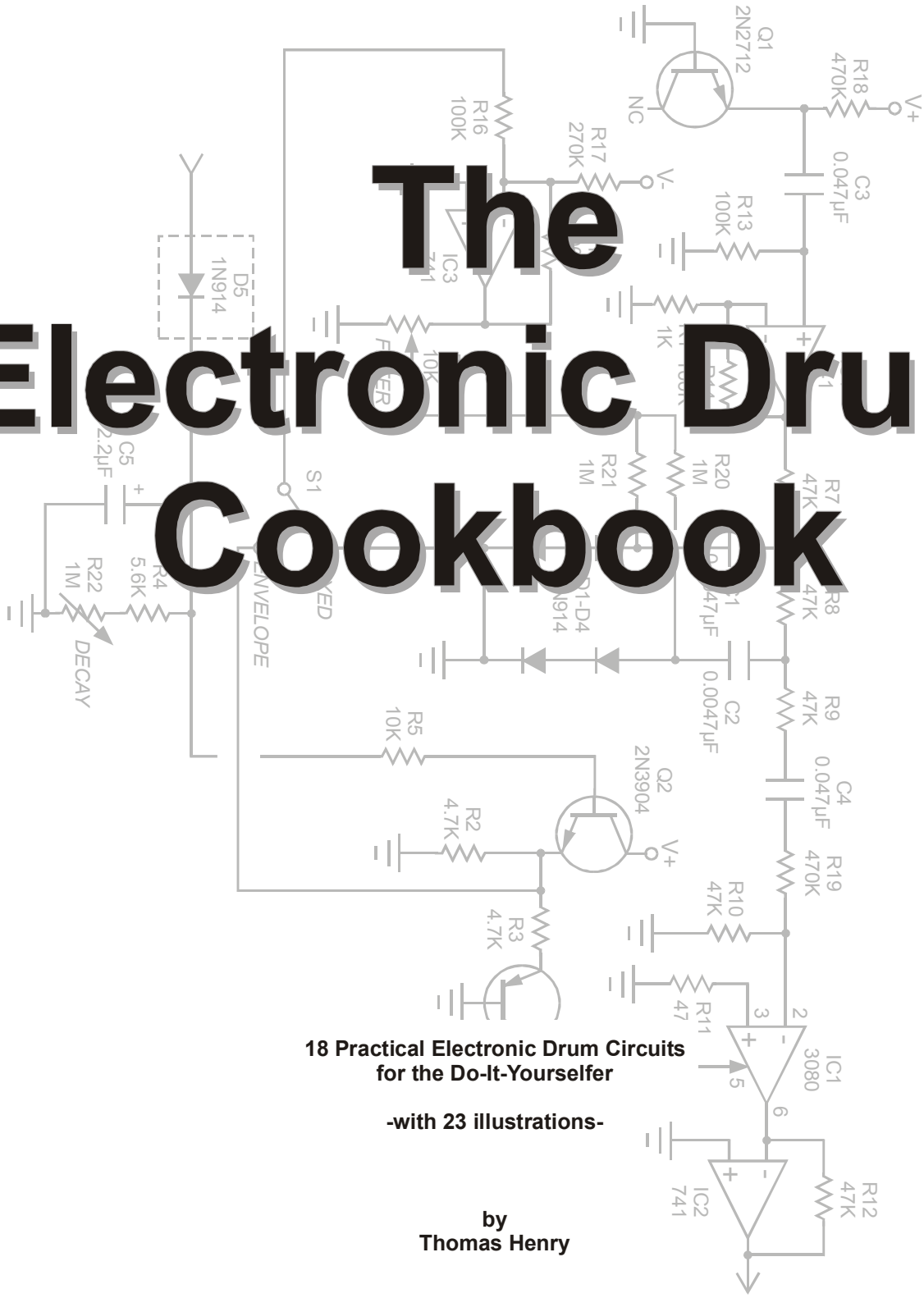
The Electronic Drum Cookbook



18 Practical Electronic Drum Circuits for the Do-It-Yourselfer

-with 23 illustrations-

by
Thomas Henry

The Electronic Drum Cookbook

First Edition
Second Printing (slightly corrected)
Third Printing (slightly updated)
Fourth Printing (updated, prepared for PDF output)

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About the Author

Thomas Henry is the author of over 100 articles and two books on the subjects of electronic music, microcomputers, astronomy, and caves. While in school he helped form the East Side Pharaohs (the Midwest's zaniest band) in which he played guitar and sang bass for nearly 18 years. After attaining in M.A. in mathematics, he taught at the collegiate level for ten years. His leisure time activities include bird watching, caving, amateur astronomy, magic, road trips to national parks, and flower gardening. The bat is his favorite mammal.

Editors Note: In the winter of 2005, I was approached by Scott Stites. Scott is an avid electronics hobbyist who had been working with Thomas Henry testing and prototyping several circuits, some of which were slated to appear in a new book. Unfortunately, Thomas had recently decided to pull the plug on his business, "Midwest Analog." The decision was a good one for Mr. Henry, and it allowed him to pursue one of his other loves, teaching, full-time. Unfortunately, this left no distribution outlet for the Thomas Henry "Cookbook" series. These books had reached near-legendary status among synthesizer hobbyists, and many people wondered if they were going to join the ranks of the myriad other out-of-print books treasured by synth fans. Scott had followed my posts on the Synthesizer DIY mailing list during a particularly interesting discussion about copyright laws and whether copying was okay in cases where publications (like the Thomas Henry books) were no longer available. Despite all logic, Scott thought I might be a good choice to carry on distributing the books. I contacted John Mahoney, with whom I had worked before, and asked if he wanted to join in on a possible venture to publish Thomas' work. The reply was an immediate and enthusiastic "yes!" And so, Magic Smoke Electronics was born. Although we have plans to create additional books and circuit kits, if we do nothing other than provide an outlet for Thomas' existing body of work, we'll consider Magic Smoke a success. This book has been published with an absolute minimum of changes from the original. The section numbering has been changed slightly to make it easier to follow, and references to defunct web links have been removed or updated. Otherwise, these books remain true to the original works, and are a marvelous source of knowledge and inspiration. John and I would like to thank Mr. Henry for allowing us to continue publishing these books, and we hope you, the reader, will enjoy them as much as we have.

Tim (Servo) Parkhurst
March, 2006

Contents

Acknowledgements

The circuits found herein have been culled from my moth-eaten engineering notebook of fifteen years. While many of them are completely original, it is nonetheless true that a number have been adapted from ideas due to others. Sometimes I found a simpler way to accomplish a similar goal, while in other cases I extended or generalized a concept. In any event, like all cookbooks you'll find a variety of ideas here which have evolved from many different sources. I have tried to be careful to cite the originators when known to me, but let me take the space to thank some of these and other individuals specially in this section.

I owe much to Craig Anderton for it was he who served as my authorial role model, and who in fact encouraged me to take up the pen in the first place. Writing, editing, designing, composing, performing: Craig is a master of each. I thank him for sharing some of his expertise with me over the years.

More than anyone else, the man responsible for putting the design of electronic music equipment on a reliable and scientific foundation is Bernie Hutchins. I can't begin to relate the countless pleasant hours I have spent poring over the vast wealth of his splendid educational materials. Without Bernie's legendary *Electronotes*, I would never have discovered the joys of analog.

Perhaps one of the most prolific wizards of electronic music is John Simonton of PAiA Electronics. You can't fail to scan the literature without bumping into a modern circuit which stems directly from some idea of his. And of all the designers I know, John is the true guru of "do more with less." I thank him for the generosity he has shown in helping me break into one of the most fascinating fields there is.

And of course, I have the warmest regards for the numerous friends who stepped forward to help keep me going on this project when things looked bleak. (I mean, how many people do you know who would trust an unemployed electronics designer?) I can't begin to thank them enough for the faith they showed in this strange little project. In particular I would like to single out Marie Bonse, Donna Evans, Mike Germo, Jerry and Lee Ann Hagen, William Henry, and Bill Smith for all of their moral (and other!) support.

Do you get the feeling that the field of electronic music circuit design is populated with some wonderful people, or that I've been blessed with fabulous friends? So do I, and I thank them all!

But last and certainly not least I wish you, the reader, happy cooking in the laboratory and the music studio. Get those drums a-banging!

Thomas Henry
North Mankato, Minnesota
May 1996

1.1 About This Cookbook

You'll find oodles of interesting circuits herein, especially suited to doing drum things. But the title says it all: this is a cookbook. While some of the designs might be suitable for a standalone percussion synthesizer, in general this is not the case. Instead, it is expected that you will mix and match the various sub-circuits to come up with your own results. The beauty of this approach is that you can whip up a musical instrument that fulfills your needs exactly! And unlike commercial manufacturers who frequently cut corners for economic or other reasons, you can make the final unit as fancy as you like. This brings up the maxim that had guided me through my electronic career:

Henry's Law

You can always **build** better than you can **buy**

It's true! Putz around with what you find in this cookbook and see for yourself. With just a little time spent at the breadboard you'll soon have an electronic drum set that rivals the big boys.

The circuits in this cookbook are meant to interface to each other in various ways. I have tried to keep everything compatible to make the interconnection as easy as possible. Along these lines, be sure to read the next chapter in this introductory section. It discusses the various standards assumed throughout this book.

Section 2 comprises **Control Circuits**. Here you will find a wealth of ideas which can be used to put most any sound generator through its paces.

The next section, **Audio Circuits**, gets to the heart of the matter. Containing Sections 3.1 through 3.8, you'll find all sorts of ideas that make, mix or modify sounds. Best of all, no exotic components are assumed here, so you should be able to start drumming right away without damaging your pocketbook or trying your patience too much.

Section 4, **Design Examples,** illustrate how the various circuits can be combined to make something new. The results are quite impressive. But don't stop here! Most useful drum units will require many of the sub-circuits within this cookbook. While the final design might appear quite complicated, it really isn't if you understand how each of the various portions functions.

The **Reference** section gives you the needed pin-outs for the ICs used in this cookbook, some sources for parts as well as a bibliography devoted to electronic percussion circuits.

So dig out your drum sticks, amplifiers and soldering irons. A whole new world of crash, boom and thwap is at your fingertips!

1.2 Standards

Before starting to put together a complete drum system, whether for studio use or the stage, it pays to spend a little time considering the overall structure you intend to obtain. This brings up the notion of "standards." I have always obeyed the following in my own work and recommend them to you. Not only will this give you a consistent set of principles from which to work, but I think that you will find any gear you create in the lab will be compatible with most other analog synthesizers and recording equipment. These standards were adapted from Bernie Hutchin's *Electronotes*.

Incidentally, it is fair game to violate these **within** a circuit if it will lead to a simpler, cleaner or quieter design. Really, it is the interface to the outside world (the inputs and outputs) we are most concerned with. But in the midst of a circuit, you can do just about anything you desire.

MECHANICAL

- ¼" phone jacks for all inputs and outputs
- Standard (19" wide) rack panels

POWER SUPPLY

- ±15VDC, regulated

TRIGGER INPUTS

- Voltage: 0 to +5V
- Impedance: 100K Ohm
- Pulse Width: 1 msec
- Overvoltage, static and reverse voltage protected

CONTROL INPUTS

- Voltage: 0 to +5V
- Impedance: 100K Ohm
- Overvoltage and reverse voltage protected

AUDIO INPUTS

- Voltage: ±5V
- Impedance: 100K Ohm
- 100k attenuators on the inputs
- DC coupled where possible

AUDIO OUTPUTS

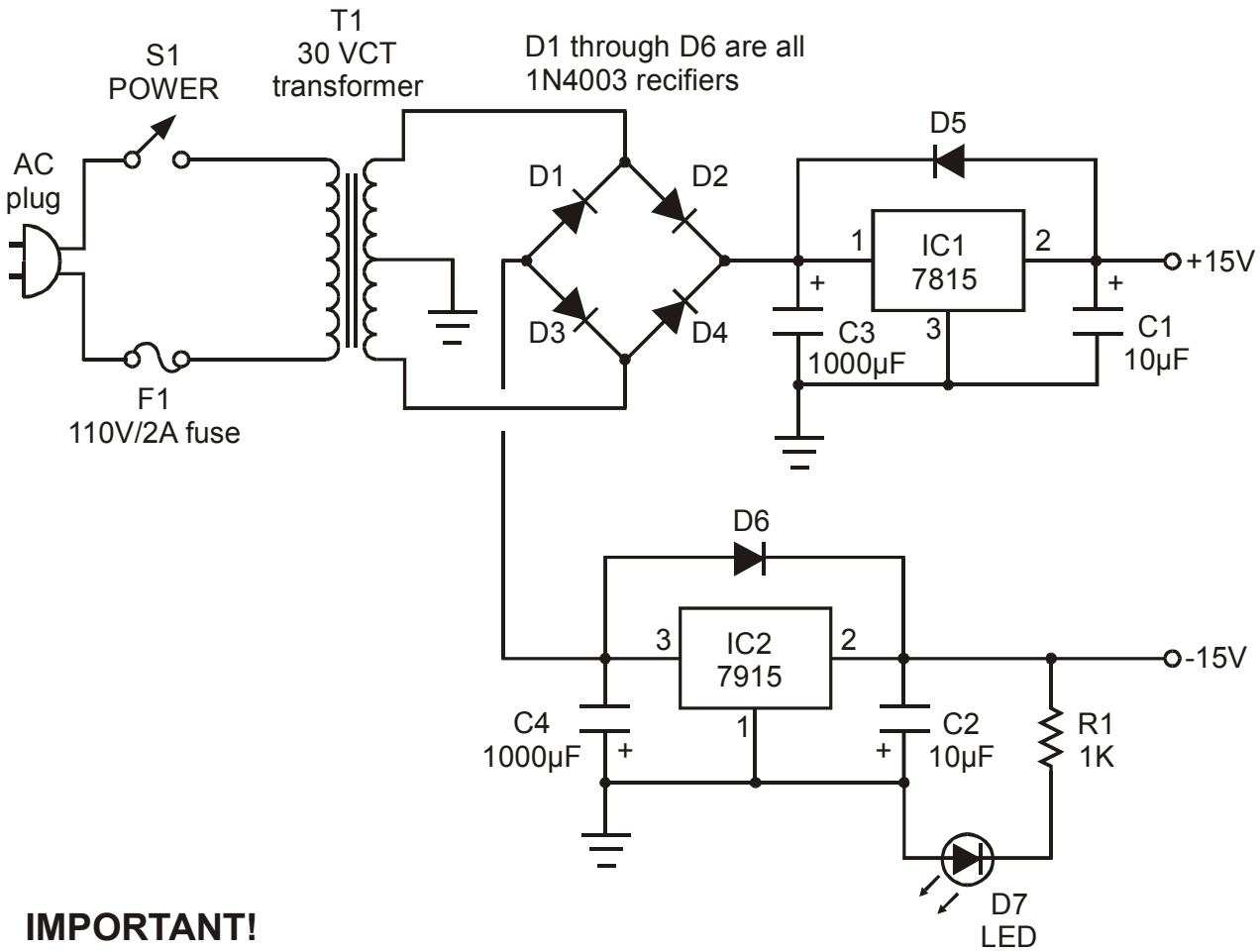
- Voltage: ±5V
- Impedance: 1K Ohm
- DC coupled where possible
- Short circuit protected

2.1 Bipolar Power Supply

PURPOSE: Convert the 110V AC voltage from an ordinary wall socket into a regulated source of +15V and -15V.

CAUTION!

Do not attempt this project unless you are skilled in working with 110V AC!



IMPORTANT!

1. This circuit uses 110V line voltage which can be lethal.
2. Cover all 110V connections with suitable insulation.
3. Notice that the pinouts of the 7815 and 7915 are NOT the same.

Figure 2.1-1
Bipolar Power Supply

BACKGROUND: Strictly speaking, this Bipolar Supply isn't really a control circuit. But since all of the remaining projects in this book depend on it, it seemed like a good idea to describe it first.

Every drum system will need a power supply. And if you expect to have quite a few modules in your system, then you will want to be sure that it is hefty enough to deliver the required current. To allow for future expansion, I always plan on about 1 Amp per side. The voltage regulators used in this project can easily provide that current if adequate heat sinks are used. And of course, you will want to make sure that the transformer is also suitably rated.

Since we want all of our drum modules to be compatible with any other gear in the studio, a bipolar 15 Volt supply seems best. Most analog synthesizer modules operate at this level. Moreover, by using these voltages instead of, say, +12V and -12V we get the added benefit of increased headroom in the signal path.

OPERATION: Refer to *Figure 2.1-1* now. The AC plug delivers ordinary 110V AC from the wall socket to the primary of the transformer. Switch S1 is used to turn the supply on or off, while fuse F1 protects the module from any unexpected high current conditions.

T1 is a 110V to 30VCT transformer, with the "CT" meaning center tap. The AC voltage across either outer leg of the secondary and the center tap will be about 21V RMS. This is just right for the regulator's needs, since the voltage applied to it should be higher than the desired output, but not so high that the regulator overheats. The secondary feeds the ring of rectifiers, D1 through D4. The outputs of these will be a plus and minus pulsating DC, with respect to the center tap. Thus, the center tap becomes the ground reference for the circuit.

C3 and C4, with values of 1000µF, smooth the pulsating signal substantially. Notice that the voltage rating for these capacitors should be 35V or so to allow for any possible overvoltage situations. The filtered DC is now sent to the regulators. The 7815 handles the positive side, while the 7915 works on the negative. Observe that the pin outs for these two chips are different. Refer to *Figure 2.1-2* for details.

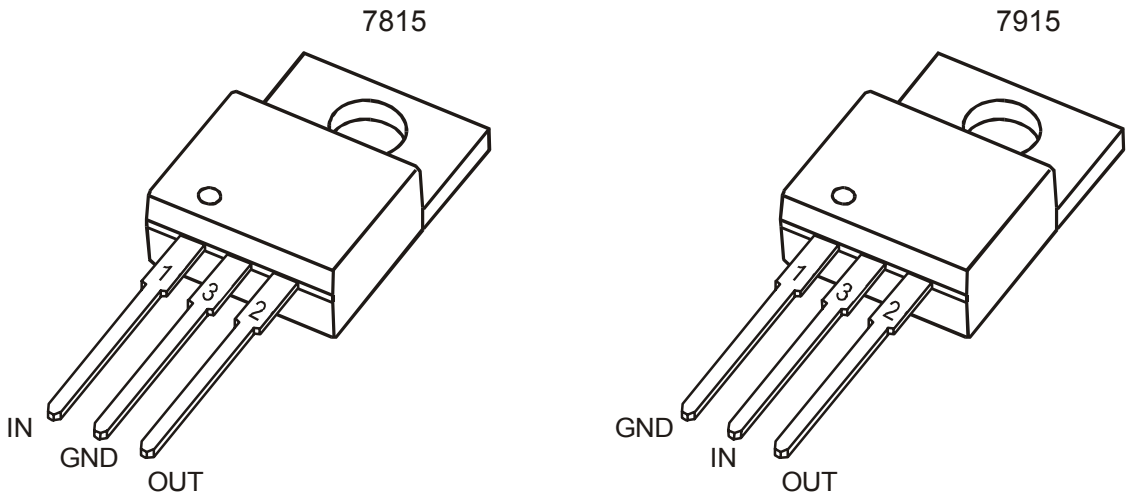


Figure 2.1-2
Pinouts of the Voltage Regulators

Adding to the reliability of the power supply is the fact that the outputs of the regulators are protected against short circuits and thermal overload. However, something many people don't realize is that the regulators are not input short circuit protected. If in fact the output voltage should rise higher than the input, irreparable damage can occur to the chips. Of course, it would take strange circumstances to cause this, but as an added precaution, rectifiers D5 and D6 provide return paths. With these in place, it is impossible for the output to exceed the input, no matter what the external cause. The outputs of the regulators are stabilized by capacitors C1 and C2. Finally, LED D7 provides visual confirmation that the circuit is on.

NOTES: The Bipolar Power Supply is a simple circuit and easy to build. However, do not attempt this project unless you are skilled in working with 110V AC. This voltage can be lethal, so please be careful. Be certain that you wrap all exposed connections to the switch, fuse and transformer primary with heat shrink tape or tubing.

Don't omit the fuse! It is an important safety feature which will protect not only the power supply, but all of the remaining modules connected to it. I like to use a panel mount fuse holder. You simply twist the cap and out pops the fuse. Not only is this style of fuse holder convenient, but it also keeps the 110V AC concealed.

The regulators need to be attached to heat sinks if you plan on drawing more than 100 milliamps from them. You can buy these, but it's just as easy to make a pair. Refer to *Figure 2.1-3.* Simply cut out a 2 1/2" by 5/8" rectangle of 1/16" aluminum stock and fold the sides up to make “wings.” Paint the whole affair flat black to aid in the thermal transfer. Then after smearing silicone heatsink grease to the regulator (*a thin, even coat between the heatsink and the regulator – Ed.*), bolt it to the heatsink using #4 hardware. Repeat for the second regulator.

Editor’s Note: The heatsink tabs on the 7815 and the 7915 are at different voltage levels. It is VERY IMPORTANT that the heatsinks do not touch each other or anything conductive like metal parts of the enclosure. Many people mount them to a non-conductive part like a PCB, making sure that they don’t touch any traces.

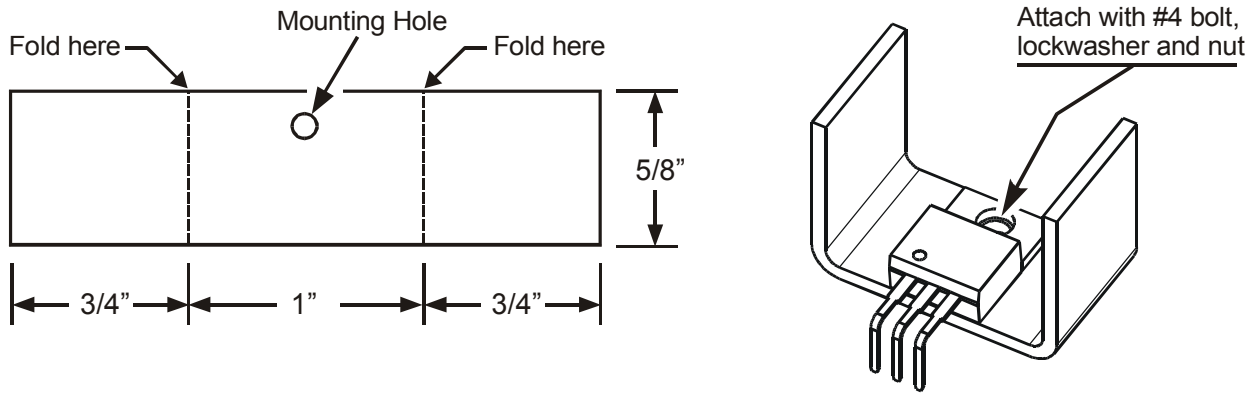


Figure 2.1-3
Making a Heatsink from 1/16” Aluminum Stock