

“The Pacifier” Battery Powered Bottle Warmer



The basic premise is to create a lightweight, portable unit for warming a baby's bottle with a minimum of design time/effort, as the baby was taking up most of my time. Commercially available “portable” solutions were unacceptable—the chemical based solution was very lightweight, but took 20 minutes to warm the bottle. Another version that plugged into a car cigarette lighter also took 20 minutes to warm the bottle—much too long for a screaming infant to deal with!

The inverter could be powered off of an automobile battery, but the battery is extremely heavy to carry around. The 18V cordless drill battery is quite lightweight, and contains just about the right amount of usable energy to boil the 2 tablespoons of water it takes to warm the baby's bottle. The bottle warmer takes approximately 200 watts of power when running. Thus the 18V battery has to supply 10-15 amps for the 2 – 4 minutes it takes to warm the bottle, and the battery will be fully discharged by the end of that time. Unloaded, the battery's terminal voltage is around 19.2 volts, when the full 10A load is applied the terminal voltage drops to around 16V, and by the time the battery is almost fully discharged, the terminal voltage under load has drooped to 10V or lower. The inverter is designed to work off of a relatively stable automotive electrical system, and will only accept input voltages in the range of 10V to 15.5V. Thus I needed to design a regulator circuit to regulate the battery output to stay within the range accepted by the inverter.

The regulator really only has to regulate for the initial part of the battery discharge. Under the very heavy load, the battery terminal voltage quickly drops to below the 15.5V inverter upper cutoff, and then the regulator needs to be as efficient as possible and drop as little voltage as possible in order not to waste power and reduce the voltage available to the inverter as it nears the low end cutoff. Most standard linear voltage regulators drop a minimum of .7V or even 1.2V in the forward direction, even when the supply voltage is less than the desired regulated output. Hence I had to build a high current Low Drop Out (LDO) regulator circuit. Once the regulator reaches drop out (battery terminal voltage below 15.5V), the regulator drops less than .25V under the full 10-15A load, allowing almost all of the battery's energy to be transferred to the inverter and allowing the inverter to keep operating until the battery terminal voltage is approximately 10.25V.

This extremely rapid discharge is quite hard on the battery, and battery life will be greatly reduced. The battery does get warm during discharge. However, the cost is relatively small compared to the enormous benefit of being free of fixed power sources and being able to get a warm bottle expediently.

Construction of your own battery powered bottle warmer is relatively simple. Most of the effort is involved in building the regulator board, which allows the inverter to work with the 18V cordless drill battery.

Battery Holder/Charger:

The battery charger is also used as the battery holder for powering the bottle warmer. The charger is modified to allow high current/high rate discharge into the regulator board. The battery holder is opened up and 14 gauge wires are soldered onto the terminals that contact the battery. Red on the positive terminal and black on the negative terminal. The wires are brought out through a gap in the plastic housing and the nylon plug is put onto the end of the wires. The charger is also still usable as a charger, so it serves a double purpose.



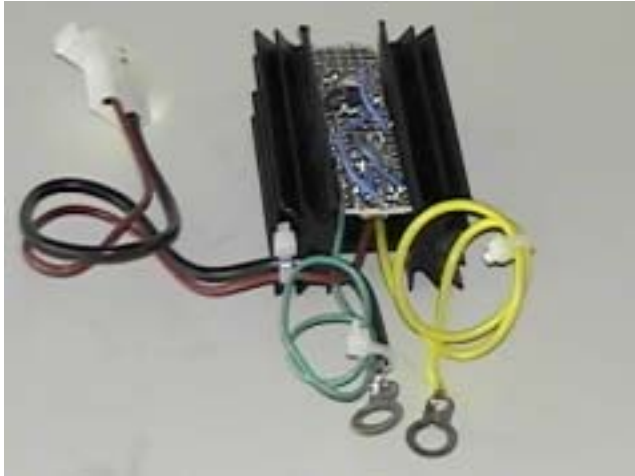
Bottle Warmer:

The Gerber Warmer is the one that was on hand. Almost any standard warmer should work, but some are faster than others, so test it first. Also check that it doesn't require much more than 200 watts, or it is likely that the battery will not be able to keep up.

Inverter:

The inverter I chose was relatively inexpensive off of Ebay. Make sure it has quite a bit of overhead from the bottle warmer power rating, as the bottle warmer has quite a power surge when it starts up. I chose an inverter with a 400 watt continuous, 800 watt peak rating. The inverter that I chose also has a small internal fan, which creates air flow that I use to help cool the regulator board. The unit I chose also had the widest range of input voltages (10V – 15.5V) that I could find, as this allows less regulation and power loss from the LDO regulator.

Regulator Board:

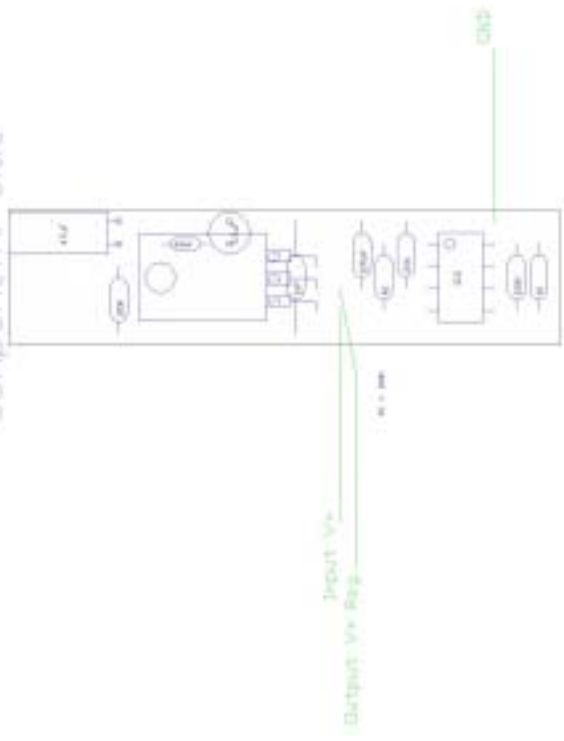


The regulator board was built on proto board. The TO-220 package on the P-FET mounts into the heat sink with an insulated TO-220 mounting kit to prevent electrical connection between the TO-220 tab and the heat sink. The TO-220 leads provide mechanical support for the board which nestles into the channel in the heat sink. The edges of the heat sink near the board are covered with electrical tape to prevent accidental contact with the copper side of the board.



The proto board is cut to size and has a number of cuts made into the copper traces. The components are mounted and then solder bridges and jumper wires are added to finish the circuitry. Alternatively, proto board with no traces could be used and all the connections made with jumper wires.

Component Side



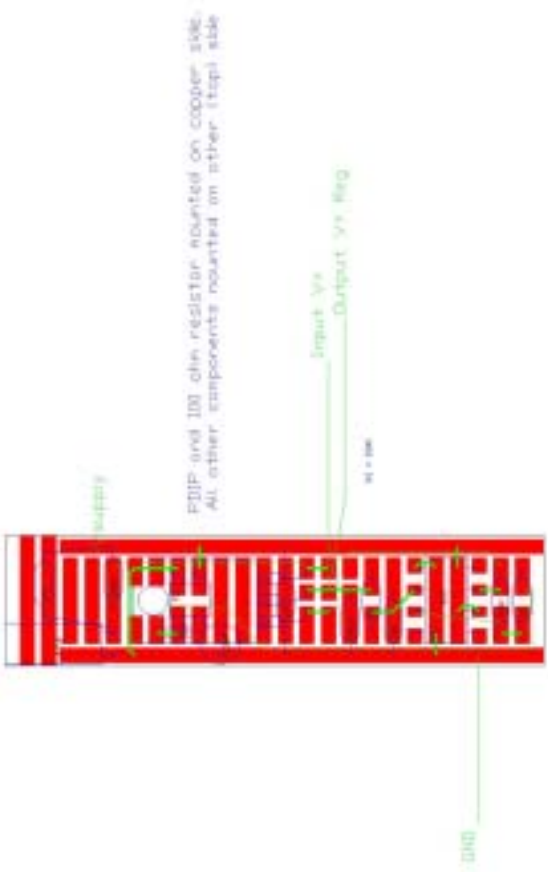
Bottom view
(copper side)

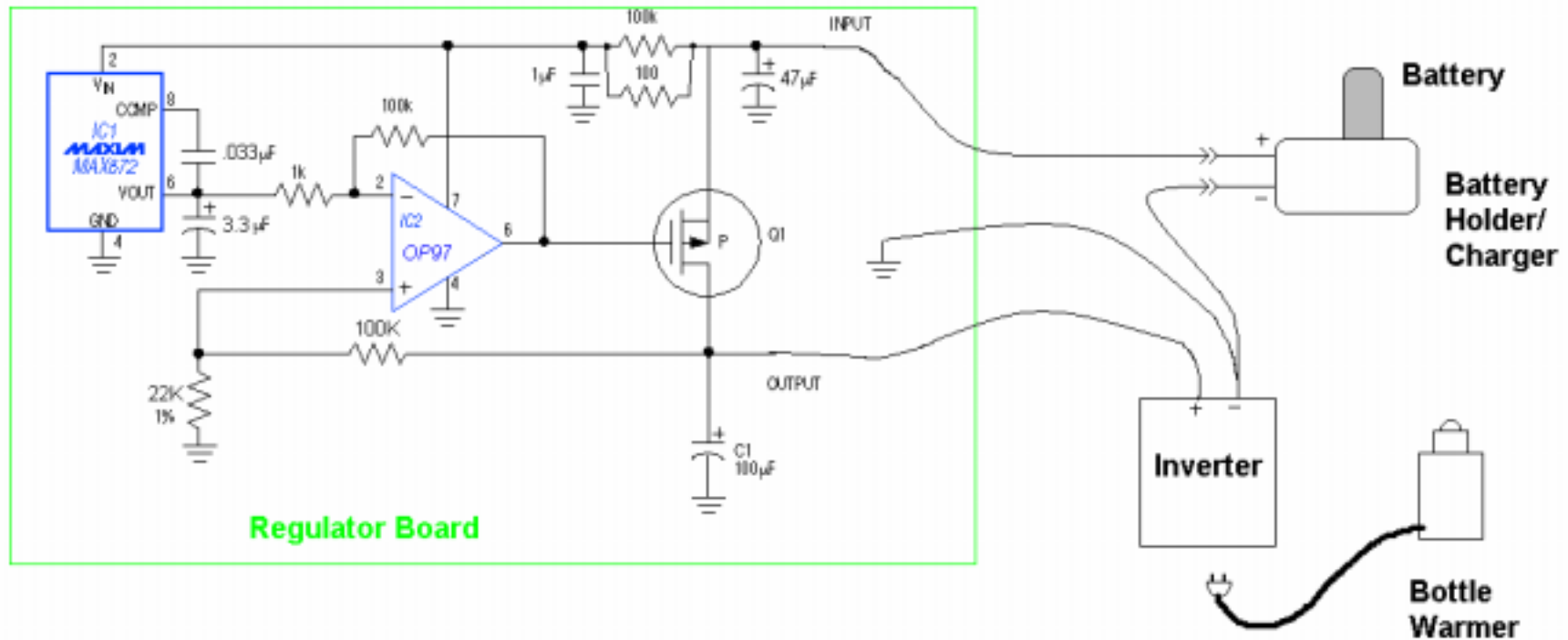


PTH legs with circles are soldered down. Other legs are lifted (not attached)



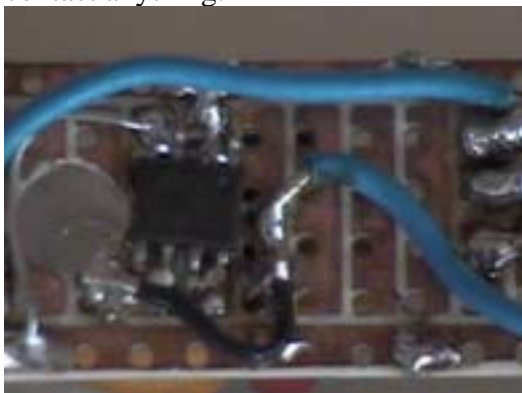
Bottom view-- see thru/all planes
(components on top are shown mirrored)





The schematic is largely derived from a Maxim applications note.

The voltage regulator chip is a surface mount PDIP package, which is a bit tricky to deal with. Fortunately, only every other pin on the package is used in this circuit, so I was able to align the package with the copper traces on the board such that each pin I needed to use was located over a different copper trace. I then soldered down those pins, and “lifted” (bent up) the remaining 4 pins to ensure that they did not contact anything.



The power input leads ran off of the board and were soldered to a connector that mated with the connector added to the battery charger. The output leads were soldered to ring terminals that matched the input posts on the inverter.

Once the board was assembled onto the heat sink, the heat sink was mounted onto the inverter right over the fan inlet, so that the air flow created by the inverter's internal fan would flow across the regulator heat sink. As it turns out, the battery voltage drops quite quickly under the heavy load imposed, and not much energy is dissipated in the regulator and it does not get very warm at all. The fan airflow is probably not required. In my case, time was of the essence, so the regulator assembly is attached to the inverter with electrical tape. A nicer bracket could be easily fabricated that would add some measure of robustness.

