AMERICAN CONTROL ELECTRONICS™
An ISO 9001:2008 Certified Company

VFD603-5

Chassis, Microprocessor-based Variable Frequency Drive with Isolation for Single and Three Phase AC Motors

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Specifications

Model	Line Voltage (VAC)	Motor Voltage Range (VDC)	Continuous Motor Current (Amps)	Horsepower Range
VFD603-5	115 or 230	0 - 230	5.0	3/8 - 1 1/2

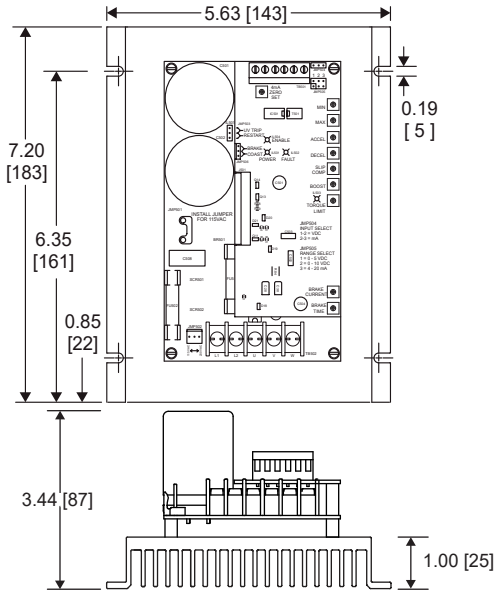
AC Line Voltage.....115/230 VAC ± 10%, 50/60 Hz, single phase
Output Frequency Range.....0 - 120 Hz
Acceleration Time Range (0 - 60 Hz).....1 - 12 seconds
Deceleration Time Range (60 - 0 Hz).....1 - 12 seconds
Adjustable DC Injection Current.....0 - 5 amps
Adjustable DC Injection Time.....1- 12 seconds
Analog Input *Voltage Range* (S1 to S2).....0 - 5; 0 - 10 VDC
Current Range (S1 to S2).....4 - 20 mA
Input Impedance (S1 to S2).....>100K ohms
Vibration *(0 - 50 Hz)*.....0.5G maximum
(>50 Hz).....0.1G maximum
Ambient Temperature Range.....10°C - 40°C
Weight.....2.48 lbs

Safety Warnings

READ ALL SAFETY WARNINGS BEFORE INSTALLING THIS EQUIPMENT

- **DO NOT INSTALL, REMOVE, OR REWIRE THIS EQUIPMENT WITH POWER APPLIED.** Have a qualified electrical technician install, adjust and service this equipment. Follow the National Electrical Code and all other applicable electrical and safety codes, including the provisions of the Occupational Safety and Health Act (OSHA), when installing equipment.
- **Circuit potentials are at 115 or 230 VAC above earth ground**. Avoid direct contact with the printed circuit board or with circuit elements to prevent the risk of serious injury or fatality. Use a non-metallic screwdriver for adjusting the calibration trim pots. Use approved personal protection equipment and insulated tools if working on this drive with power applied.
- Reduce the chance of an electrical fire, shock, or explosion by using proper grounding techniques, over-current protection, thermal protection, and enclosure. Follow sound maintenance procedures.
- **ACE strongly recommends the installation of a master power switch in the line voltage input.** The switch contacts should be rated for 250 VAC and 200% of motor nameplate current.
- **Removing AC line power is the only acceptable method for emergency stopping.** Do not use DC injection braking, decelerating to minimum speed, or coasting to a stop for emergency stopping. They may not stop a drive that is malfunctioning. Removing AC line power is the only acceptable method for emergency stopping.
- Line starting and stopping (applying and removing AC line voltage) is recommended for infrequent starting and stopping of a drive only. DC injection braking, decelerating to minimum speed, or coasting to a stop is recommended for frequent starts and stops. Frequent starting and stopping can produce high torque. This may cause damage to motors.
- **Do not disconnect any of the motor leads from the drive** unless power is removed or the drive is disabled. Opening any one lead while the drive is running may destroy the drive.
- Under no circumstances should power and logic level wires be bundled together.
- Be sure potentiometer tabs do no make contact with the potentiometer's body. Grounding the input will cause damage to the drive.
- Caution should be taken when operating fan-cooled motors at low speeds because their fans may may not move sufficient air to properly cool the motor. ACE recommends "inverter-duty" motors when the speed range is beyond 10:1.
- This product does not have internal solid state motor overload protection. It does not contain speed-sensitive overload protection, thermal memory retention, or provisions to receive and act upon signals from remote devices for over temperature protection. If motor protection is needed in the end-use product, it needs to be provided by additional equipment in accordance with NEC standards.

Dimensions



ALL DIMENSIONS IN INCHES [MILLIMETERS]

Installation

Mounting

- Drive components are sensitive to electrostatic discharge. Avoid direct contact with the circuit board. Hold the drive by the plate only.
- Protect the drive from dirt, moisture, and accidental contact.
- Provide sufficient room for access to the terminals and calibration trim pots.
- Mount the drive away from heat sources. Operate the drive within the specified ambient operating temperature range.
- Prevent loose connections by avoiding excessive vibration of the drive.
- Mount the drive with its board in either a horizontal or vertical plane. Four 0.18" (5 mm) holes in the heat sink accept #8 pan head screws.
- The heat sink should be earth grounded. Use a star washer beneath the head of at least one of the mounting screws to penetrate the anodized chassis surface and to reach bare metal.

Wiring

Use 18 - 24 AWG wire for logic wiring. Use 14 - 16 AWG wire for AC line and motor wiring.

Shielding Guidelines

As a general rule, it is recommended to shield all conductors. If it is not practical to shield power conductors, it is recommended to shield all logic-level leads. If shielding of logic-level leads is not practical, the user should twist all logic leads with themselves to minimize induced noise. It may be necessary to earth ground the shielded cable. If noise is produced by devices other than the drive, ground the shield at the drive end. If noise is generated by the drive, ground the shield at the end away from the drive. Do not ground both ends of the shield.

Fusing

The drive provides on board fusing for the AC line (L1, L2). Fuses are fast acting fuses rated for 20A at 250 VAC.

Connections

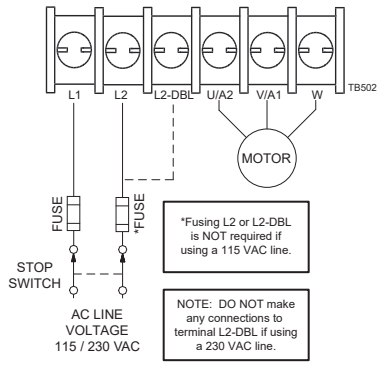
POWER (BOTTOM BOARD)

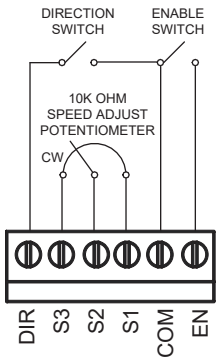
Line Input

Connect the AC line power leads to terminals L1 and L2. ACE recommends the use of a double-pole, single-throw master power switch. The switch should be rated at a minimum of 250 VAC and 200% of motor current.

Motor

Connect the motor leads to terminals U, V, and W. Refer to the Operations section for more detailed wiring setups with different AC motor types.





LOGIC (TOP BOARD)

Speed Potentiometer

Use a 10K ohm, 1/4 W potentiometer for speed control. Connect the counter-clockwise end of the potentiometer to S1, wiper to S2, and the clockwise end to S3. If the potentiometer works inversely of desired functionality, (i.e. to increase motor speed, you must turn the potentiometer counterclockwise), power off the drive and swap the S1 and S3 connections.

Analog Input Signal Range

Instead of using a speed adjust potentiometer, the drive may be wired to follow an analog input signal. This input signal can be in the form of voltage (0-5, 0 to ±10 VDC) or current (4-20 mA). Because these drives have built in isolation, the input signal can be grounded or ungrounded (floating). Connect the signal common (-) to S1 and the signal reference (+) to S2. See the Operations section for jumper settings.

Enable

Short terminals EN and COM to accelerate the motor to set speed. Open the ENABLE terminals to coast the motor to zero speed. If no ENABLE switch is desired, wire a jumper between terminals COM and EN. **Do not use the enable for emergency stopping**.

Direction

Short terminals DIR and COM to change the direction of the motor. If no direction switch is desired, leave this connection open.

Startup

SELECT SWITCHES

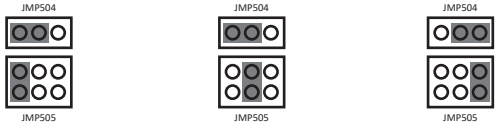
AC Line Select Jumper 1 (JMP501): If using a 115 VAC line source, place the U-shaped jumper that came attached to terminal W across JMP501.

AC Line Select Jumper 2 (JMP502): Set jumper JMP502 to 115 VAC if using a 115 VAC line. Set jumper JMP502 to 230 VAC if using a 230 VAC line.

Fault Restart / Trip (JMP503): Set jumper JMP503 to RESTART if the drive should automatically start running once a fault condition disappears. Set jumper JMP503 to UV TRIP if the drive should require a manual restart (toggling the ENABLE switch) before running again.

Control Signal Type (JMP504): Jumper pins 1 & 2 on JMP504 if using a potentiometer or analog voltage (VDC) signal. Jumper pins 2 & 3 if using a current (mA) signal.

Control Signal Range (JMP505): Jumper column 1 if using a potentiometer or 0-5 VDC analog signal. Jumper column 2 if using a 0-10 VDC analog signal. Jumper column 3 if using a 4-20 mA analog signal.



0-5 VDC or Potentiometer	0-10 VDC	4-20 mA
Jumper JMP504 1 and 2	Jumper JMP504 1 and 2	Jumper JMP504 2 and 3
Jumper JMP505 column 1	Jumper JMP505 column 2	Jumper JMP505 column 3

Braking Mode (JMP506): Jumper JMP506 to COAST to coast the motor to a stop whenever the drive is commanded to stop by opening the ENABLE switch. Jumper JMP506 to BRAKE to use DC Injection Braking whenever the drive is commanded to stop by opening the ENABLE switch. If using the BRAKE mode, trim pots BRAKE CURRENT and BRAKE TIME are in effect.

STARTUP

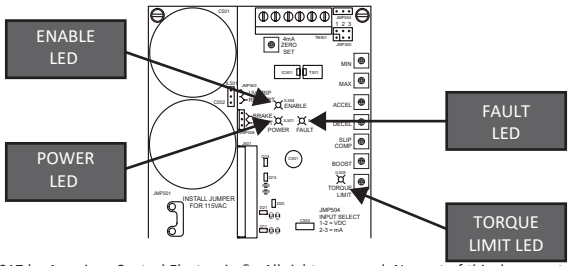
- Verify that no foreign conductive material is present on the printed circuit board.
- Ensure that all switches and jumpers are properly set.

1. Turn the speed adjust potentiometer full counterclockwise (CCW) or set the analog input voltage or current signal to minimum.
2. Apply AC line voltage.
3. Close the enable switch and verify that the green Power LED is on.
4. Slowly advance the speed adjust potentiometer clockwise (CW) or increase the analog input voltage or current signal. The motor slowly accelerates as the potentiometer is turned CW or as the analog input voltage or current signal is increased. Continue until the desired speed is reached.
5. Remove AC line voltage from the drive to coast the motor to a stop.

LEDs

Power (POWER): Green LED is solid when AC line voltage is applied to the drive.
Enable (ENABLE): Red LED is solid when the drive is enabled.
Current Limit (TORQUE LIMIT): Yellow LED is solid when the motor is trying to pull more amps than the limit set by the TORQUE LIMIT trim pot.
Fault (FAULT): Red LED is flashing when one of three fault conditions has occured:

Undervoltage - Internal DC BUS voltage dropped below 200 VDC.
Overvoltage - Internal DC BUS voltage exceeded 400 VDC.
Overcurrent Trip - Motor current exceeded 250% of drive's rating (12.5 amps)



Operation

MOTOR TYPES

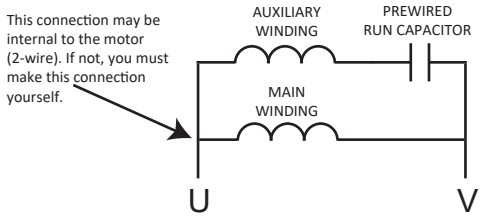
Acceptable motor types are 3-phase induction, permanent split capacitor (PSC), shaded pole, and AC synchronous. In general, the drive can work with capacitor-start motors, but it is conditional on the current pull when the capacitor is in effect and how long the application calls for a speed that the capacitor will stay in the auxiliary winding. It is recommended to contact the motor manufacturer to see if the motor can be run with a VFD.

The drive is designed to output a varying frequency and proportional voltage to vary a single phase motor's speed. However, single phase motors are optimized for full speed operation and may not operate with expected torque at speeds other than full rated speed. Since the drive has the capability to convert a single phase 115 VAC input into a three phase 230 VAC output, it is recommended to use three phase motors in new applications.

MOTOR CONNECTIONS

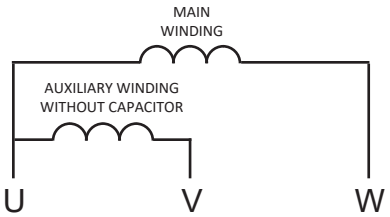
Single Phase Operation - Non-reversing

For single phase operation, connect the motor as show in the figure below. Ensure that the prewired capacitor and its associated motor coil are connected to terminals U and V as shown. This connection may be internal if using a 2-wire motor. If the motor has three leads, you must make this connection yourself.



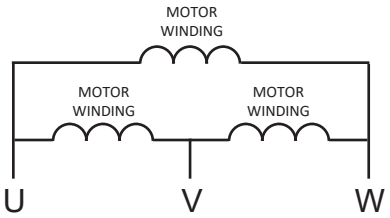
Single Phase Operation - Reversing

Remove the capacitor and connect the motor as show in the figure below. While allowing for solid-state reversing, this wiring scheme may result in sub-optimal motor operation. Depending on the motor construction and application requirements, the motor may need to be derated.



Three Phase Operation

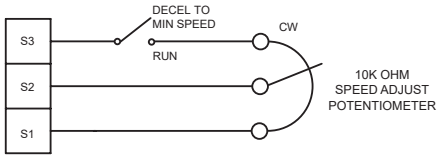
For three phase operation, connect the motor as show in the figure below. Connect to terminals U, V, and W as shown.



DECELERATING & STOPPING

Decelerate to Minimum or Zero Speed

The switch shown below may be used to decelerate a motor to a minimum speed. Opening the switch between S3 and the potentiometer decelerates the motor from set speed to a minimum speed determined by the MIN SPEED trim pot setting. If the MIN SPEED trim pot is set full CCW, the motor decelerates to zero speed when the switch is opened. The DECEL TIME trim pot setting determines the rate at which the drive decelerates. By closing the switch, the motor accelerates to set speed at a rate determined by the ACCEL TIME trim pot.



Calibration

Offset (4-20 mA ZERO SET): This setting eliminates any drift that may occur when 4 mA is applied when using a current analog signal for control. To calibrate the 4-20 mA ZERO SET trim pot:

1. Set the 4-20 mA ZERO SET trim pot full CCW.
2. Set the input current signal for minimum speed (ie 4 mA).
3. Adjust the 4-20 mA ZERO SET trim pot until the desired minimum speed is reached or is just at the threshold of rotation.

Minimum Speed (MIN): The MIN setting determines the minimum motor speed when the speed adjust potentiometer is set for minimum speed. It is factory set for zero speed. To calibrate MIN:

1. Set the MIN trim pot full CCW.
2. Set the speed adjust potentiometer or input voltage or current signal for minimum speed.
3. Adjust the MIN trim pot until the desired minimum speed is reached or is just at the threshold of rotation.

Maximum Speed (MAX): The MAX setting determines the maximum motor speed when the speed adjust potentiometer or input voltage or current signal is set for maximum speed. It is factory set for maximum motor rated speed. To calibrate MAX:

1. Set the MAX trim pot full CCW.
2. Set the speed adjust potentiometer or input voltage or current signal for maximum forward speed.
3. Adjust the MAX trim pot until the desired maximum forward speed is reached.

Check the MIN and MAX adjustments after recalibrating to verify that the motor runs at the desired minimum and maximum speeds.

Acceleration (ACCEL): The ACCEL setting determines the time the motor takes to ramp to a higher speed. To calibrate the ACCEL, turn the ACCEL trim pot CW to increase the acceleration time.

Deceleration (DECEL): The DECEL setting determines the time the motor takes to ramp to a lower speed. To calibrate the DECEL, turn the DECEL trim pot CW to increase the deceleration time.

Slip Compensation (SLIP COMP): The SLIP COMP setting determines the degree to which motor speed is held constant as the motor load changes. To calibrate the SLIP COMP:

1. Set the SLIP COMP trim pot full CCW.
2. Increase the speed adjust potentiometer until the motor runs at midspeed without load. A handheld tachometer may be used to measure motor speed.
3. Load the motor to its full load current rating. The motor should slow down.
4. While keeping the load on the motor, rotate the SLIP COMP trim pot until the motor runs at the speed measured in step 2. If the motor oscillates (overcompensation), the SLIP COMP trim pot may be set too high (CW). Turn the SLIP COMP trim pot CCW to stabilize the motor.
5. Unload the motor.

Boost (BOOST): The BOOST setting increases the motor torque at low speeds. The minimum setting is sufficient for most applications and does not need to be adjusted. If the motor stalls or runs erratically at very low speeds (below 10 Hz), the boost trim pot may need adjustment. To calibrate the BOOST:

1. Run the motor at the lowest continuous speed/frequency required.
2. Increase the BOOST trim pot until the motor runs smoothly. **Continuous operation beyond the motor's current rating may damage the motor.**

Torque (TORQUE LIMIT): The TORQUE LIMIT setting determines the maximum torque for accelerating and driving the motor. To calibrate the TORQUE LIMIT.

1. With power disconnected from the drive, connect a RMS ammeter in series with one of the motor leads.
2. Turn the TORQUE LIMIT trim pot to full CW. Apply power and adjust the motor speed to full rated speed.
3. Load the motor so that it draws the RMS current previously determined.
4. Slowly turn the TORQUE LIMIT trim pot CCW until the red LED starts flickering. Then turn the trim pot slightly more so that it just starts to reduce the motor amps on the RMS ammeter.

Brake Current (BRAKE CURRENT): The BRAKE CURRENT determines the amount current used when applying current for DC Injection Braking. The higher the setting, the more current will be injected into the motor. DC Injection Braking will only occur in Brake Mode (Jumper JMP506 = BRAKE).

Brake Time (BRAKE TIME): The BRAKE TIME determines how long the DC Injection Braking current will be applied when braking. DC Injection Braking will only occur in Brake Mode (Jumper JMP506 = BRAKE).