ULTRASONIC POWER
CORPORATION

UPCORP.COM
1-800-575-0168

USER GUIDE

Prototype v1.0

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ULTRASONIC POWER CORPORATION

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Introduction

Ultrasonic energy exists in a liquid as alternate rarefactions and compressions of the liquid. During rarefaction, small vacuum cavities are formed which collapse, or implode, during compression. This continuing rapid process, called cavitation, is responsible for the scrubbing effect which produces ultrasonic cleaning. Three factors affecting the scrubbing action are the degree of liquid degassing, the ultrasonic frequency and the chemical characteristics of the liquid at specific temperatures.

Degassing is the removal of unwanted air from the liquid. As the cavities form, they fill with the unwanted air forming bubbles, which resist collapse and tend to remain suspended in the liquid. These bubbles act as "shock absorbers," which materially reduce cleaning efficiency. The amount of air can be reduced by periodically switching off, or modulating, the sound energy to permit adjacent bubbles to coalesce, float to the surface, and escape. The type of modulation is important, for the correct balance between degassing and cleaning efficiency must be selected for each cleaning application.

Frequency affects cleaning efficiency by determining the cavity size. Low frequencies generate large but relatively few cavities with high cleaning power. High frequencies generate a great number of small cavities with good penetrating capability. The selection of the correct frequency is difficult, for it varies with each cleaning application. The frequency also affects degassing, with 40 kHz nearly optimum.

Cleaning efficiency is also affected by the chemical and physical characteristics of the liquid. For best cleaning, the liquid must chemically soften the soil, yet maintain effective cavitation and provide the desired characteristics for rinsing and drying the cleaned parts. Ultrasonic cleaning solutions are broadly characterized as aqueous or non-aqueous. Final selection is dependent upon the overall process considerations for the cleaning application.

The ultrasonic energy is created within a liquid by means of transducers, which convert electrical energy into acoustic energy. These transducers are similar in function to a radio speaker except they function at ultrasonic frequencies (40,000 Hz) and transmit acoustic energy to a liquid rather than to air. The transducers consist of vibrating elements (piezoelectric disc) bolted between thick metal plates. The transducers are bonded to the underside of the tanks containing the cleaning liquid or are encased in stainless steel for immersion within a liquid. For reliability, many transducer modules are uniformly distributed over the tank bottom rather than having a single transducer in the center of the tank working very hard. An electronic generator energizes the transducers. The generator transforms the electrical energy from the wall outlet into a suitable electrical form for efficiently energizing the transducers at the desired frequencies. All ultrasonic cleaning systems consist of the four fundamental components of transducer, generator, container for liquid, and cleaning liquid. The performance and reliability of the system depends upon the design and construction of the transducers and generators. The overall effectiveness of the cleaning is dependent upon the cleaning liquid. The size of the tank is dependent upon the size or quantity of the parts being cleaned. The number of transducers and generators is determined by the tank size. The choice of cleaning liquid depends upon the parts being cleaned and contaminant to be removed.

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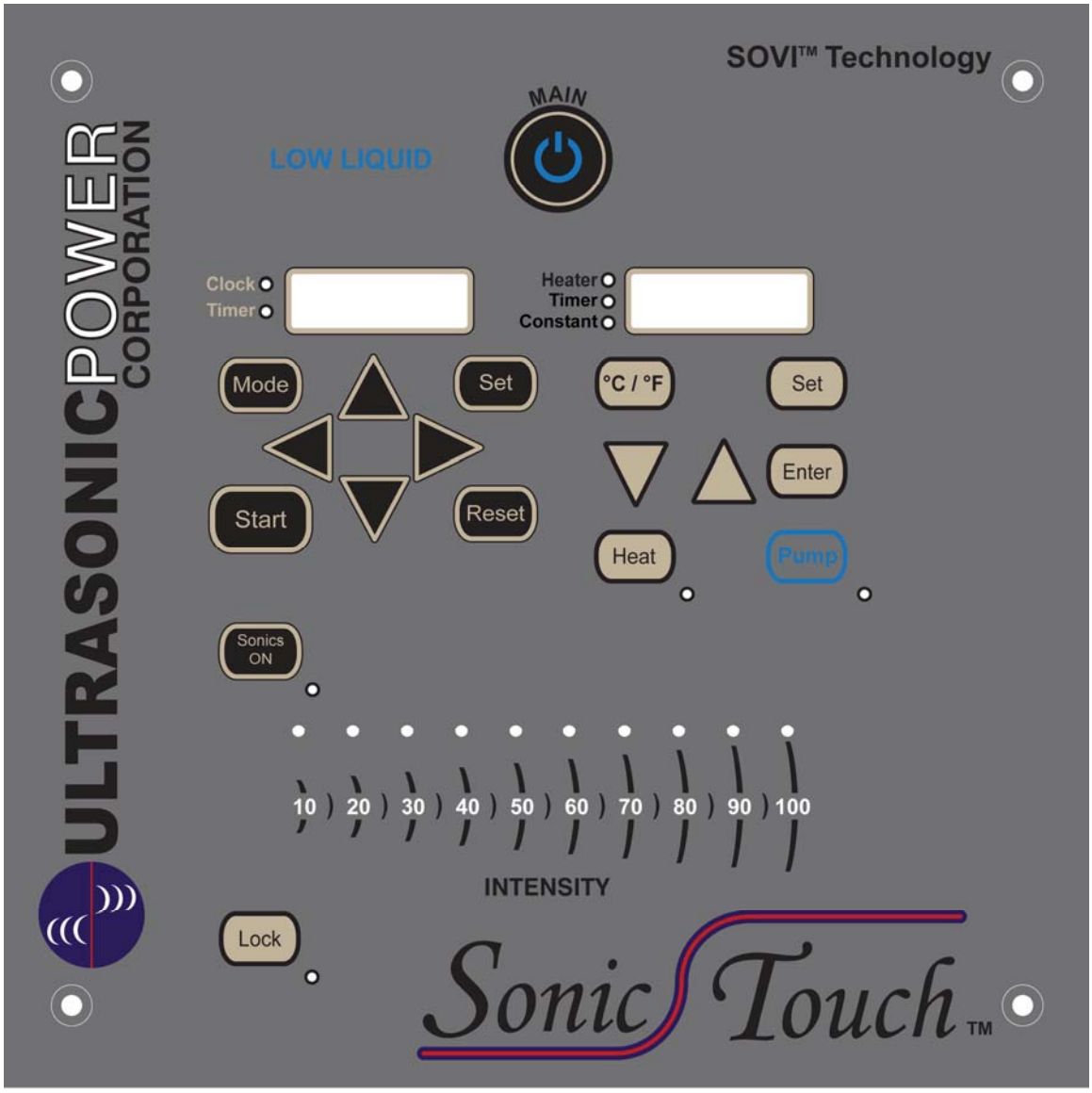
How Ultrasonic Cleaning Works

Ultrasonic cleaning is a result of sound waves introduced into a cleaning liquid by means of a series of "transducers" mounted to the cleaning tank. The sound travels throughout the tank and creates waves of compression and expansion in the liquid. In the compression wave, the molecules of the cleaning liquid are compressed together tightly. Conversely, in the expansion wave, the molecules are pulled apart rapidly. The expansion is so dramatic that the molecules are ripped apart, creating microscopic bubbles. The bubbles are not seen by the naked eye since they are so small and exist for only a split second of time. The bubbles contain a partial vacuum while they exist. As the pressure around the bubbles becomes greater, the bubble implodes (collapses) causing the fluid around the bubble to rush in. When this occurs, a jet of liquid is created at a velocity of around 600 MPH. They also rise in temperature to as high as 5000 degrees C, which is roughly the temperature of the surface of the sun. This extreme temperature, combined with the liquid jet's velocity provides a very intense cleaning action in a minute area. Because of the very short duration of the bubble expansion and collapse cycle, the liquid surrounding the bubble quickly absorbs the heat and the area cools quickly. As a result, the tank and liquid becomes only warm and does not heat up due to the introduction of parts during the cleaning process.

Operating Your Cleaner

If this is the first time you are using this cleaner, please read this entire document before attempting operation.

Familiarize yourself with the control panel:



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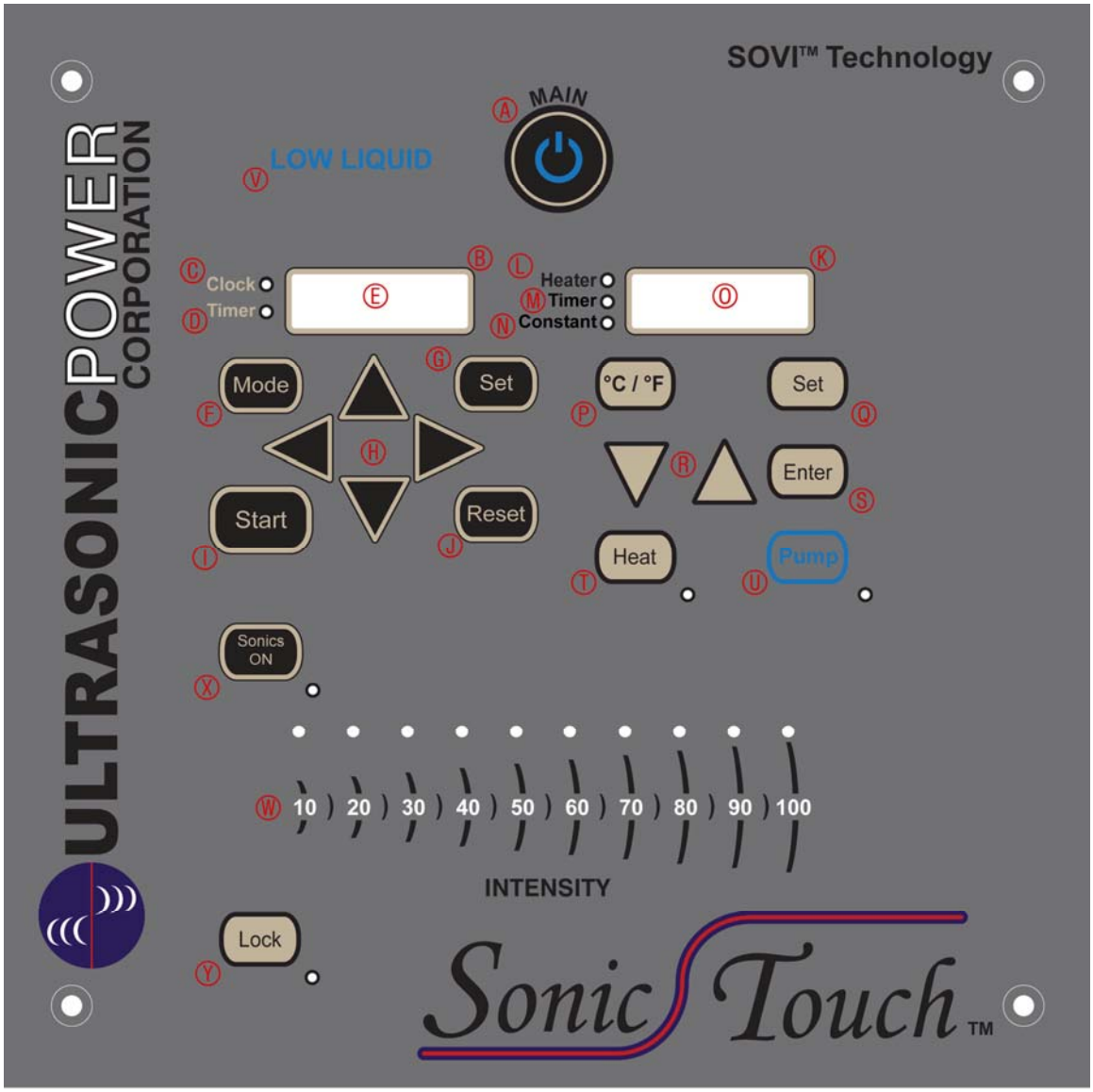
Explanation of Controls

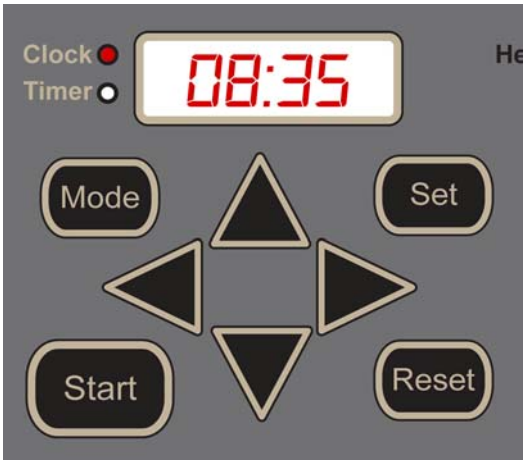
	Control / Indicator	Function
A	Main Button	Press button to energize and de-energize the system. The button will illuminate when cleaner is ON.
B	Clock / Countdown Timer	Clock can be set to automatically turn on and off the heater element at a particular time once a day. The Countdown Timer is used to run the ultrasonic cleaner for a desired period of time.
C	Clock Indicator	LED indicates display is in clock mode.
D	Timer Indicator	LED indicates display is in timer mode.
E	Clock / Timer Digital Display	Indicates current time (24 hour clock) or time left on countdown timer.
F	Mode Button	Press to change display between clock and timer mode
G	Set Button	Press to set current time, schedule heater ON and OFF times, set countdown timer (Max 9 hours, 59 minutes, 59 seconds).
H	Arrow Buttons	Up and Down buttons increase and decrease digit being set, while Left and Right buttons move to other digit to be set.
I	Start Button	Press to start Countdown timer, press to accept clock and timer setting.
J	Reset Button	Press to reset Countdown timer.
K	Thermostat	Thermostat controls desired temperature of the tank.
L	Heater Indicator	Indicates heater element is ON.
M	Heater Timer Indicator	Indicates heater is in Timer Control Mode
N	Heater Constant Indicator	Indicates heater is in Constant Control Mode
O	Thermostat Digital Display	Indicates current tank temperature in °C / °F.
P	Degree Format Button	Press to change between °C / °F.
Q	Set Button	Press to set desired tank temperature set point.
R	Arrow Buttons	Up and Down buttons increase and decrease temperature setting.
S	Enter Button	Press to accept temperature setting.
T	Heat Button and Indicator	Press to enable Master Heater Control, Once pressed the heat button indicator will illuminate. If this button has been pressed and the indicator is illuminated then the heater element can be controlled by the Clock / Timer and Thermostat
U	Pump Button and Indicator	Press to turn the Pump ON. The indicator will illuminate when pump is on. *If option is installed
V	Low Liquid Indicator	Indicates when the level of liquid in the tank is LOW. If system senses low level it will illuminate this indicator as well as disabling the ULTRASONICS, HEATER and PUMP. *If option is installed
W	Intensity Slider and Indicators	Slide finger or Press Slider to set Intensity Level. Intensity is set in 10% increments from 0 to 100%. LED indicators correspond with intensity level.
X	Sonics ON Button and Indicator	Press to turn the Ultrasonic Generators ON manually.

		When the Ultrasonic Generator has been turned on the indicator will be lit.
Y	Lock Button and Indicator	Press to turn on the Key Lock feature. When the Key Lock feature is enabled, the indicator will be lit. The Key Lock feature locks all keys except for the MAIN, START and LOCK buttons.



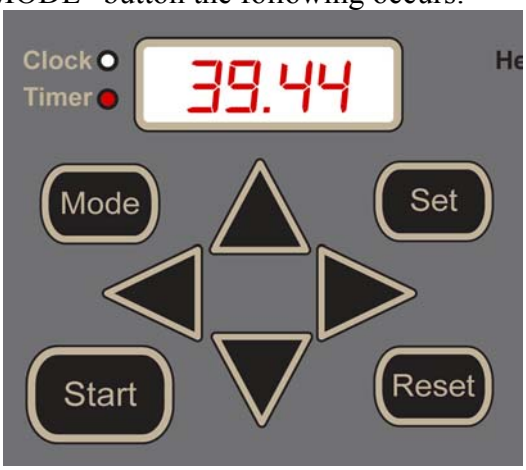
Detailed Operation

Clock – Countdown Timer Functionality



When the machine is turned on using the "MAIN" button, you will see the current time. This time is displayed in 24 hour format. Notice the LED next to the word "Clock" is illuminated.

If the user presses the "MODE" button the following occurs:

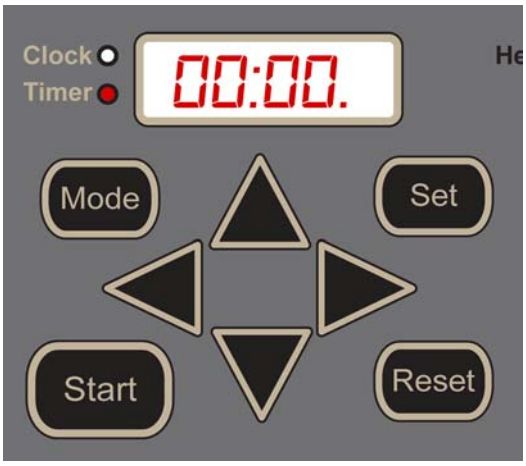


The LED next to the word "Timer" illuminates. The last "TIMER SET" value will be displayed. Currently 39 minutes and 44 seconds are displayed.
If the user hits "START" the timer will begin to count down, and the ultrasonic cleaner will begin to clean. The cleaner will run until the timer expires, or the user presses the "Reset" button. If the user allows the timer to expire, the word "Done" will be displayed for 2 seconds and the timer will be reset to the last "Timer Set" value, and wait for "Start" press.

If the user presses "Reset" the timer will be reset to the last "Timer Set" value, and wait for "Start" press.

Setting the Timer

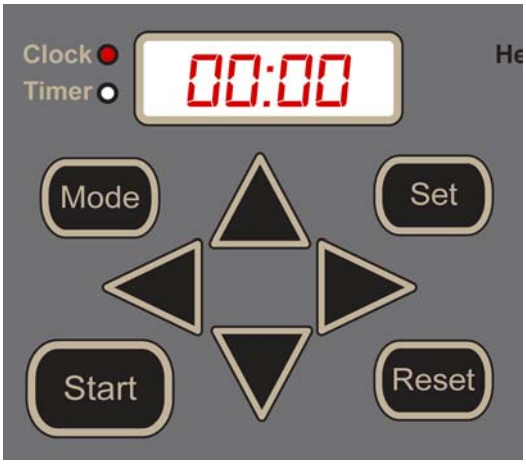
The "Set" button can be pressed at anytime. If the "Set" button is pressed while in TIMER MODE, the following occurs:



Now the user can simply use the UP, DOWN, LEFT and RIGHT arrow buttons to set the COUNT DOWN TIMER. The time being displayed will blink indicating it is being set. A maximum of 9 Hours, 59 Minutes and 59 seconds can be entered.
Once the desired time is set, the user must press the "Set" button to save the time and return to the Timer Mode.

Setting the Clock

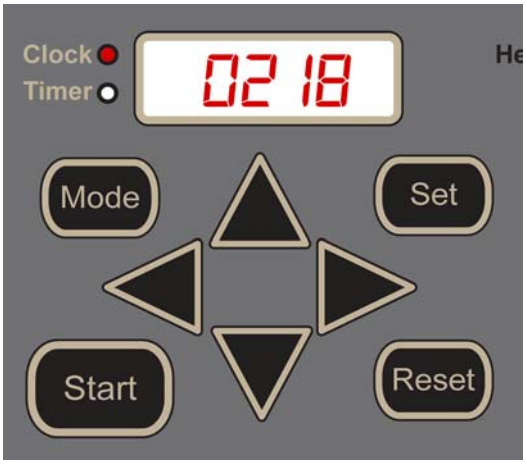
If the "Set" button is pressed while in CLOCK MODE, the following occurs:



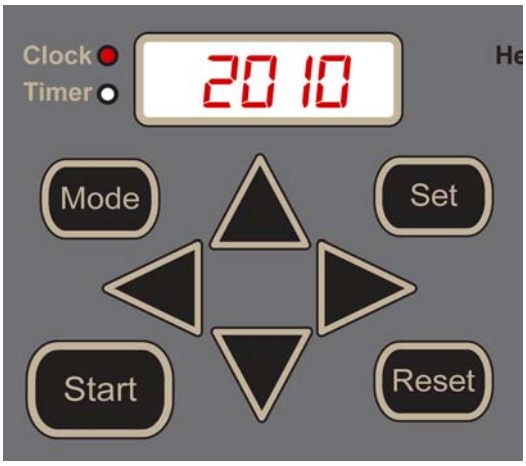
Now the user can simply use the UP, DOWN, LEFT and RIGHT arrow buttons to set the Clock. The time being displayed will blink indicating it is being set. Once the correct

current time is entered, the user must press the "Set" button to save the time. From there you will set the Date.

The first two digits are for the month. The last two digits are for the current day.



Once you are finished, press the Set button. The Example above shows February 18th. Now you will 4 digits to set the current year.



Once finished, press the Set button. The Example above shows the year 2010.

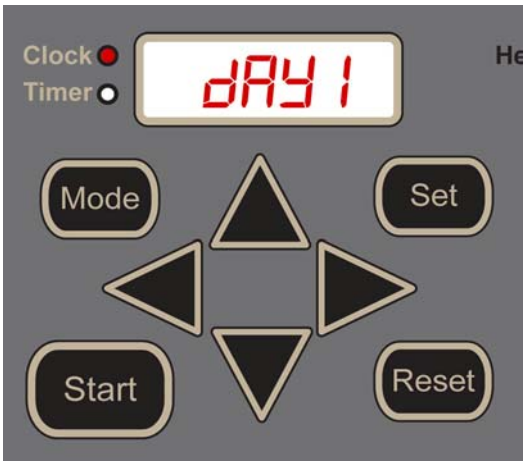
Notes:

1. The system works correctly for all years from 2000 to 2100.
2. The whole current time, month, date and year need to be set for the clock to update correctly. If there is a power loss while setting the time, month, day or year the clock needs to be set again.
3. The following input combinations are considered error by the system and "Err"will be displayed
    - Entering a time greater than 23:59
    - Entering 00 in the month or day of the month columns

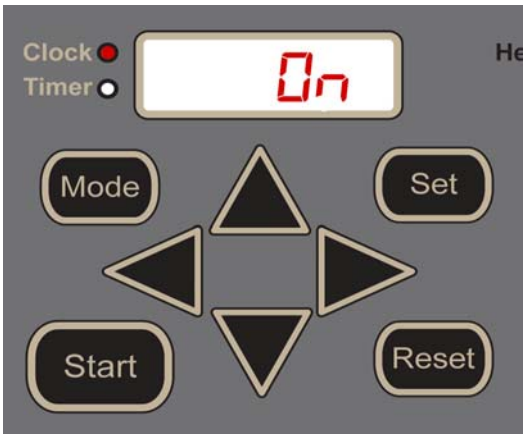
- Entering a month greater then 12
- Entering a value greater than 29 for the month of February
- Entering a day of month greater than 30 for April, June, September or November

In the above cases the values we were trying to enter will be discarded and all zeros such as 00:00 or 0000 will be displayed.

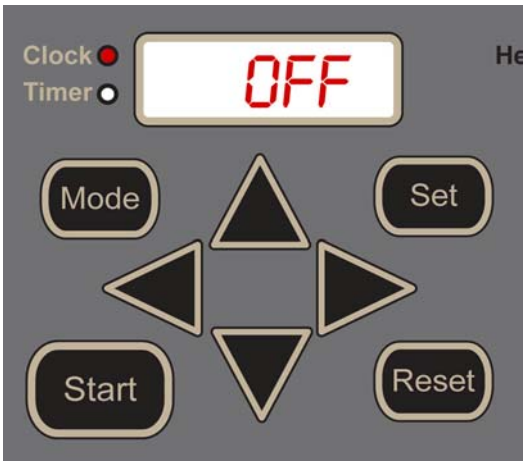
Now you will be able to program the scheduled "ON and OFF" times for the heater.
The 7 Day Week has the following code:
Sunday = 1
Monday = 2
Tuesday = 3
Wednesday = 4
Thursday = 5
Friday = 6
Saturday = 7
Day 1 (Sunday) will be the first day you set the ON and OFF times. Press "Set" on the day1 screen.



For a brief moment (2-3 seconds) you will see the following displayed:



The “On” text is merely telling you, that you are about to enter the time at which you would like the heater to turn ON. You will enter the time you would like the heater to turn on just like you did when setting the current time. Once that is complete you will press the “Set” button again. From there you will move into the “OFF” time entry. For a brief moment (2-3 seconds) you will see the following displayed:

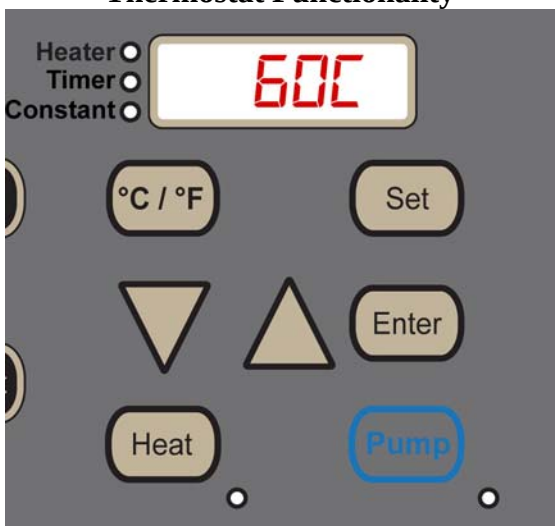


The “OFF” text is merely telling you, that you are about to enter the time at which you would like the heater to turn OFF. You will enter the time you would like the heater to turn off just like you did when setting the current time. Once that is complete you will press the “Set” button to save your entry and return to the Date Scheduler. You can then select a different Day to program. If you would like to clear the day so that nothing happens, you must set the “ON” time the same as the “OFF” time. Once all 7 days are set the display goes back to displaying the current time.

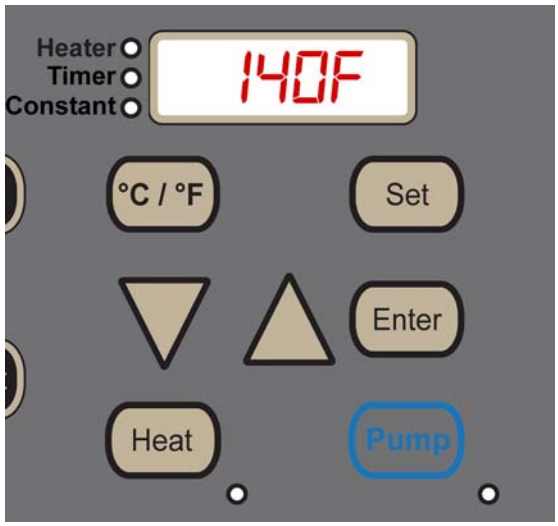
Notes:

1. The ON, OFF times for all the seven days needs to be set for the system to record the changes between power down and power ups.
2. An “Err” message is displayed if the user tries to enter a time greater than 23:59.

Thermostat Functionality



When the machine is turned on, you will see the "real time" temperature of the fluid in degree Celsius after a 1 minute delay. At this point if the user presses the "°C / °F" button the following occurs:



The temperature being displayed will be converted from Celsius to Fahrenheit or vice versa.

Setting the Temperature Set Point

The "Set" button can be pressed at anytime. Once it is pressed you can use the arrow keys to set the desired temperature set point.
Note:

1. The up arrow key increments up to 5 times in increments of 1 degree Celsius and the next 5 times in increments of 5 degree Celsius and in increments of 10 degree Celsius thereafter, if pressed and held.

2. Similarly, the down arrow, if pressed and held, decrements up to 5 times in decrements of 1 degree Celsius and the next 5 times in decrements of 5 degree Celsius and 10 degree Celsius thereafter.
3. You cannot set a temperature less than 0 degree Celsius or more than 255 degree Celsius.

Once the desired temperature is set, you must press the "set" button again to decide if the heater is to be operated in the constant control mode or timer control mode.

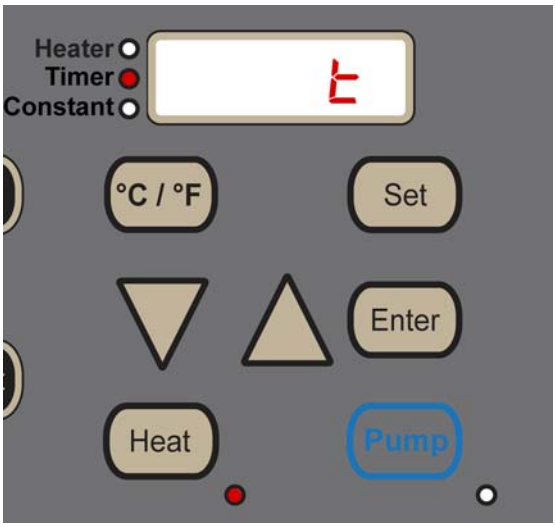
Setting the Heater Control Modes

There are two modes in which the heater will operate.

1) Timer Control Mode
2) Constant Control Mode

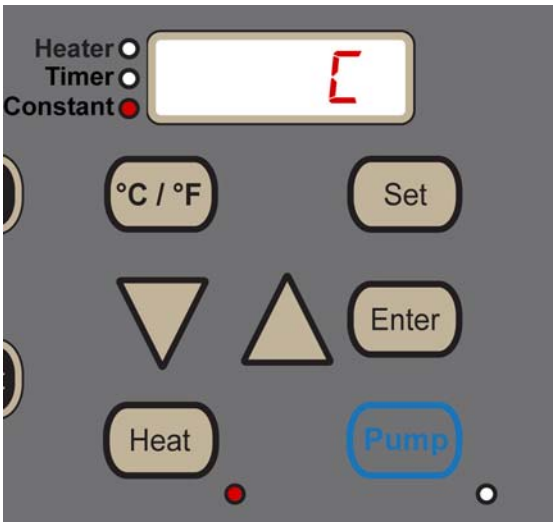
The timer control mode is enabled when the operator wants the heater to turn on and off on a scheduled time. Please see "**Setting the Clock"** on page 11 of this manual. The timer control mode is used when the operator wants the heater to turn on and off for a particular period of time during the day.

To enable this mode, after setting the temperature and pressing the "Set" button, you have to press the up arrow. The display changes as shown below:



If the operator would like to have the heater maintain the temperature set point indefinitely / regardless of the timer, the operator must put the heater into the Constant Control Mode. To enable this mode, after setting the temperature and pressing "Set button" you have to press the "down" arrow.

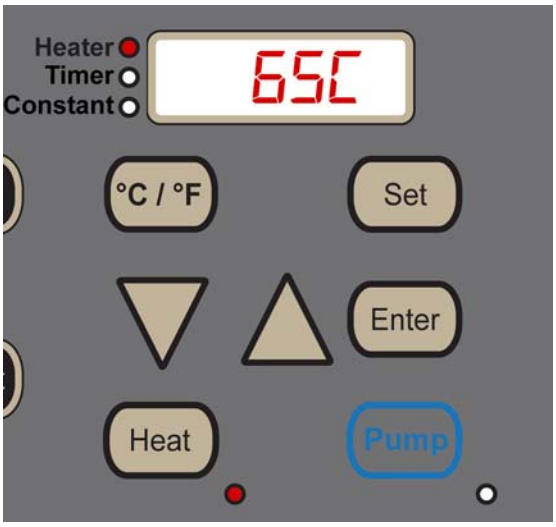
You can also change between Timer Control Mode and Constant Control Mode by pressing the up and down arrows at this stage. A screen shot of the display in constant mode is shown below.



Once, you have set the temperature and the heater control mode, press "ENTER" button to save the heater settings. The display changes and goes back to displaying the current temperature of the fluid.

Note, that in the above pictures the LED indicator next to the MASTER HEATER CONTROL BUTTON is on. This needs to be turned on. IF and only if the MASTER HEATER CONTROL BUTTON has been pressed and is illuminated will the thermostat and clock have control over the heating element.

If the temperature of the fluid is below the "temperature set point" the thermostat will turn on the heater. The Heater indicator LED will illuminate telling the user that the HEATER is ON.



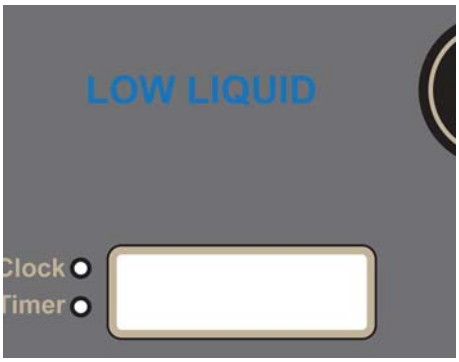
Once the temperature of the fluid reaches the "temperature set point" the heater will be turned off. The thermostat will keep the temperature of the fluid within +/- 2 degrees of "temperature set point."

Pump Control

If your machine is equipped with a PUMP, your control panel will have a back lit PUMP button. If you press the "PUMP" button the indicator located towards the bottom right of the button will illuminate and the PUMP will be active.

Note:
Do not try to connect or remove the pump while the control panel is powered.

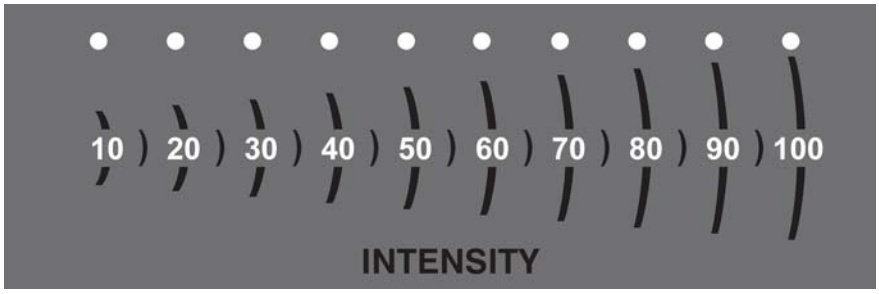
Low Liquid Warning



If your machine is equipped with a LOW LEVEL SENSOR, and there is not enough liquid in the tank, the LOW LIQUID warning will be illuminated. In this condition, the ULTRASONICS, HEATER, and PUMP will be disabled.

Note:
1. It is supposed to take 3-5 seconds after the liquid has dropped below the acceptable levels to report low liquid.
2. Similarly, it would take 3-5 seconds after the liquid has risen to safe levels to remove the warning.

Intensity Control



The intensity of the ultrasonic cleaner is controlled by this slider. Simply slide finger or press slider to set Intensity Level. Intensity is set in 10% increments form 0 to 100%. LED indicators correspond with intensity level.

Sonics Control

If you press the "Sonics ON" button the indicator located towards the bottom right of the button will illuminate and the Ultrasonic Generators will be active.

If the timer is counting down and the user presses the "Sonics ON" button, the timer will be reset, but the Ultrasonic Generators will stay on.

The Ultrasonic Generators can be turned off by pressing the "Sonics ON" button once again or by pressing the "Reset" button.

Key Lock Control

If you press the "Lock" button the indicator located towards the bottom right of the button will illuminate and the Key Lock feature will be active. The Key Lock feature simply locks out all of the buttons from accidental presses. The only keys that will be left active are the following:

Main button

Start button
Lock button

To deactivate the Key Lock feature simply press the “Lock” button again and the indicator will turn off and the feature will be disabled.

Error Codes

The Ultrasonic Cleaner is equipped with a special error reporting system. If an ultrasonic generator has a problem or the machine experiences a system error, it will send an error message to the LED displays. The display on the left will show “Err”, which represents an Error has occurred. The display on the right will show an error code. This code will tell the operator what has happened to the machine. The following is the list of error codes and their meanings:

<u>Generator Error</u>

1) Err 0001 = Generator 1 TOP
2) Err 0002 = Generator 1 BOTTOM
3) Err 0003 = Generator 2 TOP
4) Err 0004 = Generator 2 BOTTOM
5) Err 0005 = Generator 3 TOP
6) Err 0006 = Generator 3 BOTTOM
7) Err 0007 = Generator 4 TOP
8) Err 0008 = Generator 4 BOTTOM
9) Err 0009 = Generator 5 TOP
10) Err 0010 = Generator 5 BOTTOM

The control panel will be monitoring the signals coming from each generator. If the signal from the generator is “low” / ground, the panel will not display any error message because the generator is running correctly. If the signal from the generator is an “open circuit”, the panel will display the associated error message.

The machine will continue to operate while these codes are flashed.

A bank of 10 Dip Switches are located on the PCB which will allow the installer to enable / disable error reporting for any of the generators.

The following are system errors triggered by an overheating - temperature over spec situation.

System Error

11) Err 0020 = Panel Electronics Overheating
12) Err 0021 = Panel Electronics Overheating 2
13) Err 0030 = System Error - Reset

Err 0020 is generated by a small "on board" temperature probe. The temperature probe measures the temperature of the PCB. If the PCB temperature is above 60ºC (140ºF), the board will display Err 0020. The system will shut down to prevent further damage. The main relay will be turned off during this condition. The system will need to cool down and then be restarted in order to start functioning again. The main processor will write this error to its non-volatile memory, which cannot be erased by anyone other than Blue Sparq, Inc. If this panel were to ever come back in for service, we can use this and other information logged by the main processor during our problem diagnosis process.

Err 0021 is generated by thermocouple circuit / probe errors. These errors are generated in special overheating situations. The system will shut down to prevent further damage. The main relay will be turned off during this condition. The system will need to cool down and then be restarted in order to start functioning again. Just like Err 0020, this information is logged by the main processor and can be retrieved at a later date.

Err 0030 is a "processor reset" monitor. If a processor was to reset, to recover from some error or component failure this error message is displayed.

Operating the pcb over 60ºC voids the warranty.

Temperature Specification

We have designed a sensitive Auto-Zeroed Thermocouple circuit that measures the voltage at the cold junction of the thermocouple in order to accurately measure temperature at the hot junction. The ambient temperature is measured using an "on board" temperature sensor that is located as close as possible to the thermocouple connector on the PCB. This measurement is used to perform cold junction compensation for the thermocouple measurement. Our special thermal management firmware applies cold junction compensation and data linearization to determine the actual temperature of the thermocouple hot junction (tip of thermocouple temperature probe).

This system relies on the PCB operating at temperatures below 60ºC. The goal is to keep the PCB as close to room temperature as possible, giving you the highest thermocouple reading accuracy. As the temperature of the PCB rises, the temperature compensation system will try to keep the thermocouple readings accurate. It is important to note that some slight degradation to this accuracy can be noted at higher temperatures.

The maximum operating spec of this electronics system is 60ºC. Operating the pcb over 60ºC may damage the electronic components and will void the warranty.

It is very important that the machine is designed to insulate the electronics from the heat generated by the rest of the machine. Keeping the electronics cool and dry will drastically extend the life of this control panel and electronics.

ULTRASONIC POWER CORPORATION

Electrical Specification

Input Voltage	90 – 264VAC Input See attached spec sheet
Clock / Thermostat	Clock and Thermostat control **Heater** Control Relay +24V DC 350Ω Coil Relay P/N: RPF2ABD Low Side Driver – Switched Ground PCB Interface: J11 DB15 Pin 1,9
Timer	Timer controls **Ultrasonic** Control Relay +24V DC 350Ω Coil Relay P/N: RPF2ABD Low Side Driver – Switched Ground PCB Interface: J11 DB15 Pin 2,10
Pump	Pump controls **Pump** Control Relay +24V DC 350Ω Coil Relay P/N: RPF2ABD Low Side Driver – Switched Ground PCB Interface: J11 DB15 Pin 3,11
Main Power	Main controls **Main Power** Control Relay +24V DC 350Ω Coil Relay P/N: RPF2ABD Low Side Driver – Switched Ground PCB Interface: J11 DB15 Pin 4,14
	*MAX QTY OF RELAYS A total of 12 relays, or 21W can be powered by this system.
Intensity	Output is 0-10VDC 1V Increments High Side Driver Output - 150ma Max PCB Interface: J11 DB15 Pin 5,12
Low Liquid Sensor	INPUT PCB Interface: J11 DB15 Pin 6,13

	To disable this feature, simply jumper Pin 6 to Pin 13
Thermostat	"K" Type Thermocouple PCB Interface: PCC-SMP-K Connector from OMEGA J10 on PCB
Error Signal	Error Signals coming from generators PCB Interface: J14 DB15 Pin 1 = Generator 1 Top Pin 2 = Generator 1 Bottom Pin 3 = Generator 2 Top Pin 4 = Generator 2 Bottom Pin 5 = Generator 3 Top Pin 6 = Generator 3 Bottom Pin 7 = Generator 4 Top Pin 8 = Generator 4 Bottom Pin 9 = Generator 5 Top Pin 10 = Generator 5 Bottom Pin 12 = Ground

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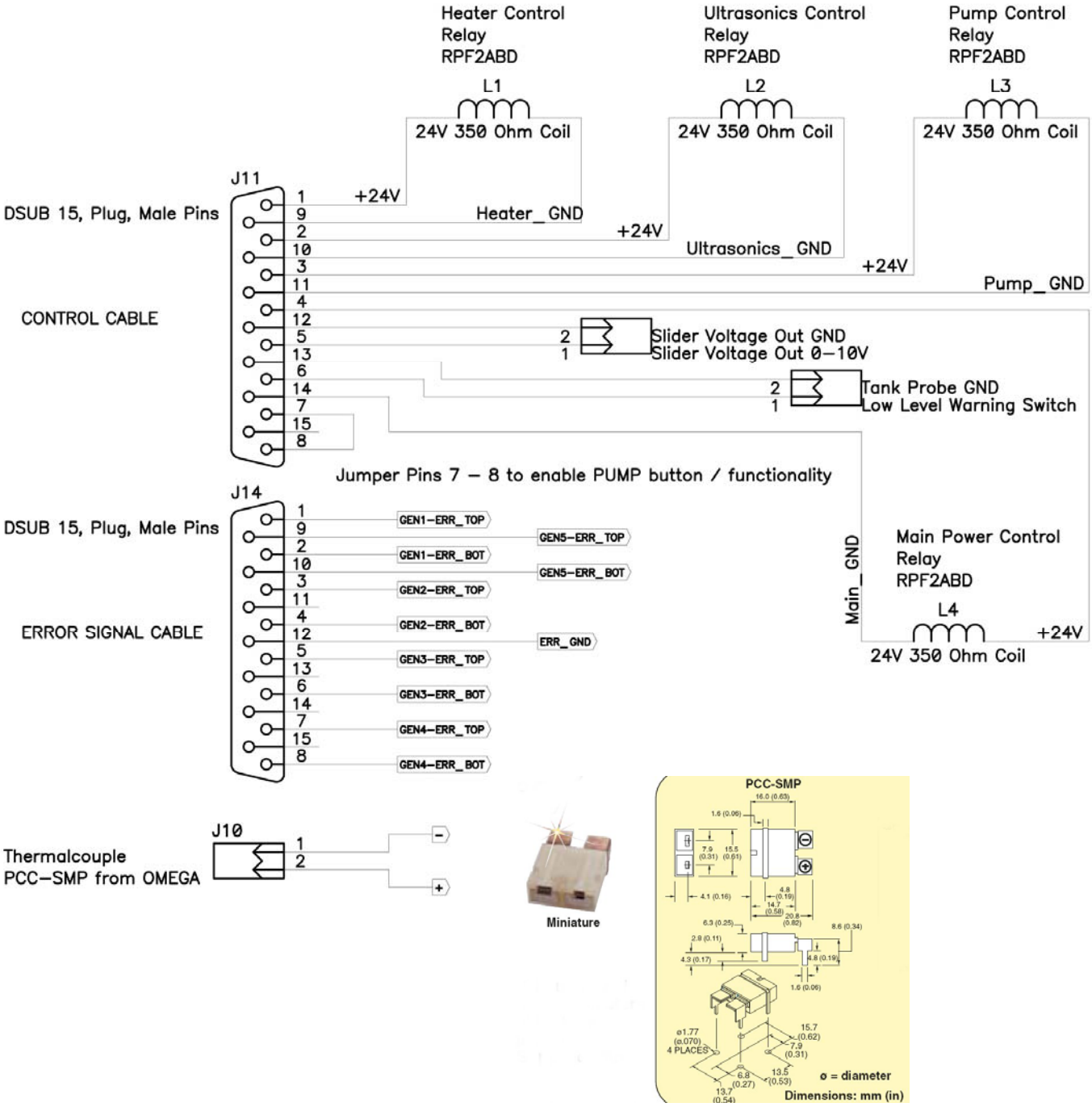
Wiring Diagrams

Power Supply input requires the following:
90 ~ 264VAC Supply line must have AC/N pin 1 and AC/L pin 3 using crimp terminal JST SVH-21T-P1.1 or equivalent and 3 position housing is JST VHR or equivalent.
Supply ground must have screw eyelet / ring connector. This line will be attached to power supply 4-40 mounting screw. Also recommended is a toroidal ferrite core placed at the end of this cable closest to this power supply.