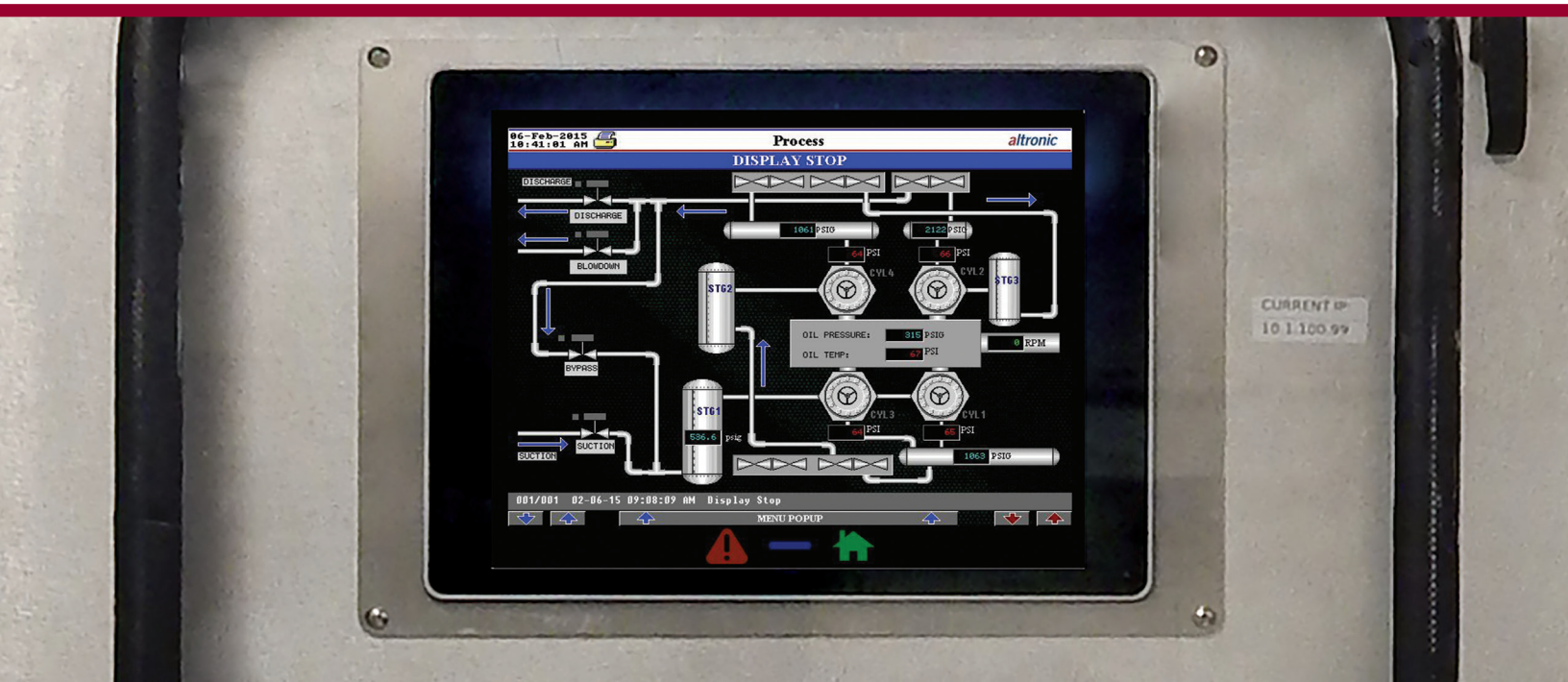
Operating Instructions

DE-3000+ Series Configurable Safety Shutdown and Control System

with Graphing Capabilities

Form DE-3000+ IOI 8-15

altronic
HOERBIGER Engine Solutions



1.0 OVERVIEW

1.1 For help locating subjects in this document, a section index is provided on page 68. A glossary of technical terms begins on page 66.

1.2 The Altronic DE-3000+ 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. A panel-mounted 10" color MIDAS HMI serves as the user interface. The DE-3000+ 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. The DE-3000+ also provides for remote data acquisition and supervisory control in a compact, low cost package for industrial compressor applications. The optimization strategies available for the management of compressor throughput include automatic prime mover speed setting as well as capacity control. On rotary screw compressors, capacity control can be done via suction throttling, or using an internal gas bypass technique employing poppet valves, turn valves or slide valves. On reciprocating compressors, capacity can be controlled using external gas bypass loops or pressure regulation techniques. A wide range of output options, including both analog current loops and digital outputs, are provided to interface with the large variety of actuation systems currently in use. In addition, automatic load limiting based upon prime mover power capabilities or other application specific limitations, such as cooling capacity, are readily implemented. There are also AUTO START and OEM ENGINE CONTROL options that are enabled using the terminal program.

1.3 The DE-3000+ has four components: 10" color MIDAS HMI (G10S0000), computer module (DE-3000+), terminal module (691171-1), and power supply module (691122-1). The MIDAS HMI and the computer module communicate via the Ethernet port using a CAT 5e cable. The computer module connects to the terminal module via a DB-25 cable. An additional terminal board may be added for 30 extra channels (691171-2) or 15 extra channels (691175-2). This increases the channel selections from 1-30 to 1-60 or 1-45 respectively.

To download the terminal program, a DB-9 cable must be connected to the to the DE-3000+.

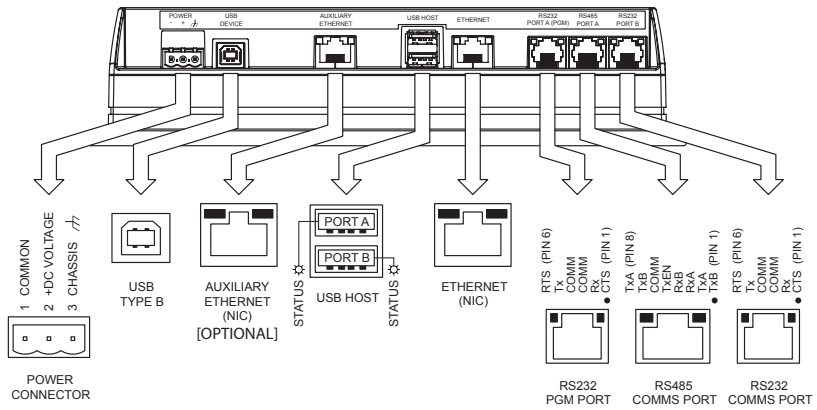
WARNING: DEVIATION FROM THESE INSTRUCTIONS MAY LEAD TO IMPROPER ENGINE OPERATION WHICH COULD CAUSE PERSONAL INJURY TO OPERATORS OR OTHER NEARBY PERSONNEL.

WARNING: THE CONTROLLER SYSTEM MUST BE CONFIGURED PRIOR TO USE ON A COMPRESSOR SYSTEM. REFERENCE THE PROGRAMMING INSTRUCTIONS (PAGE 43) FOR INSTRUCTIONS DESCRIBING HOW TO CONFIGURE THE CONTROLLER FOR THE SPECIFIC APPLICATION. VERIFY THE PROGRAM IN NONVOLATILE MEMORY (THE EEPROM) PRIOR TO STARTING THE SYSTEM.

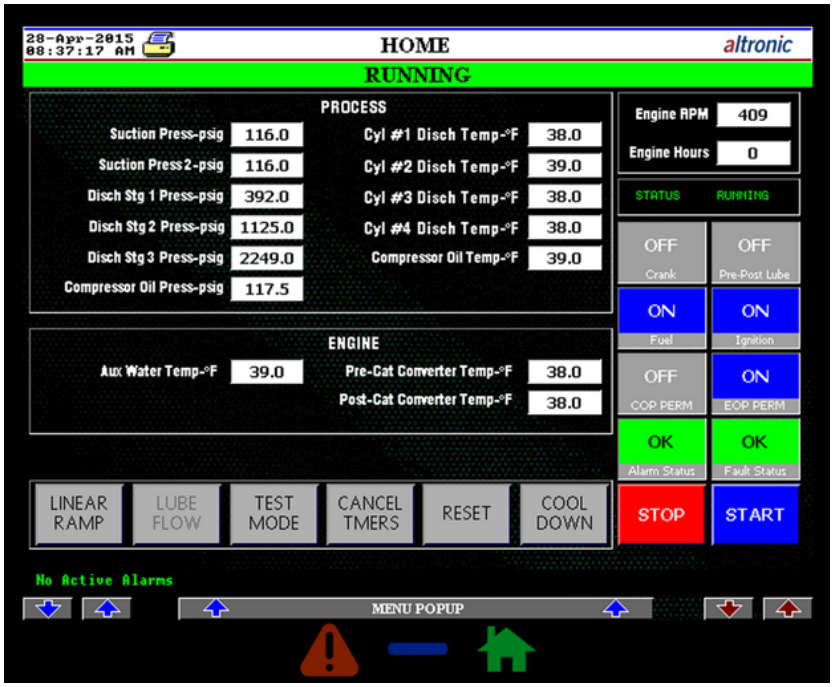
NOTE: THE DE-3000+ REQUIRES TWO 10-32VDC, 0.2A (MAX) POWER SOURCES, ONE FOR THE POWER SUPPLY BOARD AND THE OTHER FOR THE COMPUTER MODULE.

2.0 10" COLOR MIDAS HMI

2.1 The 10" color MIDAS HMI serves as the user interface for the DE-3000+ system. It is a VGA color standard touchscreen (640 x 480) outdoor model. The MIDAS HMI has one 10/100 Base-TX Ethernet Port and three fully isolated Serial Communication Ports (two RS-232 and one RS-422/485). In addition, the MIDAS HMI has one USB Type B Port and two High-retention USB Host Ports.



2.2 The MIDAS HMI available with the DE-3000+ system uses a status strip to display the controller status on top of all the screens. The 10 inch screen displays colored trends for analog values and temperatures, and bar graphs for all the PIDs. In addition, log files can be stored on the SD card, if mounted on the MIDAS HMI.



2.3 The MIDAS HMI communicates with the DE-3000+ computer module through the Modbus TCP/IP protocol. The DE-3000+ computer module has to be correctly configured to establish communication with the MIDAS HMI.

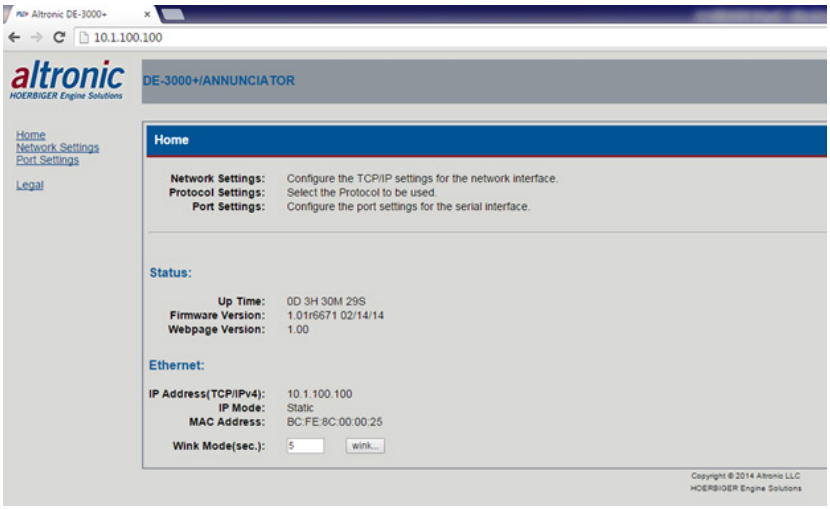
3.0 COMPUTER MODULE (DE-3000+)

3.1 The Computer Module is designed to be rail-mounted and is the interface between the Terminal and 10" MIDAS HMI and to other systems. It typically plugs directly into the Terminal Module using the DB-25 connectors and is held together with screws and screw locks.

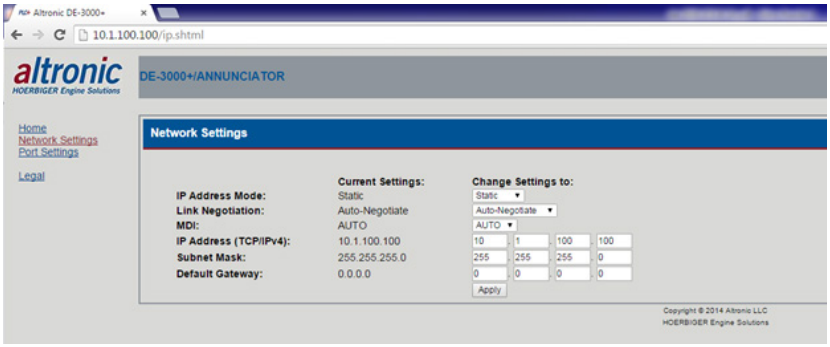
3.2 The computer module must be supplied with 10-32VDC, .2A Max current.

3.2 The computer module comes with a default IP address of 10.1.100.100. In order to configure the DE-3000+, connect it to a computer through the CAT 5e cable and type in the default IP address on the web browser. The Home page appears. User can navigate to the Network Settings and Port Settings by clicking on the menu on the left of the web page.

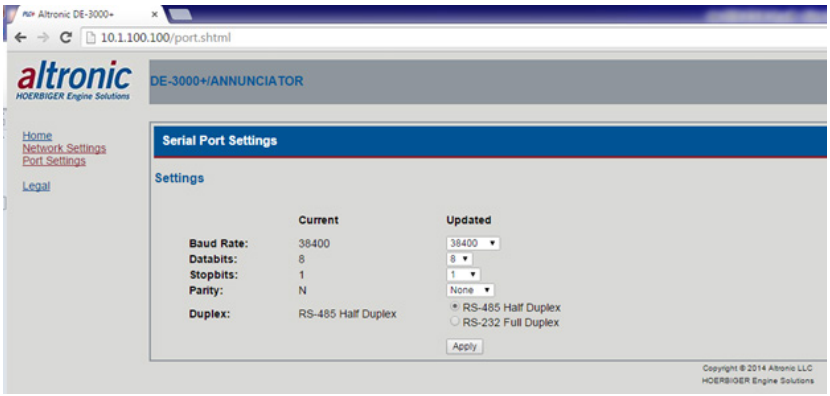
3.3 The Home page gives an overview of the DE-3000+ status. The Status shows the active time for the computer module along with the firmware and web-page version.



3.4 The Network Settings page displays the communication configuration of the DE-3000+. This is the page where the user can change the IP configuration of the system to match their network. To change the IP configuration, type in the new IP settings under "Change Settings to:" and press "Apply." The web page will reload. Reboot the computer module and access the web browser again. The new IP settings should have been accepted by the computer module.



3.5 The Serial Port Settings page displays the serial port configuration of the DE-3000+. The settings shown below under "Current" is the default setting and should be kept this way for optimum communication with the DE-3000+ terminal board(s).



4.0 POWER SUPPLY MODULE

4.1 The Power Supply Module accepts up to four industry-standard, commercially-available 0.6 inch plug-in Output Modules. The Output Modules provide a means of using the DE-3000+ Controller Safety Shutdown System status to interface with other systems on the engine/motor and compressor. A typical application would be as a relay or solenoid coil driver. The Output Modules are optically isolated, solid-state switches which are isolated from power supply minus and engine ground. The Output Modules will be in the open (de-energized) condition when the unit is not powered.

4.2 Outputs 1 and 2 can be software-configured for either normally-open (N/O) or normally-closed (N/C) operation and have an LED indicator associated with them. Outputs 3 and 4 are pre-programmed normally-open for use with the optional OEM Engine Control or Auto start feature. If an Output Module is programmed for normally-closed (energized for run), the LED will be ON in the normal run condition and OFF for a fault condition. For Normally-open configured modules the LED will be OFF for normal run condition and turn ON for a fault condition.

4.3 The standard Output Module outputs use the top row of the dual 16-position terminal strip which is marked OUT 1 through OUT 4. Each of these outputs are fused with a replaceable 6.3 amp slow-blow fuse, Altronic P/N 601653. In addition to accepting industry-standard Output Modules, a custom Altronic Output Module P/N 691124 is available for tripping ignition powered CD fuel valves and shorting CD ignition shutdown leads upon a fault. When making use of OEM Engine Control, outputs 1 and 2 will not be wired to trip the fuel and ignition valves. When both functions are required, two of these modules are used as follows: OUT 1 slot must be used to trip the fuel valve, and OUT 2 slot must be used to short the ignition. If 12-24Vdc is lost to the DE-3000+ annunciator system, the custom Output Modules will trip the fuel valve and short the ignition shutdown lead. This mimics the “fail-safe” operation of a normally-closed Output Module and therefore the LED will be ON in the normal run condition and OFF for a fault condition. In programming the system, these modules are identified by using the IGN/FUEL selection. Terminals IGN+ and IGN– are used to connect the shutdown lead, and FV1 and FV2 are used for the CD fuel valve. A capacitor is included in the Power Supply Module to supply the energy to trip the fuel valve.

4.4 The 12-24Vdc power for the DE-3000+ system is applied to the power supply terminals marked (+) and (–) 12–24Vdc INPUT POWER. A 6.3 amp replaceable slow-blow fuse protects the system from over-currents, and a power LED lights when power is applied to the system.

4.5 The external connection for the two serial RS-485 communication ports is on the Power Supply Module terminal strips. Port 2 is for RS-485 serial communication to future Altronic instruments, and port 3 communicates internally between two different boards within the computer module. Nothing should be plugged into ports 2 and 3 for normal operations.

4.6 Terminals marked IGN IN and PU IN are used by the DE-3000+ system to detect either engine rotation or ignition system firings. This input monitors changing signals such as those seen on either the ignition shutdown lead or a magnetic pickup monitoring an engine mounted gear.

THE MAGNETIC PICKUP INPUT MUST BE USED FOR APPLICATIONS ENABLING THE AUTO START OR OEM ENGINE CONTROL FUNCTION.

- The IGN IN terminal connects to the positive (+) C.D. ignition shutdown lead.
- The PU IN terminal connects to one magnetic pickup input; the other pickup wire connects to the minus (–) terminal on the Power Supply Module.

NOTE: AN INSTALLATION MAY USE ONLY ONE OF THE TERMINALS IGN IN, PU IN, OR T+.

5.0 TERMINAL MODULE

5.1 The Terminal Module is made to be rail-mounted and is the point of interface between the field sensor wiring and the DE-3000+ 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 30 inputs, where any of the 30 can be used for either a normally-open, normally-closed switch, or analog inputs including K- or J-type thermocouples. These are listed as channels 01–30 for the 691171-1 terminal board. They accept industry-standard transducer signals in the range of 0-5 VDC. Connections from the Terminal Module to the Display Module are made using the 693115-x series Cable Assembly.

691171-1 FOR CHANNELS 01-30

691171-2 FOR CHANNELS 31-60

691175-2 FOR CHANNELS 31-45

5.2 The DE-3000+ is designed to operate with industry-standard voltage or current-amplified output transducers in the range of 0 to 5Vdc or 0 to 25mA. Four series of transducers are available from Altronic: pressure transducers 691201-x, 691204-x and temperature transducers 691202/203-300, 691212/213-450.

5.3 Another terminal board assembly may be added to increase the inputs from 30 to either 45 or 60 inputs. Use cable 693133-1 to connect the two boards. The 691175-2 provides an additional 15 inputs, 4 digital outputs, 2 analog outputs and an extra speed (pickup) input. The 691171-2 provides an additional 30 inputs, 8 digital outputs, 2 analog outputs, and an extra speed (pickup) input.

5.4 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.

5.5 DIFFERENTIAL MEASUREMENTS

Differential pressures or temperatures may be measured by using two consecutive channels. The transducers used to measure differential values must be of the exact same type and range. The first channel of the pair will display the basic parameter it is monitoring and the second channel of the pair will display the numeric difference in engineering units of its value subtracted from the first channel's value. Setpoints for each channel monitor the displayed value of that channel. The second channel setpoints monitor the differential value.

5.6 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.

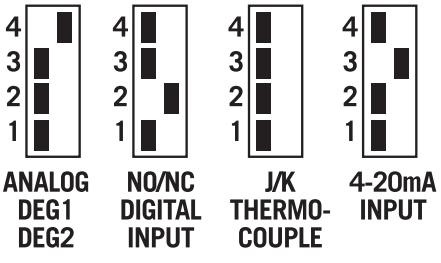
5.7 THERMOCOUPLE INPUTS

The Terminal Modules can accept industry-standard type J or K thermocouples on inputs 01–60. 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. The monitor can read type J thermocouples between -76°F and +1382°F (-60°C and +750°C) and type K thermocouples between -76°F and +1472°F (-60°C and +800°C).

5.8 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.

EACH SET SWITCH MUST BE SET FOR PROPER OPERATION



5.9 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.

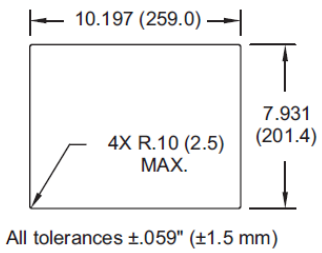
5.10 For each input, the corresponding CHANNEL SWITCH must be set according to the input type. Switches are turned ON by moving them toward the ANALOG OUT labeling.

5.11 Digital outputs 1 through 8 are pilot-duty, and turn on to common ground when closed. Outputs 1 through 8 are rated at 500mA, 60V. See FIG. 8 for wiring details.

6.0 MOUNTING

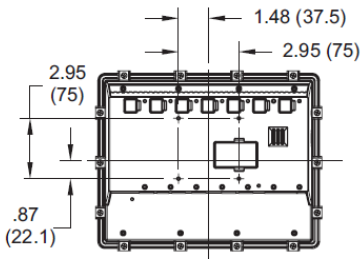
6.1 10" COLOR MIDAS HMI
The operator interface is designed for through-panel mounting. Four VESA mount tapped screw-holes (M4 x 0.7, 5 mm deep) are present on the rear of the panel to allow for stand or wall mounting. Care should be taken to remove any loose material from the mounting cut-out to prevent that material from falling into the operator interface during installation. A gasket is provided to enable sealing to NEMA 4X/IP66 specification. Install the mounting clips provided and tighten to 6.0 pound-force inch (96 ounce-force inch) evenly for uniform gasket compression.

PANEL CUT-OUT



All tolerances ±.059" (±1.5 mm)

VESA MOUNT (MIS-D 75) DIMENSIONS



NOTE: FOR HAZARDOUS LOCATION INSTALLATION, THIS DEVICE MUST BE MOUNTED IN A SUITABLE DUST TIGHT END-ENCLOSURE AND MUST BE WIRED USING DIVISION 2 WIRING METHODS AS SPECIFIED IN ARTICLE 501-4 (B), 502-4 (B), AND 503-3 (B) OF THE NATIONAL ELECTRICAL CODE, NFPA 70 FOR INSTALLATION WITHIN THE UNITED STATES, OR AS SPECIFIED IN SECTION 19-152 OF CANADIAN ELECTRICAL CODE FOR INSTALLATION IN CANADA.

6.2 POWER SUPPLY MODULE
Mount the Power Supply Module in the panel either on the bottom or the side of the main panel. The Power Supply Module is made to be rail-mounted onto commercially available 32 or 35mm DIN mounting rails. It is also made to plug directly into the Terminal Module using the DB-25 connectors and is held together with screws and screw locks. Two end brackets P/N 604199 should be used to keep the modules from sliding off the ends of the mounting rail.
Alternatively, the Power Supply Module and the Terminal Module can be mounted separate from each other on the DIN mounting rails but in the same panel; in this case, a DB-25 male/female cable such as P/N 693115-1 is used to electrically connect these modules. The operating temperature range of the Power Supply Module is –31°F to +176°F (–35°C to +80°C).

6.3 TERMINAL MODULE
Mount the Terminal Module either on the bottom or the side of the main panel. The Terminal Module and Power Supply Module can be rail-mounted onto commercially available 32 or 35mm DIN mounting rails. The Terminal Module plugs directly into the Power Supply Module using the DB-25 D-Sub connectors and is held together with screws and screw locks. Two end brackets P/N 604199 are used to keep the modules from sliding off the ends of the rail. The Terminal Module and the Display Module are electrically connected with a DB-25 male/female cable, 693115-x series or equivalent. The operating temperature range of the Terminal Module is –31°F to +176°F (–35°C to +80°C).

6.4 PRESSURE TRANSDUCER
Mount the pressure transducer in the panel or in a manifold or tube off of the engine. Do not expose the pressure transducer to temperatures above 221°F (105°C). The second terminal module should be placed close to the first and the wire connecting them should be free of high-powered panel signals.

IMPORTANT: PRESSURE TRANSDUCERS WILL WITHSTAND OVERLOADS AS HIGH AS 1.5 TIMES RATED PRESSURE. IF THE OVERLOAD RATING IS EXCEEDED, FAILURE MAY OCCUR. PRESSURE FLUCTUATIONS OCCUR IN MOST RECIPROCATING SYSTEMS; PICK THE TRANSDUCER WITH A RATING HIGH ENOUGH TO PREVENT OVERLOAD BY PEAK PRESSURES OF PULSATIONS. IT IS RECOMMENDED THAT A PRESSURE SNUBBER BE USED WHICH WILL REDUCE THE PEAK PRESSURE APPLIED TO THE TRANSDUCER. THE LIFE OF THE TRANSDUCER WILL BE EXTENDED WITH THE USE OF A SNUBBER OR PULSATION DAMPENER.

6.5 TEMPERATURE TRANSDUCER

Mount the temperature transducer in a thermowell on the engine or machine. The actual sensor is located at the bottom of the transducer body; to ensure accuracy, the tip of the probe should be surrounded by the measured media.

7.0 WIRING (SEE WIRING DIAGRAMS)

7.1 SYSTEM COMPONENT WIRING

A DB-25 male/female cable, 693115-x series or equivalent, is used to connect the Terminal Module to the Computer Module and secured with the cable lock screws. If mounted on the same mounting rail, plug the Terminal Module directly into the Power Supply Module using the DB-25 D-Sub connectors at the ends of the modules and secure them together with the screws and screw locks captive to the connectors. If the Power Supply Module and the Terminal Module are mounted separate from each other (must be mounted in the same panel) a DB-25 male/female cable such as P/N 693115-1 or equivalent is used to connect these modules. The HMI connects to the computer module through a CAT E5 cable.

IMPORTANT: DO NOT EXCEED THE ABSOLUTE MAXIMUM RATING OF THE TRANSDUCERS, 350°F (176°C) FOR THE 691202/203-300 OR 450°F (232°C) FOR THE 691212/213-450. CARE SHOULD BE TAKEN TO PROTECT THE WIRING AND CONNECTORS FROM CONTACT WITH HOT SURFACES.

7.2 Connect the supply power wires to the 10-32V input power terminals on the computer board. Connect the '+' to the 'DC+' and connect the '-' to the 'DC-' input. Do not connect any other wires into the green Phoenix module. The power rating for the computer module is 10-32V, .2A Max.

7.2 POWER SUPPLY WIRING

Connect the supply power wires to the 12-24Vdc input power terminals on the power supply, plus to terminal (+) and minus to terminal (–); power requirement is 12 to 24Vdc (10 watts max.). The DC– terminal must be connected to panel ground which should be the same as engine ground.

This is the return path for normally-open sensors and **MUST** be connected for proper operation. **DO NOT** ground this device directly to the ignition system common coil ground.

7.3 CONNECTING THE 10" MIDAS HMI TO EARTH GROUND

The third pin of the power connector is chassis ground for the unit. The unit should be connected to earth ground (protective earth).

The chassis ground is not connected to signal common of the unit. Maintaining isolation between earth ground and signal common is not required to operate the unit. But, other equipment connected to this unit may require isolation between signal common and earth ground. To maintain isolation between signal common and earth ground, care must be taken when connections are made. For example, a power supply with isolation between its signal common and earth ground must be used. Also, plugging in a USB cable may connect signal common and earth ground. The USB's shield may be connected to earth ground at the host. USB's shield, in turn, may also be connected to signal common.

7.4 10" MIDAS HMI POWER SUPPLY REQUIREMENTS

The MIDAS HMI panel requires a 24 VDC power supply. The unit may draw considerably less than the maximum rated power depending upon the features being used. As additional features are used the unit will draw increasing amounts of power. Items that could cause increases in current are modules, additional on-board communications, SD card, and other programmed features.
In any case, it is very important that the power supply is mounted correctly if the unit is to operate reliably. Please take care to observe the following points:

- The power supply must be mounted close to the unit, with usually not more than 6 feet (1.8 m) of cable between the supply and the operator interface. Ideally, the shortest length possible should be used.
- The wire used to connect the operator interface's power supply should be at least 22-gage wire suitably rated for the temperatures of the environment to which it is being installed. If a longer cable run is used, a heavier gage wire should be used. The routing of the cable should be kept away from large contactors, inverters, and other devices which may generate significant electrical noise.

- A power supply with an NEC Class 2 or Limited Power Source (LPS) and SELV rating is to be used. This type of power supply provides isolation to accessible circuits from hazardous voltage levels generated by a mains power supply due to single faults. SELV is an acronym for "safety extra-low voltage." Safety extra-low voltage circuits shall exhibit voltages safe to touch both under normal operating conditions and after a single fault, such as a breakdown of a layer of basic insulation or after the failure of a single component has occurred. A suitable disconnect device shall be provided by the end user.

7.5 SENSOR WIRING DISCRETE INPUTS

The sensor leads connect to the removable terminal strips on the Terminal Module. The terminal numbers correspond to the display numbers which also have a user assigned 20-character label associated with it. The sensor inputs are numbered 01-30, 01-45 or 01-60. With AUTO START enabled, the Remote Reset on the terminal board is wired for a start switch. Sensor inputs 01–60 can be configured as class A, class B or class C logic. Any discrete sensor point can be wired for normally-open or normally-closed operation.

- Normally-open (N/O) sensor switches are wired with one wire to the bottom terminal strip of the respective sensor number and the other to engine ground which should be the same as power minus (–). A short jumper from the bottom terminal to the top terminal must be connected for normally-open sensors. (See wiring diagrams)

- Normally-closed (N/C) sensor switches are wired with one wire to the bottom terminal strip and the other to the top terminal strip of the respective sensor number. Note that the short jumper wire must be removed.

- Remote stop and remote reset are wired the same as the sensor switches, and can be used with either normally-open or normally-closed contacts.

Use a wire size between 16 AWG (max.) and 24 AWG (min.) to connect the sensor switches to the terminal strip connector. Strip the insulation back 3/8"; twist the exposed wires tightly together. Insert the exposed wire completely into the terminal strip and securely tighten the clamping screw. Wires running to sensor switches must be in good condition or replaced with new wires. When running wires, take care not to damage the insulation and take precautions against later damage from vibration, abrasion, or liquids in conduits. An explosion-proof conduit is not required. However; wires should be protected from damage by running them in a protective conduit or in sheaths where appropriate. In addition, it is essential that the following practices be adhered to:

A. Never run sensor wires in the same conduit with ignition wiring or other high energy wiring such as the AC line power.

B. Keep secondary wires to spark plugs and other high voltage wiring at least eight inches (200mm) away from sensor and sensor wiring.

C. Sensor switches may be connected to any passive device using contacts such as standard switch gauges, pressure or level switches. **DO NOT** connect sensor leads to any voltage producing element.

D. In the case of a field conversion, where sensors have previously been used with Murphy tattletales, it is recommended that the sensors be checked frequently when the DE system is first put into use. Sensor contacts may be burned or pitted from past exposure to ignition system primary voltage. It is advisable to replace such sensors.

E. If it becomes necessary to check sensor switch to panel wiring with an ohmmeter or other checker, first DISCONNECT the plug-in terminal strips from the Terminal Module. Applying voltage to the DE-3000+ system through the sensor leads may damage the device. The area should be tested as non-hazardous before such testing commences.

ANALOG SENSOR WIRING

For each analog monitored point, inputs 01–60, select a transducer - either an Altronic pressure or temperature transducer listed above or one that outputs a signal in the range of 0 to 5 Vdc or 0 to 25 mA. Mount as described above. Use cable assembly 693008-x or similar to wire transducer to the Terminal Module. An internal 5 volt sensor supply (500 mA. max.) is available to power the Altronic transducers; See wiring diagrams. If the 5 volt sensor supply exits the panel, it must be fused with a 0.5 ampere fuse. If 24Vdc powered sensors are used, the 24 volt supply to them must be fused appropriately. Take care not to damage the insulation when installing and take precautions against later damage from vibration, abrasion, or liquids in conduits. In addition, it is essential that the following practices be adhered to:

A. Never run sensor wires in the same conduit with ignition wiring or other high energy wiring such as AC line power.

B. Keep secondary wires to spark plugs and other high voltage wiring at least eight inches (200mm) away from sensor and sensor wiring.

7.6 THERMOCOUPLES AND THERMOCOUPLE EXTENSION WIRE

Grounded or ungrounded type J or K thermocouples may be used. Use thermocouple extension wire of the same type as the thermocouple probe to connect to the terminal module. Use stranded thermocouple wire having a moisture-resistant insulation such as PVC; for higher ambient temperatures, Teflon or B-fibre insulated thermocouple wire is recommended. To ensure that an accurate signal is transmitted to the device, avoid any added junctions, splices and contact with other metals. On unused channels, leave the small jumper wire supplied with the system in place. Take care not to damage the insulation when installing and take precautions against later damage from vibration, abrasion, or liquids in conduits. In addition, it is essential that the following practices be adhered to:

A. Never run sensor wires in the same conduit with ignition wiring or other high energy wiring such as AC line power.

B. Keep secondary wires to spark plugs and other high voltage wiring at least eight inches (200mm) away from sensor and sensor wiring.

7.7 LUBE/NO-FLOW SENSOR:

Channels 27 and 28 may be used for a lube/no-flow proximity cycle switch as an option. Wire the sensor according to section 5.8. The Sensor may be wired as either a N/O or a N/C with a jumper. The DIP switches on the terminal board must be set as an analog configuration. The lube/no-flow channels generate a fault when the time between pulses exceeds the programmed run pulse time.

NOTE: ADDITIONAL CHANNEL SET UP WILL BE REQUIRED IN THE TERMINAL SOFTWARE PROGRAM.

7.8 OUTPUT SWITCH WIRING

The Power Supply Module accepts an industry-standard 0.6" Output Module. The following modules are available from Altronic:

691124 This custom module has two uses: connection to a Murphy fuel valve and directly grounding a C.D. ignition system.

A. Use in position OUT 1 to connect to a C.D. ignition-type Murphy fuel valve. Connect terminals 3 and 8 of the fuel valve to the Power Supply Module terminals marked F1 (FV1) and F2 (FV2).

B. Use in position OUT 2 to directly ground-out (stop) a C.D. ignition system. Wire the C.D. ignition shutdown lead and ignition ground to the Power Supply Module terminals marked I+ (IGN+) and I- (IGN-) observing the proper polarity for the ignition system. **DO NOT** connect directly to the ignition system common coil ground.

691125 This module is rated for 5-48 Vdc, 5.0 A., and may be used in any of the four output slots OUT 1 through OUT 4. It may be used to interrupt the DC supply to DC-powered ignition systems such as Altronic CD1, CPU-90, II-CPU or DISN.

691056 This module is rated for 5-60 Vdc, 2.0 A., and may be used in any of the four output slots OUT 1 through OUT 4.

691066 This module is rated for 5-200 Vdc, 0.67 A. and may be used in any of the four output slots OUT 1 through OUT 4.

691065 This module is rated for 24-280 Vac, 2.0 A. and may be used in any of the four output slots OUT 1 through OUT 4.

7.9 RS-485 COMMUNICATIONS WIRING

- Port 2 is for communication between the display and terminal boards.
- Port 3 is for RS-485 serial communication between the computer module and the HMI.

These should not be connected for normal operation.

7.10 SENSE ROTATION INPUT

Terminals marked IGN IN and PU IN on the Power Supply Module are used by the DE-3000+ system to detect either engine rotation or ignition system firings. On applications using multiple terminal board assemblies, the T+ terminal on the second terminal board (the one not directly connected to the power supply) can be used to add a second RPM value. The T+ input is only for use with magnetic pickups. This input monitors voltage signals such as those seen on either the ignition shutdown lead or a magnetic pickup monitoring an engine-mounted gear.

- The IGN IN terminal connects to the positive (+) C.D. ignition shutdown lead.
- The PU IN terminal connects to one magnetic pickup input; the other pickup wire connects to the minus (–) terminal on the Power Supply Module.
- **The T+ terminal connects to one magnetic pickup input; the other pickup wire connects to the ⏚ terminal on the terminal module.**

NOTE: AN INSTALLATION MAY USE ONLY ONE OF THE TERMINALS IGN IN, PU IN, OR T+.

THE MAGNETIC PICKUP INPUT **MUST** BE USED FOR APPLICATIONS ENABLING THE OPTIONAL AUTO START OR OEM ENGINE CONTROL FUNCTION.

8.0 HAZARDOUS AREA OPERATION

8.1 The DE-3000+ system is CSA-certified for CLASS I, DIVISION 2, GROUPS C and D areas when mounted in a suitable enclosure.

In addition, the following requirements must be met (refer to NFPA standard no. 493):

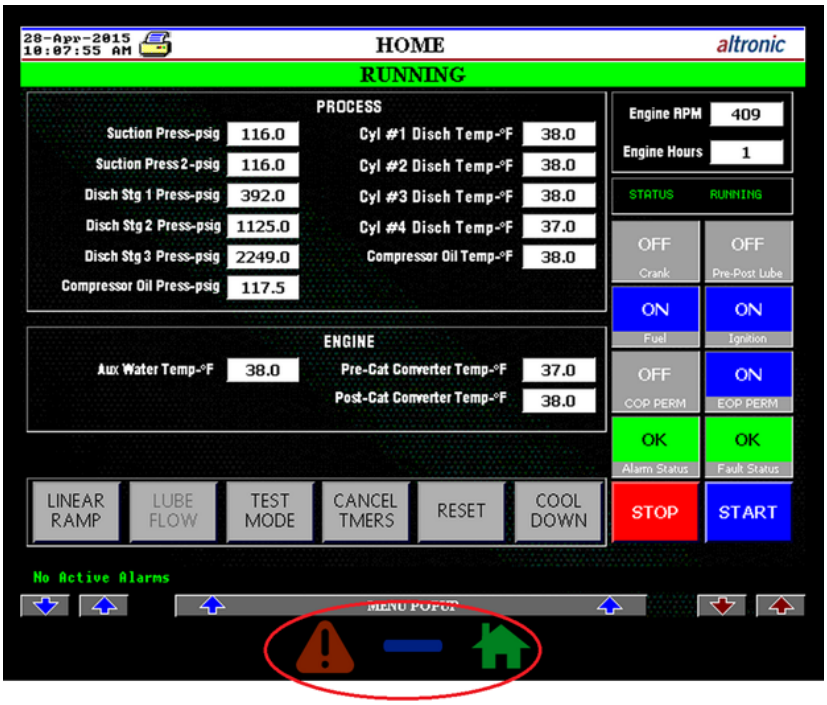
- The low voltage sensor switch wires within the panel enclosure must be kept at least two (2) inches away from other wiring. Run the sensor switch wires leaving the panel in a separate conduit from all other wiring and keep them separate
- Wiring to the sensors must have a grade of insulation capable of withstanding an AC voltage of 500 volts RMS.
- Sensor wires must be run in separate conduits and junction boxes from high voltage wires such as ignition, fuel valve, and other high voltage wiring.

WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY AND/OR SUITABILITY FOR CLASS I, DIV. 2, GROUPS C AND D. DO NOT DISCONNECT EQUIPMENT IN DIV. 2 ENVIRONMENT UNLESS POWER IS SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS.

9.0 10" MIDAS HMI MAIN MENU

9.1 The 10" MIDAS HMI has three buttons on its bezel. The red triangle directs to the Alarms page, the horizontal button in the middle directs to the Main Menu page, and the green home button directs to the Home page.

NOTE: THE SCREENS SHOWN IN THIS SECTION ON THE HMI REFLECT A GENERAL LAYOUT AND MAY APPEAR DIFFERENTLY DUE TO DIFFERENCES IN ENGINE CONFIGURATIONS.

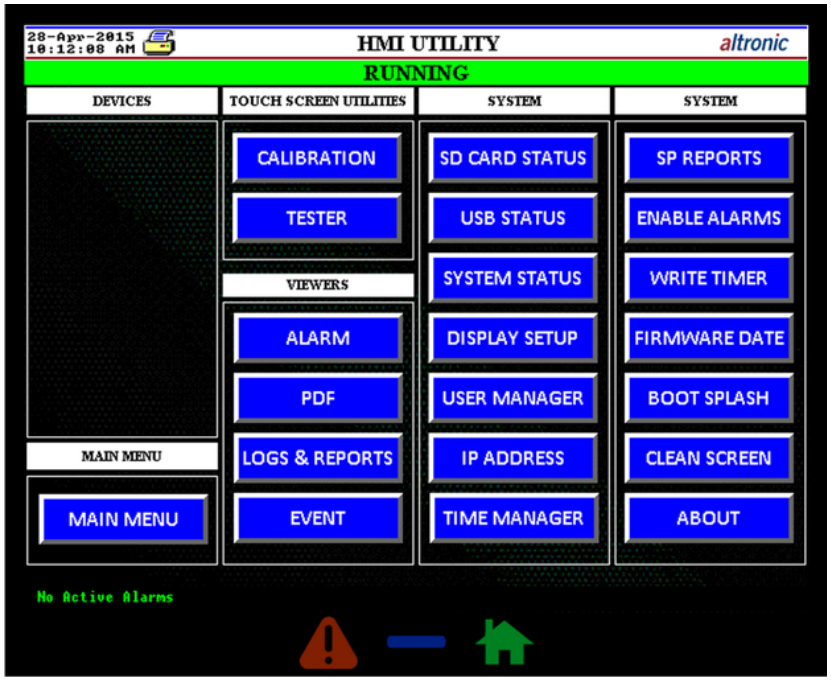


NOTE: THE HORIZONTAL BLUE BUTTON IN THE MIDDLE ONLY LIGHTS UP WHEN THERE IS A MEMORY CARD (SD) INSERTED IN THE HMI.

9.2 The 10" MIDAS HMI screens can be accessed through the Main Menu and MIDAS HMI Utility screens as shown below. The HMI Utility screen can be accessed by clicking on the "HMI UTILITY" button on the Main Menu screen.

To return from the HMI Utility screen to Main Menu screen, click on the "MAIN MENU" button on the HMI Utility screen.

9.3 To log-in to the MIDAS HMI, click on the credentials button on the Main Menu screen. When the Log-in popup appears, the status displays whether the user is logged in or not. If the “LOGOUT” is selected, click on the “LOGIN” button and enter the credentials.



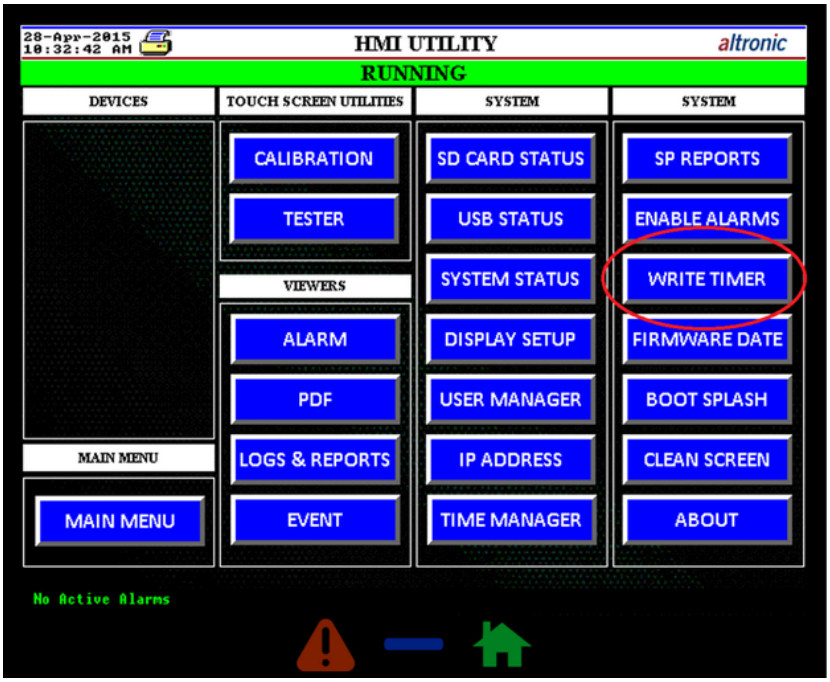
Once the credentials are authorized, the “LOGIN” button will be selected showing that the user has successfully been logged in.

9.4 Write control needs to be enabled whenever a value is to be written to the DE-3000+ controller. To be able to enable write control, press on the “CONTROL WRITE” button on the Main Menu screen.

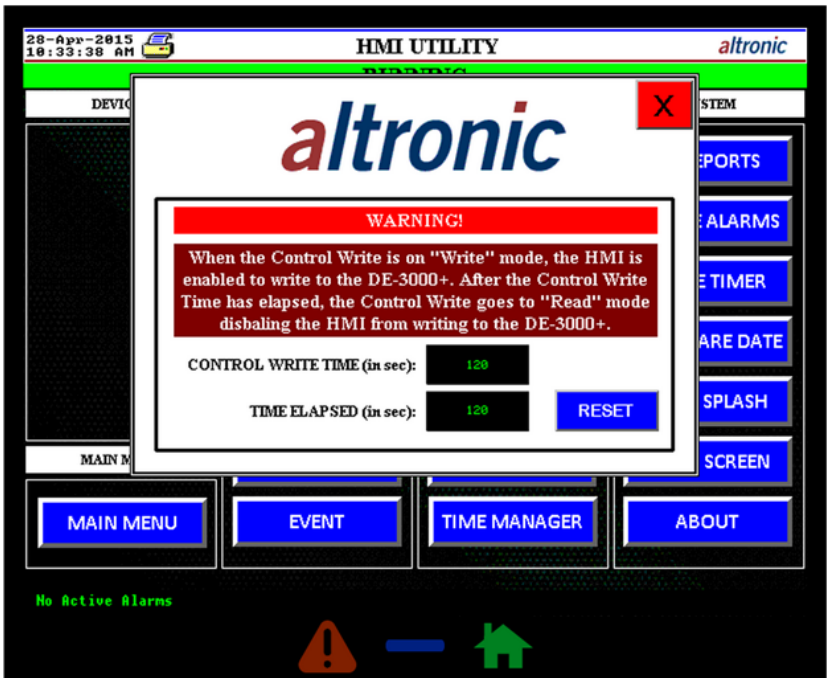
If the user is not logged in, credentials would be required before accessing the write control popup. Once the popup appears, press the “WRITE” button to enable write control.

The write control should be set to “Read” mode when not editing DE-3000+ controller registers. To avoid the write control from staying at “Write” all the time, a timer is implemented on the MIDAS HMI that changed the write control to “Read” mode after it expires. The default value of the timer is set to 120 sec, but the user can increase it up to 600 sec.

To access the write control timer, press the “WRITE TIMER” button on the HMI Utility.

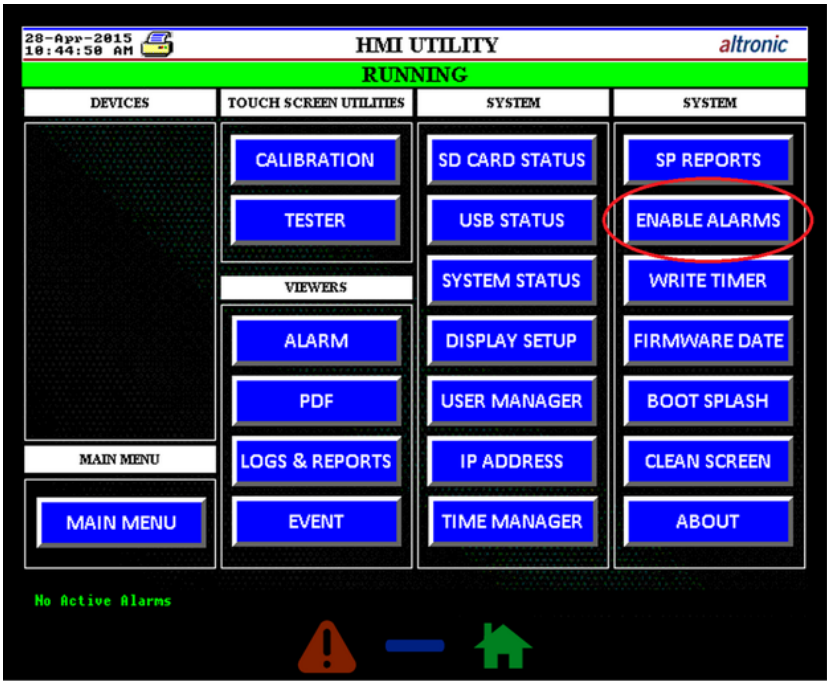


After the credentials are verified, the write control timer popup appears. The Control Write Time (in sec) can be modified to increase or decrease the time for the write feature to expire. The Time Elapsed (in sec) shows how much time is left before the write control will revert to “Read” mode.

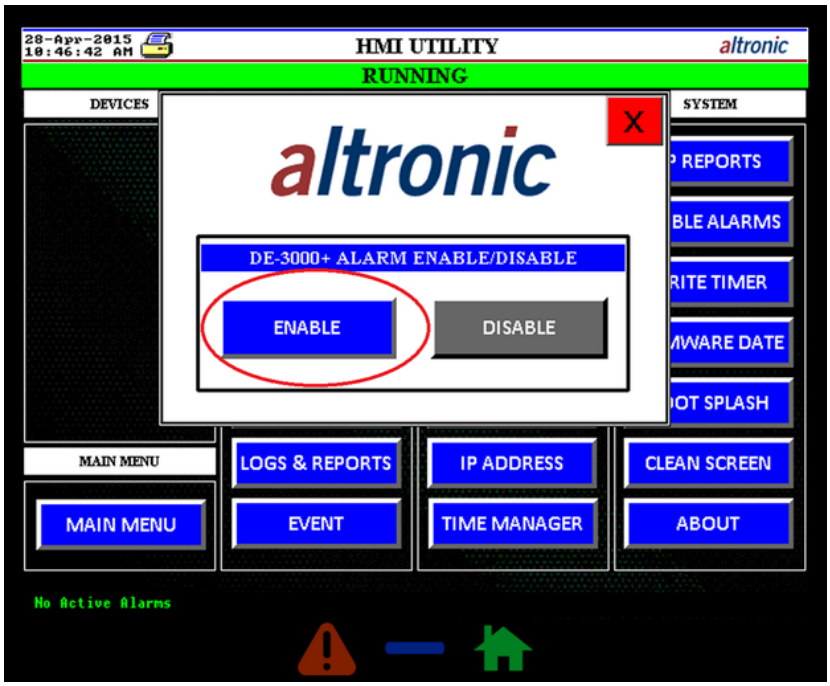


9.5 The Alarms on the DE-3000+ controller are setup and executed through the MIDAS HMI. There is a two-step alarm activation system in place that needs to be setup before alarms will become active.

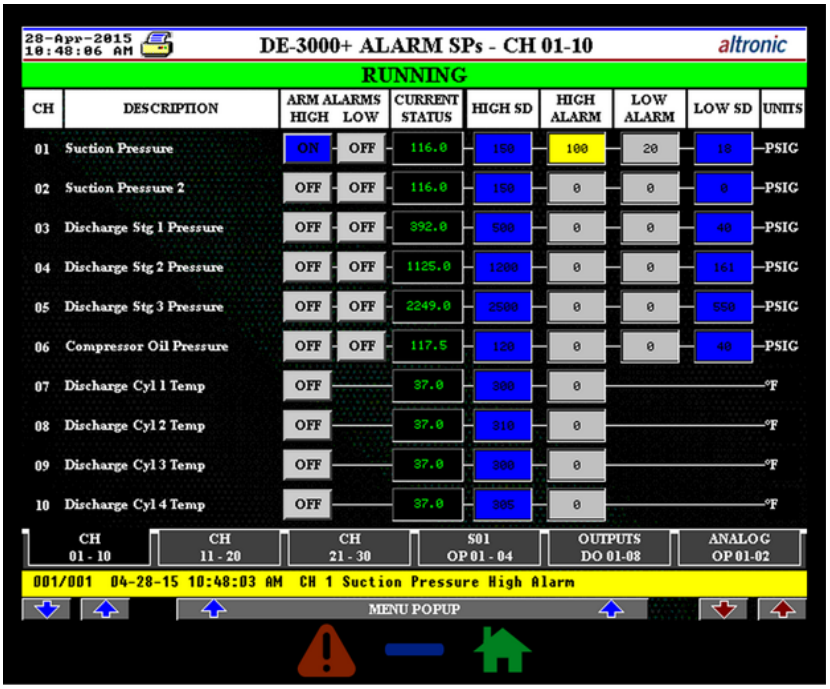
The first step is to enable the alarm on the DE-3000+ system. By default, the DE-3000+ system have the alarms disabled. To enable, press the "ENABLE ALARMS" button on the HMI Utility page.



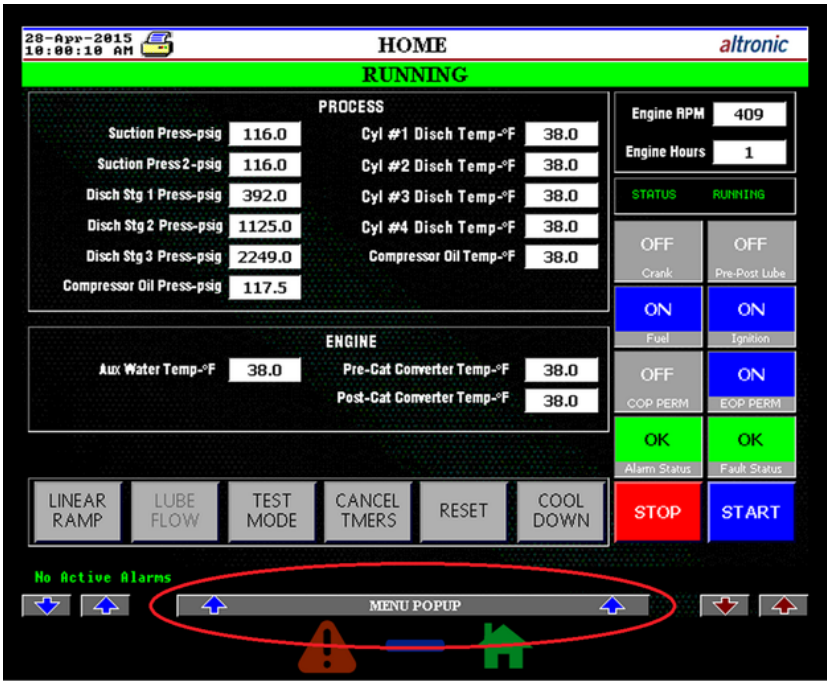
After the credentials are verified, the Alarm Enable/Disable popup screen appears. Click on the "ENABLE" button to enable the alarms on the DE-3000+ system.



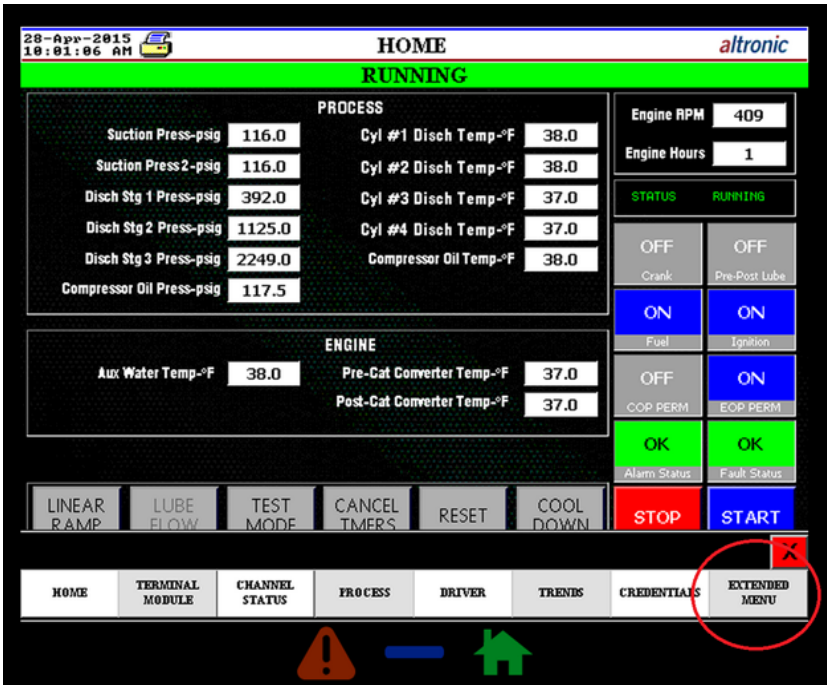
The second step is to enable the High or Low alarm on each channel. This can be done on the Channel Status page. When the High/Low Alarms are armed, and the alarm condition is met, the alarms show up as yellow on the data box and the alarm strip describing the nature of the alarm appears at the bottom of the screen.



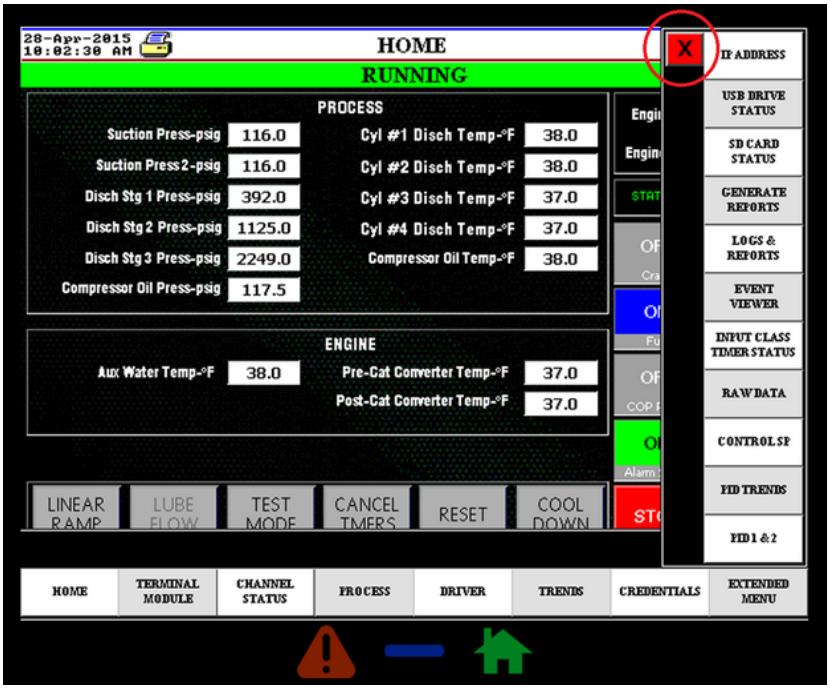
9.6 In addition to the Main Menu and HMI Utility screens, all the screens on the MIDAS HMI can be accessed through the Menu Popup at the bottom of every HMI screen.



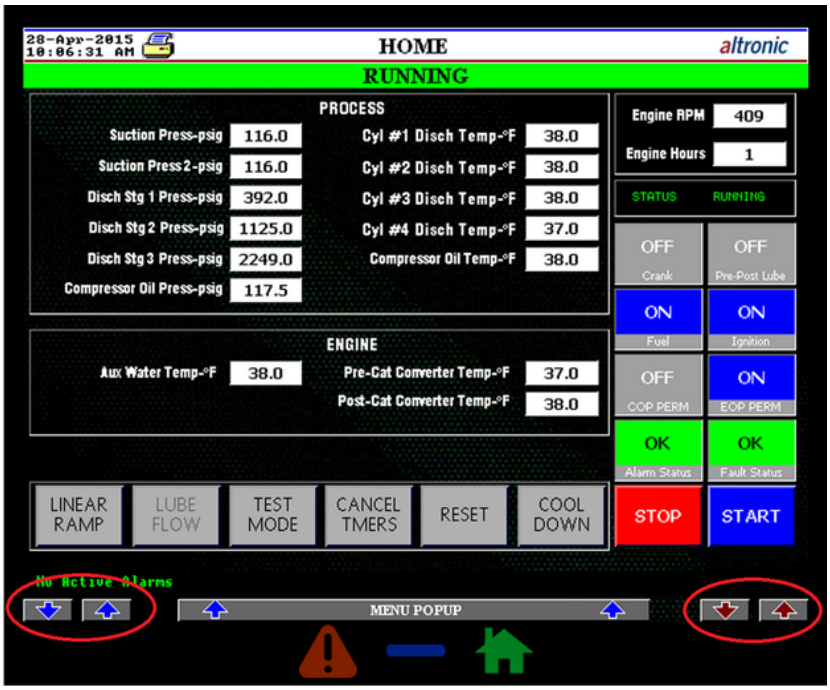
Once the Menu popup is pressed, screen navigation buttons appear at the bottom of the screen. To view more navigation buttons, press the "EXTENDED MENU" button.



The Menu Popups can be canceled by pressing the red exit button.



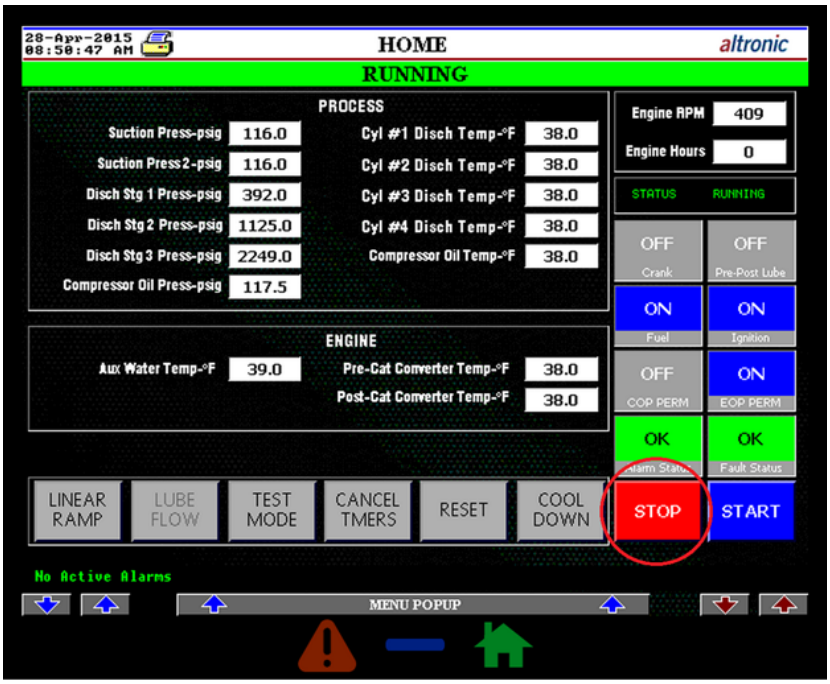
9.7 The MIDAS HMI screens can also be navigated through up and down arrow keys at the bottom of every screen. The blue arrow keys are used to move to the next or previous category of screens while the maroon arrow keys are used to move to the next or previous screen.



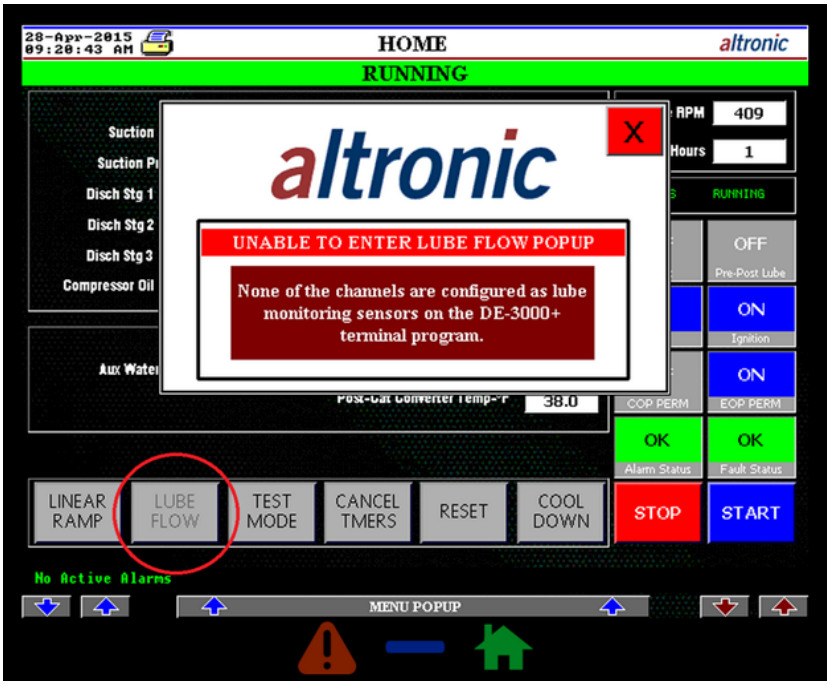
9.8 The Home Screen can be accessed by clicking on the "HOME" button on the Main Menu screen. Through the Home screen, the user can control the operation and monitor the status of the DE-3000+ controller. The screenshot shows the Home screen for a DE-3000+ system. Home screens may vary based on the project configuration.

9.9 The START button on the Home screen sends a command to the DE-3000+ controller to start.

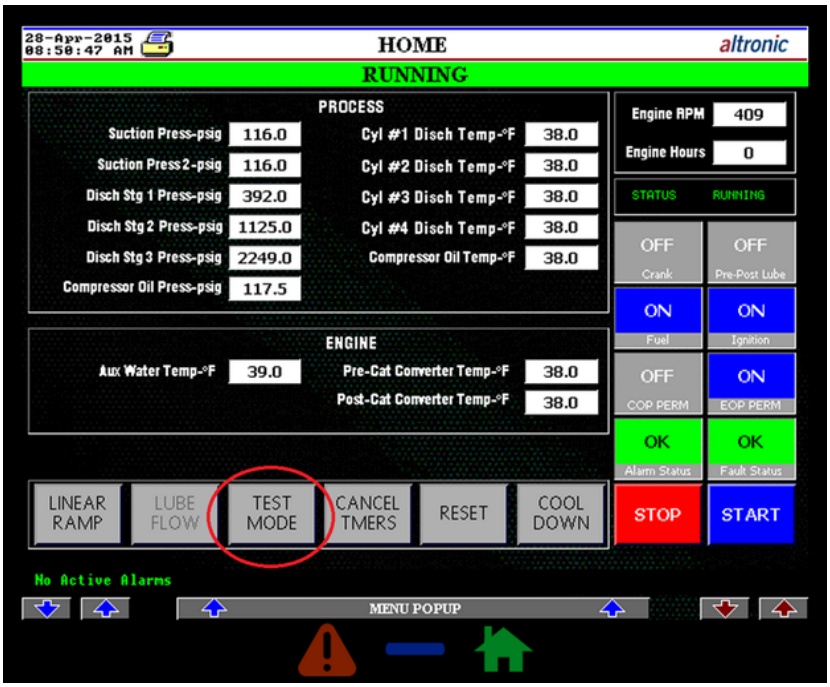
9.10 STOP key is used for a manual stop condition. By pressing the STOP key, the controller activates the configured output modules in the power supply.



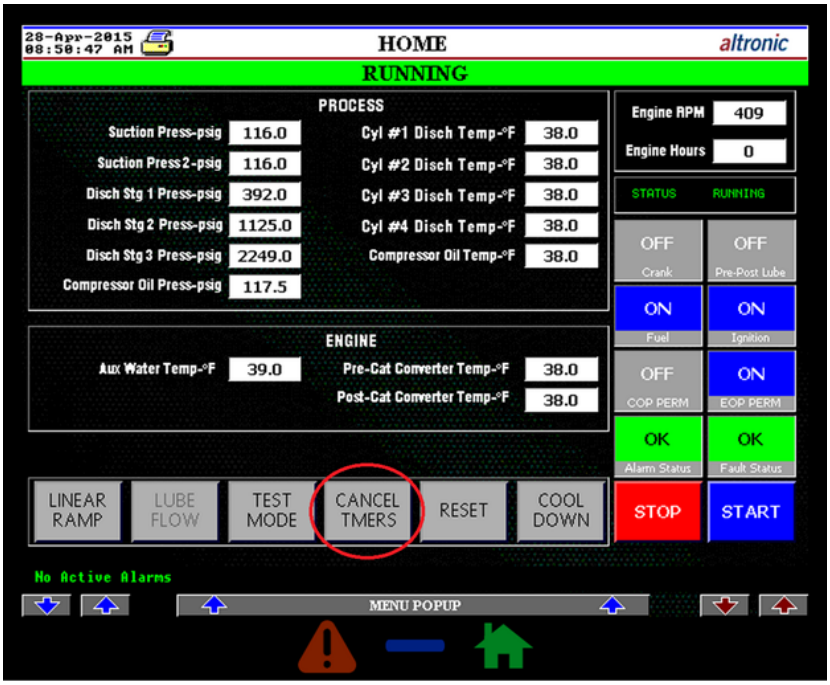
9.11 If any menu (button) is unavailable or unable to execute, it will display a grey font. If clicked, it will give a popup explaining why the menu is unable to execute. In the screenshot below, the reason Lube Flow is inactive is because none of the channels on the DE-3000+ are configured as lube monitoring sensors.



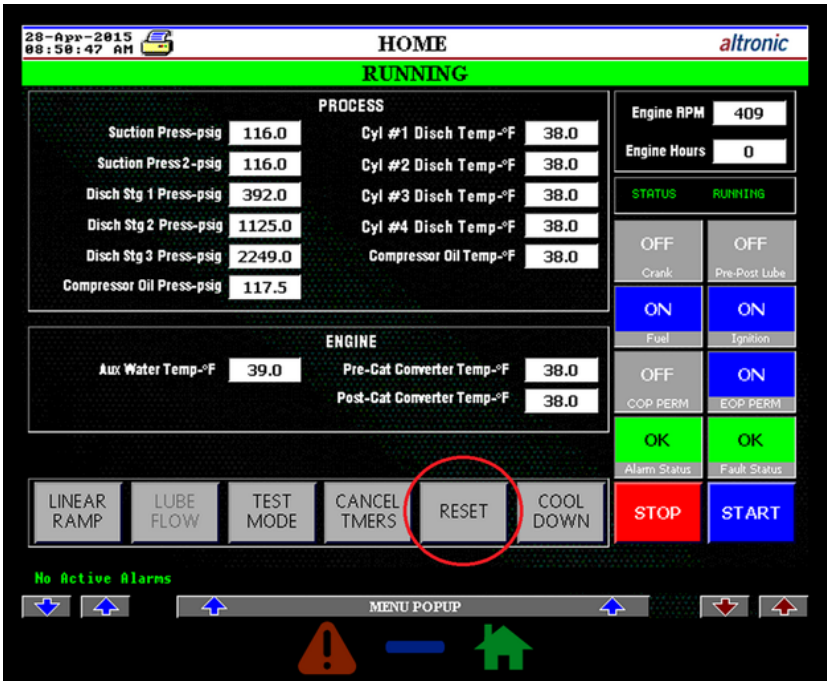
9.12 TEST key disables the output modules and allows the user to fault or test the input sensors. Every time the test button is pressed, the test timer resets to its preset value.



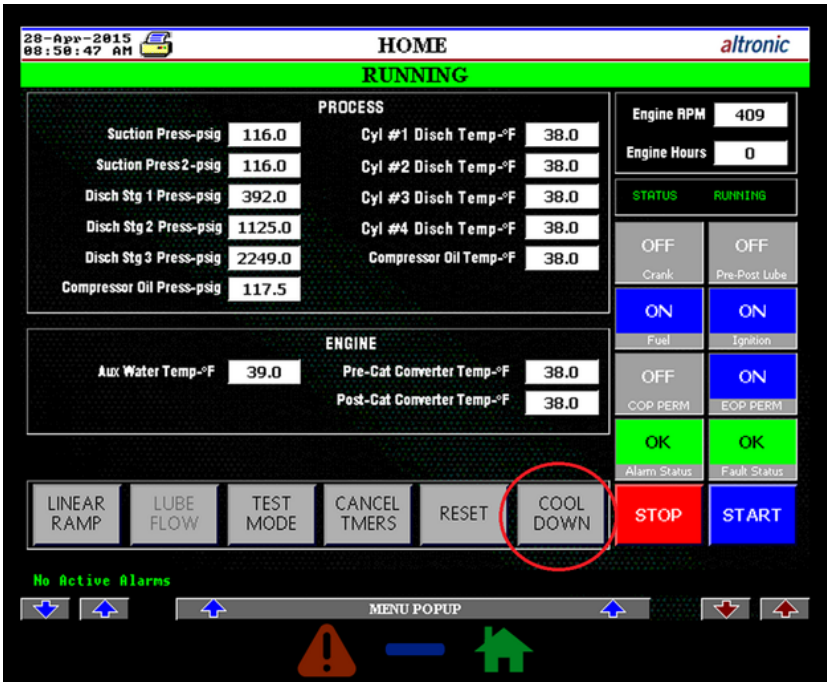
9.13 CANCEL TIMERS key cancels all timers, including the cool-down timer.



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

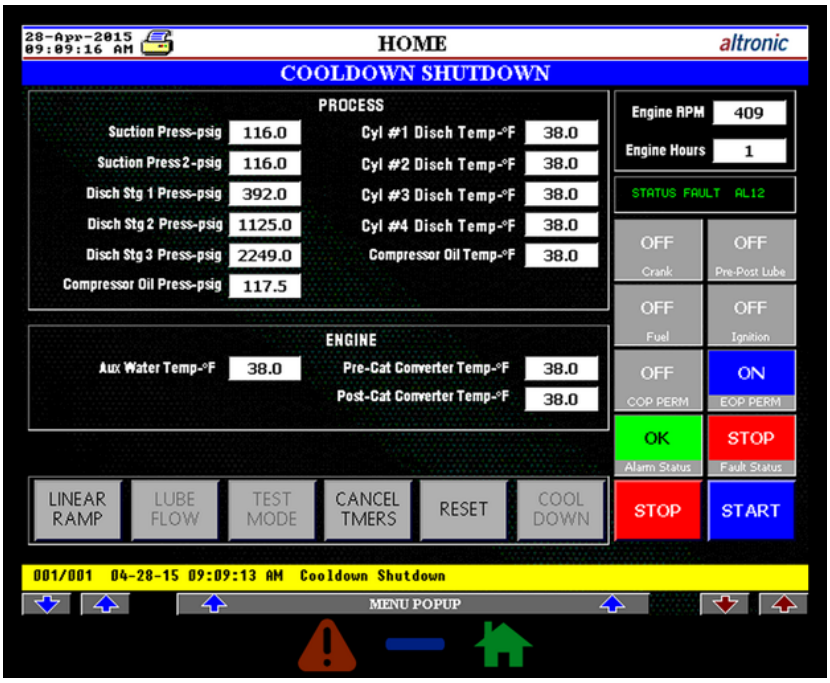


9.15 When the DE-3000+ controller is running, the “COOLDOWN” button can be pressed to initiate the cool-down timer.

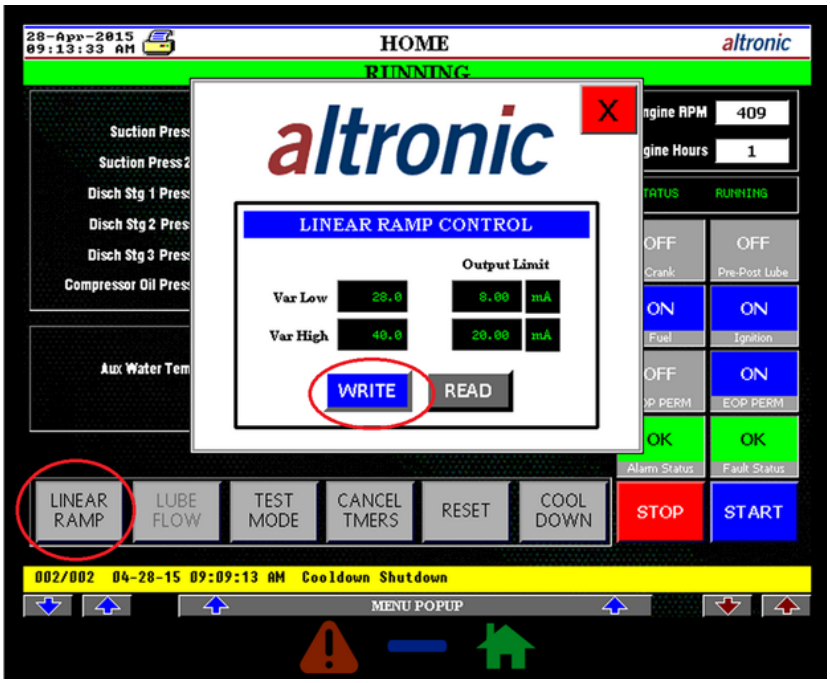


Once the cool-down timer is initiated, it can be cancelled by pressing the “CANCEL TIMERS” button.

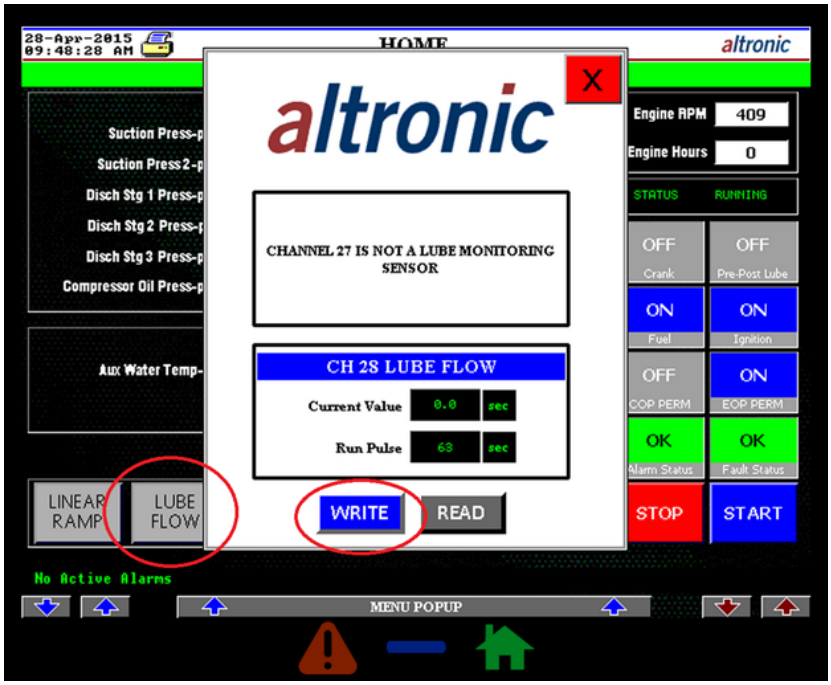
However, if the cool-down timer is allowed to elapse, the DE-3000+ controller shuts down on the COOLDOWN SHUTDOWN status.



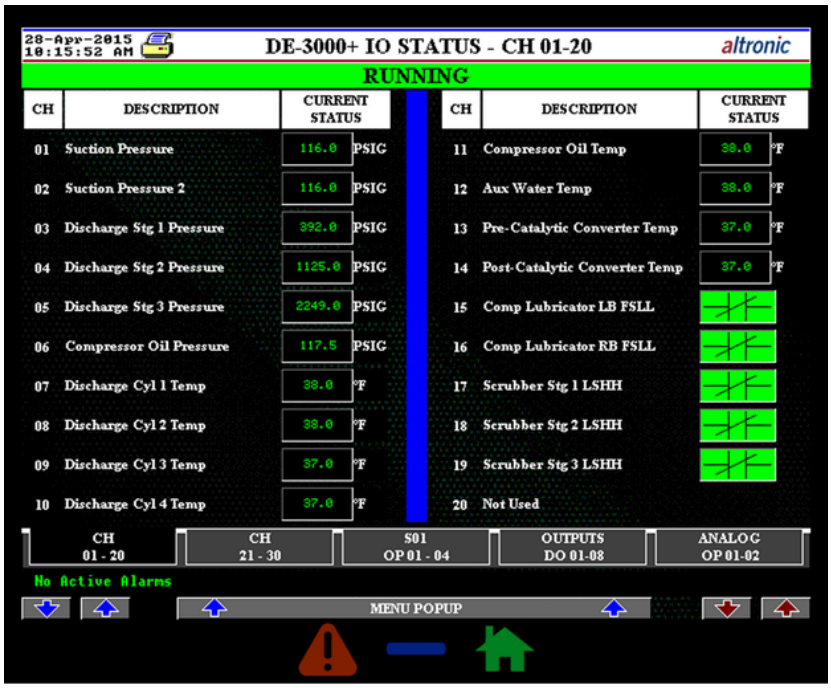
9.16 To access the Linear Ramp popup, click on the “LINEAR RAMP” button on the Home screen. After authorizing login credentials, the MIDAS HMI displays the Linear Ramp popup where Var Low and High values along with the corresponding output limits can be set up by the user. Make sure the write command is enabled before writing any new value to the controller.



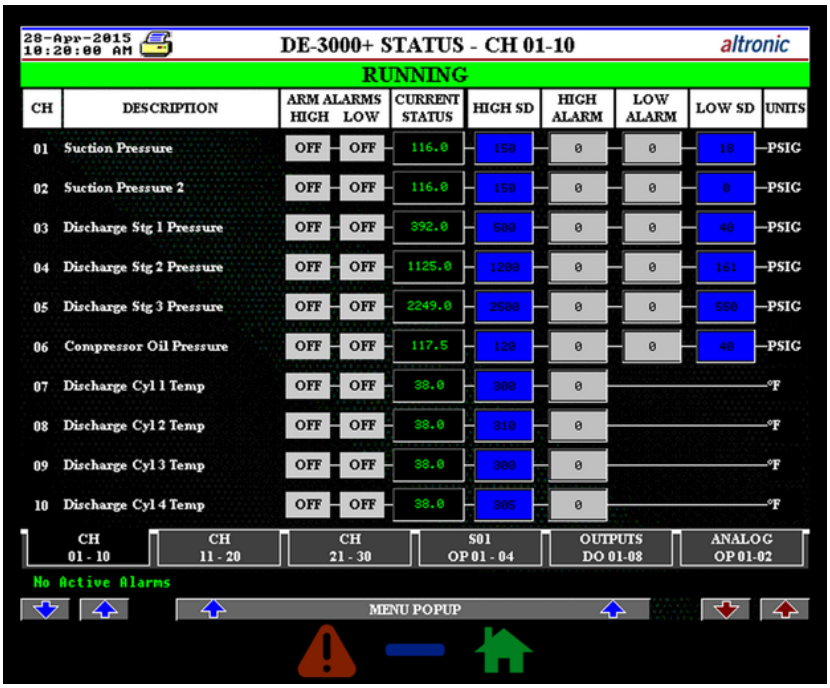
9.17 If either channel 27 or 28 is set up as a lube monitoring sensor, then the Lube Flow feature can be accessed by pressing the “LUBE FLOW” button. The “Run Pulse” value can be modified if the write command and the security credentials are enabled.



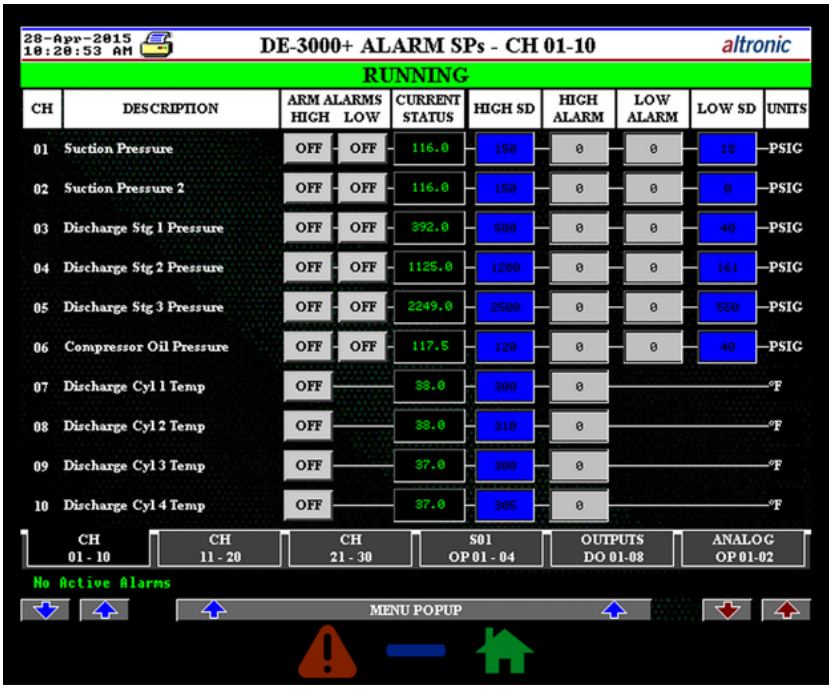
9.18 The Terminal Module screens can be accessed by clicking on the “TERMINAL MOD” button on the Main Menu screen. Through the Terminal Module screen, the user can monitor up to 20 channels in one screen. Navigation to all the channels is made easy through the labeled buttons navigating to all the screens in the IO Status category.



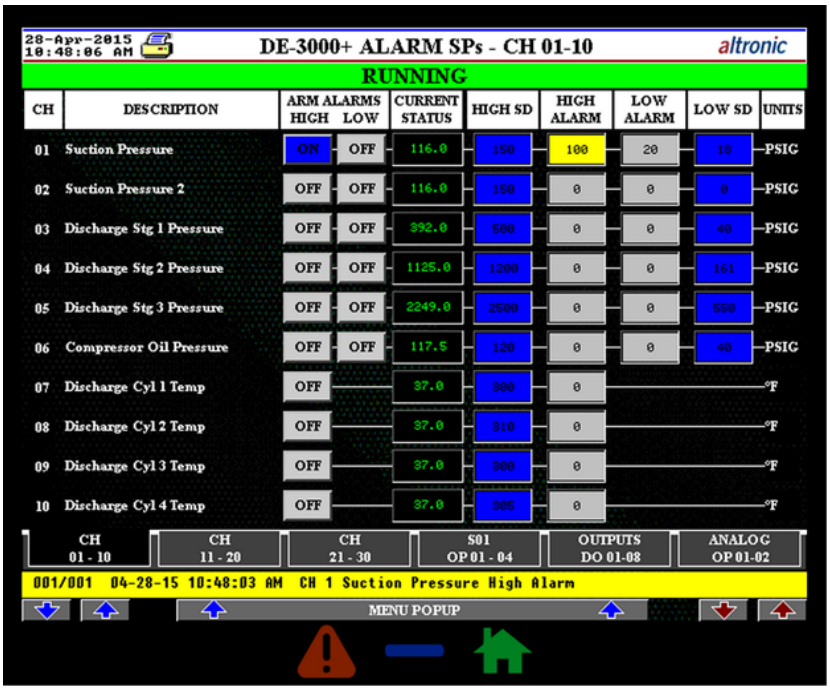
9.19 The Channel Status screens can be accessed by clicking on the "CHANNEL STATUS" button on the Main Menu screen. Through the Channel Status screen, the user can monitor and modify (if logged in) up to 10 channels in one screen. Navigation to all the channels is made easy through the labeled buttons navigating to all the screens in the IO Status category.



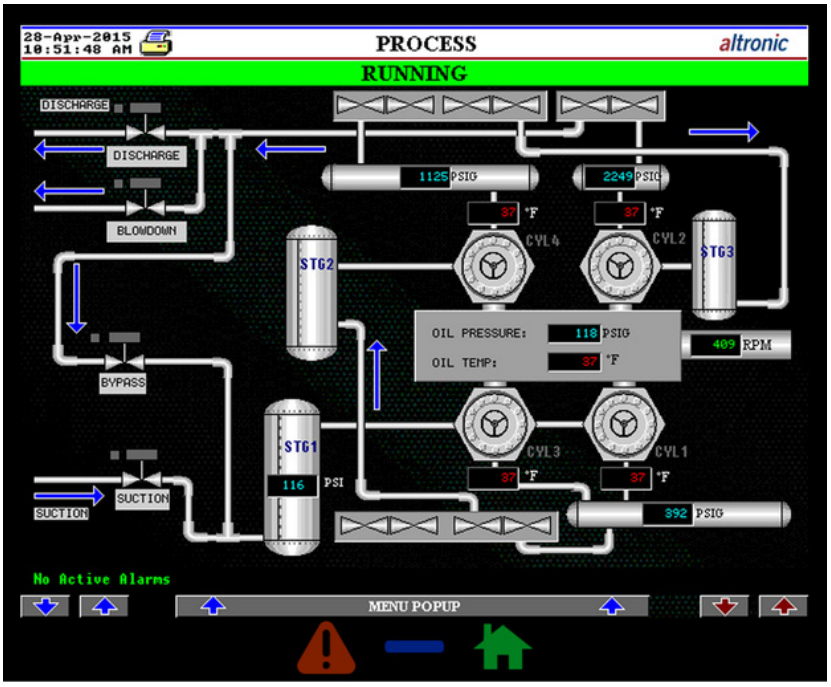
The screenshot above shows the Channel Status screen for channels 1-10. This screen can only be used to monitor as the user is not logged in.
When the user logs in with the correct credentials, the header of the screen changes to Alarm SPs and the Alarm enable buttons become visible as shown in the screenshot below.



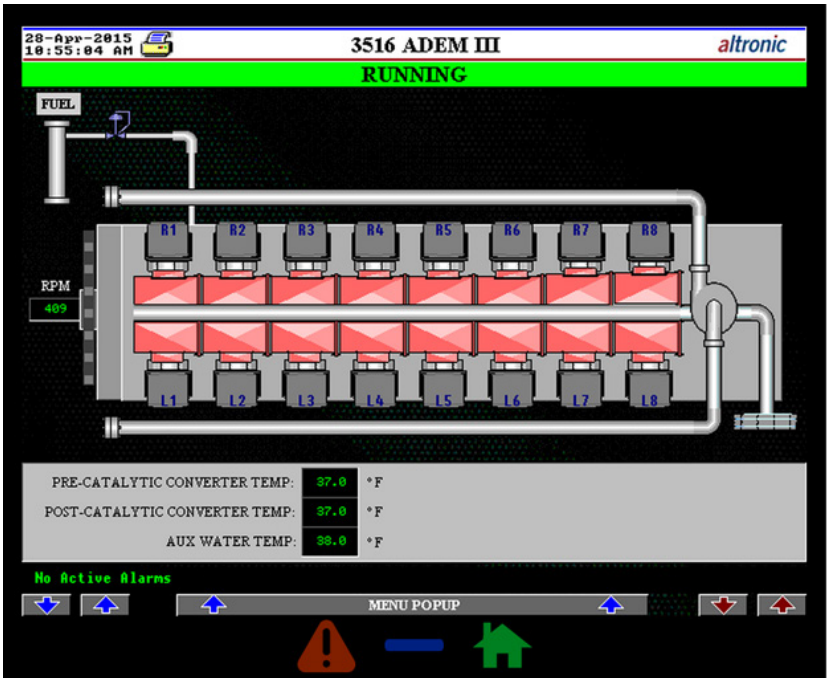
The channel status screen shows the status of every channel, whether the high or low parameters are armed, and whether there is an alarm or shutdown condition present on each channel.



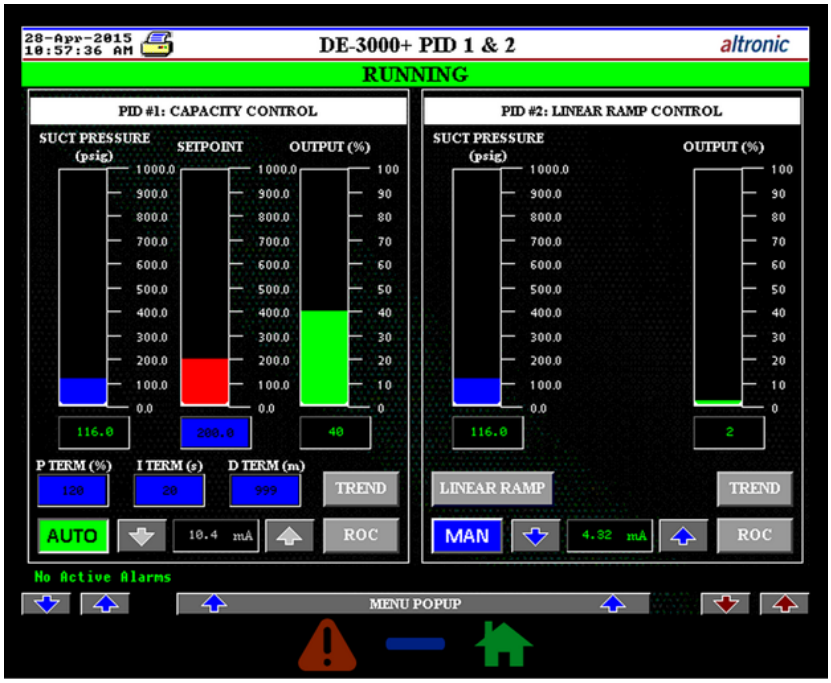
9.20 The Process screen can be accessed by pressing the “PROCESS” button on the Main Menu screen. Through the Process screen, the user can monitor and modify (if logged in) channel setpoints related to the process.



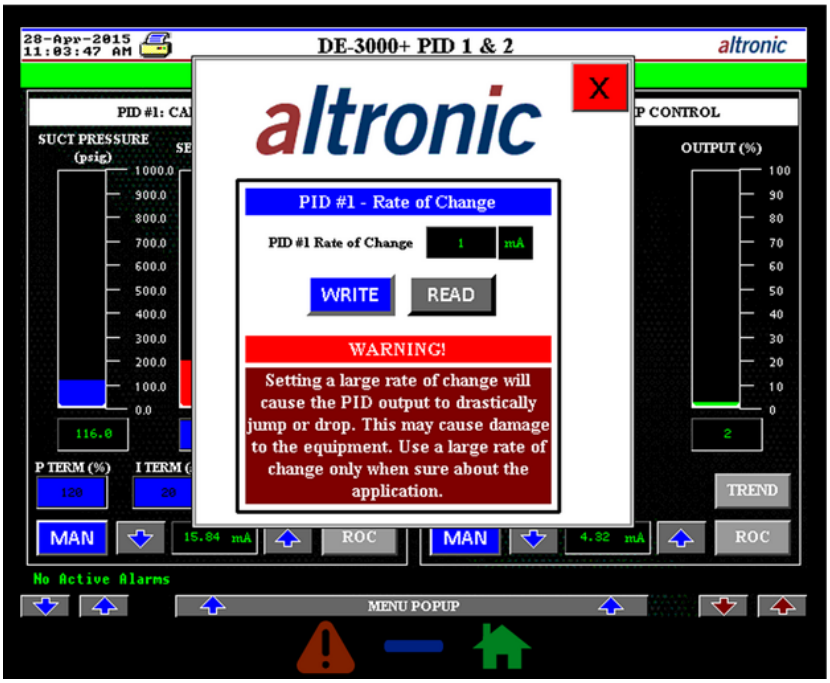
9.21 The Driver screen can be accessed by pressing the “DRIVER” button on the Main Menu screen. Through the Driver screen, the user can monitor the channels related to the engine/motor.



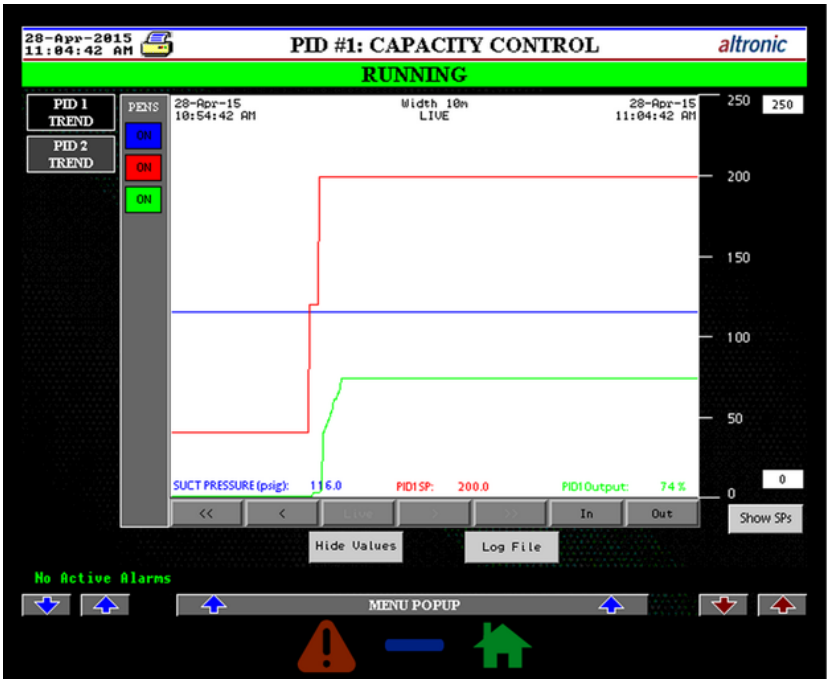
9.22 The PID screens can be accessed by pressing the “PID 1 & 2” and “PID 3 & 4” (if using a second terminal board) buttons on the Main Menu screen. Through the PID screen, the user can monitor the PID values in bar graph form for better visualization. If logged-in, the user can also modify PID setpoint and PID parameters, P, I, & D (make sure write control is enabled.)



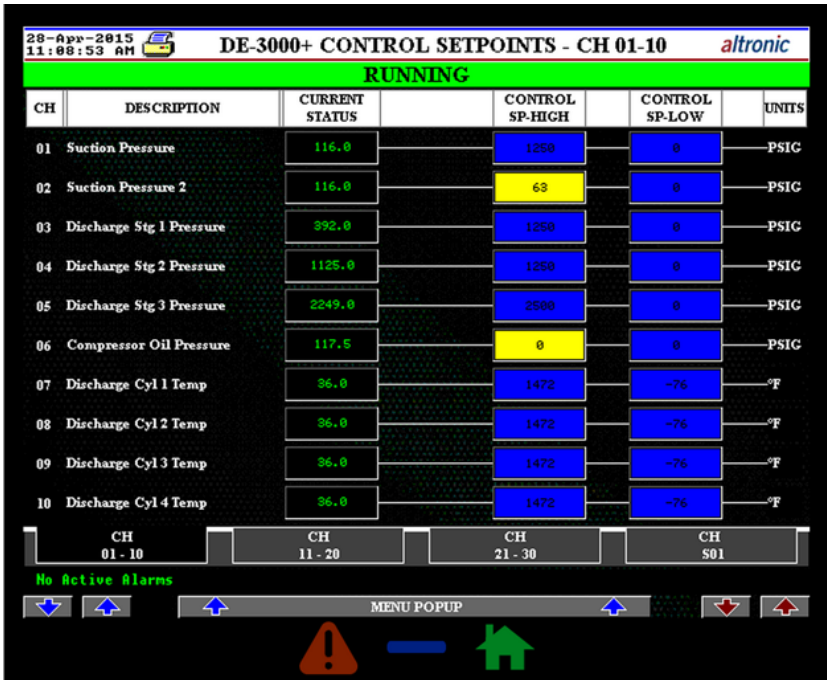
Toggling between Auto and Manual modes allows the user to change PID control with a touch of a button. When in manual mode, the operator can also modify the 4-20mA output. Before modifying the 4-20mA output, make sure that the rate of change (ROC) is setup to an appropriate value. The 'Rate of change' is the increment/decrement amount per key press of the 4-20mA in manual mode.



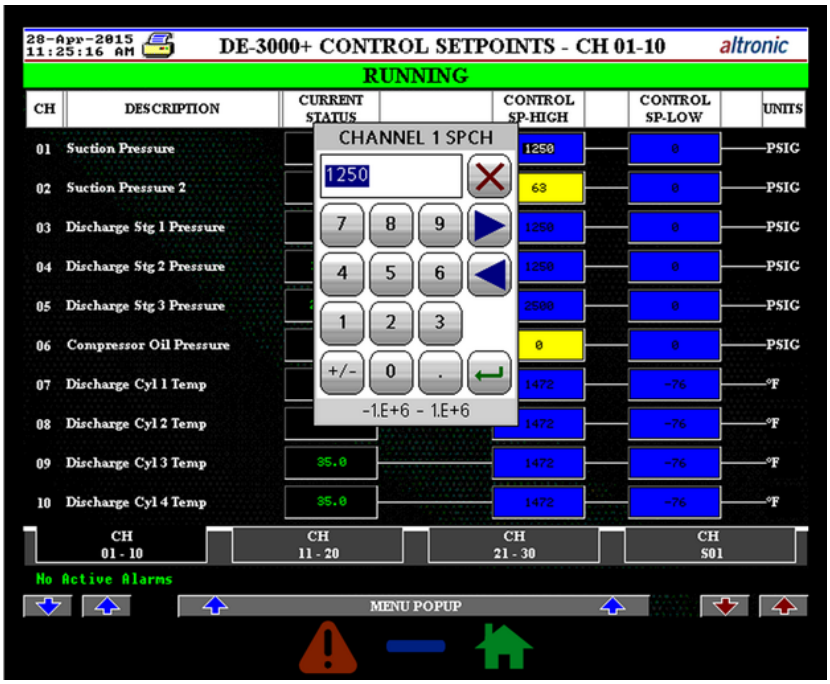
The "TREND" button can be pressed to display the PID parameter in a trend. The dynamic scaling allows the user to zoom in or out as needed.



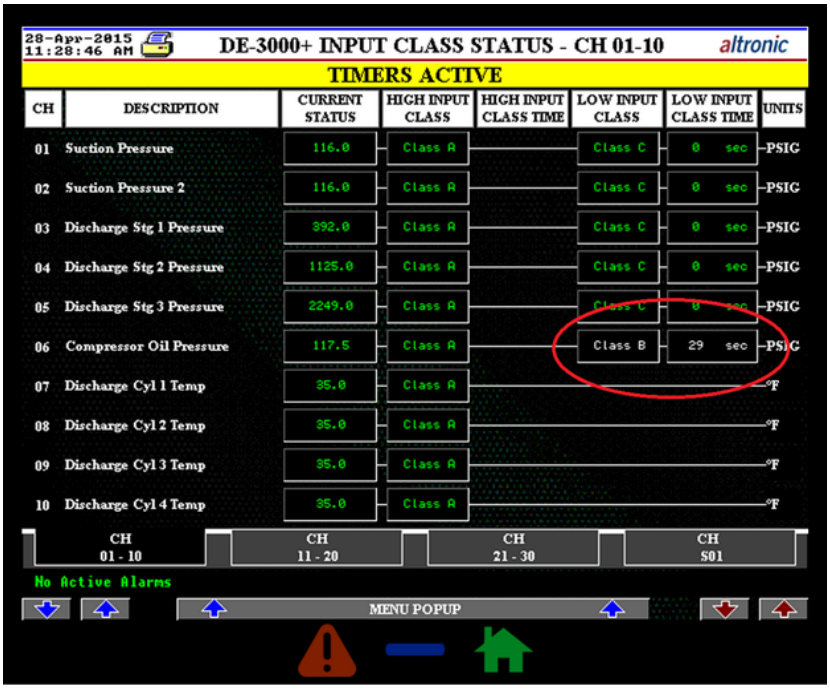
9.23 The Control SP Status screens can be accessed by pressing the "CONTROL SP" button on the Main Menu screen. Through the Control SP Status screen, the user can monitor low and high control SPs for up to 10 channels at the same time. Navigation to all the channels is made easy through the labeled buttons navigating to all the screens in the IO Status category.



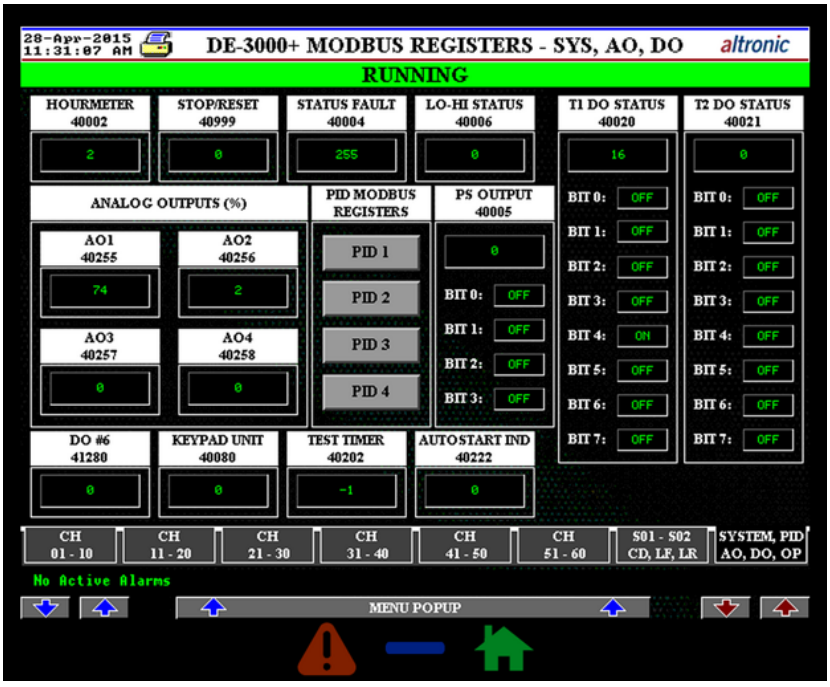
The user can modify the setpoints on the Control SP screen when logged in. When the credentials are verified and the Control SP screen selected the header of the screen changes to Control Setpoints and if the control write is enabled, the user is able to modify the control setpoints.



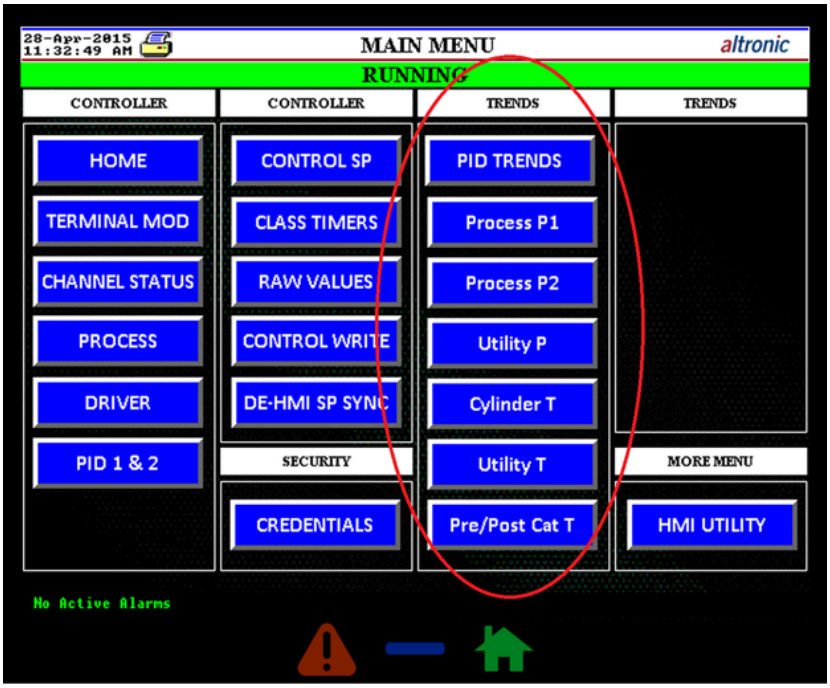
9.24 The Class Timer screens can be accessed by pressing the “CLASS TIMERS” button on the Main Menu screen. Through the Class Timers screen, the user can monitor the high/low input class and the class time for each channel. When the font is green, the channel is armed, when the font is white and the timers are counting down, the input is not armed. Navigation to all channels is simplified via the labeled buttons navigating to all the screens in the IO Status category.



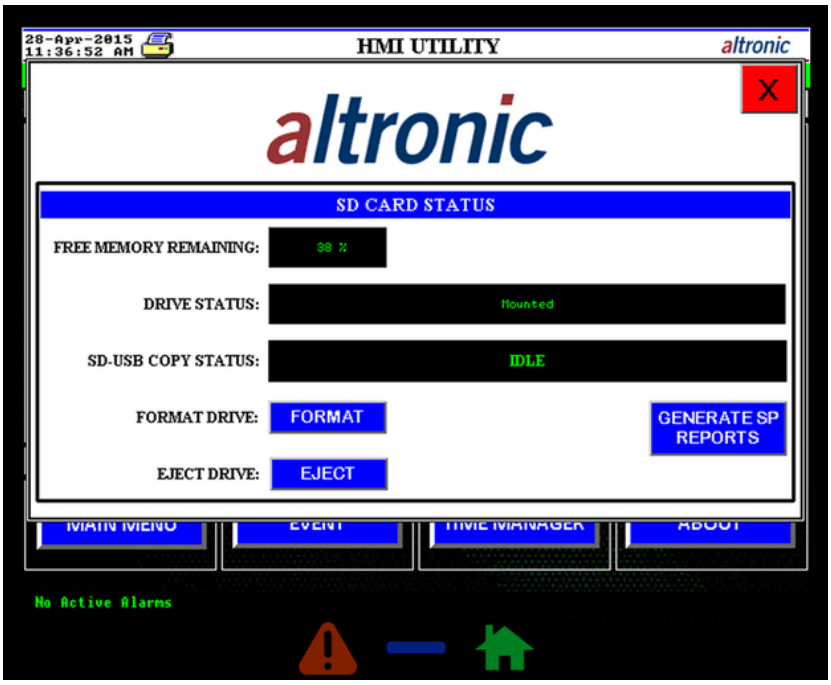
9.25 The Raw Modbus Register screens can be accessed by pressing the “RAW VALUES” button on the Main Menu screen. Through the Raw Modbus Register screen, the user can monitor the actual values that are residing inside the DE-3000+ controller at any time. This gives user a troubleshooting advantage. Navigation to all channels is simplified via the labeled buttons navigating to all the screens in the IO Status category.



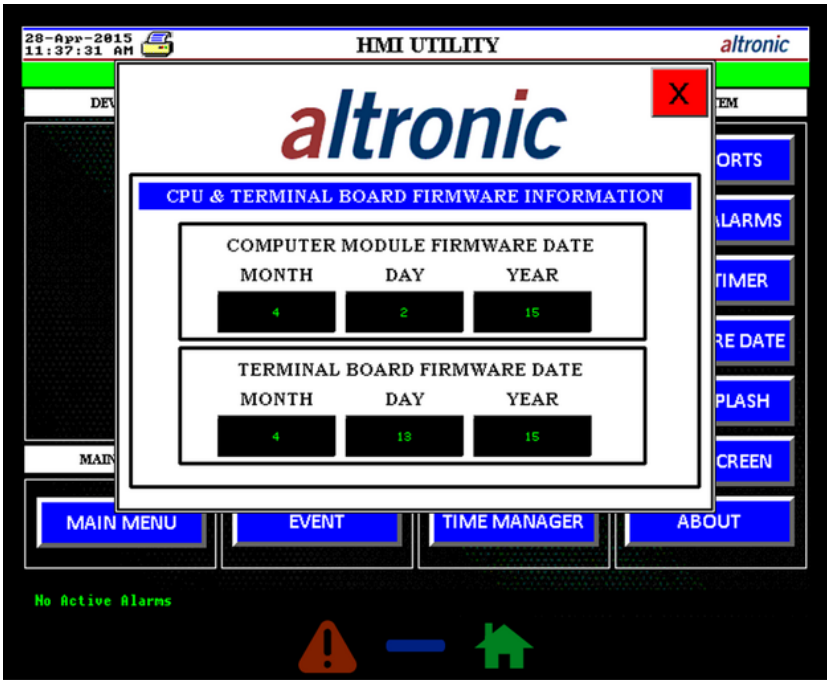
9.26 All the trend screens can be accessed by pressing the appropriate trend buttons on the Main Menu screen. The trend screen gives the user a better understanding of channel behavior. All the log values are also saved on the SD card installed on the MIDAS HMI.



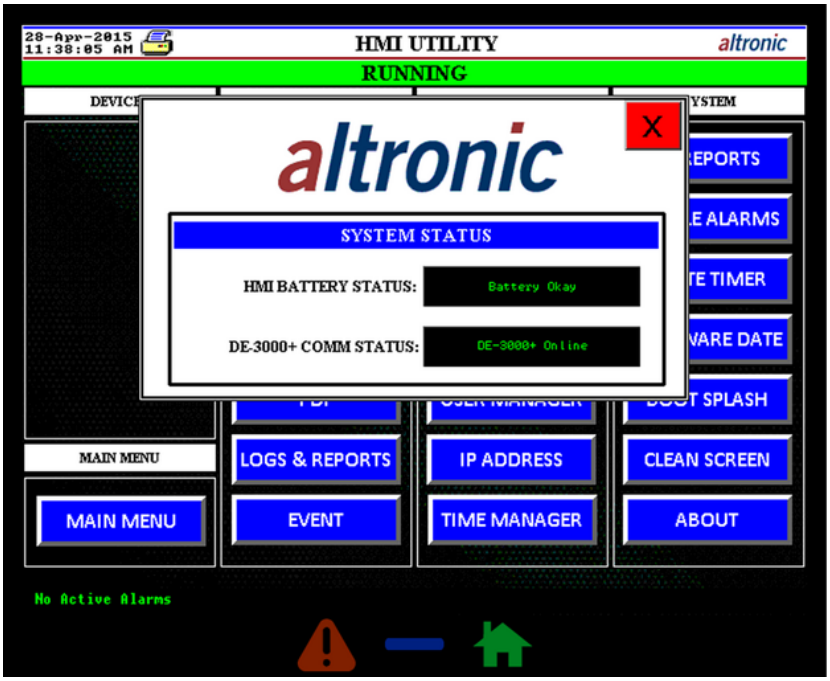
9.27 The SD Card Status popup can be accessed by pressing the “SD CARD STATUS” button on the MIDAS HMI Utility screen. The SD Card Status popup gives detail on the SD card capacity and the status while giving the user the ability to format or eject the card. The “GENERATE SP REPORTS” button allows the user to save current setpoint values on the SD card for record keeping purposes.



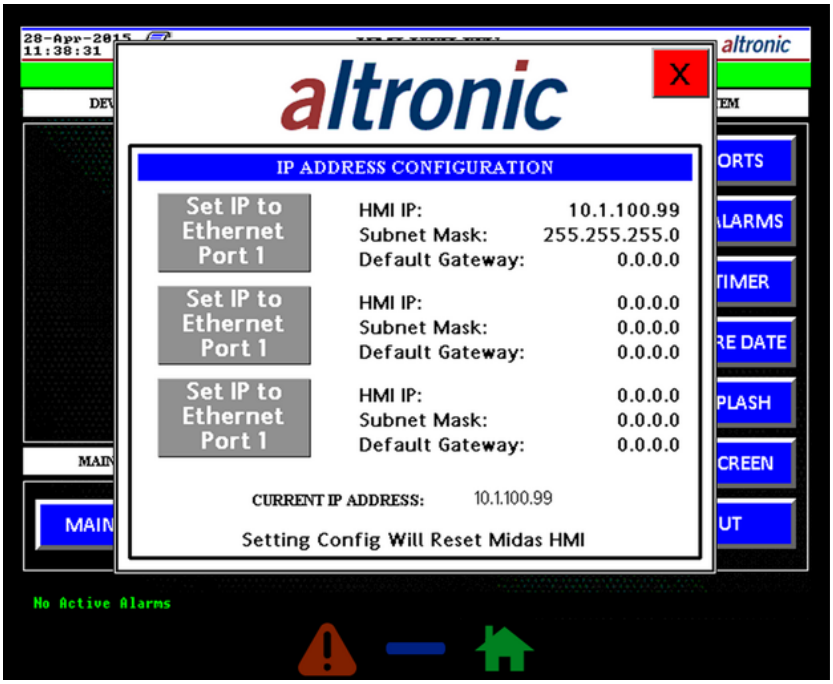
9.28 The CPU & Terminal Board Firmware popup can be accessed by pressing the "FIRMWARE DATE" button on the MIDAS HMI Utility screen. The CPU & Terminal Board Firmware popup displays the date of the firmware currently installed on the DE-3000+ computer module and the terminal board.



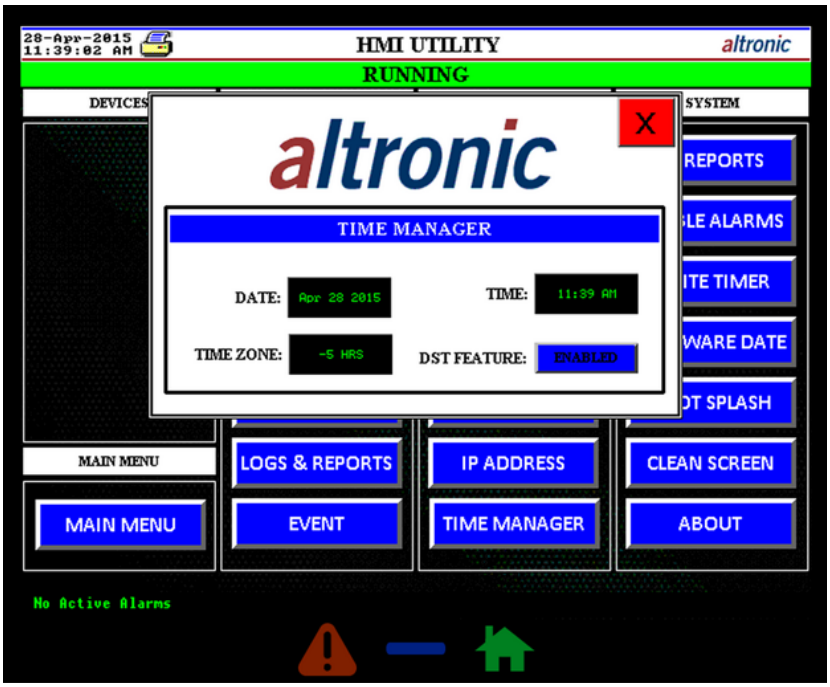
9.29 The System Status popup can be accessed by pressing the "SYSTEM STATUS" button on the MIDAS HMI Utility screen. The System Status popup displays the MIDAS HMI battery and communication status.



9.30 The IP Address Configuration popup can be accessed by pressing the "IP ADDRESS" button on the MIDAS HMI Utility screen. The IP Address Configuration popup displays the current IP address of the MIDAS HMI communicating with the DE-3000+ computer module. The user can setup a new IP configuration by inputting the IP Address, Subnet Mask, and Gateway on the data entry boxes and then clicking the "Set IP to Ethernet Port 1" button. The MIDAS HMI reboots before saving the new IP configuration into the system.

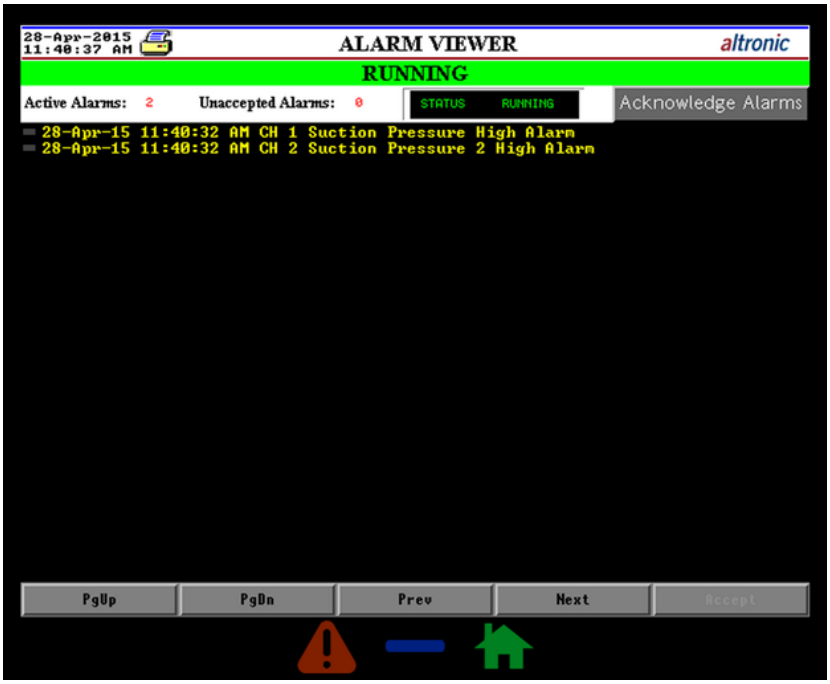


9.31 The Time Manager Popup can be accessed by pressing the "TIME MANAGER" button on the MIDAS HMI Utility screen. The Time Manager Popup displays the current time of the MIDAS HMI. This time can be modified by the user.

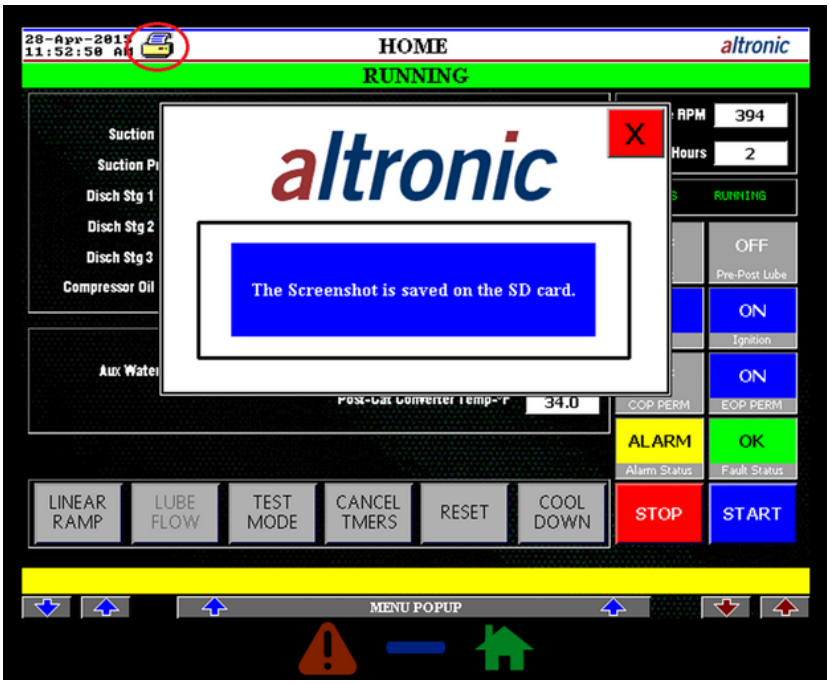


9.32 The Event screen can be accessed by pressing the “EVENT” button on the MIDAS HMI Utility screen. The Event screen displays all the events that have occurred on the DE-3000+ controller. This information is also saved on the SD card.

9.33 The Alarm Viewer can be accessed by pressing the red triangle button on the bezel of the MIDAS HMI. The Alarm viewer displays the Active and Unaccepted alarms on the DE-3000+ controller. If an alarm is no longer active, the user can press the “Acknowledge Alarms” button to accept the alarm.



9.34 All the screens on the DE-3000+ MIDAS HMI have a screen shot icon located on the top left corner of the screen. When pressed, a popup confirming that the screenshot has been saved on the SD card appears. These screenshots can then be retrieved from the SD card for record keeping purposes.



10.0 MANUAL MODE

10.1 To manually start the engine, press the RESET button. The TIMERS ACTIVE message will be displayed and remains until all Class B and Class C inputs have been armed. During the time that the Class B and Class C timers are still active, manually purge and crank the engine.

11.0 AUTO START

11.1 To automatically start the engine, AUTO START must be selected during programming and the starting procedure sequence must be defined.

NOTE: IF A CLASS A SETPOINT SHOULD FAULT AT ANY TIME DURING AN AUTO START SEQUENCE, THE SYSTEM WILL TERMINATE THE SEQUENCE AND DISPLAY THE APPROPRIATE FAULT MESSAGE RETURNING THE SYSTEM TO STATE 0.

11.2 **STATE 0: SHUTDOWN**
The AUTO START sequence must begin from an engine stopped condition, this means that the measured RPM has been at zero for at least 5 seconds. This is the system STATE 0 on the sequence chart.

11.3 **STATE 1: BEGIN AUTO START SEQUENCE TIMED DELAY PERIOD**
When the auto start command is received, the first action taken is to create an internal system reset which clears the previously set fault flags and resets the PRE-LUBE (Timer 1) and DELAY BEFORE CRANKING (Timer 2) timers to a count of zero. This is system STATE 1. The PRE-LUBE and DELAY BEFORE CRANKING timers will both begin counting at this time, but they each have an independently set value so that the PRE-LUBE pump can be set to run prior to the cranking only or thru the cranking cycle or until some point in time after the engine starts. If an optional pressure setpoint is going to be used to terminate the PRE-LUBE operation, this can be done by using a secondary control setpoint on oil pressure assigned to one of the discrete control outputs. In system STATE 1, while these timers are running, all class A setpoints are being monitored and if any of these monitored points fault, the auto start sequence will be terminated and the cause of the fault displayed, returning the unit to system STATE 0 on the sequence chart. If no faults are present during system STATE 1, the DELAY BEFORE CRANKING timer continues to count until the selected value is reached. In system STATE 1 of the sequence the system turns on the power

NOTE: AUTO START IS INHIBITED BY SENSING ANY RPM ABOVE 0 RPM. AUTO START IS ABORTED BY THE DETECTION OF ANY MONITORED FAULT. CLASS B AND CLASS C TIMERS BEGIN AT CRANKING. A LOCAL WARNING SIGNAL AT THE ENGINE SITE PRIOR TO CRANKING SHOULD BE PROVIDED.

supply OUTPUT #4, the PRE-LUBE output. This allows for the activation of an electrically controlled pre-lube pump for a programmed time period of 0 to 999 seconds prior to and/or during cranking. The use of an appropriate warning device which can be used to alert any personnel near the engine of the forthcoming start attempt is strongly recommended. This warning device (flashing lights or horn) can be activated by the PRE-LUBE output directly or through the use of auxiliary relay contacts.

11.4 **STATE 2: BEGIN CRANKING**
When cranking begins the system is at STATE 2 on the sequence chart. After a user programmed time delay, adjustable from 0 to 999 seconds and set when programming the unit; the engine cranking will begin. At the point of cranking, the Class B and Class C timers begin counting their programmed lock out delay before arming values. The reason that these counters are not started until this point in system STATE 2 is to maintain a constant lockout time from engine start before arming regardless of the time required for cranking. This allows the Class B and Class C setpoints to behave in the same manner and use the same timer values for both AUTO START and MANUAL starting sequences. The CRANKING motor is controlled via power supply OUTPUT #3, which would typically be used to control a solenoid valve or power relay connected to the starting device.

11.5 **STATE 3: PURGE 1 NO FUEL NO IGNITION**
As the engine cranking begins, the DE-3000+ system implements the engine purge cycle. The first engine purge cycle consists of a programmed roll time, 0 to 10 seconds (5 seconds typical), without fuel or ignition.

11.6 **STATE 4: PURGE 2 NO FUEL WITH IGNITION**
The second engine purge cycle is an additional programmed time from 0 to 10 seconds with the ignition firing and no fuel being supplied while still cranking.

11.7 **STATE 5: STARTING FUEL AND IGNITION ON**
After a total purge time of ten seconds, both ignition and fuel have been enabled via outputs #1 and #2 of the power supply module and the engine should begin running.

11.8 **STATE 6: ENGINE STARTED**
As the engine speed increases, the user programmable CRANK DISCONNECT speed switch function will automatically disable the starter at the selected RPM by de-energizing OUTPUT #3. This is the beginning of system STATE 6 on the sequence chart. If the crank disconnect RPM is not reached within a user programmed time period after the cranking output is energized (15 to 99 seconds), an OVERCRANK FAULT will be generated. The OVERCRANK FAULT will turn off the fuel and ignition and disable the starter until a new AUTO START command is received returning the system to STATE 0. If the DE-3000+ is set up for Multi-Start, then a delay timer will begin counting down before another start attempt is automatically triggered. Pressing any button on the display during the time between start attempts will cancel Multi-Start, and the DE-3000+ will remain in a Stop/Fault mode until it is manually restarted.

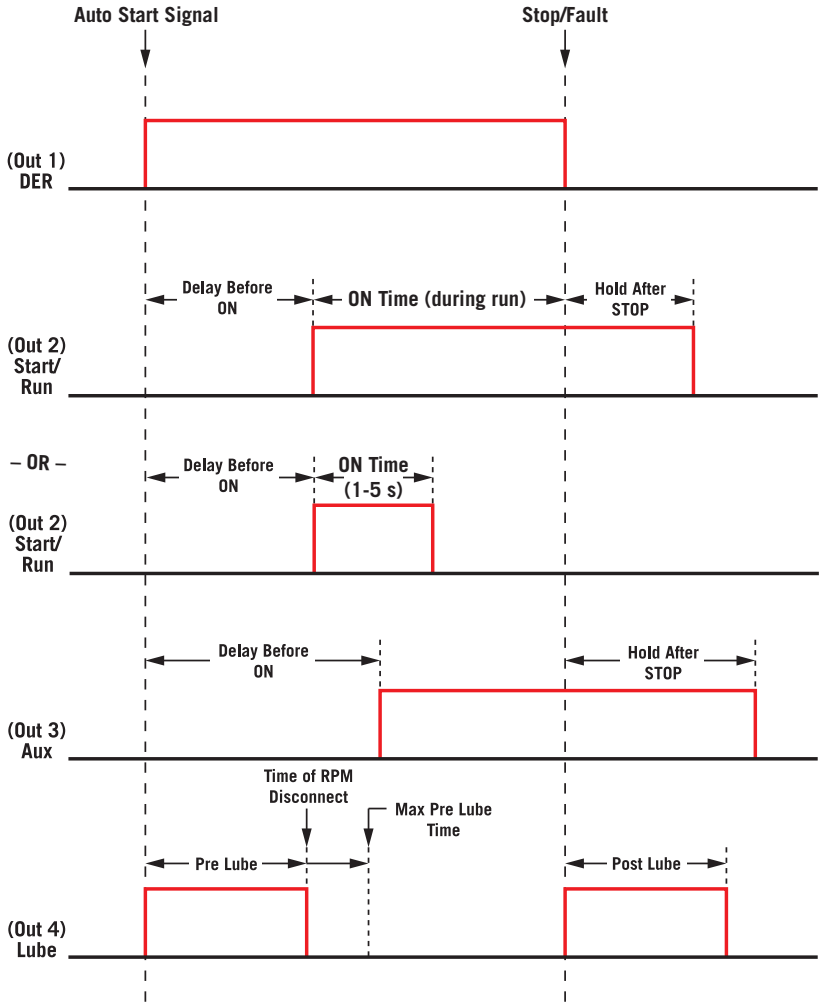
11.9 **STATE 7: ENGINE RUNNING UNLOADED WARMUP**
After the engine has started and the cranking device is turned off (system STATE 7 on the sequence chart), the 4-20mA RPM control output to the governor will be at the IDLE speed value. The RPM control output will stay at the IDLE value until a user-programmed delay of 0 to 999 minutes as set by the WARM-UP TIMER is completed.

11.10 **STATE 8: ENGINE RUNNING PID OUTPUT CONTROL STARTS**
After the WARM-UP period ends the sequence begins system STATE 8, the 4-20mA control outputs begin to adjust from their default value according to the programmed configuration. Since the programmed configuration is determined by the USER it is not possible to define a particular behavior of the system as normal. A brief description of a typical application configuration follows, although many other control schemes are equally valid. Refer to FIG. 1, sequence of operation chart.

WARNING: WHEN PROGRAMMED FOR MULTI-START, THE DE-3000+ WILL AUTOMATICALLY ATTEMPT TO START THE ENGINE AS MANY AS FOUR TIMES. RESTARTS ARE MADE BETWEEN 30 AND 90 SECONDS FOLLOWING AN OVERCRANK FAULT. PERSONNEL AROUND THE ENGINE MUST BE NOTIFIED TO TAKE THE NECESSARY SAFETY PRECAUTIONS TO AVOID INJURY OR MALFUNCTION.

12.0 OEM ENGINE CONTROL

12.1 OEM ENGINE CONTROL can be used as an engine start-up in applications where the DE-3000+ is used to signal instructions to a controller, rather than directly turning on and off fuel and ignition as is done in AUTO START. To use the OEM ENGINE CONTROL option, select and configure it in the PC terminal program under the Program Global Variables screen. The four output modules on the power supply board should be configured as follows for OEM ENGINE CONTROL: Out 1 for Driven Equipment Ready (DER), Out 2 for Start/Run Signal, Out 3 Auxiliary if necessary, Out 4 for Pre/Post Lube. OEM ENGINE CONTROL begins its sequence when an auto start command is sent to the DE-3000+. The various programmable timers for each module on the power supply board output are shown below.



12.2 The OEM ENGINE CONTROL sequence must begin from an engine stopped condition. When a DE has been configured for OEM ENGINE CONTROL and an auto start is signaled by grounding the 'R' terminal on the terminal board (or a command from the HMI), Lube turns ON, the Crank/Multi-Start disconnect timer starts, and the 'Delay before ON' timers for the Start/Run Signal and the Auxiliary output begin counting down. DER remains ON from the time the auto start signal is sent to the DE-3000+ until a manual stop or fault occurs. All class A setpoints are monitored and class B and C timers begin once the auto start signal is received.

12.3 Once the engine speed has surpassed a specified RPM, the Lube will turn OFF. This Pre Lube Disconnect must occur before the Pre Lube time expires. If it does not, a PRELUBE FAULT will occur and all four outputs will turn OFF and the sequence will terminate.

12.4 The engine speed must also reach a speed above the Crank/Multi-Start disconnect RPM before its corresponding timer expires. If it does not, an OVERCRANK FAULT will be generated and all outputs will turn OFF. If the DE-3000+ is set up for Multi-Start, then a delay timer will begin counting down before another start attempt is automatically triggered. Pressing any button on the display during the time between start attempts will cancel Multi-Start, and the DE-3000+ will remain in a Stop/Fault mode until it is manually restarted.

12.5 The Auxiliary and Start/Run Signal turn ON once their corresponding 'Delay before ON' timers expire. The Auxiliary output will remain on for the entirety of the DE's run time, but the Start/Run Signal can be programmed to turn OFF after 1-5 seconds, or just remain ON during the DE's run time.

12.6 When a manual stop or fault occurs, DER turns OFF and Lube turns ON. The Auxiliary and Start/Run Signal (if still ON) remain ON after a stop or fault for their respective 'Hold after Stop' times and then turn OFF. Lube turns OFF after its programmed Post Lube time.

13.0 SELECTING A CONTROL STRATEGY

13.1 The control strategy best suited to a particular application varies widely. The following information is offered as a set of general guidelines and definitions. Each application should be evaluated by qualified personnel familiar with the actual operating conditions.

13.2 The DE-3000+ controller can be programmed to regulate compressor throughput by controlling both capacity and engine speed. In any particular application, it may be desirable to control the total compressor throughput using only one of these.

13.3 The RPM control of the engine can be done using one of the analog control outputs of the DE-3000+ as a 4-20mA current loop which can be connected directly to an electronic governor. If a governor requiring a pneumatic setpoint (3-15psi) is used then the 4-20mA output is connected to an appropriate I/P transducer.

13.4 The CAPACITY control output of the DE-3000+ is available in two formats, to drive the most common actuating systems. The first output format is an industry-standard 4-20mA current loop used for continuously adjustable (sometimes referred to as linear) control. The 4-20mA output would typically be used to interface to a pneumatically controlled bypass valve. A second set of capacity control outputs is brought out of the controller in a digital format (discrete transistors). The digital or discrete outputs consist of two transistors which switch on to ground and are designed to drive relay coils or pilot duty solenoid valves. One switch is labeled DIGITAL OUT 1 and energizes to LOAD the compressor the other is labeled DIGITAL OUT 2 and energizes to UNLOAD the compressor.

The typical application on reciprocating compressors would be to use the 4-20mA. CAPACITY output to connect to an appropriate I/P transducer which then connects via tubing to the actuator input of a pneumatically controlled external bypass valve.

On some screw compressors utilizing an internal stepless bypass, a spring-biased turn valve, or slide valve, the 4-20mA. CAPACITY output can be connected to an appropriate I/P transducer which then connects via tubing to the actuator in order to move the valve

The second set of capacity control outputs is brought out of the controller in a digital format (discrete transistors). The digital or discrete outputs consist of two transistors which switch on to ground and are designed to drive relay coils or pilot duty solenoid valves. One switch is labeled DIGITAL OUT 1 and energizes to LOAD the compressor the other is labeled DIGITAL OUT 2 and energizes to UNLOAD the compressor. When used with the hydraulically positioned slide valve on a screw compressor application, these outputs are typically connected to a three-way solenoid valve. On reciprocating compressors, the digital outputs can be used to actuate a motor controlled bypass valve via relay contacts which energize the motor to move in the open or close directions.

13.5 The PRIMARY control input should be selected on the basis of the prevailing operating conditions at the compressor site as well as considerations of loading fluctuations, etc. Some basic approaches to compressor load control are listed below:

Suction pressure control
By holding suction pressure at a nearly constant value, a large number of limited flow rate wells can be kept productive with minimal upset conditions. Usually this approach is characterized as a relatively limited supply, or a low flow rate supply of gas, at a given site. This approach may also be required as part of various reclamation or vapor recovery programs. This is an inverse acting relationship — increasing the throughput of the compressor causes the suction pressure to decrease.

Discharge pressure control
By holding discharge pressure at a constant value, a trunk line feeding a larger compressor, or pipeline system, permits a supply of gas to be delivered at a rate approximately equal to the rate at which it is to be consumed. The amount of gas being compressed is not necessarily limited by its availability at the compressor site, but by how much has been consumed by the destination site. This is a direct acting relationship — increasing the throughput of the compressor causes the suction pressure to increase.

Engine Manifold pressure control
By adjusting the compressor throughput on the basis of engine manifold pressure, compressed gas is being produced at a rate that is determined by the horsepower available at the site. This approach would be used where there is plenty of gas available at the wellhead and all of it that is produced can be sold or consumed. In this situation, the only limitation on compressor loading is how much work the engine can do without subjecting it or the compressor to an overload. In the case of electric motor driven compressors, a motor current sensor or kW sensor works in the same manner as the engine manifold pressure sensor on a gas engine.

13.6 When programming the DE-3000+ system, the basic relationship of the Primary Control Inputs (CH1, CH2, S01), Primary Control Outputs (AO1 and AO2), and Output Actuators needs to be defined.

The relationship between a Primary Control Input and Primary Control Output is defined as either direct or inverse acting. Direct acting means that to increase the value of the Primary Control Input, the throughput of the compressor is increased. Inverse acting means that to increase the value of the Primary Control Input, the compressor load must be decreased. In the examples of common control approaches given; discharge pressure and engine manifold pressure or motor amps are direct acting. Suction pressure is an example of a control parameter that is inverse acting. In order to increase suction pressure the compressor throughput must be reduced.

13.7 The secondary control setpoint options have been modified to add more flexibility as detailed below.

- **INHIBIT AN OUTPUT INCREASE**
  The output of one or more of the control loops can be limited in the increasing direction only, while allowing the assigned out-put to freely decrease.
- **INHIBIT AN OUTPUT DECREASE**
  The output of one or more of the control loops can be limited in the decreasing direction only, while allowing the assigned output to freely increase.
- **FORCE AN OUTPUT INCREASE**
  The output of one or more of the control loops can be forced to increase even if the primary control loop requires a different action.
- **FORCE AN OUTPUT DECREASE**
  The output of one or more of the control loops can be forced to decrease even if the primary control loop requires a different action.

In addition to these actions being assignable to the analog inputs, they are also assignable to the analog outputs (AO1, AO2). This allows for the output of one control loop to interact with the other according to a programmed priority. For example, the output of Loop #2 can be inhibited until a certain output value of Loop #1 is reached.

In addition to defining the input/output relationship, the relationship of the control output value to the actuator must also be defined as either direct or inverse acting. As in the case of the control input/output relationship, the direct acting output mechanism is one where an increase in current from the controller causes an increase in load on the compressor. An inverse operating actuator is one where the current is decreased to increase the load on the compressor.

14.0 PID CONTROL

14.1 PID control may be applied to two analog outputs (4 with an extra terminal board) and is an industry standard for control. P, I and D, along with the setpoint and deadband may be set by the user for controlling processes. These values may be tuned during engine operation for system stability. Use the PC terminal program to initially configure the system.

15.0 CASCADE CONTROL

Channel 01 is used to drive the output on A02. CASCADE RPM control enables engine speed to be controlled based on the control setpoint on Loop #1. Once Loop #1 is forcing a maximum output, Loop #2 will drive an output to increase engine speed up to a maximum RPM in order to achieve the control setpoint on Channel 01. See section 13.0 for more information.

16.0 LINEAR/RAMP CONTROL

16.1 LINEAR/RAMP control maps Channel 01 setpoints to defined 4-20 mA states (mapped to RPM values) on A02. This can be set up for either direct or inverse acting. LINEAR/RAMP control can be initiated either after a specified warmup time or the time when input on Channel 26 surpasses its low control setpoint.

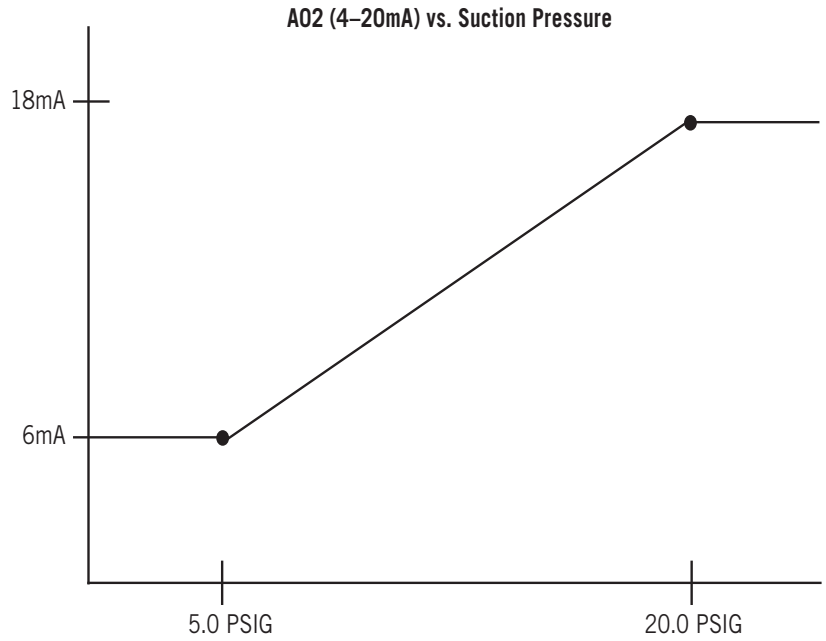
16.2 For a Linear/Ramp Control example, assume the unit is programmed as follows:

Linear/Ramp Control for suction pressure on Channel 01

Low setpoint = 5.0 PSIG at 6mA

High setpoint = 20.0 PSIG at 18mA

This will create a graph as follows:



17.0 PULSE CONTROL

17.1 The DE-3000+ offers a pulsed digital output control option on Digital Outputs #1 and #2 for use with solenoid valves or motor valves. This option is referred to as PULSE CONTROL and allows for closed loop control of the variable measured by the analog voltage measured by input channel 03. The pulse control is attached to channel 03, allowing for three independent control loops. When PULSE CONTROL is used, Digital Output #1 is used to open a valve or to increase the output when it is ON. Digital Output #2 is used to close a valve or decrease the output when it is turned ON. A decision of which output to activate and for how long is made once per cycle. A maximum ON time limit is selected when programming the unit from the PC Terminal Program.

18.0 TEST MODE

18.1 The test mode is used for testing sensors without tripping the outputs. The controller system stays in the test mode for a preset timed period. To enter the test mode, make sure the home screen status line says RUNNING, and press the TEST button. The HMI will display TEST xxx SEC; xxx being the remaining test time. To test an input, momentarily fault a sensor. The display will show the faulted point, its description and 1st FAULT for the first point tested. To test another point press the TEST button, this will clear the tested sensor from the display and will refresh the test timer to its full programmed test time.

WARNING: TEST MODE DISARMS ALL OUTPUTS. ACTUAL FAULTS WILL DISPLAY BUT WILL NOT TRIP THE SYSTEM ALARM AND SHUTDOWN OUTPUTS. USE MANUAL STOP FOR EMERGENCY SHUTDOWN.

18.2 When any of the analog channels are tested, a HIGH or LOW indication will be displayed indicating whether a high or low setpoint was tested.

18.3 Press the CANCEL TIMERS button to end the test mode. Pressing the CANCEL TIMERS takes the user to the STATUS RUNNING home screen and does not reset the class B, C and output timers. Pressing the RESET key takes the user to the STATUS TIMERS ACTIVE home screen with the class B, C and output timers reset.

19.0 COOL-DOWN

19.1 The cool-down mode enables the engine to enter a state before shutting down where a number of sensors may normally fault low. Class B and C channels that are configured for cool-down will not cause a fault during cool-down mode if an input falls below the corresponding low safety setpoint (analog channels) or switches out of its normal condition (discrete channels). These channels must first be initially configured by the PC terminal program.

19.2 When the cool-down timer expires, the home screen status line will indicate a COOL-DOWN SHUTDOWN.

20.0 CALIBRATION OF TRANSDUCERS

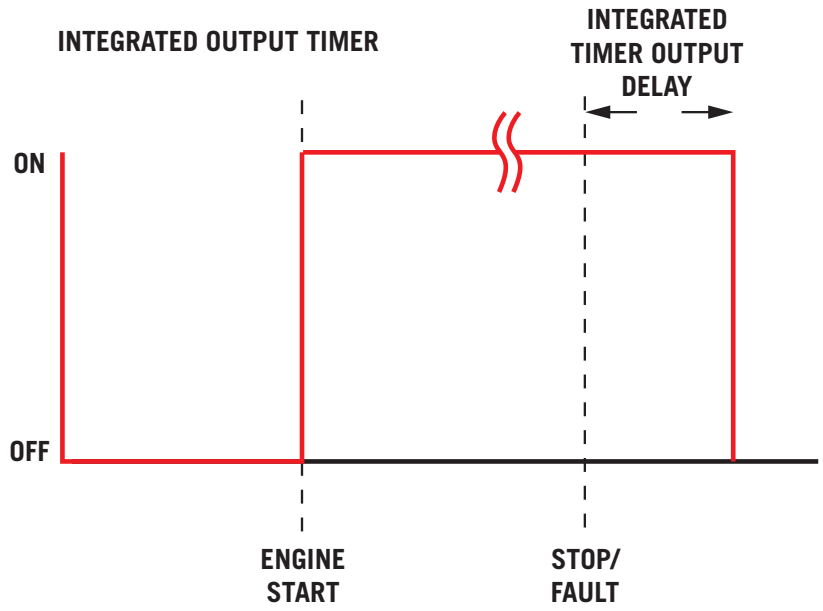
- Connect the computer cable from the computer to the DB9 port #1 on the back of DE-3000+ module.
- Using the DE-3000 software resident on the CDROM, open the DE-3000 program. Then click on the CALIBRATE button at the top of the screen.
- Select the number of channel to be calibrated.
- The sensor selection box will show either the default value or the past calibrated value.
- Under the CALIBRATION SETPOINT section is a box that reads CURRENT DATA. This is the actual information being displayed.
- On the Terminal Board connect a voltmeter between the (+) and (-) transducer output terminals for the channel being calibrated.
- Apply the desired minimum pressure or temperature to the transducer being calibrated. Next take note of the voltage being measured on the voltmeter, this voltage is to be entered in the LOW SENSOR VOLTAGE box. Then click the ACCEPT key to enter the new low value.
- Increase the pressure or temperature to the desired high reading of the trans-

ducer being calibrated. Again take note of the voltage being measured and enter the measured voltage in the HIGH SENSOR VOLTAGE box and hit accept.

Calibration of that channel is complete.

21.0 INTEGRATED TIMER OUTPUTS

21.1 Digital Outputs #5 and #13 may be configured in the terminal program to be used as integrated timers. When configured for this function, the digital outputs turn ON at the engine start and remain ON until a specified amount of time has passed since a stop or fault. This may be used, for example, to shut down the power to a panel in order to lengthen battery life. The operation of the integrated timer output is depicted in the following diagram:



22.0 PROGRAMMING THE DE-3000+

22.1 The DE-3000+ must first be programmed prior to use on an engine. Use the DE-3000 PC terminal program to complete this task. It can be downloaded from the Altronic website at http://www.altronic-llc.com/catalog-downloads.shtml under the Terminal Programs section.

23.0 MODBUS FUNCTIONALITY

23.1 The DE-3000+ is compliant to the Modicon Modbus RTU standard. The data is duplicated for the 30000's and 40000's address range. The maximum number of registers that can be read at one time has been limited to 32. Only Modbus function 06 is supported for writing, and unless otherwise noted in the Modbus Register List, the DE-3000+ only supports register reads. Registers outside of the defined list are reserved and should not be written to, to avoid undesired and potentially hazardous effects on the annunciator system.

24.0 MODBUS REGISTER LIST

ADDRESS	DESCRIPTION
40001	NULL
40002	Hourmeter; range from 0-65535
40004	STATUS: Manual Stop = 00, Fault on Channels 1-60 = 01-60, S01 = 151, S02 = 152, Overcrank = 165, Serial Fault = 166, Pre-Lube Fault = 167, Cool-Down Shutdown = 168, Power Loss = 249, Startup Sequence = 253, Timers Active = 254, Running = 255
40005	Output status; BIT0=OUT1, BIT1=OUT2, BIT2=OUT3, BIT3=OUT4
40006	Fault status; 0=NA, 1=Low Fault, 2=High fault
40020	Digital output status for terminal board #1 (Bitmap of outputs: 0 = Off, 1 = On)
40021	Digital output status for terminal board #2 (Bitmap of outputs: 0 = Off, 1 = On)
40029	Color of the DE-3000 display (1 = yellow/startup sequence, 2 = red/stop, 3 = white/not used, 4 = red/fault, 5 = green/running, 6 = yellow/timers active)
40030 – 40069	The ASCII characters of what is contained on the display of the DE-3000. The upper part of the register displays the first character; the lower part displays the next character/ This may be used for MMI/MIDAS applications.
40080	Writable register for the keypad input. Use function 6 to perform the write. See Key Press Table for the values for each key. This register, along with 40030-40069, may be used in conjunction with a MMI/Red Lion to press keys on the keypad.
40090	Channel #1 input reading (signed)
40091	Channel #2 input reading (signed)
40092	Channel #3 input reading (signed)
40093	Channel #4 input reading (signed)
40094	Channel #5 input reading (signed)
40095	Channel #6 input reading (signed)
40096	Channel #7 input reading (signed)
40097	Channel #8 input reading (signed)
40098	Channel #9 input reading (signed)
40099	Channel #10 input reading (signed)
40100	Channel #11 input reading (signed)
40101	Channel #12 input reading (signed)
40102	Channel #13 input reading (signed)
40103	Channel #14 input reading (signed)
40104	Channel #15 input reading (signed)
40105	Channel #16 input reading (signed)
40106	Channel #17 input reading (signed)
40107	Channel #18 input reading (signed)
40108	Channel #19 input reading (signed)
40109	Channel #20 input reading (signed)
40110	Channel #21 input reading (signed)
40111	Channel #22 input reading (signed)

ADDRESS	DESCRIPTION
40112	Channel #23 input reading (signed)
40113	Channel #24 input reading (signed)
40114	Channel #25 input reading (signed)
40115	Channel #26 input reading (signed)
40116	Channel #27 input reading (signed)
40117	Channel #28 input reading (signed)
40118	Channel #29 input reading (signed)
40119	Channel #30 input reading (signed)
40120	Channel #31 input reading (signed)
40121	Channel #32 input reading (signed)
40122	Channel #33 input reading (signed)
40123	Channel #34 input reading (signed)
40124	Channel #35 input reading (signed)
40125	Channel #36 input reading (signed)
40126	Channel #37 input reading (signed)
40127	Channel #38 input reading (signed)
40128	Channel #39 input reading (signed)
40129	Channel #40 input reading (signed)
40130	Channel #41 input reading (signed)
40131	Channel #42 input reading (signed)
40132	Channel #43 input reading (signed)
40133	Channel #44 input reading (signed)
40134	Channel #45 input reading (signed)
40135	Channel #46 input reading (signed)
40136	Channel #47 input reading (signed)
40137	Channel #48 input reading (signed)
40138	Channel #49 input reading (signed)
40139	Channel #50 input reading (signed)
40140	Channel #51 input reading (signed)
40141	Channel #52 input reading (signed)
40142	Channel #53 input reading (signed)
40143	Channel #54 input reading (signed)
40144	Channel #55 input reading (signed)
40145	Channel #56 input reading (signed)
40146	Channel #57 input reading (signed)
40147	Channel #58 input reading (signed)
40148	Channel #59 input reading (signed)
40149	Channel #60 input reading (signed)
40194	PID #1, P term; range 001-999% (Writable)
40195	PID #1, I term; range 001-999 s (Writable)
40196	PID #1, D term; range 001-999 m (Writable)
40197	PID #2, P term; range 001-999% (Writable)

ADDRESS	DESCRIPTION
40198	PID #2, I term; range 001-999 s (Writable)
40199	PID #2, D term; range 001-999 m (Writable)
40200	PID #1 control setpoint (Writable)
40201	PID #2 control setpoint (Writable)
40202	Indicates the time remaining for the test timer. The value is (-1) if not in test mode.
40203	Cool Down time left (s). 0 indicates not in Cool Down
40204	Cool Down time (s). Write anything to initiate Cool Down
40205	PID #3, P term; range 001-999% (Writable)
40206	PID #3, I term; range 001-999 s (Writable)
40207	PID #3, D term; range 001-999 m (Writable)
40208	PID #4, P term; range 001-999% (Writable)
40209	PID #4, I term; range 001-999 s (Writable)
40210	PID #4, D term; range 001-999 m (Writable)
40211	PID #3 control setpoint (Writable)
40212	PID #4 control setpoint (Writable)
40213	Firmware month of display (1-12)
40214	Firmware day of display (1-31)
40215	Firmware year of display (00 – 99)
40216	Firmware month of 1st terminal (1-12)
40217	Firmware day of 1st terminal (1-31)
40218	Firmware year of 1st terminal (00 – 99)
40219	Firmware month of 2nd terminal (1-12, 0 = DNE)
40220	Firmware day of 2nd terminal (1-31, 0 = DNE)
40221	Firmware year of 2nd terminal (00 – 99)
40222	Time left until a MultiStart Restart attempt (seconds). 0 if not counting down
40223	Ch 01 – 16 bitmap of armed (1) / not armed (0) status
40224	Ch 17 – 32 bitmap of armed (1) / not armed (0) status
40225	Ch 33 – 48 bitmap of armed (1) / not armed (0) status
40226	Ch 49 – 60, S01, S02 bitmap of armed (1) / not armed (0) status
40227	Counter used to track Modbus/Keypad writes to DE. (See Note 1 below)
40228	Counter used to track ASCII writes to DE. (See Note 1 below)
40230	Linear/Ramp Control Var Low (Writable)
40231	Linear/Ramp Control Var Hi (Writable)
40232	Linear/Ramp Control output limit low (4 – 20 mA mapped to 0-4095, Writable)
40233	Linear/Ramp Control output limit high (4 – 20 mA mapped to 0-4095, Writable)
40250	Speed on S01; range from 0-9999 RPM
40251	Speed on S02; range from 0-9999 RPM
40255	Analog output on A01 (%)
40256	Analog output on A02 (%)
40257	Analog output on A03 (%)

ADDRESS	DESCRIPTION
40258	Analog output on A04 (%)
40300 -- 40359	Decimal point location for channels 1-60; range from 0-3 (0=no decimal place, 1=1 decimal place, etc.)
40999	Written to trigger stop or reset function. Will respond to single write only (function code 06). Stop command: 0x53AC; Reset command: 0x41BE
41025	Channel 1 low safety setpoint (Writable)
41026	Channel 1 high safety setpoint (Writable)
41027	Channel 1 low control setpoint (Writable)
41028	Channel 1 high control setpoint (Writable)
41029	Channel 2 low safety setpoint (Writable)
41030	Channel 2 high safety setpoint (Writable)
41031	Channel 2 low control setpoint (Writable)
41032	Channel 2 high control setpoint (Writable)
41033	Channel 3 low safety setpoint (Writable)
41034	Channel 3 high safety setpoint (Writable)
41035	Channel 3 low control setpoint (Writable)
41036	Channel 3 high control setpoint (Writable)
41037	Channel 4 low safety setpoint (Writable)
41038	Channel 4 high safety setpoint (Writable)
41039	Channel 4 low control setpoint (Writable)
41040	Channel 4 high control setpoint (Writable)
41041	Channel 5 low safety setpoint (Writable)
41042	Channel 5 high safety setpoint (Writable)
41043	Channel 5 low control setpoint (Writable)
41044	Channel 5 high control setpoint (Writable)
41045	Channel 6 low safety setpoint (Writable)
41046	Channel 6 high safety setpoint (Writable)
41047	Channel 6 low control setpoint (Writable)
41048	Channel 6 high control setpoint (Writable)
41049	Channel 7 low safety setpoint (Writable)
41050	Channel 7 high safety setpoint (Writable)
41051	Channel 7 low control setpoint (Writable)
41052	Channel 7 high control setpoint (Writable)
41053	Channel 8 low safety setpoint (Writable)
41054	Channel 8 high safety setpoint (Writable)
41055	Channel 8 low control setpoint (Writable)
41056	Channel 8 high control setpoint (Writable)
41057	Channel 9 low safety setpoint (Writable)
41058	Channel 9 high safety setpoint (Writable)
41059	Channel 9 low control setpoint (Writable)
41060	Channel 9 high control setpoint (Writable)

ADDRESS	DESCRIPTION
41061	Channel 10 low safety setpoint (Writable)
41062	Channel 10 high safety setpoint (Writable)
41063	Channel 10 low control setpoint (Writable)
41064	Channel 10 high control setpoint (Writable)
41065	Channel 11 low safety setpoint (Writable)
41066	Channel 11 high safety setpoint (Writable)
41067	Channel 11 low control setpoint (Writable)
41068	Channel 11 high control setpoint (Writable)
41069	Channel 12 low safety setpoint (Writable)
41070	Channel 12 high safety setpoint (Writable)
41071	Channel 12 low control setpoint (Writable)
41072	Channel 12 high control setpoint (Writable)
41073	Channel 13 low safety setpoint (Writable)
41074	Channel 13 high safety setpoint (Writable)
41075	Channel 13 low control setpoint (Writable)
41076	Channel 13 high control setpoint (Writable)
41077	Channel 14 low safety setpoint (Writable)
41078	Channel 14 high safety setpoint (Writable)
41079	Channel 14 low control setpoint (Writable)
41080	Channel 14 high control setpoint (Writable)
41081	Channel 15 low safety setpoint (Writable)
41082	Channel 15 high safety setpoint (Writable)
41083	Channel 15 low control setpoint (Writable)
41084	Channel 15 high control setpoint (Writable)
41085	Channel 16 low safety setpoint (Writable)
41086	Channel 16 high safety setpoint (Writable)
41087	Channel 16 low control setpoint (Writable)
41088	Channel 16 high control setpoint (Writable)
41089	Channel 17 low safety setpoint (Writable)
41090	Channel 17 high safety setpoint (Writable)
41091	Channel 17 low control setpoint (Writable)
41092	Channel 17 high control setpoint (Writable)
41093	Channel 18 low safety setpoint (Writable)
41094	Channel 18 high safety setpoint (Writable)
41095	Channel 18 low control setpoint (Writable)
41096	Channel 18 high control setpoint (Writable)
41097	Channel 19 low safety setpoint (Writable)
41098	Channel 19 high safety setpoint (Writable)
41099	Channel 19 low control setpoint (Writable)
41100	Channel 19 high control setpoint (Writable)
41101	Channel 20 low safety setpoint (Writable)
41102	Channel 20 high safety setpoint (Writable)
41103	Channel 20 low control setpoint (Writable)

ADDRESS	DESCRIPTION
41104	Channel 20 high control setpoint (Writable)
41105	Channel 21 low safety setpoint (Writable)
41106	Channel 21 high safety setpoint (Writable)
41107	Channel 21 low control setpoint (Writable)
41108	Channel 21 high control setpoint (Writable)
41109	Channel 22 low safety setpoint (Writable)
41110	Channel 22 high safety setpoint (Writable)
41111	Channel 22 low control setpoint (Writable)
41112	Channel 22 high control setpoint (Writable)
41113	Channel 23 low safety setpoint (Writable)
41114	Channel 23 high safety setpoint (Writable)
41115	Channel 23 low control setpoint (Writable)
41116	Channel 23 high control setpoint (Writable)
41117	Channel 24 low safety setpoint (Writable)
41118	Channel 24 high safety setpoint (Writable)
41119	Channel 24 low control setpoint (Writable)
41120	Channel 24 high control setpoint (Writable)
41121	Channel 25 low safety setpoint (Writable)
41122	Channel 25 high safety setpoint (Writable)
41123	Channel 25 low control setpoint (Writable)
41124	Channel 25 high control setpoint (Writable)
41125	Channel 26 low safety setpoint (Writable)
41126	Channel 26 high safety setpoint (Writable)
41127	Channel 26 low control setpoint (Writable)
41128	Channel 26 high control setpoint (Writable)
41129	Channel 27 low safety setpoint (Writable)
41130	Channel 27 high safety setpoint (Writable)
41131	Channel 27 low control setpoint (Writable)
41132	Channel 27 high control setpoint (Writable)
41133	Channel 28 low safety setpoint (Writable)
41134	Channel 28 high safety setpoint (Writable)
41135	Channel 28 low control setpoint (Writable)
41136	Channel 28 high control setpoint (Writable)
41137	Channel 29 low safety setpoint (Writable)
41138	Channel 29 high safety setpoint (Writable)
41139	Channel 29 low control setpoint (Writable)
41140	Channel 29 high control setpoint (Writable)
41141	Channel 30 low safety setpoint (Writable)
41142	Channel 30 high safety setpoint (Writable)
41143	Channel 30 low control setpoint (Writable)
41144	Channel 30 high control setpoint (Writable)
41145	Channel S01 low safety setpoint (Writable)
41146	Channel S01 high safety setpoint (Writable)

ADDRESS	DESCRIPTION
41147	Channel S01 low control setpoint (Writable)
41148	Channel S01 high control setpoint (Writable)
41149	Channel 31 low safety setpoint (Writable)
41150	Channel 31 high safety setpoint (Writable)
41151	Channel 31 low control setpoint (Writable)
41152	Channel 31 high control setpoint (Writable)
41153	Channel 32 low safety setpoint (Writable)
41154	Channel 32 high safety setpoint (Writable)
41155	Channel 32 low control setpoint (Writable)
41156	Channel 32 high control setpoint (Writable)
41157	Channel 33 low safety setpoint (Writable)
41158	Channel 33 high safety setpoint (Writable)
41159	Channel 33 low control setpoint (Writable)
41160	Channel 33 high control setpoint (Writable)
41161	Channel 34 low safety setpoint (Writable)
41162	Channel 34 high safety setpoint (Writable)
41163	Channel 34 low control setpoint (Writable)
41164	Channel 34 high control setpoint (Writable)
41165	Channel 35 low safety setpoint (Writable)
41166	Channel 35 high safety setpoint (Writable)
41167	Channel 35 low control setpoint (Writable)
41168	Channel 35 high control setpoint (Writable)
41169	Channel 36 low safety setpoint (Writable)
41170	Channel 36 high safety setpoint (Writable)
41171	Channel 36 low control setpoint (Writable)
41172	Channel 36 high control setpoint (Writable)
41173	Channel 37 low safety setpoint (Writable)
41174	Channel 37 high safety setpoint (Writable)
41175	Channel 37 low control setpoint (Writable)
41176	Channel 37 high control setpoint (Writable)
41177	Channel 38 low safety setpoint (Writable)
41178	Channel 38 high safety setpoint (Writable)
41179	Channel 38 low control setpoint (Writable)
41180	Channel 38 high control setpoint (Writable)
41181	Channel 39 low safety setpoint (Writable)
41182	Channel 39 high safety setpoint (Writable)
41183	Channel 39 low control setpoint (Writable)
41184	Channel 39 high control setpoint (Writable)
41185	Channel 40 low safety setpoint (Writable)
41186	Channel 40 high safety setpoint (Writable)
41187	Channel 40 low control setpoint (Writable)
41188	Channel 40 high control setpoint (Writable)
41189	Channel 41 low safety setpoint (Writable)

ADDRESS	DESCRIPTION
41190	Channel 41 high safety setpoint (Writable)
41191	Channel 41 low control setpoint (Writable)
41192	Channel 41 high control setpoint (Writable)
41193	Channel 42 low safety setpoint (Writable)
41194	Channel 42 high safety setpoint (Writable)
41195	Channel 42 low control setpoint (Writable)
41196	Channel 42 high control setpoint (Writable)
41197	Channel 43 low safety setpoint (Writable)
41198	Channel 43 high safety setpoint (Writable)
41199	Channel 43 low control setpoint (Writable)
41200	Channel 43 high control setpoint (Writable)
41201	Channel 44 low safety setpoint (Writable)
41202	Channel 44 high safety setpoint (Writable)
41203	Channel 44 low control setpoint (Writable)
41204	Channel 44 high control setpoint (Writable)
41205	Channel 45 low safety setpoint (Writable)
41206	Channel 45 high safety setpoint (Writable)
41207	Channel 45 low control setpoint (Writable)
41208	Channel 45 high control setpoint (Writable)
41209	Channel 46 low safety setpoint (Writable)
41210	Channel 46 high safety setpoint (Writable)
41211	Channel 46 low control setpoint (Writable)
41212	Channel 46 high control setpoint (Writable)
41213	Channel 47 low safety setpoint (Writable)
41214	Channel 47 high safety setpoint (Writable)
41215	Channel 47 low control setpoint (Writable)
41216	Channel 47 high control setpoint (Writable)
41217	Channel 48 low safety setpoint (Writable)
41218	Channel 48 high safety setpoint (Writable)
41219	Channel 48 low control setpoint (Writable)
41220	Channel 48 high control setpoint (Writable)
41221	Channel 49 low safety setpoint (Writable)
41222	Channel 49 high safety setpoint (Writable)
41223	Channel 49 low control setpoint (Writable)
41224	Channel 49 high control setpoint (Writable)
41225	Channel 50 low safety setpoint (Writable)
41226	Channel 50 high safety setpoint (Writable)
41227	Channel 50 low control setpoint (Writable)
41228	Channel 50 high control setpoint (Writable)
41229	Channel 51 low safety setpoint (Writable)
41230	Channel 51 high safety setpoint (Writable)
41231	Channel 51 low control setpoint (Writable)
41232	Channel 51 high control setpoint (Writable)

ADDRESS	DESCRIPTION
41233	Channel 52 low safety setpoint (Writable)
41234	Channel 52 high safety setpoint (Writable)
41235	Channel 52 low control setpoint (Writable)
41236	Channel 52 high control setpoint (Writable)
41237	Channel 53 low safety setpoint (Writable)
41238	Channel 53 high safety setpoint (Writable)
41239	Channel 53 low control setpoint (Writable)
41240	Channel 53 high control setpoint (Writable)
41241	Channel 54 low safety setpoint (Writable)
41242	Channel 54 high safety setpoint (Writable)
41243	Channel 54 low control setpoint (Writable)
41244	Channel 54 high control setpoint (Writable)
41245	Channel 55 low safety setpoint (Writable)
41246	Channel 55 high safety setpoint (Writable)
41247	Channel 55 low control setpoint (Writable)
41248	Channel 55 high control setpoint (Writable)
41249	Channel 56 low safety setpoint (Writable)
41250	Channel 56 high safety setpoint (Writable)
41251	Channel 56 low control setpoint (Writable)
41252	Channel 56 high control setpoint (Writable)
41253	Channel 57 low safety setpoint (Writable)
41254	Channel 57 high safety setpoint (Writable)
41255	Channel 57 low control setpoint (Writable)
41256	Channel 57 high control setpoint (Writable)
41257	Channel 58 low safety setpoint (Writable)
41258	Channel 58 high safety setpoint (Writable)
41259	Channel 58 low control setpoint (Writable)
41260	Channel 58 high control setpoint (Writable)
41261	Channel 59 low safety setpoint (Writable)
41262	Channel 59 high safety setpoint (Writable)
41263	Channel 59 low control setpoint (Writable)
41264	Channel 59 high control setpoint (Writable)
41265	Channel 60 low safety setpoint (Writable)
41266	Channel 60 high safety setpoint (Writable)
41267	Channel 60 low control setpoint (Writable)
41268	Channel 60 high control setpoint (Writable)
41269	Channel S02 low safety setpoint (Writable)
41270	Channel S02 high safety setpoint (Writable)
41271	Channel S02 low control setpoint (Writable)
41272	Channel S02 high control setpoint (Writable)
43121	Auto/Manual Control of AO1. (See Note 2 below)
43122	Auto/Manual Control of AO2. (See Note 2 below)

ADDRESS	DESCRIPTION
43889	Auto/Manual Control of AO3. (See Note 2 below)
43890	Auto/Manual Control of AO4. (See Note 2 below)
43173	Channel 1 low setpoint class and time (See Note 3 below)
43174	Channel 1 high setpoint class and time
43175	Channel 2 low setpoint class and time
43176	Channel 2 high setpoint class and time
43177	Channel 3 low setpoint class and time
43178	Channel 3 high setpoint class and time
43179	Channel 4 low setpoint class and time
43180	Channel 4 high setpoint class and time
43181	Channel 5 low setpoint class and time
43182	Channel 5 high setpoint class and time
43183	Channel 6 low setpoint class and time
43184	Channel 6 high setpoint class and time
43185	Channel 7 low setpoint class and time
43186	Channel 7 high setpoint class and time
43187	Channel 8 low setpoint class and time
43188	Channel 8 high setpoint class and time
43189	Channel 9 low setpoint class and time
43190	Channel 9 high setpoint class and time
43191	Channel 10 low setpoint class and time
43192	Channel 10 high setpoint class and time
43193	Channel 11 low setpoint class and time
43194	Channel 11 high setpoint class and time
43195	Channel 12 low setpoint class and time
43196	Channel 12 high setpoint class and time
43197	Channel 13 low setpoint class and time
43198	Channel 13 high setpoint class and time
43199	Channel 14 low setpoint class and time
43200	Channel 14 high setpoint class and time
43201	Channel 15 low setpoint class and time
43202	Channel 15 high setpoint class and time
43203	Channel 16 low setpoint class and time
43204	Channel 16 high setpoint class and time
43205	Channel 17 low setpoint class and time
43206	Channel 17 high setpoint class and time
43207	Channel 18 low setpoint class and time
43208	Channel 18 high setpoint class and time
43209	Channel 19 low setpoint class and time
43210	Channel 19 high setpoint class and time
43211	Channel 20 low setpoint class and time
43212	Channel 20 high setpoint class and time

ADDRESS	DESCRIPTION
43213	Channel 21 low setpoint class and time
43214	Channel 21 high setpoint class and time
43215	Channel 22 low setpoint class and time
43216	Channel 22 high setpoint class and time
43217	Channel 23 low setpoint class and time
43218	Channel 23 high setpoint class and time
43219	Channel 24 low setpoint class and time
43220	Channel 24 high setpoint class and time
43221	Channel 25 low setpoint class and time
43222	Channel 25 high setpoint class and time
43223	Channel 26 low setpoint class and time
43224	Channel 26 high setpoint class and time
43225	Channel 27 low setpoint class and time
43226	Channel 27 high setpoint class and time
43227	Channel 28 low setpoint class and time
43228	Channel 28 high setpoint class and time
43229	Channel 29 low setpoint class and time
43230	Channel 29 high setpoint class and time
43231	Channel 30 low setpoint class and time
43232	Channel 30 high setpoint class and time
43233	Channel S01 low setpoint class and time
43234	Channel S01 high setpoint class and time
43941	Channel 31 low setpoint class and time (See Note 3 below)
43942	Channel 31 high setpoint class and time
43943	Channel 32 low setpoint class and time
43944	Channel 32 high setpoint class and time
43945	Channel 33 low setpoint class and time
43946	Channel 33 high setpoint class and time
43947	Channel 34 low setpoint class and time
43948	Channel 34 high setpoint class and time
43949	Channel 35 low setpoint class and time
43950	Channel 35 high setpoint class and time
43951	Channel 36 low setpoint class and time
43952	Channel 36 high setpoint class and time
43953	Channel 37 low setpoint class and time
43954	Channel 37 high setpoint class and time
43955	Channel 38 low setpoint class and time
43956	Channel 38 high setpoint class and time
43957	Channel 39 low setpoint class and time
43958	Channel 39 high setpoint class and time
43959	Channel 40 low setpoint class and time
43960	Channel 40 high setpoint class and time

ADDRESS	DESCRIPTION
43961	Channel 41 low setpoint class and time
43962	Channel 41 high setpoint class and time
43963	Channel 42 low setpoint class and time
43964	Channel 42 high setpoint class and time
43965	Channel 43 low setpoint class and time
43966	Channel 43 high setpoint class and time
43967	Channel 44 low setpoint class and time
43968	Channel 44 high setpoint class and time
43969	Channel 45 low setpoint class and time
43970	Channel 45 high setpoint class and time
43971	Channel 46 low setpoint class and time
43972	Channel 46 high setpoint class and time
43973	Channel 47 low setpoint class and time
43974	Channel 47 high setpoint class and time
43975	Channel 48 low setpoint class and time
43976	Channel 48 high setpoint class and time
43977	Channel 49 low setpoint class and time
43978	Channel 49 high setpoint class and time
43979	Channel 50 low setpoint class and time
43980	Channel 50 high setpoint class and time
43981	Channel 51 low setpoint class and time
43982	Channel 51 high setpoint class and time
43983	Channel 52 low setpoint class and time
43984	Channel 52 high setpoint class and time
43985	Channel 53 low setpoint class and time
43986	Channel 53 high setpoint class and time
43987	Channel 54 low setpoint class and time
43988	Channel 54 high setpoint class and time
43989	Channel 55 low setpoint class and time
43990	Channel 55 high setpoint class and time
43991	Channel 56 low setpoint class and time
43992	Channel 56 high setpoint class and time
43993	Channel 57 low setpoint class and time
43994	Channel 57 high setpoint class and time
43995	Channel 58 low setpoint class and time
43996	Channel 58 high setpoint class and time
43997	Channel 59 low setpoint class and time
43998	Channel 59 high setpoint class and time
43999	Channel 60 low setpoint class and time
44000	Channel 60 high setpoint class and time
44001	Channel S02 low setpoint class and time
44002	Channel S02 high setpoint class and time

ADDRESS	DESCRIPTION
42885	Channel 1 SPAN (Writable – See Note 4 below for Calibration)
42886	Channel 1 ZERO (Writable – See Note 4 below for Calibration)
42887	Channel 1 MIN SENSOR LIMIT (Writable – See Note 4 below for Calibration)
42888	Channel 1 MAX SENSOR LIMIT (Writable – See Note 4 below for Calibration)
42889	Channel 2 SPAN (Writable)
42890	Channel 2 ZERO (Writable)
42891	Channel 2 MIN SENSOR LIMIT (Writable)
42892	Channel 2 MAX SENSOR LIMIT (Writable)
42893	Channel 3 SPAN (Writable)
42894	Channel 3 ZERO (Writable)
42895	Channel 3 MIN SENSOR LIMIT (Writable)
42896	Channel 3 MAX SENSOR LIMIT (Writable)
42897	Channel 4 SPAN (Writable)
42898	Channel 4 ZERO (Writable)
42899	Channel 4 MIN SENSOR LIMIT (Writable)
42900	Channel 4 MAX SENSOR LIMIT (Writable)
42901	Channel 5 SPAN (Writable)
42902	Channel 5 ZERO (Writable)
42903	Channel 5 MIN SENSOR LIMIT (Writable)
42904	Channel 5 MAX SENSOR LIMIT (Writable)
42905	Channel 6 SPAN (Writable)
42906	Channel 6 ZERO (Writable)
42907	Channel 6 MIN SENSOR LIMIT (Writable)
42908	Channel 6 MAX SENSOR LIMIT (Writable)
42909	Channel 7 SPAN (Writable)
42910	Channel 7 ZERO (Writable)
42911	Channel 7 MIN SENSOR LIMIT (Writable)
42912	Channel 7 MAX SENSOR LIMIT (Writable)
42913	Channel 8 SPAN (Writable)
42914	Channel 8 ZERO (Writable)
42915	Channel 8 MIN SENSOR LIMIT (Writable)
42916	Channel 8 MAX SENSOR LIMIT (Writable)
42917	Channel 9 SPAN (Writable)
42918	Channel 9 ZERO (Writable)
42919	Channel 9 MIN SENSOR LIMIT (Writable)
42920	Channel 9 MAX SENSOR LIMIT (Writable)
42921	Channel 10 SPAN (Writable)
42922	Channel 10 ZERO (Writable)
42923	Channel 10 MIN SENSOR LIMIT (Writable)
42924	Channel 10 MAX SENSOR LIMIT (Writable)
42925	Channel 11 SPAN (Writable)
42926	Channel 11 ZERO (Writable)
42927	Channel 11 MIN SENSOR LIMIT (Writable)

ADDRESS	DESCRIPTION
42928	Channel 11 MAX SENSOR LIMIT (Writable)
42929	Channel 12 SPAN (Writable)
42930	Channel 12 ZERO (Writable)
42931	Channel 12 MIN SENSOR LIMIT (Writable)
42932	Channel 12 MAX SENSOR LIMIT (Writable)
42933	Channel 13 SPAN (Writable)
42934	Channel 13 ZERO (Writable)
42935	Channel 13 MIN SENSOR LIMIT (Writable)
42936	Channel 13 MAX SENSOR LIMIT (Writable)
42937	Channel 14 SPAN (Writable)
42938	Channel 14 ZERO (Writable)
42939	Channel 14 MIN SENSOR LIMIT (Writable)
42940	Channel 14 MAX SENSOR LIMIT (Writable)
42941	Channel 15 SPAN (Writable)
42942	Channel 15 ZERO (Writable)
42943	Channel 15 MIN SENSOR LIMIT (Writable)
42944	Channel 15 MAX SENSOR LIMIT (Writable)
42945	Channel 16 SPAN (Writable)
42946	Channel 16 ZERO (Writable)
42947	Channel 16 MIN SENSOR LIMIT (Writable)
42948	Channel 16 MAX SENSOR LIMIT (Writable)
42949	Channel 17 SPAN (Writable)
42950	Channel 17 ZERO (Writable)
42951	Channel 17 MIN SENSOR LIMIT (Writable)
42952	Channel 17 MAX SENSOR LIMIT (Writable)
42953	Channel 18 SPAN (Writable)
42954	Channel 18 ZERO (Writable)
42955	Channel 18 MIN SENSOR LIMIT (Writable)
42956	Channel 18 MAX SENSOR LIMIT (Writable)
42957	Channel 19 SPAN (Writable)
42958	Channel 19 ZERO (Writable)
42959	Channel 19 MIN SENSOR LIMIT (Writable)
42960	Channel 19 MAX SENSOR LIMIT (Writable)
42961	Channel 20 SPAN (Writable)
42962	Channel 20 ZERO (Writable)
42963	Channel 20 MIN SENSOR LIMIT (Writable)
42964	Channel 20 MAX SENSOR LIMIT (Writable)
42965	Channel 21 SPAN (Writable)
42966	Channel 21 ZERO (Writable)
42967	Channel 21 MIN SENSOR LIMIT (Writable)
42968	Channel 21 MAX SENSOR LIMIT (Writable)
42969	Channel 22 SPAN (Writable)
42970	Channel 22 ZERO (Writable)

ADDRESS	DESCRIPTION
42971	Channel 22 MIN SENSOR LIMIT (Writable)
42972	Channel 22 MAX SENSOR LIMIT (Writable)
42973	Channel 23 SPAN (Writable)
42974	Channel 23 ZERO (Writable)
42975	Channel 23 MIN SENSOR LIMIT (Writable)
42976	Channel 23 MAX SENSOR LIMIT (Writable)
42977	Channel 24 SPAN (Writable)
42978	Channel 24 ZERO (Writable)
42979	Channel 24 MIN SENSOR LIMIT (Writable)
42980	Channel 24 MAX SENSOR LIMIT (Writable)
42981	Channel 25 SPAN (Writable)
42982	Channel 25 ZERO (Writable)
42983	Channel 25 MIN SENSOR LIMIT (Writable)
42984	Channel 25 MAX SENSOR LIMIT (Writable)
42985	Channel 26 SPAN (Writable)
42986	Channel 26 ZERO (Writable)
42987	Channel 26 MIN SENSOR LIMIT (Writable)
42988	Channel 26 MAX SENSOR LIMIT (Writable)
42989	Channel 27 SPAN (Writable)
42990	Channel 27 ZERO (Writable)
42991	Channel 27 MIN SENSOR LIMIT (Writable)
42992	Channel 27 MAX SENSOR LIMIT (Writable)
42993	Channel 28 SPAN (Writable)
42994	Channel 28 ZERO (Writable)
42995	Channel 28 MIN SENSOR LIMIT (Writable)
42996	Channel 28 MAX SENSOR LIMIT (Writable)
42997	Channel 29 SPAN (Writable)
42998	Channel 29 ZERO (Writable)
42999	Channel 29 MIN SENSOR LIMIT (Writable)
43000	Channel 29 MAX SENSOR LIMIT (Writable)
43001	Channel 30 SPAN (Writable)
43002	Channel 30 ZERO (Writable)
43003	Channel 30 MIN SENSOR LIMIT (Writable)
43004	Channel 30 MAX SENSOR LIMIT (Writable)
43653	Channel 31 SPAN (Writable – See Note 4 below for Calibration)
43654	Channel 31 ZERO (Writable – See Note 4 below for Calibration)
43655	Channel 31 MIN SENSOR LIMIT (Writable – See Note 4 below for Calibration)
43656	Channel 31 MAX SENSOR LIMIT (Writable – See Note 4 below for Calibration)
43657	Channel 32 SPAN (Writable)
43658	Channel 32 ZERO (Writable)
43659	Channel 32 MIN SENSOR LIMIT (Writable)
43660	Channel 32 MAX SENSOR LIMIT (Writable)

ADDRESS	DESCRIPTION
43661	Channel 33 SPAN (Writable)
43662	Channel 33 ZERO (Writable)
43663	Channel 33 MIN SENSOR LIMIT (Writable)
43664	Channel 33 MAX SENSOR LIMIT (Writable)
43665	Channel 34 SPAN (Writable)
43666	Channel 34 ZERO (Writable)
43667	Channel 34 MIN SENSOR LIMIT (Writable)
43668	Channel 34 MAX SENSOR LIMIT (Writable)
43669	Channel 35 SPAN (Writable)
43670	Channel 35 ZERO (Writable)
43671	Channel 35 MIN SENSOR LIMIT (Writable)
43672	Channel 35 MAX SENSOR LIMIT (Writable)
43673	Channel 36 SPAN (Writable)
43674	Channel 36 ZERO (Writable)
43675	Channel 36 MIN SENSOR LIMIT (Writable)
43676	Channel 36 MAX SENSOR LIMIT (Writable)
43677	Channel 37 SPAN (Writable)
43678	Channel 37 ZERO (Writable)
43679	Channel 37 MIN SENSOR LIMIT (Writable)
43680	Channel 37 MAX SENSOR LIMIT (Writable)
43681	Channel 38 SPAN (Writable)
43682	Channel 38 ZERO (Writable)
43683	Channel 38 MIN SENSOR LIMIT (Writable)
43684	Channel 38 MAX SENSOR LIMIT (Writable)
43685	Channel 39 SPAN (Writable)
43686	Channel 39 ZERO (Writable)
43687	Channel 39 MIN SENSOR LIMIT (Writable)
43688	Channel 39 MAX SENSOR LIMIT (Writable)
43689	Channel 40 SPAN (Writable)
43690	Channel 40 ZERO (Writable)
43691	Channel 40 MIN SENSOR LIMIT (Writable)
43692	Channel 40 MAX SENSOR LIMIT (Writable)
43693	Channel 41 SPAN (Writable)
43694	Channel 41 ZERO (Writable)
43695	Channel 41 MIN SENSOR LIMIT (Writable)
43696	Channel 41 MAX SENSOR LIMIT (Writable)
43697	Channel 42 SPAN (Writable)
43698	Channel 42 ZERO (Writable)
43699	Channel 42 MIN SENSOR LIMIT (Writable)
43700	Channel 42 MAX SENSOR LIMIT (Writable)
43701	Channel 43 SPAN (Writable)
43702	Channel 43 ZERO (Writable)
43703	Channel 43 MIN SENSOR LIMIT (Writable)

ADDRESS	DESCRIPTION
43704	Channel 43 MAX SENSOR LIMIT (Writable)
43705	Channel 44 SPAN (Writable)
43706	Channel 44 ZERO (Writable)
43707	Channel 44 MIN SENSOR LIMIT (Writable)
43708	Channel 44 MAX SENSOR LIMIT (Writable)
43709	Channel 45 SPAN (Writable)
43710	Channel 45 ZERO (Writable)
43711	Channel 45 MIN SENSOR LIMIT (Writable)
43712	Channel 45 MAX SENSOR LIMIT (Writable)
43713	Channel 46 SPAN (Writable)
43714	Channel 46 ZERO (Writable)
43715	Channel 46 MIN SENSOR LIMIT (Writable)
43716	Channel 46 MAX SENSOR LIMIT (Writable)
43717	Channel 47 SPAN (Writable)
43718	Channel 47 ZERO (Writable)
43719	Channel 47 MIN SENSOR LIMIT (Writable)
43720	Channel 47 MAX SENSOR LIMIT (Writable)
43721	Channel 48 SPAN (Writable)
43722	Channel 48 ZERO (Writable)
43723	Channel 48 MIN SENSOR LIMIT (Writable)
43724	Channel 48 MAX SENSOR LIMIT (Writable)
43725	Channel 49 SPAN (Writable)
43726	Channel 49 ZERO (Writable)
43727	Channel 49 MIN SENSOR LIMIT (Writable)
43728	Channel 49 MAX SENSOR LIMIT (Writable)
43729	Channel 50 SPAN (Writable)
43730	Channel 50 ZERO (Writable)
43731	Channel 50 MIN SENSOR LIMIT (Writable)
43732	Channel 50 MAX SENSOR LIMIT (Writable)
43733	Channel 51 SPAN (Writable)
43734	Channel 51 ZERO (Writable)
43735	Channel 51 MIN SENSOR LIMIT (Writable)
43736	Channel 51 MAX SENSOR LIMIT (Writable)
43737	Channel 52 SPAN (Writable)
43738	Channel 52 ZERO (Writable)
43739	Channel 52 MIN SENSOR LIMIT (Writable)
43740	Channel 52 MAX SENSOR LIMIT (Writable)
43741	Channel 53 SPAN (Writable)
43742	Channel 53 ZERO (Writable)
43743	Channel 53 MIN SENSOR LIMIT (Writable)
43744	Channel 53 MAX SENSOR LIMIT (Writable)
43745	Channel 54 SPAN (Writable)
43746	Channel 54 ZERO (Writable)

ADDRESS	DESCRIPTION
43747	Channel 54 MIN SENSOR LIMIT (Writable)
43748	Channel 54 MAX SENSOR LIMIT (Writable)
43749	Channel 55 SPAN (Writable)
43750	Channel 55 ZERO (Writable)
43751	Channel 55 MIN SENSOR LIMIT (Writable)
43752	Channel 55 MAX SENSOR LIMIT (Writable)
43753	Channel 56 SPAN (Writable)
43754	Channel 56 ZERO (Writable)
43755	Channel 56 MIN SENSOR LIMIT (Writable)
43756	Channel 56 MAX SENSOR LIMIT (Writable)
43757	Channel 57 SPAN (Writable)
43758	Channel 57 ZERO (Writable)
43759	Channel 57 MIN SENSOR LIMIT (Writable)
43760	Channel 57 MAX SENSOR LIMIT (Writable)
43761	Channel 58 SPAN (Writable)
43762	Channel 58 ZERO (Writable)
43763	Channel 58 MIN SENSOR LIMIT (Writable)
43764	Channel 58 MAX SENSOR LIMIT (Writable)
43765	Channel 59 SPAN (Writable)
43766	Channel 59 ZERO (Writable)
43767	Channel 59 MIN SENSOR LIMIT (Writable)
43768	Channel 59 MAX SENSOR LIMIT (Writable)
43769	Channel 60 SPAN (Writable)
43770	Channel 60 ZERO (Writable)
43771	Channel 60 MIN SENSOR LIMIT (Writable)
43772	Channel 60 MAX SENSOR LIMIT (Writable)
44609	Hourmeter run time – high word (See Note 5 below)
44610	Hourmeter run time – low word (See Note 5 below)
44611	Service meter #1 hours remaining – high word (See Note 6 below)
44612	Service meter #1 hours remaining – low word (See Note 6 below)
44613	Service meter #2 hours remaining – high word
44614	Service meter #2 hours remaining – low word
44615	Service meter #3 hours remaining – high word
44616	Service meter #3 hours remaining – low word
44617	Service meter #4 hours remaining – high word
44618	Service meter #4 hours remaining – low word
44619	Service meter #5 hours remaining – high word
44620	Service meter #5 hours remaining – low word
44621	Service meter #6 hours remaining – high word
44622	Service meter #6 hours remaining – low word
44623	Service meter #7 hours remaining – high word
44624	Service meter #7 hours remaining – low word

ADDRESS	DESCRIPTION
44625	Service meter #8 hours remaining – high word
44626	Service meter #8 hours remaining – low word
44627	Service meter #9 hours remaining – high word
44628	Service meter #9 hours remaining – low word
44629	Service meter #10 hours remaining – high word
44630	Service meter #10 hours remaining – low word
44631	Service meter #11 hours remaining – high word
44632	Service meter #11 hours remaining – low word
44633	Service meter #1 reset value (hours) – high word (See Note 6 below)
44634	Service meter #1 reset value (hours) – low word (See Note 6 below)
44635	Service meter #2 reset value (hours) – high word
44636	Service meter #2 reset value (hours) – low word
44637	Service meter #3 reset value (hours) – high word
44638	Service meter #3 reset value (hours) – low word
44639	Service meter #4 reset value (hours) – high word
44640	Service meter #4 reset value (hours) – low word
44641	Service meter #5 reset value (hours) – high word
44642	Service meter #5 reset value (hours) – low word
44643	Service meter #6 reset value (hours) – high word
44644	Service meter #6 reset value (hours) – low word
44645	Service meter #7 reset value (hours) – high word
44646	Service meter #7 reset value (hours) – low word
44647	Service meter #8 reset value (hours) – high word
44648	Service meter #8 reset value (hours) – low word
44649	Service meter #9 reset value (hours) – high word
44650	Service meter #9 reset value (hours) – low word
44651	Service meter #10 reset value (hours) – high word
44652	Service meter #10 reset value (hours) – low word
44653	Service meter #11 reset value (hours) – high word
44654	Service meter #11 reset value (hours) – low word
47938 – 48124	Hour/service meter labels (See Note 6 below)
40239	Reset Service meter #1
40240	Reset Service meter #2
40241	Reset Service meter #3
40242	Reset Service meter #4
40243	Reset Service meter #5
40244	Reset Service meter #6
40245	Reset Service meter #7
40246	Reset Service meter #8

ADDRESS	DESCRIPTION
40247	Reset Service meter #9
40248	Reset Service meter #10
40249	Reset Service meter #11

Reading these registers will display zero. Writing any value to these registers will reset the (hours remaining) to the values which had been previously setup for the (reset values).

25.0 KEY PRESS TABLE

KP	FUNCTION
00	None (returns current display)
01	Cancel Timers
02	Test
03	Reset
04	Stop
05	View
06	Next
07	Up/Units
08	View Chan
09	F1
10	Right/Tens
11	Enter
12	Left/Tens
13	F2
14	Menu
15	Down/Units
16	Esc

26.0 NOTES

26.1 **Note 1: Modbus/Keypad and ASCII Write Counters**

Register 40227 (Modbus/Keypad Write Counter) will increment when:

1. A Modbus function code 6 (preset single register) occurs.
2. A value is modified through the keypad (Applicable to DE-3000 Enhanced only).

Register 40228 (ASCII Write Counter) will increment when:

1. A ">(XXXP" command occurs, writing to the display board.
2. A ">(OXT" command occurs, writing to a terminal board.

These registers cannot be written to, and cycling power to the unit will not affect the values.

26.2 **Note 2: Auto/Manual Control of Analog Outputs**

The auto/manual and increase/decrease current (in manual mode) for the corresponding analog output may be directly controlled by this register.

If the MSB=1, then the unit is in auto mode. Use the value of 8000h to put the output loop into auto mode. If the MSB=0, then the unit will be in manual mode and the lower 12 bits (range from 0-4095) will represent the 4-20mA output (0=4mA and 4095=20mA)

As the unit makes the transition from auto to manual (and vice-versa), the 4-20mA goes directly to the value specified by the Modbus register.

Registers 40255-40258 (0-100% output on AO 1-4) may be used to preload a value into the applicable Auto/Manual register before switching over to manual mode.

26.3 Note 3: Setpoint Class and Time

The highest 2 bits represent the input class ('00' – class A, '01' – class B, '10' – class C).

The lower 14 bits represent the time associated with the class (N/A for class A, seconds for class B, and minutes for class C).

For analog channels, the first register corresponds to the low setpoint input class and the second register corresponds to the high safety setpoint input class. For discrete channels, the first register corresponds to the input class and the second register is N/A.

For example, if Channel 2 is an analog input with a low setpoint class B of 60 seconds and a high setpoint class C of 10 minutes, the registers would hold the following values:

Register	Value
43175	01000000 00111100
43176	10000000 00001010

26.4 Note 4: Calibration 1

The ZERO and SPAN Modbus registers are used to 'tweak' the sensors (typically pressure) to read a known value.

SPAN – Slope of the line relating the sensor range to the domain. Typical values would be from 1-255. It is recommended that this value be read and then changed by one. This value should not be greater than 512.

ZERO – Y-intercept of the line described above. It is recommended that this value be read and then changed by 13.

MIN/MAX SENSOR LIMIT (Writable) – lowest and highest permissible displayed values that can be used on a particular channel (must also consider the channel's decimal position). These values are signed integers. While this value may be written, it is recommended that the PC terminal program perform this function.

26.5 Note 5: Hour/Service Meters

For both the remaining hours and the reset values, each meter uses two registers to represent the 32-bit integer. The first register is the low word and the second is the high word. A value of 'FFFF' indicates that the meter is unused. For example, the first two meters' current hour value would be read as follows,

Register	Description	
44609	Hourmeter	high word
44610		low word
44611	Service Meter #1	high word
44612		low word

26.6 **Note 6: Hour/Service Meter Labels**

Each label is comprised of twenty ASCII characters, denoted as bytes within a register. They are read in increasing order from left to right, as such:

Description	Register	High Byte	Low Byte
Hourmeter label	47938		ASCII char 1
	47939	2	3
	47940	4	5
	47941	6	7
	47942	8	9
	47943	10	11
	47944	12	13
	47945	14	15
	47946	16	17
	47947	18	19
	47948	ASCII char 20	

Each meter uses the same format as above, starting with the low byte on the first register and ending on the high byte of the eleventh register. The starting and ending index for each meter label is:

Description	Starting Register	Ending Register
Hourmeter	47938	47948
Service Meter #1	47954	47964
Service Meter #2	47970	47980
Service Meter #3	47986	47996
Service Meter #4	48002	48012
Service Meter #5	48018	48028
Service Meter #6	48034	48044
Service Meter #7	48050	48060
Service Meter #8	48066	48076
Service Meter #9	48082	48092
Service Meter #10	48098	48108
Service Meter #11	48114	48124

GLOSSARY:

ACTUATOR Electromagnetic devices which convert electric current to linear or rotary motion. This motion may then be used to control equipment directly, an electromechanical actuator, or it can be used to regulate a gas or liquid pressure as in a current to pressure converter (I/P).

ANALOG INPUT An input which accepts voltage signals between 0 and 5 volts. These signals are converted by the DE-3000+ to engineering units and compared by the microprocessor to user programmed safety shutdown and control setpoints.

ANALOG OUTPUT An output which provides a current between 4-20mA to external devices to control the compressor. These outputs can be used to interface directly to electrical actuators or connected to I/P transducers mechanical actuators.

CAPACITY CONTROL The capacity control of the compressor is accomplished by reducing the volume of gas moved per compressor cycle. 100% capacity is the full rated volume of gas compressed per machine cycle. Capacity control can be done on both reciprocating and screw compressors using various techniques.

COMPRESSOR CYCLE A compressor cycle is a full rotation of the compressor drive shaft. A turn of the screw on a screw compressor or a revolution of the crankshaft on a reciprocating compressor.

CONTROL SETPOINTS These are setpoints programmed by the user which are within the normal operating range of the equipment and are used to optimize the function of the equipment. Control setpoints may also be used to implement corrective actions to prevent overstress of components or to notify personnel of potential problems before they become severe enough to cause a shutdown.

CRANK DISCONNECT The RPM setting at which output #3 of the power supply will be de-energized. This will de-energize the starting device.

CRANKING DELAY The time after the auto start command before cranking will begin. Allows for pre-lube function and starting warning to personnel. Power supply output #4 is normally energized during this time. See PRE-LUBE TIME.

CURRENT STEP LIMIT The current step limit is a maximum value that the analog output will be allowed to change from one control cycle to another. The current step limit is used to prevent rapid or erratic control action of the actuator even under transient conditions or with a poorly tuned control system. A limit of about 2mA or about 10% of the output range is reasonable default value.

CYCLE TIME The time taken between adjustments of the PRIMARY CONTROL loop. The longer the cycle time selected the less responsive the control output is to variations in the controlled parameter. The cycle time is adjustable from 1 to 999 seconds.

DEADBAND The controller deadband defines a user programmed value both above and below the setpoint for which no corrective action will be taken. Deadband is used to improve control stability by holding the controller output constant in the presence of “noise” or small transient errors on the input.

DIRECT ACTING When describing control or actuator functions, direct acting is used to identify relationships where the controller must increase its output to cause an increase in the variable.

GLOSSARY:

INVERSE ACTING When describing control or actuator functions, inverse acting is used to identify relationships where the controller must decrease its output to cause an increase in the variable.

MAXIMUM RPM The maximum RPM setting is the highest governor setpoint value which will be sent by the controller in an attempt to satisfy the primary control setpoint. The maximum running RPM.

MINIMUM RPM The minimum RPM is the governor setpoint value which will be sent by the controller after the warmup delay time has been fulfilled. The minimum RPM is the speed which must be Seen by the controller to allow loading of the compressor to begin.

OVERCRANK TIME The maximum time that the starting device will remain energized by output #3 before the starting attempt is considered failed. If an overcrank occurs, the crank disconnect RPM is not reached before the overcrank time, then an overcrank fault has occurred.

PRE-LUBE TIME A user programmed time for which output #4 will remain ON after the beginning of an AUTO START sequence. Normally used for control of a pre-lube pump and to signal that a starting attempt is about to begin.

PRIMARY CONTROL The primary control is a closed loop based upon an input value selected from channels 01, 02, or 03. The throughput of the compressor is adjusted by the controller to maintain this setpoint.

PROPORTIONAL BAND The proportional band is used to tune the response of the controller to the characteristic behavior of the equipment being controlled. Proportional band is the inverse of gain expressed as a percentage. A proportional band setting of 10% is equal to a gain setting 10, a proportional band setting of 20% is equal to a gain of 5, etc. The smaller the proportional band setting the greater the controller response to a difference between the measured value and the setpoint.

RPM CHANGE/CYCLE The maximum RPM change per cycle is used to limit the rate at which the controller output to the governor will be allowed to change. This limit is used to avoid rapid speed changes during transient conditions.

SAFETY SHUTDOWN Safety shutdown setpoints are those which cause the protected equipment to be shutdown or stopped in order to protect the equipment and or the operating personnel. These setpoints must be selected to be outside the range of normal operation.

SECONDARY CONTROL Secondary or supplemental control functions are accomplished by sensing user programmed control setpoints. LOAD INHIBIT or FORCE UNLOAD strategies, as well as alarms or corrective actions can be implemented.

THROUGHPUT The total volume of gas per unit of time moved by the compressor. Throughput is varied by both speed and capacity adjustments made by the controller.

WARMUP DELAY The warmup delay time is user programmable from 0 to 99 minutes. This allows for the engine/compressor to run unloaded for this time delay as part of the auto start sequence. The engine speed output to the governor will be held at the idle RPM value during the warmup delay.

INDEX BY SECTION: PAGE

DRAWINGS SECTION:

SYSTEM STATE	0 ENGINE STOPPED	1 DELAY BEFORE CRANKING	2 CRANKING	3 PURGE 1	4 PURGE 2	5 STARTING	6 STARTED	7 WARM UP	8 RUNNING
BEGINS ON EVENT SHOWN TO RIGHT	ON A STOP OR A FAULT	AUTO START SIGNAL	AFTER TIMER T1 SECONDS	CRANKING	CRANKING	AFTER TIMER T4 SECONDS	ENGINE FIRING	ENGINE RUNNING AT IDLE RPM	ENGINE RUNNING AT USER SETTING
ENDS	AUTO START SIGNAL	AFTER TIMER T1 SECONDS	AS CRANKING BEGINS	AFTER TIMER T3 SECONDS	AFTER TIMER T4 SECONDS	AFTER TIMER T4 SECONDS + FIRING	CRANKING, MOTOR OFF AT USER SET RPM	AFTER WARM UP TIMER T5 MINUTES	ON A STOP OR A FAULT
OUT 1 FUEL VALVE CONDITION OR STATUS	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON
OUT 2 IGNITION CONTROL CONDITION OR STATUS	OFF	OFF	OFF	OFF	ON	ON	ON	ON	ON
OUT 3 CRANKING MOTOR CONDITION OR STATUS	OFF	OFF	ON	ON	ON	ON	ON	OFF LOCKED OUT	OFF LOCKED OUT
OUT 4 LUBE PUMP CONDITION OR STATUS	ON, THEN OFF AFTER POST LUBE	ON FOR TIMER T2 SECONDS, THEN OFF	ON FOR TIMER T2 SECONDS, THEN OFF	ON FOR TIMER T2 SECONDS, THEN OFF	ON FOR TIMER T2 SECONDS, THEN OFF	ON FOR TIMER T2 SECONDS, THEN OFF	ON FOR TIMER T2 SECONDS OR USER OFF RPM	OFF	OFF
ANALOG OUT AO1 VALUE	USER DEFAULT VALUE	USER DEFAULT VALUE	USER DEFAULT VALUE	USER DEFAULT VALUE	USER DEFAULT VALUE	USER DEFAULT VALUE	USER DEFAULT VALUE	USER DEFAULT VALUE	PID PER CONTROL SCHEME
ANALOG OUT AO2 VALUE	USER DEFAULT VALUE	USER DEFAULT VALUE	USER DEFAULT VALUE	USER DEFAULT VALUE	USER DEFAULT VALUE	USER DEFAULT VALUE	USER DEFAULT VALUE	USER DEFAULT VALUE	PID PER CONTROL SCHEME
CLASS A	ARMED	ARMED	ARMED	ARMED	ARMED	ARMED	ARMED	ARMED	ARMED
CLASS B	DISABLED	DISABLED	DISABLED	DISABLED	DISABLED	DISABLED	DISABLED	ARMED*	ARMED
CLASS C	DISABLED	DISABLED	DISABLED	DISABLED	DISABLED	DISABLED	DISABLED	ARMED**	ARMED
INPUT SETPOINTS AND FAULT SENSOR FUNCTION	FIRST OUT FAULT LOCKED ON TIMERS NOT RUNNING	TIMERS NOT RUNNING	TIMERS NOT RUNNING	TIMERS NOT RUNNING	TIMERS NOT RUNNING	TIMERS NOT RUNNING	B AND C TIMERS BEGIN RUNNING	* B TIMER DELAYS ** AS CLEARED OR "C" TIMER MET	

NOTE: AUXILIARY FUNCTIONS force and inhibit as assigned, and auxiliary outputs 3 through 7 are always active

FIG. 1 AUTOSTART SEQUENCE OF OPERATION

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FIG. 2 DE-3000+ SYSTEM DIAGRAM

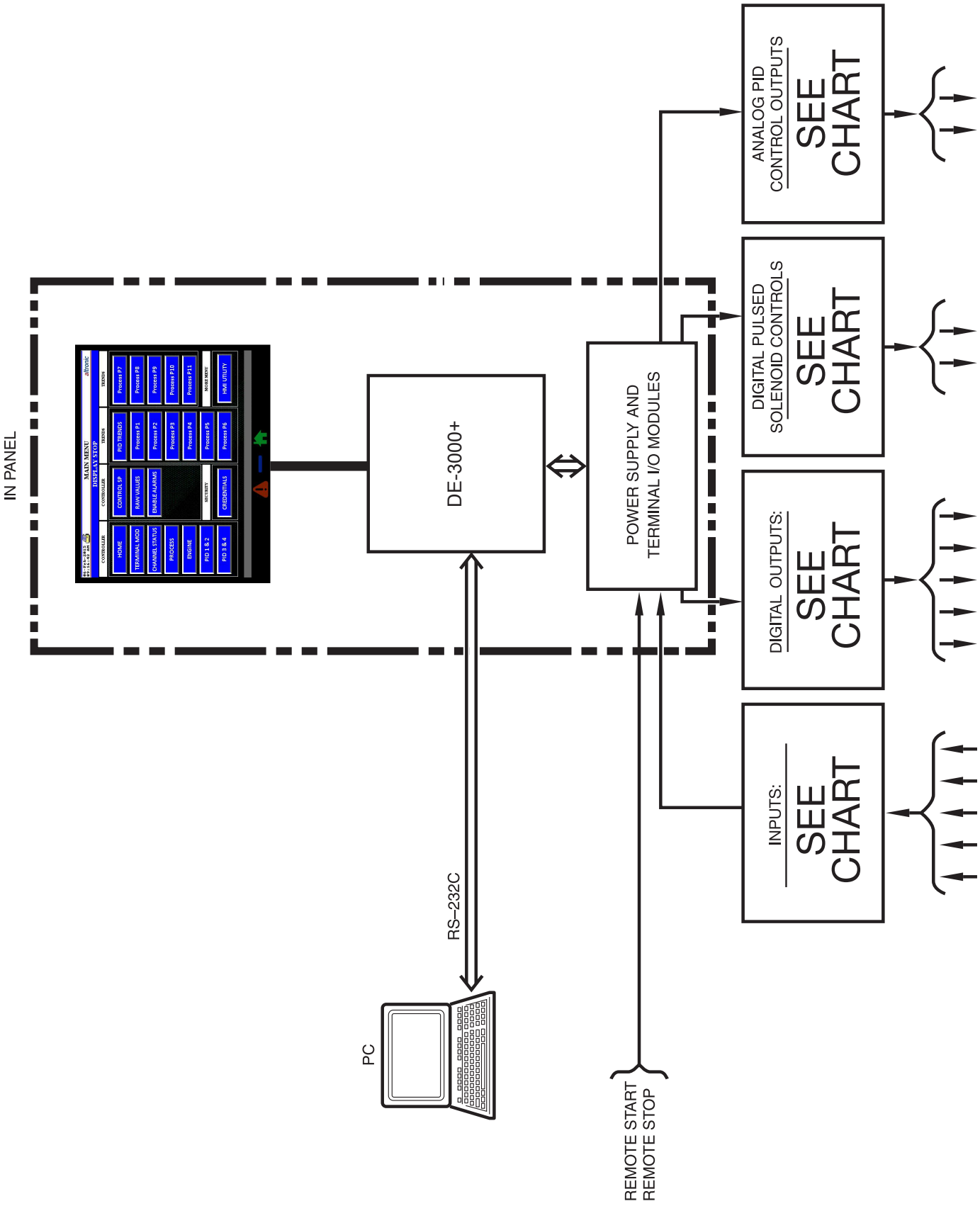


FIG. 3 DE-3000 TERMINAL MODULE AND POWER SUPPLY MODULE

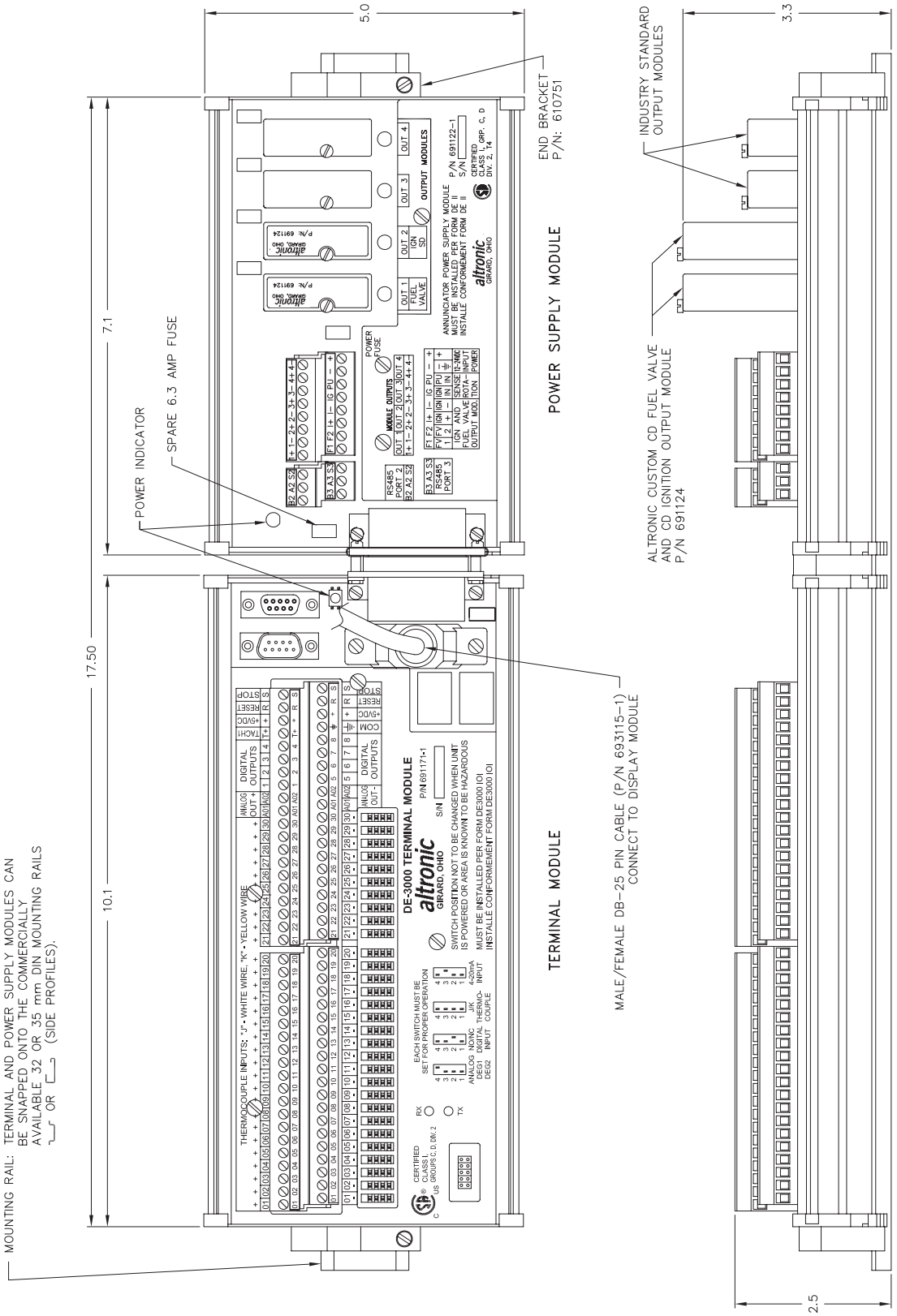


FIG. 4 WIRING DIAGRAM: GENERAL HOOK-UP

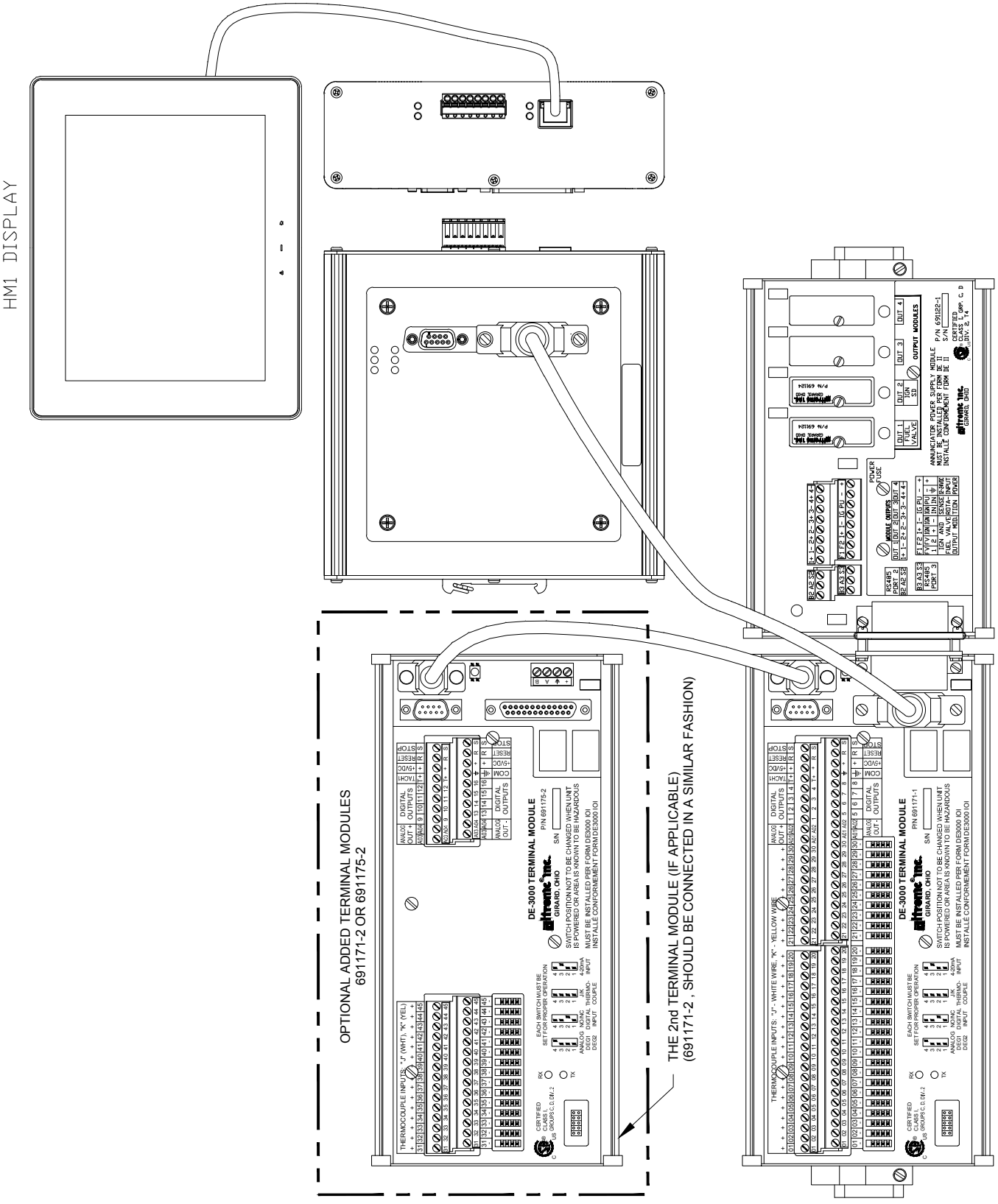


FIG. 5 WIRING DIAGRAM: PERSONAL COMPUTER

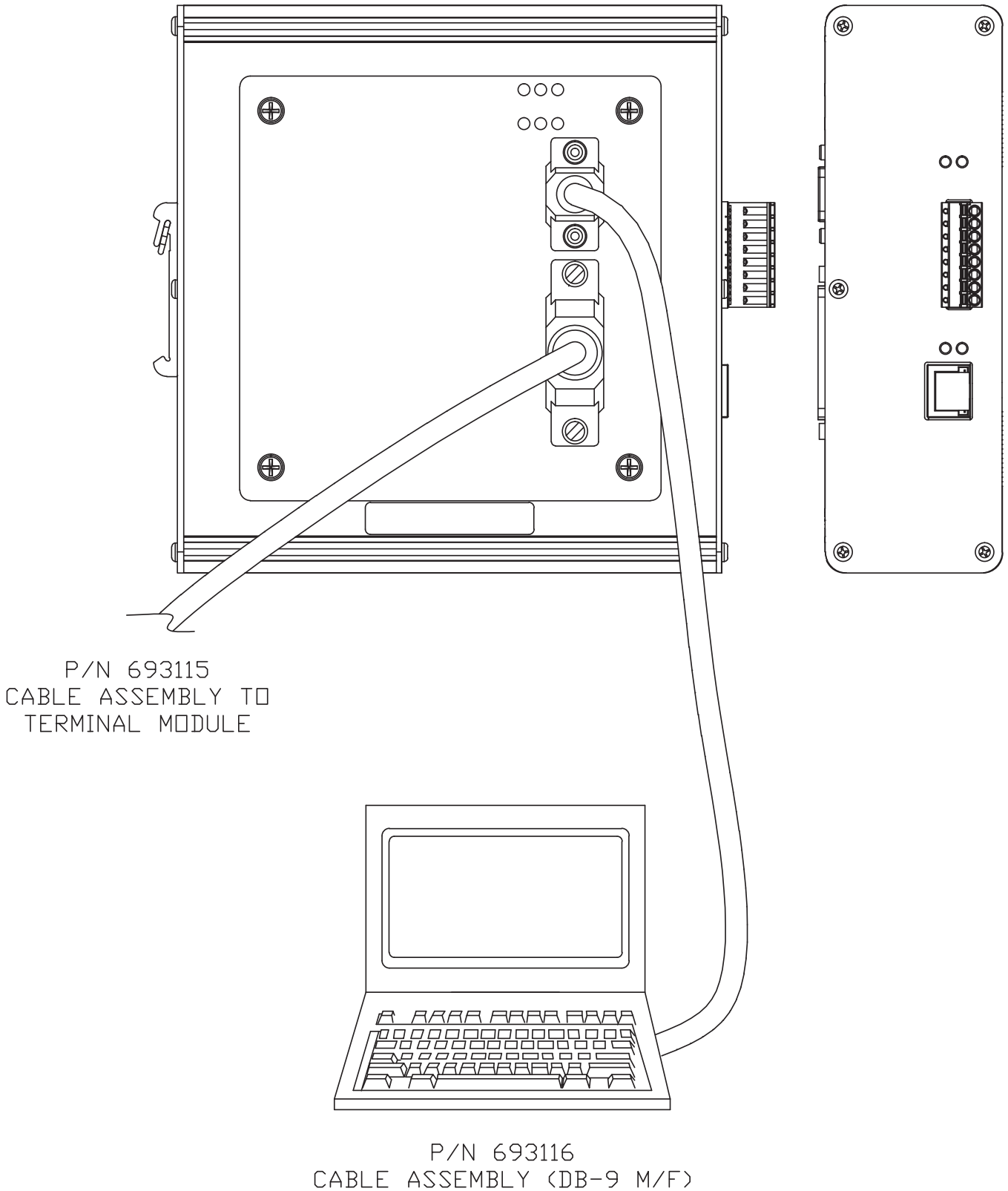
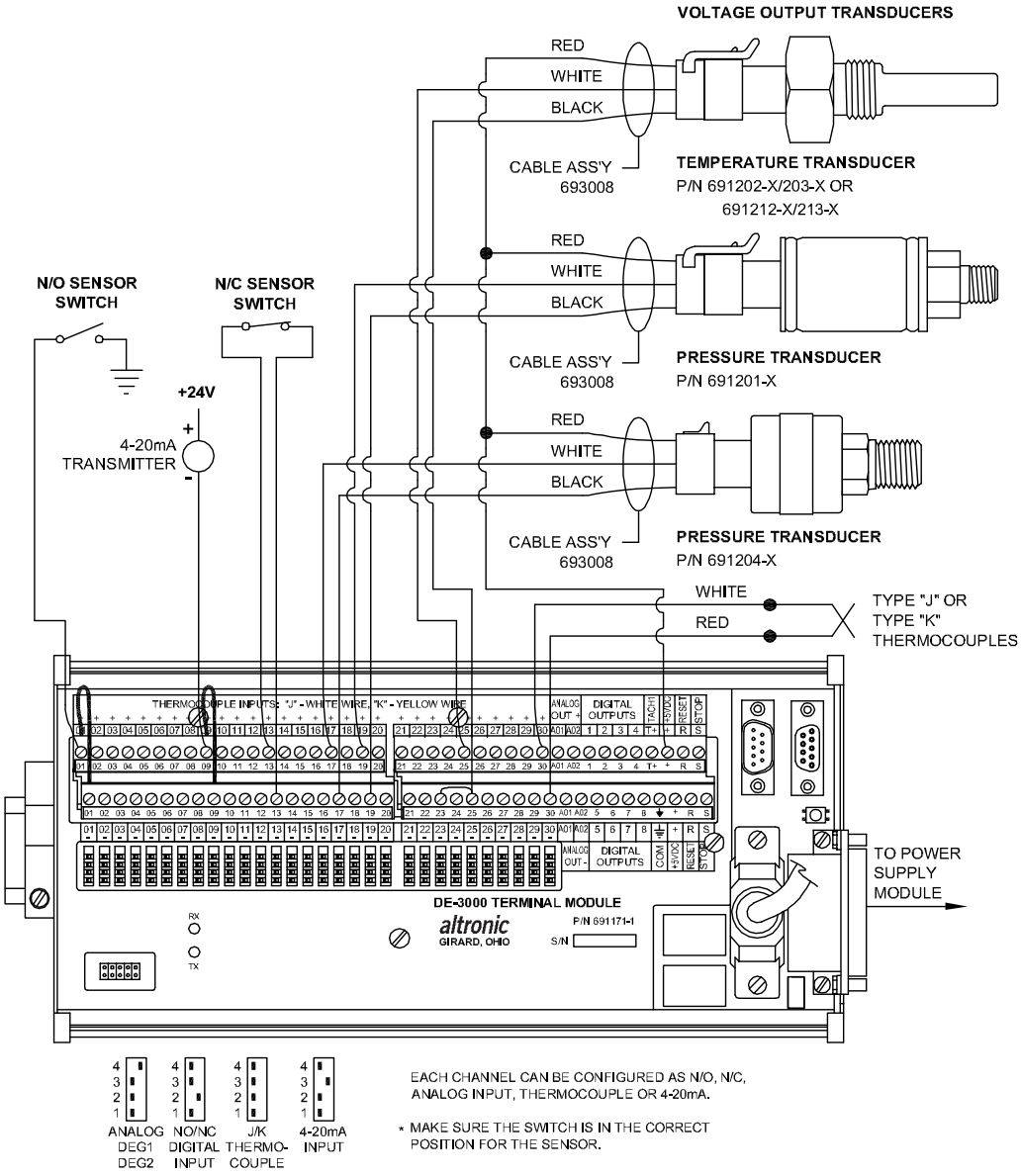


FIG. 6 WIRING DIAGRAM: SENSOR AND TRANSDUCER INPUTS



NOTE:

1. N/O SENSOR SWITCH MUST HAVE JUMPER IN PLACE BETWEEN TOP ROW AND BOTTOM ROW OF TERMINAL BLOCK. POWER SUPPLY MINUS AND SENSOR GROUND MUST BOTH BE COMMON.

2. N/C SENSOR SWITCH, REMOVE JUMPER AND PLACE SWITCH WIRES, ONE IN TOP ROW OTHER IN BOTTOM ROW.

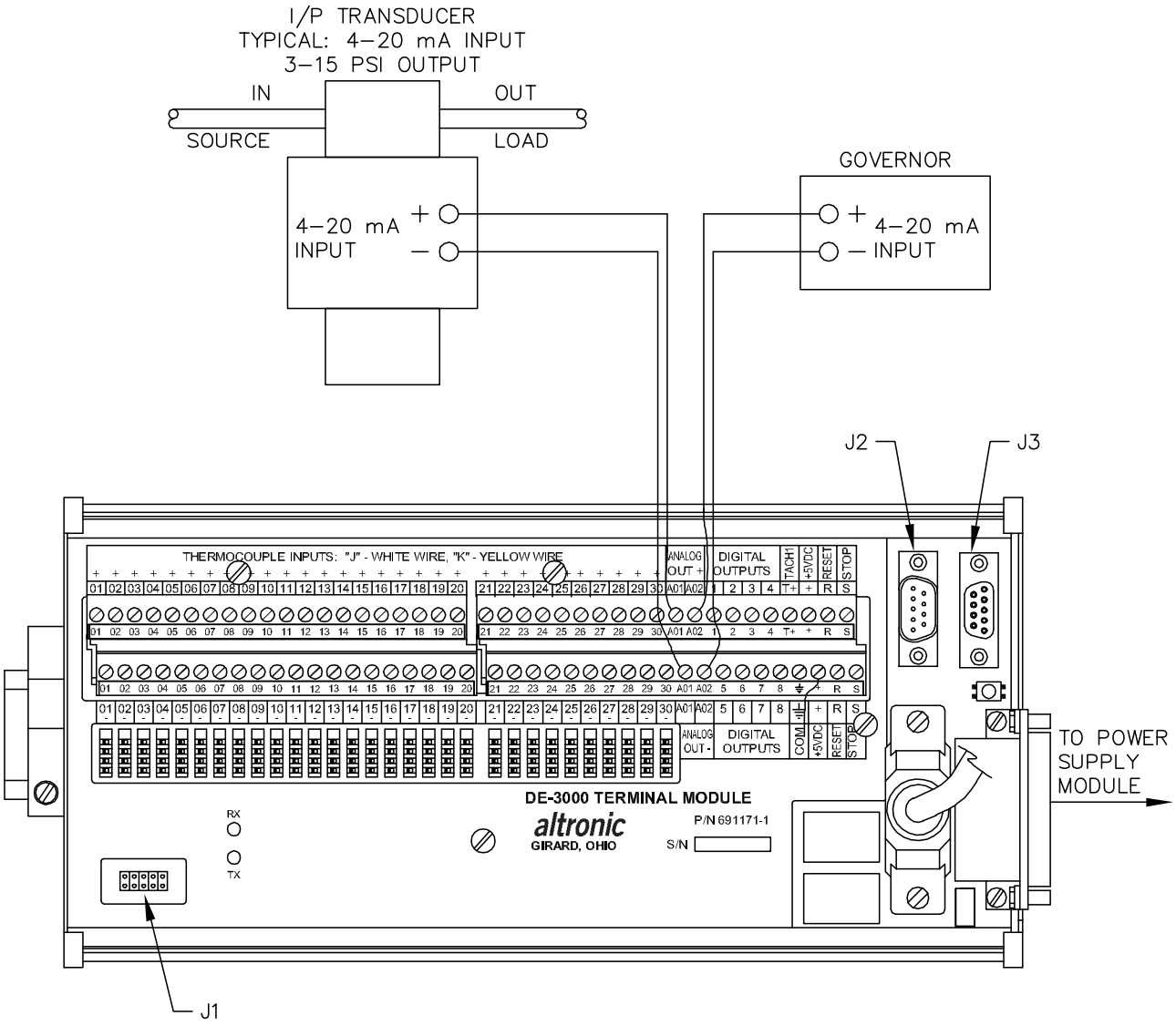
3. ALL UNUSED INPUTS MUST HAVE JUMPER WIRE IN PLACE.

4. REMOTE RESET (R) AND REMOTE STOP (S) ARE WIRED SAME AS OTHER SWITCHES. STOP OVERRIDES RESET.

5. THE +5VDC INTERNAL SUPPLY OUTPUT IS LIMITED TO 500 mA MAXIMUM. IF THIS SUPPLY EXITS THE PANEL, IT MUST BE FUSED WITH A 0.5 AMPERE FUSE. BOTH +5VDC TERMINALS ARE ELECTRICALLY CONNECTED TOGETHER. TWO TERMINALS ARE PROVIDED FOR WIRING CONVENIENCE ONLY.

6. 24 VOLT POWER TO 4-20mA TRANSMITTERS MUST HAVE A COMMON GROUND TO POWER SUPPLY FOR TERMINAL MODULES.

FIG. 7 WIRING DIAGRAM: CURRENT LOOP OUTPUTS

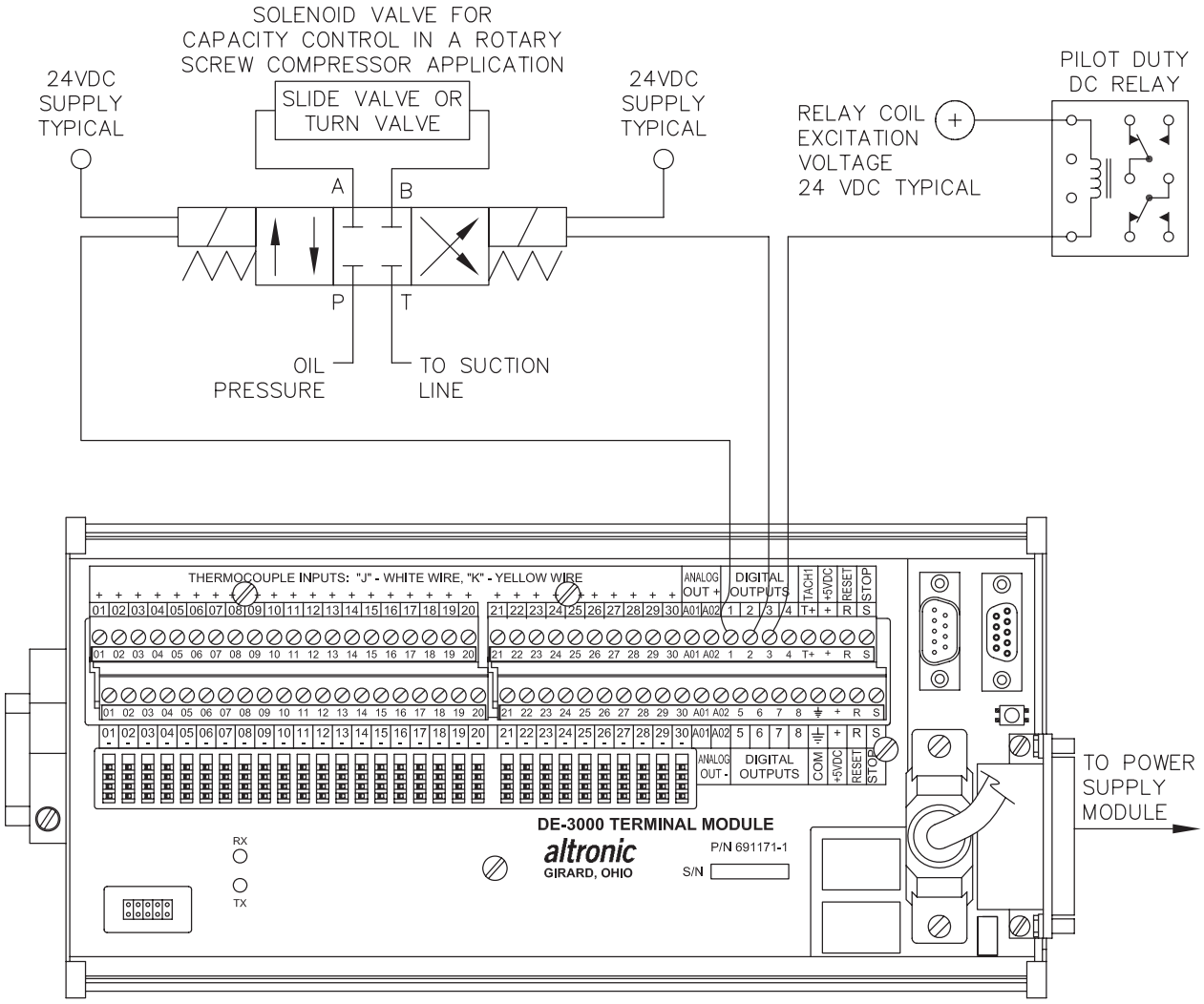


NOTES:

1. CURRENT LOOP OUTPUT 1 IS TYPICALLY USED TO CONTROL CAPACITY CONTROL. CURRENT LOOP OUTPUT 2 IS TYPICALLY USED AS A GOVERNOR SPEED SETPOINT FOR SPEED CONTROL.

2. FOLLOW MANUFACTURERS RECOMMENDATIONS FOR MOUNTING AND MECHANICAL HOOK–UP OF CURRENT LOOP CONVERTERS.

FIG. 8 WIRING DIAGRAM: DIGITAL OUTPUT SWITCHES



NOTES:

1. SOLENOID VALVE: 4 WAY SOLENOID CLOSED–CENTER TYPE.
   BOTH PORTS BLOCKED IN CENTER POSITION
   WITH BOTH SOLENOIDS DE–ENERGIZED.

2. DIGITAL OUTPUT 1 ENERGIZED TO LOAD, DIGITAL OUTPUT 2 ENERGIZED TO UNLOAD.

3. THIS DIAGRAM SHOWS TYPICAL CONNECTIONS. FOLLOW MANUFACTURERS
   RECOMMENDATIONS FOR COMPLETE SYSTEM COMPONENTS AND HOOK–UP.

4. USE PILOT DUTY RELAYS CONNECTED TO DIGITAL OUTPUTS TO CONTROL.
   - OIL OR WATER COOLERS
   - OIL TEMPERATURE CONTROL VALVE
   - OIL HEATERS
   - PRELUBE PUMPS
     AND OTHER AUXILIARY EQUIPMENT