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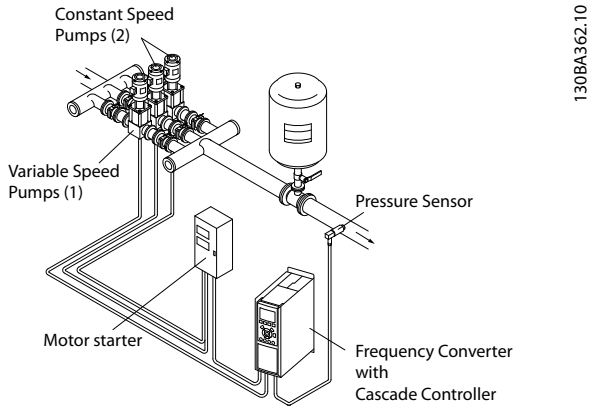
1.1 Cascade Controller



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 (DI/DO). 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 (DI/DO). 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.

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

Commands assigned to digital inputs. See *Digital Inputs*, parameter group 5-1*.

	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)

Function of buttons on LCP:

	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

1.2 Installation

1.2.1 Control Terminals

Illustration 1.1 shows all control terminals of the frequency converter. Applying Start (term. 18), connection between terminal 12-27 and an analog reference (term. 53 or 54 and 55) make the frequency converter run.

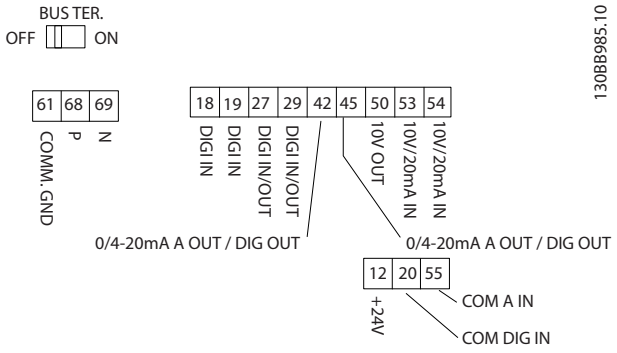


Illustration 1.1 Control Terminals

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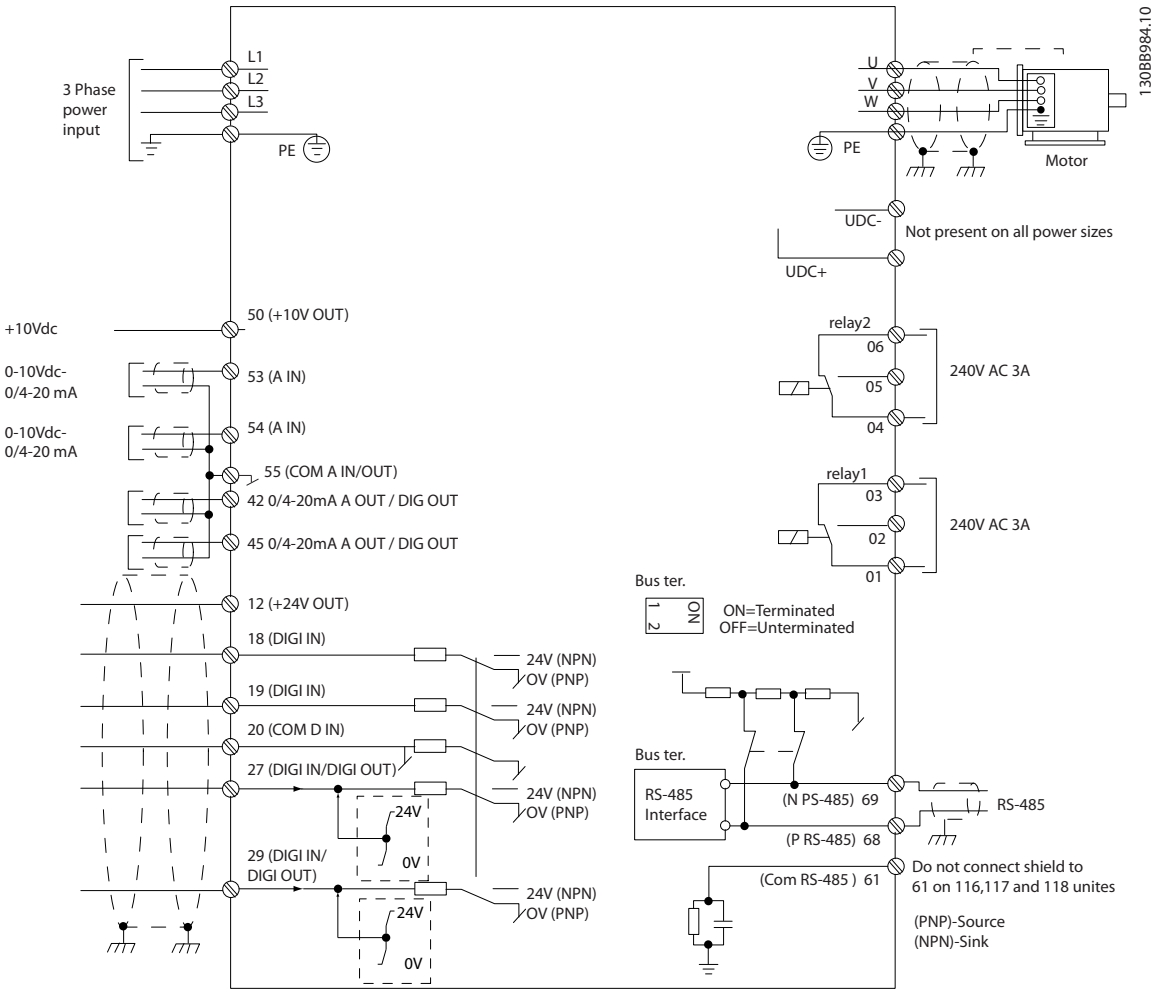
1.2.2 Electrical Overview



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
IP 20 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
Frequency Converter	**P15K**	**P18K**	**P22K**	**P30K**	**P37K**	**P45K**	**P55K**	**P75K**	**P90K**
Typical shaft output (kW)	15	18	22	30	37	45	55	75	90
IP 20 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

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1.4 Parameter Overview

Parameter Overview			
*0-** Operation / Display*	**0-11 Programming Set-up**	**0-31 Custom Readout Min Value**	[6] 0.55 kW - 0.75 Hp
0-0 Basic Settings*	[1] Set-up 1	0.00 - 1,000,000.0, * 0.00	[7] 0.75 kW - 1.00 Hp
0-01 Language	[2] Set-up 2	**0-32 Custom Readout Max Value**	[8] 1.10 kW - 1.50 Hp
*[0] English	*[9] Active Set-up	0.00 - 1,000,000.0, * 100.00	[9] 1.50 kW - 2.00 Hp
[1] Deutsch	**0-12 Link Setups**	**0-37 Display Text 1**	[10] 2.20 kW - 3.00 Hp
[2] Francais	[0] Not linked	**0-38 Display Text 2**	[11] 3.00 kW - 4.00 Hp
[3] Dansk	*[20] Linked	**0-39 Display Text 3**	[12] 3.70 kW - 5.00 Hp
[4] Espanol	*0-3* LCP Readout*	*0-4* LCP Keypad*	[13] 4.00 kW - 5.40 Hp
[5] Italiano	**0-30 Custom Readout Unit**	**0-40 [Hand on] Key on LCP**	[14] 5.50 kW - 7.50 Hp
[28] Portuguese	[0] None	[0] Disabled	[15] 7.50 kW - 10.0 Hp
[255] No Text	*[1] %	*[1] Enabled	[16] 11.00 kW - 15.00 Hp
0-03 Regional Settings	[5] PPM	**0-42 [Auto on] Key on LCP**	[17] 15.00 kW - 20 Hp
*[0] International	[10] 1/Min	[0] Disabled	[18] 18.5 kW - 25 Hp
[1] US	[11] RPM	*[1] Enabled	[19] 22 kW - 30 Hp
0-04 Operating State at Power-up	[12] Pulse/s	**0-44 [Off / Reset] Key on LCP**	[20] 30 kW - 40 Hp
	[20] l/s	[0] Disable All	[21] 37 kW-50 Hp
*[0] Resume	[21] l/min	*[1] Enable All	[22] 45 kW-60 Hp
[1] Forced stop, ref=old	[22] l/h	[7] Enable Reset Only	[23] 55 kW-75 Hp
0-06 GridType	[23] m3/s	*0-5* Copy/Save*	[24] 75 kW-100 Hp
0] 200-240 V/50 Hz/IT-grid	[24] m3/min	**0-50 LCP Copy**	[25] 90 kW-120 Hp
[1] 200-240 V/50 Hz/Delta	[25] m3/h	*[0] No copy	[26] 110 kW-150 Hp
[2] 200-240 V/50 Hz	[30] kg/s	[1] All to LCP	**1-22 Motor Voltage**
[10] 380-440 V/50 Hz/IT-grid	[31] kg/min	[2] All from LCP	50 - 1000 V
[11] 380-440 V/50 Hz/Delta	[32] kg/h	[3] Size indep. from LCP	**1-23 Motor Frequency**
[12] 380-440 V/50 Hz	[33] t/min	**0-51 Set-up Copy**	20 - 400, *(50) Hz
[20] 440-480 V/50 Hz/IT-grid	[34] t/h	*[0] No copy	**1-24 Motor Current**
[21] 440-480 V/50 Hz/Delta	[40] m/s	[1] Copy from setup 1	0.01 - (26.00), [A]
[22] 440-480 V/50 Hz	[41] m/min	[2] Copy from setup 2	**1-25 Motor Nominal Speed**
[30] 525-600 V/50 Hz/IT-grid	[45] m	[9] Copy from Factory setup	100 rpm - 6000 rpm,
[31] 525-600 V/50 Hz/Delta	[60] Degree Celsius	*0-6* Password*	**1-29 Automatic Motor Adaption ()**
[32] 525-600 V/50 Hz	[70] mbar	**0-60 Main Menu Password**	*[0] Off
[100] 200-240 V/60 Hz/IT-grid	[71] bar	0 - 999, * 0	[1] Enable Complete
[101] 200-240 V/60 Hz/Delta	[72] Pa	*1-** Load and Motor*	[2] Enable Reduced
[102] 200-240 V/60 Hz	[73] kPa	*1-0* General Settings*	*1-3* Adv. Motor Data I*
[110] 380-440 V/60 Hz/IT-grid	[74] m Wg	**1-00 Configuration Mode**	**1-30 Stator Resistance (Rs)**
[111] 380-440 V/60 Hz/Delta	[80] kW	*[0] Open loop	0.000 ohm - 99.990 ohm
[112] 380-440 V/60 Hz	[120] GPM	[3] Closed loop	**1-33 Stator Leakage Reactance (X1)**
[120] 440-480 V/60 Hz/IT-grid	[121] gal/s	**1-01 Motor Control Principle**	0.000 ohm - 999.900 ohm
[121] 440-480 V/60 Hz/Delta	[122] gal/min	[0] U/f	**1-35 Main Reactance (Xh)**
[122] 440-480 V/60 Hz	[123] gal/h	*[1] VVC+	0.00 - 999.90 ohm
[130] 525-600 V/60 Hz/IT-grid	[124] CFM	**1-03 Torque Characteristics**	**1-39 Motor Poles**
[131] 525-600 V/60 Hz/Delta	[127] ft3/h	*[1] Variable torque	2 - 100, * 4
[132] 525-600 V/60 Hz	[140] ft/s	[3] Auto Energy Optim.	*1-4* Adv. Motor Data II*
0-07 Auto DC Braking IT	[141] ft/min	**1-06 Clockwise Direction**	**1-42 Motor Cable Length**
[0] Off	[160] Degree Fahr	*[0] Normal	0 - 150, * 50m
*[1] On	[170] psi	[1] Inverse	**1-43 Motor Cable Length Feet**
0-1 Set-up Operations*	[171] lb/in2	**1-20 Motor Power**	0 - 431, * 144
0-10 Active Set-up	[172] in WG	[2] 0.12 kW - 0.16 Hp	*1-5* Load Indep. Setting*
*[1] Set-up 1	[173] ft WG	[3] 0.18 kW - 0.25 Hp	
[2] Set-up 2	[180] HP	[4] 0.25 kW - 0.33 Hp	
[9] Multi Set-up		[5] 0.37 kW - 0.50 Hp	

Parameter Overview			
1-50 Motor Magnetisation at Zero Speed	**2-04 DC Brake Cut In Speed**	**4-14 Motor Speed High Limit [Hz]**	[9] Latched start
0 - 300, * 100%	0.0 - 400.0 Hz, * 0.0	0.1 - 400 Hz, * 65.0 Hz	[10] Reversing
1-52 Min Speed Normal Magnetising [Hz]	***2-1* Brake Energy Funct.***	**4-18 Current Limit**	[11] Start reversing
0.0 - 10.0, * 0.0	**2-17 Over-voltage Control**	0 - 300%, * 110	[14] Jog
1-55 U/f Characteristic - U	[0] Disabled	**4-19 Max Output Frequency**	[16] Preset ref bit 0
0 - 999 V, *0V	*[2] Enabled	0.0 - 400.0 Hz, * 65.0	[17] Preset ref bit 1
1-56 U/f Characteristic - F	***3-** Reference / Ramps***	***4-4* Adj. Warnings 2***	[18] Preset ref bit 2
0 - 400 Hz, *(0)	***3-0* Reference Limits***	4-40 Warning Freq. Low	[19] Freeze reference
1-6* Load Depend. Setting	**3-02 Minimum Reference**	0.0-400.0 Hz, *400.0	[20] Freeze output
1-62 Slip Compensation	(-4999.000) - 4999.000, * 0.000	4-41 Warning Freq. High	[21] Speed up
-400 - 399%, * 0%	**3-03 Maximum Reference**	0.0-400.0 Hz, *400.0	[22] Speed down
1-63 Slip Compensation Time Constant	(-4999.000) - 4999.000, * 50.000	***4-5* Adj. Warnings***	[23] Set-up select bit 0
0.05 - 5.00 s, * 0.10	***3-1* References***	**4-50 Warning Current Low**	[34] Ramp bit 0
1-64 Resonance Dampening	**3-10 Preset Reference**	0.00 - 194.00 A, * 0.00	[37] Fire mode
0 - 500%, * 100	-100.00 - 100.00 %, * 0.00	**4-51 Warning Current High**	[52] Run permissive
1-65 Resonance Dampening Time Constant	**3-11 Jog Speed [Hz]**	0.00 - 194.00 A, * 194.00	[53] Hand Start
0.001 - 0.050 s, * 0.005	0.0 - 400.0 Hz, * 5.0	**4-54 Warning Reference Low**	[54] Auto start
1-7* Start Adjustments	**3-14 Preset Relative Reference**	-4999.000 - 4999.000, *-4999.000	[60] Counter A (up)
1-71 Start Delay	-100.00 - 100.00, * 0.00	**4-55 Warning Reference High**	[61] Counter A (down)
0.0 - 10.0 s, * 0.0	**3-15 Reference Resource 1**	-4999.000 - 4999.000, *4999.000	[62] Reset Counter A
1-72 Start Function	[0] No function	**4-56 Warning Feedback Low**	[63] Counter B (up)
[0] DC Hold/delay time	*[1] Analog in 53	-4999.000 - 4999.000, *-4999.000	[64] Counter B (down)
*[2] Coast/delay time	[2] Analog in 54	**4-57 Warning Feedback High**	[65] Reset Counter B
1-73 Flying Start	[11] Local bus reference	-4999.000 - 4999.000, *4999.000	[120] Lead Pump Start
*[0] Disabled	**3-16 Reference 2 Resource**	**4-58 Missing Motor Phase Function**	[121] Lead Pump Alternation
[1] Enabled	[0] No function	[0] Off	[130] Pump 1 Interlock
1-8* Stop Adjustments	[1] Analog in 53	*[1] On	[131] Pump 2 Interlock
1-80 Function at Stop	*[2] Analog in 54	**4-6* Speed Bypass**	[132] Pump 3 Interlock
*[0] Coast	[11] Local bus reference	**4-61 Bypass Speed From [Hz]**	[133] Pump 4 Interlock
[1] DC hold/MotorPreheat	**3-17 Reference 3 Resource**	0.0 - 400.0, * 0.0	[134] Pump 5 Interlock
1-82 Min Speed for Function at Stop [Hz]	[0] No function	**4-63 Bypass Speed To [Hz]**	**5-11 Terminal 19 Digital Input**
0.0 - 20.0 Hz, * 0.0	[1] Analog in 53	0.0 - 400.0, * 0.0	See par. 5-10, *[0] No operation
1-9* Motor Temperature	[2] Analog in 54	**4-64 Semi-Auto Bypass Set-up**	**5-12 Terminal 27 Digital Input**
1-90 Motor Thermal Protection	*[11] Local bus reference	*[0] Off	See par. 5-10, *[2] Coast inverse
*[0] No protection	***3-4* Ramp 1***	[1] Enable	**5-13 Terminal 29 Digital Input**
[1] Thermistor warning	**3-41 Ramp 1 Ramp up Time**	***5-3* Digital Outputs***	See par. 5-10, *[14 Jog]
[2] Thermistor trip	0.05 - 3600.00 s, *Size related	***5-** Digital In/Out***	**5-34 On Delay, Digital Output**
[3] ETR warning 1	**3-42 Ramp 1 Ramp Down Time**	***5-0* Digital I/O mode***	0.00 - 600.00 s, *0.01 s
[4] ETR trip 1	0.05 - 3600.00 s, *Size related	**5-00 Digital Input Mode**	**5-35 Off Delay, Digital Output**
1-93 Thermistor Resource	***3-5* Ramp 2***	*[0] PNP	0.00 - 600.00 s, *0.01 s
*[0] None	**3-51 Ramp 2 Ramp up Time**	[1] NPN	***5-4* Relays***
[1] Analog input 53	0.05 - 3600.00 s, *Size related	**5-03 Digital Input 29 Mode**	**5-40 Function Relay**
[6] Digital input 29	**3-52 Ramp 2 Ramp down Time**	*[0] PNP	*[0] No operation
2-** Brakes	0.05 - 3600.00 s, *Size related	[1] NPN	[1] Control ready
2-0* DC-Brake	***3-8* Other Ramps***	***5-1* Digital Inputs***	[2] Drive ready
2-00 DC Hold/Motor Preheat Current	**3-80 Jog Ramp Time**	**5-10 Terminal 18 Digital Input**	[3] Drive ready/remote control
0 - 160%, * 50	0.05 - 3600.00 s, *Size related	[0] No operation	[4] Enable / no warning
2-01 DC Brake Current	**3-81 Quick Stop Ramp Time**	[1] Reset	[5] VLT running
0 - 150%, * 50	0.05 - 3600.00 s, *Size related	[2] Coast inverse	[6] Running / no warning
2-02 DC Braking Time	***4-** Limits / Warnings***	[3] Coast and reset inverse	[7] Run in range/no warning
0.0 - 60.0 s, * 10.0	***4-1* Motor Limits***	[4] Quick stop inverse	[8] Run on ref/no warning
	4-10 Motor Speed Direction	[5] DC-brake inverse	[9] Alarm
	[0] Clockwise	[6] Stop inverse	[10] Alarm or warning
	*[2] Both directions	[7] External Interlock	[12] Out of current range
	4-12 Motor Speed Low Limit [Hz]	*[8] Start	[13] Below current, low
	0.0 - 400 Hz, * 0.0 Hz		

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Parameter Overview			
[14] Above current, high	0 - 0xFFFFFFFF, * 0	*6-7* Analog Output 45*	[167] Start command activ
[16] Below frequency, low	*6-** Analog In/Out*	**6-70 Terminal 45 Mode**	[168] Drive in hand mode
[17] Above frequency, high	*6-0* Analog I/O Mode*	*[0] 0-20 mA	[169] Drive in auto mode
[19] Below feedback, low	**6-00 Live Zero Timeout Time**	[1] 4-20 mA	[193] Sleep Mode
[20] Above feedback, high	1 - 99s, * 10	[2] Digital Output	[194] Broken Belt Function
[21] Thermal warning	**6-01 Live Zero Timeout Function**	**6-71 Terminal 45 Analog Output**	[196] Fire Mode
[22] Ready, no thermal warning	*[0] Off	*[0] No operation	[198] Bypass Mode
[23] Remote, ready, no thermal	[1] Freeze output	[100] Output frequency	[200] Full capacity
warning	[2] Stop	[101] Reference	[201] Pump 1 running
[24] Ready, Voltage OK	[3] Jogging	[102] Feedback	[202] Pump 2 running
[25] Reverse	[4] Max. speed	[103] Motor current	[203] Pump 3 running
[26] Bus OK	[5] Stop and trip	[106] Power	[204] Pump 4 running
[35] External Interlock	*6-1* Analog Input 53*	[139] Bus Control	[205] Pump 5 running
[36] Control word bit 11	**6-10 Terminal 53 Low Voltage**	**6-72 Terminal 45 Digital Output**	[211] Cascade Pump 1
[37] Control word bit 12	0.00 - 10.00 V, * 0.07	*[0] No operation	[212] Cascade Pump 2
[45] Bus Control	**6-11 Terminal 53 High Voltage**	[1] Control ready	[213] Cascade Pump 3
[60] Comparator 0	0.00 - 10.00 V, * 10.00	[2] Drive ready	[214] Cascade Pump 4
[61] Comparator 1	**6-12 Terminal 53 Low Current**	[3] Drive ready/remote control	[215] Cascade Pump 5
[62] Comparator 2	0.00 - 20.00, * 4.00 mA	[4] Standby / no warning	**6-73 Terminal 45 Output Min**
[63] Comparator 3	**6-13 Terminal 53 High Current**	[5] Drive running	**Scale**
[64] Comparator 4	0.00 - 20.00, * 20.00 mA	[6] Running / no warning	0.00 - 200.00%, * 0.00
[65] Comparator 5	**6-14 Terminal 53 Low Ref./Feedb.**	[7] Run in range/no warning	**6-74 Terminal 45 Output Max**
[70] Logic rule 0	**Value**	[8] Run on ref/no warning	**Scale**
71] Logic rule 1	-4999.000 - 4999.000, * 0.000	[9] Alarm	0.00 - 200.00%, * 100.00
[72] Logic rule 2	**6-15 Terminal 53 High Ref./**	[10] Alarm or warning	**6-76 Terminal 45 Output Bus**
[73] Logic rule 3	**Feedb. Value**	[12] Out of current range	**Control**
[74] Logic rule 4	-4999.000 - 4999.000, * 50.000	[13] Below current, low	0.00 - 100.00%, * 0.00
[75] Logic rule 5	**6-16 Terminal 53 Filter Time**	[14] Above current, high	*6-9* Analog Output 42*
[80] SL digital output A	**Constant**	[21] Thermal warning	**6-90 Terminal 42 Mode**
[81] SL digital output B	0.01 - 10.00 s, * 0.01	[22] Ready, no thermal warning	*[0] 0-20 mA
[82] SL digital output C	**6-19 Terminal 53 mode**	[23] Remote, ready, no thermal	[1] 4-20 mA
[83] SL digital output D	[0] Current mode	warning	[2] Digital Output
[160] No alarm	*[1] Voltage mode	[24] Ready, Voltage OK	**6-91 Terminal 42 Analog Output**
[161] Running reverse	*6-2* Analog Input 54*	[25] Reverse	*[0] No operation
[165] Local ref. active	**6-20 Terminal 54 Low Voltage**	[26] Bus OK	[100] Output frequency
[166] Remote ref. active	0.00 - 10.00V, * 0.07	[35] External Interlock	[101] Reference
[167] Start command activ	**6-21 Terminal 54 High Voltage**	[45] Bus Control	[102] Feedback
[168] Drive in hand mode	0.00 - 10.00V, * 10.00	[60] Comparator 0	[103] Motor current
[169] Drive in auto mode	**6-22 Terminal 54 Low Current**	[61] Comparator 1	[105] TorquereltoRated
[193] Sleep Mode	0.00 - 20.00, * 4.00mA	[62] Comparator 2	[106] Power
[194] Broken Belt Function	**6-23 Terminal 54 High Current**	[63] Comparator 3	[139] Bus Control
[196] Fire Mode	0.00 - 20.00, * 20.00mA	[64] Comparator 4	**6-92 Terminal 42 Digital Output**
[198] Drive Bypass	**6-24 Terminal 54 Low Ref./Feedb.**	[65] Comparator 5	*[0] No operation
[211] Cascade Pump 1	**Value**	[70] Logic rule 0	[1] Control ready
[212] Cascade Pump 2	-4999.000 - 4999.000, * 0.000	[71] Logic rule 1	[2] Drive ready
[213] Cascade Pump 3	**6-25 Terminal 54 High Ref./**	[72] Logic rule 2	[3] Drive ready/remote control
[214] Cascade Pump 4	**Feedb. Value**	[73] Logic rule 3	[4] Enable / no warning
[215] Cascade Pump 5**5-41 On**	-4999.000 - 4999.000, * 50.000	[74] Logic rule 4	[5] Drive running
Delay, Relay	**6-26 Terminal 54 Filter Time**	[75] Logic rule 5	[6] Running / no warning
0.00 - 600.00 s, *0.01 s	**Constant**	[80] SL digital output A	[7] Run in range/no warning
5-42 Off Delay, Relay	0.01 - 10.00, * 0.01	[81] SL digital output B	[8] Run on ref/no warning
0.00 - 600.00 s, *0.01 s	**6-29 Terminal 54 mode [0]**	[82] SL digital output C	[9] Alarm
5-5 Pulse Input*	**Current mode**	[83] SL digital output D	[10] Alarm or warning
5-9 Bus Controlled*	[0] Current mode	[160] No alarm	[12] Out of current range
5-90 Digital and Relay Bus	*[1] Voltage mode	[161] Running reverse	[13] Below current, low
Control		[165] Local ref. active	[14] Above current, high
		[166] Remote ref. active	[21] Thermal warning

Parameter Overview			
[22] Ready, no thermal warning	*[0] Digital and ctrl.word	[1] Bus	***8-9* Bus Feedback***
[23] Remote, ready, no thermal	[1] Digital only	[2] Logic AND	***8-94 Bus feedback 1***
warning	[2] Controlword only	*[3] Logic OR	-32768 - 32767, * 0
[24] Ready, Voltage OK	**8-02 Control Source**	**8-52 DC Brake Select**	***13-** Smart Logic***
[25] Reverse	[0] None	[0] Digital input	***13-0* SLC Settings***
[26] Bus OK	*[1] FC Port	[1] Bus	**13-00 SL Controller Mode**
[35] External Interlock	**8-03 Control Timeout Time**	[2] Logic AND	*[0] Off
[45] Bus Control	0.1 - 6500.0s, * 1.0	*[3] Logic OR	[1] On
[60] Comparator 0	**8-04 Control Timeout Function**	**8-53 Start Select**	**13-01 Start Event**
[61] Comparator 1	*[0] Off	[0] Digital input	[0] False
[62] Comparator 2	[1] Freeze output	[1] Bus	[1] True
[63] Comparator 3	[2] Stop	[2] Logic AND	[2] Running
[64] Comparator 4	[3] Jogging	*[3] Logic OR	[3] In range
[65] Comparator 5	[4] Max. speed	**8-54 Reversing Select**	[4] On reference
[70] Logic rule 0	[5] Stop and trip	[0] Digital input	[7] Out of current range
[71] Logic rule 1	[20] N2 Override Release	[1] Bus	[8] Below I_{low}
[72] Logic rule 2	**8-06 Reset Control Word Timeout**	[2] Logic AND	[9] Above I_{high}
[73] Logic rule 3	*[0] No function	*[3] Logic OR	[16] Thermal warning
[74] Logic rule 4	[1] Do reset	**8-55 Set-up Select**	[17] Mains out of range
[75] Logic rule 5	**8-3* FC Port Settings**	[0] Digital input	[18] Reversing
[80] SL digital output A	**8-30 Protocol**	[1] Bus	[19] Warning
[81] SL digital output B	*[0] FC	[2] Logic AND	[20] Alarm (trip)
[82] SL digital output C	[2] Modbus RTU	*[3] Logic OR	[21] Alarm (trip lock)
[83] SL digital output D	[3] Metasys N2	**8-56 Preset Reference Select**	[22] Comparator 0
[160] No alarm	[4] FLN	[0] Digital input	[23] Comparator 1
[161] Running reverse	[5] BACNet	[1] Bus	[24] Comparator 2
[165] Local ref. active	**8-31 Address**	[2] Logic AND	[25] Comparator 3
[166] Remote ref. active	1 - 247 , * 1	*[3] Logic OR	[26] Logic rule 0
[167] Start command activ	**8-32 FC Port Baud Rate**	***8-7* Bacnet***	[27] Logic rule 1
[168] Drive in hand mode	[0] 2400 Baud	**8-70 BACnet Device Instance**	[28] Logic rule 2
[169] Drive in auto mode	[1] 4800 Baud	0 - 0x400000UL	[29] Logic rule 3
[193] Sleep Mode	*[2] 9600 Baud	* 1	[33] Digital input 18
[194] Broken Belt Function	[3] 19200 Baud	**8-72 MS/TP Maxmaster**	[34] Digital input 19
[196] Fire Mode	[4] 38400 Baud	0 - 127, * 127	[35] Digital input 27
[198] Drive Bypass	[5] 57600 Baud	**8-73 MS/TP Max Info Frames**	[36] Digital input 29
[200] Full capacity	[6] 76800 Baud	1 - 65534, * 1	*[39] Start command
[201] Pump 1 running	[7] 115200 Baud	**8-74 "I am" Service**	[40] Drive stopped
[202] Pump 2 running	**8-33 FC Port Parity**	*[0] Send at power-up	[41] Reset trip
[203] Pump 3 running	*[0] Even Parity, 1 Stop Bit	[1] Continuously	[42] Auto reset trip
[204] Pump 4 running	[1] Odd Parity, 1 Stop Bit	**8-75 Intialisation Password**	[43] Key Ok
[205] Pump 5 running	[2] No Parity, 1 Stop Bit	***8-8* FC Port Diagnostics***	[44] Key Reset
[211] Cascade Pump 1	[3] No Parity, 2 Stop Bits	**8-80 Bus Message Count**	[47] Key Up
[212] Cascade Pump 2	**8-35 Minimum Response Delay**	0 - 65536, * 0	[48] Key Down
[213] Cascade Pump 3	0.001 - 0.500s, * 0.010	**8-81 Bus Error Count**	[50] Comparator 4
[214] Cascade Pump 4	**8-36 Max Response Delay**	0 - 65536, * 0	[51] Comparator 5
[215] Cascade Pump 5	0.100 - 10.000s, *5.000	**8-82 Slave Message Rcvd**	[60] Logic rule 4
6-93 Terminal 42 Output Min Scale	**8-37 Max Inter-char delay**	0 - 65536, * 0	[83] Broken belt
0.00 - 200.00%, * 0.00	0.025 - 0.025s, * 0.025	**8-83 Slave Error Count**	**13-02 Stop Event**
6-94 Terminal 42 Output Max Scale	***8-5* Digital/Bus***	0 - 65536, * 0	See par. 13-02, *[40] Drive stopped
0.00 - 200.00%, * 100.00	**8-50 Coasting Select**	**8-84 Slave Message Sent**	**13-03 Reset SLC**
6-96 Terminal 42 Output Bus	[0] Digital input	0 - 65536, * 0	*[0] Do not reset
Control	[1] Bus	**8-85 Slave Timeout Errors**	[1] Reset SLC
0.00 - 100.00%, * 0.00	[2] Logic AND	0 - 65536, * 0	***13-1* Comparators***
8-** Comm. and Options	*[3] Logic OR	**8-88 Reset FC port Diagnostics**	**13-10 Comparator Operand**
8-0* Comm. General Settings	**8-51 Quick Stop Select**	*[0] Do not reset	*[0] Disabled
8-01 Control Site	[0] Digital input	[1] Reset counter	[1] Reference

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Parameter Overview			
[2] Feedback	[19] Select ramp 2	[1] Automatic reset x 1	**15-00 Operating Hours**
[3] Motor speed	[22] Run	[2] Automatic reset x 2	0 - 2147483647, * 0
[4] Motor current	[23] Run reverse	[3] Automatic reset x 3	**15-01 Running Hours**
[6] Motor power	[24] Stop	[4] Automatic reset x 4	0 - 2147483647, * 0
[7] Motor voltage	[25] Qstop	[5] Automatic reset x 5	**15-02 kWh Counter**
[8] DC-link voltage	[26] DC Brake	[6] Automatic reset x 6	0 - 65535, * 0
[12] Analog in 53	[27] Coast	[7] Automatic reset x 7	**15-03 Power Up's**
[13] Analog in 54	[28] Freeze output	[8] Automatic reset x 8	0 - 2147483647, * 0
[20] Alarm number	[29] Start timer 0	[9] Automatic reset x 9	**15-04 Over Temp's**
[30] Counter A	[30] Start timer 1	[10] Automatic reset x 10	0 - 65535, * 0
[31] Counter B	[31] Start timer 2	[11] Automatic reset x 15	**15-05 Over Volt's**
13-11 Comparator Operator	[32] Set digital out A low	[12] Automatic reset x 20	0 - 65535, * 0
[0] Less Than	[33] Set digital out B low	[13] Infinite auto reset	**15-06 Reset kWh Counter**
*[1] Approx. Equal	[34] Set digital out C low	**14-21 Automatic Restart Time**	*[0] Do not reset
[2] GreaterThan	[35] Set digital out D low	0 - 600s, * 10	[1] Reset counter
13-12 Comparator Value	[38] Set digital out A high	**14-22 Operation Mode**	**15-07 Reset Running Hours Counter**
-9999.0 - 9999.0, * 0.0	[39] Set digital out B high	*[0] Normal operation	*[0] Do not reset
13-2* Timers	[40] Set digital out C high	[2] Initialisation	[1] Reset counter
13-20 SL Controller Timer	[41] Set digital out D high	**14-27 Action At Inverter Fault**	***15-3* Fault Log***
0.00 - 3600.00, * 0.00	[60] Reset Counter A	[0] Off	***15-30 Fault Log:***
13-4* Logic Rules	[61] Reset Counter B	*[1] On	Error Code 0 - 255, * 0
13-40 Logic Rule Boolean 1	[70] Start timer 3	**14-28 Production Settings**	***15-4* Drive Identification***
See par. 13-01, *[0] False	[71] Start timer 4	*[0] No action	**15-40 FC Type**
13-41 Logic Rule Operator 1	[72] Start timer 5	[1] Service reset	**15-41 Power Section**
*[0] Disabled	[73] Start timer 6	[3] Software Reset	**15-42 Voltage**
[1] AND	[74] Start timer 7	**14-29 Service Code**	**15-43 Software Version**
[2] OR	[100] Reset Alarm	0 - 0x7FFFFFFF, * 0	**15-44 OrderedTypeCode**
[3] AND NOT	***14-** Special Functions***	***14-3* Current Limit Ctrl.***	**15-46 Frequency Converter**
[4] OR NOT	***14-0* Inverter Switching***	***14-4* Energy Optimising***	Ordering No
[5] NOT AND	**14-01 Switching Frequency**	**14-40 VT Level**	**15-47 Power Card Ordering No**
[6] NOT OR	[0] Ran3	40 - 90%, * 90%	**15-48 LCP Id No**
[7] NOT AND NOT	[1] Ran5	**14-41 AEO Minimum Magnetisation**	**15-49 Software ID Control Card**
[8] NOT OR NOT	[2] 2.0 kHz	40 - 75%, * 66	**15-50 Software ID Power Card**
13-42 Logic Rule Boolean 2	[3] 3.0 kHz	***14-5* Environment***	**15-51 Frequency Converter Serial**
See par. 13-01, *[0] False	[4] 4.0 kHz	**14-50 RFI Filter**	**Number**
13-43 Logic Rule Operator 2	[5] 5.0 kHz	[0] Off	**15-53 Power Card Serial Number**
See par. 13-41, *[0] Disabled	[6] 6.0 kHz	*[1] On	***16-** Data Readouts***
13-44 Logic Rule Boolean 3	[7] 8.0 kHz	**14-51 DC-link Voltage Compen-**	***16-0* General Status***
See par. 13-01, *[0] False	[8] 10.0 kHz	**sation**	**16-00 Control Word**
13-5* States	[9] 12.0kHz	[0] Off	0 - 65535, * 0
13-51 SL Controller Event	[10] 16.0kHz	*[1] On	**16-01 Reference [Unit]**
See par. 13-01, *[0] False	**14-03 Overmodulation**	**14-52 Fan Control**	-4999.000 - 4999.000, * 0.000
13-52 SL Controller Action	[0] Off	*[0] Auto	**16-02 Reference**
*[0] Disabled	*[1] On	[4] Auto Low temp env	% -200.0 - 200.0, * 0.0
[1] No action	**14-08 Damping Gain Factor**	**14-53 Fan Monitor**	**16-03 Status Word**
[2] Select set-up 1	0 - 100-%, * 96	[0] Disabled	0 - 65535, * 0
[3] Select set-up 2	***14-1* Mains on/off***	*[1] Warning	**16-05 Main Actual Value [%]**
[10] Select preset ref 0	**14-12 Function at Mains**	[2] Trip	-200.00 - 200.00, * 0.00
[11] Select preset ref 1	**Imbalance**	**14-55 Output Filter**	**16-09 Custom Readout**
[12] Select preset ref 2	*[0] Trip	*[0] No Filter	0.00 - 9999.00, * 0.00
[13] Select preset ref 3	[1] Warning	[1] Sine-Wave Filter	***16-1* Motor Status***
[14] Select preset ref 4	[2] Disabled	[3] Sine-Wave Filter with Feedback	***16-10 Power [kW]***
[15] Select preset ref 5	[3] Derate	**14-63 Min Switch Frequency**	0.000-4.294, 967.500, *0.000
[16] Select preset ref 6	***14-2* Reset Functions***	1 - 16kHz, * 1	***16-11 Power [hp]***
[17] Select preset ref 7	**14-20 Reset Mode**	***15-** Drive Information***	0.000 - 2.294, 967.500 *0.000
[18] Select ramp 1	*[0] Manual reset	***15-0* Operating Data***	***16-3* Drive Status***

Parameter Overview			
16-30 DC Link Voltage	**16-72 Counter A**	**20-01 Feedback 1 Conversion**	**22-45 Setpoint Boost**
0 - 65535, * 0	-32768 - 32767, * 0	*[0] Linear	-100 - 100%, * 0
16-34 Heatsink Temp.	**16-73 Counter B**	[1] Square root	**22-46 Maximum Boost Time**
0 - 255, * 0	-32768 - 32767, * 0	***20-8* PI Basic Setting***	0 - 600 s, * 60
16-35 Inverter Thermal	**16-79 Analog output 45**	**20-81 Process PI Normal/ Inverse Control**	**22-47 Sleep Speed [Hz]**
0 - 255%, * 0	20 - 20mA, * 0	*[0] Normal	0.0 - 400.0, * 0.0
16-36 Inv. Nom. Current	***16-8* Fieldbus / FC Port***	[1] Inverse	***22-6* Broken Belt Detection***
0.00 - 655.35, * 0.00	**16-86 FC Port REF 1**	**20-83 Process PI Start Speed[Hz]**	**22-60 Broken Belt Detection**
16-37 Inv. Max. Current	-32768 - 32767, * 0	0.0 - 200.0, * 0.0	*[0] Off
0.00 - 655.35	***16-9* Diagnosis Readouts***	**20-84 On Reference Bandwidth**	[1] Warning
16-38 SL Controller State	**16-90 Alarm Word**	0 - 200%, * 5	[2] Trip
0 - 255, * 0	0 - 0xFFFFFFFFUL, * 0	***20-9* PI Controller***	**22-61 Broken Belt Torque**
16-5* Ref. and Feedb.	**16-91 Alarm Word 2**	**20-91 PI Anti Windup**	5 - 100%, * 10
16-50 External Reference	0 - 0xFFFFFFFFUL, * 0	[0] Off	**22-62 Broken Belt Delay**
-200.0 - 200.0%, * 0.0	**16-92 Warning Word**	*[1] On	0 - 600 s, * 10
16-52 Feedback	0 - 0x7FFFFFFFUL, * 0	**20-93 PI Proportional Gain**	***24-** Appl. functions 2***
-4999.000 - 4999.000, * 0.000	**16-93 Warning Word 2**	0.00 - 10.00, * 0.01	***24-0* Fire mode***
16-6* Inputs and Outputs	0 - 0x7FFFFFFFUL, * 0	**20-94 PI Integral Time**	**24-00 Fire Mode Function**
16-60 Digital input	**16-94 Ext. Status Word**	0.10 - 9999.00s, * 9999.00	*[0] Disabled
0 - 65535, * 0	0 - 0x7FFFFFFFUL, * 0	**20-97 Process PI Feed Forward Factor**	[1] Enabled Run Forward
16-61 Terminal 53 Setting	**16-95 Ext. Status Word 2**	0 - 400%, * 0	[2] Enabled Run Reverse
*[0] Current mode	0 - 0x7FFFFFFFUL, * 0	***22-** Appl. functions***	[3] Enable-Coast
[1] Voltage mode	**18-**Extended Motor Data**	***22-4* Sleep mode***	[4] Enabled - Run Fwd/Rev
16-62 Analog Input 53	**18-1* Firemode Log**	**22-40 Minimum Run Time**	**24-05 Fire Mode Preset Reference**
0.00 - 10.00, * 1.00	**18-10 Firemode log: Event**	0 - 600 s, * 10	-100 - 100%, * 0
16-63 Terminal 54 Setting	0-255, *0	**22-41 Minimum Sleep Time**	**24-09 Fire Mode Alarm Handling**
*[0] Current mode	***20-** FC Closed Loop***	0 - 600 s, * 10	*[1] Trip, Critical Alarms
[1] Voltage mode	***20-0* Feedback***	**22-43 Wake-Up Speed [Hz]**	[2] Trip, All Alarms/Test
16-64 Analog Input 54	**20-00 Feedback 1 Source**	0.0 - 400.0, * 100.0	***24-1* Drive Bypass***
0.00 - 20.00, * 1.00	*[0] No function	**22-44 Wake-Up Ref./FB difference**	**24-10 Drive Bypass Function**
16-65 Analog Output 42 [mA]	[1] Analog in 53	0 - 100%, * 10	*[0] Disabled
0.00 - 20.00, * 0.00	[2] Analog in 54		[2] Enabled (Fire Mode only)
16-61 Digital Output	[100] Bus Feedback 1		**24-11 Bypass Delay Timer**
			0 - 600 s, * 0