CONTROL A TOPO 1

Via Standard R/C

Breathing new life into an old robot ...

by Robert Doerr

I really enjoy working on the older personal robots from the '80s. It's fun to keep them running and I am always looking at ways to enhance them while keeping the original robot intact. Recently, a friend asked me to fix up his old Androbot TOPO robot. This revived my interest in a project that I have been thinking about for quite some time. I wanted an easy way to use my own TOPO robot without setting up an entire Apple II+ system to support it.

Another reason is that the original RF transmitter modules required to run the robot usually get lost. Without the transmitter, TOPO can't do anything. For the most part, this has caused a lot of TOPO robots to become nice display pieces instead of working bots.

Background Information on TOPO

Back in the early '80s, Androbot manufactured and sold TOPO robots. There were a few different versions, but for the most part there were two distinct varieties. The early ones (TOPO I) are RF based control (open loop), which allows just the remote control movements of the main drive motors. These have a single white button on the head, silver trim, and red/green LEDs near the wheels and on the body, which show the direction of movement. The later TOPO II/III robots switched to a bi-directional I/R link (closed loop), had some smarts onboard, and could talk. These had a red button on the head where the I/R transceiver was located, black trim, a black cutout for a speaker, and red LEDs near the wheels. Some of the other LEDs were eliminated.

The TOPO III is basically the same as the TOPO II, but eliminated the rest of the LEDs and had a slightly different body which replaced the fold down arms with a mount that could accept optional drink and food trays.

This article focuses on the original TOPO I robot. All references to TOPO in the rest of the article apply only to this original RF based version.

Original Control System

One nice thing about the way the RF control is on the TOPO is that it seems to be patterned after a standard 27 MHz radio control that would be used for model planes. The main board has an LM1872 and logic ICs to receive and decode all the signals. It converts them to ones similar to what a standard R/C receiver would produce. These then go to the rest of the circuitry onboard which acts like a pair of R/C to H-bridge controllers. It also has some drivers for the lights, but that's about it.

The whole thing acts just like a standard R/C receiver with a pair of R/C to H-bridge controllers all on a single board. Standard R/C to H-bridge controllers are common as they are used extensively in combat robots (I used them in my Battlebots) and can be driven from microcontrollers, like the BASIC Stamp.

The standard setup to run the TOPO I is a bit involved. It requires a custom Apple I/O card with an AM9513 timer chip to simulate the regular R/C signals which then drove an external custom 27 MHz RF transmitter. To complicate matters, the I/O board only seemed to work with an Apple II+ and not the more common Apple IIe system. The driver software was written in machine language with a portion in Basic.

To control the robot, you would run a program on the Apple to drive it around with the computer's joystick, or you could write your own Basic programs and call the driver code to control the movements. It is not the easiest thing in the world to set up and it leaves a bit to be desired in accuracy of the movements!

A little known fact is that the receiver in the robot will also accept standard R/C signals provided the transmitting channel is correct and they are in the right format. This is what this article is about.

Breathing New Life Into an Old Robot

After some research, it seems that all the TOPO robots used 27.145 MHz as their operating frequency. That crosses over to Channel A4 in the R/C world. TOPO uses Channel 1 as an analog channel for the left wheel and Channel 2 as an analog channel for the right wheel. The other channels are unused.

Since I didn't want to alter the robot at all (in case I want to set up the old Apple II+ again), I needed to perform any required modifications on the transmitter side. We really only need two channels, but most two and three channel radios map these to a single stick and would not do the proper mixing for a dual drive system. Instead, I wanted to try a dual stick radio for tank style steering.

It turns out there aren't too many 27 MHz dual stick radios available, but I did find one that was perfect. It is the Futaba 4VWD-AM four channel radio on Channel A4. If Channel A4 isn't available, you can order the radio on any 27 MHz frequency along with an A4 crystal set, then change the crystals. Without knowing for sure if this was going to work, I went ahead and purchased one from Tower Hobbies. With shipping, the radio runs around $120 plus a little extra for batteries.

Luckily, this whole project turned out to be easier than I thought it would. First, I had to make sure that TOPO was operating the way it should and that it had a fresh battery charge. Then, I set up TOPO on blocks up off his wheels, turned on the Futaba transmitter, and then turned on the robot. The wheels moved slightly. I moved the right stick up and down and the right wheel moved (but in the wrong direction). Moving the right stick left and right made the left wheel go forward and backward. The left stick needed to control Channel 1 instead of Channel 3. This was a fairly easy mod to make.

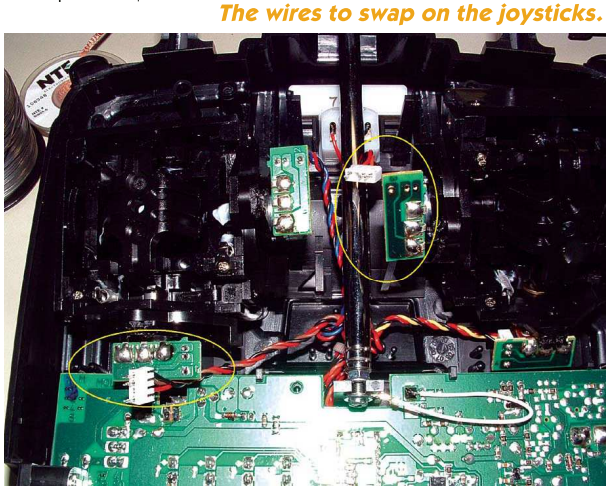
Screws to remove the joystick.

The Radio Modification

With the radio powered off, remove the four screws on the back of the radio and pull off the back cover. They show how to do this in the manual, as you may need to pull off the back cover if you want to adjust the tension on the joysticks. The modification is straightforward. You don't have to touch the main board or alter the RF section at all. This is important since doing that may make the radio broadcast out of spec and may cause issues with the FCC.

What we want to do is just change what potentiometer goes to each channel. In our case, we just want to swap Channel 1 and Channel 3. We do this at the joysticks themselves. Three screws hold each jotstick assembly. There is a fourth screw near the top center, but it's a fake one so don't try to take that one out! Unscrew each of the joystick

The wires to swap on the joysticks.



Servo reversing switches.

assemblies but do not remove them completely. We just need to lift them up a bit for clearance to unsolder and swap the wires.

Once that is done, unsolder the three leads on Channel 1 (right/left on right stick) and Channel 2 (up/down on left stick). Solder wick works well if you don't have any special de-soldering equipment. There is a plastic housing holding the three wires together for each channel so the leads won't get mixed up. Just reroute each set of wires to the other joystick and solder them back in place. The spacing is set up so it will only go in one way.

Once that is complete, screw the joystick assemblies back in place and re-install the back cover. If you unplugged the power lead to set the back cover off to the side, then make sure to plug that back in before putting the cover back on.

Now when you turn on the radio and turn on TOPO, the right stick should make the right wheel move and the left stick should make the left wheel move. The directions will most likely be backwards though. This is easily corrected. On the front of the transmitter, there is a set of switches that control the direction of travel for each of the servo channels. Just flip the switches for Channel 1 and Channel 2 to REV. The transmitter should now move the wheels in the proper directions with the correct joysticks.

If there is any movement of the wheels when the joysticks are centered, then adjust the trim tabs on each joystick until the wheels stop with the sticks centered. When properly adjusted, all of the LEDs should be off and will light when the wheels move. That's it!

With this, you now have a large remote control robot that you can easily turn on and use at any time without the grief of setting up a whole Apple II+ system to support it. This makes it much easier if you just want to take TOPO somewhere to drive it around. The biggest benefit is for those people that have a TOPO robot and have never been able to use it. Now you can finally see it do something and have some fun with it!

Ideas for Further Enhancements

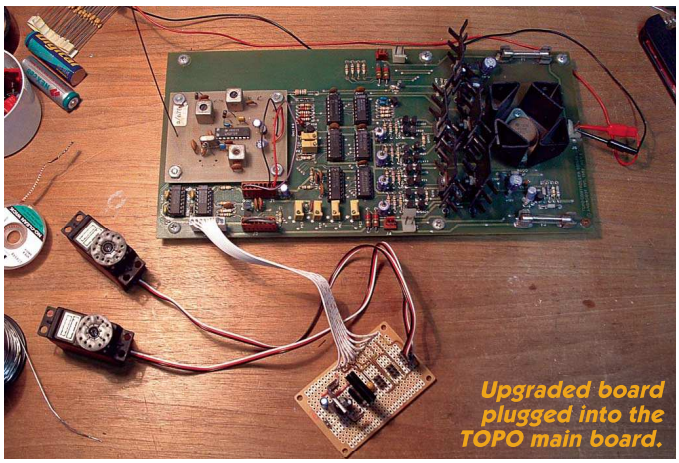
There are some other things that you can do with the robot to easily add more features. This can be done by using the extra two channels (3 and 4) on the radio to control extra devices. It can make TOPO a bit more interesting than just taking him for a spin. You could use small servos in these ports for other things.

Perhaps you may want the head to move. You could use one of these extra channels for that purpose. Another option is to use an R/C switch to control other devices. Some that I've used with excellent results are made by Team Delta. Once a certain threshold is reached on the channel, it can turn on a relay or other device. One in particular has two relays on board. If one of these were plugged into Channel 4, then moving the left stick side to side will energize the appropriate relay. This could be connected to a module with canned phrases so when driving the robot around via the remote, it can say a few things. Get creative and have some fun!

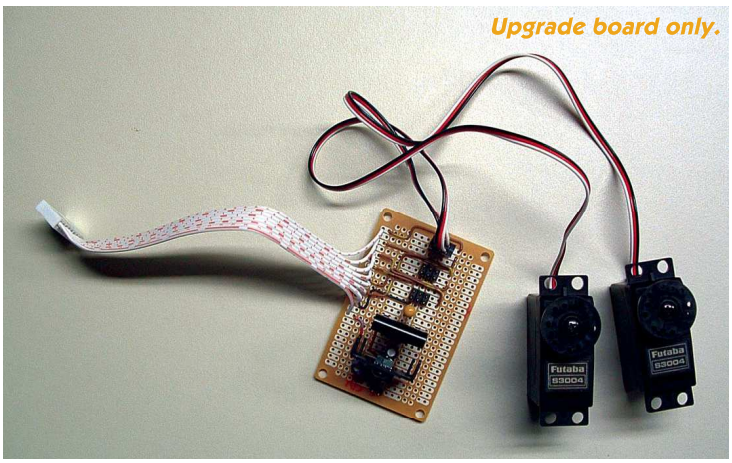
Some Plug-in Enhancements

There are a couple ways to proceed. First, you can just use the Futaba receiver that comes with the radio. The first two channels (1 and 2) will remain empty while Channels 3 and 4 are open to use. You don't even have to touch the original TOPO mainboard if you use a separate battery pack for the receiver. With this setup, the original receiver on the robot handles the drive and the Futaba receiver handles the extra stuff.

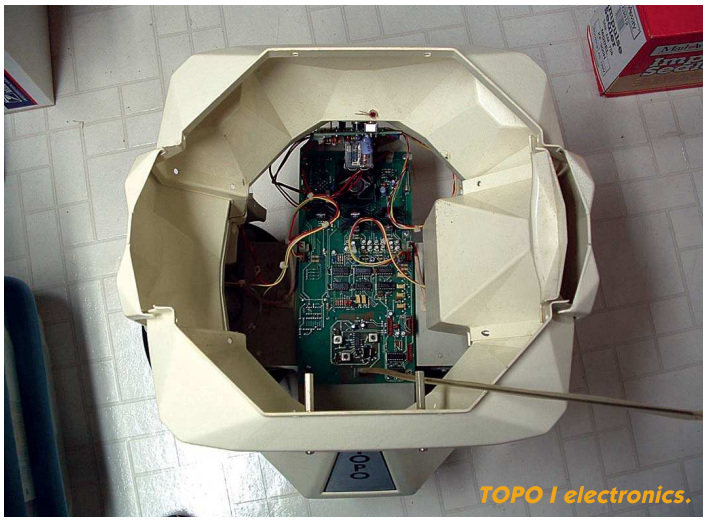
Another option which I chose to use leverages some of the untapped



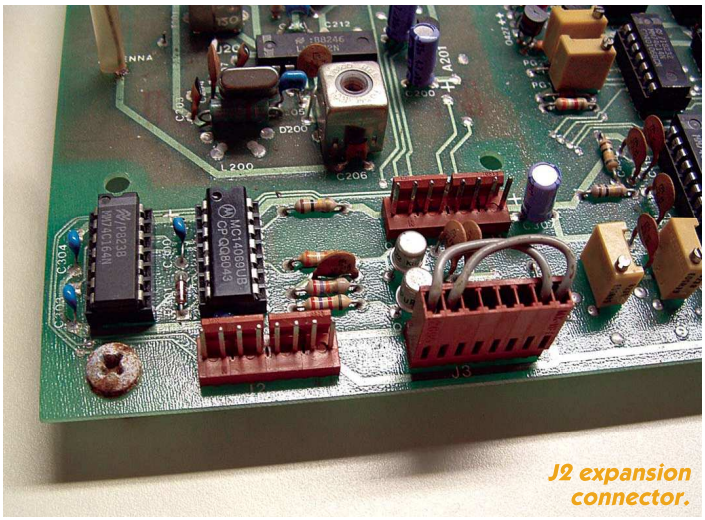
Upgraded board plugged into the TOPO main board.



Upgrade board only.



TOPO I electronics.



J2 expansion connector.

potential of the original robot. The LM1872 receiver chip on the main board normally decodes four channels (two analog and two digital) but with a couple extra ICs, it can actually decode eight channels. This is the way that it was done on the TOPO main board. They just happen to be routed to an unused eight pin expansion connector at J2 on the main board.

The connector J2 (starting at pin 1) provides +24V, GND, CH5, CH6, CH7, CH8, CH3, and CH4. Since Channels 1 and 2 are dedicated to the main drive motors, those are not routed to the expansion connector. These extra channels respond to the Futaba radio and are available. Since we're using a four channel radio, only Channels 3 and 4 work.

I did look at all the signals with the scope and it appears that the Futaba radio actually transmits six channels. It may be possible to modify the radio (depending upon its chipset) and add a couple extra switches or controls to leverage the extra channels but I'll leave that up to you to experiment with. Finding all these signals on J2 was fantastic. It makes it easy to expand the robot without the need for another receiver in the robot. I just made a small adapter that plugged into J2. The 24V from pin 1 and the ground on pin 2 goes to a couple of voltage regulators to generate +5V and +12V power for servos, solid-state switches, and other devices.

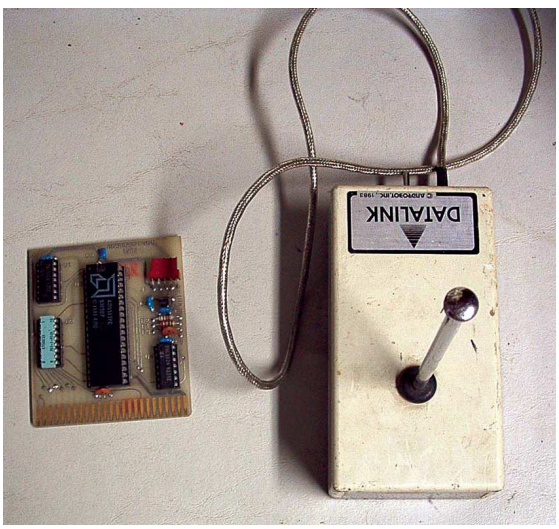
There are also some filtering caps to help condition the power. The signals for Channels 3 and 4 on pins 7 and 8 can be routed to a three-pin header to connect to a standard servo or solid-state switch module. To test it, I connected a pair of regular Futaba R/C servos to these two extra channels. Sure enough, moving the joysticks side to side on Channels 3 and 4 controlled the servos perfectly.

One really cool idea is to try something like the SpeakJet (SpeakGin) chip in its R/C mode. That way, just by moving the joysticks from side to side the robot can say a few things while moving.

For those that may want to do a little more with TOPO, there is another gem that I found while going over the main board. It is the odd jumper installed on connector J3. This is where the decoded signals for Channels 1 and 2 connect to the drive system. By removing that jumper, it is possible to isolate the receiver section from the drive system and feed your own signals to the drive electronics.

You need to feed the R/C signal into pin 7 for the right motor and in pin 8 for the left motor. The ground signal can come from J2, as well as any required power. Since these are standard servo style signals, a regular receiver on a completely different frequency can be plugged in here. This

The original Apple II + I/O card and transmitter.



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www.robotworkshop.com
Author of this article and service/repairs/upgrades of old robots

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www.robotgallery.com
Information about the early personal robots including Androbot robots

Tower Hobbies
www.towerhobbies.com
Supplier of Futaba four Channel AM radio

Team Delta
www.teamdelta.com
R/C switches and relay modules

Parallax
www.parallax.com
BASIC Stamp modules

is great If you want to drive around two robots independently since all the TOPO robots I've seen come on the same frequency.

A more interesting option is to use a small microcontroller (such as the BASIC Stamp) to send the R/C style signals to the original TOPO H-bridge circuitry for controlling the robot. This would give TOPO some sort of brain of his own. Going this route, you wouldn't need any transmitter at all.

Final Thoughts

If done carefully, many of these upgrades and modifications can be done without altering the original robot. That way, you can always go back to the way it was made.

I think that is important since these are classic robots and worth being preserved. Just something to keep in mind. SV