Q & A

READERS' QUESTIONS, EDITORS' ANSWERS

DC Fluorescent Lights

Q *In your Q&A column, September, 1997, you said, "You can't run a fluorescent light on DC." This is not true. I served on diesel electric submarines. We used fluorescent lights on submarines as long as 50 years ago, even though our circuits were powered from 120 volts DC.*

DC fluorescents differ from AC units in three ways. First, a current-limiting ballast resistor must be added in series with the reactance ballast. Second, the tube cathodes must be preheated—using a momentary-start switch—to fire up the tube. Third, to prevent the build-up of deposits at the negative end of the tube, the polarity must be reversed periodically with another switch. — Farnham M. Cornia, Chief Electrician's Mate, U.S. Navy (retired), Toledo, WA

A You're right, of course; we should have said "You can't use an inductive ballast (by itself) with DC power." When the ballast is a resistor or includes resistance, the fluorescent lamp works fine, although the resistive ballast wastes some energy.

A circuit we breadboarded to demonstrate this is shown in Fig. 1. Press the "start" button for 10 seconds to light the lamp. A better circuit would reduce the ballast resistance during starting to heat the cathodes more quickly. Thanks for writing!

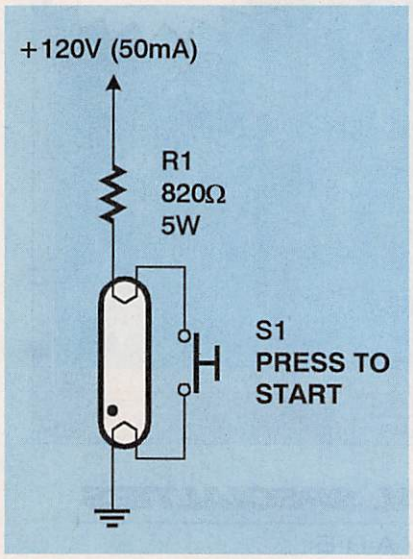

FIG. 1—HERE'S HOW TO power a fluorescent lamp from a DC source. The resistor is used as the ballast. One advantage of this is that there is no flicker or radio interference.

Battery-Low and Battery-OK Indicators

Q *I need a circuit for a low-battery indicator for a battery-operated radio. I'd like to use an LM339 quad comparator chip as a window comparator to control a two-color (common-cathode) LED that will be green when the battery is OK and red when it is low.*

My problem is that all my books show window comparator circuits with a separate power supply from the voltage under test. How can I get around this? The radio in question has a 4.7-volt regulated B+ line. Can the circuit compare this line to the main 9-volt supply, and flip when the main supply gets down to 4.7 volts? — G. B., Angola, LA

A Your last idea is a sound one, but because of the way regulators work, the 4.7-volt regulated line will always be below the main supply; when the voltage falls too low, they'll fall together. Most regulators can only subtract, not add, voltage.

The key to your problem is to compare *part* of the supply voltage to a known standard—that is, drop the voltage with a voltage divider, and compare that to a known, fixed voltage, which you can obtain with a Zener diode.

Figure 2 shows how to do it with a single LED indicator. This circuit compares *two thirds* of the input voltage to a fixed 5.6-volt level regulated by a Zener. Because it's carrying little current, the 1N5232 actually holds the voltage somewhat lower than its rated 5.6 volts; higher-wattage Zeners would be even more inaccurate. You may have to experiment with Zener diodes until you get the results you need. Changing R2 to 10K will save power, but will throw off the Zener voltage even further. Or you can simply connect pin 5 of the LM339 directly to the regulated 4.7-volt line that you already have.

If you want the LED to light when the battery is low rather than when it's

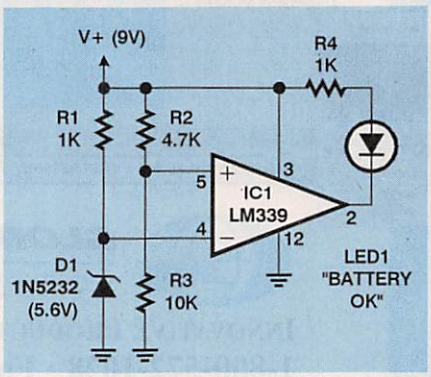

FIG. 2—IN THIS CIRCUIT, the comparator lights the LED only when V+ is above 8 volts.

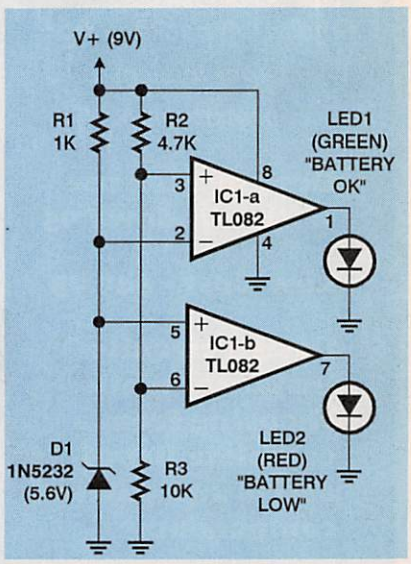

FIG. 3—THE CONDITION OF A BATTERY can be monitored using this circuit. As long as the green LED is lit, the battery is fine. The red LED lights when the battery voltage is low.

HOW TO GET INFORMATION ABOUT ELECTRONICS

On the Internet: See our Web site at http://www.gernsback.com for information and files relating to our magazines (**Electronics Now** and **Popular Electronics**) and links to other useful sites.

To discuss electronics with your fellow enthusiasts, visit the newsgroups sci.electronics.repair, sci.electronics.components, sci.electronics.design, and rec.radio.amateur.homebrew. "For sale" messages are permitted only in rec.radio.swap and misc.industry.electronics.marketplace.

Many electronic component manufacturers have Web pages; see the directory at http://www.hitex.com/chipdir/, or try addresses such as http://www.ti.com and http://www.motorola.com (substituting any company's name or abbreviation as appropriate). Many IC data sheets can be viewed online. Extensive information about how to repair consumer electronic devices and computers can be found at www.repairfaq.org.

Books: Several good introductory electronics books are available at RadioShack, including one on building power supplies.

An excellent general electronics textbook is *The Art of Electronics*, by Paul Horowitz and Winfield Hill, available from the publisher (Cambridge University Press, 1-800-872-7423) or on special order through any bookstore. Its 1125 pages are full of information on how to build working circuits, with a minimum of mathematics.

Also indispensable is *The ARRL Handbook for Radio Amateurs*, comprising 1000 pages of theory, radio circuits, and ready-to-build projects, available from the American Radio Relay League, Newington, CT 06111, and from ham-radio equipment dealers.

Copies of past articles: Copies of past articles in **Electronics Now** and **Popular Electronics** (post 1993 only) are available from our Claggk, Inc., Reprint Department, P.O Box 4099, Farmingdale, NY 11735; Tel: 516-293-3751.

Electronics Now and many other magazines are indexed in the *Reader's Guide to Periodical Literature,* available at your public library. Copies of articles in other magazines can be obtained through your public library's interlibrary loan service; expect to pay about 30 cents a page.

Service manuals: Manuals for radios, TVs, VCRs, audio equipment, and some computers are available from Howard W. Sams & Co., Indianapolis, IN 46214 (1-800-428-7267). The free Sams catalog also lists addresses of manufacturers and parts dealers. Even if an item isn't listed in the catalog, it pays to call Sams; they may have a schematic on file which they can copy for you.

Manuals for older test equipment and ham radio gear are available from Hi Manuals, PO Box 802, Council Bluffs, IA 51502, and Manuals Plus, PO Box 549, Tooele, UT 84074.

Replacement semiconductors: Replacement transistors, ICs, and other semiconductors, marketed by Philips ECG, NTE, and Thomson (SK), are available through most parts dealers (including RadioShack on special order). The ECG, NTE, and SK lines contain a few hundred parts that substitute for many thousands of others; a directory (supplied as a large book and on diskette) tells you which one to use. NTE numbers usually match ECG; SK numbers are different.

Remember that the "2S" in a Japanese type number is usually omitted; a transistor marked D945 is actually a 2SD945.

Hamfests (swap meets) and local organizations: These can be located by writing to the American Radio Relay League , Newington, CT 06111; (http://www.arrl.org). A hamfest is an excellent place to pick up used test equipment, older parts, and other items at bargain prices, as well as to meet your fellow electronics enthusiasts—both amateur and professional.

OK, swap the positive and negative inputs of the comparator.

Now for your two-color indicator: Because you are using common-cathode LEDs, the LM339, with its open-collector output, is not satisfactory. Instead, use a TL082 dual op-amp wired as two comparators, one with its inputs swapped relative to the other; see Fig. 3. Like a number of other op-amps, the TL082 can drive an LED directly without a current-limiting resistor.

However, even *that* isn't a window comparator, because it doesn't pick out a "window" (*i.e.*, a voltage range)—it just tells you whether the voltage is above or below a certain value. A window comparator tells you whether a voltage is between two specific values. That's where the open-collector outputs of the LM339 come in handy; you can tie two of them to a single load resistor so the output will be high only when both comparators are satisfied (Fig. 4). The

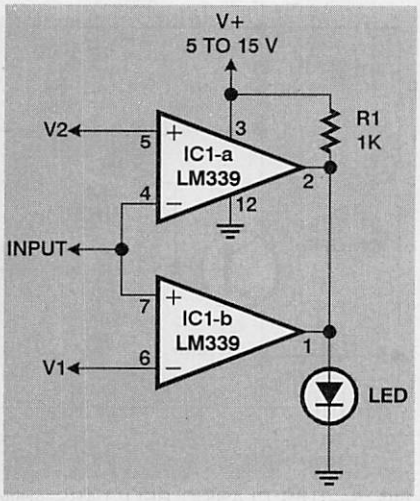

FIG. 4—IN THIS WINDOW COMPARATOR, the LED is lit only when the input voltage falls between V1 and V2.

rest of the time, the current that would go through the LED is shunted to ground by one or the other comparator.

Note that with all of these circuits, the voltages being compared should, in general, be at least 2 volts below V+ and at least 2 volts above ground. If that isn't the case, consult data sheets to make sure the voltages you're using are within the common-mode input range of the op-amp or comparator.

High Voltage Wanted

Q *I have an electronic air cleaner system for which no replacement parts are available. The original unit was powered by a positive-output DC power supply with 120-volt AC input, 7500-volt 3.3-mA DC output. Can I build a replacement power supply using easily available components? — G. K., Tipton, IN*

A Some things are easy to do with common parts, but, unfortunately, generating high voltage safely is not one of them. The trouble with building high-voltage power supplies is that even if you don't get electrocuted (quite possible at 7500 volts and 3 mA), the smallest mishap will fry all the semiconductors in the circuit and you'll have to start over.

Instead, the best choice in your situation is to fix the existing power supply if possible. Second choice is to find a surplus power supply that will fill the bill. The company that made the supply module may still be in business even if the maker of the air cleaner isn't, and a similar unit may still be available through the air cleaner industry.

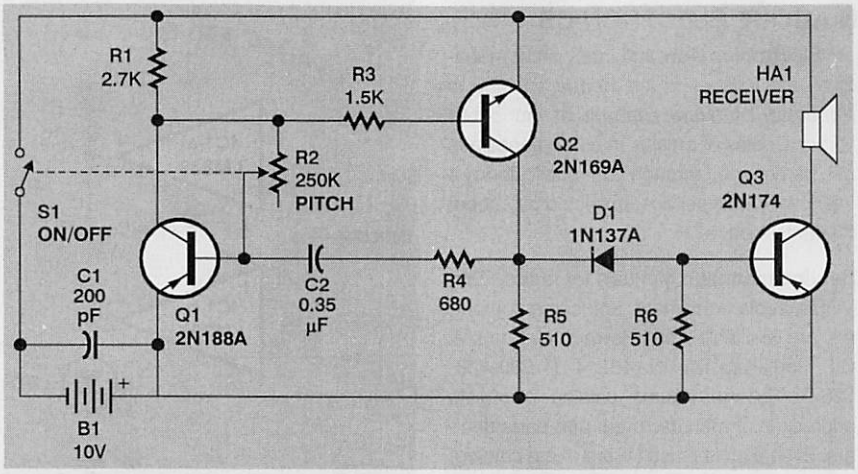

FIG. 5—THIS CLASSIC BELL LABS artificial larynx dates from the 1950s. The device labeled HA1 is the telephone receiver.

Some power supplies used in lasers have specifications similar to what you describe; maybe a laser power supply would work. Three companies that sell surplus high-voltage power supplies are Marlin P. Jones, P.O. Box 12685, Lake Park, FL 33403, Tel: 800-652-6733; All Electronics, P.O. Box 567, Van Nuys, CA 91408, Tel: 800-826-5432; and Herbach and Rademan, 16 Roland Ave., Mt. Laurel, NJ 08054, Tel: 800-848-8001. We suggest you see what they have, but remember that 7500 volts is high enough to penetrate many insulating materials, and at that voltage, a current of 3.3 mA is *potentially lethal.* Don't take chances! It might be time to just replace the whole air cleaner.

Cable Scrambling Mystery

Q *Can you explain why when I view some scrambled cable TV channels I get intermittent sound with the audio taken from the "audio out" terminals of the VCR, but uninterrupted sound with the cable signal supplied directly to the TV set? I thought the circuitry required to separate audio and video signals would be standardized by now and would be the same for both VCRs and TVs. — W. S. A., North York, Ontario, Canada*

A We assume you were viewing them without a descrambler; if that's not so, something's wrong with your descrambler.

Cable TV signals are scrambled by making them differ in some way from the standard signal. Different TVs and VCRs have different amounts of tolerance for nonstandard signals, just as different cars perform differently on bad gasoline. Even if the circuits in all TVs and VCRs were identical, which they aren't, there would still be some differences between resistors, capacitors, and transistors due to manufacturing variation.

Artificial Voice Box

Q *In response to the letter from E. C. in your February 1998 "Q&A," I am enclosing a circuit from the Sourcebook of Electronic Circuits, by John Markus, 1968 (see Fig. 5). I do not fully understand this circuit. Where does the sound come out? Why the odd (10 volts) battery voltage?*

I am a woman and would like to build this or another circuit that would be able to raise the pitch to produce a female voice. I would also like a circuit I could use that would help people understand me better when I used the telephone. — K. S., Marquette, MI

A An artificial larynx, for those who missed the February column, is a device that vibrates the throat so that a person who has no vocal cords can talk. You hold the device to your throat and whisper; the resulting speech is a robot-like monotone, but it's better than not being to speak at all.

The circuit you are asking about is about forty years old. We first saw it in the book *Transistor Circuits*, by Lou Garner, published in 1960, and it wasn't brand-new even then. The transistors are germanium; we're not at all sure the circuit would work with modern silicon transistors. Nowadays, we'd use a 555 oscillator.

The odd battery voltage is due to the fact that the circuit dates from before the standard 9-volt battery. The component labeled "HA1 receiver" is a telephone receiver, *i.e.*, the tiny speaker from a telephone handset; it probably had an impedance of about 600 ohms.

We tried to breadboard an artificial larynx and found it surprisingly difficult. The hard part is not electronic but acoustical—you have to find an output transducer that will vibrate a person's throat effectively without putting too much sound out into the air.

As regards pitch, the most understandable speech will probably result from using a frequency between 100 and 200 Hz, regardless of whether you are male or female. To be recognized as female, you can set the pitch higher (as high as 400 Hz), but understandability will suffer because vocal tract resonances lower than 400 Hz will no longer be picked up. As for an add-on circuit for your telephone, we don't know of anything simple that you can do, other than adjust the pitch for best results over the telephone. We think digital signal processing has a lot to offer, but it's not a matter of building a simple circuit—lots of creative engineering is needed.

Weak-Signal 49-MHz Reception

Q *We give 49-MHz low-power walkie-talkies to people who wander out into the desert so they can call for help, but they get out of range of our vertical whip antenna. We built a single-element quad antenna that provided much better results, but it was still not sufficient. Would a Mini-Circuits 3-stage amplifier put directly on the antenna connections help? Or a set of op-amps like that in your September, 1995 column? — G. S., Essex, CA*

A Op-amps of the ordinary kind definitely won't do the job; many of the newer ones work well at 1.5 MHz, but 49 MHz is far beyond their range. Mini-Circuits RF amplifiers are more suitable, but remember that if you're using a transceiver, you'll have to switch the amplifiers out of the circuit when you transmit. Since 49 MHz is close to the 6-meter ham band, you can use any preamplifier designed for 6-meter ham work.

As for antennas, there are two basic ways to improve VHF reception: make the antenna more directional and raise it higher off the ground. By switching to a

(Continued on page 30)

This guide also briefly explains what principles each project teaches. The Hyper Peppy for the youngest beginner teaches basic mechanical skills, while the Rug Warrior Pro Kit, their most advanced kit, teaches advanced electronics, C programming, and subsumptive behavior. This robot is used at universities world-wide.

In addition to kits, the catalog includes robot arms and legs, wheeled platforms, muscle wires, shape-memory alloy (SMA) devices, BASIC stamps and boards, software and animatronics, robotics books, and videos that feature robots. EN

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quad you've done the first; now try the second. Raise the antenna until there is always a clear line of sight between the transmitter and the receiver.

Going beyond that, though, we wonder whether it is wise to entrust people's lives to low-power radios that weren't designed for great reliability. If you need radios for safety, don't skimp. Depending on your situation, Family Radio Service or business band VHF transceivers would probably be a lot more reliable.

Writing to Q&A

As always, we welcome your questions. The most interesting ones are answered in print. Please be sure to include plenty of background information (we'll shorten your letter for publication) and **give** your full name and address (we'll only print your initials). *If you are asking about a circuit, please include a complete diagram.* Write to Q&A, **Electronics Now** Magazine, 500 Bi-County Blvd., Farmingdale, NY 11735. Due to the volume of mail, we regret that we cannot give personal replies. EN