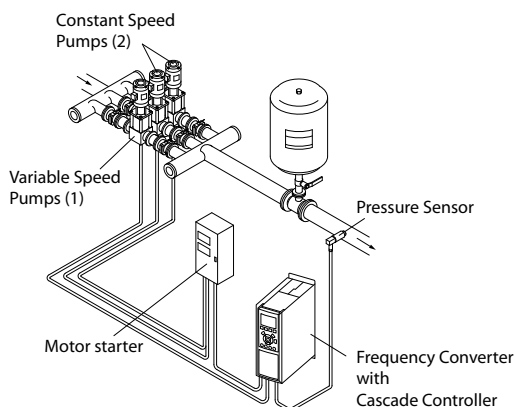




Instruction

VLT® HVAC Basic Drive
Cascade Controller

1.1 Cascade Controller



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Illustration 1.1 Cascade Controller

The Cascade Controller is used for pump applications where a certain pressure (“head”) or level needs to be maintained over a wide dynamic range. Running a large pump at variable speed over a wide for range is not an ideal solution because of low pump efficiency and because there is a practical limit of about 25% rated full load speed for running a pump.

In the Cascade Controller the frequency converter controls a variable speed motor as the variable speed pump (lead) and can stage up to two additional constant speed pumps on and off. By varying the speed of the initial pump, variable speed control of the entire system is provided. This maintains constant pressure while eliminating pressure surges, resulting in reduced system stress and quieter operation in pumping systems.

Fixed Lead Pump

The motors must be of equal size. The Cascade Controller allows the frequency converter to control up to 5 equal size pumps using the drives two built-in relays and terminal 27, 29 (digital input/digital output). When the variable pump (lead) is connected directly to the frequency converter, the other 4 pumps are controlled by the two built-in relays and terminal 27, 29 (digital input/digital output). Lead pump alternation can not be chosen when lead pump is fixed.

Lead Pump Alternation

The motors must be of equal size. This function makes it possible to cycle the frequency converter between the pumps in the system (when 25-57 Relays per Pump =1, maximum pump is 4. When 25-57 Relays per Pump =2, maximum pump is 3). In this operation the run time between pumps is equalized reducing the required pump maintenance and increasing reliability and lifetime of the system. The alternation of the lead pump can take place at a command signal or at staging (adding lag pump).

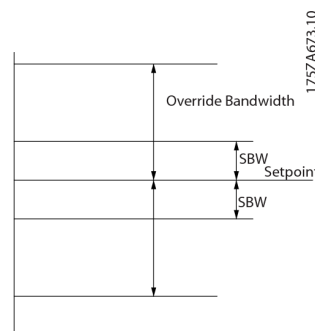
The command can be a manual alternation or an alternation event signal. If the alternation event is selected, the lead pump alternation takes place every time the event occurs. Selections include whenever an alternation timer expires, when the lead pump goes into sleep mode. Staging is determined by the actual system load.

25-55 Alternate if Load <=50%=1, if load >50% Alternation will not happen. If load <=50% Alternation will happen. When 25-55 Alternate if Load <=50% =0, Alternation will happen no matter with Load. Total pump capacity is determined as lead pump plus lag speed pumps capacities.

Bandwidth Management

In cascade control systems, to avoid frequent switching of fixed speed pumps, the desired system pressure is kept within a bandwidth rather than at a constant level. The Staging Bandwidth provides the required bandwidth for operation. When a large and quick change in system pressure occurs, the Override Bandwidth overrides the Staging Bandwidth to prevent immediate response to a short duration pressure change. An Override Bandwidth Timer can be programmed to prevent staging until the system pressure has stabilized and normal control established.

When the Cascade Controller is enabled and running normally and the frequency converter issues a trip alarm, the system head is maintained by staging and destaging fixed speed pumps. To prevent frequent staging and destaging and minimize pressure fluxuations, a wider Fixed Speed Bandwidth is used instead of the Staging bandwidth.



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Illustration 1.2 Bandwidth

1.1.1 System Status and Operation

Only when lead pump is working, the frequency converter can go into sleep mode. When the Cascade Controller is enabled, the operation status for each pump and the Cascade Controller is displayed by 25-81, *Pump Status* and 25-80, *Cascade Status* on the LCP. Cascade Controller information displayed includes:

- Pumps Status, is a read out of the status for the relays assigned to each pump. The display shows pumps that are disabled, off, running on the frequency converter or running on the mains/motor starter.
- Cascade Status, is a read out of the status for the Cascade Controller. The display shows the Cascade Controller is disabled, all pumps are running off, fixed speed pumps are being staged/de-staged and lead pump alternation is occurring.

1.1.2 Start/Stop Conditions

See 5-1* *Digital Inputs*.

Digital input commands	Variable speed pump (lead)	Fixed speed pumps (lag)
Start (SYSTEM START/STOP)	Ramps up (if stopped and there is a demand)	Staging (if stopped and there is a demand)
Lead Pump Start	Ramps up if SYSTEM START is active	Not affected
Coast (EMERGENCY STOP)	Coast to stop	Cut out (correspond relays, terminal 27/29 and 42/45)
External Interlock	Coast to stop	Cut out (built-in relays are de-energized)

Table 1.1 Commands Assigned to Digital Inputs

LCP keys	Variable speed pump (lead)	Fixed speed pumps (lag)
[Hand On]	Ramps up (if stopped by a normal stop command) or stays in operation if already running	Destaging (if running)
[Off]	Ramps down	Destaging
[Auto On]	Starts and stops according to commands via terminals or serial bus cascade controller only can work when drive in "Auto ON" mode	Staging/Destaging

Table 1.2 Function of Keys on LCP

1.1.3 Cascade Controller Parameter Detail

Parameter	Range	Default	Function
25-00 Cascade Controller	*[0] Disabled [1] Enabled	*[0] Disabled	Enable/disable the cascade controller which is used for staging multiple pumps.
25-04 Pump Cycling	*[0] Disabled [1] Enabled	*[0] Disabled	Select the method for determining the order of cutting in/out the fixed speed pumps.

Parameter	Range	Default	Function
25-05 Fixed Lead Pump	[0] No *[1] Yes	*[1] Yes	Select if the lead pump is fixed (Yes) or can be cycled (No).
25-06 Number of Pumps	2 - Expressionlimit (5)	*2	Set the total number of pumps including the variable speed pump.

Parameter	Range	Default	Function
25-20 Staging Bandwidth	1 - Expressionlimit (100) %	*10%	Set the SBW percentage to accommodate system pressure fluctuation.
	Expressionlimit (100) - 100%	*100%	Set the OBW for when to override the staging/destaging timers for immediate response.
25-22 Fixed Speed Bandwidth	Expressionlimit (1) - Expressionlimit (100) %	*Expressionlimit (10)%	Set the staging bandwidth to use when only fixed speed pumps are running.
25-23 SBW Staging Delay	0-3000 s	*15 s	Staging a pump on is delayed by the length of time programmed.
25-24 SBW Destaging Delay	0-3000 s	*15 s	Destaging a pump is delayed by the length of time programmed.
25-25 OBW Time	0-300 s	*10 s	OBW timer prevents staging a pump until the system pressure is stabilised.
25-27 Stage Function	[0] Disabled *[1] Enabled	*[1] Enabled	Enables the stage function timer.
25-28 Stage Function Time	0-300 s	*15 s	With the lead pump at maximum speed, a fixed speed pump is staged on when the programmed time expires.
25-29 Destage Function	[0] Disabled *[1] Enabled	*[1] Enabled	Enables the destage function timer.
25-30 Destage Function Time	0-300 s	*15 s	With the lead pump at minimum speed, a fixed speed pump is destaged when the programmed time expires.

Parameter	Range	Default	Function
25-42 Staging Threshold	Expressionlimit (0)-100%	*90%	The percentage [%] of maximum pump speed to stage on a fixed speed pump.
25-43 Destaging Threshold	Expressionlimit (0)-100%	*50%	The percentage [%] of maximum pump speed to destage a fixed speed pump.
25-45 Staging Speed [Hz]	0-400 Hz	*0.0 Hz	The actual staging speed based on the staging threshold.
25-47 Destaging Speed [Hz]	0-400 Hz	*0.0 Hz	The actual destaging speed based on the destaging threshold.
25-50 Lead Pump Alternation	*[0] Off [1] At staging [2] At command [3] At staging or command	*[0] Off	Changes the lead pump so all pumps run equal time.
25-51 Alternation Event	*[0] External [1] Alternation Time Interval [2] Sleep Mode	*[0] External	Choose the event that will change the lead pump.
25-52 Alternation Time Interval	1-999	*24	Set the time period between automatic alternation of the lead pump.
25-53 Alternation Timer Value			View the actual value of the Alternation Time Interval timer.
25-55 Alternate if Load <= 50%	[0] Disabled *[1] Enabled	*[1] Enabled	Choose enable to change the variable speed pump only if the pump load is less than 50%.
25-56 Staging Mode at Alternation	*[0] Slow [1] Quick	*[0] Slow	
25-57 Relays per Pump	1-2	*1	The number of relays used per pump.

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Parameter	Range	Default	Function
25-58 Run Next Pump Delay	0.1-5.0 s	*0.1 s	Time between stopping the old variable speed pump and starting the new appointed pump.
25-59 Run on Mains Delay	Expressionlimit (0.1)-5.0 s	*0.5 s	Time delay before a fixed speed pump is staged on according to normal staging sequence.
25-80 Cascade Status			View the control status for the Cascade Controller.
25-81 Pump Status	0-0	* 0	View the status for the pumps connected: X=Disabled, O=Off, D=Speed controlled, R=Mains.

Parameter	Range	Default	Function
25-84 Pump ON Time	0-2147483647	* 0	View the total operating hours of the connected pumps. Can be reset by writing 0..
25-90 Pump Interlock	*[0] Off [1] On	*[0] Off	Choose the pump to interlock for e.g. service. The pump will be taken out of any pump cycling etc.

Table 1.3

1.2 Installation

1.2.1 Control Terminals

Illustration 1.3 shows all control terminals of the frequency converter. Applying Start (terminal 18), connection between terminal 12-27 and an analog reference (terminal 53 or 54 and 55) make the frequency converter run.

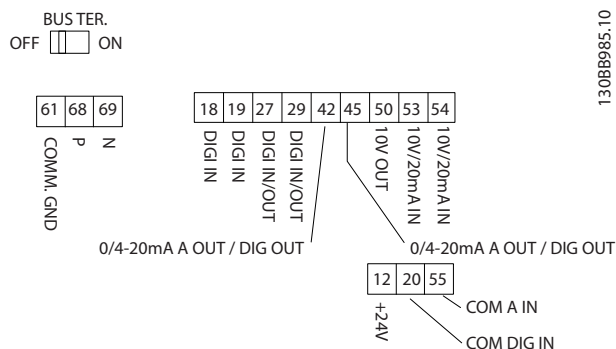


Illustration 1.3 Control Terminals

1.2.2 Electrical Overview

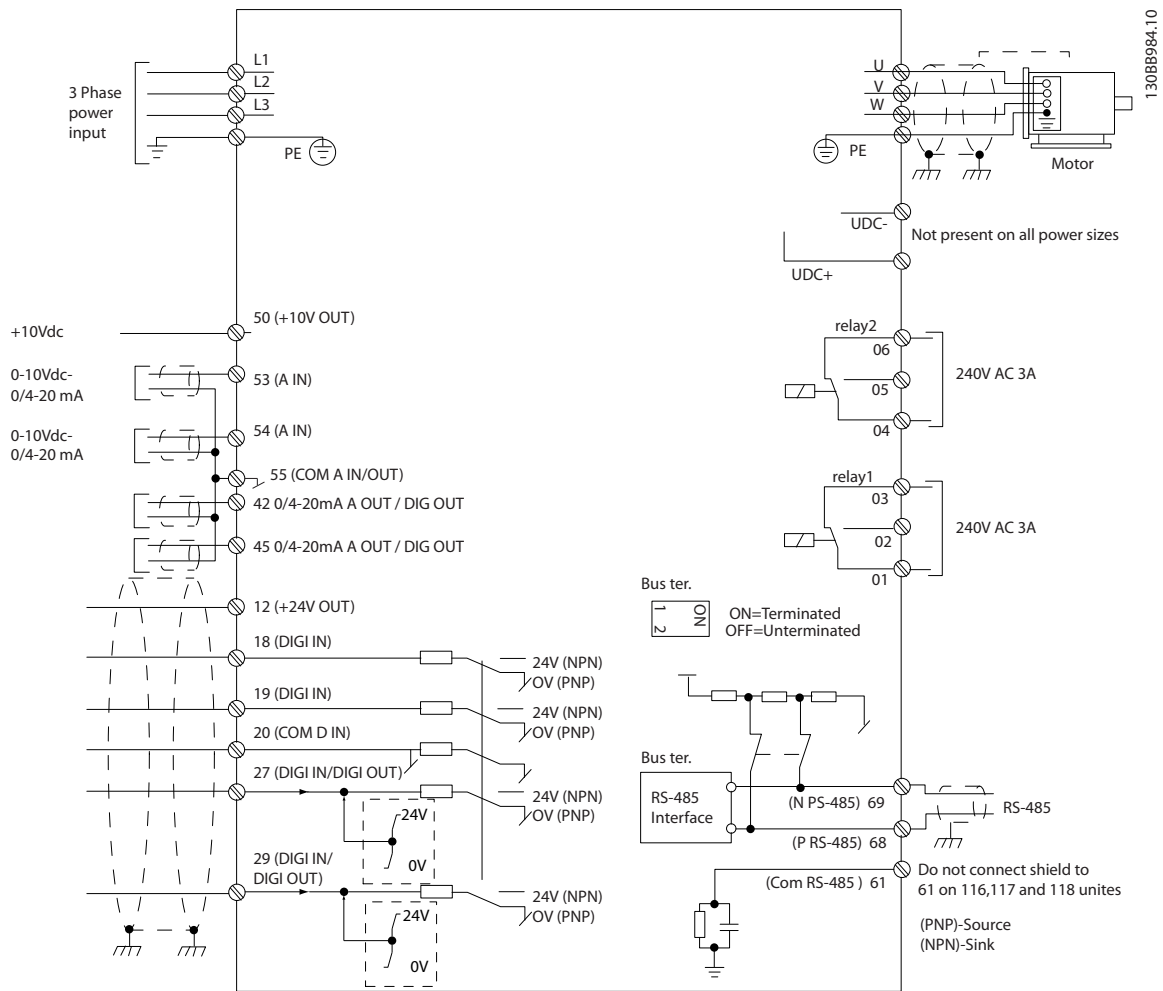


Illustration 1.4 Electrical Overview

NOTE

There is no access to UDC- and UDC+ on the following units:
 IP20 380-480 V, 30-90 kW

1.3 Specifications

1.3.1 Product General Specifications

Frequency Converter	PK37	PK75	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5	P11K
Typical shaft output [kW]	0.37	0.75	1.5	2.2	3.0	4.0	5.5	7.5	11
IP20 Frame	H1	H1	H1	H2	H2	H2	H3	H3	H4
RFI Class	A1	A1	A1	A1	A1	A1	A1	A1	A1
PCB	Coated	Coated	Coated	Coated	Coated	Coated	Coated	Coated	Coated

Table 1.4

Frequency Converter	P15K	P18K	P22K	P30K	P37K	P45K	P55K	P75K	P90K
Typical shaft output [kW]	15	18	22	30	37	45	55	75	90
IP20 Frame	H4	H5	H5	H6	H6	H6	H7	H7	H8
RFI Class	A1	A1	A1	A1	A1	A1	A1	A1	A1
PCB	Coated	Coated	Coated	Coated	Coated	Coated	Coated	Coated	Coated

Table 1.5

15-01	Running Hours	16-65	Analog Output AO42 [mA]	38-41	Name Of Analog Value 3 For BACnet
15-02	kWh Counter	16-66	Digital Output	38-42	Name Of Analog Value 5 For BACnet
15-03	Power Up's	16-67	Pulse Input #29 [Hz]	38-43	Name Of Analog Value 6 For BACnet
15-04	Over Temp's	16-71	Relay Output [bin]	38-44	Name Of Binary Value 1 For BACnet
15-05	Over Volt's	16-72	Counter A	38-45	Name Of Binary Value 2 For BACnet
15-06	Reset kWh Counter	16-73	Counter B	38-46	Name Of Binary Value 3 For BACnet
15-07	Reset Running Hours Counter	16-79	Analog Output AO45	38-47	Name Of Binary Value 4 For BACnet
15-30	Alarm Log: Error Code	16-8* Fieldbus & FC Port		38-48	Name Of Binary Value 5 For BACnet
15-31	InternalFaultReason	16-86	FC Port REF 1	38-49	Name Of Binary Value 6 For BACnet
15-4* Drive Identification		16-9* Diagnosis Readouts		38-50	Name Of Binary Value 21 For BACnet
15-40	FC Type	16-90	Alarm Word	38-51	Name Of Binary Value 22 For BACnet
15-41	Power Section	16-91	Alarm Word 2	38-52	Name Of Binary Value 33 For BACnet
15-42	Voltage	16-92	Warning Word	38-53	Bus Feedback 1 Conversion
15-43	Software Version	16-93	Warning Word 2	38-54	Run Stop Bus Control
15-44	Ordered TypeCode	16-94	Ext. Status Word	38-58	Inverter ETR counter
15-46	Drive Ordering No	16-95	Ext. Status Word 2	38-59	Rectifier ETR counter
15-47	Power Card Ordering No	18-** Info. & Readouts		38-60	DB_ErrorWarnings
15-48	LCP Id No	18-1* Fire Mode Log		38-61	Extended Alarm Word
15-49	SW ID Control Card	18-10	FireMode LogEvent	38-69	AMAL_DebugS32
15-50	SW ID Power Card	20-** Drive Closed Loop		38-74	AOCDebug0
15-51	Drive Serial Number	20-0* Feedback		38-75	AOCDebug1
15-53	Power Card Serial Number	20-00	Feedback 1 Source	38-76	AO42_FixedMode
15-9* Parameter Info		20-01	Feedback 1 Conversion	38-77	AO42_FixedValue
15-92	Defined Parameters	20-8* PI Basic Settings		38-78	DL_TestCounters
15-97	Application Type	20-81	PI Normal/ Inverse Control	38-79	Protect Func. Counter
15-98	Drive Identification	20-83	PI Start Speed [Hz]	38-80	Highest Lowest Couple
16-** Data Readouts		20-84	On Reference Bandwidth	38-81	DB_SendDebugCmd
16-0* General Status		20-9* PI Controller		38-82	MaxTaskRunningTime
16-00	Control Word	20-91	PI Anti Windup	38-83	DebugInformation
16-01	Reference [Unit]	20-93	PI Proportional Gain	38-85	DB_OptionSelector
16-02	Reference [%]	20-94	PI Integral Time	38-86	EEPROM_Address
16-03	Status Word	20-97	PI Feed Forward Factor	38-87	EEPROM_Value
16-05	Main Actual Value [%]	22-** Appl. Functions		38-88	Logger Time Remain
16-09	Custom Readout	22-4* Sleep Mode		38-90	LCP FC-Protocol select
16-1* Motor Status		22-40	Minimum Run Time	38-91	Motor Power Internal
16-10	Power [kW]	22-41	Minimum Sleep Time	38-92	Motor Voltage Internal
16-11	Power [hp]	22-43	Wake-Up Speed [Hz]	38-93	Motor Frequency Internal
16-12	Motor Voltage	22-44	Wake-Up Ref./FB Diff	38-94	Lsigma
16-13	Frequency	22-45	Setpoint Boost	38-95	DB_SimulateAlarmWarningExStatus
16-14	Motor current	22-46	Maximum Boost Time	38-96	Data Logger Password
16-15	Frequency [%]	22-47	Sleep Speed [Hz]	38-97	Data Logging Period
16-18	Motor Thermal	22-6* Broken Belt Detection		38-98	Signal to Debug
16-3* Drive Status		22-60	Broken Belt Function	38-99	Signed Debug Info
16-30	DC Link Voltage	22-61	Broken Belt Torque		
16-34	Heatsink Temp.	22-62	Broken Belt Delay		
16-35	Inverter Thermal	24-** Appl. Functions 2			
16-36	Inv. Nom. Current	24-0* Fire Mode			
16-37	Inv. Max. Current	24-00	FM Function		
16-38	SL Controller State	24-05	FM Preset Reference		
16-5* Ref. & Feeds.		24-09	FM Alarm Handling		
16-50	External Reference	24-1* Drive Bypass			
16-52	Feedback[Unit]	24-10	Drive Bypass Function		
16-6* Inputs & Outputs		24-11	Drive Bypass Delay Time		
16-60	Digital Input	25-** Cascade Controller			
16-61	Terminal 53 Setting	25-0* System Settings			
16-62	Analog Input AI53	25-00	Cascade Controller		
16-63	Terminal 54 Setting	25-04	Pump Cycling		
16-64	Analog Input AI54	25-05	Fixed Lead Pump		
		25-06	Number of Pumps		
				38-20	MOC_TestUS16
				38-21	MOC_TestS16
				38-22	TestMocFunctions
				38-24	DC Link Power Measurement
				38-25	CheckSum
				38-30	Analog Input 53 (%)
				38-31	Analog Input 54 (%)
				38-32	Input Reference 1
				38-33	Input Reference 2
				38-34	Input Reference Setting
				38-35	Feedback (%)
				38-36	Fault Code
				38-37	Control Word
				38-38	ResetCountersControl
				38-39	Active Setup For BACnet
				38-40	Name Of Analog Value 1 For BACnet



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