BY SAM GOLDWASSER

Repairing Remote Controls

WELCOME TO THE FIRST INSTALLMENT OF THE ALL NEW SERVICE CLINIC. AS YOU CAN SEE FROM THE BYLINE, MY NAME IS SAM GOLDWASSER. THOSE OF YOU THAT FREQUENT THE INTERNET MIGHT BE FAMILIAR WITH MY ONLINE repair and troubleshooting guides, located at http://www.paranoia.com/~filipg/REPAIR/, and mirrored at several sites around the world. If not, perhaps a little introduction would be in order.

An electrical engineer by profession, I have always had a passion for fixing mechanical and electronic devices. As a kid, household appliances represented the beginning of my fascination with technology. It wasn't long before the workings of the TV were of more interest to me than the shows on its screen. Naturally I had to see what was inside everything. Fairly soon, I figured out that getting things back together again was generally not that much more difficult than disassembling them in the first place. That insatiable curiosity and unending search for challenges continue to this day.

After a long and varied career in engineering, teaching, and business, these days I am an independent engineering consultant, but spend much of my time helping others on the Internet newsgroups; writing the Internet repair and troubleshooting guides mentioned above, as well as other articles; providing free repairs for those who cannot afford professional service; and doing other things that I find interesting. For now, this is more fun and much more rewarding than a real job.

With that out of the way, lets turn to our first topic.

Remote Control Repair

Fifteen years ago, a wireless remote

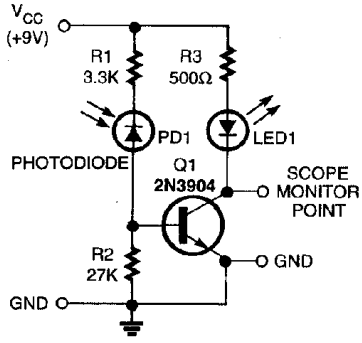
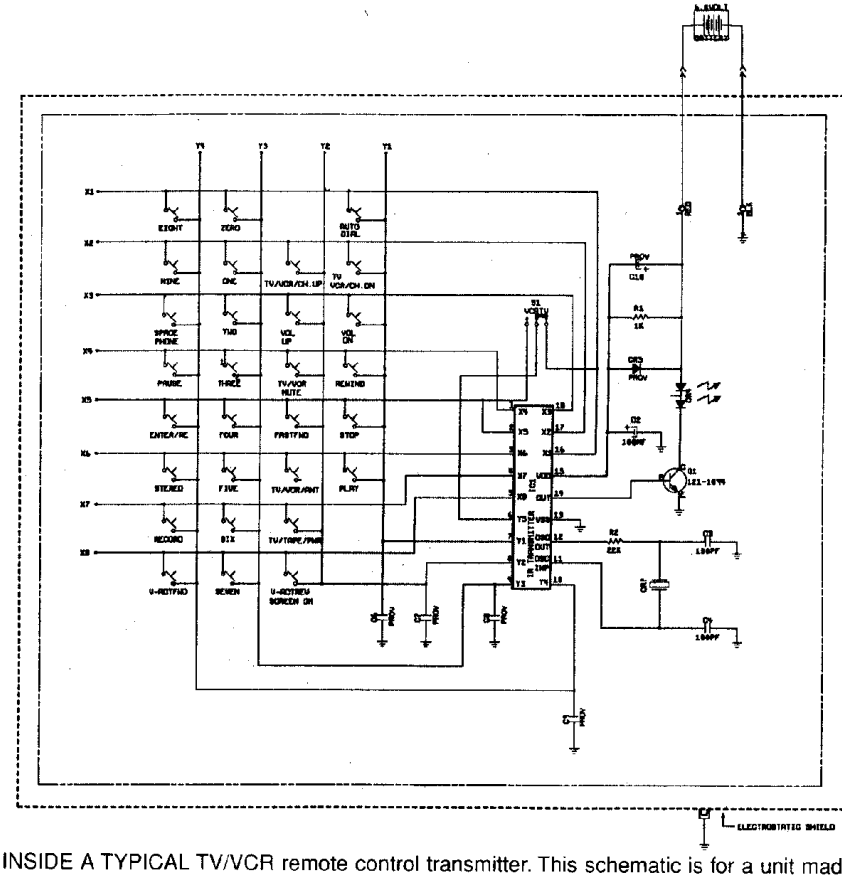


FIG. 1—THIS IR DETECTOR CIRCUIT could be used for testing IR remote controls, CD-player laser diodes, and other low-level, near IR emitters. Component values are not critical. Test points are provided for use with an oscilloscope.



INSIDE A TYPICAL TV/VCR remote control transmitter. This schematic is for a unit made by Zenith.

control was a $50 or $100 option (in 1980 dollars) to a TV or VCR. Early units used ultrasonic or RF analog signals and could perform only limited functions. You were lucky to get anything beyond on/off, volume, and channel up/down.

Today, a remote control is standard even with low-cost, basic electronic equipment. Nearly all modern remotes use Infra-Red (IR) light for digital data transmission. Some have more buttons and functions than a personal computer! Unfortunately, those added features and functions sometimes come with a burden of its own—many remotes have row upon row of tiny, identical size buttons with no logical layout of functions. On the other hand, some are masterpieces of ergonomic engineering, almost operating by themselves.

There are two kinds of problems with remotes:

1. They seem to have legs of their own and disappear at the most inconvenient times.

2. They get abused by being dropped, dunked in Coke or beer, or chewed on by the pet tiger, or are left alone to develop dead, leaky batteries.

While there are some remotes that will respond to a whistle and beep back to identify their locations, most are the ordinary deaf, dumb, and blind variety. Unfortunately, I can not help you locate your missing remote. If you suffer from disappearing remote syndrome, a well-designed universal remote—on a tether—might make a good investment.

Fortunately, most actual problems with remotes can be solved relatively easily. First of all, it is important to recognize that most failures are of a physical nature. Since remotes operate on low voltages under non-stressful conditions, spontaneous electronic failure is relatively uncommon. In short, if you don't abuse your remote control, it is likely to go a long time between failures.

Testing Remotes

All troubleshooting begins with the simplest steps. Start by eliminating the obvious. First, confirm that your problem is not simply due to a selector switch in the wrong position or an accidental press of a key selecting VCR instead of TV. If your broken unit is a universal type, make sure it has not simply forgotten its programming or codes—reinitialize it. A common cause of memory loss is the batteries failing

out or losing contact for an instant due to a fall or bump.

Also double check to be certain that you are using the correct remote. A lot of remotes look alike, and sometimes remotes for similar equipment from the same manufacturer can not be swapped.

Next, try to determine whether the problem is indeed in the remote itself and not the controlled equipment. The easiest way to do that is to temporarily program a universal remote to match your equipment. If that equipment then operates successfully, you can be pretty certain that the problem lies in the remote unit.

Diagnosing the Problem

To narrow down the problem, use an IR detector to determine if the remote is emitting an IR signal when each button is pressed. While such a device does not guarantee that the signal is correct, it eliminates most common problems from consideration. An IR detector card or an IR detector circuit (like the one shown in Fig. 1) is very handy for testing remote controls and other IR emitters. Another alternative is to use a camcorder: Some camcorders are sensitive to IR as well and will show a bright spot of light if aimed at a working source of IR.

Modern remotes use a pulse-code-modulated carrier to send the command. A typical carrier frequency is around 36- to 56-kHz, with each pulse consisting of multiple cycles (*e.g.*, 20 for each bit) of that carrier. For buttons that repeat, typical rates are 10 to 20 Hz, and the entire code might actually be sent only when the button is first pressed with only a repeat code sent while it is held down. The carrier frequency and coding schemes have apparently not been standardized and vary quite a bit, even from device to device from the same manufacturer. Therefore, it is beyond the scope of this document to enumerate them all.

If more information is needed or desired, it is possible to monitor the waveforms with an oscilloscope. That could be done by monitoring internal signals of the remote including certain pins on the main IC as well as the LED or its driver. A simpler approach would be to monitor the signal across the transistor in the detector circuit of Fig. 1; the schematic includes test points for that purpose.

Speaking of the detector circuit, the only important point to keep in mind when building the circuit is to make sure that the LED is placed so that its light

can't fall upon the photodiode. Select a photodiode that is sensitive to near IR (about 750 to 900 µm). You could also salvage one from an optocoupler or photosensor. Dead computer mice also use photodiodes that could be salvaged. Finally, a salvaged IR sensor module from a TV or VCR might also be used as an IR detector. Those usually operate from a single supply (5 V to 12 V is typical) and output a clean demodulated signal (you will not see the carrier, only the 1s and 0s).

Once we are certain that the remote is at fault, it is time to see if we can repair it, or if it is even worthwhile to do so. Unfortunately, as we have used up all of our room for now, that's a topic that will have to wait until next month. Until then, you can visit the sci.electronics.repair FAQ homepage which is located at http://www.paranoia.com/~filipg/REPAIR/. If you've got comments or questions, you can e-mail them to me at sam@stdavids.picker.com. EN

BY SAM GOLDWASSER

Repairing Remote Controls

AS WE SAID LAST TIME, MOST OF THE PROBLEMS ENCOUNTERED WITH REMOTE CONTROLS ARE THE RESULT OF THE ABUSE INFLICTED ON THEM BY KIDS, PETS AND EVEN OTHERWISE WELL-BEHAVED ADULTS. BUT, REGARDLESS OF WHY A remote fails to work, our job is to bring it back to operation. In this column I'm going to cover the most common types of problems and their solutions.

Before we go too far, however, there is one factor to keep in mind when it comes to remotes: all-purpose replacement remotes that cost less than $20 are available for most units. That means, unless you are doing the work for the pure enjoyment of it, it does not pay to expend a lot of time or money fixing a dead remote.

Getting Inside

Most of the problems with remote controls are physical in nature—dead batteries, gunk, bad connections, and such. Except for replacing bad batteries, some disassembly will be required. Manufacturers seem to be using more and more creative (read: obscure and difficult to open) methods of fastening the two halves of the remote shell together. There may be a small screw or two and/or the case may simply crack in half by gently prying with a knife or small screwdriver along the seam, or by sliding the two halves a fraction of an inch to unlock the catches. If the means of attachment is not obvious, look for screws inside the battery case, under a label on the rear, or hidden snap fasteners.

Dead Batteries

The solution for a dead-battery problem is obvious: replace them! However, if batteries tend to go dead quickly—the batteries in a remote typically last for years—then you may have a stuck button, some conductive grime under one of the buttons, or a defective IC. Then again, you might just be using cheap batteries; next time you change batteries in a remote, replace them with first-grade alkaline cells.

Corroded Battery Contacts

Corrosion caused by battery leakage is messy, but relatively easy to deal with. First dust out as much of the dried material as possible with a soft brush, and then remove the remainder with a damp, lint-free cloth or paper towel. Finish up by polishing the contacts with an ordinary pencil eraser, very fine sandpaper, or a nail file. If there is evidence that the leakage has made its way inside the case, you will need to open the remote and thoroughly clean the interior as well. Additional repairs might be needed if internal damage is evident.

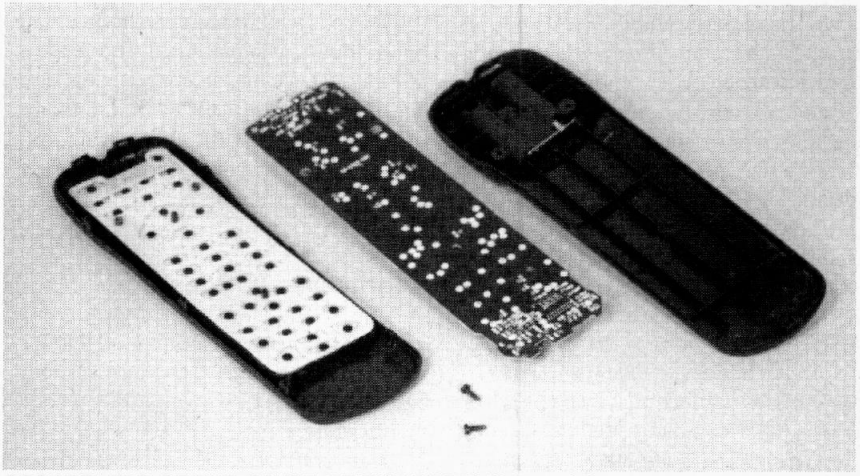
Broken or Intermittent Contacts

The place you most often find broken or intermittent contacts is between the battery connections and the circuit board. Carefully resolder and reinforce any suspect connections.

Another place to look for problem or cracked connections is at the solder joints on various component pins. Be particularly suspicious of the connections to components that are likely to be abused, such as selector switches. Reflow the solder on all suspect joints.

Broken Ceramic Resonator

The ceramic resonator, for those who



REGARDLESS OF THE CAUSE OF THE PROBLEM, servicing a remote means getting inside. If the means of fastening the two case halves is not obvious, look for screws inside the battery compartment or under a label on the rear.

do not already know, is usually a small blue or orange object that looks a little like a plastic or dipped capacitor. The circuit board marking is usually X1, CR1 or something similar. Though they are not that fragile, one could fail from shock when a remote is dropped. To test, assuming you have access to an oscilloscope, check for signals on one lead of the ceramic resonator. If all is well, you should see a signal at the carrier frequency when any button is pressed. A typical waveform should be at about 40 kHz with an amplitude of a few tenths of a volt.

Replacement resonators may be available from electronics distributors, or consider an organ transplant from a remote for equipment that has long since gone to the giant entertainment center in the sky. Just make certain your replacement is the same frequency as the original.

Dirt, Spills, and Gunk

Any of those could cause circuit problems that prevent keys from operating reliably or physical problems that result in keys that are just plain stuck or sticky. Disassemble the remote completely (and carefully), and wash both sides of the rubber membrane keypad, circuit board, and plastic case with water (and mild detergent, if necessary, to remove sugar-based grime) and then isopropyl alcohol. Dry thoroughly, reassemble, and see if the problem, is solved.

Worn or Corroded PC Pads

If you run into problems with the PC-board foil traces or pads, conductive epoxy or other similar conductive paint or ink can be used to make the repair. Alternatively, a piece of thin copper foil can be glued to the circuit board and soldered to the appropriate circuit trace. Gold foil would be even better, since it will not corrode, but might be just a tad costly for a $10 remote!

Worn Conductive Material

Compare the bottoms of frequently-used keys with those that are rarely pushed. If you can see the rubber through the conductive material after cleaning, the pad is likely worn to the point of being non-functional. That problem can be repaired with conductive epoxy, or other similar conductive paint of ink. A sliver of aluminum foil can sometimes be glued to the rubber surface. 3M makes EMI/RFI shielding tape, type 1181, that should work very well in this kind of repair.

Cracked Circuit Board

Since the circuit boards found in most remotes are quite simple, single sided, and have relatively wide traces, a cracked one generally is easy to repair. Use epoxy cement or an adhesive like Duco Cement or windshield sealer to repair and reinforce the circuit board. Scrape off any insulating coating and jumper the breaks with fine wire and solder. Don't just bridge the gaps with solder; if you do, cracks and future problems are a certainty.

Bad IR LED

Test the LEDs with an external power supply (using a current-limiting resistor) and an IR detector like the one discussed last month. If you don't have (or want to build) an IR detector, you could substitute a visible-light LED and see if it lights when keys are pressed. If the LEDs appear not to work, use an oscilloscope or DMM to monitor the voltage across them to make sure they are getting a signal. If you use an oscilloscope to monitor the drive to the LEDs, you should see the pulse-code-modulated carrier. If you determine that the IR LEDs are faulty, you can replace them with any readily available high-intensity IR LEDs.

Bad IC

Generally there is one single IC in each remote. If it is a custom chip, throw the remote away! Check each pin on the IC with an oscilloscope to determine if it is really dead. A note from one of my followers, Duane P. Mantick suggests, "An awful lot of IR remotes use ICs from the same or similar series. A common series comes from NEC and is the uPD1986C which, incidentally is called out in the NTE replacements book as an NTE1758. Many of those chips are cheap, not too difficult to find, and are in easy-to-work-with 14- or 16-pin packages. Unless you have no soldering or desoldering skills, replacement isn't difficult.

Alternatives to Repair

There are a large number of preprogrammed universal remotes available for use as replacements, starting at about $10. They are set up by inputting a code number for each piece of equipment you want to control. One piece of advice with these: Don't lose the instruction manual or you will not know what the codes are or how to enter them if the remote happens to lose its memory or the batteries go dead. Also be sure to write the settings in ink on a label on the back of the unit and slip the same information on a small piece of paper inside the battery compartment.

You should note that there are a couple of drawbacks to these as well. One is that you won't necessarily be able to control everything that you could with the original remote, especially if your unit and remote was loaded with bells and whistles. Another is that if the gear you want to control is a little more obscure, you should make sure that the universal remote can handle it.

If either of those points presents a problem, universal learning remotes are available at a higher cost, about $25 and up. The better ones are capable of memorizing all of the actual signals sent by your original remotes by viewing the IR transmission directly. Of course your existing remotes must be working properly. The advantage of a learning remote is that it can be taught to perform setup, adjustment, and programming functions as well as those for normal operation.

A third alternative is to get an exact replacement from the original manufacturer. In many cases, however, that will cost quite a bit more—the average price for a replacement is a rather inflated $40.

That's it for this month. Hope to see you again next issue with more basic servicing information to help you keep your home electronics running smoothly. EN

EQUIPMENT REPORTS

continued from page 15

wrong. If you are entering business-card information anyway, this software at least gives you a head start on the task.

All in all, the Personal Scanning Kit is a very versatile item to have in a small office. It lets you do those little things you often want to do with a personal computer, but usually can't. If you make money entering text, you could save time and effort with it. And if you dabble in desktop publishing, your new documents will sparkle with photos, custom logos, and more. It is also an easy and inexpensive way to add the ability to handle hard copy to your existing Fax modem.

For more information on the Personal Scanning Kit, contact Interactive Efx Corporation directly (1265 Birchwood Drive, Sunnyvale, CA 94089; Internet: www.interactive-efx.com), or circle 15 on the Free Information Card. EN