WARNING: DEVIATION FROM THESE INSTALLATION INSTRUCTIONS MAY LEAD TO IMPROPER OPERATION OF THE ENGINE WHICH COULD CAUSE PERSONAL INJURY TO OPERATORS OR OTHER NEARBY PERSONNEL.

1.0 SYSTEM DESCRIPTION

1.1 OVERVIEW - The AccuNOx air/fuel ratio control system is designed to control "rich" burn 4-cycle engines that employ carburetors or mixing valves. The system controls the carburetor's fuel supply pressure by biasing the fuel pressure regulator through the vent port or bias port of the regulator. The Fisher 99 or 200 series regulators are the models controllable with the AccuNOx.

The AccuNOx controller keeps the mixture from drifting lean or rich as ambient conditions vary thus keeping the exhaust gas composition correct for catalytic reduction. The AccuNOx operates as a closed-loop controller with feedback provided by an oxygen sensor and a setpoint established by the user.

1.2 AIR/FUEL RATIO MEASUREMENT AND CONTROL - The air/fuel ratio is measured by an oxygen sensor installed in the exhaust stream of each bank of cylinders. The sensor requires the gas temperature to be in excess of 650°F for proper measurement. Most of the applications will have no difficulty in meeting this requirement as most engines operating in the rich-burn mode run well over this minimum limit.

The AccuNOx provides precise control of the air/fuel ratio for each bank independently. The coarse control is provided by the normal mechanical setup of the fuel regulators and carburetors. The fuel pressure is set by the regulator which establishes the differential pressure between the incoming air and incoming fuel to the carburetor. The final mechanical step is made by the load screw on the carburetor which establishes the open-loop initial operating mixture. The AccuNOx requires that the mechanical setting is slightly richer than the ideal operating point which then allows the AccuNOx to lean the mixture down to the correct air/fuel ratio.

Control of the mixture is affected by controlling the fuel pressure. The fuel pressure regulator is controlled by the AccuNOx system. The regulator vent port pressure is used to control the regulator. The AccuNOx will lean the mixture by reducing the vent port pressure which reduces the main fuel pressure to the carburetor. The mixture is measured by measuring the percent of oxygen (0_2) in the exhaust gas which for rich-burn applications is in the area of 0.2%.

1.3 SYSTEM COMPONENTS - The AccuNOx system consists of the following items:

- Controller	691301, single channel or 691302, dual channel
- Valve Kit(s)	690185-KT (one per carburetor required)
- Sensor(s)	610621 (one per carburetor required)
- Sensor Cable	693006-1, 25 ft. length or 693006-2, 50 ft. length

1.4 THE OXYGEN (O_2) SENSOR - The O_2 sensor, sometimes referred to as the Lambda sensor, in the exhaust provides a fast (<100 ms) response to changes of the O_2 content. The sensor generates a voltage level that is inversely proportional to the percent of O_2 in the exhaust. The sensor ranges from 0.0 (lean) to 1.0 volts (rich). The total operating range is a narrow (+,- 1%) range around the stoichiometric point which is 0.5 volts at the output. Figure 1 depicts the sensor characteristics.

The sensor provides a voltage proportional to the difference of O_2 between the exhaust and the ambient O_2 concentration. This is why the sensor provides the highest output voltage on the rich side of stoichiometry when the O_2 content in the exhaust is at a minimum.

For natural gas fueled engines, the best operating point for catalytic reduction is slightly richer than stoichiometric and is normally in the range from 0.650 to 0.775 volts. The best setpoint for a specific engine is determined by measuring the CO and NOx and adjusting the setpoint of the O_2 until the optimum results are obtained. The catalytic converter best operates with a specific ratio between CO and NOx. At the converter outlet, the CO tends to decrease with an increase in NOx and vice versa. A tradeoff must be reached between the two emittants for best results. The reason for this is that the converter breaks down the NOx by the presence of CO. A lack of CO will not promote good NOx reduction.

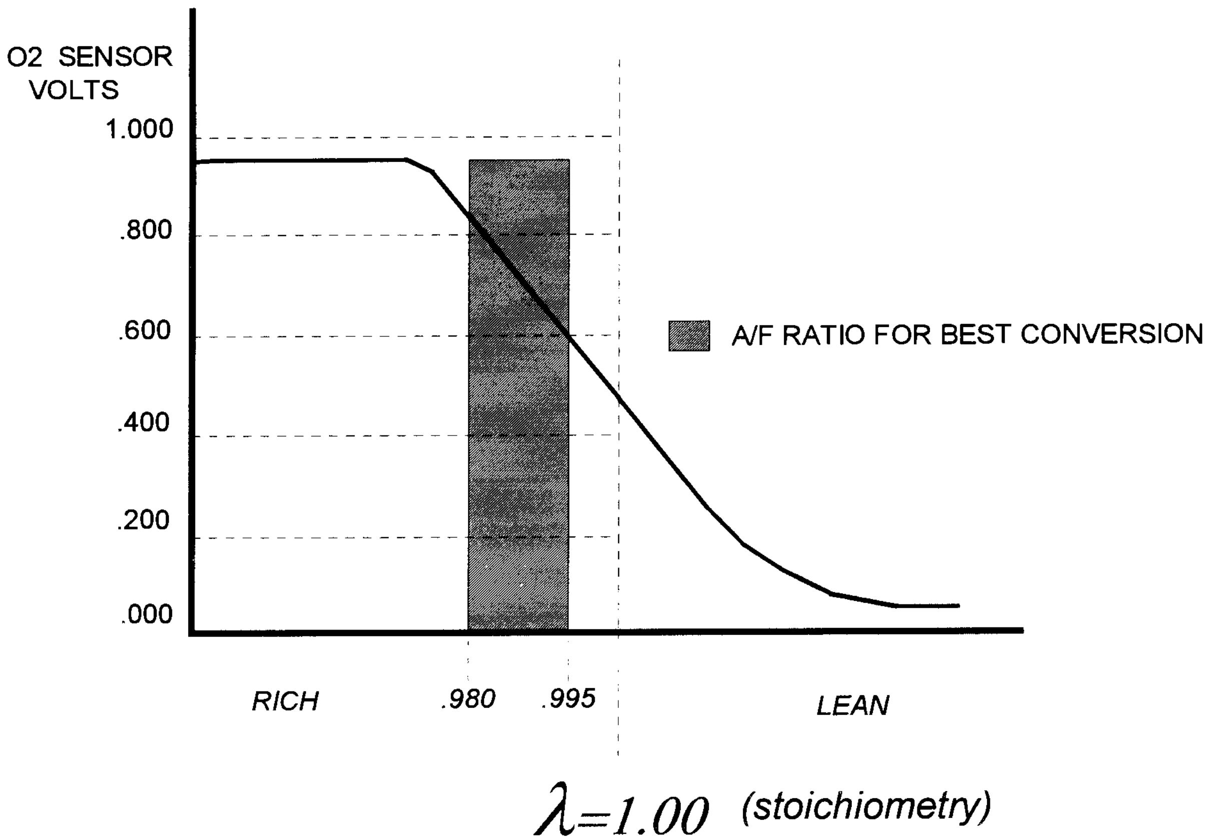
For dual bank engines it is best to observe the CO and NOx in each bank. The respective levels should be fairly equal from bank to bank but the specific O_2 levels may differ slightly to achieve a balance - thus the reason for individual bank control. The final converter output should be checked for best results with each bank producing equal levels of CO and corresponding equal levels of NOx.

In general the CO levels pre-converter are typically in the range of 5000-7000 PPM, and the NOx levels are in the range of 2500-3500 PPM. Post-converter, CO levels are typically 1000-2000 PPM and NOx levels are in the range of 50-250 PPM. These levels are typical levels; the actual limits are specified on the operating permit for the equipment.

The O_2 sensor output is used by the AccuNOx control as the feedback parameter for closed-loop operations. The air/fuel ratio (fuel pressure) is adjusted to achieve an output from the sensor as other influencing factors try to affect the O_2 content such as ambient temperature, load, barometric pressure, fuel gas BTU etc. By maintaining a fixed O_2 level the amounts of CO and NOx are also held to relatively constant values thus allowing the catalyst to perform properly.

Figure 1

SENSOR OUTPUT VS. AIR/FUEL RATIO



1.5 ENGINE PERFORMANCE REQUIREMENTS - The engine should be in good mechanical condition for the emissions control system (AccuNOx and catalytic converter) to perform properly. Basically, anything that can affect engine efficiency will have an effect on emissions; therefore it is important to have the engine and all accessories in good working order.

The AccuNOx control unit is compatible with the Fisher 99 and 200 series regulators. Any regulator of similar design would be compatible as well. The AccuNOx can control either naturally-aspirated or turbocharged engines. Two controller models are available. Model 691301 has one channel for in-line or small "V" block engines with one carburetor. Model 691302 has two independent control channels for "V" block engines using two carburetors.

Installation of the AccuNOx system includes mounting the control box and oxygen sensor(s), mounting and plumbing the control valve for each regulator and as an option, installing thermocouples. There are also interface options for status and remote control that may require additional wiring.

As a minimum, the control system can consist of the AccuNOx controller, oxygen sensor(s), control valve(s) and 24 volt DC power. The thermocouples, shutdown and warning interface devices, engine status input and mode status outputs are optional features.

1.6 INSTALLATION REQUIREMENTS

Power Source: (24VDC, 5A.) The AccuNOx requires 24 volts DC at 5 amps max. NOTE: There are internal fuses that protect external wiring, F1 and F2. F1 is a 0.5 amp fuse that is in line with the on-board electronics. F2 is a 5.0 amp fuse that is in line with the control valve, shutdown, warning and mode status output transistors. If this fuse is blown the unit will not be able to control the valves. In this case, the output driver LEDs will not illuminate as an indication; the main control electronics will remain operational.

Required Sensors: (610621) The AccuNOx requires one oxygen sensor per carburetor. The sensor port is a standard spark plug 18 mm thread. The location of the sensor is important. In the case of a turbocharged engine, it may be located before or after the turbocharger. However, care must be taken in the location selection to avoid exceeding the temperature rating of the sensor housing external of the manifold. The backshell is rated for 500°F. There may be thermal gradients around a turbocharger that exceed 500°F and can damage the sensor if it is located too close to the turbo.

There is normally one O_2 sensor per bank assuming there are separate carburetors and regulators for each bank. A "V" engine having only one carburetor and one regulator for both banks would use one oxygen sensor in the common exhaust manifold.

Required Valves: (690185-KT) One control valve per regulator is required. For "V" block engines there are usually two regulators, one for each carburetor. The supplied valve is CSA certified for Class I, Division 2, Group D hazardous locations. The electrical and pneumatic piping instructions are provided on the Mechanical and Electrical Installation drawings found in the back of these instructions. NOTE: For the case of a "V" block engine having a single carburetor, only one valve is required for the sole regulator.

1.7 THERMOCOUPLES (TYPE "K") - The use of any or all of the thermocouples is optional. One (channel 4) provides a means of over-temperature protection, and the others provide additional useful information.

Temp. Channel 1: (model 691302) Left Bank Exhaust Temperature. This input is used only for model 691302. All functioning and control for the left bank is the same as described for the right bank under Temp. Channel 2 below.

Temp. Channel 2: Single or Right Bank Exhaust Temperature. This may be used as a qualifying signal for control of this bank. The control will drop back to a monitor-only mode if the exhaust gas temperature drops below the required level for proper O_2 sensor operation; this temperature is preset to 650°F.

This feature is enabled or disabled by a dip switch. If the dip switch (S8 position 6) is open, the control will drop back to monitor mode if the temperature drops below 650°F. If closed, the temperature reading will have no affect.

All of the temperature channels have open probe detection circuitry that will cause the reading to go to 1950°F (max. temperature) if the probe's wiring becomes open. If the channel is not used, a shorting jumper should be put across the input terminals to avoid the high temperature indication.

Temp. Channel 3: (model 691302) Converter Inlet Temperature. The input is intended for a thermocouple input from the converter inlet. This temperature is displayed on the left LCD of model 691302 when selected by the top display select switch. NOTE: On model 691301, temperature channel 2 serves as both the exhaust and converter inlet temperature measurement.

Temp. Channel 4: Converter Outlet Temperature. This input is for the converter outlet temperature probe. This reading is displayed on the display of model 691301 and on the right display of model 691302, when selected by the top display select switch. The temperature is used for over-temperature protection. The default shutdown trip point is 1350°F but it may be changed in the field. Refer to section 6.2. If the temperature exceeds 1350°F, the over-temperature output transistor turns on.

The transistor output can be used to drive a relay or other engine panel devices that will subsequently shutdown the engine. A shutdown LED located on the control circuit board will turn ON and latch on even if the temperature drops back below 1350°F. The unit must be reset either by cycling power or by cycling the reset switch S1 located in the control unit.

The open probe circuit will drive the temperature reading over the shutdown setpoint if the probe or associated wiring breaks and will cause a shutdown. If this function is not used, a shorting jumper should be put across the input to keep the input at zero volts which is approximately zero degrees.

1.8 ALARM OUTPUTS RE SHUTDOWN AND WARNING OUTPUTS

Over-Temperature Output: This requires the use of the thermocouple on Temp. Channel 4 as detailed in section 1.6. The AccuNOx will activate the warning output transistor and initiate cycling of the "OVER T" LED when the converter outlet temperature reaches within 50°F of the over-temperature setpoint. When the temperature exceeds the trip point, the shutdown output transistor will turn ON and the "OVER T" LED will be ON constantly.

Bank Mode Output(s): There is an output transistor that indicates the mode of the respective bank: one on model 691301 and two on model 691302. The transistor is turned ON in the CONTROL mode as also indicated by the CONTROL LED and OFF in the MONITOR mode. This feature may be used to indicate to a remote PLC or may operate a panel light. There are circumstances when the front panel select switch may be in the CONTROL position, but due to an out of range O_2 reading the bank will drop back into the MONITOR mode as indicated by the LED. The output transistors will indicate the actual operating mode, not just the front panel switch position.

Engine ON/OFF Input: This input allows a relay contact or switch contact closure to indicate the engine status to the AccuNOx control unit. This input will cause the AccuNOx to drop out of the control mode if the input is closed. If the input is opened the AccuNOx will go back into the control mode assuming that the front panel has the control mode selected and the O_2 sensor is within the control band range.

If this input is not used, it should be left disconnected. Under normal operation the oxygen sensor will provide the controller the indication that the O_2 level is within the control range.

The Engine ON/OFF input may be used as a method of remotely controlling the AccuNOx mode function. If either bank mode switch is in the CONTROL position, the ENGINE ON/OFF input can be used to select the monitor mode by closing the input contact or it can select the control mode by opening the contact.

2.0 ELECTRICAL INSTALLATION

2.1 CONTROL UNIT - All wiring to the control unit is terminated on the internal terminal strips provided. There are two conduit entries. The left hand entry is intended for wiring to TB-1, and the right hand entry is intended for TB-2. The 25-pin socket connector is for factory test equipment only and not for field connection. This is NOT an RS-232 port. Refer to figures 11 and 12 for connection details and recommended wire sizes.

2.2 ELECTRICAL SPECIFICATIONS:

Input Power:	18-30 Volts DC, 5.0 Amps max.
Output Driver Specifications for: - Control Valves - Warning Output - Shutdown Output - Bank Mode Status	Current - 1.0 amps max. continuous Voltage - 400 Vdc max. See electrical installation drawing for connection and polarity.
Thermocouple Interfaces:	Type "K" leads
Oxygen Sensor interface:	0.0 to 1.0 volts DC Input Impedance: > 200 K Ohms Resistive
Engine On/Off Input Interface:	Dry Contact only

NOTE: See figures 2 and 3 on the next page for typical output and input interface schematics.

Figure 2

OUTPUT INTERFACE SCHEMATIC (TYPICAL)

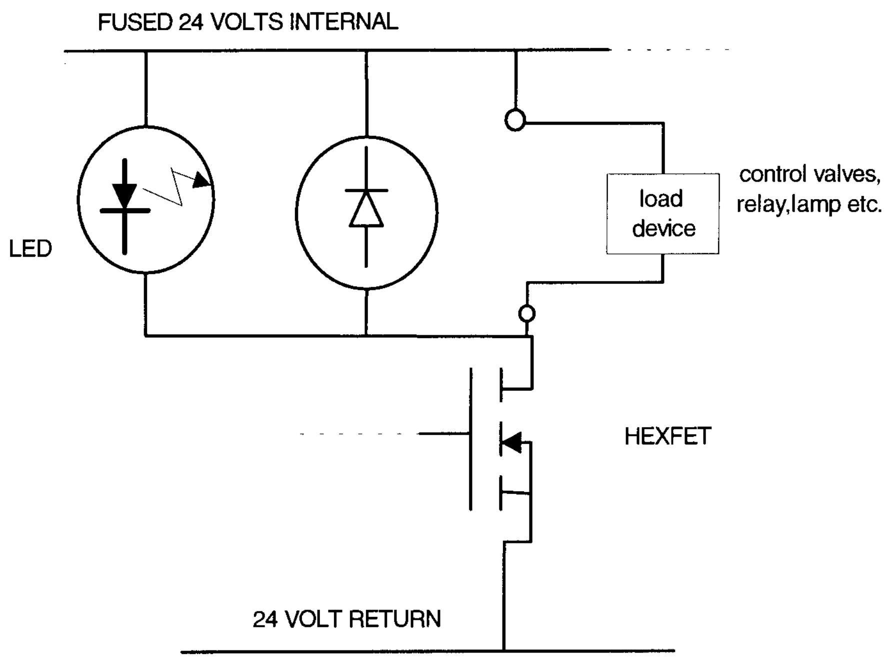
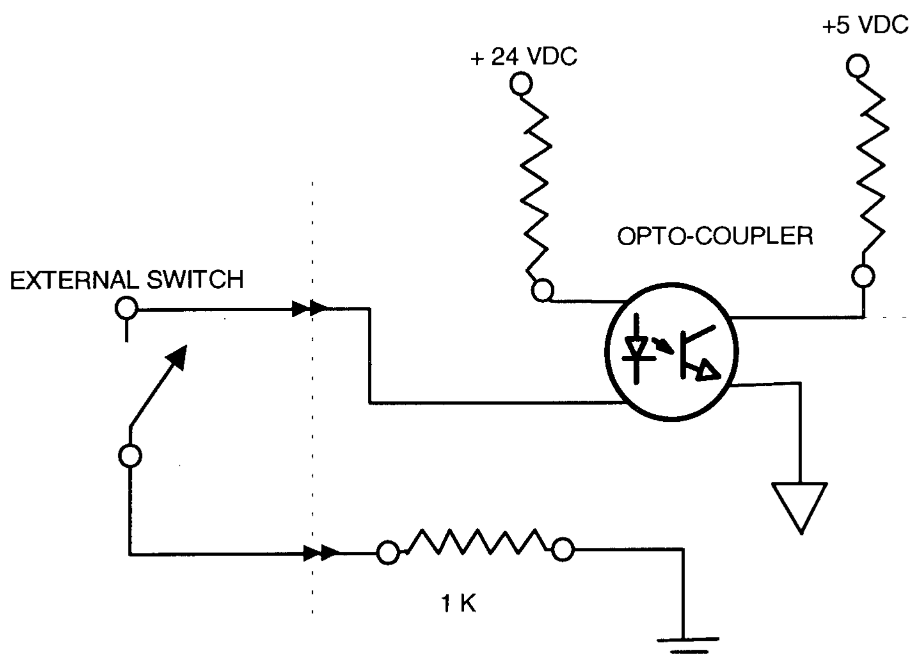


Figure 3

INPUT INTERFACE SCHEMATIC (TYPICAL)



3.0 MECHANICAL INSTALLATION

3.1 CONTROL UNIT MOUNTING - It is recommended that the unit is mounted off the engine to avoid high temperatures and vibration. A grounding strap should be connected to the paint free mounting hole and run to earth ground.

3.2 CONTROL VALVE MOUNTING - The control valve mounting should be made near the regulator valve. The air lines and electrical conduit may support the valve without additional mounting. There are four (4) 10-24 UNC holes tapped in the valve body for mounting. A simple flat piece of steel can be used as a mounting bracket. The bracket can be mounted directly to the regulator through one of the main bolts that secure the upper and lower halves of the housing. The valve is CSA certified for hazardous locations and may be mounted in any orientation. Figure 5 provides the mechanical details. A template for the bracket is provided on the last page of this manual.

3.3 PNEUMATIC INSTALLATION - The installation of the pneumatic lines is detailed on separate drawings, see the table for the applicable figure.

INDUCTION	REGULATOR	DRAWING
Naturally Aspirated	Fisher 200	Fig. 8
Turbocharged	Fisher 200	Fig. 9
Turbocharged	Fisher 99	Fig. 10

4.0 ACCUNOX FRONT PANEL DESCRIPTION

4.1 GENERAL - The front panel provides the operator with an easy means of displaying data, changing O_2 level setpoints and selecting the mode of operation. Through the front panel window the operator can monitor all of the critical parameters via the LCD(s). There are LEDs viewable through the window that indicate various conditions and mode status. The LCD display(s), one on model 691301 and two on model 691302, are controlled by a select switch. Model 691301 has one switch for mixture control and one for mode. Model 691302 has two switches each (one per bank) for mixture control and mode. The following sections describe the switches and indicators in detail.

4.2 LCD DISPLAY SELECT SWITCH - The top, 3-position switch allows the operator to select which parameter to be displayed on the LCD display(s). The selections are:

1. OXYGEN - actual averaged O_2 sensor voltage, displayed in millivolts.
2. EXH TEMP. - the exhaust gas temperature in °F. This thermocouple probe is located near the O_2 sensor. If enabled (see section 6.3), this temperature must be at least 650°F to allow the AccuNOx controller to enter the control mode.
3. Converter temperatures are displayed as follows:
   - OUTLET TEMP. selection (model 691301) gives the display on the LCD in °F.
   - INLET/OUTLET TEMP. selection (model 691302) gives the inlet temperature on the left LCD, and the outlet temperature on the right LCD (both in °F).

   Note that the converter outlet temperature can be used for over-temperature protection as well as monitoring (see section 6.2).

NOTE: If any temperature input is open-circuited, the display will show the max. temperature of 1950°F. Therefore, it is recommended that a shorting jumper be inserted across unused temperature input connections. The over-temperature shutdown output and the warning output will turn ON if the converter outlet thermocouple input (temp. channel 4) is left open.

4.3 LEAN-RICH SELECT SWITCH(ES) - Momentarily holding the switch lever to either the LEAN or RICH indication will cause the setpoint to be shown on the LCD. After a few seconds the LCD will revert back to the selected display parameter.

Holding the lever to either LEAN or RICH indication will cause the controller to change the setpoint either leaner or richer as long as the lever is held. The display will show the changing setpoint. As the desired setpoint is approached, the lever should be released followed by momentary activations until the desired setpoint is reached.

These levers also allow the operator to change the shutdown temperature trip point (see section 6.2).

4.4 CONTROL-MONITOR SELECT SWITCH(ES) - The AccuNOx operates in either the MONITOR or the CONTROL mode. There is also a special TEST mode which is discussed in Special Features, section 6.1. The switch selections are:

1. MONITOR - In the monitor mode, the AccuNOx does not adjust the air/fuel mixture. It monitors each sensor and allows the O_2 setpoint to be changed. The MONITOR mode is useful for adjusting the carburetor and for checking the fuel/air differential pressure across the carburetor for correct operating pressure.
2. CONTROL - In the control mode, the AccuNOx will adjust the air/fuel mixture continuously. The control constantly adjusts the mixture to maintain agreement between the averaged O_2 sensor reading and the established setpoint.

4.5 LEAN-CORRECT-RICH LED(s) - These show the relative O_2 level with respect to the setpoint. For example, if the setpoint is 750 mV and the reading is between 735 mV and 765 mV, the CORRECT (green) LED will be on. A reading of less 735 mV will cause the LEAN (yellow) LED to be on, and a reading greater than 765 mV will cause the RICH (red) LED to be on.

4.6 STATUS LEDs - Each bank has its own status LEDs:

1. MON (LED) - indicates the control unit is in the monitor mode and is not adjusting the mixture.
2. CONT (LED) - indicates the control is operating in the closed-loop mode. The control will make adjustments to keep O_2 reading equal to the setpoint. The front panel mode switch must be in the CONTROL position for this function. NOTE: The LED will go dim when the control reverts back to the monitor mode due to any detected out of range condition with the mode switch in the CONTROL position.
3. TEST (LED) - indicates the control is in the special test mode. In this mode the user may test the control range of the control valve and perform calibration for ambient temperature. Also in this mode, the over-temperature trip point can be changed. Full details on this feature are in Special Features, section 6.1.
4. LO T (LED) - indicates that the exhaust temperature is too low for accurate O_2 readings. The threshold is fixed at 650°F.
5. OVER T (LED) - indicates that the converter outlet temperature has exceeded the trip point. The control will cease mixture adjustment and the SHUTDOWN output transistor will turn ON. The default is 1350°F. The LED will flash when the temperature reaches 1300°F, and the WARNING output transistor turns ON at 1300°F. The trip point may be changed, refer to section 6.2 for this procedure.
6. ENGINE OFF (LED) - This LED indicates that the ENGINE ON/OFF input has been closed (shorted). This input can be connected to a manually operated switch or a pressure switch monitoring oil pressure etc. It is a way to remotely control the AccuNOx operating mode. When this input closes (shorts), the AccuNOx will immediately stop adjusting the mixture even if the O_2 is within the control range and the front panel mode switch is in the CONTROL position.

4.7 DS17-DS22 LED(s) - These LED(s) when lit indicate their respective output transistors are turned on.

DS17 - Warning output transistor
DS18 - Shutdown output transistor
DS19 - Right bank is in control
DS20 - Right bank valve is energized
DS21 - Left bank is in control
DS22 - Left bank valve is energized

5.0 SYSTEM CHECKOUT

System checkout consists of:

1. Fuel/Air Differential Pressure Adjustment
2. Carburetor Load Screw Adjustment
3. O_2 setpoint Adjustment
4. AccuNOx Control Mode
5. Optional Interface Checkout

5.1 FUEL/AIR DIFFERENTIAL PRESSURE ADJUSTMENT - The AccuNOx should be in the MONITOR mode or powered down for the fuel pressure adjustment. The following procedures are to be performed after the control valve and associated plumbing are in place and tested for leaks.

The differential pressure should be adjusted according to the engine manual and is typically in the area of 4.0 +/- 1.0 inches of water (H_2O). A water manometer is useful to make this measurement. The regulator should be adjusted so that the 4.0 inch H_2O differential pressure is present under normal load conditions. The differential pressure should remain within 1.0 inch H_2O under fixed load. Slow variations in the differential pressure will be compensated by the AccuNOx; however, fast erratic pressure variations or surges with swings over 1.0 inch H_2O in less than 0.5 seconds will show up in the emission readings as spikes in CO or NOx.

It is important to establish the differential pressure prior to adjusting the carburetor load screw since any changes in the differential pressure will affect the O_2 level.

5.2 CARBURETOR LOAD SCREW ADJUSTMENT - The AccuNOx should be in the MONITOR mode or turned off for the following adjustment. After the differential pressure is checked, the carburetor load screw can be set. Select the AccuNOx LCD display for the OXYGEN position to monitor the O_2 while adjusting the load screw to obtain the desired reading. The O_2 level should be set for a higher level than the control setpoint. This adjustment should be made under normal load conditions. Normally the carburetor should be adjusted to obtain a 775-825 millivolt level from the O_2 sensor. The default control setpoint is 750 millivolts.

5.3 O_2 SETPOINT ADJUSTMENT - The system uses 750 mV as the default setpoint. This setpoint can be easily raised or lowered. To see the setpoint, select OXYGEN on the top panel switch and push the LEAN/RICH lever to either side momentarily for the desired bank. To raise the O_2 setpoint, hold the lever toward RICH until the desired setpoint is shown. To lower the setpoint, hold the lever toward LEAN until the desired setpoint is shown.

The control will not change the mixture until the CONTROL mode is selected and the O_2 sensor reading is within the range limits for control. For initial commissioning, the 750 mV setpoint is the recommended starting point. Once the system has been checked out and functioning properly, the CO and NOx can be measured. The O_2 setpoint can then be changed to achieve the desired CO and NOx results.

5.4 ACCUNOX CONTROL MODE - With the fuel/air differential pressure set for approximately 4.0 inches H_2O and the O_2 level adjusted for approximately 800 mV, the AccuNOx can be put into control by selecting the CONTROL position on the front panel mode switch for one or both banks. It is usually a good idea to monitor the differential pressure on initial commissioning to see the change in fuel pressure as the AccuNOx leans out the mixture. The differential pressure should slowly drop from 4.0 inches H_2O down to 2-3 inches H_2O. This indicates the correct reduction in fuel pressure that should be observed.

As the differential pressure drops, a corresponding drop in O_2 level should be observed. The AccuNOx will continue to lean the mixture until the "CORRECT" LED comes on indicating that the measured O_2 is within the desired limits.

The AccuNOx is designed to maintain a constant O_2 percentage in the exhaust over the normal operating speed and load range of the engine. The AccuNOx will compensate for speed and load changes, as well as fuel BTU value changes or fuel supply pressure drifts. During load or speed change transitions, the AccuNOx will relinquish control to the regulator until the O_2 reading is back within the acceptable limits of control.

NOTE: The AccuNOx will automatically go back into control once the measured O_2 comes back into range.

5.5 OPTIONAL INTERFACE CHECKOUT - The optional interfaces are:

- Two (model 691301) or four (model 691302) Thermocouple channels
- One (1) engine on/off input
- One (1) warning output
- One (1) shutdown output
- Two (2) mode status outputs

Thermocouple Channels: The thermocouples can be checked by selecting the desired channel on the front panel display select switch.

Engine On/Off Input: The Engine On/Off input is intended to allow an external switch contact to indicate engine status to the AccuNOx control unit. The control will stop and revert to the monitor mode when this input is closed (shorted). This permits the control to automatically drop back to monitor mode if the engine is shutdown for any reason. If a pressure switch is used, the unit will drop back to monitor when the oil pressure drops. The input can also be connected to a manual switch for remote control of the mode. The verification that the input contact is made can easily be seen on the control board Engine On/Off LED. It will be ON when the input is shorted.

Warning Output: This output transistor will turn ON when the converter outlet temperature exceeds the trip point minus 50°F. If the trip point is 1350°F, the WARNING output will come on over 1300°F. This can be checked by removing one lead of the thermocouple pair. The open input will generate a high temperature reading and exceed the WARNING trip point as well as the SHUTDOWN trip point. The transistor for the WARNING output is Q1 and the associated LED is DS17.

Shutdown Output: As stated in the previous paragraph, the trip point is normally 1350°F. This may be changed by the user. The procedure is detailed in Special Features, section 6.2. To test this output, the converter outlet temperature thermocouple lead can be disconnected. This open circuit condition will generate an over-temperature reading causing the SHUTDOWN output to turn on. DS18 is the associated LED.

Mode Status Outputs: There is an output transistor (one per bank) that indicates what mode the particular bank is in. When the transistor is turned on, the associated bank is in control. If off, then that bank is in the monitor mode. This feature may be used to signal a PLC or panel that the AccuNOx is in control. This output could also be used to sound an alarm if the unit drops out of the CONTROL mode in the case where the O_2 goes out of range for any reason or if the engine shutdown and the Engine On/Off input causes the AccuNOx to go into the monitor mode. The use of this output is left up to the user's discretion.

6.0 SPECIAL FEATURES

AccuNOx provides certain Special Features or functions which are not essential to fundamental air-fuel control but which can be useful in many applications. The following Special Features are discussed in this section:

1. Test Mode (Manual Mode)
2. Converter Outlet Over-temperature Setpoint Adjustment
3. Configuration DIP Switch
4. Ambient Temperature Reference Adjustment
5. Gain Control Adjustment

6.1 TEST MODE - The Test Mode is a manual or "open loop" mode used during initial installation or for troubleshooting. When the Test Mode is activated, the control valves will begin to operate at a very low duty cycle. The duty cycle can be increased manually by holding the LEAN/RICH lever toward the LEAN indication. The duty cycle can be decreased by holding the lever toward the RICH indication.

The range of fuel pressure control can be observed as the duty cycle is increased to determine the range of operation. If the range is insufficient, then the valve plumbing may need to be reworked or the drilled orifice used for the 99 series regulators will have to be increased.

Either bank can be put in the Test Mode using the Test Slide Switches on the printed circuit board (LB and RB). For example, to put the Left Bank in the Test Mode, slide the LB Slide switch to the "TST" position.

6.2 CONVERTER OUTLET OVER-TEMPERATURE SETPOINT - The default (factory) setpoint for the Catalytic Converter Over-Temperature Setpoint is 1350°F. Although this value was chosen to satisfy most applications, it can be adjusted to a different value if necessary.

The Converter Outlet Over-Temperature Setpoint can be set to any value between 900°F and 1600°F. To view or adjust the setpoint perform the following steps:

1. Switch the RIGHT BANK to the Test Mode by sliding the "RB" internal slide switch (S-27) to the "TST" position.
2. Set the Display Select Switch to the OUTLET TEMP. (model 691301) or INLET/OUTLET TEMP. (model 691302) position.
3. To display the over-temperature setpoint, momentarily hold the LEAN/RICH lever to either side.
4. To change the setpoint:
    - To increase setpoint, hold the lever toward the RICH indication while watching the display.
    - To decrease setpoint, hold the lever toward the LEAN indication while watching the display.
5. Return switch S-27 to the normal position.

6.3 CONFIGURATION DIP SWITCH - The Configuration DIP Switch (S8) is located on the AccuNOx printed circuit board. Except for S8-7, the DIP switch is read once during the power-up sequence or when the reset switch (S1) is cycled. Therefore, with the exception of S8-7, if a change is made to the DIP switch settings, the 24 volt input power must be cycled before the new settings will become active. Any switch setting changes to S8-7 will become active immediately, without cycling power. The following functions can be enabled/disabled using the DIP Switch:

S8-1 - Left Bank Enable
- CLOSED = Enable for normal operating
- OPEN = Disable for no operation and displays "-----".

S8-2 - Right Bank Enable
- CLOSED = Enable for normal operating
- OPEN = Disable for no operation and displays "-----".

S8-3 - Calibration Mode
- CLOSED = Enable display of ambient temperature. R17 can be adjusted to display the actual temperature.
- OPEN = Disable displays of ambient temperature.

S8-4 - Front Panel Lock-Out
- CLOSED = Prevents changes to O_2 setpoint from the front panel LEAN/RICH lever switches.
- OPEN = Operator can change the O_2 setpoint from the front panel levers.

S8-5 - O_2 Range Check Disable
- CLOSED = The O_2 reading will not cause the control to cease function if the reading is out of range. The control will attempt to lean or enrichen even if the O_2 reading is beyond the control range. This implies that the control valve will drive to full open or full closed trying to achieve the correct ratio.
- OPEN = If the O_2 is above 925 mV or below 150 mV, the control will discontinue to operate the valve. This will occur during a load change. Once the O_2 comes back within the aforementioned limits, the control will automatically start controlling. The limit needs to be exceeded for 5 seconds before the control function stops. The control will start functioning immediately when O_2 falls within the stated range.

S8-6 - Exhaust Temperature Bypass Enable
- CLOSED = The exhaust temperature must be greater than 650°F before the control mode will operate.
- OPEN = The exhaust temperature is not used for qualifying controller operation.

S8-7 - Thermocouple Calibration Mode Enable
- CLOSED = Enable the thermocouple calibration mode.
- OPEN = Disable the thermocouple calibration mode.

NOTE: Any changes to this setting become active without cycling the 24 volt input power.

S8-8 - Future Use

6.4 AMBIENT TEMPERATURE REFERENCE ADJUSTMENT - The Ambient Temperature Reference is used by the AccuNOx software to compensate the thermocouple connections. This reference is calibrated at the factory using potentiometer R17. The ambient temperature reference can be checked and calibrated if needed in the field by the following steps.

1. Enable the "Calibration Mode" by setting S3 of the configuration DIP switch to "CLOSED" and cycling the RESET switch S1.
2. Display the ambient temperature by switching either bank to the Test Mode and switching the Display Select to either OUTLET TEMP. (model 691301) or INLET/OUTLET TEMP. (model 691302).
3. Adjust R17 if necessary to display the correct ambient temperature.
4. Disable Calibration Mode by switching S3 to the "OPEN" position and cycling the RESET switch S1. Slide the test switch (S27 or S28) back to normal operation.

6.5 GAIN CONTROL ADJUSTMENT - The control loop has independent gain (sensitivity) adjustment for each bank. The 10-position step switches, S4 (left bank) and S7 (right bank), provide the means for changing the gain of each side. These switches are factory set for position 5. The gain may be increased by selecting a higher position or reduced by selecting a lower position. The purpose of these switches is to allow adjustment of the gain in the field to optimize performance and prevent any tendency for the control to "hunt" for the setpoint. Since the condition of the regulator, carburetor and control valve plumbing can affect the control loop stability, these switches provide a limited means of compensating for the hunting tendencies.

The gain should be adjusted down if the control is oscillating or hunting as it tries to stabilize the O_2 reading to the desired setpoint. Increase the gain if the control is operating too sluggishly as indicated by the O_2 reading changing too slowly or if the measured CO tends to have high excursions during emissions testing. It may be difficult to determine if the gain is too low without actual measurement of the CO or NOx output. The three LEDs on the board are a good indication of loop performance. The green LED should be on most of the time with occasional short durations of yellow or red LED illumination.

If the LEDs constantly cycle red, green, yellow, green, red... etc. within a few seconds, the gain should be reduced until the LEDs indicate normal operation. If the gain adjustment does not achieve stability, further troubleshooting needs to be performed. Refer to the Troubleshooting Guide (section 7.0) for assistance.

6.6 THERMOCOUPLE CALIBRATION PROCEDURE - A calibrated temperature device should be used as a reference for this procedure. To add an offset to the temperature channels, enable configuration DIP switch S8-7 by setting it to the CLOSE position. NOTE: There is no need to cycle the 24 volt input power for this switch to become active. Choose the temperature channel to calibrate by setting the 3-Position Select Switch to either EXH. TEMP. (model 691301) or converter INLET/OUTLET TEMP. (model 691302). Hold the appropriate LEAN/RICH lever to decrease/increase the temperature channel offset in 5 degree intervals. The maximum temperature offset allowed is ±25°F.

If the power fails or is cycled, all the temperature channel offsets will remain stored in memory. To exit the temperature calibration mode, disable DIP switch S8-7 by setting it to the open position.

7.0 TROUBLESHOOTING GUIDE

7.1 INTERNAL PROBLEMS - The AccuNOx contains diagnostics that are designed to identify problems internally. They are:

1. Illegal Operation Code - checks internal instruction access continually.
2. EPROM Checksum - performed at power up only.
3. RAM Memory test - performed at power up only.

The following error codes will appear if the results of the above tests are negative:

CODE	DESCRIPTION	CORRECTIVE ACTION / PROBABLE CAUSE
E810	Illegal Operation Code	Probably noise induced, check installation: - short to ground - external interface miswiring - improper grounding Consult Factory for RAM replacement
E970	EPROM Checksum	Replace EPROM set U24 and U25.
E980	Write/Read Error to RAM Memory After Power-Up	Consult factory for RAM replacement.

7.2 THERMOCOUPLE PROBLEMS

Problem: Incorrect reading:

Cause: For initial installation the polarity should be checked. The yellow wire is positive and the red is negative. Refer to the installation drawing for the individual termination locations. Reversal of the leads will show a cold reading: < 40°F.

Cause: If the shield is lacking or broken, the reading could be higher or lower than actual by 200°F.

7.3 OXYGEN SENSOR PROBLEMS

Problem: Incorrect reading:

Cause: The reading may fall off if the ambient temperature around the sensor backshell exceeds 500°F. There may be an exhaust leak or high gradient in the vicinity of the turbocharger.

7.4 MIXTURE PROBLEMS - The basic test procedure for any mixture problem should include using the Test Mode to determine if the regulator will respond properly to the valve operation. The valve duty cycle can be set for a fixed value as described in section 6.1. The O_2 reading should remain fairly constant with a constant duty cycle. If the O_2 reading is too lean with only a few tenths of an inch of water column change, the possible cause may be that the load screw is in too far. This can be the case if the fuel pressure is more than 6 inches H_2O higher than the air inlet pressure to the carburetor. The differential pressure should be 4-5 inches H_2O as the normal mechanical setting prior to engaging the Control Mode.

Problem: Mixture fluctuations:

Cause #1: For applications using the 99 regulator the reason for fluctuations can be due to a leak in the pilot valve area or in the control valve plumbing. The 99 is more sensitive to leakage than the 200 series regulator due to the smaller volume of air being controlled. The orifice gap that the bleed air is routed through may be too large although the recommended 1/16 inch hole normally is correct.

If the bleed orifice is too small, the control will be sluggish in its response. The manometer differential pressure should show reduction in differential pressure when the unit is placed in control.

Corrective Action: Check for air leaks, check for correct regulator orifice, reduce bleed orifice on the AccuNOx control valve, check for exhaust system leaks upstream and downstream of the O_2 sensor. Also check the crankcase vapor recovery system for proper operation.

Cause #2: If only one bank is indicating instability as evident by the O_2 reading not staying within 100 mV of the setpoint under steady RPM and load, the cause may be due to excessive gain. Each bank has a separate gain adjustment, S4 for the left bank, S7 for the right bank. These are 10-position binary-step switches and are normally set at position 5 as the default value. If the O_2 indication is swinging continuously between too high and too low, the gain should be reduced by positioning the switch to a lower setting until the swinging dampens out.

8.0 INSTALLATION DRAWINGS

Figure 4: ACCUNOX ENCLOSURE DIMENSIONS - This sheet shows the overall dimensions of the control enclosure. It is recommended that the control be mounted off-engine. One of the mounting holes is left clear of paint for a ground connection. The conduit hubs should be tightened after all conduit connections are complete.

Figure 5: ACCUNOX VALVE AND MOUNTING BRACKET - This sheet has the valve dimensions and the mounting hole layout required in the associated mounting bracket.

Figure 6: OXYGEN SENSOR MECHANICAL DETAILS - The oxygen sensor provided is a 2-wire device. The sensor is coated with an anti-seize lubricant from the manufacturer; therefore, no additional lubricant is required. Care should be taken to keep the temperature of the exposed backshell below 500°F by the location chosen or by directing fresh unheated air over the sensor's backshell.

Figure 7: RECOMMENDED VALVE MOUNTING - This sheet shows a recommended mounting arrangement. It is recommended that the valve be mounted close enough so that the total line length from the valve to the regulator vent port does not exceed 1 foot for the 200 series, or 2 feet for the 99 series. This includes the line length from the vent port to the "T" and from the "T" to the valve but does not include the balance line from the intake or the vacuum port.

Figure 8: NATURALLY ASPIRATED WITH FISHER 200 SERIES REGULATOR - Naturally aspirated engine applications use the engine intake manifold vacuum for biasing the regulator. The provided filter should be located as per the drawing as close to the "T" as possible. The filter may be eliminated with a line plumbed to the air horn used instead. This is the preferred method to provide a completely closed system which will eliminate possible contamination of the vent port.

Figure 9: TURBOCHARGED WITH FISHER 200 SERIES REGULATOR - This drawing details the piping routing for the valve and regulator. The normal balance line is replaced with a new line that has a "T" for branching to the control valve. Note the exhaust port of the valve must not be blocked. If the regulator vent port is directly adjacent to the main fuel valve, the upper housing of the regulator may be unbolted and repositioned (clocked) to provide access to the vent port. Once plumbed, the connections should be tested for leakage.

The exhaust port for the bleed valve may be routed back to the engine intake in lieu of bleeding off into the atmosphere. With this alternative, the range may be extended if the manifold is at vacuum (engine at light load); normally the intake is near atmospheric pressure (engine near full load). Another reason would be to completely enclose and seal the system from the local ambient to keep debris from clogging the exhaust port.

Figure 10: TURBOCHARGED WITH FISHER 99 SERIES REGULATOR - This application requires a "T" in the balance line to the regulator pilot valve. The control valve requires an added bleed orifice restriction as shown in the drawing. The bleed orifice is required because the volume of the pilot housing is small and less bleed air is needed to change the output pressure.

The bleed orifice is made by drilling the provided cap plug with a 1/16 in. through-hole. The TEST mode should be used to check the control range. If the differential pressure cannot be reduced by at least 2" H_2O, the hole should be increased until a 2" H_2O drop can be achieved under normal operating conditions.

If the 1/16 inch orifice provides too much sensitivity (as indicated by a drastic reduction of differential pressure with the valve operating at minimum duty cycle), then a problem exists with the regulator or associated plumbing.

The control should work over a wide range of intake vacuum. The control automatically adjusts the duty cycle to achieve a balance between the O_2 reading and the setpoint for any vacuum condition. The test mode can be used to check the control range under normal operating conditions.

Figure 11: WIRING DIAGRAM - TB2 TERMINAL BLOCK - Connection diagram for INPUT signals to the AccuNOx controller.

Figure 12: WIRING DIAGRAM - TB1 TERMINAL BLOCK - Connection diagram for OUTPUT signals from the AccuNOx controller.

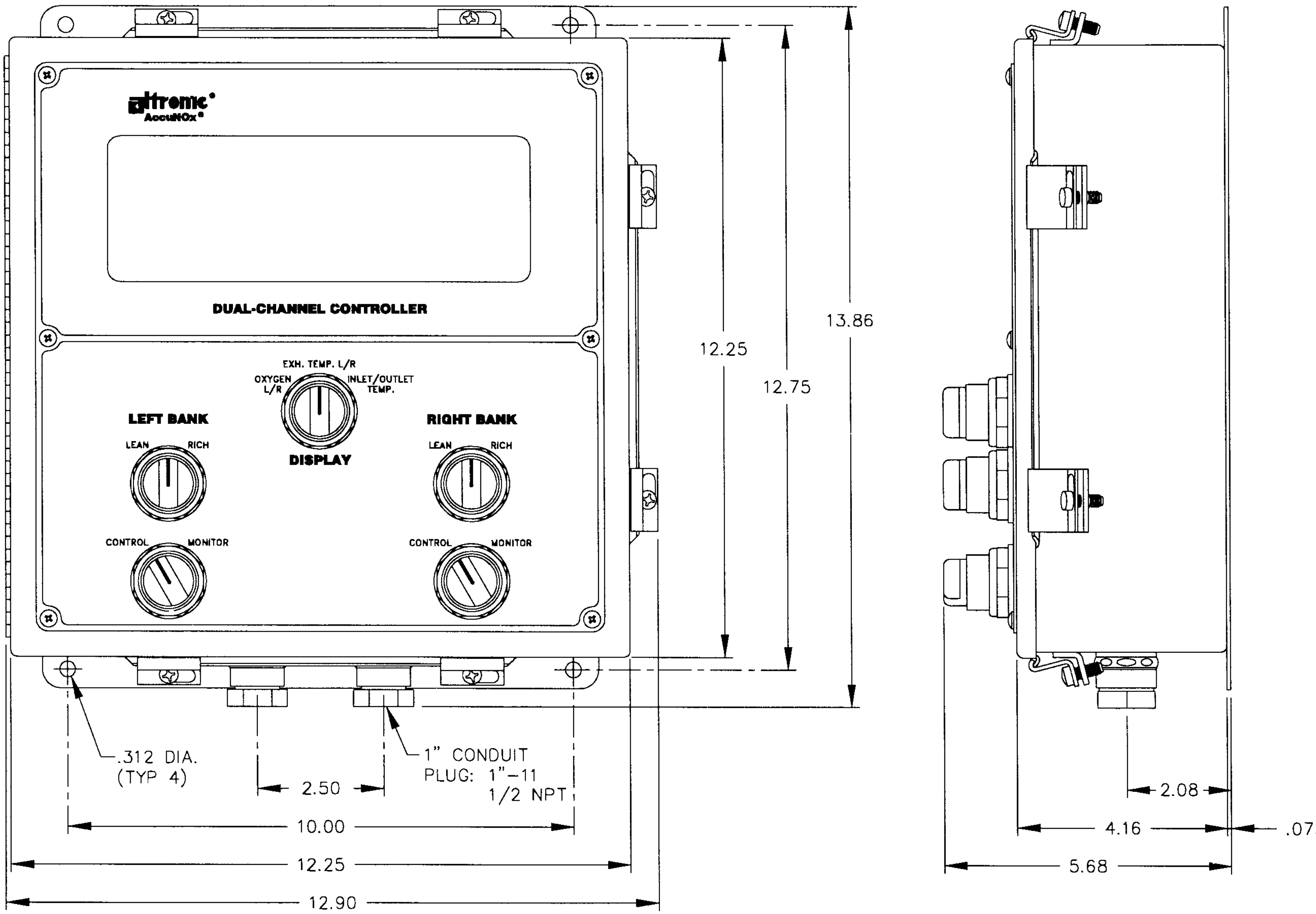

altronic
AccuNOx
DUAL-CHANNEL CONTROLLER
EXH. TEMP. L/R
OXYGEN L/R
INLET/OUTLET TEMP.
DISPLAY
LEFT BANK
RIGHT BANK
LEAN
RICH
CONTROL
MONITOR
13.86
12.25
12.75
.312 DIA. (TYP 4)
1" CONDUIT PLUG: 1"-11 1/2 NPT
2.50
10.00
12.25
12.90
2.08
4.16
.075
5.68

FIG. 4

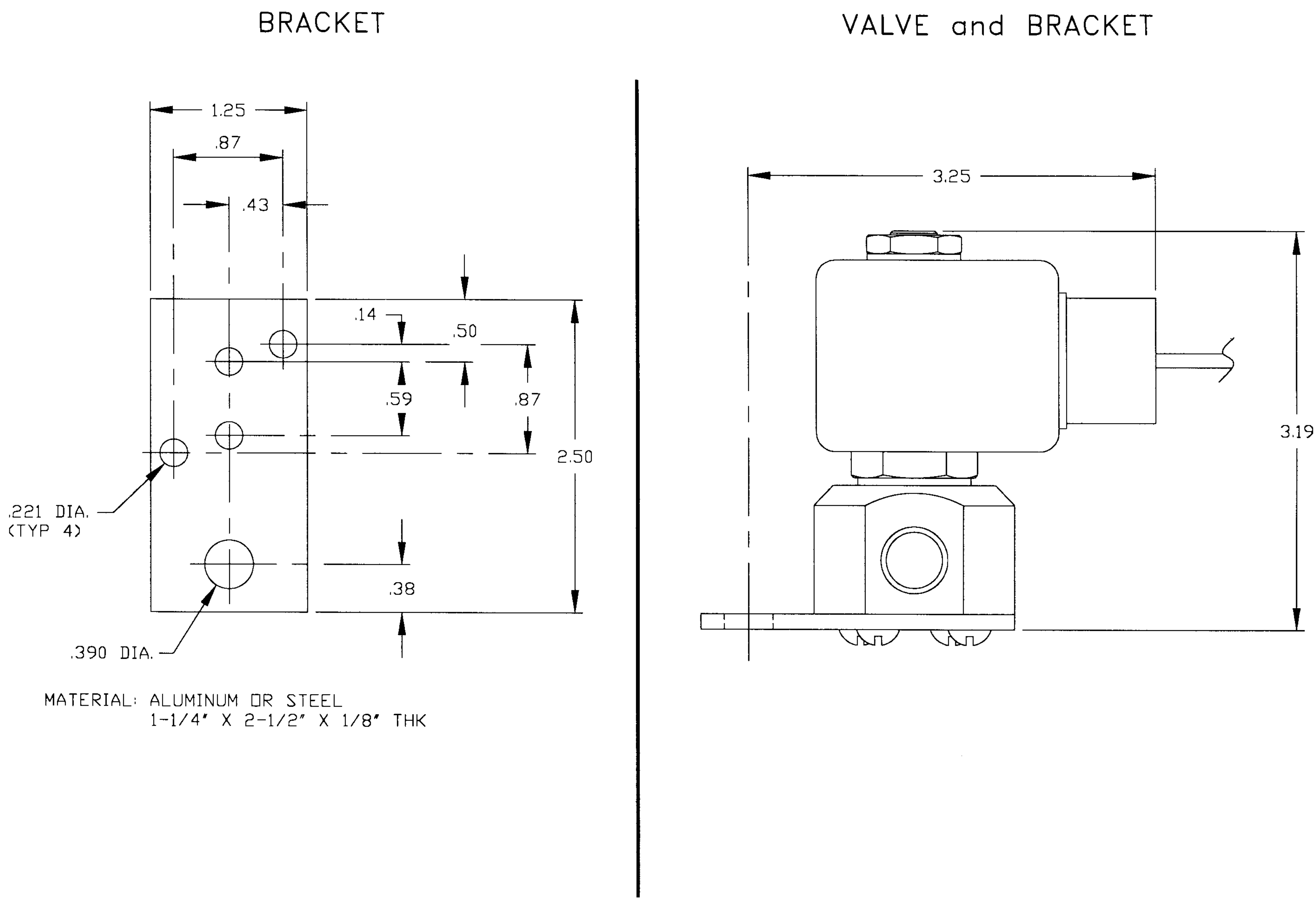
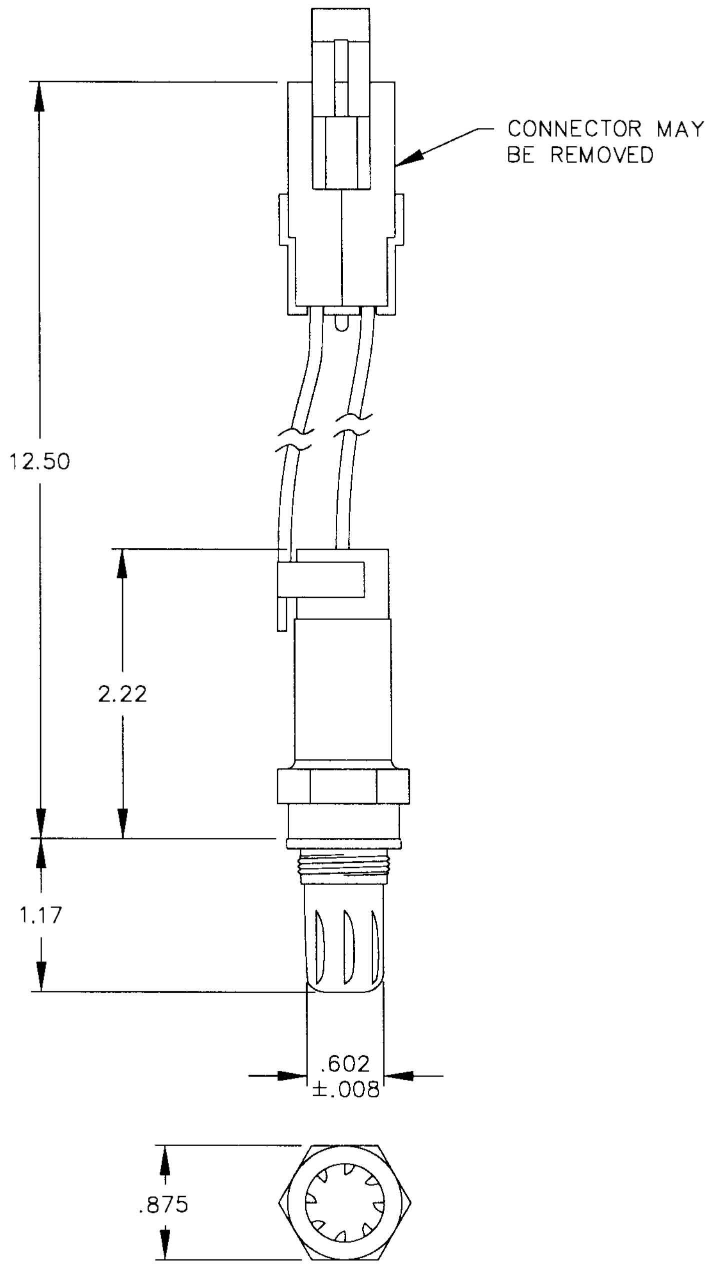

BRACKET
VALVE and BRACKET
1.25
.87
.43
.14
.50
.59
.87
2.50
.38
.221 DIA.
(TYP 4)
.390 DIA.
MATERIAL: ALUMINUM OR STEEL
1-1/4" X 2-1/2" X 1/8" THK
3.25
3.19

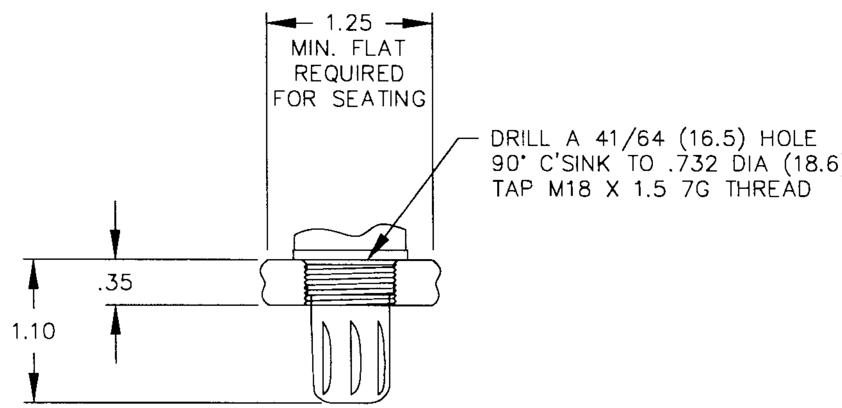
FIG. 5

OXYGEN SENSOR DETAIL



CONNECTOR PIN	WIRE COLOR	PIN AND WIRE CONNECTION
A	TAN	SENSOR (GROUND)
B	BLACK	SENSOR (OUTPUT)

MATING CONNECTOR:
PACKARD ELECTRIC DIV. PART NO. 12015781



RECOMMENDED INSTALLATION DIMENSIONS

FIG. 6

VALVE MOUNTING – FISHER REGULATOR

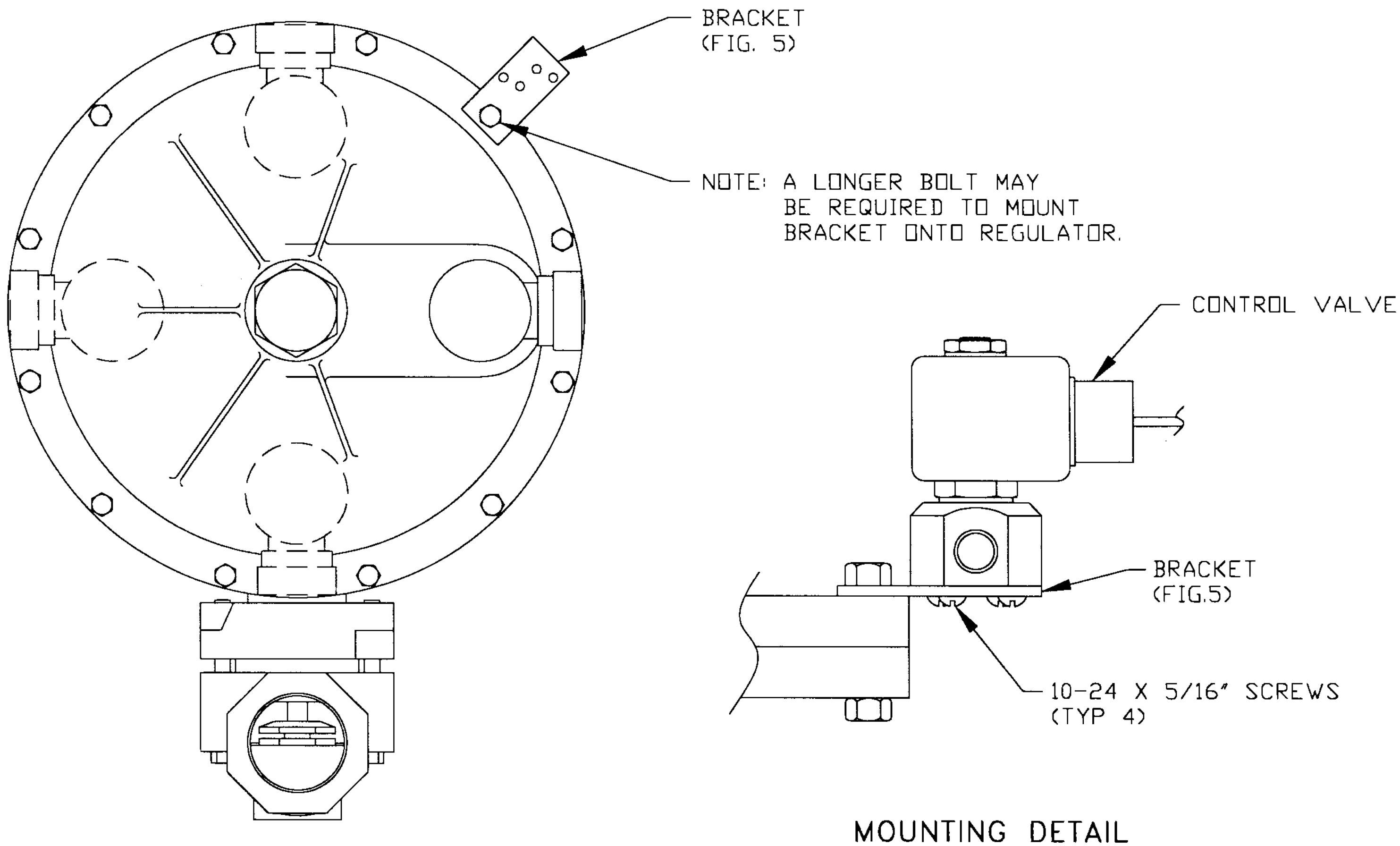


FIG. 7

NATURALLY ASPIRATED – FISHER 200 SERIES REGULATOR

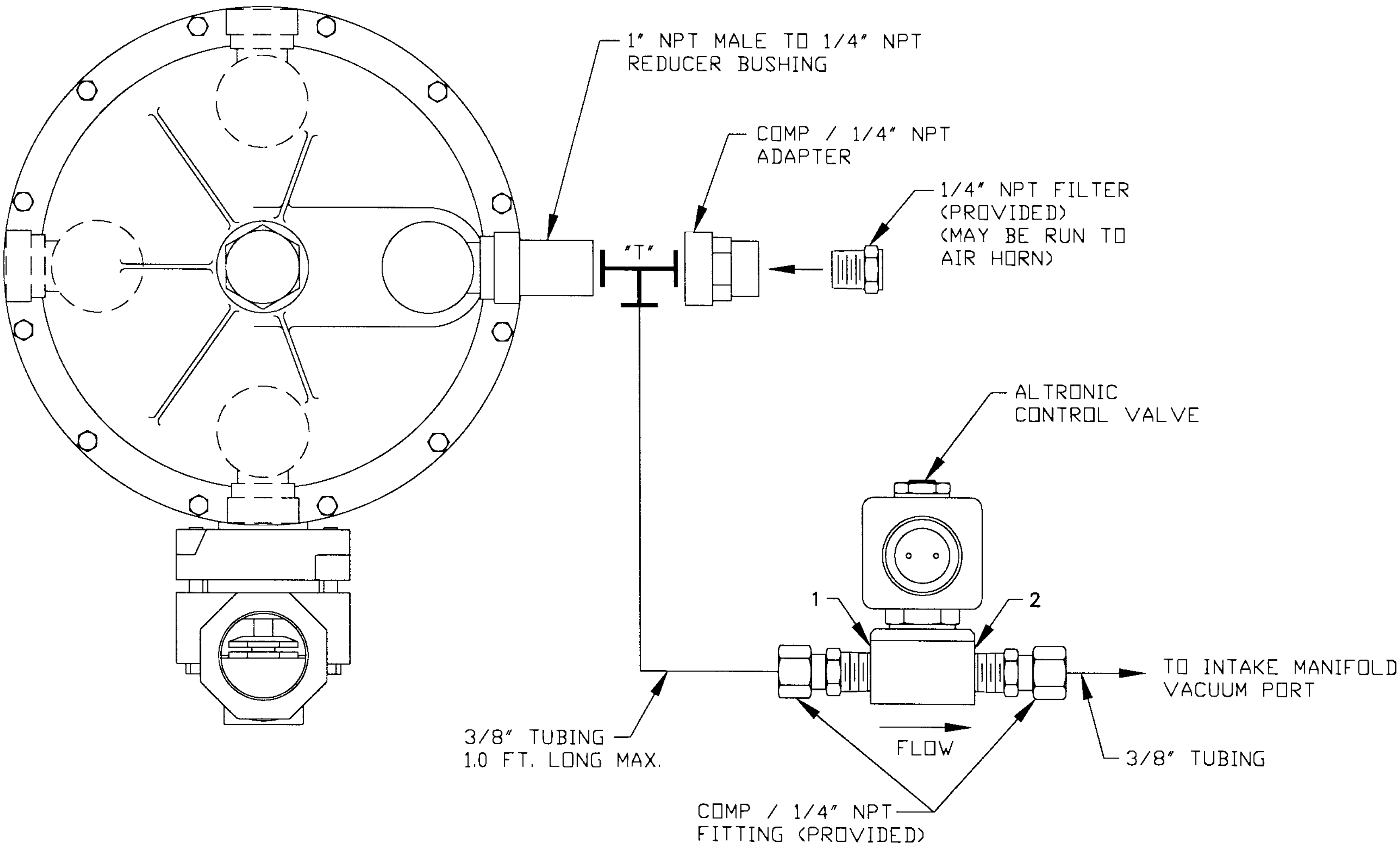


FIG. 8

TURBOCHARGED – FISHER 200 SERIES REGULATOR

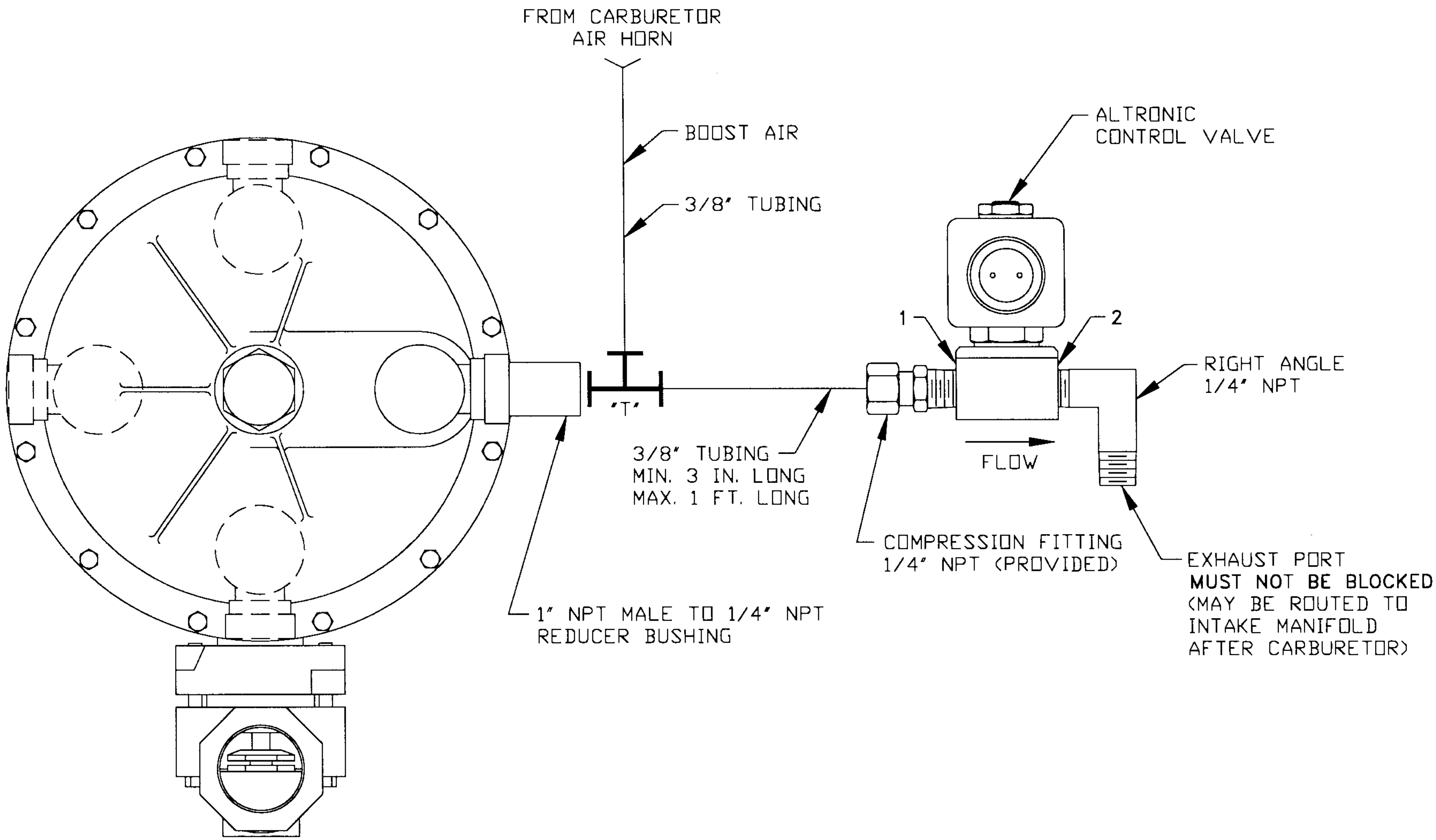


FIG. 9

TURBOCHARGED – FISHER 99 SERIES REGULATOR

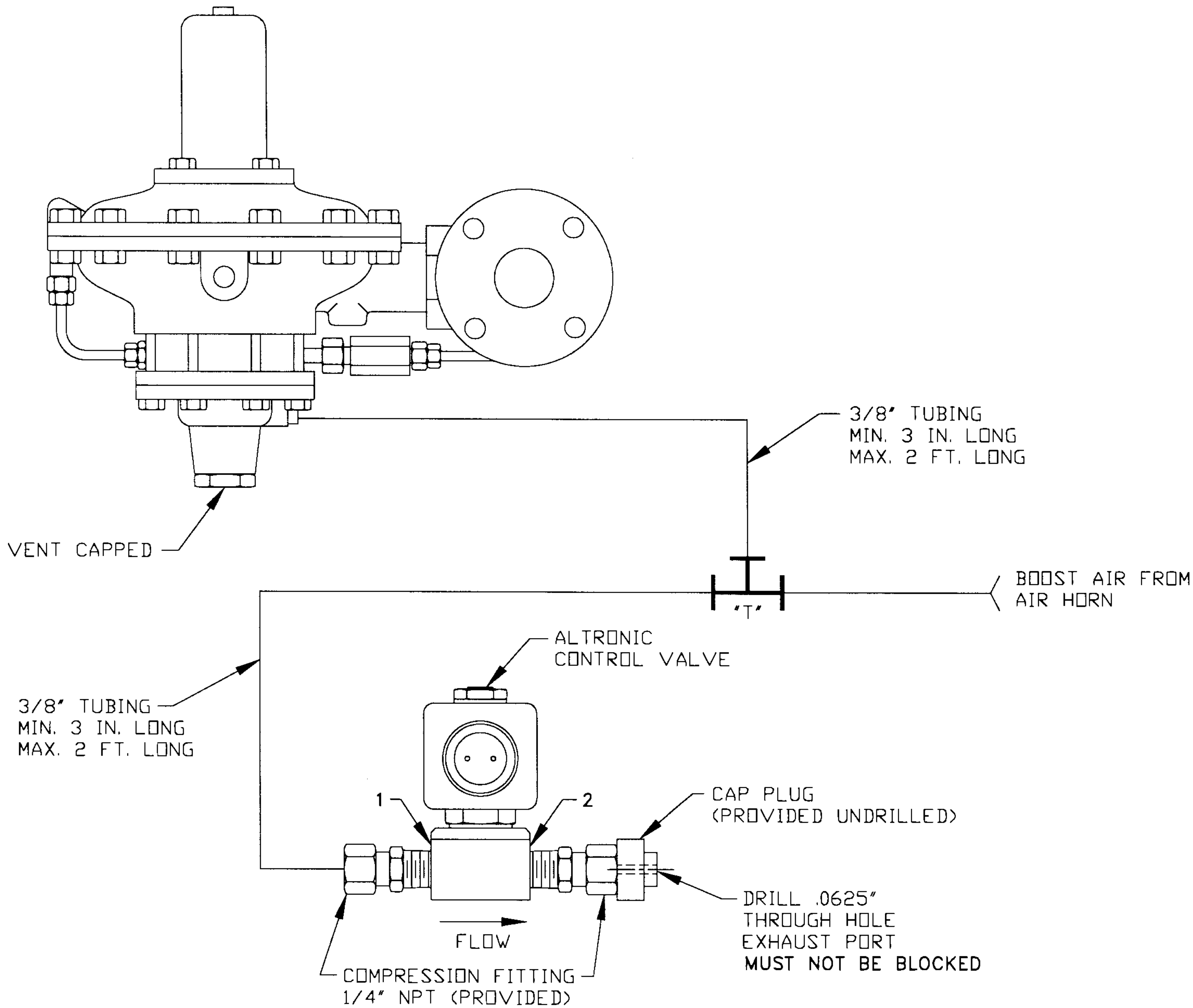


FIG. 10

WIRING DIAGRAM – TB2 TERMINAL BLOCK

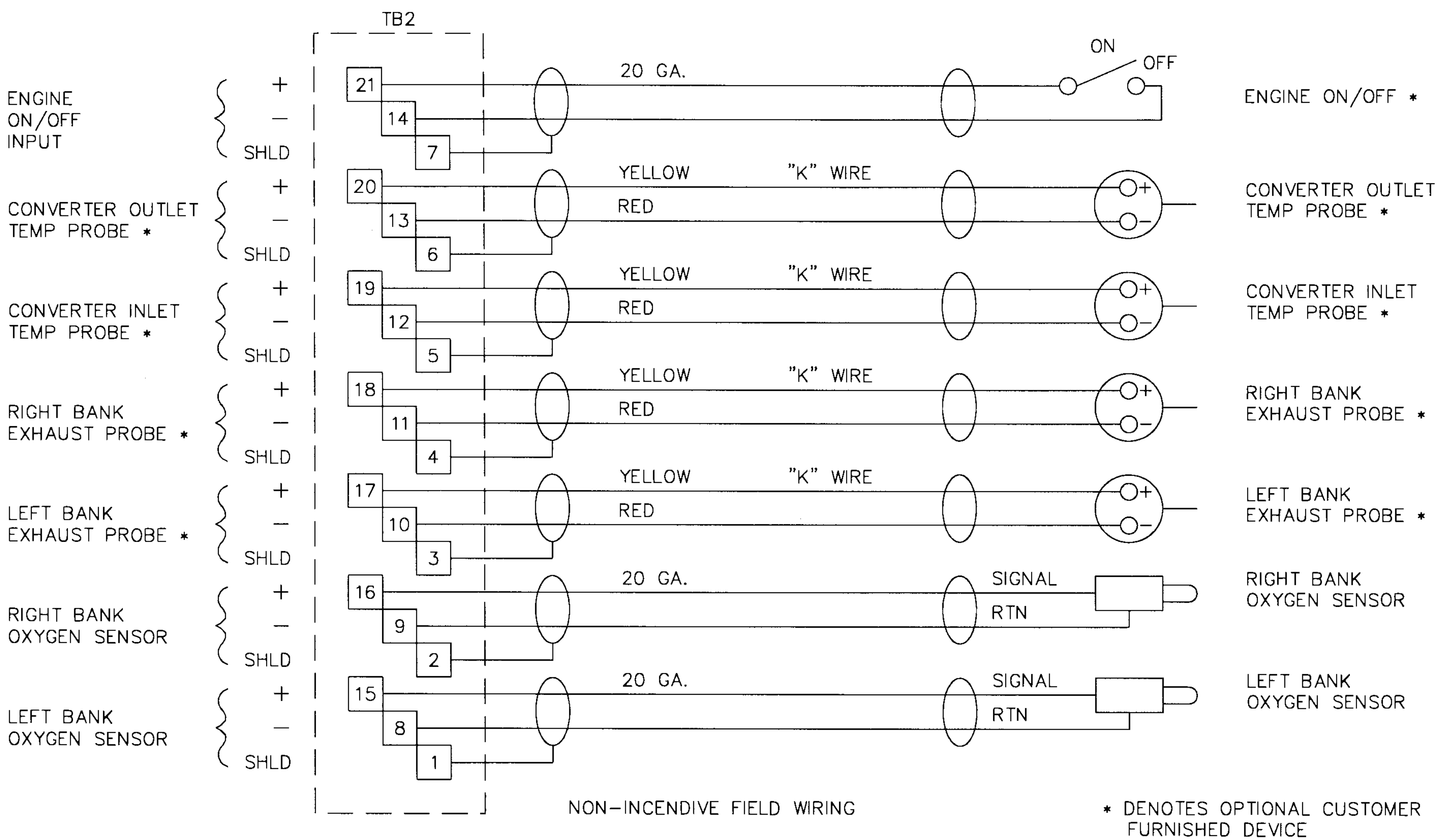


FIG. 11

WIRING DIAGRAM — TB1 TERMINAL BLOCK

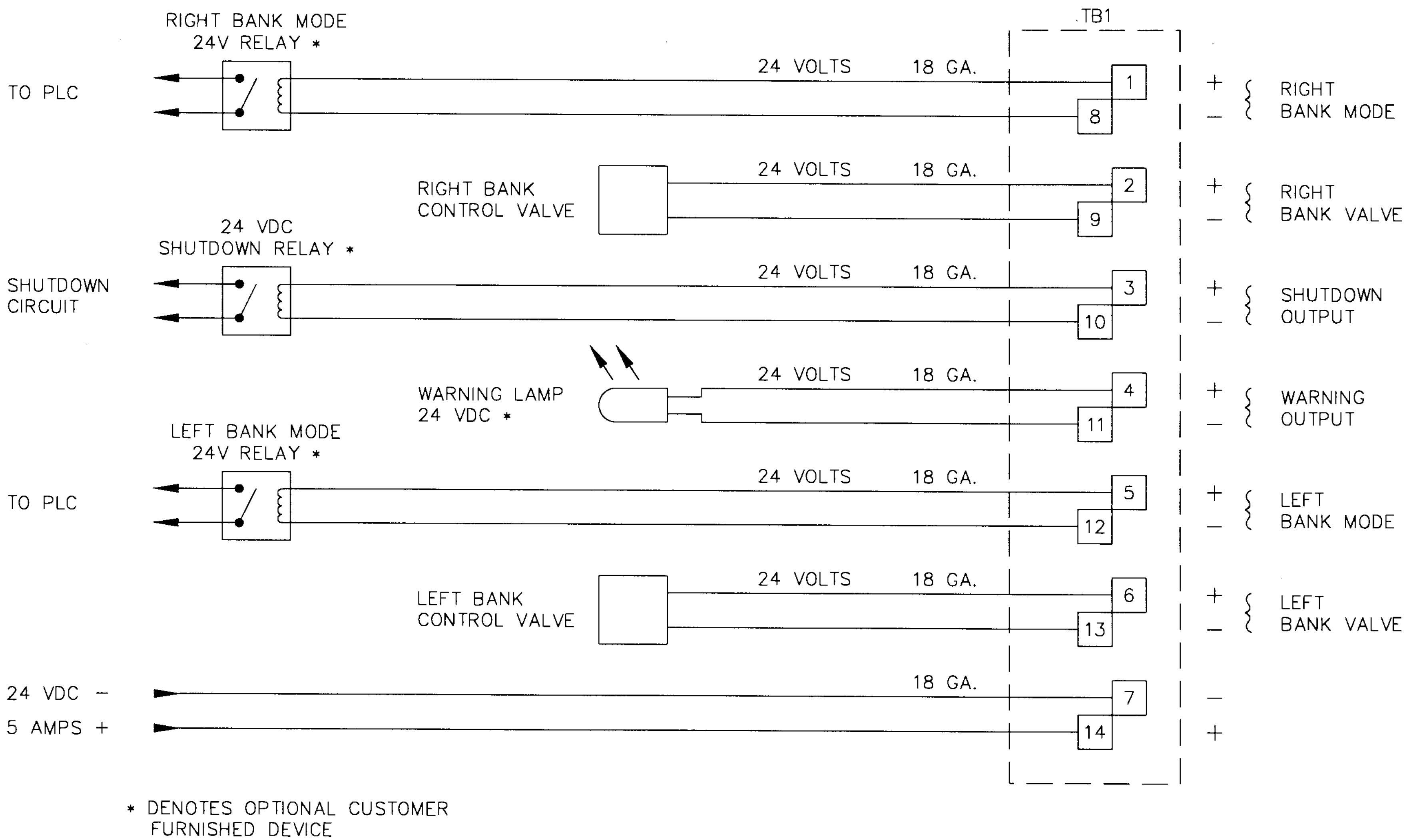


FIG. 12