MRC Model Railroad Transistor Throttle Repair

MRC (Model Rectifier Corporation) transistor model railroad throttles have been widely used for about 50 years as of 2020. They are all fundamentally identical in that they utilize a step down transformer to reduce an input 115V AC signal to about 18V AC, transform the 18V AC signal to an output 16V DC signal through the use of a 4 diode bridge rectifier, and modulate the output current through the use of a Darlington (two bipolar transistors in one 3-lead package) transistor. A wire wound potentiometer with a wire wound resistance range of about 3000 ohms feeds current to the Darlington to effect the current modulation. Over time features (e.g. momentum, ammeters and voltmeters, pulse width modulation) have been added to the basic throttle circuitry.

As of 2020 MRC no longer provides repair service for their products and it is up to the individual owner's to either scrap or repair their own throttles. Because these throttles are all UL certified owner's must be aware that any repair work done by non-UL certified technicians will render the UL certification null-and-void. Owner's are entitled to repair their own throttles but they may not re-sell these repaired units without a potential of incurring legal liability. Onward.

Fortunately, there are to date (2020) only two known (to me) functional failure modes for all these transistorized MRC throttles and both modes are repairable by an owner with some modest soldering skills and a relatively inexpensive tool set at their disposal.

Failure mode #1 is a shorted output Darlington transistor The failure symptom for a shorted Darlington transistor is that locomotives run at maximum velocity regardless of throttle setting. The solution is to simply replace the Darlington transistor. Mr. David Bodnar has a presentation on how to (http://www.trainelectronics.com/MRC_6200/) do the Darlington replacement for the MRC6200 throttle. The 50 watt MRC6200 utilizes two Darlington transistors wired in parallel so as to provide enough current for large scale (e.g. LGB) model locomotives. Typically only one of the two Darlington transistors fails in the 6200. The Tech II series (1400, 1500, 2400, and 2500), 9370, Tech 3, and Tech4 throttles have single Darlington transistor outputs and the replacement procedures are similar to that described by Mr. Bodnar.

Failure mode #2 is the "lost zero" symptom where the user cannot completely shut off the throttle and the locomotive continues to creep along at a "zero" throttle setting. This "lost zero" failure mode is due to circuit board leakages most probably due to corrosion between the solder pads. The solution is to open the throttle chassis and wipe down the circuit board/s with isopropyl alcohol and an absorbent pad of some sort (e.g. q-tip). What has happened is that the board processor has not adequately rinsed the board and has left acidic residues that absorb moisture and, bingo, conductive metal films (aka dendrites) form between the adjacent solder traces. As an added safety precaution I recommend that the potentiometer be rinsed off with an electronic circuit cleaner although I doubt that the potentiometer is involved with the "lost zero" failure mode.

To be sure there are other possible failure modes. The circuit breaker may fail and need replacement but that is a safety issue and not a functional failure (see David Bodnar's web site-referenced above). The electrolytic capacitors (those blue cylinders) are "wet" devices and, over time, those wet paper dielectric films can dry out and fail. Look for a visible "rupture" on the cover of the

electrolytic capacitor. Electrolytic capacitor replacement is relatively easy to do even for a novice solderer.

The biggest challenge in throttle repair is opening the chassis. Due to UL certification requirements a special security wrench or screwdriver is required. The 6200 security screws are not recessed and a pair of pliers may be used to grab the security screw head. All subsequent MRC throttle security screws are recessed and special tools are required. The Tech II security screws are #10 security Torx wrenches which may be purchased (as part of a set) either on the internet or at (some) Harbor Freight Tool stores. The 9370 requires a special screwdriver and I am not aware of any suitable removal tool on the market as of 2020. I made my own by using a Dremel tool to cut a notch in a normal screwdriver (see photo below). It is always possible to drill out the security screws but that risks the possibility of destroying the female posts molded into the chassis. At this point in time, I have no knowledge of what the security screws are for the Tech3 and Tech4 MRC throttles.

The attached photographs are annotated and are intended to supplement the above text.

Figure 1: MRC6200 Security Screwdriver

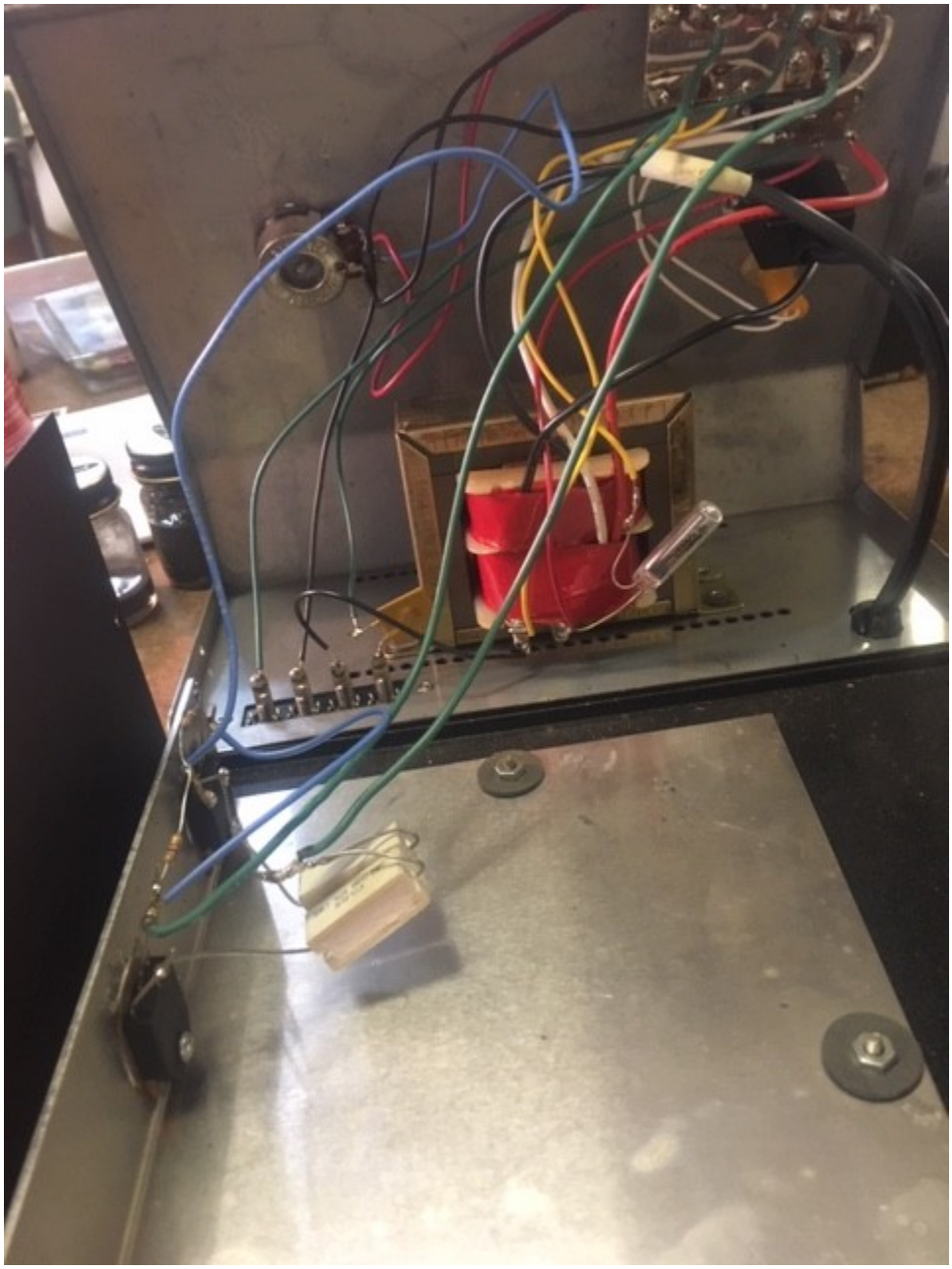

Figure 2: MRC6200 - Circuitry Layout

Re the above photo: The MRC6200 is a 50W throttle with two Darlington TIP121 transistors mounted on an Aluminum heat sink (at left in photo). There are no electrolytic capacitors for the output DC voltage is unfiltered, 60 cycle, AC.

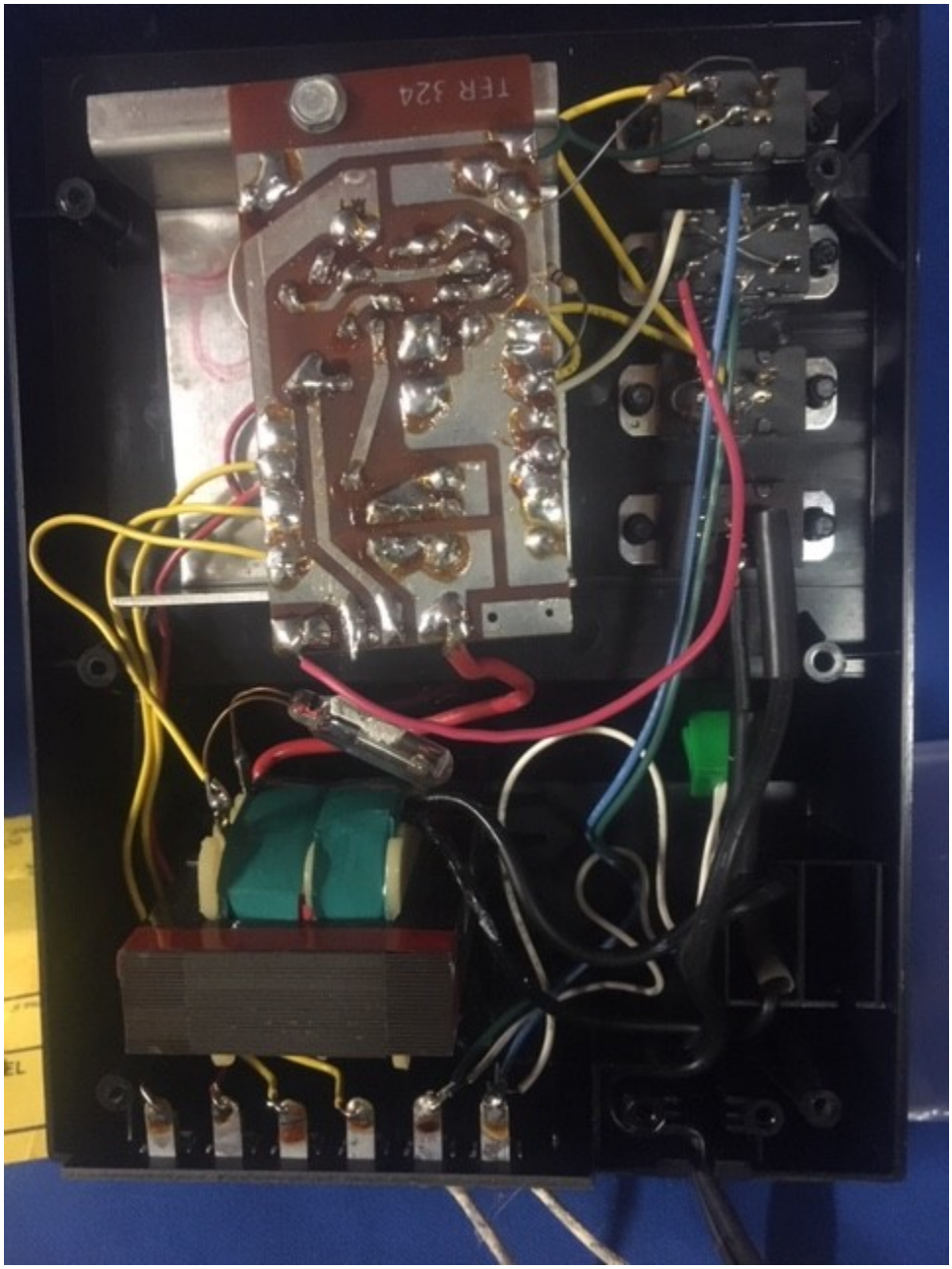

Figure 3: MRC1500 Circuit Board

Re the above photo: Residual flux is evident as the “brownish” hazy material around the solder pads. It is this residual flux residue that most probably causes the “lost zero” failure mode for all MRC transistorized throttles.

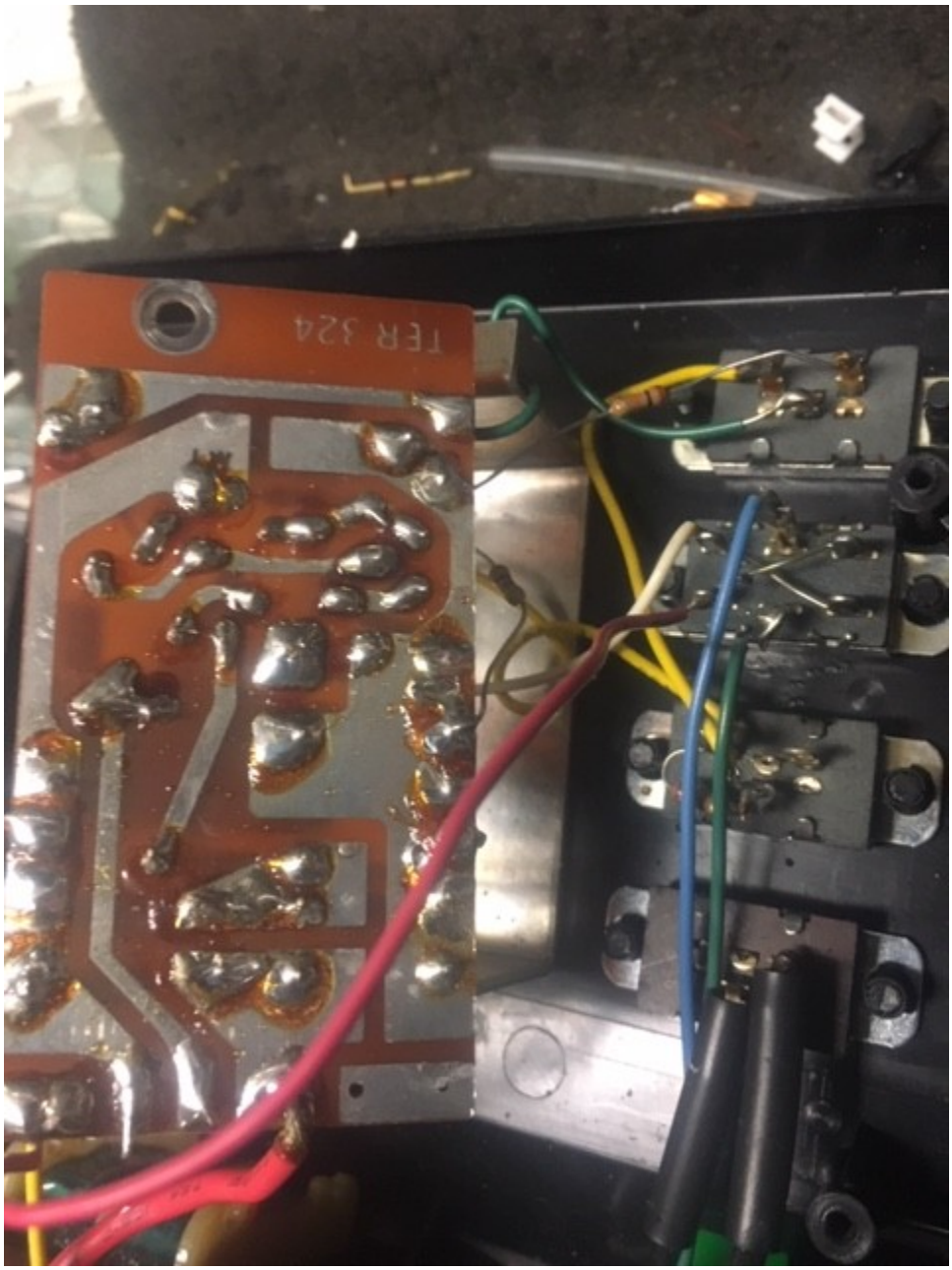

Figure 4: MRC1500 Circuit Board

Re the above photo: The flip side of the circuit board shown in Figure. The residual flux residues are the brown hazy material surrounding the solder pads.

Figure 5: 2500 Ohm Potentiometer-MRC6200

Re the above photo: The above 2500 ohm potentiometer is similar to potentiometers utilized MRC transistorized throttles. During any repair actions it is advisable to clean these potentiometers with spray of electronic cleaner.

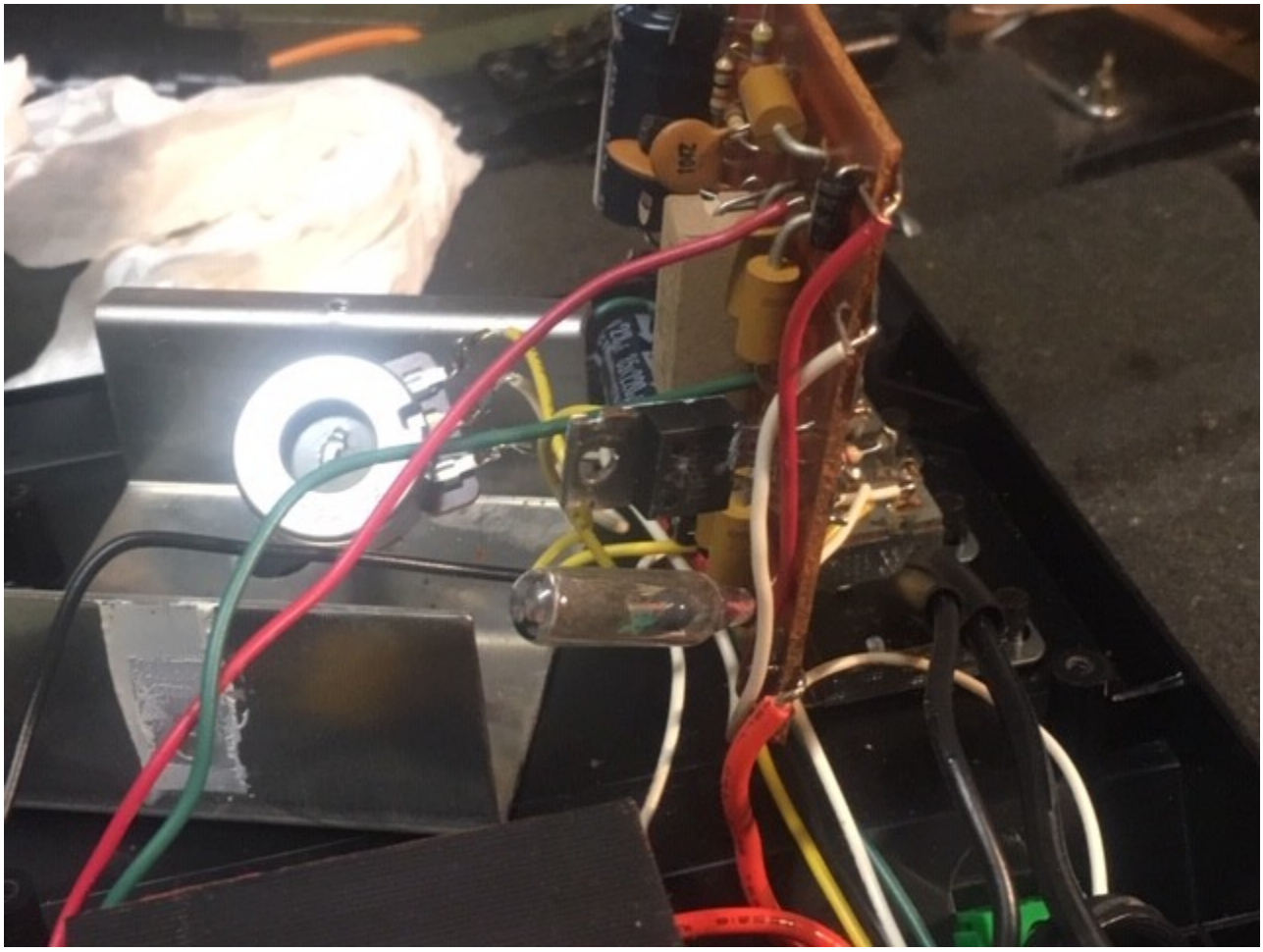

Figure 6: The Encapsulated Mercury Circuit Breaker (front and center)

Re the above: For safety reasons the above glass encapsulated circuit breaker must “open” when the throttle output terminals are connected to a short.

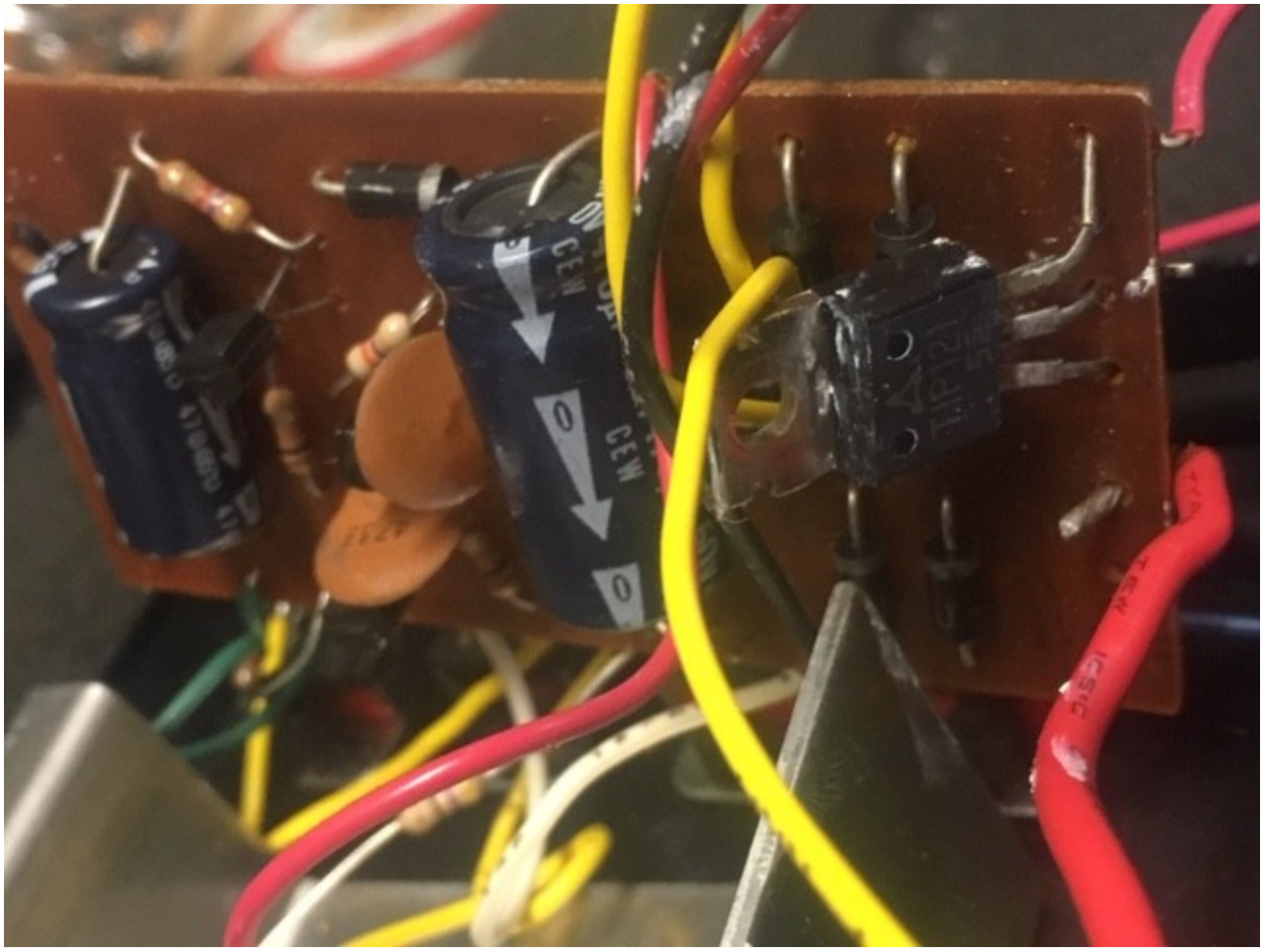

Figure 7: MRC1500 Circuit Board w/Darlington Tx and Electrolytic Capacitors

Re the above photo. The TIP121 three-pronged device on the right side of the above photograph is a Darlington transistor. The blueish, cylindrical components are electrolytic (filter) capacitors. The disc-shaped components are "disc capacitors" used for noise suppression.