

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 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 may cause harm and/or 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. Electric shock may 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.
- Do not use VGD if power or motor cable is damaged.

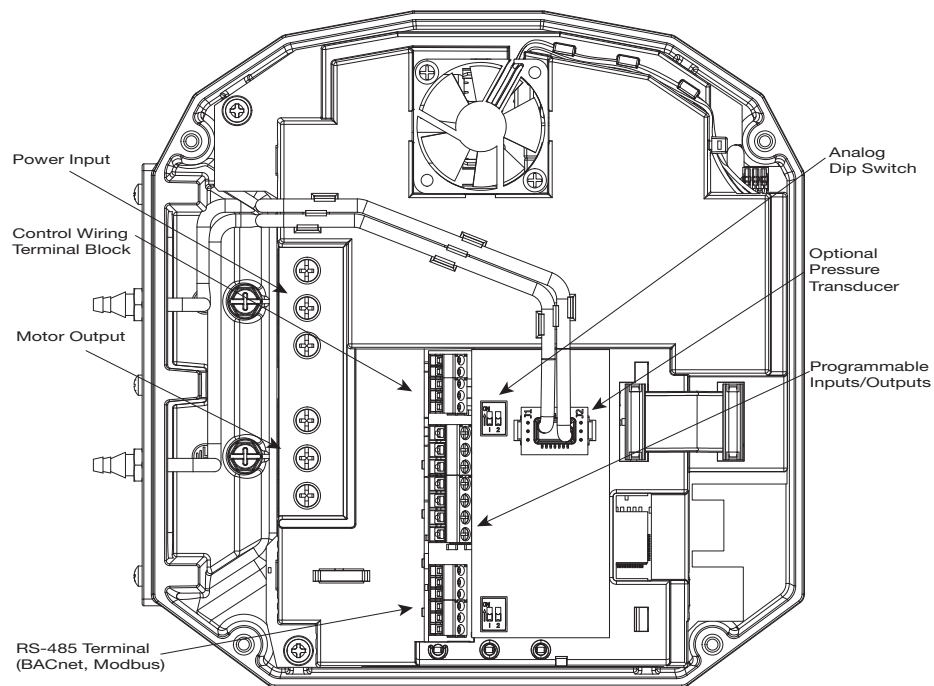
CAUTION

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

Features

- Analog input speed control options:
 - On-board dial
 - 0-10VDC signal
 - 4-20mA signal
 - Compatible with Vari-Green controls
- Power, run, fault LEDs
- 24VDC @ 0.5A, damper actuator power output
- 24VDC @ 50mA, control power output
- Motor protection
 - Thermal overload, over voltage, under voltage, input phase loss, over current, overheat, short circuit, hardware error, cooling fan failure
- R³ Filtering™
 - Helps meet IEEE 519 without an external line reactor or filter
- Bluetooth/smart phone interface
- Relay outputs
 - (2) programmable relay outputs for run, fault, proof of run
 - Configurable for normally open and normally closed
- Inputs
 - Can be configured through companion app for run FWD, stop, fireman's override, speed A, speed B, speed AB, damper limit switch, shut down, and fault reset
 - (2) configurable wet inputs
12-250 VAC/VDC, 8mA maximum
 - (2) configurable dry inputs
programmable to N.O. or N.C.
- RS-485 communications
 - Modbus
 - BACnet
- On-board PID control
 - Configurable through companion app
- Optional pressure transducer
- Turn down
 - Factory set operable range from 15 Hz to 60 Hz

Overview Diagram



Startup Procedure

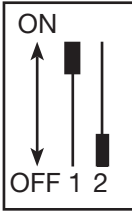
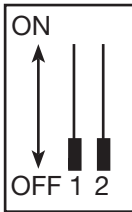
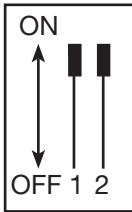
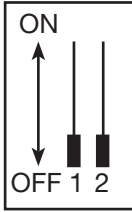
Power Wiring

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.

Power input terminals are marked R, S, T. Power output terminals (to motor) are marked U, V, W.

Note: For part numbers 385819, 385820, 386422, and 386423 the VGD has internal fuse protection and does not require a fused disconnect.

Control Wiring			
Terminal	Description	Rating	Notes
A+	Damper Output	24 VDC/ 0.5A max	Programmable activation modes
A-			
24	24 VDC Output	24 VDC/ 50mA max	Voltage or current input configurable via analog dip switches 1 & 2
AI	Analog Input	0-24V/ 0-10V/ 4-20mA	
SG			
O1	Relay Output	125VAC-0.5A / 250VAC-0.25A / 30VDC-2.0A / 125VDC-0.24A / 220VDC-0.24A	Can be configured to "N.O." (default) or "N.C."
O	Split O		
O2	Relay Output		Functions: run, fault
V1	Voltage Input 1	12-250V AC/DC / 8mA Max draw at 10V min., Off at 3V Max 52kOhm input impedance	Can be configured to "Active High" (default) or "Active Low".
V2			
V3	Voltage Input 2		Functions: enable, limit switch, fireman's override, speed A, speed B, shutdown
V4			
D1	Dry Input 1	24VDC when open / short to SG to activate	
D2	Dry Input 2		
SG	Input Common		
+	RS-485 Communications	N/A	Modbus, BACnet
-			
SG			

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.

- Model 100+

Damper output terminals can be programmed to power open or power close.

Available inputs can be programmed to accept a damper actuator end switch.

Depending on programming, the VGD will energize/de-energize the damper actuator when given a 'Run' command.

After the VGD is commanded to run, there will be either a time delay or a verification of the damper actuator end switch. When this has been met, the motor will start to accelerate.

- If an actuator of a different voltage or higher amp draw is used, this power source (A+/A-) can be used to energize an interposing relay.

Programming

All motor and fan information has been set at the factory.

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, these parameters, (such as motor, voltage, motor speed, and FLA) must be updated on the VGD via the companion app.

First Application of Power

Warning: Ensure fan is properly installed and all 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. Power output terminals are marked U, V, W.

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 0-3.9mA the fan will be off.

• Vari-Green Controls

- Refer to specific Vari-Green control instruction manual for operation details.
- Programmed speeds enacted through inputs. See companion app section.

• Belt Drive Fans

- The factory belt and pulley sizes have been selected for this fan to achieve the ordered fan RPM. The motor HP is sized to allow the belt/pulley combination to operate at 60 Hz (max motor rpm).

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. Each blink is 0.5 seconds followed by a 2 second break. The number of 0.5 second blinks indicates the fault present.

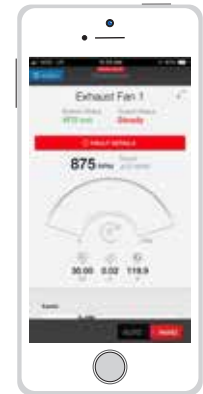
Number of LED Blinks	LED Blink Fault	Fault #	Fault
1	Overcurrent	1	Thermal Overload
		2	Motor Overcurrent
		3	Overcurrent
		5	Output Phase Open
		9	PM Motor Sync Fault
2	Over Voltage	6	Over Voltage
3	VGD Overheat	10	VGD Overheat
4	Under Voltage	7	Under Voltage
		8	Input Phase Open
5	VGD Short Circuit	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	VGD is off and there are no faults
ON	OFF	VGD is running and there are no faults
Blinking	OFF	Run command present with no proof of flow
OFF	Fault blink sequence	VGD is off with Fault

Companion App

When the companion app is connected to the VGD via bluetooth, any faults and the descriptions will be shown on the dashboard screen. Also available will be the ability to contact the factory support center. Please refer to the companion app section for more information.



Fault	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.	Make sure fan speed is not over maximum for motor size
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.	- Check if rotor is locked and/or mechanical obstructions to motor/fan - Check motor wiring and windings - Conduct a mechanical inspection on the system - Frequent starting with this fault may damage the VGD power components
VFD Short Circuit	A fault occurs when short circuit is detected on the output terminals of the VGD.	- Check output wiring - Check motor wiring
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	- Check output wiring - Ensure motor is properly connected to VGD
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.	Check line voltage and call utility company
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)	- Check line voltage - Check fuses
Input Phase Open	A fault occurs when any one of the input phases is disconnected.	- Check input wiring - Check input power - Check fuses

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 (VGD) 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 VGDs 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 pulse width modulation (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.

Companion App



The companion app for the VGD is available through the Apple app store. A quick start guide is available for the companion app under the instruction manuals at: <https://www.greenheck.com//vari-green/vari-green-drives>.

The companion app features:

- Dashboard
 - Monitor fan performance on your mobile device
 - Switch VGD to ‘Hand’ mode, for easy troubleshooting and testing, adjusting and balancing
- Set-up wizards for different control modes
 - Dial on motor
 - 0-10V control
 - 4-20mA control
 - Remote dial/touch remote
 - Multi-speed
 - Constant pressure control
 - Constant air flow control
 - VOC
 - Temp/humidity control
 - On-board PID
- Create start-up reports
- Copy current configuration and settings to apply to other VGDs
- View fault logs
- View hardware status and update firmware
- View documentation
 - Access to cut sheets, IOMs and quick start guide
- Contact technical support
 - “Call tech support” button - dial Greenheck Fan Corporation for troubleshooting, parts, information, etc.
 - “Email tech support” button - this includes an option to send the VGD’s settings and fault log, as well as pictures to the Greenheck Fan Corporation support center.



Specifications VGD Model 100+

SPECIFICATIONS		Part Numbers			
		385819	385820	386422	386423
Output Ratings	Voltage	0 - 240 VAC	0 - 480 VAC	0 - 240 VAC	0 - 480 VAC
	Max motor FLA	8.0A	6.0A	16.0A	14.0A
	Frequency*: 15 - 240 Hz	Yes	Yes	Yes	Yes
	Phase	3Φ	3 Φ	3 Φ	3 Φ
Input Ratings	Voltage (+15%/-10%)	200 - 240 VAC	380 - 480 VAC	200 - 240 VAC	380 - 480 VAC
	Frequency: 50/60 Hz (±5%)	Yes	Yes	Yes	Yes
	Phase	3 Φ	3 Φ	3 Φ	3 Φ
	Efficiency, full load	≥ 96%	≥ 98%	≥ 96%	≥ 98%
	Power Factor	≥ 0.9	≥ 0.85	≥ 0.9	≥ 0.85
	% THD (meets IEEE 519)	32.0	32.0	32.0	32.0
	On Board Fuse Protection	Yes	Yes	Yes	Yes
Environment	Max Ambient Temperature	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)
	Relative Humidity (Non-condensing)	Up to 95% RH	Up to 95% RH	Up to 95% RH	Up to 95% RH
Certifications	Agency Approvals UL Listed E223975 to 61800-5-1	Yes	Yes	Yes	Yes
	Enclosure Rating	Type 4/IP66	Type 4/IP66	Type 4/IP66	Type 4/IP66

*Actual frequency range will vary.

Wire Sizes and Terminal Lugs							
VFD Rating	Terminals	Screw Size Metric	Screw Torque			Conductor Size	
			kgf-cm	lbf-in	N-m	AWG / kcmil	mm ²
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

RS-485 Communication - Model 100+

The Vari-Green Drive (VGD) can be controlled and monitored through the Modbus RTU and BACnet MS/TP protocol over an RS-485 connection.

MODBUS RTU Communications

Modbus follows a simple client-server model. Server devices perform data read/write requests which are issued from a client device such as a PLC or building management system. Assignable addresses for server devices range from an address of 1 to theoretical maximum of 247. As a server device, the VGD communicates all data using only 16-bit holding registers. Addressing for the registers is partitioned into blocks that are multiples of 100 to group functionally similar data. If the drive is configured to accept commands via remote communications, it can be commanded to start, stop, run at a specified output frequency, target a setpoint in PID control, and reset faults. For a complete address list, please contact Greenheck Fan Corporation support center at 1-800-984-8713.

View Information Parameter Group

Modbus Address	Read/Write	Full Parameter Name	Parameter Setting Range
527	R/W	Run/Stop	0-Stop 1-Run
601	R/W	VFD Output Frequency	0.00 to 240.00 [Hz]
611	R	Output Status	0 - VFD Off 1 - Accelerate 2 - Decelerate 3 - Steady 4 - Speed search 5 - Flying start 6 - DC Output 7 - Preheat 8 - DC trip prevention 9 - Stall prevention
612	R	System Status	0 - VFD stop 1 - VFD run 2 - VFD disabled 3 - VFD fault 4 - VFD shutdown 5 - VFD Fireman's override 6 - VFD auto reset 8 - Power-on delay 12 - Signal loss 14 - PID run 15 - Open Damper

Modbus Address	Read/Write	Full Parameter Name	Parameter Setting Range
613	R	Fault	0 - None 1 - Motor Overload (C) 2 - Motor Over Current (C) 3 - VFD Over Current (C) 4 - VFD Over Heat (C) 5 - VFD Short Circuit (C) 6 - Over Voltage (L) 7 - Under Voltage (L) 8 - Input Phase Open (L) 9 - Output Phase Open (L)\ 10 - No Motor (L) 11 - Incorrect Output Wiring 12 - Power Board Uncalibrated 13 - Ground Fault (L) 41 - Limit Switch (H) 42 - Damper Overload (L) 43 - Control Reserved 45 - External Trip (M) 46 - Power Board Error (M) 47 - Control Board Error (M) 48 - VFD Cooling Fan (L) 49 - Power Board Comms Error (M) 51 - BMS Communications Loss (A) 52 - Analog Signal Loss 53 - Transducer Signal Loss (A) 54 - EEPROM Error 55 - Calibration CRC Failed 56 - Bluetooth Key CRC Failed 57 - Invalid Firmware
623	R	D1-SG Input	0-Open 1-Closed
624	R	D2-SG Input	0-Open 1-Closed
625	R	V1-V2 Input	0 - De-energized 1 - Energized
626	R	V3-V4 Input	0 - De-energized 1 - Energized
627	R	O1-O Output	0-Open 1-Closed
651	R	O2-O Output	0-Open 1-Closed

BACnet MS/TP Communication

The VGD operates as an MS/TP master device and the protocol can support addressing for up to 128 master devices in a single MS/TP network. BACnet conveys control and monitoring data as a collection of BACnet objects. The VGD supports analog input, analog value, positive integer value, binary input, multi-state value, and character string object types. The read property and write property services can be used to interface to those objects. If the drive is configured to accept commands via remote communications, it can be commanded to start, stop, run at a specified output frequency, target a setpoint in PID control, and reset faults.

Parameter Code Lists

Analog Value Object

BACnet Object Instance	Read/Write	Full Parameter Name	Parameter Setting Range
42	R	VFD Output Frequency	0.00 to 240.00

Binary Input Object

BACnet Object Instance	Read/Write	Full Parameter Name	Parameter Setting Range
0	R	D1-SG Status	0-Open 1-Closed
1	R	D2-SG Status	0-Open 1-Closed
2	R	V1-V2 Status	0 - De-energized 1 - Energized
3	R	V3-V4 Status	0 - De-energized 1 - Energized
6	R	O1-0 Status	0-Open 1-Closed
7	R	O2-0 Status	0-Open 1-Closed

Multi-State Object

BACnet Object Instance	Read/Write	Full Parameter Name	Parameter Setting Range
51	R	Output Status	0- VFD Off 1- Accelerate 2- Decelerate 3- Steady 4- Speed Search 5- Flying Start 6- DC Output 7- Preheat 8- DC Trip Prevention 9- Stall Prevention
52	R	System Status	0- VFD stop 1- VFD run 2- VFD disabled 3- VFD fault 4- VFD shutdown 5- VFD fireman's override 6- VFD auto reset 8- Power-on delay 12- Signal loss 14- PID run 15- Open damper

BACnet Object Instance	Read/Write	Full Parameter Name	Parameter Setting Range
56	R/W	Run/Stop	0- Stop 1- Run
57	R/W	Reset Fault	0- None 1- Reset
62	R	Fault	0- None 1- Motor Overload (C) 2- Motor Over Current (C) 3- VFD Over Current (C) 4- VFD Over Heat (C) 5- VFD Short Circuit (C) 6- Over Voltage (L) 7- Under Voltage (L) 8- Input Phase Open (L) 9- Output Phase Open (L) 10- No Motor (L) 11- Incorrect Output Wiring 12- Power Board Uncalibrated 13- Ground Fault (L) 41- Limit Switch (H) 42- Damper Overload (L) 43- Control Reserved 44- No Flow (L) 45- External Trip (M) 46- Power Board Error (M) 47- Control Board Error (M) 48- VFD Cooling Fan (L) 50- Overpressure (A) (P) 51- BMS Communications Loss (A) 52- Analog Signal Loss 53- Transducer Signal Loss (A) 54- EEPROM Error 55- Calibration CRC Failed 56- Bluetooth Key CRC Failed 57- Invalid Firmware 58- Option board error

End of Line Resistor, Termination		
EOL Option	Dip Switch Settings	Notes
EOL Resistor OFF		Default Removes EOL resistor from circuit
EOL Resistor ON		Adds EOL resistor to circuit

Our Commitment

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

Product warranties can be found online at Greenheck.com, either on the specific product page or in the literature section of the website at Greenheck.com/Resources/Library/Literature.

