Contents

1 Introduction

1.1 Safety and Caution

1.1.1 Safety

Rotating shafts and electrical equipment can be hazardous. Therefore, it is strongly recommended that all electrical work conform to National Electrical Code (NEC) and all local regulations. Installation, start-up and maintenance should be performed only by qualified personnel.

Factory recommended procedures, included in this manual, should be followed. Always disconnect electrical power before working on the unit. Although shaft couplings or belt drives are generally not furnished by the manufacturer, rotating shafts, couplings and belts must be protected with securely mounted metal guards that are of sufficient thickness to provide protection against flying particles such as keys, bolts and coupling parts. Even when the motor is stopped, it should be considered “alive” as long as its controller is energized. Automatic circuits may start the motor at any time. Keep hands away from the output shaft until the motor has completely stopped and power is disconnected from the controller.
Motor control equipment and electronic controls are connected to hazardous line voltages. When servicing drives and electronic controls, there will be exposed components at or above line potential. Extreme care should be taken to protect against shock. Stand on an insulating pad and make it a habit to use only one hand when checking components. Always work with another person in case of an emergency. Disconnect power whenever possible to check controls or to perform maintenance. Be sure equipment is properly grounded. Wear safety glasses whenever working on electric control or rotating equipment.

Safety Guidelines

1. The drive must be disconnected from the AC line before any service work is done.
2. The “Stop/Off” key on the LCP of the drive does not disconnect the equipment from the AC line and is not to be used as a safety switch.
3. Correct protective grounding of the equipment must be established. The user must be protected against supply voltage and the motor must be protected against overload in accordance with applicable national and local regulations.
4. Ground currents are higher than 3 mA.

Warning against Unintended Start

1. While the drive is connected to the AC line, the motor can be brought to a stop by means of external switch closures, serial bus commands or references. If personal safety considerations make it necessary to ensure that no unintended start occurs, these stops are not sufficient.
2. During programming of parameters, the motor may start. Be certain that no one is in the area of the motor or driven equipment when changing parameters.
3. A motor that has been stopped may start unexpectedly if faults occur in the electronics of the drive, or if an overload, a fault in the supply AC line or a fault in the motor connection or other fault clears.
4. If the “Local/Hand” key is activated, the motor can only be brought to a stop by means of the “Stop/Off” key or an external safety interlock

NB!
It is responsibility of user or person installing drive to provide proper grounding and branch circuit protection for incoming power and motor overload according to National Electrical Code (NEC) and local codes.

The Electronic Thermal Relay (ETR) in UL listed VLTs provides Class 20 motor overload protection in accordance with NEC in single motor applications, when par. 1-90 *Motor Thermal Protection* is set for ETR TRIP 1, ETR TRIP 2, ETR TRIP 3, or ETR TRIP 4, and par. 1-24 *Motor Current* is set for rated motor (nameplate) current.

The frequency converter DC link capacitors remain charged after power has been disconnected. To avoid an electrical shock hazard, disconnect the frequency converter from the mains before carrying out maintenance. Wait at least as follows before doing service on the frequency converter:

1

Voltage (V)	Min. Waiting Time (Minutes)				
	4	15	20	30	40
200 - 240	1.1 - 3.7 kW	5.5 - 45 kW			
380 - 480	1.1 - 7.5 kW	11 - 90 kW	110 - 250 kW		315 - 1000 kW
525-600	1.1 - 7.5 kW	11 - 90 kW			
525-690		11 - 90 kW	45 - 400 kW	450 - 1400 kW	

Be aware that there may be high voltage on the DC link even when the LEDs are turned off.

1.3.1 Introduction

The Siemens Floor Level Network (FLN) is a master/ slave control network for serial communication with various control devices. The FLN controller is RS-485 compatible, half duplex, with an operating rate of 4800 or 9600 baud. Recommended wiring is shielded, twisted pair. The FLN software protocol is designed to be general in nature to accommodate any unique properties of each device type. The node address system allows up to 96 devices to be used on any one system.

The Danfoss VLT is a programmable frequency converter, which controls the operation of 3-phase, standard induction electrical motors in the HVAC industry. The VLT control card has FLN communication protocol software built-in. The drive uses optical isolation for fault tolerance and noise immunity.

The FLN communicates directly with the VLT via the RS-485 serial interface bus. In addition to being able to control the drive, most drive configuration and control parameters can be reviewed and changed through the FLN. Also, the operational status of the drive can be read and monitored through the bus. Diagnostic and operational information stored in the VLT is easily available, such as kWh of energy used, total operation hours, drive status, motor speed, and many other useful items which can be accessed and monitored through the FLN.

The FLN is designed to communicate with any controller node that supports the interfaces defined in this document.

1.3.2 About this Manual

The documentation in this manual provides comprehensive information on the connection, programming, and startup of the VLT for use with the FLN. It is intended as both an instruction and reference manual. Functions and features of the VLT are also briefly reviewed to serve as a guideline to optimize your communication system. Read this manual before programming since important information is provided in each section. For detailed information on using the VLT, see the Operating Instructions.

1.3.3 Assumptions

This manual assumes that the controller node supports the interfaces in this document and that all the requirements and limitations stipulated in the controller node and the VLT are strictly observed. It is assumed that the user understands the general capabilities and limitation of the controller node and the VLT.

1.3.4 Available literature for VLT HVAC Drive

- Operating Instructions MG.11.Ax.yy provide the necessary information for getting the frequency converter up and running.
- Operating Instructions VLT HVAC Drive High Power, MG.11.Fx.yy
- Design Guide MG.11.Bx.yy entails all technical information about the frequency converter and customer design and applications.
- Programming Guide MG.11.Cx.yy provides information on how to programme and includes complete parameter descriptions.
- Mounting Instruction, Analog I/O Option MCB109, MI.38.Bx.yy
- Application Note, Temperature Derating Guide, MN.11.Ax.yy
- PC-based Configuration Tool MCT 10, MG.10.Ax.yy enables the user to configure the frequency converter from a Windows™ based PC environment.

- Danfoss VLT® Energy Box software at *www.danfoss.com/BusinessAreas/DrivesSolutions* then choose PC Software Download
- VLT® VLT HVAC Drive Drive Applications, MG.11.Tx.yy
- Operating Instructions VLT HVAC Drive Profibus, MG.33.Cx.yy.
- Operating Instructions VLT HVAC Drive Device Net, MG.33.Dx.yy
- Operating Instructions VLT HVAC Drive BACnet, MG.11.Dx.yy
- Operating Instructions VLT HVAC Drive LonWorks, MG.11.Ex.yy
- Operating Instructions VLT HVAC Drive Metasys, MG.11.Gx.yy
- Operating Instructions VLT HVAC Drive FLN, MG.11.Zx.yy
- Output Filter Design Guide, MG.90.Nx.yy
- Brake Resistor Design Guide, MG.90.Ox.yy

x = Revision number

yy = Language code

Danfoss technical literature is available in print from your local Danfoss Sales Office or online at:
www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/Technical+Documentation.htm

1.3.5 Abbreviations and standards

Abbreviations:	Terms:	SI-units:	I-P units:
a	Acceleration	m/s^2	ft/s^2
AWG	American wire gauge		
Auto Tune	Automatic Motor Tuning		
°C	Celsius		
I	Current	A	Amp
I_{LIM}	Current limit		
Joule	Energy	J = N•m	ft-lb, Btu
°F	Fahrenheit		
FC	Frequency Converter		
f	Frequency	Hz	Hz
kHz	Kilohertz	kHz	kHz
LCP	Local Control Panel		
mA	Milliampere		
ms	Millisecond		
min	Minute		
MCT	Motion Control Tool		
M-TYPE	Motor Type Dependent		
Nm	Newton Metres		in-lbs
$I_{M,N}$	Nominal motor current		
$f_{M,N}$	Nominal motor frequency		
$P_{M,N}$	Nominal motor power		
$U_{M,N}$	Nominal motor voltage		
par.	Parameter		
PELV	Protective Extra Low Voltage		
Watt	Power	W	Btu/hr, hp
Pascal	Pressure	$Pa = N/m^2$	psi, psf, ft of water
I_{INV}	Rated Inverter Output Current		
RPM	Revolutions Per Minute		
SR	Size Related		
T	Temperature	C	F
t	Time	s	s,hr
T_{LIM}	Torque limit		
U	Voltage	V	V

Table 1.1: Abbreviation and standards table .

1.3.6 HP / kW conversion

A conversion index for determining kW and HP ratings is shown below.

1

kW	HP	kW	HP
0.25	0.33	45	60
0.37	0.5	55	75
0.55	0.75	75	100
0.75	1.0	90	125
1.1	1.5	110	150
1.5	2.0	132	175
2.2	3.0	160	200
3.0	4.0	200	300
4.0	5.0	250	350
5.5	7.5	315	350
7.5	10	355	450
11	15	400	500
15	20	450	600
18.5	25		
22	30		
30	40		
37	50		

2 VLT Functional Features

The FLN protocol built into the VLT frequency converter allows programming of numerous features and monitoring of the drive via the serial bus and the standard RS-485 port. The VLT also has the capability to control closed or open loop systems on its own and has been designed specifically for HVAC applications. Always accessible in real-time are the system status, what the motor and drive are doing, and if there are any problems. The VLT continuously monitors all aspects of motor and drive status and issues alarms or warnings for adverse conditions. The FLN interacts with the drive based upon a point map database and the selected interface strategy. Many, but not all, drive features are accessible through the point map. See the *Operating Instructions* for more drive details. Table *Point Mapping* lists the map points and Table *Point database definitions* supplies definitions. Below is a review of some frequently used drive features and the associated point map numbers.

2.1.1 Drive Operation (03-14)

These points provide the FLN with operational status information such as output frequency, motor current, output voltage, power and energy. The run time in hours that power has been supplied to the motor is also stored for display, along with cumulative energy used in kWh.

2.1.2 Motor and Drive Thermal Protection (15, 16, 18)

The motor and drive are protected against thermal overload. The percentage of thermal load is displayed. Point 18 indicates if either the motor or drive thermal limit has been exceeded.

2.1.3 Set-up 1-4 and Day/Night operation (17, 29)

In the FLN system it is not recommended to operate in multible set-up. The drive should remain in Set-up 1 at all times.

The drive is capable of maintaining four independent program set-ups. Each set-up supports independent point map configurations. Seasonal changes, various acceleration or deceleration rates, or other operation modes can be accommodated. Point 17 indicates which setup is active. The set-up change is programmed through the drive's keypad or digital I/Os. Day/night operation is implemented in the point map (29).

2.1.4 Current Monitoring and Limits (19)

The maximum current that the drive provides to the motor can be limited. This tends to limit the torque that can be produced by the motor. Data point 19 indicates if the motor is operating at that current limit.

2.1.5 Direction of Rotation (22)

The drive responds to serial commands to reverse direction of the motor. The drive can safely reverse motor rotation while in operation. Many applications benefit from this ability, such as vane axial fans reversed for smoke extraction or cooling towers for deicing. par. 8-54 *Reversing Select*, must be set to serial communication for point 22 to command the feature.

2.1.6 Start/Stop (23)

To run the drive from the FLN or in Auto mode from the drive's digital control terminals, a start command must be given at data point 23. When a stop command is given at this point, the drive will only run in Hand mode.

2.1.7 Ramp Select (24)

Datapoint 24 selects the active ramp.

2.1.8 Freeze Mode (25, 26)

If desired, the frequency of the drive can be frozen at its present value. The mode is indicated by data point 25. It is an option available when serial interface is lost.

2.1.9 Coast (27, 28)

The coast command (28) shuts down the inverter and makes the motor freewheeling, which normally brings it to stand still. The drive cannot be restarted in any mode before the coast command is removed. It is, therefore, often used as a safety interlock. Data point 27 indicates when the drive is coasted.

2.1.10 Motor Ramp-up and Ramp-down Rate (31, 32)

The time to accelerate or decelerate the drive between 0 Hz and the motor's nominal frequency can be programmed. The drive is capable of settings between one to 3600 seconds (one hour). Only Ramp1 is accessible from the FLN network.

2.1.11 Hand/Auto Modes (34)

The *SEL HND.AUTO* shows which mode the drive is in. The drive can be commanded into either *Hand* or *Auto* mode by pressing the respective keys on the keypad of the drive. Hand mode disables any programmed control strategies and allows the drive keypad to be used to set the drive speed. The only serial communication command that can override Hand mode is data point 28, *CMD COAST*.

2.1.12 CMD RUN STOP (35)

Set data point 35 to *ON* to run the drive from the FLN with default drive parameter settings. In the *OFF* mode, the drive will run only in Hand mode or in Auto mode from the drive's digital control terminals. par. 8-53 *Start Select*, controls the interaction of point 35 and the digital run command.

2.1.13 Bus Functions (36, 37)

The amount of time the drive will wait between communication packets is programmable. If the time is exceeded, the drive will assume serial communication has stopped and respond with programmable choices. The drive can ignore the loss, freeze its current output, stop, run at a predetermined jog frequency, run at maximum output frequency or stop and trip while issuing an alarm. Wait time is selected at point 36 and the function after a timeout at point 37. See descriptions for par. 8-03 *Control Timeout Time* and par. 8-04 *Control Timeout Function* in the *VLT HVAC Drive Programming Guide*.

2.1.14 Jog Frequency and Command (38, 39)

The Jog Frequency can be set by data point 38. Setting data point 39 to [On] will cause the frequency converter to send the Jog Frequency to the motor.

2.1.15 Relay Out 1, 2 (40, 41, 43, 44)

Two programmable relay outputs (Form C, 240 VAC, 2 Amp) are available. These can be triggered through the serial bus by command points 40 and 41. This allows the FLN to utilize the drive's built-in relays as additional network programmable relays. The data points 43 and 44 indicate whether the relay is triggered or not (On/Off). Parameters 5-40.0 and 5-40.1, *Function Relay 1* and *Function Relay 2*, must be set to [45] Bus controlled, [46] Bus controlled 1, if timeout or [47] Bus controlled 0, if timeout.

2.1.16 PID Control Functions (61-65)

The VLT has a sophisticated built-in proportional, integral, derivative (PID) controller. The PID controller is activated by setting par. 1-00 *Configuration Mode*, to Closed loop through the drive's keypad.

The PID controller in the VLT supports two feedback values and two setpoints. The feedback can be received in the form of network bus signals and/or standard 0-10 V transmitters. The 2 set-point controller is capable of controlling return fans based on a fixed differential flow, secondary pumping systems, and so on. This can be used to supplement the BMS system to save on points or capacity. For details on use of the two feedback/setpoint feature, refer to the *Operating Instructions*. Data points 43 and 44 show the status of an FLN command to the drive.

The points PI GAIN and PI TIME are gain parameters similar to the P and I gains in the FLN TECs. The Danfoss PI loop is structured differently than the Siemens loop, so there is not a one-to-one correspondence between the gains. The following formulas allow translation between Danfoss and Siemens gains.

Converting from Danfoss PI gains to Siemens P and I gains:

$$P\ Gain_{SIEMENS} = PI\ Gain_{DANFOSS} \times 0.0015$$

$$I\ Gain_{SIEMENS} = \frac{PI\ Gain_{DANFOSS}}{PI\ Time_{DANFOSS}} \times 0.0015$$

Converting from Siemens P and I gains to Danfoss PI gains:

$$PI\ Gain_{DANFOSS} = P\ Gain_{SIEMENS} \times 667$$

$$PI\ Time_{DANFOSS} = \frac{P\ Gain_{SIEMENS}}{I\ Gain_{SIEMENS}} \times 667$$

2.1.17 Sleep Mode (59)

Sleep mode automatically stops the drive when demand is low over a period of time. When the system demand increases, the drive restarts the motor to reach the desired output. *Sleep mode* has great energy savings potential and saves wear and tear on equipment. Unlike a setback timer, the drive is always available to run when a preset “wakeup” demand is reached. See parameter group 22-4* Sleep Mode and 22-2* No-Flow Detection in the *VLT HVAC Drive Programming Guide* for more detail.

2.1.18 Terminals 53, 54, (87-88)

Two analog voltage/current input terminals 53 and 54 (0-10 VDC)/(0-20 mA) are provided for reference or feedback signals. The applied electrical signal can be read by data points 87 to 88 in volts and mA. This can be very useful during commissioning to calibrate transmitters. This can also be used to convert any other analog transmitter in the installation into a digital bus signal, even if the signal is not used by the drive. In this case, the input terminal should be programmed to *No Function* so it does not influence the operation of the drive.

2.1.19 Warnings and Alarms (90-94)

The drive displays a warning or tripped by a fault condition. It also can retrieve the last warning or fault trip for display. The drive can be reset through the FLN serial bus to resume normal drive operation.

2.1.20 Error Status (99)

Data point 99 is implemented in the point map but is not used in this application.

3

3 VLT Network Strategies

The VLT has its own internal PID closed loop controller. This can be turned on or off, depending on the requirements of the control strategy. A brief summary of possibilities follows. This is meant to illustrate possibilities rather than be all-inclusive. An actual application may combine features from a more than one of these strategies.

3.1.1 Strategy one

FLN Function – Monitor drive operation

FC Control – From a conventional, hardwired system

FC Mode – Open Loop.

The VLT follows hard-wired run/stop signals. An external, hard-wired PID controller provides the drive with a speed reference signal. The FLN monitors the operation of the drive without control function.

Network Inputs to the VLT:
Because the FLN is simply monitoring the operation of the drive, it provides no inputs.

Network Outputs from the VLT:
The following points are monitored by the FLN to indicate system status. This list could be expanded or shortened, depending on the requirements of the system.

03 FREQ OUTPUT

08 POWER 10 KWH

23 STOP.RUN

92 ALARM

3.1.2 Strategy two

FLN Function – Control all aspects of frequency converter operation

FC Control – From FLN network

FC Mode – Open Loop

The frequency converter follows run/stop and speed reference signals from the FLN. The FLN receives the feedback signal from the controlled system, compares this to a set-point value, and uses its own PID control loop to determine the required drive speed.

Network Inputs to the frequency converter:
The following drive points might be controlled by the FLN.

Speed Command:

53 CMD REF	This is the speed reference command. This is set as a percentage of the drive's reference range, determined by par. 3-02 *Minimum Reference* and par. 3-03 *Maximum Reference*. Setting point 53 to 0 gives the drive a reference command equal to the value stored in par. 3-03 *Maximum Reference*. Setting point 53 to 16384 gives the drive a reference command equal to the value stored in par. 3-03 *Maximum Reference*. Intermediate values for point 53 change the reference linearly between these two values.

NB!
In general, any other reference signal is added to the bus reference. Disable all other drive reference inputs when using a bus reference to control drive speed.

Start/Stop Command:
To give a start command from the FLN, the following points must be set. The frequency converter can also respond to discrete run/stop control signals that are hard wired to its control terminals. The point used to stop the frequency converter through the FLN determines the capability of these discrete command signals.

28 CMD COAST	In most cases, it is necessary to set this point to [NO] to make the drive run. If this is set to [COAST] while the VLT is running, the drive will shut off immediately and the motor will coast to a stop. When set to [COAST], the lower right corner of the drive display shows Coast. The drive will not start in either HAND mode or through discrete control signals until point 28 is set to [NO]. VLT par. 8-50 *Coasting Select*, can defeat this. See the *VLT HVAC Drive Operating Instructions* for details. Because point 28 can keep the drive from operating in any mode, this is commonly used to provide a safety interlock function.
35 RUN ENABLE	In most cases, it is necessary to set this point [ON] to make the drive run. If this is set to [OFF] while the drive is running, the drive will decelerate to a stop. When set to [OFF], the lower right corner of the display shows STAND BY. When OFF, the drive can be started in HAND mode from the keypad. It can also be started using a hard-wired discrete run command, as when par. 8-53 *Start Select*, is set to digital input.

Network Outputs from the VLT:
The points listed in Strategy One are commonly used.

3.1.3 Strategy three

FLN Function – Monitor frequency converter operation

FC Control – From a hard-wired system, including system feedback

FC Mode – Closed Loop

The frequency converter follows hard-wired run/stop signals. It uses its internal PID controller to control motor speed. The feedback signal is hard wired to the analog input and the set-point is programmed into the drive. The FLN is used to monitor the status of the FC and the value of the PID controller set-point and feedback.

Network Inputs to the frequency converter:
Because the FLN is simply monitoring the operation of the frequency converter, it provides no inputs.

Network Outputs from the frequency converter:
In addition to the points listed in Strategy One, it may be useful to monitor the following points related to the operation of the PID controller.

Feedback:

53 CMD REF	This is the set-point for the PID controller. Please consult the VLT HVAC Drive Design Guide for further information on how to set up the PID controller.
65 FEEDBACK	This is the value of the feedback signal in % for the PID controller.

3.1.4 Strategy four

FLN Function – Provide the frequency converter with set-point and feedback values using the PID controller to determine motor speed

FC Control – From the FLN

FC Mode – Closed Loop

The frequency converter follows run/stop signals from the FLN. The FLN receives the feedback signal from the controlled system. It sends this and the desired set-point to the PID controller. The frequency converter compares the feedback signal with the set-point and adjusts the speed of the FC accordingly.

Network inputs to the frequency converter:

In addition to start/stop control, which was discussed in Strategy Two, the FLN provides the frequency converter with feedback and set-point information using the following points.

Feedback:

69 BUS FBK 1	A value of -163.83 % represents the minimum feedback signal. A value of +163.83 % represents the maximum feedback signal. This should be the feedback used if only one feedback signal is supplied to the frequency converter.

NB!

If the frequency converter terminal 53 is programmed by means of par. 20-00 *Feedback 1 Source*, for feedback, any signal applied to terminal 54 is added to value provided at point 53 CMD REF. Therefore, it is generally advisable not to program par. 20-00 *Feedback 1 Source* for feedback.

Example:

In a cooling tower application, the feed-back signal comes from a temperature sensor with a range of 40 °F to 140 °F. To unbundle BUS FBK 2 (point 70) for the temperature sensor:

1. Set par. 20-13 *Minimum Reference/Feedb.* to 40.
2. Set par. 20-14 *Maximum Reference/Feedb.* to 140.
3. Intercept = 40 (since the minimum feedback value is 40)
4. Slope can be calculated as follows:

$$Slope = \frac{(Desired\ Range) \times (Slope\ of\ Existing\ Point)}{Range\ of\ Existing\ Point} = \frac{(140 - 40) \times 0.1}{16383} = 0.00061$$

Set-point:

66 SET-POINT 1	This is the PID controller's set-point, expressed in the units that were chosen in par. 20-02 *Feedback 1 Source Unit*. It can be set to any value between par. 3-02 *Minimum Reference* and par. 3-03 *Maximum Reference*. If an attempt is made to set point 69 to a value outside of this range, the set-point will not be changed. SET-POINT 1 can also be programmed using par. 20-21 *Setpoint 1*.
67 SET-POINT 2	This PID controller's set-point is used for applications, where multible feedback signals will be compared to independent set-points. Refer to the *VLT HVAC Drive Design Guide* for more details. SET-POINT 2 is expressed in the units selected in par. 3-03 *Maximum Reference*. If an attempt is made to assign point 70 to a value outside of this range, the set-point will not change. Set-point 2 can also be programmed using par. 20-22 *Setpoint 2*.

PID Controller Adjustments:

The following points adjust the operation of the PID control loop. They are generally set during start-up and only adjusted if changes in the system require it. These values can also be set using parameters. See the *VLT HVAC Drive Programming Guide* for more details.

61 PI START FREQ (par. 20-83 *PID Start Speed [Hz]*)	This sets the frequency to which the FC will accelerate following a start command. After it reaches this frequency, the frequency converter will activate its PID controller. Point 61 can have a value between the drive's minimum frequency (as set in par. 4-12 *Motor Speed Low Limit [Hz]*) and its maximum frequency (as set in par. 4-13 *Motor Speed High Limit [RPM]*). If an attempt is made to set point 61 to a value outside of this range, the drive value will not change.
63 PI GAIN (par. 20-93 *PID Proportional Gain*)	This sets the value of proportional gain for the PID controller. It can have a value between 0 and 10.

Network Outputs from the VLT:

The points listed in Strategy One are commonly used.

4

4 VLT Special Functions

4.1.1 Special functions

In addition to the control strategies described above, the frequency converter provides additional control flexibility to allow it to integrate into special control system requirements. The following are just a few examples.

4.1.2 Analog input monitoring

Points 87 and 88 can be used to monitor the value of the analog control signals applied to terminals 53 and 54. These points are active even when NO FUNCTION is programmed for the analog input of the drive. As a result, it is possible to use the frequency converter analog inputs as analog input for the FLN.

4.1.3 Drive relay control

While relay 1 and 2 in the FC usually provide drive status indications, these indications are generally not needed, when the drive is connected to a FLN network. In some applications, it can be useful to have the FLN control these relays. For example, by controlling one of the relays, the FLN could select the active pump in a pump sequencing system. For the FLN to control a drive relay, the appropriate FC parameter (5-40.0 or 5-40.1) must be set to [Bus Control]. Setting point 40 or 41 to [On] will then activate the corresponding relay.

5

5 Network Connection

5.1.1 Network connection

Connect the frequency converter to the RS-485 network as follows (see also diagram):

1. Connect signal wires to terminal 68 (P+) and terminal 69 (N-) on the main control board of the frequency converter.
2. Connect the cable screen to the cable clamps.

NB!
Screened, twisted-pair cables are recommended in order to reduce noise between conductors.

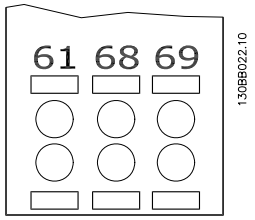

Illustration 5.1: Network Terminal Connection

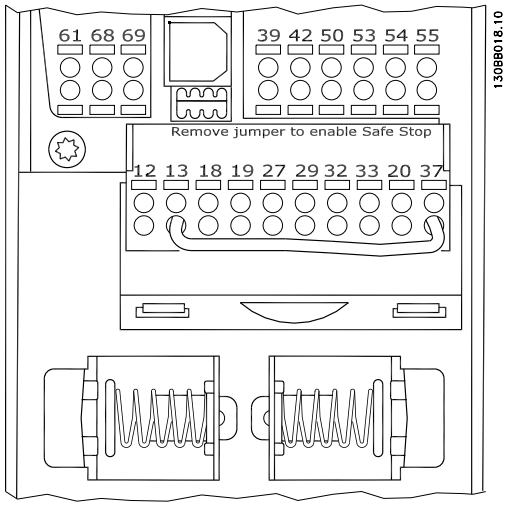

Illustration 5.2: Control card terminals

5.1.2 Frequency converter hardware setup

Use the terminator dip switch on the main control board of the frequency converter to terminate the RS-485 bus.

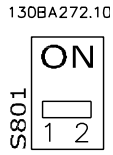

Illustration 5.3: Terminator Switch Factory Setting

The factory setting for the dip switch is OFF.

5.1.3 Electrical installation

NB!
Electrical installation: Please see VLT HVAC Drive Operating Instructions, MG.11.Ax.yy.
x=version ; yy=language code.

6

6 Parameters

6.1.1 Parameter settings

The frequency converter has a unique FLN address, which is transmitted over the RS-485 serial bus. The network will recognize the FC, which may then be programmed for setup options. The parameters listed in the table below need to be set for each FC on the FLN network. FLN communication related parameters can only be set by using the LCP.

NB!
As a minimum, it is required to set par. 8-30 *Protocol* to FLN; par. 8-31 *Address*, to the proper address and par. 8-32 *Baud Rate* to the proper baud rate. (See *VLT HVAC Drive Programming Guide*).

Par. 8-50 *Coasting Select* through par. 8-56 *Preset Reference Select* are options that select control of the drive through the digital and/or the FLN serial port.

Parameter	Default	Desired setting
*par. 8-03 *Control Timeout Time*	0	
*par. 8-04 *Control Timeout Function*	0ff	
*par. 8-30 *Protocol*	FC	FLN
*par. 8-31 *Address*	1 through 98	
*par. 8-32 *Baud Rate*	9600	4800 or 9600
**par. 8-50 *Coasting Select*	Logic or	
**par. 8-52 *DC Brake Select*	Logic or	
**par. 8-53 *Start Select*	Logic or	
**par. 8-54 *Reversing Select*	Digital input	
**par. 8-55 *Set-up Select*	Logic or	
**par. 8-56 *Preset Reference Select*	Logic or	

Table 6.1: Frequency converter parameter settings

* Minimum parameters, which must be set to operate the frequency converter via the FLN serial interface.

** When [Digital input] or [Logic or] is selected, digital inputs may interfere with serial bus commands. The setting [Serial communication] allows serial bus commands to be carried out only. See the *VLT HVAC Drive Programming Guide* for detailed descriptions.

NB!
The frequency converter can store preset references programmed in parameters 3-10.0 through 3-10.7, *Preset Reference (1-8)*. To avoid these values modifying serial bus references, set par. 3-04 *Reference Function* to [External/Preset]. See *VLT HVAC Drive Programming Guide* for detailed descriptions.

7

7 Start-up and Troubleshooting

7.1 Start-up

7.1.1 Start-up of FLN control

This procedure assumes that the frequency converter has been installed properly and is operational in Hand control mode. It also assumes the Siemens FLN data bus is connected to an operational controller. Start the FC in accordance with the following procedure.

1. Ensure that the assumptions in this procedure are correct.
2. Check that the network connections are securely fastened in accordance with Figure *Network Terminal Connection*

Verify compliance with all safety requirements listed in this manual.

3. Apply power to the frequency converter.
4. Ensure that the minimum settings listed in Table 6.1 Frequency converter parameter settings are selected.
5. Ensure that the switch positions in Illustration 5.3 Terminator Switch Factory Setting are set correctly.
6. Optional settings may be changed to meet or enhance frequency converter operation, depending on the application requirements.
7. For FLN control of the drive, press the AUTO START key on the LCP. FC operation can then be controlled through the host network device in accordance with its operation instructions.

NB!
Default setting for point number 35, *CMD RUN STOP*, is [OFF]. Drive will not operate until *Run Enable* [ON] signal is given through serial communication network.

7.2 Troubleshooting

7.2.1 Faults, warnings and alarms

A stopped motor may start unexpectedly if faults occur in electronics of drive, or if an active fault clears, such as a fault in supply AC line, fault in motor connection or overload.

The frequency converter output faults, warnings and alarms on the FLN serial bus in a numerical code. The code numbers are described in Table *Faults, Warnings and Alarms Description*. The Reset key is used for manually resetting the drive after an alarm (fault trip). In this case, the top line of the display will show TRIP (RESET). If the top line of the display shows TRIP (AUTO START), the drive will automatically restart. If the top line of the display shows TRIPLOCK (DISC. MAINS), input power to the drive must be cycled off and on again before the trip can be reset.

Refer to the *VLT HVAC Drive Operating Instructions* for detailed descriptions.

7.2.2 Alarms and warnings

A warning or an alarm is signalled by the relevant LED on the front of the frequency converter and indicated by a code on the display.

A warning remains active until its cause is no longer present. Under certain circumstances operation of the motor may still be continued. Warning messages may be critical, but are not necessarily so.

In the event of an alarm, the frequency converter will have tripped. Alarms must be reset to restart operation once their cause has been rectified. This may be done in four ways:

1. By using the [RESET] control button on the LCP control panel.
2. Via a digital input with the “Reset” function.
3. Via serial communication/optional fieldbus.
4. By resetting automatically using the [Auto Reset] function, which is a default setting for frequency converter. see par. 14-20 *Reset Mode* in VLT HVAC Drive Programming Guide, *MG.11.Cx.yy*

NB!
After a manual reset using the [RESET] button on the LCP, the [AUTO ON] button must be pressed to restart the motor.

If an alarm cannot be reset, the reason may be that its cause has not been rectified, or the alarm is trip-locked (see also table on following page).

Alarms that are trip-locked offer additional protection, means that the mains supply must be switched off before the alarm can be reset. After being switched back on, the frequency converter is no longer blocked and may be reset as described above once the cause has been rectified.

Alarms that are not trip-locked can also be reset using the automatic reset function in par. 14-20 *Reset Mode* (Warning: automatic wake-up is possible!)

If a warning and alarm is marked against a code in the table on the following page, this means that either a warning occurs before an alarm, or it can be specified whether it is a warning or an alarm that is to be displayed for a given fault.

This is possible, for instance, in par. 1-90 *Motor Thermal Protection*. After an alarm or trip, the motor carries on coasting, and the alarm and warning flash on the frequency converter. Once the problem has been rectified, only the alarm continues flashing.

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
1	10 Volts low	X			
2	Live zero error	(X)	(X)		par. 6-01 *Live Zero Time-out Function*
3	No motor	(X)			par. 1-80 *Function at Stop*
4	Mains phase loss	(X)	(X)	(X)	par. 14-12 *Function at Mains Imbalance*
5	DC link voltage high	X			
6	DC link voltage low	X			
7	DC over voltage	X	X		
8	DC under voltage	X	X		
9	Inverter overloaded	X	X		
10	Motor ETR over temperature	(X)	(X)		par. 1-90 *Motor Thermal Protection*
11	Motor thermistor over temperature	(X)	(X)		par. 1-90 *Motor Thermal Protection*
12	Torque limit	X	X		
13	Over Current	X	X	X	
14	Earth fault	X	X	X	
15	Incomp. HW		X	X	
16	Short Circuit		X	X	
17	Control word timeout	(X)	(X)		par. 8-04 *Control Time-out Function*
23	Internal fans				
24	External fans				
25	Brake resistor short-circuited	X			
26	Brake resistor power limit	(X)	(X)		par. 2-13 *Brake Power Monitoring*
27	Brake chopper short-circuited	X	X		
28	Brake check	(X)	(X)		par. 2-15 *Brake Check*
29	Power board over temp	X	X	X	
30	Motor phase U missing	(X)	(X)	(X)	par. 4-58 *Missing Motor Phase Function*
31	Motor phase V missing	(X)	(X)	(X)	par. 4-58 *Missing Motor Phase Function*
32	Motor phase W missing	(X)	(X)	(X)	par. 4-58 *Missing Motor Phase Function*
33	Inrush fault		X	X	
34	Fieldbus communication fault	X	X		
35	Option fault		X		
36	Mains failure				
38	Internal fault		X	X	
40	Overload T27				
41	Overload T29				
42	Overload X30/6-7				
47	24 V supply low	X	X	X	
48	1.8 V supply low		X	X	
49	Speed limit				
50	AMA calibration failed		X		
51	AMA check U_{nom} and I_{nom}		X		
52	AMA low I_{nom}		X		
53	AMA motor too big		X		
54	AMA motor too small		X		
55	AMA parameter out of range		X		
56	AMA interrupted by user		X		
57	AMA timeout		X		
58	AMA internal fault	X	X		
59	Current limit	X			
60	External interlock				
62	Output Frequency at Maximum Limit	X			
65	Control Board Over-temperature	X	X	X	
66	Heat sink Temperature Low	X			
67	Option Configuration has Changed		X		
68	Safe Stop Activated		X		
70	Illegal FC configuration				
80	Drive Initialised to Default Value		X		
92	No-Flow	X	X		Par. 22-2*
93	Dry Pump	X	X		Par. 22-2*
94	End of Curve	X	X		Par. 22-5*
95	Broken Belt	X	X		Par. 22-6*
96	Start Delayed	X			Par. 22-7*
97	Stop Delayed	X			Par. 22-7*
98	Clock Fault	X			Par. 0-7*

Table 7.1: Alarm/Warning code list

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
200	Fire Mode	X			Par. 24-0*
201	Fire Mode was Active	X			Par. 0-7*
202	Fire Mode Limits Exceeded	X			Par. 0-7*
250	New spare part				
251	New type code				

Table 7.2: Alarm/Warning code list, continued..

(X) Dependent on parameter

LED indication

Warning	yellow
Alarm	flashing red
Trip locked	yellow and red

Alarm Word and Extended Status Word

Bit	Hex	Dec	Alarm Word	Warning Word	Extended Status Word
0	00000001	1	Brake Check	Brake Check	Ramping
1	00000002	2	Pwr. Card Temp	Pwr. Card Temp	AMA Running
2	00000004	4	Earth Fault	Earth Fault	Start CW/CCW
3	00000008	8	Ctrl.Card Temp	Ctrl.Card Temp	Slow Down
4	00000010	16	Ctrl. Word TO	Ctrl. Word TO	Catch Up
5	00000020	32	Over Current	Over Current	Feedback High
6	00000040	64	Torque Limit	Torque Limit	Feedback Low
7	00000080	128	Motor Th Over	Motor Th Over	Output Current High
8	00000100	256	Motor ETR Over	Motor ETR Over	Output Current Low
9	00000200	512	Inverter Overld.	Inverter Overld.	Output Freq High
10	00000400	1024	DC under Volt	DC under Volt	Output Freq Low
11	00000800	2048	DC over Volt	DC over Volt	Brake Check OK
12	00001000	4096	Short Circuit	DC Voltage Low	Braking Max
13	00002000	8192	Inrush Fault	DC Voltage High	Braking
14	00004000	16384	Mains ph. Loss	Mains ph. Loss	Out of Speed Range
15	00008000	32768	AMA Not OK	No Motor	OVC Active
16	00010000	65536	Live Zero Error	Live Zero Error	
17	00020000	131072	Internal Fault	10V Low	
18	00040000	262144	Brake Overload	Brake Overload	
19	00080000	524288	U phase Loss	Brake Resistor	
20	00100000	1048576	V phase Loss	Brake IGBT	
21	00200000	2097152	W phase Loss	Speed Limit	
22	00400000	4194304	Fieldbus Fault	Fieldbus Fault	
23	00800000	8388608	24 V Supply Low	24V Supply Low	
24	01000000	16777216	Mains Failure	Mains Failure	
25	02000000	33554432	1.8V Supply Low	Current Limit	
26	04000000	67108864	Brake Resistor	Low Temp	
27	08000000	134217728	Brake IGBT	Voltage Limit	
28	10000000	268435456	Option Change	Unused	
29	20000000	536870912	Drive Initialised	Unused	
30	40000000	1073741824	Safe Stop	Unused	

Table 7.3: Description of Alarm Word, Warning Word and Extended Status Word

The alarm words, warning words and extended status words can be read out via serial bus or optional field-bus for diagnosis. See also par. 16-90 *Alarm Word*, par. 16-92 *Warning Word* and par. 16-94 *Ext. Status Word*.

7.2.3 Point mapping table

Point no.	6000 point no.	Descriptor	Factory default (SI)	Engr. Unit (SI)	Slope (SI)	Intercept (SI)	On text	Off text	Range	Max vaue (SI)	Min value (SI)	Point type	Class Type (Note 1)	Read Only	Par. No.
1	1	CTRL AD-DRESS	0	-	1	0	-	-	255	255	0	2	LAO	Yes	8-31
2	2	APPLICA-TION	2759	-	1	0	-	-	16383	16383	0	2	LAO	Yes	-
{3}	3	FREQ OUT-PUT	0	HZ	0,1	0	-	-	16383	1638,3	0	3	LAI	Yes	16-13
{4}	-	PCT OUT-PUT	0	PCT	0,01	-163,83	-	-	32767	163,83	-163,83	3	LAI	Yes	16-15
{5}	-	REF PCT	0	PCT	0,1	-1638,3	-	-	32767	1638,3	-1638,3	3	LAI	Yes	16-02
{6}	6	CURRENT	0	A	0,1	0	-	-	32767	3276,7	0	3	LAI	Yes	16-14
{7}	-	CTRL.CRD.T MP	0	DEG C	1	0			255	255	0	3	LAI	Yes	16-39
{8}	8	POWER KW	0	KW	0,1	0	-	-	32767	3276,7	0	3	LAI	Yes	16-10
{9}	-	POWER HP	0	HP	0,1	0	-	-	32767	3276,7	0	3	LAI	Yes	16-11
{10}	10	KWH	0	KWH	1	0	-	-	1023	1023	0	3	LAI	Yes	15-02
{11}	-	MWH	0	MWH	1	0	-	-	32767	32767	0	3	LAI	Yes	15-02
{12}	12	RUN TIME	0	HR	4	0	-	-	32767	131068	0	3	LAI	Yes	15-01
{13}	13	DC BUS VOLT	0	V	1	0	-	-	4095	4095	0	3	LAI	Yes	16-30
{14}	14	OUTPUT VOLT	0	V	1	0	-	-	4095	4095	0	3	LAI	Yes	16-12
{15}	15	MOTOR THERM	0	PCT	1	0	-	-	255	255	0	3	LAI	Yes	16-18
{16}	16	DRIVE THERM	0	PCT	1	0	-	-	255	255	0	3	LAI	Yes	16-35
{17}	17	ACTIVE SET-UP	0	-	1	0	-	-	255	255	0	3	LAI	Yes	0-10
{18}	-	HEATSINK TMP	0	DEG C	1	0	-	-	255	255	0	3	LAI	Yes	16-34
{19}	19	CUR.LIM.ST AT	OK	-	1	0	LIMIT	OK	255	255	0	3	LDI	Yes	16-03 [14]
20	20	OVRD TIME	0	HRS	1	0	-	-	255	255	0	2	LAO	No	

Point no.	6000 point no.	Descriptor	Factory default (SI)	Engr. Unit (SI)	Slope (SI)	Intercept (SI)	On text	Off text	Range	Max vaue (SI)	Min value (SI)	Point type	Class Type	Read Only	Par. No.
{21}	21	FWD.REV	FWD	-	1	0	REV	FWD	255	255	0	3	LDI	Yes	Note[3]
{22}	22	CMD FWD.REV	FWD	-	1	0	REV	FWD	255	255	0	1	LDO	No	CTW [15]
{23}	23	RUN.STOP	STOP	-	1	0	RUN	STOP	255	255	0	3	LDI	Yes	16-03 [11]
{24}	-	RAMP SE-LECT	RAMP1	-	1	0	RAMP2	RAMP1	255	255	0	1	LDO	No	CTW [09]
{25}	25	FREEZE OUT	OFF	-	1	0	ON	OFF	255	255	0	3	LDI	Yes	16-95 [14]
{26}	26	CMD FREEZE	OFF	-	1	0	ON	OFF	255	255	0	1	LDO	No	CTW [05]
{27}	27	COASTING	OFF	-	1	0	OFF	COAST	255	255	0	3	LDI	Yes	16-00 [03]
{28}	28	CMD COAST	OFF	-	1	0	OFF	COAST	255	255	0	1	LDO	No	CTW [03]
29	29	DAY.NIGHT (Note 2)	DAY	-	1	0	NIGHT	DAY	255	255	0	1	LDO	No	-
{31}	31	ACCEL TIME 1	0* (Note 4)	SEC	1	1	-	-	4095	3600	1	1	LAO	No	3-41
{32}	32	DECEL TIME 1	0* (Note 4)	SEC	1	1	-	-	4095	3600	1	1	LAO	No	3-42
{34}	34	HAND.AUTO	AUTO	-	1	0	HAND	AUTO	255	255	0	3	LDI	Yes	16-95 [01]
{35}	35	CMD RUN.STOP	STOP	-	1	0	RUN	STOP	255	255	0	1	LDO	No	CTW [06]
{36}	36	BUS TIME-OUT	0*	SEC	1	1	-	-	32767	18000	1	1	LAO	No	8-03
{37}	37	BUS FUNC-TION	0 (Note 6)	-	1	0	-	-	255	10	0	1	LAO	No	8-04
{38}	-	JOG FREQ	10.0	HZ	0,1	0	-	-	16383	1638,3	0	1	LAO	No	3-11
{39}	-	CMD JOG	NO	-	1	0	YES	NO	255	255	0	1	LDO	No	CTW [08]
{40}	40	CMD.RELAY 1	OFF	-	1	0	ON	OFF	255	255	0	1	LDO	No	CTW [11]

Point no.	6000 point no.	Descriptor	Factory default (SI)	Engr. Unit (SI)	Slope (SI)	Intercept (SI)	On text	Off text	Range	Max vaue (SI)	Min value (SI)	Point type	Class Type	Read Only	Par. No.
{41}	41	CMD.RELAY 2	OFF	-	1	0	ON	OFF	255	255	0	1	LDO	No	CTW [12]
{42}	-	CMD AO1	0	PCT	0,01	0	-	-	16383	163,83	0	1	LAO	No	6-53
{43}	43	RELAY 1 STAT	OFF	-	1	0	ON	OFF	255	255	0	3	LDI	Yes	16-71 [04]
{44}	44	RELAY 2 STAT	OFF	-	1	0	ON	OFF	255	255	0	3	LDI	Yes	16-71[03]
{45}	-	AO1 STAT	0	MA	0,01	0	-	-	4095	40,95	0	3	LAI	Yes	16-65
{46}	-	DI 18 STAT	OFF	-	1	0	ON	OFF	255	255	0	3	LDI	Yes	16-60 [05]
{47}	-	DI 19 STAT	OFF	-	1	0	ON	OFF	255	255	0	3	LDI	Yes	16-60 [04]
{48}	-	DI 27 STAT	OFF	-	1	0	ON	OFF	255	255	0	3	LDI	Yes	16-60 [03]
{49}	-	DI 29 STAT	OFF	-	1	0	ON	OFF	255	255	0	3	LDI	Yes	16-60 [02]
{50}	-	DI 32 STAT	OFF	-	1	0	ON	OFF	255	255	0	3	LDI	Yes	16-60 [01]
{51}	-	DI 33 STAT	OFF	-	1	0	ON	OFF	255	255	0	3	LDI	Yes	16-60 [00]
{52}	52	AT SPEED	OFFREF	-	1	0	ON.REF	OFFREF	255	255	0	3	LDI	Yes	16-03 [08]
{53}	53	CMD REF	0	PCT	0,01	0	-	-	32767	200	0	1	LAO	No	REF
{54}	-	ACCEL TIME 2	0*	SEC	1	1	-	-	4095	3600	1	1	LAO	No	3-51
{55}	-	DECEL TIME 2	0*	SEC	1	1	-	-	4095	3600	1	1	LAO	No	3-52
{56}	-	BYPASS CMD	DRIVE	-	1	0	BYPASS	DRIVE	255	255	0	1	LDO	No	31-00
{57}	-	BYPASS STAT	0	-	1	0	-	-	32767	32767	0	3	LAI	Yes	31-10
{58}	-	BO START DLY	30	SEC	1	0	-	-	4095	30	0	1	LAO	No	31-01
{59}	59	SLEEP STA-TUS	NO	-	1	0	SLEEP	NO	255	255	0	3	LDI	Yes	[21]
{60}	-	BO TRIP DLY	0	SEC	1	0	-	-	4095	300	0	1	LAO	No	31-02

Point no.	6000 point no.	Descriptor	Factory default (SI)	Engr. Unit (SI)	Slope (SI)	Intercept (SI)	On text	Off text	Range	Max vaue (SI)	Min value (SI)	Point type	Class Type	Read Only	Par. No.
{61}	61	PI STRT FREQ (Note 3)	0	Hz	0,1	0	-	-	16383	1638,3	0	1	LAO	No	20-83
{62}	42	PI STRT FR.S	0	Hz	0,1	0	-	-	16383	1638,3	0	3	LAI	Yes	20-83
{63}	63	PI GAIN	0,5	-	0,01	0			1023	10	0	1	LAO	No	20-93
{64}	64	PI I TIME	20	SEC	0,3051848	0,01	-	-	32767	10000	0,01	1	LAO	No	20-94
{65}	62	FEEDBACK	0	PCT	0,01	-163,83	-	-	32767	163,83	-163,83	3	LAI	Yes	16-05
{66}	69	SETPOINT 1 (Note 3)	0	UNIT	0,1	-1638,3	-	-	32767	1638,3	-1638,3	1	LAO	No	20-21
{67}	70	SETPOINT 2 (Note 3)	0	UNIT	0,1	-1638,3	-	-	32767	1638,3	-1638,3	1	LAO	No	20-22
{68}	-	SETPOINT 3	0	UNIT	0,1	-1638,3	-	-	32767	1638,3	-1638,3	1	LAO	No	20-23
{69}	73	BUS FBK 1	0	PCT	0,01	-163,83	-	-	32767	163,83	-163,83	1	LAO	No	8-94
{70}	74	BUS FBK 2	0	PCT	0,01	-163,83	-	-	32767	163,83	-163,83	1	LAO	No	8-95
{71}	-	BUS FBK 3	0	PCT	0,01	-163,83	-	-	32767	163,83	-163,83	1	LAO	No	8-96
{76}	76	VOLTAGE STAT	OK	-	1	0	LIMIT	OK	255	255	0	3	LDI	Yes	16-03 [13]
{77}	77	INVERT STAT	OK	-	1	0	STALL	OK	255	255	0	3	LDI	Yes	16-03 [12]
{78}	78	FREQ STAT	OUTRNG	-	1	0	IN.RNG	OUTRNG	255	255	0	3	LDI	Yes	16-03 [10]
{79}	-	FIREM. STAT	NORM	-	1	0	FIRE	NORM	255	255	0	3	LDI	Yes	16-94 [25]
{80}	-	OVC AC-TIVE	NORM	-	1	0	OVC	NORM	255	255	0	3	LDI	Yes	16-94 [15]

Point no.	6000 point no.	Descriptor	Factory default (SI)	Engr. Unit (SI)	Slope (SI)	Intercept (SI)	On text	Off text	Range	Max vaue (SI)	Min value (SI)	Point type	Class Type	Read Only	Par. No.
{81}	81	RAMPING	NORM	-	1	0	RAMP	NORM	255	255	0	3	LDI	Yes	16-94 [00]
{82}	82	RUN RE-QUEST	NORM	-	1	0	REQ	NORM	255	255	0	3	LDI	Yes	16-95 [15]
{83}	-	JOGGING	NORM		1	0	JOG	NORM	255	255	0	3	LDI	Yes	16-95 [16]
{84}	-	TERM. 53 TYP	CURR	-	1	0	VOLT	CURR	255	255	0	3	LDI	Yes	16-61
{85}	-	TERM. 54 TYP	CURR	-	1	0	VOLT	CURR	255	255	0	3	LDI	Yes	16-63
{86}	86	Q.STOP STAT	NORM	-	1	0	Q.STOP	NORM	255	255	0	3	LDI	Yes	16-00 [04]
{87}	87	TERM 53 STAT	0	V.MA	0,001	0	-	-	32767	32,767	0	3	LAI	Yes	16-62
{88}	88	TERM 54 STAT	0	V.MA	0,001	0	-	-	32767	32,767	0	3	LAI	Yes	16-64
{89}	-	REF UNIT	0	UNIT	0,1	-1638,3	-	-	32767	1638,3	-1638,3	3	LAI	Yes	16-01
{90}	90	WARNING	OK	-	1	0	WARN	OK	255	255	0	3	LDI	Yes	16-03 [07]
{91}	91	TRIP LOCK	NOLOCK	-	1	0	LOCK	NOLOCK	255	255	0	3	LDI	Yes	16-03 [06]
{92}	92	ALARM	OK	-	1	0	ALARM	OK	255	255	0	3	LDI	Yes	16-03 [03]
{93}	93	LAST ALARM	0 (Note 8)	-	1	0	-	-	255	255	0	3	LAI	Yes	15-30 [0]
{94}	94	RESET ALARM	OFF	-	1	0	RESET	OFF	255	255	0	1	LDO	No	CTW [07]
{95}	-	RESET KWH	NO	-	1	0	RESET	NO	255	255	0	1	LDO	No	15-06
{96}	-	RESET R.HRS	NO	-	1	0	RESET	NO	255	255	0	1	LDO	No	15-07
{97}	-	JOG FREQ.S	0	HZ	0,1	0	-	-	16383	1638,3	0	3	LAI	Yes	3-11
99	99	ERROR STA-TUS (Note 2)	0	-	1	0	-	-	255	255	0	3	LAI	Yes	-

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