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SNIFF OUT THE SMALLEST SPARK.

Build the Non-Contact Voltage Detector.

DINO SEGOVIS
HARDWARE HACKER

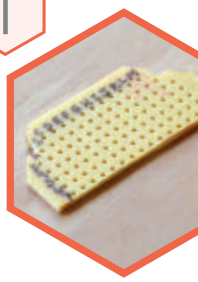
A transistor is an electrical component that functions, most basically, as a switch—in principle not so different from a light switch. Instead of a physical movement, however, a transistor is controlled by a flow of electricity. And unlike your basic light switch, a transistor can be on, off or somewhere in between.

Most transistors have three connections: one for current in, one for current out and one that controls the switch. The current flowing through a transistor can be larger than the current controlling it, so it can become an amplifier. Connect the input to a power source (like a battery) and the control lead to a weak signal (like a guitar pickup) and the output will sound like the control signal, only louder. Just how much louder depends on a lot of things, but a factor of 200 is routine. This number is called gain.

If you use the output from one transistor to control another, the gains multiply.

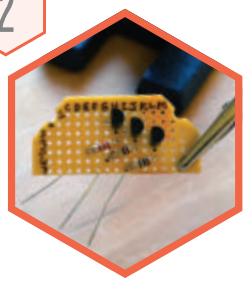
With two transistors, the ideal gain becomes 200 × 200 = 40,000, and with three transistors (as in this circuit), 200 × 200 × 200 = 8,000,000! That huge gain lets you use it to detect the tiniest movements of electricity—even those created at a distance by induction or static charge!

1



Cut a piece of perfboard 15 holes wide and seven holes tall. Also shave off the corners. Use a permanent marker to label the rows 1–7 and the columns C–M. (Columns A & B will not be used.)

2



Solder the first transistor with its emitter in L3, base in L4 and collector in L5; the second with its emitter in J2, base in J3 and collector in J4; and the third with its emitter in H1, base in H2 and collector in H3. On the copper side, bend and solder the excess leads to connect L3 to J3 and J2 to H2. Solder the 220 resistor across H4 and E5. Solder the 100K resistor across J5 and G6. Solder the 1M resistor across L6 and I7. Bend and solder the excess leads to connect H4 to H3, J5 to J4 and L6 to L5.

3

Cut 4″ each of red, black and green wires and strip the ends. Solder the red wire to the LED anode and the black wire to its cathode, then insulate the joints with heat-shrink tubing. Solder the free end of the black wire at perfboard E6 and bend and solder underneath to connect with E5. Solder the red wire at E7. Solder 3″ of black wire between one side of the switch and perfboard H7. Bend and solder underneath as needed to connect it with the resistors at G6 and I7 and with the red lead at E7. Solder the red wire from the battery clip to the other side of the switch and the black wire to perfboard I1. Bend and solder underneath to connect with the transistor emitter at H1. Solder the green wire to perfboard M4 and connect underneath with the transistor base at L4.

Build the Non-Contact Voltage Detector.

www.radioshack.com/DIT

PARTS

- ○ Dual Mini Perfboard 276-148
- ○ 2N3904 Transistor (3) 276-2016
- ○ 1/4W Resistors (1M, 100K and 220)
- ○ Hookup Wire 278-1224
- ○ 5mm Red LED 276-041
- ○ Heat-Shrink Tubing 278-1627
- ○ Momentary Pushbutton Switch 275-1556
- ○ 9V Snap Connector 270-324
- ○ 9V Battery 23-2209
- ○ Project Enclosure 270-1801
- ○ LED Holder 276-079
- ○ Copper-Clad PC Board 276-1499
- ○ Double-Sided Foam Tape 640-2343

TOOLS

- ○ Soldering Iron and Solder 64-053, 64-013
- ○ Wire Cutter 64-064
- ○ Pliers 64-062
- ○ Wire Stripper 64-224
- ○ Drill and Drill Bits
- ○ Rotary Tool and Saw Blade 64-149

4

Drill a 5/16" hole in the top right of the enclosure lid, just below the lid's screw hole. Drill a 1/4" hole in the top left, also below the lid's screw hole. Insert the LED holder into the 1/4" hole from the outside and the LED into the holder from the inside. Remove the plastic button, mount the switch body into the 5/16" hole with its bundled hardware, tighten down and reattach the button.

5

Cut a 3/4" × 1-1/2" strip of copper-clad board with a rotary tool and stick it to one end of the enclosure with double-sided tape. Drill a 1/16" hole through both copper and case near the middle of the strip. Thread the green wire from the perfboard through the hole from inside, bend it over and solder it to the copper.

6

Clip a battery to the connector and insert it, along with the perfboard, into the enclosure body. Orient the solder side of the perfboard toward the battery. Route any excess wire and gently close the lid. Screw it in place.

7

Hold the detector near an appliance cord and press the button; the LED will glow if the cord is live. The device can also be used to detect static charge. Got a feline friend nearby? Try testing the detector against its fur. Now go experiment and have fun! (But stay clear of any bare wires that might carry dangerous currents!)

CONTENTS

COLUMNS

ON THE COVER: Emily Pilloton of Project H on location in the blacksmithing room at the Crucible in Oakland.

20

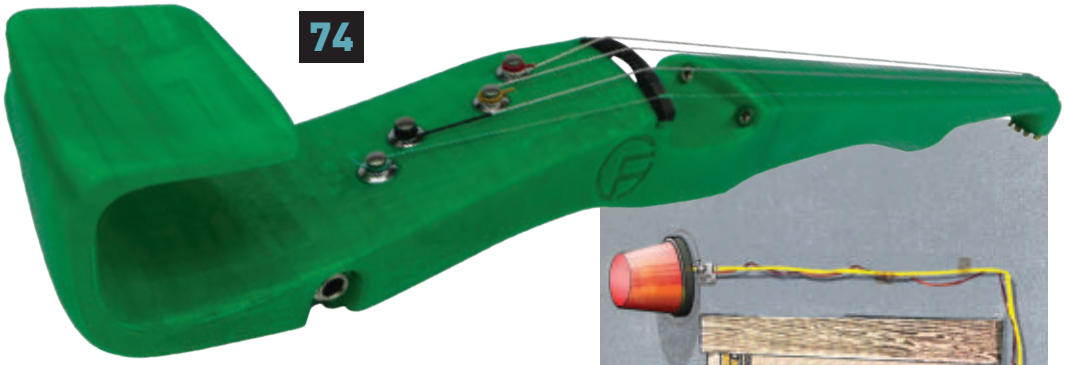
FEATURES

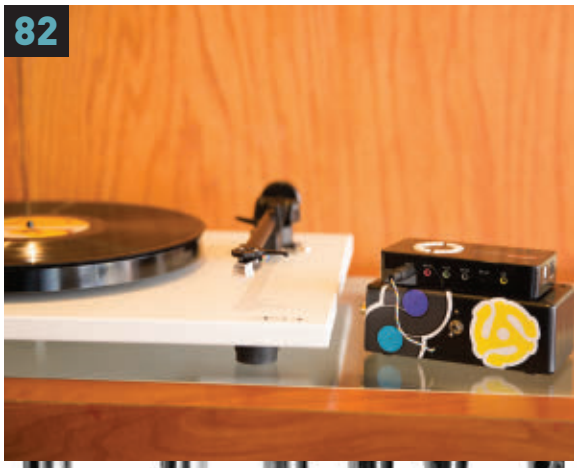
28

Special Section:

GEEK CLUB

SKILL BUILDERS





PROJECTS

TOOLBOX

Vol. 40, July 2014. *Make:* (ISSN 1556-2336) is published bimonthly by Maker Media, Inc. in the months of January, March, May, July, September, and November. Maker Media is located at 1005 Gravenstein Hwy. North, Sebastopol, CA 95472, (707) 827-7000. SUBSCRIPTIONS: Send all subscription requests to *Make:*, P.O. Box 17046, North Hollywood, CA 91615-9588 or subscribe online at makezine.com/offer or via phone at (866) 289-8847 (U.S. and Canada); all other countries call (818) 487-2037. Subscriptions are available for $34.95 for 1 year (6 issues) in the United States; in Canada: $39.95 USD; all other countries: $49.95 USD. Periodicals Postage Paid at Sebastopol, CA, and at additional mailing offices. POSTMASTER: Send address changes to *Make:*, P.O. Box 17046, North Hollywood, CA 91615-9588. Canada Post Publications Mail Agreement Number 41129568. CANADA POSTMASTER: Send address changes to: Maker Media, PO Box 456, Niagara Falls, ON L2E 6V2

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"The 3D printer gets 'em in the door, but the laser cutter keeps 'em coming back."
—Anonymous

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5 a.m.–5 p.m., PST
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PUBLISHED BY

MAKER MEDIA, INC.
Dale Dougherty, CEO

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What skill would you like to learn?

Jing Zhang
London, United Kingdom (Geek Club illustration)

I would love to learn painting properly. I learned some basics of painting when I was a kid, which is why I later developed as an illustrator. Going back to traditional artist is definitely something I'd love to achieve in my life.

Georgia Guthrie
Philadelphia, Pennsylvania (Where Are the Women?)

I would like to take a deeper dive into programming with processing. I used it a few years ago to do some experimentation with facial tracking in my grad program, but I know it's changed a lot since then.

Ronald Pattinson
Amsterdam, The Netherlands (Brew a Vintage IPA)

Learning to video edit is a skill I would love to learn. With my children approaching adulthood, I won't be able to bribe them into nailing together the scraps of video I take into something vaguely watchable for much longer.

Tony DiCola
Kirkland, Washington (Face Recognition Treasure Safe)

I'd like to learn about 3D printing and CAD so I can build custom project cases, design prototypes, and even print spare parts to fix broken things.

David Perry
Portland, Oregon (3D-Printed Electric Violin)

One of my upcoming projects combines 3D printing, microcontrollers, and textiles, so I need to brush up on my programming and electronics skills, but I'm really excited to learn to sew from scratch! I love working with my hands, and my most fun ideas come while I'm learning new things.

Makerspaces Are Working Out

BY DALE DOUGHERTY, founder and CEO of Maker Media.

"IT'S LIKE A GYM WHERE YOU GET A MEMBERSHIP TO USE THE EQUIPMENT." That was the basic idea for TechShop, as explained to me by founder Jim Newton at our first Maker Faire in April of 2006. He asked me for a table so he could hang his sign, deliver his pitch, and see if people were interested. The fact that he showed up in a vintage military transport vehicle had some bearing on my decision to say yes. The interest proved strong enough for Jim to get backers and open the first TechShop in an industrial park in Menlo Park, California, in October 2006.

Almost from inception, TechShop was a dream — not only Jim's but one shared by its members — to have unlimited access to the tools of a machine shop, plus new tools for digital fabrication such as laser cutters and 3D printers, for a modest monthly fee.

What do people really do at TechShop? There are a group of makers who show up with a pretty clear idea of what they want to do. They have a project to work on. Often it has some practical or commercial application, and they lack a place where they could develop their idea into something real. Others show up and want to belong but don't have a project or purpose. They want to learn how to use the tools, and maybe that will lead them somewhere. David Lang was one of those people, and he wrote about his experience in the book *Zero to Maker*.

Some have tried to implement what TechShop has done. In Shenzhen, China, I came across TechSpace. Others, while similar to TechShop, are different in that they're locally owned and operated, such as Maker Works in Ann Arbor, Michigan.

Gui Cavalcanti, who started a similar shared workspace in 2004, learned some key lessons from its failure and started thinking of a new model. This became Artisan's Asylum in Somerville, Massachusetts, which now occupies a 24,000-square-foot space that was originally an envelope factory. He had a budget of $40,000 to open the space and outfit it. Most of the tools were used, either donated by members or acquired for the cost of removing them from a former worksite. Artisan's Asylum is most successful at building a community among its members, some of whom rent their own workspace. It has become not just a place to do your own work but a kind of "collaborative commons," to use the phrase from Jeremy Rifkin's book, *The Zero Marginal Cost Society*.

There are also quite a number of hackerspaces, which tend to be like clubs, almost always run by volunteers. Some are members-only and others are open to the public for free, like Noisebridge in San Francisco. Some hackerspaces are rather like an eccentric's garage full of scavenged treasure and forever awaiting someone to whip it into shape. A hackerspace is as much a meeting place as a workplace.

Artisan's Asylum represents what I might call a middle tier between large-scale TechShops and small-scale hackerspaces, a trend toward the professionalization of makerspaces. That is, they must be able to perform a core set of services to support membership growth. A makerspace needs to greet new members and provide basic safety training as well as offer workshops for members who arrive without project ideas.

Indeed, a gym is a good analogy to understand makerspaces. Today's health clubs started out years ago as bodybuilding gyms. They were designed to meet the needs of a narrow, largely male membership. They weren't particularly friendly to newcomers or casual users. Yet something changed in our culture around physical fitness, and health clubs became more open and accommodating, to broaden membership by welcoming women as well as men, and the serious as well as the casual member. This is what we're seeing as makerspaces transition from volunteer efforts serving a small group of members.

Neil Gershenfeld designed and built Fab Labs, the first of which was opened in Boston in 2004. Gershenfeld's Center for Bits and Atoms might be considered the R&D lab for digital fabrication, with state-of-the-art tools organized in service of an inevitable vision of our technological future. While there are a variety of settings, from science museums to community colleges, Fab Labs are funded and managed in a top-down fashion that's consistent with their academic origins. Independently, a growing number of makerspaces are getting established at universities, such as Yale, Georgia Tech, Case Western Reserve, and SMU. These spaces are designed for students and their projects.

It doesn't much matter what you call them — TechShops, makerspaces, hackerspaces, or Fab Labs. Makers are doing cool stuff, and having access to tools, community, and mentors really does matter. We need more local places for makers to work out new ideas.

Jeffrey Braverman

Pirates, Plushies, and Proper Definitions

» As soon as we saw the Raspberry Pirate Radio project (Volume 38, page 80, makezine.com/projects/raspberry-pirate-radio), we decided to try it. My brother and I had so much fun! Our friends (who are also Raspberry Pi fanatics) came over the next day and were inspired to build one also. They live across the street from an ice rink, and one day when we were skating there, they played their radio station! We heard a few recordings that we made ("This is Schatz Radio, 93.7"), and a fake commercial for the Raspberry Pi that we added. Anyway, I want to thank *Make:* for a great time and an amazing educational experience for us.
— Nate Schatz, age 13, Kodiak, Alaska

+ Listen to their audio clips: makezine.com/go/raspirates

» I really enjoyed "DIY Video Game Plushies from 3D Models" (Volume 38, page 72, makezine.com/projects/video-game-plushies). It showed a creative use of technology that I had never dreamed of. (Even if I had tried to make a plushy from the texture-map skins of a 3D model, I probably would have approached it using papercraft techniques.) It's a great article except for one thing: It suggests stealing art and even gives detailed instructions on where to find art to steal and tools for stealing it. This is like starting an article on silversmithing by telling the reader what stores are likely to have silver and then giving tips on breaking and entering.

The second article that bothered me was "Kickstart a Kids' Makerspace" (Volume 38, page 28, makezine.com/kids-makerspace). I'm 100% behind the idea of creating makerspaces for kids and teaching the necessary skills; I am a third-generation teacher and my daughter is training to be the fourth. The #1 problem with the article is that it does not state a use case. How many students can use the space at one time? What skills will be taught and demonstrated using the space? How will it fit into an existing curriculum? Another thing that left me deeply troubled was the lack of a budget for safety equipment; for training people to supervise the makerspace; for simple things like tables, chairs, extension cords, lamps, shelves, or locking cabinets; the cost of rooms used to house the makerspace; or consumables, maintenance, or other recurring costs (other than a one-time purchase of 3D printer filament). Remember, there are always at least three ways to do anything — the one that looks obvious, quick, and simple is never one of them.
—Bob Pendleton, Round Rock, Texas

PROJECTS EDITOR KEITH HAMMOND RESPONDS:

» Bob, thanks for reading so closely! In "Video Game Plushies," we didn't tell readers to steal art. We recommended extracting 3D models from a game you own, downloading from authorized sites, or searching repositories online; it's the reader's responsibility to know and follow the law.

"Kickstart a Kids' Makerspace" was focused on choosing and financing high-tech tools, but you're right, our list should have included safety gear to accompany those tools. As for use cases and overhead costs, makerspaces are used in different ways — by classes or clubs; during, after, or completely outside school — and those considerations were beyond the scope of the article. As for housing, you might enjoy our new "CNC Makerspace Shed" project on page 30 of this issue (it comfortably seats 16 at worktables).

MAKE AMENDS:

■ Multiple designs featured in "Open-Source CNC Furniture" (Volume 39, page 74, makezine.com/magazine/open-source-furniture) and "CNC Maker Bench" (Volume 38, page 98, makezine.com/projects/cnc-maker-bench) were erroneously described as "open source." The CC BY-NC-SA license used by these designs places commercial restrictions on their use and violates the sixth provision of the Open Source Definition (Annotated): "No Discrimination Against Fields of Endeavor."