

**INTEGRATED CIRCUIT DEVELOPMENT**  
**MODEL 968S**  
**SUBAMBIENT BATH CONTROLLER**

The MODEL 968S 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. A pilot duty photoisolated triac output is used to drive a remote heater power relay. A relay output is provided for cooling. Two additional solid state relay drive outputs are included for the Pump and Drain functions.

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.

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.

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

**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. It is the standby condition for the unit. It allows all normal monitoring and timing functions, but disables the heater and cooling. The only way to exit this mode is by depressing the 'RETURN' key. 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 indicates that the Acid Recirculating Pump output is active. This output is controlled by the toggling of the Pump Switch.

**COOL** - This LED is illuminated whenever the cooling output relay 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.

**SETUP** - This is the setup mode. 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:

<u>CODE</u>	<u>DESCRIPTION</u>
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
CD	Clock Direction

<u>CODE</u>	<u>SETTING RANGE</u>
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.
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 'Reset' 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 and reset 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.

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There are six alarm LEDs. They are essentially visual annunciators of system malfunctions. The first is the "System" alarm which 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.

The second 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.

The third 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. This alerts the operator that the system has shut down and why.

The next alarm 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".

The "Low Temp" alarm 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.

The sixth alarm is "Liquid Level". 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.

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All of the alarms activate the audio tone as well as the alarm status LED and the individual alarm annunciator. The tone and the LEDs alternate 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.

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 effects 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 alarm status and alarm annunciator LEDs continue to flash to indicate the alarm and, where applicable, the output to the heater is turned off to protect the equipment from any potential damage.

In some cases it may be desirable to restrict access to the tune and program functions. Thus an "Access Code" system is incorporated in the design. In the program mode, AC may be set. 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 0001 to 9999 as programmed into the system by the customer's authorized personnel. Once this code is entered into the EEPROM using the "Save" command, any attempt to use the MODE key to gain access to the control and setup functions will cause "Code" to appear in the process display. The up and down keys are then used to set the proper code number. A second mode key entry is then required. Any other entry or the wrong code number will return the unit to the normal operating mode.

The process display shows the sensor temperature at all times during normal operation, except when the 'VIEW' key is depressed, when it displays the process setpoint.

The timer display shows the current count of the timer at all times during normal operation, except when the 'VIEW' key is depressed, when it displays the timer preset value.

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 passed 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 prewarn tone has a 50/50 duty cycle and a 1/2 second period. After the preset time has elapsed, it turns into a continuous tone. The timer must be stopped to enter the Program Mode. In the Program Mode the preset time and prewarn time are entered (see Program section).

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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.

The Pump Key on the face of the unit will toggle the Pump Solid State Relay Drive Output 'ON' and 'OFF'. This output is automatically shut off when the power to the unit is shut off. Note: the Pump output is interlocked with the Drain function. Once the unit has been put into the Drain mode, the Pump is automatically turned off and the Pump key will not turn it back on while in this mode.

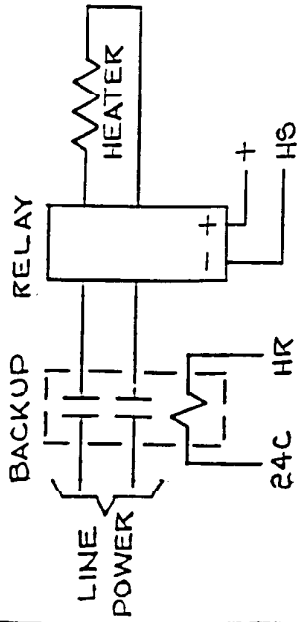
The Cooling Output Relay is automatically activated by the program based on the Cooling "CL" parameter, the Process Setpoint "PS" parameter and the Process Temperature. Whenever the Process Setpoint is set below the Cooling Setpoint, the cooling is enabled. The output will be active unless the unit is in the HOLD MODE.

INTEGRATED CIRCUIT DEVELOPMENT BACKDOOR CODE

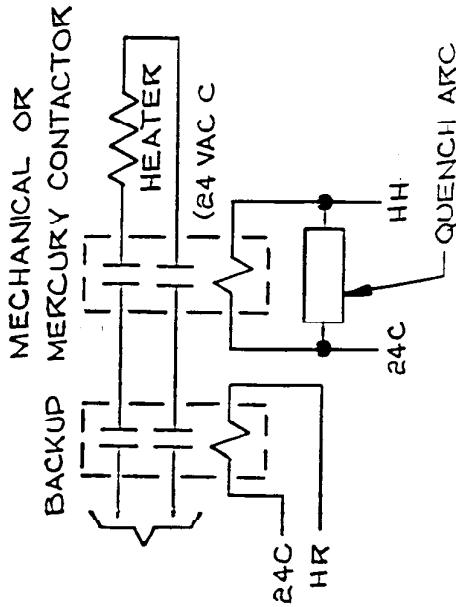
A special code has been incorporated into the software to insure factory access to all functions no matter what the customer has done with the access codes. This code is 333.



**OPTION 2**

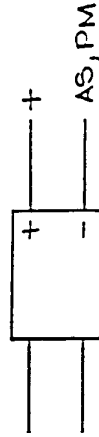


**OPTION 1**

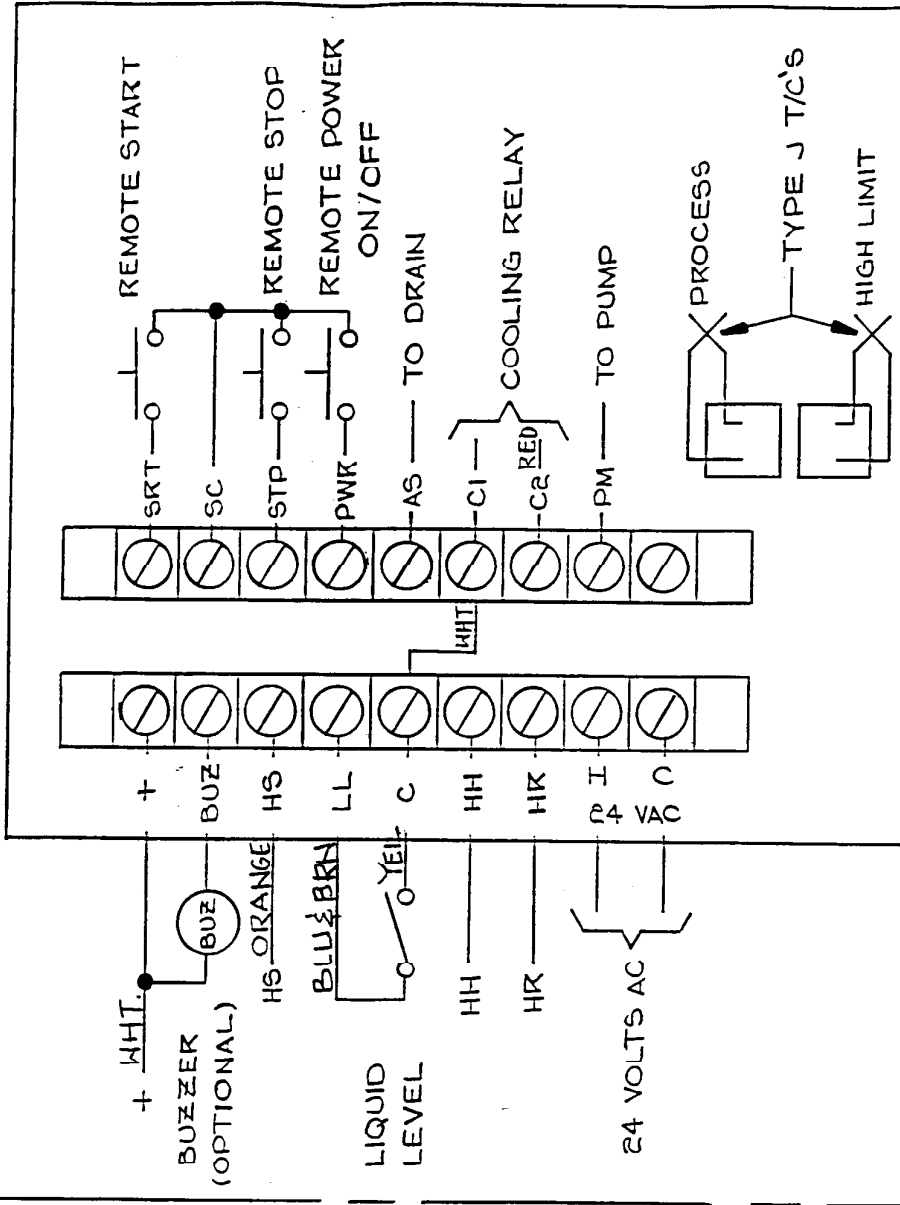


**NOTE: WE RECOMMEND THE USE OF A QUENCH ARC ON EVERY MECHANICAL RELAY IN THE SYSTEM. USE PAKTRON P/N 104M00QC100 OR EQUIVALENT.**

**SOLID STATE RELAY**



**TYPICAL FOR DRAIN AND PUMP**



**NOTE: '+' TERMINAL RATED 12~20 VDC UNREGULATED (100MA).**

TOLERANCES UNLESS OTHERWISE SPECIFIED:

<b>INTEGRATED CIRCUIT DEVELOPMENT</b>		3724 PARK PL. MONTROSE CA 91020	
<b>ICD DT9685 TEMPERATURE CONTROLLER BACK PANEL</b>			
APPROVAL	DATE	DATE	SCALE
ENG	MPJ	9/13/91	
QA	1 OF 1	13	096814
SHEET			CHECK BY
10			

ALL DIMENSIONS ARE IN INCHES

## SPECIFICATIONS

### INTEGRATED CIRCUIT DEVELOPMENT SUBAMBIENT BATH CONTROLLER MODEL DT968S

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, ~ 2500 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: ± 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	7.00 x 6 x 5.25 inches (HxWxD) 178 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	SSR: Optically isolated, zero cross, 1 Amp, 24 VAC. Relay: 1 HP, 250 VAC. SSR Drives: 20ma, 12 VDC (provided)
POWER	11 VA, 24 VAC ±10%, 50/60 HZ