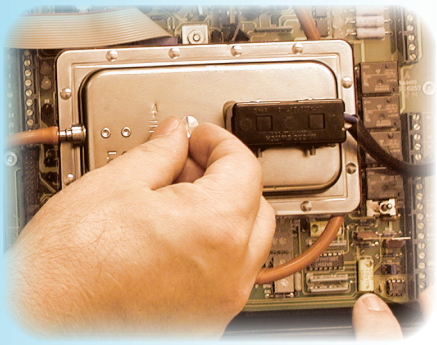
Hays Cleveland
Div. of UniControl Inc.

draft control
alarms
communications
signal retransmission
indication



low draft cutoff
high pressure cutoff
flue gas temperature

SERIES C-07720-C0 DRAFT CONTROL SYSTEM
INSTRUCTION MANUAL C-07720.11

WARNING

Do not operate or service this equipment before reading the operator's manual! Failure to do so could result in serious injury.

Alterations to hardware, wiring, or software must be approved in writing by Hays Cleveland, Division of UniControl Inc.

Your feedback is important to us! If you have comments about this document, please send them to salescombustion@unicontrolinc.com.

Revision Control

This manual is UniControl Inc. Document Number IMC07720.11 Draft Control System Manual.

DOCUMENTATION NUMBER AND REVISION LOG	
MANUAL	**REVISION DATE**
IM-C-07720.11	11/01/2015
HARDWARE	**REVISION NUMBER**
Microprocessor-based Electronics Unit	C
SOFTWARE	**REVISION NUMBER**
Controller Software	1.49

Conventions

1. This manual pertains to the application of the C-07720 Draft Control System to boiler plants. Other applications are possible.
2. Terminology (as defined by ASME CSD-1-1998 “Controls and Safety Devices for Automatically Fired Boilers”) that is used in this manual includes the following:
   a. Control: a device designated to regulate the fuel, air, water, steam, or electrical supply to the controlled equipment. It may be automatic, semiautomatic, or manual.
   b. Control, operating: an automatic control, other than a safety control, to start input, or regulate input upon satisfaction of demand.
   c. Control, primary safety: a control directly responsive to flame properties, sensing the presence of flame and, in event of ignition failure or loss of flame, causing safety shutdown.
   d. Control, safety (also known as limit): a control responsive to changes in liquid level, pressure, or temperature, which is set beyond the operating range to prevent operation beyond designed limits.

Abbreviations Used in This Manual

Term	Definition

Symbols Used in This Manual

The following symbols (if used in this manual) alert the operator to the conditions defined below.

DANGER	Danger symbol indicates an immanently hazardous situation, which, if not avoided, will result in death or serious injury.
WARNING	Warning symbol indicates a potentially hazardous situation, which, if not avoided, could result in death or serious injury.
CAUTION	Caution symbol indicates a potentially hazardous situation, which, if not avoided, could result in minor or moderate injury.
CAUTION	Caution used without the safety alert symbol indicates a potentially hazardous situation, which, if not avoided, may result in property damage.

DANGER Safety Warnings

Failure to comply in full with the following safety requirements may result in equipment damage, personal injury or death.

1. Read the entire manual to become familiar with the use and operation of this device.
2. Only qualified personnel should attempt to install, wire, commission, startup, service or operate this device.
3. This device is not suitable for use in an explosive ambient atmosphere.
4. Before working on this device, be sure that you understand the processes affected by this device completely.
5. Before working on this device, be sure that any process affected by this device is secure and safe for servicing.
6. Take appropriate precautions to avoid electric shock when working with this device near water.
7. Exercise caution while wiring or working on this device. Multiple voltage sources may be present: take appropriate precautions to avoid electric shock.
8. RFI (radio frequency interference) can affect adversely the operation of this device and devices that are connected together as a system. Do not use radios near this equipment: examples include, but are not limited to; citizen band radios (CB), walkie-talkies, transceivers, and amateur radios (HAM).

WARNING Wiring Tips

1. Remove all power from the unit before commencing any wiring operations. Wire with extreme caution!
2. All wiring must conform to the National Electrical Code and to local code regulations. Verify all electrical ratings on equipment.
3. Connecting high voltage to the low voltage circuits will damage the circuitry!
4. Mount the unit in such a manner that the wiring cable from the main electronics does not touch or approach any high magnetic sources such as motor starters, 3 ph. transformers, ignitors, etc. If mounted near a high magnetic source, electronic interference may cause the display to read incorrectly.

Storage, Handling & Unpacking

When unpacking this equipment, consult the packing list to be sure all items are present. Immediately report any missing items to the sales office where you ordered the equipment. If any part of the equipment has been damaged in transit, notify the carrier: damage claims for items shipped FOB the factory are negotiated with the carrier. Retain carton and packing materials for the claim adjuster's inspection. Retain the shipping carton for future use in case the equipment needs factory repair or calibration. The following components may be shipped individually. Specific purchase orders may include some or all of these items.

- DCS Electronics Unit
- FG probe if included
- Instruction Manual

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7.0 Customer Service Information

Tables and Drawings

1.0 INTRODUCTION

1.1 Description of Operation

The Hays Cleveland Solid State Microprocessor Draft Control System provides an economical means of controlling draft and interfacing to a burner management system or SCADA system (Supervisory Control and Data Acquisition system). This state of the art system provides an immediate, measurable improvement in fuel economy attributable to greater efficiency. The solid state design simplifies routine maintenance and greatly reduces repair expenses when compared to traditional draft controllers with mechanical switching mechanisms. The complete system includes an electronic sensor, logic panel, optional flue gas temperature indicator transmitter, draft/pressure gauge, optional low draft /high pressure cutout switch, and variable-speed floating controller assembly. Modbus communications for interface with SCADA systems or other controls is standard.

The draft sensing element is a piezoresistive silicone sensor capable of measuring positive or negative pressure. A 4–20 mA DC retransmit output is provided for remote data acquisition, recording, or other purposes. The sensor is temperature compensated; it produces an electrical output directly proportional to the pressure differential between atmosphere and the process. Adjustable electronic damping and deadband circuits are incorporated in the controller to filter out the process noise typical of draft measurement applications. Bidirectional line voltage output for electric actuators is presented through zero-crossover-switching solid state plug in relays. Actuator position feedback is not used.

The optional low draft/high pressure cut-out switch is the Cleveland Controls Series AFS sensing switch, which is specifically designed to provide precise operation and convenient features for boiler applications. The sensing switch monitors positive or negative pressure of air and noncombustible gases. It is equipped with a field adjustable set point with a 9 ± 3 second time delay relay sequence intended to prevent nuisance shutdowns caused by normal process fluctuations.

The optional flue gas temperature indicator transmitter, consisting of a thermocouple and advanced solid-state circuitry combined with microprocessor technology, provides accurate measurement and display of boiler flue gas temperatures. The thermocouple/cable assembly is a TYPE J thermocouple available in various convenient lengths, that is typically inserted into the boiler exit breeching. When the thermocouple is exposed to the media, a millivolt electric current is generated in direct proportion to the process temperature. The millivolt output is transmitted though the cable to the control assembly, where it is converted to a displayed temperature reading. The unit includes dual fail-safe SPDT contacts for remote alarm or indication. A 4–20 mA DC retransmit output is provided for remote data acquisition, recording, or other purposes. The alarm set points are adjustable from the display panel. Two alarms are offered: alarm #2 has the option of manual reset. Thermocouple failure results in a fail-safe response: the meter and retransmit output immediately go to the maximum.

The state of the art logic panel combines solid state and microprocessor technology. The logic panel interfaces with burner management systems on the market (i.e., the circuit board accommodates the wiring). 10-amp interface relays ensure reliable operation, while LED's on the I/O (input/output) assist with onboard diagnostics.

1.2 Specifications

1.21 General

Power requirements:120 V AC ± 10%, 50/60 Hz.
Ambient temperature range: 32 ºF–130º F (0 ºC–54 ºC) for electronics unit.
Fuse: One, @ 1 amp.
Housing for enclosed models: NEMA 1.
Relative Humidity: 0-90%, non-condensing.
Shipping Weight: Varies with options.
For enclosed models, 7.5–8.5 lbs.
For open-mounted models, 6.5–8.0 lbs. Add 3–4 lbs. for thermocouple assembly, if ordered.
Approvals: DEP, UL &CUL.

1.22 Draft Controller

Set point: adjustable -2.00" to +2.00" w.c. (field selectable for + or – set points).
or, adjustable -4.75” to +4.75” w.c. (field selectable for + or – set points).
Damping: adjustable, 0.0 to 15 seconds in 1.5 second increments.
Proportioning Band: adjustable, 0.03" to 0.20" w.c.
Period: fixed, 0.2 seconds.
Deadband: adjustable +/- 0.01" to 0.08" w.c.
Pressure media: dry clean gases that will not degrade polyester, vinyl, silicone or silicone-based adhesive.
Voltage output: selectable as 120 V AC switched or 24 V AC switched actuator output.

1.23 Draft Gauge

Display range: -2.00" to +2.00" w.c., fixed.
Retransmit: 4–20 mA DC directly proportional to the draft range, where
4 ma = -2.00" w.c. and 20 ma = 2.00" w.c.750 Ω maximum. (**Output is grounded but not isolated.**)

1.24 Flue Gas Temperature Gauge (optional)

Sensor:
Thermocouple, Type J, Iron and Constantan, is standard.
Suitable for use in oxidizing or reducing environments.
Thermocouple length: 50’ or 100’ (shielded).
Probe insertion up to 18".
Units: ºF or ºC.
Range: 32 °F–999 °F or 0 °C–537 °C.
Retransmit: 4–20 mA DC, directly proportional to the flue gas temperature, where 32 ºF = 4 mA DC and 999 ºF = 20 mA DC. 750 Ω maximum. Accuracy = ±5 °F. (**Output is grounded but not isolated.**)
Alarm:
Settings: 2 alarms, independently adjustable, 32 °F–999 °F or 0 °C–537 °C.
Contact rating: 10 amps, 120 V AC, SPDT, non-inductive.
Reset: Alarm 1: automatic. Alarm 2 manual or automatic.
Indication:
Visual display indicator for Alarm 1 and Alarm 2.
“Open Thermocouple” indication: in the event of thermocouple failure, the over range reading is displayed on the meter.

1.25 Low Draft/High Pressure Cutoff Switch (optional)

Range: .05–12" w.c. (draft or pressure, determine by selecting a port).
Time delay: 9 ± 3 seconds.

1.26 Modbus Communication

RTU.
9600 or 19200 Baud rate.
N/8/1 (no parity, 8 databits, 1 stop bit).

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

C - 0 7 7 2 0 - C 0 -	__ __ __ __ - __ __ - __
	A B C D E F G

1.3 Nomenclature

A= Draft Control Logic Operations

A=1 Modulating, Non-Sequencing.
(Replaces Models 7711-20 and DCP-E.)

A=2 Modulating and Sequencing with Adjustable Start Positioning Capability.
(Replaces Models 7712-41 and DCR-AS-G.)

A=3 Modulating and Sequencing with Adjustable Start Positioning Capability and Post Purge Capability.
(Replaces Models 7713-43 and DCR-AS-PP-G.)

A=4 Modulating and Sequencing with Adjustable Start Positioning Capability, Post Purge Capability, and Full Open Damper Pre-Purge Capability.
(Replaces Models 7714-20 and DCR-111.)

B= Application Options

B=0 Select whenever A=1 (Modulating and Non-Sequencing).

B=1 Gas/Oil Application.

B=2 Stoker Application (use only with A=2, above).

C= Working Range Options

C=1 Positive Pressure. Range = 0" wc to +2.0" wc.

C=2 Negative Pressure. Range = 0" wc to -2.0" wc.

C=3 Positive Pressure. Range = 0" wc to +4.75" wc.

C=4 Negative Pressure. Range = 0" wc to -4.75" wc.

D= Integral Safety Draft/Pressure Cutout Switch Wired Into Recycle Limits (Optional).

D=0 No internal air switch.

D=1 High Pressure/Low Draft Air Switch with nominal 9-second timer. **Required for DEP applications.**

E= Flue Gas Temperature (FGT) Monitoring Options

E=0 No Flue Gas Temperature (FGT) Monitoring selected.

E=1 FGT Monitoring including adjustable length “J” Type Thermocouple with 50’ cable.

E=2 FGT Monitoring including adjustable length “J” Type Thermocouple with 100’ cable.

E=3 FGT Monitoring including adjustable length “J” Type Thermocouple with special cable length.

E=4 FGT Monitoring with customer-supplied “J” Type Thermocouple.

F= Flue Gas Temperature (FGT) Hi/Hi Alarm Selection

F=0 No FGT selected. (use when E = 0).

F=1 Local Manual Reset of FGT Hi/Hi Alarm.

F=2 Remote Manual Reset of FGT Hi/Hi Alarm.

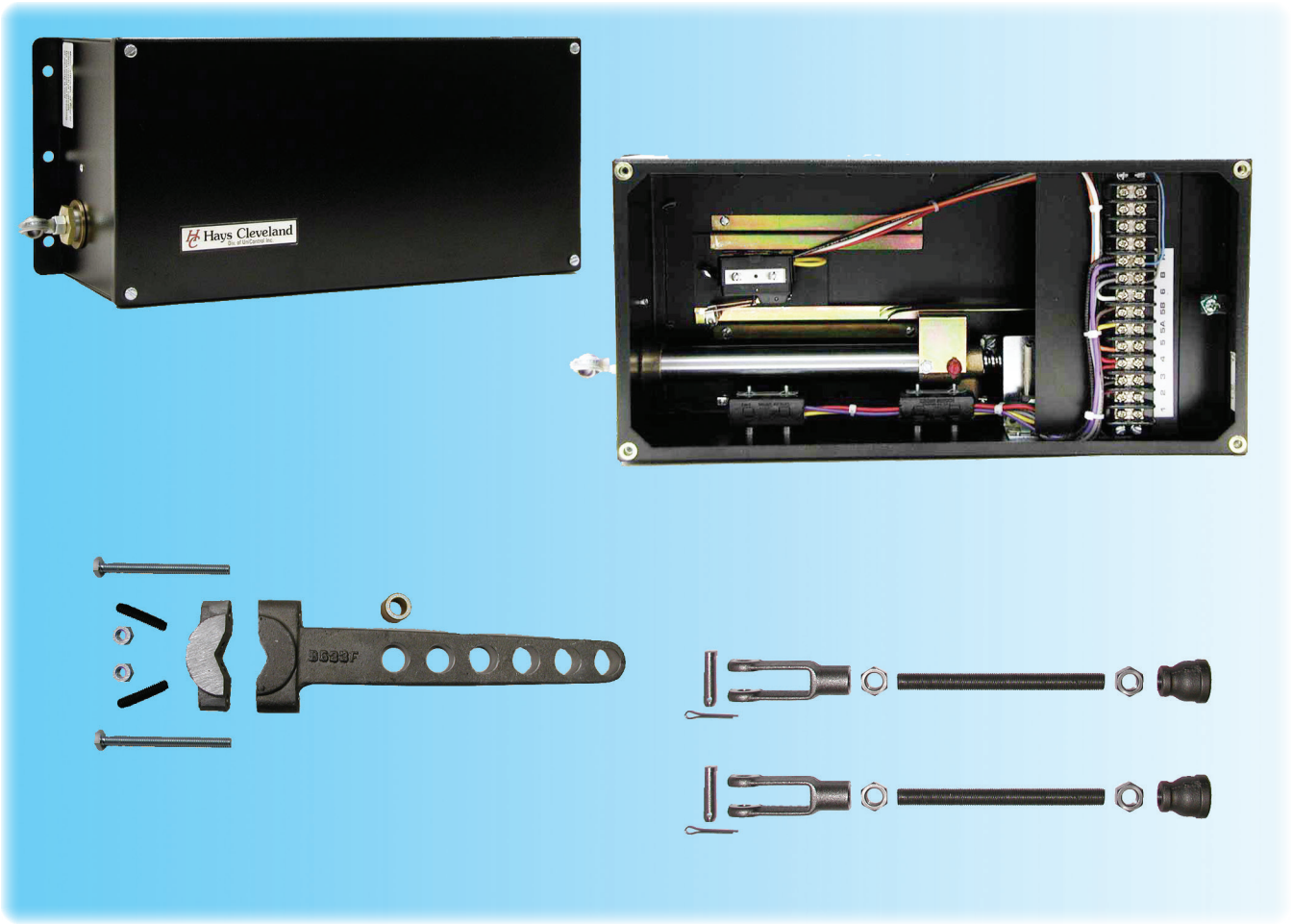
F=3 Auto Reset of FGT Hi/Hi Alarm.

G= Mounting Options

G=1 Surface Mounted NEMA 1 enclosure.

G=2 Panel Mount Kit.

G=3 Open Mount Package.



Adjustable starting draft is available with Models C-07720-*0-(2,3, or 4)XXX-XX-X when a Hays Cleveland Series F-09140-010-1-A Linear Actuator is used. Linkage for the actuator is also available: shown below, a typical set of linkage consisting of (qty. 1) P/N 11372 Damper Lever Arm assembly and (qty. 2) P/N 26908 Clevis assemblies.

For information on Hays Cleveland Series F-09140 Linear Actuators, please refer to the following literature:

For information on Hays Cleveland Series AFS-952 and AFS-952-55 Air Flow Sensing Switches, please refer to the following literature:

You may also be interested in Series D-06120 Flue Gas Temperature Meter and our line of Gauges for boiler room applications. Please refer to the following literature:

2.0 INSTALLATION

WARNING

2.1 Mounting

Mount the electronics unit in a dry location where the ambient temperatures are within the specified temperature range.

- Mount the unit away from excessive vibration.
- For open mount models, be sure that the printed circuit board is mounted with standoffs so that the board traces cannot touch the metal panel or subpanel.
- Do not mount in a wiring cabinet that has any power wiring in excess of 120 V AC.
- Mount the display unit in such a manner that the wiring cable from the main electronics does not touch or approach any high magnetic source. If mounted near a high magnetic source, electronic interference may cause the display to read incorrectly.
- Units that are equipped with the low draft/high pressure cutoff switch must be mounted with the diaphragm in the vertical plane.

2.2 Wiring

Wiring Tips
1. Wire with extreme caution!
2. All wiring must conform to the National Electrical Code and to local code regulations. Verify all electrical ratings on equipment.
3. Connecting high voltage to the low voltage circuits will damage the circuitry!
4. Mount the display unit so that the wiring cable from the main electronics does not touch or approach any high magnetic source, which could cause the display to read incorrectly due to electronic interference.
5. **Suppression for coils** is required on all relays and contactors that interface with the C-07720 DCS.
6. Three-phase wiring must be kept a minimum of 12 inches away from the printed circuit board assembly.

The following information on wiring is generally applicable to all models. Please read the additional notes in **Section 4.0 Information for Specific Models**. Refer also to the **wiring diagrams** included in this manual. (See **Appendices section of Table of Contents.)** Field wiring consists of **DC signal wiring, Modbus wiring, thermocouple wiring, and 120 V AC control wirin**g. DC signal wiring, thermocouple wiring and Modbus wiring may be run in the same conduit if practical.

DC wiring (for transmitted pressure and flue gas temperature signals) is at voltage levels of 24 V DC or less. Unless otherwise specified, all signals are 4-20 mA DC. Each signal requires a shielded 2-wire pair, 16 AWG minimum.

RS-485 Modbus wiring: plus, minus, and shield terminals are provided for Modbus communications**.** Generally, Belden 9841 shielded cable or equivalent is suggested for RS-485 communications.

Thermocouple wiring (for flue gas temperature signal) is connected directly to the draft controller. The Type J thermocouple assembly is available in several lengths (see section **1.3 Nomenclature**). Select a cable length as long or longer than needed: the cable may be shortened if necessary, but cannot be spliced. Make sure the shield is installed.

120 V AC Control wiring connects the draft control system to the burner management and the actuator. 120 V AC wiring must be 14 AWG minimum, and must not be run in conduit with low voltage signal wiring.

The general wiring diagram (Fig. 9) pertains to **non-sequencing** draft control systems. Specific wiring diagrams for various popular burner management systems interfacing with **sequencing** draft control systems are also included in this manual **as guides only**). Verify all wiring on each application: **Hays Cleveland** is not responsible for engineering changes in other manufacturers' products! Specific wiring diagrams and tie-in information for the more commonly used programming devices are available from the **Hays Cleveland Sales Office.**

2.3 Piping

A common “impulse” or “sample” line of pipe or tubing must be installed to transmit the overfire draft or pressure sample to the draft sensor. Where additional measurement points are required (such as wind box pressure or last pass draft) a separate line should be installed from the source to the sensor. Plugged tees should be used on all pipe turns to permit cleaning of the lines. Apply joint sealant to all joints. Size sample lines to suit the application.The following guidelines are provided for reference only. Specific applications often have special requirements.

Overfire Draft Connection at Boiler:

Where the sample line enters the boiler, it should be 1-½” pipe in a 2” sleeve. On new installations, the boiler specifications should call for an overfire sample line sleeve of 2” to accommodate 1-½” pipe. On existing installations, a 2” sample line sleeve should be installed through the sidewall, close to the center of the furnace and well above the fire.

The opening should be chamfered at the inside surface of the boiler wall, and the sample line should end at the chamfer, rather than extending into the firing chamber (see **Figures 48, 49,** and **50**).

The sample line should rise vertically at the boiler connection for at least 6 inches. On stoker-fired boilers, a “dirt leg” is recommended at the boiler connection.

See **Figure 48** for a brick set boiler, **Figure 49** for a water-leg boiler, and **Figure 50** for an optional method for use on conversion boilers.

Other sample line connections at the boiler:

For wind box pressure indication, the air sample should be taken from a location in the passage between the fan and the boiler where it will not be affected by turbulence or a damper opening. Avoid “dead-air” spaces in corners or ells of the passage; avoid any obstructions that would prevent an accurate air sample.

For last pass draft or pressure indication, the sample should be taken from the breeching at the boiler outlet where it is not affected by damper openings or “dead-air”. If the boiler has two outlet passages, the sample should be taken from the common breeching.

Sample line connection at instruments:

The draft controller and the overfire draft gauge should be connected separately to the common sample line. The connection between the common line and these instruments should consist of ½” pipe or –5/16” tubing no more than 18” long. Where pipe is used, unions should be installed adjacent to each instrument to facilitate installation and removal. A line should be constructed to sample fitting at the top of the draft controller housing, and to the three-way valve on the draft gauge (when a separate gauge is used).

Sample connections for wind box pressure and last pass should be to the 3-way valve on the gauges as outlined above.

For external flue gas temperature gauges and smoke indicators or controllers, follow the instructions furnished with the instruments.

Length of common sample line:	Inside diameter of pipe or tubing:
Less than 40 feet	¾"
40 to 60 feet	1"
60 to 80 feet	1-¼"
Over 80 feet	Not recommended

Table 1: Piping Recommendations

2.4 Actuator Linkage (Connection to Outlet Damper)

This section pertains specifically to **Hays Cleveland Linear Actuators**. Since **Hays Cleveland** actuators are used in the vast majority of draft control applications, we have included this information in this manual for your conveniences. If you are using a different actuator, please refer to the instructions provided with the unit.

Linkage connecting the actuator to the outlet damper consists of the following components: an adjustable lever arm, two clevis assemblies, and a length of ½" pipe (furnished by the customer). For best results, the damper should be tight fitting, but with enough clearance to move freely in the breeching. On oil or gas-fired boilers, a damper seal-stop is recommended to ensure full closure when the burner shuts off. Where a standing pilot is used, the damper should be kept slightly open during the "off" periods.

Install the actuator linkage as explained in Table 2, below (see also **Figure 7**):

Actuator Installation
1. Place the damper in the fully closed position.
2. Attach the lever arm to the damper shaft at a 45° angle to the damper (refer to **Figure 7** for vertical actuator installation or horizontal actuator installation options).
3. Insert the bronze bushing (furnished with the lever arm) in one of the holes in the lever arm. For full 6" travel, use the third hole from the rounded end.
4. Attach one clevis to the lever arm with the pin through the bushing.
5. Attach the other clevis to the actuator, with the pin through the eye in the thrust bar. The thrust bar should be fully retracted if the damper opens on the outward stroke, and fully extended if the damper opens on the inward stroke.
6. Adjust the clevis assembly until about 1" of the threaded rod extends through the adaptors.
7. Install the proper length of ½" pipe between the adaptors to complete the linkage.
8. Before operating the damper electrically with the actuator, disconnect the clevis at the actuator end by removing the pin. Operate the actuator electrically through the full cycle of travel while holding the clevis in simulated connected position and moving it to operate the damper manually. Make sure that the linkage moves freely, without restriction or binding, and that the damper moves to the maximum open and closed positions required by the particular application.
9. Reconnect the linkage and operate the damper electrically. Operating adjustments to the actuator can be made at this time, if necessary.

Table 2: Actuator Installation

3.0 OPERATION & MAINTENANCE

3.1 Continuous Display Screen

When power is applied to the unit, the continuous display screen will light. The display window indicates the following parameters:

Display	Name	Function
PV	process variable	displays actual draft or pressure.
/	micro-flipper	indicates microprocessor is running.
SPT	set point	displays selected set point.
FG	flue gas temp	displays actual flue gas temperature (optional).
A1	alarm 1	flashes when temperature exceeds alarm 1 limit (optional).
A2	alarm 2	flashes when temperature exceeds alarm 2 limit (optional).
OP	operation	↑ arrow indicates increasing output,
		↓ arrow indicates decreasing output,
		— indicates control is at set point.
PA	pressure alarm	flashes when the draft or pressure goes beyond the limit.

Table 3: Continuous Display Screen

3.2 Field Configuration

Enter the scrolling display to change and set the parameters . Press the “Enter” button repeatedly to access the desired parameter. Only the bottom line of the display will change: the top line continues to display the PV (pressure value) and the SPT (set point). Press the “Inc” button to increase the value. Press the “Dec” button to decrease the value. It is not necessary to press “Enter” after pressing “Inc” or “Dec”: the new value becomes effective immediately. The “Reset” button is used for the Manual Reset option: press it to reset FGT Indicator Transmitter Alarm 2.*
* The manual and automatic reset can be changed by the use of the application jumper located on the printed circuit board terminal block. (See Figure 4, and refer to Section 5.3 of this manual.) After the selection has been made, turn the power off and then back on to reinitialize the microprocessor.
The scrolling display includes the following parameters:

Parameter	Function
MODEL:	Displays the model number of the control as it pertains to draft logic. Model changes are made by changing the jumper located on the main printed circuit board. Once the model has been selected, turn the power to the unit off and then on again to reinitialize the microprocessor.
SETPOINT:	Displays and allows the set point to be changed. Note that the set point must be set for either positive or negative control, by means of a jumper located on the printed circuit board. Power must be cycled to activate a positive/negative control change.
DEADBAND:	Displays and allows the dead band to be changed.
PROPBAND:	Displays and allows the proportioning band to be changed.
DAMPING:	Displays and allows the damping to be changed.
PREPURGE TMR:	Displays & allows the prepurge timer to be changed (C-07720-*0-4XXX-XX-X).
POSTPURGE TMR:	Displays & allows the post purge timer to be changed (C-07720-*0-4XXX-XX-X).
FG UNITS:	Displays and allows the flue gas units to be toggled between ºC and ºF. (Optional).
FG ALM1:	Displays and allows the trip point for the flue gas alarm 1 to be changed. (Optional).
FG ALM2:	Displays and allows the trip point for the flue gas alarm 2 to be changed. (Optional).
MODBUS ADDR:	Displays and allows the Modbus address to be changed.
BAUD RATE:	Displays and allows the Modbus baud rate to be changed.

Table 4: Field Configuration

3.3 Close / Auto / Open Switch

The toggle switch located on the printed circuit board should be placed in the **AUTO** position for normal operation of the draft control system. In the **CLOSE** position the switch bypasses all automatic functions and closes the damper. In this position the limit string is opened and the boiler cannot be fired. The **CLOSE** position is used for testing and for servicing purposes. In the **OPEN** position the switch bypasses all automatic functions and opens the damper. In this position the limit string is closed and the boiler can be fired. The **OPEN** position is used to permit boiler operation during servicing.

3.4 The Low Draft (or High Pressure) Cutoff Switch

WARNING For installations that do not already have or require a **separate** air switch, an **integral** air switch is available for **Series C-07720-C0 Draft Control Systems** (see selection "**D**" in **Model Nomenclature**, section 1.3 of this manual). The information below pertains to the optional integral air switch only. For wiring separate air switches, please refer to **Figures 5** and **10 through 47** in this manual.

The plated housing contains a diaphragm, a calibration spring and a snap-acting SPDT switch. The barbed sample connections on either side of the diaphragm accept flexible slip-on tubing, which is connected (at the factory) in one of the following two configurations:

- The Top Port of the air switch is connected for low pressure cutoff applications. (Model C-07720-C0-AB21-EF-G).
- The Bottom Port of the air switch is connected for high pressure cutoff applications. (Model C-07720-C0-AB11-EF-G).

Confirm that this connection is correctly configured before operating the system.

Before pressure is applied to the diaphragm, the switch contacts will be in the normally closed (NC) position.

The set point adjustment range of the air switch is 0.05±.02"w.c. to 12.0"w.c. To adjust the set point, turn the **adjusting screw** counterclockwise until motion has stopped. Next,turn the adjusting screw 4 complete turns clockwise to engage the spring. From this point, the next ten turns calibrate the switch. Each full turn represents approximately 1.2" w.c. **Please note**: to properly calibrate this or any air switch, a digital manometer or other measuring device should be used to confirm the actual set point.

DANGER A safety switch must be present to prevent the possibility of firing the boiler when the draft (whether natural or induced) is insufficient. On balanced draft systems, the switch cuts off firing when the draft falls below a selected minimum set point. On pressure-fired systems, the switch cuts off firing when the pressure exceeds a selected maximum set point. In either case, nuisance shutdowns due to momentary "puffs" or fluctuations are avoided by means of a 9 ± 3 second delay relay in the **C-07720 Draft Control System**.

3.4.1 Changing from a Negative-fired to a Positive-fired Application:

1. Remove power from unit.
2. Move jumper on S3 from negative (1-2) position to the positive (2-3) position.
3. Move the red wire from terminal 10 to terminal 11.
4. Move the blue wire from terminal 11 to terminal 10.
5. Move the sample line connection on the low draft switch from the low port to the high port.
6. Reapply power and adjust the set point to a positive setting.

3.4.2 Changing from a Positive-fired to a Negative-fired Application:

1. Remove power from unit.
2. Move jumper on S3 from positive (2-3) position to the negative (1-2) position.
3. Move the red wire from terminal 11 to terminal 10.
4. Move the blue wire from terminal 10 to terminal 11.
5. Move the sample line connection on the low draft switch from the high port to the low port.
6. Reapply power and adjust the set point to a negative setting.

3.5 Adjustments

Display	Procedure ⚠ CAUTION
MODEL	To change model, select the correct combination of jumpers. Reinitialize the controller by turning the power off and then on. Take care when choosing a model: some models have modulation and timing features that may not be suitable for a specific application. Note: if choosing model C-07720-2, either the GAS/OIL or the STOKER application setting must be selected: for the STOKER application, jumper STK1 to STK2.
SET POINT	Make adjustments to the set point under firing conditions. The draft control must be powered, and the toggle switch on the printed circuit board must be in the AUTO position. Select SETPOINT from the scrolling displays and use the “Inc” or the “Dec” key to increase or decrease the set point. Make small changes while observing the draft or pressure reading on the display screen and permitting the actuator and damper to “settle out” after each change, until the most effective set point is located.
DEADBAND	This adjustment establishes a zone of operation above and below the set point, within which the draft controller does not produce a control action output. It establishes the magnitude of the error that results in minimal corrective control action. Select DEADBAND from the scrolling displays and use the “Inc” or the “Dec” key to increase or decrease the dead band. Make small changes while observing the draft or pressure reading on the display screen and permitting the actuator and damper to “settle out” after each change, until the most effective dead band is located.
PROPBAND	This adjustment establishes the magnitude of pressure deviation from set point required to cause the damper actuator to run at full speed in one direction, plus the opposite deviation required to cause the actuator to run full speed in the opposite direction. Pressure deviations within the proportioning band will cause the actuator to run at speeds that are proportional to the amount of deviation. Wide proportioning band settings may result in unacceptable pressure deviations under varying operating conditions. Select PROPBAND from the scrolling displays and use the “Inc” or the “Dec” key to increase or decrease the proportioning band. Make small changes while observing the draft or pressure reading on the display screen and permitting the actuator and damper to “settle out” after each change, until the most effective proportioning band is located.
DAMPING	This adjustment is a means of slowing down the controller response to the input signal so that minor deviations from the set point do not result in a change in the controller output. Proper damping keeps the controller from responding to draft signal “noise” or burner pulsations. Select DAMPING from the scrolling displays and use the “Inc” or the “Dec” key to increase or decrease the damping. Make small changes while observing the draft or pressure reading on the display screen and permitting the actuator and damper to “settle out” after each change, until the most effective damping is located. **Excessive** damping may result in a rhythmic “hunting” of the damper which must be corrected by reducing the damping.
PREPURGE TMR	(Optional) **Applies only to model C-07720-4**. Set the timer from 20–120 seconds to obtain the proper number of air changes. Select PREPURGE TMR from the scrolling displays and use the “Inc” or the “Dec” key to increase or decrease the setting.
POSTPURGE TMR	(Optional) **Applies only to model C-07720-4.** Set the timer from 0–120 seconds to obtain the proper number of air changes. Select POSTPURGE TMR from the scrolling displays and use the “Inc” or the “Dec” key to increase or decrease the setting.
FG UNITS	Optional) **Select ºF or ºC units** for the flue gas reading. Select the FG UNITS from the scrolling displays and use the “Inc” or the “Dec” key to toggle between the F or the C.
FG ALM1	(Optional) **Set the trip point for the flue gas temperature indicator transmitter alarm #1.** This alarm automatically resets when the temperature goes below the trip point. Select FG ALM1 from the scrolling displays and use the “Inc” or the “Dec” key to increase or decrease the trip point setting.

(contiinued)

Table 5: Adjustments

Display	Procedure ⚠ CAUTION
FG ALM2	(Optional) **Set the trip point for the flue gas temperature indicator transmitter alarm #2.** First set the alarm to either manual or automatic reset by jumpering terminals FGT-2 & ALM RST on the terminal strip. After the jumper has been changed, reinitialize the controller by turning the power off and then on. In the **automatic reset** mode the alarm resets when the temperature goes below the trip point. In the **manual reset** mode the alarm can be reset only if the temperature goes below the trip point **and** the “Reset” button is depressed. The “Reset” button is located on the front of the display panel or, if wired, the button can be remote. Select FG ALM2 from the scrolling displays and use the“Inc” or the “Dec” key to increase or decrease the trip point setting.
MODBUS ADDRESS	Set the Modbus address from 001– 247, using the “Inc” key to increase the value or the “Dec” key to decrease the value.
BAUD RATE	Select a baud rate of 9600 or 19200, using the “Inc” or the “Dec” key to toggle between these values.

Table 5: Adjustments, continued from previous page.

4.0 INFORMATION FOR SPECIFIC MODELS

4.1 Model C-07720-C0-1 Non-sequencing Draft Controller

4.1.1 Application

For continuous remote, electrical, modulating control of draft on any type of boiler, fired by any fuel; this model is equally efficient on positive or negative pressure applications.

4.1.2 Features of Model C-07720-C0-1

- A selector switch is provided to permit manual damper positioning (closed/open only).
- Proportioning band adjustment eliminates the control instability that can result from furnace pressure pulsations without sacrificing sensitivity.
- Adjustments eliminate instability due to “hunting.”
- Adjustments are easy to access and use. No tools are needed. Visual indication is provided.

4.1.3 Operation

A continuous sample of overfire draft provides the control signal to start, stop, or reverse the actuator motor. Movement of the actuator drive arm positions the damper to maintain the selected draft rate to ensure maximum efficiency.

4.1.4 Wiring

WARNING

Refer to **Figure 9: External Wiring for Series C-07720-C0-1 Non-Sequencing Draft Control System**. The following procedure applies only when the Hays Cleveland F-09140-000-1-A Linear Actuator is used with the Model C-07720-C0-1 Non-sequencing Draft Controller. If another actuator is used, refer to the appropriate wiring diagram in this manual.

Terminal	Procedure
1	Wire terminal 1 to line source, 120 volt, 60 cycles. **Hot (black) wire.** Wire also to terminal 1 of the **Hays Cleveland Actuator Model F-09140-000-1-A** or equal.
2	Wire terminal 2 to line source, 120 volt, 60 cycles. **Neutral (white) wire.** Wire also to terminal 2 of the **Hays Cleveland Actuator Model F-09140-000-1-A** or equal.
3	To close damper on **inward** stroke, wire to terminal 3 of the **Hays Cleveland Actuator Model F-09140-000-1-A** or equal.
4	To open damper on **outward** stroke, wire to terminal 4 of the **Hays Cleveland Actuator Model F-09140-000-1-A** or equal.

Table 6: Wiring Model C-07720-C0-1

4.2 Model C-07720-C0-2 Sequencing Draft Controller with adjustable start option

4.2.1 Application

For remote, electrical, modulating and sequencing and sequencing control of draft on any type of boiler, fired by any fuel; this model is equally efficient on positive or negative pressure applications. The **Model C-07720-C0-2** provides **modulating and sequencing** draft control. Additionally, **adjustable starting draft** is available when used with a **Series F-09140-010-1-A Linear Actuator** (which is equipped with this feature).

4.2.2 Features of Model C-07720-C0-2

- Period of delay before firing is not based on specific time interval. Damper must be full open or at adjustable start position before firing can start.
- Flame failure of gas or oil burners causes damper to go to full open (or adjustable start position) and then to the closed position. The damper remains closed until the lockout on the flame safeguard is cleared.
- Burners shut off automatically if the toggle switch is moved to the “Closed” position.
- Safe emergency maintenance firing is possible without sequence control by means of Open Damper Firing Switch.
- Adjustable proportioning band eliminates control instability resulting from furnace pressure pulsations without sacrificing sensitivity.
- All adjustments are readily accessible and easy to make without the need for tools. Visual indication shows the amount of adjustment made.

4.2.3 Sequence of Operation for Model C-07720-C0-2 DCS with Series F-09140 Linear Actuators

A continuous sample of overfire draft provides the control signal to start, stop, or reverse the actuator motor. Movement of the actuator drive arm positions the damper to maintain the selected draft rate to ensure maximum efficiency.

4.2.3.1 Standard (applies to most applications)

1. **Call for heat**: power is applied to terminal D (Limits-In); D21is lit on the draft controller.
2. The controller applies power to terminal 6 (D3 is lit) and the actuator drives to the **adjustable start** position **(if model F-0914X-0101)** or the actuator drives to the **open damper** position **(if model F-0914X-0000)**.
3. When the actuator reaches the **adjustable start** position **(if model F-0914X-0101)** or the **open damper** position **(if model F-0914X-0000, terminals 5 to 5A jumpered)**, **end of travel** signal is sent to terminal 5 of the draft controller. D1 is lit on the draft controller.
4. When sufficient draft has been maintained for 9 ± 3 seconds, D15 is lit; the **D to C circuit** is made (Limits Out, D16 is lit).
5. At this point, the flame safeguard starts its **light off** sequence.
6. When the fuel valve is energized, D22 is lit; the draft controller is **released to modulation**.

7a. **Gas or Oil Applications:** when the call for heat cycle is complete and power is removed from terminal D, the actuator drives to the **closed** position.

7b. **Stoker Applications:** when the call for heat cycle is complete and power is removed from terminal D, **modulation** of the damper continues until the next call for heat.

If Flame Failure Occurs:

1. Flame safeguard removes the fuel valve input.
2. Actuator goes to the adjustable start position.
3. Flame safeguard removes the burner input and the actuator closes the damper.

If Pilot Flame Failure Occurs:

1. Actuator goes to the adjustable start position.
2. Flame safeguard removes the burner input and the actuator closes the damper.

4.2.3.2 Fireye Burner Logix Z

1. The Z model of the Burner Logix BMS has the ability to maintain header pressure or temperature through a sensor and to modulate the boiler's firing rate.The Burner Logix Z does not provide a limit string interface for the C-07720-C0 DCS; therefore the limit string is routed through the C and NO spare relay contacts of the C-07720-C0. These contacts are held closed during normal operation. When the low draft cutoff switch senses a low draft condition, or the open/auto/close damper switch is in the "close" position, or power to the unit is interrupted, the spare relay terminals open, thereby opening the limit string to the Burner Logix.
2. The blower motor signal is applied to terminal D (Limits-In D21) and terminal L (Blower Motor D24) of the C-07720-C0-2 draft controller.
3. When the linear actuator reaches the adjustable start position (F-09141-0101 models), **OR** the open damper position (F-09141-0000 models, 5 to 5A jumpered) end of travel signal is sent to terminal 5 of the C-07720-C0-2 draft controller and D1 is lit.
4. When sufficient draft has been maintained for 8 seconds, D15 is lit: the D to C circuit is made (Limits Out, D16 is lit).
5. The Burner Logix Z flame safeguard begins its light off sequence.
6. When the fuel valve is energized (D22 is lit), the draft controller is released to modulation.
7. When the call for heat cycle is complete and power is removed from terminal D, the actuator drives to the closed position.

If Flame Failure Occurs:

1. Flame safeguard removes the fuel valve input.
2. Actuator goes to the adjustable start position.
3. Flame safeguard removes the burner input and the actuator closes the damper.

If Pilot Flame Failure Occurs:

1. Actuator goes to the adjustable start position.
2. Flame safeguard removes the burner input and the actuator closes the damper.

4.2.3.3 Siemens LMV 51/52

1. The Siemens LMV 51/52 has the ability to maintain header pressure or temperature through a sensor and modulate the boiler's firing rate. The LMV 51/52 does not provide a limit string interface for the C-07720-C0 DCS; therefore the limit string is routed through the C and NO spare relay contacts of the C-07720-C0. These contacts are held closed during normal operation. When the low draft cutoff switch senses a low draft condition, or the open/auto/close damper switch is in the "close" position, or power to the unit is interrupted, the spare relay terminals open, thereby opening the limit string to the LMV 51/52.
2. The start circuit signal is applied to terminal D (Limits-In D21) and the blower motor powers terminal L (Blower Motor D24) of the C-07720-C0-2 draft controller.
3. When the linear actuator reaches the adjustable start position (F-09141-0101 models), **OR** the open damper position (F-09141-0000 models, 5 to 5A jumpered) end of travel signal is sent to terminal 5 of the C-07720-C0-2 draft controller and D1 is lit.
4. When sufficient draft has been maintained for 8 seconds, D15 is lit: the D to C circuit is made (Limits Out, D16 is lit).
5. The Siemens LMV 51/52 flame safeguard begins its light off sequence.

6. When the fuel valve is energized (D22 is lit), the draft controller is released to modulation.
7. When the call for heat cycle is complete and power is removed from terminal D, the actuator drives to the closed position.

If Flame Failure Occurs:

1. Flame safeguard removes the fuel valve input.
2. Actuator goes to the adjustable start position.
3. Flame safeguard removes the burner input and the actuator closes the damper.

If Pilot Flame Failure Occurs:

1. Actuator goes to the adjustable start position.
2. Flame safeguard removes the burner input and the actuator closes the damper.

4.2.4 Wiring

WARNING This procedure applies when the **Hays Cleveland F-09140-010-1-A Linear Actuator** is used with the **Model C-07720-C0-2 Sequencing Draft Controller**. The draft control system is, in effect, an automatic switch in series with other primary controls. It should be the last control in the control circuit before the line starter or burner starting device. No operating or safety switch should be allowed to start the firing device without first going through the draft controller sequence.

Because the damper should be closed on gas or oil-fired boilers, but modulated on stoker-fired boilers during “off” periods, an “application jumper” in the controller adapts it to the fuel used. Make sure that the jumper on the pc board is properly positioned for the application. Follow the specific wiring instructions in Tables 7A and 7B.

Terminal	Procedure
1	Wire terminal 1 to line source, 120 volt, 60 cycles. **Hot (black) wire.** Wire also to terminal 1 of the **Hays Cleveland Actuator Model F-09140-000-1-A** or equal.
2	Wire terminal 2 to line source, 120 volt, 60 cycles. **Neutral (white) wire.** Wire also to terminal 2 of the **Hays Cleveland Actuator Model F-09140-000-1-A** or equal.
3	To close damper on inward stroke, wire to terminal 3 of the **Hays Cleveland Actuator Model F-09140-010-1-A** or equal.
4	To open damper on outward stroke, wire to terminal 4 of the **Hays Cleveland Actuator Model F-09140-010-1-A** or equal.
5	For “adjustable start” signal, wire to terminal 5 of the **Hays Cleveland Actuator Model F-09140-010-1-A** or equal.
5A	For “open damper” signal, wire to terminal 5A of the **Hays Cleveland Actuator Model F-09140-010-1-A** when the outward stroke opens the damper. When the inward stroke opens the damper, wire to terminal 5B of the actuator, and interchange the wires on terminals 3 and 4.
6	The draft control system is shipped from the factory with terminals 4 and 6 jumpered. When an actuator with the adjustable start feature is used, remove this jumper and wire terminal 6 to terminal 6 of the actuator.

Table 7A: Wiring Model C-07720-C0-2

Terminal	Procedure
A	For most applications,Terminal A is jumpered to Terminal 2. When the limit string has a different power source than terminals 1 and 2, terminal A is wired to the L2 side of the limit string.
B	For most applications,Terminal B is jumpered to Terminal A. When the fuel valve is powered by a different line source than the limit string, wire Terminal B to the L2 side of the fuel valve. For stoker applications, Terminal B is wired to the L2 side of the stoker starter coil.
C	Terminal C is wired to the limits terminal of the flame safeguard.On stoker applications, Terminal C is wired to L1 of the stoker starter coil.
D	Terminal D is the limit string input. Normally, the draft controller is the last item in the limit string.
E	Terminal E is wired to the L1 side of the fuel valve. For stoker applications, Terminal E is wired to the L1 side of the stoker starter cable.
L	Terminal L is wired to the terminal of the flame safeguard control that supplies power during the purge cycle, if available. This is usually the burner motor terminal. When this terminal is not available, jumper Terminal L to Terminal C.
M	For most applications,Terminal M is jumpered to Terminal B. When the burner motor has a different power source than Terminals 1 and 2, wire Terminal M to the L2 side of the burner motor.
STK1 & 2	For stoker applications only, Jumper STK1 to STK2.

Table 7B: Wiring Model C-07720-C0-2

4.3 Model C-07720-C0-3 Sequencing Draft Control System with post purge and adjustable start option

4.3.1 Application

For remote, electrical, modulating and sequencing control of draft on any gas or oil-fired boilers; this model is equally efficient on positive or negative pressure applications. The Model C-07720-C0-3 provides **modulating** and **sequencing** draft control with post purge when used with a **Series F-09140-010-1-ALinear Actuator** or equal. Additionally, **adjustable starting draft** is available when used with a **Series F-09140-010-1-A Linear Actuator** (which is equipped with this feature).

4.3.2 Features of Model C-07720-C0-3

• Period of delay before firing is not based on specific time interval. Damper must be full open before firing can start.

• Flame failure of gas or oil burners causes damper to go to full open (or adjustable start position). Damper stays at open purge position until flame is reestablished.

• Burners shut off automatically if the toggle switch is moved to the “Closed” position.

• Safe emergency maintenance firing is possible without sequence control by means of Open Damper Firing Switch.

• Integral post purge timing, fixed at 20 seconds (when not available from flame safeguard).

• Provision for delayed start of burner motor.

• Adjustable proportioning band eliminates control instability resulting from furnace pressure pulsations without sacrificing sensitivity.

• All adjustments are readily accessible and easy to make without the need for tools. Visual indication shows the amount of adjustment made.

4.3.3 Operation

A continuous sample of overfire draft provides the control signal to start, stop, or reverse the actuator motor. Movement of the actuator drive arm positions the damper to maintain the selected draft rate to ensure maximum efficiency. The purge delay is furnished to provide purge timing only when such timing is not available from the flame safeguard.

4.3.3.1 Standard (applies to most applications)

1. Call for heat: power is applied to terminal D (Limits-In); D21is lit on the draft controller.

2.The controller applies power to terminal 6 (D3 is lit) and the actuator drives to the adjustable start position **(if model F-0914X-0101)** or the actuator drives to the open damper position **(if model F-0914X-0000)**.

3. When the actuator reaches the **adjustable start** position **(if model F-0914X-0101)** or the **open damper** position **(if model F-0914X-0000, terminals 5 to 5A jumpered)**, end of travel signal is sent to terminal 5 of the draft controller. D1 is lit on the draft controller.

4. When sufficient draft has been maintained for 9 ± 3 seconds, D15 is lit; the D to C circuit is made (Limits Out, D16 is lit).

5. At this point, the flame safeguard starts its light off sequence.

6. When the fuel valve is energized, D22 is lit; the draft controller is released to modulation.

7. When the call for heat cycle is complete and power is removed from terminal D, the actuator drives to the open damper position. After the post purge timer has expired, the actuator drives to the closed position.

If Flame Failure Occurs:

1. Flame safeguard removes the fuel valve input.

2. Actuator goes to the open damper position for post purge.

3. Flame safeguard removes the burner input and the actuator closes the damper.

If Pilot Flame Failure Occurs:

1. Actuator goes to the open damper position for post purge.

2. Flame safeguard removes the burner input and the actuator closes the damper.

4.3.3.2 Fireye Burner Logix Z

1. The Z model of the Burner Logix BMS has the ability to maintain header pressure or temperature through a sensor and to modulate the boiler's firing rate.The Burner Logix Z does not provide a limit string interface for the C-07720-C0 DCS; therefore the limit string is routed through the C and NO spare relay contacts of the C-07720-C0. These contacts are held closed during normal operation. When the low draft cutoff switch senses a low draft condition, or the open/auto/close damper switch is in the "close" position, or power to the unit is interrupted, the spare relay terminals open, thereby opening the limit string to the Burner Logix.

2. The blower motor signal is applied to terminal D (Limits-In D21) and terminal L (Blower Motor D24) of the C-07720-C0-2 draft controller.

3. When the linear actuator reaches the adjustable start position (F-09141-0101 models), **OR** the open damper position (F-09141-0000 models, 5 to 5A jumpered) end of travel signal is sent to terminal 5 of the C-07720-C0-2 draft controller and D1 is lit.

4. When sufficient draft has been maintained for 8 seconds, D15 is lit: the D to C circuit is made (Limits Out, D16 is lit).

5. The Burner Logix Z flame safeguard begins its light off sequence.

6. When the fuel valve is energized (D22 is lit), the draft controller is released to modulation.

7. When the call for heat cycle is complete and power is removed from terminal D, the actuator drives to the open damper position. After the post purge timer has expired, the actuator drives to the closed position.

If Flame Failure Occurs:

1. Flame safeguard removes the fuel valve input.

2. Actuator goes to the open damper position for post purge.

3. Flame safeguard removes the burner input and the actuator closes the damper.

If Pilot Flame Failure Occurs:

1. Actuator goes to the open damper position for post purge.

2. Flame safeguard removes the burner input and the actuator closes the damper.

4.3.3.3 Siemens LMV 51/52

1. The Siemens LMV 51/52 has the ability to maintain header pressure or temperature through a sensor and modulate the boiler's firing rate. The LMV 51/52 does not provide a limit string interface for the C-07720-C0 DCS; therefore the limit string is routed through the C and NO spare relay contacts of the C-07720-C0. These contacts are held closed during normal operation. When the low draft cutoff switch senses a low draft condition, or the open/auto/close damper switch is in the "close" position, or power to the unit is interrupted, the spare relay terminals open, thereby opening the limit string to the LMV 51/52.

2. The start circuit signal is applied to terminal D (Limits-In D21) and the blower motor powers terminal L (Blower Motor D24) of the C-07720-C0 draft controller.

3. When the linear actuator reaches the adjustable start position (F-09141-0101 models), **OR** the open damper position (F-09141-0000 models, 5 to 5A jumpered) end of travel signal is sent to terminal 5 of the C-07720-C0-2 draft controller and D1 is lit.

4. When sufficient draft has been maintained for 8 seconds, D15 is lit: the D to C circuit is made (Limits Out, D16 is lit).

5. The Siemens LMV 51/52 flame safeguard begins its light off sequence.

6. When the fuel valve is energized (D22 is lit), the draft controller is released to modulation.

7. When the call for heat cycle is complete and power is removed from terminal D, the actuator drives to the open damper position. After the post purge timer has expired, the actuator drives to the closed position.

If Flame Failure Occurs:

1. Flame safeguard removes the fuel valve input.

2. Actuator goes to the open damper position for post purge.

3. Flame safeguard removes the burner input and the actuator closes the damper.

If Pilot Flame Failure Occurs:

1. Actuator goes to the open damper position for post purge.

2. Flame safeguard removes the burner input and the actuator closes the damper.

4.3.4 Wiring

This procedure applies when the **Hays Cleveland F-09140-010-1-A Linear Actuator** is used with the **Model C-07720-C0-3 Sequencing Draft Controller**).

WARNING

The draft control system is, in effect, an automatic switch in series with other primary controls. It should be the last control in the control circuit before the line starter or burner starting device. No operating or safety switch should be allowed to start the firing device without first going through the draft controller sequence.

Terminal	Procedure
1	Wire terminal 1 to line source, 120 volt, 60 cycles. **Hot (black) wire.** Wire also to terminal 1 of the **Hays Cleveland Actuator Model F-09140-000-1-A** or equal.
2	Wire terminal 2 to line source, 120 volt, 60 cycles. **Neutral (white) wire.** Wire also to terminal 2 of the **Hays Cleveland Actuator Model F-09140-000-1-A** or equal.
3	To close damper on inward stroke, wire to terminal 3 of the **Hays Cleveland Actuator Model F-09140-010-1-A** or equal.
4	To open damper on outward stroke, wire to terminal 4 of the **Hays Cleveland Actuator Model F-09140-010-1-A** or equal.
5	For “adjustable start” signal, wire to terminal 5 of the **Hays Cleveland Actuator Model F-09140-010-1-A** or equal.
5A	For “open damper” signal, wire to terminal 5A of the **Hays Cleveland Actuator Model F-09140-010-1-A** when the outward stroke opens the damper. When the inward stroke opens the damper, wire to terminal 5B of the actuator, and interchange the wires on terminals 3 and 4.
6	The draft control system is shipped from the factory with terminals 4 and 6 jumpered. When an actuator with the adjustable start feature is used, this jumper should be removed, and terminal 6 should be wired to terminal 6 of the actuator.

Table 8A: Wiring Model C-07720-C0-3

Terminal	Procedure
A	For most applications,Terminal A is jumpered to Terminal 2. When the limit string has a different power source than terminals 1 and 2, terminal A is wired to the L2 side of the limit string.
B	For most applications,Terminal B is jumpered to Terminal A. When the fuel valve is powered by a different line source than the limit string, wire Terminal B to the L2 side of the fuel valve.
C	Terminal C is wired to the limits terminal of the flame safeguard.
D	Terminal D is the limit string input. Normally, the draft controller is the last item in the limit string.
E	Terminal E is wired to the L1 side of the fuel valve.
L	Terminal L is wired to the terminal of the flame safeguard control that supplies power during the purge cycle, if available. This is usually the burner motor terminal. When this terminal is not available, jumper Terminal L to Terminal C.
M	For most applications,Terminal M is jumpered to Terminal B. When the burner motor has a different power source than Terminals 1 and 2, wire Terminal M to the L2 side of the burner motor.

Table 8B: Wiring Model C-07720-C0-3

4.4 Model C-07720-C0-4 Sequencing Draft Control System with full open damper prepurge, post purge, and adjustable start option

4.4.1 Application

For remote, electrical, modulating and sequencing control of draft on any gas or oil-fired boiler ; this model is equally efficient on positive or negative pressure applications. The Model C-07720-C0-4 provides **modulating** and **sequencing** draft control with **full open damper prepurge** and **post purge** when used with a **Series F-09140-010-1-A Linear Actuator**. Additionally, **adjustable starting draft** is available when used with a **Series F-09140-010-1-A Linear Actuator** (which is equipped with this feature).

4.4.2 Features of Model C-07720-C0-4

- Period of delay before firing is not based on a specific time interval. Sufficient flow through the boiler must be established before firing can start.
- Pilot flame failure or failure of the gas/oil burners causes the damper to open for a post purge cycle and then close and remain closed until the lockout on the flame safeguard is cleared.
- Adjustable pre-purge timing.
- Adjustable post purge timing.
- Adjustable proportioning band eliminates control instability.
- All adjustments are readily accessible and easy to make without the need for tools. Visual indication shows the amount of adjustment made.

4.4.3 Operation

With the operating limits open, the actuator drive arm is fully retracted and the damper is closed. When the operating limits are made, the actuator drive arm extends and opens the damper. When there is sufficient flow through the boiler, the flame safeguard begins its start-up cycle. When the actuator reaches the full open position, the pre-purge timer starts. When the timer expires, the “proof of open damper” contact closes and the actuator arm retracts toward the adjustable start position. When the actuator reaches the adjustable start position, after an 8-second delay, the “proof of adjustable start” contacts close. When the fuel valve is energized the draft controller begins to modulate the damper.

When the call for heat is satisfied and the limit string opens, the actuator drives the damper to the open position for the post purge sequence. When the post purge sequence is complete, the actuator drives the damper to the closed position.

4.4.3.1 Standard (applies to most applications)

1. Call for heat: power is applied to terminal D (Limits-In); D21is lit on draft controller.
2. The J to K circuit is completed (D17 is lit) and the ID fan is started.
3. The controller applies power to terminal 4 and actuator drives to open damper position.
4. When sufficient draft is established (terminals 9 to 10), the D to C circuit is made (D16 is lit).
5. At this point, the flame safeguard starts its light off sequence, and power is applied to the burner input, terminal L (D24). When the actuator reaches the open damper position,D2 is lit; the prepurge timer starts timing.
6. When the prepurge timer has expired, the 16 to 17 circuit is made (D6 is lit), completing the purge interlock circuit. Power is applied to terminal 6 (D3 is lit) and the actuator is driven to the adjustable start position.
7. When the actuator reaches the adjustable start position power is applied to terminal 5 of controller (D1 lit).
8. The 14 to 15 circuit is made (D3 is lit) after 9 ± 3 seconds and this completes the low fire interlock circuit.
9. When the fuel valve is energized, D22 is lit; the draft controller is released to modulation.
10. When the call for heat cycle is complete and power is removed form terminal D, the actuator drives to the

open damper position. When the post purge timer has expired or the burner motor is off, depending on which one is longer, the ID fan is turned off and the actuator drives closed.

11. The ID fan is turned off when the Flame safeguard turns the burner motor off.

If Flame Failure Occurs:

1. Flame safeguard removes the fuel valve input.
2. Actuator goes to the open damper position for post purge.
3. Flame safeguard removes the burner input.
4. The ID fan is turned off and the actuator is driven to the closed damper positioin when the post purge timer expires or the burner input is removed (whichever is greater).

If Pilot Flame Failure Occurs:

1. Flame safeguard removes the burner input.
2. Actuator drives to the open damper position.
3. When the post purge timer expires, the ID fan is turned off and the actuator is driven to the closed position.

4.4.3.2 Fireye Burner Logix Z

1. The Z model of the Burner Logix BMS has the ability to maintain header pressure or temperature through a sensor and to modulate the boiler's firing rate.The Burner Logix Z does not provide a limit string interface for the C-07720-C0 DCS; therefore the limit string is routed through the C and NO spare relay contacts of the C-07720-C0. These contacts are held closed during normal operation. When the low draft cutoff switch senses a low draft condition, or the open/auto/close damper switch is in the "close" position, or power to the unit is interrupted, the spare relay terminals open, thereby opening the limit string to the Burner Logix.
2. The blower motor signal is applied to terminal D (Limits-In D21) and terminal L (Blower Motor D24) of the C-07720-C0-2 draft controller.
3. The controller applies power to terminal 4 and the actuator drives to open damper position.
4. When sufficient draft is established (terminals 9 to 10), the D to C circuit is made (D16 is lit).
5. The Burner Logix Z flame safeguard begins its light off sequence; power is applied to the burner input, terminal L (D24). When the actuator reaches the open damper postion, D2 is lit and the prepurge timer starts.
6. When the prepurge timer has expired, the 16 to 17 circuit is made; D6 is lit, which completes the purge interlock circuit. Power is applied to terminal 6 (D3 is lit), and the actuator is driven to the adjustable start position.
7. When the actuator reaches the adjustable start position, power is applied to terminal 5 of the draft controller (D1 is lit).
8. After 8 seconds, the 14 to 15 circuit is made (D3 is lit). This completes the low fire interlock circuit.
9. When the fuel valve is energized (D22 is lit), the draft controller is released to modulation.
10. When the call for heat cycle is complete and power is removed from terminal D, the actuator drives to the open damper position.
11. The ID fan is turned off and the actuator drives to the closed position **after** the post purge timer has expired **and** the flame safeguard has turned the burner motor off.

If Flame Failure Occurs:

1. Flame safeguard removes the fuel valve input.
2. Actuator drives to the open damper position for post purge.

3. Flame safeguard removes the burner input.
4. The ID fan is turned off and the actuator drives to the closed position **after** the post purge timer has expired **and** the burner input is removed.

If Pilot Flame Failure Occurs:

1. The flame safeguard removes the burner input.
2. Actuator drives to the open damper position for post purge.
3. The ID fan is turned off and the actuator drives to the closed position **after** the post purge timer has expired.

4.4.3.3 Siemens LMV 51/52

1. The Siemens LMV 51/52 has the ability to maintain header pressure or temperature through a sensor and modulate the boiler's firing rate. The LMV 51/52 does not provide a limit string interface for the C-07720-C0 DCS; therefore the limit string is routed through the C and NO spare relay contacts of the C-07720-C0. These contacts are held closed during normal operation. When the low draft cutoff switch senses a low draft condition, or the open/auto/close damper switch is in the "close" position, or power to the unit is interrupted, the spare relay terminals open, thereby opening the limit string to the LMV 51/52.
2. The start circuit signal is applied to terminal D (Limits-In D21) and the blower motor powers terminal L (Blower Motor D24) of the C-07720-C0 draft controller.
3. The controller applies power to terminal 4 and the actuator drives to open damper position.
4. When sufficient draft is established (terminals 9 to 10), the D to C circuit is made (D16 is lit).
5. The LMV 51/52 flame safeguard begins its light off sequence; power is applied to the burner input, terminal L (D24). When the actuator reaches the open damper postion, D2 is lit and the prepurge timer starts.
6. When the prepurge timer has expired, the 16 to 17 circuit is made; D6 is lit, which completes the purge interlock circuit. Power is applied to terminal 6 (D3 is lit), and the actuator is driven to the adjustable start position.
7. When the actuator reaches the adjustable start position, power is applied to terminal 5 of the draft controller (D1 is lit).
8. After 8 seconds, the 14 to 15 circuit is made (D3 is lit). This completes the low fire interlock circuit.
9. When the fuel valve is energized (D22 is lit), the draft controller is released to modulation.
10. When the call for heat cycle is complete and power is removed from terminal D, the actuator drives to the open damper position.
11. The ID fan is turned off and the actuator drives to the closed position **after** the post purge timer has expired **and** the flame safeguard has turned the burner motor off.

If Flame Failure Occurs:

1. Flame safeguard removes the fuel valve input.
2. Actuator drives to the open damper position for post purge.
3. Flame safeguard removes the burner input.
4. The ID fan is turned off and the actuator drives to the closed position **after** the post purge timer has expired **and** the burner input is removed.

If Pilot Flame Failure Occurs:

1. The flame safeguard removes the burner input.
2. Actuator drives to the open damper position for post purge.
3. The ID fan is turned off and the actuator drives to the closed position **after** the post purge timer has expired.

4.4.4 Wiring

WARNING This procedure applies when the **Hays Cleveland F-09140-010-1-A Linear Actuator** is used with the **Model C-07720-C0-4 Sequencing Draft Controller** (refer to **Figure 14**). If another actuator is used, refer to **Figure 15** in this manual.

The draft control system is, in effect, an automatic switch in series with other primary controls. It should be the last control in the control circuit before the line starter or burner starting device. No operating or safety switch should be allowed to start the firing device without first going through the draft controller sequence.

Terminal	Procedure
1	Wire terminal 1 to line source, 120 volt, 60 cycles. **Hot (black) wire.** Wire also to terminal 1 of the **Hays Cleveland Actuator Model F-09140-000-1-A** or equal.
2	Wire terminal 2 to line source, 120 volt, 60 cycles. **Neutral (white) wire.** Wire also to terminal 2 of the **Hays Cleveland Actuator Model F-09140-000-1-A** or equal.
3	To close damper on inward stroke, wire to terminal 3 of the **Hays Cleveland Actuator Model F-09140-010-1-A**.
4	To open damper on outward stroke, wire to terminal 4 of the **Hays Cleveland Actuator Model F-09140-010-1-A**.
5	For the “adjustable start” signal, wire to terminal 5 of the **Hays Cleveland Actuator Model F-09140-010-1-A**
5A	For the “open damper” signal, wire to terminal 5A of the **Hays Cleveland Actuator Model F-09140-010-1-A**. Terminals 5 and 5a should be jumpered if the outward stroke opens the damper. When the inward stroke opens the damper, terminals 5A to 5B of the actuator and interchange terminals 3 and 4.
6	The draft control system is shipped with terminals 4 and 6 jumpered. When an actuator with the adjustable start feature is used, remove this jumper and wire to terminal 6 of the actuator.
14-15	Dry contact closure for adjustable start position.
16-17	Dry contact closure for open damper position.

Table 9A: Wiring Model C-07720-C0-4

Terminal	Procedure
A	For most applications,Terminal A is jumpered to Terminal 2. When the limit string has a different power source than terminals 1 and 2, terminal A is wired to the L2 side of the limit string.
B	For most applications,Terminal B is jumpered to Terminal A. When the fuel valve is powered by a different line source than the limit string, wire Terminal B to the L2 side of the fuel valve.
C	Terminal C is wired to the limits terminal of the flame safeguard.
D	Terminal D is the limit string input. Normally, the draft controller is the last item in the limit string.
E	Terminal E is wired to the L1 side of the fuel valve.
J	Terminal J is the power feed for Terminal K.
K	Terminal K is wired to the coil of the fan starter.
L	Terminal L is wired to the terminal of the flame safeguard control that supplies power during the purge cycle, if available. This is usually the burner motor terminal. When this terminal is not available, jumper Terminal L to Terminal C.
M	For most applications,Terminal M is jumpered to Terminal B. When the burner motor has a different power source than Terminals 1 and 2, wire Terminal M to the L2 side of the burner motor.

Table 9B: Wiring Model C-07720-C0-4

5.0 Flue Gas Temperature (FGT) Indicator Transmitter (Option)

5.1 Application

The FGT Indicator Transmitter offers accurate measurement and display of boiler exit temperature. The vacuum fluorescent display indicates the temperature variable. The thermocouple transducer and shielded thermocouple cable assembly is available in a range of lengths: see nomenclature, selection “E” in Section 1.3 of this manual.

The Type J thermocouple assembly consists of an iron constantan cable threaded through an 18’ rod with mounting flange for insertion into the boiler breeching or duct work. When the thermocouple is exposed to the process media, it generates a millivolt electrical current in direct proportion to the process temperature. The millivolt output is transmitted through the cable to the electronics assembly, where it is converted to a displayed temperature reading.

The electronics portion of the meter includes dual fail-safe SPDT contacts (10-amp rated) for remote alarm or indication. A 4-20 mA DC “retransmit” output is provided for remote data acquisition, recording, etc. The alarm set points are adjustable from the front of the draft control system. Alarm set points are viewed from the display. Both display and output are convertible, from degrees Celsius to degrees Fahrenheit.

Thermocouple failure results in a “fail safe” response: the over range reading is displayed on the meter.

The thermocouple meter is ice-point compensated.

5.2 Installation

Install the thermocouple assembly in the boiler exit above and as near as possible to the point where the gases leave the last pass of tubes or baffles. If the thermocouple assembly must be installed near the outlet damper, make sure that the damper blade does not strike the thermocouple or rod when it is turned.

Mount the thermocouple flange by drilling two 1/8” holes in the side of the breeching and using #10 sheet metal screws to fasten it to the breeching surface. Drill a 5/8” clearance hole for the thermocouple rod. Use the flange itself as a template for locating the hole positions.

Insert the thermocouple rod to a depth that reaches as close to the center of the passage as possible. In large breechings, the thermocouple rod should be inserted to its maximum depth. Tighten the set screw securely.

Run the cable from the thermocouple to the meter. Do not allow the cable to touch the hot surfaces of the breeching.

5.3 Wiring

Refer to the overall wiring diagram (**Figure 5**) for the optional FGT transmitter indicator. The FGT terminals are located on the bottom right of the printed circuit board.

FGT-1 terminals	Associated with alarm 1. Normally Open (NO), Normally Closed (NC), and Common (C) are provided. Please note when wiring: these terminals are fail-safe so that the relay contacts change state on power up.
FGT-2 terminals	Associated with alarm 2. Normally Open (NO), Normally Closed (NC), and Common (C) are provided. Please note when wiring: these terminals are fail-safe so that the relay contacts change state on power up.
FGT-1 ALM RST	Jumpered as shipped from the factory. Do not modify these terminals or jumper.
FGT-2 ALM RST terminals	Used for remote reset. An external switch (NO) is wired to these terminals. If automatic reset is required, place a jumper between these two terminals . If manual reset from the front display panel is required, do not place a jumper between these two terminals.
FLUE TEMP 4-20 mA terminals	Provide the retransmitted signal directly proportional to the flue gas temperature where: 32F (0C) = 4 mA DC; and 999F (537C) = 20 mA DC.
T/C RED WHT terminals	The shielded Type J Thermocouple wires terminate here. Note that the red wire (non-magnetic) of the thermocouple is placed on the RED Terminal and the white wire (magnetic) is placed on the WHT Terminal. The shield is placed on the “SHD” terminal.

Table 10A: Wiring the optional Flue Gas Temperature Transmitter.

5.4 Thermocouple Cable Tuning

The C-07720 Draft Control System equipped with the FGT monitoring feature is calibrated at the factory for use with the length of shielded 20-gauge, type J thermocouple cable the customer has selected (see option “E”; see section 1.3 Nomenclature). Shielded Type J thermocouple cable **must** be used in order for the FGT Indicator Transmitter to operate properly, but an **alternate gauge** may be used in place of the recommended 20-gauge. However, the FGT Indicator Transmitter **must be tuned** to operate with any cable other than the 20 gauge, using the following procedure. **(Note high voltage is present when the printed circuit board is exposed: use caution while performing this procedure!)**

1	Wire the thermocouple to the draft controller. Make sure that the thermocouple is at a stable temperature.
2	Pull the **H3** jumper off the printed circuit board, and then note the temperature on the display.
3	Replace the jumper to the **H3** position (This is a necessary part of the open thermocouple protection circuitry.)
4	Adjust R18 (T/C ZERO) to the value noted in the second step above.
5	Put unit into operation.

Table 10B: Tuning the optional Flue Gas Temperature Transmitter for use with shielded type J thermocouple cable other than 20-gauge.

6.0 Miscellaneous

6.1 Retransmission of Process Variable

Refer to the overall wiring diagram (**Figure 5**).

The terminals for the retransmission of the process variable are located on the lower left of the printed circuit board. They are marked “DRAFT 4-20 mA.” These terminals provide the retransmitted signal of the draft or pressure process. This signal is fixed (cannot be changed) at these parameters: 4 mA DC = -2” wc and 20 mA DC = +2” wc.

6.2 Modbus Communications

Refer to the overall wiring diagram **(Figure 5)**.

Terminals for Modbus communication are located on the lower left of the printed circuit board. They are marked “RS-485 +, -, SHD.” These terminals provide the following information with Modbus protocol using RS-485.

The following Modbus address assignments can be read:

40001	P V (in w.c. X 100) (signed integer).
40002	Set Point (in w.c. X 100) (signed integer).
40003	Flue Gas Temp (signed integer). Under Range: -32768 Over Range: +32767
40004	Relay Status (See **Table 12** Modbus Address 40004 Bitmap).
40005	Alarm #1 trip point (unsigned integer).
40006	Alarm #2 trip point (unsigned integer).

Table 11: Modbus address assignments.

6.3 Troubleshooting (Diagnostic LED’s)

6.31 Diagnostic LED’s

LED’s are provided for onboard diagnostic of the I/O (Input/Output). The LED’s are identified in **Figure 4**. The LED’s are associated with the functions as shown in **Table 14**.

Processor Running LED (see Figure 4). This LED indicates the state of the microprocessor by blinking at different rates as shown in **Table 13**.

6.32 Checksum Error

When the microprocessor values do not match the stored values in memory, “**Checksum Error**” is displayed. When this is displayed, all logic functions are halted. To correct this error, turn the power off and then back on. If this procedure does not rectify the error, reenter all control parameters. If the problem persists, contact **Hays Cleveland**.

7.0 Customer Service Information

7.1 Contacts

Hays Cleveland Customer Service Department

1111 Brookpark Road
Cleveland OH 44109
Telephone: 216.398.4414
Fax: 216.398.8558
email: **customerservice@unicontrolinc.com**

Visit us on the WEB! http://www.hayscleveland.com

7.2 Repairs

Damaged or defective units may be returned to the factory for repair. However, factory authorization must be obtained before shipping whether warranty or non-warranty service is required, and all units must be shipped prepaid.

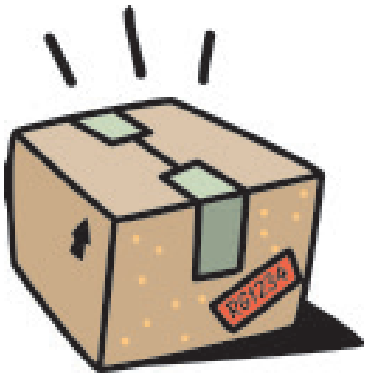
A letter of transmittal that includes the following information should accompany the returned instrument:

1. Location, type of service, and length of time in service of the unit.
2. Description of the faulty operation of the device and the circumstances of the failure.
3. Name and telephone number of the person to contact if there are questions about the unit.
4. Indicate whether warranty or non-warranty service is requested.
5. Attach Purchase Order for all out-of-warranty repairs.
6. Complete shipping instructions for the return of the repaired instrument.
7. Original purchase order number and date of purchase.
8. Return Goods Authorization number provided by the factory when you called.
9. Clearly label the shipping container:

RETURN FOR REPAIR

Model _____

RG # _____



10. Ship prepaid to:

HAYS CLEVELAND
1111 Brookpark Road
Cleveland OH 44109-5869

tel. 216.398.4414

Please follow this procedure. It expedites handling of the returned item, and avoids unnecessary additional charges for inspection and testing to determine the problem before repairing it.

7.3 Service

A Maintenance and Service Contract can ensure trouble-free, economical operation of Hays Cleveland equipment for many years. One-time onsite service by a factory-trained service engineer can also be provided as needed. Contact Hays Cleveland for information on these service options.

INTENTIONALLY BLANK

7.4 Standard Terms and Conditions of Sale

TERMS OF SALE: 1% discount if paid in ten (10) days, net amount due and payable in thirty (30) days.

AGREEMENT OF SALE: Acceptance by Seller of any order placed for goods whether submitted on Buyer's purchase order form or on seller's Sales Order Acknowledgment form, shall be subject to Seller's Standard Terms and Conditions of Sale and is conditioned upon the Buyer's acceptance of these Standard Terms and Conditions.

TERMS OF CONTRACT: Any terms or conditions of the buyer's order which are inconsistent with these terms and conditions shall not be binding on the Seller and shall not be considered applicable to the sale or shipment of goods or materials. Unless buyer shall notify Seller in writing to the contrary within ten (10) days after the mailing of the Sales Contract by Seller, acceptance of the terms and conditions hereof by Buyer shall be indicated and, in the absence of such notification, the sale and shipment by Seller of the goods and materials covered hereby shall be conclusively deemed to be subject to the terms and conditions hereof.

PRICES: All prices and specifications and applicable discounts are subject to change without notice. Sales contracts which call for delivery in the future will be billed at prices in effect at the time of shipment. Shipping weights shown are approximate and subject to change without notice.

SHIPMENT AND PAYMENTS: All prices contained on the Sales Contract are F.O.B. factory in Cleveland, Ohio. No freight is allowed on any shipments. Shipments and deliveries shall at all times be subject to the approval of Seller's Credit Department, and at any time seller may require payment in advance or satisfactory security or guarantee that invoices will be promptly paid when due. If buyer fails to comply with any terms of payment, seller, in addition to its other rights and remedies, but not in limitation thereof, reserves the right to withhold further deliveries or terminate the Agreement, and any unpaid amount thereon shall become due immediately. Terms of payment shall be as set forth on the Sales Contract.

DELAYS AND DEFAULTS: Delays or defaults in delivery by Seller of the goods and materials covered by the Sales Contract shall be excused so far as the same is caused by fire, strikes, accident, governmental regulation, or any delays unavoidable or beyond reasonable control of Seller. In no event shall Seller be liable for any consequential, special, or contingent damages on account of any default or delay in delivery.

NON-CANCELLATION: Orders are not subject to suspension, reduction, or cancellation, except on terms that will indemnify Seller against loss.

SPECIFICATIONS: Seller relies on specifications and other data furnished by the Buyer, an architect, contractor, or consulting engineer in all phases of the work covered by the Sales Contract. Seller shall be responsible to check quantities only. Alterations to or changes in specifications, approval of samples, changes in delivery instructions and all other instructions must be submitted in writing to Seller.

In the event Seller performs design or engineering work at the request of Buyer, an architect, contractor, consulting engineer, or representative in any phase of the work covered by the Sales Contract, Seller shall not be responsible for any damages claimed by Buyer as a result of alleged errors or defects in such design or engineering work.

WARRANTY AND LIMITATION OF LIABILITY: Seller warrants that the goods supplied by it have been manufactured in accordance with its standard manufacturing practices and conform to the contract or catalog description set forth in the order. Seller further warrants that the goods supplied by it are fit for the ordinary purpose or purposes specified in its catalog for which such goods are used when installed in accordance with Seller's recommended installation procedures. Except as stated herein, Seller makes no express warranty with respect to goods supplied by it and Seller makes no warranty that the goods are fit for any particular purpose.

When the use of materials not manufactured by Seller is suggested by Seller's recommended installation procedures or otherwise, Seller makes no express warranty with respect to such materials nor that such materials are merchantable or fit for any particular purpose.

Seller will, at its sole option, credit, repair or replace, any goods supplied by it which its examination shall disclose to its satisfaction are defective in workmanship or material and are returned to it within one year from the date of shipment and any claim not made within this period shall conclusively be deemed waived by Buyer. Credit, repair or replacement will be preconditioned upon examination of the goods by Seller, and, if requested by Seller, return of the goods to Seller at its direction and expense. No goods are to be returned to Seller without its written consent. Seller shall not be liable for any expense incurred by Buyer in order to remedy any defect in its goods. Seller shall not be liable for any consequential, special, or contingent damage or expense, arising directly or indirectly from

any defect in its goods or from the use of any defective goods. The remedies set forth herein shall constitute the exclusive remedies available to Buyer and are in lieu of all other remedies.

CLAIMS: Claims for shortage of goods or for mistakes or errors in billing must be presented within forty-five (45) days from the date of shipment of goods and must state the packing slip number and container number applicable to the claim. Any claim not so presented will be conclusively deemed waived.

TAXES: Any federal taxes or other government charges on the sale, shipment, or installation of the goods or equipment covered by the Sales Contract shall be added to the price and paid by Buyer, or, in lieu thereof, the Buyer shall furnish the Seller with tax-exemption certificates acceptable to the taxing authority. The procedure also applies to duty and other similar charges on export sales. Seller is not responsible for sales and/or use tax in any state other than Ohio. The purchase made under this Sales Contract must be exempt or paid directly by Buyer. If Seller is required to pay any such tax, there shall be added to the prices quoted herein all such state and local taxes. Buyer agrees to reimburse and save Seller harmless from all such state and local taxes, including interest and penalties thereon, which may at any time be payable to any state or local government unit with respect to the sale of any goods or materials covered by the Sales Contract.

CORRECTIONS: Typographical or clerical errors contained in the Sales Contract, including prices, are subject to correction by the Seller.

FAIR LABOR STANDARDS: All goods covered by the Sales Contract have been produced in conformity with all applicable provisions of the Fair Labor Standards Act of 1938 as amended.

RENEGOTIATION: Unless advised by Buyer in writing, Seller assumes that Buyer's order and the Sales Contract are not renegotiable under the Renegotiation Act of 1951.

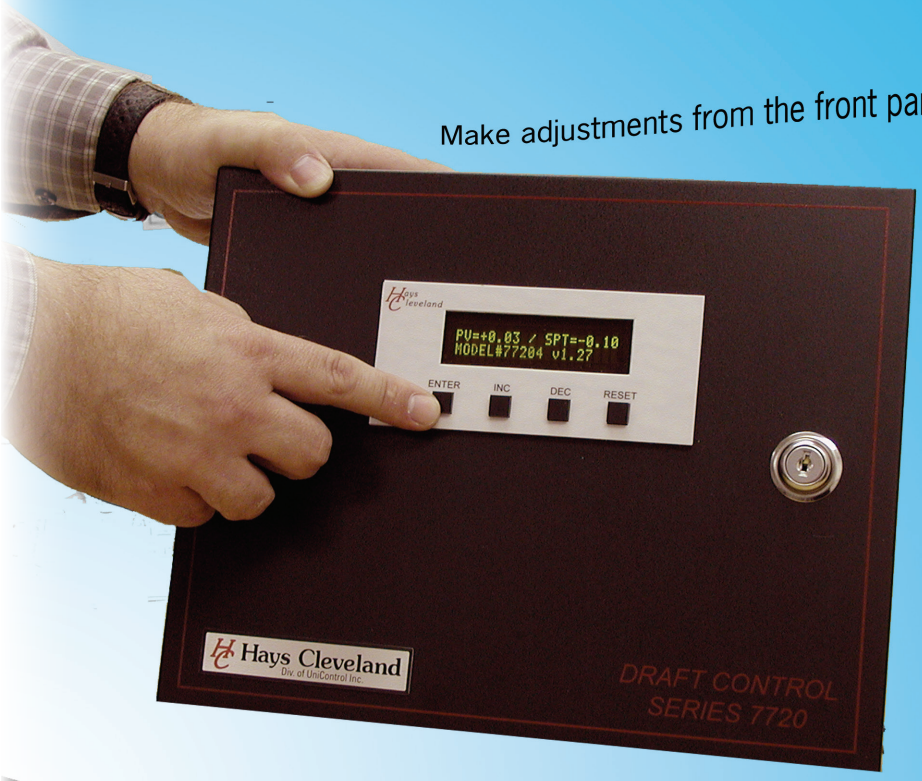
APPLICABLE LAW: All questions arising out of the Sales Contract, which shall be deemed an Ohio contract, shall be governed by the laws of the state of Ohio.

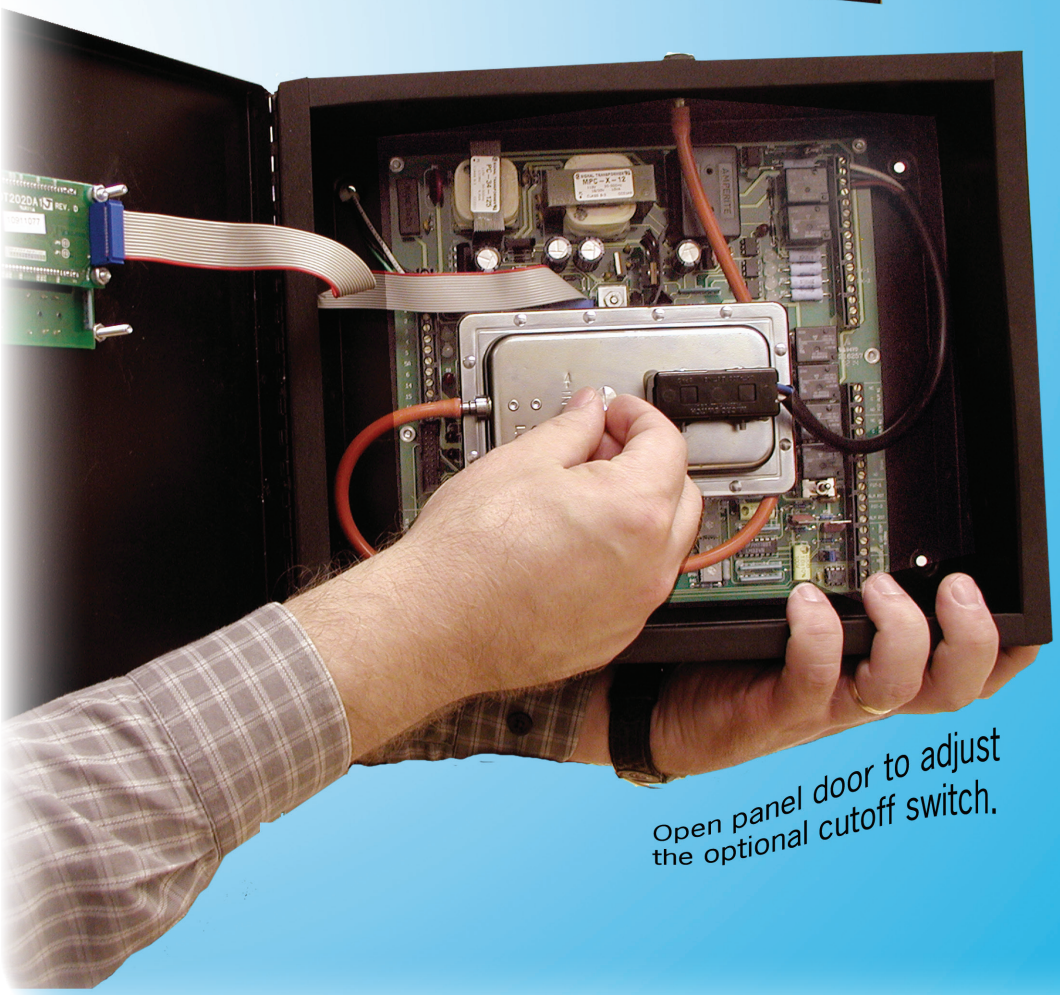
EXCLUSIVE TERMS: The Sales Contract shall constitute the complete contract between the parties, and no one has authority to depart from the terms and conditions set forth therein, nor to make any representations or arrangements other than those printed thereon whether in the execution or in the performance of the Sales Contract, unless the same are written on the face of the Sales Contract or are given in writing with it or in pursuance of it, and are fully approved in writing by an officer or authorized employee of the Seller.

LIMITATION FOR SUITS: Any controversy or claim arising out of or relating to this Sales Contract or the breach thereof, must be commenced within one (1) year after the cause of action accrued.

APPENDICES: TABLES & FIGURES

Make adjustments from the front panel!





Open panel door to adjust the optional cutoff switch.

MODBUS ADDRESS 40004							
Fuel Valve (software ver. 1.47 and later)	Air Switch (software ver. 1.47 and later)	Set Point Polarity: 0 = POS. 1 = NEG.	Burner (software ver. 1.47 and later)	Limit In	FGT Units: 0 = C 1 = F	Alarm #2	Alarm #1
MSB							
Boiler Disable Relay	Proof Open Relay	ALWAYS 0	Decrease Relay	Increase Relay	ID Fan Relay	Modulate	Adjustable Start Relay
							LSB

Table 12: Modbus Address 40004

Power ON / Reset	MCLR Reset	Brown-out Reset	Watchdog Timer Reset
0.5 Hz (1 flash every 2 seconds)	1.0 Hz (1 flash per second)	5.0 Hz (5 flashes per second)	10.0 Hz (10 flashes per second)
1000mS On / 1000mS Off	500mS On / 500mS Off	1000mS On / 100mS Off	50mS On / 50mS Off
5 flashes every 10 seconds	10 flashes every 10 seconds	50 flashes every 10 seconds	100 flashes every 10 seconds

Table 13: "Processor Running" LED

I/O	FUNCTION	DESCRIPTION
O	DECREASE	CONTROL CALLING FOR ACTUATOR TO DECREASE.
O	INCREASE	CONTROL CALLING FOR ACTUATOR TO INCREASE.
I	ADJUSTABLE START INPUT	ACTUATOR HAS TRIPPED THE ADJUSTABLE START LIMIT SWITCH.
I	OPEN DAMPER INPUT	ACTUATOR HAS TRIPPED THE OPEN DAMPER SWITCH.
O	ADJUSTABLE START POSITION	CONTROL CALLING FOR ACTUATOR TO GO TO THE ADJUSTABLE START POSITION.
O	PROOF OF ADJUSTABLE START	DRY CONTACT IS CLOSED AND AT THE ADJUSTABLE START POSITION.
O	MODULATE	INDICATES THAT THE CONTROL IS IN THE MODULATE MODE.
O	PROOF OF OPEN DAMPER	DRY CONTACT IS CLOSED AND AT THE OPEN DAMPER POSITION.
X	PROCESSOR RUNNING	WHEN FLASHING (1 SEC ON/1 SEC OFF)INDICATES THAT THE MICROPROCESSOR IS FUNCTIONING PROPERLY. SEE TABLE 5 FOR TROUBLESHOOTING.
X	PRESSURE OKAY	INDICATES THAT THE SET POINT ON THE SENSING SWITCH IS SATISFIED.
X	PRESSURE ALARM	INDICATES THAT THE SENSING SWITCH IS NOT SATISFIED.
O	LIMITS OUT	INDICATES THAT THE SIGNAL IS BEING SENT TO THE BMS.
I	LIMITS IN	INDICATES A COMPLETE LIMIT STRING TO CONTROLLER.
I	FUEL VALVE	INDICATES THAT THE BURNER MANAGEMENT SYSTEM HAS ENERGIZED THE FUEL VALVE.
I	STOKER ENABLE	INDICATES THAT THE CONTROLLER IS SET UP FOR STOKER . APPLICATION.
I	BURNER	INDICATES THAT THE BURNER (FAN) IS ENERGIZED.
O	ID FAN	DRY CONTACT USED TO START INDUCED DRAFT FAN.
O	FGT ALARM 1	ON INDICATES THAT POWER IS APPLIED TO THE CONTROL . OFF INDICATES THAT ALARM 1 IS TRIPPED (FAIL SAFE).
O	FGT ALARM 2	ON INDICATES THAT POWER IS APPLIED TO THE CONTROL . OFF INDICATES THAT ALARM 2 1S TRIPPED (FAIL SAFE).

Table 14: LED Input/Output Identification.

°Celsius	°Fahrenheit	Type J Thermocouple (Output MV)	°Celsius	°Fahrenheit	Type J Thermocouple (Output MV)
0	32	0.000	240	464	12.998
10	50	0.507	260	500	14.108
20	68	1.019	280	536	15.217
25	77	1.277	300	572	16.325
30	86	1.536	320	608	17.432
40	104	2.058	340	644	18.537
50	122	2.585	360	680	19.640
60	140	3.115	380	716	20.743
80	176	4.186	400	752	21.846
100	212	5.268	420	788	22.949
120	248	6.359	440	824	24.054
140	284	7.457	460	860	25.161
160	320	8.560	480	896	26.272
180	356	9.667	500	932	27.388
200	392	10.777	520	968	28.511
220	428	11.887	540	1004	29.642

Table 15: Type J Thermocouple Output @ 32F (0C).

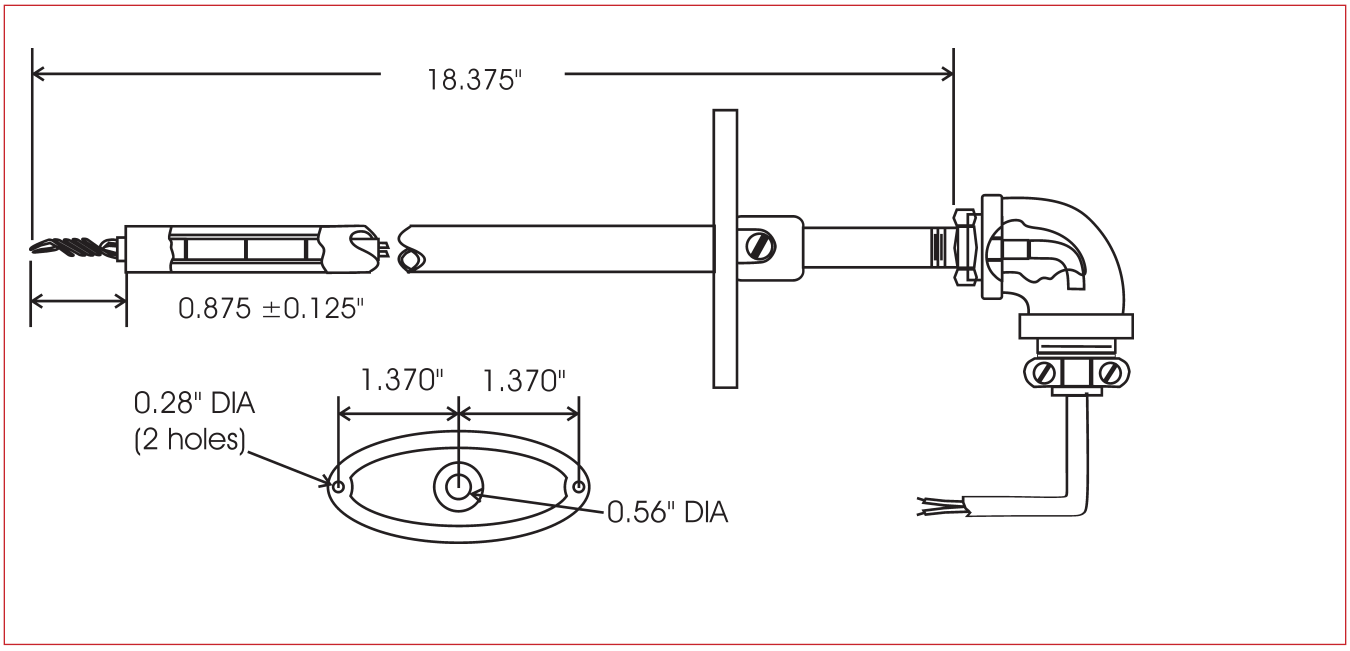
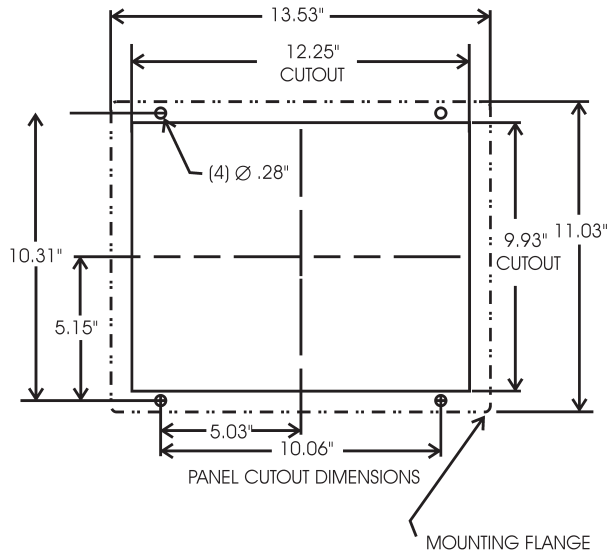
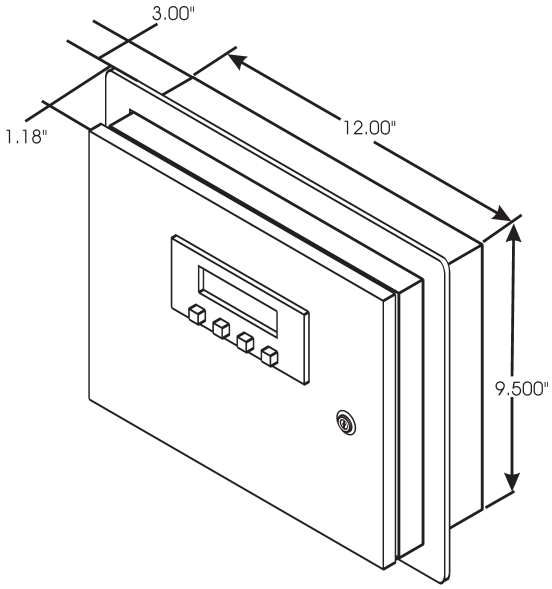
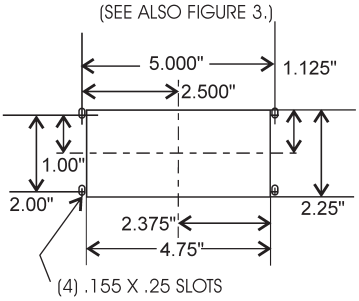


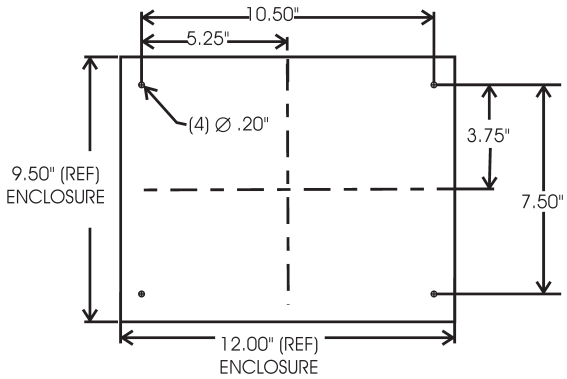
Fig. 1: Thermocouple Assembly and Mounting Flange





CUTOUT DIMENSIONS FOR OPEN MOUNT MODELS
(SEE ALSO FIGURE 3.)





SURFACE MOUNTING DIMENSIONS

Fig. 2: Panel & Surface Mounting Dimensions: Series C-07720 Draft Control System.

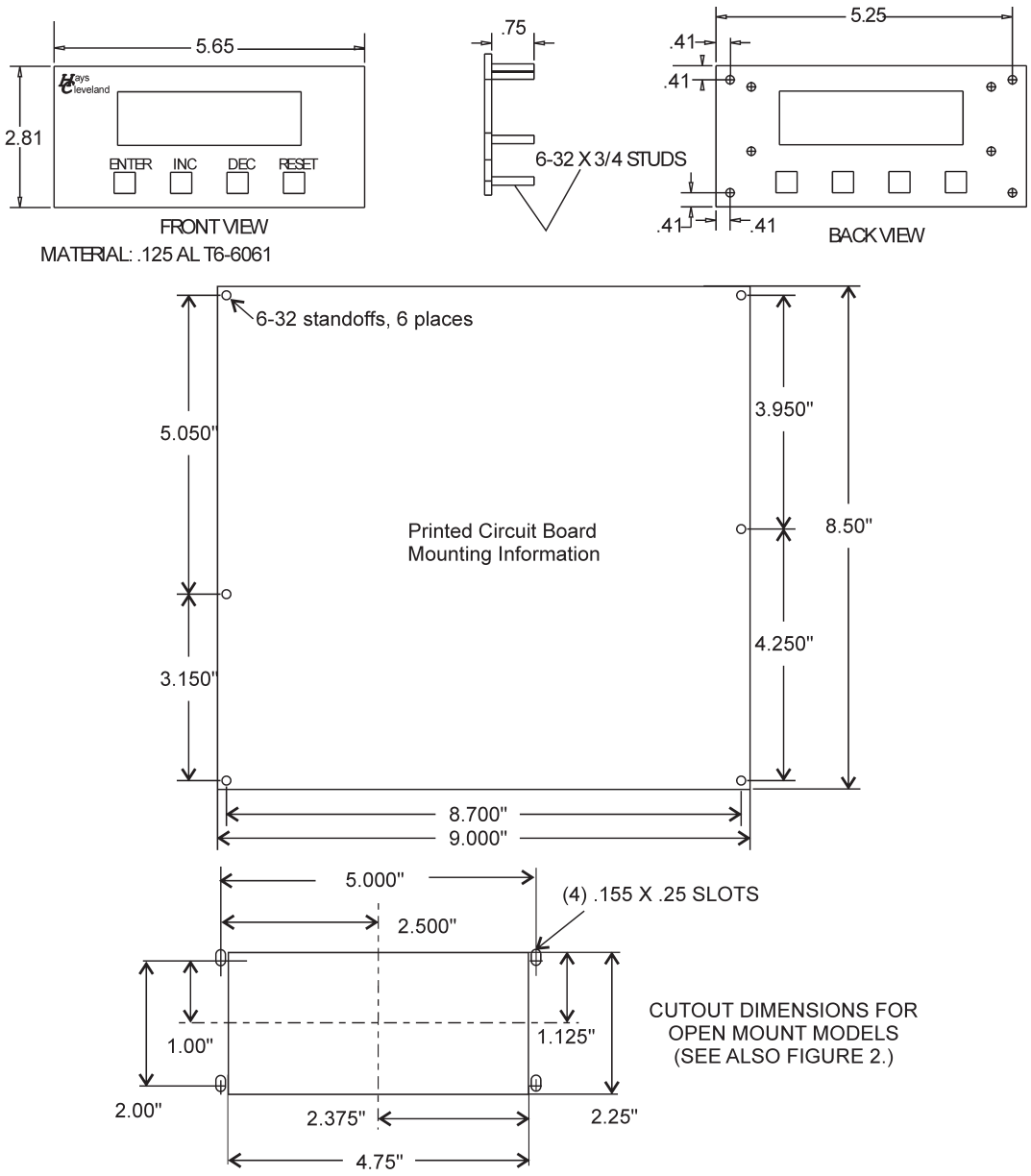


Fig. 3: Panel Mounting Dimensions: C-07720 Draft Control System (open mount models).

DIAGNOSTIC LED LOCATIONS
C-07720-C0 DRAFT CONTROL SYSTEM

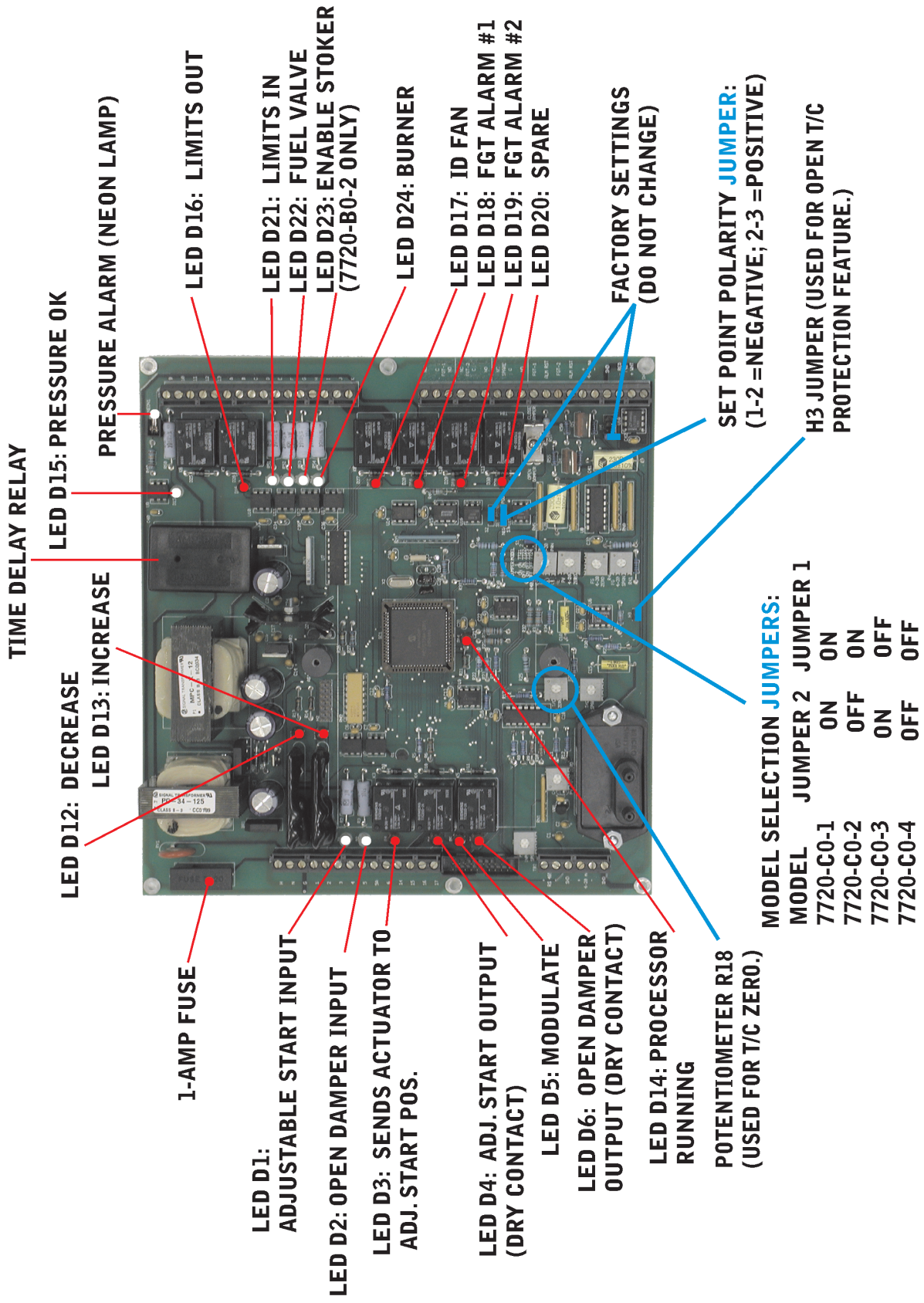
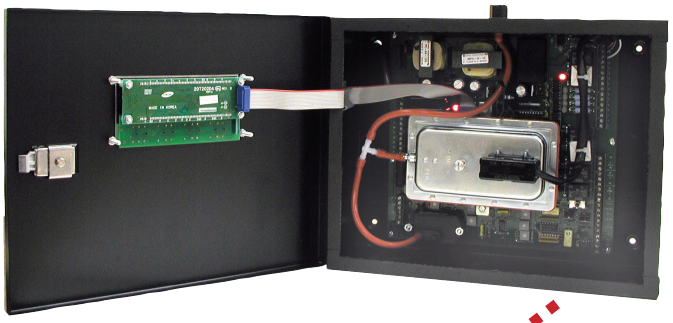
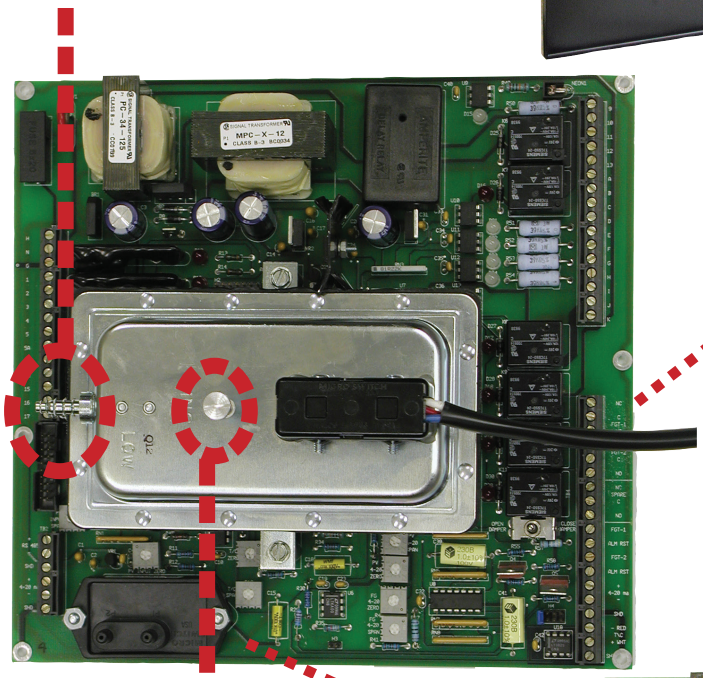
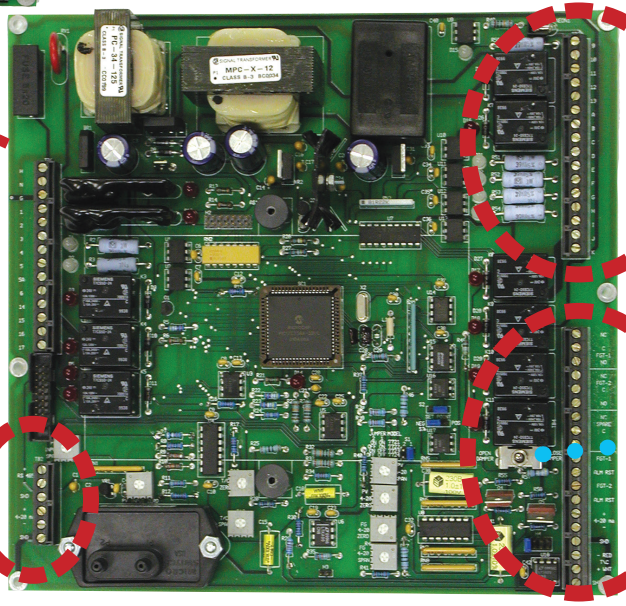


Fig. 4: Printed Circuit Board for Series C-07720 Draft Control System.

Optional air switch: sample line is connected (at factory) to **top port** for low pressure cutoff applications, **bottom port** for high pressure cutoff applications.







Set Point
Adjustment Screw

RS 485 MODBUS
COMMUNICATIONS PORT
+
-
SHD

4-20 MA BOILER
PRESSURE RETRANSMIT
4 ma = -2.00 inches w.c.
12 ma = 0.00 inches w.c.
20 ma = +2.00 inches w.c.
+
-
SHD

Fig. 5: Terminal Block Orientation for Modbus, Draft Retransmit, Cutoff Switch,Draft Controller/Burner Management Interface, and FGT Monitor.

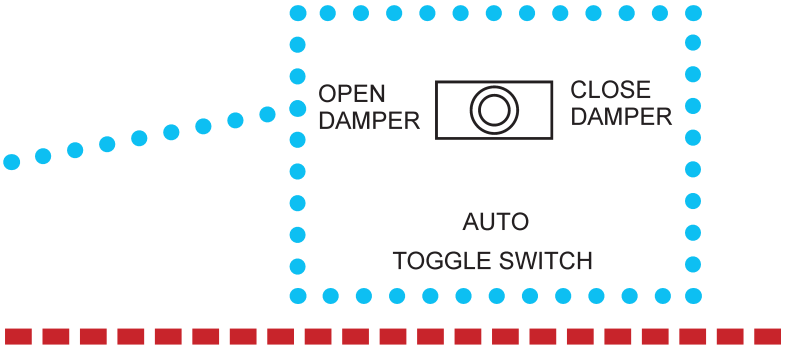
Negative Applications:

9 AIR SWITCH (COMMON: WHT WIRE)
10 AIR SWITCH (NO: RED WIRE) DRAFT OKAY
11 AIR SWITCH (NC: BLU WIRE) DRAFT LOW

Positive Applications:

9 AIR SWITCH (COMMON: WHT WIRE)
10 AIR SWITCH (NC: BLU WIRE) PRESSURE OKAY
11 AIR SWITCH (NO: RED WIRE) PRESSURE HIGH

12, 13 } REMOTE LOW DRAFT INDICATOR 120 V AC
A LIMIT STRING L2
B FUEL VALVE L2
C LIMIT STRING OUTPUT
D LIMIT STRING INPUT
E INPUT FROM FUEL VALVE
STK1 (STOKER OPTION ONLY WITH 7720-BO-22)
STK2 (STOKER OPTION ONLY WITH 7720-BO-22)
L INPUT FROM BURNER
M BURNER L2
J, K } ID FAN CONTACTS



NC, C, NO	FLUE GAS TEMPERATURE ALARM 1 CONTACTS
NC, C, NO	FLUE GAS TEMPERATURE ALARM 2 CONTACTS
NC, C, NO	SPARE
FGT-1, ALM RST	FLUE GAS TEMPERATURE ALARM 1 RESET
FGT-2, ALM RST	FLUE GAS TEMPERATURE ALARM 2 RESET
+, -, SHD	FLUE GAS TEMPERATURE RETRANSMIT 4-20 MA
-RED, +WHT, SHD	FLUE GAS TEMPERATURE INPUT TYPE J THERMOCOUPLE

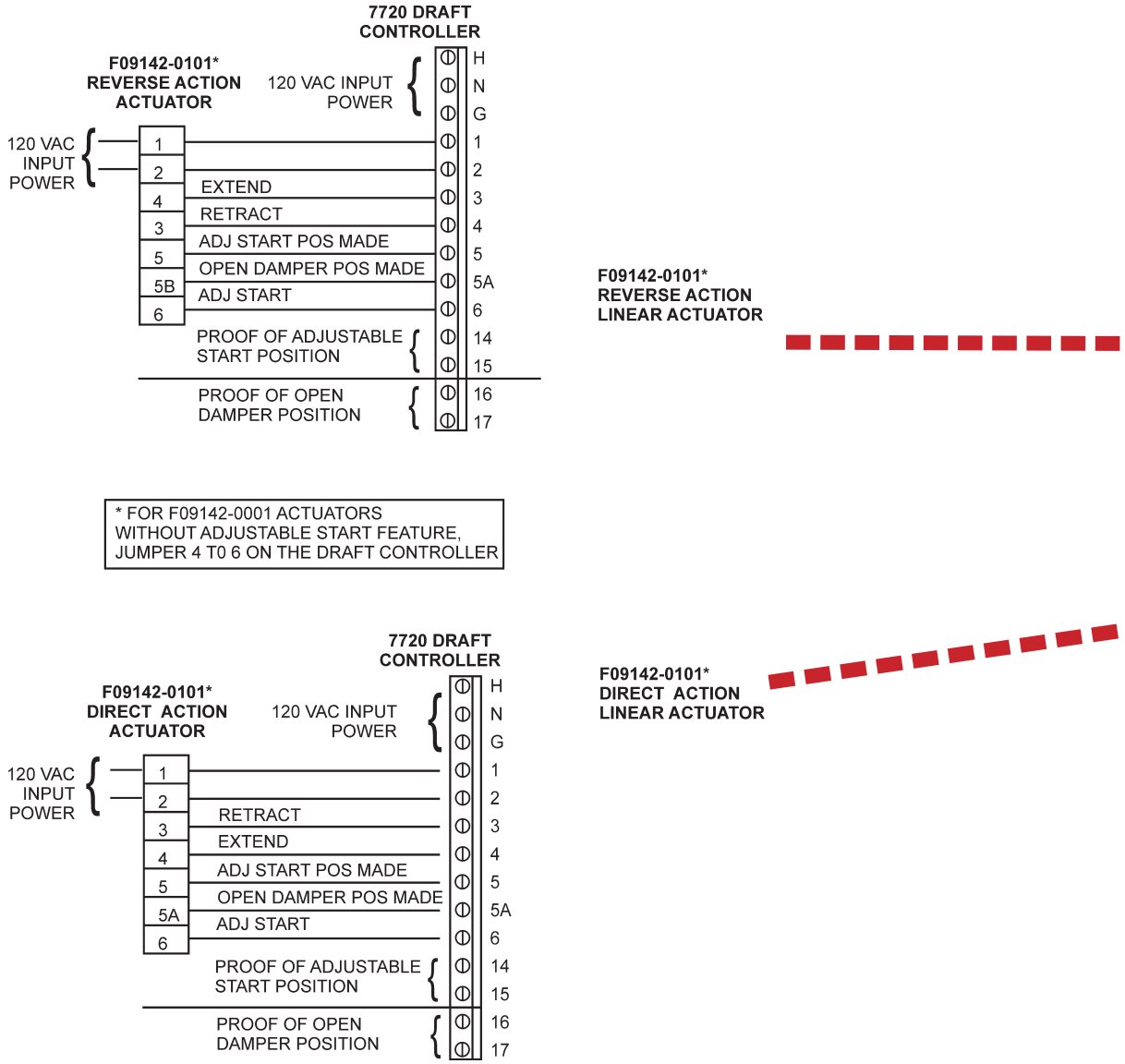
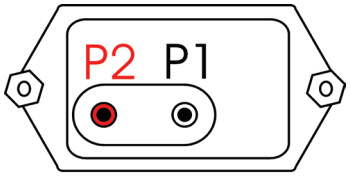
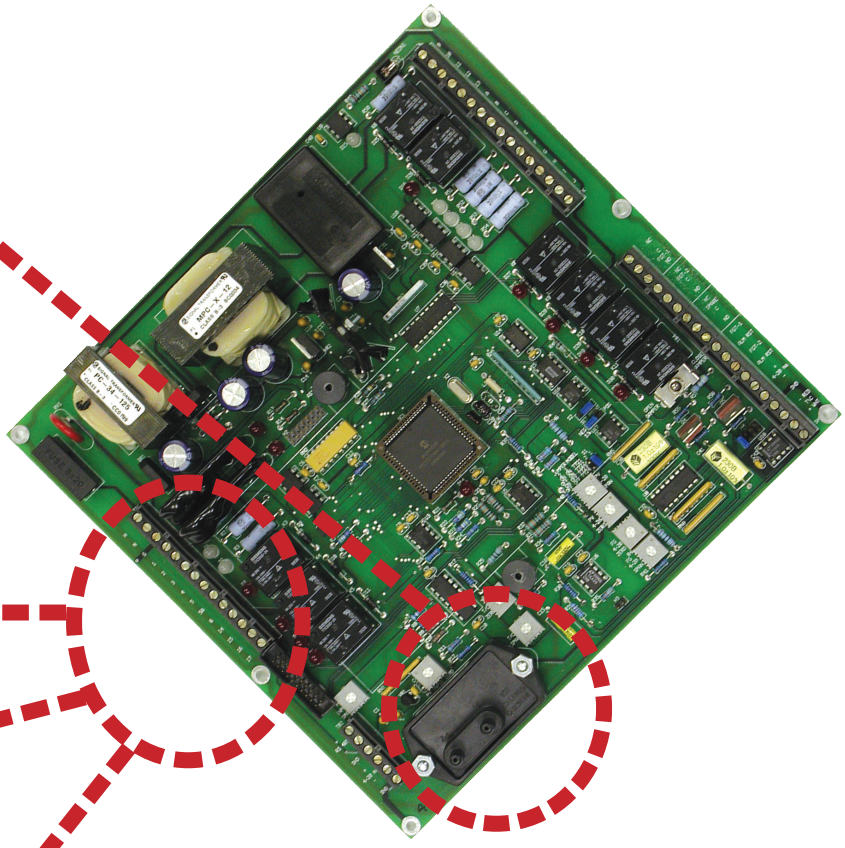


Fig. 6: Transducer Port Identification and Terminal Block Orientation for Actuator Interface.

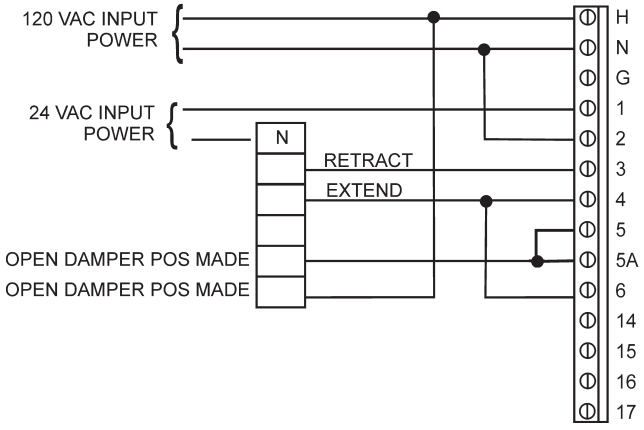


Port 2 is used for positive and negative applications.

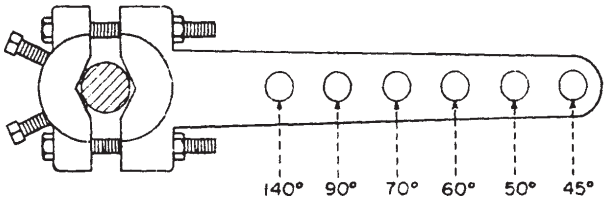


24 VOLT INPUT ACTUATOR

7720 DRAFT CONTROLLER

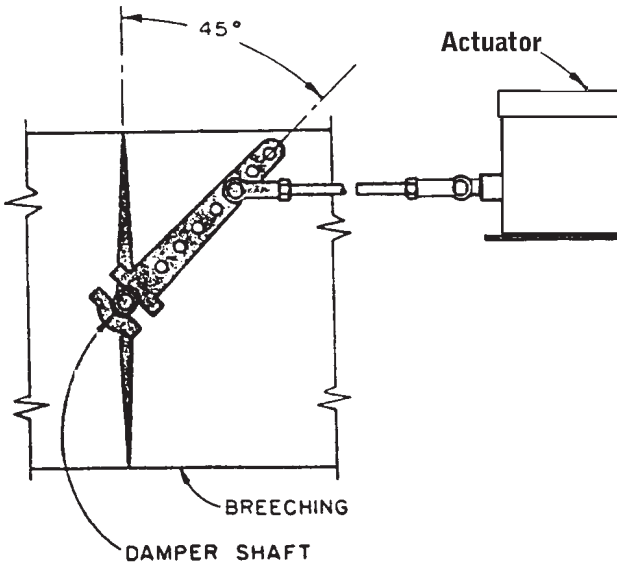


APPROXIMATE DEGREES OF DAMPER OPENING FOR EACH OF SIX HOLES IN DAMPER LEVER ARM FOR 6" STROKE OF THRUST ARM.



ACTUAL OPENING DEPENDS ON ANGLE OF THRUST AND DAMPER SHAFT DIAMETER.

DAMPER TRAVEL ADJUSTMENTS



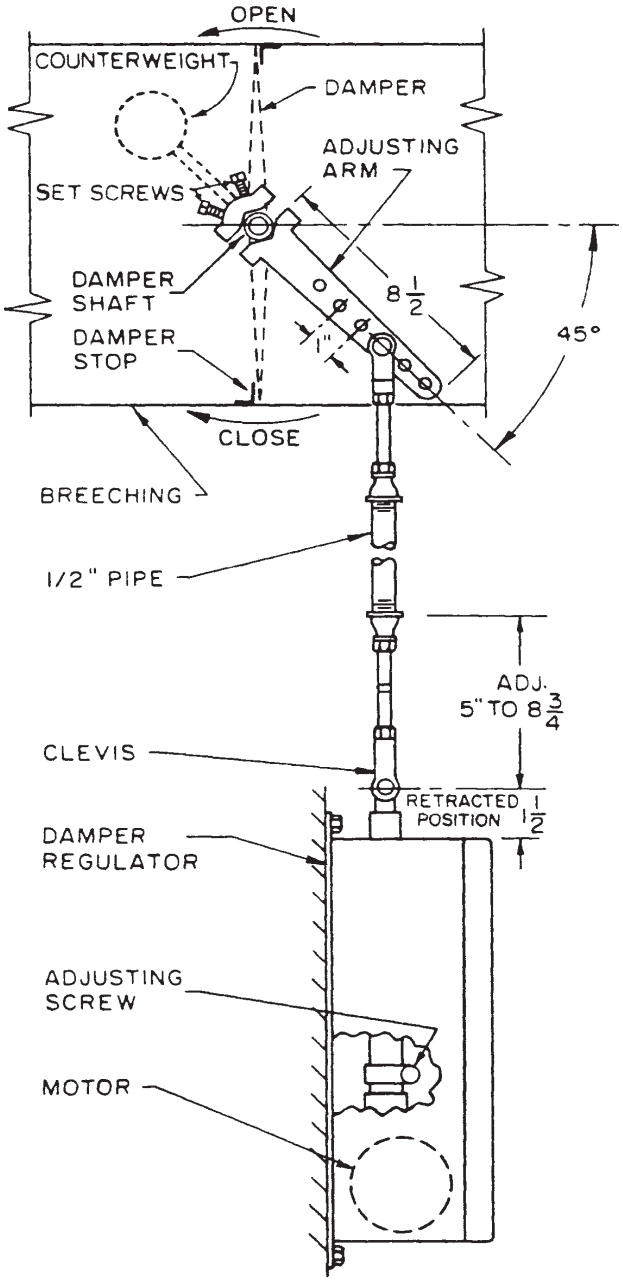


Fig. 7: Series F09140 Linear Actuator Linkage Setup.

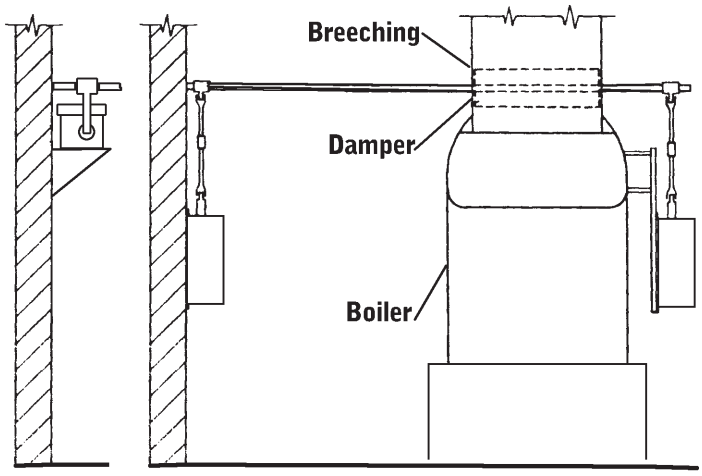


Fig. 8: Series F09140 Linear Actuator Installation.

WARNING

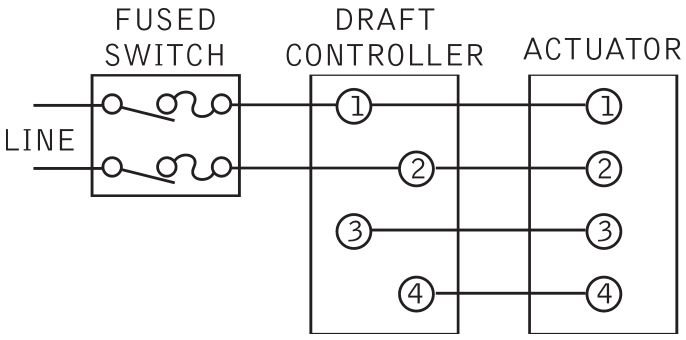
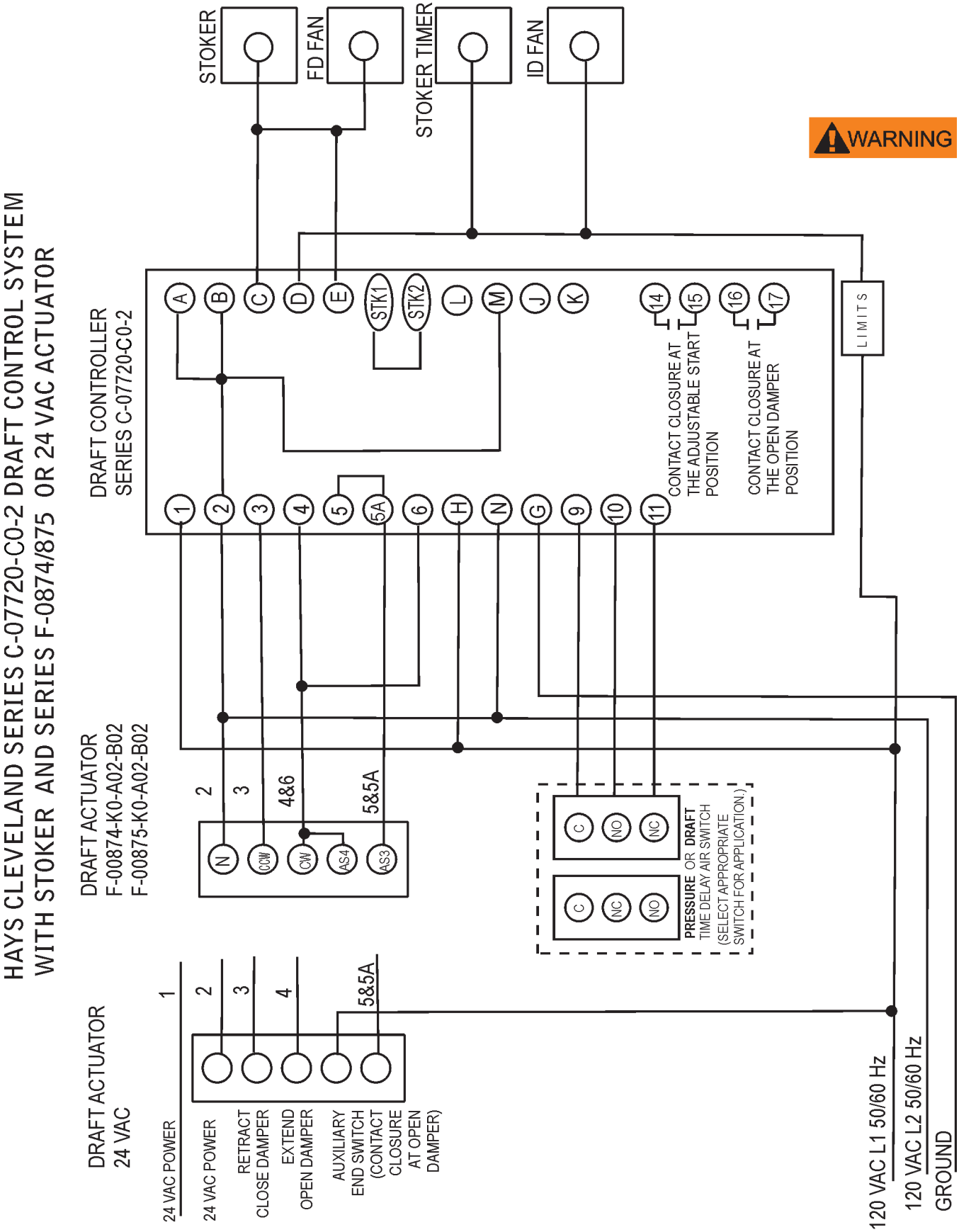


Fig. 9: External Wiring for Series C-07720-C0-1 Non-Sequencing Draft Control System.



Note: Suppression for coils is required on all relays and contactors that interface with the C-07720 Draft Controller.

Fig. 10: External Wiring (Series C-07720-C0-2 Sequencing Draft Control System with Stoker; F-0874/875 or 24 VAC Actuator)

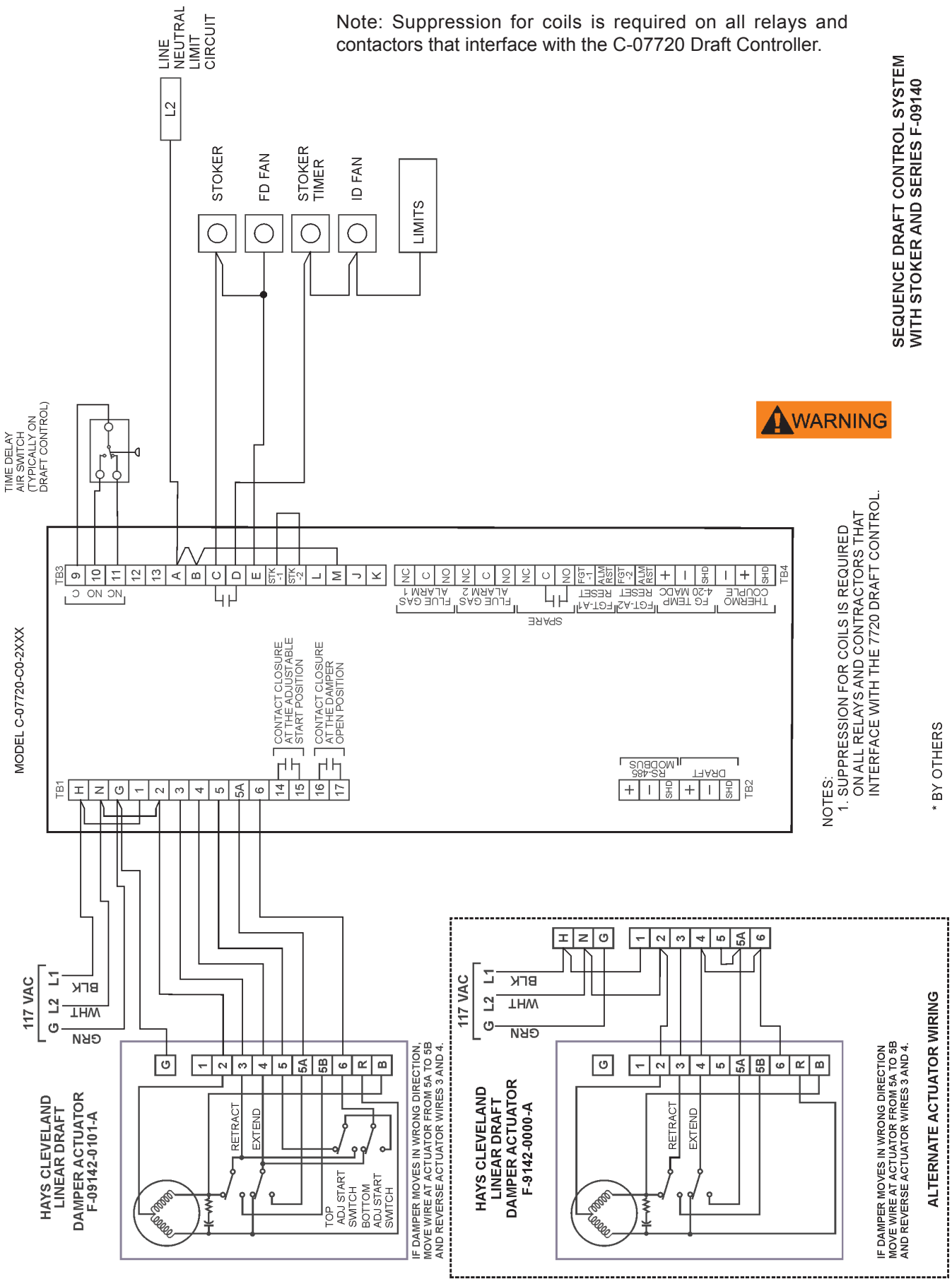
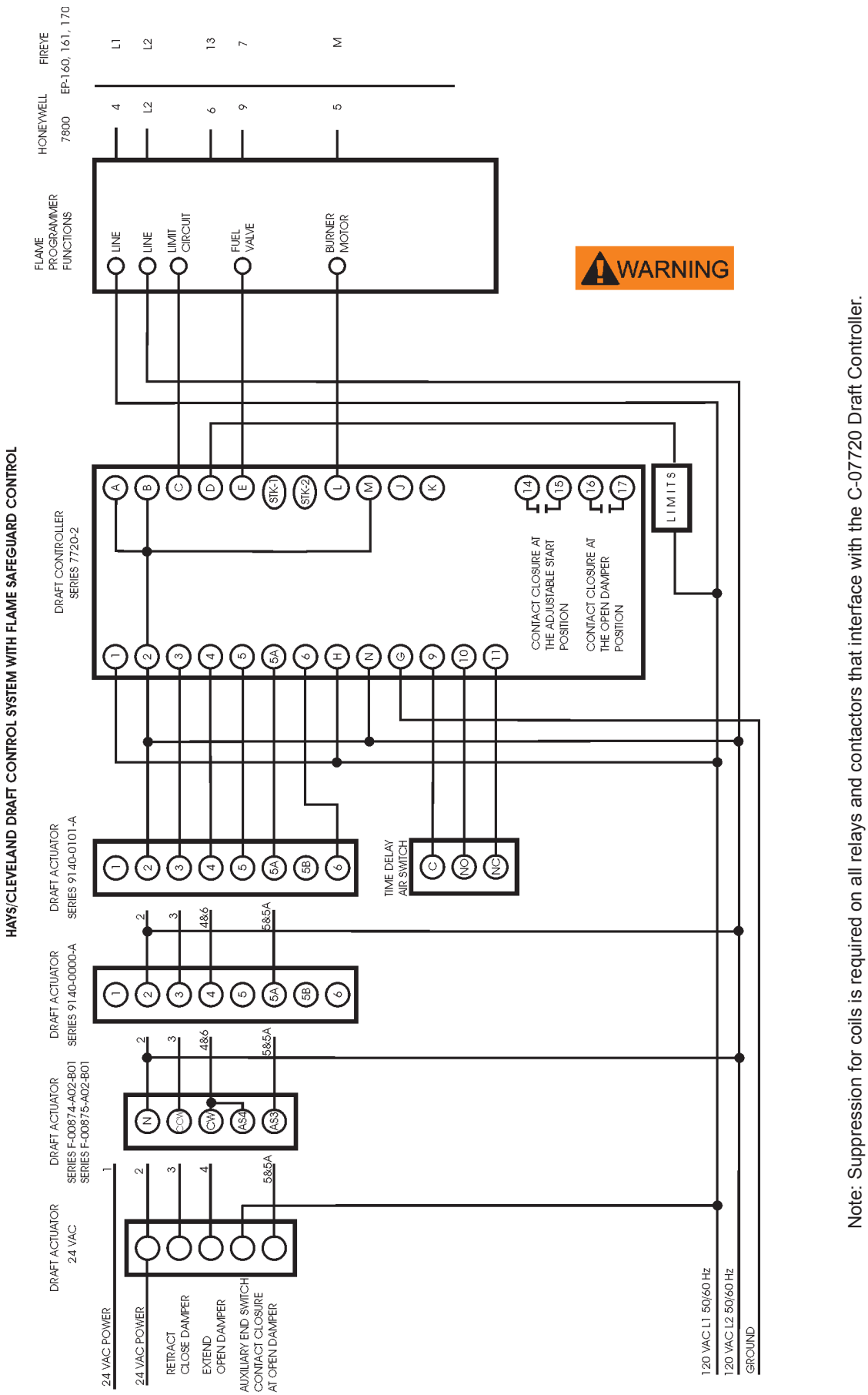


Fig. 11: External Wiring (Series C-07720-C0-2 Sequencing Draft Control System with Stoker; Series F-09141 Actuator.



Note: Suppression for coils is required on all relays and contactors that interface with the C-07720 Draft Controller.

Fig. 12: Series C-07720-C0-2xxx Draft Control Series with Flame Safeguard Control

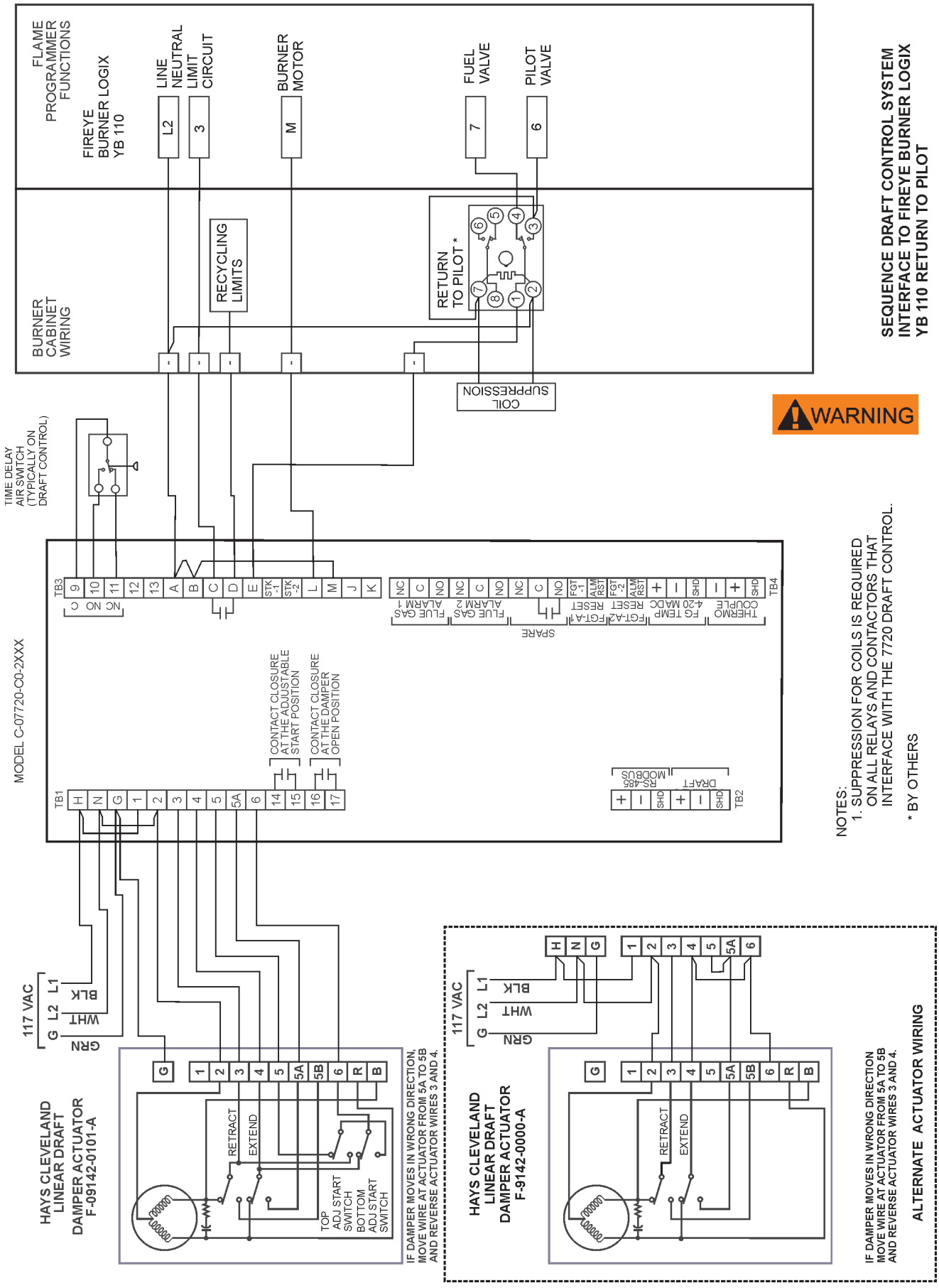


Fig. 13: Series C-07720-C0-2xxx Draft Control Interface with Fireye Burner Logix-YB 110 Return to Pilot.

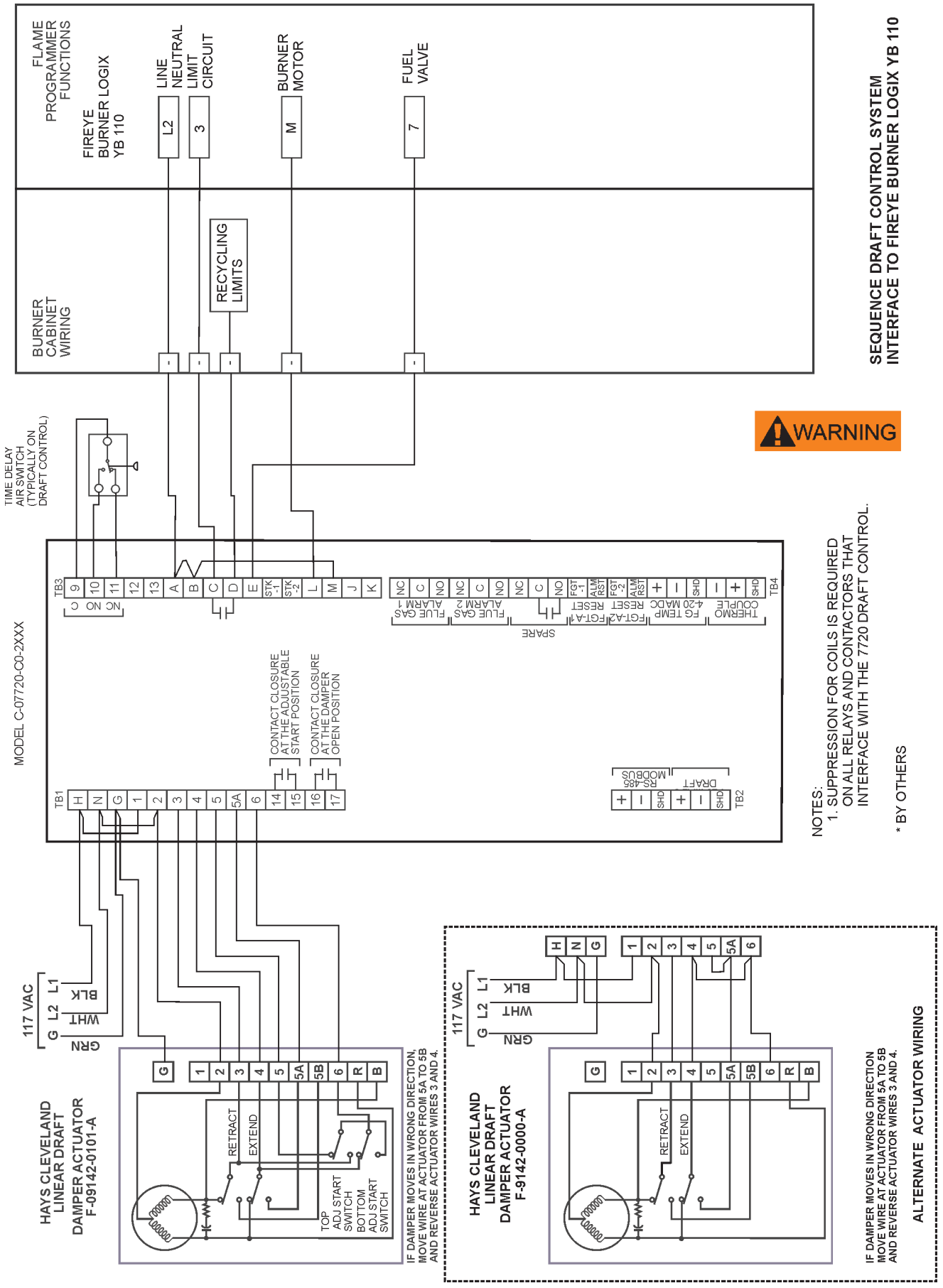


Fig. 14: Series C-07720-C0-2xxx Draft Control Interface with Fireye Burner Logix YB 110.

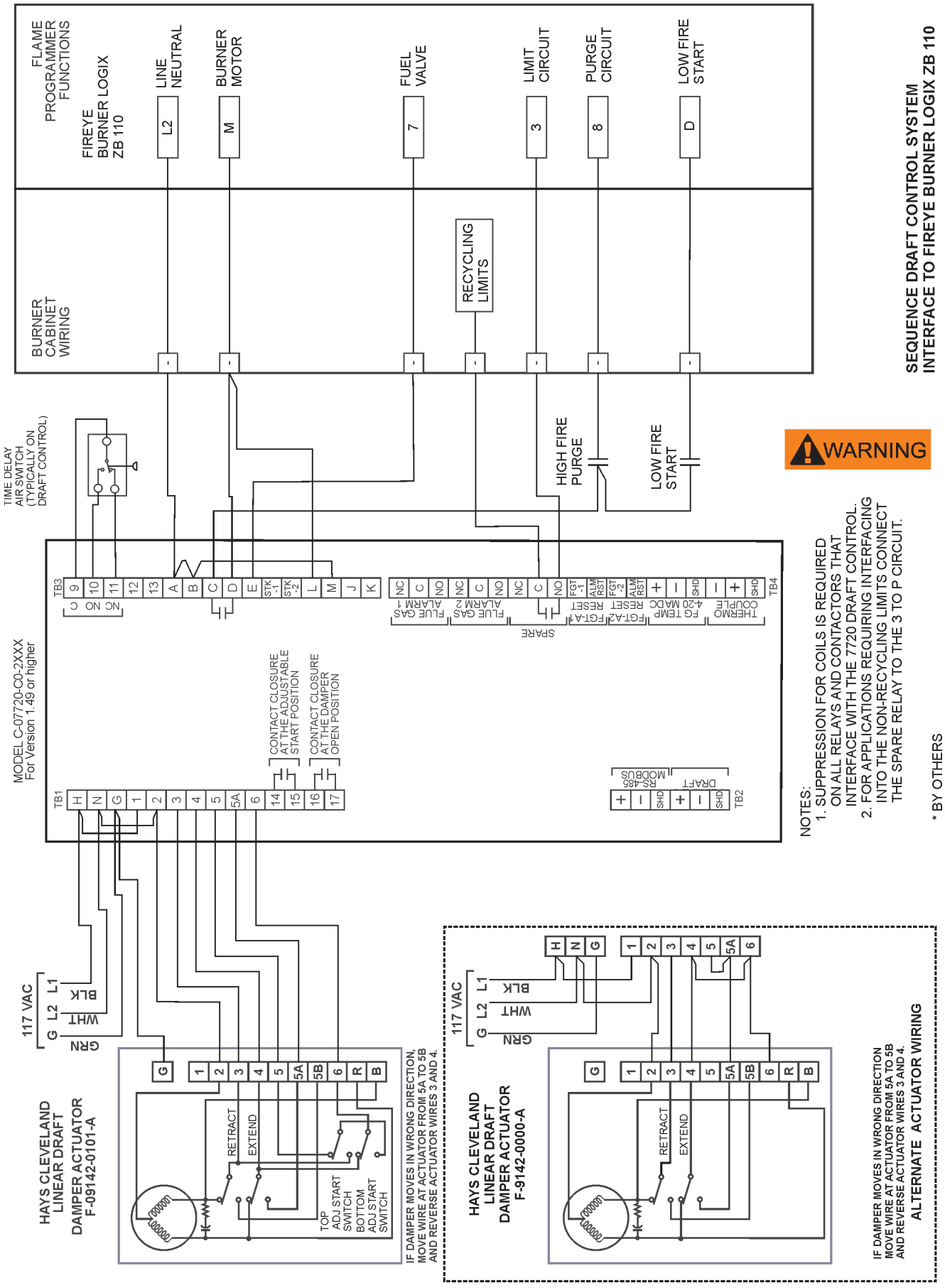


Fig. 15: Series C-07720-C0-2xxx Draft Control Interface with Fireye Burner Logix ZB 110.

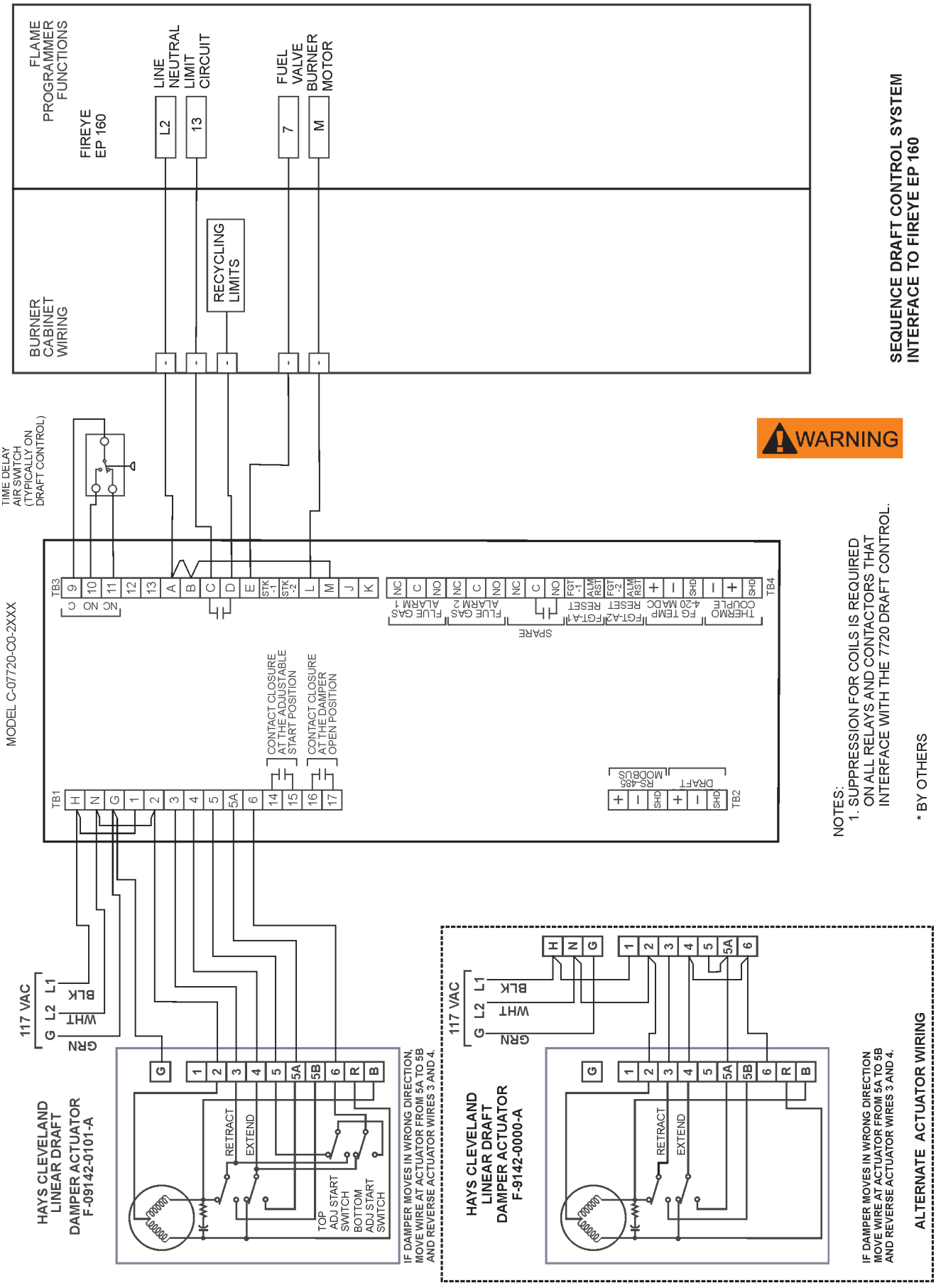


Fig. 16: Series C-07720-C0-2xxx Draft Control Interface with Fireye EP160.

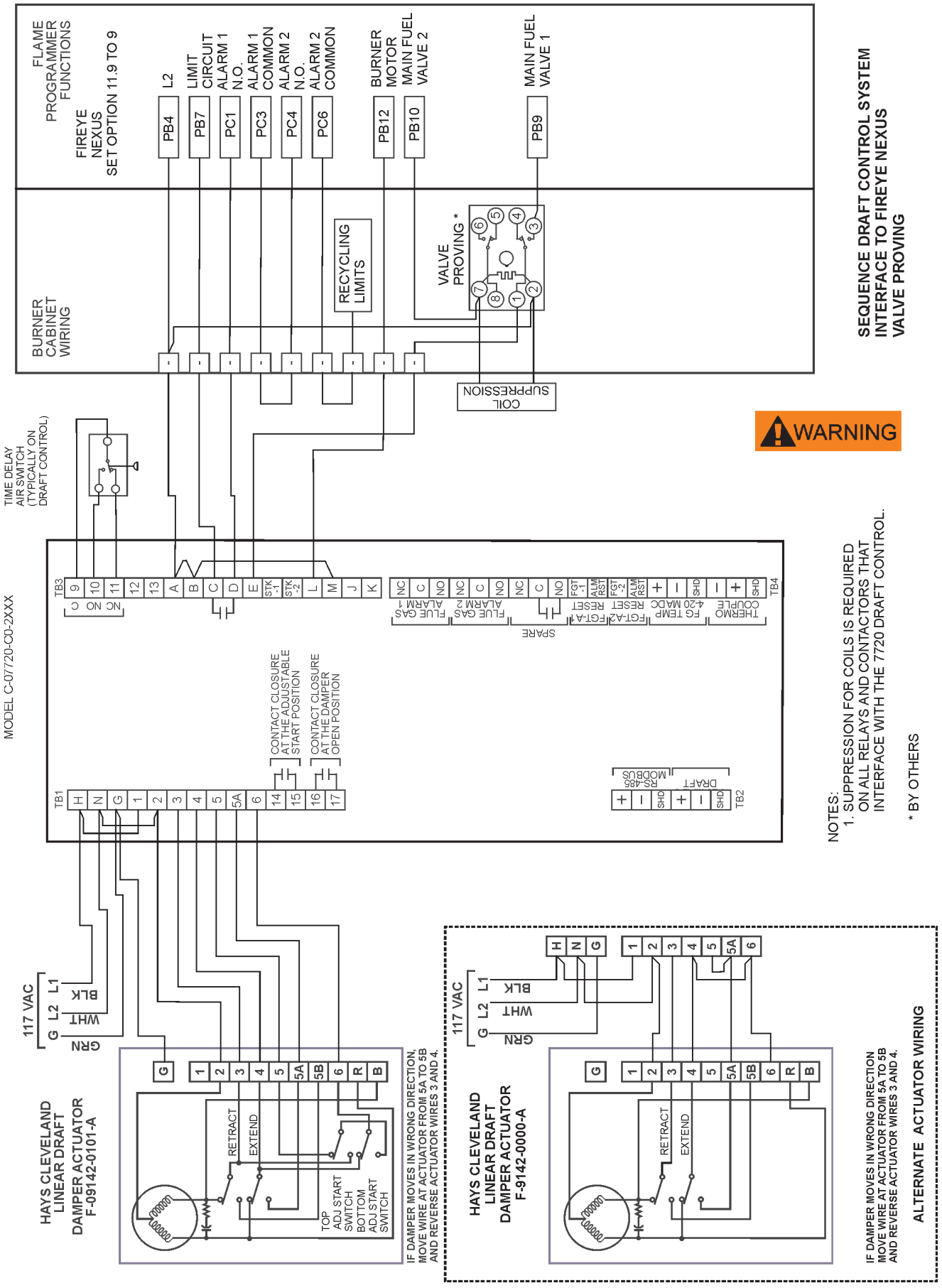


Fig. 17: Series C-07720-C0-2xxx Draft Control Interface with Fireye Nexus Valve Proving.

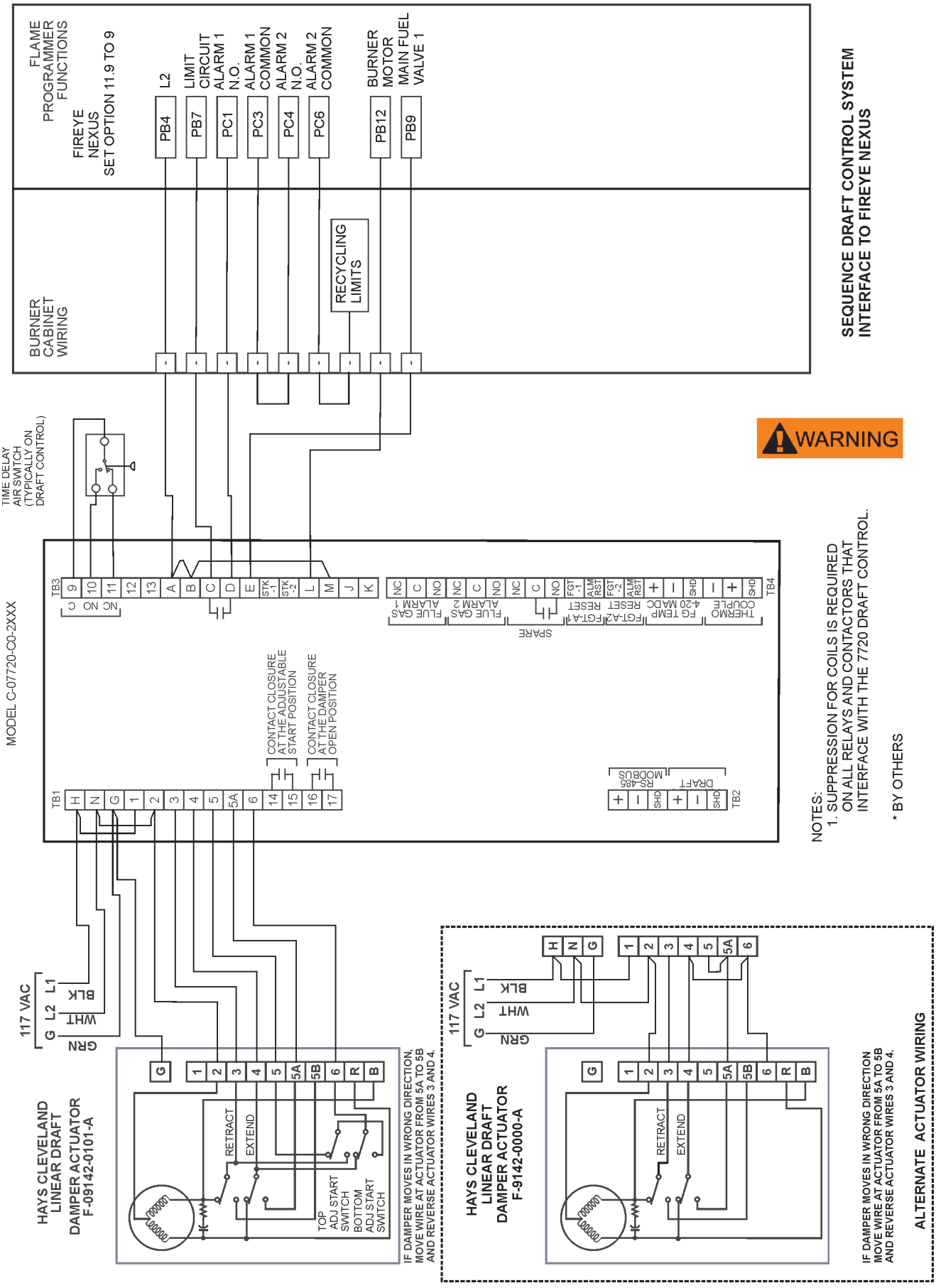


Fig. 18: Series C-07720-C0-2xxx Draft Control Interface with Fireye Nexus.

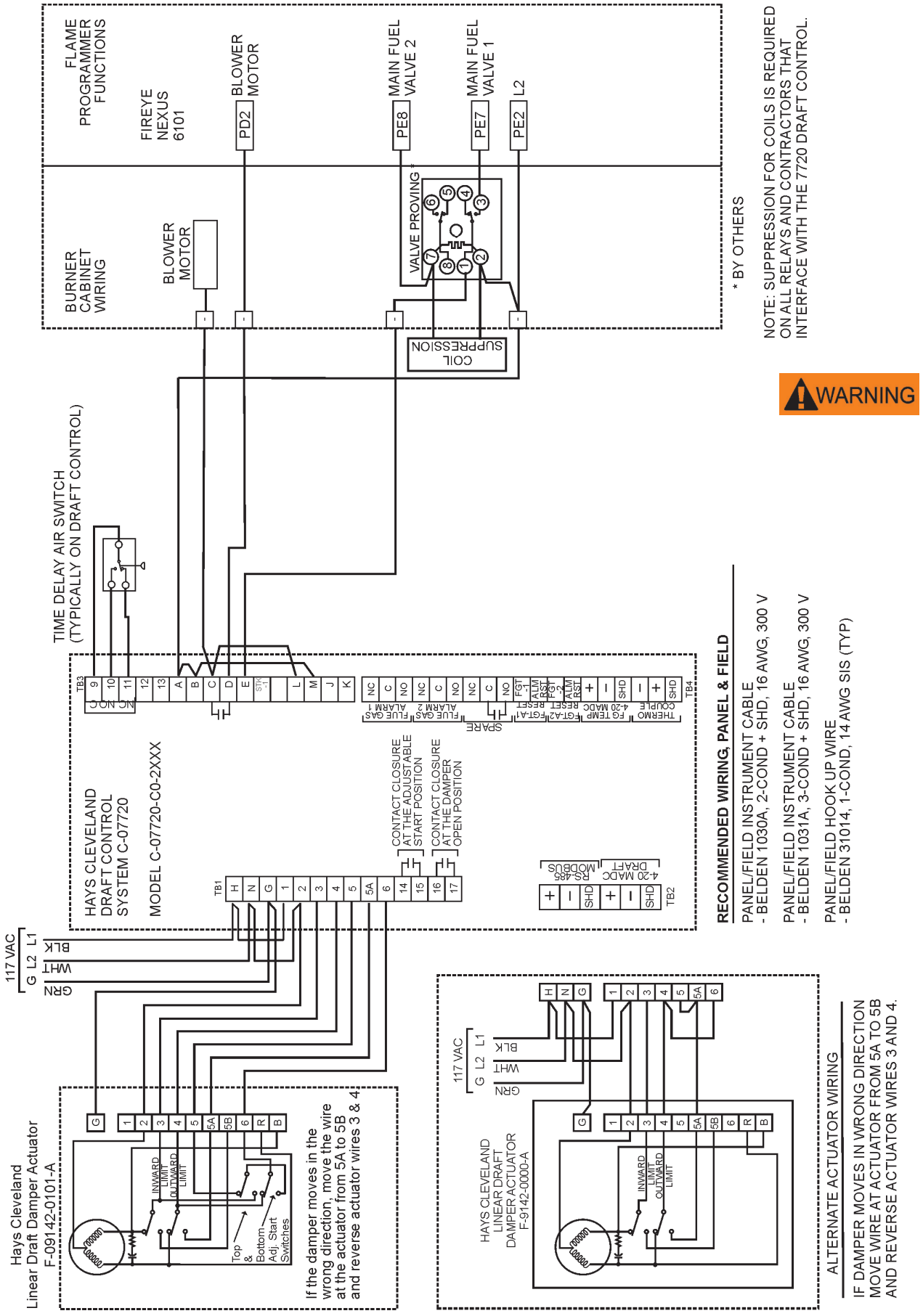


Fig. 19: Series C-07720-C0-2xxx Draft Control Interface with Fireye Nexus 6101 Valve Proving.

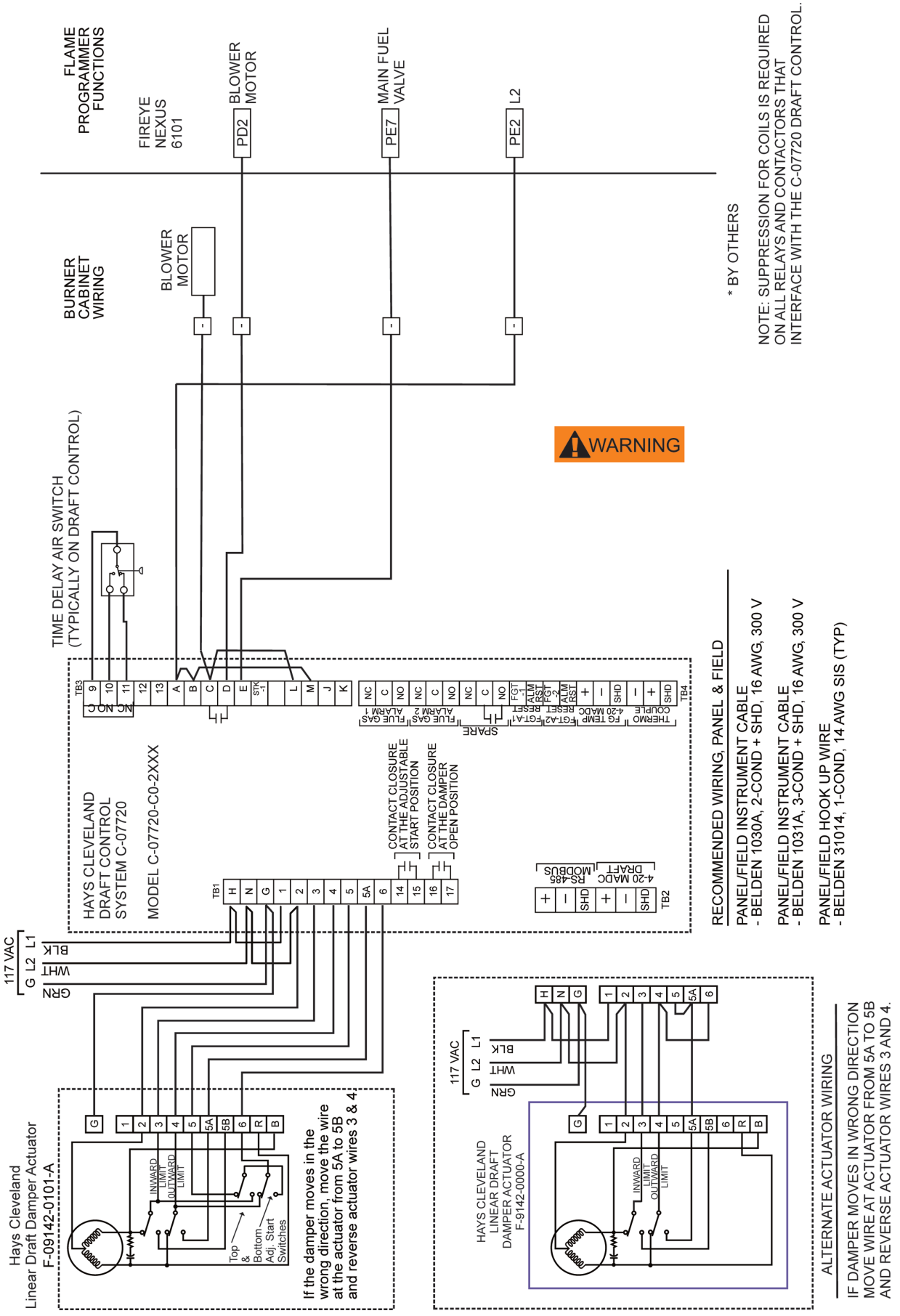


Fig. 20: Series C-07720-C0-2xxx Draft Control Interface with Fireye Nexus 6101.

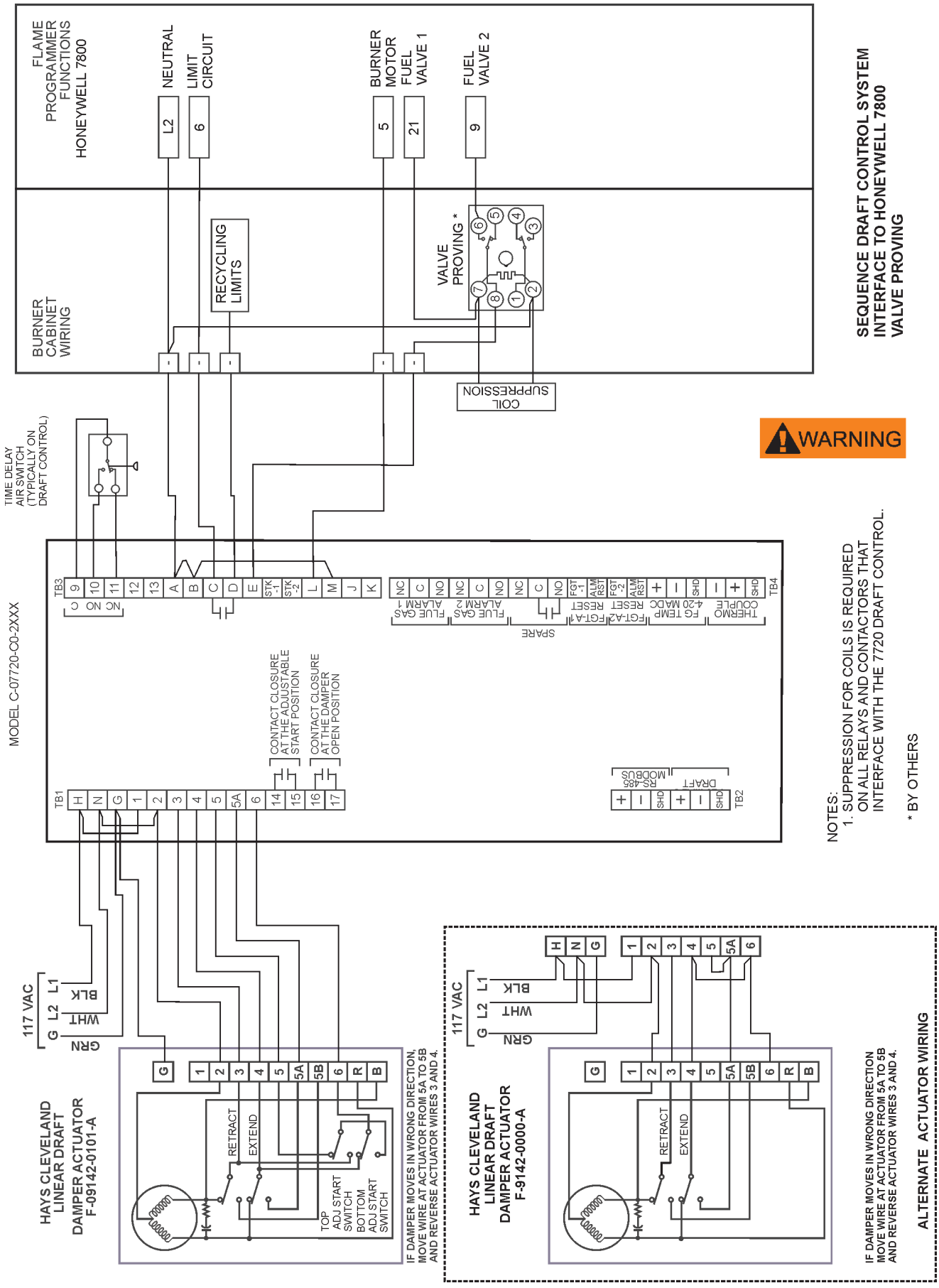


Fig. 21: Series C-07720-C0-2xxx Draft Control Interface with Honeywell 7800 Valve Proving.

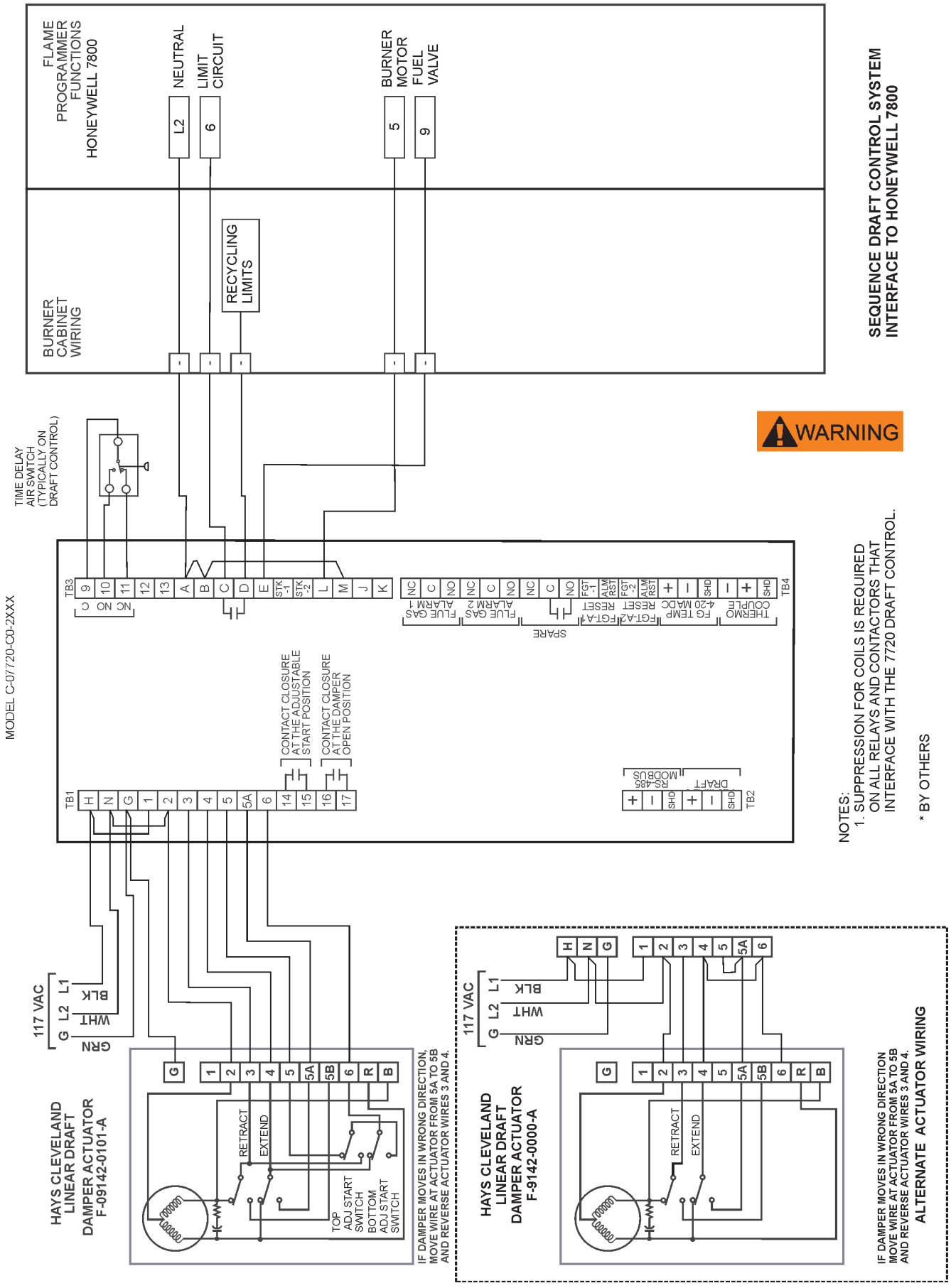


Fig. 22: Series C-07720-C0-2xxx Draft Control Interface with Honeywell 7800.

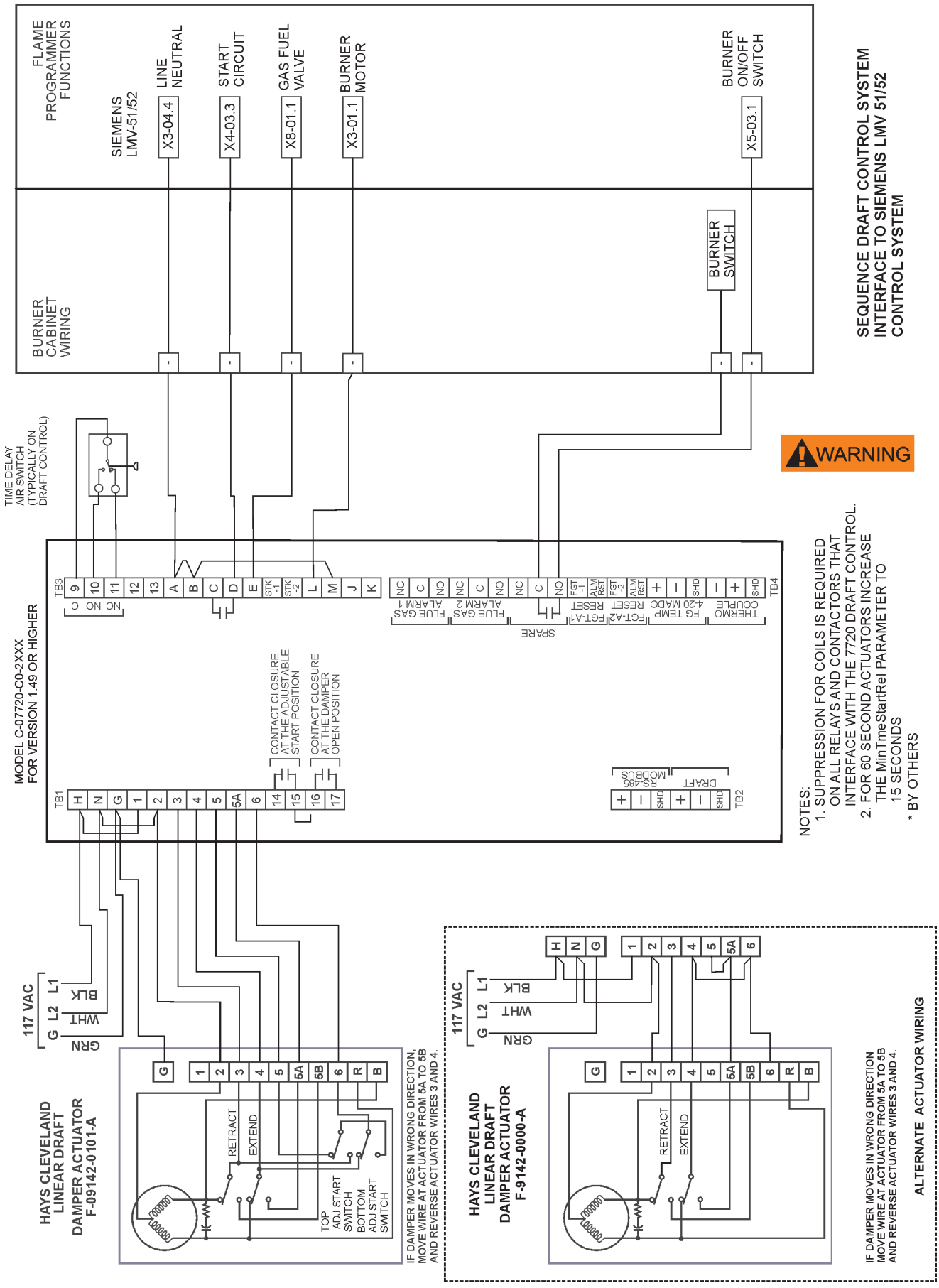


Fig. 23: Series C-07720-C0-2xxx Draft Control Series with Siemens LMV5X.

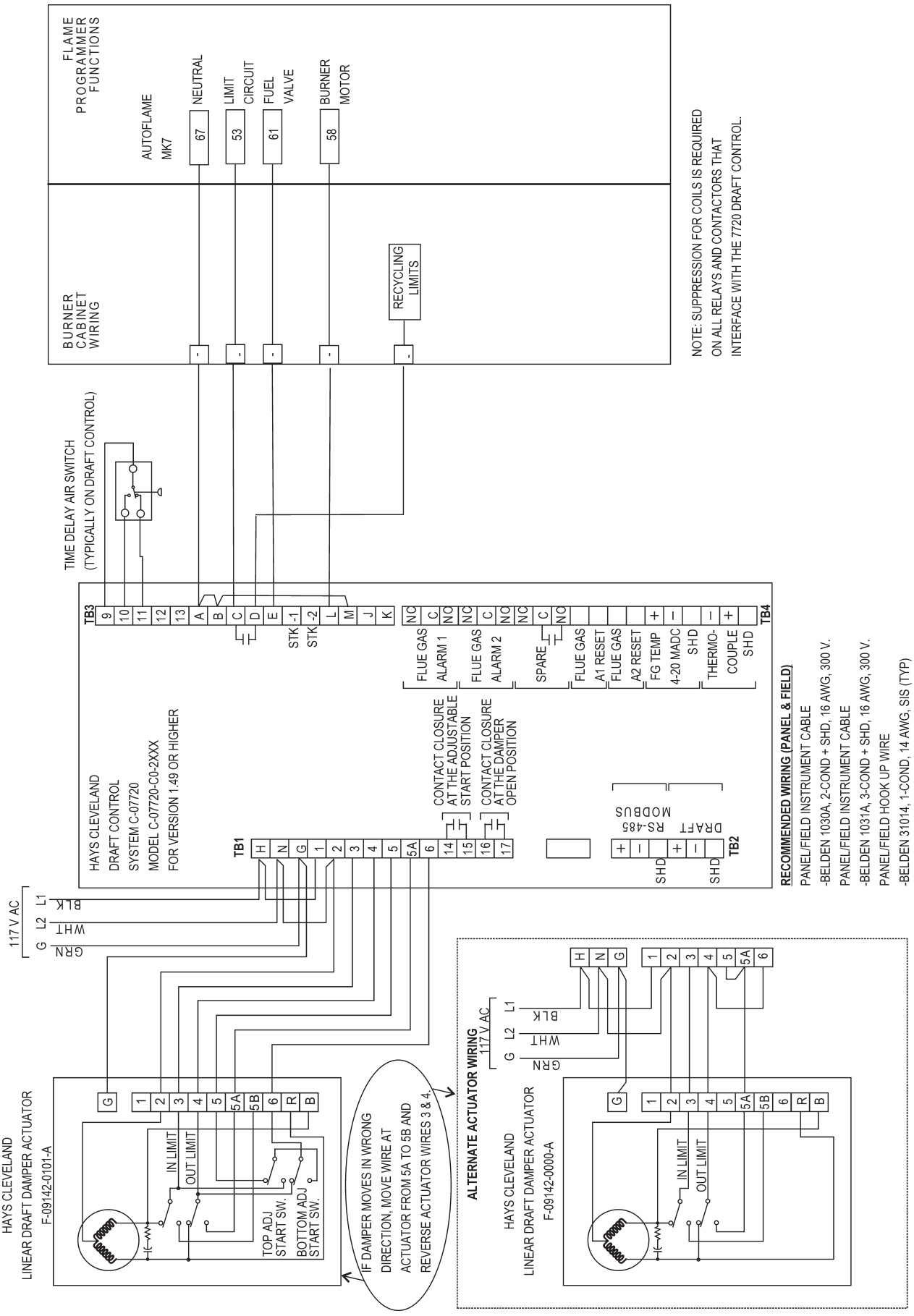


Fig. 24 Series C-07720-C0-2xxx Draft Control Series with AutoFlame MK7

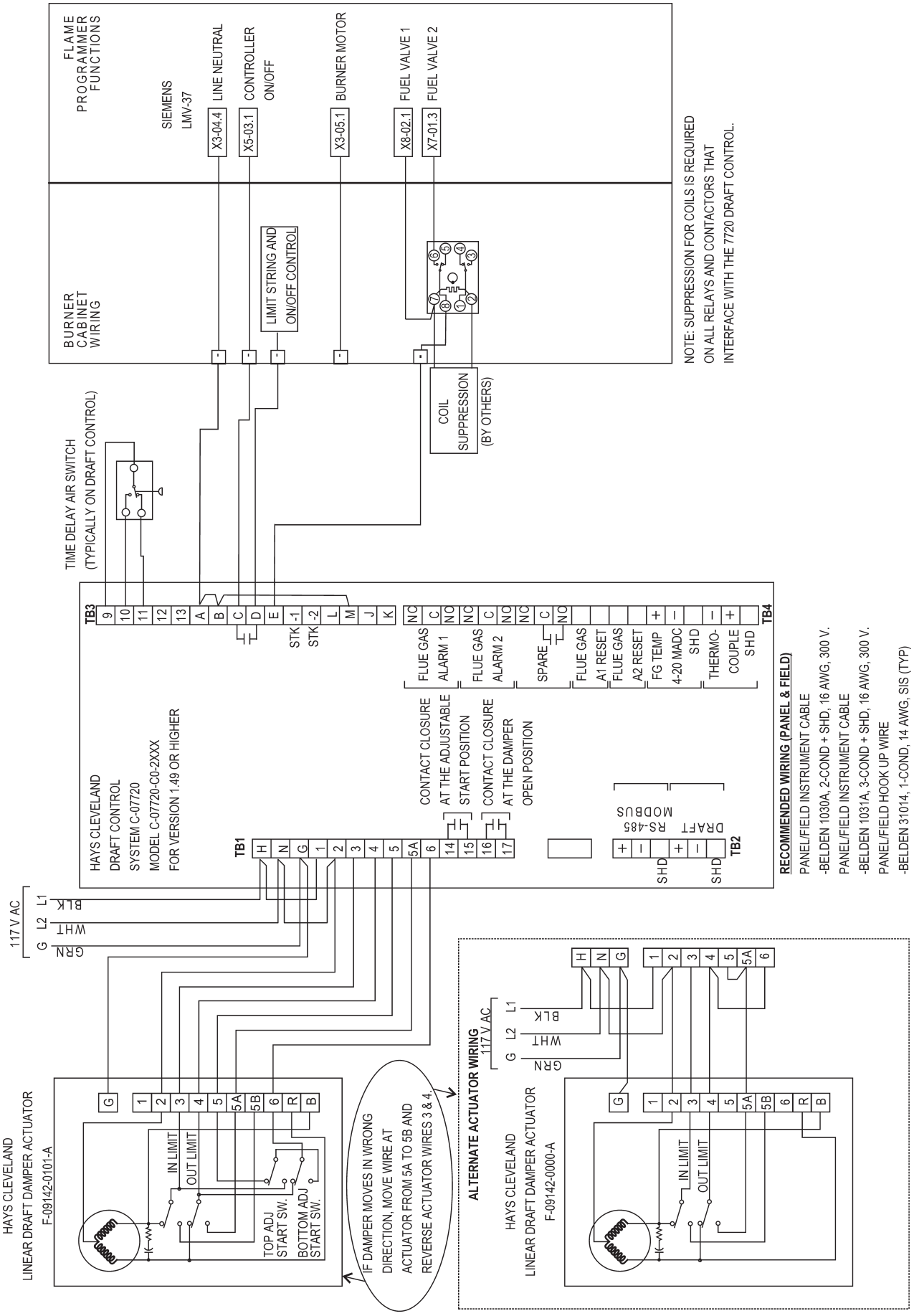


Fig. 25: Series C-07720-C0-2xxx Draft Control Series with Siemens LMV37 W_Valve Proving

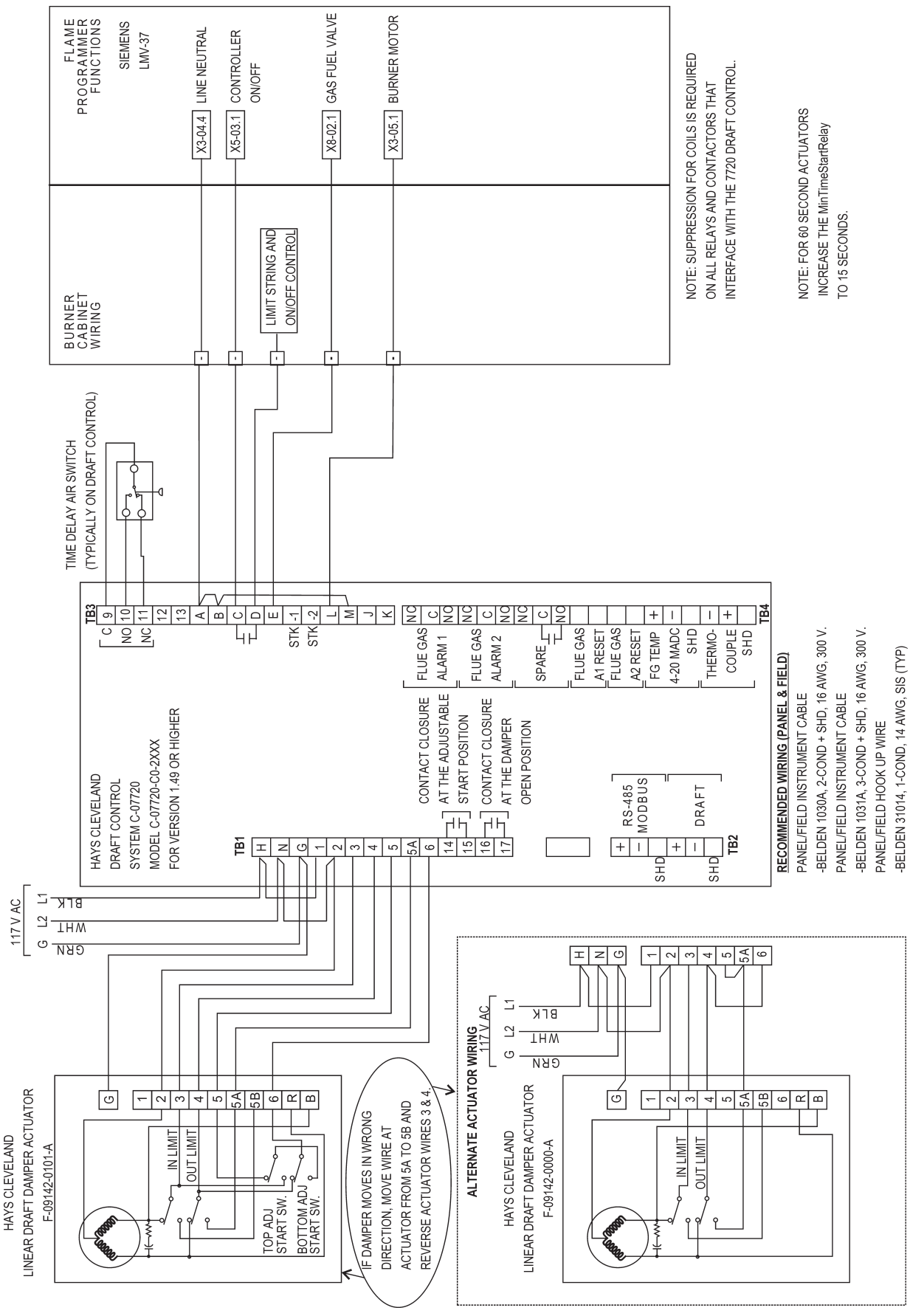


Fig. 26: Series C-07720-C0-2xxx Draft Control Series with Siemens LMV-37.

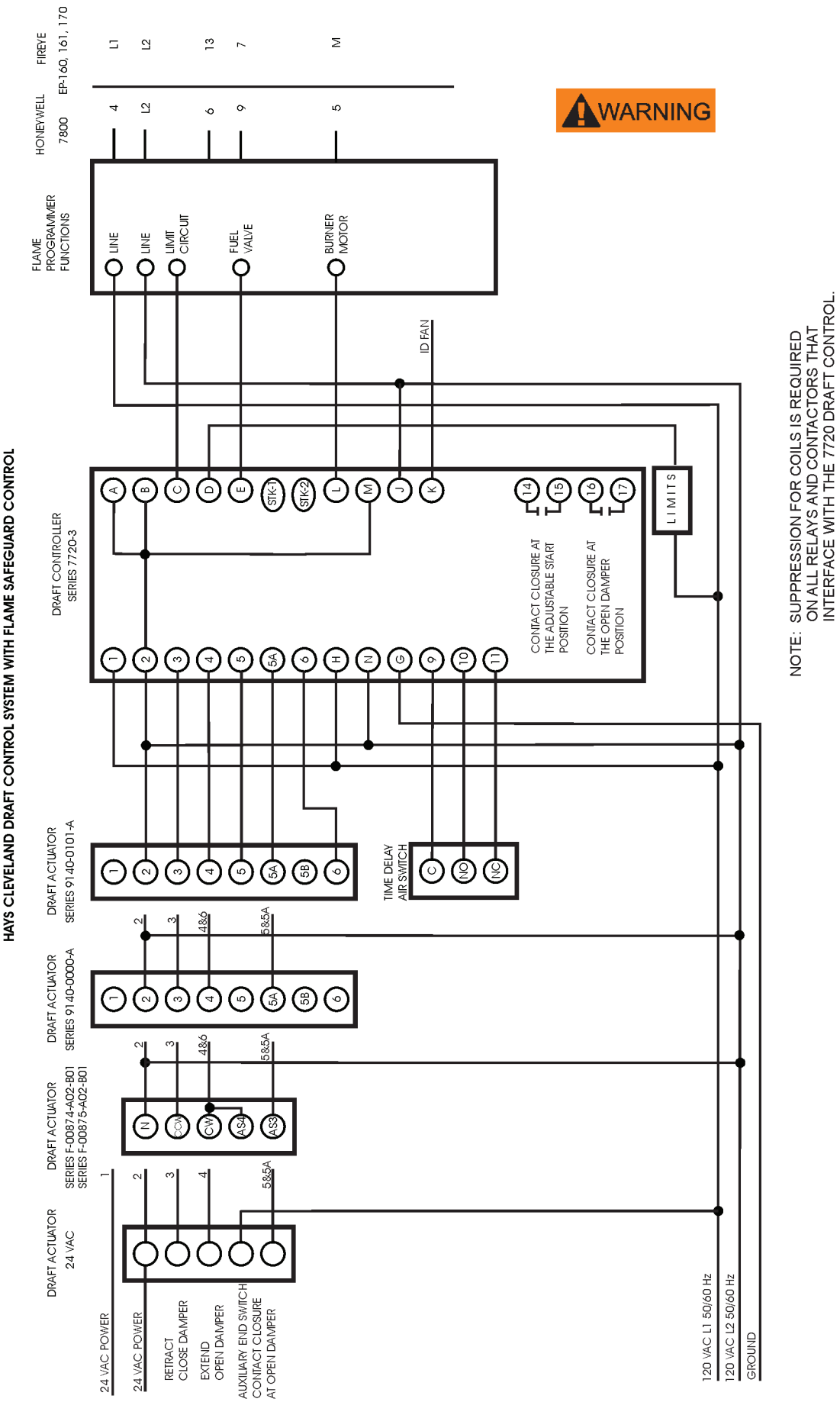


Fig. 27: Series C-07720-C0-3xxx Draft Control Series with Flame Safeguard Control.

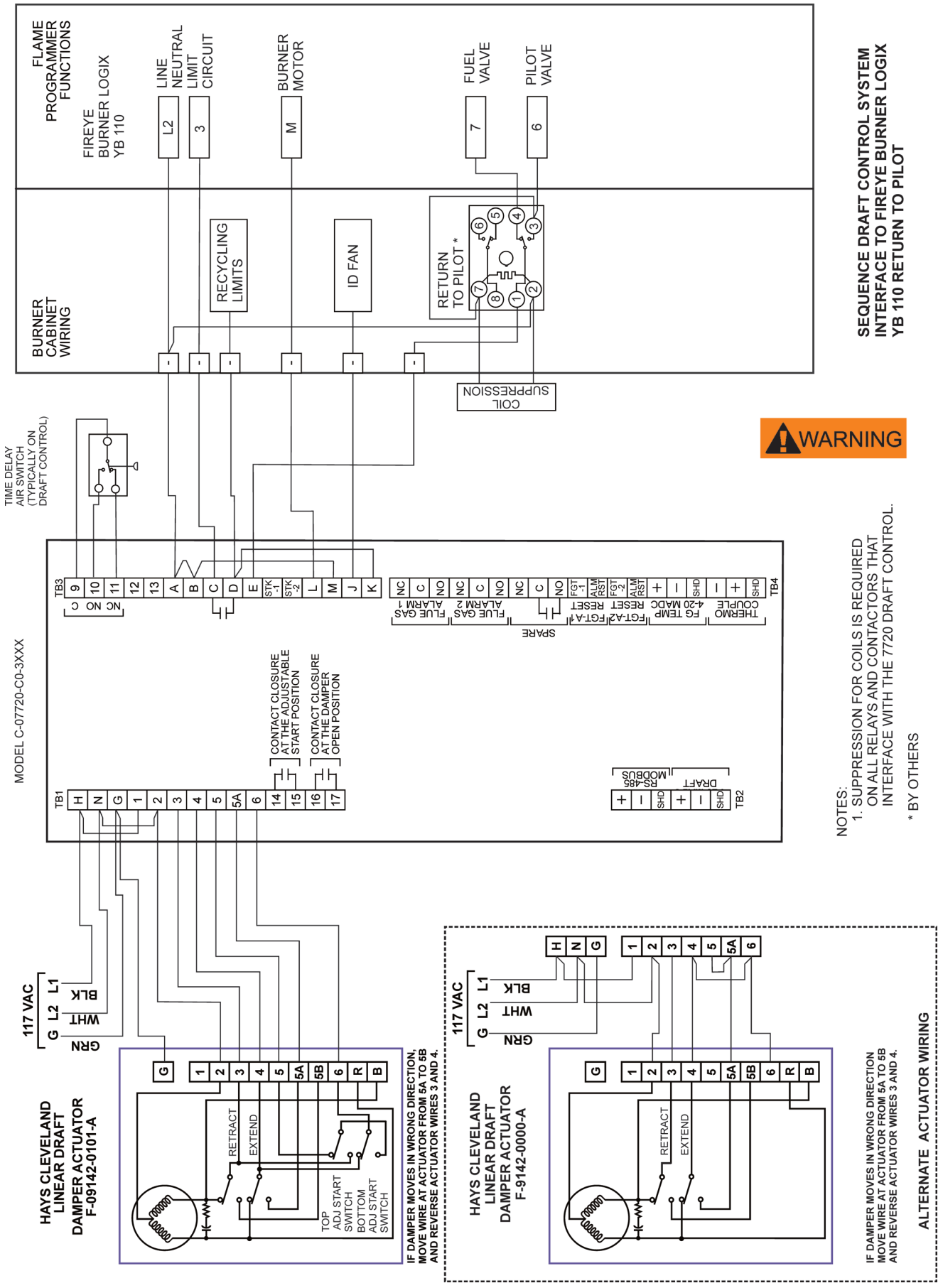


Fig. 28: Series C-07720-C0-3xxx Draft Control Interface with Fireye Burner Logix YB 110. Return to Pilot.

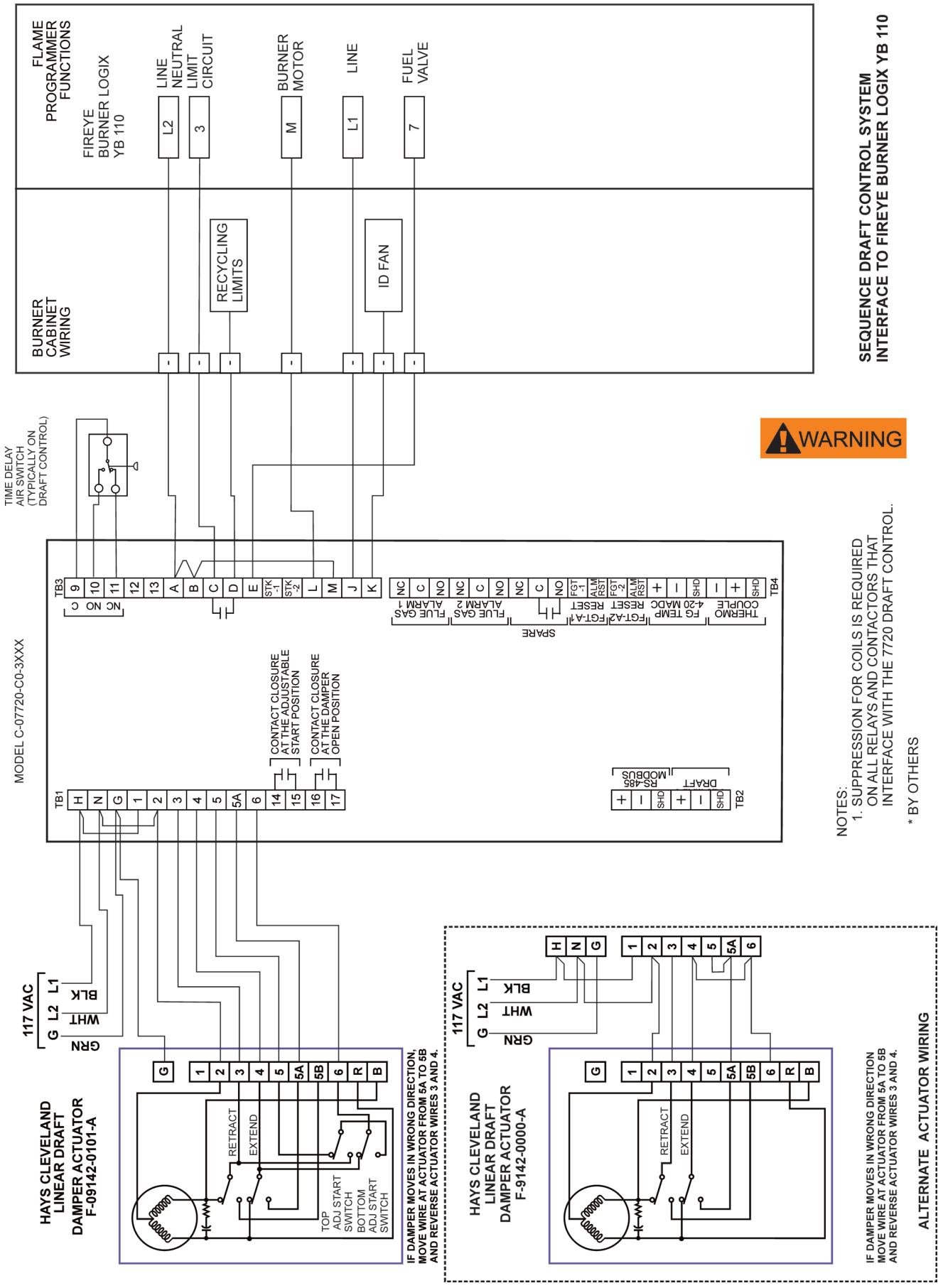


Fig. 29: Series C-07720-C0-3xxx Draft Control Interface with Fireye Burner Logix YB 110.

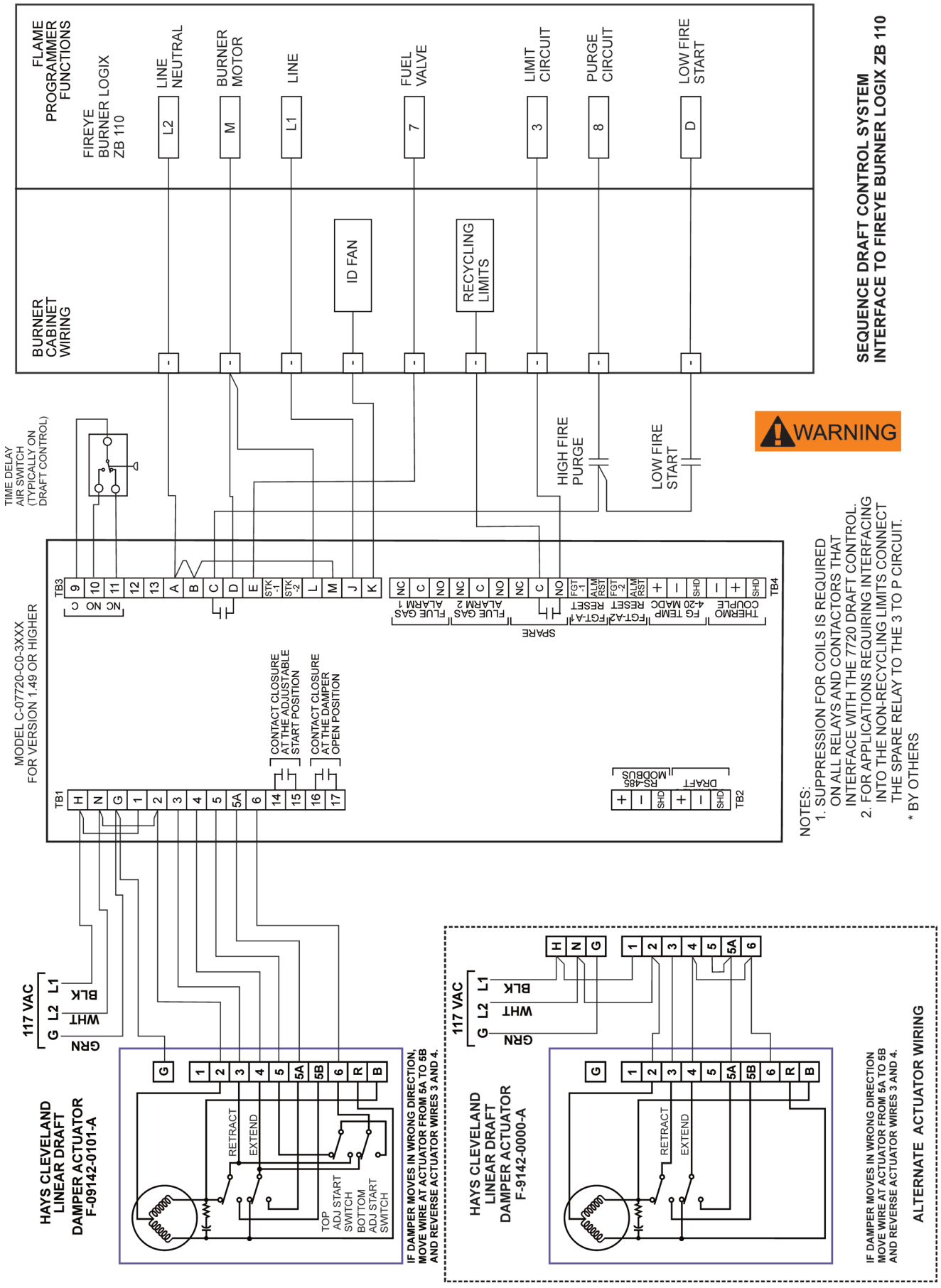


Fig. 30: Series C-07720-C0-3xxx Draft Control Interface with Fireye Burner Logix ZB 110.

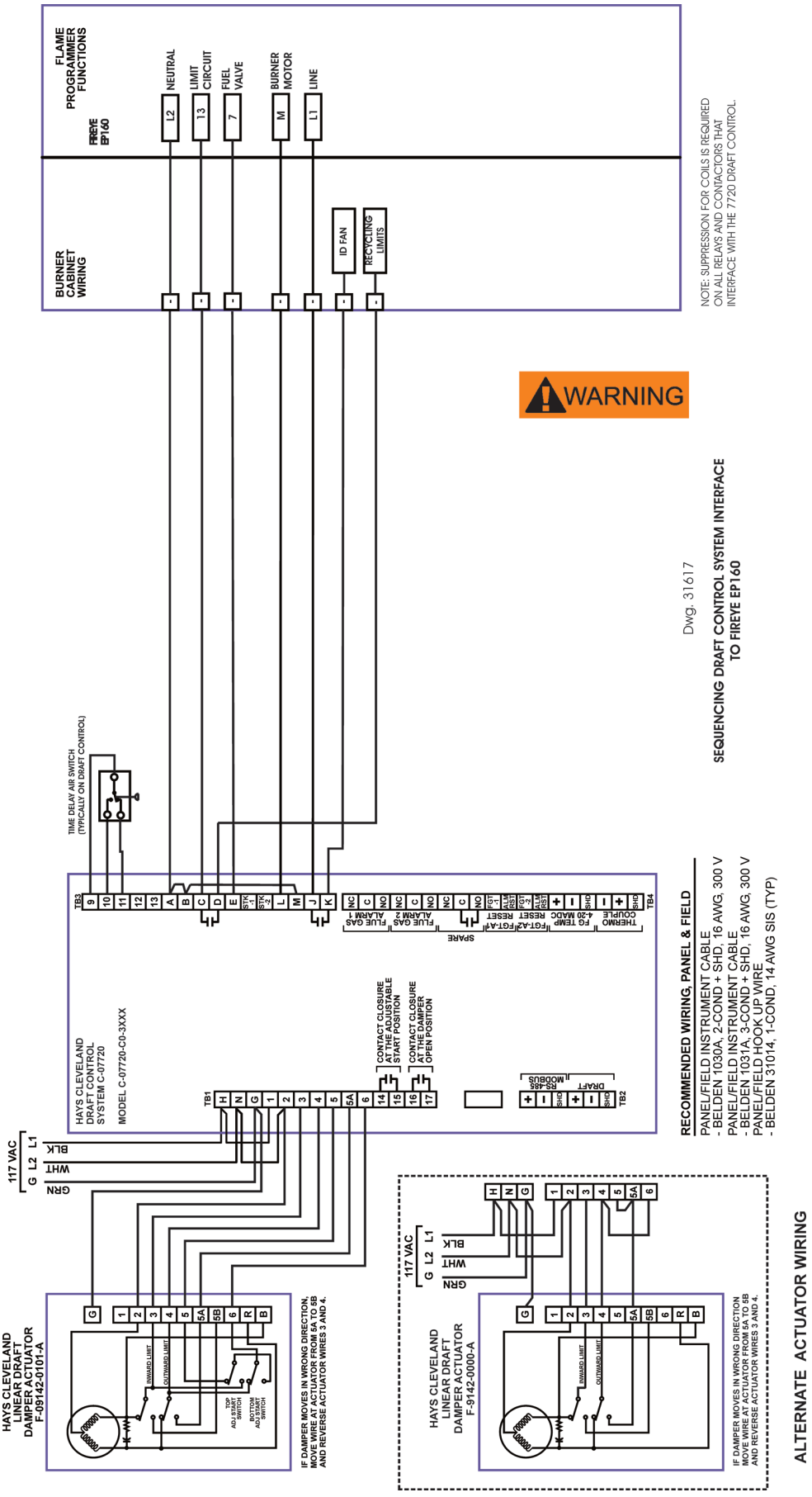


Fig. 31: Series C-07720-C0-3xxx Draft Control Interface with Fireye EP160.

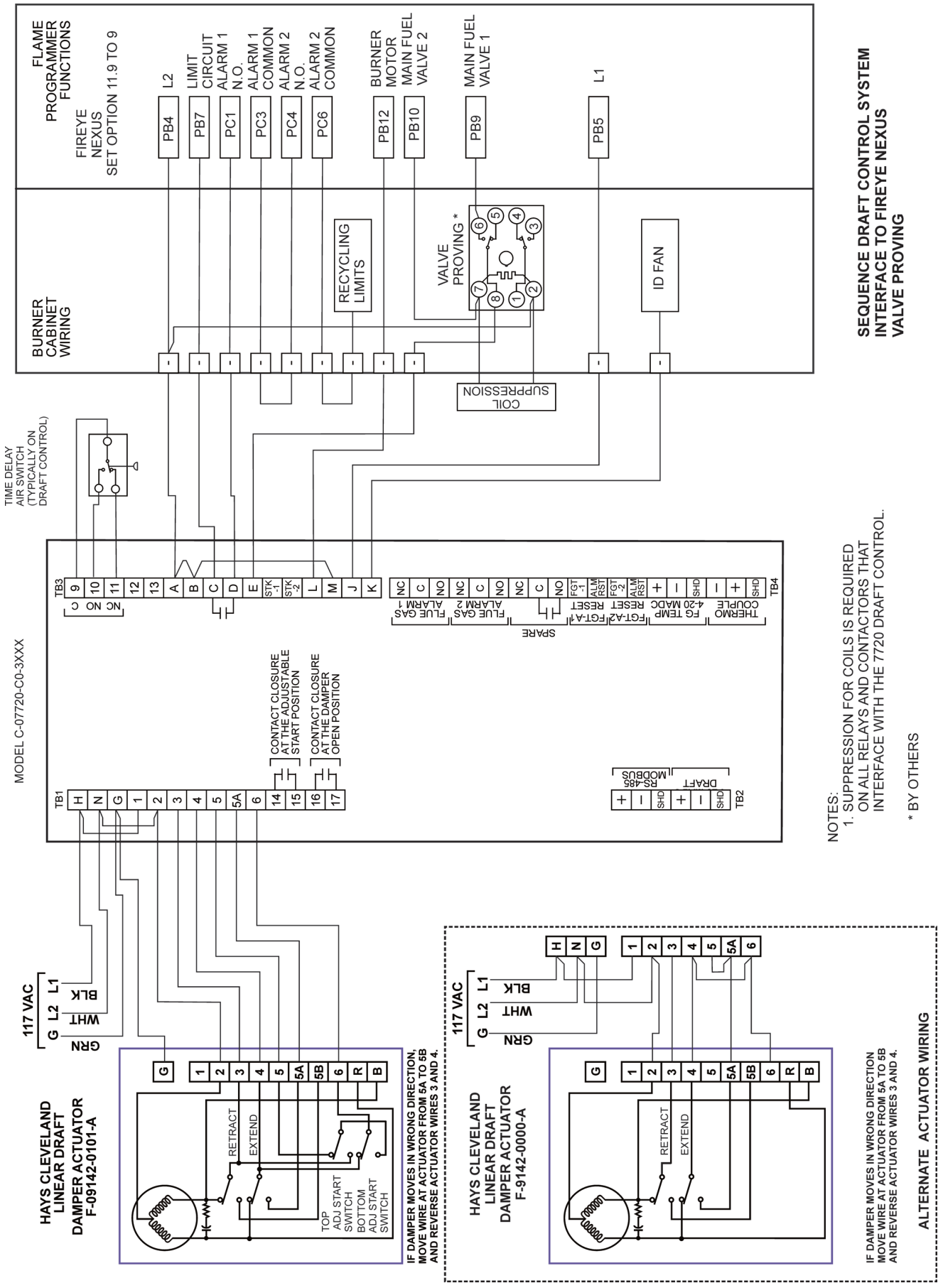


Fig. 32: Series C-07720-C0-3xxx Draft Control Interface with Fireye Nexus Valve Proving.

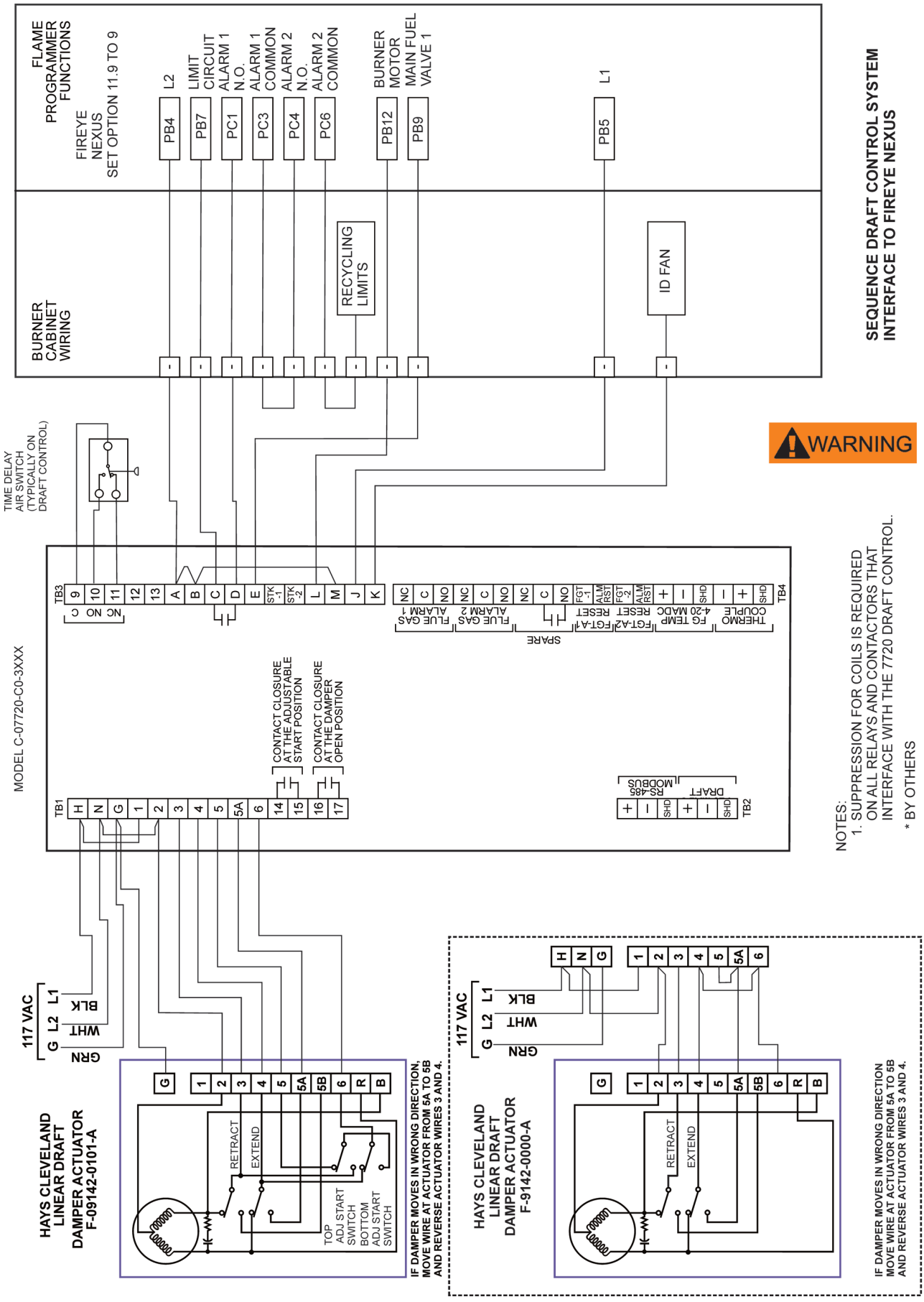


Fig. 33: Series C-07720-C0-3xxx Draft Control Interface with Fireye Nexus.

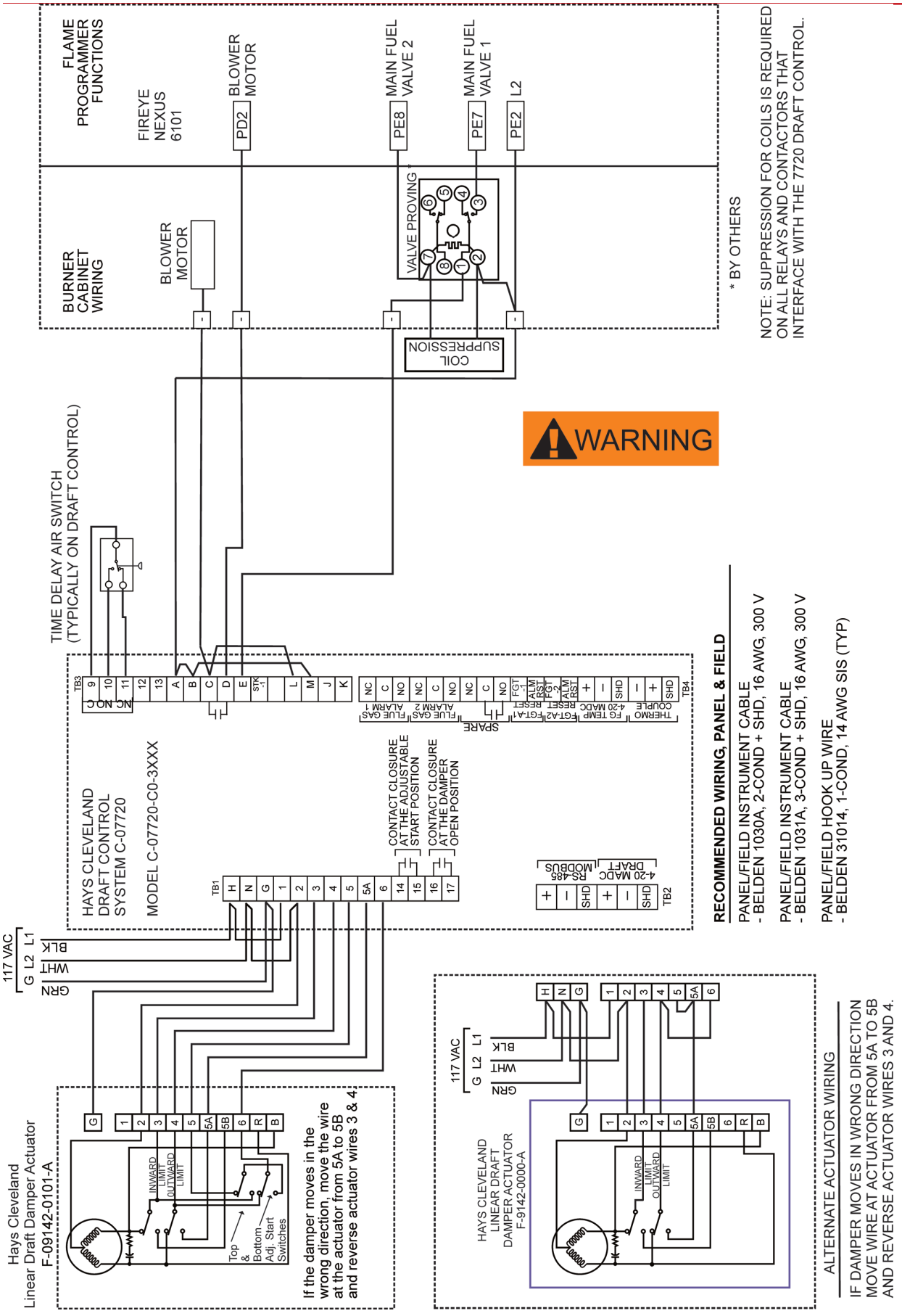


Fig. 34: Series C-07720-C0-3xxx Draft Control Interface with Fireye Nexus 6101 Valve Proving.

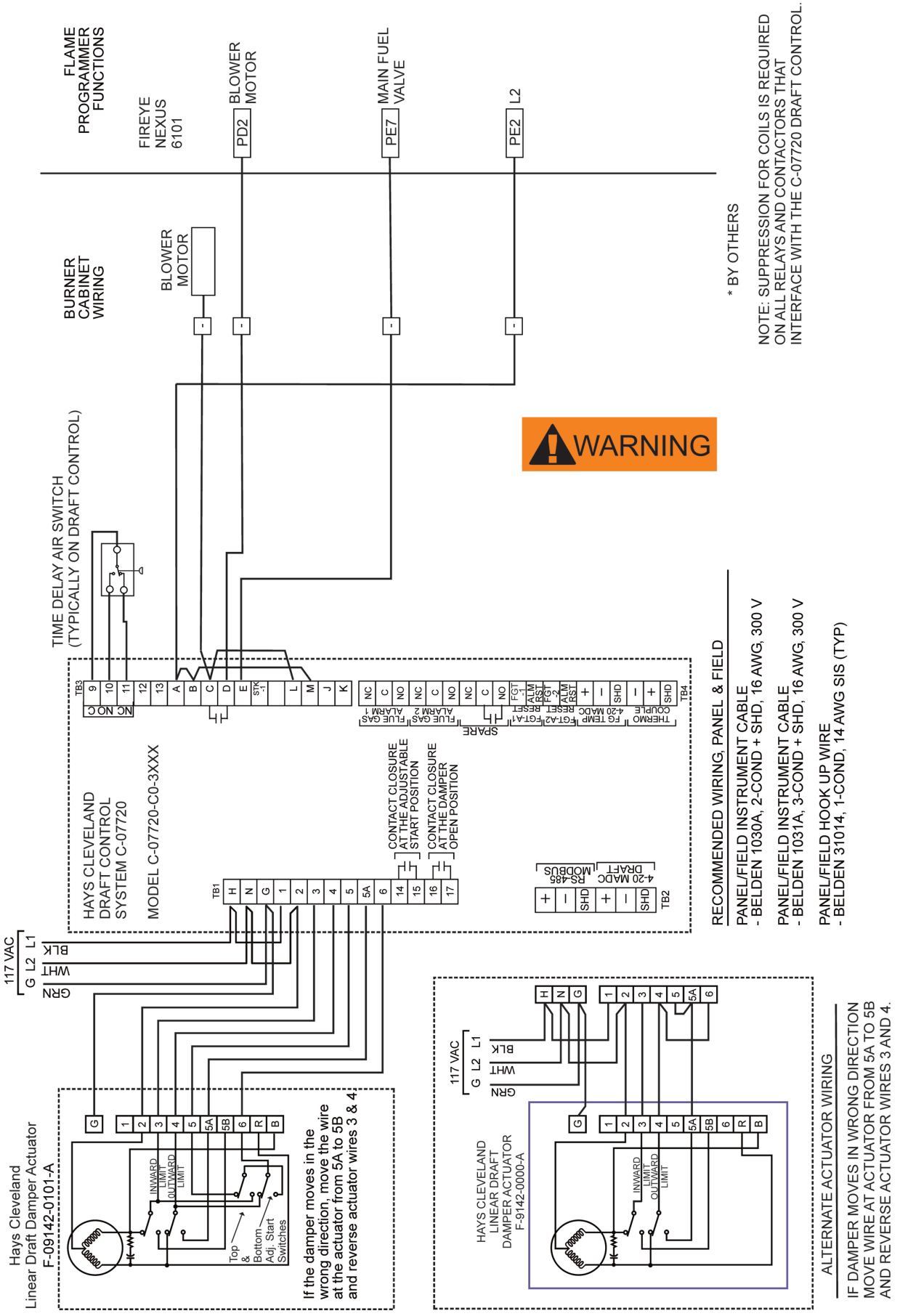


Fig. 35: Series C-07720-C0-3xxx Draft Control Interface with Fireye Nexus 6101.

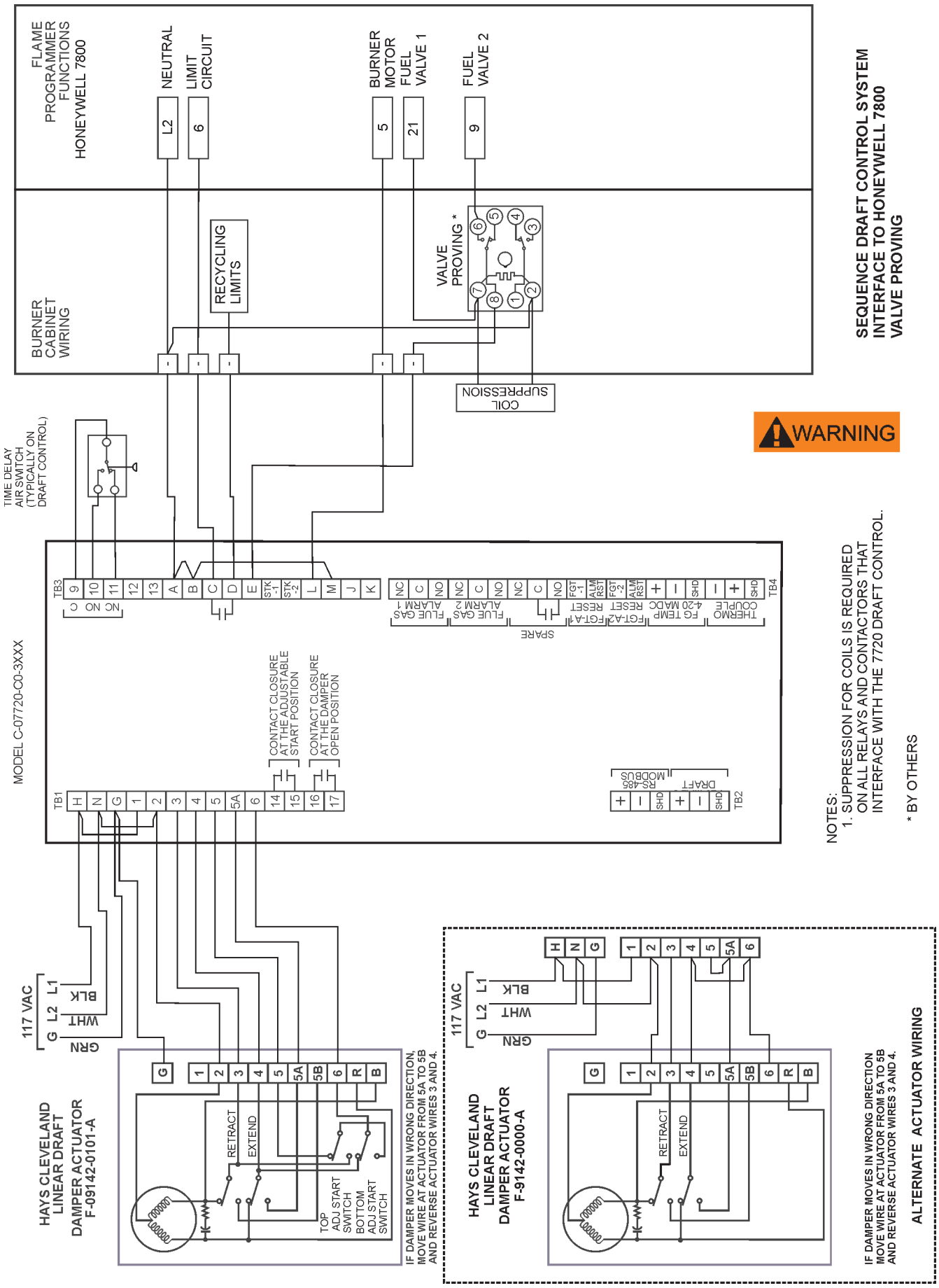


Fig. 36: Series C-07720-C0-3xxx Draft Control Interface with Honeywell 7800 Valve Proving.

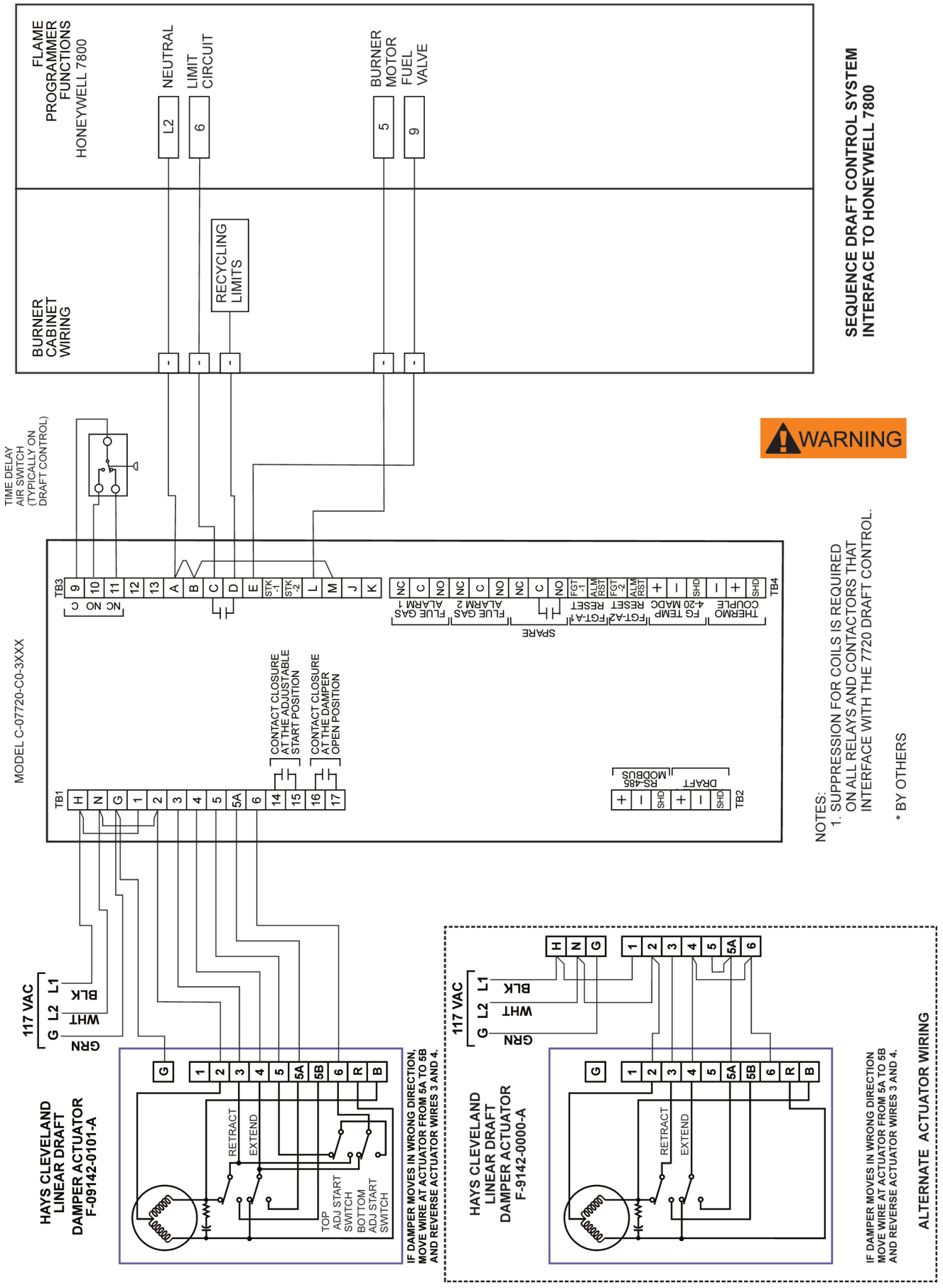


Fig. 37: Series C-07720-C0-3xxx Draft Control Interface with Honeywell 7800.

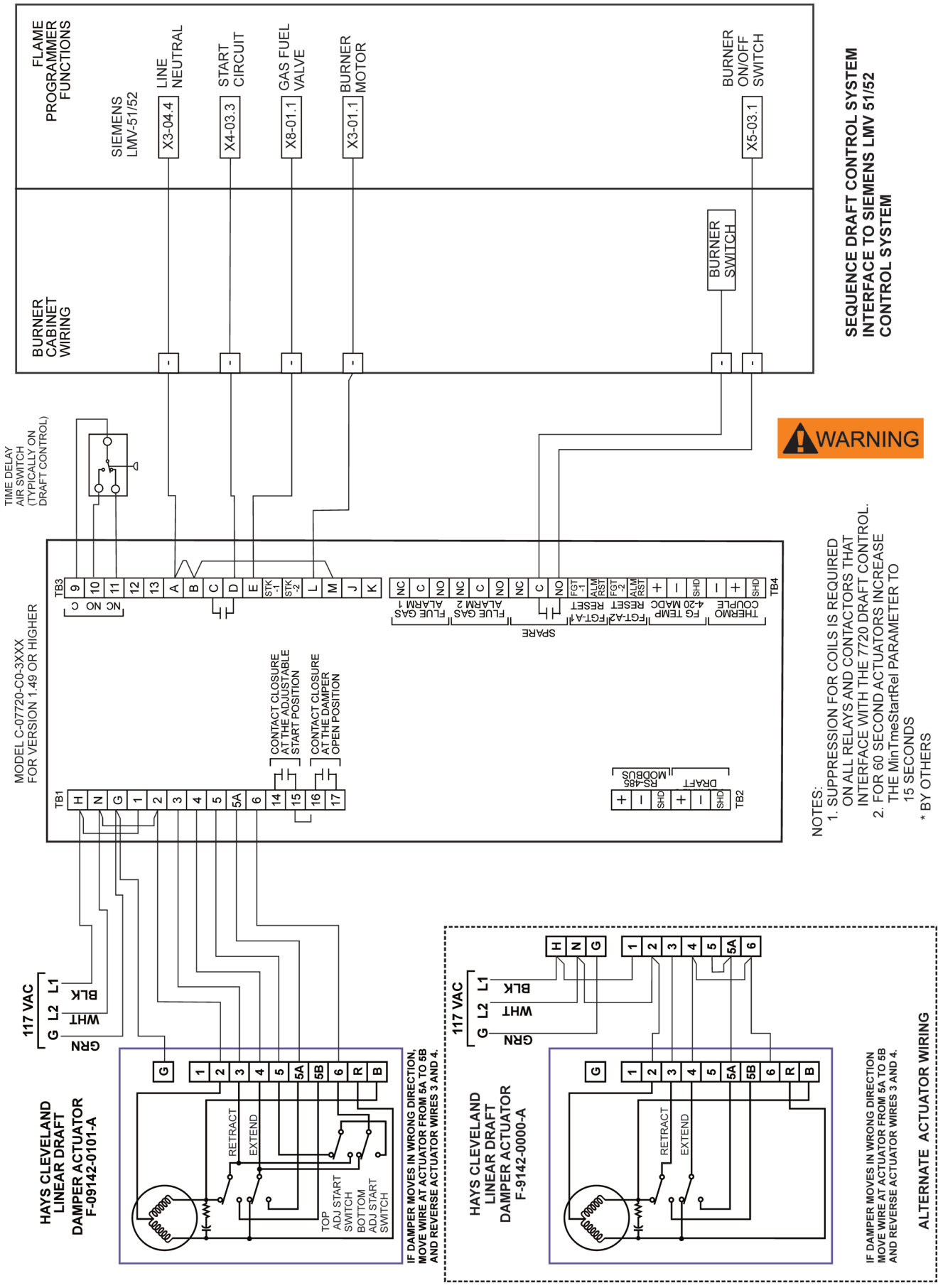


Fig. 38: Series C-07720-C0-3xxx Draft Control Interface with Siemens LMV5X.

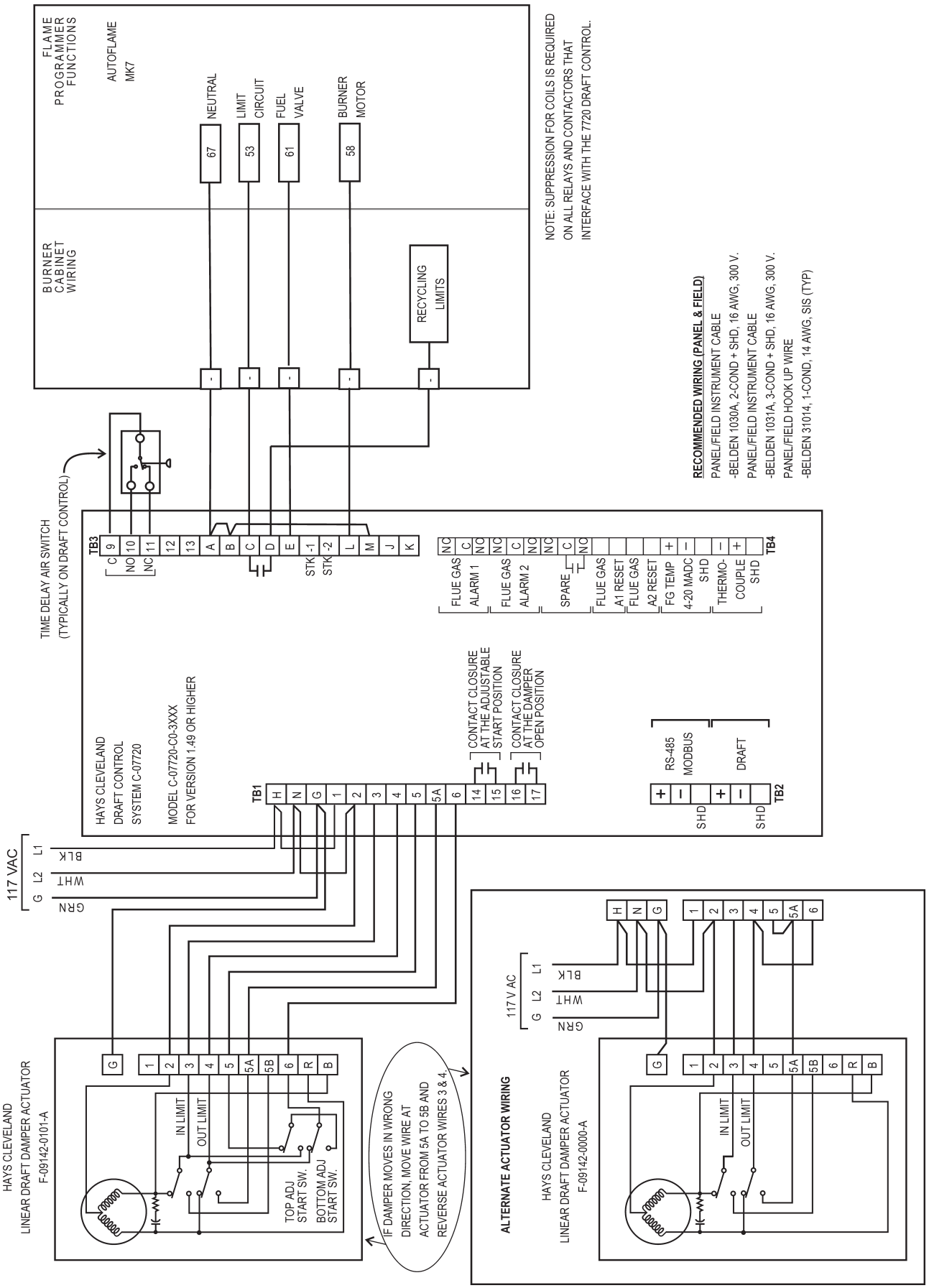


Fig. 39: Series C-07720-C0-3xxx Draft Control Interface with Autoflame MK7.

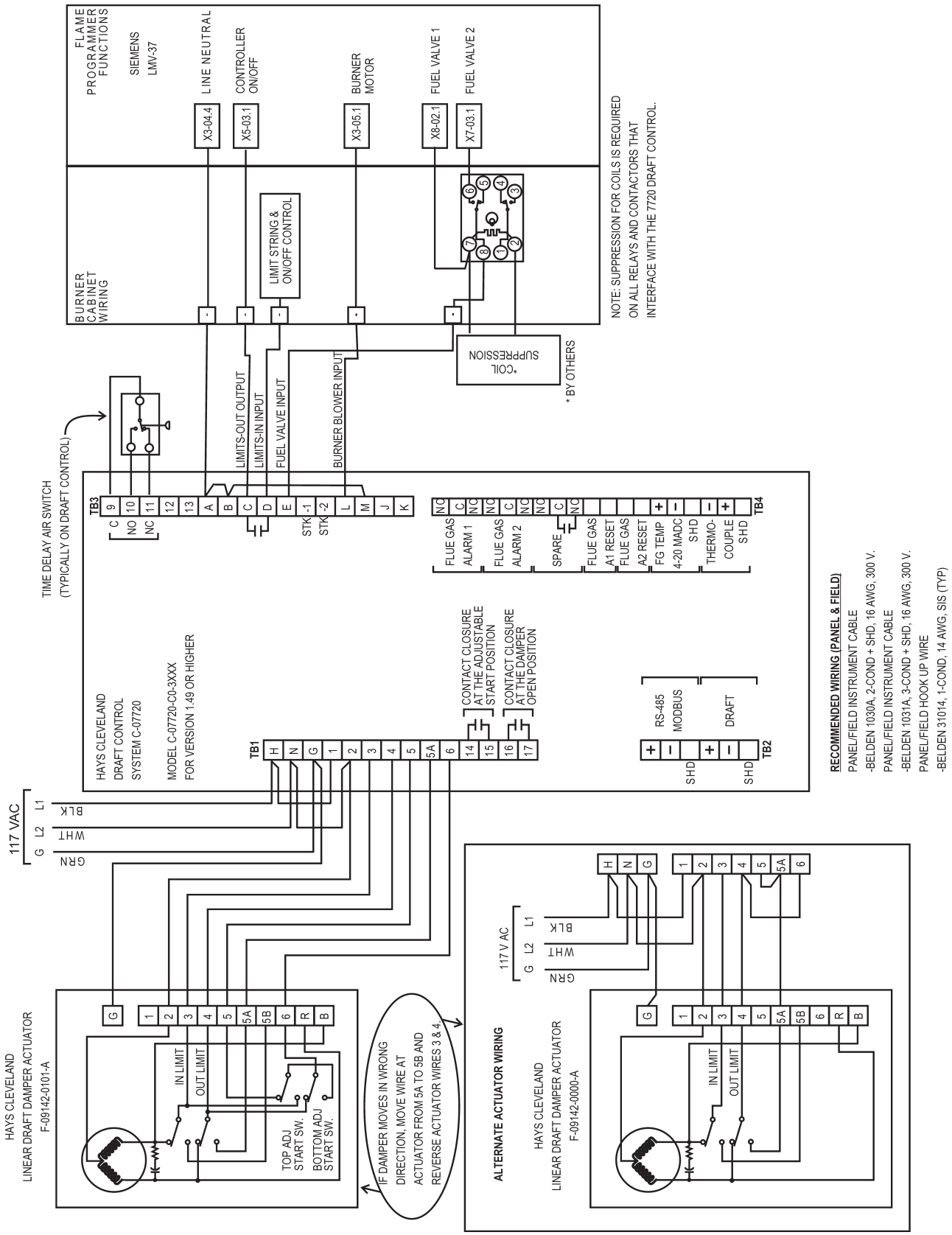


Fig. 40: Series C-07720-C0-3xxx Draft Control Interface with Siements LMV-37 with Valve Proving.

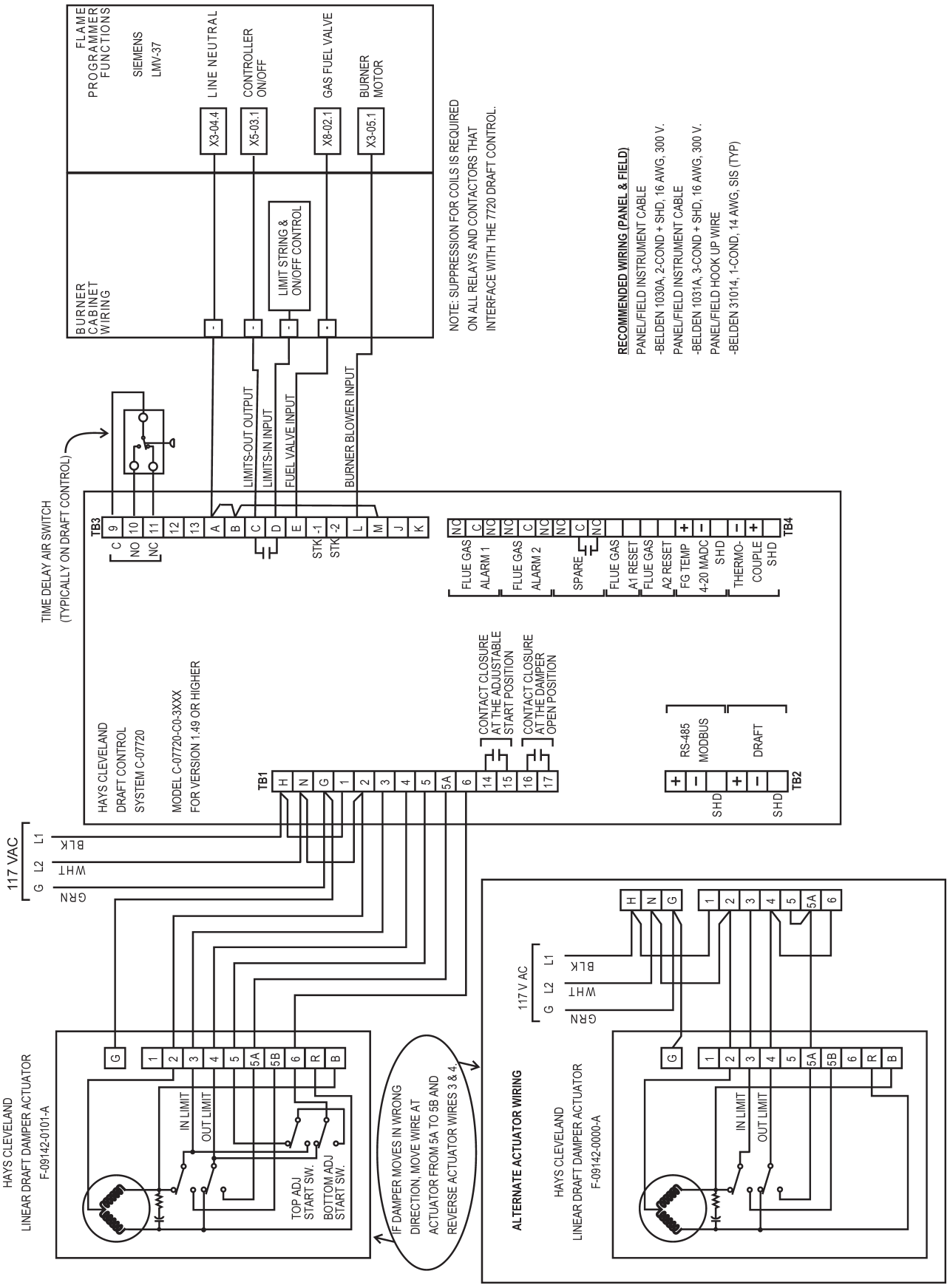
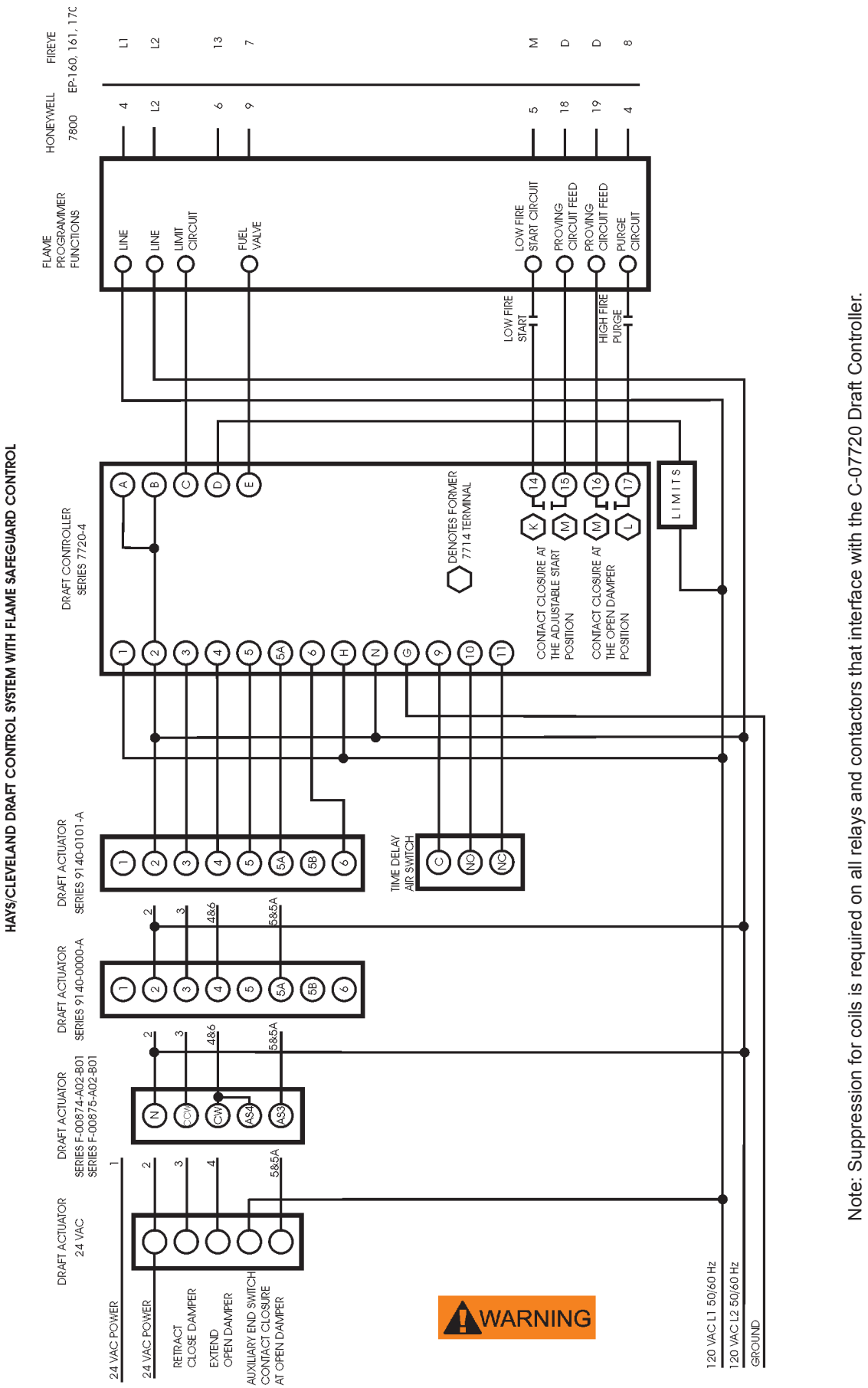


Fig. 41: Series C-07720-C0-3xxx Draft Control Interface with Siemens LMV-37.



Note: Suppression for coils is required on all relays and contactors that interface with the C-07720 Draft Controller.

Fig. 42: Series C-07720-C0-4xxx Draft Control Series with Flame Safeguard Control.

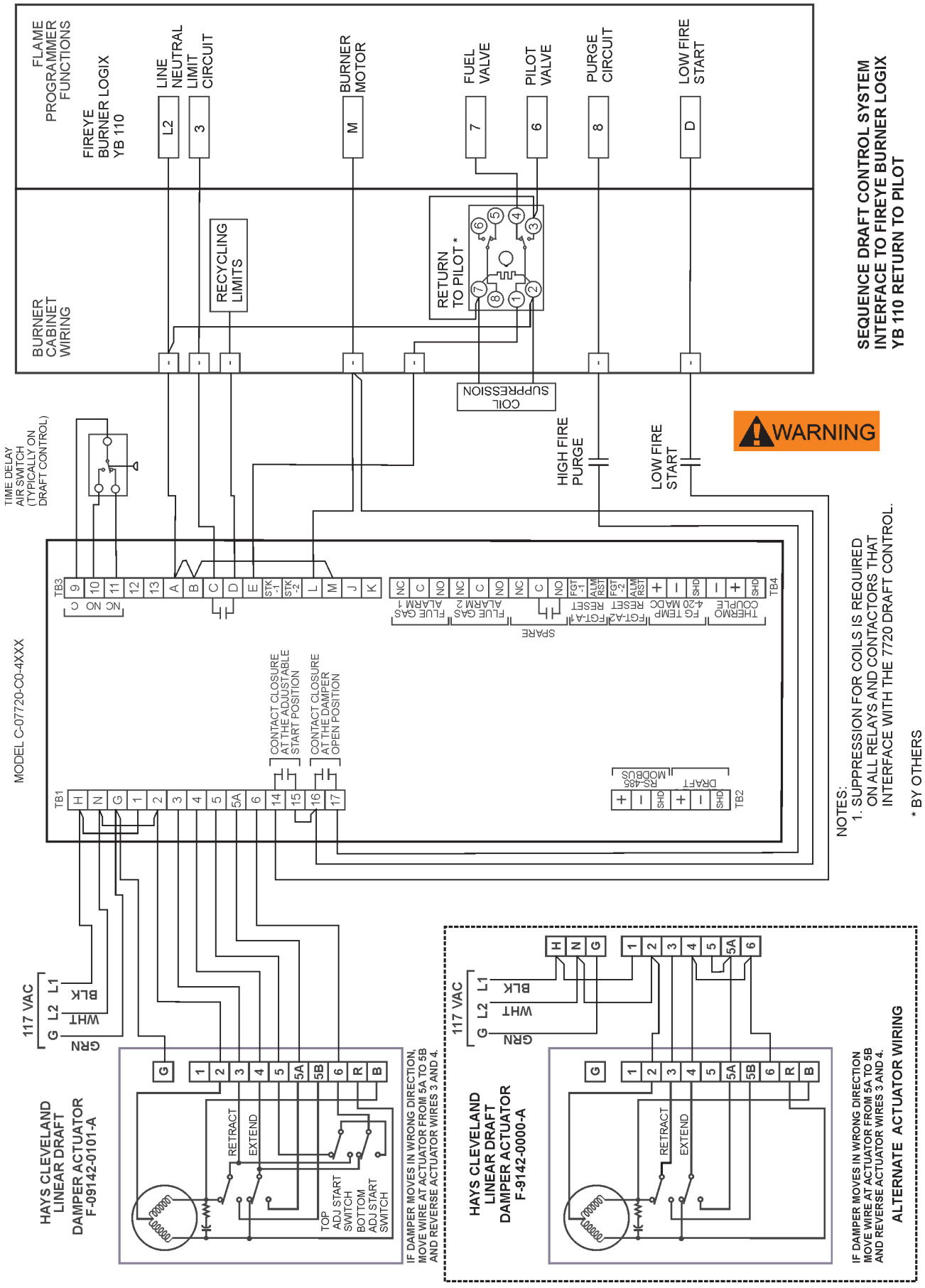


Fig. 43: Series C-07720-C0-4xxx Draft Control Interface with Fireye Burner Logix-YB Return to Pilot.

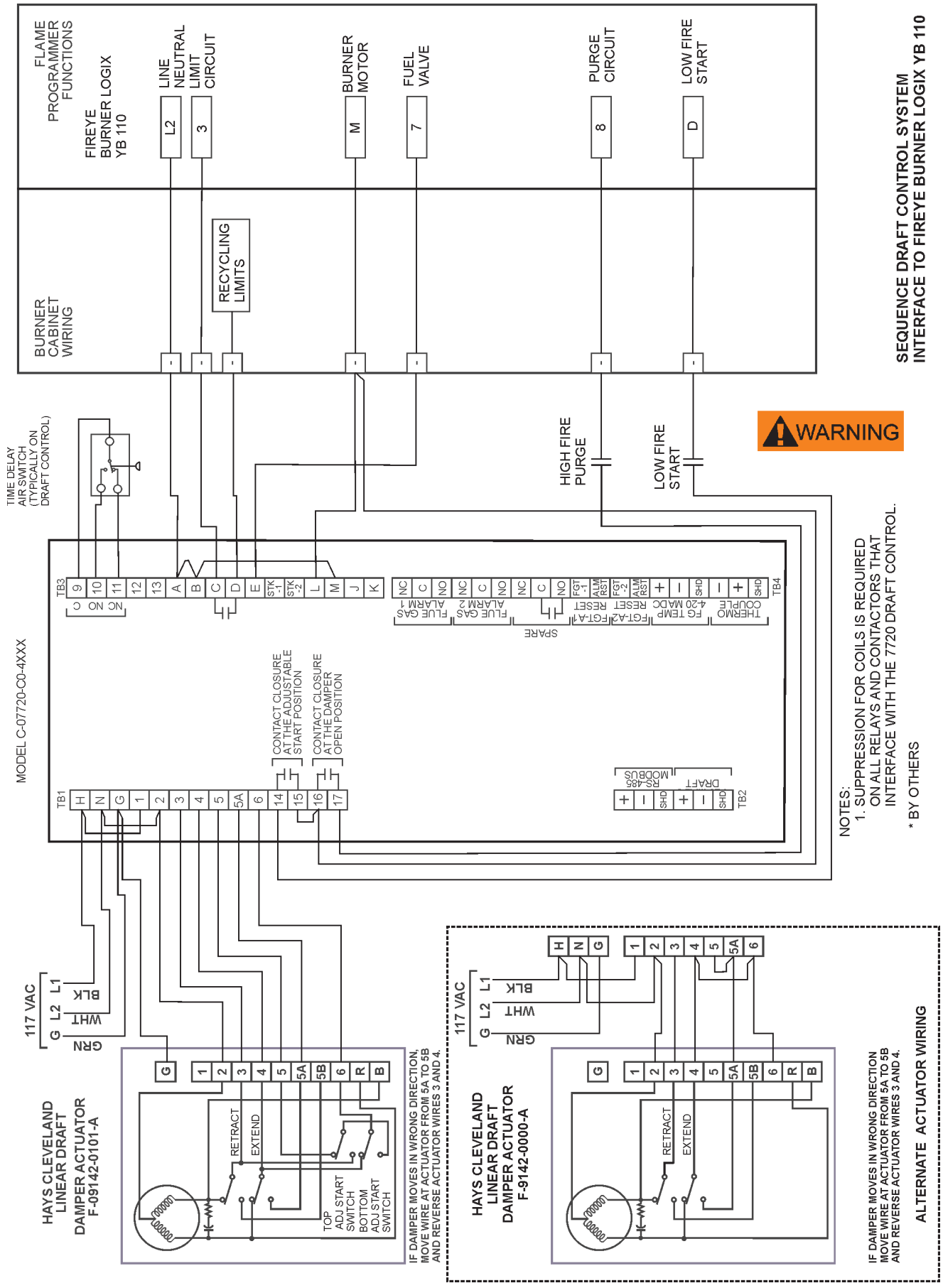


Fig. 44: Series C-07720-C0-4xxx Draft Control Interface with Fireye Burner Logix-YB 110.

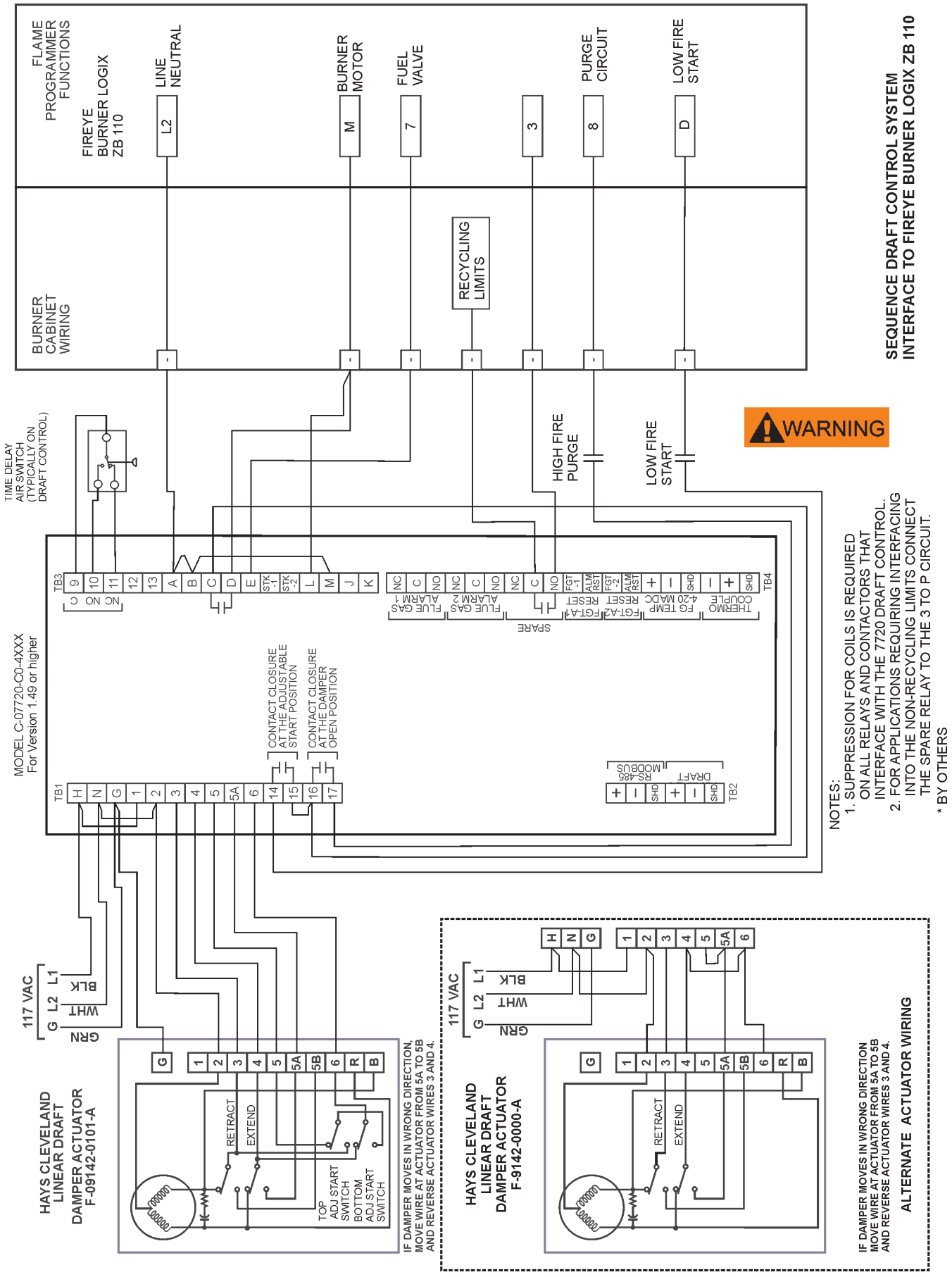


Fig. 45: Series C-07720-C0-4xxx Draft Control Interface with Fireye Burner Logix-ZB 110.

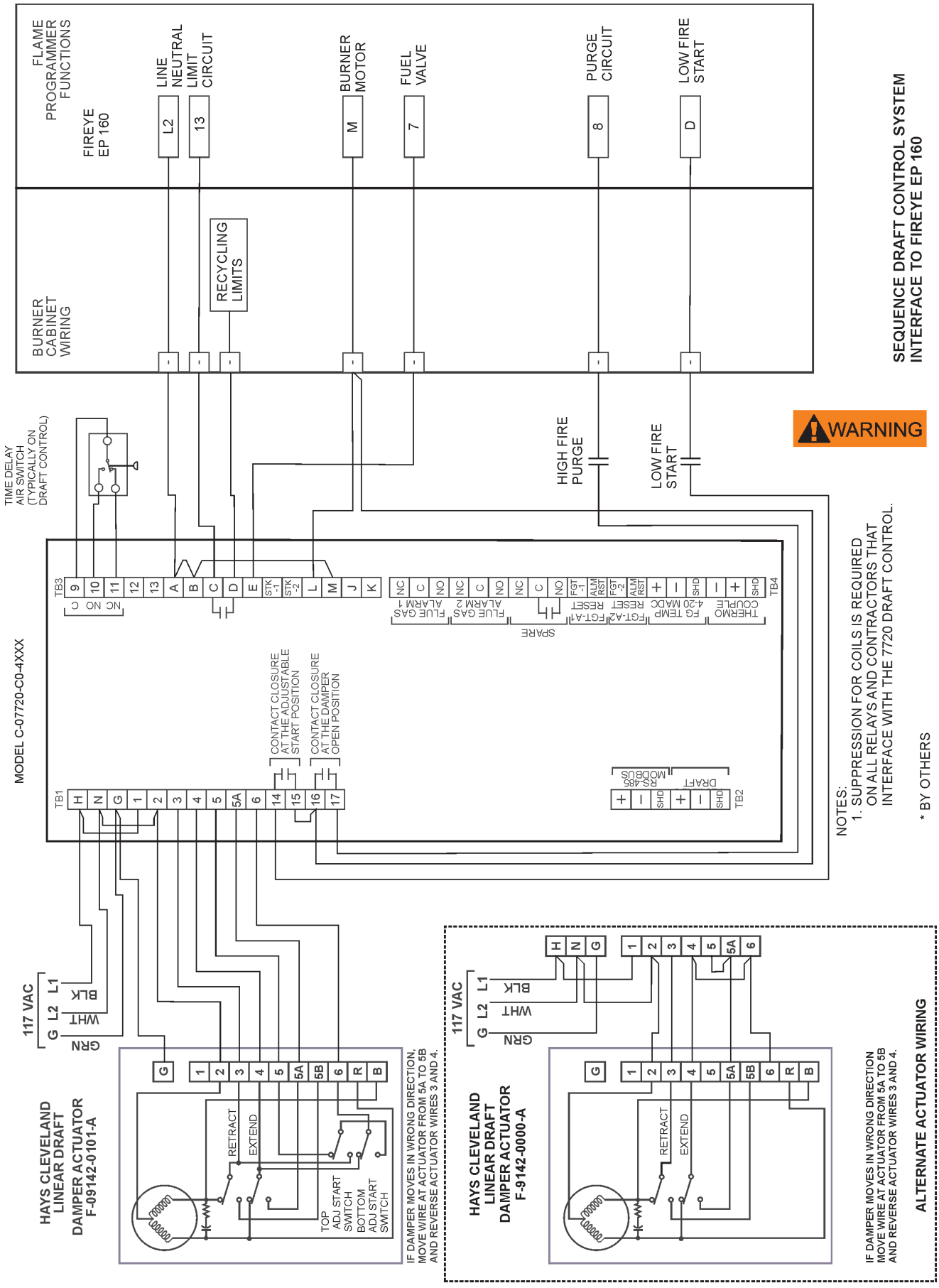


Fig. 46: Series C-07720-C0-4xxx Draft Control Interface with Fireye EP160.

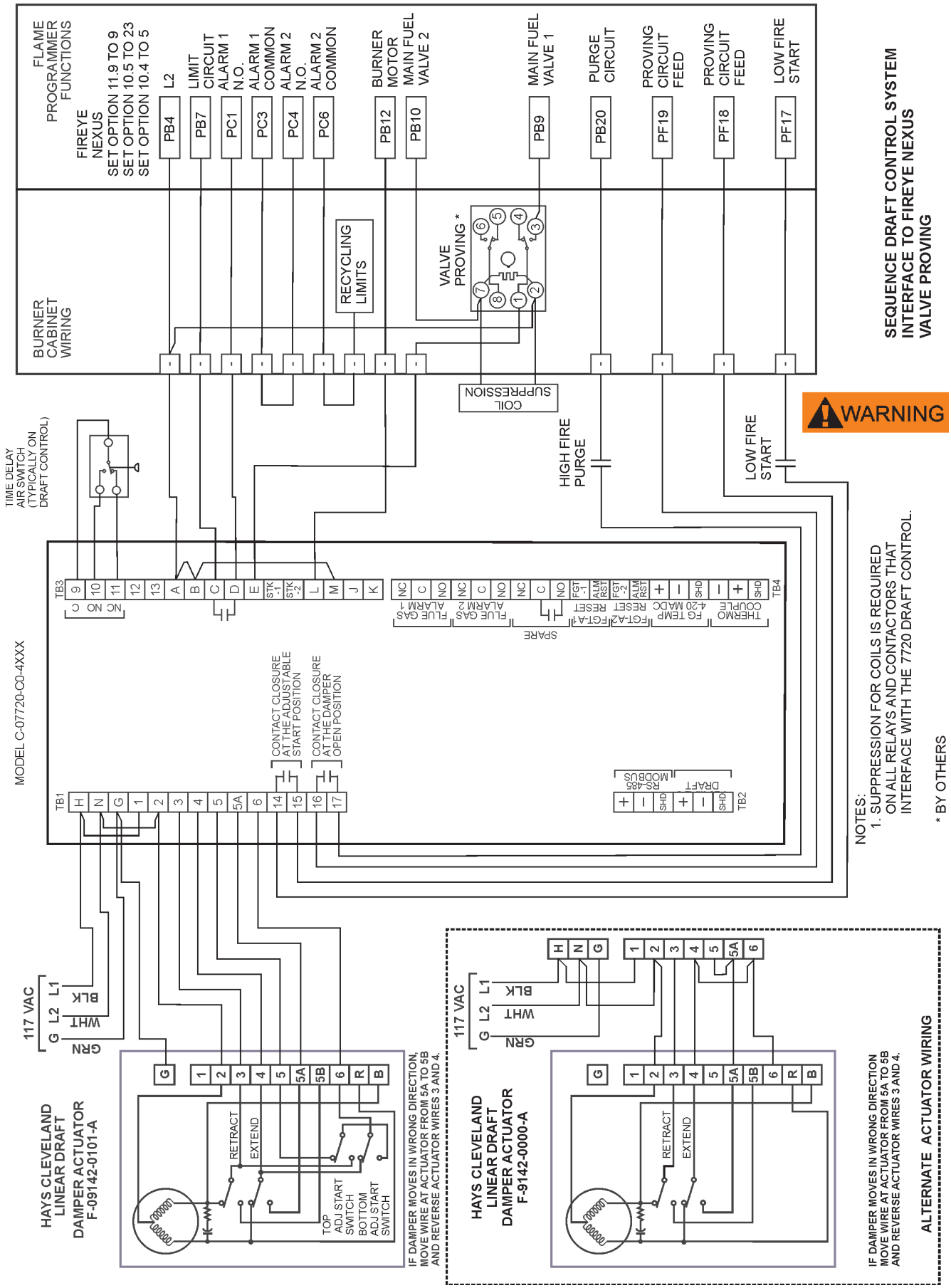


Fig. 47: Series C-07720-C0-4xxx Draft Control Interface with Fireye Nexus Valve Proving.

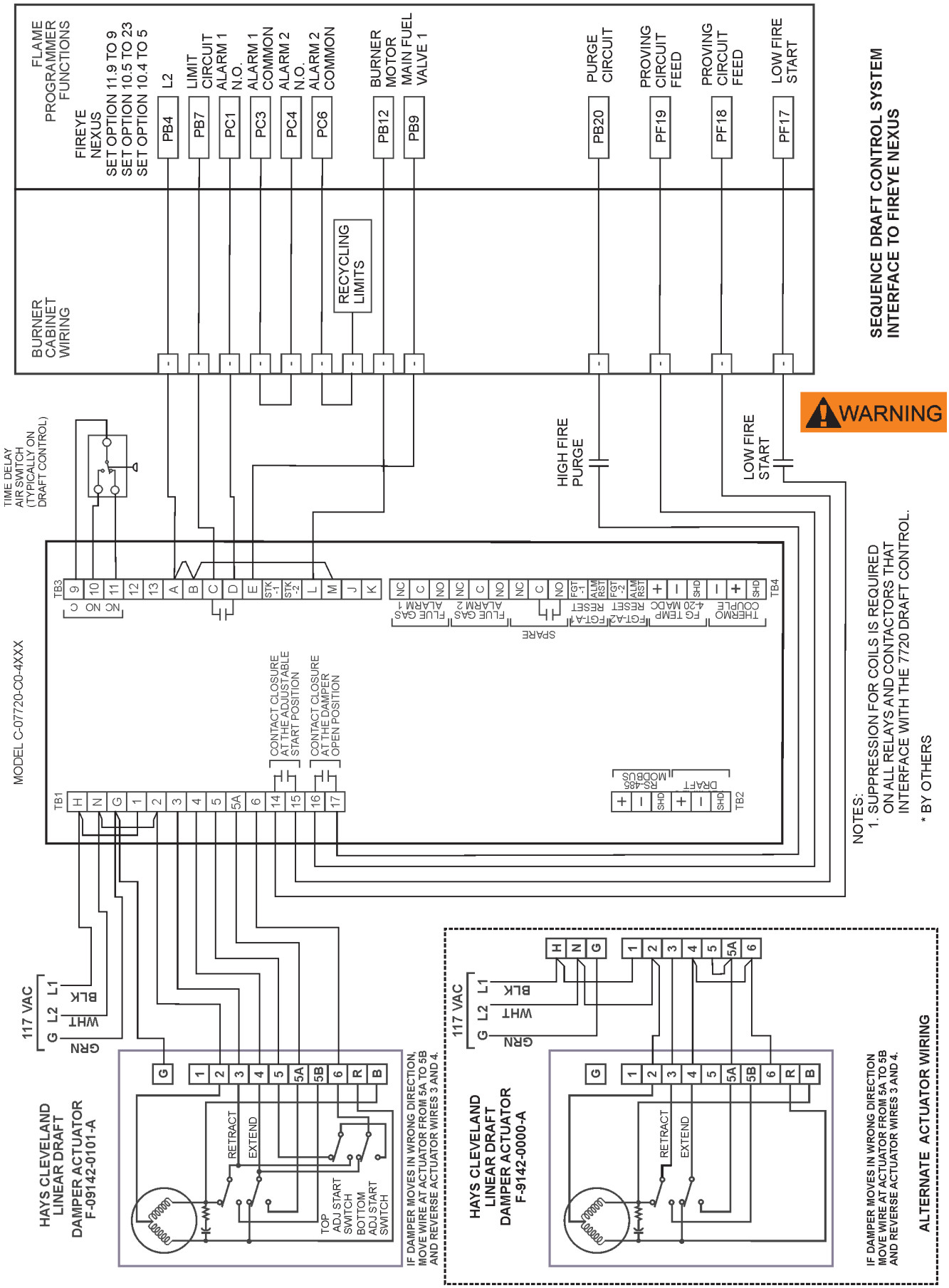


Fig. 48: Series C-07720-C0-4xxx Draft Control Interface with Fireye Nexus.

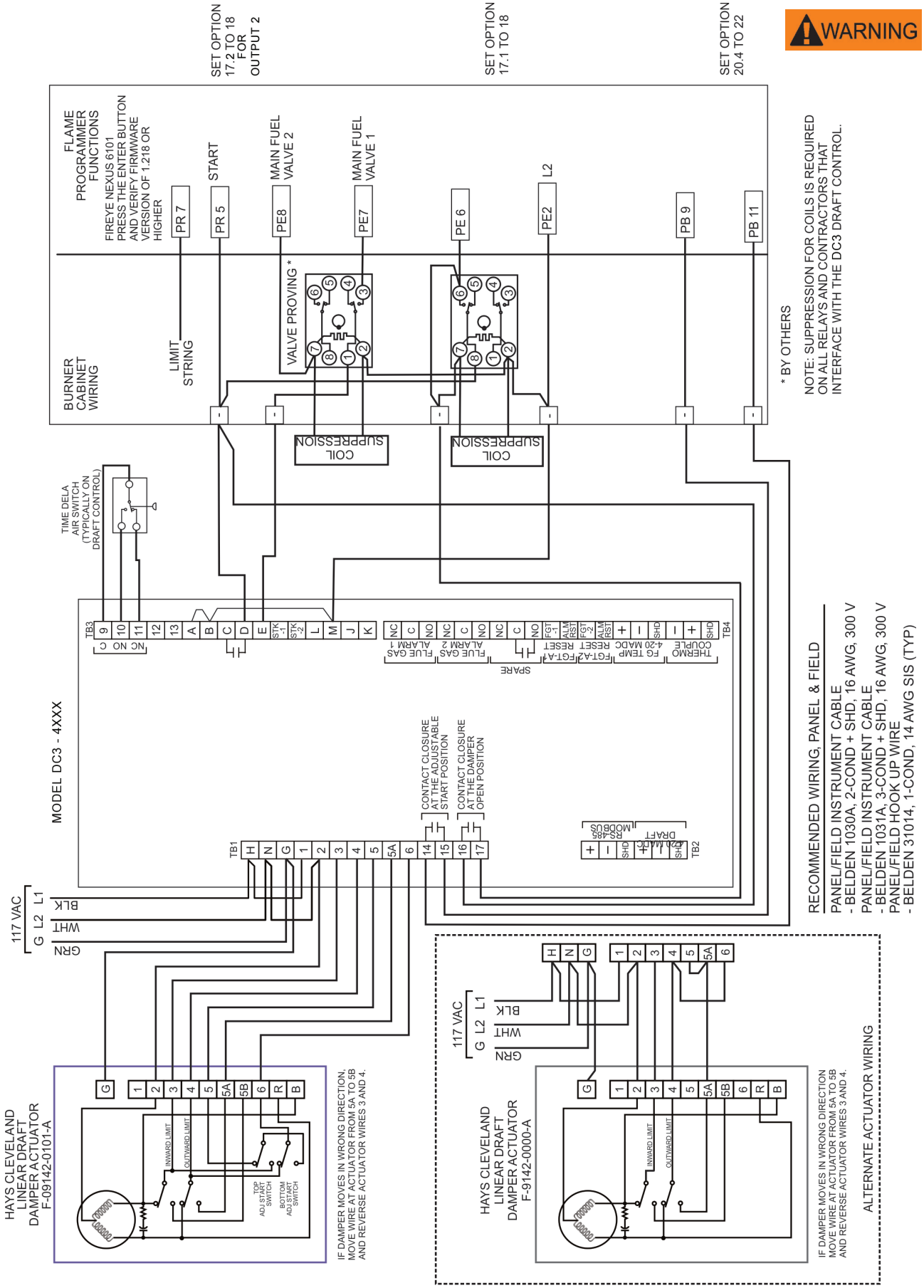


Fig. 49: Series C-07720-C0-4xxx Draft Control Interface with Fireye Nexus 6101 Valve Proving.

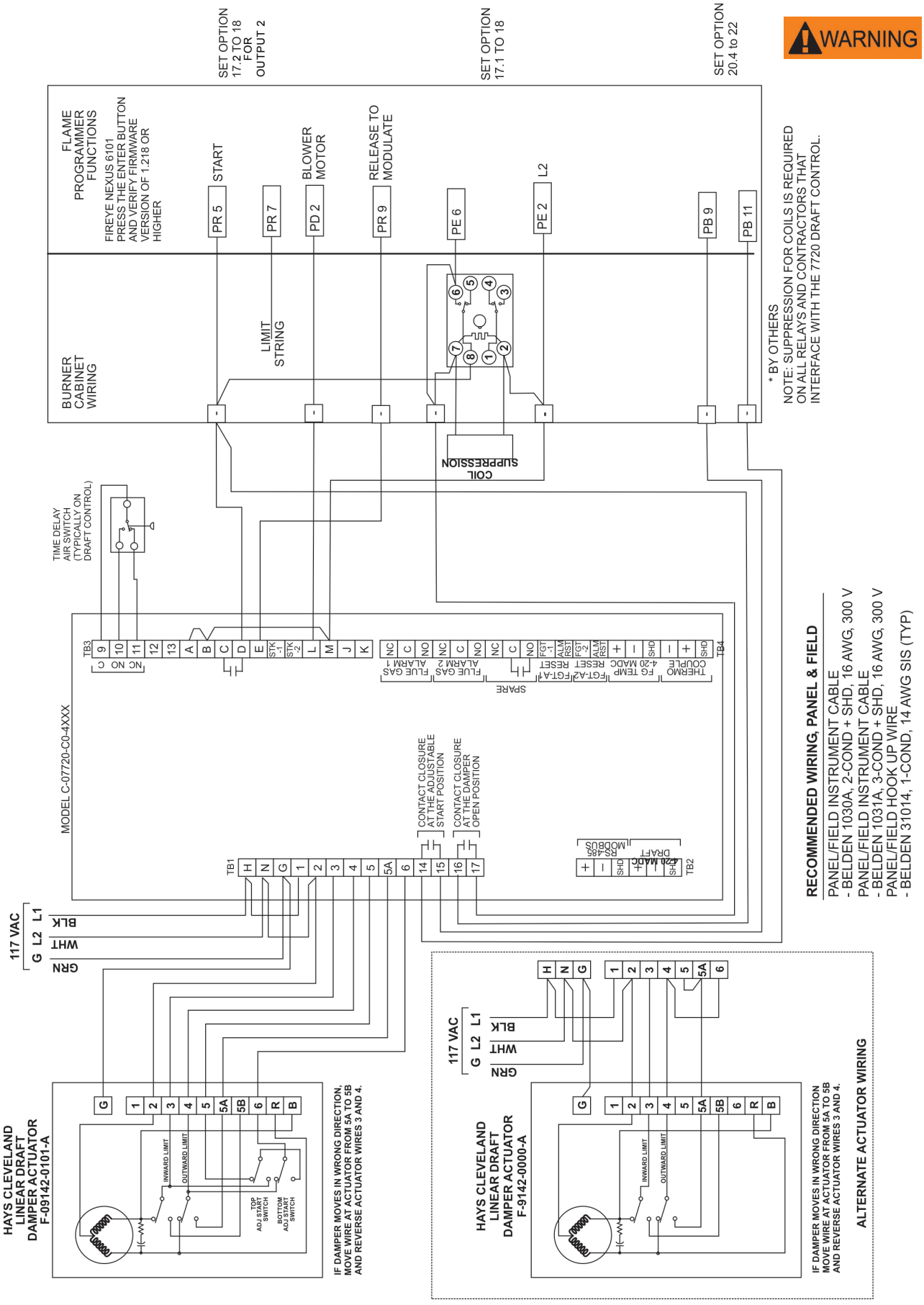


Fig. 50: Series C-07720-C0-4xxx Draft Control Interface with Fireye Nexus 6101.

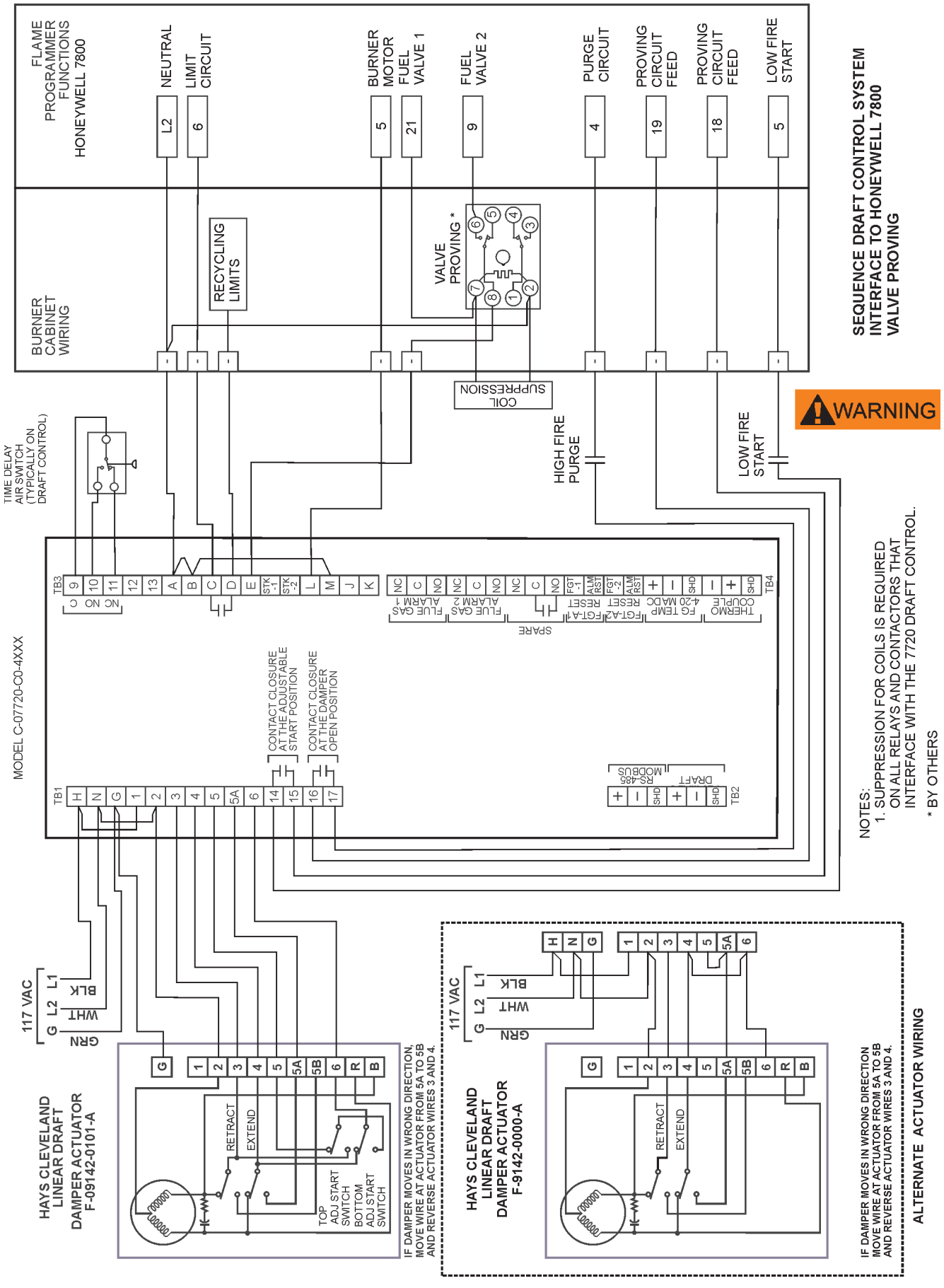


Fig. 51: Series C-07720-C0-4xxx Draft Control Interface with Honeywell 7800 Valve Proving.

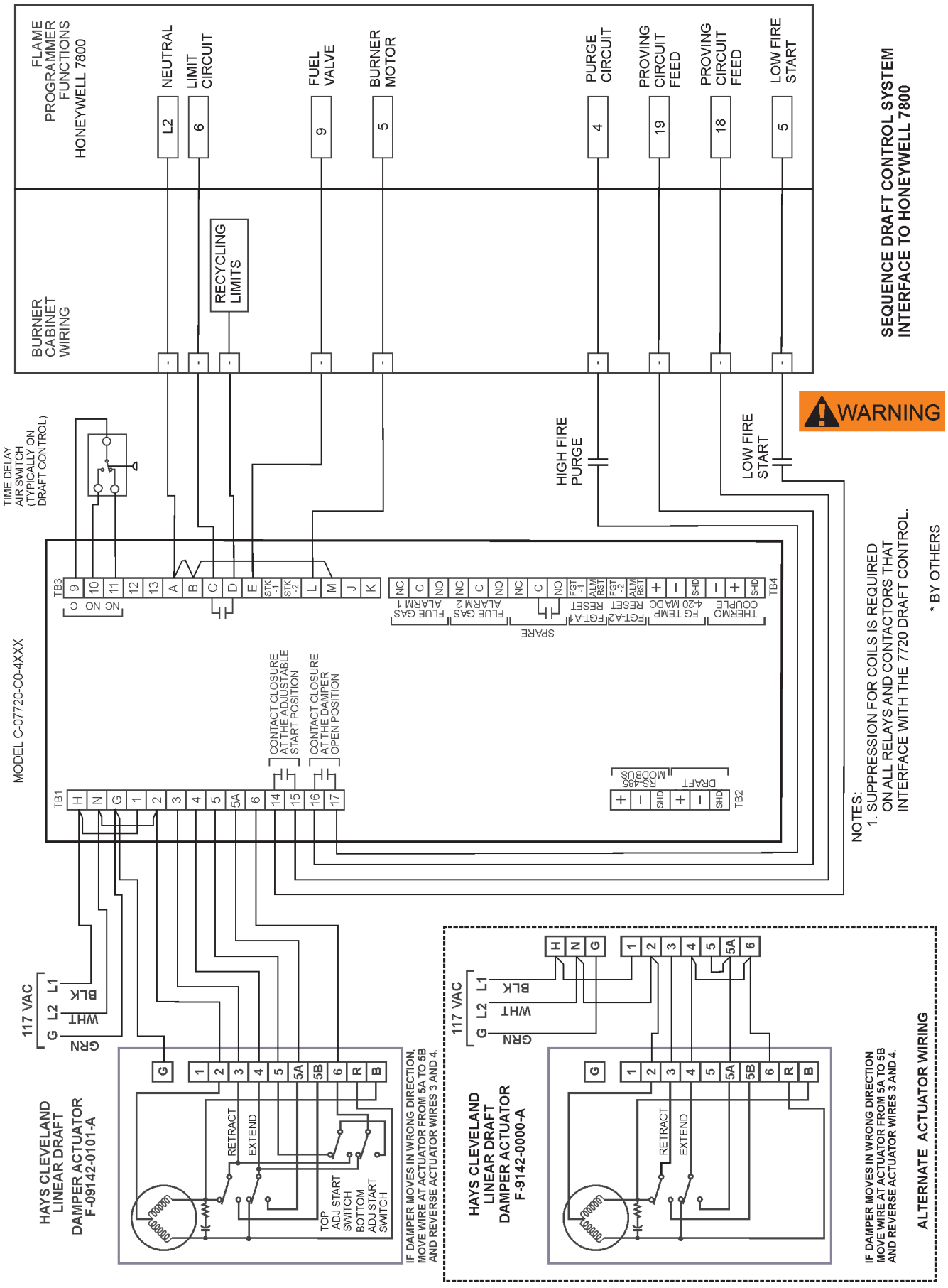


Fig. 52: Series C-07720-C0-4xxx Draft Control Interface with Honeywell 7800.

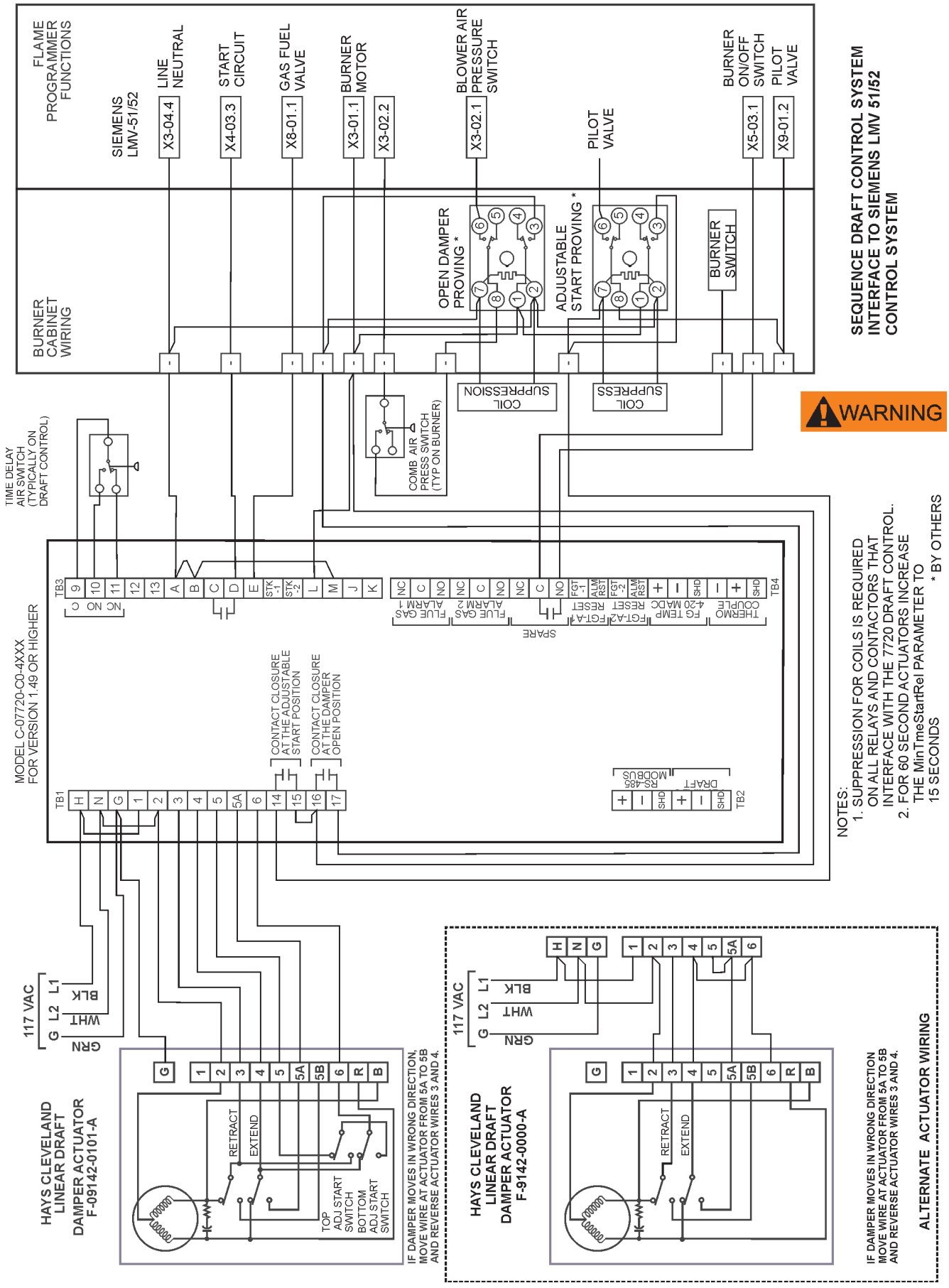


Fig. 53: Series C-07720-C0-4xxx Draft Control Interface with Siemens LMV5X.

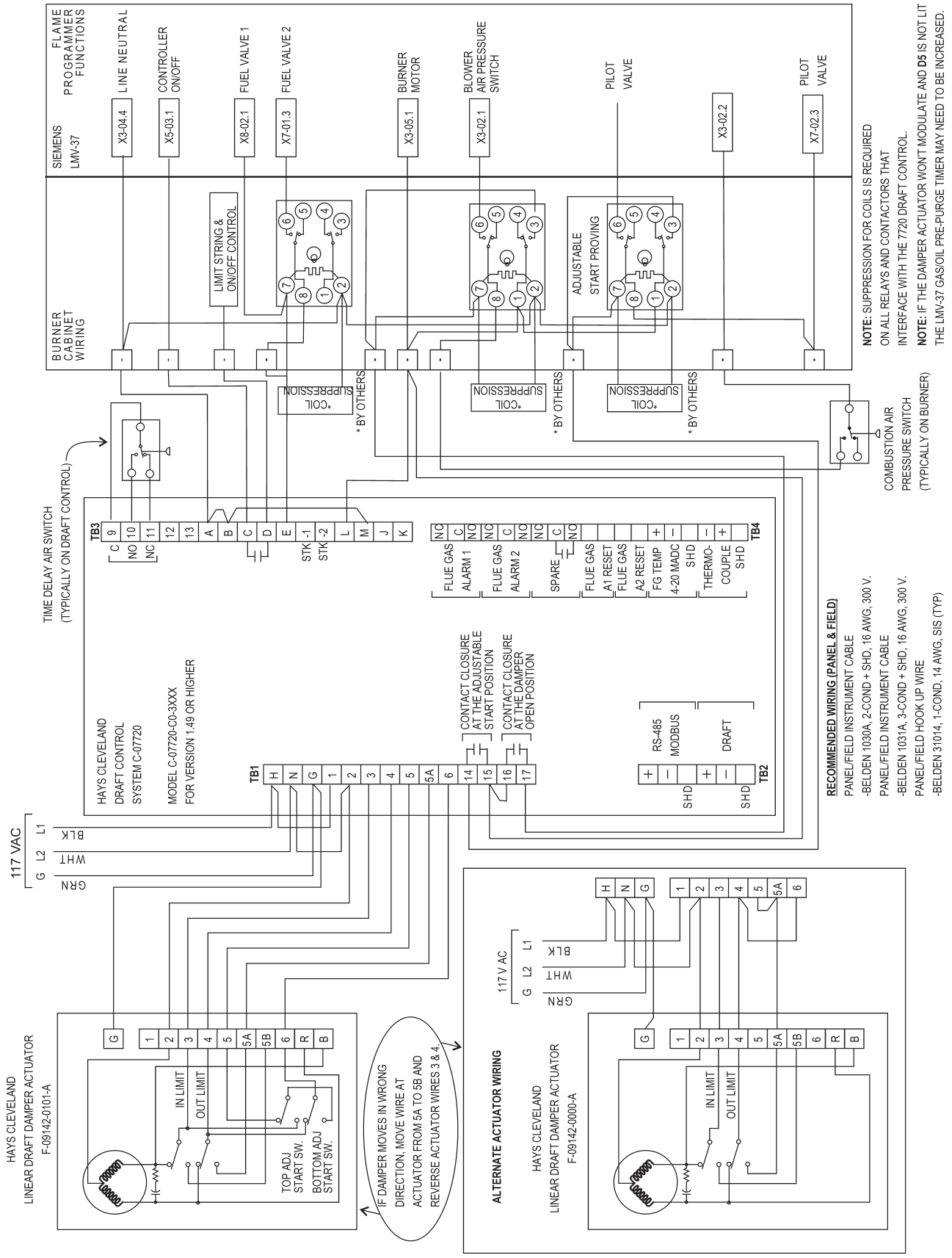


Fig. 54: Series C-07720-C0-4xxx Draft Control Interface with Siemens LMV-37 w_Valve Proving.

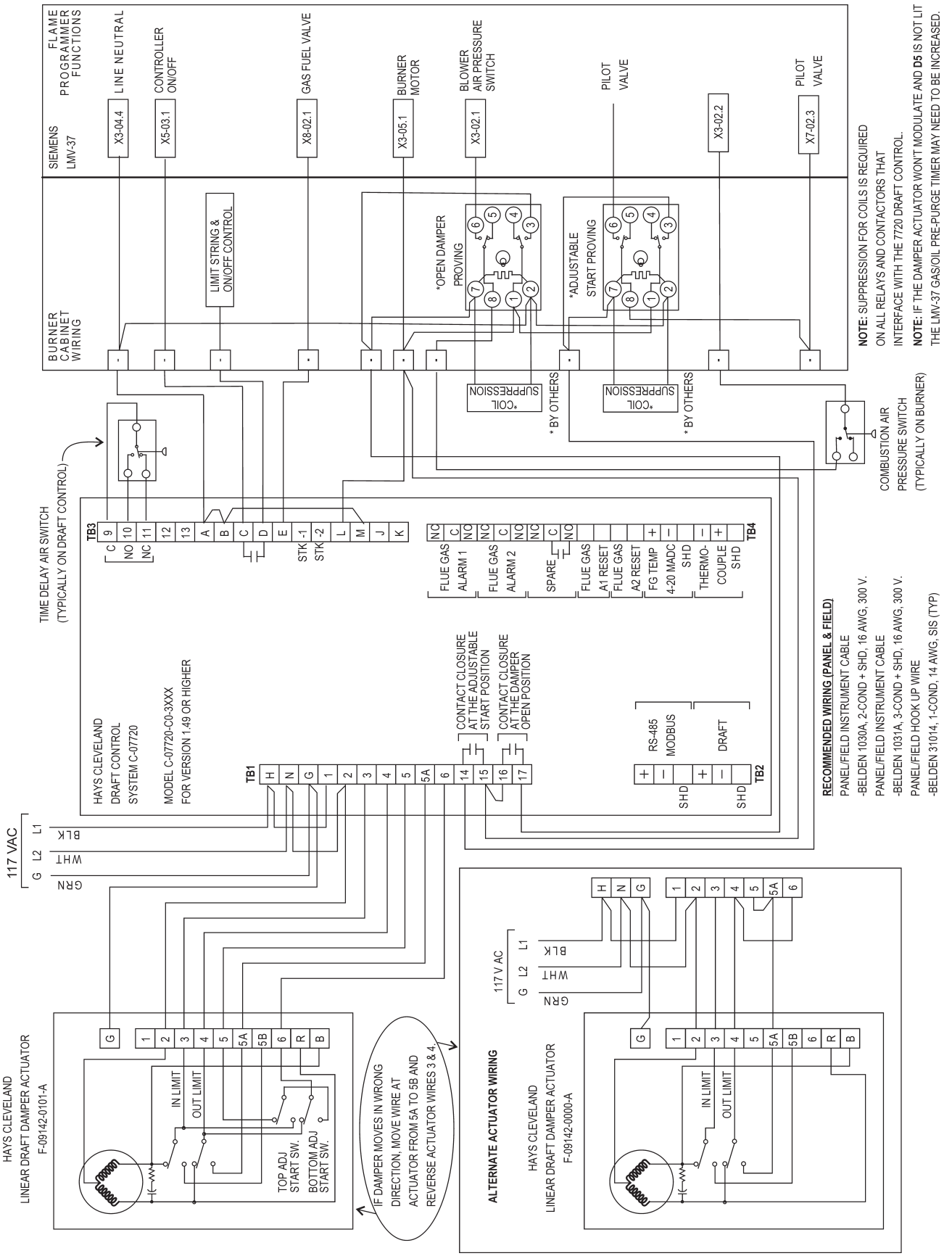


Fig. 55: Series C-07720-C0-4xxx Draft Control Interface with Siemens LMV-37.

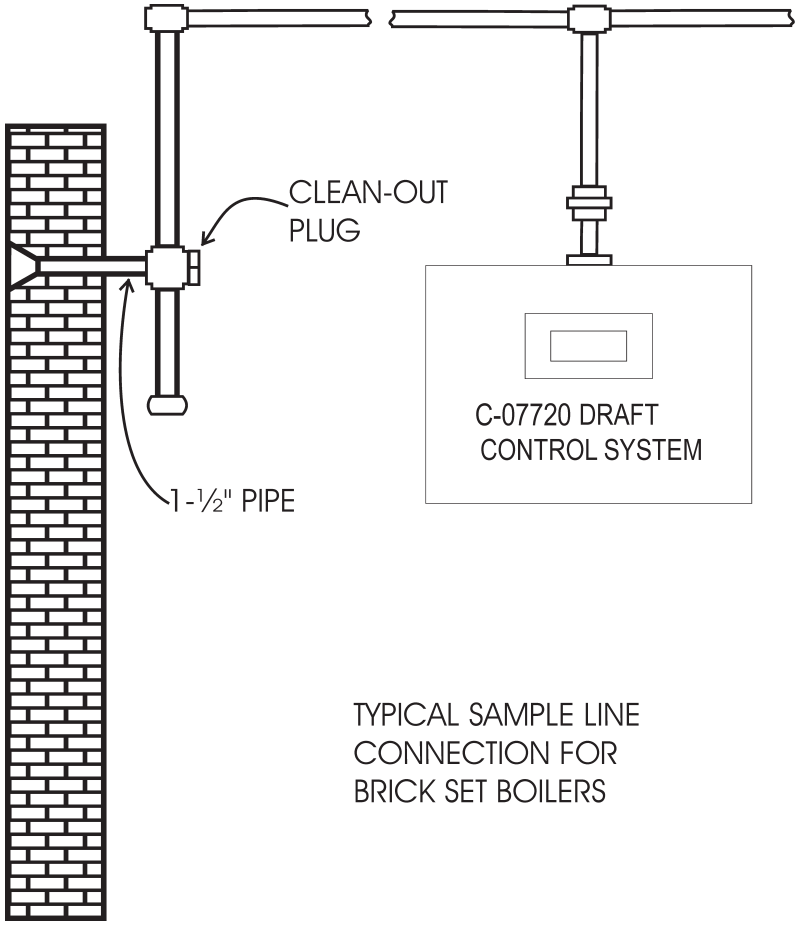


Fig. 56: Typical Sample Line Connection for Brick Set Boilers.

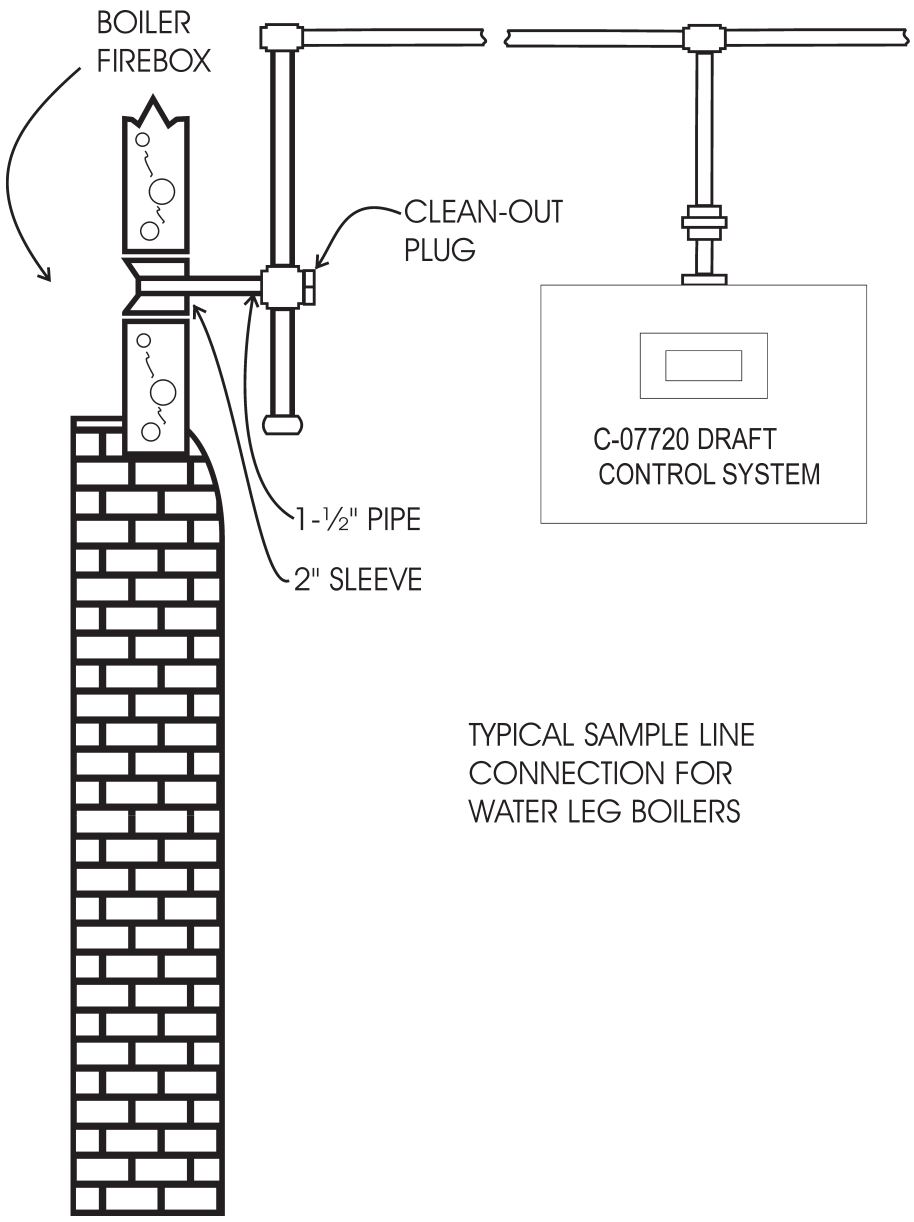


Fig. 57: Typical Sample Line Connection for Water Leg Boilers.

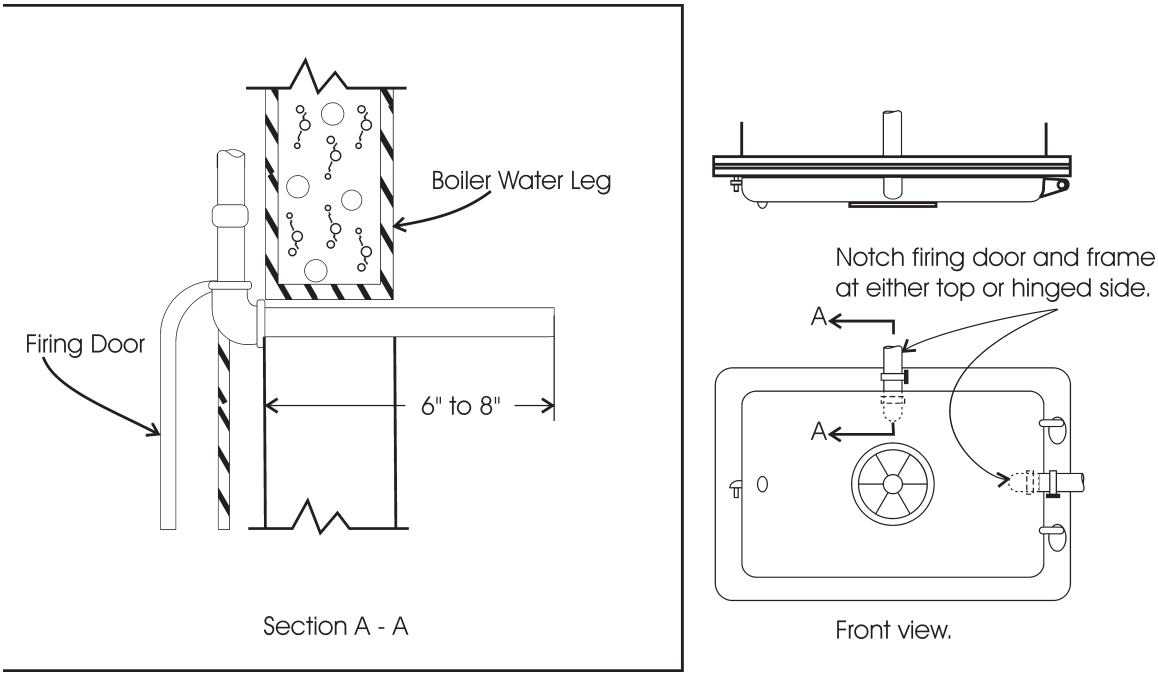


Fig. 58: Typical Sample Line Connection for Conversion Boilers.

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