Circuit Analysis and Comparison

Heat-troller™ Version 6.5 vs. Gerbing/Harley heat controller

Performed by Daniel Holt of PC Retail Services
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The following analysis was performed by Daniel Holt of PC Retail Services to determine the equivalency of two product samples provided by Mike Coan. These samples included the Heat-troller™ Version 6.5 (Heat-troller™) and the Gerbing/Harley (Gerbing/Harley) devices. The samples were disassembled and analyzed by both visual and electrical test equipment to determine the similarities and differences between them in terms of their circuit design, electrical components, and the assembly of the components on the circuit board and within the enclosure. The logical argument provided by Mike Coan is that the Gerbing/Harley unit is a functional copy of the Heat-troller™ product revision 6.5. This analysis takes the Heat-troller™ as the baseline product and compares it to the Gerbing/Harley unit.

Analysis Results Overview:
The two products provided by Mike Coan are without a doubt identical in form and function. Assuming the Gerbing/Harley unit was designed after the Heat-troller™, the Gerbing/Harley unit copied the design of the Heat-troller™ down to the smallest detail, but missed on a critical safety related function. The external packaging is different looking, but in almost all other ways, the design was copied. The copied areas include the circuit design itself, aspects of the board layout, and the function of the device.

Circuit Design

Using pencil and paper, I drew a schematic of the Gerbing/Harley unit based on the circuit board (Figure #3). This required removing the pot (designated VR1) to observe traces located under the part. Comparing my drawn schematic to the Heat-troller™ revision 6.5 schematic (Figure #4) I found it to be identical in several ways including the circuit functional blocks, reference designators, and component values.

Functional Blocks:
The overall design of the Gerbing/Harley circuit includes the same four functional blocks as the Heat-troller™:

- Variable voltage source – A user controlled voltage from the potentiometer.
- Sawtooth waveform generator – Generates a triangle waveform at a particular frequency.
- Comparitor function – Compares the user input with the waveform generator and controls the output.
- Output power switching – Power switch that turns the power on and off to the heated clothing.

Component values / part numbers:
Of the 27 components on the board, 23 have the exact same value. The differences are as follows:

Reference Designator	Heat-troller™ Value (ohms)	Gerbing/Harley Value (ohms)
R3	221,000	220,000
R4	221,000	220,000
R8	100,000	150,000

R3 & R4 above are different only by 0.45% and would be a natural change due to manufacturing availability of existing components. The manufacturer most likely had the 220,000 ohm parts available. Standard component values are not better than 1-5% anyway.

Changing R8 effects the function of the circuit by providing less hysteresis of the comparator function. This would cause a degradation in the performance of the circuit. Further, this value was used in prototypes, and possibly in the first few production Heat-troller™ units.

Reference Designators:
Reference designators are used to uniquely identify each component on both the schematic and circuit board. Examples include C1, C2, R1, U5, etc. When a circuit is designed, reference designators are chosen either by the designer, or by the software. The engineer assigns reference designators at any time durning the schematic entry process. The engineer may also allow the software to choose the designators in a process called 'annotation' as a function of the physical layout of the schematic. The final circuit board may also be re-annotated in a process called 'back-annotation' to provide a more logical layout of the actual components for the assemblers to follow.

Inspection of the Heat-troller™ and Gerbing/Harley units shows that all reference designators are identical in form and function. This can only happen in one of three circumstances:

1. The schematics were drawn identically and the schematic capture software was configured to annotate the board with the same algorithm.
2. The PCB was designed identically and the back-annotate function was configured to annotate the board with the same algorithm.
3. The designer decided to manually annotate the board as each part was placed in the schematic capture software.

There is very little chance option 1 could occur in the real world, and the schematic for the Heat-troller™ does not follow a logical annotation pattern. Option 2 was eliminated by the simple observation that the two circuit boards are arranged differently in the logic section and neither board was back-annotated to make the PCB more assembler friendly. This only leaves option 3 above. The circuit designer of the Gerbing/Harley unit manually chose the designators that are on the sample unit. There are a total of 27 unique designators on the board and all are matched perfectly.

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Circuit Board Design:
The overall layout of the Gerbing/Harley product is visibly similar to the Heat-troller™. Similarities include the positioning of the on/off switch, LED position, and location of the input/output wires. Additionally, the PCB layout for the output power switching section is very closely matched. The chances of two board designers making the exact same decisions about where parts should be placed, and more uniquely the shape of the traces and fills, is very low indeed. Looking at Figures 1 and 2 you can see a few 'unique' design elements that were copied.

Manufacturing Design

The Heat-troller™ product is 'potted' as a final manufacturing step to provide two functions. Moisture protection is a primary goal of the potting. A second goal includes reducing the temperature variance on the product as the environment gets colder. When the air temperature drops, the operator requests the unit to provide heat to a vest or gloves. This warms the potting compound and helps to hold the unit at a more constant temperature (and thus providing a more stable circuit).

The Gerbing/Harley unit has a few small dabs of RTV on the output leads and on/off switch that will provide some moisture protection, but there is no potting compound used on the product to truly seal the circuit from rain.

Design Flaw Copied

A design flaw was found in the Heat-troller™ version 6.5 design after the products were manufactured and released to market. This required a recall of approximately 100 units from the field to upgrade the units. The flaw allowed the LED to glow when the output lead was shorted to chassis ground. The Gerbing/Harley unit includes the exact same engineering design mistake.

Conclusion

There can be no doubt that the Gerbing/Harley unit provided is a direct copy of the design manufactured by The Trading Group. The sheer number of common components, circuit design, board layout, design flaw, etc. provides overwhelming proof to this fact.

Respectfully Submitted:

Dan Holt

Owner, PC Retail Services

Attachments:

Figure #1 – Front Side Picture of the Heat-troller™ and Gerbing/Harley Boards
Figure #2 – Back Side Picture of the Heat-troller™ and Gerbing/Harley Boards
Figure #3 – Copy of the hand-drawn schematic of the Gerbing/Harley Board
Figure #4 – Copy of the Heat-troller™ version 6.5 schematic
Figure #5 – Heat-troller™ Version 6.5 Bill of Material

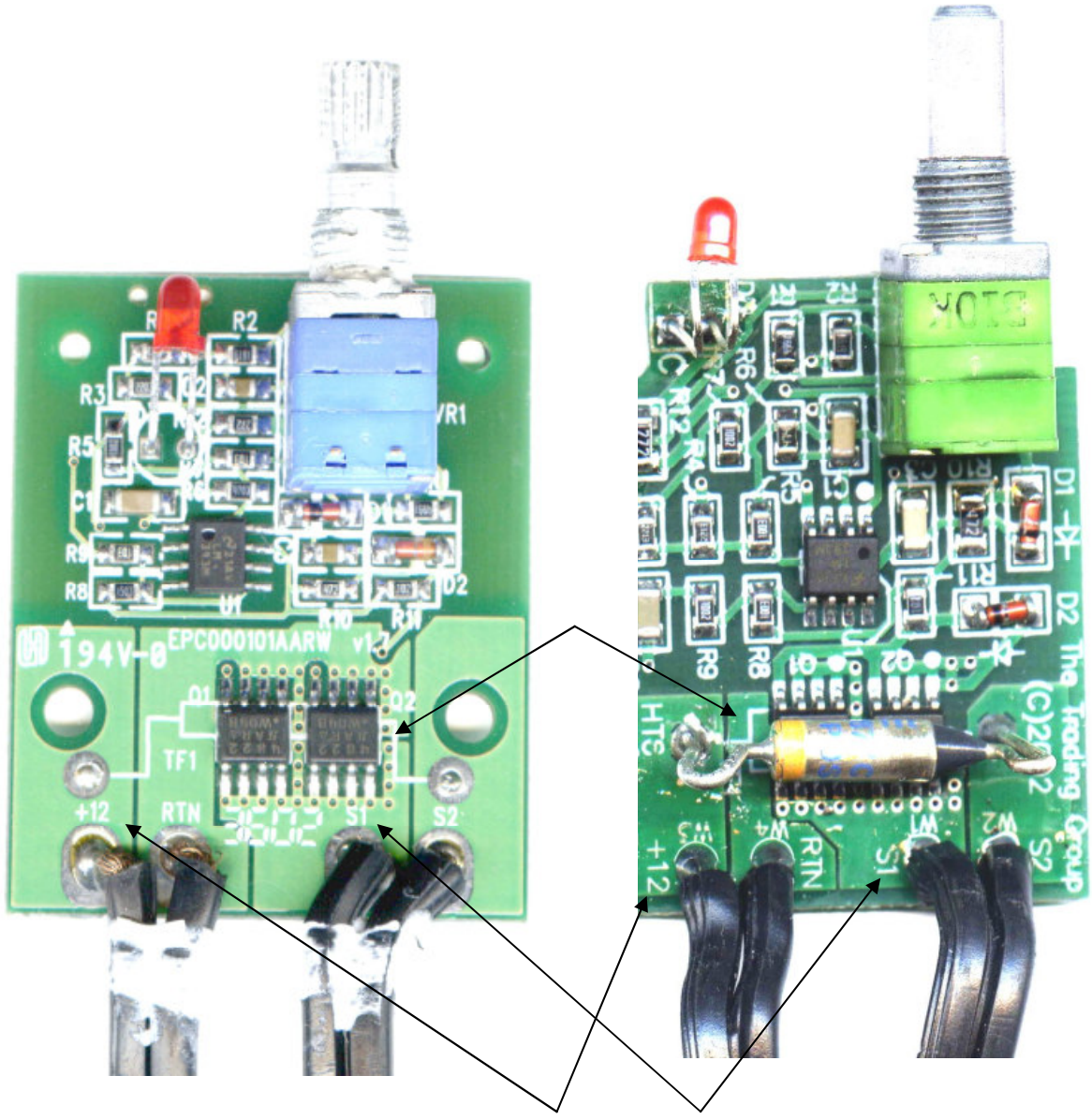

Figure #1 – Gerbing/Harley (left) vs. Heat-troller™ 6.5 (right)

Common Features:
The copied silkscreen (white text layer) that shows where the thermal fuse is supposed to be mounted. The Gerbing/Harley unit does not properly place this part on the back side, but the PCB was copied to the point of including the silkscreen location of where the part was supposed to be placed on the front side just like the Heat-troller™.

On the silkscreen layer, all reference designators match in both value and function.

The labeling is identical on the input / output wires. +12 and RTN are common labels, but S1 and S2 for an external wire is not a standard notation, and must have been copied.

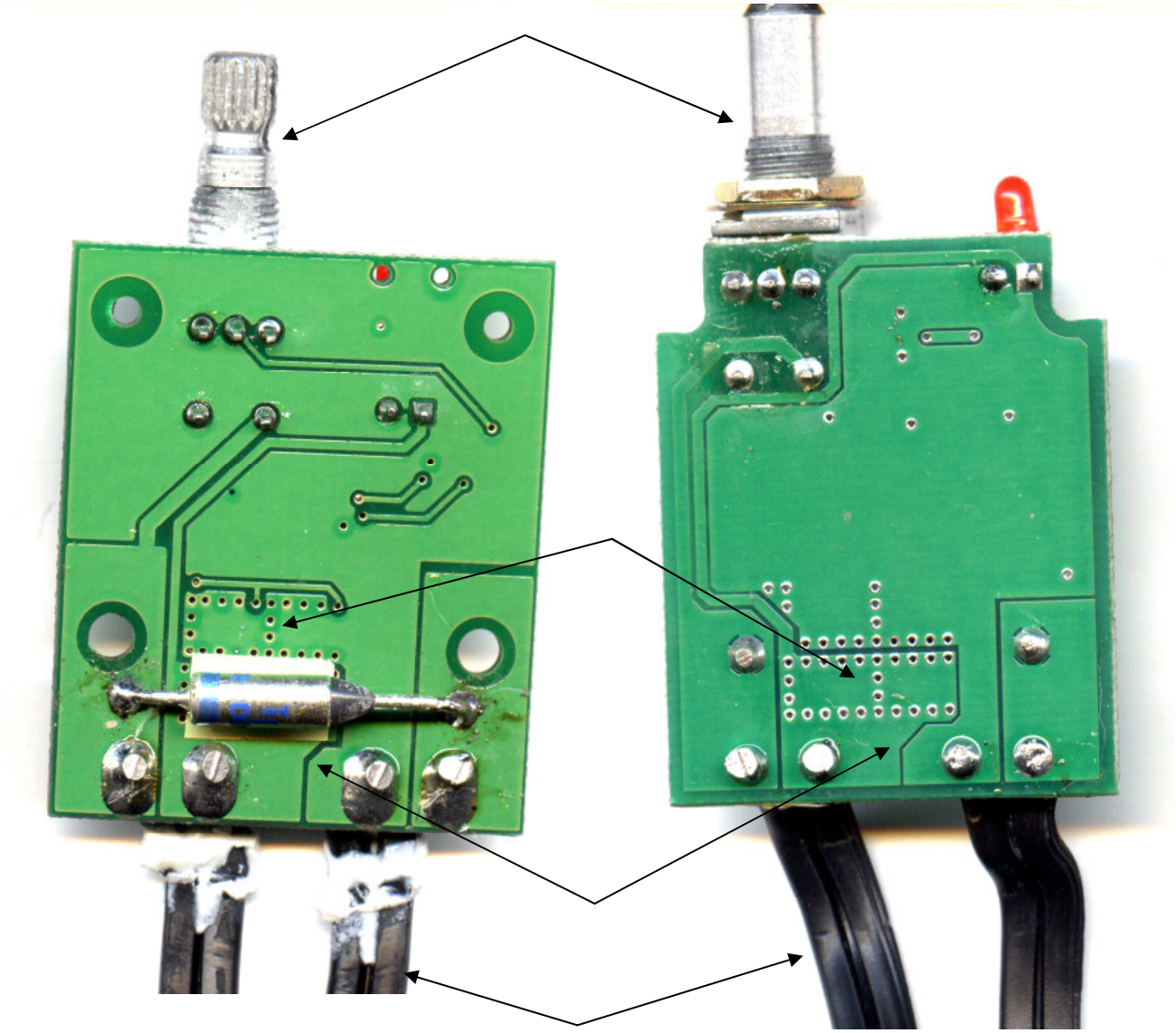

Figure #2 – Gerbing/Harley (left) vs. Heat-troller™ 6.5 (right)

Common Features:
The location of on/off switch, LED, input wires
The 'Riveting' pattern of vias (holes) around top-side mounted FETs.
The similar location and shape of the copper fills around the power section.
The input wires are identical (wire type, gauge, etc.)

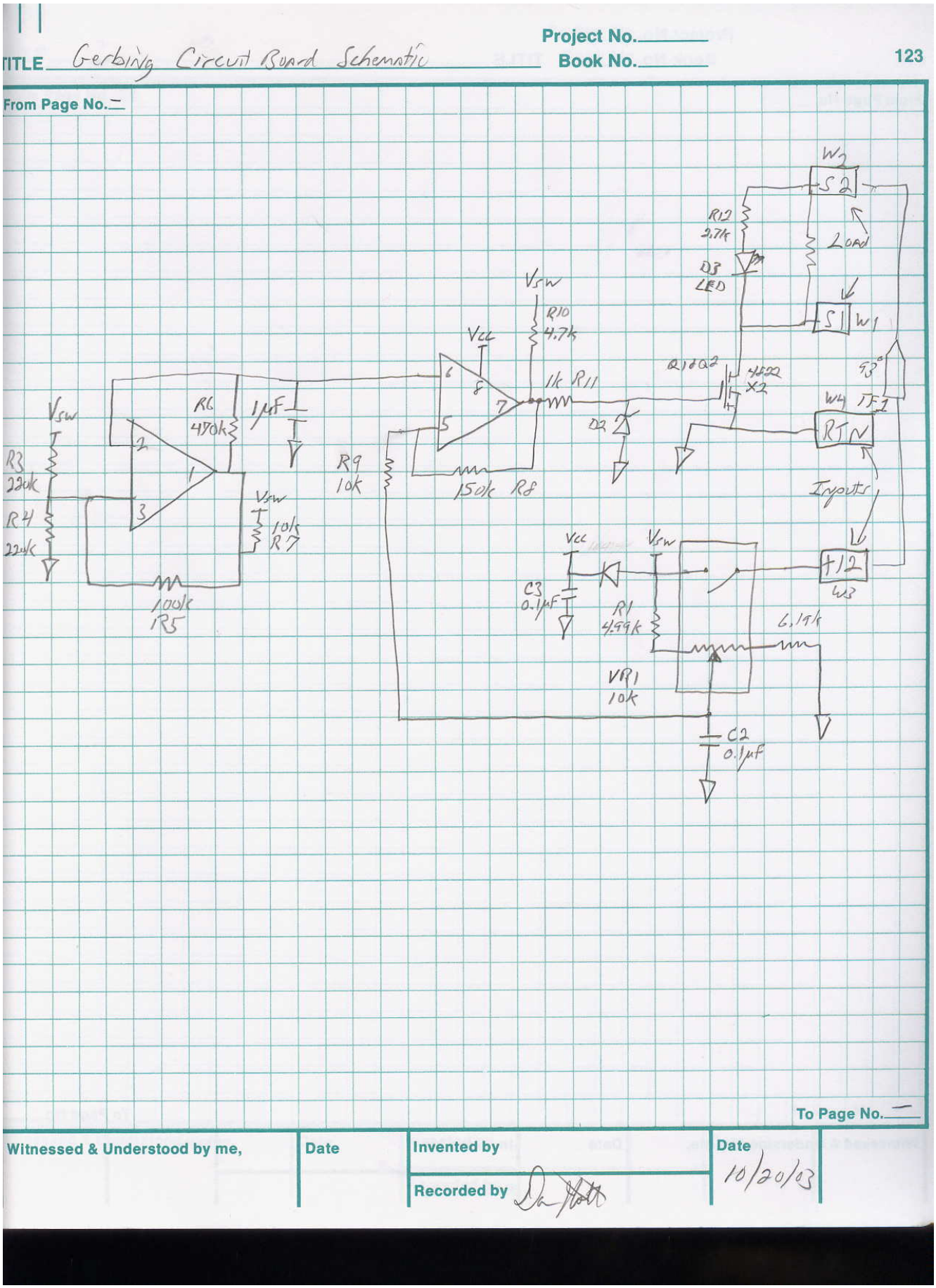

Figure #3 -- Hand Drawn Schematic of the Gerbing/Harley Sample

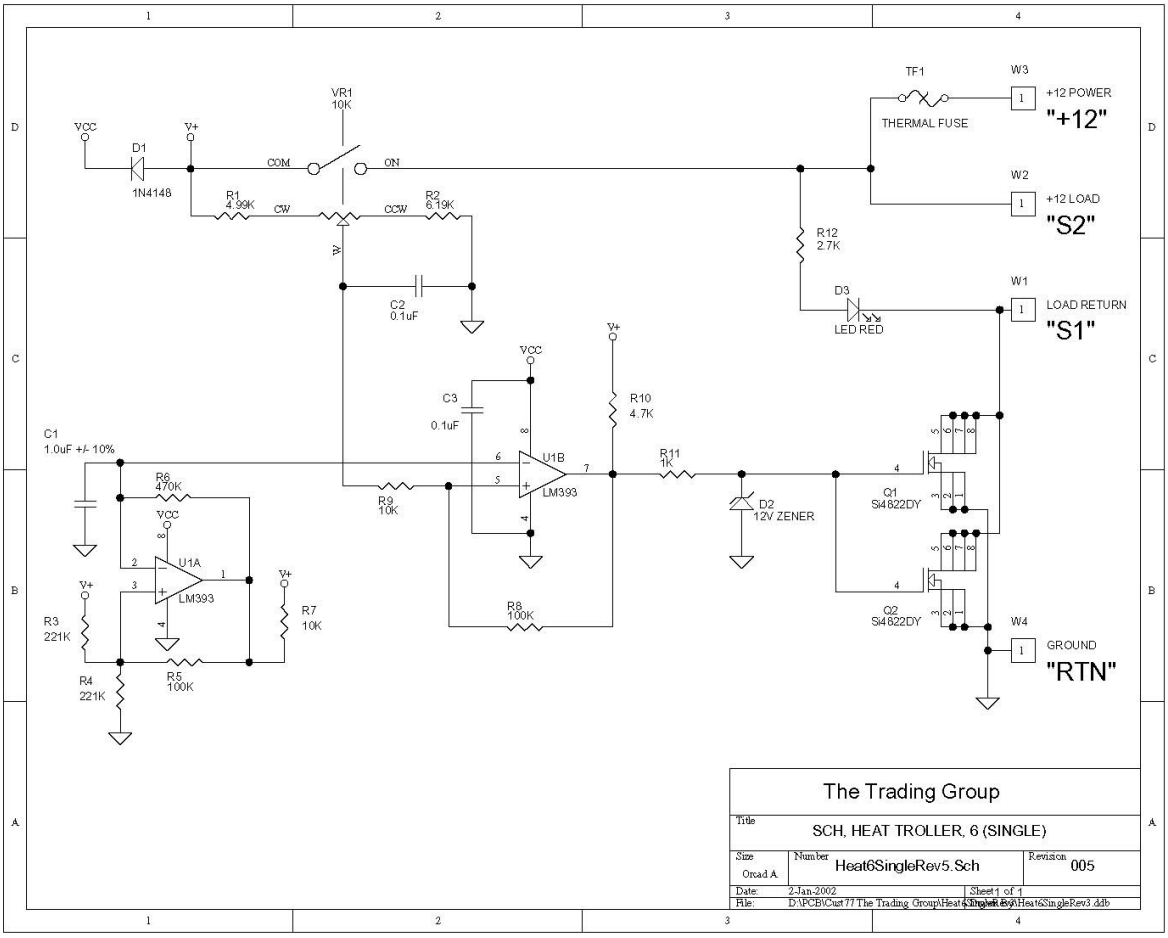

Figure #4 – Heat-troller™ Version 6.5 Schematic

Bill of Material for Heat6Single.Bom

03-05-2002

Heat Troller 6 Single Board Rev. 5

Used	Part Type	Designator	Footprint	Type
1	+12 LOAD	W2	0.080”Hole	WIRE
1	+12 POWER	W3	0.080”Hole	WIRE
1	GROUND	W4	0.080”Hole	WIRE
1	LOAD RETURN	W1	0.080”Hole	WIRE
1	0.1uF +/- 20% CER 50V	C2,C3	1206	SM CAP
1	1.0uF +/- 10% CER 25V	C1	1206	SM CAP
1	1.00K, 1% or 5%, 1/16W	R11	0805	SM RES
1	1N4148	D1	LL34	SM DIODE
1	2.7K, 5%, 1/8W	R12	1206	SM RES
1	4.7K, 5%, 1/8W	R10	1206	SM RES
1	4.99K, 1%, 1/16W	R1	0805	SM RES
1	6.19K, 1%, 1/16W	R2	0805	SM RES
1	Switch/Pot 10K ohm 20%	VR1		TH POT
2	10.0K, 1% or 5%, 1/16W	R7,R9	0805	SM RES
1	12V ZENER	D2	403A-03	SM DIODE
1	100K, 1%, 1/16W	R5,R8	0805	SM RES
2	221K, 1%, 1/16W	R3,R4	0805	SM RES
1	470K, 1% or 5%, 1/16W	R6	0805	SM RES
1	LED RED (Housing)	D3	Con2	TH LED
1	LM393	U1	SO8	SM IC
2	Si4822DY	Q1,Q2	SO8	SM IC
1	THERMAL FUSE	TF1		TH FUSE
	NTE # 8090.			

Figure #5 – Heat-troller™ Version 6.5 Bill of Material