

ROBERTS GORDON® MODULATING CONTROLS

For CORAYVAC® and Unitary Infrared Heating Systems Installation Manual



⚠ WARNING

Improper installation, adjustment, alteration, service or maintenance can result in death, injury or property damage. Read the Installation, Operation and Service Manual thoroughly before installing or servicing this equipment.

Installation must be done by an electrician qualified in the installation and service of control systems for heating equipment.

Installer

Please take the time to read and understand these instructions prior to any installation. Installer must give a copy of this manual to the owner.

Owner

Keep this manual in a safe place in order to provide your service technician with necessary information.



Roberts-Gordon LLC
1250 William Street
P.O. Box 44
Buffalo, New York 14240-0044
Telephone: +1.716.852.4400
Fax: +1.716.852.0854
Toll Free: 800.828.7450

www.robertsgordon.com

TABLE OF CONTENTS

SECTION 1: Introduction	1	SECTION 6: Variable Frequency Drive Programming	48
1.1 Safety	1	6.1 VFD Parameter Settings For Use With ROBERTS GORDON® CORAYVAC® Modulating Heating Control	48
1.2 Safety Labels and Their Placement.....	1	6.2 Altering VFD Parameters	49
1.3 California Proposition 65	1	6.3 Sequence of Operation CORAYVAC® Modulating Heating Control	52
1.4 What is a ROBERTS GORDON® CORAYVAC® Modulating Heating Control?	1	SECTION 7: Commissioning The CORAYVAC® System	55
1.5 What is a ROBERTS GORDON® COMPLETE™ Modulating Heating Control?	1	7.1 Setting The CORAYVAC® End Burner Vacuum.....	55
1.6 General Requirements	2	SECTION 8: Programming and Troubleshooting the System	58
1.7 CORAYVAC® Design Requirements (Modulating Systems).....	2	8.1 Passwords	58
1.8 CORAYVAC® Design Requirements (On/Off Systems)	2	8.2 Home Screen and Programming the System	59
1.9 VANTAGE® CTHN Multiburner Systems.....	2	8.3 Home Screen System Configuration	59
1.10 Unitary Design Requirements.....	2	8.4 Zone Temperature Setpoints	60
1.11 Control Board and Sensor Power	2	8.5 Schedule Creation.....	60
1.12 Example Site Layout.....	3	8.6 Edit Existing Schedule	62
1.13 Carton Contents	8	8.7 Zone Configuration (Zone Setup).....	62
SECTION 2: Specifications	10	8.8 Maintenance.....	63
2.1 ROBERTS GORDON® CORAYVAC® Modulating Heating Control and COMPLETE™ Modulating Heating Control (Unitary Heaters).....	10	8.9 Alarms	63
2.2 Terminating Resistor, BT485.....	10	8.10 Alarm Configuration.....	63
2.3 Repeater	10	8.11 VFD Status	63
2.4 Load Reactor	11	8.12 Unit Configuration.....	64
2.5 Temperature Sensors.....	11	8.13 Adjust Time.....	64
2.6 Touchscreen (HMI) (Located on Central Controller:...	11	SECTION 9: Troubleshooting	66
2.7 Variable Frequency Drive (Located inside CORAYVAC® Modulating Heating Control)	11	SECTION 10: Controls Start-Up Checklist	83
SECTION 3: Installation	13	SECTION 11: Replacement Parts	84
3.1 Preparation	13	11.1 CORAYVAC® Modulating Heating Control Controller Replacement Parts.....	85
3.2 Positioning CORAYVAC® Modulating Heating Control.....	15	11.2 COMPLETE™ Modulating Heating Control Controller Replacement Parts.....	86
3.3 Cable Requirements:	16	11.3 Repeater Replacement Parts.....	87
3.4 CORAYVAC® and COMPLETE™ Modulating Heating Control Installation Materials.....	16	11.4 Replacement Parts Instructions	88
3.5 Electrical Installation Requirements of CORAYVAC® Modulating Heating Control	19	SECTION 12: Integration with Building Management System (BMS)	89
3.6 Pump Requirements	19	12.1 BACnet over ARC156	89
3.7 Variable Frequency Drive Requirements.....	20	12.2 BACnet MS/TP	91
3.8 Indoor Sensor Placement and Mounting	20	12.3 BACnet PTP	93
3.9 Indoor Sensor Addressing	20	12.4 BACnet Over IP	94
3.10 Outdoor Sensor (P/N 10081500) Placement	21	12.5 BACnet over Ethernet.....	96
3.11 Outside Air Supply (P/N 90707501K)	21	12.6 Modbus	97
SECTION 4: Typical Wiring Diagrams	23	12.7 To set up the Modulating Controller for N2 on Port 1	100
SECTION 5: Communications	38	12.8 LonWorks	102
5.1 WebCTRL®	38	SECTION 13: Touchscreen Tree	104
5.2 BACnet/IP Connection	38	SECTION 14: The ROBERTS GORDON® CORAYVAC®/ COMPLETE™ Modulating Heating Control Limited Warranty	113
5.3 Integration into Building Management System (BMS).....	39		
5.4 Communications Between Multiple CORAYVAC® Modulating Heating Controls.....	40		
5.5 Setting Baud Rate	41		
5.6 Terminating Resistors.....	41		
5.7 Control Board Setup	42		
5.8 Touchscreen.....	45		
5.9 The REP485 Repeater (P/N 10060156).....	47		

© 2019 Roberts-Gordon LLC

All rights reserved. No part of this work covered by the copyrights herein may be reproduced or copied in any form or by any means - graphic, electronic, or mechanical, including photocopying, recording, taping or information storage and retrieval systems - without the written permission of Roberts-Gordon LLC.

SECTION 1: INTRODUCTION

1.1 Safety



Your Safety is Important to Us! This symbol is used throughout the manual to notify you of possible fire, electrical or burn hazards. Please pay special attention when reading and following the warnings in these sections.

Installation, service and annual inspection of controller must be done by an electrician qualified in the installation and service of control systems for heating equipment.

Installation, service and annual inspection of heater must be done by a contractor qualified in the installation and service of gas-fired heating equipment.

Read this manual carefully before installation, operation, or service of this equipment.

The appliance must be applied and operated under the general concepts of reasonable use and installed using best building practices.

This appliance is not intended for use by persons (including children) with reduced physical, sensory or mental capabilities, or lack of experience and knowledge, unless they have been given supervision or instruction concerning use of the appliance by a person responsible for their safety.

Children should be supervised to ensure that they do not play with the appliance.

For optimum heater performance and safe heating conditions, inspect and maintain heater(s) before every heating season and as necessary. Also, know and maintain heater clearances to combustibles, see heater Installation, Operation and Service Manual for further details. If you require additional manuals, contact your ROBERTS GORDON® independent distributor or Roberts-Gordon LLC at (716) 852-4400, (800) 828-7450 or at www.robertsgordon.com.

1.2 Safety Labels and Their Placement

Product safety signs or labels should be replaced by the product user when they are no longer legible. Please contact Roberts-Gordon LLC or your ROBERTS GORDON® independent distributor to obtain replacement signs or labels. *see Page 4, Figure 2 through Page 5, Figure 4.*

1.3 California Proposition 65

In accordance with California Proposition 65 requirements, a warning label must be placed in a highly visible location on the outside of the equipment (i.e., near equipment's serial plate). See label placement drawings on *Page 4, Figure 2 through Page 5, Figure 3* for label location. Avoid placing label on areas with extreme heat, cold, corrosive chemicals or other elements. To order additional labels, please contact Roberts-Gordon LLC or your ROBERTS GORDON® independent distributor.

1.4 What is a ROBERTS GORDON® CORAYVAC® Modulating Heating Control?

The ROBERTS GORDON® CORAYVAC® Modulating Heating Control is a micro-processor based control package designed for modulating control of CORAYVAC® system and/or control of ROBERTS GORDON® modulating and single stage unitary heaters based on outdoor temperatures.

This controller is capable of giving control outputs to two vacuum pumps and four heating zones. The controller also features inputs which are used for indoor and outdoor signal condition monitoring.

For the overall view of connected components for ROBERTS GORDON® CORAYVAC® Modulating Heating Control, *see Page 6, Figure 5.*

System status and settings are viewed and altered from a touchscreen, personal computer or smart device (PC and smart device not supplied).

1.5 What is a ROBERTS GORDON® COMPLETE™ Modulating Heating Control?

Similar to the CORAYVAC® Modulating Heating Control, The ROBERTS GORDON® COMPLETE™ Modulating Heating Control is a micro-processor based control package designed for modulating control of VANTAGE® Modulating (model: CTH3/HEM) unitary heaters, on/off control of single-stage ROBERTS GORDON® unitary heaters, or on/off control of CORAYVAC® or VANTAGE® Multiburner systems.

This controller is capable of giving control outputs to two vacuum pumps and four heating zones. The controller also features inputs which are used for indoor and outdoor signal condition monitoring.

System status and settings are viewed and altered from a touchscreen, personal computer, or smart device (PC and smart device not supplied).

1.12 Example Site Layout

Below is an example layout for a building where ROBERTS GORDON® CORAYVAC® Modulating Heating Control will be used to control the infrared

heating systems shown. The layout consists of four zones of ROBERTS GORDON® CORAYVAC® Modulating Heating Control.

FIGURE 1: Example Site Layout

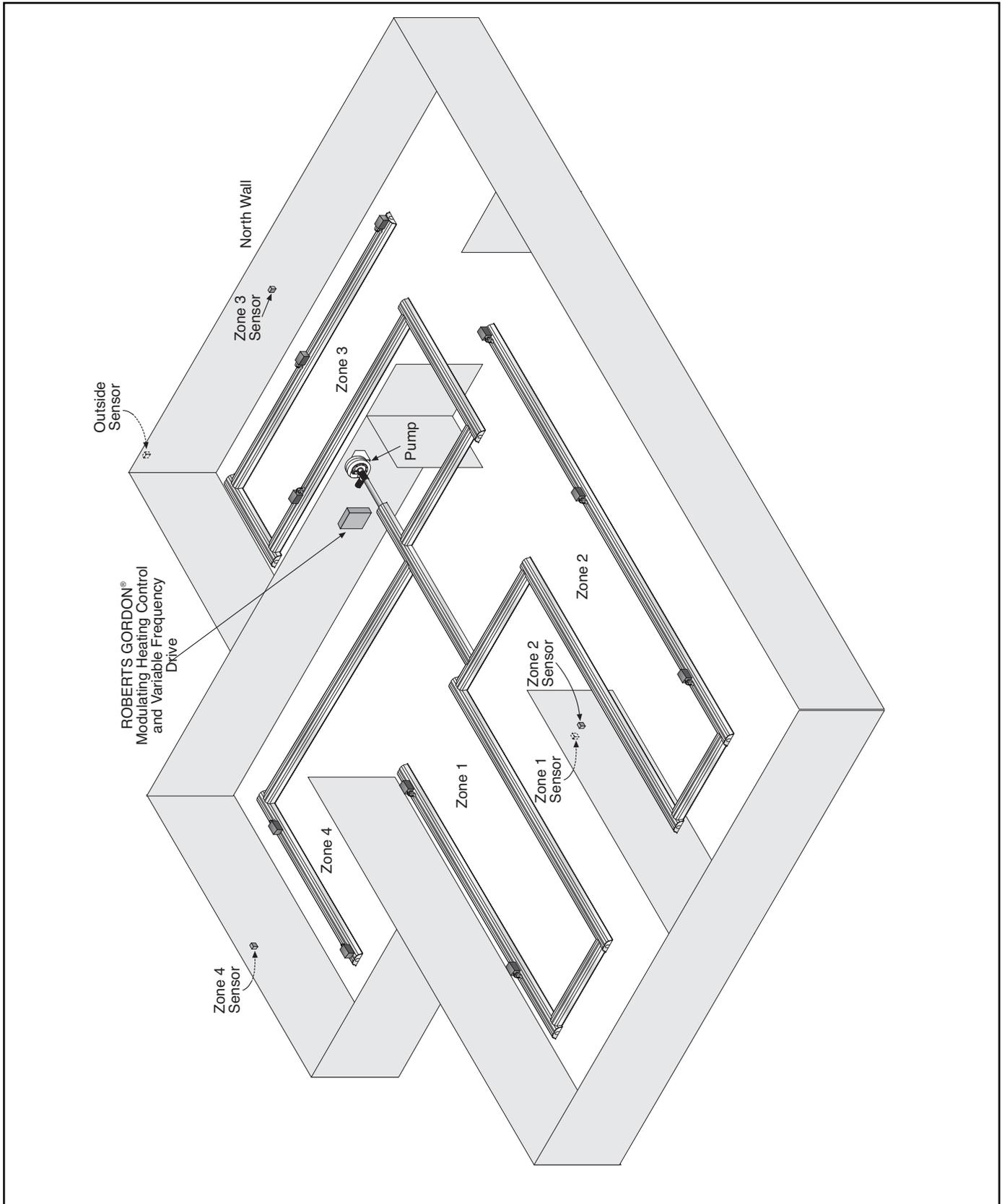


FIGURE 2: CORAYVAC® Modulating Heating Control Label Placement

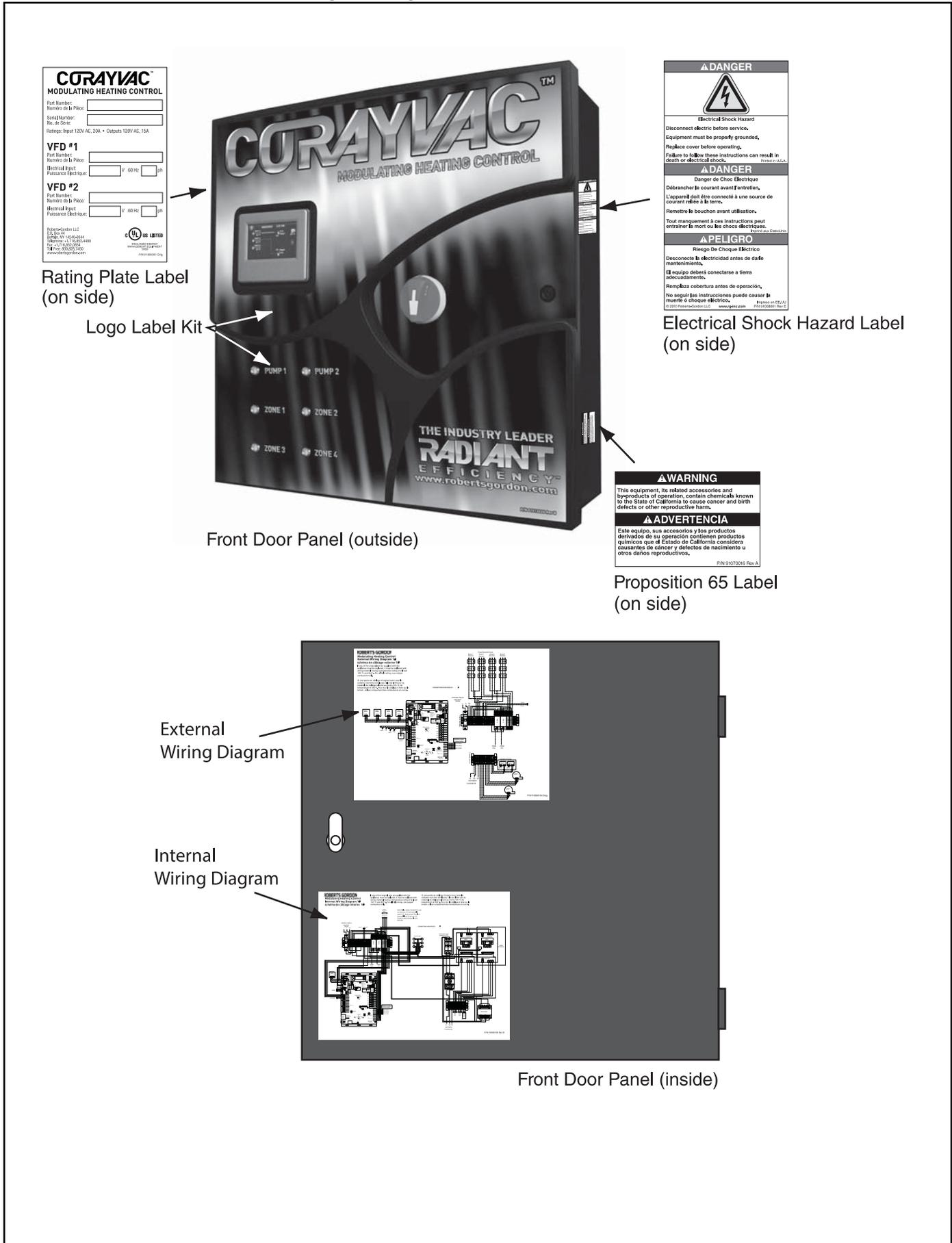
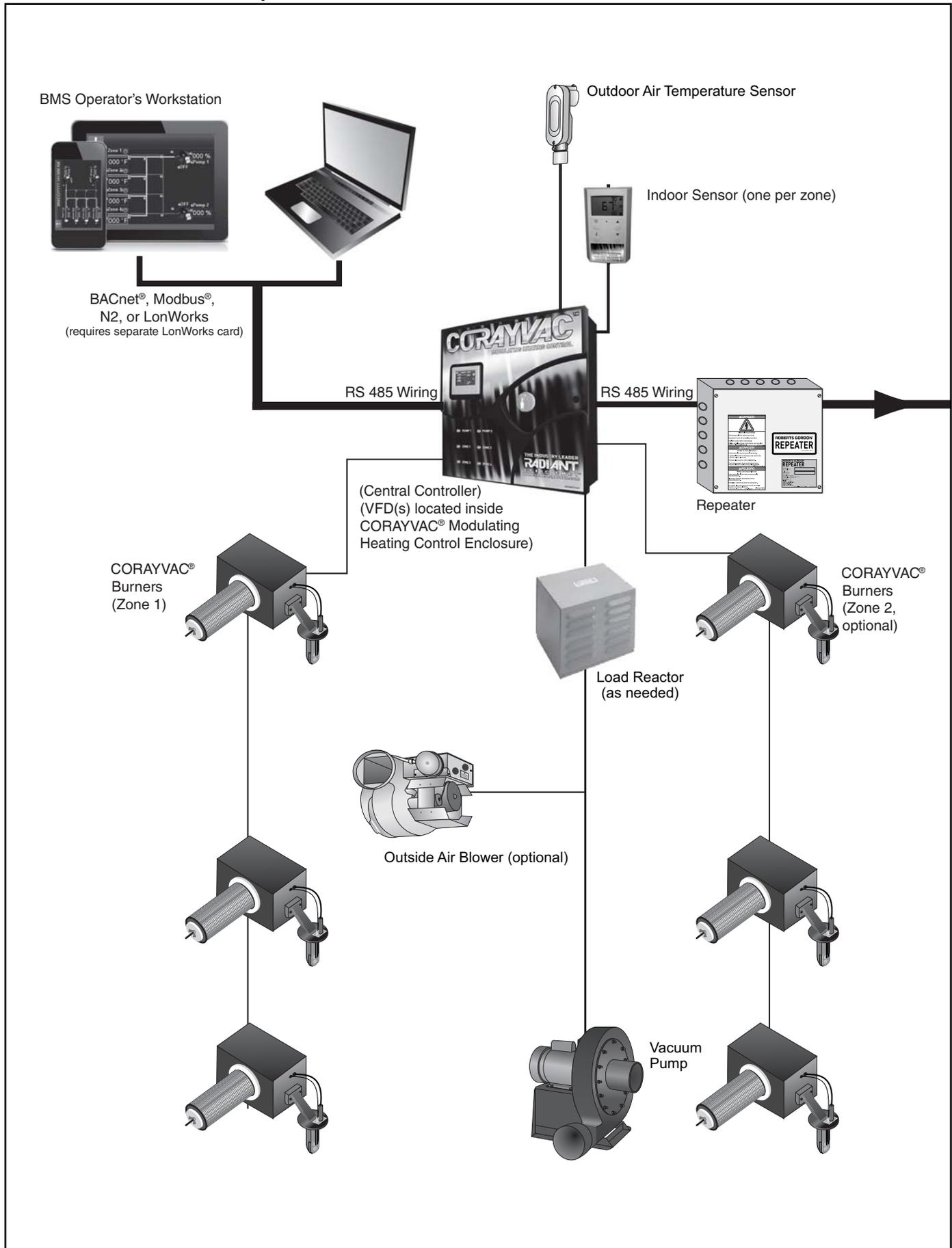
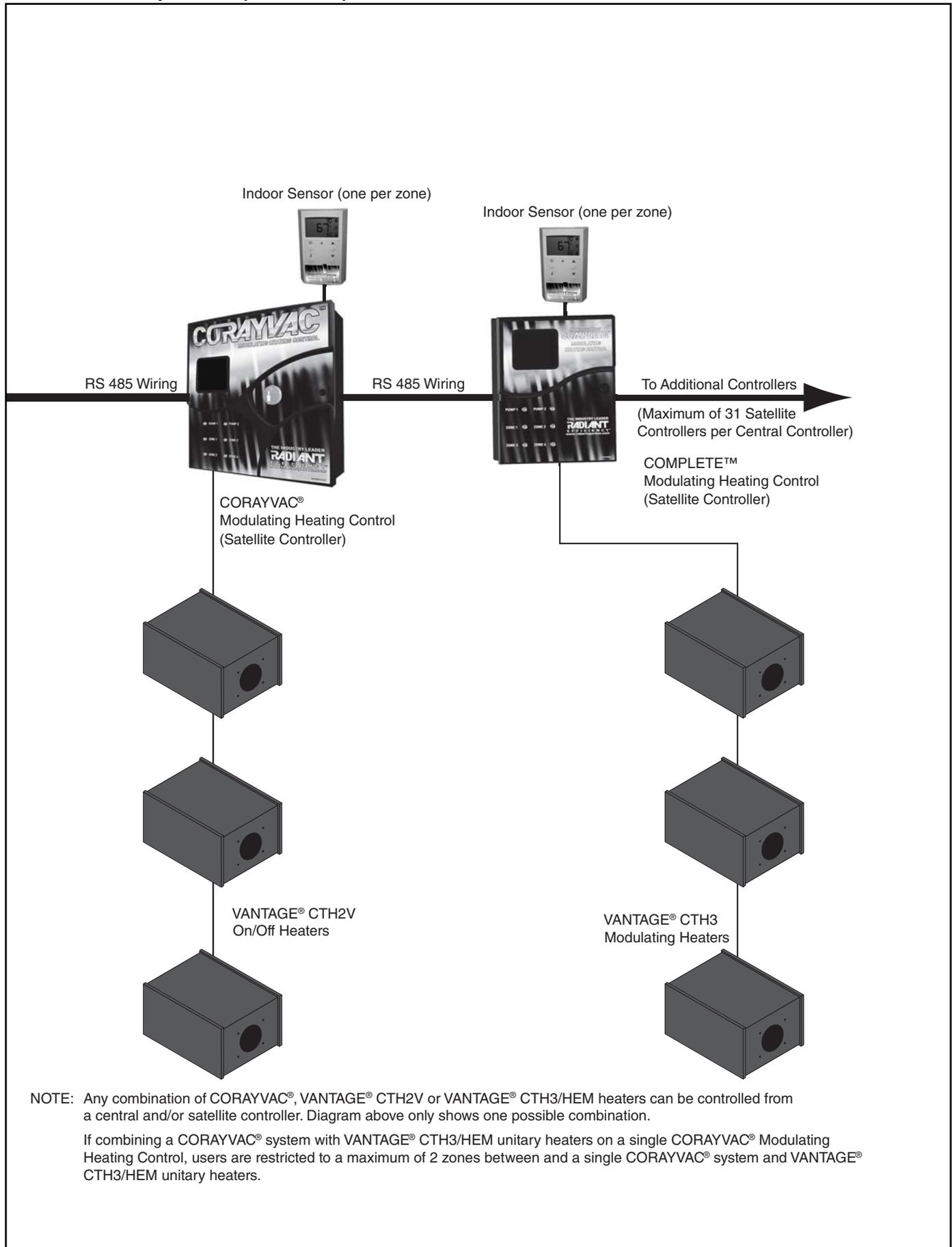


FIGURE 5: Connected Components

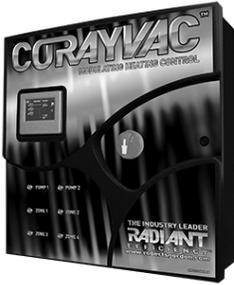


Connected Components (continued)

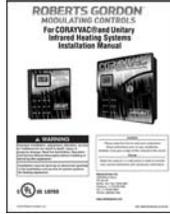


1.13 Carton Contents

100600XX: CORAYVAC® Modulating Heating Control Central Controller



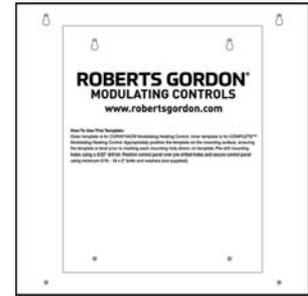
CORAYVAC® Modulating Heating Control Controller with Modem Installed



Installation Manual (P/N 1006101NA)



VFD Manual



Mounting Template (P/N 91702810)

10060XXX: CORAYVAC® Modulating Heating Control Satellite Controller



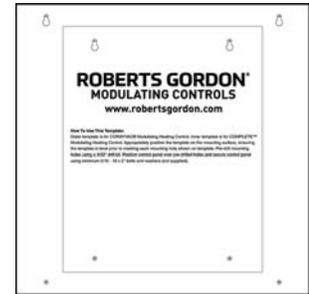
CORAYVAC® Modulating Heating Control Controller with Modem Installed



Installation Manual (P/N 1006101NA)



VFD Manual

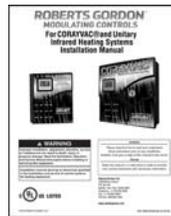


Mounting Template (P/N 91702810)

COMPLETE™ Modulating Heating Control



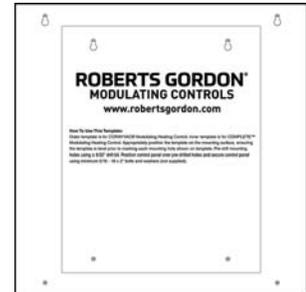
COMPLETE™ Modulating Heating Control



Installation Manual (P/N 1006101NA)

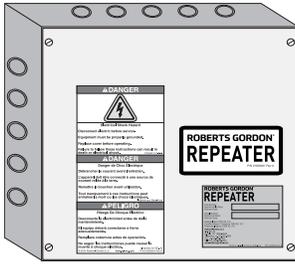


VFD Manual

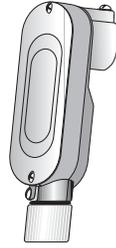


Mounting Template (P/N 91702810)

Accessories



Repeater (optional)
Supplied w/24 VAC
transformer inside
NEMA 1 enclosure
(P/N 10060156)



Outdoor Sensor
(P/N 10081501)



Indoor Sensor
(P/N 10061003)



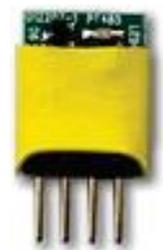
Load Reactor
(P/N 10061019)
(P/N 10061020)
(P/N 10061021)
(P/N 10061022)



LonWorks Card
(P/N 10060160)



USB-L Cable
(P/N 10061017)



Terminating Resistor, BT485
(P/N 10061018)

SECTION 2: SPECIFICATIONS

2.1 ROBERTS GORDON® CORAYVAC® Modulating Heating Control and COMPLETE™ Modulating Heating Control (Unitary Heaters)

2.1.1 Enclosures, Central and Satellite Controllers

Construction: 14 gauge painted steel, hinged door, removable knockouts provided.

Dimensions: W x H x D

CORAYVAC® Modulating Heating Control:

(in): 24.75 x 24.75 x 8.3

(cm): 16.8 x 20.75 x 8.2

COMPLETE™ Modulating Heating Control:

(in): 62.9 x 62.9 x 21.1

(cm): 41.7 x 52.7 x 20.8

Weight:

CORAYVAC® Modulating Heating Control:

70 lbs (31.7 Kg)

COMPLETE™ Modulating Heating Control:

(40 lbs (18.1 Kg)

2.1.2 Electrical

(Controller ONLY, VFD is powered separate of controller, See Page 11, Section 2.7)

Power Supply: 120 V (+/- 10%) 1 Ø, 60 Hz, 20 Amps

UL Standard: 508A, UL Type 1

Universal Inputs:

Twelve Universal Inputs

0-5 Vdc

0-10 Vdc

0-20 mA

Thermister (10k ohm type II)

1K ohm RTD

Dry Contact

Universal Outputs:

0-10 Vdc

0-20 mA

Relay

HOA (hand/off/auto) switches for all outputs

Communication Ports:

Port 1: Configurable for ARC156 or EIA-485 (2-wire). Built-in support for BACnet

(MS/TP or ARC156), N2, and Modbus

Port 2a: Configurable for EIA-232 or EIA-485 (2-wire or 4-wire). Network protocol

selectable for BACnet (MS/TP or PTP), Modbus, N2, LonWorks SLTA, or modem.

Port 2b: For LonWorks option Card.

Rnet port: Interface with a BACview5, BACview6, RS sensors, or local laptop and Equipment Touch.

Battery: CR123A, 10 yr life, 720 cumulative hours of power outage.

Note: Battery for time keeping purposes and saving trend data during power outages.

Control Board Listed by: UL-916, CE, FCC Part 15-Subpart B - Class A. BTL (BACnet Test Labs) - BACnet Building Controller (B-BC)

2.2 Terminating Resistor, BT485

(P/N 10061018)

Description: 1 plug-in terminating resistor, BT485

Operating Temperature Range: -29 to 60.0 °C; -20 to 140 °F

Overall dimensions: Width: 0.5 in, Height 0.6 in

2.3 Repeater

(P/N 10060156)

Enclosure: Fabricated in accordance with Non-Metallic

UV-Rated

NEMA 3R

Dimensions: W x H x D

(in): 12 x 12 x 4

(cm): 30.5 x 30.5 x 10.5

Weight: 8 lbs (3.63 Kg)

Power: 24 Vac ±10%, 250 mA (6.0 VA), 50-60 Hz

Port: Net A and B are both EIA-485 (optically isolated)

Power Supply: 120 V (+/- 10%) 1 Ø, 60 Hz, 0.8 Amps

Repeater Ports:

Net A and B are both EIA-485 (optically isolated)

Electronic board listed by, UL-916(PAZX)

CLU-916 (PAZX7) and CE

2.4 Load Reactor

(P/N 100610XX)

Load Reactor required on output side of VFD if total wire length between VFD and vacuum pump is more than 100' (30 m). Maximum length with load reactor is 400' (121 m). For best performance, it is recommended to mount load reactor as close to VFD as possible. Load reactor protects the VFD from short circuiting. Load reactors maximize pump performance by improving voltage and current waveforms from supply while also eliminating the possibility of the pump overheating and noise emissions. Reactors also minimize harmonic current levels within the drive supply circuit.

Voltage: 460V/3Ø,2HP- 460V/3Ø,3/4 HP-230V/3Ø.

Frequency: 60Hz Fundamental Current Maximum.

Enclosure Dimension:

(in): 10 x 10 x 8.13

(cm): 25.4 x 25.4 x 20.65

IP: 20

2.5 Temperature Sensors

Indoor Sensor

(P/N 10061003)

Dimensions: W x H x D

(in): 4.75 x 3 x 0.75

(cm): 12.1 x 7.6 x 1.9

Power: 12 Vdc

Operating Temperature Range:

32 to 122 °F (0 to 50 °C)

Features: LCD temp display, setpoint display, setpoint adjustment, override button, information screen, diagnostics screen

Outdoor Sensor

(P/N 10081501)

Dimensions: W x H x D

(in): 1.4 x 5.3 x 0.75

(cm): 3.6 x 13.5 x 1.9

Operating Temperature Range:

-40 to 221 °F (-40 to 105 °C)

Enclosure: NEMA 4 gasketed aluminum LB housing, ½" threaded connection

2.6 Touchscreen (HMI) (Located on Central Controller):

Dimensions: W x H x D

(in): 5.4 x 4.6 x 1.3

(cm): 13.7 x 11.7 x 3.3

Power: 24 Vac, 50-60 Hz

Operating temp range: -4 to 140 °F (-20 to 60 °C)

Features: 4.3" touchscreen color LCD display, temp sensor, humidity sensor

2.7 Variable Frequency Drive (Located inside CORAYVAC® Modulating Heating Control)

2.7.1 Electrical

Power Output: 230 V, 3 Ø, 0-60 Hz

(for 115 V and 230 V models)

460 V, 3 Ø, 0-60 Hz

(for 460 V models)

Speed Reference Follower: 0-10 Vdc or 4-20 mA

UL Standard: Industrial Controls Equipment

Ambient Operating Temp.:

32 - 104 °F (0 - 40 °C)

1 HP, 120V 1 Ø Drive (used with EP-203 pump)

(P/N 10061201)

Power Input: 115 V, 1 Ø, 50-60 Hz

Input Voltage Tolerance: +/- 10%

Amps: 4.3

1 HP, 208/230v 1 Ø Drive (used with EP-203 pump)

(P/N 10061202)

Power Input: 208/230 V, 1 Ø, 50-60 Hz

Input Voltage Tolerance: +/- 10%

Amps: 4.3

2 HP, 208/230V 1 Ø Drive (used with EP-303 pump)

(P/N 10061203)

Power Input: 208/230 V, 1 Ø, 50-60 Hz

Input Voltage Tolerance: +/- 10%

Amps: 7

1 HP, 460V 3 Ø Drive (used with EP-203 pump)

(P/N 10061204)

Power Input: 460 V, 3 Ø, 50-60 Hz

Input Voltage Tolerance: +/- 10%

Amps: 2.2

2 HP, 460V 3 Ø Drive (used with EP-303 pump)

(P/N 10061205)

Power Input: 460 V, 3 Ø, 50-60 Hz

Input Voltage Tolerance: +/- 10%

Amps: 4.1

1 HP, 208/230V 3 Ø Drive (used with EP-203 pump)

(P/N 10061206)

Power Input: 208/230 V, 3 Ø, 50-60 Hz

Input Voltage Tolerance: +/- 10%

Amps: 4.3

2 HP, 208/230V 3 Ø Drive (used with EP-303 pump)

(P/N 10061207)

Power Input: 208/230 V, 3 Ø, 50-60 Hz

Input Voltage Tolerance: +/- 10%

Amps: 7

SECTION 3: INSTALLATION

⚠ DANGER

Electrical Shock Hazard
Disconnect electric before service.
Controller must be properly grounded to an electrical source.
Failure to follow these instructions can result in death or electrical shock.

Installation of CORAYVAC® Modulating Heating Control and associated external electrical wiring must be done by an electrician qualified in the installation of control systems for heating equipment.

3.1 Preparation

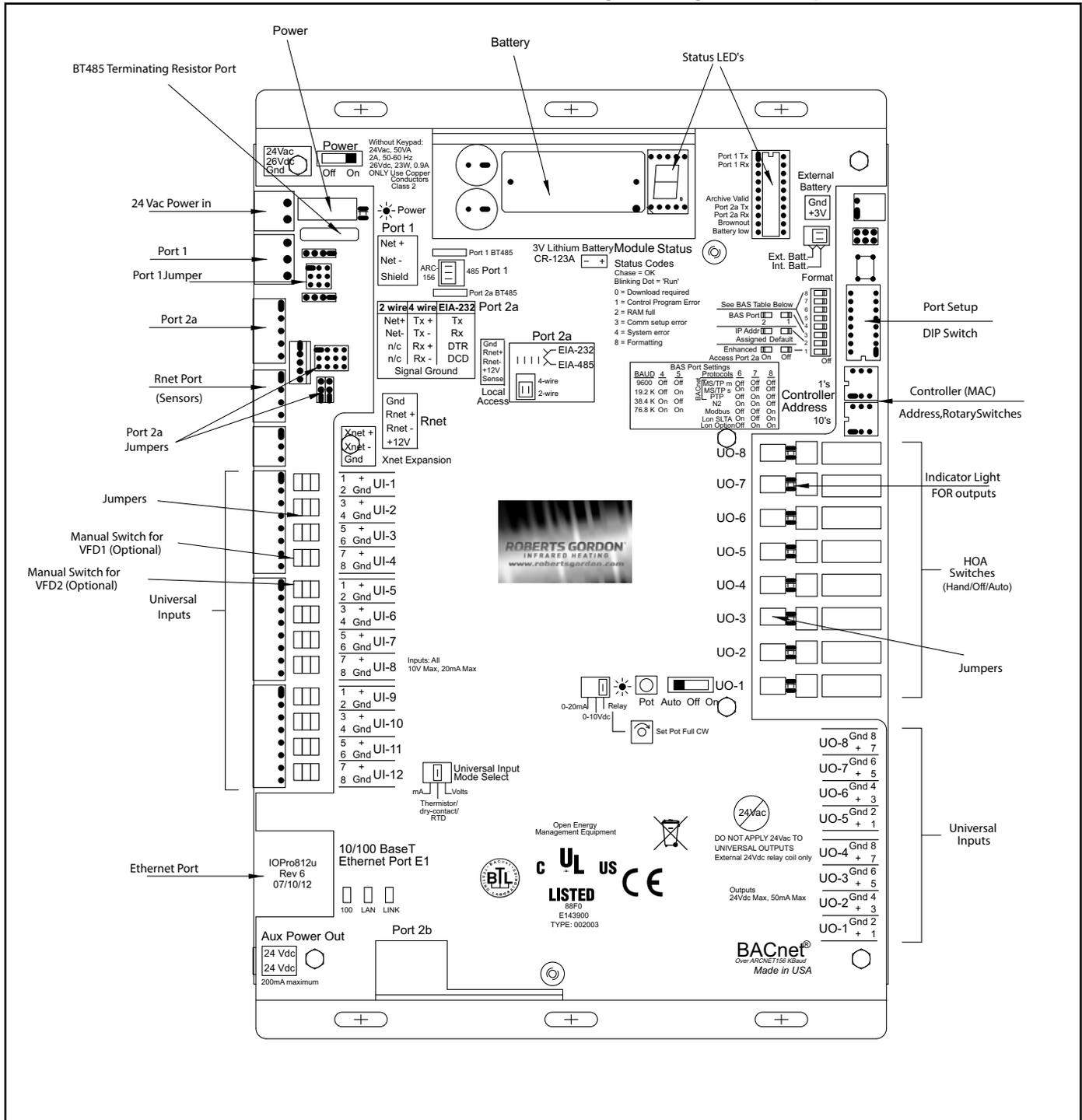
Before installing controller, observe the following:

3.1.1 Ensure that you have a copy of the site layout for the project that clearly identifies the separate zones and wiring distances between all components.

3.1.2 Familiarize yourself with the Controller and Variable Frequency Drive component names and locations. See Page 14, Figure 6, Figure 6.

Note: The VFD is located inside of the CORAYVAC® Modulating Heating Control panel. Be sure to plan accordingly.

FIGURE 6: ROBERTS GORDON® CORAYVAC® Modulating Heating Control Specifications



3.2 Positioning CORAYVAC® Modulating Heating Control

3.2.1 For serviceability, it is convenient to mount the controller at occupant level in the vicinity of the pump. For proper frequency between the VFD and pump, the wire length between controller and vacuum pump should not be more than 100' (30 m). A Load Reactor (P/N 100610XX) will be required for distances greater than 100' (30 m). Maximum distance with Load Reactor is 400' (120 m). Load reactor should be mounted as close to VFD as possible. Consult factory if distance required is greater.

Do not mount controller outdoors. Controller must not be installed where subjected to adverse conditions such as: combustible, oily, or hazardous vapors or dust; excessive moisture or dirt; vibration. To avoid damage from possible condensation leaks, do not mount controller directly beneath pump. Avoid installing the controller in mezzanines, direct sunlight, or near external heat sources because these locations usually have unpredictable temperature rises.

FIGURE 7: Controller Mounting - CORAYVAC® Modulating Heating Control

(Dimensions shown in inches)

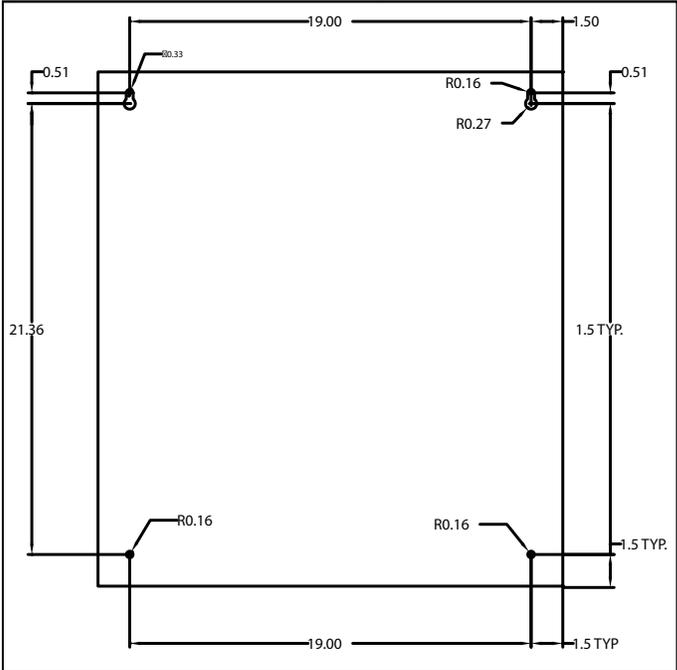
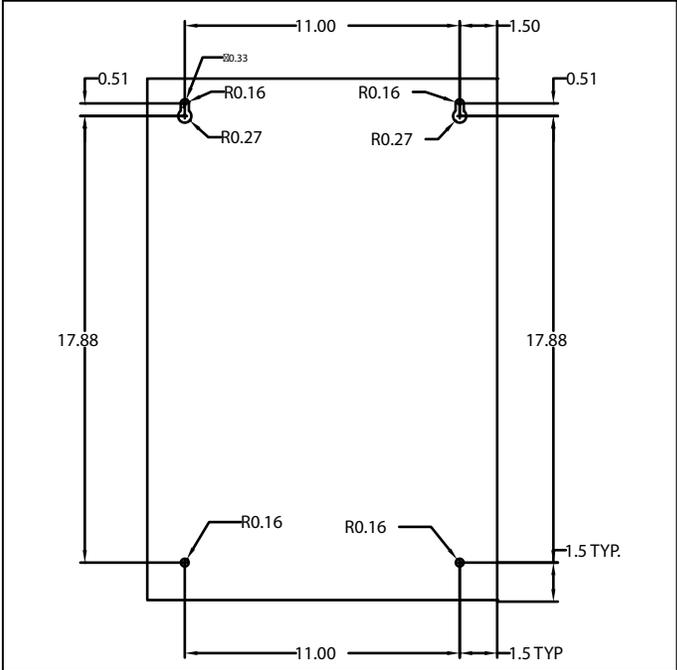


FIGURE 8: Controller Mounting - COMPLETE™ Modulating Heating Control

(Dimensions shown in inches)



Note: A paper mounting template is included with the CORAYVAC® Modulating Heating Control and the COMPLETE™ Modulating Heating Control panels. Appropriately position the template on the mounting surface, ensuring the template is level prior to marking each mounting hole shown on template. Pre-drill mounting holes using a 9/32" drill bit. Position control

panel over pre-drilled holes and secure control panel using minimum 5/16" - 18 x 2" bolts and washers (not supplied).

3.3 Cable Requirements:

As per individual building specification for class of cable to be used. Use copper conductors only. Below is the recommended cable for the various connections for CORAYVAC® and COMPLETE™ Modulating Heating Control.

CAUTION:

- **Separate line and low voltage circuits.**
- **Do not run line voltage wiring through bottom section of enclosure that houses control board.**
- **Do not run low voltage through top section of enclosure that houses the relay board.**
- **Do not run line and low voltage wiring in same conduit.**
- **Do not run wiring for vacuum pumps 1 and 2 from VFDs in the same conduit.**

Note:

Avoid running communication wires or sensor input wires next to AC power wires or the controller's relay output wires. The resulting noise can affect signal quality. Common sources of noise are:

- Spark igniters
- Radio transmitters
- Variable speed drives
- Electric motors (> 1hp)
- Generators
- Relays
- Transformers
- Induction heaters
- Large contactors (i.e., motor starters)
- Video display devices
- Lamp dimmers
- Fluorescent lights

3.4 CORAYVAC® and COMPLETE™ Modulating Heating Control Installation Materials

Note: Systems must be electrically grounded in accordance with the following codes: United States: Refer to National Electrical Code®, NFPA 70 - latest revision. Wiring must conform to the most current National Electrical Code®, local ordinances and any special diagrams furnished.

Canada: Refer to Canadian Electrical Code, CSA

C22.1 Part 1 - latest revision. Plan accordingly.

3.4.1 Switchable Loads

The controller relays are rated for switching loads no greater than 6 A. The total added current load for all 4 relays must not exceed 20 A.

3.4.2 Control Programming Details

Controllers are pre-programmed. Can be configured in the field to any combination of one/two pumps, four heating zones, single stage or modulating unitary heaters, CORAYVAC® or VANTAGE® Multiburner systems.

• **Control Power Supply Connection**

The power connection should be made with cable, size 12 AWG.

• **Four Digital Output (Relays)**

The control connection for load of each individual relay should be made with cable, size 14 AWG.

• **Modulation Signal from Control Board (UO 5-8)**

0-10V control signal from outputs UO 5-8 on the modulation controller to modulating heaters, should be made with cable, size 18 AWG.

• **Digital Input**

The wiring connection for the pressure switch should be unshielded cable, size 18 AWG.

• **Indoor Sensor Cable**

Rnet communication wires should be connected in a daisy-chain or hybrid configuration. For star configuration, contact factory. See examples on Page 17, Figure 9 through Page 18, Figure 10.

Note: Use the specified type of wire and cable for maximum signal integrity.

Description	4 conductor, shielded, CMP, plenum rated cable
Conductor	22 AWG (7x0096) bare copper
Max Length	500' (152 m)
Insulation	Low-smoke PVC (or equivalent)
Color Code	Black, white, green, red
Shielding	If shielded, Aluminum/Mylar shield (100% coverage) with TC drain wire
UL Temperature Rating	32-167°F (0-75°C)
Voltage	300 Vac, power limited
Listing	UL: NEC CL2P, or better

• **Outdoor Sensor Cable**

Cable	Shielded cable, One twisted pair of 18 AWG minimum or equivalent Belden #8451, #1503A; General Cable #C2514.
Wire Material	PVC insulated, parallel bonded (Type 2, 100-ohm platinum uses FT-4)
Operating Temperature Range	-40 to 105 °C (-40 to 221 °F)

• **Communications between Multiple Controllers (MS/TP)**

Maximum network length, 4000' (1219 m) at 19.2K baud rate, and 2000' (609.5 m) at 76.8K baud rate. Controllers should be communicating together in a daisy-chain or hybrid configuration.

FIGURE 9: Daisy-Chain Network Configuration

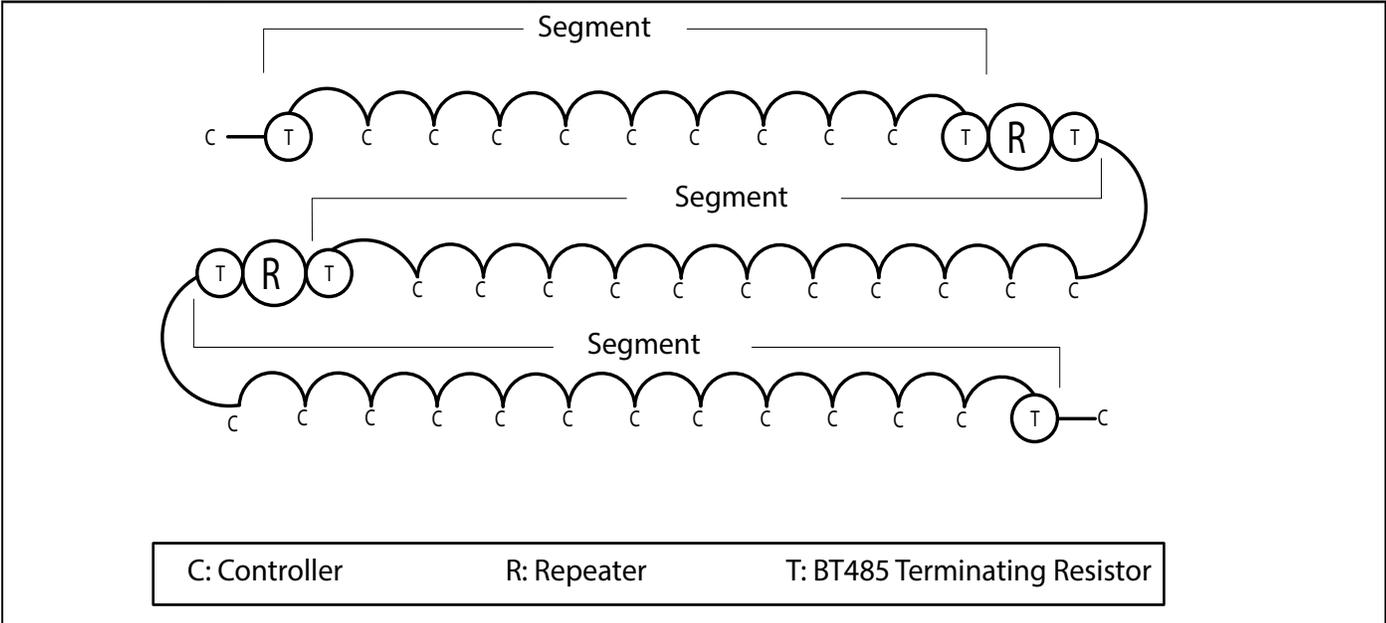
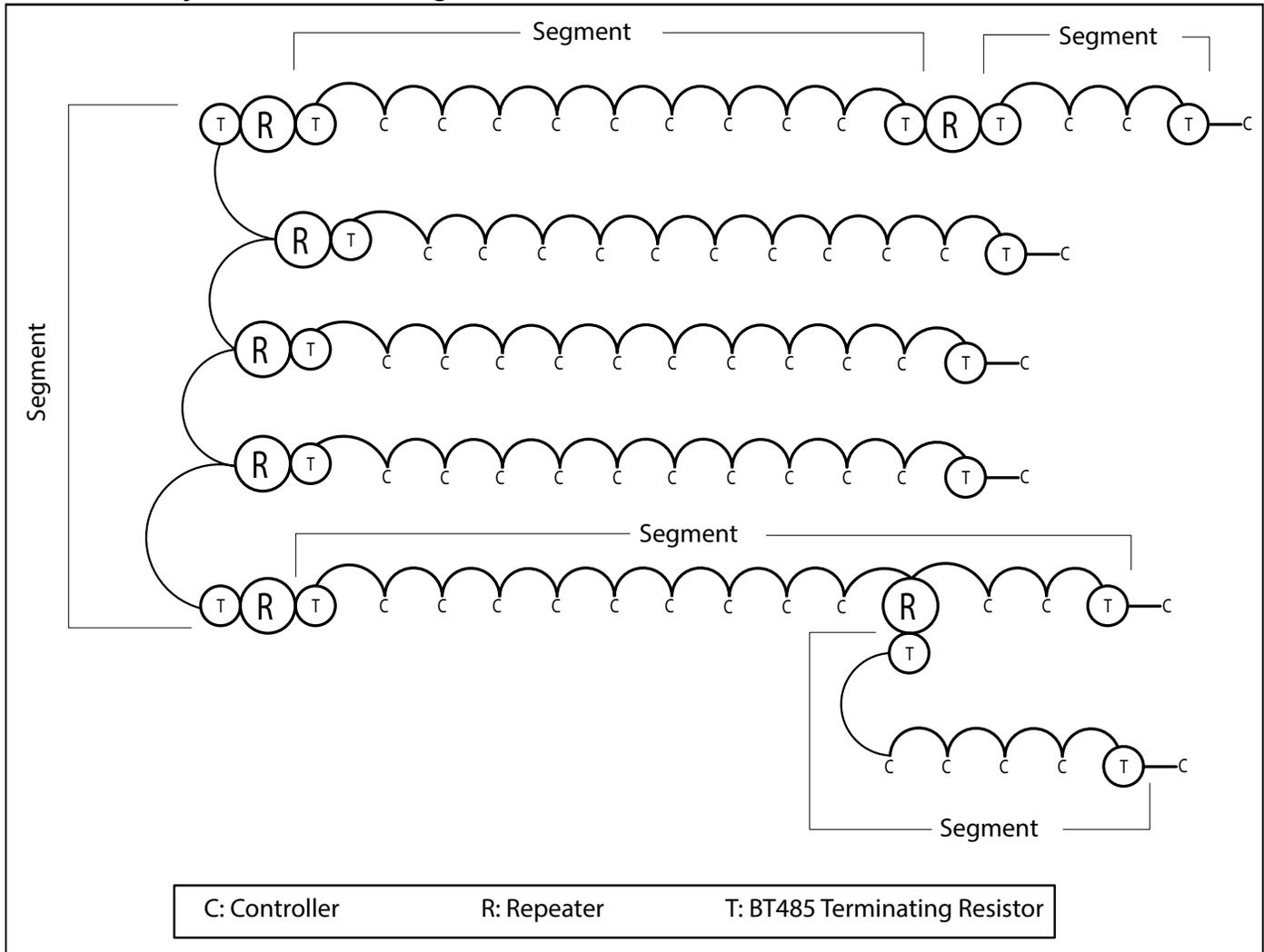


FIGURE 10: Hybrid Network Configuration



Recommended MS/TP cable specification

Description	Single twisted pair, low capacitance (12pF), CL2P, 22 AWG (7x30), TC foam FEP, plenum rated cable
Conductor	22 AWG (7x30) stranded copper (tin plated) 0.030 in. (0.762 mm) O.D. NOTE 24 AWG can be used for segments <200 ft. (60.7 m).
Insulation	Foamed FEP 0.015 in. (0.381 mm) wall 0.060 in. (1.524 mm) O.D.
Color Code	Black/White
Twist Lay	2 in. (50.8 mm) lay on pair 6 twists/foot (20 twists/meter) nominal
Shielding	Aluminum/Mylar shield with 24 AWG (7x32) TC drain wire
Jacket	SmokeGard (SmokeGard PVC) 0.021 in. (0.5334 mm) wall 0.175 in. (4.445 mm) O.D. Halar (E-CTFE) 0.010 in. (0.254 mm) wall 0.144 in. (3.6576 mm) O.D.
DC Resistance	15.2 Ohms/1000' (50 Ohms/km) nominal
Capacitance	12.5 pF/ft (41 pF/meter) nominal conductor to conductor
Characteristic Impedance	100 Ohms nominal
Weight	12 lb./1000' (17.9 kg/km)
UL Temperature Rating	SmokeGard 167°F (75°C) Halar -40 to 302°F (-40 to 150°C)
Voltage	300 Vac, power limited
Listing	UL: NEC CL2P, or better

3.4.3 Variable Frequency Drive (VFD)

Below is the recommended cable of the various connections for VFD:

• Line Power Supply

Input Wire Size Requirements

VFD	Wire Size
1 HP 120V	12 AWG
1 HP 230V 1ph	12 AWG
1 HP 230V 3ph	12 AWG
1 HP 230V 1ph	12 AWG
1 HP 230V 3ph	12 AWG
1 HP 460V 3ph	12 AWG
2 HP 460V 3ph	12 AWG

3.4.4 Repeater

Below is the recommended cable for the various connections to the repeater:

• Line Power Supply

The power connection should be made with cable, size 18 AWG.

• RS485 Repeater Communications

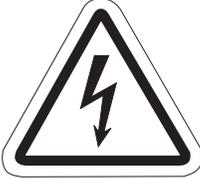
Note: Use the same polarity throughout the network segment.

Description	Single twisted pair, low capacitance (12pF), CL2P, 22 AWG (7x30), TC foam FEP, plenum rated cable
Conductor	22 AWG (7x30) stranded copper (tin plated) 0.030 in. (0.762 mm) O.D. NOTE 24 AWG can be used for segments <200' (60.7 m).
Color Code	Black/White
Twist Lay	2 in. (50.8 mm) lay on pair 6 twists/foot (20 twists/meter) nominal
Shielding	Aluminum/Mylar shield with 24 AWG (7x32) TC drain wire
Jacket	SmokeGard (SmokeGard PVC) 0.021 in. (0.5334 mm) wall 0.175 in. (4.445 mm) O.D. Halar (E-CTFE) 0.010 in. (0.254 mm) wall 0.144 in. (3.6576 mm) O.D.
DC Resistance	15.2 Ohms/1000' (50 Ohms/km) nominal
Capacitance	12.5 pF/ft (41 pF/meter) nominal conductor to conductor

Characteristic Impedance	100 Ohms nominal
UL Temperature Rating	SmokeGard 167°F (75°C) Halar -40 to 302°F (-40 to 150°C)
Listing	UL: NEC CL2P, or better
Suggested Manufacturer	Belden

3.5 Electrical Installation Requirements of CORAYVAC® Modulating Heating Control

⚠ DANGER



Electrical Shock Hazard

Disconnect electric before service.

Controller must be properly grounded to an electrical source.

Failure to follow these instructions can result in death or electrical shock.

- CORAYVAC® and COMPLETE™ Modulating Heating Control Panel

Controller panel must be feeding from a local fused isolator for a total amperage not exceeding 20 A.

Notes:

- The total added current load for each individual relay must not exceed 6 A.
- The total added current load for all 4 relays must not exceed 20 A.

3.6 Pump Requirements

The vacuum pump is powered directly from the Variable Frequency Drive (VFD). If pump wiring length is greater than 100' (30 m), a load reactor (P/N 100610XX) is required. Maximum distance with load reactor is 400' (120 m). Consult factory if distance required is greater. The VFD will be energized via a Modbus command from the control board.

3.7 Variable Frequency Drive Requirements

VFD Drive	Drive Power Supply
120 V	120 V, 50-60 Hz, 1Ø
208/230 V	208/230 V, 50-60 Hz, 1Ø + 3Ø
460 V	460 V, 50-60 Hz, 3Ø

See Page 11, Section 2.7 for additional details. VFD on/off switching and speed command is done via a Modbus control signal. The VFD output supply to the pump is 230 V 3 Ø 0-60 Hz for 120 V and 230 V models and is 460 V, 3 Ø, 0-60 Hz for 460 V models. The frequency of the output supply signal to the pump will be varied based on the Modbus signal from the control board.

3.8 Indoor Sensor Placement and Mounting

Zone Sensor (P/N 10061003) Capabilities:

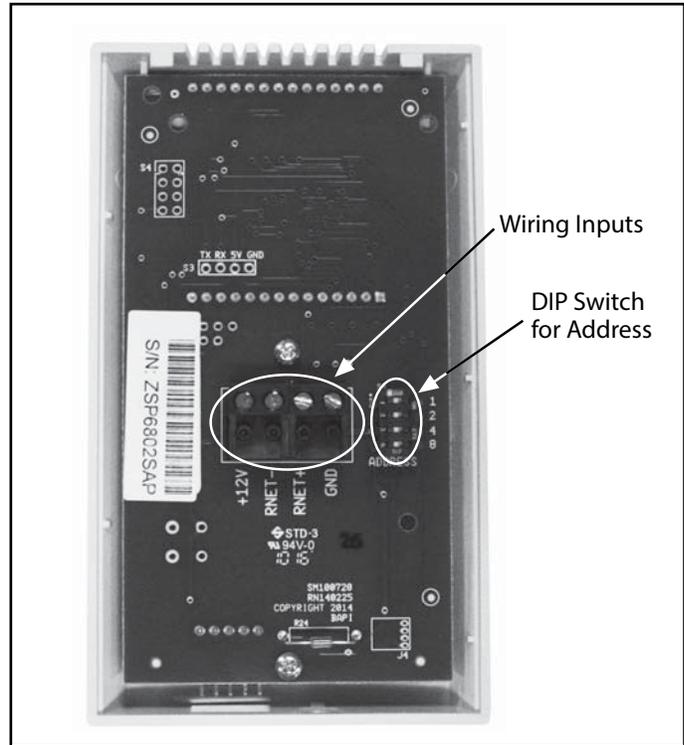
(The features listed below can be made optional via programmable permission levels)

- View information in the display such as zone temperature, setpoints, outside air temperature, and equipment status
- Override the schedule to put the zone in an occupied state
- Edit information if allowed by the control program
- Force the zone to an unoccupied state
- See that the zone is in an occupied state when the green LED is lit.

To install a Zone Sensor, remove the cover of the sensor by the screw, located on the bottom. Secure the sensor to the wall or junction box using the screws provided. The sensor measures the air temperature in the space. It is important that the sensor is located in an area within the heated zone at occupant level. For the most accurate results, sensors should be mounted on an inside wall, away from any air vents or other sources of heat and cold. In order to avoid short system cycles and inaccurate temperature readings do not mount sensors under the first section of radiant tube (first 10' (3 m) section of tube after the burner), in direct sunlight or in the path of other sources of radiant heat. The sensors are suitable for direct surface mounting or 4" (10.2 cm) x 2.13" (5.4 cm) junction box mounting. Sensors should be daisy chained together with a maximum length of the chain 500' (152 m). Maximum distance from controller to any sensor is 500' (152 m). For longer distances, communication issues may arise. Larger gauge wire may be needed (Consult Factory).

Note: Reading the number "99" on the system view zone screen (or "Err" sign on the zone sensor display) indicates that zone sensor is either disconnected, failed, or dip switch settings are not correctly addressed.

FIGURE 11: Indoor Sensor Components



3.9 Indoor Sensor Addressing

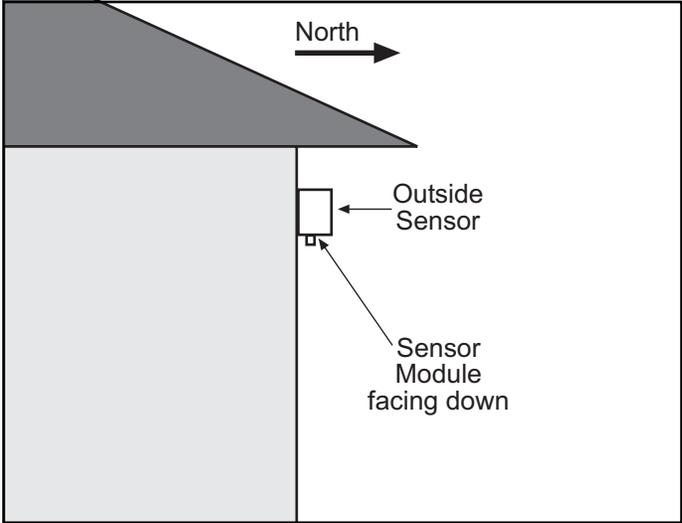
Adjust dip switches 1 through 4 to match zone number allocated to sensor.

Sensor Address	Switch Combination
1	1
2	2
3	1,2
4	3
5	1,3
6	2,3
7	1,2,3
8	4

3.10 Outdoor Sensor (P/N 10081500) Placement

The outdoor sensor measures air temperature outside the building. It is important that the sensor is located on the outside of the building on the north facing wall. Failure to mount the sensor on the north facing wall will result in artificially high temperature readings and failure to modulate as designed. If possible, locate the sensor high under an eave to prevent incorrect readings from direct sunlight and damage due to the elements.

FIGURE 12: Outdoor Sensor Placement



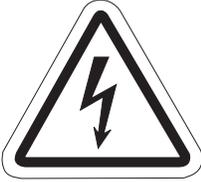
Mount the outside sensor with the sensor module facing down to prevent accumulation of dirt or water.

3.11 Outside Air Supply (P/N 90707501K)

If an outside air (O.A.) blower is to be used, modifications to the outside air blower out-of-box wiring must be made to properly time, and safety check the blower with the main pump. See Page 28, Figure 15 and Page 34, Figure 18 for external wiring details. Remove the internal connection between the pressure switch (P.S.) and the relay and wire the P.S. of the O.A. Blower in series with that of the main pump. Send 24V from Terminal Block 2 in the controller to terminals T1 and T2 in the O.A. Blower. Power the blower with its own 120V, 15A, 60Hz supply. See Page 28, Figure 15 through Page 34, Figure 18 for wiring.

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 4: TYPICAL WIRING DIAGRAMS

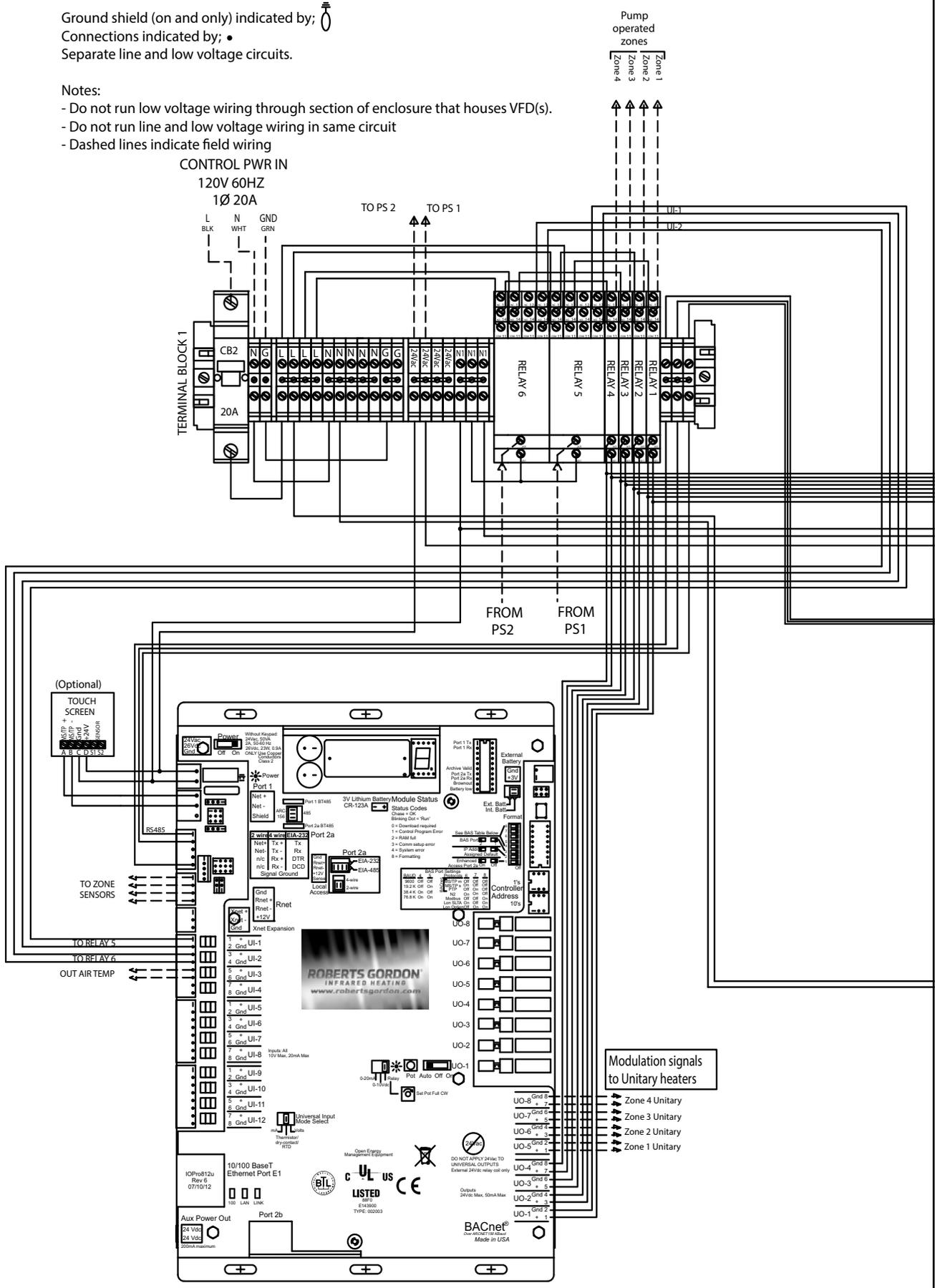
⚠ DANGER

Electrical Shock Hazard
Disconnect electric before service.
Controller must be properly grounded to an electrical source.
Failure to follow these instructions can result in death or electrical shock.

Note: Systems must be electrically grounded in accordance with the following codes: United States: Refer to National Electrical Code®, NFPA 70 - latest revision. Wiring must conform to the most current National Electrical Code®, local ordinances and any special diagrams furnished. Canada: Refer to Canadian Electrical Code, CSA C22.1 Part 1 - latest revision.

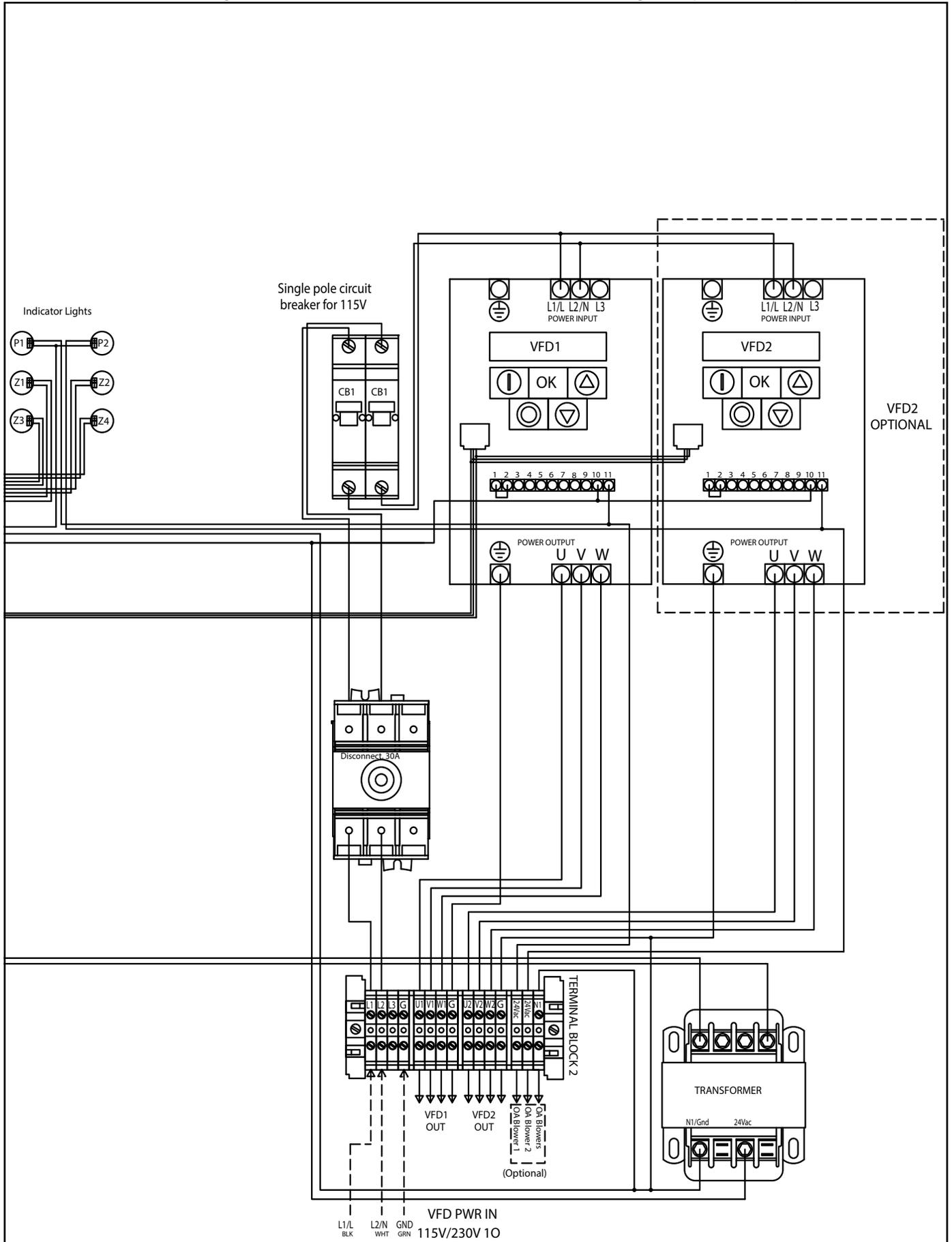
FIGURE 13: CORAYVAC® Modulating Central and Satellite Control Internal Wiring, 1Ø

Ground shield (on and only) indicated by; 
 Connections indicated by; •
 Separate line and low voltage circuits.

- Notes:
- Do not run low voltage wiring through section of enclosure that houses VFD(s).
 - Do not run line and low voltage wiring in same circuit
 - Dashed lines indicate field wiring



CORAYVAC® Modulating Central and Satellite Control Internal Wiring, 1Ø (Continued)



CORAYVAC® Modulating Central and Satellite Control Internal Wiring, 3Ø (continued)

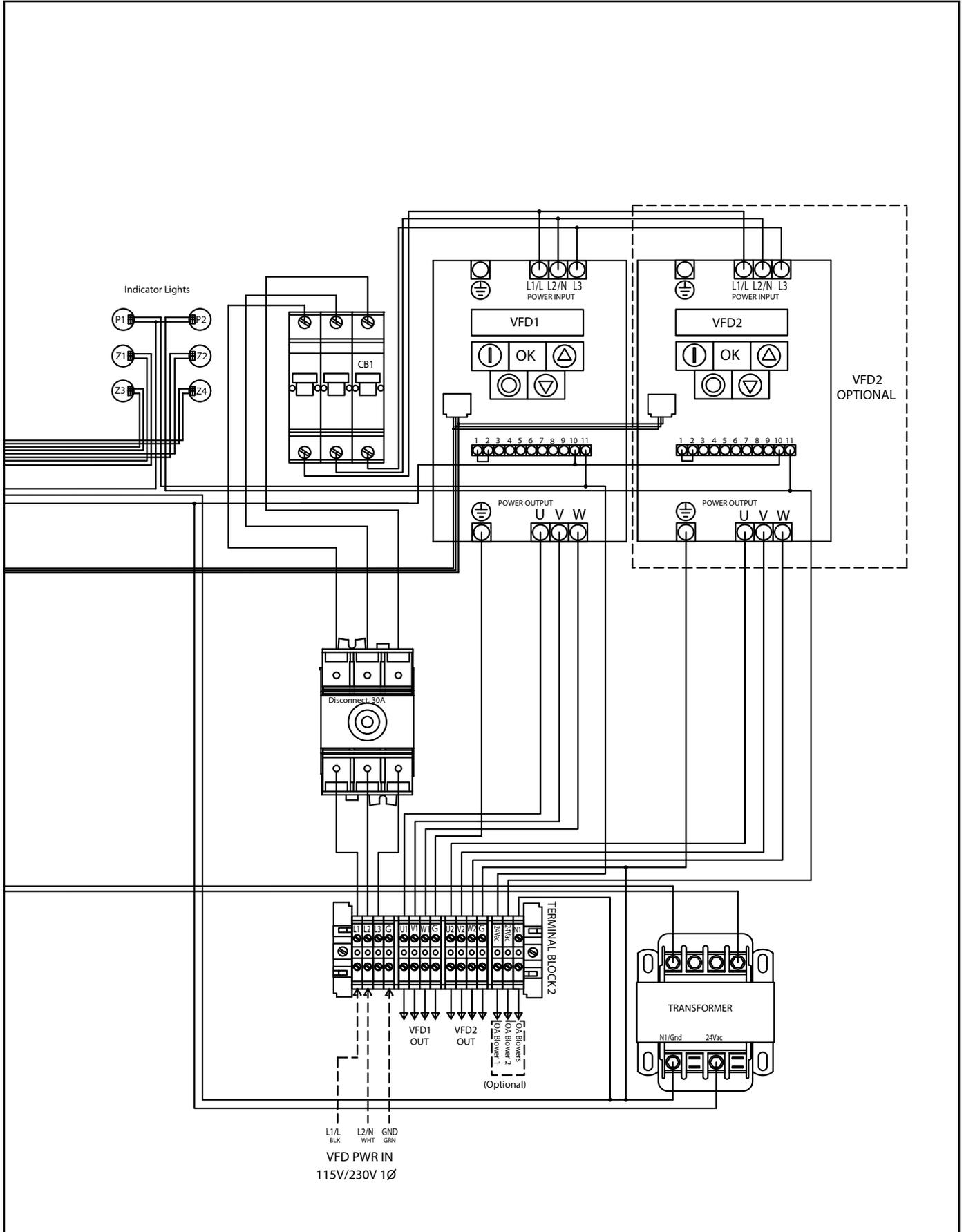
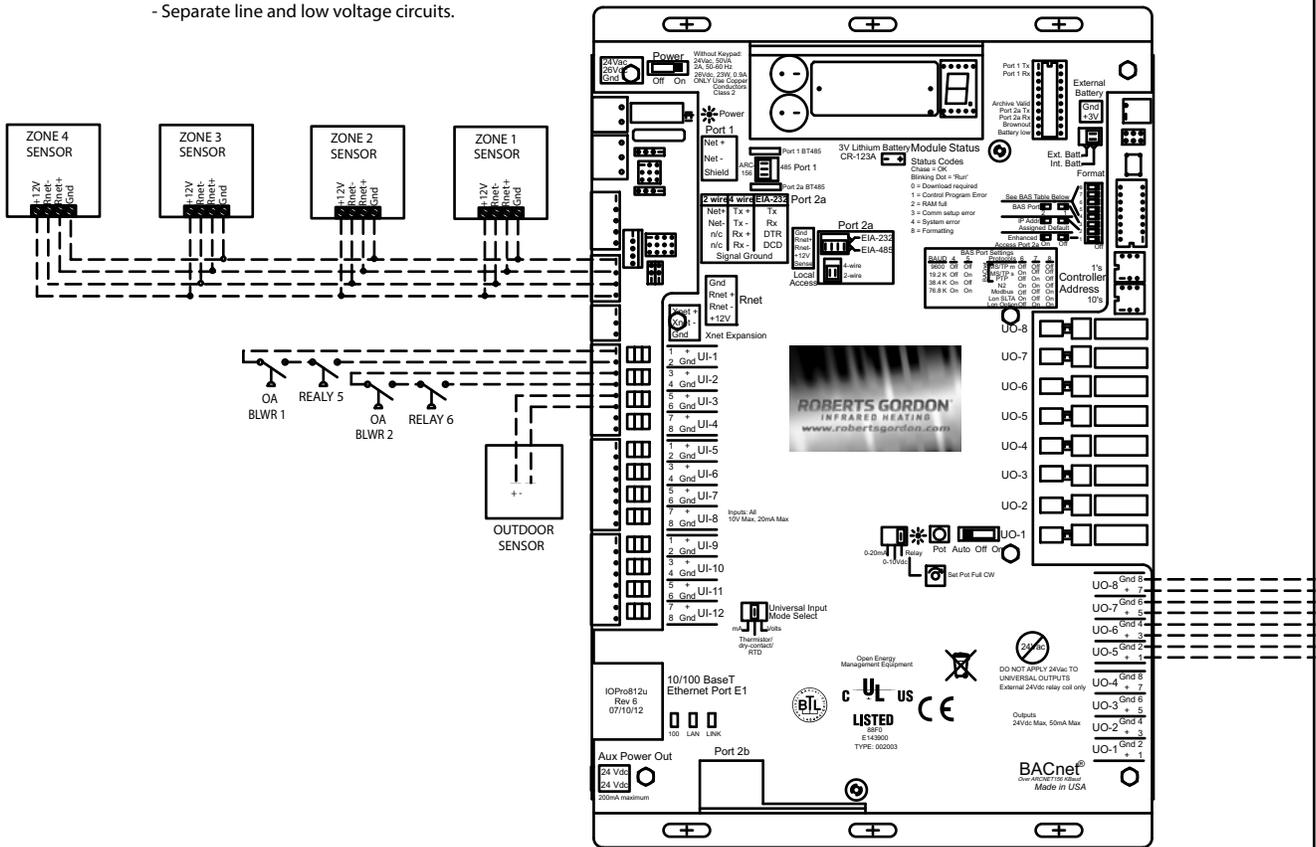


FIGURE 15: CORAYVAC® Modulating Central and Satellite Control External Wiring, 3Ø

Notes:

- Do not run low voltage wiring through section of enclosure that houses VFD(s).
- Do not run line and low voltage wiring in same conduit
- Dashed lines indicate field wiring
- Ground shield (on and only) indicated by: 
- Connections indicated by: 
- Separate line and low voltage circuits.



CORAYVAC® Modulating Central and Satellite Control External Wiring, 3Ø (continued)

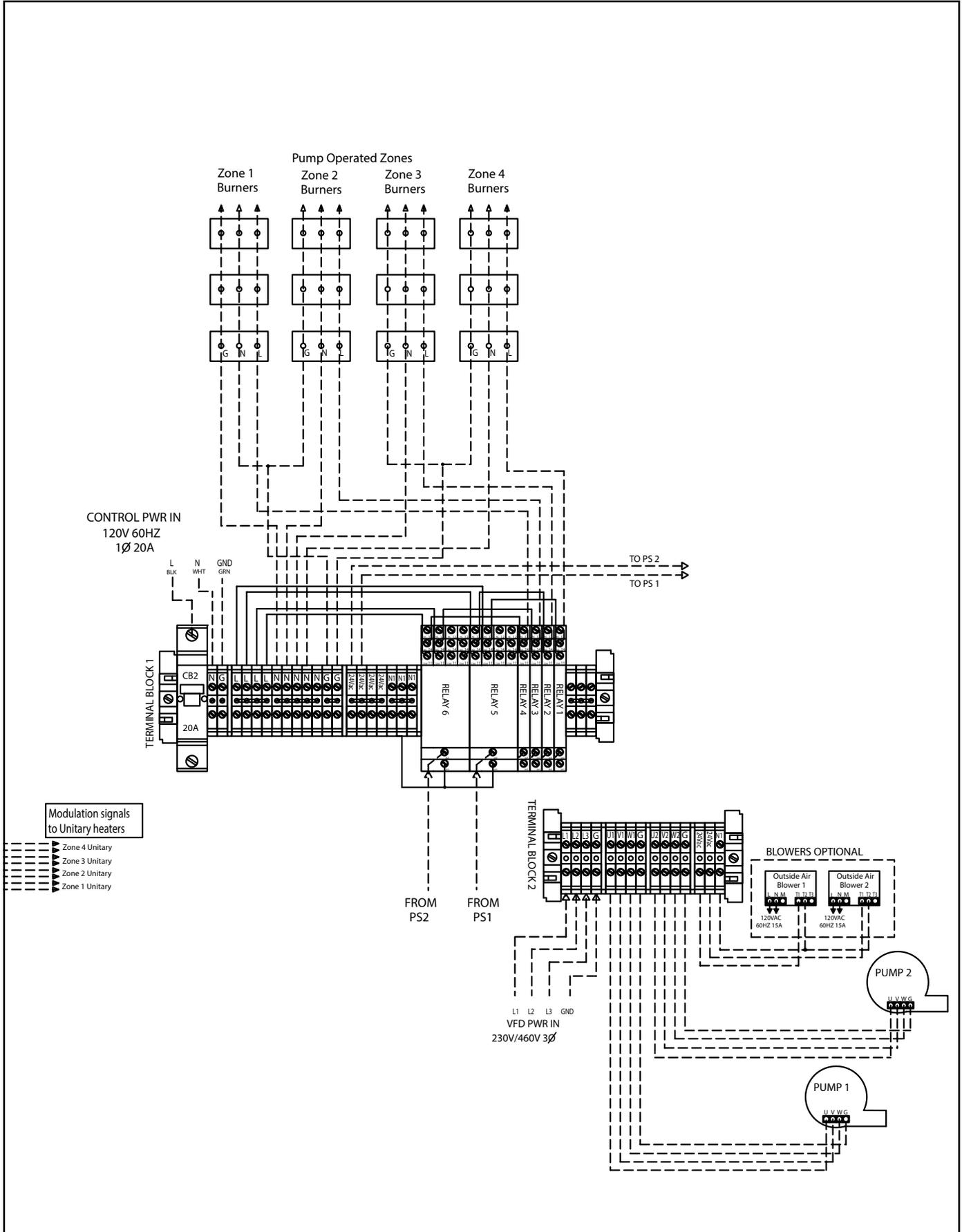
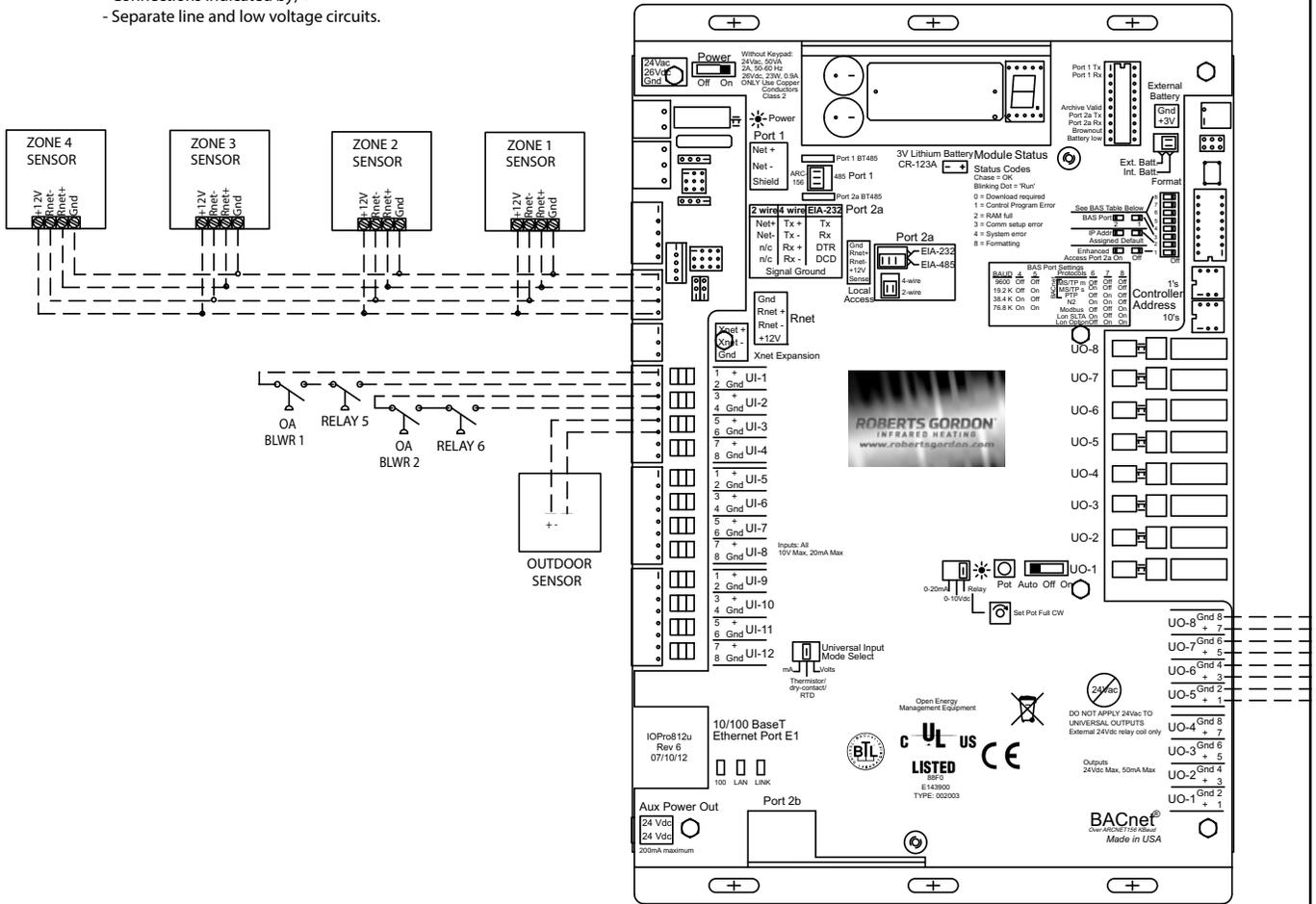


FIGURE 16: CORAYVAC® Modulating Central and Satellite Control External Wiring, 1Ø

Notes:

- Do not run low voltage wiring through section of enclosure that houses VFD(s).
- Do not run line and low voltage wiring in same conduit
- Dashed lines indicate field wiring
- Ground shield (on and only) indicated by: 
- Connections indicated by: 
- Separate line and low voltage circuits.



CORAYVAC® Modulating Central and Satellite Control External Wiring, 1Ø (continued)

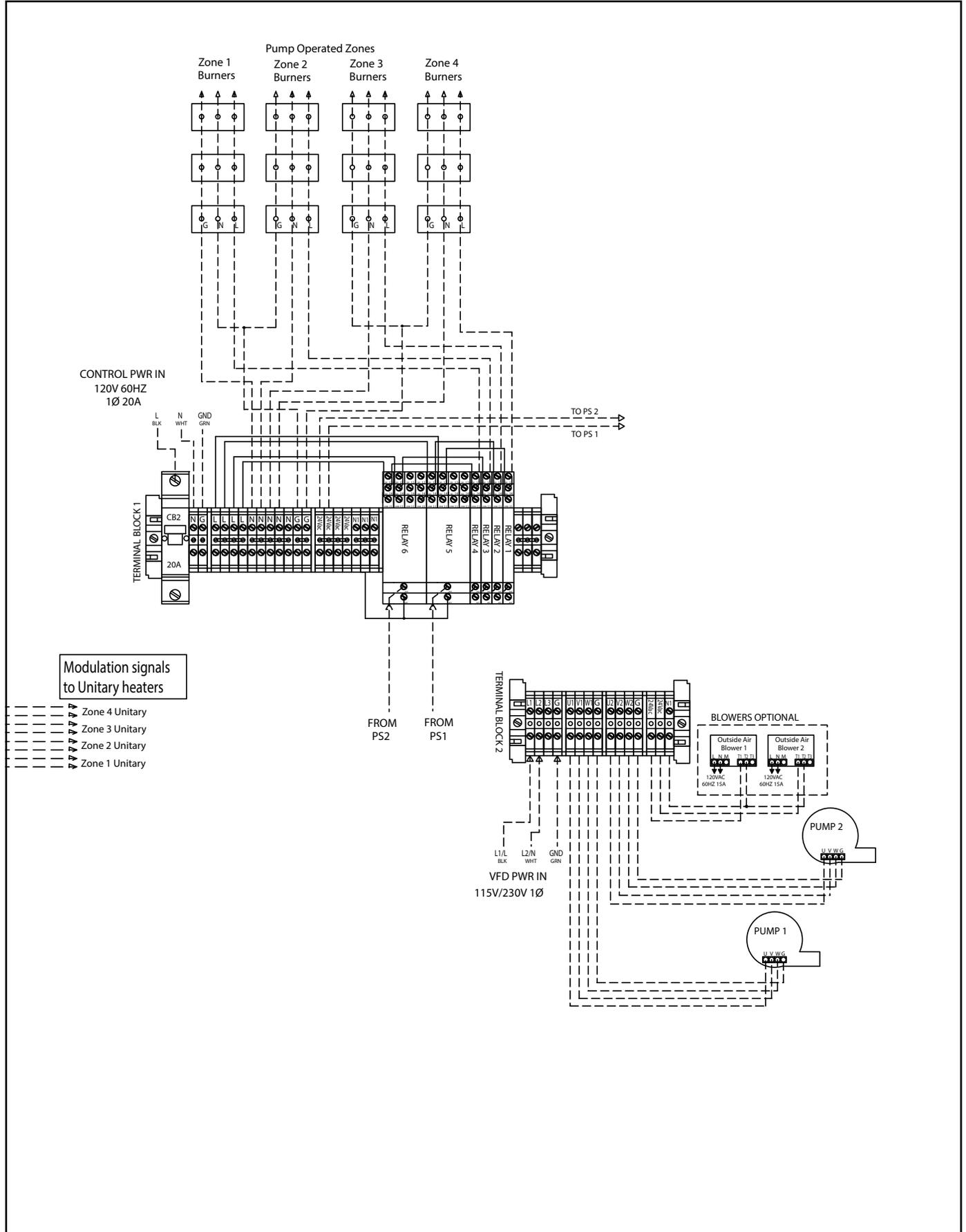
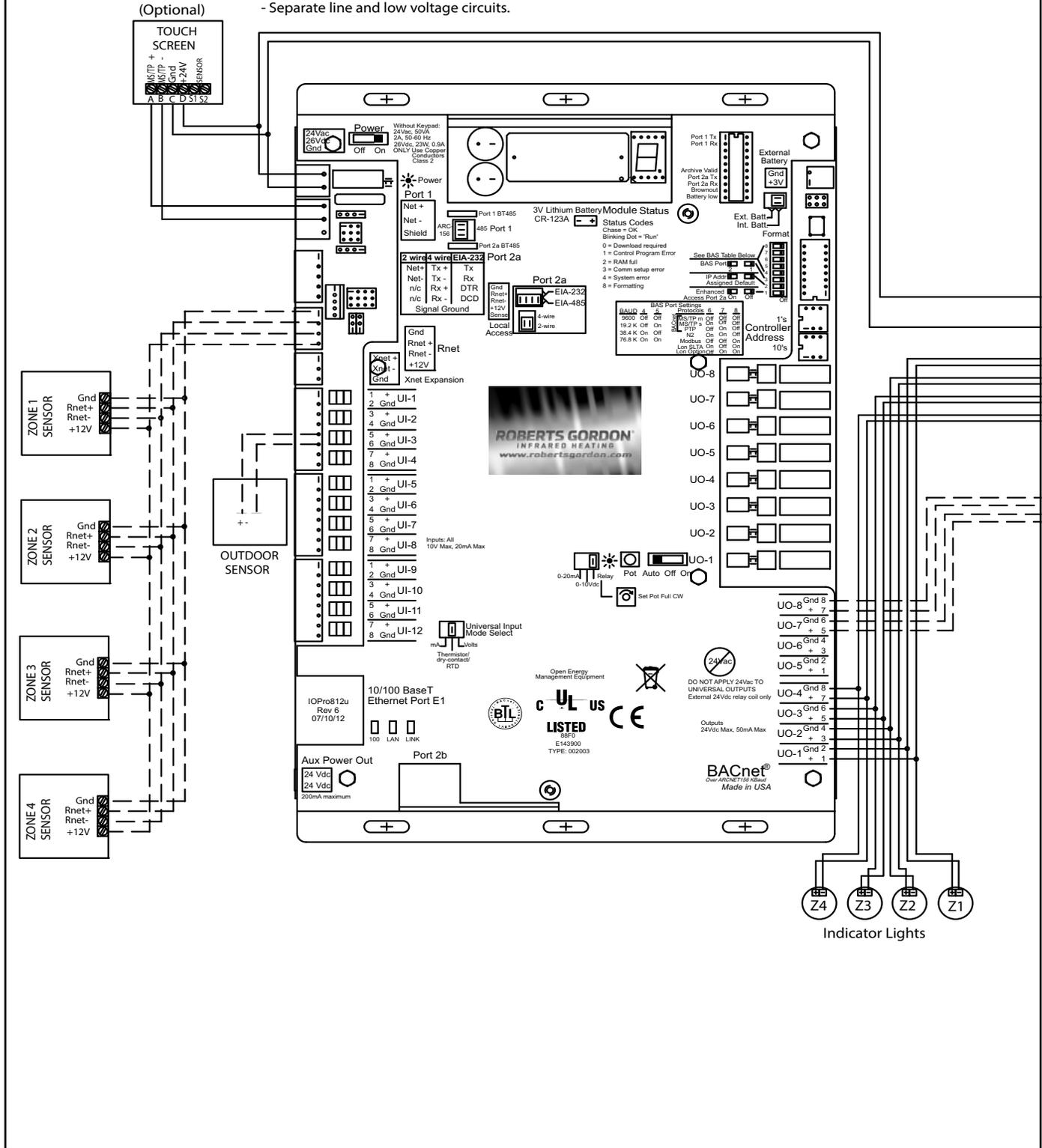


FIGURE 17: COMPLETE™ Modulating Central and Satellite Control Wiring (Unitary Burners)

Notes:

- Do not run low voltage wiring through section of enclosure that houses VFD(s).
- Do not run line and low voltage wiring in same conduit
- Dashed lines indicate field wiring

- Ground shield (on and only) indicated by: 
- Connections indicated by: •
- Separate line and low voltage circuits.



COMPLETE™ Modulating Central and Satellite Control Wiring (Unitary Burners) (continued)

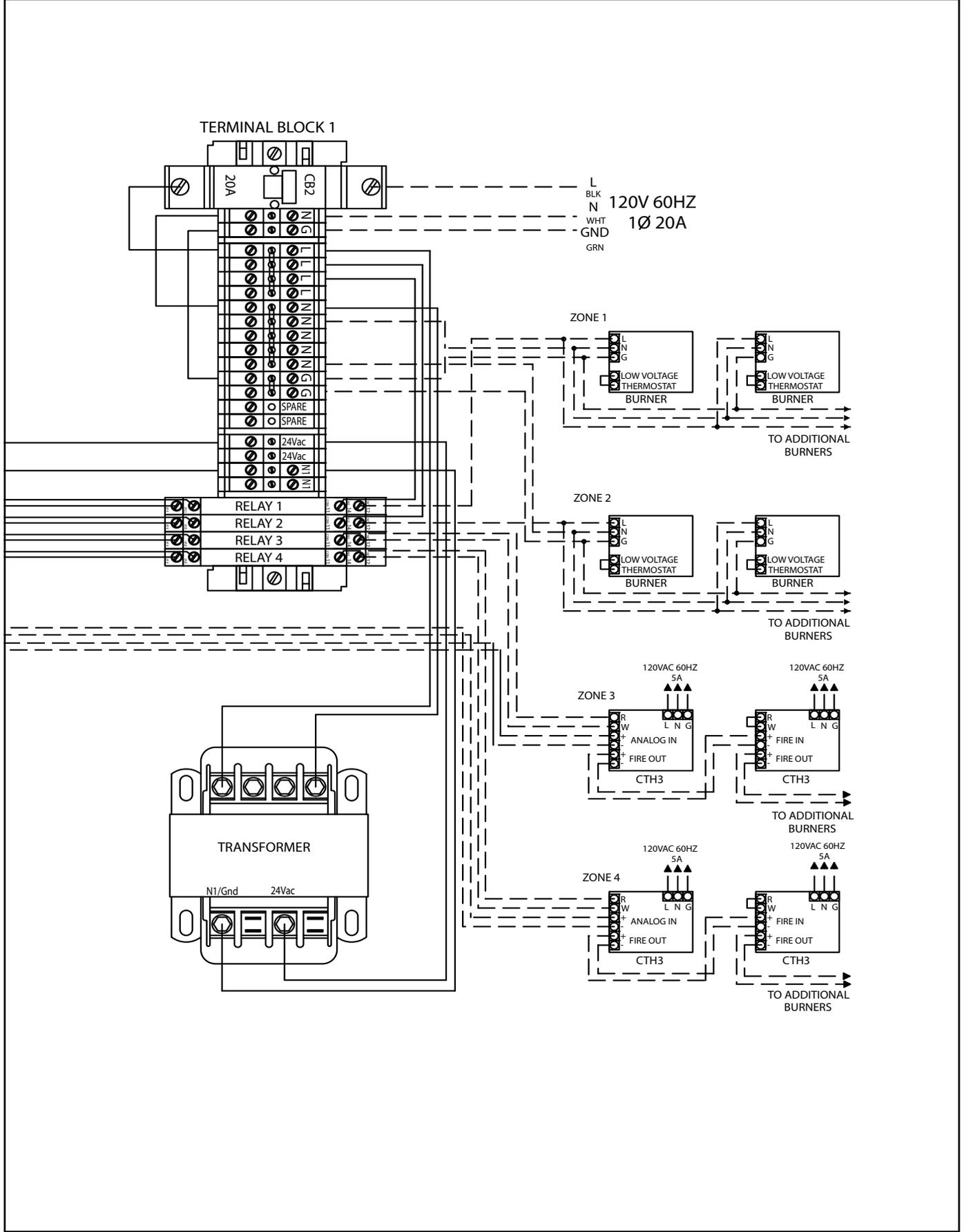
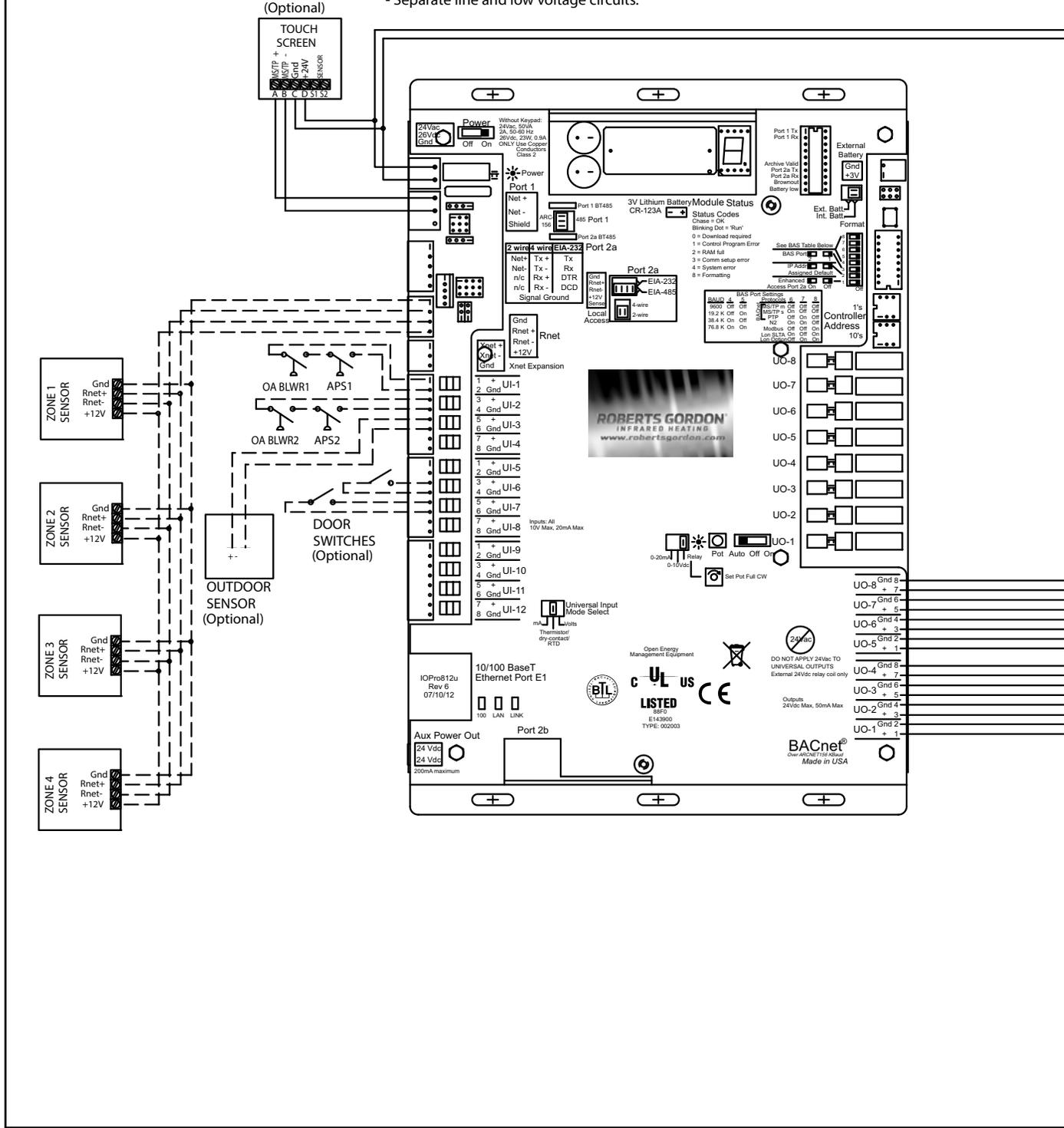


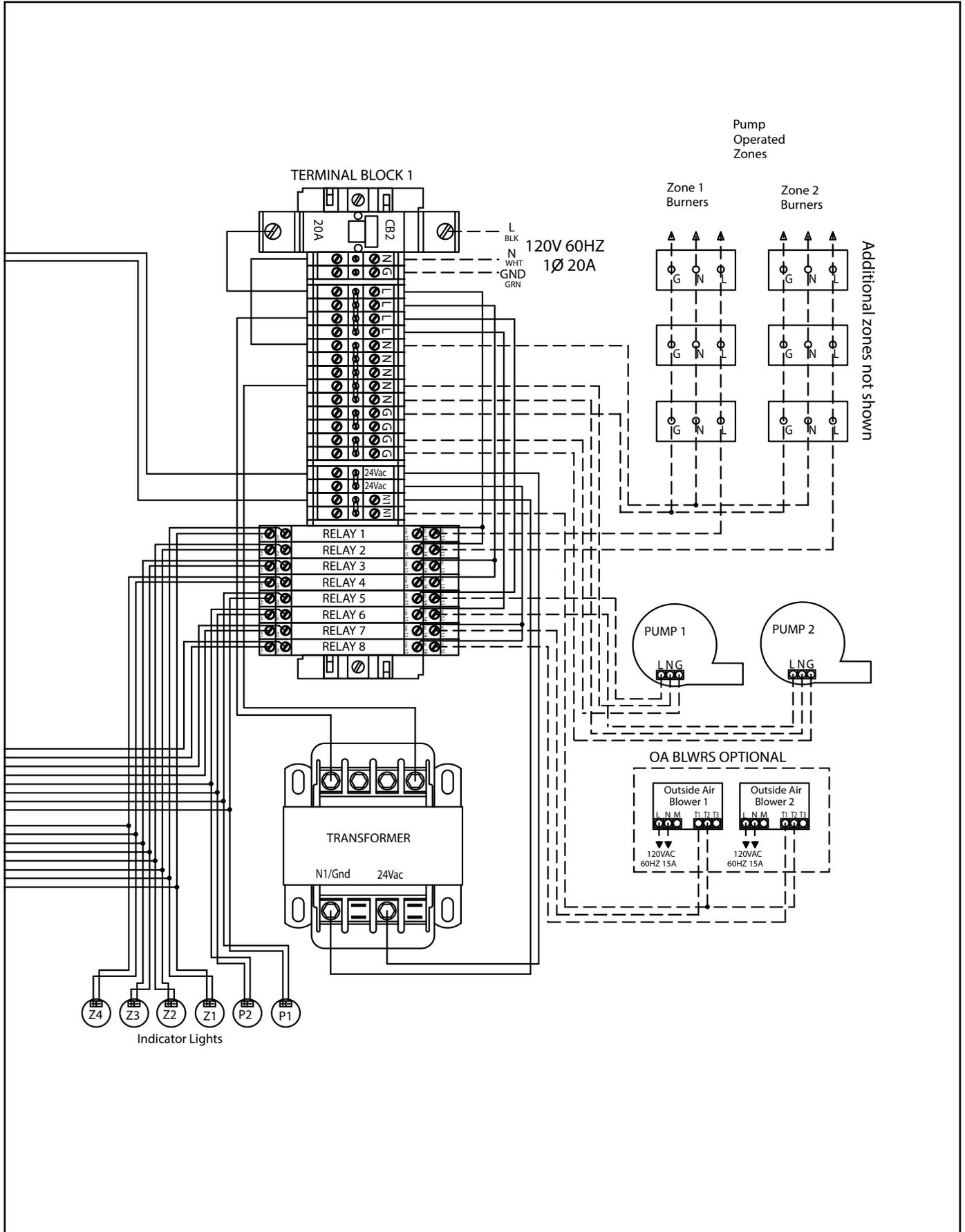
FIGURE 18: COMPLETE™ Modulating Central and Satellite Control Wiring (CRV On/Off)

Notes:

- Do not run low voltage wiring through section of enclosure that houses VFD(s).
- Do not run line and low voltage wiring in same conduit
- Dashed lines indicate field wiring
- Ground shield (on and only) indicated by;
- Connections indicated by;
- Separate line and low voltage circuits.



COMPLETE™ Modulating Central and Satellite Control Wiring (CRV On/Off) (continued)



SECTION 5: COMMUNICATIONS

One ROBERTS GORDON® CORAYVAC® Modulating Heating Control per building (called the "central controller") comes standard with a touchscreen. The central controller communicates with all satellite controllers, and COMPLETE™ unitary controllers when applicable. More than one "central" controller can be used, if desired. If multiple CORAYVAC® Modulating Heating Control controllers are being used, the additional controllers communicate to controller #1 through communication wiring arranged in series from one controller to the next. See *Page 39, Section 5.3*. An MS/TP network can be in a daisy-chain or hybrid configuration if repeaters are used as described in MS/TP network requirements. Each network segment must be in a daisy-chain configuration. See *Page 16, Section 3.4.2*.

5.1 WebCTRL®

The WebCTRL® building automation system offers an intuitive user interface and powerful tools to help facility managers keep occupants comfortable, manage energy conservation, identify key operational problems and analyze the results. The optional WebCTRL® package allows direct communication via on-site or remote off-site control to the central controller. WebCTRL® is an automation system interface through (HTTP) to communicate over the internet or Ethernet. WebCTRL® provides complete access to all touchscreen features that include but are not limited to:

- Setting and changing schedules
- Adjusting setpoints and other control properties
- Graphically trending building conditions
- Viewing and acknowledging alarms
- Custom alarm management capabilities to allow notifications via e-mail, text messaging, etc. for situations such as when zone temperatures drop below setpoints or exceed user-defined requirements.
- Graphical representation of system(s) status.
- A WebCTRL® license is issued and software installed on one computer on network. DIP switch on the controller is changed to allow new IP address configuration.

Contact Roberts-Gordon LLC or your independent ROBERTS GORDON® distributor for more details.



A WebCTRL® system supports:

- Unlimited simultaneous users
- Multiple operating systems and databases
- Mobile devices
- Built-in and custom alarms, trends, and reports
- Time-lapse

5.1.1 Client Computers

The client computer should have at least:

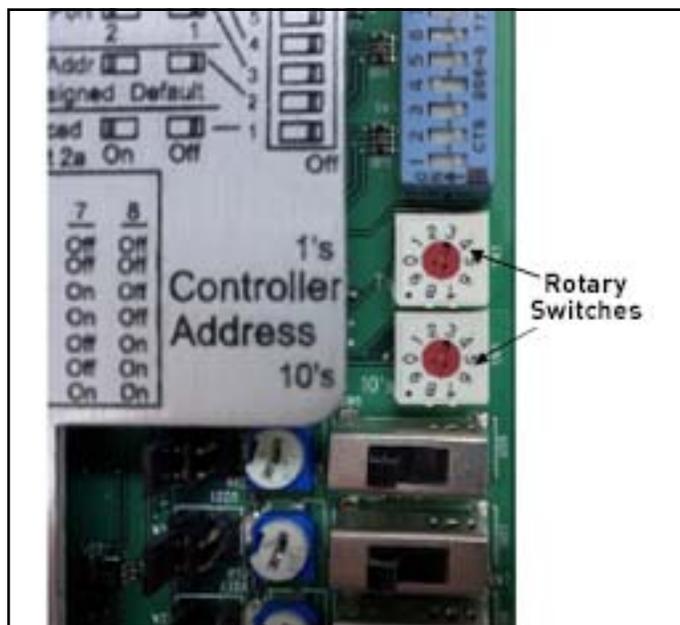
- Dual core processor
- 1.4 GB RAM
- Communications link of 10 Mbps or higher
- 64-bit processor

5.2 BACnet/IP Connection

The CORAYVAC® and COMPLETE™ Controllers have built in BACnet/IP connection capabilities. To maximize control capabilities on-site or off-site, it is recommended to obtain a WebCTRL® license (contact Roberts-Gordon LLC or your independent ROBERTS GORDON® distributor for more details). CORAYVAC®/COMPLETE™ Modulating Heating Controls can also support existing BMS systems. For BACnet® communication with WebCTRL® or existing BMS systems, follow steps below to set up an IP connection to the modulating controller control board.

Addressing The Control Board

The control board needs two addresses, a network address and an Ethernet address. The network address, known as the MAC address, is set using the rotary switches on the board.



Each control board on the network must have a unique MAC address. The IP address must be unique on the Ethernet network. The default IP address can be used or a custom IP address can be assigned. In addition to these two addresses, the IP network number must be set for each controller. Use the touchscreen provided to set these values.

The touchscreen communicates between controllers over an MS/TP network with network number 100. **This must not be changed.** The MS/TP network number is important for the broadcasting of Outside Air Temperature.

Create the MS/TP network between controllers. See *Page 40, Section 5.4*. Access the controller you wish to program through the touchscreen home menu. See *Page 45, Section 5.8* for help.

Default IP Address

IP address: 192.168.168.x where x is the MAC address

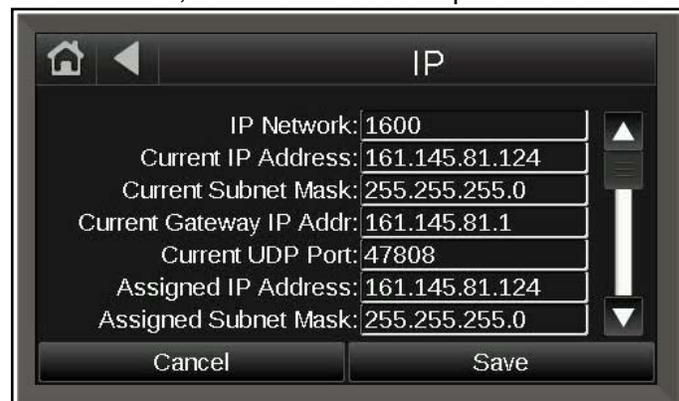
Subnet mask: 255.255.255.0

To set the MAC address on the controller, use the rotary switches located just above the HOA switches on the control board. Refer to the above photo. The switches are for the 1's place and the 10's place respectively.

Note: Changes to the switches are recognized only after power has been cycled to the control board. To properly cycle power to the control board and touchscreen, turn the circuit breaker located on the terminal strip above the control board off for 10 seconds before turning it back on. To use the **default** IP address, ensure DIP switch 2 is in the **off** position.

Custom IP Address

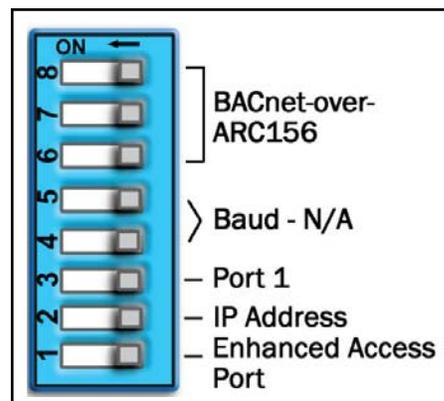
Assign a custom IP address using the touchscreen located on the central control panel provided. Open the local Menu at the bottom right of the screen scroll to the bottom, and select IP. This opens the IP menu.



IP can be reached on **Menu → IP**

Enter an IP address in the **Assigned IP Address** field. Click save.

On the control board, turn DIP switch 2 on. All other DIP switches should be off. See *Page 14, Figure 6* in manual for help locating the DIP switch.



Cycle power to the control board. Allow the touchscreen time to reload information from the board, then navigate back to the IP menu. The **Current IP Address** should now be populated with the assigned address.

IP Network Number

Finally, set the IP network number to a value other than 100 (i.e. 101). The IP network number must be set for each controller with an Ethernet connection.

5.3 Integration into Building Management System (BMS)

The controller (I/O Pro 812U) is capable of communicating with a foreign BMS. Connection can be made easily by connecting the controller to BMS by the 2-

wire, MS/TP loop which connects multiple ROBERTS GORDON® controllers. A BACnet/IP connection is also possible. For jobs which require an integration with another BMS, see *Page 89, Section 12*. An object points list is required to integrate to the CORAYVAC® Modulating Heating Control into an existing BMS system to allow for read/write access. Contact Roberts-Gordon or your local ROBERTS GORDON® independent distributor for the list of object points. A foreign BMS will have the ability to control occupancy, setpoints and more. I/O Pro 812U has ability to speak to one of the following protocols:

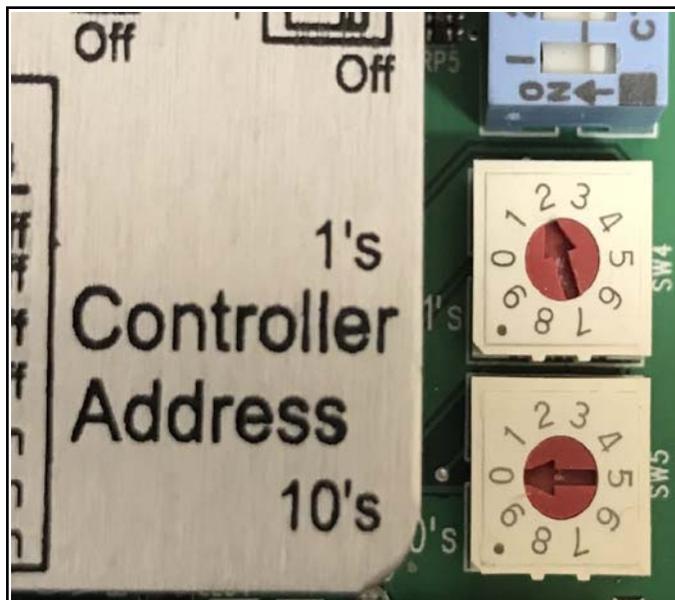
- BACnet over ARC156
- BACnet MS/TP
- BACnet PTP
- BACnet over IP
- BACnet over Ethernet
- Modbus
- N2
- LonWorks
- Refer to *Page 89, Section 12*

Contact Roberts-Gordon LLC or your independent ROBERTS GORDON® distributor for more details.

5.4 Communications Between Multiple CORAYVAC® Modulating Heating Controls

If more than one CORAYVAC® Modulating Heating Control is installed in a building, the controllers' MS/TP communications must be wired in series. See *Page 34, Figure 18*. Connect the MS/TP (Port 1) terminal on controller #1 to the MS/TP (Port 1) terminal on controller #2 and so on in a daisy chain (*Page 38, Section 5*) fashion. Shield wires for MS/TP cables should be twisted together, but not grounded, at all satellite controllers in daisy chain. Ground shield wire at central panel only.

Maximum of 31 controllers to 1 central controller. For communication cable requirements, See *Page 16, Section 3.4.2*. A MAC address is required for each central and satellite controller using the "Rotary Switches" See *Page 14, Figure 6*. There are 2 rotary switches.

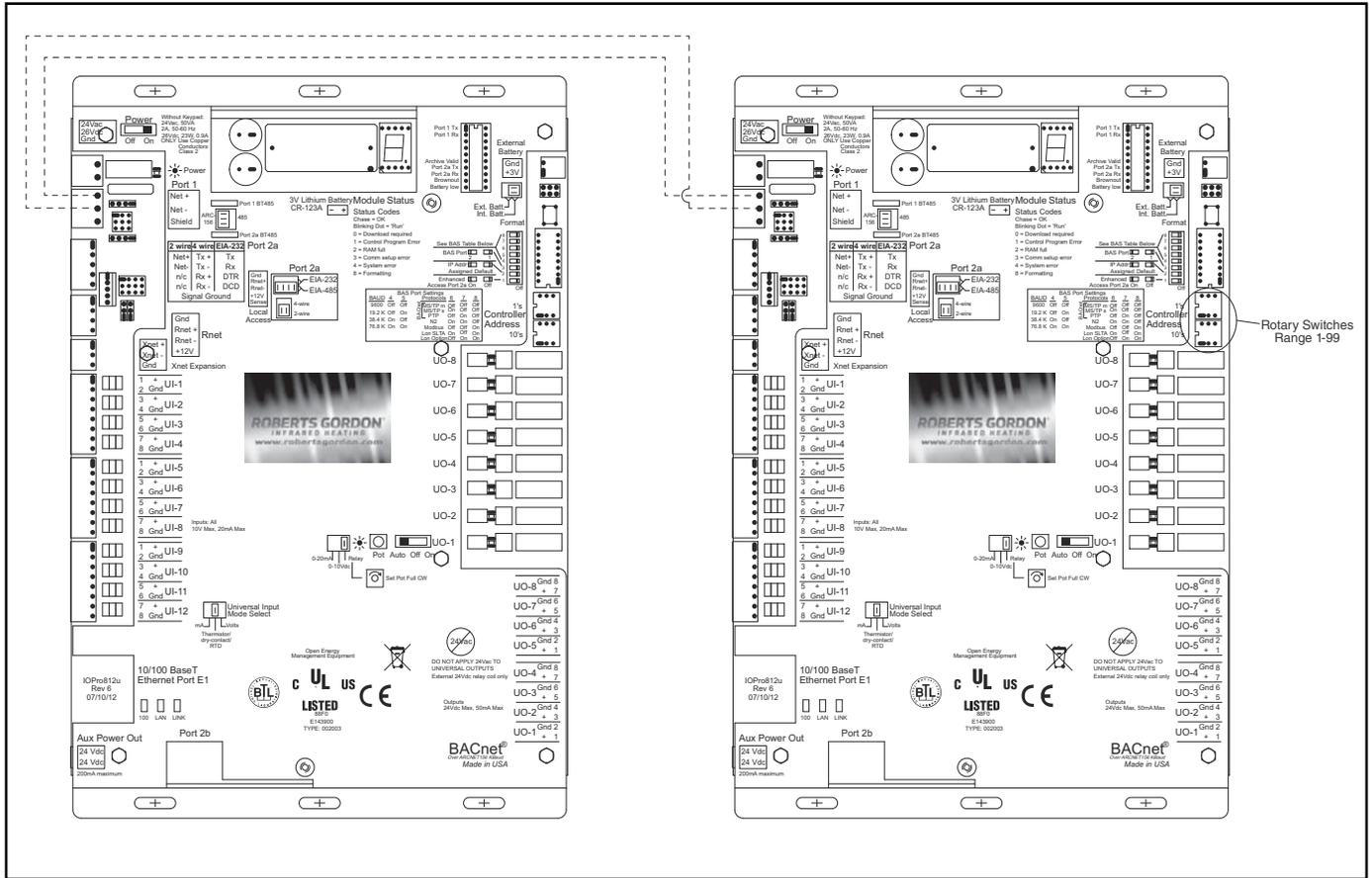


The upper rotary switch is labeled "1's" and lower rotary switch is labeled "10's". To set the MAC address for the first 9 controllers, the lower rotary switch (10's) is set to "0", the upper rotary switch (1's) is set to the appropriate controller number. To set the MAC address for controller numbers 10 and up, the setting of the lower rotary switch (10's) must be combined with the value of the upper rotary switch (1's). For example: To set the MAC address to "10", adjust the lower rotary switch (10's) to "1" and adjust the upper rotary switch (1's) to "0".

Note: All central controllers should be set to "1". All controllers should have a unique number assigned using the rotary switch dials. Changes to the rotary switches are acknowledged only after the board has been power cycled.

Contact Roberts-Gordon LLC or your ROBERTS GORDON® independent distributor, if more than 31 controllers are required.

FIGURE 21: Communications Between Multiple Controllers



5.5 Setting Baud Rate

To set the baud rate for the MS/TP network on Port 1, configure the board for a baud rate of 19.2K by setting DIP switch #4 to "OFF" and #5 to "ON". See chart in Figure 22 for baud rate settings.

Note: Changes to the DIP switches are acknowledged only after the control board has been power cycled.

5.6 Terminating Resistors

Higher baud rates can be used over shorter distances. The maximum rate of 76.8K can be used for distances up to 2000' (609m). Terminating resistors are required for 76.8K. The resistors are installed on the first and last control board on the network chain. See Page 14, Figure 6 for installation location. See Page 8, Section 1.13 for part number. A baud rate of 38.4K can be used without terminating resistors.

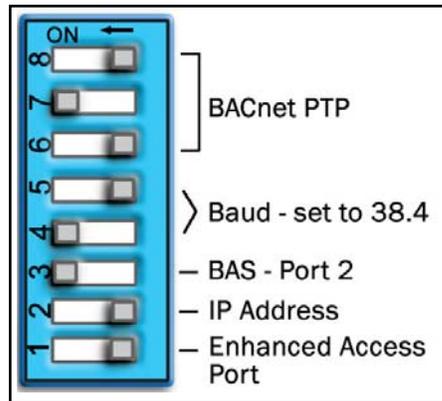
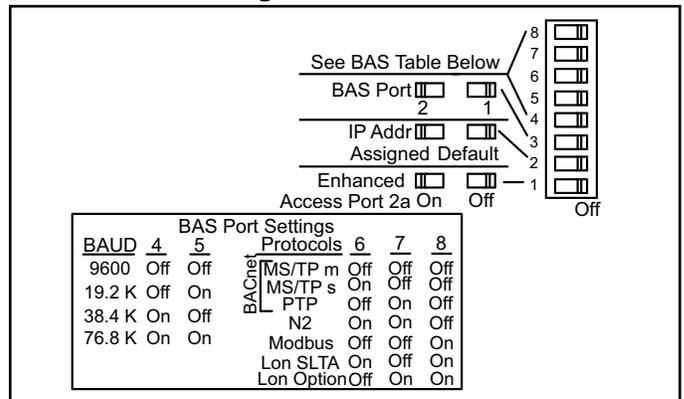


FIGURE 22: Setting Baud Rate



5.7 Control Board Setup

Universal Inputs and Outputs, Ports, Rotary Switches and DIP switches must all be configured for the board to work properly. Reference the labeled control board, *Page 14, Figure 6*, for help locating parts on the control board.

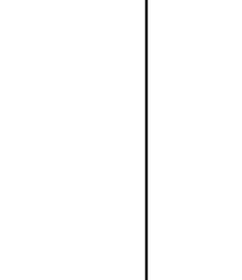
Jumper setting on I/O Pro controller,

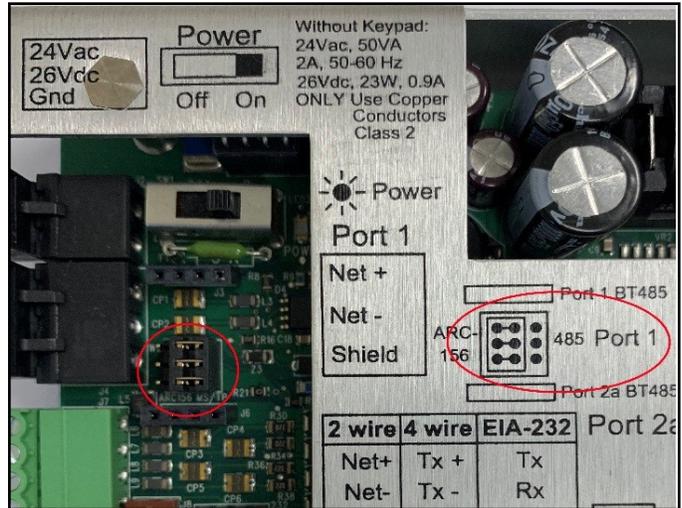
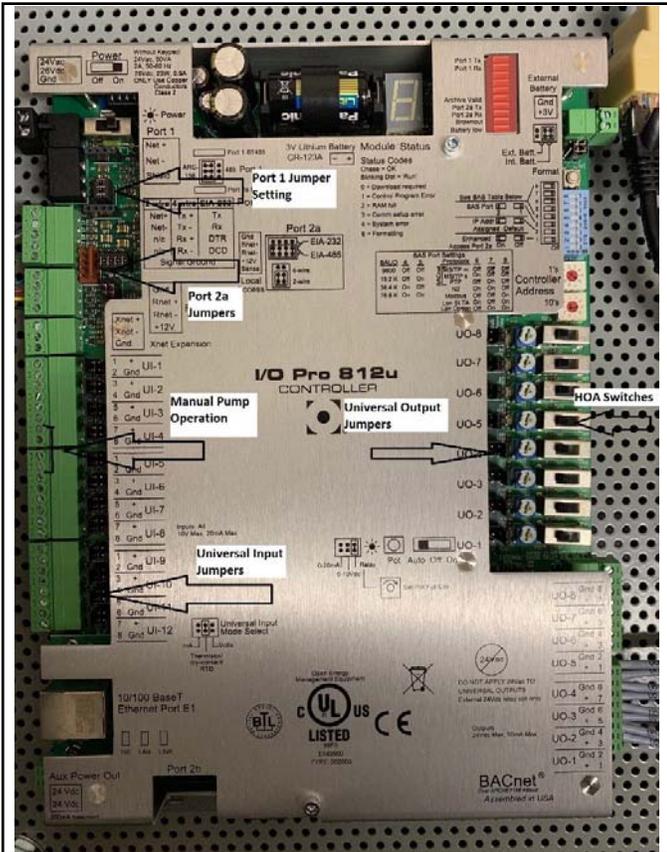
- HOA Switches set to "AUTO"
- Universal Output jumpers for UO-1, UO-2, UO-3, and UO-4 set to "RELAY"
- Jumpers for UO-5, UO-6, UO7 and UO-8 set to "0-10v"
- Universal input jumpers for UI-1, UI-2, and UI-3 set to Thermistor/dry-contact/ RTD"
- UI-4 and UI-5 can be optionally used for manual pump operation
- Port 1 jumpers set to "485"
- Port 2a jumpers configured for "EIA485, 2 WIRES"
- The CORAYVAC® On/Off system uses universal outputs 7 and 8 to control the pumps. In this case, the jumper for UO's 7 and 8 is set to Relay.

5.7.1 Module Status LED Error Code on Control Board

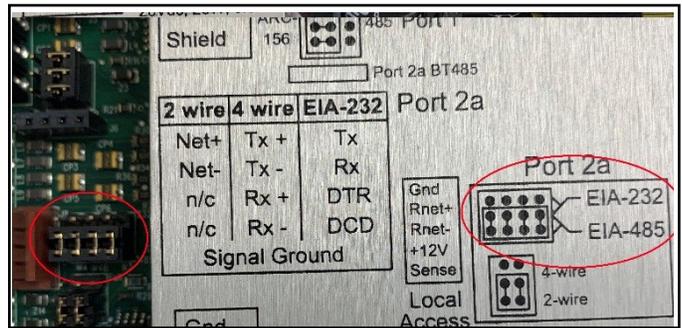
Table 1: Module Status LED Error Code on Controller Board

During normal operation, the controller Module Status LED is chasing. When a problem exists, the controller Module Status LED will indicate the number listed below.

Error Code	Indicates	Possible Solution
	The control program or driver has not been downloaded	Download memory to the controller.
	A control program error	Obtain a Module Status Report (Modstat) and look for error conditions. If you cannot determine the error from the Modstat, send a screenshot of the Modstat to Roberts-Gordon Inside Sales.
	The controller's memory is full	In the WebCTRL for OEMs application, reduce the amount of trend data being stored in the controller. In SiteBuilder, reduce the amount of control programs.
	A setup error	Verify: <ul style="list-style-type: none"> The address has been set on the rotary switches. See Addressing the controller on <i>Page 39</i>. The address is unique on the network. DIP switches are set correctly.
	A system error	Obtain a Module Status Report (Modstat) and look for error messages. If you cannot determine the error from the Modstat, send a screenshot of the Modstat to Roberts-Gordon Inside Sales.
	The controller is formatting	If this number displays continuously or flashes intermittently with another number, try each of the following: <ul style="list-style-type: none"> Turn the controller power off, then on. Restore factory defaults. Download memory to the controller. * Replace the controller. * <p>* Contact Roberts-Gordon Inside Sales.</p>



Port 2a is used as a device port to communicate with the VFD(s). Port 2a has two jumpers used to set its configuration. These jumpers should be set to **EIA-485, 2-wire**.



5.7.2

Port 1 and **Port 2a** need to be configured to operate as the BMS port and device port, respectively. To do this, a combination of Port jumpers and the DIP switch configuration is required. To ensure Port 1 is operating as the BMS/BAS Port, **switch 3** of **DIP switch** should be **OFF**. **Switches 6, 7 and 8** should be configured for BACnet MS/TP m(master) as shown in the diagram on the board. Each should be set to **OFF**. Finally, baud rate for **Port 1** is set using **switches 4 & 5**. It is important to note that the maximum communication distance achievable before a REPEATER is necessary is dependent on the baud rate. A maximum baud rate of 19.2K can be used for distances up to 4000' (1219 m). If the maximum baud rate of the Port is used, 76.8K, a REPEATER is required after 2000' (609 m) or 31 controllers, whichever comes first. Set **switch 4** to **OFF** and **switch 5** to **ON** for 19.2K.

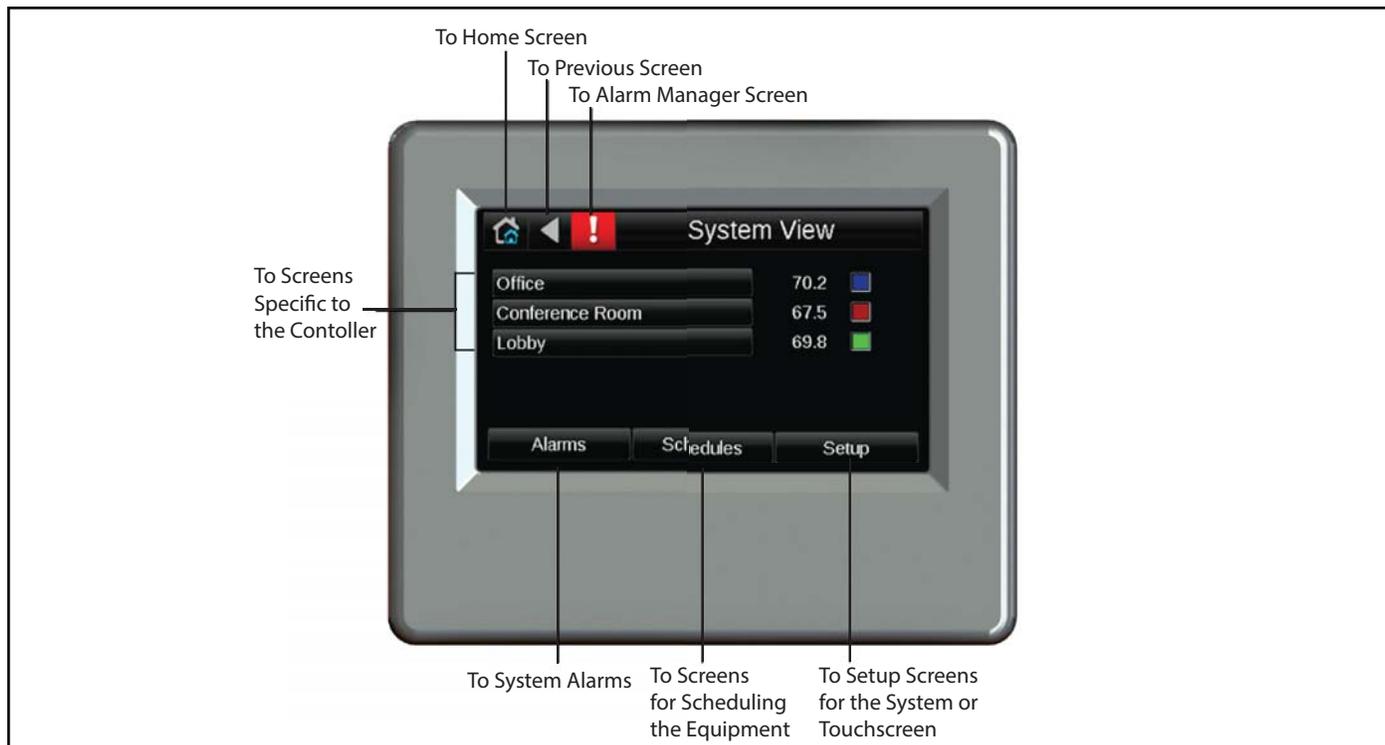
DIP switch set up is complete. Only switch 5 should be ON. Lastly, for **Port 1**, the jumper should be set to **485**.

5.8 Touchscreen

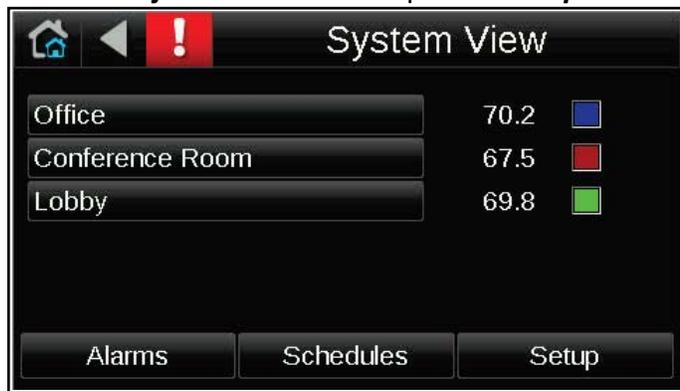
Note: For detailed touchscreen navigation, reference the Touchscreen Navigation Tree, located on Page 104, Section 13.

5.8.1 Initial Touchscreen Setup

Initial setup is required in order to communicate with all controllers within the network. Prior to initial touchscreen setup, ensure that the system(s) are properly installed and that all universal inputs and outputs, ports, rotary and DIP switches are properly configured for the system(s).



From the **System View** screen press **<Setup>**



The administrator password screen will appear prompting users to login.

Login for setup (case sensitive):

Username: **Admin**

Password: **admin**



After logging in, you will be taken to the **Setup** screen. Select **<Communications>**



Select the 19200 baud rate and press **<Save>**. This will allow the central panel to communicate with all satellite panels on the network. Check that the baud rate selected matches that set on the control board.

Next on the **Setup** screen, select **<Discovery>** then **<Set Range>**. Define a range which includes the highest and lowest MAC addresses set on each control panel then select **<Save>**.



From the **Discovery** screen, select **<Discover>**.



The system will then discover every BACnet controller found on the network. Edit names of discovered controllers if desired by selecting each of the discovered controllers shown on the screen. A key board will appear, rename the device and select **<Done>** when finished. Check the box for all controllers you want on the network or **<Select All>** and click

<Create DB>. The **System View** screen will now show the new network of connected control panels.

To access the **Home** screen, click one of the controllers in the list. It will take you to the local **Home** screen for that controller.

Optional: Users have the option to set any controller on the network as the **Home** screen. To do so, from the **System View** screen select **<Setup>** then **<Touchscreen Setup>** and then **<Home Screen Setup>**. Check the box for **<use equipment standby/home screen>**, then select a desired panel for the **Home** screen.

5.8.2 To update the System Touch's firmware

The System Touch has a USB port at the bottom that allows you to update the device's firmware from a USB flash drive.

To update the firmware:

1. The USB flash drive must be formatted as FAT, FAT16, or FAT32. Put your flash drive on your computer USB port and right click on the flash drive, then select Format, and select FAT (default format), then click start.
2. Create a folder on the flash drive called **Touch**.
3. Download the firmware from Roberts Gordon Rep. portal and put the STxxxxxx.hex file in the folder.
4. Plug the flash drive into the System Touch's USB port.
5. From the Home screen, touch **Setup > Touchscreen Setup > Reload Firmware**.
6. A warning message appears. Touch Yes to continue.
7. The following series of messages appear:
 - Verifying Firmware Image.
 - Reading Firmware Image from USB.
 - Installing Application.
 - Verifying Firmware Image.
8. When the Home screen displays, remove the flash drive.

5.9 The REP485 Repeater (P/N 10060156)

The REP485 is a repeater that boosts communication signals over lengthy runs of wire. Place a repeater after every 31 devices or after 2000' (609.6 m) (whichever is reached first) and at each branch of a hybrid network. See *Page 36, Figure 19*. Each repeater begins a new network segment. You can wire a maximum of four repeaters in series. Refer to the sample network configurations using repeaters (Daisy and Hybrid configuration sample on *Page 17, Figure 9 through Page 18, Figure 10*). If the MS/TP communications wire length is above 4000' (1219 m), a repeater must be used to extend the signal. The repeater can also be used to install in different methods:

- To extend communications beyond the standard 4000' (1219 m) limitation. See *Page 30, Figure 16*.
- To add parallel branches of ROBERTS GORDON® CORAYVAC® Modulating Heating Control communications bus wiring. See *Page 32, Figure 17*.
- To add more than 31 controllers to the network chain, the repeater counts as the last controller in the segment and the first controller in the next segment.

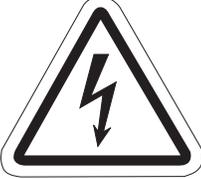
Note: The maximum number of ROBERTS GORDON® CORAYVAC® Modulating Heating Controls that can be installed without a repeater is 32.

SECTION 6: VARIABLE FREQUENCY DRIVE PROGRAMMING

6.1 VFD Parameter Settings For Use With ROBERTS GORDON® CORAYVAC® Modulating Heating Control

The VFD parameters come with factory default settings. The following parameter settings must be changed. Settings can only be altered when the pump motor is stopped.

⚠ DANGER



Electrical Shock Hazard

Enclosure contains live electrical components.

Programming must be done by a trained technician only.

Replace cover before operating.

Failure to follow these instructions can result in death or electrical shock.

6.1.1 Program Mode

To enter the PROGRAM mode and access the Parameters, hold "OK" until P01 appears. Display reads "P01".

6.1.2 Unlock Parameter Higher than P14

Use the arrow buttons to scroll to P14 (the factory set password is 0.0). Press "OK" to enter password (101). This unlocks parameters higher than P14.

6.1.3 Scroll Up or Down

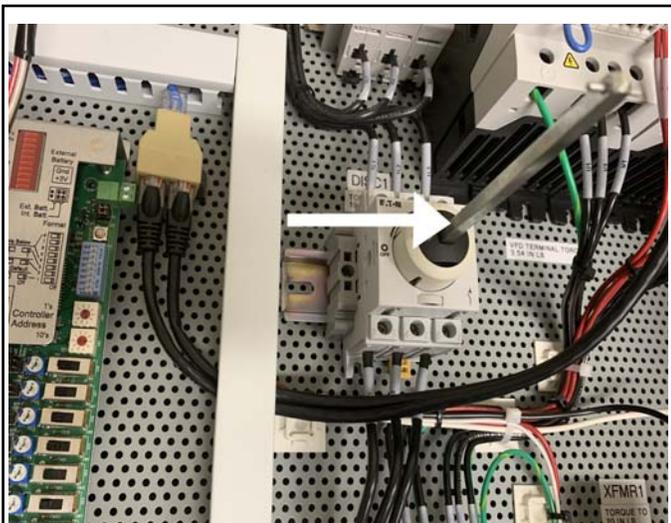
Use the arrow buttons to scroll to the desired parameter number. For new parameter settings, See Page 49, Section 6.2.

6.1.4 Change a Parameter

Once the desired parameter number is found: Press "OK" to display present parameter setting (example setting is 20.0). Use arrow buttons to change setting. Press "OK" to store new setting. Continue scrolling through the parameters.

To override the VFD parameters, turn the square rod of the rotary disconnect switch inside the Controller enclosure with a wrench clockwise to the ON position. In order to be able to close the cover of the disconnect, the rod needs to be turned back to the OFF position.

FIGURE 23: VFD Override



6.2 Altering VFD Parameters

Parameter Number	Parameter Name	Factory Default	New Setting
P01	Maximum Frequency (Hz)	50.0	60.0 (After setting the system, take right Frequency according to <i>Page 57, Step 7.1.1</i> and input.)
P02	Minimum Frequency (Hz)	0.0	40.0 (After setting the system, take right Frequency according the to <i>Page 57 Step 7.1.3</i> and input.)
P03	Accelerated Time (sec)	5	10
P04	Decelerated Time (sec)	5	10
P07	Nominal Motor Voltage (V)	230*	Rated Motor Voltage (from motor data plate)
P08	Rated Motor Current (A)	4.8	Rated Motor Current (from motor data plate)
P09	Rated Motor Frequency (Hz)	50.0	Rated Motor Current (from motor data plate)
P12	Control Level	0.0	1- Manual Run Mode 3-Modbus (internal ramp time) **
P14***	VFD Access Code	0.0	101
P36	Communication Configuration	-	VFD Slave Address (1) or (2)
		-	Modbus RTU baud rate (9.6)
		-	Time out (0)

*Depends on the VFD rated power

**VFD should be in Modbus mode, unless manual mode is desired temporarily.

***Parameter Number P14 set to 101 unlocks parameters P15-P53.

Note: Parameters not listed above should be left at factory settings.

6.2.1 Acknowledge error message (Reset)

To acknowledge and reset the current error message, you can either switch off the supply voltage or press the STOP button. Error messages (a maximum of four) are stored in parameter P-13.

6.2.2 Error Messages

The following table shows the Error messages list, the possible causes and indicates corrective measures. Refer to the supplied VFD installation and operation manual for more details or VFD troubleshooting.

Failure Code [hex]	View	Designation	Possible Cause	Notes
01	01-b	Braking chopper over current	<ul style="list-style-type: none"> Overcurrent braking resistance 	<ul style="list-style-type: none"> Overcurrent in braking resistor circuit. Check the wiring to the braking resistance. Check the brake resistor value. Make sure to adhere to minimum resistance values.
02	0L-br	Thermal overload braking resistance	<ul style="list-style-type: none"> Braking resistance overload 	<ul style="list-style-type: none"> Increase the deceleration time, reduce the load's moment of inertia, or connect additional braking resistors in parallel. Make sure to adhere to minimum resistance values.
03	0-l	Overcurrent motor	<ul style="list-style-type: none"> Overcurrent at output Motor overload Overtemperature at heat sink Short circuit / ground fault 	<ul style="list-style-type: none"> Motor with constant speed: Determine the overload or fault. Motor starts: The load stalled or has seized. Check whether there is a star/delta motor wiring error. Motor accelerates/decelerates: The excessively short acceleration/deceleration time is requiring too much power. If P-03 or P-04 cannot be increased, a more powerful variable frequency drive is required. Cable fault between variable frequency drive and motor.
04	lt-trF	Thermal motor overload	<ul style="list-style-type: none"> The DC1 variable frequency drive was switched off after more than 100% of the value set in P-08 was delivered for a period of time 	<ul style="list-style-type: none"> Check whether the decimal places are flashing (variable frequency drive overloaded) and either raise the acceleration ramp (P-03) or reduce the motor load. Make sure that the cable length matches the variable frequency drive specifications. Check the load mechanically in order to make sure that it is free, that nothing is getting jammed or locked, and there are no other mechanical faults.

05	P5-trF	Fault in power section	<ul style="list-style-type: none"> • Fault in power section 	<ul style="list-style-type: none"> • Check the wiring to the motor. • Check whether there is a short-circuit between the phases or an earth fault in a phase. • Check the variable frequency drive's ambient air temperature. Check whether additional clearance or cooling is required. Make sure that the variable frequency drive is not being overloaded.
06	O.Uo1 t	Overvoltage	<ul style="list-style-type: none"> • Overvoltage at DC link • Mains overvoltage 	<ul style="list-style-type: none"> • Power supply problem. • Increase deceleration ramp time P-04.
07	U.Uo1 t	Undervoltage	<ul style="list-style-type: none"> • DC link undervoltage • Mains Undervoltage 	<ul style="list-style-type: none"> • Usually occurs if the power is switched off. If it occurs during operation, check the power supply voltage.
08	O-t	Overtemperature	<ul style="list-style-type: none"> • Heat sink overtemperature 	<ul style="list-style-type: none"> • Check the variable frequency drive's ambient air temperature. Check whether additional clearance or cooling is required.
09	U-t	Excessively low temperature (frost)	<ul style="list-style-type: none"> • Excessively low heat sink temperature 	<ul style="list-style-type: none"> • The variable frequency drive will be switched off if the ambient air temperature is lower than 14 °F (-10 °C). • Raise the temperature over 14 °F (-10 °C) in order to start the variable frequency drive.
0A	P-dEF	Parameter default	<ul style="list-style-type: none"> • The parameter's default setting has been loaded 	<ul style="list-style-type: none"> • Press the STOP button. The DC! Variable frequency drive is ready for an application - specific configuration.
0B	E-triP	External fault	<ul style="list-style-type: none"> • External shutdown (on digital input 3). • PTC overtemperature (motor) 	<ul style="list-style-type: none"> • External safety shutdown at digital input 3. The N/C contact has opened due to some reason. • Make sure that each individual variable frequency drive on the network has a unique address.
0C	SC-trF	Communication fault	<ul style="list-style-type: none"> • Communication loss error 	<ul style="list-style-type: none"> • Check the communications connection between the variable frequency drive and external devices. • Make sure that each individual variable frequency drive on the network has a unique address.
0E	P-Lo55	Mains connection phase fault	<ul style="list-style-type: none"> • Input phase loss • Shutdown 	<ul style="list-style-type: none"> • A variable frequency drive intended for use with a three-phase power supply has lost one of its input phases.

0F	SPl n-F	Motor pick-up control fault	<ul style="list-style-type: none"> • Motor pick-up control function (for catching spinning motors) failed 	<ul style="list-style-type: none"> • The motor pick-up control function did not determine the motor speed.
10	th-Frt	Thermistor fault	<ul style="list-style-type: none"> • Defective thermistor on heat sink 	<ul style="list-style-type: none"> • Please contact Roberts-Gordon or your ROBERTS GORDON® independent distributor.
11	dAtA-F	Data error	<ul style="list-style-type: none"> • Internal memory error 	<ul style="list-style-type: none"> • Parameter not stored: restore default settings. • If the problem occurs again, please contact Roberts-Gordon or your ROBERTS GORDON® independent distributor.
12	4-20FR	Live zero error	<ul style="list-style-type: none"> • Analog input current outside range 	<ul style="list-style-type: none"> • Make sure that the input current falls within the range defined in parameter P-16.

6.2.3 Reset to Factory Default Setting

To reset VFD to the factory default setting, press the Up + Down + Stop buttons simultaneously for 5 seconds. The display will read P-DEF. Press Stop button to clear screen. Press and hold OK. Reprogram the parameter according to the instructed recommended settings.

6.3 Sequence of Operation CORAYVAC® Modulating Heating Control (CORAYVAC® System (Modulating))

1. On a call for heat from zone sensor, controller will verify that vacuum pump air pressure switch is open. If switch is open, VFD 'Run' command will be issued to start vacuum pump, vacuum pump LED on control panel will be lit, and vacuum pump will start immediately at 100% speed. If controller verifies that vacuum pump air pressure switch is closed during initial start, a fault alarm will be activated, and the system will not start. **OPTION:** If outside air blower is installed, blower will start when VFD 'Run' command is issued.

2. After a short run period, vacuum pressure switch will close, zone LED on control panel will be lit and a signal is sent to start all burners in the zone to begin ignition sequence.

3. Burner ignition module will provide a pre-purge of approximately 45 seconds prior to ignition. After pre-purge, gas valve will open, and flame is established. If flame is detected by burner flame sensor, burner gas valves remain open. If flame is not established, burner ignition sequence will repeat. After three trials, the burner module will lockout for one hour or until

manual reset.

Note: Burners in zone may not all fire at exact same time. Ignition of all burners in zone may vary 3 - 5 seconds.

4. Vacuum pump will run at 100% speed for 2 minutes from time that initial 'Run' command is issued.

5. Modulation period begins after 2-minute initial run period. CORAYVAC® Modulating Heating Control compares outdoor air temperature with zone temperature setpoint and will modulate the CORAYVAC® system appropriately to meet zone temperature setpoint.

6. If zone temperature falls X °F (Default = 5 °F) below desired setpoint, or if zone temperature is not changed within 1 °F of setpoint within 30 minutes of heat cycle, 100% heat request issued.

7. When the call for heat is satisfied, burners shut off, zone LED light on control panel turns off.

8. The pump will continue operation at 100% speed for a post-purge period of 2 minutes.

9. After the post-purge period, VFD will drop 'Run' command and vacuum pump and vacuum pump LED simultaneously turn off.

OPTION: If outside air blower is installed, blower will turn off after post purge period.

COMPLETE™ Modulating Heating Control (VANTAGE® Modulating Unitary Heaters (Model: CTH3/HEM))

1. On a call for heat from zone sensor, zone LED on control panel will be lit, and a signal is sent to start all burners in the zone to begin ignition sequence.

2. VANTAGE® Modulating (Model: CTH3/HEM) burners will go through pre-purge cycle prior to ignition sequence. Blower speed will vary as pressure switch setpoints are verified. When pre-purge is complete, heater will go into pre-ignition state and begin ignition sequence.

3. When flame is established, burner will fire at maximum input for 3 minutes. Modulation begins after 3 minute initial run period. COMPLETE™ Modulating Heating Control compares outdoor air temperature with zone temperature setpoint and will modulate the VANTAGE® Modulating burner appropriately to meet zone temperature setpoint. If flame is not established, burner ignition sequence will repeat. After four trials, the VANTAGE® Modulating burner will lockout for one hour or until reset.

4. If zone temperature falls X °F (Default = 5 °F) below desired setpoint, or if zone temperature is not within 1 °F of setpoint within 30 minutes of heat cycle, 100% heat request issued.

5. When call for heat is satisfied, burner closes gas valve, zone LED light on control panel turns off. VANTAGE® Modulating blower continues to run for a 45 second post-purge prior to shutting off.

COMPLETE™ Modulating Heating Control (Single-Stage Unitary Heaters (Models: CTH2V, CTHN, TF, HEV, BH))

1. On a call for heat from zone sensor, zone LED on control panel will be lit, and a signal is sent to start all burners in the zone to begin ignition sequence.

2. Burner ignition module will provide a pre-purge of approximately 45 seconds prior to ignition. After pre-purge, gas valve will open, and flame is established. If flame is detected by burner flame sensor, burner gas valve remains open. If flame is not established, burner ignition sequence will repeat. After three trials,

the burner module will lockout for one hour or until manual reset.

Note: Burners in zone may not all fire at exact same time. Ignition of all burners in zone may vary 3 - 5 seconds.

3. When flame is established, burner will fire until call for heat is satisfied.

Note: COMPLETE™ Modulating Heating Control will not modulate single-stage burners. Burners will function (on/off) as designed.

4. When call for heat is satisfied, burner closes gas valve, zone LED light on control panel turns off. Burners will shut off.

Note: There is no post-purge.

COMPLETE™ Modulating Heating Control (VANTAGE® CTHN Multiburner or CORAYVAC® On/Off (Non-Modulating))

1. On a call for heat from zone sensor, controller will verify that vacuum pump air pressure switch is open. If switch is open, vacuum pump LED on control panel will be lit and vacuum pump will start immediately. If controller verifies that vacuum pump air pressure switch is closed during initial start, a fault alarm will be activated and the system will not start.

OPTION: If outside air blower is installed, blower will start simultaneously with vacuum pump.

2. After a short run period, vacuum pressure switch will close, zone LED on control panel will be lit and a signal is sent to start all burner ignition sequences in the zone.

3. Burner ignition module will provide a pre-purge of approximately 45 seconds prior to ignition. After pre-purge, gas valve will open, and flame is established. If flame is detected by burner flame sensor, burner gas valve remains open. If flame is not established, burner ignition sequence will repeat. After three trials, the burner module will lockout for one hour or until manual reset.

Note: Burners in zone may not all fire at exact same time. Ignition of all burners in zone may vary 3 - 5 seconds.

4. System will continue to run until call for heat is satisfied.

Note: On/Off CORAYVAC® system will not modulate. System will function as designed.

5. When the call for heat is satisfied, burners shut off, zone LED light on control panel turns off.

6. The pump will continue operation for a post-purge period of 2 minutes.

7. After the post-purge period, vacuum pump and vacuum pump LED simultaneously turn off.

OPTION: If outside air blower is installed, blower will turn off after post-purge period.

SECTION 7: COMMISSIONING THE CORAYVAC® SYSTEM

Note: The ROBERTS GORDON® CORAYVAC® Modulating Heating Control central controller is fitted with a touchscreen for communication to the CORAYVAC® system and all CORAYVAC® Modulating Heating Control satellite controllers (maximum of 31 controllers before a repeater is needed). All wiring and control board setup must be complete prior to commissioning the system.

7.1 Setting The CORAYVAC® End Burner Vacuum

It is important to understand that the frequency that the VFD runs the motor at, determines the speed of the impeller in the pump. Variation of the impeller speed will increase or decrease vacuum in the system. The following procedure will help you set minimum and maximum VFD frequency settings to achieve proper vacuum in the system.

Step 7.1.1 Note: The VFD(s) should be programmed using the procedure and parameters described on *Page 48, Section 6 through Page 49, Section 6.2* prior to this step. At the VFD, press and hold "OK" until P-01 appears. This will allow access to the PROGRAM mode to adjust parameters. Using the arrow button, scroll to P-12 and set parameter to "01". Press "OK" to store new setting. Press "START" button on VFD to turn on the CORAYVAC® vacuum pump. Pump should ramp up to value set in P-01. Verify pump rotation. Pump impeller should be rotating in direction of arrow stamped on vacuum pump housing.

On the control board, switch the relevant "HOA" switches to "Manual On" position to turn on the zones connected to the vacuum pump. See *Page 14, Figure 6* for control board layout.

Note: The vacuum pump must be energized prior to manually switching on the zones.

Step 7.1.2 The pump should be running and the burners should light within 60 seconds. At the VFD, verify that the number displayed on the LCD screen is "60.0". If it is lower than 60.0, hit the "up" arrow button on the VFD until the number reads 60.0. Let the burners fire for approximately 20-30 minutes to warm up the system. Using a manometer, check the end vent vacuum in each zone (each branch of burners). See *Page 56, Figure 24*.

If the lowest end vent vacuum reading is above 3.0" w.c., reduce the vacuum pump speed. Generally, the

lowest end vent vacuum reading is on the longest branch of the system. Use the down arrow button on the VFD to reduce the frequency of the output signal to the pump, thus reducing the pump speed and lowering the end vent vacuum reading. Continue to reduce the frequency until the end vent vacuum reading is between 2.5" - 3.0" w.c. Make note of this frequency setting below. The frequency is found on the VFD's LCD screen.

2.5" w.c. - 3.0" w.c. VFD Frequency Setting

Record Frequency Setting Here:

To avoid damage to the pump motor, do not adjust the frequency above 60.0 Hz. Verify that the end vent vacuum readings in the remaining branches are proper. If necessary, adjust the proper damper coupling to achieve an end vent vacuum of 2.5" - 3.0" w.c. See *Page 56, Figure 24*. Damper couplings should be found near the end of the radiant portion of the pipe in each branch or where a branch connects to other branches at a cross or tee. See *Page 57, Figure 25*.

Step 7.1.3 After setting end vent vacuums between 2.5" w.c. and 3.0" w.c., while all the burners are still operating, use the down arrow button on the VFD to reduce the frequency of the output signal to the pump. Reduce the frequency of the VFD until the manometer at each of the end vents reads 1.2" w.c. - 1.5" w.c., Make note of this frequency setting below. The frequency is found on the VFD's LCD screen.

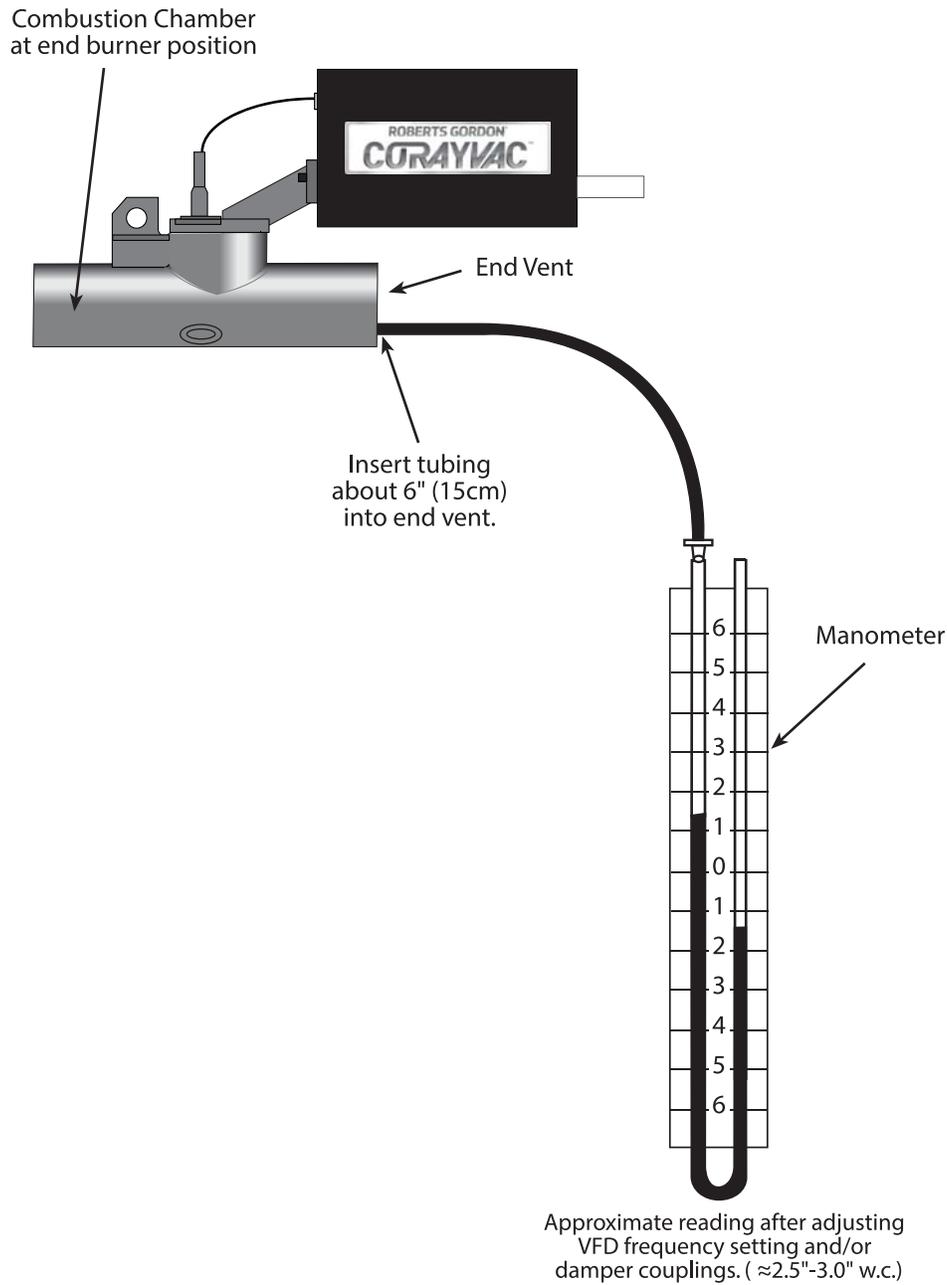
1.2" w.c. - 1.5" w.c. VFD Frequency Setting

Record Frequency Setting Here:

Step 7.1.4 Press the "STOP" button on VFD. Return "HOA" switches to "Auto".

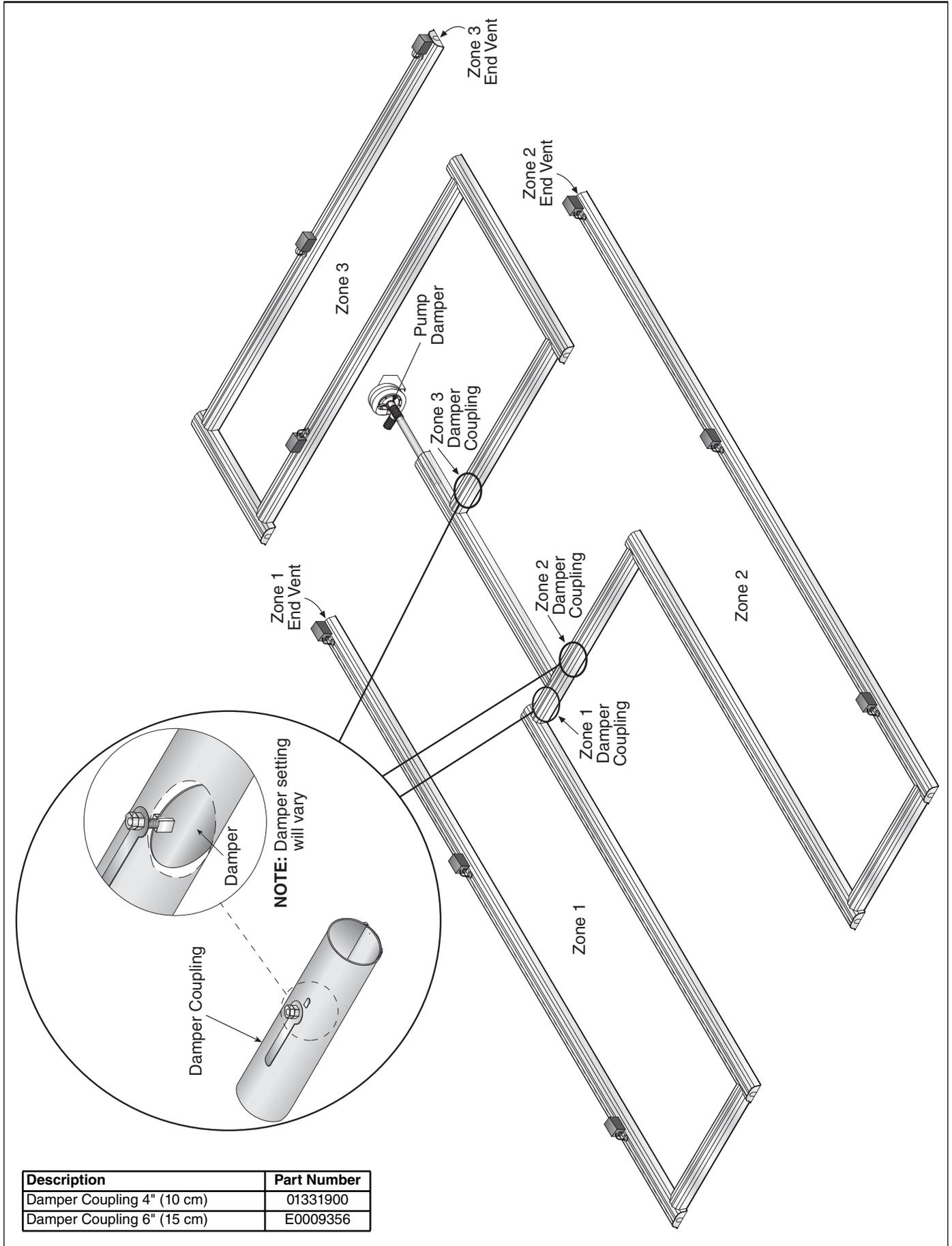
Step 7.1.5 Using the procedure described on *Page 48, Section 6*, alter parameters "P-01" and "P-02" to maximum and minimum frequency settings. Return parameter "P-12" to "03".

FIGURE 24: End Vent Vacuum



Note: System vacuum should be set by measuring vacuum pressure at end burner furthest away from vacuum pump. All other end burners on the other branches should have the same vacuum pressure reading. The vacuum pressure on end burners closer to the vacuum pump are set by adjusting the damper on the damper coupling for each branch. See Page 57, Figure 25 for possible locations of damper couplings.

FIGURE 25: Possible Damper Coupling Locations



SECTION 8: PROGRAMMING AND TROUBLESHOOTING THE SYSTEM

The CORAYVAC® Modulating Heating Control comes standard with Heater and Zone programs to operate Roberts-Gordon heating equipment. The revision of programs are shown on touchscreen under **Menu** → **Maintenance - Unit**.

Program features important to the user upon startup are described below. This section will provide details on how to modify these settings. The program defaults to 4 CORAYVAC® heating zones. The default zone designations are as follows: Zones 1 and 2 are associated with Pump 1 and Zones 3 and 4 are associated with Pump 2. The zone designations can be re-configured via the touchscreen to any combination desired, see *Page 59, Section 8.2*. It is important that hard wired configuration matches internal programs pump to zone association to avoid power being sent to burners not under vacuum. The controller comes with a standard 7am - 5pm, Monday - Friday schedule for each of the heating zones. Manual occupancy can also be started at the zone sensor or touchscreen for a chosen length of time. The heating setpoint for the Occupied and Unoccupied states default to 65 °F and 60 °F. Two settings exist to ensure setpoint is reached in various conditions. Modulation Override Temperature Offset is set to 5 °F. This feature commands 100% heat if the zone temperature falls 5 °F below setpoint. A timeout also exists such that if the zone temperature is not within 1 °F of the setpoint within 30 minutes, a 100% heat command is issued. This 30 minutes is not editable. Limits on the degree to which the setpoint can be adjusted at the zone sensor default to +/- 5 °F. The system modulates on internal and external design temperatures, and the outside air temperature. Adjustments to the external design temperature based on local, seasonal, temperatures are important to ensure the system is modulating properly. Default Internal and External temps are 65 °F and 32 °F.

For VANTAGE® Modulating unitary heaters, an initial 100% heat command is issued for 3 minutes. This overlaps the startup procedure programmed into the VANTAGE® Modulating burner. After this, the VANTAGE® Modulating burner will modulate accordingly. Post-purge operations are also programmed directly into the VANTAGE® Modulating burner. See VANTAGE® Modulating/VANTAGE® HEM installation and operation manuals (P/N 134100NA/139100NA) for further details. For CORAYVAC® systems, an initial 100% heat command is issued for 2 minutes. After the heat request has been satisfied, a 2-minute post-purge command is issued.

When networking multiple controllers together, the Outside Air Temperature (OAT) sensor can be connected locally to any controller. Once network communications have been established, the OAT will be broadcast to each controller. The controller also comes standard with an Optimum Start feature. This feature reads the OAT, current zone temperature, occupied setpoint, and time left before occupancy, and begins heating the area so that the setpoint is reached when occupancy begins. The feature is set to not start more than 30 minutes before scheduled occupancy.

Notes:

- Ensure Initial Touchscreen Setup has been completed before proceeding, see *Page 45, Section 5.8*.
- A slight delay exists when processing information on the touchscreen. Allow the screen to process information before navigating away from the current screen
- Blue text indicates an editable field. Yellow text cannot be changed

8.1 Passwords

The touchscreen comes standard with different levels of password protection. There is a User level and Admin level password. The default credentials are shown below:

User:

password: user

Admin:

password: admin

The end user is prompted for these credentials when attempting to access a protected screen. Once entered, the access level is saved until the screen sleeps. This Inactivity Timeout can be set in the **<Menu> <Touchscreen Setup> <Inactivity Timeout>** screen. The passwords can also be changed by the end user in the **<Touchscreen Setup> <Passwords>** screen.

The user can also login to any access level by opening the Property Menu and tapping [LOGIN] at the top right. Entering a username is not required. Simply enter the password for the desired level of access. Logging in as the ADMIN will grant access to both user levels. Logout at any time by tapping [ADMIN] or [USER] in the Property Menu.

8.2 Home Screen and Programming the System

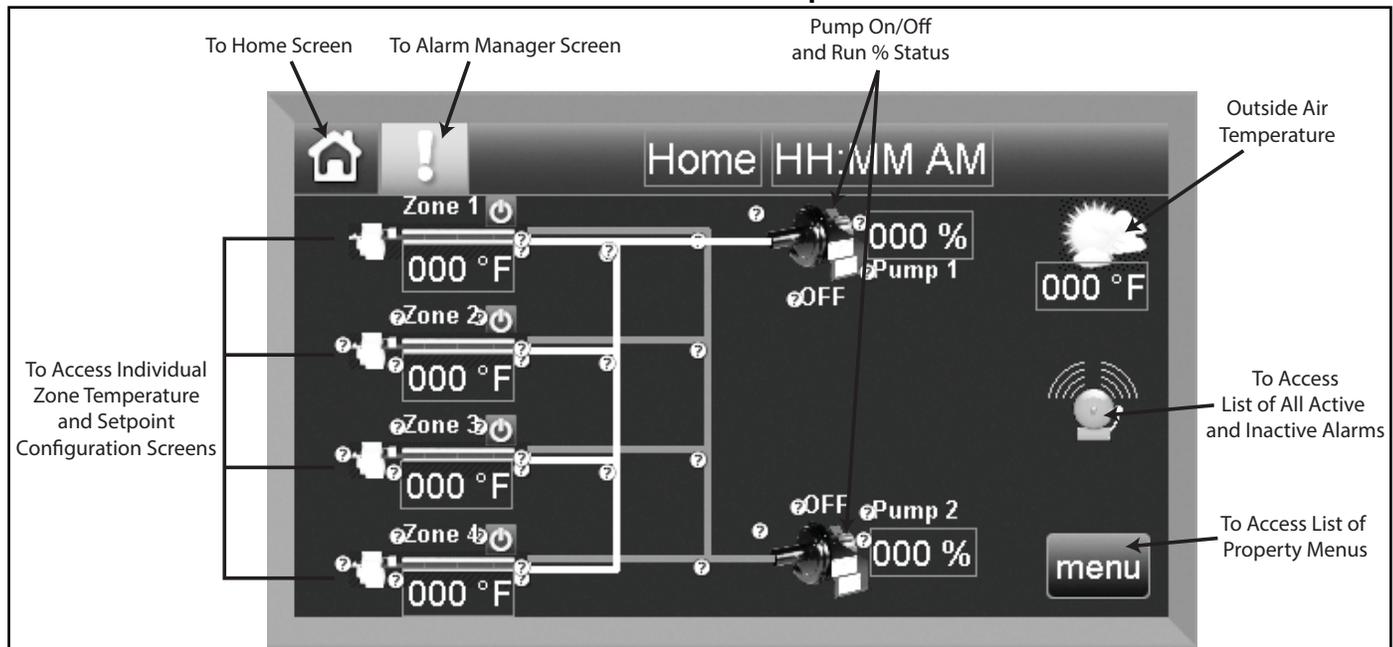
The following instructions provide a general overview of programming your system. Each controller on the network must be programmed separately. When programming for controller is complete, select the **home icon** to return to the **System View** screen. Select the next controller on the network and repeat the programming instructions. For detailed instructions, please refer to the CORAYVAC®/COMPLETE™ Modulating Heating Control installation and operation manual.

Home Icon



Note: Prior to programming the system, ensure that Initial Touchscreen Setup has been complete, see *Page 45, Section 5.8*.

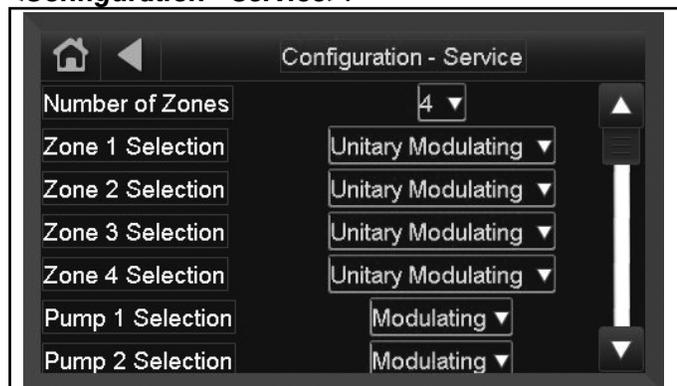
Home Screen Map



Note: For detailed touchscreen navigation, reference the Touchscreen Navigation Tree, located on *Page 104, Section 13*.

8.3 Home Screen System Configuration

From the Home screen select **<menu>** to access the list of property menus. Scroll down and select **<Configuration - Service>**.



The **Configurations-Service** screen is used to

adjust how many zones, vacuum pumps, and the type of heating system that is connected to the controller you are programming.

Select the box next to '**Number of Zones**' and set the number of zones connected to that controller. Select the box next to each '**Zone "#" Selection**' and choose the type of heating system that is associated with that zone.

Example 1: If the controller is controlling two CORAYVAC® systems with a combination of four heating zones, the user must assign which vacuum pump is associated with each zone. If zones 1 and 2 are connected to vacuum pump 1, then set '**Zone 1 Selection**' and '**Zone 2 Selection**' both to **<Vacuum Pump 1>**. Set '**Zone 3 Selection**' and '**Zone 4 Selection**' to **<Vacuum Pump 2>**.

Example 2: If the controller is controlling unitary heaters, select **<Unitary Modulating>** or **<Unitary On/Off>** (depending on what type of unitary heater is installed) to the appropriate '**Zone "#" Selection**'.

Continue to scroll down **Configuration-Service** screen and set each selection to the appropriate setting (depending on what type of heat system(s) are connected to the controller). The '**External Design Temperature**' should reference the coldest possible outside air temperature during the heating season, The "**Internal Design Temperature**" should reference the warmest desired space temperature. Press the home icon to return to the **Home** screen.

Home Icon

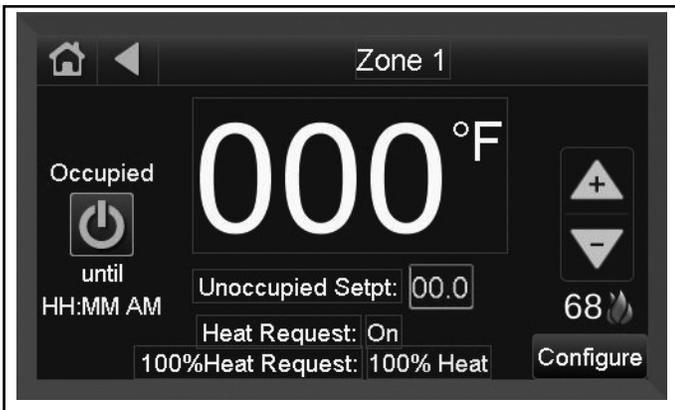


After the **Configuration-Service** screen is adjusted, the **Home** screen will show zone-to-pump associated wiring. Yellow and blue lines indicate which pump each CORAYVAC® system is connected to within the controller's logic.

Note: Ensure the hardwired connections match the connection within the logic. Repeat this configuration for each controller on the network.

8.4 Zone Temperature Setpoints

Press any of the '**Zone #'s**' displayed on the **Home** screen to access the temperature adjustments for the associated zone. If '**Zone 1**' is selected, '**Zone 1**' screen will be accessed.



From this screen, users can make adjustments to the zone temperature setpoint, or override a schedule. Adjust the occupied setpoint by pressing the up and down arrows to the desired zone temperature displayed next to the flame icon.

Arrow Buttons



To override an unoccupied temperature, select the on button icon to select the desired space temperature and the duration of the override.

On Button Icon



Note: The **<Configure>** icon will bring users to the **Configuration-Zones** screen. It is recommended to create all schedules prior to adjusting the settings in the **Configuration-Zones** screen.

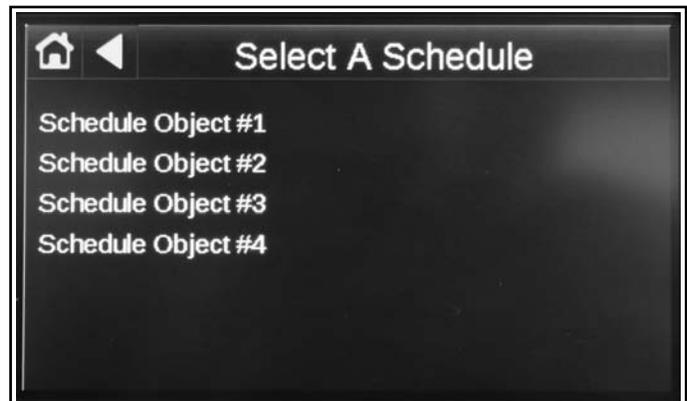
Note: Allow a few seconds after adjusting setpoint for information to process before navigating away from page.

Note: Setpoint displayed also reflects any adjustments made at the zone sensor. This is the "Effective Setpoint". For example: If the setpoint is at 68 °F and the user adjusts the setpoint to 70 °F at the zone sensor, 70 °F will appear on the zone screen. Adjustments made at the touchscreen will be from the base setpoint (68 °F). If user, then turns up the temperature 2 F° more, it will show the adjustment from 68 F°- 70 F°, and then jump to 72 F° to reflect the zone sensor adjustment.

8.5 Schedule Creation

To maximize comfort and system performance, it is recommended to program your heating schedule in accordance with your occupied and unoccupied zones and schedule. For best results, keep your night setback temperature within 5 °F to 8 °F of your occupied setpoint temperature.

In the **Home** screen select **<Menu>** then select **<Schedules>**. A list of schedule objects numbered 1 through 4 will appear. The schedule object number corresponds with each zone number. Each zone should be programmed individually.



Select **<Schedule Object #1>**, to access the Calendar View screen. **Calendar View**



To add a schedule, press the plus icon on the bottom right of the screen.

Plus Icon



- The default Schedule Name is "Schedule 1". Edit the name by pressing the box to bring up the key board. Enter new schedule name if desired and press **<Done>** when complete.

Note: When viewing schedules (shown in the following screens) only the name of the one, priority 'normal' schedule will appear. However, all programmed information is effective.

- Choose whether or not this is an occupied schedule by selecting the box to the left of '**ON Schedule (Occupied)**'. A check mark will appear in the box indicating that you have selected that option. Select the box to the left of '**OFF Schedule (Unoccupied)**' if the schedule is for unoccupied times.

- Next, choose the '**Type**' of schedule by pressing the drop down menu. Options include: Dated, Weekly, Continuous. Select '**Weekly**' to create a complete 7-day schedule.

Note: '**Dated**' will allow users to set a specific time and date for the system to be active. The date can be set to a single day or a specific day each month or each year. '**Continuous**' will allow users to select a start time and date and end time and date for the system to be active continuously.

- For '**Priority**', select '**Normal**' to create an occupied/unoccupied status in the applicable zone, for a certain time duration, for certain days dependent on the type of schedule selected.

Note: The time slot must be vacant for the schedule to be effective. Choosing '**Override**' will reverse a normal schedule which is in place by turning an occupied time to unoccupied or vice versa.

Press **<Next>** when complete

Press the times to edit the '**Starts:**' and '**Ends:**' times. Select desired '**Days:**' of the week schedule is to be active.

Optional: Users can input a date range by pressing **<Yes>** and selecting '**Starts:**' and '**Ends:**' dates.

Note: For 24/7 schedule, select all week days and select **<All Day Event>** for the start and end times.

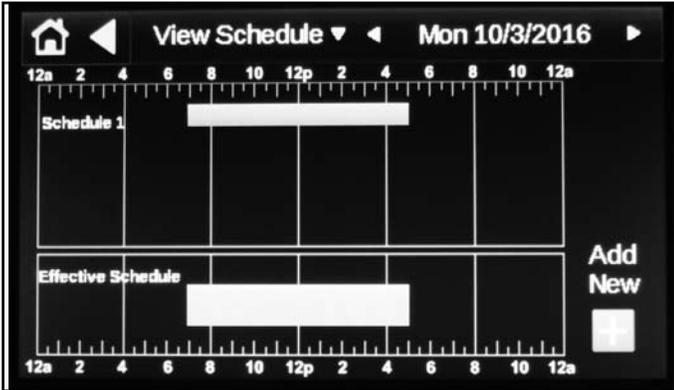
Press **<Save>** when complete.



The **Calendar View** screen populates the schedule.

8.6 Edit Existing Schedule

If at the **Home** screen, users can access the **Calendar View** screen by selecting **<Menu>** then **<Schedules>** then select the appropriate **<Schedule Object #X>**. The **Calendar View** screen will appear showing the populated schedule. To open the **Schedule Editor** screen, select the day of the week the schedule is active.

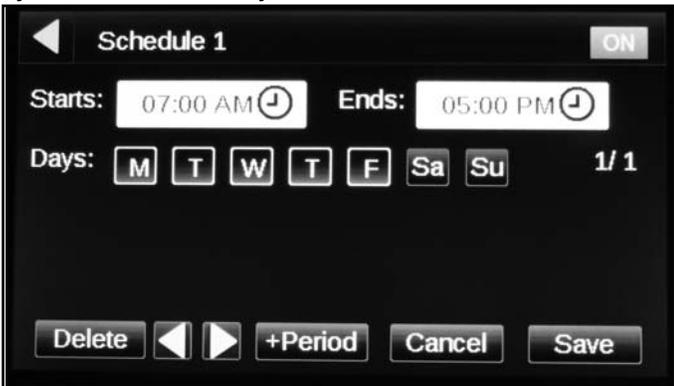


In the **Schedule Editor** screen, click on the schedule name or the green bar.

Note: If more than one 'Normal' priority schedule exists, only one name will appear.



The schedule information will be shown on the screen. To change the schedule type, priority, or occupied/unoccupied settings, the schedule must be deleted by pressing **<Delete>**, and a new schedule must be created. If users want to change the effectivity times or week days, select **<Next>**.



Edit schedule information by pressing the times to edit the **'Starts:'** and **'Ends:'** times. Select desired **'Days:'** of the week schedule is to be active.

Note: For 24/7 schedule, select all week days and select **<All Day Event>** for the start and end times. Press the arrows to navigate between multiple schedules.

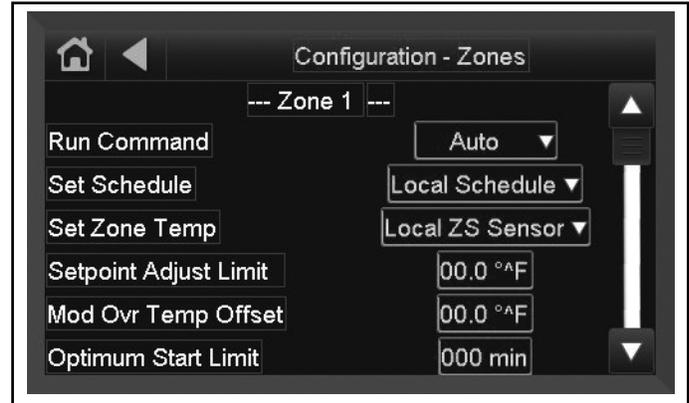


Note: If multiple **'Normal'** schedules were created, this is where information for all schedules can be viewed

Users can delete the schedule period by selecting **<Delete Period>** or delete all schedules in the zone by selecting **<Delete All>**.

Press **<Save>** when complete.

8.7 Zone Configuration (Zone Setup)



Access the **Configuration-Zones** screen by selecting **<Menu>** from the **Home** screen, scroll through the list of properties and select **<Configuration-Zones>**.

Adjust the following settings by pressing the boxes to the right. Adjust according to the recommended settings.

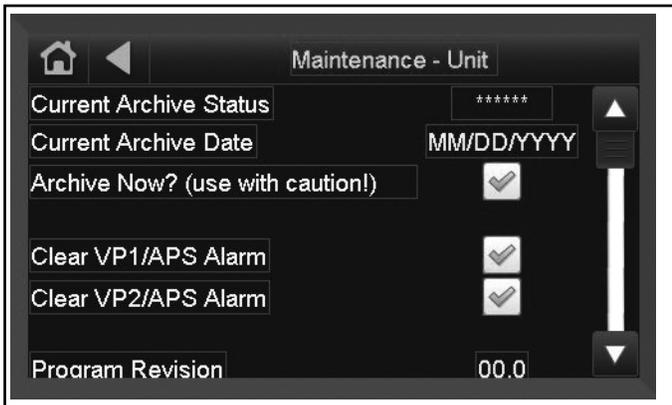
Recommended settings:

- **'Run Command':** Auto
- **'Set Schedule':** Local Schedule (allows users to read schedules created).
- **'Set Zone Temp':** Local ZS Sensor (allows users to read space temperature through zone sensor).
- **'Setpoint Adjust Limit':** 5.0 °F (limits the degree to which the setpoint can be adjust at the zone sensor).
- **'Mod Ovr Temp Offset':** 5.0 °F (if temperature within the zone falls this many degrees below the setpoint, a 100% heat request will be activated).
- **'Optimum Start Limit':** 60 minimum (maximum time allowed (before schedule occupancy) for zone to

pre-heat, bringing the temperature in the space up to occupied setpoint.)

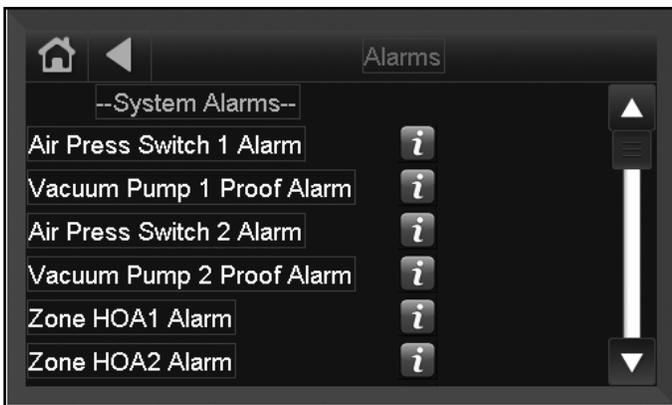
- **'Door Switch "1" and "2" Enable'**: On or Off (this setting allows users to wire in a door switch to the controller to prevent the heating system from operating while a door is open. Setting must be set to "On" in two separate locations; in the **Configuration-Zone** screen and the **Configuration-Unit** screen. If the switches are set up differently in the separate screens, power will not go to the burners. If users do not have this option in their system, set to "Off".)

8.8 Maintenance



- Use this screen to quickly clear Vacuum Pump Alarms or Air Pressure Switch (APS) Alarms.
- The Vacuum pump alarm activates when a command is issued to the VFD's to run and the pressure switch is not closed within a certain amount of time.
- The APS Alarm activates when the APS is closed before a run command is issued to the pump.
- Check the box next to the active alarm and wait for the check to clear before navigating away from the screen.

8.9 Alarms



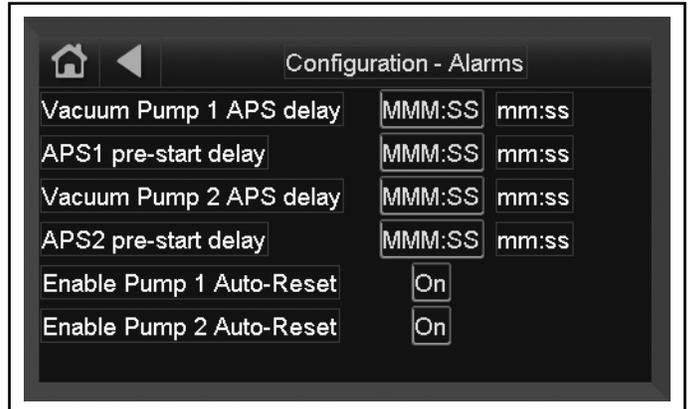
- Alarm screen can be accessed from the alarm bell on home screen or through the MENU.

- Use this screen to see which alarms are active, if any. Use the info button for more information about the alarm



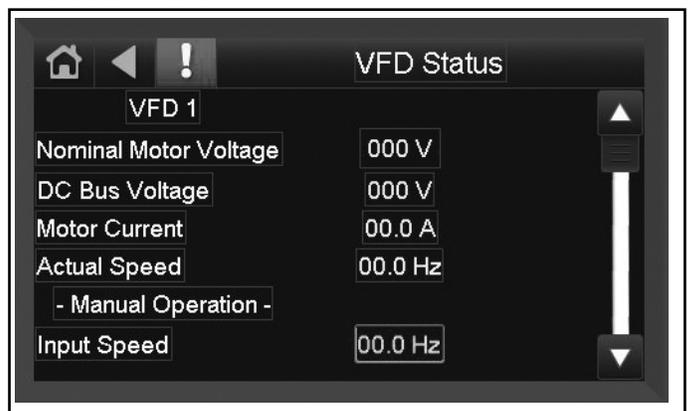
- The red exclamation point on home screen is an alarm history, NOT necessarily active alarms.

8.10 Alarm Configuration



- The preconfigured alarm times in this screen should not be changed. The Vacuum Pump 1 and 2 APS Delay alarms default to 2 minutes. This gives the system 2 minutes to prove the APS, and if the APS drops out during operation, the alarm trips after 2 minutes.
- The APS1 and 2 pre-start delay gives the system 5 seconds to check that the APS is not already closed before the pump starts.
- The Auto-Reset feature for each pump can be optionally turned OFF if desired. This feature will clear Vacuum Pump/APS related alarms up to 2X before locking out on the third alarm, within a 30 minute window. After 30 minutes if lockout has not occurred, the counter resets. Turning this feature OFF means the system will lock out at the first alarm.

8.11 VFD Status

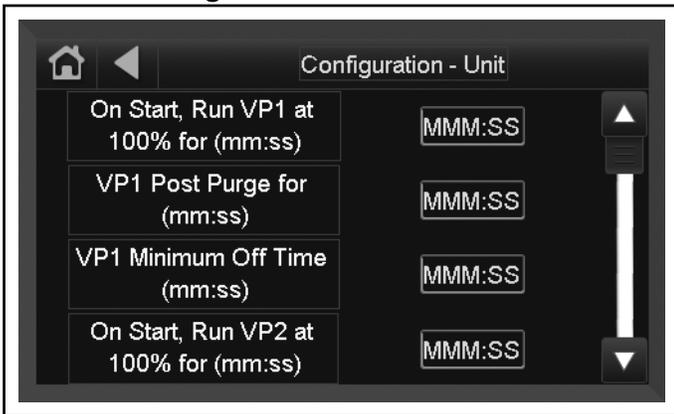


- Use this screen to check running parameters of the VFD. Nominal Motor Voltage is programmed into the drive during VFD setup. The remaining parameters are real time values.

- Use this screen to check for successful Modbus connection to the VFD. If the drives are communicating properly via Modbus, the parameters will populate with values accordingly.
- Set the manual run speed for VFD 1 and 2 here. The VFD's can be manually operated by connecting a switch to Input 4 for VFD 1 and Input 5 for VFD 2. The manual speed is limited by the high and low frequency programmed into the drive.
- Port 2a setup can be verified in this screen. Settings should be Modbus and baud rate of 9600.

- The default times for startup and post purge in this section should not be altered.
- The first timer for VP1 runs the pump at 100% for 2 minutes at startup. When the heat request is satisfied, the Post Purge timer runs the pump for an additional 2 minutes. The Minimum Off timer prevents the system from accidentally tripping an APS alarm if it cycles OFF and back ON too quickly.
- The Run Burner 1 at 100% timer is for Unitary Modulating heaters. It runs the units at 100% for 180 seconds at startup.
- Next is an override feature for the Outside Air Temperature Override the temperature to a defined value if desired. The OAT Lockout will force the equipment into an unoccupied state (setback setpts), if the OAT exceeds the setpoint.
- Door Switches allow the user to disable burner power if an input is tripped. The switches correspond to Inputs 6 and 7 on the control board. The NC or NO polarity of the switches can also be adjusted. Note that the Door Switch must be enabled here, and for each zone in the Configuration - Zones screen.

8.12 Unit Configuration



8.13 Adjust Time

To adjust the controller time, go to **<MENU>** **<TOUCHSCREEN SYSTEM>** **<SETUP>** **<MODULE SETUP>** **<SET TIME & DATE>**.

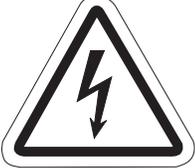
Press **<Save>** when complete.

VP2 Post Purge for (mm:ss)	MMM:SS
VP2 Minimum Off Time (mm:ss)	MMM:SS
Run Burner 1 at 100% When Started for	000 seconds
Run Burner 2 at 100% When Started for	000 seconds
Run Burner 3 at 100% When Started for	000 seconds
Run Burner 3 at 100% When Started for	000 seconds
Override OA Temp?	No
OAT Override Value	000 °F
OAT Lockout Enable	Off
OAT Lockout Setpoint	000 °F
Door Switch 1 Enable	Off
Door Switch 1 Polarity	Normal ▼
Door Switch 2 Enable	Off
Door Switch 2 Polarity	Normal ▼

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 9: TROUBLESHOOTING

⚠ DANGER



Electrical Shock Hazard
Disconnect electric before service.

More than one disconnect switch may be required to disconnect electric to the unit.

Failure to follow these instructions can result in death or electrical shock.

⚠ WARNING



Explosion Hazard
Turn off gas supply to heater before service.

Failure to follow these instructions can result in death, injury or property damage.

Table of Contents:

Page 67, Figure 26 - Vacuum pump does not turn on

Page 68, Figure 27 - VFD Turns on, but the desired zone does not turn on

Page 69, Figure 28 - VFD showing a fault sign

Page 69, Figure 29 - VFD input power issue

Page 70, Figure 30 - Vacuum pump power issue

Page 71, Figure 31 - Burner troubleshooting in manual mode

Page 72, Figure 32 – After 45 second prepurge, burners do not light

Page 74, Figure 33 - Burner intermittent lockout

Page 75, Figure 34 - APS doesn't close within 60 seconds after VFD receives run command

Page 76, Figure 35 - Zone sensor issue

Page 77, Figure 36 - Air Pressure Switch alarm

Page 78, Figure 37 - Modbus troubleshooting

Page 79, Figure 38 - Repeater troubleshooting

Page 80, Figure 39 - BACnet MS/TP troubleshooting

Page 82, Figure 40 - Touch pad troubleshooting

As a convenience, the following troubleshooting section was created as a basic guide to assist with equipment or installation issues. Protective gear is to be worn during troubleshooting in accordance with the Occupational Safety and Hazard Administration (OSHA). Gear must be in accordance to NFPA 70E, latest revision, when working with electrical components. Thin sheet metal parts have sharp edges. To prevent injury, the use of work gloves is recommended. Troubleshooting must be performed by a contractor qualified in the installation and service of equipment sold and supplied by Roberts-Gordon LLC and conform to all requirements set forth in the ROBERTS GORDON® manuals and all applicable governmental authorities pertaining to the installation, service, operation and labeling of the equipment.

If problems persist after following troubleshooting guide, contact your local ROBERTS GORDON® independent distributor, or Roberts-Gordon LLC Inside Sales at 716-852-4400.

FIGURE 26: Vacuum pump does not turn on

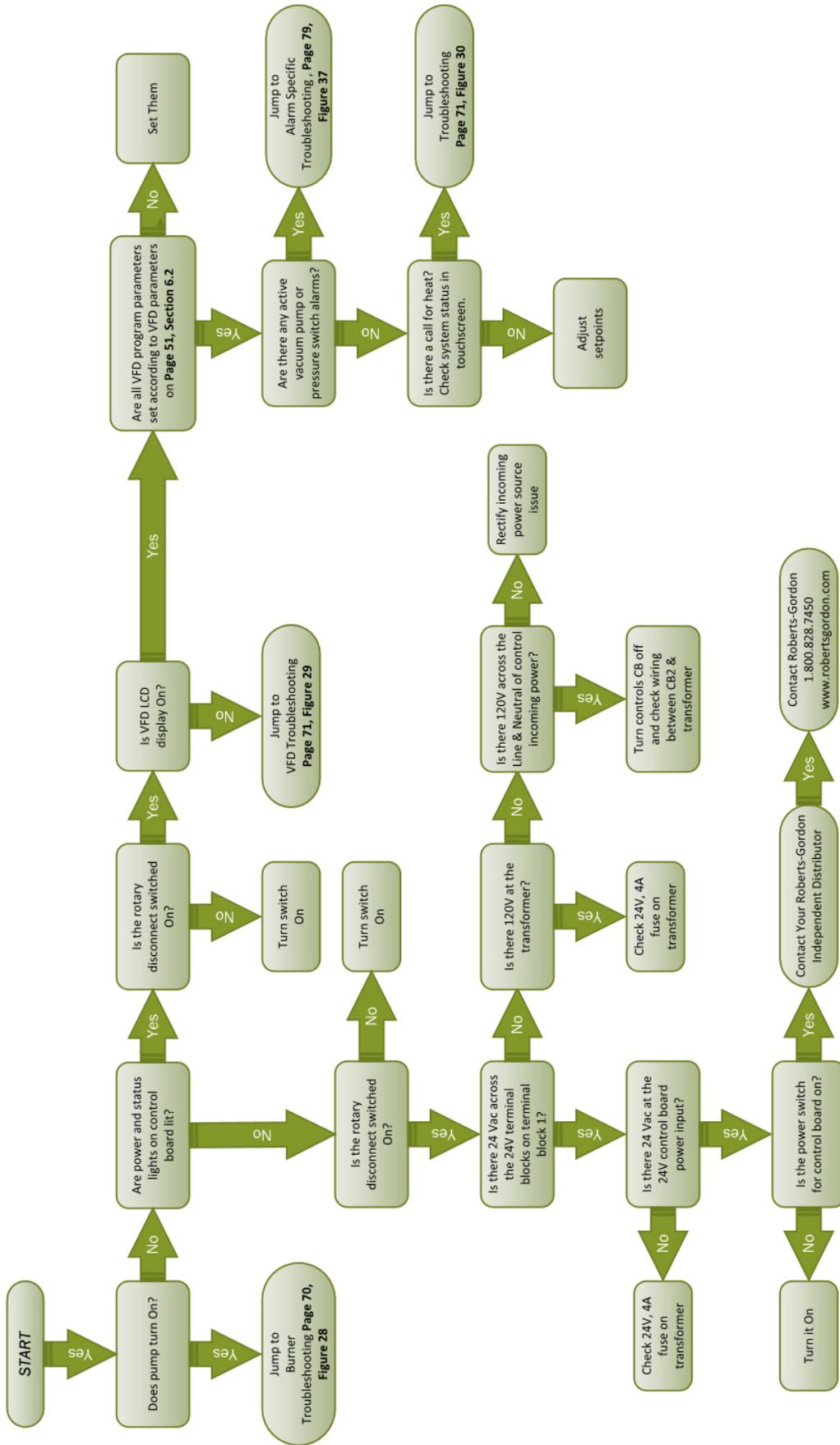


FIGURE 27: VFD Turns on but the desired zone does not turn on

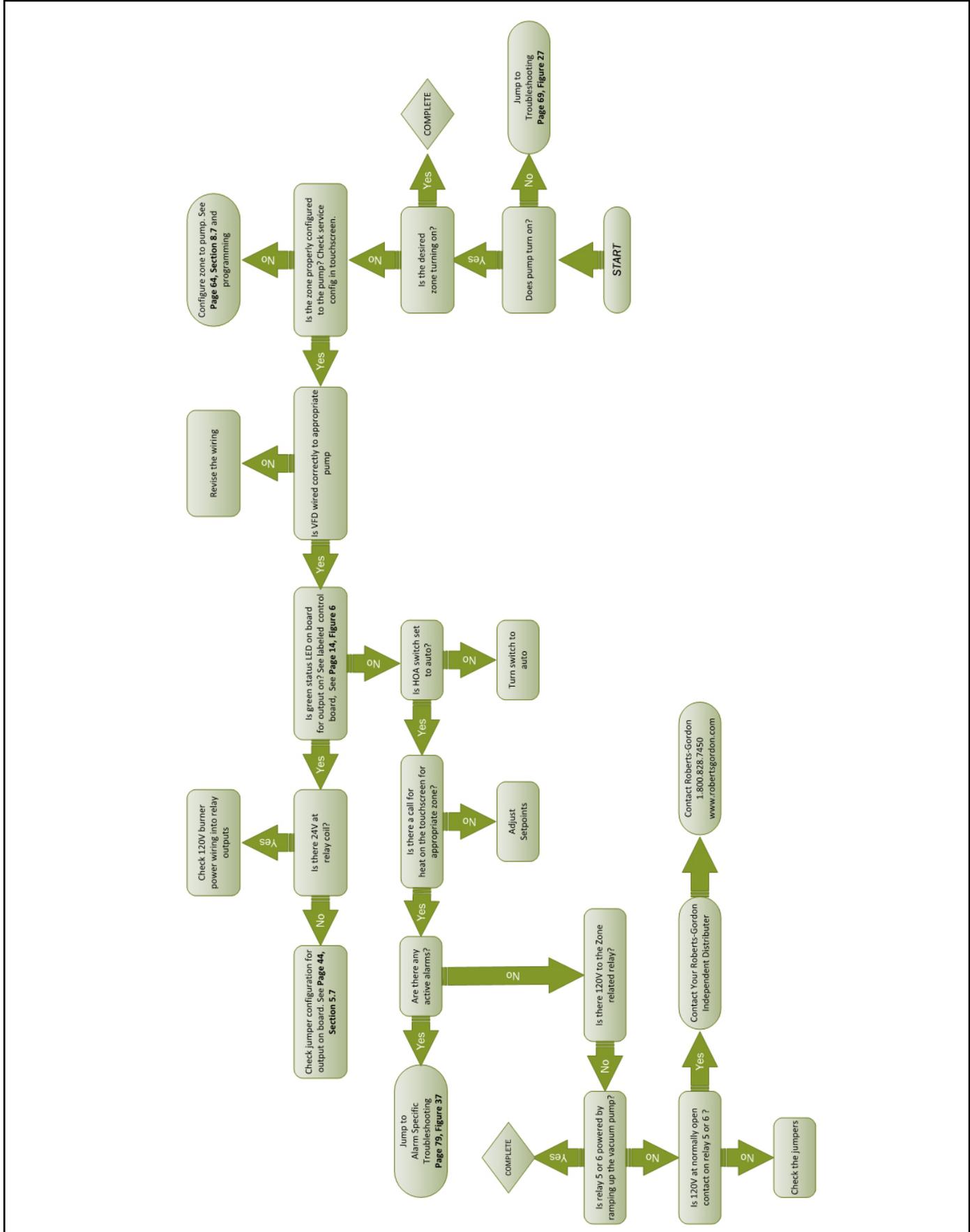


FIGURE 28: VFD showing a fault sign

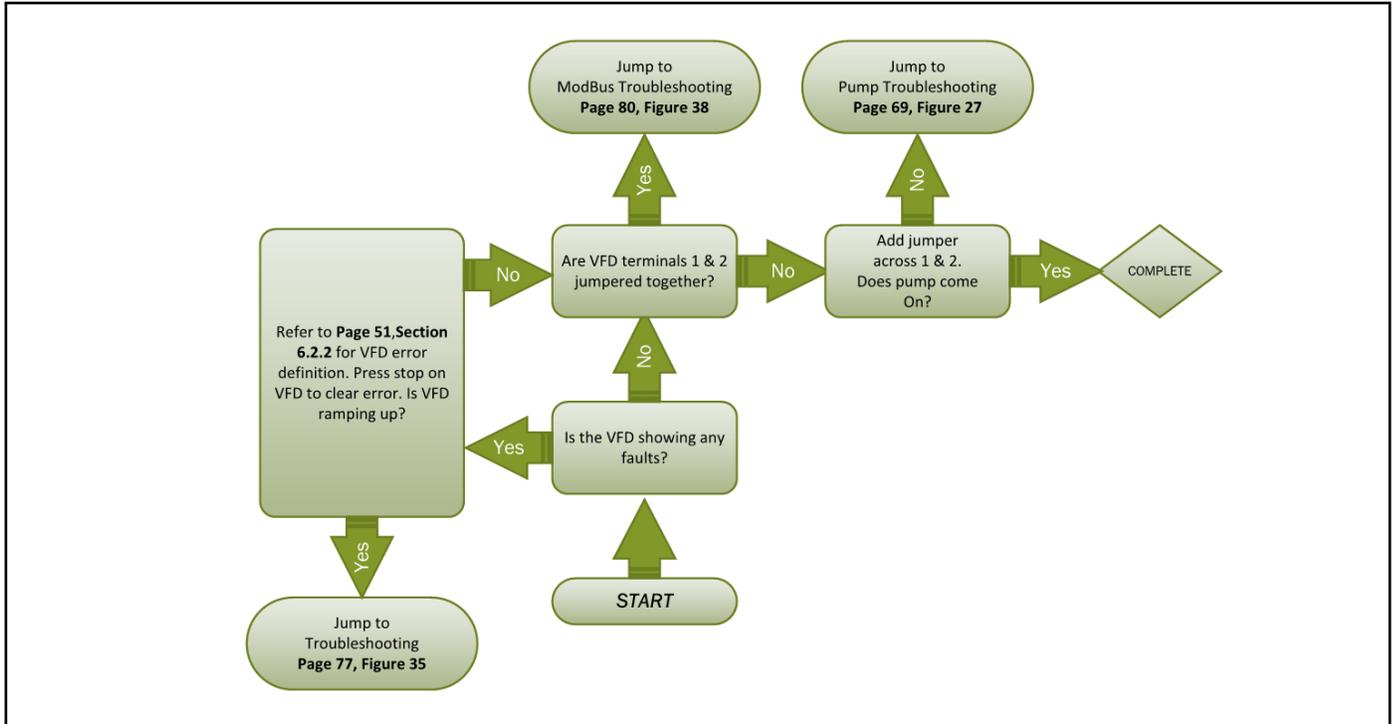


FIGURE 29: VFD input power issue

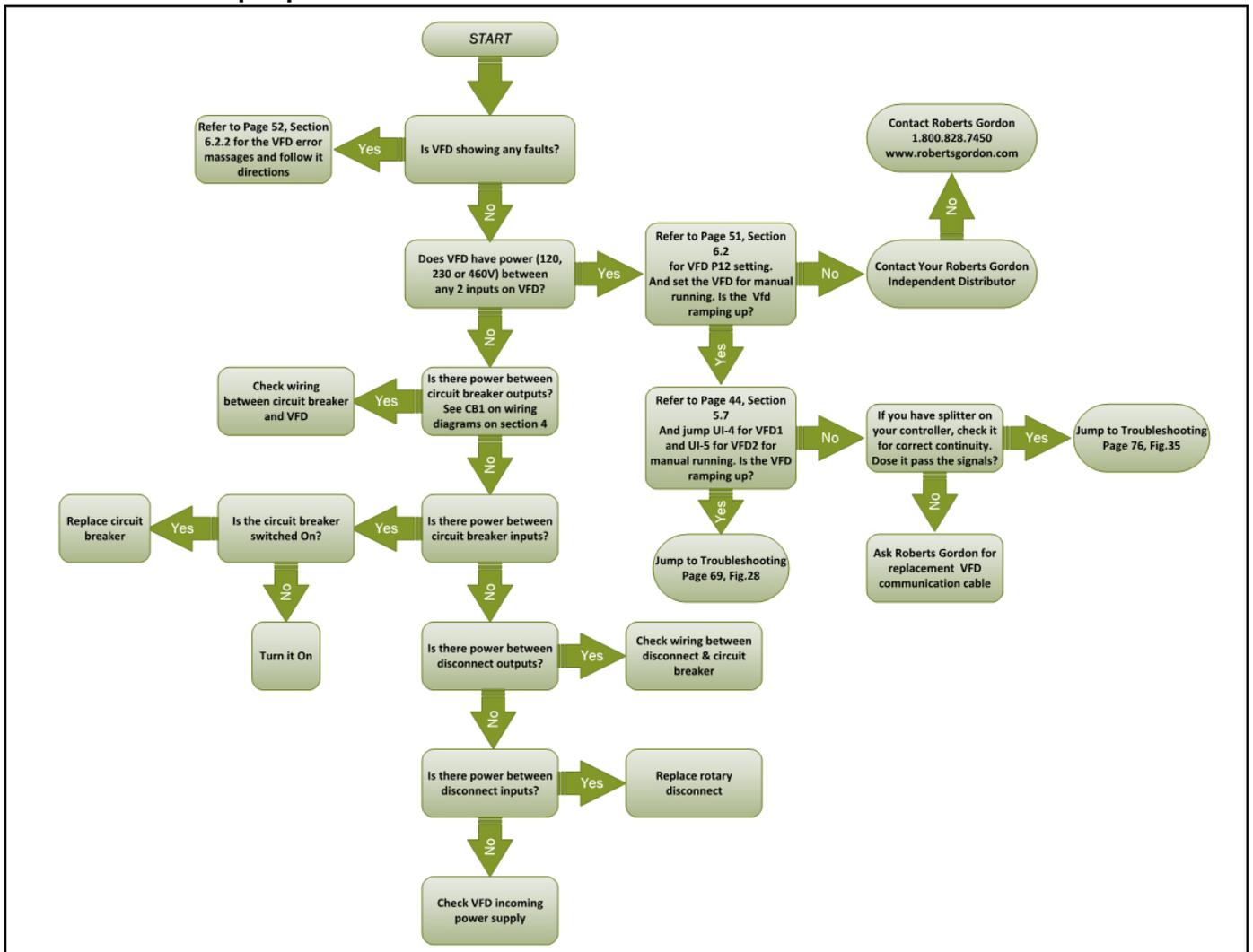


FIGURE 30: Vacuum pump power issue

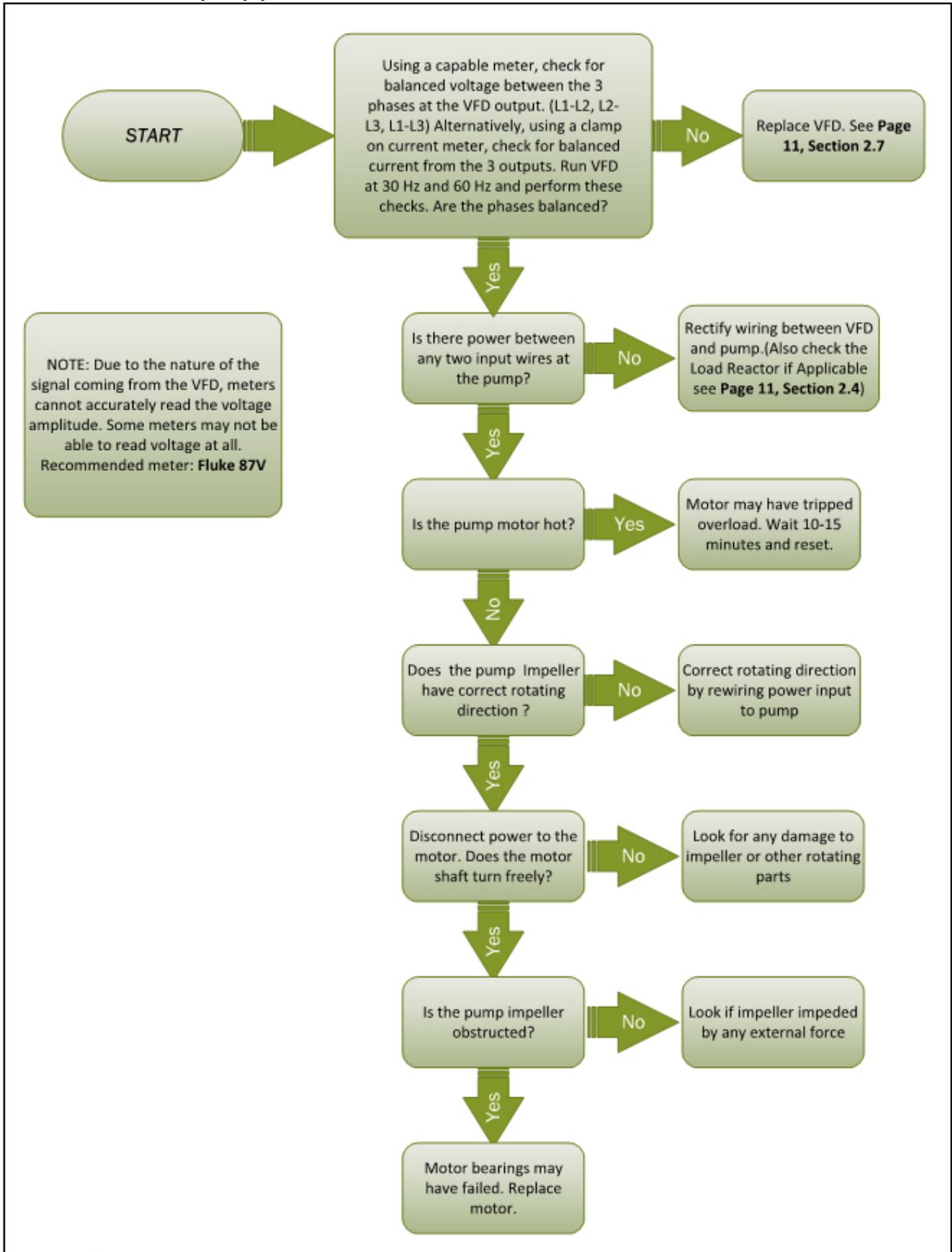


FIGURE 31: Burner troubleshooting in manual mode

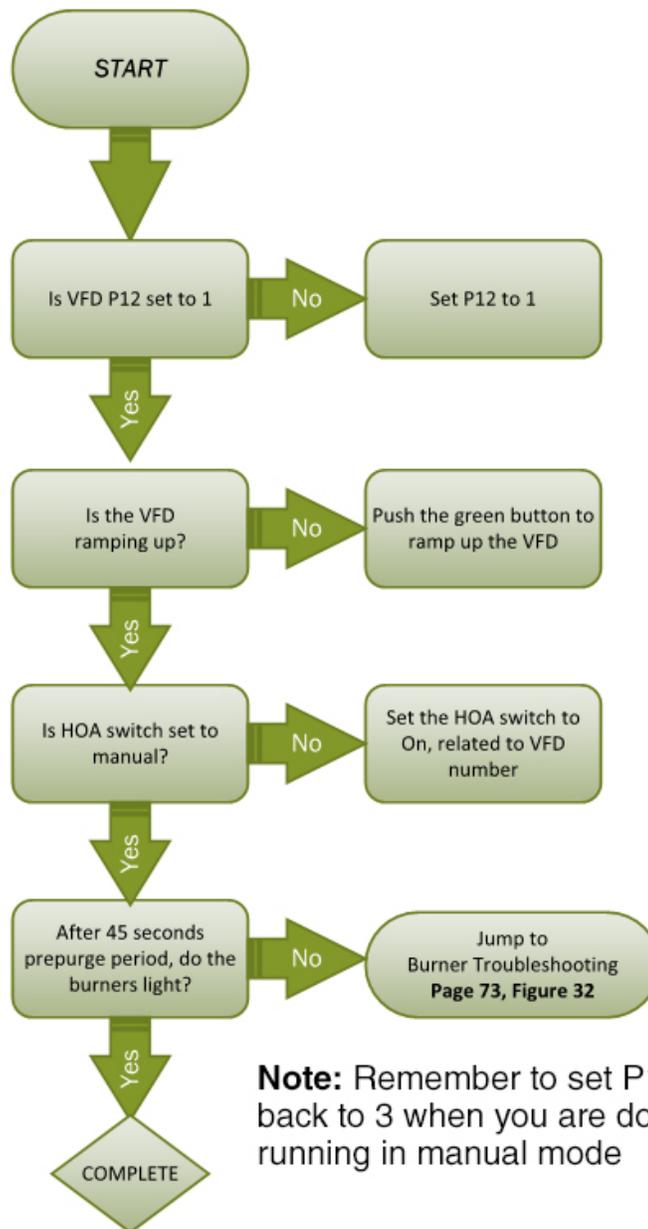
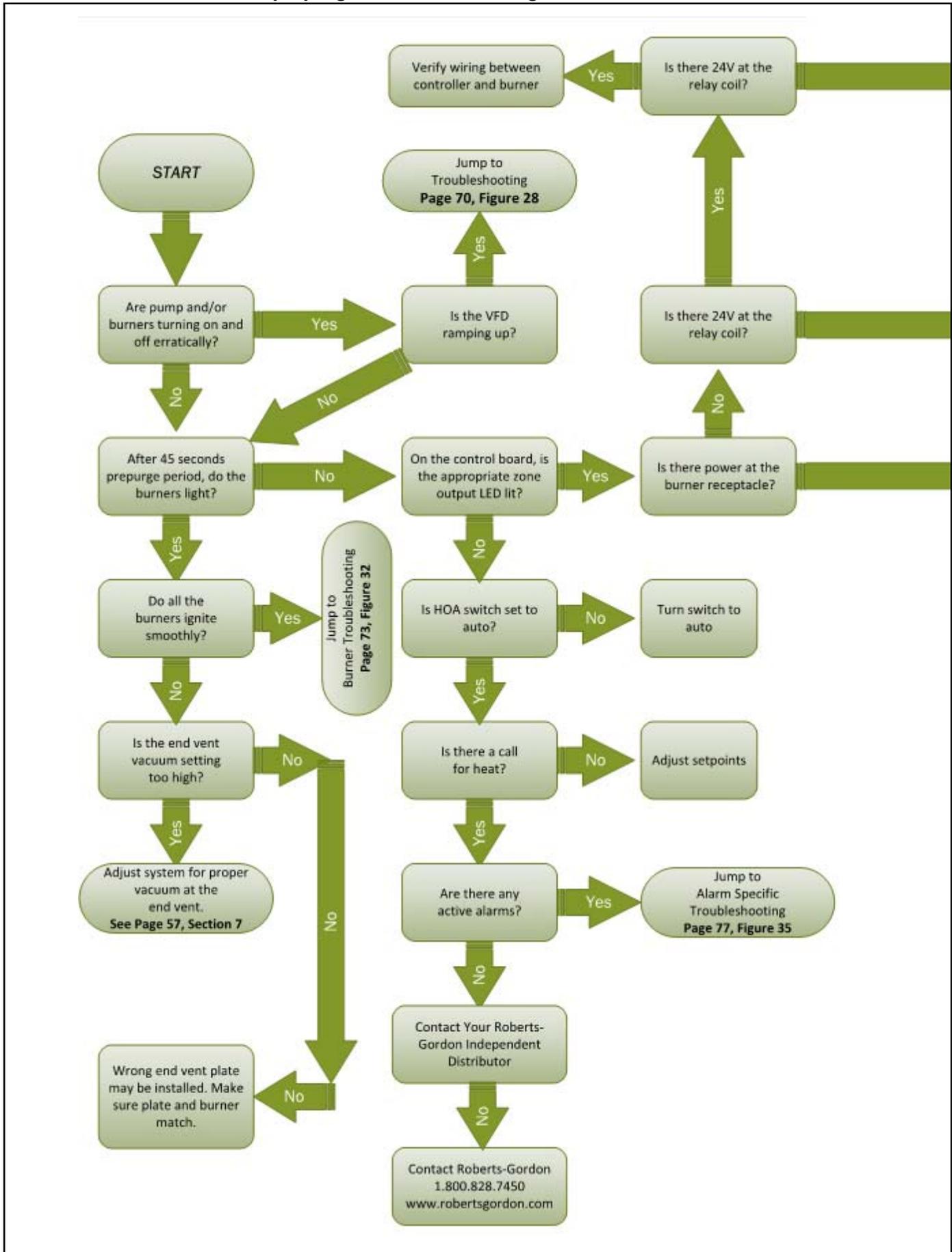


FIGURE 32: After 45 second prepurge, burners do not light



After 45 second prepurge, burners do not light (continued)

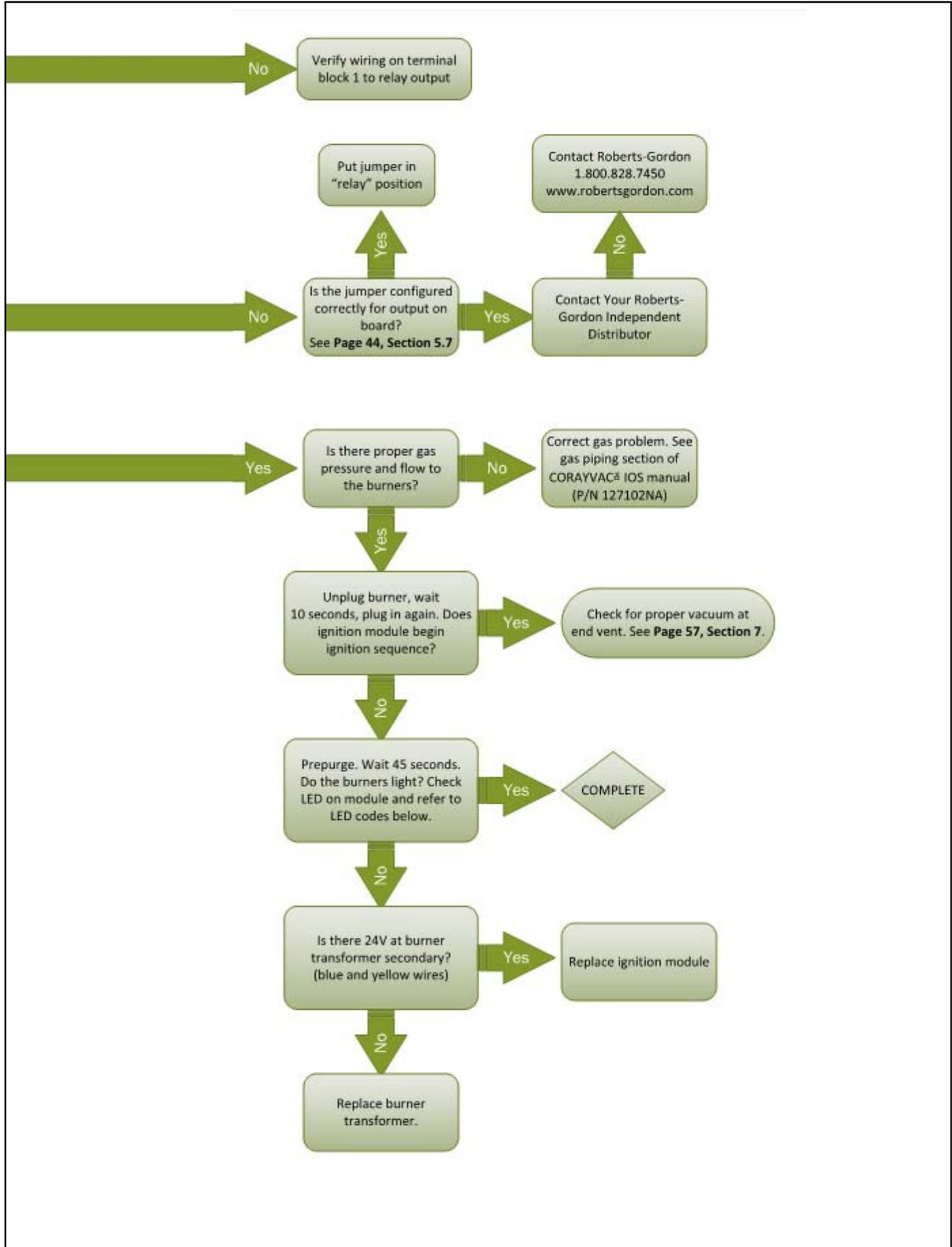


FIGURE 33: Burner intermittent lockout

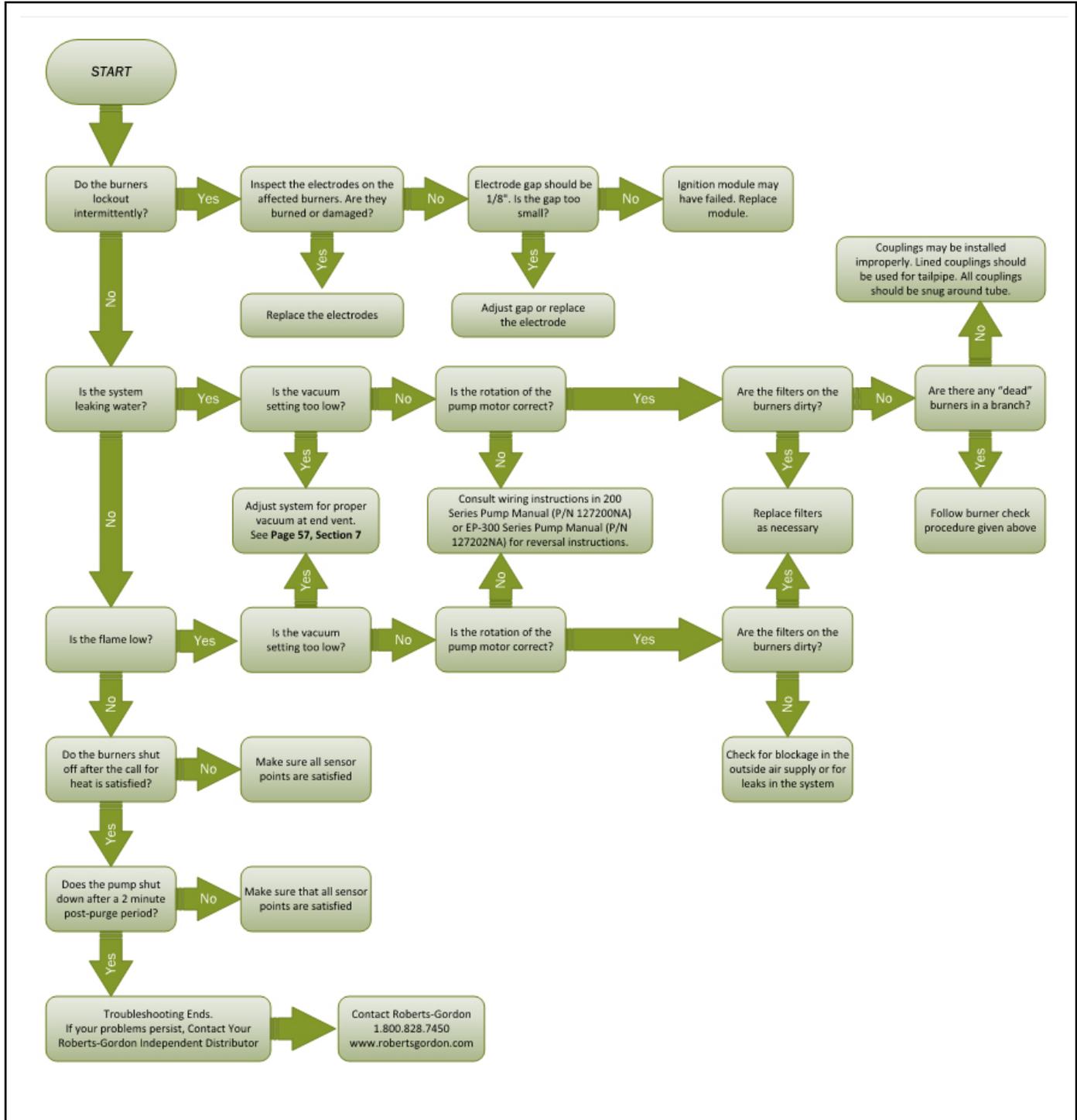


FIGURE 34: APS does not close within 60 seconds after VFD receives run command

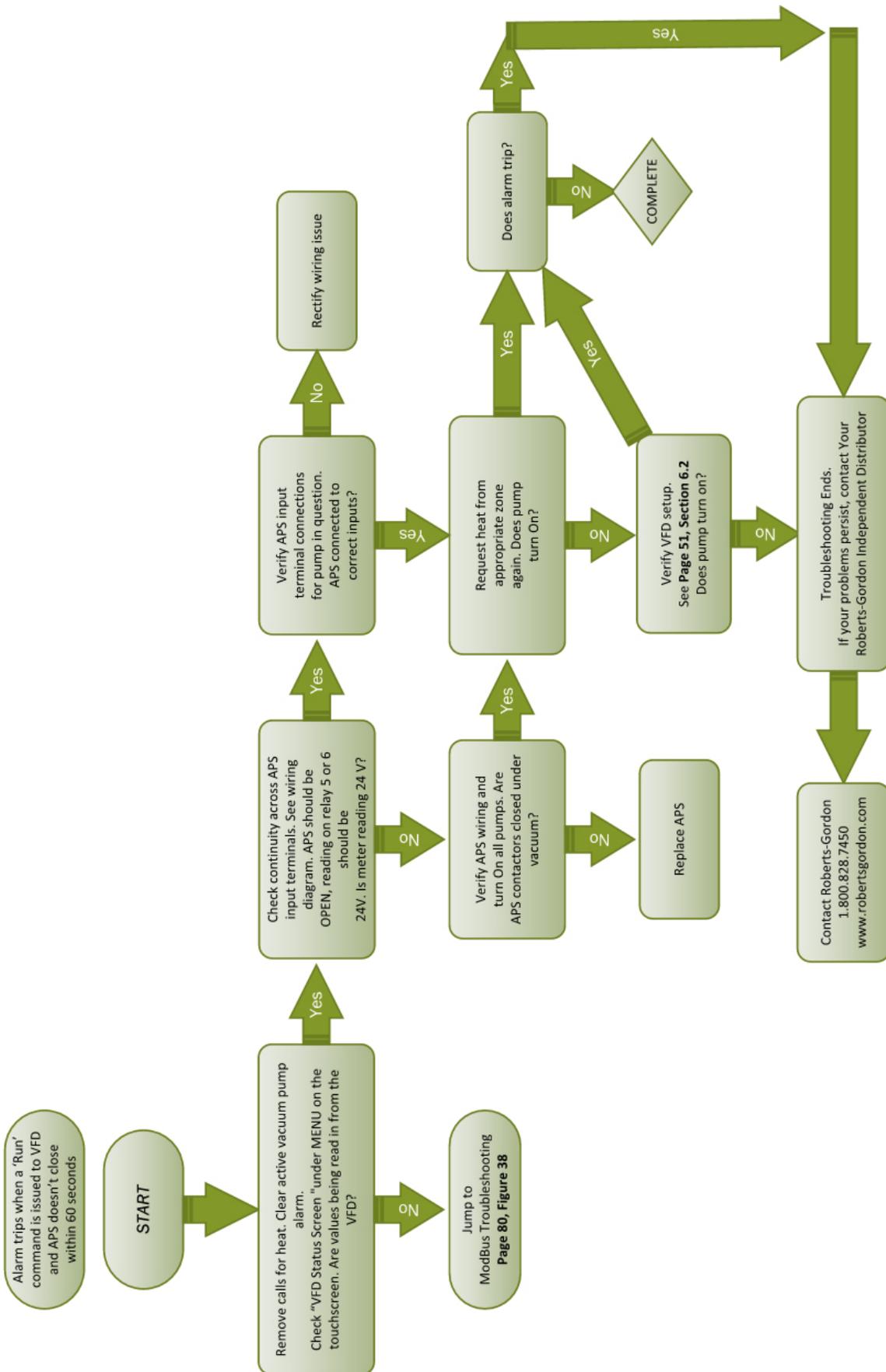


FIGURE 35: Zone sensor issue

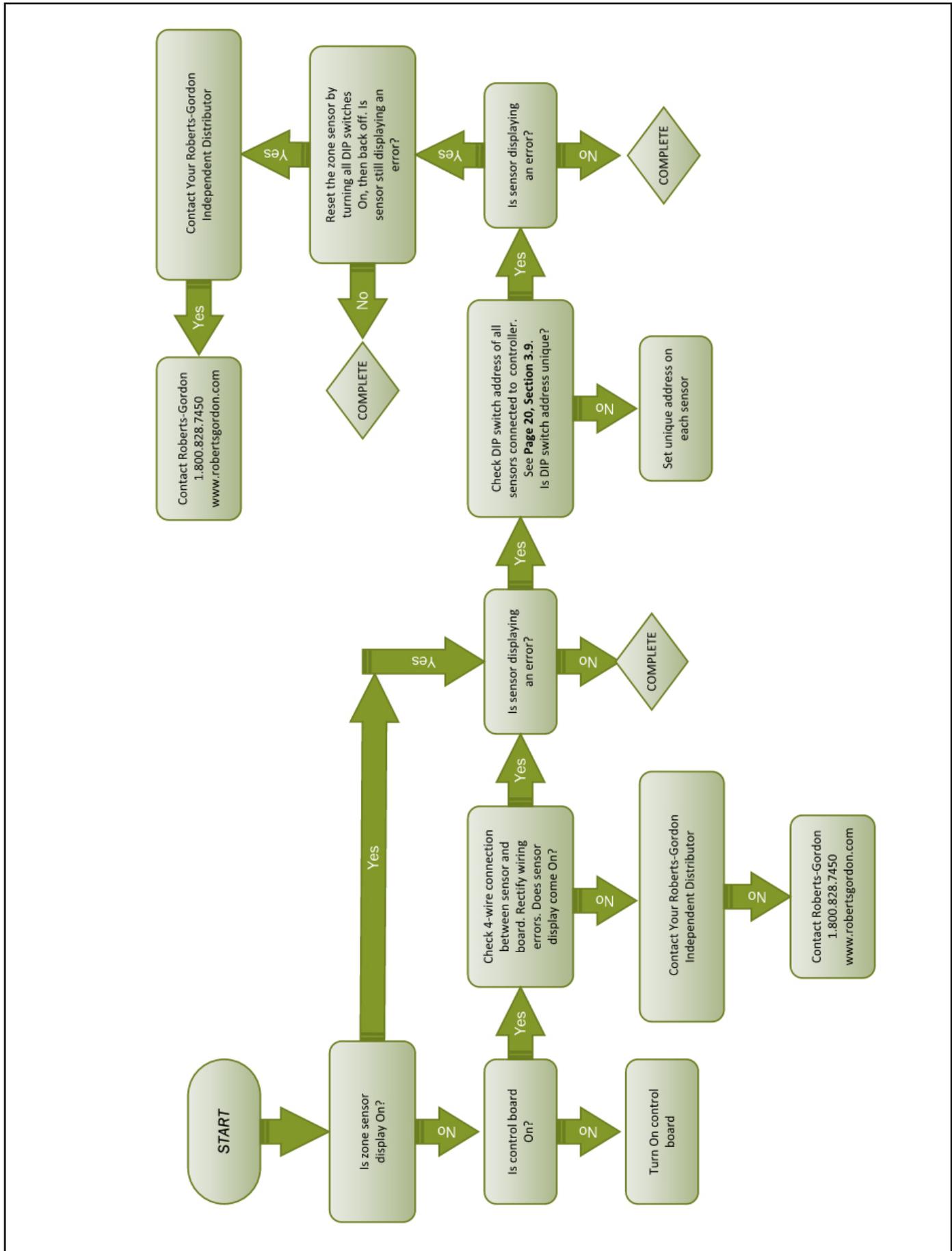


FIGURE 36: Air Pressure Switch alarm

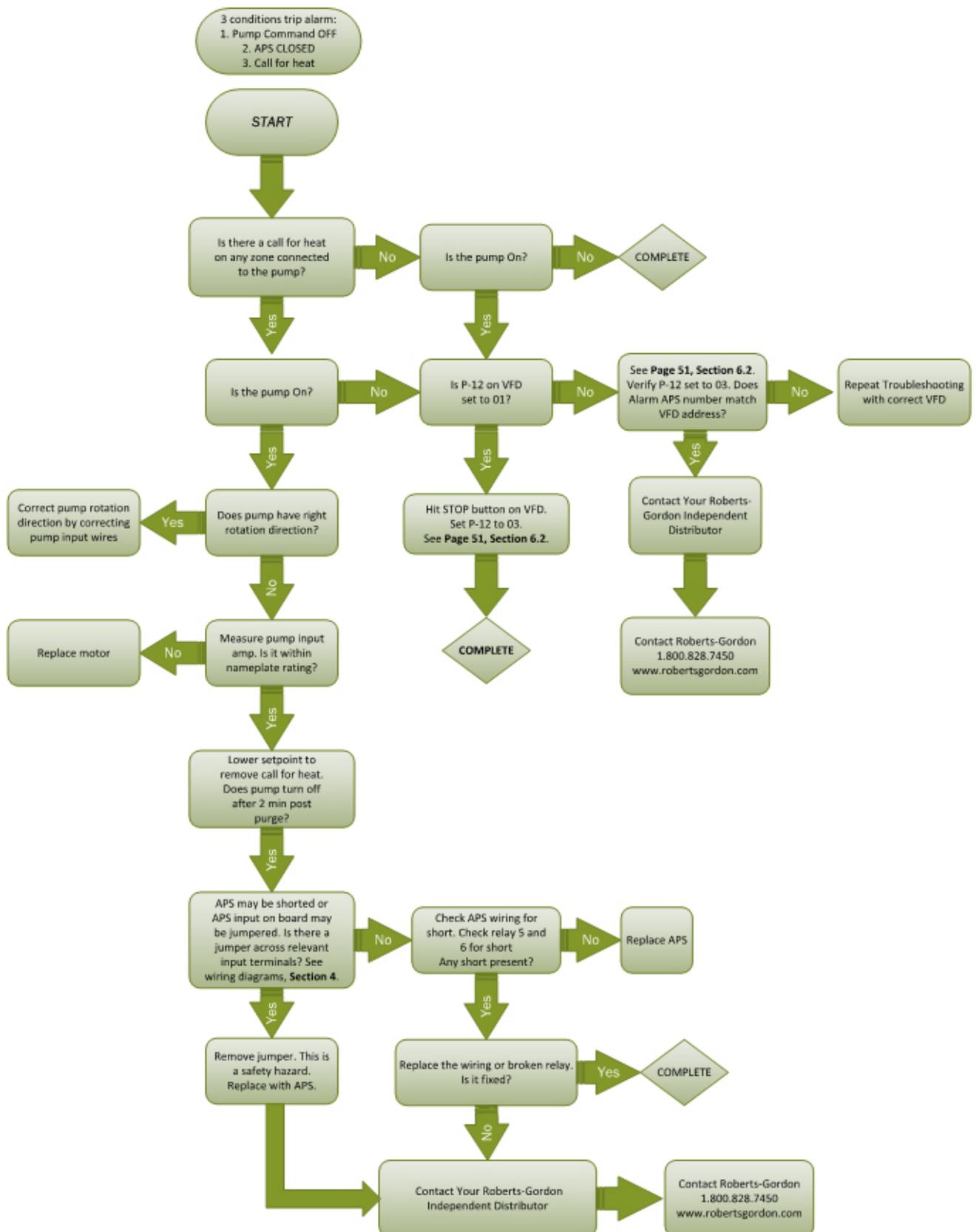


FIGURE 37: Modbus troubleshooting

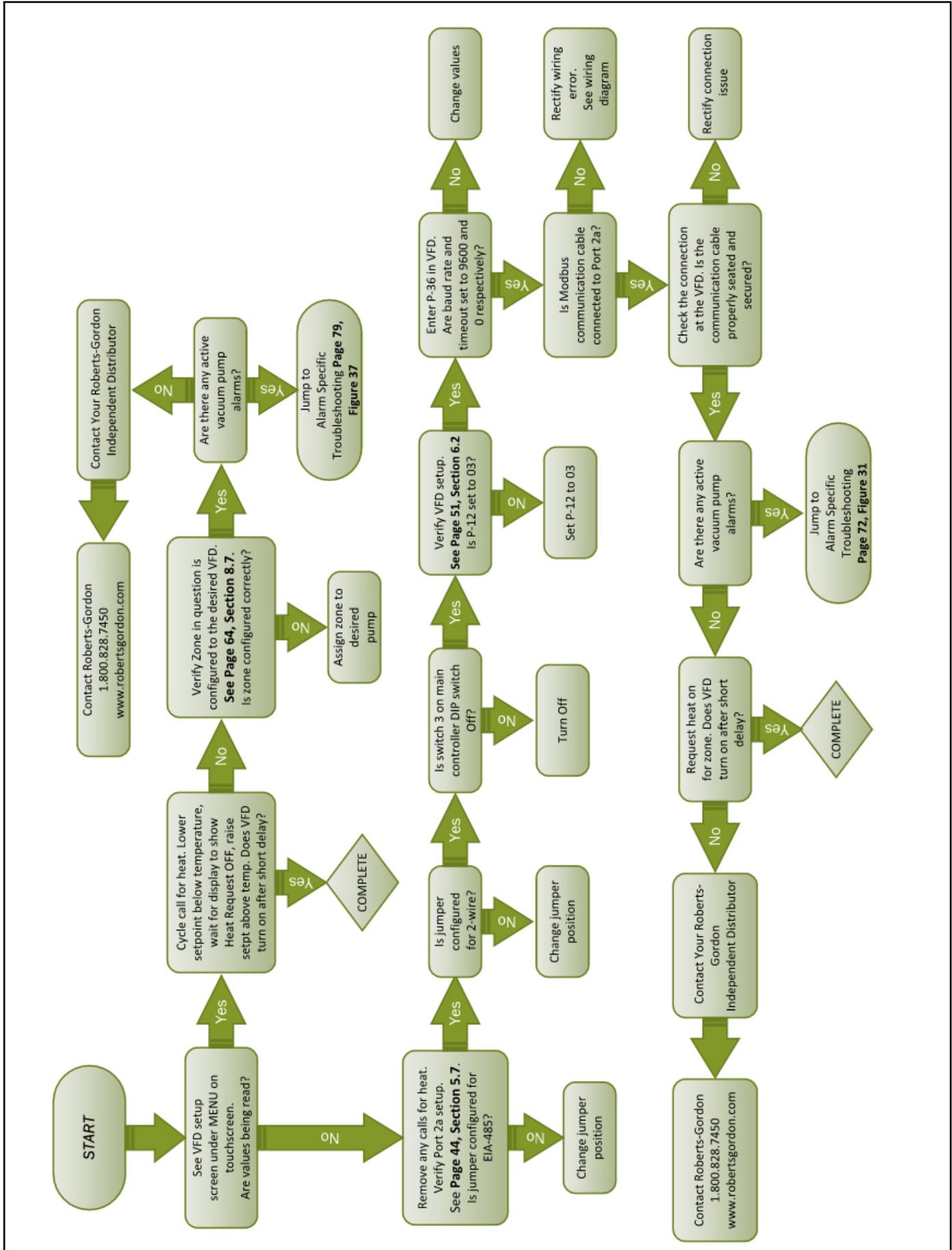


FIGURE 38: Repeater troubleshooting

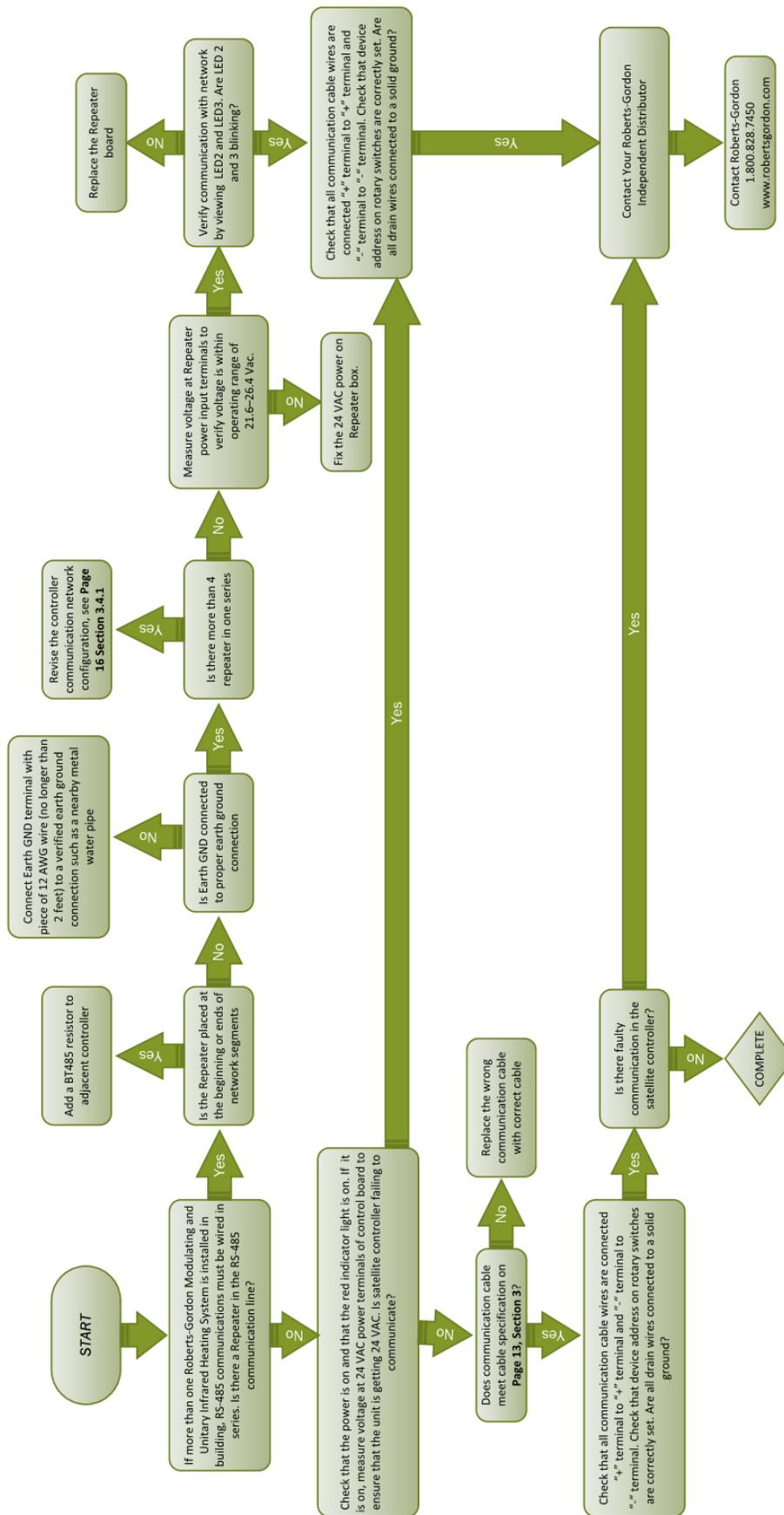
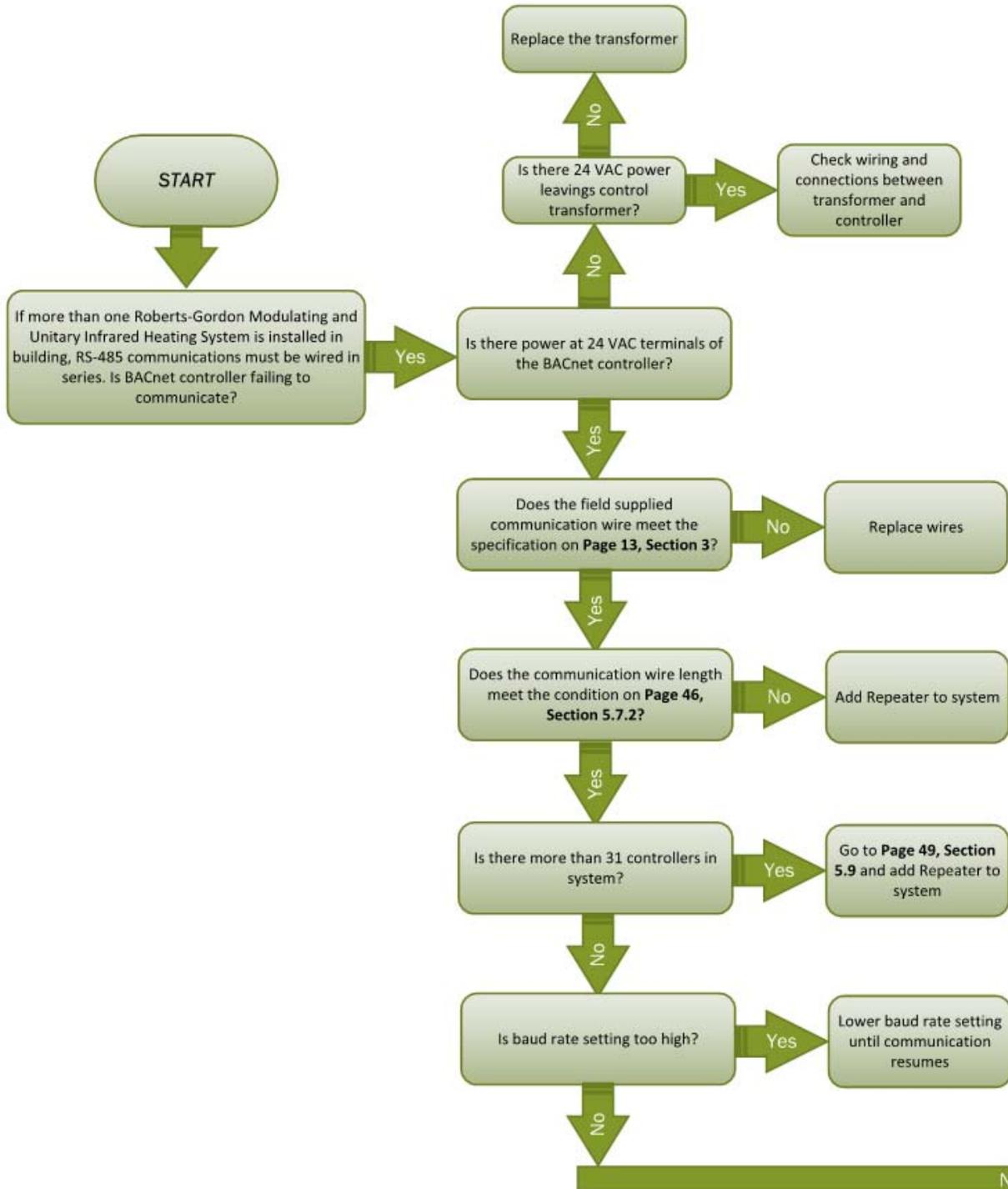


FIGURE 39: BACnet MS/TP troubleshooting



BACnet MS/TP troubleshooting (continued)

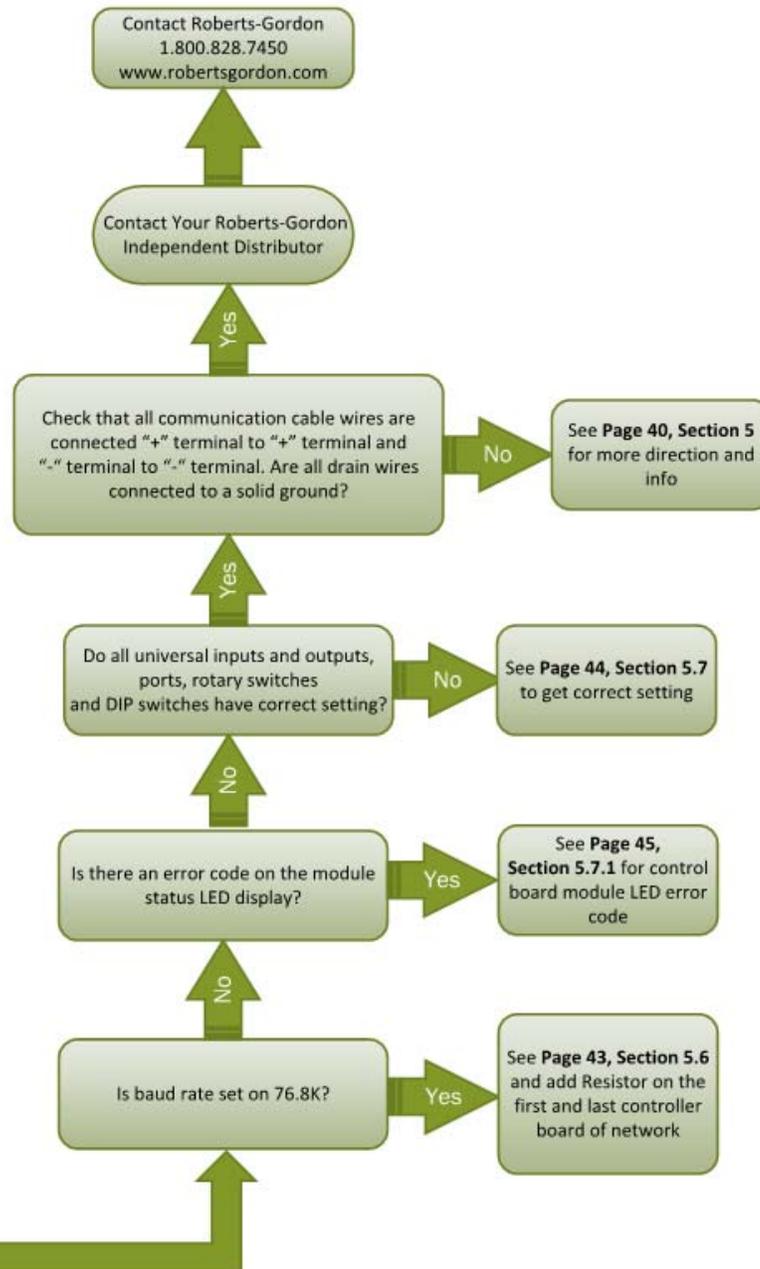
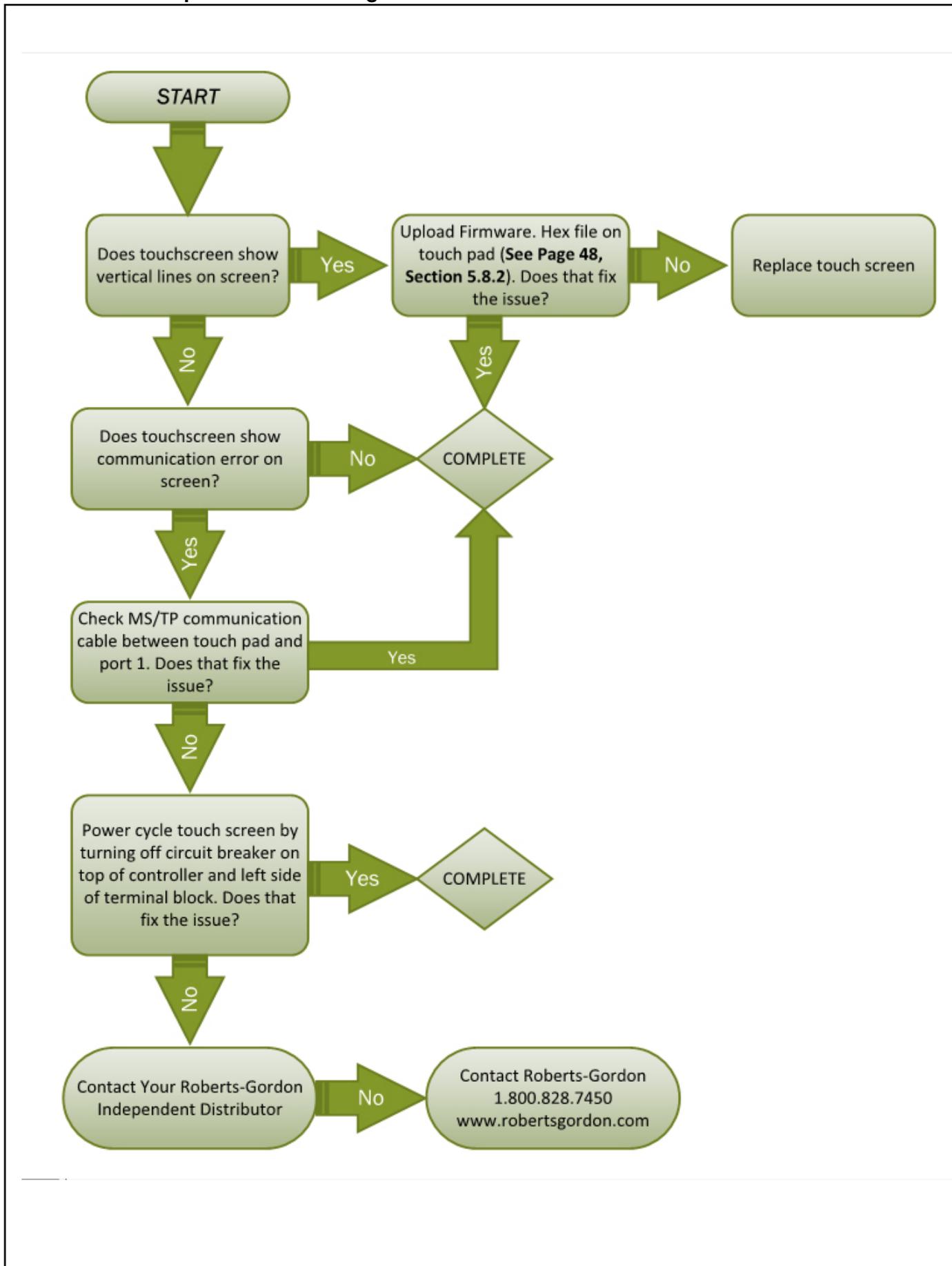


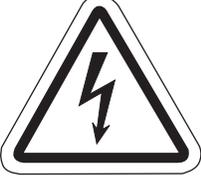
FIGURE 40: Touch pad troubleshooting



SECTION 10: CONTROLS START-UP CHECKLIST

- Mechanical system installed properly
- All utilities hooked up and on
- Power is present at panel(s)
- Panels and pumps grounded properly
- Pump rotation is correct
- All switches are wired back to panel
- Wiring is run according to building layout drawings
- Is the correct communication wire used
- Is the communication wire separate from power wiring
- Load reactor(s) installed, if required
- Repeater(s) installed, if required
- Resistor(s) installed, if required
- Are sensors installed in proper location
- Is OAT sensor installed in proper location
- VFD programmed properly (not manual mode)
- All additionally required BMS hardwire installed
- Controller MAC addresses used are unique
- All dip switches set properly
- Matching touchscreen and dip switch baud rate settings
- Schedule is set
- Design temp setpoints are set
- Is outside air blower set, if required
- Is door option assigned in controller
- Was VFD status on touch screen set correctly
- Were zones configured correctly in touchpad
- Were all zones, controllers and sensors named correctly and properly labeled at each component

SECTION 11: REPLACEMENT PARTS

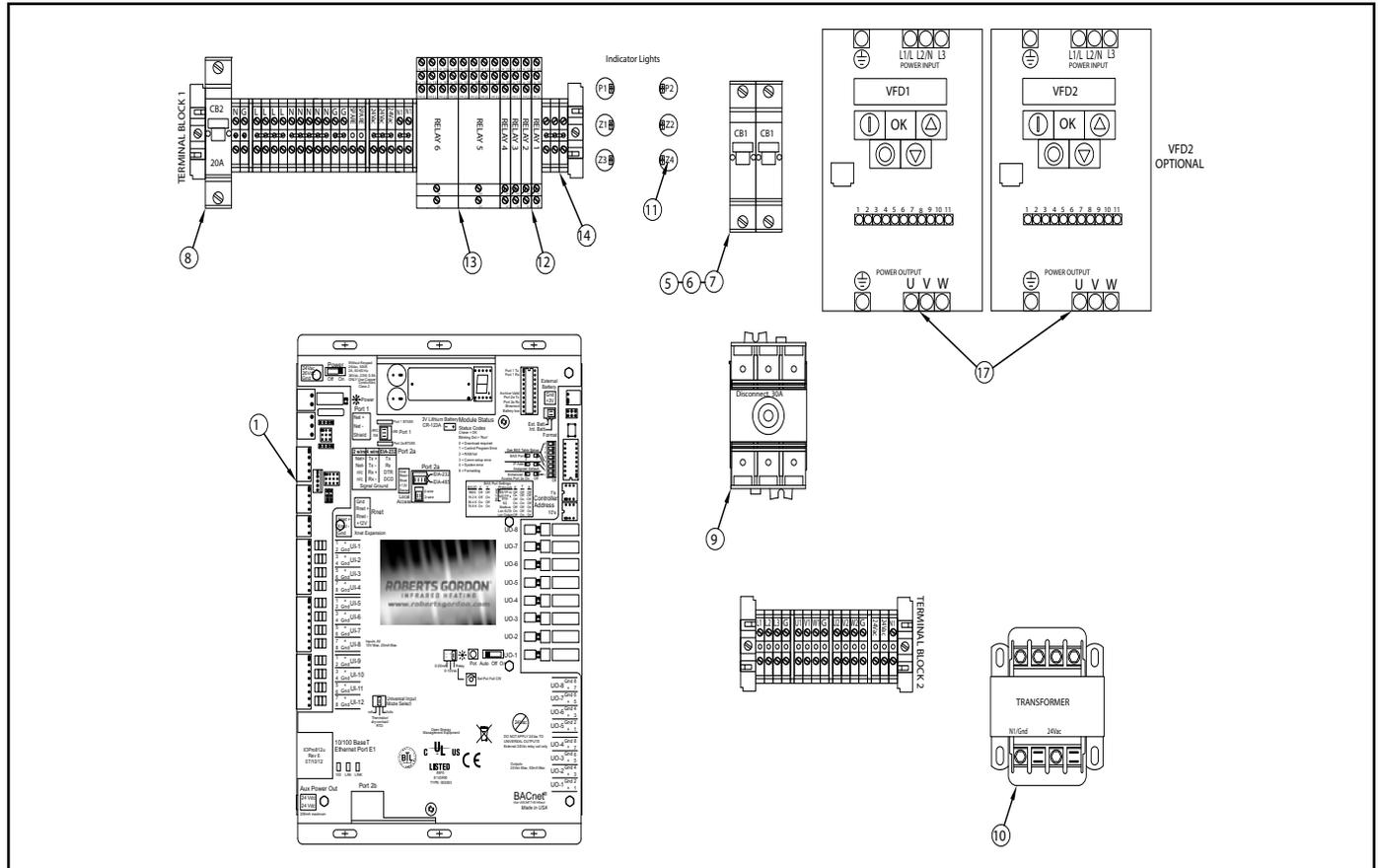
⚠ DANGER	⚠ WARNING		
			
Electrical Shock Hazard	Explosion Hazard	Fire Hazard	Carbon Monoxide Hazard
<p>Use only genuine ROBERTS GORDON® replacement parts per this installation, operation and service manual.</p> <p>Failure to follow these instructions can result in death, electric shock, injury or property damage.</p>			

See warnings and important information before removing or replacing parts. After any maintenance or repair work, always test fire the heater in accordance with the start-up instructions per the heater's current Installation, Operation and Service manual to help ensure all safety systems are in working order, before leaving the heater to operate. Minor faults may be traced by using the troubleshooting charts.

11.1 CORAYVAC® Modulating Heating Control Controller Replacement Parts

Caution: Use only genuine ROBERTS GORDON® replacement parts. Use of parts not specified by Roberts Gordon voids warranty.

FIGURE 41: CORAYVAC® Modulating Heating Control Controller Components

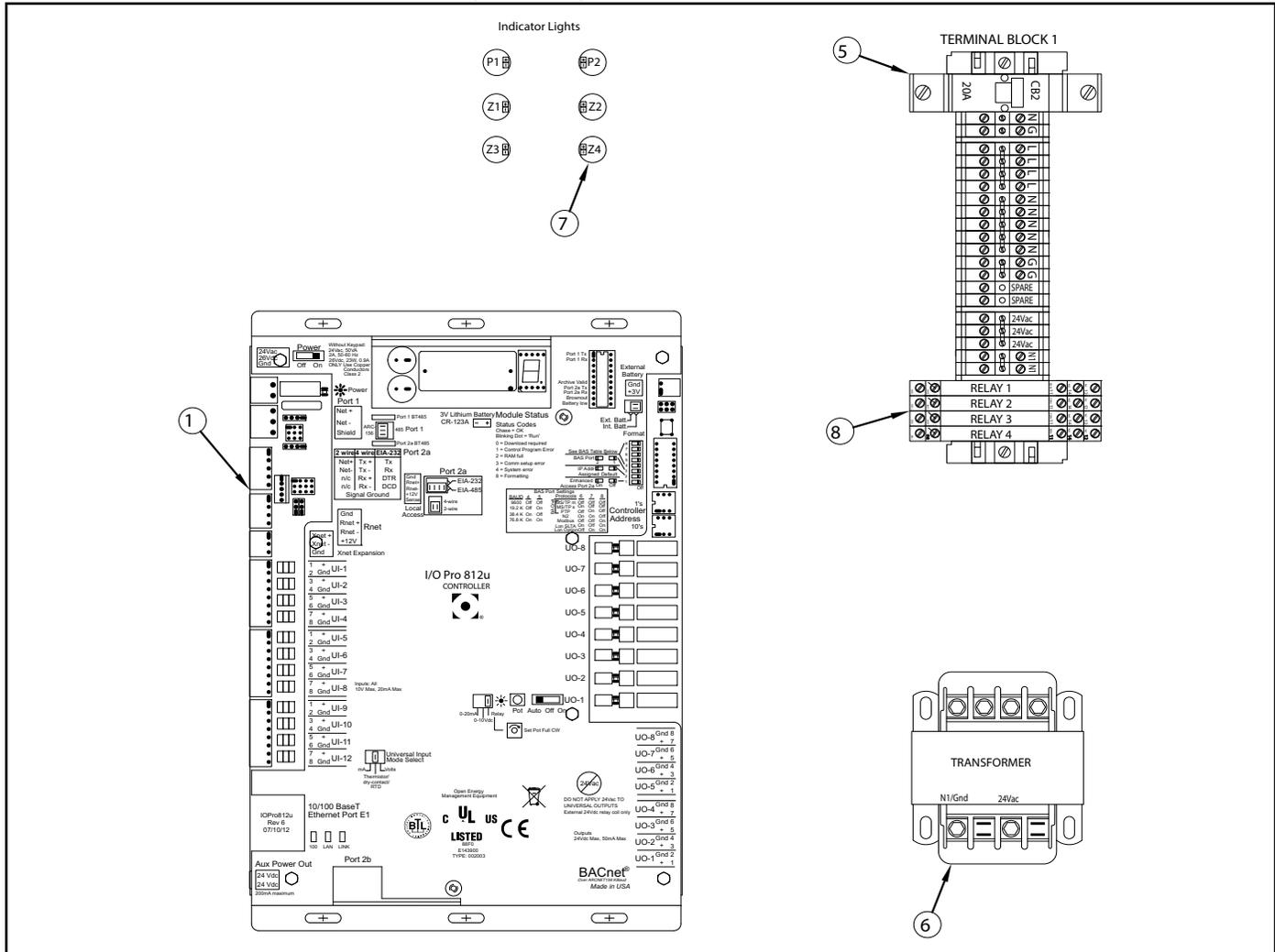


	Description	Part Number
1	I/O Pro 812-U Control Board	10061001
2	Touchscreen (not shown)	10061002
3	Indoor Sensor (not shown)	10061003
4	Outdoor Sensor (not shown)	10081501
5	1 Pole Circuit Breaker	10061004
6	2 Pole Circuit Breaker	10061005
7	3 Pole Circuit Breaker	10061006
8	120v Control Power Circuit Breaker	10061007
9	30 Amp Disconnect Assembly	10061008
10	Transformer 24vac to 120vac	10061009
11	Amber LED Light	10061010
12	SPDT Relay 6A	10061011
13	4PDT Relay 15A	10061014
14	VFD Connection Terminal Block	10060170
15	24" x 24" x 7" Enclosure (not shown)	10061012
16	20" x 16" x 7" Enclosure (not shown)	10061013
17	1HP VFD Input: 115V, 1PH; Output: 230V, 3PH	10061201
	1HP VFD Input: 230V, 1PH; Output: 230V, 3PH	10061202
	2HP VFD Input: 230V, 1PH; Output: 230V, 3PH	10061203
	1HP VFD Input: 460V, 3PH; Output: 460V, 3PH	10061204
	2HP VFD Input: 460V, 3PH; Output: 460V, 3PH	10061205
	1HP VFD Input: 230V, 3PH; Output: 230V, 3PH	10061206
	2HP VFD Input: 230V, 3PH; Output: 230V, 3PH	10061207

11.2 COMPLETE™ Modulating Heating Control Controller Replacement Parts

Caution: Use only genuine ROBERTS GORDON® replacement parts. Use of parts not specified by Roberts-Gordon voids warranty.

FIGURE 42: COMPLETE™ Modulating Heating Control Controller Components



Description	Part Number
1 I/O Pro 812-U Control Board	10061001
2 Touchscreen (not shown)	10061002
3 Indoor Sensor (not shown)	10061003
4 Outdoor Sensor (not shown)	10081501
5 1 Pole Circuit Breaker	10061004
6 Transformer 120Vac to 24 Vac	10061009
7 Amber LED Light	10061010
8 SPDT Relay 6A	10061011

11.4 Replacement Parts Instructions

⚠ DANGER

Electrical Shock Hazard
Disconnect electric before service.
Controller must be properly grounded to an electrical source.
Failure to follow these instructions can result in death or electrical shock.

11.4.1 Plug-In Relay

To replace the plug-in relay, turn off 120 V power to the relay boards. Turn off the 120 V power switch on the relay boards. Locate the malfunctioning relay and pull the relay from its socket. Fit a new relay in the socket. Return 120 V power to the relay board and turn on the 120 V power switch on the relay board. Press the reset button on the control board and close the doors.

11.4.2 Variable Frequency Drive (VFD)

To replace the Variable Frequency Drive, turn off all power to the drive assembly at the disconnect switch. Mark all wires connected to the VFD, noting the terminals to which they are secured. Remove all wires from the VFD terminals. Remove the VFD from its mounting plate by removing the four securing screws. Verify that the input voltage noted on the rating plate of the VFD matches the input voltage of the old VFD. Secure the new VFD to the mounting plate with the four screws. Return all wires to the correct VFD terminals. If possible, it may be easier to partially rewire the new VFD before mounting it to the mounting plate. Close the door and return power to the VFD. Reprogram the VFD's parameters according to *Page 49, Section 6.2*, run the system.

SECTION 12: INTEGRATION WITH BUILDING MANAGEMENT SYSTEM (BMS)

⚠ **DANGER**



Electrical Shock Hazard
Disconnect electric before service.

More than one disconnect switch may be required to disconnect electric to the unit.

Failure to follow these instructions can result in death or electrical shock.

The CORAYVAC® and COMPLETE™ Modulating Heating Controls have built in BACnet/IP connection capabilities to support existing BMS systems. Follow these steps to setup an IP connection to the controllers

Note: Reference touchscreen navigation tree (Page 104, Section 13) to navigate to the referenced screens below.

Note: Changes to DIP switch settings are acknowledged only after power to the control board has been cycled. Turn on/off power to the control board by turning off the circuit breaker located on the terminal strip above the control board.

BMS Integration Object Points List

The object points list is required to integrate to the CORAYVAC® Modulating Heating Control into an existing BMS system to allow for read/write access. Contact Roberts-Gordon or your local ROBERTS GORDON® independent distributor for the list of object points.

12.1 BACnet over ARC156

Important Note

Carefully plan your addressing scheme to avoid duplicating addresses. If third-party devices are integrated into the system, make sure your addresses do not conflict with their addresses.

ARCnet is an embedded networking technology well-suited for real-time control applications in both the industrial and commercial marketplaces. Its robust performance and the availability of low-cost silicone

makes it the network of choice in BAS's. ARC156 is a unique implementation of ARCnet. ARC156 is similar to Master Slave/Token Passing (MS/TP). The main difference between them is speed. ARC156 baud rate is 156 kbps, whereas MS/TP tops out at 76.8 kbps.

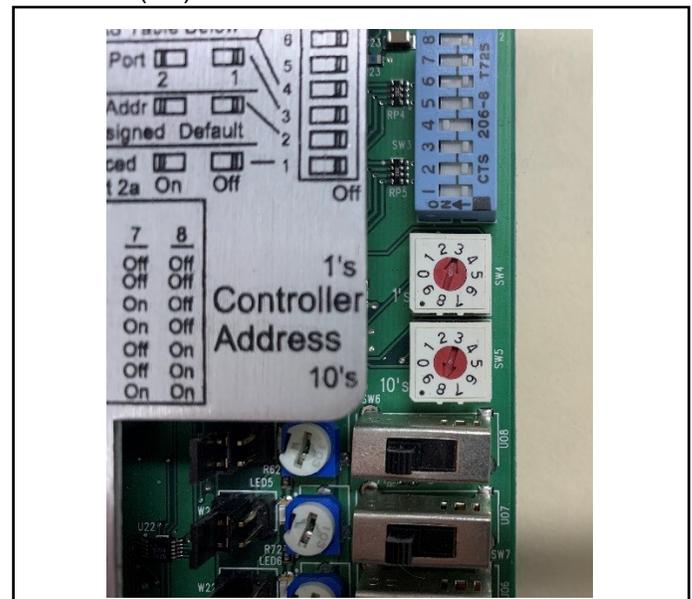
Also, ARC156 uses a separate communication co-processor to handle the network traffic and a separate processor to handle the program execution. This provides faster processing of applications and handling of communications on the network.

ARC156 is the standard communications method used by our controllers.

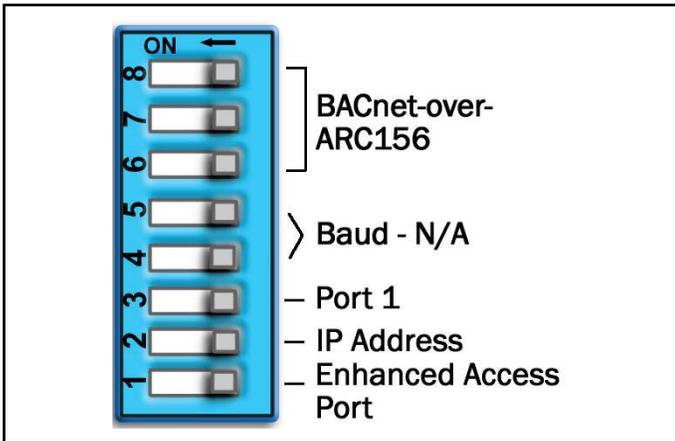
To set up the Modulating Controller for ARC156

1. Turn off power to control board.
2. Using the rotary switches, set the controller's address. Set the Tens (10's) switch to the tens digit of the address and set the Ones (1's) switch to the ones digit.

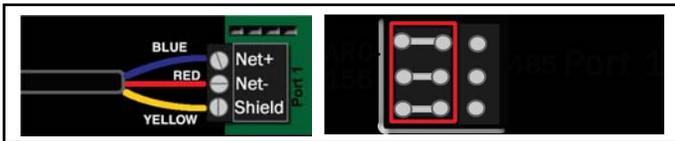
EXAMPLE If the controller's address is 38, point the arrow on the Tens (10's) switch to 3 and the arrow on the Ones (1's) switch to 8.



3. Set all of the DIP Switches 1 - 8 to OFF, see image below.



4. Port 1 on the I/O Pro 812u control board is the only port that supports BACnet over ARC 156. Connect BACnet over ARC 156 communications wiring to Port 1 in the screw terminals labeled Net +, Net - and Gnd. Set Port 1 Mode jumper to ARC 156.



Wiring Specifications

The I/O Pro 812u (control board) network can consist of multiple network segments. Each segment of an I/O Pro 812u network must:

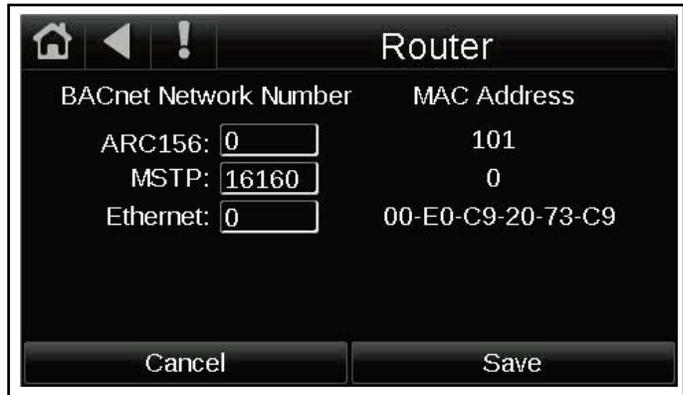
- Be wired in a daisy-chain configuration
- Be no longer than 2000' (610 m)
- Have 32 or fewer devices (controllers and repeaters)

It is required to have one of the following:

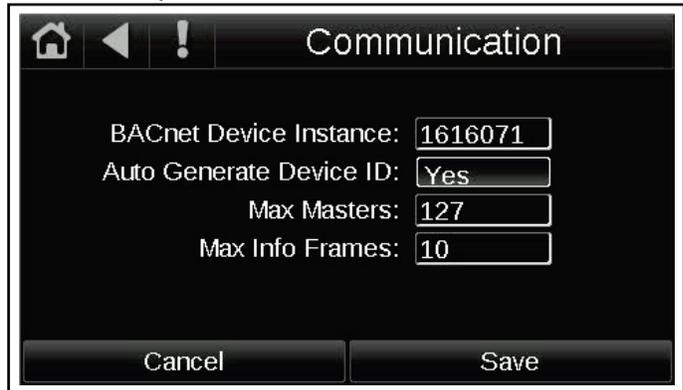
- A repeater (P/N 10060156) at each end (unless the segment is less than 10' [3 m] long) to add bias and prevent signal distortions due to echoing.
- A 1/2 watt, 120 Ohm resistor at each end to prevent signal distortions due to echoing and one DIAG485 near the center of the network segment to add bias. You must put the DIAG485's **Bias** jumper in place.

5. Turn on power to control board.

6. Set the correct network number to the unique BACnet ARC156 network at the site.



7. Set a unique Device Instance number.



The most common communication problems result from not properly following the configuration steps outlined above. Review all steps and use the following list to check your settings. Verify accuracy of the following:

Hardware settings

- ARC156 protocol DIP switches 6, 7, and 8 off.
- Proper connection wiring.
- Unique rotary address switches 1 – 99. If controllers have duplicate addresses, network communication can be lost.
- Unique BACnet Device Instance numbers. Default is 24XX, with the rotary address switches defining XX. If controllers have duplicate device instance numbers, network communication can be lost.
- The controller recognizes physical changes (DIP switches, rotary switches, and jumpers) upon power up.
- If RX LED is solid, then the terminations are incorrect.
- If the network has greater than 32 devices or exceeds 2000' (610 m) a Repeater should be installed.
- If a controller begins or ends a network segment, a terminating resistor (P/N 10061018) may be needed.

12.2 BACnet MS/TP

BACnet MS/TP is a token passing protocol. MS stands for Master-Slave and the TP stands for Token Passing. Each controller on the network has the ability to hear the broadcast of any other device on the network.

The speed of an MS/TP network ranges from 9600 bps to 76.8 kbps. There are two different ways to connect I/O Pro 812u to BACnet MS/TP.

12.2.1 To set up the Modulating Controller for BACnet MS/TP on Port 1

1. Turn off power to control board.
2. Using the rotary switches, set the controller's address. See Page 40, Section 5.4.
3. Set the Dip switches 4 and 5 for the proper communication speed. (baud rate).
4. Set the DIP switch number 3 off.
5. Set the DIP switches number 6, 7 and 8 off.
6. Connect the communication cable to Port 1, (be careful for polarity).
7. Set the Port 1, jumper to 485 setting.

Note

- A dedicated 24 AWG to 18 AWG twisted pair wire (EIA-485)
- 2000' (610 m) for 76.8 kbps
- 3000' (914.4 m) for 9600 bps, 19.2 or 38.4 kbps, before needing a Repeater
- Devices should be daisy chained and not star wired
- If the controller is at either end of a network segment, connect a BT485 Terminating Resistor (P/N 10061018) to the I/O Pro 812u.
- Use the same polarity throughout the network segment.

8. Turn on power to control board.
9. Set the correct network number to the unique

BACnet MS/TP network on the touch screen.

Router	
BACnet Network Number	MAC Address
ARC156: 0	101
MSTP: 16160	0
Ethernet: 0	00-E0-C9-20-73-C9
Cancel	Save

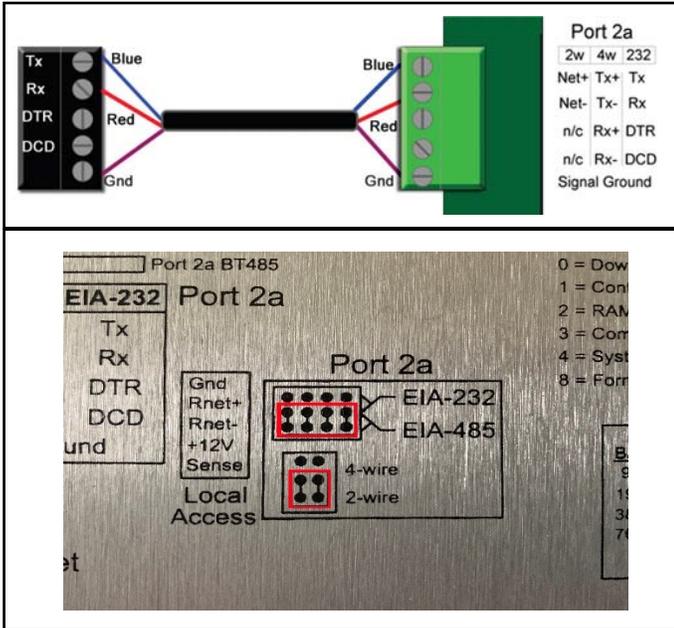
10. Set the unique BACnet Device Instance number on touch screen.

Communication	
BACnet Device Instance:	1616071
Auto Generate Device ID:	Yes
Max Masters:	127
Max Info Frames:	10
Cancel	Save

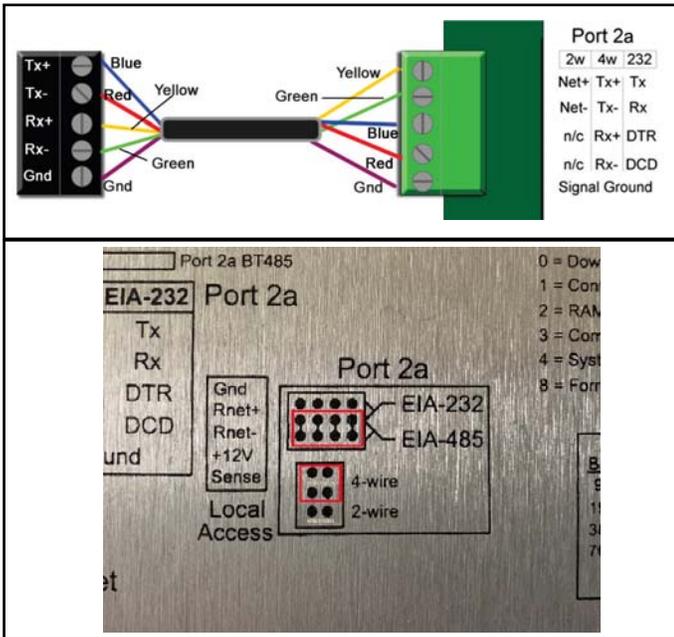
12.2.2 To set up the Modulating Controller for BACnet MS/TP on Port 2a

1. Turn off power to control board.
2. Using the rotary switches, set the controller's address. See Page 36, Figure 19.
3. Set the Dip switches 4 and 5 for the proper communication speed (baud rate).
4. Set the DIP switch number 3 on for port 2a.
5. Set the DIP switches number 6, 7 and 8 off.
6. Connect the communication cable to Port 2a, (be careful about Polarity).

• Terminal connection for ELA-485 2 wire



• Terminal connection for ELA-485 4 wire

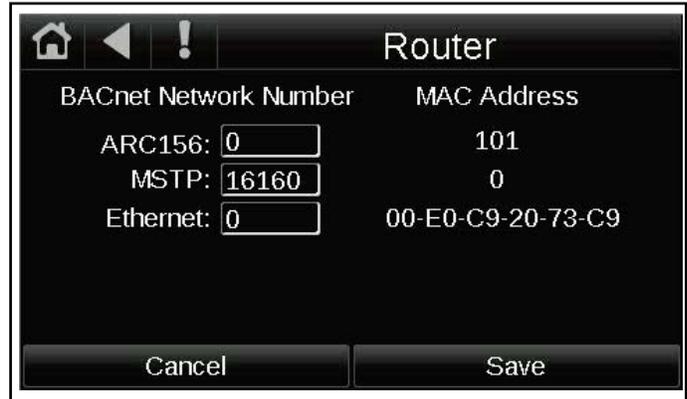


Wiring specifications

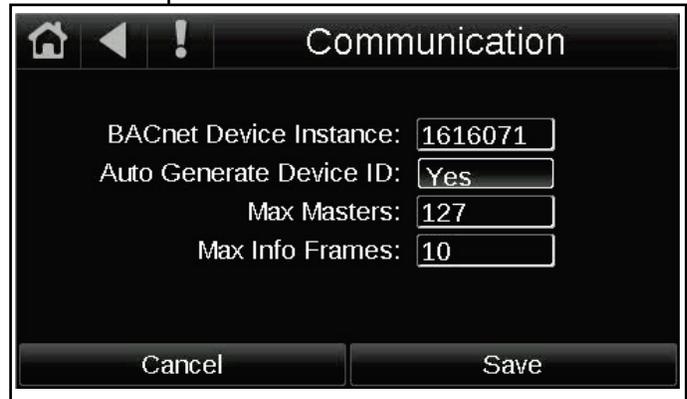
- A dedicated 24 AWG to 18 AWG twisted pair wire (EIA-485)
- 2000' (610 m) for 76.8 kbps
- 3000' (914.4 m) for 9600 bps, 19.2 or 38.4 kbps, before needing a Repeater
- Devices should be daisy chained.
- If the controller is at either end of a network segment, connect a Terminating Resistor (P/N 10061018) to the I/O Pro 812u control board.

Note: Use the same polarity throughout the network segment.

7. Turn on power to control board.
8. Set the correct network number to the unique BACnet MS/TP network at the touch screen.



9. Set a unique Device Instance number.



NOTE:

The most common communication problems are the result of not properly following the configuration steps outlined. Review steps and use the following list to check your settings.

Verify accuracy of the following:

Hardware settings for speaking BACnet MS/TP:

- Baud rate DIP switches 4 and 5
- Protocol DIP switches 6, 7, and 8 jumpers set to half duplex (2-wire) and EIA-485
- Proper connection wiring
- Unique rotary address switches 1 – 99. If controllers have duplicate addresses, network communication can be lost.
- Unique BACnet Device Instance numbers. Default is 24XX, with the rotary address switches defining XX. If controllers have duplicate device instance numbers, network communication can be lost.

NOTE:

- The controller recognizes physical changes (DIP switches, rotary switches, and jumpers) upon power up.

- If RX LED is solid, then the terminations are incorrect.
- If the network has greater than 32 devices or exceeds 2000' (610 m) a Repeater should be installed.
- If a controller begins or ends a network segment, a terminating resistor may be needed.

12.3 BACnet PTP

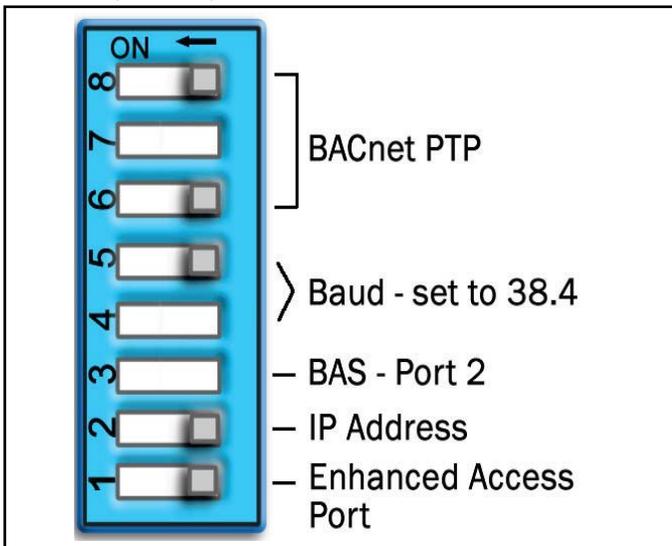
PTP is used to connect 2 distinct BACnet networks so that information can be shared between the networks. PTP uses an EIA-232 connection between 2 BACnet half-routers. This connection allows for 2 different BACnet networks to speak to each other, even at different baud rates.

To set up the Modulating Controller for BACnet PTP

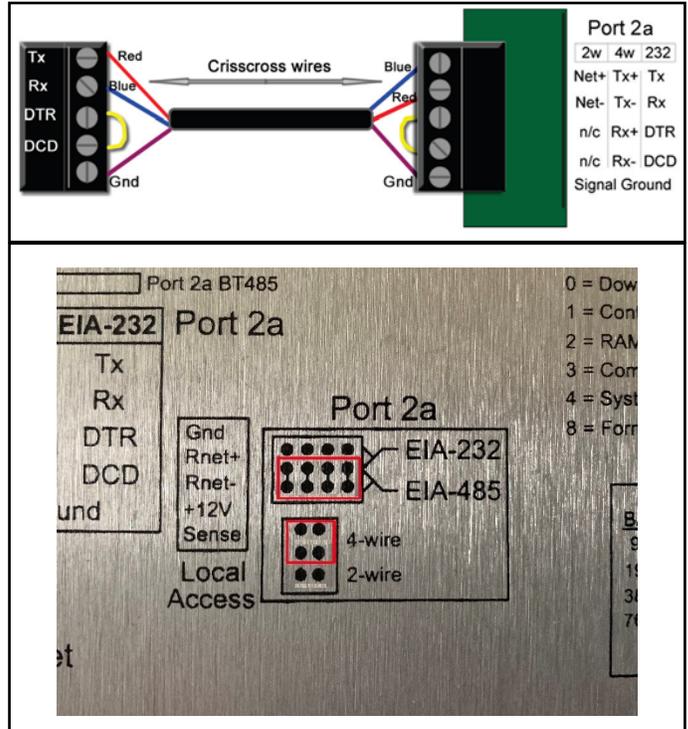
1. Turn off power to control board.
2. Using the rotary switches, set the controller's address. Set the Tens (10's) switch to the tens digit of the address and set the Ones (1's) switch to the ones digit. See Page 36, Figure 19.
3. Set the Selector DIP Switches 4 and 5 for the appropriate communications speed (9600, 19.2k, 38.4k, or 76.8k bps).
4. Set Comm Selector DIP Switch 3 to ON for Port 2.

Note: Comm Selector DIP Switch 4 (Port 1) will be set by the manufacturer.

5. Set the DIP Switch Selector 6-8 for BACnet PTP. The following example shows the DIP Switches set for 38.4k, Port 2, and BACnet PTP.



6. Connect the communications wiring to Port 2a.



Wire Specifications

- 18–28 AWG; twisted pair preferable
- 50' (15.24 m) maximum length

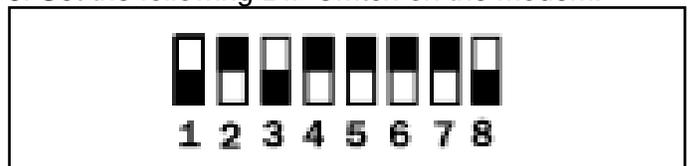
For more wire specifications See Section 6.

Note: Do not power the device from the same transformer that powers controller.

7. See table below to wire control board to a modem.

Modem (25-pin) Null Modem Cable	Null Modem Cable (9-pin)	S2-DB9 (9-pin)	Device (5 pin)
TX - pin 2	TX - pin 3	TX - pin 3	TX - pin 1
RX - pin 3	RX - pin 2	RX - pin 2	RX - pin 2
DTR - pin 20	DTR - pin 4	DTR - pin 4	DTR - pin 3
DCD - pin 8	DCD - pin 1	DCD - pin 1	DCD - pin 4
GND - pin 7	GND - pin 5	GND - pin 5	GND - pin 5

8. Set the following DIP switch on the modem.



Note: US Robotics External Modem is highly recommended.

9. Set the following DIP switch on the modem
10. Turn on power to the control board.

Note: The most common communication problems are the result of not properly following the configuration steps outlined in this manual. Review all the steps and use the following list to check your settings.

Verify accuracy of the following:

Hardware settings for speaking BACnet PTP

- Baud rate DIP switches 4 and 5
- Protocol DIP switches 6, 7, and 8 Jumper set to EIA-232
- Proper connection wiring
- Unique rotary address switches 1 – 99. If controllers have duplicate addresses, network communication can be lost.
- Unique BACnet Device Instance numbers. Default is 24XX, with the rotary address switches defining XX. If controllers have duplicate device instance numbers, network communication can be lost.
- Do not power the PTP-speaking device from the same transformer that powers the I/O Pro 812u.
- If RX LED is solid, then the terminations are incorrect.
- The controller recognizes physical changes (DIP switches, rotary switches, and jumpers) upon power up.

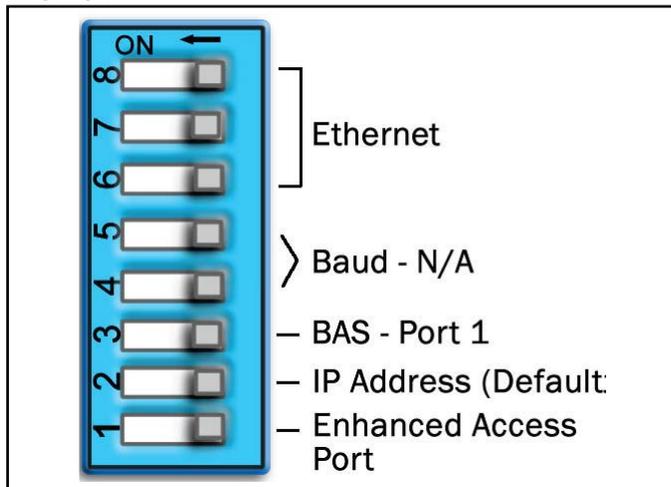
12.4 BACnet Over IP

This is used for tunneling BACnet packets inside of IP (Internet Protocol) packets for carrying BACnet messages over wide-area networks and the Internet. This network layer offers the fastest speed and allows for communication of BACnet on the highest network layer. Although the speed is very fast, there is a lot of overhead required in this kind of network topology. Overhead refers to information inside the data packet/message being passed over the network, requiring expensive high-speed computing processors.

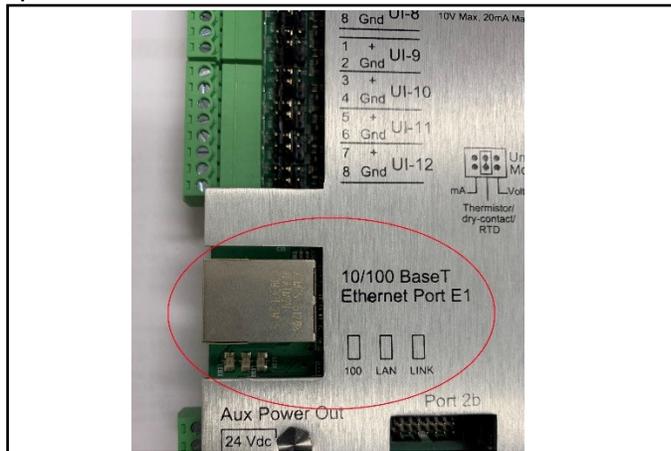
To set up the Modulating Controller for BACnet over IP (default IP)

1. Turn off power to control board.
2. Using the rotary switches, set the controller's address.
3. Set the Tens (10's) switch to the tens digit of the address and set the Ones (1's) switch to the ones digit. See Page 36, Figure 19.

Note: The default address is an intranet address. Data packets from this address is not routable to the Internet.



4. Connect Port E1, which is the only port that speaks BACnet over IP.

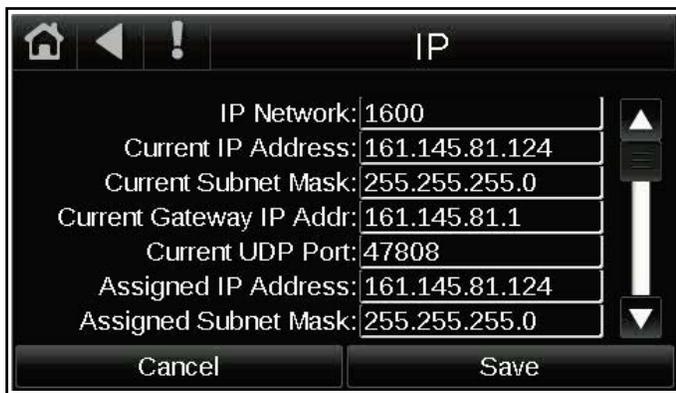


Wiring Specifications

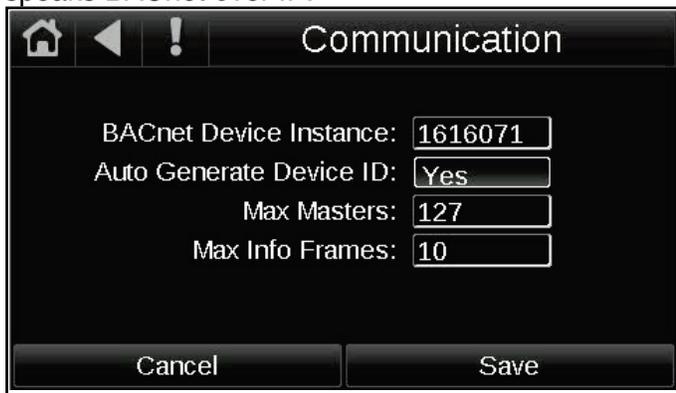
- Maximum cable length 328' (100 m).
- Use one of the following CAT5 or higher Ethernet cables:
 - A cross-over cable to connect the controller directly to the third-party device.
 - A straight-through cable to connect the controller to a hub or switch, and a second straight-through cable to connect the hub or switch to the third-party device.

NOTE: Use the same polarity throughout the network segment.

5. Turn on power to control board.
6. Set the IP address using a Touch Screen.

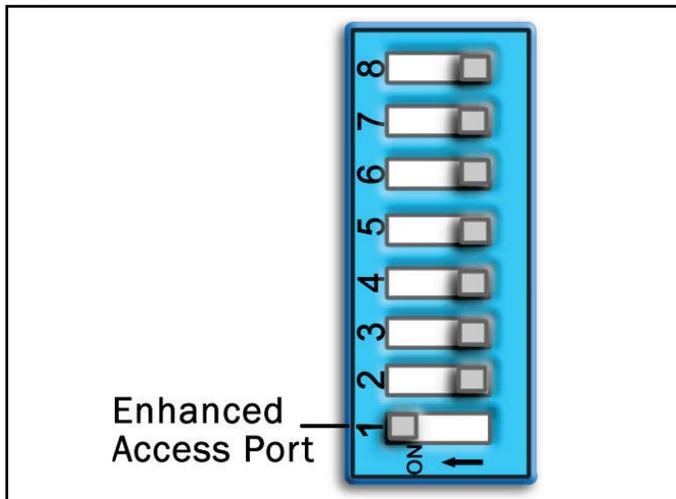


7. Connect Port E1, which is the only port that speaks BACnet over IP.

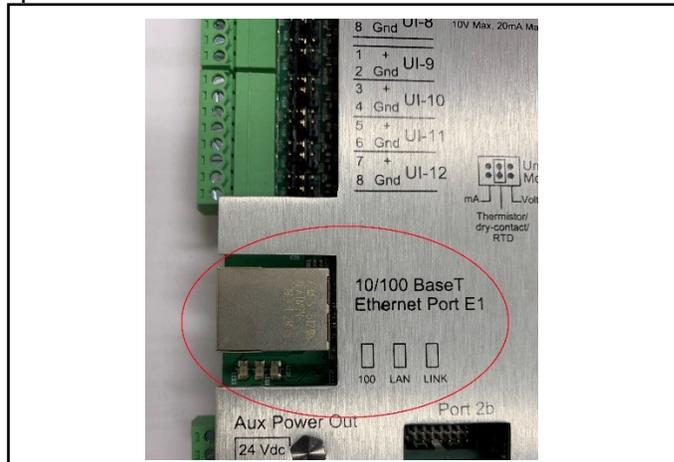


To set up the Modulating Controller for BACnet over IP (assign a custom IP)

1. Turn off power to control board.
2. Set DIP switch Selector 1 and 2 to ON and all others to OFF.



3. Connect Port E1, which is the only port that speaks BACnet over IP.



Wiring Specifications

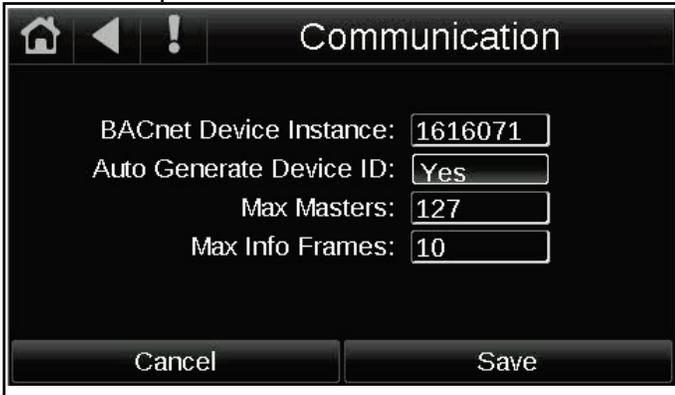
- Maximum cable length 328' (100 m).
- Use one of the following CAT5 or higher Ethernet cables:
 - o A cross-over cable to connect the controller directly to the third-party device
 - o A straight-through cable to connect the controller to a hub or switch, and a second straight-through cable to connect the hub or switch to the third-party device

Note: Use the same polarity throughout the network segment.

4. Turn on power to control board.
5. Obtain the IP address, subnet mask, and default gateway address for the controller from the facility network administrator.
6. Set the IP address using touchscreen.



7. Set a unique Device Instance number



Verify accuracy of the following:

Hardware settings for speaking BACnet over IP:

- Proper connection wiring.
- DIP switches set for default or custom IP address.
- Confirm the correct IP address through the Touch screen.
- Confirm the correct BACnet network number through the Touch screen.
- BAS is sending requests to the proper BACnet address of the controller.

12.5 BACnet over Ethernet

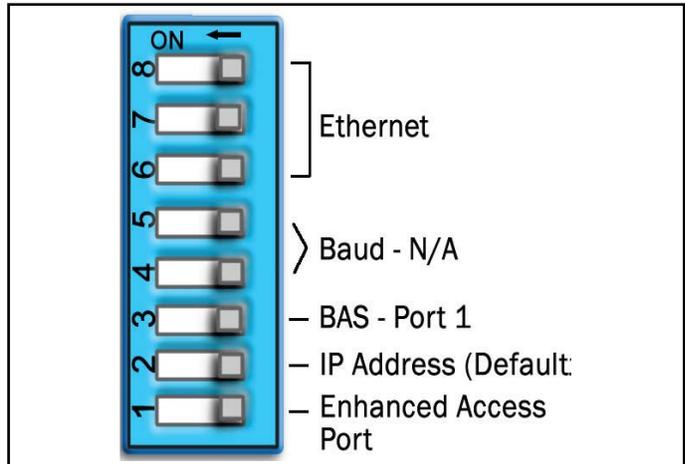
This is used for communicating BACnet packets to the device's specific MAC (Media Access Control) addresses. These specific device addresses allow BACnet messages to be sent over wide-area networks. This network layers offer the fastest speed and allows for communication of BACnet on the highest network layer.

To set up the Modulating Controller for BACnet over Ethernet

1. Turn off power to control board.

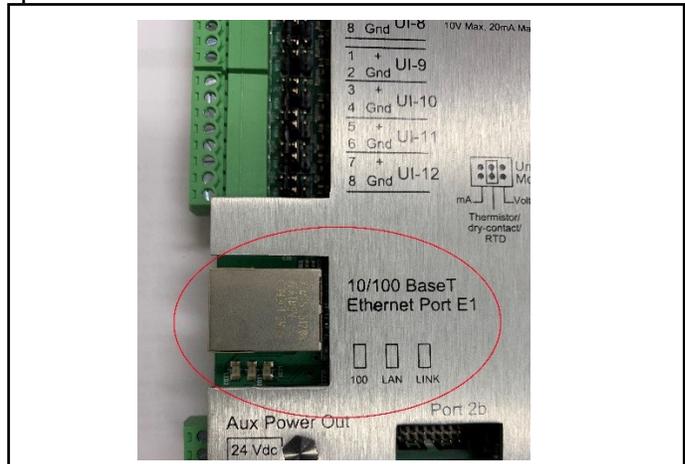
Note: The controller reads the address each time you turn it on.

2. Set Comm Selector DIP Switches 1 through 8 OFF.



Note: The default address is an intranet address. Data packets from this address are not routable to the Internet.

3. Connect Port E1, which is the only port that speaks BACnet over Ethernet.



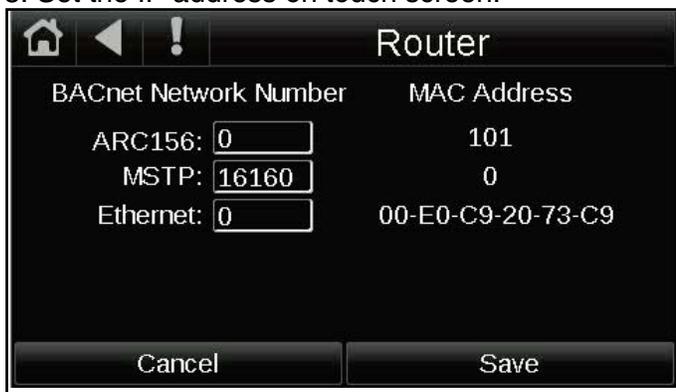
Wiring Specifications

- Max cable length, 328' (100 m)
- Use one of the following CAT5 or higher Ethernet cables:
 - o A cross-over cable to connect the Controller directly to the third-party device
 - o A straight-through cable to connect the controller to a hub or switch, and a second straight-through cable to connect the hub or switch to the third-party device

Note: Use the same polarity throughout the network segment.

4. Turn on power to control board.

5. Set the IP address on touch screen.



6. Set a unique Device Instance number. Equipment Touch screen



The most common communication problems are the result of not properly following the configuration steps outlined in this manual. Review all the steps and use the following list to check your settings.

Verify accuracy of the following:

- Proper connection wiring
- Confirm the correct BACnet network number through the Equipment Touch
- BAS is sending requests to the proper BACnet address of the controller
- Defined through the Touch screen display.
- To confirm settings, obtain a Modstat of the device.

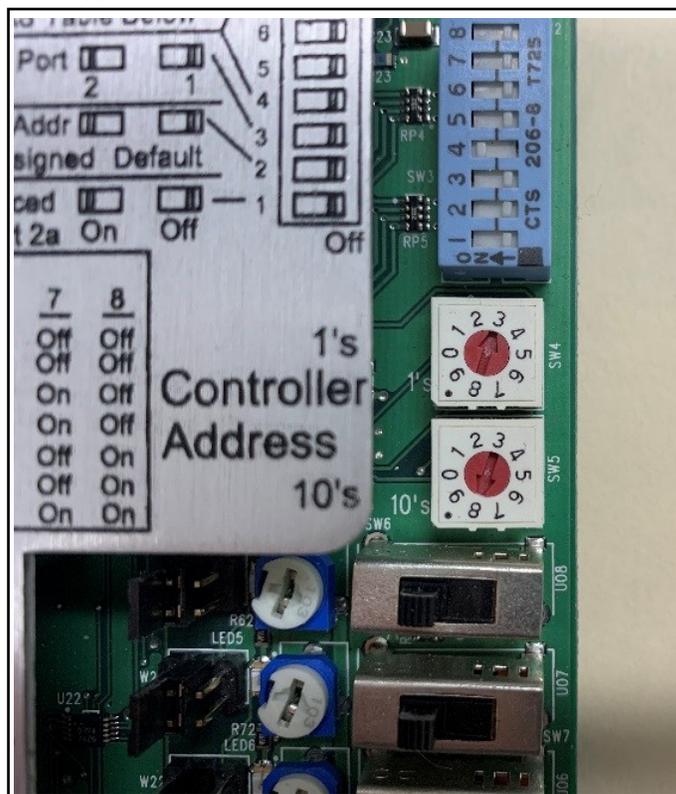
12.6 Modbus

The Modbus protocol is used mostly in the industrial process market to communicate between PLCs (Programmable Logic Controllers).

Modbus is not a protocol that is particularly well suited for building management because of its limited master/slave structure. However, many companies offer Modbus as an open protocol solution because it is relatively easy to construct an interface.

12.6.1 To set up the Modulating Controller for Modbus RTU or ASCII on Port 1

1. Turn off power to control board.
2. Using the rotary switches, set the controller's address.

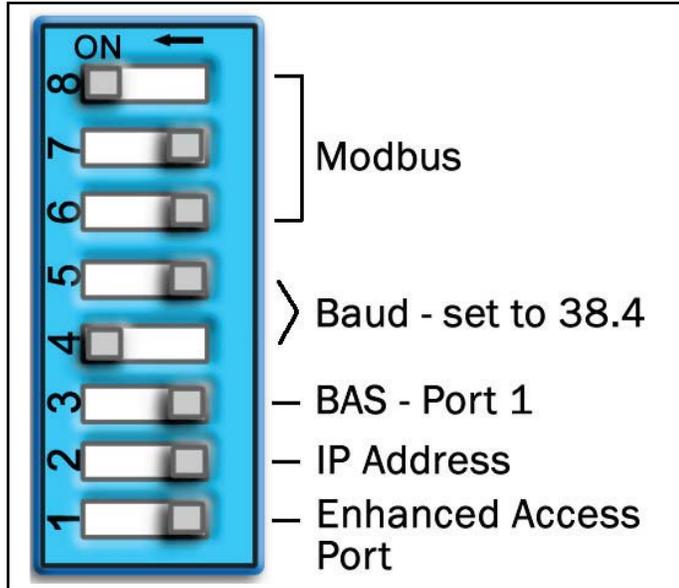


3. Set the Tens (10's) switch to the tens digit of the address and set the Ones (1's) switch to the ones digit.

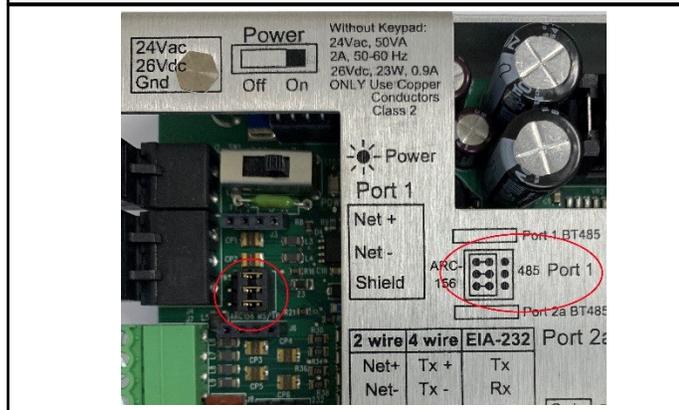
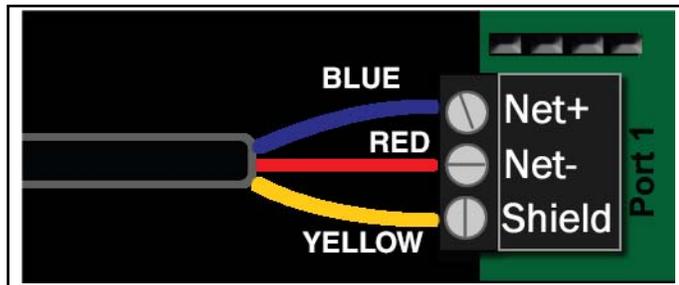
4. Set the Selector DIP Switches 4 and 5 for the appropriate communications speed (9600, 19.2k, 38.4k, or 76.8k bps).

The following example shows the DIP Switches set for 38.4k, Port 1, and Modbus.

5. Set Comm Selector DIP Switch 3 OFF for BAS Port



6. 5 Set Comm Selector DIP Switches 6 - 7 to OFF and 8 to ON.



Wiring specifications

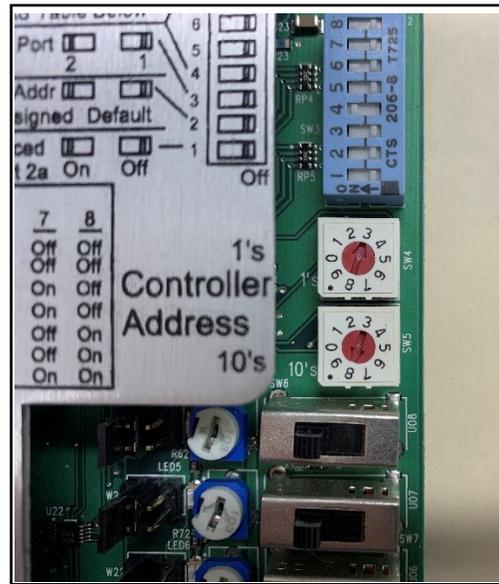
- A dedicated 24 AWG to 18 AWG twisted pair wire (EIA-485)
- 2000' (610 m) for 76.8 kbps
- 3000' (914.4 m) for 9600 bps, 19.2 or 38.4 kbps, before needing a Repeater
- Devices should be daisy chained and not star wired
- If the controller is at either end of a network segment, connect a terminating resistor (P/N 10061018) to the I/O Pro 812u

Note: Use the same polarity throughout the network segment.

7. Turn on power to control board.

12.6.2 To set up the Modulating Controller for Modbus RTU or ASCII on Port 2a

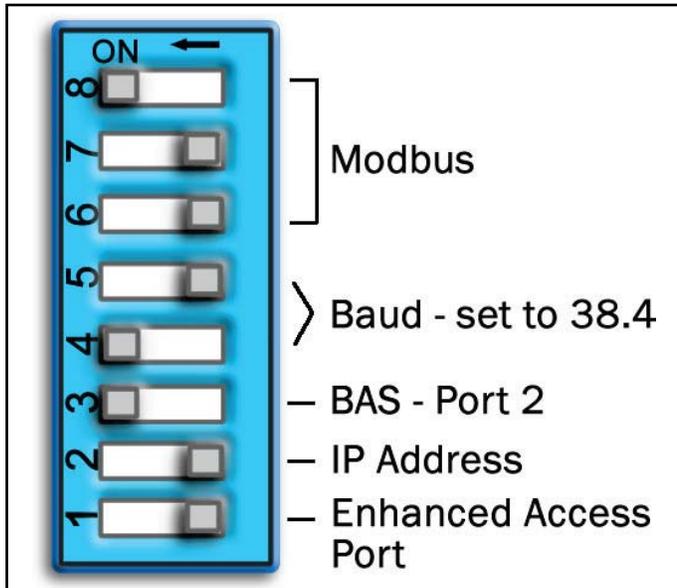
1. Turn off power to control board.
2. Using the rotary switches, set the controller's address. Set the Tens (10's) switch to the tens digit of the address and set the Ones (1's) switch to the ones digit.



3. Set the Selector DIP Switches 4 and 5 for the appropriate communications speed (9600, 19.2k, 38.4k, or 76.8k bps).
4. Set Comm Selector DIP Switch 3 to ON for Port 2.
5. Set Comm Selector DIP Switches 6 - 8 OFF for Modbus RTU or ASCII.
6. Set Comm Selector DIP Switches 5 - 8 for Modbus.

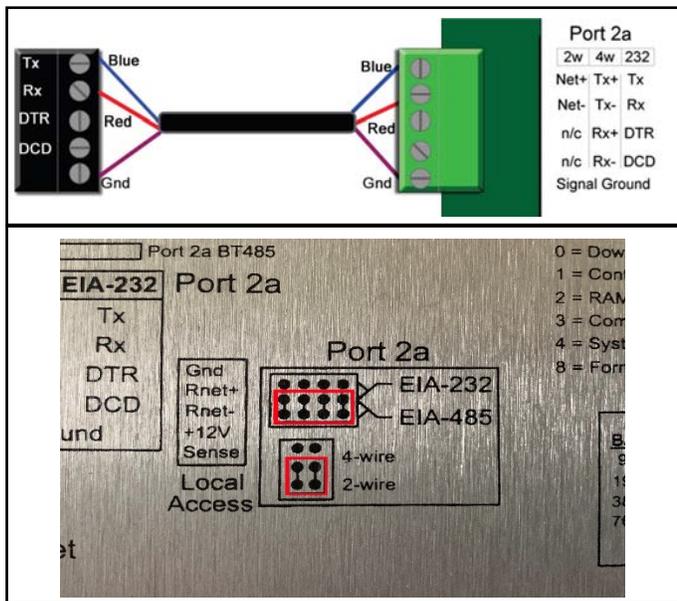
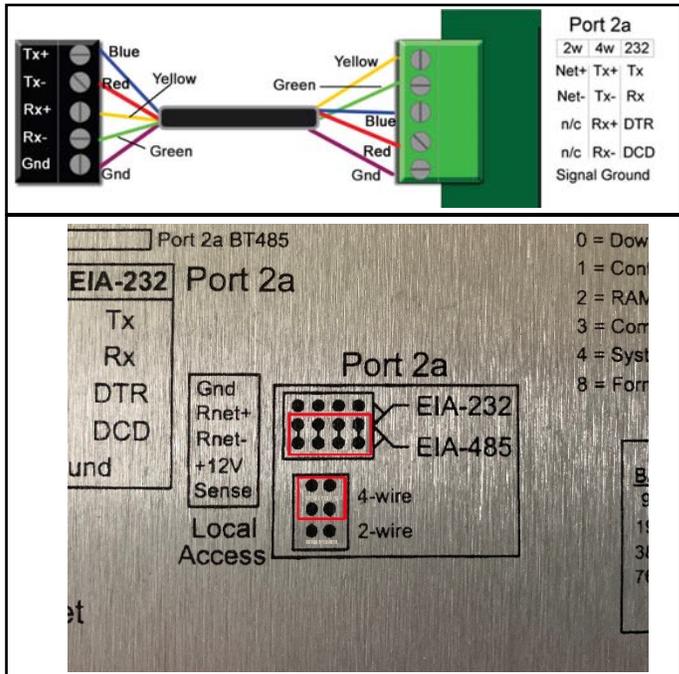
The following example shows the DIP Switches set

for 38.4k, Port 2, and Modbus.



7. Connect the communications port and jumper wiring to Port 2a.

EIA-485, 4-wire



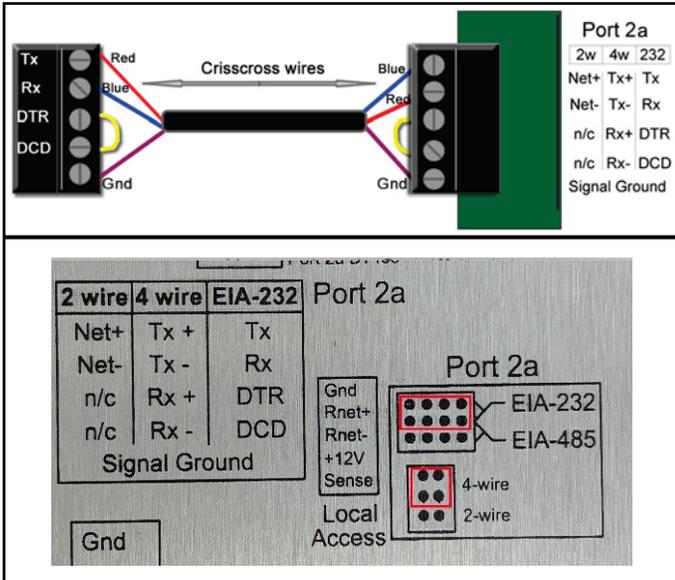
Wiring specifications

- A dedicated 24 AWG to 18 AWG twisted pair wire (EIA-485)
- 2000' (610 m) for 76.8 kbps
- 3000' (914.4 m) for 9600 bps, 19.2 or 38.4 kbps, before needing a Repeater
- Devices should be daisy chained and not star wired
- If the controller is at either end of a network segment, connect a terminating resistor (P/N 10061018) to the I/O Pro 812u

Note: Use the same polarity throughout the network segment.

EIA-232, 2-wire

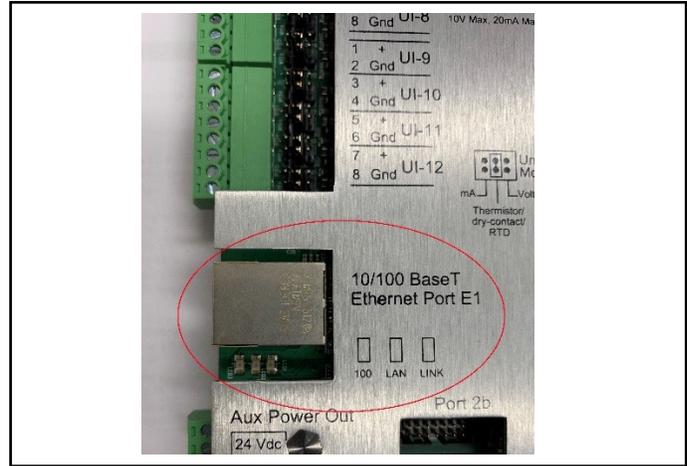
Connect to Tx, Rx, DTR, DCD, and Gnd using three wire termination with pins 3 and 4 jumpered. Wiring must go plus-to-minus and minus-to-plus, Gnd-to-Gnd.



grounds.

3. Connect Port E1 to the third-party device.

Note: Port E1 will still be capable of BACnet communication.



Wire Specifications

- 18–28 AWG; twisted pair preferable
- 50' (15.24 m) maximum length

Note: Do not power the device from the same transformer that powers the I/O Pro 812u controller.

8. Turn on power to control board.

Verify accuracy of the following:

- Baud rate DIP switches 4 and 5
- Protocol DIP switches 6, 7, and 8 jumper set correctly to EIA-232 or EIA-485
- Proper connection wiring
- Unique rotary address switches 1 – 99.
- If controllers have duplicate addresses, network communication can be lost.

NOTES: If RX LED is solid, then the terminations are incorrect. If the network has greater than 32 devices or exceeds 2000' (610 m) a Repeater should be installed. If a controller begins or ends a network segment, a terminating resistor may be needed. The controller recognizes physical changes (DIP switches, rotary switches, and jumpers) upon power up.

12.6.3 To set up the Modulating Controller for Modbus over IP

1. Turn off power to control board.
2. Check the communications wiring for shorts and

Wiring Specifications

- Maximum wire length, 328' (100 m)
- Use one of the following CAT5 or higher Ethernet cables:
 - A cross-over cable to connect the controller directly to the third-party device
 - A straight-through cable to connect the controller to a hub or switch, and a second straight-through cable to connect the hub or switch to the third-party device

Note: Use the same polarity throughout the network segment.

4. Turn on the power to the control board.

Verify accuracy of the following:

- Proper connection wiring.
- Confirm the IP address, subnet mask, and default gateway address for your router with the manufacturer.
- Confirm the correct IP address through the Touch screen.

12.7 To set up the Modulating Controller for N2 on Port 1

1. Turn off power to the control board.
2. Using the rotary switches, set the controller's

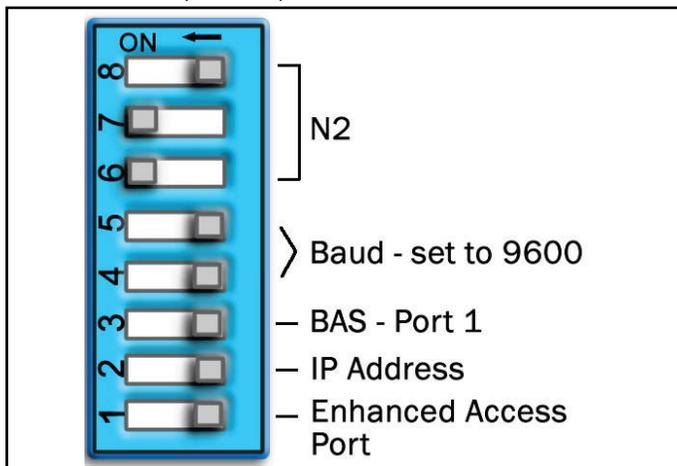
address.

3. Set the Comm Selector DIP Switches 1 - 8 for baud rate, port number, wiring, and protocol.
4. Set the Comm Selector DIP Switches 4 and 5 for 9600 bps.

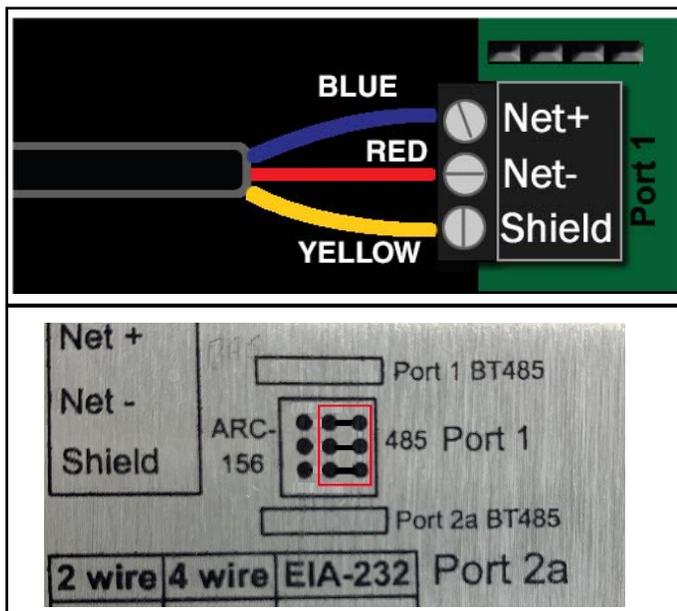
Note: Use the same baud rate for all devices on the network segment.

5. Set Comm Selector DIP Switch 3 OFF for BAS Port
6. Set the Comm Selector DIP Switches 6 through 8 for N2.

The following example shows the DIP Switches set for 9600 baud, Port 1, and N2.



7. Connect the communications wiring to Port 1a. Connect to Net+, Net- and Gnd



Wiring specifications

- A dedicated 24 AWG to 18 AWG twisted pair wire (EIA-485)
- 2000' (610 m) for 76.8 kbps
- 3000' (914.4 m) for 9600 bps, 19.2 or 38.4 kbps, before needing a Repeater
- Devices should be daisy chained and not star wired
- If the controller is at either end of a network segment, connect a terminating resistor (P/N 10061018) to the I/O Pro 812u

NOTE: Use the same polarity throughout the network segment.

7. Turn on power to control board.

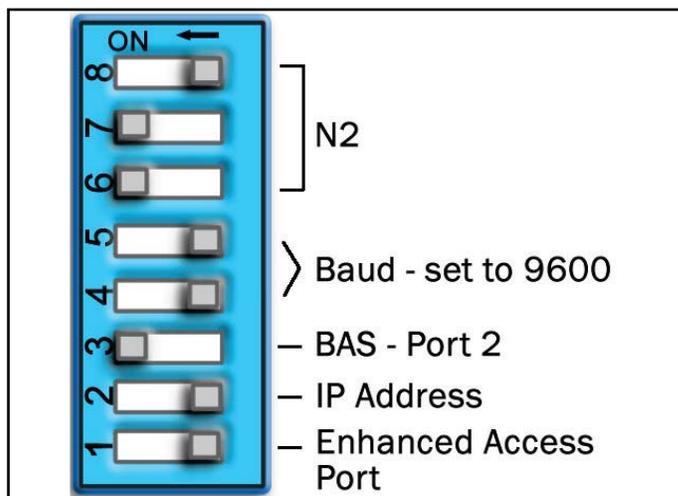
To set up the Modulating Controller for N2 on Port 2a

1. Turn off power to control board.
2. Using the rotary switches, set the controller's address.
3. Set the Comm Selector DIP Switches 4 and 5 for 9600 bps.

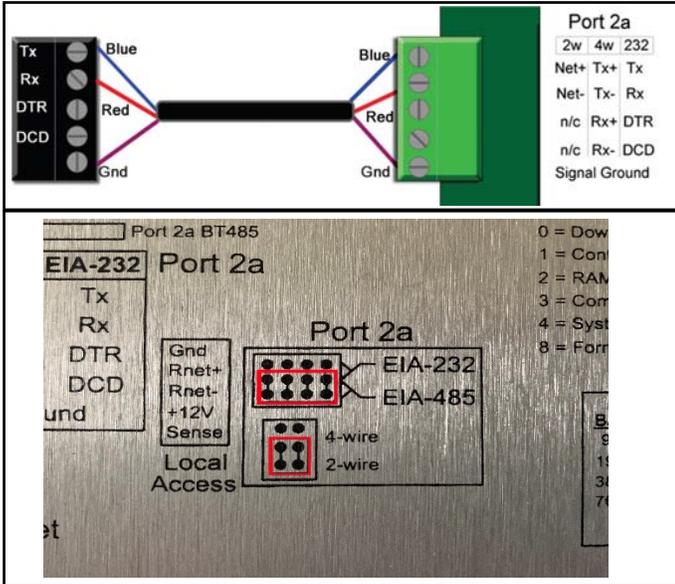
Note: Use the same baud rate for all devices on the network segment.

4. Set Comm Selector DIP Switch 3 ON for Port 2.
5. Set the Comm Selector DIP Switches 6 through 8 for N2.

The following example shows the DIP Switches set for 38.4 kbps baud rate, Port 1, and N2.



EIA-485, 2-wire



NOTES:

- If RX LED is solid, then the terminations are incorrect.
- If the network has greater than 32 devices or exceeds 2,000' (609.6 m), a Repeater should be installed.
- If a controller begins or ends a network segment, a terminating resistor may be needed.
- The controller recognizes physical changes (DIP switches, rotary switches and jumpers) upon power up.

12.8 LonWorks

LonWorks (local operating network) is a networking platform specifically created to address the needs of control applications. A separate LonWorks card (P/N 10060160), photo below, is required for LonWorks communication.

NOTE: For connecting a controller to LonWorks protocol, contact Roberts-Gordon LLC to get a mapped clipping file of controller program.

Wiring specifications

- A dedicated 24 AWG to 18 AWG twisted pair wire (EIA-485).
- 2000' (610 m) for 76.8 kbps.
- 3000' (914.4 m) for 9600 bps, 19.2 or 38.4 kbps, before needing a Repeater.
- Devices should be daisy chained and not star wired.
- If the controller is at either end of a network segment, connect a terminating resistor (P/N 10061018) to the controller.

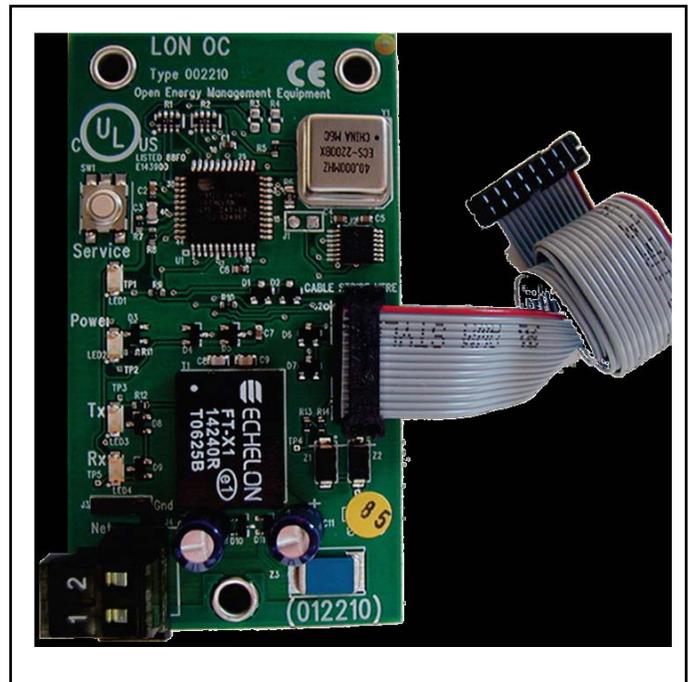
NOTE: Use the same polarity throughout the network segment.

6. Turn on power to control board.

Verify accuracy of the following:

Hardware settings for speaking N2:

- Baud rate DIP switches 4 and 5
- Protocol DIP switches 6, 7, and 8
- Jumpers set to half duplex (2-wire) and EIA-485
- Proper connection wiring
- BAS is configured to speak 2-wire EIA-485 to the controller.
- BAS is sending requests to the proper slave address of the controller.
- Unique rotary address switches 1 – 99. If controllers have duplicate addresses, network communication can be lost.

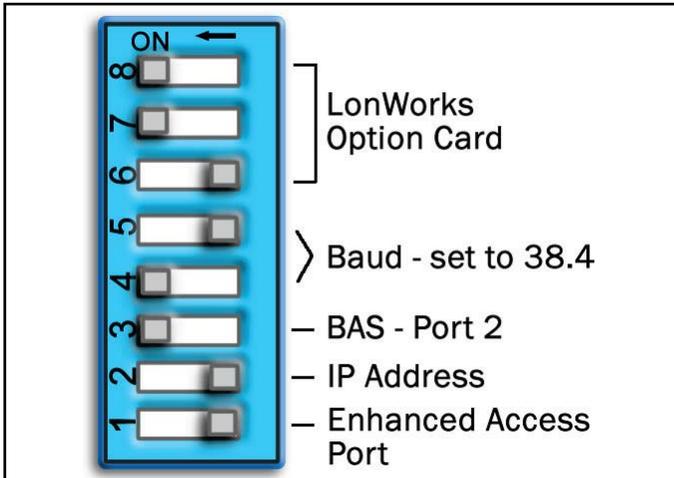


To set up the Modulating Controller for LonWorks Option Card

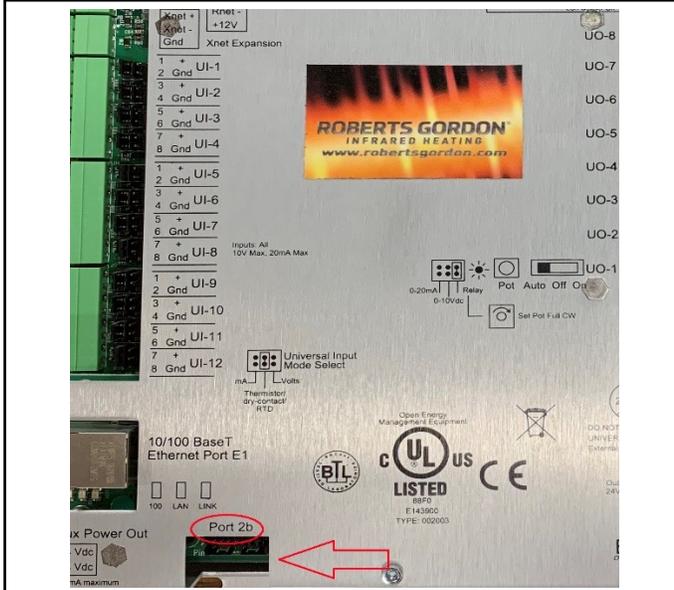
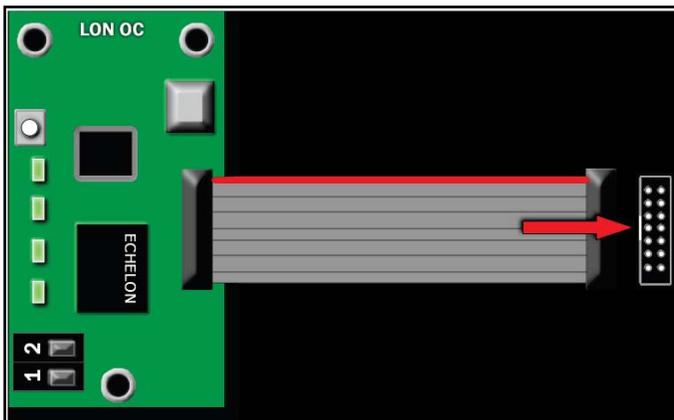
1. Turn off power to control board.
2. Using the rotary switches, set a unique address.
3. Set the Comm Selector DIP Switches 1 - 8 for baud rate, port number, wiring, and protocol.
 - Set the Communication mode for Port 2 using DIP Switch 3

- Set the Comm Selector DIP Switches 6 through 8 for LonWorks Option Card

The following example shows the DIP Switches set for 38.4k baud, Port 1 and LonWorks Option Card.



4. Plug the 's ribbon cable into the Option Port on the controller.



5. Connect the LonWorks network to the LonWorks Option Card's 2-pin Net port.

NOTE: The 2-pin Net port provides TP/FT-10 channel compatibility. The TP/FT-10 or "Free Topology" network type is polarity insensitive. Use 24 to 16 AWG twisted pair wire.

6. Turn on power to control board.

Verify accuracy of the following:

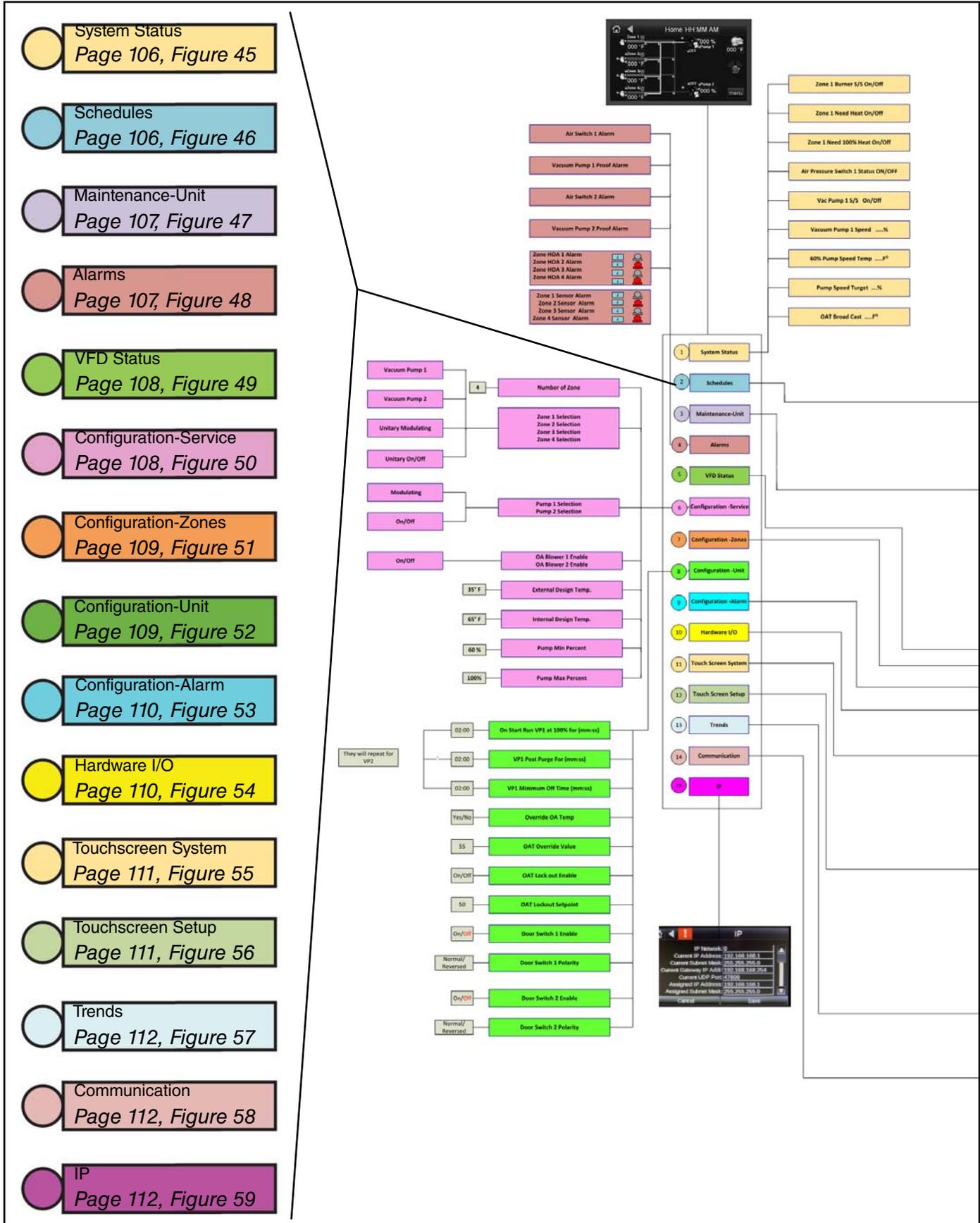
- Baud rate DIP switches 1 and 2 set to 38.4 kbps
- Protocol DIP switches 6, 7, and 8
- Jumper set to EIA-485 2-wire when using the LonWorks Option Card
- Proper connection wiring
- Unique rotary address switches 1 – 99. If controllers have duplicate addresses, network communication can be lost.

NOTES:

- If RX LED is solid, then the terminations are incorrect.
- If the network has greater than 32 devices or exceeds 2000' (610 m) a Repeater should be installed.
- If a controller begins or ends a network segment, a BT485 terminating resistor (P/N 10061018) may be required. Touchscreen Tree

SECTION 13: TOUCHSCREEN TREE

FIGURE 44: Touchscreen Tree Overview



Touchscreen Tree Overview (continued)



FIGURE 45: System Status

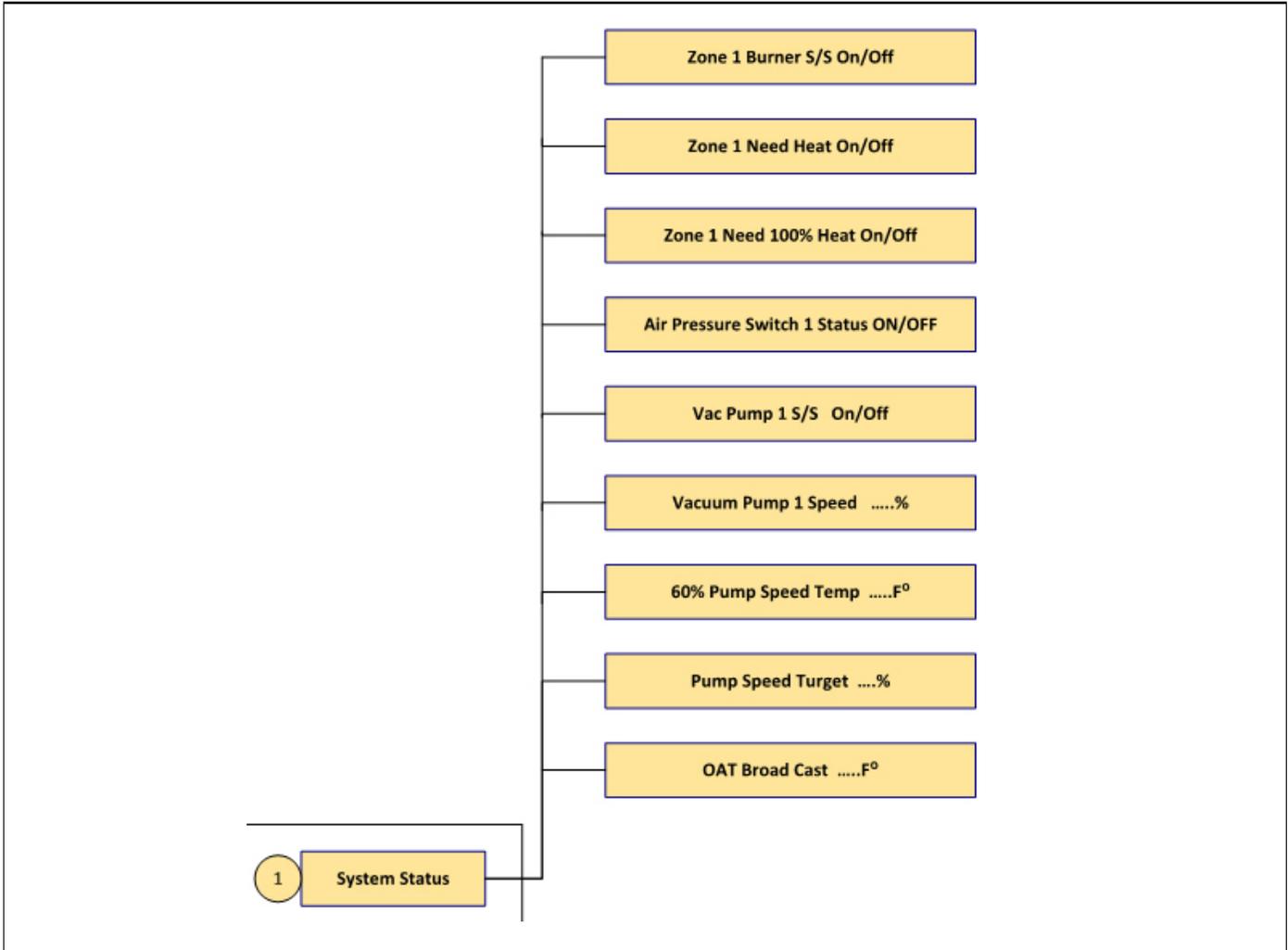


FIGURE 46: Schedules

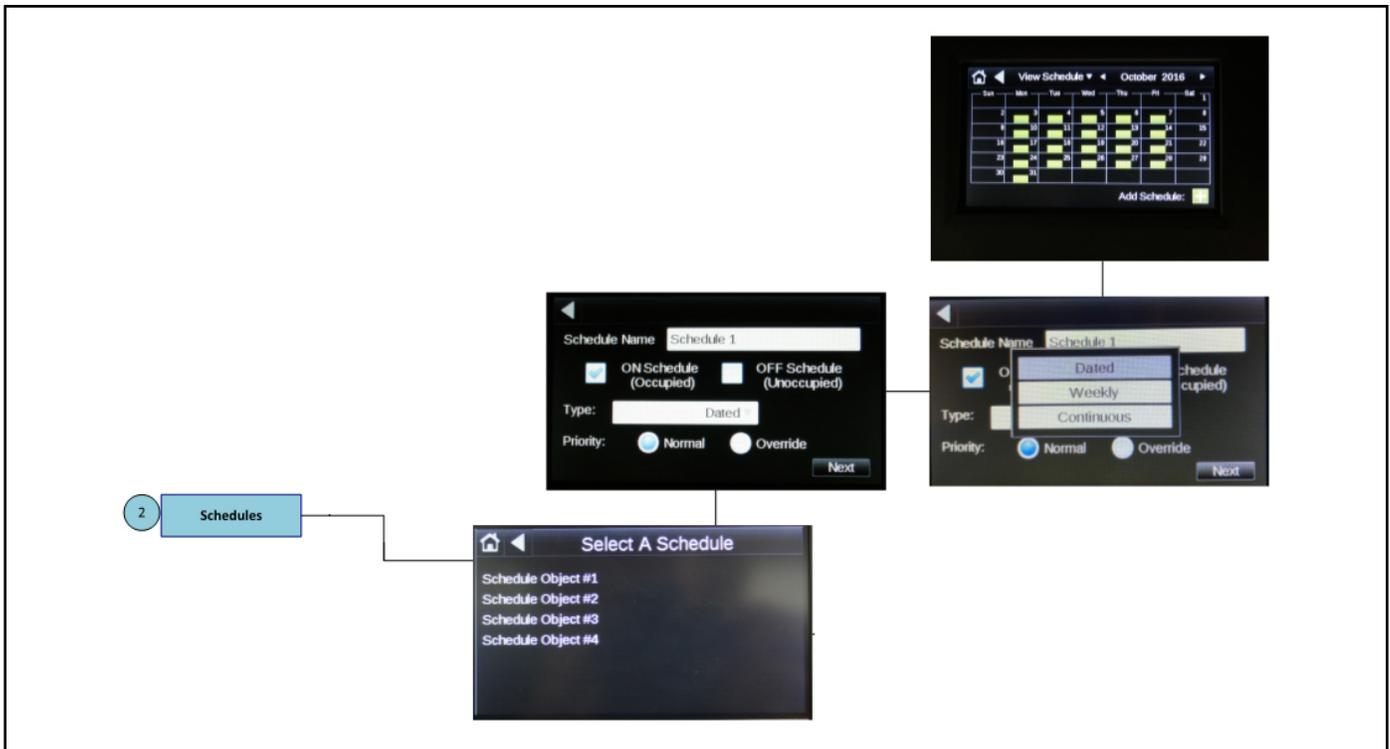


FIGURE 47: Maintenance-Unit

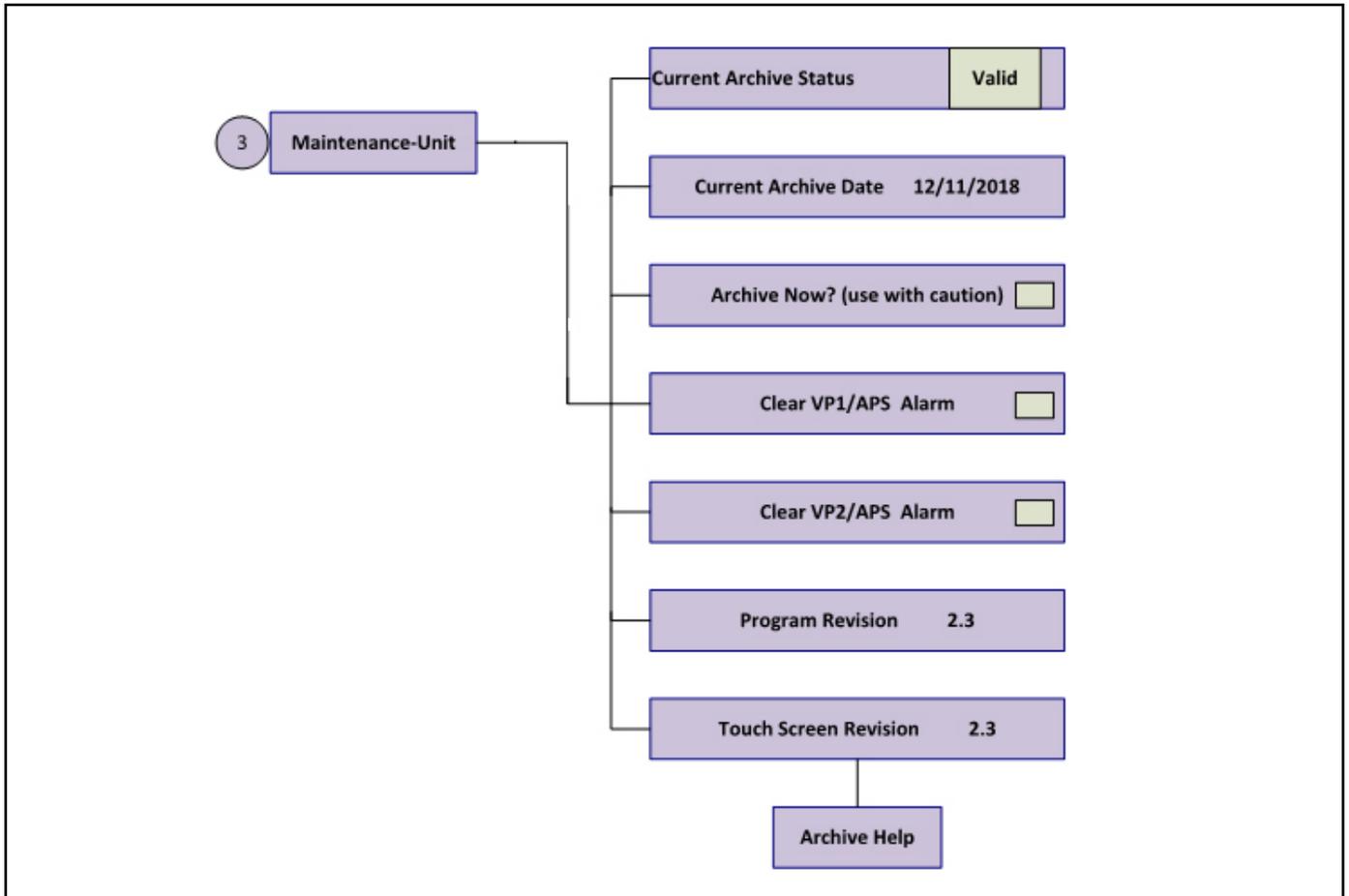


FIGURE 48: Alarms

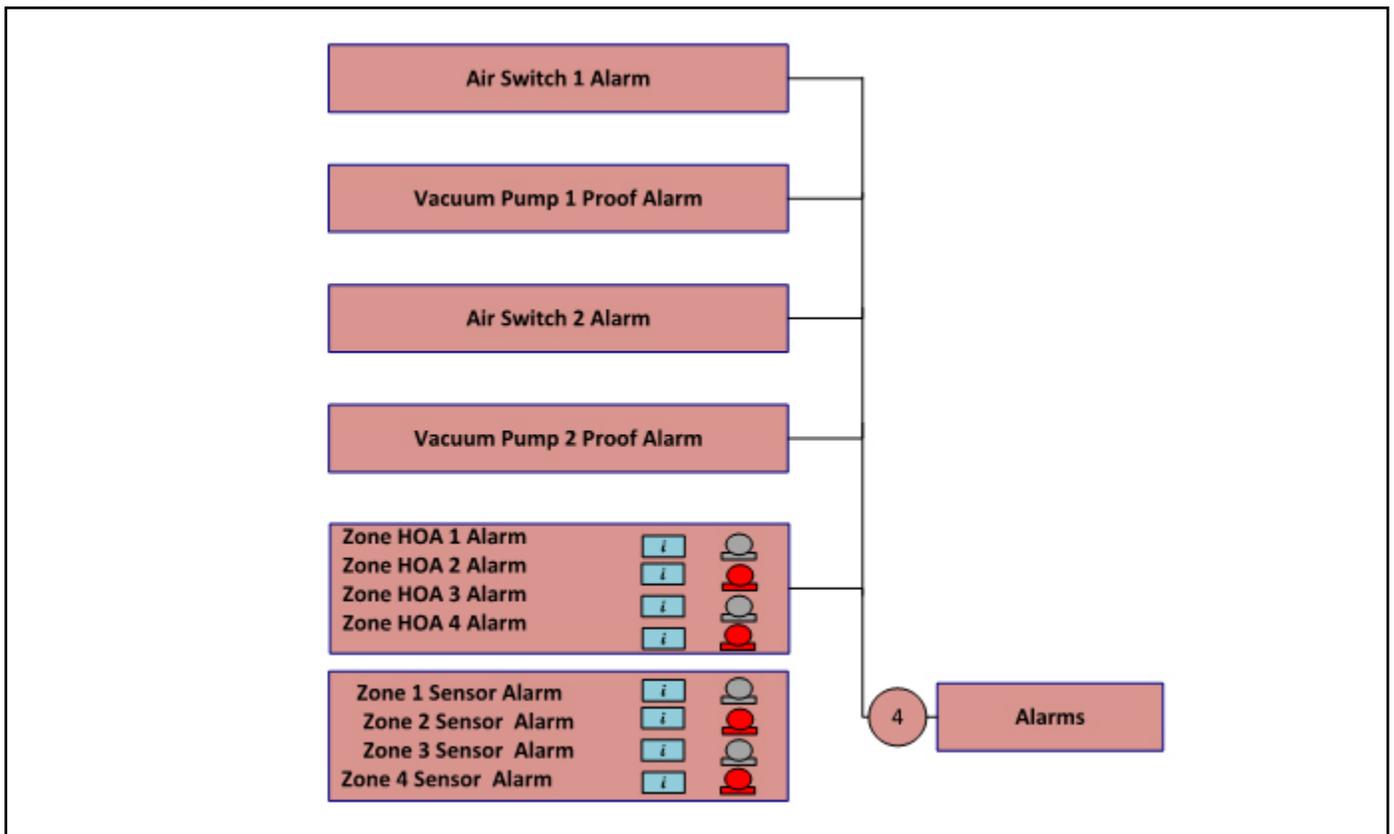


FIGURE 49: VFD-Status

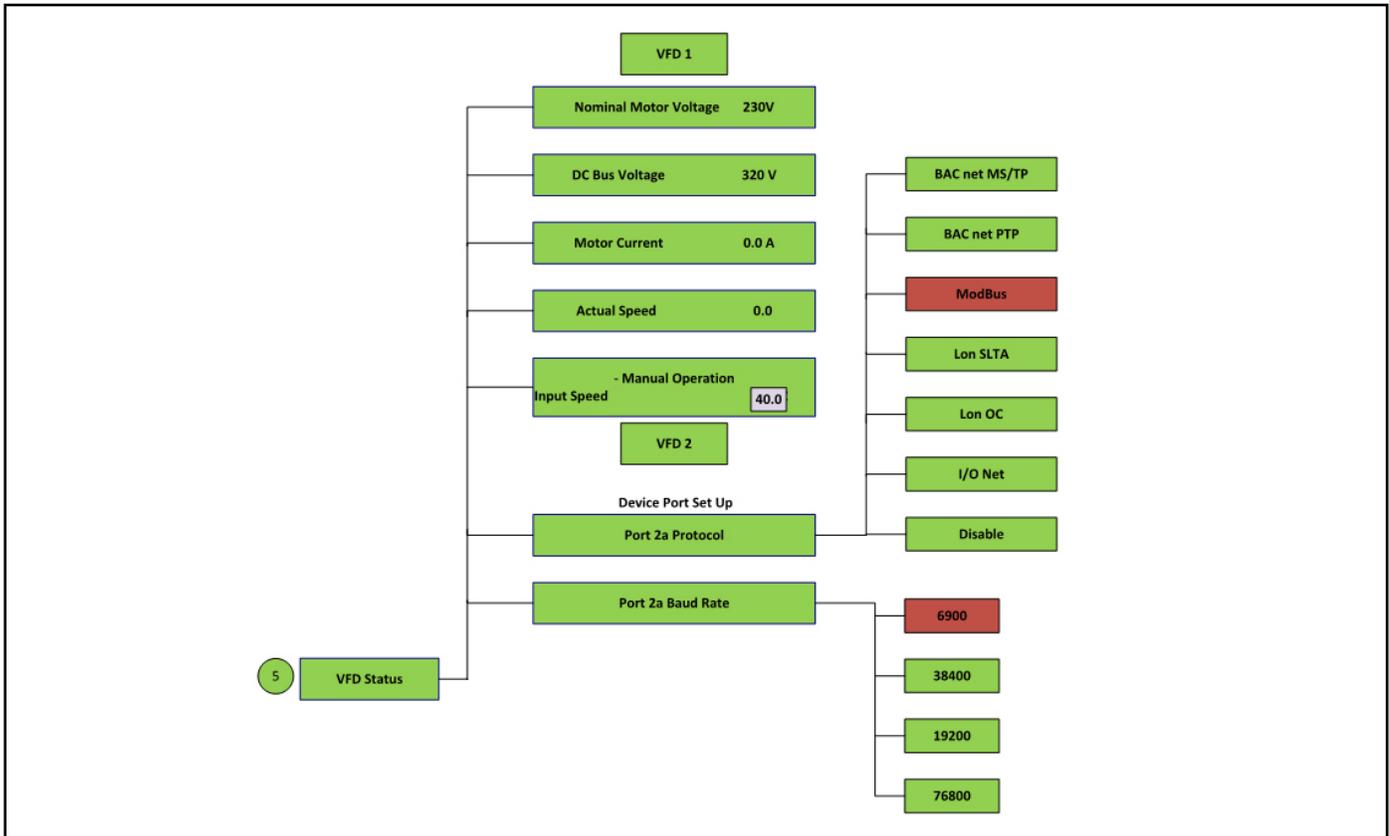


FIGURE 50: Configuration-Service

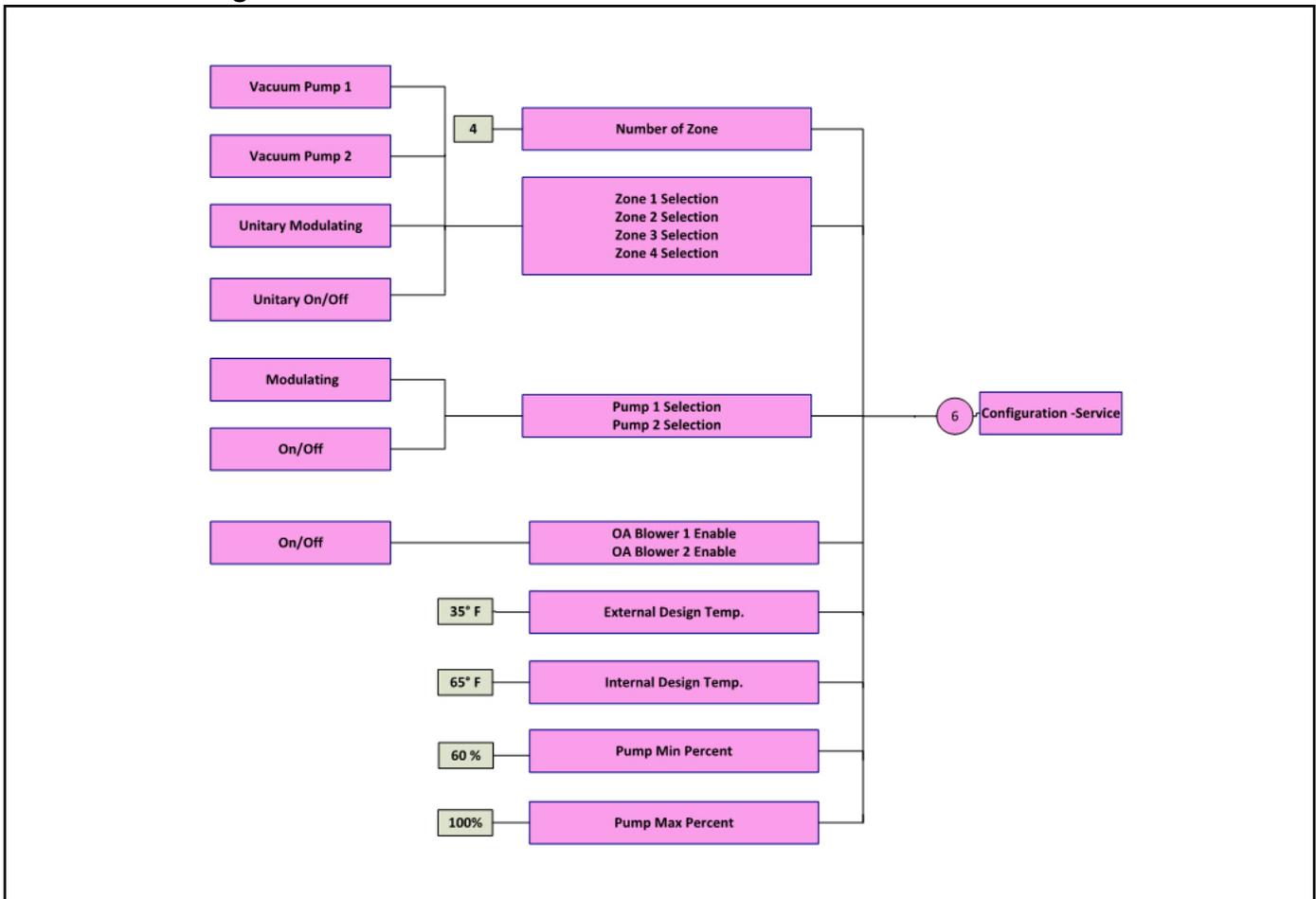


FIGURE 51: Configuration-Zones

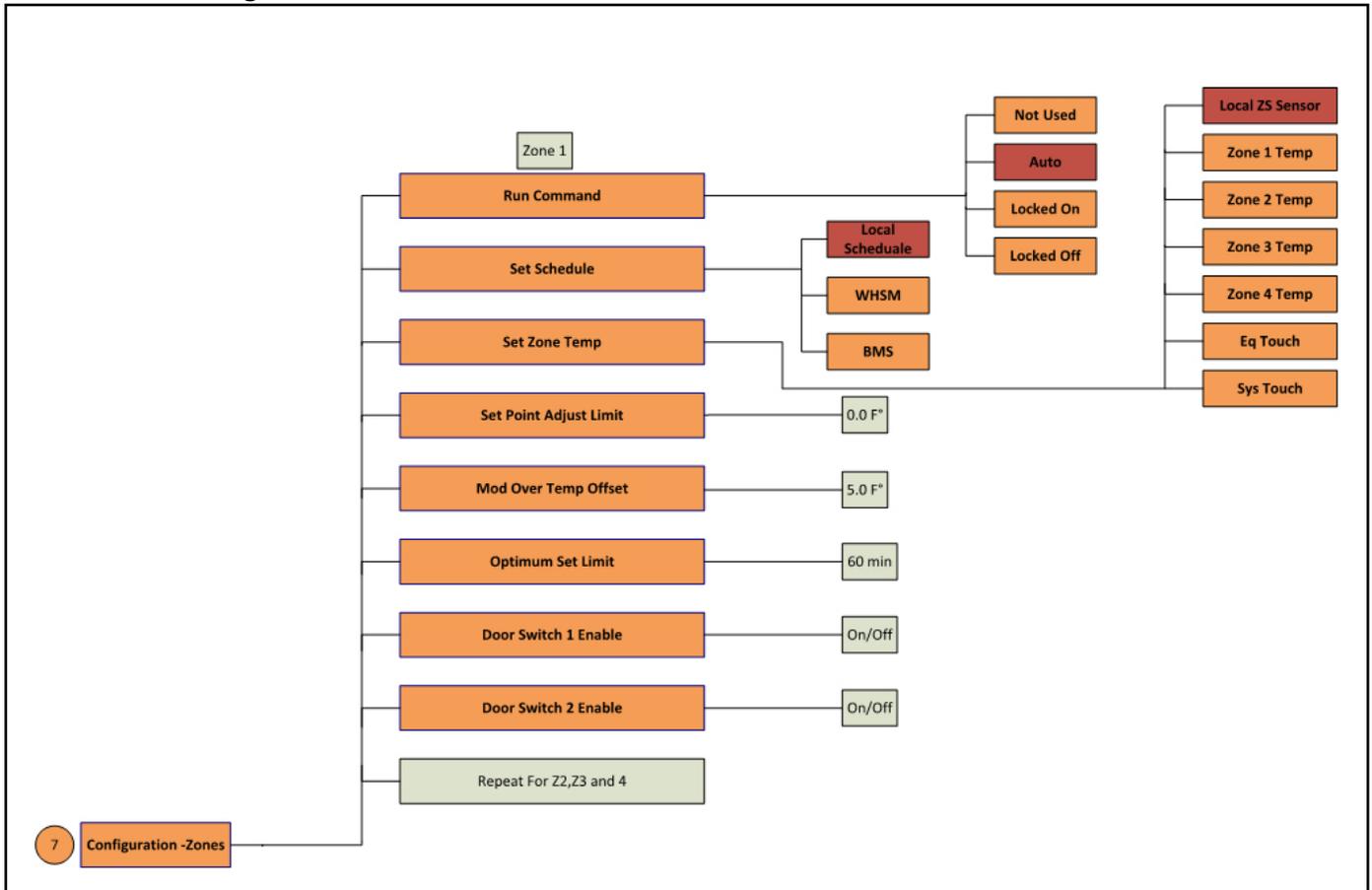


FIGURE 52: Configuration-Unit

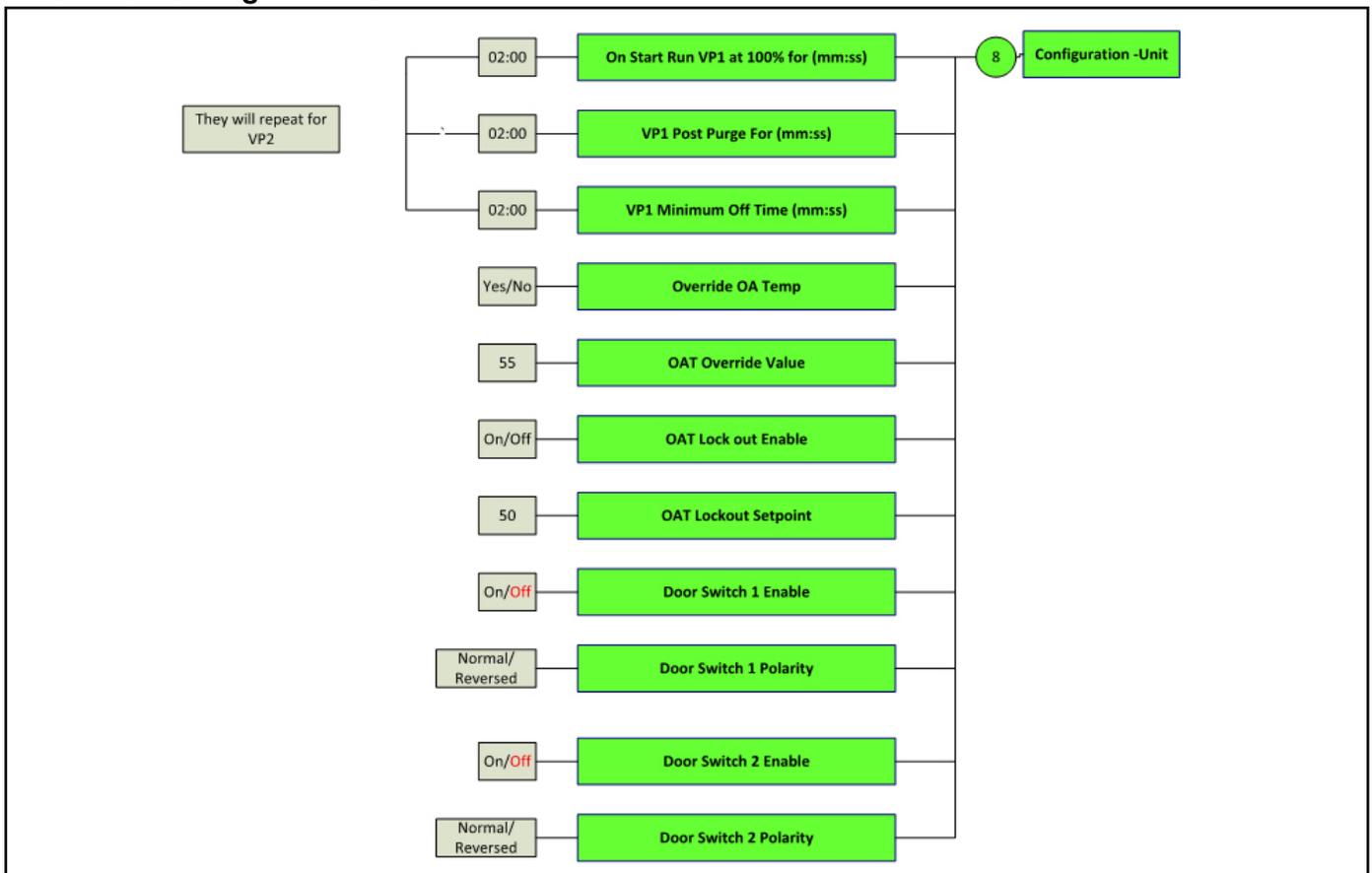


FIGURE 53: Configuration-Alarm

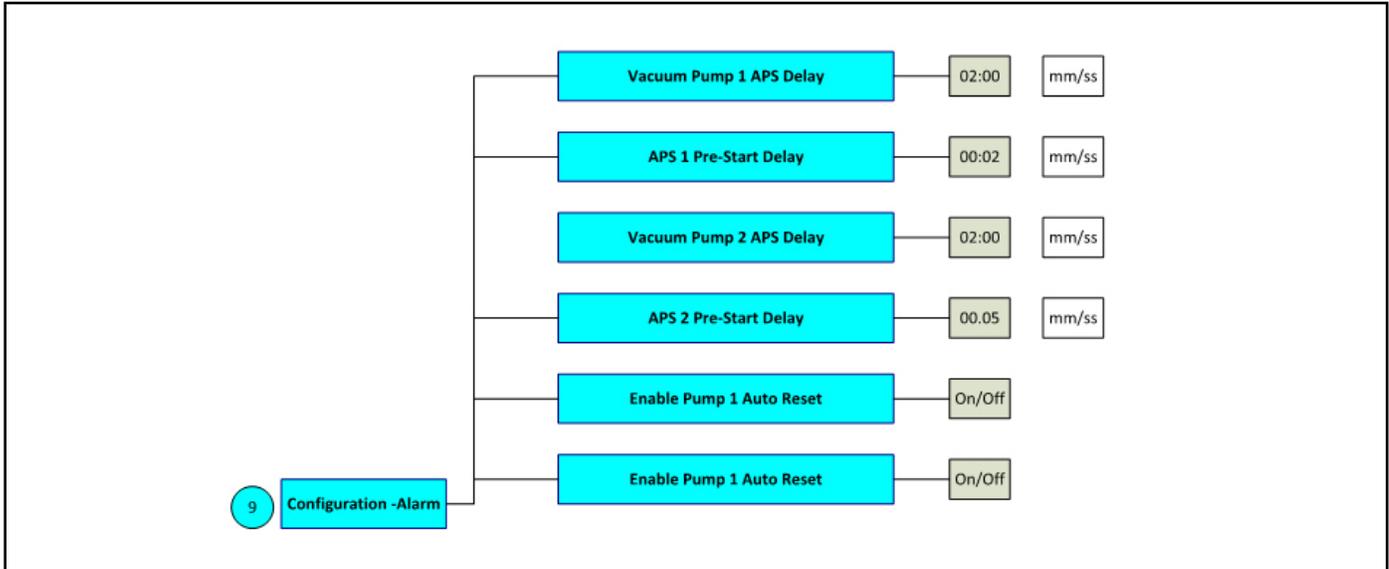


FIGURE 54: Hardware I/O

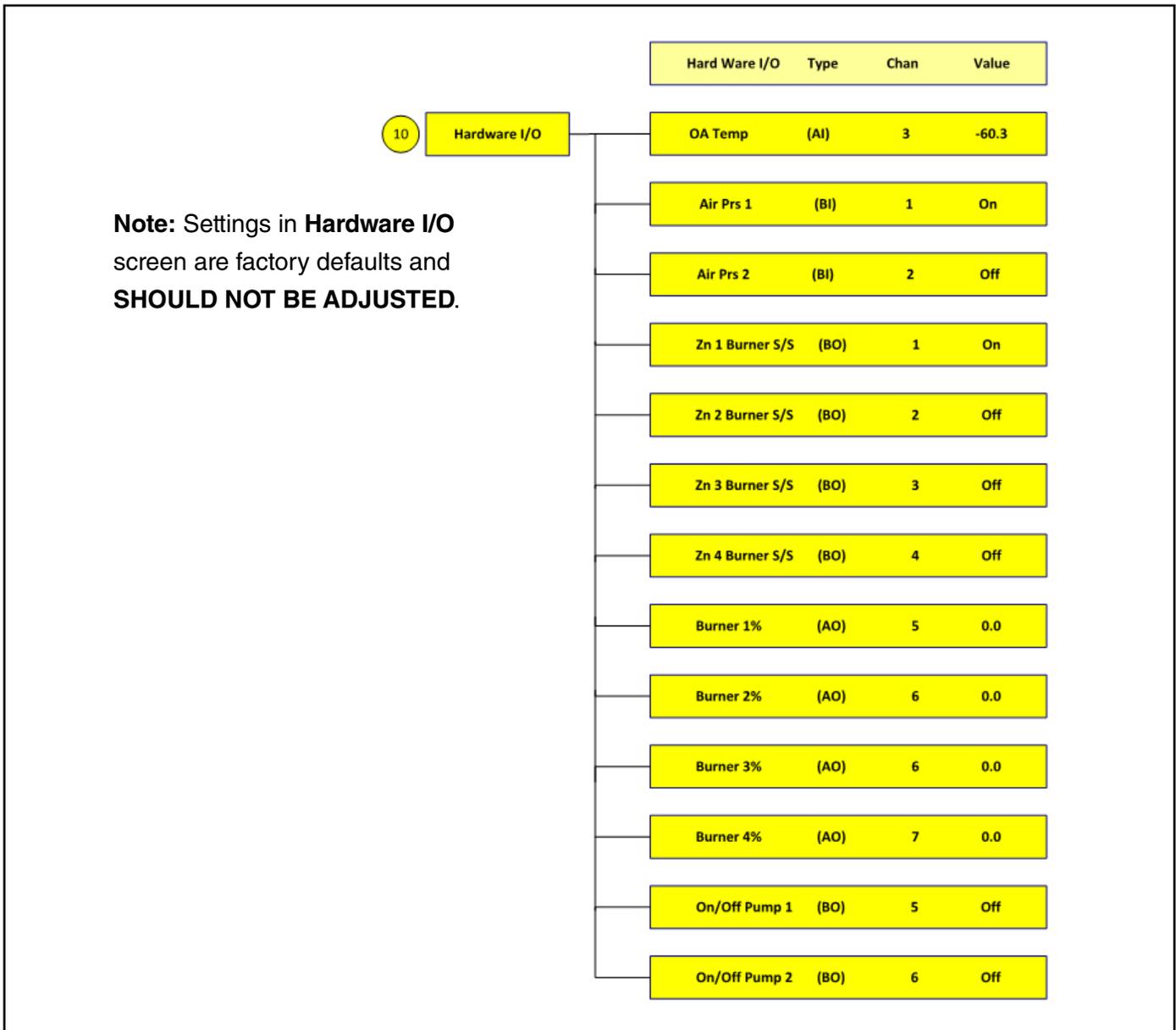


FIGURE 55: Touchscreen System

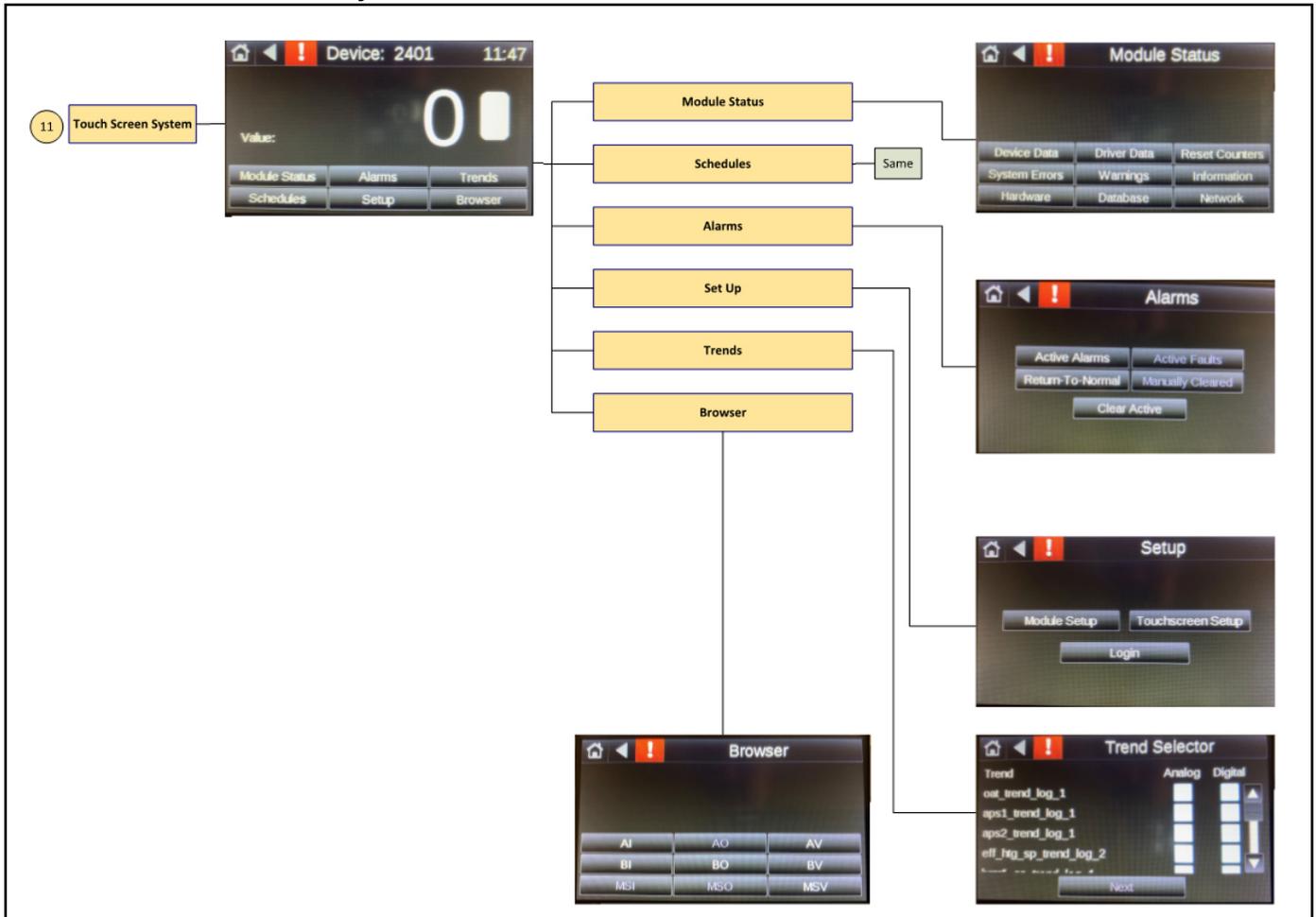


FIGURE 56: Touchscreen Setup

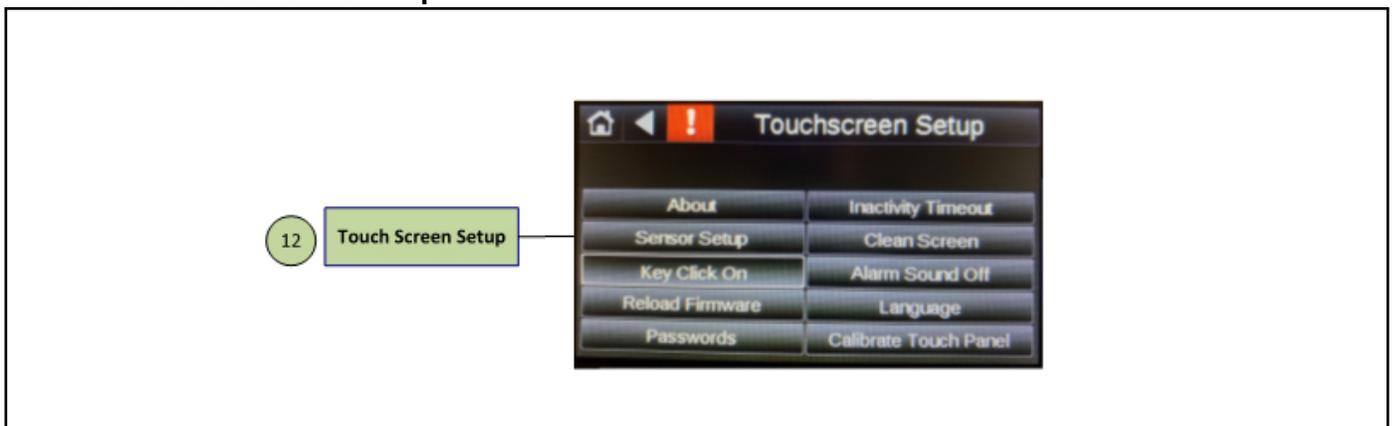


FIGURE 57: Trends

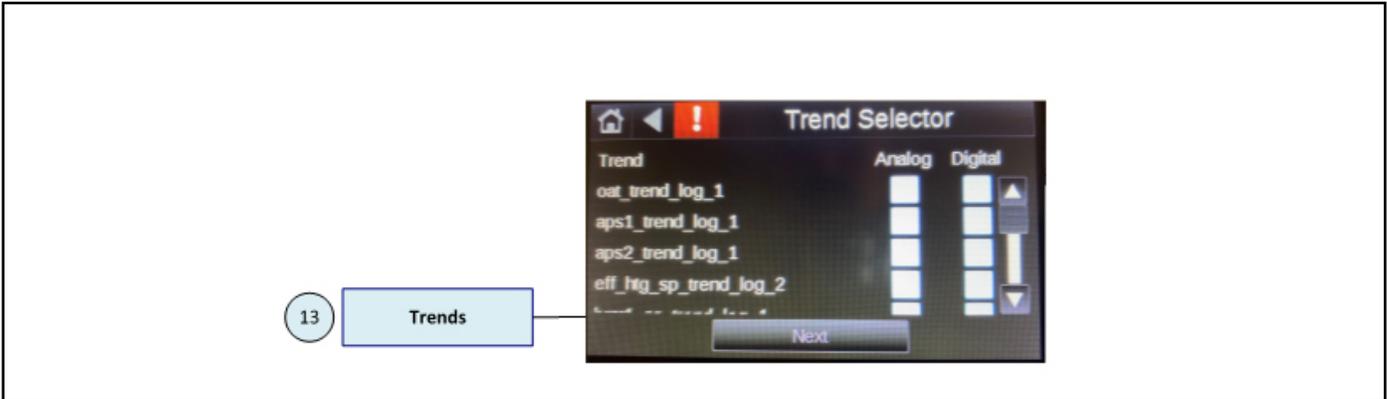


FIGURE 58: Communication

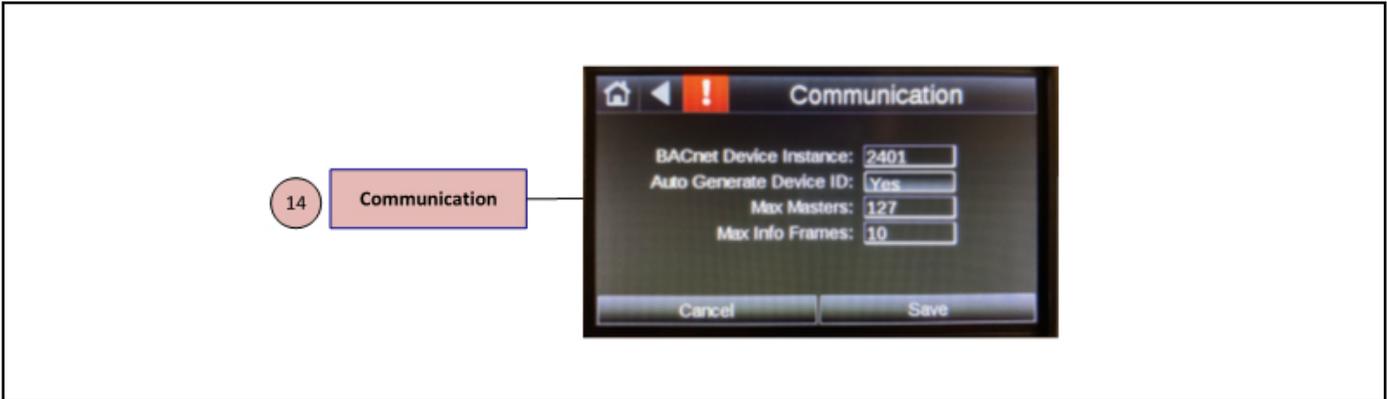
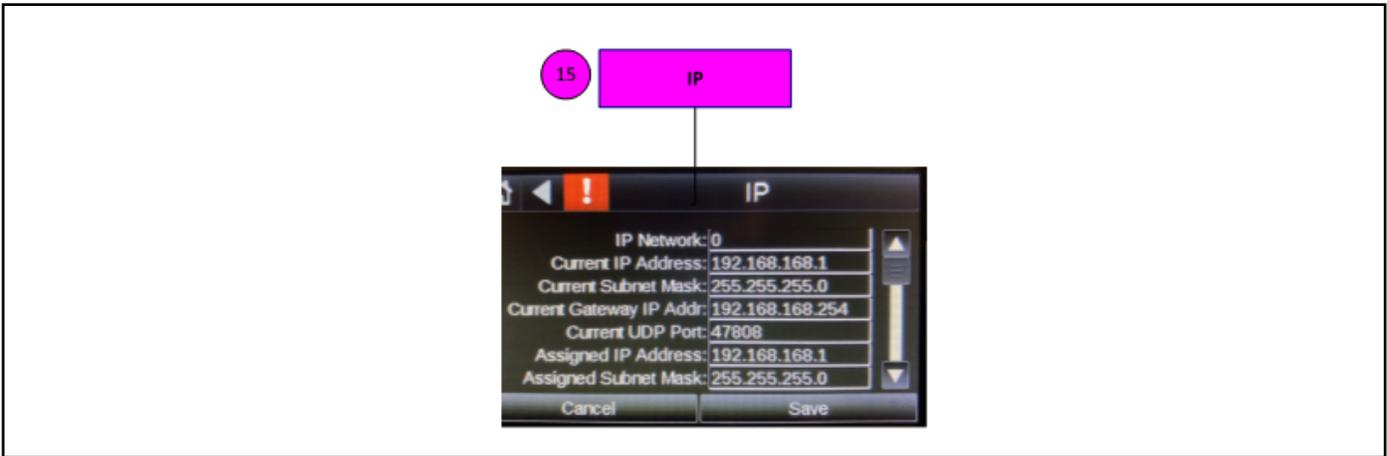


FIGURE 59: IP



SECTION 14: THE ROBERTS GORDON® CORAYVAC®/COMPLETE™ Modulating Heating Control LIMITED WARRANTY

Within 36 months from date of purchase by buyer or 42 months from date of shipment by Roberts-Gordon LLC (whichever occurs first), replacement parts will be provided free of charge for any part of the product which fails due to a manufacturing or material defect. Roberts-Gordon LLC will require the part in question to be returned to the factory. Roberts-Gordon LLC will, at its sole discretion, repair or replace after determining the nature of the defect and disposition of part in question.

ROBERTS GORDON® Replacement Parts are warranted for a period of 12 months from date of shipment from Roberts-Gordon LLC or the remaining ROBERTS GORDON® System Control warranty.

ROBERTS-GORDON WILL NOT PAY FOR:

Service trips, service calls and labor charges.

Shipment of replacement parts.

Claims where the total price of the goods have not been paid.

Damage due to:

- Improper installation, operation or maintenance.
- Misuse, abuse, neglect, or modification of the ROBERTS GORDON® CORAYVAC®/COMPLETE™ Modulating Heating Control in any way.
- Use of the ROBERTS GORDON® CORAYVAC®/COMPLETE™ Modulating Heating Control for other than its intended purpose.
- Incorrect gas or electrical supply, accident, fire, floods, acts of God, war, terrorism, or other casualty.
- Improper service, use of replacement parts or accessories not specified by Roberts-Gordon LLC.
- Failure to install or maintain the ROBERTS GORDON® CORAYVAC®/COMPLETE™ Modulating Heating Control as directed in the Installation, Operation and Service Manual.
- Relocation of the ROBERTS GORDON® CORAYVAC®/COMPLETE™ Modulating Heating Control after initial installation
- The use of the ROBERTS GORDON® CORAYVAC®/COMPLETE™ Modulating Heating Control in a corrosive atmosphere containing contaminants.
- The use of the ROBERTS GORDON® CORAYVAC®/COMPLETE™ Modulating Heating Control in the vicinity of a combustible or explosive material.
- Any defect in the ROBERTS GORDON® CORAYVAC®/COMPLETE™ Modulating Heating Control arising from a drawing, design, or specification supplied by or on behalf of the consumer.
- Damage incurred during shipment. Claim must be filed with carrier.

WARRANTY IS VOID IF:

The ROBERTS GORDON® CORAYVAC®/COMPLETE™ Modulating Heating Control is not installed by an electrician qualified in the installation and service of control systems for heating equipment.

You cannot prove original purchase date and required annual maintenance history.

The data plate and/or serial number are removed, defaced, modified or altered in any way.

The ownership of the ROBERTS GORDON® CORAYVAC®/COMPLETE™ Modulating Heating Control is moved or transferred. This warranty is nontransferable.

Roberts-Gordon LLC is not permitted to inspect the damaged controller and/or component parts.

READ YOUR INSTALLATION, OPERATION AND SERVICE MANUAL.

If you have questions about your control, contact your installing professional. Should you need Replacement Parts or have additional questions, call or write:

Roberts-Gordon LLC

1250 William Street

P.O. Box 44

Buffalo, New York 14240-0044

Telephone: +1.716.852.4400

Fax: +1.716.852.0854

Toll Free: 800.828.7450

www.robertsgordon.com

Roberts-Gordon LLC's liability, and your exclusive remedy, under this warranty or any implied warranty (including the implied warranties of merchantability and fitness for a particular purpose) is limited to providing replacement parts during the term of this warranty. Some jurisdictions do not allow limitations on how long an implied warranty lasts, so this limitation may not apply to you. There are no rights, warranties or conditions, expressed or implied, statutory or otherwise, other than those contained in this warranty.

Roberts-Gordon LLC shall in no event be responsible for incidental or consequential damages or incur liability for damages in excess of the amount paid by you for the ROBERTS GORDON® CORAYVAC®/COMPLETE™ Modulating Heating Control. Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages, so this limitation or exclusion may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from jurisdiction to jurisdiction.

Roberts-Gordon LLC shall not be responsible for failure to perform under the terms of this warranty if caused by circumstances out of its control, including but not limited to war, fire, flood, strike, government or court orders, acts of God, terrorism, unavailability of supplies, parts or power. No person is authorized to assume for Roberts-Gordon LLC any other warranty, obligation or liability.

LIMITATIONS ON AUTHORITY OF REPRESENTATIVES:

No representative of Roberts-Gordon LLC, other than an Executive Officer, has authority to change or extend these provisions. Changes or extensions shall be binding only if confirmed in writing by Roberts-Gordon LLC's duly authorized Executive Officer.

