OPERATING AND SERVICE MANUAL

MDS E-SCAN

Monitor Divert E-Scan System

Designed and Manufactured by

THE ELECTRON MACHINE CORPORATION

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Rev. -

The Electron Machine Corporation

MDS E-SCAN

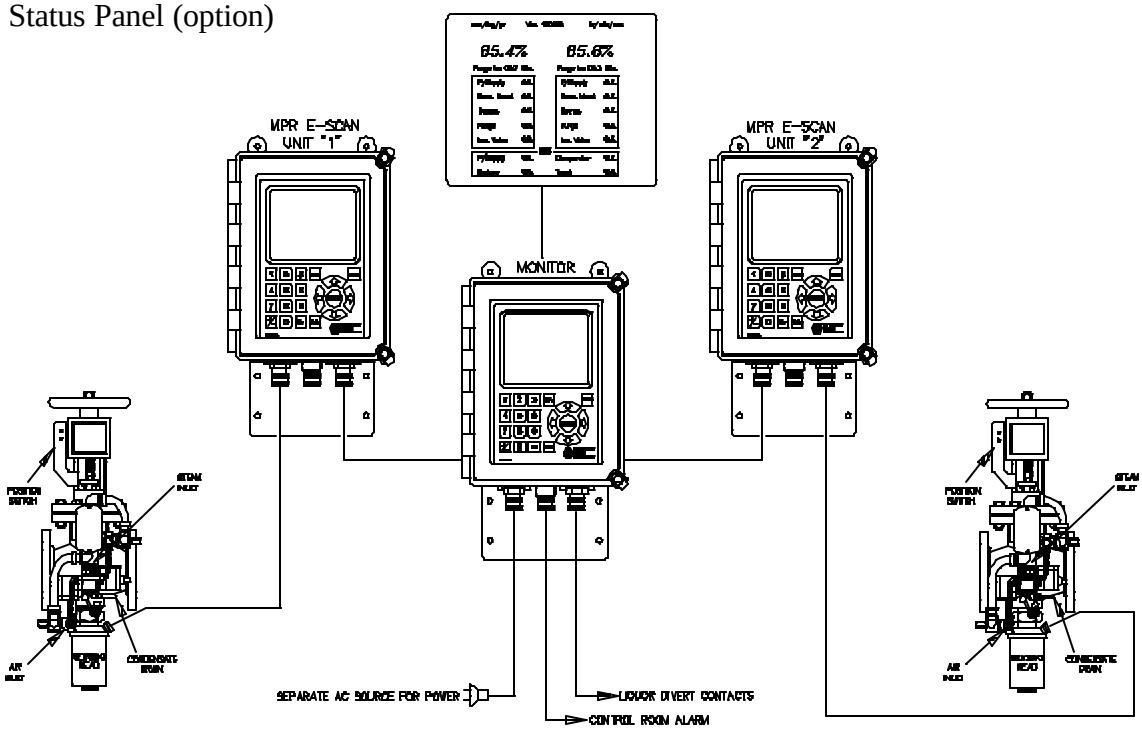
Introduction

Increasing emphasis on recovery boiler safety in pulp and paper manufacture requires highly accurate, reliable instrumentation at prescribed points in the process. In particular, the prevention of furnace explosions resulting from the introduction of low solids liquor into the furnace has been a subject of recent study by industrial insurance companies. Their recommendations include the provision of dual black liquor solids monitoring devices with adjunctive alarm and shut-off or diversion systems.

To meet these requirements, the Electron Machine Corporation whose refractometers have become the industry's worldwide standard for heavy black liquor measurement, has developed the MDS E-Scan. This system is designed to detect and display any malfunctions, which might be encountered for whatever reason during normal operation of the EMC refractometers with the additional capability, if required, of initiating an emergency shut-off or quick diversion of the process liquor.

The MDS E-Scan consists of the following equipment:

·One (1) MDS Monitor
·Two (2) MPR E-Scan Refractometers
·Two (2) Isolation Valves
·Printer
·Remote Status Panel (option)



The MPR E-Scan is a microprocessor driven critical angle refractometer. It is used to measure the refractive index of process fluids which directly correlate with customer request for dissolved solids. It is equipped with a broad range of diagnostics to aid in fault isolation without the use of special test equipment. The instrument is calibrated before leaving the factory and should not need recalibration unless some modification is made to the sensing head. Calibration procedures are available to change system parameters.

Important Manual Information

The Chapter title is at the top of each page for quick reference through the manual. Important points, reminders, and warning messages are printed in bordered boxes as:

NOTE: Box indicates important messages.

CAUTION

When removing the sensing head from an operating line***, do not assume that the line is empty or that the isolation or bypass means is working properly.*** If an EMC isolation valve is used, be sure its travel is not limited by any external attachments or other interference and the valve is closed tightly. No pressure should be felt on the head as the mounting nut is being removed.

ANY PRESSURE FELT WHEN THE NUT IS LOOSENED MUST BE INVESTIGATED BEFORE PROCEEDING. Steam should be turned off before attempting to remove the head.

Use a face shield and protective clothing. Stand to the side when removing the sensing head.

Clean all black liquor residue from spud-piece on adapter prior to re-insertion of sensing head. The o-ring seal should be replaced before re-installation.

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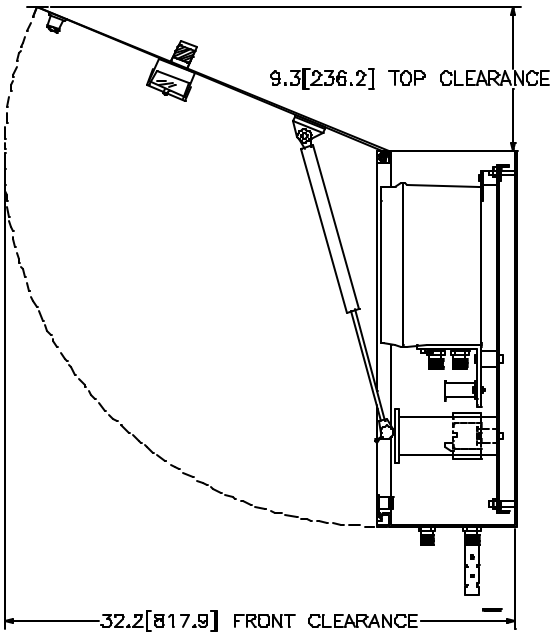
1. MDS E-Scan Installation

1.1 Site Selection

The MDS E-Scan cabinet can be mounted in any area where ambient conditions allow personnel to remain for extended periods and is suitable for the atmosphere and service conditions normal to a recovery boiler installation. A vortex cooler or a cooling fan is supplied with the cabinet to prevent excess heat build-up. The cabinet should be kept closed to maintain environmental resistance.

MDS E-Scan NEMA 4X Console



1.2 Power Requirements

The electrical power supply to the refractometer system must be from a dependable non-interrupted source. It is suggested that the power supply be the same as that used for the auxiliary burner safeguard system and the black liquor firing safety system. We recommend that cables be run in conduit.

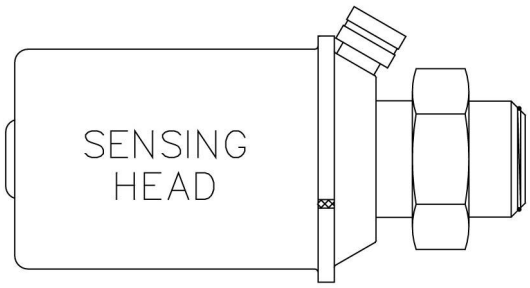
Note: The MDS E-Scan system is designed for a 120VAC power supply. If other voltages are used, a transformer must be supplied.

Once the cabinet is fastened securely in place, the interconnecting wiring may be run between TB13 and the control room. Use the interconnection diagram supplied in this manual for running the interconnecting wiring. Close observance of the required shielding will ensure proper operation of the Monitor. Signal wires should be kept separate from "POWER IN" and "RELAY CIRCUITS" to the control room. After completing the interconnection wiring, carefully recheck all connections to satisfy yourself that all are correctly terminated.

Important: Prior to shipment of an MDS E-Scan system, the sensing heads are matched to the consoles and factory calibrated**. DO NOT ATTEMPT TO CALIBRATE!**

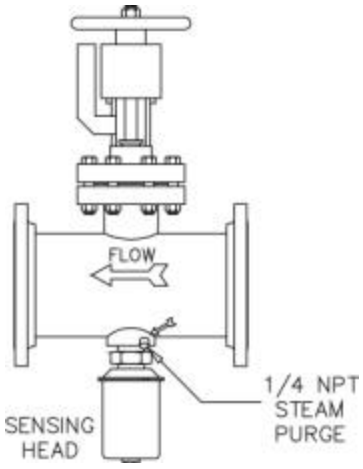
1.3 Installation of Sensing Heads

Sensing Head



The sensing heads are attached to the process line by Isolation Valves. These adapters must not be placed in an area where vibration is severe or excessive. They should be installed a minimum of six feet apart to prevent interaction of the purges.

The adapter should be oriented to place the head in a horizontal plane to assure that deposit buildup and air pocket creation will be minimal.



If the sensing head is to be mounted on a vertical pipe, the fluid flow should be upward. The arrow on the adapter should point in the direction of fluid flow. (See Sensing Head to Adapter Positioning.) The probe end of the sensing head has a groove for an interface o-ring.

The head is attached to the adapter by a 2-inch sanitary nut.

This o-ring must be in place prior to installing the head into the adapter to prevent the process leaking out.

The nut should be tightened with a wrench (supplied by EMC) to a maximum 50 foot pounds of torque (68 Newton-Metre). Alignment marks are provided to ensure that the thermistor probe will not be in a direct line of the steam blast. (See Sensing Head to Adapter Positioning)

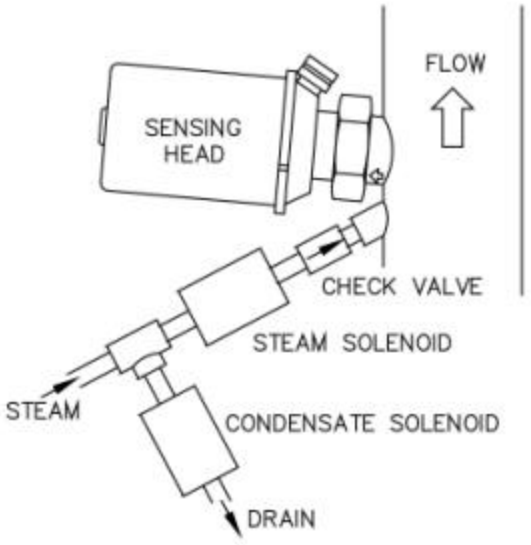
The sensing head houses optical components, which are susceptible to the effects of moisture. The cover is moisture proof and contains a small amount of desiccant to absorb any moisture remaining in the head after assembly. The sight glass on the head allows inspection of the desiccant. Sensing heads manufactured after June of 2006 use a RoHS compliant desiccant that is light orange when effective and clear when no longer effective. The desiccant can be renewed by heating to approximately 250° F (121°C) until it recovers its original color.

1.4 Steam Purge Attachment

The steam purge valve must be similarly mounted to the adapter with a minimum of 6" and a maximum of 18" from the steam port on an adapter preferably with 1/4" tubing.

It is essential that NO LEAKS be present in this line that could allow evaporation of liquids, thereby plugging the purge line**.**

Steam Purge Connections – for liquids which exhibit a tendency to "coat"



Steam pressure must be at least 50 psi (3.44 bar) above process pressure but less than 100 psi (6.89 bar) above process pressure with adequate condensation drainage at the steam valve in order to ensure hot steam for cleaning the prism. Trial and error must, of necessity, be employed in determining the minimum steam time necessary for proper steam cleaning of the prism due to variables from application to application.

To avoid excessive prism deterioration keep the intervals between the purge times at maximum, which may vary from minutes to 120 minutes, and the prism clean time at a minimum of approximately 10 seconds. IMPORTANT: A major cause of refractometer trouble is the prism wash.

1.5 Cooling System Requirements

When supplied with a vortex cooler a clean and dry air supply of the proper pressure (approximately 90 PSI at 8 cubic ft/min.) is required. If equipped with the cooling fan option the console must be mounted in a controlled environment.

1.6 Start-Up

Turn power on. Allow sufficient time for the sensing head to stabilize at the process temperature. It is recommend that no adjustments be made for at least 15 minutes after start-up.

Compare the reading against a sample taken from the process line close to where the unit is installed and at the process operating temperature. If the sample does not equal the displayed reading, adjust the analog zero per Operation/Calibration section.

Important: Prior to shipment the sensing head is matched to the console and factory calibrated. DO NOT ATTEMPT TO RE-CALIBRATE

1.7 Outputs

1.7.1 Relays

All alarm contacts are 5A, 250 VAC, resistive.

1.7.2 Printer Output

The MDS E-Scan includes a printer mounted in the cabinet.

1.7.3 Analog Outputs

The MDS E-Scan offers current or voltage outputs for the measurement. The standard output for these readings is a 4 to 20 ma signal that is referenced to ground (non-isolated) so that any device that is connected to these outputs must have a floating (or isolated) input. Isolated current output modules are available as an option.

2. MPR E-Scan Operation

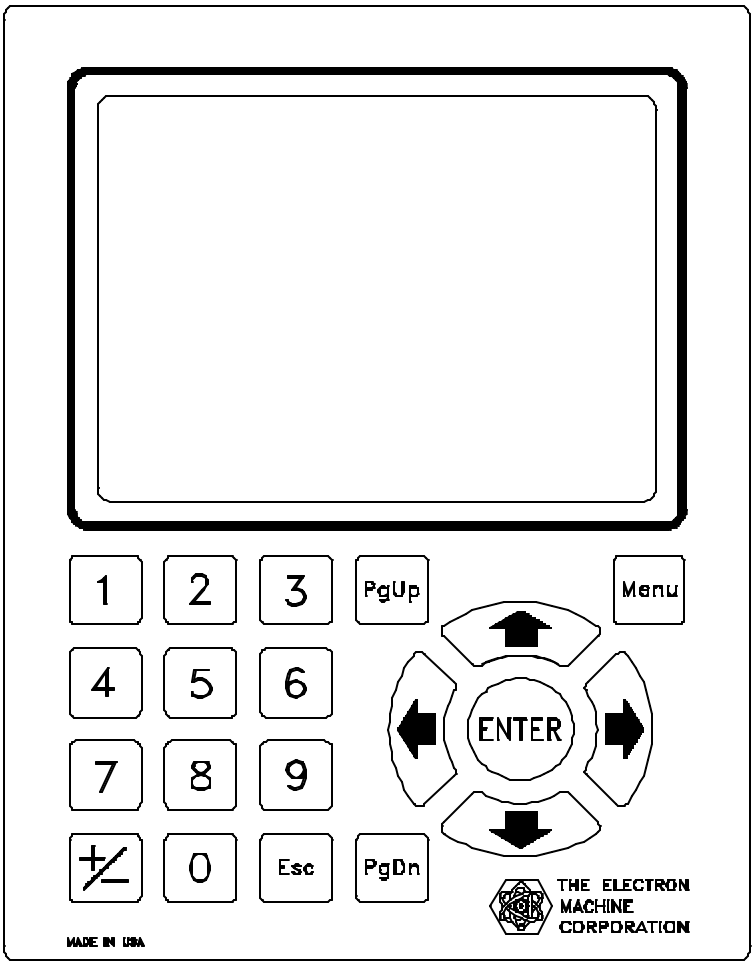
This equipment is designed for continuous operation and may be left on for extended periods of time.

2.1 The Operator's Panel

The Operator's Panel or Front Panel consists of a display and a 20-button touch pad, which form the interface between the operator and the instrument. The display consists of a 640 x 480 pixel LCD screen, which provides the operator with various messages. The 20-button touch pad allows the operator to make entries and instigate commands.

2.1.1 Display

The three basic types of messages displayed are:



Variable:
These information lines contain either set points that may be altered by the operator, or measurement variables that are updated by the CPU.

Alternate Action:
Acts much like a two position switch and is used to select various menu options. The operator is able to alternate between two states, such as ON and OFF.

Error Display:
Flashes continuously to attract operator's attention to an error condition.

2.1.2 Button Touch Pad Function Chart

Scrolls cursor horizontally to the left and also used to initiate editing of calibration voltages in the calibration table, and temperature values in the compensation table.

Scrolls cursor horizontally to the right and also used to initiate editing of all system parameters excluding those accessed by the LEFT ARROW.

Scrolls cursor vertically in the "Up" direction.

Scrolls cursor vertically in the "Down" direction.

ENTER Used to select all cursor items and to save edited data.

Esc Used to abort to previous operation without saving edited data.

Menu Used to immediately display the normal mode of operation without saving information or main menu selections if already in normal mode.

PgUp Displays previous screen of information or mode of operation, and is applicable when indicated on the screen.

PgDn Displays next screen of information or mode of operation, and is applicable when indicated on the screen.

+/– Allows data fields to be either positive or negative. Also used to create calibration table end, to toggle diagnostic options, and to record sample readings used for Analog Zero adjustment.

0 – 9 Numeric characters used to input data.

2.2 Normal Mode

2.2.1 What Normal Mode Does

In normal mode the system displays the following information:

- Name of the current product being measured along with an associated unit number.
- Software version number.
- Current time and date.
- On-line SOLIDS measurement.
- On-line temperature in Degrees Fahrenheit and Centigrade.
- Alarm points for measurement.
- Error status for system measurement, communication and voltage levels.
- Graphics menu to allow access to other MPR E-Scan system features.

Note: In normal mode set points cannot be changed or adjustments made.

2.2.2 System Indicators

C Isolation valve is closed. The MPR E-Scan will not initiate a prism clean.

T Below temperature compensation range. No prism clean allowed. Temperature at least 10 degrees C below set temperature.

H Measurement Hold. Current readings and analog outputs are maintained until complete. Indicates a cleaning cycle is in progress by a purge message, as well as a current measurement voltage display while in normal mode.

P Purge failed. This means the previous purge cycle did not properly clean the prism.

O Measurement over range. Current reading above last calibration point for MPR E-Scan in the calibration table.

U Measurement under range. Current reading below first calibration point for MPR E-Scan in the calibration table.

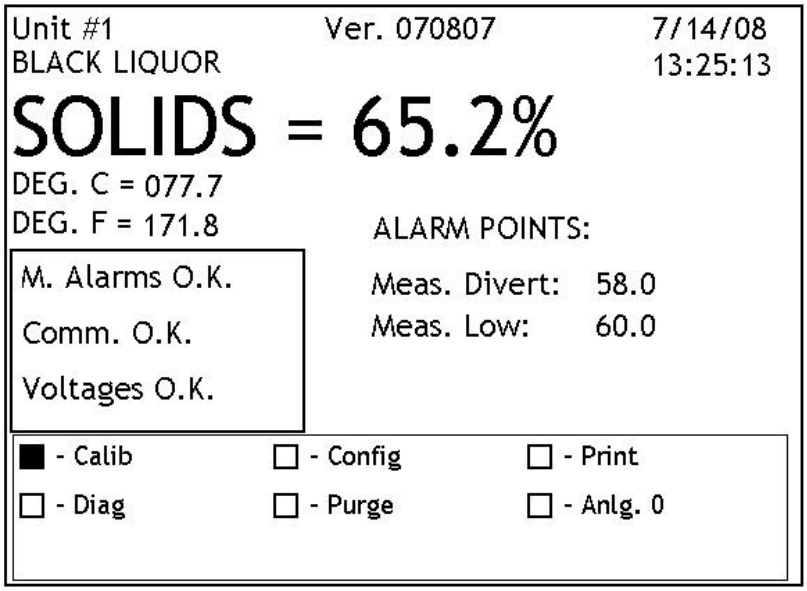
S Measurement sample reading has been recorded as the reference for Analog Zero adjustment.

2.2.3 The Menu Options in Normal Mode

Normal mode is entered by default, upon power up. To gain access to other system features select the MENU button on the Front Panel Touch Pad.

Note: The screen names and set points below are just an example, they will vary from application to application.

Normal Mode Screen With Menu Options



When the **MENU** button is selected, these menu options are displayed on the normal mode screen:

2.2.4 Overview of Menu Options

CALIB (Password required) option allows the operator to enter calibration set points. This consists of calibration limits, measurement, temperature compensation, and analog zero adjustment. Since a complete calibration is performed in advance by EMC, it would be a rare condition for the operator to access calibration measurement and temperature compensation. However, system limits may be changed more frequently if the operator chooses to change the alarm limits, analog output limits, alarm delays, purge cycle information, or other limits. An analog zero adjustment is provided to "zero in" the instrument to match lab samples or reach a target measurement if needed.

CONFIG options are selected in advance by EMC and would not normally be changed by the operator. Thus, access to system configurations is gained only by entering a correct password, except for selection of unit # 1 or 2.

PRINT option allows the operator to print all system calibration and configuration settings.

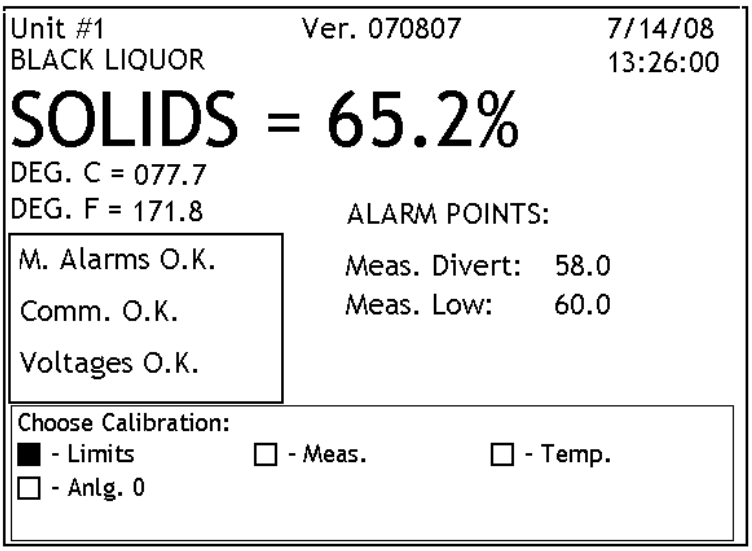
DIAG option provides the operator with data that can be used to test and troubleshoot system problems. The operator can display all voltages from the sensing head, test relays on the interface board, output min., mid., and max., analog data to test and calibrate analog output, and enter system time and date in cases of battery failure.

PURGE option allows the operator to initiate a purge from normal mode in addition to the automatic purge cycle timing setup in calibration limits. The purge function cleans the sensing head prism and since configured for intelligent cleaning will automatically start another purge cycle if the previous purge was unsuccessful. Purge can be aborted using the Front Panel ESC button.

Analg. 0 option allows the operator direct access to the calibration menu Analg. 0 section. See section 2.3 for more details concerning this type of calibration.

2.3 Calibration Selection (Note: To access calibration enter password "0000")

Calibration Mode Screen



The calibration menu contains four menu options:

1. Limits - This option contains the system limits for alarms, purge cycle, analog output and filter weight.

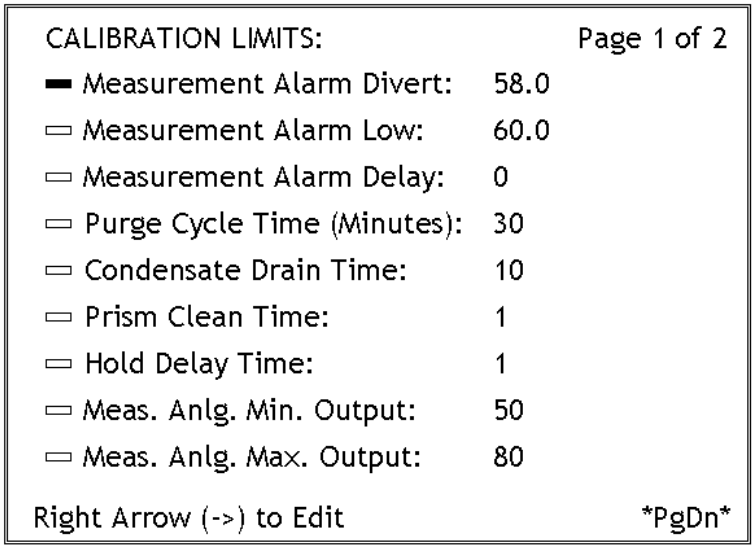
2. Meas. - This option allows entry to the calibration measurement routine. This is used to calibrate the process measurement so that a linear interpolation can be made to get the Refractive Index based on the current measurement voltage.

3. Temp. - This option allows entry to the calibration temperature compensation routines. This is used to compensate the process measurement changes that are caused by temperature changes.

4. Anlg. 0 (Analog Zero) - This option is used to adjust or "zero in" the instrument to match a target value.

Using the Front Panel buttons, the operator can highlight and then select the specified calibration menu options. Selecting the "Limits" menu option would generate the following display:

Calibration Limits Screen 1



Using the Front Panel arrow buttons, the operator can scroll through and edit selected system limits. In this example, Measurement Alarm Divert can now be changed using the **RIGHT ARROW** button.

Measurement Alarm Divert: If the measurement falls below this limit, a system alarm is activated. An error message will appear in the status window in normal mode, and the divert alarm relay will be turned off to activate a divert to the Monitor.

Measurement Alarm Low: If the measurement drops below this limit, a system alarm is activated. An error message will appear in the status window in normal mode, and the low measurement alarm relay will be turned on.

Measurement Alarm Delay: This is the alarm delay time in seconds for the process measurement that must expire while a limit is exceeded before an error is activated.

Purge Cycle Time: This is the time interval in minutes between automatic purging. During purging, all system readings and analog outputs are frozen. A "0" setting disables automatic purging.

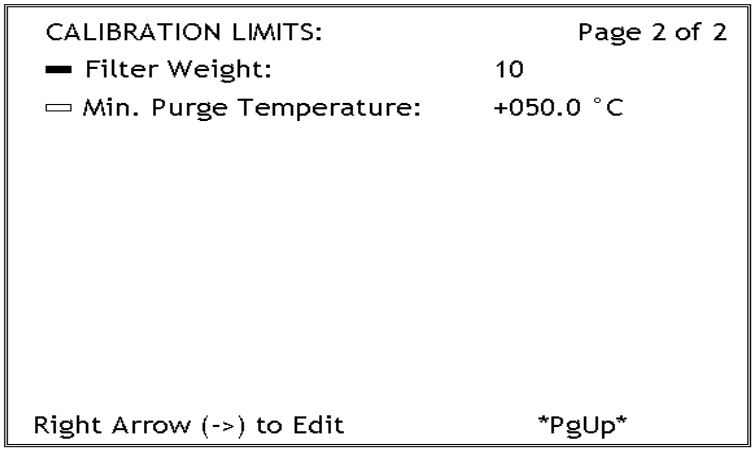
Condensate Drain Time: When the purge cycle is activated, this is the time in seconds that elapse before a prism clean occurs. During this time the condensate drain relay is activated and condensation is allowed to drain before steam cleaning.

Prism Clean Time: This is the time in seconds during which cleaning of the prism occurs and the prism clean relay is activated.

Hold Delay Time: This is the time in seconds that elapse after a prism clean occurs. This time allows a delay to occur before resuming normal process measurement. Readings are held constant during the period.

Meas. Anlg. Min. Output: This is the measurement reading that will produce a 4 ma or 0 volt output.

Calibration Limits Screen 2



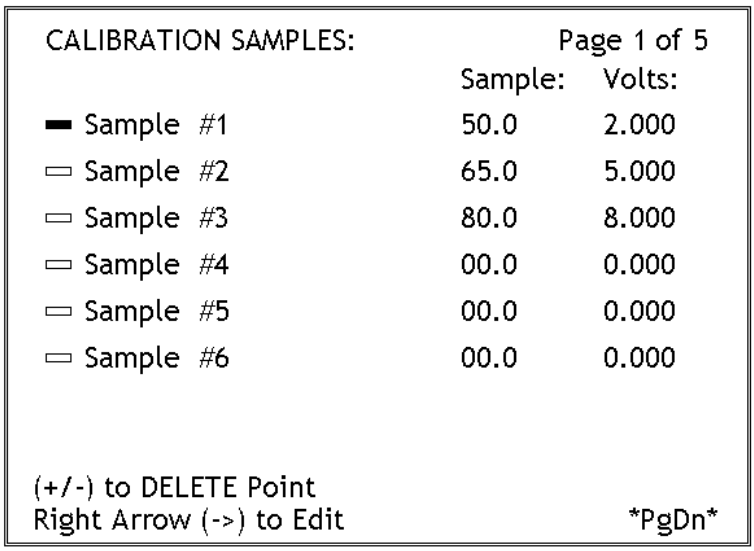
Meas. Anlg. Max. Output: This is the measurement reading that will produce a 20 ma or 10 volt output.

Filter Weight: This is a value that controls system response time to process measurement changes. The larger the value the slower the response time. The filter weight divided by 10 will give approximate response time in seconds to achieve 63% output of a step input change.

Min. Purge Temperature: This value determines the point below which a steam purge will not be allowed.

Selecting the **"Meas."** option from the calibration menu results in the following display:

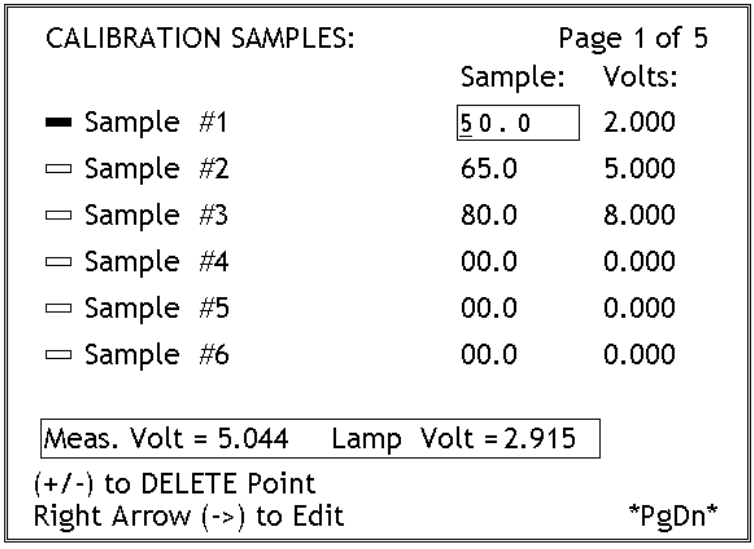
Calibration Measurement Screen



The calibration measurement table is created when you place actual solution samples to be measured on the sensing head and then save the desired measurement reading for that sample along with the current measurement voltage. This table is graphically equivalent to approximating a measurement curve with a series of straight lines.

Use the **RIGHT ARROW** button on the Front Panel to edit the sample value, and **ENTER** to capture the measurement voltage. To give the operator more flexibility, the voltages can also be edited by using the **LEFT ARROW** button. Following calibration samples, a table end should be created using the **RIGHT ARROW** button to select the sample and the +/ - button to end the table. After creating the table end, select the **ENTER** button to permanently save calibration.

Calibration Sample Example Screen

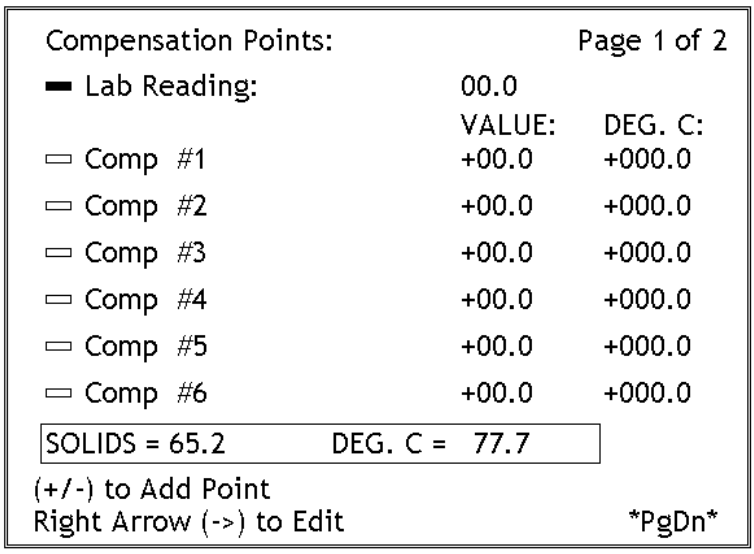


Example: what is displayed while calibrating Sample #1 shown:

At this point, sample #1 should be on the sensing head, and a sample value should be entered. When the **ENTER** button is selected, the measurement voltage displayed at the bottom is put in the table as the measurement voltage for the current sample. This measurement voltage is a raw voltage without analog 0 or temperature compensation adjustment.

Selecting the **"Temp."** option from the calibration menu results in the following display: (Circulation bath with temperature adjustment and pump is needed for temperature compensation.) (Not normally used on the MDS-E-Scan system.)

Calibration Temperature Screen



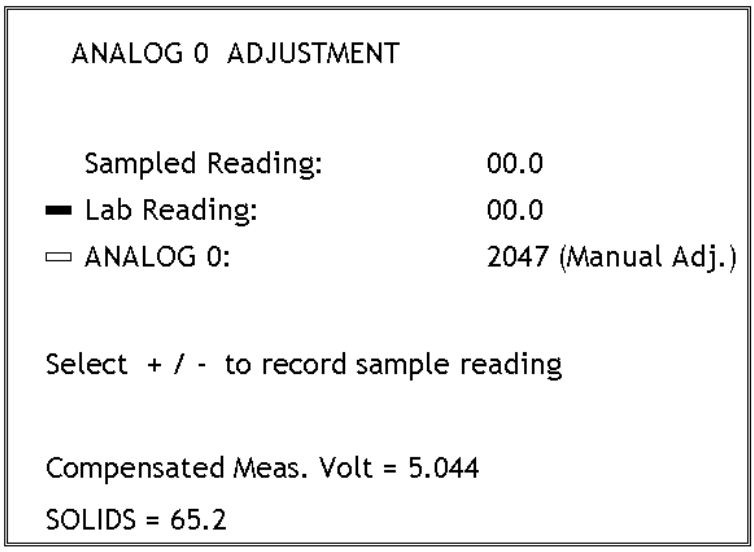
This is the temperature compensation table. The "VALUE" column represents the compensation values, and the "DEG. C" column represents the temperatures at which those compensations occurred.

Using the Front Panel buttons, both columns of data can be edited and saved. Since these values are generated by an actual temperature run, any changes made should be done with extreme caution!

Note: To save sample compensation enter Password "0000".

The final option of the calibration menu is **"Anlg. 0"** which activates the following display:

Analog Zero Adjustment Screen



The analog zero adjustment is used to correct for any shifts in the measurement voltage. After calibration and before compensation, an analog zero adjustment may be needed to "zero in" the measurement reading due to measurement voltage shifts that could occur when going from room temperature to the process base temperature used for the temperature compensation run. Analog zero adjustment may also be needed after installation to make instrument readings agree with normal testing methods.

The measurement voltage displayed contains both analog zero and temperature compensation adjustment. This is the voltage used to obtain an interpolated value from the calibration table that will reflect an accurate displayed reading in Brix, Solids... (Range is 0-10 volts.)

The analog adjustment value ranges from 0 to 4095, with 2048 representing the zero voltage point. Therefore, any value above 2048 results in a positive voltage adjustment and any value below 2048 results in a negative voltage adjustment. The maximum manual adjustment allowed in either the positive or negative direction is 1.5 volts, so there are 614 counts for a 1.5 volt span or 41 counts for a .1 volt shift. The remainder of the resolution beyond +/- 1.5 volts is used for temperature compensation.

Auto Adjustment

To perform automatic analog zero adjustment, the current measurement reading should be recorded in the E-Scan when the sample is taken from the process. This can be accomplished in normal mode of operation using the +/- button on the front panel. An "S" character is displayed on the normal mode screen to indicate that the sampled reading has been recorded. The sampled reading can also be recorded via the analog zero adjustment screen shown above.

The final part of automatic adjustment consists of entering the lab reading of the sample taken. Using the previously recorded sampled reading and the lab reading, the software will automatically determine the amount of analog offset needed to "zero" the instrument. The newly calculated analog zero value is displayed as a digital number in the range of 1434-2662.

Note: If the process measurement changes after the sampled reading is recorded then the final adjusted reading will not reflect the lab reading. However, since the adjustment is calculated from the recorded sampled reading, the final reading will be accurate and will not require further manual adjustment. Thus the lab reading should only be thought of as the desired reading if the process is stable. In all other cases, the lab reading simply provides a means of calculating an error adjustment from a previously recorded reference point.

Manual Adjustment

The operator should proceed with caution when adjusting analog zero manually since this will change the output of the instrument. To reduce the likelihood of manual adjustment error, it is suggested that the default least significant digit be altered first so the operator can observe the effects on the measurement reading. Pressing the up or down arrow buttons will output the altered analog zero adjustment.

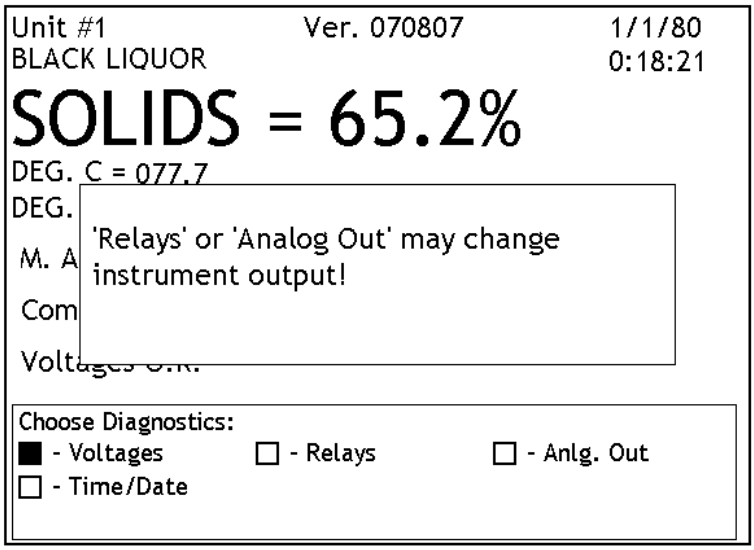
2.4 Print Selection

Prints all System Calibration and Configuration Settings.

2.5 Diagnostic Selection

The Diagnostics menu contains the following options:

Diagnostics Mode Screen



1. Voltages - This displays all pertinent system voltages such as: measurement voltage, temperature voltage, and lamp voltage.

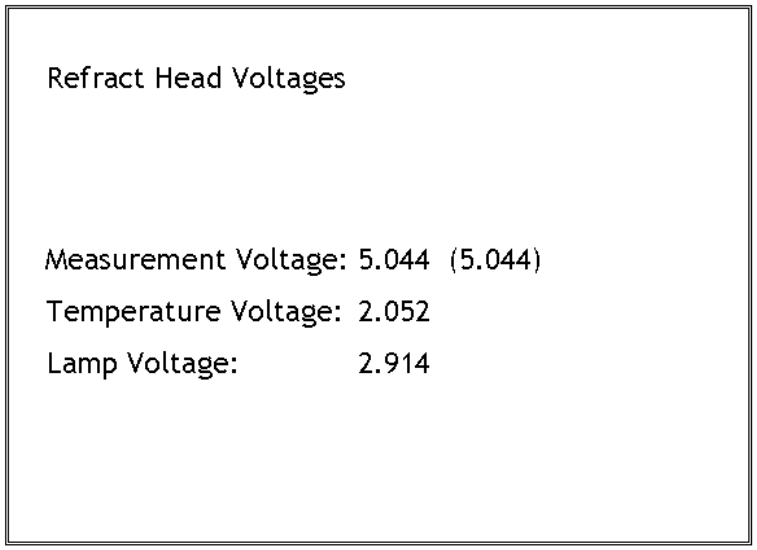
2. Relays - This allows the operator to toggle system relays for testing or troubleshooting purposes. The toggled relays can be visually checked by examining the relay LEDS on the interface board. This option also allows the operator to test custom inputs.

3. Anlg. Out - This option enables the operator to test system output as well as calibrate the output to work with various analog loads.

4. Time/Date - This option enables the operator to reset the system clock with a valid time and date. Such adjustments may be necessary as a result of time zone differences or when the system clock batteries fail.

The "Voltages option results in the following display:

Diagnostic Voltages Screen



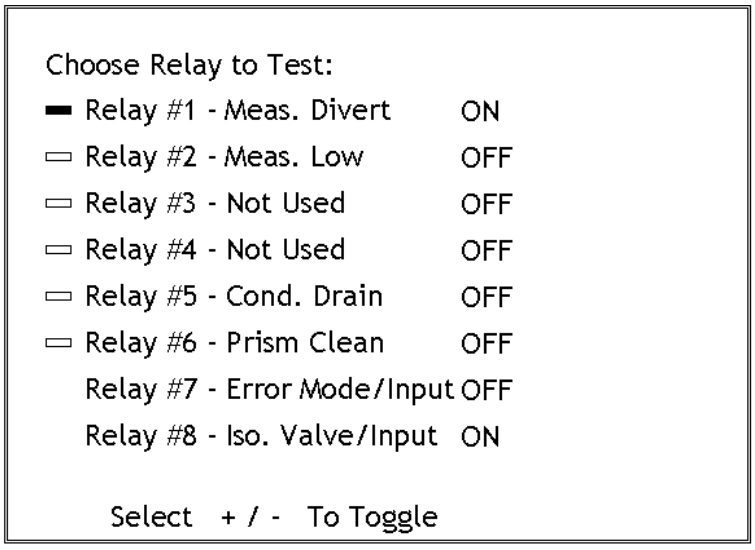
Measurement Voltage: The voltage produced when measuring a solution sample. The first voltage displayed is the raw sensing head voltage. The voltage in brackets is the compensated voltage. Range is (0-10 volts). See also Analog O menu.

Temperature Voltage: A voltage that produces the process temperature readout as follows: (Voltage - .5v) * 50 = Deg. C.

Lamp Voltage: A nominal voltage needed to maintain a signal of proper amplitude.

The **"Relays"** option activates the following display:

Diagnostics Relay Screen

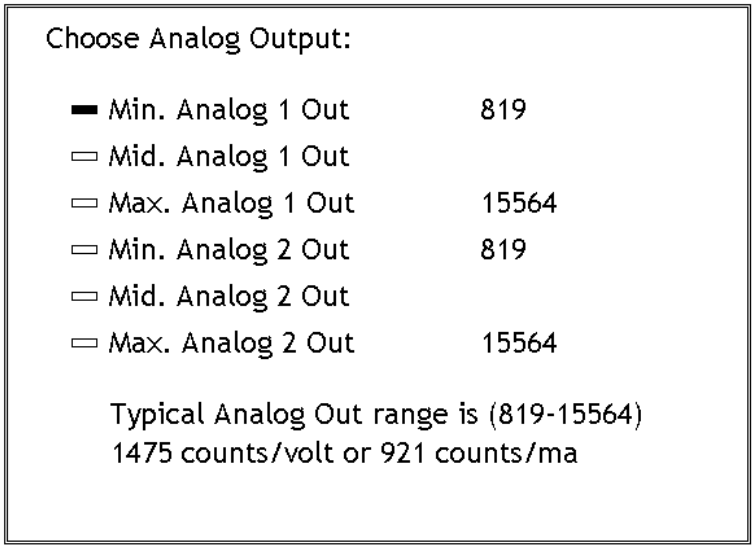


There are eight total relays, two of which are used as inputs coming from the Monitor and two are unused. The other four relays are activated when either measurement alarms are occurring or when purging.

Using the Front Panel buttons, all relays except the input relays can be tested by toggling the output conditions and visually checked by examining the relay LEDS on the interface board. Also, by supplying an external voltage, the operator can test the custom input relays.

The **"Anlg. Out"** diagnostic option activates the following display**:**

Diagnostics Analog Output Screen



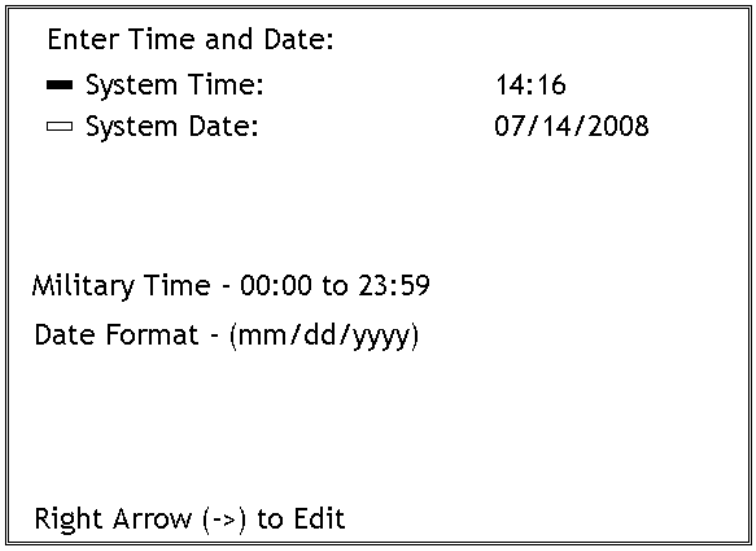
There are two standard outputs that produce a 0 - 10 volt and 4-20 ma signal and are used for process measurement and temp. They are displayed as Analog 1 Out and Analog 2 Out respectively.

Using the Front Panel buttons, the operator can test the outputs in min.., mid., and max., value conditions. Also by editing the min. and max. values, the operator can even calibrate the output to work more accurately with various analog loads.

NOTE: The information displayed at the bottom gives the operator the output resolution, which is useful when editing the output values for analog load calibration.

The **"Time/Date"** diagnostic option activates the following display:

Diagnostics Time/Date Screen



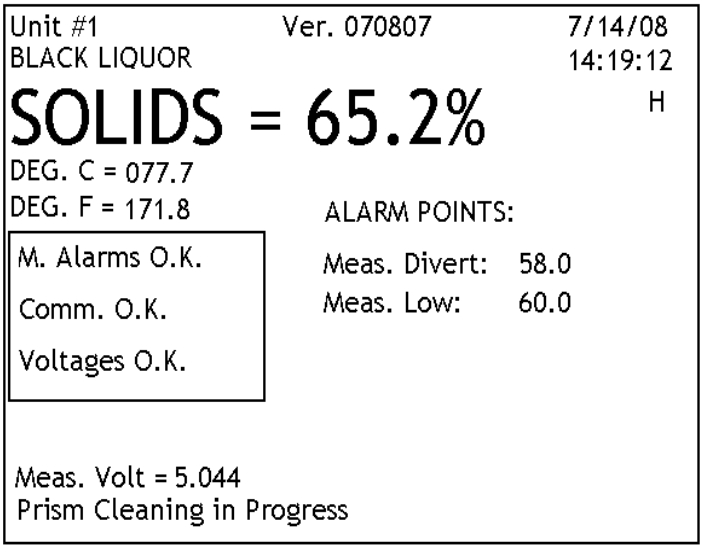
This menu enables the operator to set the system time and date.

System Time: This is the time displayed in military format in normal mode.

System Date: This is the date displayed in normal mode.

2.6 Purge Selection

Purge Mode Screen



Selecting the **"Purge"** option from normal mode adds purge information to the current display. When purging, the **'H'** system indicator (measurement hold) is displayed to the far right of the displayed reading, and the measurement voltage as well as the current purge mode is displayed at the bottom. The timing information for purging is set in the calibration limits menu.

During the purge process, all readings and analog output are "on hold" or frozen.

Each purge operation mode can be aborted before the selected time expiration by selecting the ESC button from the Front Panel at which time the system will resume normal operation. Following the termination of the purge cycle, the 'H' indicator and the information at the bottom is removed. With intelligent cleaning activated, successive purge cycles will be started if the previous purge was unsuccessful. This will continue for three entire purge cycles, at which time a 'P' system indicator is displayed if all purges were unsuccessful.

The purging consists of three internal modes:

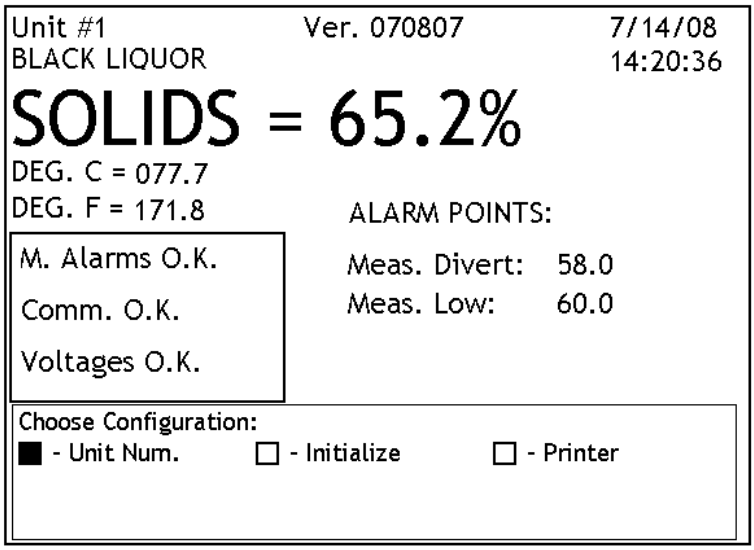
1. Condensate Drain Time: This time allows any condensation to drain before steam cleaning if steam is being used as the cleaning agent.

2. Prism Clean Time: This is the actual time during which cleaning of the prism occurs.

3. Hold Delay Time: This time allows a delay to occur before resuming normal operation.

NOTE: Purging can be automatically initiated by setting up a purge cycle time in the calibration limits.

2.7 Configuration Section Display



Unit Number
This is used to identify refract #1 or #2.

Selecting unit number requires a "0000" password.

3. MPR E-Scan Problem Analysis

3.1 Procedures

The following analysis procedures are meant to aid in isolating MPR E-Scan failures down to the board, or in the case of the sensing head--device level. Board or device replacement with a fast turnaround is available from EMC.

These abbreviations are used:

I/O	Main E-Scan I/O board	Conditions analog voltages for digital microprocessor.
CPU	Ampro 420 core module	Microprocessor, plugs into the I/O board.
IB	Interface board	Most external connections are made to this board.

Typical display ranges for voltages in test mode are:

LED voltage	2.5 - 4.0V (Varies slightly with temperature and cable length.)
Measure voltage	Varies with process 0-10V range with 2-8 Vdc nominal.
Temperature voltage	0 to 5 vdc = -25 to 225°C

Before any troubleshooting always check that all cards are properly plugged in, ribbon cables are properly socketed and that correct power is supplied.

3.2 Trouble Shooting Chart

SYMPTOM	POSSIBLE CAUSE
No display, failsafe LED off. No display, backlighting.	Fuse blown. Power supply failure, check ±15vdc and 5vdc.
No display and failsafe LED on.	Display failure. Video cable failure.
Display on but is garbled.	CPU failing, Display or Video cable failure
Buttons do not respond properly.	Connector from overlay to I/O board not, or improperly mated with J5. Front panel overlay defective. Defective I/O board (keyboard section).
E-Scan does not appear to take calibration.	CPU card failure.
"NO TEMP. VOLTAGE" flashing on display.	If voltage between TB1-3 and TB1-10 on the IB is less than 0.2 volt and the process temperature is above 25° C, check 2.5 volt regulator VR-1 in the head. Sensing head failed. I/O card failed.
"NO MEAS. VOLTAGE" flashing on display.	If positive voltage does not exist between TB1-12 and TB1-3 on the IB, check for process flow across the prism. Sensing head failed. I/O card failed.
Measurement incorrect.	Check display for O, U, or T indicators. Check for large digital offset value. Re-zero using analog zero (in software). Re-zero head using zero pot in sensing head.
"NO LAMP VOLTAGE" flashing on display.	Sensing head failed. Check for AGC voltage on LED. Analog card failed. I/O card failed.

4. MPR E-Scan Information

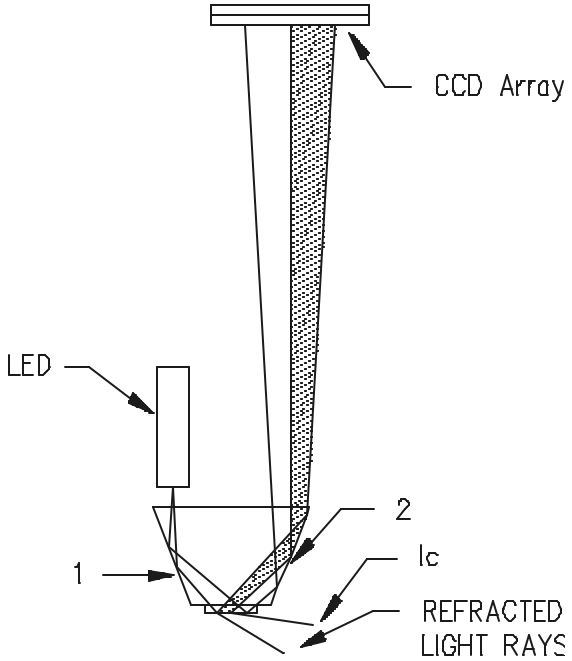
4.1 Technical Description

4.1.1 Sensing Head

The MPR E-Scan uses an LED as a light source and utilizes state of the art CCD (charge coupled device) technology to accomplish scanning the reflected light returned from the prism.

4.1.1.1 Optics

Light radiated from the LED passes through the prism surface to be reflected off mirror 1 to the prism-to-process interface. The light reaching this interface intersects the same interface over a series of angles chosen to include critical angle for the process being measured. Light intersecting the interface at an angle greater than critical angle is refracted into the solution. Light intersecting the interface at less than critical angle is reflected up to mirror 2 and out of the prism up to the CCD linear array to be scanned.



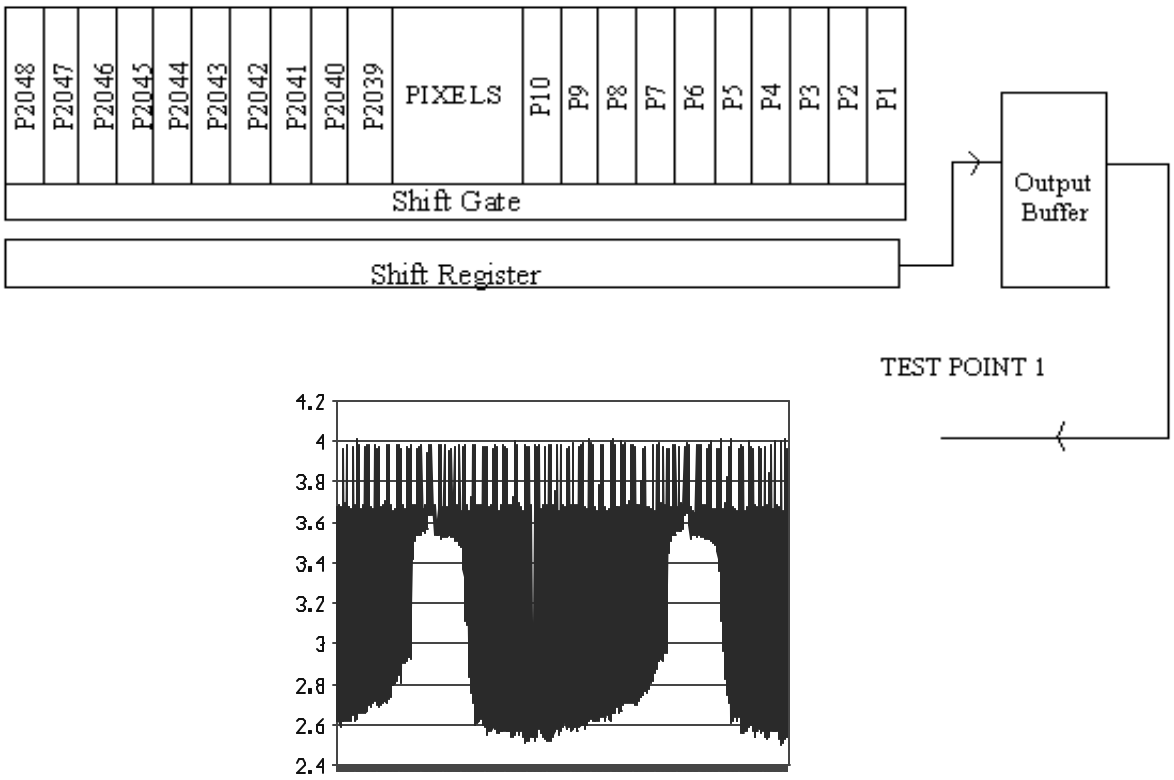
Optical Path

4.1.1.2 CCD Linear Array

The linear array used in the E-Scan includes 2048 individual photo sites. Each of these photo-diodes independently measures the incident radiation between scan intervals and stores an electrical charge, which reflects the measured intensity. At the end of this interval the shift gate is activated and the charges are simultaneously transferred into the shift register. The charges are transferred out of the shift register in "bucket brigade" fashion through the signal output buffer.

The output is an analog voltage representative of the charge per pixel (photo site) and is reset to ground between each transfer.

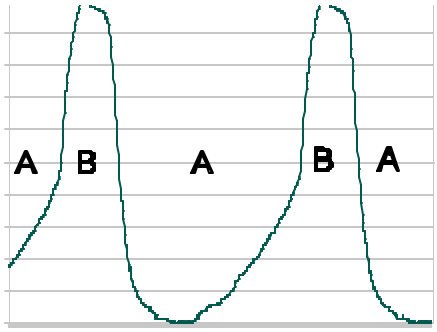
4.1.1.3 Signal



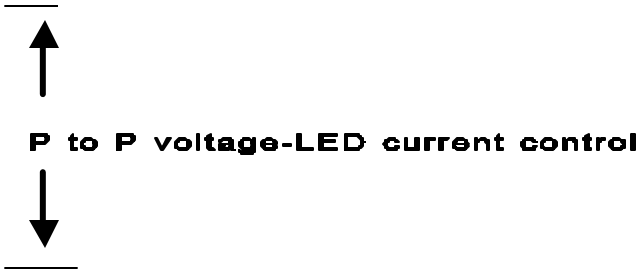
CCD Signal

To further increase resolution the signal is rectified and averaged as shown in the following figure. This signal is used to control the LED current to eliminate the effects of process color changes, suspended solids, entrained air and other problems associated with non scanning refractometers. The refractive index information is also contained in this signal in the form of the ratio of A to B.

The signal is passed through circuitry to develop a DC voltage, which is related to the ratio of the time of A to B. This voltage is sent to the console to be processed by the microprocessor and displayed in the customers preferred units of measurement.



A to B = reflected to refracted light.



Filtered CCD Signal

4.1.2 Console

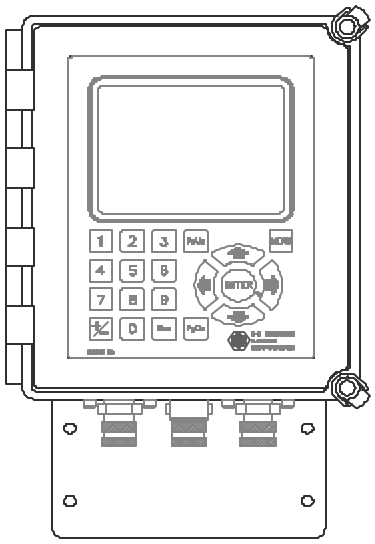
The console is constructed of molded fiberglass polyester to give protection in harsh environments.

4.1.2.1 Display

The LCD (liquid crystal display) has a pixel count of 640 by 480 to give very sharp resolution. The display is suitable for both graphics and text information.

4.1.2.2 Switch Matrix

The switch matrix is located on the outside of the console and allows the operator to make modifications and changes to the operating conditions of the instrument. The operation of this switch matrix is further explained in the operations section of this manual.



Display and Switch Matrix

4.1.2.3 IB (interface board) for external connection

The interface board is located on the back wall of the console. Most external connections are made to connectors that plug into this board. The only exceptions are optional features that require connections to optional available connectors located on the side of the console.

4.1.2.4 Power supply

The power supply is located in the top of the console and serves as a hold down clamp for the analog output modules. The power supply supplies power to both the I/O card and also the IB. The voltages supplied are +5 vdc and +/- 15 vdc.

4.1.2.5 I/O card

The I/O card handles most of the signal inputs and outputs from the instrument. Two ribbon cables route these signals from the IB to the I/O card and power is supplied through a power cable from the power supply.

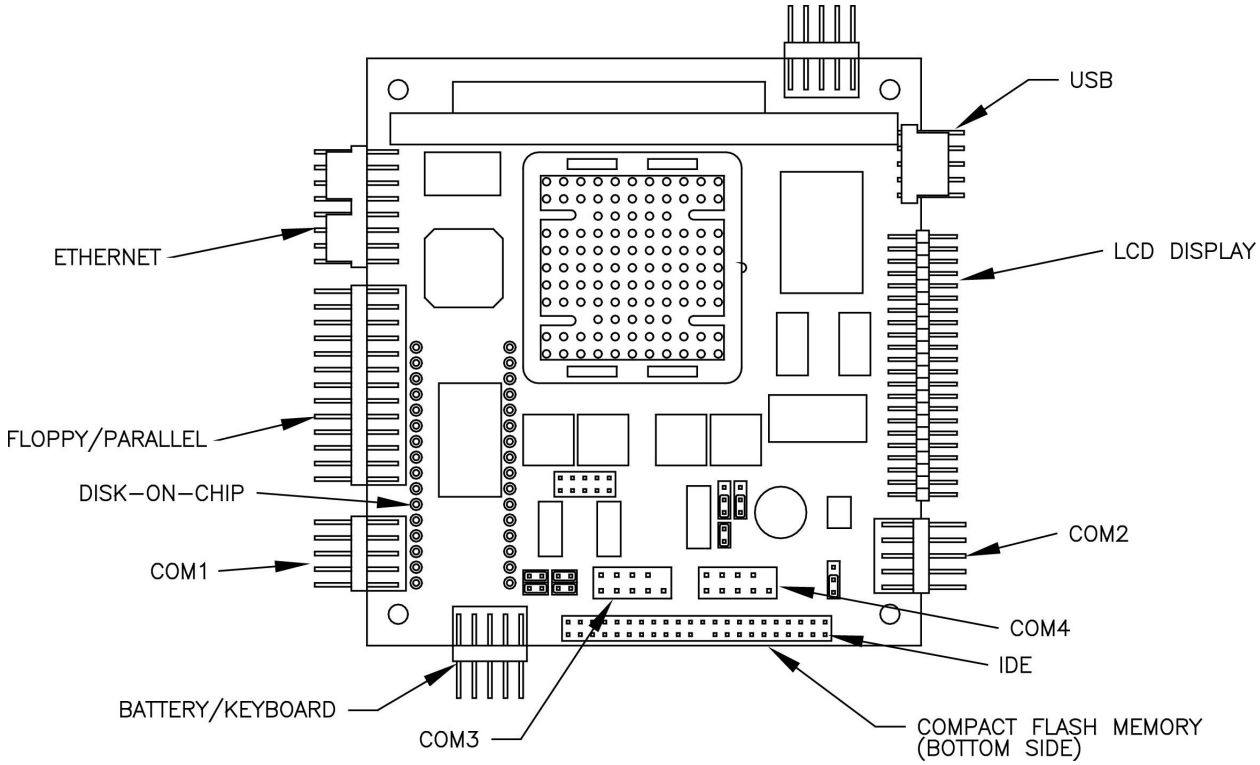
4.1.2.6 Comm/LPT card

This card is mounted to the left and above the interface board and is used to allow communication between the MPR E-Scan unit and the Monitor. It also enables the MPR E-Scan to drive the printer.

4.1.2.7 CPU Card

The CPU card is found plugged into the PC/104 bus connectors of the I/O card.

Ampro CoreModule 430 PC/104 CPU/VGA Card



The CPU card operates with a microprocessor running at 133 MHz. The CPU card has a built-in flash hard disk drive, which contains the operating software, parameters and calibration points for the system. The processing power of the MPR E-Scan is performed by the microprocessor on the CPU core module. The layout for this card, with standard cable connections, is shown on the above figure for the CPU card layout. When the Comm/LPT card connection board is supplied, cables also run between the parallel printer port and the connector board. The optional Com ports cable also connects to the CPU core module card, as shown in the RS232 Terminal Block Mounting Kit addendum.

This card is always installed on the I/O board and additional cards such as the 422 optional card are then installed above the CPU card.

The CPU card is supplied with a Compact Flash memory card that plugs into the socket on the bottom side of the CPU card.

4.1.2.8 Supplemental Card Information

Additional cards may be used for special features and options.

4.2 Refractometer Specifications

Accuracy	+/- 1% of span or .000075 R.I., whichever is greater
Span	.0015 R.I. minimum .132 R.I. maximum
Repeatability	.5% of span or better
Sensitivity	.5% of span or better
Stability	No recorded drift /24 hour period.
Response time	
Console	250m.s. to 15 min.
Head	<500m.s. for .0015 R.I. change with 90% recovery on .015R.I. span.
Process temperature	Up to 300° F (150°C)
Ambient temperature	Up to 125°F (52°C) Console – 32°F to 120°F (0°C to 50°C)
Calibration	See Engineering Order Sheet
Sensing head wetted materials of construction	2205 Duplex SS, sapphire, PEEK, Viton (other alloys and elastomers available)
Outputs	4-20ma non-isolated 0 - 10vdc non- isolated

4.3 Available Options

Optional E-Scan Outputs

1. Isolated 4-20 mA output for measurement
2. Isolated or non-isolated 4-20mA output for temperature

Optional E-Scan Features

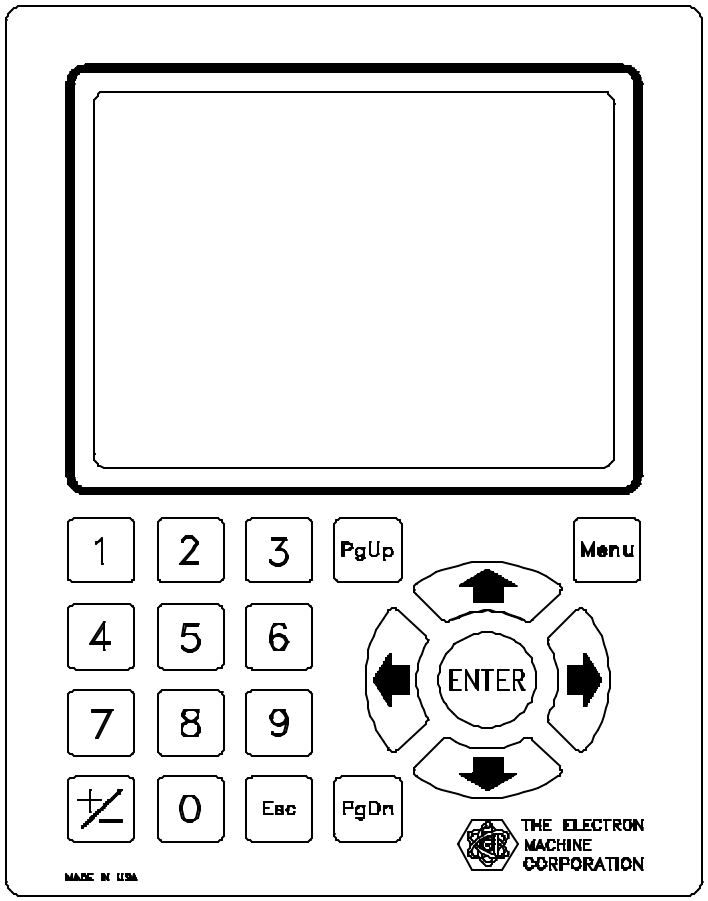
1. SS NEMA IV head connector

5. Monitor Operation

This equipment is designed for continuous operation and may be left on for extended periods of time.

5.1 The Operator's Panel

The Operator's Panel or Front Panel consists of a display and a 20-button touch pad, which form the interface between the operator and the instrument. The display consists of a 640 x 480 pixel LCD screen, which provides the operator with various messages. The 20-button touch pad allows the operator to make entries and instigate commands.



5.1.1 Display

The three basic types of messages displayed are:

Variable:
These information lines contain either set points that may be altered by the operator, or measurement variables that are updated by the CPU.

Alternate Action:
Acts much like a two position switch and is used to select various menu options. The operator is able to alternate between two states, such as ON and OFF.

Error Display:
Flashes continuously to attract operator's attention to an error condition.

5.1.2 Button Touch Pad Function Chart

	Scrolls cursor horizontally to the left.
	Scrolls cursor horizontally to the right and also used to initiate editing of all system parameters.
	Scrolls cursor vertically in the "Up" direction.
	Scrolls cursor vertically in the "Down" direction.
ENTER	Used to select all cursor items and to save edited data.
Esc	Used to abort to previous operation without saving edited data.
Menu	Used to immediately display the normal mode of operation without saving information or main menu selections if already in normal mode.
PgUp	Displays previous screen of information or mode of operation, and is applicable when indicated on the screen.
PgDn	Displays next screen of information or mode of operation, and is applicable when indicated on the screen.
+/–	Used to toggle diagnostic and configuration options.
0 – 9	Numeric characters used to input data.

5.2 Normal Mode

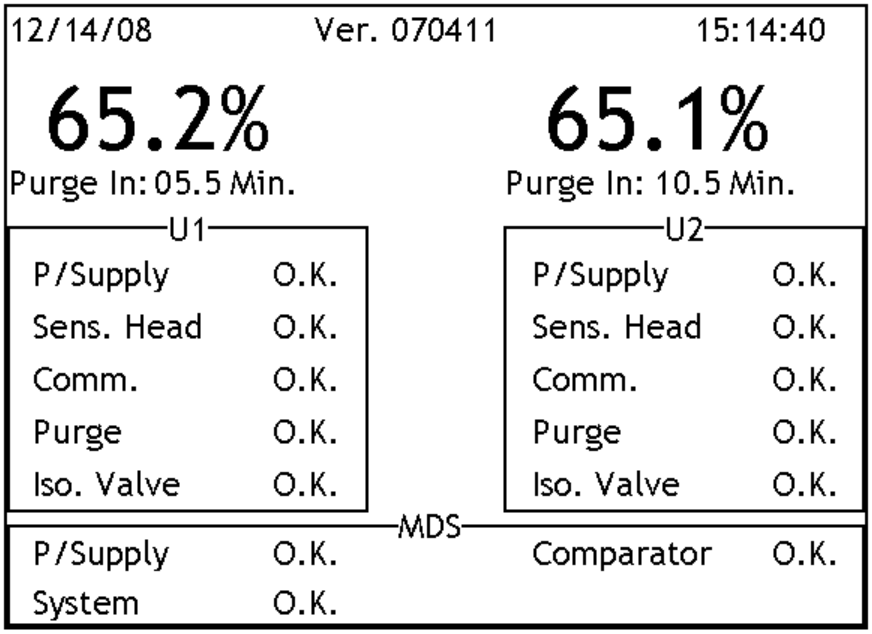
5.2.1 What Normal Mode Does

The Normal Mode of operation consists of the following information:

- System time, date and software version number.
- Current solids readings from the MPR E-Scan units.
- Current time until next purge for the MPR E-Scan units.
- System status for the MPR E-Scan units.
- System status for the Monitor.

5.2.2 Monitor MPR E-Scan Status Boxes in Normal Mode

Note: The readings below are just an example, they will vary from application to application.



P/SUPPLY:

This status field monitors the MPR E-Scan unit +15, -15, and +5 volt power supply lines. The following errors can be displayed in this status field:

+15 VOLT ERROR: This indicates that the plus 15 volt supply is outside the allowable 10% tolerance levels, which means it is either below +13.5 volts or above +16.5 volts.

-15 VOLT ERROR: This indicates that the minus 15 volt supply is outside the allowable 10% tolerance levels, which means it is either above -13.5 volts or below -16.5 volts.

+5 VOLT ERROR: This indicates that the plus 5 volt supply is outside the allowable 10% tolerance levels, which means it is either below +4.5 volts or above +5.5 volts.

SENS. HEAD:
This status field monitors the status of the MPR E-Scan unit sensing head voltage levels. The following errors can be displayed in this status field:

MEAS. VOLT ERROR: This indicates that the measurement voltage in the sensing head is out of specification and is either below 0.5 volts or above 9.5 volts.

TEMP. VOLT ERROR: This indicates that the temperature reading derived from the sensing head voltage is out of specification and exceeds the temperature high or low limits set in the Monitor Configuration Limits Menu.

LAMP. VOLT ERROR: This indicates that the voltage needed to maintain a signal of proper amplitude for the light source is out of specification. Below 2.5 or above 4.2 volts D.C.

COMM:
This status field is used to indicate an RS-232 communication error between the Monitor and the MPR E-Scan units. The following error can be displayed in the status field:

COMM. FAILED: This indicates a communication failure, which could be the result of a bad serial port, bad wiring, or a dead CPU.

PURGE:
This status field monitors all system steam purge functions. The following errors pertaining to purging can be displayed in this status field:

PURGE FAILED: This indicates that a proper measurement voltage drop was not seen by either the MPR E-Scan or the Monitor during the purge operation and thus intelligent cleaning was not effective.

PURGE MISSED: This indicates that the steam solenoid relay was not activated during the purge operation and therefore the purge did not occur.

PURGE INVALID: This indicates that either the steam solenoid relay was activated during a non-purging operation or there is an open-line condition.

PURGE NOT ACTIVE: This is caused by not having purge cycle times set. This alarm flashes above the alarm box and does not take the refractometer off line.

ISO.VALVE:
This status field monitors the Isolation Valve in order to indicate valve open or valve closed status.

VALVE CLOSED: This indicates that the isolation valve is closed.

5.2.3 Monitor Status Box MDS in Normal Mode

P/SUPPLY:
This status field monitors the Monitor +15 and -15 volt power supply lines. The following errors can be displayed in this status field:

+15 VOLT ERROR: This indicates that the plus 15 volt supply is outside the allowable 10% tolerance levels which means it is either below +13.5 volts or above +16.5 volts.

-15 VOLT ERROR: This indicates that the minus 15 volt supply is outside the allowable 10% tolerance levels which means it is either above -13.5 volts or below -16.5 volts.

COMPARATOR:
This status field monitors the readings from both MPR E-Scan units and is used to indicate an error if the difference in the solids readings exceeds the comparator limit. The operator has the capability of changing the comparator limit to a value between 1% and 2% absolute solids by using the Monitor Configuration Limits menu option.

COMPARATOR ERROR: The difference in solids readings exceeds the comparator limit.

SYSTEM:
This status field is used to monitor many system functions and to issue warnings instead of errors so that the operator can be notified of problems that are not fatal but need to be addressed. The following warnings can be displayed in this status field:

CHK LAMP VOLTAGE: This indicates the lamp voltage in a sensing head is above 4.0 volts. CAUTION- If lamp voltage reaches 4.2 volts the refractometer will be taken out of service. To adjust see Maintenance section 8.5.

CHK PURGE LOG: This indicates that a second or third attempt was needed to clean the prism. Therefore, the operator should check the purge log in order to determine how much steam time was needed during the purge operation.

CHK ANLG. SOLIDS: This indicates that the solids reading derived by the 0-10 volt input to the Monitor unit does not agree with the solids reading sent to the Monitor unit via the serial port.

CHK ANLG. TEMP.: This indicates that the temperature reading derived by the temperature voltage input to the Monitor unit does not agree with the temperature reading sent to the Monitor unit via the serial port.

CHK U1-U2 COM2: This indicates that the communication between the MPR E-Scan units via serial port 2 has failed, and therefore all communication between the MPR E-Scan units is now going through the Monitor unit.

PRINTER ERROR: This indicates that there is a problem with the printer.

TREND:
This status field is used to monitor the rate of change in solids readings in order to predict how much time would have to pass at the present rate of change until a divert occurred. This is also a warning status, and is triggered by the trend limit specified by the operator in the Monitor Configuration Limits menu option. For example, if the trend limit is set for 30 minutes, then a trend warning will only be activated if a divert is anticipated within 30 minutes.

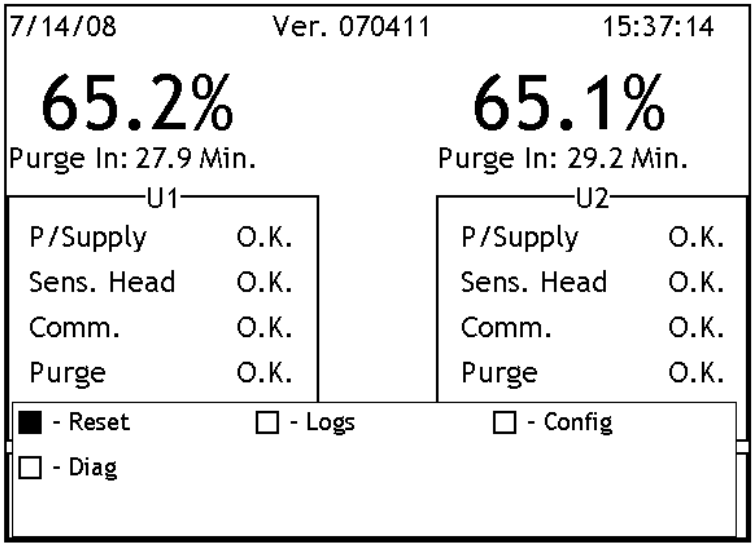
DIVERT ERROR: This indicates a divert has occurred. The cause could be any of the following which would be specified by the printout: Low solids Divert, Unit Failure Divert, Remote Divert, Diagnostic Divert.

5.2.4 The Menu Options in Normal Mode

Normal mode is entered by default, upon power up. To gain access to other system features select the MENU button on the Front Panel Touch Pad.

Note: The readings below are just an example, they will vary from application to application.

Normal Mode Screen With Menu Options



When the **MENU** button is selected, these menu options are displayed on the normal mode screen:

RESET:
Option resets the Monitor console and clears all error conditions. It performs the same function as the reset button located on the door of the MDS E-Scan cabinet. All errors require manual reset as per BLRBAC standards.

LOGS:
Option allows the operator to view historical data pertaining to system errors and warnings, purge cycle, divert conditions, and comparator readings.

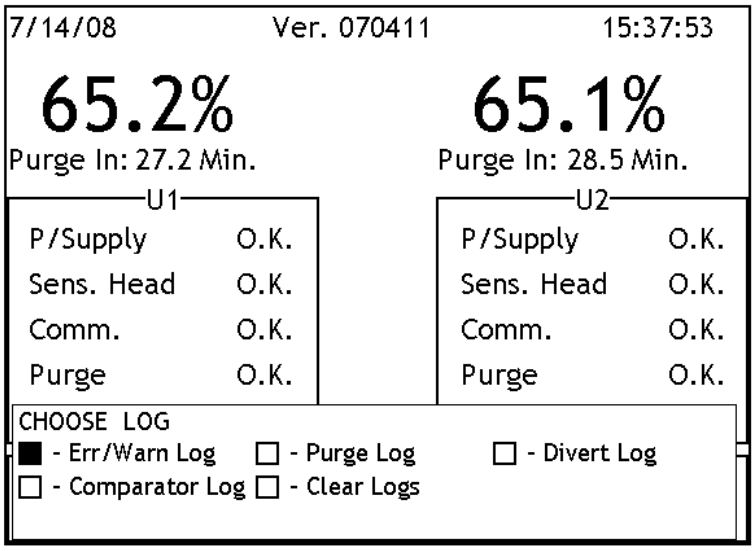
CONFIG:
Option allows the operator to change system parameters. This consists of state conditions such as trending, as well as configuration for a one or two unit divert. In addition, the operator can enter set points for all system limits, such as trending, comparator, and temperature limits.

DIAG: (DIAGNOSTICS)
Option provides the operator with data that can be used to test and troubleshoot system problems (see Diagnostics Mode Selection). The operator can display all monitored voltages, test relays on the interface board, and enter system time and date in cases of battery failure.

PRINT:
Option allows the operator to dump all system logs to the printer.

5.3 Log Selection

Log Mode Screen



The logs menu contains four menu options:

1. ERR/WARN LOG
This option allows the operator to view a log containing a history of system errors and warnings. Each log entry contains the error/warning message along with a time and date stamp.

2. PURGE LOG
This option allows the operator to view a log containing a purge history. This log will enable the operator to see how many seconds of steam cleaning were required to successfully clean the MPR E-Scan prisms during each purge cycle.

3. DIVERT LOG
This option allows the operator to view a log containing a history of divert conditions. These log entries reveal not only the time and date of the divert, but also the reason the divert occurred. This will enable the operator to determine if the cause of the divert was instrument failure, a remote device or a low solids reading.

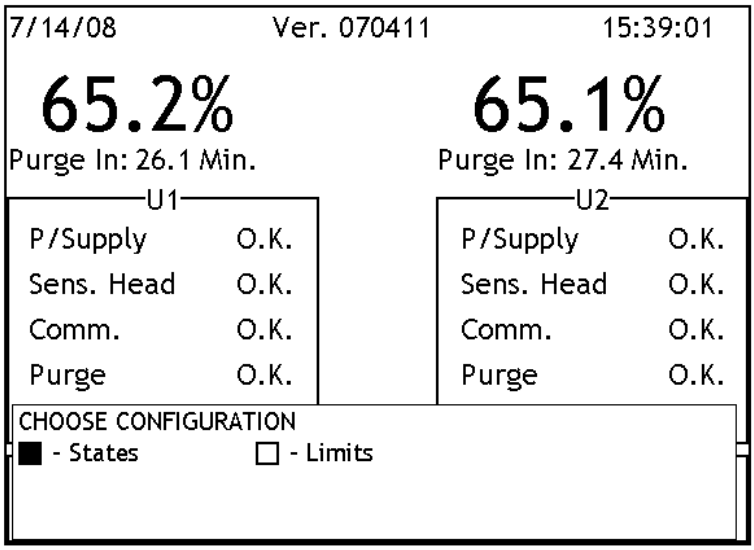
4. COMPARATOR LOG
This option allows the operator to view a log containing a history of comparator solids readings. This log keeps track of differences between the MPR E-Scan readings and enables the operator to determine the magnitude of difference, which may be useful for troubleshooting purposes.

5. CLEAR LOGS
This option allows the operator to clear all of the logs.

5.4 Configuration Selection

The configuration menu contains two menu options:

Configuration Mode Selection



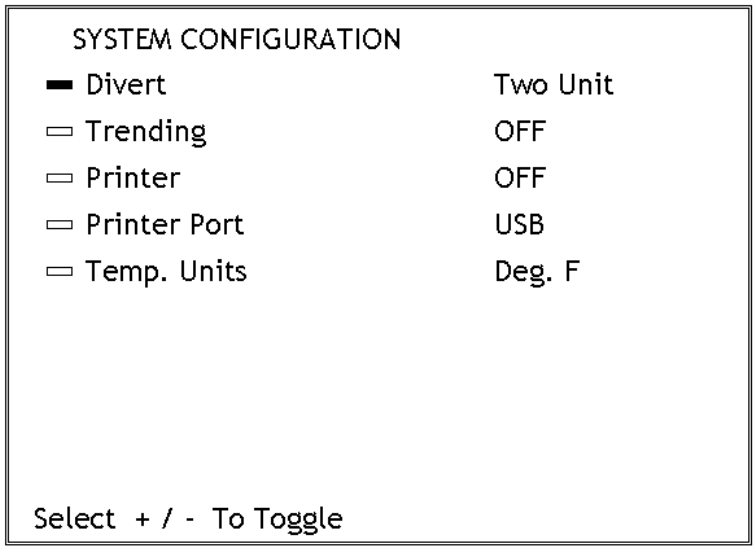
1. STATES
This allows the operator to set up the Monitor for either a 1 unit or 2 unit divert configuration. The operator can also enable/disable trending which is used as a divert prediction indicator.

2. LIMITS
This allows the operator to enter set points for all system limits, such as trending, comparator, and temperature limits.

5.5 Configuration States Selection

The first configuration option, “States”, activates the following display:

Configuration States Selection



One Unit Divert will allow the Monitor to activate the divert relay when (1) MPR E-Scan unit contains a solids reading below the divert point with no alarm present.

Two Unit Divert will allow the Monitor to activate the divert relay only when both MPR E-Scan units contain solids readings below the divert point with or without alarms. In addition, the divert relay will be activated if one unit contains a low solids reading while the other unit is purging.

Trending enables the divert prediction indicator. This will generate a warning when a divert is predicted to occur within the trend time set in Configuration Limits.

Printer allows printer to be turned off and not give warning light.

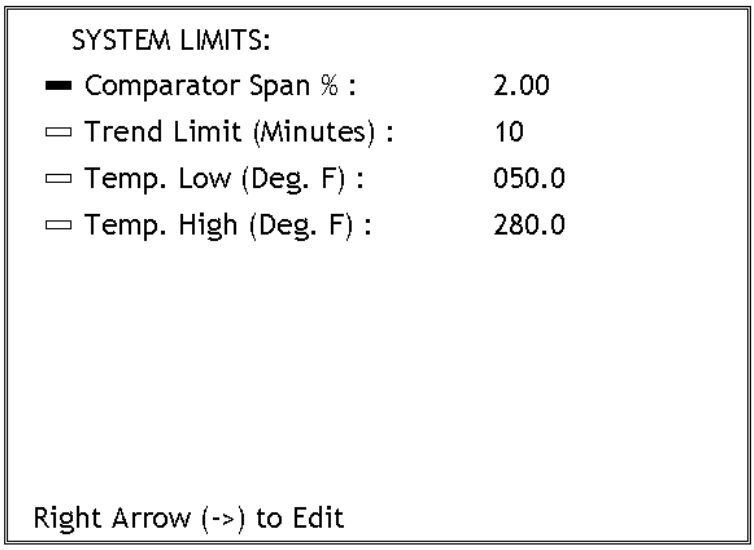
Printer Port allows the selection of type of printer to be used and port it will be connected to. The choices are USB, Com3, or LPT1. The standard configuration is LPT1 for the printer supplied with the MDS system.

Temp. Units selects RSP readout in Deg F or Deg C.

5.6 Configuration Limits Selection

The next configuration option, "Limits", activates the following display:

Configuration Limits Screen



Using the Front Panel arrow buttons, the operator can scroll through and edit selected system limits. In this example, Comparator Span % can now be changed using the RIGHT ARROW button.

Comparator Span %:
This x represents the maximum percent of solids readings difference that is allowable. If the difference in solids readings between the MPR E-Scan units exceeds this limit, a Monitor error will be activated.

The comparator span is adjustable between 1% and 2%.

Trend Limit:
This is a time frame in minutes that is used for a divert prediction indicator. If a divert is predicted within the trend limit time frame, a Monitor warning will be activated. The trend limit is adjustable between 10 and 99 minutes.

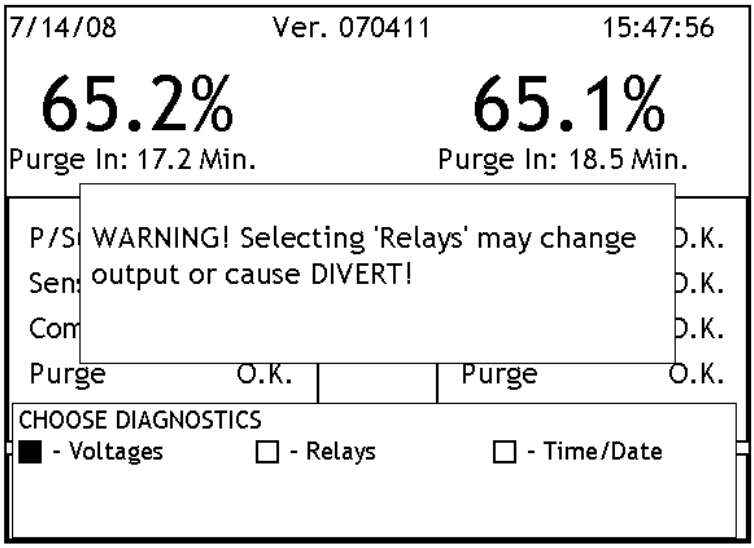
Temp. Low:
If the process temperature reading from an MPR E-Scan unit falls below this limit, a unit specific error is activated and the offending unit is taken offline. An error message will appear in the unit status window in normal mode and the unit error relay will be turned on.

Temp. High:
If the process temperature reading from an MPR E-Scan unit exceeds this limit, a unit specific error is activated and the offending unit is taken offline. An error message will appear in the unit status window in normal mode and the unit error relay will be turned on.

5.7 Diagnostic Mode Selection

The Diagnostics menu contains the following options:

Diagnostics Mode Screen



1. Voltages:
This displays all pertinent system voltages for both MPR E-Scan units as well as the Monitor.

2. Relays:
This allows the operator to toggle system relays for testing or troubleshooting purposes. The toggled relays can be visually checked by examining the relay LEDS on the Monitor /MPR E-Scan interface board.

3. Time/Date:
This option enables the operator to reset the system clock with a valid time and date. Such adjustments may be necessary as a result of time zone differences or when the system clock batteries fail.

5.8 Diagnostic Voltages Selection

The "Voltages" option results in the following display:

Diagnostics Voltages Screen

System Voltages

U1 Meas:	5.056	U2 Meas:	5.018
U1 Temp:	2.056	U2 Temp:	2.048
U1 Lamp:	2.897	U2 Lamp:	2.881
U1 0-10:	5.066	U2 0-10:	5.009
U1 +5:	4.981	U2 +5:	4.956
U1 +15:	15.614	U2 +15:	15.704
U1 -15:	15.271	U2 -15:	15.201
MDS +15:	15.508	MDS -15:	15.183

U1 Meas:
The voltage produced when measuring a solution sample. It is used by MPR E-Scan unit 1 to obtain an interpolated value from the calibration table that will reflect an accurate displayed solids reading.

U1 Temp:
A voltage that produces the process temperature readout on MPR E-Scan unit 1 as follows: (Voltage - .5v) * 50 = Deg. C.

U1 Lamp:
A nominal voltage needed to maintain a signal of proper amplitude for MPR E-Scan unit 1 light source.

U1 0-10:
An interpolated voltage based on MPR E-Scan unit 1 Meas. Anlg. Min. and Meas. Anlg. Max. Output limits.

U1 +5:
MPR E-Scan unit 1 power supply. The +5 volt supply line has a +/- .5 volt tolerance.

U1 +15:
MPR E-Scan unit 1 power supply. The +15 volt supply line has a +/- 1.5 volt tolerance.

U1 -15:
MPR E-Scan unit 1 power supply. The -15 volt supply line has a +/- 1.5 volt tolerance.

U2 Meas:
The voltage produced when measuring a solution sample. It is used by MPR E-Scan unit 2 to obtain an interpolated value from the calibration table that will reflect an accurate displayed Solids reading.

U2 Temp:
A voltage that produces the process temperature readout on MPR E-Scan unit 2 as follows: (Voltage - .5v) * 50 = Deg. C.

U2 Lamp:
A nominal voltage needed to maintain a signal of proper amplitude for MPR E-Scan unit 2 light source.

U2 0-10:
An interpolated voltage based on MPR E-Scan unit 2 Meas. Anlg. Min. and Meas. Anlg. Max. Output limits.

U2 +5:
MPR E-Scan unit 2 power supply. The +5 volt supply line has a +/- .5 volt tolerance.

U2 +15:
MPR E-Scan unit 2 power supply. The +15 volt supply line has a +/- 1.5 volt tolerance.

U2 -15:
MPR E-Scan unit 2 power supply. The -15 volt supply line has a +/- 1.5 volt tolerance.

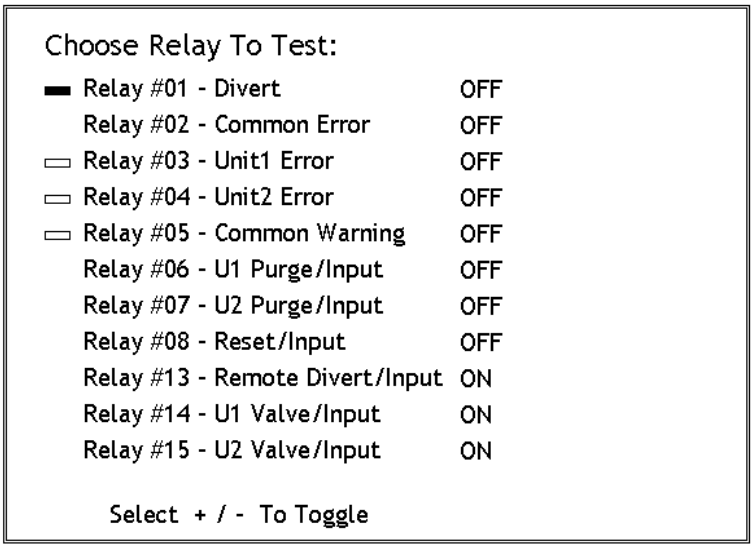
MDS +15:
Monitor power supply. The +15 volt supply line has a +/- 1.5 volt tolerance.

MDS -15:
Monitor power supply. The -15 volt supply line has a +/- 1.5 volt tolerance.

5.9 Diagnostic Relay Selection

The “Relays” option activates the following display:

Diagnostics Relay Screen



There are eleven total relays, six of which are inputs. Four input relays are activated by the MPR E-Scan units when the Isolation Valves are closed or when there are purge failures. One input is activated by pressing the reset button attached to the door of the MDS E-Scan cabinet. The remaining input is activated when the divert button is pressed on the Remote Status Panel, or when any other remote divert is configured. Relays 6, 7, 8, 13, 14 and 15 are inputs.

The remaining relays are activated by the Monitor and are as follows:

Relay #01-Divert:
This is activated to create a divert condition.

Relay #02-Common Error:
This is activated for all error conditions, whether they are Monitor or MPR errors.

Relay #03-Unit1 Error:
This is activated only for errors associated with MPR E-Scan unit 1 and is accompanied by an error message in the Monitor Unit1 status box while in normal mode**.**

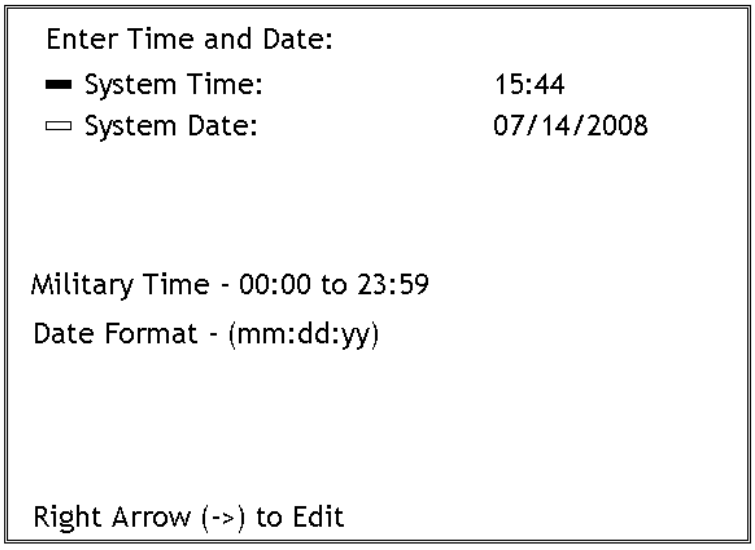
Relay #04-Unit2 Error:
This is activated only for errors associated with MPR E-Scan unit 2 and is accompanied by an error message in the Monitor Unit 2 status box while in normal mode**.**

Relay #05-Common Warning:
This is activated for all system warning conditions and is accompanied by a warning message in the Monitor status box while in normal mode.

5.10 Diagnostic Time/Date Selection

The "Time/Date" diagnostic option activates the following display:

Diagnostic Time/Date Screen



This menu enables the operator to set the system time and date.

System Time:
This is the time displayed in military format in normal mode.

System Date:
This is the date displayed in normal mode.

5.11 Print Selection

This dumps all logs to the printer for permanent hard copy output.

6. Monitor Problem Analysis

6.1 Procedures

The following analysis procedures are meant to aid in isolating Monitor failures down to the board. Board or device replacement with a fast turnaround is available from EMC.

These abbreviations are used:

I/O	Main Monitor I/O Board	Conditions analog voltages for digital microprocessor.
CPU	CPU Card	Microprocessor, plugs into the I/O board.
IB	Interface Board	Most external connections are made to this board.

Before any troubleshooting always check that all cards are properly plugged in, ribbon cables are properly socketed and that correct power is supplied.

6.2 Trouble Shooting Chart

SYMPTOM	POSSIBLE CAUSE
No display, failsafe LED off. No display, backlighting.	Fuse blown. Power supply failure, check ±15vdc and 5vdc.
No display and failsafe LED on.	Display failure. Video cable failure.
Display on but is garbled.	CPU card failing.
Buttons do not respond properly.	Connector from overlay to I/O board not, or improperly mated with J5. Front panel overlay defective. Defective I/O board (keyboard section).
Monitor does not save configuration changes	CPU card failure.

7. Monitor Information

7.1 Console Technical Description

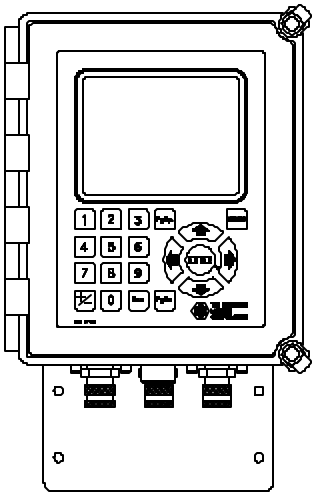
The console is constructed of molded fiberglass polyester to give protection in harsh environments.

Display

The LCD (liquid crystal display) has a pixel count of 640 by 480 to give very sharp resolution. The display is suitable for both graphics and text information.

Switch Matrix

The switch matrix is located on the outside of the console and allows the operator to make modifications and changes to the operating conditions of the instrument. The operation of this switch matrix is further explained in the operations section of this manual.



Display and Switch Matrix

7.1.1 Console Cards

IB (interface board) for external connection
The interface board is located on the back wall of the console. Most external connections are made to connectors that plug into this board. The only exceptions are optional features that require connections to optional available connectors located on the side of the console.

Power supply
The power supply is located in the top of the console and serves as a hold down clamp for the analog output modules. The power supply supplies power to both the I/O card and also the IB. The voltages supplied are +5 vdc and +/- 15 vdc.

I/O card
The I/O card handles most of the signal inputs and outputs from the instrument. Three ribbon cables from this card route the signals from the IB to the I/O card and power is supplied through a power cable to the I/O card from the power supply.

CPU card
The CPU card is found plugged into the PC/104 bus connectors of the I/O card. The CPU card operates with a X86 based STPC Atlas microprocessor running at 133 MHZ. The CPU card has a built-in flash EPROM hard disk drive, which contains the operating software, parameters and calibration points for the system.

Comm/LPT card
This card is mounted to the left above the interface board and is used to allow communication between the Monitor and the MPR E-Scan units. It also enables the Monitor to drive the printer and provides connections for the Remote Status Panel (RSP).

7.2 Monitor Specifications

Ambient temperature	Up to 125°F (52°C) Console – 32°F to 120°F (0°C to 50°C)
Processor	Ampro Core Module 420, 133mhz

7.3 Features

- Continuously monitors both refractometers and associated equipment, looking at all vital signals per unit to determine whether the displayed solids should be considered valid.

- Removes from service either refractometer whose associated signals do not meet a prescribed tolerance. An alarm will actuate, identifying the refractometer and circuit at fault. This feature greatly reduces the possibility of diverting unnecessarily due to a malfunctioning refractometer when relying on one refractometer reading low solids to divert.

- Configurable for divert when:

  Either refractometer reads dissolved solids content 58% or below, an automatic divert must take place or:

  Both refractometers read solids 58% or below an automatic diversion must take place.

  (Either of the above is in compliance with BLRBAC recommendations.)

- Provides failsafe monitoring of its own supply voltages. If a supply should fail, the Monitor will display its malfunction and go out of service.

- A trending option is also available through software configuration. This will provide a warning status that is triggered by an operator defined time constraint which acts as a divert predict window. Based on a build-in rate of change algorithm, the Monitor can determine whether or not a divert could occur within a specified time frame.

- All system errors, divert conditions, comparator and purge information are logged and can be viewed and printed by the operator.

- Intelligent Purge Cycle

  The measurement voltage is monitored in order to determine if the preceding prism wash was successful. If unsuccessful another purge cycle will be automatically initiated. In the case of three unsuccessful purge attempts, a purge error indicator is activated. In addition, the intelligent purge will terminate as soon as the prism is clean, thus protecting the prism from unnecessary purge action.

7.4 Specific Functions
(Dwg. A-11585)

Note: 58% +2% noted below are industry standards but may vary depending upon the application.

The Monitor is capable of performing the following functions:

1. Monitor the (+15), (-15) and (+5) supply voltage of each refractometer independently.
Should either refractometer's supply voltages exceed a predetermined safe operating voltage range with a minimum and maximum limit of ±10%:
a. An alarm will be activated, identifying the refractometer and circuit at fault.
b. This refractometer will automatically have its output forced low (and removed from service).
c. No liquor diversion will take place.

2. Monitor the lamp voltage of each refractometer independently.
Should either refractometer's lamp voltage exceed a predetermined safe operating voltage range with a minimum and maximum limit, steps (a), (b) and (c) will be implemented.

3. **Monitor the measurement voltage of each refractometer independently**.
Should either refractometer's measurement voltage exceed a predetermined safe operating voltage range with a minimum and maximum limit, steps (a), (b) and (c) will be implemented.

4. **Monitor the liquor temperature of each refractometer's sensing head independently.** Should either refractometer's liquor temperature exceed a predetermined safe operating range with a minimum and maximum limit, steps (a), (b) and (c) will be implemented.

5. Monitor the communications port.
Should either refractometer's serial communications port fail, steps (a), (b), and (c) will be implemented.

6. Monitor the automatic prism cleaning system of each refractometer.
Measurement signal must drop a proper amount during the purge cycle or an alarm will be activated. Also, the prism cleaning system must purge within a specified time or an alarm will be activated. In addition, any purge relays activated during non-purging operation will result in an alarm condition. In all these cases, steps (a), (b) and (c) will be implemented.

7. Monitor the isolation valve position.
A partially closed or closed valve will initiate steps (a), (b) and (c).

8. Compare meter outputs.
Should a difference of 2% solids or greater exist between refractometer readings, an alarm will be activated.

9. Monitor the supply voltages of the Monitor.
Should either supply fail, an alarm will be activated.

10. **With both refractometers in service, if either or both instruments (depending on configuration) read below 58% liquor, diversion will take place**.
If the instrument readings disagree on the percent of solids by 2%, an alarm will be activated.

11. **If one refractometer fails (or is removed from service), black liquor diversion will be controlled by the instrument remaining in service**. If this remaining instrument reaches 58% or below or an alarm is activated on remaining refractometer, diversion will take place.

12. **If the Monitor fails diversion will be controlled by the limit alarms on the refractometers**.
Both refractometers must read below 58% before diversion will take place.

13. **All system alarms are shown by flashing indicators on the Monitor**.
Requires OPERATOR or INST. TECH. action to clear. Each alarm condition is automatically printed on the Monitor on-line printer at the occurrence of the error.

7.5 Trouble Shooting Guide and Truth Table

(For unit configured for two refractometer divert.)

(X) Refrac removed from service
(Y) Refrac remaining in service now solely responsible for diversion. Diversion will occur if reading drops below 58% due to low solids or alarm being activated which would remove unit from service. (Alarms shown on next page.)

Condition for either Refractometer (1) or (2)	**Alarms Activated**	**Liquor Diversion**	**Additional Notes**
Loss of power to console, fuse open, etc.	1,2,3,5,8 (X)		(Y)
No (+)15 supply, defective component, fuse open, etc.	1,2,5,8 (X)		(Y)
No (-)15 supply, defective component, fuse open, etc.	1,2 (X)		(Y)
Loss of signal from head, lamp open, bad detector, etc.	2,7 (X)		(Y)
Process out of operating range, defective thermistor circuit, etc.	2 (X)		(Y)
Purge not cleaning prism, loss of steam, defective solenoids, etc.)	4 (X)		(Y)
Prism clean inoperative	4 (X)		(Y)
Isolation valve closed or partially closed.	5 (X)		(Y)
Drift in meter output due to defective components, improper calibration, etc.	7	If reading is below 58% solids on one unit & no alarms other than #7 are activated will divert when other refract purges	
Defective Monitor (+)15 or (-) 15 supply or loss of power.	6	If both refracs are reading below 58%.	

Condition for either Refractometer (1) or (2)	Alarms Activated	Liquor Diversion	Additional Notes
Loss of power to both refracs.	1,2,3,5,8	Will divert	
Failure of both refracs which would activate both alarms.	any combination	Will divert	
Refrac (1) and (2) indicates solids below 58%.		Will divert	
Loss of power to both refracs & Monitor.		Will divert	

7.5.1 Error Alarm Conditions

Alarm	Condition
1	Refract Power Supply out of tolerance. * +15 VDC power supply out of tolerance. * -15 VDC power supply out of tolerance. * +5 VDC power supply out of tolerance.
2	Sensing Head voltages out of tolerance. * Measurement voltage out of tolerance. * Temperature voltage out of tolerance. * Lamp voltage out of tolerance.
3	Serial communications port failure.
4	Purge errors. * Purge failure (prism not properly cleaned). * Purge missed (solenoid not activated at purge time). * Purge invalid (solenoid activated at non-purge time). * Purge not active (no times set in purge cycle).
5	Isolation valve closed.
6	Monitor Power Supply out of tolerance. * +15 VDC power supply out of tolerance. * -15 VDC power supply out of tolerance.
7	Comparator error, difference in readings greater than tolerance.

7.5.2 Warning Alarm Conditions

Alarm	Condition
8	System Warning. * Check lamp voltage, indicates lamp voltage in either sensing head is about 4.0Vdc. See maintenance section 8.5. * Check purge log, indicates successful purge after second or 3 attempt. Purge log contains duration of steam time needed. * Check analog solids, indicates direct voltage derived solids does not agree with RS-232 solids readings. * Check analog temperature, indicates direct voltage derived temperature does not agree with RS-232 temperature readings. * Check U1-U2 Com2, indicates E-Scan units are no longer able to communicate via serial port 2, thus all communications are going thru the Monitor unit. * Printer error/out of paper, indicates a problem with the printer.
9	Trend warning, indicates that a divert is predicted to occur within the operator defined trend limit time frame.

8. Service

8.1 EMC Warranty

The Electron Machine Corporation warrants that the equipment manufactured by EMC is free of defects in material and workmanship. Should such fault appear within two years of date of shipment from our factory, the Electron-Machine Corporation will repair or replace the defective part upon its prepaid return to Umatilla, Florida USA. (This warranty does not apply to equipment which has been tampered with or abused).

8.2 Return of Defective Parts

No return authorization is necessary. Pack defective parts carefully to avoid damage in transit. The shipper will be liable if, in the opinion of the carrier, insufficient packing was used. Attach a letter stating the nature of the difficulty encountered, the reason for failure (if known), the date of delivery of original equipment, and the approximate number of hours of operation.

Please include model number and serial number in all correspondence.

All return shipments must be prepaid.

8.3 Service in the Field

Services of factory trained field engineers are available at standard rates upon request. Requests should be addressed to:

Technical Services Department
The Electron-Machine Corporation
P O Box 2349
Umatilla, FL 32784-2349

For after hours emergency technical service please call 352-669-3101 to obtain the Technical Service phone number.

8.4 Spare Parts

8.4.1 How to Order Parts

Orders for parts should be addressed to:

Technical Services Department
The Electron-Machine Corporation
P O Box 2349
Umatilla, FL 32784-2349

Purchase orders should include the model number and the serial number of the equipment that the part is to be used with, in addition to the part number or drawing number and the chassis number.

If the part number or the drawing number is not known, give a detailed description including a sketch, if possible. All orders will receive prompt attention.
Phone: (352)-669-3101 Fax: (352)-669-1373 E-Mail: sales@electronmachine.com

8.4.2 Recommended Spare Parts

EMC Number	Description
511007	MDS E-Scan 'Refract' Door Assembly w/electronics
511008	MDS E-Scan 'Monitor' Door Assembly w/electronics
187304	4-20mA Module
187496	Power Supply PS-40
511002	Sensing Head E-Scan
73500	Relay 2940427 Phoenix
69655	Printer Paper
596405	O-ring 03-030 Viton
46601	Fuse Pico 5 amp (little fuse)
45801	Fuse 1 amp Slo Blo (little fuse)
44103	1 PSI Check Valve SS-4CP-2-1 (Nupro)

8.5 Maintenance

MDS E-Scan Monitor Divert System Periodic Inspection Checklist

We recommend the following checks be performed at least on a monthly basis under normal operation.

- **Desiccant condition:** The desiccant seen through the view plug on the sensing head should be light orange when effective and clear when no longer effective. The desiccant can be renewed by heating to approximately 250°F (121°C) until it recovers its original color.

- **Isolation valve position:** Verify (if equipped) it is turned fully counter-clockwise (completely open)

- **Check printer for error/warning logs:** Refer to chapter 5 in the manual for explanations. Keep a copy of printouts for EMC service personnel.

The following checks are made from the Monitor panel of the system by pressing MENU, selecting DIAG and then VOLTAGES.

- **U1 Meas / U2 Meas:** between 2.00 to 8.00 (depends on calibration and current product strength)

- **U1 Temp / U2 Temp:** Compare temp. on solids meter to the voltage using (Voltage - 0.5V)x50=°C

- **U1 Lamp / U2 Lamp:** Less than 3.80 (If not adjust R20 on Analog Board in sensing head for approx. 3.50. Measure lamp voltage in the sensing head across TB1-3 and TB1-9.)

- **U1 0–10 / U2 0–10:** Depends on range of unit and current product strength (Ex: If 50-80% is the range, 50%=0 and 80%=10)

- **U1 +5 / U2 +5:** Between 4.75 and 5.25

- **U1 +15 / U2 +15:** Between 13.50 and 16.50

- **U1 –15 / U2 –15:** Between –16.50 and –13.50

- **MDS +15:** Between 13.50 and 16.50

- **MDS –15:** Between –16.50 and –13.50

8.6 Caution

CAUTION

When removing the sensing head from an operating line**, *do not assume that the line is empty or that the isolation or bypass means is working properly***. If an EMC isolation valve is used, be sure its travel is not limited by any external attachments or other interference and the valve is closed tightly. No pressure should be felt on the head as the mounting nut is being removed.

ANY PRESSURE FELT WHEN THE NUT IS LOOSENED MUST BE INVESTIGATED BEFORE PROCEEDING. Steam should be turned off before attempting to remove head.

Use a face shield and protective clothing. Stand to the side when removing the sensing head.

Clean all black liquor residue from spud-piece on adapter prior to re-insertion of sensing head. The o-ring seal should be replaced before re-installation.

CAUTION

Close off isolation valve or remove the sensing head and replace with maintenance plug prior to steam cleaning process lines to prevent prism breakage.

-Notes-

9. Drawings List

Drawing #	Rev	Description
A-11575	B	Outline, MDS E-Scan Hoffman Console
B-11586	H	MDS E-Scan System Interconnection Diagram
A-12588	A	Outline, Remote Switch & Indicator Console
A-12587	A	Interconnection Diagram Remote Switch & Indicator Console
B-11572	K	Interconnection Diagram, MDS E-Scan Console
A-11585		Diagram-Black Liquor Measurement & Diversion Control
A-12208	A	Block Diagram - MPR E-Scan
B-12699-1	A	Assembly MPR E-Scan I/O CPLD Board (Two Sheets)
A-12698	G	Schematic MPR E-Scan I/O/ CPLD Board (Six Sheets)
B-11859	F	Isometric, Low Power MPR E-Scan Sensing Head
B-11487-1		Parts Ident., Single/Dual Head, with/without S/S Connectors
B-11365	H	Assembly MPR E-Scan Interface Board
B-11366	C	Schematic E-Scan Interface Board
B-11480	D	Assembly E-Scan MDS Monitor Interface Board
B-11481	A	Schematic MDS E-Scan Interface Board
B-13024	A	Assembly, Analog Conditioning Board
B-13025	A	Schematic Diagram, Analog Conditioning Board
A-11792	K	Assembly Low Power CCD Sensor Board
A-11794	I	Low Power CCD Sensor Board
B-11423	A	Interconnecting Cable Console to Head, E-Scan
A-11768	B	Outline, MDS E-Scan Panel Mount (Option)
A-12901		Component Assembly E-Scan Backlight
A-12902		Schematic CCFL Inverter