

INSTRUCTION MANUAL

MODEL 2041 DIGITAL FLUX CONTROL/MONITOR

MODEL 136 PROCESS MONITOR



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1. INTRODUCTION

1.1 Description

The Model 2041 Digital Control/Monitor consists of five pieces: the Model 136 Process Monitor, the Model 125 Control, the Model 120-2 Power Module, and a level control and control pump assembly. The Control unit contains a hydrometer sensitive to flux specific gravity. Electronics in the control read hydrometer position, encode the information and transmit it to the Monitor. The Power Module has system low voltage power supplies and the flux and blend pump control power relays. The Model 136 Process Monitor:

- * makes control decisions to maintain flux within about ± 0.1 degree Baume or ± 0.001 g/ml of the desired control point
- * sets off visual and audible alarms if the flux density deviates more than the user set tolerance from the set control point
- * displays in either Baume or specific gravity units
- * displays the measured deviation from the set control point
- * displays actual solution density
- * displays an LCD strip chart of the last 8 deviation data points
- * displays date and time
- * stores data on the most recent 100,000 process events in non-volatile flash memory
- * can instantly replay the archived process data on the Monitor's LCD display
- * can transfer the stored data to a PC thru a standard serial port connection.

Plug-in cables about 12 feet long are provided to connect the Monitor to the Control, Monitor to Power Module, and level control assembly to Power Module.

1.2 Principle of Operation

The control pump pumps flux into the Control. The lower level sensor in the flux tank turns on the flux supply pump to keep some flux in the tank. The specific gravity sensor controls the blend pump which adds replenisher solution to keep the density and the viscosity of the flux constant. The upper level sensor in the tank turns off both flux and blend supply pumps if the flux level gets too high.

The Control consists of two compartments, wet and dry. The wet compartment contains a hydrometer which responds to flux density. Hydrometer motion is transmitted by a pivoted beam thru an isolating elastomeric diaphragm into the dry compartment. Optical sensors in the dry side detect pivot beam position and thus hydrometer position, frictionlessly. The optical position sensor is an optical encoder which passes between light emitting diode-phototransistor pairs to cut the infrared optical beams passing between them.

During operation the flux continuously flows into the bottom of the wet inner chamber, over the dam and out the wet chamber drain. The encoder can measure deviations as much as ± 1.9 degrees Baume or ± 0.019 g/ml from the control point. The encoder hydrometer deviation information is sent to the Monitor.

The Monitor displays the resulting Baume or specific gravity deviation value for the flux. If the deviation exceeds 1.9 degrees Baume or .019 g/ml the display numbers go blank. If the power drops out for a short time the encoder will lose sync and the density display numbers will blank out. When the float either goes to the bottom of the wet chamber or passes upward through the center +/- control point sync will be re-established and the numerical display will resume. When the flux density stays above the control point for a few seconds the replenishment pump is turned on and continues to run until the flux density returns to the control point. The delay in pump turn on minimizes relay and pump wear due to excessively rapid cycling. The PUMP light on Monitor and the BLEND light on the Power Module inform the operator when power is delivered to the blend solution pump terminal. The FLUX light on the Power Module indicates that the lower float is calling for the flux supply pump to turn on. These control functions are independent of the displayed numbers and will operate correctly even if the numerical display is blanked.

The Monitor alarm has an adjustable tolerance which in Baume can be set from 0.1 to 1.9 in 0.1 increments or g/ml tolerance adjustable from 0.001 to 0.019 in .001 steps. The factory setting is 0.3 (or .003). The Monitor alarm sounds and the AUTO LED flashes if the magnitude of the displayed value exceeds the set tolerance. The plus or minus sign on the numerical display will tell whether the deviation is above or below the control point. If the blend replenishment pump has turned on to correct the out of tolerance situation the alarm will wait 5 minutes before it sounds to give the system a chance to correct automatically. The alarm also sounds if the replenish pump runs continuously more than 30 minutes. The operator can silence the alarm for 5 minutes while the situation is worked on. At power-on or after a Monitor reset the alarm is automatically silenced for 10 minutes or until the the plus sign comes on to give the 1.5 liter wet chamber time to fill up and give reliable readings.

1.3 Performance Capability

The Model 2041 Flux Control/Monitor will hold the density of the flux in its measuring chamber within +/-0.1 degrees Baume or +/-0.001 g/ml of the set control point if the replenishment feed pump and flux tank mixing are adequate to keep up with the work load.

2. OPERATING INSTRUCTIONS

2.1 Displays

2.1.1 LED Indicators

The PUMP light on the Monitor and the BLEND light on the Power Module turn on whenever the blend replenisher pump is energized. The AUTO lights on the Power Module and Monitor indicate that the steady state flux control system is powered. The FLUX light on the Power Module indicates that the lower level sensor is calling for the flux pump relay to turn on.

2.1.2 LCD Display: Normal Operation

The 2 line 16 character per line backlit LCD display shows several different pieces of process information.

The top line of the LCD shows solution density. In the upper left corner is the solution density in user selected units of Baume or g/ml. These numbers are blanked if the encoder in the Control is unable to provide valid data because it has just been turned on and is not yet initialized or it is beyond the +/-1.9 (or +/-0.019) it can report. In the upper right corner is the

deviation DEV (or DV) of the solution density from the process set point. It too is blanked if the encoder is unable to give valid data. The sign of the deviation is however always displayed to indicate whether the solution density is above or below the set point. Proper operation of blend and flux feed pumps is unaffected by display blanking.

The bottom line of the LCD display shows information related to process data logging in flash memory process data archive. The lower left corner shows the current date and time alternating. These are the date and time values which are recorded with each process data point archived. The stored date and time is used to retrieve the desired data during instant replay. The lower right half of the LCD shows the strip chart of the last 8 deviation values recorded. The LCD "strip chart" feeds from the lower right edge of the display and flows leftward just as paper would. The oldest point displayed is on the left and the newest on the extreme right. There are 7 vertical positions on the chart. The center indicates zero deviation from set point. The 3 positions above and below the center represent deviations of 0.1, 0.2, 0.3 (.001, .002, .003) in the Fine mode, 0.2, 0.4, 0.6 (.002, .004, .004) in the Course mode, or 0.1, .03, 0.9 (.001, .003, .009) in the Logarithmic mode. The user selects the mode during setup as described in Section 4.3 below. In all display modes deviations outside the display range are indicated as up or down arrows. Either an F or an H will display between the date/time and the strip chart. An F indicates that the lower level sensor is calling for the FLUX feed pump to be on; an H indicates that the upper level sensor has detected HIGH liquid level in the flux tank and shut down flux and replenisher feed pumps to prevent overflow.

2.1.3 LCD Display: Instant Replay

In the instant replay mode the LCD display shows archived data retrieved from the flash memory. The top line shows solution density and deviation from control set point recorded at some previous time. The bottom line shows the date and time at which the data displayed was recorded. The 2 positions at the right end of the bottom line report P if pump turn on is recorded and A if alarm operation is recorded. Also on the bottom line is an F if the flux pump level sensor was calling for flux or an H if the high limit level sensor was activated.

2.2 Alarm

The alarm sounds immediately if the tolerance limit is exceeded or replenisher pump(s) run continuously for more than 30 minutes. If the solution is out of tolerance but the replenisher pump is running, the control waits five minutes to give the system a chance to correct itself automatically before sounding the alarm. The operator can silence the alarm for a five minute interval by pressing the END button on the Monitor. The alarm is automatically silenced at power up for 2 minutes or until the plus sign comes on to allow time for the solution chamber to fill at start up.

2.3 Buttons

See Section 5.4 for a discussion of the Instant Replay buttons. See Section 4.3 for instructions on the setup buttons. The END button ends the alarm for 5 minutes, it ends the replay mode, it ends the setup mode, and it causes a Monitor software reset if it is pressed when one of the above conditions is not occurring.

3. INSTALLATION

3.0 Locations

The Control and Power Module are connected to the Monitor unit by cables about 12 feet long. Extension cables are available as an option. The Monitor must be where the operator can see, hear and touch it. If desired the Monitor can be mounted on top of the Control. The Power Module must be accessible enough to allow fuse replacement. The Control must be securely mounted to a vertical surface with the drain in the bottom above the flux tank to allow proper drainage. The top of the Control must be level.

3.1 Control

3.1.1 Mounting

Mount the Control securely to a vertical surface using corrosion resistant bolts thru the mounting flanges on the sides of the unit. Four quarter inch flange holes are provided. Shim between the mounting flanges and "vertical" surface as required to give a secure mount and make the top lids of the Control level. Remove the covers and carefully take the packaging material out from around the dry chamber pivots and from the float in the inner wet chamber. Replace the left cover to prevent flux droplets from settling on the circuit board in the dry chamber.

3.1.2 Plumbing Connections

Use 3/8 inch OD plastic tubing to connect between the suction tube on the level control assembly and the inlet of the control pump. Use 3/8 inch ID flexible plastic tubing and hose clamps to connect the outlet of the control pump to the Control inlet at the bottom of the wet chamber. Make sure connections are secure and tube routing will not be subject to damage or cause hazard. Use three-quarter inch ID plastic drain hose to connect the drain on the bottom of the Control to the flux tank. Make sure the drain hose routing always slopes away from the Control and does not cause a hazard. Clamp and support the drain hose securely.

Hang the level control assembly down into flux in the flux tank. Power the control pump with 120 volts AC from a convenient wall outlet and observe the time required to fill the inner chamber to the point where solution flows over the dam. If it is less than 20 seconds reduce the flow. If the fill time is over 10 minutes then increase the flow. The flow of the bellows type control pump supplied is easily adjusted by changing the stroke length. See the data packed with the pump. Carefully observe all plumbing connections and correct any leaks found.

With the 2041-IK installation kit, mount FLUX and BLEND pumps near flux and replenisher sources. Connect them to the sources with short lengths of 3/8" ID flexible tubing. Longer runs of 3/8" ID tubing up to 50 feet long can be used between pumps and flux tank. Both flux and replenisher pump outlets can be combined with a T into a single tube run between pumps and flux tank if desired. The poppet valves in the pumps will prevent the output of one pump from back feeding thru the other.

3.1.3 Optical Encoder Adjustment

Replace the right cover, remove the left cover and power the control pump. With flux in the solution chamber press down on the beam to make the encoder pass thru the slot in the circuit board. Check to make sure the encoder is vertical, approximately centered in the slot, and swings freely without rubbing on anything. If the encoder is not vertical, loosen the encoder set screw which fastens the encoder bracket to the beam, twist the encoder to vertical, and tighten the set screw. Do NOT loosen the bottom screw which clamps the encoder to the encoder bracket. If the bottom screw is loosened the encoder alignment procedure in Section 4.2 must be performed. The position of the encoder in the circuit board slot can be adjusted if necessary by loosening the screws which hold the circuit board. Position the board and retighten the screws. Turn the control pump off.

3.2 Power Module

3.2.1 Mounting

Loosen the four cover screws and remove the Power Module cover. There is a mounting hole at each corner of the Power Module. Use screws thru these mounting holes to secure the Power Module to any suitable vertical or horizontal surface.

3.2.2 Electrical Connections

Look at the voltage written on the main circuit board in the Power Module to verify that it matches the line voltage (either 120 or 230 volts, 50 or 60 Hz) which you intend to use.

Turn off the power source you intend to use. If your system came with the optional 2041-IK installation kit then electrical power connections are to the lead and receptacle pigtailed protruding from the sealed strain relief at the bottom of the Power Module. Without 2041-IK a 7/8 inch diameter hole is provided for 1/2 inch conduit or a standard cable clamp. The power AC connections are to the 8 position terminal strip near the 7/8 inch hole.

- **With** 2041-IK plug the BLEND REPLENISHR pump into the WHITE color coded pigtail. Wrap the excess pump power cord on the cord storage frame provided.
Without 2041-IK connect the P, N, and G terminals to the BLEND REPLENISHER pump's Power Neutral and Ground connections respectively.
- **With** 2041-IK plug the FLUX pump into the BLUE coded pigtail and use the cord storage frame.
Without 2041-IK connect the flux pump's Power, Neutral, and Ground lines to AUX, N, and G terminals.
- **With** 2041-IK connect the Power module wire with the stripped ends to the machine fluxer pump terminal strip. The green wire is GROUND, the WHITE wire is NEUTRAL, and the BLACK wire is LINE power.
Without 2041-IK connect the power source Neutral to N, non-current carrying Ground to a G terminal, and terminal L to the AC power source line in the machine which turns on and off with the machine's main flux pump.

- **With** 2041-IK plug the CONTROL pump into the YELLOW coded pigtail.
Without 2041-IK connect the control pump to a 120 volt AC source which turns on when the main flux pump is on. If sealed conduit is not used for AC leads then the hole they come thru into the Power Module should be sealed with silicone RTV to keep out moisture and corrosive fumes.
- Plug the 4 conductor cable from the level control assembly into the Power Module.

Turn on the AC power source and main flux pump and with a suitable test instrument verify that the L, N, and G connections are correct.

- With the Monitor cable disconnected from the Power Module the blend replenisher pump should run.
- Raise the level control assembly out of the flux tank just enough to make the lower level sensor drop and the flux pump should come on.
- Manually lift the upper sensor and both flux and blend pumps should stop.
- Turn off the power and replace the Power Module cover correctly oriented to the indicator lights and tighten the cover screws.

3.3 Process Monitor

Set the Monitor where it faces the operator and can be reached to actuate the buttons. If desired the Monitor can be positioned on top to the Control unit and fastened in place using the mounting blocks provided on the Control lid. Notice that the Monitor can be faced front, back, left, or right for the operator's convenience. Use the two #8x3/4 self tapping screws provided to fasten the Monitor in the chosen orientation to the lid to prevent it being knocked off and broken. The screws will bottom in the block holes before they are tight against the Monitor sides; this is as it should be. The looseness in the mounting screws lets the Monitor and Control expand and contract at different rates without overstressing and cracking the Monitor case. Loop any excess length of the cable around the cable windes on the bottom of the Control and wire tie them to the holes provided. Two wire ties are conveniently taped to the bottom of the Control for this purpose. Plug the Monitor cable with the circular plastic connector into the Power Module. Plug the cable from the Control into the Process Monitor.

3.4 Installation Checkout

Turn on the power. The AUTO light will come on. The LCD display will initially show a version identification screen and then the time and date stored in the battery backed clock. The density and deviation displays will be blank until the float rises off the floor of the wet chamber. When the float has risen enough to generate valid readings the deviation will start at -1.9 degrees Baume (or -0.019 g/ml) and smoothly move up toward 0.0. If the starting flux density is above the control point the deviation will go positive and the blend replenisher pump will run until the Controller is satisfied. If the starting density is below the control point then some work will have to be fed thru the machine or the control point will have to be adjusted using the method in Section 4.1 to verify the blend replenisher pump's cycling on and off.

Replace all covers that are off and tighten cover screws.

4. SERVICE PROCEDURES

4.1 Control Point Adjustment

When the controller turns off the blend replenisher pump the flux density in the flux tank can be measured with an accurate, expanded scale hydrometer. The hydrometer should read near 10 degrees Baume with 0.1 degree resolution or cover a specific gravity range around 1.080 with .001 g/ml resolution. The density thus measured is the controller's control point.

Remove the left (dry) compartment cover of the Control. The PVC weight between the optical encoder and the pivot assembly is used to adjust the set point. Moving the weight one inch toward the optical encoder lowers the set point about 3 degrees Baume or 0.03 g/ml). To move the weight loosen its set screw, slide the weight to the desired place, and tighten the screw. An auxiliary PVC weight has been provided which can be added to either the dry or wet side of the beam to increase the adjustment range.

A set of five stainless steel weights has been included to make small control point adjustments easier. Hanging these weights on the screw protruding horizontally from the optical encoder mounting bracket will reduce the operating control point density. The weights can be combined to reduce the control point from .001 to .031 g/ml in .001 steps. For example, lowering the control point .019 g/ml would use the .016, .002, and .001 g/ml weights together on the hanger screw. As shipped the controller is set for about 1.080 g/ml and by adding weights any value down to 1.049 can be obtained without moving the large weight on the horizontal beam.

Replace any covers that have been removed.

Turn on the Control/Monitor. If the set point has been lowered, allow the blend replenisher pump to run to return the deviation to 0.0. If the set point has been raised, feed some work to raise the solution solution density and raise the displayed deviation to 0.0.

Enter the Model 136 Monitor's SETUP MODE by simultaneously pressing the UP and DOWN and CURSOR buttons. Press the DOWN button once to go to the next item, the CURSOR button once, and use the UP/DOWN buttons to select whether the hydrometer available is in Baume or specific gravity (SG) units. Note that the Monitor interprets long button presses as multiple presses and will move the cursor or a value more than one step. If you overshoot the desired value just continue with short button presses until you get back to what you want.

After the units are selected, use the CURSOR button to return the cursor to the N position for next item and press the DOWN button to go to the next item which is display value setup. With the controller keeping the solution at the set point use a precision hydrometer to measure the solution density in the sump. Use the CURSOR, UP, and DOWN buttons to put the measured hydrometer value into the LCD display. Press the END button to end the setup process. The display should now show the actual solution density and it's deviation from the set point. The previously read hydrometer value should check out with the displayed density when corrected for any change in displayed deviation.

If the desired display units are different from the available precision hydrometer units used for the setup procedure then enter setup mode again, press the DOWN button once, the CURSOR button once, and use the UP/DOWN buttons to change the displayed units. Press END to end setup and the Monitor will automatically do the conversion calculation and display to the desired Baume or g/ml units.

4.2 Encoder Alignment Procedure

There are two set screws which determine the position of the encoder. The top screw controls position and twist upon the beam. The bottom screw controls tilt for proper counting. Loosen the top set screw and adjust the encoder mounting bracket to make the encoder card vertical as it swings through the slot in circuit board 124-1. Make sure the encoder does not rub against the edges of the slot. Move the bracket until the outside row of stripes (narrowest stripes) runs between the outside sensor pair (left end). Tighten the set screw but don't overtighten.

With the unit powered swing the beam and observe the Baume or specific gravity deviation numbers displayed. If it counts properly in sequence up and down, no further adjustment is needed. If there are missing or out of sequence numbers displayed as the beam is moved then the tilt of the encoder needs adjusting with the following procedure:

- 1) With the float at the bottom of its travel look directly down along the optical card's edge checking to see that the card is centered through the slot in the 124-1 board. The set screw on top of the card mounting bracket allows the card to be moved along the beam or twisted about it. Center the card in the slot making sure it is vertical. The card should not wander front to back in the slot as the beam is moved up and down.

- 2) The front to back position of the slot can be adjusted by loosening the two 124-1 circuit board mounting screws along the back edge of the board. The board can be repositioned to center the optical card in the slot front to back. Once the card is centered with the float at its lowest position, tighten the board mounting screws.

- 3) Gently raise and lower the float to make sure the card swings vertically and does not drag against the circuit board.

- 4) To adjust the tilt on the optical card toward or away from the pivots, loosen the clamping screw at the bottom edge of the card. Raise the float and tilt the card until the edge of the left most dark stripe aligns with the silver arrow on the circuit board. For proper alignment this arrow should continuously point to the strip's edge as it passes by when the float is lowered.

5) Power up the unit and raise and lower the float. The displayed value should increase smoothly from -1.9 to +1.9 (or -0.019 to +0.019) with no missing numbers as the float is raised. Look for missing numbers and reverse counting in which the displayed number changes the wrong direction as the float is moved. If the display does not count properly, the card tilt needs to be adjusted slightly. If there are missing counts try tilting the card slightly to the right. If the count seems sluggish and the display fails to count as far as it should before blanking, try tilting the card slightly to the left.

Tilting slightly too far to the left makes the - count range bad; tilting slightly too far to the right makes the + count range bad.

4.3 Setup Mode

The setup mode is provided to give the user a convenient way to enter the desired operating parameters to custom tailor the Model 136 Process Monitor to a particular application. The setup mode is entered by simultaneously pressing the UP, DOWN, and CURSOR buttons and then releasing the CURSOR button. The top line of the LCD display then scrolls the message:

"Setup menu--Select and adjust item to be setup with UP, DOWN, and CURSOR buttons--press DOWN button to go to the next item--press END button to exit setup....."

At this point the cursor is at the capital N on the bottom line and pressing DOWN moves setup to the next item which is display units. The top line now scrolls:

"Choose g/ml or Baume display units....."

while the bottom line shows:

"N SG g/ml"

Pressing the CURSOR button once moves the cursor to SG at which point the UP and DOWN buttons can be used to toggle between specific gravity g/ml and Baume degrees Baume display units. Pressing CURSOR again returns the cursor to the N and a press on DOWN will move setup to the next item which is to set the actual sump solution density into the Monitor's parameter memory. The top line now scrolls:

"Measure sump with precision hydrometer and set display to present hydrometer reading -- Machine must be ON and controller controlling in the AUTO mode....."

The bottom line now shows the present density setting in the chosen display units and an N to go to the next item. Pressing the CURSOR button moves the cursor to the first digit of the displayed density which can then be adjusted to the hydrometer reading with the UP and DOWN buttons. The process is repeated two more times to set the remaining two density digits. Another press on the CURSOR button returns the cursor to the N ready to transition to the next item with another DOWN button press. The top line now shows:

"N Set clock:"

The bottom line displays:

"mm-dd-yy hh:mm A/P"

and pressing the CURSOR button once moves the cursor into the date and time field to allow the UP and DOWN buttons to adjust to the correct values including the A or P indicating AM or PM. Returning the cursor to N and pressing DOWN takes the setup mode to alarm tolerance setting. The top line displayed is:

"Set alarm tolerance....."

The bottom line display is an N followed by the current alarm tolerance setting. The alarm tolerance is the deviation which must be exceeded to set off the alarm. Since a well functioning system can maintain ± 0.1 degrees Baume (± 0.001 g/ml) a good tolerance setting is 0.3 (0.003 g/ml) to give plenty of process fault warning without generating false alarms. If the system cannot hold the solution within ± 0.1 (± 0.001) then the tolerance can be increased to prevent false alarms. If the process needs tighter control than ± 0.3 (± 0.003) the tolerance can be reduced. The CURSOR button can be used to go to the numerical value displayed and the UP and DOWN buttons will allow adjustment from 0.1 to 1.9 degrees Baume or 0.001 to 0.019 g/ml.

Moving the cursor to N and pressing DOWN takes the system to strip chart mode setting. The top display line is then scrolls:

"Select strip chart display mode----fine, coarse, or log----display shows last digit of deviation....."

The bottom line displays B followed by the current chart mode setting. Since this is the last item in the setup mode, the B position can be used with the UP button to go back to a previous item if desired. The chart display uses the 7 available horizontal bars at each character location in the 8 characters at the end of the bottom display row. The center bar represents 0 deviation in all chart modes. The 3 bars above and the 3 below the center represent progressively larger deviation values depending on the chart mode setting chosen. Arrow heads pointing up or down indicate over range or under range respectively.

The fine mode displays 0,+1,+2,+3 with over +3 indicating over/under range.

The coarse mode displays 0,+2,+4,+6 with over +6 indicating over/under range.

The log mode displays 0,+1,+3,+9 with over +9 indicating over/under range.

Pressing END will always end setup, store the values and return to the previous operating mode. The date and time are stored in a lithium battery backed clock whenever the clock set screen is exited. The battery has an expected life of about 10 years. Should the unit lose date and time information upon normal power down the battery should be checked. It's voltage should be over 2.7 volts DC when the power is off to preserve clock data. If the battery has discharged excessively replace it with a lithium battery such as Panasonic number BR2330-1VC or equivalent. The other setup parameters are stored in microprocessor EEPROM. The EEPROM storage does not require any power source to retain parameter values and is thus said to be non-volatile.

4.4 Routine Maintenance

The unit requires no routine maintenance.

4.5 Trouble Shooting

4.5.1 No Power

If none of the indicator lights light and the pumps don't run then check the 5 amp slow blow fuse, the power source to the Power Module and the wiring connections. If the fuse is blown it must be replaced with a fuse no larger than a 5 amp slow blow.

4.5.2 Mechanical Operation

The beam should pivot freely when the hydrometer is floating in the flux filled solution chamber. If you raise or lower the beam slightly to decrease or increase the displayed Baume deviation a few tenths, the reading should return to within 0.1 degree (0.001 g/ml) of the initial displayed value when you release the beam. If the beam does not move freely check the adjustment of the optical encoder to make sure it is not rubbing on something.

4.5.3 Electronic Parts

There are five circuit boards in the system identified by numbers 120-1, 120-2, and 120-3 in the Power Module; 124-1 in the Control unit; and 136-1 in the Monitor.

4.5.3.1 Power Module Boards

Board 120-1 is the large mother board in the bottom of the Power Module box. It has the transformer, surge suppressers, and interconnections for boards 120-2 and 120-3-2. Board 120-2 has the LED's and the + and - 12 VDC power supplies. With the system powered there should be 10 VAC on the right ends of the two diodes just below the red LED. Be careful making measurements on any of the Power Module boards since they all have full power line voltage at some points on them.

Board 120-2 is ok if with Control and Monitor connected:

1. There is + 12 to + 14 VDC on the yellow lead into the AMP connector on the Power Module,
2. There is - 12 to -14 VDC on the white/red lead,
3. The green LED lights in the AUTO mode,
4. The red LED lights whenever the pump is powered,
5. The white/blue lead is less than 0.5 VDC when the AUTO light is on and over 2 VDC when the AUTO light is off and the PUMP light is on, and
6. The gray lead is less than 0.5 VDC when the PUMP light is on and over 2 VDC when the PUMP light is off and AUTO light is on.

Board 120-3-2 has the power relay to switch line power to the blend replenisher and flux pumps. The replenisher control relay is ok if the blend replenisher pump is powered when the orange lead at the AMP connector is over 2 VDC and the pumps are off when the orange lead is under 1 VDC. There should be a 2 to 3 second delay between the time the voltage on the orange lead starts to rise and the relay switches. A quick replenisher relay test when the pump is off is to unplug the Power Module to Monitor cable at the AMP connector; the relay should pull in and the PUMP light on the Power Module come on after a 2 to 3 second delay.

Board 120-3-2 also has the flux feed pump control relay. At the 4 conductor AMP connector inside the Power Module are yellow, brown, violet, and green wires. The yellow wire has +12 VDC. The brown wire has +12 VDC unless the upper level sensor is floating high. The green wire is ground. The violet wire is 0 VDC when the flux feed pump is on and +12 VDC when the lower level control float is high to turn off the flux feed pump.

4.5.3.2 Control Circuit

The signals on the Control Circuit cable can be measured on the Monitor circuit board or at the Control by scraping thru the protective coating. The signals on each wire are as follows:

BLACK	+12 volts power from the Power Module passing thru the Monitor
GREEN	ground from the Power Module thru the Monitor
BROWN	K signal low (<0.5 volts) indicates that the encoder is beyond the end of valid counting range and the display should be blanked; if high (>2.0 volts) the display should show a number
BLUE	LOW adds 0.1 to displayed deviation Baume number or .001 in g/ml
ORANGE	LOW adds 0.2 to displayed deviation Baume number or .002 in g/ml
YELLOW	LOW adds 0.4 to displayed deviation Baume number or .004 in g/ml
RED	LOW adds 0.8 to displayed deviation Baume number or .008 in g/ml
VIOLET	LOW adds 1.0 to displayed deviation Baume number or .010 in g/ml
WHITE	Pump Control and Sign: if >1.4 volts the + sign is displayed and the pump is on; if <0.5 the - sign is displayed and the pump is off

For example, if BROWN is high, WHITE is low, BLUE ORANGE and VIOLET are low, and YELLOW and RED are high; the display should show $-(0.1+0.2+1.0) = -1.3$ Baume or -0.013 g/ml at the deviation position on the LCD display.

The signals on the lines can be measured with a DC voltmeter to check for correct Control Circuit performance after the optical encoder is aligned with the procedure in Section 4.2.

4.5.3.3 Monitor

If the Power Module and Control are supplying proper signals to the Monitor and it is not functioning correctly, replace the unit or return it to Optrol for repair. There are no user replaceable circuit boards inside the Monitor case.

4.5.4 Level Sensors

The lower level sensor is operating correctly if the flux feed pump turns on when the sensor assembly is lifted out of solution and stops when the lower level sensor is below solution level. The upper high limit sensor is operating properly if the flux and replenisher pumps will run when the float is down but will not run if the upper float is raised. High solution can be simulated by raising the float with a finger in the access hole provided.

5. PROCESS MANAGEMENT

The Model 136 Process Monitor has several process management aids to prevent scrap and enable process improvement. The indicators on the Monitor and the alarm provide a direct warning of current process problems. The strip chart display shows recent deviation trends which occur over such a long time that operators may not be aware of them. The long term process data recorded in flash memory is a secure record of what happened in the past few months. It should be very useful in investigations into the process history of a board lot which has unusual failures at final inspection. The flash memory will remember things the operator has long forgotten or perhaps never noticed.

5.1 Monitor Indicators

The monitor functions can be very useful in detecting and correcting many situations which can cause quality and yield problems. Table 5.1 summarizes these functions and what they tell about the process.

Table 5.1 Process monitor functions

AUTO	PUMP	+	-	ALARM	SITUATION DETECTED AND possible corrective actions
on					NORMAL OPERATION, FLUX DENSITY IN BALANCE no action required
on	on				NORMAL REPLENISHER FEED no action required
on	on			on	INSUFFICIENT REPLENISHER REACHING TANK AND PUMP HAS RUN MORE THAN 30 MIN. CONTINUOUSLY check replenisher supply, plumbing, pump, pump size
on	on	on		on	INSUFFICIENT REPLENISHER REACHING TANK, PUMP HAS RUN 5 MIN. AND DENSITY DEVIATION IS POSITIVE AND ABOVE TOLERANCE check replenisher supply, plumbing, pump, pump size check for excessive control chamber fill time
on		on		on	DENSITY ABOVE SET POINT BUT PUMP NOT POWERED check pump relay
on			on	on	LOW DENSITY BELOW SET POINT DUE TO: NO OR LOW SOLUTION IN CONTROL cancel alarm and wait for control tank to fill or if that doesn't work check flux connection to control FLUX TANK HAS BEEN OVER REPLENISHED check for excessive control fill time check for possible replenisher siphoning and if found install a check valve or a siphon vacuum break

5.2 Strip Chart Display

The strip chart display in the lower right half of the LCD is a record of the last deviation for the last 8 times the deviation changed or the pump turned on or off. Zero deviation is shown at the center of a data location with positive deviations up and negative down from the center. When the system is operating properly all the data points will be near the center. A straight horizontal line is perfect control. Excursions away from the center could represent process problems. The data points are recorded whenever there is a change and not at some regular time. Thus the strip chart reports what has happened recently but not when. The process data stored in flash memory is available for more detailed investigation.

5.3 Process Event Logging

Each time a process event occurs the date, time, deviation, displayed density, auto/manual mode, alarm on/off, alarm cancel on/off, and pump on/off are stored in non volatile flash memory which will retain the data for as long as 10 years without power. Any change in deviation, alarm, pump or auto/manual is an event which is recorded. Every time someone enters or exits setup or replay modes the date and time are recorded.

The memory will hold over 100,000 process events which should represent several months of process data. The memory is organized like an endless tape loop so that new data simply over writes the oldest data continually and automatically. Data from last month should still be in the memory but data from several years ago will have been over written and lost. Once a process event has been recorded at a data location it will not be altered until over 100,000 new process events have been recorded to bring the “tape loop” back to the same point. The operator has no way to alter the record after an event is recorded.

5.3.1 Model 2041 Additional Data

The example below is specifically for a Model 136 Process Monitor connected to an etcher. The Model 2041 Flux Control/Monitor also records and replays the condition of the HIGH and FLUX level sensors. An H on the display indicates that the high solution limit has been reached; an F indicates that the lower level sensor is calling for the flux pump to turn on. Also the references to MANUAL operation below do not apply to the Model 2041 since it has only an AUTO mode.

5.4 Process Data Replay

The quickest and easiest way to access the stored process data is to press the [<<] replay button. This puts the Monitor into the replay mode and starts the memory scanning backwards in time just as a VCR would. The LCD changes to display stored process data and the date and time at which each data set was recorded. Recent past deviation numbers are easy to observe for patterns of interest. In the lower right part of the LCD a “P” indicates that the pump was on, an “A” indicates that the alarm was sounding, and an “M” indicates that the manual mode had been switched on.

The scan can be stopped at any point by pressing the [>>] button to “stop the tape”. Pressing [<<] again restarts the reverse scan. By watching the displayed date and time the memory can be scanned back to some desired date and time to check on the process history at some desired past time. Repeated presses of the [<<] button make the scan go faster. Holding the [<<] button down puts the system in a fast rewind mode which skips over several data sets at a time to rapidly go to the date and time of interest. When the oldest data set in the memory is reached the scan stops just as if rewind had reached the start of the tape in a VCR.

After some backwards scan the [>>] button can be pressed to replay the data in the forward direction as it really occurred. As explained above the first press on [>>] during reverse scan stops the scan. The next press on [>>] starts forward scan. Further presses speed the scan, and holding [>>] down continuously puts the system in fast forward skipping over several data sets at a time. When the newest data set is reached the scan stops just as if a VCR had reached the end of the tape. The top line of the LCD will read “ENTERED REPLAY” because that is the last event recorded. The bottom line will have the current date and the time at which replay was started.

5.5 Process Data Download to PC

Whenever the Monitor is replaying stored process data that same data is being sent to the RS-232 serial port which is accessible at the small capped circular plastic connector on the back of the Model 136 Process Monitor. When this data is downloaded to a PC (personal computer) it can be viewed as a text file, printed, or transferred to a spread sheet for further analysis. An additional advantage of the downloaded data is that it displays the seconds part of the data set time which is store in memory for each data set but not displayed on the LCD for lack of room. The seconds data permit one to exactly determine important process variables such as pump run duration and the rate at which deviation changes.

As practical matter it is not a good idea to expose a full regular computer to the corrosive environment in which the Model 136 operates. There at least two ways to avoid this difficulty. A portable notebook or palmtop PC can be wrapped in a thin clear plastic bag. The bag will conform to the keyboard and screen and protect the PC from corrosive fumes, splashes, and finger prints. The thin bags commonly used as office trash can liners are especially handy. Another solution when the machine isn't being used is to unplug the Model 136 monitor take it to the computer. The process data is stored in flash memory which does not need power to remember and can therefor be carried around at will. The Model 136 needs +12 volts DC to function and download the data. The +12 volts can be obtained by plugging into a spare Model 120 Power Module or from a wall outlet using an adapter and cable which is available from Optrol on special order.

5.5.1 Download Connections

Turn off the power to the Model 2041 and the power to the computer. Remove the sealing cap on the black circular plastic connector on the back of the Model 136 monitor and plug in the serial cable supplied. Remember to replace the sealing cap when you finish and disconnect the cable; it seals the connector to keep corrosive fumes out of the monitor.

Connect the 9-pin end to a serial port on the computer. Return power to the computer and Model 2041 systems. Note the COM port number associated with the PC connector used. If you don't know what the number is you may have to try a few in the PC setup below before you hit on the correct number. It will usually be a number from 1 to 4 so it won't take too many tries.

5.5.2 PC Setup

The PC must be setup to act as a terminal to receive the data sent by the Model 136 and put in some designated file for later use. The specific details of this procedure depend upon the particular operating system used. It is described below for three of the more common operating systems. For sake of illustration the COM port number used below is simply "n". You will have to substitute the actual COM port number you connected the cable to above.

5.5.2.1 DOS

Use a terminal or communications program such as Procomm. Set the port communication parameters as follows: port=COMn, baud rate=4800, data bits=8, stop bits=1, parity=none, flow control=none. If n=2 this might be listed as (COM2, 4800, N, 8, 1).

Get the data ready to send from the Model 136 by entering the replay mode and fast scanning back to the beginning of the data you wish to transfer. Stop the scan at the desired start date and time. To start the file transfer select the download option on the PC. Choose the ASCII or text option for the protocol. You may be required to enter a file name for the downloaded data such as 136data.txt before the transfer will begin. To start the information flowing press the [>>] button several times to maximize the scan and transfer rate. Do not hold the [>>] button down continuously since this will cause the replay to fast scan and skip data sets.

To view the file use an ASCII editor such a DOS EDIT.

5.5.2.2 Windows 3.1

First set up the Terminal program with the following procedure. Open the Accessories Group and open Terminal. From the Settings menu select Communications. In the dialog box which appears set the following parameters:

baud rate = 4800 data bits = 8 stop bits = 1
parity = none flow control = none connector = COMn

where n is the COM port number you are using. Click ok. From the File menu choose Save As. Type a file name for the configuration settings (such as mod136.trm) to save you from having to enter them again. Click ok.

To open Terminal and load the configuration do the following. Open Accessories Group and open Terminal. Click on File, Open, and then select the file name you chose to use above (mod136.trm). Click ok.

Get the data ready to send from the Model 136 by entering the replay mode and fast scanning back to the beginning of the data you wish to transfer. Pause the Model 136 replay at the desired start date and time. To start the file transfer from the Model 136 to the PC in the Terminal program click on the Transfers menu, choose Receive Text File. Enter a filename (such as 136data1.txt) for the data to be stored in the PC, and click ok. When you start the replay function by pressing the [>>] button momentarily on the Model 136, archived process data will appear in the Terminal window. The data appearing in the text window is being stored in the file you just designated. Use the [>>] or [<<] buttons to speed up or pause the transfer. Five presses on [>>] will achieve maximum available transfer rate. Do not hold the buttons down continuously since that will enter the fast scan mode in which data sets are skipped to move rapidly thru the memory. When the desired data has been transferred press the END button to return the Model 136 to normal operation. You can click on the Stop button on the bottom toolbar in the Terminal window to tell the PC that it's done.

Any text editor such as Notepad or a word processor can be used to view the text file transferred.

5.5.2.3 Windows 95

To setup Hyper Terminal first Create New Connection. From the Start menu choose Programs, then Accessories, and then Hyper Terminal. Double click the Hyperterminal icon. Enter a name for the connection to be created (such as Mod136) and then choose an icon for the new connection. Click ok. The Phone Numbers dialog box appears. Go to the Connect Using field and click on the down arrow drop down menu button at the end. Click on Direct to COMn where n is the COM port you connected to on the PC in Section 5.5.1 above. Click ok.

The COM Properties dialog box appears. Click on Port Settings. Set the parameters as follows:

bits per second: 4800	data bits: 8	parity: none
stop bits: 1	flow control: none	

Click ok. All dialog boxes should disappear leaving Hyper Terminal open. Click on File menu and choose Save. Windows places a new icon in the Hyper Terminal window named Mod136 or whatever name you entered above.

To use Hyper Terminal open the Hyper Terminal window if it is not already open by going the Start, Accessories, Hyper Terminal click route. Then double click the Mod136 icon or whatever you entered in the Create New Connection process. To transfer data from the Model 136 to the PC click on the Transfer menu. Select Capture Text. A dialog box appears showing the filename to save the data to. Use the default setting. Click the Start button in the dialog box. When you start the replay function by pressing the [>>] button momentarily on the Model 136, archived process data will appear in the Hyper Terminal window. The data appearing in the text window is being stored in the file you just designated. Use the [>>] or [<<] buttons to speed up or pause the transfer. Five presses on [>>] will achieve maximum available transfer rate. Do not hold the buttons down continuously since that will enter the fast scan mode in which data sets are skipped to move rapidly thru the memory. When the desired data has been transferred press the END button to return the Model 136 to normal operation. You can end the transfer session on the PC by going to the Transfer menu, selection Capture text, and choosing Stop. An icon labeled Capture is now present in the main Hyper Terminal window. Double

clicking on the Capture icon will open Notepad and load and display the captured text file of archived process data.

5.6 Process Data Text File

Each process data point logged gives a line of text such as:

031700080000a1200-01_____

The first 6 characters are the date, mmddyy, in this example March 17, 2000. The next 7 characters are the time, hhmmss followed by AM or PM, in this example 8:00:00 AM. The next 4 digits are the displayed density, in this example 1.200 g/ml. We know that the number recorded is g/ml and not Baume since it has 4 digits starting with 1. Baume numbers will have only 3 digits with the first character zero. The next character is the sign of the deviation. If the deviation is zero then the sign character is blank. The next 2 digits are the numerals of the displayed deviation, in this example 01 representing a display -0.001 since it is for a g/ml display. Over and under range display values are indicated by all 9's in the 6 numerical positions of the text line. For example if the above data had been for under range the line would have read: 0317000800009999-99_____.

The final four character positions indicated by the _____ after the deviation digits are for status information. The first status character will be an _, M, R, or S. M indicates MANUAL mode of operation, R indicates that the data set is recording an entry into REPLAY, S indicates that the data set is recording an entry into SETUP. The second status character will be _ or P. P indicates that the pump is powered. The third status character will be _ or A. An A indicates that the alarm is sounding. The fourth and final status character will be _ or E. An E indicates that the data set is erroneous because the flash memory failed to write correctly. This should be a very rare occurrence.

5.7 Diagnostics With Process Data

The next data set after an S or R records the exit from SETUP and REPLAY respectively. No data is logged during SETUP or REPLAY but the times of entry and exit are recorded. Excessive or unauthorized use of these two special modes is easily detected from the dates and times stored at entry and exit.

The example below would be a typical text file for startup and running first thing in the morning on 3/17/00. This data is for an etcher whose control system can be either in an auto or a manual mode. The Model 2041 Flux Control/Monitor is always in the auto mode and the Baume values logged would be closer to 10 than 20.

031700080103a0999-99_____
031700080123a0224-19_____
031700080125a0225-18_____
031700080127a0226-17_____
031700080129a0227-16_____
031700080131a0228-15_____
031700080133a0229-14_____
031700080135a0230-13_____

031700080137a0231-12 ____
031700080139a0232-11 ____
031700080141a0233-10 ____
031700080143a0234-09 ____
031700080145a0235-08 ____
031700080147a0236-07 ____
031700080149a0237-06 ____
031700080151a0238-05 ____
031700080153a0239-04 ____
031700080155a0240-03 ____
031700080157a0241-02 ____
031700080159a0242-01 ____
031700080201a0243 00 ____
031700080205a0243 00_P ____
031700080238a0243 00 ____
031700081251a0243 00_P ____
031700081328a0243 00 ____
031700080348a0243 00_P ____
031700080425a0243 00 ____
031700080445a0243 00_P ____
031700080522a0243 00 ____
031700080542a0243 00_P ____

The system starts with the float on the bottom of the empty wet chamber in the Control. The display is out of range as expected with the - sign shown indicating that the float is low. The display is in the Baume mode because the first display density shown has 3 digits preceded by a 0. The control wet side chamber fills in about one minute and the replenisher pump begins cycling on and off as work is being fed thru the etcher. This would be data for a near optimum etcher setup with the replenisher pump cycling as the sign changes on the displayed deviation while the deviation value stays 0.0. The distinguishing things about this normal pattern is that the deviation changes slowly and gradually until the replenisher pump takes control. When the pump controls it cycles on and off keeping the deviation within very tight limits. The alarm never sounds.

Many machine and controller problems will reveal themselves in the data pattern. A control which fills too slowly will show up in the time to get from startup to constant deviation followed by oscillations in the deviation which occur over periods of several minutes. Sludge in the control chamber will show up as a sudden jump in initial deviation. Instead of the deviation starting at -19 and slowly and gradually changing one step every few seconds, the initial deviations will show a rapid jump as the float comes unstuck and suddenly jumps up several steps in just a second or two. An undersized replenisher pump will give long pump run times with the deviation climbing into the positive numbers until the work feed slows down and the pump can catch up. Debris dragging on the control beam or optical card will show up as jumps in the deviation. Instead of changing slowly and gradually a step at a time it will take jumps of several steps in just a second or two as the buoyant force on the float breaks it free from the drag friction. If the density drops below the set point and stays there without the replenisher pump running it indicates that the flux's density is too low for the desired control point. If the replenisher pump shuts off while the flux is still too dense it indicates that the replenisher is too dense for the desired control point.

5.8 Process Data Spreadsheet

The process data text file downloaded from the Model 136 Monitor can also be put into a spreadsheet program for easier viewing of the data. This procedure also permits the full analytical and plotting capabilities built into typical spreadsheet programs to be used on the process data. The procedure will be illustrated with Microsoft Excel for Windows.

5.8.1 Starting Excel 5.0

Using File Manager or Windows Explorer copy the supplied Excel template file, MOD136_F.XLT to the XLSTART folder. Generally it is found in the path C:\EXCEL\XLSTART.

To open a new worksheet for Model 136 archived data which has been downloaded, go to the FILE menu and click on NEW. When the NEW dialog box appears select MOD136 and click OK. A new worksheet appears titled MOD1361. The added 1 on the end of the filename indicates that one copy of the template is open. If you make another worksheet from the MOD136 template, it will be named MOD1362.

To import the downloaded ASCII process data file open Notepad or another appropriate Windows word processor/editor program. Load the process data file (i.e. 136DATA.TXT). Highlight the desired data range by click and dragging with the mouse. From the EDIT menu click COPY to put the selected data into the Windows clipboard. Make Excel the active window. Move the cursor to cell A3 and select it by clicking once on it. From the EDIT menu click PASTE. The data selected in the word processor program and copied to the clipboard is copied into the spreadsheet starting at the third cell in column A.

The supplied Excel template for Model 136 process data files contains only 20 rows preformatted with formulas. If your selected data has more than 20 data sets then increase the number of rows as follows. Use the mouse to select row 20, columns B thru T by click and drag. Be sure to include column T. Move the cursor over the small black square on the lower right corner of the highlighted cells. The cursor will appear as a solid cross when properly positioned. Click here and drag down until the desired number of rows have been added. The formulas and formatting are copied into the new rows with all row and column references automatically updated.

To save the worksheet with its imported data go to the FILE menu and click on SAVE or SAVE AS if you want to give the worksheet file a unique name.

5.8.2 Starting Excel 97

Using File Manager or Windows Explorer copy the supplied Excel template file, MOD136_F.XLT to the Spreadsheet Solutions folder. Generally it is found in the path Program Files folder, Microsoft Office folder, Templates folder, Spreadsheet Solutions folder.

To open a new worksheet for process data go to the FILE menu and click on NEW. When the dialog box appears click on the Spreadsheet Solutions tab. Select the MOD136 icon and click OK. A new worksheet appears titled MOD1361. The added 1 on the end of the filename indicates that one copy of the template is open. If you make another worksheet from the MOD136 template, it will be named MOD1362.

To import the downloaded ASCII process data file open Notepad or another appropriate Windows word processor/editor program. Load the process data file (i.e. 136DATA.TXT). Highlight the desired data range by click and dragging with the mouse. From the EDIT menu click COPY to put the selected data into the Windows clipboard. Make Excel the active window. Move the cursor to cell A3 and select it by clicking once on it. From the EDIT menu click PASTE. The data selected in the word processor program and copied to the clipboard is copied into the spreadsheet starting at the third cell in column A.

The supplied Excel template for Model 136 process data files contains only 20 rows pre-formatted with formulas. If your selected data has more than 20 data sets then increase the number of rows as follows. Use the mouse to select row 20, columns B thru T by click and drag. Be sure to include column T. Move the cursor over the small black square on the lower right corner of the highlighted cells. The cursor will appear as a solid cross when properly positioned. Click here and drag down until the desired number of rows have been added. The formulas and formatting are copied into the new rows with all row and column references automatically updated.

To save the worksheet with its imported data go to the FILE menu and click on SAVE or SAVE AS if you want to give the worksheet file a unique name.

5.8.3 Sample Excel Worksheet

The example below is the Excel worksheet for the process data file in Section 5.7 above.

Optrol Inc. Mod. 136 - Archived Process Data Report															
ascii	Mo.	Day	Yr.	Hour	Min.	Sec.	Density	Units	Dev.	Std.	Pump	Alarm	Mode	System	Msg.
0317000	3	17	00	8	01	03	am	° Bé			OFF	OFF	Auto	Under-Range	
0317000	3	17	00	8	01	23	am	22.4	° Bé	-1.9	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	01	25	am	22.5	° Bé	-1.8	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	01	27	am	22.6	° Bé	-1.7	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	01	29	am	22.7	° Bé	-1.6	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	01	31	am	22.8	° Bé	-1.5	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	01	33	am	22.9	° Bé	-1.4	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	01	35	am	23	° Bé	-1.3	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	01	37	am	23.1	° Bé	-1.2	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	01	39	am	23.2	° Bé	-1.1	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	01	41	am	23.3	° Bé	-1	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	01	43	am	23.4	° Bé	-0.9	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	01	45	am	23.5	° Bé	-0.8	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	01	47	am	23.6	° Bé	-0.7	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	01	49	am	23.7	° Bé	-0.6	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	01	51	am	23.8	° Bé	-0.5	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	01	53	am	23.9	° Bé	-0.4	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	01	55	am	24	° Bé	-0.3	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	01	57	am	24.1	° Bé	-0.2	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	01	59	am	24.2	° Bé	-0.1	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	02	01	am	24.3	° Bé	0	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	02	05	am	24.3	° Bé	0	24.3	ON	OFF	Auto	
0317000	3	17	00	8	02	38	am	24.3	° Bé	0	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	12	51	am	24.3	° Bé	0	24.3	ON	OFF	Auto	
0317000	3	17	00	8	13	28	am	24.3	° Bé	0	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	03	48	am	24.3	° Bé	0	24.3	ON	OFF	Auto	
0317000	3	17	00	8	04	25	am	24.3	° Bé	0	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	04	45	am	24.3	° Bé	0	24.3	ON	OFF	Auto	
0317000	3	17	00	8	05	22	am	24.3	° Bé	0	24.3	OFF	OFF	Auto	
0317000	3	17	00	8	05	42	am	24.3	° Bé	0	24.3	ON	OFF	Auto	

The control chamber filled in the first 58 seconds after turn on and after that the deviation stayed 0 during 4 pump on-off cycles which took 3 minutes and 37 seconds. The upper right cell has the words “Under-Range” indicating just as the multiple 9’s in the data file did that the encoder was out of range and there is no valid data in the deviation, density, or Std. columns for that row. The Std. refers to the Standard Value which is added to the deviation to obtain the density display. The Standard Value is automatically computed and stored in non-volatile EEPROM memory during the Setup procedure when the hydrometer measurement is entered. The value shown in the worksheet is computed from density and deviation reported in the process data file. It is displayed in the worksheet to conveniently indicate when someone changes it. Other messages which could appear in the right hand cell are:

- “Over-Range” indicating deviation out of range high,
- “Enter Replay” indicating that data collection has been interrupted by entering the Replay Mode,

“Enter Setup” indicating that data collection has been interrupted by entering Setup Mode, and
“Data Error” indicating that the flash memory failed to accurately archive the data set for that particular row.

The next data set after “Enter Replay” or “Enter Setup” will record the time at which normal operation resumed. If someone uses these modes to defeat process data collection the times at which it occurred will be recorded. Also using Setup to raise alarm tolerance thresholds will be seen as higher than expected deviations without the alarm ON. The system Mode column will show “Auto” or “Man” for automatic or manual pump control modes on the Power Module switch.

LIMITED WARRANTY

Optrol Inc. warrants this Model 2041 Control/Monitor to be free of defects in material or workmanship for a period of two years from the date of shipment. In the event of such defect Optrol will at its option repair or replace free of charge any defective part which is returned, shipping prepaid, to the Optrol factory. This warranty does not apply to damage caused by misuse, neglect, accident, modification, or failure to follow instructions provided with the product. Any product repaired or replaced under warranty will itself be warranted only for the remaining portion of the original warranty.

Except as provided herein, Optrol makes no warranties, express or implied, including warranties of merchantability and fitness for a particular purpose.

In no event shall Optrol be liable for any incidental, consequential, special, indirect, punitive, or exemplary damages or lost profits from any breach of warranty or otherwise.

This warranty gives the purchaser specific rights, state laws may give other rights which vary from state to state. This written warranty is the final, complete and exclusive statement of warranty terms and no person is authorized to make any other warranties or representations on behalf of Optrol Inc.