Controller Manual

4/22/04

1 How it works

The controller provides power to the control resistors in the heaters based on the outside temperature and weekend setback. The more power applied to the resistors, the more the heater is dialed back. The knobs on the heaters can still be used to control the heaters. Power to the control resistors effectively changes the zero point on the heater knob. For instance, if a pulse width level of '35' is sent to the control resistors, this results in the heaters being off when the outside knob is set to 2.5. If the knob is now increased to 3, this results in an effective knob setting of .5.

2 Powerup

Power should be applied to the controller and then batteries inserted for battery backup. When the controller is first powered up, it begins to collect data on the power company's charge cycle and begins operating immediately. No adjustments should be required since all settings are saved in Flash memory.

The knobs on the heater should be set to 2.5.

2.1 Battery Backup

Battery backup is used to preserve the contents of RAM and the data collected by the controller to predict the next week. The following are preserved with battery backup:

- Log of high and low outside temperatures
- Historical pattern of power company power switches for the past 7 days.
- The number of times the controller entered setback control and its prediction failed, leading to undercharging.

Other settings are saved in Flash memory and do not require battery backup.

Battery backup is not strictly required. If power to the controller is interrupted without battery backup, the most significant impact is that the history switches will be lost and controller will not use setback control. The controller will require 1 week of uninterrupted operation to regain the history and begin using setback control again.

The batteries can maintain the controller for 20 days of continuous lack of power.

3 Shutting controller off

In order to shut the controller off, batteries should be removed and power shut off. Power is shut off by remove the +14vDC power wire going to the board.

4 Basic Mode

Basic mode is for viewing some key parameters of the controller. It is impossible to change any settings in Basic mode. The controller should be kept in this mode during normal operation to avoid accidental setting changes.

The switch at the top of the Controller Board is used to select Basic Mode or Setup Mode. Switch to the left for Basic, and to the right for Setup. The controller will operate with the switch in either mode.

4.1 Parameters in Basic Mode

Press the Next button to select the next parameter in the list. When you get to the last parameter, pressing the Next button will send you to the start of the list. Some parameters have multiple definitions depending on the state of the controller or whether power is being supplied by the power company.

4.1.1 Power and Controller State (oF, on, SE)

This parameter indicates the state of the current power being supplied by the power company and the status of the controller. One of the following will display:

oF	Indicates that there is currently no power being supplied by the power company to charge the heaters.
on	Indicates that there is currently power being supplied by the power company and the controller will use standard control.
SE	Indicates that there is currently power being supplied by the power company and the controller is predicting power to remain on nearly continuously (75%) in the next half day. Controller will be using setback control.

Numerical Value

In addition, a numerical value will be displayed, which indicates the amount of dial-back being supplied to the heaters. The value displayed is from 0 to 100 (with 100 indicated by - - on the 2 digit display). A value of zero would indicate that the control resistors are not being heated. A value of 100 indicates the resistors are being heated at full power. Values in between zero and 100 indicate the duty cycle of the pulse being supplied to the controller resistors in the heaters.

Pressing Up or Down

If either the Up or Down button is pressed in this mode, the display will begin cycling through all the parameters in the Basic mode. This is handy to quickly see all the settings. Pressing the Up or Down button at any time should shut off this display cycling. In addition switching to Setup mode will shut off display cycling.

4.1.2 Temperature (t, t-)

This parameter indicates the current outside temperature being measured by the controller in degrees F. A negative temperature is indicated by a minus sign after the t. For positive temperatures, no minus sign appears.

Numerical Value
The numerical value indicates the temperature. Note that the value may or may not match the outside temperature, because of the location of the pickup sensor.

Pressing Up or Down
Pressing either the Up or Down button is pressed in this mode should shut off this display cycling.

4.1.3 High Temperature(H, H-)

This parameter indicates the current maximum temperature logged by the controller in degrees F. A negative temperature is indicated by a minus sign after the H. For positive temperatures, no minus sign appears.

Numerical Value
The numerical value indicates the temperature. Note that the value may or may not match the outside temperature, because of the location of the pickup sensor.

Pressing Up or Down
If the display is rotating, pressing either the Up or Down button should shut off this display cycling. If the display is not cycling, pressing Up or Down will reset the maximum temperature.

4.1.4 Low Temperature(L)

This parameter indicates the current minimum temperature logged by the controller in degrees F. A negative temperature is indicated by a minus sign after the H. For positive temperatures, no minus sign appears.

Numerical Value
The numerical value indicates the temperature. Note that the value may or may not match the outside temperature, because of the location of the pickup sensor.

Pressing Up or Down
If the display is rotating, pressing either the Up or Down button should shut off this display cycling. If the display is not cycling, pressing Up or Down will reset the minimum temperature.

4.1.5 Prediction status (P, PP, FA, FF)

This parameter indicates the current status of predictions, and any faults in prediction detected by the controller.

P Indicates that the controller is collecting initial historical data. The numerical value provides a countdown of the number of half-days remaining (0-14) before controller has a full week of historical data.

PP Indicates that the controller is in the last half-day of collecting initial historical data. The numerical value provides a countdown of the percent of the half-day remaining (0-100) before controller has a full week of historical data.

FA Indicates that the controller has enough history to begin predicting and that the current prediction is accurate. The numerical value indicates the number of times the controller entered setback control and its prediction failed, leading to undercharging.

FF Indicates that the controller has enough history to begin predicting and that the current prediction is inaccurate (by more than 3 hrs per half day). The numerical value indicates the number of times the controller entered setback control and its prediction failed, leading to undercharging.

Pressing Up or Down

Pressing either the Up or Down button is pressed in this mode should shut off this display cycling.

5 Setup Mode

Setup mode has all the parameters of Basic mode, plus some additional parameters and data input. The switch at the top of the Controller Board is used to select Basic Mode or Setup Mode. Switch to the left for Basic, and to the right for Setup. The controller will operate with the switch in either mode.

5.1.1 Temperature at which no charging occurs (n, n-)

This parameter indicates the temperature setting at which no charging should occur. A negative temperature is indicated by a minus sign after the n. For positive temperatures, no minus sign appears. When the outside temperature reaches or exceeds this temperature, the control signal applied to the control resistors will be maximum.

Numerical Value

The numerical value indicates the current no-charge temperature setting.

Pressing Up or Down

Pressing Up will increase the setting. Pressing the Down button will decrease the setting. Note, in order to preserve the settings after power interruption, you must save them in Flash memory.

5.1.2 Temperature at which full charging occurs (F, F-)

This parameter indicates the temperature setting at which full charging should occur. A negative temperature is indicated by a minus sign after the F. For positive temperatures, no minus sign appears. When the outside temperature goes below this temperature, the control signal applied to the control resistors will be minimum.

Numerical Value
The numerical value indicates the current full-charge temperature setting.

Pressing Up or Down
Pressing Up will increase the setting. Pressing the Down button will decrease the setting. Note, in order to preserve the settings after power interruption, you must save them in Flash memory.

5.1.3 Maximum Pulse Width (PH)

This parameter indicates the maximum pulse width setting. This is the maximum pulse width the controller will output. When the outside temperature reaches or exceeds the no-charge temperature, the control signal applied to the control resistors will be the maximum pulse width setting.

Numerical Value
The numerical value indicates the current maximum pulse width setting. The value ranges from 0 to 100 (100 indicated by - -), indicating the percent duty cycle.

Pressing Up or Down
Pressing Up will increase the setting. Pressing the Down button will decrease the setting. Note, in order to preserve the settings after power interruption, you must save them in Flash memory.

5.1.4 Minimum Pulse Width during Setback Control (PS)

This parameter indicates the minimum pulse width setting and is only in effect during setback control. This is the minimum pulse width the controller will output during setback control (during normal control the minimum is always 0). When the outside temperature goes below the full-charge temperature when the controller is in setback control, the control signal applied to the control resistors will be the minumum pulse width setting.

Numerical Value
The numerical value indicates the current minimum pulse width setting. The value ranges from 0 to 100 (100 indicated by - -), indicating the percent duty cycle.

Pressing Up or Down

Pressing Up will increase the setting. Pressing the Down button will decrease the setting. Note, in order to preserve the settings after power interruption, you must save them in Flash memory.

5.1.5 Flash Read and Save (FL)

This parameter allows you to save the current settings in Flash memory (n, F, PH, PS).

Pressing Up
Pressing Up will save the current settings in Flash memory. The display will indicate SA when the settings have been saved. Pressing Mode at this point returns you to the first Basic parameter.

Pressing Down
Pressing Down will load settings from Flash memory, overwriting the current ones. The display will indicate Ld when the settings have been saved. Pressing Mode at this point returns you to the first Basic parameter.

5.1.6 Display current Pulse Width Output (PU)

This parameter displays the current pulse width output being provided to the control resistors.

Numerical Value
The numerical value indicates the current pulse width output. The value ranges from 0 to 100 (100 indicated by - -), indicating the percent duty cycle.

Pressing Up or Down
No action occurs.

5.1.7 Override the current Pulse Width Output (PA)

This parameter allows you to manually override the current pulse width output being provided to the control resistors. Note that this effectively defeats controller operation and should only be used for troubleshooting.

Numerical Value
The numerical value indicates the current pulse width output. The value ranges from 0 to 100 (100 indicated by - -), indicating the percent duty cycle.

Pressing Up or Down
Pressing Up will increase the setting. Pressing the Down button will decrease the setting.

5.1.8 Display Current Statistics (St)

This parameter displays current and historical statistics about controller predictions of power company switching times. The numerical value indicates the error of the past prediction. The value ranges from 0 to 100. A value of 100 indicates an error of 12 hrs.

Pressing Up or Down

Pressing either the Up or Down button changes the meaning of the numerical value displayed. The numerical value will now indicate the number of times the controller entered setback control and its prediction failed, leading to undercharging.

5.1.9 Display Historical Data (dA)

This parameter displays historical data the controller has collected in the past 7 days of power company switching times. The numerical value indicates the current half-day the controller is monitoring via its internal clock. The value ranges from 0 to 13. Note that this internal clock time may or may not align with the standard time provided by a clock on the wall.

Pressing Up or Down

Pressing either the Up or Down button changes the meaning of the numerical value displayed. The numerical value will now indicate the percent of power company on time for the half-day selected. You can continue to press Up or Down to go through the list of data collected for other half-day periods. The display will alternate the display with the half-day (0-13) and the percent on. Note that if the data has not been collected yet, its percent on value will be 0. Also, if a full cycle of 7 days has not yet passed, the display will show the current on time data as it is being collected. If a full cycle has occurred, the display will show historical data.

5.1.10 Display Internal Time (tI)

This parameter displays the internal time. The numerical value indicates the percent complete of the current half-day period. The value ranges from 0 to 100. Note that this internal clock time may or may not align with the standard time provided by a clock on the wall.

6 Initial Parameter Setup

1. The knobs on the heaters should be set to 2.5.
2. The temperature at which no charging occurs (n) should be set to 50 degrees F.
3. The temperature at which full charging occurs (F) should be set to 0 degrees F.
4. The maximum pulse width should be set to 35.
5. The minimum pulse width during setback (weekends) should be set to 10.
6. Be sure to save settings in flash memory.

Note: Once settings are saved in Flash memory, they do not have to be reentered, even if power is removed from the controller.

7 Display Key

oF Indicates that there is currently no power being supplied by the power company to charge the heaters.

on Indicates that there is currently power being supplied by the power company and the controller will use standard control.

SE Indicates that there is currently power being supplied by the power company and the controller is predicting power to remain on nearly continuously (75%) in the next half day. Controller will be using setback control.

Numerical Value- amount of dial-back being supplied to the heaters.

Pressing Up or Down – display cycling on/off

t Indicates the current outside temperature being measured by the controller in degrees F. A negative temperature is indicated by a minus sign after the t. For positive temperatures, no minus sign appears.

Numerical Value- Temperature in degrees F.

Pressing Up or Down – display cycling on/off

H Indicates the current maximum temperature logged by the controller in degrees F. A negative temperature is indicated by a minus sign after the H. For positive temperatures, no minus sign appears.

Numerical Value- Temperature in degrees F.

Pressing Up or Down – press to reset maximum temperature.

L Indicates the current minimum temperature logged by the controller in degrees F. A negative temperature is indicated by a minus sign after the H. For positive temperatures, no minus sign appears.

Numerical Value- Temperature in degrees F.

Pressing Up or Down – press to reset minimum temperature.

P Indicates that the controller is collecting initial historical data. The numerical value provides a countdown of the number of half-days remaining (0-14) before controller has a full week of historical data.

PP Indicates that the controller is in the last half-day of collecting initial historical data. The numerical value provides a countdown of the percent of the half-day remaining (0-100) before controller has a full week of historical data.

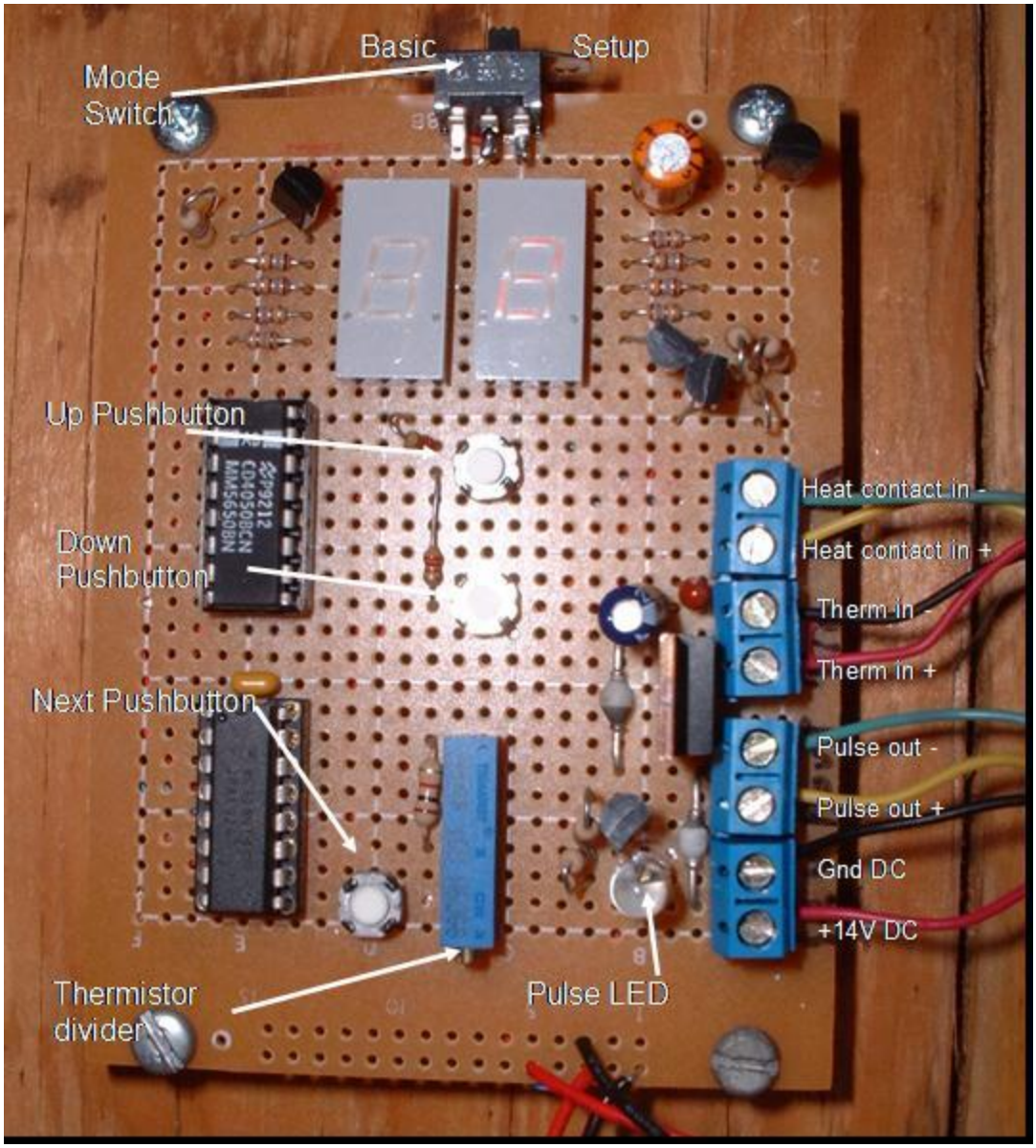
FA Indicates that the controller has enough history to begin predicting and that the current prediction is accurate. The numerical value indicates the number of times the controller entered setback control and its prediction failed, leading to undercharging.

FF Indicates that the controller has enough history to begin predicting and that the current prediction is inaccurate (by more than 3 hrs per half day). The numerical value indicates the number of times the controller entered setback control and its prediction failed, leading to undercharging.

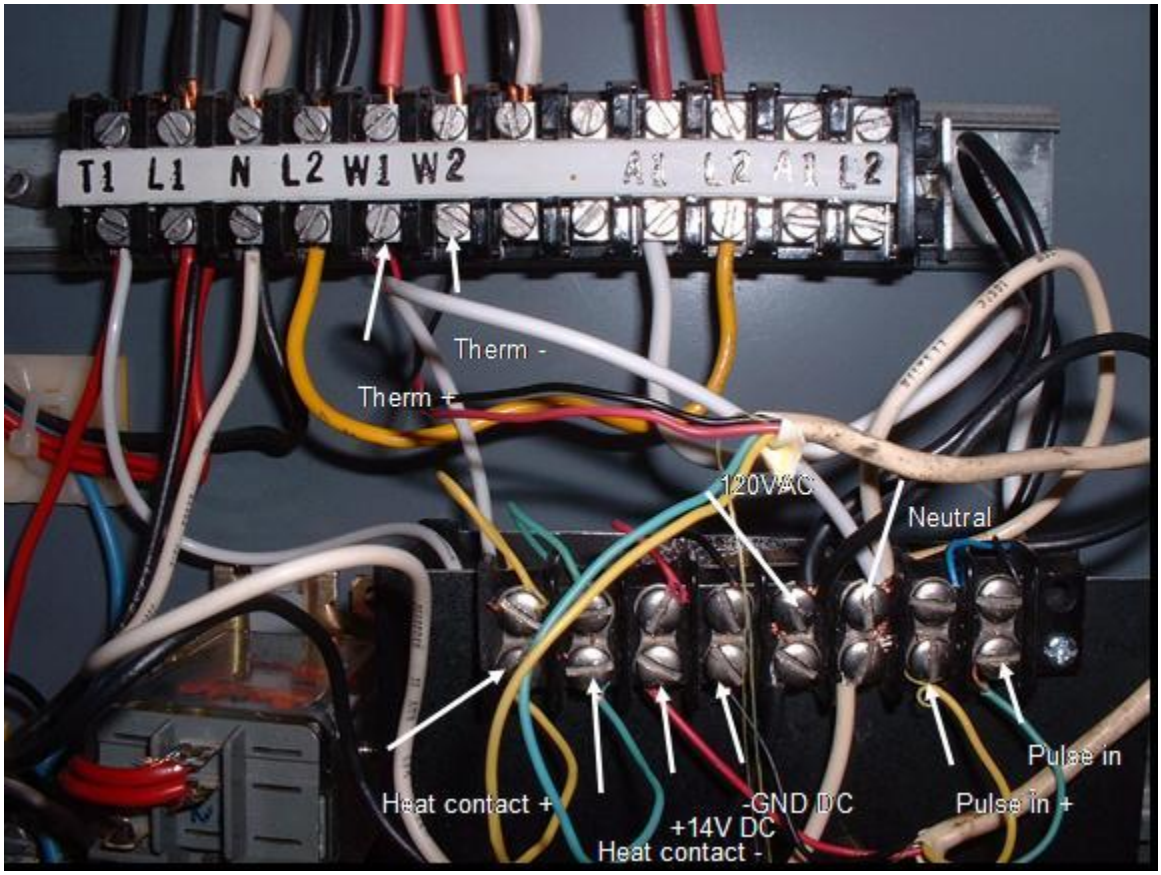
Pressing Up or Down – display cycling on/off

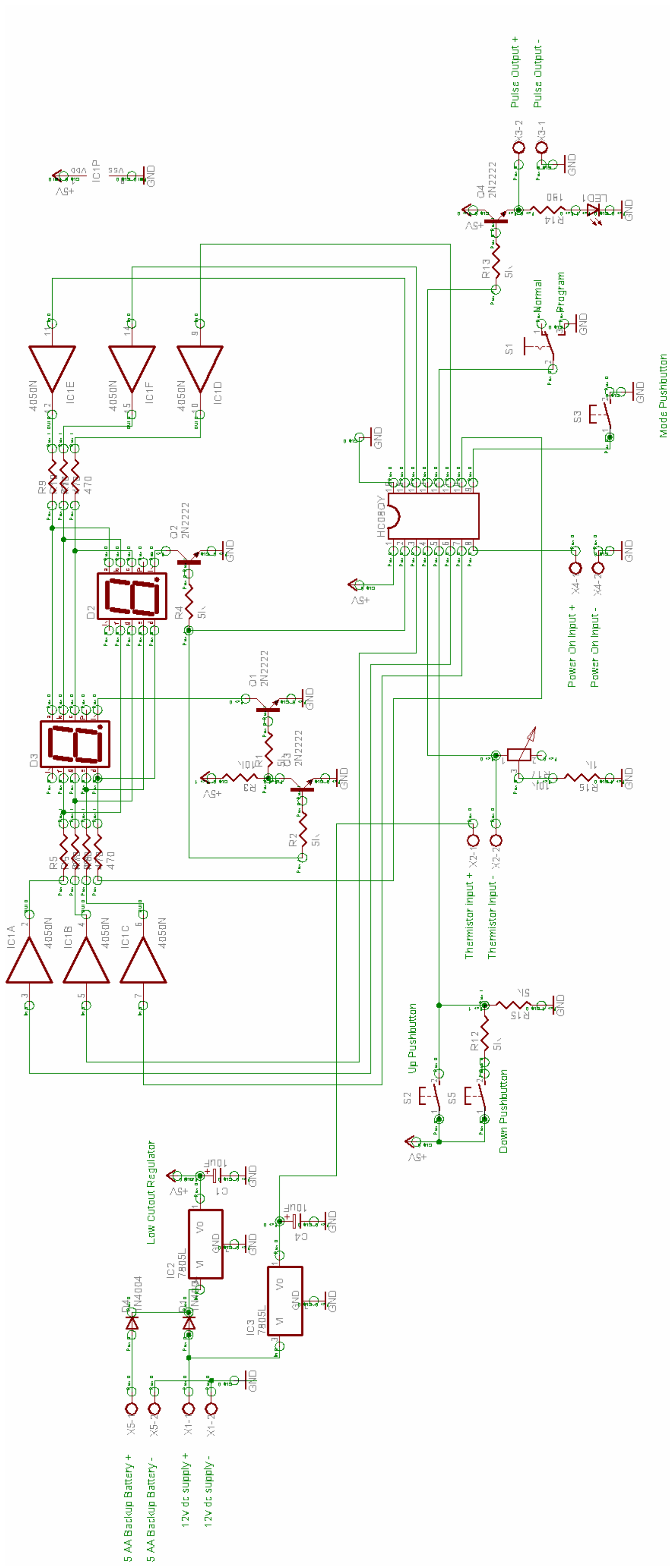
8 Pictures of Board Layout and Terminal Hookup

8.1 Controller Board



8.2 Power Board




Pulse Output +
Pulse Output -
Mode Pushbutton
Power On Input +
Power On Input -
Thermistor Input +
Thermistor Input -
Up Pushbutton
Down Pushbutton
Low Cutout Regulator
5 AA Backup Battery +
5 AA Backup Battery -
12v dc supply +
12v dc supply -
Normal
Program
GND
+5V
4050N
2N2222
7805L
1N4004
HC08QY