

## Installation, Operation and Maintenance Manual

Please read and save these instructions for future reference. Read carefully before attempting to assemble, install, operate or maintain the product described. Protect yourself and others by observing all safety information. Failure to comply with these instructions will result in voiding of the product warranty and may result in personal injury and/or property damage.



### General Information

The Vari-Green Drive (VGD) is a factory mounted and wired variable frequency drive. It is compatible with induction and permanent magnet motors. It is programmed at the factory to match the characteristics of the fan and motor on which it is installed.

### Safety Instructions

As with all electrical products, read the manual thoroughly before operating. Only qualified personnel should perform maintenance and installation. Do not disassemble or repair unit. Death or injury due to electrical shock may result.

To prevent injury and property damage, follow instructions during installation and operation of the VGD.

Incorrect operation of the VGD due to ignoring these instructions may cause harm and damage.

**This manual should be placed in a location where it can be accessed by the users of this product and by those that are responsible for its maintenance.**

#### WARNING

- Do not remove VGD cover for wiring or periodic inspections while power is applied or the unit is in operation. Otherwise, electric shock could occur from the exposed terminals and bus bars.
- Wait at least 1 minute after disconnecting the input power and also verify all LEDs including the Power and Charge LEDs are off before performing any wiring tasks and/or periodic inspections on the VGD.
- Operate VGD and control devices with dry hands. Otherwise, electric shock could occur.
- Do not use VGD if power or motor cable is damaged.

#### CAUTION

- Disconnect the input power if VGD has been damaged. Otherwise, fire and secondary damage or accidents could occur.
- Do not touch VGD immediately after shutting down or disconnecting it. It can remain hot for a few minutes. Otherwise, bodily injuries such as skin-burn or damage could occur.
- Do not apply power to a damaged VGD or to VGD with missing parts.
- Do not allow lint, paper, wood chips, dust, metallic chips or other foreign material into the drive. Otherwise, fire or accident could occur.

## Table of Contents

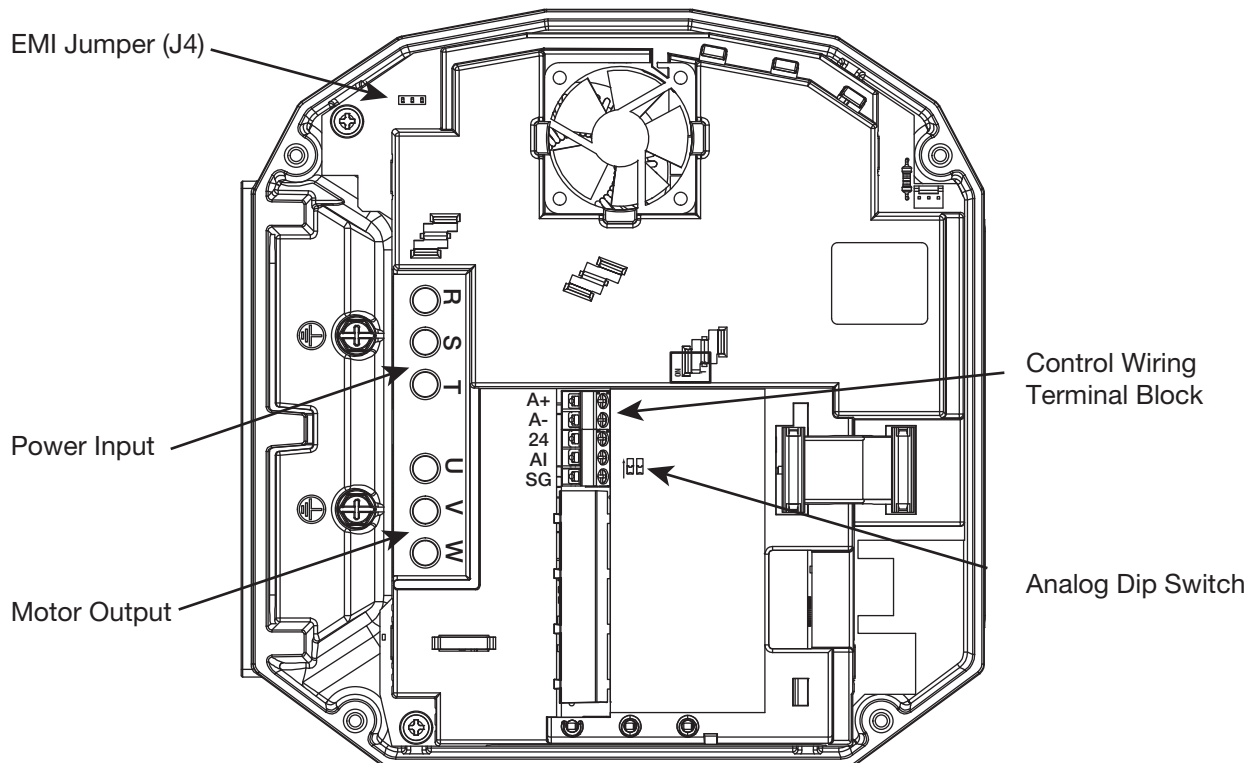
General Information . . . . .	1
Features . . . . .	2
Physical Overview . . . . .	2
Startup Procedure . . . . .	3
Programming . . . . .	4
First Application of Power . . . . .	4
Operation Notes . . . . .	4
Troubleshooting . . . . .	5-6
Maintenance . . . . .	6
Precautions . . . . .	6
Periodic Inspection . . . . .	6
Specifications . . . . .	6

## Features

### Model 100

- Speed control options:
  - On-Board Dial
  - 0-10VDC signal
  - 4-20mA signal
  - Other Vari-Green Controls
- Power, Run, Fault LEDs
- 24VDC @ 0.5A damper actuator power output
- 24VDC @ 50mA control power output for Vari-Green Controls
- Motor Protection
  - Thermal Overload, Over Voltage, Under Voltage, Input Phase Loss, Over Current, Overheat, Short Circuit, Hardware Error, Cooling Fan Failure
- R<sup>3</sup> Filtering™
  - Helps meet IEEE 519 without an external line reactor or filter.

## VGD Physical Overview Diagram



# Startup Procedure

## Power Wiring

The Vari-Green Drive power input and output connections are pre-wired at the factory. Refer to local electrical codes for branch circuit protection and proper wiring size and type.

EMI Jumper (J4): The Vari-Green Drive comes from the factory with a jumper installed that connects the EMI filter to earth ground. This jumper must be removed if the Vari-Green Drive is installed on a corner grounded power system.

**Note: For Part Number 385817, 385818**

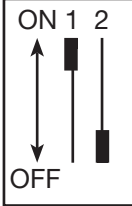
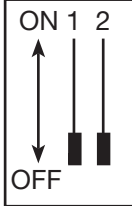
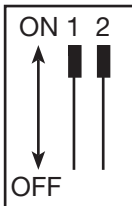
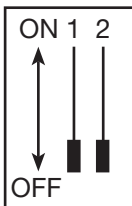
The VGD requires class J or K fuses size 20A or smaller to provide short circuit protection on the input. If a fused disconnect was not supplied by Greenheck, fuses must be provided by others.

For Part Number 386168, 386169, 386221, 386222, the VGD has internal fuse protection and does not require a fused disconnect.

## Control Wiring

There are five terminals on the control board for connecting input signals and powering/signaling a damper.

Terminal Label	Purpose
A+	+24VDC Power, 0.5A Max. On when VGD is commanding motor to run. Useful for powering appropriate damper actuator.
A-	-24VDC Power. Ground for A+ terminal.
24	+24VDC power, 50mA Max. Used to power Vari-Green controls. On when VGD is powered.
AI	Analog input signal (configurable via ANALOG dip switches)
SG	Signal Ground for analog input

Speed Control Option	Wiring Connections		Analog Dip Switch Settings	Notes
	VGD	Ex. Device		
On-Board Dial	24	RED	1: ON 2: OFF 	On-board Dial Part Number 384588
	AI	WHITE		
	SG	BLACK		
0-10VDC Signal	24	—	1: OFF 2: OFF 	2-10V Active Range
	AI	0-10VDC		
	SG	GROUND		
4-20mA Signal	24	—	1: ON 2: ON 	4-20mA Active Range
	AI	4-20mA		
	SG	GROUND		
Other Vari-Green controls	24	24V POWER	1: OFF 2: OFF 	Refer to control manual wiring diagram for connections to control
	AI	0-10V SIGNAL		
	SG	COMMON/ GROUND		

## • Motorized Backdraft Damper

- Connect 24VDC motorized backdraft damper to the A+ and A- terminals. Make sure amp draw of actuator does not exceed 0.5A.
- The VGD will energize the damper actuator when given a “Run” command.
- After the VGD is commanded to run, there will be a time delay to let the damper open before the motor starts accelerating.
- If an actuator of a different voltage or amp draw is used, this power source can be used to energize an interposing relay.

## Programming

No field programming or configuration is possible with the VGD 100 model. All motor and fan information has been set at the factory and is not adjustable.

### EXAMPLE OF PARAMETERS THAT HAVE BEEN FACTORY SET:

- Motor Voltage
- Motor Speed
- Motor FLA
- Acceleration/Deceleration Time
- Min/Max Frequency

**Note:** If the motor is changed to a motor with a different voltage, speed or FLA the VGD must be replaced as well.

## First Application of Power

**Warning:** Ensure fan is properly installed and the rotating parts can freely rotate. Loose tools, parts and clothing must be secured before starting fan. Stay clear of rotating shafts, belts and pulleys.

1. Apply the proper input voltage to the VGD after all wiring connections have been made.
2. Provide the drive with a run command (rotate dial clockwise or provide a control signal greater than 2VDC or 4mA).
3. Check rotation of fan to ensure it matches the rotation direction label on the fan. The rotation should be factory set.
  - a. If incorrect, disconnect and lock-out power, then swap any two of the three leads between the VGD and motor

**Note:** Swapping leads on the input of the VGD will have no effect on rotation.
4. Slowly ramp fan to full speed and make sure no faults are present and the fan is operating smoothly.

## Operation Notes

### • LED Status

- There are three LEDs on the front cover.
  - Power – The power LED is green when power is applied to the VGD.
  - Run – The run LED is solid green when the VGD is running the motor and drawing current.
    - The run LED will be flashing green if a run command is present but the drive does not sense motor current.
  - Fault – The fault LED will flash red when a fault has occurred. See the Troubleshooting section for fault details.

### • On-Board Dial

- Rotate the dial clockwise to increase fan speed and counterclockwise to decrease fan speed. Rotating the dial full counterclockwise will cause the fan to stop.

### • 0-10V input

- The fan will operate from 2-10VDC. 2V is minimum speed and 10V is maximum speed. 0-1.9V the fan will be off.

### • 4-20mA input

- The fan will operate between 4-20mA. 4mA is minimum speed and 20mA is maximum speed. From 0-4mA the fan will be off.

### • Vari-Green Controls

- Refer to specific Vari-Green Control instruction manual for operational details.

### • Belt Drive Fans

- Where the Vari-Green Drive is installed on a belt drive fan, the belt/pulley sizes have been selected for a fan RPM that corresponds to the max RPM for the motor size that was ordered when the VGD is running at max frequency.

**Note:** The design fan RPM may be less than the maximum fan RPM.

**Warning:** Replacing the belts/pulleys with a combination that increases the fan speed may overload the motor/VGD and cause a fault. Never exceed the maximum fan RPM.

# Troubleshooting

## Faults

When a fault is present, the VGD turns off its motor output and flashes the Fault LED. Each fault is associated with a certain number of blinks. The LED will blink for 0.5 second for each blink followed by a 2 second break. The number of 0.5 second blinks indicates the fault present.

Number of LED Blinks	LED Blink Fault	Fault #	Fault
1	Overcurrent	1	Thermal Overload
		2	Motor Overcurrent
		3	Overcurrent
		5	Output Phase Open
		9	PM Motor Sync Fault
2	Over Voltage	6	Over Voltage
3	VGD Overheat	10	VGD Overheat
4	Under Voltage	7	Under Voltage
		8	Input Phase Open
5	VGD Short Circuit	4	VGD Short Circuit
6	Cooling Fan Failure	12	Cooling Fan Failure
7	Damper	13	Limit Switch Failed to Close
		14	Damper Power Over Current
8	HW Fault	16	Hardware Failure
9	Comms loss	11	Lost Communication

## LED States

Run LED	Fault LED	Description
OFF	OFF	VFD is off and there are no faults
ON	OFF	VFD is running and there are no faults
Blinking	OFF	Run command present with no proof of flow
OFF	Fault blink sequence	VFD is off with Fault

Protective Function	Cause	Remedy
Thermal Overload	This fault occurs if current is within the inverse trip curve for motor rated current class of 10 and service factor of 1.15.	<ul style="list-style-type: none"> <li>Make sure fan speed is not over maximum for motor size</li> </ul>
Overcurrent	A fault occurs when output current is continuously above the trip current threshold multiplied by the rated Current (per VGD UL Label) for a time greater than the trip time.	<ul style="list-style-type: none"> <li>Check if rotor is locked and/or mechanical obstructions to motor/fan</li> <li>Check motor wiring and windings</li> <li>Conduct a mechanical inspection on the system</li> <li>Frequent starting with this fault may damage the VGD power components</li> </ul>
VFD Short Circuit	A fault occurs when short circuit is detected on the output terminals of the VGD.	<ul style="list-style-type: none"> <li>Check output wiring</li> <li>Check motor wiring</li> </ul>
Output Phase Open	A fault occurs when the output phase current of one phase is less than or equal to the average of the two remaining phases by the specified percentage	<ul style="list-style-type: none"> <li>Check output wiring</li> <li>Ensure motor is properly connected to VGD</li> </ul>
Over Voltage	Instantaneous Over Voltage: A fault occurs when DC Bus voltage is greater than or equal to 800VDC for 400V model and 400VDC for the 240V model.	<ul style="list-style-type: none"> <li>Check line voltage and call utility company</li> </ul>
Under Voltage	A fault occurs when DC Bus voltage is less than internal setting (that corresponds to 90% of the lowest rated input voltage (200V or 400V) for 2 seconds (continuous)	<ul style="list-style-type: none"> <li>Check line voltage</li> <li>Check fuses</li> </ul>
Input Phase Open	A fault occurs when any one of the input phases is disconnected.	<ul style="list-style-type: none"> <li>Check input wiring</li> <li>Check input power</li> <li>Check fuses</li> </ul>

## General Troubleshooting

Symptom	Possible Causes	Possible Solution
VGD does not operate fan	No control input signal	Ensure proper voltage/current is measured on the AI Terminal
	“Analog” dip switch settings incorrect	Verify dip switch matches proper control signal (pg. 3)
Speed range is incorrect	“Analog” dip switch settings incorrect	Verify dip switch matches proper control signal (pg. 3)
Cooling fan failure fault	Cooling fan unplugged/not functioning	Check cooling fan

## Maintenance

The Vari-Green Drive is an industrial electronic product with advanced semiconductor components and its operation depends on installation and operation conditions such as temperature, humidity, vibration, dust, etc. It is recommended to perform routine inspections of all operating VGD's in addition to the maintenance recommended in the fan's instruction manual.

### Precautions

- Remove input power while performing maintenance procedures.
- Use a True RMS Multimeter to ensure voltage is not present at the output terminals. Other types of voltmeters cannot read high frequency PWM output voltage correctly.

### Periodic Inspection

- Check for loose connections, bolts, nuts or rust buildup caused by surrounding conditions.
- Check for any discoloration or visual damage to the various connectors inside the VGD. Call Greenheck for support if any discolored or damaged connectors are found.
- Ensure heat sink fins underneath the VGD are free of obstructions and debris.

# Specifications VGD Model 100

SPECIFICATIONS		Part Numbers					
		385817	385818	386221	386222	386168	386169
Output Ratings	Voltage	0 - 240 VAC	0 - 480 VAC	0 - 240 VAC	0 - 480 VAC	0 - 240 VAC	0 - 480 VAC
	Max motor FLA	8.0A	6.0A	8.0A	6.0A	16.0A	14.0A
	Frequency*: 15 - 240 Hz	Yes	Yes	Yes	Yes	Yes	Yes
	Phase	3Φ	3 Φ	3 Φ	3 Φ	3 Φ	3 Φ
Input Ratings	Voltage (+15%/-10%)	200 - 240 VAC	380 - 480 VAC	200 - 240 VAC	380 - 480 VAC	200 - 240 VAC	380 - 480 VAC
	Frequency: 50/60 Hz (±5%)	Yes	Yes	Yes	Yes	Yes	Yes
	Phase	3 Φ	3 Φ	3 Φ	3 Φ	3 Φ	3 Φ
	Efficiency, full load	≥ 96%	≥ 98%	≥ 96%	≥ 98%	≥ 96%	≥ 98%
	Power Factor	≥ 0.9	≥ 0.85	≥ 0.9	≥ 0.85	≥ 0.9	≥ 0.85
	% THD (Meets IEEE 519)	32.0	32.0	32.0	32.0	32.0	32.0
	On Board Fuses	No	No	Yes	Yes	Yes	Yes
Operation	Analog Input 0-10V, 0-24V, 4-20mA (selectable via DIP switch)	Yes	Yes	Yes	Yes	Yes	Yes
	Damper Actuator Output 24VDC, 0.5A Max	Yes	Yes	Yes	Yes	Yes	Yes
	Control Voltage Output 24VDC, 50mA Max	Yes	Yes	Yes	Yes	Yes	Yes
	3LEDs: Power, Run, Fault	Yes	Yes	Yes	Yes	Yes	Yes
Environment	Max Ambient Temperature	40°C (104°F)	40°C (104°F)	40°C (104°F)	40°C (104°F)	40°C (104°F)	40°C (104°F)
	Storage Temperature	-30 to 65°C (-22°F ~ 149°F)	-30 to 65°C (-22°F ~ 149°F)	-30 to 65°C (-22°F ~ 149°F)	-30 to 65°C (-22°F ~ 149°F)	-30 to 65°C (-22°F ~ 149°F)	-30 to 65°C (-22°F ~ 149°F)
	Relative Humidity (Non-condensing)	Up to 95% RH	Up to 95% RH	Up to 95% RH	Up to 95% RH	Up to 95% RH	Up to 95% RH
Certifications	Agency Approvals UL Listed E223975	Yes	Yes	Yes	Yes	Yes	Yes
	Enclosure Rating	Type 4/IP66	Type 4/IP66	Type 4/IP66	Type 4/IP66	Type 4/IP66	Type 4/IP66
	EMC Directive 2014/35/EU	Yes	Yes	Yes	Yes	Yes	Yes

Wire Sizes and Terminal Lugs							
VFD rating	Terminals	Screw Size Metric	Screw Torque			Conductor Size	
			kgf. cm	lbf.in	Nm	AWG / kcmil	mm2
200 - 240VAC 380 - 480VAC	Input Power Terminal	M4	23.04	20	2.26	10~18	5.3~0.82
	Motor Power Terminal	M4	23.04	20	2.26	10~18	5.3~0.82
	All Control Terminals	M2.6	4.55	3.98	0.4	14~26	0.2 ~ 2.5

## Our Commitment

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*As a result of our commitment to continuous improvement, Greenheck reserves the right to change specifications without notice.*

Specific Greenheck product warranties are located on [greenheck.com](http://greenheck.com) within the product area tabs and in the Library under Warranties.

