

Application Guide

Multi-Master Cascade Control

VLT® AQUA Drive FC 202



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1 Introduction

1.1 Version History

This manual is regularly reviewed and updated. All suggestions for improvement are welcome.

The original language of this manual is in English.

Manual Version	Remarks
AB389040992368, version 02	Information in this version of the manual corresponds to software version 4.11

1.2 Purpose of the Guide

This application guide is intended for qualified personnel such as

- Automation engineers
- Configurators who have experience operating with parameters and basic knowledge of AC drives

The application guide provides information on the functions and features of the Multi-Master Control using the built-in Modbus RTU for communication between multiple FC 202 drives. The guide covers information on ordering, installation, parameter setups, and maintenance use cases.

1.3 Additional Resources

Additional resources are available with related information.

- VLT® AQUA Drive FC 202 Programming Guide.
- VLT® AQUA Drive Cascade Controller Options MCO 101/102 Operating Guide provides information on cascade options that utilise hardware interlocks rather than Modbus RTU.

Safety Symbols

The following symbols are used in this manual:

DANGER

Indicates a hazardous situation when not avoided, results in death or serious injury.

WARNING

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

CAUTION

Indicates a hazardous situation when 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).

2 Introduction to Multi-Master Cascade Control

2.1 An Overview

Benefits of Multi-Master Cascade Control setup

- Easy installation using daisy-chain Modbus connection terminal 68/69
- Easy commissioning using dialog based Smart Start
- True multi-master functionality for cascade redundancy
- Improved system performance

Significantly reduced wiring complexity as the drive communication is daisy-chained using the on-board RS485 communication terminals. The communication protocol is Modbus RTU and requires an absolute minimum setup of parameters. The dialog-based Smart Start makes configuration easy and trouble-free.

The automatic drive detection supports hot-swap providing a rigid system setup against loose connection or cable failure. In case of master drive failure, the system automatically reallocates the master functionality.

In water distribution systems, it is usually required that the cascade system has a redundant master functionality. This functionality is now an integrated solution in the drives. Multi-Master Cascade comes with improved functionalities and system performance, as the master knows the status and performance of the individual drives and pumps.

Example

The illustration shows a system with 4 AC drives, where 2 are allocated Master recognized by License Code LXX1. In case of a defect on Master Drive ID 1, the master automatically changes to ID 2 for full functionality until replaced on site.

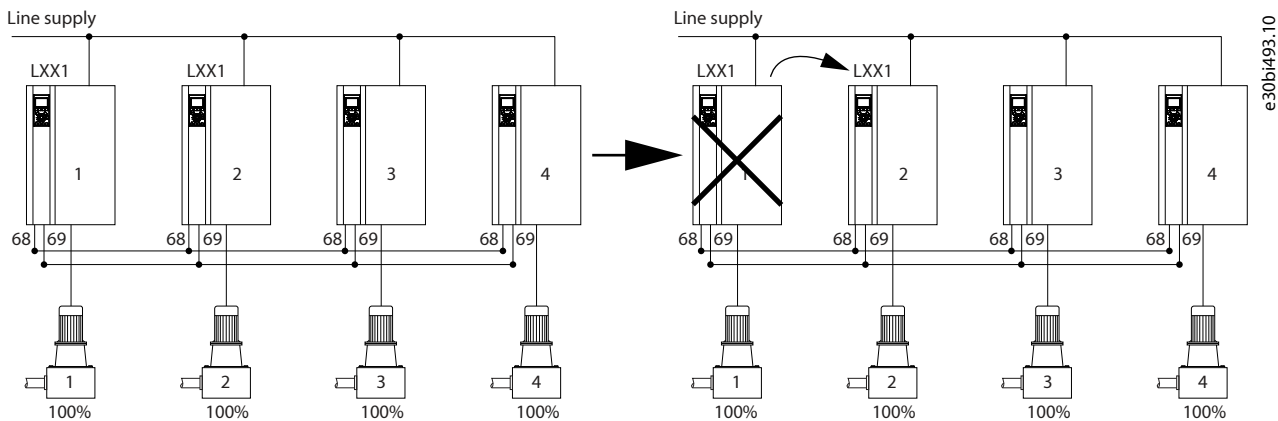


Figure 1: Illustration Example

Application requirements for the use of Modbus Multi-Master Cascade

Following are the 6 setups supported by Modbus Multi-Master Cascade

- Supports only Master Follower cascade.
- Equal sized pumps.
- A maximum of 8 pumps in cascade system.
- A master drive requires a license code (LXX1 or LX11) to unlock the master functionality and parameter **Group 27-* Cascade CTL Option**.
- A minimum of 1 master for Modbus Cascade.
- A minimum of 2 masters for accomplishing Multi-Master Cascade.

NOTICE

Modbus Multi-Master Cascade is possible in software version 3.91 and later. Setups 1 and 2 are assigned for Multi-Master. Flexibility in assigning different setups for different scenarios is limited. Setup 3 and Setup 4 are not available in Modbus Multi-Master.

NOTICE

Use of digital cascade without multi-master is available from software 3.40 and later. Setup 3 and 4 is supported through use of parameter **8-30 Protocol, [23] Modbus Multi Master**.

2.2 System Requirements and Compatibility

VLT® products and software compatibility for Multi-Master Cascade Control

To enable effective functioning of Multi-Master Cascade Control, verify the following software compatibility and system-requirements.

Table 1: VLT® Product and Software Compatibility for Multi-Master Cascade Control

VLT® Product	Minimum Software Compatibility Version
VLT® AQUA Drive FC 202	Software version 4.11 and higher on all drives in cascade system.

Table 2: Control Card Compatibility for Multi-Master Cascade Control

Control Card Version	Identification of Control Card Version	Production Identification
MKII	White USB	CW18 Y2018 or later.

Retrofit existing VLT® AQUA Drive FC 202

Following are the 3 scenarios and actions to retrofit an existing drive.

Table 3: Retrofit Existing VLT® AQUA Drive FC 202

Scenario	Control Card	Parameter 15–43	Action
1	MKII	3.91	Order license code. See 2.3.1 Overview of Ordering Multi-Master Cascade Control Flash software 4.11 or later for full functionality.
2	MKII	3.80 or older	<ul style="list-style-type: none"> Flash software version 4.11 or later. Order license code for master drive(s). See 2.3.1 Overview of Ordering Multi-Master Cascade Control.
3	MKI		<ul style="list-style-type: none"> Order new control card. Order license Code for master drive(s). See 2.3.1 Overview of Ordering Multi-Master Cascade Control. Replace old control card with new Mk II control card. Ensure to upgrade to software version 4.11 or later. Enable license code for master drive(s). <p>Note: It is not possible to order an MKII control card with pre-initialized license code activated. Activation must take place on site.</p>

2.3 Ordering Multi-Master Cascade Control

2.3.1 Overview of Ordering Multi-Master Cascade Control

Modbus multi-master is enabled with license codes. The license codes can be installed from the factory or retrofit to an existing VLT® AQUA Drive FC 202.

2.3.2 Ordering from Factory

Procedure

1. Select the license code characters [12]-[15]. For example, LXX1 replaces SXXX.

2.3.3 Ordering Retrofit on Existing VLT® Product

To proceed with creation of the unique license code, it is required to obtain the S/N number of each VLT® AQUA Drive FC 202 which is intended to operate as a master. After generating unique license code(s) these can be used for activating the feature in the drives.

Procedure

1. Order a retrofit license key via local Danfoss sales office contact.
2. Obtain the S/N number of each VLT® AQUA Drive FC 202 which is intended to operate as a master. Send the S/N information to the local Danfoss contact.

S/N can be obtained in different ways:

- o On invoice with specific drive
- o Value is identified in parameter *15-51 Frequency Converter Serial Number* using LCP or MCT-10
- o Product label

3. Enter the license key in parameter *50-01 License Code*.

After the drive accepts the license key, parameter *50-01 License Code* shows 0000-0000-0000-0000.

4. Power cycle the drive.

2.3.4 Identifying License Key for Cascade Control

Procedure

1. To identify license key for cascade control, verify the typecode using the following parameters.

Parameter	Factory delivered license code	Retrofit license code
<i>15-44 Ordered Typecode String</i>	LXX1	SXXX
<i>15-45 Actual Typecode String</i>	LXX1	LXX1
<i>50-00 License Installed</i>	Cascade 2.0	Cascade 2.0



NOTE: The ordered type code string is not changed when activating a retrofit license in the drive.

2.4 Loading new software to AC drives

Procedure

1. Create a back-up of the parameters.

- o Copy parameters to project in MCT-10.

- Save project.
2. Load the software into AC drives.
- Remove the Modbus Connector (plug 61, 68, 69) before loading the software via the USB port.
 - After connecting the USB port, right-click on the USB 1 in the software tray on the PC.
 - Click *Drive Software Upgrader*. (requires Service Level 1 access). Contact Danfoss if needed.
 - Locate the required file and click Start Upgrade.
3. After uploading the software to the drive, perform the following:
- Connect Modbus Connector (plug 61, 68, 69) again.
 - Write parameters from the project back to AC drive.
 - Power cycle AC drive.

3 Installing Modbus Multi-Master Cascade Control

3.1 Wiring the Daisy Chain Module

Ensure to install the drive using the instructions provided in VLT® AQUA Drive FC 202 Operating Guide.

Procedure

1. Wire Modbus RTU by daisy-chaining terminals 68 and 69.

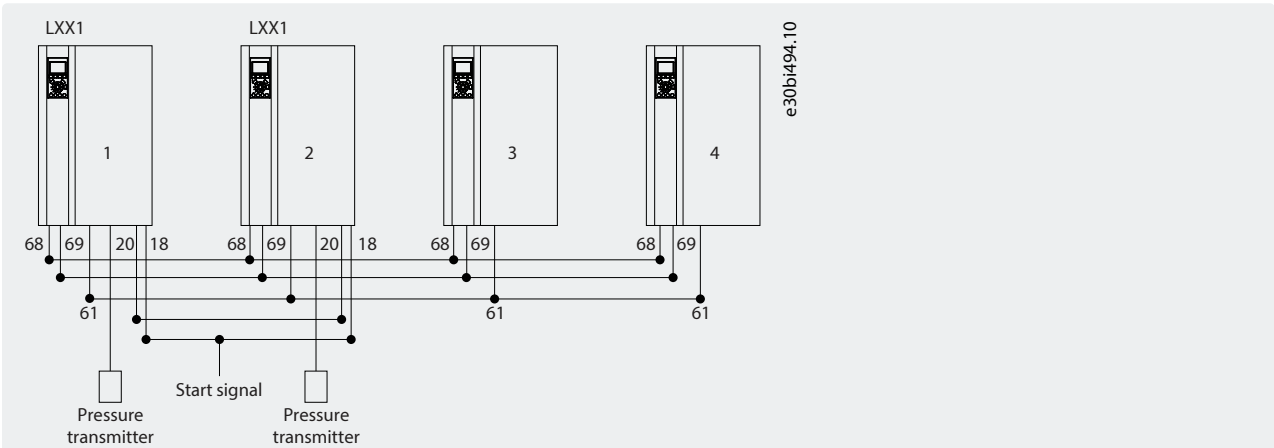

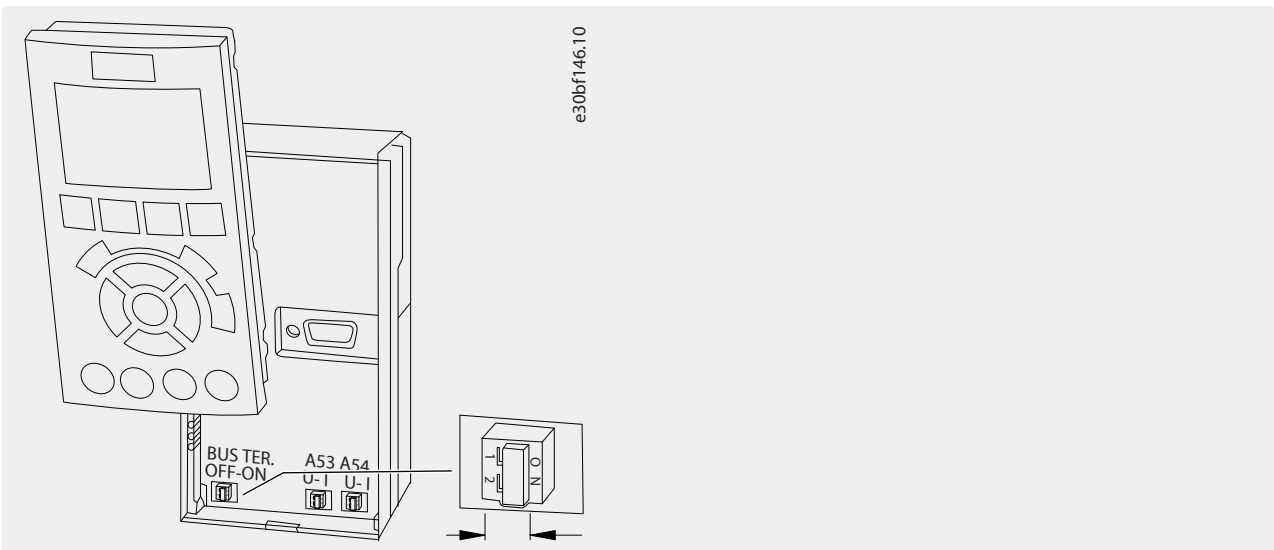


Figure 2: Wiring Daisy Chain Modbus

 **NOTE:** Each assigned master requires a start signal and closed loop feedback signal. For example, pressure transmitter and PID must be set up and tuned.

2. Terminate first and last drive by S801 ON.



4 Configuring the Multi-Master Cascade Control

4.1 Multi-Master Cascade Control Parameter Setup

A typical multi-master cascade parameter setup has the following:

- Parameter **8-30 Protocol** is set as **[23] Modbus Multi-Master** on master drives.
- A minimum of 2 master drives are required to obtain multi-master functionality. A maximum of 8 masters are allowed.
- For masters make sure of both Setup 1 and Setup 2.
- Followers make use of Setup 1 only.
- Ensure parameter **8-32 Baud Rate** is identical in all drives (masters and followers).

4.2 Assigning Correct Addresses for Modbus Multi-Master Cascade Control System

If there are multiple masters, Parameter **8-31 Address** determines which is the primary master. The lowest address is assigned as the primary master. All backup masters (those with higher addresses) are assigned as followers.

In the example below, Drive ID1 is assigned as the primary master as it has the lowest address (1).

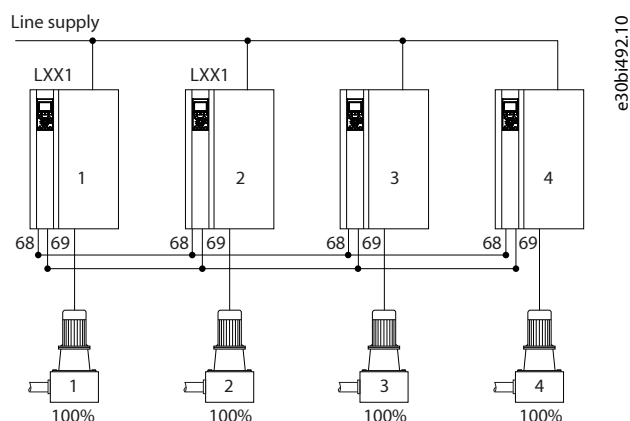


Figure 3: System Setup Example

For the system setup shown in the figure, the parameter setup and priority is as follows:

Parameter 8-31	SW	Priority
Set the value as 1	LXX1	Primary Master (Setup 1 and 2)
Set the value as 2	LXX1	Backup Master (Setup 1 and 2)
Set the value as 3	SXXX	Follower (Setup 1)
Set the value as 4	SXXX	Follower (Setup 1)

Considerations when assigning Parameter 8-31 Address:

- The drive ID must be in the order from 1–8.
- Drive IDs should be sequential. This means that a setup from 1, 3, 4, 5 is not allowed as 2 is missing.
- Masters must be assigned lowest IDs. For example, when there are 4 master drives, these drives are assigned IDs from 1–4.
- Follower drives must be assigned IDs following the master node addresses. Consider 4 masters and 4 followers, the followers must be assigned 5,6,7,8.

4.3 Maintenance and Replacement Scenario

If an assigned master is failing or being powered off due to maintenance, the next lowest address is assigned to the master drive automatically.

If a drive with lower address is reinserted into the system, the lowest address reinserts into the system as a follower. Assignment of master functionality to the lowest address in the system happens automatically.

4.4 Parameter Setup for Master Drive(s) – Basic Setup

Parameters for the master drive must be configured in Setup 1 and Setup 2.

- **Setup 1 (Master Mode):** The drive receives commands from digital input or A-option. Speed reference is obtained from PID.
- **Setup 2 (Follower Mode):** The drive receives commands from the assigned master drive in the system, ignoring digital and analog input and A options input. Speed reference (in Setup 1) must be scaled in the same way as Setup 1 in the master drive.

The following table describes the basic Setup for master drives. In the table, * indicates mandatory settings and ** indicates recommended settings.

Table 4: Basic Setup for Master Drives

Parameter	Setup 1 (master mode)	Setup 2 (follower mode)
Parameter 0-02 Motor Speed Unit	[1] Hz**	[1] Hz**
Parameter 0-10 Active Setup	[9] Multi Set-up**	[9] Multi Set-up**
Parameter 0-12 This Set-up Linked to	[2] Set-up*	[1] Set-up*
Parameter 0-21 Display Line 1.2 Small	[1652] Feedback[Unit]**	[0] None**
Parameter 0-23 Display Line 2 Large	[2794] Cascade System Status**	[39] Display Text 3**
Parameter 0-24 Display Line 3 Large	[2793] Cascade Option Status**	[38] Display Text 2**
Parameter 0-38 Display Text 2	Follower **	Follower **
Parameter 0-39 Display Text 3	Backup Master **	Backup Master **
Parameter 1-00 Configuration mode	[3] Closed Loop *	[0] Open Loop*
Parameter 3-03 Maximum Reference	[100] Application Specific**	= Par. 4-13 RPM / Par. 4-14 Hz*
Parameter 3-15 Reference 1 Source	[0] No function *	[0] No function *
Parameter 3-41 Ramp 1 Ramp Up Time	A	A
Parameter 3-42 Ramp 1 Ramp Down Time	B	B
Parameter 4-12 Motor Speed Low Limit [Hz]	C	C
Parameter 4-14 Motor Speed High Limit [Hz]	D	D
Parameter 5-10 Terminal 18 Digital Input	[8] Start*	[0] No Operation *
Parameter 6-01 Live Zero Timeout Function	[30] Warning only *	[30] Warning only *
Parameter 6-22 Terminal 54 Low Current	Application specific	Ignore
Parameter 6-23 Terminal 54 High Current	Application specific	Ignore
Parameter 6-24 Term 54 Low Ref. / Feedb. Val	Application specific	Ignore
Parameter 6-25 Term 54 High Ref. / Feedb. val	Application specific	Ignore
Parameter 8-01 Control Site	[0] Digital and ctrl.word **	[2] Control word only

Table 4: Basic Setup for Master Drives (continued)

Parameter	Setup 1 (master mode)	Setup 2 (follower mode)
Parameter 8-02 Control Source	[0] None or [3] Option A *	[1] FC Port *
Parameter 8-04 Control Timeout Function	Application specific	[0] Off *
Parameter 8-30 Protocol	[23] Modbus Multi Master *	[23] Modbus Multi Master *
Parameter 8-31 Address	1-x	1-x
Parameter 20-00 Feedback 1 Source	[2] Analog Input 54 **	Ignore
Parameter 27-10 Cascade Controller	[1] Master/Follower *	[1] Master/Follower *
Parameter 27-11 Number Of Drives	E (max 8)	E (max 8)

NOTICE

Ensure the values in parameter numbers 3-41 Ramp 1 Ramp Up Time, 3-42 Ramp 1 Ramp Down Time, 4-12 Motor Speed Low Limit [Hz], 4-14 Motor Speed High Limit [Hz], 8-31 Address, 27-11 Number Of Drives are identical in Setup 1 and Setup 2.

NOTICE

Ensure that parameter 8-04 Control Word Timeout Function is only configured when parameter 8-02 Control Word Source is set as A option. If parameter 8-02 Control Word Source is set as 0, do not set any values in parameter 8-04 Control Word Timeout Function.

4.5 Parameter Setup for Followers (Basic Setup)

A follower uses Setup 1 only and follows the commands send by the primary master. The following table details the basic setup for followers.

Table 5: Recommended Settings for Follower Setup

Parameter	Setup Follower
Parameter 0-02 Motor Speed Unit	[1] Hz **
Parameter 0-24 Display Line 3 Large	[38] Display Text 2 **
Parameter 0-38 Display Text 2	Follower **
Parameter 1-00 Configuration mode	[0] Open Loop *
Parameter 3-03 Maximum reference	= Par. 4-12 (Hz) *
Parameter 3-15 Reference 1 Source	[0] No function *
Parameter 4-14 Motor Speed High Limit [Hz]	D *
Parameter 8-01 Control Site	[2] Control word only**
Parameter 8-02 Control Source	[1] FC Port *
Parameter 8-03 Control Timeout	15.00 s**
Parameter 8-04 Control Timeout Function	[2] Stop**
Parameter 8-30 Protocol	[2] Modbus RTU *
Parameter 8-31 Address	2-x *

NOTICE

Ensure parameter 8-01 Control Site is not set to [1] Digital only.

NOTICE

A control timeout is recommended when the master drive is not active. On setting parameter **8-04 Control Word Timeout** to [2] **Stop**, the follower drive resumes when a master drive is reactivated.

4.6 Copy settings

Typically, it is recommended to copy settings to all drives in the system.

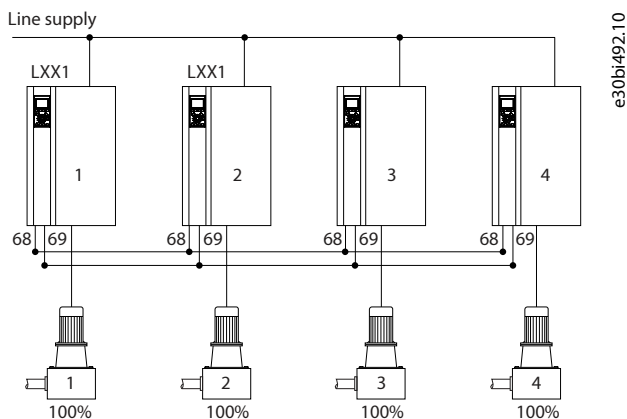
Table 6: Copy settings

Copy settings	Description
Copy Settings to all drives in the system	Copying settings is achieved by using the parameter 0-50 LCP Copy [1] All to LCP or MCT 10.
Copying from (Master to Master) or (Follower to Follower)	Ensure to change the parameter 8-31 Address so that no drives have the same address.
Copying from Master to Follower	It is not recommended to copy settings from Master to Follower.

5 Staging Parameter Setup

5.1 Overview of Staging Parameter Setup

Consider the example with 4 drives in the application. Ensure that staging parameters are set for assigned masters in setup 1. Setup 2 can be disregarded. Followers do not require configuration of staging parameters. Staging speeds and de-staging speeds are application specific.



The following sections detail recommended settings for the stage-on speeds, stage-off speeds, and general staging parameters.

5.2 Stage-On Speed

Table 7: Stage-On Speed Parameters

Parameter	Setup 1 (master mode)	Example Setting	Setup 2 (follower mode)
Parameter 27-32.0 Stage On Speed [Hz]	Ignore	48.5	Ignore
Parameter 27-32.1 Stage On Speed [Hz]	Pump 2 staging speed ⁽¹⁾	48.5	Ignore
Parameter 27-32.2 Stage On Speed [Hz]	Pump 3 staging speed ⁽¹⁾	48.5	Ignore
Parameter 27-32.3 Stage On Speed [Hz]	Pump 4 staging speed ⁽¹⁾	48.5	Ignore
Parameter 27-32.4 Stage On Speed [Hz]	Ignore	48.5	Ignore
Parameter 27-32.5 Stage On Speed [Hz]	Ignore	48.5	Ignore
Parameter 27-32.6 Stage On Speed [Hz]	Ignore	48.5	Ignore
Parameter 27-32.7 Stage On Speed [Hz]	Ignore	48.5	Ignore
Parameter 27-32.8 Stage On Speed [Hz]	Ignore	48.5	Ignore
Parameter 27-32.9 Stage On Speed [Hz]	Ignore	48.5	Ignore
Parameter 27-32.10 Stage On Speed [Hz]	Ignore	48.5	Ignore

1) The highest index speed in parameter 27-32.X Stage On Speed must be set to motor speed high limit in parameter 4-13 Motor Speed High Limit [RPM] or parameter 4-14 Motor Speed High Limit [Hz].

5.3 Stage-Off Speed

Table 8: Stage-off Speed Parameters

Parameter	Setup 1 (master mode)	Example setting	Setup 2 (follower mode)
Parameter 27-34.0 Stage Off Speed [Hz]	Ignore	0	Ignore
Parameter 27-34.1 Stage Off Speed [Hz]	Pump 1 off ⁽¹⁾	30.5	Ignore
Parameter 27-34.2 Stage Off Speed [Hz]	Pump 2 de-staging	32	Ignore
Parameter 27-34.3 Stage Off Speed [Hz]	Pump 3 de-staging	34	Ignore
Parameter 27-34.4 Stage Off Speed [Hz]	Pump 4 de-staging	36	Ignore
Parameter 27-34.5 Stage Off Speed [Hz]	Ignore	37.5	Ignore
Parameter 27-34.6 Stage Off Speed [Hz]	Ignore	39.2	Ignore
Parameter 27-34.7 Stage Off Speed [Hz]	Ignore	40.4	Ignore
Parameter 27-34.8 Stage Off Speed [Hz]	Ignore	41.3	Ignore
Parameter 27-34.9 Stage Off Speed [Hz]	Ignore	42	Ignore
Parameter 27-34.10 Stage Off Speed [Hz]	Ignore	42.5	Ignore

1) Lowest index speed in parameter 27-34.1 Stage Off Speed must be equal to or greater than motor speed low limit specified in parameter 4-11 Motor Speed Low Limit [RPM] or parameter 4-12 Motor Speed Low Limit [Hz].

5.4 General Staging Parameters

This section provides an overview of the parameters for general staging.

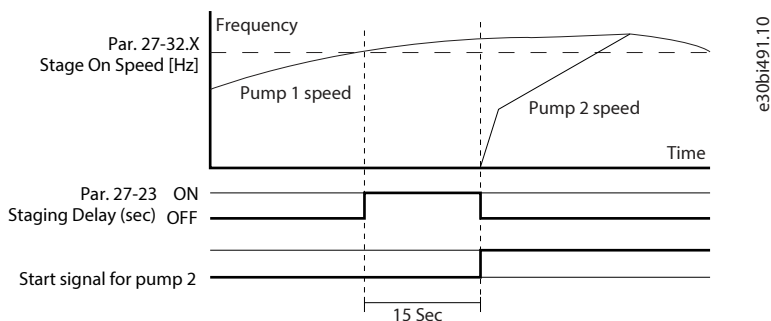


Figure 4: General Staging Parameters

Table 9: General Staging Parameters

Parameter	Setup 1 (master mode)	Setup 2 (follower mode)
Parameter 27-23 Staging Delay	15 seconds (recommended)	Ignore
Parameter 27-24 Destaging Delay	15 seconds (recommended)	Ignore

6 Sleep Mode Parameter Overview

6.1 Entering Sleep Mode

When the last pump which is operating drops below parameter **27-34.1 Stage Off Speed**, sleep mode is activated.

Sleep mode occurs when the actual speed is less than the value configured in parameter **27-34.1 Stage Off Speed** for the time in seconds configured in parameter **27-24 De-staging Delay**.

To enable sleep mode, make sure the parameter **27-34.1 Stage Off Speed** is higher than parameter **4-11 Motor Speed Low Limit [RPM]** or parameter **4-12 Motor Speed Low Limit [Hz]**.

If the value in parameter **27-34.01** is equal to or less than the value specified in parameter **4-11 Motor Speed Low Limit [RPM]** or parameter **4-12 Motor Speed Low Limit [Hz]**, the system continues to operate at minimum speed.

6.2 Activating Drives from Sleep Mode

Table 10: Recommended Parameter Settings

Parameter	Setup 1 (Master Mode)	Setup 2 (Follower Mode)
Parameter 27-21 Override Limit	10%	Ignore
Parameter 20-21 Setpoint 1	Application specific [e.g. 80]	Ignore
Parameter 3-03 Maximum Reference	Application specific (e.g. 100)	= parameter 4-14 Motor Speed High Limit [Hz] (D)

Multi-Master Control activates during sleep mode when parameter **27-21 Override Limit** is reached. Override Limit is a % of parameter **3-03 Maximum Reference**.

How to calculate:

Drive start < Setpoint in parameter **20-21 Setpoint 1** – (parameter **27-21 Override Limit** x parameter **3-03 Maximum Reference**)) Drive start < 80 – (10% x 100) = 70

7 Cascading Operation and Settings

7.1 Overview of Cascading Operation

Consider the scenario when the system is activated with a Start signal.

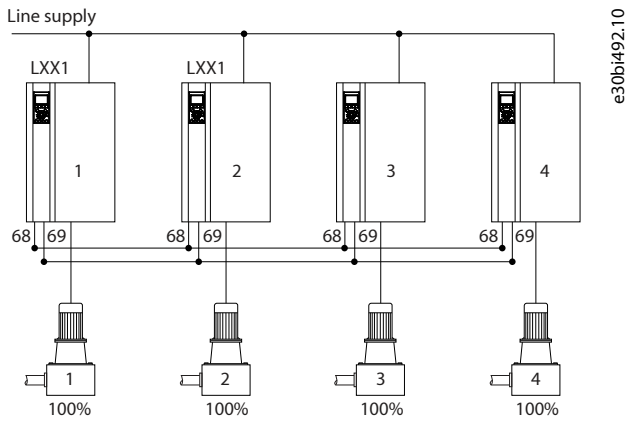


Figure 5: Scenario Illustration

The Start signal is activated via Digital Input on terminal 18.

Pump 4 is activated first as it has the least running hours. If the frequency rises above parameter **27-32.1 Stage Off Speed** for the duration specified in parameter **27-23 Staging Delay**, the subsequent pump with the 2nd least running hours begins. In this case, pump 2 is staged. If the frequency is still above parameter **27-32.2 Stage On Speed** for the duration specified in parameter **27-23 Staging Delay**, the pump with 3rd least running hours begins. In this case, pump 3 is staged on. This continues as the last pump is staged on.

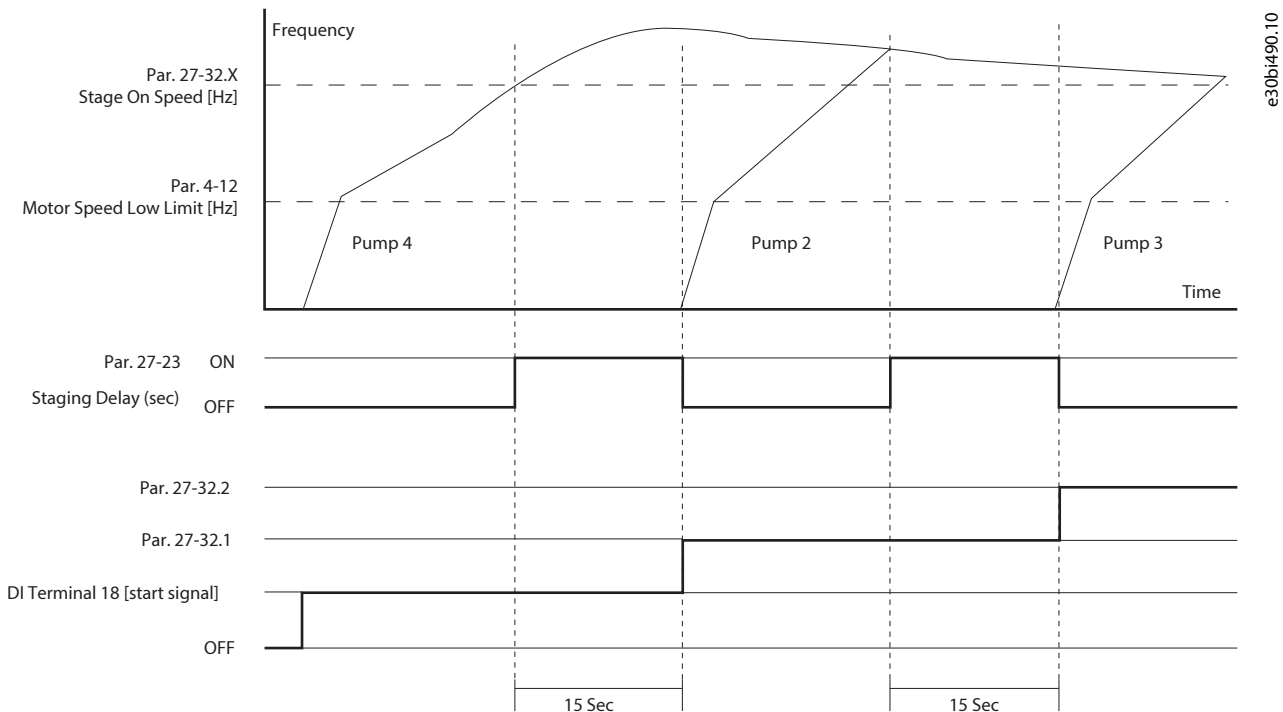


Figure 6: Cascading Operation

On the contrary, when the frequency is below parameter **27-34.X Stage Off** for duration of parameter **27-24 De-stage Delay**, the drive with the highest running hours stops. This continues until 1 pump is running at a frequency below the value specified in parameter **27-34.1 Stage Off Speed**, and higher than parameter **4-12 Motor Speed Low Limit** for the duration specified in parameter **27-24 De-stage Delay**.

The last drive stops, and the system goes into sleep mode.

NOTICE

If the parameter *4-12 Motor Speed Low Limit* is higher than the value specified in parameter *27-32.1 Stage Off Speed*, the last drive continues to operate in minimum speed until the stop signal is started.

7.2 Local Control Panel (LCP) Readings

The following table describes LCP readings for the parameter settings.

- Parameter *0-23 Display Line 2 Large* as [2794] *Cascade System Status*
- Parameter *0-24 Display Line 3 Large* as [2793] *Cascade Option Status*

The details provided on the LCP reflect the number of drives in the system which was set earlier via parameter *27-11 Number Of Drives*.

Table 11: LCP View


LCP view and notes	For 3 drives	For 8 drives
LCP view		 <div style="font-size: 8px; position: absolute; right: -20px; top: 50%; transform: translateY(-50%);">e30bj395.10</div>
Notes	Off is the current state of the unit viewed. Notice: Off is viewed in 2 places. They both mean the same. Colon is used in-between, for example, M:o	Off is the current state of the unit viewed. Notice: Off is only viewed in 1 place due to lack of space. No colon is used, for example, Mo.

Table 12: Options and Description for Display Large [2794] as Cascade System Status

Drive	Options	Description
Master (M)	o	The master drive is online but idle (not running), Mo indicates that the master drive is online but idle.
Follower (F)	o	The follower drive is online but idle.
Follower (F)	D	FD indicates that the follower drive is online and running.
Follower (F)	x	Fx indicates that the follower drive cannot be reached by network. This is possible, for example, when parameter <i>27-11 Number Of Drives</i> is set to 3, and only 2 drives are connected.
M	X	Interlock, trip, Drive not ready, Drive coast, Drive trip lock status of the master drive. MX indicates Master interlock.
Follower (F) o	X	The follower drive is online but idle.

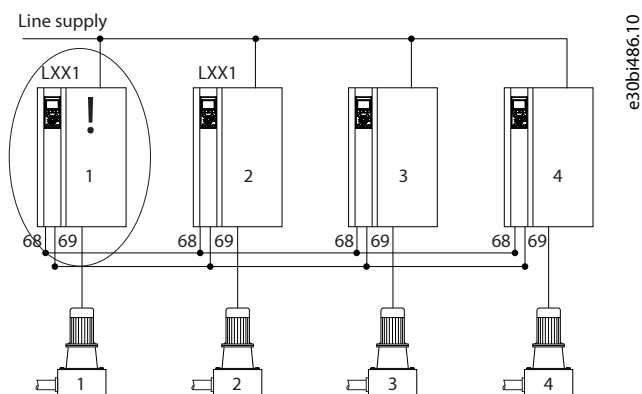
Table 13: Options and Description for Display Large as [2793] Cascade Option Status

Option	Description
Off	System is stopped
Running	System is running with 1 or more pump.
Stg	A pump is being staged in.
dstg	A pump is being de-staged.
Alt	Alternation is occurring.

8 Maintenance Scenarios

8.1 Service on Primary Master (Address 1)

Consider the scenario to stop only the primary master without stopping the drive.



It is recommended to use DI (Digital Input) [130] *Pump 1 interlock*.

An example of actions to stop the master drive and keep the system running are as follows:

- Wire DI 33
- Program parameter 5-15 *Terminal 33 Digital Input* as [130] *Pump 1 interlock*

8.2 Service on Backup Master Running as a Follower

Consider the scenario to service on backup master running as a follower.

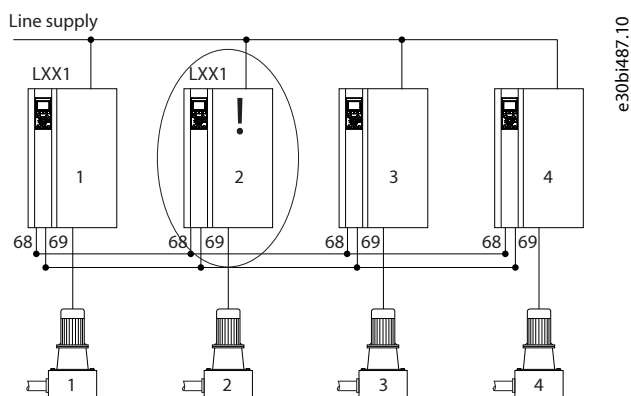


Figure 7: Service on Backup Master Drive Which Runs as a Follower Drive

[Off] mode on Drive 2 LCP, stops pump 2.

It is recommended to use pump interlock DI using [131] *Pump 2 interlock* on Master Drive, as drive 2 is the backup master and potentially becomes the master drive in cases of primary master drive break-down. The wiring should be to both primary and secondary master drive.

See [Figure 8](#).

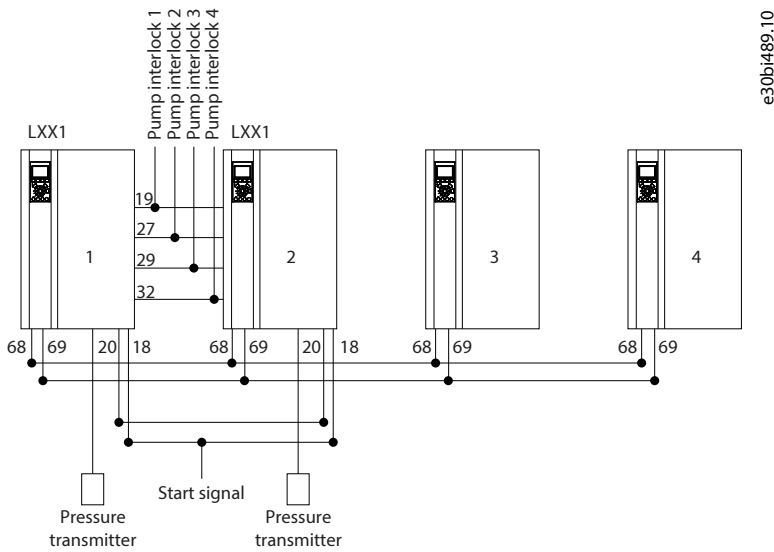


Figure 8: Wiring Example

8.3 Service on Follower

Consider the scenario when the follower drive on pump 3 fails. Any actions performed only affect the specific drive.

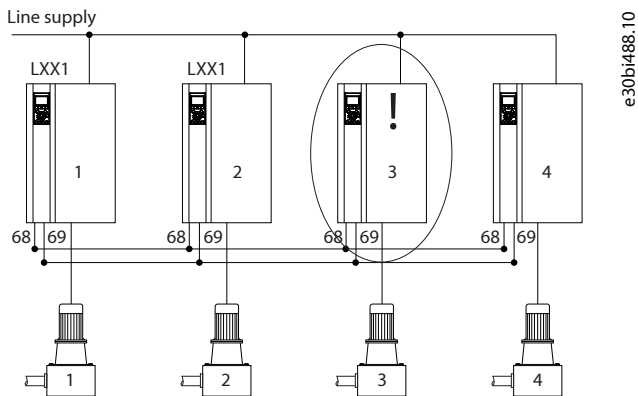


Figure 9: Service on Follower Drive

9 Alarms, Warnings, and Defects

9.1 System Setups and Actions to Alarms, Warnings

This section explains behaviors which are triggered by alarms, warnings, and defects. Following are 3 examples.

LCP status: M:X F:D F:D F:D

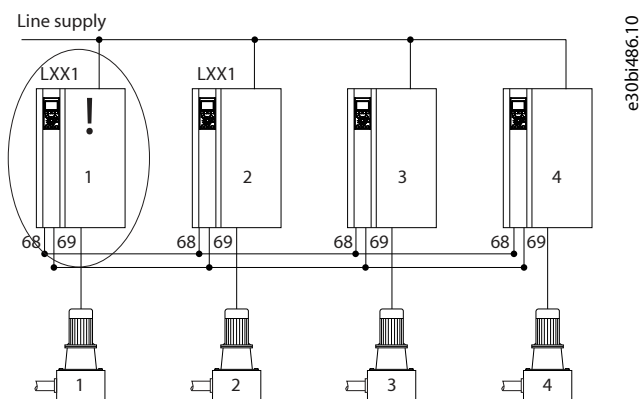


Figure 10: System Setup - Primary Master (Address 1)

Table 14: System Actions

System setup	System Action
primary master (Address 1)	<p>Change the master, when the following occurs on the primary master:</p> <ul style="list-style-type: none"> Supply power is turned off. Control card defect. Warning, Live Zero error. This is only shown if parameter 6-01 Live Zero Timeout Function is configured to [30] Warning Only. <p>The system stops when primary master detects the following:</p> <ul style="list-style-type: none"> Alarm 68, Safe Stop Activated. Alarm 94, End of Curve. Alarm 92, No Flow Alarm. Alarm 93, Dry Pump Alarm. Alarm 60, External Interlock. <p>Followers are operating, when the primary master stops:</p> <ul style="list-style-type: none"> Any other alarm/fault. LCP status: M:X F:D F:D F:D

LCP status: M:D F:X F:D F:D

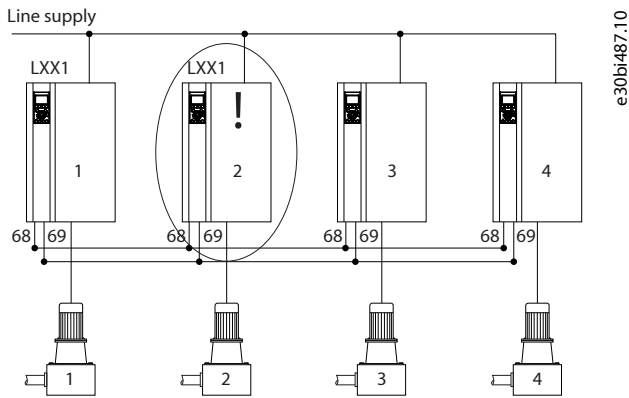


Figure 11: System Setup - Backup Master

Table 15: System Actions

System setup	System action
Backup master (running as a follower)	<ul style="list-style-type: none"> • During this alarm, the drive continues to operate. • The LCP status is M:D F:X F:D F:D.

LCP status: M:D F:D F:X F:D

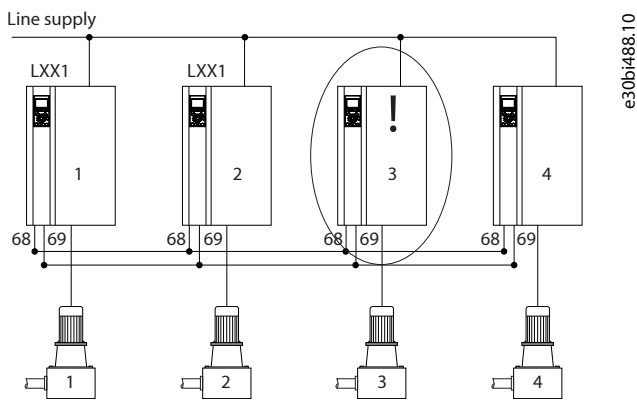


Figure 12: System Setup - Follower Drive

Table 16: System Actions

System setup	System action
Follower	<ul style="list-style-type: none"> • The follower stops. • The system continues. • The LCP status is shown as M:D F:D F:X F:D.

10 Water Features with Multi-Master Cascade

10.1 Overview of Water Features

This section provides an overview of whether specific water-related features may still be used in combination with Multi-master Cascade Control or not, and describes which parameters are used to configure these features where they are supported.

10.2 Check Valve Ramp

This feature can be used in combination with multi-master cascade control.

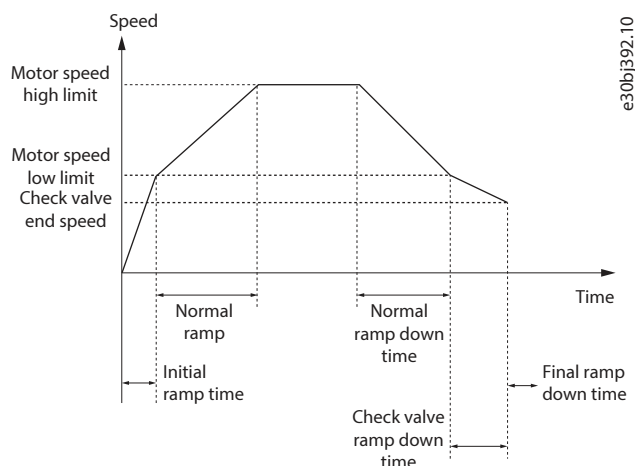


Figure 13: Check Valve Ramp

10.3 Sleep Mode

This feature can be used in combination with multi-master cascade control.

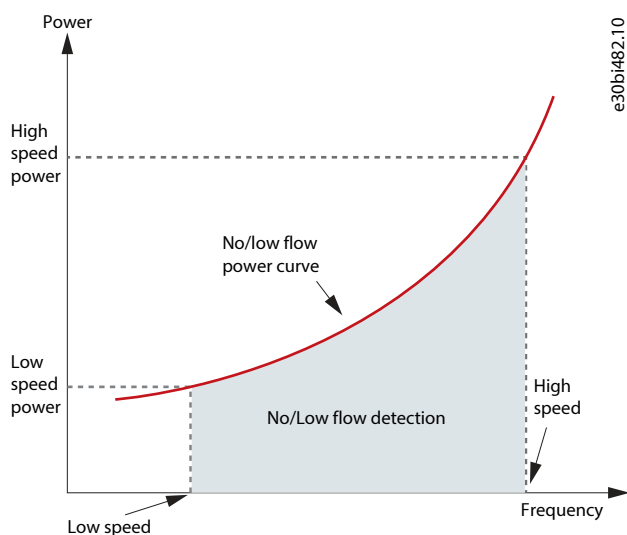


Figure 14: Sleep Mode

For more information on how to configure, see [6.1 Entering Sleep Mode](#).

10.4 Dry Pump

This feature can be used in combination with multi-master cascade control.

The feature can be used if primary master drive has priority 1 and all backup master and follower drives have priority 2, or are configured as a spare pump (which is specified via parameter **22-26 Dry Pump Function**).

NOTICE

This type of setting means that the primary master drive always operates when a demand is available and is not part of normal runtime balancing to even out the running hours of the pumps.

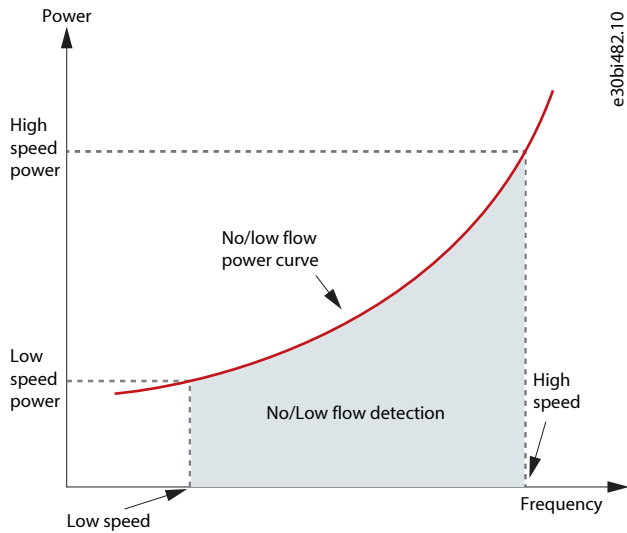


Figure 15: Dry Pump

10.5 End-of-curve Detection

This feature can be used in combination with multi-master cascade control.

The feature can be used if primary master drive has priority 1 and all backup master and follower drives have priority 2, or are configured as a spare pump (which is specified via parameter **27-16 End of Curve Function**).

NOTICE

This type of setting means that the primary master drive always operates when a demand is available and is not part of normal runtime balancing to even out the running hours of the pumps.

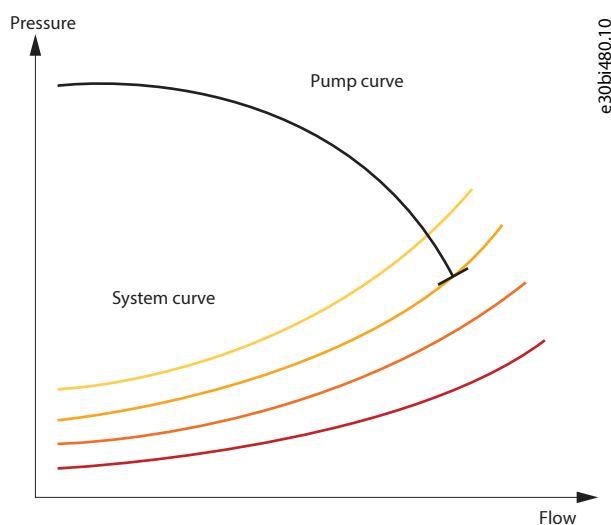


Figure 16: End-of-curve Detection

10.6 Flow Compensation

This feature can be used in combination with multi-master cascade control.

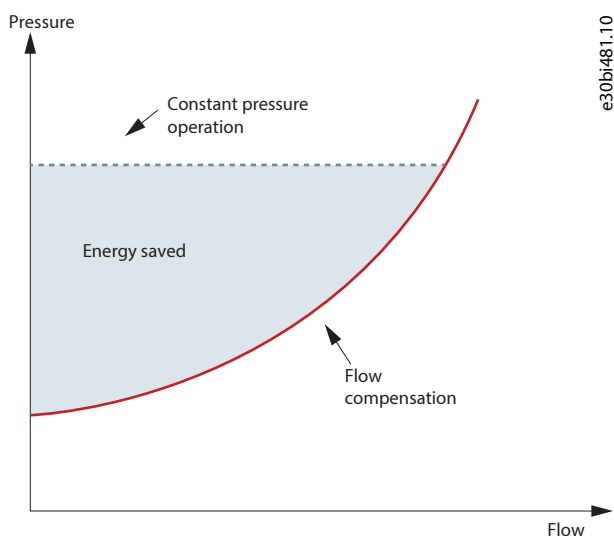


Figure 17: Flow Compensation

Configure the following parameters:

- Parameter **22-80 Flow Compensation** as [1] Enabled
- Parameter **22-87 Pressure at No-Flow Speed** to application specific settings
- parameter **20-21 Setpoint 1** to application specific settings

10.7 Pipefill

This feature can be used in combination with multi-master cascade control.

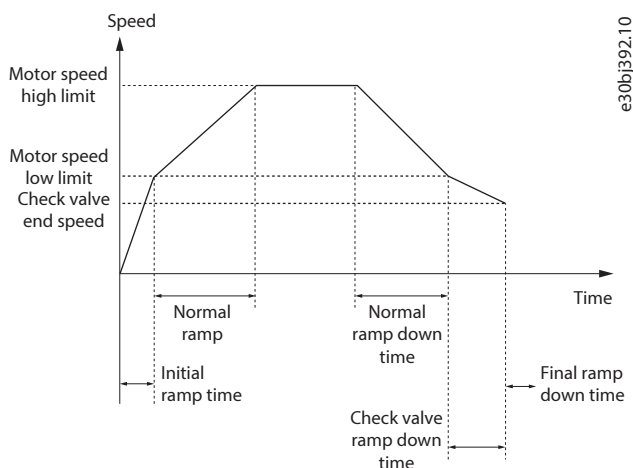


Figure 18: Pipefill

10.8 Flow Confirmation

This feature can be used in combination with multi-master cascade control.

Can be used if primary master drive has priority 1 and all back-up master and follower drives have priority 2, or spare pump which is specified in parameter **27-16 Flow Confirmation**.

NOTICE

This type of setting means the primary master drive always operates when a demand is available and is not part of normal run time balancing to even out the running hours of the pumps.

NOTICE

Flow confirmation for each pump with flow switch can be enabled in Multi-Master with programming of smart logic control.

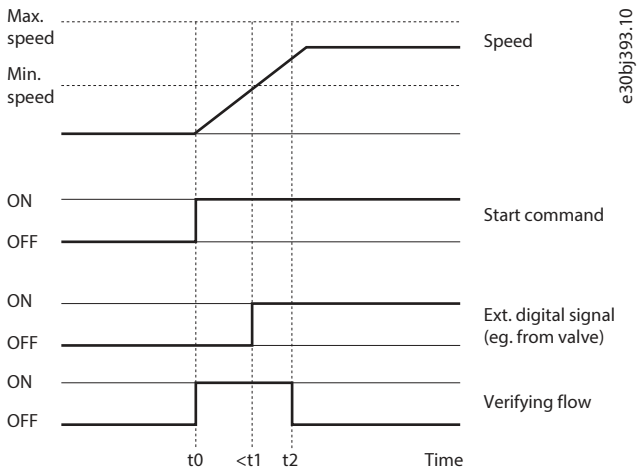


Figure 19: Flow Confirmation

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