH is available on the pump datasheet.

Based on practical observations, typical readings of parameter ***45-89 Cavitation [%]*** are at values below 10–20%, although it varies with, for example, the pump type, impeller diameter, construction, materials, and power size.

If the readings in parameter ***45-89 Cavitation [%]*** show much higher values, adjust the level of cavitation signature by setting a lower gain value in parameter ***45-81 Signature Gain***. Changing the gain can also be done if the readings are too low and not sensitive enough.

A typical characteristic of the cavitation signature over speed is a relatively flat curve. Any significant change in this curve is a sign of turbulence, which is associated with cavitation.

Execute the baseline before starting cavitation monitoring. The software does not allow any attempt to start directly with cavitation monitoring without any valid or successful baseline. In this case, index ***[6] Status*** in parameter ***45-01 Status*** shows the code ***[13] Hold - sig. gain. modified***.

For cavitation, use the same methods of launching baseline run and online baseline as described in chapter *4 Commissioning of Condition-based Monitoring*.

Set the minimum-maximum speed range of the cavitation baseline in parameters ***45-26 Min Speed*** and ***45-27 Max Speed***.

The duration of the baseline depends on the value set in parameter ***45-82 Filter Time Constant***. At the default value of 3 s, the pump must run at each speed point in steady state for a least 30 s. In this case, the baseline run must run for at least 10 minutes to cover all 20 speed points. If the baseline runs for a shorter time, it may lead to an incorrect baseline. Adjust the duration of the baseline run accordingly after changing the filter time constant.

The status of the baseline is shown in parameter ***45-21 Status*** with more information in parameter ***45-23 Baseline Result Info***. A successful completion of the baseline shows ***[3] Baseline completed*** in parameter ***45-21 Status***. If the baseline ends with a failure, the status shows an error message describing the event that caused the failure.

6.5.4 Threshold Generation

Threshold generation for cavitation monitoring is the same as for monitoring stator, load, and sensors. The default threshold levels are given based on the expected behavior, but should be adjusted based on user experience.

Fine-tuning of the thresholds is sometimes needed once the monitoring process starts to account for:

- change of external factors, such as temperature, which changes the vapor pressure point.
- variation of loading conditions, although the algorithm compensates for it.
- particularities in pump operation, accounting for a large diversity worldwide.

There are 2 use cases for generating thresholds:

- **First-time commissioning:**

  This case is the 1st installation of condition-based monitoring, where all functions (stator winding fault, load sensors, and cavitation) are commissioned at once. In this case, generate all thresholds by setting parameter ***45-45 Thresholds Generation*** to either ***[1] Generate now*** or ***[2] Auto generate***. This setting can also be done in the GUI plug-in by clicking *Generate for all* on the *Cavitation* tab on the *Thresholds* page.

  These options are not recommended if baseline/thresholds data already exists as it overwrites the existing values acquired at the last commissioning. For example, the data of a healthy stator winding fault is overwritten by new data of degraded winding. It is recommended to create a backup of initial threshold values to have them available if the need for a restore occurs.

- **Additional commissioning:**

  In this use case, new data is added to an existing baseline/thresholds after the initial commissioning.

  In this case, only generate the thresholds needed for the CBM function of interest. One example is new cavitation data for a new liquid. Another example is upgrading the software with the cavitation function where earlier baseline/thresholds exist. To generate thresholds as additional commissioning, set parameter ***45-45 Thresholds Generation*** to ***[11] Gen. now cavitation***. The setting can also be done in the GUI plug-in by clicking *Generate only for cavitation* on the *Cavitation* tab on the *Thresholds* page

6.5.5 Monitoring

Enable and launch cavitation monitoring in the same way as for other CBM functions, such as stator, load, and sensors.

The cavitation function monitors all events that cause extra turbulence in the pump relative to data recorded during baseline. Examples of typical events causing extra turbulence are:

- cavitation due to low NPSH
- cavitation due to insufficient flow or recirculation
- air bubbles intake by swirls or vortex, or due to puncture in sealings or pipes
- presence of solids in the liquid

Long pipes and complex hydraulic systems occasionally exhibit resonances and pressure pulsation, which consequently lead to more vibration and turbulent operation of pumps, leading to possible detection of cavitation.

There are several fluctuations which affect cavitation detection:

- Speed fluctuation, meaning changes or variation in pump speed.
- Load fluctuation, meaning changes or variation in load current.
- Grid fluctuation, meaning variation of either grid voltage magnitude or frequency.

As these events may disturb the cavitation signature, a supervision algorithm monitors the fluctuations and raises an internal signal that puts the cavitation detection on hold. Putting the cavitation detection on hold avoids false-positive warnings at the expense of keeping the cavitation signature at standstill at the last known good value before the event. The events are reported in index ***[6] Cavitation*** in parameter ***45-01 Status***.

The thresholds used for supervising the fluctuations are set in parameter ***45-83 Fluctuation Limits***. Increasing the limits puts the cavitation detection on hold less often, but increases the risk of disturbing the cavitation signature, which leads to false warnings.

45-83.1	Speed Fluctuation Limits	The default value is 0.1
45-83.2	Load Fluctuation Limits	The default value is 1.5
45-83.3	Grid Fluctuation Limits	The default value is 3.0

Index ***[6] Cavitation*** in parameter ***45-01 Status*** shows the status of the cavitation monitoring function. The status value shows different events that can interfere with monitoring and appropriate resolutions. To see status value information of various functions, refer to chapter *9 Parameter Descriptions*.

6.5.6 How to Commission CBM Cavitation

Commission each pump separately, even pumps with identical nameplates. The reason is that even though the pumps look identical, they may differ in, for example, wear-and-tear, impeller characteristics, and location in the installation layout.

1. Ensure that the pump works within the correct operating area.
2. Check the readout of the cavitation signature to ensure that it is within an acceptable range. The range must not be too low to be undetectable and not higher than 20–30 to be out of scale. Adjust the gain if necessary.
3. Perform the baseline.
   - Baseline run, which is more analytical but may not always be possible due to restrictions on the production line.
   - Online baseline, which is more practical, but may not cover the entire speed range.
4. Generate thresholds.
   a. Check if there are areas in the dataset with sudden increase in cavitation signature, which identify higher turbulence.
   b. Investigate if the higher turbulence is a normal situation, or if there is an actual presence of cavitation.
5. Enable monitoring.
   a. Fine-tune the thresholds if the detection is too sensitive, being too close to the thresholds.
   b. If necessary, fine-tune the fluctuation limits to address the issues that create the speed/load/grid fluctuations.

6.5.7 Fieldbus Communication - Cavitation

The following parameters can be read via a fieldbus by setting bits 2–19 to 1 of the following options:

- Parameter ***12-22.2 Process Data Config Read***:
- Parameter ***12-22.3 Process Data Config Read***:

The fieldbus can also be used to control the drive from a remote-control system. See the warning and alarm codes in 7.2.9 Alarm and Warning Words - CBM SWF.

6.5.8 Alarm and Warning Words - CBM Cavitation

The bit for each alarm and warning number is configured in parameter ***18-55 Active Alarm Number***, parameter ***18-56 Active Warning Number***, parameter ***18-67 Alarm Word 4***, and parameter ***18-68 Warning Word 4***. The alarm and warning numbers are shown in the LCP and saved in the drive logs.

Table 18: Alarm and Warnings Register

Alarm or warning overview	Alarm number Parameter 18-55	Warning number Parameter 18-56	Alarm word 4 Parameter 18-67	Warning word 4 Parameter 18-68	Description
Alarm	517	–	0x2	–	Cavitation Alarm
Warning S2	–	507	–	0x200	Cavitation Warning S2
Warning S1	–	517	–	0x100	Cavitation Warning S1
Cavitation Thld at Max/Min	–	527	–	–	Cavitation thresh-olds at maxi-mum/minimum

Table 19 shows the alarm and warning conversion. The conversion for bit, hexadecimal, and decimal are listed for parameter ***18-67 Alarm Word 4*** and parameter ***18-68 Warning Word 4***.

Table 19: Alarm and Warning Conversion Table

Bit	Hexadecimal	Decimal	Alarm word 4 Parameter 18-67	Warning word 4 Parameter 18-68
2	0x2	2	0x2	–
9	0x100	256	–	0x100
10	0x2020	512	–	0x200
9,10	0x300	768	–	0x300

6.6 Cavitation Control

6.6.1 Description

Cavitation control reduces the cavitation level by lowering the pump speed. The pump changes its operating point, which may affect production output, but avoids all the negative side effects of cavitation.

Cavitation control receives internal feedback from the CBM cavitation detection function. Once this feature is enabled via parameter ***48-00 Function***, the cavitation control checks if there is any CBM warning of cavitation. When cavitation is detected, it starts regulating the speed.

The pump speed is changed with the value defined in parameter ***48-02 Step Change in Speed***. The speed decreases with this step size as long as a cavitation warning is present. After the cavitation warning disappears, the speed increases towards the actual speed reference. The first increasing steps are of gradual increase in magnitude, eventually reaching the defined value. The reason is to allow a smooth return and avoid overshoots when transitioning from the decreasing to increasing speed.

The change in speed is done periodically at the discrete time step defined in parameter ***48-03 Step Time***. The value must be equal to or greater than any of the CBM timers defined in parameter ***46-12.6 Warning S1 Time*** or parameter ***46-11.6 Warning S2 Time***. This ensures a proper update rate of the feedback signal for the speed control process of cavitation control.

Parameter ***48-04 Return to Reference*** configures what happens after cavitation disappears. When the parameter is set to ***[1] Yes***, the speed increases towards the actual speed reference.

When set to ***[0] No***, the speed remains at the last value that avoided the cavitation. Further occurrence of cavitation reduces the speed even further and stays again at the last value avoiding cavitation. This selection is useful when the intention is to avoid cavitation for the moment, but investigate the reasons later when allowed. A later investigation may consist of servicing the hydraulic system, filters, valves, pipes, and so on.

The cavitation control decreases the speed but is limited to a lower limit as defined in parameters ***48-05 Minimum Speed [RPM]*** and ***48-06 Minimum Speed [Hz]***. Setting these parameters correctly is important for the correct operation of the cavitation control. Its value must not be lower than any of the values set in:

- parameter ***4-11 Motor Speed Low Limit [RPM]***
- parameter ***3-02 Minimum Reference***
- parameter ***45-26 CBM Baseline Min Speed***

Failure to configure cavitation control properly may cause irregular behavior of the pump control.

Each time the cavitation control takes control of the speed, the LCP shows an appropriate message to inform about the control: *Hand On Cavit Ctrl ref* for local reference or *Auto On Cavit Ctrl ref* for remote reference.

This information is also available in parameter ***48-01 Stauts***, which can be read via fieldbus.

6.6.2 Practical Aspects in Cavitation Control

Autonomy and integration

Cavitation control is a useful alternative to standalone or lower-complexity pump applications where the pump is not integrated with plant controllers, PLCs, or remote-control systems. It acts as a local controller in the drive having the control autonomy to avoid cavitation.

Examples are applications with standalone pumps used for agriculture, or pumps in remote areas lacking the necessary communication infrastructure.

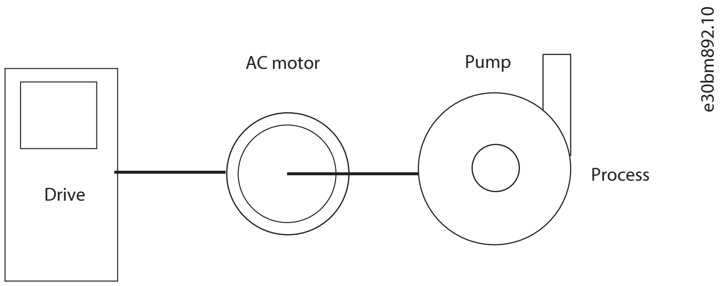


Figure 11: Application of Cavitation Control as a Standalone Autonomous Function in the Drive

Cavitation control can also be integrated with a process controller if the controller allows the drive to regulate the pump speed, which means changing the process output. The process controller can take control of the drive at any time by the following handshake, as illustrated in Figure 12:

- The process controller can overwrite parameter ***48-00 Function*** to disable at any time via remote fieldbus command, thus disabling cavitation control and its action. The speed returns to the actual speed reference. This allows the process controller to take over control of the pump system. It can also enable cavitation control via the same parameter when needed.
- The process controller is informed about the status of the cavitation control by continuously polling parameter ***48-01 Status***. For more information on cavitation parameters, refer to 9.4.1 48-0* Cavitation Control.

The process controller maintains the controllability of the entire system all the time by enabling/disabling the cavitation control when needed.

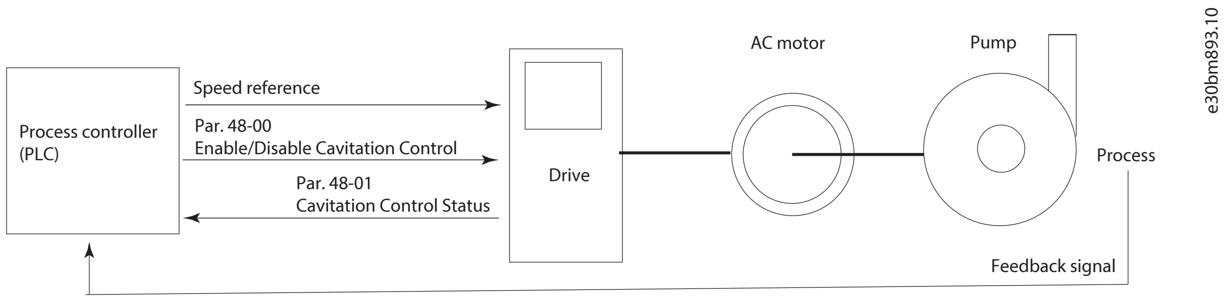


Figure 12: Integration of Cavitation Control with Process Controller

Limited data points in baseline

Cavitation control can only regulate the pump speed within the speed intervals that have valid thresholds. A particular case may appear with online baseline when the pump runs at only a few speeds. The speeds are not necessarily close neighbors, thus leaving gaps in the baseline speed data points.

Figure 13 shows an example where the pump ran at only 2 speed areas during online baseline namely 2600–3000 RPM, and 3200–3500 RPM. The other intervals are not covered, therefore the thresholds generation automatically sets the intervals at a maximum limit of 100. The CBM monitoring only reports cavitation warnings inside the 2 speed regions, which means that cavitation control only works in these 2 isolated areas. The interval 3000–3200 RPM represents a gap which the cavitation control cannot pass over.

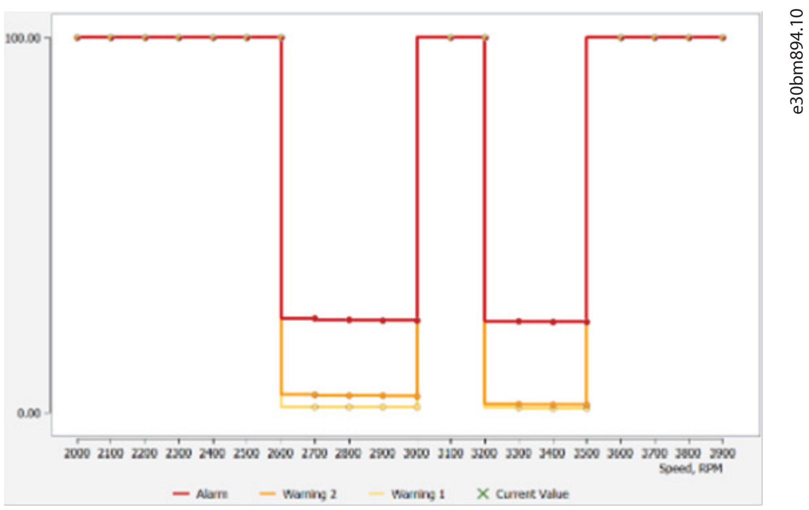
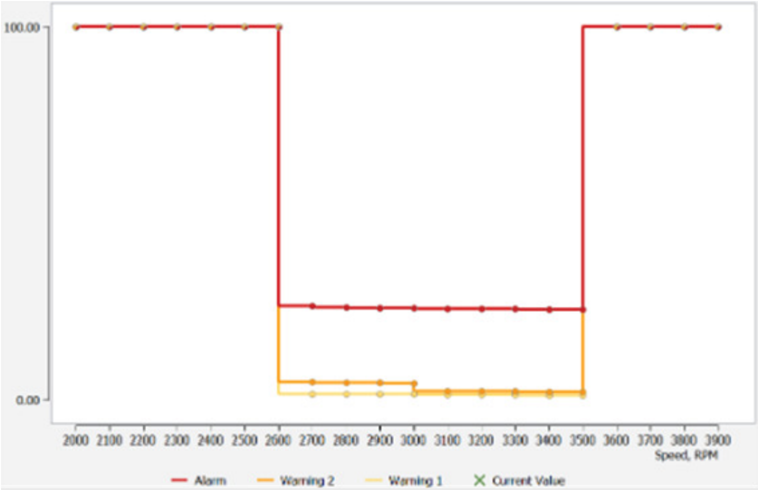


Figure 13: Result of Online Baseline with Pump Working Inside 2 Speed Areas

A workaround for the issue with gaps between speed regions is to set the thresholds for the missing speeds manually. Setting the thresholds manually creates a continuously larger speed interval with well-defined values for thresholds. The larger speed interval allows cavitation control to act on the entire speed range from 2600–3500 RPM. Figure 14 shows the result of using manually set thresholds.



e30bm895.10

Figure 14: Result After Manually Set Thresholds for Cavitation Control

7 Condition-based Monitoring of Sine Wave Filter Capacitors

7.1 Introduction

7.1.1 Overview

This chapter describes how to set up the Condition-based Monitoring - Sine-wave Filter (CBM-SWF) function for estimating capacitor degradation in sine-wave filters. The CBM-SWF functionality can be used on Danfoss and non Danfoss sine-wave filters, both newly installed filters and filters that are already in operation in the field.

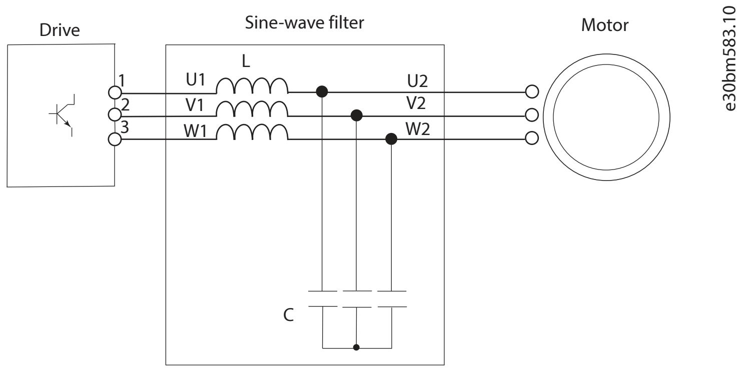


Figure 15: Filter Capacitors Connected in Star Configuration (Y Connection)

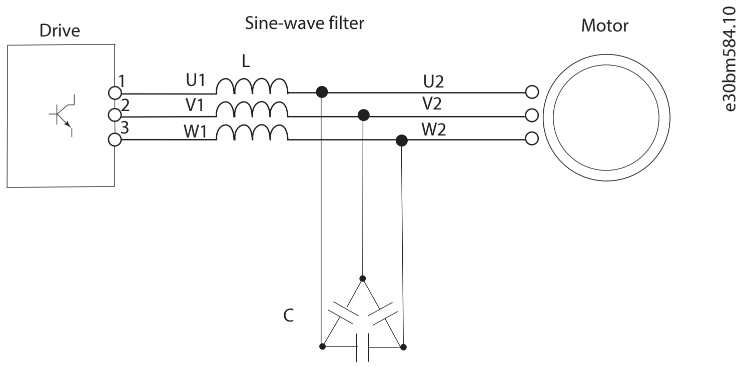


Figure 16: Filter Capacitors Connected in Delta Configuration

7.1.2 Functionality

Capacitors have an end-of-life (EOL) which is usually defined by critical parameters such as capacitance, ESR, or leakage current that are outside of the specified margins. When reaching EOL, the capacitor begins an irreversible change, and the risk of avalanche degradation increases exponentially. After passing the EOL point, it is difficult to predict the remaining lifetime. Although the capacitor may still be operating, its internal structure and materials have degraded, which poses a risk to the installation.

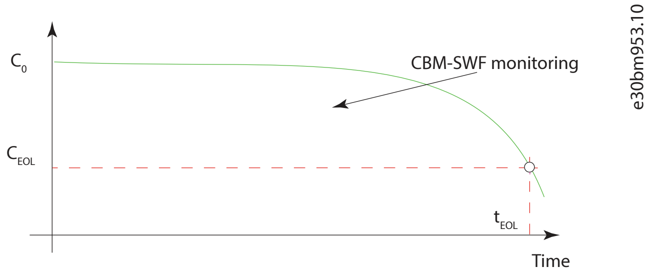


Figure 17: Degradation of Capacitor over Time

The CBM-SWF function measures capacitor degradation using the internal sensors of the drive. The advanced control generates a specific excitation and reads the resulting signature from the current and voltage signals. Using this method, the Danfoss drive determines changes in capacitance by comparing the present value to a baseline value recorded during the initial operational life.

The following is needed:

- Baseline readings:
  - The signature of a healthy capacitor is detected and saved during the baseline process.
  - The baseline process compares the measurements against nameplate capacitance values.
  - The result is given as a percentage of the nameplate capacitance.
- Monitoring readings:
  - The signature of the capacitor is measured periodically while the CBM-SWF is in operation.
  - The algorithm calculates the degradation levels by comparing the actual signature against the baseline signature.
  - The result is given as a percentage of the baseline value.

Both the baseline and monitoring processes are initiated manually, but afterwards monitoring runs autonomously. During baseline and monitoring, various messages and information on the LCP or MCT 10 guide the user. The CBM function is capable of:

- estimating the percentage capacitance change of each of the 3 capacitors in the sine-wave filter.
- indicating compete disconnection of 1 or more capacitors.
- running autonomously, detecting and reporting capacitor degradation.
- providing warnings/alarms based on user-defined thresholds.
- providing the status of the function in different stages of execution.
- integration with LCP, MCT 10, digital I/Os, relay, and fieldbus communication.

7.1.3 Stages of CBM

7.1.3.1 Baseline Measurement

Before filter monitoring can start, complete a baseline measurement. During this measurement, the sine-wave filter capacitance is measured. The baseline measurement estimates the actual installed capacitance as a percentage of the nameplate value specified in parameter ***14-56 Capacitance Output Filter***.

Accuracy is affected by the tolerance and known accuracies of both the filter capacitor and the filter inductor as specified in parameter ***14-56 Capacitance Output Filter*** and parameter ***14-57 Inductance Output Filter***. Baseline measurements of new filters may have estimation errors within ±10% of the capacitor nameplate value. Tolerance errors tend to increase over time due to component aging and drift during extended hours run.

The baseline measurement typically takes 2–3 minutes.

7.1.3.2 Monitoring Phase

During the monitoring phase, the capacitors in the sine-wave filter are measured for every 2 days. If a trigger point is exceeded, a warning or alarm is raised. The CBM-SWF adjusts automatically to have more frequent measurements when the estimated capacitance crosses the warning levels.

The actual results show the capacitance values of all 3 capacitors in the sine-wave filter as a percentage of the baseline value.

NOTE: The CBM monitoring can only measure relative changes in capacitance, starting from the time of baseline. This change is associated with capacitor degradation. The method does not measure the absolute capacitance value in Farads.

The following tables show examples of how to read the baseline and monitoring results. The percentage results are converted to their equivalent absolute capacitance in Farads for a better understanding.

Table 20: Example of Baseline Result

Nameplate value, parameter 14-56 Capacitance Output Filter	Parameter 49-13 Baseline Capacitance Value	Equivalent absolute value
30 uF	97%	30 uF x 97%=29.1 uF

Table 21: Example of Monitoring Result After the Capacitor Degraded Over Time

Start value for monitoring	Parameter 49-02 Autonomous Capacitance Value	Equivalent absolute value
100% (29.1uF)	85%	29.1 uF x 85%=24.7 uF

7.2 Commissioning of CBM-SWF

7.2.1 Introduction to Commissioning

The commissioning of CBM-SWF depends on whether the sine-wave filter is a new installation or is already in operation. If the capacitance has already started to degrade, adjust the thresholds to the actual condition, see 7.2.3 Retrofitting Installations with CBM-SWF.

7.2.2 New Installation of a Sine-wave Filter

IMPORTANT: Disconnect the sine-wave filter when running the AMA (automatic motor adaptation), see parameter ***1-29 Automatic Motor Adaptation (AMA)***.

Before running the baseline and starting the monitoring phase, ensure that the drive settings are configured correctly, and that the application runs without errors.

For easy setup, use the Smart Setup on the graphical LCP to configure the basic settings for the drive, the sine-wave filter, and the application before running the CBM-SWF baseline measurement.

7.2.3 Retrofitting Installations with CBM-SWF

For existing sine-wave filters that are already in operation, it is recommended to measure the SWF capacitor values manually before running the baseline. This can be done by disconnecting at least 2 phases of the motor cable and measuring the phase-to-phase capacitance using a capacitance meter.

The equivalent star-connected capacitance is calculated using the following formula:

$C_{\text{star equivalent}}=2 \times C_{\text{measured phase-phase}}$

Compare the measured $C_{\text{star equivalent}}$ capacitance value (in Farads) with the nameplate value of the filter and the value in parameter ***14-56 Capacitance Output Filter***. A capacitance value below 80% of the nameplate value indicates significant capacitor degradation. The manufacturing tolerance listed on the capacitor nameplate is not considered degradation.

Corrective actions, such as replacing or repairing the sine-wave filter, should be planned. Although the application can still run with a low capacitance detected during the baseline measurement, the control performance may be affected.

If the baseline capacitance level is already at an 80–90% degradation level, adjust the warning and alarm thresholds to higher levels. This accounts for the lost capacitance over time in operation and triggers the appropriate events earlier compared to a new, healthy capacitor. Figure 18 shows how to set the thresholds depending on results obtained from parameter ***49-13 Baseline Capacitance Value***. The table shows the same data rounded to the lowest integer.

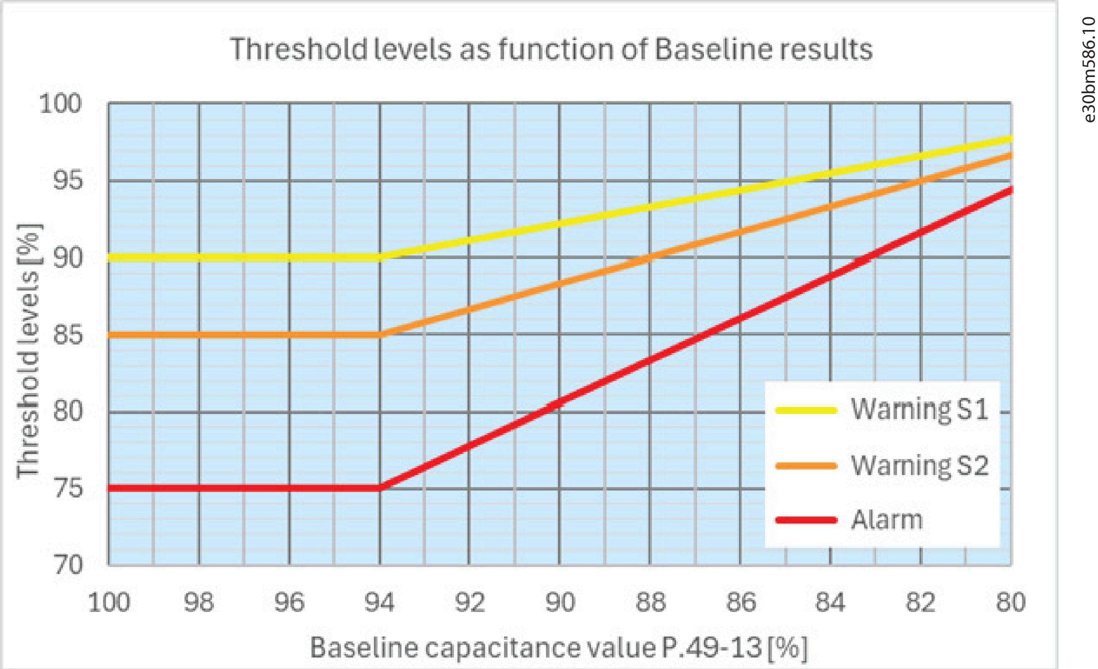


Figure 18: Threshold Levels as a Function of Baseline Results

Table 22: Threshold Values as a Function on the Estimated Baseline Results

Baseline [%]	**>100**	**94**	**93**	**92**	**91**	**90**	**89**	**88**	**87**	**86**	**85**	**84**	**83**	**82**	**81**	**80**
Parameter ***49-20 Warning S1 Threshold***	90	90	90	91	91	92	92	93	93	94	95	95	96	96	97	97
Parameter ***49-21 Warning S2 Threshold***	85	85	85	86	87	88	89	90	90	91	92	93	94	95	95	96
Parameter ***49-22 Alarm Threshold***	75	75	76	77	79	80	81	83	84	86	87	88	90	91	93	94

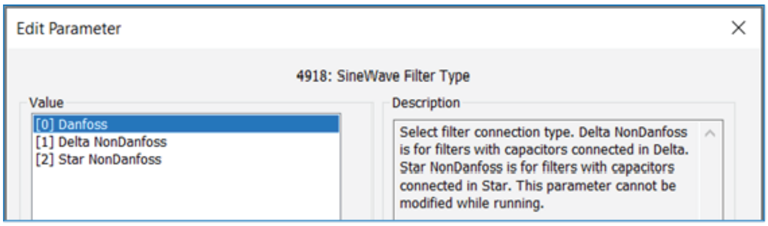
7.2.4 Commissioning Baseline Setup

Before running the baseline, ensure that the application is commissioned with motor data, the AMA is completed, and the application can run within the defined speed range. At a minimum, configure the following parameters:

- Parameter ***1-01 Motor Control Principle*** = ***[1] VVC+***
- Parameter ***14-55 Output Filter*** = ***[1] Sine-wave filter***, ***[2] Sine-wave filter fixed***, or ***[5] All mode filter***

First, select the correct sine-wave filter type in parameter ***49-18 Sine-wave Filter Type***.

- If the sine-wave filter is a Danfoss type, no extra settings are required.
- If the sine-wave filter is a non Danfoss type, select whether the capacitors are connected in start or delta, see Figure 15 and Figure 16.



e30bm587.10

Select *[1]* ***Baseline start*** in parameter ***49-10 Baseline Generate*** to start the baseline.

The baseline measurement is performed with the motor rotating at a speed and load appropriate for the application. Ideally, the motor speed is between 300 RPM and 90% of the nominal speed, for example, up to 1400 RPM for a motor with a 1500 RPM nominal speed. For increased accuracy, run the test under no-load or light-load conditions with minimal load variation.

The drive automatically executes a sequence of 4 steps to measure the capacitance. If operation conditions are outside the specified limits, parameter ***49-11 Baseline Status*** shows the corresponding fault code. To see the status codes for baseline, refer to 9.5.2 49-1* Baseline Settings.

During the baseline measurement, a change in sound around the sine-wave filter may be noticeable. The process can be stopped at any time by setting parameter ***49-10 Baseline Generate*** to ***[0] Off***.

Once the baseline completes, the measured values are automatically stored in EEPROM, overwriting any previous values. After the baseline, all capacitance values are reset to 100%, indicating the starting point for degradation monitoring. The parameters set to 100% are the following:

- Parameter ***49-02 Autonomous Capacitance Value***
- Parameter ***49-31 Capacitance of Phase U***
- Parameter ***49-32 Capacitance of Phase V***
- Parameter ***49-33 Capacitance of Phase W***

NOTE: Danfoss recommends not to perform the baseline on filters that have already run the CBM-SWF function for years, as the new baseline overwrites the previous data. If baselining is required on existing filters, refer to 7.2.3 Retrofitting Installations with CBM-SWF.

Parameter ***49-13 Baseline Capacitance*** shows an estimate of the capacitor degradation after the baseline.

Ensure that the nameplate data for the sine-wave filter parameters are set correctly. If not, the baseline results will be inaccurate.

A baseline capacitance value below 80% indicates significant capacitor degradation. Under such circumstances, plan for corrective actions such as replacing or repairing the sine-wave filter. Although the application can still be started even with a low capacitance detected during baseline, the performance may be affected.

ID	Name	Setup 1	Unit
4910	Baseline Generate	[0] Baseline Off	
4911	Baseline Status	[2] Baseline Completed	
4912	Baseline History	01-Jan-07 12:00:00 AM	
4913	Baseline Capacitance Value	102.36	%
4918	SineWave Filter Type	[0] Danfoss	

e30bm588.10

Figure 19: Example of Baseline Parameter Settings

7.2.5 Commissioning Monitoring

During the monitoring phase, the drive measures the capacitor capacitance level based on the baseline measurement results.

Start the CBM-SWF monitoring phase via parameter ***49-00 Autonomous Monitoring***. The function runs while the motor is operating.

Enable autonomous monitoring by setting parameter ***49-00 Autonomous Monitoring*** to 1 of the following:

- ***[0] Off***: The CBM-SWF function is disabled.
- ***[1] Warning***: The CBM-SWF function issues warnings if the thresholds are crossed.
- ***[2] Alarm and warning***: The CBM-SWF function issues warnings and an alarm if the respective thresholds are crossed. The drive stops on alarm.

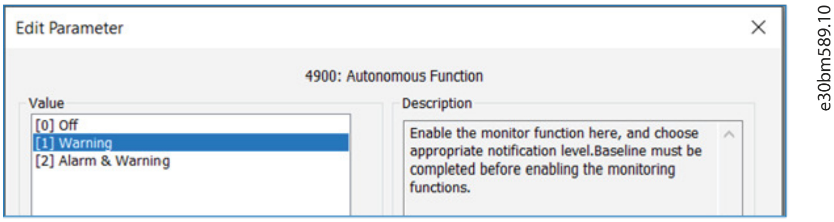
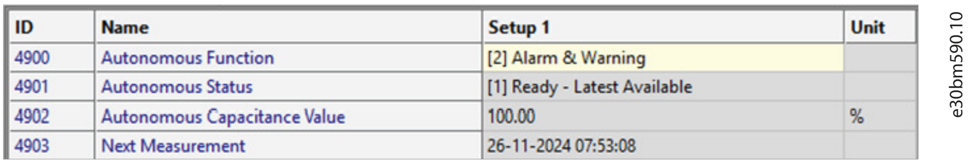


Figure 20: Possible Settings for Parameter 49-00 Autonomous Monitoring

Parameter group ***49-0* Cockpit Monitoring*** shows the latest capacitance measurements, status information, and the scheduled time for the next measurement. For more details on status information, refer to 9.5.1 49-0* Cockpit: Monitoring.

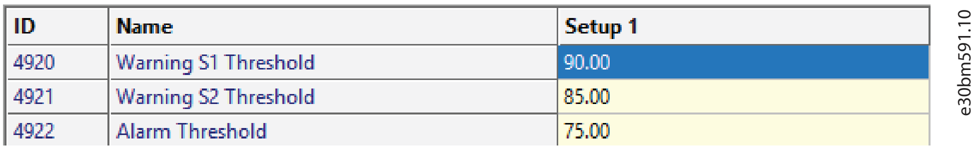


ID	Name	Setup 1	Unit
4900	Autonomous Function	[2] Alarm & Warning	
4901	Autonomous Status	[1] Ready - Latest Available	
4902	Autonomous Capacitance Value	100.00	%
4903	Next Measurement	26-11-2024 07:53:08	

Figure 21: Parameters for Cockpit Monitoring

NOTE: For manual testing and immediate, on-demand measurements (bypassing the default 2-day waiting period), toggle parameter ***49-00 Autonomous Monitoring*** from ***[1] Warning*** or ***[2] Alarm & warning*** to ***[0] Off*** and then back to the original setting.

The capacitance value in parameter ***49-02 Autonomous Capacitance Value*** is compared against the defined thresholds in parameter group ***49-2* Threshold Config*** to trigger warnings and alarms.



ID	Name	Setup 1
4920	Warning S1 Threshold	90.00
4921	Warning S2 Threshold	85.00
4922	Alarm Threshold	75.00

Figure 22: Parameters for Threshold Configuration

Parameter group ***49-3* Adv. Monitoring Readouts 1*** shows the estimated capacitance for each of the 3 phases. This information helps identify which capacitor may need replacement. However, always verify the need for replacement by measuring all 3 capacitors with a calibrated meter.

ID	Name	Setup 1	Unit
4930	Readout Setting	[0] Actual	
4931	Capacitance of phase U	84.40	%
4932	Capacitance of phase V	77.24	%
4933	Capacitance of phase W	84.63	%
4934	Measurement History	8/12/2024 14:57:11	

e30bm592.10

Figure 23: Parameters for Advanced Monitoring Readouts 1

The estimated capacitance shown in these menus is a filtered value derived from multiple raw measurements to minimize noise from the energized motor. Motor speed and load variations can introduce slight disturbances in each measurement. The estimation accuracy is maximized after approximately 5 successive measurements.

7.2.6 Autonomous Monitoring

The drive measures the sine-wave filter capacitance autonomously, following these rules:

- The measurement starts immediately after a power cycle of a drive.
- The measurement starts immediately after enabling ***Autonomous monitoring***. If ***Autonomous monitoring*** is set to ***Off***, the measurement stops immediately regardless of the current mode.
- For capacitors estimated to be healthy: every 2nd day.
- For estimated capacitance below the Warning 1 threshold: every day.
- For estimated capacitance below the Warning 2 threshold: every half day.
- When the estimated result reaches a threshold, another measurement is performed after a 10-minute interval to verify the result.

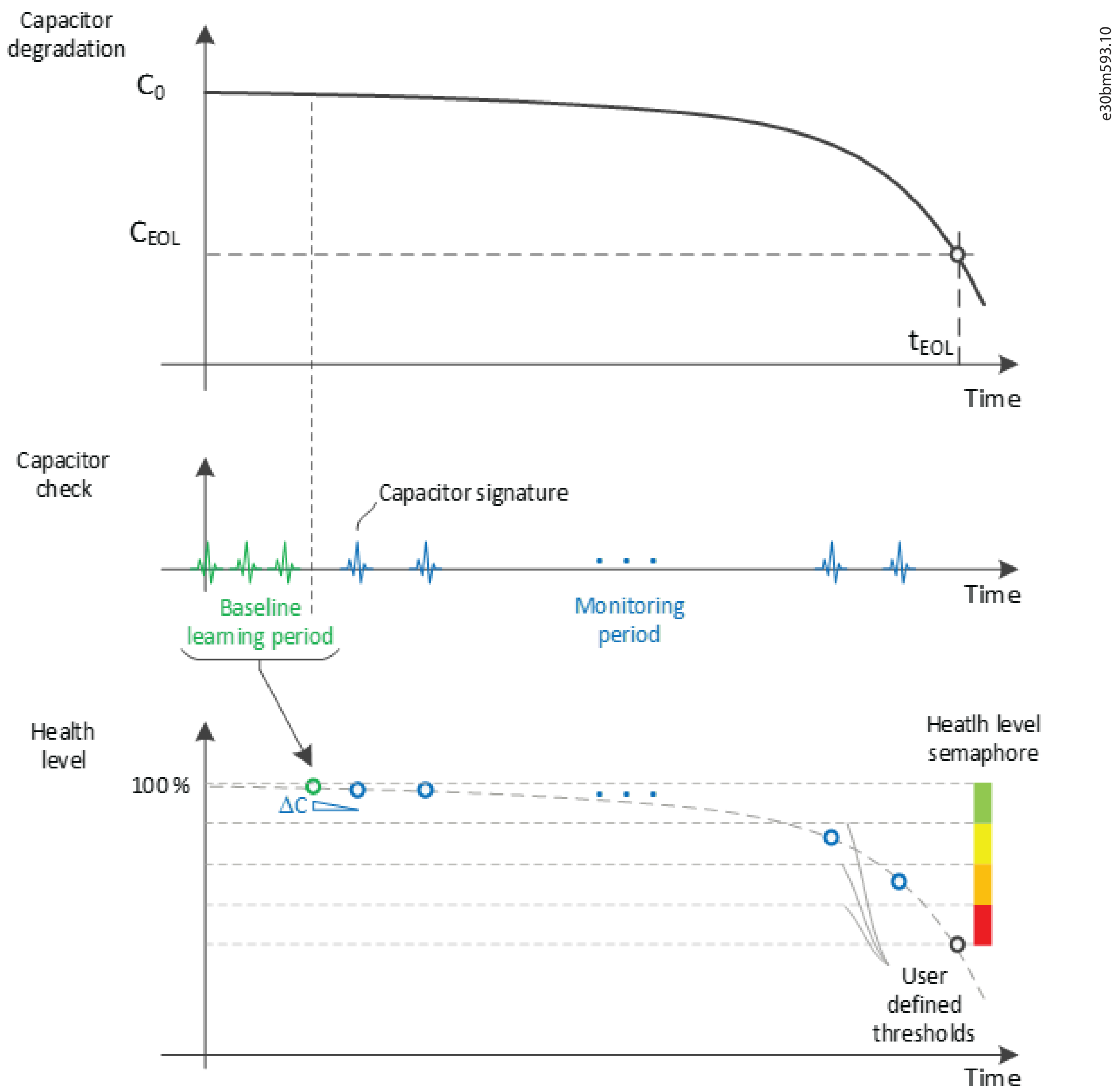


Figure 24: Periodic Measurement

The activation logic enters a temporary standby mode if the application is operating in a limitation, protection, or derating phase. Once these conditions are resolved, the autonomous function resumes operation with an immediate new measurement.

The function operates under the following conditions:

- Control type: VVC+
- Motor type: induction motor
- Speed range: 1.5 Hz...100% x nominal motor speed

7.2.7 Graphical LCP Setup

The LCP can be set up to show different values related to the CBM - Sine-wave Filter.

- Parameter ***49-01 Autonomous Status***
- Parameter ***49-02 Autonomous Capacitance Value***

- Parameter ***49-11 Baseline Status***

The best place to show data on line 1 is the 1st location which set in parameter ***0-20 Display Line 1.1 Small***. Trying to show data on line 1.3 (parameter ***0-22 Display Line 1.3 Small***) truncates the message, and it disappears from the LCP.

Example:

- Parameter ***0-20 Display Line 1.1 Small***: parameter ***49-01 Autonomous Status***
- Parameter ***0-22 Display Line 1.3 Small***: parameter ***49-02 Autonomous Capacitance Value***

7.2.8 Fieldbus Communication - CBM SWF

The following parameters can be read on a fieldbus by setting bits 2–19 to 1 of the following options:

- Parameter ***12-22.2 Process Data Config Read***: Parameter ***49-01 Autonomous Status***
- Parameter ***12-22.3 Process Data Config Read***: Parameter ***49-02 Autonomous Capacitance Value***

The fieldbus can also be used to control the drive from a remote-control system. See the warning and alarm codes in 7.2.9 Alarm and Warning Words - CBM SWF.

7.2.9 Alarm and Warning Words - CBM SWF

The bit for each alarm and warning number is configured in parameter ***18-55 Active Alarm Number***, parameter ***18-56 Active Warning Number***, parameter ***18-67 Alarm Word 4***, and parameter ***18-68 Warning Word 4***. The alarm and warning numbers are shown in the LCP.

Table 23: Bits for Configuring Alarm and Warning Numbers

Alarm or warning overview	Alarm number	Warning number	Alarm word 4 Parameter 18-67	Warning word 4 Parameter 18-68	Description
Alarm	541	–	0x1	0xC0	Sine-wave Filter Alarm
Warning S2	–	531	–	0xC0	Sine-wave Filter Warning S2
Warning S1	–	541	–	0x40	Sine-wave Filer Warning S1
Warning	–	549	–	–	SWF Out of Range Measurement

Table 24 shows the alarm and warning conversion. The conversion for bit, hexadecimal, and decimal are listed for parameter ***18-67 Alarm Word 4*** and parameter ***18-68 Warning Word 4***.

Table 24: Alarm and Warning Conversion Table

Bit	Hexadecimal	Decimal	Alarm word 4 Parameter 18-67	Warning word 4 Parameter 18-68
1	1	1	0x1	0xC0
7	40	64	–	0x40
8	80	128	–	0x80

8 Output Relays and Digital Output Terminals

Set the relays to act on CBM status of warning/alarm as follows:

- Parameter ***5-40 Function Relay***: ***[150] CBM warning***.
- Parameter ***5-41 On Delay, Relay***: 0.01 s, enter the delay cut-in time.
- Parameter ***5-42 Off Delay, Relay***: 0.01 s, enter the delay cut-out time.

Set the digital port 27 or 29 to output the CBM status of warning/alarm as follows:

- Parameter ***5-02 Terminal 29 Mode***: ***[1] Output***.
- Parameter ***5-31 Terminal 29 Digital Output***: ***[150] CBM warning***.

9 Parameter Descriptions

9.1 Parameter Group 45-** Condition Based Monitoring

9.1.1 45-0* Cockpit: Monitor

Use this parameter group to enable condition-based monitoring, define units, baseline computation, input sources, view baseline status, and progress.

45-00 Function

Default value:	–	**Parameter type:**	Option, Array [7]
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	False

Set the notification level and enable monitoring of the drive.

Option	Name	Description
[0]	Off	Notification is disabled.
[1]	Warning	Warning notifications are triggered.
[2]	Alarm & warning	Both alarm and warning notifications are triggered.

Table 25: Parameter Index

Parameter ID	Description
45-00.0	Select the required option to enable stator winding monitoring.
45-00.1	Select the required option to enable load envelope.
45-00.2	Select the required option to enable sensor 1 vibration.
45-00.3	Select the required option to enable sensor 2 vibration.
45-00.4	Select the required option to enable sensor 3 vibration.
45-00.5	Select the required option to enable sensor 4 vibration.
45-00.6	Select the required option to enable cavitation monitoring.

45-01 Status

Default value:	[0] Off	**Parameter type:**	Readout, Array [7]
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	False

The parameter shows the status of the monitor function, also when it is pending baseline completion.

Index	Name	Description
[0]*	Off	Status is disabled.
[1]	On	Shows current monitoring status.
[2]	Waiting for baseline	Baseline computation is in progress.
[3]	On - while baseline	Monitoring of cavitation is active during the online baseline, based on earlier thresholds.

Index	Name	Description
[4]	Hold - speed fluctuation	Due to fluctuation in pump speed, cavitation monitoring is put on hold to avoid false-positive warnings of cavitation. After the fluctuation disappears, the monitoring resumes. Resolution: Wait for the fluctuation to end, investigate the reason for the fluctuation. Alternatively, increase the value of parameter ***45-83.1 Speed Fluctuation Limits*** to a proper level.
[5]	Hold - load fluctuation	Due to fluctuation in pump loading, cavitation monitoring is put on hold to avoid false-positive warnings of cavitation. After the fluctuation disappears, the monitoring resumes. Resolution: Wait for the fluctuation to end, investigate the reason for the fluctuation. Alternatively, increase the value of parameter ***45-83.2 Load Fluctuation Limits*** to a proper level.
[6]	Hold - grid fluctuation	Due to fluctuation in magnitude of the power supply frequency, cavitation monitoring is put on hold to avoid false-positive warnings of cavitation. After the fluctuation disappears, the monitoring resumes. Resolution: Wait for the fluctuation to end, investigate the reason for fluctuation and address the issue. Alternatively, increase the value of parameter ***45-83.3 Grid Fluctuation Limits*** to a proper level.
[7]	Hold - load+speed fluctuation	Due to concurrent fluctuations of both pump speed and loading conditions, cavitation monitoring is put on hold to avoid false-positive warnings of cavitation. After the fluctuations end, the monitoring resumes. Resolution: Wait for the fluctuations to end, investigate the reasons for the fluctuations and address the issue. Alternatively, increase the values of parameter ***45-83.1 Speed Fluctuation Limits*** and/or parameter ***45-83.2 Load Fluctuation Limits*** to proper levels.
[8]	Hold - grid+load fluctuation	Due to concurrent fluctuations of both pump loading condition and power supply, cavitation monitoring is put on hold to avoid false-positive warnings of cavitation. After the fluctuations end, the monitoring resumes. Resolution: Wait for the fluctuations to end, investigate the reasons for the fluctuations and address the issue. Alternatively, increase the values of parameter ***45-83.2 Load Fluctuation Limits*** and/or parameter ***45-83.3 Grid Fluctuation Limits*** to proper levels.

Index	Name	Description
[9]	Hold - grid+speed fluctuation	Due to concurrent fluctuations of both pump speed and power supply, cavitation monitoring is put on hold to avoid false-positive warnings of cavitation. After the fluctuations end, the monitoring resumes. Resolution: Wait for the fluctuations to disappear, investigate the reasons for the fluctuations and address the issue. Alternatively, increase the values of parameter ***45-83.1 Speed Fluctuation Limits*** and/or parameter ***45-83.3 Grid Fluctuation Limits*** to proper levels.
[10]	Hold - grid+load+speed fluct.	Due to concurrent fluctuations of both pump speed, loading condition, and power supply, cavitation monitoring is put on hold to avoid false-positive warnings of cavitation. After the fluctuations end, the monitoring resumes. Resolution: Wait for the fluctuations to end, investigate the reason for the fluctuations and address the issue. Alternatively, increase the value of parameter ***45-83.1 Speed Fluctuation Limits***, parameter ***45-83.2 Load Fluctuation Limits***, and/or parameter ***45-83.3 Grid Fluctuation Limits*** to proper levels.
[11]	Hold - switching freq. transient	Due to fluctuation of the switching frequency of the drive, cavitation monitoring is put on hold to avoid false-positive warnings of cavitation. After the fluctuation disappears, the monitoring resumes. Wait for the fluctuation to end, investigate the reason for the fluctuation and address the issue.
[12]	Hold - DC bus transient	Due to fluctuation in the DC-link voltage of the drive, cavitation monitoring is put on hold to avoid false-positive warnings of cavitation. After the fluctuation disappears, the monitoring resumes. Resolution: Wait for the fluctuation to end, investigate the reason for the fluctuation. Alternatively, increase the values of parameter ***45-83.1 Speed Fluctuation Limits***, parameter ***45-83.2 Load Fluctuation Limits***, and/or parameter ***45-83.3 Grid Fluctuation Limits*** to proper levels.
[13]	Hold - Sig. gain modified	Cavitation monitoring is disabled as parameter ***45-81 Signature Gain*** is modified, and the value is now different from the one used during baseline. Another possibility is attempting to start cavitation monitoring without having a valid baseline. Resolution: Change the gain to the same value as used during baseline. Alternatively, run a new baseline with the new gain value.
[14]	Hold - Filter TC modified	Cavitation monitoring is disabled as parameter ***45-82 Filter Time Constant*** is modified, and the value is now different from the one used during baseline. Resolution: Change the filter time constant to the same value as used during baseline. Alternatively, run a new baseline with the new filter time constant value.

Table 26: Parameter Index

Parameter ID	Description
45-01.0	Select the required option to view the status of the stator winding monitoring.
45-01.1	Select the required option to view the status of load envelope.
45-01.2	Select the required option to view the status of sensor 1 vibration.
45-01.3	Select the required option to view the status of sensor 2 vibration.
45-01.4	Select the required option to view the status of sensor 3 vibration.
45-01.5	Select the required option to view the status of sensor 4 vibration.
45-01.6	Select the required option to view the status of the cavitation function.

45-02 Start Time

Default value:	Size related	**Parameter type:**	Readout, Array [7]
Setup:	All setups	**Conversion index:**	0
Data type:	TimeOfDay	**Change during operation:**	True

This parameter shows at which date and time the monitoring function was started.

Table 27: Parameter Index

Parameter ID	Description
45-02.0	View the timestamp for starting the stator winding monitoring.
45-02.1	View the timestamp for starting the load envelope monitoring.
45-02.2	View the timestamp for starting the sensor 1 vibration monitoring.
45-02.3	View the timestamp for starting the sensor 2 vibration monitoring.
45-02.4	View the timestamp for starting the sensor 3 vibration monitoring.
45-02.5	View the timestamp for starting the sensor 4 vibration monitoring.
45-02.6	View the timestamp for starting the cavitation monitoring.

45-03 Stop Time

Default value:	Size related	**Parameter type:**	Readout, Array [7]
Setup:	All setups	**Conversion index:**	0
Data type:	TimeOfDay	**Change during operation:**	True

This parameter shows at which date and time the monitoring function was stopped.

Table 28: Parameter Index

Parameter ID	Description
45-03.0	View the timestamp for stopping the stator winding monitoring.
45-03.1	View the timestamp for stopping the load envelope monitoring.
45-03.2	View the timestamp for stopping the sensor 1 vibration monitoring.
45-03.3	View the timestamp for stopping the sensor 2 vibration monitoring.
45-03.4	View the timestamp for stopping the sensor 3 vibration monitoring.

Table 28: Parameter Index - (continued)

Parameter ID	Description
45-03.5	View the timestamp for stopping the sensor 4 vibration monitoring.
45-03.6	View the timestamp for stopping the cavitation monitoring.

45-09 Readout Setting

Default value:	[0] Actual	**Parameter type:**	Array [7]
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	True

Set the readout setting.

Option	Name	Description
[0]*	Actual	
[1]	Actual rel. To S1 High	
[2]	Actual rel. To S2 High	
[3]	Actual rel. To Alarm High	
[4]	Actual rel. To S1 Low (Only For Load)	
[5]	Actual rel. To S2 Low (Only For Load)	
[6]	Actual rel. To Alarm Low (Only For Load)	
[7]	Actual rel. to Act.B.Mean	
[8]	Actual rel. to Prev.B.Mean	

Table 29: Parameter Index

Parameter ID	Description
45-09.0	Select the readout setting for stator winding monitoring.
45-09.1	Select the readout setting for load envelope monitoring.
45-09.2	Select the readout setting for sensor 1 vibration monitoring.
45-09.3	Select the readout setting for sensor 2 vibration monitoring.
45-09.4	Select the readout setting for sensor 3 vibration monitoring.
45-09.5	Select the readout setting for sensor 4 vibration monitoring.
45-09.6	Select the readout setting for cavitation monitoring

9.1.2 45-1* Cockpit: Actl Status

Use the parameters in this group to compare the actual monitor values to all thresholds at the current motor output speed.

45-10 Alarm High Threshold

Default value:	0%	**Parameter type:**	Readout, Array [9]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

The parameter shows the maximum threshold limit. The drive triggers a notification when threshold limit is exceeded.

Table 30: Parameter Index

Parameter ID	Description
45-10.0	Actual status of stator winding
45-10.1	Actual status of stator resonance active
45-10.2	Actual status of stator resonance load
45-10.3	Actual status of load envelope
45-10.4	Actual status of sensor 1 vibration
45-10.5	Actual status of sensor 2 vibration
45-10.6	Actual status of sensor 3 vibration
45-10.7	Actual status of sensor 4 vibration
45-10.8	Actual status of cavitation

45-11 Warning S2 High Threshold

Default value:	0%	**Parameter type:**	Readout, Array [9]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

The parameter shows the maximum threshold limit for warning stage 2 for the index. The drive triggers a warning notification when threshold limit is exceeded.

Table 31: Parameter Index

Parameter ID	Description
45-11.0	Actual status of stator winding
45-11.1	Actual status of stator resonance active
45-11.2	Actual status of stator resonance load
45-11.3	Actual status of load envelope
45-11.4	Actual status of sensor 1 vibration
45-11.5	Actual status of sensor 2 vibration
45-11.6	Actual status of sensor 3 vibration
45-11.7	Actual status of sensor 4 vibration
45-11.8	Actual status of cavitation

45-12 Warning S1 High Threshold

Default value:	0%	**Parameter type:**	Readout, Array [9]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

The parameter shows the maximum threshold limit for warning stage 1 in the parameter index. The drive triggers a warning notification when threshold limit is exceeded. Entering a value in the parameter indicates a user specified threshold limit.

Table 32: Parameter Index

Parameter ID	Description
45-12.0	Actual status of stator winding
45-12.1	Actual status of stator resonance active
45-12.2	Actual status of stator resonance load
45-12.3	Actual status of load envelope
45-12.4	Actual status of sensor 1 vibration
45-12.5	Actual status of sensor 2 vibration
45-12.6	Actual status of sensor 3 vibration
45-12.7	Actual status of sensor 4 vibration
45-12.8	Actual status of cavitation

45-13 Actual Monitor Value

Default value:	0%	**Parameter type:**	Readout, Array [9]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

This parameter shows the current value of selected signal.

Table 33: Parameter Index

Parameter ID	Description
45-13.0	Actual status of stator winding
45-13.1	Actual status of stator resonance active
45-13.2	Actual status of stator resoance load
45-13.3	Actual status of load envelope
45-13.4	Actual status of sensor 1 vibration
45-13.5	Actual status of sensor 2 vibration
45-13.6	Actual status of sensor 3 vibration
45-13.7	Actual status of sensor 4 vibration
45-13.8	Actual status of cavitation

45-14 Warning S1 Low Threshold

Default value:	0%	**Parameter type:**	Readout, Array [8]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

The parameter shows the minimum threshold limit for warning stage 1 notification in the parameter index. The drive triggers a notification when the actual monitoring value falls below the minimum threshold limit.

Table 34: Parameter Index

Parameter ID	Description
45-14.0	Actual status of stator winding
45-14.1	Actual status of stator resonance active
45-14.2	Actual status of stator resonance load
45-14.3	Actual status of load envelope
45-14.4	Actual status of sensor 1 vibration
45-14.5	Actual status of sensor 2 vibration
45-14.6	Actual status of sensor 3 vibration
45-14.7	Actual status of sensor 4 vibration

45-15 Warning S2 Low Threshold

Default value:	0%	**Parameter type:**	Readout, Array [8]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

The parameter shows the minimum threshold limit for warning stage 2 notification in the parameter index. The drive triggers a warning stage 2 notification when the actual monitoring value falls below the threshold limit specified in the parameter.

Table 35: Parameter Index

Parameter ID	Description
45-15.0	Actual status of stator winding
45-15.1	Actual status of stator resonance active
45-15.2	Actual status of stator winding load
45-15.3	Actual status of load envelope
45-15.4	Actual status of sensor 1 vibration
45-15.5	Actual status of sensor 2 vibration
45-15.6	Actual status of sensor 3 vibration
45-15.7	Actual status of sensor 4 vibration

45-16 Alarm Low Threshold

Default value:	0%	**Parameter type:**	Readout, Array [8]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

The parameter shows the minimum threshold limit in the parameter index. The drive triggers an alarm notification when the actual value falls below the minimum threshold limit.

Table 36: Parameter Index

Parameter ID	Description
45-16.0	Actual status of stator winding
45-16.1	Actual status of stator resonance active

Table 36: Parameter Index - (continued)

Parameter ID	Description
45-16.2	Actual status of stator resonance load
45-16.3	Actual status of load envelope
45-16.4	Actual status of sensor 1 vibration
45-16.5	Actual status of sensor 2 vibration
45-16.6	Actual status of sensor 3 vibration
45-16.7	Actual status of sensor 4 vibration

9.1.3 45-2* Baseline Settings

Use the parameters in this group to configure how to capture baseline data.

45-20 Type

Default value:	[0] Off	**Parameter type:**	Option
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	True

Use the parameter to select type of baseline computation.

Option	Name	Description
[0]*	Off	Baseline computation type is not set.
[1]	Baseline Run	Select the option when the application can operate from minimum to maximum speed in one sweep. On enabling this option, the condition-based monitoring function sets speed points. On completion of baseline computation, the motor is ramped down to 0. The option can only operate when Hand On mode is set via control panel.
[2]	Online Baseline	Select the option in applications where baseline run cannot be utilized. In this type of baseline computation, the drive is controlled by the application baseline and speed points are recorded and saved during the duration specified in parameter ***45-24 Duration***. The option can only operate when Auto-on mode is set via control panel.

45-21 Status

Default value:	[0] Not started	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	True

This parameter shows the current status of baseline capturing. The baseline must be completed before enabling any monitoring functions.

Index	Name
[0]*	Not started
[1]	Baseline run running

Index	Name
[2]	Online baseline running
[3]	Baseline completed
[4]	Baseline failed
[5]	Online inadequate data

45-22 Progress

Default value:	0%	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	0
Data type:	Uint8	**Change during operation:**	True

Shows the progress of baseline computation. 0% indicates that the baseline computation is not started, and 100% indicates that baseline computation is completed.

45-23 Baseline Result Info

Default value:	[0] None	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	True

The parameter shows the status of the baseline result, that is, showing the reasons for failure or inadequate data at baseline run an online baseline.

Index	Name
[0]*	None
[1]	Baseline run OFF
[2]	Reverse direction
[3]	Speed limit exceeded
[4]	Speed diff low
[5]	Step ramp timeout
[6]	Stator supply imbalance
[7]	Online baseline OFF
[8]	Online baseline count limit
[9]	Not allowed - motor running

45-24 Duration

Default value:	–	**Parameter type:**	Option
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	True

Select a suitable duration for baseline computation. If a value is not selected, by default, the system considers 2 minutes for baseline run and 1 hour for online baseline.

Option	Name	Description
[0]	1 min	
[1]	2 mins	
[3]	4 mins	
[6]	10 mins	
[9]	30 mins	
[13]	1 hour	
[16]	2 hours	
[19]	4 hours	
[23]	8 hours	
[27]	1 day	
[30]	2 days	
[33]	5 days	
[36]	1 week	
[40]	2 weeks	
[43]	1 month	
[46]	2 months	
[49]	4 months	
[52]	6 months	

45-25 Online Speed Band

Default value:	5%	**Parameter type:**	Range, 0 - 5%
Setup:	All setups	**Conversion index:**	0
Data type:	Uint8	**Change during operation:**	True

Use this parameter to define a window to capture the baseline data for different speed points when the speed of drive is within the specified band percentage. Setting the parameter increases a chance to capture all speed points in online baseline mode.

45-26 Min. Speed

Default value:	Size related	**Parameter type:**	Range, 0 - 35700 [RPM]
Setup:	All setups	**Conversion index:**	67
Data type:	Uint16	**Change during operation:**	True

Use this parameter to set the minimum speed of the drive to begin condition-based monitoring functions. Ensure to set a value which exceeds the minimum speed limit of motor. The minimum limit of motor speed corresponds to the setting in parameter ***4-11 Motor Speed Low Limit [RPM]***. For more information, refer to the drive-specific programming guide.

45-27 Max. Speed

Default value:	Size related	**Parameter type:**	Range, 100 - 35700 [RPM]
Setup:	All setups	**Conversion index:**	67
Data type:	Uint16	**Change during operation:**	True

Use this parameter to set the maximum speed of the drive for condition-based monitoring functions. Setting the minimum and maximum speed defines the speed range for condition-based monitoring functions to perform effectively. Ensure to set a value which does not exceed the maximum limit of motor speed. The maximum limit of motor speed corresponds to the setting in parameter ***4-13 Motor Speed High Limit [RPM]***. For more information, refer to the drive-specific programming guide.

45-28 Speed Points

Default value:	Size related	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	67
Data type:	Uint32	**Change during operation:**	True

Shows the baseline speed points calculated within the range defined in parameter ***45-26 Min. Speed*** and parameter ***45-27 Max. speed***.

9.1.4 45-3* Threshold Config.

45-30 Baseline Statistics

Default value:	[3] Mean ± 3 standard deviation	**Parameter type:**	Option, Array [7]
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	True

Select the type of baseline statistical data for visualizing calculated threshold limits for each parameter index. The calculated threshold is used for monitoring purposes.

Option	Name	Description
[1]	Mean	Average of the baseline data is shown.
[2]	Maximum/minimum	Maximum and minimum of the baseline data is shown.
[3]*	Mean +/- 3 standard deviation	Mean and +/-3 standard deviations of the baseline data is shown.

Table 37: Parameter Index

Parameter ID	Description
45-30.0	Threshold configuration of stator winding
45-30.1	Threshold configuration of load envelope
45-30.2	Threshold configuration of sensor 1 vibration
45-30.3	Threshold configuration of sensor 2 vibration
45-30.4	Threshold configuration of sensor 3 vibration
45-30.5	Threshold configuration of sensor 4 vibration
45-30.6	Threshold configuration of cavitation

45-31 Warning Mode

Default value:	[1] Offset	**Parameter type:**	Option, Array [7]
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	True

Select a mode to define threshold limit for warnings.

Option	Name	Description
[0]	Absolute	Absolute value is considered as threshold limit.
[1]*	Offset	Calculates threshold as a sum of the computed baseline data and the offset values.
[2]	Factor	Calculates threshold as baseline data x factor.

The values can be specified in parameter ***45-34 Warning S2 High***, parameter ***45-35 Warning S1 High***, parameter ***45-36 Warning S1 Low***, and parameter ***45-37 Warning S2 Low***. For example, if selecting ***[0] Absolute***, a warning S2 low value of 200, and a warning S1 high value of 300, the threshold limit for warning stage 2 ranges from 200–300.

Table 38: Parameter Index

Parameter ID	Description
45-31.0	Threshold configuration of stator winding
45-31.1	Threshold configuration of load envelope
45-31.2	Threshold configuration of sensor 1 vibration
45-31.3	Threshold configuration of sensor 2 vibration
45-31.4	Threshold configuration of sensor 3 vibration
45-31.5	Threshold configuration of sensor 4 vibration
45-31.6	Threshold configuration of cavitation

45-32 Alarm Mode

Default value:	–	**Parameter type:**	Option, Array [7]
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	True

Select a mode to define the threshold limits for alarms.

Option	Name	Description
[0]	Absolute	Absolute value is considered as threshold.
[1]	Offset	Calculates threshold as a sum of the computed baseline data and the offset values.
[2]	Factor	Calculates threshold as baseline data * factor.

The values can be specified in parameter ***45-33 Alarm High*** and parameter ***45-38 Alarm Low***. For example, if selecting ***[0] Absolute***, setting an alarm low value of 200, and an alarm high value of 300, the threshold limit for alarms ranges from 200 to 300.

Table 39: Parameter Index

Parameter ID	Description
45-32.0	Threshold configuration of stator winding
45-32.1	Threshold configuration of load envelope
45-32.2	Threshold configuration sensor 1 vibration
45-32.3	Threshold configuration of sensor 2 vibration
45-32.4	Threshold configuration of sensor 3 vibration

Table 39: Parameter Index - (continued)

Parameter ID	Description
45-32.5	Threshold configuration of sensor 4 vibration
45-32.6	Threshold configuration of cavitation

45-33 Alarm High

Default value:	Size related	**Parameter type:**	Array [7]
Setup:	All setup	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Type the threshold value for high alarm notification. Based on the type of alarm mode selected by the user, a high alarm threshold is calculated.

Table 40: Parameter Index

Parameter ID	Description
45-33.0	Threshold configuration of stator winding
45-33.1	Threshold configuration of load envelope
45-33.2	Threshold configuration of sensor 1 vibration
45-33.3	Threshold configuration of sensor 2 vibration
45-33.4	Threshold configuration of sensor 3 vibration
45-33.5	Threshold configuration of sensor 4 vibration
45-33.6	Threshold configuration of cavitation

45-34 Warning S2 High

Default value:	Size related	**Parameter type:**	Array [7]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during option:**	True

Type the threshold value for computing a warning S2 high notification. Based on the type of warning mode selected by the user, a warning S2 high threshold is calculated.

Table 41: Parameter Index

Parameter ID	Description
45-34.0	Threshold configuration of stator winding
45-34.1	Threshold configuration of load envelope
45-34.2	Threshold configuration of sensor 1 vibration
45-34.3	Threshold configuration of sensor 2 vibration
45-34.4	Threshold configuration of sensor 3 vibration
45-34.5	Threshold configuration of sensor 4 vibration
45-34.6	Threshold configuration of cavitation

45-35 Warning S1 High

Default value:	Size related	**Parameter type:**	Array [7]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Type the threshold value for computing a warning S1 high notification. Based on the type of warning mode selected by the user, a warning S1 high threshold is calculated.

Table 42: Parameter Index

Parameter ID	Description
45-35.0	Threshold configuration of stator winding
45-35.1	Threshold configuration of load envelope
45-35.2	Threshold configuration of sensor 1 vibration
45-35.3	Threshold configuration of sensor 2 vibration
45-35.4	Threshold configuration of sensor 3 vibration
45-35.5	Threshold configuration of sensor 4 vibration
45-35.6	Threshold configuration of cavitation

45-36 Warning S1 Low

Default value:	Size related	**Parameter type:**	Array [6]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Type the threshold value for computing a warning S1 low notification. Based on the type of warning mode selected by the user, a warning S1 low threshold is calculated.

Table 43: Parameter Index

Parameter ID	Description
45-36.0	Threshold configuration of stator winding
45-36.1	Threshold configuration of load envelope
45-36.2	Threshold configuration of sensor 1 vibration
45-36.3	Threshold configuration of sensor 2 vibration
45-36.4	Threshold configuration of sensor 3 vibration
45-36.5	Threshold configuration of sensor 4 vibration

45-37 Warning S2 Low

Default value:	Size related	**Parameter type:**	Array [6]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Type the threshold value for computing a warning S2 low notification. Based on the type of warning mode selected by the user, a warning S2 low threshold is calculated.

Table 44: Parameter Index

Parameter ID	Description
45-37.0	Threshold configuration of stator winding
45-37.1	Threshold configuration of load envelope
45-37.2	Threshold configuration of sensor 1 vibration
45-37.3	Threshold configuration of sensor 2 vibration
45-37.4	Threshold configuration of sensor 3 vibration
45-37.5	Threshold configuration of sensor 4 vibration

45-38 Alarm Low

Default value:	Size related	**Parameter type:**	Array [6]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Type the threshold value for computing a low alarm notification. Based on the type of alarm mode selected, a low alarm threshold is calculated.

Table 45: Parameter Index

Parameter ID	Description
45-38.0	Threshold configuration of stator winding
45-38.1	Threshold configuration of load envelope
45-38.2	Threshold configuration of sensor 1 vibration
45-38.3	Threshold configuration of sensor 2 vibration
45-38.4	Threshold configuration of sensor 3 vibration
45-38.5	Threshold configuration of sensor 4 vibration

45-39 Online Baseline Counter

Default value:	2	**Parameter type:**	Array [7]
Setup:	All setups	**Conversion index:**	0
Data type:	Uint16	**Change during operation:**	True

Type the minutes during which monitoring values are captured for a speed point during baseline generation. Speed points are captured for different types of condition-based monitoring during the minutes specified in this parameter.

Table 46: Parameter Index

Parameter ID	Description
45-39.0	Threshold configuration of stator winding
45-39.1	Threshold configuration of load envelope
45-39.2	Threshold configuration of sensor 1 vibration
45-39.3	Threshold configuration of sensor 2 vibration
45-39.4	Threshold configuration of sensor 3 vibration

Table 46: Parameter Index - (continued)

Parameter ID	Description
45-39.5	Threshold configuration of sensor 4 vibration
45-39.6	Threshold configuration of cavitation

45-40 Extend Factor

Default value:	1.00f	**Parameter type:**	Array [7]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

In this parameter, consider the extended factor required for setting the extended threshold generation via parameter ***45-45 Threshold Generation***.

Table 47: Parameter Index

Parameter ID	Description
45-40.0	Threshold configuration of stator winding
45-40.1	Threshold configuration of load envelope
45.40.2	Threshold configuration of sensor 1 vibration
45.40.3	Threshold configuration of sensor 2 vibration
45-40.4	Threshold configuration of sensor 3 vibration
45-40.5	Threshold configuration of sensor 4 vibration
45-40.6	Threshold configuration of cavitation

9.1.5 45-4* Threshold Generation

The parameters in this parameter group support the generation of the CBM thresholds.

45-45 Threshold Generation

Default value:	[0] Off	**Parameter type:**	Option
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	True

Option	Name	Description
[0]*	Off	Not applicable.
[1]	Generate now	Based on the selections, generate threshold for all functions from actual baseline data.
[2]	Auto generate	Not applicable.
[3]	Generate now - previous	Based on the selections, generate threshold for all functions from previous baseline data.
[4]	Gen. now - stator	Based on the selections, generate threshold for stator from actual baseline data.
[5]	Gen. now - load	Based on the selections, generate threshold for the load from actual baseline data.

Option	Name	Description
[6]	Gen. now - sensor 1	Based on the selections, generate threshold for sensor 1 from actual baseline data.
[7]	Gen. now - sensor 2	Based on the selections, generate threshold for sensor 2 from actual baseline data.
[8]	Gen. now - sensor 3	Based on the selections, generate threshold for sensor 3 from actual baseline data.
[9]	Gen. now - sensor 4	Based on the selections, generate threshold for sensor 4 from actual baseline data.
[10]	Extend auto gen.	After baseline has finished successfully, generate all function thresholds from the actual baseline data factored with the extend factor value.
[11]	Gen. now - cavitation	Based on the selections, generate cavitation thresholds from the actual baseline date.

45-46 Threshold Limits

Default value:	[0] Limits OK	**Parameter type:**	Option
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	True

Clear the threshold limit warning when the threshold is at an acceptable level.

Option	Name	Description
[0]*	Limits OK	
[1]	Limits Exceeded	

9.1.6 45-5* Sensor Config.

Select the analog input for sensor and unit configuration.

45-50 Source

Default value:	[0] None	**Parameter type:**	Option, Array [4]
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	True

Select an analog input source for receiving sensor signals. Scaling of analog inputs is performed as defined in parameter group ***6-** Analog In/Out***. For more information on parameter group ***6-** Analog In/Out***, refer to the drive-specific programming guide.

Option	Name	Description
[0]*	None	
[1]	Analog Input 53	
[2]	Analog Input 54	
[3]	Analog Input X30/11	
[4]	Analog Input X30/12	
[5]	Analog Input X42/1	

Option	Name	Description
[6]	Analog Input X42/3	
[7]	Analog Input X42/5	
[8]	Analog Input X48/2	
[9]	Analog Input X49/1	
[10]	Analog Input X49/3	
[11]	Analog Input X49/5	

Table 48: Parameter Index

Parameter ID	Description
45-50.0	Sensor 1 vibration configuration
45-50.1	Sensor 2 vibration configuration
45-50.2	Sensor 3 vibration configuration
45-50.3	Sensor 4 vibration configuration

45-51 Sensor 1 Unit

Default value:	[0] None	**Parameter type:**	Option, Array [4]
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	True

Use the parameter to set unit of monitoring signals from the sensor. The unit is specified on the vibration sensor.

Option	Name	Description
[0]*	None	
[1]	mm/s	
[2]	inch/s	
[3]	m/s2	
[4]	g	
[5]	bar	
[6]	psi	
[7]	Pa	
[8]	kPa	
[9]	MPa	
[10]	kg/cm2	
[11]	inHg	
[12]	m3/h	
[13]	US gpm	
[14]	l/h	
[15]	cfm	

Table 49: Parameter Index

Parameter ID	Description
45-50.0	Sensor 1 vibration configuration
45-50.1	Sensor 2 vibration configuration
45-50.2	Sensor 3 vibration configuration
45-50.3	Sensor 4 vibration configuration

9.1.7 45-6* Stator Res. Setting

45-60 Active Threshold

Default value:	2%	**Parameter type:**	0 - 100%
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Use this parameter to activate the resonance region supply imbalance control. Enter the threshold offset value from the baseline data.

45-61 Load Mode

Default value:	[0] Absolute	**Parameter type:**	Option
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	True

Option	Name	Description
[0]*	Absolute	Absolute value specified in parameter ***45-33 Alarm High*** is considered as notification threshold.
[1]	Offset	Notification threshold is a sum of the computed baseline data and the offset values specified in parameter ***45-33 Alarm High*** through parameter ***45-38 Alarm Low***.
[2]	Factor	Threshold limits is calculated as baseline data * factor value specified in parameter ***45-33 Alarm High*** through parameter ***45-38 Alarm Low***.

45-62 Load Threshold

Default value:	Size related	**Parameter type:**	Range, 0 - 200%
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

45-63 Imbalance Limit

Default value:	0.50%	**Parameter type:**	Range, 0.05 - 10%
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

45-64 Imbalance Value

Default value:	0%	**Parameter type:**	Readout

Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

This parameter shows the actual value of the supply imbalance.

45-65 DC-link Ripple Limit

Default value:	0.35%	**Parameter type:**	0.05 - 10%
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

When the motor output frequency matches the frequency of the DC-link voltage ripple, the threshold offset value activates.

45-66 DC-link Ripple Value

Default value:	0%	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

View the actual value of the DC-link voltage ripple.

9.1.8 45-8* Cavitation Config.

45-81 Signature Gain

Default value:	1.0	**Parameter type:**	Range, 0.1 - 10.0
Setup:	All setups	**Conversion index:**	0
Data type:	Uint8	**Change during operation:**	True

The cavitation signature varies depending on the pump type, size, and construction. Set a gain value for adjusting the magnitude of the cavitation signature. If the cavitation signature is higher than 10–20%, set a lower gain. Changing the gain requires repeating the baseline.

45-82 Filter Time Constant

Default value:	3.0 s	**Parameter type:**	0.1 - 25.0 s
Setup:	All setups	**Conversion index:**	-1
Data type:	Uint8	**Change during operation:**	True

The cavitation signature varies depending on pump type, size, and construction. Set a time constant for filtering the cavitation signature. If very dynamic cavitation signature occurs, select a high time constant value as it provides heavy filtering. Changing the time constant requires that the baseline is repeated.

45-83 Fluctuation Limits

Default value:	Size related	**Parameter type:**	Array [3]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Rapid changes in pump speed, load, or grid voltage magnitude can create false-positive events of cavitation. Set the limit for accepted fluctuation within speed, load, and grid. If the limit is exceeded, the cavitation detection function is put on hold until the fluctuation disappears.

Table 50: Parameter index

Parameter ID	Description
45-83.1	Speed fluctuation limits. Default value is 0.1.
45-83.2	Load fluctuation limits. Default value is 1.5.
45-83.3	Grid fluctuation limits. Default value is 3.0.

45-89 Cavitation [%]

Default value:	0%	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Readout of cavitation signature, which indicates the level of turbulence in the pump. This value is used for baseline and monitoring.

9.1.9 45-9* Actual Readouts

The parameters in this group are readout parameters showing the actual monitoring values.

45-90 Stator [%]

Default value:	0%	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

This parameter shows the actual stator monitor value at motor output speed.

45-91 Load [%]

Default value:	0%	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

This parameter shows the actual load monitor value at motor output speed.

45-92 Sensor 1 [%]

Default value:	0%	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

This parameter shows the actual sensor 1 monitor value in % at motor output speed.

45-93 Sensor 1 [Unit]

Default value:	0	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	-3
Data type:	Int32	**Change during operation:**	True

This parameter shows the actual sensor 1 monitor value in the selected unit at motor output speed.

45-94 Sensor 2 [%]

Default value:	0%	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

This parameter shows the actual sensor 2 monitor value in % at motor output speed.

45-95 Sensor 2 [Unit]

Default value:	0	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	-3
Data type:	Int32	**Change during operation:**	True

This parameter shows the actual sensor 2 monitor value in the selected unit at motor output speed.

45-96 Sensor 3 [%]

Default value:	0%	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

This parameter shows the actual sensor 3 value in % at motor output speed.

45-97 Sensor 3 [Unit]

Default value:	0	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	-3
Data type:	Int32	**Change during operation:**	True

This parameter shows the actual sensor 3 monitor value in the selected unit at motor output speed.

45-98 Sensor 4 [%]

Default value:	0%	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

This parameter shows the actual sensor 4 monitor value in % at motor output speed.

45-99 Sensor 4 [Unit]

Default value:	0	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	-3
Data type:	Int32	**Change during operation:**	True

This parameter shows the actual sensor 4 monitor value in the selected unit at motor output speed.

9.2 Parameter Group 46-** CBM Adv. Thresholds

9.2.1 46-0* History

The parameters in this group hold threshold history, such as timestamps of the last modification.

46-00 Last Change Time

Default value:	Size related	**Parameter type:**	Readout, Array [7]
Setup:	All setups	**Conversion index:**	0
Data type:	TimeOfDay	**Change during operation:**	True

This parameter shows the time stamp of the latest modification to a notification threshold.

Table 51: Parameter Index

Index	Description
[0]	Threshold history of stator winding.
[1]	Threshold history of load envelope
[2]	Threshold history of sensor 1 vibration
[3]	Threshold history of sensor 2 vibration
[4]	Threshold history of sensor 3 vibration
[5]	Threshold history of sensor 4 vibration
[6]	Threshold history of cavitation

9.2.2 46-0* General

46-07 Monitoring Min Speed

Default value:	0 RPM	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	67
Data type:	Uint16	**Change during operation:**	True

This parameter monitors the minimum speed as defined in parameter ***45-45 Threshold Generation***.

46-08 Monitoring Max Speed

Default value:	0 RPM	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	67
Data type:	Uint16	**Change during operation:**	True

This parameter monitors the maximum speed as defined in parameter ***45-45 Threshold Generation***.

46-09 Monitoring Speeds

Default value:	0 RPM	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	67
Data type:	Int32	**Change during operation:**	True

This parameter shows the 20 speed points in RPM. By default, the baseline minimum speed is considered.

9.2.3 46-1* Timing

46-10 Alarm Time

Default value:	10 s	**Parameter type:**	Array [7]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint32	**Change during operation:**	True

Set the time in seconds to define the duration during which the alarm is not triggered. When the value which is monitored exceeds or falls below the alarm threshold for more than the time specified in the parameter, an alarm is triggered. Alarm time is the amount of time in seconds a monitoring state should be over the alarm threshold before triggering an alarm.

Table 52: Parameter Index

Parameter ID	Description
46-10.0	Timing of stator winding
46-10.1	Timing of load envelope
46-10.2	Timing of sensor 1 vibration
46-10.3	Timing of sensor 2 vibration
46-10.4	Timing of sensor 3 vibration
46-10.5	Timing of sensor 4 vibration
46-10.6	Timing of cavitation

46-11 Warning S2 Time

Default value:	10 s	**Parameter type:**	Array [7]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint32	**Change during operation:**	True

Set the time in seconds to define the duration during which the warning S2 is not triggered. When the value which is monitored exceeds or falls below the warning S2 threshold for more than the time specified in the parameter, a warning S2 is triggered.

Table 53: Parameter Index

Parameter ID	Description
46-11.0	Timing of stator winding
46-11.1	Timing of load envelope
46-11.2	Timing sensor 1 vibration
46-11.3	Timing sensor 2 vibration
46-11.4	Timing sensor 3 vibration
46-11.5	Timing sensor 4 vibration
46-11.6	Timing of cavitation

46-12 Warning S1 Time

Default value:	10 s	**Parameter type:**	Array [7]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint32	**Change during operation:**	True

Set the time in seconds to define the duration during which the warning S1 is not triggered. When the value, which is monitored, exceeds or falls below the warning S1 threshold for more than the time specified in the parameter, a warning S1 is triggered.

Table 54: Parameter Index

Parameter ID	Description
46-12.0	Timing of stator winding
46-12.1	Timing of load envelope
46-12.2	Timing of sensor 1 vibration
46-12.3	Timing of sensor 2 vibration
46-12.4	Timing of sensor 3 vibration
46-12.5	Timing of sensor 4 vibration
46-12.6	Timing of cavitation

46-13 Interpolation Type

Default value:	[0] Linear	**Parameter type:**	Option, Array [7]
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	True

Set the type of interpolation parameter to construct accurate speed points.

Option	Name	Description
[0]*	Linear	Select this option for stator and load monitoring.
[1]	Staircase	Select this option for vibration monitoring.

Table 55: Parameter Index

Parameter ID	Description
46-13.0	Interpolation type of stator winding
46-13.1	Interpolation type of load envelope
46-13.2	Interpolation type of sensor 1 vibration
46-13.3	Interpolation type of sensor 2 vibration
46-13.4	Interpolation type of sensor 3 vibration
46-13.5	Interpolation type of sensor 4 vibration
46-13.6	Interpolation type of cavitation

9.2.4 46-2* Stator

46-20 Alarm High

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Set the threshold value which defines a high alarm for stator monitoring. When the value of the monitored value exceeds the threshold specified in the parameter for the duration of time specified in alarm time, a high alarm is triggered. The parameter contains 20 index values to manually configure Stator Winding Monitoring Alarm High Threshold for each individual speed point.

46-21 Warning S2 High

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Set the threshold value which defines a warning S2 alarm for stator monitoring. When the value of the monitored value exceeds the threshold specified in the parameter for the duration of time specified in warning S2 time, a high warning S2 is triggered. The parameter contains 20 index values to manually configure Stator Winding Monitoring Warning S2 High Threshold for each individual speed point.

46-22 Stator Warning S1

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Set the threshold value which defines a high warning S1 for stator monitoring. When the value of the monitored value exceeds the threshold specified in the parameter for the duration of time specified in warning S1 time, a high warning S1 is triggered. The parameter contains 20 index values which can be used to manually configure Stator Winding Monitoring Warning S1 High Threshold for each individual speed point.

46-23 Resonance Active

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

46-24 Resonance Load

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

9.2.5 46-3* Load

Use the parameters in this group to enter, adjust, and display threshold values for load envelope monitoring function.

46-30 Alarm High

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Set the threshold value which defines a high alarm for load envelope monitoring. When the value of the monitored value exceeds the threshold specified in the parameter for the duration of time specified in alarm time, a high alarm is triggered. The parameter contains 20 index values which can be used to manually configure Load Alarm High Threshold for each individual speed point.

46-31 Warning S2 High

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2

Data type:	Uint16	**Change during operation:**	True

Set the threshold value which defines a high warning S2 for load envelope monitoring. When the value of the monitored value exceeds the threshold specified in the parameter for the duration of time specified in warning S2 time, a warning S2 high is triggered. The parameter contains 20 index values which can be used to manually configure Load Warning S2 High Threshold for each individual speed point.

46-32 Warning S1 High

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Set the threshold value which defines a high warning S1 for load envelope monitoring. When the value of the monitored value exceeds the threshold specified in the parameter for the duration of time specified in warning S1 time, a high warning S1 is triggered. The parameter contains 20 index values which can be used to manually configure Load Warning S1 High Threshold for each individual speed point.

46-33 Warning S1 Low

Default value	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Set the threshold value which defines a low S1 warning for load envelope monitoring. When the value of the monitored value exceeds the threshold specified in the parameter for the duration of time specified in warning S1 time, a low S1 warning is triggered. The parameter contains 20 index values which can be used to manually configure Load Warning S1 Low Threshold for each individual speed point.

46-34 Warning S2 Low

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Set the threshold value which defines a low S2 warning for load envelope monitoring. When the value of the monitored value exceeds the threshold specified in the parameter for the duration of time specified in warning S2 time, a low S2 warning is triggered. The parameter contains 20 index values which can be used to manually configure Load Warning S2 Low Threshold for each individual speed point.

46-35 Alarm Low

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Set the threshold value which defines a low alarm for load envelope monitoring. When the value of the monitored value exceeds the threshold specified in the parameter for the duration of time specified in alarm time, a low alarm is triggered. The parameter contains 20 index values which can be used to manually configure Load Alarm Low Threshold for each individual speed point.

9.2.6 46-4* Sensor 1

Use the parameters in this group to enter, adjust, and display threshold values for Sensor 1 monitoring function.

46-40 Alarm High

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Set the threshold value which defines a low alarm for load envelope monitoring. When the value of the monitored value exceeds the threshold specified in the parameter for the duration of time specified in alarm time, a low alarm is triggered. The parameter contains 20 index values which can be used to manually configure Vibration 1 Alarm High Threshold for each individual speed point.

46-41 Warning S2 High

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Set the threshold value which defines a low alarm for load envelope monitoring. When the value of the monitored value exceeds the threshold specified in the parameter for the duration of time specified in alarm time, a low alarm is triggered. The parameter contains 20 index values which can be used to manually configure Vibration 1 Warning S2 High Threshold for each individual speed point.

46-42 Warning S1 High

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Set the threshold value which defines a low alarm for load envelope monitoring. When the value of the monitored value exceeds the threshold specified in the parameter for the duration of time specified in alarm time, a low alarm is triggered. The parameter contains 20 index values which can be used to manually configure Vibration 1 Warning S2 High Threshold for each individual speed point.

46-43 Warning Low

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

46-44 Alarm Low

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

9.2.7 46-5* Sensor 2

Use the parameters in this group to enter, adjust, and display threshold values for Sensor 2 monitoring function.

46-50 Alarm High

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Set the threshold value which defines a low alarm for load envelope monitoring. When the value of the monitored value exceeds the threshold specified in the parameter for the duration of time specified in alarm time, a low alarm is triggered. The parameter contains 20 index values which can be used to manually configure Vibration 2 Alarm High Threshold for each individual speed point.

46-51 Warning S2 High

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Set the threshold value which defines a low alarm for load envelope monitoring. When the value of the monitored value exceeds the threshold specified in the parameter for the duration of time specified in alarm time, a low alarm is triggered. The parameter contains 20 index values which can be used to manually configure Vibration 2 Warning S2 High Threshold for each individual speed point.

46-52 Warning S1 High

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Set the threshold value which defines a low alarm for load envelope monitoring. When the value of the monitored value exceeds the threshold specified in the parameter for the duration of time specified in alarm time, a low alarm is triggered. The parameter contains 20 index values which can be used to manually configure Vibration 2 Alarm High Threshold for each individual speed point.

46-53 Warning Low

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

46-54 Alarm Low

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

9.2.8 46-6* Sensor 3

Use the parameters in this group to enter, adjust, and display threshold values for Sensor 3 monitoring function.

46-60 Alarm High

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Set the threshold value which defines a low alarm for load envelope monitoring. When the value of the monitored value exceeds the threshold specified in the parameter for the duration of time specified in alarm time, a low alarm is triggered. The parameter contains 20 index values which can be used to manually configure Vibration 2 Alarm High Threshold for each individual speed point.

46-61 Warning S2 High

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Set the threshold value which defines a warning S2 notification for monitoring. When the value of the monitored value exceeds the threshold specified in the parameter for the duration of time specified in alarm time, a warning S2 high is triggered. The parameter contains 20 index values which can be used to manually configure warning S2 high threshold for each individual speed point.

46-62 Warning S1 High

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Set the threshold value which defines a warning stage 1 high notification for monitoring. When the value of the monitored value exceeds the threshold specified in the parameter for the duration of time specified in alarm time, a high warning is triggered. The parameter contains 20 index values which can be used to manually configure Warning S1 High Threshold for each individual speed point.

46-63 Warning Low

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

46-64 Alarm Low

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

9.2.9 46-7* Sensor 4

Use the parameters in this group to enter, adjust, and show threshold values for Sensor 4 monitoring function.

46-70 Alarm High

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Set the threshold value which defines a alarm high notification for monitoring. When the value of the monitored value exceeds the threshold specified in the parameter for the duration of time specified in alarm time, a high alarm is triggered. The parameter contains 20 index values which can be used to manually configure alarm high threshold for each individual speed point.

46-71 Warning S2 High

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Set the threshold value which defines a warning stage 2 high notification for monitoring. When the value of the monitored value exceeds the threshold specified in the parameter for the duration of time specified in alarm time, a high warning is triggered. The parameter contains 20 index values which can be used to manually configure Warning stage 2 high threshold for each individual speed point.

46-72 Warning S1 High

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Set the threshold value which defines a warning stage 1 high notification for monitoring. When the value of the monitored value exceeds the threshold specified in the parameter for the duration of time specified in alarm time, a high warning is triggered. The parameter contains 20 index values which can be used to manually configure warning stage 1 high threshold for each individual speed point.

46-73 Warning Low

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

46-74 Alarm Low

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

9.2.10 46-8* Cavitation

46-80 Alarm High

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Upper threshold limit for cavitation monitoring at each monitoring speed points. An alarm high notification is issued if the threshold is exceeded.

46-81 Warning S2 High

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Upper threshold limit for cavitation monitoring at each monitoring speed points. A warning S2 high notification is issued if the threshold is exceeded.

46-82 Warning S1 High

Default value:	0%	**Parameter type:**	Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Upper threshold limit for cavitation monitoring at each monitoring speed points. A warning S1 high notification is issued if the threshold is exceeded.

9.3 Parameter Group 47-** CBM Baseline Data

9.3.1 47-0* History

The parameters in this group hold the baseline history of start and stop timestamps of the active and previous baseline.

47-00 Actual Start Time

Default value:	Size related	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	0
Data type:	TimeOfDay	**Change during operation:**	True

This parameter shows a timestamp of when the actual baseline capturing was started.

47-01 Actual Time Stop

Default value:	Size related	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	0
Data type:	TimeOfDay	**Change during operation:**	True

This parameter shows a timestamp of when the actual baseline capturing was stopped.

47-02 Previous Start Time

Default value:	Size related	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	0
Data type:	TimeOfDay	**Change during operation:**	True

This parameter shows a timestamp of when the previous baseline capturing was started.

47-03 Previous Stop Time

Default value:	Size related	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	0
Data type:	TimeOfDay	**Change during operation:**	True

This parameter shows a timestamp of when the previous baseline capturing was stopped.

9.3.2 47-0* Speeds

The parameters in this group show the baseline speed points of active and previous baseline data.

47-04 Actual Speed

Default value:	0 RPM	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	67
Change during operation:	True		

This parameter shows the baseline speed points of the actual baseline data captured.

47-05 Previous Speed

Default value:	0 RPM	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	67
Data type:	Uint16	**Change during operation:**	True

This parameter shows the baseline speed points of the previous baseline data captured.

9.3.3 47-0* Stator

47-06 Actual Max

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

This parameter shows the maximum stator winding readings for the active baseline.

47-07 Actual Mean + 3 Std. Dev.

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

This parameter shows the mean and 3 standard deviations of stator winding readings for the active baseline.

47-08 Actual Mean

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

This parameter shows the average of stator winding readings for the active baseline.

47-09 Actual Min

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

The parameter shows the minimum value of motor stator windings for active baseline.

47-10 Actual Counter

Default value:	0	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	0
Data type:	Uint16	**Change during operation:**	False

The parameter shows the active minutes to capture monitoring values for speed points.

47-11 Previous Max

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

This parameter shows the maximum stator winding readings for the previous baseline.

47-12 Previous Mean + 3 Std. Dev.

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

This parameter shows the mean and 3 standard deviations of stator winding readings for the previous baseline.

47-13 Previous Mean

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

This parameter shows the average of stator winding readings for the previous baseline.

47-14 Previous Min

Default value:	0%	**Parameter type:**	Readout, Array [20]

Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

The parameter shows the minimum value of motor stator windings for previous baseline.

47-15 Previous Counter

Default value:	0	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	0
Data type:	Uint16	**Change during operation:**	False

The parameter shows the previous minutes to capture monitoring values for speed points.

9.3.4 47-1* Stator Res. Active

47-16 Actual Max

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the active stator resistance.

47-17 Actual Mean + 3 Std. Dev.

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the mean and 3 standard deviations of stator resistance readings for the active baseline.

47-18 Actual Mean

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

Shows the mean of stator resistance recordings for active load in the active baseline.

47-19 Actual Min

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

Shows the minimum of all stator resistance recordings for active load in the active baseline.

47-20 Previous Max

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the maximum stator resistance readings for the previous baseline.

47-21 Previous Mean + 3 Std. Dev.

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the mean and 3 standard deviations of stator resistance readings for the previous baseline.

47-22 Previous Mean

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the average of stator resistance readings for the previous baseline.

47-23 Previous Min

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

The parameter shows the minimum value of motor stator resistance for previous baseline.

9.3.5 47-2* Stator Res. Load

47-24 Actual Max

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the maximum load dependent stator resonance. An indexed parameter with 20 pointers showing stator resonance load recordings from minimum to maximum.

47-25 Actual Mean + 3 Std. Dev.

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the average and standard deviation of the stator resonance load recordings for the active baseline.

47-26 Actual Mean

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the average of the stator resonance load recordings for the active baseline.

47-27 Actual Min

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the minimum value of the stator resonance load recordings for the active baseline.

47-28 Previous Max

Default value:	0%	**Parameter Type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the maximum stator resonance readings for the previous baseline.

47-29 Previous Mean + 3 Std. Dev.

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the mean and 3 standard deviations of stator resonance readings for the previous baseline.

47-30 Previous Mean

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the average of stator resonance readings for the previous baseline.

47-31 Previous Min

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

The parameter shows the minimum value of motor stator resonance for the previous baseline.

9.3.6 47-3* Load

47-32 Actual Max

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the maximum positive load envelope recordings for the active baseline. An indexed parameter with 20 pointers of positive load envelope recordings with minimum to maximum.

47-33 Actual Mean + 3 Std. Dev.

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the active mean and 3 standard deviation of load envelope recordings for active baseline.

47-34 Actual Mean

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the active mean of load envelope recordings for the active baseline.

47-35 Actual Mean - 3 Std. Dev.

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the active mean minus 3 standard deviation of load envelope recordings for the active baseline.

47-36 Actual Min

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the minimum value of load envelope recordings for the active baseline.

47-37 Actual Counter

Default value:	0	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	0
Data type:	Uint16	**Change during operation:**	False

The parameter shows the active minutes to capture monitoring values for load envelope.

47-38 Previous Max

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the maximum value for load envelope readings for the previous baseline.

47-39 Previous Mean + 3 Std. Dev.

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Converison index:**	-2

Data type:	Uint16	**Change during operation:**	False

This parameter shows the mean and 3 standard deviations of load envelope readings for the previous baseline.

47-40 Previous Mean

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the average of load envelope readings for the previous baseline.

47-41 Previous Mean - 3 Std. Dev.

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the mean minus 3 standard deviations of load envelope readings for the previous baseline.

47-42 Previous Min

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

The parameter shows the minimum value of load envelope for the previous baseline.

47-43 Previous Counter

Default value:	0	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	0
Data type:	Uint16	**Change during operation:**	False

The parameter shows the previous minutes to capture monitoring values for load envelope.

9.3.7 47-4* Sensor 1

47-44 Actual Max

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the maximum recordings from vibration sensors for the active baseline.

47-45 Actual Mean + 3 Std. Dev.

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the average and 3 standard deviations for upper threshold of recordings from vibration sensors for active baseline.

47-46 Actual Mean

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the average value of recordings from vibration sensors for the active baseline.

47-47 Actual Min

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the minimum value of recordings from vibration sensors for the active baseline.

47-48 Actual Counter

Default value:	0	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	0
Data type:	Uint16	**Change during operation:**	False

The parameter shows the active minutes to capture monitoring values for Sensor 1.

47-49 Previous Max

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the maximum value for Sensor 1 readings for the previous baseline.

47-50 Previous Mean + 3 Std. Dev.

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the mean and 3 standard deviations of Sensor 1 readings for the previous baseline.

47-51 Previous Mean

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the average of Sensor 1 readings for the previous baseline.

47-52 Previous Min

Default value:	0%	**Parameter type:**	Readout, Array [20]

Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

The parameter shows the minimum value of Sensor 1 for the previous baseline.

47-53 Previous Counter

Default value:	0	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

The parameter shows the previous minutes to capture monitoring values for Sensor 1.

9.3.8 47-5* Sensor 2

47-54 Actual Max

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the maximum recordings from vibration sensors for the active baseline.

47-55 Actual Mean + 3 Std. Dev.

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the average and 3 standard deviations for upper threshold of recordings from vibration sensors for active baseline.

47-56 Actual Mean

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

Shows the average value of recordings from vibration sensors for active baseline.

47-57 Actual Min

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the minimum value of recordings from vibration sensors for active baseline.

47-58 Actual Counter

Default value:	0	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	0
Data type:	Uint16	**Change during operation:**	False

The parameter shows the active minutes to capture monitoring values for Sensor 2.

47-59 Previous Max

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the maximum value for Sensor 2 readings for the previous baseline.

47-60 Previous Mean + 3 Std. Dev.

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the mean and 3 standard deviations of Sensor 2 readings for the previous baseline.

47-61 Previous Mean

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the average of Sensor 2 readings for the previous baseline.

47-62 Previous Min

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

The parameter shows the minimum value of Sensor 2 for the previous baseline.

47-63 Previous Counter

Default value:	0	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	0
Data type:	Uint16	**Change during operation:**	False

The parameter shows the previous minutes to capture monitoring values for Sensor 2.

9.3.9 47-6* Sensor 3

47-64 Actual Max

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the maximum recordings from vibration sensors for the active baseline.

47-65 Actual Mean + 3 Std. Dev.

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the average and 3 standard deviations for upper threshold of recordings from vibration sensors for active baseline.

47-66 Actual Mean

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

Shows the average value of recordings from vibration sensors for active baseline.

47-67 Actual Min

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the minimum value of recordings from vibration sensors for active baseline.

47-68 Actual Counter

Default value:	0	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	0
Data type:	Uint16	**Change during operation:**	False

The parameter shows the active minutes to capture monitoring values for Sensor 3.

47-69 Previous Max

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the maximum value for Sensor 3 readings for the previous baseline.

47-70 Previous Mean + 3 Std. Dev.

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the mean and 3 standard deviations of Sensor 3 readings for the previous baseline.

47-71 Previous Mean

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2

Data type:	Uint16	**Change during operation:**	False

This parameter shows the average of Sensor 3 readings for the previous baseline.

47-72 Previous Min

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

The parameter shows the minimum value of Sensor 3 for the previous baseline.

47-73 Previous Counter

Default value:	0	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	0
Data type:	Uint16	**Change during operation:**	False

The parameter shows the previous minutes to capture monitoring values for Sensor 3.

9.3.10 47-7* Sensor 4

47-74 Actual Max

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the maximum recordings from vibration sensors for the active baseline.

47-75 Actual Mean + 3 Std. Dev.

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the average and 3 standard deviations for upper threshold of recordings from vibration sensors for active baseline.

47-76 Actual Mean

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

Shows the average value of recordings from vibration sensors for active baseline.

47-77 Actual Min

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the minimum value of recordings from vibration sensors for active baseline.

47-78 Actual Counter

Default value:	0	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	0
Data type:	Uint16	**Change during operation:**	False

The parameter shows the active minutes to capture monitoring values for Sensor 4.

47-79 Previous Max

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the maximum value for Sensor 4 readings for the previous baseline.

47-80 Previous Mean + 3 Std. Dev.

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the mean and 3 standard deviations of Sensor 4 readings for the previous baseline.

47-81 Previous Mean

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the average of Sensor 4 readings for the previous baseline.

47-82 Previous Min

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

The parameter shows the minimum value of Sensor 4 for the previous baseline.

47-83 Previous Counter

Default value:	0	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	0
Data type:	Uint16	**Change during operation:**	False

The parameter shows the previous minutes to capture monitoring values for Sensor 4.

9.3.11 47-8* Cavitation

47-84 Actual Max

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

The parameter shows the maximum value of the actual baseline statistical data captured for cavitation values.

47-85 Actual Mean + 3 Std. Dev.

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

The parameter shows the mean + 3 times standard deviation value of the actual baseline statistical data captured for cavitation values.

47-86 Actual Mean

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

The parameter shows the mean value of the actual baseline statistical data captured for cavitation values.

47-87 Actual Min

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

The parameter shows the minimum value of the actual baseline statistical data captured for cavitation values.

47-88 Actual Counter

Default value:	0	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	0
Data type:	Uint16	**Change during operation:**	False

The parameter shows the online baseline count for the actual baseline data for cavitation values.

47-89 Previous Max

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

The parameter shows the maximum value of the previous baseline statistical data captured for cavitation values.

47-90 Previous Mean + 3 Std. Dev.

Default value:	0%	**Parameter type:**	Readout, Array [20]

Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

The parameter shows the mean + 3 standard deviation value of the previous baseline statistical data captured for cavitation values.

47-91 Previous Mean

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

The parameter shows the mean value of the previous baseline statistical data captured for cavitation values.

47-92 Previous Min

Default value:	0%	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

The parameter displays the minimum value of the previous baseline statistical data captured for cavitation values.

47-93 Previous Counter

Default value:	0	**Parameter type:**	Readout, Array [20]
Setup:	All setups	**Conversion index:**	0
Data type:	Uint16	**Change during operation:**	False

The parameter shows the online baseline for the previous baseline data for cavitation values.

9.3.12 47-9* Min Max Speed

47-95 Actual Min Speed

Default value:	0 RPM	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	67
Data type:	Uint16	**Change during operation:**	True

This parameter shows the minimum speed of the actual baseline data.

47-96 Actual Max Speed

Default value:	0 RPM	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	67
Data type:	Uint16	**Change during operation:**	True

This parameter shows the maximum speed of the actual baseline data.

47-97 Previous Min Speed

Default value:	0 RPM	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	67
Data type:	Uint16	**Change during operation:**	True

This parameter shows the minimum speed of the previous baseline data.

47-98 Previous Max Speed

Default value:	0 RPM	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	67
Data type:	Uint16	**Change during operation:**	True

This parameter shows the maximum speed of the previous baseline data.

9.4 Parameter Group 48-** CBM Applications

9.4.1 48-0* Cavitation Control

48-00 Function

Default value:	[0] Disabled	**Parameter type:**	Option
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	True

Use cavitation control to lower the pump speed if a cavitation warning appears. For standalone operation, set the parameter manually. For remote operation, set the parameter via fieldbus.

Option	Name	Description
[0]*	Disabled	This selection disables cavitation control.
[1]	Enabled	This selection enables cavitation control.

48-01 Status

Default value:	[0] Disabled - local	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	False

This parameter shows the status of the cavitation controller.

Table 56: Parameter Index

ID	Status value	Description
[0]	Disabled - local	The cavitation control is disabled by a local command via the LCP or MCT 10.
[1]	Disabled - remote	The cavitation control is disabled by a remote command via field-bus.
[2]	Enabled - local ref.	The cavitation control is enabled. The drive in hand-on mode and follows the local speed reference as there is no cavitation detected yet.
[3]	Enabled - remote ref.	The cavitation control is enabled. The drive is in auto-on mode and follows the remote speed reference as there is no cavitation detected yet.
[5]	Standby - drive coasted	The cavitation control is on standby as the drive is coasted. The al-gorithm re-enables itself automatically when the drive is back in normal operation.

Table 56: Parameter Index - (continued)

ID	Status value	Description
[6]	Standby - drive standby	The cavitation control is on standby as the drive is in standby state. The algorithm re-enables itself automatically when the drive is back in normal operation.
[7]	Standby - drive off	The cavitation control is on standby as the drive is in off state. The algorithm re-enables itself automatically when the drive is back in normal operation.
[8]	Standby - drive alarm	The cavitation control is on standby due to various alarms. The algorithm re-enables itself automatically when the drive is back in normal operation.
[9]	Standby - BL running	The cavitation control is disabled for the entire duration of the baseline. Allow baseline to finish correctly and perform a proper threshold generation for cavitation. The cavitation control re-enables itself automatically when the drive is back in normal operation.
[10]	Standby - not in cavit ctrl range	The actual speed is outside the range allowed for cavitation control, which puts the cavitation control in standby. Resolution: The algorithm re-enables itself automatically when the actual speed returns to its baseline range. Alternatively, check if the limits in the following parameters are set correctly: • Parameter ***48-05 Minimum Speed [RPM]***/parameter ***48-06 Minimum Speed [Hz]***. • Parameter ***4-11 Motor Speed Low Limit [RPM]***/parameter ***4-12 Motor Speed Low Limit [Hz]***. • Parameter ***3-02 Minimum Reference***. • Parameter ***45-26 CBM Baseline Min Speed***.
[11]	Standby - not in BL speed range	The actual speed is outside of the baseline speed range, which puts cavitation control on standby due to lack of cavitation data. Resolution: The algorithm re-enables itself automatically when the actual speed returns into its baseline range. Alternatively, check if the limits in the following parameters are set correctly: • Parameter ***48-05 Minimum Speed [RPM]***/parameter ***48-06 Minimum Speed [Hz]***. • Parameter ***4-11 Motor Speed Low Limit [RPM]***/parameter ***4-12 Motor Speed Low Limit [Hz]***. • Parameter ***3-02 Minimum Reference***. • Parameter ***45-26 CBM Baseline Min Speed***.
[12]	Standby - other priority task	The application is under an operating condition which requires another function of a higher priority to take control of the pump, for example, jogging, deragging, and dry run. This forces the cavitation control into standby mode. The algorithm re-enables itself automatically when the drive returns to normal operation.

Table 56: Parameter Index - (continued)

ID	Status value	Description
[13]	Ramp down - cavit. detected	Cavitation control lowers the speed because of detecting cavitation. The speed decreases according to parameter ***48-02 Step Change in Speed***. The LCP indicates that the speed reference is controlled by cavitation control. Resolution: Verify the reasons for cavitation warnings.
[14]	Ramp up - no cavit.	Cavitation control sets the speed towards the actual speed reference since cavitation is no longer present. The actual speed reference can be local or remote. The speed increases according to parameter ***48-02 Step Change in Speed***. The LCP indicates that the speed reference is still controlled by cavitation control. Resolution: Allow sufficient time for cavitation control to reach its actual speed reference.
[15]	At min speed - cavit. detected	Cavitation control reached its minimum allowed speed while cavitation is still present. The cavitation remains at this value for the time that cavitation persists. The LCP indicates that the speed reference is controlled by cavitation control. Resolution: Verify the reasons for cavitation warnings. Alternatively, check if the speed limit is set correctly.
[16]	At no return speed	Cavitation control avoided cavitation by lowering the speed and stays at the actual speed because parameter ***48-04 Return to Reference*** is set to ***[0] No***. The LCP indicates that the speed reference is controlled by cavitation control. Resolution: Verify the reasons for cavitation warnings. Alternatively, check if the parameter is set correctly.

48-02 Step Change in Speed

Default value:	3%	**Parameter type:**	Range, 0.1 - 20%
Setup:	All setups	**Conversion index:**	-1
Data type:	Uint8	**Change during operation:**	True

Set the value of the speed change which the cavitation control performs at each step time. The value is defined in percent of the motor nominal speed set in parameter ***1-25 Motor Nominal Speed***.

48-03 Step Time

Default value:	15 s	**Parameter type:**	Range, 1 - 600 s
Setup:	All setups	**Conversion index:**	0
Data type:	Uint16	**Change during operation:**	True

Set the discrete periodical control time of the cavitation control. The value must be equal to or greater than any of the timers defined in parameter ***46-12.6 Warning S1 Time*** or parameter ***46-11.6 Warning S2 Time***.

48-04 Return to Reference

Default value:	[1] Yes	**Parameter type:**	Option
Setup:	All setups	**Conversion index:**	–

Data type:	Uint8	**Change during operation:**	True

Select if the cavitation control should remain at the last speed reference that avoided the cavitation, or if it should gradually return to the actual speed reference while continuously checking that the cavitation has disappeared.

Option	Name	Description
[0]	No	With this selection, cavitation control does not return to the actual speed reference, but remains at the last speed reference that avoided the cavitation.
[1]*	Yes	This selection, the cavitation control gradually returns to the actual speed reference.

48-05 Minimum Speed [RPM]

Default value:	Size related	**Parameter type:**	Range, par. 4-11 - par. 4-13 RPM
Setup:	All setups	**Conversion index:**	67
Data type:	Uint16	**Change during operation:**	True

Specify the minimum RPM limit for cavitation control to regulate the speed reference. This value must not be lower than any of the following:

- Parameter ***4-11 Motor Speed Low Limit [RPM]***
- Parameter ***3-02 Minimum Reference***
- Parameter ***45-26 CBM Baseline Min Speed***

48-06 Minimum Speed [Hz]

Default value:	Size related	**Parameter type:**	Range, Par. 4-12 - par. 4-14
Setup:	All setups	**Conversion index:**	-1
Data type:	Uint16	**Change during operation:**	True

Specify the minimum Hz limit for cavitation control to regulate the speed reference. This value must not be lower than any of the following:

- Parameter ***4-12 Motor Speed Low Limit [Hz]***
- Parameter ***3-02 Minimum Reference***
- Parameter ***45-26 CBM Baseline Min Speed***

9.5 Parameter Group 49-** CBM-SWF

9.5.1 49-0* Cockpit: Monitoring

Use the parameters in this group for configuring and providing overall status of the sine-wave filter monitoring functions.

49-00 Autonomous Function

Default value:	–	**Parameter type:**	Option
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	True

Autonomous monitoring function for CBM-SWF. Select ***[1] Warning*** or ***[2] Alarm & warning*** notification to start the monitoring of the sine-wave filter.

For manual testing and immediate, on-demand measurements (bypassing the default 2-day waiting period), toggle this parameter from ***[1] Warning*** or ***[2] Alarm and warning*** to ***[0] Off*** and then back to the original option.

Option	Name	Description
[0]	Off	
[1]	Warning	
[2]	Alarm & warning	

49-01 Autonomous Status

Default value:	[0] Disabled	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	False

This parameter shows the status of the monitoring function.

Index	Name	Description
[0]*	Disabled	The autonomous monitoring function is disabled. There is no check of the SWF capacitors.
[1]	Ready - latest available	Measurement is done successfully, and the latest results are available for readout.
[2]	Measurement in progress	Measurement is in progress. Notification and data will be available shortly.
[3]	Waiting for new measurement	The result of the latest measurement requires further verification. A new measurement will start at the time set in parameter ***49-03 Next Measurement***.
[4]	Standby - baseline in progress	Baseline is in progress and monitoring cannot be enabled. Allow the baseline to finish before enabling monitoring.
[5]	Standby - voltage limit	The voltage limit is reached, which temporarily stops the capacitor measurement. The algorithm re-enables itself when getting inside the normal voltage range allowed for measurement.
[6]	Standby - speed out of range	The speed limit is reached, which temporarily stops the measurement. The allowed speed range is 1.5 Hz to 1.1 times the nominal frequency. The algorithm re-enables itself automatically when getting inside the normal speed range allowed for measurement.
[7]	Standby - after alarm reset	Any alarm or reset of the drive stops the autonomous monitoring immediately and stays on hold until the alarm clears. The algorithm re-enables itself automatically. Wait until the alarm clears, then check the drive and sine-wave filter for faults.
[8]	Standby - manual interrupt local	The current measurement is manually stopped while the drive is configured to use local reference from LCP. Re-enable the autonomous function.

Index	Name	Description
[9]	High Dynamic Loading	Monitoring is temporarily on hold due to too high dynamical changes of the speed or loading. The algorithm re-enables itself automatically when normal conditions are established.
[10]	Communication failed	Monitoring is temporarily on hold due to internal communication errors. Re-enable the autonomous function. If it is not successful, contact support.
[11]	Capacitor disconnect on all phases	The monitoring detected a connection problem with all 3 SWF capacitors and it temporarily on hold. The algorithm runs again to check the capacitance at the time set in parameter ***49-03 Next Measurement***. Check if the sine-wave filter components are disconnected or damaged.
[12]	Baseline data not available	Baseline data is missing, thus monitoring is not allowed to start. Perform a new baseline.
[13]	Capacitor disconnected on phase U	The monitoring detected a connection problem, either with the capacitor or inductor of a given phase and is temporarily on hold. The algorithm runs again to check the capacitance at the time set in parameter ***49-03 Next Measurement***. Check if the sine-wave filter components are disconnected or damaged.
[14]	Capacitor disconnected on phase V	Same description as ***[13] Capacitor disconnected on phase U***.
[15]	Capacitor disconnected on phase W	Same description as ***[13] Capacitor disconnected on phase U***.
[16]	Upper measurement limit exceeded on phase U	The monitoring detected that the measurement of a given phase falls outside of the higher limit of the measurement range. The algorithm runs again to check the capacitance measurement at the time set in parameter ***49-03 Next Measurement***. Check if capacitors are disconnected or damaged. Alternatively, set the operation point of the drive at a lower loading current. Another alternative is to increase parameter ***49-15 Frequency Sweep Max*** to a higher value, for example, 1800 Hz. Then start a new baseline.
[17]	Upper measurement limit exceeded on phase V	Same description as ***[16] Upper measurement limit exceeded on phase U***.
[18]	Upper measurement limit exceeded on phase W	Same description as ***[16] Upper measurement limit exceeded on phase U***.
[19]	Lower measurement limit exceeded on phase U	The monitoring detected that the measurement of a given phase falls outside of the lower limit of the measurement range. The algorithm runs again to check the capacitance measurement at the time set in parameter ***49-03 Next Measurement***. Check if the capacitors are disconnected or damaged. Alternatively, set the operation point of the drive at a higher loading current. Another alternative is to decrease parameter ***49-14 Frequency Sweep Min*** at a lower value, for example, 150 Hz. Then start a new baseline.
[20]	Lower measurement limit exceeded on phase V	Same description as ***[19] Lower measurement limit exceeded on phase U***.
[21]	Lower measurement limit exceeded on phase W.	Same description as ***[19] Lower measurement limit exceeded on phase U***.
[22]	Upper measurement limit exceeded on all phases	Same description as ***[16] Upper measurement limit exceeded on phase U***.

Index	Name	Description
[23]	Lower measurement limit exceeded on all phases.	Same description as ***[19] Lower measurement limit exceeded on phase U***.
[24]	Motor is not connected	The motor is not connected, and monitoring is temporarily set on hold. The drive is kept in operation without any other action. It can also happen for low drive current, for example, during AEO. Check and reconnect the motor cable and restart the application. Alternatively, allow the drive current to increase.
[25]	Standby - AMA	Measurement is on hold while AMA is running. Measurement resumes once AMA is completed.
[26]	Standby - kinetic backup	Measurement is on hold during kinetic backup. Measurement resumes once kinetic backup is completed.
[27]	Standby - mains failure	Measurement is on hold during mains failure. Measurement resumes once the mains failure is resolved.
[28]	Standby - stall limit	Measurement is on hold during stall limit. Resumes measurement once the stall limit is resolved.
[29]	Standby - active power derate	Measurement is on hold during active power derate. Measurement resumes after power derate.
[30]	Communication timeout	Measurement is halted due to an error that occurred internally. The algorithm restarts measurement at the time set in parameter ***49-03 Next Measurement***.
[31]	Standby - drive OFF state	Measurement is on hold as the drive is in OFF state. Start the drive with the specified speed range.
[32]	Standby - drive in standby state	Measurement is on hold as the drive is in standby state. Enable [*Start*] digital output pin and run the drive the specified speed range.
[33]	Standby - manual interrupt remote	Current measurement is manually stopped via fieldbus by a remote reference. Re-enable the autonomous function in parameter ***49-00 Autonomous Function***.
[34]	Standby - drive in coast state	Measurement is on hold due as the drive is in coast state. Start the drive with the specified speed range.

49-02 Autonomous Capacitance Value

Default value:	0%	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the latest lowest value of U, V, W phase capacitance in percentage of parameter ***49-13 Baseline Capacitance Value***.

49-03 Next Measurement

Default value:	Size related	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	0
Data type:	TimeOfDay	**Change during operation:**	False

This parameter shows the next measurement time in the time-of-day format. The parameter is only valid if the date and time is set.

9.5.2 49-1* Baseline Settings

Use the parameters in this group for configuring how to capture baseline data. Progress and status are provided in readout parameters.

49-10 Baseline Generate

Default value:	–	**Parameter type:**	Option
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	True

Option	Name	Description
[0]	Baseline off	No baselining is taking place.
[1]	Baseline start	Select this option to start the initial baseline measurement of the sine-wave filter.

49-11 Baseline Status

Default value:	[0] Not started	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	True

This parameter shows the status of the baseline monitoring function.

Index	Name	Description
[0]*	Not started	Baseline is not yet performed, and there is no data available to start any monitoring.
[1]	Baseline running	Baseline has started to run at the selected speed and current. After all steps are successfully completed, data is saved into EEPROM. If the baseline fails, details are available in the status code via the LCP or VLT® Motion Control Tool MCT 10.
[2]	Baseline completed	Baseline is successfully completed, and data is available for use. Monitoring can be enabled.
[3]	BL fail - no connection all phases	The capacitor of a given phase is disconnected from the sine-wave filter. Check the filter capacitors or their connection and replace if needed.
[4]	BL fail - no connection U phase	Same description as ***[3] BL fail - no connection all phases***.
[5]	BL fail - no connection V phase	Same description as ***[3] BL fail - no connection all phases***.
[6]	BL fail - no connection W phase	Same description as ***[3] BL fail - no connection all phases***
[7]	BL fail - manual interrupt remote	The baseline process is remotely stopped. Restart the baseline to get capacitance data.
[8]	BL fail - alarm	An alarm occurred during baseline. Check for correct installation of the drive and its settings and restart the baseline.
[9]	BL fail - time out	The baseline step is not able to get data in due time. Check for correct drive settings and restart the baseline.
[10]	BL fail - low capacitance in U phase	The capacitor of the given phase is lower than 50% of the nameplate value and is considered abnormal to continue the baseline. Check for correct installation of the sine-wave filter. Measure and replace capacitors if needed and restart the baseline.

Index	Name	Description
[11]	BL fail - low capacitance in V phase	Same description as ***[10] BL fail - low capacitance in U phase***.
[12]	BL fail - low capacitance in W phase	Same description as ***[10] BL fail - low capacitance in U phase***.
[13]	BL fail - state B comm fail	This is an internal drive error regarding communication between processors. Check for correct settings of the drive and restart the baseline.
[14]	BL fail - others	This is an internal drive error. Check for correct settings of the drive and restart the baseline.
[15]	BL fail - upper measurement limit exceeded on phase U	Measurement of a given phase is outside the higher limit of the measurement range. Check for correct installation of the sine-wave filter, measure and replace capacitors if needed. Alternatively, set the operation point of the drive at a lower loading current. Another alternative is to increase parameter ***49-15 Frequency Sweep Max*** to a higher value, for example, 1800 Hz. Then restart the baseline.
[16]	BL fail - upper measurement limit exceeded on phase V	Same description as ***[15] BL fail - upper measurement limit exceeded on phase U***.
[17]	BL fail - upper measurement limit exceeded on phase W	Same description as ***[15] BL fail - upper measurement limit exceeded on phase U***.
[18]	BL fail - upper measurement limit exceeded on all phases	Same description as ***[15] BL fail - upper measurement limit exceeded on phase U***.
[19]	BL fail - lower measurement limit exceeded on phase U	Measurement of a given phase is outside of the lower limit of the measurement range. Check for correct installation of the sine-wave filter, measure and replace capacitors if needed. Alternatively, set the operation point of the drive at a higher loading current. Another alternative is to decrease parameter ***49-14 Frequency Sweep Min***to a lower value, for example, 150 Hz. Then restart the baseline.
[20]	BL fail - lower measurement limit exceeded on phase V	Same description as ***[19] BL fail - lower measurement limit exceeded on phase U***.
[21]	BL fail - lower measurement limit exceeded on phase W	Same description as ***[19] BL fail - lower measurement limit exceeded on phase U***.
[22]	BL fail - lower measurement limit exceeded on all phases	Same description as ***[19] BL fail - lower measurement limit exceeded on phase U***.
[23]	BL fail - motor is not connected	The motor is not detected. The baseline stops without saving the data. It can also happen at low drive current, for example, during AEO. Check and reconnect the motor cable and restart the application. Alternatively, allow the drive current to increase by using higher loading. Restart the baseline.
[24]	BL fail - speed not in range	The speed is outside the specified range of 1.5 Hz to 110% nominal speed. Set the speed in the specified range and restart the baseline.
[25]	BL fail - RMS current variation	The drive current changed by more than 15% during baseline. The baseline repeats the measurement 3 times and stops if conditions still are not met. Set the load profile to fit the given interval and repeat the baseline.

Index	Name	Description
[26]	BL fail - Drive OFF state	The drive is in OFF state which does not allow the baseline to proceed. Start the drive in hand-on or auto-on mode within the specified speed range and restart the baseline.
[27]	BL fail - voltage limit	The drive output voltage reached the maximum voltage during the measurements. The baseline repeats the measurement 3 times and stops if conditions are still not met. Set the load profile to fit the given interval and repeat the baseline.
[28]	BL fail - high dynamic	The drive current changed rapidly during measurement. Set the load profile to fit the given interval and repeat the baseline.
[29]	BL fail - AMA running	The drive is running AMA. Disconnect SWF and run the drive to finish the AMA. When the AMA is complete, restart the baseline by connecting the SWF.
[30]	BL fail - k.backup	The drive is in kinetic backup mode. Allow the drive to finish the kinetic backup and restart the baseline.
[31]	BL fail - mains failure	Mains supply does not meet the conditions for drive operation. Restore the power supply to fulfill the normal operating conditions of the drive and restart the baseline.
[32]	BL fail - coast mode	The drive is in coast mode. Allow the drive to get out of coast mode and restart the baseline.
[33]	BL fail - stall protection	The drive is in stall mode. Allow the drive to finish stall mode and restart the baseline.
[34]	BL fail - active power derate	The drive is in active power derate mode. Allow the drive to finish the active power mode and restart the baseline.
[35]	BL fail - manual interrupt local	The baseline was interrupted manually via LCP or MCT 10. Restart the baseline to get capacitance data.
[36]	BL fail - state 1 comm fail	This is an internal drive error regarding communication between processors. Check for correct settings of the drive and try to start a new baseline.
[37]	BL fail - SWF not selected	The sine-wave filter option is not selected. If the drive starts with parameter ***14-22 Operation Mode*** set to ***[2] Initialization*** after baseline completion, the baseline capacitance value shows incorrect data. Set parameter ***14-55 Output Filter*** to either ***[1] Sine-wave filter*** or ***[2] Sine-wave filter fixed***. Then set parameters ***14-56 Capacitance Output Filter*** and ***14-57 Inductance Output Filter*** to appropriate values before restarting the drive.
[38]	BL fail - motor type incorrect	The selected motor type is not supported. Set parameter ***1-10 Motor Construction*** to ***[0] Asynchron***.
[39]	BL fail - ctrl. principle incorrect	The selected motor control principle is not supported. Set parameter ***1-01 Motor Control Principle*** to ***[1] VVC+***.

49-12 Baseline History

Default value:	Size related	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	0
Data type:	TimeOfDay	**Change during operation:**	False

Time stamp of the baseline capture completion in the time-of-day format. The parameter is only valid if the date and time are set.

49-13 Baseline Capacitance Value

Default value:	0%	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the average value of the U, V, and W phase capacitance captured during baseline measurement. The average value is shown as a percentage of parameter ***14-56 Capacitance Output Filter***.

49-14 Frequency Sweep Min

Default value:	300 Hz	**Parameter type:**	Range, 100 - 1200 Hz
Setup:	All setups	**Conversion index:**	0
Data type:	Uint16	**Change during operation:**	True

If the measurement fails with a ***Lower measurement limit exceeded***, try to lower the minimum limit.

49-15 Frequency Sweep Max

Default value:	1600 Hz	**Parameter type:**	Range, Par. 49-14 - 2500 Hz
Setup:	All setups	**Conversion index:**	0
Data type:	Uint16	**Change during operation:**	True

If the measurement fails with an ***Upper measurement limit exceeded***, try to increase the maximum limit.

49-18 SineWave Filter Type

Default value:	[0] Danfoss	**Parameter type:**	Option
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	False

NOTE: This parameter cannot be adjusted while the drive is running.

Select the filter connection type.

Option	Name	Description
[0]*	Danfoss	Use this option for Danfoss sine-wave filters.
[1]	Delta NonDanfoss	Use this option for sine-wave filters with delta-connected capacitors.
[2]	Star NonDanfoss	Use this option for sine-wave filters with star-connected capacitors.

9.5.3 49-2* Threshold Config.

Use the parameters in this group for configuring thresholds for warnings and alarms.

49-20 Warning S1 Threshold

Default value:	90%	**Parameter type:**	Range, 50 - 130%

Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Enter the 1st warning threshold level, *Warning 541, SineWaveFilter*. The level for this warning must be higher than the level set in parameter ***49-21 Warning S2 Threshold***.

49-21 Warning S2 Threshold

Default value:	85%	**Parameter type:**	Range, 50% - Par. 49-20 [%]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Enter the 2nd warning threshold level, *Warning 531, SineWaveFilter S2*. The level for this warning must be higher than the level set in parameter ***49-22 Alarm Threshold***.

49-22 Alarm Threshold

Default value:	75%	**Parameter type:**	Range, 50% - Par. 49-21 [%]
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	True

Enter the alarm threshold level where the drive should stop the application (*Alarm 541, SineWaveFilter*).

49-23 Warning S1 Time

Default value:	10 min	**Parameter type:**	Range, 0 - 180 min
Setup:	All setups	**Conversion index:**	70
Data type:	Uint32	**Change during operation:**	True

Set the monitoring delay trigger time for warning S1.

49-24 Warning S2 Time

Default value:	10 min	**Parameter type:**	Range, 0 - 180 min
Setup:	All setups	**Conversion index:**	70
Data type:	Uint32	**Change during operation:**	True

Set the monitoring delay trigger time for warning S2.

49-25 Alarm Time

Default value:	10 min	**Parameter type:**	Range, 0 - 180 min
Setup:	All setups	**Conversion index:**	70
Data type:	Uint32	**Change during operation:**	True

Set the monitoring delay trigger time for alarm.

49-26 Last Modified Time

Default value:	Size related	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	0

Data type:	TimeOfDay	**Change during operation:**	False

This parameter shows the last modified time of the thresholds in the time-of-day format. The parameter is only valid if the date and time are set.

9.5.4 49-3* Adv Monitoring Readouts 1

Use the parameters in this group to show monitoring capacitance data.

49-30 Readout Setting

Default value:	[0] Actual	**Parameter type:**	Option
Setup:	All setups	**Conversion index:**	–
Data type:	Uint8	**Change during operation:**	True

Select which readout configuration to use for updating the relative readouts in parameter group ***49-3* Adv Monitoring Readouts 1.***

Option	Name	Description
[0]*	Actual	This setting represents the relative actual capacitance in respect to the baseline value.

49-31 Capacitance of Phase U

Default value:	0%	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the capacitance of the U phase measured during monitoring.

49-32 Capacitance of Phase V

Default value:	0%	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the capacitance of the V phase measured during monitoring.

49-33 Capacitance of Phase W

Default value:	0%	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	-2
Data type:	Uint16	**Change during operation:**	False

This parameter shows the capacitance of the W phase measured during monitoring.

49-34 Measurement History

Default value:	Size related	**Parameter type:**	Readout
Setup:	All setups	**Conversion index:**	0
Data type:	TimeOfDay	**Change during operation:**	False

This parameter shows the last time stamp of capacitance measured in the time-of-day format. The parameter is only valid if the date and time are set.

10 Alarms and Warnings

10.1 Alarms and Warnings Descriptions, Motor Stator Windings

Warning 500, Motor Stator Winding Warning 2

Cause

The stator winding reached condition orange. A severe fault might occur soon in the motor.

Troubleshooting

- Check the stator windings.

ALARM 510, Motor Stator Winding Alarm

Cause

Stator winding has reached condition red. A severe fault is detected in the motor.

Troubleshooting

- Check motor stator winding.

WARNING 510, Motor Stator Winding Warning 1

Cause

Stator winding reached condition yellow. An early fault is detected in the motor.

Troubleshooting

- Check the motor stator winding.

Warning 520, Stator Thld At Max/Min

Cause

The stator in the condition-based monitoring is either at its minimum or maximum limit.

Troubleshooting

- Check the threshold values at maximum or minimum in parameter group ***46-** CBM Adv Thresholds*** to parameter group ***46-2* Stator*** and adjust the values if needed.
- Acknowledge the generation by setting parameter ***45-46 Threshold Limit*** to ***[0] Limit OK***.

10.2 Alarms and Warnings Descriptions, Vibration Monitoring

Warning 502, Vibration Monitoring Warning 2

Cause

A significant increase in motor vibration is detected. The vibration levels have reached condition orange.

Troubleshooting

- Investigate the root cause for severe vibration.

Alarm 512, Sensor 1 Monitoring Alarm

Cause

There is an excessive amount of motor vibration on sensor 1. The vibration levels have reached condition red.

Troubleshooting

- Investigate the root cause for the excessive vibration. Before commissioning of condition-based monitoring, ensure to comply with the ISO10816 standard for machinery.

Warning 512, Sensor 1 Monitoring Warning 1

Cause

An increase in the Sensor 1 value is detected. The value levels in Sensor 1 have reached condition yellow.

Troubleshooting

- Investigate the root cause for the increased values.

Alarm 513, Sensor 2 Monitoring Warning 1

Cause

There is an excessive amount of motor vibration on sensor 2. The vibration levels have reached condition red.

Troubleshooting

- Investigate the root cause for the excessive vibration. Before commissioning of condition-based monitoring, ensure to comply with the ISO10816 standard for machinery.

Warning 513, Sensor 2 Monitoring Warning 1

Cause

An increase in the Sensor 2 value is detected. The value levels in Sensor 2 have reached condition yellow.

Troubleshooting

- Investigate the root cause for the increased values.

Alarm 514, Sensor 3 Monitoring Alarm

Cause

There is an excessive amount of motor vibration on sensor 3. The vibration levels have reached condition red.

Troubleshooting

- Investigate the root cause for the excessive vibration. Before commissioning of condition-based monitoring, ensure to comply with the ISO10816 standard for machinery.

Warning 514, Sensor 3 Monitoring Warning 1

Cause

An increase in the Sensor 3 value is detected. The value levels in Sensor 3 have reached condition yellow.

Troubleshooting

- Investigate the root cause for the increased values.

Alarm 515, Sensor 4 Monitoring Alarm

Cause

There is an excessive amount of motor vibration on sensor 4. The vibration levels have reached condition red.

Troubleshooting

- Investigate the root cause for the excessive vibration. Before commissioning of condition-based monitoring, ensure to comply with the ISO10816 standard for machinery.

Warning 515, Sensor 4 Monitoring Warning 1

Cause

An increase in the Sensor 4 value is detected. The value levels in Sensor 4 have reached condition yellow.

Troubleshooting

- Investigate the root cause for the increased values.

Warning 522, Sensor 1 Thld At Max/Min

Cause

The sensor 1 threshold in the condition-based monitoring is at its minimum or maximum value of the Sensor 1 function.

Troubleshooting

- Check the threshold values at maximum or minimum in parameter group ***46-** CBM Adv Thresholds*** to parameter group ***46-4* Sensor 1*** and adjust the values if needed.
- Acknowledge the generation by setting parameter ***45-46 Threshold Limit*** to ***[0] Limit OK***.

Warning 523, Sensor 2 Thld At Max/Min

Cause

The sensor 2 threshold in the condition-based monitoring is at its minimum or maximum value of the Sensor 2 function.

Troubleshooting

- Check the threshold values at maximum or minimum in parameter group ***46-** CBM Adv Thresholds*** to parameter group ***46-5* Sensor 2*** and adjust the values if needed.
- Acknowledge the generation by setting parameter ***45-46 Threshold Limit*** to ***[0] Limit OK***.

Warning 524, Sensor 3 Thld At Max/Min

Cause

The sensor 3 threshold in the condition-based monitoring is at its minimum or maximum value of the Sensor 3 function.

Troubleshooting

- Check the threshold values at maximum or minimum in parameter group ***46-** CBM Adv Thresholds*** to parameter group ***46-6* Sensor 3*** and adjust the values if needed.
- Acknowledge the generation by setting parameter ***45-46 Threshold Limit*** to ***[0] Limit OK***.

Warning 525, Sensor 4 Thld At Max/Min

Cause

The sensor 4 threshold in the condition-based monitoring is at its minimum or maximum value of the Sensor 4 function.

Troubleshooting

- Check the threshold values at maximum or minimum in parameter group ***46-** CBM Adv Thresholds*** to parameter group ***46-7* Sensor 4*** and adjust the values if needed.
- Acknowledge the generation by setting parameter ***45-46 Threshold Limit*** to ***[0] Limit OK***.

Alarm 550, Sensor 1 Low Monitoring Alarm

The value measured on Sensor 1 is very low and has reached condition red low.

Troubleshooting

- Investigate the root cause for the value reaching the red low level. For example, lost connection to analog inputs or no proper data communication on fieldbus sensors.

Warning 550, Sensor 1 Low Monitoring Warning 1

The value measured on Sensor 1 is very low and has reached condition yellow low.

Troubleshooting

- Investigate the root cause for the value reaching the red low level. For example, lost connection to analog inputs or no proper data communication on fieldbus sensors.

Alarm 551, Sensor 2 Low Monitoring Alarm

The value measured on Sensor 2 is very low and has reached condition red low.

Troubleshooting

- Investigate the root cause for the value reaching the red low level. For example, lost connection to analog inputs or no proper data communication on fieldbus sensors.

Warning 551, Sensor 2 Low Monitoring Warning 1

The value measured on Sensor 2 is very low and has reached condition yellow low.

Troubleshooting

- Investigate the root cause for the value reaching the red low level. For example, lost connection to analog inputs or no proper data communication on fieldbus sensors.

Alarm 552, Sensor 3 Low Monitoring Alarm

The value measured on Sensor 3 is very low and has reached condition red low.

Troubleshooting

- Investigate the root cause for the value reaching the red low level. For example, lost connection to analog inputs or no proper data communication on fieldbus sensors.

Warning 552, Sensor 3 Low Monitoring Warning 1

The value measured on Sensor 3 is very low and has reached condition yellow low.

Troubleshooting

- Investigate the root cause for the value reaching the red low level. For example, lost connection to analog inputs or no proper data communication on fieldbus sensors.

Alarm 553, Sensor 4 Low Monitoring Alarm

The value measured on Sensor 4 is very low and has reached condition red low.

Troubleshooting

- Investigate the root cause for the value reaching the red low level. For example, lost connection to analog inputs or no proper data communication on fieldbus sensors.

Warning 553, Sensor 4 Low Monitoring Warning 1

The value measured on Sensor 4 is very low and has reached condition yellow low.

Troubleshooting

- Investigate the root cause for the value reaching the red low level. For example, lost connection to analog inputs or no proper data communication on fieldbus sensors.

10.3 Alarms and Warnings Descriptions, Load Envelope Alarm

Warning 501, Load Envelope Warning 2

Cause

Application load has reached condition yellow.

Troubleshooting

- Investigate the root cause for the increased motor load.

Warning 506, Load Envelope Low Warning 2

The application load has reached condition orange low limit.

Troubleshooting

- Investigate the root cause for the decrease in motor load and then check the load specified for the application

ALARM 511, Load Envelope Alarm

Cause

Application load has reached condition red.

Troubleshooting

- Check root cause for excessive overload or underload.

WARNING 511, Load Envelope Warning 1

Cause

Application load has reached condition yellow.

Troubleshooting

- Check root cause for high motor load.

Alarm 516, Load Envelope Low Alarm

The application load has reached low-level condition red.

Troubleshooting

- Investigate the root cause for the decrease in motor load and then check the load specified for the application.

Warning 516, Load Envelope Low Warning 1

The application load has reached low-level condition yellow.

Troubleshooting

- Investigate the root cause for the decrease in motor load and then check the load specified for the application.

Warning 521, Load Thld At Max/Min

Cause

The load threshold in the condition-based monitoring is either at its minimum or maximum.

Troubleshooting

- Check the threshold values at maximum or minimum in parameter group ***46-** CBM Adv Thresholds*** to parameter group ***46-3* Load*** and adjust the values if needed.
- Acknowledge the generation by setting parameter ***45-46 Threshold Limit*** to ***[0] Limit OK***.

10.4 Alarms and Warnings Descriptions, Cavitation

Warning 507, Cavitation Warning 2

Cause

There is a further increase of turbulence in the pump, indicating the possibility of cavitation. The cavitation has reached condition orange.

Troubleshooting

- Investigate the root cause of the increased turbulence.
- Check if the pump operates as specified in datasheets at the correct pressure-flow operation point.
- Check the hydraulic system for pressure drop at the pump inlet.
- Check for clogged pipes or filters.

Alarm 517, Cavitation Alarm

Cause

There is an excessive turbulence at the pump, indicating the possibility of cavitation. Cavitation has reached condition red.

Troubleshooting

- Investigate the root cause of the increased turbulence.
- Check if the pump operates as specified in datasheets at the correct pressure-flow operation point.
- Check the hydraulic system for pressure drop at the pump inlet.
- Check for clogged pipes or filters.

Warning 517, Cavitation Warning 1

Cause

There is an increased turbulence at the pump, indicating the possibility of cavitation. Cavitation has reached condition yellow.

Troubleshooting

- Investigate the root cause of the increased turbulence.
- Check if the pump operates as specified in datasheets, at the correct pressure-flow operation point.
- Check the hydraulic system for pressure drop at the pump inlet.
- Check for clogged pipes or filters.

Warning 527, Cavitation Thld At Max/Min

Cause

The cavitation threshold in the condition-based monitoring is at its minimum or maximum value of the cavitation function.

Troubleshooting

- Check the threshold values at maximum or minimum in parameter group ***46-** CBM Adv Thresholds*** to parameter group ***46-8* Cavitation*** and adjust the values if needed.
- Acknowledge the generation by setting parameter ***45-46 Threshold Limit*** to ***[0] Limit OK***.

10.5 Alarms and Warnings Descriptions, Sine-wave Filter

Warning 531, Sine-wave Filter Warning 2

Cause

The sine-wave filter has reached condition orange. An increased degradation is detected on the capacitors in the output sine-wave filter. A severe fault may occur soon in the sine-wave filter.

Troubleshooting

- Investigate the root cause for the capacitor degradation, such as high ambient temperature or humidity.
- Check that the loading conditions and the drive switching frequency are within the specifications.
- Check for aging.

Alarm 541, Sine-wave Filter Alarm

Cause

The sine-wave filter has reached condition red. A severe degradation is detected on the capacitors in the output sine-wave filter. A severe fault is detected in the sine-wave filter.

Troubleshooting

- Investigate the root cause for the capacitor degradation, such as high ambient temperature or humidity.
- Check that the loading conditions and drive switching frequency are within the specifications.
- Check for aging.

Warning 541, Sine-wave Filter Warning 1

Cause

The sine-wave filter has reached condition yellow. An early degradation is detected on the capacitors in the sine-wave filter.

Troubleshooting

- Investigate the root cause for the capacitor degradation, such as high ambient temperature or humidity.
- Check that the loading conditions and drive switching frequency are within the specifications.
- Check for aging.

Warning 549, Sine-wave Filter Out of Range Measurement

Cause

The measurement range of the capacitors in the sine-wave filter reached its limits.

Troubleshooting

- Extend the measurement range by increasing parameter ***49-15 Frequency Sweep Max***, or by decreasing parameter ***49-14 Frequency Sweep Min***. Alternatively, repeat the measurement at another operating point of the motor.
- Check for correct installation of the sine-wave filter.
- Measure and replace capacitors if needed.

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Ulsnaes 1
DK-6300 Graasten
drives.danfoss.com

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