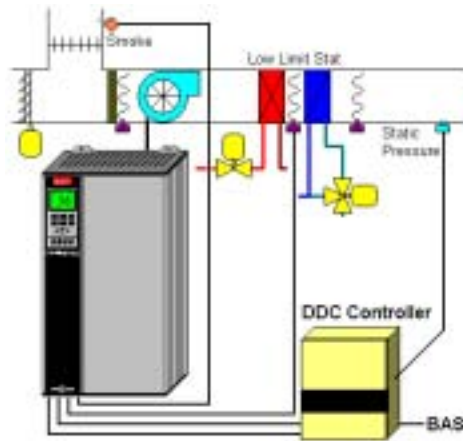


VLT® 6000 Start-Up



Oct 2003

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This presentation deals with the start-up of the Danfoss Drives VLT 6000 Variable Frequency Drive (VFD). It is designed to help you handle the start-up of the drive in normal applications. Because of the flexibility of these drives, there may be some specialized applications that are not specifically covered by these instructions. In that case, refer to the documentation that came with the drive for more information.

The VLT 6000 can be provided as a stand-alone drive, or it can be provided as part of a drive system package that includes an option enclosure.

In the picture above, the VLT 6000 is used to operate the Supply Fan of a Variable Air Volume (VAV) air handling unit. It is wired into a Building Automation System (BAS) which enables the VLT 6000 and gives it a speed reference. A smoke detector and a low limit thermostat (freezestat) is wired directly into the VLT 6000.

Outline

- 1. Warnings, Reference & Pre-Installation**
- 2. Mounting**
- 3. Wiring – Power, Motor, Control**
- 4. Initial Power & using the LCP**
- 5. Programming**
- 6. Operation**
- 7. Final Adjustments**
- 8. General Troubleshooting**

This is an outline for this training module, that covers the startup of the VLT 6000.

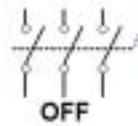
- 1) Covers the warnings, needed reference materials and pre-installation checks.
- 2) Mounting covers the important points about the mounting of the VFD, including considerations on clearance, temperature, altitude, etc.
- 3) This part covers the wiring of the VFD including, incoming power, motor output, control wiring and serial communications.
- 4) Initial Power briefly covers the items to check before power is applied.
- 5) Programming covers the general overview of the Local Control Panel (LCP) and its use in the Quick Menu, Extended Menu and operational displays.
- 6) Operation covers the Hand and Auto running of the VFD.
- 7) Final Adjustments covers the some of the final checkout points.
- 8) General Troubleshooting covers some information about finding and correcting problems.

Periodically short reviews are given to insure the information given is retained.

1) Warnings

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 **DANGER**



Touching the electrical parts may be fatal — even after the equipment has been disconnected from the AC line. To be sure that the capacitors have fully discharged, wait 15 minutes after power has been removed before touching any internal component.

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Because the drive uses large electrolytic capacitors in its power circuitry, it can maintain a dangerous voltage level for up to 15 minutes after power has been removed. Therefore, always be sure that power has been removed from the drive for at least 15 minutes before working with the power circuitry of the drive.

It is always wise to use a voltmeter to measure any potentially dangerous electrical circuit before working on it.

1) Reference Material Needed

- **VLT® 6000 Instruction Manual**
(general information)
- **Customer Connection Diagram**
(specific for the order)
- **Schematic Diagram**
(specific for the order)



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These three pieces of reference material should be available to you when you are starting up a drive.

The VLT 6000 Instruction Manual provides general information on topics like mounting clearances, drive fuses, terminal tightening torques, and drive parameters.

The Customer Connection Diagram provides a sketch indicating the layout and use of the customer connection terminals.

The Schematic Diagram provides details of the wiring between the drive, any options, and the control system.

Both the Customer Connection Diagram and the Schematic Diagram are drawn for the specific order. If you need to obtain a copy of either of these, contact your local Danfoss Drives Representative.

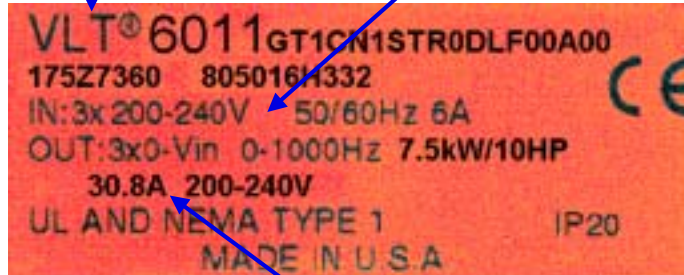
1) Pre-Installation Checks



All Drives – On the Top or Left Side of the Drive

Type Number

Input Ratings of Drive



Output Ratings of Drive

Oct 200

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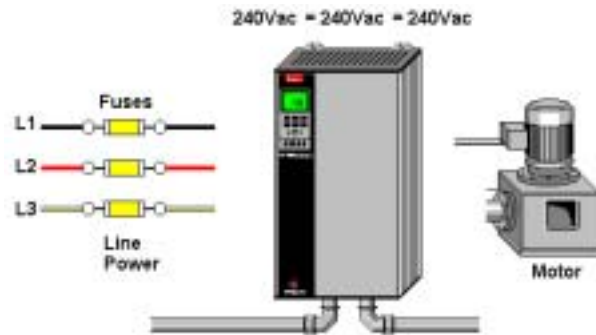
The drive has two identifying numbers.

The longer Model Number clearly codes the drive series number, its voltage rating, and its output current rating. Page 11 of the instruction manual gives all the information.

In the example above VLT 6011 is the size of the drive which is 7.5kW or 10Hp. The G always means an HVAC drive. T1 is the incoming power, which is 200-240Vac. CN1 means that this is a NEMA 1 drive. ST is standard, which means there is not braking circuitry. R0 means there is no RFI Filter. DL, it comes with a display or LCP. F00 = there is no serial communications. A00 means there is no special application card such as the Cascade Controller. If there is a C1 at the end the unit has conformal coating.

The shorter Type Number is stored in the drive's parameters and is used in other situations where the longer number would be too cumbersome. In order to describe the drive using the Type Number, you must also know its voltage rating.

1) Pre-Installation Checks



- Compare the voltage ratings of
 - Drive
 - Power line
 - Motor (check the wiring in the conduit box)

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Before installing the drive, check to be sure that the power line, the drive, and the motor are all rated for the same voltage. It may be necessary to check the wiring inside the motor's conduit box to confirm its voltage rating.

1) Pre-Installation Checks



- Write down motor data:
 - Voltage
 - Frequency
 - Full Load Current
 - Full Load Speed
 - Power
 - Power Factor (if available)

Frame	Type	Design	Identification No.	
326T	P	D	1234567890	
HP20	Volts 230V/60	Hz 60	Phase 3	
RPM 1770	Amps 50/25	S.F. 1.15	Code F	
Amb. 40°C	Duty Cont.	Encl. TEFC	Ins. Class F	
		Low Volts	High Volts	
		11 15 16	14 15 16	
		17 18 19	17 18 19	
		11 12 13	11 12 13	
		L1 L2 L3	L1 L2 L3	

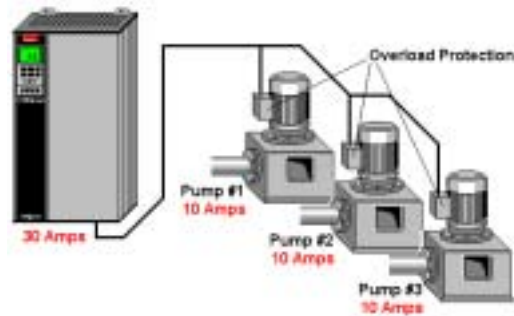
Motor Plate

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Write down the motor nameplate information. This will be important later during the start-up. A conversion chart between HP and kW is provided with the description of parameter 102 in the Instruction Manual. See page 73.

1) Pre-Installation Checks



- Compare the full load current ratings; drive and motor(s)
 - For multiple motor applications, add the full load current ratings of all motors
 - The drive can be at most one size smaller than the motor
 - If the drive rating is less than motor, full motor output can not be achieved
 - Each motor must have individual motor protection, such as thermal overloads.

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It is important to be sure that the drive is sized to provide the full load current requirement of the motor. If more than one motor is connected simultaneously to the drive, add the full load current draw of all motors that will be connected at one time and compare this to the drive's current rating.

Although the drive can control motors whose full load current draw is slightly greater than the drive's rating, it will not be able to drive them to full output. Therefore, such under-sizing of the drive should generally be avoided.

In the example above, one drive operates 3 pumps. Each pump has a Full Load Amp (FLA) of 10A. The drive must have an output current of at least 30A. Notice that each pump still has its own overload protection.

2) Mounting the Drive



- **Environment for NEMA 1 (IP 20) drives**
 - **Clean & Dry (max. 95% R.H., non-condensing)**
 - **14°F (-10°C) to 104°F (40°C) ambient temperature**
 - **3,300 feet (1000m) maximum elevation without de-rating**

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The VLT 6000 can be supplied with a NEMA 1 enclosure. This enclosure provides some degree of protection from falling dust. Therefore, drives with a NEMA 1 enclosure should be mounted indoors in a relatively clean and dry location.

Because the drive relies on the ambient air for cooling, it is important to observe the limitations on ambient air temperature and elevation. Contact the Service Department if you think that the mounting location of the drive compromises its ability to provide long term, reliable operation.

2) Mounting the Drive

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- **Modifications for other environments**
 - **NEMA 12**
 - **NEMA 3R** (requires additional cabinet)
 - **NEMA 4 or 4X** (requires additional cabinet)

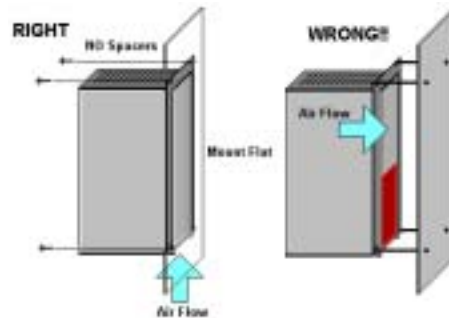
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To provide for indoor environments where the drive may be subjected to dripping water or large amounts of dirt, the VLT 6000 can be supplied with a NEMA 12 enclosure.

If the drive is to be mounted outdoors, NEMA 3R, NEMA 4 AND 4X and NEMA 12 enclosures can be supplied.

2) Mounting the Drive



- **The drive must be mounted vertically**
- **Drives with exposed heat sink fins on the back must be mounted against a solid surface**

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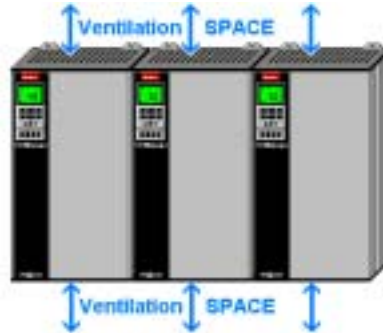
11

In order to provide proper cooling, the drive must always be mounted vertically.

It is also important to establish a "chimney" around the drive's heat sink to ensure that all cooling air passes along the entire length of the heat sink. If a drive with no option panel is not mounted directly to a vertical flat surface, it is important to see if this leaves any heat sink fins exposed in the back. If it does, a flat plate must be mounted to the back of the drive to ensure proper cooling.

Drives that include a bypass or other option enclosure are generally factory-mounted to a back plate. Therefore, this is not a concern with such drives.

2) Mounting the Drive



- **Clearance**
 - **No side clearance needed for cooling**
 - **Vertical space for cooling**
 - **Refer to the “mechanical installation” section of the Instruction Manual**

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The VLT 6000 cools itself by drawing cooling air through the bottom of its enclosure and exhausting it out the top. It is therefore important to provide enough space above and below the drive to ensure proper flow of cooling air. To determine the necessary clearances, see the “mechanical installation” section of the Instruction Manual, pages 29-31. The smallest drive requires 4” on the top and bottom, nothing on the sides. This top and bottom space goes from 4”, to 6” on larger units, then 8”, and 12” on the largest drive which is on the top only. All drives can be mounted side by side.

2) Mounting the Drive

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- **Keep the drive clean**
 - Use dust covers to keep construction dust from getting into it
 - Remove the dust covers before applying power

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If construction work will continue after the drive is mounted, it is important to keep the drive as free as possible from concrete dust and similar dirt. If the drive does not have power applied to it, it should be kept covered. If the drive must be powered up and run, this cover must be removed. It is still important to ensure that the drive stays as clean as possible. It may be necessary to clean the interior of the drive once construction is completed.

Review



1. How long must you wait to service a drive?
VLT 6100 G T4 CN1 ST R0 DL F10 A00 C0
2. Using the number shown above, what voltage range should power this VFD?
3. Does this drive have a built in RFI Filter?
4. Does it have serial communications?
5. Does it have conformal coating?
6. What distance around smallest drive?
_____top; _____bottom; _____right; _____left
7. Name two things that must be remembered for multiply motors
8. What must be done to get a NEMA 4 rating?

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Review

1. How long must you wait once power is removed, before the drive is safe to service?

Look at the following Part Number for questions 2 and 5.

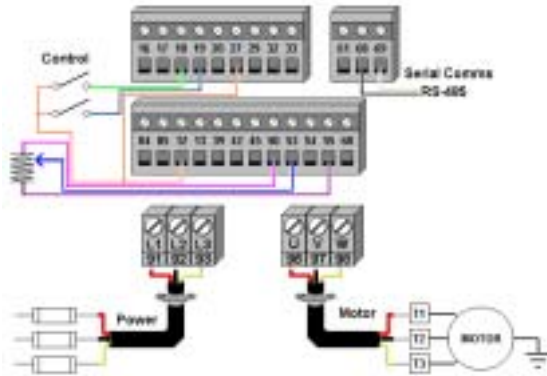
VLT 6100 G T4 CN1 ST R0 DL F10 A00 C0

2. For what voltage range of incoming power is this drive designed? _____
3. Does this drive have a built in RFI Filter? _____
4. Does it have serial communications? _____
5. Does it have conformal coating? _____
6. For the smallest drive, how much space is required around the drive for proper ventilation?
_____” top; _____” bottom; _____”right; _____” left
7. Name 2 things that must be remembered when attaching a drive to multiply motors?

8. If a customer wants a NEMA 4 drive, how does Danfoss accommodate?

3) Wiring the Drive

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- General Wiring
- Power Input
- Motor Output
- Control
- Serial Comms

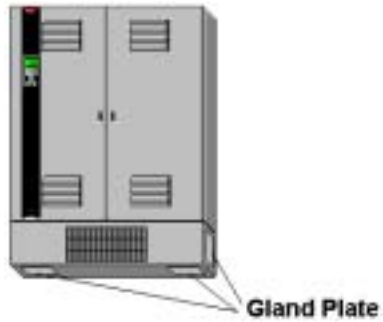
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This next section covers the wiring of the drive. The first area to be covered is general wiring practices. The other sections cover power or line wiring from the drive to incoming power. The motor wiring covers the connections between the drive and the motor. Control wiring for Digital Inputs/Outputs and Analog Input/Outputs are also covered. The last section covers the wiring for serial communications.

3) Wiring the Drive

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- **Conduit entry**
 - All wiring enter bottom of drive
 - Knock-outs are provided on many drives
 - Larger drives have a removable conduit entry or gland plate

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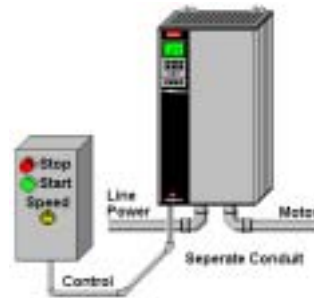
General Practices

Most smaller drives have knock-outs for conduit entry. Larger drives provide a removable conduit entry plate. It is important to remove this plate before drilling or punching it.

When a drive is supplied with an auxiliary enclosure, it is generally necessary to drill or punch conduit entry holes in the auxiliary enclosure. It is important to ensure that metal chips or filings don't get into any of the devices which are housed in the auxiliary enclosure.

3) Wiring the Drive

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- At least three separate **METALLIC** conduits must be connected to the drive
 - Power into the drive [L1, L2, L3 and a ground back to the distribution panel]
 - Power from the drive to the motor [U, V, W, and PE (power earth ground)]
 - Control wiring
- A dedicated ground wire is needed

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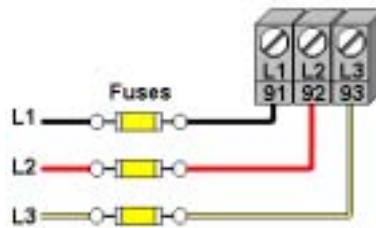
At least three separate conduits must be connected to the drive. One is for the incoming power wiring, one is for the power wiring between the drive and the controlled motor, and the third is for the control wiring.

Because the wiring from the drive to the motor carries high frequency electrical pulses, it is important to be sure that no other wires are run in this conduit. If the incoming power wiring is run in the same conduit as the motor wiring, these pulses can couple electrical noise back onto the building's power grid.

Control wiring should always be isolated from the high voltage input power wiring to the drive or the high voltage output power wiring from the drive to the motor.

3) Wiring the Drive

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- **Input fuses**
 - All drives must have input fuses installed in the power supply to the drive
 - Refer to the Instruction Manual for fuse sizing
 - Some drives will have input fuses
 - Most drives with bypasses
 - Where input fuses were specified on the order (see the Schematic Diagram)

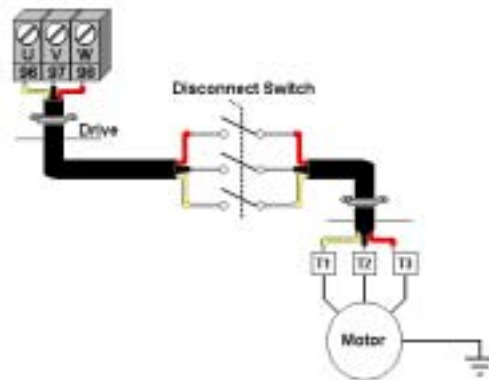
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In order to fulfill the requirements of Underwriters Laboratory (UL), all drives must be provided with fast-acting input power line fuses. The proper style and rating for these fuses is specified in the Instruction Manual on page 24.

In most cases, when the drive was ordered with a constant speed bypass, these fuses are already installed. In other cases, fuses are provided as a part of the drive package only if they were requested on the order.

3) Wiring the Drive



- If a disconnect switch is wired between the drive and motor
 - Closing this switch with the drive running causes a large current surge, it does not damage the drive but may cause the drive to trip.

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Although it may be required to meet electrical code requirements, a disconnect switch connected between the drive and the driven motor can cause problems. While running the drive when the disconnect switch is open causes no problems of itself, if the disconnect is closed while the drive is running, the motor may attempt to draw locked rotor current from the drive. This may cause the drive to shut down on an over current fault trip. In order to avoid such a nuisance trip, it is a good idea to wire an auxiliary contact from the disconnect switch back to the drive's safety interlock circuit. Then, if the disconnect is opened while the drive is running, the drive will immediately shut off. When the disconnect switch is later closed, the drive begins from a stop and smoothly accelerates the motor to the desired speed.

3) Wiring the Drive

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- **Other motor concerns**
 - **No power factor correction capacitors between the drive and the motor**
 - **Two speed motors must be wired permanently for full speed**
 - **Y-start, Δ -run motors must be wired permanently for run**
 - **Partial winding start motors must be wired permanently for run**

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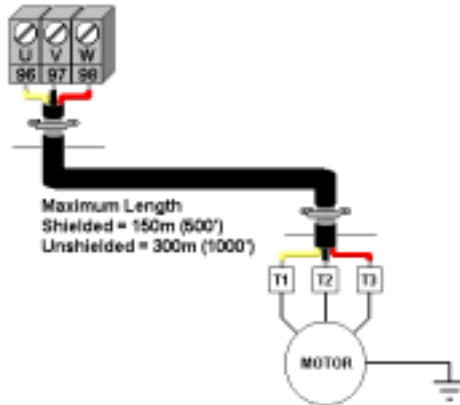
20

It is important to ensure that there is as direct a connection as possible between the drive and the motor.

In a retrofit application, any power factor correction capacitors that were used with the motor should be removed. If they are connected between the drive and the motor, the drive will trip off and refuse to start the motor. In addition, they are not needed on the input power leads to the drive because the drive already presents the power line with a 0.95 or greater displacement power factor.

If a motor has special windings or wiring to help it operate when it is connected directly across the AC power line, it is important to ensure that the motor is always connected in its full speed run configuration when it is connected to the drive's output.

3) Wiring the Drive



- **Maximum Cable Length**
 - **Shielded (Screened) = 150m (500')**
 - **Unshielded (Unscreened) = 300m (1000')**

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The maximum cable distance between the drive and motor for unshielded cable is set for 300m (1000feet). If multiple motors are wired to one drive the total distance from the drive to all the motors does not exceed 300m (1000feet).

If shielded cable is used as pictured above, the distance is dropped to 150m (500feet). The wires in the shielded cable are more compressed, which means that the capacitance between the cables is increased. A shorter distance is therefore needed for proper operation.

3) Wiring the Drive

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- **Connect control wiring shields to ground at only one end**
- **The shield should be insulated at the other end of the control cable**
- **A clamp is provided for grounding the shield at the drive end**

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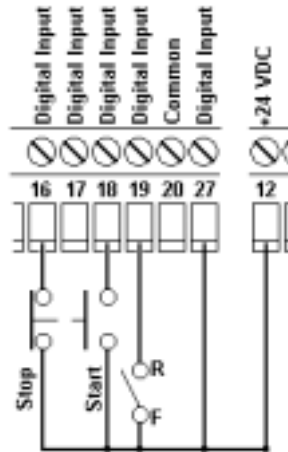
22

Whenever possible, shielded control wiring should be used. Although it may be possible to use twisted pair control wiring in some instances, shielded control wiring provides greater noise immunity when it is used properly. Proper wiring practices generally dictate connecting the shield to ground at only one end of the cable. The shield should be insulated at the other end of the cable. To provide the most effective grounding of the shield, the shield should be exposed where it runs under the drive's cable clamp. The cable clamp then acts as both a strain relief and as the shield grounding device. The shield should be kept in tact over the cable until just before the wires are connected to the drive's terminals. The shielding should never be twisted and connected as a "pig-tails".

3) Wiring the Drive



- **8 Digital inputs**
- **Term 12 & 13 are 24Vdc**
- **24V = ON, 0V = OFF**
- **Function Chart page 90**
- **Galvanic Isolation**



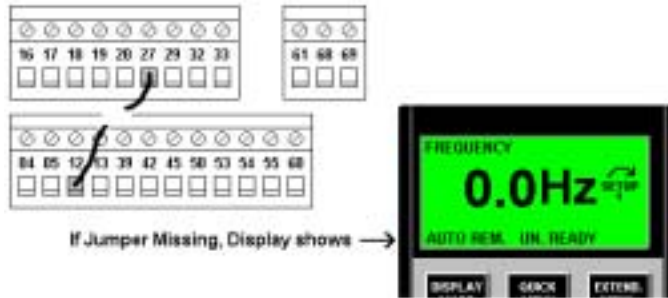
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There are 8 Digital Inputs (D in) on the VLT 6000. These terminals are used to start, stop and reset the drive. They can also be used to reverse, speed up/ slow down and change between different 4 reference fixed speeds and 4 different setups. These terminal numbers are displayed on the back of the plastic cover which protects the control wiring terminals. The terminal numbers for these inputs are 16, 17, 18, 19, 27, 29, 32, and 33. Each input can be programmed to different functions, some have more functions than others. Page 90 in the Instruction Manual shows these selections.

If the Digital Input sees 24Vdc it is seen as an "ON" signal. If the Digital Input sees a 0Vdc signal, it is an "OFF". Terminals 12 and 13 are a source for 24Vdc. Terminal 20 is an isolated ground for the Digital Inputs. There are 3 different grounds for the control wiring which prohibits most interference from other signals. This is referred to as Galvanic isolation.

3) Wiring the Drive



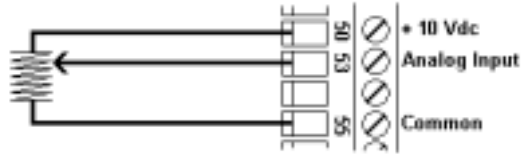
- **Terminal 27 is an enable or stop command**
- **If it does not see 24Vdc the drive does not run**
- **Display show UN. READY**

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In its default state, the way it comes from the factory, a jumper is required for operation. This “missing jumper” is a method used by some manufacturers to encourage the end-user to read the instruction manual. This method is more of a nuisance in North America than a help. The missing jumper which is NOT provided, must be connected between terminals 12 (24Vdc) and 27, which defaults to a stop command. If terminal 27 does not see 24Vdc, the drive does not operate. A display on the front of the drive is very clear when this occurs. After pressing the “Display/ Status” key, the bottom line reads, “UN. READY”. Whenever this display is seen, the jumper is missing between terminals 12 and 27.

3) Wiring the Drive



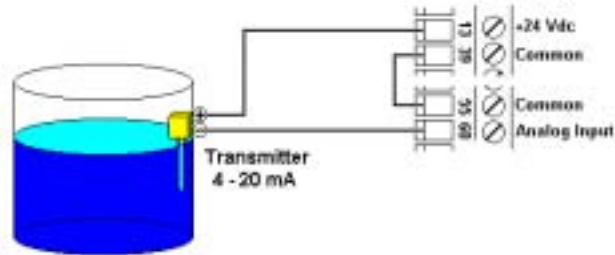
- **3 Analog Inputs**
- **Functions: Reference, Feedback or Motor Thermistor**
- **2 - Voltage Inputs, Term 53 & 54 (0-10Vdc)**
- **Terminal 50 supplies 10Vdc**

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There are 3 Analog Inputs (A In) in the VLT 6000. These Analog signals are used for reference, feedback or the motor thermistor. Two of the inputs, terminals 53 and 54 are setup for a 0 to 10Vdc or voltage signal. Terminal 50 supplied 10 Vdc to the which is usually used for a potentiometer (pictured above) in giving a reference. Terminal 55 is the common for the Analog Inputs.

3) Wiring the Drive



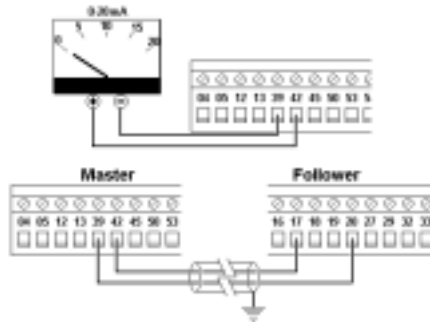
- **One mA input, terminal 60 (0 to 20mA scalable)**
- **Power for 2 wire transmitter, connect commons**
- **Used for Feedback in Closed Loop applications**

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Terminal 60 is setup for a 4-20mA or current signal. Most pressure and level transmitters are current sensors which send a feedback to the drive for closed loop applications. Terminal 55 is the common. In the picture above, a 2-wire transmitter is used to detect the level of a tank. This transmitter requires power to operate. The terminal with 24Vdc, terminal 13, in the picture above is used. Power goes to the + side of the transmitter and the – side goes to terminal 60, the current input. A jumper is placed between terminals 55 and 39. This connects the 2 different commons, the common for the AI, terminal 55 and the power out terminal 39.

3) Wiring the Drive



- **Analog or Digital Output – Terminals 42 or 45**
- **Showing Frequency, Feedback, Current, etc.**
- **0-20mA, 4-20mA, or 0-32,000 pulses**
- **Function Chart – Page 98**

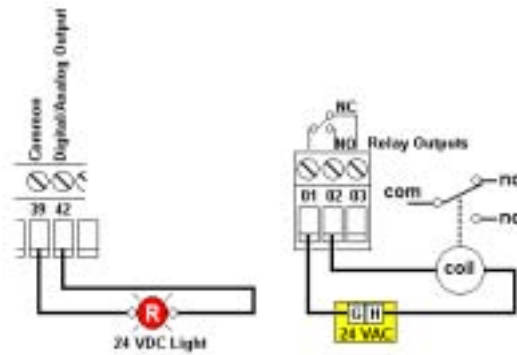
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The VLT 6000 has 2 terminals, 42 and 45, that may be programmed as either a Digital Output or and Analog Output. If programmed as an Analog Output, a meter is attached to indicate any of the following: frequency of the drive, external reference, feedback pressure, output current, or output power.

Each of these selections can be sent as a 0-20mA signal, a 4-20mA signal or a 0-32,000 pulse signal. These outputs are also used to interface drives together in a Master/Slave arrangement. These signals can also be used as confirmation back to a PLC. A functional selection chart is shown on page 98 in the Instruction Manual.

3) Wiring the Drive



- DO (terminals 42 & 45) powered with 24Vdc
- Relay Outputs (01,02,03 or 04,05) have no power
- Fault Relay (01,02,03) 240Vac-2A
- Run Relay (04,05) 30Vac-1A
- Function chart – page 102

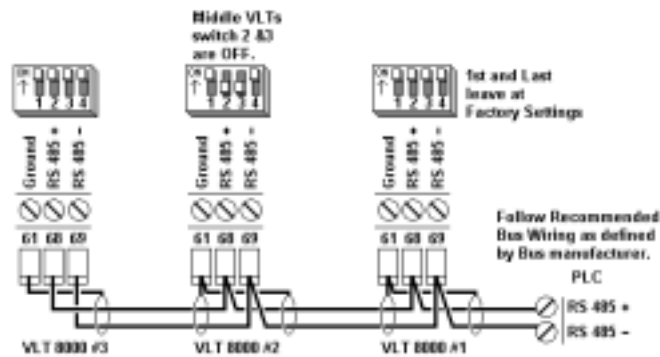
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In the diagram to the left, terminal 42 is programmed as a Digital Output. This terminal is powered by 24Vdc to turn on a light. There are 29 selections for the indication of the light, to show, running, a fault, alarm, and numerous others. Page 98 in the Instruction Manual gives a list of these selections.

In addition to the Digital Outputs, there are 2 Relay Outputs. These outputs are not powered, but are dry contacts. Relay #1 (terminals 01, 02, and 03) can be powered with 240Vac to a maximum of 2 amps. Relay #4 (terminals 04, and 05) can be powered with 30Vac to a maximum of 1 amp. The function selection chart is found on page 102. One selection involves pump alternation which also requires setup in parameters 433 and 434.

3) Wiring the Drive



- Serial Communication Wiring- Terminals 68 & 69
- Standard RS-485 connections
- Address set by Parameter # 501
- Dip switch settings for internal drives

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The last wiring section involves serial communications. Serial communications are in an RS-485 format which means all the positive terminals (#68) are connected together and all the negative terminals (#69) are connected. The RS-485 format only allows the communication wire to have 2 ends. The ends are indicated by an EOL or End of Line resistor. These resistors are built into the VLT 6000. A dip switch, which is just above the serial terminal connections, is used with these EOL resistors. If 1 or 2 drives are connected on the RS-485, no changes need to be made. When a 3rd drive and additional drives are attached to the middle of the serial communications, Pins 2 and 3 of the dip switch must be turned OFF or down to remove the EOL resistor. There are communication problems if these is not done.

Addresses for each drive are set with parameter 501. The default address is 1, so this parameter must be changed.

3) Wiring the Drive



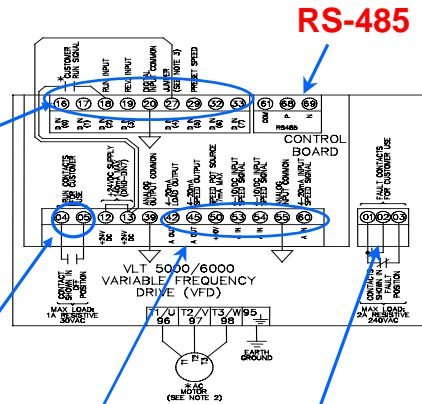
**Control Wiring
Terminal blocks
can be unplugged**

**Digital Inputs
12 & 18: Run Command
12 & 27: Safety Interlock
etc.**

**Run Relay
30 V AC, 1 A**

Analog Inputs and Outputs

**Fault Relay
240 V AC, 2 A**



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Some or all of the control wiring will be connected to the terminal blocks at the bottom of the drive's Main Control Card. For your convenience, all of these terminals may be easily unplugged from the Main Control Card.

The digital (switch) inputs, analog inputs, transistorized outputs, relay outputs, and RS-485 serial bus connections are arranged in groups for convenience.

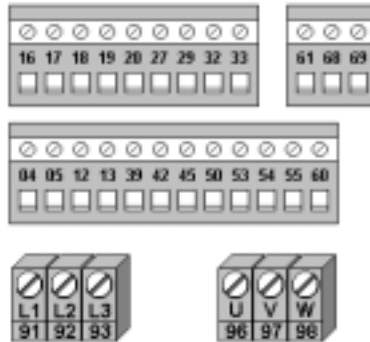
The relay contacts that are connected to terminals 04 and 05 are generally used to provide a remote run indication. It is important to notice that these contacts are rated for a maximum voltage of 30 V AC or 42.5 V DC.

The relay contacts that are connected to terminals 01, 02 and 03 are generally used to provide a remote fault indication. These contacts are rated for up to 240 V AC. Note that relay terminals 01, 02, and 03 are mounted remotely from the other control terminals and the low voltage relay's terminals.

3) Wiring the Drive



Double-Check Wiring



- **Input & output power to the correct terminals**
- **All wiring terminals are tight**

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The drive should have its own ground wire that goes directly back to a reliable earth ground. The ground wire from one drive should not be connected to the ground terminal of another drive. The building's electrical conduit cannot be used as a reliable ground.

Before applying power to the drive, double check to ensure that incoming power to the drive and the power wiring from the drive to the motor are connected to the correct terminals. Reversing the incoming and outgoing power connections will damage the drive.

Ensure that all terminals are tightened properly and all control wiring is run properly.

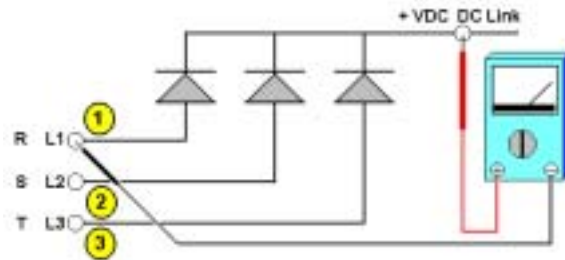
Review

1. Serial comm. wiring RS485 + _____ & RS485 – _____.
2. A jumper attached between terminal 12 and _____.
3. 4-20mA transmitter – side is attached to terminal _____.
4. Supply power to transmitter, jumper between ____ & ____.
5. Terminal numbers to the motor. _____
6. Terminal numbers to power _____
7. Identify what type of connection is 33 _____

Review

1. A serial communication wiring must be attached to the VLT 6000. The RS485 + is wired to terminal _____ and the RS485 – is wired to terminal _____.
2. In order for the VLT 6000 to operate, a jumper must be attached between terminal 12 and _____.
3. A 4-20mA pressure transmitter must be attached to the VLT 6000. The + side of the transmitter is attached to terminal 13, and the – side of the transmitter is attached to terminal _____.
4. In the wiring above a jumper must be placed to supply power to the transmitter. This jumper is wired between _____ and _____.
5. Identify the terminal numbers wired to the motor. _____
6. Identify the terminal numbers wired to incoming power _____
7. A wire is attached to terminal 33. Identify what type of connection is 33 _____

4) Initial Power Up & LCP



- Before turning unit ON, use an ohm meter to check for input or output shorts
 - Line to DC bus or
 - Line to line
- Be sure there is no external run command.
- Apply power.

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Prior to applying power to the drive, it is a good idea to use an ohmmeter to check for input or output short circuits. If the DC bus is available, it is best to check from the DC bus to the drive's input and output terminals. If the DC bus terminals of the drive are not easily accessible, it is also possible to make this test from line to line on the input and output. In this case, it is important to realize that AC fans connected to the drive's input power wiring may give a false indication of an input short circuit.

To avoid unintended starts, be sure that the automation system is not sending a run command. Then apply power to the drive.

4) Initial Power Up & LCP



LCP = Local Control Panel

- Functions
- A variety of meter displays
- Status displays
- Drive programming
 - Enter parameters
 - Store parameters
 - Transfer parameters
- Indicator lamps
- Drive controls



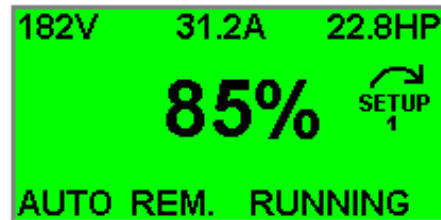
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After a few seconds, the display on the drive's Local Control Panel (LCP) should light up. The LCP provides a complete, easy to use interface between the operator and the drive.

4) Local Control Panel (LCP)

- Up to four meters
- Direction of rotation
- The active setup
- Warnings/alarms
- Status
 - Start/Stop control point
 - Speed control point
 - Current action



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The display on the LCP can provide a wealth of drive status information.

Up to four meters can be programmed to display at one time. The meters displayed can be chosen from a list of 26 functions.

The arrow over the word SETUP points in a clockwise direction for forward operation and it points in a counterclockwise direction to indicate that the drive is operating in reverse. The drive has four independent parameter setups. The number of the one that is controlling the drive is displayed below the word SETUP.

Warnings and alarms are displayed on the large second display line and the third display line of the LCP. For simplicity, these are displayed in plain language. There is no need to decode any of the drive's display messages.

The bottom line of the LCP's display shows the present operating status of the drive.

A complete listing of all of the drive's status, warning and alarm messages is provided in the back of the Instruction Manual, page 150.



5) Programming

Quick Menu

(Note Motor Parameters **MUST** be entered in order)

001	<u>LANGUAGE</u>	202	<u>MAX. FREQUENCY</u> 60 Hz
102	<u>MOTOR POWER</u> (in kW; 1Hp=0.75kW)	206	<u>RAMP UP TIME</u> Depends on application
103	<u>MOTOR VOLTAGE</u>	207	<u>RAMP DOWN TIME</u> Depends on application
104	<u>MOTOR FREQUENCY</u>	323	<u>RELAY 1 FUNCTION</u> NO ALARM
105	<u>MOTOR CURRENT</u>	326	<u>RELAY 2 FUNCTION</u> RUNNING
106	<u>MOTOR NOM. SPEED</u>		
201	<u>MIN. FREQUENCY</u> Depends on application		

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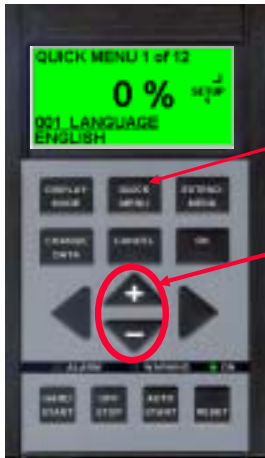
36

This is the list of the parameters in the Quick Menu.

Because entering the proper motor nameplate data is essential for reliable drive operation, this information is part of the Quick Menu.

5) Programming

Quick Menu



Quick Menu

QUICK MENU to access

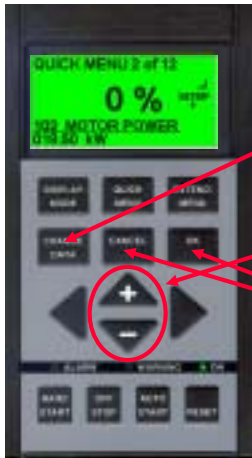
+ or - to select the menu item

The Quick Menu provides access to selected key drive parameters, including the motor data. To access it, press the QUICK MENU key. The + and – keys move through the list of parameters.

- The top line of the display show's the parameter's location in the Quick Menu.
- The third line of the display shows the parameter's number in the Extended Menu and the name of the parameter.
- The bottom line of the display shows the parameter's present value.

5) Programming

Quick Menu



Quick Menu

• **CHANGE DATA** to edit a parameter value

• **+ or –** to select from a list of choices

• **OK** to accept or **CANCEL**

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- The CHANGE DATA key allows access to the parameter's value. This is indicated by the underline moving from the third line to the bottom line of the display.
- The + and – keys allow a new parameter value to be selected from a list.
- The OK key accepts the change and writes the change to non-volatile drive memory.
- The CANCEL key exits the editing process without changing the parameter's value.

5) Programming



Numerical data

- **CHANGE DATA**
- **◀ or ▶ to select the digit**
- **+ or – to change the digit**
- **OK or CANCEL**

- When numeric data is edited, the ◀ and ▶ arrows allow selection of the digit to be edited.
- The + and – keys allow the value of the selected digit to be changed.
- The OK and CANCEL keys function as before.



5) Programming

Extended Menu

0xx

KEYB. & DISPLAY

1xx

LOAD & MOTOR

2xx

REF. & LIMITS

3xx

INPUTS & OUTPUTS

4xx

APPL. FUNCTIONS

5xx

SERIAL COMM.

6xx

SERVICE FUNCTS.

7xx, 8xx, 9xx

Special Boards

The parameters in the Extended Menu are arranged in logical groups to make it easier to find a specific parameter.

5) Programming

Extended Menu



Extended Menu

- **EXTEND. MENU**
- **◀ or ▶ to select the parameter group**
- **+ or – to select the parameter**

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The Extended Menu contains all of the drive's parameters, including those that are a part of the Quick Menu.

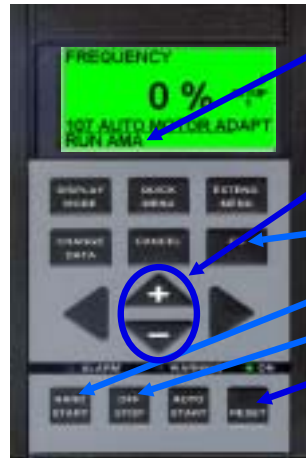
- The EXTEND. MENU key accesses it.
- For convenience, parameters are organized in functional groups. The ◀ and ▶ keys select the parameter group.
- The + and – keys select the individual parameter in each group.
- Editing parameter data is done in the same way that it was done using the Quick Menu.

5) Programming



Extended Menu

Automatic Motor Adaptation



Running AMA

- Parameter 107
- CHANGE DATA
- + or – to select RUN AMA
- OK
- HAND START
- OFF STOP
- RESET
- DISPLAY MODE

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Running Automatic Motor Adaptation (AMA) allows the drive to analyze the electrical characteristics of the motor. AMA also tests to see if the motor is electrically sound.

Because it does not cause the motor shaft to rotate, it doesn't require the motor shaft to be disconnected from the load. AMA should always be run when the system is commissioned. Motor characteristics change with temperature. AMA assumes that the motor is at room temperature. Therefore, it should only be run on a "cold" motor.

To run AMA:

- Access parameter 107 using the Extended Menu.
- Change the parameter's value to RUN AMA and press OK.
- Press HAND START.
- The bottom line of the LCP's display will indicate WORKING.
- After the process is complete (generally within 5 to 10 minutes), the bottom line of the LCP's display will either show AMA FINISHED OK or it will provide a message indicating what caused the process to stop.
- After successful completion, press the HAND START key. This will keep the motor from starting unexpectedly.
- To complete the process, press the RESET key.

If AMA didn't complete successfully, attempt using a reduced version of AMA by choosing RUN AMA WITH LC-FILT in parameter 107 and repeating the steps above.

5) Programming

AMA

Some final notes:

When working with AEO remember:

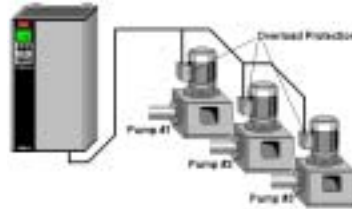
118- Set this parameter to the Power Factor of the motor.

Check the motor name plate for this number.

If unavailable talk to the motor manufacturer to obtain this number

The newest software for the drives will provide for the insertion of the motor's power factor. This will greatly improve the operation of AEO function. When working with six and eight pole motors the power factor of the motor drops below the old internal number of 0.75. AEO was never efficient if the power factor was below the internal. You now have the ability to adjust the number so the function will work better.

5) Programming



MULTIPLE MOTORS

- **TORQUE CHARACTERISTICS**
MULTIPLE MOTORS (cannot use AEO)
Use VT LOW, VT MED or VT HIGH
- 107 AUTO MOTOR ADAPT**
NO AMA
- 108 MULTIM. STARTVOLT**
The lowest value that provides a reliable start
OR Adjust for the lowest starting current

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The first thing to do once power is applied to the drive is to enter the motor information. Because the drive uses this information to produce an accurate mathematical model of the motor, this is an essential step.

Parameter 101 indicates whether the drive is controlling a single motor (AEO function) or multiple motors simultaneously.

Use parameters 102 through 106 to enter the motor nameplate data that was recorded earlier.

For a single motor application, now run the Automatic Motor Adaptation routine. In parameter 107 choose RUN AMA, press OK, and give the drive a run command. After the AMA test is successfully completed, press the RESET key on the drive to leave the test mode.

6) Operation



Off/Stop

- Stops the drive in all modes
- OFF LOCAL STOP or OFF REM. STOP is displayed on the LCP
- The second line of the LCP display **FLASHES** when this key has been pressed

The OFF STOP key on the LCP overrides all drive run commands. When it is pressed, the word STOP displays in the lower right corner of the LCP's display. In addition, the large second line of the display flashes to indicate that a local stop command was given.

6) Operation



- Total reference (%)
- Total reference (unit)
- Output frequency (Hz)
- Output frequency (%)
- Motor current
- Output power (kW)
- Output power (HP)
- Output energy (kW-h)
- Running hours
- Custom readout, related to frequency
- Setpoint 1 & 2 (unit)
- Feedback 1, 2 & total (unit)
- Motor voltage
- DC bus voltage
- Motor thermal load (%)
- Drive thermal load (%)
- Digital inputs
- Relay Status
- Analog inputs, all three
- Pulse reference
- External reference (%)
- Heat sink temp. (°C)

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It is possible to cycle through all of the meter displays by simply pressing the + or - keys on the drive's LCP.

Some of these meters, such as output frequency, motor current, and output power are useful in displaying the drive's present operating status. The custom readout can be programmed to display some speed-related quantity, such as flow, pressure, or power. The display takes into account the proper relationship between speed and the displayed quantity, whether it is linear, quadratic, or cubic.

Output energy and running hours are useful in performing studies of the operation of the controlled system over time.

The set point and feedback displays can be helpful in setting up the drive's PID controller.

Drive and motor thermal load, digital and analog input status displays and the drive's heat sink temperature provide handy troubleshooting tools.

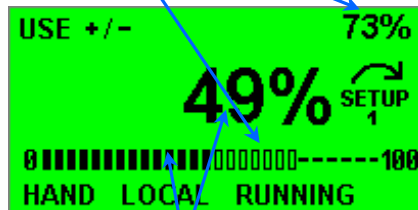
6) Operation

HAND Operation Test



- Press **HAND START**
- Press **+** to accelerate the drive to make the motor *just start*

frequency command (%)



running frequency (%)

For the initial operational test, press the HAND START key to start the drive and press the + key until the motor just starts to rotate.



6) Operation

HAND Operation Test

- **Check the motor's rotation direction from the drive**
 - **If incorrect**
 - **Disconnect input power from the drive**
 - **Reverse any two motor leads**
- **If there is a bypass, check the motor's rotation direction in bypass**
 - **If incorrect**
 - **Disconnect input power from the drive**
 - **Reverse any two input power leads**

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Check the rotation direction of the motor while it is being controlled by the drive. If it is incorrect, reverse the connections of any two of the motor leads.

If the drive is equipped with a constant speed bypass, briefly start the motor in bypass mode and again check the direction of its rotation. If it is incorrect, reverse the connections of any two of the incoming power leads. This will not change the rotation of the motor when it is controlled by the drive because the power circuitry of the drive is not sensitive to the input phase rotation.

It is important to follow these procedures to ensure proper motor rotation. Do not change any of the wiring in the drive's auxiliary enclosure or set up the drive for reverse operation to correct a rotation problem.



6) Operation

HAND Operation Test

- Press **OFF STOP**
- Press **+** to command **100% speed**
- Press **HAND START**
 - Can the drive reach maximum speed?
 - Does the top line show **CURRENT LIMIT?**
- Press **OFF STOP**

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This test is to ensure that the driven system operates as desired during maximum acceleration and deceleration.

If the drive has a bypass, be sure to switch it to DRIVE. With the drive stopped in the local speed control mode, use the + key on the keypad to set the local speed command to 100%. Then press the HAND START key. Observe the drive and the system for proper operation. Now press the OFF STOP key and observe the drive and the system as it decelerates to a stop.

Adjust the acceleration and deceleration ramp times to obtain the desired operation.

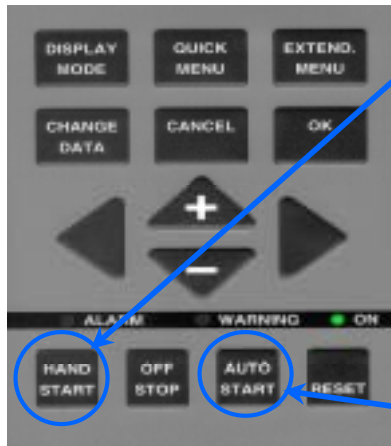
6) Operation

HAND Operation Test

- **Slowly run the drive over the entire speed range**
- **Note any resonant speeds (speeds where the motor or load begin to vibrate excessively)**

Now use the + and - keys to run the system over the entire operating range. Scan the operating speed range slowly and note any speeds where the system vibrates excessively or indicates any other operational problems. These will be addressed later.

6) Operation



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• Hand/Start

- To control drive start/stop and speed remotely
- To start the drive locally. Control drive speed using the “+” and “-” keys

• Auto/Start

The HAND START key gives the drive a run command that can start the drive regardless of the status of the building automation system's run/stop command. Generally, pressing the HAND START key also puts the drive into the local speed control mode, where its speed is determined by the operator using the LCP's + and - keys.

The AUTO START key puts the starting and stopping of the drive under the control of the building automation system's run/stop command. Generally, pressing AUTO START also puts the drive in the remote speed control mode, where the building automation system determines the speed of the drive.



6) Operation

AUTO Operation

Configuration

100 CONFIG. MODE

OPEN LOOP

The drive receives a speed command from the building automation system

CLOSED LOOP

The drive receives a feedback signal from the system, compares this with the desired set point and determines the correct motor speed

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Now it has been determined that the system can be run over the entire operating speed range. The next step is to ensure that it can be controlled by the building automation system. The most common type of a control system for the drive is open loop control. This is where the building automation system determines the proper operating speed for the drive and gives the drive a speed command.

The first step in setting up an open loop speed control system is to set the range of the speed reference signal.

Parameters 204 and 205 (maximum and minimum reference) are generally set to equal parameters 201 and 202 (maximum and minimum frequency). In this way, the drive will be at minimum speed when the speed reference is minimum and it will be at maximum speed when the speed reference is maximum. When the speed reference signal is half way between minimum and maximum, the drive's output speed will be half way between minimum and maximum speed.

6) Operation



Open Loop	Analog Inputs		
	Term 53	Term 54	Term 60
	0-10 V	0-10 V	4-20 mA
<u>FUNCTION</u> *	308	311	314
<u>SCALE LOW</u>	309	312	315
<u>SCALE HIGH</u>	310	313	316

- * Set the FUNCTION of the terminal used for speed control to REFERENCE.
Set the FUNCTION of unused terminals to NO OPERATION.

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The most common method of controlling the speed of the drive is using the analog input terminals. If the building automation system can't successfully control the speed of the drive throughout the speed range, the first thing to check is the programming of the analog input terminals. The terminal that is used for the speed reference command should have its function set to "REFERENCE". Any unused terminals should have their functions set to "NO OPERATION".

If the building automation system controls the drive's speed, but the drive doesn't run over its entire speed range, adjust the minimum and maximum scaling parameters for the input.

The drive's ability to display the actual value of all analog input signals can be very helpful in troubleshooting any problems.

6) Operation

AUTO Operation

Open Loop

Two ways to adjust the reference follower

204 MIN. REFERENCE

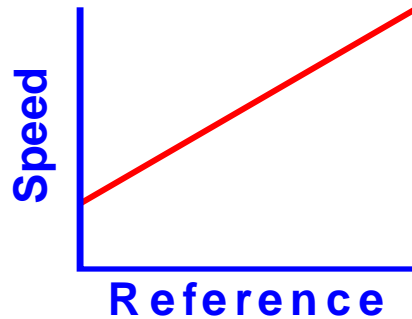
=

201 MIN. FREQUENCY

205 MAX. REFERENCE

=

202 MAX. FREQUENCY



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Now it has been determined that the system can be run over the entire operating speed range. The next step is to ensure that it can be controlled by the building automation system. The most common type of a control system for the drive is open loop control. This is where the building automation system determines the proper operating speed for the drive and gives the drive a speed command.

The first step in setting up an open loop speed control system is to set the range of the speed reference signal.

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6) Operation

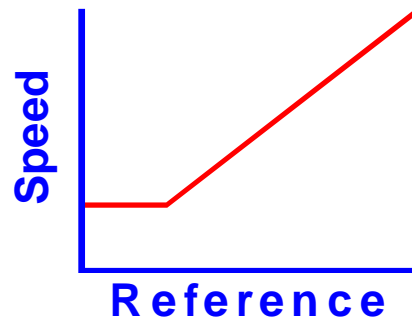
AUTO Operation

Open Loop

204 MIN. REFERENCE
= 0

205 MAX. REFERENCE
=

202 MAX. FREQUENCY



For some applications it is important for the drive to be at half speed (30 Hz) when the speed reference is half. This is accomplished by setting parameter 204 (minimum reference) to 0 Hz. Note that this method results in a "dead band" at the bottom of the speed range. Any time the speed reference signal is below the drive's minimum speed, the drive will produce minimum output speed.

6) Operation

AUTO Operation Test

Open Loop

- Press **AUTO START**
- Have the system provide
 - A run command
 - A speed reference signal
- Run the drive over the speed range
 - Does it run over the entire speed range?



To start the drive in automatic control mode, press the AUTO START key on the drive's Local Control Panel.

Have the building automation system give the drive a run command. Once the drive is running, have the building automation system command the drive to operate throughout the speed range. Ensure that this is possible.

6) Operation

AUTO Operation Note

Open Loop

For all serial communications, parameters **503** through **508** determine if the digital inputs or the serial bus controls specific drive functions

RS-485

- Terminate: SW 2&3
- Par. 500: Protocol
- Par. 501: Address
- Par. 502: BAUD
- Bus time-out function in the high 500s

High Speed Bus

- Terminate on board
- Board installed
- Address on board
- Higher parameter groups set special functions

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In addition to controlling the drive's speed using the analog and digital inputs, it is also possible to control the drive using a serial communications bus.

If the serial communications protocol used is the drive's own FC protocol (for use with VLT Software Dialog).

If a high speed bus, such as LonWorks, is used, the connections are made on the special communications card and communications is set up using parameter groups 800 and 900.



7) Final Adjustments

As Required

- **If resonance was noted during manual operation**

109 RESONANCE DAMP.
100% (OFF - 500%)

or

216 FREQ BYPASS B.W.

217 BYPASS FREQ. 1

218 BYPASS FREQ. 2

219 BYPASS FREQ. 3

220 BYPASS FREQ. 4

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The following instructions apply to either open loop or closed loop systems.

Operate the drive manually at any speeds where excessive vibration due to resonance was previously noted. First try adjusting parameter 109 to see if the drive's build-in resonance damping algorithm can solve the problem.

If the resonance problem persists, use parameters 216 through 220 to force the drive to skip over the resonant speeds.

7) Final Adjustments



As Required

402 FLYING START

ENABLE

for fans

DISABLE

for pumps

DC BRAKE AND START

for special situations

Also set

114 DC BRAKE CURRENT

115 DC BRAKING TIME

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The purpose of flying start is to allow the drive to reliably start the motor when the motor is already spinning. There are three possible settings for flying start.

ENABLE causes the drive to test to see the speed and direction of the motor before starting. It does this by producing a range of output frequencies in each direction. The drive measures the output current at the tested frequencies. If the output current is high, the output frequency tested is incorrect. When the drive's output current is low, the drive has determined the motor's speed. It then uses this frequency to start the motor.

In lightly loaded applications, the testing done by flying start may cause the motor to rotate. If this is objectionable, it may be desirable to DISABLE flying start.

In difficult applications, it may be best to use DC BRAKING to stop the motor before attempting to start it. When this option is chosen, parameter 114 is used to set the DC braking current and parameter 115 is used to set the amount of time that this current is applied before starting the motor. Experimentally determine the proper values for these parameters by running the motor at full speed and allowing it to coast. Activate DC braking and determine the values of these parameters that will bring the motor to a stop.

7) Final Adjustments



As Required

Lock-outs

012 HAND START BTTN

013 STOP BUTTON

014 AUTO START BTTN

015 RESET BUTTON

If necessary, any or all of the keys on the bottom of the Local Control Panel (LCP) can be disabled. Before doing this, be sure that the user understands the impact of disabling these keys.



7) Final Adjustments

As Required

Saving parameter settings

003 SETUP COPY
COPY TO ALL

004 LCP COPY
UPLOAD ALL PARAMET.

016 DATA CHANGE LOCK
LOCKED

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If only one setup is used, copy the parameters from this setup to all other setups. This provides a backup in case one of the parameters is changed inadvertently.

As an added backup, copy all parameters to the Local Control Panel (LCP). This can also be helpful if a number of drives are connected to similar systems. The LCP from one drive can be used to transfer its parameters to the other drives, even if they are driving different sized motors.

If the user desires, parameter 16 can be used to lock out any other parameter changes.

7) General Troubleshooting



- **Messages on the display**
 - **AUTO START**
The drive has tripped off and is in the process of automatically re-starting
 - **TRIP**
The drive has tripped off and it is necessary to press RESET to restart
 - **TRIP LOCKED**
The drive has tripped off and power must be removed to restart

If an operating problem causes the drive to stop, the message on its display will indicate its status in plain language.

7) General Troubleshooting



- Refer to the Warnings and Alarms section of the Instruction Manual
- Check the tightness of all connections
- Check all wires for proper locations
- Measure input signals using the drive's display
- Check the drive input and output for balanced voltage and current

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The back of the Installation, Operation and Maintenance Manual gives additional information about messages that the drive may display, along with providing troubleshooting assistance.

As with troubleshooting any type of electrical equipment, it is always wise to be sure that all connections are tight and are properly wired.

The displays of input analog and digital signals that are provided by the Local Control Panel (LCP) can be very helpful for control system troubleshooting.

If the problem seems to relate to the system's power circuitry, it can often be helpful to measure the input and output voltage and current of the drive. The exact values of these readings isn't always critical. It is more important to be sure that the current and voltage on all three input power leads is the same. In the same way, the output voltage and current from the drive to the motor should be balanced.