SAVING HERO Jr FROM HIGH VOLTAGE and REVERSE POLARITY and

HERO Jr RADIO FREQUENCY CONTROL SYSTEMS.

H. Holden 2013.

Background.

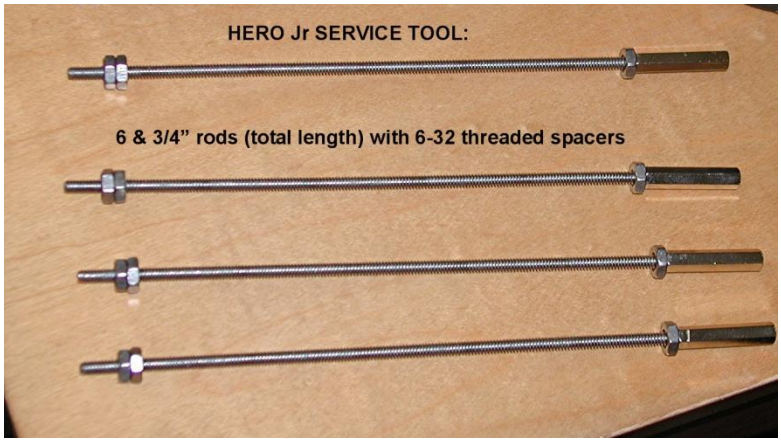
Anyone familiar with the Hero Jr Robot knows just what a charming vintage Robot he is with his Droid like appearance and personality profile and his amazing voice. The voice is based on the astonishing Votrax SC-01-A phoneme and voice synthesiser IC. And as he states: “I am your friend, companion and security guard”

The Votrax SC-01-A is not the only special purpose integrated circuit in Hero Jr. One other is the encoder & decoder IC’s in the radio transmitter & receiver. These IC’s are the R7411-1 and the R7411-2A. The radio control system IC’s appear to have their origin in home automation systems such as the key coded garage door controller.

Unfortunately some of these special IC’s have met their demise due to installation of the incorrect batteries, for example two series 12V batteries (yielding 24V) instead of two 6V batteries, or battery reverse polarity.

Working on Hero Jr.

A very useful service tool is 4 extension rods which allow the head to remain spaced away from the pcb's in a stable position, but close enough so the cabling can remain connected. (These are not required to fit the over voltage protection modification as the head does not need removing)



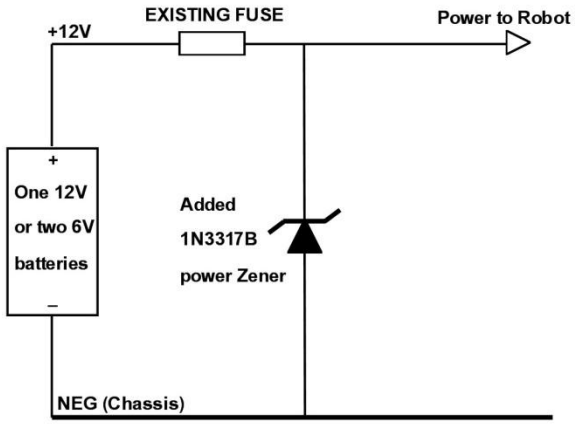
These are shown in use below:

Over-voltage & Reverse Voltage Protection:

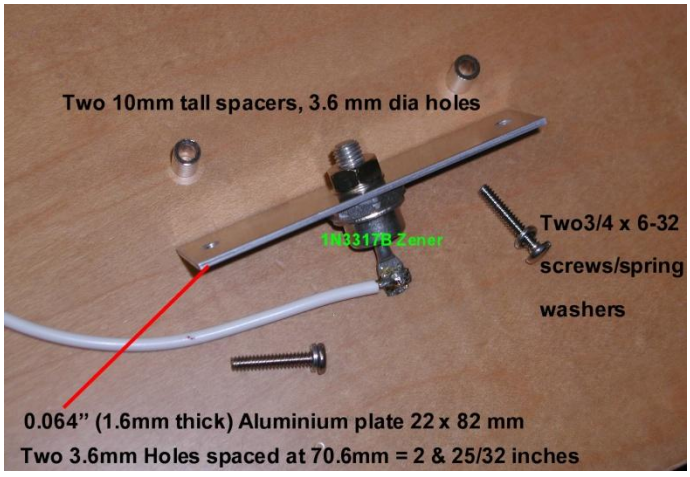
The simplest method to prevent over voltage or reverse polarity is to fit an 18V power zener diode such as the 1N3317B. In normal operation with a fully charged 12V battery at a voltage close to 14V, the power zener is 4V away from its conduction threshold. A 16V power zener would also work, but with a smaller margin. In this condition the zener draws no measurable current (less than a micro amp). If the voltage exceeds 18V the zener clamps it to that value. If 24V was applied the current would climb and blow the fuse. With reverse polarity the zener acts as a conventional power diode and limits the reverse voltage to less than one volt, once again this would cause the fuse to blow.

It is important that the Zener is placed directly ***AFTER*** the fuse as shown in the diagrams and photos below. To avoid having to drill any new holes in the Robot's metalwork the diode is simply fitted with a metal plate and two spacers to existing captive 6-32 nuts.

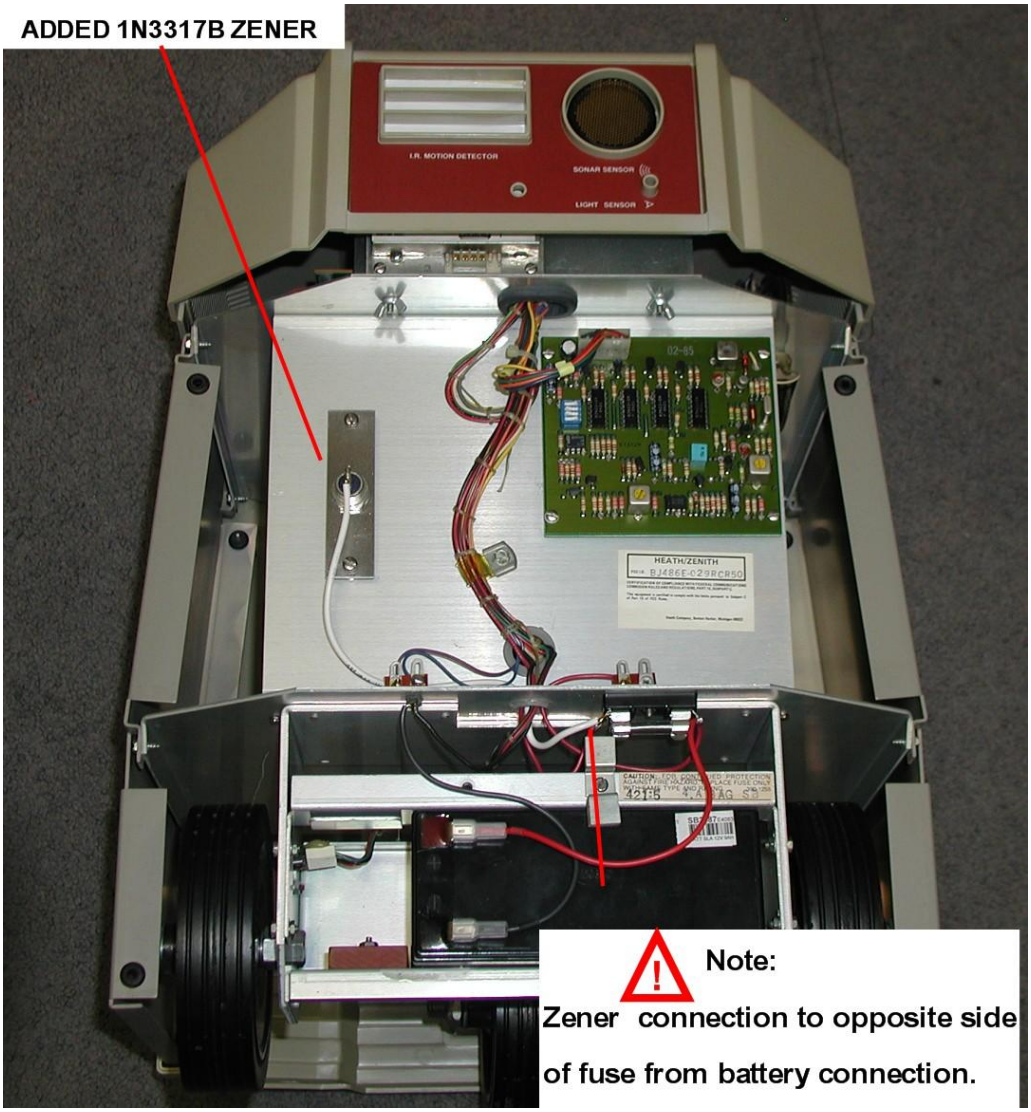
HERO Jr. REVERSE & OVERVOLT PROTECTION:



Zener Assembly:

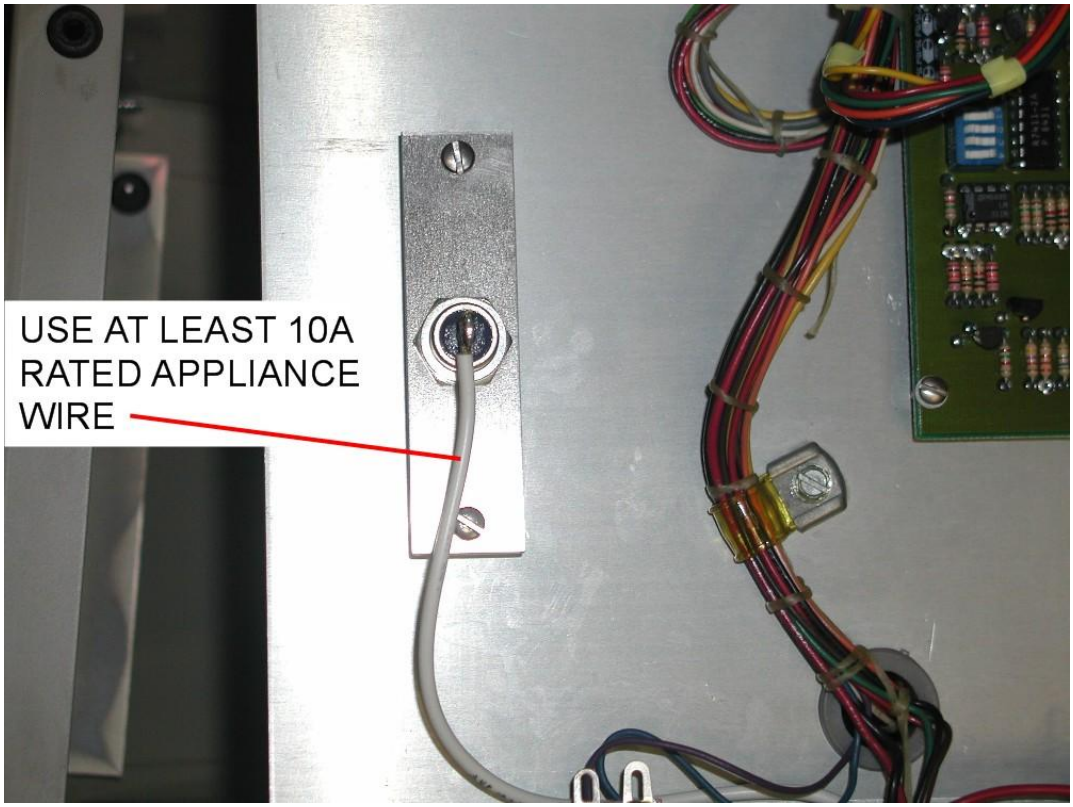


The photos below show the assembly screwed into the existing captive nuts:



It is very important to connect the zener as shown above and **not** directly to the battery terminal. With over voltage or reverse polarity very high currents will flow via the zener diode and there must be a fuse in the circuit to prevent wiring burnup.

The photo below shows a closer view. It is also important to use hookup wire that has a higher rating than the fuse:



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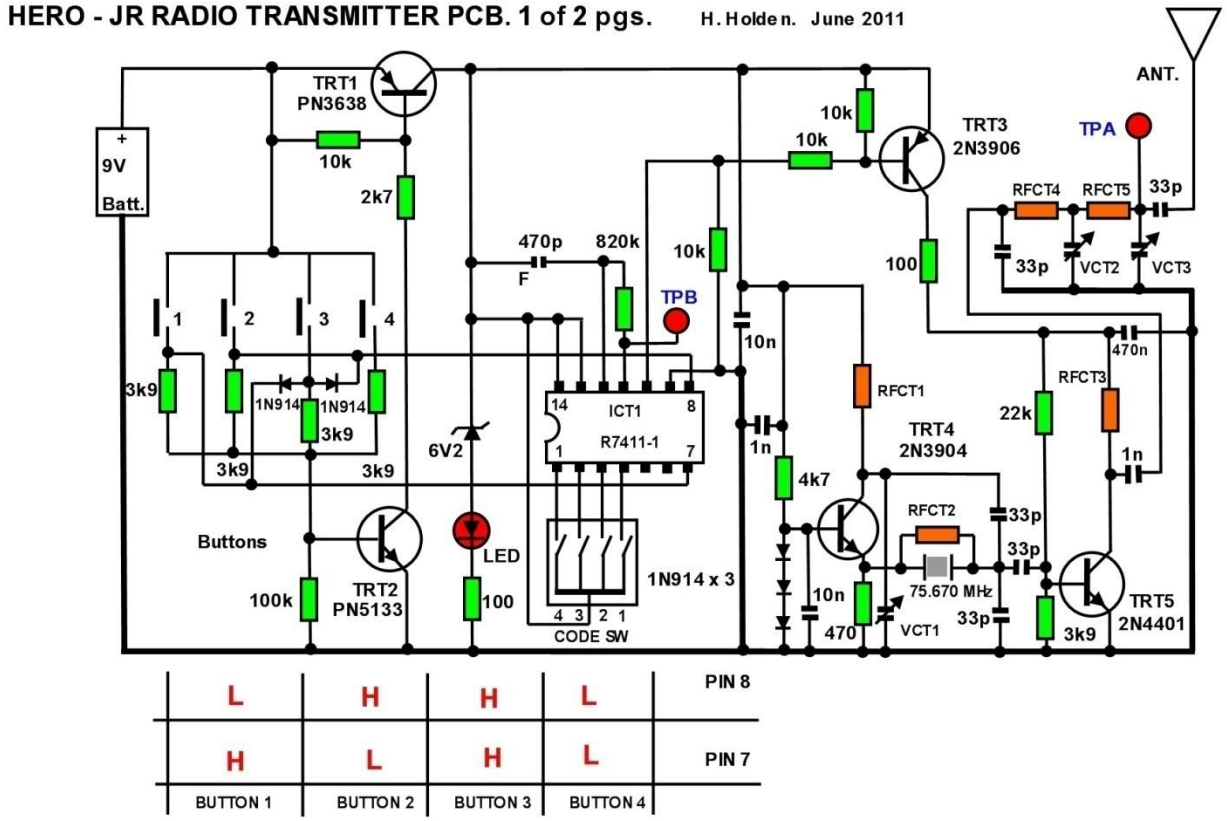
HERO Jr RADIO SYSTEMS:

The details of Hero Jr's radio control systems were not well covered in the original schematics from Heathkit. Therefore it was necessary to copy it out from the pcb's themselves. See the diagrams and discussions below:

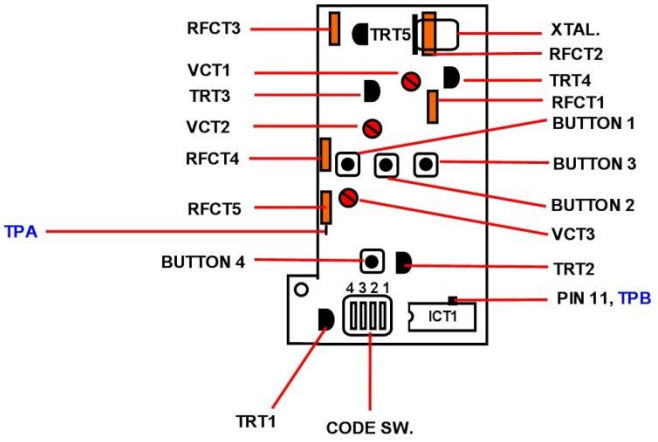


The transmitter above is based on a crystal controlled local oscillator TRT4 (a 2N3904).The 75.670 MHz is Channel 74 for radio controlled cars etc. The original Hero crystal has a 75.670 MHz label. The carrier passes to an RF output amplifier TRT5 and an elegant matching network to the whip antenna. The RF signal is amplitude modulated by TRT3 controlling the rail voltage to TRT5. The modulation is a serial code produced by the encoder ICT1 a special purpose IC type R7411-1. This IC has its own internal RC oscillator (the 470pF capacitor and 820k resistor) to set the timing of the data stream. The 4 buttons present the IC with 2 bits of binary data on pin 8 and pin 7 as shown in the table under the schematic. The code switch alters the output codes and the corresponding code switch in the receiver board must match the transmitter.

The entire transmitter is only powered via TRT1 when one of the buttons is pushed so that there is no residual battery current drain.

The following is a topographical diagram of the transmitter pcb with some useful test data:

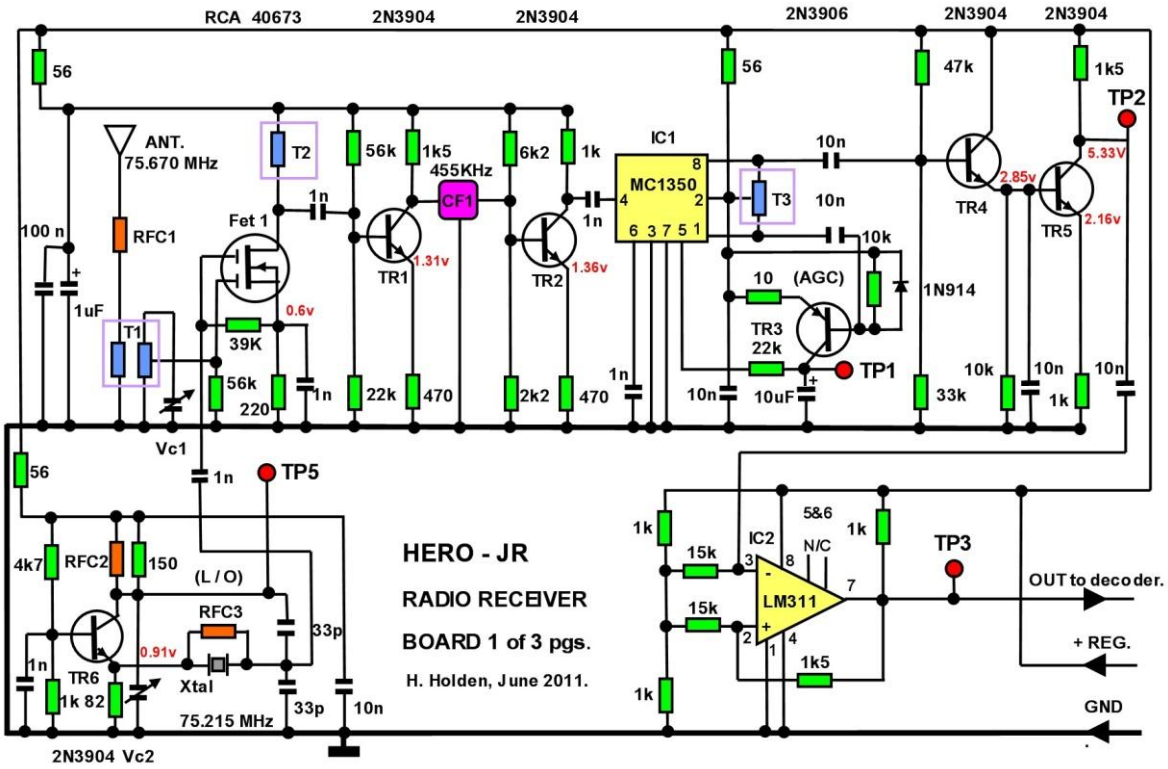
HERO - JR RADIO TRANSMITTER PCB. 2 of 2 pgs. H. Holden. June 2011



TPA: With any button pushed (x 10 probe P6137 & 2465B Tek scope): 10V pp RF > 90% modulated with a rectangular serial code from ICT1.

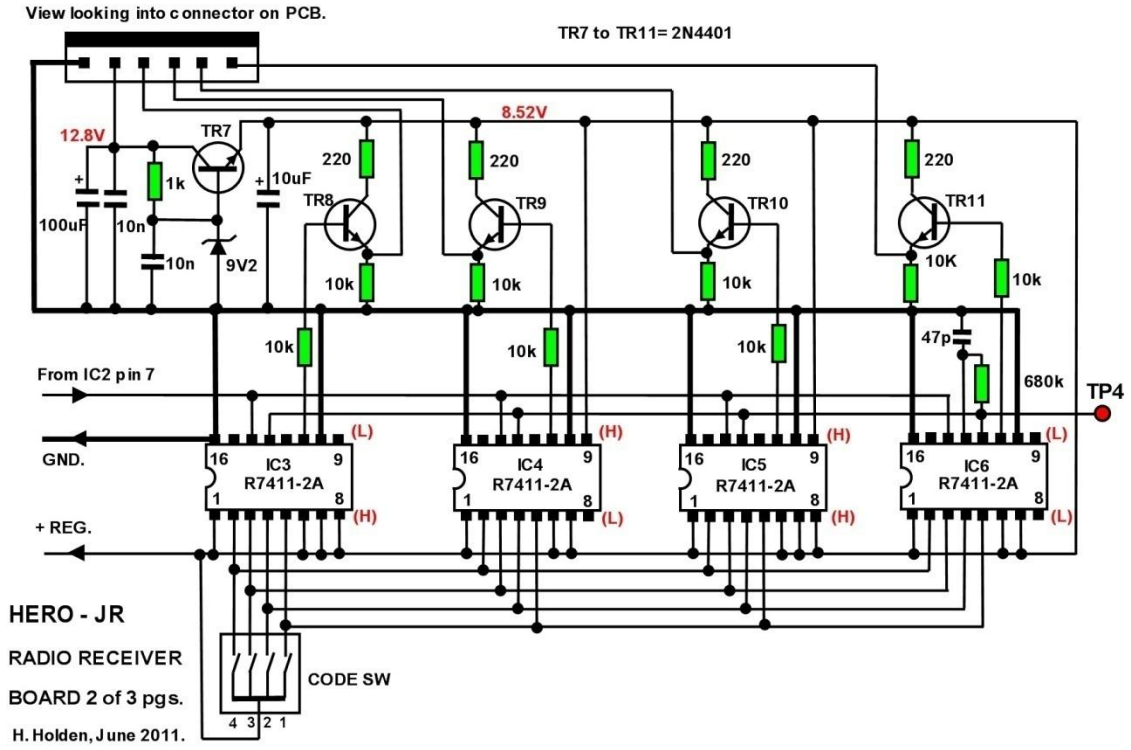
TPB: 2.4Khz rectangular waveform, clock for R7411-1.Approx 270 uS high and 156uS low.

The following schematics show the receiver & decoder with useful voltages added to the schematic:



The receiver is a Superhet based on a local oscillator TR6. The oscillator runs 455KHz below the received frequency; 75.670 – 0.455 = 75.215 MHz. The original crystal is labelled 75.215 MHz.

The antenna signal passes via Transformer 1 (TR1) into one gate of the dual gate fet and the local oscillator is injected into the other gate. The Fet acts a non linear amplifier and signal mixer. As a result the sum & difference of the received signal and local oscillator signal appear in the Fet's drain current. The difference signal is selected by the 455KHz ceramic filter CF1 and passes via TR2 to the MC1350 monolithic IF amplifier and AGC IC. The AGC voltage is amplified by TR3 and fed back to in 5 of the IC and is available on TP1 as a test point. The IF output which contains the modulated codes from the transmitter is partially filtered by the capacitor on the base of TR5 and is then passed to a comparator IC2 which squares up the signal with hysteresis (positive feedback) and regenerates the code pulses as they are at the transmitter. These pass to the decoder circuit shown below:



Pin 8 and pin 9 of each R7411-2A IC are programmed (held high or left low) to correspond to the 2 bit binary data which corresponds to each of the 4 buttons on the

transmitter. So there is one decoder IC for each button on the transmitter. Again the code switches at both ends must match up. One of the IC's, IC6, is the master clock for all of the IC's here with the 47pF and 680K RC oscillator components. The output of each decoder IC passes through an emitter follower buffer transistor before it exits the pcb.TR7 is the voltage regulator for this board and can be prone to failure if the wing nut above this pcb gets dropped behind the pcb while the board is powered.

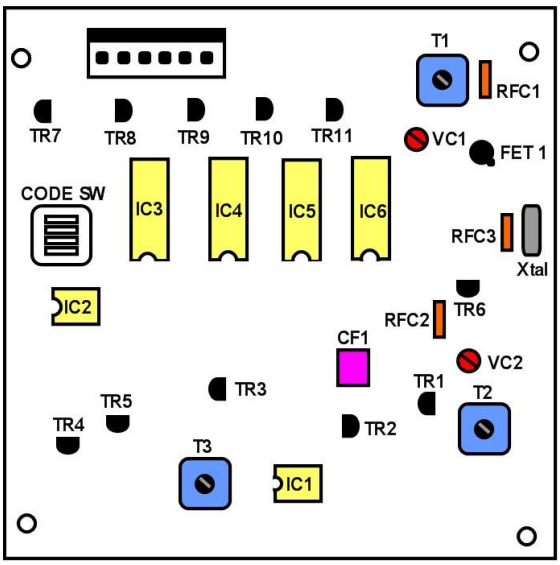
The following is a topographical view of the receiver pcb with some useful data added:

HERO - JR

RADIO RECEIVER

BOARD 3 of 3 pgs.

H. Holden, June 2011.



TEST POINT NOTES:

1) TP1: AGC voltage. With zero signal voltage 3.9 to 4.0V With transmission, transmitter with antenna down 1 meter from robot = 5.8V

2) TP2: 5.33V DC with superimposed 150mV pp signal with a transmission.

3) TP3 : Clean 8.5 volt pp switching signal corresponding to the transmitted serial modulation code generated by ICT1.

4) TP4: 20 mS on and 10 mS off, 8.5V pp waveform; a 33 to 34 KHz clock waveform generated by IC6, presumably by an inverter between pins 12 & 13.

5) TP5: 300mV pp sine wave at the crystal frequency.

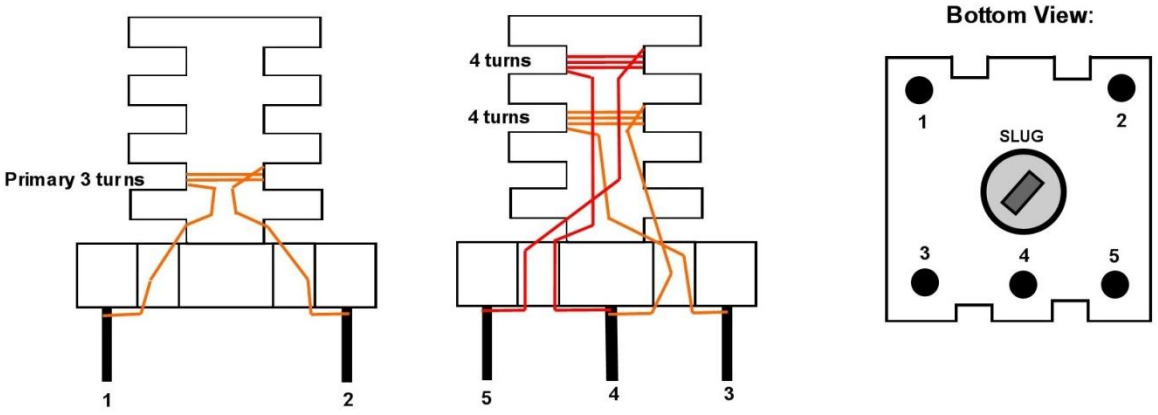
One PCB I had was missing RF transformer T1, So T1 from another pcb was opened and studied to yield the following. This is useful data for replacing a damaged coil and some other notes:

Toko RCL 75.670 Mhz input coil on Radio Receiver Board(T1). Heathkit Hero JR ROBOT.

H. Holden, 2011.

Side views of coil removed from shielding can.

Wire diameter (with enamel) 0.14mm.



OTHER NOTESON THE HERO JR RADIO RECEIVER BOARD:

 # The crystal in the Hero JR transmitter is a standard 75.670 MHz CH74 AM crystal for radio control cars etc.

 # The Yellow Top IF transformers on the Hero Jr radio board are standard transistor radio 455KHz IF transformers

Also of note the Futaba CH74 crystal pair, intended for AM use and for “Airtronics Only” radio control cars etc, has a TX crystal with a sticky label 75.670 TX and 75.670 RX. Removing these sticky labels reveals 37.835 engraved on the TX crystal and 75.215 MHz on the RX crystal. This RX crystal works in the HERO JR radio receiver board. Sometimes these crystals get damaged and need replacing as they project from the right hand side of the pcb. I do not yet know if the 37.835 MHz Futaba TX crystal would work in a second overtone manner in the Hero transmitter, I would expect not.

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