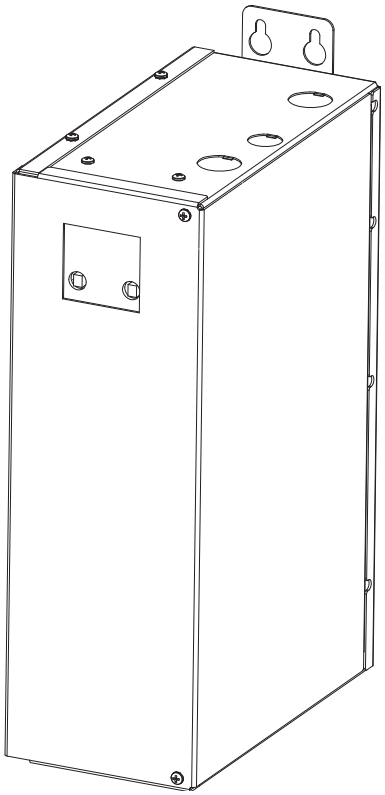
Franklin Electric
FUELING SYSTEMS

GUARDIAN SERIES™ VARIABLE FREQUENCY CONTROLLER

INSTALL GUIDE

10000009501 r5

MODEL
VFGC-220



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10000009501 r5

CONVENTIONS USED IN THIS DOCUMENT

This document includes safety precautions and other important information presented in the following format:

NOTE: This provides helpful supplementary information.

IMPORTANT: This provides important supplementary information and instructions to avoid damaging hardware or a potential hazard.

⚠ **CAUTION**: This indicates a potentially hazardous situation that could result in minor or moderate injury if not avoided. This may also be used to alert against unsafe practices.

⚠ **WARNING**: This indicates a potentially hazardous situation that could result in severe injury or death if not avoided.

⚠ **DANGER**: This indicates an imminently hazardous situation that will result in death if not avoided.

OPERATING PRECAUTIONS

Franklin Electric equipment is designed to be installed in areas where volatile liquids such as gasoline and diesel fuel are present. Working in such a hazardous environment presents a risk of severe injury or death if you do not follow standard industry practices and the instructions in this document. Before working with or installing the equipment covered in this document, or any related equipment, read this entire document, particularly the following precautions:

IMPORTANT: To help prevent spillage from an underground storage tank, make sure the delivery equipment is well-maintained, that there is a proper connection, and that the fill adaptor is tight. Delivery personnel should inspect delivery elbows and hoses for damage and missing parts.

⚠ **CAUTION**: Use only original Franklin Electric parts. Substituting non-Franklin Electric parts could cause the device to fail, which could create a hazardous condition and/or harm the environment.

⚠ **WARNING**: Follow all codes that govern the installation and service of this product and the entire system. Always lock out and tag electrical circuit breakers while installing or servicing this equipment and related equipment. A potentially lethal electrical shock hazard and the possibility of an explosion or fire from a spark can result if the electrical circuit breakers are accidentally turned on while installing or servicing this product. Refer to this document (and documentation for related equipment) for complete installation and safety information.

⚠ **WARNING**: Before entering a containment sump, check for the presence of hydrocarbon vapors. Inhaling these vapors may cause dizziness/unconsciousness, and if ignited, can explode causing serious injury or death. Containment sumps are designed to trap hazardous liquid spills and prevent environmental contamination, so they can accumulate dangerous amounts of hydrocarbon vapors. Check the atmosphere in the sump regularly while work is in process. If vapors reach unsafe levels, exit the sump and ventilate it with fresh air before resuming work. Always have another person standing by for assistance.

⚠ **WARNING**: Follow all federal, state, and local laws governing the installation of this product and its associated systems. When no other regulations apply, follow NFPA codes 30, 30A, and 70 from the National Fire Protection Association. Failure to follow these codes could result in severe injury, death, serious property damage, and/or environmental contamination.

⚠ **WARNING**: Always secure the work area from moving vehicles. The equipment in this document is usually mounted underground, so reduced visibility puts service personnel working on it in danger from moving vehicles that enter the work area. To help prevent this safety hazard, secure the area by using a service truck or other vehicle to block access to the work area.

⚠ **DANGER**: Inspect the installation location for potential ignition sources such as flames, sparks, radio waves, ionizing radiation, and ultrasound sonic waves. If any potential ignition sources are identified, implement proper safety measures.

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1 Introduction

The Variable Frequency Guardian Series™ Controller, model VFGC-220, is a submersible turbine pump controller intended only for use with variable speed, 3-Phase, 190 V, 70 Hz rated FE PETRO® pump motor assemblies. The VFGC-220 provides running and fault status of the attached pump motor assemblies when properly installed and configured per the instructions contained in this guide.

1.1 Regulatory Compliance

IMPORTANT INFORMATION - FOLLOW ALL INSTRUCTIONS

- The products contained within in this guide shall only be assembled and installed by a qualified person (see §2.7). *Use of non-qualified personnel, or any deviations from these recommended procedures, could result in damage or malfunction.*
- For Dimensional Drawings, see §3.2.2.4
- For Operating Parameters (including Electrical & Environmental), see §3.2.2
- For Required Tools, see §3.2.5
- For Wiring Diagrams, see §6.1
- For Certifications & Approvals, see §6.3

1.2 Documentation

- Instructions of this document are in English. All other language versions are translations of this original document.
- Information given in this document is provided as a guide only.
  - The Illustrations depict a typical setup and are for instruction and description purposes only.
  - It is the installer's responsibility to ensure that correct and safe procedures are followed at the worksite.
- This document and related documents are available from Franklin Electric at www.franklinfueling.com.

1.2.1 Symbol Legend

 Wear Protective Headwear

 Wear Eye Protection

 Wear Protective Clothing

 Wear High-Visibility Clothing

 Wear Protective Gloves

 Wear Safety Footwear

 Refer to instruction guide

 Ventilate Before & During Entering

 Ensure Continuous Ventilation

 Connect an earth terminal to the ground

 Lockout/Tagout Electrical Equipment

 Disconnect main plug from electrical outlet

 Disconnect before carrying out maintenance or repair

 General Warning

 Warning: Electricity

 Warning: Industrial vehicles

 Warning: Flammable Material

 No open flame; Fire, open ignition source and smoking prohibited

2 Safety/Security

2.1 General Safety Information

- Procedures in this document are only to be performed by people qualified and certified to perform them (see §2.3 and *§2.7*).
- Personnel working on or with energized equipment must be authorized by relevant regulatory bodies to carry out such work and must have the appropriate training. Check with your employer and relevant regulatory body's rules for working with energized equipment.
- Obey all local laws, rules, regulations, and instructions in this document. In case of inconsistency or contradiction between information contained in this document and any laws, rules and regulations, obey the stricter of the two.
- Keep unqualified personnel at a safe distance during installation.
- If it is necessary to remove safety/security devices, immediately reinstall the safety/security devices after completing the work.

2.2 Documentation Availability

Upon installation completion, this document shall be transferred by the qualified person or manufacturer to the owner, operator, or other responsible person of the facility where the installation is done.

- Save this guide for future use, and make sure to provide it to anyone who services this equipment (see *§2.3*).
- Always reference the guide(s) that came with the equipment for a complete list of installation and safety precautions. The most current Franklin Electric documentation can be found online at www.franklinfueling.com.

2.3 Installation & Service Access

Certified Installer or Service Technician*

Only Franklin Electric certified installers and service technicians are allowed to access both the controller interface and areas internal to the controller. *See §2.7 for information on certification training.*

Site Owner or Operator*

The site owner or operator of the controller is only allowed to access the user interface. *Access to areas internal to the console is prohibited.*

If your controller is serviced by someone who is not a Franklin Electric certified installer or service technician, **your warranty will be void.*

2.4 Hazard Assessment

Prior to beginning work and prior to recommencing work after leaving and returning to the worksite, a worksite, *pre-job hazard assessment* must be performed to identify safety and environmental needs. At a minimum, this hazard assessment should:

- Identify possible hazards and risks.
- Identify the safety needs of the job.
- Identify the correct procedures, practices and equipment.
- Eliminate unsafe conditions and actions from the worksite.
- Identify the need for personal protective equipment.
- Inspect equipment before use.
- Confirm sheaths of all cables are secured and undamaged.
- Confirm plugs and connectors are properly connected and serviceable.
- Perform ongoing risk assessment during the project.

2.5 Required Personal Protective Equipment (PPEs)

These PPEs are required during all phases of installation.


Wear Protective Clothing


Wear Eye Protection


Wear High-Visibility Clothing


Wear Protective Gloves


Wear Protective Headwear


Wear Safety Footwear

2.6 Cyber Security

This product is designed to be connected to and to communicate information and data via a network interface. It is solely the owner's responsibility to provide and continuously ensure a secure connection between the product and the Owner's network or any other network (as the case may be).

The Owner shall establish and maintain appropriate measures (such as but not limited to the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc.) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ***The Owner shall also ensure that the device and/or any connecting devices have the latest firmware version available to ensure device security features are up to date.***

The manufacturer, Franklin Electric, and its affiliates are not liable for damages and/or losses related to such security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information.

2.7 Qualifications and Responsibilities

Completion of this course is required *before certification test access will be granted for any other course (online or live):*

- Fuel System Installation Safety

2.7.1 Qualifications for Installation Certification

To be considered "qualified" to install or service this product, individuals shall pass training from the following certification training courses (online or live):

FE Online or Live Certification Training

SCAN / CLICK

Controller Specialist

- Fixed & Variable Speed Pump Controllers (60 Hz Markets)

2.7.2 Responsibilities

The following responsibilities are for guidance only and are not limited to those listed here.

It is the responsibility of:

- The owner of the install site(s) to ensure that all controller installers and service technicians shall be certified, follow all local laws, rules and regulations, along with the instructions and the specifications listed in this document.
- The certified installers and service technicians to know the controller and its safe use.
- The certified installers and service technicians to have and maintain a valid Franklin Electric training certification.

3 Pre-Installation Overview

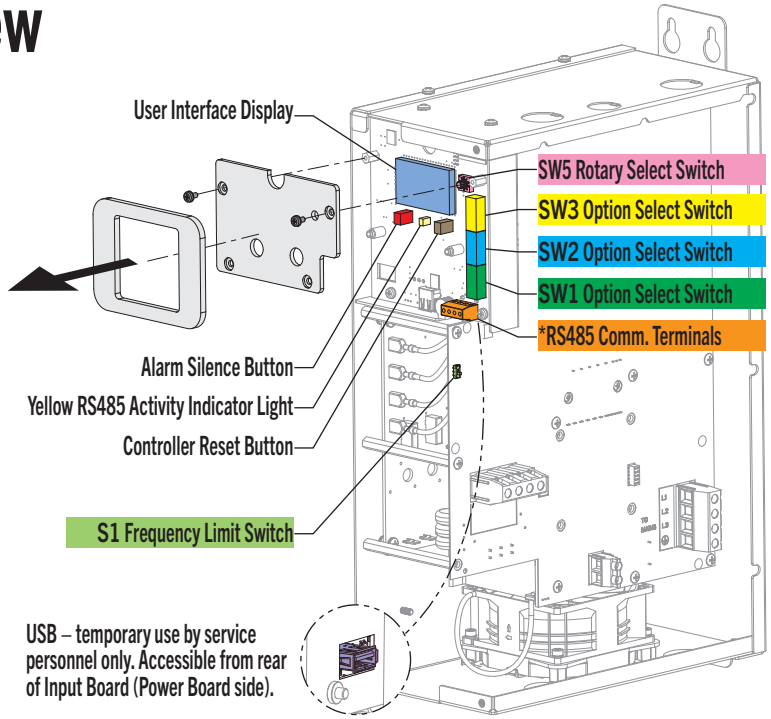
3.1 Upon Receipt of Item(s)

- Verify all items are in accordance with the order.
- Check all items for damage.
- If any item shows damage or is not in accordance with the order, inform Franklin Electric *immediately*.
- Remove the packaging material.
    - Follow all local laws, rules and regulations regarding disposal of discarded parts, packaging material or items and any subsequent components.

3.2 Technical Overview

NOTE:

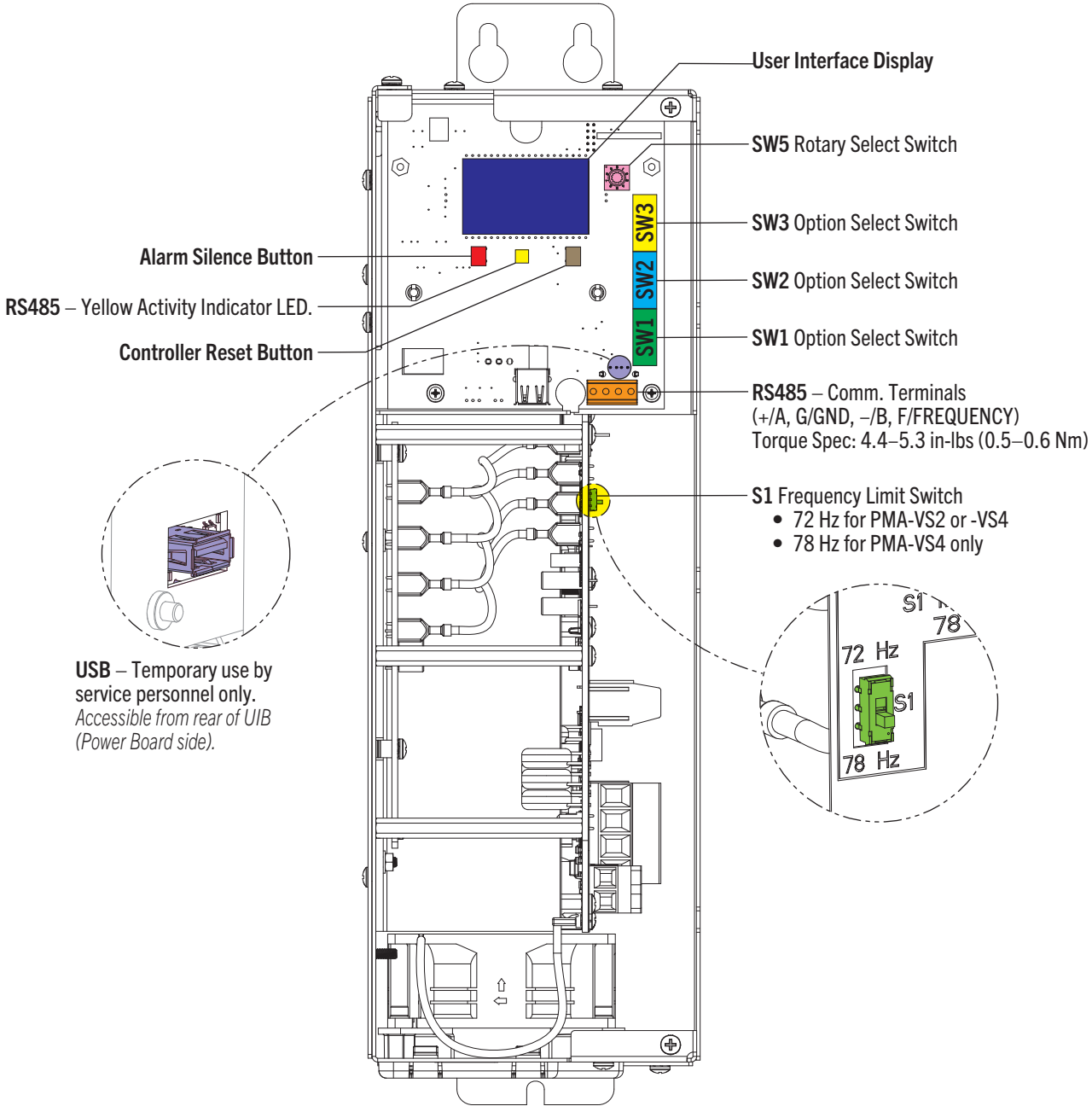
- The switches and RS-485 connector are on the User Interface Board (UIB) which is under the cover. *Only the push buttons and display are visible with the cover on.* See §6.1 for detailed information on specific wiring configurations.



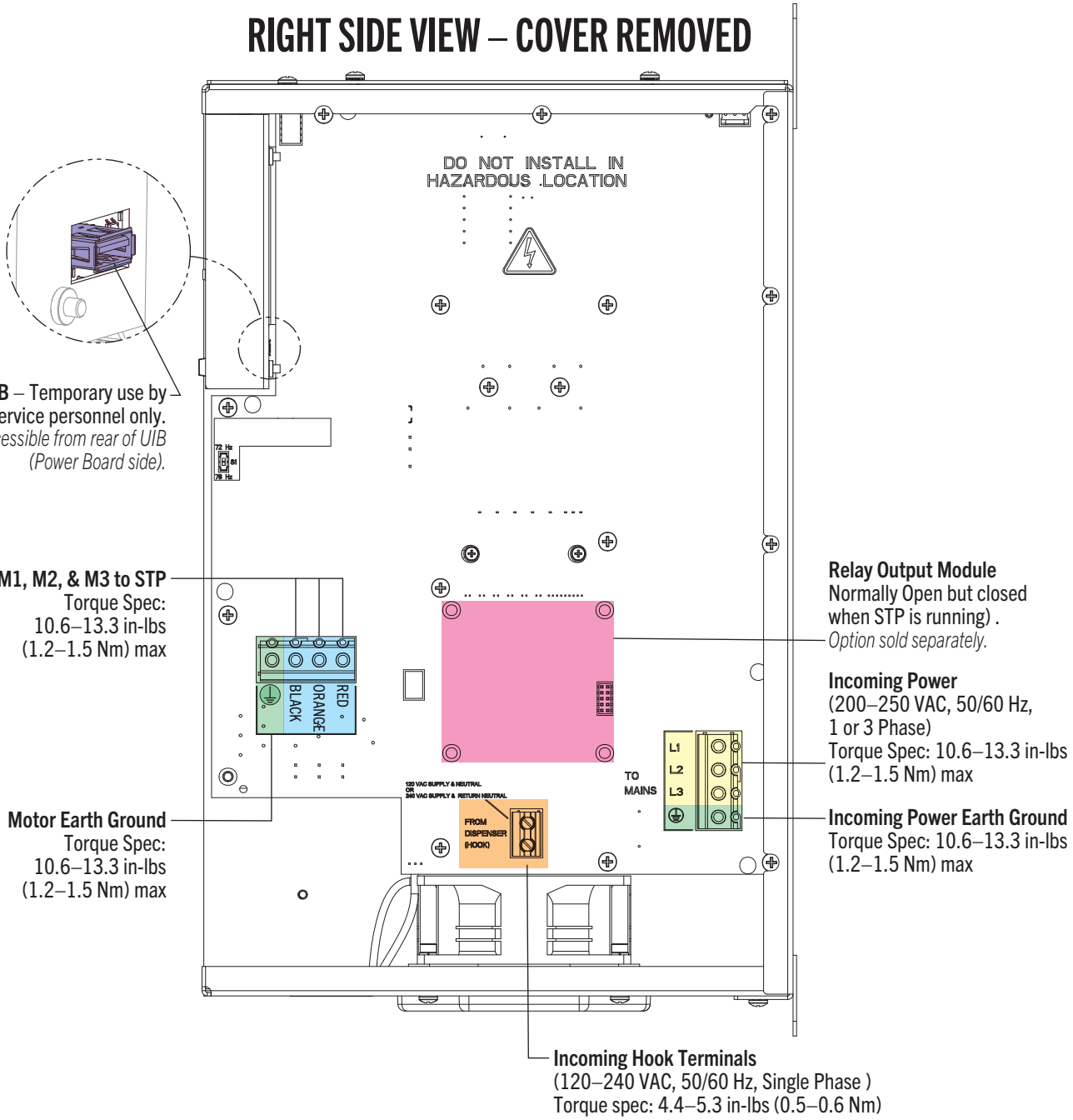
- The VFGC-220 provides motor overload protection required by the National Electrical Code (NEC). *This protection limits the motor current to 100% of the drive full load current rating.*
- The VFGC-220 *does not* provide motor over-temperature sensing.
- The VFGC-220 is suitable for use on a circuit capable of delivering not more that 5000 rms symmetrical amperes, 250 V maximum.
- The VFGC-220 requires non-current limiting inverse-time circuit breakers rated 200–250 V, 30 A maximum for branch circuit 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 NEC and any additional local codes.*

3.2.1 Identifying Components

FRONT VIEW – COVER REMOVED



RIGHT SIDE VIEW – COVER REMOVED



USB – Temporary use by service personnel only.
Accessible from rear of UIB (Power Board side).

M1, M2, & M3 to STP
Torque Spec:
10.6–13.3 in-lbs
(1.2–1.5 Nm) max

Motor Earth Ground
Torque Spec:
10.6–13.3 in-lbs
(1.2–1.5 Nm) max

Relay Output Module
Normally Open but closed when STP is running) .
Option sold separately.

Incoming Power
(200–250 VAC, 50/60 Hz, 1 or 3 Phase)
Torque Spec: 10.6–13.3 in-lbs
(1.2–1.5 Nm) max

Incoming Power Earth Ground
Torque Spec: 10.6–13.3 in-lbs
(1.2–1.5 Nm) max

Incoming Hook Terminals
(120–240 VAC, 50/60 Hz, Single Phase)
Torque spec: 4.4–5.3 in-lbs (0.5–0.6 Nm)

3.2.2 Specifications

Feature	Specification
Model	VFGC-220
Dimensions	See §3.2.2.4
Weight	20.2 lbs (9.2 kg)
Splash Resistance	Not to be exposed to direct spray, splash, or drips
Location	Non-hazardous environment, indoors where explosive or flammable vapors are not present. (see §3.2.2.2 & §6.3)

3.2.2.1 Ratings

Feature		Specification
Input Rating		
	Single Phase	200–250 VAC, 50/60 Hz, 19 A, 1-Phase
	Three Phase	200–250 VAC, 50/60 Hz, 18 A, 3-Phase
Output Rating		
	Single Phase Input	190 VAC, 70 Hz, 9.5 FLA, 3-Phase
	Three Phase Input	190 VAC, 70 Hz, 16 FLA, 3-Phase
Switch Hook		120–240 VAC, 50/60 Hz, 16 mA
Supply/Motor Wiring		12–10 AWG (3.3–5.3 mm^2), 90° C, 300 V minimum
Supply Hook Wiring		18–10 AWG (0.8–5.3 mm^2), 90° C, 300 V minimum

3.2.2.2 Environment

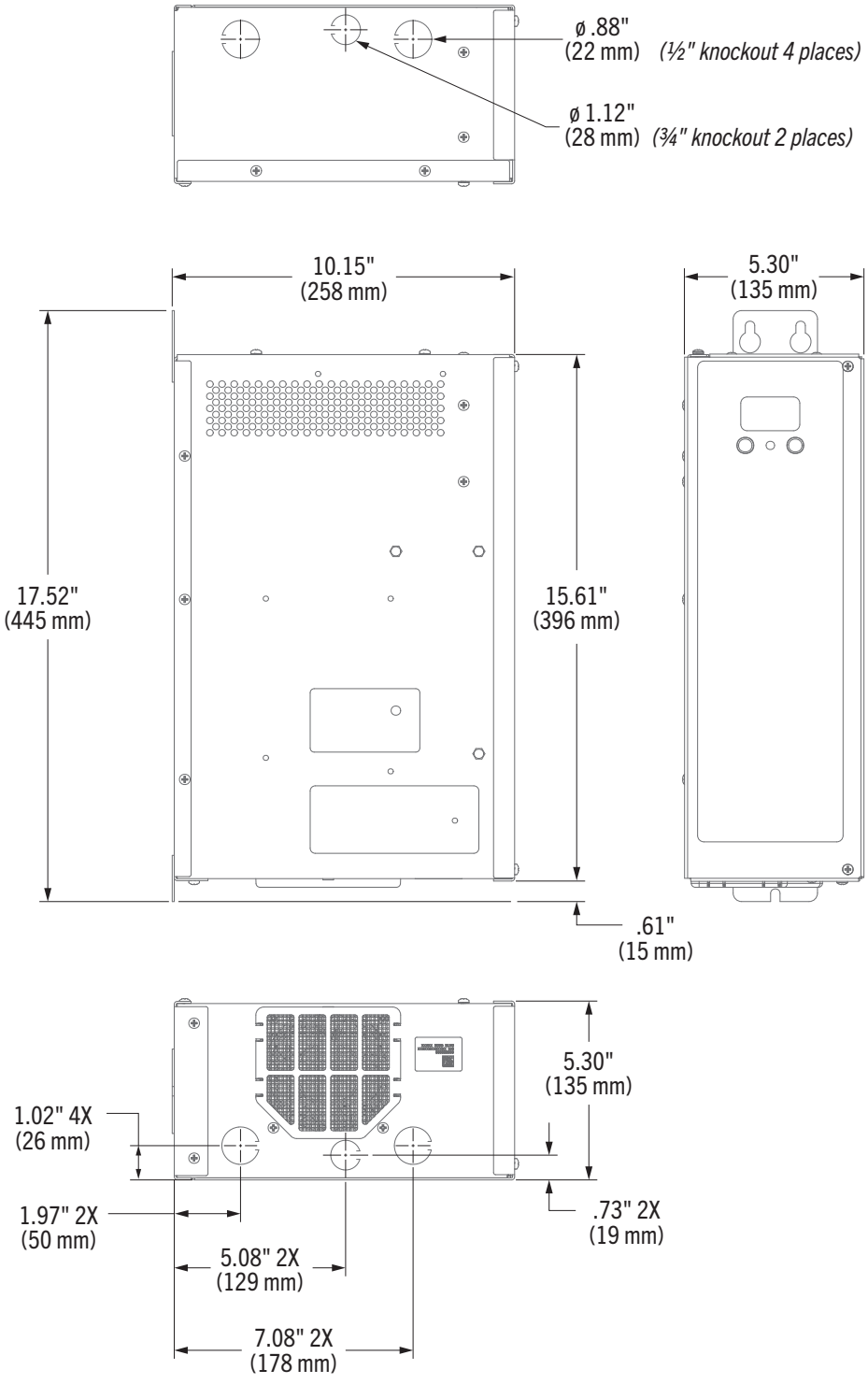
Feature	Specification
Altitude	Up to 2000 m
Temperature	40–122° F (4–50° C)
Humidity	0–95%, non-condensing
Overvoltage	UL 61800-5-1 CATEGORY III (see also §6.3)
Pollution	UL 61800-5-1 DEGREE 2 (see also §6.3)
Enclosure Type Rating	UL Type 1

3.2.2.3 Wire Size Reference

NOTE: Values shown are nominal equivalents. *Metric sizes are standardized cross-sectional areas (mm^2) and are not exact conversions of AWG diameters.*

Wire Size – AWG (mm^2)	Maximum Run – ft. (m)
10 (5.3)	650.0 (198.1)
12 (3.3)	400.0 (121.9)
14 (2.1)	250.0 (76.2)

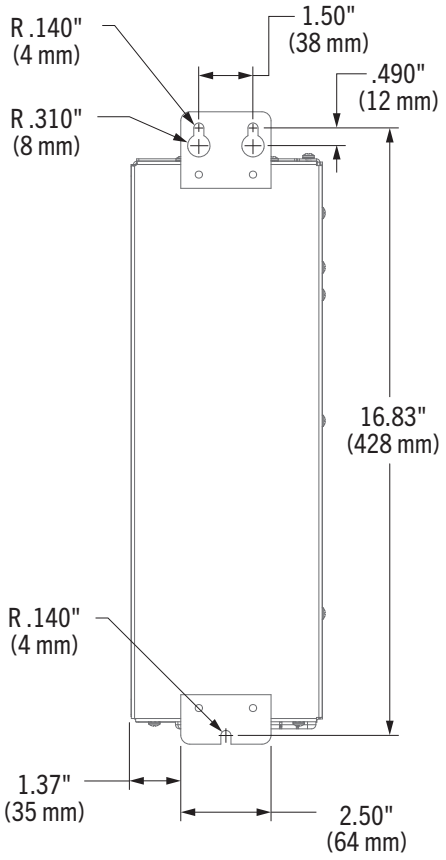
3.2.2.4 Dimensions



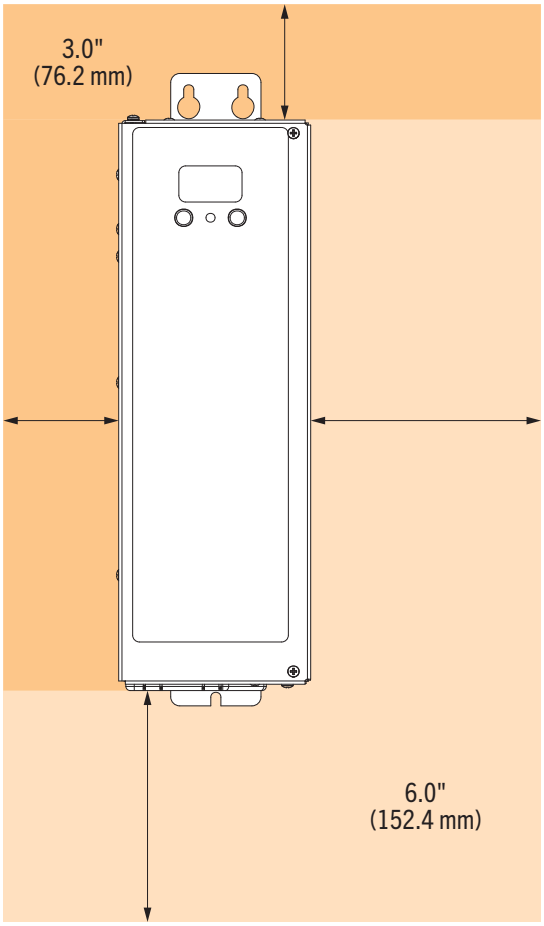
3.2.2.5 Mounting & Clearance

3.2.3

Mounting Dimensions – *Rear View*



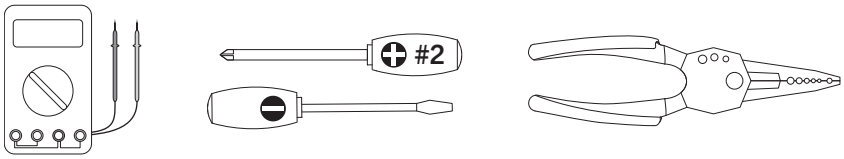
Minimum Mounting Clearance – *Front View*



3.2.4 Accessories

10000017615 – Relay Output Module

3.2.5 Required Tools



4 Installation



⚠ WARNING:

- Ensure power to the electrical circuit breakers is *turned off, tagged, and locked-out at the power panel* ***before performing any installation or service work to this and any related equipment.***
- Follow all necessary safety steps as required by federal, state and local regulations in relation to working with electrical equipment.

IMPORTANT: Always use safe electrostatic discharge practices when connecting/removing power and any work associated with making electrical connections to the console and related connected components.

NOTE:

- See §6.1 for wiring diagrams fitting specific application needs.
- When the installation is complete, ensure this guide is left with the service station owner or operator.

4.1 Install Instructions

1. Perform a facility/worksite approved Lockout/Tagout procedure for the circuit breakers to be connected to the VFGC-220 console and related systems (de-energize).
2. Install the STP according to its installation documentation.
3. Use an ohmmeter to verify that the motor leads (M1, M2, and M3) are not shorted to ground.

   IMPORTANT: The VFGC-220 may be damaged if power is turned on when the motor leads are shorted together or to ground.
4. Install a 30 A circuit breaker (if not already installed) at the electrical power panel. *This breaker shall be dedicated to supplying power only to the VFGC-220.*
   a. Mark this circuit: “VFGC-220 controller power ONLY” on the circuit label at the back of the electrical power panel door.

   NOTE: Branch circuit protection and disconnection must be provided in accordance with all applicable local, state, and federal codes. *Install the VFGC-220 on an independent branch circuit protected by circuit breaker with no other devices on the circuit to avoid electrical noise that could cause faulty operation.*
5. Select a location (see §3.2.2) for the VFGC-220 that is indoors in an area classified as non-hazardous location where ambient temperature is controlled between 40–122° F (4–50° C).

   ⚠ WARNING: To help avoid an explosion hazard that could result in environmental contamination, serious property damage, personal injury, or

death, *make sure to install the VFGC-220 in a non-hazardous, indoor location where explosive or flammable vapors are not present (see §3.2.2).*

IMPORTANT: Leave a minimum of 6" (150 mm) clearance on the bottom and right side. Leave a minimum of 3" (76 mm) clearance on the top and left side to allow room for installation of conduits, service, and proper air flow for the VFGC-220 (see §3.2.2.5).

6. Remove the VFGC-220 cover, and install the base on a wall or other flat vertical surface (see §3.2.2.5).
    - Installation holes are located in mounting tabs on the back of the controller.
    - Ensure the controller is mounted:
        - Vertically *with the fan at the bottom.*
        - Level on a vertical surface at a height of 2–6' (0.6–1.9 m) *where it is easy to view and access.*
    - Ensure fasteners for mounting the controller have sufficient load carrying capacity (see §3.2.2) and are appropriate for wall construction.
7. Connect the 200–250 VAC input power to L1, L2, (L3 if applicable, required for 4 hp applications), and connect the ground wire to the terminals as shown in the STANDALONE wiring diagram (see §6.1.1).

    IMPORTANT:
    - *Do not* apply input power until instructed to do so.
    - Input power and ground wire *shall be a minimum of 12 AWG wire size.*
    - All wiring within the VFGC-220 *shall be rated 90°C, 300 V minimum. **Failure to comply with all applicable guidelines may result in an unsafe installation.***

TABLE 4.1 – INPUT Wire Size/Run (Breaker Panel to Drive)
See §3.2.2.3 for additional notation on wire size reference

Wire Size – AWG (mm²)	Maximum Run – ft. (m)
10 (5.3)	650.0 (198.1)
12 (3.3)	400.0 (121.9)

NOTE: Electrical interference may be created by several types of equipment in a service station application (fluorescent lighting, compressors, etc). This interference may affect operation of more sensitive equipment (such as fuel management probes and sensors) that communicate through data lines. *For this reason, it is recommended that the wiring from the power source as well as the wiring to the IST/STP be in their own steel conduit, which is not broken or routed through a raceway to best avoid interference issues.*

8. Connect the motor leads to M1, M2, and M3*, and connect the ground wire to the terminals as shown in the STANDALONE wiring diagram (see §6.1.1).
    - All wiring shall conform with all applicable guidelines in accordance with all federal, state, and local codes.
    - All wiring between the VFGC-220 and the STP shall be gasoline and oil resistant.
    - Reference Table 4.1a (next page) for maximum wire length to wire gauge for motor lead field wiring between the STP and the VFGC-220.

NOTE: *If the motor leads are not connected with proper polarity, *the motor will*

run with reverse rotation causing degraded output (about 10–18 psi with 2 hp or about 17–29 psi with 4 hp attached to the controller).

TABLE 4.1a – OUTPUT Wire Size/Run (Drive to Motor)
See §3.2.2.3 for additional notation on wire size reference

Wire Size – AWG (mm²)	Maximum Run – ft. (m)
10 (5.3)	650.0 (198.1)
12 (3.3)	400.0 (121.9)
14 (2.1)	250.0 (76.2)

- To correct, swap two of the motor leads to correct rotation (for instance, swap motor leads from M1 to M2 and M2 to M1). *This method, in Bypass Mode, may be used to identify improper wiring when low output pressure is observed.*

9. Connect the Dispenser Hook Signal to the terminals, 120–240 VAC Supply, and Return according to the STANDALONE wiring diagram or PRIMARY-SECONDARY wiring diagram, whichever is appropriate. *The hook signal may come from a dispenser, isolation relay, or STP-DHI.* For more information, refer to: p/n 223844101, STP-DHI Installation and Owner's Manual.
10. Set the VFGC-220 to an operational configuration, *ensuring the the SW1, SW2, and SW3 poles 1–8 are set according to the wiring diagram for the configuration operation chosen (see §6.1.1).*

4.2 Configuration Instructions

⚠ WARNING:

- Frequency Limit Switch S1 must only be set to ***78 Hz*** *for PMA-VS4 applications.*
- Frequency Limit Switch S1 *(factory default)* setting of ***72 Hz*** *will work with both PMA-VS2 (2 hp) and PMA-VS4 (4 hp).*
- Do not set Frequency Limit Switch S1 to ***78 Hz with PMA-VS2 (2 hp).*** *If set to this configuration,* ***working pressure may exceed 50 psi (3.4 bar).***

4.2.1 Primary-Secondary / Alternating Circuit

Understanding Configuration Features

- The PRIMARY-SECONDARY feature allows additional STPs to be turned on when there is an abnormal condition or an STP needs help due to loading (flow rate).
- The ALTERNATING CIRCUIT feature continuously alternates the lead pump, so it turns on a different STP each time all dispenser hook signals are shut off and at least one dispenser hook signal turns back on.
- The PRIMARY-SECONDARY/ALTERNATING CIRCUIT configuration (combines the features of PRIMARY-SECONDARY and ALTERNATING CIRCUIT configurations.

⚠ CAUTION: Line leak detection performance can be affected when using multiple VFGC-220s. *It is not recommend using the ALTERNATING CIRCUIT feature in conjunction with electronic line leak detection. Some electronic line leak detector manufacturers require the Primary to always be turned on first.* Please refer to the manufacturer's requirements.

NOTE: The VFGC-220 is compatible with the MagVFC™ in PRIMARY-SECONDARY or ALTERNATING CIRCUIT configurations.

1. Connect the communication cable to the RS-485 terminals (+/A, G/GND, –/B, F/FREQUENCY) and wire "+" together, "G" together and, "–" together, and "F/FREQUENCY" together, then wire the shielded cable drain wire to Ground (G) at one end only. *Use at least 22 AWG three conductor shielded cable with drain wire.*
2. Ensure the Dispenser Hook Signal is connected to the VFGC-220 Primary according to the PRIMARY-SECONDARY wiring diagram, the ALTERNATING CIRCUIT wiring diagram, and the PRIMARY-SECONDARY/ALTERNATING CIRCUIT wiring diagram. *The hook signal can come from a dispenser, isolation relay, or STP-DHI.* For more information, refer to: p/n 223844101, STP-DHI Installation and Owner's Manual.

   NOTE: Ensure the incoming supply (L1, L2, L3, and ground) and out-going wiring (M1, M2, M3, and ground) are installed at each VFGC-220.
3. Configure PRIMARY-SECONDARY and ALTERNATING CIRCUIT features by setting SW2 poles 3 and 8 according to Table 4.3 (see §4.2.3).
4. Create a unique address for each controller by setting SW1, poles 1–5 according to Table 4.2.

NOTE:

- There may be only one Primary in a system, but up to 31 Secondaries. *If using Turbine Pump Interface™ (TPI) with a Franklin Electric fuel management console, the VFGC-220 cannot be configured control to address 31 (SW1 with poles 1–5 ON).*
- When configuring a VFGC-220 for TPI, *ensure the EVO™ fuel management system has the latest firmware to support proper discovery and communication with the Guardian™ controller.*
- If configuring a VFGC-220 with a TS-5 Series (blue box), *program the TPI communication as Mag/Eco Controller.*

TABLE 4.2 – SW1 (■ = ON)

Address	Pole 1	Pole 2	Pole 3	Pole 4	Pole 5
0					
1	■				
2		■			
3	■	■			
4			■		
5	■		■		
6		■	■		
7	■	■	■		
8				■	
9	■			■	
10		■		■	
11	■	■		■	
12			■	■	
13	■		■	■	
14		■	■	■	
15	■	■	■	■	
16					■
17	■				■
18		■			■
19	■	■			■
20			■		■
21	■		■		■
22		■	■		■
23	■	■	■		■
24				■	■
25	■			■	■
26		■		■	■
27	■	■		■	■
28			■	■	■
29	■		■	■	■
30		■	■	■	■
31	■	■	■	■	■

4.2.2 Factory Default Switch Settings

The STANDALONE configuration is the default factory setting (all selectable features off).

- Fault Readout
- Bypass
- Auto Restart
- Fault Shutdown
- Extended Run Disable
- Timed/Proportional Alternating Circuit

NOTE: SW2 and SW3 option select switches are detailed in §4.2.3, "Selectable Features", or are unused and should be left in the OFF position (factory default, SW3 Pole 3 and Poles 6–8). *The VFGC-220 may operate in an unpredictable manner if any of these unused switches are turned ON, unless instructed to do so by Franklin Electric Technical Support.*

TABLE 4.3 – Switch Definitions (P = Pole).

P	Description	Function
SW1		
1	Address Bit 1	Use poles 1–5 to set the addressing switches for Primary-Secondary or AC configurations. See Step 4 of the Primary-Secondary / AC section. *Default is all **OFF** (address 0).*
2	Address Bit 2	
3	Address Bit 4	
4	Address Bit 8	
5	Address Bit 16	
6	Fault Readout*	**ON** activates fault readout. *Leave in (default) **OFF** position for normal operation.*
7	Bypass*	**ON** bypasses diagnostics for 10 minutes. *Leave in default **OFF** position for normal operation.*
8	Unused	Unused switch. *Leave in default **OFF** position.*
SW2		
1	Line Leak Startup	**OFF** to startup as required by Veeder-Root™ PLLD. *Default is **ON** to provide startup desired for mechanical or LS500 electronic line leak detection.*
2	Fuel Selection	Turn this **OFF** for operation with **diesel** fuels. *Default is **ON** for operation with **gasoline**.*
3	Primary-Secondary*	**ON** designates the VFGC-220 as the Primary controller. *This switch must be set to **OFF** for Secondary and Standalone configurations.*
4	Pipe Compensation Bit 2	Turn this **OFF** during calibration to increase pipe comp by 2. *Default is **ON** (zero comp Bit 2).*
5	Pipe Compensation Bit 1	Turn this **OFF** during calibration to increase pipe comp by 1. *Default is **ON** (zero comp Bit 1).*
6	Motor Selection	Turn this **ON** for operation with 4 hp (VS4) along with S1 to 78 Hz (for optimal performance).† *Default is **OFF** for operation with 2 hp (VS2).*
7	Auto Restart***	Turning **ON** causes the controller to reset after an underload (UL) fault condition.
8	AC**	When the Primary controller is **ON**, the AC feature is active. ***OFF** indicates a Secondary or Standalone configuration.*

NOTE: See next page for **SW3** details.

TABLE 4.3 – Switch Definitions (P = Pole).

P	Description	Function
SW3		
1	Extended Run Disable***	**ON** disables the Extended Run feature. **OFF** activates the Extended Run feature.
2	Fault Shutdown Mode	If an abnormal condition is detected on any controller in a PRIMARY-SECONDARY or ALTERNATING CIRCUIT configuration, ***ON*** *causes all connected controllers to shut down.*
3	Unused	Unused switch. *Leave in default* ***OFF*** *position.*
4	Timed Alternating Circuit Mode***	Turn this **ON** to alternate controllers every 30 minutes when a hook signal is continuously applied to a PRIMARY-SECONDARY configuration.
5	Proportional Alternating Circuit Mode***	Turn this **ON** along with SW3 Pole 4 to alternate controllers based on addressing when a hook signal is continuously applied to a PRIMARY-SECONDARY configuration.
6	Unused	Unused switch. *Leave in default* ***OFF*** *position.*
7		
8		

*See § 5, *Troubleshooting,* for more information.

**See § 4.2.1, *Primary-Secondary/Alternating Circuit, Step 3* for configuration switch settings.

***See § 4.2.3, *Selectable Features,* for details.

†**WARNING**: Frequency Limit Switch S1 must only be set to 78 Hz for PMA-VS4 applications‡. Frequency Limit Switch S1 factory default setting of 72 Hz will work with both PMA-VS2 (2 Hp) and PMA-VS4 (4 Hp), but will not enhance PMA-VS4 performance.

‡*IMPORTANT: For optimized performance of PMA-VS4 applications.*

4.2.3 Selectable Features

4.2.3.1 Auto Restart Mode (SW2, Pole 7)

When this mode is selected, with (SW2, Pole 7) in the ON position, if the controller detects an empty tank/under load condition, it shuts down the pump and attempts to start the pump when a hook signal is removed and reintroduced to the controller. If the empty tank condition is still present, the controller shuts down the pump. If the empty tank condition is corrected (i.e., the tank is refilled), the controller runs the STP and clears the abnormal condition. In PRIMARY-SECONDARY configuration, if the Primary is in the under load condition, it waits until the Secondary controller calls for help before attempting to restart. *By default (SW2, Pole 7 OFF), the pump will remain shut down after UL fault detection until you manually restart or power cycle the controller.*

NOTE: When utilizing Turbine Pump Interface™ (TPI) this feature should be disabled.

4.2.3.2 Fault Shutdown Mode (SW3, Pole 2)

This is for only PRIMARY-SECONDARY and ALTERNATING CIRCUIT configurations. Select this feature only on the Primary controller (SW3 Pole 2 in the ON position) to cause the Primary and all connected Secondaries to shut down if any controllers, Primary or Secondary, detect an abnormal condition. *The Primary and all connected Secondaries will not run until the abnormal condition is corrected and the controllers are manually reset or power cycled. By default (SW3 Pole 2 OFF), an abnormal condition will shut down ONLY the controller that has detected the fault.*

NOTE: Fault Shutdown mode *is required* if using a Veeder-Root™ PLLD in a PRIMARY-SECONDARY configuration.

4.2.3.3 Extended Run Disable (SW3, Pole 1)

This switch, in the ON position, disables the extended run fault detection of the VFGC-220. *By default (SW3, Pole 1 OFF), the extended run fault shuts off the STP if it has been running for 60 minutes without a change in the motor load*.

- Example – This switch might be used with an emergency generator where the STP runs for extended periods at the same product flow (motor load).

CAUTION: Do not disable the extended run if the system requires the pump to be off for line leak detection (i.e. mechanical leak detectors or electronic line leak detection). *Disabling the extended run fault and running the STP continuously may mask a leak in the system.*

4.2.3.4 Timed Alternating Circuit Mode (SW3, Pole 4)

When this mode is selected (SW3, Pole 4 ON), the VFGC-220 will alternate controllers every 30 minutes when a hook signal is continuously applied to a PRIMARY-SECONDARY configuration. This alternating circuit option promotes utilization of configured pumps/tanks during peak times.

4.2.3.5 Proportional Alternating Circuit Mode (SW3, Pole 5)

When this mode is selected (SW3, Pole 5 ON), the VFGC-220 will alternate controllers based on addressing when a hook signal is continuously applied to a PRIMARY-SECONDARY configuration. This extension of the timed alternating circuit option correlates addressing to tank volume and runtimes (see Table 4.4), which provides a degree of leveling in tanks during peak times (continuous hook signals), *but this does not directly manage the tank levels as can be done by implementing Turbine Pump Interface™ (TPI) with a Franklin Electric fuel management console.*

TABLE 4.4 – SW1. (■ = ON)

Tank Volume Reference	SW1 Poles 1-5 Settings (VFGC Address)					Proportional Runtime (Minutes)
	Pole 1	Pole 2	Pole 3	Pole 4	Pole 5	
1	■					1.5
2		■				3.0
3	■	■				4.5
4			■			6.0
5	■		■			7.5
6		■	■			9.0
7	■	■	■			10.5
8				■		12.0
9	■			■		13.5
10		■		■		15.0
11	■	■		■		16.5
12			■	■		18.0
13	■		■	■		19.5
14		■	■	■		21.0
15	■	■	■	■		22.5
16					■	24.0
17	■				■	25.5
18		■			■	27.0
19	■	■			■	28.5
20			■		■	30.0
21	■		■		■	31.5
22		■	■		■	33.0
23	■	■	■		■	34.5
24				■	■	36.0
25	■			■	■	37.5
26		■		■	■	39.0
27	■	■		■	■	40.5
28			■	■	■	42.0
29	■		■	■	■	43.5
30		■	■	■	■	45.0
31	■	■	■	■	■	46.5

NOTE: SW1 may be set to any address as long as the addresses are unique to each controller. For example, if a primary controller of a 20,000 gallon tank were set to address 20, it would alternated to the secondary controller after 30 minutes of runtime. Proportionally, a secondary controller of a 12,000 gallon tank should be set to address 12 for a 18 minute runtime.

4.2.4 Calibration

⚠ WARNING:

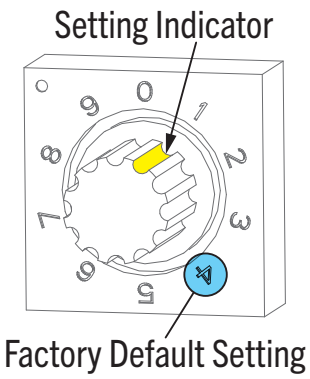
- To avoid an electrical hazard that could create a risk of severe injury or death, always make sure both power supplies (120–240 VAC hook and 200–250 VAC input) are disconnected before anyone services the equipment.
- After disconnecting power to the VFGC-220 controller, wait one minute after User Interface Display blanks before opening the cover for servicing. *Voltage stored in the capacitor bank of the VFGC-220 controller presents a potential risk of electrical shock even after power is disconnected.*

1. Replace the VFGC-220 cover and apply incoming power to the controller. *When power is applied to the VFGC-220, the display will flash firmware number and then "IdLE" until a hook signal is applied to the controller.*
2. Apply a hook signal and the display should begin alternating between RUN and an output number (in kilowatts) to the attached pump motor assembly that is now running. *Begin purging air from the system by pumping product into an approved container.*
3. After purging the system, verify that the STP manifold pressure at deadhead (pump running but no product being dispensed), is approximately the same as the SW5 rotary switch setting per Table 4.5.

   NOTE: If the motor leads are not connected with proper polarity, the motor will run with reverse rotation causing degraded output (about 10–21 psi with 2 hp or about 18–30 psi with 4 hp attached to VFGC-220). *To correct, swap two of the motor leads to correct rotation (for instance, swap motor leads from M1 to M2 and M2 to M1).*

TABLE 4.5

SW5 Setting	Approximate Deadhead Pressure (psi)
0	24
1	26
2	28
3	30
4 (Factory Default)	32
5	34
6	36
7	38
8	40
9	42



NOTE:

- Deadhead pressures in Table 4.5 are for approximate reference only. Pressure may vary in different liquids, temperature, piping systems, etc.
- If using PLLD mode (SW2 Pole 1 = OFF), expect startup pressures to be ~8 psi higher than those represented in the table above.

4. With purging complete and proper motor rotation confirmed, perform a Flow Rate Test into an approved container with a single nozzle at the dispenser closest to the storage tank to establish the desired product flow (for gasoline, target a maximum 10 gpm per US EPA fuel dispenser flow rate standard).
5. If the Flow Rate Test results are above or below the desired product flow, adjust SW5 accordingly (increase the setting to yield a higher flow rate or decrease setting to reduce the flow rate) and then rerun Flow Rate Test to verify. *Repeat this step until the desired flow rate is achieved with a single nozzle at the closest dispenser.*
6. Once the desired flow rate is achieved by adjusting SW5 with one nozzle, then optimize VFGC-220 performance by adjusting Pipe Compensation (SW3 Poles 4 and 5). Determine proper Pipe Compensation by conducting another Flow Rate Test, this time with an additional 2–3 nozzles operating on this product.
    - If the flow rate falls below the established range desired, increase Pipe Compensation by turning OFF SW3 Pole 5 and then rerun Flow Rate Test to verify results are now above or below the desired product flow.
        - If results are above desired product flow, return Pipe Compensation to factory default (SW3 Poles 4 and 5 ON).
        - If results are below desired product flow, increase setting of SW3 Pole 4 and 5 per Table 4.6. *Repeat this step until the desired flow rate is within acceptable range of the product flow established in Step 5.*

TABLE 4.6 (■ = ON)

Pipe Compensation	SW2 P4 (Bit 2)	SW2 P5 (Bit 1)	Pipe Configuration
0 (Factory Default)	■	■	Least Restrictive
1	■		
2		■	
3			Most Restrictive

NOTE: An example of a *least restrictive* pipe configuration would be a 2" UPP® semi-rigid run of about 150' supplying 6–8 nozzles. An example of a *most restrictive* pipe configuration would be a 1½" convoluted flexible piping run of approximately 90' supplying 4–6 nozzles.

5 Troubleshooting

NOTE: Reference §3.2 for Alarm Silence and Controller Reset button locations.

The VFGC-220 utilizes a microprocessor allowing the unit to diagnose abnormal conditions and communicate them through an audible alarm and LEDs on the front panel. The following describes these indications:

- When the display is illuminated, a 200–250 VAC power supply is being applied to the VFGC-220.
- If the display alternates between "RUN" and a number, the attached pump motor assembly (PMA) is running.

  ⚠ **CAUTION**: If the display flashes "RUN," even when all the dispensers are turned off, *there may still be power present at the VFGC-220 hook terminal. **If this is the case, contact Franklin Electric Technical Support for assistance.***

  NOTE: If the display is "IdLE," even when a dispenser is activated, *check the dispenser hook signal terminals on the VFGC-220. **If 120–240 VAC is across the hook terminal, and the switch settings are correct, contact Franklin Electric Technical Support for assistance.***
- If the display flashes red, and the audible alarm is beeping (see §5.2), there is an abnormal condition. *Note the flashing code displayed, and refer to the appropriate troubleshooting topic.*

5.1 Disabling the Audible Alarm

- Press the Alarm Silence button briefly to silence the audible alarm *without resetting the controller (see §3.2 for button location).*

5.2 Resetting the Controller

NOTE: See §3.2 for Controller Reset button location.

Before correcting an abnormal condition (the display is flashing red and the alarm is beeping), do the following:

1. Note the flashing code shown on the display.
2. Press the **Controller Reset** button for approximately one second, *releasing it when the screen goes blank.*
3. Check for proper operation:
   - If the controller operates correctly, the abnormal condition is resolved and normal operation is restored
   - If the abnormal condition continues:
     a. Correct the condition according to the troubleshooting guide (see §5.3 and §5.4).
     b. Reset the controller.
     c. Check for proper operation.
     d. Contact Franklin Electric Technical Support for assistance, if needed.

5.3 Troubleshooting Warnings and Error Alarms

NOTE: Some ATGs include a Turbine Pump Interface™ (TPI) that can provide additional troubleshooting information. For more information, see Franklin Electric document, p/n **AG-016** TPI Application Guide.

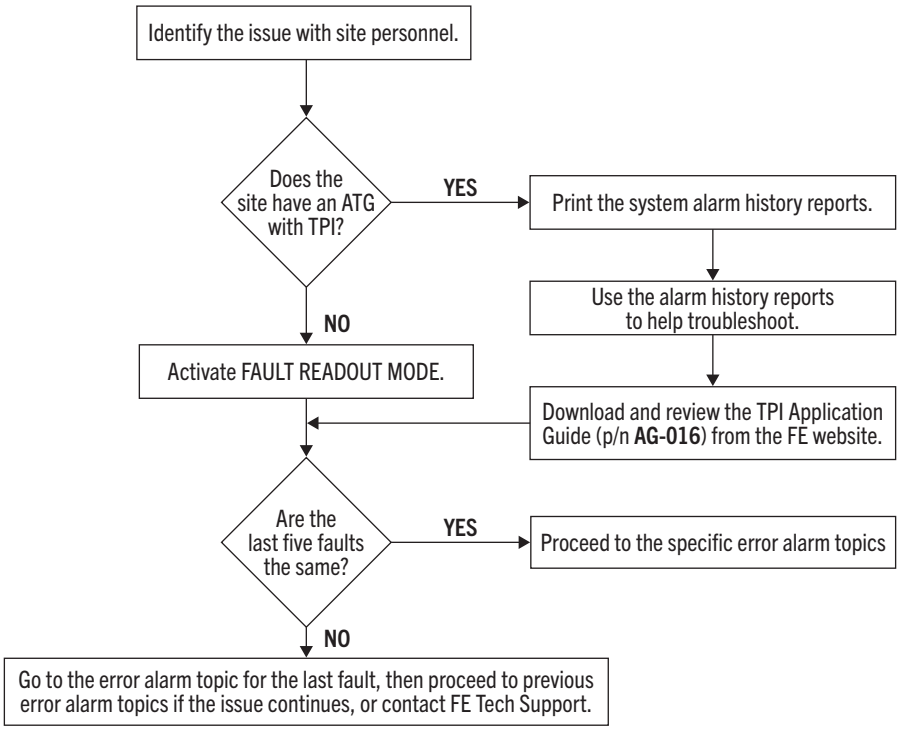


TABLE 5.1

Warning Code	Alternate Display	Condition
UbL	–	UNBALANCED LOAD – is warning that there is an unacceptable power imbalance across the three output phases of power (M1, M2, M3) from the VFGC controller. If warning persists, troubleshoot output wiring connected to the VFGC controller (capacitor inadvertently connect across motor leads, loose or faulty output wiring connections, faulty PMA, etc.). *The VFGC will continue to operate with this warning until the imbalance is resolved or the condition escalates into an error alarm.*
CL	kilowatts	CURRENT LIMIT – is warning that the VFGC is at maximum output performance (displayed in kilowatts). *This is a normal operation warning, not an abnormal operation fault condition.*
HL	kilowatts	HEAT LIMIT – is warning that the VFGC is limiting output performance (displayed in kilowatts) due to operation in a high controller temperature range. Verify that the VFGC fan is operating normally and that the ambient temperature around VFGC is within the acceptable range. *The VFGC will continue to operate with this warning until controller temperature returns to the acceptable range or HO fault inhibits operation.*
HO	Inverter Temperature	HALT OPERATION – fault inhibits the VFGC operation due to excessive controller temperature until acceptable controller temperatures are achieved. Verify the VFGC fan is operating and that ambient temperature around the VFGC is within the acceptable range (see §3.2.2 for environmental specifications).

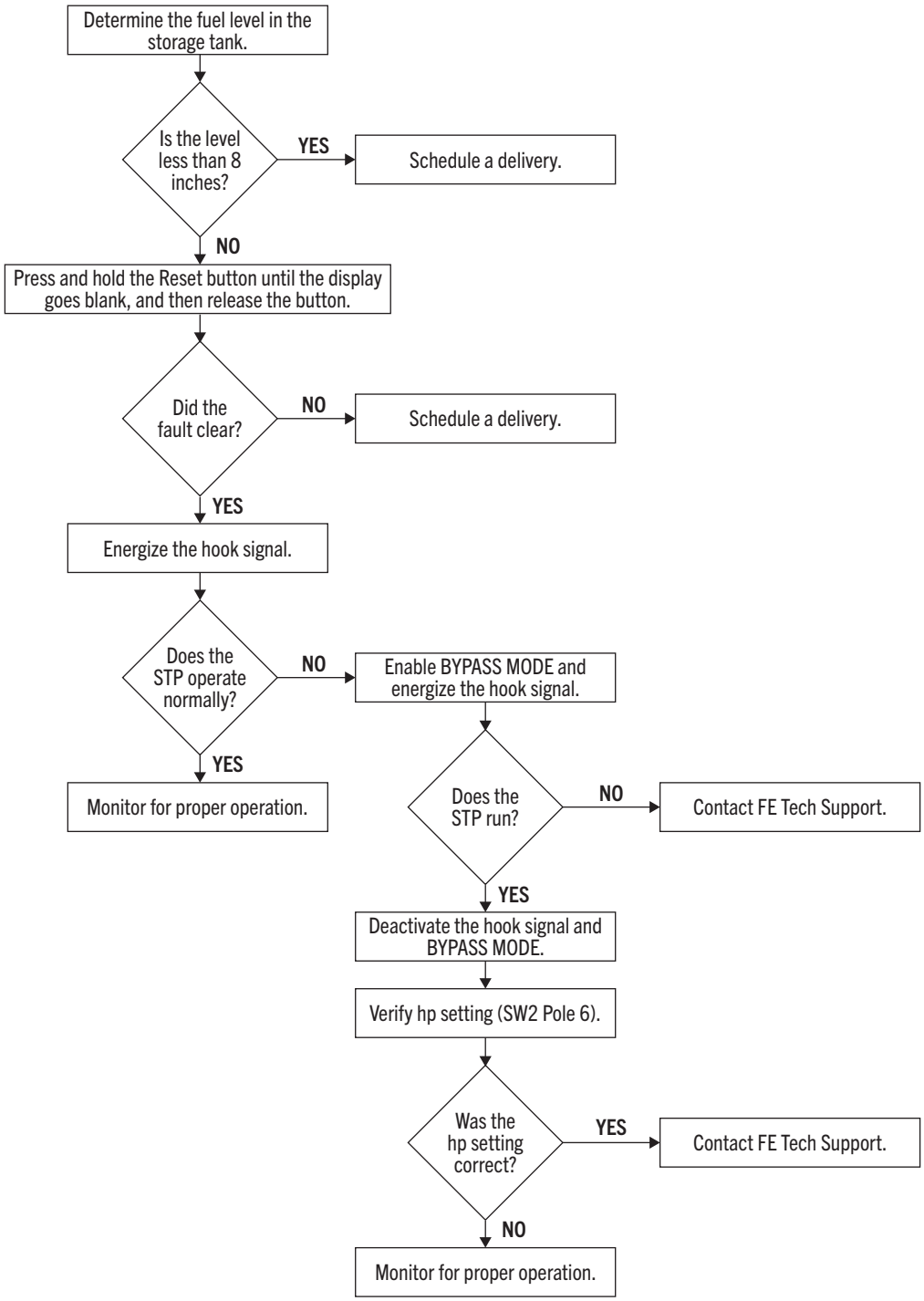
TABLE 5.2

Fault Code	Alternate Display	Condition
AH	‘Ambient Temperature	High Temperature
Er	–	Extended Run
FE	–	Firmware Error
HI	Voltage	High Incoming Voltage
HO	Inverter Temperature	High temperature
LI	Voltage	Low Incoming Voltage
OC	bL or rEd	Open circuit from MagVFC™ to motor: bL – BLACK wire or – ORANGE wire rEd – RED wire
OL	# of restarts remaining	Locked Rotor Fault at PMA
OS	Monitor that tripped	Over Speed
SC	SPU Inr bL or b o b r o r ALL	Short Circuit Incorrect Horsepower Setting SPU – Spurious Inr – Inverter bL – BLACK wire or – ORANGE wire b o – BLACK to ORANGE wire b r – BLACK to RED wire o r – ORANGE to RED wire ALL – BLACK to RED to ORANGE wire
UL	–	Under Load Tank Empty Incorrect Horsepower Setting

5.3.1 Underload Error Alarm

- Error code flashes: UL

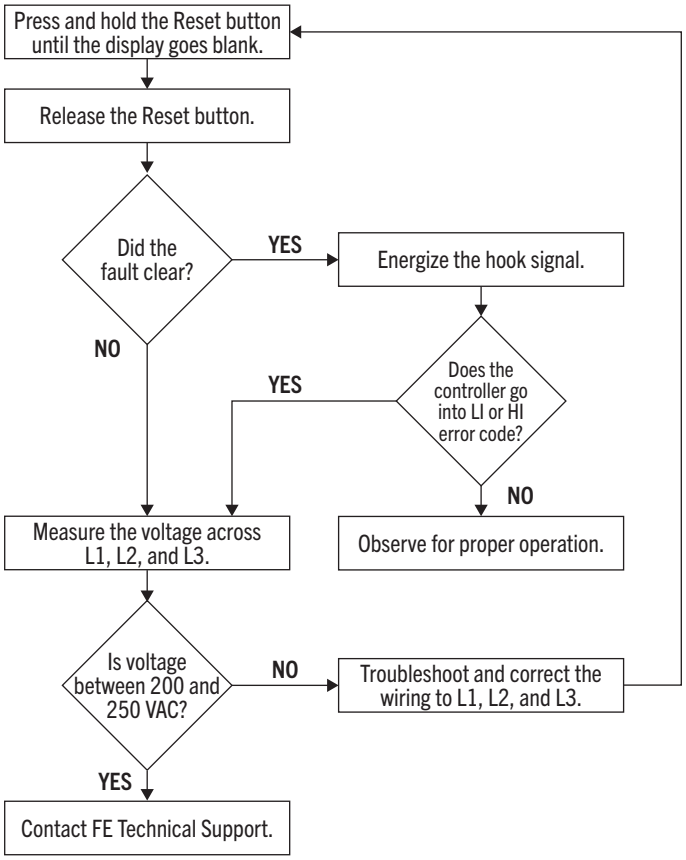
The UNDERLOAD ERROR alarm indicates that the VFGC-220 has detected that the motor power consumption (in watts) is below the acceptable range compared to the horsepower setting. This alarm is typically caused by dry running (due to a clogged intake) or improper horsepower selection (SW2 Pole 6 ON for 4 hp with VS2 attached).



5.3.2 Incoming Voltage Alarm

- Error code flashes: **LI** or **HI**

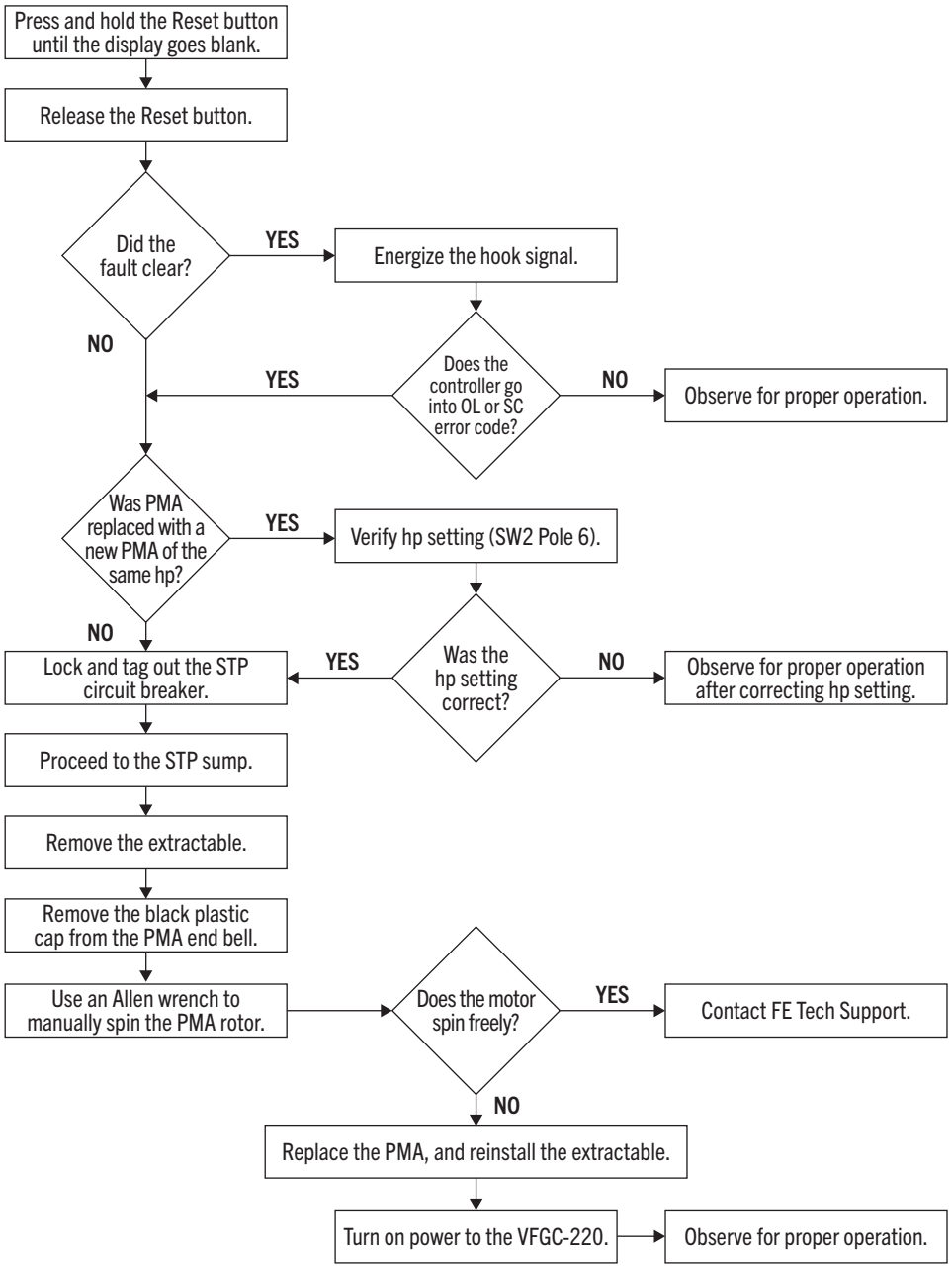
The LOW INCOMING (under-voltage) and HIGH INCOMING (over-voltage) alarms activate when the incoming voltage to the VFGC-220 (L1, L2, L3) is outside the acceptable range (LI activates below 185 V, HI activates above 260 V). The VFGC-220 automatically resets this alarm when the incoming voltage returns to the acceptable range (LI resets above 200 V, HI resets below 245 V).



5.3.3 Overcurrent Alarm

- Error code flashes: **OL** or **SC**

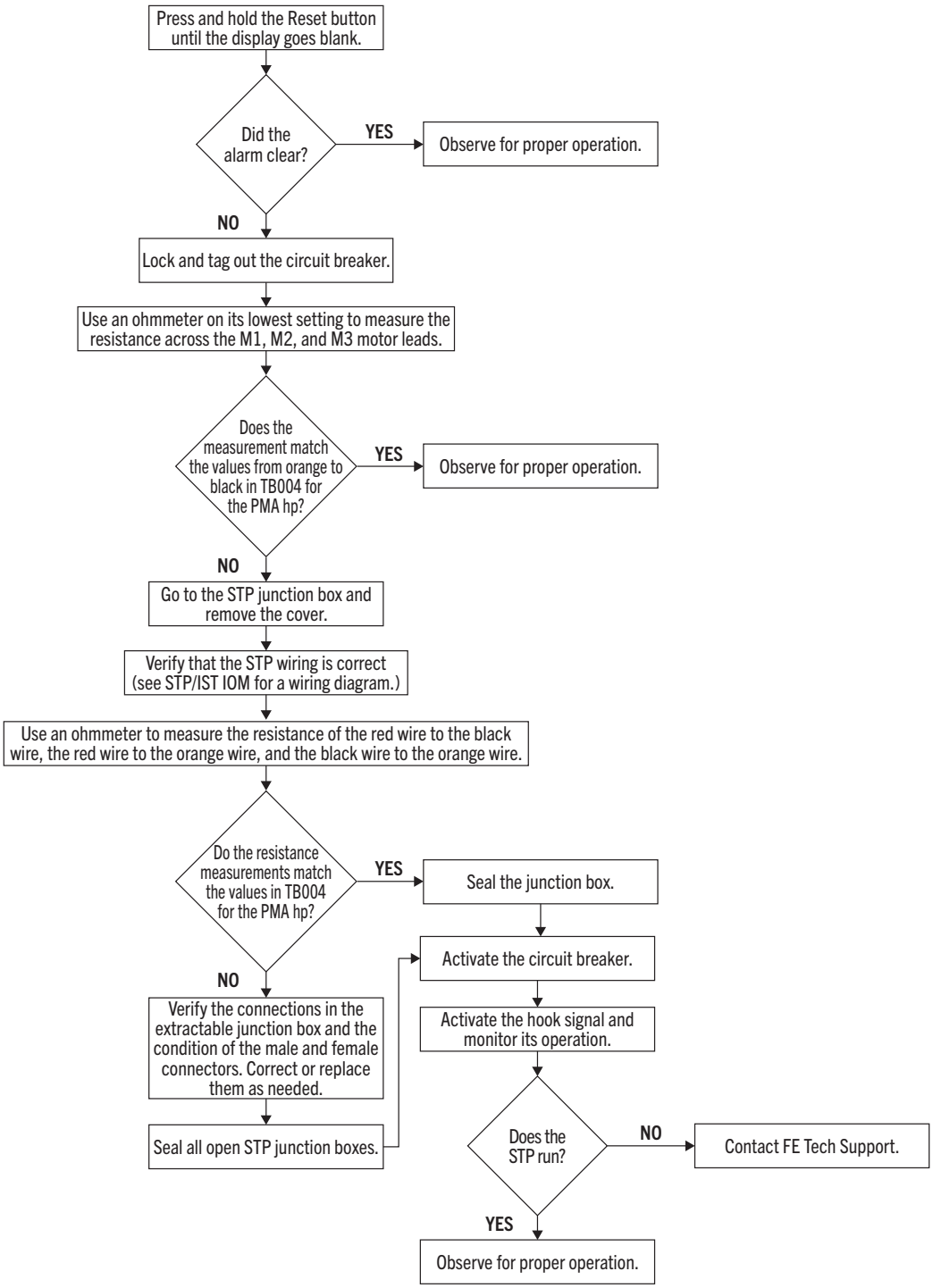
The OVERLOAD (OL) and SHORT CIRCUIT (SC) alarms indicate that the VFGC-220 has detected the motor power consumption (in watts) is above the acceptable range compared to the horsepower setting. The OVERLOAD and SHORT CIRCUIT alarms are usually caused by a locked PMA rotor (due to debris or damage), improper horsepower selection (SW2 Pole 6 OFF for 2 hp with VS4 attached), or a nicked/damaged wire (field motor wiring, STP connectors and/or lead assembly). If it is a SC fault the VFGC-220 will display an alternate code displaying the wire(s) the VFGC detects the short on. If motor wiring runs are extremely long and/or of small wire gage, a false overcurrent fault can occur. See §4.1 for recommended wire size and run.



5.3.4 Open Circuit Alarm

- Error code flashes: OC

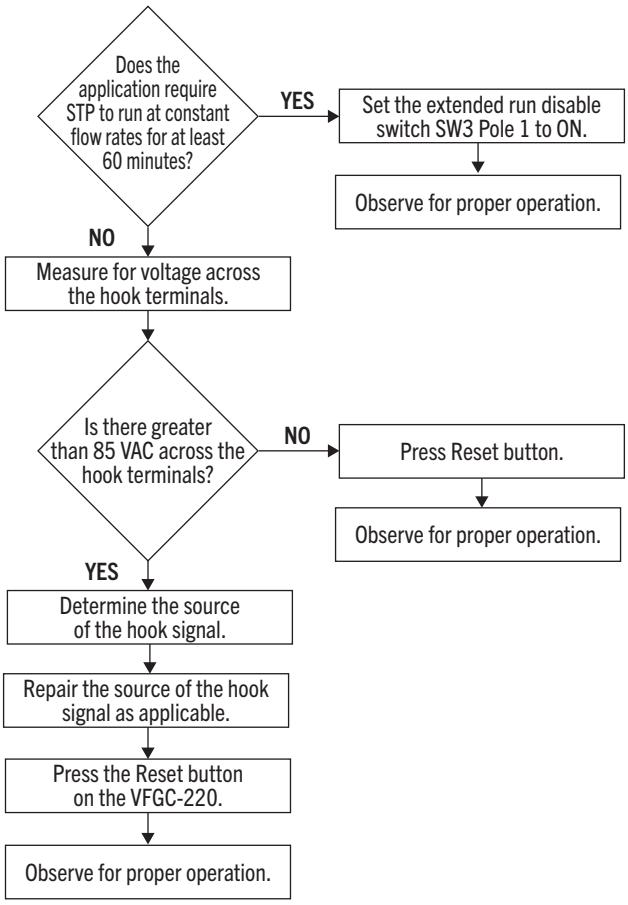
The OPEN CIRCUIT alarm activates when the VFGC-220 does not detect proper continuity on the motor load when the controller is reset. This alarm is typically caused by a broken output connection (wiring from controller to PMA) or a PMA thermal overload due to an overcurrent event. If it is an OC fault, the VFGC-220 will display an alternate code displaying the wire(s) the VFGC detects the open on. If motor wiring runs are extremely long and/or of small wire gage, a false overcurrent fault can occur. See §4.1 for recommended wire size and run.



5.3.5 Extended Run Alarm

- Error code flashes:

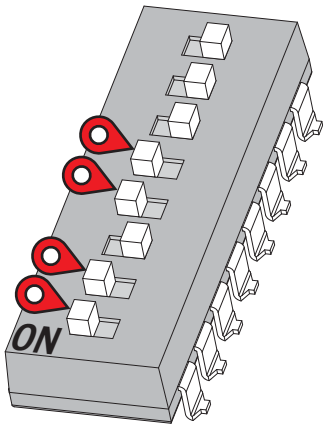
The EXTENDED RUN alarm indicates that the VFGC-220 has run for 60 consecutive minutes with no change in power consumption (motor load). See §4.2.3.3 for additional details of this selectable feature.



5.4 Selectable Features to Aid Troubleshooting

⚠ WARNING:

- To avoid an electrical hazard that could create a risk of severe injury or death, always make sure both power supplies (120–240 VAC hook and 200–250 VAC input) are disconnected before anyone services the equipment.
- After disconnecting power to the VFGC-220 controller, wait one minute after User Interface Display blanks before opening the cover for servicing. *Voltage stored in the capacitor bank of the VFGC-220 controller presents a potential risk of electrical shock even after power is disconnected.*



5.4.1 Fault Read Out Mode (SW1, Pole 6)

To enable this mode,

1. Turn off power to the VFGC-220.
2. Remove console cover.
3. Turn ON SW1 pole 6.
4. Reinstall the cover.
5. Turn on power to the VFGC-220 (to see the fault readout).

In FAULT READ OUT MODE, the controller displays the last five abnormal conditions, starting with the most recent one. First, the controller shows “F1” on the display and then shows the most recent abnormal condition. Next, it shows “F2” on the display and then shows the abnormal condition that preceded the most recent abnormal condition. The controller follows this sequence through “F5,” which is the oldest abnormal condition that is reported, and then repeats the sequence, starting with F1, as long as it is in FAULT READ OUT MODE. If there are less than five abnormal conditions, the controller still flashes “Fn” (where n=1 through 5) and then a blank display.

5.4.2 Bypass Mode (SW1, Pole 7)

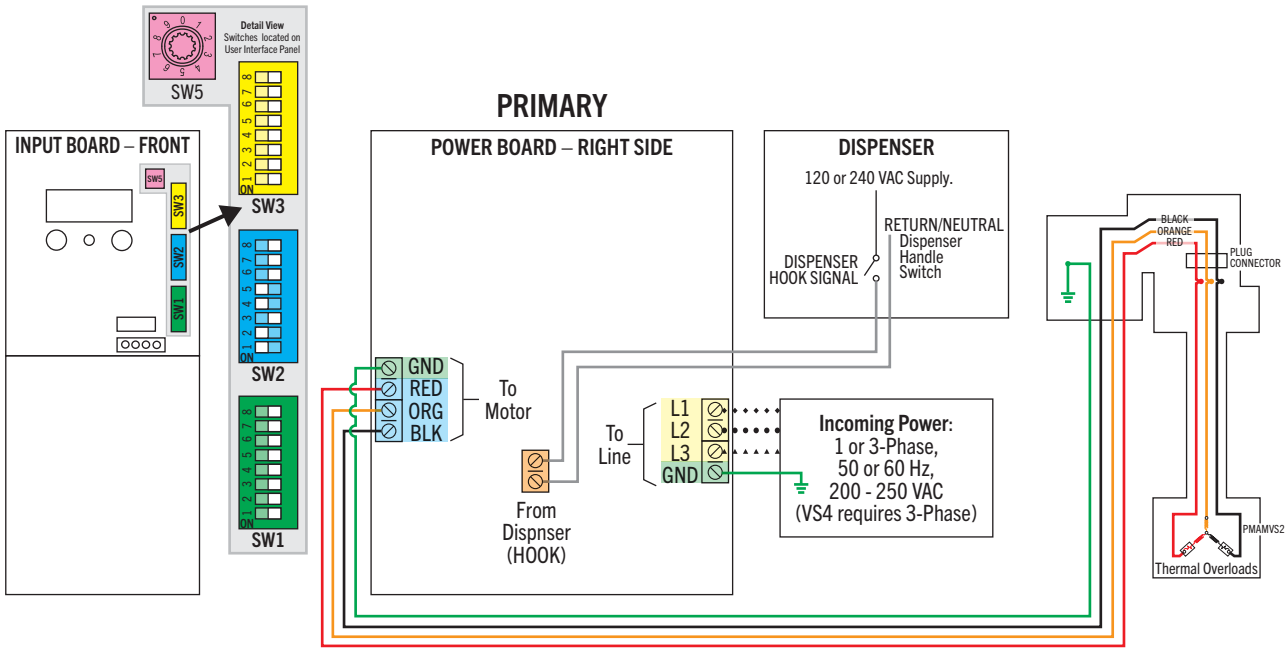
When this mode is selected, with the switch in the ON position, the controller operates at a fixed speed (60 Hz). It will not indicate or shut down due to an underload (UL), open circuit (OC), or phase imbalance (UbL) fault. The BYPASS MODE is active for a maximum 10 minutes, after which, the controller reverts to its normal operation. Push the Reset button to allow the controller to run in BYPASS MODE for another 10 minutes (the display alternates between “bP” and a countdown of the bypass time remaining in seconds).

6 Appendix

6.1 Wiring Diagrams

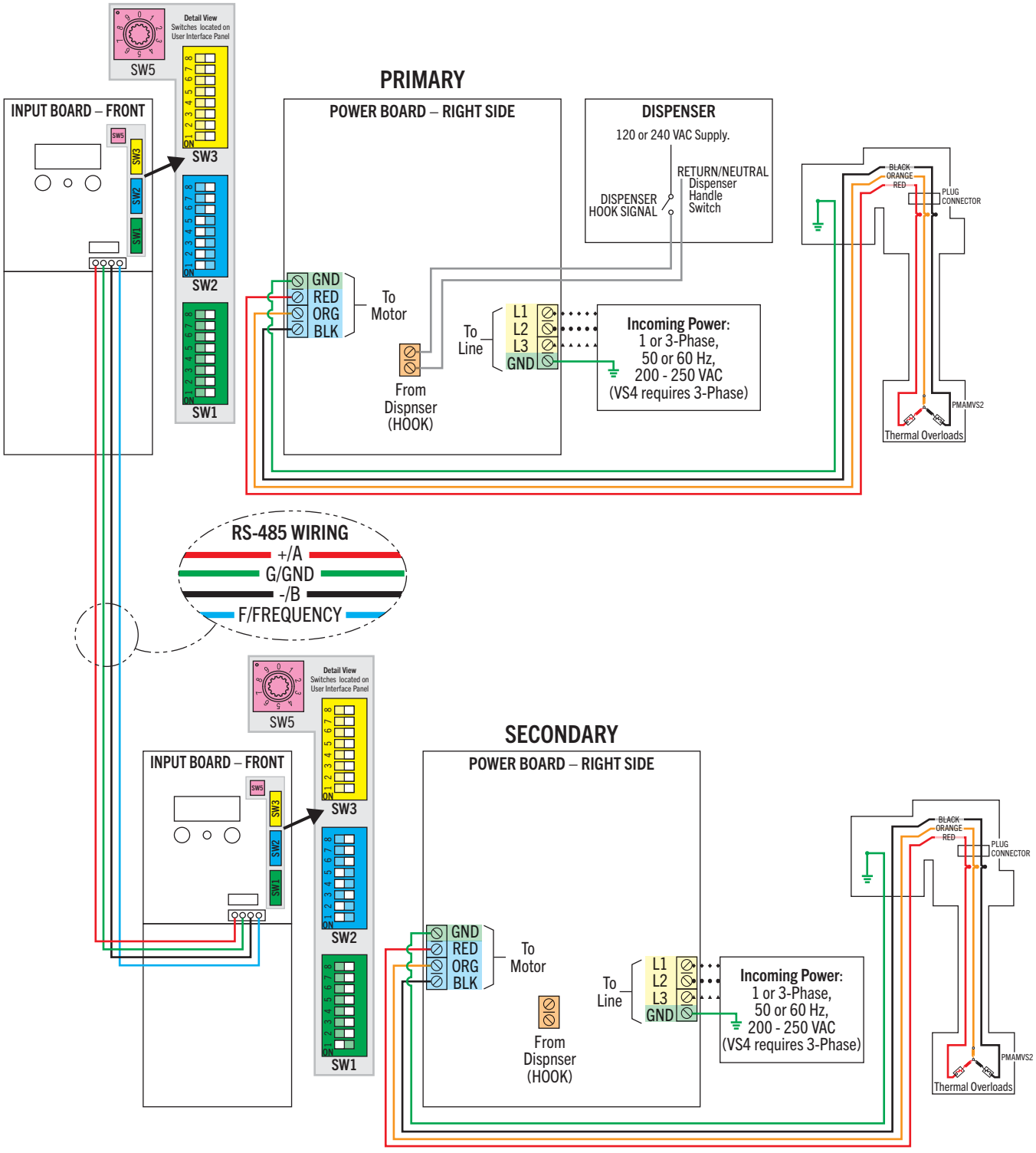
- Wiring must conform to all applicable federal, state, and local codes.
- VFGC-220 controllers are for non-hazardous, indoor use only. (§4.1, list item 4.)
- Route RS-485 wiring (where applicable) a minimum of ¼" (6 mm) away from power wiring.
- See Configuration Instructions (§4.2) for selectable features (SW1 Poles 1 thru 5 addressing for TPI, for example) and calibration settings (SW5 and PIPE COMPENSATION SW2 Pole 4 and 5, for example).
- White DIP switches in the left position are ON ( ).

6.1.1 Standalone



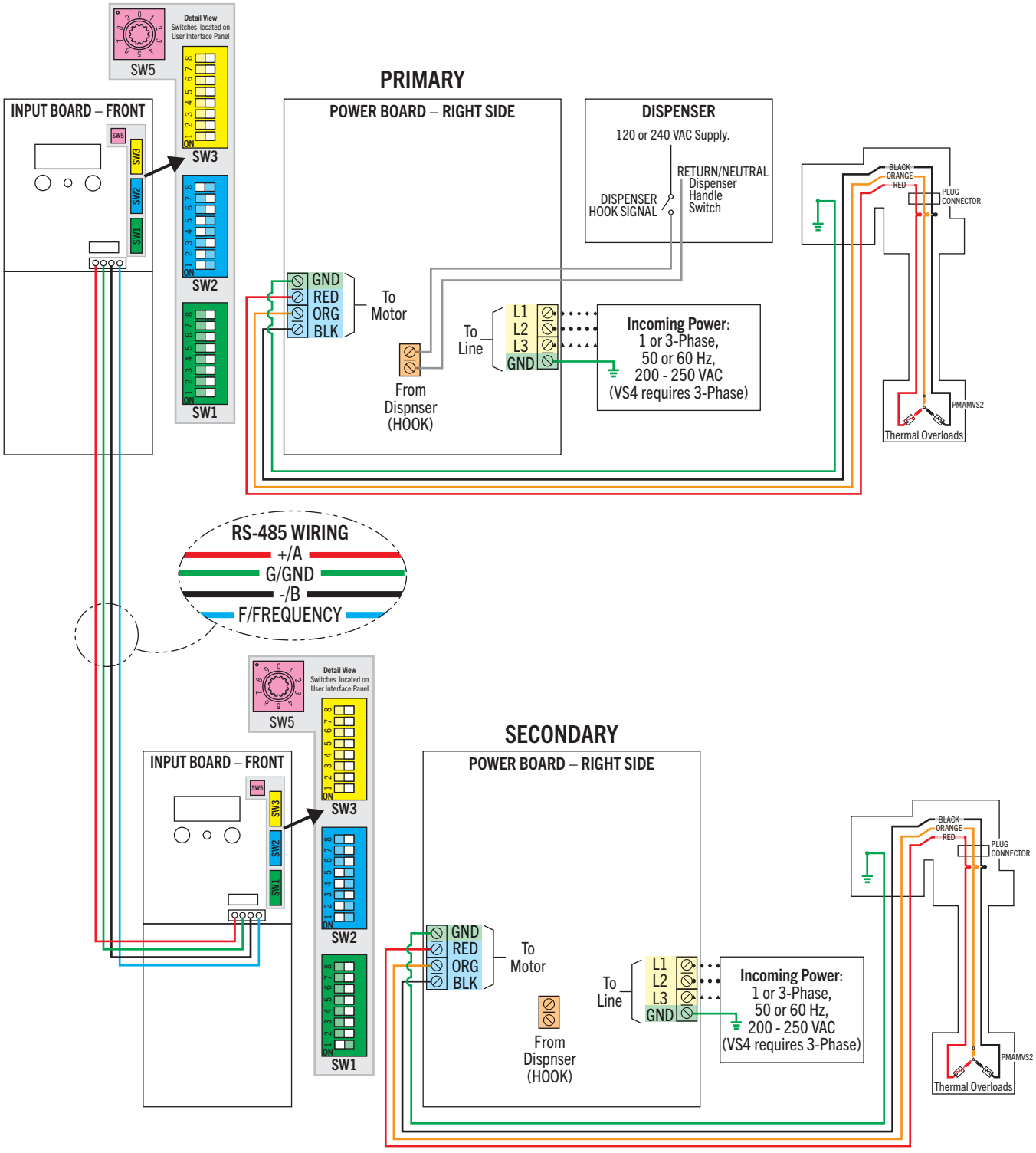
NOTE: Factory default switch settings are shown for VS2 Standalone operation in gasoline with MLD startup. Turn SW2 Pole 6 ON and S1 to 78 Hz for VS4 Standalone operation.

6.1.2 Primary-Secondary



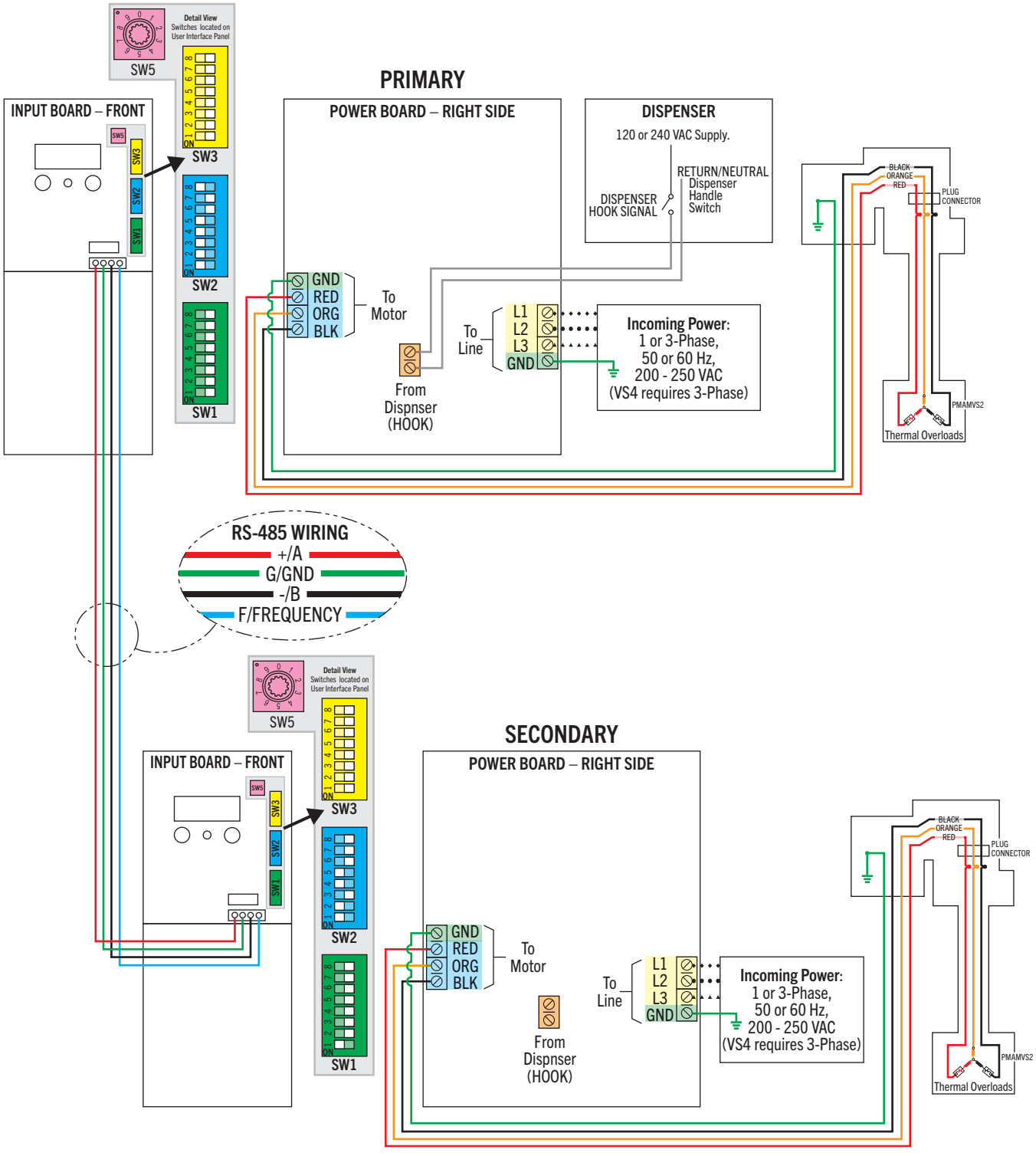
NOTE: Switch settings shown are for PRIMARY-SECONDARY operation of VS2 in gasoline with MLD startup. Turn SW2 Pole 6 ON and S1 to 78 Hz for VS4 PRIMARY-SECONDARY operation.

6.1.3 Alternating Circuit



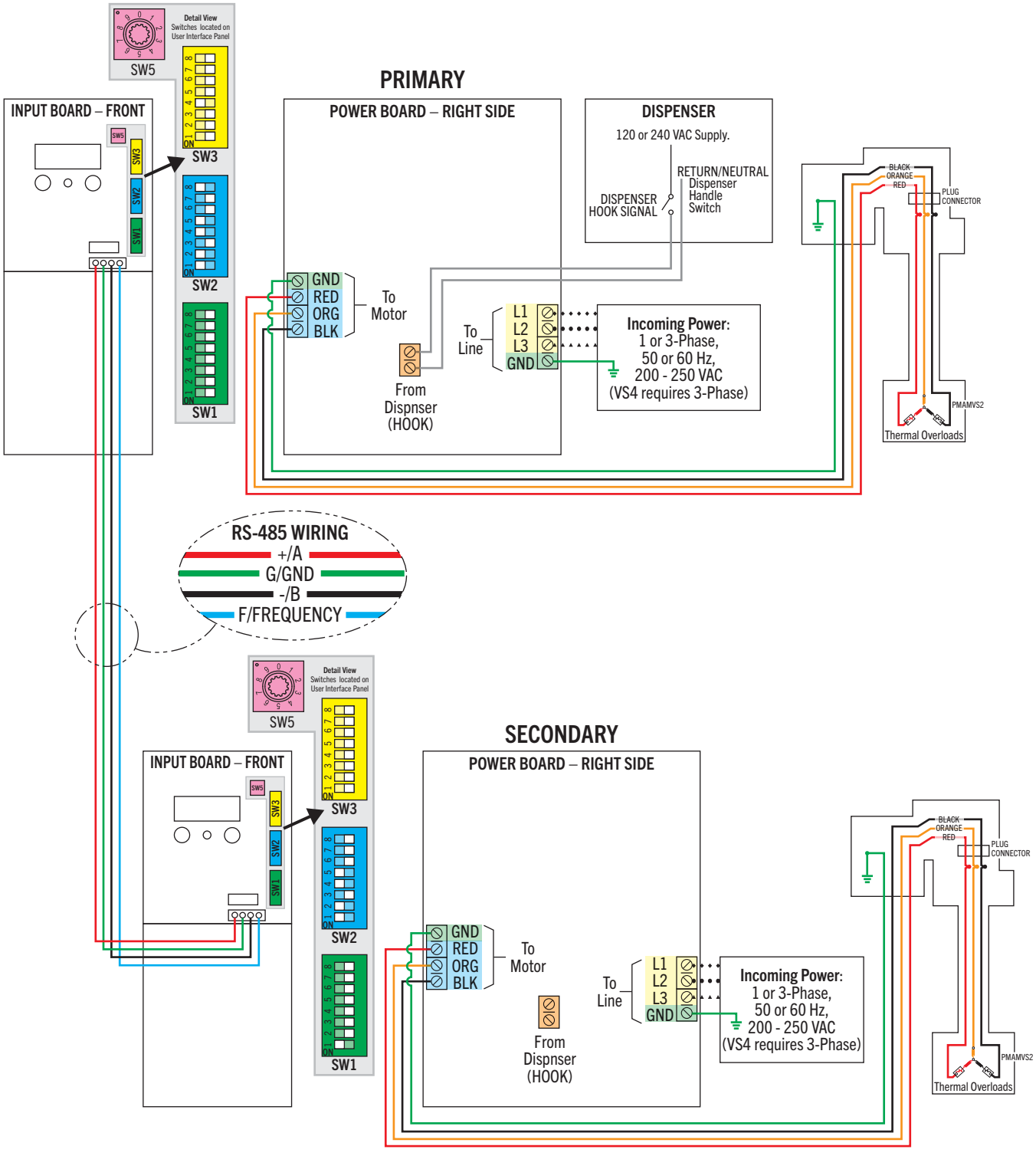
NOTE: Switch settings shown are for ALTERNATING CIRCUIT operation of VS2 in gasoline with MLD startup. Turn SW2 Pole 6 ON and S1 to 78 Hz for VS4 ALTERNATING CIRCUIT operation.

6.1.4 Primary-Secondary / Alternating Circuit



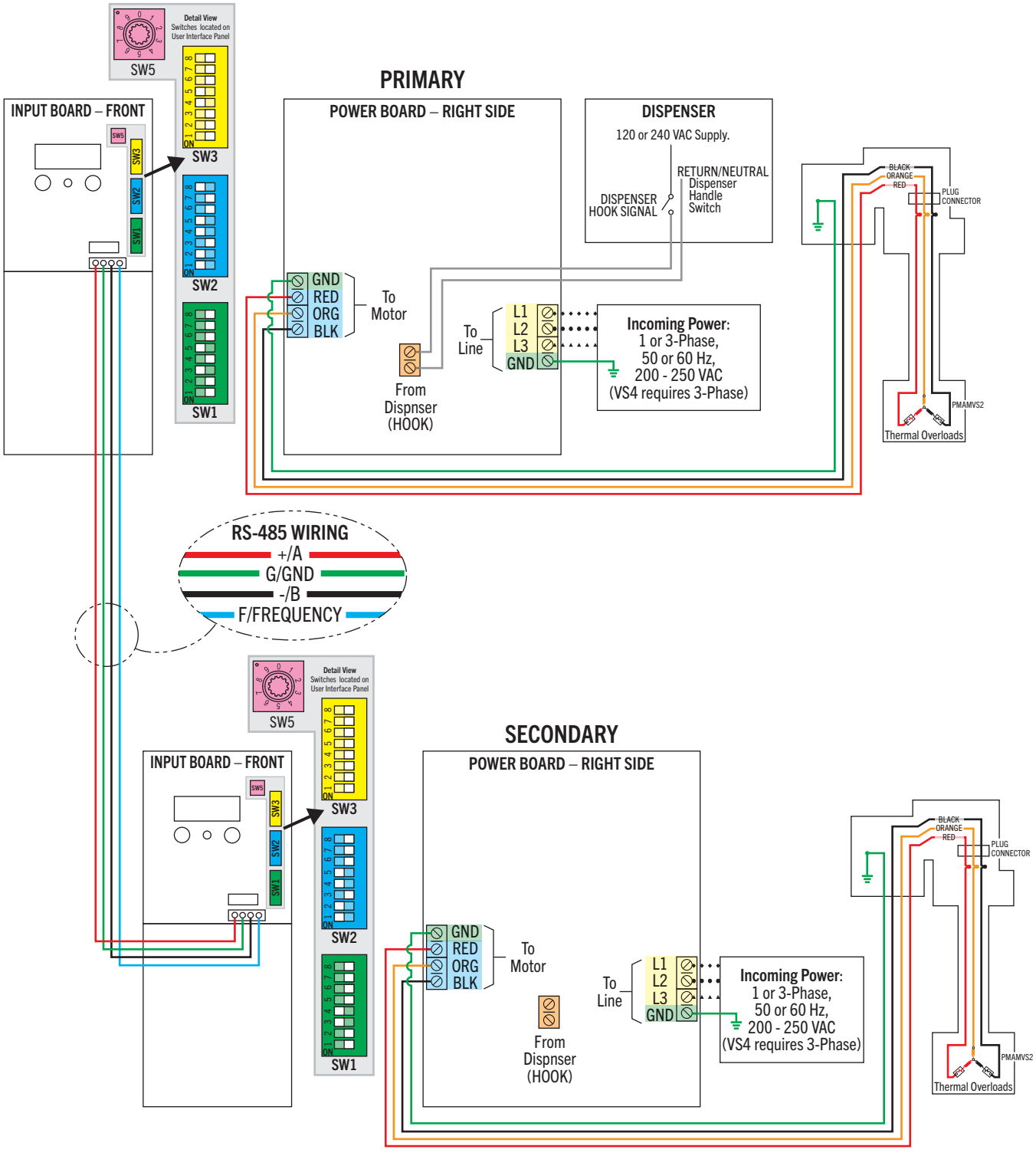
NOTE: Switch settings shown are for PRIMARY-SECONDARY/ALTERNATING CIRCUIT operation of VS2 in gasoline with MLD startup. Turn SW2 Pole 6 ON and S1 to 78 Hz for VS4 PRIMARY-SECONDARY/ALTERNATING CIRCUIT operation.

6.1.5 Timed Alternating Circuit



NOTE: Switch settings shown are for TIMED ALTERNATING CIRCUIT operation of VS2 in gasoline with MLD startup. Turn SW2 Pole 6 ON and S1 to 78 Hz for VS4 TIMED ALTERNATING CIRCUIT operation.

6.1.6 Proportional Alternating Circuit



NOTE: Switch settings shown are for PROPORTIONAL ALTERNATING CIRCUIT operation of VS2 in 20K (Primary) and 12K (Secondary) gasoline tanks with MLD startup. Turn SW2 Pole 6 ON and S1 to 78 Hz for VS4 PROPORTIONAL ALTERNATING CIRCUIT operation.

6.2 Related Documents

Documentation can be found at www.franklinfueling.com.

Part Number	Description
223844101	STP-DHI Installation and Owner's Manual
AG-016	TPI Application Guide

6.3 Certifications & Approvals

NOTE: See §3.2.2 for product specifications and operating parameters.

Agency	Certification	Standards
UL/ULC	File MH19758	**Overvoltage** : UL 61010-1CATEGORY III **Pollution**: UL 61010-1 DEGREE 2 **Safety Requirements**: UL 61800-5-1

6.4 Glossary

EPA ..... Environmental Protection Agency

PMA ..... Pump Motor Assembly.

RS-485 ..... An IEEE standard for serial communications using shielded or unshielded twisted pair cables.

STP ..... Submersible Turbine Pump.

TPI..... Turbine Pump Interface.

UIB..... User Interface Board.

USB..... Universal Serial Bus.

6.5 Notes



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April 13, 2026