Installation and Operating Instructions

DE-1550 Compressor Monitor System

DE-1550 IOI 8-18

altronic

1.0 SYSTEM DESCRIPTION

1.1 For help locating subjects in this document, a section index is provided on page 33.

1.2 The Altronic DE-1550 controller system is an electronic, microprocessor-based system designed to sense various analog and digital input points to control and monitor industrial compressors. The system is field-programmable using a PC and the supplied terminal program and contains a non-volatile memory to store the setup. Serial communications provide an interface to PC's, PLC's, modems and satellite uplinks for remote communication. A backlit, LCD display shows system status, programmed engine/motor and compressor parameters and channel labels. A front-mounted keypad serves as the user interface. The DE-1550 provides for both the safety shutdown functions needed to prevent unnecessary damage to remotely-operated equipment and the closed-loop automatic control functions needed to optimize their efficiency of operation.

With the exhaust oxygen setpoint for lowest emissions entered into the controller, the AFR controller precisely controls the flow of fuel to the engine through the AFR valve so as to maintain the target oxygen level during engine operation. The DE-1550 provides the safety shutdown functions needed to prevent unnecessary damage to the equipment.

1.3 The system includes a Display and Terminal Module. The DE-1550 has all the necessary outputs and internal controls to fully control simple engine/compressor applications. It includes control for fuel, power, bypass, vent, ignition, suction, cranking, warning and engine status indication for PLC monitoring.

1.4 The Terminal module allows for 4 discrete inputs, 20 analog inputs, one speed input, and an 02 input. The entire system allows for a total of 26 inputs.

2.0 DISPLAY MODULE

2.1 The Display Module serves as the user interface for the DE-1550 system. It is a 6.5" x 6.5" door-mounted assembly and consists of DB-25 DSUB, and DB-9 DSUB connectors and five pairs of serial port indicators. The display features 128 x 64 multi-color graphics, and uses the top line to further annunciate the engine status"Running, Timers Active, First Fault," etc.. The backlight color changes to indicate the status of the machine, e.g., green for Running, yellow for Timers Active, and red for Stop/Fault condition.

2.1 The keypad is a sealed membrane unit that contains the familiar STOP, RESET, and TEST keys as well as other keys to navigate through channel status and descriptions, view the process screens, and edit the configuration.

3.0 TERMINAL MODULE WITH INTEGRATED AFR CONTROL

3.1 The Terminal Module is made to be rail-mounted and is the point of interface between the field sensor wiring and the DE-1550 control system. A removable dual terminal strip is used for the connection of the system to the equipment mounted discrete sensors which may consist of up to 26 inputs. The terminal board actually consists of 2 separate boards with channels 10-13 for discrete inputs only. Channels 20-27 may be used for 0-5V sensors (like pressure sensors and the Deg1 and Deg2 sensors). Channel 30 is for magnetic speed input for speed. Channels 50-61 may be discrete, TC (J or K), or pressure inputs. There is a feature where an analog input may be configured for 4-20mA style sensors as well. There is also an 'OTHER' sensor for custom style sensors.

This board also has 8 discrete outputs, 2 analog outputs and control for AFR controls. The discrete outputs are pilot-duty, and turn on to common ground when closed. Outputs 1 through 8 are rated at 500mA, 60V.

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3.2 ACCESSORIES

DISPLAY MODULE
DE-1550 Display Module DE-1550

TERMINAL AND INTEGRATED AFR MODULE
DE-1550 Terminal/AFR Module 691758-1

AFR CONTROL VALVES AND ACCESSORIES
Control Valve, 1.5" NPT, below 250HP 690154-2
Control Valve, 1.5" NPT, 250-1,000 HP 690154-1
Butterfly Valve, 2.0" NPT, 500-1,500HP 690220-1
Butterfly Valve, 2.5" NPT, 750-2,000HP 690225-1
Butterfly Valve, 3.0" NPT, 1,000-3,000HP 690230-1
Accessories Kit, Rich-Burn, 25 ft. cables 691310-1
Accessories Kit, Rich-Burn, 50 ft. cables 691310-2
Accessories Kit, Lean-Burn, 25 ft. cables 691315-1
Accessories Kit, Lean-Burn, 50 ft. cables 691315-2
NOTE: Order one Accessory Kit per carburetor.
One Type K thermocouple required per carburetor (not supplied in kit).

691310-1 ACCESSORIES KIT
Oxygen Sensor 610621
Cable Assembly, Control Valve, 25 ft 693005-1
Cable Assembly, O2 Sensor, 25 ft 693006-1

691310-2 ACCESSORIES KIT
Oxygen Sensor 610621
Cable Assembly, Control Valve, 50 ft 693005-2
Cable Assembly, O2 Sensor, 50 ft 693006-2

691315-1 ACCESSORIES KIT
Oxygen Sensor 610813
Oxygen Sensor Converter 691207-1
Pressure Sensor (qty. 2) 691204-50
Cable Assembly, Control Valve, 25 ft 693005-1
Cable Assembly, Pressure Sensor, 25 ft. (qty. 2) 693008-25
Cable Assembly, O2 Sensor, 25 ft 693009-1

691315-2 ACCESSORIES KIT
Oxygen Sensor 610813
Oxygen Sensor Converter 691207-1
Pressure Sensor (qty. 2) 691204-50
Cable Assembly, Control Valve, 50 ft 693005-2
Cable Assembly, Pressure Sensor, 50 ft. (qty. 2 693008-50
Cable Assembly, O2 Sensor, 50 ft 693009-2

4.0 STARTING THE ENGINE

4.1 Press the "RESET" key followed by the "F2" to start the DE-1550 running the engine/compressor.

5.0 ANALOG INPUTS

5.1 PRESSURE TRANSDUCERS

The pressure transducers, Altronic P/N 691201-x and P/N 691204-x, are packaged in a rugged sealed case with a NPT pressure port, a corrosion resistant media cavity, and a Packard Electric Metri-Pack connector. The ranges available are 0-100, 300, 500, 1000, 2000, and 5000 PSIG for the 691201-x series and 0-50,100, 300, 500 PSIA for the 691204-x series, all of which have an overload rating of 1.5 times full scale without damage. The three wires from the transducer are: +5 volt excitation, +0.5 to 4.5 volt output, and minus return. These three wires connect directly to the back of the Terminal Module using cable assembly P/N 693008-x.

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5.2 TEMPERATURE TRANSDUCER

The temperature transducers, Altronic P/N 691202-300, 691203-300 with a temperature measurement range of +5 to 300°F and the 691212-450, 691213-450 with a temperature range of -40 to +450°F are packaged in a sealed, stainless steel housing with a 5/8"-18 UNF threaded body, and a Packard Electric Metri-Pack connector. During configuration the standard calibration for the 691202/203-300 sensor is selected as dEG1 and the standard calibration for the 691212/213-450 is selected by choosing dEG2. The three wires from the transducer are: +5 volt excitation, temperature output voltage, and minus return. These wires connect directly to the Terminal Module using cable assembly P/N 693008-x.

5.3 THERMOCOUPLE INPUTS

The Terminal Modules can accept industry-standard type J or K thermocouples on inputs 50–61. Automatic cold junction compensation is built-in. The units can be configured to °F or °C. Both a high and low setpoint is associated with each channel.

5.4 N/O and N/C INPUTS

The inputs can also accept standard normally-open and normally- closed contacts. For normally-open input, place the wire between the corresponding inputs. Ground the connection to cause a fault. Similarly, for normally-open, wire the sensor in a normally-closed connection and open it to cause a fault.

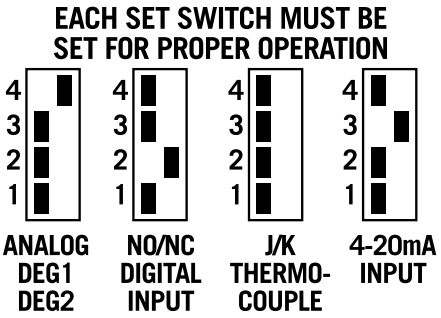
5.5 4-20mA inputs

The terminal module can accept 4-20mA inputs by selecting the internally-connected 200-ohm resistors, creating a termination voltage of .8 to 4.0 volts. The jumper wires between the + and – terminals for that channel must be connected for proper operation.

5.6 For each input, the corresponding CHANNEL SWITCH must be set according to the input type.

5.7 The DE-1550 contains a number of reserved channels which should only be assigned to specific channels. In most cases, this allows the DE-1550 to use those special channels as described in later sections of the manual. These special channels are as follows:

CH20 - SUCTION PRESSURE
CH21 - DISCHARGE PRESSURE
CH22 - FIELD PRESSURE
CH57 - POST CATALYTIC TEMPERATURE
CH61 - EXHAUST TEMPERATURE



6.0 MOUNTING

6.1 ENCLOSURE

The DE-1550 enclosure should be mounted to make reading of the Display Module convenient, and to allow easy access to the enclosure interior. Care should be taken to minimize the vibration exposure of the panel and to keep it in an environment where its maximum exposed temperature will not exceed 176°F. Where possible, it is recommended that the skid be oriented to avoid direct sunlight on the display screen in order to optimize readability.

6.2 OXYGEN SENSOR

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. 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.

6.3 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. 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.

6.4 EXHAUST THERMOCOUPLE
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 O_2 sensor. As with the O_2 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.

7.0 WIRING

7.1 POWER
The DE-1550 system requires a clean and well regulated 24Vdc power supply (72watts max.) consisting of alternator and batteries. The negative wire of the power supply must be common to the battery and engine block.

8.0 KEYPAD DESCRIPTION

The DE-1550 controller Display Module contains a sixteen-key sealed membrane keypad which is used to stop, reset and test the system. The user can also view process information screens, view channel specifics, cancel timers, and view and edit pertinent operating parameters.

8.1 STOP key is used for a manual stop condition. By pressing the STOP key, the controller stops the engine.

8.2 RESET key clears all past faulted points and resets all input and output timers to their preset values.

8.3 TEST key disables the output modules and allows the user to fault or test the input sensors. Every time the test button is pressed, the test timer resets to its preset value.

8.4 CANCEL TIMERS key cancels all timers.

8.5 VIEW CHAN key allows the user to view the status of any input channel and its user-defined label. Pushing the VIEW CHAN key after a fault will display the faulted channel and current value.

8.6 NEXT key does not have a function.

8.7 VIEW key is used to examine the history.

8.8 ENTER key is used to accept a selection and to save a new value in memory.

8.9 ESC key enables the user to exit any MENU screens and returns the user to the home screen.

8.10 MENU key allows the user to enter the edit menu. The various menus may be viewed / changed using the MENU key.

8.11 ↑UNITS/↓UNITS keys increase or decrease values by one. The →TENS/←TENS keys increase or decrease values by ten. They are used to increase or decrease channel numbers, timers and to move the pointer in the menu screen.

8.12 F1 - Function key 1.

8.13 F2 - After pressing the RESET key, the F2 key initiates an AUTO-START operation.

9.0 DISCRETE OUTPUTS

There are 8 discrete outputs. Each output as a specific purpose for general control of the engines/compressors. Each output powers up in the OFF condition. Care needs to be taken in referencing the outputs in order to prevent any

problems on power up/fault conditions. Refer to figure 8 for the timing diagram for a better understanding of the discrete outputs.

9.1 Discrete Output #1 - FUEL OUTPUT - This turns on the FUEL at a programmable time after the Crank has been initiated, and turns off immediately upon a fault/stop condition.

9.2 Discrete Output #2 - POWER OUTPUT - This output turns on at power up and turns off at a programmable time after a STOP/FAULT condition. This may be used with appropriate relays to 'TURN OFF THE PANEL' and prevent battery drainage after a fault/stop condition.

9.3 Discrete Output #3 - Bypass Valve - This output turns on for a user-programmable time for the purge and also turns on after the warm up time to load the engine and the channel permissive have been met.

9.4 Discrete Output #4 - Vent Valve - This can be pre-programmed to turn on before the crank or after the crank.

9.5 Discrete Output #5 - Ignition - This output turns on after a programmable time after fuel turns on, and turns off after the same programmable time after the fuel is shut off.

9.6 Discrete Output #6 - Suction Valve - This turns on after the warning time turns off after a fault condition.

9.7 Discrete Output #7 - CRANK

9.8 Discrete Output #8 - This output turns off after a fault has been detected and can be easily wired to SCADA/PLC to indicate a fault condition on the engine. It differentiates between a power up condition and an actual fault.

9.9 AFR Output #2 - Warning Output - This output turns on after an AUTO START has been initiated. This can be used to turn on a horn/light for a pre-programmed time to indicate the engine is about to start. This is an important safety feature for systems where field conditions can automatically start the engine.

9.10 - SEQUENCE OF EVENTS - Refer to figure 8 for the timing diagram for a better understanding of the discrete outputs. The warning (lights/horn) output is the first output that turns on when the unit is about to start. This programmable time allows the operators and nearby personnel notice the engine is about to start. Output #8 also turns on to indicate the unit is no longer in a fault mode and could be connected into telemetry equipment. After the warning time turns off, the suction output (valve) turns on as well as the bypass for the programmed purge time. After purge, the bypass turns off and the CRANK output turns on. A crank to ignition and and crank to fuel delay turn on those outputs as well.

Once the engine exceeds the CRANK DISCONNECT SPEED, the crank turns off and the WARMUP TIME begins. The bypass will not close until the WARMUP timer expires AND the permissive channel value exceeds the permissive value. Once the bypass closes, the outputs will not change state until a fault/stop condition occur. A fault/stop condition immediately causes the fuel to turn off and the Output #8 as well. Bypass, Vent, Ignition and suction turn off a few seconds later. This time is absolute difference between when the time fuel and ignition start up. Output #2 (Power down timer) will turn off after the Programmed Power Down timer expires. This output can be used in conjunction with relays to power down the panel and prevent the skid from draining the batteries.

10.0 UNDERSTANDING THE HOME SCREENS

The home screen and its two companion screens are a series of screens used to provide a quick visual of the key system parameters. The home screen's first line displays the configured MODE of the system along with the current system operational status. The other three lines, along with the lines of the two companion screens display the key operating parameters.

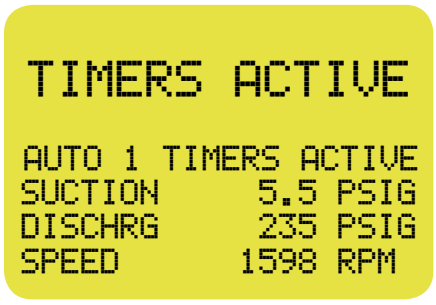
The status lines read one of the following:

RUNNING, TEST, TIMERS ACTIVE, MANUAL STOP, FAULT, or STANDBY.

The configuration mode will read MANUAL, AUTO 1, AUTO 2, AUTO 3, OR AUTO 4.
The LCD display always reverts to the home screen at power up or after 180 seconds with no keypad activity.

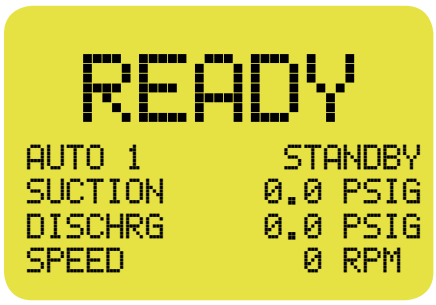
10.1 Examples of home screen:

AUTO START (based on suction pressure) configuration with the engine running and timers active.

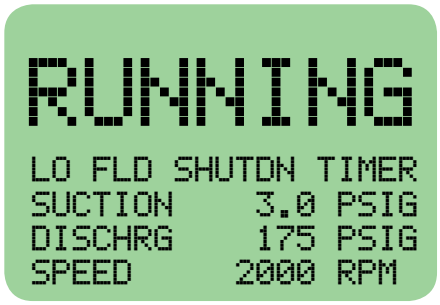


MANUAL MODE with the engine running and timers expired.

AUTO START (based on suction) configuration with the engine stopped in standby.



ENGINE RUNNING with the shut down timer active.



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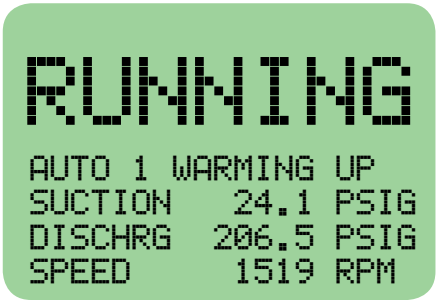
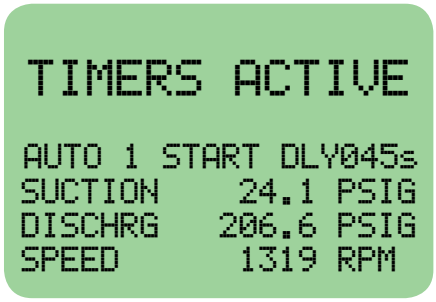
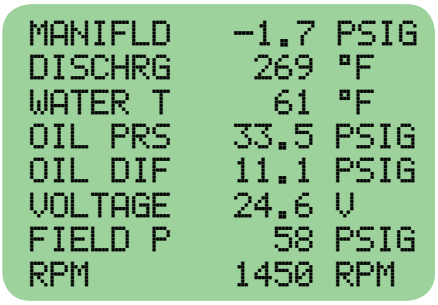
The message “WARMING UP” indicates that the permissive has not been met and the unit will stay running in the idle speed.



The ‘START DLY045s’ message indicates there is 45 seconds until the warm up timer expires.



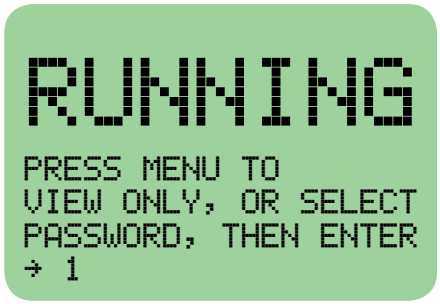
From the home screen, press the UP/DOWN key to display up to 3 sets of 8 analog inputs as defined by the PC terminal program.



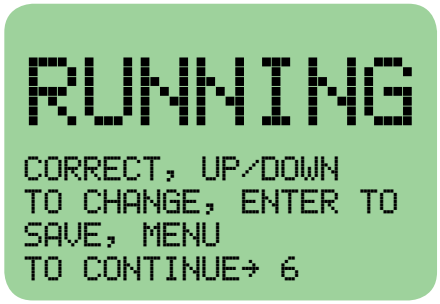
11.0 PASSWORD SCREENS

11.1 From the HOME screen, pressing the MENU key displays the PASSWORD screen.

11.2 PASSWORD FOR THE MENU
The DE-1550 contains a numerical password, which, when correct, allows the user to modify key parameters. The range of the password may be any number between 0 and 999. The same password for the MENU also applies for the NEXT key. When the MENU key is pressed, the following screen appears:



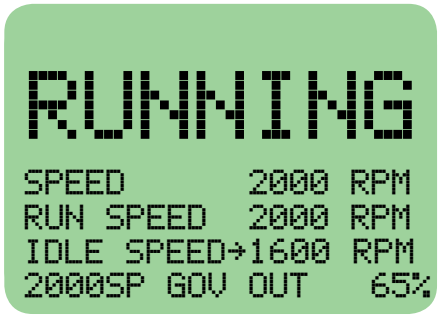
Press the MENU key again to view menu parameters and not modify them. Press the UP, UP/TENS, DOWN, DOWN/TENS keys to modify the value to the correct password value. If the password is not correct, the display shows the first MENU screen but does not allow for values to be modified. If the password is correct, the following MENU will appear:



The password may be changed at this point, or the user can continue to the MENU to view and modify menu parameters. Use the UP, UP/TENS, DOWN, DOWN/TENS key to modify the new password value and press ENTER to save the new password.

NOTE: IF THE PASSWORD IS LOST OR FORGOTTEN, CONTACT ALTRONIC PERSONNEL FOR DIRECTIONS ON RESETTING THE PASSWORD. FOR THOSE NOT WISHING PASSWORD PROTECTION, LEAVE THE PASSWORD AT '1'.

12.0 HIGH/LOW SHUTDOWN SETPOINT SCREENS (ANALOG INPUT SETPOINT SCREENS)



12.1 Since the password has been correctly entered, the user can now make changes to any of the setpoints. The first screen displayed is the SETPOINT screen for the analog input on channel 20 (suction pressure).

12.2 The cursor (horizontal arrow) on the display shows which parameter is to be changed. The ENTER key is used to move the cursor between lines to the desired setpoint to be changed. Once the cursor is in the desired location, the UP and DOWN arrow keys are used to change the setpoint value. The setpoints are immediately effective as they are changed. To advance to the next SETPOINT screen, the cursor must be moved back so that it is adjacent to the channel number. The UP arrow key is then used to advance to the next SETPOINT screen.

From any of the analog input setpoint screens, pressing the MENU key advances the display to the SPEED CONTROL screen.

13.0 SPEED CONTROL SCREENS

13.1 The speed control screens vary in content depending on whether the unit is programmed for either FIXED SPEED or LINEAR SPEED SETPOINT CONTROL.

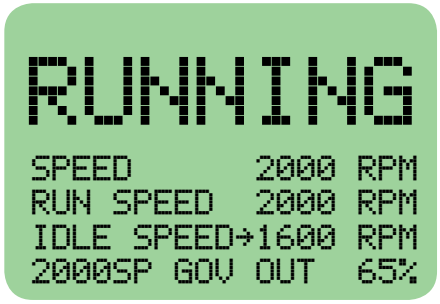
13.2 FIRST LINE SPEED - The first line shows the actual speed of the engine.

13.3 SECOND LINE SPEED SETPOINT - This shows the RUNNING SPEED whether its set for fixed or linear ramp speed control.

13.4 RUN SPEED setpoint
This screen shows the actual current engine speed, along with the RUN SPEED setpoint (speed target after the warm up timer expires). Also shown is the output of the governor expressed in terms of the percentage of the output current span to the controller that is currently in effect. The RUN SPEED setpoint can be changed by using the ENTER key to move the cursor to the setpoint that is to be changed, and then using the UP and DOWN arrow key to adjust the value.

Pressing the F2 key adds the IDLE SPEED setpoint to the screen.

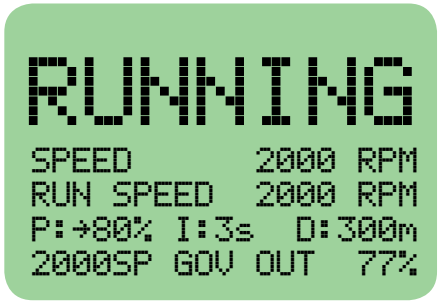
13.5 IDLE SPEED setpoint
IDLE SPEED setpoint is the speed target before the warm-up timer expires. With the cursor next to the IDLE SPEED setpoint, the value can be changed using the UP and DOWN arrow keys.



Pressing the F1 key brings up the P.I.D. line in the screen that is used to tune the dynamics of the speed control.

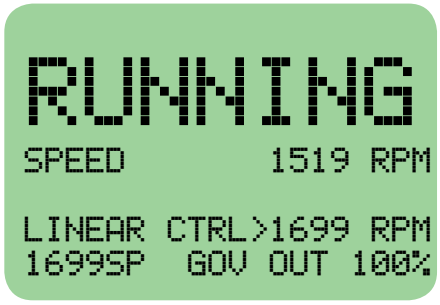
13.6 P.I.D. line
The response of the governor can be adjusted by moving the cursor so that it is adjacent to the "P" setting (Proportional), the "I" setting (Integral), or the "D" (Derivative) setting, and then using the UP and DOWN arrow keys to adjust the values. The "P" value is an indication of how much error in the actual speed from the target will be tolerated before a correction is made. The lower the number, the less error will be tolerated without correction. The "I" value serves as an indication of the speed of the controller when attempting to correct an error from the speed target. The lower the number, the faster the attempt to correct the error. Note that a fast correction setting will also result in more vulnerability to overshooting the target. The "D" value serves to attempt to minimize the overshoot. The higher the number, the more it attempts not to overshoot. This parameter acts as a sort of "damper" to the "I" value.

NOTE: When making changes to the P, I, or D setting, new values do not become effective until the cursor is moved off of the parameter using the ENTER key.



13.7 FOURTH LINE - STATUS SCREEN. This line shows the actual speed the DE-1550 is trying to control to. This allows the operator to see if its controlling to the IDLE or the RUNNING RPM, or it may show the desired speed based upon the Linear Speed setpoint control. The percent on the right shows the appropriate 4-20mA signal coming out of A02 for controlling the speed.

13.8 LINEAR SPEED SETPOINT CONTROL This screen appears similar to the FIXED MODE except the 3rd line shows "LINEAR CTRL" where this shows the value of the calculated speed based upon a pressure screen.



14.0 MODES OF OPERATION

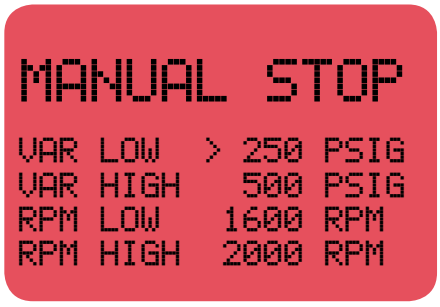
14.1 The Modes of operation may be changed to either FIXED SPEED or LINEAR SPEED SETPOINT CONTROL. Select the control method and press the ENTER key.

15.0 LINEAR RAMP SETPOINT CONTROL

15.1 If Linear Ramp Setpoint control has been selected, there are a number of new menus specific to the linear mode.

The following menu allows the operator to modify the channel used for Linear Control.

The next screen allows the user to modify the values in the Linear Speed Setpoint Control.



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16.0 CRANK SCREEN

16.1 When the controller is configured in any of the AUTO MODES, the OVERCRANK value represents the number of seconds that the controller will engage the starter during a crank attempt. CRANK/DIS is the speed that is considered to represent a successful start. When this speed is achieved during a crank cycle, the controller disconnects the starter. If the OVERCRANK time expires before this speed is achieved, the controller disconnects the starter. After a period of 10 seconds, the controller will RESET, and then reengage the starter in another crank attempt. This start cycle will be repeated until a successful start is achieved, or until three (3) crank attempts have been made without achieving the crank disconnect speed. At this point, an OVERCRANK FAULT will be logged and displayed. The OVERCRANK and CRANK/DIS parameters are only active when the panel is configured in one of the AUTO START modes. The WARM UP TIMER parameter represents the time that the engine is considered to be warming up following a successful start. Until this timer expires, the speed is held at the IDLE SPEED setpoint, and the BYPASS valve remains open.

17.0 VARIOUS MENUS

17.1 The RPM/s CHANGE allows the user to select the rate of change of the speed setpoint. This would apply to its programmed change, but not necessarily to its actual change.

17.2 START ATTEMPTS - This allows the user to change the amount of start attempts.

17.3 BETWEEN CRANKS - This is the TIME BETWEEN CRANKS and is set for seconds.

17.4 GLOBAL TEST TIME - This is the time the unit is in test each time the TEST button has been activated.

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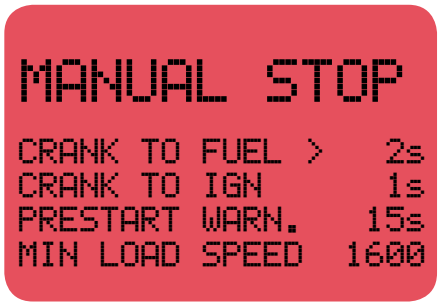
18.0 START UP SCREENS

18.1 CRANK TO FUEL

18.2 CRANK TO IGNITION

18.3 PRESTART WARN. - This is the time the WARNING message comes on when the unit is about to start.

18.4 MINIMUM LOAD SPEED - This is the speed which must be met before the DE-1550 exits the idle speed.

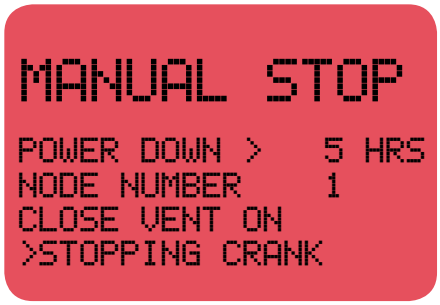


19.0 POWER DOWN SCREEN

19.1 The POWER DOWN parameter represents the time at which the controller will turn off its own power (to conserve battery life) following an engine shutdown. Following the restoration of power, the display will show the last FAULT. All FAULT information is retained in memory.

19.2 Node number - This is the node number for Port 3.

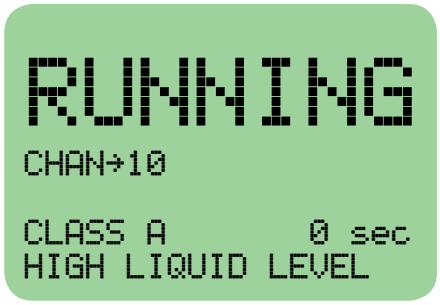
19.3 CLOSE Vent on either starting crank or stopping crank.



20.0 TIMER SCREENS

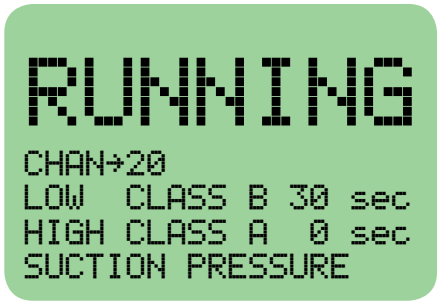
This section is composed of a number of screens used to adjust the Class B and C timers for the analog input channels. For any given screen, the first line shows the input number. The second line shows the class of the input. For digital inputs, if the input is a Class A point, the third line says NO time delay. Class A points are armed at the setpoint at all times. If the point is Class B, the display shows the timer setting. For Class B, the setpoint for that point is armed only after the timer expires. A Class C point is not armed until a minimum setpoint is met, or the timer expires, whichever occurs first. From this screen, the INPUT CLASS screens for the other inputs can be accessed with the UP and DOWN arrow keys.

20.1 INPUT CLASS screen for digital input on channel 10
This example shows the input class screen for digital input number 10, High Liquid Level. This is a Class A point on the High Liquid Level point. Class A points are armed at all times.



20.2 INPUT CLASS screen for analog input 20
This example shows the INPUT CLASS screen for analog input 20, Suction Pressure. This channel is Class B on the LOW SUCTION setpoint. The controller will not FAULT on a low suction condition at start-up until the timer shown (LOW CLASS B) expires. The HIGH SUCTION PRESSURE setpoint is shown as a Class A point, which is armed at the setpoint at all times. This timer is 0 seconds, and cannot be changed.

20.3 SHUTDOWN TIMER
The last screen of this sequence is the shutdown timer screen.



The ENTER key is used to move the cursor to the TIMER VALUE line. The UP and DOWN arrow keys are used to adjust the timer setting.

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The ENTER key is used to move the cursor to the active channel line. The UP and DOWN arrow keys are used to select the input channel, either 20 (suction pressure), or 22 (field pressure), whose low setpoint will trigger the shutdown timer.

21.0 STEPPER MOTOR CONTROL PARAMETERS

21.1 02 SETPOINT VALUE - This is the target 02 value.

21.2 DEFAULT POSITION - This is the position the stepper motor will remain during a fault/stop condition, or if the Minimum exhaust temperature has not been met.

21.3 GAIN - This determines how fast/slow the AFR will respond to control changes.

21.4 MINIMUM EXHAUST - This is the setpoint for the minimum exhaust temperature needed so that the AFR will start controlling the stepper position. The exhaust temperature must be previously setup for channel 61 as a K-type thermocouple.

22.0 STEPPER MOTOR CONTROL HOME SCREEN

22.1 This screen shows the status of the Stepper Motor Controller.

22.2 Line one shows whether the stepper motor controller is in AUTO or MANUAL mode. If its in the MANUAL mode, then the UP/DOWN/LEFT and RIGHT arrow keys allows the stepper to be manually modified.

22.3 The F1 key momentarily resets the stepper motor controller to 0.

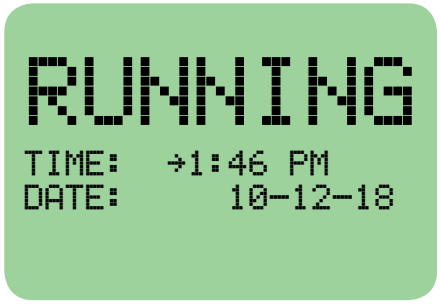
22.4 Line 3 shows the actual position of the stepper motor controller.

22.5 Line 4 shows the 02 input value.

22.6 The F2 key allows the user to go back one in the menu which allows the user to modify any of the Stepper Motor control parameters.

23.0 TIME/DATE SCREEN

23.1 This screen displays the current time and date. The cursor is moved adjacent to the number to be changed using the ENTER key, and the value is changed with the UP and DOWN arrow keys.



24.0 START MODE SELECTION SCREENS

24.1 This screen configures the controller to be MANUAL START or AUTOSTART. The selection is made by using the UP or DOWN arrow keys to move the cursor to the desired selection. When the cursor is placed adjacent to the MANUAL START line, pressing the ENTER key makes the selection, and it advances the display to the next SETPOINT screen. When the cursor is moved adjacent to AUTO START, pressing the ENTER key brings up the AUTO MODE selection screen.

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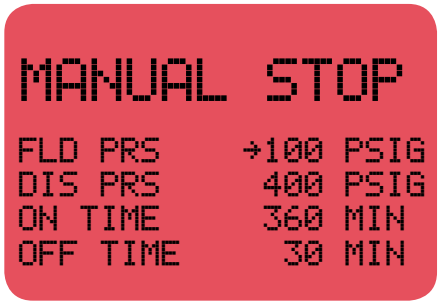
This screen allows the user to select one of four modes of AUTO START. If the cursor is next to the AUTO 1 line, pressing ENTER brings up the next screen.

The user uses the UP and DOWN arrow keys to define a minimum field pressure that once achieved, will result in an auto start of the system. This value must be set above the LOW SUCTION PRESSURE setpoint. With the engine shutdown in STANDBY and configured in the AUTO 1 mode, the panel will RESET and initiate a start sequence if the Field Pressure rises to the FIELD PRESSURE TO START setpoint.

Pressing the ENTER key when the cursor is on the AUTO 2 line will bring up this screen.

The times entered represent the number of minutes the system will run before shutting down, and the time it will remain shut down until is restarts. Refer to SECTION 29.0 for a detailed description of the start and shutdown sequence.

24.2 In this mode, the system will shut down if the discharge pressure exceeds the HIGH DISCHARGE PRESSURE setpoint. When the discharge drops below the DIS PRS (Discharge Pressure to Start) setpoint shown on this screen, the controller will RESET, open the VENT and BYPASS valves, and initiate a start sequence. Note that the DIS PRS value must be set below the HIGH DISCHARGE PRESSURE setpoint. Refer to SECTION 29.0 for a detailed description of the start and shutdown sequence.



The user presses the ENTER key to move the cursor adjacent to the value to be changed, and then uses the UP and DOWN arrow keys to adjust the values. AUTO 4 combines the AUTOSTART features of AUTO 1, AUTO 2 and AUTO 3.

NOTE: When the panel is configured in any of the AUTO START modes, and the well is open, the user initiates the first start sequence by pressing RESET and then pressing the F2 key. If the well is closed-in (suction auto mode), or the line pressure is above the HIGH DISCHARGE SET-POINT (discharge auto mode), the user can place the controller into STANDBY mode by pressing RESET followed by F2. This will not result in a start sequence until the proper conditions are met.

NOTE: The user also has the option of initiating a start from the MANUAL mode. Once the engine is running and the timers have expired, the panel can be changed to any of the AUTO START modes with the engine running.

NOTE: Field pressure is a permissive for all AUTOSTART modes. If field pressure is below the low field pressure setpoint, the unit will either enter–or remain in–STANDBY mode.

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25.0 HOURMETER SCREEN

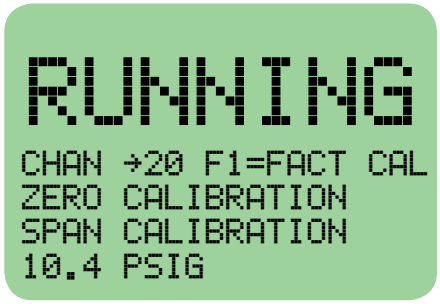
25.1 MESSAGE NUMBER is reserved for future incorporation. TOTAL HOURS is the system hour meter showing total accumulated running time of the engine.

The technician can adjust the HOURMETER reading in order to accommodate such things as a changeout of the engine on the skid. Press the ENTER key to move the cursor adjacent to the number of accumulated hours. The UP and Down arrow keys are used to edit the hour reading.

26.0 CALIBRATION SCREEN

26.1 This screen is used to adjust the ZERO and SPAN for the pressure and temperature transducers. To calibrate the ZERO setting, the ENTER key is used to move the cursor adjacent to the ZERO CALIBRATION label. With the transducer exposed to atmospheric pressure, the UP and DOWN arrow keys are used to change the displayed pressure to 0.0PSIG. To calibrate the SPAN, move the cursor adjacent to the SPAN CALIBRATION label. With the transducer exposed to a known and controlled pressure (using a calibrated device) near its upper range, use the UP and DOWN arrow keys to change the displayed pressure to match the controlled pressure. The original factory calibration settings can be retrieved by pressing the F1 key.

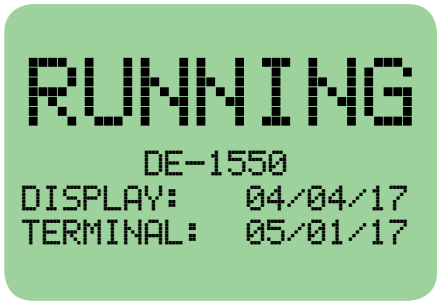
NOTE: Typically, for the accuracies required, it should only be necessary to adjust the ZERO CALIBRATION setting to compensate for differences in elevation.



27.0 FIRMWARE SCREEN

This screen displays the firmware dates contained in the display and terminal module.

27.1 Pressing the SETPOINTS key returns the display to the first SETPOINT screen. The user can use the ESC key to exit the SETPOINT screens and return to the HOME SCREEN.



28.0 HISTORY SCREENS

28.1 The HISTORY key provides the user access to data retained from the last 100 shutdowns. Each history "snapshot" identifies the FAULT condition which caused the shutdown and also retains all of the analog input values at the time of the shutdown. In addition, each snapshot has a time and date of the shutdown event. Each snapshot is numbered from 1 to 100, with snapshot number one (1) containing data from the most recent shutdown. When 100 snapshots have been saved, the controller drops the data from snapshot 100 each time a new snapshot is saved.

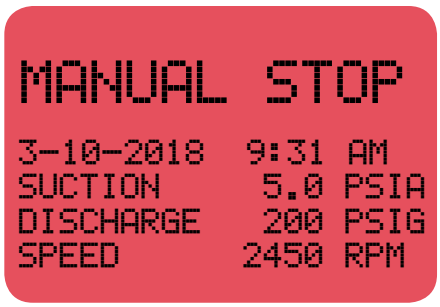
28.2 From the HOME SCREEN, pressing the VIEW key displays this screen.

Using UP and DOWN arrow key selects the desired historical snapshot to be viewed.

28.3 Pressing the ENTER key brings up a description of the shutdown event selected.

In this example, the system was configured in the AUTO START mode, and the FAULT was caused by an overspeed condition. Pressing the DOWN arrow key advances the display to the data snapshot.

28.4 This first screen provides the time and date of the FAULT condition. The UP or DOWN arrow key is used to view the remaining two screens of the data snapshot. Pressing the ESC key returns the display to the HISTORY screen. From this point, another history snapshot can be selected, or the ESC key can be pressed again to return to the HOME SCREEN.



NOTE: From any of the screens described above, the display will automatically revert to the HOME SCREEN after 180 seconds of keypad inactivity.

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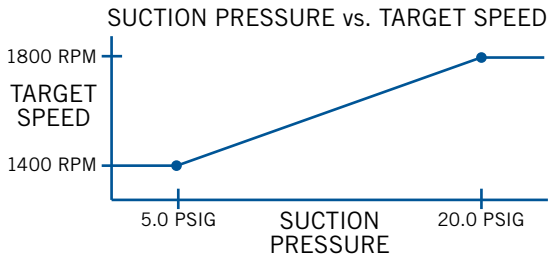
29.0 OPERATIONAL LOGIC

The following describes the operational logic and sequence of operations of the controller for each of the available control modes.

29.1 To start up the system, press the RESET key (check for any class A faults) and then press the F2 key. The unit will begin the auto-start operation by turning on the warning output and the screen will start flashing.

29.2 TARGET SPEED STRATEGY - The Target Speed Strategy refers to the speed to which the engine attempts to control when the DE-1550 has completed the warm-up time. The DE-1550 offers 2 different speed strategies. One is a fixed speed and the other is based upon another channel. The fixed speed strategy uses the Target Speed as the speed to which the engine attempts to control. Selecting the Linear Speed Setpoint control allows the user to create a table for create the Target Speed, based upon another channel. In other words, the X is the channel value and the Y is the target value. There also exists another value associated with the fixed and the Linear Speed Setpoint Control such that it is only out of warm up after the selected permissive channel has exceeded the permissive setpoint. This could be used, for example, to prevent the engine from speeding up until the oil temperature/pressure is up to speed. See the figure below to better understand how the linear speed setpoint works.

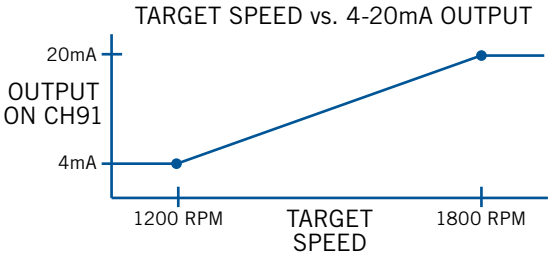


The permissive channel can be any channel from 20 to 27, and is not limited to suction pressure.

29.3 SPEED CONTROL STRATEGY
The Target Speed Strategy (see section 23.2) determines what the desired target speed should be. The Speed Control Strategy determines how the target speed will be used to control the 4-20mA output.

PID Mode of Operation: the PID strategy uses the familiar P/I/D values with the setpoint determined by the Target Speed Strategy. It can also be set to either DIRECT or INVERSE acting.

NON-PID Mode of Operation: the NON-PID strategy uses an X-Y strategy where the target speed is the X and the Y is the 4-20mA out. This strategy is useful when a 4-20mA output is sent to another device which actually does the speed control. The 4-20mA output is essentially a speed setpoint. See the figure below to get a better understanding.

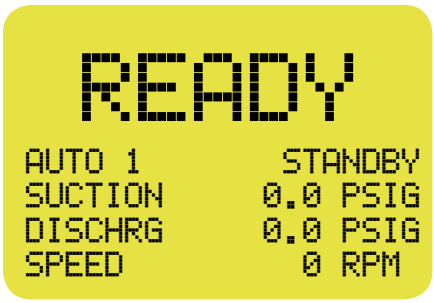


29.4 SHUTDOWN TIMER

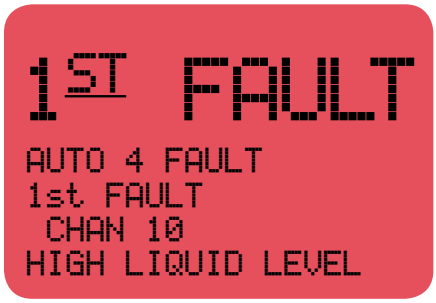
For each mode, the DE-1550 panel provides a time delay (user selectable) on a shutdown that is triggered by either a low suction pressure or low field pressure condition (depending on the user selection) to allow the compressor to continue to run for a period of time when a water slug from the well temporarily results in a drop in the gas pressure from the well. Under normal operating conditions, if the gas pressure drops below the LOW SUCTION PRESSURE or LOW FIELD PRESSURE setpoint (depending on user selection), the controller starts a shutdown timer (time set by user). If the gas pressure returns above the LOW SUCTION PRESSURE or LOW FIELD PRESSURE setpoint (depending on user selection) before the timer expires, the shutdown sequence is cancelled, and the compressor operation continues. If the timer expires before the gas supply pressure rises above these setpoints, a shutdown results.

WARNING: When configured in one of the AUTOSTART modes AND a normal shutdown occurs with no latching FAULTS, the word STANDBY will be shown on the top right of the display as shown on the screen below. This indicates that the compressor will automatically restart without warning when the required conditions are met.

This screen indicates that the compressor will restart automatically when the required conditions are met.



This screen indicates that a LATCHING FAULT has occurred. The compressor cannot be started until the panel is manually RESET.



29.5 AUTOSTART 1: SUCTION CONTROL

This AUTO CONTROL mode is used to allow the compressor to automatically start and stop in response to changes in the field pressure of the compressor (opening and closing of the well head to control the well plunger) provided there are no other FAULT conditions present. With the engine running normally and loaded, when the suction pressure drops below the LOW SUCTION PRESSURE setpoint, or the LOW FIELD PRESSURE SETPOINT (depending on user selection), the engine shuts down by removing the supply power to the ignition, and places the panel in a STANDBY mode (i.e. an auto start will be initiated when the proper conditions are met). When the controller senses loss of engine rotation, the suction solenoid output is de-energized and the VENT and BYPASS valves are opened. It will remain in this STANDBY state until the field pressure rises above the FIELD PRESSURE TO START setpoint. When this happens, the panel RESETS, supplies power to the ignition, energizes the suction solenoid output, and initiates a crank sequence.

NOTE: The FIELD PRESSURE TO START setpoint acts as a permissive in ALL of the 4 AUTOSTART modes. If field pressure drops below the FIELD PRESSURE low setpoint, the unit will remain in STANDBY mode.

If the crank attempt is unsuccessful, the suction solenoid is de-energized when the crank attempt is aborted. If no rotation is sensed within 10 seconds of the panel RESET, a NO ROTATION fault is registered. When the CRANK DISCONNECT setpoint speed is achieved (successful start), the VENT valve is transitioned to the closed position. At this point, the engine is warmed up and loaded. A shutdown sequence is also initiated if the STOP button is pressed or if any of the protection threshold settings are exceeded. In these situations, the engine

will not start automatically until the RESET and F2 keys are pressed to clear the FAULTS and reset the panel.

The operator can place the system directly into STANDBY mode if the well is still closed in by pressing the RESET and the F2 key. This will result in an automatic start sequence being initiated when the well head opens and the field pressure to start threshold is exceeded.

29.6 AUTOSTART 2: TIMED CONTROL

This feature allows the user to start and stop the compressor based on running time provided there are no other FAULT conditions present. When the ON time setting expires, the engine shuts down by removing the supply power to the ignition. When the controller senses loss of engine rotation, the suction solenoid output is de-energized and the VENT and BYPASS valves are opened. It will remain in this state until the OFF time setting expires. When this happens, the panel RESETS, energizes the suction solenoid output, supplies power to the ignition, and initiates a crank sequence. If the crank attempt is unsuccessful, the suction solenoid output is de-energized when the crank attempt is aborted. If no rotation is sensed within 10 seconds of the panel RESET, a NO ROTATION fault is registered. When the CRANK DISCONNECT setpoint speed is achieved (successful start), the VENT valve is transitioned to the closed position.

NOTE: When the engine is in the AUTO2 mode AND in the STANDBY condition, pressing the F2 key cancels the OFF timer, resulting in an autostart sequence if there are no other faults present.

A shutdown sequence is also initiated if the STOP button is pressed or if any of the protection thresholds are exceeded. In these situations, the engine will not start automatically until the RESET and F2 keys are pressed to clear the FAULTS and reset the panel.

In this mode, if a shutdown results from the expiration of the SHUTDOWN timer that is triggered when the gas supply pressure goes below the LOW SUCTION or LOW FIELD pressure setpoints (depending on user selection), the panel will remain in a LATCHED shutdown state until the RESET key is used to clear the FAULT.

29.7 AUTOSTART 3: DISCHARGE CONTROL

This AUTO CONTROL mode allows the compressor to automatically start and stop in response to changes in the downstream pressure provided there are no other FAULT conditions present. If the line pressure rises above the HIGH DISCHARGE PRESSURE setpoint, the controller shuts down the engine by removing the supply power to the ignition. It will remain in this STANDBY state until the downstream pressure drops below the DIS PRS (Discharge Pressure to Start) setpoint. When this happens, the panel RESETS, energizes the suction solenoid output, supplies power to the ignition, and initiates a crank sequence.

A shutdown sequence is also initiated if the STOP button is pressed or if any of the protection threshold settings are exceeded. In these situations, the engine will not start automatically until the RESET and F2 keys are pressed to clear the FAULTS and reset the panel.

In this mode, if a shutdown results from the expiration of the SHUTDOWN timer that is triggered when the gas supply pressure goes below the LOW SUCTION or LOW FIELD pressure setpoints (depending on user selection), the panel will remain in a LATCHED shutdown state until the RESET key is used to clear the FAULT.

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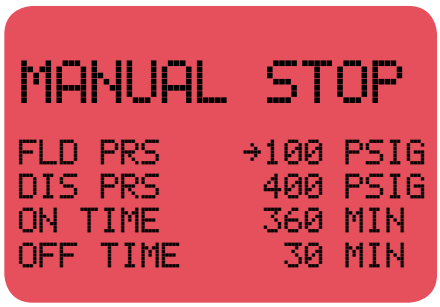
29.8 AUTOSTART 4: COMBINED CONTROL
This configuration combines the features of the first three autostart modes. When this mode is selected, the user will be presented with the display shown.



NOTE: The timer aspect of this mode can be disabled by setting the OFF time to zero.

When the compressor starts, the controller starts the ON timer. If this timer counts down to 0 under normal operating conditions, the panel removes ignition power, opens the VENT and BYPASS valves, de-energizes the inlet solenoid output, places the unit in STANDBY, and starts the OFF timer. When this timer reaches zero, and if the field pressure reading is above the FLD PRS setting, and the line pressure (pressure downstream of the discharge check valve) is below the DIS PRS setpoint, the controller initiates an autostart sequence. If the field pressure is not above the FLD PRS setting, the unit remains in STANDBY mode with the OFF timer expired until this condition is met.

When operating normally, if the suction pressure drops below the LOW SUCTION PRESSURE setpoint, or the field pressure drops below the LOW FIELD PRESSURE setpoint (depending on user setting), the panel initiates the shutdown delay timer. If this timer expires before the pressure rises back above this point, the panel removes ignition power, opens the VENT and BYPASS valves, de-energizes the inlet solenoid output, terminates the ON timer, and places the panel in STANDBY. When the field pressure rises to the FLD PRS setting, the panel initiates an autostart sequence. Once operating, the panel resets the ON timer.

NOTE: If the panel shuts down in STANDBY mode as a result of the suction or field pressure, it can only initiate an autostart based on the field pressure reading. Under this condition, it cannot initiate an autostart based on any reading of the discharge pressure, since the compressor is depressurized upon shutdown.

29.9 AUTOSTART 4: COMBINED CONTROL
When operating normally, if the discharge pressure rises to the HIGH DISCHARGE PRESSURE setpoint, the panel removes the ignition power, de-energizes the inlet solenoid output, places the unit in STANDBY mode and terminates the ON timer. When the discharge pressure drops to the DIS PRS setpoint, the panel opens the VENT and BYPASS valves, and initiates an autostart sequence. Once operating, the panel resets the ON timer.

29.10 In the manual mode configuration, the sequence of events is as follows even though it is possible that the VENT, BYPASS and SUCTION SOLENOID valves are not present.

NOTE: If the panel shuts down in STANDBY mode as a result of the discharge pressure, it can only initiate an autostart if the discharge pressure drops below the DIS PRS setpoint AND the field pressure is above the FLD PRS setpoint.

When the STOP button is pressed or a FAULT condition occurs, the engine shuts down by removing the supply power to the ignition. When the controller senses loss of engine rotation, the suction solenoid output is de-energized and the VENT and BYPASS valves are opened. It will remain in this LATCHED state until the panel is manually reset. When this happens, the panel supplies power to the ignition. The operator presses and holds the crank button to initiate a crank sequence. At the moment that the crank is initiated, and rotation is sensed, the controller will energize the suction solenoid output.

29.11 For each mode, the DE-1550 panel provides the ability to select a field pressure (FIELD PR) below which the speed is slowly reduced in an attempt to stabilize the well pressure. When the field pressure drops below the FIELD SP setpoint, the DE-1550 panel will slowly reduce the compressor speed in a linear manner between the RUN SPEED setpoint and a 1600 rpm minimum. Within this range, if the field pressure continues to decrease, the DE-1550 will reduce the compressor speed, and increase the compressor speed if the field pressure increases. If the field pressure decreases to the point of the LOW SUCTION

NOTE: In the AUTO4 mode, any change in the configuration parameters change the corresponding parameters in the other applicable autostart modes.

PRESSURE or LOW FIELD PRESSURE setpoint a normal shutdown sequence will be initiated. This speed reduction feature can be disabled by setting the FIELD PR equal to either the LOW SUCTION PRESSURE or LOW FIELD PRESSURE setpoint.

30.0 PC TERMINAL PROGRAM

30.1 The Altronic DE series terminal program operates from a standard PC and permits the operator to configure the DE system. A data sheet can be printed showing, in table form, the global, channel, home screen and view process screen data.

Altronic program required: The PC terminal program may be downloaded from the following site:

http://www.altronic-llc.com/catalog-downloads.shtml

Hardware required:
Computer: IBM-compatible PC, Windows™ XP, 7, 8, 10, hard drive (32MB free disk space required), internet access, 1 RS-232 serial or USB port, SVGA graphics (800x600 or greater preferred) with color monitor.

30.2 Installation of the Altronic Terminal program requires "Administrative Privilege". Once the DE-1550 program has been downloaded from the Altronic Website, run the file as Administrator. For Windows XP, right click on the program and select "Run As...", select the Administrator account and provide the password. For Windows 7, 8, and 10, right click on the program and select "Run As Administrator" to start the installation.

31.0 USING THE PC TERMINAL PROGRAM

31.1 The PC terminal program is the primary means of configuring / modifying values of the DE-1550. There are actually 3 files associated with the DE-1550 with extensions '.pgd', '.trd' and '.afd', although only the .pgd will be displayed when opening/saving the file. Care must to taken to include all the files when saving / backing up and sending files. Once the unit has been programmed, the user may modify key parameters through the keypad.

31.2 Create New - This button loads in a generic program into the PC terminal program, and may be used as a generic example when first starting to create files.

31.3 Load from File - This button loads a user selectable file into the PC terminal program. This allows the user to view and/or modify parameters for different engine applications.

31.4 Load from Unit - This button loads the information from the DE-1550 and displays it on the first screen The user must first be connected to the DE-1550.

31.5 Program Unit - This button allows the DE-1550 to be programmed (from the PC to the DE-1550) from a selected file.

31.6 Connect - This button allows the user to select which COM port is to be used in programming the DE-1550. You must first connect into the system through the COM port before programming or retrieving programmed information to and from the unit.

31.7 Calibrate Sensors - This button allows for analog channels to be calibrated. This feature can be helpful for configuring non-standard sensors or making changes to sensor. The unit must first be programmed before using this feature.

32.0 PROGRAMMABLE FIELDS IN THE PC TERMINAL PROGRAM

The PC terminal program allows the user to configure the DE-1550 system through a series of different screens.

32.1 EDIT CHANNEL SETTINGS - This allows the user to configure each channel, give it a unique 20 character name, and select its class and time configuration. Select NONE to create a special sensor type not currently specified.

32.2 EDIT UNIT SETTINGS

A. Site name - 30 character user defined label for the engine.

B. Hourmeter

C. Select Port 3 Node number - Allows the user to select a node number for Modbus communications.

D. Select Port 5 Node number - Allows the user to select a node number for Modbus communications.

E. Power Down (hr) - May be used with Discrete output #2 to automatically turn off panel power after a pre-configured amount of time. This may be helpful to prevent the batteries from being drained during fault conditions.

F. Overcrank (s) - The unit will fault on OVERCRANK if the crank disconnect speed has not been met by the time the overcrank time has expired.

G. Crank Disconnect (RPM) - The speed must exceed this Crank Disconnect speed before turning off the crank motor. This is associated with output #7.

H. Warmup (s) - This is the minimum time required before the bypass is closed.

I. Crank to Ignition Delay - This is the time from when the crank turns on until the ignition turns on. Refer to the timing diagram for more information.

J. Active Shutdown Channel - User may select either channel 20 or 22. For typical applications, make channel 20 Suction and channel 22 Field Pressure. Upon a RUNNING condition, field conditions could occasionally cause a disturbance in these channels which would normally cause a low fault condition. If a low fault condition occurs for more than the Shutdown time(s), then the unit will shut down.

K. Shutdown time(s). This is the time associated with the function listed above. If the low channel shutdown occurs continuously for the programmed time, then the unit will do a normal shutdown.

L. Crank to Fuel Delay on Start(s) - This is the time from when the crank starts to when the Fuel turns on. Fuel is pre-set for output #1.

M. Pre-Start Warning time - This is the time the warning output turns on indicating that the engine is about to start. Output #8 maybe wired to lights/horns for typical applications.

N. Purge time(s) - This is the time that the unit is in purge.

O. Close vent on (STARTING CRANK / STOPPING CRANK) - This selection allows a choice when the Vent valve turns on. See the timing diagram for more information.

P. Crank Attempts - This allows the user to select the number of allowed crank attempts.

Q. Time between Attempts - This sets the time between Crank Attempts.

R. Default Position (SMC) - Default position for the AFR. This position is maintained at start-up, a fault/stop condition, or when the minimum exhaust temperature has not been achieved.

S. O2 setpoint (mV)

T. Minimum Exhaust. The exhaust must surpass this value before the SMC will start controlling the Air/Fuel mixture.

U. Gain (smc)

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32.3 EDIT CONTROL SETTINGS

A. MANUAL / AUTO 1 / AUTO 2 / AUTO 3 /AUTO 4 - For each mode of operation, FIELD PRESSURE TO START, DISCHARGE PRESSURE TO START / ON TIME / OFF TIME may be required to be set.

B. RPM/s change - This allows the user to set how quickly the RPM setpoint value may change. This can be helpful in preventing upset PID conditions especially when changing from the IDLE speed to the RUNNING speed. The user may select 25, 50 or 75 RPM/s changes.

C. PID / NON-PID control

D. Inverse acting / Direct acting - This only applies for the PID control. If set for Direct Acting and the speed is below the setpoint, then the current will increase. If set for Direct Acting and the speed is above the setpoint, then current will decrease. The output will be reversed if set for Inverse Acting.

E. P / I / D - Proportional / Integral /Derivative - the DE-1550 uses standard PID controls in order to maintain engine speed.

F. Target Speed Strategy - Fixed Speed / Linear Speed Setpoint Control.

G. Channel Permissive / Permissive Value - The permissive channel may be any channel. The permissive channel must exceed the permissive value in order for the unit to transition from IDLE to the TARGET SPEED. This could typically be set for engine oil temperature for most applications. Set the value to zero if you do not want the permissive channel preventing the unit from transitioning from IDLE to the TARGET SPEED.

H. When the unit is set for Linear Speed Setpoint control, there are new parameters for the controlling channel, variable low and high, and corresponding low and high RPM targets. This section creates the relationship between the controlling channels value, and the accompanying desired speed output.

I. Idle Speed - This is the target speed after the unit first starts running and before the time delays and permissive channels are met.

J. Minimum load speed - the engine speed must be above this value before the bypass closes to load the engine.

K. TARGET SPEED - The target speed is the RUNNING speed in the fixed mode of operation. This is the desired speed setpoint and occurs after the IDLE SPEED.

L. Stable Run time / Stable Run Speed - The unit must run above a certain speed for a programmed amount of time upon start-up, or a fault will occur.

M. PPR - Used to set the pulses per revolution.

32.3 EDIT SCREEN VIEWS - This screen allows the user to configure what three channels may be viewed on the home screen, and what 8 channel may be viewed in 3 other screens. This lets the user customize the channels to their priority. Since the 20 character is too long to be properly displayed, the user may select their own label up to 9 characters

32.4 CONFIGURATION SUMMARY

A. Save to File - This allows the user to save the configured file for download, further review or as a backup. Exit the program and select 'Program Unit' if desired to configure a DE-1550.

B. Print Data - This allows the user to print the configuration.

33.0 AFR CONTROL

33.1 The primary task of AFR control on the DE-1550, in conjunction with a stepper valve, is to accurately control the air fuel ratio (AFR) of an engine. The DE-1550 is primarily for rich burn, carbureted engines. The unit controls to an O2 setpoint and must be above the minimum exhaust temperature before the unit begins to control. Prior to control, the unit will be in the default position. Control should be maintained through reasonable load and fuel BTU variations.

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.

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.

Methane => 16.09 : 1 and Gasoline => 14.70 : 1

Lambda for stoichiometric combustion would be 1.0, no matter what fuel is used.

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

33.2 An O2 sensor (lambda sensor) is used to provide AFR feedback to the DE-1550. 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.

A type K thermocouple is used to assure that exhaust temperatures are high enough for correct operation of the sensor before closed loop control is enabled. An additional thermocouple can be used to monitor outlet temperature. The DE-1550 was designed for use on small engines where the catalyst is assumed to be close to the engine. The engine out temperature is assumed to be representative of the catalyst in temperature. Temperature limit set points are provided to create a catalyst protection shutdown capability.

33.3 A stepper 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.

The DE-1550 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.

34.0 SERIAL COMMUNICATIONS

34.1 PORT 4 Communications - Port 4 on the display board needs to be wired to the terminal board in order for the DE-1550 to operate correctly. See Figure 10. No other wires should be connected into this serial port as it is used as an internal Modbus connection. Port 4 on the display board and the TX1/RX1 lights on the terminal board should always be flashing during normal operation. Failure of this communications connection will result in an AFR serial communications fault.

34.2 MODBUS CUSTOMER HOOK-UP CONNECTIONS. Refer to figure 11 to view where to connect to Ports 3 and 5 on the DE-1550. Communications set for RS-485 are fixed at 9600 baud, 8 Data bits, No Parity, 1 Stop bits. The node address of Port 3 and 5 may be set by the PC terminal program. Port 3 may also be viewed/modified through the keypad.

34.3 OVERVIEW:
The DE-1550 is compliant to the Modicon Modbus RTU standard. Maximum number of registers that can be read at one time has been limited to 32.

34.4 MODBUS REGISTERS FOR PORTS 3 AND 5

ADDRESS	DESCRIPTION	Mode	Type
40002	STATUS, 00=STARTUP, 01=RUNNING, 80=STOP, 255=Standby, XX=FAULT, 48=MODBUS SERIAL FAULT, 16=OVERCRANK, 17=NO ROTATION, 66=FAILED START ATTEMPT	READ ONLY	UNSIGNED INT
40003	1=LOW SETPOINT FAULT, 2=HIGH SETPOINT FAULT	READ ONLY	UNSIGNED INT
40004	HOURMETER	R/W	UNSIGNED INT
40060	O2 TARGET (SET POINT), mV	READ ONLY	UNSIGNED INT
40061	DEFAULT STEPPER POSITION	READ ONLY	UNSIGNED INT
40062	AFR GAIN	READ ONLY	UNSIGNED INT
40063	ACTUAL STEPPER POSITION		UNSIGNED INT
40064	MINIMUM EXHAUST, CH61	READ ONLY	UNSIGNED INT
40065	EXHAUST HIGH SAFETY SETPOINT, CH61	R/W	UNSIGNED INT
40066	AFR MODE (0=MANUAL, 1 = AUTO)	READ ONLY	UNSIGNED INT
40067	POST CAT SETPOINT HIGH	R/W	SIGNED INT
40068	SAFETY SETPOINT LOW, CH55	R/W	SIGNED INT
40069	SAFETY SETPOINT HIGH, CH55	R/W	SIGNED INT
40070	Start Mode (0=Manual, 1 = Auto Field Pressure, 2 = Auto Timed, 3 = Auto Discharge, 4 = Auto All)	R/W	UNSIGNED INT
40071	FIELD PRESSURE TO START	R/W	SIGNED INT
40072	ON TIME (TIMED MODE)	R/W	UNSIGNED INT
40073	OFF TIME (TIMED MODE)	R/W	UNSIGNED INT
40074	DISCHARGE PRESSURE TO START	R/W	UNSIGNED INT
40075	START TRIES	R/W	UNSIGNED INT
40076	OVERCRANK	R/W	UNSIGNED INT
40077	TIME BETWEEN START ATTEMPTS	R/W	UNSIGNED INT
40078	FUEL VALVE DELAY	R/W	UNSIGNED INT
40079	IGNITION DELAY	R/W	UNSIGNED INT
40080	RUN SPEED SET POINT	R/W	UNSIGNED INT
40081	WARM UP TIMER	R/W	UNSIGNED INT

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ADDRESS	DESCRIPTION	Mode	Type
40082	POWER DOWN TIMER	R/W	UNSIGNED INT
40083	CONTROL CHANNEL (20,22)	R/W	
40084	LOW SAFETY SUCTION SET POINT (CH 20)	R/W	
40085	LOW FIELD PRESSURE SETPOINT (CH 22)	R/W	
40086	HIGH DISCHARGE PRESSURE SETPOINT (CH 21)	R/W	
40087	ELECTRONIC FUEL REGULATOR OUTPUT	READ ONLY	UNSIGNED INT
40088	GOVERNOR OUTPUT	READ ONLY	UNSIGNED INT
40089	NOT USED		
40090	NOT USED		
40091	DISPLAY FIRMWARE VERSION, MMYY	READ ONLY	UNSIGNED INT
40092	TERMINAL BOARD FIRMWARE VERSION, MMYY	READ ONLY	UNSIGNED INT
40093	AFR BOARD FIRMWARE VERSION,MMYY	READ ONLY	UNSIGNED INT
40100	Channel 20	READ ONLY	SIGNED INT
40101	Channel 21	READ ONLY	SIGNED INT
40102	Channel 22	READ ONLY	SIGNED INT
40103	Channel 23	READ ONLY	SIGNED INT
40104	Channel 24	READ ONLY	SIGNED INT
40105	Channel 25	READ ONLY	SIGNED INT
40106	Channel 26	READ ONLY	SIGNED INT
40107	Channel 27	READ ONLY	SIGNED INT
40108	Channel 30	READ ONLY	UNSIGNED INT
40109	Channel 50 (AFR-1)	READ ONLY	SIGNED INT
40110	Channel 51 (AFR-2)	READ ONLY	SIGNED INT
40111	Channel 52 (AFR-3)	READ ONLY	SIGNED INT
40112	Channel 53 (AFR-4)	READ ONLY	SIGNED INT
40113	Channel 54 (AFR-5)	READ ONLY	SIGNED INT
40114	Channel 55 (AFR-6)	READ ONLY	SIGNED INT
40115	Channel 56 (AFR-7)	READ ONLY	SIGNED INT
40116	Channel 57 (AFR-8)	READ ONLY	SIGNED INT
40117	Channel 58 (AFR-9)	READ ONLY	SIGNED INT
40118	Channel 59 (AFR-10)	READ ONLY	SIGNED INT
40119	Channel 60 (AFR-11)	READ ONLY	SIGNED INT
40120	Channel 61 (AFR-12)	READ ONLY	SIGNED INT
	All analog channels in 'tenths' except for RPM		
40124	AFR STATUS BITS		
BIT 0	CONTROL ACTIVE		
BIT 1	02 MOVING RICHER		
BIT 2	> 511mV Rich		
BIT 3	02 is Rich		
BIT 4	on Target < 5mV		
BIT 5	02 is lean		

ADDRESS	DESCRIPTION	Mode	Type
BIT 6	>511mV Lean		
BIT 7	02 moving leaner		
BIT 8	exh temp. low		
BIT 9	exh temp high		
BIT 10	02 sensor < .01V		
BIT 11	02 sensor > 1.1V		
BIT 12	reserved		
BIT 13	02 sensor not ready		
BIT 14	stepper lean limit		
BIT 15	stepper rich limit		
	0 = false, 1 = true		

41005	Month, 1-12		
41006	Day, 1-31		
41007	Year, 00-99		
41008	Time, 0-2359		

INDEX BY SECTION:

1.0 SYSTEM DESCRIPTION
2.0 DISPLAY MODULE
3.0 TERMINAL MODULE WITH INTEGRATED AFR CONTROL
4.0 STARTING THE ENGINE
5.0 ANALOG INPUTS
6.0 MOUNTING
7.0 WIRING
8.0 KEYPAD DESCRIPTION
9.0 DISCRETE OUTPUTS
10.0 UNDERSTANDING THE HOME SCREENS
11.0 PASSWORD SCREENS
12.0 HIGH/LOW SHUTDOWN SETPOINT SCREENS
13.0 SPEED CONTROL SCREENS
14.0 MODES OF OPERATION
15.0 LINEAR RAMP SETPOINT CONTROL
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20.0 TIMER SCREENS
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29.0 OPERATIONAL LOGIC
30.0 PC TERMINAL PROGRAM
31.0 USING THE PC TERMINAL PROGRAM
32.0 PROGRAMMABLE FIELDS IN THE PC TERMINAL PROGRAM
33.0 AFR CONTROLS
34.0 SERIAL COMMUNICATIONS

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DRAWINGS SECTION:

FIG. 1 DE-1550 DISPLAY MOUNTING

FIG. 2 DE-1550 TERMINAL MODULE MOUNTING DIMENSIONS

FIG. 3 WIRING DIAGRAM: GENERAL HOOK-UP

FIG. 4 WIRING DIAGRAM: PERSONAL COMPUTER

FIG. 5 TEMPERATURE TRANSDUCER P/N 691212-450/691213-450

FIG. 6 PRESSURE TRANSDUCER P/N 691201-X

FIG. 7 PRESSURE TRANSDUCER P/N 691204-X

FIG. 8 DE-1550 TIMING DIAGRAM

FIG. 9 TYPICAL O2 SENSOR RESPONSE (ESTIMATED DATA)

FIG. 10 PORT 4 COMMUNICATIONS

FIG. 11 MODBUS CUSTOMER HOOK-UP CONNECTIONS

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FIG. 1 DE-1550 DISPLAY MOUNTING DIMENSIONS

FIG. 2 DE-1550 TERMINAL MODULE MOUNTING DIMENSIONS

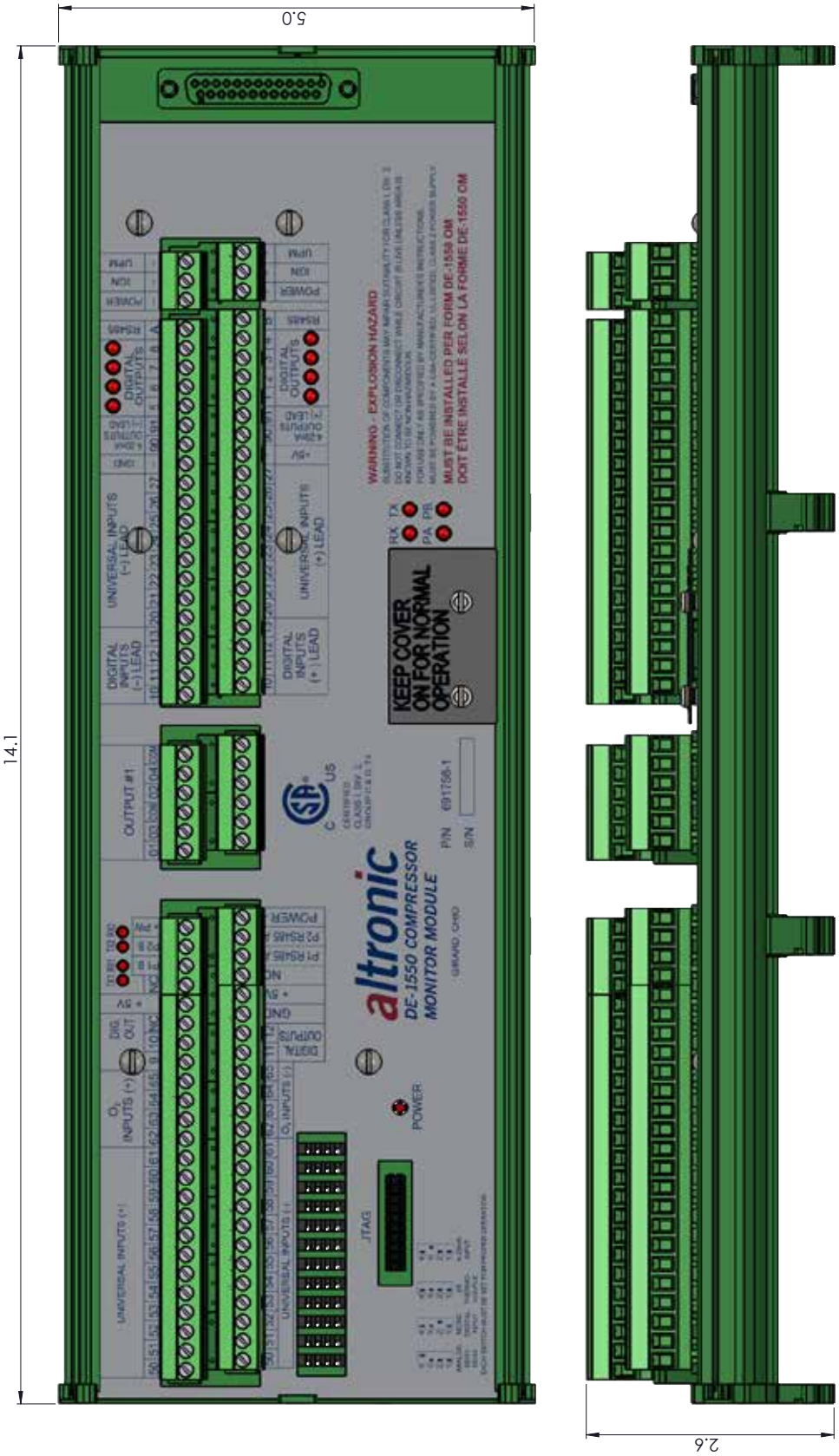


FIG. 3 WIRING DIAGRAM: GENERAL HOOK-UP

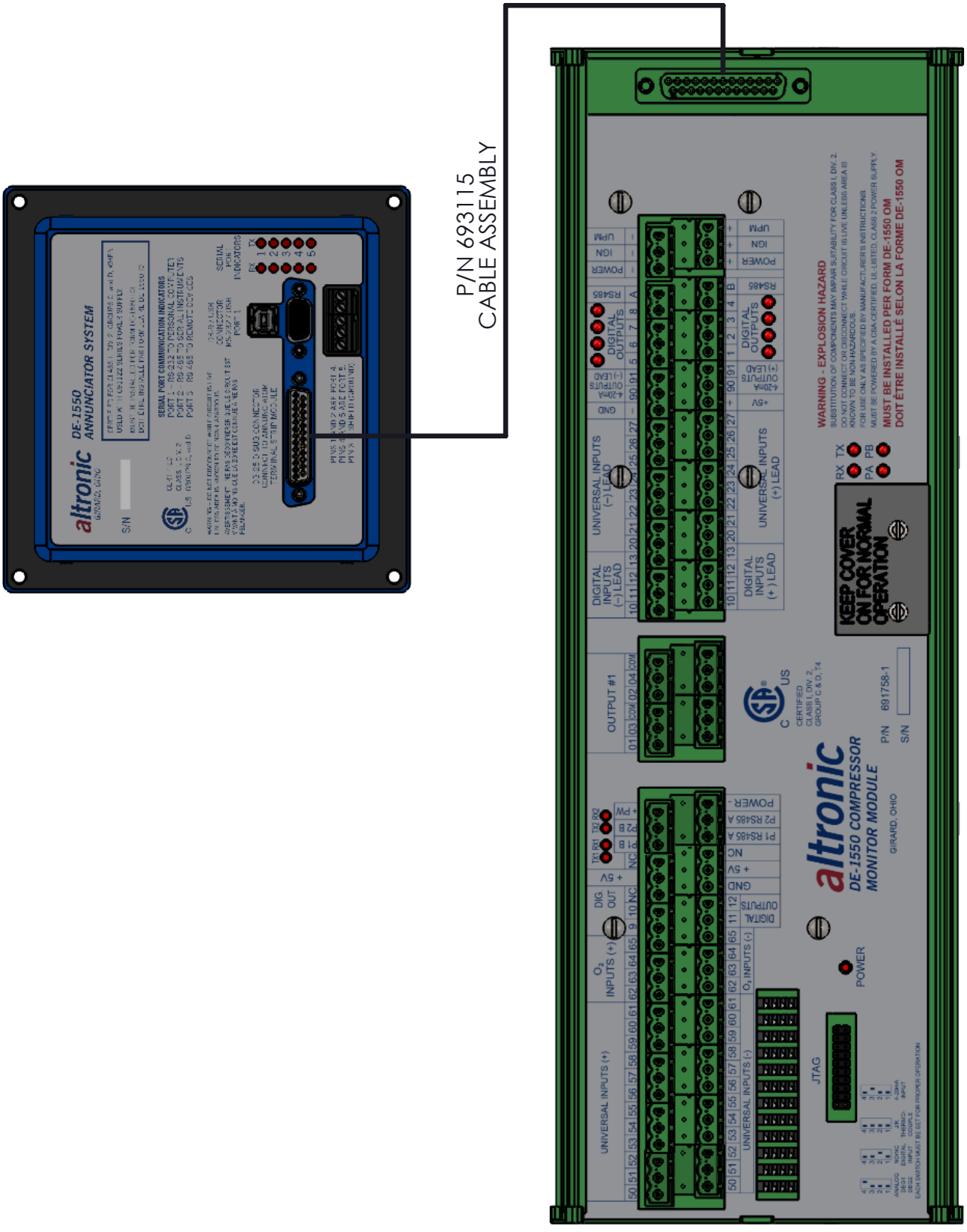


FIG. 4 WIRING DIAGRAM: PERSONAL COMPUTER

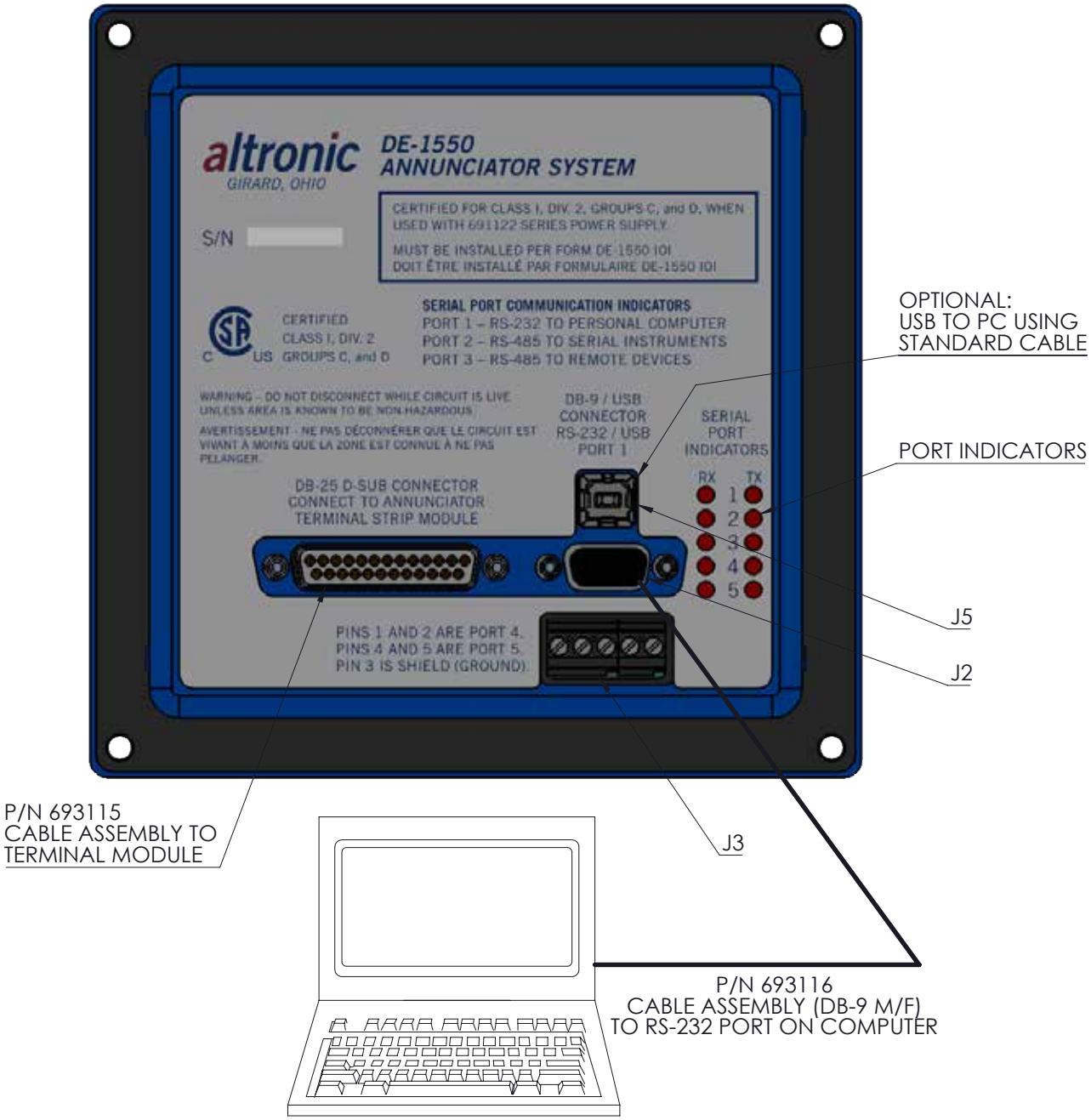
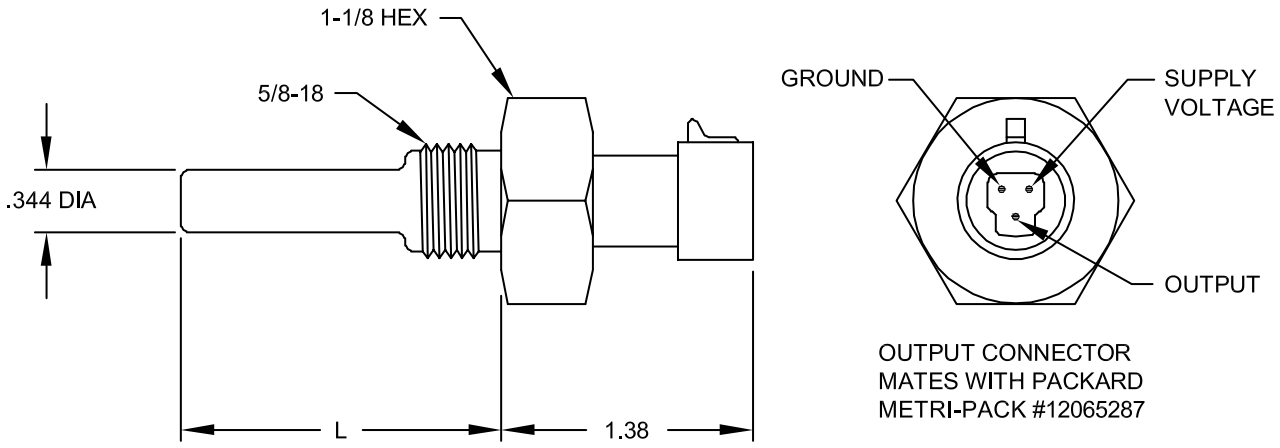


FIG. 5 TEMPERATURE TRANSDUCER P/N 691212-450/691213-450



SPECIFICATIONS:

EXCITATION VOLTAGE: +5VDC ±0.1V, 5MA MAX.

NOMINAL OUTPUT VOLTAGE RANGE: 1.36 TO3.40 (-40°F TO 450°F)

SENSOR TYPE: SILICON DIODE

CASE MATERIAL: 300 SERIES STAINLESS STEEL

ACCURACY: ±6°F OVER TEMPERATURE RANGE

OPERATING TEMPERATURE: -40 TO 450°F (-40 TO 232°C)

STORAGE TEMPERATURE: -40 TO 572°F (-40 TO 300°C)

INSTALLATION: USE A 1-1/8" WRENCH TO TIGHTEN THE TRANSDUCER.

MOUNT THE TEMPERATURE TRANSDUCER IN A THERMOWELL ON THE ENGINE OR MACHINE. THE ACTUAL SENSOR IS LOCATED AT THE BOTTOM OF THE TRANSDUCER; TO ENSURE ACCURATE READINGS, THE TIP OF THE PROBE SHOULD BE SURROUNDED BY THE MEDIA.

CAUTION: DO NOT EXCEED THE ABSOLUTE MAXIMUM TEMPERATURE RANGE OF THE TRANSDUCER WHICH IS 572°F. DO NOT USE FOR EXHAUST TEMPERATURE MONITORING AS EXHAUST TEMPERATURES MAY EXCEED THE MAXIMUM TEMPERATURE RATING.

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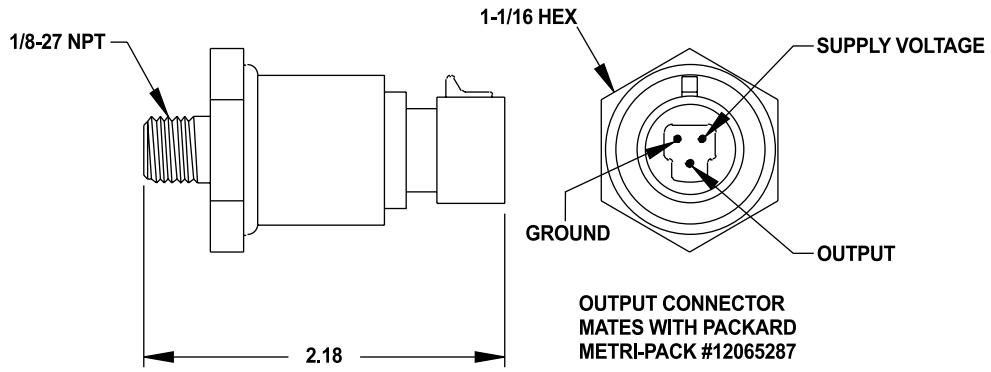
FIG. 6 PRESSURE TRANSDUCER P/N 691201-X



SPECIFICATIONS:

EXCITATION VOLTAGE: +5VDC ±0.25V, 20MA MAX. (5MA TYP.)

OUTPUT VOLTAGE: 0.50 TO 4.50V MIN. TO MAX. PRESSURE, RATIOMETRIC OUTPUT

NULL OFFSET: 0.50V

TRANSDUCER TYPE: SEALED GAUGE

MATERIAL IN CONTACT WITH MEDIA: 300 SERIES STAINLESS STEEL

OVERLOAD: 1.5X RATED RANGE WITHOUT DAMAGE
10X RATED RANGE WITHOUT BURSTING

CASE MATERTIAL: PLATED STEEL

ACCURACY @ 25°C: ±0.25% OF SPAN FROM BEST FIT STRAIGHT LINE, INCLUDES EFFECTS OF NON-LINEARITY, HYSTERESIS, AND REPEATABILITY

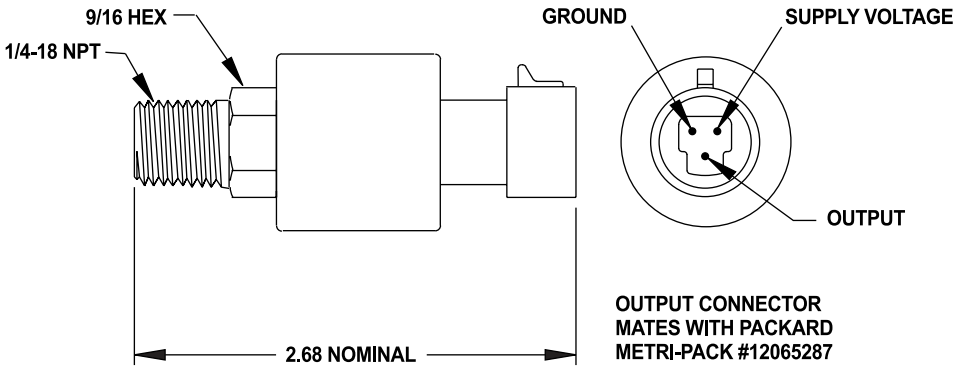
COMPENSATED OPERATING AND STORAGE TEMPERATURE RANGE: -40 TO 257°F (-40 TO 125°C)

TOTAL ERROR: ±2% OF FULL SCALE, INCLUDES THE EFFECTS OF TEMPERATURE, NON-LINEARITY, HYSTERESIS, AND REPEATABILITY

INSTALLATION: USE A 1-1/16" WRENCH TO TIGHTEN TRANSDUCER. DO NOT USE THE CASE TO TIGHTEN TRANSDUCER

CAUTION: AVOID PRESSURES IN EXCESS OF FULL SCALE PRESSURE OR VACUUM. OVERPRESSURE MAY CAUSE CALIBRATION CHANGE OR DAMAGE TO THE ELEMENT. WHEN SELECTING A PRESSURE TRANSDUCER RANGE, BOTH STATIC AND DYNAMIC OVERLOADS MUST BE CONSIDERED. PRESSURE FLUCTUATIONS OCCUR IN MOST SYSTEMS. THESE FLUCTUATIONS CAN HAVE VERY FAST PEAK PRESSURES, AS IN WATER HAMMER EFFECTS. AN OSCILLOSCOPE CAN BE USED TO DETERMINE IF HIGH PRESSURE TRANSIENTS EXIST IN A SYSTEM. WHERE PRESSURE PULSES ARE EXPECTED, SELECT A TRANSDUCER RATING HIGH ENOUGH TO PREVENT OVERLOAD BY THE PEAK PRESSURES. WHERE HIGH PRESSURE TRANSIENTS ARE UNAVOIDABLE, USE EITHER A HIGHER RANGE TRANSDUCER OR A PULSATION DAMPENER OR SNUBBER TO REDUCE THE PEAK PRESSURE APPLIED TO THE TRANSDUCER.

FIG. 7 PRESSURE TRANSDUCER P/N 691204-X



SPECIFICATIONS:

EXCITATION VOLTAGE: +5VDC ±0.25V, 5MA MAX

OUTPUT VOLTAGE: 0.50 TO 4.50V MIN. TO MAX. PRESSURE, RATIOMETRIC OUTPUT

NULL OFFSET: 0.50V

TRANSDUCER TYPE: ABSOLUTE

MATERIAL IN CONTACT WITH MEDIA: 300 SERIES STAINLESS STEEL

ENVIRONMENTAL SEAL: FLUOROCARBON

OVERLOAD: 3X RATED RANGE WITHOUT DAMAGE
5X RATED RANGE WITHOUT BURSTING

CASE MATERTIAL: 316 STAINLESS STEEL

ACCURACY @25°C: ±0.50% OF SPAN FROM BEST FIT STRAIGHT LINE, INCLUDES EFFECTS OF NON-LINEARITY, HYSTERESIS, AND REPEATABILITY

COMPENSATED TEMPERATURE RANGE: -4° TO 212°F (-20 TO 100°C)

OPERATING AND STORAGE TEMPERATURE RANGE: -40° TO 221°F (-40 TO 105°C)

TOTAL ERROR: ±3% OF FULL SCALE, INCLUDES THE EFFECTS OF TEMPERATURE, NON-LINEARITY, HYSTERESIS, AND REPEATABILITY

INSTALLATION: USE A 9/16" WRENCH TO TIGHTEN TRANSDUCER. DO NOT USE THE CASE TO TIGHTEN TRANSDUCER

CAUTION: AVOID PRESSURES IN EXCESS OF FULL SCALE PRESSURE OR VACUUM. OVERPRESSURE MAY CAUSE CALIBRATION CHANGE OR DAMAGE TO THE ELEMENT. WHEN SELECTING A PRESSURE TRANSDUCER RANGE, BOTH STATIC AND DYNAMIC OVERLOADS MUST BE CONSIDERED. PRESSURE FLUCTUATIONS OCCUR IN MOST SYSTEMS. THESE FLUCTUATIONS CAN HAVE VERY FAST PEAK PRESSURES, AS IN WATER HAMMER EFFECTS. AN OSCILLOSCOPE CAN BE USED TO DETERMINE IF HIGH PRESSURE TRANSIENTS EXIST IN A SYSTEM. WHERE PRESSURE PULSES ARE EXPECTED, SELECT A TRANSDUCER RATING HIGH ENOUGH TO PREVENT OVERLOAD BY THE PEAK PRESSURES. WHERE HIGH PRESSURE TRANSIENTS ARE UNAVOIDABLE, USE EITHER A HIGHER RANGE TRANSDUCER OR A PULSATION DAMPENER OR SNUBBER TO REDUCE THE PEAK PRESSURE APPLIED TO THE TRANSDUCER.

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FIG. 8 DE-1550 TIMING DIAGRAM

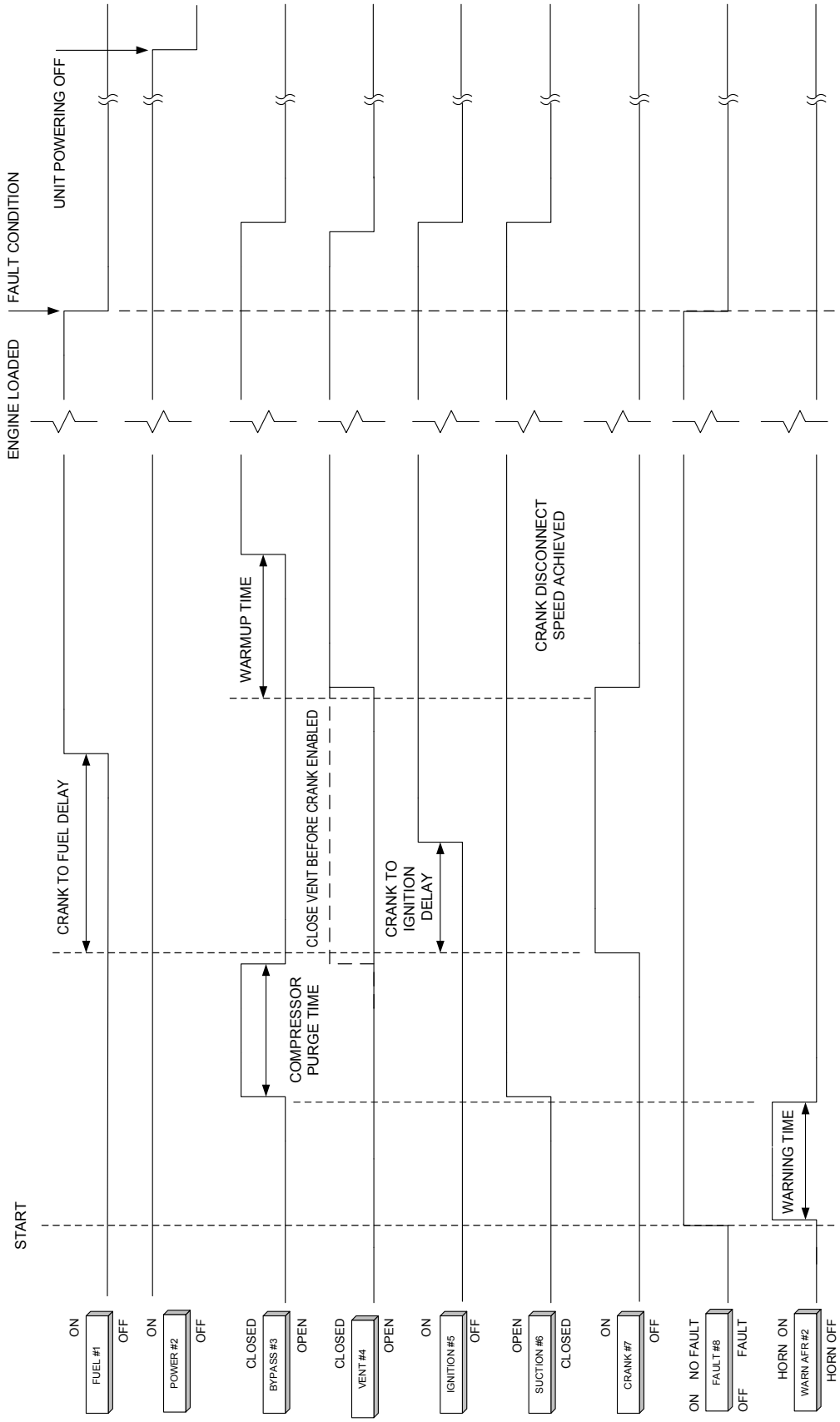

FIG. 9 TYPICAL O2 SENSOR RESPONSE (ESTIMATED DATA)

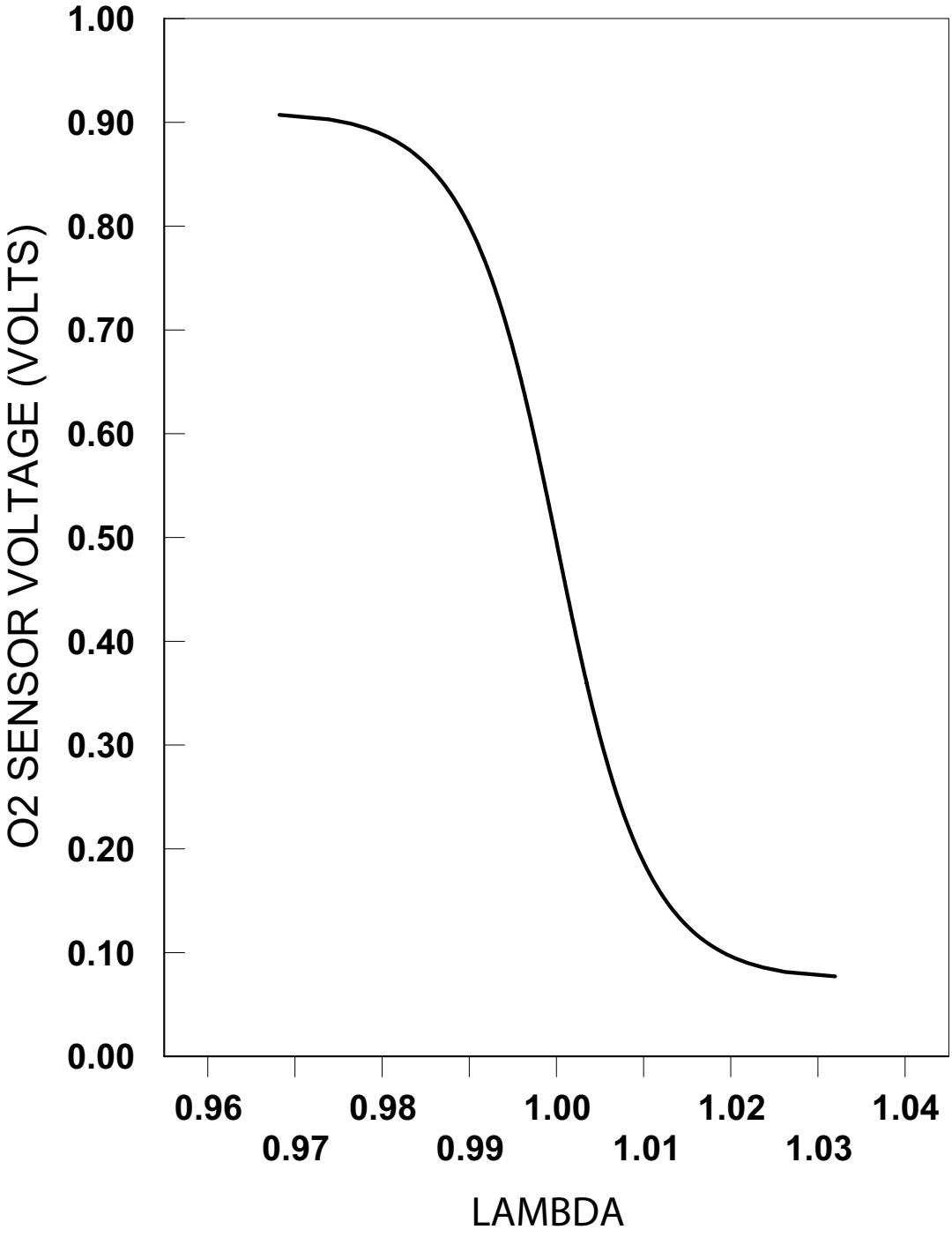

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FIG. 10 PORT 4 COMMUNICATIONS

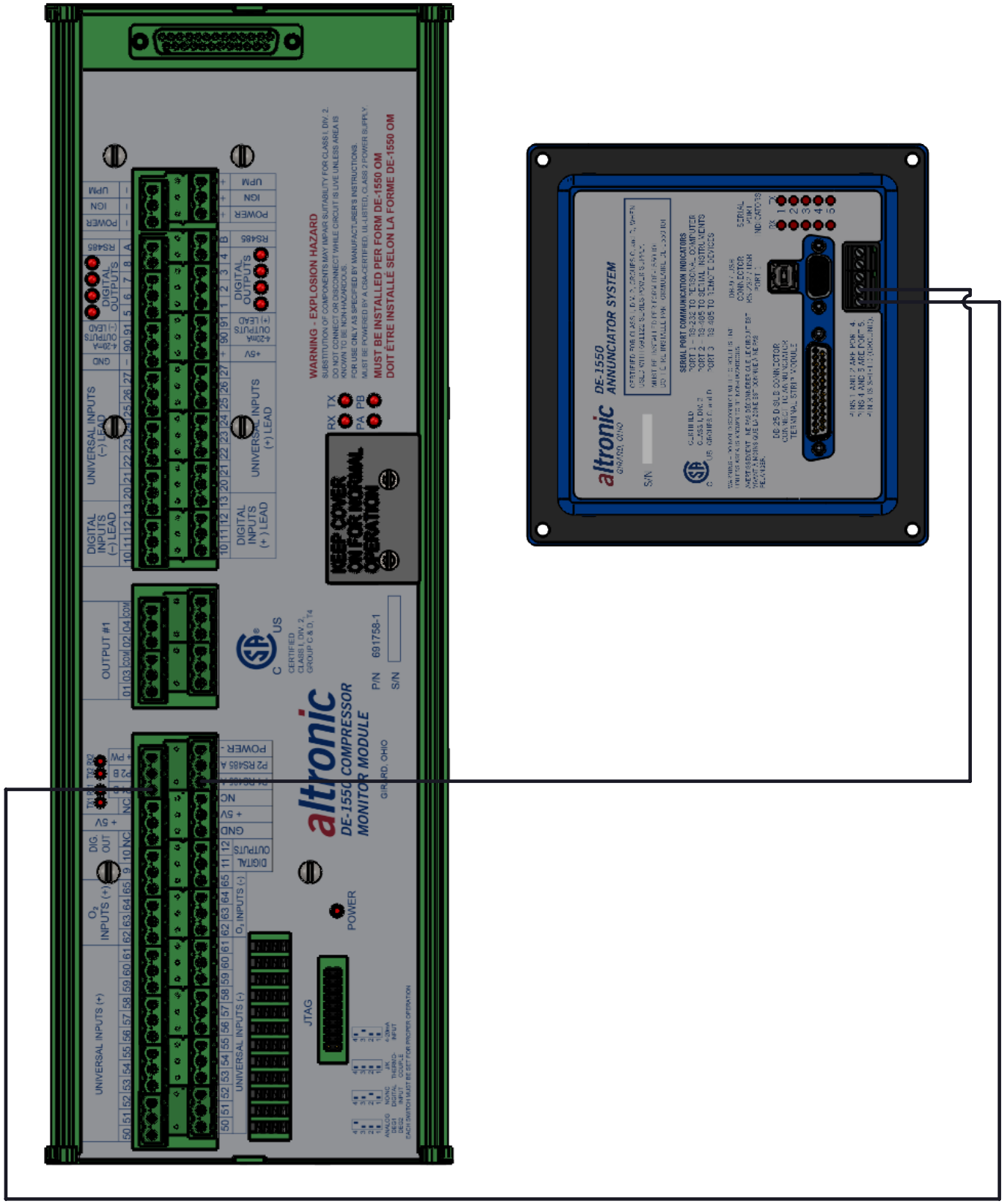
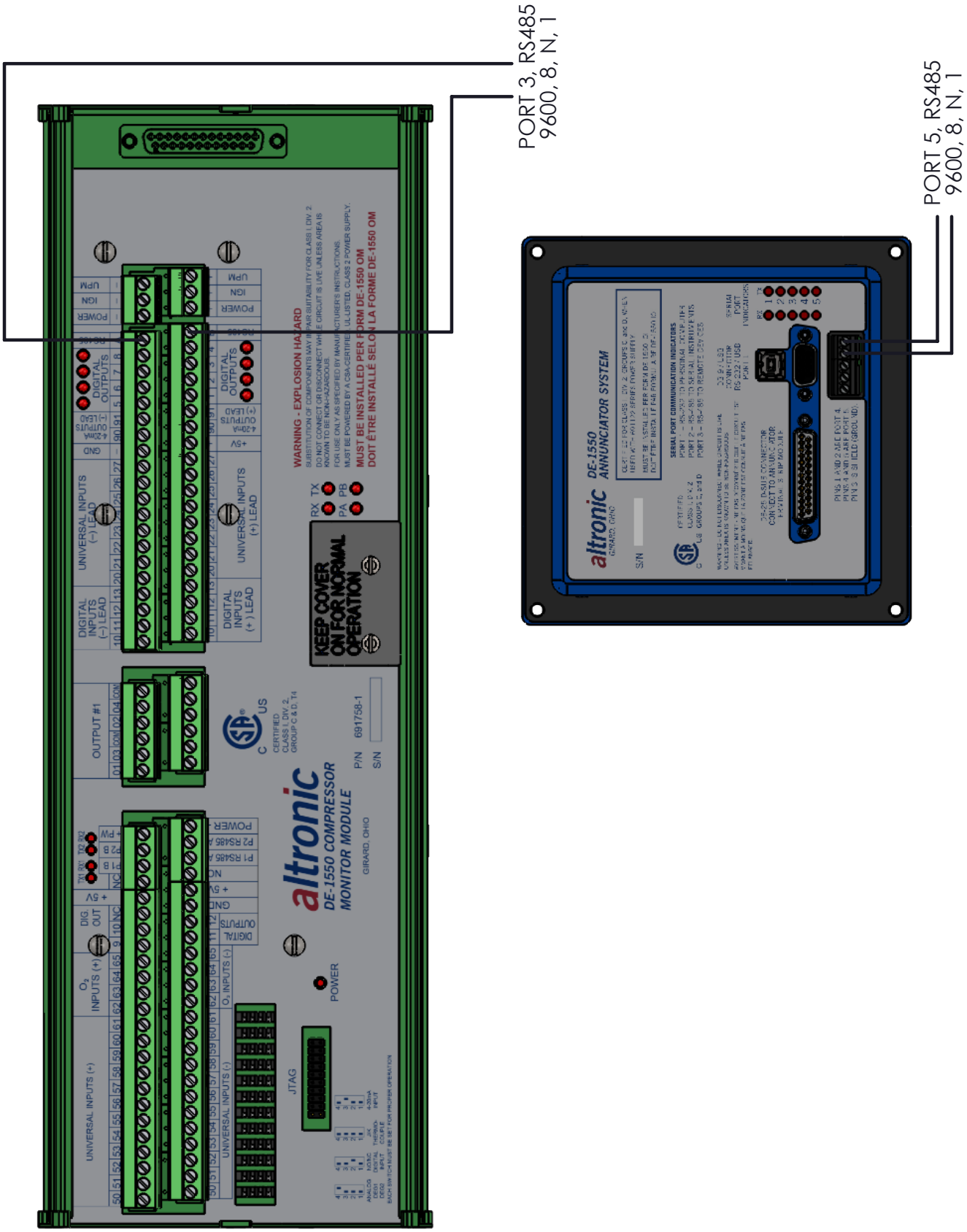


FIG. 11 MODBUS CUSTOMER HOOK-UP CONNECTIONS



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