



PHASE



PHASE CONVERTING | 115V & 230V | CONSTANT PRESSURE
NEMA 3R OUTDOOR ENCLOSURE | 2-5 HP

SAFETY MESSAGES AND WARNINGS

To ensure safe and reliable operation of Phase Technologies variable frequency drives, it is important to carefully read and understand this manual and to read and observe all warning labels attached to the drive before installing the equipment. Please follow all instructions exactly and always keep this manual with the equipment for quick and easy reference.

Definitions of Warning Signs and Symbols



CAUTION: Indicates a potentially hazardous situation that could result in injury or damage to the product.



WARNING: Indicates a potentially hazardous situation that could result in serious injury or death.



HIGH VOLTAGE: Indicates high voltage. The voltage associated with the procedures or operations referenced could result in serious injury or death. Use caution and follow instructions carefully.

| |
|----------------------------------------------------------------------------|
| <h3>READ THESE WARNINGS BEFORE INSTALLING OR OPERATING EQUIPMENT!</h3> |
|----------------------------------------------------------------------------|



WARNING: Risk of electric shock. De-energize the unit by disconnecting all incoming sources of power, then wait for the time specified on the drive warning label, before servicing the equipment.



HIGH VOLTAGE: This equipment is connected to line voltages that can create a potentially hazardous situation. Electric shock could result in serious injury or death. This device should be installed only by trained, licensed, and qualified personnel. Follow instructions carefully and observe all warnings.



WARNING: This equipment should be installed and serviced by qualified personnel familiar with the type of equipment and experienced in working with dangerous voltages.




WARNING: Installation of this equipment must comply with the National Electrical Code (NEC) and all applicable local codes. Failure to observe and comply with these codes could result in risk of electric shock, fire, or damage to the equipment.





CAUTION: The **AUX1** through **AUX4** terminals are galvanically isolated, with approximately 5V potential between them. DO NOT apply voltage to the terminals. Use dry contacts only.





CAUTION: Circuit breakers or fuses, proper ground circuits, disconnect and other safety equipment and their proper installation are not provided by Phase Technologies, LLC, and are the responsibility of the end user.


 **CAUTION:** Long leads between the unit and the motor with an unfiltered PWM voltage can lead to dangerous voltage rise from reflected harmonics. Very long leads, such as in deep well submersible pump applications, may require the use of a sine wave filter to remove most of the harmonics from the waveform. Consult the factory or a knowledgeable source on motor protection filters if your motor is more than 50 feet from the drive.


 **CAUTION:** Failure to maintain adequate clearance for free flow of cooling air may lead to overheating of the unit and cause damage or fire.


 **WARNING:** Suitable for use in a circuit capable of delivering not more than 25 kA RMS symmetrical amperes, 240 VAC.


 **WARNING:** Wire used in the motor circuit and all field wiring terminals must be rated at least 60 °C.


 **WARNING:** Use wire size suitable for Class 1 circuits.


 **WARNING:** Input power connections should be made by a qualified electrician into a nominal 230V circuit for models with 230V input, with adequate current carrying capacity. Branch circuit protection to the drive should be provided by appropriate size fuses or circuit breaker. Circuit breaker and fuse ratings for each model are listed in **Table 4**.


 **WARNING:** These devices are equipped with integral solid-state short circuit protection. Integral solid-state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes.


 **CAUTION:** Use 600 V vinyl-sheathed wire or equivalent. The voltage drop of the leads needs to be considered in determining wire size. Voltage drop is dependent on wire length and gauge. Use copper conductors only.


 **CAUTION:** Wires fastened to the terminal blocks shall be secured by tightening the terminal screws to a torque value listed in **Table 4**.


 **CAUTION:** The maximum wire gauge for the input and output terminals are listed in **Table 4**.


 **CAUTION:** Never allow bare wire to contact the metal surfaces.


 **CAUTION:** Never connect AC main power to the output terminals U, V, and W.


 **WARNING:** Under certain conditions, the motor may automatically restart after a fault has stopped it. Make sure power to the drive has been disconnected before approaching or servicing the equipment. Otherwise, serious injury may occur.


 **WARNING:** Ingesting coin cell batteries can cause severe internal injuries or death. Store batteries out of reach of children, seek immediate medical attention if ingestion occurs, and follow any other consensus medical advice.

 **CAUTION:** Use caution when applying power to the main input terminals of the unit. If the drive is programmed to allow automatic restarts, the drive will initialize in AUTO mode and the motor load may start as soon as the drive is energized.

 **CAUTION:** The AC motor load must be connected directly to the output terminals of the drive. Do not install relays, disconnect switches, or wire nuts between the drive and the motor load.

 **CAUTION:** Before the motor is connected to the output terminals, check all output lines for line-to-ground faults using a megger. There is a direct path through the drive circuitry for ground fault currents that can be triggered when power is applied to the input terminals, even though the output switches are not activated. These currents can cause serious damage to drive circuitry and are not covered under warranty.

 **CAUTION:** Before touching any printed circuit board, place a hand on a bare metal surface of the unit to discharge any static electricity. Electrostatic discharge (ESD) can damage printed circuits and their components.

 **CAUTION:** When the parameter, **1.2.1 ENABLE RESTARTS**, is set to YES, the drive will energize in AUTO mode. The motor load may automatically run as soon as the drive is energized. To stop the motor, push the STOP/OFF key until the display indicates MANUAL or OFF, or open AUX1 or AUX2. The RUN and STOP keys only work when in MAN mode. Refer to the section on Keypad and Display for instructions on operating the keypad.


 **CAUTION:** Operating the system in MANUAL mode on the keypad overrides remote signals from any remote controls. Operating the system in this mode may lead to dangerous pressures in closed plumbing systems.

TABLE OF CONTENTS

| | |
|----------------------------------------------|-----------|
| 1 MODELS AND RATINGS | 6 |
| 1.1 Specifications | 6 |
| 1.2 Model Ratings | 6 |
| 1.3 Dimensional Drawings | 7 |
| 2 INSTALLATION | 8 |
| 2.1 Mounting..... | 8 |
| 2.2 General Wiring Considerations | 9 |
| 2.3 Installing Power Cables | 10 |
| 2.4 Output Filters | 10 |
| 2.5 Control Terminals..... | 11 |
| 3 PROGRAMMING | 12 |
| 3.1 Constant Pressure Setup..... | 12 |
| 3.2 Menu Structure Overview..... | 13 |
| 4 FAULTS AND MAINTENANCE | 15 |
| 4.1 Fault Codes..... | 15 |
| 4.2 Fault Log | 16 |
| 4.3 Routine Inspection and Maintenance | 16 |
| 5 WARRANTY POLICY | 17 |

1 MODELS AND RATINGS

1.1 Specifications

Table 1 – Alpha Drive Specifications

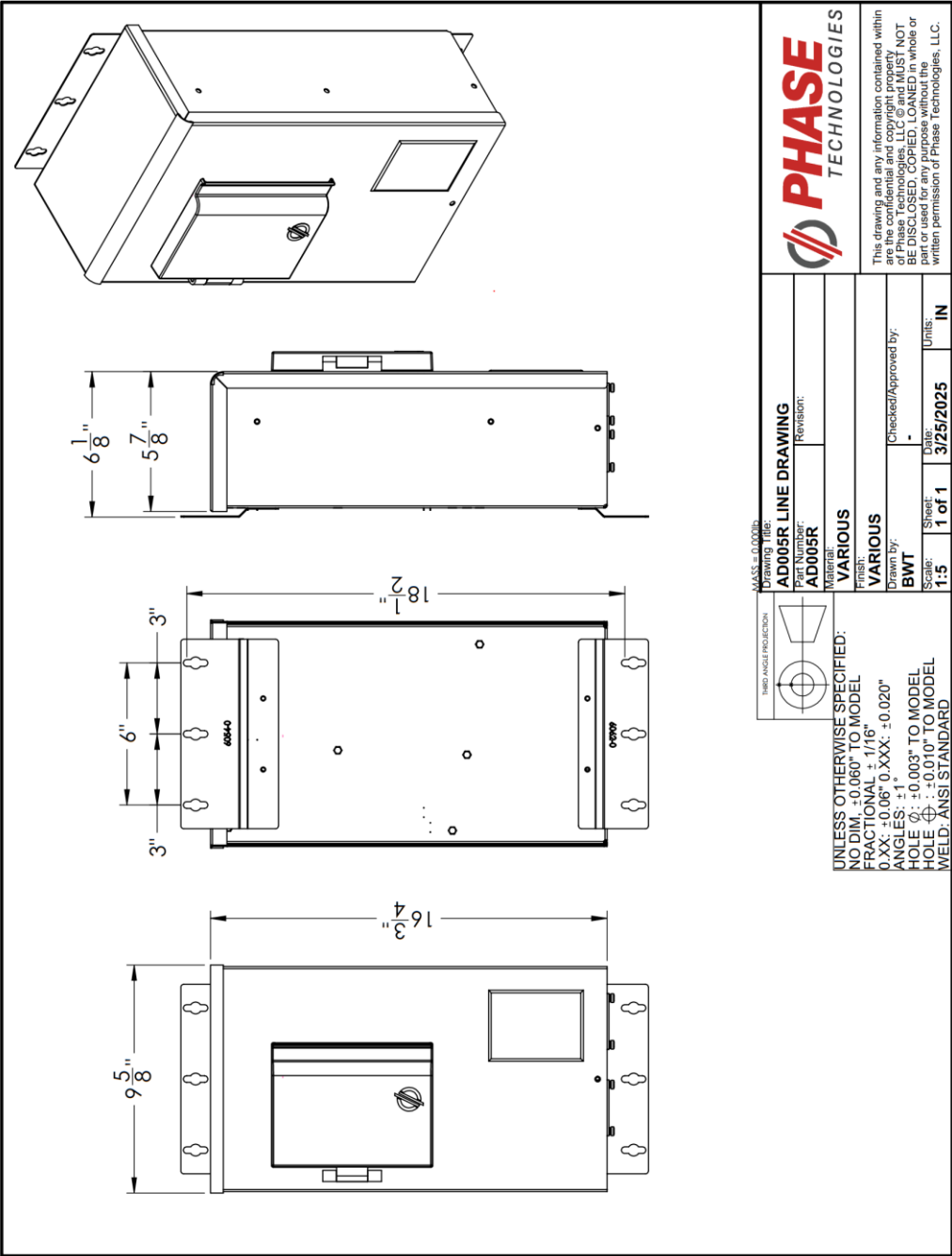
| Specs | Range |
|------------------------------|--------------------------------------|
| Operating Temperature | -20°C – 55°C (-4°F – 131°F) |
| Storage Temperature | -40°C – 60°C (-40°F – 140°F) |
| Enclosure | NEMA Type 3R |
| Input Frequency | 50/60 Hz (1-phase) |
| Output Frequency | 5 - 120 Hz |
| Switching Frequency | 2 - 8 kHz |
| Short Circuit Current Rating | 5 kA RMS symmetrical Amperes |
| Efficiency | > 98% |
| Certification | UL 61800-5-1 CSA C22.2 No. 274-17 |

1.2 Model Ratings

Table 2 – Ratings

| Model / Part Number | HP Range | Input Voltage 230V 3-Phase Output (115V 1-Phase Output) | Motor Type | Rated Current (Input) | Rated Current (Output) |
|---------------------------|-------------|---------------------------------------------------------------|-------------|--------------------------|---------------------------|
| AD002R | 0.5 - 2HP | 96V - 275V | 1 & 3-Phase | 20 A | 9 A |
| AD003R | 0.5 - 3HP | 96V - 275V | 1 & 3-Phase | 30 A | 12 A |
| AD005R | 0.5 - 5HP | 96V - 275V | 1 & 3-Phase | 47 A | 20 A |

1.3 Dimensional Drawings



2 INSTALLATION

2.1 Mounting

The drive must be mounted in an upright position with adequate clearance for cooling and maintenance access. The mounting surface must be sturdy, non-flammable, and capable of bearing the weight of the unit. Fasten the unit to the mounting surface using screws or bolts of an appropriate size through the holes on the mounting brackets. Lifting hooks are provided on the top of some enclosures.

To allow for proper cooling and air circulation around the enclosure, maintain minimum clearances depicted in **Figure 1**. The drives are cooled by fans with ventilation openings on the bottom of the enclosure. The surface around the enclosure should be non-flammable material and clear of obstacles. Locate the drawing in **Section 1** for dimensions and mounting hole locations.

⚠ CAUTION: Failure to maintain adequate clearance may lead to overheating of the unit and cause damage or fire. Obstructions blocking intake fans can damage fans.

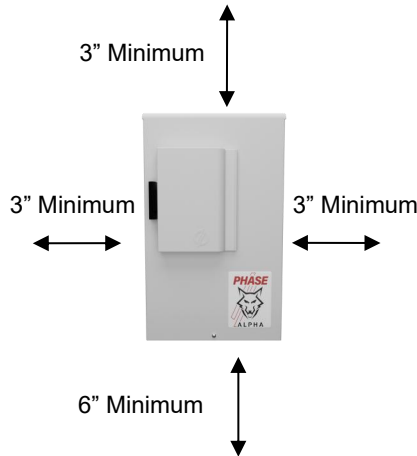


Figure 1 – Minimum Clearances

2.2 General Wiring Considerations

Installations must comply with all NEC and local electrical code requirements. Circuit breaker and fuse sizes listed in **Table 4** are maximum allowable sizes, not recommended sizes. The NEC dictates that circuit breakers must be rated at least 25% higher than the input current rating.

Table 3 – Power Terminal Descriptions

| Terminal Name | Description |
|----------------|----------------------------------------------|
| L1, L2 (Line) | Input power terminals |
| U | Start winding output power terminal |
| V, W | 1-Phase motor winding output power terminals |
| U, V, W (Load) | 3-Phase output power terminals |
| GND | Earth safety ground |

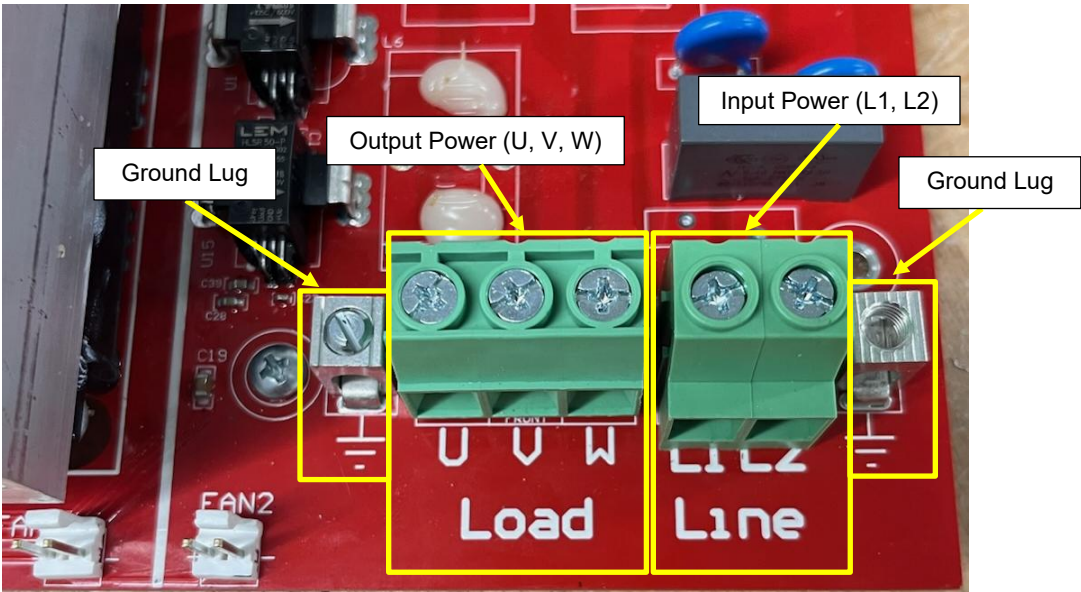


Figure 2 – Alpha Drive Power Terminal Location

Table 4 – Alpha Drive Input Circuit Breaker and Fuse Ratings (Inverse Time Circuit Breaker)

| Model | Input/Output | | | Maximum Circuit Breaker / Fuse Rating Class J |
|--------|-----------------|-------|----------------|--------------------------------------------------------|
| | Wire Size Range | | Torque (lb·in) | |
| | Min | Max | | |
| AD002R | 26 AWG | 6 AWG | 10.5 lb-in | 50 A, 600 V |
| AD003R | 26 AWG | 6 AWG | 10.5 lb-in | 70 A, 600 V |
| AD005R | 26 AWG | 6 AWG | 10.5 lb-in | 100 A, 600 V |

2.3 Installing Power Cables

⚠ CAUTION: Continuous metal conduit should be used on all power cables, both line and load side, to reduce conducted and emitted radiation of electromagnetic interference (EMI). The conduit must be securely grounded to the enclosure of the drive and the motor case. If any conduit holes remain unused, they must be covered with a 3R hole plug to maintain the NEMA 3R rating.

Mitigating Electromagnetic Interference (EMI)

Conducted and emitted noise can sometimes interfere with radio signals or sensitive electronic equipment near the installation. The use of shielded cables and rigid metal conduit on the output lines between the drive and the motor is recommended to help reduce EMI.

When it is not practical to use continuous metal conduit, special shielded cables can be used. The shielded cable should be constructed with symmetrical conductors and a copper or aluminum shield covered with an insulating jacket. A good shield results in lower EMI and lower motor bearing currents.

Routing Power Cables

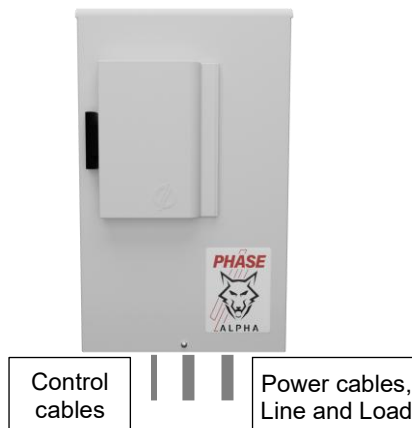
Power cables should enter only through the bottom of the drive enclosure directly beneath the power terminals. Do not install line-side power cables in the same conduit or cable tray with load-side power cables. Also, do not route control cables through the same conduit or cable tray as power cables. Unused conduit holes must be covered with a conduit hole plug.

Routing Control Wires

A separate, smaller conduit opening is supplied for control cables. If the control cables must intersect the power cables, make sure they cross at right angles.

⚠ CAUTION: Avoid routing control cables near power cables to avoid coupling EMI onto control cables.

⚠ CAUTION Use an appropriately sized hole punch. Do not use a hole saw to create openings! Metal filings may damage the drive and void the warranty.



2.4 Output Filters

Some installations may require a dV/dt filter or sine wave filter between the drive and the motor. **Output filters are typically only necessary when motor leads exceed 50 ft.** Over time, voltage spikes due to long motor

leads will degrade insulation and result in motor failure. Consult your motor manufacturer if you are unsure if it requires an output filter.

2.5 Control Terminals

⚠️WARNING: Do not connect Control Terminals to external circuits with voltage greater than that specified for each Control Terminal in **Table 5**.

The drives are equipped with control terminals that allow several control functions, including remote ON/OFF control, digital output signals, remote notification, and operation of constant pressure water systems. **4-20 mA pressure transducers should be wired into I1+ and I1-.**

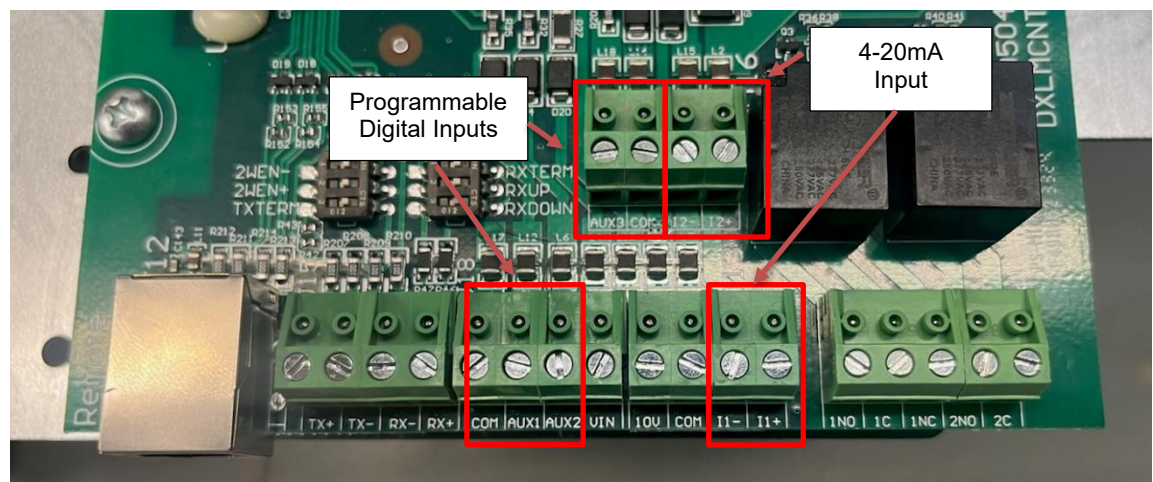


Figure 3 – Control Terminals

Table 5 – Control Terminal Ratings and Descriptions

| Terminal | Description | Rating | Comments |
|----------|------------------|---------------------------------|-----------------------------------------------------------------|
| I 1+ | 4-20 mA Positive | 4-20 mA | Analog transducer connection for analog constant pressure. |
| I 1- | 4-20 mA Negative | | |
| I 2+ | 4-20 mA Positive | | |
| I 2- | 4-20 mA Negative | | |
| AUX1 | Auxiliary 1 | < 5 Volts galvanically isolated | Programmable digital input. Commonly used for RUN/STOP command. |
| AUX2 | Auxiliary 2 | | |
| AUX3 | Auxiliary 3 | | |
| COM | Common | - | Common for all terminals except programmable relays. |

3 PROGRAMMING

3.1 Constant Pressure Setup

Upon first power up of the Alpha Drive, the screen will display the Constant Pressure (CP) Wizard. The Wizard can also be accessed at any time by resetting the drive to factory defaults by pressing and holding the **BACK** and **ENTER** buttons simultaneously for 3 seconds. The CP Wizard allows users to program constant pressure systems in only a few minutes.

Table 6 – Constant Pressure Wizard

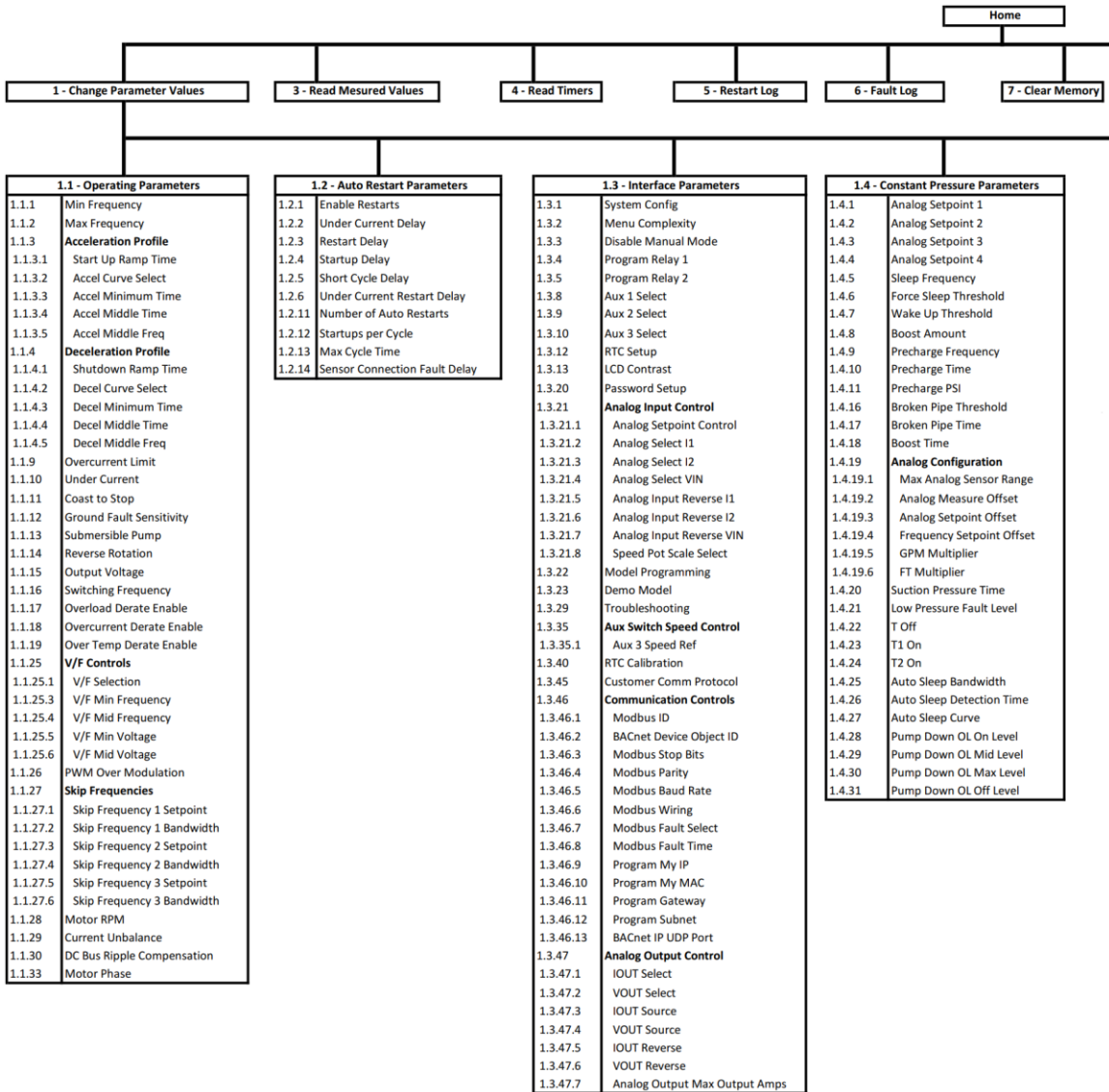
| PROMPT | DESCRIPTION |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Setup Constant Pressure Wizard? | Press ENTER to go through the wizard. Press HOME to return to Home screen. |
| Motor Phase | Select whether the motor to be run is single-phase or three-phase. |
| Input Voltage* | Select whether the incoming voltage and motor rating is 120VAC or 240VAC. |
| Motor Type* | Select whether the motor is a 2-wire or 3-wire motor. |
| Motor Manufacturer* | Select the manufacturer of the motor to be run. If your motor manufacturer is not an option listed, select "Other". |
| Max Analog Sensor Range | Set the psi range of the 4-20 mA sensor being used. Default is 150 psi. |
| Analog Setpoint 1 | Determines the pressure you want to maintain. Default is 50 psi. |
| Submersible Pump | ENABLE THIS FEATURE WITH SUBMERSIBLE PUMPS. When enabled, frequency will ramp from stop to the value set by parameter 1.1.1 MIN FREQUENCY in one second. Submersible pumps suffer damage to the thrust bearing if operated below 30 Hz for more than 1 second. Selecting NO will cause frequency to ramp in a linear fashion from 0 to 1.1.2 MAX FREQUENCY . |
| Disable Manual Mode | Selecting "YES" will disable manual operation of the VFD. Selecting "NO" will allow the VFD to be run manually at 1.1.2 MAX FREQUENCY . |
| Overcurrent Limit | Setting for motor overload protection, Trip Class 10 curve. This should typically be set to the Service Factor Amp rating of the motor. |

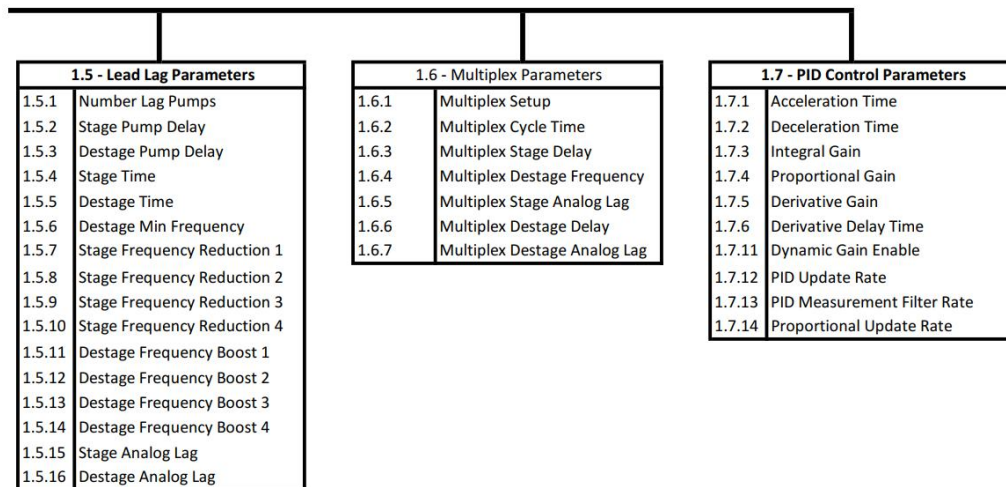
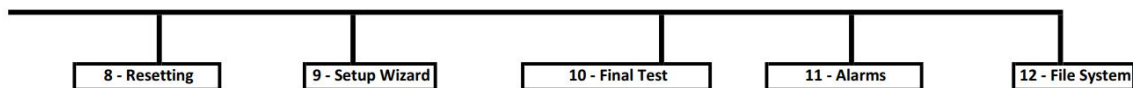
* - denotes prompts that will only be seen if Motor Phase is set to Single-Phase.

Additional Notes:

1. Motor rotation must be verified upon completion of Constant Pressure Setup.
2. If the VFD is not going to sleep, first check for leaks. If there are no leaks present, you may need to increase **1.4.5 SLEEP FREQUENCY**.
3. Set pressure tank psi to 70% of the **VFD Analog Setpoint 1**.
4. Any of these settings can be modified after initial setup. See the next two pages for a complete list of parameters. See [Alpha Drive Complete User's Manual](#) on the Phase Technologies website for a detailed description of what each parameter does.

3.2 Menu Structure Overview





4 FAULTS AND MAINTENANCE

4.1 Fault Codes

Table 7 – Fault Codes

| MESSAGE | DESCRIPTION / COMMENTS | PARAM RELATED ⁽¹⁾ | NO AUTO RESTARTS ⁽²⁾ |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|---------------------------------|
| Broken Pipe Fault | Indicates the possibility of a broken pipe. Fault is triggered when drive cannot reach the Analog Setpoint. Check parameter 1.4.16 BROKEN PIPE THRESHOLD to eliminate the possibility of nuisance fault. | X | |
| Bus Overvoltage | Sudden and severe regenerative power under high line voltage conditions may result in bus overvoltage. Check line voltage or consider increasing ramp up and ramp down times. Will trip if bus reaches 470 VDC on 230V systems or 930VDC on 460V systems. | | |
| Bus Voltage Unbalance | The DC bus voltages are more than 10% unbalanced. Can be caused by bus cap failure. | | |
| Current Unbalance | Motor current unbalance has exceeded the 1.1.29 CURRENT UNBALANCE limit. Check motor load for normal operation. Fault can be bypassed by increasing parameter 1.1.29 CURRENT UNBALANCE . | X | |
| Ground Fault | A fault between an output line and earth has been detected. Immediately disconnect input power and check output lines with a megger to verify fault. The sensitivity of fault detection can be adjusted by the parameter 1.1.12 GROUND FAULT SENSITIVITY . | X | X |
| High Input Voltage | Input voltage has exceeded the following levels for 10 seconds: 264VAC for 230V systems, 520VAC for 460V systems. Reduce input voltage. | | |
| Low Input Voltage | Input voltage has fallen below a level for safe operation of the drive. Will trip on startup if input voltage is below 190VAC for 230V systems or below 440VAC for 460V systems. | | |
| Motor Overload | Output current has exceeded the value set by parameter 1.1.9 OVER CURRENT LIMIT . Check motor load. Ensure that 1.1.18 OVERCURRENT DERATE ENABLE is set to YES. | X | |
| OP Hall Sense Hi | Current exceeded the maximum rating of the output CM board. May indicate a fault in the motor circuit or internal fault. | | |
| Output Fault | High current as measured by the IGBT. Check for short circuit on output lines and load. Output IGBT desat protection triggers this fault. | | |
| Output Overload | Indicates a large and sudden overcurrent on the output module. Check motor circuit for faults. The overcurrent may be of a very short duration that cannot be captured by amp meters. Ensure that 1.1.17 OVERLOAD DERATE ENABLE is set to YES. If an output filter is installed, verify it is wired correctly. | X | |
| Over Temperature | Internal temperature of IGBT has exceeded 113°F. Reduce ambient temp. Check fan operation and ventilation openings for obstruction. Ensure that 1.1.19 OVER TEMPERATURE DERATE ENABLE is set to YES. | X | |
| Sensor Connection Fail | 4-20mA or 10VDC analog signal is not present on Control Terminals. This could indicate failure of the analog sensor or a disconnected sensor cable. | | |
| Under Current | Motor current has fallen below the value set by parameter 1.1.10 UNDER CURRENT . Commonly used to detect a dry well condition. | X | |

1 = Fault may be related to an adjustable parameter. Always check the value of the parameter to eliminate nuisance tripping.

2 = No automatic restarts allowed. The drive has shut down due to a potentially dangerous condition. Drive will remain OFF until fault is cleared. Turn power off and troubleshoot the system before restarting.

4.2 Fault Log

The Fault Log records the number of times a particular fault has occurred. To access the Fault Log, press the MENU key until the Main Menu item, **6 FAULT LOG**, then press ENTER. The Fault Log will continue to log the number of faults that have occurred until it is reset through **5 RESTART LOG** or **7 CLEAR MEMORY**. The Fault Log is not to be confused with the restart counter.

Table 8 – Troubleshooting

| PROBLEM | POTENTIAL CAUSE | SOLUTION |
|-------------------------------------------------------------------|------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Unit does not power up | Circuit breaker tripping | If incoming circuit breaker continually trips when VFD starts, the breaker and cable sizes should be sized by a certified electrician. Consider increasing breaker size. |
| Motor not running | Is a fault code indicated? | Based on the fault code, resolve any factors that are likely causing the fault. Clear the fault by pressing ENTER on the keypad or by cycling input power OFF/ON. |
| | Are the remote AUX switches closed? | Check the status of the switches or jumpers connected to AUX1 and AUX2 on the Control Terminals. The LCD display indicates the status of AUX terminals in the default display mode. All AUX terminals must be set to ON for the motor to run in AUTO mode. |
| | Are the signals to the Control Terminals corrupted? | Shielded cable is required for AUX terminal switch leads longer than 20 ft. Regular wire will induce capacitance in the line and corrupt control signals. Shielded cable is recommended for all control signal cables. |
| | Is the keypad in MAN or OFF mode? | The keypad will override signals on the Control Terminals when MANUAL mode is selected. Keypad must be in AUTO mode for external control signals to control the motor. |
| | Is MAX FREQUENCY set to 0 Hz? | Check the parameter 1.1.2 MAX FREQUENCY . |
| | Are the input terminals energized? | Check the input circuit breaker and fuses. |
| Motor is turning the wrong direction | Phase sequence on output terminals U, V, W is out of order | Swap any two of the three motor leads on the output terminals OR use parameter 1.1.6 REVERSE ROTATION via keypad. |
| Real Time Clock (RTC) clearing or not providing fault time stamps | Dead battery | Replace CR2032 battery, located on the Interface control board to the left of the graphic display. |

4.3 Routine Inspection and Maintenance

The unit should be inspected and cleaned at least annually or more frequently if it is in an excessively warm, salty, or dusty environment.

Overall: Perform a visual inspection checking for things such as discolored wires or terminals, evidence of arcing, loose mounting screws, physical damage to the enclosure, etc.

Power terminals: Inspect for loose connections and tighten to specifications in **Table 4**.

Capacitors: Check for leakage or deformation.

Fans and heatsinks: Excessive dust buildup on the heatsink and cooling fan impellers may lead to overheating. Lightly brush and vacuum clean.

5 WARRANTY POLICY

LIMITED WARRANTY



Phase Technologies' Alpha Drives are warranted against defects in material and workmanship for a period of three years. This warranty covers both parts and labor (at Phase Technologies) for three years from the date of purchase by the original owner. Phase Technologies will repair or replace (at our option), at no charge, any part(s) found to be faulty during the warranty period specified. The warranty repairs must be performed by/at a Phase Technologies Authorized Service Center or at Phase Technologies LLC, Rapid City, SD.

Obligations of the Original Owner

1. The original Bill of Sale must be presented to obtain "in-warranty" service.
2. Transportation to Phase Technologies or an Authorized Service Center is the responsibility of the original purchaser. Return transportation is provided by Phase Technologies.
3. Installations must comply with all national and local electrical codes.

Exclusions of the Warranty

This warranty does not cover any of the following: accident, misuse, fire, flood, and other acts of God, nor any contingencies beyond the control of Phase Technologies, LLC, including water damage, incorrect line voltage, improper installation, missing or altered serial numbers, and service performed by an unauthorized facility. Phase Technologies' liability for any damage caused in association with the use of Phase Technologies' equipment shall be limited to the repair or replacement only of Phase Technologies' equipment. No person, agent, distributor, dealer, or company is authorized to modify, alter, or change the design of this merchandise without express written approval of Phase Technologies, LLC.

Forum Selection

Any suit, claim, or cause of action arising from this document or any Phase Technologies product, will be governed by the laws of the State of South Dakota. It is agreed that jurisdiction and venue for all disputes will be the federal or state courts of South Dakota.

INSTALLATIONS MUST COMPLY WITH ALL NATIONAL AND LOCAL ELECTRICAL CODE REQUIREMENTS.