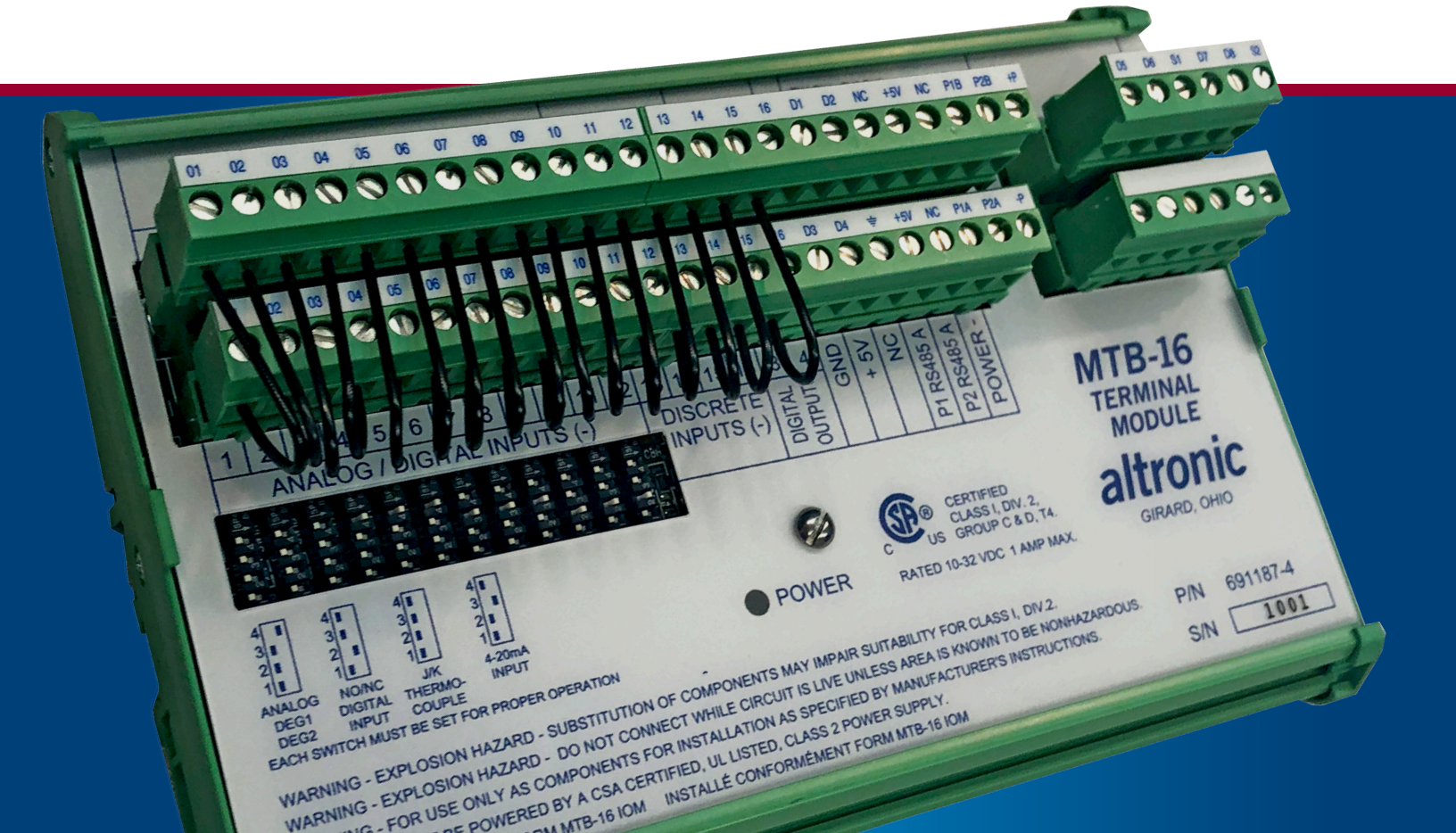
# Installation and Operating Manual

*MTB-16*

*Form MTB-16 IOM 8-20*

altronic
HOERBIGER Engine Division



## 1.0 DESCRIPTION

1.1 The MTB-16 has 2 RS-485 ports communicating as Modbus RTU slaves and can read 16 inputs. The first 12 channels can be any combination of digital inputs (N/O or N/C), K thermocouple, pressure inputs, 4-20mA inputs, or read any sensor within the range of 0-5VDC. Channels 13-16 can be used for digital inputs (N/O or N/C). Channels 15 and 16 could also be used for lubricating monitoring sensors measuring the time of pulses in seconds. Additionally, there are 8 digital outputs which are capable of sinking 60V at 500mA. Each could drive a relay, horn or other related device. All of the outputs are directly controlled by modbus commands. The MTB-16 is CSA-certified for CLASS I, DIVISION 2, GROUPS C and D areas, when mounted in a suitable enclosure.

Each RS-485 port can be individually configured through Modbus registers for various node numbers and baud rates.

This product may be used with PLC's, HMI, or any application where inputs/outputs are needed. It can be rail mounted for easy installation.

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

## 2.0 TERMINAL BOARD

2.1 A removable, dual terminal strip is used to connect the system to the equipment-mounted, discrete sensors. These sensors can be used for either a normally-open switch, normally-closed switch, or analog inputs including K-type thermocouples. These are listed as channels 01–12. They accept industry-standard transducer signals in the range of 0-5 VDC.

2.2 The MTB-16 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.

2.3 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 0-15, 0-25, 0-50, 0-100, 0-300, 0-500, 0-1000, 0-2000, and 0-5000 PSIG for the 691201-x series; and 0-15, 0-20, 0-30, 0-50, 0-100, 0-300, 0-500 PSIA for the 691204-x series. All 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 board using cable assembly P/N 693008-x.

***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.***

2.4 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 board using cable assembly P/N 693008-x.

***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.***

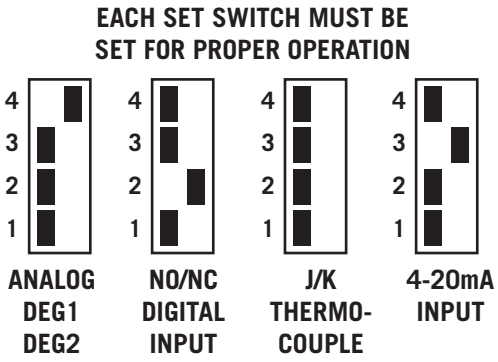
2.5 THERMOCOUPLE INPUTS
The terminal board can accept industry standard type K thermocouples. Automatic cold junction compensation is built-in. The units can be configured to °F or °C. type K thermocouples between -76°F and +1472°F (-60°C and +800°C).

2.6 N/O and N/C INPUTS
The inputs can also accept standard normally-open and normally-closed con-

tacts. Refer to figure 2 for proper wiring of these types of inputs.

2.7 4-20mA inputs
The terminal board 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.

2.8 For each input, the corresponding CHANNEL SWITCH must be set according to the input type. Switches are turned ON by moving them toward the right.




2.9 CHANNELS 13-16 DISCRETE INPUTS/CHANNELS 15, 16 LUBRICATION MONITORING INPUTS
Channels 13–16 maybe used for discrete inputs. There is no switch settings needed and these values may be read in registers 30021–30024. These registers will read nominally as 1250 open and 0 when shorted to ground. A value of 400 may be used as a threshold to determine if it's open or closed.

Additionally, channels 15 and 16 maybe used for monitoring lubrication systems. This works on the principal that the lubrication sensor will momentarily ground the input and allowing the MTB-16 to register the time. Registers 30027 and 30029 are for the lubrication time in seconds for channels 15 and 16 respectively. Registers 30028 and 30030 read the averages of the past 10 readings. If the time between pulses is greater than than the value in register 40023, then registers 30027 to 30030 get cleared to zero. No Modbus programming is necessary in order to get this function working.

Channels 13-16 MUST HAVE 10k pull up resistors (not provided) to function properly. This applies for the discrete inputs and lubrication monitoring systems. See figure 3 for a diagram of proper installation.

2.10 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.

## 3.0 MOUNTING

3.1 TERMINAL BOARD
Mount the MTB-16 either on the bottom or the side of the main panel. The terminal board can be rail-mounted onto commercially available 32 or 35 mm DIN mounting rails. The operating temperature range of the Terminal Module is –40°F to +176°F (–40°C to +80°C).

3.2 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.

3.3 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. The center of the pickup face must line up with the center of each drilled hole as the disc rotates.

## 4.0 WIRING

4.1 POWER

Connect the supply power wires to the 12-24Vdc input power terminals on the board, 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.

4.2 SENSOR WIRING DISCRETE INPUTS

The sensor leads connect to the removable terminal strips on the terminal board. 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.

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. 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 MTB-16 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, select a transducer—either an Altronic pressure or temperature transducer listed above or one that outputs a signal in the range of 0 to 5Vdc or 0 to 25mA. Mount as described above. Use cable assembly 693008-x or similar to wire transducer to the MTB-16. An internal 5 volt sensor supply (500mA max.) is available to power the Altronic transduc-

ers; 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.

4.3 THERMOCOUPLES AND THERMOCOUPLE EXTENSION WIRE

Grounded or ungrounded type 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.

4.4 RS-485 COMMUNICATIONS WIRING

There are two RS-485 communication ports.

Use a two-conductor shielded cable of fine gauge stranded wire and connect the wires to the terminals marked A and B.

## 5.0 HAZARDOUS AREA OPERATION

5.1 The MTB-16 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.

# 6.0 CONFIGURING THE MODBUS CHANNELS

6.1 Port 1 is configured by registers 40009 and 40010. 40009 is for the Modbus node number and 40010 is for the baud rate. Similarly, Port 2 configures the node number on register 40026 and the baud rate on 40027.

40009 / 40026 - Node number, from 1-99
40010 / 40027
0 = 9600 baud.
1 = 19.2k baud.
2 = 38.4k baud.
3 = 56.2k baud.
4 = 115.2k baud

***CAUTION: Brand new units from the factory, and repaired units, will always have the node number set to 3 and the baud rate set to 9600.***

***Extreme care must be taken when changing these registers as unknown values may prevent the user from communicating with the MTB-16 and locking them out. It may require the unit to be returned to the factory and reconfigured for proper communication.***

6.2 The MTB-16 must be configured prior to use. This typically requires the channels to be configured for the type of sensor to be used. Modbus registers 40028 – 40111 are responsible for configuring all the channel configurations and are stored in FLASH/EE memory and have a maximum of 100k write cycle endurance. These Modbus registers will retain their value even after a power down.

6.3 CONFIGURING STANDARD ANALOG CHANNELS
There are 7 registers associated with each channel. Refer to section 9 for configuring standard channel selections.

SENSOR TYPE - This defines what type of sensor is being used, whether it's a standard pressure sensor, Deg1, Deg 2, K-TC or a discrete input. Select the appropriate value for the defined sensor.

The next 4 registers work together to configure standard pressure / Deg1 sensor ranges.

HIGH LIMIT - This will be the high value displayed when the voltage matches the value described in the CAL ADC high.

CAL ADC HIGH - This value is the voltage and corresponds with the HIGH LIMIT number.

LOW LIMIT - This will be the low value displayed when the voltage matches the value described in the CAL ADC low.

CAL ADC LOW - This value is the voltage and corresponds with the LOW LIMIT number.

The ADC number represents a voltage and may be calculated accordingly:

ADC count = (Voltage input / 5) * 3976. Round up or down to the nearest whole unit.

For Deg2 and K-TC, the HIGH LIMIT is either a '1' for Fahrenheit or '0' for Celcius.

For discrete inputs, these values should be zero.

Fine adjust offset - This value applies to all except for discrete inputs. This value does the ZERO SPAN function. Lets say a sensor is reading 48 PSI, but the operator wants it to actually read 50. Set the value to '2' to adjust the value. Similarly, adjust the value to -5 to make it read 43.

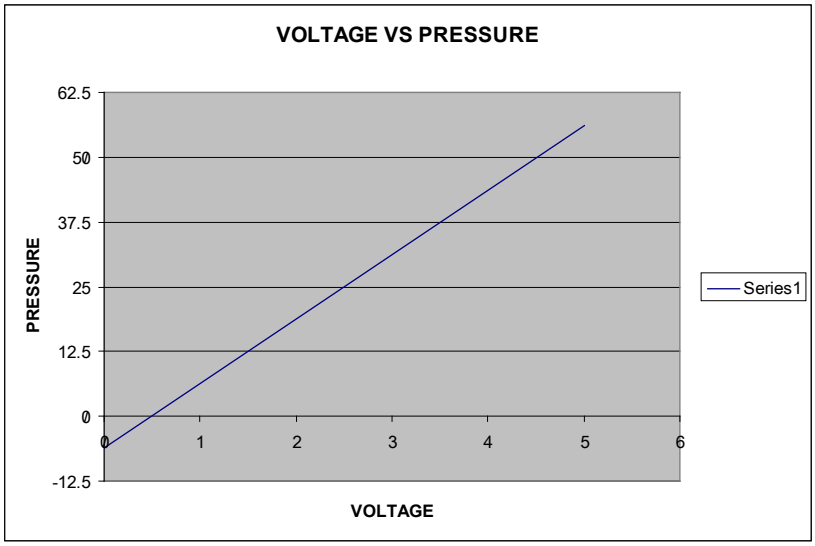
User defined - This may be any value the user wishes and can serve as scratch pad for storing data.

***DIFFERENCES BETWEEN SIGNED AND UNSIGNED NUMBERS. The MTB-16 uses signed numbers for the 30000 registers. That means it can display numbers in the range of -32768 to 32767. A 16 bit unsigned number can display in the range of 0-65535.***

***If the MTB-16 is reading, for example, decreasing numbers, 3,2,1,0....then 65535, this is an example of the number being read as an unsigned number. A channel value of 65535 (setup as an unsigned number) is actually -1 as a signed number. Keep this in mind as you configure the controller displaying the information.***

## 6.4 EXAMPLE OF SETTING UP A CHANNEL

This example shows how the 0-50 PSI sensor is setup in detail. This sensor has .5V as 0 PSI and 4.5V as 50 PSI. See the graph below:




ADC count = (Voltage input / 5) * 3976

For .5V, the ADC count = (.5 / 5) * 3976 = 397.6, rounding up to 398.

For 4.5V, the ADC count = (4.5 / 5) * 3976 = 3578.4, rounding up to 3579.

So the values for 0-50 PSI are as follows:
Sensor type: 256, given
High limit: 50, make the value 500 so the number range is 0.0 to 50.0.
Cal adc high: 3579
Low limit: 0
Cal adc low: 398
Fine Adjust offset: Start off with 0, and change if necessary.
User defined: Can be any number, or configure to zero.

If configuring 4-20mA sensors, the voltage would be as follows:
4mA * 200 ohm = .8V, ADC Count = (.8/5) * 3976 = 636.
20mA * 200 ohm = 4V, ADC Count = (4/5) * 3976 = 3181.

## 6.5 30000 REGISTERS - View section 8 for more information.

Registers 30009 - 30024 read the 16 channels. The first 12 read the value determined by how the unit is configured. It may read in Fahrenheit registers or PSI. Registers 30021 - 30024 read the 4 discrete inputs. A value of 1250 is nominally open and 0 is nominally grounded. A value of 400 could be used as a threshold.

Registers 30025 and 30026 read the board temperature and the voltage supply.

## 6.6 CONTROLLING THE DISCRETE OUTPUTS

Register 40024 controls discrete output #1. Set this register to '1' to turn on the output and '0' to turn it off. This register is stored in EEPROM and retains the information after a power down / power up.

Register 40025 controls discrete outputs 2-8. Set the register to the following to turn on the output:
Discrete out #2 - 2
Discrete out #3 - 4
Discrete out #4 - 8
Discrete out #5 - 16
Discrete out #6 - 32
Discrete out #7 - 64
Discrete out #8 - 128
More than one output may be turned on at the same. For example, if you want

to turn on outputs 3, 6 and 8. Enter the value 4 + 32 + 128 = 164.

The register in 40025 is not stored in EEPROM, but rather RAM and this information is not retained during a power down / power up. This register powers up as zero.

## 7.0 TROUBLESHOOTING

7.1 The power LED on the board is not illuminated:

- Check the power supply voltage at the 12-24Vdc input terminals; should be between 12 and 24Vdc.

7.2 Neither the RX nor the TX lights are flashing:

- MTB-16 is not receiving any MODBUS commands.
- Check wiring and communications coming from the Modbus master.

7.3 RX light is flashing, but the MTB-16 is not responding:

- Verify the baud rate, 8 data bits, no parity and one stop bit.
- Verify the node number is correct and corresponds to the node selection on the MTB-16.
- Verify that Modbus address registers are correct.
- Replace the MTB-16.

## 8.0 MODBUS ADDRESS LIST

| Modbus register | Channel |
|---|---|
| 30009 | 1 |
| 30010 | 2 |
| 30011 | 3 |
| 30012 | 4 |
| 30013 | 5 |
| 30014 | 6 |
| 30015 | 7 |
| 30016 | 8 |
| 30017 | 9 |
| 30018 | 10 |
| 30019 | 11 |
| 30020 | 12 |
| 30021 | 13 |
| 30022 | 14 |
| 30023 | 15 |
| 30024 | 16 |
| 30025 | Ambient temp/10 |
| 30026 | Vsupply/10 |
| 30027 | Current lubrication sensor time in seconds for channel 15 |
| 30028 | Current average for the past 10 readings on channel 15 |
| 30029 | Current lubrication sensor time in seconds for channel 16 |
| 30030 | Current average for the past 10 readings on channel 16 |

| REGISTERS | DESCRIPTION | CHANNEL | COMMENTS | DEFAULT |
|---|---|---|---|---|
| 40009 | Node #, port 1 | | | 3 |
| 40010 | Baud rate, port 1 | | 0=9600,1=19.2k,2=38.4k,3=57.6k,4=115.2k | 0 |
| 40023 | Lube Timer Limit | | | 300 |
| 40024 | Discrete Outputs, NON-volatile | | Bit 0 for D1. 0 turns off the output, 1 turns on the output. Information is retained after a power up. | 0 |
| 40025 | Discrete Outputs, Volatile, RAM | | Bit 1 for D2, Bit 2 for D3..... and Bit 7 for D8. 0 turns off the output, 1 turns on the output. Information is not retained after a powerup. | 0 |
| 40026 | Node #, port 2 | | | 3 |
| 40027 | Baud rate, port 2 | | 0=9600,1=19.2k,2=38.4k,3=57.6k,4=115.2k | 0 |
| 40028 | sensor type | 1 | | 256 |
| 40029 | high limit | 1 | | 500 |
| 40030 | cal adc high | 1 | | 3579 |
| 40031 | low limit | 1 | | 0 |
| 40032 | cal adc low | 1 | | 398 |
| 40033 | Fine Adjust Offset | 1 | | 0 |
| 40034 | User defined | 1 | | 0 |
| 40035 | sensor type | 2 | | 256 |
| 40036 | high limit | 2 | | 500 |
| 40037 | cal adc high | 2 | | 3579 |
| 40038 | low limit | 2 | | 0 |
| 40039 | cal adc low | 2 | | 398 |
| 40040 | Fine Adjust Offset | 2 | | 0 |
| 40041 | User defined | 2 | | 0 |
| 40042 | sensor type | 3 | | 256 |
| 40043 | high limit | 3 | | 500 |
| 40044 | cal adc high | 3 | | 3579 |
| 40045 | low limit | 3 | | 0 |
| 40046 | cal adc low | 3 | | 398 |
| 40047 | Fine Adjust Offset | 3 | | 0 |
| 40048 | User defined | 3 | | 0 |
| 40049 | sensor type | 4 | | 256 |
| 40050 | high limit | 4 | | 500 |
| 40051 | cal adc high | 4 | | 3579 |
| 40052 | low limit | 4 | | 0 |
| 40053 | cal adc low | 4 | | 398 |
| 40054 | Fine Adjust Offset | 4 | | 0 |
| 40055 | User defined | 4 | | 0 |
| 40056 | sensor type | 5 | | 256 |
| 40057 | high limit | 5 | | 500 |
| 40058 | cal adc high | 5 | | 3579 |
| 40059 | low limit | 5 | | 0 |
| 40060 | cal adc low | 5 | | 398 |
| 40061 | Fine Adjust Offset | 5 | | 0 |

| REGISTERS | DESCRIPTION | CHANNEL | COMMENTS | DEFAULT |
|---|---|---|---|---|
| 40062 | User defined | 5 | | 0 |
| 40063 | sensor type | 6 | | 256 |
| 40064 | high limit | 6 | | 500 |
| 40065 | cal adc high | 6 | | 3579 |
| 40066 | low limit | 6 | | 0 |
| 40067 | cal adc low | 6 | | 398 |
| 40068 | Fine Adjust Offset | 6 | | 0 |
| 40069 | User defined | 6 | | 0 |
| 40070 | sensor type | 7 | | 256 |
| 40071 | high limit | 7 | | 500 |
| 40072 | cal adc high | 7 | | 3579 |
| 40073 | low limit | 7 | | 0 |
| 40074 | cal adc low | 7 | | 398 |
| 40075 | Fine Adjust Offset | 7 | | 0 |
| 40076 | User defined | 7 | | 0 |
| 40077 | sensor type | 8 | | 256 |
| 40078 | high limit | 8 | | 500 |
| 40079 | cal adc high | 8 | | 3579 |
| 40080 | low limit | 8 | | 0 |
| 40081 | cal adc low | 8 | | 398 |
| 40082 | Fine Adjust Offset | 8 | | 0 |
| 40083 | User defined | 8 | | 0 |
| 40084 | sensor type | 9 | | 256 |
| 40085 | high limit | 9 | | 500 |
| 40086 | cal adc high | 9 | | 3579 |
| 40087 | low limit | 9 | | 0 |
| 40088 | cal adc low | 9 | | 398 |
| 40089 | Fine Adjust Offset | 9 | | 0 |
| 40090 | User defined | 9 | | 0 |
| 40091 | sensor type | 10 | | 256 |
| 40092 | high limit | 10 | | 500 |
| 40093 | cal adc high | 10 | | 3579 |
| 40094 | low limit | 10 | | 0 |
| 40095 | cal adc low | 10 | | 398 |
| 40096 | Fine Adjust Offset | 10 | | 0 |
| 40097 | User defined | 10 | | 0 |
| 40098 | sensor type | 11 | | 256 |
| 40099 | high limit | 11 | | 500 |
| 40100 | cal adc high | 11 | | 3579 |
| 40101 | low limit | 11 | | 0 |
| 40102 | cal adc low | 11 | | 398 |
| 40103 | Fine Adjust Offset | 11 | | 0 |
| 40104 | User defined | 11 | | 0 |

| REGISTERS | DESCRIPTION | CHANNEL | COMMENTS | DEFAULT |
|---|---|---|---|---|
| 40105 | sensor type | 12 | | 256 |
| 40106 | high limit | 12 | | 500 |
| 40107 | cal adc high | 12 | | 3579 |
| 40108 | low limit | 12 | | 0 |
| 40109 | cal adc low | 12 | | 398 |
| 40110 | Fine Adjust Offset | 12 | | 0 |
| 40111 | User defined | 12 | | 0 |

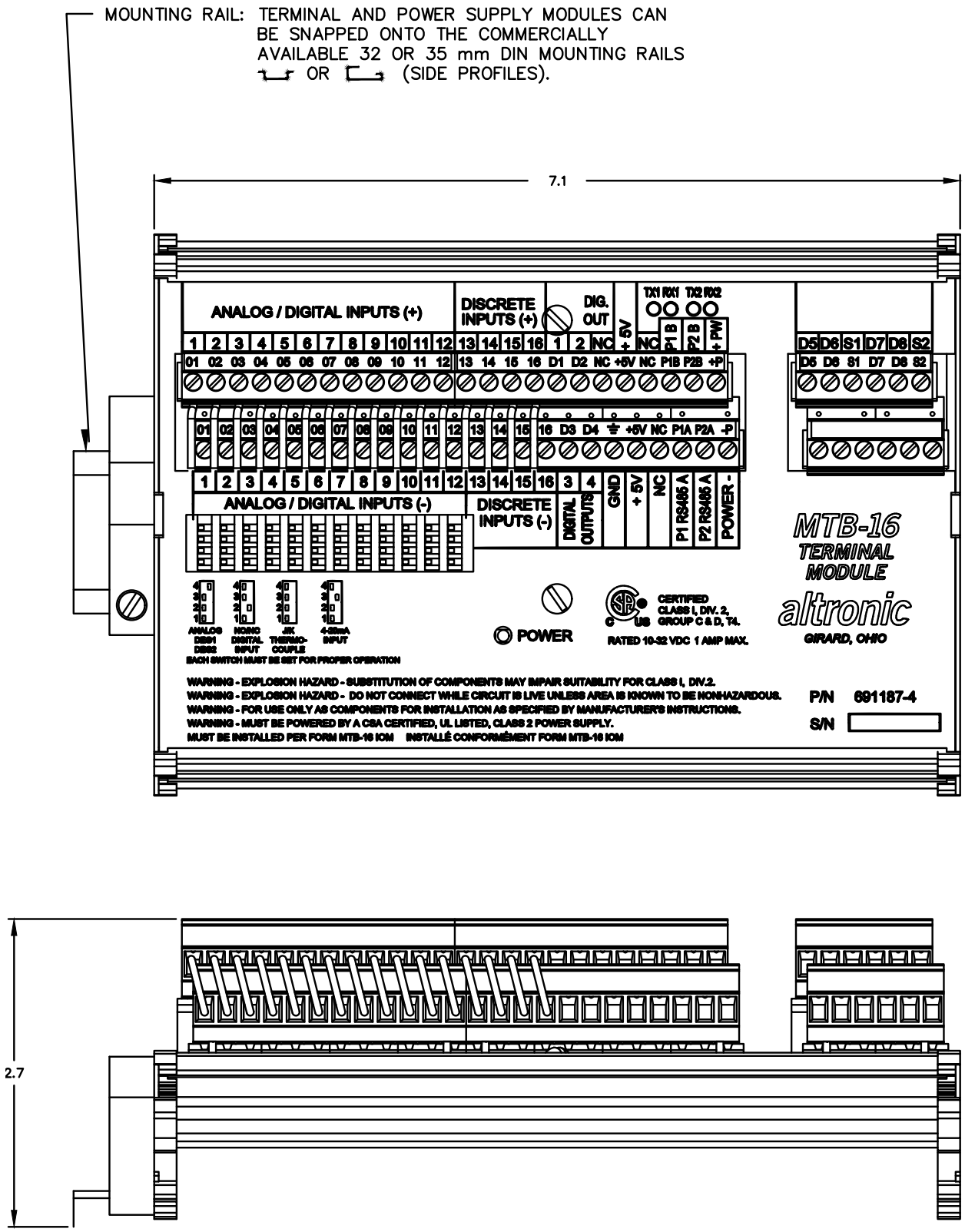
## 9.0 SENSOR TABLE

| | 0-50 | 0-100 | 0-300 | 0-500 | 0-1000 | 0-2000 | discrete | Deg1 (F) | Deg1 © | Deg2 (F) | Deg2 © | k-tc (F) | k-tc © |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sensor type | 256 | 256 | 256 | 256 | 256 | 256 | 768 | 256 | 256 | 512 | 512 | 0 | 0 |
| high limit | 500 | 1000 | 3000 | 5000 | 10000 | 20000 | 0 | 3000 | 1490 | 1 | 0 | 1 | 0 |
| cal adc high | 3579 | 3579 | 3579 | 3579 | 3579 | 3579 | 0 | 2386 | 2386 | 0 | 0 | 0 | 0 |
| low limit | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -180 | 0 | 0 | 0 | 0 |
| cal adc low | 398 | 398 | 398 | 398 | 398 | 398 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Find Adjust Offset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| User defined | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

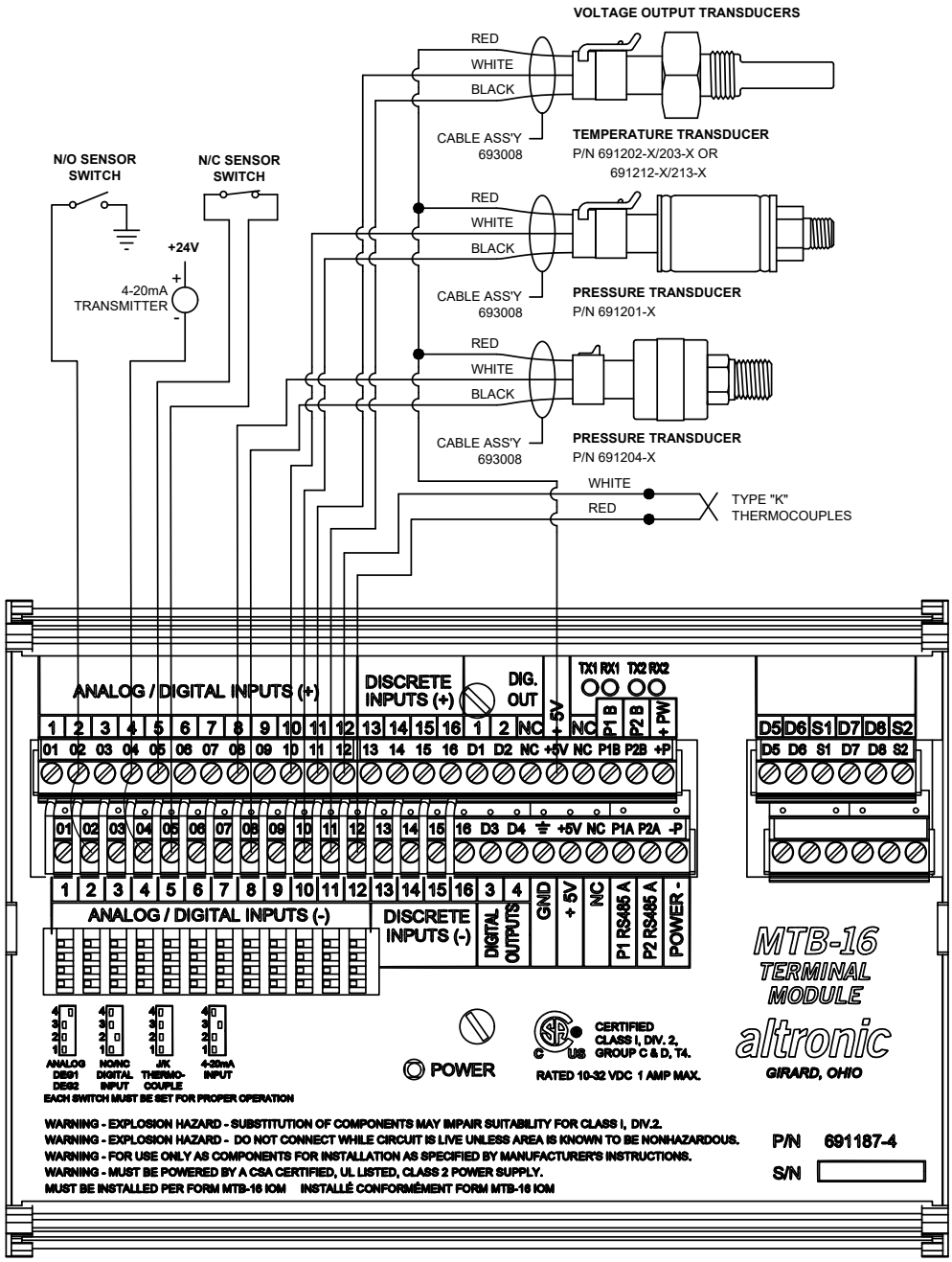
Numbers adjusted for all being 1 digit to the right of the decimal point and no changes to the discrete inputs.

**DRAWINGS SECTION:**

**FIGURE 1 — MTB-16**



## FIGURE 2 — WIRING DIAGRAM — SENSOR AND TRANSDUCER INPUTS/POWER




ANALOG DEG1 DEG2 | NO/NC DIGITAL INPUT | J/K THERMO-COUPLE | 4-20mA INPUT

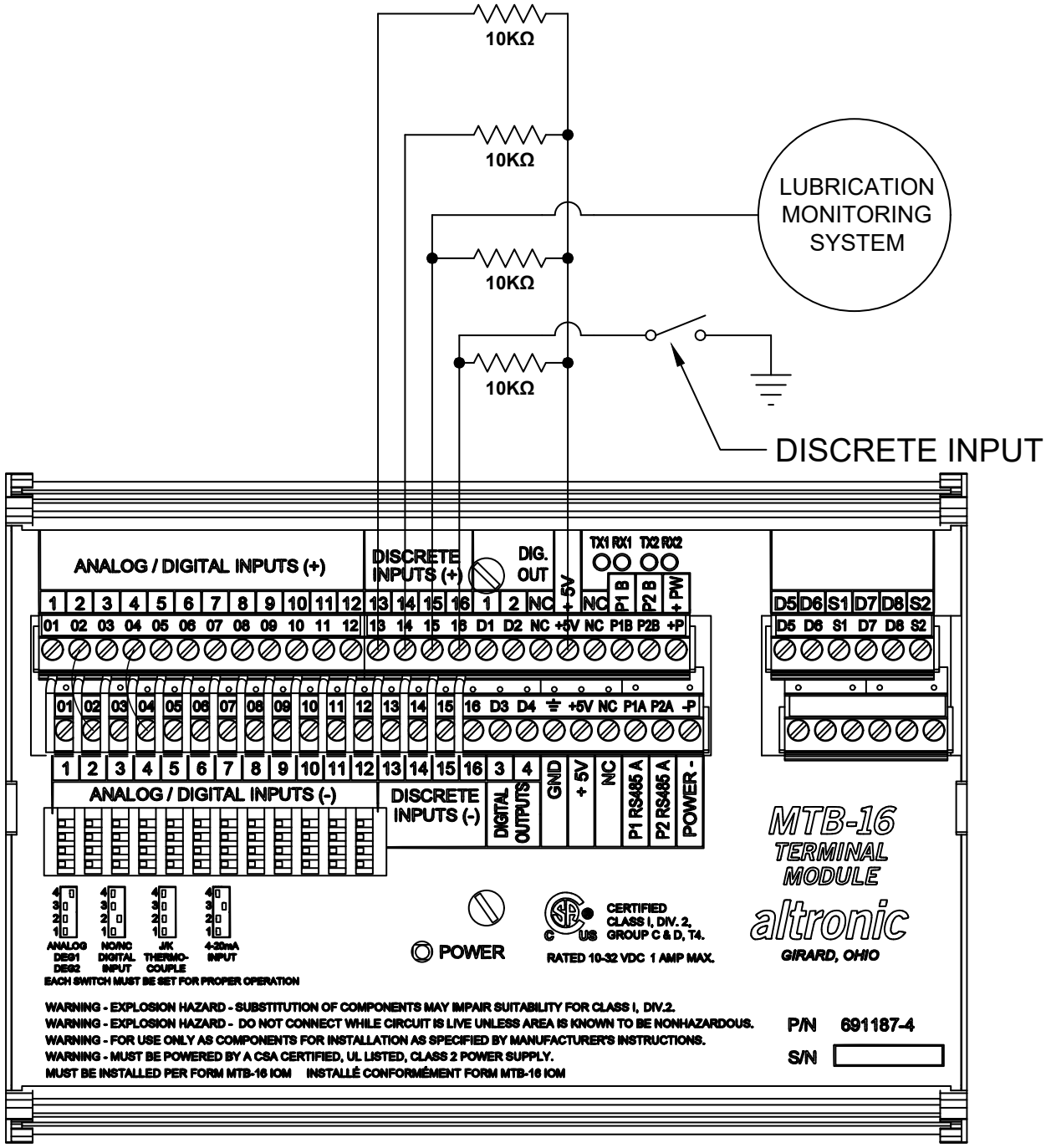
EACH CHANNEL CAN BE CONFIGURED AS N/O, N/C, ANALOG INPUT, THERMOCOUPLE OR 4-20mA.

* MAKE SURE THE SWITCH IS IN THE CORRECT POSITION FOR THE SENSOR.

NOTE:

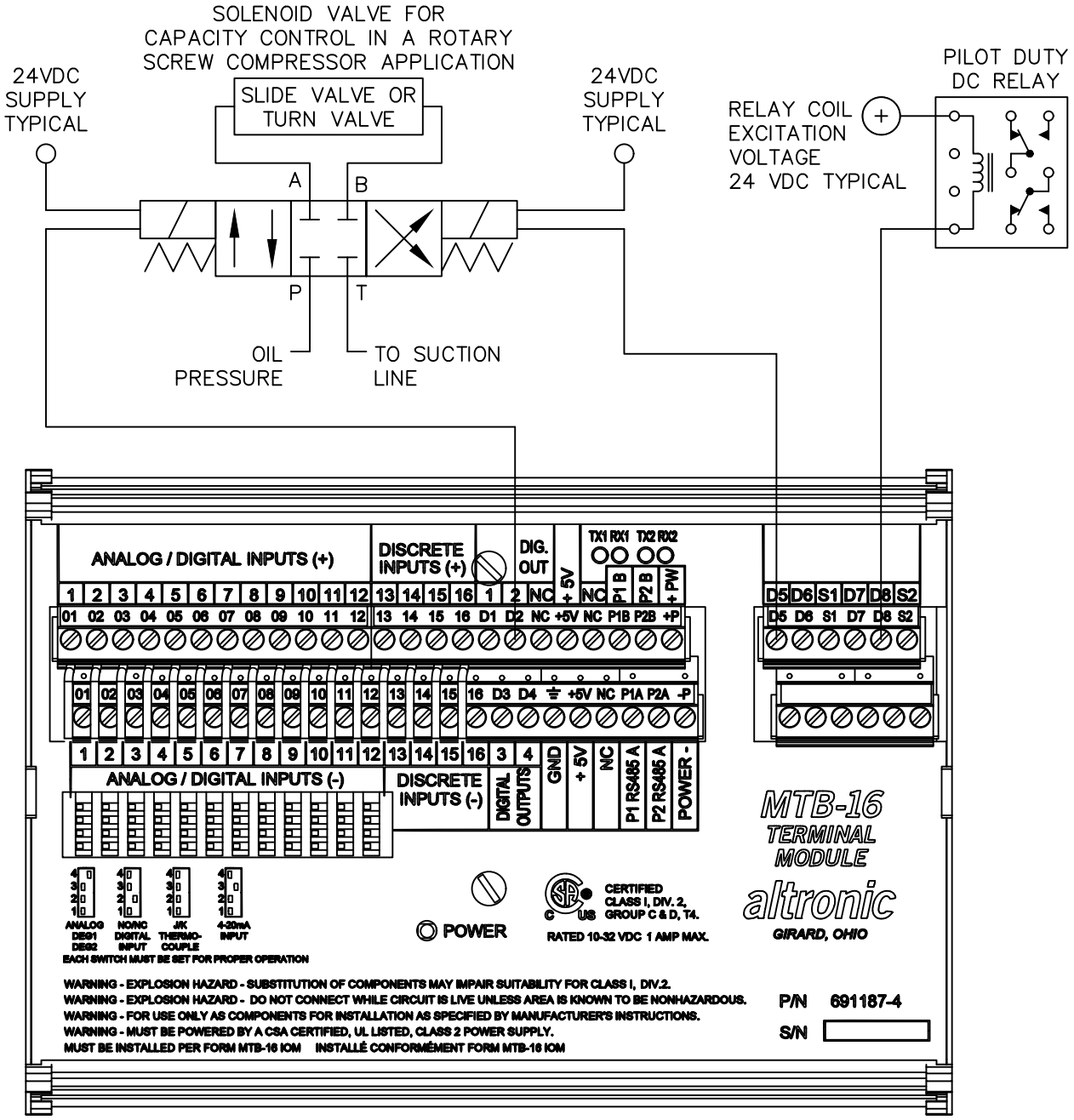
1. N/O SENSOR SWITCH MUST HAVE JUMPER IN PLACE BETWEEN TOP ROW AND BOTTOM ROW OF TERMINAL BLOCK. POWER SUPPLY MINUS AND SENSOR GROUND MUST BOTH BE COMMON.
2. N/C SENSOR SWITCH, REMOVE JUMPER AND PLACE SWITCH WIRES, ONE IN TOP ROW OTHER IN BOTTOM ROW.
3. ALL UNUSED INPUTS MUST HAVE JUMPER WIRE IN PLACE.
4. 24 VOLT POWER TO 4-20mA TRANSMITTERS MUST HAVE A COMMON GROUND TO POWER SUPPLY FOR TERMINAL MODULES.

**FIGURE 3 — WIRING DIAGRAM — CHANNELS 13 -16**




NOTE:
1. CHANNELS 13-16 MUST HAVE 10K PULL UPS IN ORDER TO OPERATE CORRECTLY.

**FIGURE 4 — 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. THIS DIAGRAM SHOWS TYPICAL CONNECTIONS. FOLLOW MANUFACTURERS RECOMMENDATIONS FOR COMPLETE SYSTEM COMPONENTS AND HOOK–UP.

3. 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