

OPERATING MANUAL

AIR-FUEL CONTROLLER EPC-110/120-1 EPC-110/120-2

FORM EPC-110/120 OM 10-07

**WARNING:**

DEVIATION FROM THESE 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** The Altronic EPC-110 and the EPC-120 are air/fuel ratio controllers for use on carbureted gas engines. These controllers utilize microprocessor technology, allowing a high level of sophistication in control strategy, ease of programming and diagnostic capability. The EPC-110 is intended for stand-alone, off-engine post- or wall-mounting. The EPC-120 is intended for off-engine, panel mounting. Both controllers are identical in operation. The EPC-110/120 is designed for use on engines operating at or near a stoichiometric air/fuel ratio (λ .95 - 1.05) and is ideally suited for application with 3-way catalytic converters.
- 1.2** The EPC-110/120-1 provides single channel operation for applications with one carburetor. The EPC-110/120-2 provides dual channel operation for applications with one or two carburetors. Inputs and outputs are used in duplicate for a V-engine with two carburetors. An oxygen sensor is used in the exhaust stream to sense O₂ content; a thermocouple input signals when proper temperatures have been reached to allow for accurate sensor operation. A fuel/control valve installed in the fuel line to the carburetor is precisely adjusted by a stepper-motor under microprocessor control to maintain the correct O₂ content in the exhaust. The desired air/fuel ratio can be easily adjusted by changing the control target voltages through the sealed membrane keypad or through the use of a PC.
- 1.3** The EPC-110/120 has an alphanumeric LCD display showing the target voltage, sensor voltage, operating temperature, stepper motor position and diagnostic information.
- 1.4** Power requirement is 24 (10–30) VDC, 1 amp. In remote areas, power can be provided by the Altronic 24 VDC Alternator Power Package. Refer to Altronic Form ALT.
- 1.5** The EPC-110/120 also incorporates thermocouple inputs and a dedicated output for implementation of catalyst over-temperature protection.



EPC-110/120 AIR-FUEL CONTROLLER

2.0 SYSTEM COMPONENTS

2.1 One part from each group below is required for each installation:

PART NO.	DESCRIPTION	QUANTITY REQUIRED
EPC-110-1	Air/fuel controller, stand-alone	1 per engine–single bank
EPC-110-2	Air/fuel controller, stand-alone	1 per engine–dual bank
EPC-120-1	Air/fuel controller, panel mount	1 per engine–single bank
EPC-120-2	Air/fuel controller, panel mount	1 per engine–dual bank
690154-1	Control Valve, standard 1.5" NPT	1 per carburetor
690154-2	Control Valve, low HP 1.5" NPT	
690154-5	Control Valve, very low HP 1.5" NPT	
690220-1	Control Valve, butterfly 2.0" NPT	
690225-1	Control Valve, butterfly 2.5" NPT	
690230-1	Control Valve, butterfly 3.0" NPT	
693005-1	Cable, control valve, 25 ft.	1 per carburetor
693005-2	Cable, control valve, 50 ft.	
693006-1	Cable, oxygen sensor, 25 ft.	1 per carburetor
693006-2	Cable, oxygen sensor, 50 ft.	
610621	Oxygen sensor	1 per carburetor
**	"K" Thermocouple Probe (ungrounded w/thermowell)	1 per carburetor, plus 2 for Catalyst In/Out
**	"K" Thermocouple Ext. Wire	50 ft. per thermocouple
**	12-16 AWG Hook-up Wire	150 ft. per engine

** Not supplied in Altronic kits.

2.2 FIG. 14 lists the accessory kit contents.

2.3 REFER TO FIGS. 1 OR 2 for the general layout of components used in the EPC-110/120 control systems.

3.0 MOUNTING THE EPC-110/120

3.1 The EPC-110 fiberglass enclosure is designed and intended for off-engine, stand-alone post- or wall-mounting. REFER TO FIG. 3

3.2 The EPC-120 traditional painted steel enclosure is designed and intended for off-engine, panel mounting. REFER TO FIG. 4

3.3 Mounting location for EPC-110/120 should be chosen to minimize exposure to vibration.

3.3 Operating temperature range is -40° to 158°F. / -40° to 70°C. Humidity specification is 0-95%, non-condensing. Housed in a

NOTE: If possible, keep the original shipping container. If future transportation or storage of the controller is necessary, this container will provide the optimum protection.

NEMA 4X enclosure, the EPC-110 is rain and weather resistant; however the mounting site should provide as much protection from inclement weather as is practical. Avoid mounting the LCD display and keypad in direct sunlight.

4.0 MOUNTING THE OXYGEN SENSORS

4.1 The sensor should be installed in the exhaust system between the engine and the catalytic converter and/or muffler. The mounting location should be as close to the exhaust manifold of the engine as possible. The tip of the sensor should be exposed to the unobstructed flow of the exhaust gases from all cylinders to be controlled by that sensor. On a V-engine using two control banks, each sensor should be mounted such that it is exposed only to exhaust from the appropriate bank of the engine. This requires that the sensors be positioned at a point before the two banks join together. On engines using only one control bank, exhaust flow from all cylinders must be sensed. This means that the sensor should be mounted near, but still before the exhaust stack. **DO NOT** locate the sensor in a coupling or in a location where the exhaust gas flow is uneven due to obstructions or sharp bends. The sensor location chosen should allow easy access since sensor replacement may be required as often as every 2000 hours in some applications. The location chosen should not subject the exterior shell of the sensor to an ambient air temperature greater than 350°F.

NOTE: A weldment boss may be required for sensor installation in soft or thin wall exhaust systems.

4.2 Drill, tap and spot face a hole in the exhaust pipe at the selected location. A flat smooth sealing surface is required to assure accurate readings since air or exhaust leaks will impact sensor operation.

SEE FIG. 5 FOR DETAILS

4.3 New sensors are packaged with an anti-seize compound already applied to the threads. There is no need to apply additional anti-seize unless reinstalling a used sensor. If required, use high temperature anti-seize very sparingly and apply only to the sensor threads. Sensors should be torqued to 28-34 lb.-ft.

5.0 MOUNTING THE K-TYPE THERMOCOUPLES

- 5.1 EXHAUST TEMPERATURE THERMOCOUPLES** are used to monitor the temperature of exhaust gases near the exhaust oxygen sensor and should be mounted as close as possible to the appropriate O₂ sensor. As with the O₂ sensor, the location should be easily accessible, and the tip of the probe, which should be enclosed by a thermowell, should be surrounded by unobstructed exhaust flow.
- 5.3 CATALYST PROTECTION THERMOCOUPLES** should be installed in the catalyst housing. Provision for thermocouple installation is normally provided for in the design and manufacture of the catalyst. Installation of the thermocouples on the inlet to the catalyst and the outlet of the catalyst provides three modes of protection: High Inlet Temp Shutdown, High Outlet Temp Shutdown and High Catalyst Temperature Rise Shutdown. Consult catalyst manufacturer's recommendations for required overtemp protection.
- 5.3 ONLY UNGROUNDED THERMOCOUPLE PROBES** can be used with the EPC-110/120. Grounded type thermocouples will not function correctly. Resistance from either lead of the thermocouple to the probe shell should be 2 megohms or greater.

NOTE: For detailed instructions covering the gas control valve, see form GCV1 OM (690154 series) or GCV2 OM (6902XX series).

6.0 MOUNTING THE FUEL CONTROL VALVES

- 6.1** In order to control the air/fuel ratio, an electronically controlled valve is connected in series between each regulator and carburetor. These valves should be installed as close to the fuel inlet of the carburetors as possible. The distance from the valve to the carburetor inlet should not exceed 12 pipe diameters in length. The valves should be installed with the control cable connector facing upward to avoid the collection of condensation in the stepper motor. Pre-drilled mounting holes are provided for user supplied brackets.
- 6.2** If possible connection piping should be of the same diameter as currently in use. The threaded connection to the valve body may require the use of thread adapters. If adapters are used, proper plumbing procedures must be followed.
- 6.3** The control valves are connected to the EPC-110/120 using the 693005 cables. If it is desired to enclose the cables in conduit this can be accomplished by cutting the 693005 cable in half. The cables are color coded and must be reconnected with each wire color matching. These cables must not be run in the same conduit as the ignition primary or other wires. A distance of 4 to 6 inches should be maintained between EPC-110/120 wiring and other engine wiring. Note that the upper connector on the EPC-110/120 controls the stepper valve for single control channel applications and the left bank valve on V-engines.

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7.0 ELECTRICAL HOOK-UP

7.1 The power connections to the EPC-110/120 must be in accordance with the National Electrical Code. The EPC-110/120 is suitable for installation in Class I, Division 2 Group D locations.

7.2 Although the input power has internal protective fuses (3 amp), an external fuse (5 amp min.) near the power source is recommended.

7.3 The EPC-110/120 can be powered in one of the following ways:

- 24 volt battery with trickle charger (1 amp min. output).
- DC power supply capable of furnishing 10-30 VDC, 2 amps.
- Altronic 24 VDC Alternator Power Package –see form ALT.

7.4 Power wiring and signal (transducers) wiring must be in separate conduits and conduit entries into the EPC-110/120 to avoid undesired electrical interaction. Separate as follows (**SEE FIG. 6**):

Left Conduit Entry: Power Wiring and Earth Grounding

Center Conduit Entry: Signal Wiring; Oxygen Sensor wiring and Thermocouple inputs.

Right Conduit Entry: Alarm Outputs

7.5 Input power supply wires (16 AWG minimum) should enter the left most conduit entry and connect to the 24 volt supply terminals of terminal block TS2A. An earth ground wire (12 AWG minimum) should enter this same location and connect to the Earth Ground terminal. This connection is in addition to the power negative which may also be grounded.

7.6 Oxygen Sensors are connected via shielded cable P/N 693006. These should be run in conduit with, **AND ONLY WITH**, the EPC-110/120 thermocouple connections. These cables should enter the EPC-110/120 enclosure through the center conduit opening and connect to terminal block TB4. The red wire should be connected to the O₂ sensor (red) terminal, and the black wire to the O₂ sensor (black) terminal. The shield wire should be cut short and not connected. Care should be taken to identify the left from right bank sensor wires. The cables provided are terminated with weather tight connectors which mate to the O₂ sensors provided by Altronic. The shield wire (green wire at connector end) must be connected to the exhaust piping near to the sensor. This shield will assist in rejecting noise from other wiring which could affect the O₂ sensor signal.

REFER TO FIGS. 5 AND 6

NOTE: Voltage and current supplied must be sufficient to operate all transducers used in the installation. If a heated Oxygen Sensor is required, the heater current must be added to the requirements shown.

NOTE: Engines using positive ground DC accessories or starter motors will require a separate dedicated ungrounded power supply for the EPC-110.

- 7.7** The thermocouple (24 AWG min. type K extension) wires should be run in a conduit with and only with the EPC-110/120 O₂ sensor wires. These thermocouple wires should enter the enclosure through the center conduit opening and connect to terminal block TB4. The yellow wire should be connected to the T/C (**YELLOW**) terminal and the red wire to the T/C (**RED**) terminal. Again, care should be taken to identify the four thermocouple wires (**LEFT, RIGHT, CATIN, CATOUT**).

Although the EPC-110/120 does not require a computer to be operated or installed, a serial port, located on the control board assembly, has been included which can be used to communicate with a personal computer. Connections to the RS-485 port are made via TS3, a 3-position plug located near the center of the circuit board. A software terminal package which permits communication with the EPC-110/120 is provided on a CD-ROM shipped with each unit. This Modbus based PC program provides operational monitoring and the capability to adjust default parameters and setpoints remotely. On screen directions and help are provided by the Altronic terminal software. Modbus communication register lists may be used to interface to PLC or SCADA systems.

SEE SECTION 20.0 FOR DETAILS

- 7.8** The **CATALYST TEMP ALARM OUTPUT** is configured as a normally closed output signal. Any of the protection shut down (**PSD**) diagnostic thresholds will cause this output to open. Connect this output to the safety shutdown system in combination with a relay to result in an engine shutdown for the purpose of catalyst protection. This output is not latching and self-resetting upon the clearing of related protection conditions. (SOLID STATE SWITCH RATED 30 VOLTS/0.5 AMPS MAX)

*Note: this output can be restored to the closed position by pressing the **ALARM ACK** key to acknowledge the condition.*

- 7.9** The **ALARM OUTPUT** is configured as a normally closed output signal. Any diagnostic relating to measured temperatures, O₂ sensor voltages, or rich or lean limit stepper positions will cause this output to open for identification of possible improper airfuel control system operation. This output is not latching and is self-resetting upon the clearing of all the alarm conditions. (SOLID STATE SWITCH RATED 30 VOLTS/0.5 AMPS MAX)

- 7.10** Although the EPC-110/120 does not require a computer to be operated or installed, a serial port, located on the control board assembly, has been included which can be used for MODBUS RTU slave communications. Connections using RS-485 (3 position plug TS3) or RS-232 (DB9 connector) are supported (**SEE FIGURE 7**). The port configuration is accomplished using the display and keypad as described in **SECTION 12.18**.

SEE SECTION 20.0 FOR MODBUS REGISTER DETAILS.

8.0 THEORY OF OPERATION

8.1 The primary task of the EPC-110/120 is to accurately control the exhaust air fuel ratio (AFR) of an engine. Control should be maintained through reasonable load and fuel BTU variations.

8.2 Three-way catalysts are used to oxidize CO and HC and to reduce NOx. These processes require high temperature and correct AFR control. Catalysts perform best for all emissions when operated near the stoichiometric AFR.

8.3 The stoichiometric AFR is the AFR at which exactly the required amount of air (O₂) is present to completely burn all of the fuel. Because no engine can perform perfect combustion, typical emission by-products include O₂, HC, NO and CO even though the engine is running at stoichiometry. The stoichiometric AFR is determined by the chemical composition of the fuel, thus they are different for each fuel, or BTU rating.

(e.g. Methane => 16.09 : 1 and Gasoline => 14.70 : 1)

8.4 Because the fuel type is not always known, it is often easier to specify the AFR target in terms of Lambda. Lambda is an indicator of AFR normalized to the appropriate Stoichiometric AFR.

(Lambda Actual AFR/Stoichiometric AFR)

Thus Lambda for stoichiometric combustion would be 1.0, no matter what the fuel.

Lambda > 1 = Lean, Lambda < 1 = Rich.

8.5 An O₂ sensor (lambda sensor) is used to provide exhaust AFR feedback to the EPC-110/120. This type of sensor uses a zirconia element which, when combined with a catalyzing outer surface, creates an output voltage used to indicate lambda. Characteristics of the sensor include: an output range of about 0.1 to 0.9 volts when above 650°F, a very high output impedance when cool, a very high sensitivity at stoichiometry and a very low sensitivity away from stoichiometry. The output signal provides a very suitable means of controlling just rich of Lambda 1.0 which is the AFR range required to obtain best catalyst efficiencies for methane-based fuels.

FIG. 4 describes a typical sensor output voltage curve versus lambda.

8.6 Type K thermocouples are used to assure that exhaust temperatures are high enough for correct operation of the sensor before closed loop control is enabled. Additional thermocouples are used to monitor catalyst temperatures: In, Out and Rise. Temperature limit setpoints are provided to create a catalyst protection shut-down capability.

- 8.7** An electronic valve is used to create a variable restriction between the fuel pressure regulator and the carburetor inlet. This restriction is used to adjust the effective inlet pressure seen by the carburetor and results in a mechanical adjustment of the air/fuel mixture delivered by the carburetor. A stepper motor adjusts the restriction by moving a plunger inside the valve. A stepper motor is a brushless motor consisting of a permanent magnet armature and a four-coil multi-pole stator. The armature is moved by sequentially pulsing the four stator coils. Coupled to a worm screw, the rotating armature of the motor provides very accurate linear positioning capability. The motor used provides 1700 steps of travel at .0005 inch/step for a total valve stroke of 0.85 inch.
- 8.8** The EPC-110/120 adjusts the stepper motor to maintain a specific input voltage from the O₂ sensor. When the sensor voltage is above the O₂ Target voltage, the system is richer than desired, and the stepper position is increased to further restrict fuel flow to the carburetor. Conversely, when the sensor voltage is below the O₂ Target voltage, the system is leaner than desired, and the stepper position is decreased to reduce the restriction of fuel flow.
- 8.9** Because the sensor voltage output is not linear with lambda, it would not be practical to adjust the system faster when the error from the set-point is greater. So in order to maximize the control response, the motors are instead adjusted faster as the error persists longer. This method provides rapid response characteristics as well as control stability. Control target voltages must be determined with the use of an exhaust analyzer to locate the operating point of lowest stack emissions. These target values are adjustable in the EPC-110/120 through the keypad. The resulting system provides accurate and stable control of air/fuel ratio which results in high catalyst efficiencies and reduced stack emissions.

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9.0 PRE-START INSTALLATION CHECKLIST

9.1 BEFORE APPLYING POWER TO THE EPC-110/120:

- A. Measure the power supply voltage to assure voltage is within limits (10-30 volts). Leave unit un-powered.
- B. Inside the EPC-110/120, disengage terminal block TB4 and measure resistance between the red and black O2 sensor wires. Resistance should be higher than 2 megohms if sensors are cool. This verifies that wires are not shorted in conduit.
- C. Inside the EPC-110/120, disengage terminal block TB4 and measure voltage between yellow and red thermocouple wires. The voltage should be 0.80-1.50 mV for temperatures 60-100°F. This verifies that thermocouple wires are terminated. If engine had been running, measurements will be higher, reflecting higher actual temperatures.
- D. With the terminal block still disengaged, measure resistance between the red wire and the still connected earth ground terminal. Resistance should be very high or open circuit. Repeat measurement between yellow wire and earth ground. This verifies that thermocouples are ungrounded and that wires are not shorted in conduit.

9.2 WITH THE EPC-110/120 POWERED UP AND THE ENGINE NOT RUNNING:

- A. Display should follow the power-up sequence **DESCRIBED IN SECT. 11.2.**
- B. Display of O2 sensor voltages should go to 0.5 volts. This may require a few minutes. **SECTION 14.0** explains how to view data screens.
- C. Data display screen for exhaust temperatures should indicate ambient temperatures.
- D. Disengage terminal block TB4 and measure voltage between black O2 sensor wire and still connected earth ground terminal. The voltage should be 0 volts \pm 50 mV. This is to test for potential ground loop problems.
- E. Control valve operation should be verified during a start position command. This can easily be done if the valves are not yet fully installed in the fuel line. Press **ALARM ACK** if the alarm LED is on. Then press **F1** followed by **START POS.** During the start position activity, the left valve plunger should be fully retracted then positioned near the middle of its travel, followed by the right valve. No movement, erratic movement, or movement in the wrong direction will result from incorrect wiring of the stepper cables.

NOTE: If engine was running recently, temperature will be higher.

NOTE: Ground loops could be more significant when the engine is running. The addition of other electrical devices may affect EPC operation with regard to signal offsets.

F. RETURN THE SET-UP VALUES TO THE FACTORY DEFAULTS:

This can be done by slowly pressing the following keys in order **F1, F3, F2, F4**. Then, once the screen indicates that you are in the set-up mode, press **F2** followed by **F2** again to restore default setup values. Then press **F4** to exit the setup mode. The default values are set as follows:

Gain Value = 0.50

Left O₂ Target = 0.80 volts

Left Default Position = 1000 steps

Right O₂ Target = 0.80 volts

Right Default Position = 1000 steps

NOTE: Settings should be established based on catalyst manufacturer's recommendation.

G. CONFIGURE CATALYST PROTECTION THRESHOLDS:

This can be done by slowly pressing the following keys in order **F1, F3, F2, F4**, Then, **F1** to view each successive set-up parameter:

Exh Temp Hi = 1000°F

Exh Diff Hi = 200°F

Cat In Hi = 1000°F

Cat Out Hi = 1100°F

Cat Rise Hi = 100°F

9.3 When all of these checks have been made successfully, move on to the Start-Up Procedure.

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10.0 START-UP PROCEDURE

10.1 BEFORE STARTING ENGINE:

- A. Check for fuel leaks where the fuel line was modified.
- B. Verify that a catalyst over-temp thermocouples and thresholds are in place and functional according to catalyst provider requirements and recommendations.
- C. Press **F1**, then press **START POS** on the EPC-110/120 keypad to reset stepper position and enable the warm-up delay.
- D. Be sure that the power screw adjustments on carburetors are full open or full rich. If these adjustments are not fully open, then the control range of the stepper control valve will be limited.
- E. If the alarm outputs of the EPC-110/120 are being used, temporarily disconnect or override these signals so that an alarm indication will not shut down the engine during setup.
- F. Verify that the catalyst protection output is wired and functional to cause a shutdown in an overtemp condition.
- G. Place EPC-110/120 controller in **MANUAL** mode by pressing **LEFT MANUAL**, then **RIGHT MANUAL** keys.
- H. Start and warm-up engine.

10.2 WITH THE ENGINE RUNNING:

- A. Load engine to desired operating point.
- B. Verify that the exhaust temperature data screen is displaying reasonable values, and that the temperatures exceed 650°F. **REFER TO SECTION 14.0 FOR DISPLAY KEY OPERATION**
- C. Enable automatic control by pressing the **AUTO OPER** key. The unit should begin adjusting the stepper valves trying to control the engines air/fuel ratio. Use any diagnostic warnings which may occur to trouble-shoot the system. Rich or lean limit errors are a good indication that the pressure regulators need some adjustment.
- D. Once the unit has gained control of the engine (O2 sensor voltage very near the target voltage), adjust the fuel pressure regulators until the EPC-110/120 is controlling with the stepper valve positions near 1000 steps. This is approximately the middle of the valve's control range.

10.3 FINETUNE THE CONTROL SETPOINTS:

- A. Using an exhaust analyzer, determine the set-point voltage which results in the best emission performance. This can be done by incrementally adjusting the O₂ Target voltage in the Set-Up Mode. Reference section 12.0 for an explanation of the setup mode. Alternatively, manual mode can be used to adjust the control valves to the positions which give the best emissions performance. **REFERENCE SECTION 15.0** for an explanation of manual mode operation. Then the O₂ Target voltages should be adjusted to match the actual sensor voltages using the **SET-UP** mode.
- B. The control gain rate and default stepper positions can also be adjusted now; however, the default values represent the best typical values for these parameters.

10.4 ONCE THE SYSTEM IS CONTROLLING AT THE BEST EMISSIONS POINT, THE ALARM OUTPUT CAN BE RE-ENABLED.

10.5 AT THIS POINT, THE EPC-110/120 SET-UP IS COMPLETE; THE UNIT SHOULD BE CONTROLLING THE ENGINE.

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11.0 GENERAL: KEYPAD AND DISPLAY OPERATION

11.1 The EPC-110/120 includes a front-mounted keypad and an LCD display which permits the monitoring and adjustment of various parameters and actions. Two LED indicators are also included. The power LED (**GREEN**) is illuminated any time there is power to the unit. The alarm LED (**YELLOW**) will come on momentarily on power up then go out as soon as the unit is running. The alarm LED is used to indicate when a diagnostic test is violated. **REFERENCE SECTION 16.0** for more detail regarding diagnostics and the alarm indicator.

11.2 The keypad and display function together as the user interface. Only one key on the pad should be pressed at one time. Some commands require a key sequence (a series of key presses, one followed by the next). Whenever possible, special messages indicate what is happening or why a command is not accepted.

11.3 With the engine not running (cool exhaust), when power is first applied to the EPC-110/120, the display will show an Altronic product description message.

```
Altronic Inc.  
EPC110/120 Stoic
```

11.4 After a few seconds the display will indicate that the controller is in warm-up mode. This display indicates that the thermocouples are still reading temperatures too cool for the O2 sensors to function correctly. The number at the end of the message indicates the current stepper valve position in steps. If the engine is not started this condition will persist for 10 minutes.

```
L AutoWarmUp1000  
R AutoWarmUp1000
```

11.5 After 10 minutes with a cool exhaust, the display will now begin rotating the diagnostic messages for low exhaust temperature. All diagnostic messages include the **!** character for recognition. Diagnostics exist for several functions and are **EXPLAINED IN DETAIL IN SECTION 16**. When any diagnostic condition is present, the status containing **!** will appear, then all of the appropriate descriptions will follow in rotation. The number in the warning message represents the present stepper valve position.

```
L!Auto!.802v1000  
R!Auto!.802v1000
```

AND

```
L! EXH TEMP LO !  
R! EXH TEMP LO !
```

11.6 Press **ALARM ACK** and the alarm LED which was turned on by the above warning will begin to flash. The low temperature alarm has now been acknowledged and the EPC-110/120 will accept other keypad commands. Any time the alarm LED is on steady, no keypad commands will be accepted until the **ALARM ACK** key is pressed. The display will indicate that the unit is responding to this command with message **WORKING**.

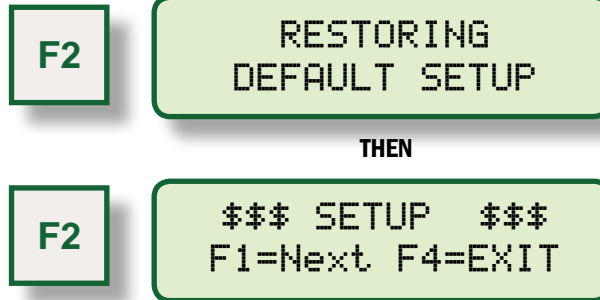
12.0 SETUP MODE: KEYPAD AND DISPLAY OPERATION

NOTE: all screens in setup mode include the \$ character.

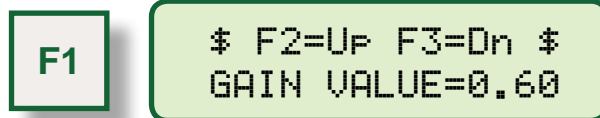
12.1 Once the alarm LED is no longer on steadily, press **F1** followed by **F3** followed by **F2** followed by **F4**. This is the setup mode entry key sequence. The display will indicate that the setup mode is now active.

\$\$\$ SETUP \$\$\$
F1=Next F4=EXIT

12.2 Press **F2** then press **F2** again to restore factory default parameters. This special command can be used only from this screen when the user wants to restore factory default values. A message will indicate that the default values have been restored, then will return to the main setup message. **NOTE DEFAULT VALUES LISTED IN SECTION 9.2**

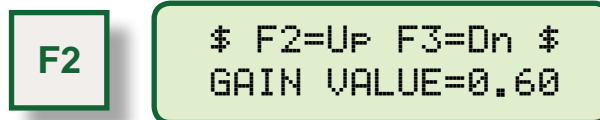


12.3 Press **F1** to increment to the control gain setup screen. The factory default value for this parameter is 0.50 as shown on the display. This parameter determines the stepper valve adjustment rate when in automatic mode. The higher the value the faster the controller will move the stepper in response to the O2 sensor.



NOTE: Multiple presses of the key are required to continue incrementing the value. If the key is held, the value will be adjusted at a progressively faster rate.

12.4 Press **F2** to increase the value for the gain parameter. The display will indicate that the value has been changed. At this point the value is updated and will be used until the value is changed again.



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- 12.5** Press **F3** to decrease the value. Now the value is decreased to the default value again. The range for the gain value is limited to (0.1 to 2.0). The value cannot be moved beyond its limits.

F3 \$ F2=Up F3=Dn \$
GAIN VALUE=0.50

- 12.6** Press **F1** to increment to the left O2 Target setup screen. The factory default value for this parameter is 0.80 volts as shown on the display. Like the gain value, the target can be increased and decreased with the **F2** and **F3** keys. The typical range is near 0.8 volts. The allowable range is 0.01 to 1.05; however most sensor's output range is limited to 0.1 to 0.9 volts.

F1 \$ F2=Up F3=Dn \$
L02SetPnt=0.800v

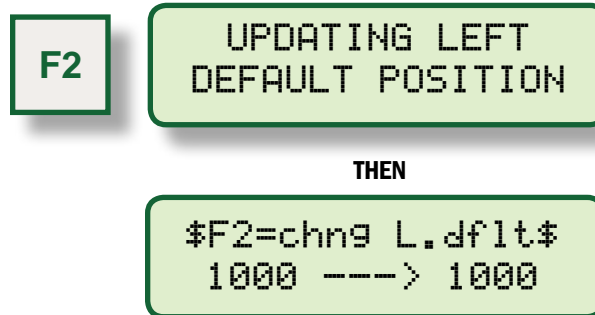
- 12.7** Press **F1** to move to the right O2 Target setup screen. This screen functions just like the one described in section 12.6 for the left bank. In a single bank application, this set-up screen would be skipped.

F1 \$ F2=Up F3=Dn \$
R02SetPnt=0.800v

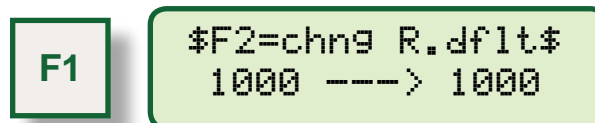
- 12.8** Press **F1** to rotate to the left default stepper position screen. The default position is used when any of the O2 sensor or thermocouple diagnostics are active. The number on the right is the current default position. Because the temperature diagnostic is still active, the actual stepper position on the left is also 1000.

F1 \$F2=chn9 L.dflt\$
1000 ---> 1000

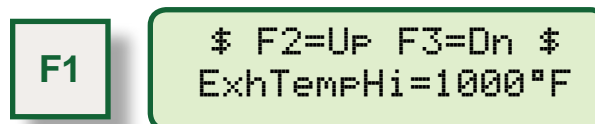
- 12.9** Press **F2** to update the default position (on right) with the value of the current position (on left). Since both values are the same no change was actually made in this example. By using the manual mode which is **DESCRIBED IN SECTION 15.0**, the actual position can be adjusted to the desired position before entering the setup mode.



- 12.10** Press **F1** to move to the right default stepper position screen. This screen functions just like the one described in section 12.7 for the left bank. In a single bank application, this set-up screen would be skipped.

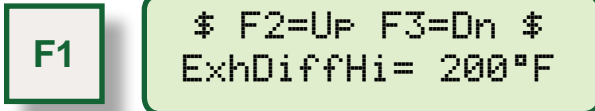


- 12.11** Press **F1** to rotate to the first temperature protection setup value. The **EXHAUST TEMPERATURE HI** setpoint represents the maximum permitted engine exhaust temperature as sensed by the left and right (dual bank) thermocouples mounted near the O2 sensors. High temperatures at these locations may indicate engine overload or engine misfire. The **CATALYST TEMP ALARM** output as well as the **ALARM** output switch will open if this threshold is exceeded to cause a protection shutdown. The same value is used to test both left and right bank temperatures.

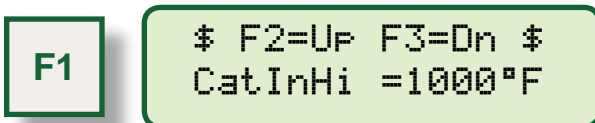


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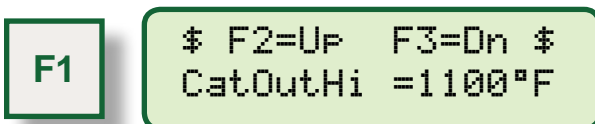
- 12.12** Press **F1** to rotate to **LVS R EXHAUST TEMPERATURE DIFFERENCE HI** setting. For dual bank applications, the absolute difference between the left and right bank thermocouples will be compared to this threshold. If the temperature difference exceeds the setpoint, then the **CATALYST TEMP ALARM** output as well as the **ALARM** output switch will open to cause a protection shutdown. A condition of misfire or improper bank to bank engine balance are potential conditions identified by this test.



- 12.13** Press **F1** to display the **CATALYST-IN HI** temperature setpoint threshold. If the inlet temperature to the Catalyst should exceed this setting, then the **CATALYST TEMP ALARM** output as well as the **ALARM** output switch will open to cause a protection shutdown. Conditions of misfire or overload or improper engine operation may be identified by this test. Extreme temperature at the inlet to the catalyst will lead to premature failure of the catalyst element and its support structure. Consult the catalyst manufacturer for the recommended inlet temperature shutdown limits.



- 12.14** Press **F1** to display the **CATALYST-OUT HI** temperature setpoint threshold. If the outlet temperature of the Catalyst should exceed this setting, then the **CATALYST TEMP ALARM** output as well as the **ALARM** output switch will open to cause a protection shutdown. Conditions of misfire or overload or improper engine operation may be identified by this test. Extreme temperature at the outlet of the catalyst indicates that the catalyst is being damaged by the operation conditions of the engine. Provision may be provided in the catalyst to mount a temperature probe at the catalyst element. This location may serve as an alternative to catalyst outlet temperature. Consult the catalyst manufacturer for the recommended outlet-temperature shutdown limits.



12.15 Press **F1** to display the **CATALYST TEMPERATURE RISE HI** setpoint threshold. The temperature difference Outlet – Inlet is compared to this setpoint to identify excessive temperature rise across the catalyst. This condition of temperature rise is an indication that the catalyst is reacting unburned air and fuel that may result from a misfire or condition. If the temperature rise across the Catalyst should exceed this setting, then the **CATALYSTTEMPALARM** output as well as the **ALARM** output switch will open to cause a protection shutdown. Consult the catalyst manufacturer for the recommended temperature rise shutdown limits.

F1 \$ F2=Up F3=Dn \$
CatRiseHi= 100°F

12.16 Press **F1** to display the **NUMBER OF BANKS** setting screen. Should a dual bank EPC-110/120 be applied to a single bank application, this screen provides the opportunity to select the single bank operation mode. This setup value is not presented on the single bank EPC-110/120 model.

F1 \$ F2=Up F3=Dn \$
Number Banks = 2

12.17 Press **F1** to display the **MODBUS NODE ID** setup screen. Valid node ID's are 1 to 250 permitting the communication system to incorporate multidrop communications to various ModBus slave devices.

F1 \$ F2=Up F3=Dn \$
ModBus ID=100

12.18 Press **F1** to display the **MODBUS PORT** setup screen. Various baud rates and parity modes are supported by the EPC-110/120. The selections include baud rates of (300, 600, 1200, 4800, 9600, 19200, 38400, 57600). The selection of parity includes (Even, Odd and None). The selection of port types includes (RS485 and RS232, both support half-duplex ModBus RTU).

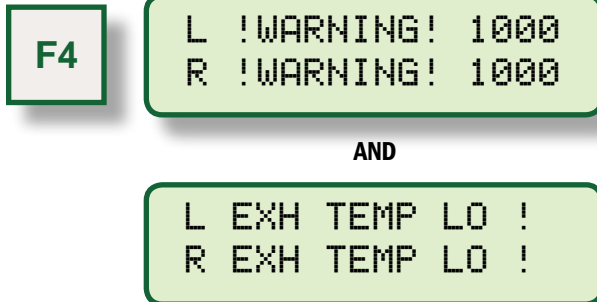
F1 \$ F2=Up F3=Dn \$
485ModBus9600n81

12.19 Press **F1** to rotate back to the main screen.

F1 \$\$\$ SETUP \$\$\$
F1=Next F4=EXIT

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12.20 Press **F4** to exit the setup mode. **F4** can be used from any setup screen. Remember all setup screens have the **\$** character on them somewhere. This returns the display to the warning message which was caused by low exhaust temperatures.



Note: Loading default settings as shown in section 12.2 does not affect settings relating to the Catalyst Temp Alarm Output or ModBus configuration.

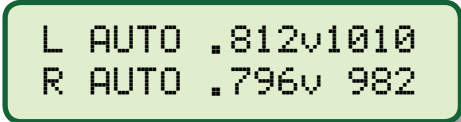
13.0 ENGINE STARTUP: KEYPAD AND DISPLAY OPERATION

13.1 Press **ALARM ACK** to acknowledge alarms if alarm LED is **ON**.

13.2 Press **F1** then press **START POS** to send the steppers to start position (stepper default position) and disable the alarm warnings for 10 minutes. The controller will return each stepper to its start position and then display the warm-up screen. This procedure should **ALWAYS** be used when starting the engine.



13.3 Now the engine should be started, warmed up and loaded. Temperature requirements would be met before the 10 minute delay expires and the controller would go into automatic control. Both the current left O2 sensor voltage, and the current left stepper valve position are provided on the automatic display screen.



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14.0 DATA VIEWING: KEYPAD AND DISPLAY OPERATION

14.1 Press **DSPL SEL** to display the first data view screen. The first data screen displays the current O2 sensor voltages.

DSPL SEL

DUAL BANK

```
L O2Sensor=.812v
R O2Sensor=.796v
```

SINGLE BANK

```
AUTO .625v 985
O2Sensor=.625v
```

14.2 Press **DSPL SEL** again to display current O2 target voltages.

DSPL SEL

DUAL BANK

```
L O2Target=.800v
R O2Target=.800v
```

SINGLE BANK

```
AUTO .625v 985
O2Target=.800v
```

14.3 Press **DSPL SEL** again to display the exhaust temperature readings from the thermocouples near the O2 sensors.

DSPL SEL

DUAL BANK

```
L EXH TMP=1024°F
R EXH TMP=1049°F
```

SINGLE BANK

```
AUTO .625v 985
EXH TMP=1049°F
```

14.4 Press **DSPL SEL** again to display the Catalyst temperatures.

DUAL OR SINGLE BANK

DSPL
SEL

Cat Rise=+ 24°F
In=1098 Out=1125

14.5 Press **DSPL SEL** again to loop back to the automatic screen.

DUAL BANK

DSPL
SEL

L AUTO .811v1010
R AUTO .796v 982

SINGLE BANK

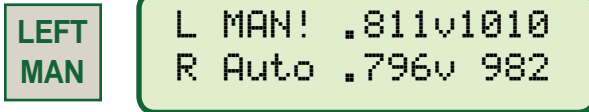
DSPL
SEL

AUTO .811v1010

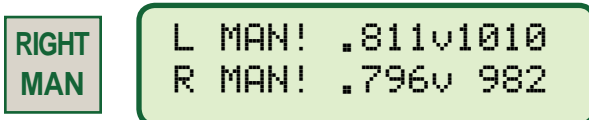
EPC-110/120 AIR-FUEL CONTROLLER

15.0 MANUAL MODE: KEYPAD AND DISPLAY OPERATION

15.1 Press **LEFT MAN** to enter the manual mode for the left bank. The display will indicate **WORKING** and then return with the left bank in manual mode. This mode can be used to help setup the controller, and to diagnose problems. Because no diagnostic alarms are present, it was not necessary to acknowledge alarms. Also, once in manual mode, diagnostic alarms for that bank are disabled. The alarm LED will flash while in manual mode to serve as a reminder that the EPC-110/120 is not in automatic control.

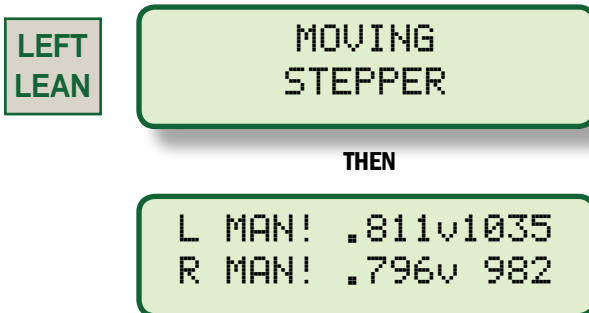


15.2 Press **RIGHT MAN** to enter the right bank manual mode.

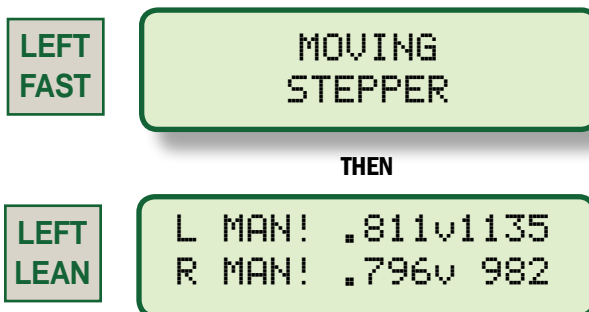


NOTE: Both the **ALARM LED** and the **ALARM output** return to the normal condition when the system fault is corrected.

15.3 Press **LEFT LEAN** to increase the stepper position by 25 steps. A descriptive message will be displayed and then the modified position will be returned. Increasing the position causes the valve to close and the mixture to change in the lean direction.



15.4 Press **LEFT FAST**, then press **LEFT LEAN** to increase the stepper position by 100 steps.



NOTE: When **F1** then **START** are pressed before starting the engine, the exhaust temperature diagnostic will be delayed 10 minutes displaying the warm-up screen.

- 15.5** Press **LEFT RICH** to decrease the stepper position by 25 steps. Decreasing the position causes the valve to open and the mixture to change in the rich direction. These same commands are used to operate the right bank using the **RIGHT LEAN**, **RIGHT RICH** and **RIGHT FAST** keys.

LEFT RICH MOVING STEPPER

THEN

LEFT MAN L MAN! .811v1110
R MAN! .796v 982

- 15.6** Press **AUTO OPER** to return to automatic mode. Any time this key is pressed, automatic mode will be enabled for both banks.

AUTO OPER L AUTO .811v1110
R AUTO .796v 982

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16.0 DIAGNOSTIC DISPLAYS AND OPERATION

16.1 ALARM LED AND ALARM OUTPUT

The **ALARM** LED and **ALARM** output operate in conjunction with the diagnostic features of the EPC-110/120. The three operation modes of these alarm features are described below:

A. Alarm LED OFF

Indicates that the unit is operating correctly in automatic mode, or in warm-up mode waiting for the exhaust temperatures to increase.

B. Alarm LED ON Steady

Indicates that the unit is attempting automatic control; however one of the diagnostic criteria has not been satisfied. The alarm indicator will stay on solid until the alarm acknowledge key is pressed at which time the LED will flash. A solid on yellow LED also indicates that the alarm output terminal is in its alarm state.

C. Alarm LED Flashing

Indicates one of two things; either an acknowledged alarm condition still exists, or the unit is in manual operation mode. The flashing LED should simply signify to the operator that the unit is not in normal automatic control. The alarm output terminal is in its normal state if the LED is flashing.

16.2 ALARM OUTPUT

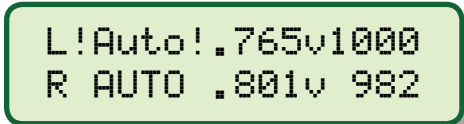
The **ALARM** output is configured as a **NORMALLY CLOSED** output signal. Any system fault will open the alarm circuit including loss of power, diagnostic warnings, etc. As described above, the alarm output would be in its fault condition (open) any time that the alarm indicator on the front panel is **ON** solid.

16.3 SYSTEM DIAGNOSTICS

The system diagnostics included in the EPC-110/120 are designed to identify conditions which are not considered normal operation. These diagnostic tests are performed continuously while the controller is in automatic mode. Each of the diagnostics will display a descriptive message, turn on the **ALARM LED (YELLOW)** and place the alarm output in the fault condition (**OPEN**).

16.4 DIAGNOSTIC WARNING MESSAGES

Active diagnostic warning messages include the **!** character and are displayed in rotation, each message being displayed for about 1 second. The home screen uses the **!** character to indicate the status and that other diagnostics will follow in rotation.



16.5 EXHAUST TEMPERATURE

The Exhaust Temperature diagnostic monitors the exhaust temperatures near the O₂ sensors as measured with the thermocouples. If the temperature is below 650°F or above 1400°F, then the EPC-110/120 displays the appropriate low or high message and activates the **ALARM** LED and **ALARM** output. Automatic control is also disabled and the stepper valves are positioned at the default stepper position. Thermocouple probe or thermocouple connection failures will also activate this diagnostic.



```
L EXH TEMP LO !  
R Auto .800v 982
```

OR



```
L EXH TEMP HI !  
R Auto .800v 982
```

16.6 SENSOR NOT READY

The Sensor Not Ready diagnostic is designed to identify problems with the O₂ sensor. The controller has a very high impedance pull up resistor to 0.5 volts in parallel with each exhaust sensor input. When the sensor is too cool or disconnected this will force the input to read 0.5 volts. If the controller sees that the sensor output is 0.5 volts for 10 or more seconds the EPC-110/120 will display the sensor not ready message and activate the **ALARM** LED and **ALARM** output. Automatic control is also disabled and the stepper valves are moved to the default stepper position. The sensor ready test is only performed if the exhaust temperature requirements of 16.5 are satisfied. Failure of this test indicates a cold, disconnected or failed sensor.



```
L O2 NOT READY !  
R Auto .800v 982
```

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16.7 SENSOR INPUT VOLTAGE

The Sensor Input Voltage diagnostic is also designed to identify problems with the O₂ sensor. Normal input voltages should be between 0.1 and 0.9 volts. If the sensor input voltage is less than 0.1 volts or more than 1.1 volts, the EPC-110/120 will display the appropriate low or high message and activate the **ALARM** LED and **ALARM** output. Automatic control is also disabled, and the stepper valves are moved to the default stepper position. Failure of this diagnostic test indicates shorted wiring or a failed sensor.

```
L O2 SIGNAL LO!  
R Auto .800v 982
```

OR

```
L O2 SIGNAL HI!  
R Auto .800v 982
```

16.8 LEAN AND RICH LIMIT

The Lean and Rich Limit diagnostic monitors the stepper positions. If the position of a stepper valve is at the minimum (0) or maximum (1700) travel limit, the EPC-110/120 displays the appropriate message and activates the **ALARM** LED and **ALARM** output. The rich limit warning indicates that the engine is too lean and the controller cannot open the valve any further to enrich the mixture. The lean limit warning indicates that the engine is too rich and the controller cannot close the valve any further.

```
L RICH LIMIT !  
R Auto .800v 982
```

OR

```
L LEAN LIMIT !  
R Auto .800v 982
```

16.9 ENGINE OUT EXHAUST OVER-TEMPERATURE

When the left or right bank exhaust temperature exceeds the setup threshold, the alarm output will open, the alarm LED will turn on, the Catalyst Protection Alarm output (PSD) will open, and the messages below may be displayed.

DUAL BANK

```
!L ExhTempHiPSD!  
R AUTO!WARN! 875
```

OR

```
L AUTO!WARN! 905  
!R ExhTempHiPSD!
```

SINGLE BANK

```
AUTO!WARN! 905  
!L ExhTempHiPSD!
```

16.10 ENGINE OUT EXHAUST DIFFERENTIAL

On a dual bank application, when the engine exhaust temperature differential between the banks exceeds the setup threshold, the alarm output will open, the alarm LED will turn on, the Catalyst Protection Alarm output (PSD) will open and the message below is displayed.

```
!LvsR Delta PSD!  
!LvsR Delta PSD!
```

16.11 CATALYST INLET OVERTEMP OVER-TEMPERATURE

When the inlet temperature of the catalyst exceeds the setup threshold, the alarm output will open, the alarm LED will turn on, the Catalyst Protection Alarm output (PSD) will open and the message below is displayed.

```
L AUTO!WARN! 905  
!CatInTempHiPSD!
```

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16.12 CATALYST OUTLET OVER-TEMPERATURE

When the outlet temperature of the catalyst exceeds the setup threshold, the alarm output will open, the alarm LED will turn on, the Catalyst Protection Alarm output (PSD) will open and the message below is displayed.

```
L Auto!WARN!1000  
!CatOutTmPHiPSD!
```

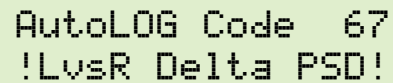
16.13 CATALYST TEMPERATURE RISE

When the temperature from the inlet to the outlet of the catalyst exceeds the setup threshold, the alarm output will open, the alarm LED will turn on, the Catalyst Protection Alarm output (PSD) will open and the message below is displayed.

```
L Auto!WARN!1000  
!CatTmPRise PSD!
```

17.0 AUTOLOG FEATURE

17.1 Press “F3” to display the first out Autolog screen which provides the first most recent detected cause for leaving normal automatic operation. The cause is logged to a modbus register and also presented as below on the screen using a text string. The example below indicates that a difference in the left to right bank temperatures exceeded the setpoint which resulted in a catalyst protection alarm which triggered the snapshot of auto log values. The auto log values are updated on every transition out of fully automatic control without alarms. The table of auto log causes is shown below.



```
AutoLOG Code 67
!LvsR Delta PSD!
```

```
L! EXH TEMP LO !
R! EXH TEMP LO !
L! EXH TEMP HI !
R! EXH TEMP HI !
L! O2 SIGNAL LO!
R! O2 SIGNAL LO!
L! O2 SIGNAL HI!
R! O2 SIGNAL HI!
L! O2 NOT READY!
R! O2 NOT READY!
L! LEAN LIMIT !
R! LEAN LIMIT !
L! RICH LIMIT !
R! RICH LIMIT !
!L EXHTEMPHIPSD!
!R EXHTEMPHIPSD!
!L VSR DELTA PSD!
!CATINTEMPHIPSD!
!CATOUTTMPHIPSD!
!CATTMPRISE PSD!
!L USER MANUAL !
!R USER MANUAL !
```

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17.2 The following screens are viewed in rotation, displaying the next screen on each press of **F3**.

```
AutoLOG EXHtemps  
L 817° R 1021°
```

Identifies the left and right bank temperatures at auto log event.

```
AutoLOG CATtemps  
In 985° Out1057°
```

Identifies catalyst temperatures at auto log event trigger

```
AutoLOG EXH O2V  
L 804v R .799v
```

Identifies O2 voltage measurements at auto log event trigger

```
AutoLOG Steppers  
L 1191 R 990
```

Identifies stepper positions at auto log event trigger

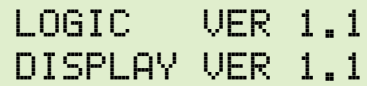
```
AutoLOG Supply V  
5.04vdd 2402v
```

Identifies internal and supply voltage at auto log event trigger

18.0 ADDITIONAL DISPLAY SCREENS

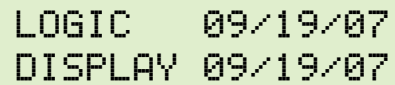
18.1 Three additional screens exist which can be helpful in obtaining information about the version and supply voltage and temperature of the EPC-110/120. They can be viewed as follows.

Press **F1** then **DISP-SEL**, to view the version number of EPC-110/120 firmware.




```
LOGIC   VER 1.1  
DISPLAY VER 1.1
```

Press **F2** then **DISP-SEL**, to view the version date of EPC-110/120 firmware.



```
LOGIC   09/19/07  
DISPLAY 09/19/07
```

Press **F1** then **F2** then **DISP-SEL** to view the supply voltage and temperature.



```
SUPPLY 24.3volts  
Vdd=5.0  23.3°C
```

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19.0 TROUBLE-SHOOTING THE EPC-110/120 SYSTEM

19.1 GREEN LED AND LCD DISPLAY ARE BLANK; POWER IS INTERRUPTED.

- A. Check power supply voltage at EPC terminal block TS2A (18-30 volts), while still connected.
- B. Power down unit, then remove and check resistance of on-board fuses (**F1**) (< 2 ohms).
SEE FIG. 9
- C. Verify tight cable connections between control and display boards.

19.2 DISPLAY READS (EPC Bottom Board **!NOT Running!**); CONTROL BOARD IS NOT RUNNING.

- A. Power-down unit for 1 minute. Re-power, check display and status of **LED1C** on logic board.
- B. **LED LIT AND NOT BLINKING INDICATES:**
 - Firmware mismatch of versions
 - OR**
 - Cable between logic and display loose or broken
 - OR**
 - Display board damaged
 - OR**
 - Logic board damaged
- C. **BLINKING LED INDICATES:**
 - Logic board not running properly.
 - Verify IC in blue socket installed properly.
 - Replace logic board assembly.
- D. **LED NOT LIT INDICATES:**
 - Replace logic board assembly

SEE FIG. 10 OR 12

19.3 DISPLAY TOP ROW IS DARK, BOTTOM ROW IS LIGHT; DISPLAY BOARD IS NOT RUNNING.

- A. Power-down unit for 1 minute. Then re-power and check display.
- B. On back of display board, examine both blue socketed IC's for tight engagement.
- C. Check cable connection between control and display boards.
- D. Replace display board assembly. **SEE FIG. 10 OR 12**

19.4 DISPLAY IS BLANK, BUT GREEN LED IS ON. CONTRAST ADJUSTMENT REQUIRED.

- A. On back of display board adjust contrast potentiometer.
Clockwise = Lighter; Counterclockwise = Darker.
SEE FIG. 10/11 OR 12/13 FOR LOCATION.
- B. Replace display board assembly. **SEE FIG. 10 OR 12**

19.5 KEY PAD ENTRIES CAUSE NO DISPLAY RESPONSE.

- A. At bottom of display board, verify connection of keypad ribbon connector.
- B. Replace enclosure and keypad assembly. **SEE FIG. 10 OR 12**

19.6 ALARM LED IS ON SOLID.

- A. Read the warning message on the display, and reference the diagnostic section for an explanation of the warning.
- B. Press **ALARM ACK** to permit normal keypad operation and to disable the alarm output terminal.

19.7 EPC-110/120 WILL NOT MOVE STEPPER VALVES DURING **F1 THEN START POS. COMMAND.**

- A. Check stepper cable connections at EPC-110/120 and at stepper valve.
- B. Inside EPC-110/120 verify that red LED on control board is **ON**. If LED is off, or flashing check the fuses on the control board.
- C. Examine blue socketed I.C. for tight engagement.
- D. Test EPC-110/120 with a spare stepper valve assembly.
- E. Test EPC-110/120 and stepper valve assembly, with a spare stepper cable.
- F. Replace entire control board assembly. **SEE FIG. 10 OR 12**

19.8 HIGH OR LOW EXHAUST TEMP WARNINGS PERSIST.

- A. Observe thermocouple readings for reasonable values using display select screens in **SECTION 14**.
- B. Compare observed readings to, and verify feasibility of catalyst protection setpoints as described in **SECTION 9.2 (G)**.
- C. If engine is not running, start and warm up engine.
- D. Test the disconnected thermocouple reading at EPC-110/120 with an alternate thermocouple reading device.
- E. Replace thermocouple or correct wiring if temperatures are incorrect. The life of thermocouple probes is highly dependent on the use of a thermowell and on corrosives in exhaust.
- F. If low temperature is a problem during first installation, an alternate sensor and probe location may be required. Please contact the factory before pursuing any other action to raise sensor temps.
- G. Replace entire control board assembly. **SEE FIG. 10 OR 12**

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19.9 RICH OR LEAN LIMIT WARNINGS PERSIST.

- A. A misfiring engine can cause the system to shift in the rich direction. Check the engine for misfiring cylinders using a timing light or exhaust pyrometer.
- B. Use an exhaust analyzer and the EPC-110/120 manual mode to adjust the %O₂ before the converter to around 1.0%. If the %O₂ cannot be manipulated in the manual mode, then test to make sure the stepper valve is functioning as was done during installation.
- C. If manual mode moves the %O₂ but cannot attain 1.0%, then the fuel system may need to be readjusted. First verify that the load screw adjustments on the carburetors are full rich or full open. If they are not full open, the control range of the stepper valves will be limited. Second, adjust the fuel pressure regulators so that when in automatic mode, the stepper valves are controlling near 1000 steps.
- D. If the fuel system appears to be adjusting correctly, use an exhaust analyzer and the EPC-110/120 manual mode to sweep the %O₂ from around 3% down to 0.2% while watching the O₂ sensor voltage on the display. The voltage should move from around 0.2 volts toward 0.8 volts as the %O₂ is changed. If this is not the case, a new sensor should be tested.
- E. If EPC-110/120 O₂ sensor voltage display does not match actual sensor voltage, test for ground loop problems.
DESCRIBED IN SECTION 9.2D.
- F. Replace entire control board assembly. **SEE FIG. 10 OR 12**

19.10 SETUP VALUES ARE LOST AT POWER-DOWN; BATTERY FOR BBRAM IS FAILED.

- A. Replace entire control board assembly. **SEE FIG. 10 OR 12**

20.0 EPC-110/120 MODBUS REGISTER LIST

The EPC-110/120 incorporates a half-duplex RS-485 or RS232 port which is Modbus RTU slave compliant. The protocol used follows the Modicon Modbus RTU standard. A complete listing of the Modbus registers is included on the EPC-110/120 Terminal program CD along with a PC-based Modbus-compatible monitoring program. The default configuration for the port is 9600 baud N81 with a node ID of 100. The Modbus communications will allow the EPC-110/120 to meet the needs of continuous emissions monitoring should it be required.

The 10xxx registers are read-only binary and support Modbus standard function 1. These registers are read in multiples of 8 (1 byte) addressed at each 8 bit boundary (10001-10008, etc.). A single Boolean read from registers 10001 to 10064 can be made which will return all 64 values as a group of 8 bytes. These registers also support an Altronic custom function 101 which will return a descriptive label for each specific register. The custom label function can be used to reduce the need for the Modbus master to maintain a current listing of all of the register labels for each unit.

REGISTER	16-BIT BINARY REGISTER VALUE
10001	Left Bank Manual Override
10002	Right Bank Manual Override
10003	Left Bank Warm-up
10004	Right Bank Warm-up
10005	Left Bank Stepper Resetting
10006	Right Bank Stepper Resetting
10007	Reserved
10008	Unacknowledged Alarm Preset
10009	Left Bank Exh Temp Low
10010	Left Bank Exh Temp High
10011	Left Bank O2 Signal Low
10012	Left Bank O2 Signal High
10013	Reserved
10014	Left Bank O2 sensor Not Ready
10015	Left Bank Stepper Lean Limit
10016	Left Bank Stepper Rich Limit
10017	Right Bank Exh Temp Low
10018	Right Bank Exh Temp High
10019	Right Bank O2 Signal Low
10020	Right Bank O2 Signal High
10021	Reserved
10022	Right Bank O2 sensor Not Ready
10023	Right Bank Stepper Lean Limit
10024	Right Bank Stepper Rich Limit

EPC-110/120 AIR-FUEL CONTROLLER

REGISTER	16-BIT BINARY REGISTER VALUE
10025	Right Bank Step Coil Open Pin C
10026	Right Bank Step Coil Open Pin B
10027	Right Bank Step Coil Open Pin A
10028	Right Bank Step Coil Open Pin F
10029	Left Bank Step Coil Open Pin C
10030	Left Bank Step Coil Open Pin B
10031	Left Bank Step Coil Open Pin A
10032	Left Bank Step Coil Open Pin F
10033	Left Auto Control is Active
10034	Left Getting Richer
10035	Left Very Rich Offset >512 mv
10036	Left Rich
10037	Left On Target +/-5 mv
10038	Left Lean
10039	Left Very Lean Offset >512 mv
10040	Left Getting Leaner
10041	Right Auto Control is Active
10042	Right Getting Richer
10043	Right Very Rich Offset >512 mv
10044	Right Rich
10045	Right On Target +/-5 mv
10046	Right Lean
10047	Right Very Lean Offset >512 mv
10048	Right Getting Leaner
10049	Right Bank Step Coil 1 On
10050	Right Bank Step Coil 2 On
10051	Right Bank Step Coil 3 On
10052	Right Bank Step Coil 4 On
10053	Left Bank Step Coil 1 On
10054	Left Bank Step Coil 2 On
10055	Left Bank Step Coil 3 On
10056	Left Bank Step Coil 4 On
10057	Reserved
10058	Reserved
10059	Reserved
10060	Reserved
10061	Reserved
10062	Reserved
10063	Reserved
10064	Dual Bank System

REGISTER	16-BIT BINARY REGISTER VALUE
10065	TC ENG LEFT HiTemp PSD
10066	TC ENG RGHT HiTemp PSD
10067	TC ENG LvsR HiDelta PSD
10068	TC CAT IN HiTemp PSD
10069	TC CAT OUT HiTemp PSD
10070	TC CAT Delta HiDelta PSD
10071	no function PSD
10072	no function PSD
10089	no function
10090	no function
10091	no function
10092	OUTPUT ALARM legacy ALM +PSD
10093	no function
10094	OUTPUT A CATALYST ALARM
10095	no function
10096	OUTPUT B Auto Operation Active

The 30xxx registers are read-only, 16 bit, analog values. The Modbus standard function 4 is supported. These registers also support an Altronic custom function 104 which will return a descriptive label for each specific register.

REGISTER	16-BIT BINARY REGISTER VALUE
30001	Left Exh TC Temp 1 deg F/cnt
30002	Right Exh TC Temp 1 deg F/cnt
30003	Left Exh O2 Volt 1 mv/cnt
30004	Right Exh O2 Volt 1 mv/cnt
30005	Left Stepper Position
30006	Right Stepper Position
30007	CJT Deg C +/- 0.01 deg C/cnt
30008	Supply Voltage 0.1 v/cnt
30009	Logic Voltage 1 mv/cnt
30010	Left Est. LAMBDA .01/cnt
30011	Right Est. LAMBDA .01/cnt
30012	CATALYST IN TC 1 deg F/cnt
30013	CATALYST OUT TC 1 deg F/cnt
30030	EXHAUST TEMP DELTA LEFT-RGHT
30031	CATALYST TEMP RISE (OUT-IN)
30101	CJT Comp 1 uv/cnt
30102	A/D 0 Filtr 2.5 v reference
30103	A/D 1 Filtr supply voltage
30104	A/D 2 Filtr vss
30105	A/D 3 CJT

EPC-110/120 AIR-FUEL CONTROLLER

REGISTER	16-BIT BINARY REGISTER VALUE
30106	A/D 4 O2 Right Legacy
30107	A/D 5 O2 Left Legacy
30108	A/D 6 TC Right Legacy
30109	A/D 7 TC Left Legacy
30110	A/D 8 TC Right Aux
30111	A/D 9 TC Left Aux
30127	Warm-Boot Counter
30128	Cold-Boot Counter

The 40xxx registers are read/write, 16-bit, analog values and they support the Modbus standard functions 3, 6 and 16. These registers may have new values written to them in order to make setpoint adjustments from a remote location. They also support a custom function 103 which will return a label describing each specific register.

REGISTER	16-BIT BINARY REGISTER VALUE
40001	Left Bank O2 Target mV
40002	Right Bank O2 Target mV
40003	Left Bank Start Position steps
40004	Right Bank Start Position steps
40005	Control Gain Rate value/40
40006	Exh Temp HI Alarm deg F
40007	Exh Temp LO Alarm deg F
40008	Exh O2 HI Alarm Setpoint mV
40009	Exh O2 LO Alarm Setpoint mV
40010	Exh O2 Ready HI Setpoint mV
40011	Exh O2 Ready LO Setpoint mV
40012	TC ENGOUT HI PSD degF
40013	TC ENG LvsR HI PSD degF
40014	TC CAT IN HI PSD degF
40015	TC CAT OUT HI PSD degF
40016	TC CAT DELTA HI PSD degF
40125	EPC 110/120 SELECT BITS
40126	Modbus Port Config Code
40127	Modbus Node ID / Slave ID
40128	Modbus Key Command Register

Detailed below are the command values which can be written to the Modbus Key Command Register (40128).

1. Reg(40128) 00510 Select auto mode for both banks
2. Reg(40128) 00765 Select manual mode for left bank
3. Reg(40128) 01020 Select manual mode for right bank
4. Reg(40128) 01275 F1-Start stepper reset
5. Reg(40128) 01530 Alarm acknowledge
6. Reg(40128) 01785 Decrement left O2 target
7. Reg(40128) 02040 Increment left O2 target
8. Reg(40128) 02295 Decrement right O2 target
9. Reg(40128) 02550 Increment right O2 target
10. Reg(40128) 02805 Decrement control gain rate
11. Reg(40128) 03060 Increment control gain rate
12. Reg(40128) 03315 Reload calibration defaults
13. Reg(40128) 03570 Update left start position with current pos
14. Reg(40128) 03825 Update right start position with current pos
20. Reg(40128) 05355 Manual move left stepper rich (- 25)
21. Reg(40128) 05610 Manual move left stepper lean (+ 25)
22. Reg(40128) 05865 Manual move left stepper rich (-100)
23. Reg(40128) 06120 Manual move left stepper lean (+100)
24. Reg(40128) 06375 Manual move right stepper rich (- 25)
25. Reg(40128) 06630 Manual move right stepper lean (+ 25)
26. Reg(40128) 06885 Manual move right stepper rich (-100)
27. Reg(40128) 07140 Manual move right stepper lean (+100)

The EPC-110/120 units also support a Modbus function 17 which will return the unit information including the Version, Date and Name.

30. Reg(40128) 07905 decrement Hi Exhaust Temp Threshold
31. Reg(40128) 08160 increment Hi Exhaust Temp Threshold
32. Reg(40128) 08415 decrement Hi Exhaust Temp Delta Threshold
33. Reg(40128) 08670 increment Hi Exhaust Temp Delta Threshold
34. Reg(40128) 08925 decrement Hi Catalyst Temp In Threshold
35. Reg(40128) 09180 increment Hi Catalyst Temp In Threshold
36. Reg(40128) 09435 decrement Hi Catalyst Temp Out Threshold
37. Reg(40128) 09690 increment Hi Catalyst Temp Out Threshold
38. Reg(40128) 09945 decrement Hi Catalyst Rise Temp Threshold
39. Reg(40128) 10200 increment Hi Catalyst Rise Temp Threshold
199. Reg(40128) 51118 autolog reset
200. Reg(40128) 51256 increase modportcfg
201. Reg(40128) 51511 decrease modportcfg
202. Reg(40128) 51766 increase modidcode
203. Reg(40128) 52021 decrease modidcode

EPC-110/120 AIR-FUEL CONTROLLER

FIGURES SECTION:

FIG. 1 EPC-110/120 GENERAL INSTALLATION LAYOUT: SINGLE BANK

FIG. 2 EPC-110/120, GENERAL INSTALLATION LAYOUT: DUAL BANK

FIG. 3 MOUNTING DETAIL, EPC-110

FIG. 4 MOUNTING DETAIL, EPC-120

FIG. 5 OXYGEN SENSOR DETAIL

FIG. 6 EPC-110/120, WIRE ROUTING DETAIL

FIG. 7 EPC-110/120, MODBUS COMMUNICATION CONNECTIONS

FIG. 8 EPC-110/120, TERMINAL LAYOUT

FIG. 9 TYPICAL O₂ SENSOR RESPONSE (ESTIMATED DATA)

FIG. 10 EPC-110 PARTS BREAKDOWN

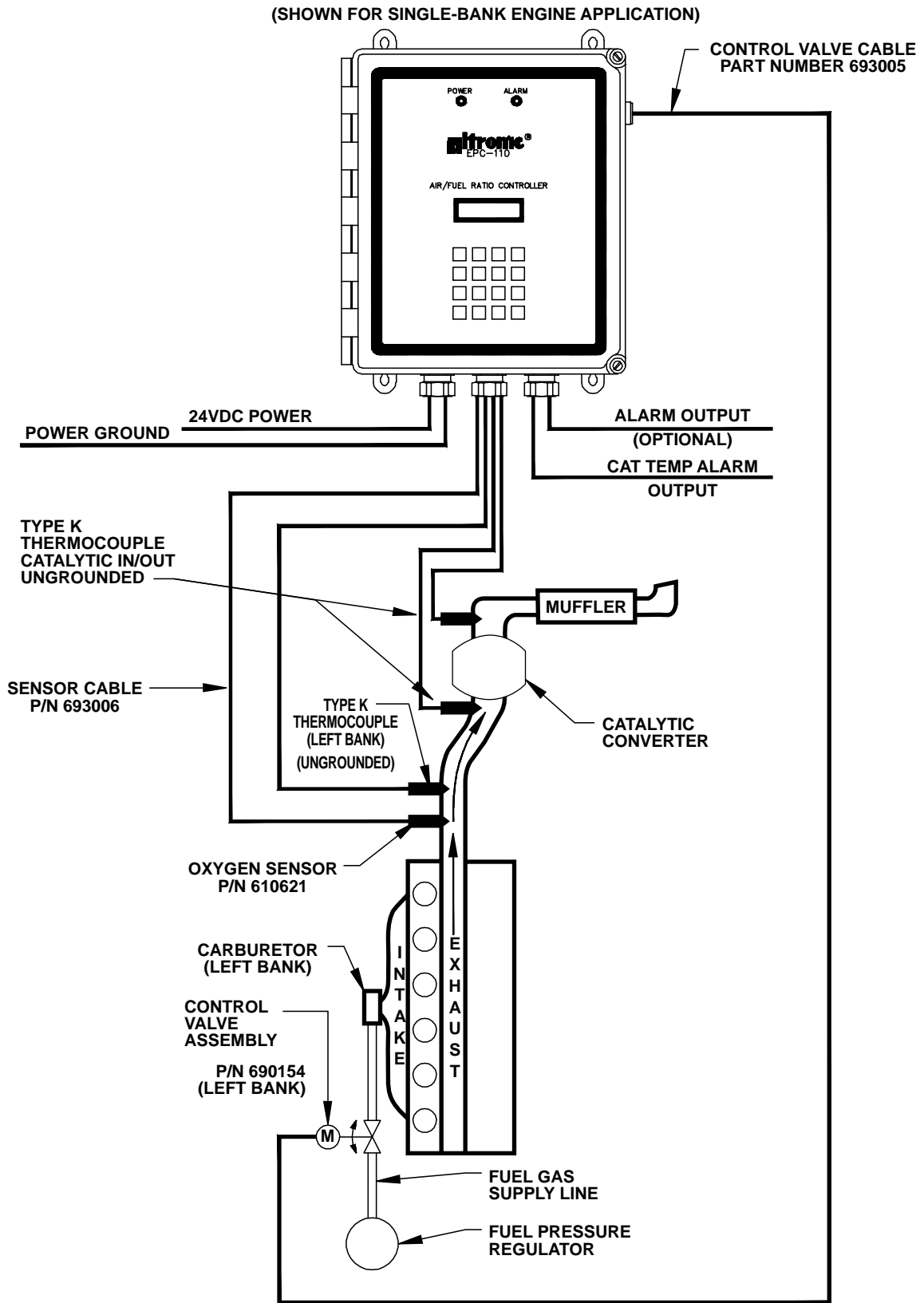
FIG. 11 EPC-110 PARTS IDENTIFICATION

FIG. 12 EPC-120 PARTS BREAKDOWN

FIG. 13 EPC-120 PARTS IDENTIFICATION

FIG. 14 EPC-110/120 ACCESSORY KIT IDENTIFICATION

FIG. 1 EPC-110/120 GENERAL INSTALLATION LAYOUT: SINGLE BANK



EPC-110/120 AIR-FUEL CONTROLLER

FIG. 2 EPC-110/120, GENERAL INSTALLATION LAYOUT: DUAL BANK

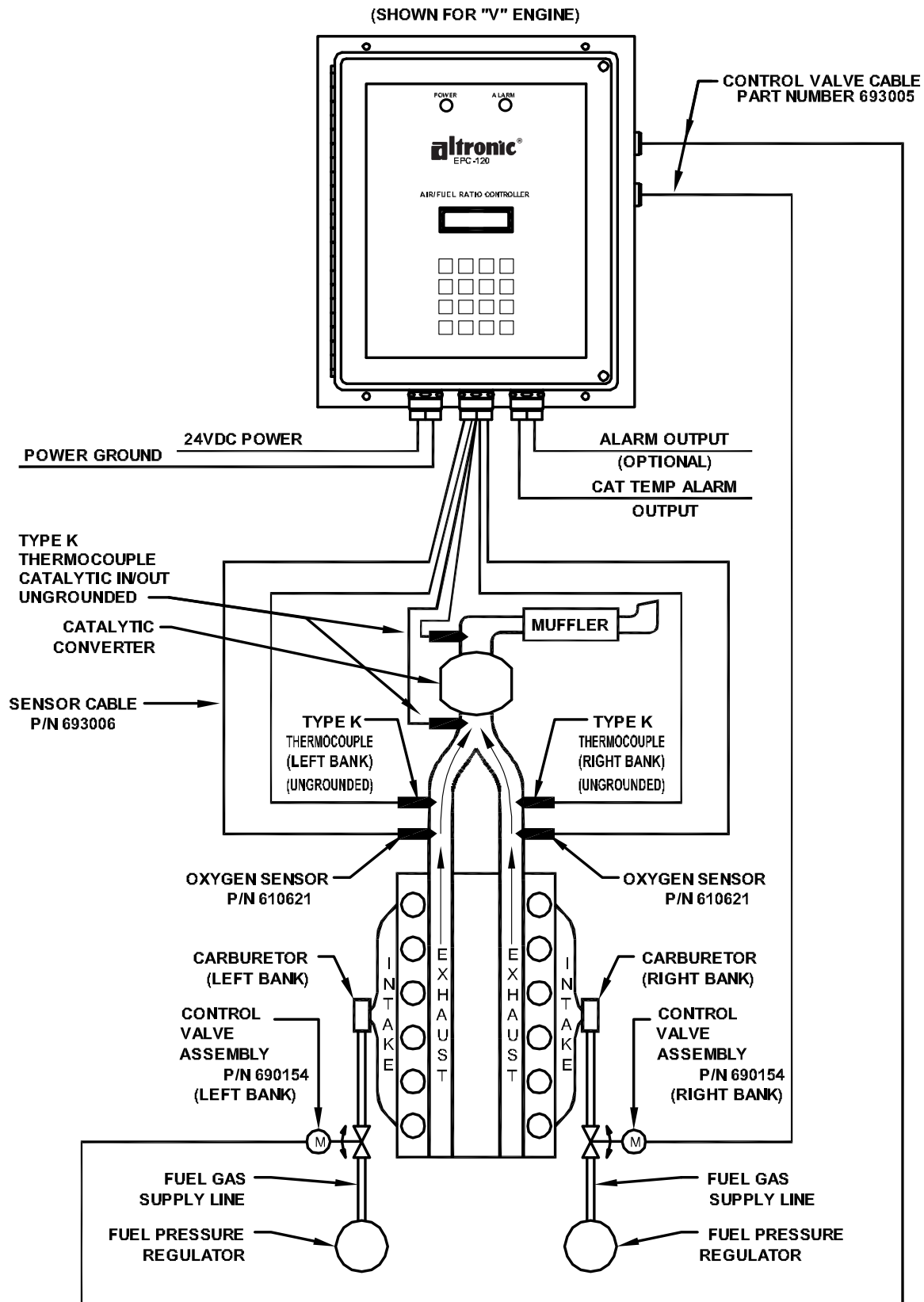
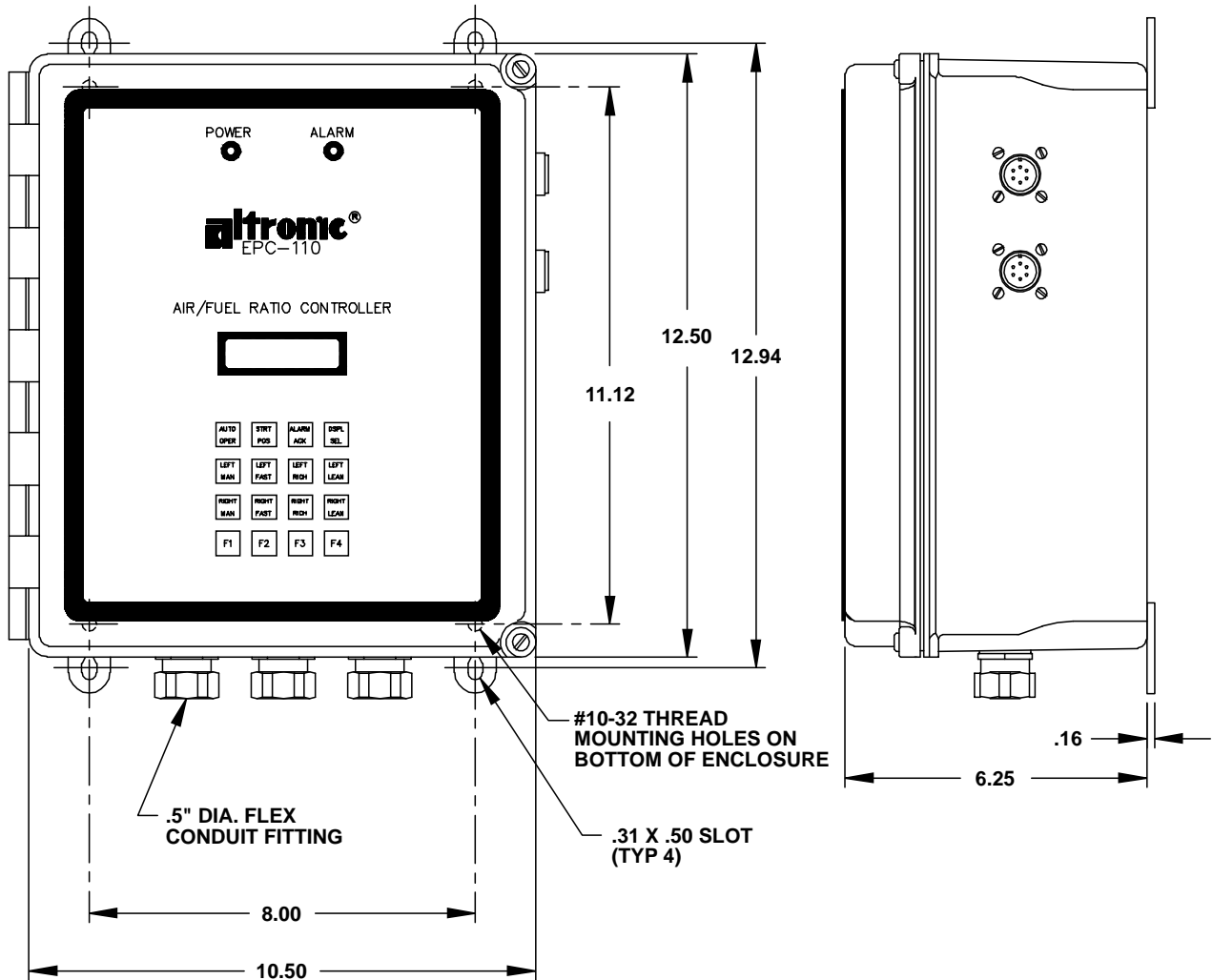
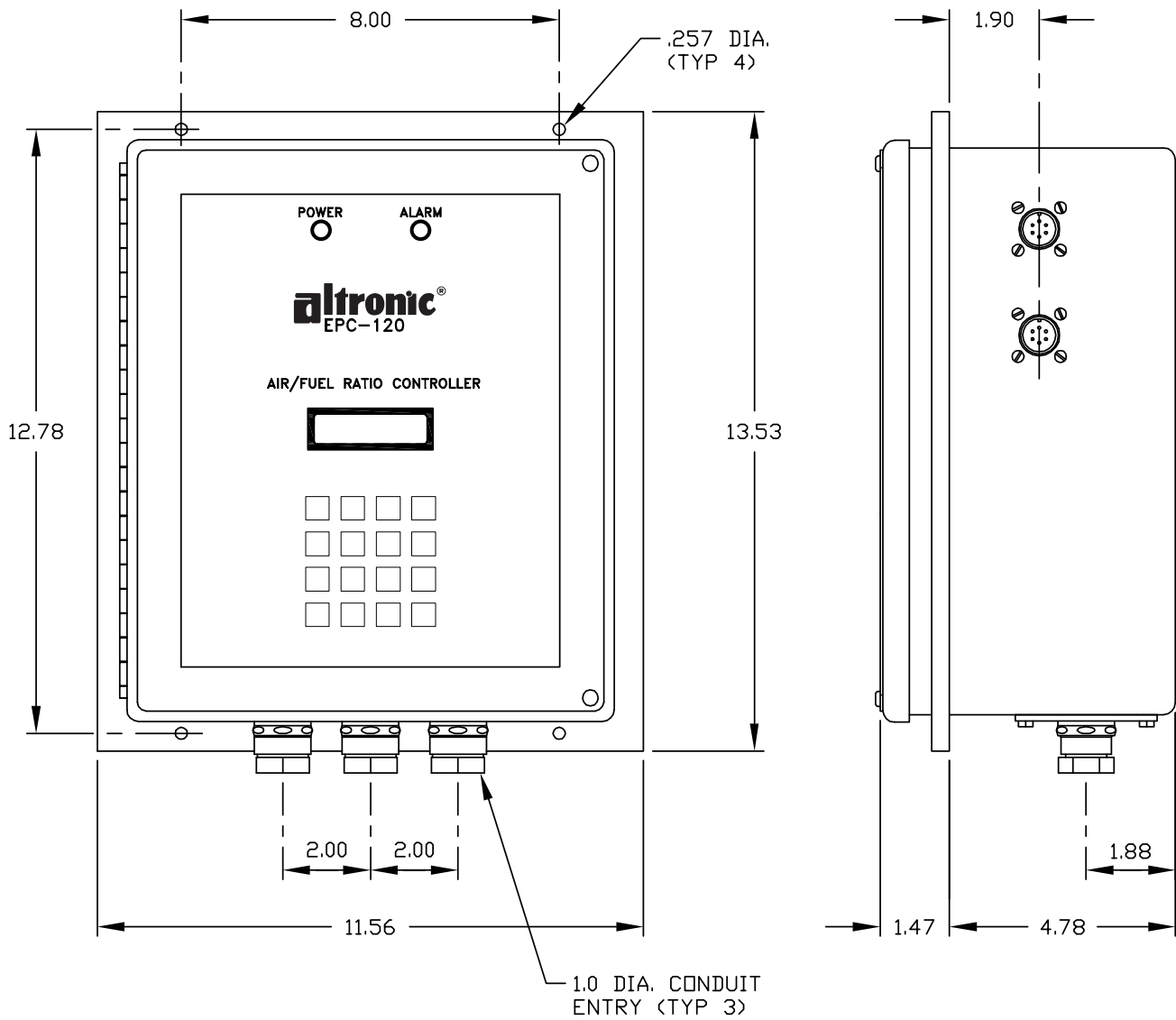


FIG. 3 MOUNTING DETAIL, EPC-110



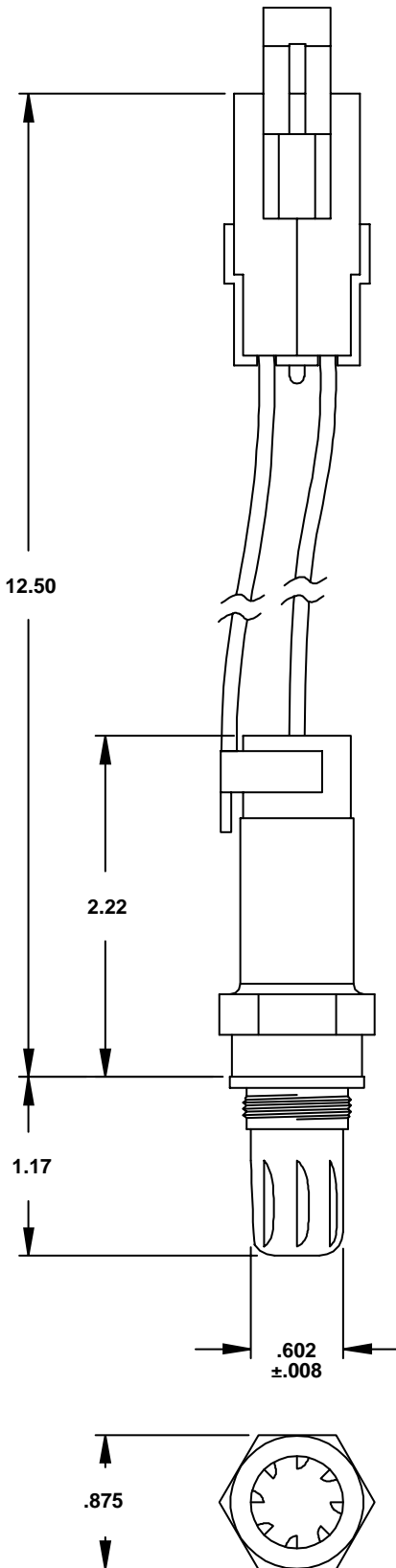
EPC-110/120 AIR-FUEL CONTROLLER

FIG. 4 MOUNTING DETAIL, EPC-120



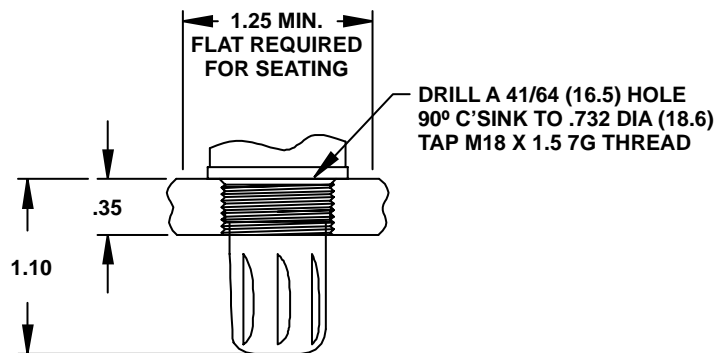
NOTE: PANEL CUT-OUT IS 10.12 X 12.12.
ALL DIMENSIONS ARE IN INCHES.

FIG. 5 OXYGEN SENSOR DETAIL



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

MATING CONNECTOR:
PACKARD ELECTRIC DIV. PART NO. 12010501



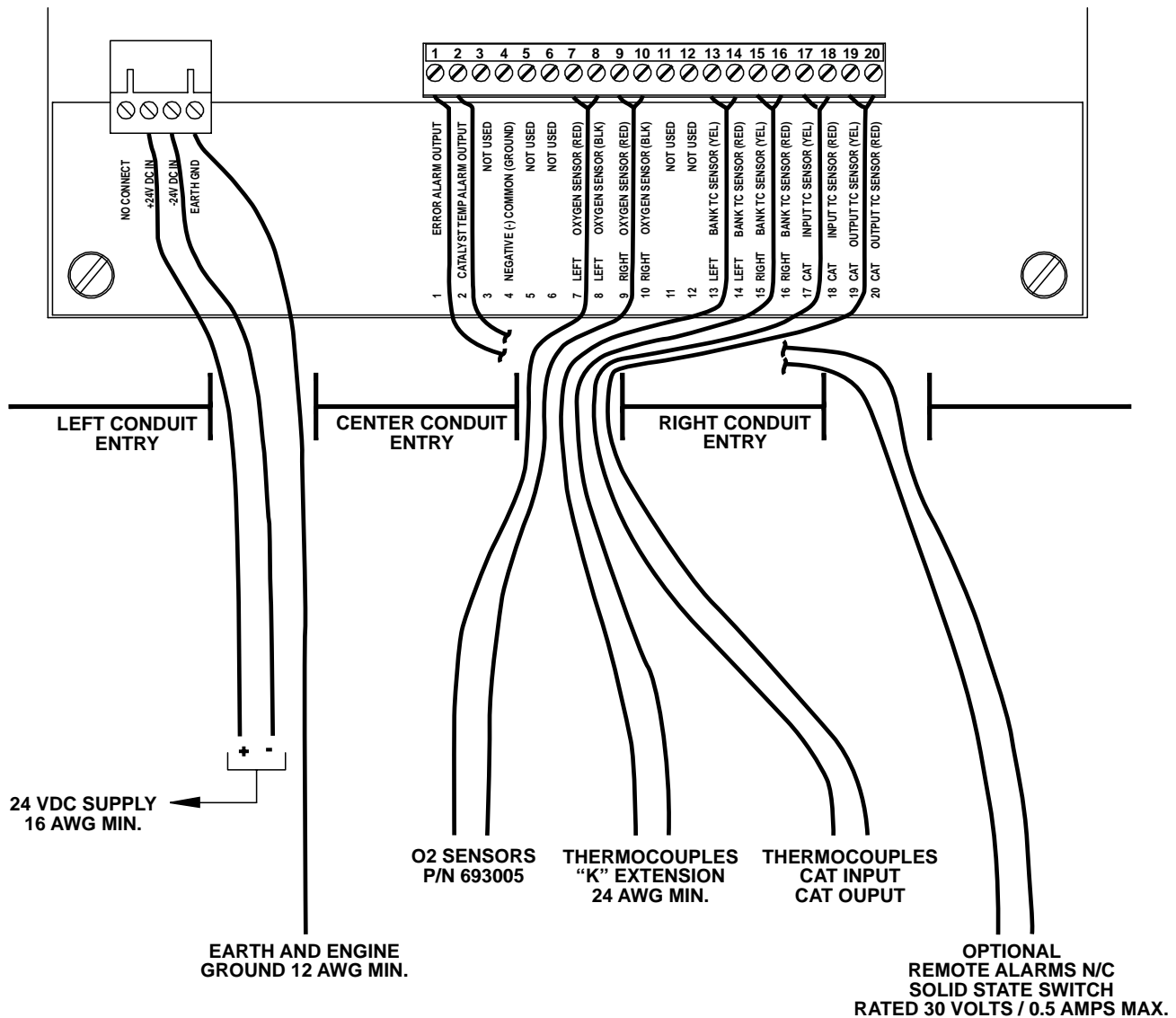
RECOMMENDED INSTALLATION DIMENSIONS

INSTALLATION INSTRUCTIONS:

1. INSTALL IN THE APPROPRIATE MOUNTING HOLE TO A TORQUE OF 28-34 LB. FT.
2. USE A 7/8" WRENCH SIZE.
3. SENSORS ARE TO BE SUPPLIED WITH THREADS COATED WITH MS-0572 ANTISEIZE COMPOUND. CAUTION: DO NOT APPLY ANTISEIZE COMPOUND TO AREAS OTHER THAN THE MOUNTING THREADS.
4. FOR OPTIMUM RESISTANCE TO WATER INTRUSION, AC RECOMMENDS MOUNTING SENSORS SUCH THAT THE EXPOSED END (WIRE END) OF THE SENSOR IS ORIENTED AT OR ABOVE HORIZONTAL.
5. THIS SENSOR IS DESIGNED FOR WATER SPLASH RESISTANCE.

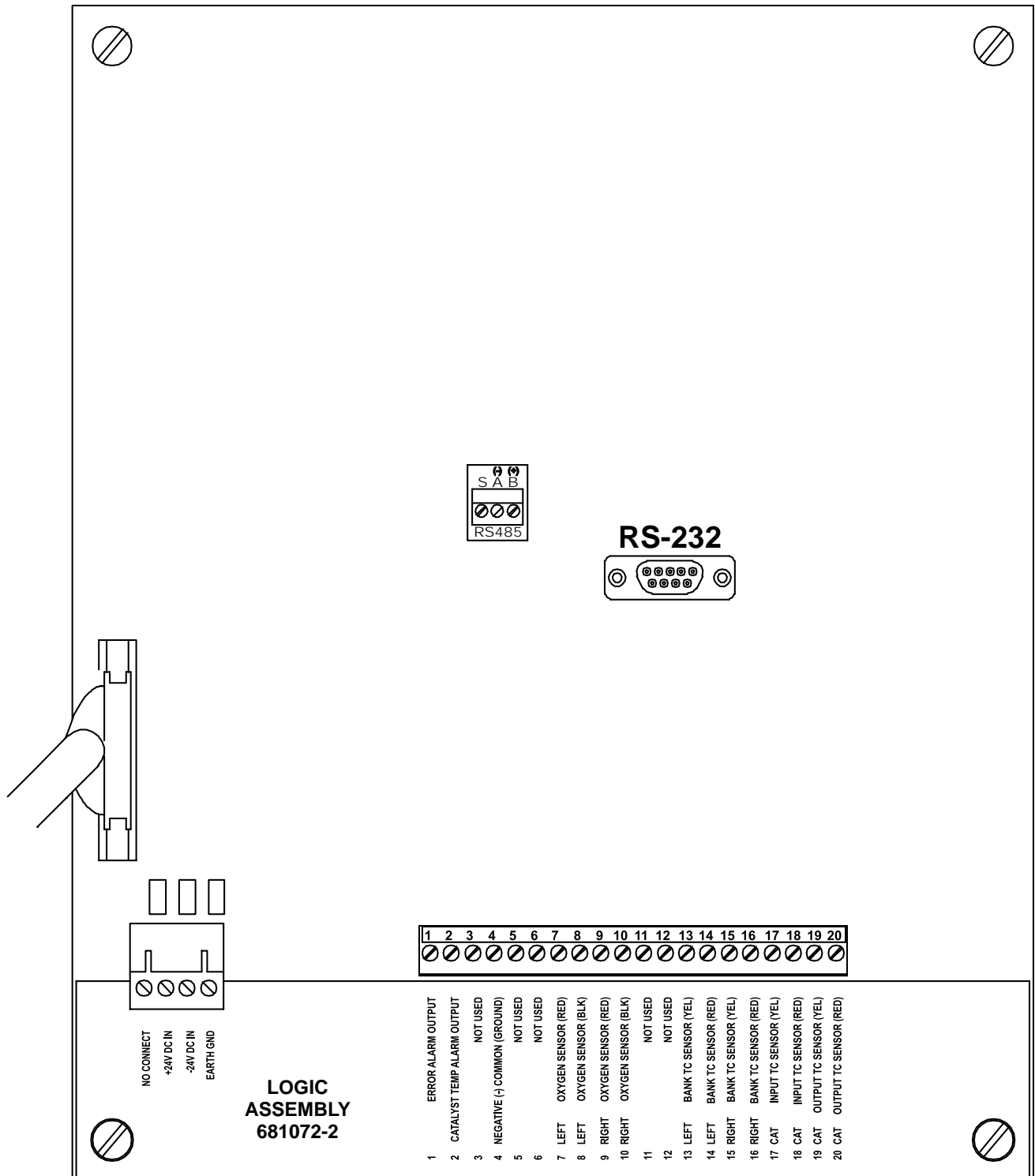
EPC-110/120 AIR-FUEL CONTROLLER

FIG. 6 EPC-110/120, WIRE ROUTING DETAIL



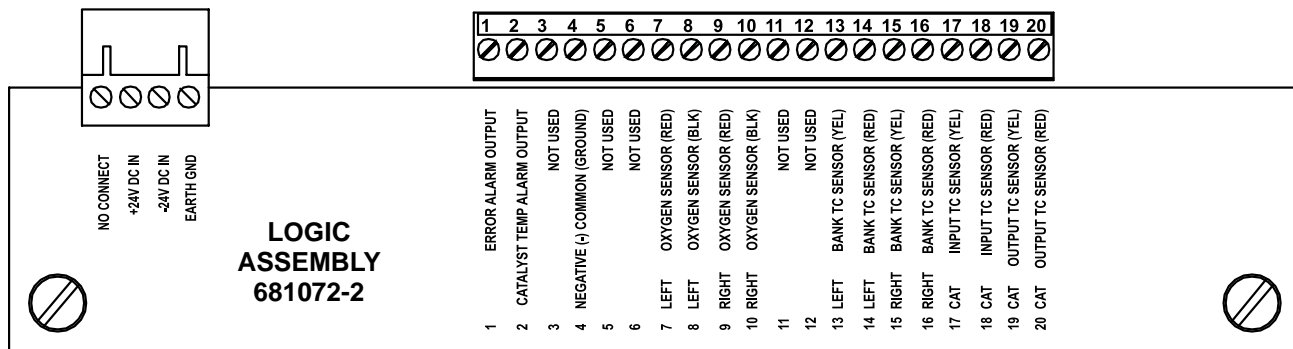
NOTE: DO NOT ROUTE WIRES INTO UNIT IN ANY OTHER MANNER. MAINTAIN SEPARATION AFTER LEAVING ENCLOSURE. IF CONDUIT IS USED, THREE SEPARATE CONDUITS ARE REQUIRED.

FIG. 7 EPC-110/120, MODBUS COMMUNICATION CONNECTIONS



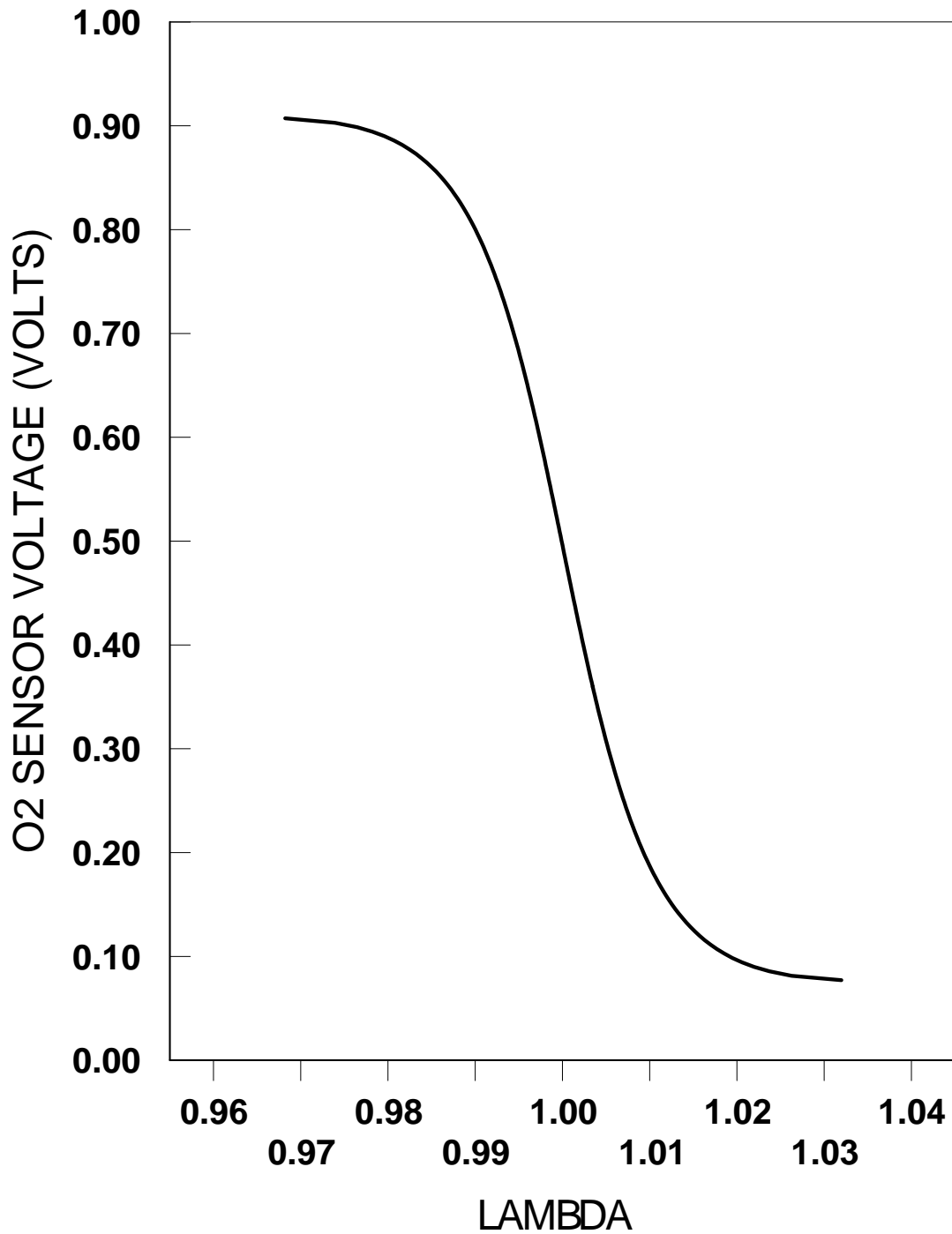
EPC-110/120 AIR-FUEL CONTROLLER

FIG. 8 EPC-110/120, TERMINAL LAYOUT



- PIN 1 EPC-110/120 ERROR ALARM OUTPUT**
- PIN 2 CATALYST TEMP ALARM OUTPUT**
- PIN 3 NOT USED**
- PIN 4 NEGATIVE(-) COMMON (GROUND)**
- PIN 5 NOT USED**
- PIN 6 NOT USED**
- PIN 7 LEFT OXYGEN SENSOR (RED)**
- PIN 8 LEFT OXYGEN SENSOR (BLK)**
- PIN 9 RIGHT OXYGEN SENSOR (RED)**
- PIN 10 RIGHT OXYGEN SENSOR (BLK)**
- PIN 11 NOT USED**
- PIN 12 NOT USED**
- PIN 13 LEFT BANK TC SENSOR (YEL)**
- PIN 14 LEFT BANK TC SENSOR (RED)**
- PIN 15 RIGHT BANK TC SENSOR (YEL)**
- PIN 16 RIGHT BANK TC SENSOR (RED)**
- PIN 17 CAT INPUT TC SENSOR (YEL)**
- PIN 18 CAT INPUT TC SENSOR (RED)**
- PIN 19 CAT OUTPUT TC SENSOR (YEL)**
- PIN 20 CAT OUTPUT TC SENSOR (RED)**

FIG. 9 TYPICAL O₂ SENSOR RESPONSE (ESTIMATED DATA)



EPC-110/120 AIR-FUEL CONTROLLER

FIG. 10 EPC-110 PARTS BREAKDOWN

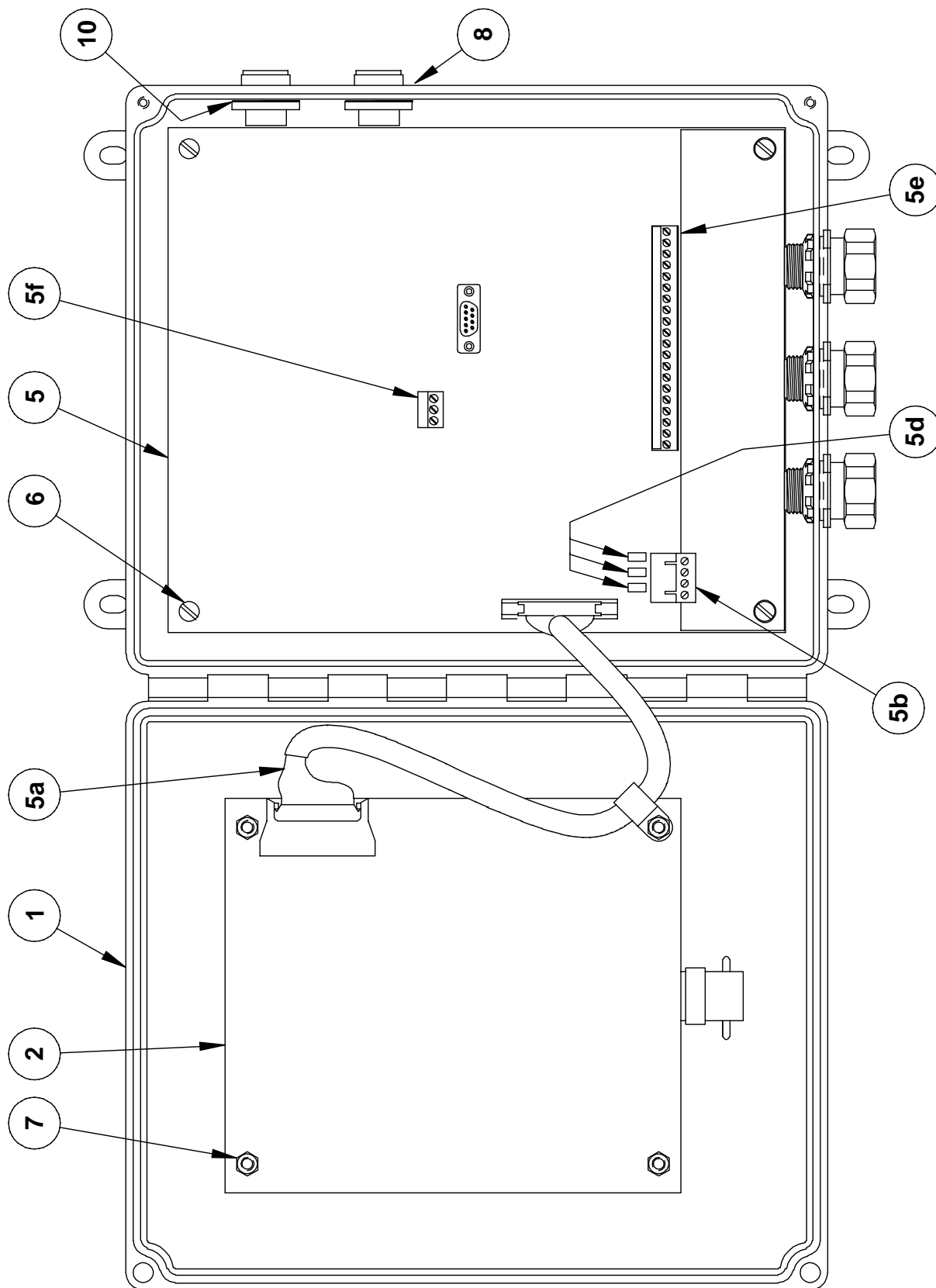


FIG. 11 EPC-110 PARTS IDENTIFICATION

Replacement parts are available from authorized Altronic distributors.

REF. NO.	QTY.	PART NO.	DESCRIPTION
1	1	670053-1	Enclosure/keypad assembly (-1)
1	1	670053-2	Enclosure/keypad assembly (-2)
2	1	672124-4	Display board assembly
5	1	681072-1	Control/stepper board assembly (-1)
5	1	681072-2	Control/stepper board assembly (-2)
5a	1	610583	Cable assembly, display board
5b	1	604137	Terminal block - 4 position
5d	3	601653	Fuse, control board
5e	1	610243	Terminal block - 20 position
5f	1	610241	Terminal block - 3 position
6	4	902439	Screw 10-32 x 3/8"
7	4	901682	Nut 10-32
8	8	902648	Screw 6-32, seal
10	2	501335	Gasket, connector

EPC-110/120 AIR-FUEL CONTROLLER

FIG. 12 EPC-120 PARTS BREAKDOWN

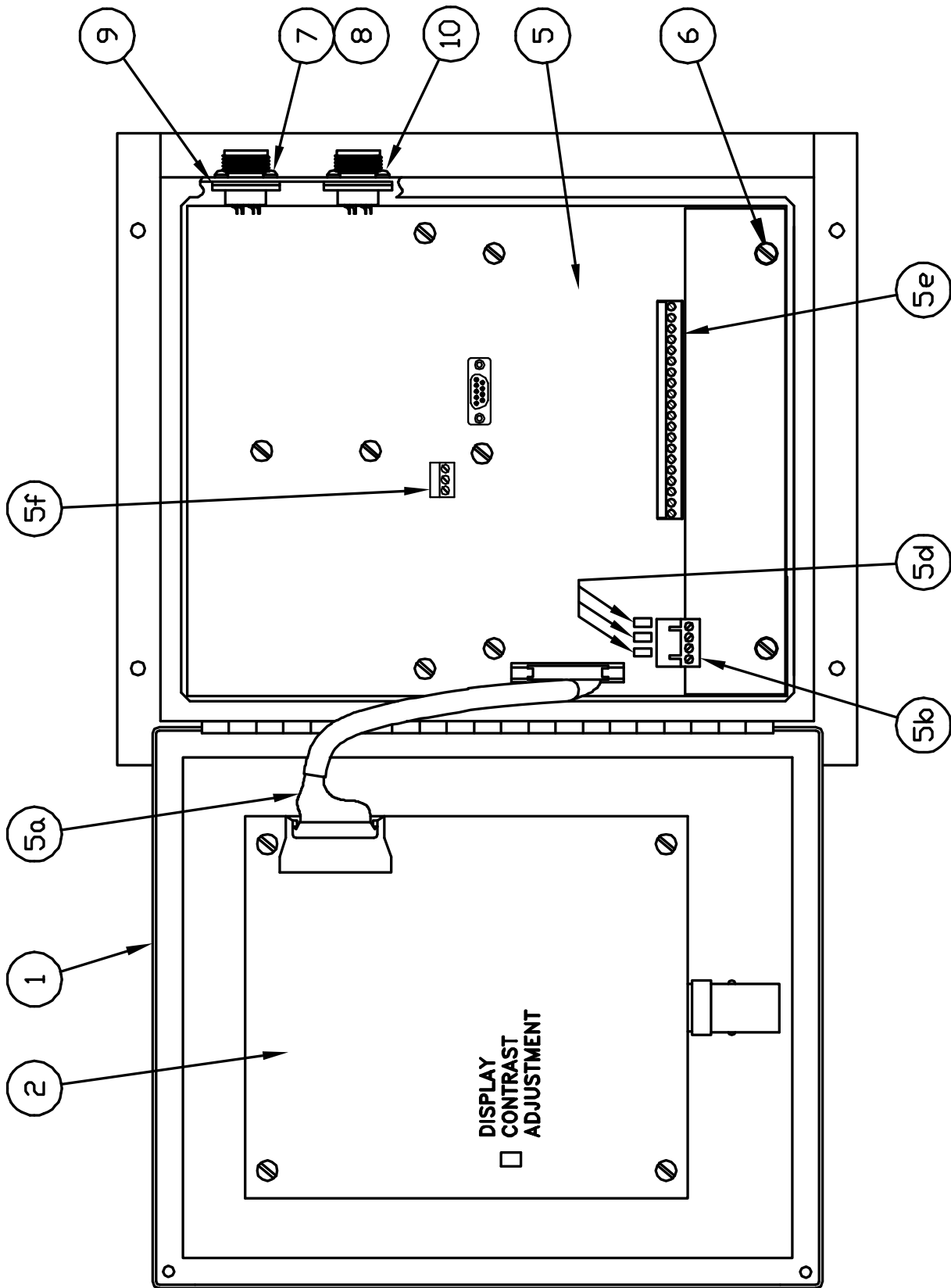


FIG. 13 EPC-120 PARTS IDENTIFICATION

Replacement parts are available from authorized Altronic distributors.

REF. NO.	QTY.	PART NO.	DESCRIPTION
1	1	670040-3	Enclosure/keypad assembly
2	1	672124-4	Display board assembly
5	1	681072-1	Control/stepper board assembly (-1)
5	1	681072-2	Control/stepper board assembly (-2)
5a	1	610583	Cable assembly, display board
5b	1	604137	Terminal block - 4 position
5d	3	601653	Fuse, control board
5e	1	610243	Terminal block - 20 position
5f	1	610241	Terminal block - 3 position
6	13	902439	Screw 10-32 x 3/8"
7	8	902064	Screw 6-32
8	8	901000	Lockwasher, #6
9	2	501335	Gasket, connector
10	1	615119	Blanking plug, 6-pin (-1 only)

FIG. 14 EPC-110/120 ACCESSORY KIT IDENTIFICATION

Contents of Accessory Kit 691310-1:

REF.NO.	QTY.	PART NO.	DESCRIPTION
1	1	693005-1	Cable Assembly, Control Valve, 25 ft.
2	1	693006-1	Cable Assembly, Oxygen Sensor, 25 ft.
3	1	610621	Oxygen Sensor

Contents of Accessory Kit 691310-2:

REF.NO.	QTY.	PART NO.	DESCRIPTION
1	1	693005-2	Cable Assembly, Control Valve, 50 ft.
2	1	693006-2	Cable Assembly, Oxygen Sensor, 50 ft.
3	1	610621	Oxygen Sensor