ACS880 Cavitation detection control program
Supplement

ACS880 Cavitation detection control program

Supplement

| Table of contents | |

Table of contents

Further information

1

Introduction to the manual

Contents of this chapter

This chapter contains general information on the manual. It also contains information on the compatibility, safety and intended audience.

Applicability

This document is a supplement to *ACS880 Primary control program firmware manual* (3AUA0000085967 [English]). This manual applicable to ACS880 Cavitation detection control program (version 8.2.1.2 or later).

This supplement contains only information relevant to ACS880 Cavitation detection program. For information on general firmware-related issues (parameters, faults, warnings etc.) concerning ACS880 Primary control program, see *ACS880 Primary control program firmware manual* (3AUA0000085967 [English]).

Safety instructions

Obey all safety instructions delivered with the drive.

• Read the **complete safety instructions** before you install, commission, or use the drive. The complete safety instructions are delivered with the drive as either part of the *Hardware manual*, or, in the case of ACS880 multidrives, as a separate document.

• Read the **firmware function-specific warnings and notes** before changing parameter values. These warnings and notes are included in the parameter descriptions presented in chapter *Parameters (page 23)*.

Target audience

This manual is intended for people who design, commission, or operate the drive system.

Related manuals

Name	Code
Drive hardware manuals	
Drive hardware manual (varies depending on the drive type)	
Drive firmware manuals and guides	
ACS880 primary control program firmware manual	3AUA0000085967
Quick start-up guide for ACS880 drives with primary control program	3AUA0000098062
Option manuals and guides	
ACX-AP-x assistant control panels user's manual	3AUA0000085685
Drive composer start-up and maintenance PC tool user's manual	3AUA0000094606
Manuals and quick guides for I/O extension modules, fieldbus adapters, encoder interfaces, etc.	

Terms and abbreviations

See *ACS880 primary control program firmware manual* (3AUA0000085967[English]).

2

Program Features

Contents of this chapter

This chapter describes functions of the control program.

Cavitation detection overview

The Caviation detection control program is an IEC program loaded on ACS880 drive. The program uses the drive torque, the drive speed or a combination of these two to detect high variations of torque or speed in the pump motor. In most cases, these variations are caused by cavitation or other mechanical issues.

The program detects cavitation by monitoring torque, speed or the combination of these two. The user can select the most suitable monitoring method depending on the application. It varies, case by case, which is the most suitable method.

Cavitation detection function based on torque

The Cavitation detection function based on the torque monitoring operates in these three consecutive (and constantly repeated) phases:

1. The function measures torque samples during a user-defined sample period (*88.03*), and calculates:

   - average torque (*09.02*),

   - for each sample, the sample variation vs. the average torque,

   - the effective (rms) value of all sample variation values (*09.01*).

2. The function compares the actual variation value (*09.01*) to the reference/normal variation value (*88.02*) defined during the Autodetection period (*88.08*) by forming a relation between theses two variation values (*09.03*).

3. The function compares the variation relation (*09.03*) to the allowed threshold value (*88.04*). If the relation exceeds the threshold value for a time longer than the user-defined delay (*88.10*), the program indicates cavitation (*86.09*).

Note: The indication is given only if the Cavitation detection control program is active (*86.01*), *87.08 Operation mode selection* is set to value Torque and the selector for the cavitation trigger signal (*86.02*) must point to torque.

If the Cavitation detection control program detects a change in speed reference, the Cavitation detection function is temporarily disabled to avoid false signals caused by torque or speed variations. The disabling only takes place if the change is in effect for a certain time period. For calculating this time period, the function uses the change in speed reference, speed scaling (*46.01*), acceleration/deceleration times (*23.12*/*23.13*) and a time coefficient (*88.06*).

■ Settings and diagnostics

Parameters: *09.01*, *86.01*, *86.02*, *87.08*, *88.01*, *88.02*, *88.03*, *88.04*, *88.05*, *88.06*.

Events: *E100 Cavitation fault*, *E200 Pump not started*, *E201 Pump does not reach speed*, *E202 Cavitation alarm*.

Cavitation detection function based on speed

The Cavitation detection function based on the speed monitoring operates in these three consecutive (and constantly repeated) phases:

1. The function measures torque samples during a user-defined sample period (*88.03*), and calculates:

   - average speed (*09.06*),

   - for each sample, the sample variation vs. the average speed,

   - the effective (rms) value of all sample variation values (*09.05*).

2. The function compares the actual variation value (*09.05*) to the reference/normal variation value (*88.09*) defined during the Autodetection period (*88.08*) by forming a relation between theses two variation values (*09.07*).

3. The function compares the variation relation (*09.07*) to the allowed threshold value (*88.11*). If the relation exceeds the threshold value for a time longer than the user-defined delay (*88.10*), the program indicates cavitation (*86.09*).

Note: The indication is given only if the Cavitation detection control program is active (*86.01*), *87.08 Operation mode selection* is set to value Speed and the selector for the cavitation trigger signal (*86.02*) must point to speed.

If the Cavitation detection control program detects a change in speed reference, the Cavitation detection function is temporarily disabled to avoid false signals caused by torque or speed

variations. The disabling only takes place if the change is in effect for a certain time period. For calculating this time period, the function uses the change in speed reference, speed scaling (*46.01*), acceleration/deceleration times (*23.12*/*23.13*) and a time coefficient (*88.06*).

■ **Settings and diagnostics**

Parameters: *09.05*, *86.01*, *86.02*, *87.08*, *88.03*, *88.09*, *88.10*, *88.11*, *88.13*

Events: *E100 Cavitation fault*, *E200 Pump not started*, *E201 Pump does not reach speed*, *E202 Cavitation alarm*.

Cavitation detection function based on torque and speed

The Cavitation detection function based on monitoring torque and speed operates in these three consecutive (and constantly repeated) phases:

1. The function measures torque and speed samples during a user-defined sample period (*88.03*), and calculates:

    • average speed (*09.06*) and average torque (*09.02*),

    • for each sample, the sample variation vs. the average value (calculated separately for torque and speed),

    • the effective (rms) values of all sample variation values (calculated separately for torque (*09.01*) and speed (*09.05*)).

2. The function calculates the sum of relative variation values (sum of *09.03* and *09.07*). This sum is shown in *88.16*.

3. The function compares the sum *88.16* to the allowed threshold value (*88.14*). If the relation exceeds the threshold value for a time longer than the user-defined delay (*88.11*), the program indicates cavitation (*86.09*).

Note: The indication is given only if the Cavitation detection control program is active (*86.01*), *87.08 Operation mode selection* is set to value Combination and the selector for the cavitation trigger signal (*86.02*) must point to combination.

If the drive detects a change in speed reference, the Cavitation detection function is temporarily disabled to avoid false signals caused by torque or speed variations. The disabling only takes place if the change is in effect for a certain time period. For calculating this time period, the function uses the change in speed reference, speed scaling (*46.01*), acceleration/deceleration times (*23.12*/*23.13*) and a time coefficient (*88.06*).

■ **Settings and diagnostics**

Parameters: *86.01*, *86.02*, *87.08*, *88.03*, *88.06*, *88.14*, *88.15*, *88.16*, *88.17*

Events: *E100 Cavitation fault*, *E200 Pump not started*, *E201 Pump does not reach speed*, *E202 Cavitation alarm*.

Autodetection function in normal conditions

The Cavitation control program can calculate torque variation rms, speed variation rms or a combination of both in normal conditions with the Autodetection functions. These reference values are used when the program monitors cavitation.

◼ **Normal torque rms autodetection**

Normal torque rms autodetection calculates the torque rms variation value in normal conditions. The function measures torque samples during a user-defined sample period (*88.08*), and calculates:

• average torque (*09.02*),

• for each sample, the sample variation value vs. average torque,

• the effective (rms) value of all sample variation values (*88.02*).

Parameters of the Normal speed rms autodetection function are these:

• autodetection activation (*88.07*),

• autodetection time (*88.08*),

• variable selection (*87.08*) = Torque,

• average torque (*09.02*),

• normal torque variation rms value calculated by the autodetection (*88.02*),

• filter time for motor torque (*46.13*).

The autodetection calculates the normal torque variation rms value at one operation point (speed reference value). Autodetection starts when:

• user has set the activation parameter (*88.07*) to value Run pump autotune,

• user has set the variable selection (*87.08*) = Torque,

• user has started the drive,

• the drive operates at its speed reference value.

Possible auto-detection failures are:

• User does not start the drive: Drive indicates warning *E200 Cavitation alarm*, and autodetection (*88.07*) changes back to Done. Normal torque variation rms value (*88.02*) remains unchanged.

• The control program detected a motor speed change (acceleration/deceleration), and the change lasted too long: Drive shows a warning *E201 Pump Does not reach speed* and autodetection (*88.07*) changes back to Done. Normal torque variation rms value (*88.02*) remains unchanged.

Settings and diagnostics

Parameters: *09.02*, *87.08*, *88.02*, *88.07*, *88.08*.

Events: *E200 Pump not started*, *E201 Pump does not reach speed*.

◼ **Normal speed rms autodetection**

Normal speed rms autodetection calculates the speed variation rms value in normal conditions. The function measures speed samples during a user-defined sample period (*88.08*), and calculates:

• average speed (*09.06*),

• for each sample, the sample variation value vs. average speed,

• the effective (rms) value of all sample variation value (*88.09*).

Parameters of the Normal speed rms autodetection function are these:

- autodetection activation (*88.12*),
- autodetection time (*88.08*),
- variable selection (*87.08*) = Speed,
- average speed (*09.06*),
- normal speed variation rms value calculated by the autodetection (*88.09*),
- filter time for motor speed (*46.11*).

The auto-detection calculates the normal speed variation rms value at one operation point (speed reference value). Autodetection starts when:

- user has set the activation parameter (*88.12*) to value Run pump autotune
- user has set the variable selection (*87.08*) = Speed
- user has started the drive
- the drive operates at its speed reference value.

Possible autodetection failures are:

- User does not start the drive: Drive indicates warning *E200 Pump not started*, and autodetection (*88.12*) changes back to Done. Normal speed variation rms value (*88.09*) remains unchanged.
- The control program detected a motor speed change (acceleration/deceleration), and the change lasted too long: Drive shows a warning *E201 Pump Does not reach speed* and autodetection (*88.12*) changes back to Done. Normal speed variation rms value (*88.09*) remains unchanged.

Settings and diagnostics

Parameters: *09.06*, *87.08*, *88.08*, *88.09*, *88.12*.

Events: *E200 Pump not started*, *E201 Pump does not reach speed*.

▪ **Combination rms autodetection**

The combined autodetection calculates both the torque variation rms value and the speed variation rms value in the normal conditions. The sum value is then used in the Cavitation detection function. See the corresponding sections in the section *Cavitation detection*.

Parameters of the Combination rms autodetection function are these:

- autodetection activation (*88.18*)
- autodetection time (*88.08*)
- variable selection (*87.08*) = Combination
- the sum of torque variation rms and speed variation rms in normal conditions (*88.16*)
- filter time for motor torque (*46.13*) and filter time for motor speed (*46.11*).

The autodetection calculates the normal torque and normal speed variation rms values at one operation point (speed reference value). Autodetection starts when:

- user has set the activation parameter (*88.18*) to value Run pump autotune
- user has set the variable selection (*87.08*) = Combination
- user has started the drive
- the drive operates at its speed reference value.

Possible autodetection failures are:

- User does not start the drive: Drive indicates warning *E200 Cavitation alarm*, and autodetection (*88.18*) changes back to Done. Speed and torque combination indicator (*88.16*) remains unchanged.

- The control program detected a motor speed change (acceleration/deceleration), and the change lasted too long: Drive shows a warning *E201 Pump Does not reach speed* and autodetection (*88.18*) changes back to Done. Speed and torque combination indicator (*88.16*) remains unchanged.

Settings and diagnostics

Parameters: *87.08*, *88.07*, *88.08*, *88.09*, *88.15*, *88.16*, *88.18*.

Events: *E200 Pump not started*, *E201 Pump does not reach speed*.

# Pump speed reference connection and control

You can use the Cavitation detection control program in two ways:

1. To detect and indicate cavitation.

2. To detect and indicate cavitation, and to control the pump speed (Cavitation protection).

If you want that the Cavitation detection control program controls the pump speed, you must set the speed reference output of the control program (*09.04*) as the speed reference source for the drive (parameter *22.11* or *22.12*). Make consistent selections in parameters *22.13* and *22.14*. See the diagram below and the *ACS880 Primary control program firmware manual* (3AUA0000085967 [English]).

When the pump operates normally, the output reference of the Cavitation detection control program (*09.04*) is equal to its input reference (*87.05*). If the program detects cavitation, the value of the output reference (*09.04*) changes as the control program decreases its speed reference output by the pre-defined steps. See *Cavitation protection (page 16)*.
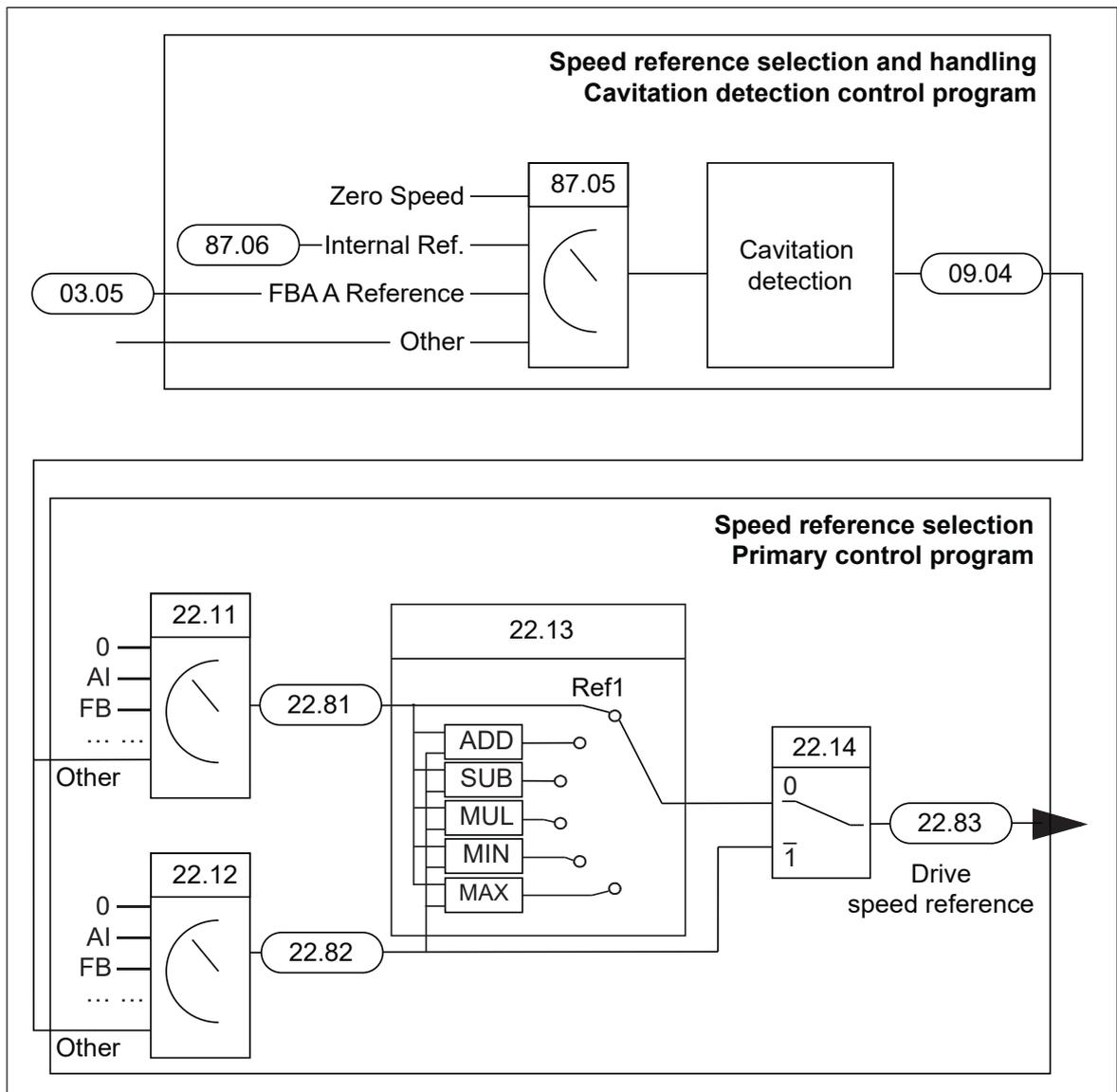
◼ Settings and diagnostics

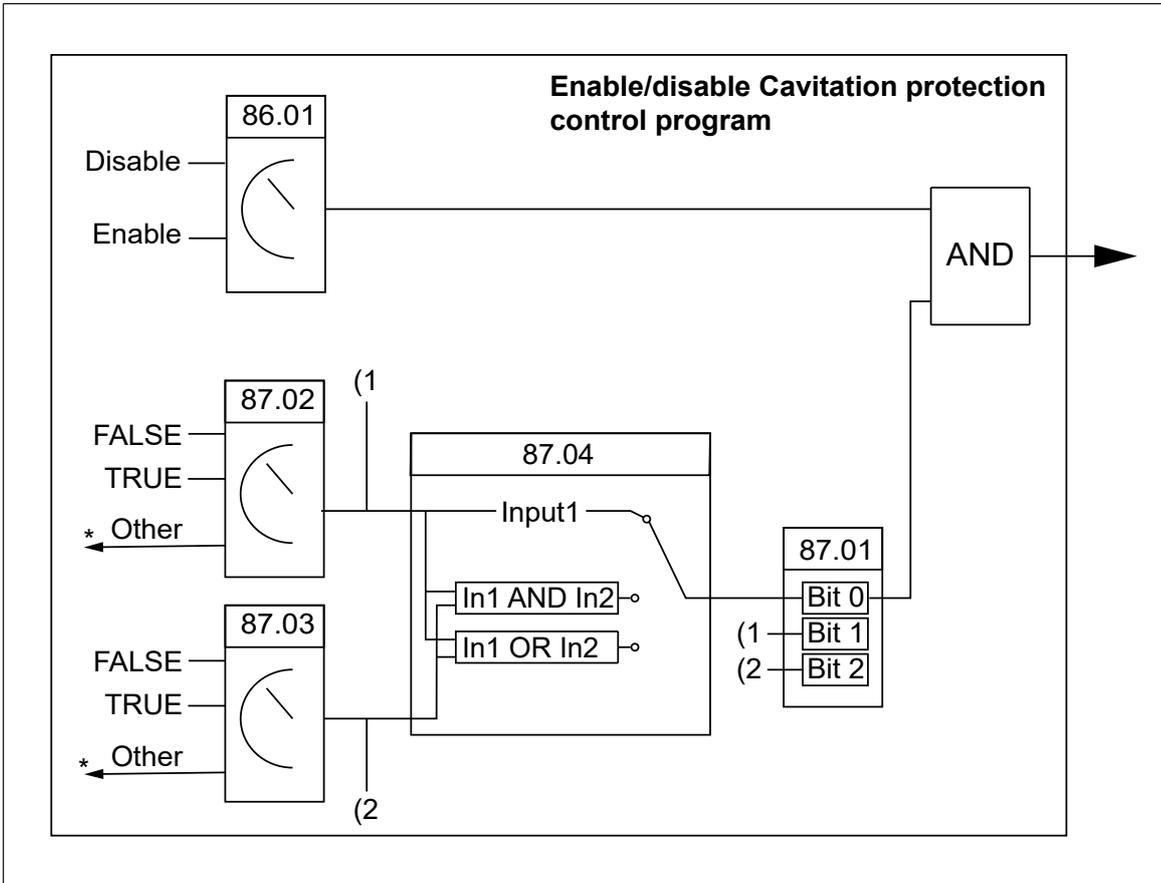Parameters: *22.11*, *22.12*, *22.13*, *22.14*, *87.05*

Events: -

Enabling/disabling the Cavitation detection control program

The Cavitation detection control program is enabled by two signals:

1. *86.01 Cavitation Protection En/Dis* must be set to Enable.

2. The mode selection parameters (*87.04*, *87.02* and *87.03*) must enable the operation (bit 0 of *87.01* must be 1 (true)).

The Cavitation detection control program operates only when it is enabled with the enable/disable parameter (*86.01*). In addition, there is also a separate function that you can use for the enable/disable control, the Pump mode monitoring (*87.01*, *87.02*, *87.03* and *87.04*). This function monitors two user-defined signals, and on basis of their states, it forms the additional enable/disable signal for the Cavitation detection control program. With this function, you can, for example, enable the operation of the control program only in the

external (remote) control mode of the drive, and disable it every time that user switches the drive in local control mode (operates the drive with the panel). See the block diagram below.

▪ Settings and diagnostics

Parameters: *86.01*, *87.01*, *87.02*, *87.03*, *87.04*.

Events: -

Cavitation protection

In the Cavitation detection control program, the Cavitation detection function is active always when the program is enabled. The program protects the pump only when the program controls the motor speed in case of cavitation.

If the Cavitation detection control program detects a possible cavitation situation and the program has been configured to control the drive speed (*09.04* is set as the speed reference source in *22.11* or *22.12*), the program starts to decrease the speed by steps (*86.05*) in order protect the pump. After each step, the program examines if there is still cavitation. If cavitation continues, the drive reduces the speed more after a time delay (*86.06*) by a new speed step.

If the program reduces the drive speed to the minimum protection speed (*86.04*) and cavitation continues for a predefined time (*86.07*), the protection function generates a fault or warning depending on the user selection (*86.03*).

At each speed step, if the drive does not detect cavitation for the pre-defined time (*86.08*), the speed reference starts to increase by steps (*86.05*).

Cavitation detection and protection are inactive if:

- the speed reference input (*87.05*) connected to the Cavitation detection control program changes.

- Normal torque rms autodetection (*88.07*), Normal speed rms autodetection (*88.12*) or Combination rms autodetection (*88.18*) is ongoing.

- Mode selection parameters disable the protection function (Bit 0 is False in *87.01*). See *Enabling/disabling the Cavitation detection control program (page 15)*.

- the Cavitation detection control program is disabled (*86.01*).

Examples of Cavitation protection:

- The program detects cavitation continuously and the pump is set to trip after 5 seconds of running at minimum speed.
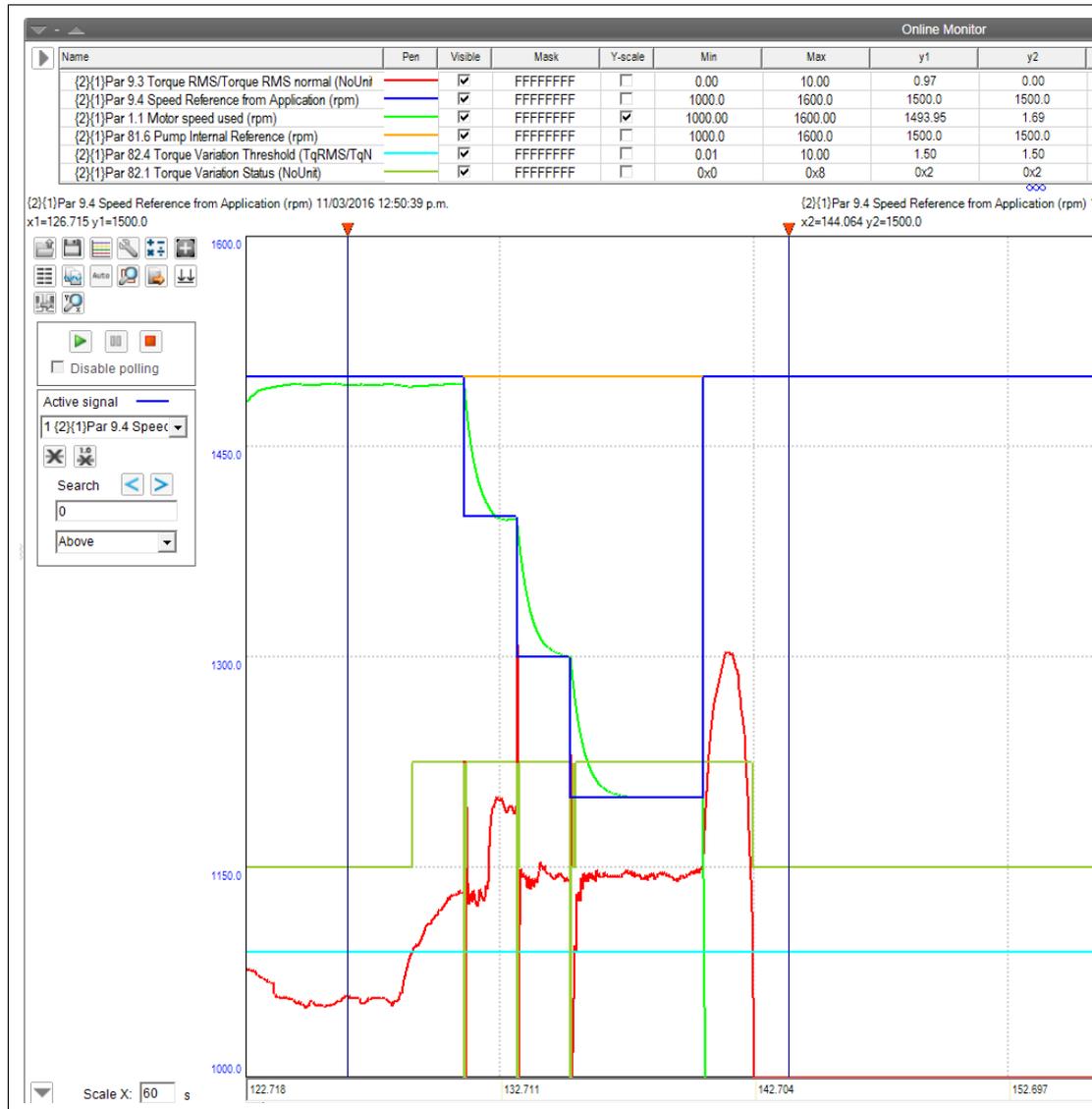
- The drive detects cavitation occasionally and the speed goes up and down. At minimum speed, the program detects cavitation for a time that is shorter than *86.07*, so the drive does not trip.

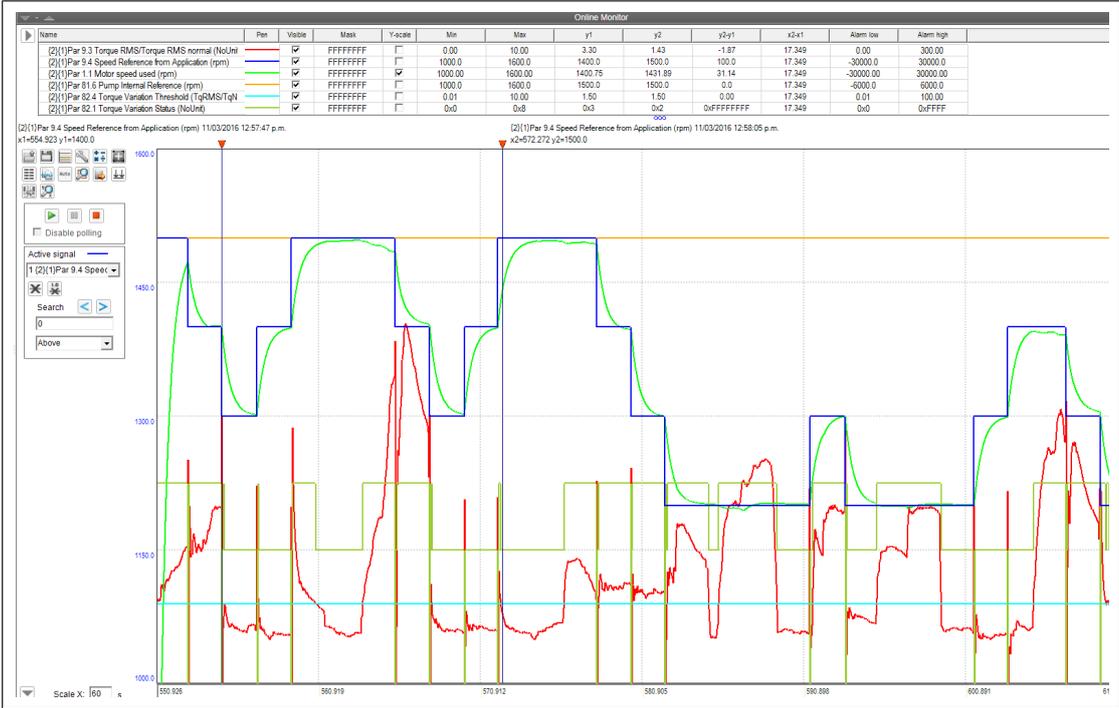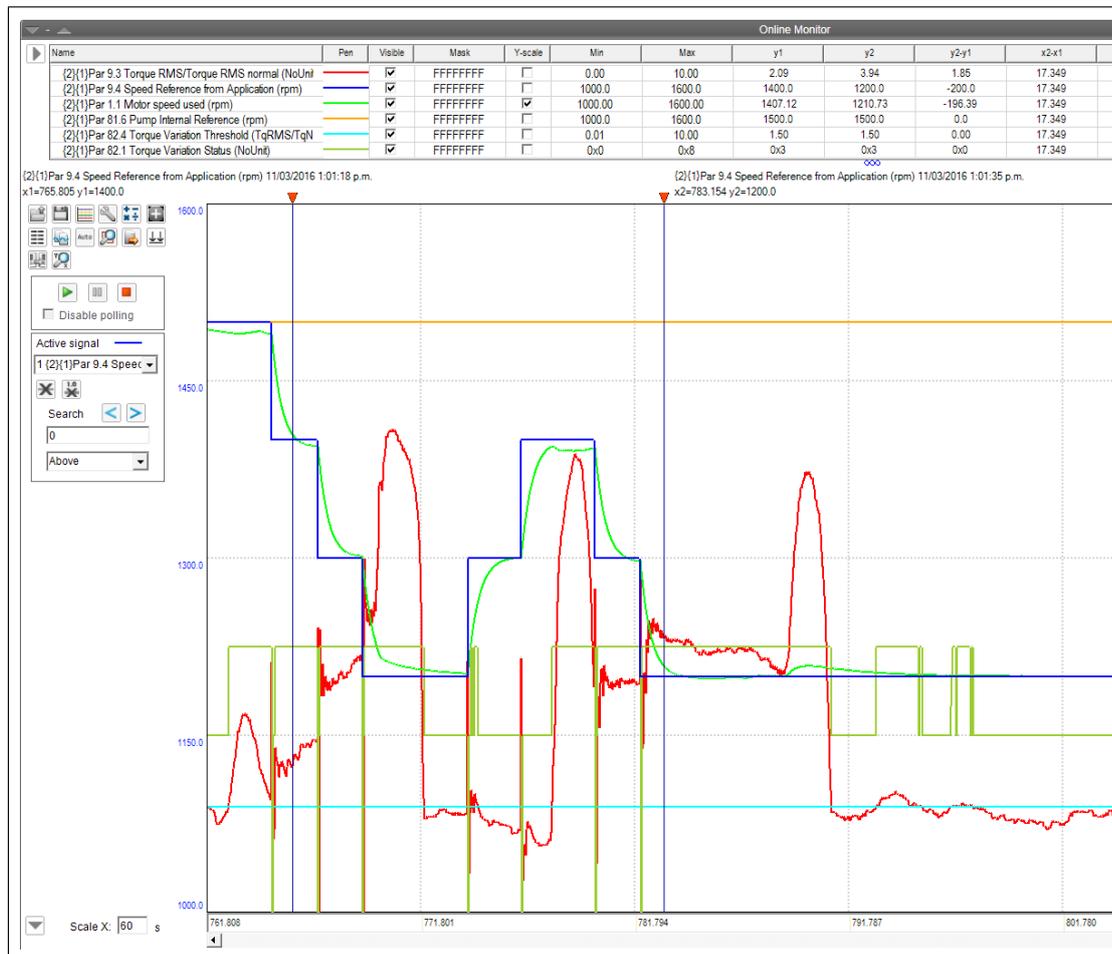- *86.03 Cavitation Fault/Alarm* is set to Alarm and *86.10 End of Tank Detection* to Enabled. The program does not increase speed after the drive has run for 3 seconds at minimum speed although cavitation continues.

▣ **Settings and diagnostics**

Parameters: *86.01*, *86.03*, *86.04*, *86.05*, *86.06*, *86.07*, *86.08*, *86.10*, *87.01*, *87.05*, *88.07*, *88.12*, *88.18*.

Events: *E100 Cavitation fault*, *E200 Pump not started*, *E201 Pump does not reach speed*, *E202 Cavitation alarm*.

End of tank function

The End of Tank function (*86.10*) is suitable for applications in which a pump is used to empty a tank, and it is essential to get the tank completely empty before a re-fill, despite of the pump cavitation. If End of tank function is enabled (*86.10*), the counter of the End of tank delay (*86.11*) starts when the drive reaches the minimum speed (*86.04*). If there is cavitation throughout the whole delay time (*86.11*), the End of tank function starts. The End of tank function prevents the program from increasing speed, even if cavitation is not detected at some point, thus the drive runs at minimum speed until it is stopped (or the drive trips to a fault). If the program does not detect cavitation during End of tank delay (*86.11*), the End of tank function does not start and the drive can increase the speed again. If you enable the End of tank function, you usually also set the fault/warning selection (*86.03*) to Warning to prevent the cavitation fault trip during the End of tank period.
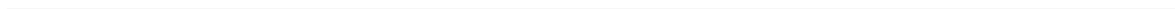
Note: The End of tank function does not stop the drive. You must stop it separately when the tank is completely empty.

■ Settings and diagnostics

Parameters: *86.03*, *86.04*, *86.07*, *86.10*, *86.11*.

Events: *E100 Cavitation fault*, *E200 Pump not started*, *E201 Pump does not reach speed*, *E202 Cavitation alarm*.

3

Parameters

Contents of this chapter

This chapter describes the service level parameters and signals of the ACS880 Cavitation detection control program.

Terms and abbreviations

See *ACS880 primary control program firmware manual* (3AUA0000085967[English]).

Parameter listing

This supplement lists only the parameters that are relevant to the ACS880 Cavitation detection control program.

◼ 07 System info

No.	Name/Value	Description	Def/FbEq16
07	System info	Information on the drive hardware, firmware and control program. All parameters in this group are read-only.	
07.21	Application environment status 1	Shows which tasks of the application program are running. For this program, only Appl task2 must be running.	0004h
	Pre task	1 = Pre-task running.	0
	Appl task1	1 = Task 1 running.	1
	Appl task2	1 = Task 2 running.	2
	Appl task3	1 = Task 3 running.	3
	Reserved		4…14
	Task monitoring	1 = Task monitoring enabled.	15
07.23	Application name	Shows the first five ASCII letters of application name.	ACPRT

No.	Name/Value	Description	Def/FbEq16
07.24	Application version	Shows the program version.	1.2.0.0

■ 09 Application Signals

No.	Name/Value	Description	Def/FbEq16
09	Application Signals	Basic signals for monitoring torque and speed calculation results and speed reference output.	
09.01	Torque Variation RMS	Shows the torque variation from average torque (*09.02*) as a rms value. The calculation uses the samples of actual motor torque (*01.10*), average torque (*09.02*), 20 ms sample interval (*46.13*), and a user-defined sample period (*88.03*). The value is constantly updated when the control program is enabled (*86.01*). See *Cavitation detection function based on torque (page 9)*.	-
	0.00…300.00 %	Torque variation value (rms)	100 = 1
09.02	Torque Average	Shows the value of the average motor torque calculation. The calculation uses the samples of actual motor torque (*01.10*), 20 ms sample interval (*46.13*), and a user-defined sample period (*88.03*). The value is constantly updated when the Cavitation control program is enabled (*86.01*). See *Cavitation detection function based on torque (page 9)*.	-
	0.00…300.00 %	Average torque value calculated for an array of samples of *01.10 Motor torque*.	100 = 1
09.03	Torque RMS/Torque RMS Normal	Shows the relation between the two torque variation values defined by parameters *09.01* and *88.02*. This value is used in the cavitation detection on motor torque monitoring. See *Cavitation detection function based on torque (page 9)*.	-
	0.00…300.00	Relation *09.01*/*88.02*	100 = 1
09.04	Speed Reference from Application	Shows the speed reference output of the Cavitation detection control program. If this value is set as the speed reference source (*22.11* or *22.12*) for the drive, the Cavitation detection control program controls the pump speed and can protect the motor and pump in case of cavitation. When the pump operates normally, this output is equal to the Cavitation protection input reference (*87.05*). If the program detects cavitation, the value of the output reference decreases by steps (*86.05*). See *Cavitation protection (page 16)*.	1450.0
	-30000.00…30000.00 rpm	Speed reference	1 = 1
09.05	Speed Variation RMS	Shows the speed variation from average speed (*09.06*) as a rms value. The calculation uses the samples of actual motor speed (*01.01*), 20 ms sample interval (*46.11*), and a user-defined sample period (*88.03*). See *Cavitation detection function based on speed (page 10)*.	-
	0.00…300.00 rpm	Speed variation value (rms)	100 = 1
09.06	Speed Average	Average motor speed calculation. The calculation uses the samples of actual motor speed (*01.01*), 20 ms sample interval (*46.11*), and a user-defined sample period (*88.03*). See *Cavitation detection function based on speed (page 10)*.	-
	0.00…30000 rpm	Average speed value calculated for an array of samples of *01.01 Motor speed*.	1 = 1
09.07	Speed RMS/Speed RMS Normal	Shows the relation between the two speed variation values defined by parameters *09.05* and *88.09*. See *Cavitation detection function based on speed (page 10)*.	-

No.	Name/Value	Description	Def/FbEq16
	0.00…5.00	Relation *09.05*/*88.09*	100 = 1

■ 86 Cavitation Protection

No.	Name/Value	Description	Def/FbEq16
86	Cavitation Protection	Parameters that enable and disable the Cavitation detection control program and determine the response, when cavitation is detected.	
86.01	Cavitation protection En/Dis	Enables the Cavitation detection control program. **Note:** The mode selection parameters must also enable the operation (bit 0 of *87.01* must be 1 (true)).	Enable
	Disable	Disables the Cavitation detection control program.	0
	Enable	Enables the Cavitation detection control program.	1
86.02	Cavitation Trigger Source	Selects the signal that triggers action when the cavitation monitoring is ongoing. Triggering takes place when the selected signal indicates cavitation situation. See also the operation mode selection (*87.08*), and make sure that these two parameters have consistent selections.	Torque RMS
	Not selected	Not selected.	0
	Forced	Forces the status signal to on (cavitation detected).	1
	Torque RMS	Bit 0 of *88.01 Torque Variation Status*. (Cavitation detected based on the torque variation monitoring.)	2
	Speed RMS	Bit 0 of *88.13 Speed Variation Status*. (Cavitation detected based on the speed variation monitoring.)	3
	Combination RMS	Bit 0 of *88.17 Combination Variation Status*. (Cavitation detected based on the torque and speed variation monitoring.)	4
	Other	Other bit pointer. It is possible to use an external cavitation detection input.	-
86.03	Cavitation Fault/Alarm	Selects the event (fault or warning) that the program generates if cavitation at minimum speed (*86.04*) continues longer than a predefined time (*86.07*). See *Cavitation protection (page 16)*.	Fault
	Alarm	The drive displays a warning *E202 Cavitation Alarm* and continues to run at minimum speed.	0
	Fault	The drive displays a fault *E100 Cavitation Fault* and trips. The pump stops.	1
86.04	Minimum Protection Speed	Defines the minimum speed limit used by Cavitation protection function. See *Cavitation protection (page 16)*. When cavitation is detected, the program decreases the speed by steps (*86.05*) until cavitation disappears or the drive reaches the minimum speed.	850.0
	-6000.00…6000.00 rpm	Minimum speed limit	1 = 1
86.05	Speed Change Step	Defines the speed steps for the Cavitation protection function. See parameter *86.04*.	100
	-6000.00…6000.00 rpm	Speed step	1 = 1
86.06	Speed Down Delay	Defines the time delay before the program starts decreasing the speed by steps (*86.05*). See parameter *86.04*. The cavitation trigger signal (*86.02*) indicates cavitation for the whole delay period.	5.0 seconds

No.	Name/Value	Description	Def/FbEq16
	0.00…3200.00 s	Delay	10 = 1 second
86.07	Protection Action Delay (Fault/Alarm)	Defines the time delay for the event selection (*86.03*).	5.0 seconds
	0.00…3200.00 s	Delay	10 = 1 second
86.08	Speed Up Delay	Defines the time before the speed increases, if the program does not detect cavitation. The drive speed reference increases until it reaches the Pump reference given in *87.05 Pump Reference Selection*. See *Cavitation protection (page 16)*.	10.0 seconds
	0.00…3200.00 s	Delay	10 = 1 second
86.09	Protection Status	Shows the status of the Cavitation detection control program.	-
	0	Disabled. The program is disabled by the enable/disable parameter (*86.01*), or by the pump mode mode parameters (*86.02*, *86.03*, and *86.04*).	0
	1	The program is enabled and the program does not detect cavitation.	1
	2	The program is enabled and the program does not detect cavitation. The pump recovers from cavitation.	2
	4	The program is enabled and the program detects cavitation.	4
	8	The Cavitation detection control program is enabled and the program displays Fault or Warning depending of settings in parameter *86.03 Cavitation Fault/Alarm*.	8
86.10	End of Tank Detection	Enables the End of tank function. When the drive reaches the minimum speed (*86.04*), the counter for the End of tank delay (*86.11*) starts. If the program detects cavitation continuously throughout the delay (*86.11*), the End of Tank function starts. The function keeps the drive operating at minimum speed (*86.04*) until the user stops the drive (or the drive trips to a fault). See *End of tank function (page 20)*.	Disable
	0	Disabled.	0
	1	Enabled.	1
86.11	End of Tank Time Delay	Defines the delay for the End of tank detection function. See parameter *86.10* and *End of tank function (page 20)*.	3.0 seconds
	0.00 … 3200.00 s	Delay	10 = 1 second

■ 87 Pump Mode and Reference Selection

No.	Name/Value	Description	Def/FbEq16
87	Pump Mode and Reference Selection	Sets the pump reference source and the control modes in which Cavitation detection control program (*86.01*) is enabled.	
87.01	Pump Mode status	Shows status of selections *87.04 Pump Mode Logic Operation*, *87.02 Pump Mode condition 1*, and *87.03 Pump Mode Condition 2*. Default settings of the parameters (*88.02*, *88.03* and *88.04*) enable the Cavitation detection control program. See *Enabling/disabling the Cavitation detection control program (page 15)*.	-

No.	Name/Value	Description	Def/FbEq16
	Bit 0	Value of *87.04 Pump Mode Logic Operation*. When value is true (1), the bit enables the Cavitation detection control program. When the bit is false (0), the bit disables the program. You can control the value of the bit by parameters *87.02*, *87.03* and *87.04*.	True
	Bit 1	Value of *87.02 Pump Mode condition 1*	True
	Bit 2	Value of *87.03 Pump Mode condition 2*	False
87.02	Pump Mode Condition 1	Defines input 1 of pump mode condition monitoring. See parameters *87.03*, *87.04* and *87.01*. See also *Enabling/disabling the Cavitation detection control program (page 15)*	TRUE
	FALSE	False	0
	TRUE	True	1
	Other	A bit pointer to a bit of a drive parameter, for example *6.16.11 Drive Status Word 1: EXT2 active*	-
87.03	Pump Mode Condition 2	Defines input 2 of pump mode condition monitoring. See parameters *87.02*, *87.04* and *87.01*. See also *Enabling/disabling the Cavitation detection control program (page 15)*.	FALSE
	FALSE	False	0
	TRUE	True	1
	Other	A bit pointer to a bit on any of the drive parameter for example *6.16.08 Drive Status Word 1: Local control*	-
87.04	Pump Mode Logic Operation	Selects between input 1 of pump mode monitoring, or defines a logical operation that uses both inputs. The selection (or the result of the logical operation) is written to bit 0 of parameter *87.01*. The bit value enables (or disables) the Cavitation detection control program. See parameters *87.01*, *87.02* and *87.03*. See also *Enabling/disabling the Cavitation detection control program (page 15)*.	Input1
	Input1	Copies the status of *87.02 Pump Mode Condition 1* to the bit 0 of *87.01 Pump Mode Status*.	0
	In1 AND In2	Logical AND between status of *87.02* and *87.03*. Output is written to *87.01* bit 0.	1
	In1 OR In2	Logical OR between statuses of *87.02* and *87.03*. Output is written to *87.01* bit 0.	2
87.05	Pump Reference Selection	Selects the input speed reference for the Cavitation detection control program. See *Pump speed reference connection and control (page 14)*.	Internal Reference (*87.06*)
	Zero Speed	Speed reference output of the Cavitation detection control program is 0 rpm.	0
	Internal Reference (P.87.06)	Speed reference is a constant value given in *87.06*.	1
	FBA A Reference	The program receives the speed reference from Fieldbus adapter A and it is the value of *03.05 FB A reference 1*. If you set FBA A Reference as the input speed reference, you must set FBA A ref1 type (*50.04*) = Speed.	2
	Other	A pointer to a parameter of REAL type, for example *12.12 AI1 Scaled value*	
87.06	Pump Internal Reference	Sets a constant speed reference that is used when *87.05 Pump reference selection* is set to Internal Reference (*87.06*).	1450
	-6000.00 … 6000.00 rpm	Speed reference	1 = 1

No.	Name/Value	Description	Def/FbEq16
87.08	Operation mode selection	Selects the signal which the control program calculates and monitors for cavitation detection. Make sure to use consistent selection with the Cavitation trigger signal selection (*86.02*).	-
	Torque	Torque variation rms values	1
	Speed	Speed variation rms values	2
	Combination	Sum of relative torque and speed variation rms values	3
	Idle	No signal is selected (calculation or monitoring is not possible).	0

◾ 88 Variable Variations Calculations

No.	Name/Value	Description	Def/FbEq16
88	Variable Variations Calculations	Settings for torque and speed variation calculations	
88.01	Torque Variation Status	Shows the status of the cavitation detection based on motor torque.	-
	Bit 0	True, when the program detects cavitation.	-
		If the cavitation trigger source selection (*86.02*) is Torque RMS, the trigger signal is the value of this bit. It triggers action depending on the settings in parameter group *86*.	
	Bit 1	True when torque cavitation detection is active (*86.01 Cavitation Protection En/Dis* is set to Enable, *87.01 Pump mode Status* bit 0 is True) and the drive speed is constant or Autodetection is ongoing.	-
88.02	Torque RMS Normal	Shows the calculated rms value of variation from average torque in normal operating conditions. This parameter is the result of Normal torque rms autodetection (*88.07*). See *Normal torque rms autodetection (page 12)*.	0.20
		The value of this parameter can also be adjusted manually. Another method for estimating this value is to run the pump at a constant speed for a period of time, while monitoring *09.01 Torque Variation RMS* with a Drive Composer PC Tool. The calculated average value of the recorded torque variation rms can then be given in this parameter manually.	
	0.10 … 100.00 %	Torque variation value (rms) in normal operating conditions	100 = 1
88.03	RMS Period	Sets the time period used for the variation and average value calculations (*09.01*, *09.02*, *09.05*, *09.06*). The program measures the samples for the calculations for a time given in this parameter. The samples are recorded in 20 ms intervals (internal task time).	2.00
	1.00 … 4.00 s	Calculation time period	10 = 1
88.04	Torque variation threshold (TqRMS/TqNormRMS)	Sets a threshold value for the Cavitation detection based on torque. *88.01 Torque Variation Status* is set to True, if the relative torque variation *09.03* > *88.04* is true for a time delay (*88.05*). If the value of *88.05* is set to 0.00 ms, the status of the bit 0 in *88.01 Torque Variation Status* changes to True as soon as the condition *09.03* > *88.04* is true. See *Cavitation detection function based on torque (page 9)*.	1.50
	0.01 … 100.00	Cavitation threshold coefficient	100 = 1
88.05	Torque variation Over Threshold Time Delay	Sets a torque variation threshold time delay. See parameter *88.04* and *Cavitation detection function based on torque (page 9)*.	3000
	0 … 3000 ms	Threshold time	1 = 1

No.	Name/Value	Description	Def/FbEq16
88.06	Speed Change Time Coefficient	Sets a coefficient that is used to calculate the time it takes for the drive to change the speed from a previous reference speed to new reference speed. When a change of reference is sensed by the program, the rms value calculations are stopped for this period and the sample values array is reset.	1.25
	1.00 … 3.00	Speed change time	100 = 1
88.07	Pump Normal Torque RMS Auto-detect	Starts the Normal torque rms autodetection function that calculates a value for torque variation rms, when the pump operates in normal conditions. See *Normal torque rms autodetection (page 12)*.	Done
	Done	Autodetection function done (or never started)	0
	Run Pump Auto-tune	Starts the Normal torque autodetection.	-
88.08	Normal RMS Tune Time	Sets the time used by Autodetection functions (*88.07*, *88.12* and *88.18*).	4.0
	1.00 … 5.00 s	Auto-tune time	10 = 1
88.09	Speed RMS Normal	Shows the calculated rms value of variation from average speed in normal operating conditions. This parameter is the result of Normal speed rms autodetection (*88.12*). See Normal speed *Normal speed rms autodetection (page 12)*. The value of this parameter can also be adjusted manually. Another method for estimating this value is to run the pump at a constant speed for a period of time, while monitoring *09.05 Speed Variation RMS* with a Drive Composer PC Tool. The calculated average value of the recorded speed variation rms can then be given in this parameter manually.	0.00
	0.10 … 100.00 rpm	Speed variation value (rms)	100 = 1
88.10	Speed Variation Over Threshold Time Delay	Sets a speed variation over threshold time delay. See parameter *88.11* and *Cavitation detection function based on speed (page 10)*.	3000
	0 … 3000 ms	Threshold time	1 = 1
88.11	Speed Variation Threshold (SpdRMS/SpdNormRMS)	Sets a threshold value for the speed based cavitation detection. *88.13 Speed Variation Status* changes to True, if *09.07* > *88.11* is true for a time *88.10*. If the value of *88.10* is set to 0.00 ms, the status of the bit 0 in *88.13* changes to True as soon as the condition *09.07* > *88.11* is true. See also *Cavitation detection function based on speed (page 10)*.	2.50
	0.01 … 100.00	Cavitation threshold coefficient	100 = 1
88.12	Pump Normal Speed RMS Autodetect	Enables Normal speed rms autodetection, see *Normal speed rms autodetection (page 12)*.	-
	Done	Autodetection function done (or never started)	0
	Run Pump Auto-tune	Starts Normal speed autodetection.	-
88.13	Speed Variation Status	Shows the status of cavitation detection based on motor speed.	-
	Bit 0	True, when the program detects cavitation. If the cavitation trigger source selection (*86.02*) is Speed RMS, the trigger signal is the value of this bit. It triggers action depending on the settings in parameter group *86*.	-
	Bit 1	True when speed cavitation detection is active (*86.01 Cavitation Protection En/Dis* is set to Enable, *87.01 Pump Mode Status* bit 0 is True) and the drive speed is constant or the Autodetection is ongoing.	-

No.	Name/Value	Description	Def/FbEq16
88.14	Combination Variation Threshold	Sets a threshold value for cavitation detection based on the combination of speed and torque monitoring. If the relative combination variation (*88.16*) is above the Combination variation threshold longer than the time delay (*88.15*), the program indicates cavitation by bit 0 of *88.17 Combination Variation Status*. If *88.15* is set to 0.00 ms, the status of the bit 0 in *88.17* changes to True as soon as *88.16* goes above *88.14*. See *Cavitation detection function based on torque and speed (page 11)*.	2.00
	0.00 … 5.00	Cavitation threshold coefficient	
88.15	Combination Variation Over Threshold Time Delay	Sets a Combination variation threshold time delay. See parameter *88.14* and *Cavitation detection function based on torque and speed (page 11)*.	3000
	0 … 3000 ms	Threshold time	1 = 1
88.16	Speed and Torque Combination Indicator (S)	Shows the sum of relative torque and speed variation values (*09.03* and *09.07*).	0.00
	0.00 … 500.00	Sum of relative torque and speed variations	
88.17	Combination Variation Status	Shows the status of cavitation detection based on combination of torque and speed variations.	
	Bit 0	True when the program detects cavitation. If the cavitation trigger source selection (*86.02*) is set to Combination RMS, the trigger signal is the value of this bit.	-
	Bit 1	True when combination cavitation detection is active (*86.01 Cavitation Protection En/Dis* is set to Enable, *87.01 Pump Mode Status* the bit 0 is True) and the drive speed is constant or it is in Autodetection is ongoing.	-
88.18	Combination RMS Tune Autodetect	Enables Combination rms autodetection function that calculates the sum of torque variation rms and speed variation rms, when the pump operates in normal conditions. See *Combination rms autodetection (page 13)*. Select Combination for variable calculations in *87.08 Operation mode selection*.	-
	Done	Autodetection function done (or never started)	0
	Run Pump Auto-tune	Starts the Autodetection function.	-

4

Fault tracing

Contents of this chapter

This section lists warning and fault messages including possible causes and corrective actions. This section contains the faults and warnings that are specific only for the ACS870 Cavitation detection control program. See *ACS870 Primary control program firmware manual* (3AUA0000085967 [English]) for the other warnings and faults.

Warning messages

Code (hex)	Warning	Cause	What to do
E200	Pump not started	Parameter *88.07*, *88.12* or *88.18* is changed to Run Pump Auto-tune before the pump is started.	Start the pump before starting autodetection function.
E201	Pump does not reach speed	Autodetection function could not start because it detected a motor speed change (acceleration/deceleration), and the change lasted too long.	Wait until motor has reached the speed suitable for the Autodetection function (normal operation point, constant speed, no cavitation). Restart the Autodetection function.
E202	Cavitation alarm	Cavitation detection function has generated a cavitation warning. All of these conditions are valid: • Parameter *86.03 Cavitation Fault/Alarm* is set to value Alarm. • The control program has lowered the motor speed to the minimum speed (*86.04*) due to cavitation. • The drive has run at the minimum speed and with the cavitation ongoing for time longer the predefined time (*86.07*).	If the warning is incorrect (there is no cavitation), check the parameter settings for the Cavitation detection function and the related event selection (alarm/fault).

Fault messages

Code (hex)	Fault	Cause	What to do
E100	Cavitation fault	Cavitation detection function has generated a cavitation warning. All of these conditions are valid: • Parameter *86.03 Cavitation Fault/Alarm* is set to value Fault. • The control program has lowered the motor speed to the minimum speed (*86.04*) due to cavitation. • The drive has run at the minimum speed and with the cavitation ongoing for time longer the predefined time (*86.07*).	If the fault is incorrect (there is no cavitation), check the parameter settings for the Cavitation detection function and the related event selection (alarm/fault).

Further information

Product and service inquiries

Address any inquiries about the product to your local ABB representative, quoting the type designation and serial number of the unit in question. A listing of ABB sales, support and service contacts can be found by navigating to www.abb.com/searchchannels.

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