Air Conditioner
Kit Build Instructions
January 2011

This is a very straightforward project. The only caveat is the requirement for the correct sequence in the assembly of the various major components.

Radiator PEM Nuts

For purpose of discussion, the radiator face with the ¼" NPT pipefittings will be referred to as the backside. The radiator frame has four punched holes designed to fit an 80 mm DC fan frame. These four holes and two additional holes on the front face of the radiator need to be drilled out with a #19 drill size in order to accept clinch type PEM captive nuts. Prior to any drilling, temporarily lay a piece of sheet metal on the radiator finned surface and slide it into the corner for the hole being drilled. This is a vital safety shield to protect the very thin finned tubing of the radiator. If the drill bit grabs the frame metal and pulls thru, you do not want it to destroy the radiator. (Don't ask how I know.)

Drill 6 ea #19 holes (4 on back side & 2 on front side.) Slide in a piece of sheet metal to protect radiator when drilling.

Upon completion use a pair of hemostats to guide the PEM nut under the hole. A ¾" x 4-40 **S**ocket **H**ead **C**ap **S**crew and a ½" long aluminum cylinder are provided in the kit for setting the clinch on the PEM nut. Slip the SHCS thru the aluminum sleeve, thru the radiator edge hole and into the PEM nut. Align the serrated nut flange with the hole and tighten the socket head screw until it pulls the PEM nut flush with the top surface of the radiator frame. Remove the SHCS and the sleeve for use on the remaining 5 PEM nut installs.

PEM Clinch Set tool & 3/32" Allen wrench

Fan mount

The brushless DC fan is attached to the radiator with 4 each 4-40 x ¼" pan head screws. Note the airflow direction arrows molded into the fan frame.

Additionally, two semicircular notches have been cut into one face of the fan frame in order to clear the input and output plumbing fittings.

Drill Template

Print out the case mounting and drill template. Attach the template to the left side of the cooler case with tape or spray glue. Drill 4 each #43 (.089")holes in the exterior surface of the case. Do not drill deep. A 1/16" penetration to break the surface of the blow-molded case is all that is required. You will want to maximize the grip of the attaching #4 x ½" sheet metal screws that go into the foam case wall filler. Also drill two pilot holes thru the case wall for the water ports. Enlarge these two holes with a ½" diameter spade bit. Also drill a ¼" thru hole for the water pump cable.

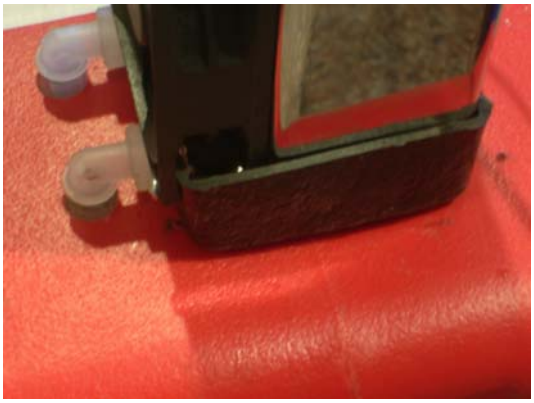
Plumbing

Install the Nylon right angle hose bibs on the radiator and orient the barb ends parallel to the radiator frame. Cut a 5" length of the ¼" ID Tygon tubing and attach it to the lower hose barb. The remaining length is attached to the upper hose barb.

Back view

Remove the paper drill template and install the black ABS plastic mount on the left side of the cooler case using 4 each #4 x ½" sheet metal screws. Note its orientation. There is a front and topside. The bottom surface plane has a 1-degree tilt to compensate for the 1-degree draft angle of the blow-molded cooler case. The deep cutout in the back side of the mount is for clearance of the pipefittings. In addition to the sheet metal screws, I would recommend application of some ABS /PVC pipe dope between mount and the case wall just prior to tighten the screws.

Guide the Tygon tubing thru the holes in the case and align the radiator in its mount. Use two ea 4-40 x 1/4" pan head screws to secure the mount to the front face of the radiator. The back face of the ABS mounts seats just inside of the rear flange of the fan frame. It is secured to the mount by two each #4 sheet metal screws.



ABS mount goes inside fan flange and over the front lip of the radiator

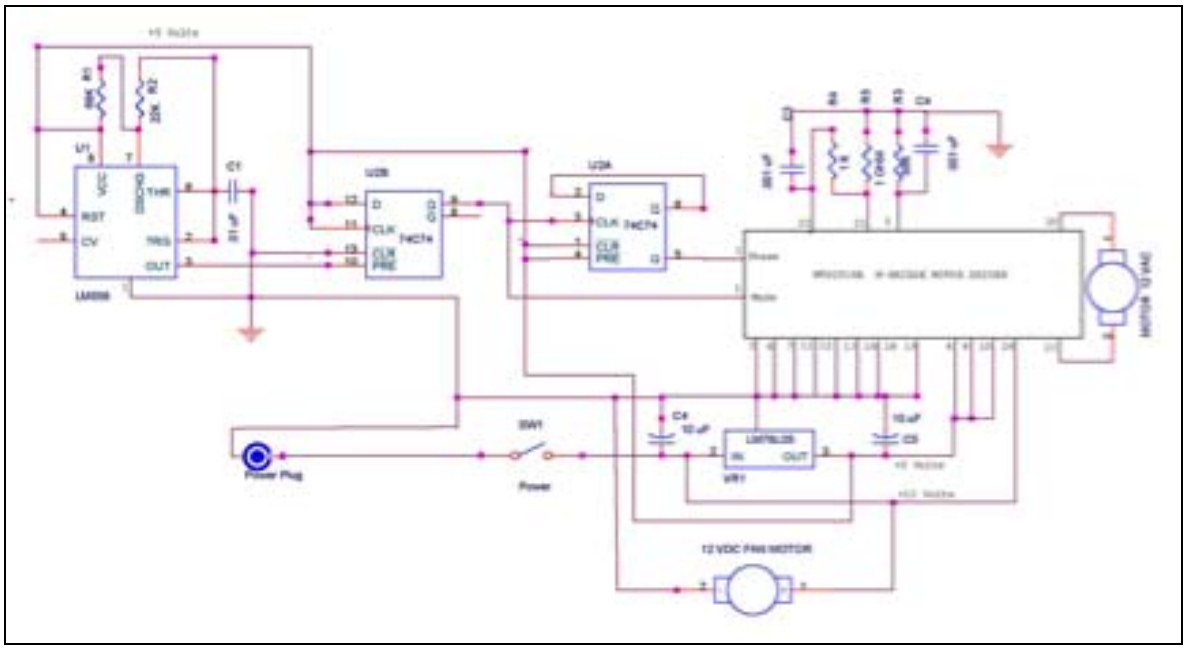
Pump Mount

Fit the lower Tygon hose on to the water pump output stub and the apply cement (RTV or Goop) to the bottom of the suction cup feet on the water pump and position it on the floor of the cooler near the back wall. Use some weight and block to hold the pump in position until the glue cures. Route the pump power cord thru the case sidewall. Apply RTV glue generously around the tubing /wall and pump power cord /wall interface to make it watertight.

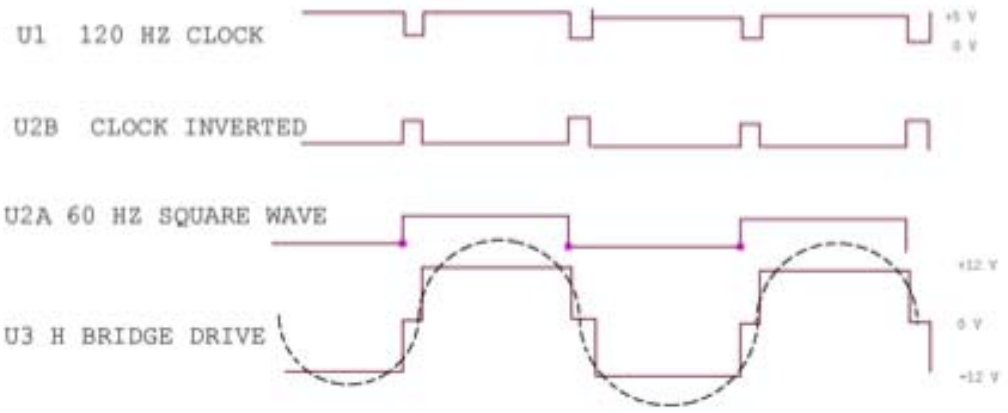
Position and glue the ABS 2x4” sheet on top of the radiator.

Inverter drive electronic for the water pump

This circuit uses an LM555 timer to create a 120 Hz clock pulse. Next a 74HC74 dual flip-flop inverts the clock pulse and performs a divide by 2 function to generate a symmetrical 60 Hz square wave. The MTS2916A is a single chip stepper motor controller and a dual H-bridge stepper motor drive. These devices are typically used to run printer motors. One of its various mode-control options permits summing the inverted clock pulse with square wave input to create a synthetic quasi-sine wave suitable for running the circulation pump motor.



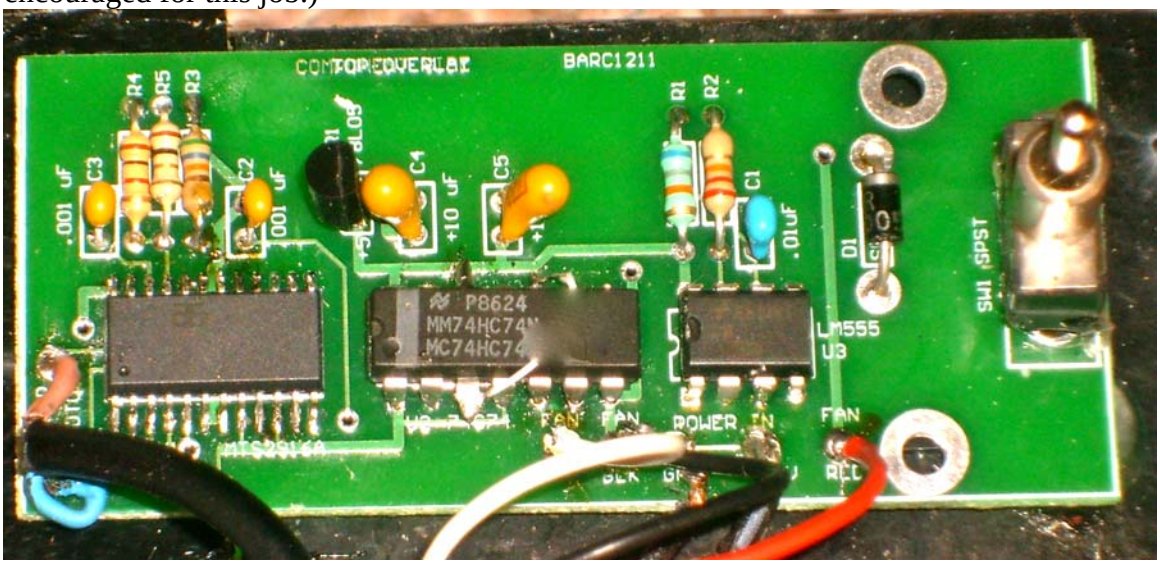
12 volt DC to 12 volt AC Inverter Circuit

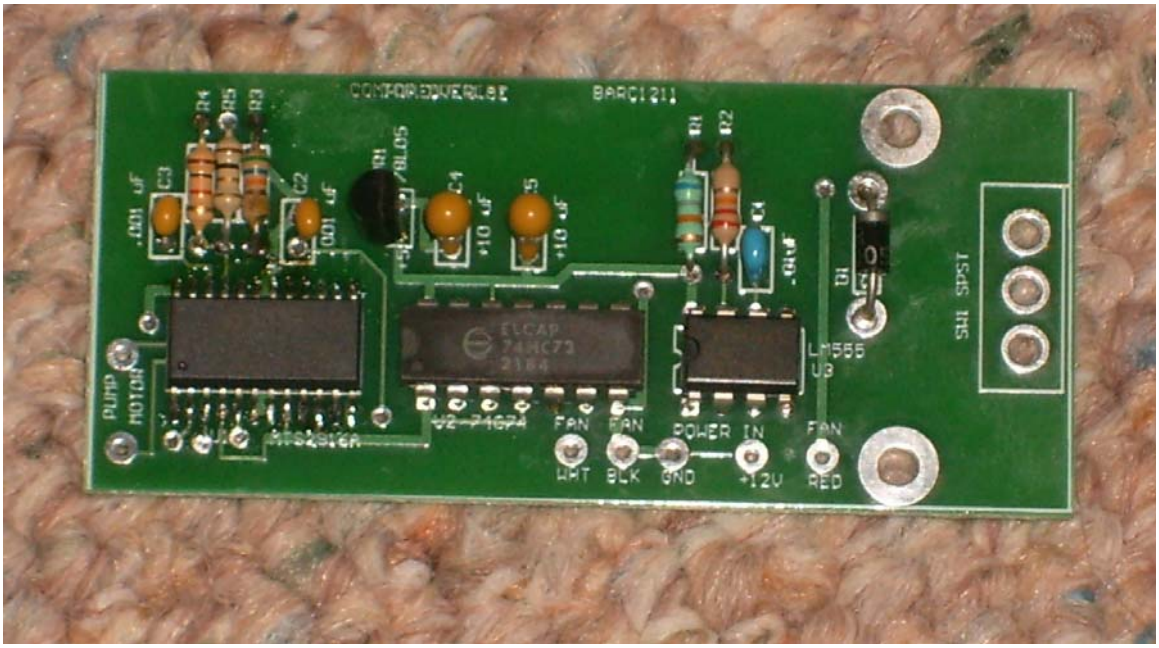


Inverter Quasi-sine Waveforms

PC board Assembly

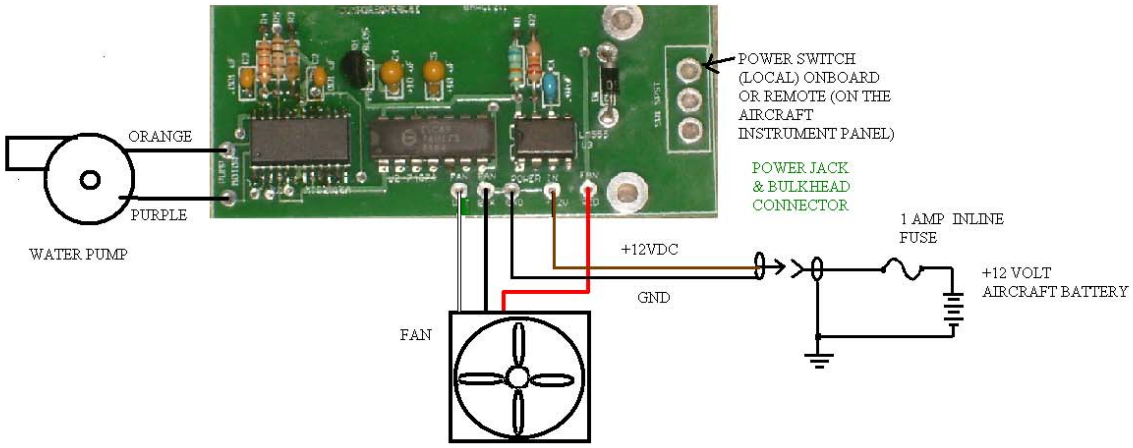
The MTS 2916a is an SOP-24 type of surface mount chip. I normally try to avoid using high-density surface mount lead format Integrated Circuit chip for these "Do-It-Yourself" projects. The very tight 0.050" lead spacing for surface mount parts can be a bit of a learning curve for "first-timers" soldering very tiny stuff. But in this case there were no other viable part options. So, use 0.032" diameter solder and a very fine needlepoint-soldering tip. Also, have a roll of solder wick braid handy to extract solder in case of a solder bridge between adjacent legs on the MTS 2916A part. Tin corner pads on the PC board U1 part location. Orient and position the IC on the PC board pads and then re-flow solder onto diagonal corner legs to secure the IC before soldering the rest of the legs. Place the soldering iron tip on each leg and apply very small 032" diameter wire solder to each pad and allow the solder to flow between the PC board pad and the IC foot. The U2 and U3 chips are standard thru-hole mounting devices and have the larger 0.1" lead spacing making then easier to work with. (A visor-mounted set of magnifiers is strongly encouraged for this job.)





Circuit Board with Components Installed

Note: There is a layout error on the PC board . The offending trace has been cut and a jumper wire added. Leave this jumper wire in place when installing and soldering the components. Parts kit: www.barkeraircraft.com



PUMP DRIVER BOARD HOOKUP TO FAN AND PUMP

Mount the PC board to the ABS floor plate glued to the top surface of the radiator .Use 2 ea. 4-40 screws. Wire up the pump, fan and power cord as shown in the above illustration. Depending on your aircraft, the location of the bulkhead female power connector is left up to you. I do encourage you to fuse the connector as close to its supply bus as possible. A 12 volt power cord is routed to the connector of your choice (cigarette lighter et al) I installed a miniature Power jack in the rear of my cabin and wired the jack directly to the aircraft bus with an inline fuse installed right at the battery /master relay. This is philosophically similar to the fusing of the aircraft clock and master relay power switch. (If a short should occur, the fuse interrupts power right at the

battery.) Bundle the wires to exit the slot in the top ABS board cover. I recommend securing the top board cover in two to four spots with some hot glue. (This permits easy removal if necessary) Do this after you power up for testing.

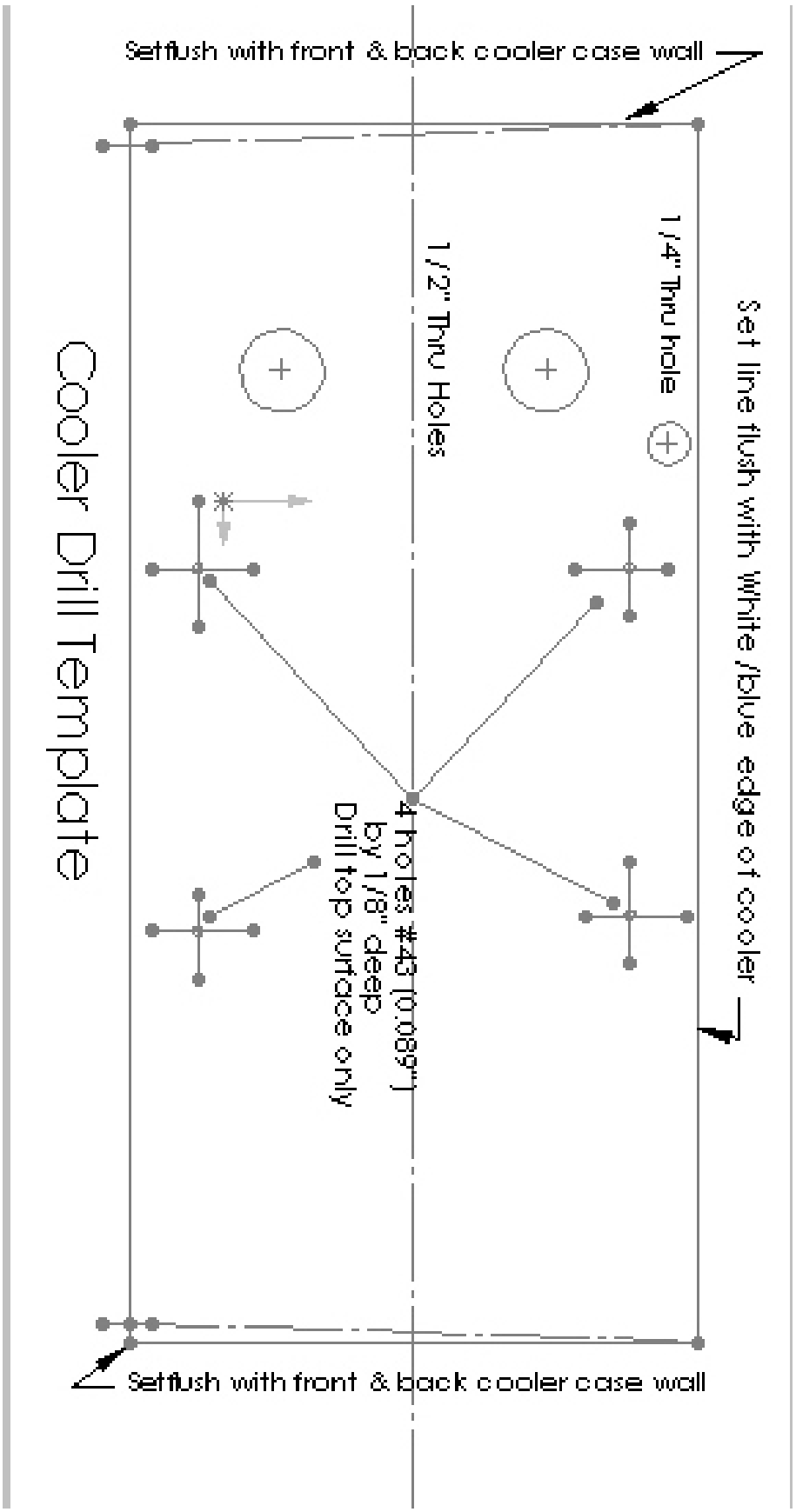
For a full parts list and/or full kit of all components go to: www.barkeraircraft.com

Test

For the initial power up test I recommend using a 12 Volt bench power supply that is current limited to ~ 1 amp. This will help preclude damage in case something got assembled wrong. Upon power up you should feel a small vibration in the pump that will let you know it is running. Check the fan airflow thru the radiator. Add enough water to submerge the pump to check the system flow and for leaks.. Please note there is a flow rate lever adjustment on the side of the pump. This should be kept in the wide-open position. In fact, a dab of RTV glue on the lever is advisable.

Application and Use

Load the cooler with ice cubes and add ~ 1" of chilled water to submerge the pump. Mount the AC unit in the rear of your plane (hat shelf or the baggage clothes hook) Connect to aircraft 12-volt power and turn it on. The pump will circulate cold water thru the radiator and return it back over the ice. The fan provides that welcome stream of cold air. Operating time is of course, temperature dependent, but you can expect up to an hour or more of cool air before melting all of the ice. Ice takes 80 calories per gram to convert from 0°C ice to 0°C melt water (32°F). This energy /adsorption or release is called the heat of fusion. Each additional degree of temperature change requires only 1 calorie per gram per degree. Thus the bulk of the cooling capacity is stored in the melt phase transition of the ice. I have found that filling the cooler case with ice cubes has been sufficient for my type of flying. It has been most comforting in getting me from the hangar, down the taxiway, and a climb to cooler altitudes. I have usually had sufficient remaining ice for the decent back into the hotter air near Earth. On longer trips in the more hot and humid environments of the Deep South or Texas, you may want to add a drain tube and bring along an ice refill.


Setflush with front & back cooler case wall
1/4" Thru hole
1/2" Thru Holes
Set line flush with White /blue edge of cooler
4 holes #43 (0.089")
by 1/8" deep
Drill top surface only
Cooler Drill Template
Setflush with front & back cooler case wall