WEBSTER COMBUSTION
A Selas Heat Technology Company

Webster Combustion Technology
619 Industrial Road, Winfield, KS 67156

TEMPATRIM

Air Density Control System

Installation, Operation & Maintenance Manual

Manual Part No. 950069 Rev.3
www.webstercombustion.com
September 2014

SAFETY PRECAUTIONS

Good safety practices must be used when working on burner equipment. The potential energy in the electrical supply, fuel and related equipment must be handled with extreme care to prevent equipment failures, injuries and potential death. Throughout this manual, the following symbols are used to identify potential problems.

WARNING

This indicates a potential hazardous situation, which if not avoided, could result in personal injury or death.

CAUTION

This indicates a potentially hazardous situation, which if not avoided, could result in damage to the equipment.

WARNING

The VFD control will retain power for several minutes after de-energizing. Wait at least 10 minutes before servicing the VFD. Failure to do so could result in personal injury or death.

The following general safety precautions apply to all equipment work.

WARNING

IF YOU SMELL GAS, OPEN WINDOW, EXTINGUISH ANY OPEN FLAMES, STAY AWAY FROM ELECTRICAL SWITCHES, EVACUATE THE BUILDING AND IMMEDIATELY CALL THE GAS COMPANY.

IN ACCORDANCE WITH OSHA STANDARDS, ALL EQUIPMENT, MACHINES AND PROCESSES SHALL BE LOCKED OUT PRIOR TO SERVICING.

IF THIS EQUIPMENT IS NOT INSTALLED, OPERATED AND MAINTAINED IN ACCORDANCE WITH THE MANUFACTURERS INSTRUCTIONS, THIS PRODUCT COULD EXPOSE YOU TO SUBSTANCES IN FUEL OR FROM FUEL COMBUSTION WHICH CAN CAUSE DEATH OR SERIOUS ILLNESS AND WHICH ARE KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER, BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM.

IMPROPER SERVICING OF THIS EQUIPMENT MAY CREATE A POTENTIAL HAZARD TO EQUIPMENT AND OPERATORS.

SERVICING MUST BE DONE BY A FULLY TRAINED AND QUALIFIED PERSONNEL.

BEFORE DISCONNECTING OR OPENING UP A FUEL LINE, BEFORE CLEANING OR REPLACING PARTS OF ANY KIND,

- **TURN OFF THE MAIN MANUAL FUEL SHUTOFF VALVES INCLUDING THE PILOT COCK, IF APPLICABLE. IF A MULTIPLE FUEL BURNER, SHUT OFF ALL FUELS.**
- **TURN OFF ALL ELECTRICAL DISCONNECTS TO THE BURNER AND ANY OTHER EQUIPMENT OR SYSTEMS ELECTRICALLY INTERLOCKED WITH THE BURNER.**

TABLE OF CONTENTS

ACRONYMS

TAT .....TEMP A TRIM
ADT .....Air Density Trim
VFD .....Varibale Frequency Drive
FSG .....Flame Safeguard
LED .....Light Emiting Diode
VDC ..... Volts DC
VAC ..... Volts AC

A. GENERAL INFORMATION

This manual covers the TEMP A TRIM (air density trim) control system offered by Webster Combustion, LLC. This control is intended for applications on burners offered by Webster Combustion. The control system can be used with any fuel and on any burner horsepower application. The control may be provided as an integral part of a new burner package or it can be installed as a retrofit control for an existing Webster burner.

WARNING

DO NOT ATTEMPT TO START, ADJUST OR MAINTAIN THIS CONTROL WITHOUT PROPER TRAINING OR EXPERIENCE. FAILURE TO USE KNOWLEDGEABLE TECHNICIANS CAN-RESULT IN EQUIPMENT DAMAGE, PERSONAL INJURY OR DEATH.

READ AND SAVE THESE INSTRUCTIONS FOR REFERENCE

The installation and startup of this equipment requires the skills of an experienced and properly trained burner technician. Inexperienced individuals should not attempt to adjust this equipment.

THE INSTALLATION OF THIS EQUIPMENT SHALL BE IN ACCORDANCE WITH THE REGULATION OF AUTHORITIES HAVING JURISDICTION, INCLUDING THE NATIONAL ELECTRIC CODE, CSA STANDARDS, THE CANADIAN ELECTRIC CODE AND ALL LOCAL CODES.

TEMP A TRIM Model Designation
New & Retrofit Applications

TAT - R - 07 - 220T - 11 - M - S - 1* - 3*

* All Engineering Specials need to be listed separately.

OPTION SERIES	
TAT	TAT SERIES

APPLICATION	
N	Installed On New Burner
R	Retrofited to Existing Burner

BLOWER MOTOR HORSEPOWER	
02	1/4
03	1/3
05	1/2
07	3/4
10	1
15	1.5
20	2
30	3
50	5
75	7.5
100	10
150	15
200	20
250	25
300	30
400	40
500	50
600	60
750	75
1000	100
1500	150
2000	200

VFD VOLTAGE (Blower Motor) Must match motor voltage/phase/60Hz		
110S	110-120 vac	Single Phase
220S	200-240 vac	Single Phase
220T	220-240 vac	Three Phase
440T	440-480 vac	Three Phase
575T	575-600 vac	Three Phase
Note: The TAT circuit board is always powered by 110 vac single phase.		

ENGINEERING SPECIALS	
BLANK	None
1	Board By-Pass Sw.
2	Oil By-Pass
3	Board Failure Alarm Light
4	Air Conditioning
5	VFD Modbus
6	VFD By-Pass Sw.

OPTIONAL SAVINGS METER	
N	Not Included
S	Savings Meter System

CIRCUIT BOARD LOCATION	
R	Stand Alone
M	In Main Panel

Note 1. There is a 50 foot wire run limitation between the temperature sensor and the TAT circuit board.
Note 2. Remote panel applications require the TAT board to be mounted on the burner in its own enclosure (R).
Note 3. The temperature sensor must be located at the air louver box.
Note 4. All retro-fit applications are considered to be “Stand Alone” - R under “APPLICATION”.

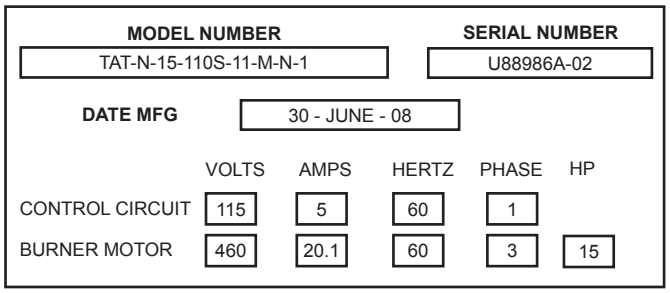
VFD NEMA RATING	
1	Nema 1
4	Nema 4

Note 1: For NEMA 1, VFD is not supplied with an enclosure but comes with a NEMA 1 wiring kit.
Note 2: For NEMA 4, VFD will be installed in a NEMA 4 enclosure. Cooling may be necessary.

TAT BOARD NEMA ENCLOSURE	
1	Nema 1
4	Nema 4

1. The above represents the common model designations. Contact the factory for other options and special applications.
2. For Retrofit applications, the burner motor must be “inverter duty” or manufactured after 1995. If the motor was manufactured prior to 1996, a new motor must be used.

Figure A-1 Nameplate



Every attempt has been made to accurately reflect the TEMP A TRIM (TAT) construction; however product upgrades and special order requirements may result in differences between the content of this manual and the actual equipment. These special components will be described in the information provided with the control and should be used as the controlling document.

1. Nameplate Information

a. If the unit is sold as an integral part of a new burner package, the burner nameplate will cover all electrical ratings of the control and the burner. In addition, the Variable Frequency Drive (VFD) will have a separate nameplate covering its rating information.

b. On retrofit packages, the control will have a nameplate with important job details (see Figure A -1). The nameplate identifies the control circuit voltage and current requirements as well as the combustion air fan motor maximum current and operating voltage.

c. The serial number or shop order number represents the unique number for that order, and is required information whenever communicating with Webster Combustion on this unit.

2. Your Complete Manual

In addition to this manual, there are several other documents that should be considered as part of the complete manual. All of these documents are needed to support the installation and startup of the unit. These additional items include:

a. The wiring diagrams for the TEMP A TRIM and burner which provides the specific controls, limits and interconnections for this application.

b. The manual for the specific VFD supplied for this application, which includes the setup criteria for the VFD.

c. The burner manual.

d. The Flame Safeguard manual which defines the operating sequence of the burner management system. This will be a critical document for any troubleshooting.

e. VFD program parameters set at the factory.

3. Product Offering and Applications

a. The TEMP-A-TRIM product is available for the full line of burners offered by Webster Combustion.

b. The TAT can be used on any size burner, although the size of the VFD varies with the size, voltage and frequency of the combustion air motor. The VFD size will increase as the motor horsepower increases and/or the voltage decreases.

c. Any fuel can be handled with the TAT, except that burners with an integral oil pump cannot have the TAT operational when firing oil, as the reduced speed of the motor will also reduce the oil pump speed and capacity. Combination units can be equipped with TAT using a “Gas Only“ circuit that prevents the TAT from operating when on oil, but does allow the TAT to operate on gas firing.

d. There are several different voltages available for use with the TAT, and it can be applied to either single phase or three phase applications. The control is limited to 60 hertz at the time of this writing.

e. When the TAT is used, only the VFD controlled by the TAT can be in operation. Control functions for VFD’s on other control systems cannot be used with the TAT, as there will be a conflict in control requirements.

f. There are only certain specific Variable Frequency Drive Models that can be used with TAT. The control system and safety checks require very specific communications between the TAT and VFD, and the VFD must be able to read and deliver that information.

g. Any common commercial or industrial flame safeguard system can be used with the TAT, except as noted elsewhere. The flame safeguard systems are looking at valve positions and limits for operating control, and not at the mass flow or fuel-air-ratio of the combustion process. This includes parallel positioning controls.

h. The TAT can be used in combination with Oxygen Trim Systems, and in fact the TAT will help the Oxygen Trim system by providing a base correction of the Fuel-Air-Ratio based on combustion air temperature.

i. The TAT can be used with any NOx system (Flue Gas Recirculation or NOx Cone technologies) offered by Webster Combustion.

j. For retrofit applications, the motor must be three (3) phase and inverter duty (built after 1995). The TAT operates over a small speed range which makes motor applications less critical.

B. COMPONENT DESCRIPTION

1. General

The Temp-A-Trim product uses a common group of components and component types to fill applications of different burner sizes, operating systems, fuels, flame safeguards and optional equipment. This section covers those basic components and how they are integrated into the system.

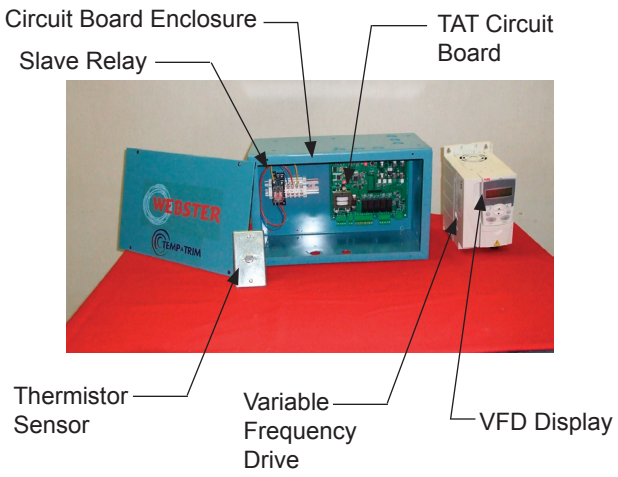


Figure B-1 Common Components

2. Control Panel

The circuit board, relay and connections are made inside a control panel. Depending on the application, this could be the main burner control panel (see Figure B-2) or in a separate junction box (see figure B-1).

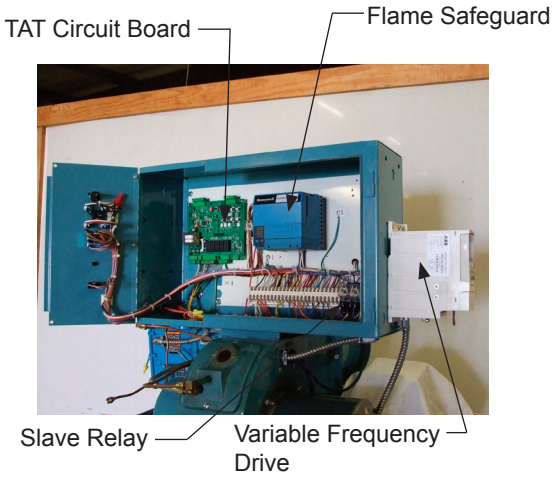


Figure B-2 Burner mounted Cabinet

All retrofit packages use a separate junction box to insure there is adequate space for the required components. A new burner application will also use a separate junction box if it has a remote panel, to insure that the wiring run to the circuit boards are not too long (the temperature sensor is limited to 20 ft in total wire length).

3. Variable Frequency Drive

The TEMP A TRIM uses the Variable Frequency Drive to vary the fan speed in relationship to the combustion air temperature. There are specific requirements for the VFD to work properly with the control circuit, and limit which VFD's can be used. The two common drives offered are from ABB and Emerson. The VFD is programmed at the factory and will **NOT** need any additional programming in the field.

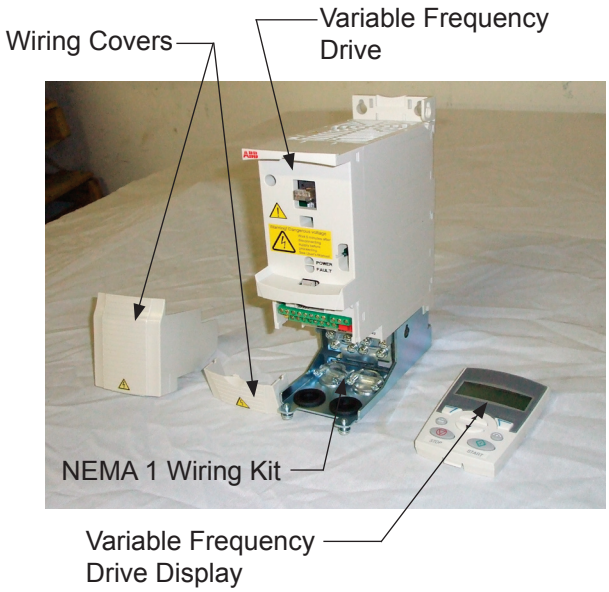


Figure B-3 Typical VFD

The ABB drive has a digital display that can be used to view the operating conditions of the drive.

4. Circuit Board

a. The circuit board contains a microprocessor that is used to perform the control functions as well as several relays, lights (LEDs), terminal strips, fuses and other electronic components (see Figure B-8).

CAUTION

THE CIRCUIT BOARD IS A FRAGILE COMPONENT THAT CAN BE EASILY DAMAGED IF NOT HANDLED CAREFULLY. DO NOT TOUCH THE BOARD WHEN IT IS POWERED. DO NOT PUT ANY PART OF THE BOARD OR CONNECTORS UNDER STRESS WHEN WIRING. REMOVE TERMINAL CONNECTORS BEFORE CONNECTING WIRES.

5. Temperature Sensor

The temperature sensor is mounted in a small box which is located near the combustion air inlet. It is connected to the circuit board by two wires. These wires must be routed clear of high voltage wiring, including 115 VAC wiring to prevent electrical interference.

A mounting bracket is included with the retro-fit package to simplify mounting (see Figure B-5). The bracket can also be used as a template to locate the mounting holes for the box or bracket.

TAT CIRCUIT BOARD CONNECTIONS AND COMPONENTS		
Nomenclature	**Terminal(s)**	**Description**
Power In	1, 2, 3, 24	This is the 120 vac electrical supply to the unit and includes line, neutral and ground connections. This should come from the burner panel power supply.
24 vdc	5, 6	The TAT obtains the 24 vdc power from the VFD through these terminals.
Fan enable	7	24 vdc motor start signal from TAT to VFD.
ADT contact	9, 10	Relay contact tied into burner running interlock circuit, proving TAT is working properly. Rating is 10 amps.
Modulation enable	11	24 vdc to VFD to enable speed control.
Alarm contact	13, 14	A dry contact is provided on the circuit board that closes when an alarm condition occurs. It can be used to operate a light or other devise (optional connection). Rating is 5 amps.
Temperature out	15, 16	This is a control signal used by the efficiency monitor to calculate the savings from the operation of the TEMP A TRIM. This is an optional component.
Fan out	17, 18	4-20ma signal out of TAT to VFD for speed control.
Thermistor	20, 21	The temperature sensor connects to these terminals. The sensor is a thermistor, which is a specific type of temperature sensor.
Fan on	23	120 vac from FSG to TAT signaling fan to come on.
Fuel on	25	120 vac from FSG to TAT signaling fuel valve to open.
Alarm input	29	24 vdc signal from VFD, signalling VFD alarm condition.
Fan input	31, 32	4-20ma feedback signal from VFD indicating fan speed.
RS-485	34,35	The circuit board has a RS-485 connection that will allow a computer connection to view operating information.
Lights (LED's)	**NA**	**The circuit board has five indicating lights (LED's)**
ADT on	on board	This light indicates operation is okay.
Fan on	on board	This light indicates that the signal has been sent to the VFD to turn on the combustion air motor.
Mod on	on board	This light indicates that the modulating speed control circuit is operating and that the fan speed should correspond to the combustion air temperature at the inlet to the fan (see figure C-5).
Alarm on	on board	This light indicates that the TAT has an alarm condition.
Fault blink code	on board	This light is used to define the alarm condition and the sequence of the blinking of the light indicates the specific type of failure. See section G for details.
Switches		
Reset button	on board	This is a momentary contact switch that is used to reset the control after an alarm or shutdown sequence. Press and hold for one second to reset control.
Dip switch	on board	These are small two position slide switches used to select the combustion air temperature range, which can be either 10-90 ^{O}F or 40-120 ^{O}F. See section E-1 for details.
Test - Run switch	on board	This switch can be used to make the fan operate at full speed. It is useful in evaluating the gains in efficiency and electrical use with the control as well as a check of the system operation.
Fuses	on board	Fast acting 100ma 250V rating

Chart B-4
TAT Circuit Board Connections and Components

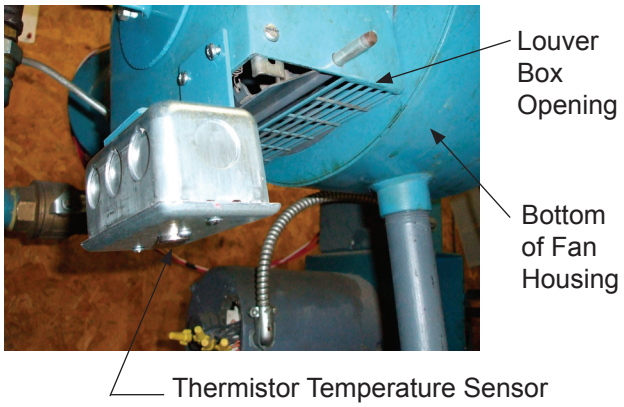


Figure B-5 Temperature Sensor Installation

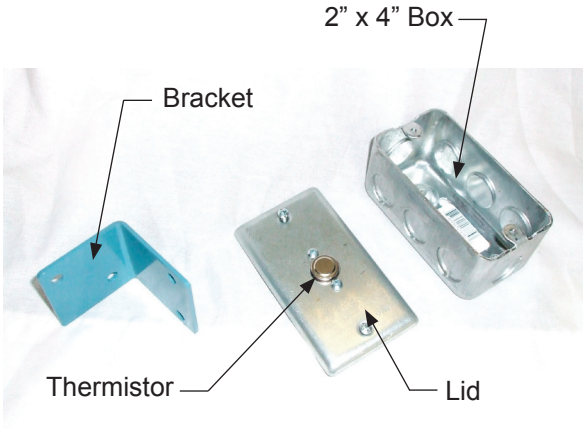


Figure B-6 Temperature Sensor Components

6. By-Pass Switch (Option)

The Temp-A-Trim can be wired with an electrical by-pass which will use the VFD as a motor starter. In this manner, the burner can continue to operate even with a fault in the Temp-A-Trim hardware or circuit board.
THE BY-PASS SWITCH MUST BE IN THE AUTO POSITION FOR START-UP AND ADJUSTMENT.

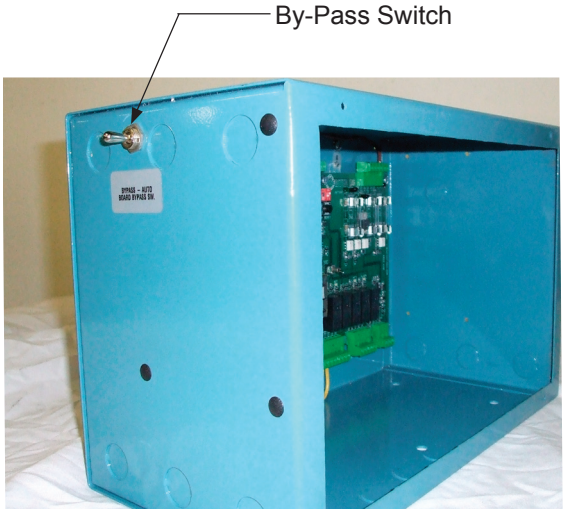
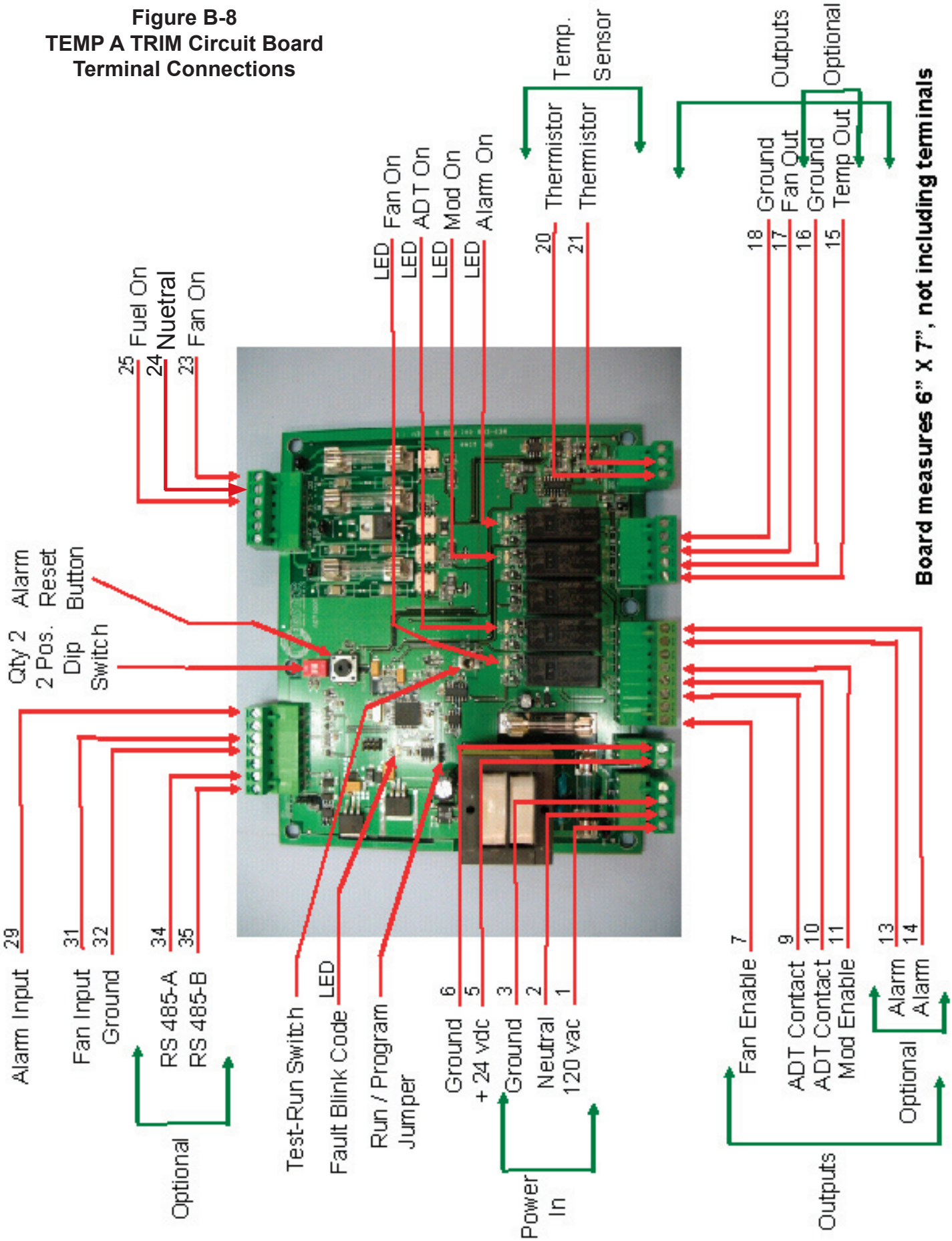


Figure B-7 By-Pass Switch

7. Efficiency Display (Option)

A digital display is offered as an option to display the efficiency gain with the Temp-A-Trim product. This option includes a stack temperature monitor and digital display. The digital display is pre-programmed with the savings calculation.

Figure B-8
TEMP A TRIM Circuit Board
Terminal Connections



C. PRINCIPAL OF OPERATION

The TEMP A TRIM system is a control system for use on power burners to improve the efficiency of the burner. It will maintain a more constant excess air rate (O_2 percentage) by adjusting the air volume to compensate for changes in combustion air temperature. It will also reduce the electrical usage by reducing the combustion air fan motor speed.

1. Existing Combustion Control

The combustion air flow and fuel flow to the burner is determined by valve position. The correct valve position is determined at the time of start-up and the linkage or parallel positioning control are adjusted to maintain that same position for all future operating conditions. If the burner is modulation or LHL, there will be multiple valve positions to provide different firing rates. These valve positions act to limit the volume of air and fuel passing through the valve, which provides the basic control required for the burner.

These controls will provide a constant volume of air flow, but not a constant mass flow of air. Changes in temperature and pressure, especially for air, can result in large changes in the density of the air, and ultimately the pounds or mass flow of air to the burner. The largest normal variation is in the air temperature, which can vary daily and seasonally. When a burner fuel-air-ratio is tuned, it must be done with this in mind, so that future temperature changes do not result in extreme rich or lean operation. If a burner is tuned during cool weather, then when the air temperature increases, the actual mass flow to the burner will decrease. The “Ideal Gas Law” can be used to define this change in mass flow due to temperature. If a burner is set up with 15% excess air when the air temperature is 50 ^{O}F, then the excess air will drop to 5% excess air when the air temperature increases to 90 ^{O}F. This low excess air usually results in high levels of unburned fuel and CO, greatly decreasing the burner efficiency because it is not burning all of the fuel supplied. Figure C-1 shows a typical burner excess air change due to combustion air temp. change.

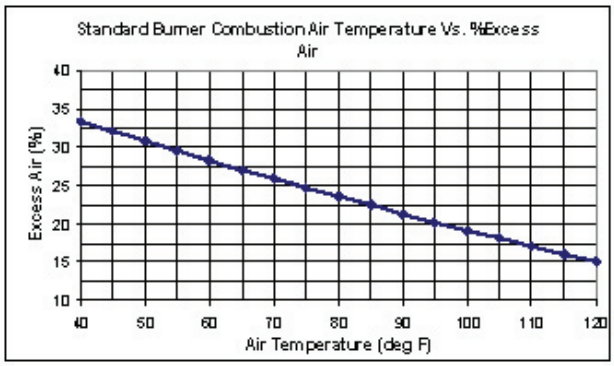


Chart C-1
Excess Air (O_2) readings without TEMP A TRIM

Air Temperature vs Excess Air With TEMP A TRIM Control

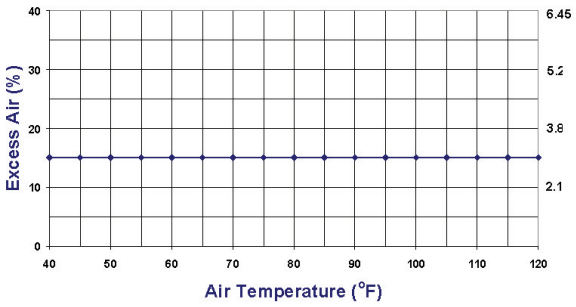


Chart C-2
Excess Air (O_2) readings with TEMP A TRIM

2. Air Density Trim Control

With the TEMP A TRIM control, the air temperature is monitored and the flow of air to the burner is regulated according to the temperature to maintain a constant excess air rate. If the burner is adjusted to 15% excess air at 50 ^{O}F, it will still be 15% excess air at 90 ^{O}F or even 120 ^{O}F. It does this by changing the combustion air fan motor speed, running faster when the air is hot and less dense and slower when it is cool and denser.

The control will automatically vary the motor speed according to the combustion air temperature from 40 ^{O}F to 120 ^{O}F, as shown in Figure C-5. Above 120 ^{O}F and below 40 ^{O}F the fan speed is fixed at the rate for these temperatures. The results of this control is a constant excess air rate, as shown in Figure C-2.

3. TEMP A TRIM Operation

The TEMP A TRIM system works as part of, and in addition to, the burner combustion control system.

The burner control system will start the burner in a normal manner. The flame safeguard sends a 120 volt Fan On signal to the circuit board when the blower motor needs to start. The circuit board sends a 24vdc Fan Enable signal to a VFD input terminal to start the blower motor, and the Fan LED lights. The blower motor will start and run for pre-purge at full rpm. A VFD relay is used to tell the burner flame safeguard that the drive is in operation. An ADT proving contact on the TEMP A TRIM board tells the flame safeguard the board is operational, and the ADT LED lights. These two proving contacts must be closed within 10 seconds of the Fan On signal, or a safety shutdown and lockout will occur.

After prepurge, the FSG will light the main flame with the motor speed at full rpm. The FSG sends a 120 volt, Fuel On, signal to the circuit board that the fuel valve is on. 15 seconds after the Fuel On signal, the TEMP A TRIM system is allowed to control motor speed, and the Mod LED lights. The circuit board sends a 24vdc, Modulation Enable, signal to a VFD input terminal, allowing it to control motor speed based on the 4-20ma signal from the

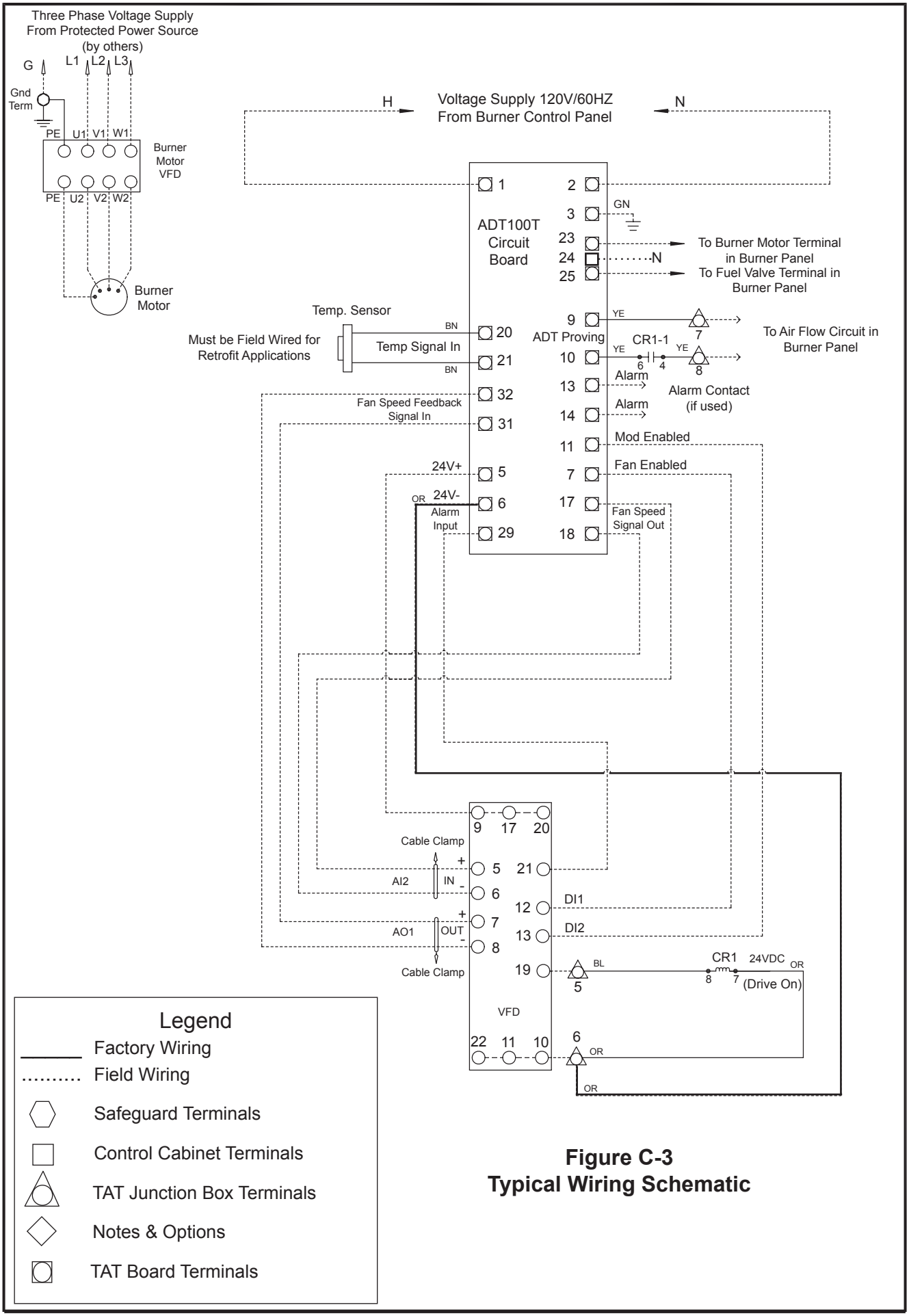
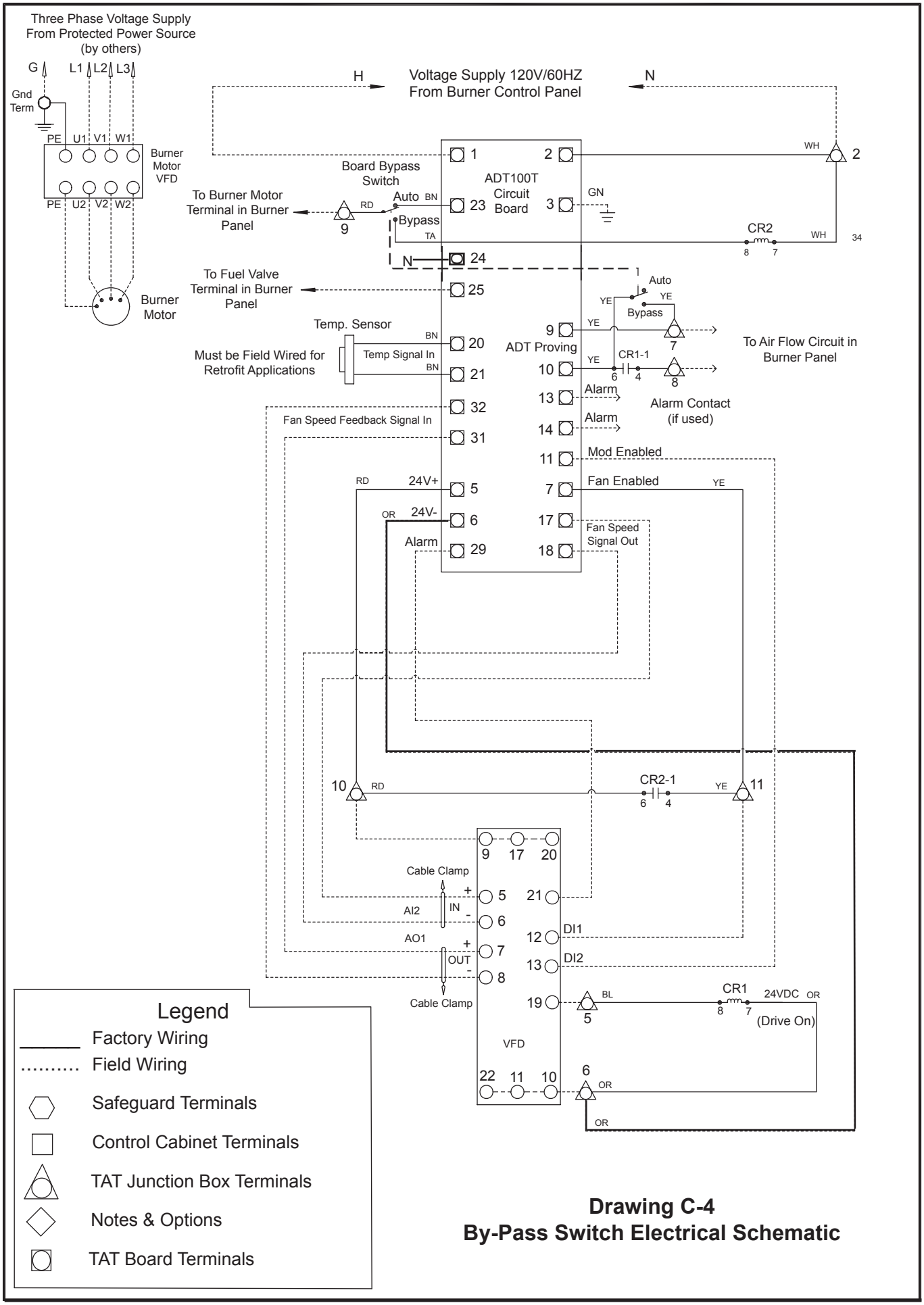


Figure C-3
Typical Wiring Schematic



Drawing C-4
By-Pass Switch Electrical Schematic

circuit board to the VFD. After a 10 second delay, the fan speed control signal must match the VFD feedback signal within 1ma, or the ADT Contact will open, causing the burner to shut down.

The 4-20ma signal is based on the output of a temperature sensor, sensing the incoming combustion air temperature to the burner. That 4-20ma signal corresponds to one of two temperature ranges, 40°F to 120°F, or 10°F to 90°F. The temperature ranges are selectable by dip switches. The VFD is programmed to adjust motor speed from 2900 rpm to 3450 rpm, based on the 4-20ma signal.

After the burner firing cycle is complete, the flame safeguard de-energizes the burner fuel valves. The 24 vdc Modulation Enable signal for controlling speed is removed, and the burner motor goes to full speed for postpurge. After postpurge is complete, the flame safeguard removes the Fan On signal, and the burner motor stops.

The VFD is programmed so that any time the Modulation Enable signal is not present, the motor will be at full speed.

If a VFD alarm condition occurs, a 24vdc Alarm signal is sent to the circuit board. The circuit board then removes the 24vdc Modulation Enable signal to the drive, and the blower motor goes to full speed operation. The ADT Contact opens, causing the burner to shut down.

A Run-Test switch on the circuit board allows the system to return the motor speed to full rpm for testing. With the switch in the Test position, the Modulation Enable signal is removed

Any failures of the circuit board will cause the circuit board to open the ADT Contact which will cause the burner to shut down. The 24vdc Modulation Enable signal to the drive is removed, and the blower motor goes to full speed operation for postpurge, then will shut down. The Alarm LED lights. Circuit board will require manual reset.

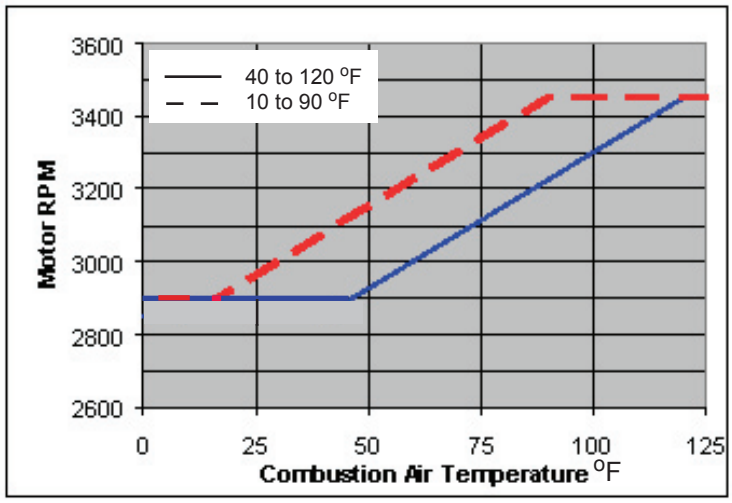


Figure C-5
Controlled Motor RPM
Motor RPM vs Combustion Air Temperature

D. INSTALLATION

WARNING
DISCONNECT AND LOCK OUT THE MAIN POWER SUPPLY IN ORDER TO AVOID THE HAZARD OF ELECTRICAL SHOCK. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

1. General Considerations

This section deals primarily with the retrofit applications. Most components are already installed on a new burner application, however the following information should be used for any components that may require installation in the field.

THE INSTALLATION OF THE EQUIPMENT SHALL BE IN ACCORDANCE WITH THE REGULATION OF THE AUTHORITIES HAVING JURISDICTION, INCLUDING THE NATIONAL ELECTRIC CODE, INSURANCE REGULATIONS, CSA STANDARDS, THE CANADIAN NATIONAL ELECTRIC CODE AND ALL LOCAL CODES

In the initial planning of the installation, several items must be considered:

a. Prior to starting, all of the technical literature should be collected and reviewed. At a minimum, this includes the operating manual for the burner, VFD and this manual. All manuals should be read and thoroughly understood prior to starting any work.

WARNING
INSTALLATION SHOULD ONLY BE PERFORMED BY PROPERLY TRAINED AND EXPERIENCED INDIVIDUALS. FAILURE TO USE KNOWLEDGEABLE TECHNICIANS CAN RESULT IN EQUIPMENT DAMAGE, PERSONAL INJURY OR DEATH.

b. A general overview of the installation should be made prior to the installation. Check the location of access doors and insure that they will be able to function properly when the equipment is installed. The junction box should have sufficient space around it to gain access for inspection, wiring and maintenance.

c. There may be several individuals that need to be informed of this installation activity, including the owner's representative, the mechanical contractor, the electrical contractor, the service organization and the plant manager.

d. The installer must clearly identify the main electrical power disconnect for this equipment. It should be easily seen from the operator's position and clearly labeled.

2. Sensor Location

The temperature sensor must be located in or adjacent to the combustion air flow stream to operate correctly (see Figure B-4). A bracket is provided that can be bolted to the air damper inlet and allows the sensor to be in the air stream. This will typically require that two holes be drilled into the air damper box to mount the bracket. Make sure to locate the holes above the damper so that it does not prevent the damper blade from moving. Also, the bolt should be installed from the inside, so that it protrudes outside the box, to prevent interference with the damper blade movement.

3. Junction Box Location

The junction box must be relatively close to the air temperature sensor, as the wiring between these two components has a maximum length of 50 feet of wire length. Normally this box would be mounted adjacent to the existing control panel or junction box, but it can be located in any convenient place. They would be bolted together through the sides of the panels. Remember that you will need access to the internals of the junction box.

4. Variable Speed Drive Location

The VFD should be located close to the motor, as this wiring can be large, expensive and difficult to route. It must be mounted securely to a surface or support leg. See the VFD manual for more specifics on mounting, as they will vary with the motor size and VFD manufacturer.

5. Component Wiring

a. Follow the specific Wiring Diagram for this burner, which has been modified to include all of the controls and options intended for this specific order. The amount of wiring to be done and number of components provided will depend on if this is a new burner with it's optins or a retrofit. The typical wiring diagrams in this manual are for general information and cannot be used to wire the unit.

b. Follow the VFD manufacturer's instructions for wiring of the VFD.

c. It is extremely important to have proper grounding for the system. Make sure that the burner motor, VFD control, junction box and control cabinet(s) are properly grounded, as shown on the wiring diagram and VFD manual.

d. The TAT circuit board has terminal numbers printed on the board, as shown in figure B-8. The terminal blocks are removable for ease of wiring. After removing the blocks and connecting the wires, be sure to put the connectors back in the correct position. Each connector has a different number of pins, so they can only properly fit in one location. The range of wire sizes that can be attached to the circuit board terminal blocks is 22 to 12 gauge.

e. Where shielded cable is required, as shown on the wiring diagram, use a # 18 ga. minimum size.

f. After the wiring is complete, it is highly recommended that a check of the wiring be done to insure that each wire is properly located. This is especially important because a wiring error could destroy the circuit board.

E. STARTUP AND ADJUSTMENT

This section covers the startup of the TEMP A TRIM control and related burner tuning. It is imperative that the individual performing these functions has the proper knowledge and experience to safety carry out these tasks. **IF YOU ARE NOT QUALIFIED TO PERFORM THESE FUNCTIONS, DO NOT CONTINUE. CALL YOUR LOCAL SERVICE PERSON TO PERFORM THESE TASKS.**

WARNING

BURNER OPERATION AND COMBUSTION ADJUSTMENTS SHOULD ONLY BE PERFORMED BY PROPERLY TRAINED AND EXPERIENCED INDIVIDUALS. ATTEMPTING TO PERFORM THESE FUNCTIONS WITHOUT THE PROPER TRAINING AND EXPERIENCE CAN RESULT IN EQUIPMENT DAMAGE, PERSONAL INJURY OR DEATH.

1. Pre-Start Check List

a. Prior to starting, all of the technical literature should be collected and reviewed.

b. All components are securely mounted in position.

c. All wiring has been completed, checked and tested for tightness by pulling on the wires.

d. A combustion analyzer is available, and has CO, O2 and if required, NOx readings. Has the analyzer recently been calibrated?

e. Other test equipment including a VOM is available

2. Circuit Board Adjustment

a. There are two settings on the circuit board, the Run-Test switch and the dip switches. The Run-Test switch should be placed in the "**RUN**" position for START-UP and ADJUSTMENT and normal operation. This will allow the control to operate in the normal manner. The "Test" position will force the control to operate at full speed, and can be used to verify the operation of the unit as well as the gains in efficiency and reduced electrical usage. **"DO NOT USE TEST"** position for start-up and adjustment.

b. The dip switches determine which of the two operating temperature ranges are used (see Figure E-1).

The control range that best fits the expected combustion air temperature should be selected. If the temperature goes above or below the selected range, the burner will continue to operate properly, but the correction for the density change, beyond that operating range, will not be applied. **ONCE THE BURNER IS TUNED WITH A SPECIFIC CONTROL RANGE, THE BURNER WILL NEED TO BE RETUNED IF THE RANGE IS CHANGED.**

c. There are two dip switches on the circuit board. Each switch has two positions, and they can be adjusted by simply sliding the position indicator. Figure E-1 shows how to position each switch to obtain the desired control range. When both switches are in the "ON" position, the control range will be 40-120 ^{O}F. When both switches are in the "OFF" position, the control range will be 10-90 ^{O}F.

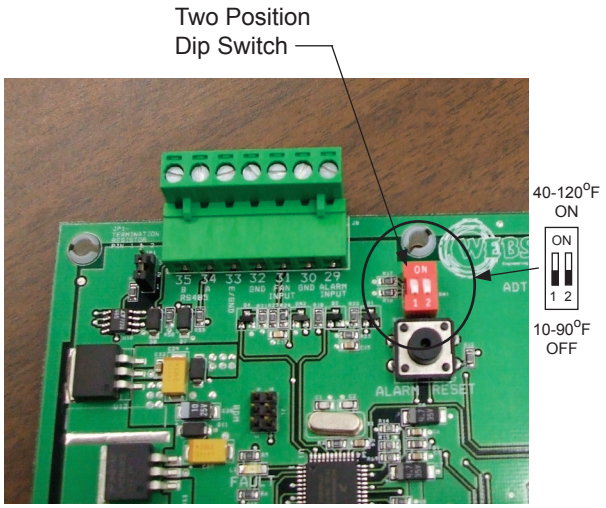


Figure E-1 Dip Switch Positions

3. Variable Speed Drive Adjustments

The VFD has already been programmed with all of the requirements to operate with the TAT control system. **CONTROL PARAMETERS MUST REMAIN AS PROGRAMMED BY WEBSTER**, as there is always a potential for problems when other changes are made. A copy of the program parameters for the specific application is included in the documentation.

4. Startup & Operation

The TAT runs in an automatic mode, and requires no programming or adjustments beyond those outlined above. The "Run-Test" switch must be placed in the **RUN** position and the optional "By-Pass" switch (if used) must be in the **AUTO** position, but no other settings or adjustments are required.

IF THE COMBUSTION AIR TEMPERATURE IS OUTSIDE THE RANGE THAT THE TAT IS SET FOR START-UP AND/OR TUNING CANNOT TAKE PLACE. THE TAT WILL NOT PROPERLY ADJUST FOR TEMPERATURE CHANGES IN THE COMBUSTION AIR.

The control will automatically adjust the combustion air fan speed, based on the combustion air temperature. When the air temperature rises, reducing the density and mass flow, the fan speed will increase to provide a higher volume of air to the burner and a constant mass flow of air.

Likewise, when air temperature drops, increasing the density and mass flow, the fan speed will decrease to provide a lower volume of air to the burner and a constant mass flow of air.

5. Operating Sequence

The operating sequence of the burner with the TAT will vary slightly from a unit without TAT. The initial startup of the motor will be slower because of the soft start feature of the VFD system. This means it will take slightly longer for the motor to reach full speed, but it will not require the high inrush current flow and will be much less stressful on the motor.

The unit will always start (purge cycle, prove pilot and main flame) at full rpm, and once main flame is established, the fan speed will drop to the speed appropriate for the air temperature (see Figure C-5). Likewise, during the post purge cycle the motor will ramp up to full speed before shutting off.

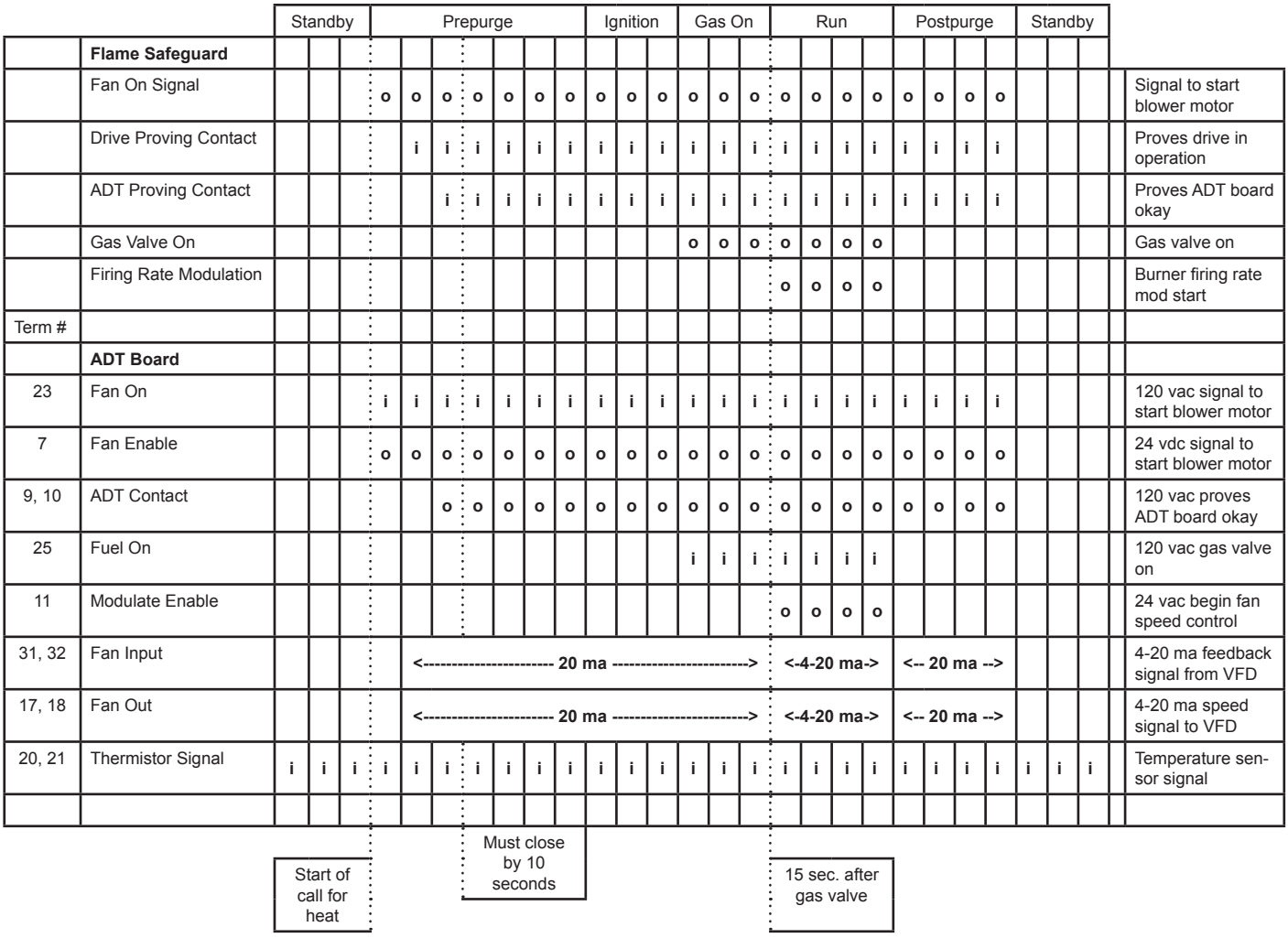
The LED's on the circuit board will also help identify the operating sequence. On initial burner start-up the "FAN ON" and "ADT ON" (see Fig. B-8) LED's will be on. The "MOD ON" LED comes on when the TAT starts to control the fan speed. All these lights will go off when the burner shuts off. The "FAULT Blink Code" LED will flash when there is a failure.

6. Testing System Operation

There are two simple test methods that can be used to verify the operation of the TAT control.

a. Positioning the RUN-TEST switch (see Figure B-8) in the test position will cause the motor to run at full RPM. Moving the switch to RUN position will slow the motor speed to the correct RPM for the combustion air temperature and bring excess air reading back to what was achived during start-up and adjustment. If correct, the RUN-TEST switch must be left in the RUN mode. Also, The optional By-Pass switch (if used) must be in the AUTO position for start-up and adjustment.

b. The thermistor can be cooled or heated to demonstrate a change in combustion air temperature thus driving the blower motor to a different motor speed.



Code: **o Output from device** **i Input to device** **If a box is empty, the signal is off.**

Figure E-2
Operating Sequence

F. MAINTENANCE

1. General Considerations

This control has been designed to provide many years of trouble free operation. The reliability can be greatly improved with some simple inspection and maintenance programs.

One of the best tools for a good maintenance program is to keep a log of the key parameters of the burner and boiler, including the controls. These would include operating temperatures and/or pressures, motor rpm, inspections and preventative maintenance activities. This can be used to detect changes in the operating characteristics of the unit, before they become a major problem. This should be a log that covers all areas of the controls, burner and vessel.

2. Physical Inspection

Looking at and listening to the burner can detect many problems. Loose parts and wires are a common problem that is easy to detect and remedy if caught early. Often, if the sound changes, that can be an indication of a problem.

The motor speed should drop when completing startup cycle and go into automatic operation at a slow speed. The alarm lights are an obvious indicator of a problem.

3. Schedule of maintenance and inspections

The following list covers the TAT system except the VFD. The manual for the specific VFD used in your application must be reviewed for its maintenance requirements.

Daily Inspections:
Check alarm status

Visually look for loose components and wiring

Monthly:
Verify motor speed is correct for the combustion air temperature (a reduction in speed)

Seasonal or Annual:
Verify combustion readings at time of burner tune-up

G. TROUBLESHOOTING

WARNING
DISCONNECT AND LOCK OUT THE MAIN POWER SUPPLY IN ORDER TO AVOID THE HAZARD OF ELECTRICAL SHOCK. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

a. If a failure occurs with the TEMP A TRIM circuit board, the burner shuts down and the alarm LED lights. The fault LED blinks to provide fault identification. The led code repeats until the fault is corrected. To clear the fault, press the reset button (see Figure B - 8).

b. TEMP A TRIM circuit board fault LED blink codes (# of blinks)

1	Thermistor short/open
2	VFD and TAT speed mismatch
3	VFD alarm
4	Software section 1 checksum error
5	Problem with timing circuit
6	Problem with timing circuit, clock is slow
7	Problem with timing circuit, clock is fast
8	Data memory corruption
9	Problem in fuel valve sensing circuit
10	Problem with external reset IC
11	VFD fan speed sensing circuit problem
12	Controller reference voltage problem
13	Software section 2 checksum error
14	Controller instruction execution & decoding problem
15	Software logical sequence problem

FAULT CODES

1. Thermistor Short/Open - Indicates the thermistor sensor is not connected to the TEMP A TRIM circuit board, or the thermistor is shorted. Check wiring between the sensor and the circuit board for any problems. Replace the thermistor

2. VFD and TAT speed mismatch - This indicates the 4-20 ma fan speed signal from the TEMP A TRIM board to the VFD unit, does not match the 4-20 ma feedback signal coming from the VFD unit to the TEMP A TRIM board. Check wiring between the VFD unit and the TEMP A TRIM board for problems. Check VFD parameters. Check speed signal accuracy of the VFD and TAT and replace if faulty signal. Replace TAT circuit board.

3. VFD alarm - Indicates that a VFD alarm has occurred. See the VFD unit display to determine the fault. See the VFD instruction manual for help correcting the fault.

4-9. These faults are errors occurring internal to the TEMP A TRIM circuit board. Contact Webster Combustion if any of these faults occur.

10. Verify Run / Program jumper on circuit board is in the Run position

11-15. These faults are errors occurring internal to the TEMP A TRIM circuit board. Contact Webster Combustion if any of these faults occur.

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