Nuts & Volts

Exploring Electronics And Technology For The Hobbyist And Professional

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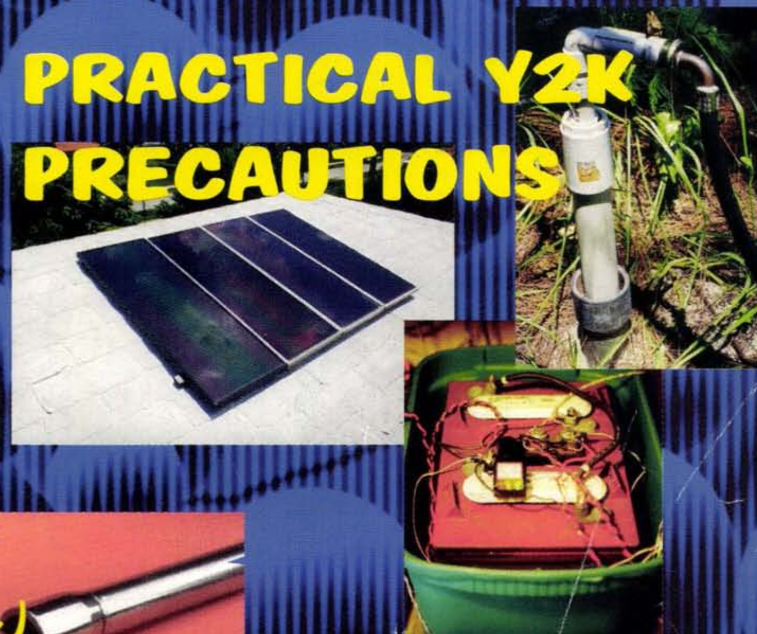
PRACTICAL Y2K PRECAUTIONS



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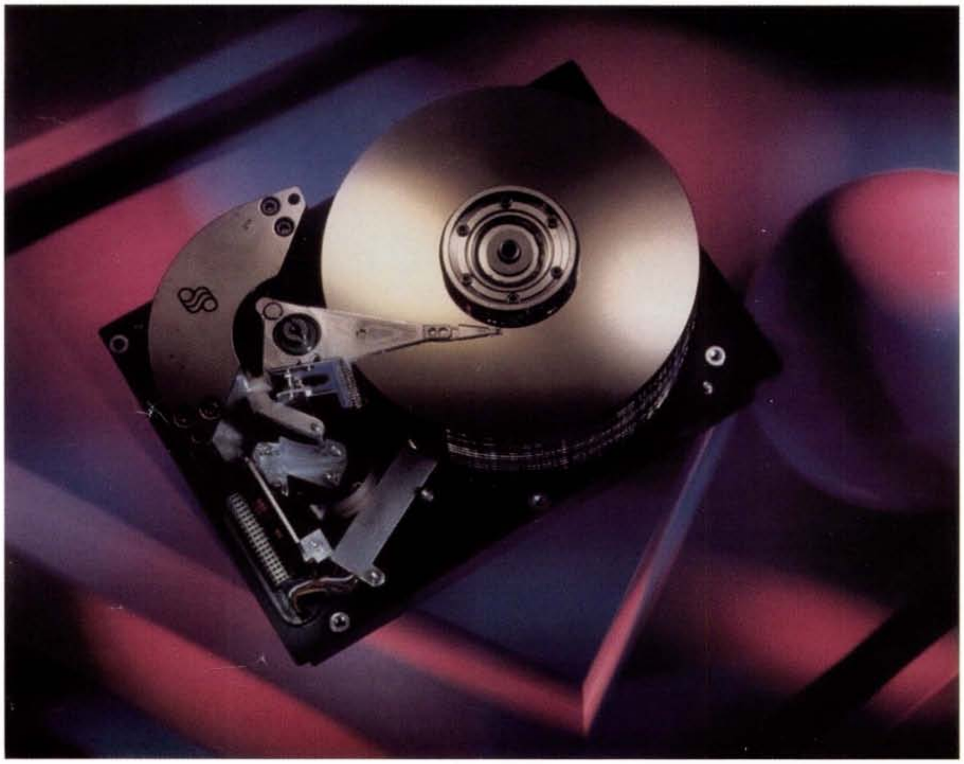

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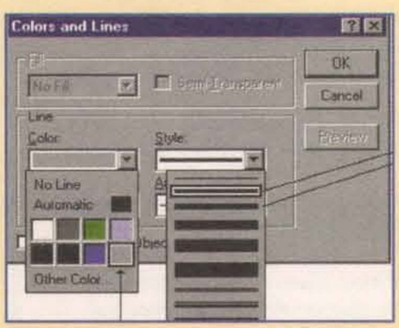

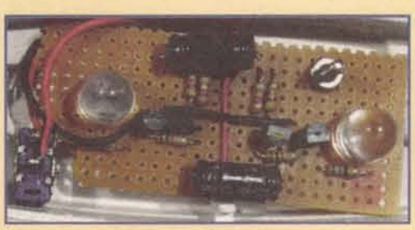

PRACTICAL Y2K PRECAUTIONS

by Kenton Chun

One of the more humorous comments I have heard about the impending Y2K phenomenon is that if it weren't for the people who insist on abbreviating stuff like "Y2K," we wouldn't be in this fix in the first place. But now that we are staring it in the face, it is a good time to take a look at some practical Y2K precautions.

By far, the greatest danger of Y2K is in simply assuming that you will be unaffected. If you think you are already prepared, try this simple test. If your computer runs "Windows," click on control panel, regional settings, date. If your short date reads M/d/yy, you were not prepared. Windows defaults to the short date for year, "yy." On New Year's Day, all of the dates in your computer would read "00." It is easy enough to change, but relatively few people are aware that "Windows" automatically defaults to the short date.

As hardware hackers, it is perhaps even a little bit exciting to imagine employing technology to battle natural disasters. However, it is important to realize that survival is the only factor to consider when disaster strikes. Should the worst possible scenario develop, excessive technology can become a hindrance instead of an asset. Part of the horror of contemplating a breakdown of our technological infrastructure is imagining how we would survive if suddenly we were without the things we often take for granted.

By far, the greatest danger of Y2K is in simply assuming that you will be unaffected.

One of the assignments I give to technical writing students is to have them write a paper describing three items they would take with them if they were put into a time machine and permanently transported back to a more primitive era in the past. The three items would have to aid in their survival and could not be used to create or contribute to a time paradox. I am constantly amazed by the numbers of students who decide to take laptop computers, digital cameras, and compact disk players back with them to the 12th century!

There are three top priorities to surviving a natural disaster. In order of importance, you need water, shelter, and food. Without water, you will last one or two days, depending on the environmental conditions. Without shelter, you can last a few days, unless the conditions are extreme, in which case, the time can be even shorter than being without water. Without food, you can go for perhaps a week.

Since Y2K is probably not going to destroy your house, you are best off staying there. Grabbing a sleeping bag and heading for the hills is far more likely to get you into trouble than staying put. For most people, Y2K effects will be most noticeable in the first quarter of the year 2000 and, unless you live in Miami or southern Arizona, it can be cold!

WATER

Clearly, applying the priorities I mentioned above, your first thought should be about how you can protect or guarantee your water supply. With recent concerns about municipal utility Y2K preparedness, it may be a good idea. If you have a water well, you are in good shape. Make sure you can get potable water out of it, either manually, or by means of an electric pump.

Standard deep-well or jet-pumps have enormous start-up current requirements, and many generators are not up to the task of starting them. You need to do some experiments to see if you have the electrical backup load capacity to start them. If not, put together a DC pump arrangement which will run off a battery that will pull enough water out of the well to provide at least two gallons of water per member of the family, per day. If the well is exposed to the outdoors, consider building an insulated structure around the wellhead to prevent freezing (Figure 1).

If you do not have a well, your only alternative is to "stockpile" water in some form or another. Start saving up gallon water or milk jugs now. If you are lucky enough to have a cistern or large water tank, this can be employed, but remember that these will require careful monitoring of the water quality to prevent contaminants from becoming an issue. Treating the water with a small amount of bleach will help.

Figure 1 — Y2K Water Wellhead. A small solar pump supplies 2GPH, enough for survival.

SHELTER

If systems fail below freezing, pipes can burst. Since you could lose electrical power, you may not have the kilowatts to heat an entire house and may be forced to retreat into a smaller zone. Make sure you have insulated the pipes that are in the extremities of the house to minimize the chances they will freeze and burst. Shut off outdoor spigots and cover them with Styrofoam casings available at your hardware superstore.

Last winter, an interesting phenomenon occurred in Maine during the great ice storm. Newer houses were not constructed with traditional iron stoves or fireplaces and, when the ice cut off power lines, people with full tanks of heating oil nearly froze anyway because they didn't have any power to run a simple furnace blower! If you have gas or oil heat, take a careful look at the power requirements of the oil pump and blower to see what you will need to supply them. Amazingly, the

Figure 2 — Pair of Trojan T105 Golf Cart Batteries. An inexpensive automobile cigarette lighter charge meter monitors the charge level. Place batteries in a plastic tub to prevent accidental spillage of battery acid. Provide adequate ventilation!

power requirements for these items are surprisingly low. A moderate capacity power inverter and battery may actually be enough to run it, if sized properly. Something along the lines of a 1,000-watt inverter will usually be enough.

Fortunately, most modern furnaces are designed with power failure failsafe modes so, if the power is killed or runs out, the gas supply will automatically be valved off. You should test this to make sure before setting up an alternative backup power supply for your furnace. Be careful when re-lighting pilots!

If you do not have the means to run the furnace in backup mode, clean up your fireplace and start laying in a wood supply. In temperate climates, a cord or two will get you through the winter if conservatively used. Heating efficiencies are higher if you can provide the combustion chamber directly with outside air, instead of pulling in cold outside air through cracks in the house to draft the fire. Now is the time to experiment, not when it is 14 degrees below zero outside.

FOOD

Other than a few panic runs, the food supply will probably not "disappear" after New Years. However, if you are prudent, you will stockpile some necessary items, remembering that the daily calorie count must be higher the colder the climate is. Do not lay in hundreds of pounds of frozen food. If the power goes down, it will all be lost. Buy canned items with decent nutritional value and don't go overboard. Try to buy stuff you would use anyway, after the crisis has passed. This will minimize waste.

If you have gas service, consider renting or buying a backup LP gas bottle that you can "valve" in somewhere after the main. If the gas utility should fail, you can then cut the main valve and go on

Other than a few panic runs, the food supply will probably not "disappear" after New Years.

backup. If you don't have experience in doing this, get a professional installer to do it for you. Don't look for an installer on New Year's Eve.

If you have electric cooking, forget it. Electric stoves use far too much power to be practical in an emergency. In this case, you are better off buying a propane camp stove. Don't use a camp stove indoors or you could die of carbon monoxide poisoning!

Fill your freezer with as much

Figure 3 — 12W Halogen Mounted on Desk Lamp Arm. Switch is SPST toggle.

Figure 4 — Japanese Lamp Shade. Allows the hardware hacker to combine DC back-up lighting with standard AC overhead light.

ice as you can get into it. This will create a "cooling capacitance" which will help to maintain low temperatures through power hits. The refrigerator is also a good place to store the jugs of potable water you prepare. If they are not filled to the very top, they can be frozen as well.

TECHNOLOGY

The American Red Cross says the formula for panic is based on three factors. The first is a situation that is out of control that has no escape. The second is a lack of communication. The third is a perception of imminent danger.

If you are in control of the survival factors I mentioned above, the first panic factor is alleviated. For the second and third factors, technology can help.

COMMUNICATIONS

For years, American ham radio operators and the ARRL have supported emergency communications in times of national crisis and disaster. Many of the techniques developed by ham radio can be applied here.

Start by putting together a short list of simple items in your house that can be used to enhance communication.

The cellphone is okay, but after a major disaster, the cell transceivers may be down or congested. If cellphone is your only means of communication, consider switching back to a system that has both analog and digital coverage. Analog coverage, while sometimes of poorer quality, will have far more cell coverage sites than digital systems. At the same time, you may wish to put together an alternative.

In remote areas, the old CB radio can still be used. Many police and emergency management organizations will monitor CB channel 9. If you are a licensed ham, even better. Now is the time

The perception of imminent danger often results from misinformation or the lack of information altogether.

to tune up the "shack" and establish your network of communication in the event of emergency.

Get an AM-FM portable radio

Analog coverage, while sometimes of poorer quality, will have far more cell coverage sites than digital systems.

that will run on a readily-accessible alternative power source. I like 12-volt devices because of the ease of finding 12-volts — a car battery, or a pair of Trojan T105 six-volt golf cart batteries wired in series, like I have in my home (Figure 2). The same goes for the television.

Try to avoid monster sized TVs; they will eat power you don't have. Also, look for portable televisions that do not have "instant on" features. This means that they draw idle current in standby mode all of the time. You don't want a constant draw on a limited power source like a battery if you can help it. Otherwise, disconnect the devices from the power source when you are not actually using them.

A good radio or television will supply you with much of the information you will need to survive the outage.

Lighting is another problem. If the lights go out for extended periods of time, it will be impossible to do anything at night. Set up some low-voltage lighting now. I have found that small halogen spotlights throw a great deal of light and have low power consumption. Set up a few 25-watt halogen spotlights in critical areas of the house like the kitchen and living areas. You can run a few of these for days on a good car battery. If you charge the battery regularly, either through solar panels or by running the car alternator, this will provide you with dependable lighting almost indefinitely (Figure 3).

Get an AM-FM portable radio that will run on a readily-accessible alternative power source.

I have found that an inexpensive Japanese-style lamp shade does a very nice job of hiding both the primary and the backup light sources (Figure 4). If you are fortunate enough to live in an area of the country where solar energy is plentiful, consider solar panels as a possible alternative for charging a battery. Solar panels are silent, "green" (environmentally friendly), and have a long operational life (Figure 5).

Get to know your automobile again. This time, calculate your "mileage" at zero miles an hour. This means if you use the car as a battery charger, figure out how long it will run at idle. In this case, the smaller your car, the better. To get a sense of this, take a look at your worst-case scenario. If your car gets 30MPG on the highway, you are burning approximately a gallon of gas per hour (in one hour, you are traveling 30 miles on a gallon of gas, assuming about 60 miles an hour of speed).

If your gas tank capacity is 10 gallons, you have a 10 hour capacity at this load. Idle loads are far less, so you can estimate far more time just charging batteries, but you may want to do an idle fuel consumption test to know exactly what you can expect. Just pick a day, and with a full tank of gas, turn on the headlights and the radio and run the car at idle for an hour. Then top off the tank and divide the tank capacity by the amount you just put back in. That's how many hours you have. Don't run the car in enclosed spaces like the garage because the exhaust gases can kill.

Figure 5 — Solar Panels. 60 watts of panels will allow you to run a pair of DC halogen lights all night without discharging the battery. Reserve is over a week!

INFORMATION RESOURCES

Nuts & Volts is a great place to start. Review my UPS Conversion article in Dec. '97, and the Solar Power articles in Aug. '99. You can get a good idea of the practical limitations and advantages of setting up solar power alternatives. There have been a couple of other good articles about Y2K in this magazine. Get informed. Use the Internet and take what you read with a grain or two of salt.

The perception of imminent danger often results from misinformation or the lack of information altogether. Being caught in an elevator when the power goes out is not particularly dangerous because since Otis, elevator cars are counterbalanced, and equipped with safety brakes. Although the elevator will never go plunging to the basement killing all aboard, one of the passengers going "berserk" very well may.

Y2K has been a sobering experience to those who depend on technology with their lives and for their livelihood.

For this reason, it makes sense not to be travelling or in an uncontrolled environment on New Year's Eve or shortly after. It's not technology so much that needs to be feared, but uninformed people who are in a blind panic.

Y2K has been a sobering experience to those who depend on technology with their lives and for their livelihood. For the hardware hacker, it is a chance to let one's imagination run wild and to use the creative process for preparation. For the vast majority out there, it will be worst-case, a chance to catch up a bit on one's reading. This magazine is a great place to start. Remember to have fun whatever you do! NV

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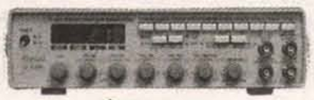

$225

This sweep function generator with counter is an instrument capable of generating square, triangle, and sine waveforms, and TTL, CMOS pulse over a frequency range from 0.2Hz to 2MHz.

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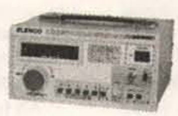

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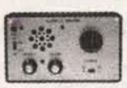

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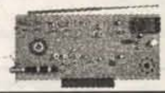

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Dear Nuts & Volts:

A response to John E. Lemmer.

Yes, you're right on the 525 lines. I mixed up this figure with another figure which was the actual usable lines on the TV set which fall between 460 and 490, thus the #480.

Your 1/30 figure, however, is useless without the interlace which is another 1/30 of a second, and thus one full signal each 1/60 of a second, or "60 times" each second?

As to resolution, no you're incorrect. Less lines or pixels mean less resolution, period. There is no way to make up more resolution from less information. The total usable pixels which usually aren't mentioned on inexpensive cameras are always less than the standard TV set, with the exception of scientific cameras which aren't cheap. On top of this, when they mention that there are 410 lines they mean it. "Should have or would have" 525 lines isn't 525 lines and, therefore, there is less resolution. Resolution, by the way, is a mathematic value and not a subjective value given by the user or his eye.

As to the lux question and "the short version" that I wrote for lux, I gave a fairly accurate answer to what lux is, or how lux is measured, or at least understood, and my answer is basically correct. It is a quantitative value of light in a given area being measured, and it is not a scenario based upon an individual item or circumstance or the ability of that given object to reflect or refract light, or anything else.

It is the "after the fact" measurement of that light in that given space. It's approximately (the short version) equal to a value of radiant light exhibiting outward, one candle (candela) worth of light in one cubic meter of free space, at any point of measurement, anywhere within that cubic meter of space.

Measuring one lux of light in scientific terms explains nothing to the layman unless you convert its meaning to something usable to that layman, and thus "one lux of light, or its measurement is approximately equal to one candle worth of light in a given cubic meter of free space."

If I gave the long version of M (-2) cd. sr, I would have lost all including the scientist when candela and steradian were attempted to be explained. These meanings have no value outside the physicists world of abstract words and meanings. To the layman, one candle and one meter of free space will suffice.

Getting lost in the "f" stop and its meaning has nothing to do with lux, whatsoever. The "f" stop of any lens has everything to do with the way a lens is assembled, out of what materials, what the focal length is, etc., but nothing to do with the external fact of a light source, namely lux. Yes, it affects the input of light inside the camera, after the fact, but it doesn't control the external light quantity known as lux, outside of the camera.

There is a relationship between lux and "f," but they are independent of each other, and they don't control each other until after they enter the camera. Nowhere is there mention in either my writings or the manufacturers writings of any camera, "how to convert" these esoteric numbers or settings to be useful to a layman, nor should there be!

My statement of "mm" as a component of diameter is theoretically correct only when using the "f" value of 1. A lens having an "f" value of one and a focal length of, say, 4mm will be 4mm in diameter. I use these figures "figuratively speaking" to represent what the lens will be like in terms of size or diameter. I realize that this is not an accurate statement across the board, unless you have an "f-1" lens.

As to the answer #7992 and my response, make up your mind. You say I give double talk and then you repeat my words exactly, to the letter, and then say you're right? Where did "not an inherent characteristic" come from? Certainly not my words?

Altering the frequency will "over" heat the windings period! It may or may not be severe enough to do damage, but it will increase the heat in that given impedance winding.

In order to alter the rotation speed of that motor significantly, a large frequency difference would be necessary and thus the overheating will follow.

As to the chopper circuit on drills and lathes, as spoken, they chop badly at slower speeds and on a lathe, at slow speed while cutting, the finish is marred. I know, I have a lathe with both of these units available for use, as well as a drill press. Only the variac works at slower speeds without any noticeable pulsing.

You do not have full control over any single phase motor with either controllers and yes, you lose torque at slower speeds, but they work just fine between 40 and 60 volts AC, and will reduce the rotation speed by a factor of 2/3 depending on your motor, thus fulfilling Mr. Billetts needs. However, they do not respond well to capacitor run motors with only a small amount of control available on these motors.

Yes, the best motor which allows the largest range of variable speed and power is the "brush type AC or DC motor." The answer that was given to Mr. Billett was not an attempt to change his mind, or the motor on his lathe, but was rather an "answer to his question." I filled that need and didn't split hairs.

As to the auto transformers "moving," there was no mention of "physical" movement. As the sweeper moves, one transformer (part) gains from this movement while the other loses from this movement, thus "they move in relationship to each other" via the brush. Again splitting hairs will only make you bald!

As to "remaining a constant current" while the brush is moved, that is exactly what it does. The voltage varies while the current remains (relatively) the same.

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Chris
Bieber, CA

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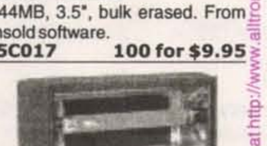

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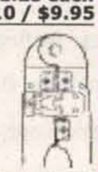

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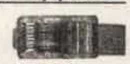

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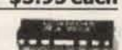

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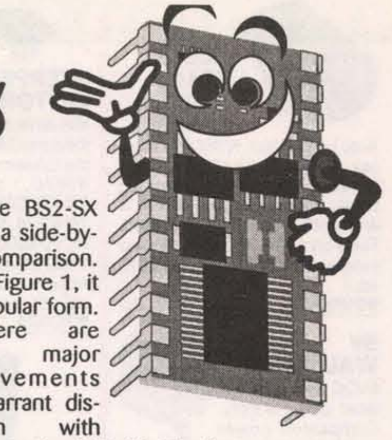
STAMP APPLICATIONS

by Lon Glazner



Putting the Spotlight on BASIC Stamp Projects, Hints, and Tips

Faster, Stronger, Better: The BASIC Stamp 2-SX

This article is less an application than it is a primer describing the differences between the BASIC Stamp 2 (BS2) and the BS2-SX. There are some minor hardware differences, a few new commands, and some timing differences in a handful of the older BS2 commands. But, in general, the learning curve to upgrade from the BS2 to the BS2-SX could be best described as a gently sloping incline.

Overview

I've been somewhat remiss in not writing a column on the BASIC Stamp 2-SX (BS2-SX) that was released by Parallax quite a few months ago (actually unveiled November 1998). I was really waiting for an application that required the additional speed and program memory available in this new member of the Stamp family. Of course, I tailor my applications in this column so that they fit into a format that can be well described in just a few pages. It dawned on me this month that that process would likely prevent me from defining applications that "required" a BS2-SX.

So, I'm making it a point to describe Parallax's BS2-SX in this article, and use it for applications in the next couple of issues of *Nuts & Volts* Stamp Applications.

Defining The Design

As I mentioned earlier, this article shouldn't be considered a design in and of itself. But it is the jumping-off point for an application making use of some of the BS2-SX features. Next month, we'll be going into an in-depth application called StampNet. StampNet will cover some of the intricacies of a well-defined RS-485 network. This will include electrical requirements, as well as a Master-Slave communication protocol. The StampNet design will be a generic overview that describes a multi-node network. Many electronic disciplines will be touched on during the StampNet application, and the BS2-SX will be the heart of this system.

What's Different

So what's the big difference between the BS2 and BS2-SX? On first glance I'd have to say the color! Yep, the BS2-SX comes with a new shiny blue paint job. In fact, it is somewhat reminiscent of the midnight-metallic-blue paint job of the '71 Mustang that I had in high school. But, like the Mustang, what really counts is what is under the hood.

But on the electronics front, I would have to say that the most significant difference between the BS2 and the BS2-SX is the Scenix Semiconductor SX28AC that Parallax designed into the BS2-SX. This processor can operate with a much faster oscillator than the previous Microchip PIC16C57 based BS2. With this speed increase of 250% comes an operating current increase of 750%. But we all knew that no improvement comes without a price. Our price is increased power dissipation, and additional operating current.

One of the easiest ways to visualize all of the differences between the BS2 and the BS2-SX is with a side-by-side comparison. So, in Figure 1, it is in tabular form.

There are three major improvements that warrant discussion with regards to the BS2-SX. The first is the massive increase in memory available for program storage. There are now eight 2K byte blocks available for program storage. This huge increase in program memory does have one drawback. The memory is not contiguous. In other words, these memory blocks can not be crossed with GOTO or GOSUB commands (or straight line coding). Each 2K byte block should be considered a separate program, and is defined as such in the BS2-SX manual.

This is not to say that you can not fully utilize the eight separate blocks of program memory. The new RUN command allows you to switch between the eight different program blocks. This aspect of the BS2-SX is described in more detail in the New Commands and Code Example sections which follow.

A second difference exhibited by the BS2-SX is also related, to a degree, to the program memory block requirements. The BS2-SX has 63 bytes of user-accessible scratch pad RAM

	BS2	BS2-SX
processor	PIC16C57	SX28AC
program execution speed	4000 inst./sec.	10000 inst./sec
oscillator frequency	20MHz	50MHz
program memory	2k bytes	2k bytes x 8
variable RAM	32	32
user scratch pad RAM	none	63 bytes*
operating current - normal	8mA	60mA
operating current - SLEEP	100uA	200uA
sink/source I/O limitations	25mA/20mA	30mA/30mA
command set (number of)	36	39

Figure 1: Major Differences Between the BS2 and BS2-SX

*64 bytes actually, but address 63 is a read-only byte so I didn't include it.

(really 64, but see the asterisk below Figure 1). This scratch pad RAM is somewhat different, and in addition to, the 32 bytes of variable RAM available in the BS2. As previously stated, each program memory block (0-7) is considered a separate program accessed by the RUN command. You may pass variable data between programs. One method of doing this is to ensure that your variable definitions are defined exactly the same for all programs that are accessed. Another, more eloquent, method of doing this involves the use of the scratch pad RAM.

Using the GET and PUT commands, byte-sized pieces of data may be stored or retrieved from the scratch pad RAM. For instance, if program 0 needs to pass two byte-sized variables to program 6, you would use the PUT command to store each byte and then execute a RUN 6. Program 6 would define the variables that it needs, and then use the GET command to retrieve the data stored in scratch pad RAM.

While on the subject of memory storage, I should also touch on the use of the READ and WRITE commands which are used to store data in unused portions of EEPROM (program memory) in the BS2 and BS2-SX. These commands still function as they did in the BS2. But each of the eight (0-7) possible programs in the BS2-SX can only access EEPROM that is unused in their own 2K byte section of program memory.

Therefore, you could not power up, store data in an EEPROM location, execute a RUN command, and then retrieve the same data from EEPROM while in your second program. The data desired would be in a different 2K byte block of EEPROM, and would be accessible only from the program that originally stored it.

Even if you could pass data from program to program in the BS2-SX, you would still have to take into consideration the limited number of writes available in EEPROM, as well as the potential effect on program execution when accessing program memory EEPROM. The short of it is that these problems are avoided with the introduction of scratch pad RAM.

Finally, the third improvement is speed. This baby is 2.5X faster than its predecessor, the BS2.

New Commands

Previously, I touched on the three new commands that are related to the new program memory allocation in the BS2-SX. Here we'll talk about them in greater detail.

As a refresher, the GET and PUT commands are used to retrieve and store data in the scratch pad RAM. The RUN command is used to execute any of the programs residing in the BS2-SX program memory. Program 0 is always accessed on power up or after a reset. Additionally, the scratch pad RAM is always initialized to zero on power up or after a reset. The GET command takes the form …

```
GET        location,variable
```

where location is the memory location 0-63 that you want to read from. This may be a variable or constant. Scratch pad RAM location 63 is a read only byte which tells the "reader" which program (0-7) is currently active. The variable defined for the GET command is the variable in which you wish to store the value from the scratch pad RAM. An example of using the GET command to read scratch pad RAM address 5, and store it in a variable named Stuff would be …

```
'
Stuff              var      byte
'
GET                5,Stuff
DEBUG     "Stuff = ",DEC Stuff,CR
END
```

The PUT command is used to write data to scratch pad RAM. The PUT command takes the form …

```
PUT        location,value
```

where location is the memory location 0-62 that you want to write to. This may be a variable or constant. The value specified in the PUT command must be a byte-sized value (0-255), and may be a constant or variable. An example of using the PUT command to write the contents of a variable register called Stuff to scratch pad address 6 would be …

```
'
Stuff              var      byte
'
PUT        6,Stuff
END
```

Using a "location" value greater than the specified 0-63 for either the GET or PUT command will cause a rollover (or wrap) internal to the BS2-SX. In other words, a location of 64 will access scratch pad RAM location 0.

The RUN command is used to switch between any of the eight different program blocks which may reside in the BS2-SX. Program 0 is always accessed on power up. It is important to note that you can only access the beginning of any individual program stored in the BS2-SX program memory. While this precludes program jumps similar to those implemented by GOSUB commands, you can store condition values in scratch pad RAM. Condition values can be used to direct a newly accessed program to specific subroutines within that program. So, with a little house-keeping, the non-contiguous nature of the BS2-SX program memory is not a major roadblock. In Listing 1, the PUT, GET, and RUN commands are used to create a conditional jump.

Old Commands That Have Changed

All of the original 36 commands residing in the BS2 have been incorporated into the BS2-SX. While all of these commands function in the same manner, 11 of the commands do exhibit timing differences due to

Command	Change
COUNT	*Period* variable/constant is now in time units of 0.4ms
DTMFOUT	*Ontime-Offtime* variable/constant is now in time units of 0.4ms
FREQOUT	*Duration* variable/constant is now in time units of 0.4ms
	Freq1,2 variable/constant is now in frequency units of 2.5Hz
PULSIN	*Result* variable is now loaded with time units of 0.8us
PULSOUT	*Time* variable is now in time units of 0.8us
PWM	*Cycles* variable/constant is now in time units of 0.4ms
RCTIME	*Result* variable is now loaded with time units of 0.8us
SERIN	bit period = INT(2,500,000/Baud Rate)-20 - **see Figure 3.**
SEROUT	bit period = INT(2,500,000/Baud Rate)-20 - **see Figure 3.**
SHIFTIN	data is clocked in at 42KHz
SHIFTOUT	data is clocked out at 42KHz

Figure 2: Modifications Exhibited by BS2-SX in BS2 Commands

Baud Rate	8N1 inverted	7E1 inverted	8N1	7E1
600	20530	28722	4146	12338
1200	18447	26639	2063	10255
2400	17405	25597	1021	9213
4800	16884	25076	500	8692
9600	16624	24816	240	8432
19200	16494	24686	110	8302
38400	16429	24621	45	8237

Figure 3: Baud Rate Conversion Table for BS2-SX

```
'Program 0
Condition        var       byte                'Define condition variable

Condition        = 1                           'Condition defaults to 1
if IN15 = 1 then No_Change                     'P15 state determines Condition
Condition        = 0                           'If P15 is low then Condition is 0
No_Change:
        PUT              0,Condition           'Store condition in scratch pad RAM
        RUN              1                     'Execute program 1
        END

'Program 1
Point            var       byte                'Program LED state

        GET              0,Point               'Retrieve Condition variable
        if Point = 0 then LED_off              'Test condition
        HIGH             14                    'Light LED
        GOTO             Done
LED_off
        LOW              14                    'Extinguish LED
Done:
        RUN              0                     'Execute program 0
        END
```

Listing 1

the change in operating speeds between the BS2 and the speedy BS2-SX. These changes are listed in an abbreviated form in Figure 2.

For most BS2 users, these changes will only create minor modifications in old BS2 code when porting it over to the new BS2-SX. Of course, if you've got code running on a BS2, and it's doing the job, there is no reason for a conversion. I listed these changes simply to give someone familiar with the BS2 some insight into differences they might expect when using the BS2-SX for the first time.

I seem to find myself making use of the Stamp's SERIN and SEROUT commands more often than any other instruction. I'm assuming that that may be true of a lot of other Stamp users as well. For that reason, I've included the SERIN/SEROUT baud rate conversions in Figure 3; 8N1 is defined as 8 data bits, no parity, and 1 stop bit; 7E1 is similarly defined as 7 data bits, even parity, and 1 stop bit. Inverted data is data defined by a logic high start bit.

Code Example

While developing these code fragments, I made use of the Parallax BASIC Stamp Win Interface v1.091. This is a beta version of a Windows 95/98/NT 4.0 interface with many features. This, and older programming software (such as DOS versions), can be downloaded from the Parallax web site at no charge (www.parallaxinc.com).

This beta software did not appear to be too buggy, although the programs I was working with were extremely short. Since this was my first attempt at using the BS2-SX with the Windows interface that Parallax provides, I felt it was best to keep things short and sweet.

My BS2-SX was connected to the PC via a Parallax Board of Eduction for this software test, but any interface hardware that works with a BS2 should work with a BS2-SX.

I wrote three programs which made use of the GET, PUT, and RUN commands to blink a couple of LEDs. The rate of the blinking was based on a variable that was loaded by programs 1 and 2. This variable was modified by program 0, which caused the rate of blinking to cycle from fast to slow.

I couldn't find any well-documented examples of loading multiple programs into the BS2-SX with the Windows Interface software. But from the READ.ME file, and through trial and error, I was able to get all three programs to load whenever I loaded program 0.

Over the next few weeks, I'll be contacting Parallax to get the low-down on this process, check for updated documentation, and see if any new information is available. I'll be sure to include whatever information, or corrections, I receive in the next Stamp Applications article.

The trick to linking all of your programs appears to be through the use of the {$STAMP BS2SX} directive. This directive takes the form …

{$STAMP BS2SX,file1,file2,…,file7}

where each file is the actual path and file name

```
'*******************************************************
'Program 0 - bsx_prg0.bsx
'{$STAMP BS2SX,C:\Parallax\bsx_prg1.bsx,C:\Parallax\bsx_prg2.bsx}
'0:bsx_prg0.bsx

Timer           var     byte                    'Define constants/variables
'
        GET             0,Timer                 'Get old Timer
        Timer           = Timer + 10            'Modify Timer
        DEBUG  "Timer = ",DEC Timer,CR          'Display Timer
        PUT             0,Timer                 'Store new Timer
        RUN             1                       'Execute program 1
        END
'
'*******************************************************
'Program 1 - bsx_prg1.bsx
        Grn_LED         con     15              'Define constants/variables
        Red_LED         con     14
        Timer           var     byte
'
        GET             0,Timer                 'Get Timer
        LOW             Red_LED                 'Turn off LEDs
        LOW             Grn_LED
        PAUSE   Timer                           'Pause
        RUN             2                       'Execute program 2
        END
'
'*******************************************************
'Program 2 - bsx_prg2.bsx
        Grn_LED         con     15              'Define constants/variables
        Red_LED         con     14
        Timer           var     byte
'
        GET             0,Timer                 'Get Timer
        HIGH            Red_LED                 'Turn on LEDs
        HIGH            Grn_LED
        PAUSE   Timer                           'Pause
        RUN             0                       'Execute program 0
        END
'
'*******************************************************
```

Listing 2

that belongs to your BS2-SX project. My programs were all stored in the C:\Parallax directory. If your files are stored elsewhere, you will want to select the correct path for your directory structure.

You will also wish to set the software up to communicate with a BS2-SX. This can be done through the EDIT®PREFERENCES®EDITOR OPERATION menus. Just select the correct communication port and ensure the BS2-SX is selected. After doing this, you can use the CTRL+I shortcut to identify the Stamp version you are connected to. If there is a communication problem between your PC and the Stamp, it will show up here.

Each of the three programs are listed together, but I think it is important to point out that each program was actually written in a separate editor window of Parallax's Win Interface software. The software makes it easy to switch between editing windows. I believe that this method of writing software for the BS2-SX will actually help with program organization. This is especially true of Stamp users who have not written code extensively for other microcontrollers (which can get quite large).

In Closing

The two major shortcomings of the BS2 were limited program storage space, and slow instruction execution speed. Both of these shortcomings have been addressed with the release of the BS2-SX. The BS2-SX creeps closer to the performance available in application specific microcontrollers. While the performance of the BS2-SX still does not match that of a custom-designed microcontroller, its ease of use is unmatched. Also, on the plus side, the addition of the faster BS2-SX, with a much larger memory map, has not resulted in a steep learning curve.

In fact, the greatest trouble I had resulted in the minimal documentation available for the Windows interface software. And I'm sure Parallax is working on this aspect of their "design environment."

All in all, the BS2-SX appears to be a fine addition to the BASIC Stamp product line. Next month, we'll go into more depth and learn how to use the multiple program capability of the BS2-SX to develop a versatile communication interface. Hope you can make it! **NV**

RESOURCES

For more information on the BASIC Stamp, contact:

Parallax, Inc.
3805 Atherton Road, #102
Rocklin, CA 95765
phone **(916) 624-8333**
http://www.parallaxinc.com

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Sierra Vista, AZ 85635
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OCTOBER 1-2

AR - SPRINGDALE - Hamfest. Northwest AR ARC, Clarence Morrow KC5UEW, 501-631-9231

OCTOBER 1-2-3

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OCTOBER 2

AK - FAIRBANKS - Hamfest. Arctic ARC, Fred Brown KL7CUS, 907-452-3452. E-Mail: fbrown@mosquitonet.com. Jim Movius KL7EGO, 907-452-6347. E-Mail: ajmovius@gci.net Web: http://www.aarc.uaf.edu

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

FL - MAITLAND - Hamfest. Bahia Shrine AR Unit, Cecil Morehouse K4KEN, 407-281-9169

MO - WARRENSBURG - Hamfest. Warrensburg Area ARC, Keith Haye WE0G, 816-697-3426. E-Mail: we0g@microlink.net

NJ - LEONARDO - Hamfest '99. Croydon Hall, Leonardville Rd. east of Hosford Ave. 8am. VE Exams. Talk-in: 145.485 (-). Middletown Township OEM & Garden State ARA, Mario Sellitti N2PVP, 732-787-7184. E-Mail: gsara@monmouth.com Web: http://www.monmouth.com/~gsara

NY - SYRACUSE - Hamfest. Pompey Hills Fire Dept., off Rt. 20. 8am-2pm. Talk-in: 147.90/30. RAGS, Vivian Douglas WA2PUU, 315-469-0590. E-Mail: ragsonline@hotmail.com Web: www.pagesz.net/~rags

PA - LEWISBURG - Computer, Amateur Radio & Electronics Show & Flea Market. Silver Moon Antique & Flea Market Show Area. Rt. 15, 2.3 mi N of Rt. 45. 9am-4pm. Talk-in: 147.270 Repeater & 146.52 simplex. Susquehanna Valley ARC, George Machesic 570-286-2086. E-Mail: gpmac@netscape.net, Dave Welker k3si@hotmail.com Web: http://loveland.dynip.com/svarc

SC - ROCK HILL - Hamfest. York County ARS, Haney Howell K2XN, 803-323-4534. Web: http://www.ycars.org

TX - BELTON - Hamfest. Bell County Expo Center. Temple ARC, Mike LeFan WA5EQQ, 254-773-3590. E-Mail: hamexpo@tarc.org Web: www.tarc.org

OCTOBER 3

IA - WEST LIBERTY - Hamfest. Iowa City & Muscatine ARCs, Bruce Dagel WB0GAG, E-Mail: wb0gag@excite.com Web: http://www.netins.net/showcase/mrc/pictures/hamfl.jp

IN - BEDFORD - Hamfest. Hoosier Hills Ham Club, Keith Harris N9KH, 812-275-3415. Web: http://dmrtc.net/~jscheiwe/hamfest.html

NY - QUEENS - Hamfest. Hall of Science parking lot, Flushing Meadow Park Corona, 47-01 111th St. 9am-3pm. Talk-in: 444.200 repeat, PL 136.5, 146.52 simplex. Hall of Science ARC, Stephen Greenbaum WB2KDG, 718-898-5599. E-Mail: WB2KDG@Bigfoot.com

PA - WRIGHTSTOWN - Hamfest. Middletown Grange Fairgrounds, Penns Park Rd. Talk-in: 146.52 simplex. Mt. Airy VHF RC, Mark Schreiner NK8Q, 610-847-2285, E-Mail: nk8q@amsat.org. Bob Minch N3XEM, 215-822-0779, E-Mail: raminch@bellatlantic.net Web: http://www.ij.net/packrats/l

OCTOBER 8-9

FL - STARKE - Hamfest. Bradford County Fairgrounds, US 301 N. Fri: 2pm-8pm, Sat: 8am-4pm. Talk-in: 145.150-. Bradford Area ARC, Walt Terrell 904-755-4964 or Tony Spatafore 904-964-9328. E-Mail: wb2fgl@techcomm.net Web: http://www.angelfire.com/fl/arcba/index.html

NH - ROCHESTER - Hamfest. Fairgrounds. Hoss Traders, Joe Demaso K1RQG, 207-469-3492. E-Mail: k1rqg@aol.com Web: http://www.qsl.net/k1rqg/

OCTOBER 8-9-10

CA - BAKERSFIELD - Hamfest. Bakersfield ARA, Robert Gerner Jr. KB6JFL, 661-588-7065. E-Mail: w6bar@hotmail.com Web: http://members.tripod.com/~w6bar/bara.html

OCTOBER 8-9-10-11

CA - SAN DIEGO - 17th Space Symposium & AMSAT-NA Meeting. Duane Naugle KO6BT, 619-273-4088. E-Mail: ko6bt@amsat.org Web: http://www.amsat.org

OCTOBER 9

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

GA - AUGUSTA - Hamfest. Westside High School, 1002 Patriots Way. 9am-3pm. Talk-in: 145.490-. ARC of Augusta, Terry Brown KE4MHN, 706-796-1128. E-Mail: cookie4u@cheerful.com Henry Arostegui KN4AV, 706-793-1625, E-Mail: kn4av@bellsouth.net. E-Mail: w4dv@hotmail.com, or w4dv@arrl.net Web: http://www.gabn.net/kd4ahqweather/arca.html

NJ - TEANECK - Hamfest. Bergen ARA, Jim Joyce K2ZO, 201-664-6725. E-Mail: jjjoyce@cybernex.net Web: http://www.bara.org

WA - BREMERTON - Hamfest. President's Hall, Kitsap County Fairgrounds. License Exams 10am. Talk-in: WW7RA repeater 146.620-, tone 103.5, simplex 146.520. North Kitsap ARC, Marcie Stilwell, 360-697-2797. E-Mail: nkarc@yahoo.com Web: http://www.silverlink.net/nkarc

OCTOBER 9-10

FL - TAMPA - Hamfest. 4050 Dana Shore Dr. Sat & Sun 9am-3pm. Egypt Temple ARA, George Dixon 813-933-4350; Len Smith 813-684-4408; Larry Padgett 813-948-6500, E-Mail: kf4iti@ij.net

OCTOBER 10

CT - WALLINGFORD - Connecticut State ARRL Convention. Mountainside Special Event Facility, High Hill Rd. 9am-3pm. Nutmeg CT Conv. Nutmeg Hamfest Alliance, Gordon Barker K1BIY, 860-342-3258 E-Mail: k1biy@juno.com. E-Mail: nutmeghamfest@qsl.net Web: http://www.qsl.net/nutmeghamfest

IL - OAK BROOK TERRACE - Hamfest. Chicago ARC, George Sopocko WA9JEZ, 773-545-3622

MD - WEST FRIENDSHIP - CARA Hamfest. Howard County Fairgrounds, S of I-70, E of Rt. 32. 8am-3:30pm. VE Exams. Talk-in: 147.135 (-) repeater, 146.52 simplex. CARA, 410-796-2587. Web: http://www.ocbs-nt-server.umaryland.edu/cara/hamfest.htm

MI - MASON - Hamfest. Ingham County Fairgrounds. 8am-2pm. Talk-in: 145.390-. Central MI ARC & Lansing Civil Defense Repeater Assn., Don Tillitson WB8NUS, 517-321-2004. Web: http://www.qsl.net/cmarc/hamfair-html

NC - MAYSVILLE - Hamfest. Jo Ann Taylor WD4JYR, 252-393-2120

OH - LIMA - Hamfest. Northwest OH ARC, Greg Schwark N8WBD, 419-647-6321. E-Mail: gas1950@aol.com

OCTOBER 15-16

MS - BILOXI - Hamfest. MS Coast ARA, Wayne Miller KB5AAU, 228-539-9929. E-Mail: kb5aau@worldnet.att.net Web: http://www.ametro.net/mcara

OCTOBER 15-16-17

CA - CONCORD - Pacific Div. Convention. Mt. Diablo ARC, Dick Brown KT6X, 925-676-9048. E-Mail: paccon99@pacbell.net Web: http://www.pacificon.org

OCTOBER 16

AZ - TUCSON - Hamfest. OPRC/ARCA, Glenn Henderson WA7OBG, 520-749-5478. E-Mail: linus@primenet.com Web: http://www.hamsrus.com

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

IL - GODFREY - Hamfest. Community College, River Bend Arena. VE testing. Talk-in: 145.230, 442.225. Lewis & Clark RC, Harold Elmore N9HE, 618-466-1909. E-Mail: n9whh@ezl.com Web: http://www.ezl.com/~lmiller/lcrc.html

MT - BOZEMAN - Hamfest. Gallatin Ham Radio Club, Laura Marino Lubner KJ7UN, 406-586-6659. E-Mail: ghrc@bigfoot.com Web: http://ghrc.webjump.com

TN - GRAY - Hamfest. Appalachian Fairgrounds, off I-181. Kingsport, Bristol, and Johnson City Radio Clubs, Wendell Messimer K4ZHK, 423-928-4407. E-Mail: messimerw@ten-nash.ten.k12.tn.us Web: http://home.naxs.com/jcara

TX - DENTON - Hamfest. Denton County ARA, Don Mathis KB5YAM, 972-292-1203. E-Mail: dmathis@lsic.net. Web: http://lsic.net/dhf

UT - CEDAR CITY - Color Country Hamfest. Russ Roberts K7USN, 435-865-7822

UT - CEDAR CITY - Hamfest. Rainbow Canyons ARC, Jerry Renna KB7BCL, 435-865-0908. E-Mail: renna@netutah.com

OCTOBER 16-17

FL - PALM BEACH GARDENS - Hamfest. AMARA Shrine Temple, 3650 RCA Blvd. Sat: 9am-4pm, Sun: 9am-2pm. Talk-in: 147.165/147.765. Palm Beach Repeater Assn., Ken Summerell KD4CTG, 561-640-9447. E-Mail: sum@flinet.com

OCTOBER 17

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html

MI - KALAMAZOO - Hamfest. County Fairgrounds. Talk-in: 147.040 K8KZO. Kalamazoo ARC & SW MI AR Team, Charles Burgstahler KA8BLO, E-Mail: ka8blo@net-link.net Web: http://www.qsl.net/ka8blo/hamfest.html

OH - ASHLAND - Hamfest. County Fairgrounds, Claremont Ave. 8am-2pm. Talk-in: 147.105+, 71.9PL. Ashland Area ARC, David Fike N8UCA, 419-289-1082, daytime. Mike Stroub KC8LCH, 419-945-2777, nighttime. E-Mail: aaarc@hotmail.com

PA - SELLERSVILLE - Hamfest. NEW Sellersville Fire House, Main St. Bethlehem Pike. 7am-1pm. VE Exams. Talk-in: 145.31 (144.71 input) W3AI repeater. R. F. Hill ARC, Linda Erdman KA3TJZ, 215-679-5764. Web: http://www.rfhill.ampr.org

WA - CHEHALIS - Hamfest. The Southwest Washington Fairgrounds. Talk-in: 147.06+ 110.9 pl, simplex 146.46. Chehalis Valley ARS, Jim Kruger KK7AB, 360-748-1930; KK7AB@ARRL.net or Bill Harwell KC7QHJ, 360-748-8086. E-Mail: bharwell@localaccess.com Web: http://www2.localaccess.com/teaser/cvars/

OCTOBER 23

LA - LAKE CHARLES - Hamfest. Southwest LA ARC, Dick Rogers WB5TUG, 318-474-7947. E-Mail: hotred@linknet.net

NH - NASHUA - Hamfest. Res Ctr Church, Antique RC, 617-923-2665

OK - ALTUS - Hamfest. Altus Area ARA, Mike Schenkel W5VXU, 580-846-5578. E-Mail: w5vxu@juno.com

OR - RICKREALL - Swap-Toberfest. Polk County Fairgrounds. 9am-3:30pm. Talk-in: 146.86-. Mid-Valley ARES, Bob Boswell, W7LOU 503-623-2513, E-Mail: w7lou@goldcom.com Web: http://www.teleport.com/~n7ifj/swaptobe.htm

TN - CHATTANOOGA - Hamfest. C. Jordan in E. Ridge. Chattanooga ARC, David Hoffman KE4FGW, 423-877-7398. E-Mail: w4am@qsl.net Web: http://www.qsl.net/w4am

OCTOBER 24

IN - LEBANON - Hamfest. Boone County Fairgrounds. 8am-1pm. VE testing. Boone & Clinton County ARC, Sara Lecklitner KB9OEZ, 765-482-9152

MD - WESTMINSTER - Mason-Dixon Computer & Hamfest. Carroll County Ag Center. 8am. VE Exams. Talk-in: 145.410 CCARC Repeater. Carroll County ARC, Wayne Wilson N3UN, 410-795-2556 (ph/fax). E-Mail: k3pzn@qis.net. Web: http://www.qis-net/~k3pzn

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The Events Calendar is a free service for publicizing electronic events such as amateur radio hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days in advance. Include your flyer, estimated attendance, name of the person to contact, and phone number.

Complimentary issues are available upon request for distribution to your attendees. A street address for UPS is required.

While we strive for accuracy in our calendar, we can not be responsible for errors or cancellations. The information contained in this column is for the use of the readers of *Nuts & Volts* and may not be republished in any form without the written permission of T & L Publications, Inc.

All listing information should be sent to:
Nuts & Volts Magazine
Events Calendar
430 Princeland Court
Corona, CA 91719
Phone 909-371-8497
Fax 909-371-3052
E-mail events@nutsvolts.com

COMPUTER SHOWS

AGI Shows, 317-299-8827.
E-Mail: info@agishows.com
http://www.agishows.com

Blue Star Productions
612-788-1901.
http://www.supercomputersale.com

Computers And You, 734-283-1754.
www.a1-supercomputersales.com

Computer Central Shows
847-412-1900 & 1-888-296-6066.
E-Mail: compcent@megsinet.net
www.computercentralshows.com

Five Star Productions
810-379-3333. E-Mail: jeff@fivestar
www.fivestarshows.com

Georgia Mountain Productions
706-838-4827.
E-Mail: gamtnpro@blrg.tds.net
georgiamountain.com

Gibraltar Trade Center, Inc.
734-287-2000. Taylor, MI.
E-Mail: taylor@gibraltartrade.com
www.gibraltartrade.com

Gibraltar Trade Center, Inc.
810-465-6440. Mt. Clemens, MI.
E-Mail: mtclemens@gibraltartrade.com
www.gibraltartrade.com

KGP Productions
1-800-631-0062, 732-297-2526.
E-Mail: kgp@mail.com

MarketPro, Inc., 201-825-2229.
http://www.marketpro.com

MarketPro, Inc., 301-984-0880.
E-Mail: md@marketpro.com
http://marketpro.com

Narisaam Computer Show
770-663-0983.
E-Mail: narisaam@aol.com
Web: http://www.shownsale.com

Northern Computer Shows
978-744-8440.
E-Mail: inquiries@ncshows.com
Web: ncshows.com

Peter Trapp Computer Shows
603-272-5008.
Web: www.petertrapp.com

MI - WARREN - Hamfest. Utica Shelby Emergency Comm. Assn. Debbi Cokewell KB8YYB, 810-263-0227. E-Mail: cuer@juno.com Web: http://www.useca.org

NY - LINDENHURST - Hamfest. Great South Bay ARC, Tom Carrubba KA2D, 516-422-9594. E-Mail: info@gsbarc.org Web: http://www.gsbarc.org

PA - GREENSBURG - Hamfest. 8am-2pm. Talk-in: 147.180+. Foothills ARC, Jim Yex WB3CQA, 724-864-6228. E-Mail: jpyex@sgi.net Web: http://www.geocities.com/Heartland/Acres/7896/

OCTOBER 29-30

FL - JACKSONVILLE - Greater Jacksonville Amateur Radio & Computer Show. Morocco Shrine Auditorium, 3800 South St., Johns Bluff Rd. Fri: 1-8pm, Sat: 9am-5pm. VE Exams. Greater Jacksonville Hamfest, Woody Parker KF4GSK, 904-743-3121. E-Mail: sbarber@mediaone.net. Web: http://www.ccse.net/~lrich/hamfest98.htm

OK - KINGSTON - Hamfest. Texoma Hamarama, Herb Sleeper WB5PHM, 940-855-5820. E-Mail: retmarine@cst.net Web: http://www.qsl.net/kc5sig/hamarama

OCTOBER 30

CT - WATERFORD - Auction. Tri-City ARC, Austin Wolfe AA1SV, 860-443-2459. E-Mail: aa1sv@downcity.net

MN - ST. PAUL - Hamfest. The New RiverCentre. 8am-4pm. VE Exams. Twin City FM Club, Dale Reak KB0VCV, 612-687-9535. Web: http://www.hamfestmn.org

OCTOBER 31

IA - DES MOINES - Hamfest. Tikva Tracer ARC, Randall Lees N0LMS, 515-279-4241. E-Mail: hamfestiowa@juno.com Web: http://www.bestofiowa.com/hamfestiowa/

MO - ST. LOUIS - Hamfest. St. Louis ARC & Gateway to Ham Radio Club, Steve Welton WB0IUN, 314-638-4959. E-Mail: slw@partyline.net

OH - MARION - Hamfest. Marion ARC, Karen Eckard N8KE, 740-499-3565. E-Mail: meeker@gte.net

OH - MASSILLON - Hamfest. Stark County Fairgrounds. Talk-in: 147.18+ & 442.85. Massillon ARC, Don Wade W8DEA, 330-497-7232. E-Mail: marc.hamclub@juno.com

NOVEMBER 1999

NOVEMBER 6

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

FL - SORRENTO - Hamfest. East Lake Chamber of Commerce Bldg. VE Exams. Talk-in: 147.255. Lake ARA, John Wentz W8HFK, 352-728-2615. E-Mail: capias@gate.com Chuck Crittenden KE4EXM, 352-669-2075

IL - BELLEVILLE - Hamfest. Belleville Area College, Carlyle Rd. (Rt. 161) & Green Mount Rd., Main Campus. 8am-2pm. VE testing. Talk-in: 147.120 K9GXU repeater. Scott Composite ARS, Howard "Skip" Mize KA9VKE, 618-277-9767. E-Mail: fiuinc@peaknet.net

IN - FORT WAYNE - Hamfest & State Conv. Allen County War Memorial Coliseum Expo Center. Sat: 9am-4pm, Sun: 9am-3pm. Talk-in: 146.88-. ACARTS, 219-484-1314. Web: http://www.pipeline.com/~dagagnon/

KY - HAZARD - Hamfest. Kentucky Mountains ARC, John Farler K4AVX, 606-436-5354. E-Mail: jfarler@mis.net Web: http://www.geocities.com/SiliconValley/2564/kmarc.ht

NH - MANCHESTER - Hamfest. St. John Church. 305 Kelley St. Talk-in: 146.850 PL 85.4. Paul K1LLX 603-432-1538. E-Mail: K1LLX@juno.com

OK - ENID - Hamfest. Enid Hamfest Group, Tom Worth N5LWT, 580-233-8473. E-Mail: n5lwt@hotmail.com

SC - MYRTLE BEACH - Beachfest '99. Old Myrtle Beach Air Force Base. 7am-2pm. Talk-in: 147.120 +600. Grand Strand ARC, Jim Wood KF4CJE, 843-238-0800. E-Mail: kf4cje@juno.com Web: http://www.w4gs.org

WI - MILWAUKEE - Hamfest. Milwaukee Repeater Club, Mike Borchardt N9NPB, 414-367-3953. Web: http://execpc.com/~mrc/friendlyfest.htm

NOVEMBER 6-7

GA - LAWRENCEVILLE - Hamfest. Gwinnett County Fairgrounds. Talk-in: 145.45- (PL 107.2), 444.25+ (PL131.8), 146.76- (PL 107.2). Alford Memorial RC, Hotline: 770-410-3989. E-Mail: hamfest@totrbbs.radio.org

TX - ODESSA - Hamfest. West Texas ARC, Robert Jordan N5RKN, 915-335-7980. E-Mail: n5rkn@apex2000.net Web: http://www.wt5arc.org Web: http://nonprofit.apex2000.net/hamfest/

NOVEMBER 7

MI - ST. JOSEPH - Hamfest. Blossomland ARA, Duane Durflinger KX8D, 616-982-040‹ E-Mail: comdac@comdac.com Web: http://www.comdac.com/bara

NY - POUGHKEEPSIE - Hamfest. Mt. Beacon ARC, Ken Akasofu KL7JCQ, 914-485-9617. E-Mail: kl7jcq@arrl.net Web: http://www.mhv.net/~fritzing

PA - LINGLESTOWN - Hamfest. Linglestown Fire Hall. VE testing. Talk-in: 145.470 & 146.520 simplex. Central PA Repeater Assn., Harold Baer KE3TM, 717-566-8895

WI - KAUKAUNA - Hamfest. Starlight Club. VE testing. Talk-in: 146.52 simplex. Fox Cities ARC, Chad Pennings N9PRC, 920-993-0485. E-Mail: n9prc@kb9byq.ampr.org Web: http://www.w9zl.ampr.org

NOVEMBER 13

AL - MONTGOMERY - State Convention. Garrett Coliseum, South AL State Fairgrounds, Federal Dr. 9am-3pm. FCC exams. Talk-in: 146.24/84, W4AP. Montgomery ARC, Phil Salley K4OZN, 334-272-7980 after 5pm CST. E-Mail: wb4ozn@worldnet.att.net Web: http://jschool.troyst.edu/~w4ap/

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

NM - SOCORRO - Hamfest. Socorro ARA, Al Braun AC5BX, 505-835-3456. E-Mail: ac5bx@juno.com Web: http://www.ees.nmt.edu/sara/homepage.html

NOVEMBER 13-14

IN - FORT WAYNE - IN State ARRL Convention & Hamfest. Allen County War Memorial Coliseum Expo Center. Sat: 9am-4pm, Sun: 9am-3pm. Talk-in: 146.88-. Allen County AR Technical Society, Doug Jones N9NNT, 219-484-1314; E-Mail: djones2233@aol.com, Jim Boyer KB9IH, 219-484-3317. Web: http://www.acarts.com

NOVEMBER 14

IL - PEORIA - Autonomous Sumo Robot Competition. 1pm. Central IL Robotics Club, Jim Munro. E-Mail: jimmn@xnet.com Web: http://circ.mtco.com/contest.htm

NY - FARMINGDALE - Hamfest. Radio Central ARC, Neil Heft KC2KY, 516-737-0019. E-Mail: nheft@ibm.net Web: http://www.li.net/~n2mdq

NOVEMBER 19-20

Events CALENDAR

MS - OCEAN SPRINGS - Hamfest. St. Martin Community Center. Fri: 5-9pm, Sat: 8am-2pm. VEC testing Sat: 11am. Talk-in: N5OS 145.11-. West Jackson County ARC, Phil Hunsberger W9NZ, 228-872-1499. Stan Hecker N5SP, 228-875-0222

NOVEMBER 20

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

CO - GOLDEN - Hamfest. Jefferson County Fairgrounds, 15200 W. 6th Ave. 8am-2pm. VE testing. Talk-in: 144.62/145.22. Rocky Mountain Radio League, Inc., Ron Rose N0MQJ, 303-985-8692. E-Mail: n0mqj@arrl.net Web: http://rmrl.hamradios.com

MA - NEWTONVILLE - Auction. Masonic Hall, second floor, 460 Newtonville Ave. 11am-4pm. WARA/1200 RC, Eliot Mayer W1MJ, 617-484-1089. E-Mail: W1MJ@amsat.org Web: http://our world.compuserve.com/homepages/emayer/auct

OH - GEORGETOWN - Hamfest. Grant ARC, Gordon Neal W8YGW, 513-379-1659. E-Mail: wb8ygw@juno.com Web: http://www.qsl.net/~n1djs

NOVEMBER 20-21

FL - TAMPA - Suncoast Hamfest, FL State ARRL Convention. State Fairgrounds, Expo Hall. Florida Gulf Coast Amateur Radio Council, Jean Endicott KC4KZU, 727-525-5178. E-Mail: swaps@fgcarc.org Web: http://www.fgcarc.org

NOVEMBER 21

NC - BENSON - Hamfest. Johnston ARS, Doug Williams KS4TI, E-Mail: ks4ti@nceye.net Web: http://www.jars.net

NOVEMBER 27

IN - EVANSVILLE - Hamfest. EARS, Neil Rapp WB9VPG, 812-479-5741. E-Mail: earsham@aol.com Web: http://members.aol.com/earsham

NC - GREENSBORO - Hamfest. Greensboro Coliseum Special Events Center. GGH, 336-851-1676. Web: http://www.sabwc.com/gsohamfest

NOVEMBER 28

CA - SANTA ANA - Swapmeet. ACP parking lot. Mary Russo 714-558-8813

IL - WHEATON - Hamfest. DuPage County Fairgrounds. GMRS of IL, Inc., 815-436-7090 or 630-393-3937

NY - PATCHOGUE - Hamfest. Mid-Island ARC, Mike Grant N2OX, 516-736-9126. E-Mail: globalcm@erols.com Web: http://www.qsl.net/mid-islandarc/hamfest.html

DECEMBER 1999

DECEMBER 4

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

FL - OKEECHOBEE - Hamfest. Okeechobee ARC, Bill Gastle, E-Mail: wgastle@okeechobee.com

GA - CLAXTON - Hamfest. Claxton ARES, John Perkins W4HYU, 912-739-4589. E-Mail: w4hyu@juno.com

LA - MINDEN - Hamfest. Minden ARA, Lowell A. "Dusty" Collins KB5WFE, 318-371-0636. E-Mail: dustyc@microgear.net Web: http://www.microgear.net/gwinford/mara.htm

DECEMBER 5

IN - GREENFIELD - Hamfest. Greenfield Central High School Pavilion, N. Broadway St. Talk-in: 145.330, 444.725. Hancock ARC, Tom Donaldson N9LFU, 317-326-3168. E-Mail: tomd@freewwweb.com Web: http://www.iei.net/~n9hqo

DECEMBER 11

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

SC - UNION - Hamfest. Armory. Union County ARC

DECEMBER 18

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-005

JANUARY 2000

JANUARY 8

IN - SOUTH BEND - Hamfest. Michiana Valley Hamfest Assn., Bob Denniston KA9WNR, 219-291-0252

WI - WAUKESHA - Hamfest. West Allis RAC, Phil Gural W9NAW, 414-425-3649.

JANUARY 15

MO - ST. JOSEPH - Hamfest. MO Valley & Ray-Clay ARCs, Kevin R. Phillips KC0AWM, 816-320-2129. E-Mail: KevinRPhillips@hotmail.com Web: http://www.kc.net/~oconnor

JANUARY 15-16

FL - SARASOTA - Hamfest. Sarasota ARA, William Eddie Martin KI4ZJ, 941-954-1869. E-Mail: ki4zj@msn.com Web: http://www.saraclub.org

JANUARY 16

MI - HAZEL PARK - Hamfest. High School, 23400 Hughes St. 8am-2pm. Talk-in: 146.64 (-). HPARC, Tom Krausnick WC9F, E-Mail: wc9f@arrl.org Web: http://www.qsl.net/w8hp

NY - YONKERS - Flea Market. Lincoln High School, Kneeland Ave. 9am-3pm. VE Exams. Talk-in: 440.425 PL 156.7, 223.760 PL 67.0, 146.910, 443.350 PL 156.7. Metro 70cm Network, Otto Supliski WB2SLQ, 914-969-1053. E-Mail: wb2slq@juno.com Web: http://www.metro70cmnetwork.com

JANUARY 22

FL - PENSACOLA - Hamfest. University of West FL ARC, Ray Killough KE4UNR, 850-968-1048. E-Mail: ke4unr@spydee.net Web: http://qso.arc.uwf.org/~hamfest

MO - ST. CHARLES - Hamfest. St. Louis Repeater, Brad Ziegler KC0CDG, 314-569-5775. E- Mail: kc0cdg@qsl.net

NC - WINSTON-SALEM - Hamfest. Forsyth ARC, John Kippe N0KTY, 336-723-7388. Web: http://members.xoom.com/w4nc/hamfest.htm

NH - NASHUA - Hamfest. Res Ctr Church. NE Antique RC 617-923-2665

JANUARY 29

AL - GREENVILLE - Hamfest. Butler County Fairgrounds. 8am-3pm. Talk-in: 146.67 or 145.19. Butler County & Pike County RACES, Jerry McCullough KE4ERO, 334-382-7644. E-Mail: KE4ERO@alaweb.com

JANUARY 30

MD - ODENTON - Hamfest. MD Mobileers ARC, William Hampton N3WGM, 410-766-2199. E-Mail: diamondb@space4less.com Web: www.space4less.com/usr/mmarc

Continued on page 36

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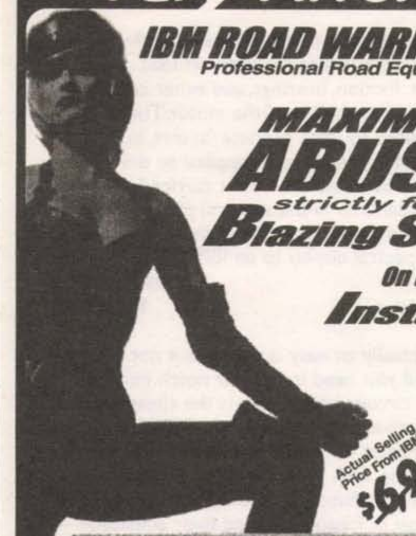

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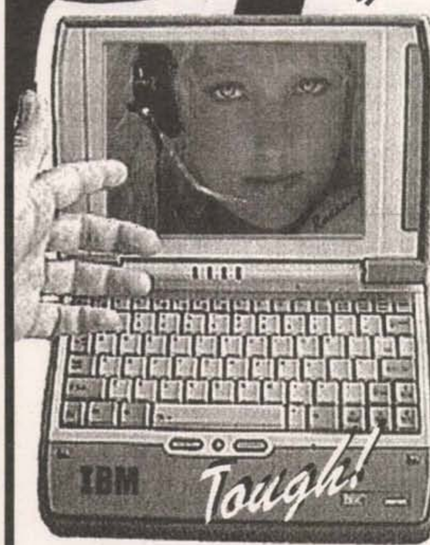

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ELECTRONICS Q & A

With TJ Byers

In this column, I answer questions about all aspects of electronics, including computer hardware, software, circuits, electronic theory, troubleshooting, and anything else of interest to the hobbyist. Feel free to participate with your questions, as well as comments and suggestions. You can reach me at:

TJBYERS@aol.com
TJBYERS@juno.com
or by snail mail at Nuts & Volts Magazine, 430 Princeland Ct., Corona, CA 91719.

What's Up:

Lots of **useful circuits**, ranging from a **basic 555 timer** to **60 Hz notch filters** to **remote phone relay**. And **some theory**, including a deeper look at **DSS polarization, Playing with lightning**, NASA style. Plus some useful **tech support Web sites.**

Flyback Is Back

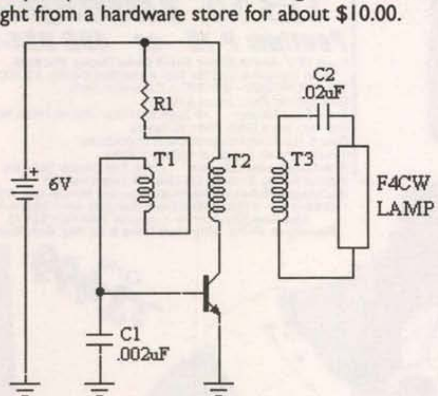
Q. I have this little fluorescent light that contains a transformer, one transistor, four caps, two resistors, and runs off four (1.5V) ordinary batteries. I'm trying to learn transistor theory, but this circuit eludes me because the base voltage seems to be wrong. Here are the measured voltages on the transistor using a 6.8-volt supply:

Vc = 6.5V
Vb = 1.14V
Emitter is tied to ground.

Now, my question. This seems like a VERY simple circuit, but I'm just not sure how it works. Is this transistor being used as a switch in what appears to be a flyback transformer? And why is the base voltage 1.14 volts when the textbooks say it's supposed to be 0.7 volts?

Tim
via Internet

A. You're quite right. Your fluorescent light is driven by a flyback circuit. Here's a diagram of one that I bought from a hardware store for about $10.00.



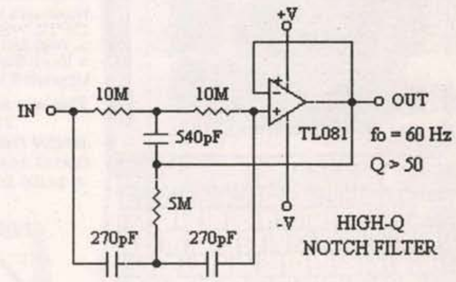
Although this version uses just one resistor and two capacitors, it works the same. Basically, the transformer is the heart of the circuit and the transistor is nothing more than a switch. When power is applied, current flows through the resistor and turns the transistor on, which causes current to flow through the T2 winding of the flyback transformer. This induces a voltage in the T1 winding, which opposes the base current — that is, it tries its best to shut off the base current. At some point, it succeeds and current ceases to flow through the collector, which causes the magnetic field to collapse and generate a high voltage in winding T3 to spark the fluorescent lamp. Current now flows through the base again and the process starts all over. The frequency of oscillation is set by the flyback transformer, and is typically somewhere around 25 kHz. Why is the base at 1.14 volts? Because of the way your voltmeter interprets the voltage. Your DMM is a digital meter and not a true analog device. That is, it converts analog voltages into digits using an A/D converter then displays them as numbers. In the conversion process the high-voltage kick is integrated into the normal 0.7-volt base voltage, hence 1.14 volts. An analog meter with a needle would be closer to the true value, but will still show a little higher than 0.7 volts because of the flyback effect.

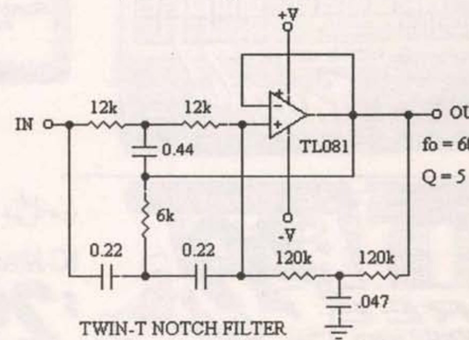
Electric Motor Monitor

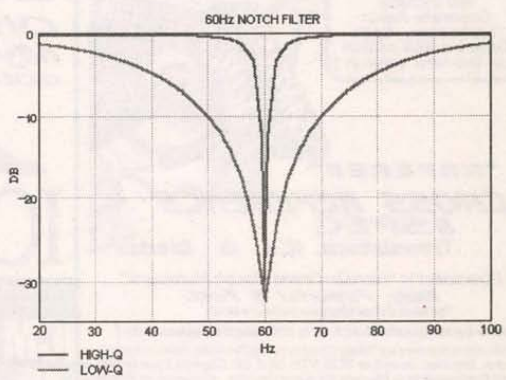
Q. When an electric motor drives a mechanical system, it experiences variations in load caused by gears, pulleys, friction, bearings, and other conditions that may change over the life of the motor. The variations in load caused by each of these factors, in turn, causes a variation in the current supplied to the motor. These variations modulate the 60 Hz carrier frequency and appear as sidebands in the spectral plot. Is there a circuit to demodulate the signal from the 60 Hz carrier and present a spectral display to an IBM PC?

Danny Meadows
Boron, CA

A. This is actually an easy question, but not a cheap solution. All you need is a 60 Hz notch filter like one of the two circuits below (this is the cheap part) and a plug-in oscilloscope board for your PC. These boards range in price from $200.00 to over $1,000.00, and generally come with spectrum analyzer software. Now what's going to happen is the PC screen will show you a range of frequencies and their amplitude — minus the 60 Hz power. These screens can be saved to a file and compared over a period of time as the motor/mechanism ages.







These two filters are essentially the same, with the exception of the feedback path. In the twin-T filter, the signal is returned to ground, which lowers the Q of the circuit. In the high-Q circuit, the signal is bootstrapped to the output of the op amp. This raises the Q of the filter and sharpens the notch. You'll have to experiment with the bandwidth of the filter to find the response that works best for your application. I suggest you go to the "Test & Measurements World" Web site (http://www.tmworld.com) for more information on this topic. Meanwhile, here's a short list of vendors who make oscilloscope/spectrum analyzer boards.

Allison Technology Corporation
http://www.atcweb.com/default.htm
1-800-980-9806

Keithley Instruments
http://www.keithley.com/
1-800-552-1115

PC Instruments, Inc.
http://www.pcinstruments.com
330-762-8500

Satellite Antennas Polarization

Q. Even though I've taught high school electronics for 40 years and have been a ham for 50 years, I always have questions. What I'm interested in is satellite antennas. What is RHCP and LHCP? How is it developed? How does it look as a diagram? I own a 10-foot dish and know I must change polarization using the +13 and +18 volts, but is the satellite antenna at 45 degrees when my receive antenna is at 45 degrees? Isn't the satellite spinning? Where can I get more information on satellite antennas?

Jim Allen W8FJD
via Internet

A. This is a good question because the answers are often confused by "experts" in the satellite field. Technically, the two signals are circular polarized: RHCP means right hand polarization and LHCP stands for left hand polarization. Here's how it looks and how to remember it.

Hold out your fists with your thumbs pointed up. Notice that the right fist has the fingers curled counterclockwise and that the left fist has the fingers curled clockwise. This is exactly how the satellite distinguishes between the signals — one is clockwise and the other is counterclockwise. By doing this, the satellite can double the number of channels it can send. But here's where the technophobia gets in the way. If you go to the Good Guys, they call RHCP horizontal polarization and LHCP vertical polarization — which it can't be because, as you astutely point out, the satellite has a spin to it. There's no way the satellite can guarantee horizontal and vertical orientation, hence the reason for RHCP and LHCP. Here's a good Web site for more information on the subject:
http://www.21st-satellite.com/sat_tv.html.

Current A-to-D Converter

Q. I know DMM meters can read current and display them in digital format. How is this accomplished? I've been looking for a circuit that will allow me to measure telephone line current and include this circuit in a handheld device I am working on.

Tim Edwards
via Internet

A. Basically, what the DMM is doing is measuring the voltage drop across a series resistor. Using Ohm's Law, E = IR, we can see that anytime current flows through a resistance, voltage is developed. The off-hook current through the phone line is typically 20 mA, so let's use this value to calculate the size of the resistor. That formula is R = E/I. Now we have to pick a voltage. Let's say that in one case we need one volt to trigger the mechanism and in the other we want 200 mV as the trigger point. Here's the math.

$R = E/I = 1V/20mA = 50$ ohms
$R = E/I = 200mV/20mA = 10$ ohms

What you need to do is break one of the phone lines and insert the resistor. You can now use any A/D device to translate the line current into a voltage by rearranging the Ohm's Law formula around to I = E/R.

If the R is 50 ohms and the E is 0.5 volts, then the line current is 10 mA (I = 0.5V/50 ohms = 10 mA). I don't know what your application is, but a very cheap way to digitize voltages like this is the CA3162 chip from Harris (who has recently become Intersil). It's available from several sources, including **Digi-Key (1-800-344-4539; http://www.digikey.com)** and **Jameco (1-800-831-4242; http://www.jameco.com).**

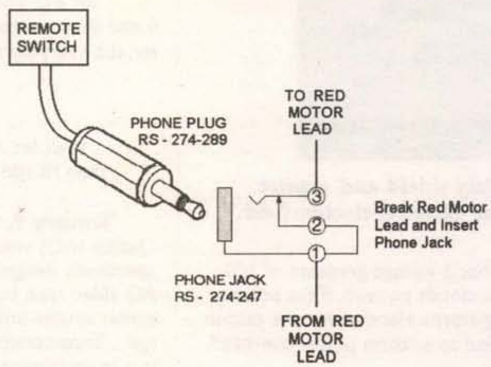
If, however, all you want to do is activate a relay when the receiver is off hook, I'd use the simple remote switch relay circuit shown in the "Add Remote Control to Cassette Recorder" question below.

Add Remote Control to Cassette Recorder

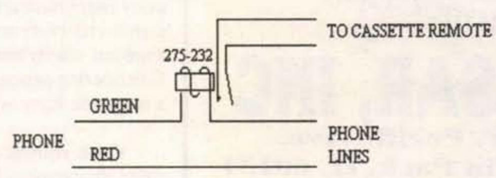
Q. RadioShack has a new nifty miniature standard cassette tape recorder, the Optimus CTR-114 (14-1120). It has automatic reverse, two speeds, normal/extended recording speed, vox — everything one might want, except for one. They didn't put a remote jack in it for activation by a telephone line or remote switch. Could you give me a circuit that can be installed within the unit that will work with a remote switch? Perhaps you could show a picture and indicate where a jack might be installed and how it would be wired into the existing circuit?

B/O/B
via Internet

A. What I'd do with this recorder is control the remote function via the motor, not the electronics or battery power. When the motor is off, the tape doesn't move but the electronics are active. This ensures that all your settings are in place and ready to roll when the motor is turned on. However, you need to have the motor active when the remote switch is unplugged, which is easily done using a closed-circuit jack like the RadioShack 272-247. Here's how the jack is wired.



First, find a convenient spot to mount the jack and drill a hole. Next, locate the red wire going to the drive motor and cut it in half. Now, insert the jack into the cut line as shown above extending the wires, if necessary and mount the jack into the case. Finally, wire the remote switch into the plug. Need a remote switch for the phone line? Here's one that's easy on the pocketbook and easier to build.



In this circuit, a relay is put in series with the phone line. This simple solution works because both the dial tone and relay are current activated. When you pick up the headset, a current of about 20 mA flows through the red and green wires. The voltage isn't important — it's the current, which is enough to pull in the relay and start the recorder. When you hang up, the relay drops out and stops the tape.

Field Mill Monitors Lightning

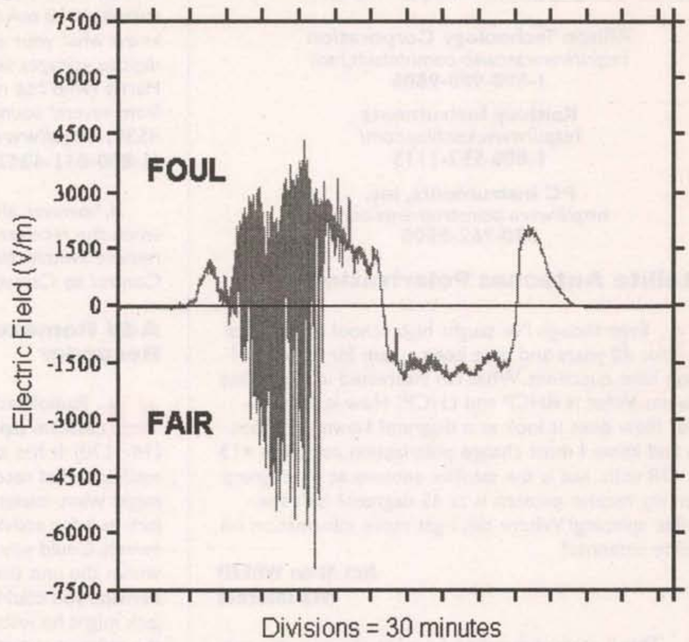
Q. Are you familiar with a device called a "field mill?" It's a machine that's used to detect atmospheric electrostatic charge. NASA uses them around the Cape Canaveral launch sight to warn them of potential lightning storms prior to rocket launches. Apparently, they have a slowly spinning disk, possibly with slots as part of the sensor unit, to monitor the amount of the charge. I'd be interested in hearing about field mill theory.

Forrest Cook WB0RIO
via Internet

A. A field mill monitoring device is nothing more than a very sophisticated electrometer. There is always an electrical charge in the atmosphere. What a field mill does is monitor the atmospheric charge for voltage and polarity, looking for clues that could indicate a change in the weather. However, electrometers are notoriously unstable, which leads to inaccurate measurements. The field mill solves this problem by placing a bowtie-shaped shield over the electrostatic sensors. A small motor spins the rotor to alternately shield and expose the sensors to the atmospheric charge, thus converting it into an AC signal. Op amps have long used this trick to minimize drift by alternately grounding the input and then applying the signal voltage via a circuit called a chopper.

The "bowtie" rotor spins to alternately shield and expose the pie-shaped inner electrodes to the external electric field.

Under normal conditions, the atmosphere has a voltage graduate of 100 volts per meter with the earth negative and the clouds positive. If the polarity reverses, it could indicate an advancing lightning storm. Here's what the output of a field mill looks like over an eight-hour period as a storm passes overhead. The spikes are lightning strikes.



Here are the specifications of a typical field mill instrument, like the kind used to monitor the weather around launch sites.

Number of Electric Field Sensors: 10, expandable to 16.
Electric Field Mill Sensor Specs:

- DC to 10 Hz Dynamic Range: ±1 volt/meter to ±32 kilovolts/meter.
- 16-bit digitizer (50 samples/second).
- Brushless DC motor for low noise and low maintenance.
- Remotely controlled self-calibration.

Tape Trials

Q. Is there any difference between a regular high-quality VHS tape (used for everyday recording) and an extra high-quality VHS tape (used for hi-fi and library recording)? Even though the extra high-quality tape says it's better, the everyday tape seems, logically, to be the more durable tape.

Edvis Shahbazian
Glendale, CA

A. Well, let me take a few excerpts from a couple of TDK press releases, then I'll add my two cents and let you decide for itself.

"**January 9, 1997** — TDK today announced its new line of Advanced Quality (AQ) video cassettes, an affordable, high-quality VHS video tape that's specifically designed to withstand the rigors of daily VCR use. The super-strong AQ video tape boasts superior durability, thanks to a specially engineered binder system and an extra-strong base film that resists stretching and breakage ... Tests conducted by TDK reveal that the formulation shows virtually no loss in performance after as many as 200 complete record/playback cycles."

"**January 9, 1997** — TDK, the world's leading manufacturer of high-quality video tape, today announced it will highlight the extraordinary DSS satellite recording capabilities of its advanced Hi-Fi and HD-X Pro VHS video tape with on-pack DSS icons. According to Tim Sullivan, TDK's VP of Marketing, 'To capture the great quality of DSS pictures and sound, you need a tape designed for maximum resolution, low noise and full frequency response — even at EP recording speeds. In this critical six-hour mode, where most tapes achieve poor resolution and less than ideal color reproduction, our advanced formulation E-HG Hi-Fi and HD-X Pro cassettes can capture DSS broadcasts with superior clarity and true home theater sound.' TDK's Multi High-Press Calendering process, along with a high-pressure Shine Finishing process creates a magnetic layer with the smoothest, most mirror-like surface achievable."

If this sounds confusing to you, you're not alone. Lots of times the advertising department is unclear on the concept and makes misleading statements. Basically, the price and quality of the tape has three parts: the size of the magnetic dust, the durability of the plastic backing, and the polish of the surface. Obviously, the coarser the magnetic media, the lower the cost and video quality. This is normally where the cheap tapes cut corners. This also leads to a more abrasive polish, which wears out the heads faster. At the top end, you'll find highly-polished tape with grain so fine it puts cigarette smoke to shame. In between are the "premium" grades, which is what you'll find on most store shelves. The finer the grain, the better the video (or DSS) image at any tape speed — and the longer the tape and your VCR heads will last. Like many things in life, you get what you pay for. Tape quality can usually be judged by it's price.

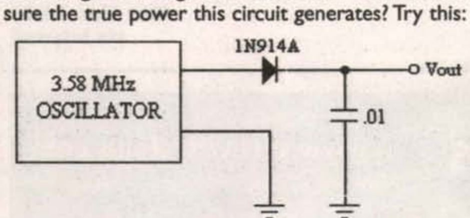
Which tape is best for you? It all depends on what you plan to use it for. For a daily soap that you record while at work to watch that evening, cheap to premium quality is perfect. For movies that you want to save, choose no less than premium quality; they bear the designation high-grade to very-high grade. If you're into digital TV or DSS and want to save the broadcast for posterity, use S-VHS quality tape.

No Free Lunch

Q- I have a RadioShack Micranta range doubler (22-204A) volt-ohmmeter. On all ranges, except current and ohms, my meter goes off scale when I try to measure a 5-volt, 3.58 MHz squarewave by connecting the meter through a 200 pF cap. It even happens on the 1000V AC range. When I reverse the leads, the needle slams negative. I have fun showing this quirk around. Not all meters will do this. There is no measurable voltage across the meter terminals, so I assume the needle movement is caused by magnetic energy (monopole) deposited on the armature. This could be a new power source. Please let your readers know.

name withheld
via Internet

A- So tell me, how many 40W bulbs were you able to light from this untapped power source? No, I'm not making fun of you, because this phenomenon has tricked more than one person. In fact, I interviewed a man from Mississippi several years ago who actually tried to patent this idea as a "perpetual" power source. Sorry to say, though, there's no such thing as a free lunch. Yes, the meter is measuring unseen energy — RF energy, to be exact. The reason the needle pegs is caused by something called dv/dt — the energy spent on raising the voltage from zero to V+ at an extremely fast rate. Want to measure the true power this circuit generates? Try this:



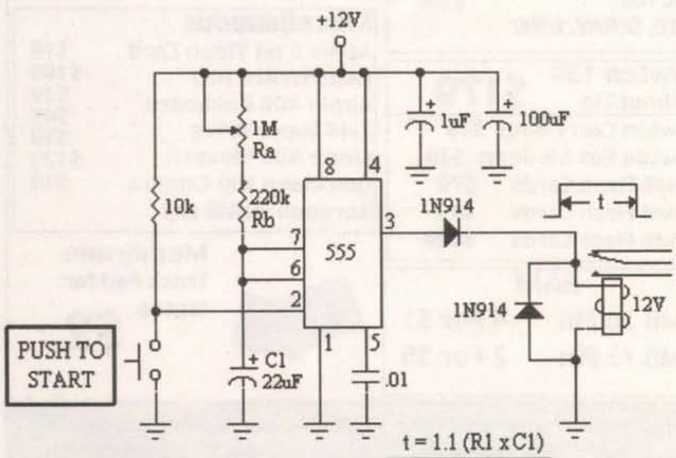
Basically, the diode rectifies the RF output and the 0.01uF capacitor filters it. I suspect the output will be 2 to 3 volts unloaded. Slap a 100-ohm resistor across the output, though, and you'll discover there's not as much power there as you suspect as the voltage drops to about 0.2 volts.

555 Relay Circuit

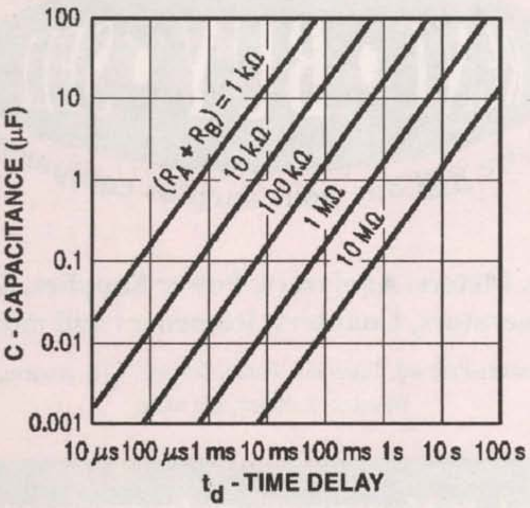
Q- What I need is a circuit which can be used in a 12-volt automobile that, once activated, stays on for an adjustable period of 10 to 30 seconds. I've looked in every book and publication I can get my hands on, but find nothing anywhere close to what I want. Can you help me?

Frank Schwartz
via Internet

A- This requirement is easily satisfied using a 555 timer chip.



This is your basic 555 monostable multivibrator. When a negative pulse is applied at pin 2, by pressing the Start button, it turns off a transistor that normally shorts C1 to ground. This causes the output (pin 3) to go high. The capacitor now charges at a rate determined by the series resistors (Ra and Rb), using the formula t = 1.1 (R1 x C1). When the charge on C1 equals 2/3 Vcc, the output goes low and the timing cycle screeches to a halt until the Start button is pressed again. With the values given, the timer ranges from about eight seconds to a little over 30 seconds. Here's a graphics that you can use to calculate different time-out periods.



Need Technical Help? Check Out These Web Sites

HelpMe — http://www.helpme.com
Interesting tech stories plucked from various publications and links to other help Web sites.

Windows 95 Information Site — http://www.mbnet.mb.ca/win/Window95.html
Links to Microsoft tech support and independent Windows 95/98 support sites.

TJ Byers
Q & A Editor

MAILBAG

Dear TJ Byers:

In your discussion of digital thermometers in the July '99 issue, you described the Kelvin with "It's the same measurement as centigrade." As I recall, "centigrade" is a pseudo measurement that went out with high-button shoes. It's obvious that many of us living in North America abhor the metric system, and when some reporters saw "°C" on a temperature dial, they invented an avoirdupois scale to fit "degrees C" without going metric. People are now using the world-wide scale of Celsius. "Centigrade" has passed on, along with micro-micro-farad and "mickey-mikes" (now picofarad).

Joseph Kish
via Internet

Dear TJ Byers:

There was a question in your last column about how to find shorted components the easy way. A method I've used in business radio, etc., involves two multimeters. Set one of the meters to ohms, and attach it to the power input points of the unit under test. This will give you a low current voltage drop from the meter to the short. Now, take the second meter on volts (a DMM works best), and search down the circuit until you find a component with zero volts to ground across it and you are on the doorstep of your short. There are some exceptions to the above method, but it will eliminate a good share of the circuit and put you in the area of the short. One such case is that in which you have more than one bad component to find, but it will lead you to them one at a time if you just hang in there. Please pass this one along to the next generation of technicians. Thanks.

Lewis Baker W7PAW
(Ret. Elec. Tech)
via Internet

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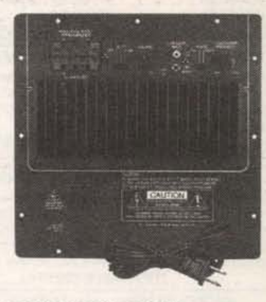

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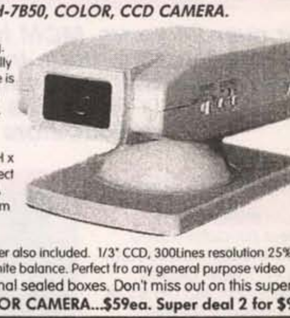

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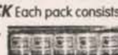

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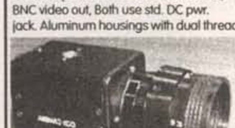

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Model Z5......$349ea. Model Z10......$399ea.
New ZOOM LENS CONTROLLER...............$169ea.

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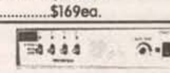

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WEATHER RESISTANT Camera Enclosure,

Solid, extruded aircraft aluminum. Glass window. Strain reliefs for cables. Size: 3.5"w x 3.7"h x14"L,
Special.$59ea. w/110V heater..$69ea.
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Audio Design With Op-Amps

by Thomas Henry

There's no doubt that the development of the op-amp has simplified audio design to the point where even beginners can get involved fairly early on.

Op-amps are a snap to use, difficult to damage, and give stable performance under a variety of conditions. And the literature on the subject is immense; there are no end of books and magazine articles explaining their use.

Unfortunately, most of these resources tend to treat only the "ideal op-amp" and fail to take into account the real-world subtleties that lead to a polished design.

So, the purpose of this article is to fill in the gaps by showing you some of the op-amp techniques required for the design of high quality, low noise audio circuits. You'll find the basic formulas you need to get started, of course, in addition to a few not so well-known tricks.

We'll assume that you're already somewhat familiar with op-amp basics. However, to make sure we're all starting from the same point, let's review two essential principles. First, an op-amp has two inputs and one output. The inputs are differential in nature; one of them inverts the incoming signal while the other one doesn't. Not surprisingly, these are called the inverting and non-inverting inputs, respectively. A signal appearing at the inverting input will be subtracted from the final mix, while that appearing at the non-inverting input will be added.

Next, as it comes off of the shelf, an op-amp has a huge amount of inherent gain when it runs open loop. But in the real world, a huge amount of gain means lots of headaches like self-oscillation, distortion, and noise. So one of the basic principles of op-amp design is that, for stable performance, it is best to feed some of the output signal back around to the inverting input. Since we're now subtracting from the overall mix, this has the effect of reducing the gain to a more sensible figure. The name given to this is "negative feedback." With these basic ideas in mind, then, let's turn to some practical circuits.

VOLTAGE FOLLOWERS

As you might suspect from an examination of Figure 1, the voltage follower is the simplest of op-amp configurations. Recall from above that the signal fed back from the output to the inverting input lowers the gain of an amplifier. In this case, we have 100% feedback.

As the output tries to rise, the signal fed back to the inverting input pulls it back down again. The upshot is that the voltage follower has a gain of 1. That might seem like a useless feature until you look into what's happening to the current. While the voltage isn't amplified at all, the current is.

To put it another way, the output impedance is very low, typically below 100 ohms for most op-amps. Add to this the fact that the input impedance is gigantic (from several to many megohms for most op-amps) and the purpose of the voltage follower becomes obvious: It's superb as a buffer. (Input impedance is abbreviated as "In Z" in all of the figures.)

In audio circuits, we use buffers to keep the input of one stage from loading down the output of the previous. Loading is definitely something we can do without; it leads to a drop in the high end response of an audio circuit, and attenuation in general.

There is a problem with Figure 1(a), however. With a gigantic input impedance, a wire leading up to the non-inverting input can act as an antenna for RF (radio frequency) signals. In some circumstances, you might actually detect a radio broadcast, but more likely you'll get some nasty distortion as the RF interacts with the audio signal.

The way to get around this is simple: Reduce the input impedance to a more sane level. Figure 1(b) shows how to do this. Since the outboard resistor parallels the inherent input impedance of the op-amp (which is so much larger), for all practical purposes, the resulting impedance is just the resistance of R.

There are several factors you'll have to balance when choosing R for your voltage follower. First, if it's too small, then obviously you're losing the advantage of the buffer. Remember, a low input impedance can load down the previous stage. And if it's too large, you're back to the problem of RF interference. As a general rule of thumb for most audio circuits, values between 100K and 1M are about right, with 500K being a good choice to start with. (More about this later when we take up the topic of source resistance.) But there's another easy trick we can pull to minimize RF reception.

Notice how capacitor C straddles R in Figure 1(b). This attenuates the signals above a certain frequency by dumping them to ground. The equation in the diagram gives the -3dB point, that is, the frequency in Hertz at which the signal starts to fall off at a more rapid clip.

In general, audio circuits need only pass signals lying between about 20Hz to 20KHz. So if we choose the -3dB point to be somewhat above this, say 33KHz or so, then we can be assured that all of the audio information will be passed while the supersonic garbage will be dispensed with.

Figure 2 shows an application for the voltage follower which is not so well known and yet is extremely handy. It's a blend control which can be used to mix two audio signals continuously in any desired proportion. This is the sort of thing you might need in a musical instrument amplifier, for instance, when you wish to combine the straight sound with a reverb effect.

The circuit performs very well, however, there are two points to keep in mind when using it. First, the two signals which are combined at the ends of the potentiometer must come from low impedance sources. Generally, you'll be mixing the outputs of two preceding op-amp stages so that won't be a problem. Next, if the potentiometer is mounted on a front panel which is more than several inches away from the circuit board, then it is vital that shielded cabling be used.

The 500K pot represents a fairly high impedance (hence the need for a voltage follower to buffer it), and the wires connecting to it can pick up hum and interference unless shielded.

By the way, the shield of each wire should connect to ground at one end only, say on the circuit board side. This keeps you from getting into ground loop troubles which can be another potential source of hum.

THE NON-INVERTING AMPLIFIER

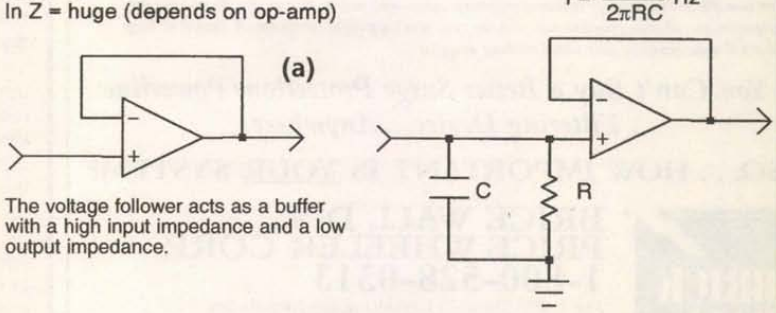
Figure 3 illustrates another useful op-amp configuration, the non-inverting amplifier. Recall that with a voltage follower, there is 100% negative feedback which forces that circuit to have a gain of 1. But here the output is applied to a voltage divider comprising R2 and R3. Hence, only a portion of the output (tapped off of the tie point of the two resistors) is fed back to the

FIG. 1 — The Voltage Follower

Gain = 1
In Z = huge (depends on op-amp)

Gain = 1
In Z = R

$$f = \frac{1}{2\pi RC}\ \text{Hz}$$



The voltage follower acts as a buffer with a high input impedance and a low output impedance.

Adding resistor R lets you set the input impedance to some practical value. C is used to dump any RF or supersonic oscillations above the frequency f to ground.

inverting input. This lets us set the gain of the non-inverting amplifier to any value above unity, depending only on the ratio of R2 and R3. Figure 3(a) gives the required formula. Due to the fixed term of 1 in the equation, the gain can never be less than that value.

By the way, R1 is used to set the input impedance of the amplifier as before. We already know that choosing the value of this resistor balances good buffering against RF reception. But there is a third concern that we should look into right now.

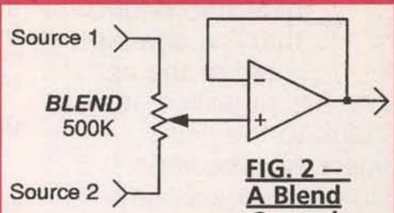


FIG. 2 — A Blend Control

The 500K potentiometer lets you pick off a continuously variable blend of Source 1 and Source 2. The voltage follower buffers this mix.

In engineering terms, R1 is usually called the source resistance. It is a fact of physics that anytime current passes through a resistor, electrical noise is produced. The source resistance, of course, is connected to an amplifier with possibly high gain, and so the noise will also be boosted. Incidentally, some types of resistors (like carbon composition) are noisier than others.

It can be shown by simple experimentation that for bipolar op-amps in general, a low source resistance gives the best noise performance. For example, with a 741 op-amp, lowering the source resistance from 100K to 10K drops the noise amplitude by a factor of about four.

On the other hand, bifet op-amps (like the TL071) are a trifle noisier than bipolar types, but only with low source resistances. In fact, the noise level barely rises as you move from 10K to 100K. This suggests a couple useful rules of thumb.

First, for low noise performance, it is generally best to keep the source resistance relatively low. Second, if you must have a high source resistance, switch over to a bifet type op-amp which gives much quieter performance than a bipolar type in this case.

We can apply what we've just learned to a really slick application sure to be popular with electric guitarists. See Figure 3(b). This is still a non-inverting amplifier whose gain is set by R2 and R3. But notice now how the input is fed directly by the guitar pickup, which is nothing more than a coil type transducer. (R1 is simply there to protect the op-amp from static electricity discharge and needn't figure into our discussion).

With this arrangement, we obtain an extremely low source resistance, on the order of several kilohms, since the pickup coil is merely a hank of wire. This brings the noise level down quite nicely, as discussed earlier.

But there are a couple other advantages to the approach taken in Figure 3(b). Since the pickup coil is applied directly to the op-amp (again, ignoring R1), we get the benefit of the non-inverting input's gigantic impedance. The buffering is as good as it gets here! The frequency response of this circuit will be excellent since loading is all but eliminated.

Finally, consider that most guitar gear of the past has been AC coupled; that is, the electric guitar signal passes through a capacitor, and then on to the preamplifier. But the direct connect method shown here avoids the cap altogether which leads to better phase and frequency response.

Before leaving this unusual application, observe that there is one condition which must be met for good performance. We've already noted that a long wire leading up to the non-inverting input of an op-amp can act as an antenna.

So, this suggests that the circuit is at its best when built literally right inside the electric guitar. This keeps the connection from the pickup coil to the op-amp relatively short. And, of course, the connecting wire should be shielded, with the braid connecting to ground at one end only.

THE INVERTING AMPLIFIER

The inverting amplifier configuration is shown in Figure 4. In this circuit, the output will always be a mirror image of the input (positive becomes negative, and vice versa). As usual, the principle of negative feedback is used to adjust the gain as desired, obeying the formula shown in the diagram. Notice now that its value can be set less than 1 if desired (ignoring the sign change, of course). This is just one of the reasons why we frequently use the inverting amp in lieu of the non-inverting amp.

But another reason this configuration is so useful depends on a characteristic of the inverting input. Due to the internal components of the chip, the inverting input behaves as though it were sitting at ground potential. In fact, the term "virtual ground" is applied to it. This suggests that we can combine a variety of signals here; since they're all being driven through their respective resistors into what is apparently just a ground point, interaction is minimized. And that's exactly what we want from a mixer.

Figure 4(b) explains this. In this case, "n" different inputs are applied to "n" separate resistors, respectively, and these are summed into the virtual ground of the inverting input. A mixed (and inverted) version is now available at the output. Notice that you can set the gain and input impedance for each source independently of the others.

When you're calculating the values of the resistors in a mixer, be sure to take into account what the largest possible output might be if all of the signals should max out at once. An op-amp is typically powered by a bipolar supply, usually between 9V and 15V. And most op-amp outputs can only swing up to within a volt or two shy of the supply rails. So, to avoid distortion, make certain that your mix never bumps into either the plus or minus extremes. If it does, adjust the feedback resistor RF downward to lower the gain of the mixer.

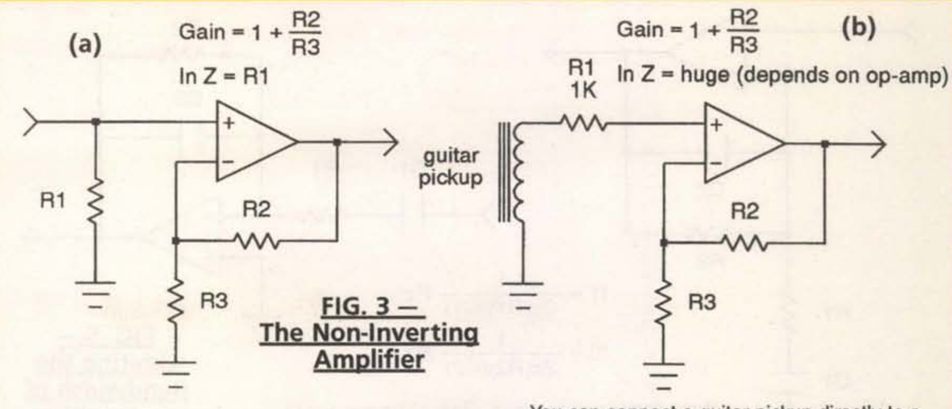
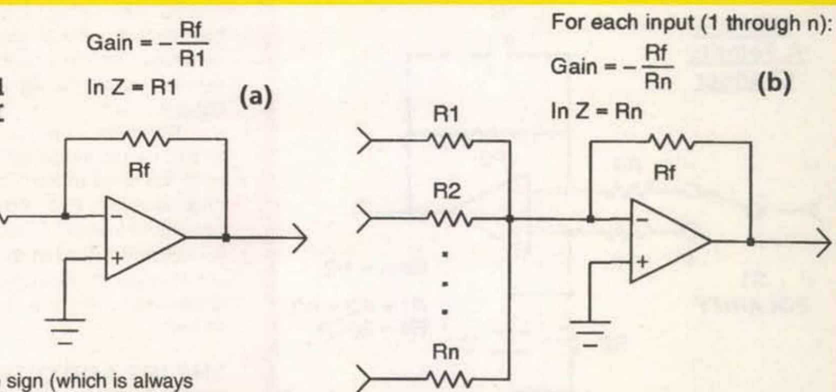


FIG. 3 — The Non-Inverting Amplifier

This is the basic non-inverting amplifier. Notice that the gain can never be less than 1.

You can connect a guitar pickup directly to a non-inverting amplifier for greatly improved noise, frequency, and phase performance.

FIG. 4 — The Inverting Amplifier



Ignoring the sign (which is always negative), the gain of an inverting amplifier may be greater than or less than 1.

A mixer is created by applying the technique of part (a) repeatedly. The gain and impedance of each input can be set independently of the others.

BANDWIDTH LIMITING

We've already seen how to dump RF garbage to ground in the voltage follower. Let's generalize this now by taking up the subject of bandwidth limiting. The basic notion here is that if frequencies above and below the audio band contribute nothing to the overall sound, then why not get rid of them altogether. You might think attenuating frequencies beyond human hearing would have no discernible impact. For example, if radio signals of, say, 100KHz are running through your system, will you even notice them? As it turns out, RF garbage can, in fact, alias downward and corrupt audio signals, popping up again as distortion.

Another good reason for bandwidth limiting is that some types of op-amps can start to self-oscillate at super high frequencies under certain conditions. In fact, this is fairly common when a bifet type is driving a capacitive load. Under such circumstances, the chip starts to draw a hefty current and can even heat up to the point of being harmful to its health. By limiting the high end somewhat, we can stop this unwanted behavior at once.

Figure 5 shows how to limit the low and high response of audio circuits built around op-amps. The calculations are simple to do, and the formulas are easy to remember owing to their similarity. Best of all, they apply to both the inverting and non-inverting amplifiers. The formula for f1 determines the frequency where the bass response falls by -3dB. Similarly, the formula for f2 determines where the treble response falls off by -3dB.

Using these formulas, then, you could decide to limit the low response at 10Hz, say, and the high response at 33KHz, for example. The pass band is plenty wide enough to permit audio frequencies through, and yet narrow enough to reject any subsonic or supersonic rubbish.

A POLARITY CHANGER

Figure 6 shows a rather unusual circuit that is extremely useful in audio modification devices like phase shifters or analog delay units: a polarity changer. As the name suggests, its purpose is to either invert or not invert the input signal, depending on the switch setting. As it turns out, adding or subtracting a modified signal from the straight signal often leads to two very different sounds.

The circuit is easy to understand, since it is really nothing more than a combination of the voltage follower and inverting amplifier already discussed. When S1 is in the "minus" position, then R1 simply floats, while R2 ties the non-inverting input to ground. The signal passes through R4 to the inverting input. As you can see, this is the inverting amplifier configuration. The ratio of R3 and R4 gives the gain, which is half since R3 is half the value of R4.

By flipping the switch to the "plus" position, R4 now floats, and R3 simply provides a 100%

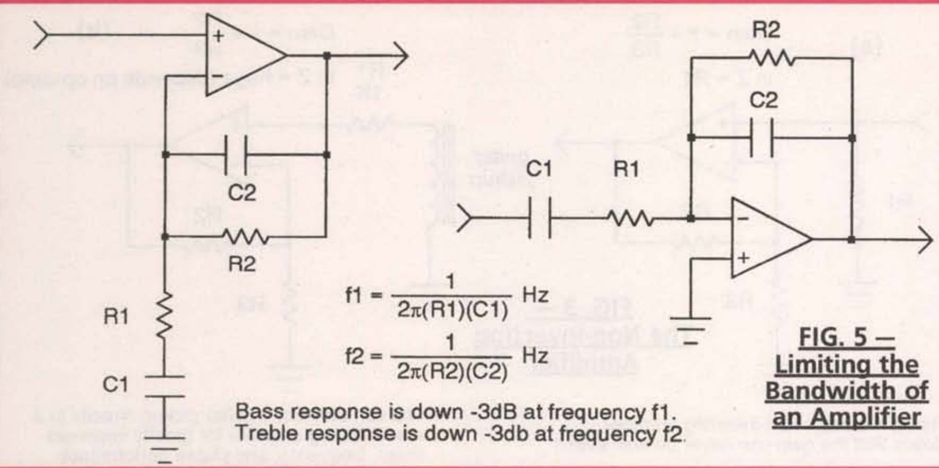


FIG. 5 — Limiting the Bandwidth of an Amplifier

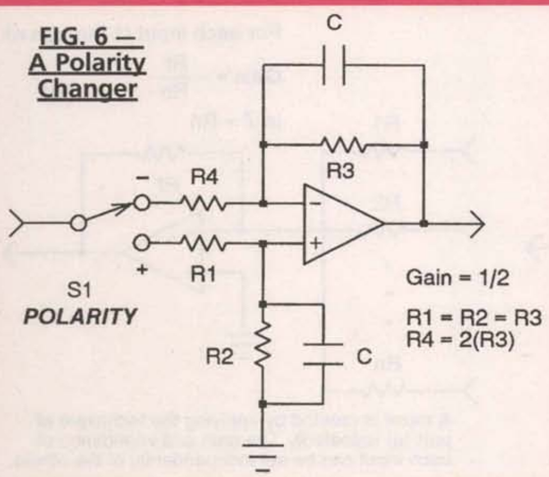


FIG. 6 — A Polarity Changer

A polarity changer is used to either invert or leave the input unchanged, depending on the setting of S1. The output amplitude is one-half that of the input in either case. The capacitors attenuate any undesired RF garbage.

negative feedback loop. The input signal is dropped across the voltage divider comprising R1 and R2. The voltage follower then buffers the signal at the tie point of these two resistors. Since the resistors are equal, the signal is again halved.

The three wires connecting S1 to this circuit should be shielded, with the braid of each attached to ground at one end only. The two capacitors labeled C help knock any RF nonsense dead in its tracks. Use the formula for f2 from Figure 5 to determine where the -3dB point is to be.

THE INS AND OUTS OF VOLUME CONTROLS

Many of the audio circuits you design with op-amps will need to have their gains tamed with a volume control of some sort. Believe it or not, even a simple feature like this involves a fair amount of subtlety. Figure 7 shows four different approaches; let's examine them one-by-one.

As we've already seen, in an inverting amplifier, the smaller the feedback resistor, the less the gain (with the input resistor held fixed). Many beginners attempt to apply this fact by coming up with the circuit in Figure 7(a).

Theoretically, there's nothing wrong with the method. But consider what could happen with a "real-world" potentiometer. Suppose the wiper loses contact with the resistive element in the pot (and this can happen depending on age and quality). All of a sudden, the op-amp is running open loop, with a gain of thousands! You might hear a single pop, or you might hear an uncontrolled roaring, depending on the rest of the circuit. In either case, your ears aren't going to like it! So we'll eschew this type of volume control as a general rule. Let's see some better ways of handling things.

Figures 7(b) and 7(c) show how to string up a pot on the front end of an amplifier. In the first, we buffer the wiper of the volume control with a voltage follower. R1's full range value becomes the input impedance and all of the previous considerations apply when selecting its value. As usual, we strap in C to attenuate any potential RF interference.

In the case of the inverting amplifier of Figure 7(c), the input impedance varies depending both on the value and setting of the potentiometer and the value of R2. Things can get pretty tricky in short order since there's a parallel resistance effect going on and one of the resistors is continuously variable! (R1 provides a path to ground, and R2 provides a parallel path to a virtual ground).

However, there is a decent rule of thumb which will generally hold you in good stead: choose R2 to be 10 times the value of R1. Thus, the impact of R2 is minimized, and you can consider the input impedance to be simply the value of R1. But there's an even more important benefit to this choice and it has to do with the "feel" of the control. The response of a pot, called its taper, establishes this.

A linear taper potentiometer moves smoothly across all values from low to high in a straight line fashion. But an audio taper pot is logarithmic in nature and acts a little more quickly at the low end, while slowing down at the top. You select the taper of the potentiometer according to your application.

Now, if R2 were equal to R1, say, then you'd get into that variable parallel resistance business mentioned above. The feel of the control would become distorted. Keeping resistor R2 large compared to R1 lessens the effect.

By the way, this circuit makes a good front end for the mixer shown in Figure 4(b). For most audio work, choosing the pots to be 10K and the resistors to be 100K works quite well.

It is frequently the case that you'll want to control the volume of some final output stage just as the signal makes its exit to any outboard gear. Figure 7(d) shows how to do this. Notice that the capacitor precedes the output pot, and not the other way around. The reason for this is simple, but not all that obvious.

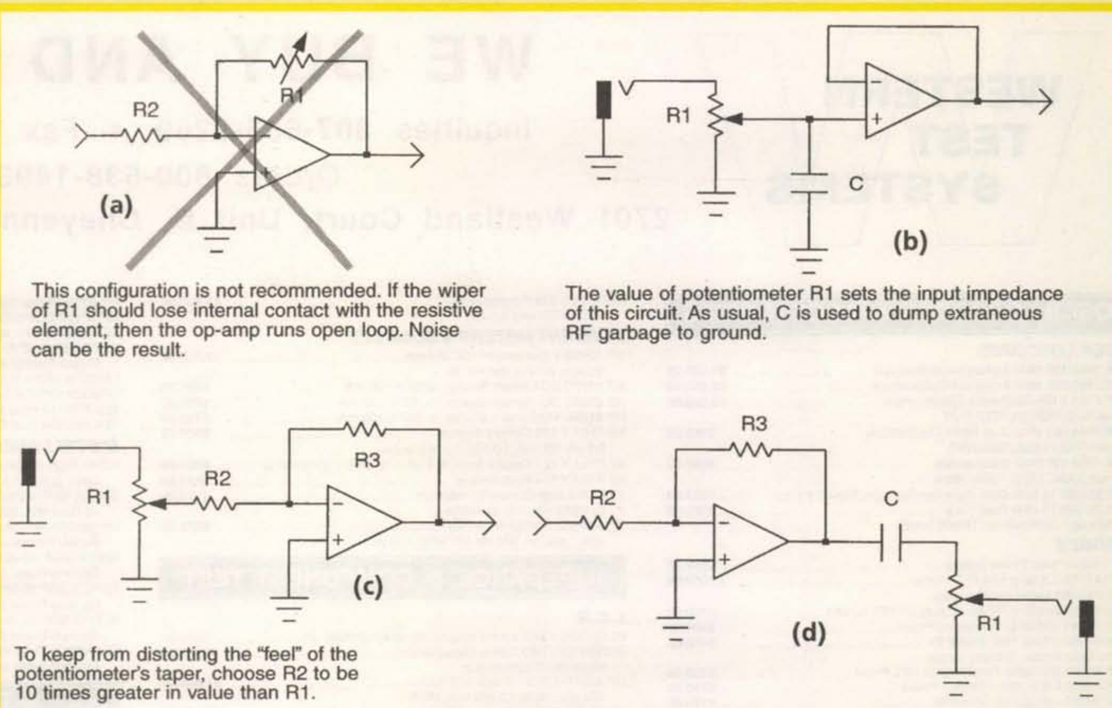
If there should happen to be any DC bias riding on the signal as it leaves the op-amp, the capacitor will block it before it gets to the potentiometer. This helps reduce any scratchiness or pops as you spin the pot shaft.

Be sure to pick C large enough so that you don't limit the bass response unintentionally. For example, with a 10K potentiometer (a common value for audio circuits), C should be 2.2 mfd or even 10 mfd. This guarantees that the -3dB point is well under the lowest perceivable audio frequency. And the cap should probably be a nonpolarized electrolytic, unless you are certain of the polarity of any preceding DC bias.

THIS IS JUST THE START!

And there you have it, a collection of tips and ideas for designing your own low noise audio circuits with op-amps. Of course, there is much more to the subject, but this should provide you with a solid groundwork on which to build.

Naturally, you'll want to turn to other articles and books to increase your expertise. But perhaps, even more important, is the time you spend in the lab actually building and testing various devices. That's where you'll really start to get a feel for circuit actions. And if you learn from your experiences (keep a notebook!), you'll soon find yourself becoming quite a pro at audio design with op-amps. **NV**



This configuration is not recommended. If the wiper of R1 should lose internal contact with the resistive element, then the op-amp runs open loop. Noise can be the result.

The value of potentiometer R1 sets the input impedance of this circuit. As usual, C is used to dump extraneous RF garbage to ground.

To keep from distorting the "feel" of the potentiometer's taper, choose R2 to be 10 times greater in value than R1.

C blocks any DC from the potentiometer, which helps prevent a scratchy sound.

FIG. 7 — Adding a Volume Control to an Op-Amp Circuit

ACKNOWLEDGMENT: Craig Anderton came up with the clever idea of interfacing an electric guitar pickup directly to the non-inverting input of an op-amp. He first described it in his article, "Low Noise Preamp Input Stage," which appeared in DEVICE Newsletter, Volume 1, Number 12, p. 11. I want to thank Craig here for writing that and his countless other articles which have so greatly influenced all of us who love do-it-yourself audio projects.

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HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz	$800.00
HP 33321K Programmable Step Atten., 0-70 dB, DC-26.5 GHz, 3.5mm	$475.00
HP 33327L-006 Programmable Step Attenuator, 0-70 dB, DC-40 GHz, 2.9mm	$1,000.00
HP 774D Dual Directional Coupler, 20 dB, 215-450 MHz	$275.00
HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz	$275.00
HP 778D-011 Dual Dir. Coupler, 20 dB, 100-2000 MHz, APC7 test port	$450.00
HP 8431A 2-4 GHz Band Pass Filter, N(m/f)	$150.00
HP 8472A Crystal Detector, 10 MHz-18 GHz, negative polarity, SMA	$175.00
HP 8494G-002 Programmable Step Attenuator, 0-11 dB, DC-4 GHz, SMA	$350.00
HP 8495H-002 Programmable Step Attenuator, 0-70 dB, DC-18 GHz, SMA	$400.00
HP 8496A-002 Step Attenuator, 0-110 dB, DC-4 GHz, SMA	$375.00
HP 8497K-004 Programmable Step Attenuator, 0-90 dB, DC-26.5 GHz	$750.00
HP K382A WR42 Direct Reading Attenuator, 0-50 dB, 18-26.5 GHz	$2,900.00
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz	$350.00
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz	$450.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz	$275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz	$300.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz	$650.00
HP R422A WR28 Crystal Detector, 26.5-40 GHz	$400.00
HP R532A WR28 Frequency Meter, 26.5-40 GHz	$500.00
HP R752C WR28 Directional Coupler, 10 dB, 26.5-40 GHz	$450.00
HP R752D WR28 Directional Coupler, 20 dB, 26.5-40 GHz	$450.00
HP R914B WR28 Moving Load, 26.5-40 GHz	$250.00
HP V365A WR15 Isolator, 25 dB, 50-75 GHz	$750.00
HP V752D WR15 Directional Coupler, 20 dB, 50-75 GHz	$650.00
HP X870A WR90 Slide Screw Tuner	$150.00
HUGHES 45712H-1000 WR22 Frequency Meter, 33-50 GHz	$900.00
HUGHES 45714H-1000 WR15 Frequency Meter, 50-75 GHz	$900.00
HUGHES 45716H-1000 WR10 Frequency Meter, 75-110 GHz	$900.00
HUGHES 45721H-1000 WR28 Direct Reading Attenuator, 0-50 dB, 26.5-40 GHz	$900.00
HUGHES 45724H-1000 WR15 Direct Reading Attenuator, 0-50 dB, 50-75 GHz	$1,000.00
HUGHES 45732H-1200 WR22 Level Set Attenuator, 0-25 dB, 33-50 GHz	$250.00
HUGHES 45772H-1100 WR22 Thermistor Mount, -20 to +10 dBm, 33-50 GHz	$400.00
HUGHES 45773H-1100 WR19 Thermistor Mount, -20 to +10 dBm, 40-60 GHz	$650.00
HUGHES 45774H-1100 WR15 Thermistor Mount, -20 to +10 dBm, 50-75 GHz	$750.00
HUGHES 45775H-1100 WR12 Thermistor Mount, -20 to +10 dBm, 60-90 GHz	$800.00
HUGHES 45776H-1100 WR10 Thermistor Mount, -20 to +10 dBm, 75-110 GHz	$850.00
HUGHES 47316H-1111 WR10 Tuneable Detector, 75-110 GHz, positive polarity	$600.00
HUGHES 47741H-2310 WR28 Phase Locked Gunn Osc., 32.000 GHz, +18 dBm	$2,000.00
HUGHES 47742H-1210 WR22 Phase Locked Gunn Osc., 42.000 GHz, +18 dBm	$2,750.00
HUGHES 47974H-1000 WR15 SPST PIN Switch, 250 MHz speed, 60-62 GHz response	$375.00
KRYTAR 2616S Directional Detector, 1.7-26.5 GHz, K(f/m)/SMC	$200.00
M/A-COM 3-19-300/10 WR19 Directional Coupler, 10 dB, 40-60 GHz	$450.00
MICA C-121S06 Circulator, 17.5-24.5 GHz, SMA(f/m/m)	$75.00
MIDWEST MICROWAVE 3537 DC Block, 0.1-12.4 GHz, SMA(m/f) *NEW*	$40.00
MINI-CIRCUITS ZFDC-20-4 Directional Coupler, 19.5 dB, 1-1000 MHz, SMA(f)	$25.00
NARDA 3000-SERIES Directional Couplers	$150.00
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz	$300.00
NARDA 3090-SERIES Precision High Directivity Couplers	$225.00
NARDA 368BNM Coaxial High Power Load, 500 Watts, 2.0-18 GHz, N(m)	$500.00
NARDA 3752 Coaxial Phase Shifter, 0-180 deg./GHz, 1-5 GHz	$1,000.00
NARDA 3753B Coaxial Phase Shifter, 0-55 deg./GHz, 3.5-12.4 GHz	$1,000.00
NARDA 4000-SERIES SMA Miniature Directional Couplers	$75.00
NARDA 4226-10 Directional Coupler, 10 dB, 0.5-18.0 GHz, SMA(f)	$275.00
NARDA 4227-16 Directional Coupler, 16 dB, 1.7-26.5 GHz, 3.5mm(f)	$325.00
NARDA 4242-20 Directional Coupler, 20 dB, 0.5-2.0 GHz, SMA(f)	$100.00
NARDA 4247-20 Directional Coupler, 20 dB, 6.0-26.5 GHz, 3.5mm(f)	$200.00
NARDA 4247B-10 Directional Coupler, 10 dB, 6.0-26.5 GHz, 3.5mm(f)	$200.00
NARDA 5070-SERIES Precision Reflectometer Couplers	$300.00
NARDA 562 DC Block, 10 MHz-12.4 GHz, 100 V max., N(m/f)	$65.00
NARDA 765-10 10 dB Attenuator, 50 Watts, DC-5 GHz, N(m/f)	$165.00
NARDA 768-10,-20 10 dB or 20 dB Attenuator, 20 Watts, DC-11 GHz, N(m/f)	$120.00
NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz	$375.00
NARDA 794FM Direct Reading Variable Attenuator, 0-40 dB, 4-8 GHz	$375.00
OMNI-SPECTRA 2085-6010-00 Crystal Detector, 1-18 GHz, negative polarity, SMA(m/f)	$50.00
PAMTECH KYG1014 WR42 Junction Circulator, 18.0-26.5 GHz	$250.00
SONOMA SCIENTIFIC 21A3 WR42 Circulator, 20 dB, 20.6-24.8 GHz	$75.00
TRG B510 WR22 Direct Reading Attenuator, 0-50 dB, 33-50 GHz	$1,000.00
TRG V551 WR15 Frequency Meter, 50-75 GHz	$600.00
TRG W551 WR10 Frequency Meter, 75-110 GHz	$750.00
WAVELINE 100080 WR28 Terminated Crossguide Coupler, 30 dB	$200.00
WEINSCHEL DS109 Double Stub Tuner, 1-13 GHz, N(m/f)	$150.00
WEINSCHEL DS109LL Double Stub Tuner, 0.2-2.0 GHz, N(m/f)	$150.00

COMMUNICATIONS

HP 3780A Pattern Generator / Error Detector, 1 kb/s - 50 Mb/s	$1,000.00
HP 59401A HPIB Bus Analyzer	$400.00
TEK 1410R NTSC Gen., w/SPG2 sync. generator, TSG7 color bars	$800.00
TEK 1411R PAL Gen.,w/SPG12 sync;TSG11 color bars;TSG13 linearity	$750.00
TEK 1411R PAL Test Gen., w/SPG12,TSG11,TSG13,TSG15,TSG16	$1,000.00
TEK 1411R PAL Test Gen., w/SPG12,TSG11,TSG12,TSG13,TSG15,TSG16	$1,100.00
TEK 1411R-opt.04 PAL Test Gen.,w/ SPG12,TSG11,TSP11,TSG13,TSG15,TSG16	$1,400.00
TEK 147A NTSC Test Signal Generator, with noise test signal	$800.00
TEK 148 PAL Insertion Test Signal Generator	$700.00
TEK 520A NTSC Vectorscope	$750.00
TEK 521A PAL Vectorscope	$750.00

MISCELLANEOUS

FLUKE 2180A RTD Digital Thermometer	$500.00
HP 7090A Measurement Plotting System	$1,500.00
KEITHLEY 705 / 2x7055 Scanner	$400.00
P.A.R. 5206-95,98 Two-Phase Lock-in Amp., 2 Hz-100 kHz, GPIB	$1,500.00
TEK TM5003 5000-series 3-slot Programmable Power Module	$450.00
TEK TM5006 5000-series 6-slot Programmable Power Module	$600.00
TEK TM504 500-series 4-slot Power Module	$175.00
TEK TM506 500-series 6-slot Power Module	$250.00
TEK TM515 500-series 5-slot Traveller Power Module	$275.00

Write in 93 on Reader Service Card.

Events CALENDAR

Continued from page 20

FEBRUARY 2000

FEBRUARY 5

MI - NEGAUNEE - Hamfest. Hiawatha ARA, Bill Beitel N8NRG, 906-226-2779.
E-Mail: n8nrg@portup.com

SC - NORTH CHARLESTON - Hamfest. Charleston ARS, Jenny Myers WA4NGV, 843-747-2324. E-Mail: brycemyers@aol.com
Web: http://www.qsl.net/wa4usn/index.html

FEBRUARY 5-6

FL - MIAMI - Southeastern Division Convention. Dade Radio Club, Evelyn Gauzens W4WYR, 305-642-4139. E-Mail: w4wyr@bellsouth.net
Web: http://www.hamboree.org

FEBRUARY 11-12-13

FL - ORLANDO - State Convention. Orlando ARC, Ken Christenson KD4JQR, 407-291-2465.
E-Mail: KD4JQR@Juno.Com
Web: http://www.oarc.org/hamcat.html

FEBRUARY 26

VT - MILTON - NVT Winter Hamfest. High School, Rt. 7. Mitch W1SJ, 802-879-6589. E-Mail: w1sj@arrl.net Web: http://www.ranv.together.com

FEBRUARY 27

FL - ZEPHYRHILLS - Hamfest. Zephyrhills ARC, Ernie Vanselow KD4VRV, 813-783-8389
E-Mail: kd4vrv@gte.net

MARCH 2000

MARCH 4-5

FL - NEW PORT RICHEY - Hamfest. Gulf Coast ARC, Rickie Brown KF4GXS, 727-863-1457. E-Mail: richar@gte.net. Don KK4VK, 727-848-8000.
Web: http://homel.gte.net/koerner/gcarc.htm

MARCH 5

NY - LINDENHURST - Hamfest. GSBARC & SCRC, Lenore N2KYP, 516-785-0826. E-Mail: info@gsbarc.org Web: http://www.gsbarc.org

MARCH 11-12

NC - CHARLOTTE - Charlotte Hamfest and Computerfair. Mecklenburg Amateur Radio Society.

MARCH 18

FL - STUART - Hamfest. Martin County ARA, Romund Madson KS4KM, 561-337-1841

MARCH 18-19

TX - MIDLAND - West Texas ARRL Section Convention, Beverley Harwood KC5BNT, 915-686-1841. E-Mail: shamrock@apex2000.net
Web: http://www.lxnet/edge/midswap.htm

MARCH 19

OH - MAUMEE - Hamfest. Lucas County Recreation Center, 2901 Key St. 8am-2pm. Talk-in: 147.27+ or 442.85+. Toledo Mobile RA, Paul Hanslik, 419-385-5056.
Web: www.tmrahamradio.org

MARCH 25-26

MD - TIMONIUM - Greater Baltimore Hamboree & Computerfest/MD State ARRL Convention. Timonium Fairgrounds, York Rd. Sat: 8am-5pm, Sun: 8am-4pm. VE Exams. Baltimore ARC, Sharon Dobson N3QQC, 410-HAM-FEST or 800-HAM-FEST. E-Mail: n3wd@amsat.org
Web: http://www.gbhc.org

APRIL 2000

APRIL 8

WA - SPOKANE - Hamfest. Lilac City ARC, Warren Kelsey KJ7BB, 509-534-8443

APRIL 9

NC - RALEIGH - State Convention. Raleigh ARC, Chuck Littlewood K4HF, 919-872-6555.
E-Mail: k4hf@arrl.net

WI - STOUGHTON - Hamfest. Madison Area Repeater Assn., Paul Toussaint N9VWH, 608-245-8890. E-Mail: n9vwh@arrl.net

APRIL 16

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html

MI - GROSSE POINTE - Hamfest. South Eastern MI ARA, Jerry Rosner N8FGK, 313-331-3336.
E-Mail: n8fgk@amsat.org

APRIL 21-22

AR - LITTLE ROCK - Little Rock Hamfest, Jim Blackmon K5VZ, 870-246-7833 (h) or 870-246-6734 (w). Fax: 870-246-6736.
E-Mail: lrhamfest@usa.net
Web: http://www.aristotle.net/~ares/hamfest/

APRIL 22

NH - NASHUA - Hamfest. Res Ctr Church. NE Antique RC 617-923-2665

APRIL 29

AL - MOULTON - Hamfest. Bankhead ARC, Web: http://www.n4idx.org

IA - DES MOINES - Hamfest. Des Moines RAA, Duane Bower WB0UCY, 515-287-6542.
E-Mail: duaneab@uswest.net

MAY 2000

MAY 6

WI - CEDARBURG - Hamfest. Ozaukee RC, Joe Holly AA9HR, 262-377-2137; E-Mail: aa9hr@execpc.com. Skip Douglas, 262-284-3271

MAY 6-7

AL - BIRMINGHAM - Hamfest. Glenn Glass KE4YZK, 205-681-5019.
E-Mail: ke4yzk@bellsouth.net Web: http://www.bro.net/barc/slideshow/index.html

MAY 7

NY - YONKERS - Flea Market. Lincoln High School, Kneeland Ave. 9am-3pm. VE Exams. Talk-in: 440.425 PL 156.7, 223.760 PL 67.0, 146.910, 443.350 PL 156.7. Metro 70cm Network, Otto Supliski WB2SLQ, 914-969-1053.
E-Mail: wb2slq@juno.com
Web: http://www.metro70cmnetwork.com

MAY 12-13

NH - ROCHESTER - Hamfest. Fairgrounds. Hoss Traders, Joe, 207-469-3492

MAY 19-20-21

OH - DAYTON - ARRL National Convention. Dayton ARA, Dave Coons, WT8W, 937-849-0604.
E-Mail: wt8w@arrl.org
Web: http://www.hamvention.org

MAY 21

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html

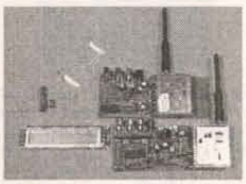
HAM GEAR FOR SALE

WANTED: ROCKWELL-Collins HF-80 equipment, 851S-1, 237B-3 log periodic, Collins literature. Jim Stitzinger 805-259-2011, 805-259-3830 (fax), bfl-jfs@smart link.net

50KW RF generators. made by Westenhouse. Call Mike, phone/fax: 828-684-7672. HTTP://WWW.CHIGE OR.COM

FOR SALE: ORBIT 360 antenna rotator. Full instructions. Never used, $40 obo. 949-494-0072.

LML RADIO & electronics. Let us be your one stop shop for all your radio equipment, test equipment & other surplus needs. Free catalog. Call 909-873-1319 or fax on demand 24 hr. 909-820-1885 & our new web catalog: Http://members.aol.com/hrh6/LMLinc or LML, 424 E. Shamrock, Rialto, CA 92376.



GET FULL control of frequencies from 2.2GHz to 2.7GHz on your existing RF link or Matco transmitters and receivers. These easy-to-assemble kits are fully PIC controlled, have an easy-to-read LCD and store set frequencies in memory. Kits are $59.95 ea. or $99.95 ea. pre-assembled. Additional price breaks are available when sold with transmitter and receiver combination. Inquire at: atvcam@excite.com

ATV-2400, 2.4GHz 8 channel designed for legal use in ham bands. EZATV, www.4atv.com

DRAKE TR7 & R7 service kit extender boards and digital jumper card. Same as originals, $63.20. Bob 509-765-4721. rsrolfne@atnet.net

http://www.hackersheaven.com

HAM GEAR WANTED

ARC-5 RECEIVERS and original manuals. John Broussard, 312 Guilbeau, Breaux Bridge, LA 70517.

WANTED: PROGRAMMER for ICOM IC-H10 handheld radio. 2 versions were available. The stand-alone EX-704 and the PC software version EX-1211 (ver. 4 or higher). Will gladly pay for copying of PC version & instructions. Ph: 217-852-6646.

CB – SCANNERS

HALCON COMMUNICATIONS Wholesale only: Cobra, Uniden, Midland, Galaxy, CTE, Super Star, Kenwood, Yaesu, Icom. Free catalog, Free call 1-800-683-6999.

SALES & SERVICE: CB equipment, modification kits, meters, antennas, mics, radios, transistors, repairs & hard-to-find items. Complete list $4. D&R Electronics, 10 Park St., Thomaston, CT 06787. 860-283-9492 or RTed821836@aol.com

CB MODIFICATIONS! Frequencies, books, kits, high-performance accessories, plans, repairs, amplifiers, 10-meter conversions. The best since 1976! Catalog $3. CBCI, Box 1898NV, Monterey, CA 93942. www.cbcintl.com

Discount electronics books. See the NV Bookstore ad on page 6.

240+ CHANNEL CB/HAM/COMMERCIAL radios: AM/FM/SSB/CW export/domestic: RCI, Motorola, Uniden, Cobra, Alinco, Kenwood. Mics, antennas, linears, meters, books, night scopes, and tons more stuff! Catalog $3. MAXTECH, Box 8086, New York, NY 10150. 718-547-8244.

SHOOTING STAR, Palomar, Superstar, Galaxy, Uniden, Cobra, exports, police & fire & military scanners, microphones, power supplies, antennas, modifications, repairs, more!! 15 yrs. in same location, 5 page picture price sheets $1 (refundable). Galaxy, Box 1202, Akron, OH 44309. (Also, Red Devil & Messinger Products.)

MUSIC & ACCESSORIES

COMPUTER HARDWARE

450MHz BAREBONE systems from $250. 486 computers $99. Brand new Pentiums from $199. Motherboards $20, 1.44/1.2 floppies, speakers $10. Call 714-778-0450.

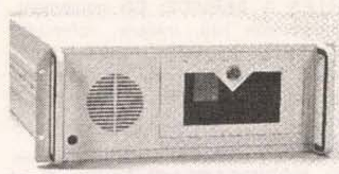
Write in 38 on Reader Service Card.

NEW JVC external SCSI CD-recorder kit with Adaptec card and Adaptec software $130, includes 11 pcs. of media in jewel cases plus cables! New 4meg PCI video card (ATI clone) $25. There are other deals too! For the latest dealsheets E-Mail: dealsheets@utwe.com or call 626-930-1121 (10am-5pm Pacific) or fax 626-930-1123. E-Mail: sales@utwe.com

CRTs CHEAP. Buy direct from the manufacturer. Save money. Mfg. all CRT types since 1950. **3 year warranty**. Reg-Res 19" tubes $75; 25" $100; hi-res 13" tubes from $80. We specialize in **hi-resolution** video/computer CRTs. **T.M.C.** 215-226-0749/215-223-0388.

PC CABLES: http://www.cablesusa.com 100s of hard-to-find new cables and parts, pictures, free technical information. Low prices, RS232, SCSI, keyboard, network, VGA, Cat-5, USB, Firewire, fast secure online ordering & browsing. 954-418-0817.

WE CARRY a variety of cables, switch boxes, accessories, and adapters to connect PCs, printers, Mac's, networks, telecommunications, and audio/video equipment. We offer: custom cables, free catalogs, and same day shipping on most orders. Visit our website at www.rogerssystems.com or call 1-800-366-0579.



19" RACKMOUNT ATX PC chassis, $169 (with ad). 972-242-8087, www.cti-tx.com

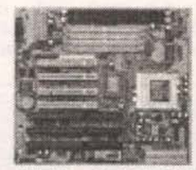
http://www.hackersheaven.com

SONY/AMIGA/MAC/IND. MULTISCANS CPD-1302/1390 TTL/analog sync/gen. Refurb. 6 mo. warr. $175. Pikul & Assoc. 314-937-0335.

TOKEN RING card. SMC Master 32 (EISA). New, unused, $40 ppd. OBO Peter Haas, 720 Portage Trl., Cuyahoga Falls, OH 44221-3035. Pete702@Juno.com

DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dilog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 937-847-2300 OR fax 937-847-2350.

EVERYTHING NEW w/warranty! Motherboards with CPU 450MHz $195, monitors 15" $125. Pentium systems from $195. Modems, multimedia kits, scanners, 2.5 gigabytes hard drive $65. Call 714-778-0450. E-Mail: cci@surfside.net



433MHz INTEL CELERON/A 128K cache CPU and Pentium II motherboard super combo deal including AGP 3D 8MB video, 3D 32 voice PCI digital sound, 1 floppy, 2 UDMA/66 IDE, serial/parallel, USB, IF and PS2 ports, 56K modem/FAX/voicemail, 10/100 LAN, ATX or normal power connectors, CD-ROM disc w/drivers & many FREE applications software, 2 year warranty and super confident upgrade tech support. Only $179. Order and find latest prices or more information at 847-657-1160 or www.saveware.com

433MHz PII system with Intel CELERON/A 128K cache MMX CPU, 6.2 gigabyte hard drive, 44X CD-ROM, 1.44 floppy, 32 megabytes SDIMM memory, 8MB AGP 3D video, 56K modem/voice/fax, 32 voice 3D sound, 360 watt speakers, multimedia keyboard, Internet mouse, ATX professional case, 2 year parts and labor warranty, with the best lifetime tech support to keep you and your computer happy! Only $489! Everything installed with FULL versions WIN95B $49, WIN98 $99. Order and find more information plus latest lower prices at 847-657-1160 or www.saveware.com

SONY PLAYSTATION GAME ENHANCER, mod-chip function plays backup COPY of CD. You do not need to have original loaded to play backup. Simply plug the enhancer in back of playstation! Skips both Sony logos, many preloaded cheat codes, type in more found on the Internet. Memory management function, view video/movie files from CD, PC computer link port $29. Quantity prices available. 240 save game memory card $25. 847-657-1160 or www.saveware.com

4 MB, 72 pin SIMMs $4 ea. **P-100** CPU $25 ea., 400 VA UPS $30 ea. Pikul & Assoc. 314-937-0335.

AMAZING MINI MICRO FM RADIO! $7.50
Much lighter than a heavy jam box with really good sound! This tiny radio (1.5"x1.06"x0.38") has a seek button, reset control, and an on/off switch. Personal listening has never sounded better! Ideal for ballgames, studyhall, and workouts. Battery and nugget style earphones included.

GIANT ARROW KIT
$23.95

It flashes, it chases, it lights up in pretty colors! This giant arrow features 81 yellow and green LEDs, an on/off switch, and a potentiometer to adjust the speed of the arrow action. Comes complete with these and all other parts, a clearly marked circuit board, and an assembly instruction sheet with schematic diagram and troubleshooting tips. Operates on 12VDC, so you can run it on your car battery, a wall pack, or any other appropriate power source you select.

Passive Infra-red Talking Motion Detector !!!
$27.50

"Stay out of that refrigerator !", "Watch your step!", "Do your homework", "Don't touch that remote!" ... The possibilities are mind-boggling with this talking motion detector. You speak into it to record your message (upto 12 seconds long), turn the unit on, and instantly your voice (or your mother-in-laws) reminds anyone in the vicinity that you were expecting them. Message can be changed with the flip of a switch. Uses 4 AA batteries (not included), or an external power source (built-in jack). May be used independently (80 db output) or with an amplified speaker to blast your message throughout the house. Approx 4"x 3-1/2"x 1-1/2".

PHOTON II MICROLIGHT

The popular photon microlight has been improved. These super-bright (better than 8 candellas!) LED lights are visible over a mile away. The LED is secured in a tough ABS case and offers a squeeze button for quick use, and a constant on slide switch for prolonged lighting needs. The lithium batteries last a very long time (10 year shelf life!) and are included. The light won't burn out because it is an LED! Specify your choice of five incredible bright colors. Great for home or office use, popular with fire and rescue professionals, pyrotechnicians, stage performers, and dimly lit restaurant patrons. PHOTON II microlights include a keyring and come in ruby red ($13.50), amber yellow ($13.50) orange ($13.50), sapphire blue ($17.50), diamond white ($17.50), turquoise ($17.50), and emerald green ($17.50). Includes two replaceable 2016 lithium batteries.

RF LINEAR POWER BOOSTER AMPLIFIER KIT $39.95

A quick and simple boost for signal generators, transmitters, and other low power devices, this kit can boost power up to 1 watt over a frequency range of 100 KHz to over 1000 MHz. Operates on 12 to 15 vdc @ 250 mA, via a 2.1mm male power jack. 38 dB gain at 10 MHz, 10dB at 1000 MHz. Optional case $14.95

Geophone
vibration sensing kit
Detect a fly stomping across the desk!

Well maybe not that sensitive, but almost. These vibration sensors made by Geosource® were used in oil exploration to determine geological statistics. They are made with a magnet suspended in a coil and are very sensitive to vibration.

Compact size, the unit measures approx. 1.6" high and 1.2" dia. The kit includes a geophone vibration sensor along with parts to build a basic detector that will light an LED. In addition we include a schematic that will show you how to operate a relay. The sensitivity is adjustable, so you can set it to detect elephants and other small creatures. Similar units were used by our armed forces to detect enemy troop movements...the perfect device to alert you to the pitter patter of little Leroy's feet! Unit sensitivity can be set high enough to detect a business card dropped on a table, and we've made it work with vibrations up to 40 feet away! Earthquake or Aunt Agatha...you decide! It's a fun gadget with many uses.

COMPLETE GEOSENSOR KIT....$ 9.95
GEOSENSOR UNIT ONLY....$7.95

4 inch color video monitor
$195.00

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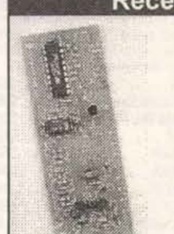

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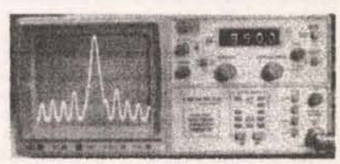

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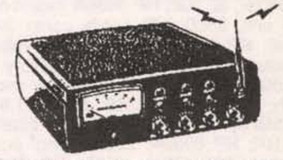

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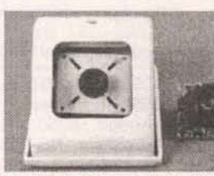

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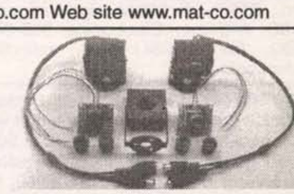

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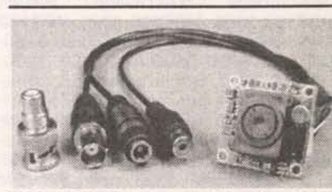

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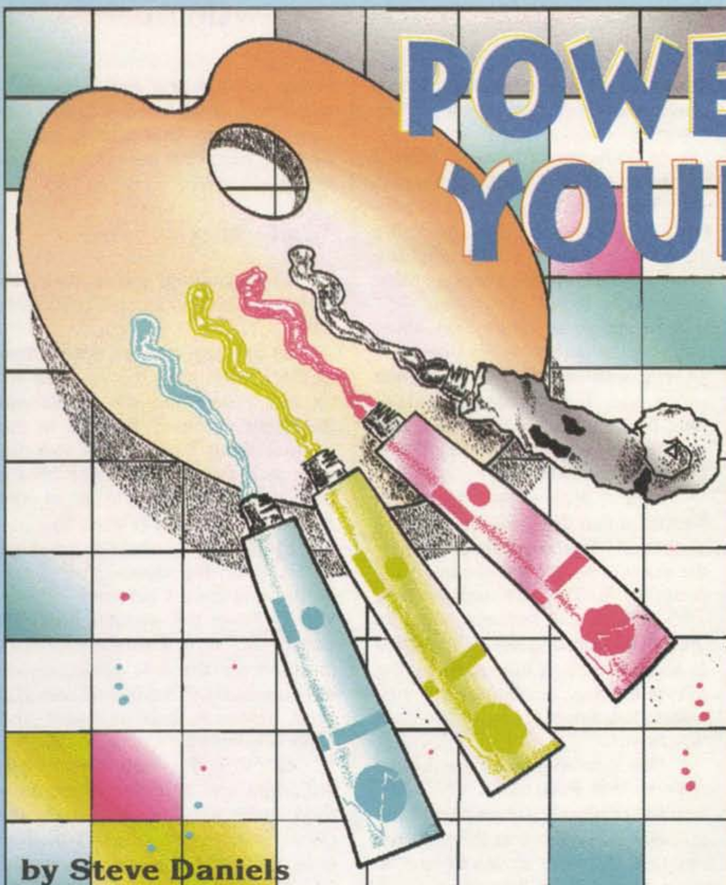
POWERPOINTING YOUR PROJECTS

Part 2



by Steve Daniels

Part 1 described using Microsoft PowerPoint to create a template of schematic symbols. We then used those symbols to draw a complete schematic for a two-chip oscillator circuit.

This article shows the construction of another PowerPoint template — one that will allow us to create artwork for making PC boards. With this new tool, we will be able to take a schematic like the one we just drew and turn it into a finished device.

Design Considerations

To position components accurately on an on-screen "virtual board," we need to create an array of pins or holes a known distance apart. This is used as a background against which to lay down actual-size outlines of components.

When I first tried using PowerPoint to do a PC board, I wanted to draw the array on .10" centers — exactly the same spacing as on the perfboard that I typically use for prototypes. This didn't work well, probably because it pushed the limits of the program and my PC's memory, so I compromised and put the holes on .20" centers.

When drawing, I keep in mind that there is a hole in-between each two holes in my array, and I put components in the spaces, as well as on the holes.

Figure 2 shows a small piece of an array of this scale with a few component outlines and traces positioned both on and in-between the holes.

The finished template (Figure 1) includes a variety of standard component outlines positioned conveniently around the outside of a 6" x 4" composition area.

Laying out a PC board is done in somewhat the same way that we drew a schematic: component outlines are copied to the composition area as required, and connected with straight or angled lines that represent the copper traces on a board.

So that we can see both the components and the connection pattern as it takes shape, the component outlines are deliberately created either semi-transparent or with no fill.

Lines representing traces are gray for contrast when doing a drawing in this "X-Ray" view, but they can easily be made black for printing an etch pattern to transfer to a physical board.

Since the background array of holes is created as a single PowerPoint object, it can be deleted easily when it is no longer needed.

I have used the template shown in Figure 1 for several years now to design boards up to 4" x 6" for many projects; now that I have a 19" monitor, I can go to 5" x 7".

I can generate from one template the three drawings that I need to make and document a board: a component side layout drawing, a pattern of traces for fabricating the solder side, and an "X-Ray" view that shows both the components and the traces.

This article will treat the construction of the background array and accompanying component outlines. Next month, we will use the tool to generate an etch pattern for the schematic that we created in Part 1.

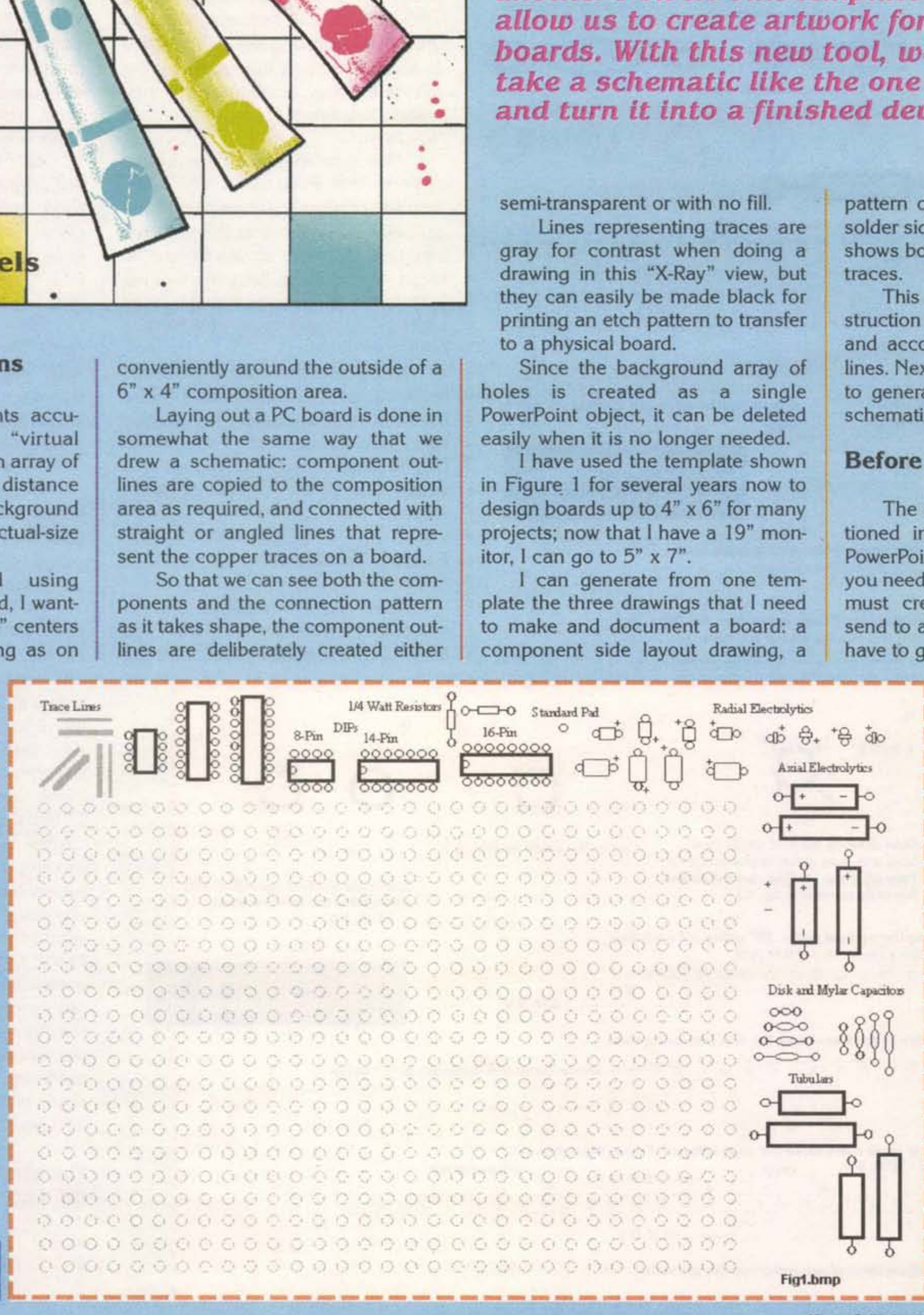


Figure 1 — Finished Template

Before You Start To Draw

The same caveats that I mentioned in Part 1 also apply here: PowerPoint isn't a CAD program; if you need precision to .001", or if you must create Gerber photoplots to send to a PC-board fab house, you'll have to go through the pain of learning to use one of the many commercial board-layout packages out there.

My PowerPoint method will work well for the hobbyist who needs a cheap, technically simple way to create a board or two for his/her own use.

In this article, all menu choices and instructions refer to PowerPoint v7.0; earlier (or later) versions will also work, but some functions needed for this job will be found in different places.

Also, the number of component outlines that you can fit in the library area will depend on the size of your monitor; 17" or better is preferred.

Last, you must be

fluent with the drawing functions of PowerPoint to tackle this template.

Before we forge ahead: In creating this template, we make heavy use of the Guides feature to do precise drawing. Since I don't expect that even experienced users of PowerPoint will have a lot of experience positioning objects to .01", I want to share some things I have noticed about how the Guides feature works at high magnification. Unfortunately, Microsoft's help desk (normally very helpful) couldn't confirm whether my experience represents the way the program is "supposed" to work; they have little documentation on the Guides. See Figure 3.

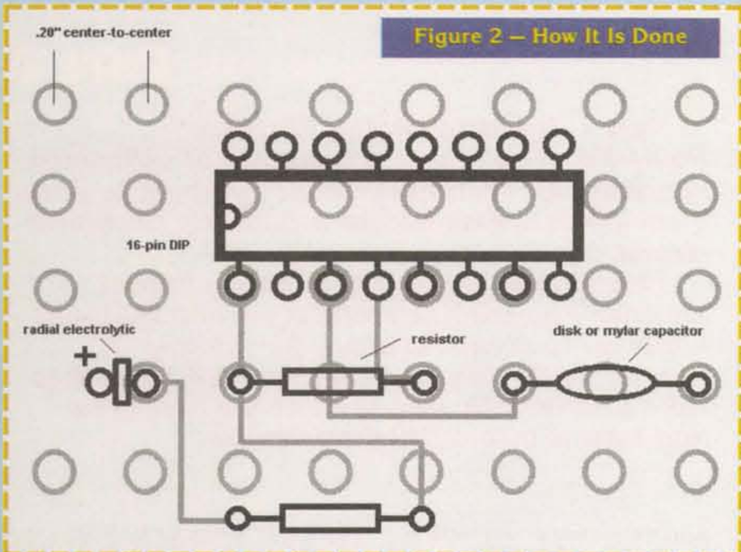


Figure 2 — How It Is Done

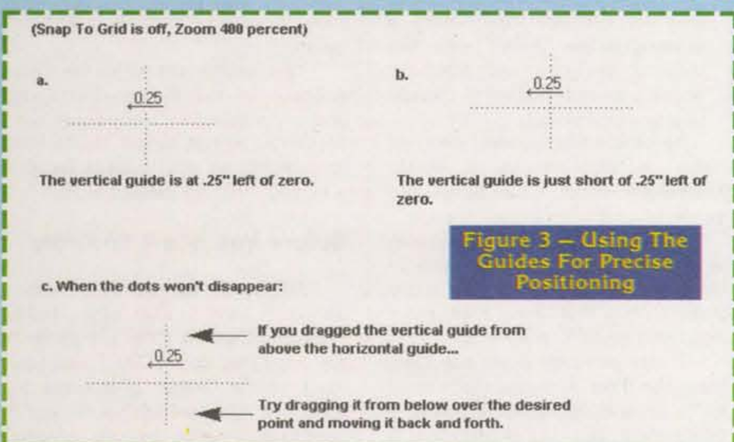


Figure 3 — Using The Guides For Precise Positioning

At 400% magnification, I found that each dot on a guide represents .01". Therefore, to get an object centered to .01" at some location, the guides must be adjusted so that the two dots that represent that location are right on top of each other.

As shown in Figure 3(a), when a dot on the vertical guide intersects exactly with one on the horizontal guide, they both disappear. This is fine; it gives a good "bullseye" indication of when we are "really" at a particular position.

Figure 3(b) shows what can happen if you don't use the bullseye indication. The program says that the guide is at .25" left of zero, but it really isn't. The dot representing .25" vertical is in between two dots on the horizontal guide. If you tried to align a series of objects using the guides this way, you'd get very frustrated. *You have to make the dots disappear.*

This is usually easy, but I have noticed that PowerPoint will occasionally, randomly, refuse to give the bullseye indication that the dots are intersecting. I have always been able to get it to do so by dragging a guide from the side opposite the one I was on and moving it back and forth a couple of times.

Sometimes I've had to go back-and-forth between above and below the horizontal, and unselecting whatever I was trying to align seemed to help on some occasions. Figure 3(c) shows this problem and my workaround.

Ready To Work?

Open a new PowerPoint presentation and set up a new, blank slide as you did previously. All toolbars except for Drawing should be inactive. Zoom should be set to 400 percent, Snap To Grid should be on, and the ruler and guides should be active.

Refer to Figure 4.

a) Position the guides at exactly 0 H, 0 V (0.00 horizontal, 0.00 vertical).

b) Starting from the intersection of the guides, draw the smallest circle that PowerPoint will permit and then turn off Snap To Grid. In the Format menu, Colors and Lines dialog, click the No Fill Color choice and ensure that Style is at the thinnest line setting (Figure 5).

c) Place the circle so that its center is on the intersection of the guides and leave it selected.

d) Move the vertical guide to exactly .20" right. Execute a CTRL-D to duplicate the first circle, nudge the copy to 0.00" horizontal and .20" right, center it there precisely and leave it selected.

e) Move the vertical guide to .40" right and duplicate again. This third copy may not automatically come out centered, so use the arrow keys to nudge it perfectly parallel with the first two and centered on .40" vertical.

Now continue the process — move the vertical guide .20" to the right, execute a CTRL-D and nudge the new circle into position, if necessary. The last circle in this series should be centered on 3.0" right and 0.00 horizontal.

f) Select all of the circles in the series except the very first one that you drew, group them, leave the group selected, and bring the vertical guide back to 0 horizontal.

g) Execute a duplicate (CTRL-D) so that you get a second series of circles. Move the vertical guide to .20" left. Drag the newly created group to the left, and nudge it so that its rightmost circle is centered at zero vertical and .20" left. Ungroup this group and click once on any blank area to unselect everything. Check the positions of the individual circles against the vertical guide, moving the guide left in precise .20" increments. Nudge into alignment any circles that didn't come out where they should be. Do the same to the right of zero so that you have a parallel 6" line of circles at even .20" intervals. Ungroup the group to the right of 0 H, 0 V and then group the whole line. Move the horizontal guide up to + .20". Move the vertical guide back to 0 and set the Zoom to 100 percent.

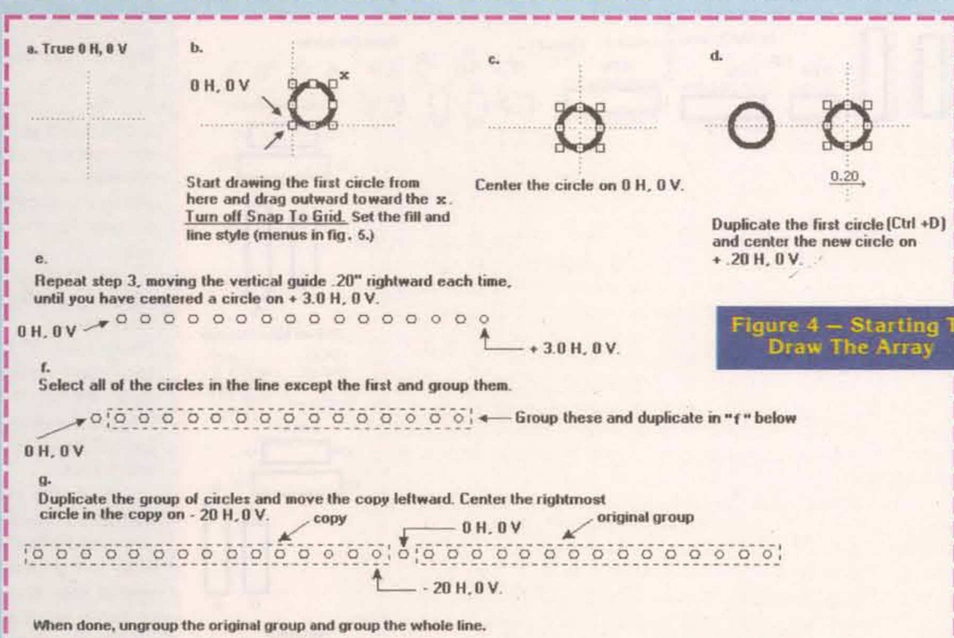


Figure 4 — Starting To Draw The Array

Create The Upper Half Of The Array

Refer to Figure 6.

a) Duplicate the first line of circles and nudge it into rough position at + .20" vertical. Increase the zoom to 400%.

b) Ungroup the new line. In my experience (which includes doing this template on a couple of different PCs with different versions of PowerPoint), if you created the previous line accurately, you should be able to nudge this one into place as shown and all the circles should be correctly lined up horizontally. Unselect everything and use the vertical guide to verify vertical alignments. Check both left and right of zero all the way to the end. If any circles are out of alignment, unselect everything and use the vertical guide and the arrow keys to nudge them into place. When everything is okay, move the vertical guide back to 0.00.

c) At 100% zoom, re-group the line. Move the horizontal guide up to + .40", duplicate the last group of circles and repeat steps a and b: center the copy at 0" horizontal and + .40" vertical, go to 400% zoom, ungroup, and check alignments. Continue this process until you create a 10th line above zero at 2.0" vertical. Reduce the zoom to 100%.

Complete The Array

Refer to Figure 7.

a) You have 11 rows of circles. Ungroup all of the circles in the top 10 rows, create one group, and duplicate this group. Lower the horizontal guide to -.20" vertical. Drag and nudge the new group down and into position on the guide. Restore the zoom to 400%.

b) Ungroup the new group and unselect everything. Just as when you duplicated lines, if you created the previous group accurately and nudged the copy into its correct position, all the circles should be correctly lined up horizontally. Unselect everything and use the vertical guide to verify vertical alignments. Check both left and right of zero all the way to the end. If any circles are out of alignment, use the vertical guide and the arrow keys to nudge them into place. Then correct vertical alignments as you did in 6 (b).

c) When you are satisfied, make one group of all the circles and color it light gray. Our array is finished (Figure 8).

As you saw in Figure 2, each component lead is terminated with a circle, smaller than the holes of the array, that is used to orient the component. Creating this "standard pad" is the next step, as shown in Figure 9.

a) Create a new slide in this presentation. With zoom at 400 percent, the guides centered at 0 horizontal and 0 vertical, and Snap To Grid on, draw from the intersection of the guides the smallest circle the program will permit, as in Figure 4. Also, set No Fill and the thinnest possible line style as you did before. Turn off Snap To Grid.

b) From the Draw menu, select Scale and reduce the size of this circle to 84 percent of original. Copy this circle to the slide with the array. (You may have to reduce zoom to 100% to find it.) Now that the "template" slide contains a complete array, take care that the array is not selected when you actually want to move some other object on the slide. If you accidentally move the array, use the undo command (CTRL-Z) to restore it to its position.

c) You can now move the pad up to the area where sample component outlines will be placed, and label it.

Now we can create some component outlines, starting with the most common of all: a quarter watt resistor.

See Figure 10.

a) Go to the slide where you created the pad. Make sure Zoom is at 400%, the guides are visible, and Snap To Grid is off. Drag and nudge a standard pad to center on the guides at 0 H, 0 V. The right outside edge of the pad should be at .03" right of zero.

b) Move the vertical guide to .11" right. From .11" right, draw a straight line back to the right side of the pad. The right edge of the pad should pass through the center of the handle of the line.

c) Set the vertical guide to .29" right and the horizontal to .03" above zero.

d) From the intersection of the guides and dragging left and slightly downward, draw a rectangle. Stop where the edge of the connecting line begins.

e) The result should look like this.

f) Use the horizontal guide to ensure that the lower edge of the rectangle is at - .03", and adjust the rectangle's size, if necessary. Give the rectangle No Fill and make sure that

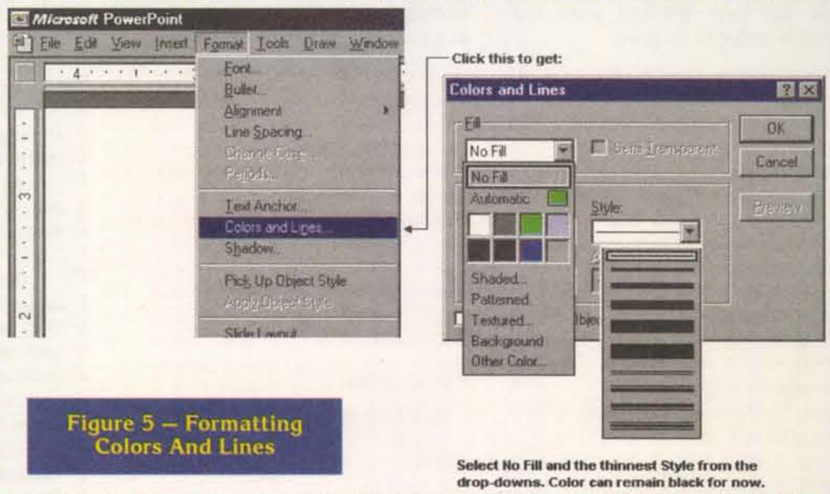


Figure 5 — Formatting Colors And Lines

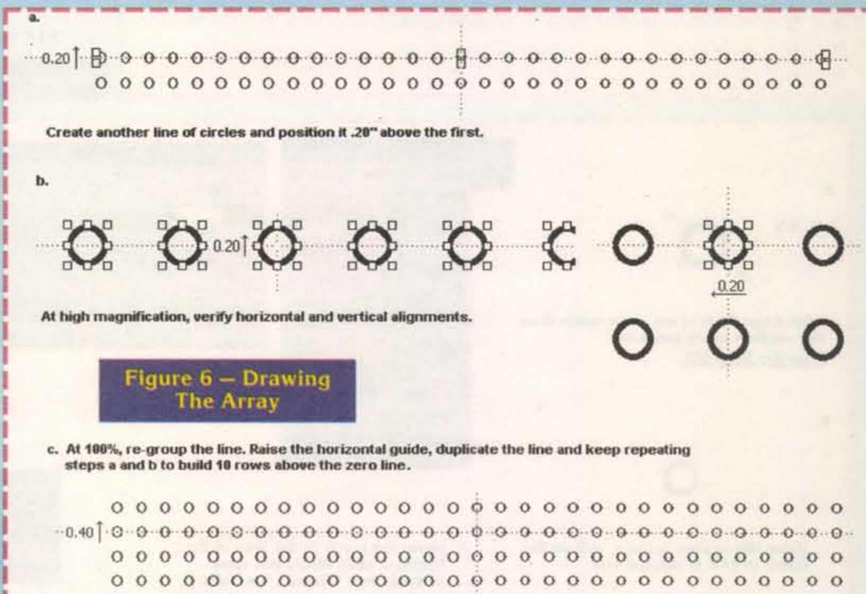


Figure 6 — Drawing The Array

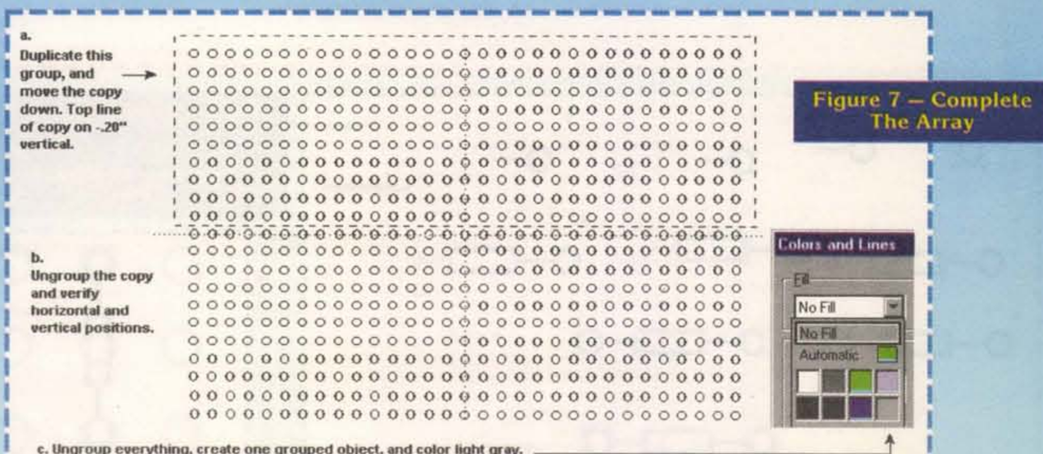


Figure 7 — Complete The Array

its Line Style is the thinnest possible.

g) Set the vertical guide to .36" right and the horizontal guide to precisely 0.00. Draw a line from the intersection of the guides toward the resistor body. Stop drawing right where the outside edge of the body starts. The connecting lines of the resistor body must be centered exactly on the horizontal guide when you draw them (see the figures) or they will look crooked when the zoom is reduced to 100%.

h) Copy a second pad and nudge it into place.

i) When you have the design correct, group the figure together.

j) Copy the resistor outline to the template slide and view it at 100% zoom against the array. You may find one or both pads not centered in the gray background hole.

k) Ungroup the figure and adjust the size of one or both pads so that each pad is centered as well as possible against the corresponding hole in the array.

l) Regroup the figure and look at it again at 100% against the array. You can go back to high magnification and tweak again, if necessary.

Figure 11 shows how to create the same figure, but oriented vertically.

a) With the zoom at 400%, copy the horizontal resistor and rotate it right. In my experience, rotating will distort the copy slightly.

b) Ungroup the copy.

c) Re-size the pads and lines slightly to make the figure symmetrical and re-group it.

d) View the figure against the array at 100%. Repeat a) through c) if it still isn't perfect.

The outlines we have created so far fit on holes .40" apart. Disk and dipped mylar capacitors would likely be the next most common components on a typical board, right? Since many types fit the same profile as a resistor, create an outline for a capacitor of that size as shown in Figure 12.

a) Center a standard pad on 0 H, 0 V and bring a line out to .11" right.

b) Set the guides as you did to draw the resistor body: vertical guide at .29" right and horiontal at +.03".

c) Starting from the intersection of the guides, draw an ellipse back toward the connecting line.

d) The result should look like this.

e) Move the horizontal guide back to zero and make sure the ellipse is centered. If it isn't, I found that the best way to adjust it is to resize it slightly from the center handle.

f) Finish the figure as you did the resistor with a connecting line and another pad.

g) Group the figure, copy to the template and view it against the array. Tweak the size, if necessary.

h) View the figure at 100%. If it looks good, copy it to the library.

i) As you did with the resistor, make a vertical outline by rotating to the right a copy of the original figure. Ungroup the copy.

j) Adjust the sizes of individual elements and regroup the figure. Copy to the library.

k) You will certainly need a capacitor outline .30" long at some point, so try drawing one to these dimensions. Again, create a vertical copy as well. For the template in Figure 1, I also created and added outlines on centers of .20" and .50".

Tubular capacitors come in many footprints. I looked at a couple of types in my stock that I expected to use a lot and drew the basic outline shown in Figure 13. These particular items looked like they would take up .20" or so of board width; if yours are wider or narrower, take this into account. I kept a piece of perfboard handy while drawing and used this as a gauge for estimating footprints.

Unless you have a 19" monitor, your library of outlines will outgrow the border of the template at some point. When this happens, you may want to expand the library to a separate slide.

If you have stayed with me and drawn everything so far, you should have four outlines for tubular capacitors — two horizontal and two vertical. Many axial electrolytics will fit the same profile, but they need polarity markings. Try this:

Select all four tubular capacitor outlines and duplicate. Move the

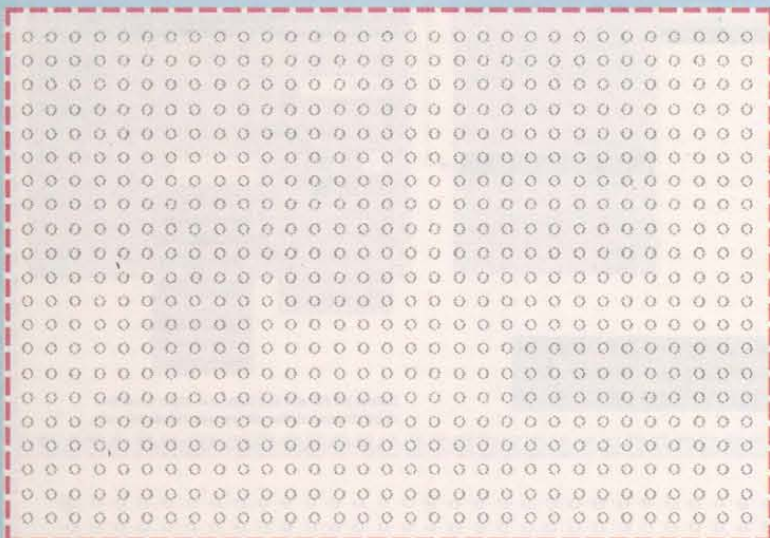


Figure 8 — The Array

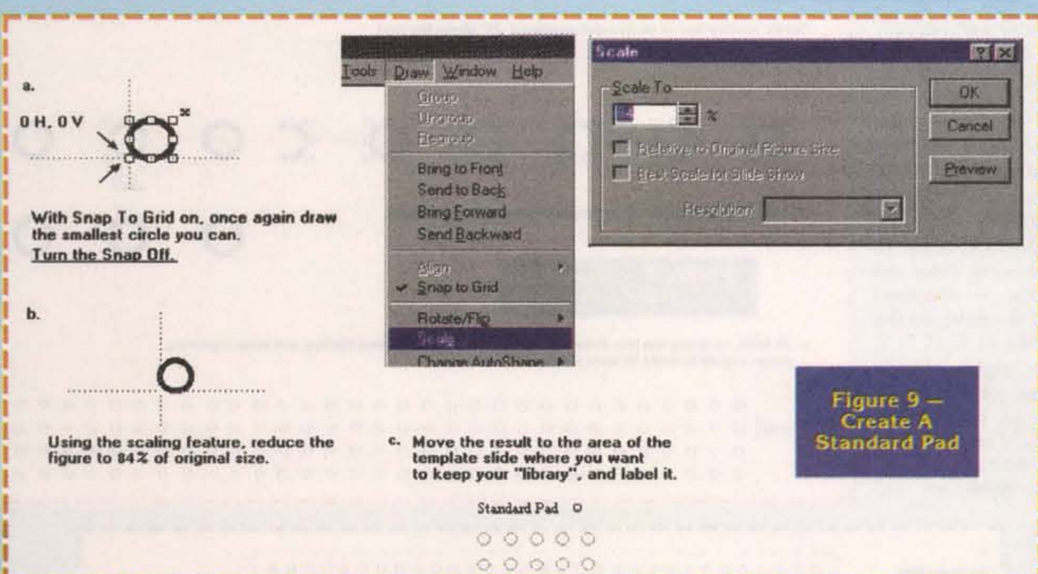


Figure 9 — Create A Standard Pad

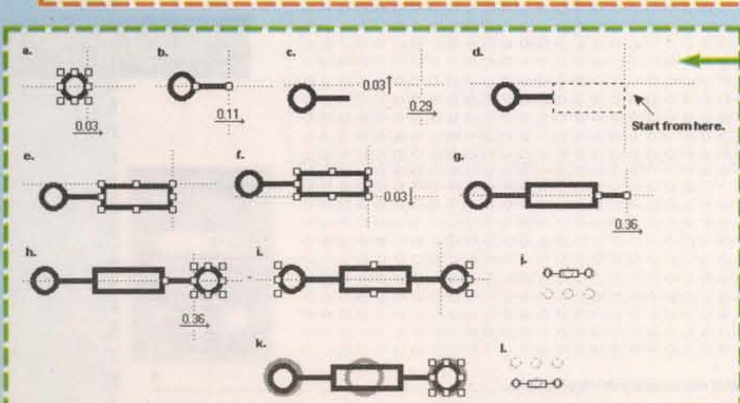
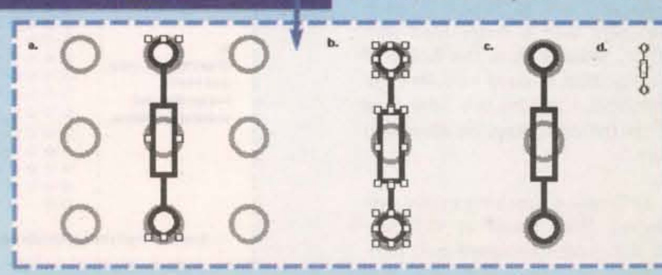


Figure 10 — Draw A Resistor

Figure 11 — Vertical Resistor Outline



copies to another area of the library and label them "Axial Electrolytics." Now see Figure 14.

a) At 400% zoom, ungroup any capacitor outline.

b) Create two text boxes. One should contain a plus sign and the other an underscore character (I found that this makes a better negative terminal indication than the usual minus sign). For the signs that go inside .20" wide outlines, I set the font to Arial 8 point bold. Make each text box as small as the program will allow.

c) Make copies of the text boxes, position the copies carefully within the capacitor body and regroup the figure.

d) Now add polarity markings to the other capacitor outlines. I also put copies of the + and - signs in the library for future use.

Radial electrolytic capacitors come in a gazillion values, but you can accommodate the smaller, most common ones with a relatively few outlines. Figure 15 shows how to create the smallest one, on .10" centers.

a) At 400% zoom, create two standard pads centered at 0.00 and .10" right.

b) Move the vertical guide out of the way. From approximately the point shown, draw a rounded rectangle (in the autoshapes) downward and to the right. (I found it easier to eyeball this than to use the vertical guide, and I chose this shape rather than a circle to distinguish the body from the pads.)

c) Adjust the width of the body on both sides of the horizontal guide. As shown here, its vertical sides should just butt against the sides of the pads. Give it white fill and the thinnest line style.

d) Create a text box with the + symbol in Arial 7 point bold, position as shown, and group everything.

e) Copy this figure to the template and view it against the array, first at 400% and then at 100%. I wasn't happy with the symmetry, so I went back to 400% zoom, ungrouped the figure, squeezed each pad slightly smaller and regrouped.

f) This was the result. Again for the sake of later convenience, duplicate the symbol several times and rotate the copies to orientations that you might want to use later.

g) You might want to add similar outlines drawn on .20" and .30" centers.

Our last job before we can use the template is to draw some DIPs, starting with a 16-pin. From that, we can easily hatch 14- and 8-pin versions.

See Figure 16.

a) Start by again locating a standard pad at 0 H, 0 V.

b) Move the vertical guide to exactly + .10" right. Duplicate the first pad, center the copy at 0 H, + .10" right, and leave it selected. Move the vertical guide to + .20" right, duplicate again, and another copy will show up close to +.30" right. Nudge this copy into position.

c) Continue creating pads until you have a line of 8. When you have the line complete, group it, and then duplicate it.

d) Lower the horizontal guide to .30" below zero. Move the copy into place, ungroup it, and correct the

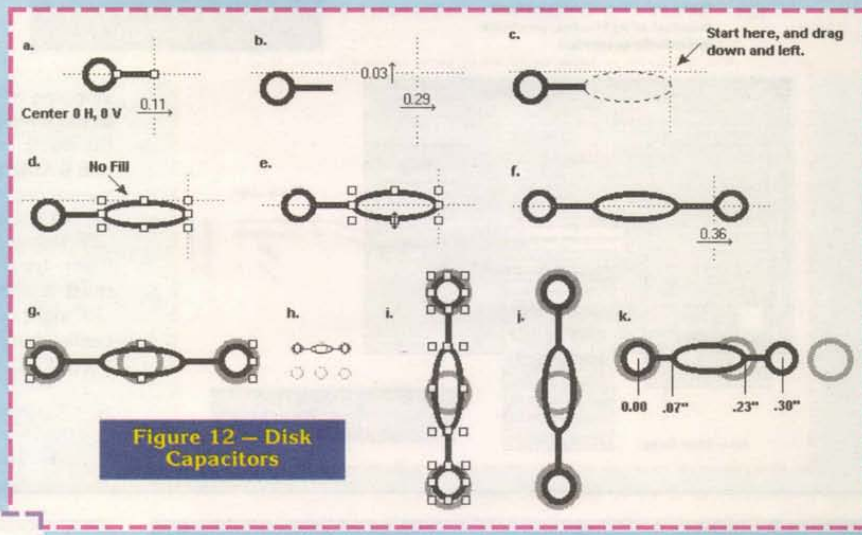
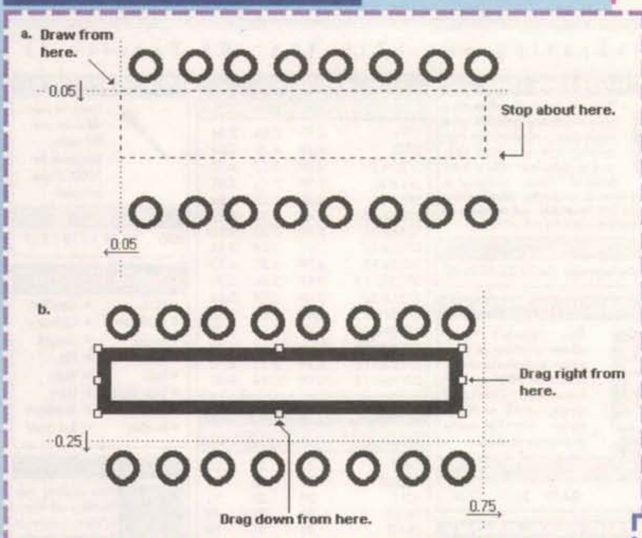


Figure 12 — Disk Capacitors

Figure 17 — Drawing A 16-pin DIP



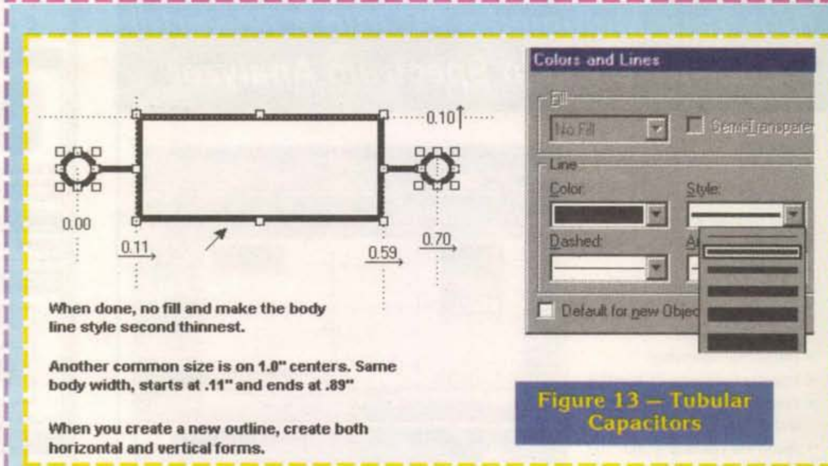


Figure 13 — Tubular Capacitors

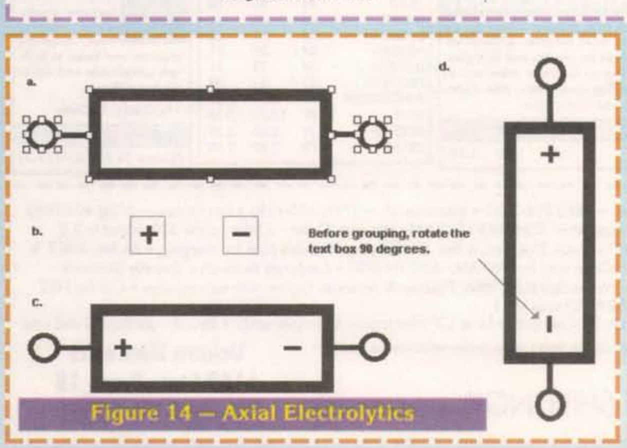


Figure 14 — Axial Electrolytics

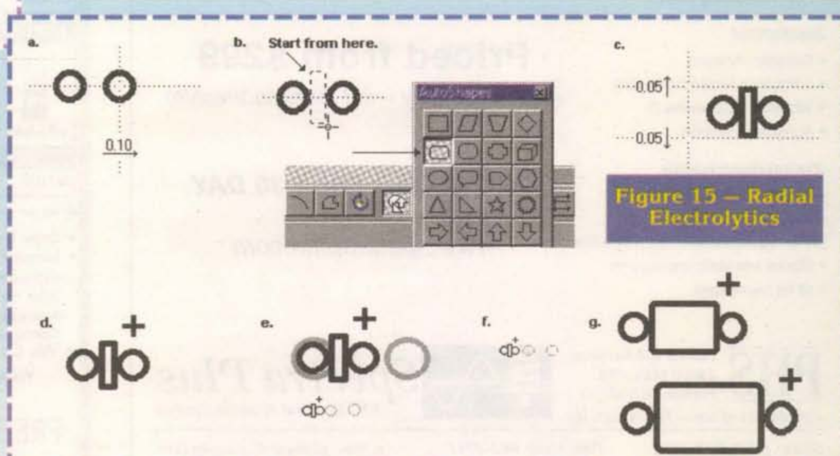


Figure 15 — Radial Electrolytics

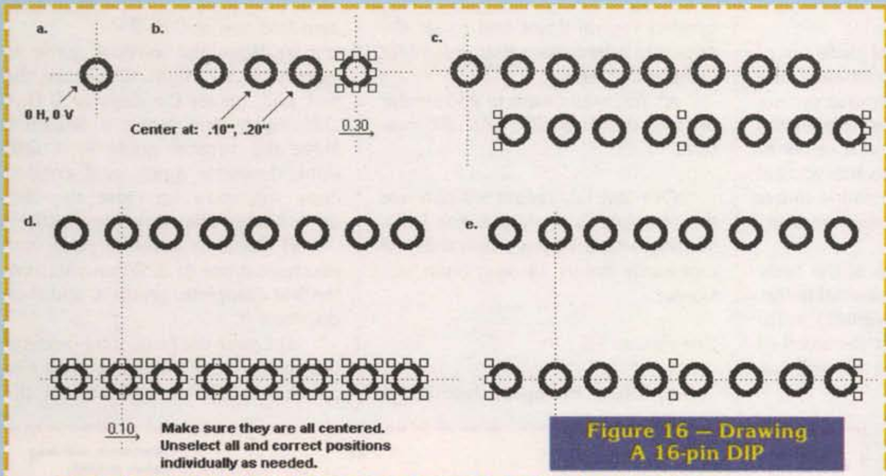


Figure 16 — Drawing A 16-pin DIP

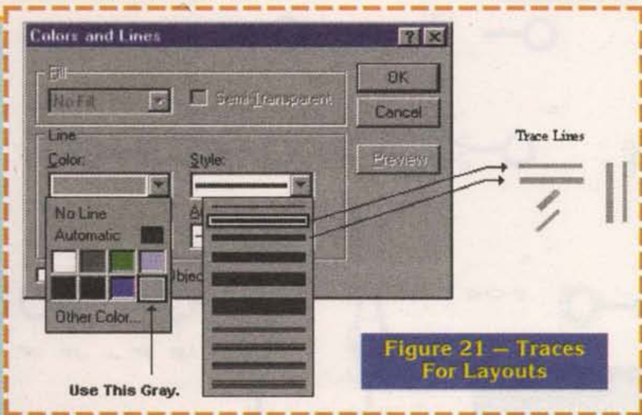


Figure 21 — Traces For Layouts

positions of individual pads so that they are parallel and centered .10" apart.

e) Group the line when you're done.

See Figure 17.

a) To create the body of the DIP, position the horizontal guide at .05" below zero and the vertical guide at .05" left of zero. Draw a rectangle, moving downward and to the left as shown, stopping a little more than half way to the lower line of holes and short of the outer edges of pad numbers 8 and 9. Give this rectangle No Fill and the second thinnest line style.

b) Lower the horizontal guide to .25" below zero and drag the center lower handle of the rectangle to meet it. Move the vertical guide to .75" right of zero and drag the right center handle of the rectangle to meet it.

See Figure 18.

a) The resulting rectangle should look like this.

b) Unselect the rectangle. Restore the vertical guide to 0.00 and set the horizontal guide at exactly .03" below zero.

c) From just inside the top edge of the body to the horizontal guide, draw the first connecting line. Adjust the size and position so that the line appears as you see it here. In particular, the lower handle of the line should not extend into the white space of the pad. If this seems too finicky, remember that we will be reducing the size of the figure a lot; if you want a clean outline with no misplaced or distorted lines, care now is essential. When the line looks correct, leave it selected.

d) Move the vertical guide to .10" right, and duplicate the first line (CTRL – D). Nudge the copy into place with the arrow keys.

See Figure 19.

a) Keep moving the vertical guide, duplicating the previous line and nudging each successive copy into place.

b) Go through the same process with the lower line of pads.

c) This is the completed figure.

d) To mark pin 1, position a standard pad as shown, with the left side of the DIP body making it effectively a half-circle.

See Figure 20.

a) Ungroup both lines of pads, and select everything. Group the whole figure together.

b) Copy the result to the template, reduce zoom to 100 percent, and see what the outline looks like. I went back to 400 percent, ungrouped the outline, and adjusted the positions of a few items to get the result shown. The result can go in the library.

c) To get a 14-pin DIP, make a copy of the 16-pin outline. Ungroup it and remove pins 8 and 9.

d) Reduce the width of the body and regroup.

e) In a similar way, create an 8-pin DIP.

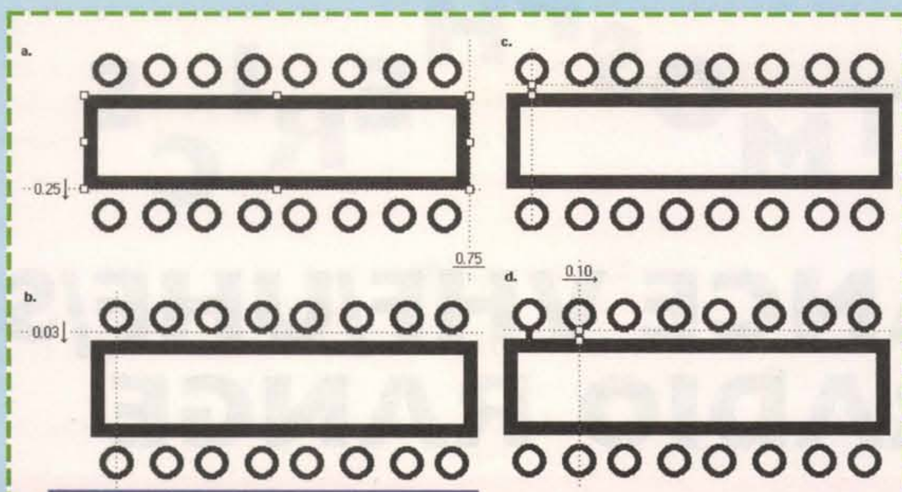
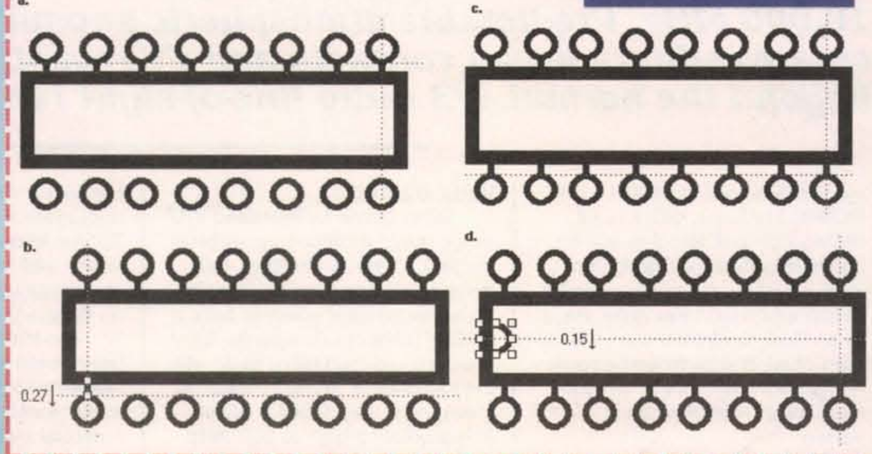


Figure 18 — Drawing A 16-pin DIP

Figure 19 — Drawing A 16-pin DIP



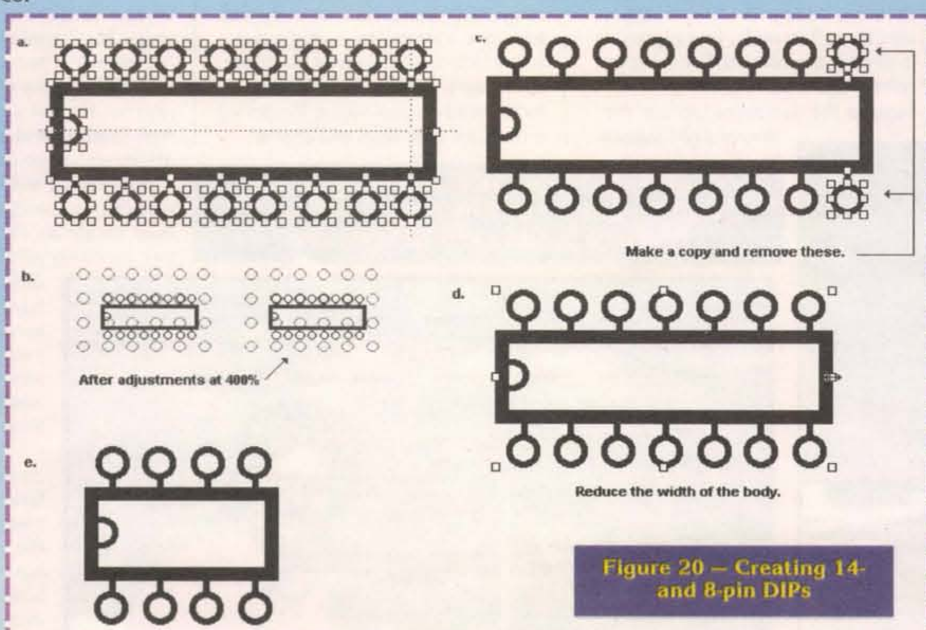


Figure 20 — Creating 14- and 8-pin DIPs

I know it's been a lot of work, but if you have gotten this far, you have learned all of my tricks for getting things correctly sized and positioned.

Since at some point you will surely need to position a DIP rotated 90 degrees, use the method I have described to create a 16-pin DIP in this orientation and then "hatch" 14-pin and 8-pin versions.

When you use these versions, you can decide on the spot whether pin 1 is upward or downward and add the indicator accordingly.

Figure 21 shows some typical trace lines used for layout and how to create them. We are ready to draw some PC board patterns!

Next month, we will design a PC board for the circuit whose schematic we drew in Part 1, turn the artwork into a finished board, and end up with a useable project — a horn for a child's bike.

If you would prefer the convenience of starting with a copy of the template shown in this article, I will E-Mail to you a PowerPoint 7.0 file. Send your E-Mail address with a check or money order for $10.00 to: Small Bear Electronics, 123 Seventh Avenue Suite 156, Brooklyn, NY 11215. You can E-Mail me directly at smallbearelec@ix.netcom.com.

See you next month! **NV**

by Gordon West

ATMOSPHERICS

ENHANCE VHF/UHF/SHF RADIO RANGE

There is no coincidence when summer and fall weather bring enhanced radio range to frequencies 100 MHz to 10,000 MHz. Predictable atmospheric anomalies may create radio two-way contacts and TV reception well beyond the normal 4/3 radio line-of-sight range.

This is one of the few times of the year that we can truly blame the weather on how well we receive VHF FM and TV radio signals over extended paths. We can also blame the weather on unusual radio occurrences where the Miami Police Department responds to a call that was really directed to a Galveston, TX traffic unit. We can also blame the atmosphere for the Chicago VHF weather station drowning out the local NOAA transmissions in Virginia Beach. And you can imagine the surprise of United States Coast Guard station Long Beach, CA answering a call for a tow from a sailboat that ran out of wind 2 miles south of Hilo Harbor, HI!

And now for the super-weird, thanks to the September and October atmosphere — beachgoers in Tampa watch a freighter go by on the horizon, UPSIDE DOWN! In Alaska, offshore oil drilling rigs look like they are on one-mile-high stilts. And in New York, air traffic controllers wonder if their equipment has gone snafu when close-in airplanes are barely seen at all, and outbound aircraft hundreds of miles away continuously stay locked into their screen.

This long-range radio phenomena begins to affect frequencies from 100 MHz, and higher. It is technically atmospheric super-refraction where signals go well beyond the 4/3 radio horizon for line-of-sight signals. WELL BEYOND!

Other terms for extended VHF range may be called tropospheric ducting, inversion ducting, and inverted mirage communications. These long-range contacts have EVERYTHING to do with the local weather, and NOTHING to do with the ionosphere. While sporadic-E ionospheric skip COULD affect frequencies as high as 300 MHz, the ionospheric skip for long-range VHF contacts may only last for a few minutes to — at most — a few hours, and signals fluctuate in strength rapidly. In contrast, local weather conditions triggering a tropospheric duct will create enhanced VHF and UHF plus microwave long-range radio and TV conditions for six to eight hours, and sometimes three or four continuous days, with almost no fluctuations in signal strength.

The VHF, UHF, and microwave line-of-sight range is usually considered 4/3rds the optical path. In other words, radio waves will take a natural bend beyond normal line-of-sight to the horizon. This occurs because of the refractive index of normal air, abbreviated "n," which is around 1.000310. Consider the lower case "n" as normal air. But during the summer months and early fall, the air above us sometimes gets very ABNORMAL! Warm air may override cool air, and windless days may create air stratification that can be easily seen as smog and dirty air simply hanging on the horizon. Air stratification can also be seen as smoke that rises, and then abruptly tops out horizontally.

When we have stratification of different air consistencies and densities, the refractive index may change abruptly. If the refractive index change is sharply pronounced, VHF-and-higher frequencies may be super-refracted over

California Tropo. Below tropo is seen hanging over the Los Angeles basin. Pictured is Chip margelli K7JA.

extremely long distances. And since this occurs in the troposphere, the word "tropospheric ducting" appropriately describes how extremely short wave lengths travel within the tropospheric duct, much like a wave guide.

Long-range VHF/SHF ducting occurs over regions sitting under the effects of a high-pressure system. When you have a cell of high pressure that stalls out, the extra weight of the air aloft in the high will begin to sink. This SUBSIDENCE of air compresses into a band of hot air that overlies cool surface air at ground level. If the boundary between cool air below and the sandwiched warm air exceeds a 10-degree F temperature change, this may be enough to trigger long-range VHF/UHF/microwave ducting over hundreds, and sometimes thousands, of miles.

California Hawaii high
Bermuda Azores high
The Australian high
South America Africa high

And I'm happy to say, in late summer and fall, the stationary high that many times stalls out over the mid-US, leads to some exciting 1,000-mile tropo ducts!

Well-respected atmospheric expert, Bruce Eggers WA9NEW, further explains what might happen below a stationary high-pressure system triggering the radio duct:

The formation of a duct is the result of the physics of the fluid. Any combination of parameters which contribute to a sufficiently thick layer of super-refractivity causes ducting. And a sufficiently thick super-refractive layer, such as to minimize losses through the top and of sufficient altitude so as to minimize losses at the surface, causes a field strength attenuation nearly proportional to 1/r rather than 1/r2. Hence, under ideal ducting conditions, a signal from a transmitter 5,000 miles away has the same field strength as an identical transmitter only 70.7 miles away, assuming all else equal and "line of sight" propagation. Common are frontal layers and early morning radiational cooling of the lower layer of the atmosphere. Transpacific tropospheric ducting is well documented, too.

Colorado Tropo.

California Tropo.

Eggers also talks about the Bermuda high and good reason to believe that some of the infamous Bermuda triangle aircraft/ship losses may well have resulted from the same kind of anomalies communications problems.

Within the duct, the big refractive index change is from pressure, temperature, and water vapor content. Within the duct, a sharp increase in temperature occurs. Relative humidity that normally decreases with altitude may sharply increase within the duct. Here on the Pacific Coast, hurricanes to our south may contribute to trapped warm moist air feeding the duct. And within the duct, pressure may rise, rather than fall with altitude. And once the duct forms up, expect some surprising short-range radio communications that will extend over some long-range paths!

- VHF/UHF and microwave from California to Hawaii
- Microwave from Australia to New Zealand
- VHF and UHF path between Nova Scotia and Miami
- Television reception between Chicago and Texas
- Microwave contacts from the Midwest to the East Coast

For those of you with cell phones, you may experience enhanced coverage to distant areas you couldn't normally access before. If you are into scanning, your programmable scanner will start picking up calls on local frequencies that you might not have ever heard before. And if there are some hills near you, drive up to within the duct and have a virtual pipeline of scanning excitement. And how do you know you are within the duct? Hot smoggy air, temperature increases, the air smells musty, and your car's altimeter may show you going down when you are actually going up!

If you are into television DXing with an outside antenna, tune those channels that are not local, and watch typical snow turn into full color TV with audio. And just when you thought you had your direct satellite dish pointed exactly at the right spot, severe tropospheric ducting episodes may cause your signal to freeze-frame, and you may need to go out and tweak your little portable dish to improve the incoming signal during the ducting episode.

Some good 24-hour "beacons" to alert you of enhanced VHF radio conditions might be unused VHF weather channels in your area:

162.550
162.400
162.475
162.425
162.450

On UHF, try scanning 460.000 MHz to 460.500 MHz, and tune in distant public safety transmissions. And up on the higher frequencies, try and score the trunked radio sounds around 856.4625 MHz; a public safety frequency that is permitted for legal scanning.

Ham operators throughout the country will tune into VHF and UHF propagational beacons in the CW mode. These can be found around 144.280, 432.075, and 1296.0.

Communication distance records are quite impressive from ham radio tropo contacts:

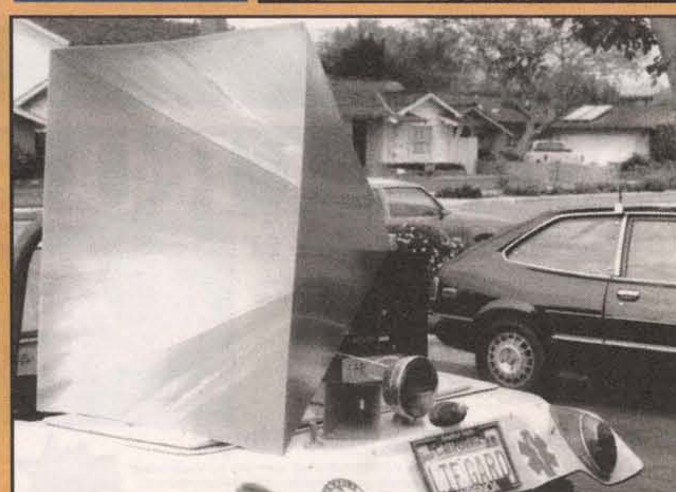
144 MHz: 4,333 kilometers
432 MHz: 4,142 kilometers
903 MHz: 4,061 kilometers
1296 MHz: 4,142 kilometers
2304 MHz: 3,973 kilometers
3456 MHz: 3,973 kilometers
5760 MHz: 3,973 kilometers
10,000 MHz: 1,124 kilometers

Many of the tropo records are held by Paul Lieb KH6HME, the recent recipient of the technical award at the recent Dayton Hamvention™. Paul is in Hawaii on the side of the Moana Loa volcano, and he regularly communicates on VHF, UHF, and microwaves to ham operators along the Pacific Coast as far north as Washington. Paul and I hold a one-way distance record for amateur television over that path, too.

So, stand by this fall for exciting tropospheric ducting conditions. Watch your weather maps for a stalled high-pressure system sitting over you and a distant city that you might easily tune in on VHF or UHF. During periods of hot windless days with smog hanging on the horizon, get set for some extraordinary radio conditions that go well beyond line of sight on VHF frequencies, and higher. **NV**

2,400 miles on five watts on 434 MHz to Hawaii on these cubical quads (right).

Gordo's big 10 GHz system ready for more Hawaii tropo (below).



Automatic Night LED (With Other Worthwhile, Associated LED Projects)

by Evert Fruitman W7RXV

Many older people can remember some of the exciting things they did when they were young, like sneaking a flashlight into the bedroom at night so they could finish reading a thrilling book after "lights out." Even if they managed to put back the flashlight without getting caught, the seemingly short battery life may have aroused suspicions as to what had happened.

With the advent of the white Light Emitting Diode (LED), you can have almost as much excitement without having to worry about running down the batteries, or a trip to the woodshed. You can also make several useful, practical, portable lights.

One of the many space-age spin-offs that we enjoy, even take for granted, LEDs gave designers a reason for excitement. They had at their finger tips a cold, low voltage, low current light source. Too bad that the early LEDs also had relatively low light output. As the technology advanced, it became possible to get brighter red, as well as brighter yellow, green, orange, and blue LEDs. Although the price of these LEDs dropped and the light level went up, they still gave off only their own, single color.

These LEDs found use in toys, and as pilot lights, warning lights, key chain lights, and several other practical applications. However, their single color output limited their uses. For example, a small key chain light could help you find a lock in a dark location, but you would not want to read with only a yellow or a green light. Someone finally got around to making a white LED, and letting the public know about it. That LED can do all of the tasks just mentioned, and it gives a good, bright, useful light. We will look at several ways to make use of those white LEDs, plus a couple of uses where you can substitute the ultra bright, jumbo LEDs.

With the white LEDs, you can make a flashlight suitable for carrying in your pocket, purse, or backpack. You can make a very portable, low power, long life, but practical reading light. With or without a few modifications, you might want to take it camping. I have used it for reading in the back seat of a car on a long trip after sunset. It sure beat looking at the back of the front seat.

The white LEDs also lend themselves to a small beacon. You can use either the white LEDs or the extra bright, jumbo red or orange LEDs for an attention-getting light on the back of your backpack or on the back of your bike. Price and availability help in part to determine which LED you might choose.

PHOTO A

LED Flashlight
Deluxe, pocket-purse model.

PHOTO B

Easier-to-make LED Flashlight
Probably not too well suited for home construction, either.

How Much Light?

A small, two-cell penlight gives a lot of useful light. However, you can get or make a practical penlight with LEDs. Sporting goods stores sell them. The web has ads for white LED flashlights for about $35.00 plus shipping and handling.

The first white LEDs that I found cost just under $10.00. Several of my camping friends thought that they would make a great light for them, even at that price. Since then, I have found some for about $4.00 each; less if you and some friends want to get together to buy 10 at a time. The two types give comparable results: light vs. current consumption. For particulars on where to get them, look in the parts list.

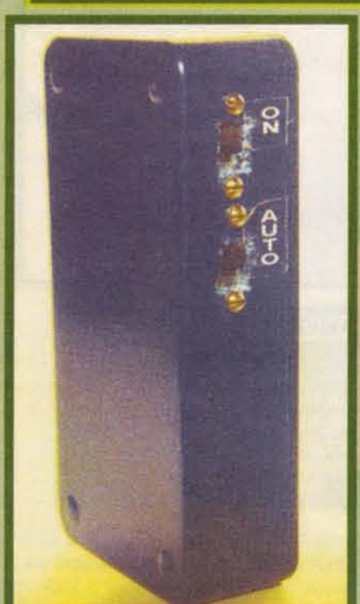
For comparison, a two-cell penlight will light up the other side of a normal size room, while the LED lights that I have made need to get close to the far wall for the same amount of reading light. Either that, or put a magnifying glass on the front of the light and focus the light. That does work at the expense of a narrower light beam. A pair of the white LEDs makes a good reading light without a focusing lens. We will decide what we need in the construction section.

Power Drain

The typical two-cell penlight will have a lamp that draws close to 300mA, 0.3 amps, at 3 volts. That figures out at just under one watt: 0.9W. These

PHOTO C

Automatic Night LED, Rear View
Practical version, if you do not run a lathe. In the AUTO mode, will turn on/off depending upon ambient light.



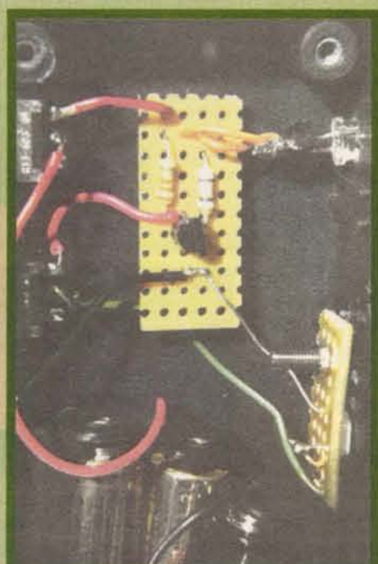


PHOTO D

Automatic Night LED, Interior view
Top left: ON/OFF switch. Mid Left: AUTO/MANUAL switch. Center: circuit board with base bias resistor on the upper left, 68 ohm current limit resistor upper right, transistor lower center. Upper right side of box: LED. Lower right side of box: crude but effective way to mount the photocell.

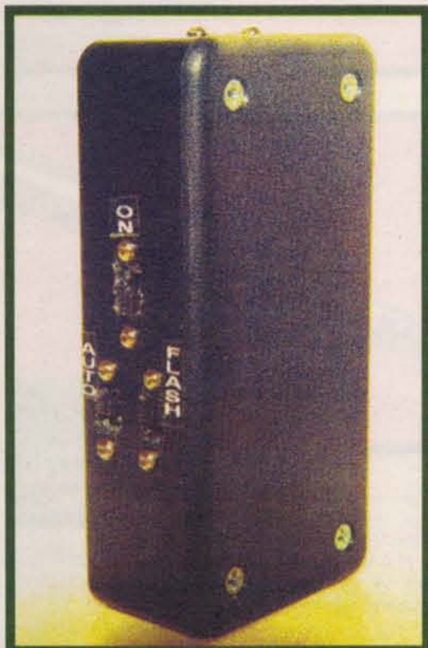


PHOTO E

Automatic Night LED, Beacon
Switches on back, photocell on the top. You may set the switches for steady light, automatic light, or automatic blinking beacon. Hang it in your tent or car. Put it in the steady mode and place it on a table in front of a book while camping, or just use it as a flashlight.

LEDs must not have more than 25mA, 0.025A through them. They will have a nominal 3.6 volts across them. The arithmetic shows that as 0.09W; about one-tenth the power of a regular penlight. Still, a one or two LED lamp makes a practical, long life light. Expect 30-50 hours battery life.

How To Power a LED

Light emitting diodes, like many other semiconductors, have to have a certain minimum voltage across them before they will start to pass a current. A common power diode, such as the 1N4007 must have about 0.5 volts across it, or it will not allow current through it. Under normal operating conditions, that diode will have about 0.6-0.9 volts across it. Once the power supply exceeds that voltage limit, there must be a current limit or the diode will overheat, which usually results in its destruction. Some of the more common LEDs will have about 1.2-1.8 volts across them during normal operation. You will find these ratings on the package.

Due to the nature of their construction, LEDs need more voltage than do small, power supply diodes. Again, once the diode starts conduction, it must have a current limiter or you will have a dead LED. Under certain conditions, you may exceed the ratings on the package for special effects, but that takes special circuitry.

For example, most LED readouts have extra high current pumped into them for a fraction of a second at a time. That gives a bright display without wasting a lot of valuable board space with current-limiting resistors. That also keeps from wasting power in the series resistors. But, it takes more complex circuitry than we want or need here. One package lists the LED current as 25mA continuous or 80mA peak. They did not say how long the peak could last.

The white LEDs need around 3.6 volts to give their panchromatic light. I have seen people place a red LED across a battery without a current limiting resistor. They just happened to get the right battery voltage for their particular LED. It did not fully turn on the LED. Figure 1A shows the more common way of connecting a LED to a power source.

The values given are for a white LED with its higher voltage drop. If you want to make a basic, bare-bones LED light with the lower voltage LEDs, use a three-volt battery or increase the value of R1 to 150-220 ohms for the battery shown in Figure 1.

Something Special

By adding a transistor and its bias resistor to the basic circuit, you have a convenient way to control the current through the LED. Add a photocell to the circuit as shown in Figure 1B, and you have an automatic night LED. Let's take a look at

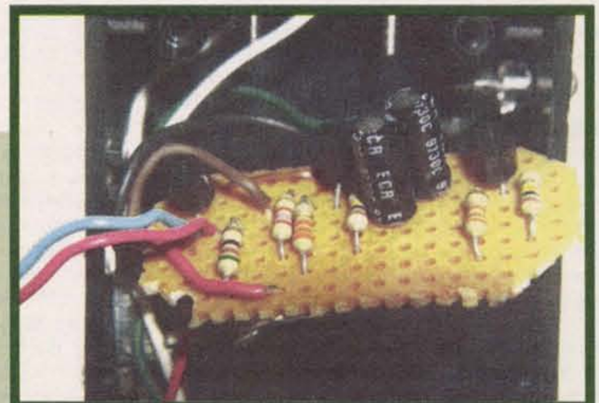


PHOTO F

Automatic Night LED, Beacon, Interior view
Left side of board: driver transistor for LED.
Center: timing capacitors. Right side of box: LED.
Prototype board.

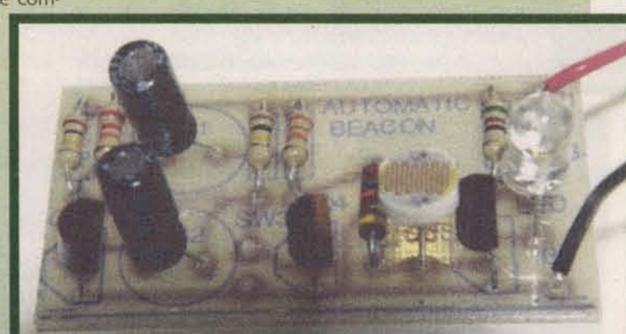
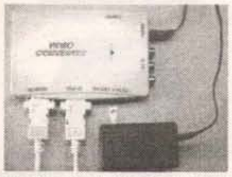


PHOTO F1

Automatic Night LED, Beacon
The clear silkscreening on the PCB makes it easy to see what parts go where, even without a diagram. In this version, the photocell is mounted on the board rather than on the side of the box. Switch wires added after the photo session.

Continued on Page 87

Continued from page 42



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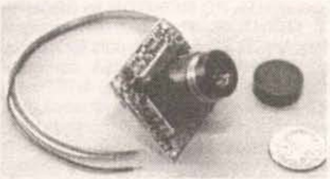

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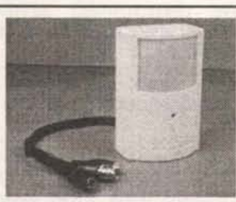

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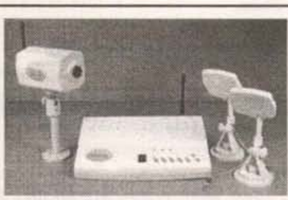

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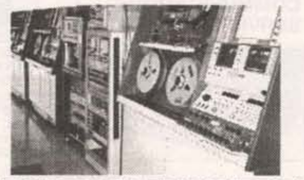

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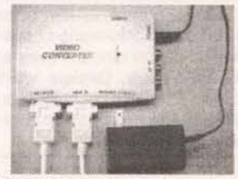

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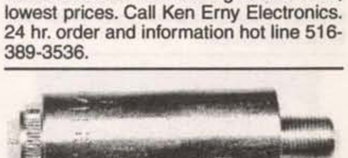

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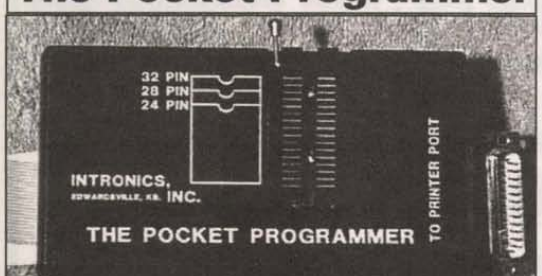

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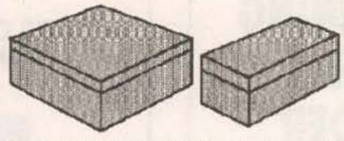

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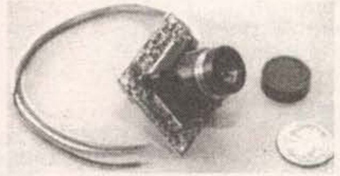

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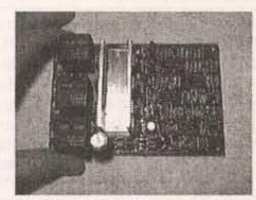

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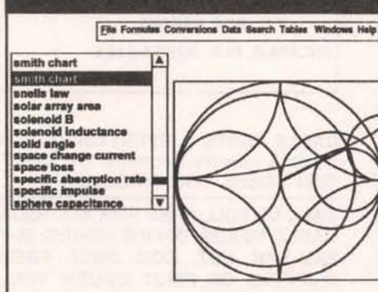

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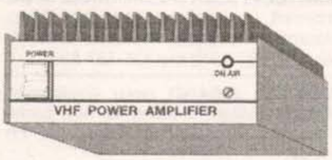

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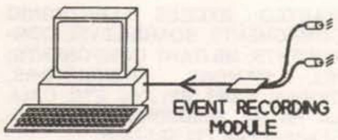

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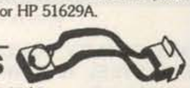

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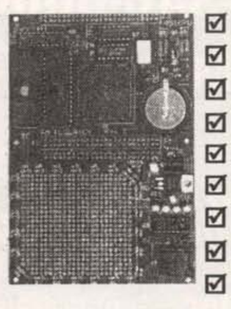

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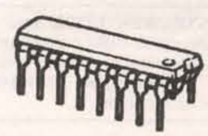

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Every now and then, I like to engage in a little whimsical fancy related to my passion for old radios. I collect old radios and naturally gravitate towards anything pertaining to old radios ...

So when Frank at **Ocean State Electronics** [6 Industrial Drive, Westerly, RI 02891; **401-596-3080** (voice) and **401-596-3590** (FAX); **1-800-866-6626** (orders)] told me he had some new kits based on vacuum tube technology I had to bite (or is that "byte" in this computer age).

The kit that I got from Ocean State was the **Vintage Radio Kit Company** (427 North Main Street, Sharon, MA 02067) CP5TR Cakepan Transceiver Kit (Figure 1). To make matters more interesting, it is built on a cake pan. I recall building on cake pans and pie tins in the early days before we could afford aluminum chassis (uhhh ... my mother didn't know ...), so I was doubly intrigued.

The kit consisted of the cake pan and cover, and a collection of parts. Some of the parts were already mounted. Tube sockets, for example, were mounted using a soldering process. Other parts (transformers, switches, potentiometers, and capacitors) you will have to mount.

The bands are changed between 80 and 40 meters by manually changing coils. The front panel controls include: RF gain, key/mike, regen, main tuning, fine tuning, and a mode switch that selects between Spot, CW 5W, CW 1W, and AM. On the left side of the cake pan is a control that selects the AM carrier level. Along the read panel are: Audio out, hum balance, fuse, AC line, and the SO-239 UHF connector used for the antenna. Because this transceiver kit is crystal-controlled on transmit, you will be limited to a few frequencies for which you have crystals. Normally, the crystals used are HC-6/U types, although you can add FT-243 if you would like them.

The plate tuning capacitor ("Final Tune") is used as a preselector in the receive mode and plate loading of the 6AQ5 transmitter stage in transmit. Tuning the transmitter is simplicity itself; tune for maximum output using the Final Tune control. The main receiver controls are the Regen, Main Tuning, and Fine Tuning controls. The two tuning controls are connected together so they form a pair. They are highly interactive, so one must learn to operate them together.

The Regen control means regeneration is used. This controls the point of regeneration. The more regeneration it puts into the circuit, the less sensitive the receiver. It is standard practice to operate this control near the edge.

For AM detection, the regenerative action should go over into oscillation ... but not quite there. For CW operation, you will find the level experimentally, but close to oscillation is a good place to start.

The RF gain control does double duty as the power on/off control. The RF gain control is used to set the RF gain of the receiver so that it does not overload on strong signals.

The top of the chassis has more than just tubes and transformers, it contains a CW audio filter and a clipper circuit. The CW audio filter should only be used with headphones. It will attenuate load adjacent signals (while reducing audio generally).

The audio clipper is used only for removing the loud "thumping" sound in the receiver output while sending CW. There are three positions to the switch: hard, soft, and off. The soft position is especially useful for eliminating atmospheric noise.

The front panel controls contain a combination mike/key quarter inch phone plug. Wire the ring on the phone plug for the microphone, and tip to the push-to-talk (assuming you are using the Astatic D-104 "chrome lollipop" type of microphone or its equivalent).

The spec sheet for the CP5TR Cakepan Transceiver lists 12 hours as the assembly time. It took me a few hours longer (about 15 hours). The receiver specifications include ham band coverage plus 75 KHz, with 100 KHz on 40-meters. The transceiver can be used on 160-meters, 80/75-meters, and 40-meters (coils come for all three bands). Tuning rate is 8:1 with velvet smooth vernier tuning and fine tuning of ±6 KHz. The audio output is 750-mW into an 8-ohm headphone (which is plenty). Receiver drift test after a five minute warm-up; 600 Hz in one hour, 200 Hz drift per hour after that point.

The transmitter puts out 5 watts, but is switchable to 1 watt. The transmitter is crystal-controlled (Pierce oscillator). The carrier is 1.5 watts on AM, and it is cathode modulated. Audio quality is

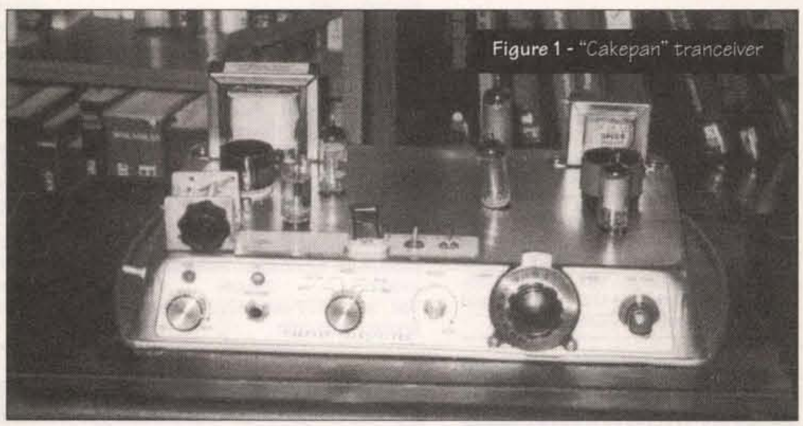


Figure 1 - "Cakepan" tranceiver

"... unrestricted 20 Hz to 10 KHz" although you will probably want to restrict the bandpass to 3,000 Hz.

The pictorials for the kit are a little crude, in fact they are hand drawn. They are adequate to the purpose, however. There were two negative aspects to this kit. First, the knobs came through with no set screws (one knob had the set screw), but that was easily overcome with some RadioShack knobs. The second downer was that the SO-239 holes were not drilled correctly. Two of the four holes lined up, but two were off by quite a bit. A quick drill job fixed the problem.

My conclusion is that the CP5TR Cakepan Transceiver is a very interesting "old-new" technology kit. It's very worthwhile and provided me with a good diversion for a week or so of evenings.

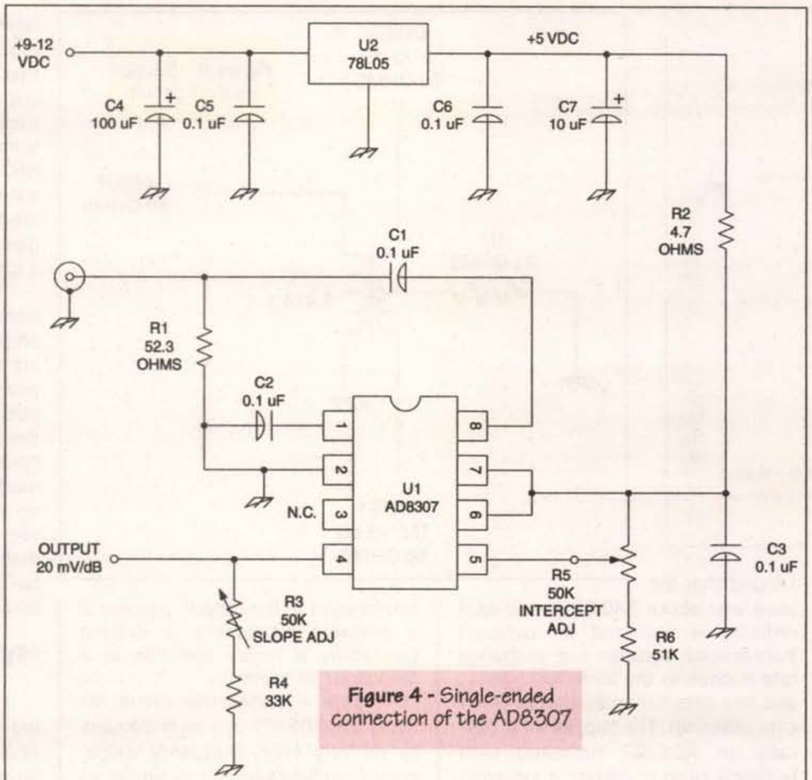


Figure 4 - Single-ended connection of the AD8307

More on the AD8307 Chip

The AD8307 is a log compression amplifier made by **Analog Devices, Inc.** [One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106; **781-329-4700** (voice), **781-326-8703** (FAX), and **http://www.analog.com** (web site)]. The chip uses a method of serial logarithmic compression in which each stage provides a little bit of the total compression (92 dB) to provide a DC 500 MHz chip. A cascade chain of six logarithmic amplifiers provides the lower two-thirds of the dynamic range of the device, while a series of three "top-end detectors" provide the upper third of the dynamic range. The chip provides a 25 mV/dB output with a -75 dBm to +17 dBm range.

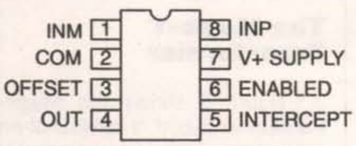


Figure 2 - Pin-outs of AD8307

With a single supply of 2.7 volts minimum (5 volts is more common, 5.5 volts is the maximum), it will operate with only 7.5 mA of DC current. The input signal path is DC coupled and differential. The input impedance is 1,100 ohms with 1.4 pF in parallel with it.

The pin outs (Figure 2) are as follows:

1. INM — Signal input, negative polarity
2. Common
3. Offset alignment
4. Out
5. Intercept — Adjusts intercept ±6 dB
6. Enabled — CMOS compatible Chip Enable (active-HIGH)
7. V+ supply (2.7 volts to 5.5 volts)
8. INP — Signal input, positive polarity

Figure 3 shows the basic connections for the AD8307 chip (without offset connection). The input section is coupled through capacitors C1 and C2 (a pair of 0.001 µF units). These capacitors ought to be SMD (surface mount) types if very high frequencies (VHF) are anticipated. The normal high frequency cut-off of disk ceramic capacitors is too low for this chip because the chip produces -3 dB gain to 500 MHz.

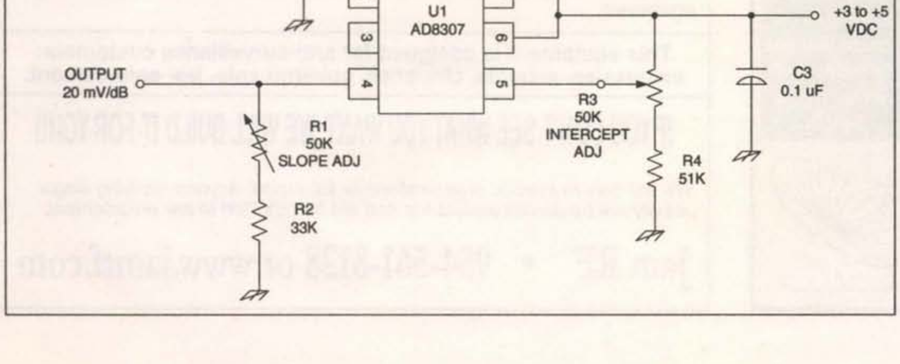


Figure 3 - Basic connection of AD8307

The output section places a resistance in series with the output terminal and passes a current through it to produce a 25 mV/dB output function. By placing potentiometer R1 and R2 in the circuit, we do two things. First, we reduce the gain to 20 mV/dB. And

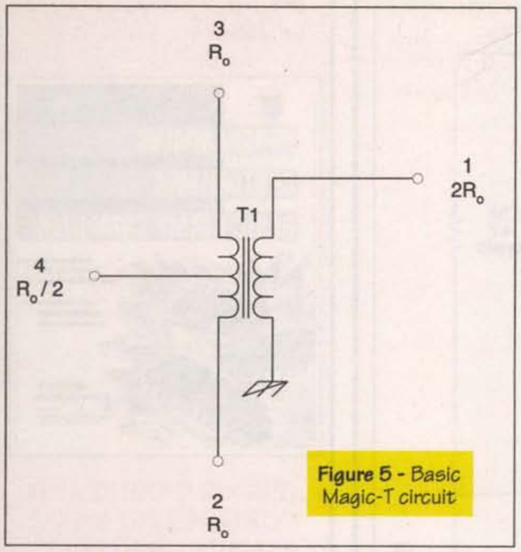


Figure 5 - Basic Magic-T circuit

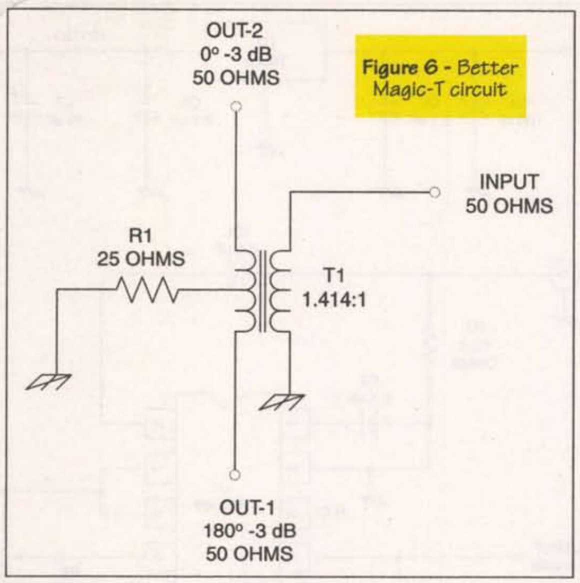


Figure 6 - Better Magic-T circuit

second we provide control over the output slope. The circuit works without the R1/R2 combination, but it is highly recommended if you desire a calibrated output. This network is in parallel with the internal network, which accounts for the reduced output function.

The intercept can be adjusted at pin no. 5 over a range of ±6 dB (this pin is also optional, but highly recommended). There is a certain amount of ambiguity relative to both the output and the intercept point, and the two potentiometers are design features that permit adjustment to a much smaller ambiguity function. As a result, both are highly recommended in cases where output and intercept integrity are desirable features.

I am intrigued with this chip, and have built several projects based on it.

One of my projects was an RF decibel meter (based on a foreign magazine article) from Stippler-Electronik, Inh. [Postfach 1109, D-86656, Bissingen, Germany] in Europe. This kit is priced in deutchmarks, but with credit card ordering, I found that the price was about $40.00 (credit card ordering is preferred for overseas transactions because the exchange rate is close to the New York rate ... and one gets the protection of credit card ordering). The Stippler kit is basically an AD8307 front-end with buffered output circuit. It operates from 100 KHz to 110 MHz with an error of < 1 dB, with an output scale factor of 10 mV/dB. The input of the kit is 50 ohms.

Other uses for the AD8307 include field strength meter with dB output, cable driving amplifier, 1 µW to 1 kW RF power meter, 120-dB measurement system (which depends on the properties of an AD603 amplifier), bandpass frequency meter, and low frequency dB meter.

The field strength meter application is particularly intriguing to me. The circuit uses a pair of antennas that total one-meter in length, with the feedpoint in the center. The circuit in Figure 3 can be used for the field strength meter. The capacitors are increased to 0.01 µF for high frequency operation. A digital voltmeter can be used as the output indicator if a portable instrument is desired (portability is highly desirable in a field strength meter!).

Figure 4 shows the circuit for using the AD8307 in a high frequency or Very High Frequency single-ended configuration. It is similar to the previous circuit except for the input details. The signal is applied to the positive input (INP) through capacitor C1, while the negative input is grounded through capacitor C2. The input impedance is 50 ohms when combined with the internal 1,100-ohm impedance because of the 52.3-ohm resistance. You will have to hand select this resistor from either a pair of 100-ohm resistors, or a 51-ohm resistor (either one can be a five percent resistor). Otherwise, just forget it and use a 51-ohm resistor in this slot ... it will result in a small mismatch.

Lightning Detector — Revisited

A number of readers contacted me about the lightning detector project. I failed to give the gains of the amplifiers in the article. Actually, that was intentional because the gain will depend on the nature of the oscilloscope used. If you have a very sensitive oscilloscope, then use X1 to X50 for the amplifiers. If the oscilloscope used is low sensitivity (an older model), use X50 to X500 for the gains. As you can see, there is quite a large range of gains required!

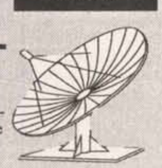
In most cases, ordinary operational amplifiers can be used for the amplifiers. DC differential amplifiers are needed, and the gain must be provided over about 50 KHz. This puts the devices used clearly within the range of CA-3140 or CA-3240 op-amps. These are high-frequency models. You can't use ordinary 741 op-amps for this application because the frequency compensation (that makes them "unconditionally stable") keeps the bandpass down to a few Kilohertz.

Hybrid Couplers

Hybrid couplers are an interesting class of devices. The most interesting property is that they will split an input power two ways. Each of these outputs receives -3 dB of the input power (i.e., a two-way split). Some hybrids produce in-phase outputs, others (called "quadrature" hybrids) produce 90-degree outputs, and others produce 180-degree (out-of-phase) outputs. There are a number of devices that are useful, but among those that I find most interesting are the Magic-T devices. We will take a look at the fascinating Magic-T. The Magic-T produces 180-degree, out-of-phase outputs.

The Magic-T Transformer

Figure 5 shows the Magic-T transformer hybrid. It consists of one center-tapped winding and one non-tapped winding; which is used as the input or output depends on the



application. The relationship of the impedances is shown in Figure 5. The system impedance, Ro, appears at the ends of the center-tapped winding (Port 2 and Port 3), while the impedance at the tap (Port 1) is Ro/2. The impedance at the ungrounded end of the non-tapped winding (Port 4) is 2Ro.

Let's take a look at two situations. First, a signal is applied to Port 1. If Ports 2 and 3 are properly terminated in the system impedance, then the power will split 3 dB to each port, but the voltage appearing at the two ports is 180° out of phase. Port 3 is thus 180° with respect to Port 2. Both Port 2 and Port 3 are -3 dB with respect to the input level. Because Port 4 is the common between ports 2 and 3, the voltage is zero, so Port 4 is the isolated port.

The next case would be a signal applied to Port 4. This signal is split two ways, -3 dB each to Port 2 and Port 3. The signal at Port 1 will be zero because equal but opposite currents from Port 1/Port 2 and Port 1/Port 3 are induced into the untapped winding, thus canceling each other.

Practical 50-Ohm Example

The combiner/splitter shown in Figure 6 is designed for 50-ohm systems, so the tap is terminated in a 25-ohm non-inductive resistor. The input is the non-tapped winding. In order to reduce the 100-ohm impedance that one would expect from the previous case, where the turns ratio is 1:1, the turns ratio is adjusted to 1.414:1 although, in practice, a 1.5:1 ratio is normally used. This transforms the impedance to close to 50 ohms.

A different approach to input impedance transformation is to use a transformer to couple the output. The circuit is otherwise similar to the previous circuit, except that the transformer turns ratio is the same as the straight Magic-T, i.e., 1:1. A second transformer is used to transform the 100-ohm impedance reflected from the tapped winding to 50 ohms. The transformer is an auto-transformer, i.e., a transformer made with a single tapped winding rather than two windings. The tap is placed at the two-thirds point from ground.

Construction

The Magic-T can be built for any power level using appropriate toroidal ferrite or powdered iron cores for transformer T1. For receive-only Magic-Ts you can use cores such as the T-50-2 and T-50-6 in the 1 to 30 MHz high frequency (HF) region, or T-50-15 in the 100 KHz to 15 MHz medium wave region. For receiver applications, use #24 AWG or #26 AWG enameled wire.

For QRP transmitters, you can use a core of the same material (the "dash number" in the type numbers above), but should increase the size to something between the 100 (1-inch) and 240 (2.4-inch) sizes. Use wire in the #22 AWG to #18 AWG, or larger, if power levels are more than a few watts.

If you build one for transmitting at higher power, then you will need to use one of the larger hybrids commonly found on high power BALUN transformers. Also, scale the wire size up according to the power level used.

One of the applications of this type of coupler is to combine the signals from two antennas. Although any type of antenna can be used, let's consider the case of the quarter wavelength vertical spaced a half wavelength apart. These can be fed either in-phase or 180 degrees out-of-phase, depending on the direction that you want to squirt signal. A high power Magic-T and some switching can be used for feeding the antenna.

Why? One fellow told me that he would simply use a half wavelength extra of coax to the 180 degree antenna, and that would take care of the phase shift. Yes, it would, but it also distorts the pattern. Loss in the coaxial cable means that the two antennas will receive different currents, and that messes up the radiation pattern. By using the Magic-T device, you can use equal lengths of identical coaxial cable to the two antennas. If you want to feed them in-phase, then don't use the Magic-T. But if you want to feed them out of phase, connect the Magic-T into the circuit such that Port 2 and Port 3 goes to the two antennas, and Port 1 goes to the transmitter.

Science Fair Participants and Judges

Once again, I put out a plug for participating in your local science fair if you are a student, and judging science fairs if you are an adult. I participate in several local fairs every year and find it very rewarding (as a judge ... I am a little past the age where one can participate!). This is the season for creating the types of projects that will generate a little interest at your local fair, so why not do one of these projects and enter it? I have written in this column before regarding the things it takes to win a science fair, so I will not bore you with the details again except to say that participation is a good thing. **NV**

Connections ...

I can be reached by snail mail at P.O. Box 1099, Falls Church, VA 22041, or via E-Mail at CARRJJ@AOL.COM.

HOW TO PLACE A CLASSIFIED AD

TYPE or PRINT your **ELECTRONICALLY RELATED** ad copy **CLEARLY (not all caps)** on a separate piece of paper. Spell out words when submitting handwritten copy. Calculate the number of words and multiply it by the appropriate rate (see RATE PER WORD section). Include any charges for **bold** and/or CAPPED words, any artwork costs that would be applicable, and/or costs for boxing your ad (explained below). Choose the appropriate classification for your ad(s) to appear in (see below). If no classification is indicated, it will be placed in Misc. Electronics or wherever we deem most suitable. **Enclose your name, address, phone number, and *Nuts & Volts* account number from your mailing label** (if available) for identification purposes. Include full payment — **CLASSIFIEDS RUN ON A PRE-PAID BASIS ONLY** — and mail your completed order to:

NUTS & VOLTS MAGAZINE, 430 Princeland Ct., Corona, CA 91719.

RATE PER WORD

The ad rate for **current PAID subscribers** is **60¢** per word. All others pay **$1.20** per word. There is a **$9.00 minimum** charge per ad per insertion.

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Words to be set in **bold** or CAPS are each 10¢ extra PER WORD. **BOLD CAPS** are 20¢ extra per word. The first two words of each ad are bold capped at no charge. Indicate bold words by underlining. Words normally written in caps (e.g., IBM) and accepted abbreviations such as VAC or MHz are NOT charged as all cap words. Use a two-letter abbreviation for states.

PHOTOS, DRAWINGS, AND BOXES

A photo or drawing may be run at the top of your classified ad for an additional **$10.00** (1" depth max.) for camera-ready art. No wording is allowed in this area. Add a one-time charge of **$5.00** to enlarge, reduce, or duplicate line art, or **$8.00** for halftone of photographs. To **BOX** your ad, include an additional **$50.00** for copy-only ads, or **$75.00** for ads with art or photos.

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You may fax in ad copy or changes before the closing date (5:00pm on the **5th**) at 909-371-3052 using MasterCard or Visa. Include credit card expiration date, the name that appears on the card, a daytime phone number, and your *Nuts & Volts* account number. Ads without credit card information will not be listed as received until payment is received in full. **WE DO NOT CALL OR FAX BACK VERIFICATION OR QUOTES OF FAXED-IN ADS.** For verification of faxed-in ads, please call 909-371-8497.

DEADLINE

Prepaid ads received by 5:00pm on the **closing date (5th of the month)** will appear in the following month's issue. Ads postmarked through the **5th**, but received after the closing date, will be placed in the next available issue. No cancellations or changes after the 5th. Cancellations and changes must be submitted in writing.

IMPORTANT INFORMATION

All classified ads are running copy only. No special positioning, centering, dot leaders, extra space, etc. is allowed. All advertising in *Nuts & Volts* is limited to **electronically related items ONLY**. All ads are subject to approval by the publisher. We reserve the right to reject or edit any ad submitted. We do not take ad copy or changes over the phone. We do not bill for classified ads. Repeat ads or ads run in multiple classifications within the same issue are allowed. Paid subscribers may run ads at the 60¢ rate only through their subscription expiration date. **NO REFUNDS**. Credit only. No credit for typesetting errors will be issued unless you *clearly* print or type your ad copy.

Choose a category for your ad from the classifications listed below.

10. Ham Gear For Sale	80. Test Equipment	120. Components	155. Manuals/Schematics Wanted
20. Ham Gear Wanted	85. Security	125. Microcontrollers	160. Misc. Electronics For Sale
30. CB/Scanners	90. Satellite Equipment	130. Antique Electronics	170. Misc. Electronics Wanted
40. Music & Accessories	95. Military Surplus Electronics	135. Aviation Electronics	175. BBS & Online Services
50. Computer Hardware	100. Audio/Video/Lasers	140. Publications	180. Education
60. Computer Software	110. Cable TV	145. Robotics	190. Business Opportunities
70. Computer Equipment Wanted	115. Telephone/Fax	150. Plans/Kits/Schematics	200. Repairs/Service

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Questions & Answers

TECH FORUM

This is a READER TO READER Column. All questions AND answers will be provided by *Nuts & Volts readers* and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. All questions submitted are subject to editing and will be published on a space available basis if deemed suitable to the publisher. All answers are submitted by readers and *NO GUARANTEES WHATSOEVER* are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals. Always use common sense and good judgement!

QUESTIONS

Send all material to **Nuts & Volts Magazine**, 430 Princeland Court, Corona, CA 91719, OR fax to (909) 371-3052, OR E-Mail to **forum@nutsvolts.com**

I need an inexpensive volume control circuit that could connect to the tape in/out jacks on my stereo for remote volume control. (Momentary press of a push-button switch to raise volume, momentary press of a second push-button switch to lower volume.) Or, a source of low-cost commercial unit to do this, perhaps infrared remote.

10991 **Jim Farago**
Minneapolis, MN

I need help in obtaining service literature for Dictograph model #100/101 circa 1955.

10992 **Art Heyman**
Apple Valley, CA

I am interested in mastering both the theory and practice of programmable logic controllers (PLCs). Can anyone recommend good training hardware and some good textbooks?

10993 **Thomas Ng**
San Jose, CA

I need to project the image from an 8mm camcorder tape onto a screen larger than a television screen. This is for a club with a number of people viewing it. I have thought of using an old optical movie camera (8mm) photographing the television screen and showing this through a projector.

Obviously, there would be losses doing this, the worst being loss of sound. Can anyone suggest a technique for accomplishing this?

10994 **Charles Forman**
San Diego, CA

I am looking for a source of 434 MHz miniature TV transmitters. Any ideas?

10995 **Rich Roznoy**
Westport, CT

I am searching for a program to read a DS1820 in Visual Basic RS232.

10996 **Pierre Verreault**
via Internet

I need to locate a hard drive caddy (the frame/casing which the hard drives mounts in, and which has the connector that mates with the body of the computer) for a Dell Latitude 433MC laptop. Dell no longer supports this model, and they were not able to suggest any third-party sources that sell this item.

Any suggestions on vendors that I might be able to purchase this from?

10997 **Mike Kluger**
via Internet

I have a JVC prologic receiver with a bad transformer in it. I cannot locate the company or any replacement info on this part. It has a shorted primary coil and labeled with: BANDO, ETP1200-62JAJ, BD21A10-0008, and BEM1-0FA.

10998 **Rick Horne**
via Internet

I am seeking a schematic/parts list/parts placement list for a Gateway Monitor CS11572FS. Also need identity to a part (rectifier?) numbered exactly as follows: 3H 15DF8.

I have the horizontal waves traveling up the screen.

Besides the resistor R331, any other likely parts? I need to fix at least one.

10999 **Nicholas I. Oshana, Jr.**
via Internet

Does anyone know the pinouts for the Sony HVM-302 Watchman Camera?

It should be 6V DC positive, negative, audio, and video. However, I don't know which is which, and I don't want to damage the unit by using the trial and error method.

109910 **Eric Dubiel**
St. Clair Shores, MI

I have acquired a Compaq Portable III (one of those lunchbox computers), but unfortunately the information on this beast is hard to come by.

Compaq has a listing of parts, most of which are, of course, out of stock. It runs fine, but I have plans ...

However, I am primarily interested if anyone has information on the plasma display. The cabinet interior has plenty of room to pull out the other components and make a nice luggable Linux box.

109911 **Coyt D. Watters**
via Internet

I need program code numbers and instructions for extended transmit frequencies for my Dai AT-600 dual band transceiver.

109912 **Clarence**
via Internet

I am using a Bearcat BC235XLT "Trunk Tracker" portable scanner with a (BNC) rubber duck when in transit.

My main areas of listening are VHF lo/high band, aircraft, police, fire and rescue, V/DOT crews (during the winter), VA Power, and REA/Southside Electric Cooperative during power failures.

I would like to experiment with the used/junked TV/FM antennas for reception when at home, and at the same time save alot of money.

What kind of TV/FM antennas have omni directional reception capabilities, as well as the fixed-position types used to aim at the source of the broadcast signal?

I have picked up the Chesterfield (VA) 800MHz Trunked system using just a set of "rabbit-ears" using an N to BNC adapter.

109913 **Sean**
Amelia, VA

I am desperately seeking a schematic on how to build a battery load tester. Preferably, a sealed lead-acid type used in the alarm industry. Something that would be switchable from 4 to 7 amphour, 12 VDC, and would have three simple LED readouts, for good, fair, and bad.

109914 **Michael Hussar**
via Internet

I recently bought a Leviton DHC X-10 Inductive Dimmer Switch module from Smarhome.com. The ad says it's especially good for fans and transformers, and other inductive loads.

I tried it on my ceiling fan and it worked, but it caused an annoying hum, loudest at high speeds. The hum is coming from the motor, and it's just loud enough to be annoying in a fairly quiet room.

Their tech support said that's common in some fans, and offered to refund my money, but I really want to see if I can get rid of the hum.

I am considering replacing the triac inside of it with a Teccor "Alternistor," Digi-Key P/N Q2015L6-ND. The description for it says it has "been specifically designed for applications which are required to switch highly inductive loads, and has better turn-off characteristics than a triac."

Would this improve the hum? Is it safe to attempt this kind of modification? I am familiar with DC motor back-EMF and the common countermeasures, but not with AC motors.

109915 **Randy Gamage**
Rocklin, CA

ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of $25.00 will be sent if your answer is printed.
- In most cases, only one answer per question will be printed.
- Your name, city, state, and E-Mail address, (if submitted by E-Mail), will be printed in the magazine, unless you notify us otherwise with your submission.
- Due to space limitations, we can not reprint the original questions with the answer. The question number and the issue it appeared in are printed above the answer.
- Unanswered questions from a past issue may still be responded to.
- Comments regarding answers printed in this column may be printed in the Reader Feedback section if space allows.

QUESTION INFO

TO BE CONSIDERED FOR PUBLICATION

All questions should relate to one or more of the following:
1) Circuit Design 3) Problem Solving
2) Electronic Theory 4) Other Similar Topics

INFORMATION/RESTRICTIONS

- No questions will be accepted that offer equipment for sale or equipment wanted to buy.
- Selected questions will be printed one time on a space available basis.
- Questions may be subject to editing.

HELPFUL HINTS

- Be brief but include all pertinent information. If no one knows what you're asking, you won't get any response (and we probably won't print it either).
- Write legibly (or type). If we can't read it, we'll throw it away.
- Include your Name, Address and Phone Number. Only your name will be published with the question, but we may need to contact you.

TECH FORUM

ANSWERS

ANSWER TO #7996 - JULY 1999

I need a source to obtain a Gauss meter to measure emissions of electric applicances, buildings, fields, etc.

For your application, you will probably want an extremely-low-frequency (ELF) triaxial Gauss meter. There are three suppliers that I know about:

Alphalab, Inc.
1280 S. 300 W.
Salt Lake City, UT 84101
801-487-9492

F.W. Bell/Teslatronics
6120 Hanging Moss Rd.
Orlando, FL 32807-3798
1-800-775-2550

Walker Scientific, Inc.
Rockdale St.
Worchester, MA 01606
508-852-3674

Ross Wollrab
Des Plaines, IL

ANSWER TO #9995 - SEPT. 1999

I mounted an electric window system in my car. The driver's window used to go automatically up or down — a complete course — at a single touch of the button. Now, this system is broke. I have to keep pushing the button to completely open the window.

I want to make a circuit that would keep the motor running until the window opens completely, and then turn it off.

Without building an elaborate sensing circuit, you can couple a latching relay and feed the power that runs and holds this relay on, through a simple flasher relay. Using a two-bulb flasher will give you approximately a two to three amp trip value while an emergency flasher unit will give you up to five amps (or more) power before tripping.

Most car window motors run between a couple of amps and perhaps five amps max and, while the power is fed through a simple flasher unit it will run the motor and latch the relay that is feeding this motor. When the motor reaches the top position and virtually jams, the amperage draw will go up and overload the bi-metal switch and it will pop, thus dropping the latch part of the latching relay, and then it will reset in the off position.

These flasher relays are designed to overload and reset almost indefinitely, or at least for years on end without damaging the unit.

They make great circuit breakers, but they are better than the ordinary circuit breaker in that they are designed to cycle on and off continuously and indefinitely without damage. Also, fuse the entire circuit to around 10 or 15 amps at the feed panel to protect the wiring overall.

There is a drawback to this design of all the way and stop, and that is when someone gets stuck in the window, and it takes a half second to shut off. Even your original design doesn't deal with this adequately.

Chris
Bieber, CA

ANSWER TO #99914 - SEPT. 1999

I am looking for a way to keep my car engine at about 1,000 RPMs while I have my A/C on.

My car is a 1977 Plymouth Fury station wagon (land yacht) with A/C. The engine is a 360CC two-barrel carb., eight cylinder.

Every year, I have to put up with a battery going dead because the alternator drops out at low RPMs and the car also overheats due to slow fan when the RPMs are low.

If AC came stock on your car, everything you need to keep your idle up when the AC is on, is already there. Remove your air filter assembly, and look at the base of the carb. You should see a solenoid which has one wire coming out of it. That solenoid when powered, will extend and bump your idle speed up. Reasons it might not be working could be adjustment (it just screwed in), or it could be disconnected or possibly nonfunctional.

Apply power to it and see if it extends. If not, replace it. If it does, hunt down the fuse/fusible link for it.

John M. Hoyt
Easley, SC

ANSWER TO #99921 - SEPT. 1999

I am looking for a circuit design for a ISO-9141-2 to RS-232 converter to allow me to see the information coming out of the On Board Diagnostic II system found on all '96 and higher Chrysler and import vehicles.

One place you might want to check out is www2.ari.net/avt-inc. They sell OBDII adaptors and software.

Dan Hockey
via Internet

ANSWER TO #9998 - SEPT. 1999

I am building a robotics platform using two stepper motors for locomotion.

Is there any formula for figuring how much weight a stepper motor can carry, and also two together?

The weight that a motor can handle is determined by its torque. For example, if a motor is specified at 20 ounce-inches, then the motor can lift 20 ounces with a pulley radius of

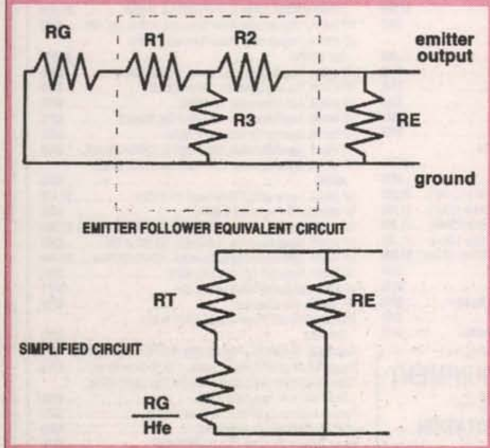
ANSWERS TO #9999 - SEPT. 1999

I always thought that the output impedance of an emitter follower was the resistance of the emitter resistor.

I recently built a class A, two-stage single ended emitter follower transistor amplifier to provide a low Z output. Measurements reveal a lot lower impedance than the 100-ohm load resistor would lead me to believe. Am I missing something?

#1 - You are right. You are missing the internal resistance of the common collector transistor and its source resistance. In the equivalent circuit, I have called the source resistance RG and the external emitter resistor RE.

The resistors inside the dashed lines comprise the transistor equivalent circuit. R1 is the base spreading resistance divided by the current gain. R2 is the emitter internal resistance and is inversely proportional to the emitter current. R3 is the collector resistance and is large enough to neglect.



These resistor values are hard to find and difficult to measure, but you can get a rough estimate with this equation: RT = R1 + R2 = 0.024/IE where IE is the current through RE.

The equation for the output resistance, for the simplified circuit is: Rout = RE (RT + RG/Hfe) [RE + RT + RG/Hfe].

For example, if RG = 10K, RE = 1K, IE = 10mA, and Hfe = 100, then Rout = 92.9 ohms. When you use this as the RG for the second stage, the final output is much lower.

Russell Kincaid
Milford, NH

#2 - The output impedance formula you cited is for a common emitter amplifier — not an emitter follower. A transistor essentially has two diode junctions in close proximity, and that tells you what the impedances are.

The collection-base junction is reverse-biased, so the collector looks like an open circuit. For small signal transistors, the collector impedance will be on the order of 200 kilohms. Consequently, the output impedance of a common emitter transistor will be set by the load resistor (which is much less than 200K).

The emitter-base junction is forward-biased, so the output impedance of the emitter looks like a conducting diode (i.e., almost a short). The small signal impedance of an emitter follower is the diode's dynamic impedance, (kT/q)/I. At room temperature, (kT/q) is about 25mV. If the emitter current is 1mA, then the impedance looking into the emitter is 25mV/1mA = 25 ohms. If the emitter current is 10mA, then the impedance is 2.5 ohms.

Your cascaded emitter follower is probably running more than 10mA, and that is why the output impedance looks so small.

The base impedance would be the same as emitter impedance except that the current gain (beta) of the transistor comes into play. Because the collector junction is so close to the emitter, most of the emitter current is swept away by the collector.

The base current is about (1/beta) of the emitter current, so the base impedance is about beta times the emitter impedance. If beta is 100, then a 1mA emitter current implies a base impedance of 2,500 ohms.

The apparent output impedance of an amplifier can be lowered using negative feedback. Audio amplifiers often employ class B amplifiers with output impedances less than 0.1 ohms.

Gerald Roylance
Mountain View, CA

#3 - Junction transistors have a parameter called the "Intrinsic Emitter Resistance" (Re). Re should be expressed with a lower case r, and read "r sub e," but subscripts don't usually survive the E-Mail process, so I will use Re.

The same comment applies to Hfe, Ro, Rs.

Let Ic = collector current; Hfe = Beta (common emitter current gain of the transistor); Rer = The emitter resistor resistance; Ro = Output resistance of the emitter follower (ignoring effect of Rer); Ro'= Output resistance of the emitter follower (including effect of Rer); and Rs = Source resistance of the signal source for the emitter follower.

For a silicon transistor: Re=25/Ic, with Ic expressed in mA, Re expressed in ohms.

Then Ro = Re + Rs/(Hfe+1) (ignores the contribution of the emitter resistor).

Example: Hfe = 50 (Beta); Ic = 10 mA (Collector Current); Rer = 100 ohms (Emitter Resistor); and Rs = 1000 ohms (Source Resistance).

Ro = 25/10 + 1000/(50+1)
= 2.5 + 19.6
= 22.1 ohms

Ro appears in parallel with the emitter resistor Rer, so the net output resistance is given by the parallel resistors formula:

Ro' = 22.1 x 100/(22.1 + 100)
= 18.1 ohms.

As long as the emitter resistor is large compared to Ro, it has very little influence on the net output resistance Ro'. The major players are Ic, Hfe, and Rs.

For a two-stage emitter follower, the output resistance of the first stage would be the source resistance for the second stage.

Good beginner level coverage of the emitter follower can be found in Horowitz and Hill, *The Art of Electronics*, Cambridge University Press.

Jon Lark
via Internet

one inch. If the pulley radius is 0.1 inch, then the motor can lift 200 ounces.

Gear trains can also change the weight a motor can lift. Gearing down allows you to lift more weight, but you cannot do it as fast.

There are limitations because gear trains have losses. Gear strength is also an issue. A friend of mine built a robot arm that was always breaking gear teeth. You should calculate the forces and torques throughout the drive train to avoid similar mistakes.

If your robot only moves on a hard, flat surface, then the motor only needs enough torque to overcome the friction in the drive train.

If you want the vehicle to accelerate quickly, then calculate Newton's F=mA to find the dynamic force the wheels must apply. From that, and the wheel radius, you can determine the required shaft torque to get the required acceleration.

If your robot will climb hills, then the motor must also lift a fraction of the vehicle's weight.

Gerald Roylance
Mountain View, CA

ANSWER TO #99910 & 99917 - SEPT. 1999

Where can I get the plans to build a 6 VDC to 12 VDC converter to *install a new radio into an old six-volt car.*

From the J.C. Whitney catalog #630J, page 137: A 6-12 volt converter designed specifically to supply juice to an auto radio is available from **Custom Autosound**. They've even got a toll-free number: **1-800-88TUNES** 10:30a.m-7:30p.m. central time.

You need to tell them whether the car with the six-volt system has a negative or a positive ground. It will cost you about $89.00. It's rated at seven amps. You don't order it from J.C. Whitney, they just tell you where to find it.

Jack Dennon
Warrenton, OR

ANSWER TO #99911 - SEPT. 1999

I am a university student currently doing a project involving the MC68HC811E2FN52PLCC. I can't find the microcontroller in my country (Malaysia).

Can someone help?

The Motorola MC68HC811E2 is a common, general-purpose microcontroller. Information on the part can be found at: http://mot-sps.com/products/microcontrollers/8_bit/m68hc11_family/68hc811e2.html.

Features of this part include 512 bytes RAM, 2KB EEPROM, SCI/SPI ports, eight-channel, eight-bit A/D, 16-bit timer, 38 general-purpose I/O. The part should be available from most distribution channels, as well as direct from Motorola.

The device in question is supplied in a 52-pin PLCC package.

The Motorola Distributor Contacts web page http://mot-sps.com/support/sales/ gives the following distributors in or near Malaysia:

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Joe Grand
via Internet

ANSWERS TO #9994 - SEPT. 1999

Note - The remaining answers all pertain to question #9994.

I have an engineering calculations program "ECALC" written in IBM BASICA. It will not run in Windows or even in DOS on the new Pentium processor computers. How can I get IBM BASICA to run on a Windows machine?

There are three approaches to the problem of running a program that requires BASIC A on a modern PC. I will describe them, starting from the simplest and moving to the more complex.

Continued on page 77

ANSWER TO #8994 - AUG. 1999

I need a circuit to cycle up to a 1 hp 120 VAC motor, at any off/on (continuous) interval (selectable in five minute increments) up to 60 minutes. (Same time off as on.)

The timing intervals of N x 300 seconds (five minutes) for N = 1 to 12, may be obtained with the following circuit.

U1 is a SPG6851B from Epson America (Digi-Key SE3104-ND). This programmable crystal oscillator has 57 different output frequencies. As shown in the schematic, the control inputs of the SPG8651B will provide the timing you need.

I have shown S1 and S3 to illustrate how you may change the timing. You may switch all six control inputs of the device to obtain a wide range of timing, if required.

The output of U1 is divided by U2 (CD4040B) and the four-bit binary count is presented to U3 (CD4585B) where it is compared to a binary value selected by S2. Each time the values match, RLY1 will change states from off to on and then on to off (with a 50% duty cycle). S2 must be constructed so that decimal values from 1 to 12 in binary are presented to U3.

It is important not to present all zeros to U3, and therefore you will need to construct the binary codes required from a 12 position, four-pole rotary switch.

Binary 0001 = five minutes on, five minutes off. Binary 1100 = 60 minutes on, 60 minutes off. U4 (CD4013B) will reset the count of U2 and toggle Relay RLY1. The circuit essentially counts from one five minute period to 12 five minute periods continuously.

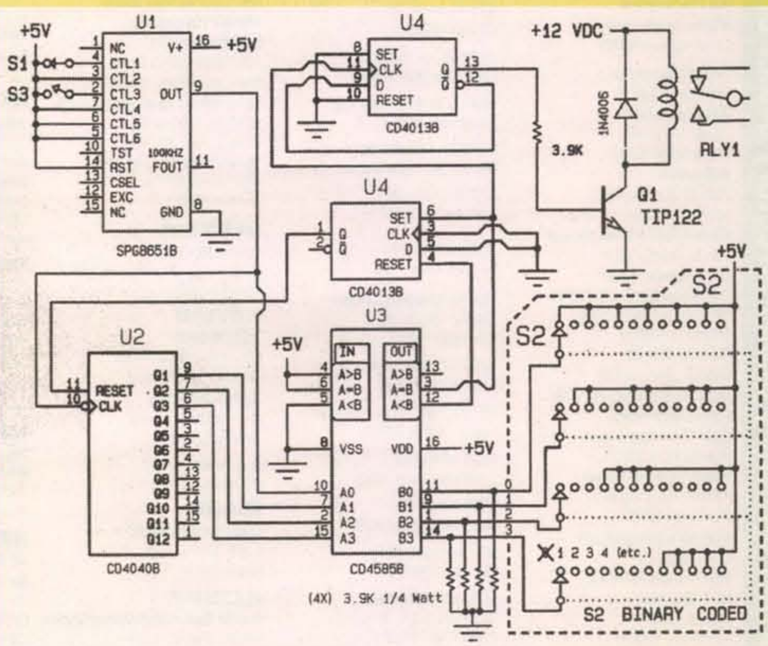
For testing, you may program U1 for faster times by adding switches to the six control lines per the data sheet for the SPG8651B. All resistors are ¼ watt 3.9K ohm.

To control a 1 HP 120 VAC motor with the circuit, you will need to connect a large power relay such as Newark part number 93F7669 between RLY1 and your 1 HP motor.

RLY1 will require 1 amp 120 VAC contacts, which will operate the coil of the large power relay. If you do not want to build a circuit, you may purchase a recycling timer in the configuration you seek.

Grainger sells several from Omron described as universal timers. Again, you should operate the coil of a larger power relay and control the 1 HP motor with the larger contacts of the power relay, because the timer contacts are not rated for 1 HP.

David R. Howland
Aptos, CA



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Servos, Steppers, and Optical Encoders — Part 3

by TJ Byers

Which one works best in your robotic or R/C project? Here's everything you need to know. This month: Bipolar stepper motor electronic controllers.

Whether you play with robots, model planes, or boats, there are motors inside which supply the muscles and habits that make them go. Choosing the right motor for your project, though, can be a daunting experience. Motors that provide locomotion aren't the same as those that move robotic arms or pilot a plane.

Basically, controller motors come in three flavors: servos, steppers, and encoders. Last month, we looked at the construction of bipolar stepper motors. In that article, you discovered that there are three methods used to make them spin, along with the pros and cons of each. This month, I show you the electronics that drive bipolar stepper motors.

Bipolar Stepper Motor Drivers

Bipolar stepper motors present a dilemma because of the design trade-offs. On one hand, the motor is simpler to construct and more versatile than the unipolar stepper because it has only two windings (the unipolar has four). On the other hand, the drive circuitry needed to reverse the polarity of the coils is more complex. Until the advent of high-power integrated circuits, this was a real deterrent because the part count is high and costly.

The key to bipolar stepper motor operation is an H-bridge, which is basically two op-amps or push-pull circuits wired in a bridge circuit (Figure 1). When the output of one op amp is high, the other is low. This circuit is found in many applications, including audio amplifiers and DC motor controllers. For complete bipolar motor control you need two H-bridges — one for each stator winding.

The schematic in Figure 2 shows a typical H-bridge driver for a bipolar stepper motor, made with just four NPN transistors, that can power small stepper motors with current ratings up to 800 mA. For motors that require more current, the 2N2222A transistors can be replaced with more powerful ones, like the TIP31 or 2N3055. However, you may need to make adjustments in the value of the 1k resistors if the gain (hFE) of the replacement transistors is below 150.

While the circuit looks complicated, it's easy to follow how it works.

Before I begin, you must realize that the respective coil inputs can't be high simultaneously. That is, coil A1 and coil A2 inputs can't be high at the same time, but it's okay for them to be low at the same time. (This is a logical state and has nothing to do with possible Vs to GND shorts.) Also, this discussion applies to the A coil only, but the B coil operation is identical, so there's no reason to repeat myself.

At rest, with no inputs to coil A1 or coil A2, both the X and Y leads of the stator winding are connected to V+, hence, no current flows through the coil. Now if the coil A1 input goes high, it turns on Q2, which shorts the base of Q1 to ground, which turns Q1 off. This action also connects the X stator lead to ground, which causes current to flow through the winding. Now let's make the coil A2 input high and toggle coil A1 low. This turns off Q2 and causes Q4 to conduct current and shut off Q3 which, in turn, grounds the Y lead and forces the X lead high. Voila, we have polarity reversal.

While this is a perfectly good design, a simpler solution is to use an integrated circuit H-bridge driver specifically designed for stepper motor applications, like the L298 from STMicro-electronics (781-259-0300; http://www.st.com). This 15-pin IC contains two complete bridge drivers (Figure 3), each controlled by two logical inputs identical to those used in the transistor controller in Figure 2 and an enable input. This chip is capable of supplying up to two amps of drive current, and is available from several sources, including jobbers of the ECG7071, for under $10.00.

All the logic gates inside the L298 are TTL compatible; that is, they operate from a five-volt source which is supplied by the Vref voltage regulator. This voltage is separate from the Vs input which can switch up to 40 volts. To prevent switching glitches from upsetting

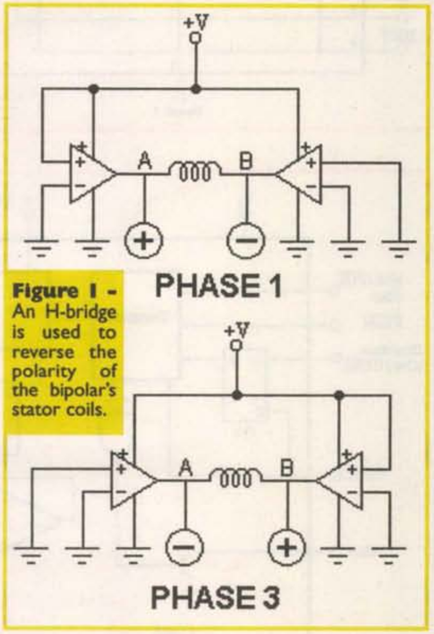
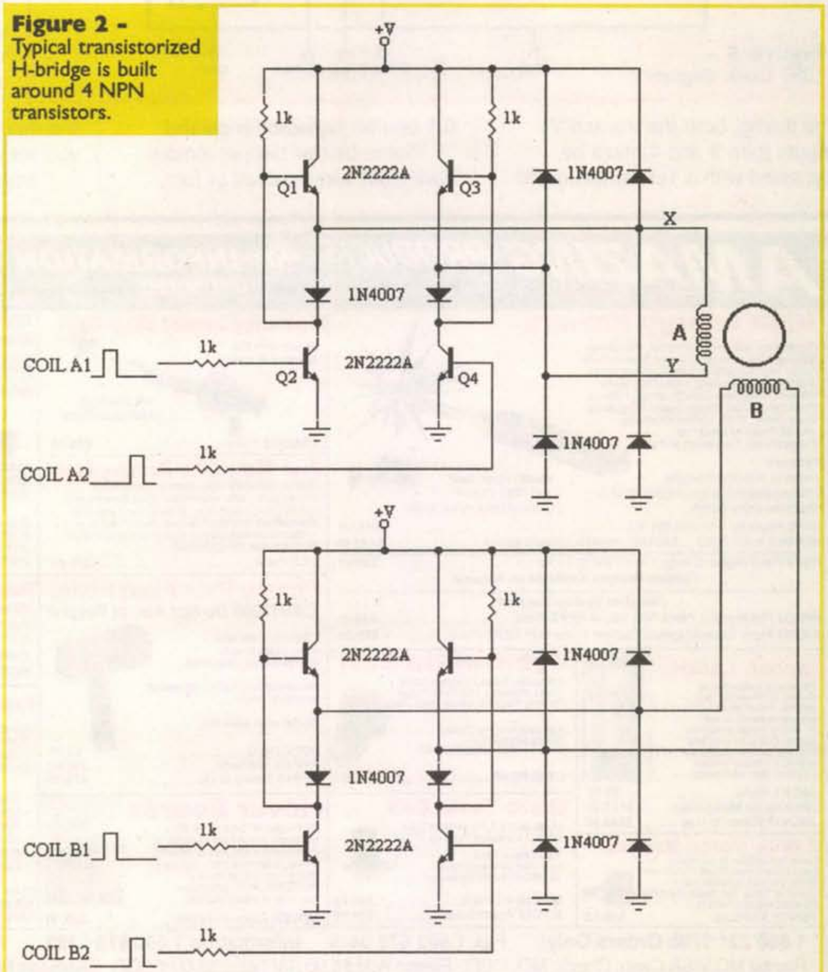


Figure 1 - An H-bridge is used to reverse the polarity of the bipolar's stator coils.

Figure 2 - Typical transistorized H-bridge is built around 4 NPN transistors.



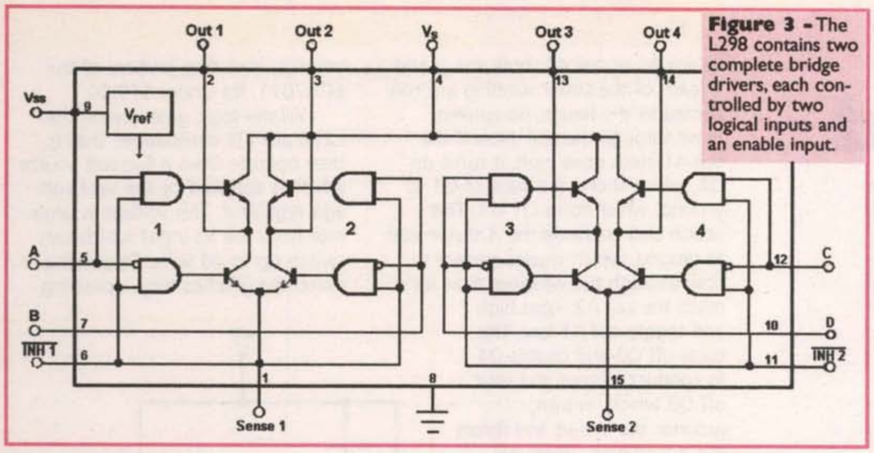


Figure 3 - The L298 contains two complete bridge drivers, each controlled by two logical inputs and an enable input.

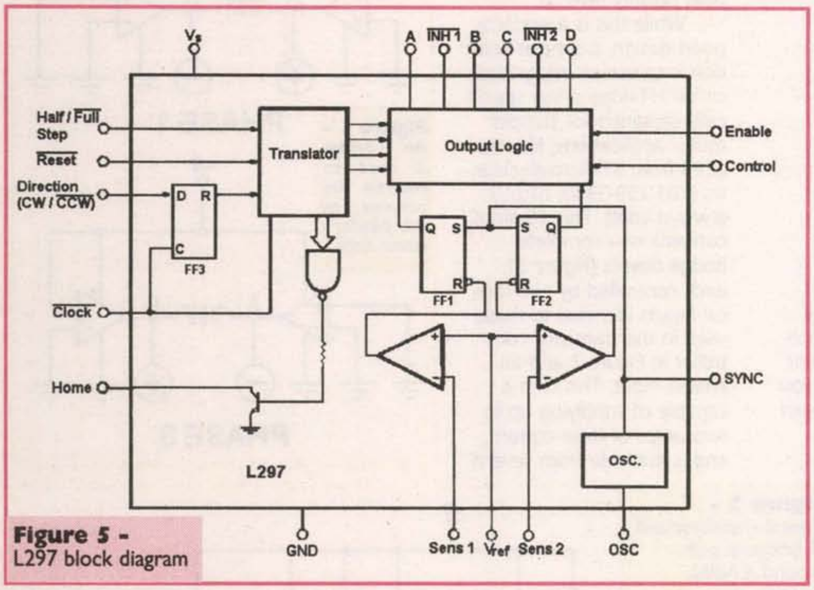


Figure 5 - L297 block diagram

the timing, both the Vss and Vs inputs (pins 9 and 4) must be bypassed with a 1uF tantalum and 0.1 ceramic capacitor in parallel.

Some bipolar stepper motors have eight wires instead of four, which are connected to four internal coils. These coils can be wired in parallel to produce more torque or in series to reduce the current (at the expense of torque).

Bipolar Stepper Motor Controllers

Now that we have the brawn, we need a brain – which is called a stepper motor controller. While the L298 can be connected to any stepper motor controller – including a BASIC Stamp or PIC microcontroller – the logical match-up is an L297 – L298's companion chip.

The controller circuit that drives the push-pull transistors of the H-bridge is a digital sequencer, which basically converts a clock input into a proper sequence of events, like that shown in Figure 4.

This sequence is for the popular two-phase operating mode where both coils are energized at the same time. This mode provides the most torque and is the simplest timing sequence to generate. That's why it's often called the normal mode, and the mode used for the torque specs you see in catalogs.

Inside the L297 (Figure 5) are three major elements. The most critical is the translator circuit. It's in this circuit that the clock pulses are forged into the stator coil sequence needed to rotate the stepper motor in its various modes. The stepper motor operating mode is determined by three input pins.

The HALF/FULL STEP input selects between the full wave/two phase and half step modes. Notice that the full wave and two phase modes are selected using a logic low.

The difference between them is the state of the translator at the time this pin is pulled low. If the translator is in the even mode, it generates a full wave pulse sequence; in the odd mode it generates a two phase sequence. The reset input can be used to initialize the translator in the even mode, and the home output is used to indicate the translator's current state. The direction input determines the direction of rotation and the clock input sets the rotational speed.

Overdriving Stator Windings With High Voltage

The output of the translator goes to the output logic circuit, which drives the input of the H-bridge. The output of the output logic can be further controlled using the on-board PWM (pulse-width modulator). What this circuit does is control the amount of current flowing through the stator windings.

You see, coils are inductors and it takes time for the current to build up to full power – just like it takes time for the voltage across a capacitor to come up to full voltage. You can speed up the process by applying a larger than rated voltage across the winding. In fact, many stepper motor manufacturers recommend driving 12-volt steppers from a 36-volt source. The trick is to remove the voltage before the current exceeds the coil's maximum current rating. This is where the PWM circuit comes in.

There are two pins on the L297 called SENSE1 and SENSE2. These inputs sense the current through their respective stator winding by measuring the voltage drop across a resistor to ground and comparing it to a reference voltage (Vref). These resistors are located on pins 1 and 15 of the L298 H-bridge chip.

Essentially, it's a return path for the bottom emitter of the H-bridge to ground. When the voltage drop across the SENSE resistor equals the reference voltage, a flip-flop triggers and interrupts the output logic driver until the next PWM clock pulse arrives. This OSC clock pulse is generated internally and has no relationship to the clock input pulse that controls the rotational speed of the stepper motor. Think of it as a switching voltage regulator in that the chopper frequency is way faster than the current it's controlling.

Using this method, the stepper motor can achieve higher speeds and greater torque without exceeding the current rating of the coils.

Be aware, though, that this feature is built into the L298 – a feature not all H-bridges support. The 2N2222A H-bride in Figure 2, for example, doesn't have current sense. When not using the PWM, it has to be turned off by grounding the SENSE pins and connecting Vref to Vs.

Finished Bipolar Controller

Now that you know how the L297 and 298 work, here's how to make them work together (Figure 6). This bipolar stepper motor circuit will drive any bipolar motor up to two amps. The typical upper step rate is 25 kHz— about 12,000 steps-per-second in the two-phase mode. At 400 steps (0.9 degrees/step) per revolution, that calculates to be 1800 RPM; at 7.5 degrees per step, it's 15,000 RPM. There's nothing new that we haven't already talked about in this perfect match-up of L297 to L298, so you won't find any surprises here. But here are some things you need to know about if you want to duplicate this circuit.

The recovery diodes are very important because they prevent the back EMF from the collapsing field of the stator winding from burning out the H-bridge transistors. Notice that the damper diodes are also a critical part of the 2N2222A H-bridge – for the same reason. But because of the switching speed of the L297 (up to 40 kHz at times), you need very fast recovery diodes – something on the order of 200 nS or less at 2A. A 1N4007 won't cut it.

Individually, these fast-recovery diodes cost about a buck apiece, and you need eight of them. However, you can buy an L6210 or UC2610 – which has eight of these diodes in one IC package – for under $5.00. Whichever way you go, just make sure the diodes are in place before you apply power or you can kiss your L298 good-bye.

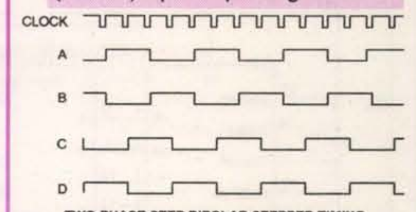
Next on the agenda is the control interface. No doubt those of our readers familar with microcontrollers know just what to do, and they can have at it. But there are still a lot of us who are comfortable with flipping switches rather than data bits. With that in mind, I've taken the liberty to present this design in a more elementary, hardware level.

For example, a single toggle switch reverses the direction of the motor and a 555 timer pulse generator adjusts the stepper rate. So now you have speed and direction control with nothing more than a potentiometer and a switch – no software needed. The mode inputs are also hard-wired for half-step mode, which provides high resolution and good torque. It may not be the most versatile bipolar controller, but it works just fine for many hobby applications.

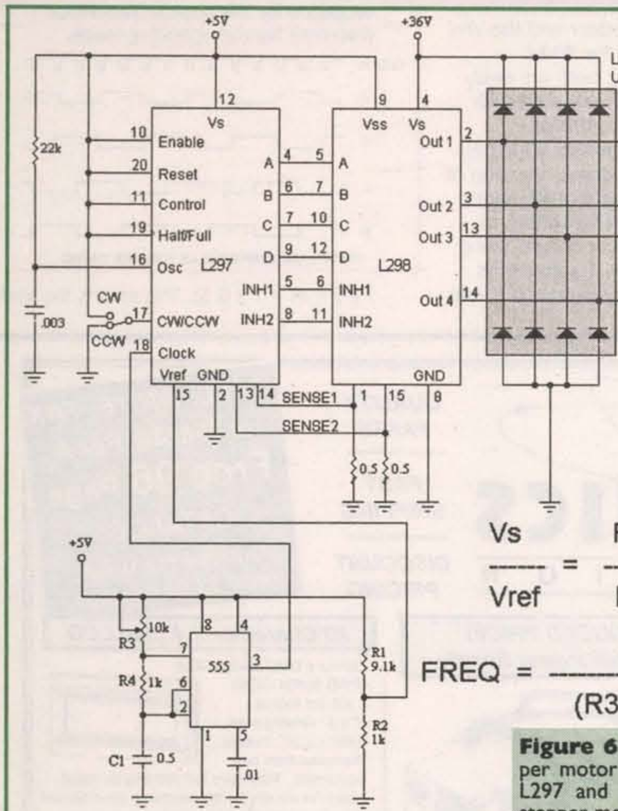
The two variables in this design are the clock rate from the 555 pulse generator and the Vref voltage of the PWM. Fortunately, both are easily calculated. Let's start with the PWM controller.

Let's say that your stepper motor draws one amp of current, and that the sense resistors are 0.5 ohms, as the schematic shows. Using Ohm's Law, 1 amp across 0.5 ohms generates 0.5 volts

Figure 4 - This is the timing sequence for the popular Two-Phase (Normal) bipolar operating mode.



(E = IR = 1 x 0.5). This means the Vref



$$\frac{Vs}{Vref} = \frac{R1}{R2}$$

$$FREQ = \frac{1.44}{(R3 + 2R4)\ C1}$$

Figure 6 - This bipolar stepper motor controller, using an L297 and an L298, can drive stepper motors up to 2A.

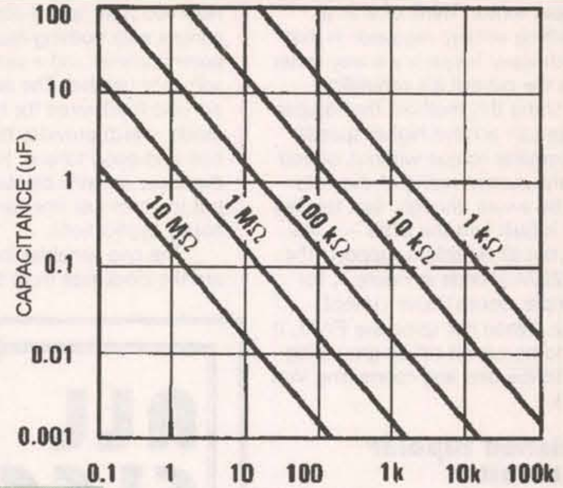


Figure 7

voltage should be 0.5 volts for a one-amp stepper motor. This reference voltage can be generated using a simple resistance divider. The formula is:

$$\frac{Vs}{Vref} = \frac{R1}{R2}$$

Let's say R2 is 1k, then, using Ohm's Law again, we need a current of 5 mA to generate 0.5 volts across R2. To generate a current of 5 mA from a 5-volt source, the total resistance is 10k. Subtracting 1k from 10k gives us a value of 9k for R1; the standard value is 9.1k, which is close enough. For 2 amps, the Vref voltage is 1 volt.

Given the above scenario, that means R1 equals 8k and R2 is 2k. Just keep in mind that this is a ratiometric function. As the value of R2 increases, R1 decreases by the same amount. Personally, I'd place a 1N4001 diode from Vref to ground (anode up) and a 1k resistor from Vref to Vs. That stabilizes Vref at 0.7 volts, which should serve most 1A through 2A steppers.

On to the stepper rate, which is a function of the clock pulse frequency. For the sake of argument, let's say the stepper motor moves in 15-degree increments. That means it takes 24 steps to complete one revolution. In the half-step mode, that number becomes 48 steps per revolution. In the half-step mode, one clock pulse equals one step. So, if you want to spin the motor at 1,000 RMP, you need to generate 48,000 pulses. Divided into seconds, the number is 800 – or 800 Hz. The math is

$$FREQ = \frac{RPM \times STEPS\ per\ REV}{60}$$

The next question is, what value of C1 does it take to generate 800 pulses a second?

Here's that formula.

$$FREQ = \frac{1.44}{(R3 + 2R4)\ C1}$$

In our example, the values are: R3 = 5k, R4 = 1k, and C1 = 0.5uF. Of course, moving the wiper of the potentiometer from its mid-position of 5k (10k being total) will speed up and slow down the motor. But isn't that what we wanted? Adjust the values of C1 and R3 to fit your needs; leave R4 alone. Here's a nomograph that does the math for you (Figure 7).

One More To Come

For those readers who have suffered through this series on servos and steppers, rest assured there's just one more installment to come. It will deal with the unipolar and variable reluctance stepper motors, and touch briefly on encoders. So 'til next time, get those bipolars spinning. **NV**

Continued from page 71

1. You can install an alternative BASIC to BASIC A. Get the free "BWBASIC" (Bywater BASIC, a clone of GWBASIC) from ftp://oak.oakland.edu/pub/unix-c/languages/basic/basic.tarz.

You will need a C compiler to build this, or else get someone else to do this for you. See if this version of BASIC will work with the program either under Windows or in DOS.

2. Consider the possibility that it is the DOS that ships with Windows 9X, MS DOS 7, that is incompatible with BASIC A, rather than the Pentium processor.

Proceeding on that assumption, partition your hard drive. You will need a program such as Partition Magic to do this or you can start over from scratch by wiping your hard drive, creating two partitions, and reinstalling Windows on the first one.

In either case, you will install an alternative DOS version on the second partition. Free DOS from http://www.freedos.org will cost you nothing. Now install BASIC A on that partition and try loading your program.

3. Rewrite the program in VB or VC. If you lack the programming skills to do this, get an aspiring programmer from a local tech school or from a user group to help you.

Mendel Cooper
St. David, AZ

ANSWERS TO #9994 - SEPT. 1999

BASIC A, sometimes referred to as "Advanced BASIC" — a superset of the original IBM BASIC — was built into the chips of the original IBM machines, and did not support disk drives. IBM-DOS added BASIC A, which supported disk drives by adding some software code to the original BASIC hardware.

However, since clone-makers could not use the original IBM chips that contained BASIC without violating IBM copyright, they used MS-DOS, which included GREASILY, sometimes referred to as "Gee Whiz BASIC" or "Graphics with BASIC," since it added some additional features — but would also run BASIC A programs.

Then along came QUICK BASIC and BASIC in later versions of MS-DOS and early Windows versions. These will run BASIC A only if the program is saved in the ASCII format, an option in earlier BASICs.

More recent versions of Windows do not include any version

Continued on page 86

ANSWERS TO #99913 - SEPT. 1999

I need to hook up my Apple Personal Laserwriter NT, with a DIN connection, to my PC running Windows 98.

#1 - The Apple LaserWriter family supports a variety of host connections, many of which are configurable by software.

A Mini-DIN 8 connector (DB-9 on the original LaserWriter and LaserWriterPlus) is used for LocalTalk (Apple's proprietary LAN) and for RS-422. A DB-25 connector is used for RS-232. An Amphenol "57" connector is used for Centronics parallel.

Not all logic board models have all interfaces, but all have at least a LocalTalk interface and an RS-232 interface.

Some LaserWriters, such as the LaserWriter II and the Personal LaserWriter, support more than one logic board type.

The easiest way to interface a LaserWriter (of whatever model and logic board type) to a PC is through the RS-232 interface.

Set the baud rate to 9600 — the LaserWriter's default — and then use the Add Printer function to set hardware handshaking. Once communications is established, it is possible to change the baud rate to 19,200 or, in some cases, to a higher rate.

Peter
via Internet

#2 - The mini-DIN connection on your Personal LaserWriter NT is a LocalTalk port which is used for Apple's LocalTalk networking. You will probably not use this port with your PC. However, that printer also has a DB-25 serial port which you can use for printing if you have an available serial port on your computer.

The cable you need looks like this:

Printer DB-25	Computer DB-9
2	2
3	3
4	8
5	7
6 & 8	4
7	5
20	1 & 6

The printer supports both PostScript and HP PCL emulation.

There is a configuration dial switch on the printer which sets both the emulation and the port parameters. You will probably have the best luck using the PostScript driver built into Windows.

Switch position 1 sets the DB-25 connector on the printer to serial 9600 baud, 7N1, XON/XOFF handshaking, and PostScript Batch Mode which should work with the same settings on the PC.

All of this information and more can be found in Apple's Tech Info library.

The two most relevant entries are "Personal LaserWriter NT: Connecting to a Windows Based PC" at http://til.info.apple.com/techinfo.nsf/artnum/n30991 and "Personal LaserWriter NT: Switch Settings" at http://til.info.apple.com/techinfo.nsf/artnum/n7439.

Doug Smith
Roscoe, IL

AMATEUR ROBOTICS NOTEBOOK

by Robert Nansel

Last month, I covered the more intricate details of I2C timing, including multi-master bit arbitration and clock synchronization and stretching. I then showed a simple logic circuit that detects I2C START and STOP conditions — an essential tool for triggering an oscilloscope to display I2C signals.

Unfortunately, in my discussion of bit arbitration, I said that the ninth bit transmitted by a master is the R/W bit, which is flat wrong. It's the eighth bit. The ninth bit is the ACK bit. It was shown correctly in the illustration. Sorry for any confusion this may have caused.

This month, I'll jump right into building a software-only I2C master.

It's all in the timing

Writing a software-only master is not too difficult because excellent pseudocode is available from Vincent Himpe's I2C FAQ (www.ping.be/~ping0751/i2cfaq/i2cfaq.htm), and the data timings are fairly relaxed.

Software slaves are another story. The immediate problem you face is getting the slave to reliably detect a START condition. A master, (unless it can also be addressed as a slave), doesn't need to detect START, only that the bus is free and, if the bus is not free, a master can usually wait until it is.

Not so with a slave. A slave must know the I2C bus state at all times. In the absence of hardware to detect START, it must sample the bus continually at a rate that guarantees it will detect START within a few microseconds of its occurrence.

The first number of relevance here is tbuf: the amount of time the bus must be free after the last STOP and before the next START can be asserted. The minimum is 4.7 microseconds, and a software slave must sample both SDA and SCL at least twice during that time to determine if the bus is free.

For a 10 MHz 16F84, this ordinarily would mean that you'd have only five or six processor cycles for the loop; very tight. If a slave could sample the bus every five processor cycles, there could be as much as a five-cycle (2 usec) delay before the slave would recognize START. There are ways to relax the sampling rate requirement, but for now it's sufficient to know that it's not a trivial problem.

```
; ** Create I2C START condition
;       entry:  I2C Bus idle
;       exit:   SDA, SCL = 0

start
        bsf     STATUS, RP0     ;  (Tris in Bank1)
        bcf     TRISA, SDA      ; Signal START condition
;       delay   T_hdsta-1       ; Delay to meet T_hdsta spec
        nop                     ; NOPs to pad out 4 µsec delay
        nop
        nop
        nop
        nop
        nop
        nop
        nop
        nop
        bcf     TRISA, SCL      ; Start clock low period
        bcf     STATUS, RP0     ;  (Ports in Bank0)
        return
```

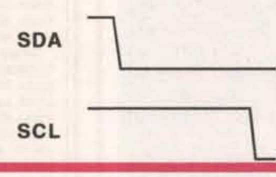


Figure 1: START Routine

```
; ** Create I2C STOP Condition
;       entry:  SDA = X, SCL = 0
;       exit:   SDA = 1, SCL = 1  (I2C Bus idle)

stop
        bsf     STATUS, RP0     ;  (Tris in Bank1)
        bcf     TRISA, SDA      ; SDA=0
        bsf     TRISA, SCL      ; SCL=1
;       delay   T_susto-1       ; Delay to meet T_susto spec
        nop                     ; NOPs to pad out 4 µsec delay
        nop
        nop
        nop
        nop
        nop
        nop
        nop
        nop
        bsf     TRISA, SDA      ; SDA=1
        bcf     STATUS, RP0     ;  (Ports in Bank0)
        return
```

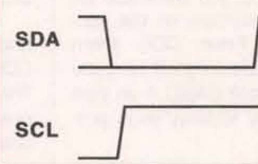


Figure 2: STOP Routine

For a master, however, the important thing to remember is that it's not trying to detect a 4.7 usec bus free condition, but to detect a bus free condition that is at least that long. It's okay, for example, for masters to allow the bus to idle longer than that. The bus is intended to be lightly loaded, but if a master waits too long, it may lose its chance at the bus that time around should a faster master assert START in the mean time.

The second number of concern is thd;sta: the hold time for START. This is 4.0 usec minimum from the time SDA drops low until SCL begins to go low, or 10 processor cycles. The third number is tlow: the 4.7 usec minimum time SCL must be low during each bus clock pulse. This is 11 processor cycles.

Assuming a slave can detect START, these numbers are easier for it to deal with, especially since what the slave really cares about is detecting the first and subsequent data bits. Referring to the timing diagram and table values from last month, this means the slave has thd;sta + tlow = 8.7 usec before SCL goes high. Actually, it might be less since you have to figure in, worst case, the above mentioned 2-usec delay between the master's assertion and the slave's recognition of START.

This gives the slave only 6.7 to 8.7 usec — 17 to 21 cycles — to get ready to receive the first bit. If the slave has the same 0 to 2 usec delay for recognizing the rising edge of SCL, then it would sample SDA somewhere during the first half of thigh. This would probably work, but the slave wouldn't be doing much else.

The only real way to know if it will work, though, is to build a slave and test it out. But, in order to test the slave, you have to have a master to test it with.

In Search of a Master

For the next couple articles of this series, I'll be presenting I2C project software as a work-in-progress. That means the code will be functional, but it might also be uglier than normal, and quite probably buggy. I'm approaching this as an iterative process: build and test, refine, and repeat the process until I have a working system. It's a useful way to go about implementing any system of modest complexity. As Fred Brooks of *The Mythical Man-Month* fame says, "Plan to throw one away; you will anyway."

Despite all my study, I won't really understand the problem until I've implemented a solution at least once. With luck, the second time around maybe I'll have learned enough to do it right.

The first job, then, is to build enough of a master to produce in-spec I2C waveforms. Now, since the I2C spec calls for open collector drivers, how do you implement this with a PIC16F84, which doesn't have open-collector outputs available? There is a trick.

What I2C needs is a low-impedance output when outputting a logic zero and a high-impedance (i.e., floating) output when outputting a logic one. If you place a zero in an I/O pin output latch, that will take care of the low-impedance zero output when its corresponding TRIS bit is zero (TRIS=0 configures the pin as an output).

Writing a one to TRIS configures the I/O pin as a high-impedance input. The external pull-up resistor pulls the high-impedance output up to logic one. All you have to do, then, is initialize the output latches for SDA and SCL with zeros, then thereafter write the desired I2C levels directly to the TRIS register.

The only complication is that you must remember that writes to the I2C bus are done by writing to the TRIS register (which is in Bank 1), not to the port itself (which is in Bank 0). Reads are still done by reading directly from the I/O pins of the port. Anyway, it's time to stop talking theory and start banging bits together.

```
; ** Put Byte
;     entry:  byte to send in i2c_outbuf, SDA = X, SCL = 0
;     exit:   byte sent, SDA = 1, SCL = 0

put_byte
      bsf     STATUS, RP0     ; (Tris in Bank1)
      movlw   8               ; # of bits to shift
      movwf   bit_count

shift_out
      rlf     i2c_outbuf      ; Shift msb into C
      btfsc   STATUS, C       ; If bit set
      goto    set_SDA         ; then set SDA bit

clr_SDA
      nop                     ; equalize loops
      bcf     TRISA, SDA      ; else clear SDA data bit
      goto    clock_out

set_SDA
      bsf     TRISA, SDA
      nop                     ; equalize loops
      nop
;>>* Bit arbitration check
;     bcf     STATUS, RP0     ; (Ports in Bank0)
;     nop
;     btfss   PORTA, SDA      ; Did SDA go high?
;     goto    i2c_wait        ; No, other node won arbitration

clock_out
      bsf     TRISA, SCL      ; begin 4.0 us SCL high time
;>>* Clock stretch check goes here
;     bcf     STATUS, RP0     ; (Ports in Bank0)
;     nop
;     nop
;SCL_wait
;     btfss   PORTA, SCL      ; Did SCL go high?
;     goto    SCL_wait        ; No, SCL being stretched
      nop                     ; NOPs pad out 4.0 µsec delay
      nop
      nop
      nop
      nop
      nop
      nop
      nop
      nop
      nop
      bcf     TRISA, SCL      ; begin 4.7 us SCL low time
      nop
      nop
      nop
      decfsz  bit_count       ; All bits shifted out?
      goto    shift_out       ; no, go shift next bit
      bsf     TRISA, SDA      ; yes, clean up
      bcf     STATUS, RP0     ; (Ports in Bank0)
      return
```

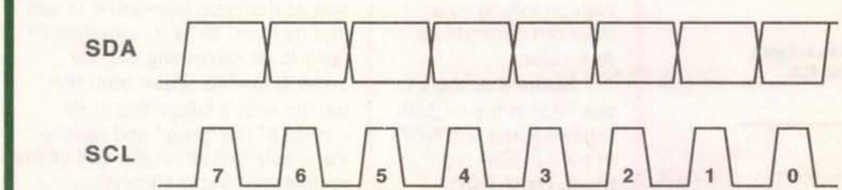


Figure 3: Byte Transmit Routine

START & STOP

Appropriately, first up is the routine that generates the I2C START condition. Figure 1 shows Start, as well as the waveform it generates. On entry, it assumes that the bus is idle, SDA and SCL both high. It asserts START by bringing SDA low while SCL remains high. It then delays thd;sta (4.0 usec) with a series of NOPs before bringing SCL low to begin the low period before the first SCL clock cycle.

Eventually, I'll write a macro that will accept as an argument the number of processor cycles to delay. This would allow me to generate more code-space efficient delays than long strings of NOPs but, for now, this is commented out. NOPs may not be elegant, but they get the job done.

Also note the following convention: I set to Bank 1 on entry to, and reset to Bank 0 on exit from, every routine. I could shave two processor cycles from each routine if I let every routine assume Bank 1 on entry and exit, switching to Bank 0 only as needed, but this could lead to hard-to-diagnose bugs outside of the routines.

I've opted instead for the simplicity of always operating from Bank 0 until I need to access registers (such as TRIS) in Bank 1, then switching back before exiting. If, in later development, I need extra processor cycles, I can change this.

The Stop routine in Figure 2 is quite similar to the Start routine. Stop cannot assume that SDA is already low on entry, and, since SDA must be low before STOP is

```
;>>* Get ACK -> this versions ignores any returned ACK
;       entry:  I2C Bus address or data write has just occurred,
;               SDA = 1, SCL = 0
;       exit:   W = ACK status, SDA = 1, SCL = 0

get_ack
        bsf     STATUS, RP0  ;  (Tris in Bank1)
        bsf     TRISA, SCL   ; begin 4.0 us SCL high time
;       bcf     STATUS, RP0  ;  (Ports in Bank0)
;>>* Clock stretch check goes here
;       nop
;       nop
;SCL_wait4
;       btfss   PORTA, SCL   ; Did SCL go high?
;       goto    SCL_wait4    ; No, SCL being stretched
        movlw   SDA_mask     ; Isolate SDA bit
        andwf   PORTA, w     ;

;>>* Commented out to ignore ACK for initial timing tests
;       btfsc   STATUS, Z    ; SDA = 0 ?
;       retlw   no_ack       ; no, signal No ACK
        nop                  ; NOPs to pad out 4.0 usec delay
        nop
        nop
        nop
        nop
        nop
        bsf     STATUS, RP0  ;  (Tris in Bank1)
        bcf     TRISA, SCL   ; begin 4.7 us SCL low time
        bsf     TRISA, SDA   ; clean up
        nop                  ; NOPs to pad out 4.7 usec delay
        nop
        nop
        nop
        nop
        bcf     STATUS, RP0  ;  (Ports in Bank0)
        retlw   ack          ; Signal ACK
```

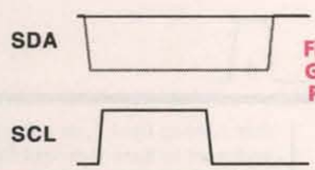


Figure 4: Get ACK Routine

asserted, I set it low before bringing SCL high. NOPs force a delay to meet the tsu;sto spec (4.0 usec) before bringing SDA high again.

Put Byte

To send addresses or data, I need a routine that sends eight bits, MSB first, one SCL pulse per bit. Put byte in Figure 3 does this. First, Put byte sets up the number of bits to send, then enters the shift_out loop, which shifts out the data in the buffer i2c_outbuf until all eight bits have been sent. It leaves SDA high on exiting so a slave can generate an ACK pulse.

Notice that there is one NOP in the clr_SDA segment, and two NOPs in the set_SDA segment. These NOPs ensure both branches of the loop execute in the same amount of time, in particular that SDA is set or cleared after the same amount of time for every bit. This isn't strictly necessary since both branches are executed before the clock pulse is generated, but I wanted the output waveform to be as predictable as possible for the sake of debugging and timing checks.

Note there are two segments of code commented out. The first is a stab at doing multimaster bit arbitration. It's not needed for a simple test data pattern generator, so it's commented out in this version of Put byte. It also needs a bit of work in its current form because: 1) It doesn't signal to the calling routine that this master has just lost arbitration and should therefore make an access attempt later; 2) It jumps directly to the i2c_wait routine instead of doing a proper return.

This last wart is left over from when I converted my original version of this code from inline to subroutine form. To fix it, I suppose I'll need to do something like use "retlw failure" to return from the routine with a failure flag in W instead of the "goto," and replace the simple "return" at the end of the routine with "retlw success" ... (What, you only like eating sausages, not watching them being made?)

The second commented-out segment is a first try at making the master aware of clock stretching. It hasn't been tested, and it has one known bug that would hang the processor as long as SCL is held low. There really needs to be a timeout on this so the master can recover from a bus fault condition, if only to dump debug information to help track down the problem. When I have a slave capable of doing clock stretching, though, it should suffice for initial testing.

Get ACK

Figure 4 shows the Get ACK routine. For my first tests, I knew I wouldn't have a slave hooked up to the master, so there would be nothing to respond to the master with an ACK pulse. To deal with this, I simply commented out the instructions that check for an ACK. Unlike Put byte, Get ACK does signal success or failure (or will when the ACK-check segment is uncommented).

Get ACK also has its clock-stretch check commented out (also with the same timeout bug as above). In preparing this article, I found a different, more subtle bug in this segment. Can you spot it?

The sharp-eyed among you might have already noticed that I

Listing 1

```
    title "testmast.asm"

; testmast.asm  -  Generate I2C Master test data pattern
;               (c) 1999 by Robert Nansel
; This program is free software; you can redistribute it and/or
; modify it under the terms of the GNU General Public License as
; published by the Free Software Foundation. Details of the GNU
; GPL can be found at www.fsf.org or by writing to the Free
; Software Foundation, Inc., 59 Temple Place, Suite 330, Boston,
; MA 02111-1307, USA.
; It comes with ABSOLUTELY NO WARRANTY, implied or otherwise.
;
    LIST P=16F84, F=INHX8M, R=DEC     ; 16F84 Runs at 10 MHz
    errorlevel 0,-305
    INCLUDE "\progra~1\mplab\p16F84.inc"

; Registers

    __CONFIG _CP_OFF & _WDT_OFF & _HS_OSC & _PWRTE_ON

i2c_clr         equ     0xFC
i2c_set         equ     0x03
idle_out  equu  0x03
start_out equu  0x01

ack             equ     0x00
no_ack          equ     0xFF

SCL             equ     0           ; Ser. Clock, bit 0 PortA
SDA             equ     1           ; Ser. Data, bit 1 PortA
SDA_mask        equ     0x02

; ** Delay values
;
; (these will eventually be used when invoking the delay macro)
;
F_Osc           equ     10                      ; 10 MHz XTAL
T_cyc           equ     10000/((F_Osc*10)/4)    ; T_cyc ns/cycle
T_buf           equ     ((47000/T_cyc)+5)/10    ; 4700 ns
T_hdsta         equ     ((40000/T_cyc)+5)/10    ; 4000 ns
T_low           equ     ((47000/T_cyc)+5)/10    ; 4700 ns
T_high          equ     ((40000/T_cyc)+5)/10    ; 4000 ns
T_susto         equ     ((40000/T_cyc)+5)/10    ; 4000 ns

; RAM Usage

        CBLOCK 0x00C
_w                      ; ISR context storage
_status
bit_count ; bit shift counter
i2c_outbuf              ; output buffer
i2c_inbuf ; input buffer
temp                    ; temporary storage
        ENDC

        PAGE

        org 0

; ** Test datagram write
;       entry:
;       exit:

test
        call    i2c_init
test2
        call    i2c_wait        ; Wait for bus free condition
        call    start           ; Create START condition
        movlw   0x70            ; Set to write to addr 0111000b
        movwf   i2c_outbuf
        call    put_byte        ; Send the address & R/W flag
        call    get_ack
        movlw   0xB5            ; Set up data 10110101b
        movwf   i2c_outbuf
        call    put_byte        ; Send data
        call    get_ack
        call    stop            ; Create STOP condition
        goto    test2           ; repeat forever


i2c_init
        bsf     STATUS, RPO     ;  (Tris in Bank1)
        movlw   i2c_set         ; Set up PA0, PA1 as inputs
        andwf   TRISA           ;
        bcf     STATUS, RPO     ;  (Ports in Bank0)
        movlw   i2c_clr         ; Set up active low zeros
        andwf   PORTA           ; in PORTA
        return

; ** Wait for I2C Bus Free condition
;  (paranoid version)

i2c_wait
        bsf     STATUS, RPO     ;  (Tris in Bank1)
        movf    TRISA           ; Get I2C bits
        andlw   i2c_clr         ;
```

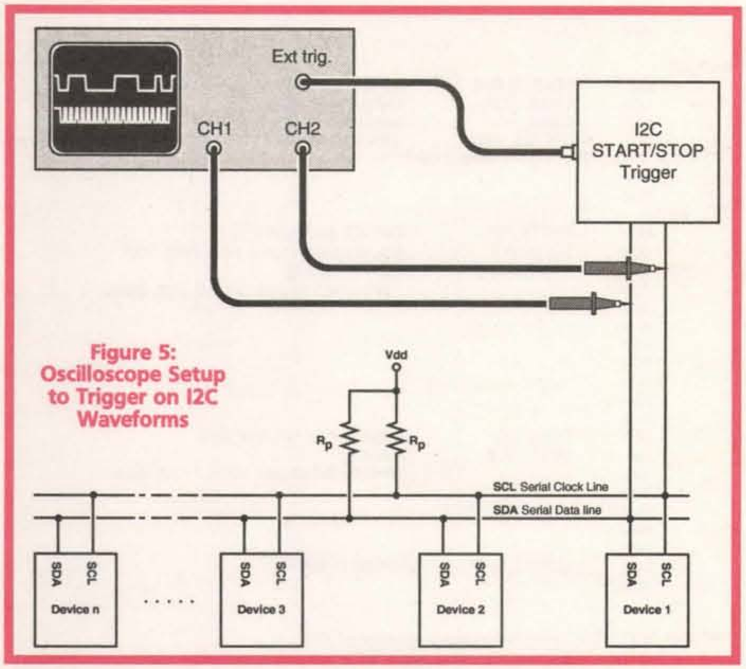


Figure 5: Oscilloscope Setup to Trigger on I2C Waveforms

commented out the switch to Bank 0 at the top of the segment; that causes the next two instructions to access TRIS instead of PORTA as intended. I corrected this in the main listing, but left the bug in the figure as an object lesson.

Other than decreasing execution time by one cycle, the bug doesn't affect the operation of this routine. Why? Because the routine ignores the results of those instructions!

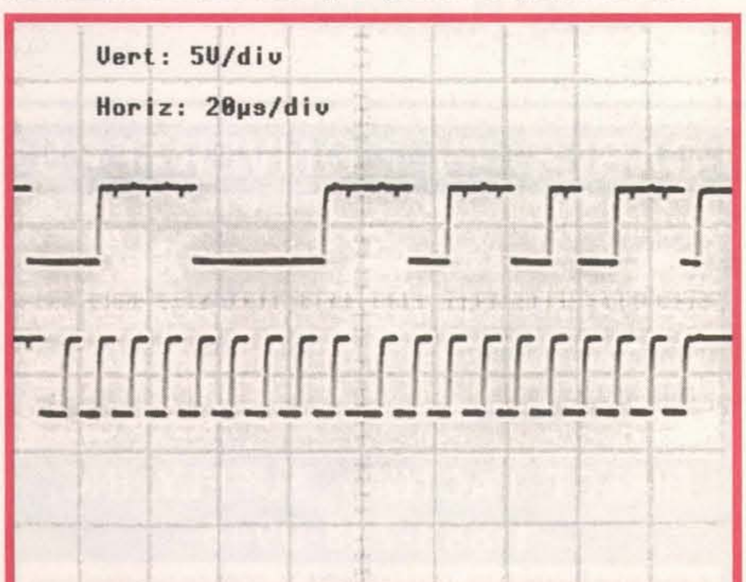
The bug would have reared its head only had I tried testing the code with the ACK-check uncommented. It would have always acted as if the slave had given an ACK, even if it hadn't. More sausage.

Making a Datagram

With the above four routines, (plus i2c_init and I2c_wait in Listing 1), we can put together a simple program that generates I2C test data waveforms. The main routine test first calls i2c_init to set up the I/O lines, then i2c_wait to ensure the bus is free before transmitting. There is only one master and no slaves in this test, so the bus should be idle (if it isn't, there's a hardware problem).

The program asserts START by calling Start. Next, it loads i2c_outbuf with the address (binary 0111000) in the upper seven bits and the R/W bit (binary 0, a write) in the LSB, and it calls put_byte to send the address and R/W bit. This is followed by a call to get_ack to generate a dummy ACK pulse.

The second byte of the datagram – the data itself – (binary 10110101), is sent in the same fashion, also followed by a call to get_ack. Finally, stop is called, and




```
        iorlw   idle_out  ; SCL=1, SDA=1
        movwf   TRISA            ; Output bus pin values
        bcf     STATUS, RPO      ; (Ports in Bank0)
        nop                      ; Let bus settle 1.2 usec to
                                 ; meet I2C 1 usec max rise time
wait2   movlw   idle_out         ; SCL=1, SDA=1
        xorwf   PORTA, w;        Check bus state
        andlw   i2c_set          ;
        btfss   STATUS, Z        ; I2C bus idle?
        goto    wait2            ; No, go wait for bus idle
        movlw   idle_out         ; Yes, continue
        xorwf   PORTA, w; Check I2C bus state 2nd time
        andlw   i2c_set          ;
        btfss   STATUS, Z        ; Bus still idle?
        goto    wait2            ; No, go wait for bus idle
        movlw   idle_out         ; Yes, continue
        xorwf   PORTA, w         ; Check I2C bus state 3rd time
        andlw   i2c_set          ;
        btfss   STATUS, Z        ; Bus still idle?
        goto    wait2            ; No, go wait for bus idle
        return                   ;

; ** Create I2C START condition
;       entry:  I2C Bus idle
;       exit:   SDA, SCL = 0

start
        bsf     STATUS, RPO      ; (Tris in Bank1)
        bcf     TRISA, SDA       ; Signal START condition
;       delay   T_hdsta-1        ; Delay to meet T_hdsta spec
        nop                      ; NOPs to pad out 4 usec delay
        nop
        nop
        nop
        nop
        nop
        nop
        nop
        nop
        bcf     TRISA, SCL       ; Start clock low period
        bcf     STATUS, RPO      ; (Ports in Bank0)
        return

; ** Create I2C STOP Condition
;       entry:  SDA = X, SCL = 0
;       exit:   SDA = 1, SCL = 1 (I2C Bus idle)

stop
        bsf     STATUS, RPO      ; (Tris in Bank1)
        bcf     TRISA, SDA       ; SDA=0
        bsf     TRISA, SCL       ; SCL=1
;       delay   T_susto-1
        nop                      ; Hard-coded 4 usec delay
        nop
        nop
        nop
        nop
        nop
        nop
        nop
        nop
        bsf     TRISA, SDA       ; SDA=1
        bcf     STATUS, RPO      ; (Ports in Bank0)
        return

; ** Put Byte
;       entry:  byte to send in i2c_outbuf, SDA = X, SCL = 0
;       exit:   byte sent, SDA = 1, SCL = 0

put_byte
        bsf     STATUS, RPO      ; (Tris in Bank1)
        movlw   8                ; # of bits to shift
        movwf   bit_count

shift_out
        rlf     i2c_outbuf       ; Shift msb into C
        btfsc   STATUS, C        ; If bit set
        goto    set_SDA          ; then set SDA bit

clr_SDA
        nop                      ; equalize loops
        bcf     TRISA, SDA       ; else clear SDA bit
        goto    clock_out

set_SDA
        bsf     TRISA, SDA
        nop                      ; equalize loops
        nop

;>>* Bit arbitration check
;       bcf     STATUS, RPO      ; (Ports in Bank0)
;       nop
;       btfss   PORTA, SDA       ; Did SDA go high?
;       goto    i2c_wait         ; No, other node won arbitration

clock_out
        bsf     TRISA, SCL       ; begin 4.0 us SCL high time
```

```
;>>* Clock stretch check goes here
;         bcf     STATUS, RP0     ; (Ports in Bank0)
;         nop
;         nop
;SCL_wait
;         btfss   PORTA, SCL      ; Did SCL go high?
;         goto    SCL_wait        ; No, SCL being stretched
          nop                     ; NOPs pad out 4.0 usec delay
          nop
          nop
          nop
          nop
          nop
          nop
          nop
          nop
          nop
          bcf     TRISA, SCL      ; begin 4.7 us SCL low time
          nop
          nop
          nop
          decfsz  bit_count       ; All bits shifted out?
          goto    shift_out       ; no, go shift next bit
          bsf     TRISA, SDA      ; yes, clean up
          bcf     STATUS, RP0     ; (Ports in Bank0)
          return

;>>* Get Byte -> Note: this routine not yet tested
;         entry:
;         exit:

get_byte
          movlw   8               ; # of bits to shift
          movwf   bit_count
          clrf    i2c_inbuf       ;
          bcf     STATUS, C       ; Clear C to shift in zeros
          bsf     STATUS, RP0     ; (Tris in Bank1)
shift_in                          ;
          bsf     TRISA, SCL      ; begin 4.0 us SCL high time
          bcf     STATUS, RP0     ; (Ports in Bank0)
; ** Clock stretch check goes here
;         nop
;         nop
;SCL_wait2
;         btfss   PORTA, SCL      ; Did SCL go high?
;         goto    SCL_wait2       ; No, another node is stretching clock
          movlw   SDA_mask        ; Isolate SDA bit
          andwf   PORTA, w;
          btfsc   STATUS, Z; SDA = 1 ?
          bsf     i2c_inbuf, 0    ; yes, set LSB
                                  ; else, LSB already clear
          rrf     i2c_inbuf ;
          nop                     ; Hard-coded to pad out 4.0 usec delay
          nop
          bsf     STATUS, RP0     ; (Tris in Bank1)
          bcf     TRISA, SCL      ; begin 4.7 us SCL low time
          nop                     ; Hard-coded to pad out 4.7 usec delay
          nop
          nop
          nop
          nop
          decfsz  bit_count       ; All bits shifted in?
          goto    shift_in        ; no, go shift next bit
          bsf     TRISA, SDA      ; yes, clean up
          bcf     STATUS, RP0     ; (Ports in Bank0)
          return

;>>* Give ACK -> Note: this routine not yet tested
;         entry:
;         exit:

give_ack
          bsf     STATUS, RP0     ; (Tris in Bank1)
          bcf     TRISA, SDA      ; Output ACK pulse
          bsf     TRISA, SCL      ; begin 4.0 us SCL high time
;         bcf     STATUS, RP0     ; (Ports in Bank0)
; ** Clock stretch check goes here
;         nop
;         nop
;SCL_wait3
;         btfss   PORTA, SCL      ; Did SCL go high?
;         goto    SCL_wait3       ; No, another node is stretching clock
;         bsf     STATUS, RP0     ; (Tris in Bank1)
          nop                     ; Hard-coded to pad out 4.0 usec delay
          nop
          nop
          nop
          nop
          nop
          nop
          nop
          bcf     TRISA, SCL      ; begin 4.7 us SCL low time
          bsf     TRISA, SDA      ; clean up
          nop                     ; Hard-coded to pad out 4.7 usec delay
          nop
          nop
          nop
          nop
          bcf     STATUS, RP0     ; (Ports in Bank0)
          return

;>>* Get ACK -> this versions ignores any returned ACK
;         entry:  I2C Bus address or data write has just occurred,
;                 SDA = 1, SCL = 0
;         exit:   W = ACK status, SDA = 1, SCL = 0

get_ack
          bsf     STATUS, RP0     ; (Tris in Bank1)
          bsf     TRISA, SCL      ; begin 4.0 us SCL high time
          bcf     STATUS, RP0     ; (Ports in Bank0)
;>>* Clock stretch check goes here
;         nop
;         nop
;SCL_wait4
;         btfss   PORTA, SCL      ; Did SCL go high?
;         goto    SCL_wait4       ; No, SCL being stretched
          movlw   SDA_mask        ; Isolate SDA bit
          andwf   PORTA, w;

;>>* Commented out to ignore ACK for initial timing tests
;         btfsc   STATUS, Z; SDA = 0 ?
;         retlw   no_ack          ; no, signal No ACK
          nop                     ; NOPs to pad out 4.0 usec delay
          nop
          nop
          nop
          nop
          nop
          bsf     STATUS, RP0     ; (Tris in Bank1)
          bcf     TRISA, SCL      ; begin 4.7 us SCL low time
          bsf     TRISA, SDA      ; clean up
          nop                     ; NOPs to pad out 4.7 usec delay
          nop
          nop
          nop
          nop
          bcf     STATUS, RP0     ; (Ports in Bank0)
          retlw   ack             ; Signal ACK

          end
```

NOTEBOOK

– except for i2c_init – the whole procedure repeats.

The result is the datagram is repeatedly output to the I2C bus. With the I2C START/STOP trigger circuit from last month, it's easy to observe the complete waveforms on the oscilloscope to verify timing parameters. The oscilloscope set-up is shown in Figure 5, and the actual waveforms I observed are in the photo – a screenshot of my 'scope.

Linux Update

As usual, I'm running out of space before I've run out of material. A quick update on my new development system:

I've got my Linux box up with Red Hat 6.0. I'm learning my way around the system, and relearning via the editor I loved to hate in college. I've also learned that the best Linux books aren't always the thickest ones, nor even the most recent.

Case in point: *Running Linux*, 2nd ed. by Matt Welsh and Lars Kaufman (ISBN1-56592-151-8, O'Reilly) was published back in 1996. There are very few screenshots or instructions specific to one distribution, and there's no CD-ROM included. All the same, this one is my favorite Linux book. The information in it is as timeless as it's possible to be in this field.

By comparison, Naba Barkakati's *Red Hat Linux Secrets* (900+ pages plus a CD-ROM!) published in 1998 is already quite dated since it assumes you're dealing with Red Hat 5.1. It might work for you, but I couldn't bring X-Windows up with 5.1 (it didn't recognize my video card).

I could have with *Running Linux* because it gives enough examples. And even though *Running Linux* has only 630 pages, O'Reilly books traditionally emphasize clear writing over flashy screenshots, so there's more useful information and examples crammed into those pages than Barkakati's. And it costs 40% less.

As it turns out, a third edition of the book should be available by the time you read this, so the best old book on getting started with Linux is now the best new book. The price is a couple dollars more (they added some pages), but well worth it.

My recommendation: Skip the books with CD-ROMS, buy the Welsh book, and order one of the $1.98 Linux distributions from Linux Mall. You could pick up a Penguin Power T-shirt, too, while you're there, and still save money.

Later, y'all

Next time: more I2C, more Linux, more robotics, and a surprise or two. **NV**

As always, if you have suggestions for improving Breadbot, if you've built a Breadbot, or if you have questions or comments about amateur robotics topics, you can reach me at:

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Pittsburgh, PA 15202
E-Mail: bnansel@nauticom.net

TECH FORUM

Continued from page 77

of BASIC.

So, to run your BASIC A program, which was most likely NOT saved in ASCII, you must leave Windows and get into DOS, and you must have a copy of GREASILY, widely available from old-timers.

Also, your BASIC A program is probably on a 5.25-inch floppy, so you'll need to find a machine with 5.25-inch and 3.25-inch floppies to have someone make a copy of the program onto a 3.25-inch diskette for use in most machines today that do not include 5.25-inch disk drives. Then it's just a matter of loading in GREASILY and using standard BASIC commands.

Fred Blechman
West Hills, CA

ANSWERS TO #9994 - SEPT. 1999

The reason IBM BASIC A won't run on your (or anyone's) Windows machine is BASIC A requires "True Blue" IBM BIOS chips with "cassette BASIC."

Unfortunately, even today's "True Blue" IBM machines do not have "cassette BASIC" in their BIOS chips any more.

All may not be lost, however, if you can locate someone who still has MS/PC-DOS versions packages prior to 4.0 (or you still have an old MS-DOS 3.2/3.3 package), get the program "GWBASIC.EXE." GWBASIC was IBM BASIC A with the "Required ROM Stuff" added so BASIC A programs can run on "clone" machines.

In my experience, GWBASIC will run 99% (or more) of BASIC A programs, and the programs it "won't run" only need minor coding changes (usually in single-line FOR..NEXT loops, IF..THEN statements, and some SCREEN function calls).

If you can't locate a GWBASIC source, look on your Windows install CD-ROM (or floppies) in the "OLDDOS" (or "OLDMSDOS") folder for "QBASIC.EXE."

QBasic, which appeared with MS-DOS 5, was a stripped-down version of the once-popular Microsoft QuickBASIC 4.5 compiler. QBasic essentially replaced GWBASIC and is 99.9% compatible with programs written for BASIC A/GWBASIC (again, some "stubborn" programs need minor changes). The only "caveat" is you cannot compile your programs into "stand-alone" programs. NOTE: to get QBasic to properly run, you need to install the "QBASIC.EXE" ("interpreter") and "QBASIC.HLP" (on-line HELP).

If you absolutely cannot locate either of these programs, E-Mail me at cloner@foxinternet.net and I'll be more than happy to send you one of them for your use.

Ken Simmons
Auburn, WA

ANSWERS TO #9994 - SEPT. 1999

To run BASIC A on a Windows system, you can use the DOS Window. The following steps worked on my Windows 95 system.

Copy the two files BASICA.CMM and BASICA.EXE from your old DOS system onto a 3.5" floppy disk. At your Windows computer, select "Programs" and then "MSDOS prompt."

If you get the miniature DOS screen, enlarge it to full screen by using the "big window" button at the upper corner next the "X" button. Change to the root directory with the command CD . . " That's CD space period period. (DOS doesn't require the space in there, but it's good practice for when you convert to Linux.)

Make a subdirectory for BASIC A with the command MKDIR BASICA.

You can give it any name you like, but this one will help you remember what it's for. Now go to that new subdirectory with the command CD BASICA.

Copy both of the BASIC A files to your hard drive with the command COPY A:BAS*.*.

You will need to copy all of your ECALC files to this same subdirectory. The DOS Window is not really an exact copy of a real DOS system, so if you run into problems, then you should try the real DOS that also is available to you even on a Windows system. You get to it through the "Shutdown" menu.

Simply select the option "Restart your computer in DOS mode." That DOS should look very much like the system that your program is accustomed to. When you are done, return to Windows with the command EXIT.

If all comes to naught, then what you have is called a "project." You print out listings of ECALC, take out a clean sheet of paper, and convert it line by line to QBASIC. You may learn things you didn't even want to know.

BTW, if QBASIC is not already on your hard drive, you can find it on your Windows CD-ROM at D:\OTHER\OLDMSDOS.

Jack Dennon
Warrenton, OR

Continued from Page 54
how it works and what else we can do with it.

How and Why

In the basic circuit (Figure 1A), the resistor limits the current through the LED to about 15mA, 0.015A. That assumes about 3.5 volts dropped across the LED. It also allows for the battery to sag a bit with use. At no time will it allow too much current (more than 25mA) to flow through the LED.

Electronic Switch

In Figure 1B, we still have the same circuit, but we added a transistor and its bias resistor. The transistor makes a good electronic switch. With the 33,000-ohm bias resistor, the transistor will have about 1.2mA base bias current. With a nominal current gain of 150-250, that much base current will saturate the transistor. It will turn the transistor on like an on/off switch. That will connect the LED and the resistor across the battery with only a slight loss in the transistor. It makes a good, but not a perfect switch.

A perfect switch would have zero volts lost across it. A voltmeter across this transistor switch showed 95mV, 0.095V across it. That makes it a practical, if not a perfect switch. The LED showed 3.48V across it with 10mA through it. At reduced current, the LEDs have somewhat less voltage across them.

Automatic, At Last

Add the switch and the photocell shown in Figure 1B and you have an automatic system. With SW2 closed, the system will respond to incident light. If the resistance from the base to the emitter goes low enough, the bias resistor will not be able to supply enough base current to keep the transistor turned "on." When the transistor turns off, so does the LED.

Photocells: A Crash Course

When light strikes the sensitive surface of either a phototransistor or a photoconductive cell, the resistance between the terminals decreases. The stronger the light, the lower the resistance. Depending upon the type of cell and the amount of light, the resistance can fall to a value as low as a few ohms. For our purposes, if it falls to something lower than about 4,000 ohms, the transistor in Figure 1B will not have enough base current and will turn off. That will turn off the LED.

As a practical consideration, the photocell will change resistance as the light level changes. A slow change in light level will cause a gradual change in collector current of the transistor thereby making the LED fade on or fade off. More complex circuitry would make the transistor and the LED snap on or off. The slow fade with its attendant higher voltage drop across the transistor will not harm it. That will also let us make a simpler circuit for an automatic light. We can make it turn on and off with sunset, sunrise, or we can turn it off when a room light turns on. It also makes the basis of a dandy science fair project. Details another time.

Pick a Package

Depending upon our need, we can package the white LED in a variety of ways. Pick the package that best suits your idea. Photo A shows the deluxe "pocket model." However, unless you are on close speaking terms with a lathe or with a machinist, you will probably go for something like the model in Photo C.

The idea of a bright white LED in a plastic rod caught the fancy of a good friend, Jim Haubert. He spends lots of time with a lathe. I let him. If you want details of how he made the holder, the on/off switch, etc., feel free to send him a note at haubert@casagrande.com. He can also give details of the somewhat easier to make model in Photo B. That one uses three "N" cells and a smaller current limit resistor. It will give a brighter light and still give decent battery life: about 50 hours. Figure 1A gives the circuit. DO remember the current limit resistor.

Automatic Flashing Night LED

Since my 'machine work' gives Jim and his asso-

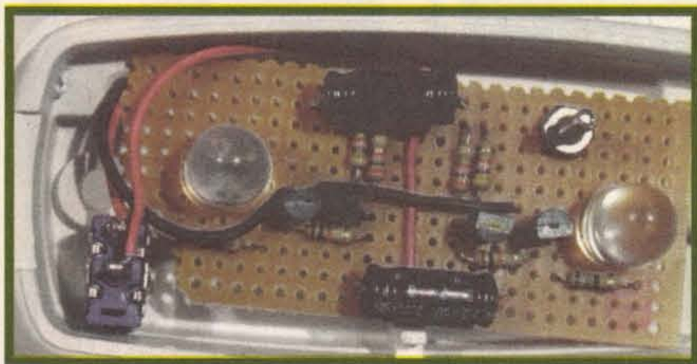


PHOTO G

Backpack/Bike Light, Parts Placement
Close-up of prototype board. Even if you do not get one of the boards from Far Circuits, the perfboard version gives excellent service. The oscillator transistors are on the inside of the board. The driver transistors sit next to their LEDs. A clip or a clamp goes on the back of the main assembly to hold it to a backpack or to a bike.

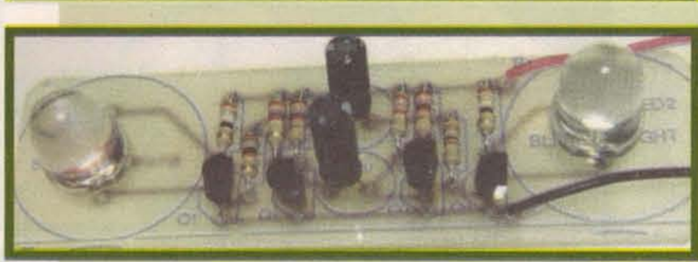


PHOTO G1

Backpack/Bike Light, Parts Placement
Close-up of printed board from Far Circuits. The oscillator transistors are on the inside of the board. The driver transistors sit next to their LEDs. Quick, clean wiring with the PCB. Since the manufacturer raised the allowable current for the LEDs, the 68 ohm resistors on this board were changed to 39 ohms.

ciates a good laugh, I have to use the off-the-shelf boxes from the various parts outlets. Photo C shows the Automatic Night LED. Figure 1B gives the circuit for it.

If you like to bike, hike, or camp, maybe you can think of a couple of uses for a blinking LED with automatic turn on and automatic turn off. Figure 2 gives the circuit for turning the basic, controlled-LED circuit into an automatic beacon, as seen in Photo E. The values shown work best for the white LED. Later, we will see how to adjust just one value to make the circuit work for the lower voltage LEDs. Most likely, you can get the single color, jumbo LEDs easier than the small, white ones. Usually the single color LEDs cost less and lend themselves to many of these applications. Some of the suppliers, however, have started selling the white LEDs at competitive prices.

What Makes It Tick

In Figure 2, Q3 is the same as Q1 in Figure 1B. It does the same thing and has close to the same values. In either circuit, when the base resistor, R5, in Figure 2 gets connected to the plus side of the battery, the transistor turns on the LED. In Figure 2, the base resistor connects to the cold side of R4 and to the collector of Q2. When Q2 is in its "off " or open state, R5 connects to the battery through R4.

Flip-Flop

The circuit made up of Q1, Q2 and most of the parts around them may look familiar. They make up a free running multivibrator, sometimes called a flip-flop. Either Q1 turns on and connects R2 to battery minus, or Q2 turns on and connects R4 to battery minus. With R4 and R5 connected to battery minus, Q3 has no base current. That keeps the LED off.

When Q1 turns on, that forces Q2 to let virtually all of the current from R4 flow into R5, which turns on Q3 and the LED. The two transistors turn on and off at a rate determined mostly by the size of the base resistors and the cross-coupling capacitors, C1 and C2. Battery voltage and circuit loading will also affect the speed.

Options

By adding SW3 to the base circuit of Q2, we can force Q2 to stay turned off. That keeps the flip-flop from running. That also turns on Q3 and the LED. Again, by adding SW2 and the photocell to the base of Q3, we have automatic light control. Even if the photocell turns off the light, the rest of the circuit draws only a small amount of current: 300uA (300 microamps) with a 4-1/2 volt power supply. That figure came from a direct measurement on the workbench.

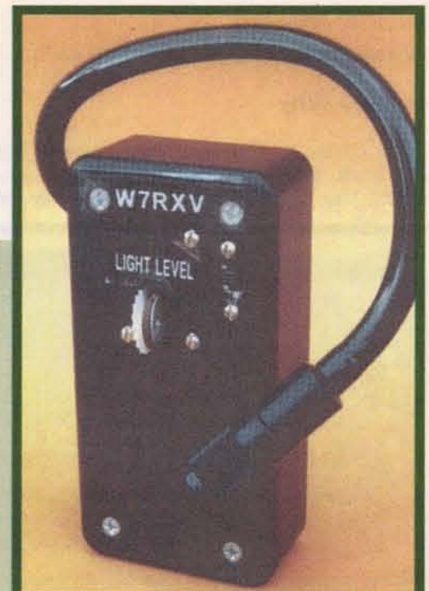


PHOTO H

Reading Light
Adjustable light level,
Adjustable beam placement
Hang it on a tent line or clip it to your shirt for hands-free reading. You can even clip it to a book. Due to the regulator circuit, the light level will remain relatively constant despite wide variations in battery voltage. This one will operate from five to 45 volts.

Let me mention here that unless otherwise stated, what I write is based on WORKING models. Some of them have sat on the workbench running for many days and nights uninterrupted. If I make a wet-finger-in-the-wind approximation, I will make it clear that I am giving just a good guess. Normally, all of my circuits get thorough tests before I write about them. We have all seen circuits that worked one time, but not the next time. Since I know that that can happen, I try to make it less likely that you will have unexpected, undesired, surprise results.

Biking, Hiking

For those who like to hike or bike, we can make a few additions and have a useful, practical, addition to our equipment. You can change the values shown in the circuit of Figure 2. By using capacitors with different values, you can make the LED flicker on, flicker off, or have uniform on/off times. The suggested values give uniform on/of times. The smaller capacitors give a rapid-fire effect.

Package that circuit so that you can clip it to your backpack, and friends will find it easier to follow you when hiking in dimly lit areas. If several in your camping/hiking group wear one of these beacons, you will find it easier to keep track of each other. Use either white LEDs or the jumbo yellow LEDs, and package it in a housing with a yellow lens and you have good light for the front of your bike. One that lets others see you. Of course, you still need a good, bright headlight that will let you see the road.

Back Light

Use a pair of extra bright red or yellow LEDs in the light, as in Figure 3 and Photo G, and you have an out-

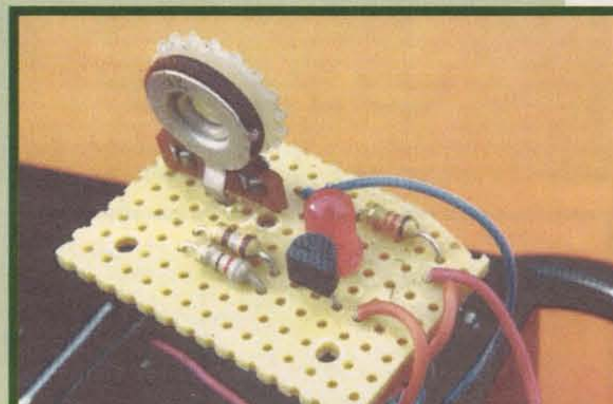


PHOTO I

Adjustable-Light Circuit Board
Upper left: trim pot used to adjust the light. Next to that, LED used as voltage reference. Upper right: base bias resistor. Center left: fixed resistor with trim resistor, not shown in circuit. Front right: the single transistor used for the regulator circuit. This circuit, like that of Photos C and D, and Figure 1B, uses so few parts that it seems that there is no need for a printed circuit board. Front left and right: two of the mounting holes. The next version will have the trim pot replaced with a two-position (ON/OFF) switch and fixed resistors for High/Low Light level. A small rotary switch with fixed resistors would give High, Medium, and Low.

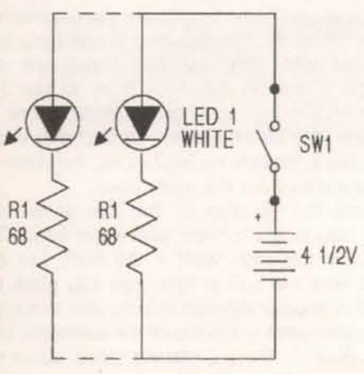


FIGURE 1A.
Basic, bare-bones LED Light
Depending upon how you package it, suitable for pocket, purse, or use as a reading light.

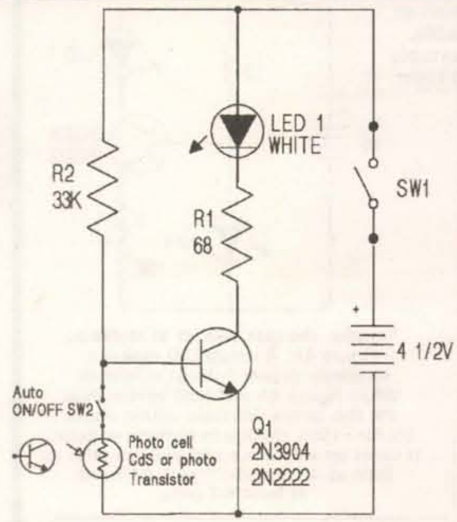


FIGURE 1B.
Automatic Night LED

For the ultimate in a small, long life light, Figure 1A. For a little more effort, an automatic night LED, Figure 1B. Figure 1A can take many forms, limited mostly by your imagination. Figure 1B needs a slightly larger holder, but it has more uses. The values shown will give about 13mA LED current. A 39-ohm resistor will give close to 23mA. That is close to the 25mA maximum LED current. It will make a bright light. As indicated by the dashed lines, you may add more LEDs to any of these circuits. Just use a separate resistor for each LED. With "N" cells and 13mA total drain, expect about 60 hours operating time. At 25mA, expect 32 hours.

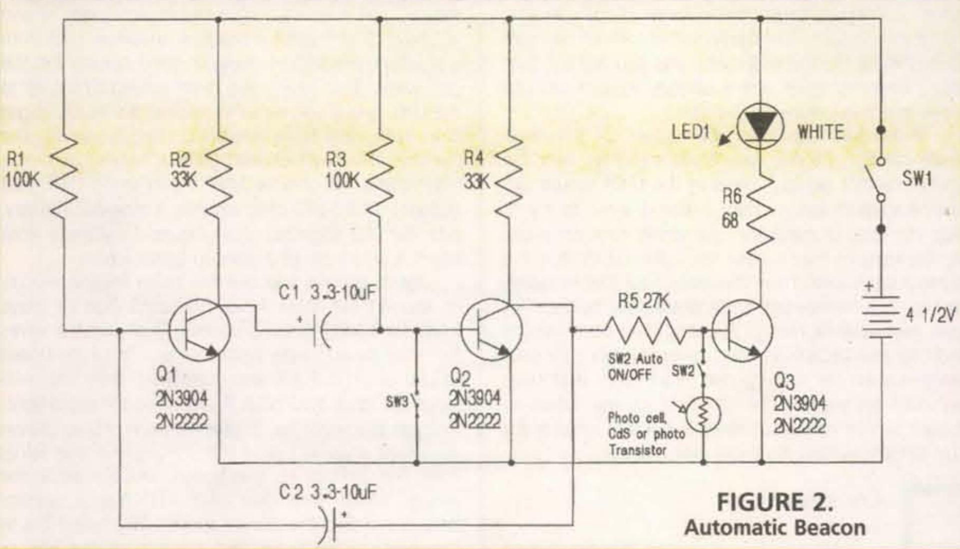


FIGURE 2.
Automatic Beacon

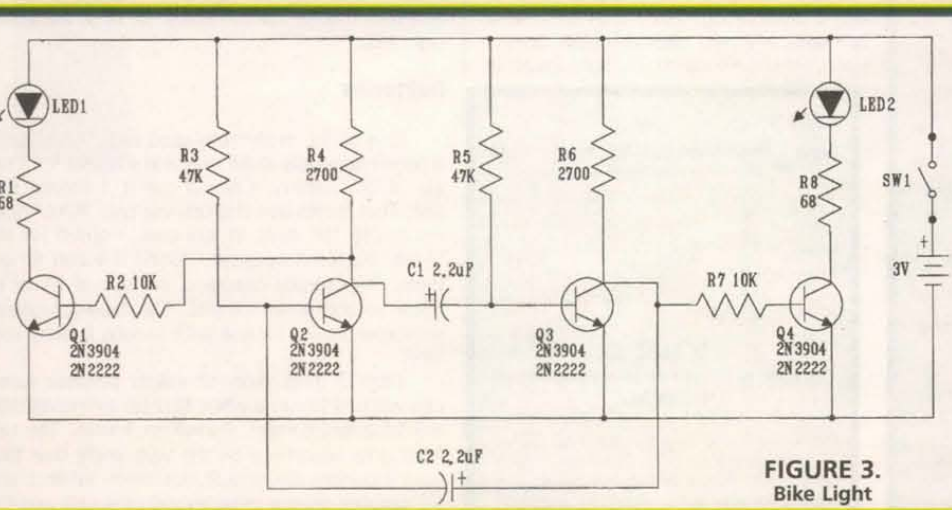


FIGURE 3.
Bike Light

For an exceptionally bright back light, use high brightness red or orange LEDs. For an even brighter light for the front of the bike, use one or two of the white LEDs and a yellow lens. Just raise the battery to three cells, 4-1/2 volts to take care of the extra voltage drop in the white LEDs. The rest of the values may stay as they are drawn. These compact, attention-getting blinkers work well for use on the trail when biking or hiking.

standing back light for your bike. These lights use the jumbo, 10mm, extra bright LEDs. They have cut the price, made them easier to get, and made them many times brighter than the early 'extra bright' LEDs. While you can use the white LEDs for these applications, unless you can get them at a good price, the red or yellow LEDs give plenty of light and attract a lot of attention. And you thought that we were just going to make a flashlight.

More Than Just a Flashlight

The white LEDs give a lot of useful, visible light. While some of the red, orange, and yellow LEDs carry a high MCD rating, the eye responds differently to different colors. The eye will perceive some lights as brighter than others even though they may have the same MCD rating. Most of the people that have seen the white LED lights say that they look brighter than the red or the yellow LEDs. That puts more than "... beauty in the eye of the beholder."

Changing the values of C1, C2, or both, will give a variety of interesting and useful effects. You can make the LED flicker on, flicker off, or give uniform on/off times. The suggested values give uniform on/off times. The smaller caps give a rapid-fire effect. For use with a 6V battery, make R1 150 ohms; with 9V, 390 ohms. For use with the other types of LEDs, use a 3V battery.

Regardless of what a light meter indicates, how the eye sees the light is what counts.

Reading Light for Campers and Others

A large flashlight cannot compete with a two-mantle gaslight. Of course, an LED light does not begin to compete with that, at least until they make great improvements in the LEDs. You could always put several white LEDs into a single light. If it does not drain your budget, it would not drain the batteries. It will put out a lot of light.

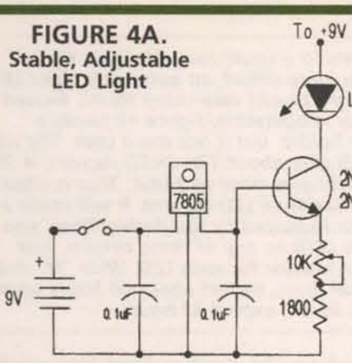
One of my camping friends has a reading light made for camping. It clips onto the side of a book. He replaced the Tungsten light bulb with one of the white LEDs. The original light drew 0.3A at about 6V. It gave many nights worth of reading. When I got to it, the batteries measured just over five volts, meaning that they had seen a fair amount of use.

We calculated the proper value for the current limit resistor and put in the LED. (Basic circuit of Figure 1A.) He turned the lamp on and took it home. It still had the used batteries in it. The light ran for more than eight weeks day and night. He said that it compared favorably with the original light. It just did not light up as much of the room. A little more arithmetic indicated that he could shrink the package, which uses four "C" cells. That would allow the use of smaller batteries and still give several weeks of normal use when camping.

What Size Resistor?

The camping light just mentioned came with

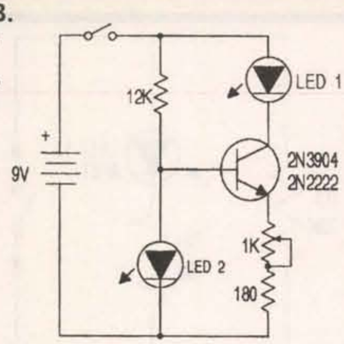
FIGURE 4A.
Stable, Adjustable LED Light



With the resistors set for higher current as indicated in the caption below, this could make a good reading light. The light would not fade when the batteries do, as it does with the simpler battery, resistor LED circuits such as Figure 1.

The values shown will give an LED current of ~0.36-2mA. The battery voltage may range from 8-30 volts. This might be a good way to light the keyboard on a laptop computer in an otherwise relatively dark place. For more light, change the resistors to 180 ohm fixed and a 1,000 ohm adjustable. In a test, that gave 3-22mA. If you want to use more than one LED, put them in series and raise the battery voltage. It took just over 12 volts to get this to work with two white LEDs in series.

FIGURE 4B.
Almost as Stable, Adjustable LED Light



Simpler, cheaper, almost as stable as Figure 4A. A cheap LED makes a relatively decent voltage reference. While Figure 4A will hold better than 1%, this circuit will hold within about 5% for ~150% change in battery voltage. It takes up less space and will run with as little as 4-1/2 volts. Figure 4A needs at least 6-7 volts.

four batteries. It was easier to adjust the size of the current limit resistor to accommodate four batteries, than it would have been to repackage the lamp with just three batteries. To get the value of the resistor, subtract the voltage across the LED from the battery voltage. Then divide by the current that you want in the LED. For example, 6V battery minus the 3.6V in the LED equals 2.4V. Divide that by the current 15-20mA, 25mA if you are braver than I am, and you get 160-120 ohms.

For the maximum current the manufacturer allows, 25mA, use 96 ohms. Six volts (battery) minus 3.6 volts (across the LED) equals 2.4 volts (2.4V/0.015A=160 ohms). The nearest standard values are 150 for the 160-ohm resistor, 120 for the 120, and 100 for the 96. You can get a 91-ohm resistor, but that would allow a calculated value of 26+ mA.

I do not like to push the ratings of these types of semiconductors. If you use real fresh batteries and the resistor is a bit on the low side of its tolerance ... Keep in mind that a fresh "1.5V" alkaline battery measures, and delivers, 1.6V. Three of them deliver 4.8V. Do the arithmetic and you will see that three fresh batteries and a 68-ohm resistor will put close to 17 mA through the LED.

If you had calculated your values for the maximum current, 25 mA, you could easily go over the limit. I cannot guess how long the LEDs would survive. I suspect longer than I would want to try it. But, do keep in mind the real world considerations as the reasons that I make the values such that the current stays away from the limits. Feel free to experiment, but remember semiconductors seldom let you exceed their ratings for long. My observations indicate that LEDs have even lower tolerance for over current than do some power transistors that have survived on my test bench. One of the tables in Figure 5 may help you select a suitable resistor for the battery voltage that you want to use.

Table 1
4-1/2 volts, 3 cells

LED current, mA	10	15	20	25
nearest standard resistor	91	56	47	39

Table 2
6 volts, 4 cells

LED current, mA	10	15	20	25
nearest standard resistor	220	150	120	100

Table 3
9 volts, 6 cells

LED current, mA	10	15	20	25
nearest standard resistor	560	390	270	220

Table 4
12 volts, 8 cells

LED current, mA	10	15	20	25
nearest standard resistor	820	560	390	330

Table 5
14 volts, automotive

LED current, mA	10	15	20	22
nearest standard resistor	1000	680	560	470

FIGURE 5.
Tables for voltage, resistor, and LED current for white LEDs.

This should help you pick a resistor for the desired battery and current for a white LED. For a 6V lantern battery and 25mA, use a 100-ohm resistor. Do not mistake 12 volts for automotive. An automotive electrical system runs closer to 14 volts than it does to 12 volts. Do keep that in mind if you want to run one of these beacons in your car. They draw so little current that they could run many hours on a car battery without cause for concern about battery drain.

Construction

As mentioned earlier, the models in Photos A and B do not lend themselves to home construction; unless you have a lathe at home. My next door neighbor does, I don't. He lets me watch. The light shown in Photo C uses slide switches. I prefer toggle switches. However, toggle switches can turn on by accident in a backpack or even in a pocket. The small slide switches have fewer tendencies to get turned on or be broken off by accident.

The real small switches do not need a machinist to install them. The fact that I had early bad experiences with slide switches makes me shy away from them. Double-check them to see that they are of a good, solid construction. Some of those early slide-switches made contact only when they felt like it. Despite my inhibitions, they have to be the first choice for this application.

Putting the switches on the side of the box makes it easy to get to them with either hand. The photocell, in this case, went in the front. The box shades it from the built-in light. You may place the photocell in another location as suits your thoughts. The photocell went in the top of the automatic beacon, see Photo E. There is nothing critical about the layout. As usual, the neat, clean printed circuit board from Far Circuits makes quick work of the board wiring.

Table 6

Type	milliamphours to about the one-volt level
76	110
9V	580
N	800
AAA	1100
AA	2800
C	7800
D	15,000

FIGURE 6.
Current ratings for several popular batteries.

The values came from various manufacturers and are presented without personal verification. They may help you select the battery for your particular need. Example: With type 76 cells, 110mAH and a 15mA drain -- such as the light in Photo A -- expect about 6-7 hours. With a 9V battery, 580mAH hours, and a 20mA drain, expect 25-30 hours. With a 25mA load and AA batteries, you could look for around 110 hours. That is a lot of reading or looking for things in dark places.

Milling and Drilling

You may find it easiest to make the holes for the LED and the photocell first. If you make the hole for the LED just a bit small, you can make a tight fit and not have to cement it in place. A couple of pins from a machine-pin socket make a good socket for the LED wires. That keeps you from having to solder to the LED, and if you need to reverse the wires to get it to light, you have simplified that. Normally, the package shows which lead goes to battery plus. You may save a bit of time later if you verify that. Just connect a 560-680 ohm resistor, a nine-volt battery, and the LED together as in Figure 1. Make a note which lead of the LED goes to battery plus.

Next, lay out and drill the holes for the switches. Install them. Wire the circuit board. Run the wires from the board to the switches. Then run the wires from the board to the photocell and from the board to LED or LEDs if you use more than one. The transistor can drive two LEDs if you want the extra light. Just put in a separate resistor for each LED as shown in dotted lines in Figure 1A. Finally, run the wires from the battery to the board. Double-check the wiring. Make sure that each LED has a resistor between it and the power source. The board fits in between the batteries and the top of the box as seen in Photo D. If everything looks good, turn it on and start reading, or just enjoy the cool, automatic night LED.

Batteries

One of the prototypes used four "AAA" cells. If someone would make available a holder for a single "AAA" battery, I would use it. I cannot find one. That leaves two choices: use two "AAA" holders or use "N" cells. In this case, I opted for the "AAA" batteries because I found it easier to get them. That meant changing the size of R1 or its equal in the other circuits. The tables suggests resistance values for use with various battery voltages.

Table 3 gives nine-volt values because someone wanted to run a white LED on a nine-volt battery at a low current: 0.3mA to 3.5mA. The LED flashlights advertised on the web imply that they have a current adjust built into them. While a simple variable resistor in series with the LED and the battery would allow adjustment of the current, I made a constant-current generator. That gave this researcher an adjustable, as well as a stable light.

Independent LED Current

Figure 4A gives the circuit of an almost precision constant-current generator. This circuit will let you put from 8-30 volts across it. The light will remain quite stable despite the changes in battery voltage. It makes the light level virtually independent of battery voltage. That holds until the battery voltage falls too low for the regulator. No figures, as I did bother to measure it with a light meter.

Current Regulator

The 7805 regulator in Figure 4A maintains five volts across the emitter-base junction of the transistor. That keeps close to 4.4 volts across the resistors in the emitter circuit. Divide the resistance in the emitter into the voltage, and you get the current. That is the basis for some simple, effective, practical constant current generators. Make the emitter resistors adjustable and, in this case, you have made the light level adjustable.

You also made LED current independent of the battery voltage. It will allow you to put two or more LEDs in series without adding extra resistors. The minimum battery voltage must equal the voltage drops across the LEDs, and the voltage in the regulator. Two LEDs equal 7.2V, the regulator equals five, for the 7805; that adds up to just over 12 volts. With the slightly less precision LED used as a reference (Figure 4B), you get around eight volts. These values are for two LEDs in series.

Simpler, Cheaper

Figure 4B gives the circuit for a simpler and somewhat cheaper constant-current generator. The voltage drop across common LEDs runs around 1.6-1.8 volts. It varies almost enough to notice with 'normal' temperature variations. However, it gives the circuit enough stability for this application. You can put as little as five volts and as much as 35, even 45 volts across this circuit. Large changes in battery voltage will cause the light to vary more than the circuit in Figure 4A. But this circuit will allow a wider range of voltages, particularly at the low end. Photo H shows a clip-on reading light made with this circuit.

If you want it for use in a tent or other place with limited battery power, package it so that you could clip the power connections to a lantern battery. That would give a long life reading light. Table 4 gives millampere hour ratings of several common batteries.

From that, you can make a good guess as to what kind of life to expect from the batteries in your reading light or bike light. It can help you choose the type of battery and the size of the package. The slightly, rounded off figures in Table 4 came from several manufacturers. They assume a useful battery down to about the one-volt level.

The gooseneck lamp holder came from a reading-light as did the clip on the back of the box. That allows you to clip the light onto the book, to a line in your tent, or onto your shirt for hands-free reading. Feel free to E-Mail me at Evertf@asu.edu if you want more details on that or on anything else mentioned here. I do reply to all correspondence.

Bike Light

Some of the more common back lights for bikes use several of the small, bright LEDs. All of them turn on or off at the same time. The circuit in Figure 3 gives the details of the backpack/bike light. This one uses two LEDs that flash back and forth. That way, one light is always on, and it gets a lot more attention than the model that turns all of the lights on and off at the same time.

Photo G shows the works. The housing comes from an automotive supply store. Here, we take advantage of the optics they built into the side-lights normally found on trailers. We place the LEDs as close as practical to the focal point of the lens; about 1.9 inches center to center. That narrows the beam a bit, but projects it a lot. The plastic lens (not pictured) also diffuses the light a bit. That gives it a wider viewing angle.

You do not have to be directly in line with the light for it to get your attention. With two extra bright LEDs flashing alternately, and a lens on the unit, it makes itself quite visible. On a dark street, or one with normal lighting, it is easy to spot one of these lights two blocks away.

Bike or Backpack

Depending upon whether you want it for bike or backpack, you can get a housing with either a red or a yellow lens. White LEDs will work with any color lens that you want. Red LEDs cost the least, and are the most traditional. You can get an exceptionally bright orange LED, 12,000MCD. However,

Parts Lists

Basic, Bare-bones LED Light (No Photo, Figure 1A)

R1 39-68 ohms for 25-13mA per LED
LED 1 SL-A05C11C1-SB; **1-800-722-6445** *for local Selecta distributor*
CMD333UWC 1-800-344-4539 Digi-Key; same part number for Chicago Miniature Lamps Co. Digi-Key will ship small orders (under $25.00), some mail-order companies will not.
SW1 ON/OFF SPST slide switch 275-406 (**RadioShack**)
Battery holder "N" 270-405; three each
BOX 270-1802, approx. 4x2x1

Auto ON/OFF (Photo C, Figure 1B)

R1 39-68 ohms for 25-13mA per LED
R2 33K
LED 1 SL-A05C11C1-SB; **1-800-722-6445** *for local Selecta distributor*
CMD333UWC 1-800-344-4539 Digi-Key; same part number for Chicago Miniature Lamps Co. Digi-Key will ship small orders (under $25.00), some mail-order companies will not.
SW1 ON/OFF SPST slide switch 275-406 (**RadioShack**)
SW2 Auto-ON/OFF SPST slide switch 275-406 (**RadioShack**)
Battery holder "N" 270-405; three each
BOX 270-1802, approx. 4x2x1
Batteries "N" three each
Q1 2N3904 276-1617 (pkg. of 15) NPN transistor
Photo Cell CdS or Phototransistor 276-1657 or 276-145

Automatic Night LED (Photo E, Figure 2)

R1 100K
R2 33K
R3 100K
R4 33K
R5 27K
R6 39-68 ohms for 25-13mA LED current
C1, C2 3.3-10uF, 272-1024, 4.7uF smallest RS lists; 272-1025, 10uF
Q1-3 2N3904 276-1617 (pkg. of 15) NPN transistor
LED 1 SL-A05C11C1-SB; **1-800-722-6445** *for local Selecta distributor*
CMD333UWC 1-800-344-4539 Digi-Key; same part number for Chicago Miniature Lamps Co. Digi-Key will ship small orders (under $25.00), some mail-order companies will not.
Photo Cell CdS or Phototransistor 276-1657 or 276-145
SW1 ON/OFF SPST slide switch 275-406 (**RadioShack**) Pkg. Of 2. Two packages would give you an extra switch.
SW2 Auto-ON/OFF SPST slide switch 275-406 (**RadioShack**)
SW3 Blink ON/OFF SPST slide switch 275-406 (**RadioShack**)
Battery holder "N" 270-405; three each
BOX 270-1802, approx. 4x2x1
Batteries "N" three each
Perf board or Circuit board **Far Circuits**, 18N640 Field Court, Dundee, IL 60118

Bike Light (Photo G, Figure 3)

R1 68 ohms
R2 10K
R3 33K-47K; 33K probably best if you can not get 2.2uF caps and have to use 4.7uF. 27K may give an even better flash rate with the 4.7uF cap.
R4 2700
R5 33K-47K; 33K probably best if you can not get 2.2uF caps and have to use 4.7uF 27K may give an even better flash rate with the 4.7uF cap.
R6 2700
R7 10K
R8 68 ohms
C1, C2 3.3-10uF, 272-1024, 4.7uF smallest RS lists; 272-1025, 10uF
SW1 ON/OFF SPST slide switch 275-406 (**RadioShack**)
LEDs Orange 276-206
Yellow 276-205
Red 276-086
Battery holder 270-408 (enclosed 2-"AA" holder)
Batteries "AA" two each
Housing Auto supply clearance marker light; Peterson, PM V138R for red or 138A for yellow. Of course, if you cannot find one of these, you may build it in some other housing. These housings have a lens that focuses the light.
Circuit Board **Far Circuits**, 18N640 Field Court, Dundee, IL 60118

Adjustable Reading Light (Photo H, Figure 4A, 4B)

Figure 4A	Figure 4B Photo I
7805	12K
0.1uF, two each	180
10K trim pot	1K trim pot
1800 ohms	Cheap LED
2N3904	2N3904
2N2222	2N2222

LED 1 SL-A05C11C1-SB; **1-800-722-6445** *for local Selecta distributor*
CMD333UWC 1-800-344-4539 Digi-Key; same part number for Chicago Miniature Lamps Co. Digi-Key will ship small orders (under $25.00), some mail-order companies will not.

Comments

At this time, you can find the white LEDs only at the two places listed. As they become more popular, you should find it easier to get them. The parts list gives the information needed to make the basic, bare-bones LED light, Figure 1A. Photos A and B show machinist versions. No photo for the practical version. Of course, it could go in a slightly smaller package than the Automatic Night LED seen in Photo C.

the eye may be more sensitive to the cheaper yellow LED. It carries a 6,000MCD rating. Either of these works well with a yellow lens. I have done both. My son gave his stamp of approval as he put one on his bike and the other one on his wife's bike and said thanks as they rode off.

Assembly

Once you decide which housing you want, you may pry the lens off of the clearance light with a flat-bladed screwdriver. Next, remove the 12-volt lamps and their sockets.

Save them for other projects. Install the resistors, transistors, capacitors, and your choice of LEDs in the boards. Note carefully the polarity of the LEDs. Run wires from the board to the switch, then the wires from the battery holders to the board.

As usual, I used toggle switches in my bike lights. If you can find waterproof switches and want to water-proof the housing, do it. Here in Phoenix we do not have to, or even get to ride in the rain that often.

Check Out Time

When you finish the wiring, as always, check the placement of the capacitors and the LEDs. When that looks good, apply power. Remember that the red, orange, and yellow LEDs use a three-volt, two-cell battery pack. A pair of "AA" penlight batteries gives reasonably long life; an estimated 120 hours.

By using the circuit in Figure 3 – separate flip-flop with LED drivers – the circuit will keep on ticking even when the battery voltage falls to less than two volts. It will get dimmer, of course, but it will still tick tock.

The textbooks tell you that an ordinary dry cell has run down when it falls to about 80% of its new voltage. That figures out as 1.2 volts for a 1.5-volt battery. Even at 2.4 volts, these lights still make themselves quite visible.

Cheaper Circuit

You could change the values of R3-6, as well as the size of the capacitors, and eliminate the driver transistors. At the same time, you could get rid of R2 and R7. That would save a few parts. I tried it on the workbench.

When the power supply voltage dropped too low, both LEDs just turned on and gave a dim, steady glow. Since that did not save enough parts or space for the less desirable results, I did not make a drawing.

What Color LEDs?

You can use the white LEDs in this dual, flashing light, but you will have to increase the battery voltage by one battery: 1.5 volts. That will get you over the threshold voltage for the white LEDs. The 68-ohm resistor will work. That will give about 13mA lamp current.

You may want to increase that by using a 47-ohm resistor for R1 and R8. That will give about 19mA and still have reasonable battery life.

Since you have some room and want long battery life, "AA" cells seem like a good choice.

You can get a single "AA" holder. That lets you use just 4-1/2 volts for the battery supply. That will let you use either the more useful white LEDs or the easier to get red, orange, or yellow LEDs.

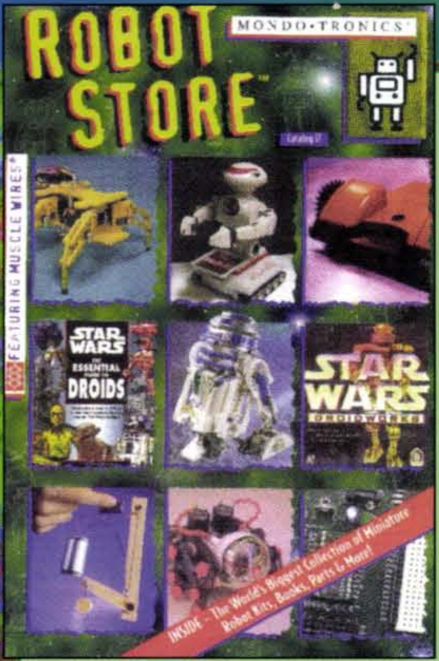
You Pick It

Select the type of LEDs, the package, the options, and the battery voltage that gives you the camping, biking, reading, or flash light best suited to your activities. That may include hiking, biking, or reading a book after "lights out."

These LEDs give an astounding amount of light for such a surprisingly small amount of current. That makes these applications of these lights especially practical. You can probably think of additional applications.

We hope that whether you use the automatic night LED or one of the other circuits, it will make your camping, hiking, biking, or late night reading a bit more enjoyable. **NV**

New Product News



NEW 17TH EDITION "ROBOT STORE" CATALOG

Mondo-tronics' Robot Store unveils the world's biggest collection of hobby robot kits, books, and parts in its free catalog.

The catalog features the newest Lego® MindStorms™ sets, including the new Star Wars® Droid™ Developer Kit and the Robotics Discovery Set™.

Another recent addition is the Cye™ robot, a fully-assembled, programmable platform for advanced household functions. Wagon and vacuum attachments, sold separately, let you put the Cye robot to work cleaning house and fetching refreshments. Cye opens new realms for practical home and office robotics using just a common desktop PC.

The Picza 3-D scanner and Modela 3-D fabricator bring a new frontier of creative technology to hobbyists of all ages.

The simple, inexpensive Picza digitizing scanner uses a thin piezo feeler to sample scan an object and build a map of its surface.

The Modela fabricator drives a 4500 RPM cutter to carve objects from a wide range of materials, including jeweler's wax, modeler's foam, balsa wood, even plaster of Paris. Finished models can be used directly, or as masters for casting in other materials.

The catalog offers a combo pack which includes both scanner and fabricator, plus TrueSpace 3D software, a modeling and animation tool which helps you design your own custom robots, parts and systems, then bring them to life on your computer before you build them.

LATEST LEGO® MINDSTORMS™ ROBOT KITS

Robot Store features latest Lego® MindStorms™ Robot Kits.

The Star Wars® Droid™ Developer Kit lets budding robot designers combine the power of the force with their imaginations to create classic droids from the Star Wars movies. Starting at the first level, Jedi apprentices can build and program R2-D2 and L-3GO droids using step-by-step building instructions and guided help from the CD-ROM, then using the building tips to construct even more complex droids.

At Jedi Master status, the force guides in the creations. Partial building instructions for master level droids like a battle droid and a Gungan sub get you started, but then you're on your own. Let the force be with you!

The kit includes the Micro Scout, the smallest Lego microcomputer with a built-in light sensor, motor, and seven built-in programs. Each droid can be built separately using the same pieces.

The MindStorms Robotics Discovery Set provides everything needed to bring Lego creations to life, using the included Scout microcomputer, which lets you create over 3,000 different behaviors with the touch of a button.

The constructapedia manual gives step-by-step guidance in building three different robot creatures: The Bug, Intruder Alarm, and the Hoop-o-bot. After you master these bots, take the challenges from the constructapedia and build the Radar Runner, the PhotoBot, and many more!

For more information, contact:

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4286 REDWOOD HWY. PMB-N, DEPT. NV
SAN RAFAEL, CA 94903
415-491-4600 FAX: 415-491-4696
E-MAIL: info@mondo.com
WEB: www.RobotStore.com

WIRELESS SURVEILLANCE SYSTEM AS-1004

Matco's AS-1004 wireless surveillance system combines state-of-the-art performance with an easy wireless setup.

The AS-1004 operates on an FCC approved 2.4 GHz frequency for sharp, interference-free images and sounds. Its 300-foot range in a home-office setting is much higher if an optional patch antenna is used.

This system has audio capabilities and can be expanded to monitor up to four cameras simultaneously; with channels being either held or skipped. If more than four locations must be monitored, but not simultaneously, unused cameras can be switched on or off as needed. For example, if eight cameras are used, four cameras can be used during the day, and a different four cameras can be monitored at night. So by juggling cameras, a wider coverage area can be handled.

Each camera operates on its own separate noise-free FM channel, has a built-in 3.6mm wide angle lens with a high 400 TV lines of resolution.

System prices start at $169.00, which includes a transmitter, receiver, camera, power adapters, complete mounting hardware, and color coded video and audio plugs, for monitor or VCR hook-up. Additional cameras may be purchased.

For more information, contact:

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NEW DIP ADAPTER MODULES

Accutek Microcircuit Corporation introduces a new series of adapter modules that eliminate the need to redesign costly motherboards.

Accutek DIP adapter modules feature 8 to 32 pins for converting an IC that is packaged in a surface mount SOJ, TSOP, PLCC, or SOIC package to a pin compatible direct drop-in replacement for end-of-life DIP ICs. Developed for users with motherboard designs that require DIPs now obsoleted by manufacturers, they include an on-board decoupling capacitor.

Measuring from 0.400" to 1.600" long, depending upon the number of pins, Accutek DIP adapter modules can incorporate 0.300" to 0.600" row-to-row spacing with 0.100" lead spacing.

Custom configurations up to 200 pins and multi-chip and double-sided modules are also available.

Applications include VME, DSP, video, COTS, medical instruments, and industrial computers.

Accutek DIP adapter modules are priced according to configuration, are fully tested and include a lifetime limited warranty.

For more information, contact:

ACCUTEK MICROCIRCUIT CORP.
2 NEW PASTURE RD., STE. 1, DEPT. NV
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1-800-652-7505 or 978-465-6200
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Max Sweep Rate	2nS/Div to 0.2S/Div	0.1µS/Div to 0.2S/Div	0.1µS/Div to 0.2S/Div	0.2µS/Div to 0.5S/Div
Delay Sweep	YES	ALT-MAG	ALT-MAG	ALT-MAG
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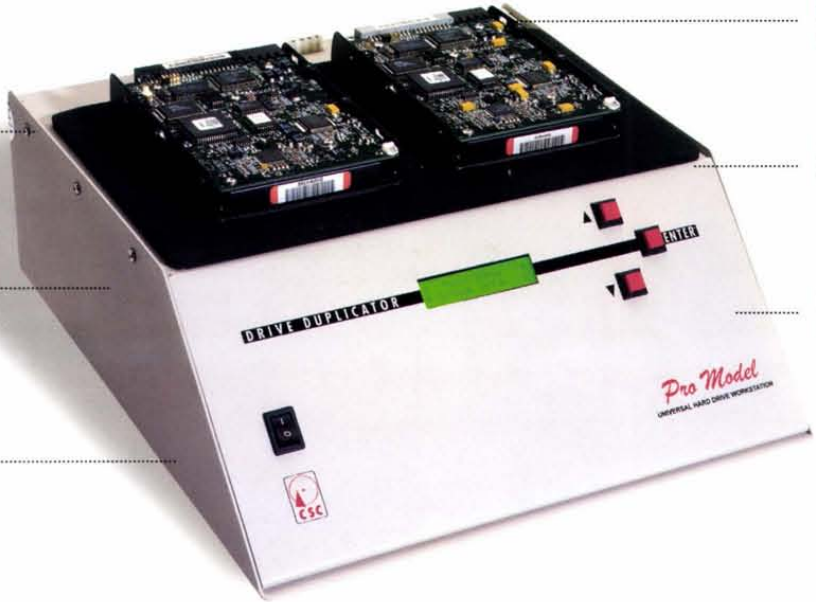

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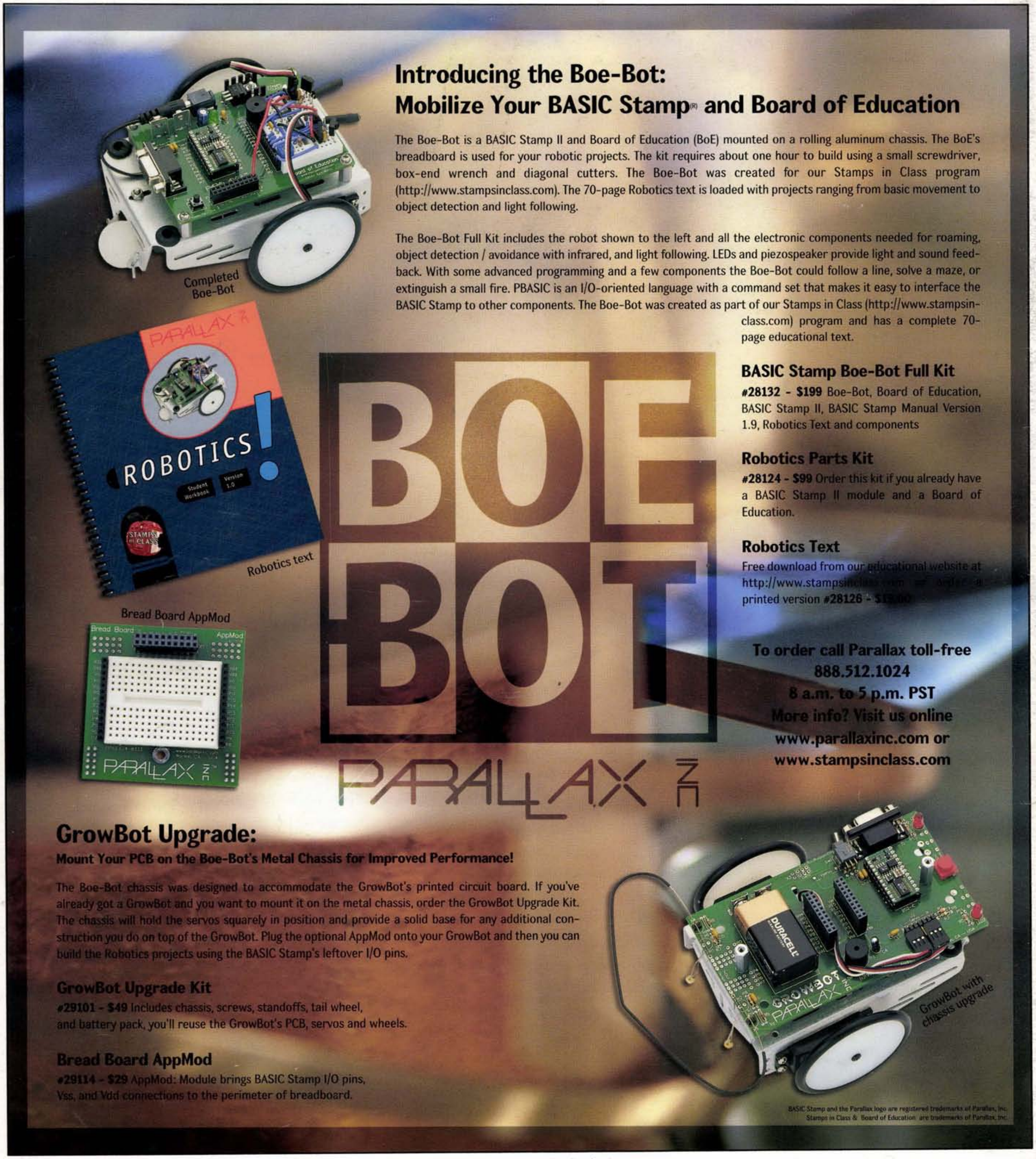

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