Marathon Sensors Inc.
VersaPro Dew Point Controller/Monitor
Installation and Operation Handbook

Marathon
Sensors Inc.

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Safety and Environment Information

Please read this section carefully before installing the controller

This instrument is intended for industrial applications used in conjunction with Marathon Sensors zirconia oxygen sensors and standard thermocouple types. It is assumed that any installation meets either CE standards for industrial safety or NEC standard wiring practices. Failure to observe these standards or the installation instructions in this manual may degrade the safety or electrical noise protection provided by this instrument. It is the installer's responsibility to ensure the safety and electrical noise compatibility of any installation.

Service and repair

This controller has user replaceable fuses but no other user serviceable parts. Contact your Marathon Sensors Service (800-547-1055) for repair.

Caution: Charged capacitors

Before removing an instrument from its case, disconnect the supply and wait at least two minutes to allow capacitors to discharge. Failure to observe this precaution will expose capacitors that may be charged with hazardous voltages. In any case, avoid touching the exposed electronics of an instrument when withdrawing it from the case.

Electrostatic Discharge (ESD) Precautions

When the controller is removed from its case, some of the exposed electronic components are vulnerable to damage by electrostatic discharge. Anyone who is not probably ground using an ESD wrist strap or in contact with a ground while handling the controller may damage exposed electronic components.

Installation Safety Requirements

Safety Symbol

Various symbols are used on the instrument, they have the following meaning:

Caution, (refer to the accompanying documents)

Functional earth (ground) terminal

The functional earth connection is required for safety ground add to ground RFI filters.

Personnel

Installation must be carried out by qualified personnel.

Enclosure of live parts

To prevent hands or metal tools touching parts that may be electrically live, the controller should be installed in an enclosure. The contacts on the rear of the instrument case or finger save but it is still possible for loose wiring, or metal objects to come in contact with live terminal connections. It is recommended that power be removed from the instrument connections before they are disconnected. However, instrument's power connector can be removed with power applied. Care should be taken that the connector does not come in contact with any grounded object.

Live sensors

The dc inputs, dc logic, and dc outputs are all electrically isolated from chassis ground. If the temperature sensor is connected directly to an electrical heating element then the inputs will also be live. The controller is designed to operate under these conditions. However you must ensure that this will not damage other equipment connected to these inputs and that service personnel do not touch connections to these terminals while they are live. With a live sensor, all cables, connectors and switches for connecting the sensor and non-isolated inputs and outputs must be mains rated.

Wiring

It is important to connect the controller in accordance with the wiring data given in this handbook. Take particular care not to connect AC supplies to the low voltage sensor input or other low level inputs and outputs. Only use copper conductors for connections (except thermocouple inputs) and ensure that the wiring for installations comply with all local wiring regulations. For example, in the UK, use the latest version of the wiring regulations, BS7671. In the USA use NEC Class 1 wiring methods.

Power Isolation

The installation must include a power isolating switch or circuit breaker. This device should be in close proximity to the control actuator, and within easy reach of the operator. There is no means of disconnecting power from the instrument other than removing the connectors from the rear of the instrument. It is recommended that additional power disconnects are provided in the installation to remove power from these connectors as well.

Earth leakage current

Due to RFI Filtering there is an earth leakage current of less than 0.5mA. This may affect the design of an installation of multiple controllers protected by Residual Current Device, (RCD) or Ground Fault Detector, (GFD) type circuit breakers.

Over Current protection

The instrument has an internal 3.15 Amp fuse (P/N MFU-3.15PCTT) for instrument power and 1 Amp fuses (P/N MFU-1.0PCTT) for the control contacts and alarms. It is recommended that additional protection against excess currents be used for loads exceeding this rating. Fusing and interposing relays should be added to the control circuit if high current or large inductive loads are used.

Voltage rating

The maximum continuous voltage applied between any of the following terminals must not exceed 250VAC:

- line or neutral to any other connection;
- relay output to logic, dc or sensor connections;
- any connection to ground.

The controller should not be wired to a three phase supply with an unearthed star connection. Under fault conditions in this supply could rise above 264VAC with respect to ground and the product would not be safe.

Voltage transients across the power supply connections, and between the power supply and ground, must not exceed 2.5kV. Where occasional voltage transients over 2.5kV are expected or measured, the power installation to both the instrument supply and load circuits should include a transient limiting device.

These units will typically include gas discharge tubes, metal oxide varistors, and constant voltage transformers help suppress voltage transients on the supply line due to lightning strikes or inductive load switching. Devices are available in a range of energy ratings and should be selected to suit conditions at the installation.

Conductive pollution

Electrically conductive pollution must be excluded from the cabinet in which the controller is mounted. For example, carbon dust is a form of electrically conductive pollution. To secure a suitable atmosphere in conditions of conductive pollution, fit an air filter to the air intake of the cabinet. Where condensation is likely, for example at low temperatures, include a thermostatically controlled heater in the cabinet.

Over-temperature protection

When designing any control system it is essential to consider what will happen if any part of the system should fail. In temperature control applications the primary danger is that the heating will remain constantly on. Apart from scrapping the product, this could damage any process machinery being controlled, or even cause a fire.

Reasons why the heating might remain constantly on include:

- the temperature sensor becoming detached from the process;
- thermocouple wiring becoming a short circuit;
- the controller failing with its heating output constantly on;
- an external valve or contactor sticking in the heating condition;
- the controller setpoint set too high.

Where damage or injury is possible, we recommend fitting a separate over-temperature protection unit. Factory Mutual requires that any over temperature device use an independent temperature sensor, which will isolate the heating circuit.

Please note that the alarm relays within the controller will not give protection under all failure conditions. This instrument is not suited for over temperature protection and should not be used as a safety device.

Grounding of the temperature sensor shield

In some installations it is common practice to replace the temperature sensor while the controller is still powered up. Under these conditions, as additional protection against electric shock, we recommend that the shield of the temperature sensor be grounded at one end of the wire. Do not rely on grounding through the framework of the machine.

Installation requirements for EMC

To ensure compliance with European EMC directives certain installation precautions are necessary as follows:

- When using relay outputs it may be necessary to fit a filter suitable for suppressing the emissions. The filter requirements will depend on the type of load. For typical applications such as Schaffner FN321 or FN612 line filters or equivalents.
- If the unit is used in table top equipment which is plugged into a standard power socket, it is likely that compliance to the commercial and light industrial emissions standard is required. In this case, to meet the conducted emissions requirement, a suitable mains filter should be installed. Recommended filters would be Schaffner types FN321 and FN612 or equivalents.

Routing of wires

To minimize the pick-up of electrical noise, the wiring for low voltage dc and particularly the sensor input should be routed away from high-current power cables. Where it is impractical to do this, use shielded cables with the shield grounded at one end.

VersaPro Features

The VersaPro is a single loop process controller / monitor has the following capabilities:

- Two channel 24 bit Sigma-Delta ADC for thermocouple, probe millivolt, with cold junction compensation.
- Two (2) Form A alarm contacts (threshold limits in monitor only).
- Internal relay for oxygen sensor verification.
- Internal relay for sensor impedance testing.
- Serial EEPROM stores setup and calibration values.
- Two (2) 4-20 milliamp outputs for control or chart recorder.
- Sixteen character LCD with two four digit LED segment displays.
- RS 485 serial communication port for either MSI protocol or Modus.
- Two (2) Form A control contacts.
- Two (2) Form A user configurable alarm contacts.
- Auto-tuning routine for process control.
- PID, ON/OFF, Valve Position control modes.
- User Configured Digital Input Event.

Installation

The VersaPro instrument is designed for up to 1/8" panel mounting in a DIN standard opening of 3.62" square (adapter panels available by special order). Required rear clearance is 7" to allow for wiring.

As with all solid state equipment, the controller should be located away from excessive heat, humidity, and vibration. Since the unit uses LED and LCD display devices, it should also be located so that direct sunlight will not interfere with the display's visibility. The instrument requires 120/240 VAC 50/60 Hz and should not be on the same circuit with other noise-producing equipment such as induction machines, large electrical motors, etc. Signal wiring <u>must</u> be run separate from control wiring. It is suggested that signal wiring at the rear terminals of the instrument be routed in one direction (up or down) while the AC power wires are routed in the opposite direction.

The following figure shows the rear terminals locations on the rear of the VersaPro.

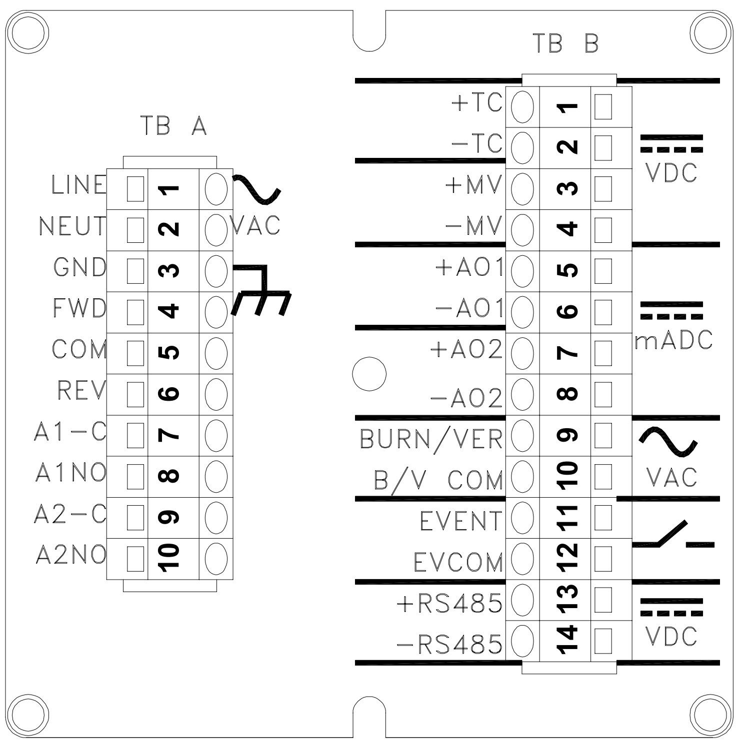


Figure 1 VersaPro Rear Panel

Mounting

To mount the instrument in a control panel, a hole must be cut 3.62" square in the necessary location on the panel. The following procedure should be followed to mount the VersaPro in the panel.

1) Insert the unit into previously cut out 3.62" square hole in panel.

2) While supporting unit, insert one clamping bracket into the groove on the bottom of unit, and then install the 6-32 set screw.

3) Repeat step 2 for the top of the unit.

4) With a HEX KEY wrench, alternately tighten the screw on either side of instrument to a torque of six in.-lbs. Insure rigidity of mounting. DO NOT OVER TIGHTEN. This can wrap the instrument enclosure and make removal difficult.

To remove the instrument from the panel, reverse the above procedures.

Process Control Options

The Versapro can be configured to perform a number of specific control functions. The following table outlines the available process functions for the Dew Point controller / monitor.

Table 1 Instrument Control Options

Function	Description
Dew Point	Uses the millivolt and temperature signals from a zirconia sensor to calculate Dew Point concentrations and control to an Dew Point set point.
Linear Input A	Uses the millivolt signal from a linear sensor connected to terminals +TC / -TC
Linear Input B	Uses the millivolt signal from a linear sensor connected to terminals +MV / -MV

Control Modes

The VersaPro controller provides:

- ON/OFF (OF)
- ON/OFF with compliment (OC)
- ON/OFF Dual (OD)
- Valve Positioning (PP)
- Time Proportional Single (TP)
- Time Proportional Dual (TD)
- Time Proportional Compliment (TC)

The instrument controls with two control contacts or direct 4-20mA output from two analog output channels. The control function can be set to direct acting or reverse acting. The monitor option is the only option shown when the instrument has been configured as a monitor only.

Time Proportioning (TP)

Time proportioning adjusts the duty cycle of the control device to maintain control. This is usually done with solenoid valves controlling the flow of a trim gas or addition to the process. The control loop percent output is the ON time percentage of the value relative to total cycle time. The cycle time is the ON time plus OFF time.

For example if the control loop percent output is 34% and the cycle time is 10 seconds, then the ON time would be 3.4 seconds and the OFF time would be 6.6 seconds. The selection of the proper cycle time is a trade off between excess wear and tear on the solenoid valve with short cycle times and rough (pulsing) flow of the control material with long cycle times. Only the first control contact is used in this mode.

Time Proportioning with Complement (TC)

This mode is identical to the time proportioning mode except that both control outputs are used. The second control output is the complement of the first. That is when the first output is ON then the second is OFF and vice versa. This mode is used with single action motorized valves that open quickly when a voltage is applied to one terminal and close quickly when voltage is applied to the other terminal.

Time Proportioning Dual (TD)

This mode is used when there are two processes to control that have complementary effects; like gas and air. The time proportioning dual mode uses two control outputs; one for gas and one for air. There is never a time when both outputs are on simultaneously. The control loop computes a percent output from -100 to +100%. When positive, the proportioning action applies to the forward output (gas). When negative the proportioning action applies to the reverse (air) output.

Position Proportioning (PP)

This mode is used with motorized valves that do not have slidewire feedback. This mode is sometimes referred to as the "bump" mode because it "bumps" the valve slightly more open or closed. This mode uses both control outputs; one to drive the motor forward (open) and the other to drive it reverse (closed). The control output is the difference between the new percent output and the last percent output. If the difference is positive than the valve motor is driven open for that percentage of the cycle. If negative it is driven closed by that percentage of the cycle time.

For example if the new percent out is 60% and the old was 45% then the motor is driven open for 15% of the cycle time. If the cycle time is set to the time that the motor takes to move from fully closed to fully open, then the flow is theoretically increased by 15%. Two special cases exist. If the control output is computed at 100% then the motor is driven continuously in the open direction. Likewise if the control output is computed as 0% then the motor is driven continuously closed.

ON/OFF (OF)

ON/OFF control is exactly what it implies, the control action is either ON or OFF. With true ON/OFF control the control output is ON whenever the process is below the setpoint value and OFF when the process is at or above the process value. In many real world applications this simple control method will cause "contact chatter" because of noisy signals which will switch the ON and OFF states rapidly. Also since the control action does not turn OFF until the setpoint is reached, the process will overshoot due to lags in the control action.

Marathon controllers incorporate two features that prevent these problems from occurring; hysteresis and deadband. Hysteresis provides a delay between the control on point and the off point. Noise will not cause the control output to “chatter” with this gap applied.

Deadband allows the process to deviate away from the setpoint by the width of the deadband before any control action occurs. The deadband is adjusted through the Proportional Band in units of the displayed setpoint value. The reset and rate values have no effect in ON/OFF control.

Lets assume the process setpoint is 45.0 with a proportional band of 1 and a hysteresis of 2. This represents a deadband of one degree which is a band of +1 and –1 degree dew point around the setpoint. The hysteresis represents 2% the displayed setpoint or .1 degree. The output is turned on when the process drops below 1 (degree dew point) of a process setpoint of 45.0 (degree dew point). Hysteresis is added by not turning off the output until the process value is within 2% of the setpoint, which in this case would be 0.9 degrees dew point.

ON/OFF with Complement (OC)

This mode is exactly like ON/OFF control with the addition of a second control output. The second control contact is turned ON when the first is control contact is OFF and vice versa.

ON/OFF Dual (OD)

This mode is similar to the time proportioning dual mode. The forward output acts as described in the ON/OFF description above. The reverse output responds when the process is above the setpoint.

Using the Dew Point example with a proportional band (deadband) of 1, the gas contact would turn on when the process was 1 degree below the setpoint of 45.0 and would turn off when it came within 2% of the setpoint (45.0 degrees dew point). Likewise the air contact would turn on when the process rose 1 degree above the setpoint and would turn off when it dropped to within 2% of the setpoint (45.0 degrees dew point).

Direct Current Output

The analog outputs can be configured to control the process or provide 4 to 20mA signals proportional to selectable process values. The Analog Output Offset and Range can be set to correspond to the process range.

If a chart recorder is used, it should have input specifications of 0 - 5 VDC or 4 - 20 mA. If the recorder only responds to a DC voltage input, it will be necessary to add a 250 ohm dropping resistor across its input terminals and scale the analog output as 0 – 20mA.

The ideal location of the recorder is adjacent to the instrument but it may be located remotely if the connecting wires are properly shielded. For best results, the chart recorder input(s) should be isolated from ground. When ever possible, it is preferable to use a 4-20mA signal since it is less susceptible to noise.

Alarms

The instrument has two types of alarms, process alarms and diagnostic alarms. If an alarm has been selected and conditions are such that the alarm becomes active, the instrument will display this condition on the center LCD display. The alarms a numbered as Alarm 1 and Alarm 2. The various displays for active alarm conditions would be displayed as shown below. N indicates the position of the alarm number, 1 or 2.

ALARM DISPLAY	CONDITION	ACTION
FULL HI N	Alarm contact assigned	Full Scale High, Contact automatically resets unless latched.
FULL LOW N	Alarm contact assigned	Full Scale Low, Contact automatically resets unless latched.
DEV BAND N	Alarm contact assigned	Deviation Band, Contact automatically resets unless latched.
DEV HIGH N	Alarm contact assigned	Deviation High, Contact automatically resets unless latched.
DEV LOW N	Alarm contact assigned	Deviation Low, Contact automatically resets unless latched.
OUTPUT HIGH	Alarm contact assigned	Power Output High, Contact automatically resets unless latched.
OUTPUT LOW	Alarm contact assigned	Power Output Low, Contact automatically resets unless latched.

PROBE IMPEDANCE	Alarm contact assigned	Probe Impedance High, Contact automatically resets unless latched.
VERIFICATION	Alarm contact assigned	Probe Verification out of tolerance, Contact automatically resets unless latched.
LLLL	Display only	Displays process value within display range or exponent setting
HHHH	Display only	Displays process value within display range or exponent setting
FLASH CSUM	Alarm contact assigned	Reset instrument power. Return to Marathon if error does not clear.
EEPROM CSUM	Alarm contact assigned	Reset instrument power. Return to Marathon if error does not clear.
KEYBOARD	Alarm contact assigned	Reset instrument power. Do not push any keys while instrument is powered on. Return to Marathon if error does not clear.
FLASH ERASE	Alarm contact assigned	Programming error, Reset instrument power, attempt reload.
FLASH / EE SIZE	Alarm contact assigned	Programming error, Reset instrument power, attempt reload.
ADC FAULT	Alarm contact assigned	Reset instrument power. Return to Marathon if error does not clear.
TEMP OPEN	Alarm contact assigned	Check thermocouple for open condition or loose connection.
MV OPEN	Alarm contact assigned	Check probe millivolt signal for open condition or loose

		connection. This signal can only be tested if the probe temperature is above 1300°F and exposed to process gas.

Process Alarms
The process alarms can be setup to activate either or both of the two alarm contacts provide on the VersaPro. Nine user selectable modes are available.

OFF
Disables the alarm function and the alarm contacts.

Full Scale HI (monitor and controller)
An alarm is generated any time the process value goes above the Full Scale HI alarm value. This alarm is reset if the process falls below the alarm value or acknowledgement from the front panel or through the event input (if configured).

Full Scale LO (monitor and controller)
An alarm is generated any time the process value drops below the Full Scale LO alarm value. The alarm will arm once the process is measured above the alarm value. This alarm is reset with an acknowledgement from the front panel or through the event input (if configured).

Deviation Band (controller only)
An alarm is generated any time the process value goes above or below the band alarm setting. The alarm setting is ± value of the band. For example, if a value of 10 is entered as the alarm value, an alarm is generated if the process goes 10 units above or 10 units below the set point. Units are the process units such percent or degrees. This alarm will not arm until the process is in-band of the set point.

Deviation High (controller only)
An alarm is generated any time the process value goes above the band alarm setting. The alarm setting is number of units allowed above set point. Units are the process units such percent or degrees. This alarm will not arm until the process is in-band of the set point.

Deviation Low (controller only)
An alarm is generated any time the process value goes below the band alarm setting. The alarm setting is number of units allowed below the set point. Units are the process units such degrees Dew Point or degrees Temperature. This alarm will not arm until the process is in-band of the set point.

Output High (controller only)
An alarm is generated any time the control percent output exceeds the alarm value. The alarm setting is maximum percent output allowed.

Output Low (controller only)
An alarm is generated any time the control percent output drops below the alarm value. The alarm setting is minimum percent output allowed.

Fault (monitor and controller)
An alarm is generated any time an open input occurs on either the T/C or MV inputs. Both inputs are pull up to a maximum value if no input is connected or if the input fails in an open circuit mode. An open T/C input fault is ignored for the Linear configuration. The center display will indicate which of these conditions has caused the alarm. The alarm process will also become active if any of the listed hardware faults occur. The center display will indicate which of these conditions has caused the alarm.

Probe (monitor and controller)
An alarm is generated any time the probe exceeds the maximum probe impedance setting, or the verification test tolerance. All of the probe values and limits are configured in the Probe Menu. The center display will indicate which of these conditions has caused the alarm.

Alarm Action

Each alarm can be configured to operate in several different modes. Each alarm can be configured as a reverse (normally closed) contact. This mode is usually used for failsafe alarms that will open during an alarm condition, fault, or power failure. Each alarm can also be configured as a direct (normally open) contact that closes when an alarm condition occurs. In both cases the alarm will automatically clear if the alarm condition is resolved.

Each alarm can also be configured for either reverse or direct latched conditions. In this mode the alarm contact will remain active until an acknowledgement is received through the event port or by pressing the ENTER key.

Alarm Delay Times

Each alarm can have delay ON, delay OFF, or both delays applied. Delays can be applied in increments of a second, up to a maximum of 250 seconds. ON delays are helpful if a known upset in the process can be ignored. This avoids nuisance alarms but still maintains an active alarm if the alarm condition persists following the delay. OFF delays will hold the alarm contact active for a determined period of time once the alarm condition has cleared. This can be helpful as an interlock to other process functions that may have to recover following an alarm condition.

Diagnostic Alarms

A diagnostic alarm is shown on the instrument's center display when a fault is detected in the internal hardware during power up. These alarms included:

FLASH CSUM	A fault has been detected in the Flash memory.
EEPROM CSUM	A fault has been detected in the EEPROM.
KEYBOARD	A key is stuck or was held down during power up.
FLASH ERASE	This error may occur during instrument programming. The Flash memory may be faulty. Retry programming, make sure the communications link to the instrument is working properly.
FLASH / EE SIZE	This error may occur during instrument programming. The Flash memory may be faulty. Retry programming, make sure the communications link to the instrument is working properly.
ADC FAULT	The analog / digital converter has failed to initialize or failed self calibration.

If either alarm contact is configured for a fault this alarm will engage if any of the above faults occur. The LCD display will indicate the fault condition.

The front panel display will show 0000 if the process value is below the display resolution, or HHHH if the process value is above the display resolution. It may be necessary to adjust the decimal point settings if these symbols occur. For Dew Point, the display decimal point setting is fixed at 1.

Digital Input Event

The VersaPro has a single digital input. This input is activated by making an isolated contact closure between terminals TB-B 11 and 12. This input is debounced for a momentary closure of at least 0.6 seconds.

NOTE

Do not connect either terminals 11 or 12 to any AC or DC potentials. These connections are at the internal microprocessor DC potential. Use only an isolated contact connection across these terminals

The input event can be set to any one of the following functions: OFF, PROB, AUTO, REM, or ACK.

OFF
This selection disables the input event function. This is the default condition of this feature unless another function is selected.

PROB
This selection will start the impedance (10Kohm) tests and probe verify. The various probe tests will run only if they are selected in the Probe Menu. The PROB input event will have no effect if no tests are selected.

If a probe test interval time is set to any value other than zero, activating this function will reset the interval count down timer. If the probe test interval time is set to zero this function will operate only when the contact closure is made. The contact closure must open and close each time to initiate another probe test.

AUTO (controller only)
This selection will force the instrument from manual mode into automatic mode. No change will occur if the instrument is already in automatic mode.

REM (controller only)
This selection will force the instrument from local setpoint mode into remote setpoint mode. No change will occur if the instrument is already in remote setpoint mode.

ACK
This selection will acknowledge an alarm. This function will have no effect if the alarm is configured as a latched alarm and the alarm condition is still present.

Serial Interface

The VersaPro has a single RS-485 half duplex communications port. This port can be configured for either the Marathon protocol or a RTU Modbus protocol. Baud rates and parity are selectable. See the section on communications for details on both of these protocols.

Front Panel Operation

The instrument has a display/keyboard assembly. This assembly has a 2 x 4 keyboard group, two groups of four LED seven segment displays (upper and lower), and a single line sixteen character LCD display.

Figure 2 VersaPro Display

The LEDS to either side of the LED segment arrays light when the corresponding function is active.

- COMM flashes when the instrument is properly interrogated over the RS485 port.
- PWR is hard wired to the instrument 5VDC supply
- AUTO is lit when the instrument is controlling to a set point (controller option)
- REM is lit when the instrument is controlling to a remote set point (controller option)

The upper display indicates the process value or the Setup Menu Heading when the SETUP key has been pressed.

The center display will indicate what scaling is being used for the Dew Point measurement. In figure 2 the instrument is indicating that Dew Point is being measured.

The center display also shows the parameter name in Setup mode or flashes a fault or alarm message if any are active.

The lower display shows the instrument set point if the controller is in automatic or remote mode. The display will switch to control output level when the instrument is changed to manual. The monitor option will display the probe temperature by default. The lower display can be configured to display other parameters based on the instrument option.

Remote Key

Pressing the REM key causes the VersaPro to cycle between Remote, Automatic, or Manual control. This key has no function in the monitor version. When switching from Automatic to Manual or Manual to Automatic, the control output remains at the last output value in either mode. This allows for a bumpless control transition between either mode.

When the controller is set to Automatic mode the “Auto” LED lights and the lower display indicates the process setpoint (default).

When the controller is set to Remote mode the “Rem” LED lights and the VersaPro will accept a remote setpoint from a master on the host serial interface. The lower display indicates the process setpoint (default).

When the controller is set to Manual mode both the “Rem” and “Auto” LED’s are dark and the lower display indicates the power output of the controller. This value can be manually increased or decreased in 1% steps by pressing the UP or DOWN arrow keys. Pressing the RIGHT or LEFT arrow keys changes the output in 10% steps. The output will remain in the last control level if the instrument is switched into manual mode from remote or automatic or back to either setpoint control mode.

SETPT Key

The SETPT key provides access to the instrument process set point. When the key is pressed the center display will show “SET POINT”. The set point value in the lower display can then be manually changed by moving the flashing digit cursor with the RIGHT or LEFT arrow keys and increasing or decreasing the selected digit with the UP or DOWN arrow keys. You can exit the set point function by pressing the SETPT key again. Any changes that are made to the set point are then displayed in the lower window if the instrument is set up of Automatic control.

The following table outlines the options available under the Set Point key.

Table 2 Setpoint Ranges

Parameter Name	Range	Description
SET POINT	-99.9 – 212.0 DewPt 0 – 9999	Units for dew point are based on display resolution and exponent setting or scaled linear input.

Setup Key

The instrument can be placed in setup mode by pressing and holding the SETUP key for 5 seconds. The upper display initially shows the first setup menu while the center and lower displays are blank. At this level you can select different menus by pressing the RIGHT or LEFT arrow keys. The upper display will change accordingly.

You can enter a menu by pressing the ENTER key when the desired menu heading is being displayed. Pressing the arrow keys can change menu parameters. Value changes can be saved or the next parameter can be selected by pressing the ENTER key. The menu parameters will continue to cycle through the display as long as the ENTER key is pressed. A new menu can be select only when the menu heading is displayed. You can exit from the Setup mode by pressing the SETUP key at any time.

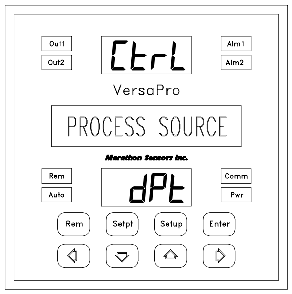
The following tables outline the Setup menus available in the VersaPro Controller and Monitor when the operator presses the SETUP key.

Table 3 Setup Menus

Setup Menu Heading	Description
CtrL	Control functions and PID
InPt	Thermocouple type and Millivolt setup
CALc	Process Factor Setting
Prob	Probe tests and verification parameters
Aout	Analog output selection and parameters
Allr	Alarm contact configurations
Eunt	Digital Input function selection
HoSt	Communication protocols and parameters
InFo	General information displays
CAL	Input / Output calibration

You have to press the SETUP key for five seconds to activate the setup mode. If a lock level of 1 or higher is set, you may also have to enter a password to proceed.

Initially when the setup mode is activated, the LCD display will show the first menu heading, the upper and lower LED displays are blank. Page to the next Menu heading by pressing the RIGHT or LEFT arrow keys. The menu headings will continue to wrap around as the RIGHT or LEFT arrow keys are pressed. Pressing the SETUP key at any point while in the Setup Menus will return the display to the normal process display. See figure 3.



The displayed menu is selected by pressing the ENTER key. The first parameter name in the selected menu list will appear in the center display. The upper LED group continues to display the menu name, the center display shows the parameter name, and the lower LED group shows the parameter value. A flashing cursor in the lower LED display indicates which digit can change if the parameter value is numeric. The UP or DOWN arrows increase or decrease the digit value. The RIGHT or LEFT arrow keys move the cursor to the right or left digit. No wrap-around is provided for the cursor.

If the parameter has a table of choices such as thermocouple types, the various selections can be displayed by pressing the UP or DOWN arrows. No digit flashes in parameter displays that have a choice selection. In either case, the selection is set when the ENTER key is pressed and the display advances to the next parameter.

In the example shown above, the selected menu is Control (CtrL), the selected parameter is Control Type, and the displayed parameter value is Time Dual (td). This is one of several control types that are available. Different control selections can be made by pressing the UP or DOWN arrow keys.

Pressing the SETUP key at any time escapes from the menu display and returns to the normal process display. You can only select another menu heading when the display is at a menu heading.

The following figures and tables outline the menu options and parameters under the Setup key.

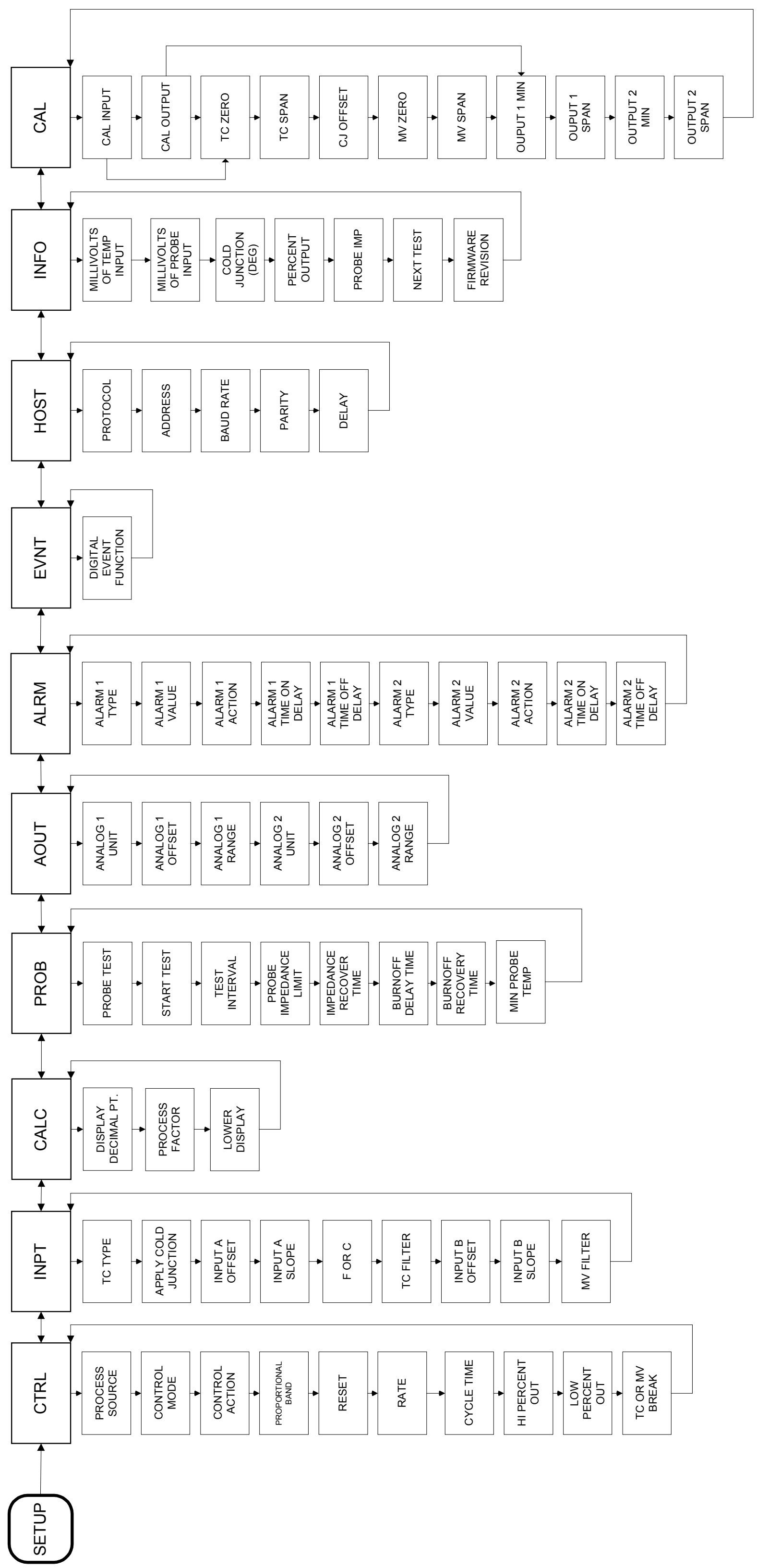


Figure 3 Setup Menu Tree

Table 4 Control Menu (CtrL)

Parameter Name	Units or Options	Range	Description
PROCESS SOURCE	DewPt INPUT A INPUT B	Display range: -99.9 to 212.0 for dew point, scaled input A or B	Control type only available on instrument's specific configuration. This selection controls what other parameters will be available.
SENSOR OPEN		0% OUTPUT HOLD	0% OUTPUT sets the control output to 0 if a thermocouple break and/or an open mV input are detected. HOLD holds the output to the last averaged output prior to a break and/or open input.
CONTROL MODE	TP, TC, TD, PP, OF, OC, OD or NON		See Control Modes if configured as a controller, shows NON (MONITOR) only if the instrument is configured as a monitor.
CONTROL ACTION	DIR/REV		Direct or Reverse control action
PROPORTIONAL BAND	Process Value	0 – 9999	Proportional Band value in displayed process units for PID control or Deadband in ON/OFF control
RESET	repeats/min	00.00 – 99.99	Integral control value, no effect in ON/OFF settings
RATE	Minutes	00.00 – 9.99	Derivative control value, no effect in ON/OFF settings
CYCLE TIME	SECONDS	0 – 250	Proportional time period (TP, TC, TD) Motor cycle time (PP) Minimum ON time (OF,OC,OD)
HI PERCENT OUT	MAXIMUM OUTPUT	0 – 100	Sets max. forward control. Output
LOW PERCENT OUT	MINIMUM OUTPUT	-100 to 100	Sets min. reverse control output
TC OR MV BREAK	ZERO / HOLD		Sets output control to zero or holds current output if a TC or millivolt input open condition occurs. Input A

			only checks TC input, Input B only checks mV input.

Table 5 Input Menu (I nPt)

Parameter Name	Units or Options	Range	Description
TC TYPE	B, E, J, K, N, R, S, T		See Input calibration for thermocouple ranges. Has no effect in Linear mode, see IN A OFFSET and IN A SLOPE.
COLD JUNC APPLY	YES or NO		Applies the cold junction correction or not when a thermocouple type is selected. In LINEAR mode the cold junction is never applied. Default is NO.
IN A OFFSET	Only in Linear mode	-999 – 9999	Linear offset to scale Input A to Engineering Units when INPUT A is selected as the process source.
IN A SLOPE	Only in Linear mode	-999 – 999 -99.9 – 99.9 -9.99 – 9.99 -.999 - .999	Linear slope to scale Input A to Engineering Units when INPUT A is selected as the process source. This is the slope number in the linear calculation where: EU = SLOPE(mV) + OFFSET See key
TEMP SCALE	F OR C		Sets temperature scale.
TC FILTER		0 – 3276	Temperature filter time constant. Filters the temperature value with a moving average time window. Higher number allows for faster display updates
IN B OFFSET	Works only in mV Mode	-999 – 9999	Linear offset to scale Input B to Engineering Units when INPUT B is selected at the process source. This is the offset in used in the SLOPE(mV) + OFFSET equation.

IN B SLOPE	Works only in mV Mode	-999 – 999 -99.9 – 99.9 -9.99 – 9.99 -.999 - .999	Linear slope to scale Input B to Engineering Units when INPUT B is selected as the process source. This is the slope number in the linear calculation where: EU = SLOPE(mV) + OFFSET
MV FILTER		0 – 3276	Millivolt filter time constant. Filters the millivolt reading with a moving average time window. Higher number allows for faster display updates.

Table 6 Calculation Menu (CALC)

Parameter Name	Units or Options	Range	Description
CARBON PROCESS FACTOR		0 – 1999	Used to correct displayed carbon value when compared to shim stock readings.
DISPLAY DECML PT	Decimal point	0-4	Sets decimal pt., for Input A and Input B. Carbon defaults to 2.
LOWER DISPLAY	SETP, PO, TENP		Allows the operator to change the displayed value in lower LED display during REM and AUTO modes. Setpoint (SETP) is the default. MAN defaults to percent output (PO). Probe temperature (TENP) can be displayed if explicitly set to this selection. Linear input selections are blank.

Table 7 Probe Setup Menu (PrOb)

Parameter Name	Units or Options	Range	Description
PROBE TEST		NONE RES BOFF	No test (NONE), Impedance (RES), Burnoff (BOFF), or BOTH

		BOTH	impedance and burnoff can be selected.
START TEST		YES/NO	If probe test interval is 0, then test only runs once. If probe test interval is set then test run continuously from start point and at each interval time. Test stops when changed back to NO. Probe temp must be >= the minimum probe temperature setting.
TEST INTERVAL	HRS.TENTHS	0 – 99.9	Sets time interval between automatic probe tests, 0 disables automatic testing.
PROBE IMP LIMIT	KOHMS	10 – 100	Sets maximum impedance for Probe alarm
IMP RECVRY TIME	SECONDS	0 – 250	Sets maximum Probe recovery time, timer cut short if probe recovers faster. The Probe alarm is set if the probe signal does not recover while this timer is active.
BURNOFF DELAY	SECONDS	0 – 999	The period of time when air is allowed to flow to the tip of the sensor.
BURNOFF RECOVERY	SECONDS	0 – 999	Recovery time for probe following the burnoff test. The PROBE alarm is set if the probe signal does not recover before this timer expires.
MIN PROBE TEMP	F OR C	1100° – 2000° F 590° – 1090° C	Minimum temperature for probe impedance and verification tests.

Table 8 Analog Output Menu (AOUt)

Parameter Name	Units or Options	Range	Description
ANALOG 1 UNIT	DewPt, LIN, TENP, POUT, PO1, PO2, PROG,	4 to 20mA output.	DewPt – retransmits dew point value when selected as process source. **LIN** - scaled millivolt value of either input A or

			input B, depending on which one is selected as process source. **TENP** - probe temperature when Dew Point is selected as process source and a thermocouple type is selected. **POUT** – Power output is available for the controller, allows for –100% to 100% for split actuators. PO1 or PO2 allow for just 0 – 100% output for either control contact. **PROG** - allows the output to be controlled from the DACV1 memory location.
ANALOG 1 OFFSET	Offset for selected process value or percent output.	-30.0 to 300.0 for O2 and LIN -300 to 3000 for temperature LOPO for POUT 0 or DAC_OFFSET for PROG	This is the minimum value of the process associated with the 4mA output. The magnitude of this number is based on the display resolution. In POUT mode the offset is fixed to the LOPO value. When PROG is selected the offset is fixed at 0
ANALOG 1 RANGE	Span scaling for selected process value or percent output.	0 to 9999 for O2, LIN, and Temp HIPO for POUT 4096 or DAC_SPAN for PROG	This is the maximum value of the process associated with the 20mA output. The magnitude of this number is based on the display resolution.When POUT is selected this value is fixed to the HIPO value. When PROG is selected the range is fixed at 4096
ANALOG 2 UNIT	O2, LIN, TENP, POUT, PO1, PO2, PROG		Same as Analog 1
ANALOG 2 OFFSET	Offset for		Same as Analog 1

	selected process value or percent output.		
ANALOG 2 RANGE	Span scaling for selected process value or percent output.		Same as Analog 1

Table 9 Alarm Menu (ALr)

Parameter Name	Units or Options	Range	Description
ALARM 1 TYPE	OFF FSHI, FSLO DBAN DHI DLO OHI OLO FALT PROB		**OFF** disables alarm contact. **FSHI - Full Scale HI**, active when process is above ALARM 1 VALUE. **FSLO - Full Scale LO**, active when process is below ALARM 1 VALUE. **DbAn – Deviation Band** available for the controller only, active when process is outside of symmetrical band around setpoint. **DHI – Deviation High**, defines a process band above the process setpoint. The alarm is active if the process moves outside this band. **DLO – Deviation Low,** defines a process band below the process setpoint. The alarm is active if the process moves outside this band. **OHI – Output High,** this alarm sets the threshold for the maximum control output allowed which is set by ALARM 1 VALUE. **OLO – Output Low,** this alarm sets the threshold for the minimum control output allowed which is set by ALARM 1 VALUE.

			Falt – Fault, open inputs for mV, thermocouple or hardware fault. **Prob – Probe**, fault active if impedance or verification are out of range.
ALARM 1 VALUE			Trigger set point value
ALARM 1 ACTION	REV, LREV, DIR, LDIR		REV = Reverse (N.C.) can be acknowledged even if the condition still exists. LREV = Latched Reverse (N.C.) can not be acknowledged if the condition still exists. DIR = Direct (N.O.) can be acknowledged even if the condition still exists. LDIR = Latched Direct (N.C.) can not be acknowledged if the condition still exists.
ALRM 1 TM ON DLY	0 – 250 SECONDS		Delay ON time for ALARM1
ALRM 1 TMOFF DLY	0 – 250 SECONDS		Delay OFF time for ALARM1
ALARM 2 TYPE	Same as ALARM 1 TYPE	OFF	Same as ALARM 1 TYPE
ALARM 2 VALUE			Trigger set point value
ALARM 2 ACTION			Same as ALARM 1 ACTION
ALRM 2 TM ON DLY	0 – 250 SECONDS		Delay ON time for ALARM2
ALRM 2 TMOFF DLY	0 – 250 SECONDS		Delay OFF time for ALARM2

Table 10 Event Menu (EUnt)

Parameter Name	Units or Options	Range	Description
DIGITL EVNT FUNC	OFF, PROB, AUTO,REN, ACK, HOLd		PROB = Contact on/off starts probe tests (if configured) AUTO = Contact on/off switches to automatic control. (controller only)

			REN = Contact on/off switches to remote control (controller only) ACK = Contract on/off resets alarm (if not currently active) HOLd= Process control and analog outputs are frozen while event contact is closed.

Table 11 Communication Menu (HOSt)

Parameter Name	Units or Options	Range	Description
PROTOCOL	PROP OR BUSS		PROP is Marathon Sensors, Inc. protocol, BUSS is Modbus
ADDRESS	1 TO 15 (MSI) 1 TO 254 (MOD)		
BAUD RATE	2400,4800,9600, 19.2K		
PARITY	None/Even/Odd		
DELAY	NONE / 10		NONE = 0 Delay 10 = 10 ms delay

Table 12 Info Menu (I nFO)

Parameter Name	Units or Options	Range	Description
MILLIVOLT TEMP IN	MILLIVOLTS	-10-100	Displays direct mV of Temperature input
MILLIVOLT PROB IN	MILLIVOLTS	0-2000	Displays direct mV reading of probe input
COLD JUNCTION	DEG (F OR C)	0 – 60°C	Displays actual cold junction temperature
PERCENT OUTPUT	% Output	LOPO to HIPO	Displays actual % output
PROB IMPEDANCE	Kohms	0 – 100	Displays last probe impedance value.
IMP RECVRY TIME	SECONDS	0 – 250	Displays last impedance recovery time.
BURNOFF MV	MILLVOLTS	0 – 2000	Millivolts read at the end of the probe burnoff cycle

BURNOFF TEMP	°F OR °C	0 – 2000	Displays probe temperature read at the end of the probe burnoff cycle
BURNOFF RECVRY TIME	SECONDS	0 – 250	Time taken for probe to return to 98% of pre-test millivolt reading.
NEXT TEST	Hours.tenths		Time to next probe test, shows 00.0 if test automatic test is disabled.
FIRMWARE REV	Version number		

Table 13 Calibration Menu

Parameter Name	Units or Options	Range	Description
CAL INPUT	NO / YES		Default to NO, must be changed to YES to enter input calibration routine.
TC ZERO			Changes calibration value for thermocouple zero
TC SPAN			Changes calibration value for thermocouple span
CJ OFFSET (CAL IN)		0 – 60° C 0 – 140° F	Sets the cold junction offset depending on the temperature range selected
CAL OUTPUT	NO / YES		Default to NO, must be changed to YES to enter output calibration routine.
OUTPUT 1 MIN (CAL OUTPUT)			Sets signal level for the minimum mA output.
OUTPUT 1 SPAN (CAL OUTPUT)			Sets signal level for the maximum mA output.
OUTPUT 2 MIN (CAL OUTPUT)			Sets signal level for the minimum mA output.
OUTPUT 2 SPAN (CAL OUTPUT			Sets signal level for the maximum mA output.

Pressing the Setup key once at any point in the Setup menu will return the instrument to the normal process display.

Dual Key Functions

The VersaPro was three dual key functions as defined below:

ENTER / RIGHT arrow	Initiates probe test sequence
ENTER / REM	Factory Service Monitor Mode

Starting Probe Tests

Pressing the ENTER / RIGHT arrow keys simultaneously will start the probe tests if a probe test function has been selected in the Probe Setup Menu, parameter Probe Test, and the probe temperature is above the minimum probe temperature parameter in the same menu.

If there is a value other than 0 entered in the Probe Test Interval parameter the probe test will be preformed after the selected interval time has elapsed from the time the test was manually started. If the interval time is set to 0 then no additional tests will be preformed until the next manual start. Starting the test through this dual key function is the same as if the Start Test parameter in the Probe menu had been changed from NO to YES.

Factory Service Monitor Mode

Pressing and holding the ENTER / REM keys will place the instrument in Factory Service Monitor mode. This condition allows service personnel access to memory locations in the instrument via the RS485 port using a standard ASCII terminal interface. The instrument sends out a standard test header over the RS485 port when it enters this mode. Instrument status or memory can be read as well as programming the instrument FLASH memory. Reset power or send an ‘X’ command to return to normal control mode.

Probe Impedance Test

The probe impedance test is performed by measuring the open circuit voltage of the probe, applying a known shunt resistor across it and measuring the shunted voltage output. The value of the shunt resistor is 10kohm for oxygen sensors.

To run a probe impedance test it is necessary setup the probe testing parameter in the SETUP Probe Menu. Please refer to Probe parameters table for an explanation of these setup parameters. It is necessary to have the impedance (RES) test or both (BOTH) selected at the PROBE TEST parameter in order to run the impedance test. You may choose to accept the defaults for the other parameters in this menu or change them to suit your applications. It is necessary that the sensor be above the MIN PROBE TEMP parameter setting for this test to run. It is also necessary for the probe to be measuring a stable process gas during this test.

There are two ways to start this test. From the Probe Setup menu at the START TEST parameter, you can change this parameter from NO to YES and then press the ENTER key. The instrument will exit the Setup mode and display the test name and sequence number on the front display. The LCD display will indicate "IMPEDANCE TEST" while the lower LED display will show the test sequence number as listed in the following table.

It is also possible to start the test in the process display mode by pressing the ENTER and RIGHT ARROW keys at the same time. The test can be stopped by returning to the START TEST parameter and changing YES to NO and then pressing ENTER.

If the TEST INTEVAL parameter has a number other than 00.0 then the test will continue to run each time the test interval timer counts down to 0. This test interval can be stopped by setting the interval timer to 00.0.

The following table explains the various operations of the impedance test.

Table 14 Probe Impedance Sequence

Sequence #	Description
1	Inhibit process variable calculations. Freeze all process controls and outputs.
	Freeze alarms at last state except clear any previous probe test failure alarm.
	Store present probe millivolt reading
	Apply shunt resistor across probe
2	Wait for impedance test timer, fixed time of 30 seconds

	Compute impedance of probe and remove shunt resistor. Save measured impedance as PROBE IMPEDANCE in INFO menu.
	If impedance is greater than PROBE IMP LIMIT then set probe test failure alarm.
3	Wait for probe to recover to >=99% of original millivolts.
	Evaluate actual recovery time to IMP RECVRY TIME
	If recovery time is greater than IMP RECVRY TIME then set probe test failure alarm.
	Store recovery time (or max value) as IMP RECVRY TIME in INFO menu
4	If verification is to be performed then go to step 1 of verification sequence
	Otherwise wait 30 seconds and resume normal operation of all instrument functions.

Why Measure Sensor Impedance?

It is important to track sensor impedance over a period of time to help determine the replacement schedule for the sensor. A high impedance (>50 KΩ) indicates that the electrode contact on the probe zirconia has deteriorate to a level that probably warrants replacement. High sensor impedance results in a lower signal output from the sensor and an eventual failure of the electrode connection on the process side of the zirconia ceramic. This deterioration is more of a factor in highly reducing atmospheres. In such applications, it may be necessary to check the impedance at least once a month. Under light reducing, annealing, or brazing operations, the impedance may not have to be check unless there is a question about the probe's performance.

A typical impedance for a new probe is less than 1 KΩ. As the probe starts to age the impedance will increase. Past 20 KOHM the sensor should be monitored more closely. Above 50 KΩ, the sensor should be replaced. If it is necessary to replace the sensor, remove it carefully, following the instructions supplied with the sensor. Do not discard a sensor with a high impedance. It may be possible to rebuild the sensor if the ceramic parts are intact. Contact Marathon Sensors, Inc. for information on rebuilding your sensor.

An impedance test can only be performed if the probe temperature is at or above 1300°F with stable atmosphere present. The instrument freezes all control functions and process signals during the test.

A 10Ω resistor is shunted across the sensor output. The sensor impedance is calculated as:

$$Rx = [(Eo/Es)-1]*Rs$$

Where Rx = sensor impedance, Eo = sensor's open circuit voltage, Es = shunted sensor's voltage, and Rs = shunt resistor. The units of Rx are the same as Rs.

Probe Burnoff

Probe burnoff is performed by flowing air into and around the oxygen sensor internal ceramic substrate. This air creates a flame at the tip of the sensor that burns off any accumulated carbon or soot. A ¼" CPI compression fitting at the mounting hub of Marathon Sensors sensor is provided for the air connection. This air floods the probe sheath and flows out and around the sensor. The sensor does have to be above the MIN PROBE TEMP parameter found in the PROBE setup menu. This value is typically 1300°F or higher.

To run a probe burnoff it is necessary setup the probe test parameters in the SETUP Probe Menu. Please refer to Probe parameters table for an explanation of these setup parameters. It is necessary to have the burnoff (BOFF) test or both (BOTH) selected at the PROBE TEST parameter in order to run the burnoff. You may choose to accept the defaults for the other parameters in this menu or change them to suit your application. It is necessary that the sensor be above the MIN PROBE TEMP parameter setting for this test to run. It is not necessary for the probe to be measuring a stable process gas during this test.

There are two ways to start this test. From the Probe Setup menu at the START TEST parameter, you can change this parameter from NO to YES and then press the ENTER key. The instrument will exit the Setup mode and display the test name and sequence number on the front display. The LCD display will indicate "BURNOFF TEST" while the lower LED display will show the test sequence number as listed in the following Table.

It is also possible to start the test in the process display mode by pressing the ENTER and RIGHT ARROW keys at the same time. The test can be stopped by returning to the START TEST parameter and changing YES to NO and then pressing ENTER.

If the TEST INTEVAL parameter has a number other than 00.0 then the test will continue to run each time the test interval timer counts down to 0. This test interval can be stopped by setting the interval timer to 00.0.

Readings are averaged to eliminate variations in measurement due to initial flow conditions. There are three operator inputs for verification time periods;

- TEST INTERVAL is an interval timer that sets the time between automatic verifications in hours and tenths. The verification can be manually initiating by pressing and holding the Enter key and then the Left Arrow key. Setting the test interval time to zero disables automatic testing.
- BURNOFF TIME is the period in seconds burnoff air is flowing to the sensor.
- BURNOFF RECOVERY is the time period in seconds that allows the probe to recover and return to the process level.

The following table outlines the actions the instrument takes at each sequence step.

Table 15 Probe Burnoff Sequence

Sequence #	Description
1	Inhibit process variable calculations. Freeze all process controls and outputs.
	Freeze alarms at last state except clear any previous probe test failure alarm.
	Close burnoff contact and wait the BURNOFF time period.
2	Release the burnoff contact and wait the BURNOFF RECOVERY time period.
	Save the mV reading as in INFO menu.
3	Resume normal operation of all instrument functions.

Tuning

Before attempting to tune the instrument make sure you understand the *Operation and Setup* part of the instrument.

What is tuning?

Tuning the controller means that the control characteristics of the controller are matched to those of the process in order to obtain hold the process to setpoint. Good control means:

- Stable, 'straight-line' control of the process variable at setpoint without fluctuation
- No (minimum) overshoot, or undershoot, of the process variable relative to setpoint
- Quick response to deviations from the setpoint caused by external disturbances, thereby rapidly restoring the process variable to the setpoint value.

Tuning involves calculating and setting the value of the parameters listed the following table. These parameters appear in the Control Setup menu.

Table 16

Parameter	Meaning or Function
Proportional band	The bandwidth, in display units, over which the output power is proportioned between minimum and maximum.
Integral time (Reset)	Determines the time taken by the controller to remove steady-state error signals.
Derivative time (Rate)	Determines how strongly the controller will react to the rate-of-change of the measured value.
Cycle Time	The total amount of time used to calculate the combination of percent on and percent off periods of the control function.

The Versapro uses the Proportional Band as a representation of the Proportion section of PID, the Reset as a representation of the Integral section of PID, and the Rate as a representation of the Derivative section of PID. Thus by following a simple procedure, PID tuning can easily be implemented in any control situation. A suggested procedure is diagramed in the next figure.

All of the PID parameters may be altered by changing these parameters in the Setup / Ctrl menu. The following procedure assumes the initial PID values for a typical batch furnace. You may be able to start with a proportional band setting of 10 or less for a smaller box or temper furnace.

You must determine want the initial cycle time should be. If you are using control motors or continuous motors, set the cycle time to the time it takes the control motor or actuator to fully open and fully close. If you are using quick acting solenoids to control the process the cycle time setting is a compromise between longer times to limiting contact cycles and extend the life of the actuator or shorter times to maintain good control. A good rule is to watch to process value and turn on the solenoid. Measure the time it takes for the process to react with a 5% change. Double this time and enter it as the cycle time. Decrease the cycle time to get a smoother control.

If, after following the procedure, the process continues to oscillate, it may be necessary to change the HIPO or LOPO parameters. Make sure that the control output is linear through the full range from LOPO to HIPO. In situations where the system is difficult to tune, it is most likely the output is not linear or there is too much lag time between the control command and measurable changes in the process. Test the system in manual mode to verify the output is linear.

A much higher proportional band may be necessary for extreme lag in the process response. In most cases, the derivative part of the control equation is not necessary. Generally, furnace control can be maintained using only the proportional band and the reset parameters.

Make sure you record <u>all</u> operating parameters and keep them in a secure place for later reference.

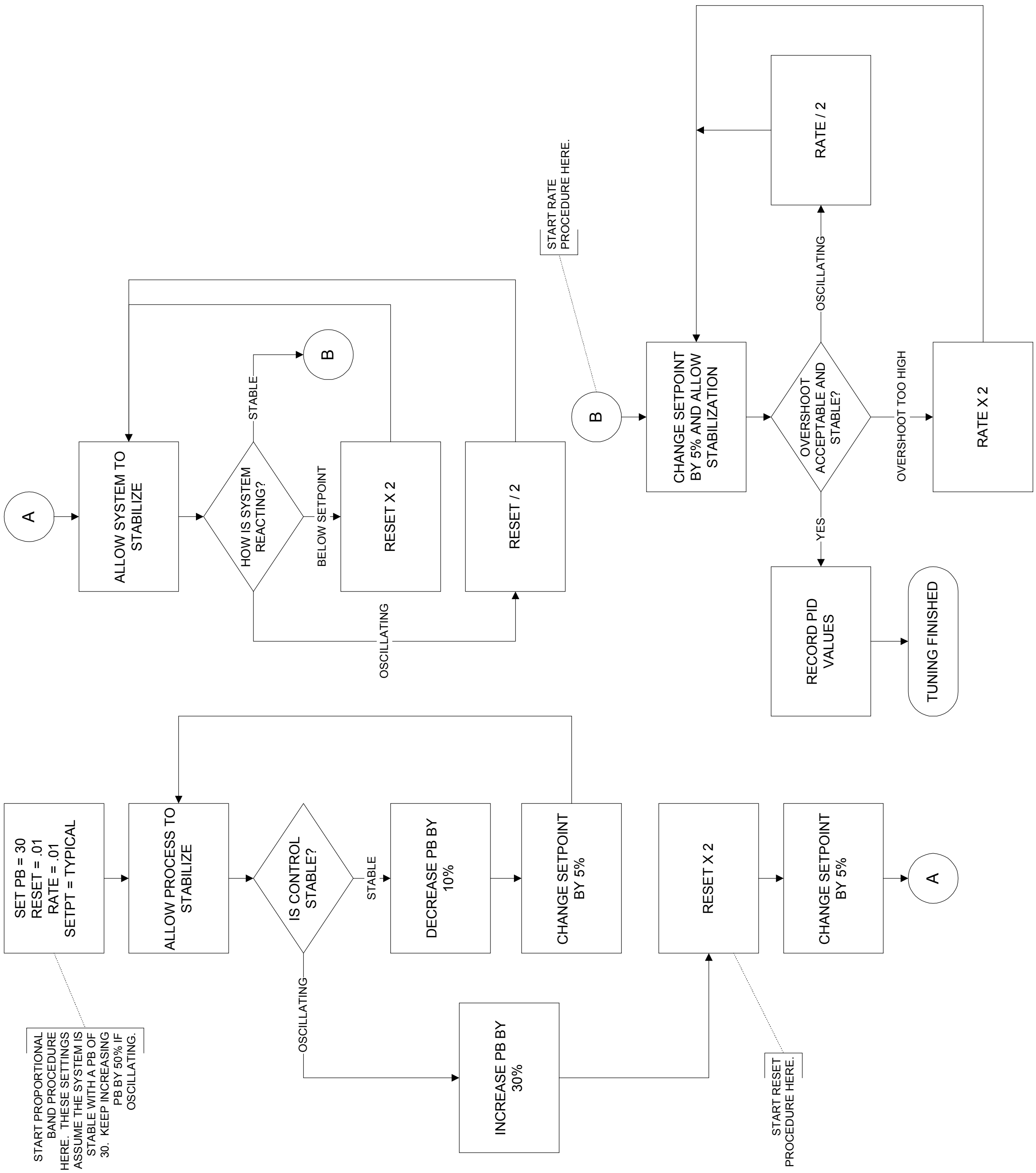


Figure 4 PID Manual Tuning Procedure

Scaling Analog Inputs

If either input is set to Linear mode the displayed value for that input can be scaled to desired engineering units. This is helpful if the measured linear value has to be scaled and re-transmitted on one of two analog output channels.

Using the equation y = mx + b, where
Y is the desired engineering unit to be displayed
X is the linear millivolt value
M is the Slope of the y/x relationship
B is the y intercept

Linear A example

Let us use Input A as a linear input for a linear dew point sensor which outputs a 0mV to 53.2mV signal over a 0 to 212 degrees dew point range. Since both the signal output and the process minimum are both 0, the Input A offset will be 0. The slope can be calculated by dividing the maximum process value (212) by the maximum input level (53.2mV). The gives a slope value of 3.985. Set the decimal point setting to 1, which allows the slope parameter a 10^{th} digit. The actual number to be entered is 4.0.

These scaling values produce a calculated process value of 212.8 for a maximum sensor input of 53.2mV. The process display can be configured to display either 212.0 or 212 depending on the display decimal point setting. This process value can then be retransmitted to other control devices are a recorder. The control model of the Versapro will be able to control to a set point for the new process value.

Keyboard Function during Input Slope

The three left digits in the slope display can be change from 0 to 9. The most significant digit position allows you to shift the decimal point by pressing the LEFT arrow key. The decimal point will loop from first digit to the third digit as the LEFT arrow key is pressed. The RIGHT arrow key moves the display cursor back to the numbered digits.

Scaling Analog Outputs

The analog outputs are scaled to simple offset and span values. For example if analog output 1 is to be scaled for a –99.9 to 212 degree dew point value, the offset value would be –99.9 and the span value would be 212.

The same rules apply to analog output 2. The range of the offset and span numbers depends on the range of the process value that has been selected for either analog output. Typical scaling for the second output would be the sensor's temperature, such as 0 for the offset and 2000 for the full scale degrees.

Additional selections for Power Output and Program mode have fixed offset and span values. The power output offset and span values are fixed to the LOPO and HIPO values selected for the control outputs under the Setup Control menu.

The Program mode selection has a fixed offset of 0 and a fixed span of 4096. When this output mode is selected the analog output can only be changed by writing a value to either the DACV1 or DACV2 registers.

Calibration

There are two analog inputs, a cold junction compensation sensor, and two analog outputs on the VersaPro. The input level is determined by which terminals are used for the input signal. There are two pairs of input terminals: TB-B 1, 2 for the thermocouple (T/C) input and TB-B 3, 4 for the probe millivolt input.

The 4 – 20mA analog outputs are at TB-B 5, 6 and TB-B 7, 8.

The following is a brief description of input/output and its specifications.

a) T/C Input

Input range	-10 to +70 millivolts ± 2 µV
TC burnout	>full scale

b) Probe mV Input

Input range	-50 to +2000 millivolts ± .1 mV, linear
Input impedance	40 megohm
Open input	>full scale

c) Output 1

Output range	0 to 20 milliamps
Max. Load	650 ohms

d) Output 2

Output range	0 to 20 milliamps
Max. Load	650 ohms

Calibration Displays and Keyboard Operation

When entering the Calibration Menu, the operator has to answer one of two questions depending on which I/O functions have to be calibrated. If the CALIBRATION IN prompt is answered with a YES, then the parameters related to the thermocouple input, millivolt input, and cold junction can be changed. If this prompt is skipped by pressing the Enter key, then a second prompt, CALIBRATION

OUT is displayed. If this prompt is answered with a YES, then the zero and span values for both analog outputs can be changed.

In the Calibration Menu the displays and front panel keys take on special assignments. The LCD display shows the input and calibration point being calibrated. The upper LED display indicates that the instrument is in CAL mode. The lower LED display indicates the actual input level for the input channels or the calibration factor for the output channels.

It is very important that the display is indicating the proper I/O parameter before making an adjustment or the wrong value will be changed.

Once the particular calibration mode is selected the following keys perform the described functions:

Key	Function
UP ARROW	Increases the displayed value.
DOWN ARROW	Decreases the displayed value.
RIGHT ARROW	Shifts to the upper digits to adjust the calibration factor for the analog output calibration.
LEFT ARROW	Shifts to the lower digits to adjust the calibration factor for the analog output calibration.
ENTER	Cycles to next input value and saves the calibration changes.
SETUP	Exits the calibration mode.

Preparing for Input Calibration

All that is required to calibrate both the thermocouple and millivolt inputs is;

A calibrated millivolt source, 0 – 2000mV with a 1mV resolution.
Copper wire to connect the millivolt source to the instrument.

The inputs are calibrated in linear mode. The thermocouple setting has no effect on the calibration of the thermocouple input. This procedure calibrates the linear response of the analog to digital converter of the instrument. Temperature values are only shown in normal process mode. Temperature is determined by comparing the actual voltage level to thermocouple tables and adjusting for cold junction compensation if this feature is selected.

Calibration of the Thermocouple Input

Calibration procedure:

1. Connect terminals TB-B 1, 2 to an isolated, stable millivolt source calibrator using standard copper wire, 20 AWG is sufficient.
2. Set the calibrator output to 0.00 mV.
3. Activate the calibration mode by entering the SETUP menus, selecting the Calibration menu and changing Calibration IN - NO to YES.
4. Use the Enter key to select the TC ZERO mode.
5. Using the arrow keys, adjust the displayed value to equal the calibrator input.
6. Press the Enter key to select the TC SPAN mode.
7. Set the calibrator output to 50.0mV (70mV maximum).
8. Using the arrow keys, adjust the displayed value to equal the calibrator output.

Calibration of the Probe Millivolt Input

Calibration procedure:

1. Connect terminals TB-B 3, 4 to an isolated, stable millivolt source calibrator using standard copper wire, 20 AWG is sufficient. A maximum output of 2000 mV is required.
2. Set the calibrator output to 0.00 mV.
3. Activate the calibration mode by entering the SETUP menus, selecting the Calibration menu and changing Calibration IN - NO to YES.
4. Use the Enter key to select the MV ZERO mode.
5. Using the arrow keys, adjust the process value to equal the calibrator input.
6. Press the Enter key to select the MV SPAN mode.
7. Set the calibrator output to the required millivolt span (2000 mV maximum).
8. NOTE: The number that is displayed are mV digits XX.X. If 1823.2 mV is connected to the input, only 823.2 will be displayed. The upper thousands digit is not shown. Using the arrow keys, adjust the process value to equal the calibrator output.

Calibration of the Analog Output Channels

The same calibration procedure can be used for either output channel.

Calibration procedure:

1. Connect terminals TB-B 5, 6 (or 7, 8) to a multimeter such as a Fluke 77. Select the milliamp measurement range and verify that the test leads are plugged into the milliamp jack and common on the multimeter.
2. Activate the calibration mode by entering the SETUP menu, selecting the Calibration menu, press the ENTER key until CAL OUTPUT - NO is displayed.

3. Change the NO prompt to YES using the UP arrow key.
4. Press the ENTER key to select the OUTPUT 1 MIN mode. If OUTPUT 2 is required, continue pressing the ENTER key until OUT 2 MIN is displayed.
5. Using the UP or DOWN arrow keys, adjust the displayed number from 0 to 9. Press the RIGHT or LEFT arrow keys to select the adjustment sensitivity. Adjust the displayed value until the multimeter indicates the desired minimum output. This is typically set for 4 mA (cal factor ~ 800), but this level can be adjusted to 0mA (cal factor ~ 0).
6. Press the ENTER key to select the OUTPUT 1 SPAN mode. If OUTPUT 2 is required, continue pressing the ENTER key until OUTPUT 2 SPAN is displayed.
7. Using the arrow keys as explained in step 5, adjust the output to read 20mA on the multimeter. A typical cal factor for 20mA is 3150. The maximum cal factor is 4095.
8. Press the SETUP key to save the calibration values and exit the calibration routine.

Communications

Modbus

The MODBUS protocol describes an industrial communications and distributed control system (DCS) that integrates PLCs computers, terminals, and other monitoring, sensing, and control devices. MODBUS is a Master/Slave communications protocol, whereby one device, (the Master), controls all serial activity by selectively polling one or more slave devices. The protocol provides for one master device and up to 247 slave devices on a half duplex twisted pair line. Each device is assigned an address to distinguish it from all other connected devices.

The VersaPro only recognizes three Modbus RTU (Remote Terminal Unit) commands. These are: read single I registers (command 4), read a single H register (command 3), and preset a single H register (command 6)

In the RTU protocol sends data in 8-bit binary characters. Message characters are transmitted in a continuous stream. The message stream is setup based on the following structure:

Number of bits per character:	
Start bits	1
Data bits (least significant first)	8
Parity (optional)	1
	(1-bit sent for even or odd parity, no bits for no parity)
Stop bits	1
Error Checking	CRC (Cyclical Redundancy Check)

The VersaPro can be configured for any parity option with a single stop bit.

The instrument never initiate communications and is always in the receive mode unless responding to a question.

RTU Framing

Frame synchronization can be maintained in RTU transmission mode only by simulating a synchronous message. The instrument monitors the elapsed time between receipt of characters. If three and one-half character times elapse without a new character or completion of the frame, then the instrument flushes the frame and assumes that the next byte received will be an address. The follow message structure is used.

T1,T2,T3	ADDRESS	FUNCTION	DATA	CHECK	T1,T2,T3
	8-BITS	8-BITS	N X 8-BITS	16-BITS	

Address Field

The address field immediately follows the beginning of the frame and consists of 8-bits. These bits indicate the user assigned address of the slave device that is to receive the message sent by the attached master.

Each slave must be assigned a unique address and only the addressed slave will respond to a query that contains its address. When the slave sends a response, the slave address informs the master which slave is communicating.

Function Field

The Function Code field tells the addressed slave what function to perform. MODBUS function codes are specifically designed for interacting with a PLC on the MODBUS industrial communications system. Command codes were established to manipulate PLC registers and coils. As far as the VersaPro is concerned, they are all just memory locations, but the response to each command is consistent with Modbus specifications.

The high order bit in this field is set by the slave device to indicate an exception condition in the response message. If no exceptions exist, the high-order bit is maintained as zero in the response message.

Data Field

The data field contains information needed by the slave to perform the specific function or it contains data collected by the slave in response to a query. This information may be values, address references, or limits. For example, the function code tells the slave to read a holding register, and the data field is needed to indicate which register to start at and how many to read.

Error Check Field

This field allows the master and slave devices to check a message for errors in transmission. Sometimes, because of electrical noise or other interference, a message may be changed slightly while it is on its way from one device to another. The error checking assures that the slave or master does not react to messages that have changed during transmission. This increases the safety and the efficiency of the MODBUS system.

The error check field uses a CRC-16 check in the RTU mode.

MSI Message Protocol

The Marathon Sensors message protocol format is shown below.

A I C dddd D L E

(E)End of Transmission (EOT) HEX(04)

(L) LRC is the result of an XOR function performed on all previous character in the messeage.

(D) Delimter marks the end of DATA and signals the up coming EOT character.

NUL HEX(00) or Backspace HEX(08)*
*If LRC was going to be an EOT HEX(04) then D = HEX(08).

(dddd) Data character definition based on teh C (command) character.

(C) Command character from teh command set designated by the instrument prefix.

(I) Instruement Prefix: U = Versapro instrument prefix.

(A) Address of instrument.

Instrument Address Range

ASCII	or	BROADCAST MODE
0 – F (15)		? character
		or
		@ character

If an error free and valid message is received by the VersaPro, it will respond with the first character being an (ACK) HEX(06). It then echoes the message received, inserting any requested data. If an error was detected or an invalid request made, the first character sent is a (NAK) HEX(15).

The MSI (Marathon Sensors Inc.) command set supports the extensive capabilities of the MSI line of instruments. The command set consists of the characters shown in the following table.

Table 17 MSI Command Set

Update	Read	Description
E	e	Memory
P		Program Start
Q	q	Memory Update
R	r	Remote Program Access
X	x	Parameters
/	*	Block Transfer

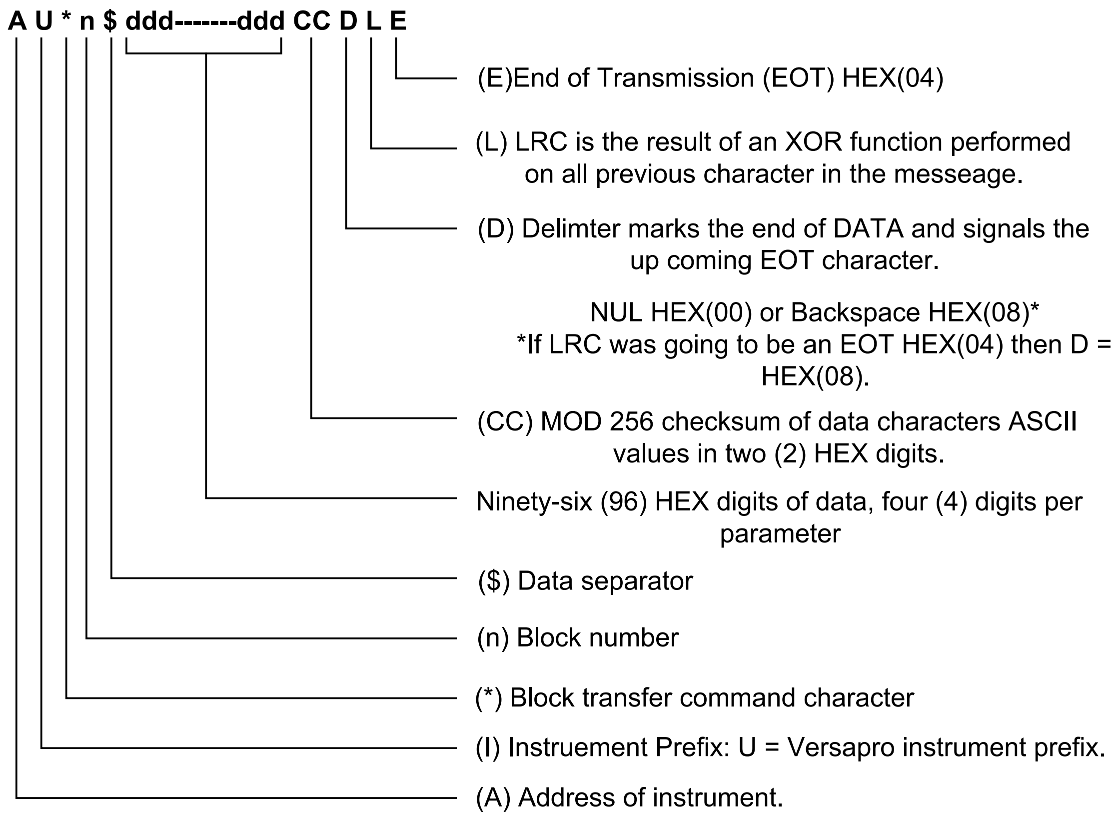
"X" Protocol
The "X" protocol allows almost unlimited access to all instrument parameters. The "X" protocol software involves the Parameter Table.

a. To WRITE a "data" value to a "parameter number" in the instrument, use the format: **AUXparameternumber$data**.

b. To READ a data value from a "parameter number" in the instrument, use the following format: **AUxparameternumber**.

Therefore, to write a value to the instrument for a specific parameter, use the uppercase X. To read a specific parameter from the instrument, use the lowercase x. The parameters supported by the instrument are listed in Appendix XX. The listing includes the parameter name, number, and a short description that includes bit and byte mapping.

Block Transfer
A block transfer is used to read the values of twenty-four (24) parameters with one command. The Block transfer is also used to read a program. The parameter table is divided into ten (10) consecutive blocks numbered 0 through 9. The reply to a Block transfer request is shown below.



Block Transfer Reply

Process Calculations

Dew Point Process Control

```
                        4238.7
Dewpoint = ----------------------------------
            9.55731 - log10(E / (Tk x 0.0215)
```

Where:
E = probe millivolts + mv offset, Tk = probe temperature in degrees Kelvin.

NOTE:
This calculation is only valid for Endothremic Rx gas in a state of equilibrium. The equation will not work for a dew point calculation on Exothermic gases.

Technical Specification

Environmental ratings

Panel sealing:	Instruments are intended to be panel mounted. The rating of panel sealing is IP64.
Operating temperature:	0 to 55°C. Ensure the enclosure provides adequate ventilation.
Relative humidity:	5 to 95%, non condensing.
Atmosphere:	The instrument is not suitable for use above 2000m or in explosive or corrosive atmospheres.

Equipment ratings

Supply voltage:	100 to 240Vac -15%, +10%, or optionally:
Supply frequency:	48 to 62Hz.
Power consumption:	15 Watts maximum.
Relay 2-pin (isolated):	Maximum: 264Vac, 2A resistive. Minimum: 12Vdc, 100mA.
Relay changeover (isolated):	Maximum: 264Vac, 2A resistive. Minimum: 6Vdc, 1mA.
Over current protection:	External over current protection devices are required that match the wiring of the installation. A minimum of 0.5mm^2 or 16awg wire is recommended. Use independent fuses for the instrument supply and each relay output. Instrument supply: 85 to 264Vac, 2A. Relay outputs: Triac outputs: 1A.
Low level I/O:	All analog input and output connections are intended for low level signals less than 24VDC.
DC output (Isolated):	0 to 20mA (650Ω max), 0 to 10V (using a 500Ω dropping resistor).
Fixed digital inputs:	Contact closure. (common to internal 5VDC source.)
DC or PV input:	As main input plus 0-1.6Vdc, Impedance, >100MΩ. (isolated.)
Transmitter supply:	30Vdc at 20mA. (isolated.)
Digital Comms:	EIA-485 half duplex. (isolated).

General

Thermocouple input:	Type B, K, R, and S accuracy after linearization +/- 1 deg F
Millivolt input:	0 to 2000 millivolts +/- 0.1 millivolt
Cold junction compensation:	0 to 60°C +/- 1 deg F
Calibration accuracy:	The greater of ±0.2% of reading, ±1 LSD or ±1°C.
Isolation:	1000V DC/AC Power input to signal inputs Power input to communications

Calculations:	Percent carbon 0 – 2.55% (no CO compensation) Dewpoint -99 – 212 °F (no hydrogen compensation) Percent oxygen. 0 – 20.9% (Small oxygen concentrations can be measured by changing the exponent setting.)

Accuracy: +/- 1% of LSD of process value.
Probe Care: Probe verification and impedance for oxygen probes.

Communications port: RS-485 Half Duplex Only
- Protocol: 10Pro, MMI block transfer, or Modbus RTU
- Baud rates: 1200, 2400, 4800, 9600, 19.2K
- Parity: Even, odd, or None

Control Mode

- Time Proportioning Single Contact Direct
- Time Proportioning Single Contact Reverse
- Time Proportioning Dual Contact Direct
- Time Proportioning Dual Contact Reverse
- Position Proportioning Direct
- Position Proportioning Reverse
- On / Off Direct
- On / Off Reverse

Alarm Type (both Alarm 1 and 2)

- High Limit Temp
- Low Limit Temp
- Process Deviation Band
- Process Deviation High
- Process Deviation Low
- Control Percent Out
- Input Fault (mV or Thermocouple)

Digital Event Input (isolated contact closure)

- Probe Burnoff
- Manual/Auto
- Local/Remote
- Alarm Acknowledgement

Electrical safety (pending approval)

Standards: EN 61010, Installation category II, pollution degree 2.
Installation category II: Voltage transients on any mains power connected to the instrument must not exceed 2.0 kV.
Pollution degree 2: Conductive pollution must be excluded from the cabinet in which the instrument is mounted.

Environmental Conditions

Operating Temperature	-20 °C to 65 °C (-4 to 176 F)
Storage Temperature	-40 °C to 85 °C (-40 to 185 F)
Operating and Storage Humidity	85% max relative humidity, noncondensing, from –20 to 65°C

Electromagnetic Compatibility (pending approval)

Immunity

Electrostatic discharge	EN 61000-4-2	Level 2: ±8 kV air Level 2: ±4 kV contact
Electromagnetic RF fields	EN 61000-4-3	Level 3: 10 V/m 80 MHz – 1000 MHz
Fast Transients	EN 61000-4-4	Level 3: ±1 kV I/O Level 3: ±2 kV power
RF conducted interference	EN 61000-4-6	Level 3: 10 V/rms 150 KHz – 80 MHz
Power Freq Magnetic Fields	EN 61000-4-8	30 A/m, x y z planes
Surge	EN 61000-4-5	±1kV L-L, ±2kV L-PE 5 / min at 0°, 90°, 270°
Voltage Variations	EN 61000-4-11	70% of operating voltage 0.5 cycles/10ms

Emissions

RF Emissions	CSIPR Class B
Conducted Emissions	CISPR Class B
Harmonic Current Emissions	EN 61000-3-2
Voltage Fluctuation	EN 61000-3-3

Note: Specifications may change without notification.

Versapro Memory Map

BLOCK 0			
HEX	DEC	PARAMETER	DESCRIPTION
00	0	Not used	
01	1	RSETPT	Remote setpoint sent to the instrument from the Host port. This number has to be scaled to the range of the displayed process value based on the decimal point and exponent settings of the instrument. Range = -999 to 9999 Default = 0.000 For example: If the process = oxygen, display decimal point = 2, and exponent = 6, as remote setpoint of 1234 would be interpreted and displayed as 12.34 ppm.
02	2	LSETPT	Process setpoint set by the operator through the Setpoint menu. This number is scaled to the range of the displayed process value based on the decimal point and exponent settings of the instrument. Range = -999 to 9999 Default = 0.000
03	3	TSETPT	Timer setpoint set via the Host port or locally. Range = 0 to 999 minutes Default = 0
04	4	PROC	This value is the calculated process value shown as an integer. The decimal point and exponent values are required to determine the actual scaled value. Range = -999 to 9999. For example: If the process = oxygen, display decimal point = 2, and exponent = 6, and PROC = 1234, then the actual value and displayed as 12.34 ppm.
05	5	TIME	This is the remaining time on the timer as it counts down from Time Setpoint. Zero indicates timer has stopped. Range = 0 to 999 minutes BITS 0 – 15 TIMER VALUE BIT 16 = Timer Disabled (0), Timer Enabled (1) BITS 17 – 23 = SPARE

			Default = 0
06	6	ALARM1	Alarm value is based on process value display decimal point and exponent. Both are required to determine the real alarm value. Range = -999 to 9999. Default = 0000
07	7	ALARM2	Alarm value is based on process value display decimal point and exponent. Both are required to determine the real alarm value. Range = -999 to 9999. Default = 0000
08	8	ALRMMD	**LOW BYTE – Alarm 1 configuration** BITS 0 – 3 0000 = OFF (DEFAULT) 0001 = DEVIATION BAND 0010 = BAND LOW 0011 = BAND HIGH 0100 = PERCENT OUT LOW 0101 = PERCENT OUT HIGH 0110 = FULL SCALE LOW 0111 = FULL SCALE HIGH 1000 = PROBE IMPEDANCE / VERIFY 1001 = SPARE 1010 = SPARE 1011 = SPARE 1100 = SPARE 1101 = SPARE 1110 = SPARE 1111 = FAULT BIT 4 ACTION CONTROL 0 = DIRECT 1 = REVERSE BIT 5 NO LATCH = 0, LATCHED = 1 BIT 6 – 7 SPARE **HIGH BYTE – Alarm 2 configuration** BITS 8 – 11 0000 = OFF (DEFAULT) 0001 = DEVIATION BAND 0010 = BAND LOW 0011 = BAND HIGH 0100 = PERCENT OUT LOW

			0101 = PERCENT OUT HIGH 0110 = FULL SCALE LOW 0111 = FULL SCALE HIGH 1000 = PROBE IMPEDANCE / VERIFY 1001 = SPARE 1010 = SPARE 1011 = SPARE 1100 = SPARE 1101 = SPARE 1110 = SPARE 1111 = FAULT BIT 12 ACTION CONTROL 0 = DIRECT 1 = REVERSE BIT 13 NO LATCH = 0 LATCHED = 1 BIT 14 – 15 SPARE
09	9	EVNT	Input Event Configuration Bits 0 – 3 0000 = None 0001 = Auto Mode Selected 0010 = Remote Setpoint Selected 0011 = Acknowledge alarms 0100 = Timer hold 0101 = Timer reset 0110 = Timer standby 0111 = Start probe test 1000 = Process hold Bits 4 – 7 not used.
0A	10	PB	Proportional Band – Based on display units Range = 1 to 9999 Default = 20
0B	11	RESET	Reset – Based on seconds Range = OFF to 9999 Default = OFF (reset value = 0)
0C	12	RATE	Rate – Based on seconds Range = OFF to 9999 Default = OFF (rate value = 0)
0D	13	CYCTIM	Cycle Time – Based on seconds Range = 0.2 to 999.9 Where 0002 is assumed to be 000.2 seconds Default = 30.0
0E	14	PF	Process Factor for Carbon or Dewpoint

			Range = 0 to 4095 Default = 150
0F	15	HIPO	Control Output High Limit Range = -100 to 100 where HIPO is always greater than LOPO. Default = 100
10	16	LOPO	Control Output Low Limit Range = -100 to 100 where LOPO is always less than HIPO. Default = 0
11	17	CONMD	Control Type setting BITS 0 – 2 = CONTROL PARAMETER 000 = SPARE 001 = Temperature 010 = Millivolt INPUT B 011 = Carbon 100 = Dewpoint 101 = Oxygen 110 = Redox 111 = Millivolt INPUT A BIT 3 = NORMAL (0) FREEZE CONTROL OUTPUT (1) BITS 4 – 6 = MODE 000 = TIME PROPORTIONING 001 = TIME PROP W/ COMPLEMENT 010 = TIME PROP, DUAL 011 = SPARE 100 = ON/OFF 101 = ON/OFF W/ COMPLEMENT 110 = ON/OFF, DUAL 111 = VALVE POSITIONING W/ FEEDBACK BIT 7 = DIRECT (0) OR REVERSE (1) ACTING BIT 8 = MANUAL (0) OR AUTO (1) BIT 9 = SETPT LOCAL (0) OR SETPT REMOTE (1) BIT 10 = MONITOR (0), CONTROLLER (1) BITS 11 = SENSOR BREAK OUTPUT 0 (0),

			OUTPUT HOLD (1) BITS 12 – 15 NOT USED
12	18	CONFIG0	Input Configuration **BITS 0-3 TC Input TYPE** 0000 = B (DEFAULT) 0001 = C 0010 = E 0011 = J 0100 = K 0101 = N 0110 = NNM 0111 = R 1000 = S 1001 = T 1010 = SPARE 1011 = SPARE 1100 = SPARE 1101 = SPARE 1110 = SPARE 1111 = SPARE BIT 4 = SPARE BIT 5 0 = NO CJ APPLIED, 1 = CJ APPLIED BIT 6 0 = °F, 1 = °C BIT 7 0 = 60HZ FILTER **BIT 8 – 11 Millivolt Input TYPE** 0000 = LINEAR (DEFAULT) All other bit combinations are spare BITS 12 – 15 are spare
13	19	CTRLOUT	Control Output Actual control output where: 1000 = 100.0% and –1000 = -100.0%
14	20	ALRMT1	ALARM 1 ON/OFF TIMES RANGE = 0 – 255 SECONDS DEFAULTS = 0 BIT 0-7 = ON TIME BIT 8-15 = OFF TIME
15	21	ALRMT2	ALARM 2 ON/OFF TIMES RANGE = 0 – 255 SECONDS DEFAULTS = 0 BIT 0-7 = ON TIME BIT 8-15 = OFF TIME
16	22	FAULT	FAULT BIT MAP BIT 0 = CPU Fault BIT 1 = Min Idle counter = 0

			BIT 2 = Keyboard failure, stuck key or a key was pressed during power up. BIT 3 = Flash Erase Failed BIT 4 = Flash Checksum Failed BIT 5 = EEPROM Checksum Failed BIT 6 = Flash/EEPROM Size Fault BIT 7 = ADC Fault BIT 8 = Temperature Input Open BIT 9 = MV Input Open BIT 10 = Range of input is low BIT 11 = Range of input is high BIT 12 = Monitor/Controller failed BITS 13= Probe Care Fault BITS 14 – 15 = SPARE
17	23	SPARE	

BLOCK 1			
HEX	DEC	PARAMETER	DESCRIPTION
18	24	COMP	COMPENSATION VALUES LOWER BYTE = CO COMP RANGE 0 – 255 DEFAULT = 20 (% CO) This value takes effect when the process value is CARBON. UPPER BYTE = HYDROGEN COMP RANGE = 0 – 255 DEFAULT = 40 (% hydrogen) This value takes effect when the process value is DEW POINT.
19	25	ASRC	ANALOG OUT SOURCES **LOW BYTE, ANALOG OUTPUT 1** BITS 0 – 3 0000 = N/A 0001 = Temperature 0010 = Input A or B 0011 = Carbon value 0100 = Dewpoint value 0101 = Oxygen value 0110 = Redox value 0111 = Output Power 1000 = Control Output 1 1001 = Control Output 2 1010 = Reference Number* 1011 = Programmable*

			*For Reference Number and Programmable, write required output value into DACV1, where DACV1 = 0 is minimum output and DACV1 = 4096 is maximum output. BITS 4 – 7 SPARE **HIGH BYTE, ANALOG OUTPUT 2** BITS 8 – 12 0000 = N/A 0001 = Temperature 0010 = Input A or B 0011 = Carbon value 0100 = Dewpoint value 0101 = Oxygen value 0110 = Redox value 0111 = Output Power 1000 = Control Output 1 1001 = Control Output 2 1010 = Reference Number* 1011 = Programmable* *For Reference Number and Programmable , write required output value into DACV2, where DACV2 = 0 is minimum output and DACV2 = 4096 is maximum output. BITS 13 – 15 SPARE Special case: If Analog Output 1 = CONTROL OUTPUT 1 and Analog Output 2 = CONTROL OUTPUT 2 and the Control Mode is dual, then Analog Output 1 is 4-20ma for 0 to +100% PO and Analog Output 2 is 4-20ma for 0 to -100% PO.
1A	26	TEMPFIL	Temperature Input Filter in seconds Range = 0 to 9999 Where 9999 represents filter setting of 999.9 seconds and 0 is no filtering applied. This is a time averaging window applied to the temperature input signal. DEFAULT = 0
1B	27	MVFIL	Millivolt Input Filter in seconds Range = 0 to 9999 Where 9999 represents filter setting of 999.9 seconds and 0 is no filtering applied. This is

			a time averaging window applied to the millivolt input signal. DEFAULT = 0
1C	28	CONFIG2	SETUP VALUES **BITS 0 - 4 OXYGEN EXPONENT** RANGE = 0 to 31, where 2 = % and 6 = ppm DEFAULT = 2 **BITS 5 - 6 DISPLAY DECIMAL PLACE** where: 0 = no decimal point in display 1 = Display XXX.X 2 = Display XX.XX 3 = Display X.XXX DEFAULT = 0 **BITS 8 – 12 REDOX METAL NUMBER** RANGE = 0 – 14 DEFAULT = 0 **BITS 13 – 15 SPARE**
1D	29	COLDJCT	COLD JUNCTION Where 1 COUNT = 1°F (°C) RANGE = -99 TO 255°F (°C)
1E	30	TEMP	MEASURED TEMPERATURE Where temperature is presented in degrees C or F, based on the C/F setting. This value is scaled in 1/8 degree increments, i.e. -2721 = -341.38. Range = max / min range of selected thermocouple.
1F	31	MV	MEASURED MILLIVOLT Where this value is scaled in 1/8 mV increments, i.e. 2721 = 341.38. Range = 0 to 2000 mV.
20	32	AOUTOF1	ANALOG OUTPUT 1 OFFSET Minimum source value that correlates to minimum Analog Output of 4 mA. The source value is based on the selection in ASRC lower byte
21	33	AOUTRN1	ANALOG OUTPUT 1 RANGE Maximum source value that correlates to maximum Analog Output of 20 mA. The source value is based on the selection in ASRC lower byte where
22	34	AOUTOF2	ANALOG OUTPUT 2 OFFSET

			Minimum source value that correlates to minimum Analog Output of 4 mA. The source value is based on the selection in ASRC upper byte
23	35	AOUTRN2	ANALOG OUTPUT 2 RANGE Maximum source value that correlates to maximum Analog Output of 20 mA. The source value is based on the selection in ASRC upper byte where
24	36	CJTRM	COLD JUNCTION TRIM RANGE = –128 TO +127 WHERE 1 COUNT = 1 DEG (C or F)
25	37	HADR	HOST ADDRESS BITS 0-7 RANGE = 0 – 255
26	38	SIOSET	SIO SETUP BITS 0 – 1 00 = Even Parity, 7 bits, 1 Stop bit 01 = No Parity, 8 bits, 1 Stop bit 10 = Odd Parity, 7 bits, 1 Stop bit BIT 2 0 = Non delay applied to response 1 = 10ms delay applied to response BITS 3 SPARE BITS 4 – 6 BAUD SELECT 000 = 76.8K 001 = 38.4K 010 = 19.2K (DEFAULT) 011 = 9600 100 = 4800 101 = 2400 110 = 1200 111 = 600 BIT 7 HOST FORMAT 0 = MSI (PROP) 1 = MODBUS (DEFAULT)
27	39	SPARE	
28	40	SPARE	
29	41	DACV1	ANALOG OUTPUT 1 0 to 4095 is 4 to 20 mA In dual mode 4mA =

			-100, 12mA = 0, 20mA = +100
2A	42	DACV2	ANALOG OUTPUT 2 0 to 4095 is 4 to 20 ma In dual mode 4mA = -100, 12mA = 0, 20mA = +100
2B	43	LOCK	BITS 0 – 2 LOCK LEVEL; 0-3 0 is full lock, 3 is wide open
2C	44	SPARE	
2D	45	SPARE	
2E	46	SPARE	
2F	47	SPARE	

BLOCK 2			
HEX	DEC	PARAMETER	DESCRIPTION
30	48	PIMP	LAST PROBE IMPEDANCE VALUE (KOHMS X 10) i.e. 25 = 2.5 KOHMS
31	49	PRTM	LAST PROBE RECOVERY TIME (SECONDS) RANGE = 0 to 255 Burnoff function available for Redox, Carbon, and Dewpoint.
32	50	PBOMV	LAST PROBE BURN OFF MILLIVOLTS RANGE = -99 TO 2048 i.e. 1018 = 1018 mV Burnoff function available for Redox, Carbon, and Dewpoint.
33	51	PBOTC	LAST PROBE BURNOFF TEMPERATURE RANGE = 0 to 3000 i.e. 1715 = 1715° (F or C based on CONFIG0 BIT 6) Burnoff function available for Redox, Carbon, and Dewpoint.
34	52	PBORT	LAST PROBE BURNOFF RECOVERY TIME RANGE = 0 – 255 SECONDS Burnoff function available for Redox, Carbon, and Dewpoint.
35	53	PREMT	REMAINING TIME TO NEXT PROBE TEST RANGE = 0 – 999 Where 999 = 99.9 hours
36	54	PTINT	PROBE TEST INTERVAL SETTING (HRS) Operator input for interval setting RANGE = 0 – 999 Where 999 = 99.9 hours

			DEFAULT = 0 (Disable Probe test)
37	55	PTRECT	PROBE TEST RECOVERY TIME SETTING (SECONDS) RANGE = 0 to 999 DEFAULT = 30
38	56	BOTM	BURN OFF TIME SETTING (SECONDS) RANGE = 0 to 999 DEFAULT = 30 Burnoff function available for Redox, Carbon, and Dewpoint.
39	57	BOREC	BURN OFF RECOVERY TIME SETTING (SECONDS) RANGE = 0 to 999 DEFAULT = 30 Burnoff function available for Redox, Carbon, and Dewpoint.
3A	58	VSTD	VERIFY TEST GAS STANDARD This is the test standard value used to verify the probe. RANGE = 0 to 999 Where the value 999 = 99.9% oxygen DEFAULT = 30 (3.0%) Verify function available for Oxygen.
3B	59	VTOL	VERIFY TEST TOLERANCE SETTING This setting establishes the limit as VSTD ± VTOL when comparing to the measured value VGAS Range = 0 to 999 Where 0005 = 00.5% DEFAULT = 0005 Verify function available for Oxygen.
3C	60	TAVE	VERIFICATION SAMPLE AVERAGING SETTING (SECONDS) RANGE = 0 to 999 DEFAULT = 2 Verify function available for Oxygen.
3D	61	TDEL1	VERIFY DELAY 1 SETTING (SECONDS) RANGE = 0 to 999 DEFAULT = 30 Verify function available for Oxygen.
3E	62	TDEL2	VERIFY DELAY 2 SETTING (SECONDS) RANGE = 0 to 999 DEFAULT = 30 Verify function available for Oxygen.
3F	63	VGAS	MEASURED VERIFY GAS VALUE

			Value / 8 = Actual measured % oxygen Verify function available for Oxygen.
40	64	TMIN	MINIMUM TEMPERATURE FOR PROBE CARE TEST This setting establishes the lowest process temperature allowed for a probe test to proceed. RANGE = 1100°F to 2000°F (590°C to 1090°C) DEFAULT = 1400°F (760°C)
41	65	PMC	PROBE MAINTENANCE CONTROL WORD BITS 0 – 1 00 = START FULL MAINTENANCE 01 = START BURNOFF (VERIFY) ONLY 10 = START PROBE IMP ONLY 11 = NONE BITS 2 – 6 UNDEFINED BIT 7 = NORMAL (0), CANCEL (1) BITS 8 – 15 = PROBE MAINTENANCE SEQUENCE NUMBER
42	66	PLIM	PROBE IMPEDANCE LIMIT, 0 – 255 KOHMS, DEFAULT VALUE = 20K
43	67	SPARE	
44	68	SPARE	
45	69	SPARE	
46	70	SPARE	
47	71	SPARE	

BLOCK 3			
HEX	DEC	PARAMETER	DESCRIPTION
48	72	T/C ZERO	OFFSET CALIBRATION FOR T/C
49	73	T/C SPAN	SPAN CALIBRATION FOR T/C
4A	74	MV OFFSET	OFFSET CALIBRATION FOR MV
4B	75	MV SPAN	SPAN CALIBRATION FOR MV
4C	76	DAC_OFFSET_1	DAC 1 OFFSET CALIBRATION
4D	77	DAC_SPAN_1	DAC 1 SPAN CALIBRATION
4E	78	DAC_OFFSET_2	DAC2 OFFSET CALIBRATION
4F	79	DAC_SPAN_2	DAC2 SPAN CALIBRATION
50	80	AZERO	LINEAR OFFSET, Y INTERCEPT LINEAR SCALING CALCULATION FOR INPUT A
51	81	ANUM	LINEAR SPAN VALUE AS AN INTEGER FOR INPUT A
52	82	ADENOM	DECIMAL PT DIVIDER OF ANUM FOR INPUT A

53	83	BZERO	LINEAR OFFSET, Y INTERCEPT LINEAR SCALING CALCULATION FOR INPUT B
54	84	BNUM	LINEAR SPAN VALUE AS AN INTEGER FOR INPUT B
55	85	BDENOM	DECIMAL PT DIVIDER OF BNUM FOR INPUT B
56	86	PITC	PID INTEGRATOR TIME CONSTANT
57	87	PDTC	PID DERIVATIVE TIME CONSTANT
58	88	PPTC	PID PROPORTION TIME CONSTANT
59	89	PGIN	PID GAIN INTEGRATION NUMERATOR
5A	90	PGID	PID GAIN INTEGRATION DENOMINATOR
5B	91	PGDN	PID GAIN DERIVATIVE NUMERATOR
5C	92	PGDD	PID GAIN DERIVATIVE DENOMINATOR
5D	93	PGPN	PID GAIN PROPORTIONAL NUMERATOR
5E	94	PGPD	PID GAIN PROPORTIONAL DENOMINATOR
5F	95	SPARE	