1.1.1. Master/Follower Operation Application

Application Description

The system used as example contains 4 equal sized pumps in a water distribution system. They are each connected to a Danfoss VLT AQUA Drive. A pressure transmitter with an analogue format of 4-20mA is used as feedback and connected to one of the drives named the master drive. The master drive also includes the Danfoss VLT Extended Cascade controller option MCB-101. The purpose of the system is to maintain a constant pressure in the system.

Reasons for using Master / follower instead of the standard cascade control mode can be:

- In old and weak pipe system where huge pressure surges can lead to leakage, the high performance of the master / follower mode can be a real benefit.

- In constant pressure water systems the pumps can be operated in the most energy efficient way by using Master / follower operation.

- In systems with large variances in flow, the fast reacting Master / Follower mode will safely and fast maintain a constant pressure.

- Very easy installation - no need for external equipment. The drives can be delivered in IP55 or even IP66, which means no need for panels, except for fuses.

Issues to keep in mind

Compared to traditional cascade control the number of running pumps is controlled by speed instead of feedback. To obtain the highest energy saving the stage on and off speed must be set correctly according to the system. To understand the principle better, please note figure 1.

The stage on and off speed is set by the user for each stage. The right speed depends on the application and the system. In VLT AQUA software version above 1.05 the speed will be autotuned by the drive. The right settings can also be determined by using the Danfoss PC software called MUSEC, which is downloadable from the homepage: www.danfoss.com To begin with the settings showed in table 1 can be used as a start in most applications.
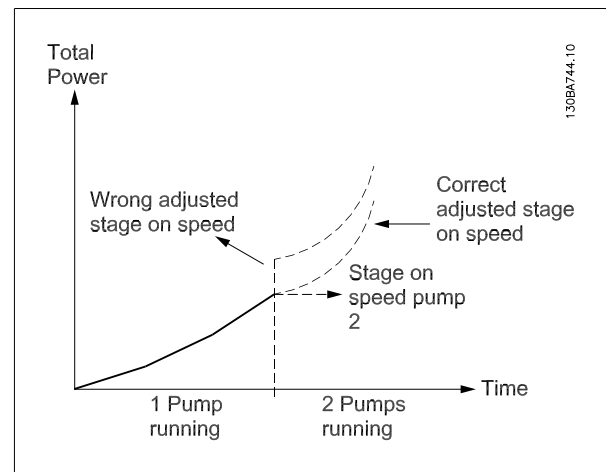
	Stage on speed (Par. 27-31)	Stage off speed (Par. 27-33)
Stage 1	0	33
Stage 2	49	35
Stage 3	47	37
Stage 4	45	39

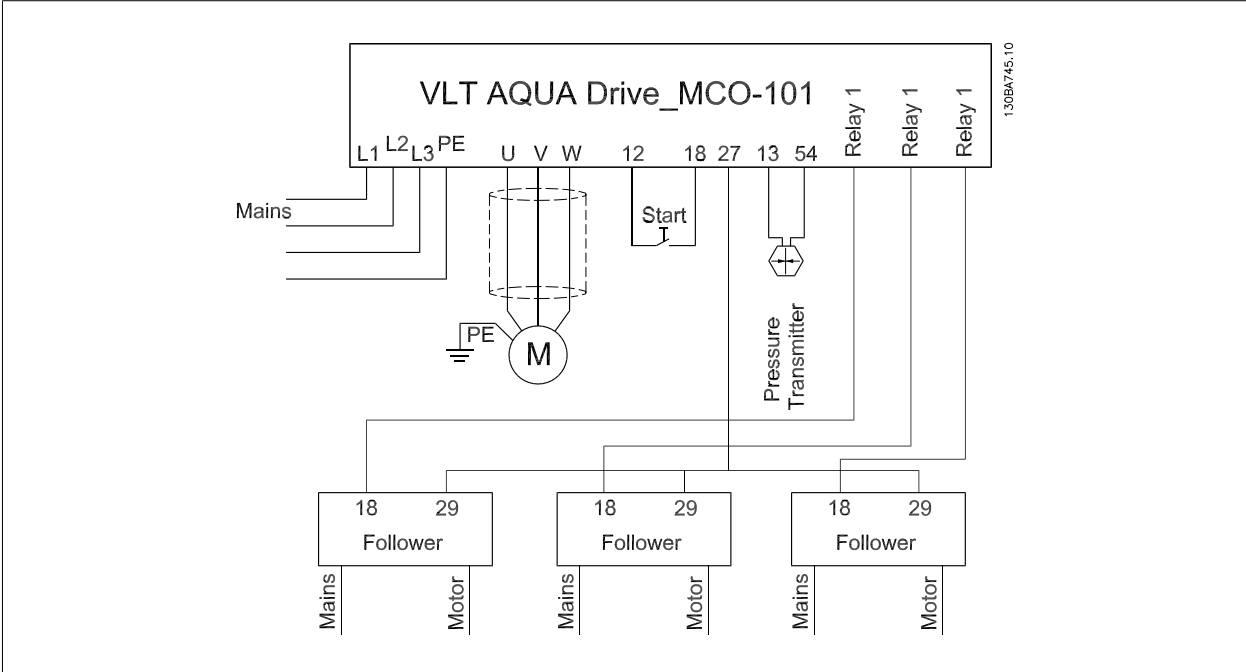Table 1.1: Example of stage on and stage off speed

Illustration 1.1: Electrical wiring. Terminal 27 on master drive is used as pulse output reference. Terminal 29 on the follower drives is used as pulse input reference. All follower drives are connected to mains and motor the same way as the master drive symbolised with the text: *Mains* and *Motor*.

> **NB!**
> Please note: the format of the analogue input is set using switch S201 below the LCP.

Parameter settings

Basic settings for both master and follower drives:

Parameters:	
Change from RPM to Hz as speed unit	par. 0-02
Motor rated power	par. 1-20/par. 1-21 (kW/HP)
Motor rated voltage	par. 1-22
Motor Current	par. 1-24
Motor Rated Speed	par. 1-25
Check Rotation Check	par. 1-28
Enable Automatic Motor Adaptation (AMA in par. 1-29)	

Ramp Up Time	par. 3-41	(5 sec.* Depending on size)
Ramp Down Time	par. 3-42	(5 sec.* Depending on size)
Motor Min Speed	par. 4-11	(25 Hz)
Motor Max Speed	par. 4-13	(50 Hz)

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Settings for the master drive only

1. Use the "Closed Loop" Wizard under "Quick Menu_Function Setup", to easily set up the feedback settings and the PID controller.

2. Set up the master configuration in par. 27-**

Enable Master/Follower	par. 27-10
Set number of drives	par. 27-11
Set the staging speed according to table 1	par. 27-3*
Configure Relay 1 to: Drive 2 enable	par. 27-70
Configure Relay 2 to: Drive 3 enable	par. 27-70
Configure Relay 10 to: Drive 4 enable	par. 27-70

Settings for the follower drives only	
Set terminal 29 to pulse input	par. 5-13
Set terminal 29 high frequency to 5000 Hz	par. 5-51

Operation

When the system is set to operation, the master drive will only be running with the needed number of pumps depending on the demand. If for some reason the user prioritises the motors to be running at most times it is possible to prioritise the pumps in par. 27-16 in three levels. (Priority 1, Priority 2 and spare pump) Pumps with priority 2 will only be staged on when there is no priority 1 pumps available. It might be needed to fine adjust the *stage on/off* speed to optimise the energy consumption.