



From lab to production,
providing a window into the process



Continuous Melt Rheometer CMR IV

MONITORING YOUR CONDITIONS FOR CONSISTENT RESULTS

Operating Manual



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Safety Instructions

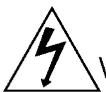
All safety instructions must be heeded and observed. Non-observance of safety instructions may cause damage to life and health of persons, environmental damage and/or extensive damage to property.

Observing the safety instructions included in the operating instructions will help to avoid dangers, to operate the installation profitably and to secure the full use of the product.

Warnings and Danger Symbols

General safety instructions concerning the activities are given at the beginning of the relevant chapter. Special safety instructions concerning the individual steps of action will be given together with the corresponding step of action.

The following pictographs are used in the present operating instructions

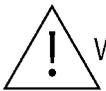


HIGH
VOLTAGE!

This symbol indicates that special danger to the life and health of persons will be given due to electric potential!



This symbol indicates that special danger to the life and health of persons will be given due to hot surfaces!



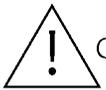
WARNING!

This symbol indicates that death, serious bodily injuries or considerable damage to property may occur if the corresponding safety measures are not observed



DANGER!

This symbol indicates that death, serious bodily injuries or considerable damage to property will occur if the corresponding safety measures are not observed!

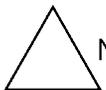


CAUTION!

This symbol indicates that death, minor bodily injuries or minor damage to property may occur if the corresponding safety measures are not observed!



This symbol indicates that sufficient personal protective equipment must be worn when working with the Dynisco component. The type of personal protective equipment will be defined in detail!



NOTE!

This symbol signals user hints and other special information, which may be useful. This symbol does not signalise safety instructions!

Please also note that a safety symbol may never substitute the text of a safety instruction - therefore, the text of a safety instruction must always be read completely!

Safety Summary

The following are recommended safety precautions unrelated to any specific procedures in this manual and therefore do not appear elsewhere. Personnel must understand and apply them as appropriate during all phases of operation and maintenance. **IN ALL CASES, BE PRUDENT.** Keep away from live circuits.



Do not replace components or make adjustments inside equipment with power turned on. To avoid injuries, always remove power and discharge and ground a circuit before touching it. When making electrical connections, the services of a qualified electrician must be employed. Contact with live electrical circuits can cause serious personal injury or death. Be sure no circuits are energized during installation, connection or removal of any electrical cables or lines.



Wear protective clothing (gloves, apron, goggles, etc.) approved for the materials and tools being used.



Provide ventilation to remove heat and noxious odors and to prevent the accumulation of asphyxiates such as nitrogen gas.



Keep hands away from hot surfaces and materials. Contact with hot surfaces or materials can cause blistering and third degree burns. Wear approved, clean, thermally insulated gloves when handling these components. Should injury occur; immerse injured area in cold water and get immediate medical attention.

Obligation of the operator to exercise due care

The Continuous melt rheometer (CMR IV) was planned and constructed taking into consideration a hazard analysis and after having carefully selected the harmonised standards as well as further technical specifications. Thus, the Dynisco component conforms to the state of the art technology and ensures a maximum of safety. In practical operation, this safety can, however, be achieved only if all necessary measures are taken. The obligation of the plant operator to exercise due care includes planning these measures and supervising their execution.

Especially, the operator has to ensure that:

- The Dynisco component will be used only in accordance with the intended purpose.
- The Dynisco component will be operated in a flawless, functionally efficient condition and that, in particular, the functional efficiency of the safety devices will be checked at regular intervals.
- The necessary personal protective equipment for the operating, maintenance, and service personnel will be available and used by them.
- The operating instructions are always available completely and fully legibly at the installation location of the Dynisco component. It must be guaranteed that all persons who have to work with the Dynisco component can consult the operating instructions at any time.
- Only sufficiently qualified and authorized personnel will operate, maintain, and repair the Dynisco component.



- Instructions concerning all relevant questions of industrial safety and environmental protection will regularly be given to the personnel, and that these persons will know and understand the operating instructions and, particularly, the safety instructions contained.
- All safety and warning instructions, attached to the Dynisco component, will not be removed and will remain fully legible.
- The service instructions in accordance with the industrial safety legislation and the ordinance for the use of work materials will have to be made available as a supplement to the operating instructions.

Obligation of the personnel to exercise due care

The Continuous melt rheometer (CMR IV) may only be operated by persons trained, instructed and authorized to do so. These persons must know the operating instructions and act accordingly. The respective competences of the staff must be clearly determined.

The following work described in the operating instructions may be carried out by qualified persons only:

- Assembly
- Start-Up
- Operation
- Servicing

Especially, the staff has to ensure that:

- Operating personnel to be instructed to work with the Dynisco component are supervised by an experienced person.
- All persons operating or maintaining the Dynisco component have read the operating instructions and confirm by their signature that they understood the instructions.
- Unauthorized persons must not stay in the working area of the Dynisco component.
- The working area must be posted with the hazards of hot and movable parts.
- Additionally to the operating instructions and service instructions may need clarified within the meaning of the observed industrial safety legislation and ordinances for the use of the machine, tools, and work materials.
- In case of a malfunction, the operator or the supervisors must be informed immediately.
- The necessary and approved personal protective equipment (PPE) for the operating, maintenance, and service personnel must be used.

Important Intrinsicly Safe Information

This information is specifically for equipment supplied to meet the requirements of Class 1, Division 2, Groups C & D.

WARNING: EXPLOSION HAZARD—SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2, GROUPS C & D RATING.

If the RCU cabinet is equipped with a BEBCO EPS cabinet purge system. The requirements for this purge system are:

Operating Temperature:	-20°F to 120°F (-30°C to 50°C)
Operating Pressure:	80 PSI (5.5Bar) to 120 PSI (8.27 Bar)Maximum
Capacity & Filtration:	3.8 Oz. @ 40 Microns
Gas Supply:	Clean Air or Inert Gas
Exchange Pressure:	3" to 5"
Exchange Flow Rate:	10 SCFM
Exchange Time:	1 Minute per each 2.5 Cubic Feet (RCU cabinet is 7.3 ft3)

NOTE: A minimum purge time of 5 minutes is recommended before operation

There are no switching components in the rheometer head, therefore, no purge is required.

If the cabinet seal is broken, the control system will detect this failure, shut the control outputs off and set an alarm. The alarm should be wired to an external alarm system that is located in a constantly occupied area.

The temperature of the incoming material must not exceed 350°C (660°F).



System Description

The DYNISCO POLYMER TEST On-Line Rheometer is a PLC based rheometer designed specifically for the polymer process industry to make rheological measurements on the general class of thermoflow polymers, blends and variations as well as that of other flow-able materials.

The rheometer performs capillary rheology at a test temperature on a small sample stream of polymer melt taken from the process extruder. Extruder pressure is required to feed the rheometer metering pump. The metering pump controls the flow rate through the test capillary and a pressure transducer measures the capillary pressure drop. The rheometer can be set up to provide a constant pressure test (ASTM, CIL, etc.) measuring flow rate to calculate “Melt Flow” units, or the rheometer can be set up to provide a constant flow rate test, measure pressure drop across a capillary and calculate “Viscosity” units.

Rheometer Control Unit

The Rheometer Control Unit (RCU) contains the control and display components of the rheometer. It is comprised of the PLC, power supplies, and logic control circuitry to drive the Rheometer. The RCU is designed to operate in a non-hazardous location or, with appropriate air purge equipment, in an IS division/classified area.

Rheometer

The Rheometer contains the flow producing and flow measurement components of the rheometer. It is comprised of the positive displacement metering pump, variable speed DC motor, pressure transducer, capillary, temperature sensors and heaters. The rheometer must be close-coupled to the customer’s polymer melt source.

Field Wiring

Customer provided field wiring connects the RCU to the Rheometer and the analog and digital signals to the remote process computer. The field wiring is provided by the customer unless otherwise specified.



Equipment List

Because of the system options available, the customer should refer to the purchase order for the particular configuration and accessories. However, the following items are part of the standard DYNISCO Polymer Test rheometer system:

- Orifices
- Calibration Adapter
- Jam Nut
- Jam Nut tool

Equipment Required – But Not Supplied

The two pieces of equipment required for calibration of the rheometer is a dead weight tester that is sufficient range to cover the pressure of interest, and a temperature simulator. Trouble shooting routines will isolate to the module level and should require only a multimeter

General Specifications

System Power Requirements:	230/240 VAC (refer to field wiring diagram) 50/60 Hz, 1 phase 1000 W nominal (2000 W during heat up) – if an auxiliary heat zone is connected, it is limited to 150W Max
Rheometer:	
Pressure Transducers:	
	250 PSI (optional 500, 1500, 3000 PSI)
Combined Error:	0.5% FSO
Repeatability:	0.1% FSO
Metering Pump:	0.160 cc/rev (optional 0.297, 0.584 cc/rev)
Gear Reducer:	23.95:1 ratio
Heaters:	350 watts each zone
Motor:	1800 RPM HP Permanent Magnet
Tachometer:	Hall Effect pulse output
Temperature Probes:	
Melt /Block Temperatures:	100Ω RTD (0.385a)
Surface Temperatures:	100Ω RTD (0.385a)



Rheometer Control Unit (RCU):	
Analog Output Signals:	4 to 20 mA DC – maximum load 650Ω
7 Output Channels Available:	User selectable from a list that includes MFR, pump speed, pump zone temperature, capillary zone temperature, melt temperature, pressure, and viscosity. Each output is individually scalable
Analog Input Channels:	4 to 20 mA DC current, remote sourced
2 Input Channels Available:	User selectable from a list that includes pressure, speed, and temperature. Each input is individually scalable
Digital Output Signals:	Dry contact relays – 50 VA maximum, System Fault Alarm, System Warning Alarm, Local/Remote status, Pump operating status
Digital Input Signal:	24 VDC, Remote Test On/Off, Remote Heat On/Off, Remote Mode (Press/Speed)
Physical Characteristics:	See enclosed drawings for actual unit dimensions.

Theory Of Operation

Melt viscosity measurements such as Melt Flow Index have long been a primary specification on thermoplastic resins. Because MFI and melt viscosity are related to polymer molecular properties, these numbers give the customer some measure of the physical properties of the product as well as the polymer processability.

The DYNISCO POLYMER TEST rheometer duplicates the test conditions used in laboratory rheometers. These conditions are specified in ASTM D1238. With the laboratory rheometers, pellets are dropped into a test chamber where they are melted, and a weighted plunger on top forces the melt through a capillary orifice. The weight of the extrudate in terms of 'grams/ 10 minutes' is called 'Melt Flow Index (MFI)'. This is a very simple and effective viscosity measurement. However, because of the short capillary L/D, this rheometer measures not only the viscous losses in the capillary but also the visco-elastic losses in the capillary entrance. The measurement in the ASTM plastometer therefore is a function of both the rheometer geometry as well as polymer viscosity. For this reason the ASTM D1238 standard defines both the plastometer as well as the polymer test conditions (Figure 1).

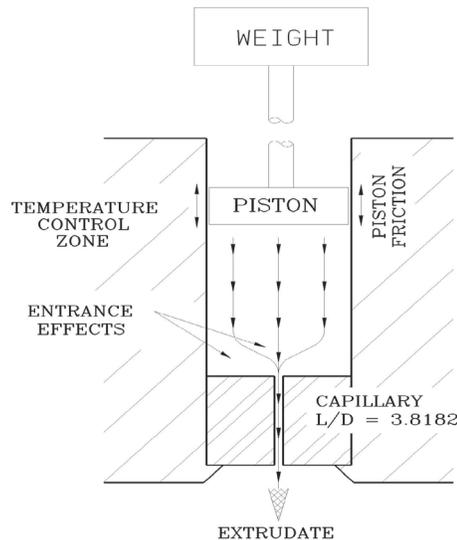


Figure 1 Laboratory Rheometer

Whereas laboratory rheometers are hand loaded with pellets and use weights to create shear conditions, on-line rheometers use the metering pump, orifice and pressure transducer to generate and measure shear conditions. Typical on-line rheometers rely on the process pressure to force the polymer melt into a metering pump and the pump then generates the flow rate and the pressure to extrude the polymer through a precision orifice. Orifice pressure is measured by one or more pressure transducers depending on the type of rheometer. In the on-line rheometer, the test polymer extrudes to atmosphere (falls to the floor) and a single pressure transducer is located above the capillary. This simple type of on-line rheometer very closely duplicates the internal geometry of the ASTM plastometer therefore the capillary entrance effects. In the ASTM mode of operation, constant pressure defined by the ASTM method is set by controlling the gear pump flow rate (Figure 2). Gear-pump speed, pump flow rate and flow density then gives MFR directly as a function of pump RPM.

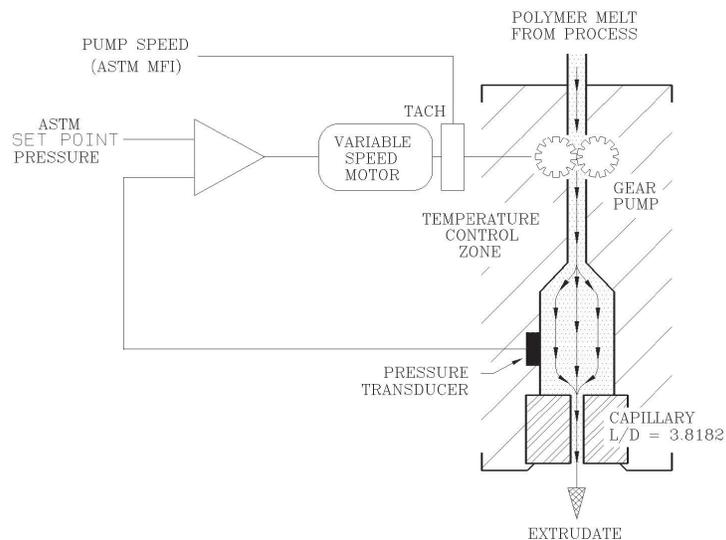


Figure 2 ASTM MFR Mode

In the VISCOSITY mode of operation, constant gear pump speed (SR) is set by controlling the gear pump RPM. The capillary L/D and pump volume can also be changed to set the SR to the necessary range. The pressure is measured above the capillary and used to calculate the SS. The VISCOSITY is calculated from the SS and the SR (Figure 3).

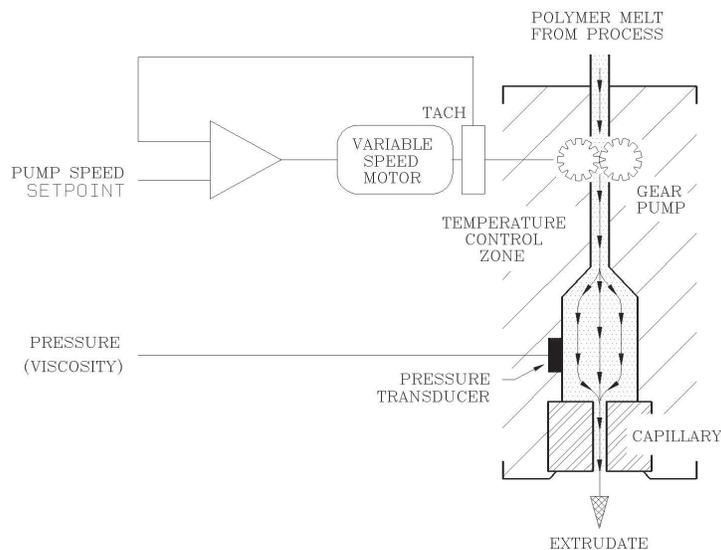


Figure 3 Viscosity Mode



Rheometer Operation

This portion of the manual provides information on how to operate the rheometer. It is recommended the user review the Operator Display section IV to get familiar with the operation of the display.

Local Operation

Motor ON

1. Depending on what test is needed, pressure (MFI) or speed (viscosity) control, select that mode on the Process Setpoints screen. Confirm that the Pressure setpoint and Speed setpoint show the correct value.
2. On the Pressure Calibration screen, confirm that the calibration method field shows “Automatic”. If the calibration method is not “Automatic”, perform the pressure transducer calibration given in the Calibration section of this manual.
3. The heat must be on and at temperature. Press the “Motor is OFF” button. The button will change to “Motor is ON”. Change the speed setpoint in the Setpoint screen.
4. Verify that the pump speed and pressure slowly increases to the setpoint.
5. Depending on the required test, speed or pressure, the speed or pressure should settle at the appropriate setpoint. For most MFI tests, the mode of operation is PRESSURE and the pressure set point is 43.2 PSI.
6. Verify that the indicated pressure is within the pressure transducer’s nominal range (between 10% and 90% of full-scale range).

Motor OFF

1. Press the “Motor is ON” button. The button will change to “Motor is OFF”.



Remote Operation

The signals must be momentary with a minimum duration of 4 seconds.

External Air Purge Panel Operation (if so equipped)

1. Refer to the manufacture's instruction manual for detailed instruction of the proper use of the purge panel.
2. In summary, the air supply must be applied to the purge panel for 30 minutes before the cabinet power can be turned ON.

Heat ON

1. Apply power to the rheometer control cabinet.
2. In the Machine Configuration screen, heat must be enabled for control from a remote source. Enable the remote control in the Setpoint screen.
3. When the Remote Process Computer closes the contacts, the heaters are enabled. After 2 to 3 minutes, the indicated temperature should start to climb.

Heat OFF

1. The command to disable the heaters may come from the Remote Process computer.
2. When the Remote Process Computer opens the contacts, the heaters are disabled.

Motor ON

1. In the Machine Configuration screen, motor must be enabled for control from a remote source. Enable the remote control in the Setpoint screen.
2. The command to enable the motor may come from the remote process computer. When the remote contact is closed, the motor will be enabled, and when the remote contact is opened, the motor will be disabled.

Motor OFF

1. The command to disable the motor may come from the Remote Process computer. When the Remote Process Computer opens the contacts, the motor is disabled.

Recommended Service Schedule

Visual Leak Inspection – every week.

Gear Reducer – after an initial operating period of approximately 250 hours, the gear reducer should be drained (preferably while warm) and refilled with fresh oil. Under normal operating conditions, the gear reducer should be lubricated every 2500 hours, of operation, or every 6 months, whichever comes first.

Pressure Transducer Calibration - every 60 days or after service.

Motor Speed Controller Calibration - every 6 months or after service.



Unpacking The Equipment

Provide adequate handling equipment and personnel when moving the packaged equipment. This electric instrumentation equipment should be handled with care to prevent damage during unpacking and installation. Before opening the packing crates ensure that the equipment is oriented properly (refer to markings on crates to determine which end is up). Open crates and boxes with proper equipment so as not to puncture and damage breakable equipment inside.

After removing the equipment from the crates, carefully inspect each item for shipping damage. Check for dents, scratches, chipped paint, etc., that could have been incurred during transit or while opening the crates. Open the Control Unit and Rheometer and check for broken parts and wires.

**** IMPORTANT ****

Check the equipment received against the packing list to make sure that all equipment listed has been received. Use established procedures and report immediately any damage or shortages to the carrier.

Installation

Rheometer Control Unit (RCU)

The rheometer is designed to be installed in a process environment. The RCU is housed in a NEMA 4 cabinet and should be located near the Rheometer. Refer to the OUTLINE DIMENSION for mounting information.

Considerations for Rheometer Control Unit Location

- Locate the RCU so that the operator interface on the front panel is easily accessible and at eye level for easy operator access.
- Clearance must be provided to open the RCU door for service and trouble shooting.

Rheometer Installation

The Rheometer is installed at the source of polymer melt. Refer to the OUTLINE DIMENSION (Rheometer) for mounting information.

Considerations for Rheometer Location and Installation

1. Free access is available to change capillaries and to calibrate the transducer.
2. Access is available to the extruder adapter shutoff and bleed valves.
3. Extrudate from the capillary and extruder bleed valves can be easily removed.
4. The Rheometer does not interfere with other equipment.

Interconnecting Field Wiring

Refer to the Field Wiring Diagram for Remote Control Unit to Rheometer wiring and Remote Control Unit to customer equipment wiring. The Field Wiring diagram also gives required wire size information.

Grounding

All equipment must be grounded in accordance with applicable electrical codes.



Rheometer Control Unit (RCU) Technical Information

This manual section covers the operation of the RCU (Rheometer Control Unit) software and hardware. This discussion assumes access to the local operator display. Operation of the local operator display is discussed in another section of this manual.

The RCU controls the operation of the rheometer. The RCU is able to display data and receive commands from the local display, respond to digital commands from a remote process computer, and provide analog signals to the remote process computer. The RCU can be controlled from a remote IBM-PC compatible computer running optional control software.

The primary functions of the RCU software are: (1) executing feedback control loops (temperature control and motor control), (2) checking for alarm conditions (high temperature, high pressure, high speed, etc.), and (3) communicating with the operator via the local display, the remote control signals and/or the optional remote PC, and (4) performing the system calculations.

On power up, the RCU enters the “IDLE-NOT READY” process state. The process state and the process status are displayed in the HMI screen. The process states are Idle-Not Ready, Warm-up, Idle-Ready, Run, Soak, and Standby. Figure 4 shows the process states.

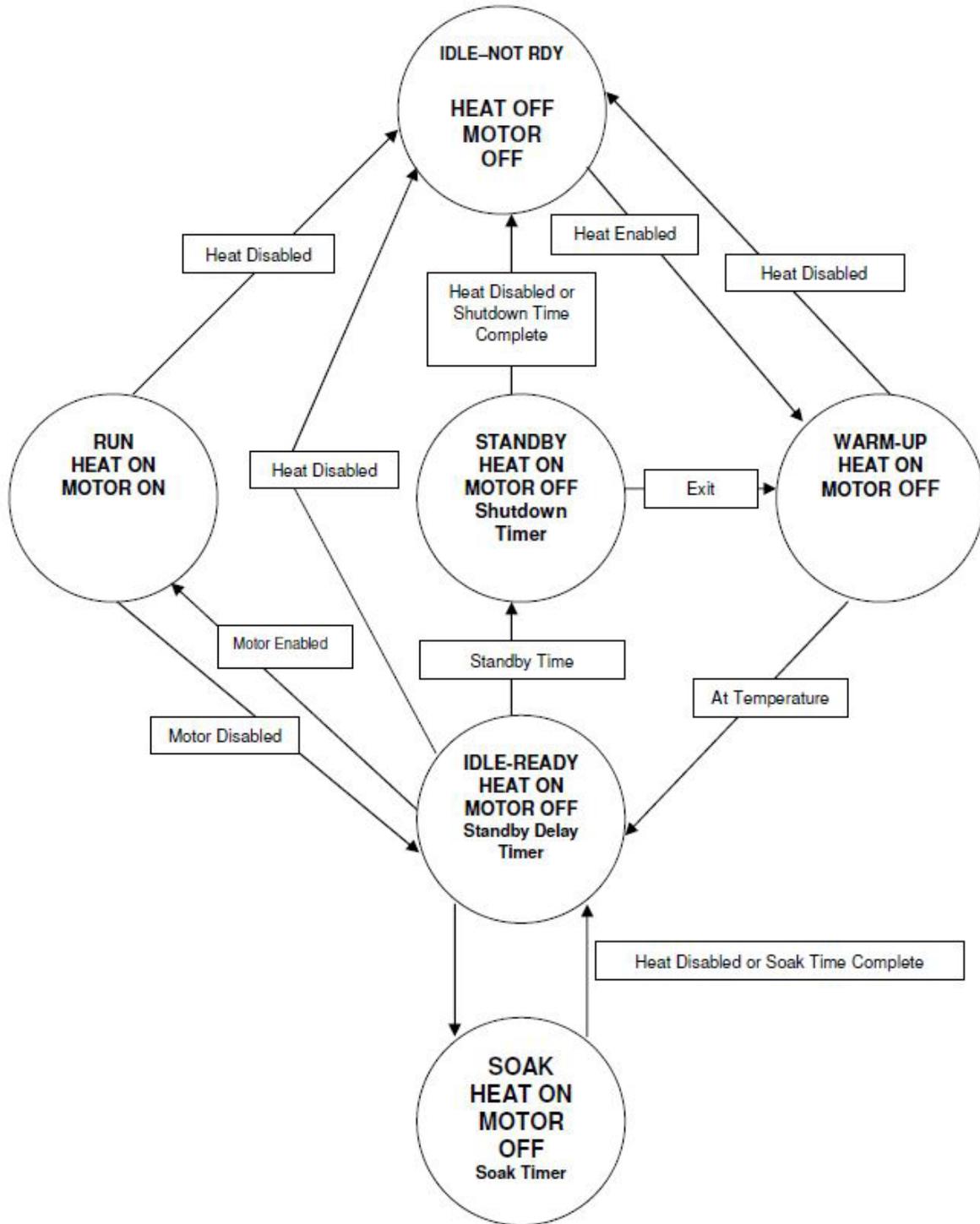


Figure 4 Process States



Software Operation

A computer program (software) resides in the CPU module in the RCU. This program controls the operation of the rheometer head.

Software Timing

In the main loop the following functions are performed at the given intervals:

- Check for alarms -- 500 msec interval
- Update the machine state -- 500 msec interval
- Read 4-20 mA setpoints -- 1 second interval
- Read remote discrete inputs -- 1 second interval
- Write to HMI -- 1 second interval
- Write 4-20 mA outputs -- 1 second interval
- Write RS-232 outputs --- 1 second interval
- Acknowledge alarms -- 1 second interval
- Perform rheometer calculations -- 2 second interval
- Update HMI faults/warnings -- 2 second interval

Every 250 milliseconds, a CYCLIC INTERRUPT routine is executed. The cyclic interrupt controls the timing for the following functions:

- All pressures are sampled every 250 milliseconds and converted to the desired engineering units. The sampled values are averaged over a 5 second window to produce the pressure value. When the motor is running, the motor PID loop controls the motor depending on the mode selected (PRESSURE or SPEED).
- The metering pump speed is sampled every 250 milliseconds and converted to engineering units (RPM). The sampled values are averaged over a 1 second window to produce the speed value. When the motor is running, the motor PID loop controls the motor depending on the mode selected (PRESSURE or SPEED).
- The temperatures are sampled every 500 milliseconds and converted to engineering units (degrees Celsius). The sampled values are averaged over a 5 second window to produce the temperature value. When the heat is on, all temperature PID loops are controlling the temperatures.

Every minute an interrupt routine is executed. This routine handles the soak/standby/shutdown/purge timers along with the machine hour statistics. The accuracy of the timers is +/- 1 minute.

Test parameters and transducer calibrations values are stored in the battery-backed memory and will be “remembered” if the rheometer is powered off. If a PROGRAM ERROR occurs (any error that could “lock up” the CPU), the motor and heaters will be turned off.

Alarm/Fault Logic

One of the major functions of the RCU control system is to check for various alarms detailed below. Some of these alarms are “warnings”. Warnings appear in yellow in the process status on the HMI. Warnings also deactivate the warning relay (contacts will open). Warnings exist for information only. In these cases, the RCU takes no further action beyond the indication. Faults are conditions that can result from a hardware failure and could result in equipment damage. Faults appear in red in the process status on the HMI. Faults deactivate the fault relay (contacts will open). Each alarm is described below along with the action the RCU will take.



Warnings

Temperature Low

- CAUSE: The heat is enabled, the motor is disabled, and the temperature is below the low limit as set in screen 257 CFG – Limits

Temperature High

- CAUSE: The heat is enabled and the temperature is above the high limit as set in screen 257 CFG – Limits

Pressure Low

- CAUSE: Pressure is below the low limit as set in screen 257 CFG – Limits
- CAUSE: Pressure is below 10% of the full scale transducer range

Pressure High

- CAUSE: Pressure is above the high limit as set in screen 257 CFG - Limits

Speed Low

- CAUSE: In speed mode, the motor is enabled and the speed is below the low limit as set in screen 257 CFG – Limits
- CAUSE: Speed is less than the minimal allowable speed (1 RPM)

Speed High

- CAUSE: In speed mode, the motor is enabled and the speed is above the high limit as set in screen 257 CFG – Limits
- CAUSE: Speed is 1% over the maximum allowable speed (80 RPM)

MFI/MV/RV/IV Low

- CAUSE: The material property selected in screen 132 Setup-Warning is below the low limit selected.

MFI/MV/RV/IV High

- CAUSE: The material property selected in screen 132 Setup-Warning is above the high limit selected.



Faults

Fault	Possible Cause	Action
Temperature Low	The heat is enabled and the motor is enabled (RUN state) and the temperature is below the low limit as set in screen 257 CFG – Limits.	Shuts off the motor
Temperature High	The temperature exceeds the maximum temperature as set in screen 257 CFG – Limits.	Shuts off the motor - Shuts off the heater
Pressure Low	The scaled pressure transducer reading is 5% below the transducer's zero output.	Shuts off the motor
Pressure High	The scaled pressure transducer reading exceeds the full scale range of the transducer by 5%.	Shuts off the motor
Speed Low	Speed is less than the minimal allowable speed (1 RPM) for 1 minute.	Shuts off the motor
Speed High	The speed exceeds the maximum motor speed by 1% (40.4 RPM) for 1 minute.	Shuts off the motor
Motor Fault	A motor fault has occurred.	Shuts off the motor
Emergency Stop	The emergency stop input has been deactivated.	Shuts off the motor – Shuts off the heater
Calib Error	Occurs when attempting to calibrate the pressure transducer under the following conditions: 1. Heat is OFF. 2. Rheometer is “Below Temp”. 3. Motor is running.	Unable to start the motor
Temperature Fault	No sensor or faulty sensor connected to the PLC module.	Shuts off the motor - Shuts off the heater
Pressure Fault	No sensor or faulty sensor connected to the PLC module.	Shuts off the motor
Speed Fault	No sensor or faulty sensor connected to the PLC module.	Shuts off the motor



CPU OK Indicator

To indicate the PLC software is executing, PLC module 9 the last LED (second group channel 7) will flash. This is the CPU is alive indicator. To indicate communication to the HMI, the LED above the CPU indicator will flash. This is the HMI is alive indicator.

Hardware Description

Major RCU components include AC power devices, DC power supplies, MSC (Motor Speed Controller), the PLC modules including analog and digital signal conditioning modules.

AC Power Protection

Main power is supplied through Main Power switch S-1. Breaker BR1 provides protection for the RCU cabinet. The motor speed controller (MSC) contains an input and output fuse for protection. Refer to the proper assembly drawings for details.

AC Power Relays

There are two high current relays to switch line power to the heater circuits and the MSC (ENABLE relays). In the heat control circuit, SSR's (solid state relays) send the line AC power to each individual heater.

Power Supplies

There are three DC power supplies in the RCU. A 24 VDC power supply provides power for the analog and digital modules (external power), the heater control relays, power enable relays and the motor over-temperature switch. A 10 VDC power supply provides power for the pressure transducer. The PLC has an internal 24 VDC power supply, which also provides power for the local display panel. The frequency-to-voltage converter module supplies the power for the tachometer.

CPU Module

The CPU module is the “brain” of the RCU. Major functions include supervising the rheometer heaters and drive motor, providing the operator display feature, and communicating data to the optional PC and/or network.

Analog Signal Conditioning

Low-level analog signals generated by RTD's pressure transducers, and tachometer voltages are not compatible with the digital circuits that comprise the CPU. These analog signals must be converted into a form suitable for the CPU.

Analog Input Modules

The PLC uses two analog input modules. The first input module is setup to read the RTD sensors inputs. The second input module is setup to read the pressure transducer millivolts, the tachometer voltage, and any optional remote analog input signals.

Shown below is an example of how the remote analog inputs are converted into set points. The remote analog inputs are selected on screen 255 CFG mA in. The analog inputs are calibrated and scaled on screen 241 Ana In Cal 2.



$$\left(\frac{(\text{input}_{\text{mADC}} - 4_{\text{mADC}})}{16_{\text{mADC}}} \right) \times \text{RANGE} + 4_{\text{mA_value}} = \text{SP}_{\text{eng}}$$

RANGE = 20_mA_value – 4_mA_value
(Set the 20 mA and 4 mA limits in screen 241 Ana In Cal 2.)

SP = setpoint_{engineering units}

With the 4-20 mA input scaled to 0-100 RPM, a 6 mA input produces a speed setpoint of 12.5 RPM.

$$\left(\frac{(6.00_{\text{mADC}} - 4_{\text{mADC}})}{16_{\text{mADC}}} \right) \times (100 - 0)_{\text{RPM}} + (0)_{\text{RPM}} = 12.5_{\text{RPM}}$$

Analog Output Modules

The PLC uses two analog output modules. This module provides a 0 to 10 VDC control signal to the motor speed controller and the 4 to 20 mA output signals for the remote process computer.

Shown below is an example of how values are converted into a 4 to 20 mA DC output signal. The remote analog outputs are selected on screen 256 CFG mA out. The analog outputs are calibrated and scaled on screens 242 Ana Out Cal 1, 243 Ana Out Cal 2, and 244 Ana Out Cal 3.

$$\left(\frac{PV_{\text{eng}} - PV_{\text{min}}}{PVFS_{\text{eng}}} \right) \times 16_{\text{mADC}} + 4_{\text{mADC}} = \text{Output}_{\text{mADC}}$$

PV = Process variable_{engineering units}

PVmin = min mA value

PVFS = Process variable full scale_{engineering units} = max mA value – min mA value

Max and Min mA values are set in screens 242-244

With a temperature of 200 C, a min scaled value of 0.0 C, and a max scaled value of 400.0 C, the output is 12 mA.

$$\left(\frac{200.0\text{C} - 0.0\text{C}}{400.0\text{C} - 0.0\text{C}} \right) \times 16_{\text{mADC}} + 4_{\text{mADC}} = 12.00_{\text{mADC}}$$

Digital Signal Conditioning

DIGITAL INPUT MODULE

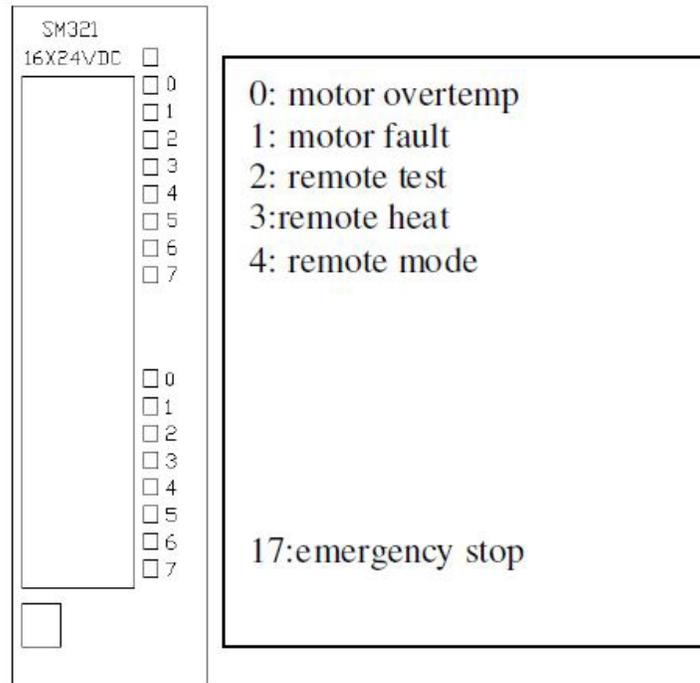


Figure 5 - Digital Input Module

Digital Input Module

All digital input signals to the PLC are 0 (zero) or 24 VDC. The digital input signals are generated internally (safety voltage, etc.) or from an external source (Remote Test Start/Stop, etc.). The internal digital input signals are connected directly to the digital input module. The remote digital input signals are connected to a PLC RELAY. The PLC RELAYS are used to isolate each PLC digital channel. The PLC RELAY is discussed elsewhere in this section. Each digital input channel has an LED to indicate when the input signal is present.

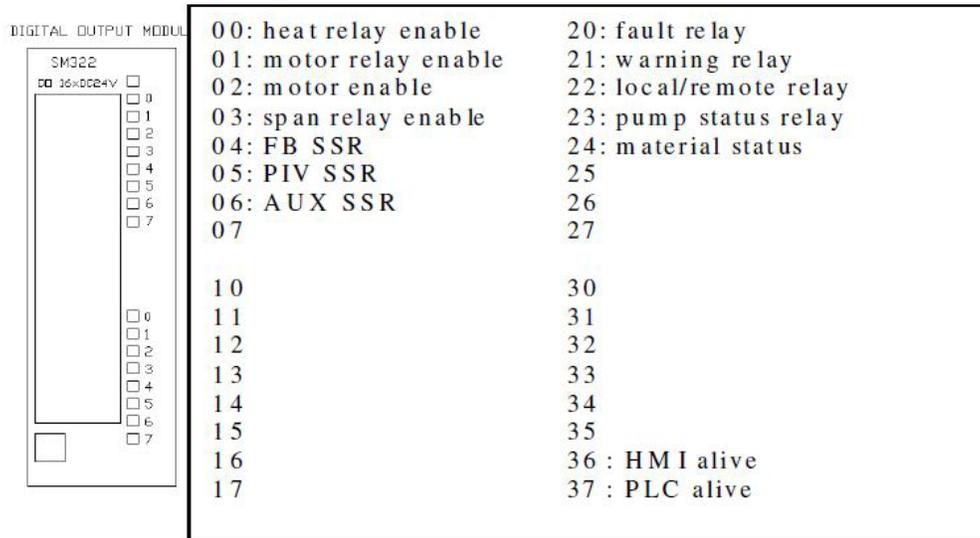


Figure 6 - Digital Output Module

Digital Output Module

All digital output signals from the PLC are 0 (zero) or 24 VDC. The digital output signals are used internally to drive various relays (Heat Enable, Temperature Control, etc.) or provide a dry contact for an external device. The internal digital output signals are connected directly to a control relay. The digital input signals used for an external device are connected to a PLC RELAY. The PLC RELAYS are used to isolate each PLC digital channel. The PLC RELAY is discussed elsewhere in this section. Each digital output channel has an LED to indicate when the output signal is present.

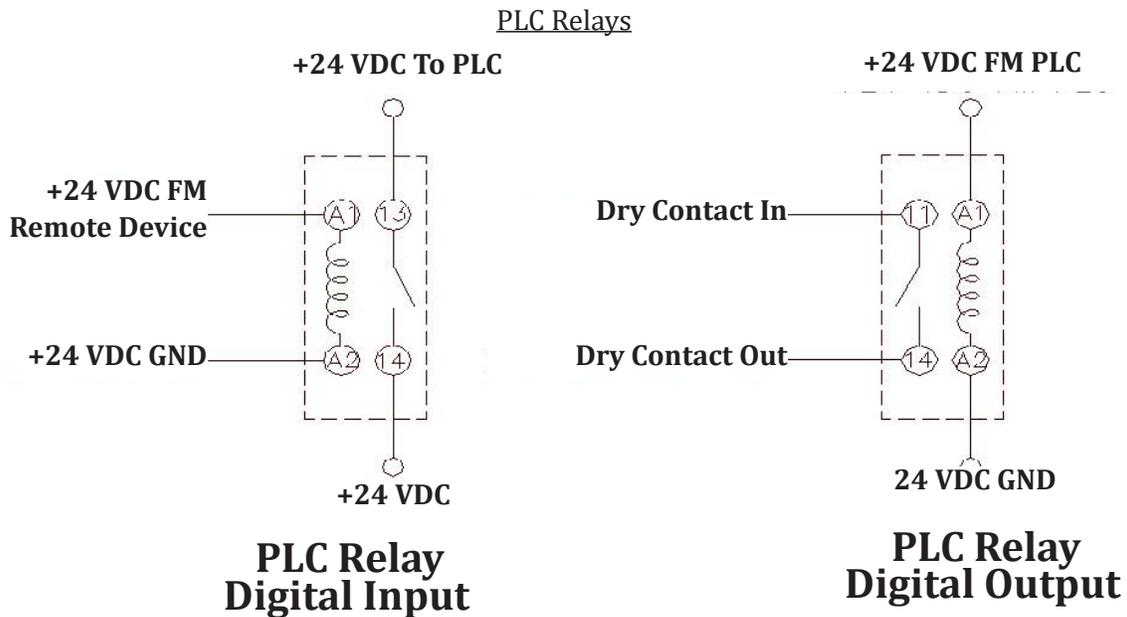


Figure 7 - PLC Relays

The purpose of the PLC-RELAY is to isolate the PLC from external devices, both input and output. The RCU uses a single pole single throw normally open PLC-RELAY. 24 VDC input coils are used unless otherwise specified.

Temperature Indication and Control

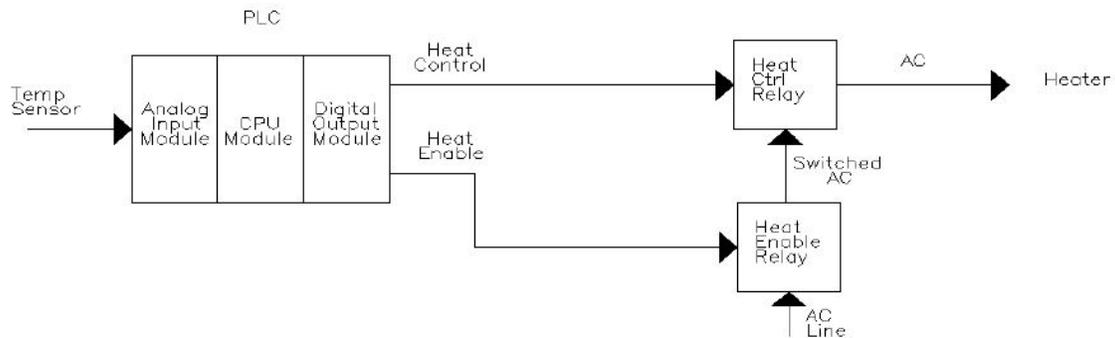


Figure 8 - Simplified Temperature Indication and Control

Temperature Indication

Each individual temperature is read by a grade “A” 100Ω RTD. The low-level temperature signal is connected to the rheometer control unit via the field wiring. The low-level signal is fed to the PLC ANALOG INPUT MODULE where it is converted into a digital code. This digital code is used by the PLC’s firmware to calculate the indicated temperature in engineering units.

Temperature Control

The indicated temperature is compared to the temperature setpoint in the temperature PID control loop. The output of the temperature control loop is the value necessary to maintain the temperature setpoint. This output value is 0 to 100%. The output signal is known as a TPO (Time Proportional Output) signal. Figure 8 shows an example of a 50% duty cycle heater’s control signal for 2 one-second cycles.

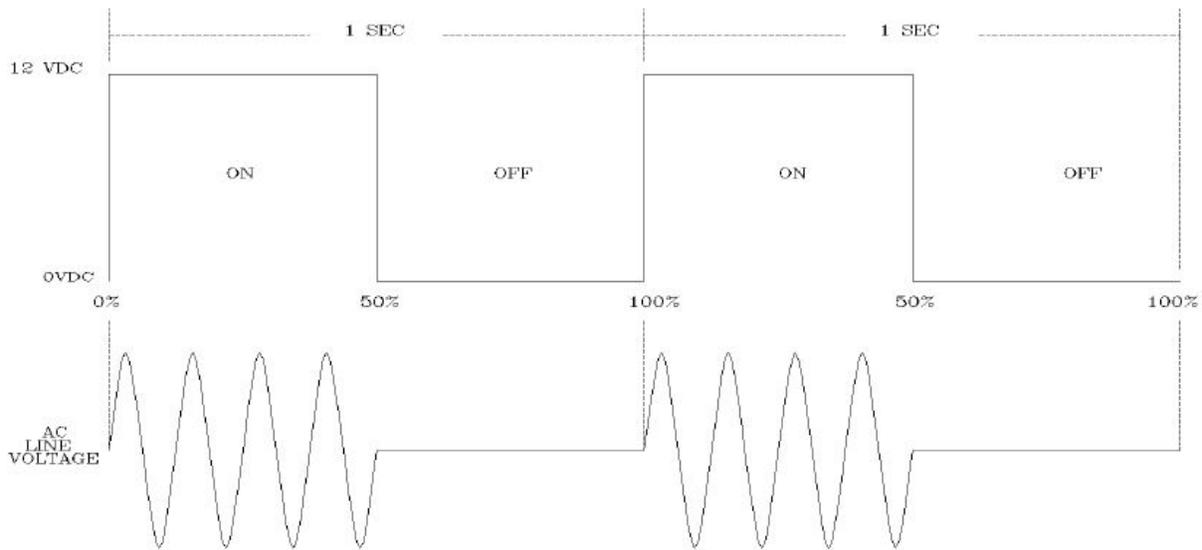


Figure 8 - Time Proportional Control Signal

The TPO heater control signal is fed via the cabinet wiring to the HEAT CONTROL PLC Relay and then to the SSR (solid state) relay. When the LED on the DIGITAL OUTPUT MODULE for that TPO channel is ON, the DC TPO control signal is fed to the heat control SSR. The CPU also switches the AC power to the HEAT ENABLE relay. When the operator turns the HEAT ON, the PLC enables the HEAT ENABLE relay. When the LED on the DIGITAL OUTPUT MODULE for that channel is ON the HEAT ENABLE relay feeds the line AC voltage to each HEATER CONTROL SSR relay. When the heat control SSR relay is on, it acts like a switch and allows the line AC voltage to be delivered to the heater (based on the control signals duty cycle). Figure 8 shows a 50% duty cycle DC control signal and the associated heater AC signal.

Motor Indication and Control

Pressure Indication

The capillary pressure is read by its sensor (unbonded strain gauge wheat stone bridge). This low-level pressure signal is connected to the RCU via the field wiring. The low-level signal is fed to the ANALOG INPUT MODULE where it is converted into a digital code. This digital code and the pressure calibration data are used by the CPU's firmware to calculate the pressure in engineering units.

Speed Indication

The motor/metering pump speed is a 0 to 2400 Hz signal generated by the tachometer. This frequency signal is fed to a frequency to voltage converter. The output of the frequency to voltage converter is a 0 to 10 VDC signal. The low-level signal is fed to the ANALOG INPUT MODULE where it is converted into a digital code. This digital code and the speed calibration data are used by the CPU's firmware to calculate the pump speed in engineering units.

Motor Control

The meter pump speed or capillary pressure (depending on the mode selected) is compared to the motor setpoint in the CPU. The output of the motor control loop is the value necessary to maintain the motor setpoint. This output value is scale to the range of 0 to 100 %. This signal is fed to the ANALOG OUTPUT MODULE where it is converted into a 0 to 10 VDC motor control signal. Min and Max pots are adjustable on the MSC. The CPU also switches the AC power to the MOTOR ENABLE relay. When the operator turns the MOTOR ON, the MOTOR ENABLE Relay is energized. When the LED on the DIGITAL OUTPUT MODULE for that channel is ON the MOTOR ENABLE relay feeds the line AC voltage to the motor speed controller.

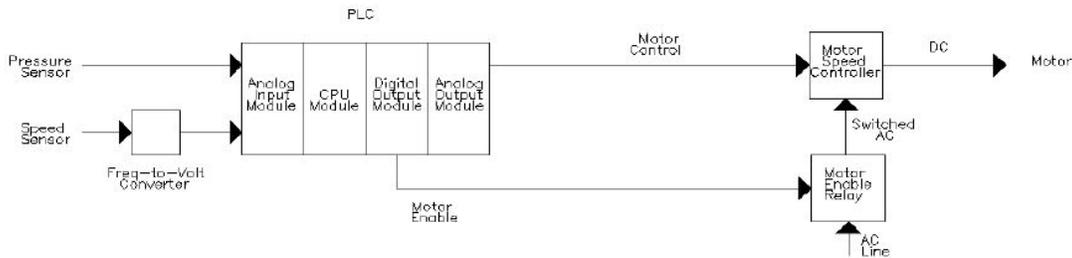


Figure 9 - Simplified Motor Indication and Control

Hardware Safety Interlocks

Voltage from the 24 VDC power supply is sent to the rheometer through the field wiring. This voltage is connected to the normally closed (NC) contacts of a thermostat located inside the Rheometer motor and returned to the RCU. This signal is sent to the Digital input module. When the motor internal temperature exceeds 100°C, the 24 VDC path is broken, indicating an over temperature condition. The PLC then disables the motor and heaters until the alarm condition is cleared.

Optional External Skin Temperature monitors are available that measure the heater temperature and in event of a heater thermal overrun condition, 24V supply voltage is removed from the Digital output module which in turn disables the heater zones. The PLC also monitors this alarm signal and indicates a skin temp alarm on the HMI screen. Heat cannot be restored until the alarm condition is corrected.

		PARTS LIST			
	ITEM NO.	PART NO.	QTY REQD	DESCRIPTION	
PLC	01	9067-4966	1	PS307 115/230 VAC P/9 24VDC	
	02	9067-4957	1	CPU, SIEMENS	
	03	9067-4958	1	MICRO MEMORY CARD, SIEMENS	
	04	9067-4990	1	ANALOG INPUT	
	05	9067-4991	2	ANALOG OUTPUT	
	06	9067-4992	1	DIGITAL INPUT - 16	
	07	9071-495	1	DIGITAL OUTPUT - 32	
	08	9067-4632	1	MODULE, RTD INPUT SIEMENS	
	09	9071-992	1	PLC MODULE, RS232	
	10	9067-4955	4	TERMINAL BLOCK, 20 PIN	
	11	9071-486	2	TERMINAL BLOCK, 40 PIN	
	12	-	-	-	
	13	-	-	-	
MODULES	14	9067-4670	1	POWER SUPPLY 30W 24VDC	
	15	9097-4020	1	POWER SUPPLY ASSY, 10VDC	
	16	9067-4615	1	FREQ TO VOLT CONVERTER	
	17	9067-3809	1	FILTER, EMC/EMI	
	18	9067-3759	1	FILTER, POWER INPUT	
	19	9071-997	1	SIGNAL CONDITIONER	
	20	-	-	-	
	21	-	-	-	
	22	9067-3797	1	DISCONNECT SWITCH, 3 POLE	
RELAYS/BREAKERS	23	9067-4286	1	SWITCH EXTENSION SHAFT	
	24	9071-959-8	1	CIRCUIT BREAKER, DP, 8A	
	25	9071-959-10	1	CIRCUIT BREAKER, DP, 10A	
	26	9071-702	2	CIRCUIT BREAKER, SP, 1A	
	27	9068-3091	3	RELAY 10 A 120/240V SOLIDSTATE	
	28	9067-4614	2	RELAY	
	29	9066-8376	2	SOCKET RELAY	
	30	9067-1397	2	SPRING RELAY	
	31	9067-4613	1	RELAY, 24V	
	32	9066-8832	1	SOCKET, RELAY	
	33	9066-9830	1	SPRING SUPP. RELAY	
ELECTRONICS	34	9067-4617	17	PLC RELAY	
	35	9067-4620	3	SEPARATOR PLATES	
	36	9067-4820	1	PLUG-IN BRIDGE, BLUE	
	37	9067-4821	1	PLUG-IN BRIDGE, RED	
	38	-	-	-	
	39	9067-3891	3	VARISTOR	
	40	9067-3284	3	MODULE, INDUCTIVE RECEIVER 1A1000V	
	41	-	-	-	
	42	-	-	-	
	TERMINALS/DIN RAILS	43	9067-4994	19	NDUNTING RAIL, 120mm, 19"
44		9068-5223-01	56.5	NDUNTING RAIL, 35mm, 31", 15", 10.5"	
45		9066-8220	8	TERMINAL BLOCK	
46		9071-486	46	TERMINAL BLOCK	
47		FV215453	20	TERMINAL BLOCK, 3 CONTACTS	
48		FV218422	5	TERMINAL BLOCK, 6NO, 3 CONTACTS	
49		13510000	2	DIN RAIL JUMPER, 10' POSITIONAL WITH SCREWS	
50		FV219424	5	TERMINAL BLOCK COVER	
51		9071-497	2	TERMINAL BLOCK COVERS	
52		9066-5223	1	TERMINAL BLOCK COVER	
53		9066-5206	18	CLAMP, END	
54		9067-4874	1	METAL DIN RAIL CAP, FOR 10V PS	
55		9068-5209	2	MARKER SYSTEM S8SR: 1-20	
56		9068-5210	2	MARKER SYSTEM S8SR: 21-40	
57		9067-4636	1	MARKER SYSTEM S8SR: 41-80	
58		-	-	-	
RACEWAY		60	9067-3827	75	RACEWAY, WHITE, 1": 15", 20", 17", 5.625", 17"
	61	9067-3828	73	RACEWAY, GREY, 1": 30", 17.25", 11.25", 14"	
	62	9071-904	12	RACEWAY, 1/2" GREY	
	63	9067-3828	75	RACEWAY COVER, WHI, 1": 15", 20", 17", 5.625", 17"	
	64	9067-3830	73	RACEWAY COVER, GREY, 1": 30", 17.25", 11.25", 14"	
	65	9071-906	12	RACEWAY COVER, 1/2" GREY	
	66	9067-3827	2	SHIELD RAIL	
HARDWARE	67	9066-8798	4	SPACER, 80 X, 820	
	68	9067-39	6	SCREW, 1/4-20 X 1-1/4 HHCS	
	69	AW010	6	WASHER, 1/4 EXTERNAL T80TH	
	70	FV401007	60	SCREW, 8-32 X 5/8 BRASS SS	
	71	7024-0688	10	SCREW, 10-32 X 3/8 PH FHL	
	72	9043-0910	12	SCREW, 8-32 X 3/8 PH FHL	
	73	591349	10	WASHER, 48 LOCK	
	74	AX036	2	TERMINAL RING SOLDERLESS 1/4"	
	75	90118	3 FT	WEAP SPIRAL 1/2" OD CLEAR	
	76	9067-4711	1	PLATE, NDUNTING, RED/PLC	
CMR	77	F803	4	SCREW, 8-32 X 3/4 PH FHL	
	78	9068-1040-02	1	VSC, S8CO 1/4-1/2HP 230VAC	
	79	9067-4677	9	SOFTWARE, CMR4 PLC V	
	80	9067-3318	1	ROU 600 CPU4E	

Figure 11 - Rcu Parts List



PLC Module List:	
Module	Type
1	Power supply
2	CPU
3	Not used (reserved for expansion rack)
4	Analog input (RTD)
5	Analog input (Voltage/Current)
6	Analog output
7	Analog output
8	Digital input
9	Digital output
10	RS-232 Serial ASCII data string output

Digital Inputs Module 8		Digital Outputs Module 9	
Term #	Function	Term #	Function
2	Not used	2	Heat relay enable
3	Motor fault	3	Motor drive enable
4	Remote test/start	4	Not used
5	Remote heat	5	Xd span
6	Remote mode	6	Flow block heater SSR
7	Load recipe 1	7	PIV heater SSR
8	Load recipe 2	8	AUX heater SSR
9	Load recipe 3	9-15,20,21	Not used
10-11	Not used	16-19	Recipes 1-4 active
12	BEBCO (optional)	22	Fault relay
13	Skin temp (optional)	23	Warning relay
14	Load recipe 4	24	Local/remote relay
15-18	Not used	25	Motor/pump is on relay
19	Emergency stop	26	Material status relay
		27-29	Not used
		30	HMI is alive indicator
		31	CPU is alive Indicator



PLC Relay List:		
Module	Function	I/O
1	Fault	Output
2	Warning	Output
3	Local/remote status	Output
4	Pump run status	Output
5	Material status	Output
6	Recipe 1 active	Output
7	Recipe 2 active	Output
8	Recipe 3 active	Output
9	Recipe 4 active	Output
10	Remote motor start	Input
11	Remote heat enable	Input
12	Remote mode (pressure/speed)	Input
13	Load recipe 1	Input
14	Load recipe 2	Input
15	Load recipe 3	Input
16	Load recipe 4	Input

Refer to field wiring drawing for connection to the PLC relays.

Local Operator Display

The DYNISCO Polymer Test RCU is equipped with an operator interface device mounted in the RCU cabinet or in a remote location determined by the customer. The operator interface is used to view and modify the system variables. This includes current measured values, test setpoints, trend screens, and alarm condition indicators. The display is a color touch screen.

Environmental Considerations

The display will operate at temperatures between 32° and 122°F (0 to 50C). Humidity may be between 10% and 90%. The unit is rated for NEMA-4 (watertight) and NEMA-12 (dust-tight) provided the mounting gasket is intact.

Security

Three levels of security are provided for operating the display.



User Name:	Password:	Authority
Setup	330	Ability to change material specific parameters
CMR	CMR	Ability to change material specific parameters
Maintenance	Alpha	Access to instrument configuration and test functions
Service	Alpha	Access to instrument configuration and test functions
MAINT	ALPHA	Access to instrument configuration and test functions
Factory	Call factory	Access to advanced instrument configuration

Maintenance privileges allow access to the diagnostic screens. Extreme care must be used while accessing the diagnostics since the instrument can be damaged by untrained personnel!

Calculations

$$\text{TEMP_CORR} = e^{\left(\frac{E/R}{\left(\frac{1}{\text{REF_TEM}+273.15} - \frac{1}{\text{MELT_TEMP}+273.15}\right)}\right)}$$

$$\text{MI_BASIC} = 10 * \text{PUMP_SPEED} * \text{PUMP_VOL} * \text{DENSITY} * \text{CF} * \left(\frac{1}{\text{TEMP_CORR}}\right) * \left(\frac{0.0825}{\text{CAP_DIA}}\right)^3$$

$$\text{MELT_INDEX} = \text{MI_BASIC} * \text{CAP_SHIFT} * \left(\frac{\text{REF_PRESS}}{\text{PRESSURE}}\right)^{\left(\frac{1}{\text{FLOW_INDEX}}\right)}$$

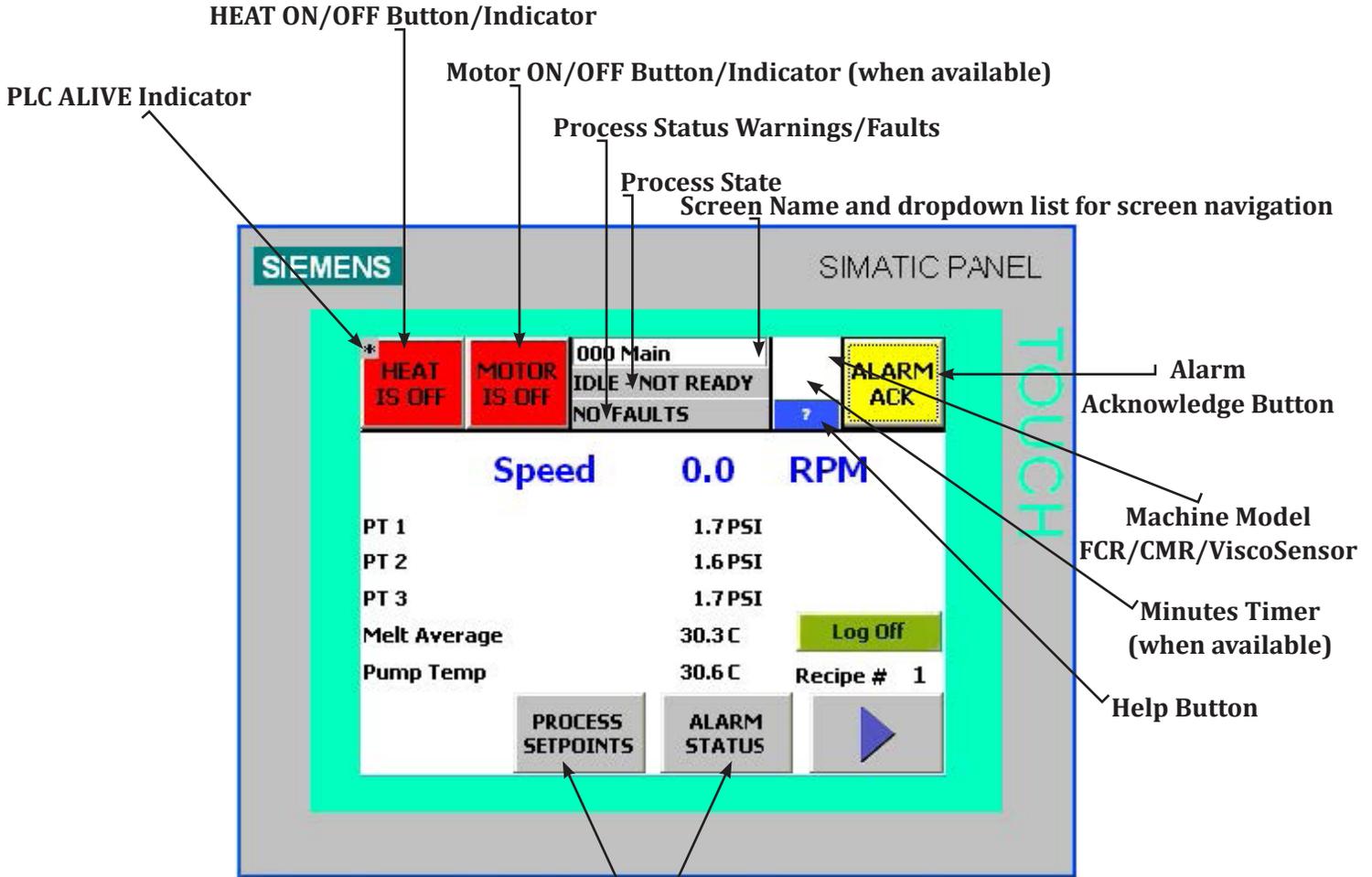
$$\text{SHEAR_STRESS} = \left(\frac{1723.69 * \text{PRESSURE}}{\text{L/D}}\right)$$

$$\text{SHEAR_RATE} = \left(\frac{0.01036 * \text{PUMP_SIZE} * \text{PUMP_SPEED}}{\text{CAP_DIA}^3}\right)$$

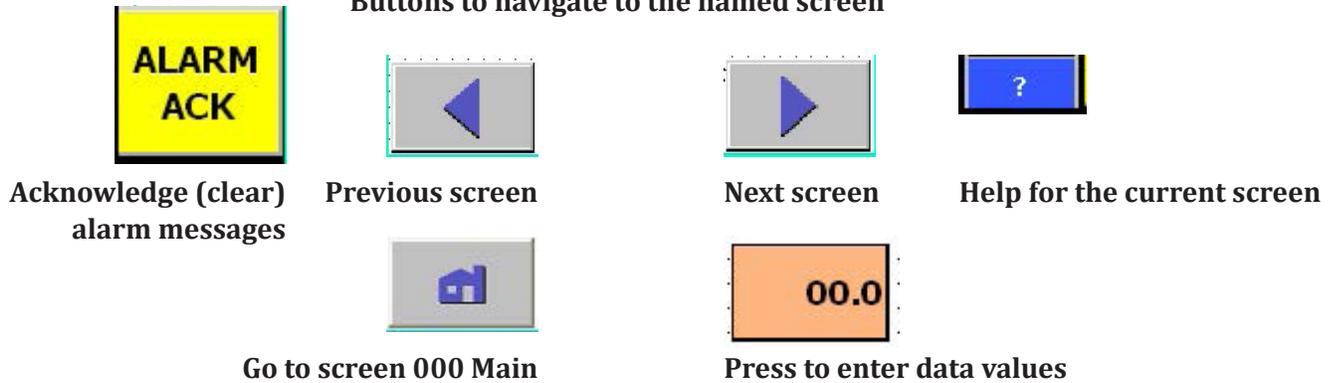
$$\text{VISCOSITY} = \text{TEMPCOR} * \left(\frac{\text{SHEAR_STRESS}}{\text{SHEAR_RATE}}\right)$$

HMI Screen Display Overview

At the top of most of the screens is an area called the “Fixed Window”. Items in the fixed window are labeled below. The display screens are shown on the following pages.



Buttons to navigate to the named screen





Press to enable the heat



Press to disable the heat



Press to enable the motor



Press to disable the motor

Screens on the display are divided into groups. A brief description of each group is followed by a detailed section.

Startup screen

MAIN screen and MENU screens (000,100,200,300)

- The items displayed on the MAIN screen are configured in the Operator Setup screen. The right arrow key opens the MENU screens that are used to select and display items of interest.

Process Setpoints (110)

- This screen is used to set the temperature, pressure, and speed control setpoints.

Equation Constants (120-123)

- These screens are used to set the capillary diameter, length to diameter ratio, pump volume, correlation factor, flow index, activation energy, flow density, reference temperature, reference pressure, the intrinsic viscosity coefficient, and the intrinsic viscosity exponent.

Operator Setup (130-138)

These screens are used to

- Select the items to be displayed on the MAIN screen,
- Configure the soak mode,
- Configure the standby mode,
- Configure the shutdown mode,
- Configure the warning for material of range,
- Configure the sample/purge mode,
- Set the ASCII communication interval and the information to be communicated, and
- Set the date and time

Recipes (140)

- Job setup recipes are used to store the configuration of the instrument such that it can be recalled at a later date. This aids in change over from one material to another.

Process Status (150)

- This screen is used to observe the process temperatures, pressures, and speed.

Equation Results (160)

- This screen is used to observe the melt flow index, shear rate, shear stress, melt viscosity, relative viscosity, and intrinsic viscosity.

Alarm Status (170-172)

- These screens show the status of the temperature RTDs, the pressure transducer, the motor, and the emergency stop.

Trending Graphs (180-186,190-196)

- These screens graph the selected value over a 10/60 minute time window. Trend screens are provided for temperature, pressure, speed, melt flow index, shear rate, melt viscosity, relative viscosity, and intrinsic viscosity.

Temperature Calibration (210-211)



- Calibrate temperature measurements by entering offset values for the appropriate RTD temperature measurement.

Pressure Calibration (220-222, 230-232)

- These screens provide a method to calibrate the three pressure transducers. Calibration options include default, auto cal, and manual.

Analog I/O Calibration (240-245)

These screens allow for

- Calibration and scaling of the motor speed input from the tachometer
- Calibration and scaling of the 4-20 mA input setpoints
- Calibration and scaling of the motor speed output from the PLC to the motor speed controller
- Calibration and scaling of the 4-20 mA output values

Machine Configuration (250 - 259, 25A - 25C)

These screens are used for configuring the instrument. The following items get configured:

- Instrument model type
- Units for length, temperature, and pressure
- RTD and pressure transducer configuration
- Installing options
- Selecting the 4-20 input and output parameters
- Setting the over temperature
- Setting the temperature, pressure, and speed warning limits
- Setting the PID control constants

Manual Purge (320)

- This screen is used to purge the system of material. The system will operate at the set speed for a given amount of time. After the time expires, the motor/pump will stop and the heat will be disabled.

Error Log (270-272)

- The last 25 faults are logged with a date and time stamp.

Diagnostics (260-268)

These screens allow for

- Viewing all the analog inputs
- Ability to force 0-10 analog outputs to 0, 5, or 10 volts
- Ability to force 4-20 mA analog outputs to 4, 12, or 20 mA
- Viewing all the digital inputs
- Ability to force all digital outputs ON or OFF
- Special motor testing ability

IO Status (250)

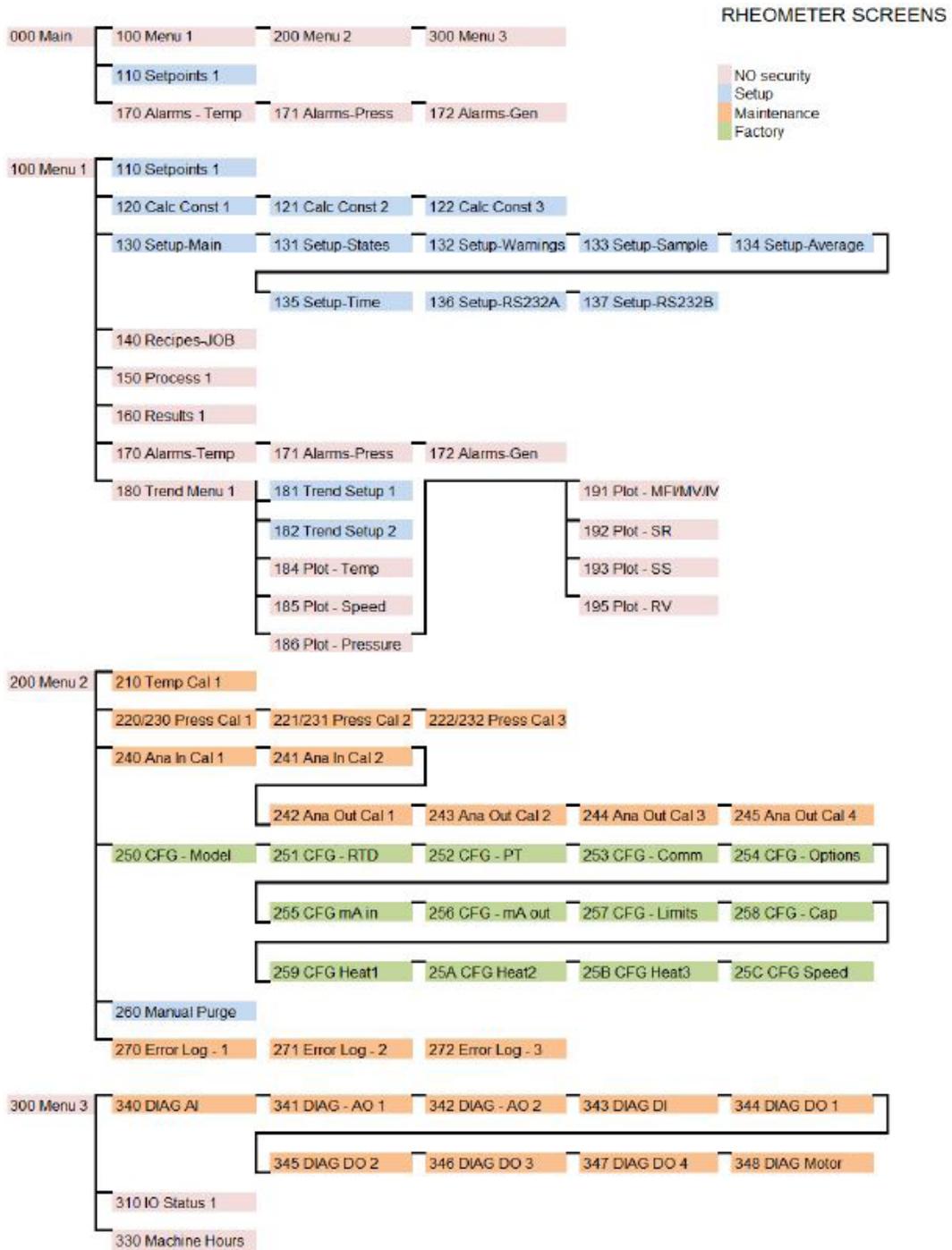
- This screen displays the status of major inputs and outputs on the RCU.

Machine Hours (330)

- This screen shows statistics for the number hours of instrument operation.

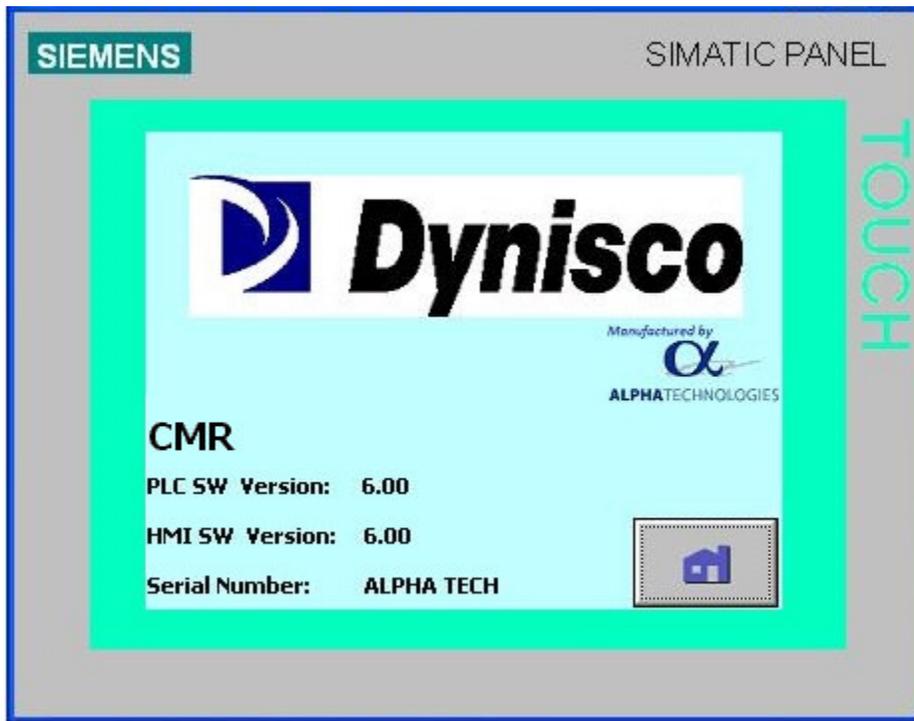
Set IP Address (320)

- If option supplied, the CMR network address is set here

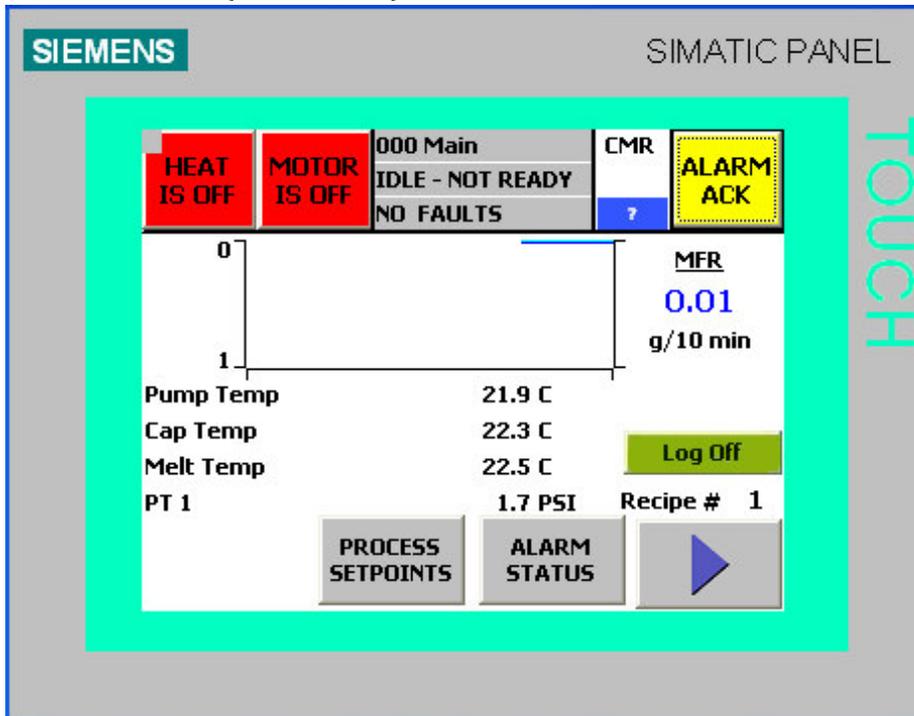


Start-up Screen

The start-up screen is displayed for about 5 seconds on power up. The PLC software version number, HMI software version number and the instrument serial number are important when calling for customer service.



Main Screen (000) and Menu Screens (100,200,300)



The Main screen can be configured in screen 130 Setup-Main to display a trend graph and four data items or display up to six data items. The graph data and the data items displayed are selectable from a list of items in the Operator Setup. The trend graph shows the most recent 10 minutes of the selected parameter in real-time.

Menu Screens (100, 200, 300)

SIEMENS
SIMATIC PANEL

HEAT IS OFF	MOTOR IS OFF	100 Menu 1 IDLE - NOT READY NO FAULTS	CMR ?	ALARM ACK
----------------	-----------------	---	----------	--------------

PROCESS
SETPOINTS

EQUATION
CONSTANTS

OPERATOR
SETUP

RECIPES

PROCESS
STATUS

EQUATION
RESULTS

ALARM
STATUS

TRENDING

◀

🏠

▶

TOUCH

SIEMENS
SIMATIC PANEL

* HEAT IS OFF	MOTOR IS OFF	200 Menu 2 IDLE - NOT READY NO FAULTS	CMR ?	ALARM ACK
------------------	-----------------	---	----------	--------------

Temperature
Calibration

Pressure
Calibration

Analog I/O
Calibration

Machine
Configuration

MANUAL
PURGE

Error
Log

◀

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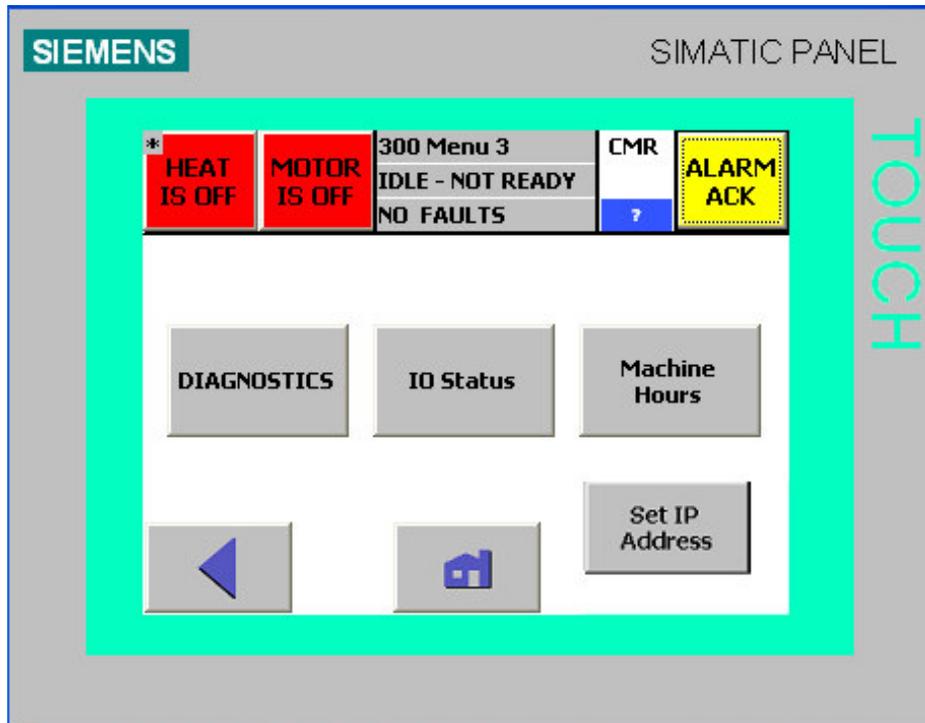
▶

TOUCH

P/N: M0707 | Rev: 0717 | ECO: V6.02a

www.dynisco.com

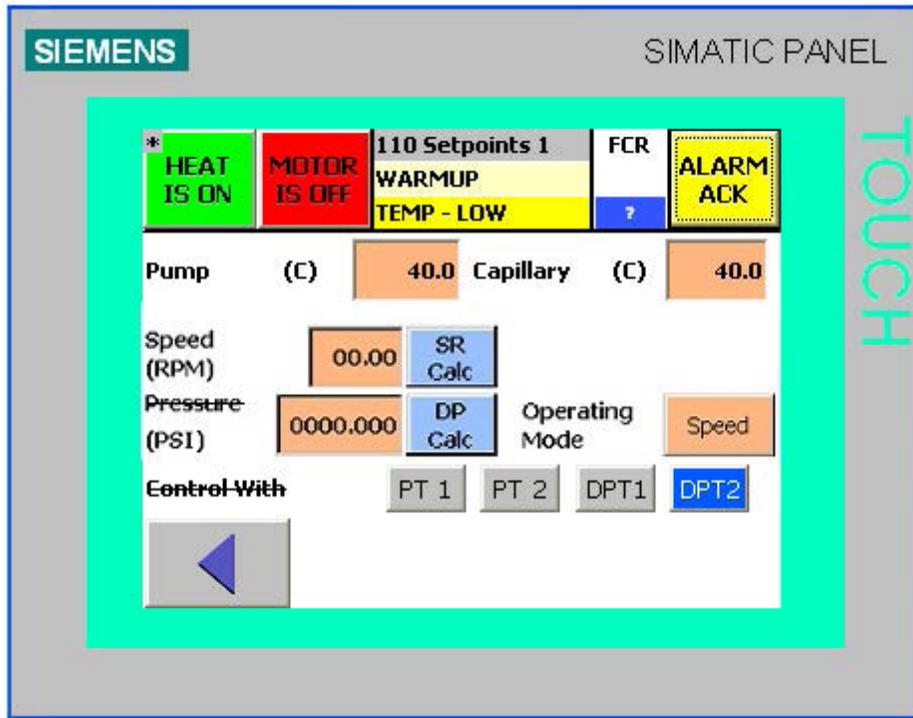
-36-



Set IP Address -

This menu item is visible only when Ethernet is enabled in the configuration. The Ethernet address is set through this screen. If option supplied, used to set the network address of the CMR

Process Setpoints (110)



Process control setpoints

- Flow Block (Melt) temperature
- PIV (Process Isolation Valve) temperature
- Speed while in the speed mode
- Pressure while in pressure mode

Speed

- Press this button to change from speed mode to pressure mode

RMT is ON/OFF – the rheometer is being controlled externally via the heat/motor enable discrete signals and the 4-20 mA inputs for setpoints.

MBUS is ON/OFF – the rheometer is being controlled via the Modbus communication port.

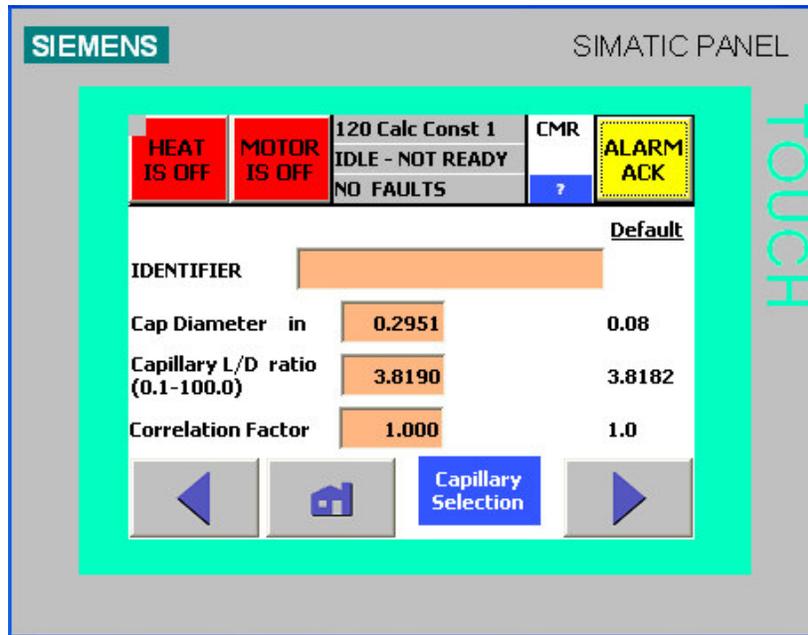
DP-DP is ON/OFF - the rheometer is being controlled via the Profibus DP-DP coupler.

ENET is ON/OFF - the rheometer is being controlled via the Ethernet communication port.

NOTE: The MBUS/DP-DP/ENET buttons are only visible if the desired communication module is installed in the rheometer. The RMT communications is configured in the Machine Configuration screen 253 CFG-Comm.

SR Calc & DP Calc – open calculators to determine operating speed from desired shear rate and operating pressure from the laboratory ASTM test weight.

Equation Constants (120-123)

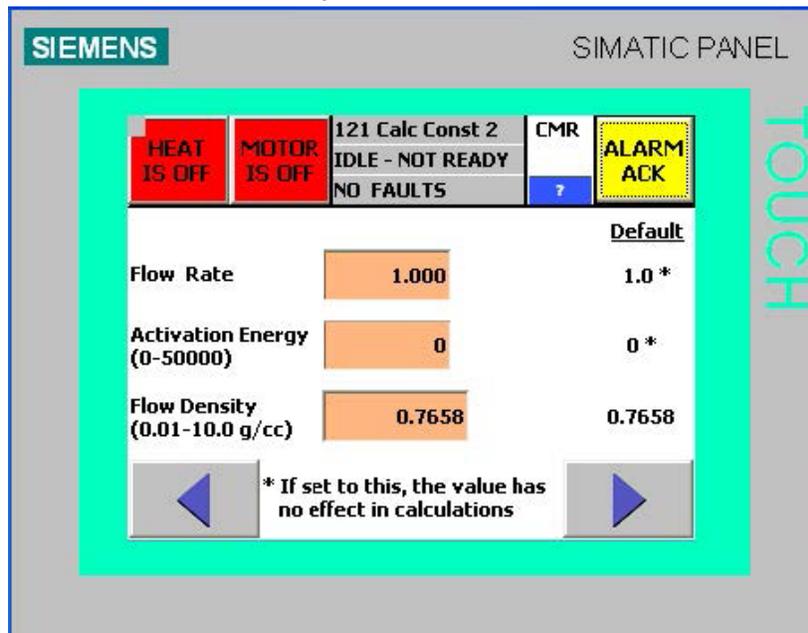


Identifier: An up to 20 character capillary identification.

Cap Diameter: Diameter of the capillary die

Capillary L/D ratio: Capillary die length divided by the capillary diameter

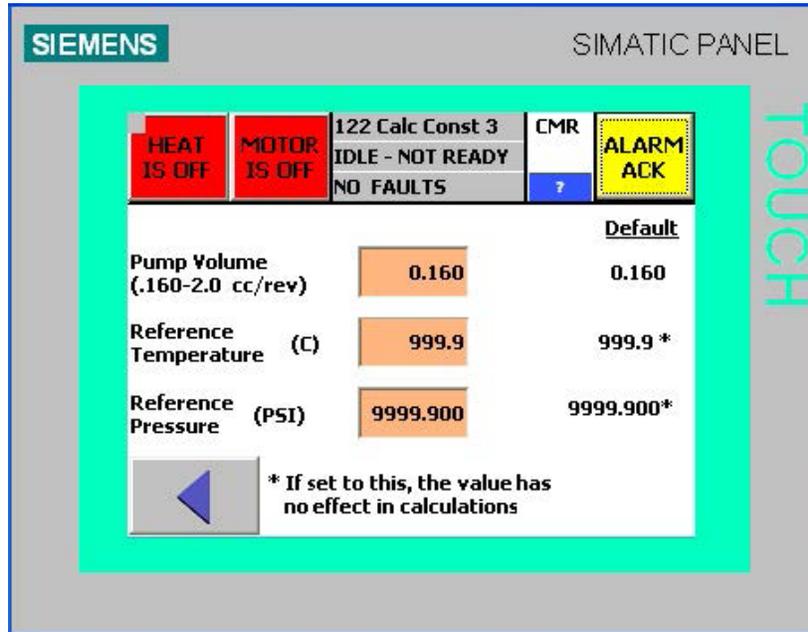
Correlation Factor: Laboratory MFI divided by the Rheometer MFI (Corrects for any measurement differences between the laboratory and the online instrument). The default is 1.0



Flow Rate: $MFR_{ref_pressure} = (ref_pressure/process_pressure)^{(1/Flow_rate)}$ The default is 1.0

Activation Energy: $Temp_correction = EXP(act_energy * ((1.0/(ref_temp + 273.15)) - (1.0/(process_temp + 273.15))))$ The default is 0.0

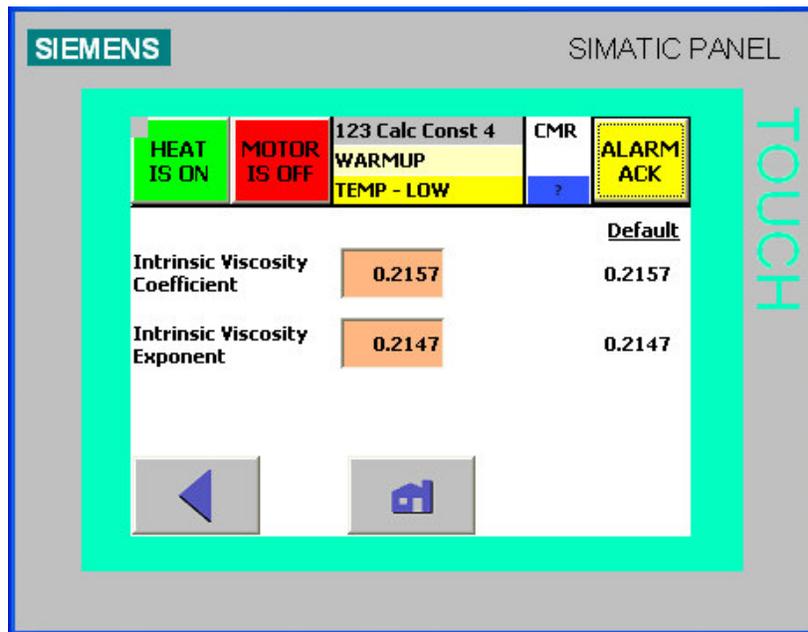
Flow Density: Material density in g/cc. Used for calculating the MFR



Pump Volume: Volume of the pump in cc/rev

Reference Temperature: $Temp_correction = EXP(act_energy * ((1.0/(ref_temp + 273.15)) - (1.0/(process_temp + 273.15))))$ The default value of 999.9 produces no temperature correction

Reference Pressure: $MFI_ref_pressure = (ref_pressure/process_pressure) ^{(1/Flow_index)}$ The default value of 9999.9 produces no pressure correction



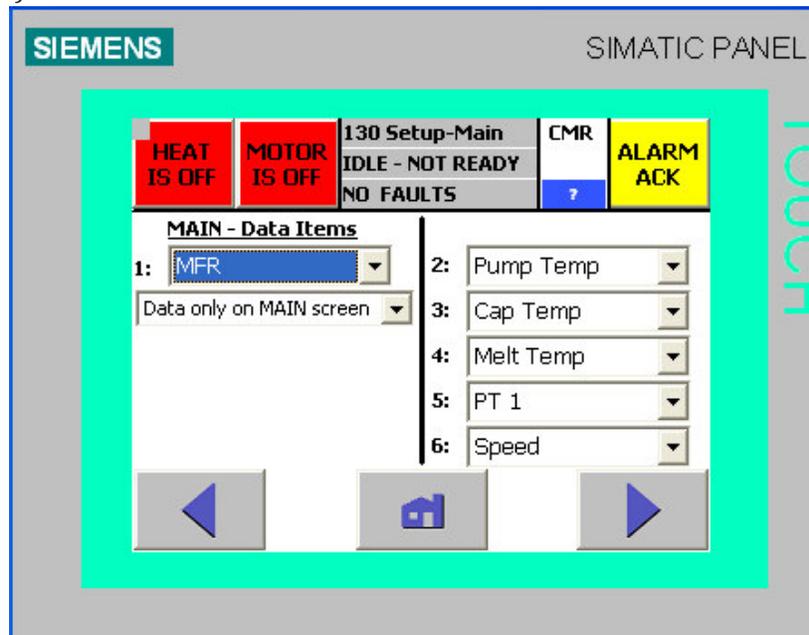
Intrinsic Viscosity Coefficient:

Intrinsic_Viscosity (IV) = $IV_coef * (melt_viscosity ^{IV_exp})$, the default is 0.2157

Intrinsic Viscosity Exponent:

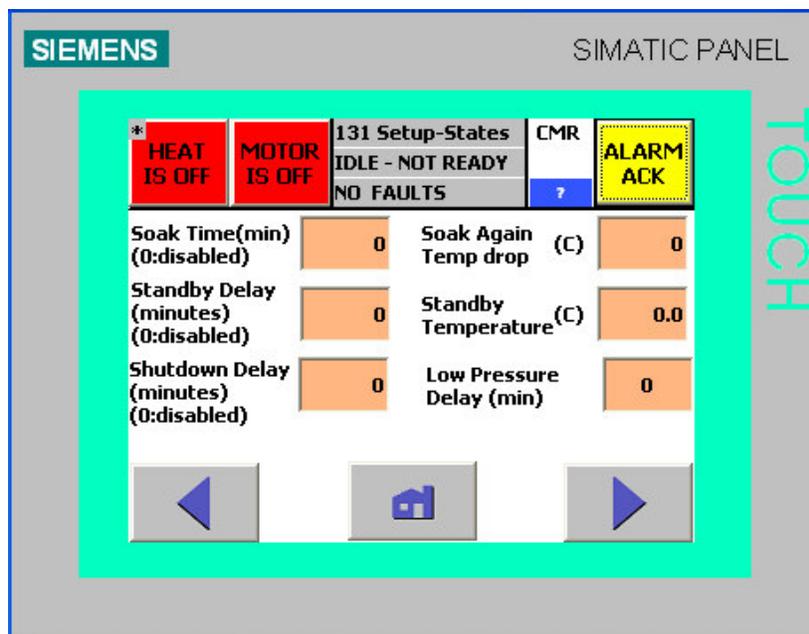
Intrinsic_Viscosity (IV) = $IV_coef * (melt_viscosity ^{IV_exp})$, the default is 0.2147

Operator Setup (130-138)



Main - Data Items

Press the down arrow button on the right side of the “1:” box. A drop-down box contains the selections. Highlight the desired selection. Press the down arrow button to select whether to display the 10-minute trend graph for the selected item on screen 000 MAIN. The 5 or 6 items selected here will be displayed on the 000 Main screen. The choices include temperatures, pressures, pump speed, MFR, shear rate, shear stress, melt viscosity, relative viscosity, and intrinsic viscosity. Press the down arrow button on the right side of the 2 through 5 (6 if no trend) boxes to highlight the desired selection.





The Setup-States screen is used to configure the rheometer soak, standby, and shutdown conditions.

Soak Time (min)

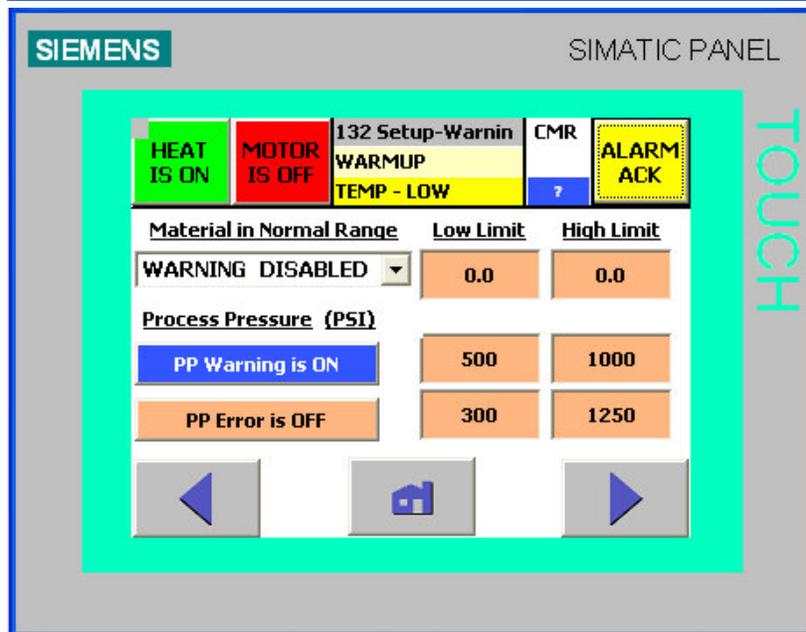
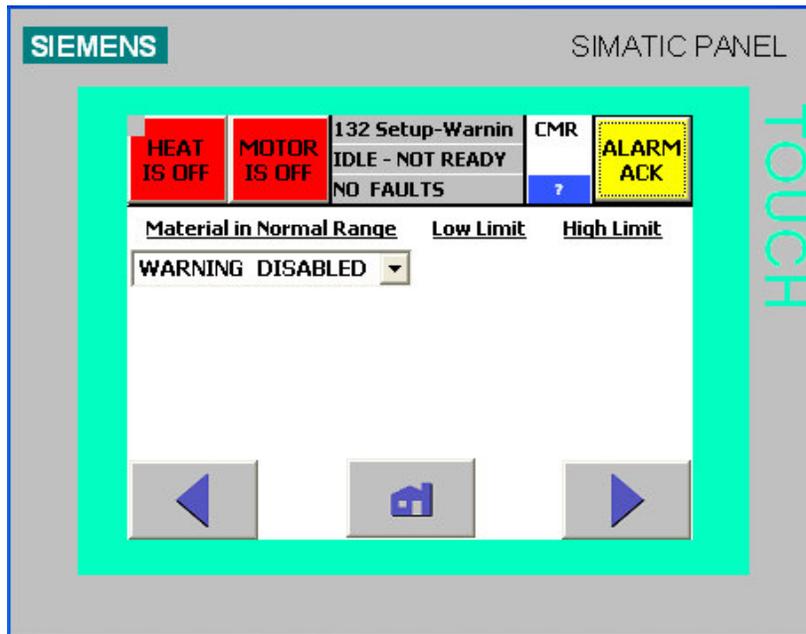
The soak conditions are used to “soak” the material at a given temperature for a period of time before permitting the motor/pump to operate. On power-up, the soak time begins when there are no low temperature warnings. A soak will also be initiated if the temperature ever drops below the selected limit (temperature setpoint minus the soak again temp drop) for 1 minute. During the soak process, the instrument state will change to SOAK and the soak timer will be displayed. No motor enable button will be visible until the soak time has completed. The soak process can be stopped by pressing the BYPASS SOAK button. This button appears during the soak process where the Motor enable/disable button is located. When set to 0, the soak function is disabled.

Standby Delay (minutes)

If the instrument is in an IDLE – READY state for the standby delay time, the instrument state changes to STANDBY. In the standby state, the temperature setpoint changes to the standby temperature. Press the EXIT Standby button to return to the process setpoint. The standby timer is displayed while in the IDLE-READY state. When set to 0, the standby function is disabled.

Shutdown Delay (minutes)

If the instrument is in the Standby state for the shutdown delay time, the heat will be disabled and the state will change to IDLE – NOT READY. The shutdown timer is displayed while in the Standby state. When set to 0, the shutdown function is disabled.



Material in Normal Range selections

- WARNING DISABLED- No material range check
- MFR WARNING
- MV WARNING
- IV WARNING
- RV WARNING
- MFI (2) WARNING
- MV (2) WARNING

The selected material property is normal when the property is within the given low and high limits. A warning message is displayed and the warning relay is activated when the limits are exceeded after the motor has been operating for over 30 seconds.

Low Limit - Lower limit for the selected item (MFR/MV/IV/RV), the low limit is ignored when the warning is disabled.

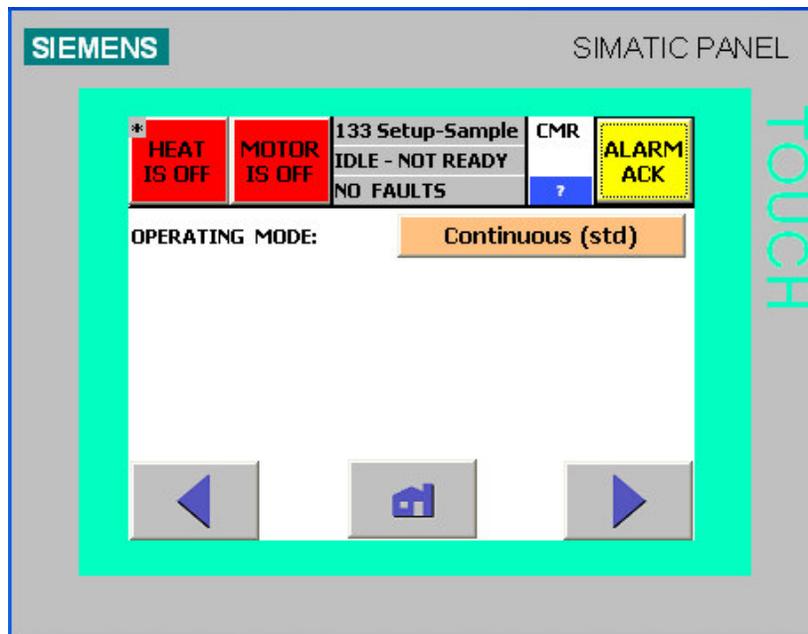
High Limit - High limit for the selected item (MFR/MV/IV/RV), the high limit is ignored when the warning is disabled.

Material in Normal Range - Select the desired material property from the list in the pull down menu. The low/high limit values are ignored when WARNING DISABLED appears.

Process Pressure - To enable the Process Pressure (PP) warning and error conditions, Process Pressure must be enabled on screen 254 CFG-Options and a pressure transducer must be mounted on the PIV and wired accordingly. The process (input) pressure is normal when the pressure is within the given low and high limits. An error message is displayed and the error relay is activated when the limits are exceeded.

PP Warning - Press the button to toggle the process pressure warning on/off. The low/high limit values are ignored when the PP Warning is OFF. The process (input) pressure is normal when the pressure is within the given low and high limits. A warning message is displayed and the warning relay is activated when the limits are exceeded.

PP Error - Press the button to toggle the process pressure error on/off. The low/high limit values are ignored when the PP Error is OFF.



Operating Mode:

Continuous (standard mode of operation):

Normal operating mode, the rheometer operates continuously at the set speed while in constant speed mode. The rheometer operates continuously at the set pressure while in constant pressure mode.

Sample/Purge:

The rheometer operates at a constant speed/pressure while sampling the material. After the sampling time, the rheometer changes to a higher speed/pressure to purge the existing material. During this purging process, the material properties are not calculated and the last results are held constant on the display. This mode should only be used when there is a long transfer path from the process to the rheometer. The Sample/Purge operating mode can be used when a faster response time is required. This is beneficial when the installation requires a long transfer length and the material requires a slow pump speed.

In the Sample/Purge mode, the rheometer samples the material and calculates the material properties (MFR/ Viscosity) for the set amount of time. After the sample time expires, the rheometer operates at a faster speed for the set amount of time to purge the transfer line of material and to provide fresh material to the rheometer. After the purge time expires, the rheometer returns to the material sampling operation. While sampling the material, the MFR and viscosity parameters are calculated and updated on the HMI. While purging, the MFR and viscosity parameters are not calculated and the last calculated value is “frozen” on the display.

Sample Time – range 3-32767 min

- Amount of time for the rheometer to operate normally

Purge Time -- range 15-900 sec

- Amount of time for the rheometer to operate at a higher speed with no MFR or viscosity updates

Purge Pressure % of max -- range 5 to 90% of the maximum for transducer 1

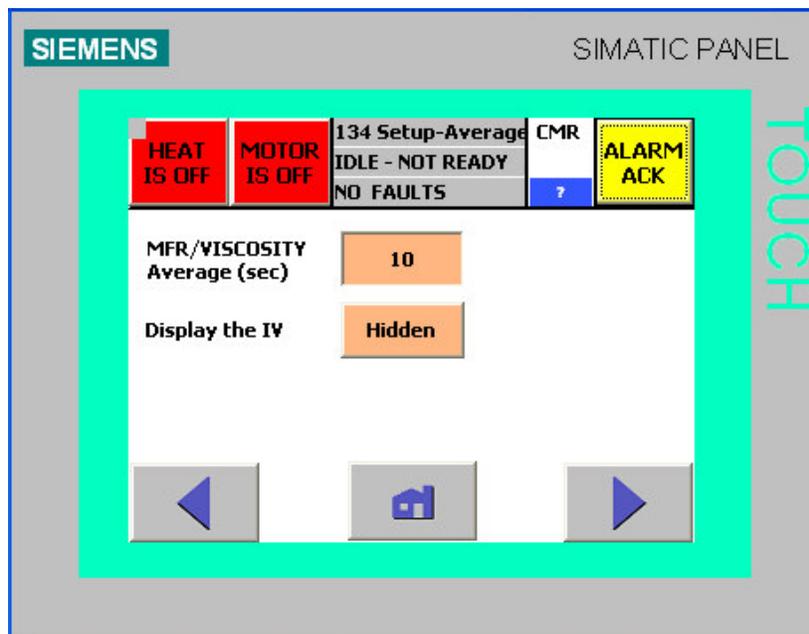
- Pressure setpoint for purging at a constant pressure

Purge Speed -- range 3 RPM to the maximum allowable

- Speed setpoint for purging at a constant speed

Purge at constant Speed / Purge at constant Pressure

- Purge at constant Speed -- purge at the purge speed setting
- Purge at constant Pressure -- purge at the constant pressure determined by the purge pressure % of max

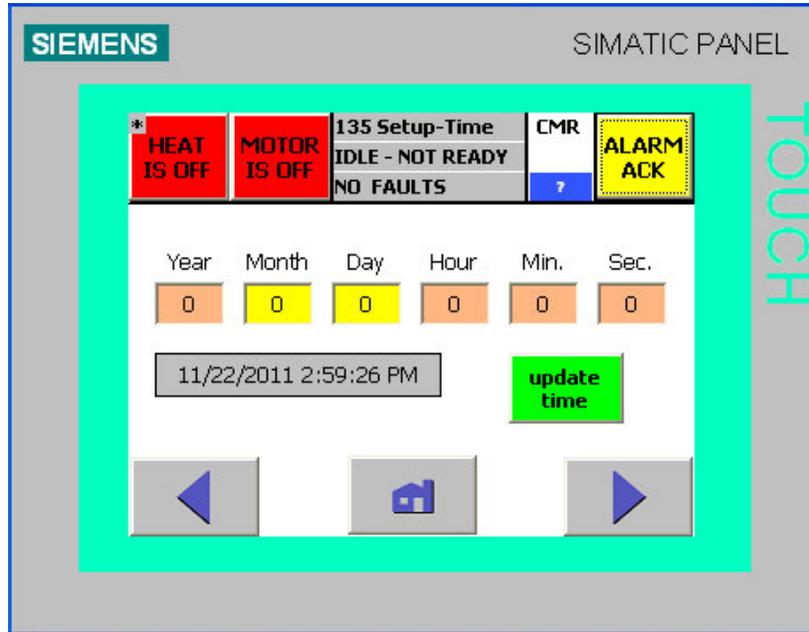


MFR/VISCOSITY Average (sec) – range 2-1800 seconds

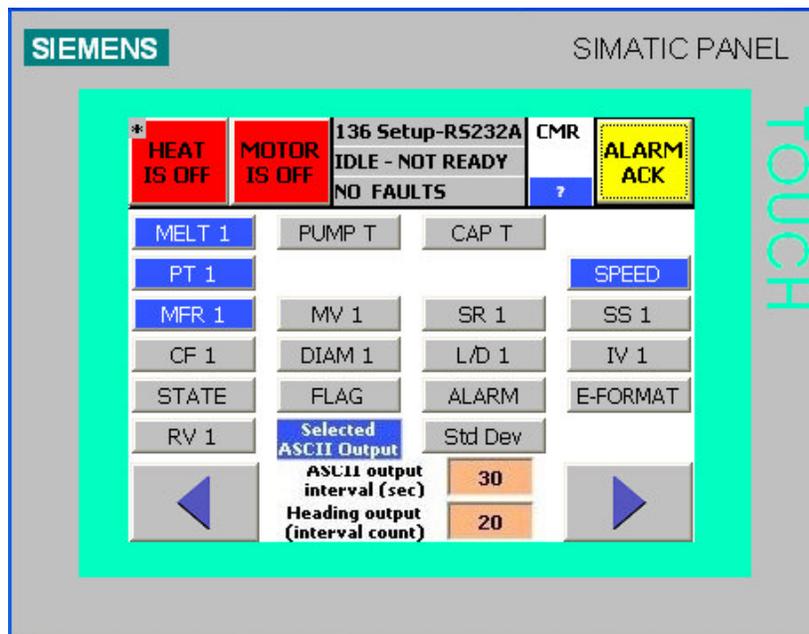
- The MFR, Melt Viscosity, and Intrinsic Viscosity measurements are averaged over the time period.

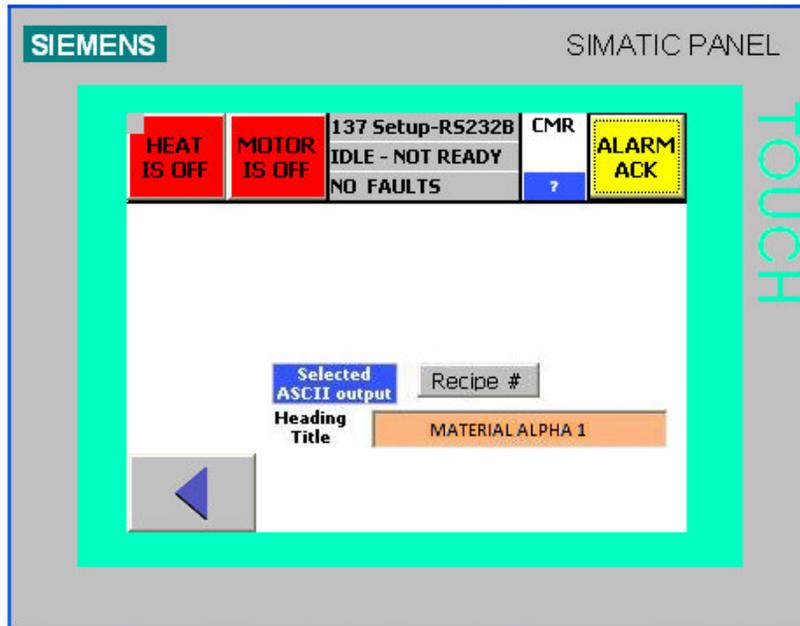
Display the IV

- Visible: IV parameters are visible
- Hidden: IV parameters are hidden



The date and time entered are used in the PLC and in the HMI. The time is used for all trend graphs and for the error log. To set the time: press each box to enter the year/month/day/hour/min value, press the Update Time box, the new time is then visible in the grayed box.





The rheometer is capable of transmitting rheometer data over an RS-232 communication port at a user set interval. A maximum of 25 data items can be selected:

The RS-232 (ASCII) output is factory set at 9600 baud, no parity, 8 data bits, 1 stop bit, and no flow control (9600:N:8:1)

Select the data items in screens 136 that are to be communicated by pressing the button for the item. Selected items are shown in blue. Press the ASCII output interval button to enter the desired interval. An interval of 0 seconds disables the output. The maximum interval is 28800 seconds (8 hours). A header can be output at the set interval count. The header includes the selected output items in proper order. A setting of 0 disables the header and 20 sets the header to be output every 20th data output. The header can include a title with up to twenty characters. A leading space or blank will disable the title output.

The data is output in text format and can be captured with a terminal program or on a flash drive if the optional datalogger is supplied. The file can be imported into Excel as a space delimited text file.

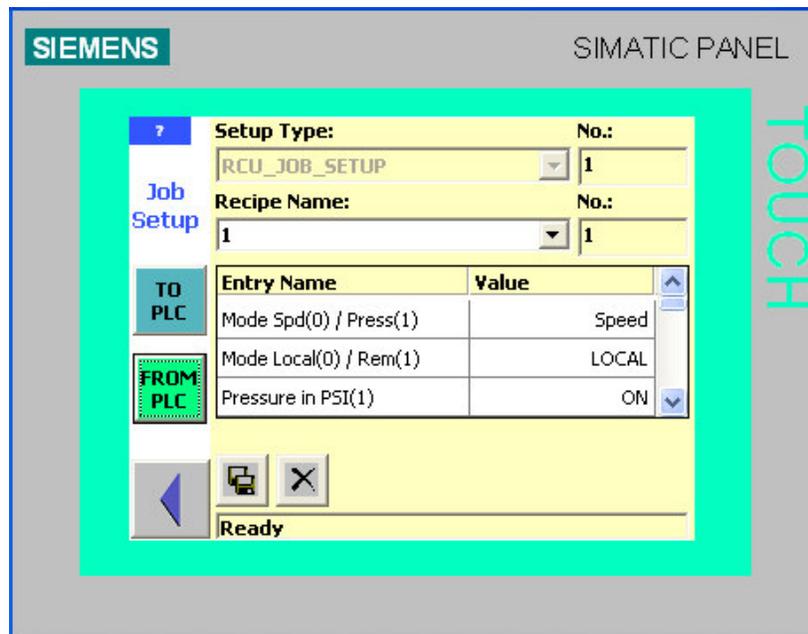
The standard format for the data is shown below:

mm-dd-yy hh:mm:ss +xxxx.x +xxxx.x ...

The E-format is required to communicate values greater than 32767. The E-format is shown below:

< mm-dd-yy hh:mm:ss +1.0000000E+00 +1.0000000E+00 >

Recipes (140)



Recipe Name - Used to add new recipes or recall a previously saved recipe files

Entry Name - List of stored values within a recipe, this list is inclusive of all possible recipe parameters and some will not be applicable

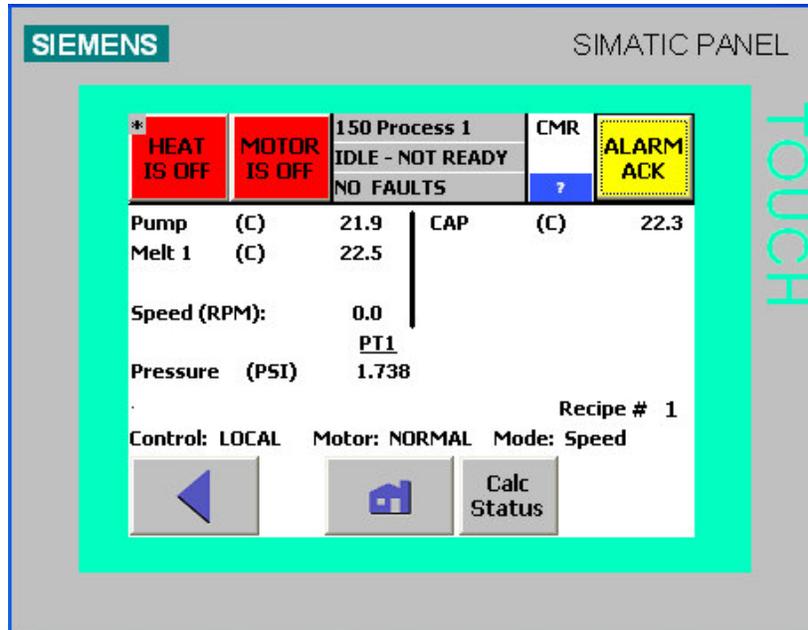
TO PLC - Sends the currently viewed HMI recipe to be stored in the PLC

FROM PLC - Reads recipe stored in the PLC into the current HMI recipe
NOTE: after reading from the PLC, in order to activate the just read values, the recipe screen must be exited and re-entered

- Saves the current recipe in a file, the file name will be prompted for and if a file of that name exists, a prompt will ask if it is to be overwritten

- Permanently removes a stored recipe file, a prompt will ask if the action is to be performed

Process Status (150)



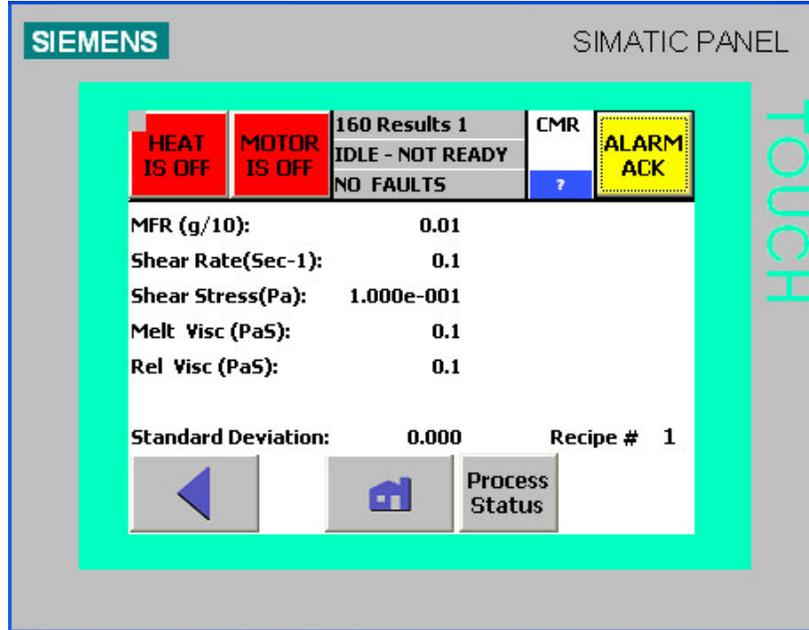
All items on screen 150 are view only. Temperature, pressure, and speed readings are calibrated readings.

Control: LOCAL - all instrument control is performed at the HMI
 REMOTE - a remote station can perform control

Motor: - NORMAL
 FAULT

Mode: - Pressure - the motor speed is controlled to provide a constant pressure
 Speed - the motor is controlled to provide a constant speed

Equation Results (160)



SIEMENS SIMATIC PANEL

HEAT IS OFF **MOTOR IS OFF** **160 Results 1** **CMR** **ALARM ACK**

IDLE - NOT READY **?**

NO FAULTS

MFR (g/10): 0.01
 Shear Rate(Sec-1): 0.1
 Shear Stress(Pa): 1.000e-001
 Melt Visc (PaS): 0.1
 Rel Visc (PaS): 0.1

Standard Deviation: 0.000 Recipe # 1

Process Status

TOUCH

All items on screen 160 Results 1 are view only.

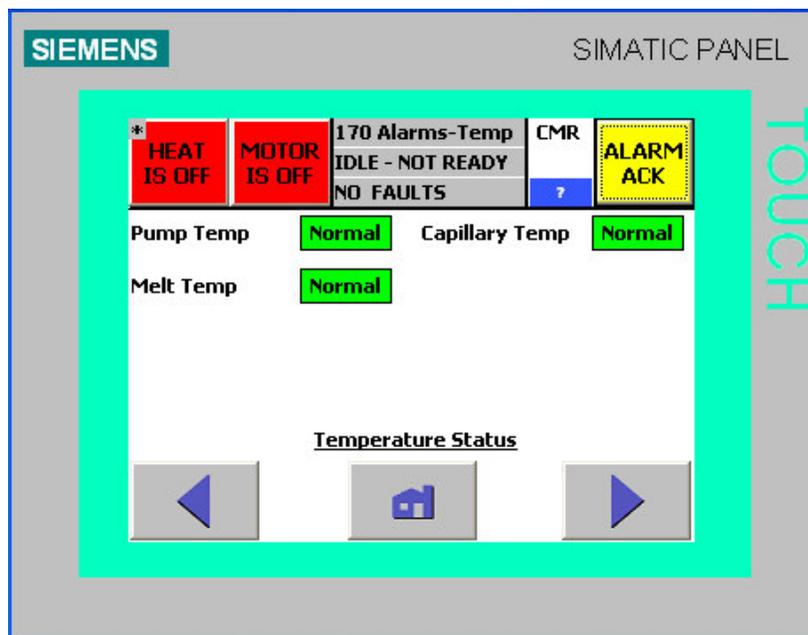
Alarm Status (screens 170-172)

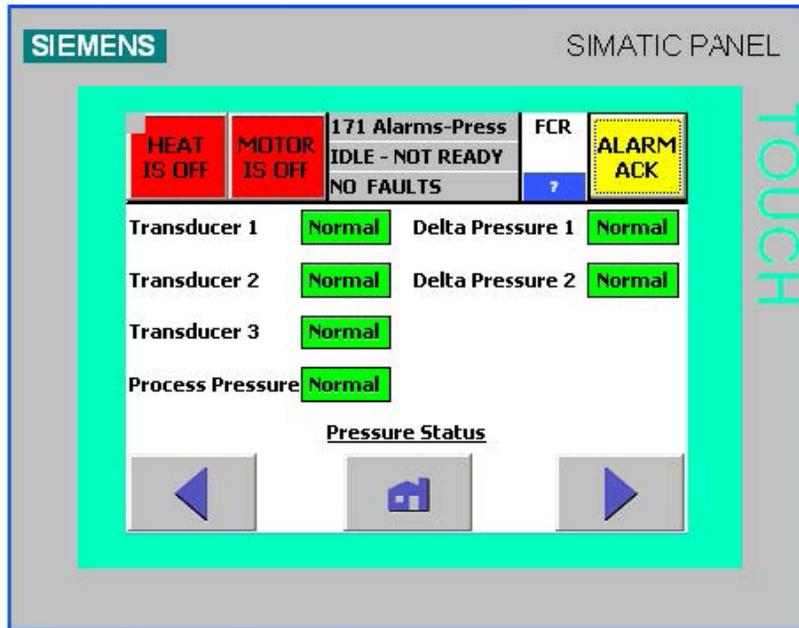
The following status conditions are displayed in the status screens:

- Normal (green) conditions are within the normal limits
- Low (yellow) warning that condition is below the lower limit
- Low (red) fault that condition is low
- High (yellow) warning that condition is above the upper limit
- High (red) fault that condition exceeds high limits
- Fault (red) fault that sensor is faulty or disconnected
- Alarm (red) fault caused by an alarm condition

Warning conditions activate the warning output relay. The motor/pump cannot be enabled while warnings are present. Warnings do not need to be acknowledged. Warning messages clear when the condition has returned to normal.

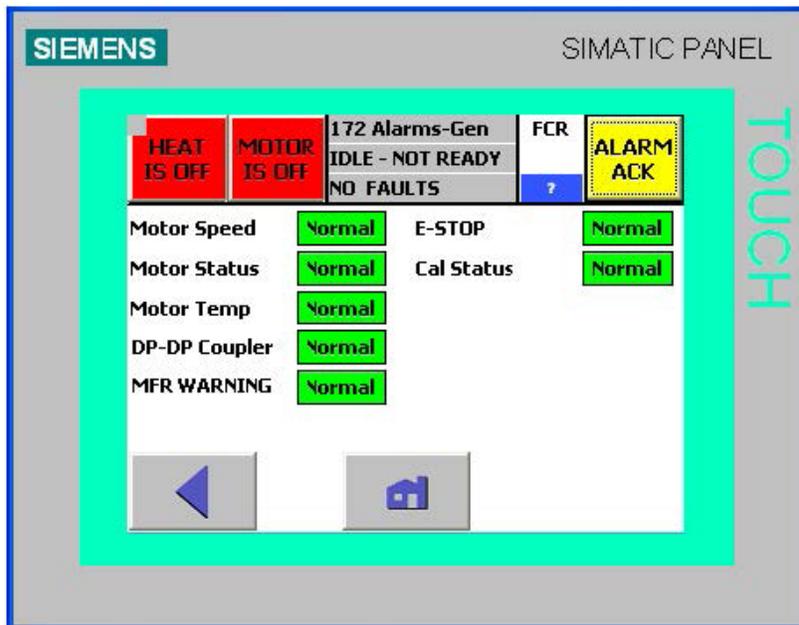
Fault conditions activate the fault output relay. The motor/pump cannot be enabled while faults are present. The heat cannot be enabled when a high temperature fault is present. Faults need to be acknowledged. Faults occurrences get date and time stamped and recorded in the screen 270 Error Log-1.





To view the Process Pressure status

- 1) The Process Pressure must be enabled on screen 254 CFG-Options.
- 2) A pressure transducer must be mounted on the PIV and wired accordingly.



Motor Speed- Low Warning: speed less than 1 RPM or speed less than the normal range
 High Warning: speed greater than the normal range
 High Fault: speed 1% over maximum for 1 minute

Motor Status- Alarm: motor drive fault



DP-DP coupler (if enabled)- OFF: Coupler installed and disabled warning
Fault: No DP-DP coupler “ALIVE” signal detected from the DCS

Material Warning (if enabled)- Low Warning: Material property less than the normal range
High Warning: Material property exceeds the normal range Set the normal range in the 132 SETUP- WARNING screen.

E-STOP- Alarm: E-stop condition

Cal Status Fault: Error in the auto calibration of a pressure transducer

Trending Graphs (180-199)

Trending screens graph data over a rolling 10 or 60-minute period of time. For example, Speed-10 graphs the speed over a 10-minute window while Speed-60 graphs the speed over a 60-minute window.

Set the Y-axis limits in the TREND SETUP screens (181-183). Set the Y-axis lower limit less than the lowest data value to be displayed. Set the Y-axis high limit greater than the highest data value to be displayed. This ensures that the data will be viewable in the graph.

Press the appropriate button to view the following graphs:

Temperature-10 minutes	Temperature-60 minutes
Speed-10 minutes	Speed-60 minutes
Pressure-10 minutes	Pressure-60 minutes
MFR-10 minutes	MFR-60 minutes
SR-10 minutes	SR-60 minutes
SS – 10 minutes	SS – 60 minutes
MV-10 minutes	MV-60 minutes
RV-10 minutes	RV-60 minutes
IV-10 minutes	IV-60 minutes

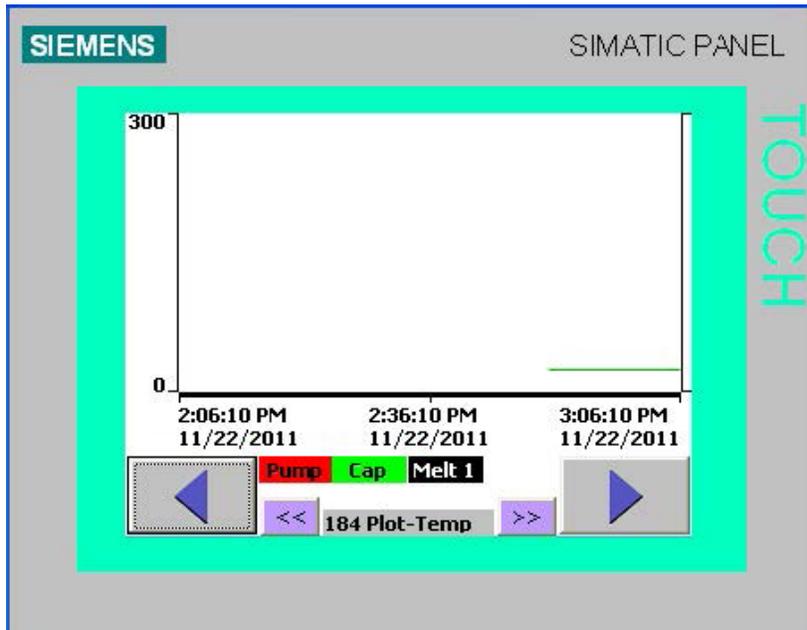
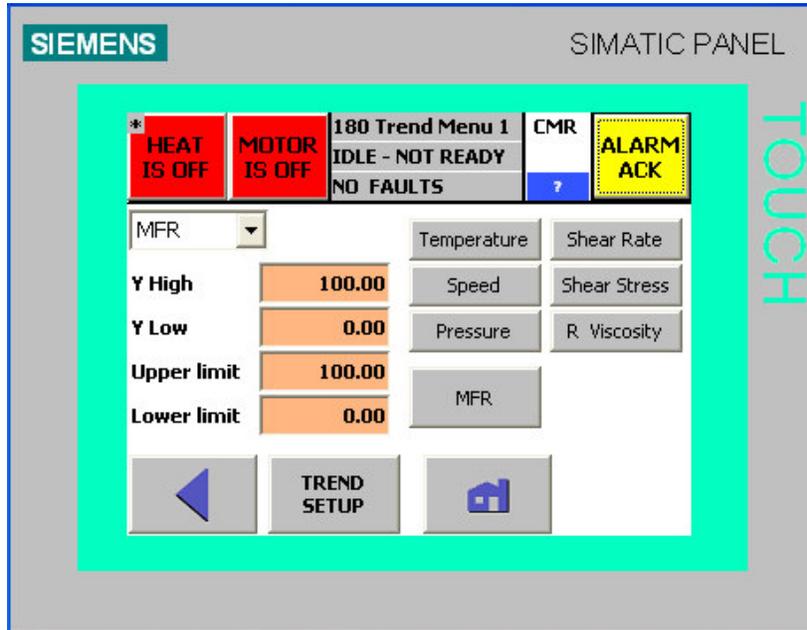
While viewing a trend graph, press the left/back arrow to return to the trend menu. Press the right arrow to proceed to the next trend graph.

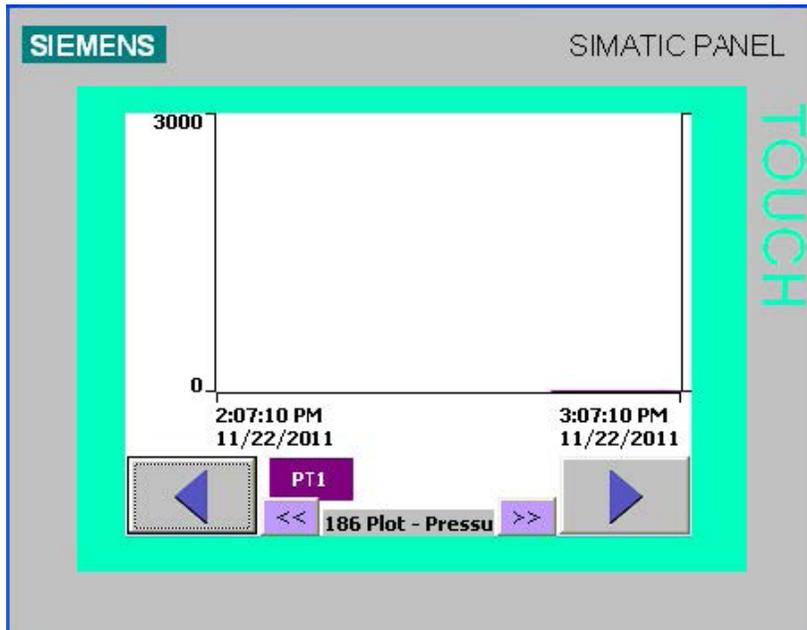
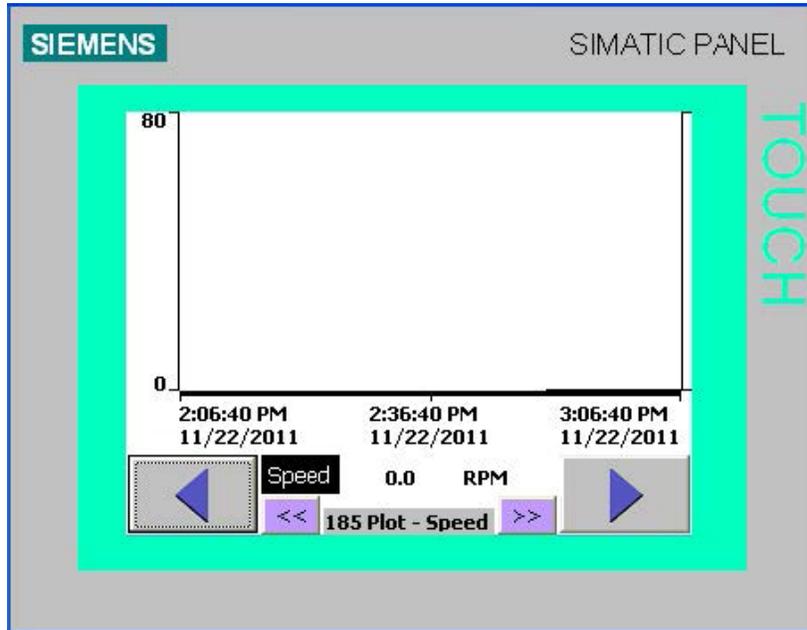
The trend menus are shown on screens 180.

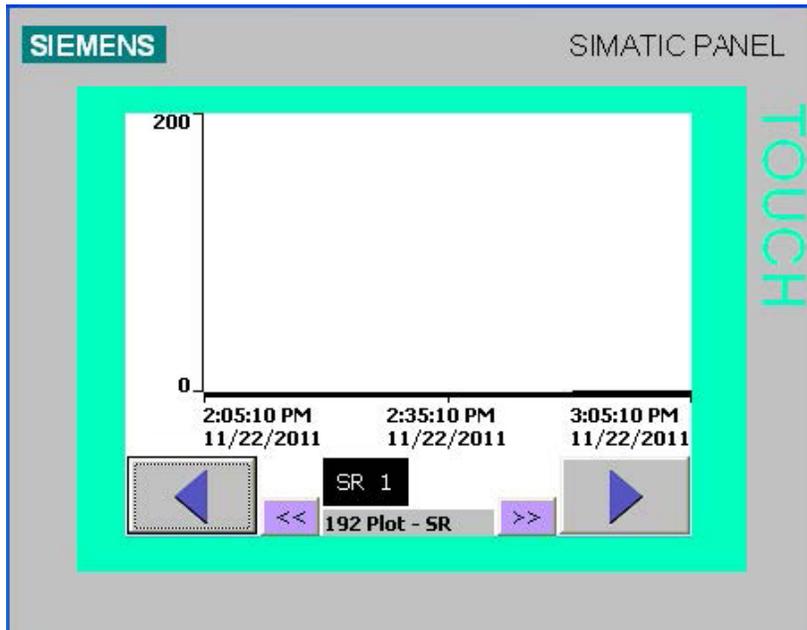
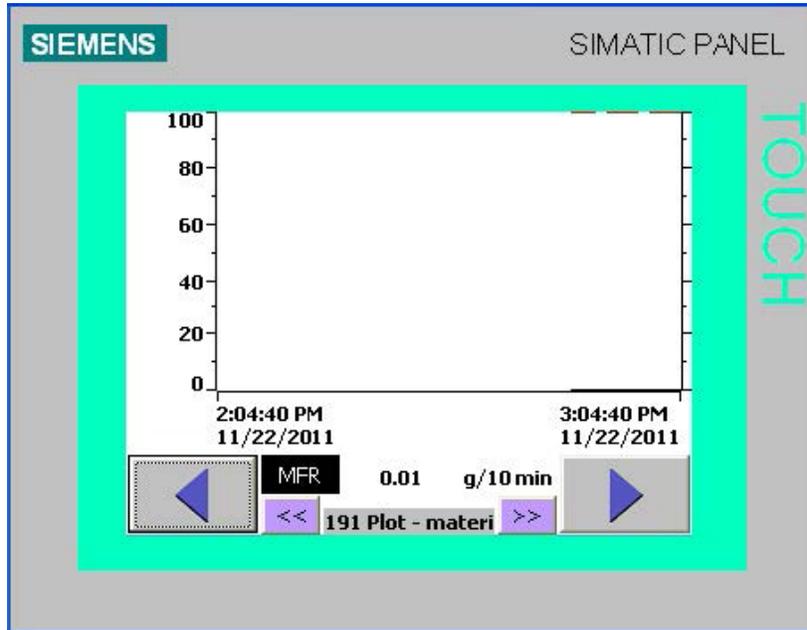
The trend setup conditions are shown on screens 181-182.

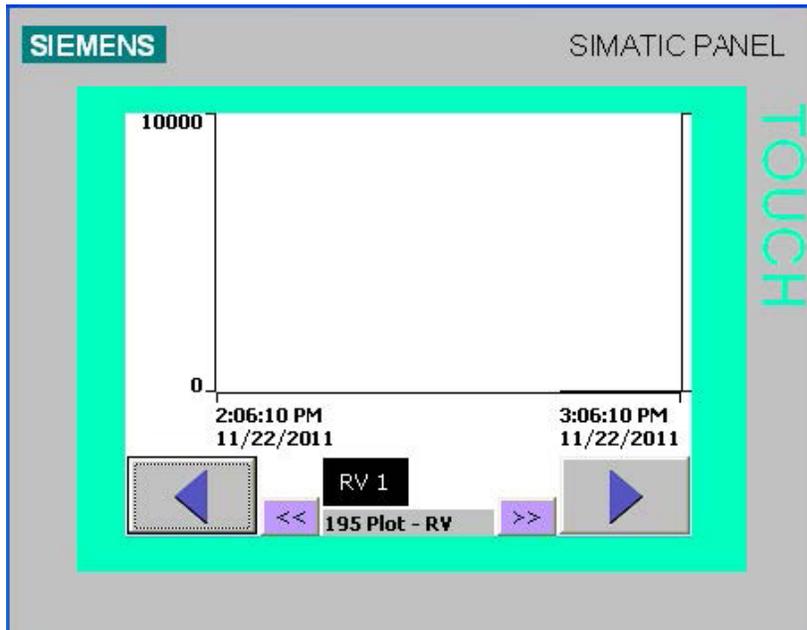
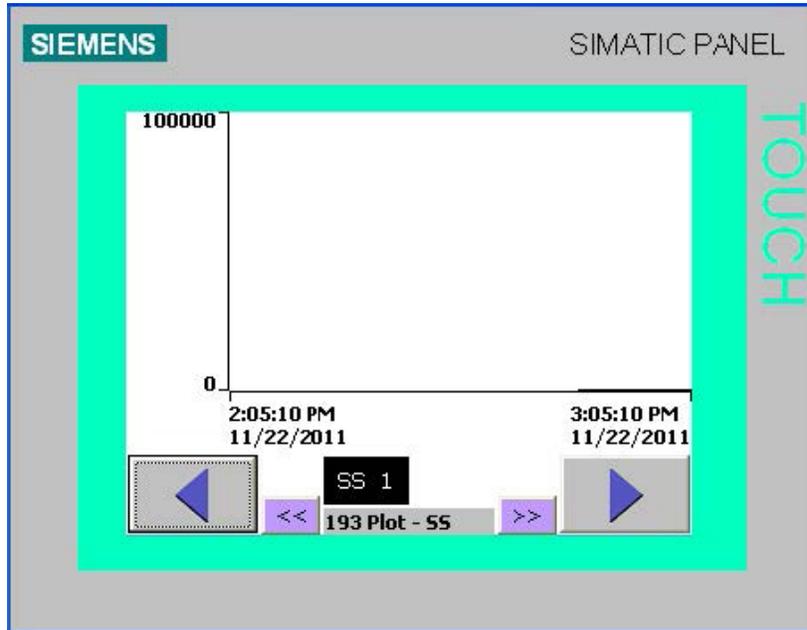
The trend graphs are shown on screens 184-186 and 191-196.

When using the 60 minute trend time axis, the  and  buttons will contract and expand, respectively, the time axis.



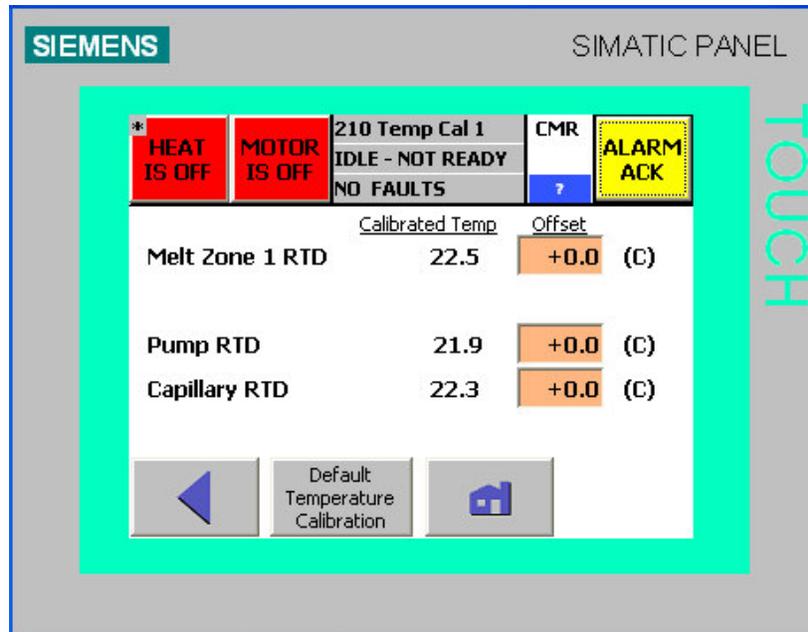






Temperature Calibration (210)

Calibrating a temperature measurement is performed by entering a positive or negative offset to the raw temperature measurement. Enter an offset for the RTD such that the calibrated value on the screen matches the measuring device. Press the default temperature calibration button to zero the offset values.



Pressure Calibration (220-222, 230-232)

Each pressure transducer must be calibrated individually. Pressure transducers can be calibrated in any of three different ways. These are Default, Automatic Cal, and User Cal.

Default Pressure Calibration – press the Default Settings button

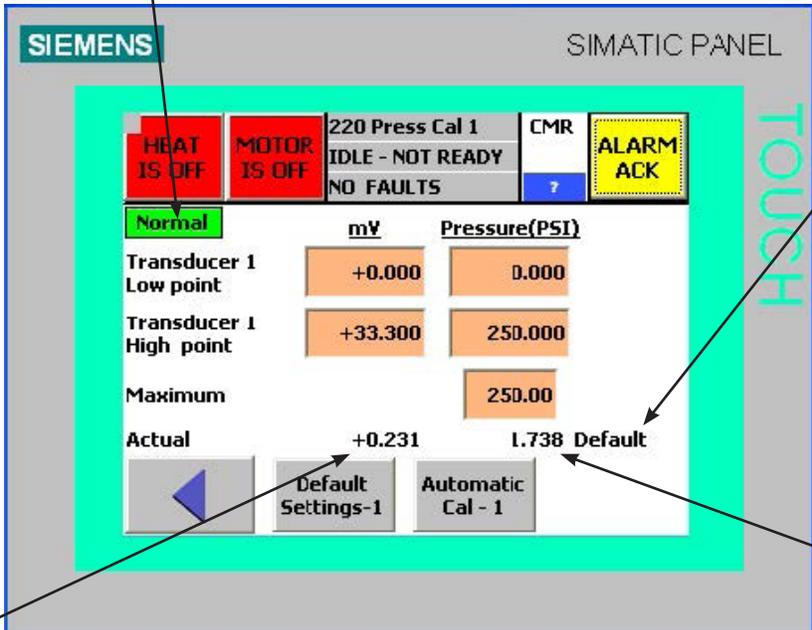
- Low point: 0.0 mV 0.0 PSI
- High point: 33.3 mV maximum PSI

Automatic Pressure Calibration – press the Automatic Cal button

- The automatic calibration process takes about 15 seconds.
- The pressure transducers must be at ambient pressure for accurate results.
- The heat must be enabled with no temperature warnings to perform the Auto Cal.
- Automatic Calibration utilizes a precision resistor within the transducer.

User/manual Calibration –

- mV readings and the associated pressure are manually entered for the two pressure data points. This method is the most accurate.



Status (points to HEAT IS OFF and MOTOR IS OFF)

Transducer calibration method (points to Normal)

Transducer Voltage (points to +0.231)

Calibrated Pressure (points to 1.738 Default)

	mV	Pressure(PSI)
Transducer 1 Low point	+0.000	0.000
Transducer 1 High point	+33.300	250.000
Maximum		250.00
Actual	+0.231	1.738 Default

Analog I/O Calibration (240-245)

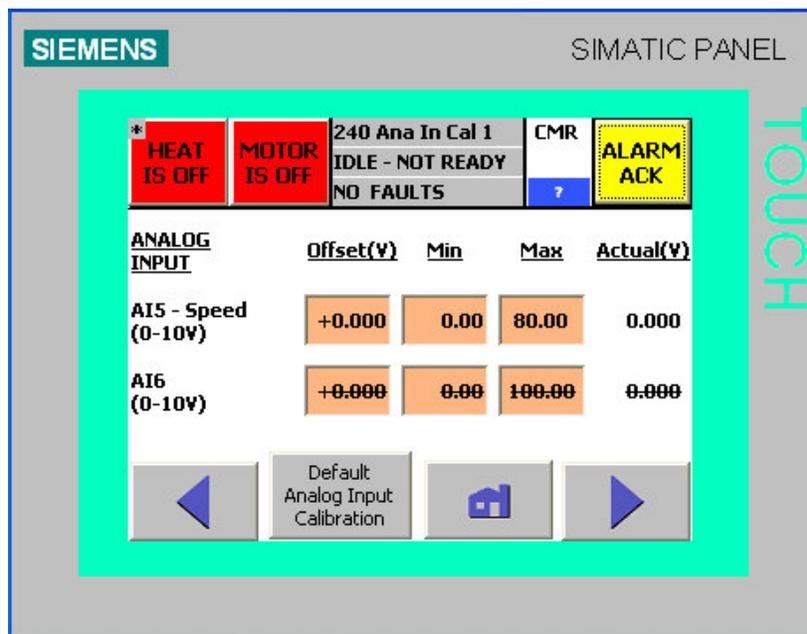
CAUTION: AI5 (speed) and AO1(0-10V) should only be calibrated by a trained service person! Poor calibration will cause errors in calculations and may damage the motor and drive.

Convert an analog (4-20 mA) input to a rheometer process setpoint

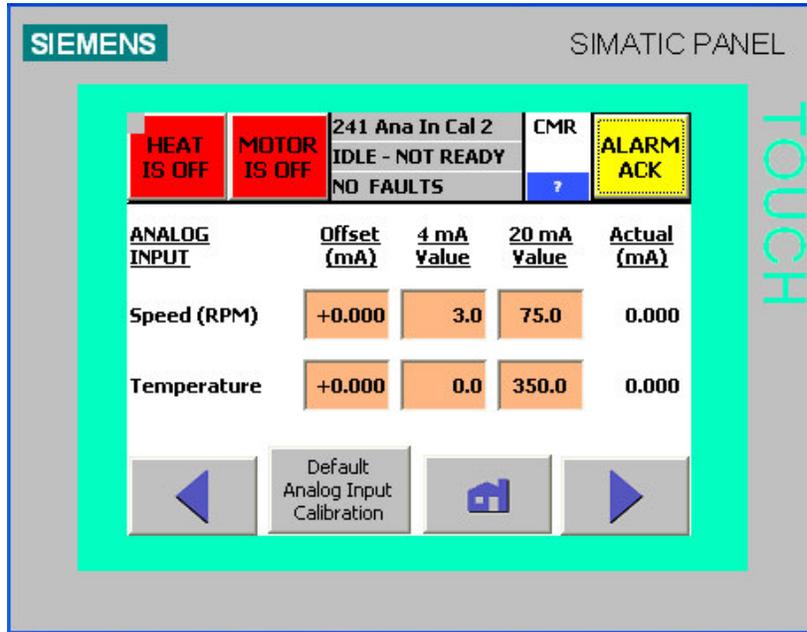
1. Select the process setpoint to be set by the analog input on screen 255 CFG mA in.
2. Install the analog inputs for process control by setting 4-20 mA inputs enabled in screen 253 CFG-Comm.
3. Scale the analog input on screen 241 Ana In Cal 2. Set the 4 mA value and the 20 mA value. For example, 4 mA represents 0.0 C and 20 mA represents 100.0 C.
4. Enable the analog inputs in screen 110 Setpoints 1 by setting RMT is ON
5. If necessary, calibrate the analog input on screen 241 Ana In Cal 2 such that the actual mA on the HMI matches the DCS analog output mA.

Convert a rheometer process value to an analog (4-20 mA) output

1. Select the process parameter to output on screen 256 CFG mA out.
2. Scale the analog input on screen 241 Ana In Cal 2. Set the 4 mA value and the 20 mA value. For example, 4 mA represents 0.0 C and 20 mA represents 100.0 C.
3. If necessary, calibrate the analog output on screens 242-244 Ana Out Cal.

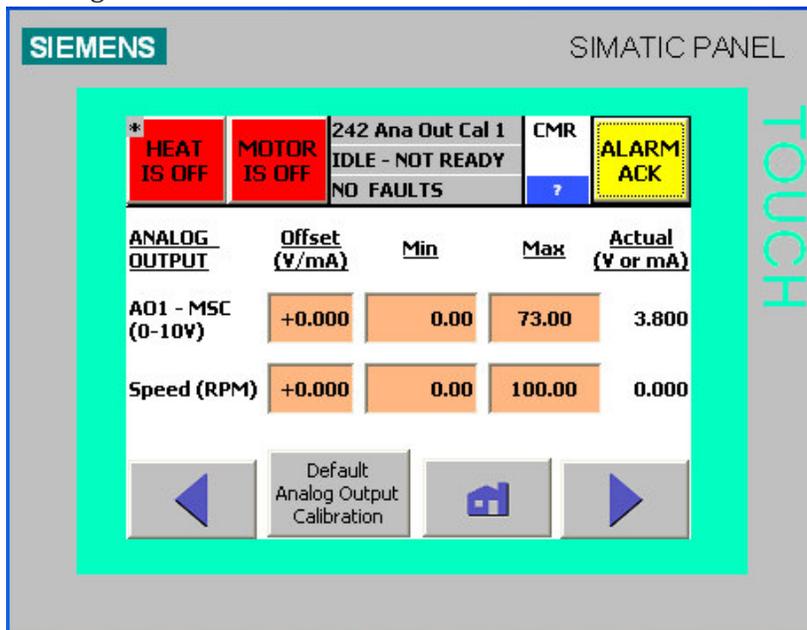


AI5 - Speed is set at the factory.
AI6 - Not applicable for the CMR



4-20 mA inputs are calibrated and scaled in screen 241. The analog inputs shown were selected in screen 255 CFG – mA in.

- Offset(mA): Used to calibrate the 4-20 mA input signal such that the Actual mA matches the mA output of the DCS.
- 4 mA Value: Used to scale the 4-20 mA input. For example, 4 mA may represent a temperature setpoint of 0.0 C
- 20 mA Value: Used to scale the 4-20 mA input. For example, 20 mA may represent a temperature setpoint of 60.0 C
- Actual (mA): mA input reading



A01 - (010V) is factory set to control the motor speed output.

4-20 mA outputs are calibrated and scaled in screens 242-244. The analog outputs shown in screens 242-244 were selected in screen 256 CFG - mA out.

- Offset(mA): Used to calibrate the 4-20 mA output signal
- 4 mA Value: Used to scale the 4-20 mA output. For example, 4 mA may represent a Speed of 0.0 RPM.
- 20 mA Value: Used to scale the 4-20 mA output. For example, 20 mA may represent a Speed of 80 RPM.
- Actual (V or mA): Output value

SIEMENS SIMATIC PANEL

HEAT IS OFF MOTOR IS OFF 243 Ana Out Cal 2 CMR ALARM ACK
 IDLE - NOT READY NO FAULTS ?

ANALOG OUTPUT	Offset (mA)	Min	Max	Actual (mA)
Melt Temp	+0.000	0.00	350.00	0.000
Pump Temp	+0.000	0.00	350.00	0.000

Default Analog Output Calibration

TOUCH

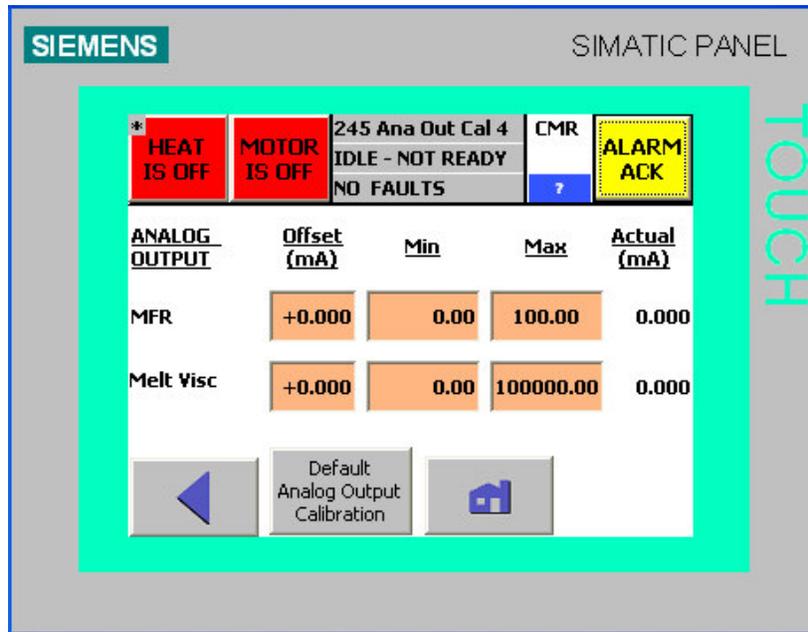
SIEMENS SIMATIC PANEL

HEAT IS OFF MOTOR IS OFF 244 Ana Out Cal 3 CMR ALARM ACK
 IDLE - NOT READY NO FAULTS ?

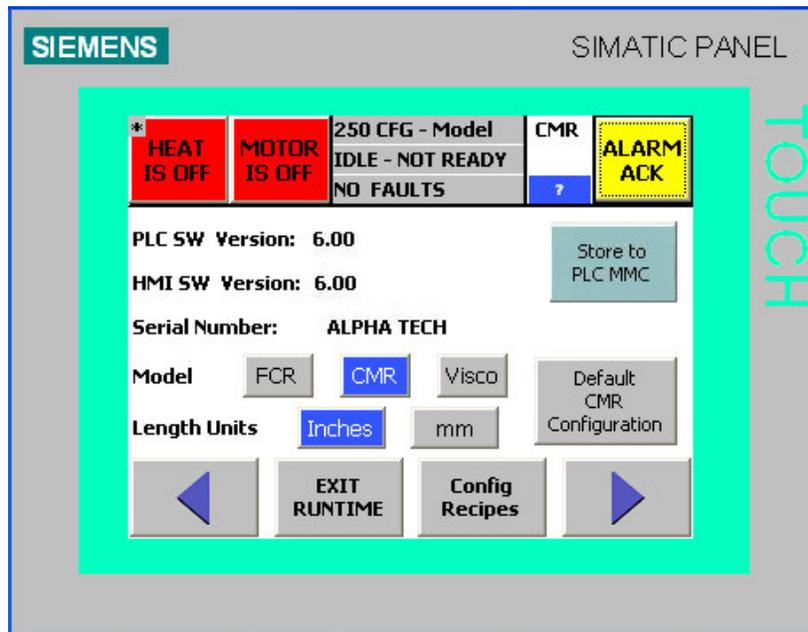
ANALOG OUTPUT	Offset (mA)	Min	Max	Actual (mA)
Cap Temp	+0.000	0.00	350.00	0.000
PT 1	+0.000	0.00	3000.00	0.000

Default Analog Output Calibration

TOUCH



Machine Configuration (250 - 259, 25A - 25C)



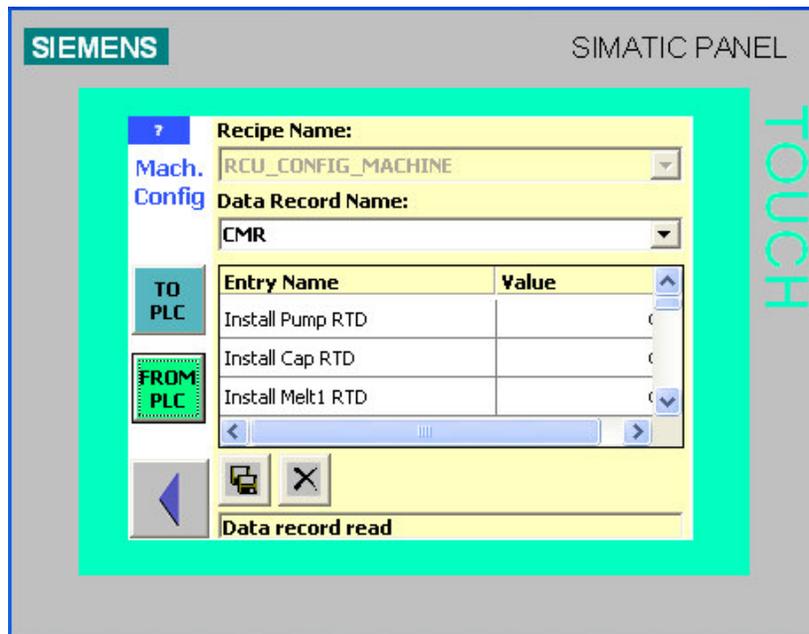
This screen should only be used if new software is loaded. All settings have already been configured at the factory. The model CMR must be selected. Items that are selected or enabled are shown in blue. The units of length are used when entering the capillary die diameter. The Default Values button will set all setpoints and equation constants to default values. The Default CMR configuration button will configure the default RTDs, pressure transducers, and 4-20mA inputs and outputs for the CMR.

EXIT RUNTIME is pressed to access the operating system on the HMI. EXIT runtime on the HMI to calibrate the touchpad, adjust the display contrast, or to load new HMI software.

Config Recipes is pressed to access the Machine Configuration recipe screen for saving the instrument configuration to the HMI memory card.

The Store to MMC button saves all configuration and setup parameters to the CPU MMC. This permits all parameters to be restored when the MRES procedure is done.

NOTE: It is recommended to use Store to MMC any time a change is made to the CMR settings, otherwise, if the MRES procedure is done, any un-stored settings will require re-entry manually.



Data Record Name - Used to add a new configuration or recall a previously saved configuration files

Entry Name - List of stored values within a configuration, this list is inclusive of all possible configuration parameters

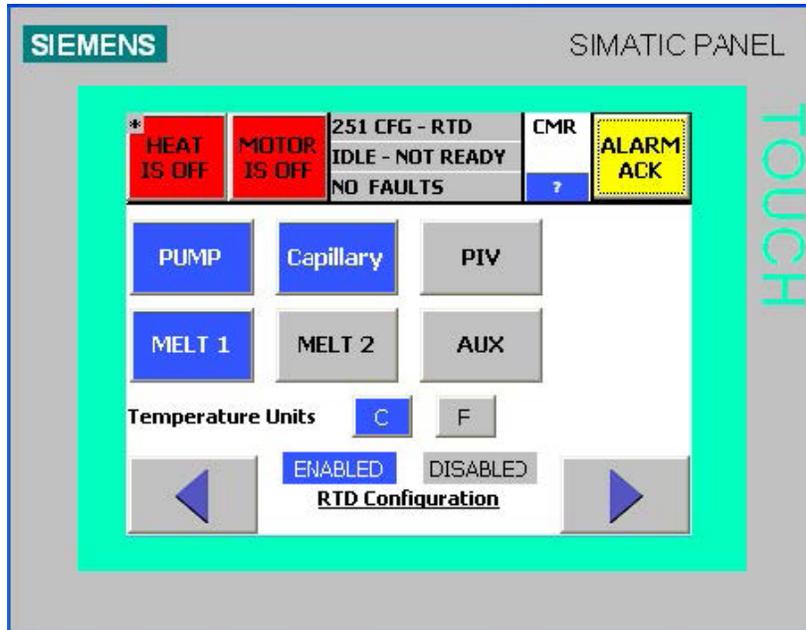
TO PLC - Sends the currently viewed machine configuration to the PLC

FROM PLC - Reads configuration stored in the PLC into the current machine configuration on the HMI
NOTE: after reading from the PLC, in order to activate the just read values, the configuration screen must be exited and re-entered

 - Saves the current configuration in a file, the file name will be prompted for and if a file of that name exists, a prompt will ask if it is to be overwritten

 - Permanently removes a stored configuration file, a prompt will ask if the action is to be performed

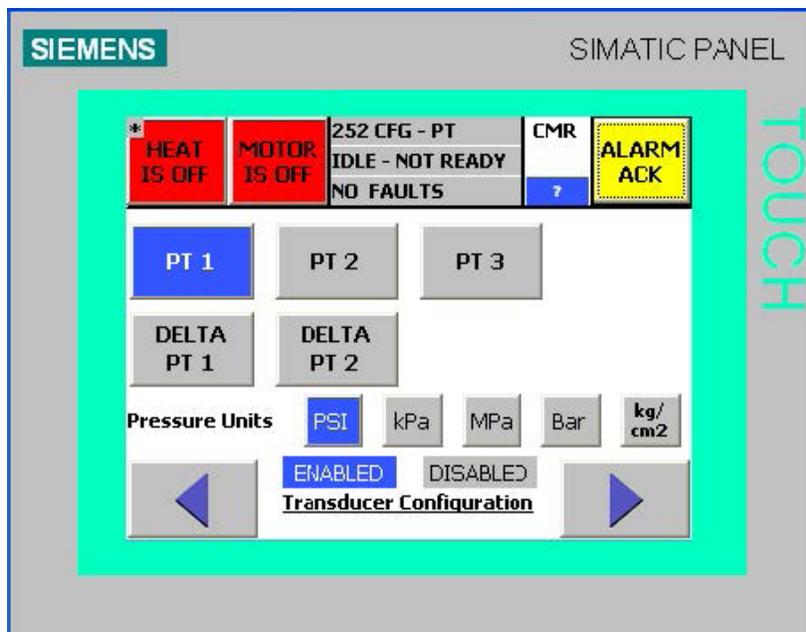
Screen 251 shows the standard configuration for the RTDs on an CMR.



Temperature units can be displayed in either C or F. Press the button to select the desired units.

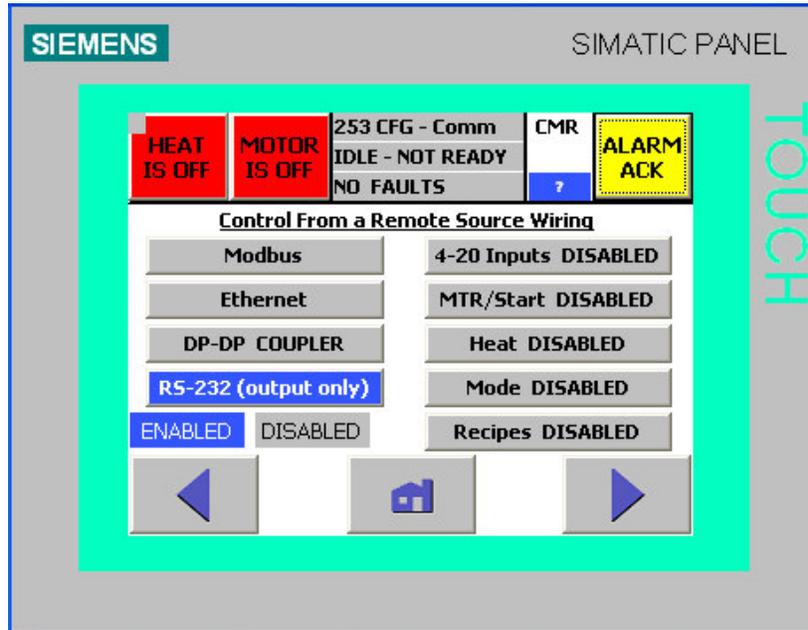
If an optional AUX heater and RTD are installed, AUX needs enabled here. Press the AUX button to enable the AUX heater and RTD.

Screen 252 shows the standard configuration for the pressure transducers on an CMR.



Pressure units can be displayed in either PSI, kPa, Mpa, Bar, or kg/cm². Press the button to select the desired units.

Screen 253 shows the standard configuration for communications on an CMR. Modbus, Ethernet, and Profibus DP-DP are communications options. The RS-232 ASCII output communication module is standard. The RS-232 (ASCII) output is factory set at 9600 baud, no parity, 8 data bits, 1 stop bit, no parity, and no flow control (9600:N:8:1).



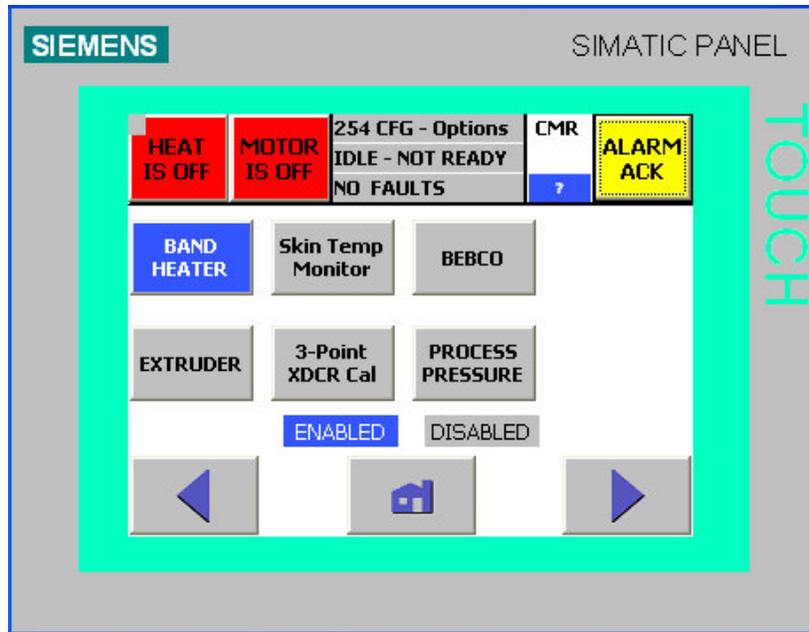
4-20 Inputs DISABLED/ENABLED – DISABLED: analog inputs are ignored with remote on and with remote off; ENABLED: inputs are read every second by the PLC when the remote is ON. The input is converted to the input selected in screen 255 and scaled in screen 241.

Heat DISABLED/ENABLED – DISABLED: discrete heat enable input is ignored with remote on and with remote off; ENABLED: discrete heat enable input is read every second by the PLC when the remote is ON

Motor DISABLED/ENABLED – DISABLED: discrete motor enable input is ignored with remote on and with remote off; ENABLED: discrete motor enable input is read every second by the PLC when the remote is ON

Mode DISABLED/ENABLED – DISABLED: discrete mode (speed/pressure) input is ignored with remote on and with remote off; ENABLED: discrete mode (speed/pressure) input is read every second by the PLC when the remote is ON

Screen 254 shows optional accessories that have been installed at the factory.



Band/Cast Heater – BAND: Adjusts the PID heat constants for a non-hazardous band heater
CAST: Adjusts the PID heat constants for a hazardous area cast heater.

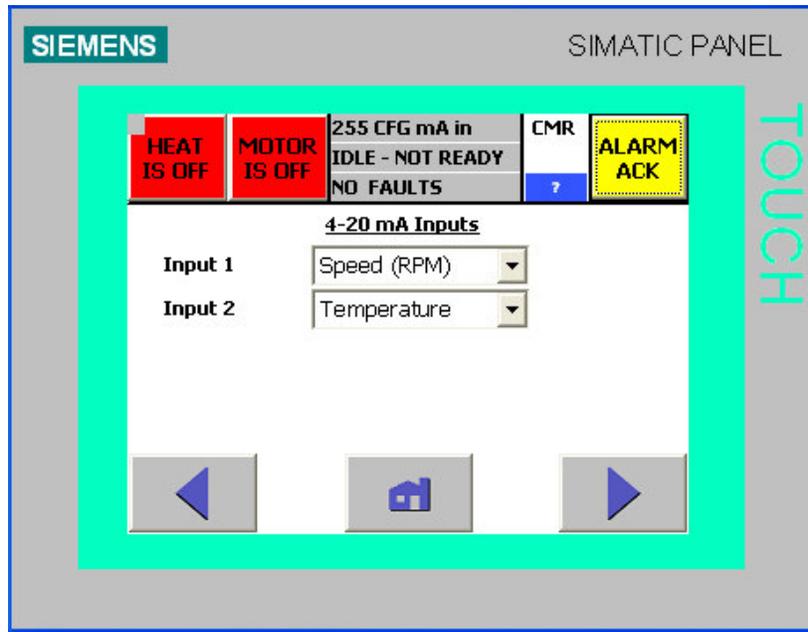
Skin Temp Monitor – ENABLED: Temperature monitors are wired into the system such that a skin temperature exceeding the area temperature limit causes a rheometer fault. A skin over temperature fault activates the fault relay and disables the rheometer heat.

BEBCO – ENABLED: An input signal is required to enable the heaters.

Extruder – ENABLED: A Dynisco REX system is connected to the rheometer.

3-Point XDCR Cal – DISABLED: Screens 220-222 Press Cal are used for pressure calibration, A 2-point pressure calibration curve is used to determine the pressure; ENABLED: Screens 230-232 Press Cal are used for pressure calibration, A 2-point or 3-point pressure calibration curve can be used to determine the pressure.

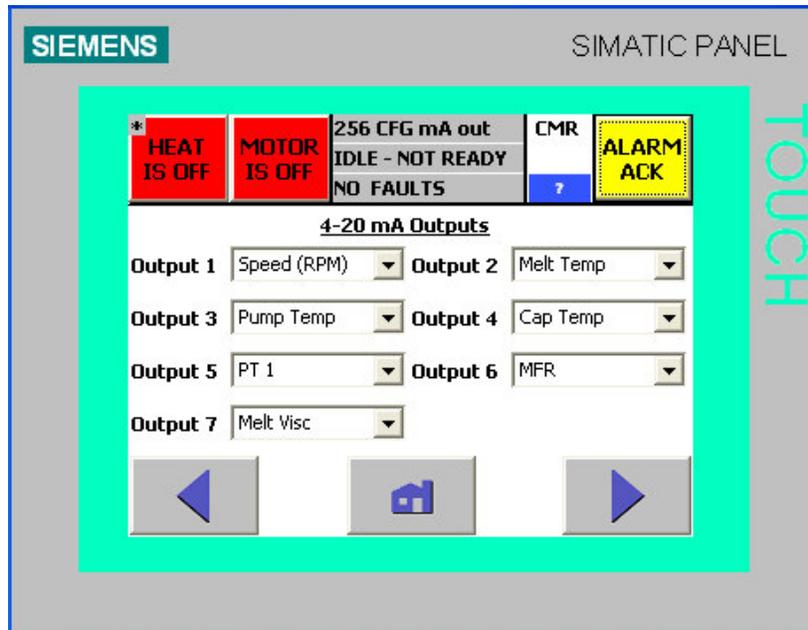
Process Pressure – ENABLED: A pressure transducer is attached to the PIV to monitor the input pressure to the rheometer. Low and high pressure limits can be set to activate warnings and faults. Configure the limits on screen 132 Setup-Warnings.



Configure the 4-20 mA inputs to set a process setpoint value. The parameter selected for Input 1 (2) is received by the rheometer on connection AI-1 (2) in the field wiring diagram. Select the parameter in this screen (255), enable inputs on 253, and scale and calibrate the input in the Analog I/O Calibration screen 241.

The 4-20 mA input can be used to set the following setpoints:

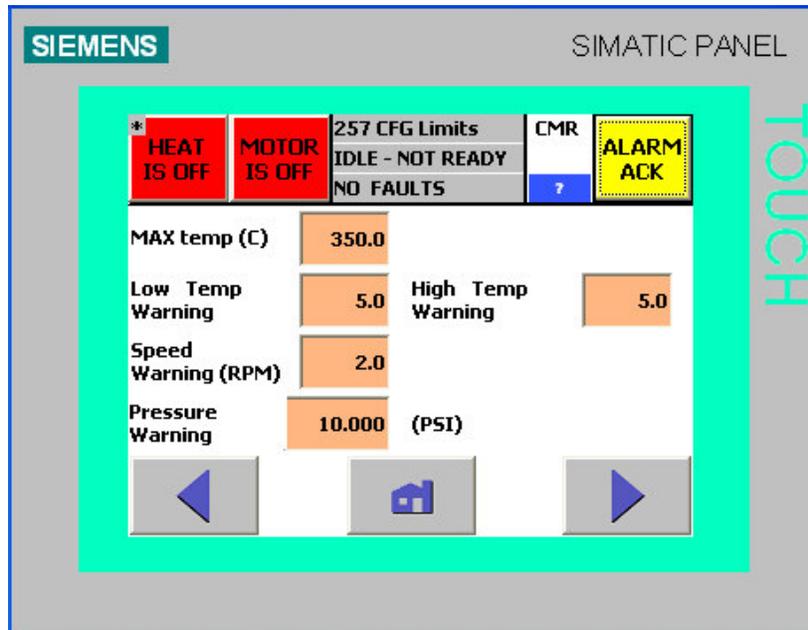
- Pump temperature
- Capillary temperature
- Aux temperature
- Speed
- Pressure
- All temperatures (pump, capillary, and aux)



Configure the 4-20 mA outputs on the rheometer by selecting the desired parameters in this screen (256). The parameter selected for Output 1 (2/3/4/5) is transmitted by the rheometer on connection AO-1 (2/3/4/5) in the field wiring diagram. Scale and calibrate the outputs in the Analog I/O Calibration screens 242-245.

The 4-20 mA output can be selected from the following choices:

- Pump temperature
- Capillary temperature
- Melt 1 temperature
- Melt 2 temperature
- Melt temperature average
- Aux temperature
- Speed
- Pressure transducer 1 pressure
- Pressure transducer 2 pressure
- Pressure transducer 3 pressure
- Delta pressure 1
- Delta pressure 2
- MFR
- Shear rate
- Shear stress
- Melt viscosity
- Relative viscosity
- Intrinsic viscosity



MAX temp - Maximum allowable temperature of the instrument. When any of the RTD readings reach this temperature, the heat is disabled and the fault relay is opened.

Low Temp Warning - A yellow warning message is displayed when a temperature reading deviates this many degrees below the setpoint.

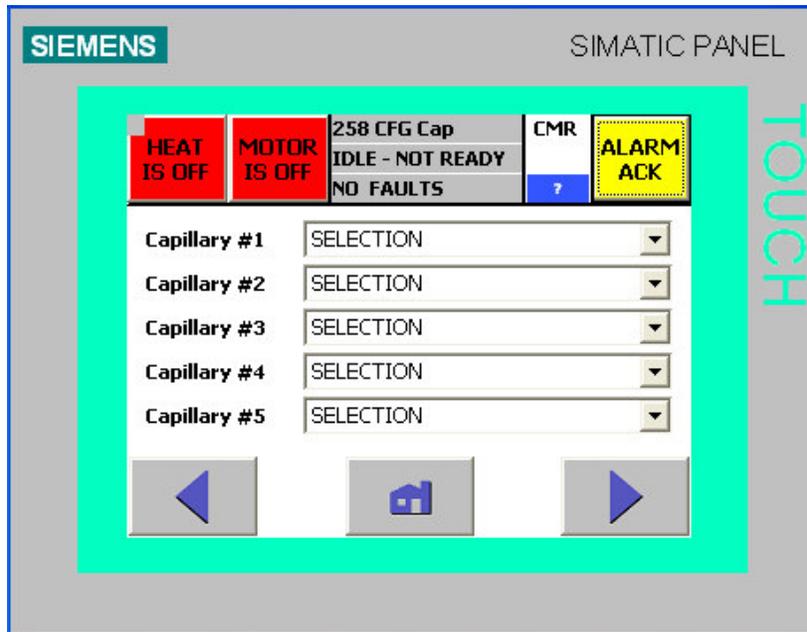
High Temp Warning - A yellow warning message is displayed when a temperature reading deviates this many degrees above the setpoint.

Speed Warning - In speed mode, a yellow warning message is displayed when the actual speed deviates this many RPM above/below the setpoint.

Pressure Warning - In pressure mode, a yellow warning message is displayed when the actual pressure deviates this many units above/below the setpoint.

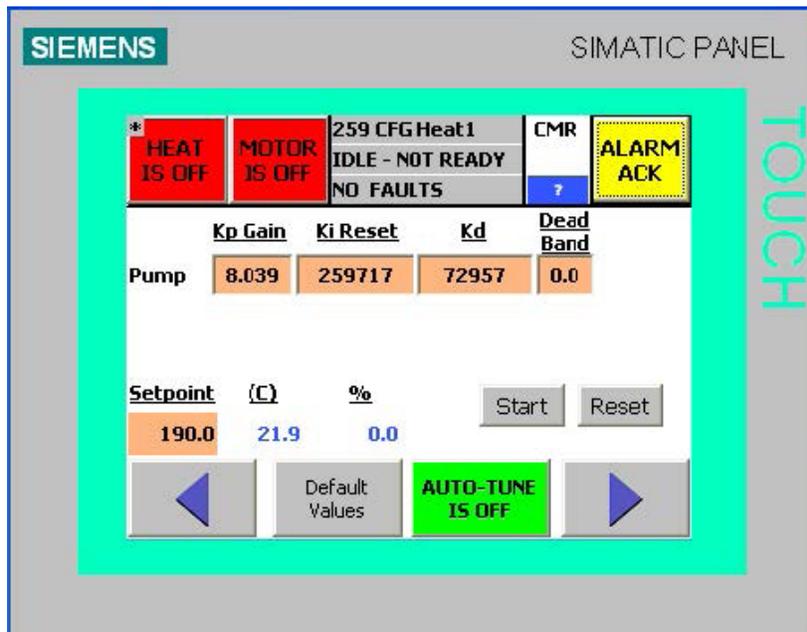
The warning relay is closed when no warnings are present. The warning relay is open when power is OFF or a warning exists. Warnings do not need to be acknowledged and will clear when the cause ends.

The fault relay is closed when no faults are present. The fault relay is open when power is OFF or a fault exists. Faults need to be acknowledged and are logged in the error log.



Capillary Selection - Capillary entries stored here are accessed and placed into the Capillary box on the Capillary Selection screen (accessed by the button on screen 120).

Screens 259, 25A, 25B and 25C are used for setting the PID Control loop constants. These constants have been factory set and should only be changed by trained personnel.



SIEMENS SIMATIC PANEL

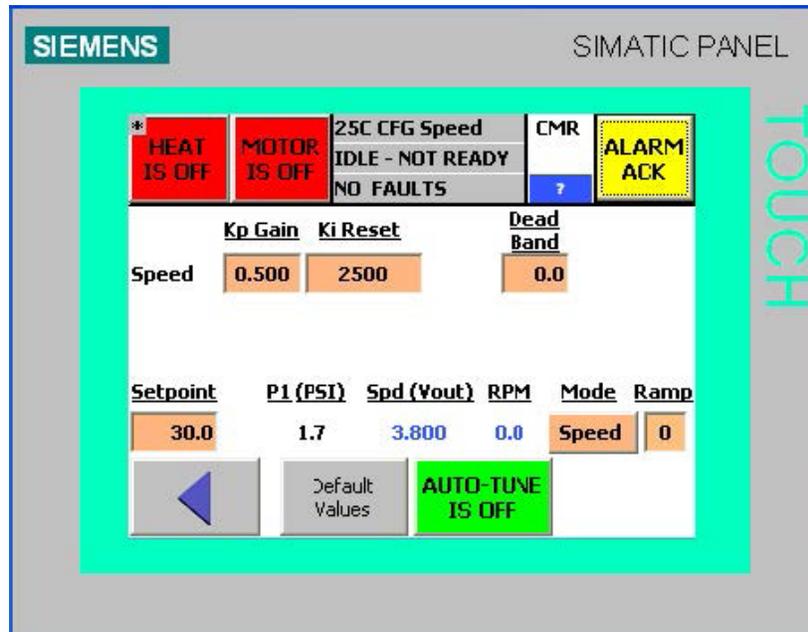
TOUCH

HEAT IS OFF	MOTOR IS OFF	25A CFG Heat2 IDLE - NOT READY NO FAULTS	CMR ?	ALARM ACK
Kp Gain	Ki Reset	Kd	Dead Band	
CAP 8.492	236024	59523	0.0	
Setpoint (C)	%			
190.0	22.3 0.0			
◀	Default values	AUTO-TUNE IS OFF	▶	

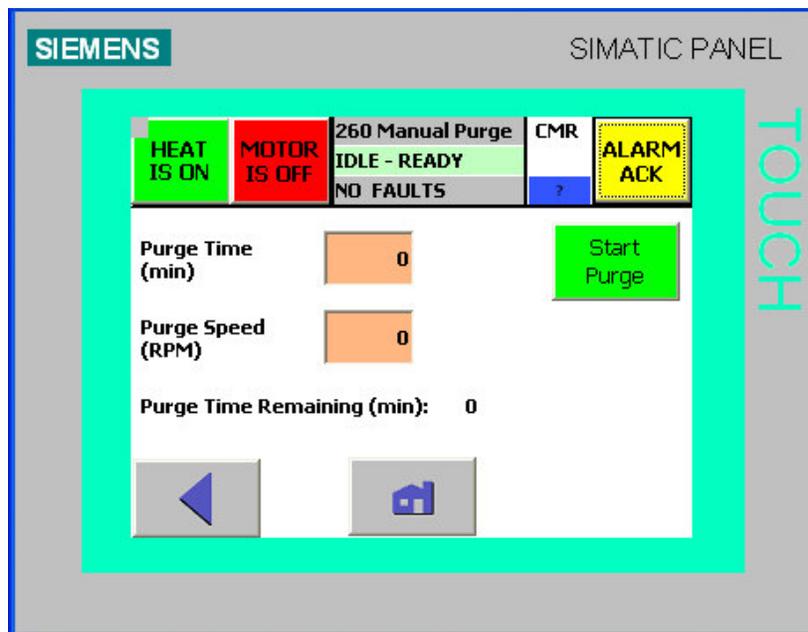
SIEMENS SIMATIC PANEL

TOUCH

* HEAT IS OFF	MOTOR IS OFF	25B CFG Heat3 IDLE - NOT READY NO FAULTS	CMR ?	ALARM ACK
Kp Gain	Ki Reset	Kd	Dead Band	
AUX 6.840	223386	57312	0.0	
Setpoint (C)	%			
◀	Default values	AUTO-TUNE IS OFF	▶	



Manual Purge (260)



A manual purge is used to clear the rheometer of material. After the purge has completed, the rheometer heat is disabled.

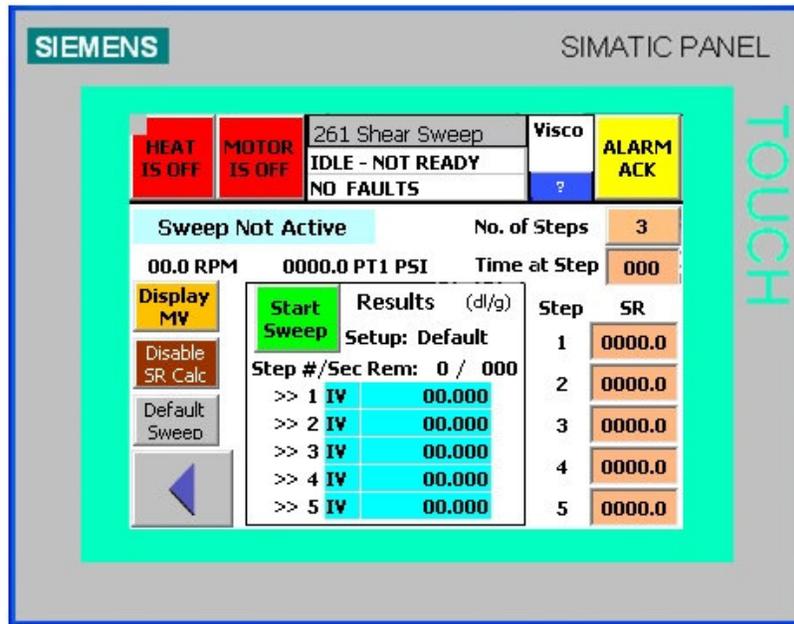
Purge Time - range 0-1440 minutes,

Purge Speed - range minimum to maximum allowable speed (RPM)

Start Purge - button is visible when the rheometer state is IDLE-READY

Stop Purge - button is visible while purging, Press to interrupt the purge process.

Shear Sweep (261)



The Shear Sweep runs the material through 3 to 5 steps of varying shear rates (SR). The Default sweep has 5 steps lasting 30 seconds each and the SR at each step is an equal division between steps of the determined minimum and maximum SR that can be obtained within the speed and pressure limits and with the configured setup. The number of steps and the step time may be changed. The SR at each step may be Custom, but the step values will be limited to the possible SR limits. A sweep may be manually started when the rheometer is in run and the rheometer will be stopped at the end of the sweep. The operation can be set to be automatic on screen „133 Setup-Sample“ with the setting of Sample/Sweep/Purge or Sample/Sweep, where the rheometer is cycled through successive operations of Sample, and/or Shear Sweep, and/or Purge.

The minimum and maximum shear rates are calculated by internally setting the minimum running pressure to 5% of the pressure transducer maximum pressure and then setting the maximum running pressure to 95% of the transducer maximum. The calculation takes in to account the limits of the pump rotational speed. The calculation of the minimum and maximum SR can take up to 20 seconds each. This calculation is done at the start of each shear sweep unless the Disable SR Calc is active. In this case the calculation is done only the first time a shear sweep is run after the rheometer is started and the sweep is run by an automatic operation.

No. Of Steps - The number of shear sweep steps can be set to 5 (default), 4, or 3.

Time at Step - The time at each step can be set between 30 (default) and 300 seconds.

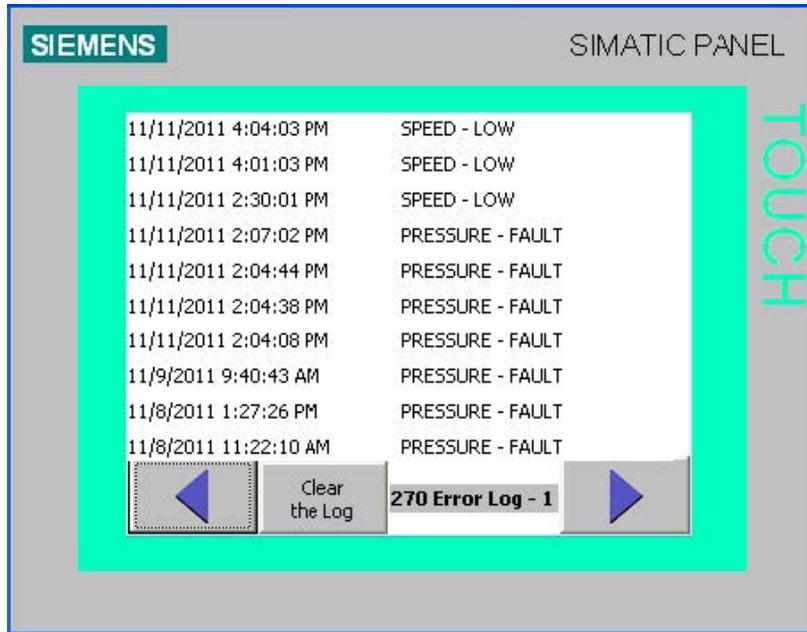
Step and SR - This is the step number and the SR that will be run at that step. If an SR step entry is custom, it is checked and limited to the maximum and minimum SR and it will be displayed with a different background color. The step number of a limited entry will flash during the sweep in which it was determined to be beyond the limits, but on successive runs the flashing will cease.

Start Sweep / Stop Sweep - A manual shear sweep can be started by starting the rheometer and then pressing this button. In automatic operation, a sweep can be started any time. Pressing Stop Sweep will stop the rheometer.

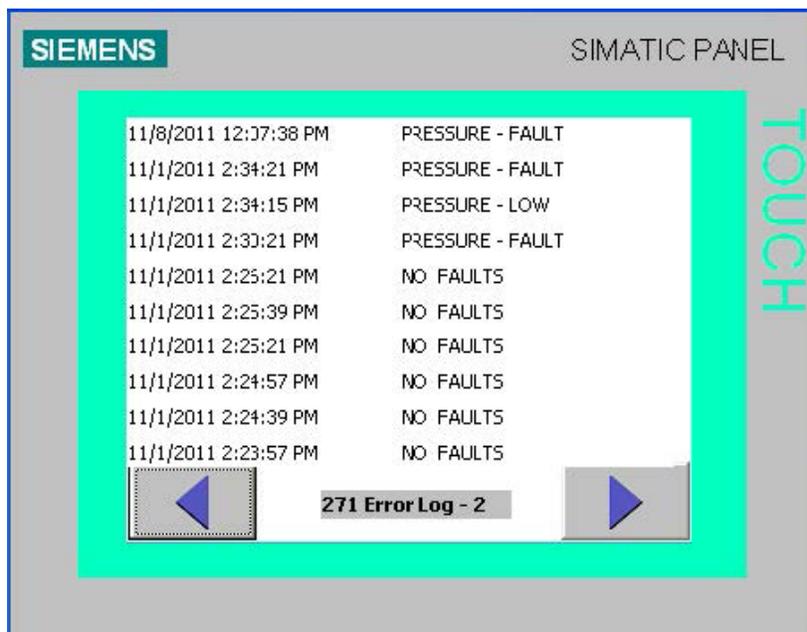
Display MV / Display IV - The Results display can be changed between Melt Viscosity, in Pa-s, and Intrinsic Viscosity, in dl/g, at any time.

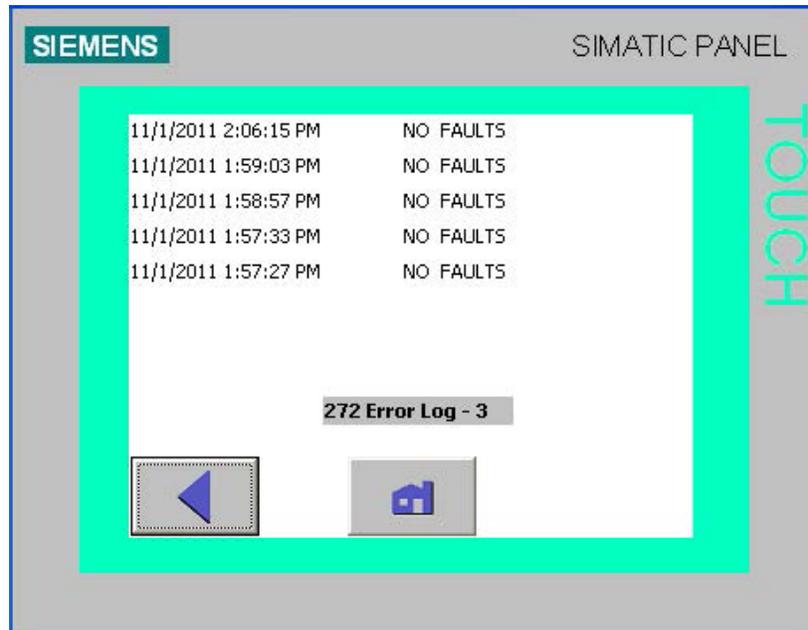
Disable SR Calc/ Enable SR Calc - When Disable SR Calc is displayed, each shear sweep will start with a minimum and maximum SR calc. Pressing this will change it to Enable SR Calc and the min/max calculation will only be done the first time an automatic sweep is run after the rheometer is started. This button will appear grayed-out when the rheometer is stopped or the initial min/max calculation has not been performed.

Error Log (270-272)



The most recent 25 faults are displayed on screens 270-272 Error Log. The most recent fault is displayed first. Faults are displayed along with the date and time of the occurrence. Clear the error log by pressing the Clear the Log button.



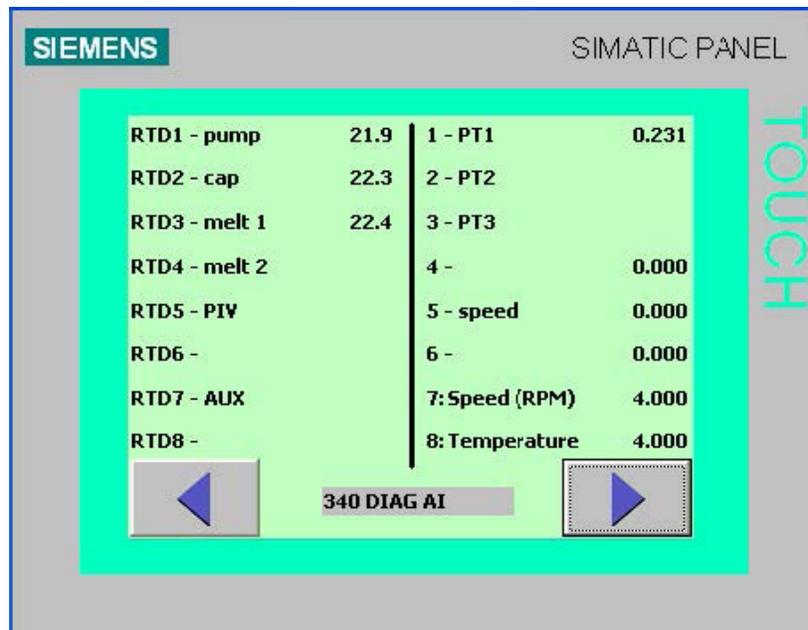


Diagnostics (340-348)

CAUTION - ALL outputs are manually controlled in the DIAGNOSTICS screens! Normal operation is suspended when using the DIAGNOSTICS!

CAUTION - DO NOT ENABLE THE MOTOR WHILE IN THE DIAGNOSTICS UNLESS THE HEAT IS AT TEMPERATURE OR THE MOTOR IS DISCONNECTED FROM THE PUMP! THIS WILL DAMAGE THE PUMP!

This Diagnostics screen shows the status of all the analog inputs.



These two Diagnostic screens show the status of all the analog outputs. The analog output can be forced to the value shown in the button by pressing the button. Use these for troubleshooting 4-20 mA field wiring.

SIEMENS SIMATIC PANEL

TOUCH

Description	Value	ZERO	MIDDLE	MAX
1: MSC 0-10V	0.0	ZERO	5 V	10 V
2: Speed (RPM)	0.0	4 mA	12 mA	20 mA
3: Melt Temp	0.0	4 mA	12 mA	20 mA
4: Pump Temp	0.0	4 mA	12 mA	20 mA

341 DIAG AO 1

Navigation buttons: Left arrow, Home icon, Right arrow

SIEMENS SIMATIC PANEL

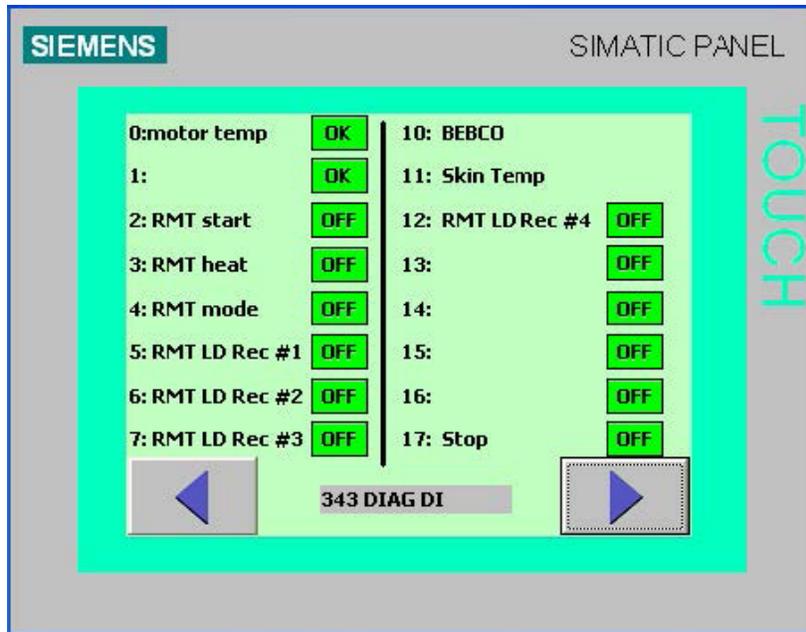
TOUCH

Description	Value	ZERO	MIDDLE	MAX
5: Cap Temp	0.0	4 mA	12 mA	20 mA
6: PT 1	0.0	4 mA	12 mA	20 mA
7: MFR	0.0	4 mA	12 mA	20 mA
8: Melt Visc	0.0	4 mA	12 mA	20 mA

342 DIAG AO 2

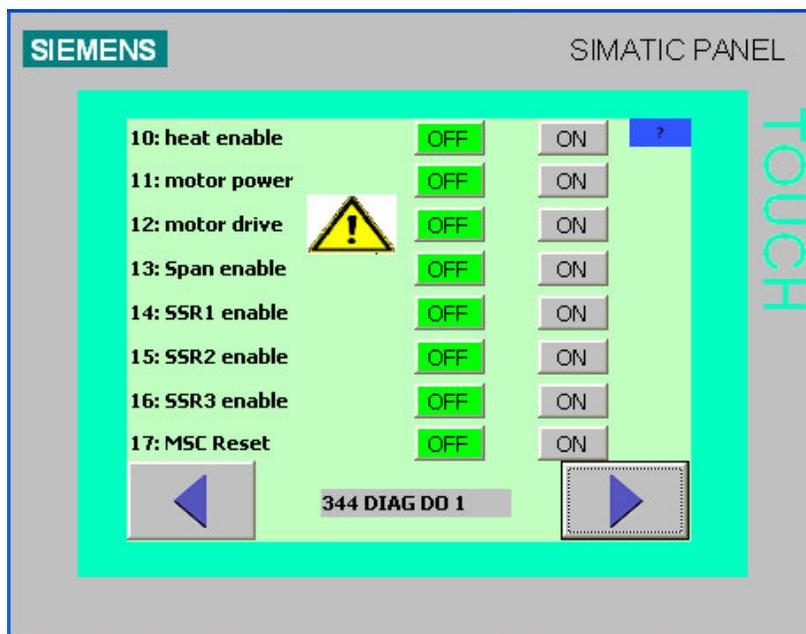
Navigation buttons: Left arrow, Home icon, Right arrow

This Diagnostic screen shows the status of all the digital inputs.



Screens 264-267 show the status of all the digital outputs. Press the OFF button to force the output OFF. Press the ON button to force the output ON.

CAUTION - DO NOT ENABLE THE MOTOR WHILE IN THE DIAGNOSTICS UNLESS THE HEAT IS AT TEMPERATURE OR THE MOTOR IS DISCONNECTED FROM THE PUMP! THIS WILL DAMAGE THE PUMP!



SIEMENS SIMATIC PANEL

TOUCH

20:	OFF	ON
21:	OFF	ON
22:	OFF	ON
23:	OFF	ON
24: Recipe #1 active	OFF	ON
25: Recipe #2 active	OFF	ON
26: Recipe #3 active	OFF	ON
27: Recipe #4 active	OFF	ON

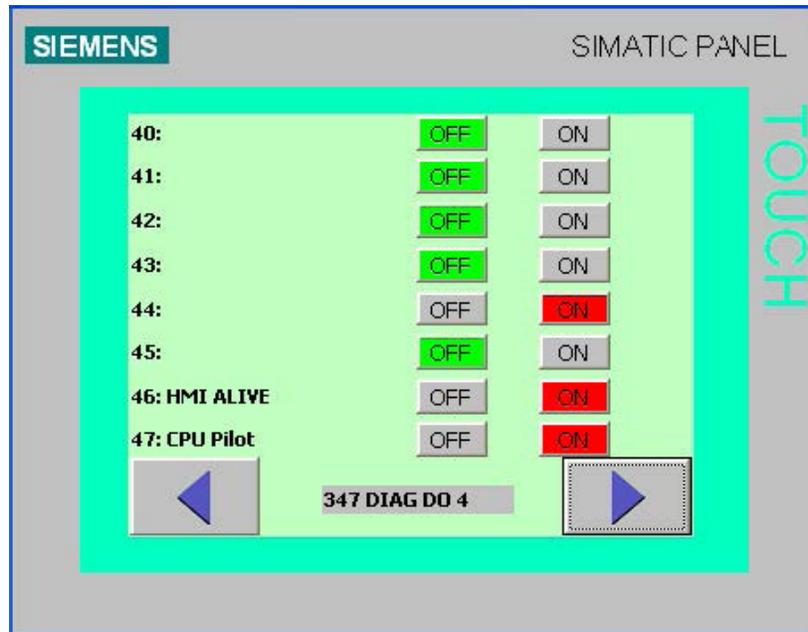
345 DIAG DO 2

SIEMENS SIMATIC PANEL

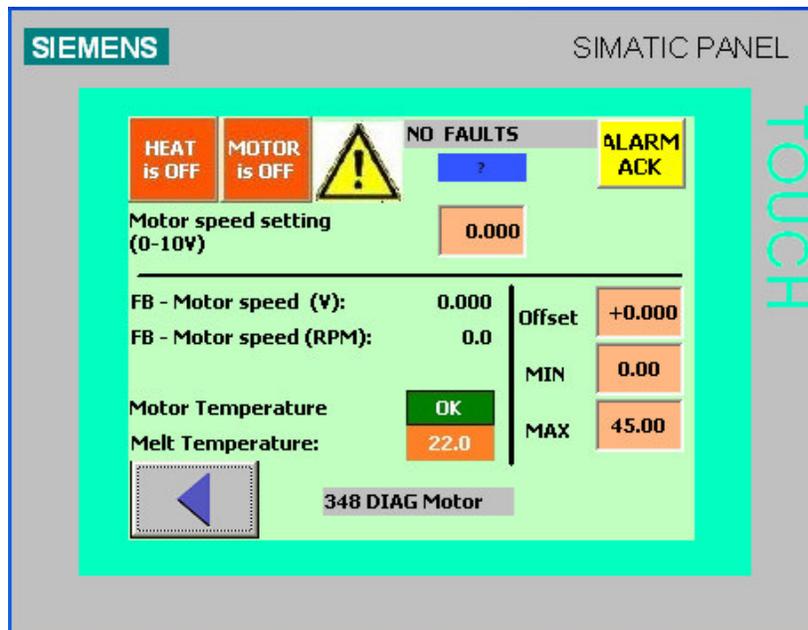
TOUCH

30: fault relay	OFF	ON
31: warning relay	OFF	ON
32: local/remote	OFF	ON
33: motor status	OFF	ON
34: Material in range	OFF	ON
35:	OFF	ON
36:	OFF	ON
37:	OFF	ON

346 DIAG DO 3



CAUTION - DO NOT ENABLE THE MOTOR WHILE IN THE DIAGNOSTICS UNLESS THE HEAT IS AT TEMPERATURE OR THE MOTOR IS DISCONNECTED FROM THE PUMP! THIS WILL CAUSE DAMAGE TO THE PUMP!



This screen is to be used by trained service personnel for calibrating the motor speed. Call the factory for assistance.



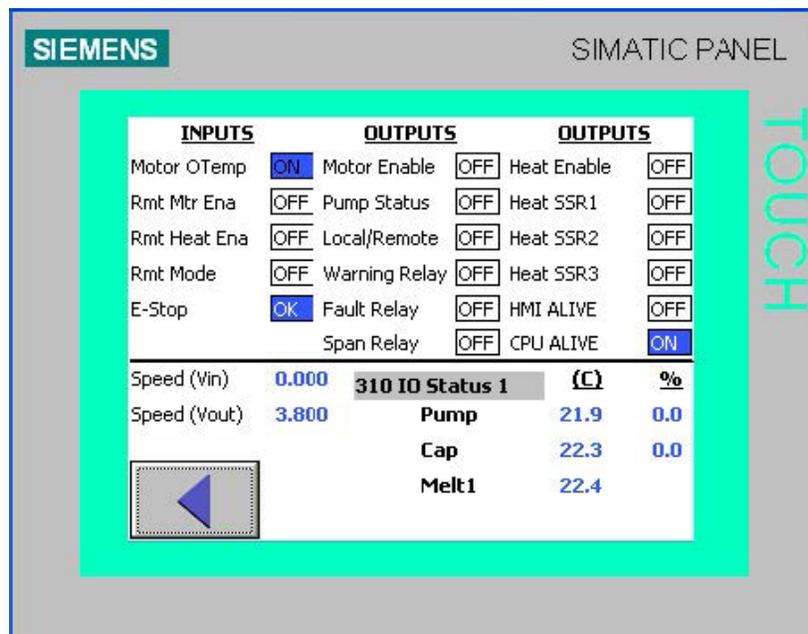
IO Status (310)

The status of inputs is shown in the left column.

The status of outputs is shown in the middle and right columns.

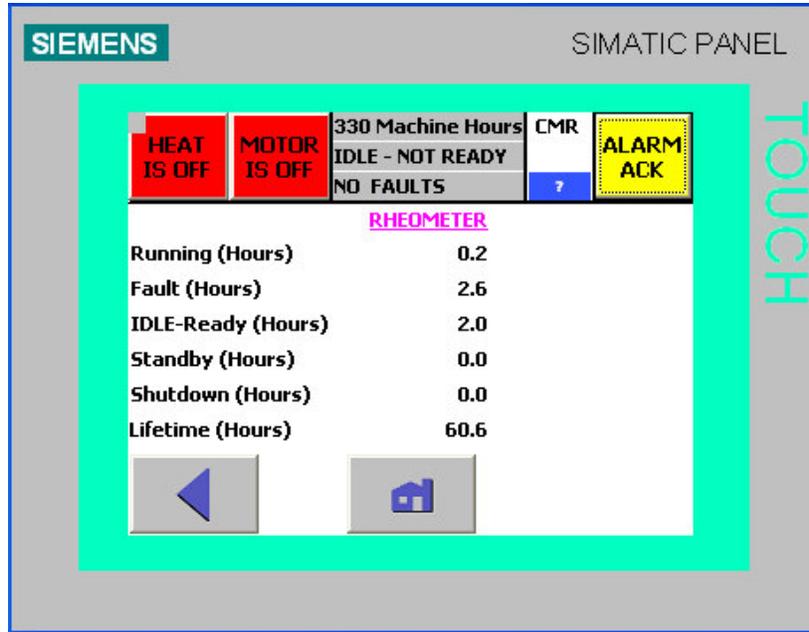
The HMI alive and CPU alive outputs should cycle on and off about 1 time every second. These two outputs show that the HMI and the CPU/PLC are executing.

The temperature associated with the three heat zones is shown along with the percentage of time the output is on. The AUX zone will only be shown if the optional AUX RTD is installed.



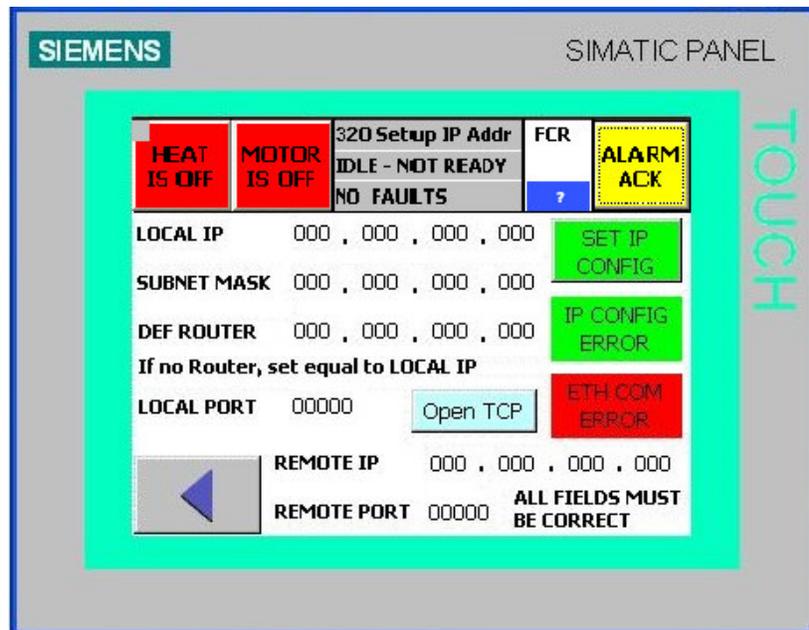
INPUTS		OUTPUTS		OUTPUTS	
Motor OTemp	<input checked="" type="checkbox"/>	Motor Enable	<input type="checkbox"/>	Heat Enable	<input type="checkbox"/>
Rmt Mtr Ena	<input type="checkbox"/>	Pump Status	<input type="checkbox"/>	Heat SSR1	<input type="checkbox"/>
Rmt Heat Ena	<input type="checkbox"/>	Local/Remote	<input type="checkbox"/>	Heat SSR2	<input type="checkbox"/>
Rmt Mode	<input type="checkbox"/>	Warning Relay	<input type="checkbox"/>	Heat SSR3	<input type="checkbox"/>
E-Stop	<input checked="" type="checkbox"/>	Fault Relay	<input type="checkbox"/>	HMI ALIVE	<input type="checkbox"/>
		Span Relay	<input type="checkbox"/>	CPU ALIVE	<input checked="" type="checkbox"/>
Speed (Vin)	0.000	310 IO Status 1		(C)	%
Speed (Vout)	3.800	Pump	21.9	0.0	
		Cap	22.3	0.0	
		Melt1	22.4		

Machine Hours (330)



- Running - number of hours the instrument has been in the RUN state
- Fault - number of hours the instrument has been in a fault condition.
- IDLE-Ready - number of hours the instrument has been in the IDLE-Ready state
- Standby - number of hours the instrument has been in the Standby state
- Lifetime - number of hours the instrument has been powered up

Setup IP Address (320) (if option supplied)





Local Display System Operations

To change the local display's setup parameters, the display's CONTROL PANEL must be accessed. Access to the CONTROL PANEL is possible when power is applied to the display and by using the EXIT RUNTIME button on the Machine Configuration screen. When power is applied to the display, a short self-test is performed, next a menu screen with three buttons is visible for approximately 3 seconds. If none of the buttons are pressed, the display will automatically show the Start Up screen followed by the MAIN screen of the application software.

The four buttons on the menu are TRANSFER, START, CONTROL PANEL, and TASK BAR. When the CONTROL PANEL button is pressed, a WINDOWS type control panel should be seen. All the WINDOWS properties will apply. To exit the CONTROL PANEL, press the "X" in the upper right corner of the screen. The TRANSFER, START, and CONTROL PANEL menu should be seen. Press START, the application software MAIN screen should be seen after a few seconds.

Display Contrast

From the display's WINDOWS control panel, double tap the OP icon. Select the DISPLAY tab from the OP PROPERTIES screen. Use the UP and DOWN buttons to adjust the display contrast. Tap the OK button to return to the CONTROL PANEL.

Touch Screen Calibration

If the display is not responding to the selected touch field, it may be necessary to recalibrate the touch panel. From the display's WINDOWS control panel, double tap the OP icon. Select the TOUCH tab from the OP PROPERTIES screen. Follow the on-screen instructions. Tap the OK button to return to the CONTROL PANEL.

Resetting Display Systems Data

A copy of the display's operating systems data is stored on a memory card located on a rear side panel of the display. It may be necessary to restore the operating system data if,

1. New display software is needed.
2. The operation of the display is erratic.

To restore the operating systems data,

1. Press the EXIT RUNTIME pushbutton on the Machine Configuration screen. The four-button menu, TRANSFER, START, and CONTROL PANEL, and TASK BAR should be seen.
2. Press the CONTROL PANEL pushbutton. A Windows type control panel should be seen. All the Windows properties will apply.
3. Press the BACKUP/RESTORE icon. Follow the RESTORE on-screen instructions.
4. To exit the CONTROL PANEL, press the "X" in the upper right corner of the screen. The TRANSFER, START, and CONTROL PANEL menu should be seen.
5. Press START, the application software MAIN screen should be seen after a few seconds.

Rheometer Technical Manual

Introduction

The rheometer is the “sensing end” of the system. It is connected to the polymer melt to be tested through the transfer line and is driven by the RCU. The rheometer receives the polymer melt then pumps it through a capillary orifice measuring both flow rate and pressure drop across the capillary. With these measurements, the shearrate/shear-stress relationship of a polymer can be determined and converted into such standard items as Melt Flow Rate or Apparent Viscosity.

General Operation

Pressure Measurement System

The pressure transducers located in the measurement head convert the cavity pressure to an electrical signal. The transducers are unbonded strain gauge (2 active arm bridge) which makes direct contact with the polymer. Changes in cavity pressure produce stress changes in the transducer bridge resistance, which results in an electrical signal proportional to the pressure. The transducers are mounted deep within the capillary end of the flow passage barrel, just above the capillaries, and are specially designed to withstand the high-test temperatures. Refer to the RCU Technical manual section for a further discussion of this function.

Speed Measurement System

The metering pump, pump motor and tachometer are directly coupled. The tachometer signal is calibrated to read out pump speed. The 2400 Hz. Tachometer signal is fed directly to the RCU and using system parameters this frequency is converted into pump shaft RPM. Refer to the RCU Technical manual section for a further discussion of this function.

Temperature Control System

The temperature control system maintains the polymer melt at the precise test temperature. In the flow passage barrel (measurement head), the melt temperature is regulated by two zones of closed loop temperature control (with polymer residence time, thermal mass and proper insulation). The first control zone is around the metering pump, and largely accounts for differences between polymer feed and test temperatures. The second temperature control zone regulates temperature around the test zone itself (capillary-transducer area). The process temperature is read by a grade “A” 3-wire RTD. Refer to the RCU Technical manual section for a further discussion of this function.

Maintenance

Maintenance is generally limited to changing and cleaning capillaries and occasional gear-reducer oil changes. Covers must be removed for access to pump and transducer.

Anti-Seize Compound

When replacing components that are connected to the flow passage barrel, a “high-temperature anti-seize” compound should be used on all threads.

Insulation

Good flow measurements are directly related to good insulation practices because of the temperature sensitivity of polymer viscosity. Any part of the polymer flow system (polymer tap, transfer line, and measurement head) should have good temperature control and proper insulation. These parts should also be protected from water and large air currents (especially the exposed bottom of the capillary). Within the measurement head, general insulation practice is to pack the capillary zone (lower section) heavily and the pump zone (upper section) lightly with a half thickness of insulation. If the insulation becomes oil soaked during transducer calibration, it should be replaced.

Capillary Removal / Replacement

Capillaries are accessed from the bottom of the unit and should only be removed or changed when the measurement head is at test temperature. See figure 12. Use anti-seize compound on the jam nut each time, however do not let the compound build up. The following procedure is recommended:

Removing the Capillary

1. Measurement Head must be at test temperature and the pump motor stopped
2. With the break-over and socket on the capillary jam nut, hit the handle sharply to loosen
3. Remove jam nut (check for compound build-up and clean if necessary)
4. Remove capillary Note: Although the capillary may fall out, it is removed with a long #10-32 screw or pushed out with polymer by running the motor.
5. Clean the capillary sealing surface and orifice before it cools. Use a soft cloth and clear the capillary by pushing a close-fitting drill bit through the capillary. Capillaries can also be cleaned with a solvent if necessary.

CAUTION: DO NOT DAMAGE THE SEALING SURFACE ON THE ORIFICE

CAUTION: REMOVE 20-50% OF THE POLYMER ABOVE THE CAPILLARY SO THAT WHEN A NEW CAPILLARY IS INSTALLED THERE WILL BE NO DANGER OF OVER PRESSURING THE TRANSDUCER WHILE SCREWING IN JAM NUT.

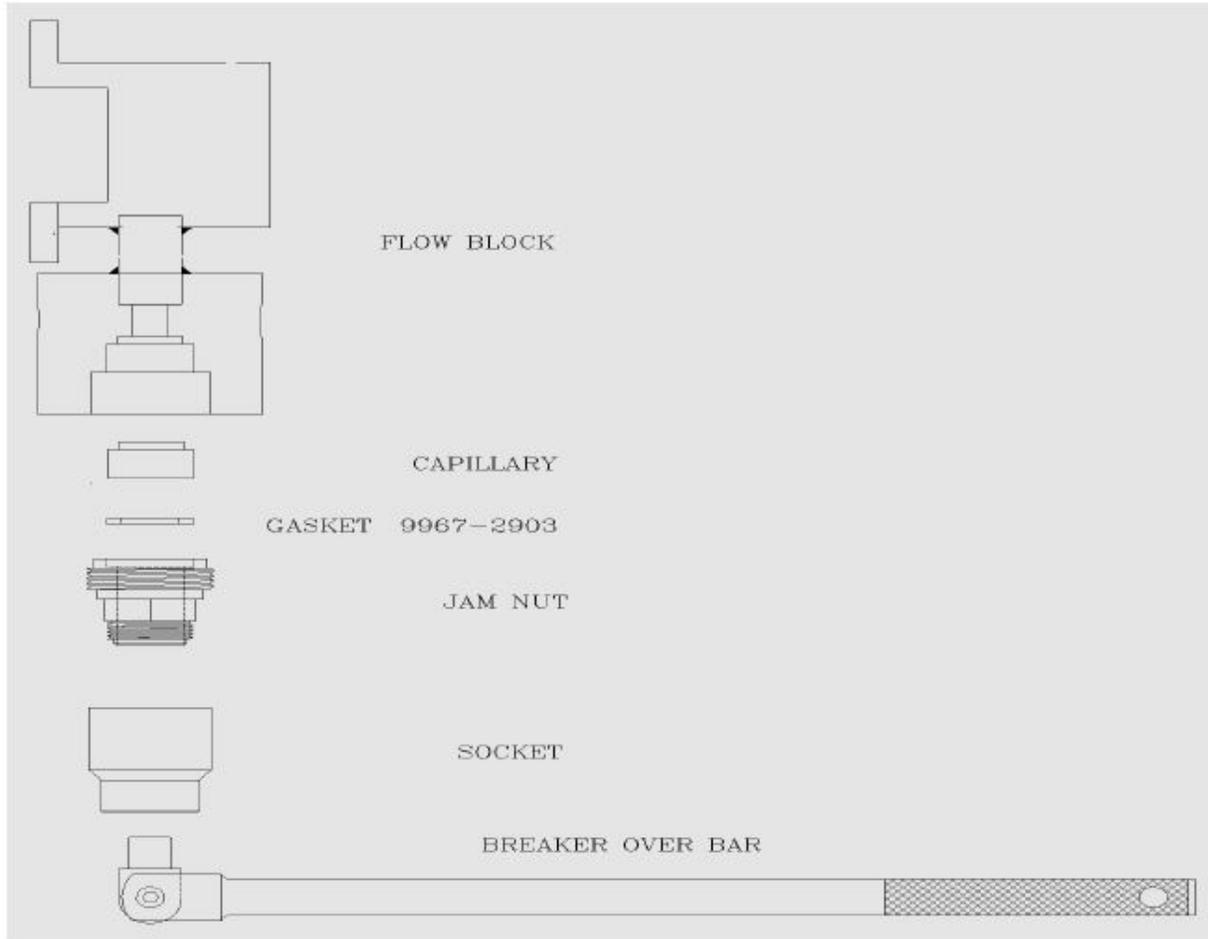
CAUTION: DO NOT TOUCH TRANSDUCER FACE

Installing the Capillary

6. Place the capillary in the jam nut and hand-tighten jam nut (Use anti-seize compound on threads). Note: the lettering side of the capillary should be down.
7. Let the capillary heat up (5-7 minutes) then tighten the jam nut to 120 inch-lb.

WARNING: Do not over-tighten the jam nut; it will be difficult to remove later and excessive torque can cause misalignment of the gear reducer / pump coupling.

Figure 12 Capillary Installation



Metering Pump Replacement

The pump must be removed when hot. The protective covers must be removed for access. The following procedure is recommended:

Pump Removal

1. Rheometer must be at test temperature.
2. Rheometer motor must be stopped.
3. Close the inlet and outlet valves.
4. Loosen the set screws on the gear reducer /pump coupling and open coupling
5. Remove the center section of the coupling. Note: Do not lose.
6. Loosen the four pump mounting screws and slide the pump out. Note: If there is any doubt about the pump drive pin (shear pin), it can be checked while hot. Clean the pump passages and, while looking into the passages, turn the pump by hand and see if the gears turn.
7. Clean the pump seating surface on the flow passage block with a soft copper cloth or, if necessary, a soft copper putty knife.

Note: See manufacturer's manual for pump disassembly instructions.

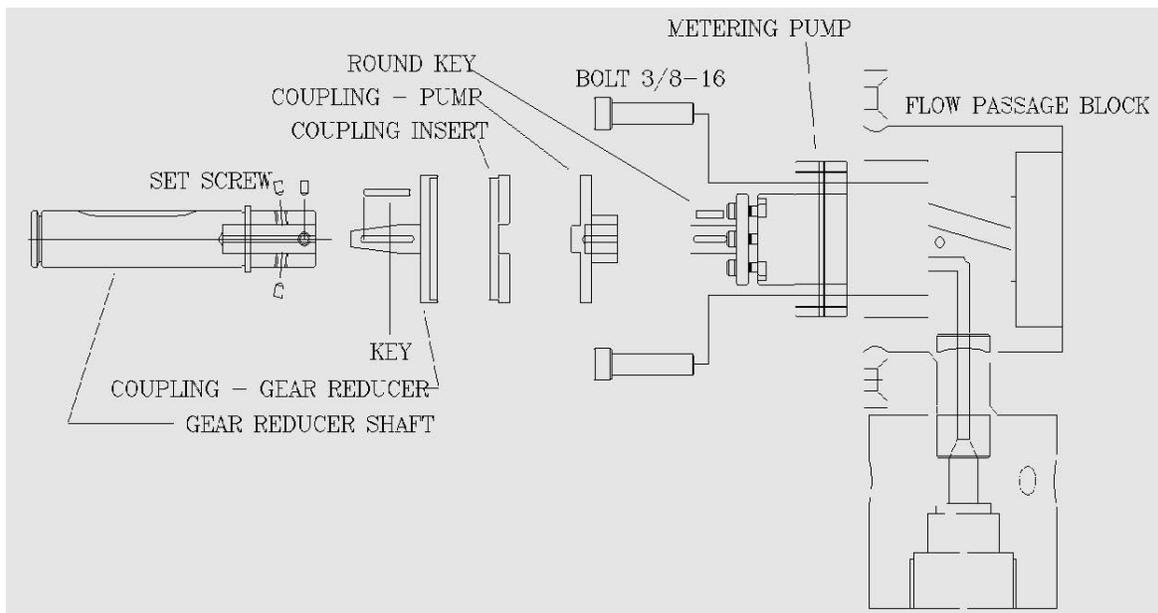


Figure 13 Exploded View Meter Pump And Drive Shaft

Pump Installation

1. Reverse removal procedure to install pump using anti-seize compound on the screw threads.

Note: snug the pump screws up so that the pump can move, and repositioned the coupling. Run the motor and let the pump align itself before tightening bolts.

2. Tighten bolts after pump has had time to heat.
3. Check the pump for leaks during operation.
4. Ensure that the pump coupling is aligned as shown. If alignment is required, make adjustments to the flow block mounting bolts and/or the block stabilizer arms.

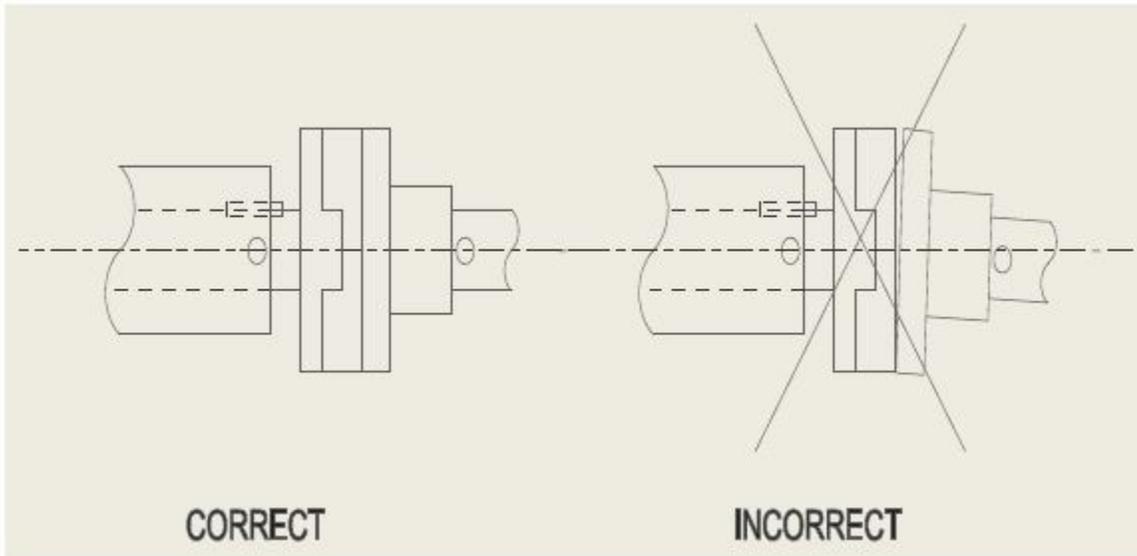


Figure 14 Pump Coupling Alignment

Transducer Replacement

Transducers must be replaced while the Measurement Head is hot. After a transducer is removed, clean and check the transducer seat (use a soft cloth). The following procedure is recommended:

Transducer Removal

1. Measurement Head must be at test temperature
2. Remove capillary
3. Disconnect transducer leads
4. Remove transducer electronic body from the clamp
5. With great care, push the transducer body through the large elongated hole in the Measurement Head base plate until the transducer is in a somewhat straight position
6. Unscrew the transducer tip
7. Clean most of the polymer out of the cavity in front of the transducer
8. Clean the transducer seat with a soft cloth and wipe anti-seize out of threads

Transducer Installation

1. Check that the new transducer is the correct range
2. With anti-seize on threads, screw transducer body in "snugly". Do not let electronics body fall.
3. Let transducer heat for 5 minutes then tighten gently (100in-lbs max.).
4. Very gently, bend transducer electronics body through elongated hole and position in clamp
5. Connect leads
6. Run fresh polymer through system
7. Let transducer stabilize at test temperature and perform transducer calibration (See Calibration section of this manual)
8. Replace capillary

Tachometer Replacement

The tachometer is a magnetically coupled detector that counts the teeth on a gear as it passes by the face of the tachometer. It should be positioned as follows:

WARNING: Do not place tools or fingers in tachometer hole

1. Allow the unit to heat to test temperature
2. Remove capillary. Run the motor at a slow speed.
3. Screw the tachometer, with only one lock nut, into the tach ring until approximately 90% of the threads are in the ring. Connect signal cable.
4. Align the small flats on the tachometer body to the gear that is located in the tach ring as shown.
5. Check the control unit for a speed indication.
6. If there is not a speed indication, screw the tachometer another ½ revolution into the tach ring.
7. Repeat previous two steps until a speed indication is seen on the local display.
8. Tighten the tach lock nut such that the tachometer cannot rotate.

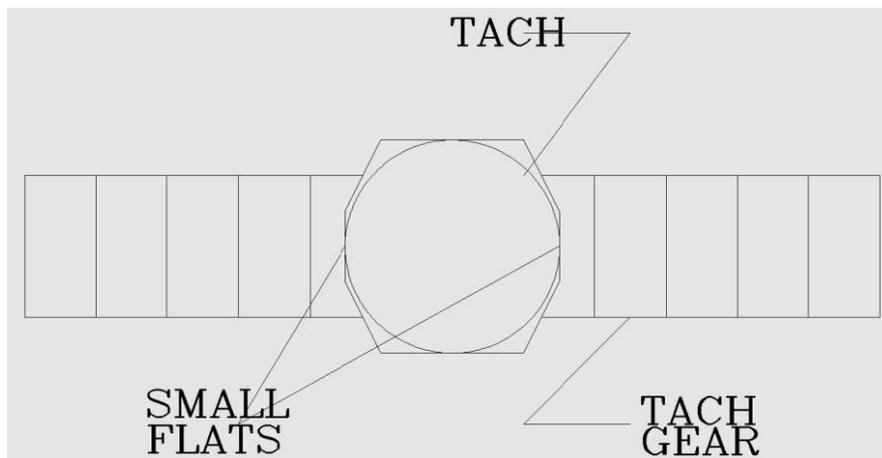


Figure 15 Tachometer Installation

Gear Reducer Maintenance

The Measurement Head uses a high efficiency helical gear reducer. Oil should be maintained at the halfway point on the gear case. Remove a screw at either the 3 o'clock or 9 o'clock position on the gear reducer and check that the oil is near level with screw hole. Refer to the manufacturer's manual for details.

Draining Procedure:

1. Position a container below the gear-reducer; remove the gear-reducer plug, located at the 6 o'clock position, and drain oil.
2. Replace drain plug

Refilling Procedure:

1. Remove the plugs at the 3 o'clock and 9 o'clock positions on the gear reducer. Using a length of plastic tubing inserted in either the 3 o'clock or 9 o'clock hole, add oil until it flows out either hole. Note: a squeeze bottle works well.
2. Replace all screws

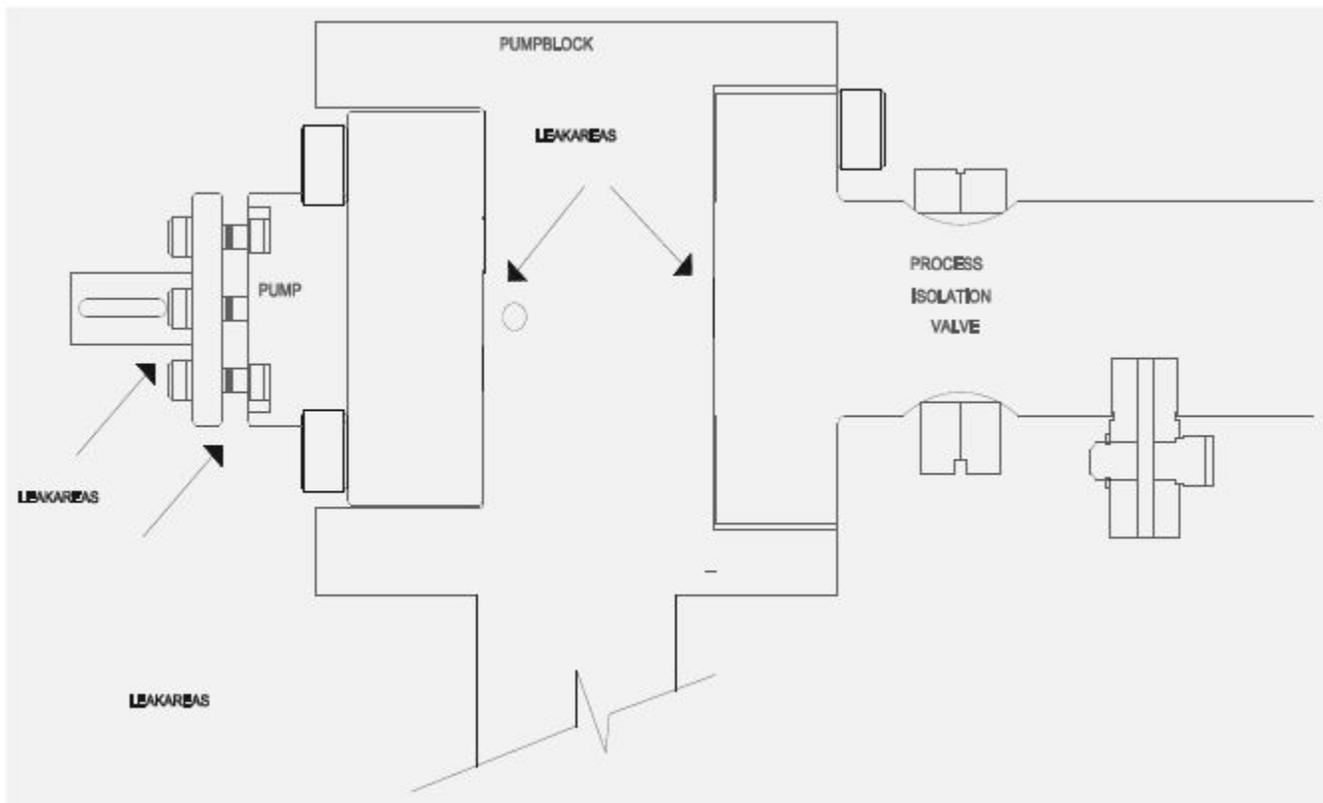


Figure 16 Location Of Possible Polymer Leaks

Flow Block Leak Inspection

It is recommended that the flow block be inspected for polymer leaks every week. This will allow the maintenance technician to correct small leaks before the block is encapsulated in polymer. The above figure shows the common areas where leaks occur.

To stop the leaks, tighten the affected cap head socket screws. If the leak continues, it will be necessary to remove the part and clean the sealing surface. The metering pump is designed to “weep” polymer. This small amount of polymer is used to lubricate the bearing surfaces. The small weepage should flake off of the drive shaft and not cause a problem. If the polymer weepage is sufficient enough to flow a ball of polymer or fails to flake off the drive shaft, tighten the three pump packing gland screw.

WARNING- Tighten pump packing gland screws in small increments to avoid damage to the pump and pump drive system.

Troubleshooting

Polymer Flow Problems

Pump Motor Will Not Turn

1. Abnormal alarm condition – clear alarms.
2. Motor drive or motor failure. Repair – replace motor speed controller

Pump Motor Turns But No Polymer Flow From Capillary

1. PIV shut off valve closed – open valve
2. No flow in sample line – open the bleed valve and check for polymer in sample line.
3. Broken shear pin in metering pump – replace / repair pump.
4. Pump coupling failure – replace / repair pump coupling.

Over Speed Alarm In MFR Mode

1. Transducer failure – test / replace transducer.
2. Pump starvation – install proper range capillary

Unstable Measurement

1. Large variations in process temperatures.
2. Large variations in flow block temperatures.
3. Pump loading – alignment or dragging.

Large Measurement Error

1. Incorrect control setpoints or test parameters
2. Incorrect capillary installed
3. Transducer calibration - bad low end sensitivity.

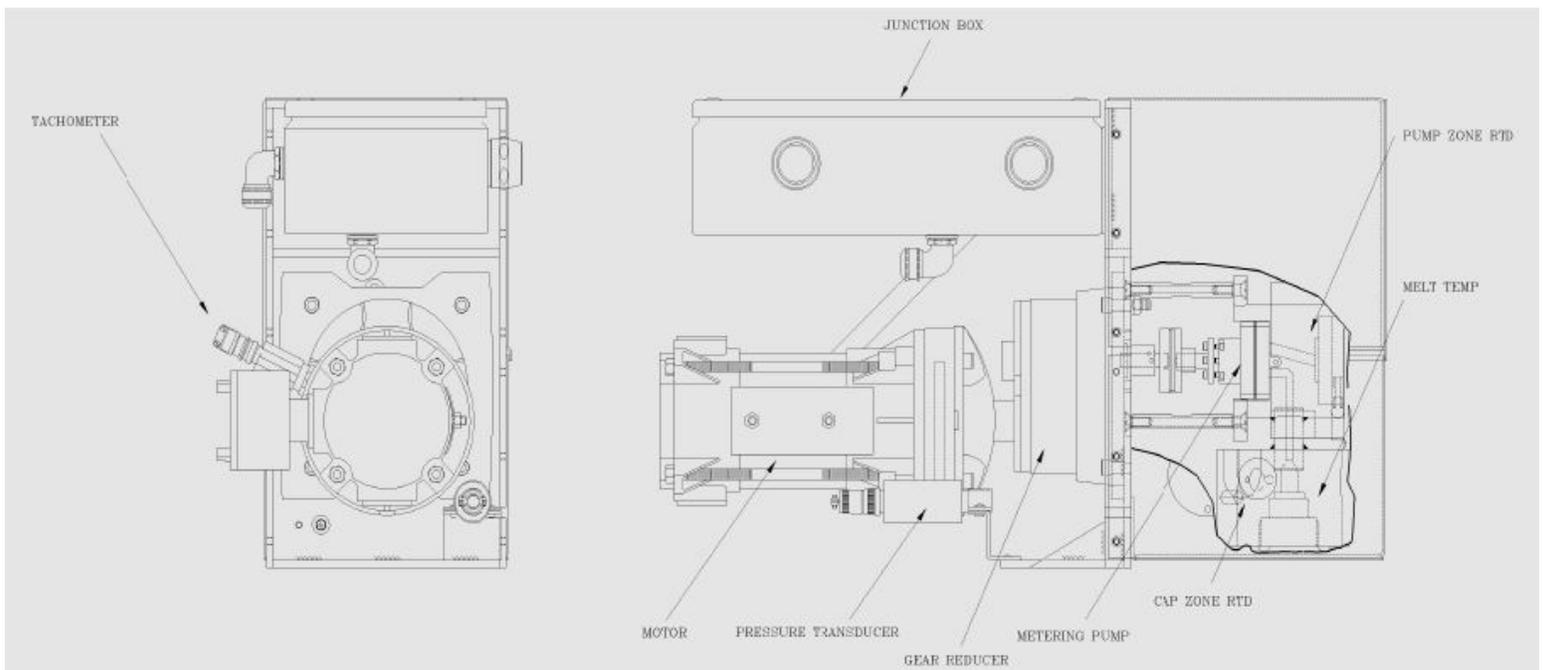


Figure 17 Rheometer Parts Location



Calibration

Introduction

In the Rheology Measurement System, there are three components requiring calibration: the pressure transducers, the temperature sensors, and the Motor Speed Controller.

Equipment Required To Calibrate System

There are two pieces of equipment required for calibration of the rheometer, (1) is a dead weight tester that has sufficient range to cover the pressure of interest, and (2) a device to test the temperature indication electronics. The best device to do this is a controlled temperature bath (the probe and the electronics are tested). The next best device is a temperature probe simulator. Contact DYNISCO for the manufacture information for each of these devices. Trouble shooting routines will isolate to the board level and should require only a multimeter.

Pressure Transducer Calibration

The software located in the CPU converts the raw mVolt signal from the pressure transducer, into engineering units (PSI). During the pressure transducer's calibration routines, the raw mV for pre-programmed pressures are stored in the CPU. Using the stored millivolts, the CPU generates a line that connects the calibrations points. In the software, there are three transducer curves (1) default, (2) auto-cal, and (3) manual-cal. These curves are shown in figure 18. The "default" curve passes through 0 PSI/0 mV and the theoretical 100% of pressure and millivolts. This curve is used after a "cold start" or Factory default setting. The simplified equation is shown below:

$$P_{\text{Reading}} = \frac{E_{\text{Meas}}}{E_{\text{FS}}} * P_{\text{FS}}$$

NOTE: The following terms will apply to all pressure formulas found in this section.

P_{reading} – indicated pressure transducer output in PSI.

E_{meas} – pressure transducer output in millivolts.

E_0 – recorded pressure transducer output at atmosphere in millivolts.

E_1 – recorded pressure transducer output at cal point 1 in millivolts.

E_2 – recorded pressure transducer output at cal point 2 in millivolts.

E_{RCal} - recorded pressure transducer output at R-Cal in millivolts.

E_{FS} – pressure transducer theoretical output at full-scale (33.33mVDC).

P_0 – pressure 0 PSI

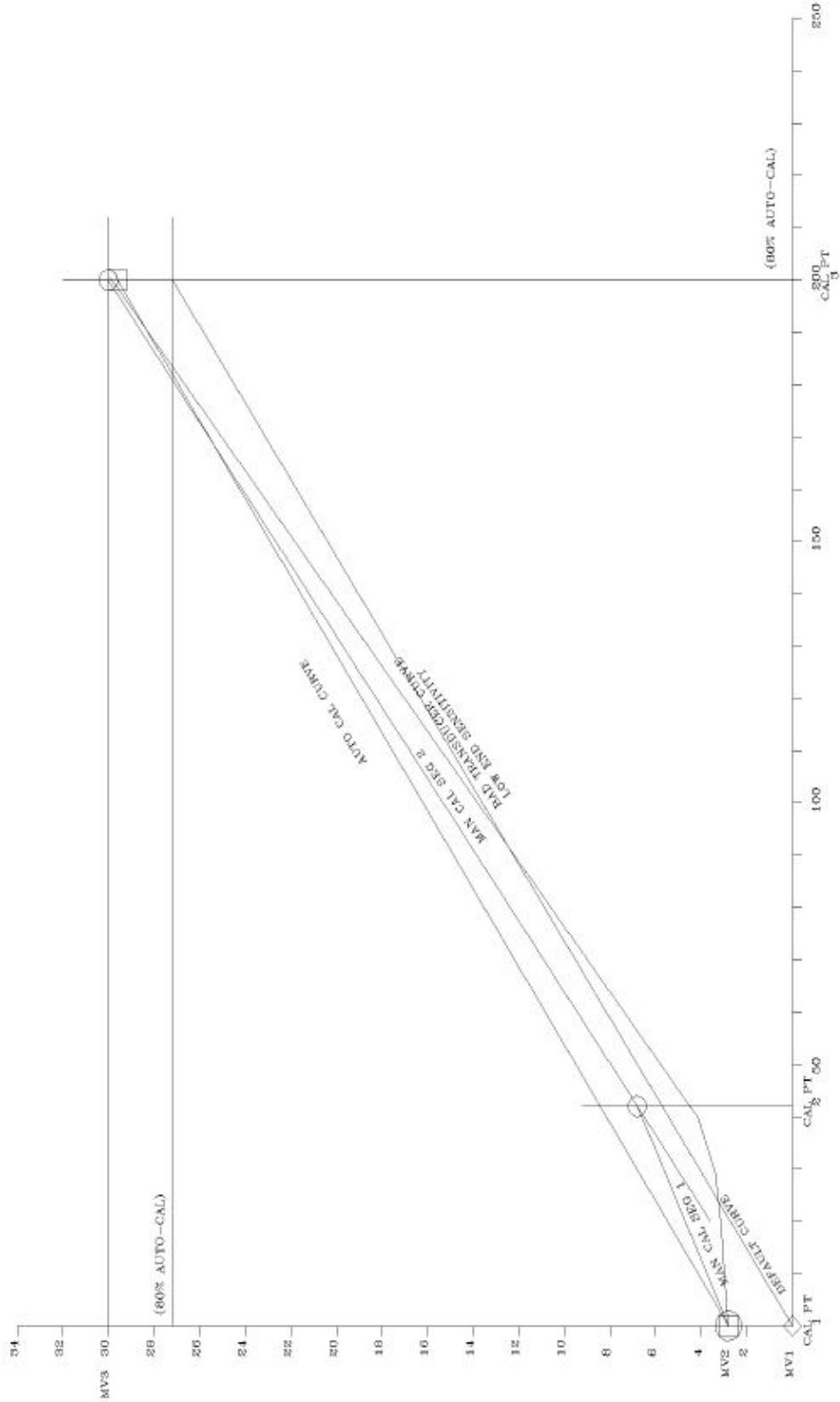
P_1 – pressure at cal point 1 in PSI.(Older Umac systems only)

P_2 – pressure at cal point 2 in PSI.

P_{RCal} - pressure at R-Cal (80%) in PSI.

P_{FS} - pressure full-scale value.

Figure 18 Transducer Curves





The “auto-cal” curve uses a precision resistor etched on the sensing diaphragm of the pressure transducer to produce an electrical signal equal to 80% of the full-scale mV output. DYNISCO recommends that the automatic calibration feature only be used after the linearity of the pressure transducer has been verified using the pressure standard. Auto calibration does not check the condition of the sensing diaphragm. During the manual calibration, the technician actually puts a known pressure on the diaphragm of the transducer.

NOTE: IF THE TEST TEMPERATURE IS CHANGED, RECALIBRATE / ZERO SHIFT THE TRANSDUCERS.

Changing the Transducer Range

The Rheology Measurement System has the ability to operate using different pressure transducer ranges. This increases the systems flexibility because it allows the client to use low-pressure transducers for MFR measurements and then change to higher pressure-transducers for viscosity measurements.

1. On the HMI, select Pressure Calibration to enter/verify the correct transducer range for each PT.

Automatic Calibration

When the AUTOMATIC CALIBRATION mode is selected, a “Span” pressure of 80% of the transducer full-scale value automatically is entered into the CPU. When Automatic Cal is executed, the CPU reads the mV output of the pressure transducer at atmosphere and records this value. Next, the CPU closes the SPAN relay, which places a calibrated resistance in parallel with one leg of the transducer strain gauge. This produces a mV signal equal to 80% of the pressure transducer output. This mV value is recorded as the span millivolts. The CPU calculates the transducer pressure by converting the transducer millivolts to a pressure using the millivolts at 0 (zero) PSI and the span millivolts at the span pressure.

$$P_{\text{Reading}} = \frac{(E_{\text{Meas}} - E_0)}{E_{\text{RCal}}} * P_{\text{RCal}}$$

NOTE: The pressure transducer must be at atmospheric pressure before performing an Automatic Cal!

Each transducer is calibrated individually. Perform the automatic calibration with the heat ON and no temperature errors or warnings. After a successful automatic calibration, Auto will be displayed as the transducer cal method on the pressure calibration screen.

Manual Calibration

The MANUAL CALIBRATION function allows the maintenance technician to place a known pressure on the diaphragms of the pressure transducers using a pressure standard such as a Dead Weight Tester. Two different pressures are required for a manual calibration.

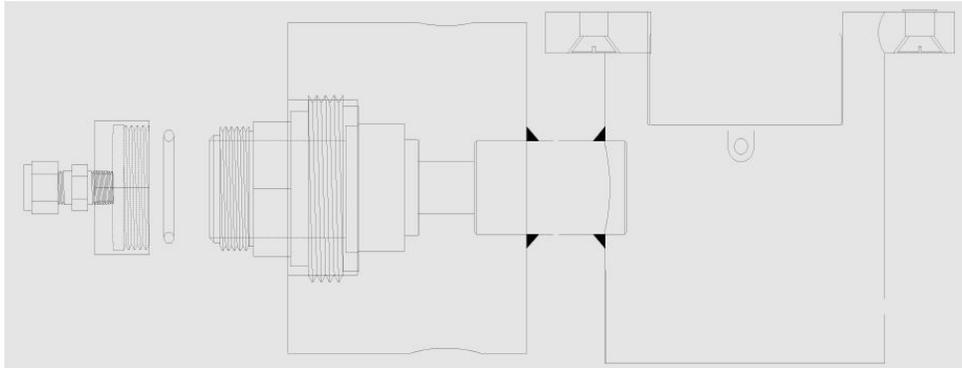


Figure 19 Calibration Adapter

NOTE: Calibration procedure must be performed in the proper order or a CAL ERROR will occur.

1. Verify that the heat is ON and the unit is at test temperature.
2. Verify that the motor/pump is OFF.
3. Verify that the maximum pressure is set for the transducer in the calibration screen.
4. Install the cal adapter as shown in figure 19 (note: remember the o-ring) and connect the dead weight test (DWT) as show in figure 20. Open the DWT to atmosphere.
5. When the displayed transducer mV output has stabilized, record the transducer raw mV output at atmosphere. This reading will be used to check the transducer low-end sensitivity.
6. Enter the mV value and pressure as the low point in the pressure calibration screen.
7. Apply the calibration pressure and allow the displayed mV reading to stabilize. Record the transducer mV output at this cal pressure.
8. Enter the mV value and pressure as the high point in the pressure calibration screen.
9. Upon proper completion of the manual calibration, manual is displayed in the pressure calibration screen.
10. Remove the DWT, and install the capillary.

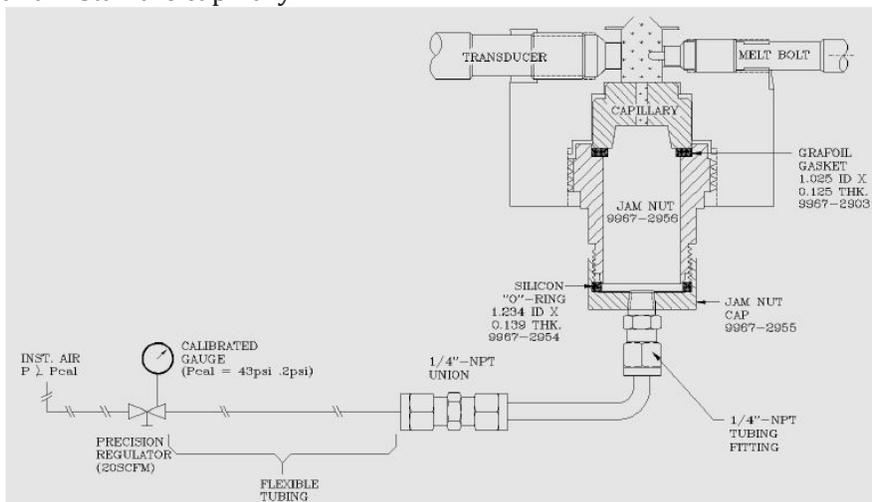


Figure 20 DWT Connection

Transducer Low-End Sensitivity

The bottom 10% of the transducer range is the most non-linear. Historically, most transducers fail due to a lack of low-end sensitivity. The low-end sensitivity can be quickly checked during the transducer calibration by comparing the transducer mV output at atmosphere and the first calibration pressure. Using a 250-psi transducer, 43.2 psi is approximately 17% of 250 psi. The expected full-scale mV output for the transducer is 33.3 millivolts, 17% of 33.33 millivolts is approximately 5 millivolts. In other word, you should see an increase of 5 ± 0.5 millivolts in the recorded mV outputs from atmosphere and the first calibration pressure.

Example 1: Output @ 0 psi 1.2 mv
 Output @ 43.2 psi 6.0 mv
 Conclusion - good transducer.

Example 2: Output @ 0 psi 1.2 mv
 Output @ 43.2 psi 4.5 mv
 Conclusion - bad transducer.

Motor Speed Controller Adjustments

The Motor Speed Controller input is 0 to 10 VDC from the CPU. The “Minimum” and “Maximum” adjustments are located on the isolation circuit assy. On the motor speed controller (see figure 21) perform the following steps with unit at test temperature and polymer flowing in the system. **WARNING: remove the capillary to avoid damaging the transducer.**

1. On the HMI, go to the Analog Outputs Diagnostic screen.
2. For output 1:speed 0-10V, press the ZERO button and measure the voltage from MSC/TB3/1 (Com) to MSC/TB3/3 (+). Adjust the SC1 zero pot for a reading of 0.001 V.
3. For output 1:speed 0-10V, press the 10 V button and measure the voltage from MSC/TB3/1 (Com) to MSC/TB3/3(+). Adjust the SC1 span pot for a reading of 10.000 V.
4. Repeat steps 2 and 3 until no pot adjustments are required.
5. On the HMI, go to the Motor and Drive Diagnostic screen.
6. Ensure unit is at test temperature by enabling the heat on the Diagnostic screen.
7. Enter a Motor Speed Setting of 0.137 V. Enable the motor on the Diagnostic screen. With the motor ON, adjust the MIN pot (R27) on the MSC isolation (daughter) board until the HMI shows a motor speed of 1.0 RPM. The average of the F/V converter display should be 32 Hz.
8. Enter a Motor Speed Setting of 10.0 V. With the motor ON, adjust the MAX (R28) pot on the MSC isolation board until the HMI shows a motor speed of 73.0 RPM. The average of the F/V converter display should be 2336 Hz.
9. Repeat step 7 and step 8 until no pot adjustments are required.
10. Verify motor speed either with a tachometer or by checking visually the rotation speed of the motor to pump coupler. Visually counting revolutions over a one minute time frame should be a quick way to verify if the Motor Speed Settings have been done correctly.

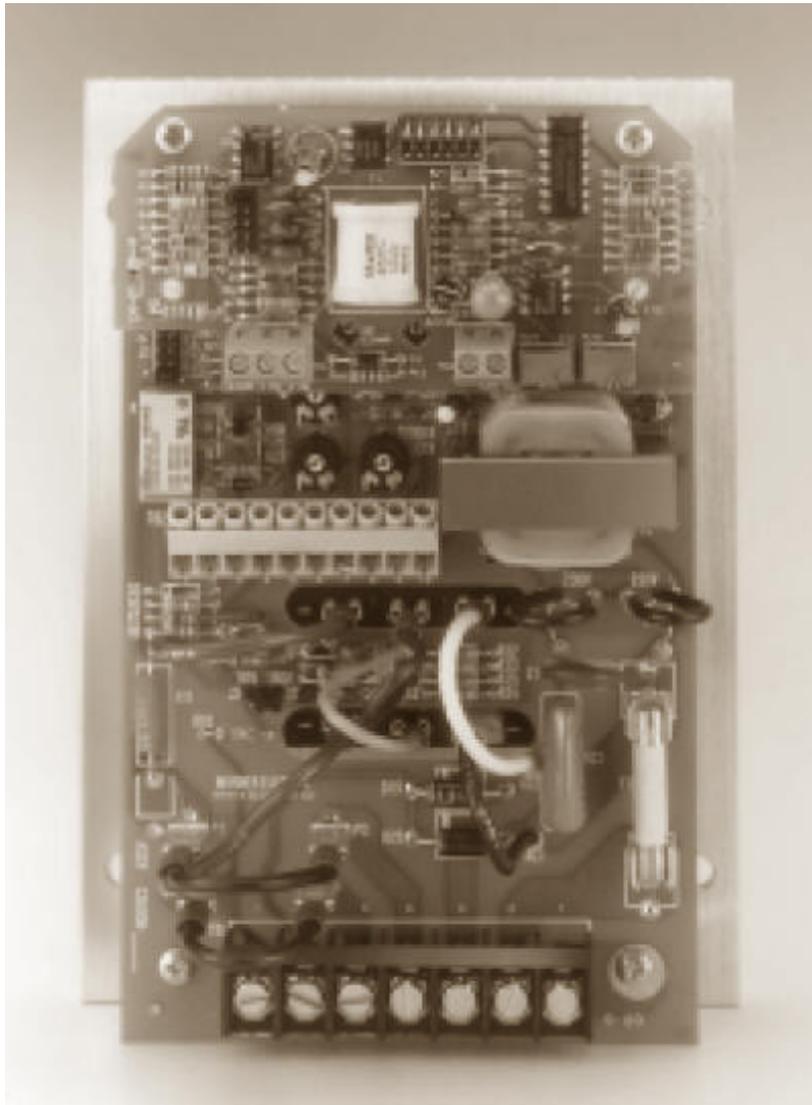


Figure 21 Motor Speed Controller



Strip Chart Output Level Test

The following procedure will “force” all 4 to 20 mA DC outputs to a user-defined level. This will allow the remote computer to compensate for any line loss.

1. Go to the Analog Output diagnostic screen.
2. Press the desired button to force 4/12/20 mA to the selected output.
3. Calibration offsets can be entered in the Analog I/O calibration screens to adjust for line loss.

Temperature Calibration

The temperature of the polymer melt is critical to achieve proper results. DYNISCO uses grade A RTD’s for important temperature measurements and the client should order grade A RTD’s to use as spare parts. Along with the sensor, the associated electronics need to be checked to ensure the accuracy of the measurement.

There are two methods to test and calibrate the rheometer temperatures. The best method is to use a controlled temperature bath (the probe, field wiring and the electronics are tested). The next best device is a probe simulator (the field wiring and electronics are tested). The procedure is the same for each method.

1. Go to the Temperature Calibration screen. Enter the temperature offset such that the displayed calibrated value is accurate.
2. Wait while the displayed temperature stabilizes.

CPU

CPU Indicators

The CPU is provided with several LED indicators that are helpful when diagnosing problems with the RCU. Each indicator is discussed below.

SF LED (RED): Indicates that a system fault has occurred. Contact Dynisco for more troubleshooting information.

BF LED (RED): Indicates that a bus fault is present in the CPU. Contact Dynisco for more troubleshooting information.

DC5V LED (Green): Indicates that the CPU has OK 5 volt level.

FRCE LED (Yellow): Indicates that a variable is being changed internally. Used only when in programming mode.

STOP LED (Yellow): Indicates that the program is in the Stop mode and the program is not running. Contact Dynisco for more troubleshooting information.

CPU Switch Position Meaning Description

RUN: RUN mode. The CPU executes the user program.

STOP: STOP mode. The CPU does not execute a user program.

MRES: Refer to the section CPU Memory Reset to reset the PLC memory.



CPU MEMORY RESET

It may be necessary to reset the CPU's memory under the following conditions:

1. Installation of new software.
2. Resetting all system values to the factory default.
3. The CPU SF LED is illuminated.
4. Erratic operation.

The application software is stored on the removable flash EPROM in the CPU module. All system variables are stored in the CPU RAM. To reset the CPU memory,

1. Place the CPU RUN-STOP-MRES switch to STOP. The CPU front panel LED's should change from RUN to STOP.
2. Hold the RUN-STOP-MRES switch in the MRES position for 3 seconds. The STOP LED should flash.
3. Release the RUN-STOP-MRES switch, the switch should return to the STOP position.
4. Wait 2 seconds and again hold the RUN-STOP-MRES switch in the MRES position. The STOP LED should flash and then stay ON.
5. If the CPU SF LED is ON, repeat 2 through 5.
6. Place the RUN-STOP-MRES switch in the RUN position. The CPU pilot LED on the Digital Output module should flash every 1/2 second.

Memory Card Installation

A SIMATIC Micro Memory Card (MMC) is used as memory module. You can use MMCs as load memory and as portable storage medium.

Note: The CPUs do not have an integrated load memory and thus require an MMC for operation.