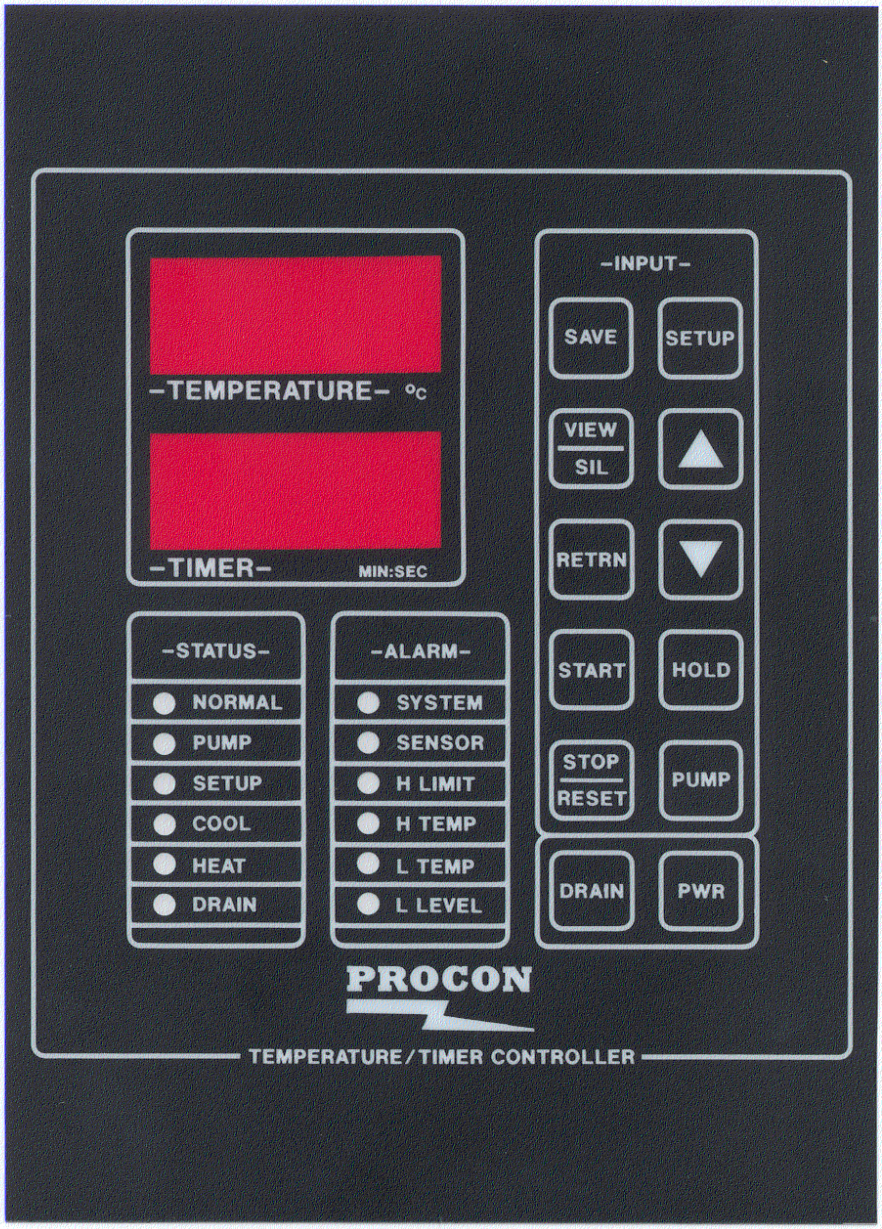
PROCON

MODEL 900S / RS232
SUBAMBIENT TEMPERATURE CONTROLLER

5/3/00
Rev01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-TIMER-
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VIEW
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RETRN
START
HOLD
STOP
RESET
PUMP
DRAIN
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-STATUS-
NORMAL
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PROCON
MODEL 900S/RS232
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COMMUNICATIONS SUPPLEMENT

i i i **N O T I C E** i i i

JPC CONTROLS RESERVES THE RIGHT TO MAKE CHANGES TO ITS PRODUCTS OR SPECIFICATIONS AT ANY TIME, WITHOUT NOTICE, IN ORDER TO IMPROVE THE DESIGN OR PERFORMANCE AND TO SUPPLY THE BEST POSSIBLE PRODUCT. THE INFORMATION IN THIS MANUAL HAS BEEN CAREFULLY CHECKED AND IS BELIEVED TO BE ACCURATE. HOWEVER, NO RESPONSIBILITY IS ASSUMED FOR INACCURACIES.

PROCON
MODELS 900S/RS232
TEMPERATURE CONTROLLER

The Model 900S/RS232 is a Microprocessor based controller/timer. It monitors temperature utilizing a Type J thermocouple sensor and controls bath temperature with a standard three mode (PID) control scheme, with anti-reset windup. Numerous status and alarm functions are incorporated to monitor various system parameters. Additionally, a down-count/up-count programmable timer, with cumulative over timer and pre-warn is integrated into the system. Two solid state relay drive outputs are included for the Chiller and Heater. A relay output is provided for the Acid Pump and Timer. An RS232 link is also provided. For information on the RS232 interface, see the Communications Supplement. The following are highlights of some of the main features:

* USES TYPE J THERMOCOUPLES
* THERMOCOUPLE COLD JUNCTION COMPENSATION
* LIQUID LEVEL SENSOR INTERLOCK
* HI LIMIT CIRCUITRY INDEPENDENT OF MICROPROCESSOR
* BI-DIRECTIONAL TIMER
* ACCESS CODE PARAMETER PROTECTION
* EEPROM PARAMETER MEMORY
* AUDIO ALARM/ANNUNCIATOR
* ALL PARAMETERS SET IN SOFTWARE-NO POTS OR SWITCHES
* WET STATION ENCLOSURE
* BRIGHT FOUR DIGIT LED DISPLAY (2)
* SMOOTH FACE CONSTRUCTION

The Base 900 Controller has two variants, the main difference between them being line voltage. The chart below shows the differences between the controllers.

MODEL NUMBER	LINE VOLTAGE	HEATER CONTROL	RS232
900SA/RS232	24 VAC	Pilot Duty	YES
900SB/RS232	120 VAC	Pilot Duty	YES

The 900SA & SB Model has two Pilot Duty Solid State outputs that drive a heater load. One is to run an external solid state relay. The other is designed to run a mercury relay coil.

An independent high limit circuit is provided. It is powered by an isolation transformer that draws power from the primary side of the master relay. The sensor is a Type J thermocouple. This circuit shuts off the internal master relay should an over temperature condition occur.

Inputs are provided for the connection of a Thermal Snap Switch. This input will turn the unit off, if a High Temperature condition is sensed and this connection is opened.

Twelve discrete LEDs are utilized to indicate system and display status as well as annunciate various alarms. A 12 key membrane switch is incorporated in the facepanel to allow for user setup and adjustment of the system, plus full timer control.

Two numeric displays are utilized to allow the viewing of both the process temperature and the timer simultaneously. Additionally, each of the displays has multiple diagnostic and setup functions that may be activated by the keyboard or by the Microprocessor during various setup and alarm conditions.

The microprocessor section consists of two circuit boards, one for display and the other for control. The control board contains two transformers and provides the isolated DC supplies (+5 and +12 volts) necessary to run the system. In addition, it contains an instrumentation amplifier, A/D converter, EEPROM memory and the microprocessor. The display board contains all of the seven segment and LED displays as well as the audio transducer.

LED INDICATORS

Six primary status modes are indicated by LEDs on the faceplate and are marked NORMAL, PUMP, SETUP, COOL, HEAT and DRAIN.

NORMAL - This mode is the normal condition for the system. It indicates that the system is operating within the defined parameters.

(HOLD) - This is a buried mode indicated by the blinking of the Normal LED. It allows all normal monitoring and timing functions, but disables the heater and cooling. To exit this mode, either the 'RETURN' or 'HOLD' key may be depressed. NOTE: For safety, the unit always starts up in this mode initially or after a power failure. When in this mode, the process display reads 'Hold '.

PUMP - This LED is illuminated whenever the Acid Pump relay is active. A key is provided on the face panel to manually activate and deactivate this function.

SETUP - This is the Programming mode. When in this mode, the SETUP key causes the controllers to setup through the parameters.

COOL - This LED is illuminated whenever the cooling output is active.

HEAT - This LED is illuminated whenever the heater is on. Note that when the unit is near the setpoint, the LED will continually cycle on and off.

DRAIN - This LED is illuminated whenever the DRAIN output is active.

ALARM LEDS

There are six alarm LEDs. They are essentially visual annunciators of system functions.

SYSTEM - The first is a catch-all indicator for the miscellaneous diagnostics. An example would be the malfunction of the EEPROM save routine. This would simply indicate to the user that something has gone wrong and he should either repeat the command or reset the unit.

SENSOR - This alarm is for a defective 'SENSOR ' (Thermocouple). This indicates that the sensor is either open or not connected. Special circuitry has been incorporated to monitor the sensor for an open circuit. The processor continually monitors the input and if it detects an open sensor, it shuts off the heater output and activates the 'SENSOR ' alarm. The process display will alternately flash the temperature and 'OP ' for open sensor.

H LIMIT - This alarm is the 'High Limit '. This LED is wired directly to the high limit circuit and lights whenever the high limit turns the master relay off. Since it is powered by the high limit power supply, it remains on, even after the master relay has de-energized and shut the controller off.

H TEMP - This is the 'High Temp ' alarm. It is activated anytime the process temperature exceeds the high alarm setpoint. When activated, the process display alternately displays the process temperature and the code 'HI '.

L TEMP - This is the 'Low Temperature ' alarm. It acts much like the 'High Temp ' alarm, except it compares the process temperature to the low alarm setpoint. If the process temperature drops below the setpoint once it has initially come out of the warmup mode, this alarm will be activated. In this case, the code 'LO ' is alternately flashed with the process temperature.

L LEVEL - This is the 'Liquid Level ' alarm. It monitors an optional remote liquid level sensing circuit and activates when a low liquid level is detected. The code 'LL ' is alternately flashed with the process temperature.

All of the alarms activate the audio tone and the individual alarm annunciator. The tone alternates on and off to draw attention to the alarm. As has been noted above, many of the alarms have additional visual displays to further define or draw attention to them.

KEYS

VIEW/SILENCE - This is a multifunction key. Its function depends on the current mode of the controller.

> **ALARM** - The alarm silence key is provided to allow for the elimination of the audio portion of the alarm as well as the portion of the alarm display that affects the process display. This essentially allows the unit to be returned to a functional condition where setpoints can be examined and reset without the interference of the special alpha displays. However, the appropriate alarm annunciator LEDs continue to be illuminated.
>
> **NORMAL MODE** - This key is used to VIEW the Process Setpoint and Programmed Process Time, when not in the SETUP mode. It is a momentary key that will change displays to show the corresponding setpoints, as long as it is held down.

SETUP - This key is used to put the system into the SETUP mode and once in that mode, advance through the parameters.

Depressing the key once will place the unit into the SETUP mode. (Note: if the access code protection is selected, an additional step is required, see Access Code below). Depressing the key after entering the SETUP mode will allow the user to scroll through the SETUP parameters. To exit the SETUP mode, the RETURN key is depressed.

UP - In the SETUP mode, depressing the 'UP' key will cause the display to advance. Depressing the key once and releasing will allow accurate setting of the least significant digit. Holding the key down will activate the automatic, rapid incrementing of the display.

DOWN - In the SETUP mode, depressing the DOWN key will cause the display to decrease. Depressing the key once and releasing will allow the accurate setting of the least significant digit. Holding the key down will activate the automatic, rapid decrementing of the display.

RETURN - This key is used to return the system from the SETUP or DRAIN REQUEST modes. If in either of these modes, depressing the key will place the system back into the normal operating mode. If in 'HOLD', it will exit the HEATER HOLD mode.

SAVE - This key is only active in the SETUP mode and is used to permanently save the system parameters.

HOLD - This key will toggle the unit IN and OUT of the HOLD mode. It enables/disables the heater output. (The RETURN key may also be used to exit this mode). Note: for safety, the unit always starts up in this mode initially or enters it after a power failure. When in this mode the timer display reads 'HOLD '.

START - This key is used to activate the timer. It will start the system if it is reset or it will continue if the Timer has been placed in the HALT mode (see STOP/RESET).

STOP/RESET - This is a multifunction key whose function varies with the current system mode.

> **RUN MODE** - If the Timer is running, depressing STOP/RESET will stop the count and place it in the HALT mode.
>
> **HALT MODE** - If the Timer is in the HALT mode, depressing this key will RESET the Timer in preparation for the next run.

DRAIN - This key is utilized to activate or deactivate the DRAIN mode.

PWR - This key is utilized to toggle the internal electronic latch and master relay ON and OFF. This cycles the main power to the controller.

PUMP - This key is utilized to toggle the PUMP output ON and OFF.

SETUP

The SETUP mode is entered by depressing the SETUP key. When in this mode, the 'SETUP' key causes the controller to step through the parameters. The following is a table of the displays that will appear:

CODE	DESCRIPTION
CS	Clock Setpoint
PA	Pre-Alarm Offset
PS	Process Setpoint
HI	High Alarm Setpoint
LO	Low Alarm Setpoint
DR	Drain Setpoint
CL	Cooling Setpoint
AC	Access Code
CR	Cycle Rate
Pb	Proportional Band
rE	Reset
rA	Rate
CA	Calibration
RL	Relay Logic
CD	Count Direction

CODE	SETTING RANGE
CS	0:00 to 99:59 Minutes:Seconds
PA	:00 to :59 Seconds
PS	0.0 to 199.9 Degrees C.
HI	0.0 to 199.9 Degrees C.
LO	0.0 to 199.9 Degrees C.
DR	0.0 to 199.9 Degrees C.
CL	0.0 to 199.9 Degrees C.
AC	0 to 9999
CR	0 to 19 Seconds
Pb	0 to 19.9 Degrees C.
rE	0 to 19.9 Minutes
rA	0 to 19.9 Minutes
CA	+ or - 9.9 Degrees C.
RL	0 to 2
CD	UP/DN (Up or Down)

While in this mode, depressing either the 'up' or 'down' key will cause the display to advance or retard. Depressing the key once and releasing will allow the accurate setting of the least significant digit. Holding either key down will activate the automatic, rapid incrementing or decrementing of the display. To exit this mode 'Return' is depressed.

This system may operate in either a one, two or three mode configuration. Setting the "RATE' or 'RESET' variables to 0.0 will eliminate the respective function. It should be noted that the RATE andRESET settings adjust the sampling period directly in tenths of minutes. Thus, smaller numbers create more rapid sampling.

The Calibration 'CA' adjustment allows the elimination of various sensor and system errors. Thermocouple sensors are manufactured within a specific tolerance. The tolerance may lead to a difference between the actual bath temperature and the temperature displayed. This error coupled with the differential error caused by sheathing the sensor in materials such as Teflon may cause a difference in the actual bath temperature and display temperature. This can simply be corrected by monitoring the bath temperature and utilizing the offset to add or subtract the appropriate number of degrees to bring the display into compliance with the actual bath temperature.

While in the Program mode, depressing the 'SAVE' key will cause the setup parameters to be written into the EEPROM memory. This is a permanent (10 year minimum life) memory that does not require battery backup. The save routine takes about two seconds to complete and is indicated by a series of dashes through the displays. This feature provides the O.E.M. with the ability to program in initial conditions prior to shipment. It then allows the user to modify these conditions and permanently save his new parameters all from the keyboard.

OPERATION

TIMER - The Timer may be configured to either countup or countdown. In the SETUP mode, the Timer is programmed to a specific time, a specific pre-alarm offset and a count direction.

The UP/Down count timer is presettable and will count down from the preset time or count up to the preset time depending on the mode selected. In both cases, it has the additional feature of accumulating overcount. In the Countdown mode, this means that once it counts down to zero, it begins counting back up to record the time that has elapsed past the preset time. In the up count mode, once it has reached the preset value, it returns to zero and again counts up to record the time that has elapsed past the preset time. In both cases, the display flashes to indicate that the displayed count is an overcount. The 'View' key may be used to examine the Preset time. This value and the initial preset time are stored in the EEPROM memory, thus they automatically are ready when initially powered up.

The 'START ' key is used to start the timer. When this key is depressed, the timer will begin counting, if the unit is in the normal mode and the timer has been reset. The 'STOP/RESET ' key is used to stop the timer. Anytime the timer is in the RUN mode, this key will halt its operation. The display will be frozen on the current timer value. If the count is 'over ', the display will flash. A second depression of this key will cause the timer to reset. This will place the preset value in the timer display, stop the display flashing and cancel any timer audio tones. If the START key is hit when the timer is in the HALT mode, the timer will continue from its current count.

The PA parameter (Pre-Alarm) may be selected to provide a tone prior to the Timer reaching the completion of its count. This applies to both UP count and DOWN count timer configurations. For example, if the Pre-Alarm is set to 15 seconds, the Timer will alert the operator to the fact that the Timer is about to finish its count for the last 15 seconds of that Count Up or Count Down.

The prewarn tone has a 50/50 duty cycle and a □ second period. After the preset time has elapsed, it turns into a continuous tone. The timer must be stopped to enter the Setup Mode. In the Setup Mode the preset time and prewarn time are entered (see Setup).

AUXILIARY RELAY - The logic for the relay is selected by the 'RL' parameter in the SETUP stack. The relay will respond as follows:

> **RL=0 (During)** - This configures the Auxiliary Relay as a Timer Relay. It will be active for the period that the Timer is active. It will activate when the Timer is started and deactivate when the Timer has completed its count.
>
> **RL=1 (Done)** - This configures the Auxiliary Relay as a Timer Relay. It will activate at the completion of the Timer Cycle. It will remain active until the Timer is reset.
>
> **RL=2** - This configures the Auxiliary Relay as an Alarm Relay. It will activate whenever an alarm is present.

HIGH LIMIT - The unit contains special High Limit Circuitry. This circuitry actually consists of a redundant single setpoint temperature monitor built into the same package. This section is powered by a separate isolation transformer and utilizes the totally independent high limit thermocouple. Its purpose is to monitor the bath for excessive temperature and should such a condition occur, physically turn the unit off.

It should be noted that this is different than the High Alarm Setpoint which is a software function under microprocessor control. This is a redundant hardware function that is capable of turning the controller 'Off ', independent of the basic control system.

The High Limit Thermocouple is processed through an instrumentation amplifier that also provides the reference and cold junction compensation. This signal which is a measure of the thermocouple temperature, is compared to a pre-calibrated mechanical setpoint. If the temperature at the thermocouple exceeds the preset value, the circuit turns off the internal load carrying master relay. It also lights the High Limit LED alarm light. The LED will remain illuminated as long as the signal is in excess of the preset value.

If the unit is on when this condition occurs, it will shut off. If the unit is off, it can not be turned on until this high limit is cleared. Again, it should be noted that the high limit circuit is powered by its own transformer and thus remains on at all times even when the power switch is off. The heater and microprocessor sections are electrically connected to the master relay output and thus are disabled by this alarm.

ACCESS CODE - In some cases it may be desirable to restrict access to the SETUP mode. An 'Access Code ' system is incorporated. If the code is set to 0000, the function is eliminated and the system operates as previously described. The security code is simply any number from 1 to 9999 as programmed into the system by the customer's authorized personnel. Once this code is entered into the EEPROM, any attempt to enter the SETUP mode will cause 'AC' to appear in the data display. The UP and DOWN keys are then used to enter the access code. Once the proper code has been selected, the user simply depresses the SETUP key once again to gain entry into the SETUP parameters. Any other entry, the wrong number, or no action for 30 seconds will return the unit to the normal operating mode.

RATE/RESET - The controller may operate in either a one, two or three mode configuration. Setting the RATE or RESET variables to 0.0 will eliminate the respective function. It should be noted that the RATE and reset setting adjust the sampling period directly in tenths of minutes; smaller numbers will create a more rapid sampling. (see Tuning)

DRAIN - The Drain function provides a Temperature Interlocked Drain cycle. In the setup parameters, the user may program the temperature (DR) above which the Drain Function will not work. The Drain key may be used to start the Drain Cycle and also stop it.

To help prevent an accidental Drain, a dual key entry is necessary to initiate the cycle. When the Drain key is first depressed, the unit will acknowledge with 4 beeps. The key must then be depressed for a second time for the cycle to be activated. If the initial depression was in error, the Return key may be depressed to cancel the Drain request.

In the DRAIN mode, the system is locked into the HOLD mode. The heater may not be activated while in this mode.

COOL - The Cooling Output is automatically activated by the program based on the Cooling (CL) parameter, the Process Setpoint (PS) parameter and the Process Temperature. Whenever the Process Setpoint is set below the Cooling Setpoint, the Cooling Output is capable of turning the cooling on.

PUMP - The Acid Recirculation Pump is controlled by a solid state relay that is driven from the PUMP output on the rear of the controller. The Pump Key will toggle this output 'ON' and 'OFF'. The controller must be powered for this output to be active.

REMOTE KEYS - On the rear of the unit, 3 terminals are provided for the connection of a Remote Keypad. These keys will duplicate the function of the START and STOP RESET keys for full function control of the Timer.

SNAP SWITCH INPUT - Two terminals provided on the rear of the unit to connect an external THERMAL SNAP SWITCH. It should be noted that a connection must be made between these two terminals, if a SNAP SWITCH is not utilized for the unit to function.

If during normal operation, the THERMAL SNAP SWITCH opens, the unit will shut off and the power to the HR terminal, which controls the external main contactor, will be removed.

TUNING

The control scheme used in this controller is a standard PID system with anti-reset windup. This section will briefly review PID control as it relates to this system. It should be noted that this discussion specifically relates to this device and may be somewhat different than other systems.

The terms PID and 3 Mode are interchangeable. The first mode of control, 'P ' (Proportional) refers to the basic control scheme. The concept is that the controller will determine the percentage of heat required by the system and adjust the average power input to the heater to balance the system. The power to the heater is either fully on or fully off. The proportioning is obtained by ratioing the amount of time 'on' to the amount of time 'off'. Thus proportional control in this application is more correctly termed Time Proportioning.

The CYCLE RATE (CR) setting is used to determine the rate at which the heater power is turned on and off. The proportioning of the output power is accomplished by varying the percentage of time that the unit is on during the period. For example, if CR = 10, then the unit will cycle on and off once every 10 seconds. If the process has determined that the system requires only half of the full power output of the heater to maintain a specific temperature, the output will be ON for 5 seconds and OFF for 5 seconds in a continuous cycle. As the heat requirement varies, this percentage will increase to slightly longer periods ON, such as 5.1 seconds ON, 4.9 seconds OFF. The opposite is true for decreasing heat load requirements. Thus, when the system is at or near the setpoint, the HEAT LED in the status box will continually flash to indicate the time proportioning of the heater.

To compute the required percentage of 'on ' time, the system utilizes the Proportional Band (PB) as set in the programming mode. It is over this band that the output will vary from 0 to 100%. If for example, the setpoint is at 100 degrees C. and the proportional band is set at 10 degrees C., the controller will time proportion the output from 100% to 0% when the process temperature varies from 90 to 100 degrees C. When the process temperature is at 90 degrees C. and less, the output will be fully on, between 90 and 100 degrees C. the output will time proportion from 100% down to 0%. At any temperatures above 100 degrees C., the output will be fully off.

At this point, it is important to note that we are discussing systems in which the RATE and Reset functions are not used. RATE and Reset will cause a shifting in the Proportional Band and vary the percentages just discussed. However, RATE and Reset do not affect the basic theory, only the position of the Proportional Band at any moment in time.

Now we will tie the Proportional Band and CYCLE Rate together in the example used above. We had a CYCLE RATE of 10 seconds with a Proportional Band of 10 degrees C. and a setpoint of 100 degrees C. When the process temperature is 96 degrees, we will note that it is 40% into the Proportional Band. Based on this position we require 40% heater output, with the 10 second CYCLE RATE, this means that the heater will be ON for 4 seconds and OFF for 6 seconds.

Obviously, a proportional control requires a certain degree of error to have the heat on. Therefore, in the example just given if we find that only 10% of the heat is required to maintain the desired temperature. The unit will cycle 1 second ON and 9 seconds OFF and the temperature will stabilize at 99 degrees. This is not the desired 100 degrees. The difference between the two is termed Droop. Droop is the difference between the setpoint and the control point in a proportional system.

To remove this Droop, we need the 2nd mode. This is the 'I' (Integral) mode or commonly termed Automatic Reset Mode. The program calculates the difference between the current process temperature and the desired setpoint and mathematically corrects the system to compensate for this error. How often this is done, is based on the parameter that is programmed in the 'RE ' (Reset Adjustment).

Anti-Reset Windup is a special feature incorporated in the software that locks out the Reset function when the system is outside of the Proportional Band. Obviously, if the system were automatically adjusting the DROOP before the system was nearing stability, large errors would occur. Anti-Reset Windup is used to eliminate such potential errors.

The third mode in the PID scheme is the D (Derivative) mode commonly referred to as RATE. When a system has large step changes in heat requirements, it may require this third mode to compensate for such changes. Its primary function is to eliminate overshoots as the temperature is stabilizing. It controls the rate of change of the temperature when large temperature fluctuations occur. On systems where overshoot is not a problem, the RATE function may be eliminated for simplicity. In general, bath control requires reset on all occasions. RATE may not be required and should be set to zero, unless overshooting occurs.

SPECIAL SUBAMBIENT NOTES

Subambient control loops involving external recirculators have special setup requirements. In essence, these are brought about by the fact that the heater is located remotely from the bath and there is a substantial time lag between the power adjustments that are made to the heater and any resulting temperature rise in the bath. Generally, this makes the system very slow to response and as such, a substantially smaller proportional band may be utilized. For setpoints below 35 degrees C., initial proportional band settings between 1.0 and 2.0 are advised.

Additionally, Reset Settings (RE) should be in the 3.0 to 5.0 minute range.

Utilizing cycle rates in the 5.0 to 10.0 second range should be quite satisfactory for most applications. The RATE Parameter (RA) should always be set to zero.

While this information is not absolute for any specific installation, it should prove generally helpful in at least providing the initial setup for the system.

PROCON BACKDOOR CODE

A special code has been incorporated into the software to insure factory access to all functions no matter what the customer has done with the access codes. This code is 900.

MANUAL REVISIONS

Rev #	Program #	Eng #	Revisions Made
Rev 0	DT900ASA	DT900S	Origination
Rev1	DT900SA	DT900S	AddedDrawings

SPECIFICATIONS

MODEL 900SA/RS232
SUBAMBIENT BATH CONTROLLER

RANGE (Temperature)	0.0 - 199.9 Degrees C.
RESOLUTION (Temperature)	0.1 Degrees C.
NOISE REJECTION	NMR - 60 db @ 60 HZ CMR -120 db @ 60 HZ
RANGE (Time)	0:00 - 99:59 Min:Sec
RESOLUTION (Time)	1 Sec.
MEASURING TIME	4 Conversions/Sec
DISPLAY	Eight, 0.56 Inch High, Seven Segment, LED Uniplanar numerals. Twelve Discrete LEDs (Red, Green, Amber).
ANNUNCIATOR	Audio Tone, ~ 3200 HZ
SETUP MEMORY	EEPROM, All Parameters
MEMORY RETENTION	10 Years w/o Power
SENSOR	Standard - Type J Thermocouple, Cold Junction Compensation, Up Scale Break Protection.
CONTROL	PID with Anti-Reset Windup.
ADJUSTMENT	Cycle Rate: 0 - 19 Sec. Proportional Band: .1 - 19.9 Deg. C Reset (Integral): .1 - 19.9 Sec. Rate (Derivative): .1 - 19.9 Sec. Calibration Offset: $\pm$ 9.9 Deg. C
OPERATING RANGE	0 to 50 Degrees C

STORAGE RANGE	-40 to 60 Degrees C
CONSTRUCTION	Enclosure - Kydex. Face - Lexan, Back Printed
SIZE	8.25 x 6 x 5.25 inches (HxWxD) 210 x 152 x 133mm
WEIGHT	< 4 Lbs. (1.8 kg)
CONNECTION	Rear, Screw-Type, 3/8 Inch Centers; T/C Miniature, Type J, Jack.
OUTPUT	Relay: 1 HP, 250 VAC. SSR Drives: 20ma, 12 VDC (provided)
POWER	11 VA, 24 VAC ±10%, 50/60 HZ

SPECIFICATIONS

MODEL 900SB/RS232
SUBAMBIENT BATH CONTROLLER

RANGE (Temperature)	0.0 - 199.9 Degrees C.
RESOLUTION (Temperature)	0.1 Degrees C.
NOISE REJECTION	NMR - 60 db @ 60 HZ CMR -120 db @ 60 HZ
RANGE (Time)	0:00 - 99:59 Min:Sec
RESOLUTION (Time)	1 Sec.
MEASURING TIME	4 Conversions/Sec
DISPLAY	Eight, 0.56 Inch High, Seven Segment, LED Uniplanar numerals. Twelve Discrete LEDs (Red, Green, Amber).
ANNUNCIATOR	Audio Tone, ~ 3200 HZ
SETUP MEMORY	EEPROM, All Parameters
MEMORY RETENTION	10 Years w/o Power
SENSOR	Standard - Type J Thermocouple, Cold Junction Compensation, Up Scale Break Protection.
CONTROL	PID with Anti-Reset Windup.
ADJUSTMENT	Cycle Rate: 0 - 19 Sec. Proportional Band: .1 - 19.9 Deg. C Reset (Integral): .1 - 19.9 Sec. Rate (Derivative): .1 - 19.9 Sec. Calibration Offset: $\pm$ 9.9 Deg. C
OPERATING RANGE	0 to 50 Degrees C
STORAGE RANGE	-40 to 60 Degrees C

CONSTRUCTION	Enclosure - Kydex. Face - Lexan, Back Printed
SIZE	8.25 x 6 x 5.25 inches (HxWxD) 210 x 152 x 133mm
WEIGHT	< 4 Lbs. (1.8 kg)
CONNECTION	Rear, Screw-Type, 3/8 Inch Centers; T/C Miniature, Type J, Jack.
OUTPUT	Relay: 1 HP, 250 VAC. SSR Drives: 20ma, 12 VDC (provided)
POWER	11 VA, 120 VAC $\pm$10%, 50/60 HZ

LIMITED WARRANTY

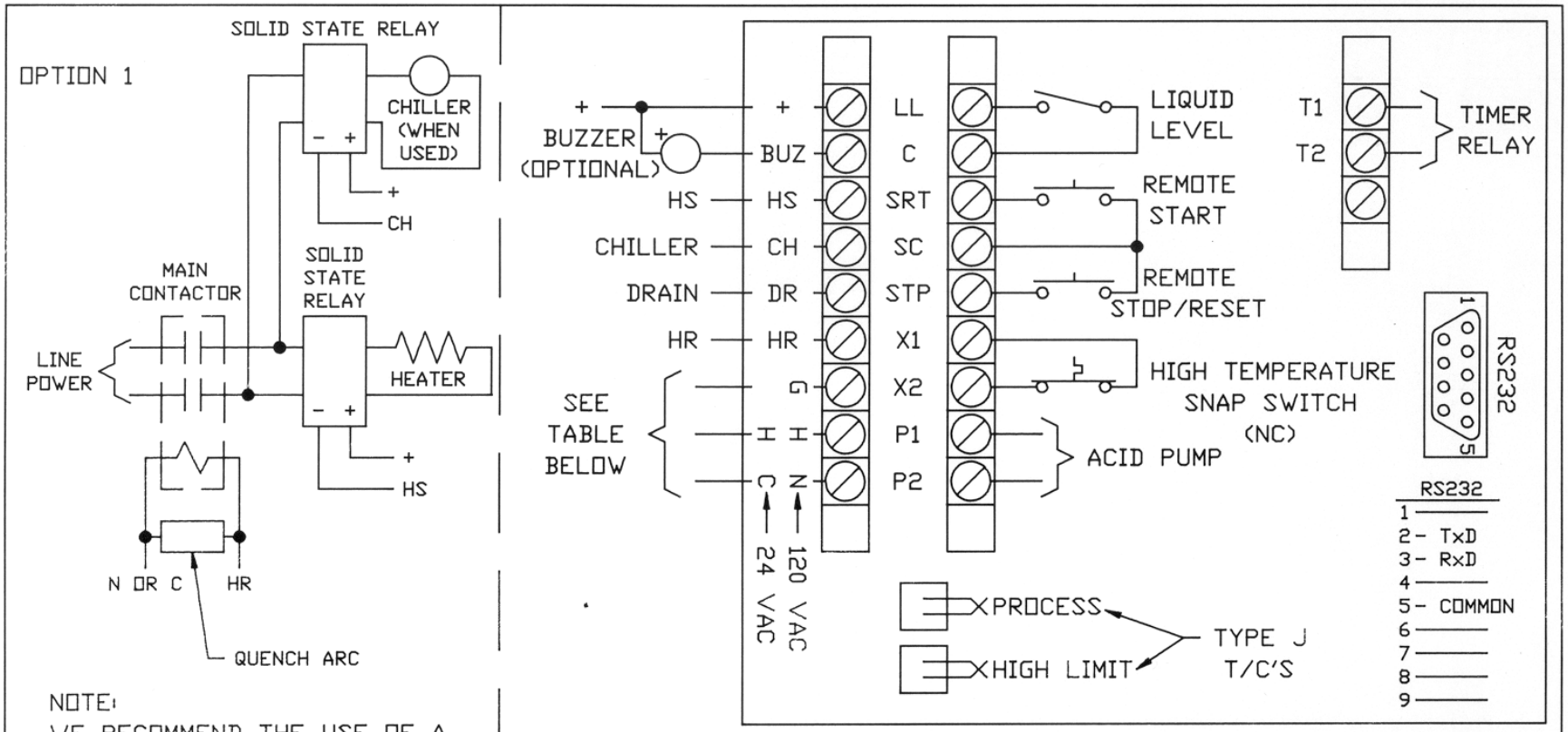
WARRANTY: JPC CONTROLS WARRANTS ITS NEW PRODUCTS TO BE FREE FROM DEFECTS IN MATERIALS AND WORKMANSHIP UNDER THE SERVICE FOR WHICH THEY ARE INTENDED. THIS WARRANTY IS EFFECTIVE FOR TWELVE MONTHS FROM THE DATE OF SHIPMENT.

EXCLUSIONS: THIS WARRANTY IS **IN LIEU OF** ANY OTHER WARRANTY EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF **MERCHANTABILITY** OR FITNESS FOR A PARTICULAR PURPOSE.

JPC CONTROLS IS NOT LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.

NO PERSON OTHER THAN AN OFFICER IS AUTHORIZED TO GIVE ANY OTHER WARRANTY OR ASSUME ANY LIABILITY.

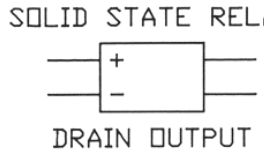
REMEDIES: THE PURCHASER'S SOLE AND EXCLUSIVE REMEDY SHALL BE: (1) THE REPAIR OR REPLACEMENT OF DEFECTIVE PARTS OR PRODUCTS, WITHOUT CHARGE. (2) AT THE OPTION OF **JPC CONTROLS**, THE REFUND OF THE PURCHASE PRICE.



NOTE:
WE RECOMMEND THE USE OF A QUENCH ARC ON EVERY MECHANICAL RELAY AND SOLENOID IN THE SYSTEM. USE PAKTRON P/N 104M06QC100 OR EQUIVALENT.

MODEL	VOLTAGE
900SA/RS232	24 VAC
900SB/RS232	120 VAC

NOTES:
1. LIQUID LEVEL ALARMS ON OPEN CONDITION.
2. + TERMINAL RATED 12 - 20 VDC UNREGULATED (100mA).



TOLERANCES UNLESS OTHERWISE SPECIFIED

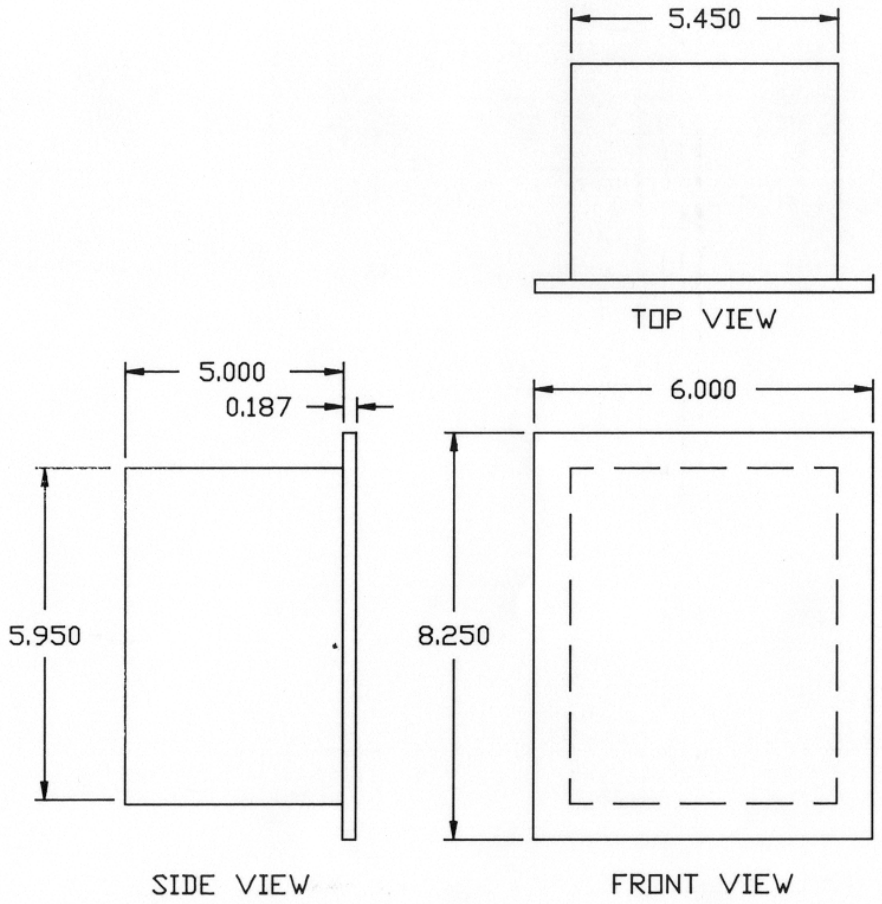
ALL DIMENSIONS ARE IN INCHES

PATH = E:\CC\DT900\900SB10.DWG

JPC CONTROLS A DIVISION OF LLOYD INDUSTRIES, INC.
102 COMPASS PT. DR. STE. D ST. CHARLES, MO. 63301 (314) 946-3300

PROCON 900SA/RS232 AND 900SB/RS232 CONTROLLER REAR PANEL

APPROVAL		DWN BY	DATE	SCALE	CHKD BY	
ENG	DATE	MPJ	5/4/00	NONE		
QA	DATE	SHEET 1 OF 1	13	090062	10	00



TOLERANCES UNLESS OTHERWISE SPECIFIED

ALL DIMENSIONS ARE IN INCHES

PATH = E:\CC\DT900\900SP10.DWG

JPC CONTROLS A DIVISION OF LLOYD INDUSTRIES, INC.
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PROCON 900SA/RS232 AND 900SB/RS232 CONTROLLER
PHYSICAL DIMENSIONS

APPROVAL		DWN BY	DATE	SCALE	CHKD BY	
ENG	DATE	MPJ	5/9/00	NONE		
QA	DATE	SHEET 1 OF 1	44	090067	10	00

COMMUNICATIONS SUPPLEMENT

This supplement contains information relating to the RS232 communications interface for the Model 900CN/900CNA Temperature Controllers. This allows the user to have direct access to the Controller via a standard RS232 link. Through this serial link, all of the standard functions of the Controller may be activated, tested and adjusted.

Since this unit is a Controller, it does not handle a great deal of data. Therefore, the link has been optimized to allow the user, through very simple instructions, to control and interrogate the unit.

Ten 'key' commands allow the user to instruct the Controller to perform all of its normal operations. However, only a couple of these are actually required for computer operation. The remainder are provided, but are not often used, since these keys are utilized in programming. The serial link has direct access to the programming stack through the 'READ', 'WRITE', 'UP LOAD' and 'DOWN LOAD' commands without using 'key' commands. Utilizing these commands, the serial link can interrogate or overwrite any or all of the items in the PROGRAM stack.

The basic status conditions for the Controller are accessed through 4 bytes. These bytes may be read out at any time using the 'STATUS' command.

The Controller may be hooked to any standard terminal or computer system via the DB9 connector on the back panel. The pin out follows the standard IBM DB9 configuration. Therefore, it may be wired directly to an IBM PC/AT or its equivalent. The link is fixed at 9600 baud, 8 bit, 1 stop and 1 start bit, no parity. This link only requires 3 leads to function. As viewed from the Controller, Pin 5 is the 'Signal Ground', Pin 3 is 'Receive Data' and Pin 2 is 'Transmit Data'.

The internal ACIA utilizes a full duplex interrupt driven transmission scheme. Thus, the unit may receive and transmit simultaneously, as well as continue to perform its normal functions. Therefore, the Controller may be interrogated even though it is performing its program.

The Protocol for the serial link consists of 7 basic commands:

K - KEY
S - STATUS
R - READ
W - WRITE
D - DOWN LOAD
U - UP LOAD
X - CANCEL (CLEAR)

All commands will be prefixed by one of these 7 letters. The data format is standard ASCII and all data, with the exception of the Status Bytes are BCD values. The Status Bytes are transmitted in ASCII as hexadecimal, since they contain bit information.

UP LOAD and DOWN LOAD are the only group commands. They each have a specific format and a specific number of bytes of information. They are structured to DOWN LOAD all of the programming information at one time or READ the complete programming stack. All of the rest of the commands are structured to handle the data one byte at a time.

The following is a breakdown of each of the commands and the way they are accessed. It should be noted that the format allows for the unit to be hooked directly to a dumb computer terminal. This can be very useful in checkout. The unit will echo all characters that are typed to it. When used with a terminal, this will provide the appropriate display. When used with a computer system, this will provide direct feedback of the fact that unit has accepted the data.

All commands are completed with a carriage return from the computer. With the exception on the CANCEL command (X), all commands will be acknowledged by a carriage return, line feed ($0D,$0A).

KEY COMMAND

The KEY COMMAND allows the user to instruct the Controller just as would be done by depressing the Face Panel keys. The exact operation and sequence for these keys is covered in the Controller manual. This description will simply indicate how the link may be used to send these key functions.

The command is entered as a letter followed by 2 numbers, followed by a carriage return:

K01(Return)

The 'K' indicates that this is to be a KEY command. The '01' indicates the KEY number and the 'Return' activates the command.

The following is a listing of the key numbers:

KEY NUMBER	KEY
01	DOWN
02	SAVE
03	SILENCE
04	VIEW
05	START
06	UP
07	SETUP
08	RETURN
09	HOLD
10	STOP/RESET
11	DRAIN
12	PUMP

When a KEY command is sent, the Controller will echo each of the characters and acknowledge with a carriage return line feed, once the command is entered. If an invalid command is detected, it will simply be ignored, although it will acknowledge the fact that the command has been received.

READ COMMAND

The READ command is utilized to read from the Controller any of the program data. The format for the command is essentially the same as the KEY command.

R07(Return)

The 'R' indicates to the Controller that the command is to be a READ command. The next two digits indicate the information that is to be read. The carriage return indicates that the command is to be activated. The following is a listing of the data locations that may be read:

DATA LOCATION	DESCRIPTION
01	CS
02	PS
03	HI
04	LO
05	AC
06	DR
07	CL
08	UNUSED
09	PA
10	CR
11	PB
12	RE
13	RA
14	RL
15	UNUSED
16	UNUSED
17	CD (1=UP, 4=DOWN)
18	PROCESS TEMPERATURE
19	REMAINING TIME

It should be noted that while most of the values will read out directly as they appear on the unit, the Time Values will display in Minutes and Seconds, but will read out in seconds only. Therefore, the clock setpoint on the unit may be programmed for 5:00 (Minutes:Seconds). The data that is read from the unit will come out as 0300 seconds.
All data is returned in ASCII format with 4 BCD characters. When the controller displays information, such as the Proportional Band in tenths of degrees C., the data that is returned will be in tenths of degrees. For example, 10.0 degrees C. will be transmitted as 0100. The user should refer to the Controller Manual to determine the exact meaning of each of these readings.

STATUS

The STATUS command is utilized to access 4 bytes of information that are utilized by the Controller to indicate its operating status. The same format as the KEY and READ commands is utilized to READ the status bytes:

S01(Return)

The 'S' indicates the activation of a STATUS command. The number indicates the status byte that is to be read out. The carriage return activates the command. The following is a listing of the available bytes:

NUMBER		DESCRIPTION
01	ALARM	ALARM CONDITIONS
02	MODBYT	SYSTEM MODE
03	SYSBYT	TIMER MODE
04	OUTBYT	OUTPUTS

Each of these bytes contains bits that are set internally by the control algorithms and indicate all the operating information for this system. The ALARM and MODE bytes (MODBYT) are displayed on the Controller via the ALARM and MODE LEDs. The 'System Byte' (SYSBYT) contains information about the current status of the Timer. The 'Output Byte' (OUTBYT1) indicate the condition of the outputs. The following is a description of the appropriate bits that may be utilized to monitor the system functions:

ALARM	MODBYT	SYSBYT	OUTBYT
7- ---	7-NORM	7- ---	7- ---
6- ---	6-HOLD	6- ---	6-PUMP
5- ---	5-WARMUP	5 - ---	5-DRAIN
4-LL	4-ALARM	4- ---	4-HEAT
3-LO	3-PROG	3-TMR OVER	3-EXTERNAL AUDIO
2-HI	2- ---	2-PREWARN	2-CHILLER
1-SENSOR	1- ---	1- ---	1- ---
0-SYS	0- ---	0-TMR RUNNING	0-TIMER RELAY

The meaning for each of the ALARM and MODE LEDs is covered in the Controller Manual. The SYSTEM BYTE indicates whether the Timer is running or not, and whether it is in the OVERTIME or PREWARN modes.

The OUTPUT BYTE contain both positive and negative logic bits. For those bits that are unmarked, a '1' indicates that the output is ON. For those bits that are marked with a not (GGGGG), the outputs are on when the bit is '0'.

Also, it should be noted that many of the undefined bits are used internally and therefore may be either '1' or '0' at any given reading.

These bytes require data transmission in a hexadecimal format. The actual data is sent as an ASCII character, but its meaning is translated in hexadecimal to determine the appropriate bit pattern. For example, the ASCII transmission of $31,$30 would translate to a hex reading of 10, which would indicate for the ALARM BYTE that a low alarm condition existed.

After the carriage return, the Controller will acknowledge with a carriage return line feed and then send the two ASCII characters that indicate the hex representation for the appropriate bit pattern requested.

WRITE

The WRITE command allows the user to overwrite most of the information in the programming stack. The calibration value is not accessible. It should be noted that while this information may be over written, it will not be permanently saved in the controller without first accessing the SETUP mode and then activating the SAVE command via the keys. If the values written are to be permanently saved in the controller's EEPROM memory, after all changes have been made, a K07 (SETUP) followed by a K02 (SAVE) must be transmitted.

If it is not desirable to have these values permanently saved, the user may simply go in and overwrite the current information for temporary use. When the system is repowered, the information that is currently stored in its EEPROM will be reinserted into the SETUP stack.

The following is the format for this command:

W020750

The command essentially follows the same format as all the previous commands. The 'W' indicates that it is a WRITE command, the next two characters indicate the location that is to be written to and the last four characters indicate the data value that is to be entered. Again, the data is in BCD and transmitted in an ASCII format. The example WRITE command would put 75.0 Degrees C. in the Process Setpoint.

The data locations are the same as those covered in the READ command section. However, locations 18 and 19 are READ only and may not be written to. Locations 18 and 19 simply provide a Read Out for the current Process Temperature and Remaining Time.

UP LOAD

The UP LOAD command is utilized to READ all of the items in the SETUP Stack at one time. The following is the format for this command:

U(Return)

This is a single character command that instructs the controller to do a direct dump of the complete programming stack. The data will be transmitted as described in the READ COMMAND section with a carriage return line feed between each parameter.

DOWN LOAD

The DOWN LOAD command allows the user to overwrite the complete setup stack with one command. The following is the format for this command:

Dxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx(Return)

Where small 'x' is replaced by the data to be DOWN LOADED starting with data location 1 and running through data location 17.

The Controller will echo each of the characters as it is transmitted to confirm that it has been correctly received.

The data locations and the appropriate descriptions are identical to the stack shown under the READ command.

CANCEL

The CANCEL command is simply a way to reestablish proper control, should an error occur or an incorrect command be transmitted. For the most part, an incorrect command will simply be ignored and the controller will prepare for an additional command. However, a command may be canceled midstream by transmitting an 'X' (ASCII). This command does not require a carriage return, nor will it acknowledge with a carriage return. However, it will echo an 'X' to indicate that the CANCEL command has been received.

The command may also be utilized as a clear and/or acknowledgment of the Controller being on line.