MICROCOMPOUNDER

OPERATION MANUAL

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FOR MICROCOMPOUNDER WITH COMPUTER INTERFACE

DACA instruments

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WARNINGS

High operating temperatures and moving parts of DACA Instruments' processing instruments are potentially dangerous; therefore the user should observe the following safety precautions and be aware of the possible dangers at all times.

OPERATOR SAFETY

Users who are to install and operate the equipment should study this Operation Manual and all referenced documentation prior to installation and/or operation of the equipment. Carefully read installation instructions and operating instructions; observe all WARNINGS and CAUTIONS.

Ensure that the equipment setup and the actual use do not present a hazard to personnel. Common sense and good judgment are the best safety precautions.

GENERAL SAFETY

The following statements apply to all users of DACA Instruments' processing instruments.

1. HIGH SPEEDS AND FORCES

Be aware at all times of moving components which are potentially dangerous due to high speeds and forces. Do not permit anyone to operate a processing system who is unaware of its function or unskilled in its use.

2. SUPPLY VOLTAGES EXCEEDING 50V

DACA Instruments designs do not permit the operator to be exposed to voltages exceeding 50V under normal operation of the instrument. However, if any covers are removed from the instrument, all safety precautions should be strictly observed when carrying out servicing procedures. Also, always disconnect the instrument from the main power source whenever checking or changing fuses.

3. ROTATING MACHINERY

The source of power for rotating machinery is electrical. Always disconnect the test instrument or equipment from the power source before removing any cover which gives access to rotating machinery, (e.g., belts, gears, screws or shafts).

4. MEDIUM AND HIGH TEMPERATURE COMPONENTS

It is essential to display a WARNING notice concerning high temperature operation whenever high temperature equipment is in use; always use special handling gear and protective clothing under these conditions. High temperature refers to all equipment with a temperature exceeding 60°C (165°F). Note that the hazard from high temperature can extend beyond the immediate area of the instrument.

5. HIGH PRESSURE COMPRESSED AIR

The MicroCompounder uses compressed air for cooling. High pressure compressed air is potentially dangerous. Always follow the operating instructions. Before releasing an air connection, disconnect the air supply and reduce to zero any system pressure and stored pressure.

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SECTION 1
Basic Operation

1. Introduction

GENERAL DESCRIPTION

This apparatus is a micro scale, twin-screw, batch mixer. This equipment is of particular importance in that it allows:
1) accelerated research and development of new polymer blends, and
2) efficient studies of the effects of additives on polymers.
Its small scale allows the rapid and economical testing of the various parameters which affect the properties of the final blends.

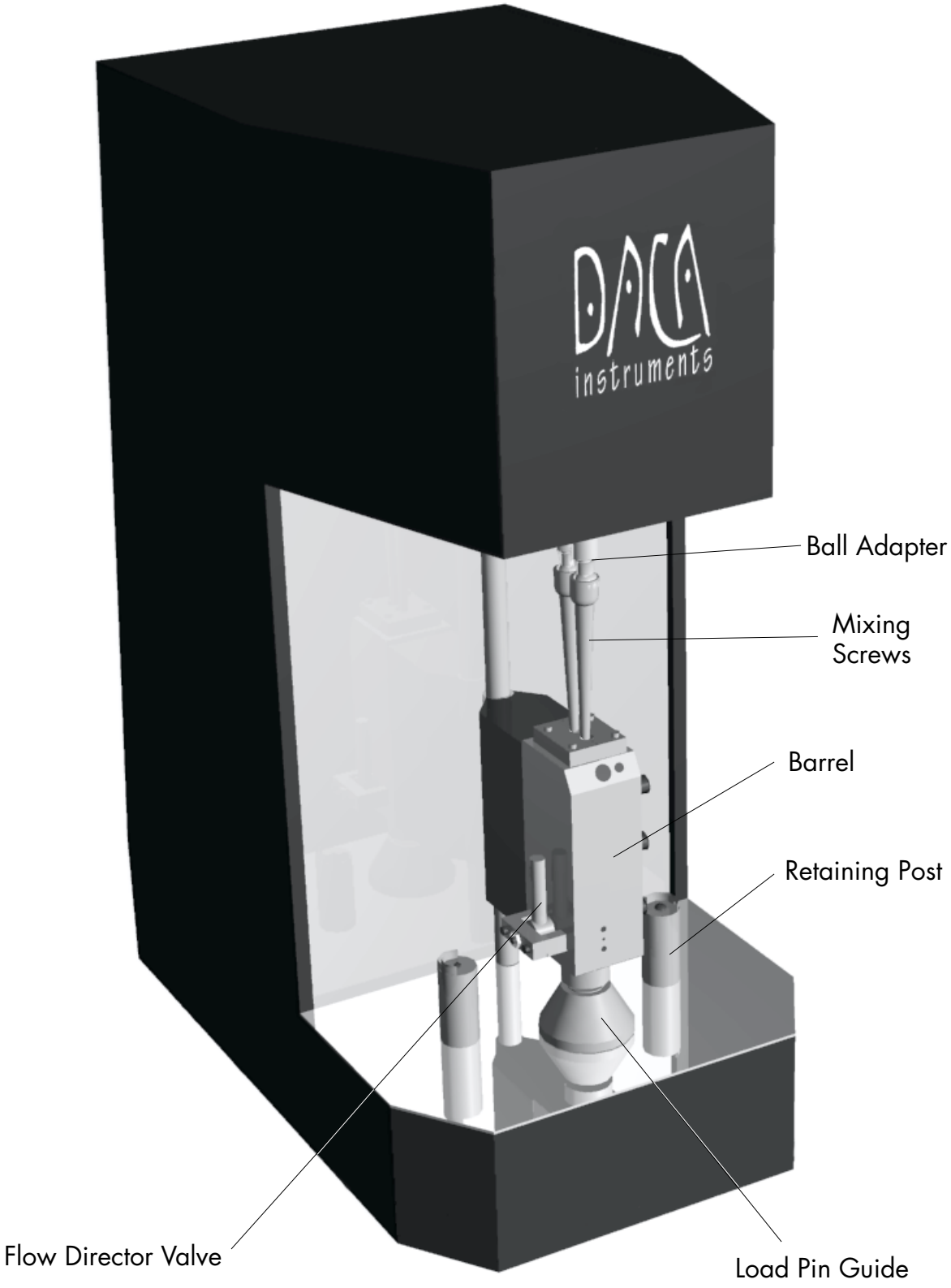
The equipment is designed to mimic the behavior of large production compounding machines. It offers excellent control of mixing temperature and speed and provides for uncoupled residence time. Residence time in commercial machines is determined by the screw length, and limited by mechanical constraints. By contrast, a unique design allows DACA Instruments' mixer to recirculate stock indefinitely.

Potentially, this equipment can be used by any polymer research facility investigating polymer blends, polymer additives, polymer compounding, or the processing of highly viscous liquids. This equipment will be of particular interest to those working with costly or hard-to-produce compounds.

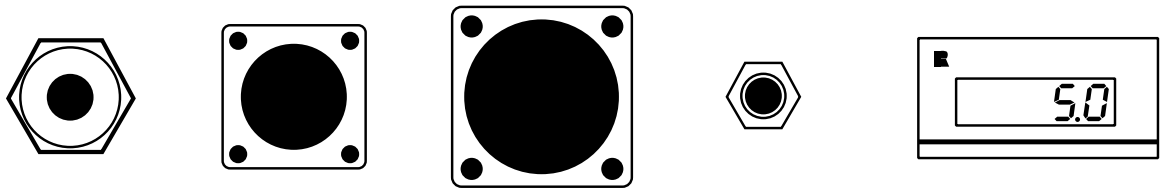
1.1 Specs & Schematics

MIXING VOLUMES	Sample size	4.5 cc max
	Min. Unextruded	0.4 cc
HEATERS	Barrel heaters (ea. side)	400°C, (4x150 W), 220V AC
	Temperature Controls	EUROTHERM 2416: Digital auto tune PID closed loop
	Thermocouples	Type K
MOTOR AND MOTION CONTROL	Motor	Baldor 1/3 hp DC gearmotor (5:1)
	Armature Voltage	180 VDC
	Speed Control	Digital control, 1 RPM increment
	SpeedRange	10-360 RPM
ADDITIONAL SENSORS	Load Sensor	0–5000 N, Limit alarm at 5000N
	Torque Display	0-6.2 N•m, Limit Alarm at 7.0 N•m
ELECTRICAL	Voltage	220V AC
	Frequency	50/60 Hz
	Max. current	10A
	Phase	1
PHYSICAL	Dimensions Compounder	30 cm W x 53.5 cm D x 70 cm H
	Weight Compounder	75 Kg
	Dimensions Controller	30.5 cm W x 26 cm D x 18 cm H
	Weight Controller	4.3 Kg

GENERAL SCHEMATIC



SCHEMATIC OF CONNECTOR PANEL



208-230V 50/60Hz
1Ph 10 Amp

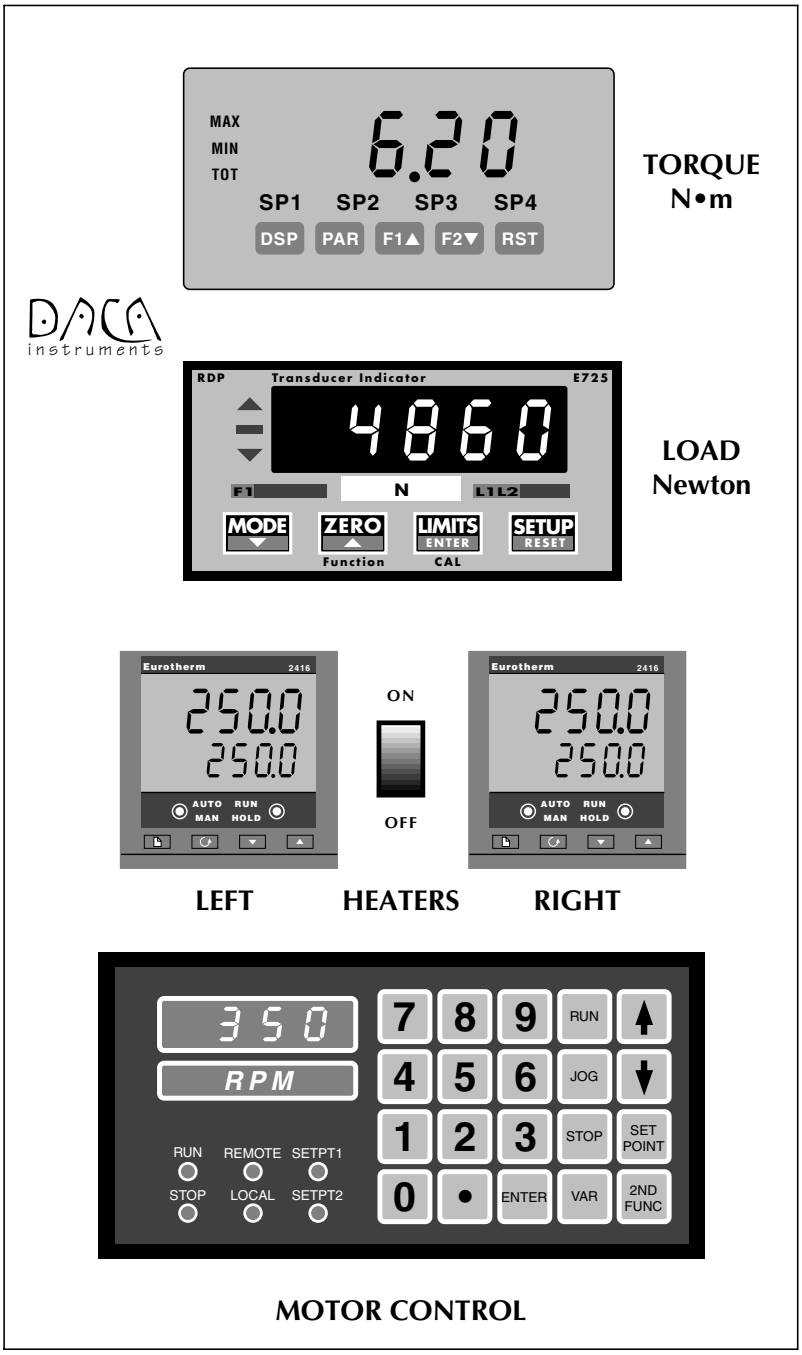
CONTROLLER
POWER

CONTROLLER
SIGNALS

COOLING AIR
80 PSI (5.6 BAR)
MAX

MOTOR ON TIME
(HRS)

SCHEMATIC OF CONTROLLER



2. INSTALLATION

UNPACKING

SHIPMENT DAMAGE

Merchandise shipped is carefully packed in compliance with carrier requirements. Claims for loss or damage in transit must be made with the carrier by the customer. All shipments should be unpacked and inspected immediately upon receipt. If damage is concealed and does not become apparent until shipment is unpacked, the customer must make a request for inspection by the carrier's agent and file a claim with the carrier. Any external evidence of loss or damage must be noted on the freight bill or carrier's receipt and signed by the carrier's agent. Failure to do this will result in the carrier refusing to honor the claim. For the customer's protection, DACA Instruments' billings include insurance for damage or loss in transit.

The wooden crate should contain the following items:

1 MicroCompounder with 1 pair of Mixing Screws

1 Controller

1 Small cardboard box containing:
- This Operation Manual
- Quick Operation Card
- Registration Card
- 1 BackBox RS232 <–> RS485 converter
- Other small optional items ordered

1 Long cardboard box containing:
- 1 Bag with 1 Kg of purging compound
- 1 Set of interconnecting cables
- 1 Toolbox containing:
  - 2 Filling Tools
  - 1 Plug to seal feed port during mixing
  - 1 Tool for operating the flow directing valve
  - 1 Reverse Ring-type pliers for opening the barrel when hot
  - 1 Drill bit with handle for cleaning the exit channel
  - 1 Short lenght of Teflon tubing for the purge cap
  - 1 Set of Metric Hex wrenches
  - 1 Metric Hex screwdriver 6 mm
  - 1 10 mm combination wrench
  - 6 Brass brushes for cleaning the Barrel and screws: 2 large, 2 small, 2 round

If any of these items is missing, please contact DACA Instruments immediately so that we may ship replacements.

INSTALLATION

LOCATION

The MicroCompounder should be set up on a leveled, sturdy table or bench. The normal operating temperature of the MicroCompounder can be as high as 400 °C (750 °F); therefore, the instrument should be placed away from other heat-sensitive equipment and high traffic areas where people might accidentally come in contact with the hot instrument.

ELECTRICAL

The MicroCompounder requires an electrical connection. The instrument operates with 220V 50/60Hz, 10Amp, single phase. The power cord has been fitted with a standard 220V plug for operation in the United States. For proper operations outside the U.S. the plug might have to be replaced with a different one.Consult your local electrical code. The wires inside the plug have been labeled for easier connection to a different plug.

OPERATOR INTERFACE

A separate controller box contains the temperature and speed controllers. This box also contains the displays for motor torque, and compounder load displays. An interconnecting cable is supplied to connect the controller to the Micro-Compounder. The cable is composed of two armored cables joined together in several places by cable ties. One of the cables carries power to the controller the other carries all the signal wires to and from the controller. The end connectors of the two cables are different to prevent misconnection.

The cables must be connected to the MicroCompounder and the controller before turning the power on. The cable is 1.5 meters long to allow placement of the controller box at a convenient location next to the compounder. The controller might also be placed on top of the compounder.

COOLING AIR SUPPLY

A fixture is provided on the back of the compounder to connect a compressed air line used for cooling the barrel. The air must be dry in order to prevent corrosion of the internal components. The normal operating pressure should be 2.8 BAR (40 PSIG). The supply line must have a valve to control the flow rate through the system and provide emergency shut off. The maximum pressure of the air must not exceed 5.5 BAR (80 PSIG). Excessive pressure will cause damage to the gas lines and solenoids inside the instrument.

3. General Operation

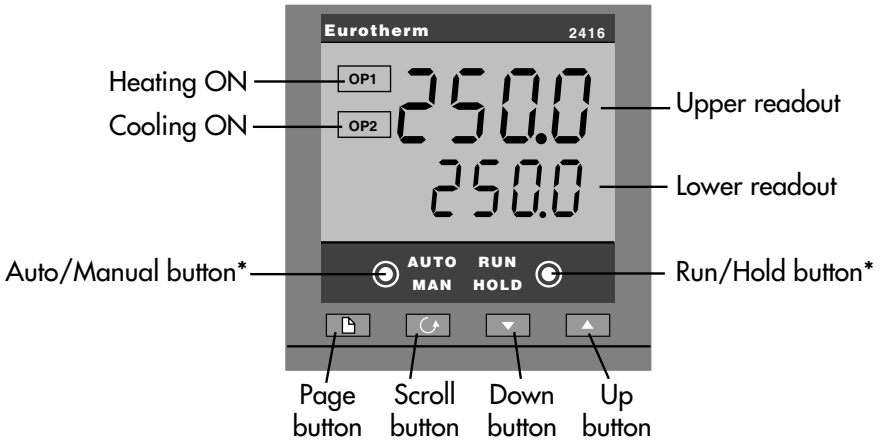
The general procedure for operating the MicroCompounder is described below. The detailed description of each step is provided in the following pages.

- Turn on the MicroCompounder
- Turn on and set the temperature controllers to the desired compounding temperature.
- Without turning the motor on, set the speed controller to the desired compounding speed (100 RPM recommended).
- After placing the two mixing screws in place, close the two halves of the barrel and lightly tighten the 6 locking screws using the 6 mm hex screwdiver.
- After the compounder reaches its operating temperature, further tighten the locking screws to 34 N•m (25 ft•lb) using the long, 6 mm hex wrench provided. This will prevent leakage of the sample from the barrel during processing.
- Unscrew the supporting pin of the load sensor until the load indicator reads ≥ 50 N. **The motor will NOT start unless the load value is ≥ 50 N.**
- Close the output valve (back position). Press the RUN button on the motor controller to turn on the motor, then begin filling up the compounder using one of the filling tools provided.
- Compound the material for the desired length of time.
- Open the output valve (front position) and empty out the compounder. Press the STOP button on the motor controller.
- Open the compounder and clean out the material remaining in the compounder using the brass brushes provided. If the material compounded is too sticky (e.g. Nylon, PET) run a charge of cleaning compound through the compounder to remove the sticky material first. Any remaining cleaning compound will be easier to remove from the barrel and screws.
- Begin a new test.

3.1 TEMPERATURE CONTROL

Portions © EUROTHERM CONTROLS Inc. Temperature of the barrel is controlled by two independent EUROTHEM model 2416 temperature controllers. A separate power switch has been provided for the temperature controllers. The two controllers allow for independent adjustment of the temperature for each side of the barrel. However, the two temperatures must be set to the same value for proper operation of the MicroCompounder.

FRONT PANEL LAYOUT



* Factory Disabled

OP1	When lit, it indicates that the controller is heating
OP2	When lit, it indicates that the controller is cooling
AUTO/MAN	disabled
RUN/HOLD	disabled
Page button	Press to select a new list of parameters.
Scroll button	Press to select a new parameter in a list.
Down button	Press to decrease a value in the lower readout.
Up button	Press to increase a value in lower readout.

BASIC OPERATION

Switch on the power to the controllers. It runs through a self-test sequence for about three seconds and then shows the temperature, or process value, in the upper readout and the setpoint in the lower readout. This is called the Home display. It is the one that you will use most often.

On this display you can adjust the setpoint by pressing the ▲ or ▼ buttons. Two seconds after releasing either button, the display blinks to show that the controller has accepted the new value.

NOTE: You can get back to the Home display at any time by pressing [ ] and [ ] together. Alternatively you will always be returned to the Home display if no button is pressed for 45 seconds, or whenever the power is turned on. If, however, a flashing alarm message is present the controller reverts to the Home display after 10 seconds.

OPERATING MODES

The controller has two basic modes of operation:

- **Automatic mode** in which the output power is automatically adjusted to maintain the temperature or process value at the setpoint. This is the default mode for the MicroCompounder. The **AUTO/MAN** button has been disabled therefore the Manual mode cannot be accessed unless the configuration is changed.

- **Manual mode** in which you can adjust the output power independently of the setpoint.

AUTOMATIC MODE

The Home display

Check that the **AUTO** light is on.
The upper readout shows the measured temperature, or process value. The lower readout shows the setpoint.
To adjust the setpoint up or down, press ▲ or ▼.
(Note: If Setpoint Rate Limit has been enabled, then the lower readout will show the active setpoint. If ▲ or ▼ is pressed, it will change to show and allow adjustment of, *the target setpoint.)*

Press [↻] *once to show the*

Display units

A single press of the [↻] button will flash the display units for 0.5 seconds, after which you will be returned to the **Home** display.
Flashing of the display units may have been disabled in configuration, in which case a single press will take you straight to the display shown below.

Press [↻] *twice to show the*

% Output power demand

The % output power demand is displayed in the lower readout. This is a read-only value. You cannot adjust it. Press [↻] and [🗋] together to return to the Home display.

Pressing [↻] from the Output Power display may access further parameters if the access level of the controller has been changed (see Appendix B*)*. When you reach the end of this scroll list, pressing [↻] will return you to the Home display.

ALARMS

If the controller detects an alarm condition, it flashes an alarm message in the Home display. For a list of all the alarm messages, their meaning and what to do about them, see *Alarms* at the end of this chapter.

Alarm Annuncation

Alarms are flashed as messages in the Home display. A new alarm is displayed as a double flash followed by a pause, old (acknowledged) alarms as a single flash followed by a pause. If there is more than one alarm condition, the display cycles through all the relevant alarm messages. Table T-1 and Table T-2 list all of the possible alarm messages and their meanings.

Alarm acknowledgement and resetting

Pressing both [↻] and [🗋] at the same time will acknowledge any new alarms and reset any latched alarms.

Alarm modes

Alarms will have been set up to operate in one of several modes, either:

- **Non-latching**, which means that the alarm will reset automatically when the Process Value is no longer in the alarm condition.
- **Latching**, which means that the alarm message will continue to flash even if the alarm condition no longer exists and will only clear when reset.
- **Blocking**, which means that the alarm will only become active after it has first entered a safe state on power-up.

ALARM TYPES

There are two types of alarm: Process alarms and Diagnostic alarms.

Process alarms

These warn that there is a problem with the process which the controller is trying to control.

Alarm Display*	What it means
_FSL	PV Full Scale Low alarm
_FSH	PV Full Scale High alarm
_dEu	PV Deviation Band alarm
_dHi	PV Deviation High alarm
_dLo	PV Deviation Low alarm
_LCr	Load Current Low alarm
_HCr	Load Current High alarm
_FL2	*Not available in 2416*
_FH2	*Not available in 2416*
_LOP	Working Output Low alarm
_HOP	Working Output High alarm
_LSP	Working Setpoint Low alarm
_HSP	Working Setpoint High alarm
4rAt	PV Rate of change alarm Always assigned to Alarm 4

** In place of the dash, the first character will indicate the alarm number.*

Table T-1 Process alarms

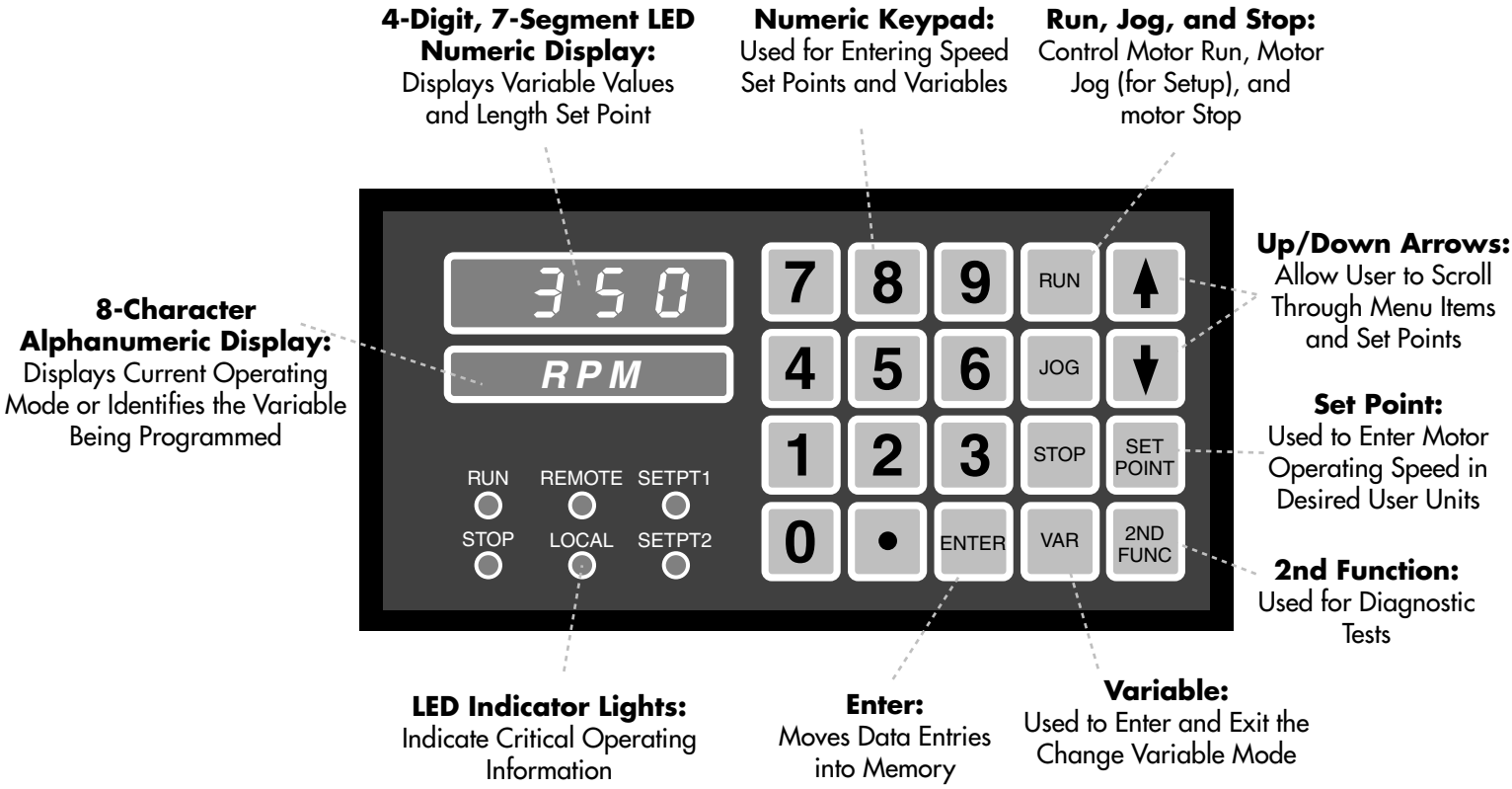
Diagnostic alarms

These indicate that a fault exists in either the controller or the connected devices. See following page.

Display shows	What it means	What to do about it
EE.Er	Electrically Erasable Memory Error: The value of an operator, or configuration, parameter has been corrupted.	This fault will automatically take you into Configuration level. Check all of the configuration parameters before returning to Operator level. Once in Operator level, check all of the operator parameters before resuming normal operation. If the fault persists, or occurs frequently, contact Eurotherm Controls.
S.br	Sensor Break: Input sensor is unreliable or the input signal is out of range.	Check that the sensor is correctly connected.
L.br	Loop Break The feedback loop is open	Check that the heating and cooling circuits are working properly.
Ld.F	Load failure Indication that there is a fault in the heating circuit or the solid state relay.	This is an alarm generated by feedback from a Eurotherm TE10S solid state relay (SSR) operating in PDSIO mode 1 It indicates either an open or short circuit SSR, blown fuse, missing supply or open circuit heater.
SSr.F	Solid state relay failure Indication that there is a fault in the solid state relay.	This is an alarm generated by feedback from a Eurotherm TE10S solid state relay (SSR) operating in PDSIO mode 2 It indicates either an open or short circuit condition in the SSR.
Htr.F	Heater failure Indication that there is a fault in heating circuit.	This is an alarm generated by feedback from a Eurotherm TE10S solid state relay (SSR) operating in PDSIO mode 2 It indicates a blown fuse, missing supply, or open circuit heater.
Hw.Er	Hardware error Indication that a module is of the wrong type, missing, or faulty.	Check that the correct modules are fitted.
no.io	No I/0 None of the expected I/0 modules are fitted.	This error message normally occurs when pre-configuring a controller without installing any of the required 1/0 modules.
rmt.F	Remote input failure. Either the PDSIO input, or remote DC input, is open or short circuit	Check for open, or short circuit wiring on the PDSIO, or remote DC, input.
LLLL	Out of range low reading	Check the value of the input.
HHHH	Out of range high reading	Check the value of the input.
Err 1	Error 1: ROM self-test fail	Return the controller for repair.
Err2	Error 2: RAM self-test fail	Return the controller for repair.
Err3	Error 3: Watchdog fail	Return the controller for repair.
Err4	Error 4: Keyboard failure Stuck button, or a button was pressed during power up	Switch the power off and then on, without touching any of the controller buttons.
Err5	Error 5: Faulty internal communications.	Check printed circuit board interconnections. If the fault cannot be cleared, return the controller for repair.

Table T-2 Diagnostic Alarms

3.2 Speed Control



PROGRAMMING THE SPEED CONTROLLER

The speed of the motor is governed by a Drive Control Systems MicroSpeed 196 controller which uses a closed-loop digital system capable of controlling the motor speed precisely and reproducibly. The MicroSpeed 196 receives a feedback signal generated by a magnetic pickup sensor that monitors a precision gear mounted on the motor belt pulley. The converter reads the velocity dependent feedback signal and corrects its analog output to bring the motor back to the set speed. The analog output is sent to a Pulse Width Modulation (PWM) driver inside the compounder which in turn sends to correct high voltage to the motor.

ENTERING AND ALTERING SET POINTS

The set point can be adjusted to any speed by pressing SET POINT, entering a new speed using the number keys, and then pressing ENTER. This changes the programming of the current set point (Set Point 1, 2, 3, or 4). The motor will immediately ramp to the new setting. If you wish to change a non-selected set point, press SET POINT, then press the ▲ or ▼ keys until the desired set point is displayed, and enter the new set point.

Note: Decimal locations are fixed via programmable variables, and are not entered when changing set points. The front panel LED displays will indicate which set point is active.

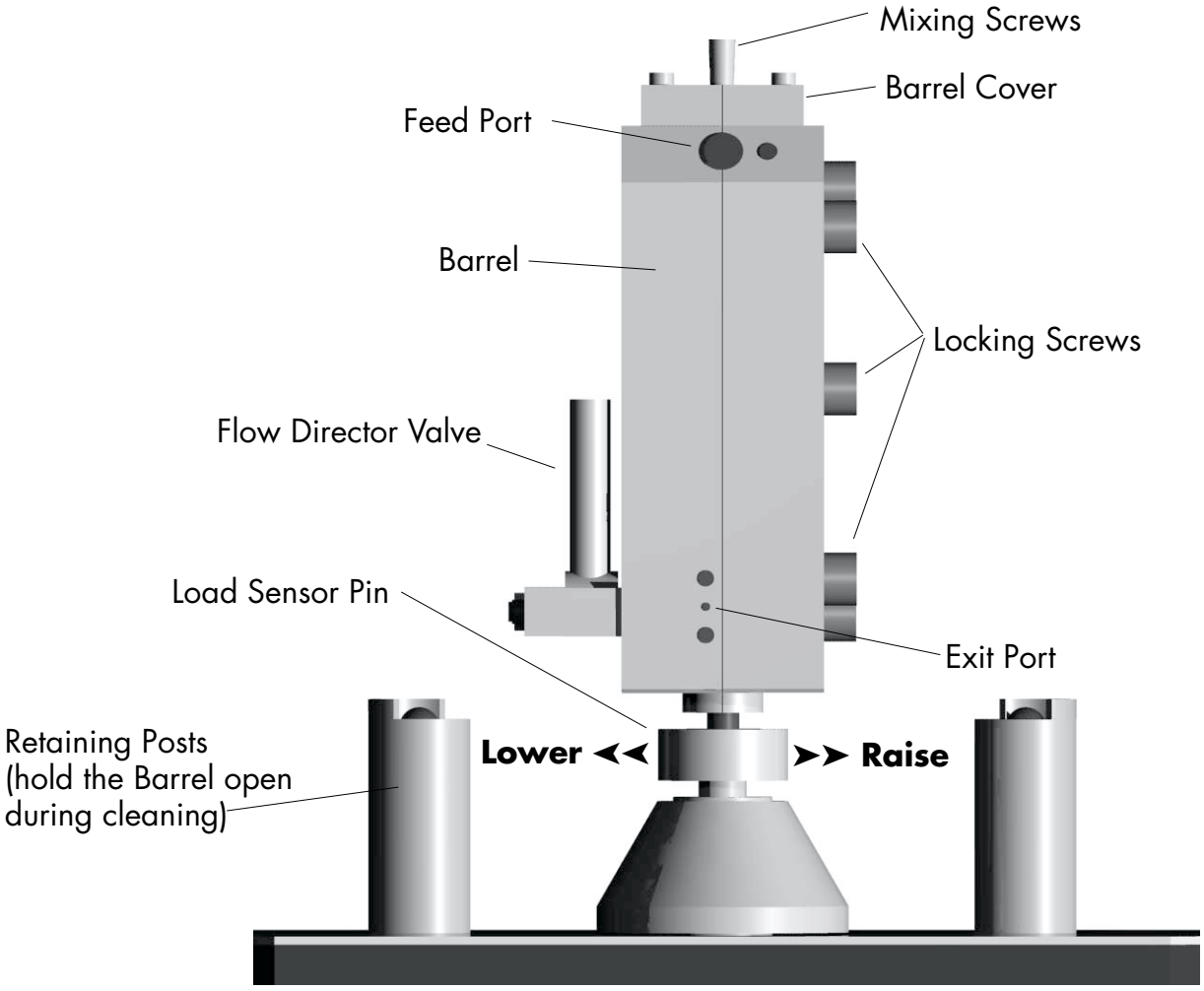
SET POINT LIGHTS ON	ACTIVE SET POINT
1	1
2	2
1 & 2	3
NONE	4

Using the ▲ and ▼ Keys to Alter Set Points - Minor adjustments to the set point can be made by pressing the ▲ or ▼ arrows while the system is running. If an ▲ or ▼ arrow key is pressed, the active set point will increase or decrease. The rate of this change will increase if the key is held. This is the only way to alter the current set point when the controller is in Remote mode.

STARTING AND STOPPING THE MOTOR

To start the motor press the RUN on the keypad. Note that the load reading must be >50 N in for the motor to start (see description of load indicator). Pressing the RUN button with the load reading <50N will cause a No FEEDBACK error that must be cleared by pressing STOP.

To stop the motor press STOP on the keypad.



Names of key parts of the MicroCompounter

3.3 Mixing and Cleaning

WARNING! The barrel and all metal parts in contact with the barrel will be very hot during operation. Wear appropriate protective gloves and clothing to prevent injury.

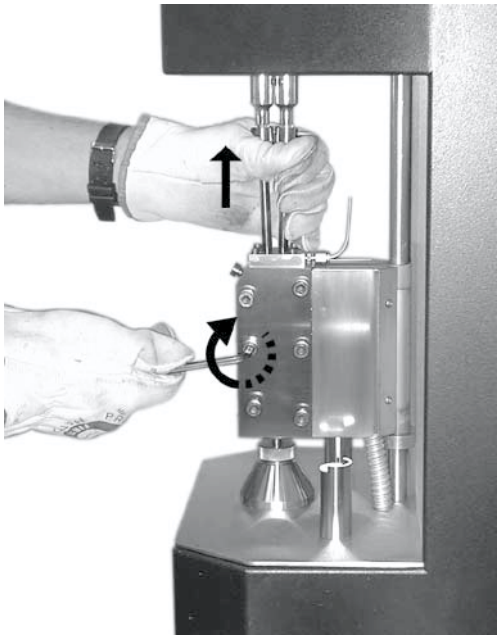
SCREWS AND BARREL SET-UP

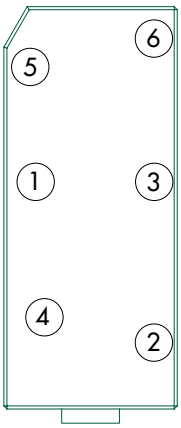
Once the processing temperature and speed have been set and the barrel has reached the desired operation temperature, the screws and barrel can be assembled to begin operation. The procedure consists of three steps:

- Installing the mixing screws onto the ball adapter.
- Closing the barrel and tightening the six screws that hold it together.
- Setting the initial value for the load sensor.

The conical mixing screws provided with the MicroCompounder have been designed to be interchangeable. The two mixing screws are identical and can be placed in the front or rear ball adapter. These mixing screws will be held on the ball adapter by a retaining ring. After the mixing screws are in place, bring their tips together and close the two halves of the barrel.

There is a small amount of vertical free play when the mixing screws are attached to the ball adapters and it is important to keep the mixing screws at their highest position while tightening the barrel. Hold the mixing screws and pull them up towards the top of the machine before tightening the first locking screw. If the mixing screws are too low when the barrel is tighten, the barrel might clamp on the screws and prevent their rotation.



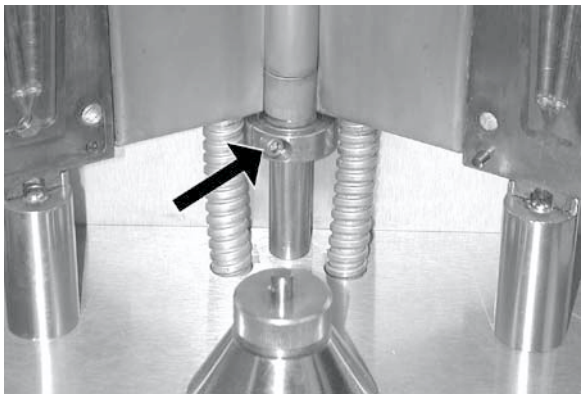


If it is difficult to close the barrel, the position of the load sensor pin might be too high. Lower the load pin by turning it clock wise (CW). After closing the barrel, tighten the six screws around the barrel to seal the compounding chamber. If the barrel is cold or just heating, use the hex screw driver to lightly tighten the screws. Once the barrel has stabilized at the desired compounding temperature, tighten the screws to a 34 N•m (25 ft•lb) using the hex wrench provided to complete the seal of the barrel. The bolts should be tightened in a cross pattern to insure a proper seal.

VERY IMPORTANT! Before loading the material to be mixed into the compounder, set the initial value of the load sensor to read ≥ 50 Newtons by turning the load sensor pin counter clock wise (CCW). This is extremely important in order to provide proper support to the barrel and minimize wear of components. The motor wil NOT start unless the load is ≥ 50 N.

HIGH TEMPERATURE OPERATION

There is a collar that maintains the proper position of the barrel on the support shaft. The position is set at the factory to allow that barrel to work properly under common operation conditions. However, at very high temperatures (>300°C) thermal expansion can cause the barrel and the mixing screws to grind against each other even when there is polymer inside the instrument. At these temperatures it might be necessary to readjust the height of the barrel. Open the barrel and let it rest against the retaining posts. Loosen the screw on the shaft collar (see photo) and lower the collar 2-3 mm (0.08-0.12") and tighten the collar screw. This position of the shaft collar will accommodate the thermal expansion of the barrel at high temperature. However, it will place the barrel lower than the top of the retaining posts. Consequently, the barrel will have to be lifted onto the post for cleaning. Please be aware that at these high temperatures fingers and skin burn very fast. Use protective clothing and high temperature gloves to operate the instrument at elevated temperatures.



LOADING POLYMER INTO THE COMPOUNDER

After the barrel is set up and the temperature has stabilized, the material to be compounded can be loaded in to the mixer. The MicroCompounder is capable of mixing many high viscosity materials such as molten polymers, waxes, pastes, and gels. The seal of the two halves of the barrel, when properly set, prevents leakage of any material (including liquids) loaded into the compounder. This feature is useful for dissolving polymers into solvents at high temperatures and mixing the resulting high-viscosity solution. However, in order to have the material circulate through the compounder during mixing, it must be viscous enough to develop pressure at the end of the barrel. This pressure will push the mixed material through the recirculation channel.

CAPACITY

The MicroCompounder has a maximum capacity of 4.5 cc of material (3.5-5 g depending on viscosity). For most efficient mixing, it is preferable to fill the compounder to capacity. Of this material, a minimum of 0.4 cc cannot be extruded from the barrel after compounding because it will remain trapped in the recirculation and exit channels. In addition, a small amount of material will remain attached to the screws and walls of the compounder. Most of this remaining material can be recovered once the barrel is opened for cleaning.

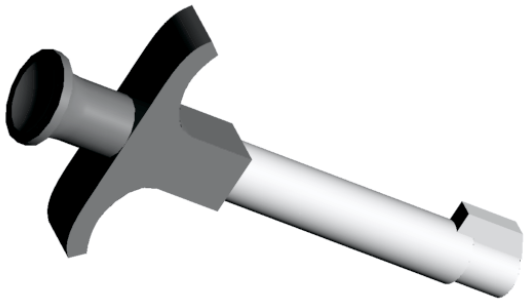
FILLING

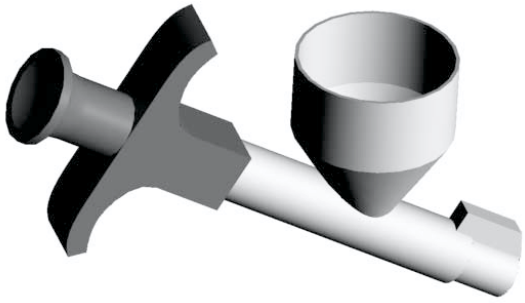
Make sure the flow directing valve is turned to the recirculate position (back). Turn the motor on before introducing any material into the compounder. Solid polymers, particularly pellets, should be fed SLOWLY into the compounder to allow them to completely melt before they reach the bottom of the

barrel. Pellets, in general, need to melt where they first contact the mixing screws in order to be conveyed down the barrel.

When blending unmeltable powders into polymers, it is important that the two components are added to the MicroCompounder simultaneously at the desired final ratio i.e. premixed in the solid state. This is particularly important if the concentration of the unmeltable solid is high (>40% by vol). The blended material needs to flow at all stages. If a glob of unmeltable powder reaches the return channel before it is blended into the polymer, the compacted powder will block the channel and the MicroCompounder will not work properly. This situation might also cause an quick raise of the load or torque and the machine will stop. Increasing the mixing speed (>200 RPM) and introducing the components slowly into the compounder will also help the processing of highly loaded blends.

Two filling tools have been provided to aid introducing material into the compounder. The tool with an attached funnel is used to introduce pellets and powders into the compounder. The funnel tool can be loaded with powder or pellets prior to attaching it to the compounder. Once the tool is into the feeding port it can be locked into place using the locking screw. This will prevent the filling tool from coming out of the filling port when the material is being pushed into the compounder.





The tool without the funnel is useful for pastes and waxes. In the latter case, the paste can be loaded into the tool using a spatula and then “injected” into the compounder.

NOTE: As the material is introduced into the compounder, the force measured by the load pin will increase. The final load will depend on the viscosity and amount of material. If the load exceeds 5000 N at any time, a safety alarm in the load sensor will automatically stop the motor. This safety mechanism will prevent damage to the bearings in the gear box due to excessive load. In addition, if the viscosity becomes high enough to exceed the torque rating of the motor, another safety device will reduce the motor output. In this case, the motor will automatically resume operation when the viscosity is reduced. If any of these two conditions is encountered, stop the experiment and manually remove the material from the compounder (see instructions for cleaning).

Once all the material has been introduced into the mixer, remove the filling tool from the entry port and cover the port with the filling plug. This plug will push any material remaining in the filling channel into the compounder and will prevent any material from coming out of the filling port during mixing.

NOTE: The filling port plug has been machined to precisely fit the inner curvature of the barrel at the insertion point. It is machined together with the barrel and cannot be replaced without replacing the barrel. DO NOT LOSE IT.

MIXING

The design of the MicroCompounder allows unlimited residence time of the material during compounding. Usually 5 minutes mixing time is enough to compound most materials. At the end of the compounding time, turn the flow

director valve to the outflow position (front) and collect the compounded material from the exit port. After the material has been extruded from the compounder, stop the motor and clean the barrel.

WARNING!

It is recommended that cleaning of the screws and barrel be performed while the compounder is at the processing temperature for the resin. WEAR PROTECTIVE GLOVES, PROTECTIVE CLOTHING, AND SAFETY GLASSES to prevent injuries.

CLEANING

Cleaning the screws and barrel of the compounder can be accomplished by:

- opening the barrel and manually cleaning the screws and barrel walls, or
- running purging compound or clean resin through the compounder.

If cross-contamination between tests does not affect the results of the experiments, cleaning is not required and the second sample can be loaded into the compounder after the first one is extruded. Carefully load the second sample. Slightly less material will be needed due to the small residue left in the compounder from the previous experiment.

If it is important not to cross-contaminate the material being compounded from one experiment to the next, it is necessary to open up the barrel and manually remove any unextruded material from the return channel, the barrel walls, and the screws. As mentioned previously, a *minimum* of 0.4 cc of material will remain trapped in the return and exit channels and will not be extruded from the compounder. Additional material will remain in the compounder if the resin is particularly sticky or the screws are worn out. To remove this remaining material by hand, begin by removing the six screws that hold the barrel closed and open the barrel until the halves are held firmly in place by the two retaining posts. A tool (ring-type plier) is provided to facilitate opening the barrel while it is hot.

Remove the screws from the ball adapters and clean them with the brass brush provided. Do not use steel or other brushes made of hard metals since they will scratch the surfaces of the screws and barrel thus reducing their lifetime. Remove the major portions of leftover material from the return channel and barrel using a small pair of tweezers. The rest can be removed by using the brass brushes provided. Use the smaller (softer) brushes when possible.

Pay particular attention to the bottom of the barrel near the flow director valve and the feeding port. The exit port can be cleaned using the provided small drill bit with the brass handle. Carefully push the drill bit from the exit hole towards the flow valve while rotating clockwise to “drill” out any material remaining in the channel.

If the material compounded is very sticky, it is easier to remove it from the compounder by running one or two charges of purging compound through the mixer. After the compounded material has been extruded, close the flow director valve (back position) and fill the compounder with purging compound. Mix this material for five minutes and extrude it as described above. If the processing temperature of the material being tested is > 250 °C, introduce the purging compound at the processing temperature then lower the temperature of the compounder to 180 °C to increase the cleaning efficiency of the purging material. Mix at the lower temperature for five minutes and extrude. After the purging compound is extruded, open the barrel and manually clean it as described above.

3.4 Other Indicators

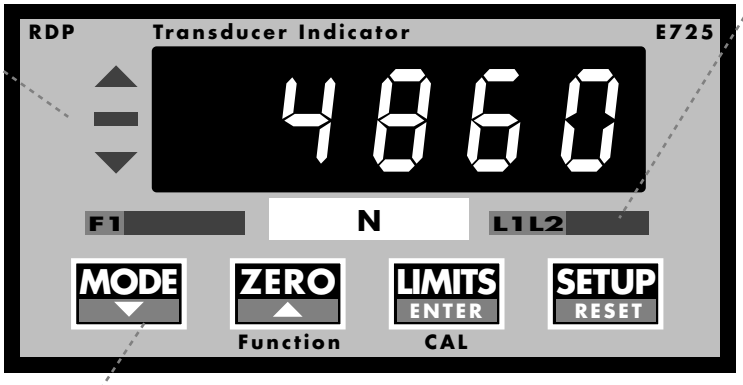
LOAD INDICATOR

Portions © RDP Electronics, Ltd.

Because of the conical design of the MicroCompounder, high pressures will be generated at the narrow end of the mixer during operation. For a constant volume of material compounded, the pressure generated will be proportional to the viscosity of the material and to the processing speed. This pressure creates a downward force that pushes the barrel down and away from the mixing screws. This force is monitored using a load sensor placed at the end of the supporting pin and is displayed in the LOAD indicator in the controller box. The force is measured and displayed in Newtons and it has a range of 0–5000 N. The load sensor is also a safety device which monitors the process load and cuts power to the motor if the load exceeds 5000 N. The main purpose of this limit is to protect the instrument, particularly the bearings inside the gear box.

The up arrow indicates that the display is showing the MAX value, the down arrow indicates that MIN is being displayed and both together indicate that the TIR is being displayed. The horizontal bar between the up and down arrows provides the negative indication when all 5 digits are in use.

Four LEDs indicate the status of the LIMITS. An illuminated LED indicates that a particular LIMIT has been triggered.



Four control keys provide functions as described below

BASIC OPERATION

- Before closing the barrel, ZERO the display by pressing the Zero Key. This will correct any drift in the reading due to changes in temperature of the load cell.
- After closing the barrel and tightening the locking screws, unscrew the supporting pin of the load sensor until the load indicator reads >50N. This minimum load insures proper contact of the supporting pin with the barrel, and minimum displacement of the barrel during the test.
- Proceed with the experiment as described in the general operation section.

SAFETY LIMITS

Two limits are preprogrammed into the indicator:

L1 (Low limit):

This limit has been programmed to activate at 50 N. Once activated, theL1 indicator will light up to indicate that the motor can be turned on.

L2 (HIGH LIMIT):

This limit has been programmed to activate at 5000 N. Once activated, the motor will stop, thus ending the test. The L2 indicator will also light up. After the test stops, the load will most likely drop resetting the limit.

Two conditions will cause the load to exceed the allowed setting:

- the viscosity of the material being compounded is too high.
- the return channel is blocked preventing proper recirculation of the material through the mixer.

In either case, the barrel should be opened and manually emptied before continuing with other tests. Do NOT continue to compound the material which triggered the alarm since damage to the compounder will occur.

CONTROL KEY FUNCTIONS

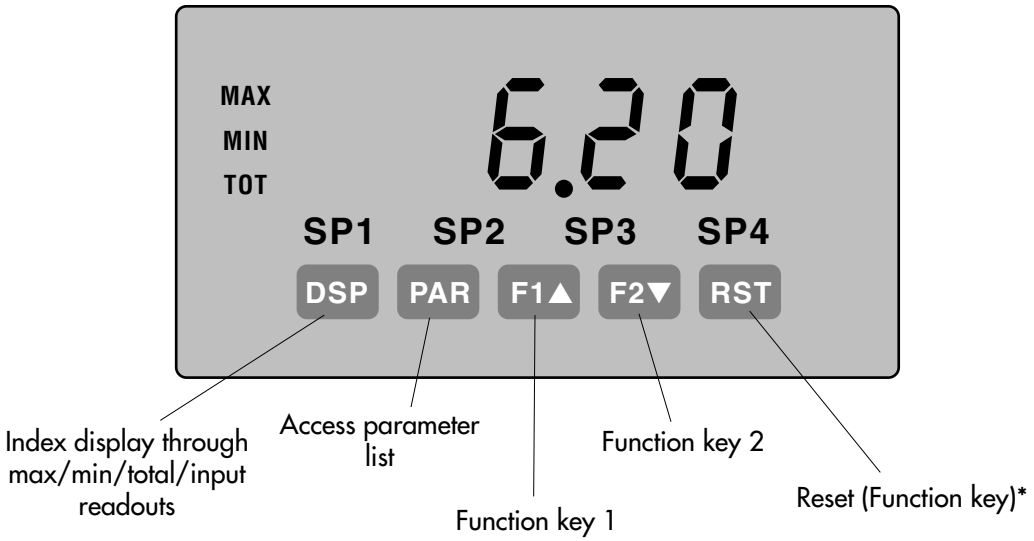
The E725 has four membrane keypads with tactile feedback. These keys select and control the functions of the E725. The following table concerns itself only with the functions available in the E725's normal operating mode, it does not detail any of the programming or calibration functions.

Key functions. In order to...	**Press...**
Zero the display	ZERO ZERO
Return to calibration zero (clear Zero)	ZERO ZERO & RESET SETUP RESET together
Change display (MAX to MIN to TIR to NORMAL)	MODE MODE
Reset (MAX & MIN & TIR)	MODE MODE & RESET SETUP RESET together
Change function mode (if available)	MODE MODE & FUNC ZERO together
Display shunt cal reading	MODE MODE & CAL LIMITS ENTER together
Reset latched limits	LIMITS LIMITS ENTER & RESET SETUP RESET together

TORQUE INDICATOR

Portions © Red Lion Controls

Another useful parameter to monitor during processing is the torque output by the motor since it gives an indication of the mechanical energy put into the system. The torque indicator used for the MicroCompounder gives a close approximation of the motor's torque output by monitoring the current drawn by the motor and converting it to a torque reading. For the DC motor used the torque output is proportional to the current used by the motor. The speed of the motor is controlled by the voltage applied to the motor. The indicator is set to display 6.2 N•m (max. motor torque) when the current drawn by the motor is 2 Amps. In addition to being an approximation, this reading does not take into account any mechanical losses due to the drive geometry, or the gear box. This is a read only display. The unit comes programmed for the appropriate function an range and no further programming is necessary.



*Factory setting for the F1▲, F2▼, and RST keys is NO Function mode.

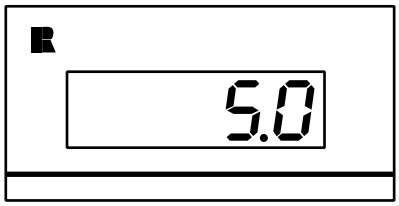
SAFETY LIMIT

A limit is preprogrammed into the torque indicator to stop the experiment in case of a high torque condition. The PWM drive inside the compounder housing has been set to limit the current to the motor to 2.0 Amp (6.20 N•m). Under normal operation this is a slow acting function and if reached, it will limit the current supplied to the motor to 2.0 Amp but will not stop the experiment.

The limit on the Torque Indicator is programmed to activate at 7.0 N•m and is designed to stop the experiment in case of a sudden jump in the current to the motor. This condition might occur if the polymer where to suddenly freeze while the motor is turning. The condition that triggers the limit must be cleared continuing the experiment. Do NOT continue to compound the material which triggers this alarm since damage to the compounder will occur.

MOTOR ON TIME INDICATOR

An hour meter has been included in the back of the compounder to keep track of the time that the motor is on. This information is useful to time oil changes of the gear box and perform other regular maintenance of the MicroCompounder.



4. Computer Control

The controllers used in the MicroCompounder have been chosen so that they can be easily interfaced with a computer for complete instrument control and data acquisition. A simple software program has been included with the Micro-Compounder that will enable data collection. The data file generated can be use with other graphing software to further analyze the changes of the polymer during the compounding experiment.

INSTALLATION

HARDWARE INSTALLATION

The controller for the MicroCompounder uses RS-485 communication protocol. Since most Macintosh or PC are equipped with an RS-232 communications port, a hardware converter box has been included to translate the commands between protocols.

Note: You must supply your own computer and the appropriate RS-232 cable.

The connection is very simple. Connect the cable with the 9 PIN, D style connector from the BLACK BOX converter to back of the MicroCompounder controller. Connect the proper RS-232 serial cable from your computer to the D-25 connector of the converter (this cable is not supplied). Then connect the BLACK BOX power transformer the appropriate power outlet.

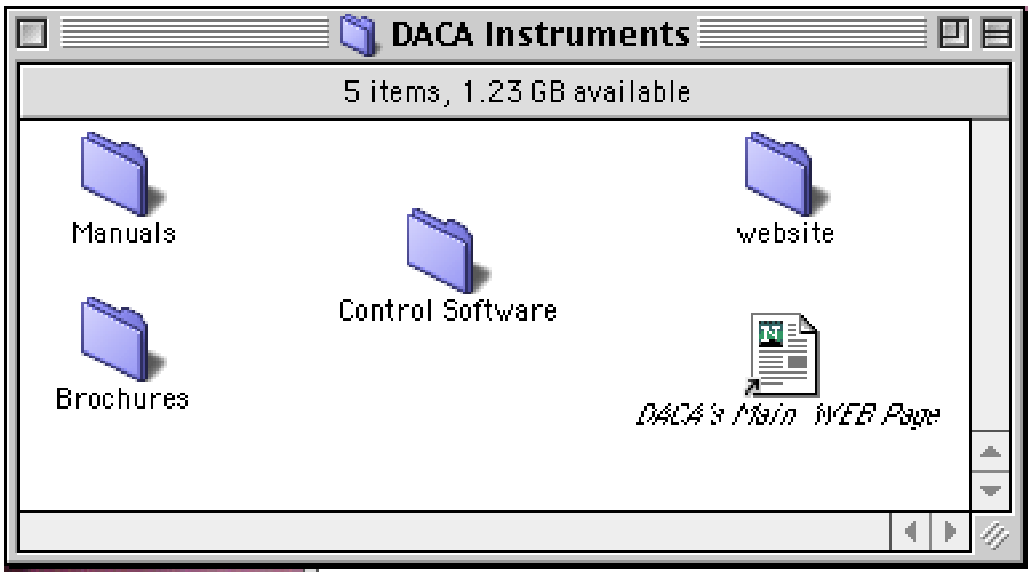
SOFTWARE INSTALLATION

Note: This description assumes that you have a very good knowledge of the operation of your computer.

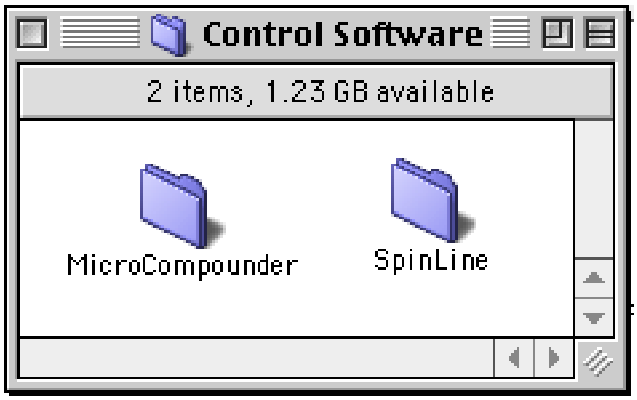
The software is supplied compressed in a single CD ROM. Once the software is installed and the computer is properly connected to the MicroCompounder turn on the compounder and start the program.

MACINTOSH:

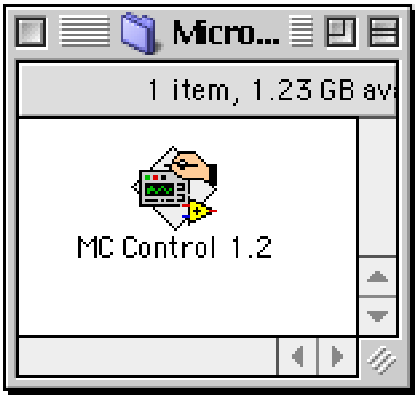
Insert the CD in the CDROM drive and open the disk.



Open the Control Software folder:



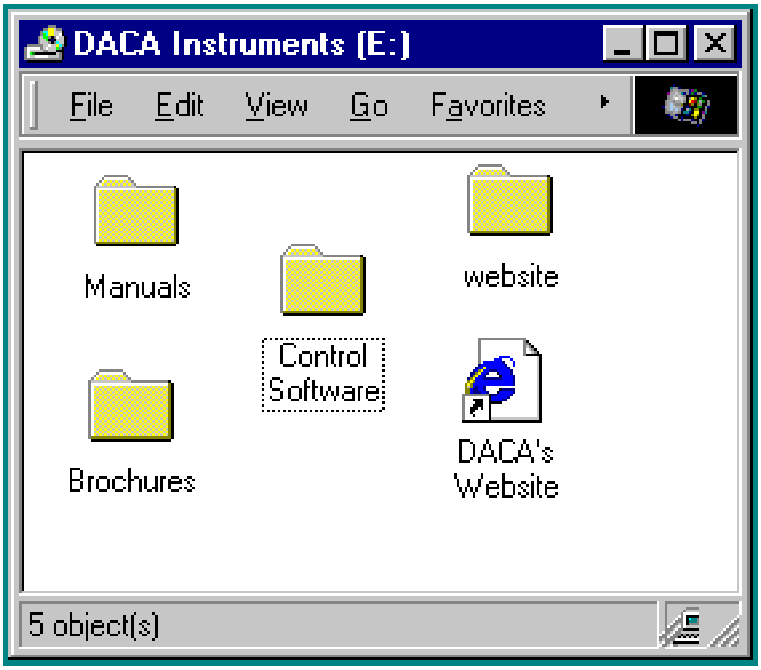
Open the MicroCompounder folder:



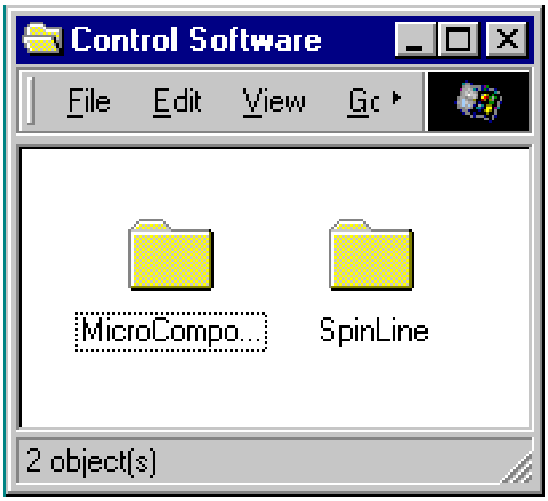
Copy the MC Control file to your hard disk
and run the program for your hard disk.

WINDOWS:

Insert the CD in the CDROM drive and open the disk from your file explorer.



Open the Control Software folder:



Open the MicroCompounder folder:

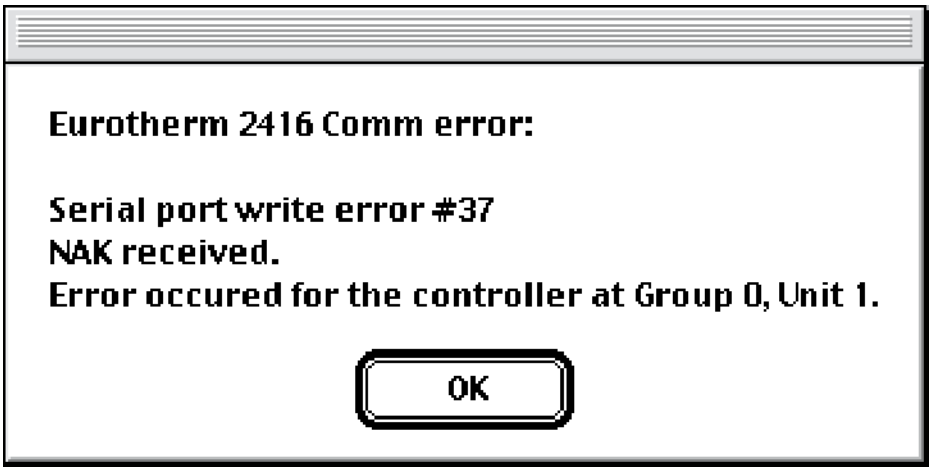
Double-click on the Setup icon. The installer will ask for permission to install the software in your C: drive. Once the installation is complete you can run the program from you computer. An entry will be made in your Start > Programs > MicroCompounder menu to make the launching process simpler.

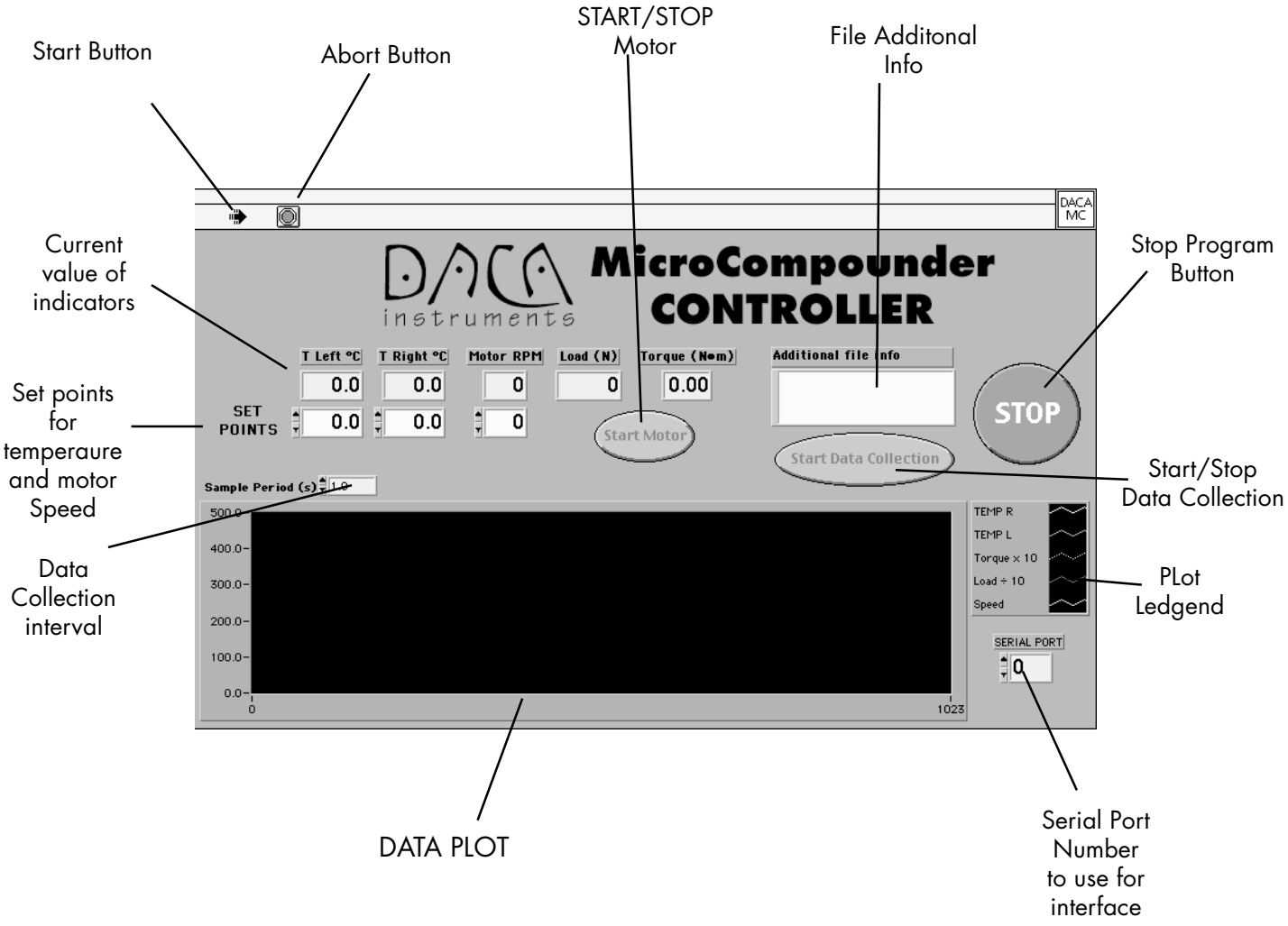
LAUNCHING THE SOFTWARE

To run the program double click on the software icon MC Control 1.0 (Mac) or MC Control.exe (PC).

Note: When the program is launched it will attempt to communicate with the MicroCompounder. Make sure that the hardware is properly connected, the MicroCompounder is turned on. In addition, the temperature controllers must also turned on and the Motor controller must be set to Remote operation (see sec. 7.2). If any of these steps are not performed, the following dialog box will be displayed when the program is launched.

If all the steps taken above were performed correctly, the following screen will be displayed and the software will start controlling the MicroCompounder.


Eurotherm 2416 Comm error:
Serial port write error #37
NAK received.
Error occured for the controller at Group 0, Unit 1.
OK


Start Button
Abort Button
START/STOP Motor
File Additonal Info
Current value of indicators
Stop Program Button
Set points for temperaure and motor Speed
Start/Stop Data Collection
Data Collection interval
PLot Ledgend
DATA PLOT
Serial Port Number to use for interface
DACA instruments
MicroCompounder CONTROLLER
T Left °C
T Right °C
Motor RPM
Load (N)
Torque (N•m)
Additional file info
SET POINTS
Start Motor
Start Data Collection
STOP
Sample Period (s)
TEMP R
TEMP L
Torque x 10
Load ÷ 10
Speed
SERIAL PORT

START BUTTON:

As mentioned before the program will automatically start to control the MicroCompounder when launched. If the program is stopped using the abort or Stop button, the Start button looks like  . At this point the program is not controlling the MicroCompounder. To start controlling the compounder press the button and it changes to look like  .

ABORT BUTTON:

Use this button to abort (stop) the program if it is working improperly or it seems to hang up and not controlling the MicroCompounder. It will stop the program but it might close the data file (if one was open) improperly.

STOP PROGRAM BUTTON:

This button gracefully stops the program after properly closing any open data files and stopping the motor.

CURRENT VALUE OF INDICATORS: These boxes indicate the current value of the respective controller.

SET POINTS:

These boxes are for changing the set point value of the two temperature controllers and the motor speed. A changed of a set point in will also be reflected in the hardware. Conversely, if the software is controlling the Micro-Compounder and the set points are changed on the physical controllers, the new set point will also change in the software.

SERIAL PORT NO.:

Set the number of the serial port being used for communication with the MicroCompounder in this box. This number will be used when you start the program and then it will not be read anymore until the program is stopped. It is set to a default of 0 (Zero) and if the actual port is different, i.e. 1 or 2, the error box described above will be displayed. In this case, click OK to stop the program, change the value of the Serial Port No. and start the program again.

START/STOP MOTOR:

This will start or stop the motor. Like the set point, if the program is controlling the MicroCompounder at the motor is started or stopped by pressing, the actual keypad on the controller and the software will detect this and change the status of the software button.

FILE ADDITIONAL INFO:

Any text entered in this box will be attach to the beginning of the data file. Use this box to enter any data about the experiment being performed before the data collection button is pressed.

START/STOP DATA COLLECTION: Use this button to start and stop saving the data collected to a file on the disk. When pressed, a dialog box will ask for the file name and the location to save the file to. A sample data file is shown later in this chapter.

DATA COLLECTION INTERVAL:

Use this box to vary the interval between data points. Note that due to the program overhead the minimum interval between point is ~1.75 sec regardless of the number entered in this box.

DATA PLOT:

This box shows all 5 data points being collected. To make the values easier to display in a single chart the load value is divided by 10 and the torque value is multiplied by 10. The number shown on the x axis (bottom) is the number of the data point being collected and not the time collected. The plot acts like a strip chart in that after 1023 points the plot lines will start to move to the left while new points are added to the right end of the chart. The two number in the X axis will change accordingly.

PLOT LEGEND:

Shows which color is used by each data line

RUNNING A TEST

As mentioned earlier when the program is launched it will start to control the MicroCompounder and display the values of the various parameters on the strip chart. In addition the temperature and speed set points will be set to zero upon launching the program.

Change the temperature set points to the desired value by clicking on the small ▲ or ▼ arrows next to the set point box or by typing the desired value directly in the set point box.

Alternatively, the setpoints can be changed directly on the controllers and the new values will be reflected by the software.

Once the desired temperature is reached and stablized, start the motor by pressing the RUN button on the motor controller or the Start Motor button on the software. The motor will accelerate to the desired setpoint and the software button will change to read Stop Motor.

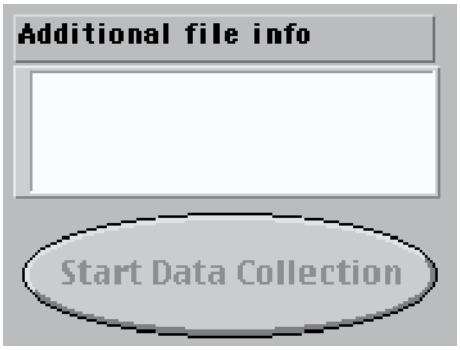
Loading the polymer into the machine, compounding and extrusion is described elsewhere in the manual. Please refer to section 3.3 for additional information.

To stop the motor press the STOP button on the motor controller or the software Stop Motor button.

SAVING DATA TO DISK

The value of the parameters being displayed on the strip chart can be saved to disk any time that the software is controlling the MicroCompounder. To start saving the data to disk press the Start Data Collection button. A standard dialog box will come up asking for the file name and the place on the drive to save the data.

Note: Only the data generated after the Start Data Collection button is pressed will be saved to disk. Any data displayed on the chart prior to that point cannot be saved. Make sure you start the data collection before you start the compounding experiment.



In addition to the controller data, the current time and date will be written to the beginning of the file. These values will be read from the computer internal clock therefore you need to make sure that this clock is set correctly. Additional information about the test can be written in the Additional File Info box. The desired information must be written before the Start Data Collection button is pressed. Changes to the text in this box while the data is being saved to disk will be ignored.

To stop saving data to disk press the Stop Data Collection button.

A sample data file is shown below. The data is saved as an tab delimited ASCII text file which can be opened by any data analysis program such as EXCEL, Kaleidagraph, or SigmaPlot for further analysis, replotting and printing.

```
test 6
11/5/99
12:51 PM
testing all controllers and data intervals
Time (s)  Tleft   TRight Speed RPM Load (N)  Torque (Nm)
1         20.60   22.00  0         72.0      0.000
3         20.80   22.00  0         72.0      0.000
5         20.70   22.00  0         72.0      0.000
6         20.70   21.90  0         71.0      0.000
8         20.80   21.80  0         73.0      1.100
10        20.80   21.90  63        78.0      1.080
12        20.70   21.90  63        78.0      1.070
13        20.80   22.00  63        75.0      1.070
15        20.60   22.00  63        74.0      1.070
17        20.80   21.90  63        77.0      1.050
18        20.80   22.00  63        75.0      1.040
20        20.80   21.70  63        77.0      1.040
```

The first 5 lines are:
Name of the file
Date of test
Time of test
Text entered in the Additional File Info box
Headers for the data columns

Because of software overhead and data verification subroutines the time interval between data points might not be even, particularly if the value of the Sample Period box is set to <3.0 sec.

5. MAINTENANCE

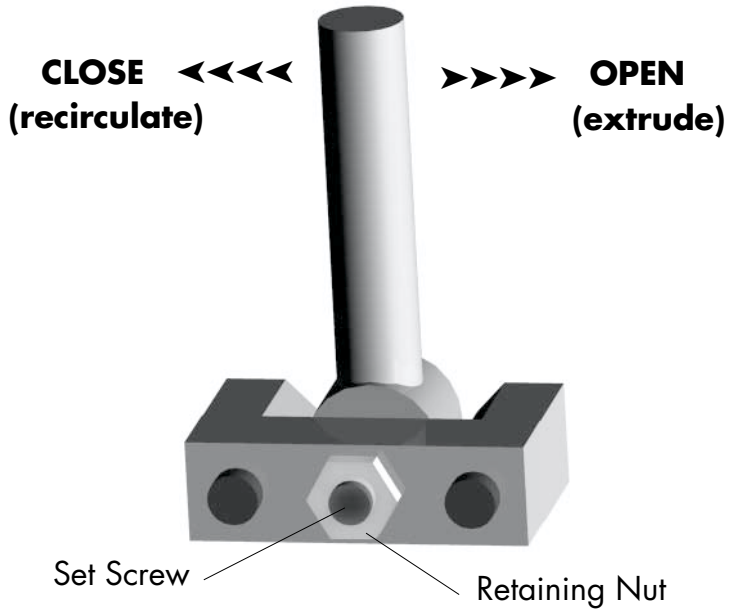
Maintenance of the MicroCompounder is relatively simple. There are only four general maintenance areas:

- cleaning of body and screws
- lubrication of screw coupling
- lubrication of gear box
- replacement of brushes in the motor

CLEANING

Periodically the barrel should be cleaned thoroughly to remove all polymer particles attached to any of the surfaces and screw holes. Use the brass brushes provided to facilitate cleaning. Steel tools (except brushes) may be used taking extreme care not to scratch the surfaces.

If the flow directing valve becomes hard to operate at any temperature, polymer residue might be trapped in the cavity of the valve. The valve can be removed for cleaning by first removing the bracket that holds the valve in place. The valve should be removed by pulling it out of the barrel while gently rotating it back and forth. It is easier to remove a sticky valve by heating the barrel to the melting temperature of the polymer trapped in the channel.



WARNING: DO NOT PUSH THE VALVE FROM INSIDE. Doing so will damage the inner surface of the valve and allow the sample to leak through the exit port during tests.

After cleaning the valve and orifice, lubricated them with antiseize before reasembly. After reassembly, the closing force of the valve might have to readjusted to prevent leakage of polymer from the exit port during a test. To adjust the valve, the set screw that maintains the exact position of the valve must be tightened. Loosen the retaining nut and tighten the set screw. For this adjustment, it is helpful to run a test sample of polyethylene and observe for leakage as the set screw pressure is increased. Do not overtighten the set screw. After the valve is properly set, retighten the retaining nut of the set screw. If the leakage persists, the valve might be worn out and need replacing.

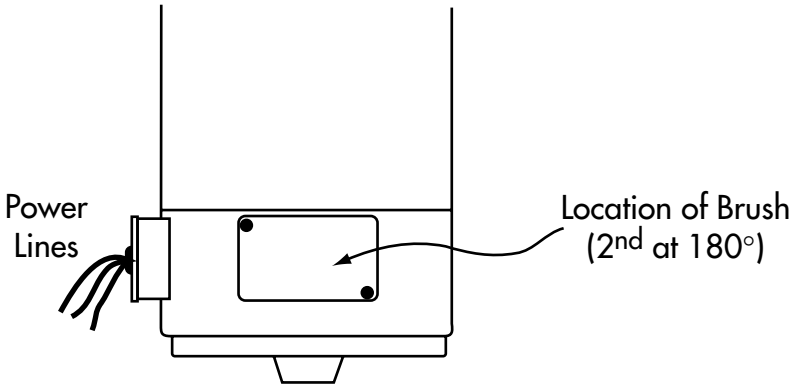
MIXING SCREWS

The coupling between the screw and the ball adapter must be lubricated to insure proper operation of the coupling. Use a high temperature grease such as

Lubriplate™ when the existing lubrication has been removed.

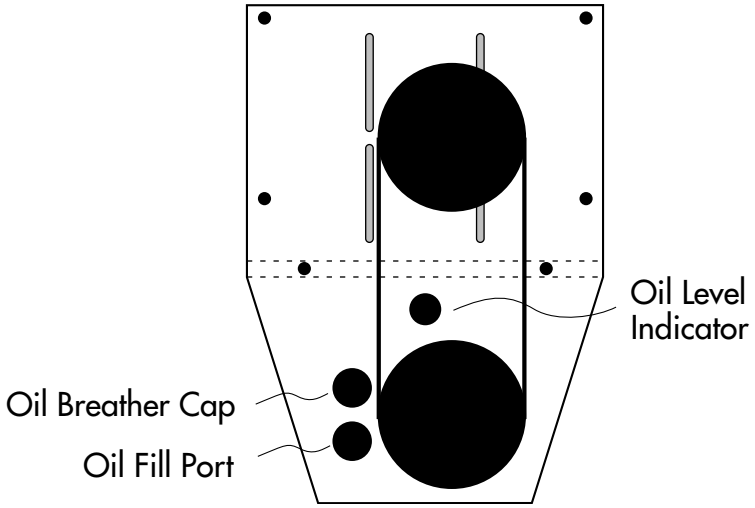
ELECTRICAL MOTOR

The brushes for the motor should be checked every six months to determine their wear status. Because of the position of the motor, only one of the brushes can be checked easily. Remove the back cover of the MicroCompounder and disconnect the cable to the fan. Remove the small rectangular cover at the bottom of the motor and remove the brush. If the brush is less than 7 mm long, replace BOTH brushes.
BRUSH TYPE: AB01
Please contact DACA Instruments for replacement brushes and additional instructions.



GEAR BOX

The gear box is filled with lubricating oil. This oil should be replaced after 4000 hr of motor ON time. The level of the oil should be checked regularly using the indicator located on top of the MicroCompounder near the drive belt. Open the rear cover and disconnect the fan. Locate the indicator as shown in the figure and pull out the cap. Verify that the oil level about 35 mm (1.4") from the top of the tube. If the oil level is low, add oil through the oil fill port.



Additional oil might be obtained through DACA Instruments. To replace the oil the chassis must be removed to access the drain plug in front of the gear box. For instructions contact DACA Instruments.

RECOMMENDED OILS:
USA: Mobilgear 630 (Mobil)
Europe: Mobilgear 630 (Mobil), Omala Oil220 (Shell), Spartan EP220 (Esso), Energol GR-XP200 (BP).
Other countries:
Lubrication Oil: CLP 220 DIN 51517 (mineral oil)
Viscosity according to: ISO VG220 DIN 51519
Capacity: 1.3 liters

6. TROUBLESHOOTING

If you experience any problem with the MicroCompounder, please contact DACA Instruments for assistance.

DACA Instruments
P.O. Box 991
Goleta, CA 93116
Phone: +1 (805) 967-6959
FAX: +1 (805) 967-4331
e-mail: daca@daca.com

MOTOR PROBLEMS

The drive system for the MicroCompounder is comprised of several components. Power is provided by a permanent magnet, DC gear motor. The motor is rated at 1/3 Hp with a base speed of 1725 RPM. A 5:1 gear reducer coupled to the motor reduces the top speed to 360 RPM. The current to the motor is controlled by a Pulse Width Modulated (PWM) driver. This small electronic component is located inside the mixer chassis. A speed controller, located on the control box, uses a speed feedback signal from a magnetic RPM transducer and regulates the voltage supplied by the driver to the motor. The output shaft of the motor is coupled to the parallel shaft gear box by means of an 8 mm pitch timing belt and pulleys. The parallel shaft gear box converts the single input from the motor to two parallel, co-rotating shafts that drive the mixing screws. There is a small speed increase in this gear box but it is compensated by the way the speed is read at the motor timing pulley.

Most problems, if they do occur, will appear at initial start-up of the speed controller system. The more common problems are described below.

If your speed controller fails to operate as it should after you have followed the suggestions found in this list, contact DACA Instruments for technical assistance.

IF THE MOTOR WILL NOT RUN:

1. Verify that the load sensor pin has been adjusted to display ≥ 50 N on the load indicator before turning on the motor. (see page 26.)

2. Check that the screws are not clamped by the barrel. Loosen the locking screws and press the start button. (The Load must be ≥ 50N). If the instrument operates this way, follow the instructions on page 25 before re-tightening the locking screws.

3. Check the fuse located in the PWM driver. This driver is located to the left of the base of the motor.

4. Check the status of the brushes in the motor.

5. The speed control may be damaged. Disconnect the speed controller from the driver. Connect a 10 KΩ speed adjust potentiometer to the driver. Check whether the motor runs properly. (Contact DACA instruments for further instructions.)

6. The motor may be defective. Test system with another motor.

IF THE MOTOR WILL NOT LOCK INTO SPEED:

1. Confirm that the pickup sensing tip of the speed sensor is directly over the center of the gear teeth and is no farther than 0.3 mm above the teeth. Extensive shaft runout is the most common cause of this type of problem.

2. Check continuity and shielding of pickup leads. Electrical noise can cause the speed controller to attempt corrections that are not justified.

IF MOTOR RUNS AT TOP SPEED REGARDLESS OF THE SET SPEED:

1. There may be an electromechanical defect in the pickup, a break in the pickup leads, or in the leads from any sensor. Also, check the alignment of the pickup over the gear. Without accurate feedback information fed to the speed controller, the system cannot be expected to operate correctly.

2. The driver may be defective. Replace the speed controller with the speed potentiometer and check whether the motor runs properly.

CONTROLLER PROBLEMS

IF THE CONTROLLER DOES NOT TURN ON:

There is a separate fuse to protect the controller in case of a short circuit. If this fuse is damaged, the compounder itself eill have power (fan is urning) but the controllers will not turn on.

1. Confirm that the fan on the back of the Compounder is functioning.

2. Check that the POWER interconnect cable is properly attached and locked into place.

3. Steps 1 and 2 are OK, you'll need to check the fuse iniside the Compounder. Unscrew the back cover of the compounder and check the status of the fuse located in position 8 (see appendix for the wiring diagram).

4. Replace the fuse if it is damaged.

HEATERS AND TEMPERATURE CONTROLLER PROBLEMS

HEATERS

If either side of the barrel fails to heat up after turning on the temperature controllers, check the fuses located inside the MicroCompounder in positions 5 and 6 of the terminal barrier. The fuses are rated 4 Amps, fast blow.

Under normal operating conditions, the barrel (closed with mixing screws in place and no polymer) should heat from room temperature to 180°C in 7-8 min. If the heating time is several minutes longer it is possible that one or more of the heaters is damaged. Another good indicator of heater damage is uneven heating of the two sides of the barrel. Because the two sides are turned on at the same time, they should reach the final temperature almost at the same time (unless the two set points are not the same). The message LP.br should be displayed on the temperature controller if one of the heaters is faulty.

The temperature controllers can detect if there is a break in the control loop due to a fuse burnout, heater burnout, faulty output device or loose wiring. The operator is warned by the message LP.br. The message is latching, resettable by touching any button on the front panel. The controller assumes a break in the control loop if the output to the heaters remains at 0% or 100% and the measured value moves less than 1/2 of the ProP setting (proportional band) towards the setpoint within the setting of LP.br (loop break time). These two values are determined during the autotune procedure.

CAUSES:	SOLUTIONS:
Fuse Burnout	Check the appropriate fuse inside the compounder. Replace if necessary.
Heater damaged or burned out	Replace heater. Contact DACA Instruments for instructions.

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SECTION II

Configuration and Tuning of Controllers

7.1 Temperature Controller

7.1.1 TUNING

Portions © Eurotherm Controls, Inc.

Before tuning please read Section 7.1.3, *Access Levels,* to learn how to select and change a parameter.

What is tuning?

In tuning, you match the characteristics of the controller to that of the process being controlled in order to obtain good control. Good control means:

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

Tuning involves calculating and setting the value of the parameters listed in Table 7-1. These parameters appear in the 'Pi d', list.

Parameter	Code	Meaning of Function
Proportional band	Pb	The bandwidth, in display units, over which the output power is proportioned between minimum and maximum.
Integral time	ti	Determines the time taken by the controller to remove steady state error signals.
Derivative time	td	Determines how strongly the controller will react to the rate-of change of the measured value.
High Cutback	Hcb	The number of display units, above setpoint, at which the controller will increase the output power, in order to prevent undershoot on cool down.
Low cutback	Lcb	The number of display units, below setpoint, at which the controller will cutback the output power, in order to prevent overshoot on heat up.
Relative cool gain	rEL	Only present if cooling has been configured and a module is fitted. Sets the cooling proportional band, which equals the Pb value divided by the rEL value.

Table 7-1 Tuning parameters

AUTOMATIC TUNING

Two automatic tuning procedures are provided in the 2416:

- A one-shot tuner which automatically sets up the initial values of the parameters listed in Table 7-1.
- Adaptive tuning which continuously monitors the error from setpoint and modifies the PID values if necessary.

The 'one-shot' tuner works by switching the output on and off to induce an oscillation in the measured value. From the amplitude and period of the oscillation, it calculates the tuning parameter values.
If the process cannot tolerate full heating or cooling being applied during tuning, then the level of heating or cooling, can be restricted by setting the heating and cooling power limits in the 'oP' list. However, the measured value

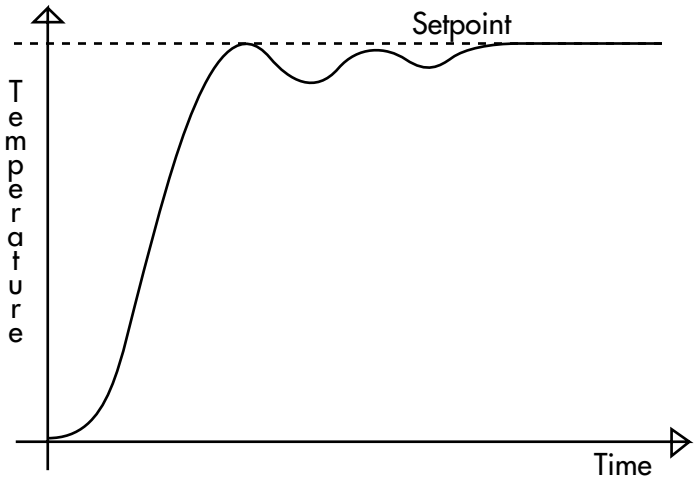
must oscillate to some degree for the tuner to be able to calculate values.
A One-shot Tune can be performed at any time, but normally it is performed only once during, the initial commissioning of the process. However, if the process under control subsequently becomes unstable (because its characteristics have changed), you can re-tune again for the new conditions.
It is best to start tuning with the process at ambient temperature. This allows the tuner to calculate more accurately the low cutback and high cutback values which restrict the amount of overshoot, or undershoot.

How to tune

1. Set the setpoint to the value at which you will normally operate the process.
2. In the 'AtUn' list, select 'tUnE' and set it to 'on'.
3. Press the Page and Scroll buttons together to return to the Home display. The display will flash 'tUnE' to indicate that tuning is in progress.
4. The controller induces an oscillation in the temperature by first turning the heating on, and then off. The first cycle is not complete until the measured value has reached the required setpoint.
5. After two cycles of oscillation the tuning is completed and the tuner switches itself off.
6. The controller then calculates the tuning parameters listed in Table 4-1 and resumes normal control action.

If you want 'Proportional only', 'PD', or 'PI' control, you should set the 'ti' or 'td' parameters to 'OFF' before commencing the tuning cycle. The tuner will leave them off and will not calculate a value for them.

TYPICAL AUTOMATIC TUNING CYCLE



Calculation of the cutback values

Low cutback and *High cutback* are values that restrict the amount of overshoot or undershoot that occurs during large step changes in temperature (for example, under start-up conditions). If either low cutback, or high cutback, is set to 'Auto' the values are fixed at three times the proportional band, and are not changed during automatic tuning

Adaptive tune

Adaptive tuning is a background algorithm, which continuously monitors the error from setpoint and analyses the control response during process disturbances. If the algorithm recognizes an oscillatory, or under-damped, response it recalculates the Pb, ti and td values.

Adaptive tune is triggered whenever the error from setpoint exceeds a trigger level. This trigger level is set in the parameter 'drA.E, which is found in the Autotune list. The value is in display units. It is automatically set by the control-

ler, but can also be manually re-adjusted.

Adaptive tune should be used with:
1. Processes whose characteristics change as a result of changes in the load, or setpoint.
2. Processes that cannot tolerate the oscillation induced by a One-shot tune.

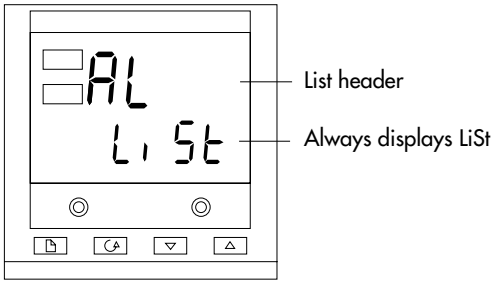
Adaptive tune should not be used:
1. Where the process is subjected to regular external disturbances that could mislead the adaptive tuner.
2. On highly interactive multiloop applications. However, moderately interactive loops, such as multi-zone extruders, should not give a problem.

PARAMETERS AND HOW TO ACCESS THEM

Parameters are settings within the controller that determine how it will operate. For example, alarm setpoints are parameters that set the points at which alarms will occur. For ease of access, the parameters are arranged in lists as shown in the navigation diagram on the following page. The names of these lists are called the *list headers*. The lists are:

Home list	PID list	Communications list
Run list	Motor list	Information list
Programmer list	Setpoint list	Access list.
Alarm list	Input list	
Autotune list	Output list	

Each list has a 'List Header' display.



Typical list header display

A list header can be recognized by the fact that it always shows 'Li St' in the lower readout. The upper readout is the name of the list. In the above example, AL indicates that it is the Alarm list header. List header displays are read-only.

To step through the list headers press [ ]. Depending upon how your controller has been configured, a single press may momentarily flash the display units. In this case, a double press will be necessary to take you to the first list header. Continued pressing of [ ] will step through the list headers eventually returning you to the **Home** display.

To step through the parameters within a particular list, press [ ]. When you reach the end of the list, you will return to the list header. From within a list you can return to the list header at any time can by pressing [ ]. To step to the next list header, press [ ] once again.

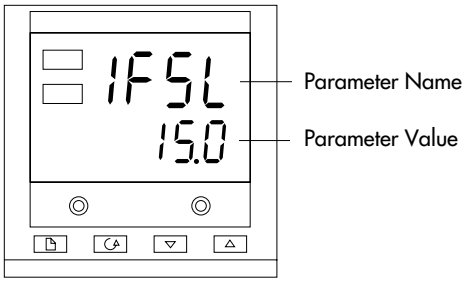
PARAMETER NAMES

In the navigation diagram, each box depicts the display for a selected parameter. The upper readout shows the name of the parameter and the lower readout its value. The Operator parameter tables later in this chapter list all the parameter

names and their meaning.

The navigation diagram shows all the parameters that can, *potentially*, be present in the controller. In practice, only those associated with a particular configuration will appear.

The shaded boxes in the diagram indicate parameters that are hidden in normal operation. To see all the available parameters, you must select Full access level. For more information about this read section 7.1.3, *Access Levels.*



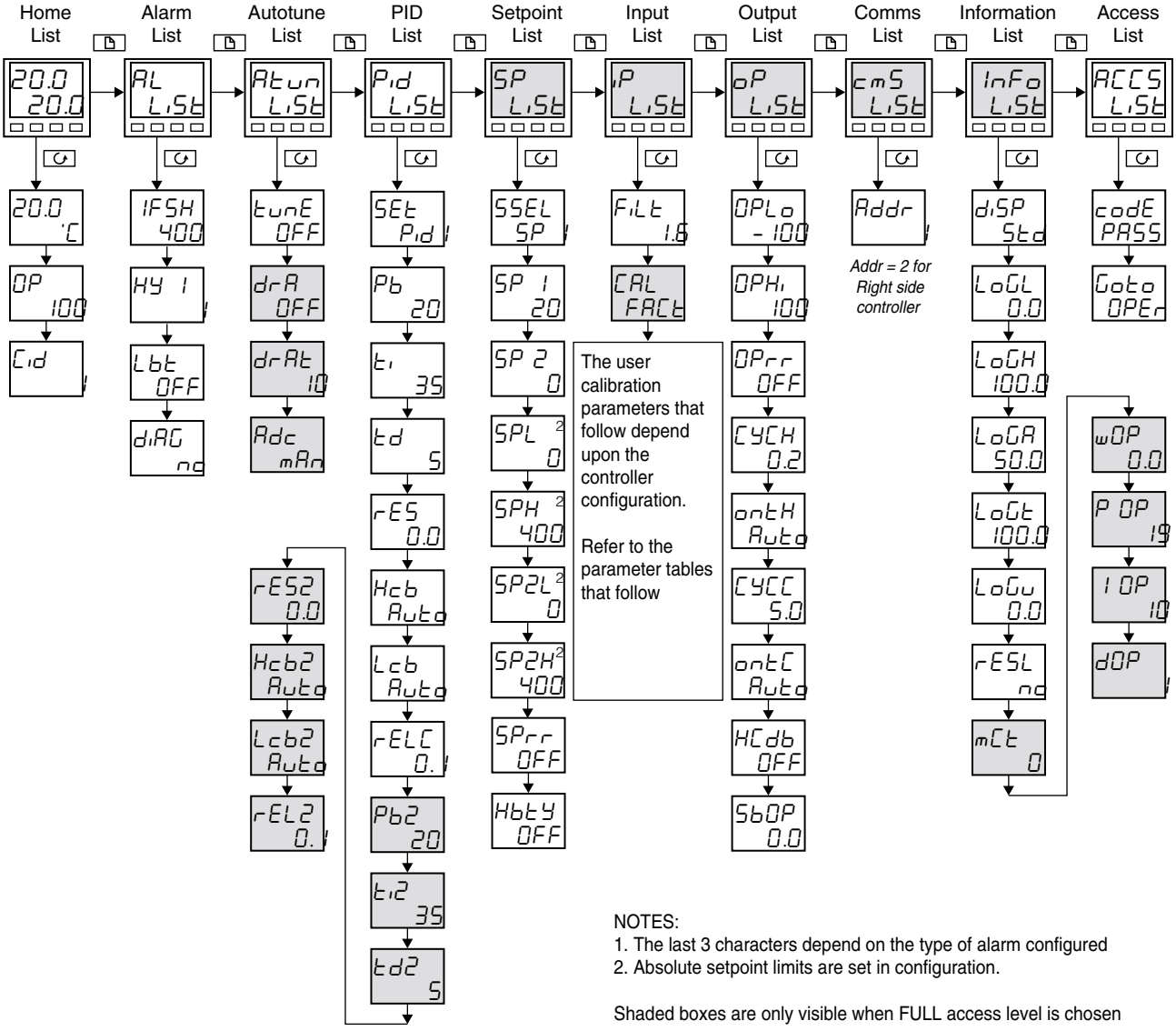
Typical parameter display

Parameter displays show the controller's current settings. The layout of parameter displays is always the same: the upper readout shows the parameter name and the lower readout its value. Alterable parameters can be changed using ▲ or ▼. In the above example, the parameter mnemonic is IFSL (indicating *Alarm 1, full scale low),* and the parameter value is 10.0.

TO CHANGE THE VALUE OF A PARAMETER

First, select the required parameter. The parameter name is shown in the upper readout and the parameter value in the lower readout.
To change the parameter value, press either ▲ or ▼. During adjustment, single presses change the value by one digit.
Keeping the button pressed speeds up the rate of change.
Two seconds after releasing either button, the display blinks to show that the controller has accepted the new value.

OPERATION PARAMETERS DIAGRAM



NOTES:
1. The last 3 characters depend on the type of alarm configured
2. Absolute setpoint limits are set in configuration.

Shaded boxes are only visible when FULL access level is chosen

7.1.2 PARAMETER TABLES

HOME LIST

NAME	DESCRIPTION
	Home list *Extra parameters may be present if promote feature has been used.*
Home	Measured value and Setpoint
OP	% Output level
SP	Target setpoint (if in Manual mode)
m-A	Auto-man select
AmPS	Heater current (With PDSIO mode 2)
C.id	Customer defined identification number

PROGRAM RUN LIST

NAME	DESCRIPTION
run	**Program run list** -*Present only in setpoint programming controllers*
PrG	Active program number (Only on 4 program versions)
StAt	Program status (OFF, run, hoLd, HbAc, End)
PSP	Programmer setpoint
CyC	Number of cycles remaining in the program
SEG	Active segment number
StyP	Active segment type
SEGt	Segment time remaining in the segment units
tGt	Target setpoint
rAtE	Ramp rate (if a rate segment)
PrG.t	Program time remaining in hours
FASt	Fast run through program (no / YES)
out.n	Event output states (OFF / on) (not 8-segment programmer)
SYnc	Not operational in 2416. Set to no.
SEG.d	Flash active segment type in the lower readout of the home display (no / YES)

PROGRAM EDIT LIST

NAME	DESCRIPTION
PrOG	**Program edit list** -*Present only in setpoint programming controllers*
PrG.n	Select program number (Only on 4 program versions)
Hb	Holdback type (OFF, Lo, H, or bAnd)
Hb U	Holdback value (in display units)
rmP.U	Ramp units_(SEc, min, or Hour) [for both rmP.r and rmP.t- type segments]
dwL.U	Dwell units (SEc, min, or Hour)
CYC.n	Number of program cycles (1 to 999, or 'cont')
SEG.n	Segment number
TYPE	Segment type:(End) (rmP.r=ramp rate) (rmP.t=ramp time) (dwEll) (StEP) (cALL)

The following parameters depend on the tYPE selected, as shown below.

	End	rmP.r	rmP.t	dwEll	StEP	cALL	
Hb		✔	✔	✔	✔		Holdback type: OFF Lo Hi or bAnd
tGt		✔	✔		✔		Target setpoint for a rmP or StEP segment
rAtE		✔					Ramp rate for a rmP.r segment
dur			✔	✔			dwEll time / time to target for a rmP.t segement
PrG.n						✔	cALLed PrOGram number
cYc.n						✔	No. of cycles of cALLed program
outn	✔	✔	✔	✔	✔		Event output: OFF/on (not 8-segment programmer)
sync		✔	✔	✔	✔		Not operational in 2416. Set to no.
End.t	✔						End of prog - dwEll, FSEt, SOP
Pwr	✔						Power level in end segment

ALARM LIST

NAME	DESCRIPTION
	Alarm list:
1- - -	Alarm 1 setpoint value
2 - - -	Alarm 2 setpoint value
3 - - -	Alarm 3 setpoint value
9 - - -	Alarm 4 setpoint value
In place of dashes, the last three characters indicate the alarm type as follows: [*Note: It is possible to indicate only up to four alarm conditions (known as soft alarms). They can be "wired" to operate relays within the limitations of the number of output modules available.*]	
-FSL	PV Full scale low alarm
-FSH	PV Full scale high alarm
-dEu	PV Deviation band alarm
-dHi	PV Deviation high alarm
-dLo	PV Deviation low alarm
-LCr	Load Current low alarm
-HCr	Load Current high alarm
-FL2	Not available in 2416
-FH2	Not available in 2416
-LOP	Working Output low alarm
-HOP	Working Output high alarm
-LSP	Working Setpoint low alarm
-HSP	Working Setpoint high alarm
4rAt	Rate of change alarm (AL 4 only)
HY 1	Alarm 1 Hysteresis (display units)
HY 2	Alarm 2 Hysteresis (display units)
HY 3	Alarm 3 Hysteresis (display units)
HY 4	Alarm 4 Hysteresis (display units)
Lbt	Loop Break Time in minutes
diAG	Enable Diagnostic alarms 'no'/YES'

AUTOTUNE LIST

NAME	DESCRIPTION
AtUn	**Autotune list**
tunE	One-shot autotune enable
drA	Adaptive tune enable
drA.t	Adaptive tune trigger level in display units. Range = 1 to 9999
Adc	Automatic Droop Compensation (PD control only)

PID LIST

NAME	DESCRIPTION	
Pid	**PID list**	
G.SP	If Gain Scheduling has been enabled, this parameter sets the PV below which Pid.1 is active and above which Pid.2 is active.	
SEt	Pid.1 or Pid.2 selected	(SEt 1)
Pb	Proportional Band (in display units)	(SEt 1)
ti	Integral Time in secs	(SEt 1)
td	Derivative Time in secs	(SEt 1)
rES	Manual Reset (%)	(SEt 1)
Hcb	Cutback High	(SEt 1)
Lcb	Cutback Low	(SEt 1)
rEL.C	Relative Cool Gain	(SEt 2)
Pb2	Proportional Band	(SEt 2)
ti2	Integral Time in secs	(SEt 2)
td2	Derivative Time in secs	(SEt 2)
RES.2	Manual Reset	(SEt 2)
Hcb2	Cutback High	(SEt 2)
Lcb2	Cutback Low	(SEt 2)
REL.2	Relative Cool Gain	
The following three parameters are used for cascade control. If this facility is not being used, then they can be ignored.		
FF.Pb	SP, or PV, feedforward propband	
FF.tr	Feedforward trim %	
FF.du	PID feedforward limits ± %	

SETPOINT LIST

NAME	DESCRIPTION
SP	**Setpoint list**
SSEL	select SP 1 to SP 16, depending on configuration
L-r	Local (Loc) or remote (rmt) setpoint select
SP 1	Setpoint one value
SP 2	Setpoint two value
rm.SP	Remote setpoint value
rmt.t	Remote setpoint trim
rAt	Ratio setpoint
Loc.t	Local setpoint trim
SP L	Setpoint 1 low limit
SP H	Setpoint 1 high limit
SP2.L	Setpoint 2 low limit
SP2.H	Setpoint 2 high limit.
SPrr	Setpoint Rate Limit
Hb.tY	Holdback Type for setpoint rate limit (OFF, Lo, Hi, or bAnd)
Hb	Holdback Value for setpoint rate limit in display units. (Hb.tY ≠OFF)

INPUT LIST

NAME	DESCRIPTION
iP	**Input list**
FiLt	IP filter time constant (0.0 - 999.9 seconds).
The next 3 parameters appear only if User Calibration has been enabled. By default they are hidden when in Operator level. To prevent unauthorized adjustment, we recommend that they are only made available in FuLL access level.	
CAL	FACt- reinstates the factory calibration and disables User calibration. Next 2 parameters will not appear. USEr - reinstates any previously set User calibration. All parameters below now appear.
CAL.S	Selected calibration point – nonE, iP iL, iP iH
AdJ*	User calibration adjust, if CAL.S = iP iL, iP iH
OFS.1	IP calibration offset
mU.1	IP measured value (at terminals)
CJC.1	IP Cold Junction Compensation
Li.1	IP Linearised Value
PU.SL	PV Select. Not operational in 2416

OUTPUT LIST

NAME	DESCRIPTION
OP	**Output list**
Does not appear if Motorised Valve control configured.	
OP.Lo	Low power limit (%)
OP.Hi	High power limit (%)
Oprr	Output Rate Limit (% per sec)
FOP	Forced output level (%) -
CYC.H	Heat cycle time (0.2S to 999.9s)
hYS.H	Heat hysteresis (display units)
ont.H	Heat output min. on-time (secs) Auto (0.05S), or 0.1 - 999.9S
CYCC	Cool cycle time (0.2S to 999.9S)
hYS.C	Cool hysteresis (display units)
ont.C	Cool output min. on-time (secs) Auto (0.05S), or 0.1 - 999.9S
HE.db	Heat/cool deadband (display units)
Sb.OP	Sensor Break Output Power (%)

INFORMATION LIST

NAME	DESCRIPTION
inFo	**Information list**
diSP	Configure lower readout of Home display to: nonE, Std, Lcur, OP, StAt, PrG.t
LoG.L	PV minimum
LoG.H	PV maximum
LoG.A	PV mean value
LOG.t	Time PV above Threshold level
LoG.u	PV Threshold for Timer Log
rES.L	Logging Reset –'YES/no'
The following set of parameters is for diagnostic purposes.	
mCt	Processor utilisation factor
w.OP	Working output
FF.Op	Feedforward component of output
UO	PID output to motorised valve
P OP	Proportional component of output
IOP	Integral component of output
d OP	Derivative component of output

ACCESS LIST

NAME	DESCRIPTION
ACCS	**Access List**
codE	Access password
Goto	Goto level-OPEr, FuLL, Edit or conF
ConF	Configuration password

COMMUNICATION LIST

NAME	DESCRIPTION
cmS	**Comms list**
Addr	Communications Address

7.1.3 ACCESS LEVELS

This chapter describes the different levels of access to the operating parameters within the controller.

THE DIFFERENT ACCESS LEVELS

There are four access levels:

- **Operator level**, which you will normally use to operate the controller.
- **Full level**, which is used to commission the controller and the process being controlled.
- **Edit level**, which is used to set up the parameters that you want an operator to be able to see and adjust when in Operator level.
- **Configuration level**, which is used to set up the fundamental characteristics of the controller.

Access level	Display shows	What you can do	Password Protection
Operator	OPEr	In this level, operators can view and adjust the value of parameters defined in Edit level (see below).	No
Full	FuLL	In this level, all the parameters relevant to a particular configuration are visible. All alterable parameters may be adjusted.	Yes
Edit	Edit	In this level, you can determine which parameters an operator is able to view and adjust in Operator level. You can hide, or reveal, complete lists, individual parameters within each list and you can make parameters read-only or alterable. (See Edit level at the end of this chapter).	Yes
Configuration	conF	This special level allows access to set up the fundamental characteristics of the controller.	Yes

Access levels list

SELECTING AN ACCESS LEVEL

Access to Full, Edit or Configuration levels is protected by a password to prevent unauthorised access.

ACCESS LIST HEADER

Press [ ] until you reach the access list header 'ACCS'.

Press [ ]

PASSWORD ENTRY

The password is entered from the 'codE' display. Enter the password using ▲ or ▼. Once the correct password has been entered, there is a two second delay after which the lower readout will change to show 'PASS' indicating that access is now unlocked.
The pass number is set to '1' when the controller is shipped from the factory.

Note; A special case exists if the password has been set to '0'. In this case access will be permanently unlocked and the lower readout will always show 'PASS'.

Press [ ] to proceed to the Gotopage.

(If an *incorrect* password has been entered and the controller is still 'locked' then pressing [ ] returns you to the 'ACCS' list header.)

ACCESS TO READ-ONLY CONFIGURATION

From this display, pressing ▲ and ▼ together will take you into Read-Only

Configuration without entering a password. This will allow you to view all of the configuration parameters, but not adjust them. If no button is pressed for ten seconds, you will be returned to the Home display. Alternatively, pressing [↻] and [📄] together takes you immediately back to the Home display.

LEVEL SELECTION

The GotO display allows you to select the required access level.
Use ▲ and ▼ to select from the following display codes:

- OPEr: Operator level
- FuLL: Full level
- Edit: Edit level
- conF: Configuration level

Press [↻]

If you selected OPEr, FuLL, or Edit level you will be returned to the ACCS list header in the level that you chose. If you selected conF, you will get a display showing 'ConP in the upper readout (see below).

CONFIGURATION PASSWORD

When the ConF display appears, you must enter the Configuration password in order to gain access to this level. Do this by repeating the password entry procedure described in the previous section. The configuration password is set to 2 when the controller is shipped from the factory.

Press [↻]

CONFIGURATION LEVEL

Contact DACA Instruments about changing the configuration of the controller.

RETURNING TO OPERATOR LEVEL

To return to operator level from either FuLL or Edit level, repeat entry of the password and select OPEr on the GotO display.
In Edit level, the controller will automatically return to operator level if no button is pressed for 45 seconds.

EDIT LEVEL

Edit level is used to set which parameters you can view and adjust in Operator level. It also gives access to the 'Promote' feature, which allows you to select and add ('Promote') up to twelve parameters into the Home display list, thereby giving simple access to commonly used parameters.

SETTING OPERATOR ACCESS TO A PARAMETER

First you must select Edit level, as shown on the previous page.
Once in Edit level, you select a list, or a parameter within a list, in the same way as you would in Operator, or Full, level - that is to say, you move from list header to list header by pressing [📄], and from parameter to parameter within each list using [↻].
However, in Edit level what is displayed is not the value of a selected parameter, but a code representing that parameter's availability in Operator level.
When you have selected the required parameter, use ▲ and ▼ buttons to set its availability in Operator level.

There are four codes:

- ALtr Makes a parameter alterable in Operator level.
- Pro Promotes a parameter into the Home display list.
- rEAd Makes a parameter, or list header, read-only (it can be viewed but not altered).

HIdE Hides a parameter, or list header.

HIDING OR REVEALING A COMPLETE LIST

To hide a complete list of parameters, all you have to do is hide the list header. If a list header is selected, only two selections are available: rEAd and HIdE. (it is not possible to hide the ACCS list, which always displays the code: to LISt.)

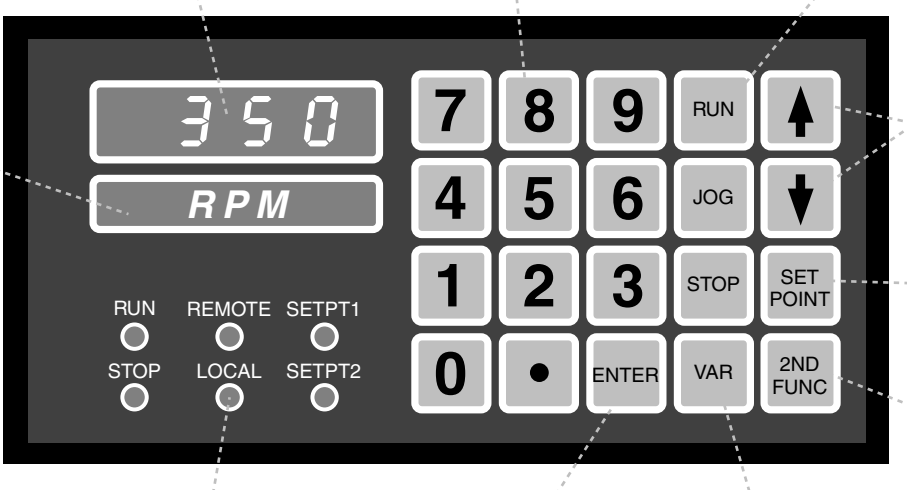
PROMOTING A PARAMETER

Scroll through the lists to the required parameter and choose the Pr0 code. The parameter is then automatically added (promoted) into the Home display list. (The parameter will also be accessible, as normal, from the standard lists.) A maximum of twelve parameters can be promoted. Promoted parameters are automatically 'alterable'. Please note, in the Pr0G LIST the parameters from segment number (SEG.n) onwards *cannot* be promoted.

CALIBRATION AND CONFIGURATION

For additional information on calibration and configuration of the temperature controller, please contact DACA Instruments.

7.2 SPEED CONTROLLER



4-Digit, 7-Segment LED Numeric Display: Displays Variable Values and Length Set Point

Numeric Keypad: Used for Entering Speed Set Points and Variables

Run, Jog, and Stop: Control Motor Run, Motor Jog (for Setup), and motor Stop

8-Character Alphanumeric Display: Displays Current Operating Mode or Identifies the Variable Being Programmed

Up/Down Arrows: Allow User to Scroll Through Menu Items and Set Points

Set Point: Used to Enter Motor Operating Speed in Desired User Units

2nd Function: Used for Diagnostic Tests

LED Indicator Lights: Indicate Critical Operating Information

Enter: Moves Data Entries into Memory

Variable: Used to Enter and Exit the Change Variable Mode

IMPORTANT:

The MicroSpeed 196 is factory set for REMOTE MODE to allow computer control of the MicroCompounder. In this mode the VAR, 2ND FUNC, and JOG keys are NOT accessible from the front panel. In order to access theese the keys and change any parameters, the unit must be changed to LOCAL MODE by changing a small switch located on the back of the MicroSpeed 196. Remove the right side cover of the control box to locate the small white switch on the back of the MicroSpeed. *Computer control will not be possible when the MicroSpeed is set to Local mode.*

PROGRAMMING THE VARIABLES

The MicroSpeed 196 is programmed by entering data into a menu of variables. Only the variables that affect operation of the unit as it relates to the application must be programmed. Upon power up, the MicroSpeed. 196 will display **READY** on the alphanumeric display. This indicates that the MicroSpeed 196 is ready for operation or programming. To program a variable, press **VAR** on the front panel keypad. The alphanumeric display will prompt for a variable number, and the numeric display will indicate two zeros (00), which will reflect the variable number entered. Enter the desired variable number and press **ENTER**. If you are unsure of the variable, the ▲ and ▼ keys on the keypad will allow you to scroll through the menu of variables. As you scroll, the numeric display will indicate the number of the variable, and the alphanumeric display will name the variable. Press **ENTER** when the desired variable is displayed.

When the variable to be programmed is accessed, enter data using the numeric keys, and then press **ENTER**.

Note: A decimal point cannot lead an entry; the decimal place must be preceded by a zero (0).

After E**NTER** is pressed, the display will ask for another variable number. If there is no other variable data to be entered, press the **VAR** key to return to the **READY** mode.

LIST OF VARIABLES

Reference Variables: These variables tell the MicroSpeed 196 how to control the motor, and can be changed in READY mode only:

01 Maximum RPM
02 User Units at Maximum RPM
03 Feedback Pulses per Revolution
04 Maximum Lead RPM (Follower)
05 Lead Pulses Per Revolution (Follower)
23 User Unity Ratio (Follower)

Operational Variables:
06 Jog Speed in User Units
07 Acceleration Time
08 Deceleration Time
10 User Unit Label
11 Keypad Lockout Selection
21 Display Selection
22 Follower Display Selection
29 Jog Ramp Selection

Control Loop Variables: These variables tell the control how to correct for speed errors:
09 Maximum Lead Wind-up (Follower)
12 Gain - P
13 Reset - I
14 Rate - D

Status and Alarm Outputs:
15 High Alarm
16 Low Alarm
17 Deviation Alarm (Follower)
18 Drive Enable

Auxiliary Mode Variables: Allows for a third frequency, i.e., dancer systems, to trim the Follower mode ratio:
24 Auxiliary Mode Selection
25 Auxiliary Reference Frequency
26 Auxiliary Gain Percentage
27 Auxiliary Trim Selection
28 Auxiliary Input Delay

PROGRAMMING REFERENCE VARIABLES

Program the following variables when using the MicroSpeed 196 in any mode. (These are the only required variables if the MicroSpeed 196 will be used exclusively in Master mode.) After programming the variables, go to Section "TUNING THE MICROSPEED 196."

Variable 01 - Maximum RPM - This number represents the revolutions per minute of the shaft on which the feedback sensor is mounted, when the MicroSpeed 196 is running the motor at maximum operating speed. (for MC: 350)

Note: The drive system must be able to run 10% faster than the value programmed into Variable 01 (maximum rpm.)

Variable 02 - User Units at Maximum RPM - This number will set up the

MicroSpeed 196 to translate rpms to units of production that are more appropriate to the user, such as "Feet per Minute," or "Gallons per Hour," etc. The Speed Set Points and the linear tach display will then be relative to the operation. To use this variable, first determine the value of the user units at maximum rpm. If the rpm of the monitored shaft is desired, enter the same value as Variable 01. Otherwise, you must calculate the user unit at the speed entered into Variable 01. Or you can enter the same value as Variable 01, run at that speed, measure the actual units, and then enter the measured value. Use Variable 10 to program the alphanumeric display to show the appropriate user unit, i.e., FPM, GPM, GPH, etc. (see Section, "PROGRAMMING OPERATIONAL VARIABLES" in this manual for details and the list of display options. (for MC: 350)

Variable 03 - **Feedback Pulses Per Revolution** - This is the number of digital pulses produced by the feedback sensor on the monitored shaft for each shaft revolution. (for MC: 115)
Note: Variable 03 will not accept decimals, the entry must be a whole number.

PROGRAMMING OPERATIONAL VARIABLES

Variable 07 - **Acceleration Time** - When the acceleration time is accessed, the alphanumeric display will read AcelTime. Enter the time in seconds desired for acceleration from 0V (motor stop) to maximum output. The smallest unit of time is 1/10 second.

Variable 08 - **Deceleration Time** - When the deceleration time is accessed, the alphanumeric display will read DcelTime. Enter the time in seconds for deceleration from maximum output to 0V (motor stop). The smallest unit of time is 1/10 second.

Variable 11 - **Keypad Lockout** - When Variable 11 is accessed, the alpha-numeric display will read Key Lock. Each zero represents a different section of the keypad that can be independently "locked." The section of the keypad that is locked is determined by placing a I (one) in the appropriate location. Any section or combination of sections can be locked. (See chart below for lockout positions and descriptions.) After all programming and tuning is complete, activate the lock out by installing a jumper on TB1- 12 to TB1- 11 -

Note: It is recommended that you "lock out" your variables, so that the MicroSpeed 196 cannot be inadvertently reprogrammed.

Positions: 0 0 0 0 (Unlocked)
1 1 1 1 (Locked)

- **VAR** key and **2ND FUNC** Key
- **SET SPEED** Key
- ▲ and ▼ Keys
- **RUN**, **STOP**, and **JOG** Keys

Variable 21 - **Display Selection** - This Variable allows the user to select the information that will be displayed on the Numeric display. Mode 0000 is commonly used in normal operation, while modes 0001 through 0007 are typically used during setup or troubleshooting only. When Variable 21 is selected, the alphanumeric display will read **Display#**. To select the numeric display mode during operation, enter a number from the following list:

0000 = Tachometer in User Units
0001 = Feedback Frequency in Hertz or Kilohertz
0002 = Lead Frequency in Hertz or Kilohertz (Follower)

0003 = Auxiliary Frequency in Hertz (Auxiliary Mode)
0004 = Follower Error in Number of Pulses
0005 = Total Output in DAC Bits (0 to 4094)
0006 = Output Error in DAC Bits (-999 to 4094)
0007 = Alarms (a "1" Indicates the alarm is active)
1000 = Zero Speed
0100 = High Alarm
0010 = Low Alarm
0001 = Deviation Alarm

Variable 10 - **User Unit Label** - This variable allows the user to select what the alphanumeric display will display during normal operation -when the display is in Tach in User Units mode. The default label is **RPM**. To program Variable 10, enter the code that corresponds to the desired user unit label from the table below.

MicroSpeed User Unit Labels

0 - RPM	1 - FPM	2- GPM
3 - REV/SEC	4 - REV/MIN	5 - REV/HR
6- INCH/SEC	7- INCH/MIN	8- INCH/HR
9- FEET/SEC	10- FEET/MIN	11 - FEET/HR
12 - YARD/SEC	13 - YARD/MIN	14 - YARD/HR
15 - MM/SEC	16 - MM/MIN	17 - MM/HR
18- CM/SEC	19- CM/MIN	20- CM/HR
21 - MET/SEC	22- MET/MIN	23- MET/HR
24- OZ/SEC	25- OZ/MIN	26- OZ/HR
27- GAL/SEC	28- GAL/MIN	29- GAL/HR
30 - ML/SEC	31- ML/MIN	32- ML/HR
33- LIT/SEC	34- LIT/MIN	35- LIT/HR
36- HERTZ	37- KHERTZ	38- MHZ
39- BOT/SEC	40- BOT/MIN	41- BOT/HR
42- CAN/SEC	43- CAN/MIN	44- CAN/HR
45- LBS/SEC	46- LBS/MIN	47- LBS/HR
48- TURN/SEC	49 - TURN/MIN	50 - TURN/HR
51 - THRD/SEC	52 -. THRD/MIN	53 - THRD/HR
54- PART/SEC	55 - PART/MIN	56 - PARTS/HR
57- Percent%	58 - RATIO%	65 - Customized

STATUS AND ALARM OUTPUTS

Variable 18 - **Drive Enable** - This output is designed to give the MicroSpeed 196 control of the **Run/Stop** input on the controlled drive or other MicroSpeed 196's, based on the conditions it is monitoring. Drive Enable is actuated when **RUN** or **JOG** is pressed, and is deactivated automatically when **E-Stop** is pressed, or upon loss of power, thus disabling the drive. Drive Enable will perform one of the following options when a normal **STOP** command is given.

The following options can be entered into Variable 18: (for MC: 0003)

Variable 18 - **0001** The Drive Enable output waits for the Command Output Voltage to reach 0V (zero) before disabling the drive.

Variable 18 - **0002** The Drive Enable output waits for the Command Output Voltage to reach 0V (zero) and for the Feedback frequency to reach 0Hz (zero) before disabling the drive.

Variable 18 - **0003** The Drive Enable output immediately disables the drive upon a STOP command, and the Analog Output goes to zero (0) immediately.

Note: Disabling the drive prevents any motor creep or other unwanted motor movement when the motor is stopped.

Variable 15 - **High Alarm** - This output is activated if the speed of the monitored shaft exceeds the value programmed. When High Alarm is accessed, the alphanumeric display will read "Hi Alarm". Enter the speed in user units above which the High Alarm output will be activated.

Variable 16 - **Low Alarm** - This output is activated if the speed of the monitored shaft drops below the level of the number entered in this variable. When the Low Alarm is accessed, the alphanumeric display will read "Lo Alarm". Enter the speed in user units under which the Low Alarm output will be activated.

Variable 17 - **Deviation Alarm** - This output is active in the Follower mode only, and is programmed in revolutions of the follower feedback sensor. No decimal points are allowed in this entry. The output will activate if the follower feedback sensor deviates ahead or behind the lead shaft exceeding the programmed revolutions.

TUNING THE MICROSPEED 196

CALIBRATING THE ISOLATED COMMAND OUTPUT TO THE DRIVE:

1. Program the MicroSpeed 196 variables.

Note: The MicroSpeed 196 must be in local mode and Variable 03 PPR must be programmed.

2. Select the proper polarity of the Command Output Voltage using the Forward/ Reverse Input. (Open = Positive; Closed = Negative)

3. Access Diagnostic 9 (Digital Potentiometer) by pressing 2nd Function key, then the 9 key. The alphanumeric display will read **Pot % 00**.

4. Adjust the Zero Offset potentiometer (located on the back of the MicroSpeed 196 clockwise (or counterclockwise if reverse is selected), until the motor begins to creep, then back off until it stops creeping.

5. Press and hold the ▲ key until the alphanumeric display reads **Pot % 90**. The numeric display will be showing motor speed in RPM. Adjust the Output Span potentiometer (cw increases, ccw decreases) until the rpm displayed in the numeric display is equal to the maximum rpm programmed in Variable 01.

Note: The drive and motor are set up to run at maximum speed while the MicroSpeed 196 is providing 90% Command Outputs, so that 10% Command Authority will be available to compensate for slowdown caused by loading, etc., when the motor is running at maximum set point.

6. Press and hold the ▼ key until the alphanumeric display reads **Pot % 00**.

7. Press **2ND FUNC** to exit the Digital Potentiometer mode.

FUNCTION AND TUNING OF THE PID VARIABLES:

The PID Variables make up the difference between the Expected Analog Output and the Required Analog Output. The Expected Analog Output is based on a linear relationship of 0–90% Command Output equal to 0–100% of the maximum speed entered into Variable 01. The Required Analog Output is the actual Command Output necessary to maintain the correct speed. A 0–100%

Command Output is equal to 0–4094 DAC bits.

IMPORTANT! Higher values in the PID Variables result in a faster correction time and a tighter motor speed control. If the difference between the Expected Output and the Required Output is extreme, the MicroSpeed 196 will begin changing its output in the wrong direction, before the increasing error allows the PID Variables to overcome this. Therefore, adjusting the output to the drive is very important.

PID VARIABLES:

Variable 12 - (P) Proportional (or Gain) - Gain is the most active and important tuning Variable. The Gain correction takes place every .01 seconds. A higher value entered in this Variable (a number between 1 and 100) results in a faster change in the Command Output to correct for error and, therefore, tighter motor control.

In the Master mode, the correction amount is based on the formula:

Percent error from the desired speed x Gain number x the last DAC value x a constant.

In Master Mode, the correction is limited to 25% of the total output per 10 msec cycle.

Variable 13 - (I) Integral (or Reset) - The Integral operates as a long term correction. It will add or subtract one DAC bit based on a positive or negative error. If the Integral error is set at 100, this will happen every 20 msec. Each whole number below 100 will add 10 msec to the loop time this bit is added.

Variable 14 - (D) Derivative (or Rate) - The Derivative operates as a boost to the Gain (Variable 12). Its function is to reduce the time it takes to eliminate a large error. In Master mode, it operates identically to the Gain, except it has only half the authority to change the output. In Follower mode, it operates identically to the Gain with the same authority, but is only active when the error is greater than one Follower Feedback Sensor revolution.

STEPS TO TUNE THE PID VARIABLES:

Note: Before beginning PID tuning, be sure that the Command Output has been calibrated to the drive, and that all ACCEL and DECEL adjustments on the drive have been set to their minimum positions. Failure to make these adjustments will degrade the accuracy of the control.

1. Set Variable 13 (I) and Variable 14 (D) to zero (0).

2. Start the motor and set the speed to run at the most common operating speed.

3. Begin increasing the Gain (Variable 12) until instability (over and under-shooting) occurs. At this point, decrease the Gain until the motor stabilizes. The motor should now be operated at different speeds throughout the operation range to ensure stability.

4. Begin adding Integral (Variable 13) into the control loop. Keep increasing this number until the motor begins to hunt above and below the Set Point, then back off the number until the hunting stops.

5. Derivative (Variable 14) can then be activated. Again, increase the value until instability occurs and then back off. The most common value is usually from 50 - 100% of the value in the GAIN 'Variable.

6. Run the motor at all operating speeds to ensure stability. If instability occurs, retune the PID parameters at the unstable speed.

DIAGNOSTIC TESTS AND 2ND FUNCTION KEY

To access the Diagnostics and 2nd Functions, the unit must be in the "Ready" mode, press **2ND FUNC**, then enter the number of the diagnostic test desired. To exit the diagnostic test, press **2ND FUNC** again.

Diag. 0 - **Custom User Label Programming** - THIS IS NOT A TEST! PLease contact DACA Instruments for information.

Diag. 1 - **Keypad Test** - In this test, pressing each key on the front panel keypad will result in the alphanumeric display showing the name of the key pressed. The numeric display will show 0000 for keys that are not numbers, and will display the numeral (for example: 1111, 2222, etc.) when the number keys are pressed. If any key does not produce the proper display, that key may not be functioning. Contact the factory if this occurs.

Diag. 2 - **Display Test** - This test is to make sure that all of the LED segments on the displays and all of the LED indicator lights are working correctly. During the test, the Numeric display will scroll through all the numbers (i.e. 1111, 2222, 3333, etc.) and will place the decimal point in each possible location. The alphanumeric display will also display all of the numbers (i.e. 11111111, 22222222, etc.). The six LEDs on the front of the unit indicating switch position and operating condition will light up one at a time. If a segment is missing, or an LED indicator light fails, contact the factory.

Diag. 3 - **Input Switch Test** - This is a test for each of the remotely wired inputs. Each possible input (Local/Remote, Keypad Lockout, Forward/ Reverse, etc.) is represented by a 0 or a 1 on the alphanumeric display. The E-Stop, Run, Jog, and Stop inputs are represented by a 0 or a 1 on the speed display. Toggle the input to check whether or not it is properly wired. When the digit corresponding to that input is displayed as 0 the switch is Open, when it is displayed as 1 it is activated. E-Stop and Stop are 1 when opened and 0 when closed. Left to right, the eight digits on the alphanumeric display (00000000) correspond to the following inputs: Closed/Open Loop; Master/Follower; Forward/Reverse; Keypad Unlocked/Locked out; Set Point 1(3)/2(4); Set Point 3 & 4 Disabled/Set Point 3 & 4 Enabled; No Scroll/Scroll Down; No Scroll/ Scroll Up. Left to right, the four digits on the numeric display (0000) correspond to the following command inputs: E-Stop; Run; Jog; Stop.

Diag. 4 - **Memory Test** - This is an internal test by the micro-processor on its memory locations. The alphanumeric display will show "Test ROM" for a few seconds, then it will show either, "ROM ok" or "Fail." If the test fails, contact the factory.

Diag. 5 - **Alarm Output Test** - This is a test of the Status and Alarm outputs. In this test, pressing a I through 6 on the keypad will result in completion of one of the Output circuits. When in this diagnostic, the alphanumeric display will read "Output" until a key (I through 6) is pressed, then it will name the output being tested and the circuit will be completed. A light wired into the circuit will illuminate, a relay will actuate, or an alarm will sound, depending on how the circuit is wired. After an output is tested, press the STOP button to turn the output off. To exit the Diagnostic, press the Stop, then the 2ND FUNC key. The following numbers correspond to the following outputs: I = Ramp Complete; 2 = Zero Speed; 3 = High Alarm; 4 = Low Alarm; 5 = Deviation Alarm; 6 = Drive Enable

Diag. 6 - **Communications Test** - This test is used to test the RS422 hardware. To perform the test, place a jumper wire between the Send and Receive lines at the terminal (RXD- to TXD- and RXD+ to TXD+). The MicroSpeed 196 tests its communication circuitry to make sure it is functioning. If it is, the alphanumeric display will read "Pass" and the numeric display will name the node address. If it is not functioning properly, the alphanumeric display will display "Fail."

Diag. 7 - **Reset to Factory Programming** - THIS IS NOT A TEST! Pressing 2ND FUNC, then accessing Diag. 7 will reset the programming in memory to the factory defaults (see bellow for factory and DACA default settings). The alphanumeric display will read “Reset”.

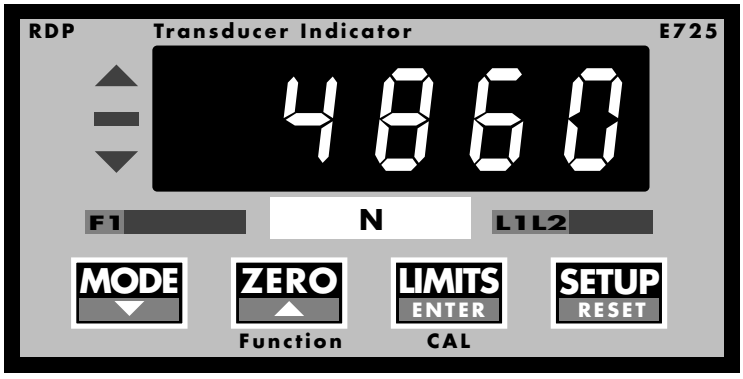
Diag. 8 - Not Used.

Diag. 9 - Digital Speed Pot - This function is explained in Section“Calibrating the Isolated Command Output to the Drive “. It can be used as a test of the analog output.

DEFAULT VARIABLE VALUES AND VARIABLE RECORD

VARIABLE	NAME	DEFAULT	MC VALUE
01	Maximum RPM	1800	360
02	User Units @ Max. RPM	1800	360
03	Feedback PPR	60	115
04	Max Lead RPM	1800	N/A
05	Lead PPR	60	N/A
06	Jog Speed	500	100
07	Accel Time	10	10
08	Decel Time	10	10
09	Max Lead Wind Up Error	100	N/A
10	User Unit Label	00	00
11	Keypad Lockout Selection	0001	0000
12	Gain - P	20	40
13	Reset -1	70	100
14	Rate - D	20	20
15	High Alarm	1500	400
16	Low Alarm	750	390
17	Deviation Alarm	100	NA
18	Drive Enable	01	03
19	Node Address	01	05
20	Baud Rate	02	06
21	Display Selection	0000	0000
22	Follower Display Selection	0000	N/A
23	User Unity Ratio	1.000	N/A
24	Auxiliary Mode Selection	0000	N/A
25	Auxiliary Reference Frequency	2000	N/A
26	Auxiliary Gain Percentage	0010	N/A
27	Auxiliary Trim Selection	0000	N/A
28	Auxiliary Input Delay	0000	N/A
29	Jog Ramp Selection	0010	N/A
30	External Switch Enable in Remote	0000	1111

7.3 Load Indicator



CONTROL KEY FUNCTIONS

The E725 has four membrane keypads with tactile feedback. These keys select and control the functions of the E725. This section concerns itself only with the functions available in the E725's normal operating mode, it does not detail any of the programming or calibration functions.

Key functions. In order to...	**Press...**
Zero the display	ZERO ZERO
Return to calibration zero (clear Zero)	ZERO ZERO & RESET SETUP RESET together
Change display (MAX to MIN to TIR to NORMAL)	MODE MODE
Reset (MAX & MIN & TIR)	MODE MODE & RESET SETUP RESET together
Change function mode (if available)	MODE MODE & FUNC ZERO together
Display shunt cal reading	MODE MODE & CAL LIMITS ENTER together
Reset latched limits	LIMITS LIMITS ENTER & RESET SETUP RESET together

PROGRAMMING

Programming overview

Various features of the E725 are user programmable. This section of the manual outlines the general approach to programming and describes some specific programming steps.

Reading this section enables the user to access menus, enter numbers, select items and program some specific features.

MENU ACCESS

Programming procedure is based on a menu approach. There are three menus, these are called the CONFIGURATION, CALIBRATION and LIMITS menus.

Access to the menus is protected by three passwords. Each password is in fact a five digit number (i.e. five digits including leading zeros). The passwords are called P1, P2 and P3.

The factory default values and access provided by each password are as follows:

Password	Default	Access
P1	00001	LIMITS menu only
P2	00002	CALIBRATION and LIMITS menus
P3	00003	CONFIGURATION, CALIBRATION and LIMITS menus

It should be noted that the procedure for accessing the CONFIGURATION, CALIBRATION and LIMITS menus is almost identical for each menu. The only difference is the password which the user chooses to enter.

Each menu offers several items, which allow particular features to be programmed. Once a menu has been accessed, the user can step forwards and backwards through that menu making particular items appear on the display. Once an item is displayed it can be selected to allow a feature to be programmed.

The structure of CONFIGURATION, CALIBRATION and LIMITS menus is shown in Section 6.8, The CONFIGURATION menu automatically leads in to the CALIBRATION menu which, in turn automatically leads in to the LIMITS menu. In this way the CONFIGURATION menu gives full access to all user-programmable features.

EXAMPLE A

To access a menu from the unit's normal operating mode, press the **SETUP** key for at least one second. The display will show the prompt UL 1. Press the ▲ to step through the various options which are:
UL1 User Setup (pasword 00001)
UL2 Calibration and Setup (pasword 00002)
UL3 Configuration, Calibration and Setup (pasword 00003)
When the required level is displayed, Press ENTER. The display will show a number entry prompt (00000 with the last digit flashing). At this point the relevant password should be entered.

NUMBER ENTRY

Certain programming steps require number entry. When number entry is required, the display shows a five-digit number with the last digit flashing.

The password number entry prompt is 00000.

In other cases (for example ENGINEERING OFFSET) any existing value is shown. For example, if the existing value of ENGINEERING OFFSET is 1000, when ENGINEERING OFFSET is selected, the display shows 01000, and the last digit is flashing.

Pressing the ▲ and ▼ keys increases and decreases the flashing digit in the range 0 to 9.

Pressing the **ENTER** key accepts the current digit and causes the next (to the left) digit to flash. The user must enter the required number working from right-to-left across the display. The number contains five digits including leading zeros.

Pressing the **RESET** key at any stage in the number entry process discards changes and restarts the process. The original existing value is displayed with the last digit flashing. This is the only way of moving the flashing digit to the right.

A minus sign is entered with the most significant digit (i.e. the one to the left of the display). When the most significant digit is flashing, pressing the ▲ and ▼ keys increases and decreases the flashing digit in the range -9 to +9.

When the display shows the required new value, this number is entered in one of two ways.

1) If the most significant digit is flashing, pressing the **ENTER** key enters the new value.
2) If any other digit is flashing, pressing the **ENTER** and **RESET** keys together enters the new value. (This alternative simplifies the entry of low values such as 00003, the default value for password P3.)

In both cases the unit accepts the new value and goes to the relevant menu. The display now shows the next item in the relevant menu. In the case of password number entry, if an incorrect password is entered, the unit returns to its normal operating mode.

EXAMPLE B (this is intended to illustrate general points).
To enter the password -00031 from the password number entry prompt.

	DISPLAY SHOWS	ACTION
1	0000<u>0</u>	press ▲ to change digit
2	000<u>0</u>1	press ENTER to step to next digit
3	000<u>0</u>1	press ▲ three times
4	00<u>0</u>31	press ENTER to step to next digit
5	00<u>0</u>31	press ENTER to step to next digit
6	0<u>0</u>031	press ENTER to step to next digit
7	<u>0</u>0031	press ▼ for minus sign
8	-<u>0</u>0031	press ENTER to enter password

(an underlined digit represents a flashing digit)

EXAMPLE C
To enter the password 00003 (factory default value for password p3) from the normal operating mode.

	DISPLAY SHOWS	ACTION
1	numeric data	press SETUP for at least one second
2	[UL1]	press ▲ twice
3	[UL3]	press ENTER to select User Level 3
4	0000<u>0</u>	press ▲ three times
5	0000<u>3</u>	press ENTER & RESET together to enter password and gain access to configuration menu

MENU ITEM SELECTION

When a menu has been accessed the user can make available items appear on the display using the ▲ and ▼.

EXAMPLE D

To step through the configuration menu, having gained access as described in example C.

	DISPLAY SHOWS	ACTION
1	FP	press ▼
2	Edit.P	press ▼
3	Ecn	press ▼
4	GAin	press ▲
5	Ecn	press ▲
6	EditP	press ▲
7	FP	

To select a displayed item, press **ENTER**. The resulting display depends on which item has been selected. The action required once an item is selected depends on the item in question. Examples of selection of items EDIT PASSWORDS and FILTER are given in the following sections.

FILTER

The item FILTER allows the user to adjust the display filter. The display filter acts on the display and serial output, but has no effect on the analogue output. The filter is low pass. It has five possible values corresponding to cut off (-3db) frequencies as shown below.

FILTER VALUE	CUT OFF (-3db) FREQUENCY
FILt.1	100 Hz
FILt.2	75 Hz
FILt.3	50 Hz
FILt.4	25 Hz
FILt.5	**10 Hz**

When this item is selected the user enters a sub-menu comprising the five possible filter -values shown above. ▲ and ▼ allow the user to step through this sub-menu. When the required value is displayed, pressing **ENTER** selects value and exits the sub-menu. Alternatively, pressing **RESET** exits the sub-menu without changing the filter value. In either case the display will then show Ecn (EXCITATION), the next item in the CONFIGURATION menu.

EXAMPLE E

To change filter value from 4 to 5, having gained access to the configuration menu as described in example C.

	DISPLAY SHOWS	ACTION
1	Edit.P	press ▼
2	Filt	press ENTER to select filter
3	FILt.4	press ▲ to change value
4	FILt.5	press ENTER to select value 5
5	Ecn	

RETURNING TO NORMAL OPERATING MODE

When the display is showing any of the items offered in the first level of the CONFIGURATION, CALIBRATION or LIMITS menus, it is possible to return to the normal operating mode by either of two actions.

1 Press **RESET**.

2 Press ▼ the required number of times to step through all items in all menus until the display shows the item run Press **ENTER**.

In both cases the unit will pause for approximately two seconds before returning to the normal operating mode.

Menu map

To access a menu from the unit's normal operating mode, press the setup key for at least one second. The display will show a number entry prompt (00000 with the last digit flashing). At this point the relevant password should be entered.

PASWRD	DISP	MC	MENU ITEM
P3	FP	ON	Switch front panel ON/OFF
	EdiEP	No Change	Edit Passwords
	Ecn	10	Excitation Voltage
	GA In	1	Gain Range
P2	dP	00000	Decimal Point
	CAL IP	*	Calibrate Input
	L InIP	0	Linearize Input
	E.Off	0	Engineering Offest
	tPt	0	Tare Point
P1	F ILt	5	Filter
	L 1-4	see p.81	Limits setup (4 limit option)
	L 1-2	N/A	Limits setup (2 limit option)
	run		Run. Exit menus and return to normal operating mode

* Calibrated at DACA. Cannot be field calibrated

CALIBRATION

Calibration overview

The E725 can operate with a wide range of transducers. Calibration is a procedure, involving an E725 and a transducer, to set up the E725 to read correctly in engineering units (e.g. bar) as required.

For example, when using an E725 with a pressure transducer, the user may want to see a display of 0 to 100.0 over a pressure range of 0 to 100 bar. This is achieved through calibration.

One of several possible approaches to the above example could be to apply 0 bar to the transducer and program the E725 to display 0.0 at this pressure, then apply 100 bar to the transducer and program the E725 to display 100.0 at this pressure.

This section describes procedures, including programming, for the calibration of a single transducer.

The E725 is capable of compensating for transducer non-linearity using either multi-point or polynomial techniques. It is anticipated that many users will not require these facilities, therefore they are covered in separate documentation.

Excitation voltage

Almost all transducers require an input voltage. This is generally called "excitation" in the case of unamplified strain gauge transducers, and "supply voltage" in the case of amplified transducers. The E725 can work with a wide range of transducers. A variety of excitation and supply voltage arrangements are possible.

This section deals with excitation voltage available at pins 1 and 2 of the 9-pin D-type transducer connector (see Section 5). Excitation and supply voltage connections could involve other pins on this connector. This section is only relevant if pins 1 and/or 2 are to be used.

The excitation voltage on pins 1 and 2 is user selectable to 1.5, 3, 5 or **10 V** nominal. This voltage is bipolar, e.g. if the excitation is set to 10 V, then pin 1 will be at +5 V and pin 2 will be at -5 V with respect to 0 V (ground).

For the MicroCompounder the correct exitation voltage is 10V.

For many re-calibrations or calibrations of replacement transducers, it may not be necessary to change the excitation voltage. The existing voltage level will probably apply in the new situation. For this reason the item EXCITATION is on the CONFIGURATION rather than the CALIBRATION menu.

However, in general, the excitation voltage will need to be set to suit the transducer being calibrated. This must be done before starting the main calibration procedure.

To establish the correct excitation voltage, refer to the transducer manufacturer's data-sheets or calibration sheets. In the case of unamplified strain gauge transducers it is usually best to set the excitation voltage to the maximum level allowed by the manufacturer.

To change the excitation voltage it is necessary to understand E725 programming.

CHANGING EXCITATION WILL ERASE EXISTING CALIBRATION DATA.

When the item EXCITATION in the CONFIGURATION menu is selected, the user enters a submenu comprising the four possible excitation values shown in volts. ▲ and ▼ allow the user to step through this sub-menu. When the required voltage is displayed, pressing **ENTER** selects that voltage and exits the sub-menu. Alternatively, pressing **RESET** exits the sub-menu without changing the range. In either case the display will then show GAIN, the next item in the CONFIGURATION menu.

GAIN RANGE

The E725 can accept a full-scale signal in a band from ±0.003 to ±10.0 V. This band is divided into eight ranges numbered 1 to 8.

For many re-calibrations or calibrations of replacement transducers, it may not be necessary to change the gain range. The existing gain range will probably apply in the new situation. For this reason the item GAIN is on the CONFIGURATION rather than the CALIBRATION menu.

However, in general, the gain range will need to be set to suit the transducer being calibrated. This must be done before starting the main calibration procedure.

The required gain range setting depends on the full-scale signal input to the E725 (i.e. the full scale output from the transducer).

Typically, manufacturers' data sheets or calibration certificates state transducer full scale output (in V) or sensitivity (in mV/V). The sensitivity relates output at full scale to excitation voltage. It may be necessary to calculate the full-scale output from the sensitivity figure (sometimes referred to as the calibration factor on manufacturers' calibration sheets).

The transducer full scale output is the full scale input to the E725. The following table relates gain range to full scale input.

GAIN RANGE	FULL-SCALE INPUT (V)
1	**3.0 to 10.0**
2	1.0 to 3.0
3	0.3 to 1.0
4	0.1 to 0.3
5	0.03 to 0.1
6	0.01 to 0.03
7	0.003 to 0.01
8	0.0025 to 0.003

For the MicroCompounder the correct gain is 1.

To change the gain range it is necessary to understand E725 programming.

CHANGING GAIN RANGE WILL ERASE EXISTING CALIBRATION DATA.

When the item GAIN in the CONFIGURATION menu is selected, the user enters a sub-
menu comprising the eight possible gain ranges. ▲ and ▼ allow the user to step through this sub-menu. When the required range is displayed, pressing **ENTER** selects that range and exits the sub-menu. Alternatively, pressing **RESET** exits the sub-menu without changing the range. In either case the display will then show dP (DECIMAL POINT), the first prompt in the CALIBRATION menu.

Exiting the sub-menu via the **ENTER** key (as opposed to the **RESET** key) will erase existing calibration data, even if the gain range has not been changed.

DECIMAL POINT

Before starting the main calibration procedure it is necessary to set the position of the decimal point. This will define the number of decimal places displayed when in normal operating mode.

To do this it is necessary to understand E725 programming.

CHANGING DECIMAL POINT WILL ERASE EXISTING CALIBRATION DATA AND LIMIT CONFIGURATION.

When the item **DECIMAL POINT** in the **CALIBRATION** menu is selected, the display shows 00000 with the decimal point in its existing position. Its position can be shifted to the left or right by pressing ▲ or ▼ respectively. When the decimal point is in the required position, pressing **ENTER** accepts that position. The user is returned to the CALIBRATION menu, the display shows the next item CAL.1 P (CALIBRATE INPUT).

CALIBRATE INPUT

CALIBRATE INPUT is the menu item where the main calibration procedure must be carried out. Before this procedure is started, the transducer must be connected to the E725, the excitation voltage must be programmed, the gain range must be programmed and the decimal point position must be programmed.

For optimum performance the E725 should be allowed to warm up (with excitation or supply voltage applied to the transducer) for at least twenty minutes before calibration.

The user must establish what display arrangement is required. For example, if the transducer in question is a ±250 lbs. tension/compression load cell, the E725 may be required to display ±250.0 lbs., ±113.5 kg, ±1112 N etc.

If a direct calibration is to be performed, the user must decide on the calibration point. This may be the same as the transducer full scale, but it may be less. For example, if a user plans to use a ±250 lbs. load cell over a range of ±150 lbs., never exceeding 150 lbs. in tension or compression, it would be reasonable to choose a calibration point of 150 lb.

If a shunt calibration is to be performed, the user must calculate a calibration point from data given on the transducer calibration sheet. This calculation is dealt with within EXAMPLE F below**.**

Here is a checklist for what the user must decide.

Engineering units	e. g.	Kg
Display full scale	e. g.	100 Kg
Display resolution	e. g.	100.0 Kg
Display polarity	e. g.	±100.0 Kg, positive in tension
Calibration zero point	e. g.	0 displayed at zero load

Calibration point (this is a user decision for direct calibrations, it must be calculated for shunt calibrations, see EXAMPLE F).

To perform a calibration it is necessary to understand E725 programming.

When the item CALIBRATE INPUT in the CALIBRATION menu is selected, the display shows a number entry prompt. This is the value of the calibration point and can be edited. Pressing **ENTER** or **ENTER** and **RESET** together (as appropriate) selects the value displayed. The E725 enters CALIBRATION MODE, the display shows a transducer reading in counts or engineering units (depends on whether the E725 was already calibrated).

In **CALIBRATION MODE**, the front panel keys take on specific functions.

MODE and ZERO together	Clears any previous calibration.
ZERO	Fixes the calibration zero point.
ENTER	Takes a cal reading (positive or negative) for bipolar cal.
SETUP	Scales the transducer reading.
MODE and ENTER together	Performs a shunt calibration.
MODE and SETUP together	Accepts the calibration and exits CALIBRATION MODE. The display will then show E.OFF, the next relevant item in the CALIBRATION menu.

If it is necessary (e.g. due to an error) to exit CALIBRATION MODE and restart the main calibration procedure, press **MODE** and **SETUP** together. The display shows E.OFF (ENGINEERING OFFSET). Press ▲ as required to display item CALIBRATE INPUT, press **ENTER** to select CALIBRATE INPUT and proceed as before.

EXAMPLE F – SHUNT CALIBRATION

POINTS TO NOTE REGARDING SHUNT CALIBRATION.

1) Shunt calibrations are applicable to most (but not all) types of unamplified strain gauge transducers. They are not appropriate for other types of transducer used with the E725.
2) The technique involves the E725 internally connecting a shunt resistor across one arm of the transducer's strain gauge bridge. This produces a transducer output that can be used as a calibration reference.
3) The internal resistor value is 59k ohm. In some cases it may be necessary to change this resistor to achieve an appropriate transducer output. Instructions for this procedure are available on request.
4) A particular transducer connection arrangement is necessary if a shunt calibration is to be used.

To calibrate a 2000 lb pressure transducer to display 0 to 8896 N using a shunt calibration technique, where the manufacturer's calibration certificate for the transducer states the following.

CAPACITY 2000 lb
SHUNT CAL FACTOR 1.4928 mV/V
CALIBRATION FACTOR 1.8771 mV/V
SHUNT RESISTOR 59K OHM

CALCULATION OF CALIBRATION POINT

$$CP = \frac{SCOP}{FSOP} \times TFS$$

WHERE CP = CALIBRATION POINT
SCOP = SHUNT CAL. OUTPUT
FSOP = FULL SCALE OUTPUT
TFS = TRANSDUCER FULL SCALE

The SHUNT CAL. Output is given on the transducer calibration certificate, it is sometimes referred to as "SHUNT CAL FACTOR". It is usually expressed in mV or mV/V.

The full scale output is given on the transducer calibration certificate, it is sometimes referred to as "CALIBRATION FACTOR". It is usually expressed in mV or mV/V. In the above equation, SHUNT CAL. Output and full scale output must be in the same engineering units (e.g. both be in mV/V).

The transducer full scale is given on the transducer calibration certificate, it is sometimes referred to as "CAPACITY". It may be necessary to convert the engineering units of this value. In fact this is the case in our example. The transducer full scale is 2000 Lb, since the E725 is required to display in Newton, 2000 Lb must be converted to Newton and the transducer full scale becomes 8896 N.

The shunt resistor value is not used in the example calculation, but it must be 59k ohm for the calculation to be valid.

Returning to the previous equation.

$$CP = \frac{1.4928}{1.8771} \times 8896 = 7075N$$

PROGRAMMING STEPS.

1 Access CONFIGURATION menu (example C)
2 Change EXCITATION if necessary
3 Change GAIN RANGE if necesssary

	DISPLAY SHOWS		ACTION
4	dP		Press ENTER to select item DECIMAL POINT
5	00000		Press ▲ to shift decimal point
6	00000		Press ENTER to accept decimal point position
7	CAL.1P		Press ENTER to select CAL.IP
8	00000		Press ▲ five times (editing CAL PT)
9	00005		Press ENTER
10	00075		Press ▲ seven times
11	00075		Press ENTER
12	00075		Press ENTER
13	00075		Press ▲ seven times
14	07075		Press ENTER & RESET together (accepts CAL PT)
15	345	*1	Press MODE & ZERO together (clears previous CAL)
16	23	*2	Apply zero pressure, press ZERO
17	0	*3	Maintain zero pressure, press MODE & ENTER together perform shunt calibration
18	7075	*3	For approximately five seconds, the display reads the transducer output while the shunt resistor is in circuit. No action is required for the display to revert to normal.
19	00	*4	Press MODE & SETUP together
20	E.OFF		If no other menu items are required, exit the calibration menu by pressing reset. After a 2 second delay, the unit will go to normal operat ing mode. See important note at end of section.

*1 Any number may appear (in counts or engineering units).
*2 The display will read transducer output in uncalibrated counts. A display greater than 50000 or less than -50000 indicates a problem. Check connections and gain setting.
*3 System noise may cause slight fluctuation about the reading shown in the example
*4 At this stage the actual applied load (or pressure etc) is displayed.

IMPORTANT NOTE Calibration menus should only be re-accessed by appropriate personnel. Subsequent errors in these menus could lead to a need for re-calibration.

SHUNT CALIBRATION AS A CALIBRATION CHECK

Whether the original calibration is performed using a direct or shunt technique, the shunt calibration feature can often be used as post calibration check. This applies to most types of unamplified strain gauge transducer, connected as "With Shunt Calibration".

Any display offset that has previously been applied (via **ZERO** key or digital input) will confuse the shunt function so press **RESET** and **ZERO** to remove any display offset.

When the E725 is in normal operating mode, pressing **MODE** and **LIMITS** together brings the shunt resistor into circuit for about five seconds, the number displayed will increase by an amount called the shunt calibration reading. Therefore the shunt cal reading is equal to the display with shunt cal, minus the display without the shunt cal. After five seconds, the display reverts to normal reading.

This operation should be performed when the transducer is measuring a static quantity (most conveniently, zero but do not press **ZERO** as this may confuse the calculation).

Engineering offset

The item **E.OFF** (ENGINEERING OFFSET) in the CALIBRATION menu allows an engineering offset to be added to the calibrated transducer signal. For example, if a transducer has been calibrated to read ±1000 g and the ENGINEERING OFFSET is set to +100, in normal operating mode the display will read -900 to +1100 g.

The ENGINEERING OFFSET is not the same as the CALIBRATION OFFSET, which is fixed during the main calibration procedure.

The ENGINEERING OFFSET is not the same as the ZERO DISPLAY function, which is applied via the **ZERO** key or equivalent digital input.

If an ENGINEERING OFFSET has been programmed, when in normal operating mode the function of the ZERO key (or equivalent digital input) will be to set the display to the value of the ENGINEERING OFFSET (assuming the tare point has not been used to override this).

When the item E.OFF (ENGINEERING OFFSET) in the CALIBRATION menu is selected, the display shows a number entry prompt. Pressing ENTER or ENTER and RESET together (as appropriate) selects the value displayed. The user is returned to the CALIBRATION menu, the display shows the next item, **t.Pt** (TARE POINT).

Tare point

The item **t.Pt** (TARE POINT) in the CALIBRATION menu allows a tare point to be defined. The tare point is the reading obtained in normal operating mode when the ZERO key is pressed (or the equivalent digital input is applied).

The default value for the tare point is 0, i.e. when in normal operating mode, pressing the ZERO key sets the display to 0. If an engineering offset is programmed, the tare point is automatically set to the value of the engineering offset.

For example, if a transducer has been calibrated to read ±1000g and the ENGINEERING OFFSET is set to +l00, in normal operating mode the display will read -900 to +1100 g. The tare point is automatically set to +100, so pressing the ZERO key sets the display to +100.

It may be necessary to override the arrangement described above. For example, if it is required that a ZERO key operation sets the display to 0 rather than +100, this can be achieved by changing the tare point value to 0.

When the item **t.Pt** (TARE POINT) in the CALIBRATION menu is selected, the display shows a number entry prompt. Pressing **ENTER** or **ENTER** and **RESET** together (as appropriate) selects the value displayed. The display shows **L 1-4** which is the first item in the LIMITS menu.

LIMITS

PROGRAMMING LIMITS

In order for the limits to function, it is necessary to program the limit values and some other factors associated with their operation.

When the Limits menu is accessed, the display reads **L 1-4** , denoting Limits 1 to 4. This will read **L 1-2** if you have option FR or FRS fitted as there are 2 limits available with the fast limit option.

Press **ENTER**.

Press the ▲ or ▼ until the display shows the limit you wish to change. For example **L 2** . Press **ENTER** to select your chosen item.

Again using the ▲ and ▼ keys, choose the operation mode of the limit. The choices and their description are as follows:

OFF OFF. The limit is turned OFF which is the DEFAULT CONDITION. Selecting OFF exits the set up of the current limit. If the current limit is the last limit (L2 for option FR and FRS, L4 for all other cases), the unit will exit the limits menu.

Hi HIGH. The limit activates when the input signal is higher than the set point.

Lo LOW. The limit activates when the input signal is lower than the set point.

dti on DEVIATION. The limit activates when the input signal deviated from the set point by more than a specified amount. For example, a set point of 100 with a deviation of 10 would be activated below 90 and above 110.

Press **ENTER** to make your selection.

The display will briefly show Funct.

Using the ▲ and ▼ keys, view the six LIMIT INPUTS available to be monitored. For most applications the **n-1 P** will be appropriate. Full details are as follows:

n-1P NET INPUT is the value seen on the display of the unit in normal operational mode.

G-1P GROSS INPUT disregards any zero offsets (eg by pressing the ZERO key) since calibration.

t-1P TARE INPUT is the zero offset introduced by the ZERO function.

n-1P WITH MAX INDICATOR. MAX INPUT is monitored.

n-1P WITH MIN INDICATOR. MIN INPUT is monitored

n-1P WITH TIR INDICATOR. TIR INPUT is monitored.

Press **ENTER** to make your selection.

The display will briefly show *Set.Pt* (SET POINT) and then show a number. Enter the required value of the set point. It can be any value between minus 99999 and plus 99999. Section 6.3 deals with number entry if you're not sure.

If you have selected *dti on* (DEVIATION) as the operation mode, the unit will at this point request the level of deviation allowed. (dti on will appear on the display briefly). Input this value. THIS STEP WILL BE OMITTED IF THE OPERATION MODE IS NOT dti on.

Next the unit will momentarily display HYS . Hysteresis provides a dead band around the limit value. If for example, the signal from the sensor has a lot of fluctuation, as the average signal approaches the set point, the limit will be

rapidly triggered on and off. The hysteresis value allows a dead band to be configured. If for example the limit is a high limit with a set point of 100 and hysteresis of 10, the limit will trigger at 100 but not go off until 90.

Finally, the display will show LAt-n (LATCHING NO). This sets the limits to be non-latching. If this is set to Lat-Y (LATCHING YES) using the UP ARROW key, once the limit is triggered, it will stay triggered even if the signal falls below the set point. The limit must be reset before it will go off. See Section 4 for details of how latched limits are reset. Press ENTER once the required selection is made.

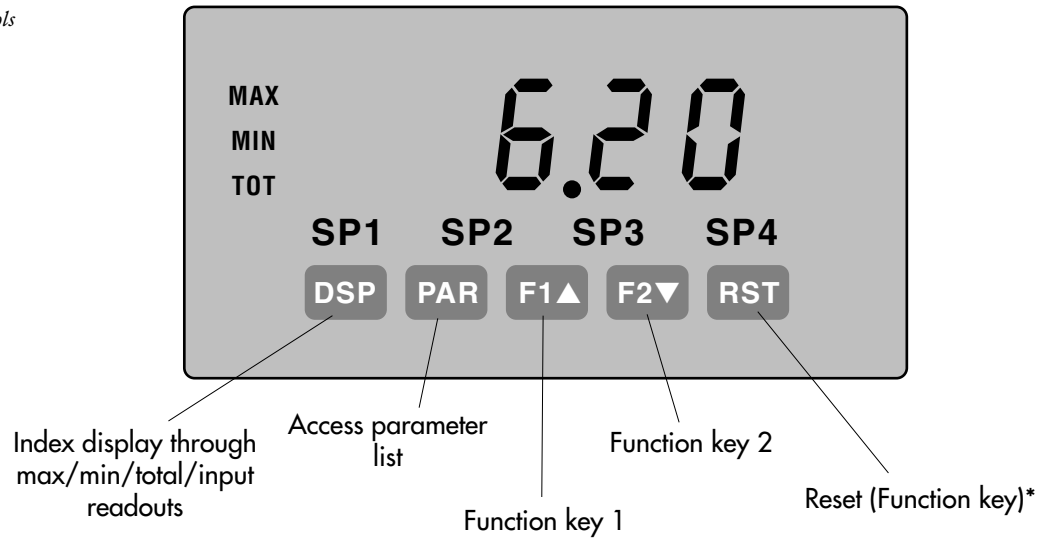
The display will now prompt entry of the next limit unless this was the last limit (L4 for R and RS, and L2 for FR and FRS). If it was the last limit, the display will show RUN. Press enter (and wait for 2 seconds). The unit has now left set-up mode and is in normal operating mode.

To make a quick exit from the limits menu, whilst the display is showing L1, L2, L3 or L4, press RESET. The display will then show run. Press **ENTER** and after a 2 second delay, the unit will return to normal operating mode.

The limit values used for the MicroCompounder are:

Limit	**Mode**	**Funct**	**Setpoint**	**Hyster**	**Latch**
L1	HI	n-1p	50	5	LAt-n
L2	HI	n-1p	5000	10	LAt-n

7.4 TORQUE INDICATOR



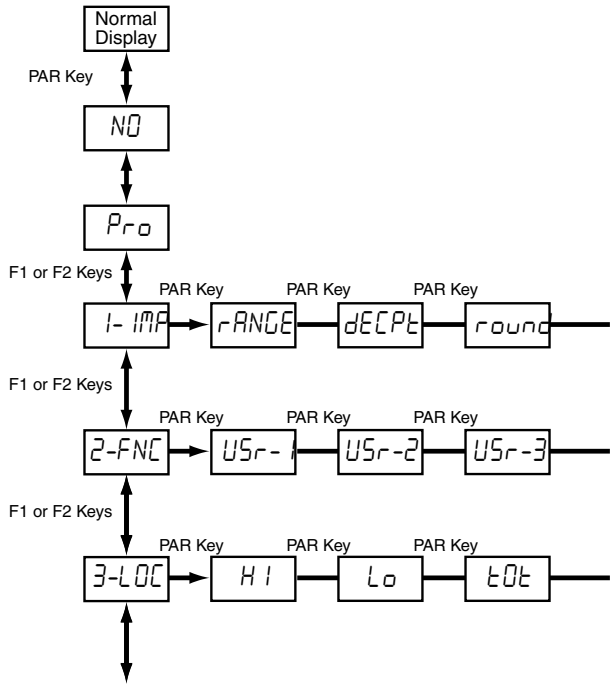
KEY	PROGRAMMING MODE OPERATION
DSP	Quit programming and return to display mode
PAR	Store selected parameter and index to next parameter
F1▲	Increment selected parameter value
F2▼	Decrement selected parameter value
RST	Hold with F1▲, F2▼ to scroll value by x 1000

PROGRAMMING THE METER

OVERVIEW

PROGRAMMING MODE ENTRY (PAR KEY)

The Display Mode is the normal operating mode of the meter. The Programming Mode is entered by pressing the **PAR** key. If it is not accessible, enter the necessary code requested or check for an active user input. Once in programming mode the front panel keys take on diferent functions.



Parameter module entry (arrow & par keys)

The Programming Menu is organized into modules. These modules group together parameters which are related in function. The display will alternate between **PRO** and the current parameter module. The arrow keys (F1 and F2) are used to select the desired parameter module. The displayed module is entered by pressing the **PAR** key.

Parameter menu movement (par key)

Each parameter module has a separate module menu (which is shown at the start of each parameter module discussion). The **PAR** key is pressed to advance to a particular parameter without changing the programming of preceding parameters. After completing a module, the display will return to Pro NO Programming may continue by accessing additional parameter modules.

Selection/value entry (arrow & par keys)

In the parameter module, the display will alternate between the current parameter and the selections/values for that parameter. The arrow keys (F1 and F2) are used to move through the selections/values for that parameter. By pressing the **PAR** key, the displayed selection is stored and activated. This will also advance the meter to the next parameter.

Programming mode exit (dsp key or par key)

The Programming Mode is exited by pressing the DSP key (from anywhere in the Programming Mode) or the **PAR** key (with **Pro NO** displayed). This will commit any stored parameter changes to memory and return the meter to the Display Mode. If a parameter was just changed, the **PAR** key should be pressed to store the change before pressing the **DSP** key. (If power loss occurs before returning to the Display Mode, verify recent parameter changes.)

PROGRAMMING TIPS

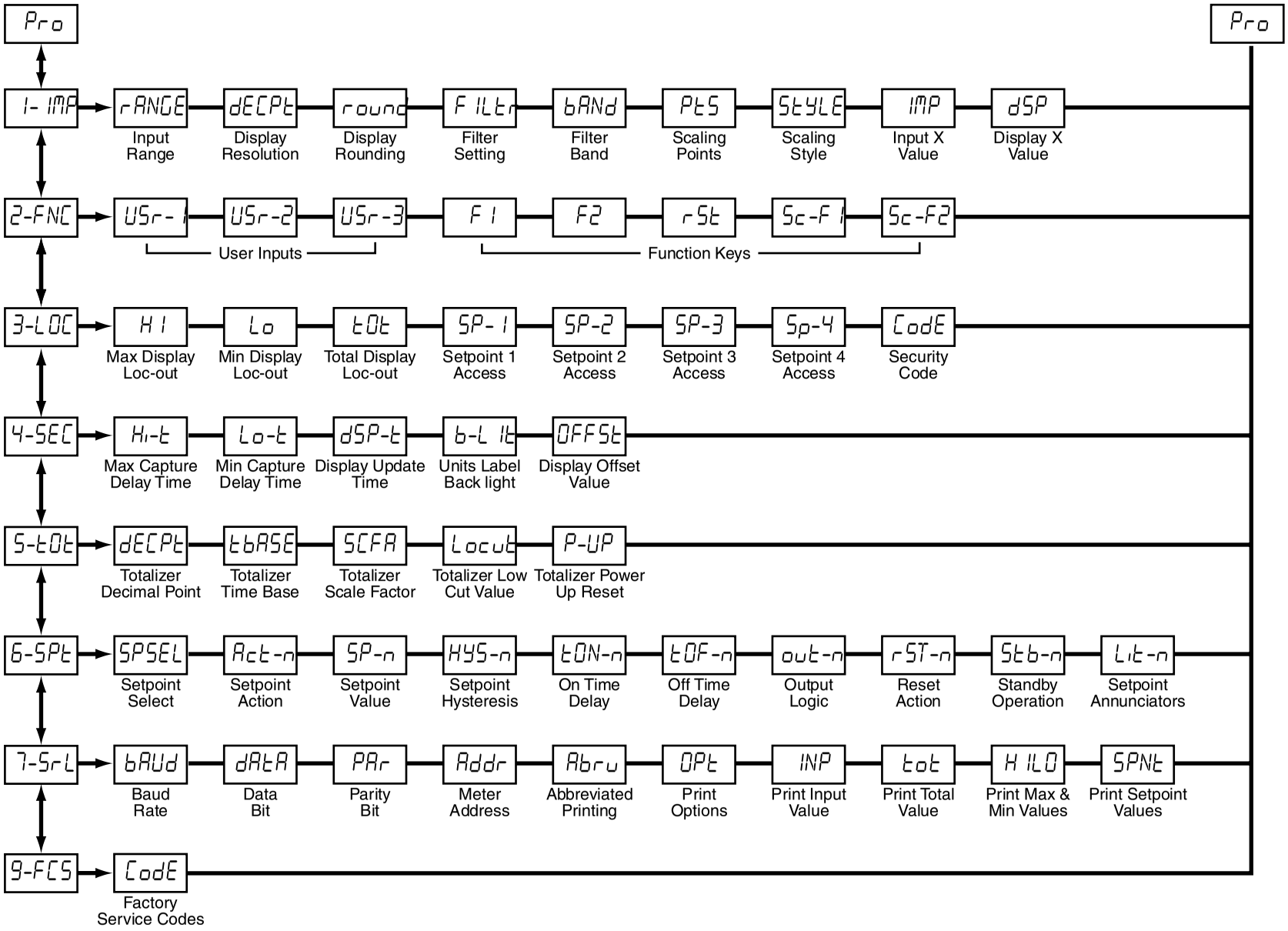
It is recommended to start with Parameter Module 1. If lost or confused while programming, press the **DSP** key and start over. When programming is complete, it is recommended to record the parameter programming on the Parameter User Chart and lock-out parameter programming with a user input or lock-out code.

FACTORY SETTINGS

Factory Settings may be completely restored in Parameter Module 9. This is a good starting point for programming problems. Some parameters may be identified that their Factory Settings can be used without affecting basic startup. At these parameters, try the settings unless a specific selection or value is known.

ALTERNATING SELECTION DISPLAY

In the explanation of the parameter modules, the following dual display with arrows will appear. It is to illustrate the display alternating between the parameter on top, and the parameter's factory setting on the bottom. In most cases, selections and values for the parameter will be listed on the right.


Pro
1-IMP
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5-tOt
dECPt
Totalizer Decimal Point
tbASE
Totalizer Time Base
SCFA
Totalizer Scale Factor
Locut
Totalizer Low Cut Value
P-UP
Totalizer Power Up Reset
6-SPt
SPSEL
Setpoint Select
Act-n
Setpoint Action
SP-n
Setpoint Value
HYS-n
Setpoint Hysteresis
tON-n
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Off Time Delay
out-n
Output Logic
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Stb-n
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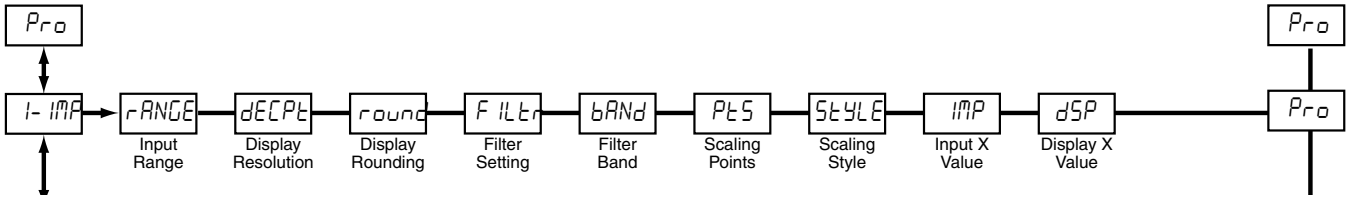
bAUd
Baud Rate
dAtA
Data Bit
PAr
Parity Bit
Addr
Meter Address
Abru
Abbreviated Printing
OPt
Print Options
INP
Print Input Value
tot
Print Total Value
HILO
Print Max & Min Values
SPNt
Print Setpoint Values
9-FCS
CodE
Factory Service Codes
Pro

SIGNAL INPUT PARAMETERS



INPUT RANGE

SELECTION	RANGE RESOLUTION	SELECTION	RANGE RESOLUTION
200uA	±200.00 µA	2u	±2.0000 V
0.002A	±2.0000 mA	20u	±20.000 V
0.02A	±20.000 mA	300u	±300.00 V
0.2A	±200.00 mA	100o	100.00 ohm
2A	±2.0000 A	1000o	1000.0 ohm
0.2u	±200.00 mV	10ko	10000 ohm

Select the input range that corresponds to the external signal. This selection should be high enough to avoid input signal overload but low enough for the desired input resolution. This selection and the position of the Input Range Jumper must match.

DISPLAY DECIMAL POINT

0 0.0 0.00 0.000 0.0000

Select the decimal point location for the Input, **MAX** and **MIN** displays. (The **TOT** display decimal point is a separate parameter.) This selection also affects **round, dSP 1** and **dSP 2** parameters and setpoint values.

DISPLAY ROUNDING*

2 5 10 20 50 100

Rounding selections other than one, cause the Input Display to 'round' to the nearest rounding increment selected (ie. rounding of '5' causes 122 to round to 120 and 123 to round to 125). Position of the decimal point should be ignored when programming this selection. Remaining parameter entries (scaling point values, setpoint values, etc.) are not automatically adjusted to this display rounding selection.

FILTER SETTING*

0.0 to 25.0 seconds

The input filter setting is a time constant expressed in tenths of a second. The filter settles to 99% of the final display value within approximately 3 time constants. This is an Adaptive Digital Filter which is designed to steady the Input Display reading. A value of '0' disables filtering.

FILTER BAND*

0.0 to 25.0 display units

The digital filter will adapt to variations in the input signal. When the variation

** Factory Setting can be used without affecting basic start-up*

exceeds the input filter band value, the digital filter disengages. When the variation becomes less than the band value, the filter engages again. This allows for a stable readout, but permits the display to settle rapidly after a large process change. The value of the band is in display units, independent of the Display Decimal Point position. A band setting of '0' keeps the digital filter permanently engaged.

SCALING POINTS*

2 to 16

Linear - Scaling Points (2)
For linear processes, only 2 scaling points are necessary. It is recommended that the 2 scaling points be at opposite ends of the input signal being applied. The points do not have to be the signal limits. Display scaling will be linear between and continue past the entered points up to the limits of the Input Signal Jumper position. Each scaling point has a coordinate-pair of Input Value **(1NP)** and an associated desired Display Value **(dSP)**.

Nonlinear - Scaling Points (Greater than 2)
For non-linear processes, up to 16 scaling point may be used to provide a piece-wise linear approximation. (The greater the number of scaling points used, the greater the conformity accuracy.) The Input Display will be linear between scaling points which are sequential in program order. Each scaling point has a coordinate-pair of Input Value **(1NP)** and an associated desired Display Value **(dSP)**. Data from tables or equations, or empirical data could be used to derive the required number of segments and data values for the coordinate pairs. In the SFPAX software, several linearization equations are available.

SCALING STYLE

KEY key-in data
APLY apply signal

If Input Values and corresponding Display Values are known, the Key-in *(KEY)* scaling style can be used. This allows scaling without the presence or changing of the input signal. If Input Values have to be derived from the actual input signal source or simulator, the Apply **(APLY)** scaling style must be used.

INPUT VALUE FOR SCALING POINT 1

-19999 to **19999**

For Key-in *(***KEY***)*, enter the known first Input Value by using the arrow keys. (The Input Range selection sets up the decimal location for the Input Value). For Apply *(***APLY***),* apply the input signal to the meter, adjust the signal source externally until the desired Input Value appears. In either method, press the **PAR** key to enter the value being displayed. The **DSP** key can be pressed without changing the previously stored **INP 1** value in the **APLY** style.

DISPLAY VALUE FOR SCALING POINT 1

-19999 to **19999**

Enter the first coordinating Display Value by using the arrow keys. This is the same for **KEY** and **APLY** scaling styles. The decimal point follows the **dECPt** selection.

INPUT VALUE FOR SCALING POINT 2

-19999 to **19999**

For Key-in (**KEY**), enter the known second Input Value by using the arrow keys. For Apply (**APLY**), adjust the signal source externally until the next desired Input Value appears. (Follow the same procedure, if using more than 2 scaling points.)

DISPLAY VALUE FOR SCALING POINT 2

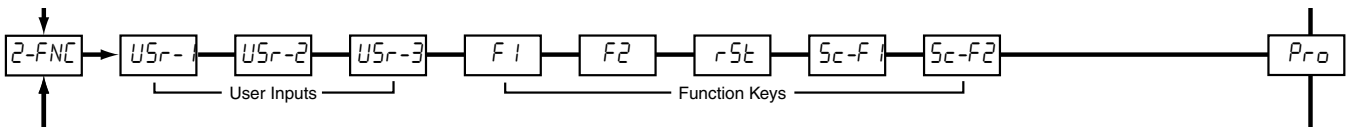
-19999 to 19999

Enter the second coordinating Display Value by using the arrow keys. This is the same for **KEY and APLY** scaling styles. (Follow the same procedure, if using more than 2 scaling points.)

GENERAL NOTES ON SCALING

1. Input Values for scaling points should be confined to the limits of the Input Range Jumper position.
2. The same Input Value should not correspond to more than one Display Value. (Example: 20 mA should not equal 0 and 10.) This is referred to as read out jumps (vertical scaled segments).
3. The same Display Value can correspond to more than one Input Value. (Example: 0 mA and 20 mA can equal 10.) This is referred to as readout dead zones (horizontal scaled segments).
4. The maximum scaled Display Value spread between range maximum and minimum is limited to 65,535. For example using +20 mA range the maximum +20 mA can be scaled to is 32,767 with 0 mA being 0 and Display Rounding of 1. (Decimal points are ignored.) The other half of 65,535 is for the lower half of the range 0 to -20 mA even if it is not used. With Display Rounding of 2, +20 mA can be scaled for (32,767 x 2 =) 65,535 but with even Input Display values shown.
5. For input levels beyond the first programmed Input Value, the meter extends the Display Valueby calculating the slope from the first two coordinate pairs (INP1 /dSP1 & INP 2/dSP2). If INP1 = 4 mA and dSP1 = 0, then 0 mA would be some negative Display Value. This could be prevented by making INP1 = 0 mA / dSPI = 0, INP2 = 4 mA / dSP2 = 0, with INP3 = 20 mA / dSP3 = the desired high Display Value. The calculations stop at the limits of the Input Range Jumper position.
6. For input levels beyond the last programmed Input Value, the meter extends the Display Value by calculating the slope from the last two sequential coordinate pairs. If three coordinate pair scaling points were entered, then the Display Value calculation would be between INP2 / dSP2 & INP3 / dSP3. The calculations stop at the limits of the Input Range Jumper position.

USER INPUT AND FRONT PANEL FUNCTION KEY PARAMETERS



The three user inputs are individually programmable to perform specific meter control functions. While in the Display Mode or Program Mode, the function is executed the instant the user input transitions to the active state.

The front panel function keys are also individually programmable to perform

specific meter control functions. While in the Display Mode, the primary function is executed the instant the key is pressed. Holding the function key for three seconds executes a secondary function. It is possible to program a secondary function without a primary function.

In most cases, if more than one user input and/or function key is programmed for the same function, the maintained (level trigger) actions will be performed while at least one of those user inputs or function keys are activated. The momentary (edge trigger) actions will be performed every time any of those user inputs or function keys transition to the active state.

Note: In the following explanations, not all selections are available for both user inputs and front panel function keys. Alternating displays are shown with each selection. Those selections showing both displays are available for both. If a display is not shown, it is not available for that selection. USr - 1 will represent all three user inputs. F I will represent all five function keys.

No function
No function is performed if activated. This is the factory setting for all user inputs and function keys. No function can be selected without affecting basic start-up.

Programming mode lock-out
Programming Mode is locked-out, as long as activated (maintained action). A security code can be configured to allow programming access during lock-out.

Zero (tare) display
The Zero (Tare) Display provides a way to zero the Input Display value at various input levels, causing future Display readings to be offset. This function is useful in weighting applications where the container or material on the scale should not be included in the next measurement value. When activated (momentary action), **rESEt** flashes and the Display is set to zero. At the same time, the Display value (that was on the display before the Zero Display) is subtracted from the Display Offset Value and is automatically stored as the new Display Offset Value **(oFFSt).** If another Zero (tare) Display is performed, the display will again change to zero and the Display reading will shift accordingly.

Relative/absolute display
This function will switch the Input Display between Relative and Absolute. The Relative is a net value that includes the Display Offset Value. The Input Display will normally show the Relative unless switched by this function. Even when the Input Display is changed from Relative, all meter functions continue to operate based on relative values. The Absolute is a gross value (based on Module I **DSP and INP** entries) without the Display Offset Value. The input display switches to Absolute display as long as the user input is activated (maintained action) or at the transition of the function key (momentary action). When the user input is released, or the function key is pressed again, the input display switches back to Relative display. **AbS** (absolute) or **rEL** (relative) is momentarily displayed at transition to indicate which display is active. Unless a Zero Display was performed or the Display Offset Value **(oFFSt)** was changed, Relative and Absolute will be the same.

Hold display
The shown display is held but all other meter functions continue as long as activated (maintained action).

Hold all functions
The meter disables processing the input, holds all display contents, and locks the state of all outputs as long as activated (maintained action). The serial port continues data transfer.

Synchronize meter reading
The meter suspends all functions as long as activated (maintained action). When the user input is released, the meter synchronizes the restart of the A/D with other processes or timing events.

Store batch reading in totalizer
The Input Display value is one time added (batched) to the Totalizer at transition to activate (momentary action). The Totalizer retains a running sum of each batch operation until the Totalizer is reset. When this function is selected, the time based operation of the Totalizer is overridden.

Select totalizer display
The Totalizer display is selected as long as activated (maintained action). When the user input is released, the Input Display is returned. The DSP key overrides the active user input. The Totalizer continues to function including associated outputs independent of being displayed.

Reset totalizer
When activated (momentary action), **rESEt** flashes and the Totalizer resets to zero. The Totalizer then continues to operate as it is configured. This selection functions independent of the selected display.

Reset and enable totalizer
When activated (momentary action), **rESEt** flashes and the Totalizer resets to zero. The Totalizer continues to operate as it is configured while active (maintained action). When the user input is released, the Totalizer stops and holds its value. This selection functions independent of the selected display.

Enable totalizer
The Totalizer continues to operate as it is configured as long as activated (maintained action). When the user input is released, the Totalizer stops and holds its value. This selection functions independent of the selected display.

Select maximum display
The Maximum display is selected as long as activated (maintained action). When the user input is released, the Input Display is selected. The **DSP** key overrides the active user input. The Maximum continues to function independent of being displayed.

Reset maximum
When activated (momentary action), **rESEt** flashes and the Maximum resets to the present Input Display value. The Maximum function then continues from that value. This selection functions independent of the elected display.

Reset, select, enable maximum display
When activated (momentary action), the Maximum value resets to the present Input Display value. The Maximum continues from that value while active (maintained action). When the user input is released, the Maximum stops and holds its value. This functions independent of the selected display. The DSP key overrides the active user input display but not the Maximum function.

Select minimum display
The Minimum display is selected as long as activated (maintained action). When the user input is released, the Input Display is returned. The **DSP** key overrides the active user input. The Minimum continues to function independent of being displayed.

Reset minimum
When activated (momentary action), **rESEt** flashes and the Minimum resets to the present Input Display value. The Minimum function then continues from

that value. This selection functions independent of the selected display.

Reset, select, enable minimum display

When activated (momentary action), the Minimum value resets to the present Input Display value. The Minimum continues from that value while active (maintained action).
When the user input is released, the Minimum stops and holds its value. This selection functions independent of the selected display. The **DSP** key overrides the active user input display but not the Minimum function.

Reset maximum and minimum

When activated (momentary action), **rESEt** flashes and the Maximum and Minimum resets to the present Input Display value. The Maximum and Minimum function then continues from that value. This functions independent of the selected display.

Setpoint selections

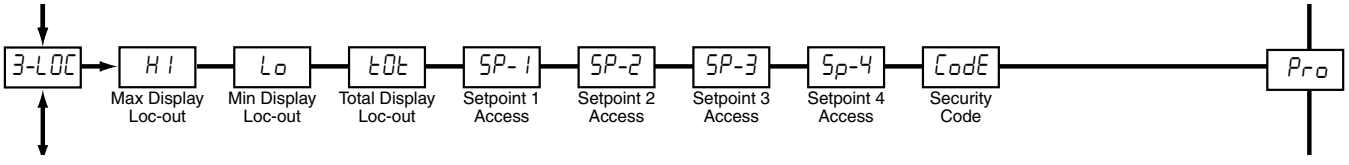
The following selections are accessible only with the Setpoint plug-in card installed. Refer to the Setpoint Card Bulletin shipped with the Setpoint card, for explanation of their operation.

Setpoint Card Only	LISt- Select main or alternative setpoints r - 1 - Reset Setpoint 1 (Alarm 1) r - 2 - Reset Setpoint 2 (Alarm 2) r - 3 - Reset Setpoint 3 (Alarm 3) r - 4 - Reset Setpoint 4 (Alarm 4) r - 34 - Reset Setpoint 34 (Alarm 34) r -234 - Reset Setpoint 234 (Alarm 234) r - ALL - Reset Setpoint All (Alarm All)

Print request

The meter issues a block print through the serial port when activated. The data transmitted during a print request is programmed in Parameter Module 7. If the user input is still active after the transmission is complete (about 100 msec), an additional transmission occurs. As long as the user input is held active, continuous transmissions occur.

DISPLAY AND PROGRAM LOCK-OUT PARAMETERS



Maximum display lock-out*
Minimum display lock-out*
Totalizer display lock-out*

These displays can be programmed for **LOC** or **rEd**. When programmed for **LOC**, the display will not be shown when the **DSP** key is pressed regardless of Program Lock-out status. It is suggested to lock-out the display if it is not needed. The associated function will continue to operate even if its display is locked-out.

SP-1 SP-2 SP-3 SP-4 setpoint access*

The setpoint displays can be programmed for *LOC*, *rEd* or *Ent* (See following table). Accessible only with the Setpoint plug-in card installed.

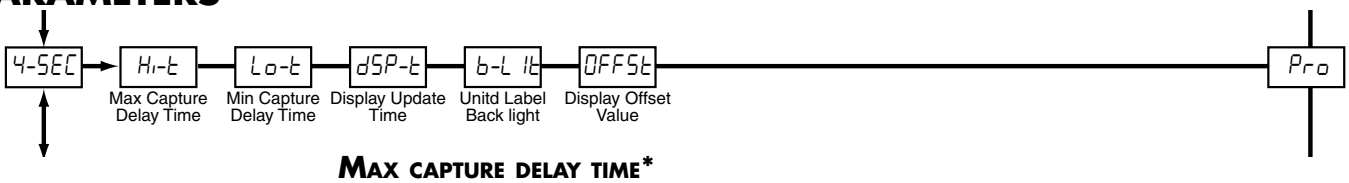
Selection	Description
LOC	Not visible in Display Mode.
rEd	Visible, but not changeable in Display Mode during Program Lock-out.
Ent	Visible and changeable in Display Mode during Program Lock-out.

PROGRAM MODE SECURITY CODE*

0 to 250

By entering any non-zero value, the prompt *CodE 0* will appear when trying to access the Program Mode. Access will only be allowed after entering a matching security code or universal code of 222. With this lock-out, a user input would not have to be configured for Program Lock-out. However, this lock-out is overridden by an inactive user input configured for Program Lock-out.

SECONDARY FUNCTION PARAMETERS



MAX CAPTURE DELAY TIME*

0.0 to 3275.0 sec.

When the Input Display is above the present MAX value for the entered amount of time, the meter will capture that display value as the new MAX reading. A delay time helps to avoid false captures of sudden short spikes.

MIN CAPTURE DELAY TIME*

0.0 to 3275.0 sec.

When the Input Display is below the present MIN value for the entered amount of time, the meter will capture that display value as the new MIN reading. A delay time helps to avoid false captures of sudden short spikes.

DISPLAY UPDATE RATE*

1 **2** **5** **10** **20** updates/sec.

This parameter determines the rate of display update. It does not affect the update rate of other meter functions. However, when set to 20 updates/second, the internal re-zero compensation is disabled. This allows for the fastest possible output response.

UNITS LABEL BACKLIGHT*

ON OFF

The Units Label Kit Accessory contains a sheet of custom unit overlays which can be installed in to the meter's bezel display assembly. The backlight for these custom units is activated by this parameter.

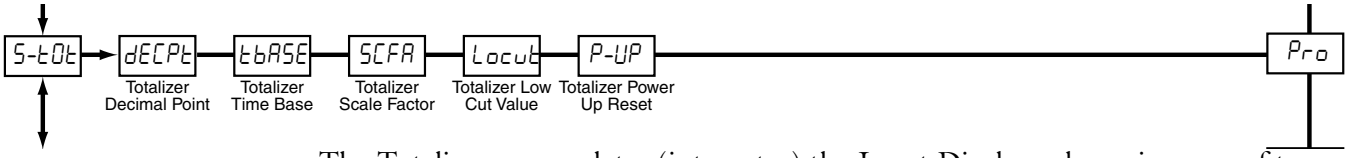
* Factory Setting can be used without affecting basic start-up.

DISPLAY OFFSET VALUE*

-19999 to 19999

Unless a Zero Display was performed or an offset from Module I scaling is desired, this parameter can be skipped. The Display Offset Value is the difference from the Absolute (gross) Display value to the Relative (net) Display value for the same input level. The meter will automatically update this Display Offset Value after each Zero Display. The Display Offset Value can be directly keyed-in to intentionally add or remove display offset. See Relative / Absolute Display and Zero Display explanations in Module 2.

TOTALIZER (INTEGRATOR) PARAMETERS



The Totalizer accumulates (integrates) the Input Display value using one of two modes. The first is using a time base. This can be used to provide an indication of total flow, usage or consumption over time. The second is through a user input or function key programmed for Batch (one time add on demand). This can be used for weighting applications where accumulation is based on a completed event. If the Totalizer is not needed, its display can be locked-out and this module can be skipped during programming.

TOTALIZER DECIMAL POINT*

0 0.0 0.00 0.000 0.0000

For most applications, this normally matches the Input Display Decimal Point (dECPt). If a different location is desired, refer to Totalizer Scale Factor.

TOTALIZER TIME BASE

SEC -seconds (÷1) **hour** - hours (÷3600)
_IN -minutes (÷60) **dAY**- days (÷86400)

For most applications, this normally matches the Input Display rate. Example: Input Display is in gallons per minute, then use minutes time base. If the Totalizer is being accumulated through a user input programmed for Batch, then this parameter does not apply.

TOTALIZER SCALE FACTOR*

0.000 to 65.000

For most applications, the Totalizer reflects the same decimal point location and engineering units as the Input Display. In these cases, the Totalizer Scale Factor is 1.000. The Totalizer Scale Factor can be used to scale the Totalizer to a different value than the Input Display. Common possibilities are:

1. Changing decimal point location (example tenths to whole)
2. Changing engineering units (example inches to meters)
3. Changing both decimal point location and engineering units.

TOTALIZER LOW CUT VALUE*

- 19999 to 19999

A low cut value disables Totalizer when the Input Display value falls below the value programmed.

TOTALIZER POWER UP RESET*

NO Do not reset buffer
rSt Reset buffer

The Totalizer can be reset to zero on each meter power-up by setting this parameter to reset.

* Factory Setting can be used without affecting basic start-up.

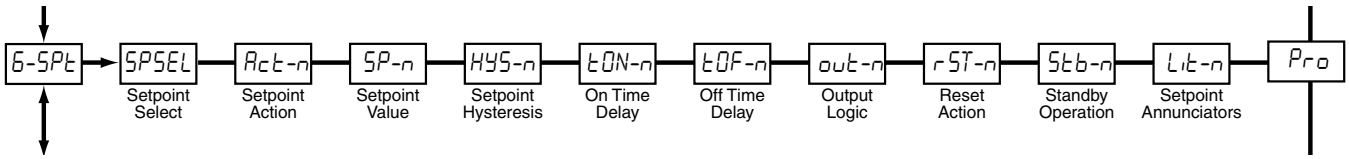
TOTALIZER HIGH ORDER DISPLAY

When the total exceeds 5 digits, the front panel annunciator **TOT** flashes. In this case, the meter continues to totalize up to a 9 digit value. The high order 4 digits and the low order 5 digits of the total are displayed alternatively. The letter "h" denotes the high order display.

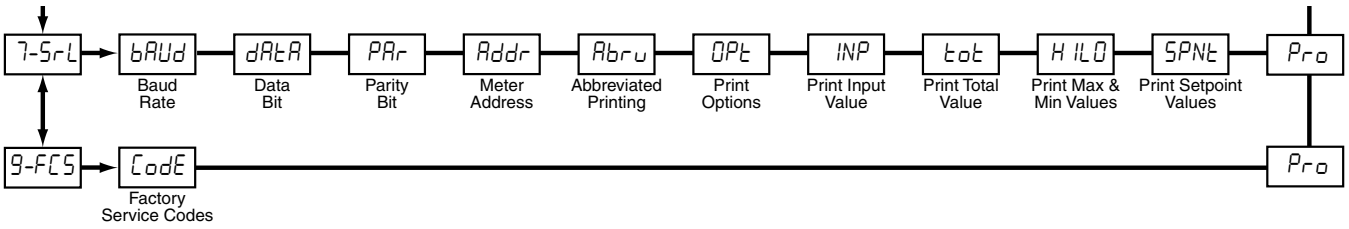
TOTALIZER BATCHING

The Totalizer Time Base is overridden when a user input or function key is programmed for store batch (hft). In this mode, when the user input or function key is activated, the Input Display reading is one time added to the Totalizer (batch). The Totalizer retains a running sum of each batch operation until the Totalizer is reset. This is useful in weighting operations, when the value to be added is not based on time but after a filling event.

SETPOINT (ALARM) PARAMETERS



DISPLAY	PARAMETER	POSSIBLE SETTING
SPSEL	SELECT SETPOINT	no, SP-1, SP-2, SP-3, SP-4
Act-n	SETPOINT ACTION	OFF, Ab-HI, Ab-LO, AU-HI AU-LO, dE-HI dE-LO, bAnd, totLo, totHI
SP-n	SETPOINT VALUE	-19999 to 99999
HYS-n	SETPOINT HYSTERESIS	1 to 65000
tON-n	ON TIME DELAY	0.0 to 3275.0 sec
tOF-n	OFF TIME DELAY	0.0 to 3275.0 sec
out-n	OUTPUT LOGIC	nor, rEu
rSt-n	RESET ACTION	AUto, LAtC1, LAtC2
Stb-n	STANDBY OPERATION	NO, YES
Lit-n	SETPOINT ANNUNCIATORS	OFF, Nor, rEu, FLASH



SERIAL COMMUNICATIONS PARAMETERS

This module is for RS232 and **RS485.**
See section 8.4 for the expalnation of these parameters

DISPLAY	PARAMETER	POSSIBLE SETTING
BAUd	BAUD RATE	300, 600, 1200, 2400, 4800, 9600, 19200
dAtA	DATA BITS	7, 8
PAr	PARITY BIT	Odd, EVEN, NO
Addr	METER ADDRESS	0 to 99
Abru	ABREVIATED PRINTING	NO, YES
Opt	PRINT OPTIONS	INP, tot, HILO, SPNt
out-n	OUTPUT LOGIC	nor, rEu
rSt-n	RESET ACTION	AUto, LAtC1, LAtC2

TROUBLESHOOTING THE TORQUE DISPLAY

PROBLEM	REMEDIES
NO DISPLAY	CHECK: Power level, power connections
PROGRAM LOCKED-OUT	CHECK: Active (lock-out) user input ENTER: Security code requested
MAX, MIN, TOT LOCKED-OUT	CHECK: Module 3 programming
INCORRECT INPUT DISPLAY VALUE	CHECK: Module 1 programming, Input Range Jumper position, input connections, input signal level, Module 4 Display Offset is zero, DSP is on Input Display PERFORM: calibration (If the above does not correct the problem.)
"OLOL" in DISPLAY(SIGNAL LOW)	CHECK: Module 1 programming, Input Range Jumper position, input connections, input signal level
"ULUL" in DISPLAY(SIGNAL HIGH)	CHECK: Module 1 programming, Input Range Jumper position, input connections, input signal level
JITTERY DISPLAY	INCREASE: Module 1 filtering, rounding, input range CHECK: Wiring is per EMC installation guidelines
MODULES or PARAMETERS NOT ACCESSIBLE	CHECK: Corresponding plug-in card installation
ERROR CODE (Err 1-4)	PRESS: Reset KEY (If can not clear contact factory.)

For further assistance, contact DACA Instruments

PARAMETER VALUE CHARTS

InP Signal lnput Parameters

DISPLAY	PARAMETER	FACTORY SETTING	MC SETTING
rANgE	INPUT RANGE	300µ	0.2 µ
dECPt	DISPLAY RESOLUTION	0.00	0.00
round	DISPLAY ROUNDING INCREMENT	0.01	0.01
FiLtr	FILTER SETTING	1.0	5.0
bAnd	FILTER ENABLE BAND	0.10	0.50
Pts	SCALING POINTS	2	2
StyLE	SCALING STYLE	KEy	KEy
inP 1	INPUT VALUE 1	0.00	0.00
dSP 1	DISPLAY VALUE 1	0.00	0.00
inP 2	INPUT VALUE 2	100.00	20.00
dSP 2	DISPLAY VALUE 2	100.00	6.20

SEC Secondary Function Parameters

DISPLAY	PARAMETER	FACTORY SETTING	MC SETTING
H Ht	MAX CAPTURE DELAY TIME	0.0	0.0
LO-t	MIN CAPTURE DELAY TIME	0.0	0.0
dSP-t	DISPLAY UPDATE TIME	2	2
b-L t	UNITS LABEL BACKLIGHT	OFF	OFF
OFFSt	DISPLAY OFFSET VALUE	0.00	0.00

tOt Totalizer (integrator) Parameters

DISPLAY	PARAMETER	FACTORY SETTING	MC SETTING
dECPt	TOTALIZER DECIMAL POINT	0.00	0.00
tbASE	TOTALIZER TIME BASE	- 10	- i n
SCFAC	TOTALIZER SCALE FACTOR	1.000	1.000
Locut	TOTALIZER LOW CUT VALUE	- 199.99	- 199.99
P-UP	TOTALIZER POWER-UP RESET	NO	NO

SPt Setpoint (Alarm) Parameters

DISPLAY	PARAMETER	FACTORY SETTING	MC SETTING
	SET POINT 1 SP-1		
ACt -n	SETPOINT ACTION	OFF	abHI
Sp-n	SETPOINT VALUE (main)	10.00	6.30
HYS-n	SETPOINT HYSTERESIS	0.02	0.02
tON-n	ON TIME DELAY	0.0	0.0
tOF-n	OFF TIME DELAY	0.0	0.0
out-n	OUTPUT LOGIC	nor	nor
rSt-n	RESET ACTION	Auto	Auto
Stb-n	STANDBY OPERATION	NO	NO
L t-n	SETPOINT ANNUNCIATORS	nor	nor
	SET POINT 2 SP-2		
ACt -n	SETPOINT ACTION	OFF	abHI
Sp-n	SETPOINT VALUE (main)	10.00	7.00
HYS-n	SETPOINT HYSTERESIS	0.02	0.2
tON-n	ON TIME DELAY	0.0	0.0
tOF-n	OFF TIME DELAY	0.0	0.0
out-n	OUTPUT LOGIC	nor	nor
rSt-n	RESET ACTION	Auto	Auto
Stb-n	STANDBY OPERATION	NO	NO
L t-n	SETPOINT ANNUNCIATORS	nor	nor

SrL Serial Communication Parameters

DISPLAY	PARAMETER	FACTORY SETTING	MC SETTING
bAUd	BAUD RATE	9600	19200
dAtA	DATA BIT	7	7
PAr	PARITY BIT	Odd	Even
Addr	METER ADDRESS	0	3
Abru	ABBREVIATED PRINTING	YES	YES
OPT	PRINT OPTIONS	YES	NO

LOC Display and Program Lockout Parameters

DISPLAY	PARAMETER	FACTORY SETTING	MC SETTING
H I	MAX DISPLAY LOCKOUT	rEd	rEd
LO	MIN DISPLAY LOCKOUT	rEd	rEd
tOt	TOTAL DISPLAY LOCKOUT	rEd	rEd
SP- I	SETPOINT 1 ACCESS	LOC	LOC
SP-2	SETPOINT 2 ACCESS	LOC	LOC
SP-3	SETPOINT 3 ACCESS	LOC	LOC
SP-4	SETPOINT 4 ACCESS	LOC	LOC
CodE	SECURITY CODE	0	0

FnC User input and Function Key Parameters

DISPLAY	PARAMETER	FACTORY SETTING	MC SETTING
USr- I	USER INPUT 1	NO	NO
USr - 2	USER INPUT 2	NO	NO
USr - 3	USER INPUT 3	NO	NO
F I	FUNCTION KEY 1	NO	NO
F2	FUNCTION KEY 2	NO	NO
rst	RESET KEY	NO	NO
Sc-F I	2nd FUNCTION KEY 1	NO	NO
Sc-F2	2nd FUNCTION KEY 2	NO	NO

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SECTION III

Serial Communication

8. RS485 BASICS

This section describes the RS485 communication protocol and the way to use it with all the controllers. Information for properly configuring each controller is also provided.

The RS485 communication standard allows the connection of up to 32 devices on a single pair of wires, distances up to 4,000 ft. and data rates as high as 10M baud (the meter is limited to 19.2k baud). The same pair of wires is used to both transmit and receive data. An RS485 bus is therefore always half-duplex, that is, data cannot be received and transmitted simultaneously.

If more than one slave device is connected to the interface, a unique node address must be assigned to each device. The meter then requires each command to be prefaced by an address specified (N). If only one device is connected, the address specifying command may be ignored.

COMMUNICATION FORMAT

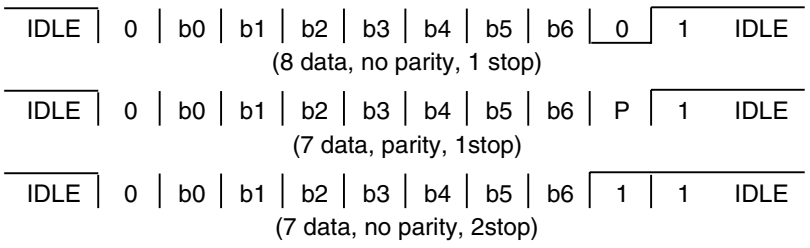
Data is transferred from the meter through a serial communication channel. In serial communications, the voltage is switched between a high and low level at a predetermined rate (baud rate) using ASCII encoding. The receiving device reads the voltage levels at the same intervals and then translates the switched levels back to a character.

The voltage level conventions depend on the interface standard. The table lists the voltage levels for each standard.

LOGIC	INTERFACE STATE	RS485*
1	mark (idle)	a-b < -200 mV
0	space (active)	a-b > +200 mV

*Voltage levels at the Receiver

Data is transmitted one byte at a time with a variable idle period between characters (0 to ∞). Each ASCII character is “framed” with a beginning start bit, an optional error detection parity bit and one or more ending stop bits. The data format and baud rate must match that of other equipment in order for communication to take place. The following figure list the data formats employed by the controllers.



START BIT AND DATA BITS

Data transmission always begins with the start bit. The start bit signals the receiving device to prepare for reception of data. One bit period later, the least significant bit of the ASCII encoded character is transmitted, followed by the remaining data bits. The receiving device then reads each bit position as they are transmitted. Since the sending and receiving devices operate at the same transmission speed (baud rate), the data is read without timing errors.

PARITY BIT

After the data bits, the parity bit is sent. The transmitter sets the parity bit to a zero or a one, so that the total number of ones contained in the transmission (including the parity bit) is either even or odd. This bit is used by the receiver to detect errors that may occur to an odd number of bits in the transmission. However, a single parity bit cannot detect errors that may occur to an even number of bits. Given this limitation, the parity bit is often ignored by the receiving device. The PAX meter ignores the parity bit of incoming data and sets the parity bit to odd, even or none (mark parity) for outgoing data.

STOP BIT

The last character transmitted is the stop bit. The stop bit provides a single bit period pause to allow the receiver to prepare to re-synchronize to the start of a new transmission (start bit of next byte). The receiver then continuously looks for the occurrence of the start bit.

COMMAND RESPONSE TIME

The meter can only receive data or transmit data at any one time (half-duplex operation). The meter ignores commands while transmitting data, but instead uses RXD as a busy signal (See Busy). When sending commands and data to the meter, timing restrictions are imposed when sending another command thereafter. This allows enough time for the meter to process the command and prepare for the next command.

At the start of the time interval t1, the computer program prints or writes the string to the com port, thus initiating a transmission. During t1, the command characters are under transmission and at the end of this period, the command terminating character (*****) is received by the meter. The time duration of t1 is dependent on the number of characters and baud rate of the channel.

t1 = (10***** # of characters) / baud rate

At the start of time interval t2, the meter starts the interpretation of the command and when complete, performs the command function. This time interval t2 varies from 2 msec to 50 msec. If no response from the meter is expected, the meter is ready to accept another command.

If the meter is to reply with data, the time interval t2 is controlled by the use of the command terminating character. The standard command line terminating character is '*****'. This terminating character results in a response time window of 50 msec minimum and 100 msec maximum. This allows sufficient time for the release of the sending driver on the RS485 bus. Terminating the command line with '$' results in a response time window t2) of 2 msec minimum and 50 msec maximum. The faster response time of this terminating character requires that sending drivers release within 2 msec after the terminating character is received.

At the beginning of time interval t3, the meter responds with the first character of the reply. As with t1, the time duration of t3 is dependent on the number of characters and baud rate of the channel. t3 = (10 ***** # of characters)/baud rate. At the end of t3, the meter is ready to receive the next command.

The maximum serial throughput of the meter is limited to the sum of the times t1, t2 and t3.

8.1 TEMPERATURE CONTROLLER

This chapter introduces the principles of the EI-Bisynch communication protocol. EI-Bisynch is a proprietary Eurotherm protocol based on the ANSI X3.28-2.5 A4 standard for message framing. Despite its name, it is an ASCII based asynchronous protocol. **Data is transferred using 19200 baud, 7 data bits, even parity 1 stop bit.**

EXPLANATION OF TERMS

ADDRESS

Each instrument has a configurable address consisting of two digits, the fist being a 'group' number 0 to 9, and the second a 'unit' number 0 to 9. There are, in principle, therefore 100 different addresses that may be used, 00 to 99, although in Series 2000 instruments, address 00 is reserved for use in configuration mode, leaving addresses 01 to 99 available.

The address is set on the CmS LiSt, using the Addr parameter. It may be necessary to use FuLL user interface via the ACCS LiSt to view and change the value of this parameter; see the instrument manual for more information.

MNEMONICS

EI-Bisynch identifies parameters within an instrument using what are known as 'mnemonics'. These are usually two letter abbreviations for a given parameter, for example PV for Process Variable, OP for Output, SP for Setpoint, and so on. Tables giving the mnemonics for parameters used in the 2000 Series is provided in Chapter 5.

CHANNELS

EI-Bisynch provides for 'channel' data. This would be used, for example, when a single physical unit contains several independent control loops, each having their own Process Variable, Setpoint, and Output Power. In this case, the values for each loop are obtained by specifying different channel numbers: '1', '2', etc.

The 2000 series supports an optional channel number of '1', since it is a single loop controller. Other channel numbers will be rejected as invalid, with the exception of channel '9' which has a specialized function described elsewhere in this manual.

The channel number, if used, is encoded as a single ASCII character preceding the mnemonic, for example 1PV.

CONTROL CHARACTERS

Several ASCII control characters are used in the framing of EI-Bisynch messages. These are:

Hex Value	Name	Usage	PC Control Char
02	STX	Start of data in a message	B
03	ETX	End of message	C
04	EOT	End of transmission sequence	D
05	ENQ	Enquiry for a value	E
06	ACK	Positive Acknowledge	F
15	NAK	Negative Acknowledge	U

DATA FORMATS

Data in Bisynch messages is sent as a sequence of ASCII printable characters. Two principal data formats are used in Series 2000 instruments, Free format, and hex format.

FREE DATA FORMAT

Parameter values returned from the instrument in 'free format' are of variable length. The instrument returns the value as it would be displayed on its front panel, with no leading or trailing spaces, e.g.:

-99.9
123.4
123 *(integer value)*

Note that trailing decimal point characters are suppressed. Any 'sign' must precede the number itself.

Values written to the instrument may contain leading and trailing spaces, leading or trailing zeros, or sign indications.

This format is used for almost all parameters available over EI-Bisync in the 2000 series, with the exception of a few status words and prime set parameters which use 'hex format'.

NB: Because the returned value is of variable length, it is necessary to use the terminating ETX character to delimit the data value. It is not usually possible to make assumptions regarding the number of characters used to represent a value unless you are operating in a very restricted numeric range, 10.0 to 99.9 for example, where all possible values will take 4 characters to transmit.

HEX DATA FORMAT

This format is used for a few status words and prime set parameters. The value is preceded by a '>' (hex 3E) character, and normally consists of 4 hexadecimal characters, although it is acceptable to suppress leading zeroes when parameters are written. These characters represent the value of a 16 bit unsigned integer in hexadecimal (base 16) notation. Upper or lower case representations of 'A' to 'F' are acceptable, although the instrument will always return upper case. For example

>2040 *equivalent to* 8256 *decimal*
>ABCD *equivalent to* 43981 *decimal*

This format is also used in conjunction with the channel 9 specifier to set up instrument scroll lists. More information on this operation is given later in this manual.

READING DATA FROM THE TEMPERATURE CONTROLLER

To read data, a 'poll' message is issued to the instrument. This message takes the following format:

[EOT] (GID) (GID) (UID) (UID) (CHAN) (C1) (C2) **[ENQ]**

Each item in the above description represents a single ASCII character. The items in bold type and square brackets are control characters used to 'frame' the message, whose values may be determined by reference to the table on P4.2. The bracketed items in normal type have the following significance:

GID The group id, or the first digit of the instrument address. E.G. '1' (31 hex) for instrument address 12, '0' (30 hex) for instrument address 1 (which is equivalent to address 01). The GID is sent twice, as a validation mechanism,

UID The unit id, or the second digit of the instrument address. E.G. '2' (32 hex) for instrument address 12, '1' (31 hex) for instrument address 1. The UID is sent twice, as a validation mechanism.

CHAN The channel number, which is optional. If used, send a value of '1' for Series 2000 single loop controllers.

C1 The first character of the mnemonic for the parameter being accessed, e.g. 'P' for Process Variable.

C2 The second character of the mnemonic for the parameter being accessed, e.g. 'V' for Process Variable.

If the instrument receives the message correctly and the mnemonic is valid, it will reply with

[STX] (CHAN) (C1) (C2) <DATA> [ETX] (BCC)

CHAN Echo of the channel number from the poll message, if used. Otherwise not returned

C1, C2 Echo of the mnemonic from the poll message.

DATA The value of the parameter in a given display format. E.G 99.9, 1.2, -999, >1234 etc.

BCC This is a block checksum that is generated for data validation. It is computed by XORing (exclusive or) all the characters after and excluding the STX, and including the ETX. Note that it may take the value of 'EOT' and care must be taken when writing a protocol driver to ensure that this is not seen as an 'End of Transmission' sequence.

If a request is made for a non existent mnemonic, or a mnemonic representing a parameter that is not configured, the instrument will reply with a single 'EOT' character. If there is no reply at all, one of the following errors is possible:

- Incorrect wiring or faulty hardware (Cable, PC, RS422/485 adapter, •Instrument Comms Module)
- Instrument Address set wrong (PC, Instrument)
- Wrong Line set-up, should be 19200 baud, 7 data bits, even parity, 1 stop (PC)
- Baud rate set wrongly (PC, Instrument)
- Parity error detected by instrument (Suspect line noise)
- Incorrect message format (PC)

To determine the cause of any communications problems, work systematically through the possible causes.

Example of a **Parameter Read**

For example, when reading PV from instrument address 1, the following sequence of characters will be sent and received:

Master: [EOT] 0011PV [ENQ]
Instrument: [STX] PV16.4 [ETX] (BCC)

Note that the BCC is a single character, that in this case has a value of 18 hex.

In hexadecimal, the transaction is as follows:
Master: 04 30 30 31 31 50 56 05
Instrument: 02 50 56 31 36 2E 34 03 18

FAST POLL

Fast polling provides a means of rapidly obtaining a set of parameter values, following an initial successful parameter read carried out as specified above. To

read the next parameter in the 'fast poll' list, the master must send an 'ACK' control character following receipt of a valid poll response message, whereupon a reply message in the same format as the poll response will be received.

Parameters are only returned if they are configured, and the order in which parameters are returned sorted alphabetically by mnemonic, excluding program segment data. The only real use of this facility is to build an image of the parameter database in an instrument, and its use in other scenarios is not recommended.

REPEATED POLLING OF THE SAME PARAMETER

This facility provides a means of repeatedly obtaining a particular parameter value, following an initial successful parameter read carried out as specified above. To repeat the last poll operation, the master should transmit a 'NAK' control character following receipt of a valid poll response message, whereupon a reply message in the same format as the poll response will be received.

WRITING DATA TO THE TEMPERATURE CONTROLLER

To write data, a 'select' message is issued to the instrument. This message takes the following format:

[EOT] (GID) (GID) (UID) (UID) **[STX]** (CHAN) (C1) (C2) <DATA> **[ETX]** (BCC)

Each item in the above description represents a single ASCII character. The items in bold type and square brackets are control characters used to 'frame' the message, whose values may be determined by reference to the table on P 4.2. The bracketed items in normal type have the following significance:

GID The group id, or the first digit of the instrument address. E.G. '1' (31 hex) for instrument address 12, '0' (30 hex) for instrument address I (which is equivalent to address 01). The GID is sent twice, as a validation mechanism.

UID The unit id, or the second digit of the instrument address. E.G. '2' (32 hex) for instrument address 12, '1' (31 hex) for instrument address 1. The UID is sent twice, as a validation mechanism.

CHAN The channel number, which is optional. If used, send a value of '1' for Series 2000 single loop controllers.

C1 The first character of the mnemonic for the parameter being accessed, e.g. 'P' for Process Variable.

C2 The second character of the mnemonic for the parameter being accessed, e.g. 'V' for Process Variable.

DATA The value of the parameter in a given display format. E.G 99.9, 1.2, -999, >1234 etc.

BCC This is a block checksum that is generated for data validation. It is computed by XORing (exclusive or) all the characters after and **excluding** the STX, and **including** the ETX.

If a parity or address format error is detected, the instrument will not reply. Otherwise, the instrument will reply with either

[NAK] Failed to write: BCC is incorrect, or Parameter not available or not configured, or Parameter is read only, or attempt has been made to read a parameter that is outside limits. A read of the EE mnemonic will give

more information.
OR
[ACK] Parameter write was successful.

If there is no reply at all to a write request, one of the following errors is possible:

- Incorrect wiring or faulty hardware (Cable, PC, RS422/485 adapter, Instrument Comms Module)
- Instrument Address set wrong (PC, Instrument)
- Wrong Line set-up, should be 19200 baud, 7 data bits, even parity, 1 stop (PC)
- Baud rate set wrongly (PC, Instrument)
- Parity error detected by instrument (Suspect line noise)
- Incorrect message format (PC)

To determine the cause of any communications problems, work systematically through the possible causes.

Example of a **Parameter Write**
For example, when writing a value of 22.0 to the setpoint to an instrument at address 1. the following sequence of characters will be sent and received:

Master: [EOT]0011[STX]SL22.0[ETX](BCC)
Instrument: [ACK]

Note that the BCC is a single character, that in this case has a value of 32 hex.

In hexadecimal, the transaction is as follows:
Master: 04 30 30 31 31 02 53 4C 32 32 2E 30 03 02
Instrument: 06

Broadcasts

A particular GID (group identifier) and UID (unit identifier) address is reserved for use in broadcast messages; the tilde character '-', hex 7E, can be used as a wild card in the GID and/or UID to selectively broadcast to all or to specific groups of instruments. In this case, no reply to the write request will be sent by any instrument. The only foolproof method of determining whether the write has succeeded is therefore to read back the parameter from each instrument and verify that it is set correctly. *Broadcast is only recommended for systems where failure to communicate a value due to physical failure of wiring or other equipment will not cause damage to equipment.*

ERROR CODES HELD IN EE

The special 'EE' mnemonic may be used to give the status of the last communications transaction. It is a hex format parameter, and the values it may contain are as follows:

0: No Error
1: Invalid Mnemonic
2: Parameter is read only
7: Incorrect message
8: Limit error

BISYNCH MESSAGE LATENCY

The time taken for the Series 2000 instrument to process a message and start the transmission of a reply is called the latency. This does not include the time taken to transmit the request or reply.

Parameter read functions for 2000 Series EI-Bisynch take place with a latency of between 2 and 10 ms.

Parameter write functions for 2000 Series EI-Bisynch take place with a latency of between 5 and 50ms.

It is possible to artificially increase the latency by setting the 'Comms Delay' parameter in the Mod HA configuration list. This is sometimes required to allow a guaranteed gap between requests and responses, needed by some RS485 adapters to switch from transmit to receive states.

MESSAGE TRANSMISSION TIME

The time required to transmit a message will depend on the length of the message and the baud rate.

$$\text{Message transmission time} = \frac{\text{Number of bytes in the message} * \text{Number of bits per character}}{\text{Baud rate}}$$

The number of bytes in a message can be determined by reference to the information given above.

The number of bits per character will be ten. (1 start bit, 7 data bits, an even parity bit and 1 stop bit).

8.2 SPEED CONTROLLER

USING THE REMOTE SERIAL INTERFACE

To control through the RS485 Serial Interface, the **Local/Remote Input** switch must be closed (see section 7.2). This allows the MicroSpeed 196 to accept commands over the RS485 link. The MicroSpeed 196 can be set up to only accept commands over the RS485 link, or to allow some operator control as programmed with Variable 30. All new set points and programming must come over the RS485 link, except for speed changes with the scroll, or set point 1 - 4 switches. The **RUN, STOP, and E--Stop** inputs are also active in any mode of operation, and cannot be disabled.

IMPORTANT: These remote set up variables must be set up from the keypad. The unit must be in LOCAL mode (see section 7.2)

VARIABLE 19 - NODE ADDRESS - Enter an address from 1 - 99. This address will be used in the command format to talk to the MicroSpeed 196 with that specific address. When using a global command (address 00) the MicroSpeed 196 with node address 01 will be the only MicroSpeed 196 to answer the host computer, but all MicroSpeed 196's will respond to global commands. Never duplicate an address on the same communications port. (for MC: 05)

VARIABLE 20 - BAUD RATE - Enter the number (1-6) corresponding to the desired operating baud rate. Each character has one start bit, eight data bits, one stop bit, and no parity.

1 = 300
2 = 1200
3 = 2400
4 = 4800
5 = 9600
6 = 19200 (MC)

VARIABLE 30 - EXTERNAL SWITCH ENABLE IN REMOTE MODE - This variable allows the external inputs to be active during Remote mode. Entering a I enables the function. Entering a 0 disables the function. Default is 0000, or all functions controlled by the RS485 link. Any combination of functions can be selected: (for MC: 1111)

0001 = Run, Stop, and Jog inputs enabled
0010 = Forward/Reverse, Master/Follower, Closed/Open Loop, Scroll up and Scroll Down inputs enabled
0100 = Set Points 1,2,3&4 Enabled
1000 = Keypad RUN, STOP, and JOG enabled

Variable 48 - Buffer Error - This variable is used to help diagnose communication errors. If the variable displays a 1, then characters outside the MicroSpeed 196 protocol format have been received by the MicroSpeed 196. If the variable displays a 2, then transmissions have been sent to the MicroSpeed 196 faster than it can process the information and respond. The most recent error is kept in this variable until you set it to 0.

COMMUNICATION PROTOCOL

The communication protocol is a 13-character command format. Each character has one start bit, eight data bits, one stop bit, and no parity. The host sends messages in this format and the addressed MicroSpeed 196 responds in the identical format. The time from the end of the host message to the beginning of the MicroSpeed 196 message can vary from 10 to 30 milliseconds, depend-

ing on the type of the host message. The following diagram shows the command format.

0	1	2	3	4	5	6	7	8	9	10	11	12
stx	device type	node addr 10's	node addr 1's	mess type	var# 10's	var# 1's	data 1000's	data 100's	data 10's	data 1's	dec. pt. loc.	etx

Char#	Description	ASCII	Value	Typical Keyboard
0	stx (start of transmission)	02	hex	ctrl-B
1	device type	30	hex	0
2	node address (10's digit)	30-39	hex	0-9
3	node address (1's digit)	30-39	hex	0-9
4	message type	30-33	hex	0-3
5	variable (10's digit)	30-39	hex	0-9
6	variable (1's digit)	30-39	hex	0-9
7	data (1000's digit)	30-39	hex	0-9
8	data (100's digit)	30-39	hex	0-9
9	data (10's digit)	30-39	hex	0-9
10	data (1's digit)	30-39	hex	0-9
11	decimal point location	30-34	hex	0-4
12	etx (end of transmission)	03	hex	ctrl-C

DESCRIPTION OF CHARACTERS:

Character 0 - **stx** - This character is used to indicate the start of a message. The MicroSpeed 196 uses this character to open a new segment in the receive buffer.

Character 1 - **Device Type** - Always a 0 for the MicroSpeed 196.

Character 2 and 3 - **Node Address (10's and 1's digits)** - Used to select an individual MicroSpeed 196 on the communications link. Corresponds to Variable 19 on the MicroSpeed 196. Character 2 is the 10's location and character 3 is the 1's location. A node address of 00 is a GLOBAL COMMAND. All MicroSpeed 196 units are affected by a global command, but only address 01 will return a response to the host.

Character 4 - **Message Type** - Tells what kind of message is being sent. This is also the location at which the MicroSpeed 196 will indicate an error in a host communication. Valid characters from the host are 0 (command), I (read variable), or 2 (write variable). The MicroSpeed 196 will echo the host in this character location unless the host communication message has an error; if this occurs, it will send back a 3 (error).

Characters 5 and 6 - **Variable Number (10's and 1's digits)** - These are variable number specifiers during read and write messages. In command messages, the Character 6 (I's) location specifies the type of command (start, stop, etc). In an error response from the MicroSpeed 196, the error type is specified in Character 6.

Characters 7-10 - **Data Field** -These characters hold the data being passed between the host and the MicroSpeed 196. Ch#7 = 1000's, Ch#8 = 100's, Ch#9 = 10's, Ch#10 = 1's.

Character 11 - **Decimal Location** - This specifies the location of the decimal point in the data field.

Value Entered	Decimal Location
0	X.XXX
1	XX.XX
2	XXX.X
3	XXXX.
4	XXXX (no decimal point)

Character 12 - **etx** - This character signifies the end of the message transmission.

USING THE SERIAL PROTOCOL

Global Messages - The global message is given using the Node Address 00. Only Node 01 will return a response, but all Microspeed 196 units will act on the message. *Note: Global Read commands are not allowed and will prompt Node 01 to respond with an error message.*

READ A VARIABLE - 1

Select the Node Address (you cannot do a global read). Enter the message type as 1 (Ch#4). Enter the variable you wish to read into Characters 5 and 6. The MicroSpeed 196 will mirror the message string with the data and decimal field filled.

Example: Read Node 1, Variable 01, when Variable 01 = 1800
Message Sent – stx00110100000etx
Message Returned – stx00110118004etx

WRITE TO A VARIABLE - 2

Used just like a read, only the message type is 2, and you must fill the data field and decimal locator. A global write command is allowed.

Example: Write Node 27, Variable 02, the Data 15.00
Message Sent - stx02720215001etx
Message Returned - stx02720215001etx

COMMAND MESSAGES - 0

There are 9 different command messages that can be sent to the MicroSpeed 196. Enter the 0 as the message type (ch# 4) and the command type (0-8) is entered into the character 6 location (var# 1's).

MESSAGE TYPE	COMMAND TYPE	FUNCTION
0	0	Start
0	1	Stop
0	2	E-Stop
0	3	Set to factory defaults.
0	4	Change set point (immediate change).
0	5	Load master set point (wait for execute).
0	6	Execute loaded master set point.
0	7	Load follower set point (wait for execute).
0	8	Execute loaded follower set point.

Example: Command All MicroSpeed 196 units to Stop
Message Sent - stx00000100000etx
Message Returned – stx00100100000etx

COMMAND MESSAGE TYPE DEFINITIONS

Start - **0** - Starts the specified MicroSpeed 196. If the front or back panel stop has been enabled (with Var 30) and Stop is held, this command will be ignored.

Stop -**1** - Stops the specified MicroSpeed 196.

E-stop - **2** - E-stops the specified MicroSpeed 196.

Set to Factory Defaults - **3** - Sets all variables, except Node Address (Var 19) and Baud Rate (Var 20), to the default values.

SET POINT CHANGES

Only the active set point can be changed via commands 4 - 8. To change a non-selected set point, use the write message type. The decimal location is fixed by Variable 02 in the Master mode or Variable 23 in the Follower mode. You cannot write to the active set point's variable while running.

Change Set Point - **4** - Changes the presently selected set point to the value sent.

Load Master Set Point - **5** - Allows for a new speed set point to be loaded, but not executed. The value will be stored in Variable 49.

Execute Master Set Point - **6** - Moves the loaded speed set point into the active set point (1 - 4), and ramps to the new value.

ERROR MESSAGE - 3

If the MicroSpeed 196 detects an error in a message, it will respond with a 3 in the Character #4 position. The type of error will be specified in the Character #6 position.

Error type	Problem
1	Parity Error (Standard Definition)
2	Data Error (Data Outside of Range 1 - 9)
3	Global Read Error (Cannot Use the Address 00 During Read)
4	Etx Error (Etx Came Early, Late or Not At All)
5	Command Error (Reference Below)

Command Error - Any of the following conditions will give a command error:

- Message type out of range (0-2).
- Command type out of range (0-8).
- Variable value out of range.
- Write command sent to a protected variable while running.
- Command or write sent while in local mode.
- Load or execute new Master set point while in Follower mode.
- Load or execute new Follower set point while in Master mode.

REMOTE VARIABLES

The Following variables are only available over the RS485 serial port (remote mode):

49 - New Set Point (Explained in Command, Changing Set Points - Monitor only)
50 - Serial Status (Explained Below - Monitor Only)
51 - Master or Follower Mode (0=Master, 1 =Follower)
52 - Closed or Open Loop (0=Closed Loop, 1 =Open Loop)
53 - Forward or Reverse (0=Forward, 1 =Reverse)
54 - Master Set Point 1 in User Units
55 - Master Set Point 2 in User Units
56 - Master Set Point 3 in User Units
57 - Master Set Point 4 in User Units
58 - Follower Set Point 1 in User Ratios
59 - Follower Set Point 2 in User Ratios
60 - Follower Set Point 3 in User Ratios
61 - Follower Set Point 4 in User Ratios
62 - Display (Explained Below - Monitor Only)
63 - Alarm Status (Explained Below - Monitor Only)

Serial Status: Variable 50 - Contains information on the present state of the MicroSpeed 196. The data is returned in Characters 7 - 10.

Char #7 (1 000's)	**Char #8 (1 00's)**	**Char #9 (10's)**
Operation status	**Local/Remote**	**Active Set Point**
0 = E-Stop	0 = Local	1 = set point 1
1 = Deceling	1 = Remote	2 = set point 2
2 = Stopping		3 = set point 3
3 = Accelin		4 = set point 4
4 = Running		
5 = Ready Mode		
7 = No Feedback		
8 = Digital Speed Pot Mode (Diag #9)		

Variable 62 - **Display** - This variable will return whatever is on the numeric display of the MicroSpeed 196. Refer to display variables 21 and 22 for information on what can be displayed.

Note: It is possible to receive a negative sign in Character #7, (1000's data) if the follower error pulses, or the error output is being displayed.

Variable 63 - **Alarm Status** - Refer to Display (Variable 21) for coding. This will return the status of the alarm outputs, per Variable 21, Option 7.

MICROSPEED 196 SERIAL COMM. TROUBLESHOOTING

Protected Variables in the Run Mode:

Var 01	Maximum Speed in RPM
Var 02	User Units at Maximum Speed
Var 03	PPR
Var 04	Maximum Lead RPM
Var 05	Lead PPR
Var 23	User Unity Ratio
Var 51	Master/Follower

The active set point will only change with a Change Set Point command. A write command to the active set point while running will return an error message.

Possible Causes for No Communications.

The unit does not act on or respond to messages sent.

1 .Check Baud Rate and Address.
2. Check wiring.
3. Check Variable 48 for buffer communication errors.
4. All 13 characters not sent.
5. Check power to unit.
6. Do a Diagnostic 6 communications test.

The unit acts on a message but does not return a response.

1. Using global commands without Node I on line.
2. Not waiting long enough for response.
3. The MicroSpeed 196 transmit lines are open or shorted.
4. More than one MicroSpeed 196 with the same node address.
5. Do a Diagnostic 6 communications test.

8.3 LOAD INDICATOR

POWER UP INFORMATION

The E725 is fitted with a RS485 interface so that the E725 can be quickly and easily connected to a computer. The communication interface between the E725 and the host computer has been designed to be very flexible by using simple English commands. This makes it very simple to program the E725 using a terminal emulation program. The default communication protocol is 1 start, 8 data and 1 stop bit at 19200 baud.

If you are unsure which communication protocol is fitted or the programmed baud rate then switching the E725 off and on, will force the E725 to display the following prompts:

a) Instrument Identification (e.g. E725).
b) Software Version Number (e.g. 1.00)
c) The input and option board fitted (e.g. AC-O).

Where O = Option Board :
- 0 = No board fitted.
- 1 = Relay.
- 2 = Fast Limits
- 3 = Fast MAX / MIN / TIR.
- 4 = Dual Channel Computational.

d) Summary of the current COMMS settings in the format "XX.Y.Z".

where XX = Module Address.

Y = Communication Mode:
- 0 = RS232
- 1 = RS485

Z = Baud Rate:
- 0 = 600
- 1 = 1200
- 2 = 2400
- 3 = 4800
- 4 = 9600
- 5 = 19200
- 6 = 38400
- 7 = 57600

A POWER ON with the RESET key pressed will clear the communications settings back to RS232 communication at 96000 baud, so it is necessary to use the **#nn SET COMMS** command to reconfigure the serial communications protocol.

COMMUNICATION BASICS

Since the E725 is used on a RS485 network, all units expect to be sent a two digit hexadecimal address before any command, this address must be preceded by # and the command line must be terminated by a carriage-return, line-feed sequence (C_RL_F). If the address of the command line does not match the programmed address of the E725 then the command will be ignored.

The E725 can only respond to serial communications only during normal operation (i.e., pressing a front panel key, applying a digital input, or if the instrument is in the setup menu, disables serial communication).

For example, suppose we want to zero the display using serial communication on the E725 with address 00, then the following command must be sent

#04 ZERO C_RL_F

In this section, all the E725 commands will have the following format

#nn COMMAND,P1,P2 C_RL_F

Where

#nn	Please substitute nn with the address of the E725 instrument with which you wish to communicate.
COMMAND	The command to be sent.
,P1,P2	Optional command line parameters.
C_rL_f	Is the end of line sequence (carriage return, line feed).

The E725 can also be configured for software handshaking, so that the E725 will respond with either

OK	If a valid command that does not request data (e.g. **ZERO)** has been received.
ERROR	If the E725 does not recognize the command or the necessary password has not been set.
Data String	If the host computer requests data (e.g. **Print Data).**

All responses from the E725 are terminated with a carriage-return, line-feed (ASCII characters 13, 10) sequence.

RUNTIME COMMANDS

The following table quickly lists all the runtime commands that do not require a password.

Command	Description
SYS	Prints software version number.
GET ERROR	Prints error status
CLR ERROR	Clears error status.
RESET	Resets the E725.
RESET PEAKS	Clears the stored MAX, MIN and TIR values.
RESET LIMITS	Resets any latched limits.
CLR USER LEVEL	Clears the current user level (password).
ZERO	Calculates the tare reading (i.e. zeros the display)
CLR ZERO	Clears the tare reading.
DISPLAY INPUT	Displays the normal input signal
DISPLAY MAX	Displays the MAX input signal.
DISPLAY MIN	Display the MIN input signal.
DISPLAY TIR	Display the TIR input signal.
DISPLAY F1	Selects display function 1
DISPLAY F2	Selects display function 2
DISPLAY F3	Selects display function 3
DISPLAY F4	Selects display function 4
PRINT DATA	Prints the current display value.
PRINT CAL	prints the shunt calibration value (DC Board) or the excitation voltage (AC Board)

The following table quickly lists all the setup commands that REQUIRE a password, the relevant password is listed on the far right hand side of the page next to the command. For example, to quickly configure and calibrate an E725 using the serial communication port, send the following commands to the E725.

#04 SET USER LEVEL,3,3C_RL_F
#04 SET FILTER VALUE,5$C_RL_{F\,f}$
#04 SET EXCITATION,10C_RL_F
#04 SET GAIN,1C_RL_F
#04 SET DP,0,7075C_RL_F
#04 SET SCALING, 7075C_RL_F
#04 SAVEC_RL_F

It can be seen from the above example that the highest level password (i.e. P3) has been used which allows access to all the commands. Whereas, if the second level password (i.e. P2) had been used it would not have been possible to access the **SET FILTER VALUE, SET EXCITATION,** or **SET GAIN** commands.

Commands	Description
CLR SETUP	Clears the current setup
SAVE	Saves the current setup
SET PASSWORDS	Programs passwords 1, 2, and 3
SET COMMS	Programs the communications protocol and baud rate
SET FILTER VALUE	Programs the filter value
SET EXCITATION	Programs the excitation voltage for the DC input board
SET GAIN	Programs the gain for the input board
SET DP	Programs the number of decimal places and the full scale value (i.e. calibration point)
SET SCALING	Calibrates the input signal
SET LINEARISATION	Programs the straight lline linearisation
SET POLYNOMIAL	Programs polynomial linearisation
SET ENGINEERING OFSET	Programs the engineering offset
SET TARE POINT	Programs the tarepoint
SET LIMT	Programs the limits

DESCRIPTION OF COMMANDS

#nn SYS C_RL_F
Sending this command causes the E725 to return the current software version

#nn GET ERROR C_RL_F
The unit returns either the number of command lines it had received before the erroneous line and after the last **CLR ERROR** command or **OK** if no errors have occurred.

This facility allows a number of lines of command to be sent in a block and then error checked afterwards.

The **GET ERROR** command only returns the line number on which the FIRST error occurred. Also please ensure that the **CLR ERROR** command is used before the set up lines are re-sent.

#nn CLR ERROR C_RL_F -
Causes the error counter to be reset. The error counter stores the number of commands which have been received since the last **CLR ERROR** command and before an erroneous command.

#nn RESET C_RL_F
This causes the E725 to restart the program which is equivalent to switching the E725 off and on.

This command will clear any changes made to the E725 since the last **SAVE** command.

#nn RESET PEAKS
This causes the E725 to reset the MAX, MIN and TIR values.

#nn RESET LIMITS
This causes the E725 to reset any latched limits.

#nn CLR USER LEVEL
This command clears the current user level (password) so that it is not possible to access any of the setup commands.

#nn SET USER LEVEL,L,P
The E725 has 3 levels of security UL1, 2 & 3. Each level has a separate password. To change a user level you must enter both the level and the password.
L: User Level
P: Password for L

#04 SET USER LEVEL,3,3C_RL_F

#nn ZEROC_RL_F
This command compares the input signal against the programmed tare point. For example, prior to starting a test it is possible to zero the input signal by using either the front panel, digital input or serial communication. Alternatively in a gauging application this facility enables a master to be inserted in the jig and any errors can then be quickly removed prior to acquiring data. The tare reading is calculated as follows:

Tare Reading = f(x) + E - T

Where f ( ) = Scaling Function
E = Engineering offset
T = Tare Point.
X = ADC Counts.

The **ZERO** command does not affect the analogue output

#nn CLR ZERO
This command clears the tare reading (i.e. tare reading = 0)

The **CLR ZERO** command does not affect the analogue output

#nn PRINT DATA
This command prints the current display value.

#nn PRINT CAL
This command will either print the excitation voltage (ac input board only) or the shunt cal value (dc board only).

The shunt cal value display will be the gross value (i.e. the local zero offset will not be subtracted from the reading so that the shunt cal value is constant regardless of the tare reading).
It is important to remember that:

a) The analogue output will change when the PRINT CAL command is sent to the E725.
b) If the instrument is fitted with the fast limit board then the limits will monitor either the AC excitation or the DC shunt cal value
c) If the fast MAX/MIN/TIR is fitted then the analogue peak catchers will catch either the excitation voltage or the shunt cal value.

PASSWORD PROTECTED COMMANDS

#nn CLR SETUP
This command is password protected and clears the setup parameters according the current password. For example, if the entered password is P3 then all the setup parameters are cleared, if the entered password is P2 then only the calibration and limits parameters are clear and if the entered password is P1 then only the limits setup parameters are cleared.

#nn SAVE
This command saves all of the settings to non-volatile memory. Until this command is used, all settings will be lost if the power is switched off or a **RESET** command is sent to the E725.

#nn SET PASSW0RDS,P1,P2,P3
This commands reprograms the three passwords, which are used to access the various E725 setup facilities

Where
P1 is the password used for the limits menu.
P2 is the password used for the calibration menu.
P3 is the password used for the Configuration Setup Menu.

#nn SET COMMS, Address, Protocol, BaudRate, HandShaking,
This command sets up the communications parameters for the E725.

Changing any of the serial communications parameters has an immediate effect on the E725 communications.

Address Sets the module address of the E725. This only needs to be changed if a number of E725 instruments are connected to the same RS485 network. Acceptable values are 00 to FF hexadecimal. (**04**)
Protocol Sets the communications protocol for the E725. Acceptable values are 232 or **485**.
BaudRate Sets the communications baud rate of the E725. Acceptable values are 600, 1200, 2400, 4800, 9600, **19200**, 38400 or 57600.
HandShaking Sets the response made by the 725 to a command. If OFF, then the 725 does not make any response to commands otherwise if **ON**, the 725 will respond with OK or ERROR if the command was erroneous.

For example, to set the E725 address to four, RS485 communication at19200 and software hand-shaking the command would be:

#04 SET COMMS,04,485,19200,ON C_RL_F

#nn **SET FILTER VALUE,**Value
This command is used to set the filter value. Acceptable values are 1, 2, 3, 4, or **5**.

#nn **SET EXCITATION,***Value*
This command is used to set the excitation voltage. Acceptable values are 1, 3, 5 or **10**.

#nn SET GAIN,Value
This command is used to set the gain of the input board. Acceptable values are 1, 2, 3, 4, 5, **6**, 7, o r 8.

#nn SET DP,Resolution,Ful Scale (**no dp**)
This command is used to set the number of decimal places and the transducer calibration point (i.e full scale value).

Resolution Sets the number of decimal places to be displayed. Acceptable values are 0, 1, 2, 3 o r 4.
Full Scale Sets the transducer calibration point (i.e. full scale value).

#nn SET SCALING,M,C
This command is used to set the transducers calibration data, so that the transducer is scaled according to the following formulae

$$Y = Mx + C + E - T$$

where Y = Scaled data in engineering units.
M = Calibration scaling factor.
C = Calibration zero offset.
E = Engineering offset
T = Tare Reading.
X = ADC Counts.

#nn SET LINEARISATION,Cp_0,M_0,C_0,CP_1,M_1,C_1,..., Cp_n,M_n,C_n
This command is used to set the transducers calibration data, so that the transducer is linearised using the straight line method.

Cp_0 First calibration break point.
M_0 First scaling constant.
C_0 First offset constant.

This option cannot be used if either the fast limit or the fast MAX/MIN/TIR board is fitted and the maximum number of break points is eleven.

#nn SET POLYNOMIAL,Cn,..., C_1, C_0
This command is used to set the transducers calibration data, so that the transducer is linearised using a polynomial.

This option cannot be used if either the fast limit or the fast MAX/MIN/TIR board is fitted and the maximum number of coefficients is 16 i.e. n=15).

#nn SET ENGINEERING OFFSET, Value (**0**)
This command is used to set the engineering offset and tare point to the entered value.

#nn SET TARE POINT, Value (**0**)
This command is used to set the tare point to the entered value.

#nn SET LIMIT,Limit, Operation, Mode, Set Point, Deviation, Hysteresis, Latched

This command is used to configure the selected limit and the command line parameters are:

Limit	Defines the limit to be configure. Acceptable values are L1, L2, L3 and L4.
Operation	Defines the operation of the limit. Acceptable values are OFF, HI, LO and DEVIATION.
Mode	Defines the signal that the limit is to be compared against, Acceptable values are GROSS, NET, TARE, MAX, MIN and TIR.
Set Point	Defines the limits set point.
Deviation	Defines the limits deviation value.
Hysteresis	Defines the limits hysteresis value.
Latched	Defines whether the limit is working is latched or unlatched mode. Acceptable values are LATCHED or UNLATCHED.

8.4 TORQUE INDICATOR

SENDING COMMANDS AND DATA

When sending commands to the meter, a string containing at least one command character must be constructed. A command string consists of a command character, a value identifier, numerical data (if writing data to the meter) followed by a command terminator character * or $.

COMMAND CHART

Command	Description	Notes
N	Node Address Specifier	Address a specific meter. Must be followed by one or two digit node address. Not required when node address = 0.
T	Transmit Value (read)	Read a register from the meter. Must be followed by register ID character.
V	Value change (write)	Write to register of the meter. Must be followed by register ID character and numeric data.
R	Reset	Reset a register or output. Must be followed by register ID character
P	Block Print Request(read)	Initiates a block print output. Registers are defined in programming.

COMMAND STRING CONSTRUCTION

The command string must be constructed in a specific sequence. The meter does not respond with an error message to illegal commands. The following procedure details construction of a command string:

1. The first 2 or 3 characters consist of the Node Address Specifier (N) followed by a 1 or 2 character node address number. The node address number of the meter is programmable. If the node address is 0, this command and the node address itself may be omitted. This is the only command that may be used in conjunction with other commands.
2. After the optional address specifier, the next character is the command character.
3. The next character is the register ID. This identifies the register that the command affects. The P command does not require a register ID character.
4. If constructing a value change command (writing data), the numeric data is sent next.
5. All command strings must be terminated with the string termination characters * or $. The meter does not begin processing the command string until this character is received. See timing diagram figure for differences of * and $ terminating characters.

REGISTER IDENTIFICATION CHART

ID	Value	Abbv.	Applicable Commands/Comments
A	Input	INP	T, P
B	Total	TOT	T, P, R (Reset command resets total to zero)
C	Max Input	MAX	T, P, R (Reset command resets MAX to current reading)
D	Min Input	MIN	T, P, R (Reset command resets MIN to current reading)
E	Setpoint 1	SP1	T, P, V, R (Reset command resets the setpoint output)
F	Setpoint 2	SP2	T, P, V, R (Reset command resets the setpoint output)
G	Setpoint 3	SP3	T, P, V, R (Reset command resets the setpoint output)
H	Setpoint 4	SP4	T, P, V, R (Reset command resets the setpoint output)
I	Analog Output Register	AOR	T, V (Applies to manual mode)
J	Control Status Register	CSR	T, V

COMMAND STRING EXAMPLES:

1. Node address = 17, Write 350 to Setpoint 1, response delay of 2 msec min
   String: N17VE350$
2. Node address = 5, Read Input value, response delay of 50 msec min
   String: N5TA*
3. Node address = 0, Reset Setpoint 4 output, response delay of 50 msec min
   String: RH*

SENDING NUMERIC DATA

Numeric data sent to the meter must be limited to 5 digits (-19,999 to 99,999). If more than 5 digits are sent, the meter accepts the last 5. Leading zeros are ignored. Negative numbers must have a minus sign. The meter ignores any decimal point and conforms the number to the scaled resolution. (IE: The meter's scaled decimal point position = 0.0 and 25 is written to a register. The value of the register is now 2.5 In this case, write a value = 25.0).

Note: Since the meter does not issue a reply to value change commands, follow with a transmit value command for readback verification.

RECEIVING DATA

Data is transmitted by the meter in response to either a transmit command (T), a print block command (P) or User Function print request. The response from the meter is either a full field transmission or an abbreviated transmission. In this case, the response contains only the numeric field. The meter response mode is established in programming.

FULL FIELD TRANSMISSION

Byte	Description
1,2	2 byte Node Address field [00-99]
3	Space
4–6	3 byte Register ID field
7–18	12 byte data field; 10 bytes for number, one byte for sign, one byte for decimal point
19	<CR>
20	<LF>
21	Space*
22	<CR>*
23	<LF>*

*These characters only appear in the last line of a block print.

The first two characters transmitted are the node address, unless the node address assigned =0, in which case spaces are substituted. A space follows the node address field. The next three characters are the register ID.

The numeric data is transmitted next. The numeric field is 12 characters long (to accommodate the 10 digit totalizer), with the decimal point position floating within the data field. Negative value have a leading minus sign. The data field is right justified with leading spaces.

The end of the response string is terminated with a carriage return <CR> and <LF>. When block print is finished, an extra <PS><CR> <LF> is used to provide separation between the blocks.

ABBREVIATED TRANSMISSION

Byte	Description
1–12	12 byte data field, 10 bytes for number, one byte for sign, one byte for-decimal point
13	<CR>
14	<LF>
15	Space*
16	<CR>*
17	<LF>*

*These characters only appear in the last line of a block print.

The abbreviated response suppresses the node address and register ID characters, leaving only the numeric part of the response.

METER RESPONSE EXAMPLES:

1. Node address = 17, full field response, Input = 875
   17 INP 875 <CR><LF>

2 Node address = 0, full field response, Setpoint 2 = -250.5
   SP2 -250.5<CR><LF>

3. Node address = 0, abbreviated response, Setpoint 2 = 250, last line of block print
   250<CR><LF><SP><CR><LF>

SERIAL COMMUNICATIONS PORT PROGRAMMING

Baud rate

bAUd 300 1200 4800 **19200**
600 2400 9600

Set the baud rate to match that of other serial communications equipment. Normally, the baud rate is set to the highest value that all of the serial communications equipment is capable of transmitting.

Word length

dAtA 7 8

Select either 7 or 8 bit data word lengths. Set the word length to match that of other serial communication equipment. Since the meter receives and transmits 7-bit ASCII encoded data, 7 bit word length is sufficient to request and receive data from the meter.

Parity

PAr NO Odd **EVEN**

Set the parity bit to match that of the other serial communications equipment used. The meter ignores the parity when receiving data, and sets the parity bit for outgoing data.

If no parity is selected with 7-bit word length the meter transmits and receives data with 2 stop bits. (i.e.. 10 bit frame with mark parity)

Node address

Addr 0 to 99 **3**

Enter the serial node address. With a single unit on a bus, an address is not needed and a value of zero can be used (RS232 applications). Otherwise, with multiple bussed units, a unique address number must be assigned to each meter. The node address applies specifically to RS485 applications.

Abbreviated output

Abu **YES** N0

Select abbreviated transmissions (numeric only) or full field transmission. When the data from the meter is sent directly to a terminal for display, the extra characters that are sent help identify the nature of the meter parameter displayed. In this case, select NO. When the data from the meter goes to a computer, it may be desirable to suppress the node address and mnemonic when transmitting. In this case, set this parameter to YES.

PRINT OPTIONS

OPt YES **N0**

YES - Enters the sub-menu to select those meter parameters to appear in the block print. For each parameter in the sub-menu select YES for the parameter to appear with the block print, and NO to disable the parameter.

Input	INP	YES, NO
Max and min	h IL 0	YES, NO
Total	tot	YES, NO
Setpoint values	SPNt	YES, NO

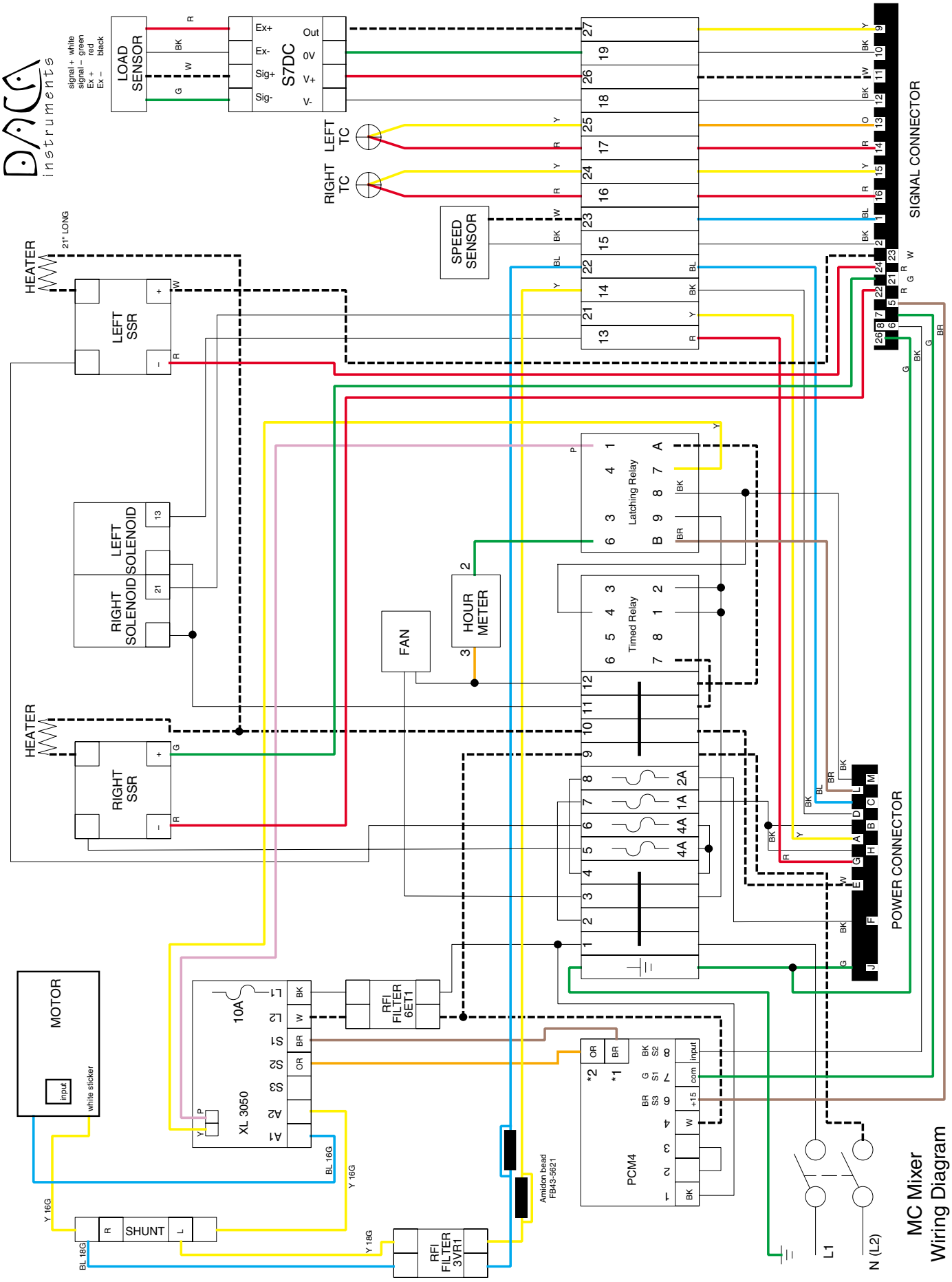
*Either two setpoint values or four setpoint values are transmitted. This is dependent on whether a dual or quad setpoint card is installed. If no setpoint card is installed, this parameter does not appear.

N0 - Skips the sub-menu for selecting programmed output transmission parameters.

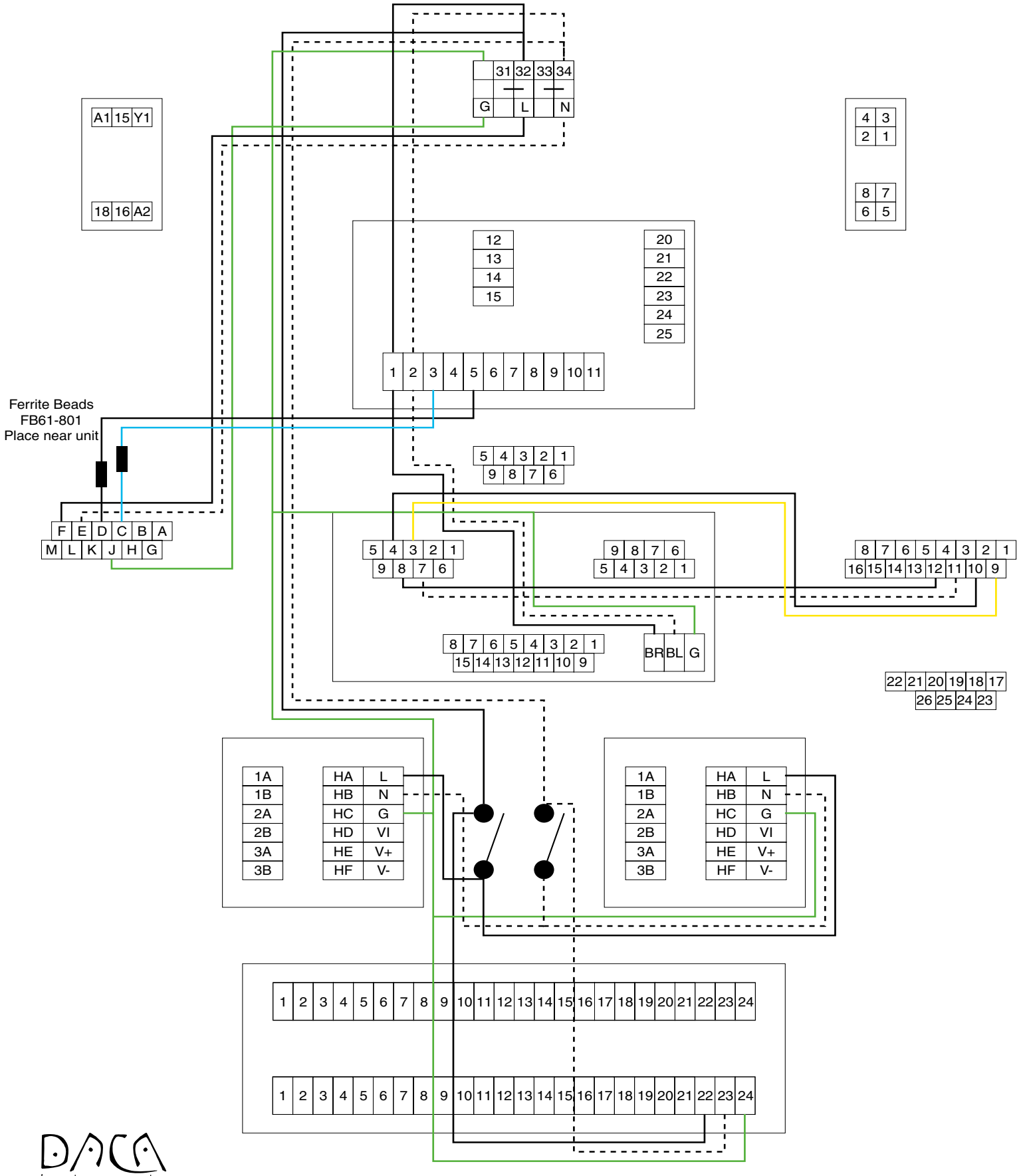
SECTION IV

Appendix

APPENDIX A: SCHEMATICS OF THE ELECTRICAL WIRING



CONTROL UNIT: POWER, TORQUE, LOAD

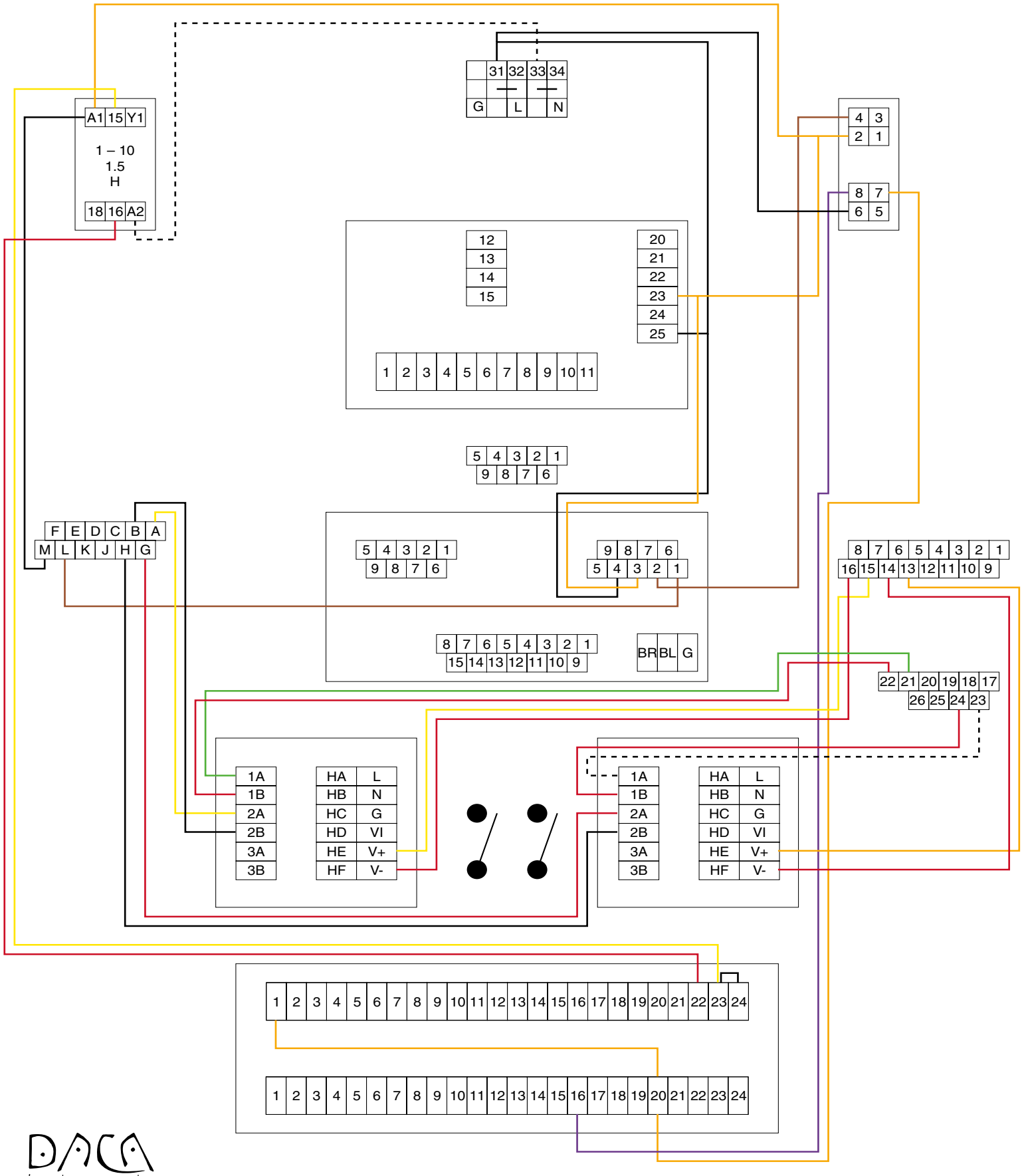


DACA instruments

MC Control
Wiring Diagram

LOAD & TORQUE POWER

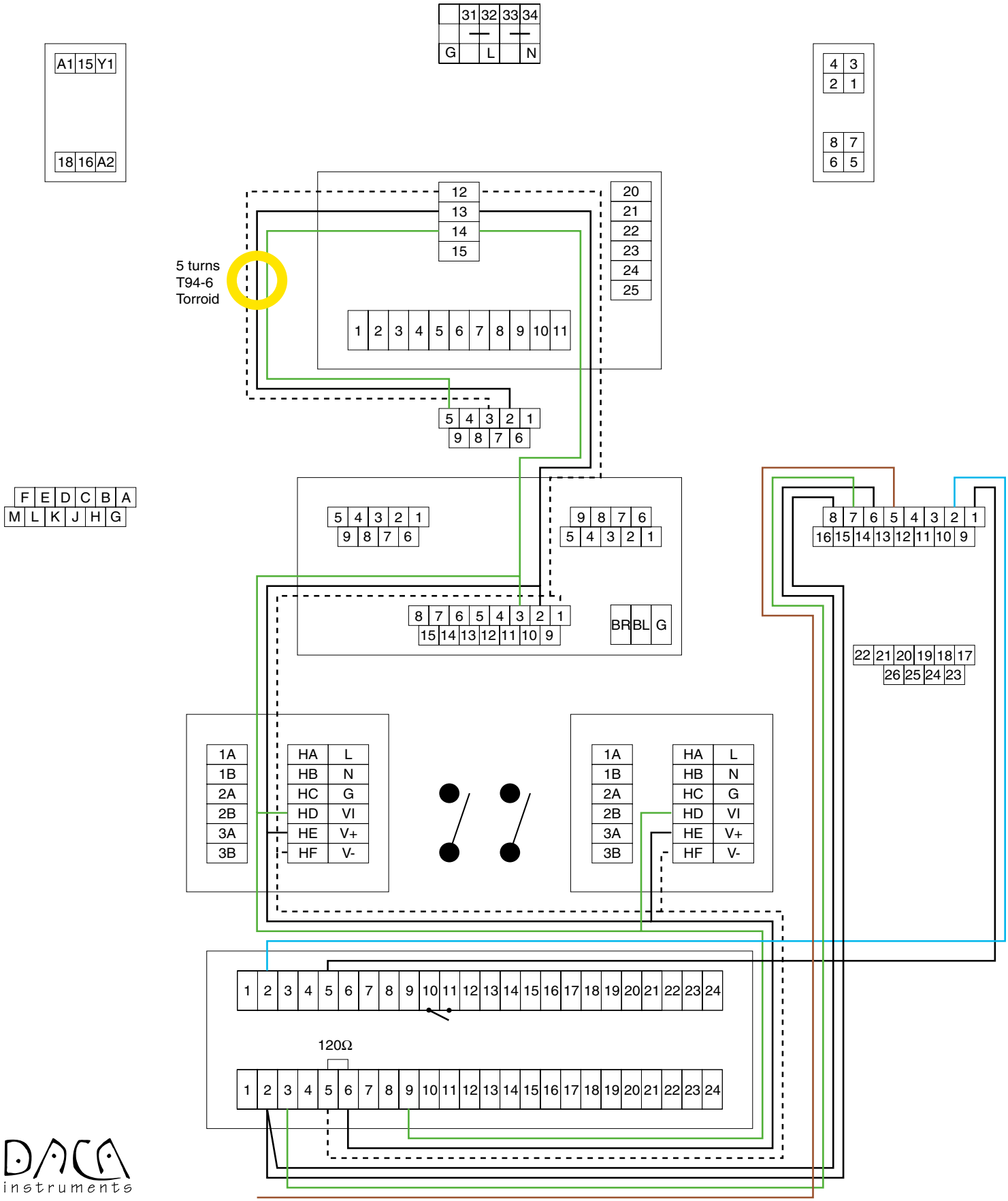
CONTROL UNIT: TEMPERATURE, LIMITS



DACA instruments

MC Control
Wiring Diagram

TEMPERATURE LIMITS



DACA instruments

MC Control
Wiring Diagram

RS-485 MOTOR

APPENDIX B: WARRANTY

Our Pledge

It is the goal of DACA Instruments to have every article bearing the DACA name give you, the Customer, complete satisfaction. To achieve this end, we maintain the highest standards for our workmanship and materials, and for the inspection of our products. If the article you have purchased should experience any problem during its lifetime, contact us and we will do all we can to fix the problem. (We will fix it almost for free during the first year.) However, if you abuse the article or accidentally "drop it on your foot," it's your problem!

PLEASE COMPLETE AND RETURN THE WARRANTY CARD WHICH IS INCLUDED WITH YOUR INSTRUMENT SHIPMENT. Although it is not a requirement to validate the warranty, it will allow us to send you (and not the purchasing department) information about new products, as well as modifications to the product you purchased.

LIMITED WARRANTY

DACA Instruments warrants this equipment to be free of defects in materials and workmanship for a period of thirteen (13) months from date of shipment. DACA's Warranty adds an additional one (1) month grace period to the normal one (1) year product warranty to cover handling, shipping and set-up time. This ensures that our customers receive maximum coverage on each product. Our liability under this warranty is limited to the repair and replacement, at our expense, of any defective item or part thereof with a similar item or part thereof free from defect. This warranty does not apply to any equipment altered by Customer or which malfunctions because of Customer's fault or negligence or to components which experience normal wear. If during the warranty period the equipment malfunctions and the Customer contacts DACA Instruments, describing the problem being encountered, DACA Instruments will analyze the problem to the extent possible and either advise of corrective action that the Customer can perform or request the return of the equipment to DACA Instruments for factory repair. If factory repair is required, Customer will return the equipment in accordance with DACA Instruments' instructions at Customer's expense. Upon receipt, DACA Instruments shall either repair the equipment or replace it with an equivalent unit(s), and return such equipment to Customer at DACA Instruments' expense. THE WARRANTIES CONTAINED IN THIS PARAGRAPH ARE IN LIEU OF ALL OTHER WARRANTIES, AND NO OTHER WARRANTIES WHATSOEVER, EXPRESS OR IMPLIED, INCLUDING THE WARRANTIES OF MERCHANTABILITY OR FITNESS, APPLY TO THIS EQUIPMENT, AND NO EXPRESS WARRANTY OR GUARANTY, EXCEPT AS MENTIONED ABOVE, GIVEN BY ANY PERSON, FIRM OR CORPORATION WITH RESPECT TO THIS EQUIPMENT, SHALL BIND DACA INSTRUMENTS.

This warranty gives the Customer specific legal rights, and the Customer may also have other rights that vary from state to state, province to province, or country to country.

LIABILITY

These units are inherently dangerous and are intended to be installed and used only by qualified personnel. Our liability is conditioned upon the installation, operation, maintenance, storage, service and repair of the item in accordance with written plans and instructions prepared or approved by us. In no event will DACA Instruments be liable for any damages, including any lost revenue or other indirect, incidental, special, consequential, punitive or exemplary damages arising out of the use or inability to use equipment purchased from DACA Instruments. By accepting this equipment, the Customer will assume all liability for any damages which may result from its use or misuse by the purchaser, his/hers/its employees or by others. No warranty extended herein will apply if such unit is installed or used by unqualified personnel. Further, the customer agrees that any liability of DACA Instruments for all claims if any shall not exceed the amount actually paid by customer.

Further, the Customer and/or its End Users shall indemnify and hold harmless DACA Instruments from all loss, damage, costs and expenses of whatever nature, including

attorney's fees, arising from or in any way connected with any injury to person or damage to property resulting from an unauthorized modification or alteration of the Product.

PATENTS: The sale of any product or products by DACA Instruments pursuant to this order does not convey to the Purchaser any license, by implication, estoppel, or otherwise, respecting any patent, trademark or trade name claims or rights of DACA Instruments covering said product or products or any combination thereof with or without other devices or elements.

MODIFICATIONS TO THE TERMS OF SALE: No addition to, deletion from, nor modification of any of the provisions of the Terms & Conditions of Sale of this order shall be binding upon DACA Instruments unless acknowledged and accepted in writing by DACA Instruments. Any change made by DACA Instruments will be deemed accepted by Customer unless, within ten (10) days from written notice of such change, Customer notifies DACA Instruments. Any waiver of the Terms & Conditions of Sale shall not be deemed to be a continuing waiver or a waiver of any other default or of any other of these Terms & Conditions of Sale, but shall apply solely to the instance to which the waiver is directed. Any agreed upon modifications shall be specified on both the Customer's purchase order and DACA's order acknowledgement document.

MISCELLANEOUS PROVISIONS: This Agreement is entered into, shall be governed by, and is to be construed according to the laws of the State of California.Any dispute, controversy, or claim arising out of or relating to the enforcement, interpretation, or alleged breach of this Agreement shall be submitted to and resolved by binding arbitration in the Santa Barbara County, California before one (1) neutral arbitrator appointed in accordance with the Commercial Arbitration Rules of the American Arbitration Association and judgment upon the award may be entered in and enforceable by any court having jurisdiction. In the event that any matter respecting this Agreement is submitted to arbitration or if either party hereto files suit to enforce and/or interpret this Agreement, the prevailing party in such proceedings shall be entitled to reasonable attorney's fees and costs. In addition, jurisdiction and venue of any claim filed to enforce and/or interpret this Agreement shall lie with the appropriate State of California court in the County of Santa Barbara

The parties hereto agree that if any provision of this Agreement or the application thereof is held to be invalid, then such invalidity shall not effect any other provisions of this Agreement or the application thereof and to this end the provisions of this Agreement are declared severable.

This Agreement contains the entire agreement of the parties concerning any and all matters described herein, and supersedes any prior or contemporaneous agreements with respect thereto.

DACA instruments

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