NUTS & VOLTS MAGAZINE

OUR 17th YEAR

$3.50
VOL. 17 NO. 8
AUGUST 1996

Exploring Electronics And Technology For The Hobbyist And Professional

New modem technology lets you talk and send data – at the same time – over a single, analog phone line!

DSVD: Talking Modems

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Micromint Introduces Small, Ultrafast BASIC and C Computing!

There is no debating that the BASIC Stamp® I is a great little controller. Unfortunately, it has to sacrifice speed and performance to bring you the convenience of BASIC. Now, Micromint offers Stamp users the best of all worlds: assembly language speed, BASIC and C programmability, and enhanced performance.

Micromint introduces the three little PicStics™. PicStics™ are BASIC Stamp® I I/O-compatible 14-pin boards with a little extra. The primary enhancement is *speed*. Any program you have for a Stamp will automatically run faster on a PicStic™ using the PBASIC compiler. Besides getting at least a 15-times increase in execution speed and typically double the instruction space of the Stamp I, you also increase your code's security.

PicStics™ also have more I/O lines and onboard features. The PicStic™ 2 has a battery-backed hardware clock/calendar. Most people just call it a real-time clock because it allows you to trigger program events based on a particular time of day or day of the month. PicStic™ 3 connects you to the analog world through its high-speed, 2-channel, 12-bit A/D converter.

Small size, high speed, improved performance, and lower cost. That's the new PicStic.

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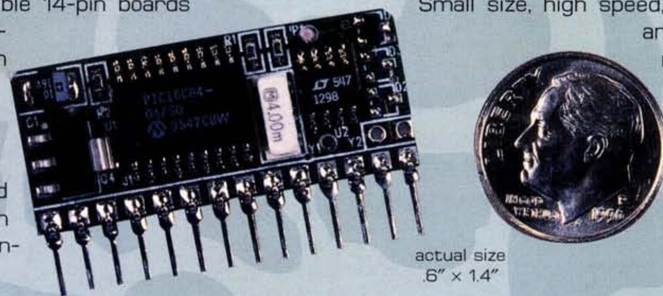

actual size
.6" × 1.4"

	Micromint PicStic™ 1	Micromint PicStic™ 2	Micromint PicStic™ 3	BASIC Stamp® I
Price	**$29**	**$39**	**$39**	$34
BS1 software compatible	yes	yes	yes	yes
Reprogrammable EEPROM	yes	yes	yes	yes
I/O lines	**10**	**9**	**10**	8
Extra features	none	**real-time clock**	**2-channel, 12-bit ADC**	none
Programming language	PBASIC compiler, C, assembly lang.	PBASIC compiler, C, assembly lang.	PBASIC compiler, C, assembly lang.	PBASIC interpreter
RAM (variables)	**22 bytes**	**22 bytes**	**22 bytes**	14 bytes
Max. program length	150 inst*	150 inst*	150 inst*	80 inst*
Clock speed	4 MHz	4 MHz	4 MHz	4 MHz
Execution speed	**50k inst/s***	**50k inst/s***	**50k inst/s***	2k inst/s
Max. serial I/O	2400 bps**	2400 bps**	2400 bps**	2400 bps
Packaging	14-pin SIP	14-pin SIP	14-pin SIP	14-pin SIP

*Maximum program length and execution speed are determined by instruction mix. Overall speed gain is typically at least 15 times while individual instructions may be 100 times faster.

**Comm speed is presently set for compatibility. New compiler versions will allow 9600 bps.

PicStic™ Development System includes:

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PicStic Most Asked Questions

1. Is PicStic BASIC Stamp® compatible?
Using the PBASIC compiler, PicStics are 100% BASIC Stamp program compatible, but typically run 15 times faster (7 times faster than BS2) and allow more variables. If you have an existing BS1 program, it can be compiled using the PBASIC compiler and executed exactly as before. The only exception is that because PicStic uses a compiler, interactive features like debug are not compiled with the program.

2. I have a BASIC Stamp® development system. Can I use it?
No. Parallax BASIC Stamps® use an interpreted BASIC with a tokenized BASIC downloader. PicStics use an EEPROM-programmable processor with a compiled PIC assembly language program. So, yes, you'll need a PicStic programmer with either the PicStic C or PBASIC compiler development system.

3. How fast is the PicStic ADC?
PicStic uses an LTC1298 12-bit ADC. In a typical application, the ADC can provide 1000 samples per second or more.

4. How much current can I draw from PicStic's onboard regulator?
For a 9-V input at 25°C, the 5-V output is typically 100 mA.

5. Why does PicStic have two more I/O lines and interrupts too?
PicStic has the same eight general-purpose I/O lines supported in PBASIC, but because PicStic uses an EEPROM PIC16C84, the two lines required for programming the Stamp aren't required on PicStic. These two I/O lines and the four interrupt sources are available using assembly language (or calls from PBASIC or C).

6. Just how universal is the PicStic?
Even though PicStic is packaged in a BS1 pin-compatible layout with optional ADC or clock, it still uses a PIC16C84 EEPROM PIC and executes PIC assembly language programs. PicStic can be programmed with any compatible PIC programmer.

7. What about the 9600 bps or 10 MHz PicStics?
The best part about using PicStic and a compiler is that we can start by being 100% compatible and then add powerful new instructions as they are written. Next versions of the PBASIC compiler will allow 9600 bps, Peek and Poke, and increased clock speeds.

PicStic™

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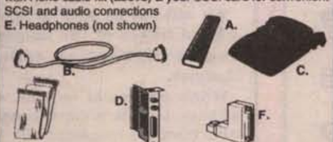

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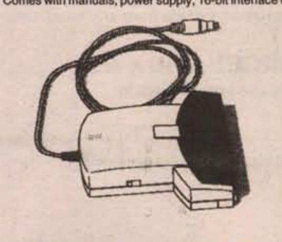

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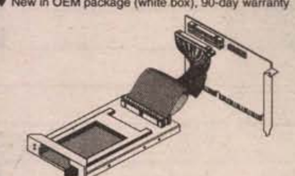

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Nuts & Volts Magazine encourages article submissions and queries. Send a SASE for a copy of our writer's guidelines.

All submissions should be on 5-1/4 or 3-1/2 inch diskettes and include hard copy as well. If return of materials is requested, include a SASE with your submission.

Deadlines should be discussed in advance with the editor, but generally all material should be submitted by the 1st of the month for the next month's issue.

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reader FeedBack

Dear Nuts & Volts:

The new Web page looks good. I'm looking forward to your stated improvements.

Keep up the good work with the magazine. My only suggestion (at this time):

Go to the smaller format. Postal persons fold my copy at least twice to fit their bags, then my mailbox! Same thing happens with *EE Times*; it's usually in shreds by the time I get it.

Bob G. Roberts
broberts@intersurf.com

Dear Nuts & Volts:

In the June '96 issue (page 83) in *Nuts and Volts*, a question about refilling Hewlett-Packard Deskjet cartridges was answered with incorrect information. There is no "rubber bladder that holds ink," nor is any rubber punctured to fill the cartridge. The following discussion applies to the more recent high-capacity cartridges; the older type, and color cartridges, have only a sponge that is refilled by simply injecting ink into it slowly.

The ink is in the body of the cartridge and the rubber part is really a plastic "lung-like" bladder that is built to collapse when not pressurized with air. Here is how the cartridge works: The ink is placed in a tank that ends up being sealed except for the ink jets and a tortuous spiral path that leads to a vent on the bottom of the cartridge. If it were not for the bladder, the weight of the ink would cause ink to drip out of the jets and the vent. If the bladder is inflated before the tank is sealed, it exerts a negative pressure or pull on the ink inside the tank and this prevents the ink from dripping. The bladder is open to the outside, but cannot collapse unless air enters the tank. This is where the spiral path and the tiny jets play their part; because ink wets the inside of the jets and the spiral path (capillary action) it tries to crawl into the holes and pathway. However, the pull of the bladder pulls the ink back towards the tank. The net result is a balance between the bladder and the spiral. If the bladder pulls too strongly, the spiral "loses" the tug-of-war and some air bubbles enter the tank to relieve some of the negative pressure. If the bladder is not pulling strongly enough, ink drips out (expanding the bladder to make up for the lost volume of ink) and eventually the bladder starts pulling strongly enough to stop the dripping.

To fill a cartridge with ink and have it work properly, it is necessary to end up with a tank full of ink and a bladder which is expanded at the time the tank is sealed. There are many ways to achieve the desired final result. All rely on sealing the bottom spiral-path vent and the jets with tape or a rubber surface pressing at the holes until the job is done.

1. Remove the plug (usually a ball or tape or rubber stopper), fill the tank with ink, pressurize the bladder vent hole to expand the bladder, and then seal the tank fill-hole.

2. Remove the plug, fill the tank with ink, evacuate the tank above the ink (from the fill hole) to expand the bladder, seal the bladder vent-hole with a finger or tape so it won't collapse, plug the fill hole and unseal the bladder vent.

3. Remove the plug, fill the tank with ink and seal the fill-hole. When the bottom vent is opened, ink will drip out (or can be sucked out) until the bladder expands enough to prevent further dripping. This wastes ink, but does work.

4. Remove the plug, fill the tank with ink and seal the fill hole. The tank is then inverted and the bottom vent is opened. Air is evacuated from the tank via the bottom vent to expand the bladder and the tank is then returned to its upright position.

5. Same as above except pressurize the bladder vent while the cartridge is inverted. Air will escape from the bottom vent while the bladder expands. Put the tank upright when the bladder expands fully.

When any of these procedures is completed, the seals over the bottom vent hole and over the jets can be removed. If the cartridge is not to be used immediately, it is best to leave the tape in place. In fact, it is better not to refill a cartridge until just before it is needed.

The most likely cause of eventual cartridge failure is the depositing of sediment in the jets. I keep a clean cartridge on hand and fill it when it is needed. Then I clean the empty cartridge and save it for use when the next refill is needed. Before I clean the cartridge, I tape the spiral vent hole with tape and open the fill hole. Then I fill it

continued on page 104

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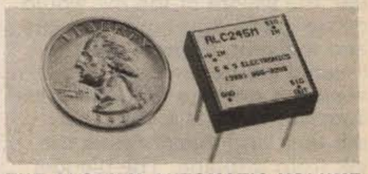

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by Jeffrey Mazur

UNDERSTANDING PROGRAMMABLE LOGIC DEVICES

PART 3

Last month, we examined Boolean logic — the language used to design and program Programmable Logic Devices (PLDs). This month, we continue with a discussion of the hardware and software tools needed to use these devices. We will then present a real-world example of circuit design using PLDs.

Designing with PLDs

Figure 1 shows the basic steps involved when designing a circuit using PLDs. The first step is to break the design down into logical blocks. Determine what signals need to be created and from what inputs. Then you can try to fit the required logic into the capabilities of various PLDs. At this point, you then need to synthesize the logic equations which will be implemented by each PLD.

Once the logic equations have been determined, they are entered into a PLD assembler or compiler program such as CUPL or ABEL (see SOURCES for more information; other programs such as PALasm, PLAN, or PLDasm may not currently be available, but an older copy will work just fine). These programs all generate a standard JEDEC (Joint Electronic Device Engineering Council) output file. This file contains a binary image of the fuses to be programmed. The programmer then uses this file to "burn" the logic into a PLD. Figure 2 details the actual programming process.

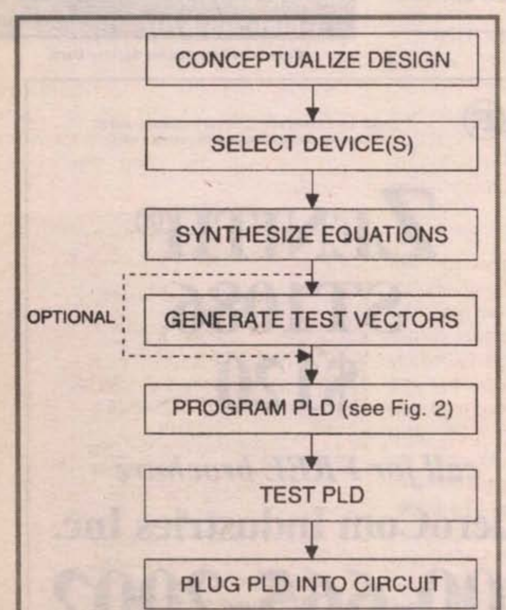


FIGURE 1. The PLD design process.

There are many compilers and programmers available for the PC, Macintosh, and various other computer platforms (although the vast majority run on MS-DOS compatible machines). In our example which follows, we will be using the PLAN (Programmable Logic Analysis by National) PLD Development Software from National Semiconductor. The actual "PLD burning" will be done using a BP Microsystems Model CP-1128 combination EPROM/PLD programmer.

A PLD Design Example

As a real-world example, let us consider the design outlined in Figure 3. The goal here is to add a small amount of static RAM to an existing microprocessor design (the processor here is a Motorola 68030). This should be quite simple since most of the address and data lines of the SRAM attach directly to the processor bus. All we need to add is some glue logic to provide a chip enable for the SRAM and handshake signals (DSACK0 and DSACK1) back to the microprocessor.

To make matters slightly more complicated, we will also add a form of write-protection so that the contents of the SRAM will be protected against accidental modification.

The large number of inputs and wide AND gates in PLDs make them especially useful as address decoders in microprocessor designs. In our example, the first thing we need to generate is a Chip Enable for the SRAM. We wish to map it into the address space 5800 0000 - 5FFF FFFF (our SRAM only occupies 8 KB within this entire 32 MB range; with our minimal decoding, the SRAM will appear to repeat itself many times within this space). Therefore, we start by generating the /CE term as follows:

/CE = /A31 * A30 * /A29 * A28 * A27 * /AS

The last term, /AS, is the address strobe signal which indicates that a valid address is present on the address bus.

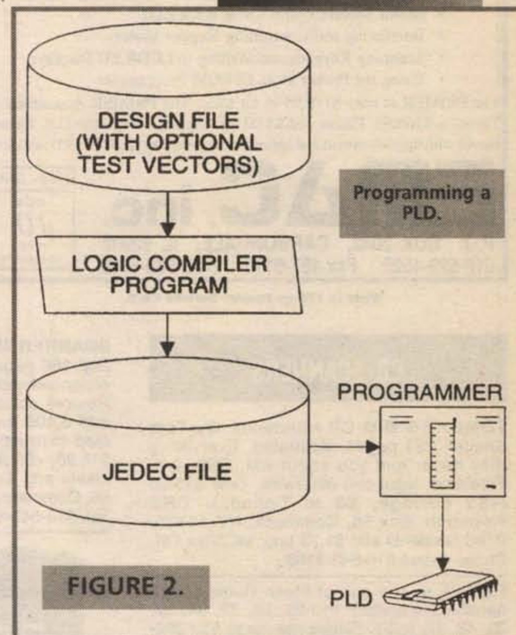
Let's see what must transpire for the microprocessor to read data from our SRAM. When software instructs the processor to read the SRAM, it will place an address within the above space onto the address lines and assert /AS.

Upon detecting such an address, our circuit must then enable the SRAM so that it can be read by the processor. By asserting its /CE signal, the SRAM will place the appropriate data onto the data bus. When the data from the SRAM is ready to be read by the CPU, we must assert /DSACK0 and de-assert /DSACK1 (this signals the microprocessor that we have one byte of data to be read). When not selected, the DSACK lines must be tri-stated so that other parts of the computer system can control them.

Since we wish to use an inexpensive SRAM, we will need to accommodate chips with access times up to 200 nS. Therefore, we need to delay setting of the DSACK signals until the /CE signal has been active for that long.

We can accomplish this by using several registers as a counter and clocking them with a 16 MHz signal which is available. We'll come back to that in a moment.

To implement our write protection scheme, we will feed the R/W (Read/Write) signal from the processor through our PLD and then to the SRAM. This allows us to prevent writing into the SRAM until a software controlled "lock" within the PLD is opened. This lock is also implemented by several cascaded registers which must be set in the proper order for the lock to be opened.



Programming a PLD.

FIGURE 2.

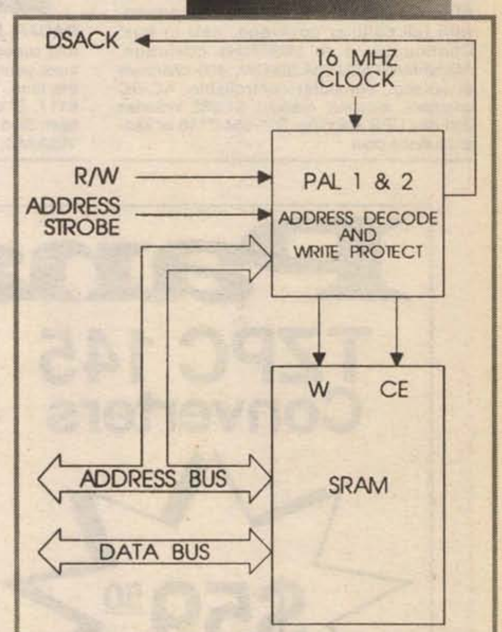


FIGURE 3. Block diagram of a write-protected RAM module for a 68030-based computer.

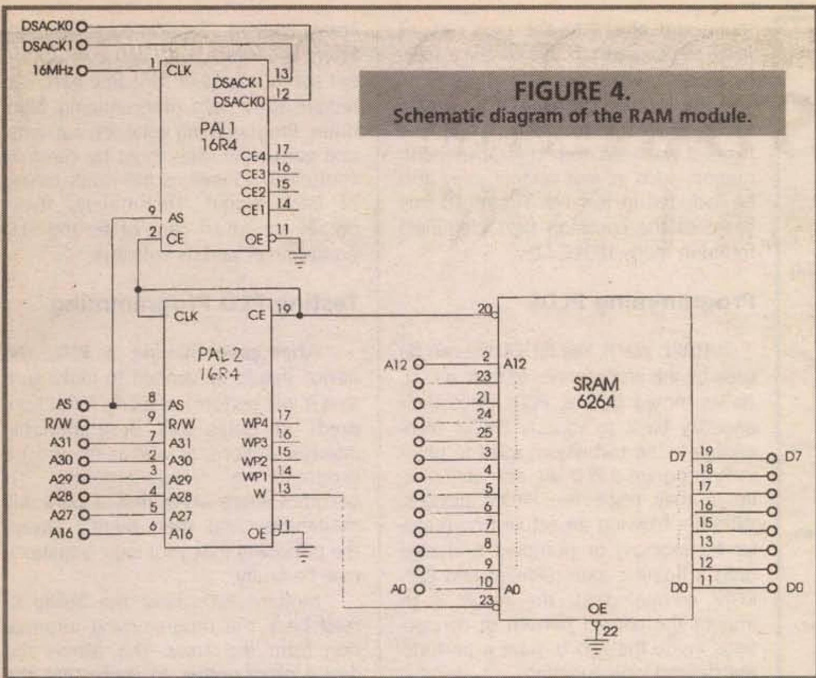


FIGURE 4. Schematic diagram of the RAM module.

```
PAL16R4; UHURA/30 PAL1
CLK CE  nc  nc nc nc nc nc AS GND
OE DSACK0 DSACK1 CE1 CE2 CE3 CE4 nc nc
VCC
/CE1 := CE * /AS
/CE2 := CE * /AS * /CE1
/CE3 := CE * /AS * /CE2
/CE4 := CE * /AS * /CE3
/DSACK0 = /AS
DSACK0.TRST = /AS * /CE4
/DSACK1 = AS
DSACK1.TRST = /AS * /CE4
```

FIGURE 5. Contents of file: PAL1.BEQ.

```
PAL16R4; UHURA/30 PAL2
CLK A30 A29 A28 A27 A16 A31 AS RW GND
OE nc  W WP1 WP2 WP3 WP4 nc CE VCC
/CE  = /A31 * A30 * /A29 * A28 * A27 *
/AS
/WP1 := /RW * A16
/WP2 := /WP1 * RW * /A16
/WP3 := /WP2 * RW * A16
/WP4 := /WP3 * /RW * /A16
   + /WP4 * /A16
/W  = /RW * /WP4 * /AS
```

FIGURE 6. Contents of file: PAL2.BEQ.

```
PLAN v3.14  01-09-1996  22:30
Source filename: PAL2.BEQ  Device: PAL16R4
UHURA/30 PAL2 *
QP20* QF2048* F0*
L0000
11111111111111111111111111111111
01111011011101111111101110111111*
L0512
11111111111111110101111111111011
11111111111011111011111111111111*
L0768
11111111111111110110111111110111*
L1024
11111111111111110111110111110111*
L1280
11111111111111110111111111111011*
L1536
11111111111111111111111111111111
11111111110111111111111111011011*
C21E6* 0000
```

FIGURE 8. Contents of file: PAL2.JED.

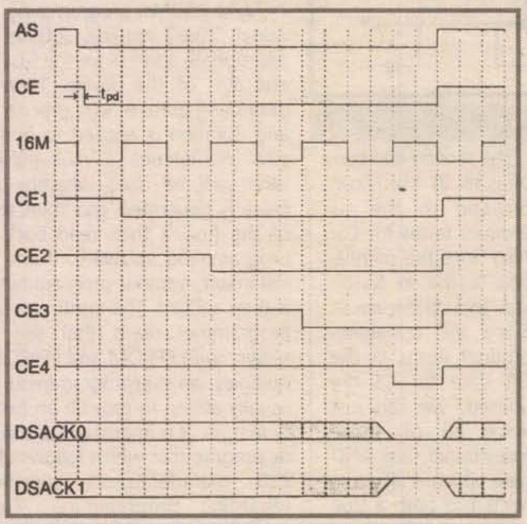


FIGURE 7. Timing diagram for the RAM module.

Synthesis of the PLD Logic Equations

Our design requires nine inputs and four outputs. We also need eight registers, although none of them actually are used outside of the PLD. Many PLDs have "buried registers" for just this purpose; they can be used within the PLD, but do not take up any external pins. There are numerous ways to implement these functions in one or more PLDs. Because we were already using a number of 16R4 PALs and they are quite inexpensive, the decision was made to implement this design using two 16R4s. Figure 4 shows the final schematic for our design.

The full equation lists for the two PALs are shown in Figure 5 and Figure 6. Note that these Boolean Equation files (.BEQ) consist of three parts: a header which describes the device; a pin-list which gives labels to each pin on the device; and finally the actual logic equations to be implemented.

We start with the /CE signal which is generated by PAL2. Notice that this signal is also fed back to the clock input of its registers. Thus each of the write protect registers (WP1-WP4) is clocked by any access to an address within our decoded range. The rest of the lock works as follows: /WP1 is set whenever we attempt to write to an address in our range that also has A16 high (e.g., 5801 0000). At this point, nothing gets written to the SRAM because the write signal is blocked by WP4 being high.

If the next access to our range is a read with A16 being low (e.g., a read access to location 5800 0000), then /WP2 will be set. Any other access will clear /WP2. Likewise, /WP3 is set if, and only if, the very next access is a read to the A16 high address. Finally, if we get this far and the next access is a write to the low address, we set /WP4 which unlocks the write access to the SRAM. The second term in the equation for /WP4 keeps it unlocked until there is an access to the high address. Since our SRAM fully resides below that address, we can write to as much of the SRAM as desired; when we are finished writing, we can simply access the high address to lock the SRAM back up. The full sequence would then have to be repeated to gain write access again. This simple scheme is sufficient to preserve the contents of the RAM through a reboot of the processor and to protect it from any wayward program that might inadvertently go stomping through memory.

PAL 1 is used to generate the delayed, tri-stateable DSACK handshake signals. In this PAL, we clock the registers with a 16 MHz signal whose period is 1/16 MHz, or approximately 62 nS. Once again, we make the /CE signal from PAL2 ripple through all four registers, finally asserting CE4 after 217 nS (see the timing diagram in Figure 7). Since the /AS signal remains low during this time, when CE4 finally goes low, it satisfies the product terms for the output enables of /DSACK0 and /DSACK1. To actually make /DSACK0 go low and /DSACK1 go high, we set them to the value of /AS and AS, respectively.

Note the use of the extension .TRST in the equations for DSACK0 and DSACK1. This tells the compiler that these equations are used to control the output enable terms. Other extensions are often used to specify internal clocks, latches, and register inputs.

Using a Logic Compiler Program to Generate the JEDEC Files

At this point, we have the Boolean equations necessary to define the function of our PALs. These equations must now be turned into a binary fuse map – the standard JEDEC file – for use by the PLD programmer. The logic equations are entered using any simple text editor or word processor. The files are saved as "text only" and, for use with our logic compiler, given an extension of .BEQ.

After passing the Boolean equation files (PAL1.BEQ and PAL2.BEQ) through the PLAN compiler, we generate two JEDEC files (PAL1.JED and PAL2.JED). Figure 8 shows the contents of the file PAL2.JED. As we describe this file, compare it to the logic diagram in Figure 9 which shows the locations of those fuses which need to be left intact. Note that we have also included labels to indicate the absolute fuse number for each location.

The JEDEC file consists of several parts, each terminated by an asterisk. The first three lines represent a header which gives information on the device and the compiler used to generate the JEDEC file. The next line contains three fields: QP20 specifies that our device has 20 pins; QF2048 indicates that there are 2,048 programmable fuses; and F0 denotes that any fuses not explicitly listed should default to state 0, that is, left intact.

The next section of the JEDEC file lists rows of fuses to be programmed. The line L0000 indicates that we are starting with fuse number 0000. The state of each fuse is then listed, with a "1" signifying that the fuse should be blown. Notice that the first line consists of all 1s. This means that all of the fuses for the first product term (the output enable for CS) will be blown. This leaves only a pull-up resistor which will permanently keep the output enabled.

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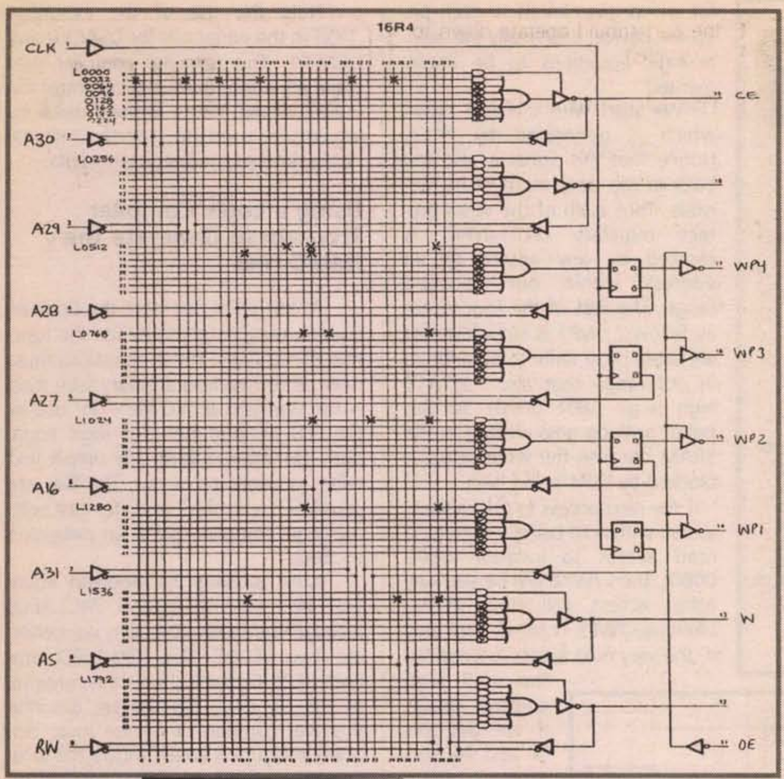


FIGURE 9. Programming for PAL2.

QF	Number of fuses in device
QP	Number of pins in device
QV	Maximum number of test vectors
F	Default fuse state
L	Fuse list
C	Fuse checksum
X	Default test condition
N	Note
V	Test vectors
P	Pin sequence
D	Device
G	Security fuse
R,S,T	Signature analysis
A	Access time

FIGURE 10. JEDEC field identifiers.

The second line contains six 0s which correspond to the six product terms for CS. Also note the correlation to the six Xs on line two of Figure 9. Since the remaining product terms in the OR gate for CS are unused, we can just leave all of those fuses intact (any AND gate which is left connected to both a true and inverted input signal will never be satisfied). According to our default of leaving fuses intact, we can thus jump ahead to the next row of fuses to program. In this way, we specify precisely which fuses to blow.

The last line of the JEDEC file contains a checksum for verifying that the fuse list was read correctly. Other information, such as test vectors, may also be included in this file. Figure 10 lists some of the common field identifiers found in many JEDEC files.

Programming PLDs

At this point, the JEDEC file can be used by the programmer to burn a PLD. As we noted before, PLDs trace their ancestry back to various PROM technologies. The techniques used to physically program a PLD are also very similar to their respective PROM devices. Whether blowing an actual fuse (bipolar technology) or pumping a charge onto a floating gate (EPROM and EEPROM technologies), the result is to imprint the correct pattern of connections inside the PLD to have it perform the desired logic function.

Like PROMs, programming an individual "fuse" requires setting up the appropriate address for the fuse on several pins of the device. Then a programming pulse of very precise voltage and duration is applied to one of the pins. Sometimes a multi-pulse algorithm will be used whereby a small pulse is generated and then the state of the fuse is then read back by the programming software. If the fuse is still intact, another programming pulse is then applied. This continues until the programmer reads that the fuse is blown; with EPROM and EEPROM technologies, an overprogramming pulse is usually added to provide an extra safety margin. It is important to use a quality programmer which follows all of the PLD manufacturer's specifications regarding programming. This will ensure that the device will work properly under all supply voltage conditions and also for many years after the device has been programmed.

With PROMs, the fuse addressing is quite straightforward. An individual fuse is associated with a particular binary address and a binary data bit. Thus, we program a PROM by setting up each address on the PROM's address inputs, setting the desired data onto the data outputs (which during programming are used as inputs), and applying the appropriate programming pulse.

Since PLDs are not memory devices, there is no similar correlation to the fuses. Instead, we have seen that each fuse within the PLD is given a number and the exact setup to select a particular fuse is part dependent. Because of this, there is no universal algorithm for PLD programming. Each part requires a special program which your programming tools must have in their library. Indeed, identical parts from different manufacturers, and even different speed ratings of the same part, can require their own programming algorithm. Programming voltages, currents, and even slew rates must be carefully controlled, as well as the exact timing of each signal. Fortunately, these details are taken care of by the PLD programmer and its software.

Testing PLD Programming

After programming a PLD, the device should be verified to make sure that it will perform properly. With hundreds of gates and programmable interconnections, as well as the precise programming requirements, it becomes more likely that a part will misbehave. And then there's always the possibility that your logic equations may be faulty.

Modern PLDs have the ability to read back the programming information from the array. This allows the device programmer to verify that the information programmed into the PLD actually matches the instructions contained in the JEDEC file. Although this can determine that a part has been programmed correctly, it does not actually verify that the part will perform correctly. This can happen if one or more of the gates inside the PLD are defective (although very rare, this can happen and may be extremely difficult to troubleshoot once the PLD is placed in a circuit).

To further verify the operation of a programmed PLD, we can build a table of test conditions and have the programmer input these signals into the device. Then we can compare the outputs from the PLD with the expected values to see if there are any discrepancies. These test conditions and their expected results are referred to as test vectors. We can write simple vectors to check out combinational functions or we can also write very complicated sequential vectors to verify the operation of registered functions over many clock cycles. State machines should also be tested for illegal conditions and to verify their recovery from such states into a known good state. To aid in such testing, most PLDs have a register preload function which enables the user to set each register into a known state while the device is being tested.

Writing test vectors for a PLD can sometimes be more time-consuming than putting together the actual programming equations. But in a production environment where many parts are being programmed, testing complex devices before they are actually used can save a lot of time down the road tracking down a failed device. Another test which many programmers can perform is to check operation of the PLD at various supply voltages within the range at which the part should operate. Once again, a part which operates correctly at 5.0 volts may fail when placed in a circuit where the power supply is only 4.8 volts (even though the data sheet may specify that

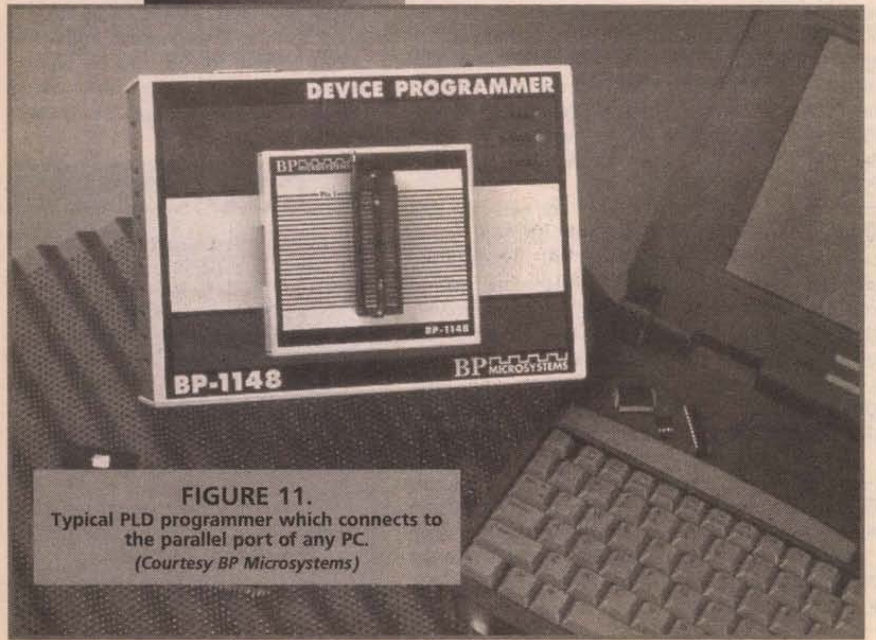


FIGURE 11.
Typical PLD programmer which connects to the parallel port of any PC.
(Courtesy BP Microsystems)

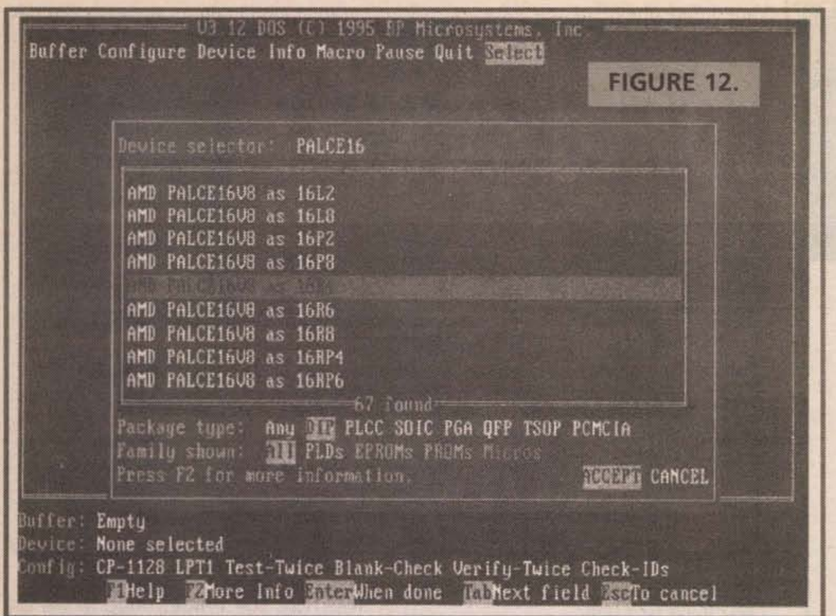


FIGURE 12.

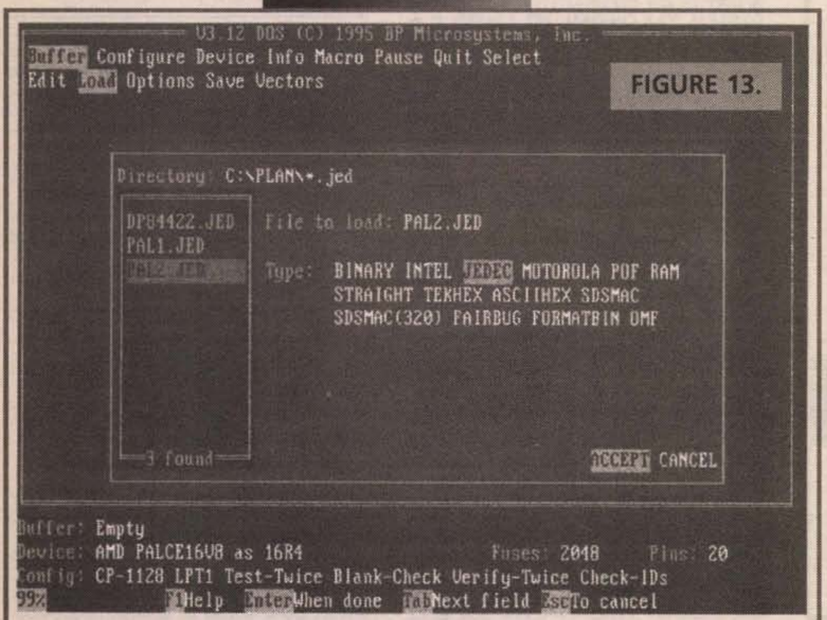


FIGURE 13.

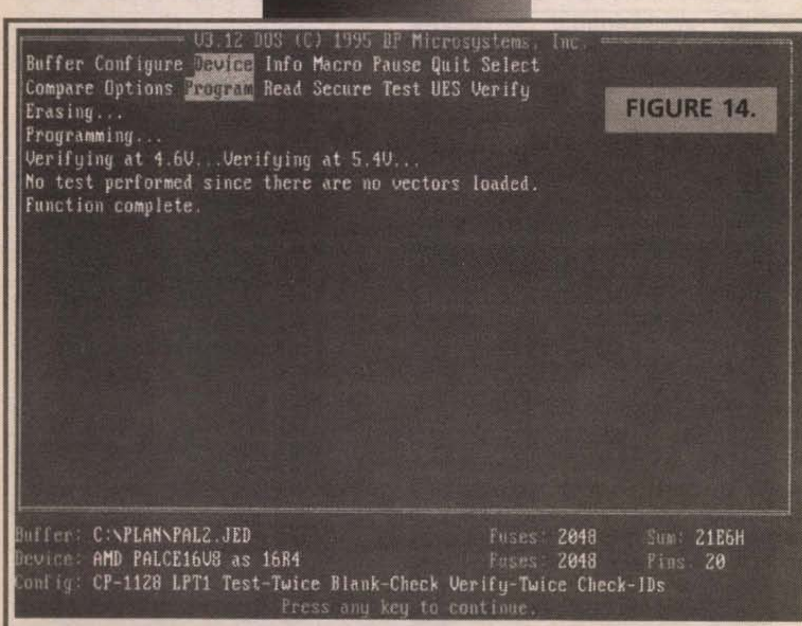


FIGURE 14.

the part should operate down to 4.75 volts).

The Moment of Truth

Now that we have the JEDEC files for our PLDs, it's time to fire up the programmer. Like many programmers for the PC, the CP-1128 connects to the parallel printer port of the computer and has a ZIF (Zero Insertion Force) socket to hold the PLD to be programmed (see Figure 11). After starting up the programmer's software application, we begin by selecting the part number of the device we wish to program.

In this case, we happen to have a PALCE16V8 from AMD (similar to a GAL) which we would like to use in place of the PAL16R4. As shown in Figure 12, we can indicate this to the programmer by typing most of the part number and then selecting the appropriate device description in the scrolling window.

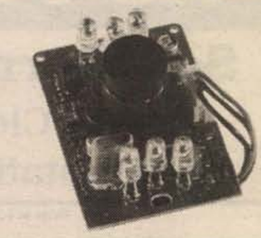
After selecting the device, we next need to load the JEDEC file into the programmer's buffer. This is accomplished as shown in Figure 13. The final step is to execute the Device Program command. This causes the programmer to first erase (since this is a reprogrammable, EEPROM-based device) and then program the PLD. The part is then verified at its guaranteed minimum and maximum voltages. If test vectors are available, it would then go through these tests.

In just a matter of seconds, we have created a customized logic device which now can be placed into a circuit and evaluated. If all goes well, the circuit will perform as expected and the design is complete. If small errors are found, they can sometimes be corrected by simply changing the equations and re-burning the PLD.

Computer Aided Design

As we have seen, the logic compiler can greatly simplify the creation of a JEDEC file for programming PLDs. Computer Aided Design (CAD) programs take this one step further. By entering the desired schematic into our computer, we can let a software program find the best fit into one or more PLDs. Most programs also let you perform timing analysis, device selection, and optimization for least parts count.

For simpler functions like address decoding, the logic equations may be sufficient for direct entry into the PLD programming software. Software also exists for translating PAL device files into equivalent PLD files. Of course, high-end development software will even lay out and route complete circuit boards. **NV**



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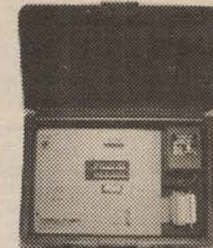

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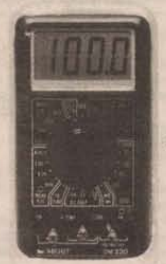

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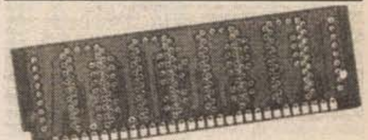

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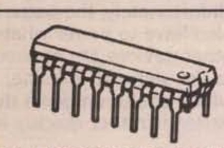

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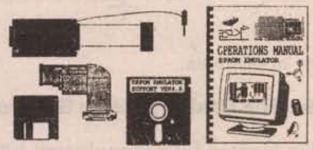

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ELECTRONICS Q & A

With TJ Byers

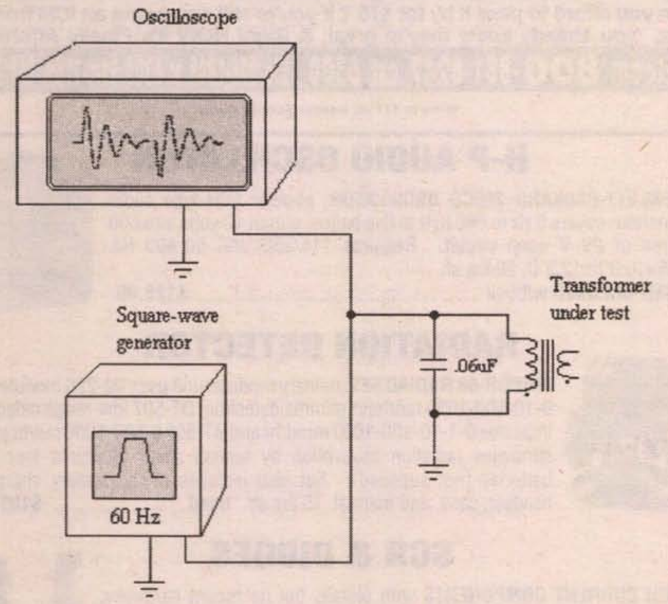
In this column, I answer questions about all aspects of electronics, including computer hardware and software. This column doesn't replace the Tech Forum that you've grown to love and support. Instead, it will supplement it, so feel free to participate as always with your questions and answers. You can reach me on America Online at TJBYERS, on the Internet at TJBERS@aol.com or by snail mail at Nuts & Volts Magazine, 430 Princeland Ct., Corona, CA 91719.

It Has A Familiar Ring

Q. I have an old tube-type TV receiver that I'd like to restore. The problem is it doesn't have any high voltage. I remember fixing these sets many years ago, and I used a ringer generator to test the flyback transformer. However, I don't remember how the ringer tester works or the equipment needed. Can you help?

Gerry Evans
Falls Church, VA

A. Ringing is a cheap and reliable way to test all sorts of transformers and chokes for shorts and open windings. The test is based on the fact that an inductor will oscillate with a parallel capacitor when it's triggered by a pulse. A good transformer will ring with a classic dampened sinewave for several cycles. If the transformer has a shorted winding, the oscillation will last for only a couple cycles or be absent altogether. An oscilloscope is used to monitor the ringing. You can use any convenient fast-rise voltage source for the test pulse, like a sparked battery or a squarewave generator. If your scope has a calibrator, you can probably use it as the pulse source. The test set-up looks like this.



If memory serves me, the resonant capacitor in these TV sets was typically 0.06 uF, but any value between 0.01 uF and 0.1 uF will work for this test. Place the capacitor across the winding with the highest resistance. If the ringing appears marginal, place a shorting wire across each of the secondary windings, one at a time. If the shorting wire doesn't distort the waveform, the winding is defective.

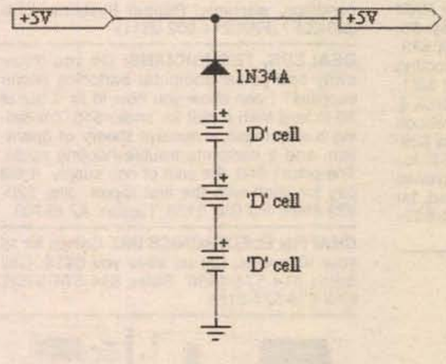
I had a system crash that trashed my Q & A file. If any reader sent me E-Mail between June 10, 1996 and June 22, 1996, and don't see your question here or in the Tech Forum, please E-Mail me again. Sorry for the inconvenience.

It's Always 12:00 At My House

Q. I live in an area of northern Virginia where the electricity is prone to frequent power interrupts ranging from three seconds to five hours in length. This necessitates resetting the VCR, TV, and digital clocks several times a week. What I'd like to do is add a small NiCad battery or a big capacitor to the memory chip of as many of these devices as I can. My plan is to use a simple circuit consisting of a current limiting resistor between the "memory" pin of the devices "brain" chip and my battery. This will prevent overloading the power supply during charging and limit the output from the battery when the power is off. What I need is help locating the "brain" chip or chips and finding their specs.

Charles M. Schwab, Jr.
Lovettsville, VA

A. What you really need is a strongly-worded letter to your local power company, and a copy of the same to your congress person. Having power outages of up to five hours several times a week is not in the public interest, and is downright dangerous (as in spoiled food, etc.). Now, how to solve your "it's always midnight" problem. Most "brain" chips in today's appliances are proprietary. That is, they are made by a silicon foundry to specifications set forth by the vendor. So finding the magic "memory" pin is like looking for a needle in a haystack. What I would do is go back to the power supply and identify the +5-volt source. Look for a large electrolytic capacitor or an LM7805 or similar voltage regulator chip. This is the source most clocks run off. Now, using a diode isolator, connect a battery of three D-size alkaline cells to this terminal (see schematic below).



When the AC power is present, the diode is back biased and the batteries are in a state of limbo. Should the AC power source fail, the battery pack provides about 4.7 volts (with fresh batteries) to your clock chip. Unfortunately, the batteries also have to power whatever other devices are connected to the same +5-volt line, which could run down the batteries rather quickly in some appliances.

Tada: The Grid-Dip Meter Solution

Q. I'm looking for a formula that tells me where to place taps on a coil that is part of a parallel resonant LC circuit in the amateur radio bands (2-30 MHz). Specifically, I have a 2.5-inch coil of #14 wire with six turns per inch. What I need to know is at what turn do I place the tap for 10 meters, 15 meters, and so forth. It would be nice to have a formula that would let me enter these parameters into my programmable hand calculator, then get a tap number. I'd rather not monkey around with alligator clips to search for the taps experimentally (and no roller coils). Perhaps you know exactly where these formulas are; a hands-on set of them, not some complicated integrals. This LC circuit is the main part of a ham antenna tuner I'm building.

Milton S. Ash
Santa Monica, CA

A. An LC circuit consists of two parts, an L (inductance) and a C (capacitance). When the two are in tune, they resonate at a specific frequency. So far you've only provided half of the equation, the L part. For the moment, let's not worry about the C component. First you have to determine the inductance of your single-layer, spaced coil, which can be done using the formula:

$$L = L0 - urRN(5/4 - \ln(p/re) + H)$$

Where L0 equals

$$L0 = 3.14urR2N2/b[1 + (2rn/b)2]-1/2$$

And H is derived from the following table

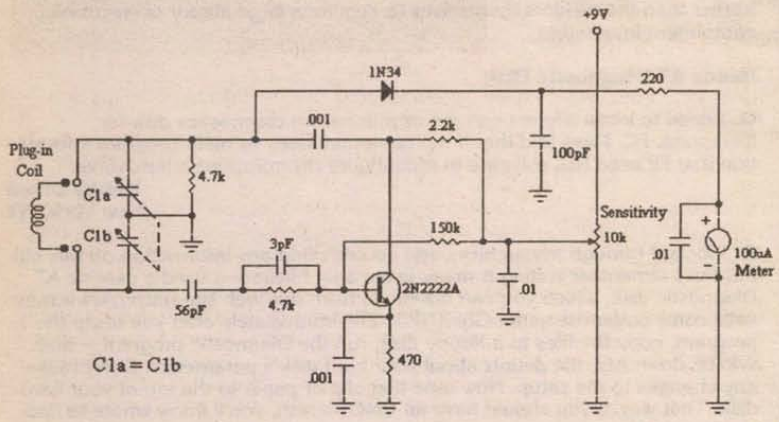
N	1	2	5	10	50	>1000
H	0	0.1137	0.2180	0.2664	0.3182	0.3379

These and many more equations can be found in the *Electronics Designers' Handbook* (McGraw-Hill). Now you have to plug this information into an LC formula, something like

$$f = 1/(LC)-1/2$$

So much for a simple solution. There are just too many variables. What I'd do is use a grid-dip meter to establish the tap points. What's a grid-dip meter, you ask? Originally built around a triode vacuum tube, the grid-dip meter is a variable frequency oscillator that has an external coil, or "wand," for an antenna.

When the frequency of the grid-dip meter matches the resonant frequency of a mutually-coupled tuned circuit, there's a dip in the current flow through the monitoring meter. You can either construct your own grid-dip meter using the circuit shown below, or buy one ($89.95) from Sun Equipment Corp. (**800-870-1955**).



If you build your own grid-dip meter, you'll have to wind your own sense coils and calibrate the instrument using a frequency counter (the grid-dip meter generates a signal that the counter can measure). If you decide to buy a grid-dip meter, it comes with six plug-in coils that are factory calibrated, with a specific ham band at its center. To use a grid-dip meter, set the grid-dip meter to the desired tap frequency, place the sense coil close to your coil, and move the tap point until the meter dips. Yes, I know you didn't want to use alligator clips to find the tap points, but you only have to do it once (make yourself a table of the taps as you locate them).

Amateur Rocketry Question

Q. I have been experimenting with amateur pyrotechnic special effects and model rocketry for a few years now. The problem is that the batteries just don't last very long, and they become too weakened to use just after five ignitions. I've tried various types of wire, including copper wire from desoldering braid and 30 AWG nichrome. They both work, but they drain the battery too quickly to be practical. The only wire I've tried that doesn't kill the cell is a single strand of steel wool. But it's too brittle. So what I need is a company that sells fine steel wire, or a source for electric matches and squibs. Preferably, all of the above.

Michael D. Caigoy
Los Angeles

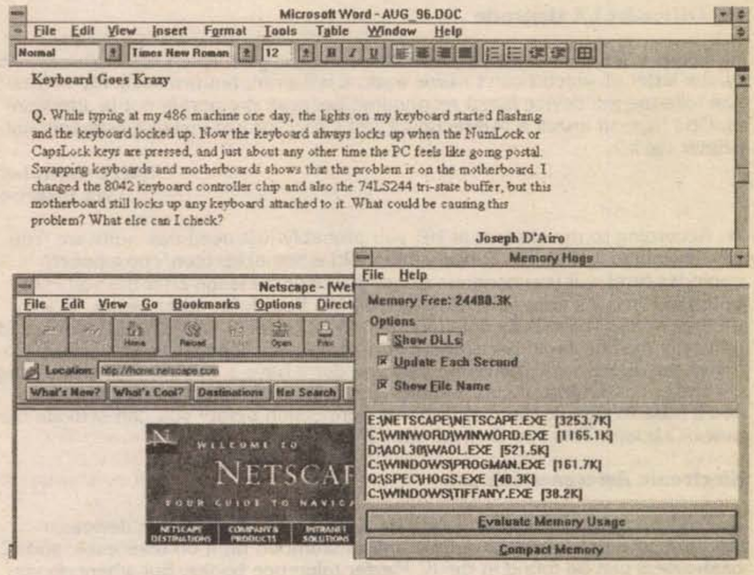
A. Most incendiary devices, like squibs, are controlled by state and federal laws, so it's not something you can order though the mail. And whatever you do, please don't play with electric "matches." There are better, safer ways to launch a rocket. My suggestion is to join a local rocketry club and learn more about the hobby. In your area I'd contact ROC (Rocketry Organization of California) at http://www.advradio.com/~jds/roc.html#top (**909-245-2098**). This Web site also provides links to other model rocket clubs across the US and Canada.

Keyboard Goes Krazy

Q. While typing at my 486 machine one day, the lights on my keyboard started flashing and the keyboard locked up. Now the keyboard always locks up when the NumLock or CapsLock keys are pressed, and just about any other time the PC feels like going postal. Swapping keyboards and motherboards shows that the problem is on the motherboard. I changed the 8042 keyboard controller chip and also the 74LS244 tri-state buffer, but this motherboard still locks up any keyboard attached to it. What could be causing this problem? What else can I check?

Joseph D'Airo
West Islip, NY

A. The keyboard is actually a simple serial communications device. Basically, the keyboard and PC communicate over a pair of clock and data lines. At the end of the two lines is an open-collector transistor that allows either the keyboard or PC to force the line low. When a key is depressed, the keyboard checks the status of the clock line. If the line is low, the keystroke is stored in a buffer located in the keyboard and transmission is deferred until a later time when the PC can accept it. If the keyboard finds the clock line high, it checks to see if the status line is high, too. When both lines are high, the keyboard sends an 11-bit word to the PC, and the PC replays with a "thank you." From what you've said about your very thorough troubleshooting, I suspect that the PC's BIOS is the culprit, because it's the job of the BIOS to decode the key strokes — including the control keys, which seem to be causing the problem. Now the question is how to test my theory without breaking your piggy bank. While the problem may not be in the BIOS chips, it'll cost you about $80.00 to find out (the price of a BIOS replacement). On the other hand, a new 486 motherboard will cost you $135.00. And for $250.00 you can buy a Pentium motherboard with a 90-MHz CPU. Like I've said in past columns, it's often cheaper to buy a new motherboard than it is to upgrade or fix. Before you throw up your hands in disgust, though, there's an outside chance the problem could be in your RAM memory. So, before you buy a new motherboard, you may want to check it out. I've located a nifty Windows memory-checking shareware program called HOGS16.ZIP that shows your RAM usage, what's working, and what's not. You can download it from our Web site at: http://www.nutsvolts.com



Heathkit Still Lives

Q. I just bought a Heathkit Apache Model TX-1, which I plan to use as soon as I get my amateur radio license. (I'm 70 years old, and starting on my second childhood, thank you). Unfortunately, it came without a microphone, and I haven't a clue where to get one. Do you know where I can find one?

John. L. Trolla
Fort Collins, CO

A. The Heathkit Apache uses a high-impedance mike, like the Astatic model D104. This mike is very popular with ham operators and avid CBers, and can be found at flea markets and hamfests (amateur radio swap meets). The Apache is an AM/CW transmitter that can be converted to SSB with the addition of a SB10 adapter, also made by Heathkit. The worst feature of the Apache is its inherent frequency drift that is found in many tube type units of that era. This was not important in the days of AM, but today with SSB the predominant mode, frequency stability is important because a very slight shift in frequency causes a very noticeable change in the sound of the voice. Good luck with your new hobby. I wish to thank Ryan Byrd (rbyrd@InfoAve.Net) for providing the above information on the Apache. He, too, is retired and has a lifetime of experience as an electronics technician that he's willing to share.

All About SIMMs

Q. I have two HP Vectra computers, a 486-50U and a 486-66U, each of which has 8 MB of RAM. I would like to put all the old SIMMs in one computer, and get two new 8 MB SIMMs for the other computer. Do I need expensive, special SIMMs from HP ($479.00), or can I use generic SIMMs that sell for $80.00?

Ray Marion
via Internet

A. You can use generic SIMMs. While we're on the subject, let's talk about the types of SIMMs on the market today. The most asked question is: What is the difference between parity and non-parity SIMMs? When the IBM PC was introduced, back in 1980, memory was very expensive and terribly unreliable. All too often memory errors would occur. IBM solved the problem by adding a parity bit to their memory. Basically, the parity bit is a ninth number that's appended to the 8-bit byte. If the sum of the first 8 bits is even, the parity bit is set to 0; if the sum is odd, the parity bit is 1. If the parity bit didn't agree with the byte, the PC would flash a parity error message on the screen and lock up the PC. What a pain! Thankfully, today's memory is much more reliable, and all but a handful of PC vendors have dropped the parity bit. The two big holdouts are IBM, of course, and some high-end Compaq PCs. Parity SIMMs are usually advertised as 1 x 36 or 4 x 36 memory; non-parity SIMMs are described as 1 x 32 or 4 x 32. You can usually identify the SIMM type by counting the number of chips on the SIMM board. A parity SIMM generally has an odd count of ICs, whereas a non-parity SIMM has an even count of ICs. However, this rule isn't carved in stone, and there are plenty of exceptions. A recent entry into the SIMM fray is the EDO (Extended Data Out) SIMM. According to reports, the EDO SIMM provides anywhere from a 15% to 50% increase in performance. The EDO SIMM is non-parity memory which uses special control signals that lets the PC address new data while processing data still in the RAM, thereby improving throughput. EDO memory sells for the same price as non-parity SIMMs, and can be used in all 72-pin non-parity systems. In fact, EDO memory may be the only kind of non-parity SIMMs you can buy a year from now. However, your motherboard has to be EDO compliant before you realize the performance increase. If not, you'll just get regular performance.

HP OfficeJet LX Upgrade

Q. I have a 486 PC with a HP OfficeJet LX fax/copier which has scan capability, the latter of which I can't make work. It will print, but not scan. My screen just tells me the device is not responding because the port is not bi-directional. Do I have to install a bi-directional LPT1 port, or just install a bi-directional printer cable?

Larry Campbell
via Internet

A. According to my contact at HP, you probably just need new software. You can download it from HP at http://hpcc998.external.hp.com/cposupport/cpoindex.html — If you continue to get the error message after the software upgrade, *then* it's time to invest in a new I/O board. (In other words, let's try the free — and most likely solution — first.) I/O boards cost about $30.00, and normally include serial ports and a combination of floppy/IDE controllers. So follow the directions carefully so that you don't have a conflict with an existing controller or I/O port. If your parallel port is embedded in the motherboard, you'll have to disable the motherboard connection before you can activate the new I/O board. This you do from the CMOS set-up.

Electronic Reference Library

Q. I'm having trouble locating data on a few types of electronic devices. Resistors and capacitors have their values stamped right on their case, and IC parameters can be found in the IC Master reference books. But where do you find manuals with specifications for transformers, transistors, and inductors?

Ken Williams
Orlando, FL

A. Many transistor parameters, like breakdown voltage and case style, can be found in the pages of most semiconductor cross reference guides, such as Radio Shack's *Semiconductor Reference Guide.* Similar reference guides are published by Philips ECG and Thompson Consumer Electronics. The most comprehensive semiconductor guide that I've seen lately is the *NTE Selection Guide.* They cost less than $5.00, and are available from Allied Electronics (**800-433-5700**), or by special order from Radio Shack (**800-843-7422**). Inductor specifications can be found in the J. W. Miller catalog (**310-515-1720**) and you can learn a lot about transformers by reading the pages of a Stancor catalog (**314-865-8799**). In other words, you don't have to go any further than the vendors themselves to acquire a large library of electronic component knowledge.

Needs AT Diagnostic Disk

Q. I need to know where I can get or purchase a diagnostics disk for Computek PC. I was told that if my computer loses its main program information that I'll need this software to reconfigure my computer's hard drive.

Bobby Dixon
New York, NY

A. I looked through my archives and couldn't find any information on this old PC, but I remember testing it many years ago. I believe it used a generic AT Diagnostic disk, which you can download from our Web site (http://www.nutsvolts.com) under the name GSETUP31.ZIP. Immediately after you unzip the program, copy the files to a floppy disk, run the Diagnostic program — and WRITE down ALL the details about your hard disk's parameters. Don't make any changes to the setup. Now tape that slip of paper to the top of your hard disk. That way, if you should have an CMOS crash, you'll know where to find your hard disk.

Wants To Install Two CD-ROMs

Q. I need help installing an Acer 665A-128TB CD-ROM. In my system I have an IDE hard disk and an IDE CD-ROM, each sharing an EIDE controller. The system works well, until I try to add the Acer CD-ROM, then the system goes to sleep. Does anyone know how to wake up this CD-ROM? Are there any commands (I don't see any in the user guide) to resolve timing problems?

Joe Vallely
Audubon, NJ

A. The EIDE (Enhanced IDE) controller is capable of supporting up to four IDE devices. The EIDE controller is divided into two channels: IDE channel A and EIDE channel B. One data cable is required for each IDE channel, and up to two IDE devices may be attached to each data cable (see below), for a total

Continued on page 60

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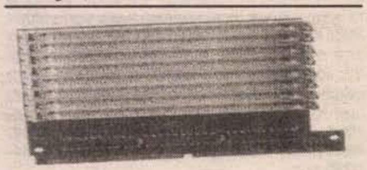

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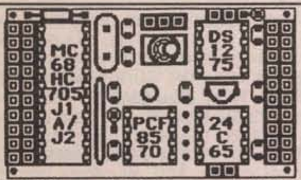

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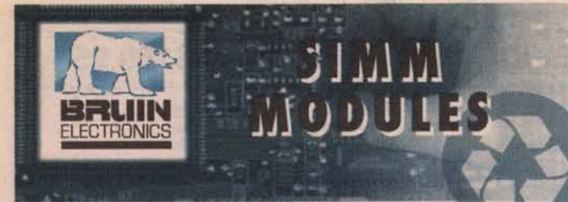

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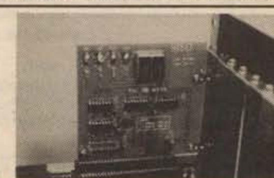

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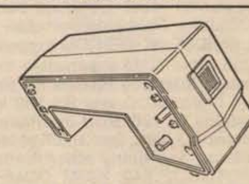

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Stamp Applications:

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

by Scott Edwards

Getting an analog voltage out of the Stamp is no problem at all. Just use the PWM (pulse-width modulation) instruction as shown in the manual, and you're done.

Need Analog Output from the Stamp? Dial it in with a Digital Potentiometer

Using the DS1267 pot as a versatile digital-to-analog converter

There are some drawbacks to PWM, however. The Stamps can't output PWM continuously, so you have to either buffer the output with analog circuitry, or write your program to output PWM as often as possible. PWM is also by definition noisy, since it's made up of a string of pulses. So it may not agree with some loads that require clean input voltages. Depending on the characteristics of your filtering and buffering circuitry, the PWM-generated voltage may not be completely linear in proportion to the input duty-cycle value. Finally, PWM is only readily convertible into an output *voltage*, not a resistance.

What we need is a do-it-all digital-to-analog converter (DAC).

My nominee for the do-it-all DAC title isn't a DAC at all — it's a digital potentiometer called a DS1267. This month, we'll look at how to interface this goody to the BS1 and BS2, and how to use it in a variety of applications.

In BASIC for Beginners, we'll look at two's complement — a method of working with negative numbers using integer math.

Stirring the Pot

A potentiometer, affectionately called a *pot* by techies, is a resistor with a movable contact whose position is controlled by turning a knob or sliding a lever. Moving the wiper changes the resistance between it and the fixed legs of the resistor. The closer the wiper is to a leg, the lower the resistance between them.

A pot's resistance rating is the total resistance between the fixed legs. The total resistance is also equal to the sum of the resistances from the wiper to each of the legs. I guess that's somewhat obvious, but it leads to a another conclusion: a pot is a great voltage divider.

When you place a pair of resistors across an input voltage, the voltage across one of them — call it R1 — is the ratio of that resistance to the total resistance multiplied by the total voltage. In symbols: Vr1 = Vtotal * (R1/(R1+R2)).

You can think of a pot as being two resistors — one above the wiper, and one below. The total of the two resistors is always the same; it's the rated resistance of the pot. When you move the wiper, one resistance goes up and the other goes down, but the total is fixed.

This makes the voltage-divider formula work out neatly, since R1 + R2 never changes. At the bottom of Figure 1, labeled Variable Voltage, suppose the pot shown was rated at 10K (10,000 ohms). If the wiper is set so that there's 2K between it and ground, and +V is 5 volts, what's the output voltage between the wiper and ground?

Vwg = 5V * (2,000/10,000) = 1V

(Vwg is just my shorthand for "the voltage from wiper to ground.")

Yet another way of thinking about the voltage-divider characteristics of a pot is this: The output voltage at the wiper is proportional to the position of the wiper as a portion of its travel. In other words, in a circuit like the one at the bottom of Figure 1, when the pot is set for 50% of its travel, the voltage out is 50% of +V.

This applies only to linear pots; there are also audio pots designed for volume controls whose relationship of resistance to travel is warped to match human hearing.

To summarize: Pots can be wired for variable resistance or variable voltage. Variable voltage is achieved by wiring the pot as a voltage divider. With a linear pot, voltage divider output is proportional to the wiper setting.

A Digital Pot

Pots are so handy that it was inevitable that somebody would make a digital version. Dallas Semiconductor offers the DS1267 dual digital pot, shown in Figure 2. It's available in three resistance ratings: 10K, 50K, and 100K. Typical price in single quantity is $5.00.

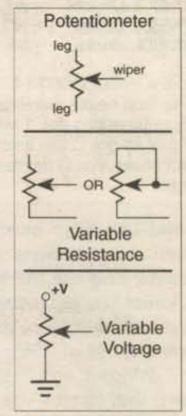
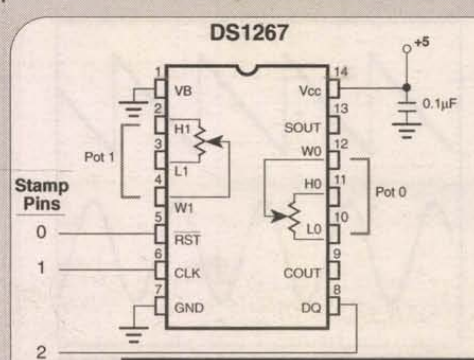


Figure 1 - A pot can be used to adjust resistance or voltage.

The DS1267 is easy to connect to a Stamp via its synchronous-serial interface. This is well-plowed ground by now, since we've featured quite a few serial devices (LTC1298 analog-to-digital converter, MAX7219 LED driver, DS1620 thermometer) that use this kind of interface. To recap, bits are sent one at a time on the DQ (data) line. The CLK (clock) line is pulsed to tell the receiving device when to grab the data bit. Then the next bit is sent the same way until all the bits the receiving device expects have been sent. So many parts use this kind of interface that the BS2 instruction set has it built right in.

So that's how you communicate with the DS1267; what do you say to it? Basically, you tell it two eight-bit settings for the two pots. Those values, 0 to 255, represent the wiper positions relative to the legs of the pots. For example, if you're using a 100K DS1267, and you give pot 0 a setting of 100, the resistance between the wiper and the lower leg of the pot will be (100/255) * 100K = 39.22K.

There's an additional bit in the DS1267 protocol that allows you to combine the two pots into a single, larger one. That bit is called stack select, and it simply determines which pot's wiper will be connected to the Sout pin. The idea is that you connect the low leg of pot 1 to the high leg of pot



Explanation of DS1267 Pins

VB: Substrate bias voltage. Usually grounded, but can be connected to voltages as low as –5.5V for signals that go below ground

H0, H1: High end of pots 0 and 1

L0, L1: Low end of pots 0 and 1

W0, W1: Wiper of pots 0 and 1

RST: Reset pin; high to input new data, low to update pot settings

CLK: Clock to synchronize input of serial data

DQ: Serial data input

COUT: Cascade output; connect to next DS1267 DQ for daisychaining

SOUT: Stack output; common wiper output used when pots are stacked

Figure 2 - DS1267 with hook-up information for demo programs.

Listing 1. DS1267 Demo Program for BS1

```
' Program: DS1267.BAS
' This program controls the DS1267 digital potentiometer chip.
' This chip is very versatile as a digital-to-analog converter.
' It can output a variable voltage, can adjust current (up to
' 1 mA), or it can serve as the variable resistance in a
' resistor-capacitor timing circuit such as a timer or oscillator.

' Hardware interface with the DS1267:

SYMBOL RST      = 0      ' Pin number of reset connection.
SYMBOL CLK      = 1      ' Pin number of clock connection.
SYMBOL DQ_n     = 2      ' Pin number of data (DQ) connection.
SYMBOL DQ       = pin2   ' Pin variable of data connection.

' Variables used by the program:
SYMBOL DSpot0   = b2     ' Variable for setting of pot 0.
SYMBOL DSpot1   = b3     ' Variable for setting of pot 1.
SYMBOL DSpots   = w1     ' Word variable holding both pot values.
SYMBOL DSxfer   = w0     ' Word variable for transferring pot values.
SYMBOL clocks   = b4     ' Index variable for counting clock pulses.

let dirs = %00000111              ' Output pins 0,1,2 to DS1267.
' The loop below increments pot 1 in 10-unit steps from 0 to 255.
' By subtracting pot 1 value from 0 and writing that to pot 0,
' it makes pot 0 the inverse of pot 1. In other words, as pot 1
' increases, pot 0 decreases.
Begin:
for DSpot1 = 0 to 255 step 10         ' Pot 1 increasing: 0 to 255.
  let DSPot0 = 0 - DSPot1             ' Pot 0 decreasing.
  let DSxfer = DSpots                 ' Store data in transfer variable.
  gosub outPot                        ' Send to the pots.
next                                  ' Next value for pots.
goto Begin                            ' Repeat endlessly.

'=================DS1267 SUBROUTINE==================
' This code shifts data out to the DS1267. Because the shift
' process causes the data to be lost, we use a copy of the
' data to perform the transfer (DSxfer). The DS1267 expects
' a total of 17 bits: first the stack-select bit, which
' selects wiper 0 or wiper 1 for connection to Sout; then
' 16 bits representing the 8-bit values of pots 1 and 0,
' most-significant bit (msb) first.
outPot:
high RST                   ' Take RST high to start transfer.
low DQ_n                   ' Set stack-wiper to 0.
pulsout CLK,10                 ' Pulse the clock line.
for clocks = 0 to 15           ' Now send 16 data bits.
  let DQ = bit15               ' Put msb on data line.
  pulsout CLK,1                   ' Pulse the clock
  let DSxfer = DSxfer * 2      ' Shift 1 bit to the left.
next                           ' Repeat for all 16 bits.
low RST                        ' Take RST low to finish transfer.
return                         ' Return to program.
```

0, and use Sout as the wiper connection for the combined pot. Send both pots identical eight-bit settings, and use the stack select bit as a 9th data bit. Voila! You get a single pot with double the rated resistance and twice the resolution (512 resistance steps instead of 256).

Listings 1 and 2 are sample BS1 and BS2 programs that control the DS1267. They don't use the stacking feature, so they don't bother setting the stack-select bit to a particular state; they just send one extra clock pulse to satisfy the DS1267's 17-bit protocol.

To demonstrate the DS1267, I wired its pots as voltage dividers (low legs L1 and L0 to ground; high legs H1 and H0 to +5 volts). I ran the programs in Listings 1 and 2 and watched the wiper outputs on a digital oscilloscope. As Figure 3 shows, you can plainly see the voltage climbing on one pot's output and falling on the other as their values are incremented and decremented, respectively.

If you're using a BS2 and you have an oscilloscope handy, you can use this set-up to get a graphical look at the BS2's integer sine function. In Listing 2, just replace the line beginning with DSpot0 = ... with the following:

```
DSPot0 = SIN DSPot1 + 127
```

Adding 127 to the sine value is necessary because the BS2 expresses sines as two's complement values with a range of ±127. (Two's complement is a way of representing negative values in binary. When you add the two's complement of a number to another number, it has the same effect as subtracting that number from the other. See this month's BASIC for Beginners.) Figure 4 shows the sine output.

You can use the DS1267's digital pots in pretty much any circuit that employs a mechanical pot. There are just a few limitations to bear in mind:

• All pots have some wiper resistance — additional resistance that looks like a resistor in series with the wiper. In mechanical pots, this resistance is generally too low to worry about. In the DS1267, it can be as high as 1,000 ohms. This won't affect a voltage-divider circuit, provided that you keep current draw through the pot to a minimum. But in a variable resistance application, your minimum pot setting may be as high as 1K.

• All pots have some limit as to the amount of current they can handle safely. In the case of the DS1267, the limit is pretty low; 1 mA. Make sure that your circuit never draws more than this amount of current through the DS1267, or you risk damaging it.

• If the signal or voltage you plan to control with the DS1267 can be negative with respect to ground, you must connect the VB (bias) pin to a supply that's more negative; up to -7 volts.

I could probably devote a half-dozen columns to potential applications for the DS1267, because anywhere there's a pot, there could be Stamp/computer control. That's a lot of territory. The audio and electronic music possibilities alone are mind-boggling. Not to mention electronic control and calibration of analog instruments, interfacing to conventional motor controls, management of old-fashioned 555 timer circuits, creation of automated test equipment, control of linear power supplies, etc.

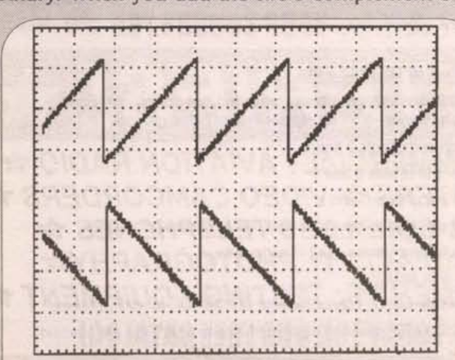


Figure 3 - Oscilloscope trace of Listings 1 and 2.

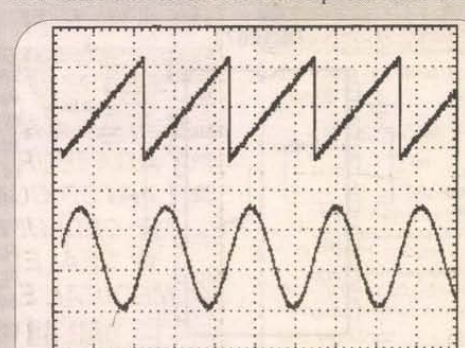


Figure 4 - Listing 2 modified for sine output.

BASIC for Beginners

The Stamps' 16-bit integers have a range of possible values of 0 to 65,535. They don't support larger values, decimal points, or negative numbers. That's what it says in the manual, and that's what I always say here.

But it's not entirely true. Any computer that can handle positive integers of a particular size can also work with negative numbers.

Let's start by defining a negative number. They take about 10 pages to do this in a math textbook, but I'm going to use a short and convenient definition: A negative number is what you get when you subtract the corresponding positive number from zero. For instance, -10 is the result of subtracting +10 from zero.

That definition is almost meaningless in human terms, but really profound when you're working with computers. Try this: On a BS1, run the following lines of code:

```
w1 = 0 - 10
debug "-10 is equal to: ",#w1,cr
w1 = 50 + w1
debug "50 + (-10) = ", #w1
```

The first debug instruction shows the number 65526, and the second one — the result of adding 50 and 65526 — shows 40. So subtracting 10 from 0 gives us 65526, but adding 65526 to another number has the same effect as subtracting 10. Hey, adding 65526 works the same as -10!

Why does this work? Remember that the Stamp uses a limited number of bits — in this case 16 — to represent numbers. When you count up and exceed the maximum number that the available bits can hold, the value wraps around to 0 and starts counting over. For example: 65533, 65534, 65535, 0, 1, 2 ... The same wraparound occurs when you count down. 2, 1, 0, 65535, 65534, 65533 ...

You can regard addition and subtraction as just special cases of counting up and down. To subtract 10, just count down 10 times. Or, since the numbers wrap around, you could count up 65,526 times to subtract 10. That's the basis for two's complement negative numbers.

These numbers are called two's complement because of the other way of calculating them: Take a number and invert the individual bits; that is, change all 1s to 0s and 0s to 1s. That's called a complement, or a one's complement. Add one to the one's complement, and you have a two's complement. The result is the same as subtracting the same number from 0.

There are a couple of peculiarities in the two's complement system. The first is that a two's complement negative number is only sure to act like a proper negative number within its original bit size. For example, the 16-bit version of -10 is 65526, but the 8-bit version is 246, and the 32-bit version is 4,294,967,286. The conversion is pretty easy; going from a larger bit size to a smaller one just requires lopping off the extra bits. This happens automatically when you put a 16-bit value into an 8-bit variable in PBASIC. Naturally, things fall apart if the 16-bit negative number is larger than an 8-bit variable can hold. The ranges of possible values are:

Four bits (nibbles): ±7
Eight bits (bytes): ±127
Sixteen bits (words): ±32767

To convert in the other direction — to move an 8-bit negative value into a 16-bit variable — you must pad the resulting 16-bit number with 1s. To do this properly, you must first determine whether the number is negative. Technically, an eight-bit two's complement number is negative if its most-significant bit is 1. In regular unsigned math, that bit is 1 when a number is greater than or equal to 128. If the 8-bit number is negative, then its 16-bit equivalent must have all of the upper 8 bits set to 1s. Here's the code to convert an 8-bit, two's complement number into a 16-bit variable (PBASIC 1):

```
w1 = b2
if b2 <= 128 then skip
w1 = b2 | $FF00
skip:          ' Program continues.
```

The other peculiarity of two's complement is that there's always one outlaw value that is its own two's complement. This value has a 1 in the leftmost bit, and 0s in all the lower bits; for example, the 8-bit value 128 (%10000000 binary). What makes this value an outlaw is this: Subtract 128 from 0 in an 8-bit integer. What do you get? Yep, 128. Obviously, we can't have a system in which +128 and -128 are represented by the same number. So programs that use two's complement should be written to regard these values as errors:

Four bits (nibbles): 4
Eight bits (bytes): 128
Sixteen bits (words): 32768

Although two's complement gives you a way to represent negative numbers in PBASIC, remember that you have to adjust your thinking. Comparison and math operations assume positive integers, so two's complement values won't always return the results you expect. And the debug/serial output instructions of the BS1 don't automatically handle the minus sign; you have to do that yourself. (The BS2 has functions for displaying numbers in signed decimal and hex formats.) **NV**

Sources

Send questions, suggestions, or requests for future Stamp Applications to:

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The DS1267 is available from **Newark Electronics**, phone **312-907-5436**. You may also contact Dallas Semiconductor directly, phone **214-450-0448**; fax **214-450-0470**.

For more information on the BASIC Stamp, contact:

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Listing 2. DS1267 Demo Program for BS2

```
' Program: DS1267.BS2
' This program controls the DS1267 digital potentiometer chip.
' This chip is very versatile as a digital-to-analog converter.
' It can output a variable voltage, can adjust current (up to
' 1 mA), or it can serve as the variable resistance in a
' resistor-capacitor timing circuit such as a timer or oscillator.

' Hardware interface with the DS1267:

RST     con 0          ' Pin number of reset connection.
CLK     con 1          ' Pin number of clock connection.
DQ_n    con 2          ' Pin number of data (DQ) connection.

' Variables used by the program:
DSpots  var   word             ' Word variable holding pot values.
DSpot0  var   DSPots.lowbyte   ' Variable for setting of pot 0.
DSpot1  var   DSPots.highbyte  ' Variable for setting of pot 1.

DIRA = %0111                   ' Output pins 0,1,2 to DS1267.

' The loop below increments pot 1 in 10-unit steps from 0 to 255.
' By subtracting pot 1 value from 0 and writing that to pot 0,
' it makes pot 0 the inverse of pot 1. In other words, as pot 1
' increases, pot 0 decreases.
Begin:
for DSpot1 = 0 to 255 step 10   ' Pot 1 increasing: 0 to 255.
  DSPot0 = 0 - DSPot1           ' Pot 0 decreasing.
  gosub outPot
next                            ' Next value for pots.
goto Begin                      ' Repeat endlessly.

'==================DS1267 SUBROUTINE==================
' This code shifts data out to the DS1267. Since it uses
' the Shiftout instruction, which does not alter the variable
' being shifted, we don't have to make a copy of the pot data.
outPot:
  high RST                      ' Take RST high to start transfer.
  pulsout CLK,1                 ' Pulse for stack-select bit (don't care).
  Shiftout DQ_n,CLK,msbfirst,[DSpots\16]   ' Shift out pot values.
  low RST                       ' Take RST high to end transfer.
return
```

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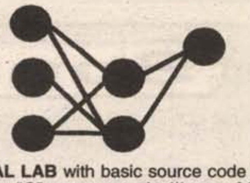

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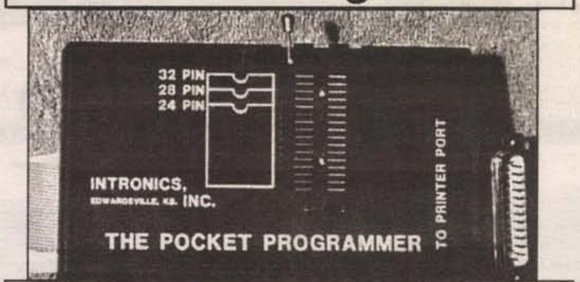

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QUESTIONS

I have an Apple Laser 128 E-II. The computer will not activate the printer. The printer will go through the test pattern. It was working okay. I didn't use it for several months, turned it on, and the printer wouldn't work. My son said it could be the cord from the computer to the printer. Has anyone any suggestions on how to fix this problem?
8961 **Pat Pritchard**
Bell, CA

I would like to use a small Walkman-type AM/FM tape player on a GoldWing motorcycle. The unit has an input/external source jack for a three-volt source. I would like to use as few components as possible. Also, how can I improve AM/FM reception?

I am using a Sony 20-watt car amp to power the 4" speakers mounted in fairing. Any ideas on this subject would probably help many others who would like to add sound to their older GoldWings.
8962 **G.R. Gallier**
Bozeman, MT

How do I make a universal dongle for software so that I can use software which is protected by a dongle circuit plug?
8963 **R. Larsen**
Glostrup, Denmark

Recently, I purchased a new 25-channel phone that operates on the 46-49 MHz band. What are the exact frequencies of these new channels?
8964 **John Witkowski**
Pearle Naples, FL

I am trying to develop a circuit arrangement to control a 5 KW, pure resistive load, at 115 or 240 VAC. The load should operate proportionally to the system demands, let's say from 20% of resistance capability up to 100% (5 KW). I thought of using a thyristor to control the load, however, how can I trigger the thyristor's gate (SCR, TRIAC) by conditioning a bridge's output? The sensor will provide a signal (mV) that once conditioned would trigger the gate at different points of the cycle. In short, change the conduction angle of the thyristor from ideally 0° to about 180°, to give as close as possible to the 100% of full power to load at maximum setting.
8965 **Mathew**
Fresno, CA

My friend in a small foreign country needs an aircraft transceiver. How can I convert a two-meter Gonset transceiver and move it down to the 120 MHz area? It now operates on 144 MHz. Besides new crystals, how do I move the oscillator in the receiver and transmitter down in frequency?
8966 **Jack Mento**

I own an ICOM R7100 receiver. It works great; however, the squelch circuit has poor range and is difficult to set. It also tends to squelch when a signal is being modulated. Are there any mods that can be done to improve it? I'm also looking for mods to improve the 120 VAC to 13.8 VDC power supply. It runs very hot and recently failed. I have the service manual.
8967 **Allen Goodcase**
Brookfield, IL

My Radio Shack model HTX-100 10-meter SSB/CW transceiver operates normally except for a blank frequency display.

At turn-on, the display is okay for about two seconds, then disppears.

Any hints?
8968 **G. Frank Humiston**
Santee, CA

I would like to modify my Quadram Micro-Fazer (hardware print spooler) to use leftover standard PC clone 256K SIMMs (or larger).

I also need Micro-Fazer schematics and source code.
8969 **G. Frank Humiston**
Santee, CA

How can I reduce both transmit and receive on my two-meter to access company repeater 100 MHz lower? How can I reverse scan (400 to 1) on my Pro 2004, so I can quickly find active channels? Search goes both ways, but scan only goes up, i.e., 1-400.
89610 **G. Maxwell**
British Columbia, Canada

I have an old computer and I'm hoping someone can help me find parts and accessories for it. It's featured in the 1988 Radio Shack catalog no. 419 on page 162. It's a Tandy 128K Extended BASIC Color Computer 3. Its specifications are:

Microprocessor: 68B09E 8/16 bit. Clock speed: 0.894 MHz or 1.788 MHz. Keyboard: 57 keys, including control, alternate, F1, and F2. Video display: 16 lines or 32 characters (uppercase only) to 24 lines or 80 characters (upper and lowercase). Color graphics capabilities range from 64 x 32 (eight colors) to 640 x 192 (four colors) with six intermediate display formats. High-resolution graphics are available through machine language, Extended BASIC or program paks. Memory: 128 K RAM internally expandable to 512 K, 21 commands in enhanced Extended BASIC. Input/Output: 1500 baud cassette recorder. Two joystick ports, RS-232 (4 pin only) and standard TV (300 ohms).

I need to locate software of all types including games, word processor, communications, etc. I'd also like to have a color printer, and if possible, a CD-ROM. I have a CCR-81 computer cassette recorder. If I could get some data cassettes, that would be nice. If I could also get a 3-1/2" floppy disk drive, that too would be nice.

If someone out there could help, I could use it; as I said, this is an old computer, but it's the only one I can afford right now and I don't want to give it up.
89611 **George Myers**
Benton, KY

I'd like a custom anti-theft for my '90 5.0L Mustang. Perhaps based on solenoid activation of the inertia switch or electronic switching of fuel pump on pump relay. I'd prefer remote control, sequenced with manual overide. No keys and no computer function splices. Voice recognition? Polarity inversion (with protection), DTMF, switched resistance, or remote fuse(s), pressure switches, odd power connections, e.g., phone plug by BNC.
89612 **G. Maxwell**
British Columbia, Canada

I have a Dauphin model 1050, 386 laptop computer that has an internal modem. Does anyone know how to turn this modem on? There is not a setting in the CMOS set-up, so it must be a program or a key sequence.
89613 **Mike Young**
Newville, AL

The antenna of the Ricochet wireless modem uses a very unusual connector. To mount the antenna outside of a metal building, I would like to make a short extension coax cable. Any idea where these keyed coax connectors could be found? I've looked in Dovtek ...
89614 **Anonymous**

ANSWERS

ANSWER TO #7966 - JULY 1996

Let's being by saying that the reason most home power installations are done at 12 or 24 volts is the high cost of recharging. To run 10 batteries in series would give 130+ volts, but the associated charging costs would be immense. Imagine 150 volts of solar panels, or even a windmill that puts out 150 to 200 volts in an average wind at several amperes, not to mention the booster autotransformer needed for your gasoline generator if it is not equipped with a 220 volt output. Chargers for these voltages are easy to come by and relatively inexpensive; the K & W unit that charges a 130 volt stack at (max) 20 amperes is $750.00 without the BL-20 line booster.

The dangers involved would also be considerable. 130+ volts DC can deliver a lethal shock in just a few milliseconds; 50 amp-hour deep-cycle batteries at 130 volts (total stack) would store over 7 KW of energy, almost 15 KW if you elect to use 100 amp-hour Trojan 5SH(P) batteries! And unlike the typical series-parallel stack you now use, a string of 10 batteries fall prey to

ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of $25.00 will be paid within four weeks of publication if your answer is printed.
- Only one answer per question will be printed.
- If you do not want your name, address, or phone number available to the reader please so indicate or it will be assumed that you have no objection.
- In the event that more than one person submits the same solution, the choice will be made at the discretion of the publisher.
- 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.

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.

single-cell failures that can reverse a cell and destroy the unit battery.

On the plus side, 130 volts could be used to run almost any universal motor or appliance in your home, including lights. To convert to 60 Hz AC (modified sine) could be done in one of two ways: 1) Remove the DC to DC section of your Damark inverter and feed the (both sides fused) 130 volts directly into the 60 Hz inverter; or 2: Build a simple push-pull step-ramp controller with, say, a BASIC Stamp II-IC and feed your inexpensive MOSFETs into a 220 VAC to 220 VAC center-tapped power transformer. The output would approach a modified sine if you keep your steps on the ramps at a high enough number; the BS2-IC has the processing power to make it happen.

Commercial potential? Yes, but it is very expensive, not to mention the safety hazards we spoke about earlier. I'm afraid that you will have a one-of-a-kind system if you elect to spend the money.

Hank Hamarman
Perkiomenville, PA
n3nid@voicenet.com

ANSWER TO #7961 - JULY 1996

If you look at your Motorola flip phone from the back of the unit with the accessory connector at the bottom, the eight pins from left to right (the leftmost pin being pin #1, and the rightmost pin, closest to the three battery pins, being pin #8) are for the following:

PIN #1 – GROUND for external power
PIN #2 – +7.5 volts external power

PIN #3 –
PIN #4 – Pins 3-5 are for Motorola programming
PIN #5 –

PIN #6 – AUDIO GROUND
PIN #7 – SPEAKER audio out
PIN #8 – MIC audio in

None of these pins have any external antenna or RF output, so you won't be able to do what you originally planned, but you could make a "hands-free" speaker-phone unit and get or make a bracket to hold the flip phone up to the inside of a window for better range. An external power, hands-free unit specifically for Motorola flip phones is made by at least two different companies and should be available from one of your nearby cellular stores, if you don't want to make it yourself.

Paul Patch
Wheeling, IL

ANSWER TO #5966 - MAY 1996

The inductance of a ballast can be estimated by considering the voltage and current which are driving the fluorescent lamp. Consider a modest-size ballast which drives a 40 watt lamp operating from a 120 VAC line. 40 watts/120 volts equals 0.3 amps. 120 volts/0.3 amps equals 400 ohms. Therefore, the ballast must present about 400 ohms of reactance at 60 Hz. Reactance equals 2(pi)fL. Therefore, L must be about one henry, which is far below your desired value of 30-700 henries. Many ballasts would need to be connected in series, and the current capacity would be limited to less than an amp. Ballasts for low-wattage lamps would be expected to have higher inductance and lower current capacity. The opposite is true for ballasts driving higher wattage lamps.

Anonymous

ANSWER TO #6964 - JUNE 1996

Like Gerry Evans, I serviced TV several years ago and used an oscilloscope to check flyback transformers, yokes, etc. Only a small modification to the scope is necessary; that is making a connection in the scope to the output of the sweep oscillator through a .001 capacitor and adding a "sweep output" terminal on the front panel. Some scopes already have this feature. The old, old Tecktronics model 511A that I have has the sweep output.

When the sweep output is connected to a good flyback or yoke and fed into the vertical input, the scope shows a sinewave with a gradual decay. A coil having only one or two shorted turns will usually display only part of the first cycle and then straight line. I have used this same procedure to identify shorted field coils in motors used in drills, saws, etc.

By selecting the proper sweep time on the scope and comparing tests of known good and defective transformers, the results should be quite accurate. In some cases, it is better to check the flyback or yoke out of the circuit.

Raymond Shetrone
Ft. Myers, FL

ANSWER TO #7965 - JULY 1996

The item you have purchased is a Motorola Series II cellular transceiver. It has a maximum output power rating of three watts and it will operate on all 832 channels available in the AMPS system used in North America. From the serial number, you can determine that this unit was manufactured in Dec. '89 and it had a three-year warranty. The first "socket" you describe is used to connect power, ground, and handset control via a combination power/data cable. The other "socket" is a Mini-UHF female antenna connector.

Larry Block
Scarsdale, NY

ANSWER TO #7962 - JULY 1996

The power supply required for the Laser 128 computer is +17 VDC. The power supply provides raw DC with the rest of the required voltages (+5, +12, -12) developed within the computer itself.

The power adapter pinout is as follows:

1,7 – N/C
2,3 – -17 VDC
5,6 – +17 VDC @ 1.8 A
4 – Shield Ground

Regarding an LCD screen, good luck. Years ago, I attempted to locate a screen, and the closest I ever came was Sun Remarketing. They occasionally got an LCD unit that could be used, but it was very expensive and in really short supply. Since the video output is an NTSC signal, you may consider something in the line of an overhead transparency unit. It should work, but it would still be expensive. I have the *Laser 128 Technical Reference*

Continued on page 113

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AMERICAN EXPRESS

FLUKE 7220A-opt.111 1.3 GHz Communications Counter, TCXO option $650.00
HP 5305B/5300B-001 1.3 GHz Counter Package w/TCXO ref., high res. audio $450.00
HP 5340A-001,011 18 GHz Frequency Counter, OCXO reference, HPIB $1,900.00
HP 5340A-005,011 23 GHz Frequency Counter, HPIB $2,000.00
HP 5342A-001,011 18 GHz Frequency Counter, OCXO, HPIB $2,750.00
HP 5342A-003,011 18 GHz Freq. Counter, +22 dBm,-20 dBm dynamic range,HPIB $2,750.00
HP 5342A-01,04,05,11 24 GHz Frequency Counter, OCXO, DAC, and HPIB $3,900.00
HP 5382A 225 MHz Frequency Counter $200.00

STANDARDS

HP 105A Quartz Oscillator, 0.1/ 1.0/ 5.0 MHz $750.00
HP 5087A-031 Distribution Amp., 0.1/1.0/5.0 MHz x 4 channels each $1,250.00

AUDIO & BASEBAND

SPECTRUM ANALYZERS

HP 8556A LF Section, 20 Hz-300 kHz $500.00

DISTORTION ANALYZERS

HP 334A Distortion Analyzer, 5 Hz-600 kHz, -60 dB, auto nulling $550.00
HP 339A Distortion Analyzer, built-in low distortion osc. $2,400.00
TEK DA4084 Programmable Distortion Analyzer, 0.0025% THD, w/frame $1,500.00

RMS VOLTMETERS

FLUKE 8920A True RMS Voltmeter, 180 uV-700V, 10 Hz-20 MHz $700.00
FLUKE 8921A True RMS Voltmeter, 180 uV-700V, 2 Hz-2 MHz $700.00
HP 3400A RMS Voltmeter, 10 Hz-10 MHz $250.00

OSCILLATORS

FLUKE 6011A Synthesized Generator, 10 Hz-11 MHz, 10 Hz res. $1,200.00
HP 204D Oscillator, 5 Hz-1.2 MHz, 5VRMS, 80 dB step attenuator $200.00
HP 209A Sine/Square Wave Generator, 4 Hz-2 MHz, 5VRMS max. $225.00
HP 652A Test Oscillator, 10 Hz-10 MHz $300.00
ROCKLAND 5100 Synthesizer, 1 mHz-1.999999999 MHz $350.00
TEK 067-0938-00 Calibration Fixture, for SG505 Oscillator $500.00
TEK SG502 Sine/Square Osc., 5 Hz-500 kHz, 70 dB step atten.,TM500 .... $350.00
TEK SG505-opt.01 Low Distortion Oscillator, 10 Hz-100 kHz, intermod.opt. $1,000.00

MISCELLANEOUS

HP 3575A-001 Phase-Gain Meter, 1 Hz-13 MHz, dual display $900.00
HP 4437A Step Attenuator, 0-119.9 dB, DC-1 MHz, 600 ohms unbal. $200.00
KROHN-HITE 3103 High/Low Pass Filter, 10 Hz-3 MHz, 24 dB/octave $500.00
KROHN-HITE 3202 / 3202R Dual High-Pass/Low-Pass Filter, 20 Hz-2 MHz, 24 dB/oct $600.00
KROHN-HITE 3342 Dual HP/LP Filter, 0.001 Hz-99.9 kHz, 48 dB/octave $1,100.00
KROHN-HITE 3750 LP/HP/BP/BR Filter, 0.02 Hz-20 kHz, 6/12/18/24 dB/oct. $700.00
ROCKLAND 852 Dual Highpass/Lowpass Filter, 0.1 Hz-111 kHz $1,000.00
TEK AM502 Differential Amplifier, 0.1 Hz-1 MHz, TM500 series $575.00

RF & MICROWAVE

SPECTRUM ANALYZERS

HP 11517A/18A/19A/20A Mixer, 12.4-40 GHz, w/adapters, for 8555A, 8565A, etc. $675.00
HP 11970A WR28 Harmonic Mixer, 26.5-40 GHz $1,100.00
HP 11970Q WR22 Harmonic Mixer, 33-50 GHz $1,400.00
HP 11970U WR19 Harmonic Mixer, 40-60 GHz $1,400.00
HP 11971A WR28 Harmonic Mixer, 26.5-40.0 GHz, for 8569B $1,100.00
HP 11971K WR42 Harmonic Mixer, 18.0-26.5 GHz, for 8569B $1,100.00
HP 5371A Modulation Domain Analyzer, 125 mHz-500 MHz $4,000.00
HP 8406A Comb Generator, 1/10/100 MHz increments, to 5 GHz $450.00
HP 8444A Tracking Generator, 0.1-1300 MHz, for 8554B $800.00
HP 8444A-059 Tracking Generator, 0.5-1500 MHz, for 8554,8568,etc. $1,500.00
HP 8445B Preselector, 1.8-18.0 GHz, for HP 8555A $800.00
HP 8552B IF Section $750.00
HP 8553B RF Section, 1 kHz-110 MHz $500.00
HP 8554B RF Section, 0.1-1250 MHz $800.00
HP 8554B/8552B/141T Spectrum Analyzer, 100 kHz-1250 MHz, 100 Hz resolution $2,000.00
HP 8555A RF Section, 0.01-18 GHz $950.00
HP 8555A/8552B/141T Spectrum Analyzer System, 10 MHz-18 GHz, 100 Hz res. $2,250.00
HP 8555A/8552B/8445/141 As above, w/1.8-18 GHz Preselector, opt.003 freq.display $3,000.00
HP 8558B/181TR Spectrum Analyzer, 0.1-1500 MHz, 1 kHz res., w/display $2,250.00
HP 8559A/853A Spectrum Analyzer, 10 MHz-21 GHz, 1 kHz res., w/display $5,500.00
TEK 492-opt.1,2,3 Spectrum Analyzer, 50 kHz-21 GHz, 100 Hz min.res.bw. $8,000.00
TEK 496P Spectrum Analyzer, 10 kHz-1.8 GHz, 30 Hz res., GPIB $5,500.00
TEK 7L13/7613 Spectrum Analyzer, 1 kHz-1.8 GHz, 30 Hz min.res.,w/frame $2,250.00
TEK TR502 Tracking Generator, 0.1-1800 MHz, for 7L12/13/14 .... $1,250.00
TEK TR503 Tracking Generator, 0.1-1800 MHz, for 492/4/5/6 .... $1,375.00

NETWORK ANALYZERS

HP 11590A Bias Network, 1.0-12.4 GHz, N(f/f) $375.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7 .... $450.00
HP 11665B Modulator, 0.15-18.0 GHz, for use with 8755/6/7 .... $375.00
HP 11666A Reflectometer Bridge, 0.04-18 GHz, for 8755/8756 .... $1,200.00
HP 8407A/8412A/8601A Network Analyzer, 100 kHz-110 MHz, with sweep generator $1,250.00
HP 85027E Directional Bridge, 10 MHz-26.5 GHz, for 8757 series $2,000.00
HP 85050D APC7 Calibration Kit, for 8510 series $1,100.00
HP 8505A-005/8503A Network An., 0.5-1300 MHz, w/S-Parameter & phase lock $5,000.00
HP 8755C/(3)11664A/182T Scalar Network An. w/3 detectors, 10 MHz-18 GHz & frame $1,750.00
HP 8756A/(3)11664A Scalar Network Analyzer, w/(3) detectors, 0.01-18 GHz $3,750.00
NARDA 7000A/7202/7206 Microwave Multimeter System: scalar analysis 0.1-18 GHz $1,950.00
WILTRON 640/G50/E(2)/7B50(2) Network An., w/1-1500 MHz source, (2) log amp, (2) det. $1,675.00

SIGNAL GENERATORS

FLUKE 6060A/AN Synthesized Signal Gen., 10 kHz-520 MHz, 10 Hz res,GPIB $2,000.00
GIGATRONICS 600/10-18, opt.06 Synthesized Source, 10-18 GHz, 1 MHz res., OCXO, GPIB $3,000.00
GIGATRONICS 875/50 Levelled Multiplier, x4, 50.0-75.0 GHz output, -3 dBm $3,500.00
GIGATRONICS 875/86 Levelled Multiplier, 26.5-40.0 & 50.0-75.0 GHz outputs $7,000.00
GIGATRONICS 910/12-18,opt6,14, 16 Synthesized Source/Sweeper, 12-18 GHz, 1 Hz res., OCXO $3,500.00
HP 85100V Frequency Mult., 10-15 GHz in / 50-75 GHz out >0 dBm $4,250.00
HP 8616A Signal Generator, 1.8-4.5 GHz $450.00
HP 8640B-001,002,003 Signal Gen., 0.5-1024 MHz, AM, FM, var. audio osc. $2,750.00
HP 8654A Signal Generator, 10-520 MHz, calibrated AM & uncal. FM $625.00
HP 8656A Signal Generator, 0.1-990 MHz, AM, FM, HPIB $2,900.00
WAVETEK 907 Signal Generator, 7.0-11.0 GHz, 0 dBm levelled $1,000.00

SWEEP GENERATORS

HP 8350A/86290B-H08 Programmable Sweep System, 2.0-22.0 GHz, +4 dBm lvl'd $5,500.00
HP 8600A Digital Marker, for HP 8601A $400.00
HP 8601A Generator/Sweeper, 0.1-110 MHz, +20 dBm levelled $500.00
HP 8620C Sweep Oscillator Frame $550.00
HP 8620C-011 Sweep Oscillator Frame, HPIB programmable $675.00
HP 86220A RF Plug-in, 10-1300 MHz, +10 dBm levelled $800.00
HP 86222B-002 RF Plug-In, 10-2400 MHz, crystal markers, 0-70 dB atten $1,750.00
HP 86230B RF Plug-in, 1.8-4.2 GHz, +10 dBm unlevelled $675.00
HP 86240A RF Plug-in, 2.0-8.4 GHz, +16 dBm levelled $1,000.00
HP 86240A-002 RF Plug-in, 2.0-8.4 GHz, +14 dBm lvld., 70 dB step att $1,200.00
HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled $500.00
HP 86242D-004,008 RF Plug-In, 5.9-9.0 GHz, +10 dBm levelled $500.00
HP 86245A RF Plug-in, 5.9-12.4 GHz, +16 dBm levelled $1,100.00
HP 86260A RF Plug-in, 12.0-18.0 GHz, +10 dBm unlevelled $800.00
HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, +10 dBm unlevelled $800.00
HP 86290A RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled $1,750.00
HP 86290B RF Plug-in, 2.0-18.6 GHz, +10 dBm levelled $2,250.00
HP 86290C RF Plug-in, 2.0-18.6 GHz, +13 dBm levelled $2,500.00
WAVETEK 962 Sweep Generator, 1.0-4.0 GHz, markers, +12 dBm unlvld. $2,000.00

POWER METERS

ANRITSU MP-81B WR10 Power Sensor, 75-110 GHz, for ML83A or ML4803A $1,875.00
ANRITSU MP-82B WR8 (Pin Flange) 90-140 GHz Power Sensor $2,500.00
BOONTON 4200-01B/-4G Power Meter w/sensor,1 MHz-26.5 GHz,-60 to +10 dBm,GPIB $1,500.00
BOONTON 42B/41-4E Analog Power Meter, with 1 MHz-18 GHz sensor $500.00
BOONTON 42B/42A-S3 Analog Power Meter, with 1 MHz-8.4 GHz N(f) sensor $375.00
GENERAL MICROWAVE 476/4240A Power Meter & Sensor, 0.01-18 GHz, -35 to +10 dBm $375.00
HP 432A/8478B Power Meter, 0.01-18 GHz, -20 to +10 dBm f.s. $500.00
HP 432C Autoranging Digital Power Meter, 10 uW-10 mW f.s. $425.00
HP 435A/8481A Power Meter, 10 MHz-18 GHz, -30 to +20 dBm $1,000.00
HP 435A/8482A Power Meter, 100 kHz-4.2 GHz, -30 to +20 dBm $1,000.00
HP 435A/8482H Power Meter, 0.1-4200 MHz, -15 to +34 dBm $1,150.00
HP 435A/8483A Power Meter, 0.1-2000 MHz, -30 to +20 dBm, 75 ohms $1,000.00
HP 435A/8484A Power Meter, 10 MHz-18 GHz, -70 to -20 dBm $1,000.00
HP 436A-022 Digital Power Meter, HPIB option $1,400.00
HP K486A WR42 Thermistor Mount, 18.0-26.5 GHz, for 432 series $400.00
HP Q8486A Power Sensor, 33.0-50.0 GHz, WR22, for 435/6/7/8 .... $1,500.00
HP R486A WR28 Thermistor Mount, 26.5-40.0 GHz, for 432 series $400.00

RF MILLIVOLTMETERS

RACAL 9303 TRMS Level Meter, 10 kHz-2 GHz, -77 to +23 dBm, GPIB $875.00

AMPLIFIERS, MISCELLANEOUS

AILTECH 7618E Noise Source, 10 MHz-18 GHz, SMA(m), 15 dB ENR $500.00
BOONTON 82AD FM/AM Modulation Meter, 10-1200 MHz $800.00
HP 11715A AM/FM Test Source, 11-13.5/ 88-108/ 352-432 MHz $1,375.00
HP 8447A-001 Dual Amplifier, 0.1-400 MHz $500.00
HP 8901A-002,010 Modulation Analyzer, 150 kHz-1300 MHz, OCXO, int. cal. $5,500.00

M.P.D. LAB2-1020-2A Amplifier, 34 dB, 1.0-2.0 GHz, 2 Watts $800.00
M.P.D. LAB2-714-3A Amplifier, 34 dB, 0.7-1.4 GHz, 3 Watts $800.00
MARCONI TF2304 AM/FM Modulation Meter, 18-1000 MHz, FM dev.1.5-150 kHz $500.00
MICROWAVE SEMI.CORP. MC5112 Noise Source, 25.5 dB ENR, 1.0-12.4 GHz, N(m), +28 VDC $325.00

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AMERICAN NUCLEONICS AM-432 Cavity Backed Spiral Antenna,LHC, 2-18 GHz,TNC(f) *NEW* $95.00
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GR 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz $450.00
GR 900-Q GR900 14mm Interseries Adapters $125.00
HP 11691D Directional Coupler, 22 dB, 2-18 GHz $450.00
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz $800.00
HP 775D Dual Directional Coupler, 20 dB, 450-940 MHz $275.00
HP 776D Dual Directional Coupler, 20 dB, 940-1900 MHz $275.00
HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz $275.00
HP 778D Dual Dir.Coupler, 20 dB, 100-2000 MHz, N(m/f/f/f) $550.00
HP 778D-011 Dual Dir.Coupler, 20 dB, 100-2000 MHz, APC7/N(f/f/f) $400.00
HP 8472A Crystal Detector, 10 MHz-18 GHz, neg. pol., SMA(m) $150.00
HP 8497K-004 Programmable Step Atten., 0-90 dB, DC-26.5 GHz, APC3.5 .... $750.00
HP 8498A-030 30 dB Attenuator, 25 Watts, DC-18 GHz, N(m/f) $600.00
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz $350.00
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz $500.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz $650.00
HP R375A WR28 Variable Attenuator, 0-20 dB, 26.5-40 GHz $375.00
HP R422A WR28 Flat Broadband Detector, 26.5-40 GHz $400.00
HP R532A WR28 Frequency Meter, 26.5-40.0 GHz $500.00
HP R914B WR28 Moving Load, 26.5-40 GHz $300.00
M/A-COM 3-19-300/10 WR19 Directional Coupler, 10 dB, 40-60 GHz $450.00
NARDA 26298 20 dB Attenuator, 150 Watts, DC-1 GHz, N(f/f) $200.00
NARDA 3000-SERIES Directional Couplers $150.00
NARDA 3090-SERIES Precision High Directivity Couplers $225.00
NARDA 369BNF / 369BNM High Power Termination, 175 Watts, 0.7-18 GHz, N $325.00
NARDA 3752 Coaxial Phase Shifter, 0-180 deg./GHz, 1-5 GHz $1,250.00
NARDA 4000-SERIES SMA Miniature Directional Couplers $75.00
NARDA 4203-6 Directional Coupler, 6 dB, 2-18 GHz, SMA(f/f/f) $225.00
NARDA 4246B-10 Directional Coupler, 10 dB, 6-18 GHz, SMA(f) $100.00
NARDA 4317-2 Power Divider, 18.0-26.5 GHz, 3.5mm $175.00
NARDA 5070-SERIES Precision Reflectometer Couplers $300.00
NARDA 765-20 20 dB Attenuator, 50 Watts, DC-5 GHz, N(m/f) $135.00
NARDA 768-20 20 dB Attenuator, 20 Watts, DC-11 GHz, N(m/f) $125.00
NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz $375.00
PAMTECH KYG1014 WR42 Junction Circulator, 18.0-26.5 GHz $250.00
SPACEK LABS DQ-1 WR22 Flat Broadband Detector, 33-50 GHz $550.00
TRG V510 WR15 Precision Rotary Vane Atten., 0-50 dB, 50-75 GHz $1,000.00
TRG V551 WR15 Frequency Meter, 50-75 GHz $600.00
TRG V559-10 WR15 Directional Coupler, 10 dB, 50-75 GHz $400.00
TRG W510 WR10 Precision Rotary Vane Atten., 0-50 dB, 75-110 GHz $1,000.00
TRG W551 WR10 Frequency Meter, 75-110 GHz $900.00
TRG W559-10 WR10 Directional Coupler, 10 dB, 75-110 GHz $475.00
WAVELINE 822 WR42 Precision Rotary Vane Atten., 0-50 dB, 18-26.5 GHz $1,250.00
WILTRON 60NF50 SWR Bridge, 5-2000 MHz, N(f) test port, 40 dB dir. $475.00
WILTRON 87A50 VSWR Bridge, 2-18 GHz, 35 dB dir., APC7 test port $750.00

LOGIC

HP 5005A Signature Multimeter $350.00
HP 8170A-002 Logic Pattern Generator, 2 MB/s, address driver option $1,200.00
TEK 1240 Logic Analyzer, w/(36) 50 MHz channels $1,500.00

COMMUNICATIONS

HP 4972A/18182A LAN Protocol Analyzer, with software $2,500.00
HP 59401A HPIB Bus Analyzer $700.00
TEK 1410R-opt.04 NTSC Test Signal Gen. w/SPG2,TSG1,TSP1,TSG3,TSG5,TSG6 .... $2,750.00
TEK 1411R-opt.04 PAL Test Gen. w/SPG12,TSG11,TSP11,TSG13,TSG15,TSG16 .... $2,750.00
TEK 144 NTSC Test Signal Generator $675.00
TEK 147A NTSC Test Signal Generator, with noise test signal $800.00
TEK 520A NTSC Vectorscope $1,200.00

MISCELLANEOUS

P.A.R. 5202 Two-Phase Lock-in Amplifier, 0.1-50 MHz $3,000.00
P.A.R. 5205-94,95,96,98 Lock-In Amp, 20 Hz-20 kHz, int. osc., lin/log, GPIB $2,750.00
P.A.R. 5206 Two-Phase Lock-In Amplifier, 2 Hz-200 kHz $2,500.00
P.A.R. 5208-92,94,97,98 Two Phase Lock-In Amp., 5 Hz-20 kHz or 200 kHz, GPIB $3,250.00
TEK TM5006 5000-series 6-slot Programmable Power Module $600.00
TEK TM503 500-series 3-slot Power Module $175.00
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

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PIC DEVELOPMENT TOOL

The EBP-1000 from EBLabs is a programmer/downloader for the PIC16C84, PIC16C7X, PIC16C6X, PIC16C62X, and PIC14000. It provides in-circuit development capabilities at low cost for the hobbyist, as well as the serious developer.

The EBP-1000, complete with Windows software, programmer/downloader hardware, AC adapter, and parallel port cable, costs $99.00.

For more information, contact:

EBLABS
6305 RUGGLES AVE. S.
DEPT. NV
SALEM, OR 97306
503-362-9681 FAX: 503-362-9851
E-Mail: ebl@open.org
Home Page:
http://www.open.org/ebl/

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INNOVATION WEST introduces two new low-cost data acquisition products designed for PC-based applications. Typical uses are measuring pressure, light level, humidity, temperature, force, voltages or current, and to control up to 24 relays, lamps, heaters, or switches. The included utility software and manual with programming examples allow users to easily develop their own programs in Basic, C, Pascal, or other languages.

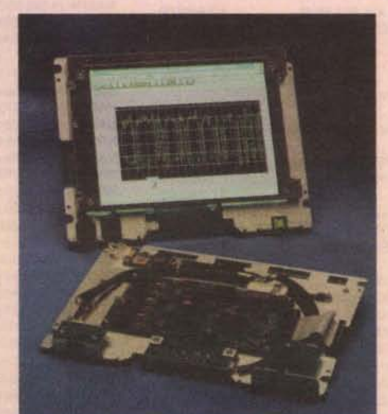
Model PCDA is an ISA bus unit with an eight-channel, eight-bit analog-to-digital converter, 24 programmable digital input/output lines, and one 12-bit counter.

Model PPDA attaches to the printer port and sports an eight-channel, eight-bit analog-to-digital converter, along with eight digital input lines, and eight digital output lines.

For more information, contact:

INNOVATION WEST
2275 HUNTINGTON DR., STE. 265
DEPT. NV
SAN MARINO, CA 91108
818-309-6085 FAX: 818-309-9972
E-Mail: inovwest@aol.com

SLIMPLICITY 10VLCD



The Slimplicity 10VLCD is a new, thin, and easy-to-use 10.4" TFT LCD panel from The Saelig Company that displays up to 256K colors at 640 x 480 pixel resolution.

The Slimplicity 10VLCD backlit display comes complete with contrast and brightness controls, as well as a unique On Screen Display (OSD) to allow full set-up of the monitor. Its slimness is another important feature — a mere 1.25" — great for mounting on panels, in a desk or console, or in restricted spaces.

The Slimplicity 10VLCD is available from stock at $2,995.00.

For further details, contact:

THE SAELIG COMPANY
1193 MOSELEY RD., DEPT. NV
VICTOR, NY 14564
716-425-3753 FAX: 716-425-3835

AMATEUR RADIO RESOURCE DIRECTORY

Resource Solutions announces that the 5th Edition of the 1996 *Amateur Radio Mail Order Catalog and Resource Directory* has been published and is now marketed by the American Radio Relay League, Inc. (ARRL). The ARRL is the largest publisher and distributor of amateur radio publications in the world and has an excellent reputation with such "standards" as the *Amateur Radio Handbook*, the *ARRL Antenna Book*, and *QST Magazine*.

The 1996 *Amateur Radio Mail Order Catalog and Resource Directory* is a source book of electronic parts, components, software, books, and equipment for the amateur radio or electronic enthusiast. The main feature is the extensive listing of vendors and dealers in 220 categories from alternative energy to wire and cable.

The 5th Edition can be obtained from ARRL (Order No. 5242) or from your dealer. Retail price is $15.95.

For more information, contact:

RESOURCE SOLUTIONS
6050 PEACHTREE PARKWAY
STE. 340-228, DEPT. NV
NORCROSS, GA 30092
770-448-9836

OPTOLINX

Optoelectronics, Inc. announces the OPTOLINX. The OPTOLINX universal interface adapts a wide variety of radios, scanners, decoders, frequency counters, GPS receivers, and other devices for connection to an RS-232C personal computer serial port. Both full- and half-duplex devices can be connected simultaneously using software to switch between them.

The OPTOLINX will interface to the Optoelectronics Scout Frequency Recorder for downloading of Scout frequencies to a PC using the disk supplied with the Scout, then check the frequencies against the FCC database using the Spectrum CD-ROM. Also, the Optoelectronics M1 Frequency Counter, using Optolog software, can be interfaced to the OPTOLINX for computer controlled datalogging of all frequencies that the M1 captures. The OPTOLINX will also computer control the ICOM R7000, R7100, and R9000 receivers.

The price for the OPTOLINX universal interface is $129.00.

For more information, contact:

OPTOELECTRONICS, INC.
5821 N.E. 14TH AVE., DEPT. NV
FT. LAUDERDALE, FL 33486
954-771-2050

WINCAM.ONE

StarDot Technologies announces the introduction of WinCam.One. WinCam.One is a complete desktop imaging system that plugs into your PC's serial port, eliminating the need for video capture cards and camcorders. The package includes a tripod and a slide adapter for digitizing 35mm slides. The camera includes a manually focusable lens that can capture images as close as an inch away, and the included slide adapter allows users to digitize 35mm slides at 360 dpi.

For more information, contact:

STARDOT TECHNOLOGIES
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DEPT. NV
BREA, CA 92621
714-528-9719 FAX: 714-579-6641
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FIVE NEW GORDON WEST CASSETTE COURSES

The W5YI distribution group announces an exclusive marketing agreement with Gordon West Radio School, immediately adding five new audio cassette courses to their existing product line-up of Gordon West amateur radio theory books and two-cassette code and theory courses.

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Continued on page 88

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TIRED OF paying high prices to get Tektronix, Hewlett Packard, Wavetek, IFR, etc., repaired, calibrated, certified? Give us a call. Free estimates, fast service. We also sell and rent test equipment. For information: Feitek, 2752 Walton, St. Louis, MO 63114. 314-423-1770.

PORTABLE SCOPES: Tek 465 (100MHz) $425. **Tek 465B/DM44** (100MHz, multimeter) $590. **Tek 475A** (250MHz) $675. **Tek 466** (100MHz, storage) $750. All with bright CRTs; excellent condition, warranty. Pepper Systems, 214-353-0257.

SIGNAL GENERATORS/OSCILLATORS HP 8656A/001 100KHz to 990MHz synthesized signal generator $2,995, HP 8640B 512MHz signal generator $1,795, HP 8640B/001/002 1024MHz signal generator $2,795, HP 8683B 2.3 to 6.5GHz signal generator $1,550, HP 8620C sweeper mainframe $395, HP 86290C 2 to 18.6GHz RF plug-in $2,395, HP 86222B 0.01 to 2.4GHz RF plug-in $1,795, HP 204C 5Hz to 1.2MHz audio oscillator $125, HP 651B 10Hz to 10MHz test oscillator $125, HP 654A 10Hz to 10MHz test oscillator $175, HP 86602A 1200MHz RF plug-in $895, HP 4204A 10Hz to 1MHz digital oscillator $150, GIGATRONICS 900/0.5-12 50MHz to 12.4GHz synthesized signal generator $2,995, WAVETEK 1062A 400MHz sweep generator $595, WAVETEK 952 1 to 4GHz microwave source $995. **30-day warranty** & manual. Calibration available. MasterCard & Visa accepted. **CALL 1-800-435-1516, FAX 908-280-0111.**

COMMUNICATIONS SPECTRUM ANALYZER, Polarad model CSA 290. 10Hz-40MHz @ 10Hz resolution, $500; with 2-tone generator TTG-29 $600. Spec sheet available by fax 707-747-5277. **Psitech Plus** 707-745-4804.

SPECTRUM ANALYZERS: Tek 7L13 1KHz-1800MHz, 30Hz RBW $1,750. **Tek 7L5/L3** 20Hz-5MHz $1,400; with tracking generator $1,900. **HP 3580A** 5Hz-50KHz, 1Hz RBW, adaptive sweep, tracking generator: $790 (mech), $1,250 (LED). **Tek TR 503** tracking generator $975. Excellent condition, warranty. Pepper Systems, 214-353-0257.

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Fluke 8505A, Digital Multimeter, AC, DC, Ohms	$400
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Wavetek 2002A, Signal Gen. Sweeper, 1-2500MHz	$1,600
Wavetek 452, Filter, Dual Hi/Lo, 1Hz-10KHz	$450
Wavetek 7530A, FFT Spectrum Analyzer 0-100KHz	$1,000
Wavetek 859, Programmable Waveform Gen.	$1,000
Wavetek 907, 7-11GHz Signal Generator	$650

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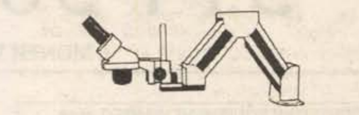

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HP 141T, 8555A, 8552B, $2,000; HP 141T, 8554B, 8552B, $1,800; HP 8553B, $500; HP 8660A, $250; HP 86290A, 2-18 GHz, sweep plug-in, $1,800; HP P532A, wavemeter, $150; Scientific Atlanta programmable microwave receiver, with digital phase gain meters, phase meters, $2,500; Fluke 332B voltage calibrator, $600; HP 3320B, $400; HP 3330B, $500; Rockland 5100 synthesizer, $400; HP 334A, distortion ana., $450; HP 332A, $300; HP 331, $250; HP 333A, $350. Send for test equipment sales list. A-Comm Electronics, 7198 S. Quince Street, Englewood, CO 80112. 303-290-8012.

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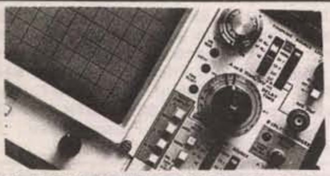

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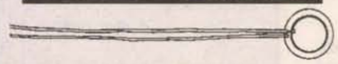

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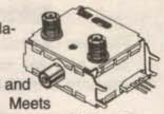

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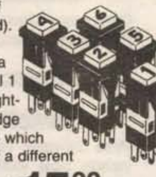

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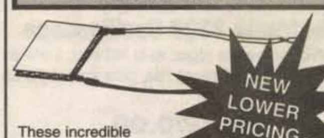

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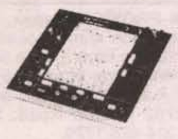

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AMATEUR ROBOTICS

Hacking the Ready-Set-Go

Sometimes you can find a toy that makes a perfect robot platform. With just a little effort on your part, you can convert a battery-powered car or tank into a great experimental base for your robot projects. I found just such a toy in the Ready-Set-Go (RSG) computer-controlled electric truck, which my wife, Linda, gave me last Christmas. (Who says 40-something guys can't get toy trucks for Christmas, anyway?)

The accompanying pictures, being black and white, can't do justice to the color scheme on this foot-long jacked-up truck. The bright red plastic body, white bumpers fore and aft, and yellow undercarriage make this baby really stand out. What would be the truck bed contains an array of nine large, brightly labeled pushbuttons. You use these keys to enter commands into the truck's computer memory. When finished, you just press the GO button, and the truck executes the commands you've entered in sequence.

Even cooler, the RSG has a very high-quality sound system on it. Each time you press a key, the truck speaks the desired action, such as "Left" or "Reverse." Additionally, the truck has a very realistic engine noise that runs while the truck is sitting still, as if it were idling. The RSG even has a "wheelie" button, which causes it to go real fast and rear back on special struts as it races forward, accompanied by the appropriate tire squeals.

And I haven't mentioned the two bright white lights built into the truck's roll bar. They add a nice touch as the truck takes off across the floor, lights flashing to get the cat out of the way. All told, the RSG is a perfect toy for the robot hacker in your family, and I couldn't wait to tear mine apart.

Inside the RSG

The RSG innards contain several excellent robotics subassemblies, already designed and tested for you. The motor assembly consists of two inexpensive Mabuchi-style motors, built into a dual gear train to provide independent drive on both rear wheels. The gear system is open, which means you have physical access to all gears in the system. This lets you add encoders to each drive train, by positioning a small IR emitter-detector near the surface of a gear and adding a black ink mark on the gear's surface.

The keypad consists of a separate printed circuit board (PCB) laid out in a matrix arrangement. Wires connect this PCB with the main board, which contains the 28-pin microcontroller (MCU), motor drive electronics, sound chip, and amplifier. This board, in turn, is wired to the motor assembly and the two battery compartments through a rat's nest of wires.

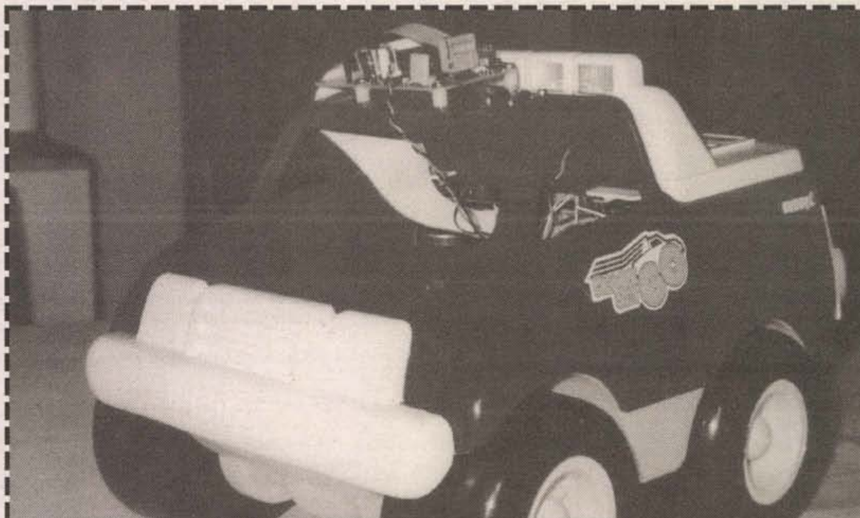
The two battery compartments are a nice touch. The smaller compartment holds three AA batteries, providing 4.5 VDC to the computer board, assuming you use alkaline batteries. The larger section carries three D cells for the motors. This two-supply design really keeps the motor noise out of the MCU circuitry, and it also protects the MCU from voltage sags when the motors kick in from a standing stop.

I played with my RSG for a while, to determine the system's external design elements, then reached for my screwdriver. A handful of self-tapping screws hold the plastic shell together. I removed the cab seat, which contains a cute little plastic driver, complete with blue sunglasses and backwards-facing baseball cap. With the seat gone, the interior space of the cab opens up, yielding extra room for batteries and electronics.

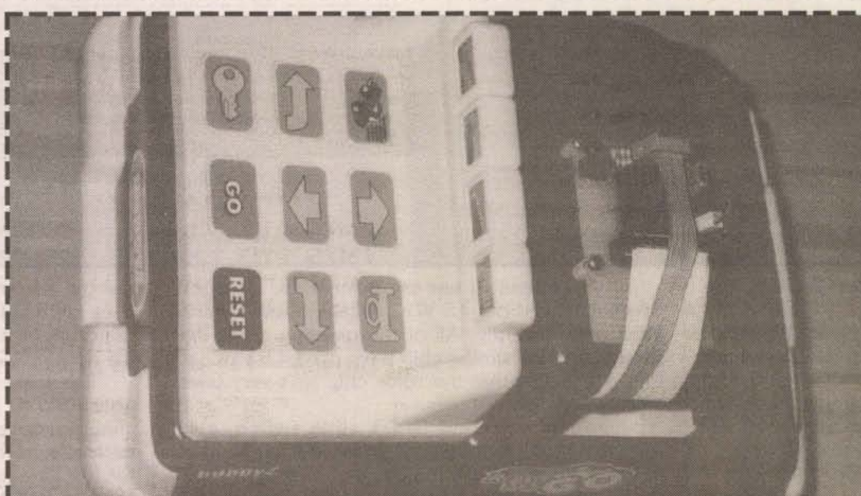
I spent some time trying to trace out the motor control circuitry on the MCU's PCB, but finally gave up. It uses several discrete transistors, arranged in some bizarre bridge system, to provide PWM drive in both directions for each motor. I finally decided that I really didn't have to know what the circuit looked like, only how it functions.

I traced out the wiring to determine the four MCU pins responsible for driving each element of the motor circuitry. Actually, this PCB uses two I/O lines, wired in parallel, to drive a single motor control line. Apparently, the MCU, which is house-numbered and therefore unknown, has pretty weak drive so the designer had to double up the I/O lines.

I hooked my voltmeter to one of the I/O pairs, then made the RSG move forward. The voltmeter showed a reading of 2.0 VDC. Since I knew from the circuitry that the I/O lines were pulled high to 4.5 VDC, this meant the MCU was using some form of PWM to control the motor's speed. Additional probing and motor motions produced a complete table of control signals. As you can see, the MCU uses separate lines for forward and backward drive on each motor.



My Ready-Set-Go truck, complete with BOTBoard mounted on the cab's roof. I removed the yellow plastic cab and little plastic driver to make room for the cabling.



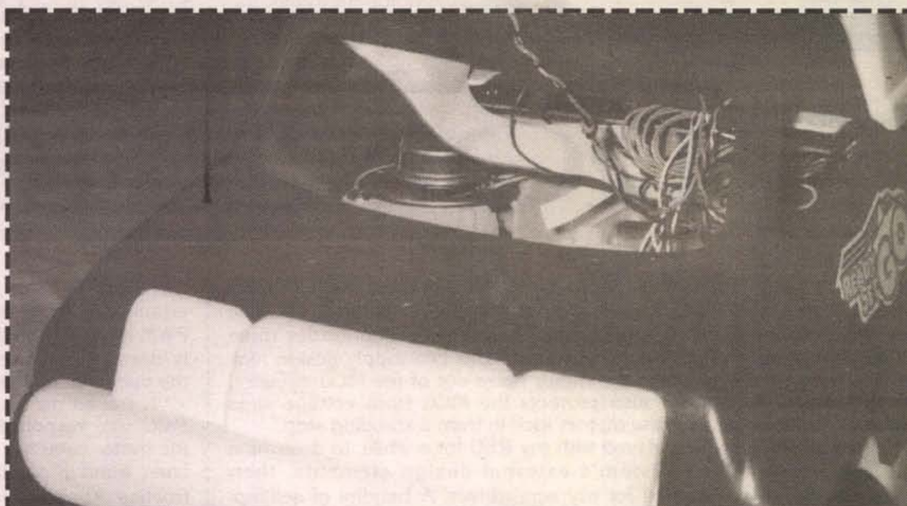
I mounted the BOTBoard to the roof using 4-40 hardware, then ran the cables through the cab window. Here you can see the large keypad available for input to your programs. The truck is slightly over one foot long.

Next, I traced out the control lines for the lights. No surprises here; the MCU uses one I/O line to control the right light and one to control the left. Bringing a light control line low turns off that light, while driving it to 4.5 VDC turns that light on.

The sound system proved much more sophisticated. A small amount of on-board electronics drives a second, tiny PCB mounted vertically on the main board. This tiny board looks like the guts of one of those talking birthday cards, the kind you can use to record your own greeting. The sound board connects to the main board with seven solder pads, which provide both electrical hook-up and mechanical mounting. Three of the pads connected to I/O lines on the MCU. I probed these three lines with my oscilloscope while I pushed various buttons to make the truck talk.

Two of the lines have obvious functions. Pin 1 of the voice chip is a serial data line; the patterns on it vary as a different button is pushed. Pin 2 carries eight clock pulses, used to clock in the data from the MCU via pin 1. Pin 3 shows a complex burst of data, lasting much longer than the clock stream. Ultimately, this last line stymied me. As of this writing, I do not yet have the voice system running. If I get it figured out, I'll pass the solution along in a later column.

Only the keypad remained. The nine keys on the pad form a 3x3 matrix, with one exception. The ignition key, in the lower-left corner, acts as a MCU reset switch, and is brought out separately. The remaining eight switches are arranged in a standard scanned matrix. I probed each MCU pin hooked to the keypad and noted the signal changes as I pressed each key. It only took a few minutes to develop the wiring layout for the keypad. I finished up by noting items such as the power and ground hook-ups, and jotted down all the details in my robotics notebook.



Looking through the front window at the rat's nest of wiring that goes to the MCU board. The speaker for the voice card sits to the left. Work carefully when moving the MCU board around, so you don't break any vital connections.

```
const DEBOUNCE = 10
keytable:
datab    0, 'W', 'F', 0, 'H', 'L', 'B', 0, 'R', '?', 'G', 0, 'X'

ScanKeys:
keyrow = $30                                              ' mask to pull one row low
for n=0 to 2                                              ' for all three rows...
        pokeb portc, ((peekb(portc) and $c0) or keyrow)   ' pull a row low
        scnkey = peekb(portc) and $07                     ' read the cols
        if scnkey <> 7                                    ' if one col is low...
                exit                                      ' leave the loop now
        endif
        keyrow = lshft(keyrow) + $08                      ' move to next row
        keyrow = keyrow and $38                           ' keep within proper 3 bits
next
pokeb portc, (peekb(portc) or $38)                        ' leave with all rows high
scnkey = scnkey xor 7                                     ' invert result bits
if scnkey = 0                                             ' if 0, no key was pressed
        n = 0                                             ' show as return value
else
        n = (n * 4) + scnkey                              ' convert to unique value
endif
return n


GetKey:
newkey = usr(ScanKeys)                                    ' check the keys
if newkey = 0                                             ' if nothing pressed...
        oldkey = 0                                        ' mark this as a released key
        return 0                                          ' show it and leave
endif
keywait = DEBOUNCE                                        ' get debounce delay
do
loop until keywait = 0                                    ' wait it out
if usr(ScanKeys) = newkey                                 ' if the same key is down...
        if newkey <> oldkey                               ' and different from last time...
                oldkey = newkey                           ' record the new key
        else                                              ' this is same key as last time...
                newkey = 0                                ' only show key on first press
        endif
else                                                      ' key changed between scans; noise
        newkey = 0                                        ' show nothing pressed
        oldkey = 0                                        ' erase memory also
endif
return  peekb(addr(keytable) + newkey)                    ' convert to ASCII
```

Now came the serious step. Using a set of narrow-jawed wire cutters, I carefully cut each pin of the MCU as close to the chip's body as possible, then removed and discarded the chip. Next, I carefully turned the board over and removed all of the residual pins, leaving empty solder pads for all 28 pins. Obviously, once I've taken this step, I can no longer go back to verify any operation, so my notes had better be accurate.

My goal was to replace the MCU with a BOTBoard running a 68hc811e2 in single-chip mode. The 2K of code space on the 'e2 would hold enough code for most simple applications, and I could always rewire a larger board in place, if necessary. I soldered a 24-pin dual-row male header in the larger connector pattern on the BOTBoard, to give me access to port E, port B, and parts of port A. I also added a 10-pin male header to the smaller connector layout, so I could use port C.

NOTE: I used a 24-pin dual-row header for the larger connector, even though the BOTBoard layout has 26 holes. I mounted my header so pins 1 and 2 of the original layout are empty. Thus, pin 1 of my large ribbon connecter actually hooks to pin 3 of the BOTBoard layout. All references to pin numbers in this article are to my 24-pin connector, NOT to the BOTBoard's 26-pin layout.

I changed the MCU power supply wiring slightly, to accommodate the BOTBoard. I removed the AA-battery connection from the MCU board and wired it to a small DPDT slide switch that I installed in the truck's roof. I then wired from the center terminal of that switch to the BOTBoard's power connecter. Finally, I hooked the two +5 VDC wires in the BOTBoard's 24-pin ribbon cable to pad 28 on the MCU layout. This arrangement means that the BOTBoard gets its power from the truck's AA batteries, and the MCU board gets its power through the large ribbon cable.

If you intend to use the voice chip, I suggest you not exceed the 4.5 VDC voltage of the original MCU power supply. All of the greeting cards I've seen that use a similar chip have used 4.5 VDC, so I have a feeling that the voice chip isn't very tolerant of excessive voltages.

I added a second DPDT slide switch, also mounted in the truck's roof, to control the voltage to the motors. I also wired this switch in series with the remaining half of the first switch. This means that I cannot have voltage on the motors unless the MCU is active, so there is no chance that the motors will accidently see the full 4.5 VDC battery supply. Perhaps this is excessive caution, but the RSG designer took great care to never let the motors see the full battery voltage, so I figured I'd better do the same.

I then hooked up the remaining wires on the two ribbon cables to the appropriate pads on the MCU board. This gives me full control of the RSG subassemblies from my BOTBoard. Refer to the accompanying charts of RSG connections.

Please note that support for the keypad requires that you add three pull-up resistors on the BOTBoard. You must pull lines PC0, PC1, and PC2 to Vcc or your code will not be able to read the keypad properly.

The software

The 2K of EEPROM in the 68hc811e2 lets me write my software in SBasic, which sure beats using assembly language. I've included source code for the two most important functions: motor control and keypad scan. Both functions turn up often in amateur robotics, and the RSG design makes the motor control code different enough to warrant taking a look.

I'll start by describing the real-time interrupt (RTI) interrupt service routine (ISR) code. This module generates the PWM signals for both motors, and is executed once every 4.2 msecs. The mainline code sets up the 68hc11 RTI subsystem, then enables interrupts. When an RTI interrupt occurs, control automatically transfers into this routine.

First, the ISR rearms the RTI subsystem, so another interrupt can occur 4.2 msecs later. Next, the code handles a couple of variables, WAIT and KEYWAIT, treating them as down-counting timers. If a variable is not yet zero, this code decrements the variable. This action causes the variables to "magically" decrement every 4.2 msecs, until they eventually reach zero, where they stay until changed later. Thus, code can generate a one-second delay by loading a variable such as WAIT with 250, then periodically testing WAIT. When WAIT hits 0, the one-second delay is finished.

Next, the ISR code must build up a PWM value, used to control the two motors. Recall that the motor control lines are tied to PB0 through PB3, the low four bits of port B. I'll describe the technique used to control the right motor; the left motor code is similar.

The ISR code first tests the low bit of the variable RPWM. If the low bit equals 1, the motor should receive voltage, so the ISR code stores the current right motor control mask in variable T. If the low bit equals 0, however, the motor should not receive voltage for this time slice, so the right motor control mask is not added to T. After going through this same process for the left motor, the ISR code modifies the low four bits of port B to hold the new control mask in T. The code then

1	PE7	N/C	
2	PE3	N/C	
3	PE6	N/C	
4	PE2	N/C	
5	PE5	N/C	
6	PE1	N/C	
7	PE4	N/C	
8	PE0	N/C	
9	PB0	24, 25	1 = right motor forward, 0 = off (must use PWM)
10	PB1	22, 23	1 = right motor reverse, 0 = off (must use PWM)
11	PB2	20, 21	1 = left motor forward, 0 = off (must use PWM)
12	PB3	18, 19	1 = left motor reverse, 0 = off (must use PWM)
13	PB4	10	1 = right light on, 0 = off
14	PB5	11	1 = left light on, 0 = off
15	PB6	N/C	
16	PB7	N/C	
17	PA0	N/C	
18	PA1	N/C	
19	PA2	N/C	
20	PA7	N/C	
21	+5 VDC	28	MCU power
22	+5 VDC	28	MCU power
23	GND	12, 14	GND
24	GND	12, 14	GND

Connections between BOTBoard and RSG MCU pad layout, 24-pin cable

1	+5 VDC	N/C	
2	GND	N/C	
3	PC0	1	keybrd, column 1 (input)
4	PC1	27	keybrd, column 2 (input)
5	PC2	26	keybrd, column 3 (input)
6	PC3	6	keybrd, row 1 (output)
7	PC4	5	keybrd, row 2 (output)
8	PC5	4	keybrd, row 3 (output)
9	PC6	8	voice board, serial data
10	PC7	9	voice board, serial data

Connections between BOTBoard and RSG MCU pad layout, 10-pin cable

rotates the RPWM value one bit position to the right, updating the low bit for the next time slice in 4.2 msecs.

The interaction between RPWM and RMTR make this motor control scheme work. RPWM holds a 16-bit value that serves as a PWM mask. Each bit in RPWM is 1 if the motor should receive voltage, or 0 if it should not. The pattern stored in RPWM gets rotated one bit position on each RTI interrupt, so the low bit is constantly updated. This means that the motor will see a series of voltage pulses matching the pattern of 1-bits in RPWM.

For example, a value of $5555 in RPWM means that the right motor will see alternating bursts of 4.5 VDC and 0 VDC, with each burst lasting 4.2 msecs. This works out to a 50% duty cycle. Using a value of $aaaa in RPWM results in the same 50% duty cycle, while a value of $eeee generates a 75% duty cycle.

The variable RMTR controls the direction and motion of the right motor. Whenever the low bit of RPWM is 1, the ISR adds the value in RMTR to the motor mask being built. Thus, if RMTR contains a 1 in the bit position for controlling the forward motor driver, the right motor will see a burst of voltage on the forward control line. If, however, the RMTR variable holds the mask for the reverse motor driver, the motor will see a burst of voltage on the reverse driver. RMTR is also used to stop the right motor. If code stores a value of 0 in RMTR, neither control line will be set to 1, even if the low bit in RPWM is 1 at that moment. Thus, your code can use RPWM to control a motor's speed, while using RMTR to control direction or stopping.

The code for reading the RSG's keypad is much more complex. The keypad looks like a 3 x 3 switch matrix, with columns 1 through 3 wired to PC0 through PC2, and rows 1 through 3 wired to PC3 through PC5. Note that the code sets up PC0 through PC2 as inputs, with the other three lines configured as outputs.

The scan operation is straightforward. The code in ScanKeys steps across each of the three rows, momentarily pulling a row line low. It then tests the three column lines to see if one of them went low also. If so, then the row and column lines uniquely define the pressed key. If no column line goes low, ScanKeys moves to the next row and tries again. If no column line goes low for any row, then no key was pressed.

If ScanKeys detects a pressed key, it converts the column lines into a number from 1 to 7, for later use as an index into an array. This explains the XOR operation at the end of ScanKeys, used to invert the column value into an index. The math operation on N converts the row and column values for a pressed key into the final array index, which is returned to the calling routine.

The code in GetKey calls ScanKeys to check for a pressed key. If no key is pressed, GetKey returns a 0 to the calling routine. If a key is detected, however, GetKey sets up variable KEYWAIT as a debounce timer. After a suitable delay, GetKey again calls ScanKeys, to see if the pressed key is still down.

If the same key is down after the debounce delay, GetKey compares this new key value (in NEWKEY) to the last known key (in OLDKEY). If the two match, then the pressed key is simply the original key, still being held down. In this case, GetKey ignores the pressed key by putting a 0 in NEWKEY.

Finally, GetKey uses NEWKEY as an index into an array of key codes in KEYTABLE. If NEWKEY holds a 0, GetKey returns the value in the 0th element of KEYTABLE, which is a 0. Otherwise, GetKey returns an ASCII character corresponding to the pressed key. I arbitrarily mapped keys that made sense to me; thus, pressing the right arrow key returns an ASCII R, while pressing the GO key gets a value of G.

You can modify the code in GetKey to produce a typematic effect, if you want. This involves recording how many scans elapse with the same key held down, then issuing a second keypress for the same key after enough successful scans. I chose the simpler method of only returning a keypress when the key is first pressed, then ignoring all subsequent scans for that same key until I get a scan with no key pressed.

Conclusion

This article has described converting a popular, well-designed toy into a useful robotics platform. As you can see from the chart of connections between the 68hc11 and the RSG, a number of I/O lines remain available for your own use. Particularly, the SPI lines on port D and all of the A/D inputs on port E remain unused. You should have plenty of growth space for adding IR detectors, bumper switches, and other goodies.

I'm very pleased with the care shown in the RSG's design. The separate power supplies, open gear drive system, and cool packaging can make this a showcase robot. The interior, once you remove the little plastic driver and cab seat, can hold extra circuitry or a larger battery. And having a large keypad always available lets you do on-the-fly control of your robot.

I will post the complete code for this project on my Web page. I will also include a few color .GIFs of the RSG robot, so you can take a look at how it is evolving. And if any of you have modified other toys for robotics, drop me an electron and let me know what you did. **NV**

```
const RMTR_FWD = $01
const RMTR_REV = $02
const LMTR_FWD = $04
const LMTR_REV = $08
const RMTR_STOP = 0
const LMTR_STOP = 0
'
' RTI interrupt service routine
'
' This ISR supports down-counting timers, such as WAIT. It also
' supports PWM of both motors, through the RPWM and LPWM pattern
' variables and the two motor control variables, RMTR and LMTR.
'
' This routine assumes port b controls the motors. See the constant
' declarations above for pin assignments.

interrupt $fff0                              ' RTI ISR
pokeb tflg2, $40                             ' rearm rti
if wait <> 0
        wait = wait - 1
endif
if keywait <> 0
        keywait = keywait - 1
endif
t = 0
if rpwm and 1 = 1
        t = rmtr
endif
if lpwm and 1 = 1
        t = t or lmtr
endif
pokeb portb, ((peekb(portb) and $f0) or t)
rpwm = rroll(rpwm)
lpwm = rroll(lpwm)
end
```

As always, you can reach me at:
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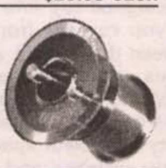

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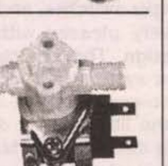

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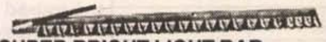

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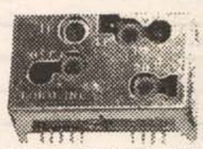

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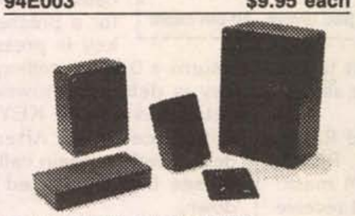

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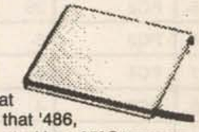

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USED TEST EQUIPMENT. HP, TEKTRONICS, FLUKE. WHOLESALE PRICES. CALL TO RECEIVE LIST BY FAX OR MAIL. TJ'S WHOLESALE SURPLUS. 904-897-6482.

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HP 214A pulse generator, $250; HP 222A pulse gen. $150; HP 3311A 1MHz function gen. $150; HP 3310B 5MHz function gen. $250; HP 339A distortion ana., $1,500; HP 8660D, 86603A, 86632B; $5,000; HP 86240A, $800; Wavetek 907, $700. A-Comm Electronics 303-290-8012.

EQUIPMENT MANUALS we have 1000's of service and operators manuals for all types of test and measurement equipment from 1950 to present. All test equipment manufacturers are represented. Call, write, or fax your want list. Please include mfg.'s manual P/N unit serial numbers if known. **Manuals Plus**, Box 549, TAD #601, Tooele, UT. 801-882-7188, FAX 801-882-7195.

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WANTED: SPECTRUM analyzers, sweepers, network analyzers, HP, Tektronix. Also looking for radio service monitors, Motorola R-2001/A/B/C/D, R-2200/A/B/IFR-500/1100/1200/1500, Wavetek 3000/3100/2100, Cushman-50/6020/7000/31, Marconi 2955/2957. We pay within 24 hours via Fedex. Call Paul Zeppa at 408-929-2244 or fax your list to 408-929-0962, RF imaging and comm.

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WANTED: TRANSMISSION TEST SETS. HP 3551A, HP 4935A, AMERITEK. CALL 1-800-476-2526 OR FAX INFO TO 601-868-0133.

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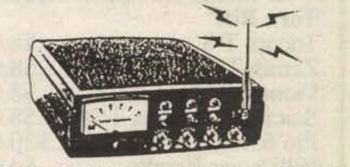

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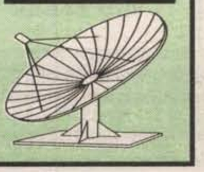

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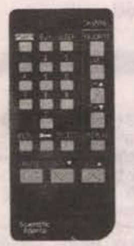

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Events CALENDAR

AUGUST 1996

The Events Calendar is a free service limited to electronic events such as computer shows, hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days prior to the event. 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.

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AUGUST 2-3

VT - CHARLOTTE - Ham/Electronic Flea Market. BARC. Ralph 802-878-6454

AUGUST 2-3-4

TX - AUSTIN - Texas State Convention. Joe Makeever 512-345-0800
UT - PARK CITY - Rocky Mountain Division Convention. Duane Anderson 801-288-1859

AUGUST 3

CA - HAYWARD - San Francisco Scientific & Technical Antique and Collectible Show. Centennial Hall. Al Roberts, The Rational Past 310-476-6277
CA - OAKLAND - Robert Austin Computer Show. Convention Center. 1-800-346-0100
CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
MA - MARLBOROUGH - Computer Show. Royal Plaza Trade Center. KGP Productions 908-297-2526
MA - WELLESLEY - Ham/Electronic Flea Market. Pepsi Pav. Barb 617-329-2628
MI - ESCANABA - Delta County ARS Hamfest. John Anderson 906-789-9148
MO - SPRINGFIELD - MO State Convention. Karen Thorpe 417-889-6775
NC - HIGH POINT - High Point ARC's Lomer L McMahan Memorial Hamfest. National Guard Armory. 910-887-3039
NY - CLAYTON - Jefferson County RAC1000 Island Int'l Hamfest. Clayton Recreation Park Arena. Janet Long 315-788-8543
NY - WHITE PLAINS - Computer Show. Westchester County Center. MarketPro Shows 201-265-1075
OH - COLUMBUS - ARRL Hamfest. Voice of Aladdin ARC. Bill Stebleton 614-861-7610

AUGUST 3-4

CA - SAN DIEGO - Computer Show. MarketPro. Scottish Rite Center. 415-456-6730
FL - JACKSONVILLE - Northern FL Section Convention and Greater Jacksonville Hamfest & Computer Show. Prime F Osborn III Convention Center. Karl Hassler 904-268-2302
WA - SPOKANE - Spokane Hamfest. University High School. KBARA, NW Tri-State ARO, Spokane Radio Amateurs, & Inland Empire Radio Amateurs. JoAnn 509-928-1808

AUGUST 4

CA - LIVERMORE - Swapmeet. Las Positas College. Noel Anklam 510-447-3857
CA - MODESTO - Computer Show. Centre Plaza at Red Lion. MarketPro. 415-456-6730
IL - PEOTONE - Hamfest. Hamfesters Radio Club. Will County Fairgrounds. 708-535-0580
MA - WELLESLEY - Ham Radio Flea Market. Pepsico Pavilion, Babson College. Wellesley ARS & Babson Wireless Club. Barbara 617-329-2628
MI - FARMINGTON HILLS - Computer Show Farmington Hills Activity Center. 313-283-1754
MI - FOWLERVILLE - Livingston County HamFair. Fowlerville Fairgrounds. Livingston Amateur Radio Klub. Ray 517-546-9209
MI - PORT HURON - Eastern MI ARC Swap '96. St. Clair Co. Community College, Student Center. Jim 810-367-3059
NY - STONY BROOK - Computer Show. SUNY Stony Brook. MarketPro Shows 201-265-1075
OH - RANDOLPH - Portage ARC Hamfair. Portage Co. Fairgrounds. Joanne 330-274-8240
PA - EASTON - Hamfest. Career Institute of Tech. Delaware Lehigh ARC. Amy 717-386-3513
PA - MATAMORAS - Tri-State ARA Hamfest. Ray Rothstein 914-856-0426
PA - NORTHAMPTON COUNTY - Delaware Lehigh ARC Hamfest. Amy Zimmerman 717-386-3513
PA - WASHINGTON TWP - Skyview Radio Society Hamfest. Robert Reihms 412-727-2194
VA - BERRYVILLE - Shenandoah Valley ARC Winchester Hamfest & Computer Show. Clarke County Ruritan Fairgrounds. Irv Barb 540-955-1745

AUGUST 9-10-11

CANADA - BRITISH COLUMBIA - VERNON - Sky High Hamfest. Silver Star Mountain Resort. North Okanagan Radio Amateur Club. Leigh 604-542-9362

AUGUST 10

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
CA - LOS ALTOS HILLS - Electronics Flea Market. Foothill College, Parking Lot A. 408-734-4453
CA - STOCKTON - Computer Show. Civic Auditorium. MarketPro. 415-456-6730
FL - PALM BEACH GARDENS - Computer Show & Sale. Palm Beach Gardens Marriott. Narisaam 1-800-436-6707
IL - QUINCY - Western Illinois ARC Hamfest. Jim Funk 217-336-4191
IN - VALPARAISO - Porter County ARC Hamfest. Rich Ard 219-762-0484
KS - CHANUTE - Hamfest. CAARC. Central Park Pavilion. Jerry 316-431-3268
NH - NASHUA - Computer Show. Rivier College. MarketPro Shows 201-265-1075
NJ - HACKENSACK - Computer Show. FDU/ Rothman Center. KGP Productions 908-297-2526
NY - DRYDEN - Tompkins County ARC Finger Lakes Hamfest. Dryden High School. Ross 607-844-4302
NY - TROY - Computer Show. Troy Armory. MarketPro Shows 201-265-1075
PA - LEWISTOWN - Hamfest. Decatur FC Grounds. Juniata Valley ARC & Decatur Township Fire Company. Richard Yinling 814-237-1591
TN - CROSSVILLE - Plateau ARC Hamfest. Nicholas Smith 615-484-8220
WA - TACOMA - Tacoma Electronics Fleamarket. Charles Wright Academy. Radio Club of Tacoma. Alan 206-840-4947
WV - HUNTINGTON - Tri-State ARA Hamfest. Georgia Overby 304-522-1811

AUGUST 10-11

LA - BOSSIER CITY - Shreveport ARA Hamfest. Alice Prudhomme 318-872-9232
OH - PAULDING - Paulding County ARG Hamfest. Paulding Co. Fairgrounds. Jon 419-399-4507

AUGUST 11

CA - SANTA ROSA - Computer Show. Sonoma Co. Fairgrounds. MarketPro. 415-456-6730
IA - CEDAR RAPIDS - Cedar Valley ARC Hamfest. Wayne Kolosik 319-393-4224
FL - BOCA RATON - Computer Show & Sale. Embassy Suites Hotel. Narisaam 1-800-436-6707
KY - FRANKFORT - Bluegrass ARS Hamfest. Western Hills High School. Bill DeVore 606-273-8345
MA - WEST SPRINGFIELD - Computer Show. Eastern States Exposition. MarketPro 201-265-1075
ME - PORTLAND - Computer Show. Verrillo's Conv. Center. Northern Computer Shows. 508-744-8440
MI - DEARBORN - Computer Show. Adray Sports Arena. 313-283-1754
MI - JACKSON - Jackson Hamfest & Computer Show. Jackson Community College. 517-784-2398
MN - ST. CLOUD - St. Cloud ARC Hamfest. Jack Maus 320-685-8295
NC - CHARLOTTE - Charlotte ARC Hamfest & Computer Fair. Roll-A-Round Skate Center. Buck 704-522-4971 ext. 3330

AUGUST 15-16-17-18

MD - BOWIE - International EME Convention. Willie Mank 301-645-5584

AUGUST 17

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center. 317-299-8827
IN - WARSAW - Tailgate Hamfest. Market Place of Warsaw parking lot. Hoosier Lakes Radio Club. Jim 219-839-5203
MN - WARROAD - Hamfest. Warroad Community Center. Lake of the Woods Repeater Association. David Landby 218-386-1092
NH - SEABROOK - Computer Show. Seabrook Greyhound Park. Northern Computer Shows. 508-744-8440
NJ - OAKLAND - Ramapo Mountain ARC Ham Radio & Computer Flea Market. American Legion Hall. Steve Oliphant 201-962-4584
PA - WASHINGTON - Computer Show. Ft. Washington Expo Center. KGP Productions 908-297-2526
RI - WEST WARWICK - Computer Show. West Warwick Civic Center. MarketPro Shows 201-265-1075
VA - VIRGINIA BEACH - Computer Show. Independence Hall. Pro Am Shows 804-463-1136
WA - LONGVIEW - Ham Radio, Computer, & Electronic Equipment Swap Meet. Cowlitz County Fairgrounds. Lower Columbia ARA. 360-425-6076
WI - SUGAR CAMP - Rhinelander Repeater Assn. & Northwoods ARES Hamfest. Sugar Camp Town Hall. Mary Berger 715-362-9296

AUGUST 17-18

AL - HUNTSVILLE - AL Section Convention. Steve Jones 205-883-5479
CA - OXNARD - Computer Show. Community Center. MarketPro. 415-456-6730
CA - SACRAMENTO - Computer Show. Scottish Rite Center. MarketPro. 415-456-6730
CA - SAN FRANCISCO - Robert Austin Computer Show. Cow Palace. 1-800-346-0100
GA - MARIETTA - ComputerShow. Cobb County Civic Center. ComputerShow 770-907-6225
NM - ALBUQUERQUE - NM State Convention. Judy Kirby 505-891-9132
PA - YORK - York Hamfest & Computer Show. York Interstate Fairgrounds. 717-751-9675

AUGUST 18

CA - GOLETA - Santa Barbara ARC Hamfest. Marvin Johnston 805-682-1405
CO - GOLDEN - Ham Radio and Computer Hobbyist Swapfest & ARRL State Convention. Jefferson Co. Fairgrounds. Denver Radio Club. 303-674-5389
CT - WATERBURY - Computer Show. Waterbury Sheraton. MarketPro Shows 201-265-1075
DE - GEORGETOWN - Sussex ARA & Delmarva Hamfest Assn. Hamfest. Tom 302-856-2938
IL - ORLAND PARK - Orland Park Computer Show. Civic Center. 24-Hour Hotline 708-974-3123
IL - STICKNEY - DuPage ARC Hamfest & Computer Show. Hawthorne Race Course. 708-985-9256
KS - SALINA - Central Kansas ARC Hamfest. Bicentennial Center Heritage Hall. Dan 913-263-8540
MA - CAMBRIDGE - Flea Market. MIT. Nick 617-253-3776
MI - MADISON HEIGHTS - Computer Show. UF & CW Hall. 313-283-1754
NJ - NEWARK - Computer Show. Holiday Inn, Newark Airport North. 609-924-2344
NY - YONKERS - Westchester Emergency Communications Assn. Hamfest. Tom 914-769-1486
OH - BROADWAY - Union County ARC Hamfest. Community Building. Gene Moore 513-246-5943
OH - CINCINNATI - Hamfest. Kolping Center. Greater Cinti ARA. 513-563-7373
OH - CLEVELAND - Computer Show. Holiday Inn, Strongsville. Peter Trapp Shows 607-369-2796
OH - WARREN - Hamfest. Warren ARA. Al VanSlyke 330-889-3378
VA - NEWPORT NEWS - Computer Show. Knights of Columbus Hall. Pro Am Shows 804-463-1136

AUGUST 19-20-21

VA - MCLEAN - Surveillance Expo '96. McLean Hilton. Michael Sheehan 718-437-0160

AUGUST 23-24-25

CT - VERNON - Eastern VHF-UHF Conference. Quality Inn & Conference Center. Mark 413-566-2445
WV - WESTON - WV State Convention. L. Ann Rinehart 304-768-9534

AUGUST 24

MA - DEDHAM - Computer Show. Holiday Inn Dedham. MarketPro Shows 201-265-1075
MA - GARDNER - Mohawk ARC Hamfest. John Dould 508-249-5905
MI - WESTLAND - Great Lakes Computer Expo. Wayne-Ford Civic Center. 313-416-1015
NJ - BRIDGEWATER - Somerset County ARS Hamfest. 4H Center. Pete 908-429-9093
NY - CHAFFEE - Hamfest. Manion Park. Pioneer Radio Operators Society. Michael 716-496-8241
TX - GAINESVILLE - Cooke County ARC Hamfest. Doug Covington 817-665-4924
WI - ONALASKA - Hamfest & Computer Expo. Omni Center. Riverland ARC & Western Wisconsin Radio Collectors Club. Dick Low 608-784-9176
WV - JACKSON'S MILL - Hamfest & ARRL Convention. West Virginia State Amateur Radio Council. Dave 304-462-7560

AUGUST 24-25

CA - VALLEJO - Computer Show. Solano Co. Fairgrounds. MarketPro. 415-456-6730
CO - WOODLAND PARK - Mountain ARC 15th Annual Campfest. Colorado Lions Campgrounds. Don 719-687-3692
CT - VERNON - VHF/UHF Conference. Quality Inn & Conference Center. Ron Klimas 860-768-4758
NJ - EDISON - Computer Show. New Jersey Convention & Expo Center. KGP Productions 908-297-2526

AUGUST 25

CA - BAKERSFIELD - Computer Show. Red Lion Inn. MarketPro. 415-456-6730
CO - GOLDEN - Computer Show & Swap Meet. Jefferson County Fairgrounds. Greg 303-444-2664
IL - DANVILLE - Vermilion County ARA Hamfest. Gary Denison 217-759-7389
IL - WOODSTOCK - Hamfest. Tri-County Radio Group. McHenry Co. Fairgrounds. 847-658-1678
MA - BOXBOROUGH - Computer Show. Holiday Inn. MarketPro Shows 201-265-1075
MI - CORUNNA - Five County Amateur Radio & Computer Swap & Shop. Shiawassee County Fairgrounds. Bay Area ARC. 517-893-3475
MI - GRAND RAPIDS - Computer Show. Crowne Plaza. 313-283-1754
MO - ST. CHARLES - Hamfest '96. St. Charles ARC. Blanchette Park. Scott Schultz 314-928-7267
NJ - MULLICA HILL - Gloucester Co. ARC Hamfest. John Lloyd 609-358-1285
NY - YONKERS - Hamfest/Computerfest. Yonkers Municipal Parking Garage. Yonkers ARC. John Costa 914-963-1021
TN - LEBANON - Hamfest. Short Mountain Repeater Club. Thomas Page 615-444-0233

AUGUST 30-31

LA - NEW ORLEANS - International DX Convention. Michael Mayer 504-486-6739

AUGUST 31

CA - ANTIOCH - Computer Show. Contra Costa Fairgrounds. MarketPro. 415-456-6730
CA - FRESNO - Computer Show. Fresno Fairgrounds. MarketPro. 415-456-6730
MA - GARDNER - Ham/Electronics Flea Market. Drive-in. MARC. Paul 508-632-9432
MI - TAYLOR - Computer Show. Democratic Club Hall. 313-283-1754
NM - ALAMOGORDO - Alamorgordo ARC Hamfest. Larry Moore 505-437-0145
WI - HAYWARD - Namekagon Valley Wireless Assn. Hamfest. Mary Lindberg 715-378-2368

AUGUST 31-SEPTEMBER 1

CA - SAN DIEGO - Computer Show. Scottish Rite Center. MarketPro. 415-456-6730
NC - SHELBY - Hamfest. Shelby ARC. June Melvin 704-739-2583

continued on page 116

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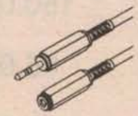

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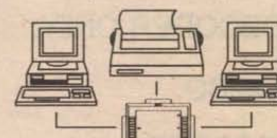

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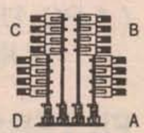

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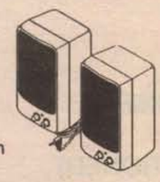

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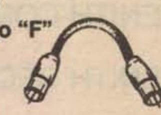

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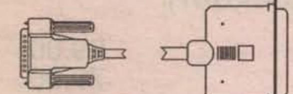

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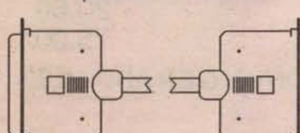

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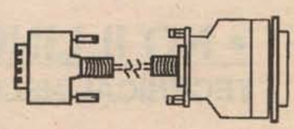

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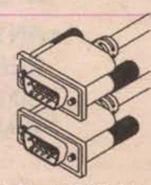

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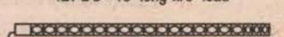

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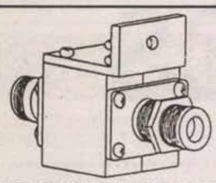

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Write in 91 on Reader Service Card.

MARINE WORLDWIDE SSB FREQUENCIES

by Gordon West

Your new $2,000.00 marine single sideband installation is finished, and the technician steps off the boat saying that his wattmeter was showing 100 watts of power output. He says your VSWR is nice and low, and this is meant to say that everything should be dandy for you to place radio calls all over the world.

Maybe not. Few marine electronic technicians will take the extra hour to show you how to run your new SSB set. "Just read the instruction manual," is the typical tech comment. Or, if you did get a few seconds or minutes of joint hands-on, the channel number scheme probably went in one ear, and has never been seen again.

"To talk local, you wanna go on 4A. They sometimes call that 4-alpha. It's good in the mornings, and 4-alpha on your set is 4-2. Some sets have it as 4-1, but that's really 4-S. You can look up this channel as 451, which is really 4146. Got it?"

The mysteries of SSB channelization get worse. Did you know that international distress frequency 2182 KHz may NOT be the best place to cry Mayday when you are halfway across the sea? And if you call Mayday on Coast Guard working channel 816 or 1205, they could be "duplexing" a weather report and not listening to their input frequency. So WHO do you call in an emergency, anyway, on marine SSB?

And what about making phone calls? Are you really charged $25.00 just for getting an answering machine? I am happy to report, NO.

So let's demystify that new marine SSB installation, and compare the channels and frequencies I list in this article with what is stored in your SSB memory.

ALL THOSE CHANNELS

Marine single sideband frequencies are assigned specific channels within certain MHz regions (see Table 1).

Each marine band of frequencies skips off the ionosphere and refracts signals back down to earth at different angles. Two and 4 MHz come back down relatively close into your vessel. Eight and 12 MHz are excellent for medium-range, day and night, skywave "skip" contacts. On 16 and 22 MHz, skywaves fade out at night, but offer the longest range during daylight hours. The best range usually follows the direction of the sun.

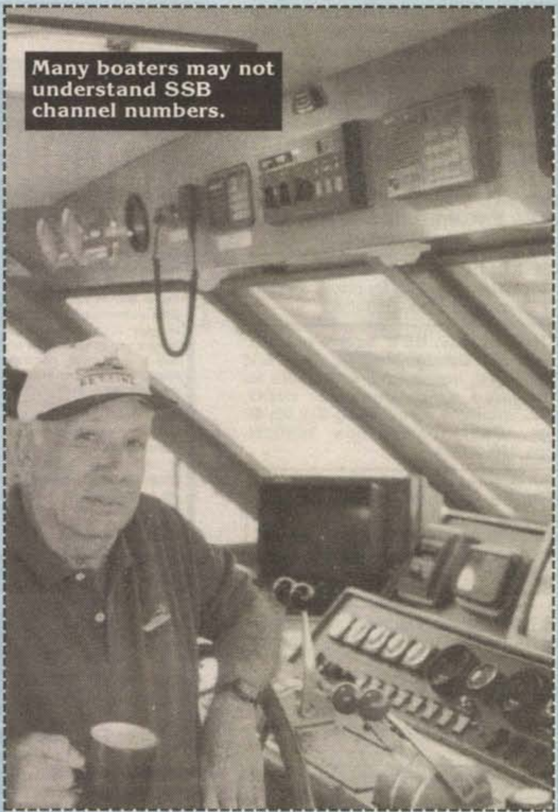
Choose the MHz range that will skip your signal to the approximate distance you want to reach. Eight and 12 MHz are the favorites during the day, and 4 and 6 MHz are the favorite bands during the night. Two MHz is clobbered with noise, and you won't get zip. Twenty-two MHz is too high for reliable daily contacts. Choose 8 and 12 MHz as your "bread and butter" bands.

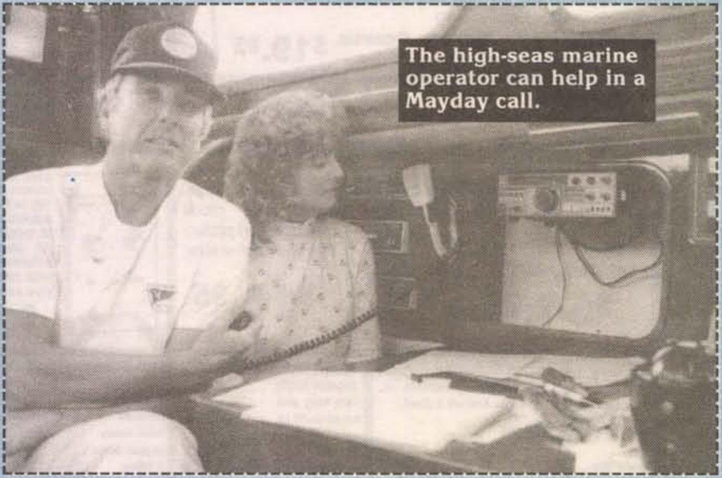
Marine radio channels are assigned ITU designators. ITU stands for International Telecommunications Union, and assigns commonality to every country's marine SSB set.

But there are differences between each manufacturer of SSB equipment on how they read out the channels, so stay tuned. More to follow.

Most 2 MHz frequencies have little use. Even 2182, the international distress and calling frequency. The range is so limited, you would do better to squawk Mayday on VHF Channel 16. Most 2 MHz frequencies go by their actual numerical frequency in KHz, not by three-digit channel designators. Lucky for us, a KHz readout on the radio dial is common among all marine SSB radios in every country.

Four MHz to 22 MHz marine channels are all listed by a three-digit or four-digit channel designator. An example would be marine Channel 401, or marine Channel 809, or marine Channel 1206. These channel numbers, common worldwide, are assigned to pairs of radio frequencies that make up a radio channel. Both the marine telephone companies of the world, and the United States Coast Guard and rescue agencies throughout the world, operate on frequency PAIRS where they transmit on one frequency, and listen on another. This is called DUPLEX. But you don't need to worry about the individual frequencies for ship transmit and ship receive because your marine SSB has all of these channels pre-stored in ITU memory. If you dial up marine Channel 808, your set automatically receives on 8740 KHz, and transmits automatically on 8216 KHz. It is pre-stored duplex, so all you need to worry about is the channel number and what service goes with which channel numbers.


Many boaters may not understand SSB channel numbers.


The high-seas marine operator can help in a Mayday call.

AT&T runs the high seas maritime radiotelephone services from three stations that serve this half of the world. From Australia to Africa, and everything in between, the AT&T marine operator offers you high-quality radiotelephone service on the channels shown in Table 2.

Choose the channel on a likely frequency that will skip your waves into the particular AT&T maritime services station closest to you. If you're in the South Seas, you might try Channel 1602 to AT&T coast station in California. If you're in the Caribbean, try AT&T coast station in Florida on Channel 403. And if you're sailing to Spain, you might to try AT&T coast station New Jersey on 1203.

Try tuning these channels in now and listen to the ship-to-shore traffic. You will hear only the shore side of the conversation because the ships are transmitting duplex. Phone calls cost under $5.00 a minute, with no land-line charges. There is a three-minute minimum, so once you start gabbing, go for three minutes and make it a $15.00 bill.

If you get an answering machine, tell the operator to cancel the call, and you pay nothing. Radio checks with AT&T are free. Calling the Coast Guard through AT&T is also free. What? Calling the Coast Guard through the high seas marine telephone service? Why?

COAST GUARD CHANNELS

2182 KHz - distress	816
424	1205
601	1625

These are United States Coast Guard working channels and are not necessarily monitored 24 hours a day for a distress call. These are the channels where you will hear automated Coast Guard weather. It is digital speech synthesized, and will sound like someone sitting on a fish hook.

If you need the Coast Guard anywhere in the world, call on the high seas marine operator duplex channels. I guarantee they are listening because they're looking to make money on an incoming phone call. They won't make money on a Coast Guard call because they will patch you through, free. But once your situation is stabilized, the Coast Guard will ask you to switch over to one of their working channels. Suggest a channel near the MHz band you are presently going through the marine operator on. Just look at your radio dial — if it's reading 1201, then you are on the 12 MHz band. You would suggest to the Coast Guard you can work them on ITU Channel 1205. Switch over, and you will hear their friendly voice.

The Coast Guard tracks commercial shipping all over the world on a computer in New York — and if you need help or evacuation anywhere out on the sea, they can probably find someone within 300 miles near you and request them to divert and lend assistance. This is part of the Coast Guard's AMVER program.

Any idea what 7.2940 J3E means?

Unlike ham radio sets, marine SSBs may show ITU channel designators, not frequencies.

SHIP-TO-SHIP

Here is where SSB radio manufacturers have split from the normal simplex channeling scheme. Table 3 shows the ITU channels that SHOULD come up on your marine SSB for ship-to-ship safety and routine calls.

Not all marine SSB transceivers list these ship-to-ship channels by the ITU duplex number. Most ICOM marine SSB transceivers list ship-to-ship simplex frequencies by the MHz band, a hyphen, and numbers 1 through 9. Sometimes the number 1 and 2 correspond with ship-to-ship A and B channels, yet other times they number up from the safety channel so A now becomes "-2." But not to worry, just double-check the frequency with the ship-to-ship channels and frequencies I have just listed, and go with the frequency and don't sweat the unique ICOM numbering system. It's the same channel.

TABLE 1

Channel	MHz	Approximate Range
2XX	2 MHz	100 miles day; 300 miles night
4XX	4 MHz	300 miles day; 800 miles night
6XX	6 MHz	400 miles day; 1,000 miles night
8XX	8 MHz	500 miles day; 1,200 miles night
12XX	12 & 13 MHz	800 miles evenings; 2,000 miles days
16XX	16 & 17 MHz	Unreliable evenings; 4,000 miles days
22XX	22 MHz	Daytime only band, worldwide

The safety channels are restricted to navigation, safety, and weather information, similar to what takes place on marine VHF Channel 6. No gabbing on the marine SSB safety channels. The marine ship-to-ship channels may also be used by private coast stations so you can talk from ship to shore and bypass the marine operator. Towing and salvage companies, plus marine stores regularly conduct business on ship-to-ship channels 4A, 8A, and 12A. Now go back to the list and double check the frequencies:

4A = 4146 KHz
8A = 8294 KHz
12A = 12,353 KHz

Now find these channels on your own SSB radio, and verify the channel number agreeing with the actual ship-to-ship/ship-private coast shore frequency.

WEATHER FACSIMILE

Unbelievably, no marine SSB manufacturer loads high-frequency weather facsimile signal frequencies into memory. You get to do that because the technician that just stepped off the boat said it was not his job to do it. Most marine SSB transceivers offer 100 channels of user-programmable memory, and you load in the SSB channels in KHz, making sure to deduct 1.9 KHz from the listed carrier frequency. The best book listing worldwide radio facsimile weather transmitting stations and frequencies is from Alden, and costs about $20.00 by phoning 508-366-8851. Coincidentally, Alden is getting out of the weather facsimile machine and receiver business, so better get your book quick because this will probably be the last printing. You can also order the book through the Superintendent of Documents, but I don't even need to tell you what an experience that would be. For you brave souls, the book is US Government *Selected Worldwide Marine Weather Broadcasts*, and you should also pick up *Admiralty Lists of Signals, Volume 3* and have fun dealing with the government's bookstore. But I'll give you a head start (see Table 4).

You might also memorize aeronautical East Coast and West Coast tower channels 13,282 KHz and 13,270 KHz. I would also fill up one of those user-programmable memory channels with 13,300 and 5547 KHz, both upper sideband, aeronautical in-route frequencies. If you can't raise the Coast Guard in an emergency, squawk Mayday to an airliner! It's been done before.

Marine SSB manufacturers have been seen advertising their marine sideband as being type-accepted for amateur radio use, too. Not exactly. A ham radio does not get type-accepted like a Part 80 marine radio. A ham radio can really be any kind of radio, including a marine radio. But a ham radio can't be a marine radio when the marine radio is a marine radio. Figure that one out.

FCC rules prohibit a marine radio being shared with another radio service. But if you are a voluntary-equipped sailboat, you are not required by law to have a marine radio onboard — so one day you consider it a marine radio, and the next day you consider that marine radio a ham radio. Trust me. It works, but only if the marine radio has capabilities already unleashed as a ham radio.

SGC 2000, including ADSP head
ICOM IC-M710
ICOM M700

You would memorize the ham frequencies into any one of the 100 user-programmable marine channels.

3968 KHz, lower sideband, West Coast marine nets

The frequency 2182 KHz is not a great frequency to place a long range Mayday call.

KMI/CA	WOM/FL	WOO/NJ
804, 809, 822, 1201, 1202, 1203, 1229, 1602, 1603, 1624, 2214, 2223, 2228, 2236	403, 412, 417, 423, 802, 810, 814, 825, 831, 1206, 1208, 1209, 1215, 1223, 1601, 1609, 1610, 1611, 1616, 2215, 2216, 2222	410, 411, 416, 808, 811, 815, 1203, 1210, 1211, 1605, 1620, 1626, 2201, 2205, 2210, 2236

TABLE 2

7268 KHz, lower sideband, East Coast waterway net

7238 & 7294 KHz, lower sideband, morning West Coast nets

14,300 KHz, upper sideband, 24-hour ham maritime mobilenets

Channel	Frequency	Use and Designator
450	4125 KHz	Safety, "4S"
451	4146 KHz	Ship-to-ship, "4A"
452	4149 KHz	Ship-to-ship, "4B"
453	4417 KHz	Ship-to-ship, "4C"
650	6215 KHz	Safety, "6S"
651	6224 KHz	Ship-to-ship, "6A"
652	6227 KHz	Ship-to-ship, "6B"
653	6230 KHz	Ship-to-ship, "6C"
654	6516 KHz	Ship-to-ship, "6D"
850	8291 KHz	Safety, "8S"
851	8294 KHz	Ship-to-ship, "8A"
852	8297 KHz	Ship-to-ship, "8B"
1250	12,290 KHz	Safety, "12S"
1251	12,353 KHz	Ship-to-ship, "12A"
1252	12,356 KHz	Ship-to-ship, "12B"
1253	12,359 KHz	Ship-to-ship, "12C"
1254	12,362 KHz	Ship-to-ship, "12D"
1255	12,356 KHz	Ship-to-ship, "12E"
1650	16,420 KHz	Safety, "16S"
1651	16,528 KHz	Ship-to-ship, "16A"
1652	16,531 KHz	Ship-to-ship, "16B"
1653	16,534 KHz	Ship-to-ship, "16C"
2248	22,159 KHz	Ship-to-ship, "22A"
2249	22,162 KHz	Ship-to-ship, "22B"
2250	22,165 KHz	Ship-to-ship, "22C"
2254	22,168 KHz	Ship-to-ship, "22D"
2255	22,171 KHz	Ship-to-ship, "22E"

TABLE 3

14,340 KHz, upper sideband, West Coast 11:00 am mañana net

14,313 KHz, upper sideband, Pacific evening maritime net

You need a ham license to talk on these frequencies, but you don't need a license to listen. Indeed listen and glean great weather information. In an emergency, you can holler for help on these frequencies without any questions asked. But it better be a real life-and-death emergency. You know how hams are. I'm one of them, too!

Finally, your SSB transceiver should be put into the AM double sideband mode, and the time signals and shortwave broadcast signals memorized to get up-to-date weather information, the correct time, and the latest news from BBC and Voice of America.

5, 10, 15, and 20 MHz time signals
5975 KHz AM shortwave
7435 KHz AM shortwave
9575 KHz AM shortwave
11,835 KHz AM shortwave
13,760 KHz AM shortwave
15,120 KHz AM shortwave

Tune anywhere around these AM shortwave frequencies for plenty of foreign and USA broadcasts.

BUT IS MY RADIO WORKING?

Even though the FCC rules have changed regarding small boats and relaxed VHF license requirements, for marine SSB you indeed need a ship station license with all of the proper SSB, VHF, EPIRB, and radar categories checked off. The fee is about $75.00 for a 10-year license, and you need it.

Your best radio check is with the high seas marine operator. You must call them for a minimum of 45 seconds in order for them to beam you in with their massive antenna systems.

A quick call will lead to no contact. Make it a long call, giving your vessel name, official FCC call sign or ship registration number, your position, the ITU channel you are communicating over, and repeat the process over and over and over and over again for 45 total seconds. Close talk the mike — push the plastic right up against your lips. If you talk six inches away from the mike, your power output will be zilch. SSB mikes are all noise-canceling, and you must absolutely touch the mike to your lips to get a signal out on the airwaves.

As you talk, you may notice your panel lights blinking, your anemometer exceeding 100 knots, your electric head going into the masticate mode, and various other pieces of marine electronics including autopilots going nuts on transmit. This is perfectly normal. It means you're putting out one walloping signal. You must live with it. There is no simple cure.

Your radio check to the marine operator should finally achieve success on one of their working channels. If one MHz band doesn't work, dial in another marine operator in another part of the country, and give THEM a try. Or tail in at the end of another ship contact when the marine operator is ready to sign off. If you can hear the marine operator well, they should pick you up well.

One of the best radio checks is from the technician that is charging you top-dollar to install the marine SSB. Don't let them off the ship until they reach a marine operator at least 1,000 miles away and get a good radio check on the air. Accept no excuses. If the technician installing the equipment can't raise someone more than 1,000 miles away for a radio check, don't pay your bill. I have seen marine SSB installations that look good on a wattmeter, but over the air sound like dog poo.

An improperly installed automatic antenna tuner cable rectifies the RF wave and brings it back into the radio, scrambling your audio to sound like you are talking underwater. You can't see it on a meter, but you'll sure know you have this problem if absolutely nobody comes back to your request for radio checks.

With more and more radiotelephone calls going satellite aboard ships, be assured that the high seas marine SSB radiotelephone service is looking for more activity out there on the airwaves, and the technicians are eager to get you into their computers and will regularly run radio checks with you to give you the confidence of knowing they can reach out almost anywhere to take your incoming or outgoing phone call. Radio checks are free.

Have I been hard on marine electronic technicians or marine SSB manufacturers in this article? Quite frankly, yes. The technicians are quick to install the equipment, and immediately jump ship without spending an extra hour or two showing you how to run your new expensive investment.

The marine SSB radio manufacturers are shipping out equipment more designed for the radio guru than the active sailor with other things on the mind rather than is 451 really 4-1 or is it really 4-alpha? ICOM America M810 marine SSB has the capability of the technician programming the screen to read out the channel use, in addition to just the channel number and frequency. Great idea if they will just do it.

A marine single sideband is a powerful communications device for worldwide cruising and sailing. Know its capabilities, and know what the channels can do for you. There is absolutely nowhere in the world that you could cruise that you couldn't get back to a shore-side station on marine SSB on one of the MHz bands. EVERYWHERE there are domestic and foreign shore-side stations ready to take your duplex channel activity.

The modern marine SSB has all of these channels in memory, and now you have a better idea of where to go to make that ship-to-ship, or ship-to-shore, or emergency distress call. NV

HOT WEATHER FACSIMILE CHANNELS
all upper sideband

Pacific Coast	8680.1 KHz
Pacific Coast/long-range	12,728.1 KHz
Hawaii	11,088.1 KHz
Pacific/Hawaii	16,133.1 KHz
Hawaii	9980.6 KHz
New Gulf frequencies	8506 KHz & 12,788 KHz
Boston	6340.5 KHz
Atlantic	10,863.2 KHz, 12,748.1 KHz, 8078.1 KHz, & 15,957.1 KHz

TABLE 4

CABLE TV *cont.*

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NOW AVAILABLE "The CATV Suppliers Catalog." Nine-page listing of companies selling descramblers, converters, filters, turn-on chips, quickboards, and accessories. Catalog currently updated May 1996. No filler names used. All phone numbers active. Send $12 to: APC, PO Box 34090 Dept. NV66, Chicago, IL 60634-0090.

ZENITH 1000, 1086, 1600. Call: 405-631-1856.

CBTV CONVERTERS: RX-400-DIC, RZ-DIC: $59. Pio BA-5XXX: $150, BA-61XX $175, 63XX: $200, Stealth 1000-P: $49, FTB-3 $49; M-80, Pio-Brown; 63XX, green: $69. We carry most Pan-cake. Call for low-cost, 60-channel plain converter only: $29. Tel: 405-634-1535, FAX: 405-634-1587.

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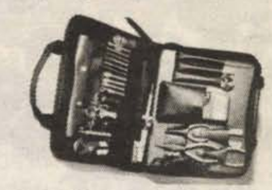

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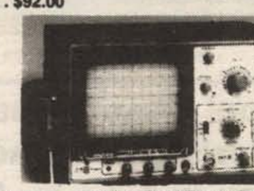

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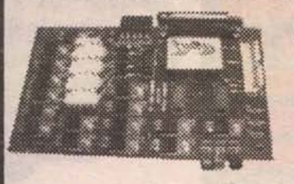

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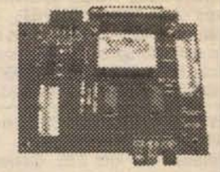

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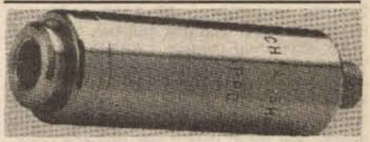

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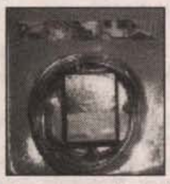

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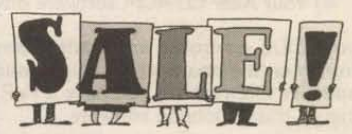

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Write in 154 on Reader Service Card.

of four. Most EIDE controllers come configured with only the A channel enabled. From the description of your symptoms, I can guess the following, in the order of likelihood.

1) You're trying to connect three IDE peripherals to channel A. This will lead to a conflict that'll lock up the system.

2) Channel B is enabled, but the interrupts are not set properly. To distinguish between the two channels, the primary channel is assigned to IRQ14 and channel B uses the IRQ15 interrupt. If this conflicts with another of your adapter boards, you'll have to make changes accordingly.

3) Channel B is disabled, and you've already installed the new Acer drivers, in which case, the system could lock up because the software can't find the CD-ROM.

4) Your Acer CD-ROM software driver needs upgrading.

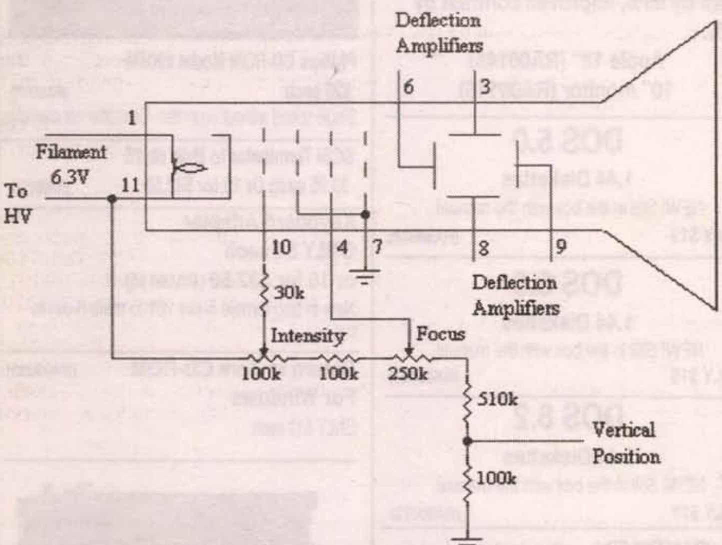
If your EIDE controller was made before PnP (Plug-and-Play), there are jumpers on the board which select which channels are active, and their respective interrupts. If you have a PnP EIDE controller (generally of the PCI variety), this is done in software.

Vintage Oscilloscope Needs Fixing

Q. I have a Jackson wideband oscilloscope model CRO-1. Does anyone have a schematic drawing for this instrument, or for any scope using a 5UP1 tube? Actually, a partial schematic showing the pinout connections of the tube, and those parts and wires associated with the filament, cathode, control, focus, and power supplies for the same is all I need.

John W. Lippert
Menomonee Falls, WI

A. Here's the schematic for a similar oscilloscope from the same era.



The fact that you specifically requested just this section of the circuit leads me to believe you either have a focus or a brightness problem. Before you spend a lot of time on troubleshooting, spray the controls with a good tuner cleaner (like Radio Shack part number 64-3320). Next, check the voltages around the CRT using the chart below.

Pin Number	Voltage	Comments
1	-1380	Filament
2	0	
3	+100 to -100	Deflection plate
4	-1100	G3, focus
5	0	
6	+100 to -100	Deflection plate
7	0 G2	
8	+100 to -100	Deflection plate
9	+100 to -100	Deflection plate
10	-1380	G1, intensity
11	-1380	Filament, cathode

This test will show you if one of the divider resistors is open (the most likely cause). Pay special attention to the 100 K resistor between the Intensity and Focus controls. It's a 1 watt device, which means it runs quite hot and is usually the first to fail. Just remember that you're dealing with very high voltages here, so don't be tempted to place your finger on the resistor to see how hot it's running.

How To Fix A Confused Monitor

Q. I was given several Zenith 1390 VGA monitors. But so far I have only been able to power up one of them, and not too well. When I connect it to an Orchid Pro Designer Plus VGA adapter, the picture acts like the horizontal frequency needs to be adjusted. Two or three images appear, continuously scrolling from side to side. When I first power up the monitor, the images move right to left, slow, stop, and then move left to right. The symptom is similar to the old TV sets where you could adjust a coil on the back of the set to achieve the correct display. But, I don't have a schematic and the only adjustable coil is the width coil.

Don Oldfield
via Internet

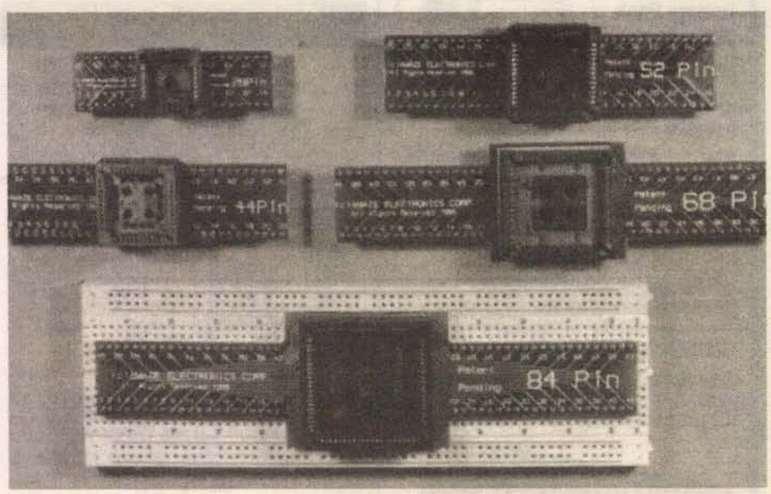
A. Yes, this is a classic "old TV" symptom. The problem is the lack of sync. Since both the horizontal and vertical are affected, I suspect a power supply problem. I once had this happen to an NEC 3D monitor. The problem turned out to be a burned 100-ohm resistor feeding the sync circuit. It was easy to find because it looked like a crispy critter. Simply replacing the resistor solved the problem. BTW, the most common failure of this monitor is the CRT, which costs more than the monitor itself, followed by flyback transformer breakdown (see "It Has A Familiar Ring" elsewhere). Unlike most 14-inch monitors, which operate at 14 KV, the 1390 powers the CRT with 25 KV — which puts a lot of stress on the components. In fact, it's the only monitor I know of that has it's own cooling fan. You can obtain a schematic of the Zenith 1390 monitor from Howard W. Sams (**800-428-7267**). Unfortunately, it's not listed as the Zenith 1390 or 1390A (Zenith was changing hands and its name to ZDS at the time). According to the Sams librarian I spoke with, you'll have to go to a Sams distributor and look through the catalog and folders to find it (use the manufacturing date on the back of the monitor to zoom in). When you locate it, please drop me or Sams a line so that it can be cross referenced. Thanks!

SMT Breadboard Adapters

Q. I would like to use the Motorola MPS13176 AM/FM transmitter IC to establish one end of a 320-MHz AM data link. The problem is that this IC only comes in a surface mount package, and I've never worked with SMT devices before. In fact, I have never even etched a PCB — I use breadboards instead. If you could help me with the actual circuit layout for etching the board, and be so kind as to provide pointers for mounting the chip onto the board, you would make me the happiest kid on the block!

Lesley Yaldizian
San Francisco, CA

A. The MPS13176 comes in a SMT package because of the high frequencies involved. The stray inductance on a leaded IC would cause the circuit to be unstable. First, I'd obtain a data sheet or an application note on this semiconductor from Motorola Literature at **800-441-2447**. Many times, Motorola data sheets show a typical circuit design with a printed circuit layout pattern. If this is the case, you can transfer the pattern to a copper clad circuit board using iron-on artwork materials supplied by Dyna-Art Designs (**805-943-4746**) or Techniks, Inc. (**908-788-8249**). Etching the board itself will require a kit of chemicals, like that from Radio Shack (276-1576). You'll also need special SMT solder paste, this will hold the chip in place, and special soldering tools. Check out your new main library for more information on the technique.
For those readers with lower-frequency demands who would like to experiment with SMT devices in solderless breadboard and wire wrap applications, you can buy surface mount adapters from Digi-Key (**800-344-4539**), under the brand name Surfboards from Capital Advanced Technologies, and Amaze



Electronics (**800-996-2008**). The Amaze PLCC adapter (above) are available in 28, 44, 52, 68, and 84 pin sizes.

I Want To See Double ... And More

Q. I'm looking for a circuit that will allow me to display four NTSC signals simultaneously on a monitor. My application is my home security system. I have four cameras mounted around the house and currently switch the input from one camera to the next. I would like to view all four on one screen — one

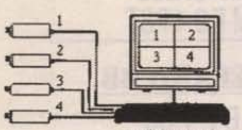
Electronics Q & A

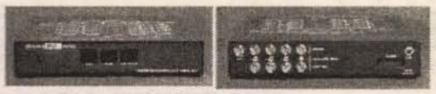
in each quadrant. I assume that I need to strip out the sync signals and recreate new ones, but I'm not sure how to do it. Any help or schematics that you could offer would be greatly appreciated.

Matt Van Steen
via Internet

View and Record 4 Video Cameras on One Screen

or Picture in Picture





This professional quad screen splitter combines 4 separate video camera signals into one signal for display or recording. Select All 4 simultaneously on screen, full screen in sequence, picture in picture (2 cameras static), picture in picutre sequencing (one camera static and 3 sequencing) or full screen. Alarm inputs allow automatic full screen call up. Individual input brightness control. Loop through outputs. Black and white operation only. BNC input/output connectors.

Our Price: $559

A. Why reinvent the wheel, when you can buy what you're looking for cheaper? For just $559.00, you can buy a four-panel video display compressor from Home Automation Systems (http://www.techmall.com/smarthome/7720.html; **800-762-7846**) that interfaces directly with your existing security system. Two panel and switched display controllers are also available.

Homebrew Movies

Q. I have seen some multi-tracked video tapes with images that are faded, layered, and phased to create different effects. I have always wondered how this is done. I know there is professional equipment that's used by the large studios, but I want something cheap and effective.

T. Gold
Clearwater, FL

A. It's done using video mixers and pattern generators. They go under the generic name of video editors. Basically, there are two ways to create the special effects you ask about. The most effective method to use a computer and special software, like DC1 Pro from Miro Computer Products (**617-329-5400**) and TelevEyes from Digital Vision (http://www.digvis.com; **415-855-0940**). A good entry level book is *Introducing Desktop Video* by Tom Benford, 2329 Hwy. 34, Suite 201, Manasquan, NJ 08736 ($34.95). A cheaper route is to process the video using VCR-based video editors, like those from Radio Shack (**800-843-7422**) and Videonics (http://www.wholesaleproducts.com/videonics.html; **800-843-3697**). Check out Bob Hoffman's article at http://edweb.sdsu.edu/edweb_folder/EET/Video_Editing:Video_Editing.html for an overview of the computer-less process.

Where To Get HP Service Manuals

Q. I have an HP 3465 benchtop multimeter that I need help with. The unit works fine for a short period of time, then shuts down completely as if losing

Continued on page 118

THE LASER EXPERIMENTER

Conducted by
Anthony Charlton

Welcome! There are several types of radiation detectors around. We did a construction article on one back in the Mar. '94 issue of Nuts & Volts. That type used a Geiger-Mueller tube which could register "hits" by alpha, beta, gamma, and x-ray radiation. While that type is useful and sensitive, the output is audio. We also supplied a digital signal for counter circuitry or computer tracking of radiation events.

We hope the following *Intermediate Level* Project is different, and perhaps more fun since you can SEE the tracks of the radiation particles with the help of a laser, and then can discern the difference between the three types of ionizing, detectable radiations, by which can be seen in our homemade chamber by eye. A helium-neon laser is used as the illuminating light source, although you can use other bright lights such as a slide projector. A rotating laser scanner would be helpful for illumination. We shall leave the light source and/or laser details up to the builder, because there are many possible configurations and we'll not constrain the builder with one version.

This design will not show x-rays unless they're of very high energy. And there is no safe way for laser experimenters to generate x-rays of such power without expense and an extreme health risk. We will use a small, safe, but potent source of radiation which is easily seen in this chamber. The source is a tiny pellet of Americium 241 imbedded in a metal clasp, which can be found in any ionization-type smoke detector (a photodetective smoke detector will not contain any radioactive material). If you have an old detector, you can rob its source, or go out and buy a model on sale, which only will cost you five or six bucks for a cheap no-frills model purchased from a chain store. The source is removed from its plastic holder by carefully deburring or cutting the plastic rivets.

Laser-Assisted Radiation Detection Apparatus

Figure 1 shows the basic construction details of a home-built radiation detector where you will SEE the particles. It is called a Cloud Chamber. The design is one which has been in use for years and years. School science supply houses still sell kits to assemble a similar Cloud Chamber.

The advantage of the laser here is in its brightness. You can expand the beam with a plano or double convex lens, and see the particles much better than with conventional light sources. **We repeat our long-standing caution here not to gaze into the beam or look at strong reflections.**

A one milliwatt laser should be fine for observation, but a stronger laser shouldn't be used. Why? Because of its more powerful brightness. Position the laser so it shines into the radioactive source about one to two feet away; using an expander lens would be ideal. Figure 1 shows the apparatus from two different perspectives.

Radioactive Source is Very Visible

The Americium 241 source used for this experiment has a strength of one micro Curie. One Curie equals 3.7 [10] radioactive particle disintegrations per second, so this quantity would amount to 37,000 disintegrations per second if the Americium 241 is fresh. It should be fresh, because its half-life — or the length of time the material will diminish by one-half its radioactive strength — is reported to be 432 years {1}. It is a strong Alpha emitter, and the good part of Alpha radiation is it does not travel in air more than a few inches. It'll never get out of our Cloud Chamber.

There is a small amount of gamma radiation emitted from this material, however, I have never seen that get out of the chamber either. You'll see the particles as a haze next to the source. The Cloud Chamber will operate periodically as the vapor reaches saturation, and then becomes de-saturated.

Expect to see the particles sometimes and sometimes not. Of course, once the dry ice evaporates, it will stop functioning.

Handle the Americium source with caution. Even though the particles don't travel more than a few inches in air, use rubber gloves and forceps when using the material. The gloves will stop the Alpha particles from penetrating your skin. Even a piece of paper will stop the particles. Try this in your Cloud Chamber.

Another interesting experiment is to position a piece of aluminum foil a small distance from the Americium. Once in awhile, you'll see a particle knocked out of the foil. I think these are aluminum nuclei, but it's difficult to detect this with this simple apparatus.

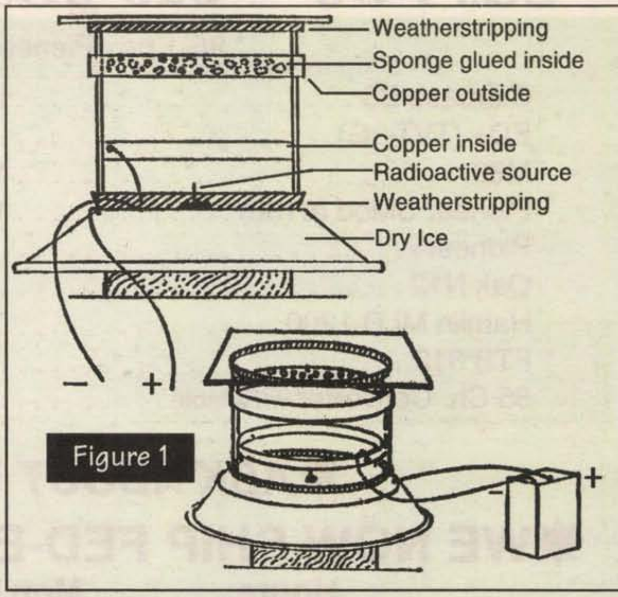


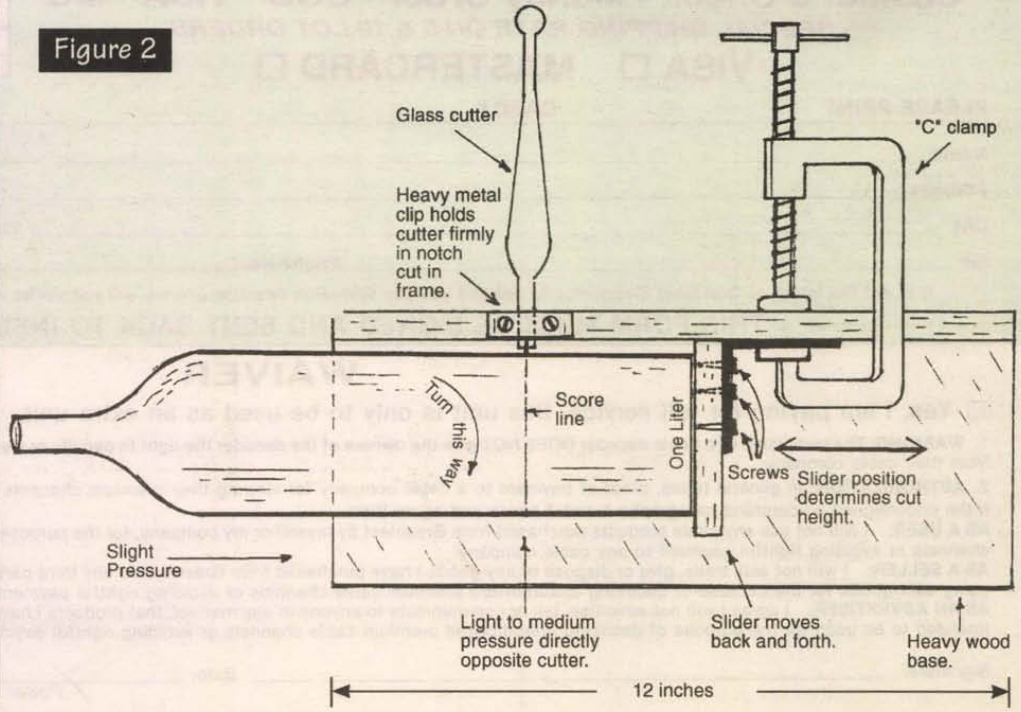
Figure 1

Supercooled Dry Ice Enhances an Alcohol Detection Mechanism

The apparatus works by this principle: Alcohol vapor is released from the sponge glued at the inside top of the glass containment chamber. This vapor becomes supersaturated as it is cooled by the metal of the pie tin which is in contact with a block of dry ice. That is at a temperature of 108 degrees below zero! Thus, there is more vapor in the lower part of the chamber's air than could normally exist without condensing. Any radioactive particle(s) passing though this supersaturated layer, ionizes some of the alcohol vapor and also many air molecules, thus leaving a nice track which the bright laser beam highlights for you to see.

Shellac thinner or pure grain alcohol, the latter of which which can be purchased at a package store {2}, will successfully operate the apparatus. However, the shellac thinner is about 1/4 the price. Anhydrous 99%

Figure 2



THE LASER EXPERIMENTER

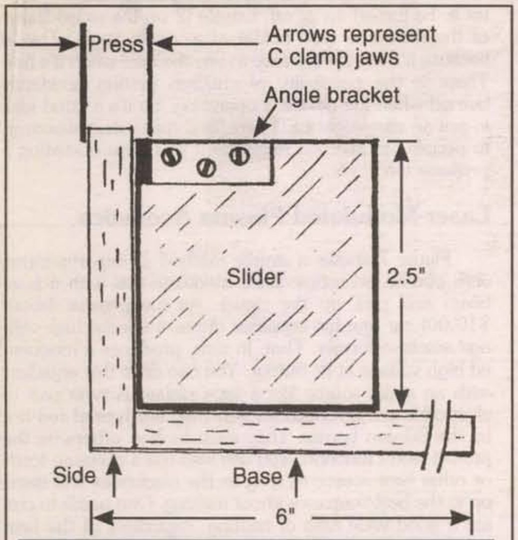


Figure 3
End view of slider shows how the "C" clamp presses the angle bracket firmly against the side of the scoring jig's base.

isopropyl alcohol, purchased from a pharmacy may work, although I haven't tried this chemical yet. Needless to say, use caution and don't breathe in any quantity of these chemicals. Especially the ispropyl alcohol or shellac thinner, both of which are poisonous if ingested. Keep in mind a LITTLE bit of the fumes won't hurt you though.

A small amperage, high-voltage DC supply clears the chamber of dust particles and stray ions present in the air via electrostatic attraction. Both would tend to produce fog in the chamber and thus obscure observation of radiaoactive decay products. There is a good deal of latitude here concerning the HV supply.

First, it's GOT to be low enough in amperage so as not to present a shock hazard! Surplus self-contained micro-ampere range power supplies are occasionally available from several advertisers in *Nuts & Volts* (however, on an occasional basis, as with any surplus items). An ideal type is called a "PTK" power supply, which produces about 10 KV at several microamps. I have used these for various projects; they usually require a 9-12 VDC battery or regulated supply. PTKs are available for as low as $5.00. Any supply from 2 to 10 KV is fine, as long as you obey the amperage caution.

An alternative is to build your own power supply. I'll be happy to provide a FREE life-size pattern and data, from which you can make your own PC board and power supply, for just about $15.00. This is relatively easy to do now that such material is available like the Toner Transfer paper manufactured by Dyna-Art Designs {3}. They will sell you this paper directly. Or you can buy it from Digi-Key. Our PCB pattern is nice and big, so you have plenty of room to work with. Even novices can easily assemble their own 12 VDC powered supply for this or other projects. Write to The Laser Experimenter's P.O. box for this material.

. Construction of the Cloud Chamber is simple enough. You have to obtain a one-gallon mayonnaisse jar, clean it out thoroughly, and cut the neck and bottom off. Delicatessens throw these out. They would be happy to give you some jars, especially if you buy a lunch there!

Cutting is easy to do with the simple glass-cutting apparatus described shortly. Part of the key components of the Cloud Chamber apparatus are two copper bands formed from standard copper roof flashing.

They serve two purposes. {4} The first is a thermal conduct, positioned on the outside of the jar, used to help vaporize the alcohol in the sponge by conducting room heat through the glass of the apparatus. The second band, positioned inside, serves as the negative terminal. The positive terminal is connected to the pie tin. Wire for this connection is run under the bottom of the jar.

Insulating the pie tin will help to greatly conserve the dry ice for several hours of continuous operation. An ideal insulation is the pink fiberglass material used for households. Set the dry ice on some wood covered with a thin layer of the fiberglass. About 1/2" will be adequate. You can separate the fiber into any thickness if carefully done. Be sure to remove the fiber from its backing. Gloves are necessary for this project, as the glass fiber (sans gloves) tends to get all over one's body and causes a miserable lasting itch if it does so.

Anticipate condensation and water-ice. Of course, nothing at -108 F is going to avoid condensing SOME moisture out of room-temperature air. Use weatherstripping on the top and bottom of the jar, inside and out (see Figure 1), to effect a good seal for the thermal containment area of the Cloud Chamber. A caulking of Vaseline or Silicone adhesive will insure an airtight vessel. While the apparatus is at room pressure, the better the seal, the better its function. Plus it will help to conserve the dry ice. The top cover originally was made from glass, but a better, less fragile, and more thermally insulating material would be Plexiglass or Lexan. Those can be cut by scoring with a razor blade or an angle-bladed Stanley knife.

Glass Bottle Cutter

While not laser-related, I thought I'd share this project with you, so that you can enable easy cutting of the gallon mayo jug used in the Cloud Chamber — and other bottles you wish to cut. Including glass tubing (home Chemists take note!). This apparatus allows you to make dozens of useful items from old glass bottles, such as Petri dishes from glass beer or soda containers (helpful if you're into bacteria or microbial culturing). Your imagination is the limit; one can even make pretty wind chimes from Pyrex tubing if one is artistically inclined. This is a *Beginner Level* type of project.

The assembly consists of three major parts. The first is a simple scoring jig made from hard pine or hardwood. This is shown in Figure 2. A window glass cutter is secured in the wood frame using a metal clip. Note the slider assembly (detailed in Figure 3) held by the "C" clamp. Here we show a one-liter wine bottle in the process of being scored. A clean, even score will assure the bottle will cut all the way around, and where you want it to be cut. Practice scoring several bottles until you get the hang of it.

Keep in mind the score does not need to be deep. But it wants to be even and continuous. Lubricate the wheel of the cutter periodically with turpentine, kerosene, WD-40, or a light machine oil. This helps a lot. Don't go over the same score or it will dull the cutter in record time. Besides, it isn't necessary. Replace the cutter as soon as it starts skipping traces, or you'll find you have to put a lot of pressure on it to make a proper score. This is unlikely to make a good cut! Cutters cost about $1.00. What's a buck compared to the aggravation of having a poor job?

Next comes the hot Nichrome wire cutting element. This is shown in Figure 4. The element causes a thermal stress on the score line which creates a crack that evenly follows the score line as the bottle is rotated against the

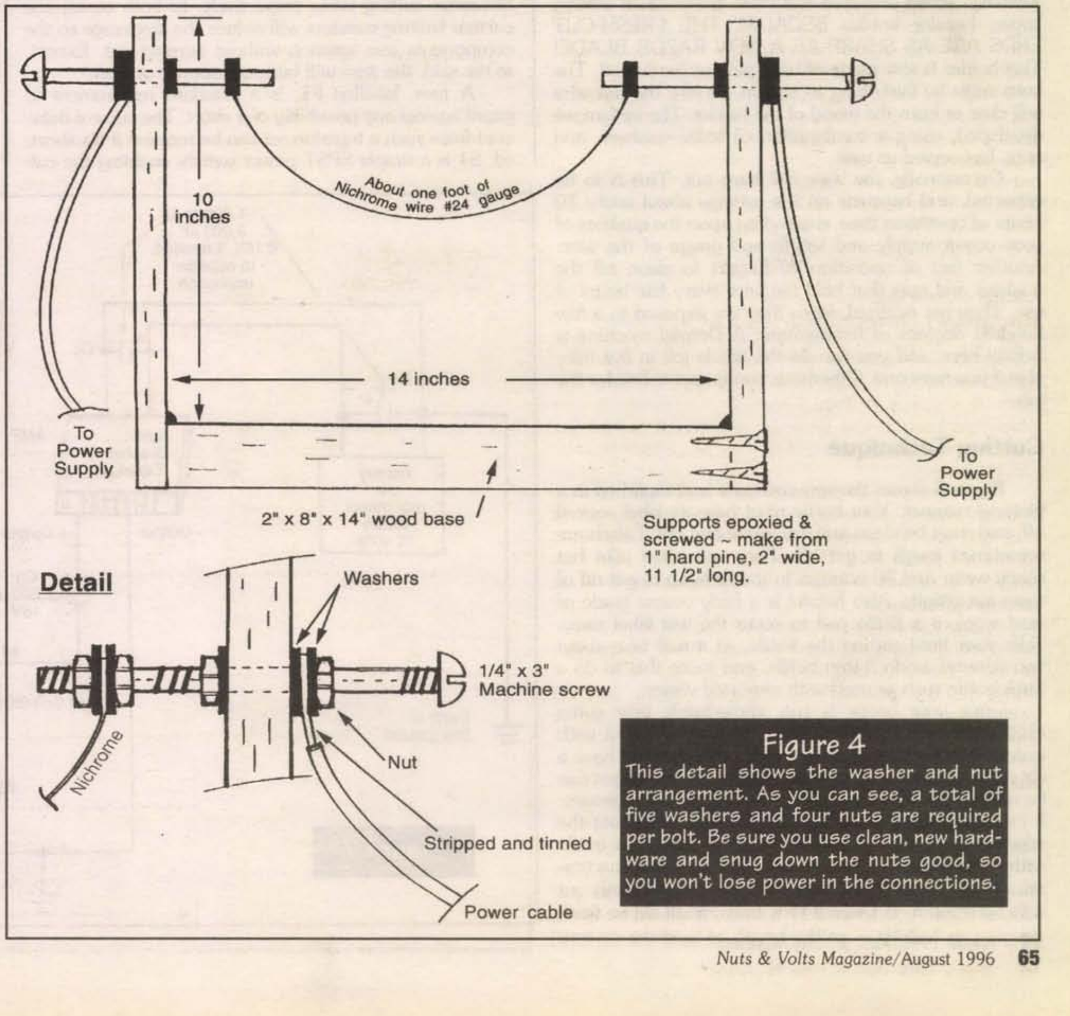


Figure 4
This detail shows the washer and nut arrangement. As you can see, a total of five washers and four nuts are required per bolt. Be sure you use clean, new hardware and snug down the nuts good, so you won't lose power in the connections.

Footnotes:

1} As per Pocket Ref, by Thomas E. Glover, c. 1993, Sequoia Publishing, Inc, Littleton, CO, ISBN #0-9622359-0-3. This fine book is carried by Digi-Key.

2} Grain alcohol is very high percentage, being 190 proof. This is over twice as strong as pure vodka! The shellac thinner would raise fewer eyebrows, eh?

3} Dyna-Art is listed in "Sources."

4} Copper roof flashing is available at any hardware store. Usually it's sold by the pound and cut by the inch. Don't let them try and sell you a whole roll of the stuff, or you'll wind up paying $50.00. An alternate is aluminum flashing, also usually sold by the inch. It's not as good a heat conductor though, so the performance of the Cloud Chamber will suffer somewhat if you make this compromise.

NOTE: Nichrome wire, gauge #24, is available from the author for $3.00 postpaid for a three-foot length.

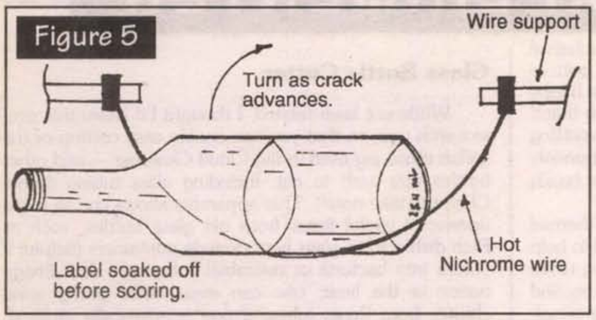


Figure 5

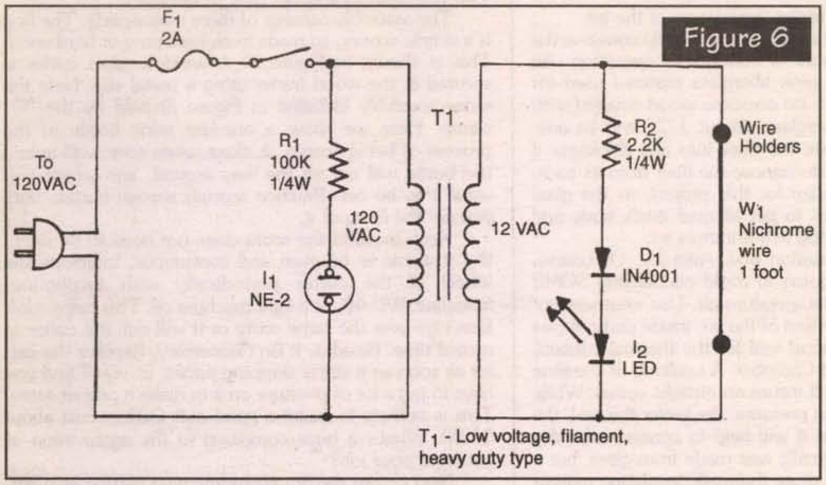


Figure 6

wire. Eventually the crack penetrates the thickness of the bottle glass, and once it travels the circumference of the bottle, the two halves fall apart. This can happen quite suddenly, so be prepared and wear gloves when cutting larger, heavier bottles BECAUSE THE FRESH-CUT ENDS ARE AS SHARP AS A NEW RAZOR BLADE! This holder is also made of hard pine or hardwood. The bolts must be fairly long as shown, or else the hot wire will char or burn the wood of the holder. The system we developed, using a combination of bolts, washers, and nuts, has served us well.

Occasionally, the wire will burn out. This is to be expected, and happens on the average about every 10 hours of operation time, depending upon the qualities of your power supply and length and gauge of the wire. Another fact of operation is: Expect to clean off the washers and nuts that hold the wire every few hours of use. They get oxidized, since they are exposed to a few hundred degrees of temperature. A Dremel machine is helpful here, and you can do the whole job in five minutes if you have one. Otherwise, sandpaper is fine for the job.

Cutting Technique

Figure 5 shows the way cutting is accomplished in a pictorial manner. Your bottle must have its label soaked off, and must be clean and dry inside and out. Labels are sometimes tough to get off. They will often take hot soapy water and 30 minutes in the dishpan to get rid of them sucessfully. Also helpful is a fairly coarse grade of steel wool or a Brillo pad to scour the wet label away. Take your time cutting the bottle, as it will take about two minutes to do a thin bottle, and twice that to do a thick bottle such as used with imported wines.

Once your bottle is cut, immediately take some #320 Wetordry or crocus-cloth sandpaper, wet it with water, and smooth the sharp edges so you don't have a cut hazard. After several minutes of work, the edges can be reliably made safe enough, even for drinking glasses. It just takes a little patience and an eyeball to note the edges that are getting rounded. Tip: Don't use a bottle with a "pip" or "pit" on the cut edge as a drinking vessel, as these are notoriously hard to safely smooth out with sandpaper. A Dremel tool with one of those small sanding bands will speed your job. They must be used dry, and do wear out fast smoothing glass. In this case, you MUST wear protective eyewear because the high speed of the Dremel can, and occasionally will, throw off bits of glass chips and certainly glass dust. Plus, don't breathe the dust, either.

Cheap Cutter Power Supply

Perhaps the best inexpensive power supply is built around a salvaged color TV set's power transformer. Here, we're speaking of an older transformer that's installed in a big set. Your local dump, believe it or not, is often a great source for free parts! This transformer should have a rating of 12 volts on its secondary winding, and must supply 4 to 5 amps of current to adequately heat the wire. Because if the wire is insufficiently powered, it won't get hot enough to cut the glass. Advertisers in *Nuts & Volts* also carry transformers that have adequate voltage and current ratings.

Figure 6 shows the schematic of the power supply. A power indicator neon lamp, labelled I1, and an LED lamp allows one to see presence of the 120 VAC voltage and the lower voltage used to operate the nichrome cutting wire, respectively. In both cases, the current limiting resistors will reduce the amperage so the components can function without burning out. Except, as we said, the wire will burn out sooner or later.

A fuse, labelled F1, is a standard requirement to guard against any possibility of a short. The current delivered from such a transformer can be massive if it's shorted. S1 is a simple SPST power switch, enabling the cutter to be turned on or off. Locate I2 on the wood frame of the nichrome wire holder at a visible angle. This is because it's not always easy to see the wire when it's hot. There is the possibility of children getting accidently burned when the device is operating. So it's a good idea to put an ultrabright LED here, and make stern warnings to people just like you might do if you were operating a propane torch, etc.

Laser-Modulated Plasma Acoustics

Figure 7 shows a simple method of experimenting with plasma acoustics. We'll modulate this with a laser beam and pick up the signal. An inexpensive (about $10.00) car graphic equalizer drives a special high-voltage autotransformer. That, in turn, produces a modulated high voltage at its output. You can drive this equalizer with an audio source like a tape player. A twin pair of electrodes are arranged so that they are heated red hot by the Bunsen burner. They must be hot, otherwise the project won't function. You can also use a propane torch or other heat source as long as the electrodes will stand up to the heat sources without melting. One needs to create a good wide area of heating, regardless of the heat source.

A saturated solution of Potassium Nitrate (chemical formula KNO_3) is used to create ions in the flame. KNO_3 is also known as saltpeter, and can be purchased for about $1.00 per jar from any pharmacy.

A kerosene wick seeds the flame with the ions that will produce the plasma effect. The autotransformer has a green wire which is its output. The other two copper wires are easily identified by your DVM. Wire #1 will be only a few ohms, whereas wire #2 will show a few hundred ohms relative to the output wire. Three large value capacitors are used for various purposes. C1 and C2 are filtering capacitors whose function is to provide a stable power supply. C3 couples the audio output from the equalizer to the autotransformer. A good earth or power supply ground is essential for this project. That is because stray high voltage charges may ruin the equalizer and the audio source inputted to it.

Bypassing the power supply with 0.1 uF capacitors always will help with any HV project. However, these are not shown on the schematic because they are left up to the unique assembly of each builder.

Adjust the equalizer for high-frequency response. Turn up the volume on the equalizer and audio source

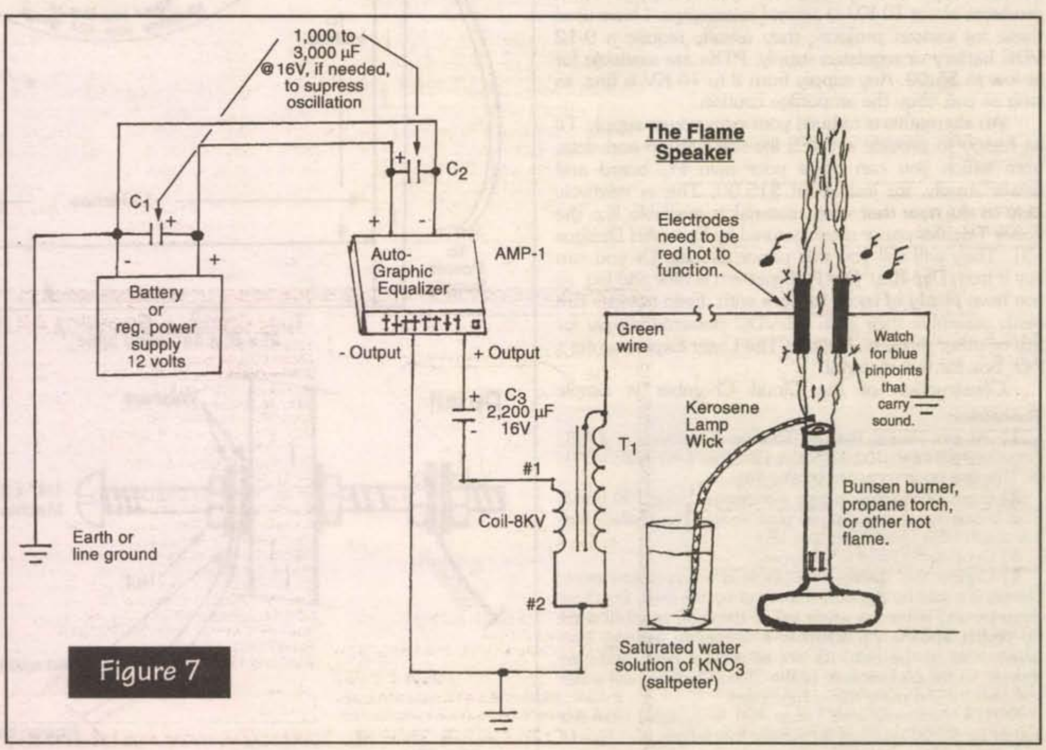


Figure 7

until you can hear the flame speak.

Laser Modulation

Last month's column contained a high-sensitivity receiver for receiving all types of modulated light. This is perfect for laser modulation reception. You can hear the sound of the audio source as it passes through the flame using this receiver. Adjust the controls on the receiver for maximum reception. Adding a polarizer to the optical path helps. What's even better is to add a narrow-band-pass filter which admits only the laser beam and not the ambient light. These filters are available from Edmund Scientific (see "Sources"). Although they will run you about $25.00, they are an extremely useful addition to any laser experimenter's lab.

The mechanism whereby the beam is capable of being modulated is by the flame, changing its index of refraction from the heated, modulated plasma. You will want to adjust the angle of the laser beam for maximum audio effect. The higher parts of the flame usually work the best, depending upon what kind of heat source you use.

Conclusion

Thank you all for your help in providing advice and material. We'll see you next month! **NV**

Parts List

Nichrome Wire Bottle Cutter:

- **F1** — 2-amp fuse
- **R1** — 100,000-ohm resistor
- **R2** — 2,220-ohm resistor
- **I1** — NE-2 or similar neon indicator lamp
- **I2** — Ultrabright LED
- **D1** — 1N4001 rectifier
- **T1** — Transformer (see text)
- **S1** — SPST switch
- **W1** — Nichrome wire

Misc: Glass cutter, nuts, bolts, and washers, wood frame, C clamp, etc.

Flame Speaker:

- **T1** — 8 KV Autotransformer
- **C1, C2** — 1,000 to 3,300 uF aluminum electrolytic capacitors, as needed
- **C3** — 2,200 uF aluminum electrolytic capacitor
- **AMP-1** — Auto graphic equalizer
- **1** — Audio source such as a tape player
- **1** — Kerosene lamp wick
- **1** — Bunsen burner or other gas heat source with a gas source
- **1** — Saltpeter
- **1 pr** — Electrodes (see text)
- **1** — 12-volt battery or regulated power supply, capable of supplying 4 to 5 amps continously

NOTE: The special 8,000 VAC Autotransformer is available from Images Company, P.O. Box 140742, Staten Island, NY 10314. Ph: (718) 698-8305, FAX (718) 982-6145. Price is $27.45 postpaid. Includes data.

SOURCES

North Forty Electronics, Inc., 7010 Palmer Road, New Carlisle, OH 45344-9621. Ph: (513) 845-3057, FAX: (513) 846-1710. Supplier of surplus HeNe lasers and accessories, power meters, electronic test equipment, and robotic supplies.

Midwest Laser Products, P.O. Box 262, Frankfort, IL 60423. Ph: (815) 464-0085, FAX: (815) 464-0767. Free catalog. Carries new and used laser equipment and inexpensive start-up systems. Also currently carrying ruby laser, Army tank rangefinder units.

Dyna-Art Designs, 3535 Stillmeadow Lane, Lancaster, CA 93536-6624. Ph: (805) 943-4746, FAX: (805) 943-3776. Desktop fabrication equipment for printed circuit boards; toner-transfer paper for easy hobbyist & OEM prototype do-it-yourself PC board making.

Images Company, P.O. Box 140742, Dept. N, Staten Island, NY 10314. Ph: (718) 698-8305. Carries holography supplies, optical components, components for laser power supplies, stepper motors, CCD camera.

LNS Technologies, 20993 Foothill Blvd., Suite 307, Hayward, CA 94541. Inquiries: (510) 886-9296, orders: (800) 886-7150. Visible laser diodes and a driver kit, also carries a line of high-technology electronic kits. Accepts major credit cards. Catalog $1.00.

MWK Industries, 1269 West Pomona, Unit 112, Corona, CA 91720. Ph: (909) 278-0563, FAX: (909) 278-4887. Hours: 8-5 PST weekdays, 10-3 Saturdays. Free catalog. Source for new and used laser equipment, supplies, and optics. Carries a wide variety of He-Ne and other lasers suitable for the experimenter & hobbyist.

Edmund Scientific Company, 101 East Gloucester Pike, Barrington, NJ 00807-1380. Ph: (609) 573-6250, FAX: (609) 573-6295. Free catalog. Supplier of a wide variety of educational and scientific equipment including lasers and an extremely comprehensive line of optics.

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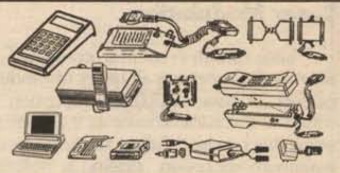

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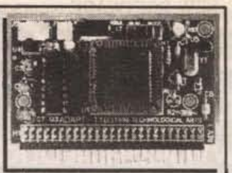

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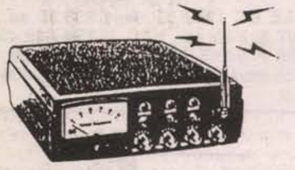

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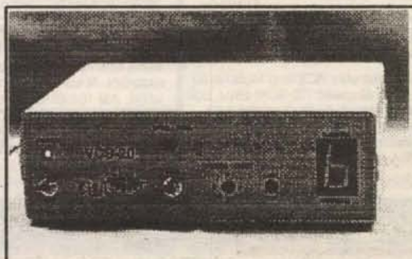

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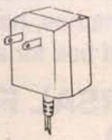

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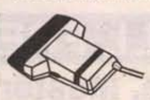

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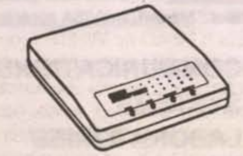

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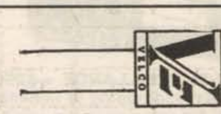

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Telephone/ Computer Interface

by Terry Weeder

After spending hours developing your own custom program on your PC to control various things in your home, from your personal security system to your X-10 home automation devices, you realize how great it would be if you could only access this program from places other than your keyboard. With the help of the Telephone/Computer Interface kit as explained in this text, it is now possible to send commands directly to your computer via any touch-tone telephone in the world! Change the set-up of your customized home automation program while on vacation, or call your home and turn off your security system so a neighbor can enter and feed your cat, water the plants, etc.

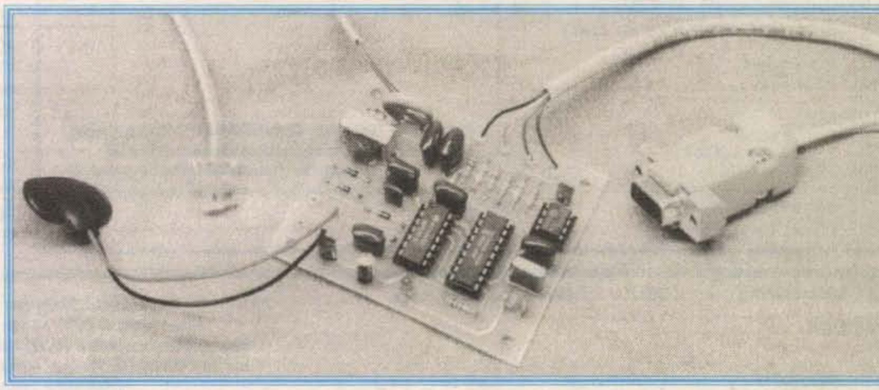
The Telephone/Computer Interface is a direct link between your telephone wall jack and the RS-232 serial port of your computer. All numbers entered from a touch-tone telephone are decoded and sent to the PC in standard ASCII format. The serial communications interface network used on this device was specifically designed to share the same RS-232 port with other projects of its kind. Multiple units may be paralleled on the same com port and be connected to different phone lines, or the Telephone/Computer Interface can be used in conjunction with the Home Automation Controller to transmit X-10 commands in response to DTMF tones entered from a remote telephone. This project can even be used to keep a running log of all outgoing calls made from any telephone on the line or lines.

Digit	Output Code			
	D8	D4	D2	D1
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
0	1	0	1	0
*	1	0	1	1
#	1	1	0	0
A	1	1	0	1
B	1	1	1	0
C	1	1	1	1
D	0	0	0	0

***Figure 1** - Logic levels which are placed on IC1's output pins when the corresponding DTMF digit is received at its input.*

Circuit Theory

Refer to the schematic diagram shown in Figure 5. C1, C2, and transformer T1 isolates the circuit from the phone line and provides coupling of the DTMF tones from the line to pin 7 of IC1. MOV1 is a metal oxide varistor which protects the circuit from high-voltage spikes on the line, and D3 and D4 clamps the ringer voltages. IC1 is a DTMF receiver manufactured by Motorola which converts the tones generated by your phone into four-bit TTL level data. The table in Figure 1 shows the combination of logic 1s and 0s which are placed on IC1's output pins (D1, D2, D4, and D8) when each corresponding DTMF tone is received at pin 7.



The heart of the circuit is IC2 (part no. PIC16C54-XT/P), an EPROM-based eight-bit CMOS microcontroller manufactured by Microchip. This microcontroller has one eight-bit I/O port, one four-bit I/O port, and internal EPROM memory which holds the program used for decoding the data being output by IC1, reading and writing data to and from the EEPROM (IC3), and sending serial data to the RS-232 port. A detailed description of IC2's firmware is explained later.

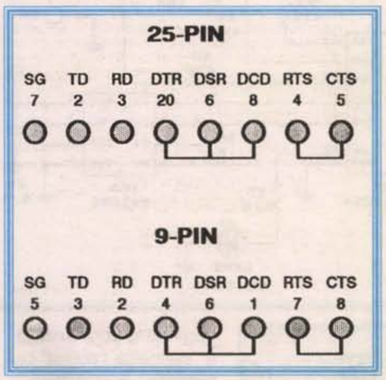


***Figure 3** - Hook-up diagram for both a 9-pin and 25-pin RS-232 serial connector. Include the jumpers as shown.*

The voltage levels used for serial communications on an RS-232 port are +3V to +25V for a logic 0, and -3V to -25V for a logic 1. Most RS-232 devices use +12V and -12V, respectively. Bit 6 of port-B is used to send data to the serial port. A logic 1 is generated by placing bit 6 at a high level which turns off Q1, thus allowing the -12V from the TD (Transmit Data) pin to be applied to the RD (Receive Data) pin through R2. Bit 6 is sent low to produce a logic 0 which turns on Q1, pulling the RD pin to +5V.

Because the TD pin of an RS-232 port is normally at a marking level (-12V), it is possible to "steal" from it the negative voltage needed for communications at RS-232 levels, and a separate supply is not required. Bit 7 of port-B is tied to the DTR (Data Terminal Ready) pin through R5 and determines when the Telephone/Computer Interface kit is plugged into an active RS-232 port. Bit 3 of port-A is tied to the RD pin through R4 and is used to verify an idle RS-232 state prior to sending any serial data. This will avoid a collision with the data sent from any other projects which are sharing the same RS-232 port.

IC3 (part no. 93LC56) is a 2K serial EEPROM (Electrically Erasable Programmable Read Only Memory) manufactured by Microchip and is used as a 256-character buffer to store all decoded DTMF data until it has the chance to be sent to the computer.

The 93LC56 uses a three-wire interface which is connected to port-A of IC2. Of the three wires, there is a CHIP SELECT, CLOCK, and DATA IN/OUT. Because the DATA IN and DATA OUT lines of IC3 share the same I/O pin of IC2, the 1K resistor (R6) is used to limit the current flow during those transition times between WRITE and READ when there are conflicting logic levels. IC2 communicates with the 93LC56 by placing a high on the CHIP SELECT pin. Data is then transferred serially to and from the 93LC56 on the positive transition of the clock pin.

Each READ or WRITE function is preceded by a start bit, an opcode — identifying the function to be performed (read, write, etc.) — then an eight-bit address, followed by the eight bits of data which is being written to, or read from that address.

Power for the circuit is derived from a 12 VDC wall transformer which is converted to 5 VDC by IC4

```
CLS
OPEN "COM1:1200,N,8,1" FOR INPUT AS #1
OPEN "C:\LOG" FOR APPEND AS #2
ON COM(1) GOSUB RECEIVE
COM(1) ON
DO
LOOP UNTIL INKEY$ = CHR$(27)
CLOSE #1, #2
END

RECEIVE:
     COM(1) OFF
     IF INPUT$(1, #1) = "O" THEN
        LINE INPUT #1, NUM$
        MONTH$ = LEFT$(DATE$, 2)
        DAY$ = MID$(DATE$, 4, 2)
        TME$ = LEFT$(TIME$, 5)
        IF LEFT$(NUM$, 1) = "0" OR LEFT$(NUM$, 1) = "1" THEN
           NUM$ = LEFT$(NUM$, 1) + "-" + MID$(NUM$, 2, 3) + "-" + MID$(NUM$, 5, 3) + "-" +
           MID$(NUM$, 8, 4) + " " + MID$(NUM$, 12, 99)
        ELSE NUM$ = LEFT$(NUM$, 3) + "-" + MID$(NUM$, 4, 4) + " " + MID$(NUM$, 8, 99)
        END IF
        PRINT MONTH$; "/"; DAY$; " "; TME$; " "; NUM$
        PRINT #2, MONTH$; "/"; DAY$; " "; TME$; " "; NUM$
     ELSE LINE INPUT #1, DISCARD$
     END IF
     COM(1) ON
     RETURN
```

***Figure 2** - This simple QuickBASIC program will keep a running log of all outgoing telephone calls.*

```
CLS
OPEN "COM1:1200,N,8,1" FOR RANDOM AS #1
ON COM(1) GOSUB RECEIVE
COM(1) ON

DO
LOOP UNTIL INKEY$ = CHR$(27)
CLOSE #1
END

RECEIVE:
    COM(1) OFF
    IF INPUT$(1, #1) = "O" THEN
        LINE INPUT #1, CODE$
        IF CODE$ = "12341" THEN X10$ = "A1AJA2AJALALALALALALALAL": GOTO TRANSMIT
        IF CODE$ = "12342" THEN X10$ = "A1AKA2AK": GOTO TRANSMIT
        'other IF THEN statement
        'other IF THEN statement
        'etc.
    ELSE LINE INPUT #1, DISCARD$
    END IF
    COM(1) ON
    RETURN

TRANSMIT:
    COM(1) OFF
    X10$ = "X" + X10$
    PRINT #1, X10$
    LINE INPUT #1, DISCARD$
    COM(1) ON
    RETURN
```

***Figure 4** - Use this QuickBASIC program with the Home Automation Controller and Telephone/Computer Interface kits to send X-10 commands using a remote telephone.*

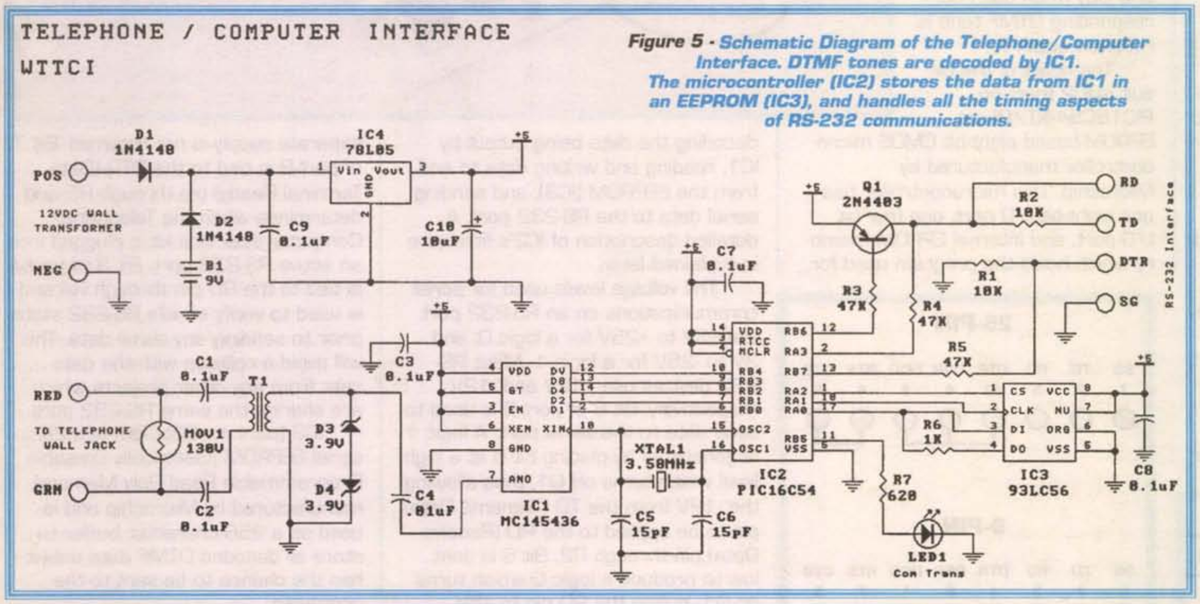


***Figure 5** - Schematic Diagram of the Telephone/Computer Interface. DTMF tones are decoded by IC1. The microcontroller (IC2) stores the data from IC1 in an EEPROM (IC3), and handles all the timing aspects of RS-232 communications.*

Parts List

Resistors (All are 1/4-watt, 10% units)
R1, R2 - 10,000 ohm
R3, R4, R5 - 47,000 ohm
R6 - 1,000 ohm
R7 - 620 ohm
Capacitors
C1, C2, C3, C7, C8, C9 - 0.1 uF, Mylar
C4 - .01 uF, Mylar
C5, C6 - 15 pF, ceramic disc
C10 - 10 uF, 35-WVDC, electrolytic
Semiconductors
IC1 - MC145436 DTMF receiver (Motorola)
IC2 - PIC16C54-XT/P (pre-programmed) 8-bit microcontroller (Microchip)
IC3 - 93LC56 serial EEPROM (Microchip)
IC4 - 78L05 low-power 5-volt regulator
Q1 - 2N4403, general-purpose PNP silicon transistor
D1, D2 - 1N4148, general-purpose silicon diode
D3, D4 - 1N748A 3.9-volt zener diode
LED1 - light emitting diode, red
Other Components
MOV1 - 130 VRMS, metal oxide varistor
T1 - 600-ohm primary, 600-ohm secondary, audio transformer
XTAL1 - 3.58 MHz, TV colorburst crystal

B1 - 9-volt transistor battery (optional)

Miscellaneous: Enclosure, PC board, IC sockets, 12 VDC wall adapter, telephone cord with modular plug, RS-232 connector & cable, battery clip, solder, hardware, etc.

The following items are available from **Weeder Technologies**, P.O. Box 421, Batavia, OH 45103. **513-752-0279.**

- Double-sided etched and drilled PC board (WTTCI-B), $9.50
- All board mounting components including pre-programmed PIC16C54 (WTTCI-C), $24.00
- A pre-programmed PIC16C54 only (PIC-TCI), $15.00

All orders must include an additional $4.00 for shipping and handling. Ohio residents add 6% sales tax.

— a 78L05 voltage regulator — and filtered by C10. C9 stabilizes IC4. A nine-volt battery (B1) together with switching diodes D1 and D2, can be used as shown to serve as a back-up at times when there is a loss of AC line current.

The PIC Firmware

A PIC16C54 microcontroller which has been pre-programmed with the Telephone/Computer Interface firmware can be purchased from the supplier mentioned in the parts list.

At power-up, and after the microcontroller (IC2) initializes several of its internal registers, including setting the EEPROM address to the beginning and writing a "carriage return" to memory, it monitors the DV (data valid) pin of IC1. When a DTMF tone is present at the input of IC1 (pin 7), IC1 sends its DV pin high. This high is seen by IC2 on bit 4 of port-B. IC2 verifies this high after a period of 20 ms, then reads the code placed on IC1's output pins (D1, D2, D4, D8). This four-bit code is converted to an ASCII character — equivalent to the digit shown in the table in Figure 1, then stored in the EEPROM (IC3).

The microcontroller waits for the next DTMF tone to be decoded by IC1 and places it in the next memory location, repeating until a lapse of at least five seconds occurs without any new tones being received. After five seconds of silence, IC2 writes a "carriage return" to memory, sets the "end of memory" pointer to the last character placed in memory, and sets a bit in the status register to indicate that there is data ready to be sent to the RS-232 port. The DTR pin of the RS-232 port is then polled to see if the Telephone/Computer Interface kit is connected to a live serial port. If not, IC2 continues to watch IC1's DV pin, placing any subsequent strings of decoded DTMF tones in memory, and re-positioning the "end of memory" pointer.

When the DTR pin finally goes assertive, IC2 watches the RD pin and waits for a silent period of at least 500 ms (absence of data being transmitted by other devices) then, following the first "carriage return" found in memory, IC2 transfers the data from the EEPROM to the RS-232 port in the same order as received, ending with the character indicated by the "end of memory" pointer. The status register bit is then cleared, the EEPROM address is set back to the starting position, and IC2 returns to monitor the DV pin of IC1.

Construction

The complete circuit fits nicely on a PC board measuring just under 3" x 2.5". The artwork is provided here for those who wish to etch and drill their own PC boards, or a pre-fabricated one can be purchased from the supplier mentioned in the parts list.

Refer to the parts placement diagram show in Figure 6. Identify the component side of the PC board which is marked and begin by soldering in the three IC sockets. Next, solder in all resistors and capacitors paying attention to the orientation of the polarized capacitor C10. The four diodes (D1, D2, D3, and D4) should be mounted with their band positioned as shown in the diagram.

Because the primary and secondary windings are the same, the transformer (T1) can be mounted in either direction. The center lead is not used in this application and should be cut off prior to soldering to the PC board.

Mount the red LED positioned so its "long" lead corresponds with the hole labeled "A" on the parts placement diagram, and solder in the varistor (MOV1).

Care should be taken when soldering in the transistor (Q1) and the regulator (IC4) to avoid a solder bridge between their closely spaced pads. Finish by soldering in the crystal (XTAL1). Note, leave a small gap between the bottom of the crystal and the PC board to avoid the chance of its metal case shorting the two pads together.

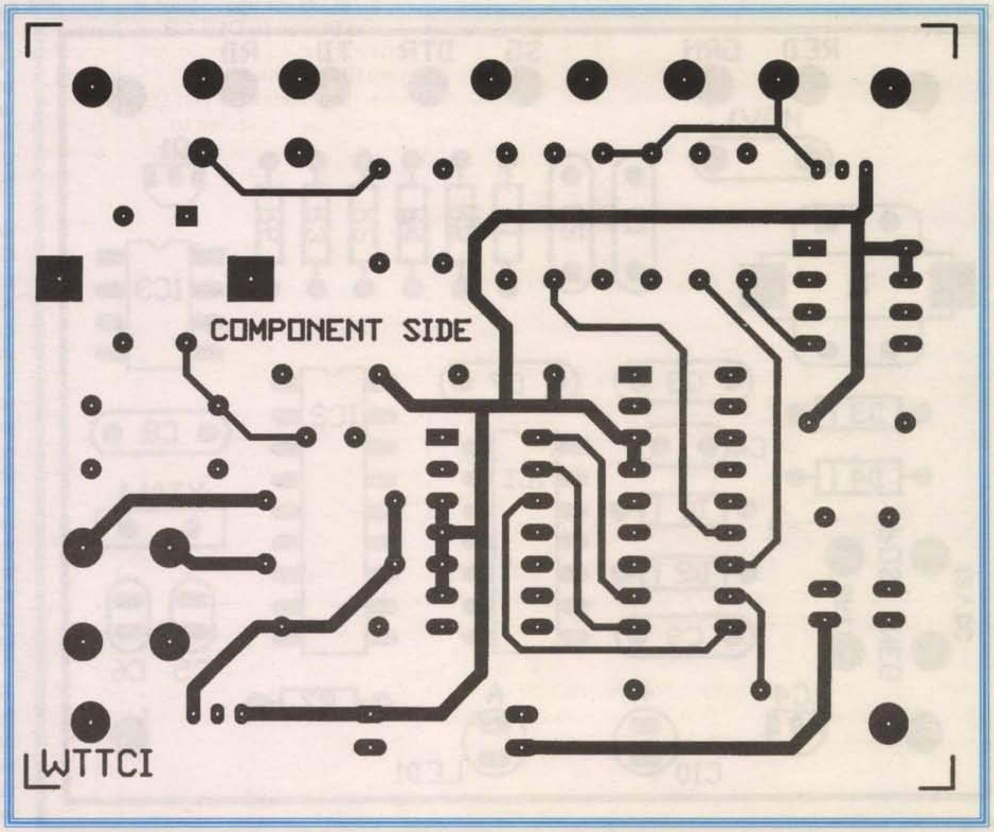
Obtain a piece of four-conductor telephone modular cord (available from Radio Shack), cut off one of the connectors, strip and tin the red and green wires, and solder them to the terminals marked "RED and "GRN" on the board. The yellow and black wires are not used. Use another piece of four-conductor telephone cord to run between the PC board and an RS-232 connector.

Figure 3 shows the hook-up diagram for both a 9-pin and a 25-pin RS-232 connector. Match the "DTR," "RD," "TD," and "SG" connections on the board with their corresponding pins on the connector you are using, as shown in the diagram. Solder a jumper wire on the RS-232 connector between pins "RTS" and "CTS," and between "DTR," "DSR," and "DCD" as shown.

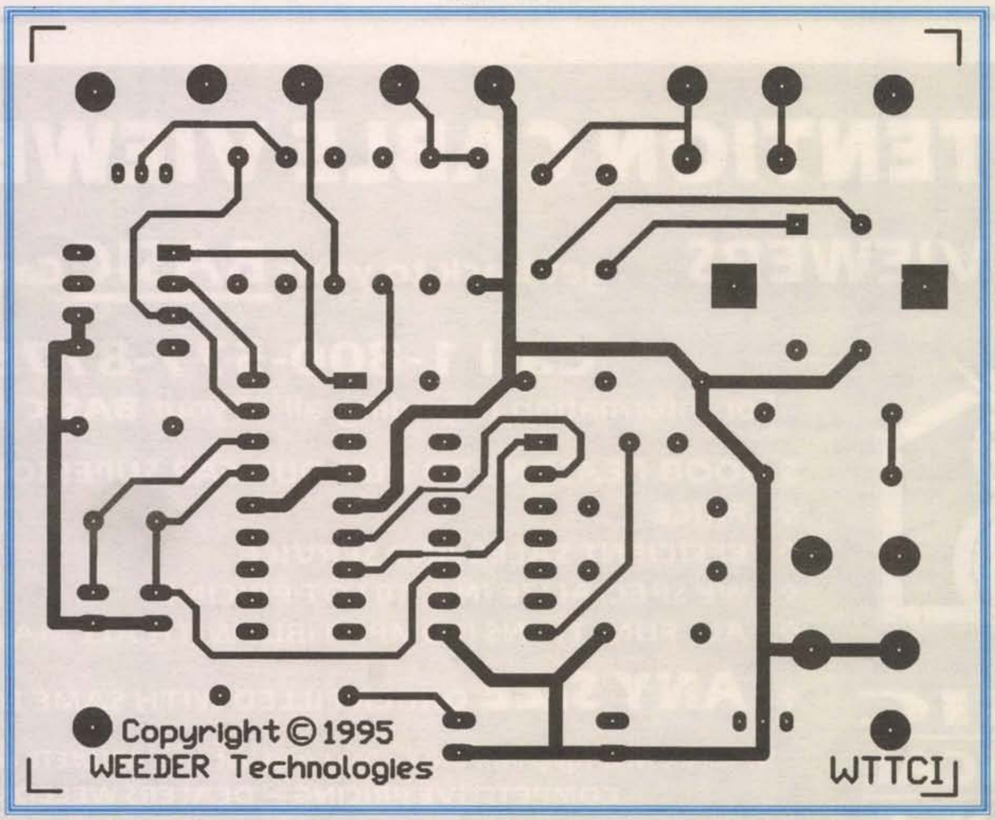
Use a 12 VDC wall transformer (also available from Radio Shack), cut off the connector at the end of the wires, use a voltmeter to determine positive and negative, and solder those wires to the appropriate connection on the PC board.

If you wish to use a battery for back-up during a power outage, solder a nine-volt battery clip to the terminals labeled "BAT" shown on the diagram. Note, if a battery is not being used, a 9 VDC wall transformer can be substituted for the 12 VDC version.

After all components and wires have been soldered, closely examine both sides of the PC board for solder bridges and/or cold solder joints and re-solder, if necessary. Carefully plug IC1, IC2, and IC3 into their sockets using the orientation as shown in the parts placement diagram.



TOP SIDE (above)/BOTTOM SIDE (below)
Scale = 2:1



Mount the board in a plastic enclosure and cut three notches in the seam of the box for the cords to exit. Tie a knot on each cord for strain relief, then assemble the two halves of the box placing the knots on the inside.

Operation

The Telephone/Computer Interface kit can share the same RS-232 serial port as other kits of its kind simply by wiring each kit in parallel to the same RS-232 connector. You must, however, remove R1 and R2 on any subsequent kit (i.e., of all the kits parallelled on the same port, only one kit should have R1 and R2 installed). Doing this will allow you to piggyback an unlimited number of kits — enabling you to read the DTMF tones from multiple phone lines, or use the Telephone/Computer Interface kit with the Home Automation Controller kit.

Use the simple program written in QuickBASIC and shown in Figure 2 to test out the circuit. Plug the wall transformer into an outlet, plug the modular plug into a telephone wall jack, and plug the RS-232 connector into your computer. Note, always apply power to the kit before plugging into an active RS-232 port or the oscillator may fail to start. Start the program, pick up a touch-tone telephone which is using the same line as your kit, and dial any 7- or 11-digit number, then hang up. After a period of five seconds following the last button pressed on the phone, the LED will flash and the number dialed together with the date and time will appear on the computer screen. This data will also be written to the file C:\LOG. As each new telephone number is dialed, the info will be displayed on the next line of the screen and stored in the next line of the file. Hit the "ESC" key at any time to exit the program.

If the LED fails to flash after the five second timeout, there is either an error in your RS-232 cable/connector wiring, or your program is not successfully opening the same port that the Telephone/Computer Interface is plugged into. Carefully inspect your RS-232 cable/connector wiring and assure that the connector is plugged into the same port used in the OPEN COM statement in your QuickBASIC program.

The Telephone/Computer Interface kit will store the telephone number from each outgoing call (up to 256 characters) when the computer is off or not running the QuickBASIC program. As soon as the program is started, the LED will flash, and all data stored in the EEPROM (IC3) will be sent to the computer. Note, because the date and time of all outgoing calls are derived from the computer's system clock, those calls made during any time the program is not running will be appended with the date/time that the program resumes and the data is dumped to the computer.

Creating Your Own Program

The Telephone/Computer Interface communicates at 1200 baud, no parity, eight data bits, and one stop bit. Your program should contain the line OPEN "COM1:1200,N,8,1" FOR INPUT AS #1, or similar. Also the ON COM GOSUB statement should be used as shown in the sample programs to handle branching to a subroutine when DTMF data is received.

All data which is sent from the kit to the serial port is preceeded by an "0" — identifying the string as the telephone DTMF data, and ending with a carriage return. Note, always use the COM(1) OFF statement at the beginning of your subroutine branched to by the ON COM GOSUB statement, then a COM(1) ON statement at the end after all characters have been received. Failure to turn off event trapping in this case will cause communications errors between the PC and the Telephone/Computer Interface.

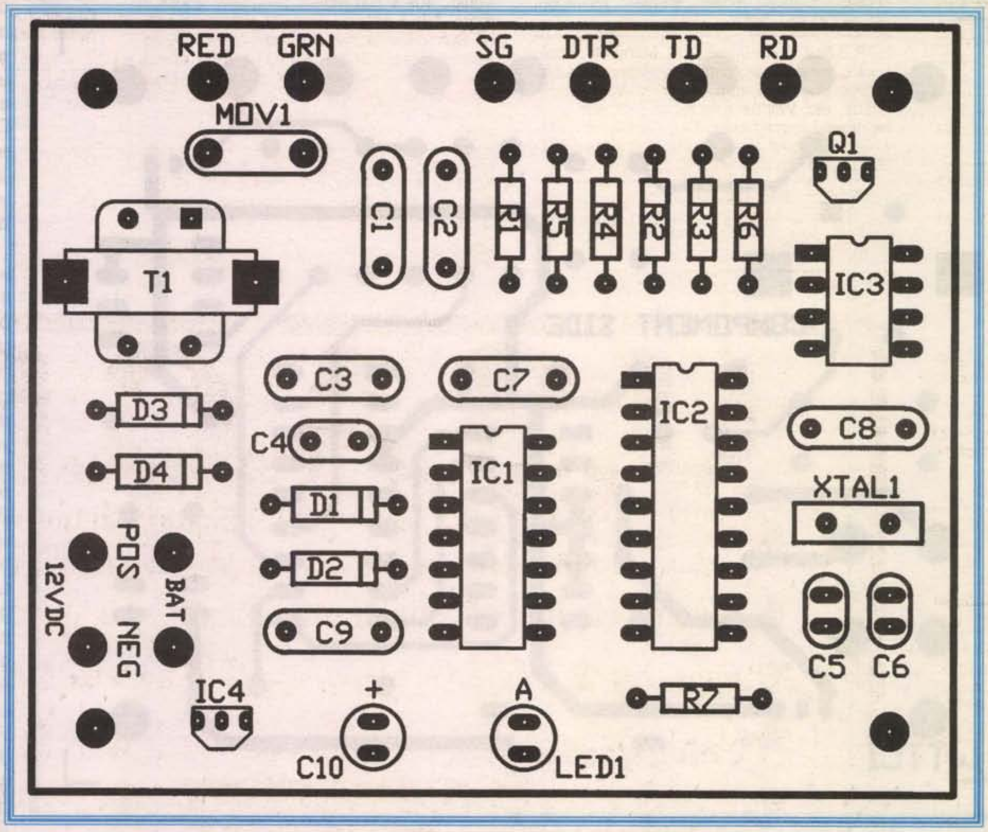


Figure 6 - Use this parts placement diagram when assembling the PC board.

Figure 4 shows a program which uses the Telephone/Computer Interface kit together with the Home Automation Controller kit to control your X-10 modules via a remote telephone.

Call your home, wait for your answering machine to pick up and finish its announcement, then enter the password of "1234" followed by either a "1" (which will turn on a device set to the address of A1, turn on a lamp set to the address of A2 then dim that lamp to 50%) or "2" (which will turn off both devices).

You can add as many IF THEN statements in this format as you want to set up different home automation configurations which can be selected from anywhere in the world having access to a touch-tone telephone. **NV**

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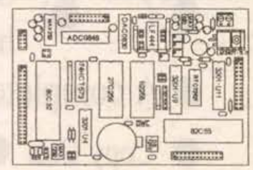

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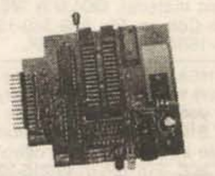

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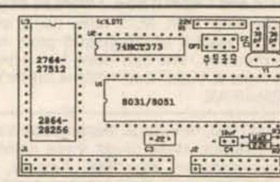

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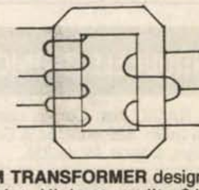

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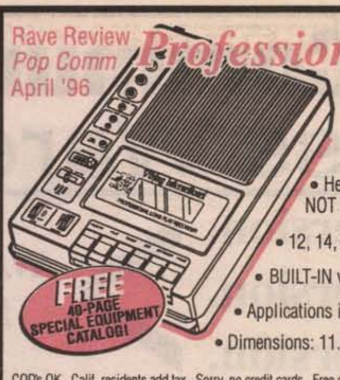

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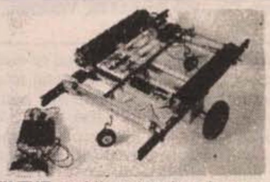

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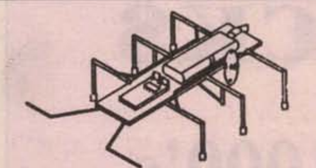

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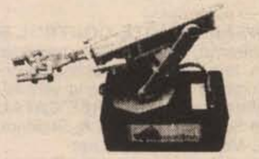

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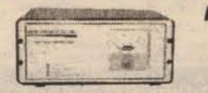

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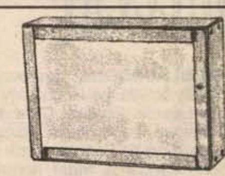

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RESOURCE BIN

number fifty five

Exploring the web for your first time.

Our usual reminder here that the *Resource Bin* is now a two-way column. You can get tech help, consultant referrals, and off-the-wall networking on nearly any electronic, *tinaja questing*, personal publishing, money machine, or computer topic by calling me at (520) 428-4073 weekdays 8-5 Mountain Standard Time.

I'm now in the process of setting up my new *Guru's Lair* web site you will find at (where else?) /www.tinaja.com — This is the place you go for instant tech answers. Among the many files in our library, you will find complete reprint sets for all of the *Resource Bin* columns. Along with some new "rich text" global search features.

The site is still under construction, but I fully intend to move thousands of my files here. So, definitely come visit. But bear with me for a while till things really get into gear.

You will get the best results if you have both *Netscape Gold* and *Acrobat Amber*. These are downloadable from *www.netscape.com* or *www.adobe.com*

Why the Web?

These days, getting yourself on the web has become *absolutely essential*. Why? First and foremost, for instant E-Mail anywhere in the world. Second, because of the superb cyberspace info and entertainment values.

Third, because of the great heaping stacks of free or nearly free software. For *any* computer, no matter how old or unpopular. Fourth, to quickly find an expert in virtually any field.

Fifth, there is that great "equalizer effect" where you instantly can locate the exact market price and the dealer margins of any used car. Or the latest changes in a stock price.

Sixth, that mind-boggling array of movies, sound, animation, real-time radio stations, and even the ability to phone toll-free anywhere.

Seventh on through four thousand, two hundred and ninety fifth ... well, you've got the general idea.

The net is *the* way nearly *everything* will get done in the future. The really big things about the net are its *speed* and its *efficiency*.

Benefits come about through the complete elimination of middlemen — retailers, wholesalers, distributors, the junk mail printers, postal bureaucrats, shippers, agents, and warehousers.

The stuff goes directly from who makes it to who needs it. Only when, where, and as wanted. Ridiculously faster. At vastly lower costs.

No sending out a hundred pieces of mail in hopes of getting three orders back. No having unsold products get hauled across the country only to get returned for credit years later.

All the while *strongly* favoring you individuals and small scale start-ups over slow reacting and hidden agenda Fortune 500 megacorps.

Yeah, there are a few spots on the web that may appear less than stellar at first glance. Like the site that is the definitive location for color images of Vienna Sausage can labels. With, of course, *Spam* can wallpaper.

Or the church that combines new age and traditional beliefs. They call themselves the *Krystal Methodists*. That unique *www.cybersluts.com* site certainly gives deep new meanings to the term "technical expertise."

NEXT TIME:
Don shows us how to start up your personal web page.

So ...

This month, I thought I'd take you step-by-step into exactly how to get on the Internet. First to find out what the excitement is all about. Then later, I'll get you started on setting up your very own personal web site.

It is usually a good idea to separate finding what the net is all about and getting yourself online-literate apart from actually starting a web page.

I'd recommend that you spend at least *one full month* wandering around online. Before you even think about creating a home page or attempting to deliver content. In fact, to make sure you get a month's practice, we'll hold off on home pages till next month.

Getting Connected

To surf over the net, you will first need a current computer such as a Windows 95 PC or a Mac. You will need some essential and free *browser* software from *Netscape*. And you will need some way to connect to the net through an *Internet Service Provider*.

Or ISP for short.

In turn, there are four main ways to find an ISP: Your phone company, a commercial online info service, your local service provider, or with your own dedicated net server.

Regardless of which ISP route you pick, *make sure it is a local call!* Certain phone companies already do offer direct Internet access. *AT&T* has a five-free-hours-per-month deal going. But their less publicized fine print deals are a better buy. Especially if you intend on using the net more than a paltry 10 minutes per day.

Also, their current backlog is way over half of a million impatient users. And the phone company is less likely to provide the kind of hand holding a local ISP can.

Thus, your first step is to call your local phone company and see exactly what they have to offer when. There's no reasonable doubt that typical net users will choose the phone company for net access within a year or two.

The commercial online services are not nearly as good a deal as they used to be. All of them, without exception, are in deep trouble. Most users, most of the time, find they get more content faster and cheaper on their own.

The main problems are that the one thing the services were once best at — running lots of toll free lines around the country — is utterly useless today. And all their proprietary software has been unacceptably slow in keeping up with that fast changing net. Severely restricting your access options.

Access charges can easily approach several hundred dollars per month if you are not careful. Most people drop their trial subscriptions within one or two months at the most.

The biggies here are *America Online*, *CompuServe*, *Prodigy*, and the *Microsoft Network*. Plus a fast fading *Genie*.

By the way, quite a few of my 1600+ older files and reprints are available on *GEnie PSRT*.

But I'm adding support and new content *only* to that *www.tinaja.com* web site. Although I am moving these files over, it probably will take several years to complete the transfer.

SOME INTERNET START-UP RESOURCES

Adobe Acrobat 1585 Charleston Rd Mountain View CA 94039 (800) 833-6687	**Inter@ctive Week** 100 Q Roosevelt Blvd #508 Garden City, NY 11530 (516) 229-3700	**Internic Registration Svcs** 505 Huntmar Park Dr Hernon VA 22070 (703) 742-4777	**Netscape Gold** 501 E Middlefield Rd Mountain View CA 94043 (415) 528-3777	**WEBsmith** Po Box 55549 Seattle WA 98155 (206) 782-7733
Boardwatch 8500 W Bowles Ave #210 Littleton CO 80123 (303) 973-6038	**Internet Life** One Park Avenue New York NY 11016 (212) 503-3500	**LDS/WEB Trac** 571 Central Avenue Murray Hill NJ 07974 (800) ASK-LDSI	**Nuts & Volts** 430 Princeland Court Corona, CA 91719 (909) 371-8497	**WEB Week** 20 Ketchum Street Westport CT 06880 (708) 564-1385
Gale Research 835 Penobscot Blvd Detroit MI 48226 (313) 961-2242	**Internet World** 20 Ketchum Street Westport CT 06880 (203) 341-2872	**The Net** 1350 Old Bayshore #210 Burlingame CA 94010 (415) 696-1688	**Synergetics** Box 809 Thatcher AZ 85552 (520) 428-4073	**Wired** 544 2nd St 3rd Fl San Francisco CA 94107 (415) 904-0664
GEnie PO Box 6430 Rockville MD 20849 (800) 638-9636	**Internet Yellow Pages** 2600 Tenth Street Berkeley CA 94710 (800) 227-0900	**NetGuide** 600 Community Drive Manhasset NY 11030 (516) 562-5000	**WEB Techniques** 600 Harrison Street San Francisco CA 94107 (303) 661-1885	**Yahoo Corp** 635 Vaqueros Avenue Sunnyvale CA 94086 (408) 328-3300

These days, most users opt for a local ISP. You should find their ads in your local paper, typically at $19.50 per month. This should be a local call for you. Shop around.

But one big warning here: ISPs are very much an endangered species. Do *not*, under any circumstances, sign a long term contract with one of them! Even paying three months in advance is fraught with peril.

ISP quality varies all over the lot, so you may have to try a few before you get one that is acceptable.

Becoming your own ISP takes a big time computer, possibly a UNIX box, an uninterruptable power supply or two, bunches of specialized telecom equipment, hundreds of dollars per month in telco charges, lots of arcane software skills, and at least 30 to 90 hours a week of your time.

You do get slightly faster graphics access this way, though. But even if you know you are going to make the major commitment to high profile net access, chances are you'd be better off first using a local ISP and changing over later. Lots later.

Hmm. I guess we just might add cable companies as your fifth possible ISP route. But they are nearly certain to foul this one up big time. Because those cable systems are one direction only. And because their management does not have the faintest clue what they are up against.

And because of the little known fact that your telco's "last mile" currently handles compressed two-way video a lot *better* than cable does.

I recommend avoiding cable ISPs entirely. At least till the dust settles.

Temporary Set-up

Let's assume you went with a local ISP and have some sort of temporary browser software that came with your computer or was given to you. If not, grab an older copy of Netscape for $30.00 or so from a local computer store.

Your first goal should be to teach the temporary software exactly where you want to go on the net.

If you are on a Win 95 PC, click on the *Dial up Networking* file that's in the system file whose default name is *My Computer*. Then click on *Make a New Connection*. Enter a name for the new service and select the modem you are going to use. Go to *Configure* then to *General*, and select your port, volume, and maximum speed.

Go to *Connection*. Then select your data bits, parity, stop bits, and the call preferences. Eight data bits, no parity, and one stop bit is the norm. Go back to the main connection screen, select next, and enter the area code, phone number, and country code of your ISP service provider.

Next, reach into your *Control Panel* folder and click on your Internet icon. Enter the name of the service you are going to use. Click on the *Server Type*. Select the type of dial-up server your ISP can handle, with *PPP Win 95* the norm. Select the protocols your ISP can handle, with *TCP/IP* as the norm. Click on *TCP/IP Settings*.

Now for the tricky part. Select a *Server Assigned IP Address* and *Specify Name Server Addresses*. You will then want to type in a pair of hyphenated four group numbers which your ISP should have given you. One group for the *Primary DNS*. Another for the *Secondary DNS*. Usually you will also select the default gateway.

Now, go into your browser itself and adjust its preferences. If you have Netscape, you can select *Options* and then the *Mail and News Preferences*. On general preferences appearance, pick picture and text, Netscape Browser, and underlined links.

On mail and news preferences, go to *Servers*. Then enter your temporary out and in E-Mail addresses.

Your E-Mail address will have been assigned to you by the ISP. Then do the same with your *identity* selections. On *Appearance*, use Netscape for both mail and news selections.

All of this is a lot easier and faster than it sounds here. If you have any trouble, find some seventh grade net rat to do it for you. Or ask your ISP to talk you through it.

To review, what you have done is told your computer who to dial, what internet server address to select with what protocol, and where to go.

Going Online

Next, you click on your temporary browser. The *Connect* screen should come up. Enter your user name and password which your ISP gave you. Click on *Connect* and your modem should dial-tone and beppity-bloop.

A logging dialog box or two should come up. You should then have your browser connected. If not, puzzle out the error messages or talk them over with your ISP until connected.

Let's use my own web site as your own target practice location. In your *Location:* box, enter a *http://tinaja.com* — Hit enter and this should bop you on into the *Guru's Lair* blue screens.

Don't worry just yet if the site looks a little wierd. As with nearly all of the newer and better net sites, mine has gotten carefully optimized *exclusively* for use with Netscape.

So, the very first thing you'll want to do is ...

Getting Netscape

Your first and foremost net project *must* be to get yourself the latest free version of a *Netscape Navigator*. Any bright blue text you'll find in *Guru's Lair* is called a *hot link*. Clicking on a link may take you elsewhere within *The Guru's Lair*. Or surf you around the world on the web.

At this time, you click *only* on the *Netscape* hot link. You should quickly move to the main Netscape site found at *http://www.netscape.com* — Select their *download software* option. And get yourself the latest free trial version of Netscape Navigator.

In general, there are two flavors: Regular Netscape is for full Internet and mail access. Netscape Gold adds an editor that makes it easy for you to build your own web pages later on.

Go for the gold.

Getting E-Mail

At this point, you go back to square one and re-install your new Netscape Gold software in your computer. You then link your new browser to your existing ISP and server settings.

Next, you want to make sure your E-Mail works. When online, there's a little envelope at your Netscape lower screen right. A question mark beside it means your mail has not yet been checked. An exclamation point means you have new mail.

So, try sending yourself an E-Mail letter. Don't be surprised if it takes a minute or two to return; depending on the exact routing, it may have to go through Omaha.

By way of Beirut.

There is a pretty good chance you may end up changing your ISP or else getting your own registered web site in a month or two. Both of which are likely to change your E-Mail address. So it pays to view your initial internet address as *temporary*. Don't spread it too far or print it. Maybe even keep a list of who you gave it to.

Remember that it does not matter how long a guy's internet address is. It is what he does with it that counts.

Getting Acrobat Amber

Now go back to *http://tinaja.com* and my screens should look normal. Your next step should be to get free *Acrobat Amber 3.0* reader software. Most tech sites (including my own) are rapidly going to that Adobe Acrobat system for content presentation. The Acrobat advantages are overwhelming when it comes to full camera-ready docs with high-quality illustrations. Plus easily searched and viewed reprints.

So, here we go again. Click *Acrobat Amber* to surf to *http://www.adobe.com* and follow the download instructions for Amber reader 3.0 or better.

Your Amber installation should be more or less automatic. But one *very* important point: Amber *must* install *into* Netscape *if* you are to receive its full benefits. So always get Netscape *first* and Acrobat *second*.

As a check on proper installation, click on *C:*, then on *NavGold*, then on *Program*. A plug-in named *ambr32a2* or something vaguely similar should be present in the folder.

To test Amber, get back online into *www.tinaja.com* and select the *Resource Bin* hot link or else click the *Technical Library* button. Then click on library selection RESBN55.PDF.

A multi-color copy of this column should magically show up on your computer screen. Note how you have full camera ready text here. With an infinite variety of precisely controlled fonts. Easily magnified with the "+" button. For "-" just use *control "+"* instead. On your Amber options, be sure to use smoothed text for easier reading and better legibility.

Amber access should be fairly fast. It will get much faster whenever ISPs start picking up a newer net feature that allows file block downloads. And as the sysops all update to the latest Acrobat net optimizations.

Finally ...

Okay, you have an ISP, Netscape, and Acrobat Amber. And have everything talking to each other. Time to surf the web. At this point, you might want to temporarily change out your *Netscape Options General Preference StartWith* location to *http://www.tinaja.com* — At least until you get your own personal web site. This can be a launch point for you. One which immediately leads you to hundreds of other sites.

By the way, some sites demand a *www.* in mid-address. In other sites, mine included, that *www.* is optional and works either way. It is simplest to always leave the *www.* in.

As you pick up sites that you find useful, you can save them to a special *Bookmark* file. Saving a lot of retyping for you. For now, jot down all of the addresses that you do visit in a small notebook. For easy return.

So, what is all of this surfing stuff about anyhow?

Get back into */www.tinaja.com* — Click on *Surf to Interesting Web Sites.* Go halfway through the list and click on the *Nuts & Volts Magazine* button. Presto. You have just jumped from Thatcher, AZ on west to Corona, CA in a single keystroke.

When you have finished exploring this site, click on your Netscape *Back* arrow to get back to Thatcher. Try the other buttons and see where they lead you. To go completely off the planet, click on *Church of the SubGenius.*

Now for some serious surfing. Go to the *Yahoo* button near the bottom of the list. Then click on their dice icon. Their dice lets you *hypersurf.* And will drop you *somewhere* in cyberspace.

I urge you to hit their dice icon at least *several hundred times* over the next few days. To see exactly where it takes you. And to get the full flavor of what the net is all about.

But don't expect more than one hit in 20 to be useful. After all, *url* is short for an *utterly rancid location.* And *www* is a *world wide wait.*

And I predict you will install a new 28.8K or a faster modem somewhere around dice hit number 327.

One *very* important rule whenever you use the dice icon: *Be sure to write down the url address or you will never find it again!* The odds of a second hit are one in sixty million.

Finding Useful Sites

A smaller notebook is by far your best way to initially accumulate a list of useful web resources. What you'll want to watch for are *gateway locations* which have useful links to dozens or even hundreds of additional sites.

One of the goals of my *Guru's Lair* is to become a gateway site for just about anything related to whatever it is we are up to here. By the way, if you ever find out, please be certain to let me know.

There are several printed Internet directories out there. Sadly, most of these are woefully incomplete and out-of-date. Two fairly good ones are the Gale *Guide to Internet Data Bases,* and the *Internet Yellow Pages.*

You'll find scads of brand new net magazines and trade journals. I have posted a great heaping list of them to MUSE100.PDF. Again, of course, on my *www.tinaja.com* I have also newly excerpted and updated a few of these magazines as this month's sidebar.

There are a number of freebie web search services that can make finding things a lot easier. Although *Yahoo* is the most obvious, *Lycos* and *Inktomi* seem to me to be the best. Some other search services include *WebCrawler, Open Text, Alta Vista, DejaNews,* and great heaping bunches more.

But best of all are those overlain *multiple* search services which let you simultaneously use *all* of the biggies at once. On one screen.

The best way to search is to hit the *Yahoo* button on *tinaja.com* — Then ask Yahoo to search for anything. Give it any old subject. Your bottom of their search *results* page has hot links to the biggies, while hitting their *more* hot button leads you to all of those really useful secondary search services.

This Month's Contest

Tell me about three web sites: The very *best* one you have found. That *worst* one you've found. Plus the one that is *so bad it is good.*

For the latter, apply *mesmerizingly awful* as your criteria. Do tell me why these three are your choices.

There will be a largish pile of my new *Incredible Secret Money Machine II* books going to the dozen or so better entries, plus an all-expense-paid (FOB Thatcher, AZ) *tinaja quest* for two that will go to the very best of all.

Send all your *written* entries to me here at *Synergetics,* rather than to *Nuts & Volts* editorial.

Let's hear from you. **NV**

Microcomputer pioneer and guru Don Lancaster is the author of 33 books and countless tech articles. Don maintains his no-charge US tech helpline found at (520) 428-4073, besides offering all of his own books, reprints, and consulting services. Don also has two free catalogs full of his resource secrets waiting for you. Your best calling times are 8-5 on weekdays, Mountain Standard Time.

Don is in the process of setting up his Guru's Lair at http://www.tinaja.com

Full reprints and preprints of all Don's columns and ongoing tech support appear here. You can reach Don at Synergetics, Box 809, Thatcher, AZ 85552. Or send any messages to his US Internet address of don@tinaja.com

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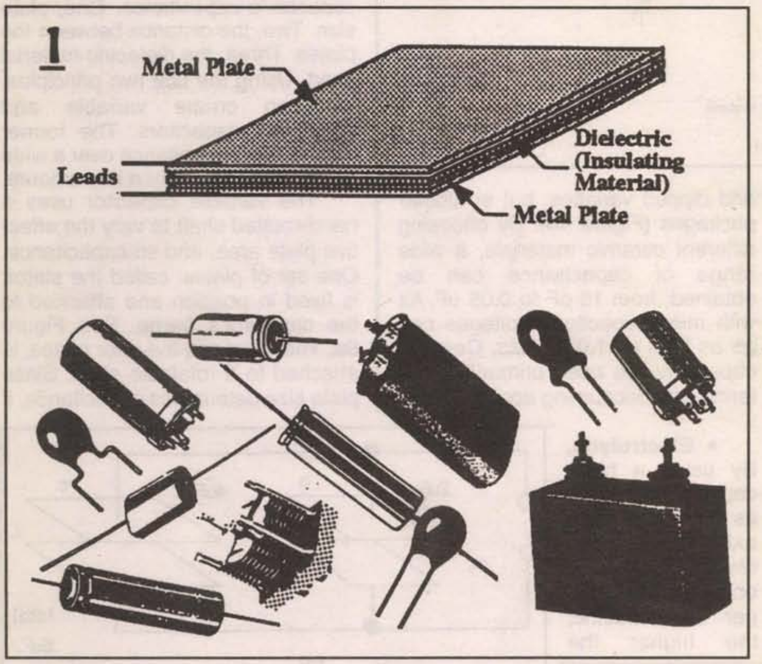
Capacitors: Hold That Charge!

by Ronald A. Reis

After the resistor, the capacitor is the most widely used component in electronic circuits. From tiny rice-sized surface mount ceramic chip types rated as low as 10 picofarads, to giant electrolytic "cans" with thousands of microfarads, capacitors are everywhere, working to temporarily store an electrical charge.

Capacitors find wide use in filter, timing, coupling, tuning, and phase shift circuits, to name but a few applications. One of three passive components (the other two being the resistor and inductor), the capacitor is there to support operation of its active component cousins: transistors, SCRs, triacs, opamps, and integrated circuits.



In this article, we'll discuss the design, construction, and circuit function of capacitors. Emphasis will be on how the capacitor is used, from filtering to differentiating. In the end, you'll see why the capacitor is a component "worth getting charged up about."

Born to Charge

All capacitors, fixed or variable, consist of two plates separated by an insulator, or dielectric (Figure 1). The plates can be aluminum discs, aluminum foil, or a thin metal film applied to opposite sides of a solid dielectric. The dielectric can be plastic, film, mica, glass, ceramic, paper, air, or a vacuum.

The capacitor has one purpose — to store electrons. Thus, it's a temporary battery. How much charge a capacitor holds, and for how long, is primarily a function of its size. The larger the capacitor, the greater a charge it will hold for a longer time.

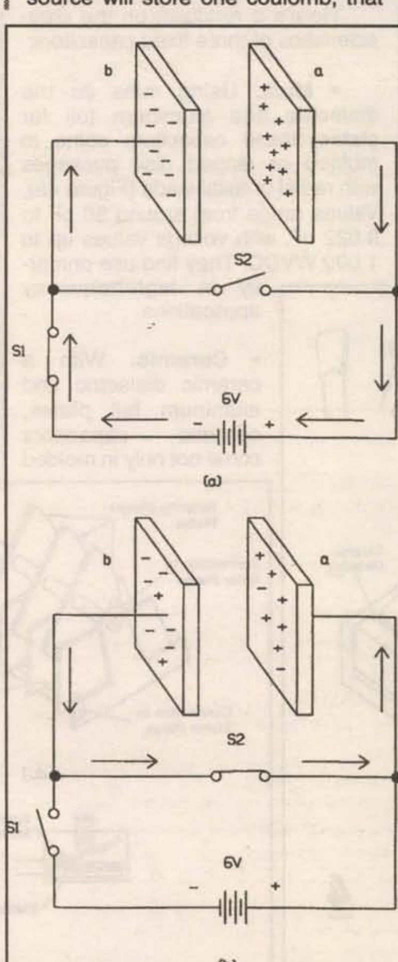
If a capacitor is placed across a voltage source, the capacitor will charge (Figure 2a). With Switch S1 open, no current flows and no difference in charge exists across the capacitor plates. When the switch is closed, however, electrons are attracted from plate a to the positive terminal of the battery. At the same time, electrons are repelled from the battery's negative terminal to fill plate b. Thus, current flows to charge the capacitor. When the voltage across the capacitor equals the source voltage — in this case, six volts — the capacitor is said to be fully charged. At this point, current ceases.

If we now disconnect the capacitor from the circuit by opening S1, the capacitor will remain in its charged condition. If Switch S2 is then closed, a path exists across the charged capacitor, as seen in Figure 2b. The excess electrons on plate b flow through the conducting wire to the positive plate a. The capacitor is now discharging. When an equal number of electrons exist on both plates, the capacitor is fully discharged.

Note, in Figure 2, the current to charge the capacitor flows in one direction while the current to discharge it flows in the opposite direction. Note, also, no current actually flowed through the capacitor. Remember, the space between the plates is an insulator (dielectric).

Capacitor Specs

The maximum charge of a capacitor is its capacitance. Capacitance is measured in farads (F). One farad is a lot of capacitance. To be specific, a one-farad capacitor connected to a one-volt source will store one coulomb, that is, 6,280,000,000,000,000,000 (6.28 X 10^{18}) electrons!



Current flows only while capacitor charges.

2

Current flows only while capacitor discharges.

Most capacitors are nowhere near a farad (boom-box car stereo battery back-up caps, aside).

Typically, capacitors are rated in microfarads (millionths of a farad) or picofarads (trillionths of a farad). Here are the designations:

1-farad = 1 F

1-microfarad = 1 uF = 0.000 001 F = 10^{-6} F

1-picofarad = 1 pF = 0.000 000 000 001 F = 10^{-12} F

Capacitors aren't perfect — the manufacturer can't guarantee a 10 uF capacitor is exactly 10 uF. All capacitors have a tolerance, typically from ±5% to as poor as ±100%. Dipped silver mica capacitors tend to have the tightest tolerance, electrolytics the worst.

Capacitors also have a voltage rating, often referred to as the DC working voltage (WVDC for short). Typical voltage values range from 8 to 1,000 WVDC.

When substituting a capacitor, make sure the capacitor you use meets or exceed the required voltage rating. Otherwise, the dielectric could be zapped, rendering the capacitor useless.

The capacitor value, tolerance, and voltage rating must be shown on the capacitor's exterior. An alphanumeric system is used to indicate the capacitor's specifications, as shown in Figure 3.

With tubular types, which tend to be large in size, the information is basically uncoded (Figure 3a). You want to look for value in microfarads or picofarads, a tolerance figure (preceded by ± or followed by %), and a voltage rating. Any other numbers are manufacturer's codes. They can be ignored.

With disc-type capacitors, certain decoding rules have to apply (Figure 3b). If a decimal point exists, for example 0.01 or 0.001, then the value is in microfarads. If no decimal point exists, for example 60 or 220, the value is in picofarads. However, if the third digit in a three-digit number is other than 0 (1 to 9), then it is a multiplier and describes the number of zeros to be added to the picofarad value. How, then, would a capacitor labeled 104 be interpreted? It would be a 100,000 pF capacitor (10 plus four zeros).

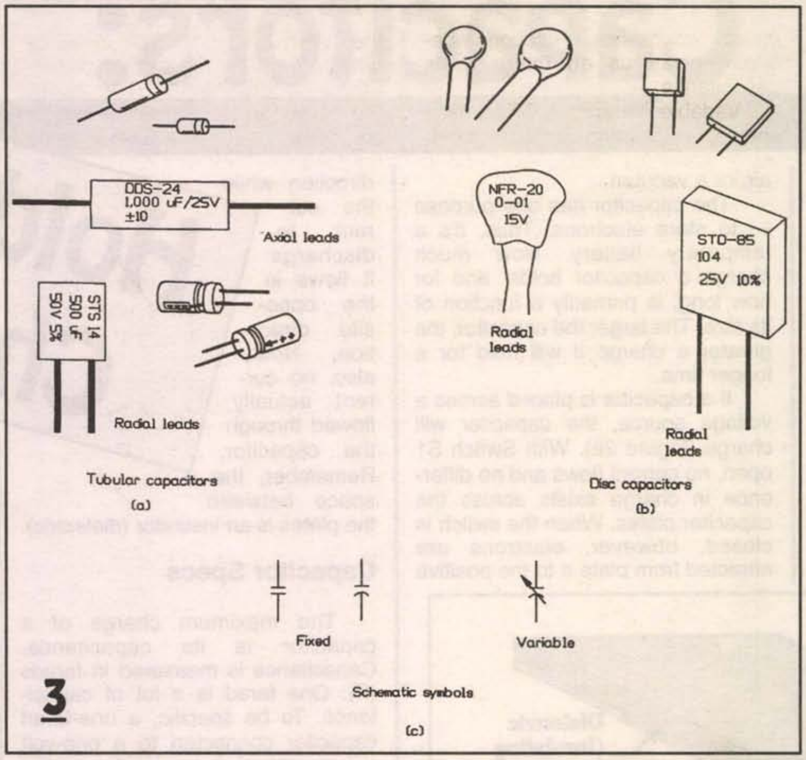
Fixed Capacitors

Like resistors, capacitors are fixed or variable. The former remains constant, they cannot be varied. The latter can have its value changed, usually by varying a shaft. Schematic symbols for both types are shown in Figure 3c. In this section, we'll look at fixed capacitors.

Fixed capacitors are classified by dielectric material: mica, ceramic, and electrolytic being the most popular. Actually, we have mica capacitors, ceramic capacitors, electrolytic capacitors. In addition, there are mylar, tantalum, and even polycarbonate, polyester, and polythelyne capacitors. We'll examine the first three in a moment.

Fixed capacitors are also nonpolarized or polarized. Nonpolarized capacitors tend to be under 1 uF while the polarized electrolytics are 1 uF and up.

In addition, we classify fixed capacitors with regard to packaging: tubular and disc (Figure 3a). Furthermore, two lead configurations exist: axial and radial.



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Here's a rundown on the characteristics of three fixed capacitors:

- **Mica.** Using mica as the dielectric and aluminum foil for plates, these capacitors come in molded or dipped disc packages with radial or axial leads (Figure 4a). Values range from around 50 pF to 0.022 uF, with voltage values up to 1,000 WVDC. They find use primarily in high-frequency applications.

- **Ceramic.** With a ceramic dielectric and aluminum foil plates, ceramic capacitors come not only in molded and dipped varieties, but in tubular packages (Figure 4b). By choosing different ceramic materials, a wide range of capacitance can be obtained, from 16 pF to 0.05 uF. As with mica capacitors, voltages can go as high as 1,000 volts. Ceramic capacitors are used primarily in filtering and decoupling applications.

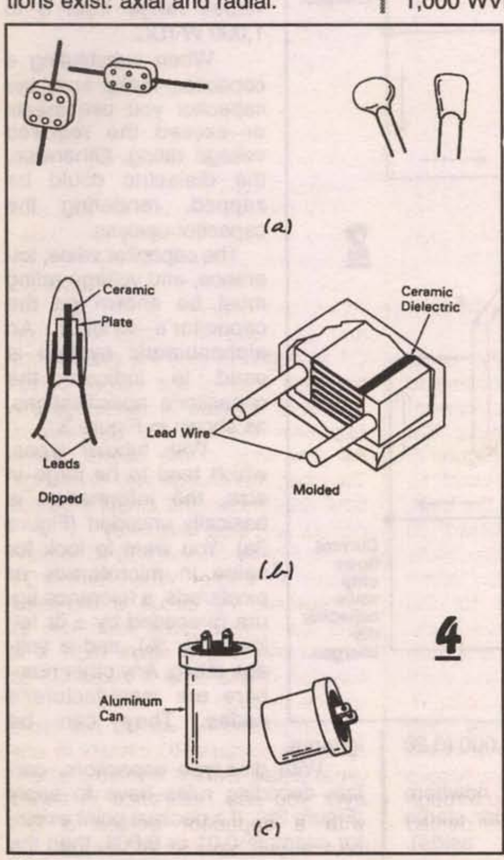
- **Electrolytic.** By using a high-capacity electrolyte as the dielectric, an extremely thin dielectric is obtained. The thinner the dielectric, the higher the capacitance value because the plates are closer together. With electrolytic capacitors, values from 1 uF to 100,000 uF, or more, are common. Working voltages can go as high as 1,000 volts (Figure 4c).

Electrolytic capacitors differ from other fixed types in one critical respect: they are polarized; that is, they have a positive and negative terminal. Connect this type of capacitor in a circuit backwards and not only won't it work, it will probably blow up. Be cautious when working with these "workhorse" capacitors. Electrolytics are usually used in power supply filtering circuits, for bypassing, and to handle low-frequency audio coupling.

Variable Capacitors

Three factors determine a capacitor's capacitance. One, plate size. Two, the distance between the plates. Three, the dielectric material used. Using the first two principles, we can create variable and adjustable capacitors. The former changes its capacitance over a wide range, the latter, over a tiny amount.

The variable capacitor uses a hand-rotated shaft to vary the effective plate area, and so capacitance. One set of plates, called the stator, is fixed in position and attached to the capacitor's frame. See Figure 5a. The other set, the rotor plates, is attached to a rotatable shaft. Since plate size determines capacitance, if



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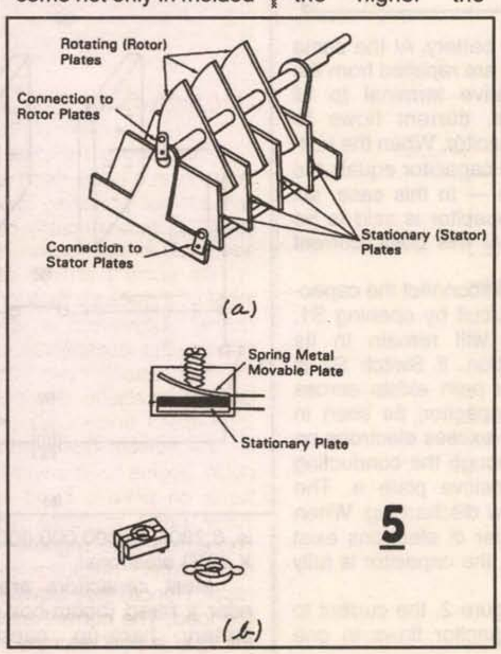

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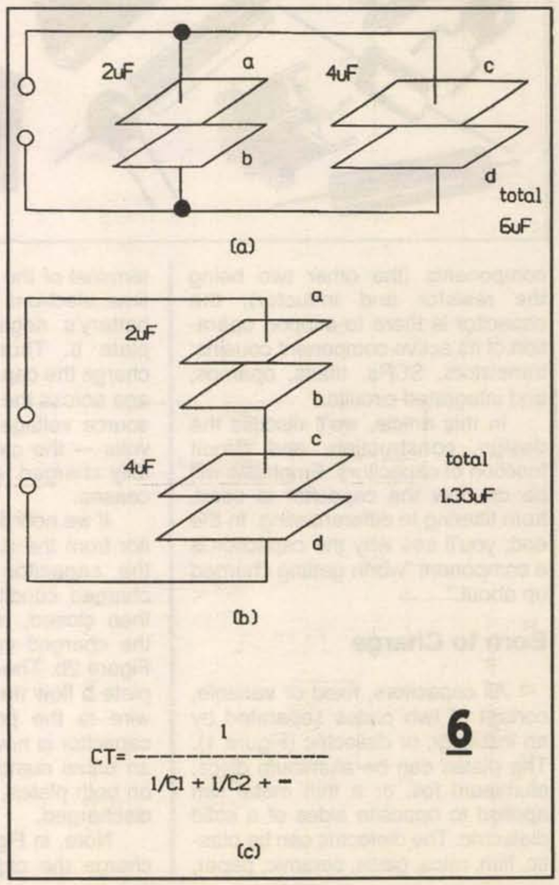

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the rotor plates are moved such that they aren't "facing" the stator plates, the "effective" plate area is zero. Minimum capacitance exists.

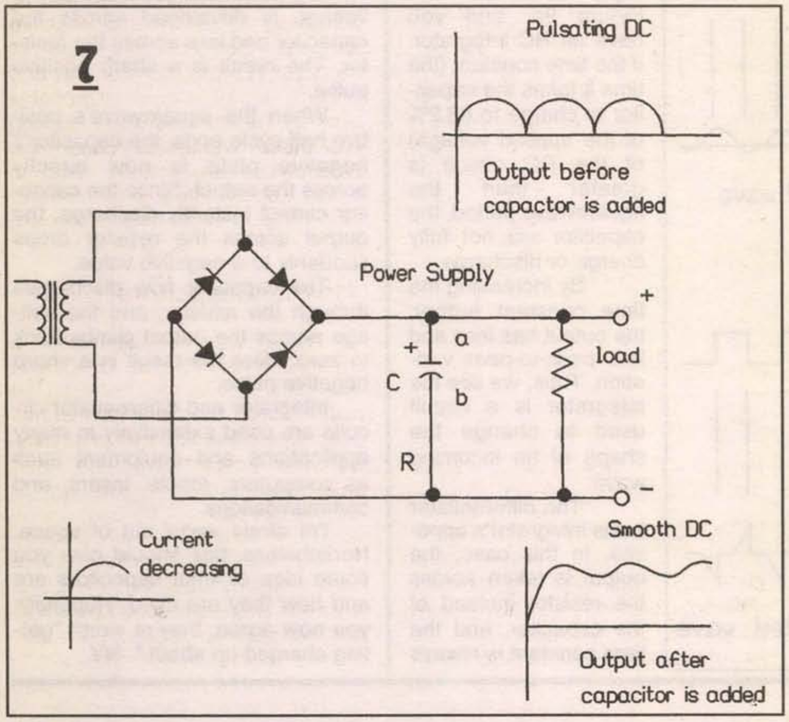
On the other hand, if the rotor and stator plates completely "cover" each other, plate size has increased to maximum, with the resulting maximum capacitance. Rotation inbetween gives us an intermediate capacitance.

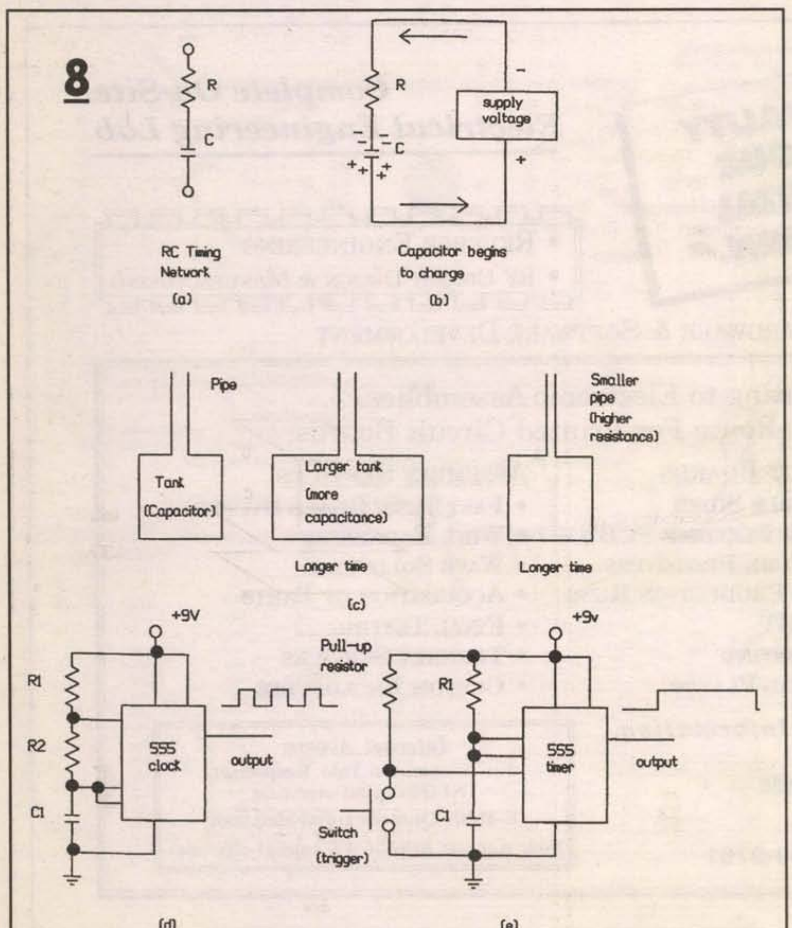
Variable capacitors, of the type shown, with ganged (connected) stator and rotor plates, are used in radio tuning circuits.

Adjustable capacitors work on the principle that the distance between a capacitor's plates determines its capacitance. The closer the plates are together, the higher the capacitance. The further away they are, the lower the capacitance.

The adjustable capacitor, Figure 5b, generally has one stationary plate and one spring metal moving plate. The screw forces the spring metal plate closer or farther away from the stationary plate, varying the distance between the plates and so changing capacitance.

Adjustable capacitors are used to tune oscillators like those used in digital watches. When they are connected in parallel with other capacitors they are called "trimmers."





Capacitors in Series and Parallel

Like resistors, capacitors can be connected in either series or parallel. We often do this to increase or decrease the total capacitance.

Figure 6a shows a 2-uF and 4-uF capacitor connected in parallel. Obviously, the total plate area has increased. And remember, greater plate area, greater capacitance. The total capacitance is now 6 uF. The formula for determining the total capacitance in a parallel network is CT = C1 + C2 ..., where CT is total capacitance.

In Figure 6b, we see the same two capacitors connected in series. Only the outer two plates (a and b) actually form the new, single capacitor. The inner plates can be ignored. Thus, the spacing between the plates has increased. You will recall, increasing the distance between a capacitor's plates reduces the capacitance. The formula for determining the total capacitance in a series network is shown in Figure 6c. Applying it, what would be the total capacitance of the series network? Did you get 1.33 uF?

Capacitors as PDC Filters

Capacitors, especially electrolytics, are often used as filters to smooth out pulsating direct current (PDC) in power supply circuits. We see such an application in Figure 7.

As current arrives at point R, most of it goes up through the load. Some, however, is diverted to charge the capacitor's lower plate (b). The capacitor has "stolen" some current normally destined for the load. Don't worry, it will give it back.

As current during the first half-cycle begins to decrease, the electrons on plate b head to point R. They can't go back where they came from (the negative end of the transformer) because like charges repel. Hence, they travel up through the load. The current earlier denied the load is now returned.

In the process, it fills in the gaps, or "valleys," between the pulsating direct current pulses. The result is an almost smooth DC.

Capacitors used in power supplies tend to be large electrolytics. Use a minimum of 1,000 uF, while following the rule: "the more the better." In microcomputer power supplies, for instance, it's not uncommon to see "cans" with 40,000 to 50,000 microfarads.

Timing Out

When a capacitor is connected in series with a resistor, an RC (resistance/capacitance) timing network is formed, Figure 8a. Such a network is one of the most important and widely used circuits in all of electronics.

If a voltage is applied to the network, the capacitor begins to charge (Figure 8b.) How long it takes the capacitor to charge is a function of capacitor and resistor values. The larger either component, the longer it will take the capacitor to charge.

Think of the capacitor as an empty tank and the resistor as a pipe supplying water (Figure 8c). If the tank size is increased (larger capacitor), it will take longer to fill. If the pipe is made smaller in diameter (higher resistance), it will also take longer to fill the tank. Either way, larger capacitance or higher resistance, the longer it will take to charge the capacitor. Conversely, if either resistor or capacitor is reduced in amount, the capacitor takes less time to charge.

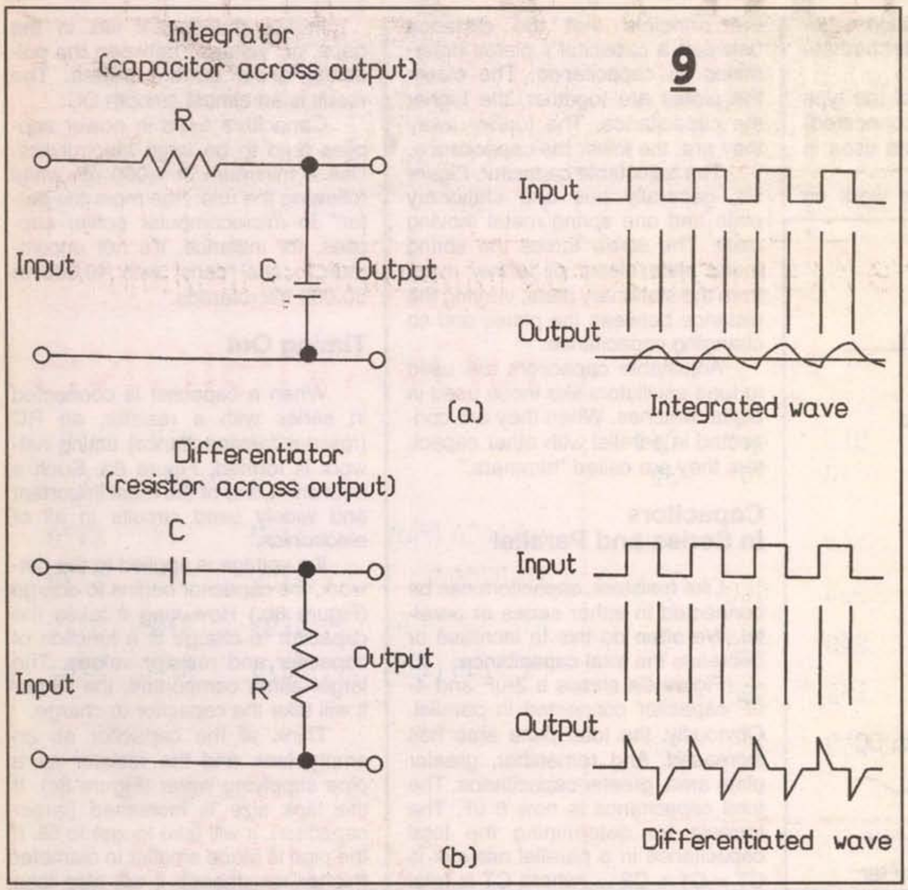
What is true for the charging cycle is true for the discharge cycle. How long it takes to discharge a capacitor depends on how large it is and how much resistance it discharges through.

RC circuits find use in clock and timing circuits, to name two widespread applications. In the 555 IC clock circuit shown in Figure 8d, an RC circuit consists of R1 plus R2 and C1. The time it takes to charge C1 through R1 plus R2 determines the high time of the output pulse. The time it takes to discharge the capacitor through R2 determines the low time of the output pulse. Together, the charge and discharge time determines the circuit's output period, and thus frequency.

In Figure 8e, the 555 IC is configured as a timer. When Switch S1 is pressed, the circuit is triggered and the output goes from low to high. How long it stays high is a function of the time it takes C1 to charge through R1.

Unfortunately, we do not have space to discuss RC circuits in any great detail. Suffice it to say, whenever you see resistance in series with a capacitor across a DC source, you have an RC circuit.

Hold That Charge!



Integrators and Differentiators

Connect an RC circuit across a squarewave input and take the output off the capacitor, as shown in Figure 9a, and you have an RC integrator. If the time constant (the time it takes the capacitor to charge to 63.2% of the applied voltage) of the RC circuit is greater than the squarewave period, the capacitor will not fully charge or discharge.

By increasing the time constant further, the output has less and less peak-to-peak variation. Thus, we see the integrator is a circuit used to change the shape of an incoming wave.

The differentiator is the integrator's opposite. In this case, the output is taken across the resistor instead of the capacitor, and the time constant is always short with respect to the input waveform (Figure 9b).

When the input waveform goes positive, all the circuit voltage is across the resistor, and, therefore, at the output, as the capacitor cannot charge instantly. As the capacitor begins to charge, more of the voltage is developed across the capacitor and less across the resistor. The result is a sharp positive pulse.

When the squarewave's positive half-cycle ends, the capacitor's negative plate is now directly across the output. Since the capacitor cannot instantly discharge, the output across the resistor drops suddenly to a negative value.

The capacitor now discharges through the resistor, and the voltage across the output climbs back to zero. Here the result is a sharp negative pulse.

Integrator and differentiator circuits are used extensively in many applications and equipment such as computers, robots, lasers, and communications.

I'm afraid we're out of space. Nonetheless, this should give you some idea of what capacitors are and how they are used. Hopefully, you now agree, they're worth "getting charged up about." **NV**

PLANS – KITS – SCHEMATICS *cont.*

REVERSE ENGINEERS BIBLE. Theory and operation behind reverse engineering: computers, cell phones, descramblers, GALS/PALS, encryption, dongles, patents, and more. Software included for file editing and comparison, logic determination, cracking, disassembling, and more. $46.45 postpaid 520-726-2833. **TELECODE**, PO Box 6426-NV, Yuma, AZ 85366-6426.

MANUALS/SCHEMATICS WANTED

MILITARY COMPONENTS wanted. Capacitors, resistors, diodes, transistors, semiconductors, ICs. Electronic Material Industries, 818-842-5953, FAX: 818-845-3613.

WANTED: DIAGRAMS for radio frequency heating equipment. Induction, dielectric, plastic, microwave. YOUNGSON's, INC., 6701 Melrose Ave., Louisville, KY 40216. 502-448-6228.

WANTED: EASYTRAX PCB software manual. I have the software but not the manual. I don't have modem to download the manual. Will pay all costs. Emil Kubanek W8BVR, 6298 Old Allegan Rd., Saugatuck, MI 49453.

MANUALS WANTED for amateur, audio, test equipment, TV, VCR. A.G. Tannenbaum, Box 386, Ambler, PA 19002. 215-540-8055, FAX 215-540-8327.

WANTED: TEST EQUIPMENT SERVICE MANUALS! And catalogs for HP, Tektronix, Fluke, etc. Pepper Systems, 214-353-0257; 214-902-9511 FAX.

WANTED: COLLINS Radio Company literature. Jim Stitzinger, 805-259-2011, FAX 805-259-3830.

MISC. ELECTRONICS FOR SALE

FOR SALE: NIB MILITARY ISSUE KNEE KEYS, KY-116/U(J37), $40 EA.; SET OF FIVE MILITARY TEC MANUALS FOR COLLINS KWM2A AND ACCESSORIES, $100; NEW COLLINS 30L1 TRANSFORMER, $100; NEW JAN 6EA8 TUBES, $2; NEW 4CX350A EIMAC TUBE, $100; ONE PAIR, NIB, EIMAC JAN 7034 FOR COLLINS, $150; MFJ ROLLER INDUCTER TUNER MODEL 986, $175; DENTRON W2 WATTMETER, $65; JAMES MILLEN GRID DIP METER MODEL 90651, COMPLETE, $80; HEATH 102 WATTMETER, $40; DELTA ELECTRONICS TUNABLE NOTCH FILTER, $200; ADVANCED ELECTRONICS APPLICATIONS AT300 ANT. TUNER, $125; NEW ACCOPIAN POWER SUPPLY, 0-50V 0-5AMP, $80; YAESU FT290R PORTABLE ALL MODE 2MTR $395; HAMMARLUND HQ110A W/CLOCK, $175; ORIGINAL TEABERRY MODEL T TUBE TYPE CB W/MIC & MANUAL, $100; NIB AMDEX 12" MONOCHROME MONITORS, $25; FOR THE DIVER, NIB, DACON DELUXE PRESSURE GAUGES, 0-50001B, $25; MIL BROWN PORCELAIN INSULATORS, $2; MILITARY 24FT COPPER BUSS KIT, $10. VISA/MC/DISC, CALL 717-865-5001.

SOLAR-POWERED FAN HAT. Baseball type hat with solar powered fan. Great for sports fans, golfers, etc. Available in red or blue. $19 plus $2.00 shipping. CA residents add 7.75% sales tax. Visa/MC/Disc/Amex OK. H.T. Orr Computer Supplies, 249 Juanita Way, Placentia, CA 92670. 714-528-9822, 1-800-377-2023, FAX 714-993-6216.

ELECTRONIC ASSEMBLY MACHINERY. We buy and sell assembly machinery including solder machines and board cleaners, insertion machines and lead formers. Petlock Inc., Rialto, CA. 909-877-8900, FAX 909-877-8902.

Write in 48 on Reader Service Card.

Continued from page 32

New Products

four-set Advanced theory and brand new 1996-2000 four-set Extra class theory cassettes. These theory cassettes are ideal "car study" when used with the popular Gordon West theory books.

W5YI distributing also offers Gordon West six-tape cassette code courses. Each six-set code course offers nine hours of code practice. Zero to seven wpm teaches the code at seven wpm Farnsworth, 16 wpm character rate, and prepares applicants to pass the entry-level Novice code test: 5-16 wpm code course prepares hams to pass the General class code test, and also prepares hams to pass their second class radiotelegraph exam, too: 10-28 wpm prepares amateur operators to pass Extra class, and also prepare for the commercial radiotelegraph first class code test.

For more information, contact:

W5YI
1-800-669-W5YI

AL220 MICROCONTROLLER

Adaptive Logic introduces a one-chip reconfigurable microcontroller that provides dedicated, stand-alone control using fuzzy logic technology. At the same time, to support the AL200, Adaptive Logic is introducing INSiGHT IIe™, Windows™-based, state-of-the-art development tool for design development, simulation, real-time emulation, and programming.

The AL220 analog microcontroller with fuzzy logic on chip allows the designer to design the device directly into analog control loops with no additional components. It delivers a one-chip hardware alternative to the cumbersome solution of embedded microcontrollers utilizing separate fuzzy logic software. The deficiencies of the traditional microcontroller and software solution include higher cost, slower speeds, complex design, and generally are not reconfigurable.

The INSiGHT IIe Windows-based development tool provides the key to ease of design because you program the AL220 using fuzzy-logic rules instead of an algorithmic programming language. So, the designer can focus on solving the application rather than writing lines of code. INSight IIe improves design debugging through an equation editor. INSiGHT IIe also features real-time hardware emulation.

Analog microcontroller applications include temperature control, motion and position control, power management, and smart analog applications, among others. Recent design wins have included intelligent battery charging, automatic gain control, and closed loop process control.

The AL220 provides a patented FLOATING MEMBERSHIP™ function allowing calculation of derivatives and eliminating the need for look-up tables. Four analog inputs are processed through the core to control four analog outputs. On-chip A/D and D/A converters give the designer a unique one-chip solution.

Devices are available in 18-pin DIP and 20-pin SOIC EEPROM packages.

With INSIGHT IIe, designers have the freedom to use real-language rules rather than algorithmic programming languages, and they can program the chip directly on the INSiGHT IIe programmer. The equation editor makes it easy to define all the input variables, and interactive I/O allows closed-loop system simulation to minimize the frustration of debugging. Any input, output, variable, or rule can be set to a constant to isolate and debug problems quickly. INSiGHT IIe also provides notebook development and real-time hardware emulation via a parallel port.

For more information, contact:

ADAPTIVE LOGIC
800 CHARCOT AVE., STE. 112
DEPT. NV
SAN JOSE, CA 95131
408-383-7200 408-383-7205
FAX: 408-383-7201

RS232 TIME/DATE STAMP LOGGER

The RS232 Time/Date Stamp Data Logger (TDSL) is a portable, one-megabyte memory, storage device that records data when connected to an RS232 transmitting device. Recorded data is then downloaded to a computer file for subsequent viewing or for input to a spreadsheet program. The TDSL is user programmable from an RS232 port on a terminal or computer.

The TDSL filters the incoming data, records the data at programmable time intervals, then time/date stamps the recorded event. The TDSL has the ability to filter out selected fields of incoming data as instructed by a user-programmable mask. The user also sets up the desired interval for logging. This allows the user to log only the data fields needed at a desired interval thereby conserving memory and reducing the overall size of a file. This ability can extend the total useful recording time to years. The TDSL may be used locally or at remote locations.

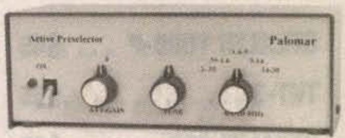
Primary power is provided by a nine-volt battery. Supplemental power is provided by a 120-volt AC-to-DC adaptor. The TDSL also utilizes power from the RS232 transmitting device itself to extend the life of the nine-volt battery.

The price of the TDSL is $399.00, and custom input options are available.

For more information, contact:

ELECTRONIC PRODUCT DESIGN, INC.
6963 BLUEBELLE WAY
DEPARTMENT NV
SPRINGFIELD, OR 97478
1-800-616-5521

ACTIVE PRESELECTOR



Palomar Engineers announces a new preselector for SWLs and mediumwave DXers. It covers 200 KHz to 30 MHz in five bands. Its high Q tuned circuits reduce cross modulation and receiver overload from strong out-of-band signals.

A new FET-bipolar amplifier tolerates higher signal levels without overload to operate in today's high-signal density environment. It also features continuous control of gain and attenuation. Connectors are SO-239 and it operates on 12 VDC.

Model P-508 is priced at $99.95 + $6.00 S&H. Model PS-90 AC adapter is available at $9.95.

For further information, contact:

PALOMAR ENGINEERS
P.O. BOX 462222, DEPT. NV
ESCONDIDO, CA 92029
619-747-3343 FAX: 619-747-3346

MONITOR DOCK-IT

StarTech Computer Products has recently introduced the Monitor Dock-It, a contour fit anti-glare/anti-radiation filter plus a monitor organization system all in one! The major benefit for users is the ability to "snap-on" accessories to the Dock-It thus resulting in increased workstation organization and efficiency.

The Monitor Dock-It is perfectly contoured to the shape of the monitor and therefore, when installed, looks like an integrated part of the monitor. The Monitor Dock-It easily attaches to the front of the monitor and instantly creates a workstation control center. Key accessories and peripherals are "snapped-on" to the Monitor Dock-It's "docking" track for easy access by users. The variety and number of accessories attached to the system is up to the user. Accessories can be easily moved from one monitor to another at any time and are interchangeable left or right. The organizational benefits of the Monitor Dock-It ensure space-saving efficiency by reducing home/office workstation clutter. The Monitor Dock-It is perfect as a multimedia workstation.

For more information, contact:

STARTECH COMPUTER PRODUCTS
100 PICCADILLY ST.
UNIT 103, DEPT. NV
LONDON, ONTARIO
CANADA N6A 1R8
VOICE MAIL:
519-438-8529 EXT. 244
FAX: 519-438-6555

HOME AUTOMATION CONTROLLER

Weeder Technologies introduces a home automation controller board (part no. WTHAC) which interfaces an RS-232 serial port of a computer to a TW523 power line interface module. X-10 control signals which are used by popular home automation systems are decoded by the WTHAC and sent to a computer in the form of standard ASCII character pairs. The computer can, in turn, transmit any X-10 control signals over the power line by sending ASCII character pairs to the WTHAC through its serial port.

Users may create their own programs to interact with their home automation systems; turning on/off any number of lights or appliances which are plugged into X-10 modules in response to date/time or the reception of another X-10 command. Sample programs — written in QuickBASIC — are included.

Priced at $38.50, the unit comes in kit form consisting of a double-sided plated-thru-hole PC board measuring just 2.2" x 1.8" and all board mounted components. Power is supplied from the RS-232 port.

For more information, contact:

WEEDER TECHNOLOGIES
P.O. BOX 421, DEPT. NV
BATAVIA, OH 45103
513-752-0279

SATSCAN EXPLORER

SatScan Electronics Corporation introduces the first of a family of products that provide professional quality audio reception of SCPC and FM2 signals from C and Ku band satellites at consumer price levels.

The SatScan Explorer tunes the entire satellite band and provides a direct digital readout of the tuned frequency. A special software algorithm provides digital automatic frequency control to compensate for drift. A 160 channel memory comes preloaded with many favorite stations such as BBC and National Public Radio. The retail price is $479.00.

For additional information, contact:

SATSCAN ELECTRONICS CORP.
P.O. BOX 1109, DEPT. NV
SULTAN, WA 98294
360-793-7533 FAX: 360-793-0359
E-MAIL: mikel@satscan.com

ALC-247

The ALC-247 extension speaker/amplifier with built-in audio level controller provides a nearly constant output level whether the input signal is a whisper or a scream. A three-band equalizer is provided to further reduce unwanted noise and tailor the audio to meet individual requirements. The unit is powered from the included power module or external 12-volt power source.

The ALC-247 is ideal for radio amateurs, commercial radio, SWL, scanner, CB, PA, and TV applications when a constant audio level is desirable for comfort and safety. The cost is $49.95.

For more information, contact:

C & S ELECTRONICS
P.O. BOX 2142, DEPT. NV
NORWALK, CT 06852-2142
203-866-3208 FAX: 203-854-5036

PHOTOETCHED METAL PARTS

PEI photoetched metal parts feature intricate designs including bend lines, part numbers, or logos and can be formed into flat or three-dimensional shapes without burrs, stresses, or deformation. Providing exact part-to-part repeatability, they can be made from metals such as copper, brass, nickel, gold, and pewter and can be polished and plated with rhodium, silver, or gold.

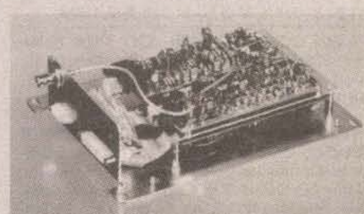
Produced by chemical action rather than stamping, PEI photoetched metal parts can be made in sizes from .025" up to several feet square and .00039" to .125" thick; with tolerances to within 10% of material thickness on all feature dimensions. Parts can be supplied flat and then formed, welded fastened, or soldered into three-dimensional objects and packaged to customer requirements.

PEI photoetched metal parts are priced according to material complexity, and quantity. Tooling typically costs less than $500.00.

For more information, contact:

PHOTOFABRICATION ENGINEERING, INC.
500 FORTUNE BLVD., DEPT. NV
MILFORD, MA 01757
508-478-2025 FAX: 508-478-3582

TELEMETRY LINK



Not every application demands multiple channels, synthesized control, or high-speed data rates. For those applications, RF Neulink has a complete line of low-cost, crystal controlled, single channel, telemetry products. This hardware is available in the VHF, UHF, and 900 MHz frequency bands. These units provide the customer with a highly reliable, very economical alternative, when a state-of-the art, high-tech device is not really required to perform the task. The DCL series, low-cost telemetry links are available off the shelf.

For additional information, contact:

RF NEULINK
7610 MIRAMAR RD., DEPT. NV
SAN DIEGO, CA 92126-4202
619-549-6340 FAX: 619-549-6345
1-800-233-1728
COMPUSERVE: 102061.2261
INTERNET:
102061.2261@compuserve.com

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The Ultra Low-Noise Synthesizer (825 to 1025 MHz) can be used for low-noise applications. The phase noise is better than <-102 dBc/Hz at 1 KHz offset and <-110 dBc at 10 KHz offsets. It has its own internal reference oscillator and will accept an external reference as well.

For more information, contact:

RF PROTOTYPE SYSTEMS
9400 ACTIVITY RD., STE. J
DEPT. NV
SAN DIEGO, CA 92126
619-689-9715 FAX: 619-689-9733
1-800-874-8037

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Power-Track Technical Systems introduces the PS-1, and DV-1 ground velocity sensor systems to accurately measure and record any low-frequency vibration or ground motion signals.

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For more information, contact:

POWER-TRACK TECHNICAL SYSTEMS
1135 CONSTITUTION ST.
DEPT. NV
TARENTUM, PA 15084-1019
412-224-0814 FAX: 412-224-7970

PORTABLE RADIOMETER

The IL1400A Radiometer and LED Probe measures the peak intensity of an LED and is photopically corrected to provide the exact quantitization of colors with less than 1% integral error. Easy to use, the handheld barrel probe has an aperture which accepts LEDs up to 6 mm diameter and the radiometer instantly displays their direct luminous intensity readings in candela.

The IL1400A Radiometer and LED Probe (SED033/Y/H/H/P2) are priced at $1,480.00 (list).

For more information, contact:

INTERNATIONAL LIGHT, INC.
17 GRAF RD., DEPT. NV
NEWBURYPORT, MA 01950
508-465-5923 FAX: 508-462-0759

HI-CAP DATA ACQUISITION SYSTEM

Sibex, Inc. announces the release of its HI-CAP, PC compatible data acquisition system. The HI-CAP is a stand-alone unit capable of digitizing and storing large quantities of information at very fast rates.

The HI-CAP can also be used as a high-speed data transfer and storage unit for applications such as video. In this application it can both read and write data at rates up to 10 megabytes/second for continuous files up to 2 gigabytes in length.

For more information, contact:

SIBEX, INC.
1040 HARBOR LAKE DR.
DEPT. NV
SAFETY HARBOR, FL 34695
813-726-4343 FAX: 813-726-4434

REMOTE CONTROL TESTER

Model ES-RCT is now available from Effron Sales. This low-cost device requires only a nine-volt battery to check any infrared remote (for every TV and VCR). This rugged tester carries a $9.95 suggested retail price.

For more information, contact:

EFFRON SALES
P.O. BOX 8744, DEPT. NV
FOUNTAIN VALLEY, CA 92728
714-962-1016 FAX: 714-964-7763

MISC. ELECTRONICS FOR SALE *cont.*

TUBES, NEW, unused. Send self-addressed, stamped envelope for list. Fala Electronics, Box 1376-3, Milwaukee, WI 53201.

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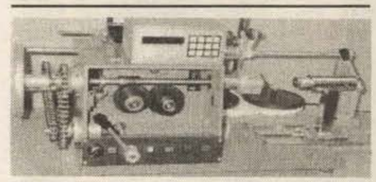
MILITARY TRANSISTORS & DIODES & INTEGRATED CIRCUITS WANTED. ELECTRONIC MATERIAL INDUSTRIES 818-842-3539, FAX 818-845-3613.

ICs BLANK PIC56s $2.10. 68HC705s $12.95. For other ICs call for prices. Remote 550 compatible hand units $2. For other remotes $5.50 and up. 702-265-1716.

TOTAL HOME lightning protector. Internet URL http://www.mindspring.com/lnp-inc 1-800-776-8357.

RADAR GUNS: MPH Industries, model K-55. Displays your speed & target speed. Comes w/case & instructions. Only $300. 1-800-539-2859.



HEAVY COIL winder, 8-20ga., 60rpm, hi-torque, 9" coil, 4" traverse, computer controlled, bench-top, low-hours, cost new $7,500, sell $2,500, call: IMS 408-727-3640.

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Write in 163 on Reader Service Card.

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by TJ Byers

DSVD: Talking Modems

New modem technology lets you talk and send data at the same time over a single, analog phone line.

Like many readers, I work out of a home office — one that's loaded with enough communications equipment to keep the phone company fat and sassy at my expense. In my office, I have three PCs (each with a modem), several phones, a fax machine, and an answering machine. Unfortunately, I only have two phone lines, one of which is dedicated almost exclusively to the fax. As you can imagine, my phone lines often look like an LA freeway at rush hour, with pending communications stacked bumper to bumper.

Now, thanks to a new modem technology called Digital Simultaneous Voice and Data (DSVD), I can make better use of my limited phone resources. These modems allow me to send data while simultaneously talking with the person receiving the transmission — on a single, analog telephone line. (Figure 1)

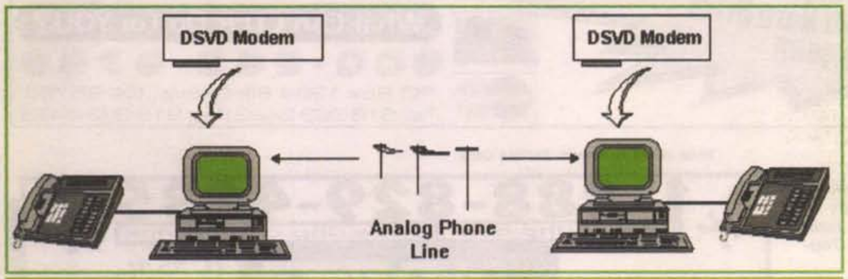

Figure 1.
DSVD modems let you send data while simultaneously talking with the callee on a single, analog telephone line.

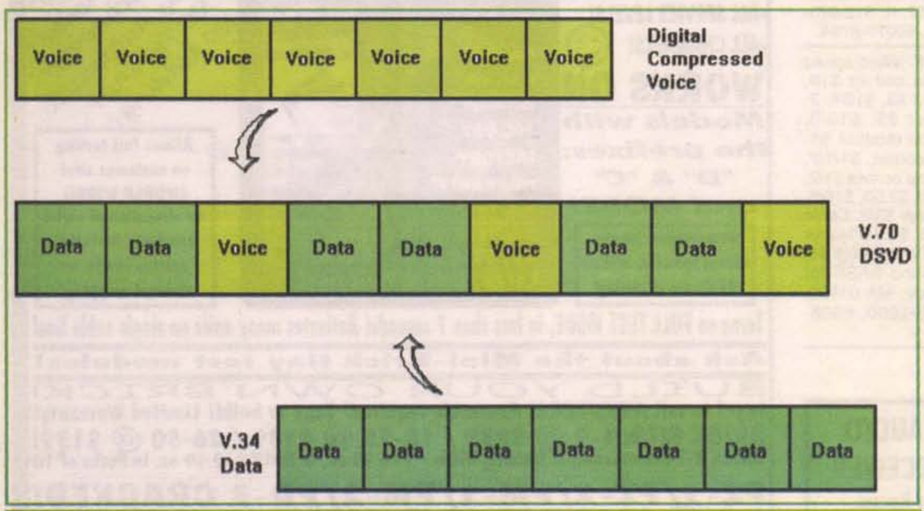

Figure 2.
Time splicing is a lot like shuffling a deck of cards. Slices from stack A (data) and stack B (voice) are interleaved. The result is simultaneous voice and data transmission over a single phone line.

For example, in my line of work, illustrations are often the springboard of a successful article. At the beginning of a project, I have to discuss photos and artwork with editors and the art director. Until I acquired my DSVD modem, I had to compose a "slide" show, send the file to the editor, then call the editor the next day to discuss the particulars. The problem was, if he wanted to look at something not contained in the original package, I had to hang up the phone, fire up the modem, upload new artwork, then call him back and hope we wouldn't get involved in a game of telephone tag. Today, I simply call the editor, we discuss the project in general terms, and then I send the artwork — one image at a time via a DSVD modem — as we discuss the illustration's merits. This saves me several hours because I can tell by the direction of the conversation which images to send and which would be a waste of time.

DSVD modems are also popular with computer gamers who have discovered the exhilaration of interactive game playing over the phone while talking to their opponent in real time — and with executives who share information via a "whiteboard" in meetings and phone conferences. Tech support finds them useful, too, because they can probe your machine while you're telling them your problems.

DSVD Modem Operation

In the past, when you wanted to talk and simultaneously send data to someone, you had to have two phone lines: one for the modem and one for the telephone. With DSVD, the telephone and modem share a single phone line. A DSVD modem has three states of operation: analog voice, data, and DSVD.

In the analog voice state, the modem is a non-participant. In other words, it does absolutely nothing other than to serve as a wire splice between the telephone and the phone wall outlet.

In the data state, the DSVD modem behaves like an ordinary modem, moving data through the phone line at speeds up to 33.6 Kbps (Kbytes per second). In this state, the modem disconnects the telephone from the phone wall outlet.

You start all calls in one of these two states, and switch to the DSVD state when you activate both states simultaneously. A DSVD link generally starts when you phone your callee. At this point, the modem is in the analog voice state only. The next step is to enable the data state and establish a data link between the two PCs. This is easily done by running the DSVD software. The modem is now in the DSVD state, which lets you send data and talk at the same time. The process works in reverse, too. You can establish the data link first, then pick up the phone at any time afterwards to switch on the DSVD state and chat with your modem partner. If you hang up the phone or quit the data state, the DSVD state is disabled, and the connection defaults to the analog voice or data state.

The DSVD modem uses tone patterns to identify the placement of the handsets and the status of the modem states. When you place the handset on-hook, a high-low tone (beep-boop) is sent across the voice channel, which signifies to the other party that you've hung up the phone. The data link still exists, of course. If you pick the handset back up, the other person's modem beeps a low-high tone (boop-beep). During a DSVD session, you can hang up or pick up the handset as many times as you wish without losing the data connection.

Every time you pick up the phone handset, though, it slows down the data throughput. The voice channel uses up to 9.6 Kbps of the modem's bandwidth (8.5 Kbps for voice and about 1 Kbps for protocol overhead). This means the speed of a 28.8 Kbps modem slows down to 19.2 Kbps, and a 33.6 Kbps modem's speed is reduced to 24 Kbps. However, this is still close to normal speed, and not a noticeable loss at these rates.

Speech Compression

Key to the success of the DSVD modem is voice processing. Normal voice communications over the phone lines are analog in nature. In the DSVD state, the voice is digitally compressed.

Specialized speech encoders/decoders (CODEC) are designed to encode the human voice by using analytical models of the human vocal system. Defined parameters in these models emulate the various speech sounds that humans make.

The voice is first divided into many short segments, then the CODEC finds the parameters that generate the closest approximation to the sound in each seg-

DLCI	Values
0	DTE-to-DTE Data
1-31	Reserved by V.42
32	DSVD Audio
33-62	Not Reserved by V.42
63	Reserved for control function information by V.42

Table 1. Allocation of DLCI Values

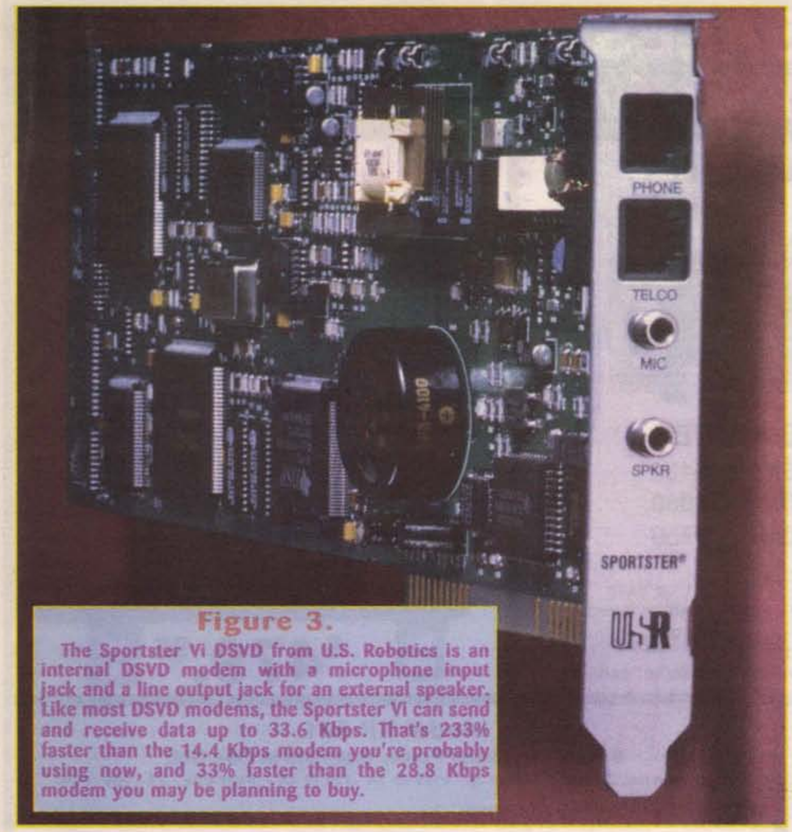

Figure 3.
The Sportster Vi DSVD from U.S. Robotics is an internal DSVD modem with a microphone input jack and a line output jack for an external speaker. Like most DSVD modems, the Sportster Vi can send and receive data up to 33.6 Kbps. That's 233% faster than the 14.4 Kbps modem you're probably using now, and 33% faster than the 28.8 Kbps modem you may be planning to buy.

Figure 4.
External V.70 DSVD modems, like the Multi-Tech MT2834PCS, cost slightly more than internal modems, but are more flexible. They are easily adapted to both desktop and notebook computers, and can be moved between the PC and Macintosh platforms.

ment. This is not unlike the way a synthesizer produces voices using combinations of different sounds. (Anybody remember the Moog, or talking Radio Shack clocks?) The resulting sequence of sounds is the digitally compressed speech. Decoding consists of sending the parameter strings to the CODEC model to recreate the sequence of audio segments. This method of speech compression and decompression is known as linear predictive coding (LPC).

Unfortunately, the LPC method can give the recovered speech a robot-like sound, particularly at higher compression ratios, that over extended periods can make many people feel uncomfortable or stressful. This inaccuracy can be greatly reduced if the encoder compares the synthetic model with the original speech and inserts a predefined code that characterizes the errors. When the CODEC decompresses the sound, it decodes the compressed voice first, then checks to see if it needs to make sound adjustments as described in the error code to normalize the voice. This improved compression scheme is known as codebook excited linear predictive (CELP) encoding. It provides much higher-quality speech than LPC for a given compression ratio. However, it typically requires an order of magnitude more processing power to encode in real time (e.g., a faster DSP chip).

Although DSVD protocol provides a default voice compression algorithm, continuing research in audio compression algorithms is likely to produce vendor-specific voice compression schemes of superior quality in the near future

Consequently, the DSVD protocol is an open protocol that gives the DSVD user a choice of audio compression algorithms. This allows the user to write software that determines if the other party has an advanced DSVD algorithm, and to use it when available.

Cut-and-Splice Technology

The DSVD modem uses a technique called time splicing to integrate voice with data. First, the data and voice information are divided into small packets, called frames. The modem then interleaves the voice and data frames together in the same way you shuffle a deck of cards by alternating cards from one pile with those of the other (Figure 2).

The data-to-voice interleave ratio is typically two frames of data for every one voice frame. If you listen to the rhythm of your speech, though, you'll discover there's a lot of dead time between letters, words, and phrases. This is wasted time that can be used to send data. What the DSVD modem does is monitor the speech pattern and adjust the interleave ratio so that there are more data frames and fewer voice frames per second during these periods of vocal silence, thus increasing the data throughput. This constant adjusting of voice/data packets maximizes the modem's bandwidth, and provides the most efficient use of the phone line.

The receiving DSVD modem is able to identify which frame is voice and which is data by reading a header attached to the beginning of each frame. The information in this header identifies the contents of the frame, as to whether it's voice or data, how many bytes there are in the frame, the frame's position (ID number) in its voice or data sequence, and an optional error correction code. While some of this information is redundant — especially that related to error checking and correction — it gives the DSVD protocol room to grow as technological advances put more and more demands on the modem.

Verify All This

This isn't new technology, though. In fact, it's the same technology the 386 and 486 CPUs use to simulate multitasking, where the PC appears to run two or more programs at the same time. Time splicing is also a common practice in satellite communications and long-distance phone calls. What is new is incorporating the technology into everyday modem communications.

Chat 'n Play

DSVD is poised to revolutionize the way personal computers will communicate and exchange information. With a single standard phone line, PC game zealots can go head-to-head with human opponents continents away. Corporate managers can perform audio and visual teleconferencing. And overworked editors may find time to smell a rose or two. **NV**

Modem Terminology

DCE - Data Communication Equipment. Essentially, DCE is a modem.
DLCI - Data Link Control Identifier. An LAPM channel address (Table 1).
DSVD - Digital Simultaneous Voice and Data.
DTE - Data Terminating Equipment. Originally a data terminal, DTE is now considered any modem connected to a PC.
DTMF - Dual Tone Multiple Frequency. A tone signaling method used to represent letters and numbers on a 12-button keypad, like that found on a touch-tone phone.
HDLC - High Level Data Link Control.
I frame - LAPM frame for error corrected data transmission.
LAPM - Link Access Procedure for Modems.
V.22bis - The modulation standard for 2400 bps modems.
V.32 - The modulation standard for 9600 bps modems.
V.32bis - The modulation standard for 14.4 Kbps modems.
V.34 - The modulation standard for 28.8 Kbps modems; 33.6 Kbps standard pending.
V.42 - Error correction protocol.
V.42bis - Data compression protocol.
V.70 - The modulation standard for DSVD modems.

CoolTalk: Simultaneous Voice and Data Communications Over The Internet

A major drawback of today's high-tech telecommunications market is the high cost of doing business. Making a DSVD conference call from San Francisco to New York, for example, can cost a king's ransom. Fortunately, it appears that the Internet may provide a solution to high-cost technology.

CoolTalk is an Internet telephone tool included with Netscape Navigator 3.0 that provides high-quality audio conferencing, a full-featured whiteboard, and simultaneous voice communications. With CoolTalk you can now talk and work collaboratively with friends and colleagues anywhere in the world via the Internet.

While you talk with a colleague via CoolTalk, you can both view the same graphic image and edit it in real time with a full range of drawing and mark-up tools. This audio conferencing feature lets you talk with full duplex sound so that you can speak and be heard simultaneously. CoolTalk supports several compression formats which allow low-bandwidth operation, while letting users with faster network and high-speed modem connections take advantage of the highest audio quality. And since CoolTalk works seamlessly with Navigator 3.0, you can send and receive calls directly from any web page.

Other CoolTalk features include a web-based phonebook to locate other CoolTalk users, a speed dialer, Caller ID, call screening, and an answering machine that records messages and caller information while you're away.

But the best part is yet to come, because all it costs to use all these cool features is a local phone call. No longer do you have to pay outrageous long-distance charges. You can download a copy of Netscape Navigator from our *Nuts & Volts Magazine* web site: (http://www.nutsvolts.com), or from Netscape at http://www.netscape.com

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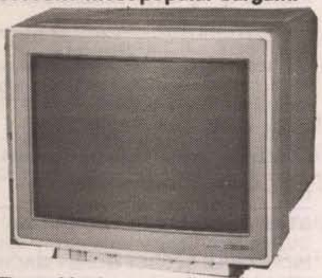

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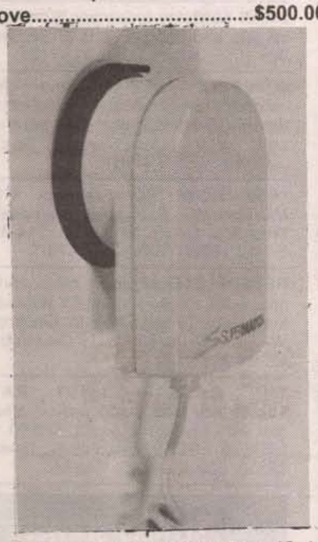

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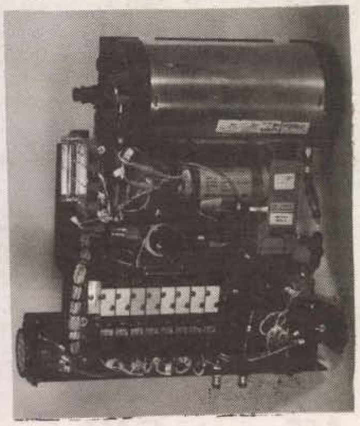

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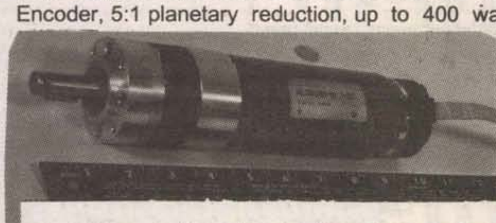

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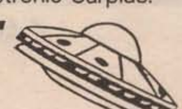

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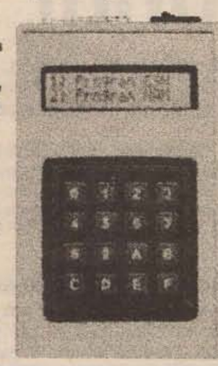

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reader FeedBack

Continued from page 5

with distilled water through the fill hole. I fill and then shake the water out several times until the dumped water is fairly clean. Then I fill the tank with distilled water and place the jets on a piece of paper towel that has been folded over itself several times to make a thicker pad. The ink and water will flow out of the jets to clean them. Keep refilling the tank and replacing the paper until no color weeps out of the jets. At this stage, a little ultrasonic cleaning does a lot of good if a jet was plugged while the cartridge was in use.

That's it. Sorry to run on so long, but at least the description is complete. I think that if people understand how the cartridge system works, they can understand what is happening when something goes wrong and can use a refill kit more effectively, perhaps by not following the directions exactly because a more convenient method is possible with the equipment at hand.

Bill Shuff

The above letter is correct, but long winded. What the reader has done is take a simple response and made it very technical. I stand by my simpler solution as the way most readers see an ink jet refill.

TJ Byers

Dear Nuts & Volts:

Although somebody before Arthur C. Clark may have used the term "geosynchronous orbit," Arthur is without a doubt the coiner of this phrase. He not only conceived the modern-day satellite, he did this before WWII.

Chris Bieber, CA

Dear Nuts & Volts:

Since it's important that a tutorial article — such as the one on resistors in your July '96 issue provide accurate information, I could not leave it unchallenged.

Although there were several other inaccuracies in the paper, the most flagrant one was the assertion that carbon composition resistors are the most common type of fixed resistor.

This statement probably would have been true 30 years ago, but starting about 20 years ago, they started being replaced by carbon film resistors, and in the last five years it would have been very difficult for the man

continued on page 107

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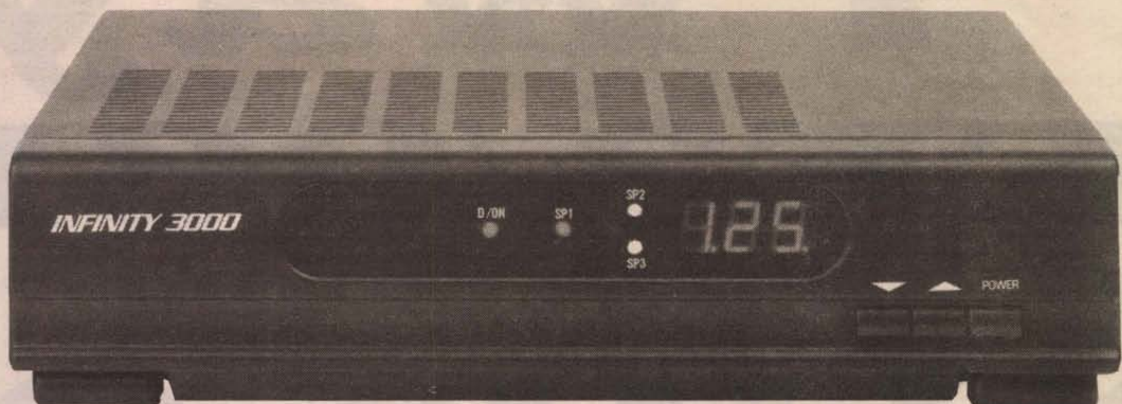

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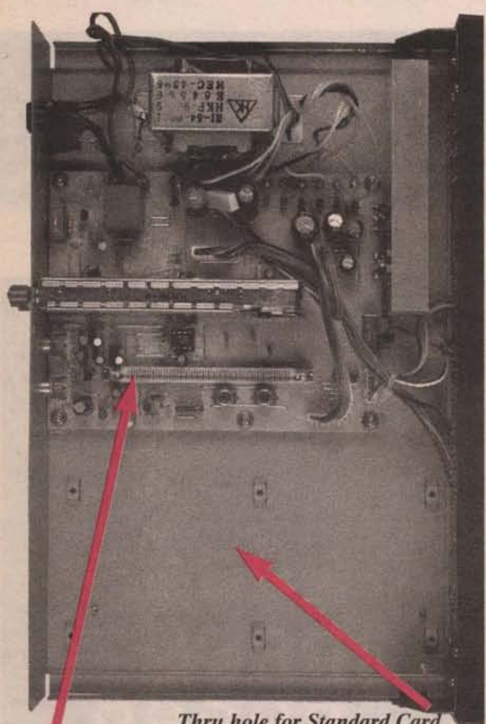

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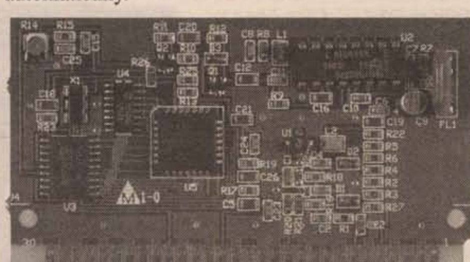

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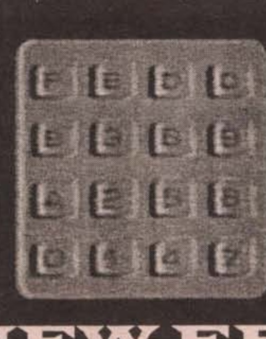

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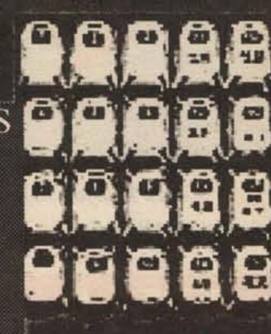

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reader FeedBack

Continued from page 104

on the street even to find one.

As a final blow, it was recently announced that Allen-Bradley will stop making carbon-comp resistors on August 15th. While it may be possible to buy resistors called carbon-comp from other sources, the Allen-Bradley line was always considered THE standard for the qualities most desirable, and it is difficult for me to see how it will be possible to replace them in some applications. A glance at their construction will show why this is true.

The A-B carbon comp resistor had an inner core of powdered graphite mixed with an appropriate percentage of a suitable non-conducting material; higher resistance values would have a greater proportion of insulating material. Wire leads would be inserted in this core and the whole assembly would be surrounded by a rigid thermosetting plastic shell. This whole assembly would then be hot-molded under high pressure and temperature until the whole unit was a solid void-free unit. This resulted in a unit which had very low inductance and was capable of withstanding much higher short-term overloads than other resistor types. It was, of course, inherently difficult to manufacture these resistors to a close tolerance, but this could be overcome by testing and sorting at the factory before the units were color-coded. Because of the above characteristics, they will be extremely difficult to replace in certain RF and pulse applications.

Carbon film resistors, on the other hand, are constructed by depositing a very thin layer of carbon on a ceramic cylinder resulting in a unit which will be lower than the desired resistance value. Then a spiral groove is cut through the film until the desired resistance value is achieved. This results in a unit which not only has a higher inductance than the carbon-comp unit, but which also may vary from unit to unit of the same resistance value. In addition, since the film is so thin it is more easily damaged by short-term overload or mechanical damage.

Robert C. Skar
Glen Ellyn, IL

Response:

Thanks for the update. From what you've said, though carbon composition resistors are no longer the most popular type, they should be. Sometimes if it's not broken, we shouldn't fix it.

Ron Reis

Experimenting with a Magnetic Sensor that has Frequency Output

Open Channel

by Joseph J. Carr
K4IPV

A reader recently contacted me about some of the very low frequency (VLF) receivers that we've discussed in this column over the past year or so. While talking with him, the topic of magnetic sensors came up. Actually, what came up was his forthcoming trip to England. Earlier he had recommended a hotel in London to me, and asked how it went. He then mentioned that his company [Fat Quarters Software, 24774 Shoshonee Drive, Murrieta, CA 92562; 909-698-7950 (voice) and 909-698-7913 (FAX)] was importing a small magnetic field sensor that is made in the United Kingdom by a firm called Speake & Co., Ltd.

Figure 1 shows the Speake FGM-3 magnetic field sensor. It is 60 mm long by 15 mm diameter (2.36" x 0.59" for those Americans who don't like foreign rulers). A set of three leads provides operation:

Red	+5 VDC
Black	0 Volts
White	Output Signal

The magnetic detection rating of the device is ±0.5 Oersted (±50 µTesla). This range is said to cover the earth's magnetic field. Multiple sensors can be used to provide compass orientation, three-dimensional orientation measurement systems, and three-dimensional gimballed devices such as virtual reality helmet display devices. It can also be used to provide magnetometry (including earth field magnetometry), ferrous metal detectors, wreck finders (divers take note), conveyer belt sensors or counters, and a host of other applications where a small change in magnetic field is the important transduction event.

The FGM-series device output is a +5 volt (TTL) pulse whose period is directly proportional to the applied magnetic field strength. This relationship makes the frequency of the output signal directly proportional to the magnetic field strength. The period varies typically from 8.5 µS to 25 µS, or a frequency of 120 KHz to 50 KHz. For the FGM-3, the linearity is about 5.5 percent over the ±0.5 Oersted range. Speake and Fat Quarters literature claims that these sensors are superior to Hall Effect devices because they have a much better temperature coefficent.

Two related devices (to be available this month) are the FGM-1 and FGM-2 sensors. The FGM-1 is a smaller version of the FGM-3, with a range of ±0.7 Oersted (±70 µTesla). It is basically the three-terminal FGM-3 device, but in smaller form and with a fourth lead wire to permit feedback for linearity improvement and zeroing of the output frequency under external control.

The FGM-2 is an orthogonal sensor that has two FGM-1 devices on a circular platform at right angles to one another. This orthogonal arrangement permits easier implementation of orientation measurement, compass, and other applications. One possible application that intrigues me is as an antenna orientation sensor.

The price of the FGM-3 is $36.50 as of this writing. There is also a high sensitivity, limited range device called the FGM-3h for $38.75. Shipping and handling is $2.00 for the first item, and $1.00 each for additional items in the same package. The price of the FGM-1 is $36.50, and FGM-2 is $54.75. Keep in mind that these are imported sensors, so the vagaries of the currency exchange rate could affect the actual price. If you order now, I suspect that the prices quoted in their literature (and reproduced above) are valid, but if you wait awhile, until they have to restock, then you will risk an increase in price, as the dollar and pound sterling move relative to each other.

Other Speake products offered by Fat Quarters are integrated circuit devices intended for use with these magnetic sensors. The SCL006A IC is used with the Ferranti ZN429E-8 digital-to-analog converter to produce a current output that will drive a 100 µA DC microammeter or, with a suitable resistor, a high impedance 0 to 1 volt DC voltmeter. If you are using a computer with direct digital input, then the ZN-429E-8 can be deleted and the data lines from the SCL006A input directly to the computer.

Another possibility is to keep the DAC and input the voltage to the computer via an A/D converter, or the Radio Shack digital voltmeter that has a computer interface. If the Radio Shack software will run on a laptop computer, then the system makes a dandy little portable magnetic field data logging system.

The other IC devices intended for use with FGM-series sensors are the SCL001 magnetic field nulling system and gaussmeter, the SCL007 high sensitivity gradiometer and magnetic anomaly detector, and the SCL002 vehicle detector.

Note: The applications literature for the FGM-series sensors and related integrated circuits can be obtained through Fat Quarters Software (see address earlier). You will find that the circuits use the European method of specifying components. For example, a 4.7 µF capacitor is listed as "4µ7;" a 0.47 µF is "µ47;" a 4.7 kohm resistor as "4k7;" and so forth. They also use the units nanofarads

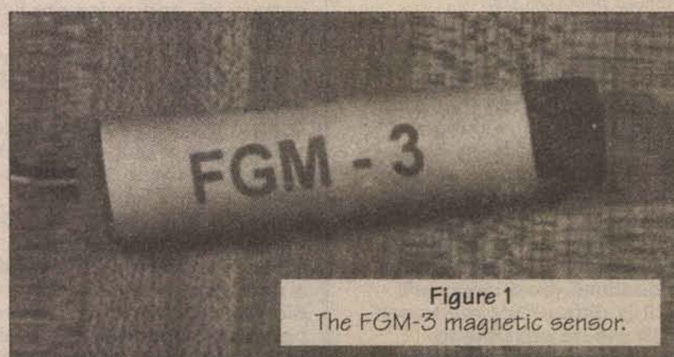


Figure 1
The FGM-3 magnetic sensor.

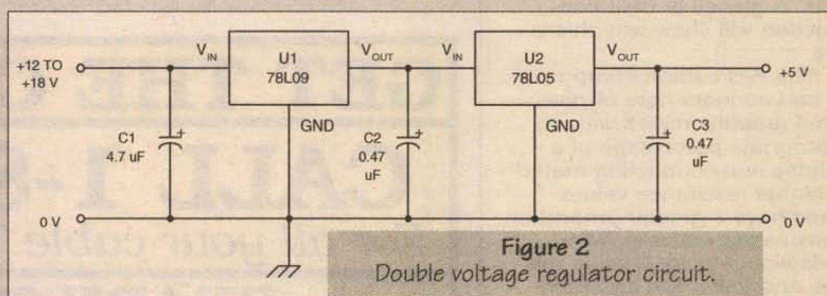


Figure 2
Double voltage regulator circuit.

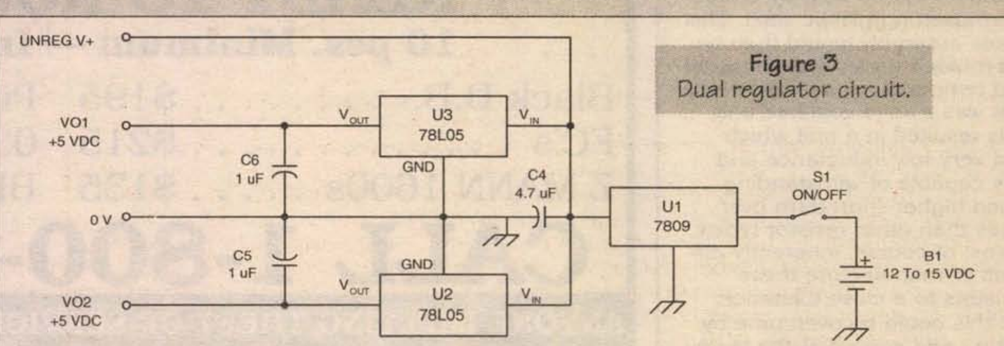


Figure 3
Dual regulator circuit.

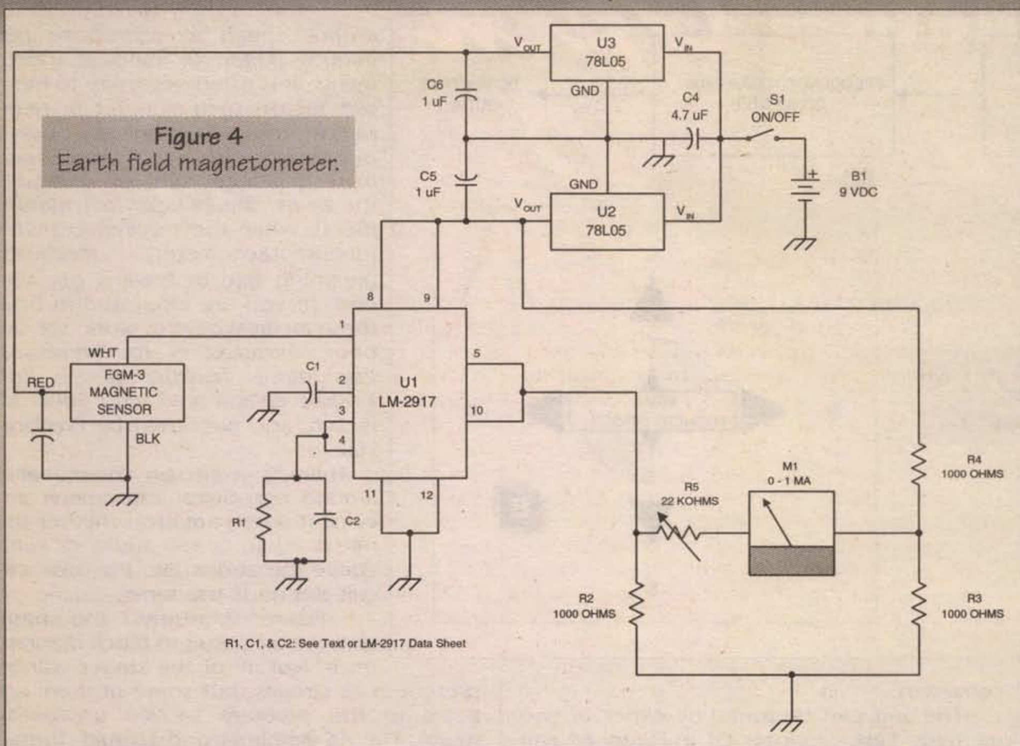


Figure 4
Earth field magnetometer.

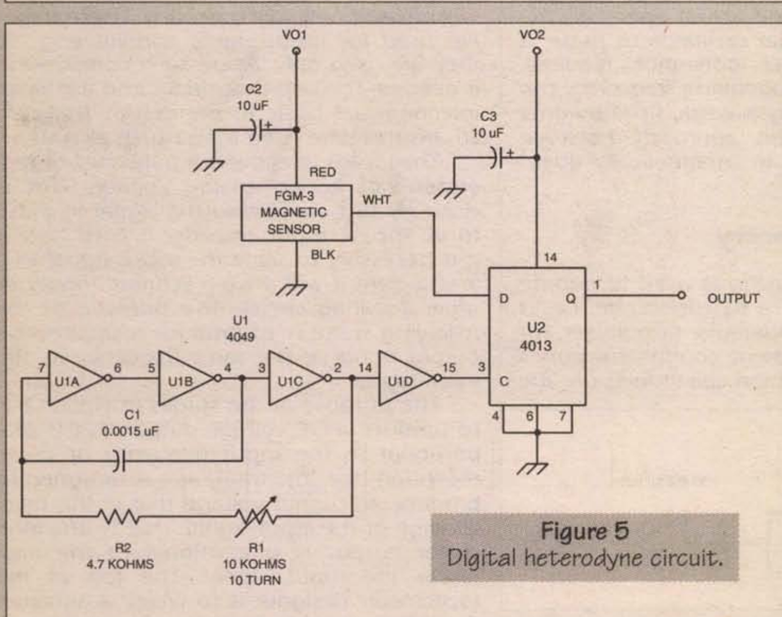


Figure 5
Digital heterodyne circuit.

(nF), which may be unfamiliar to North American readers. One nanofarad is 10^{-3} microfarads, so 1 nF = 0.001 µF = 1,000 pF. When you see a "1N5" capacitor listed, it is 1.5 nF or 0.0015 µF.

DC Power Circuit for the FGM-Series Sensors

The FGM-series sensors operate from DC power supplies of 5 ±0.5 volts, and must not see more than 7 volts, or damage may occur. It is also necessary that the DC power supply be regulated. In fact, Speake and Fat Quarters recommend double regulation of the DC power supply if it is derived from the 60 Hz AC power lines through a transformer and rectifier scheme (battery operated devices can use a single regulated DC supply).

Figure 2 shows a double regulated +5 VDC supply that will do the trick for the FGM-series devices. The input voltage is a DC source of 12 to 18 volts. It is filtered by a 4.7 µF capacitor (C1) before being applied to the input of an LM78L09 voltage regulator (U1). The ratings of U1 are 9 volts output, at a maximum of 100 mA current load (which is what the "L" in the type number infers). The output of the first regulator is filtered by C2, and is then applied to the input of the second voltage regulator (U2), which is a 5-volt, 100-mA device.

Another DC power supply is shown in Figure 3. This device is also dual-regulated, but uses two separate +5 volt outputs. This approach is fairly common in providing excitation voltage to sensors. The problem is that noise generated by the following circuitry could conceivably affect the operation of the sensor. The circuit of Figure 3 is like the circuit of Figure 2, but there are two 78L05 regulators (U2 and U3) connected to the output of the 78L09 device (U1). The UNREG output is not actually unregulated, but is only single-regulated. The two double-regulated +5 VDC outputs are VO1 and VO2. In the circuit discussed below, you will see an application of this "two-fer" power supply.

Portable Magnetic Monitor

Figure 4 shows a circuit recommended by Speake and Fat Quarters for making a small, portable magnetic field monitor. It does not require any of the specialist IC devices mentioned above, but instead uses an LM-2917 frequency-to-voltage converter. This chip is easily available in a wide variety of parts sources.

The DC power supply circuit for this circuit is a modified version of the voltage regulator of Figure 3. In this case, because the device is powered from a nine-volt battery, the 78L09 pre-regulator is not needed. One regulator (U2) provides power to the LM-2917 (U1), while the other provides power to the FGM-3 device.

The input required for the LM-2917 is a frequency, and it prefers a TTL squarewave of the sort provided by the FGM-3. The operating frequency range of the LM-2917 is set by capacitors C1 and C2, plus resistor R1. Capacitor C1 is for the charge pump on the V-to-F converter, and should be kept >500 pF according to the National Semiconductor databook (*Linear 3*); values of 0.01 to 0.05 µF seem to be most popular. Typical values for R1 and C2 are 100 kohms and 1 µF, respectively. However, these values can be optimized experimentally for any given application (or see *Linear 3*, p. 5-200, for additional procedure on setting these values).

The output of the LM-2917 is a current from pins 5 and 10. This current is provided to a species of balanced bridge circuit consisting of R2, R3, and R4, with a detector consisting of meter M1 (0-1 mA) and R5 (which acts as a sensitivity control).

A Digital Heterodyne Circuit for Small Field Measurement

In cases where you need to detect small magnetic field variation, e.g., in ferrous metal detection or earth magnetic field fluctuations due to magnetic storms, you can improve the sensitivity by using digital pseudo-heterodyning (so-called because it isn't true heterodyning). Figure 5 shows a suitable circuit. The output of this circuit is a pulse train with a frequency equal to the difference between sensor and clock frequencies. The application of this circuit is to provide a larger percentage change for a smaller change in the magnetic field.

The clock in Figure 5 is a CMOS 4049 device connected as a RC controlled oscillator (U1A-U1C, with U1D serving as output buffer). The "mixer" is a CMOS 4013 Type-D flip-flop (aka "latch"). The Type-D flip-flop transfers whatever level appearing on the D-input to the Q-output whenever the clock ("C") input is HIGH. In this particular circuit, the SET and RESET inputs are disabled by being tied to ground. Resistor R1 is used to set the clock frequency close to the FGM-3 operating frequency.

Earth Field Magnetometer

Figure 6A shows the block diagram for an earth's field magnetometer based on the LM-2917 (or some other F-to-V converter), the digital heterodyne, and the FGM-3 magnetic

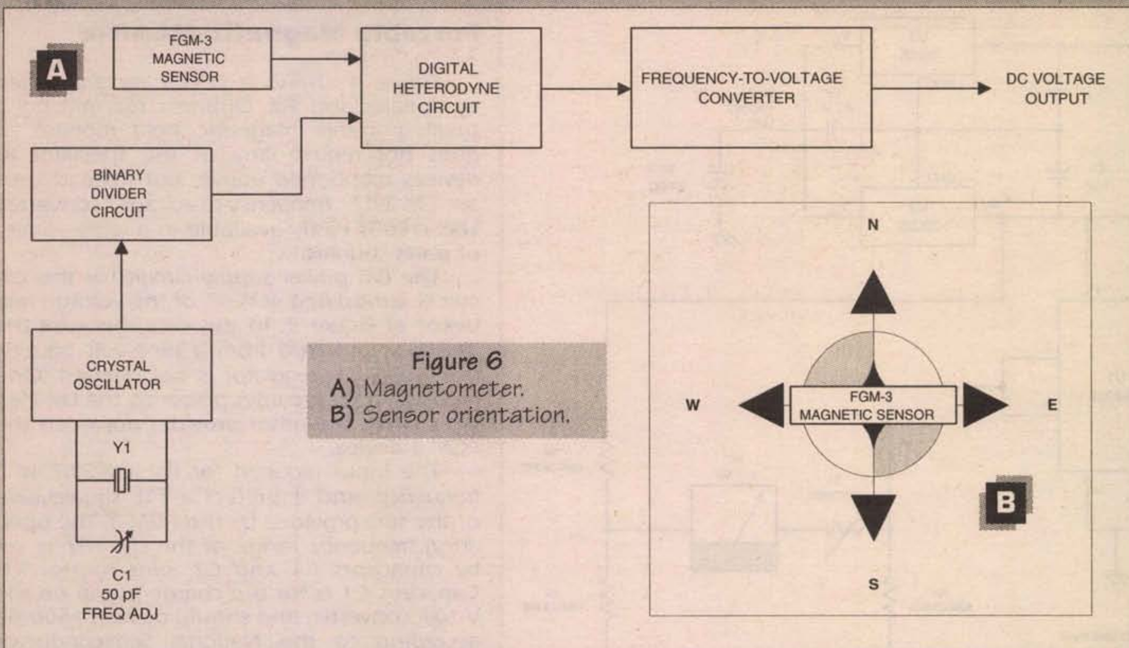


Figure 6
A) Magnetometer.
B) Sensor orientation.

sensor.

To build such a circuit, orient the FGM-3 in an east-west direction (Figure 6B), and measure the mean output frequency (use a digital frequency counter). Next, select a combination of crystal oscillator and binary divider chain that outputs a frequency about 500 Hz below the mean output frequency of the FGM-3. Both the FGM-3 output signal and the binary divider output frequency are fed to the inputs of the binary heterodyne circuit shown earlier. The output of the heterodyne circuit will swing about 0 to 1,000 Hz for a field variation of around ±500 gamma ($1\gamma = 10^{-5}$ Oersted). The output signal from the digital heterodyne circuit can then be processed directly in a computer or using the LM-2917 V-to-F converter circuit discussed earlier (or some other V-to-F converter).

The unit can be tuned by either of two methods. First, capacitor C1 in Figure 6A can be used to adjust the actual operating frequency of the crystal oscillator to make it nearer the 500 Hz difference required. Second, the FGM-3 operating frequency can be pulled by placing a weak, fixed magnet near the sensor. This approach, however, must only be done in "magnetically quiet" locations.

Analog Tachometry

The word tachometry is used to denote the measurement of a repetition rate, i.e., a frequency. In the automotive tachometer, for example, the instrument counts the pulses produced by the ignition coil to measure the engine speed in revolutions per minute (RPM). In medical instruments, it is often necessary to measure factors such as heart or respiration rate electronically using tachometry circuits. A heart rate meter (cardiotachometer) measures the heart rate in beats per minute (BPM), while the respiration meter (pneumotachometer) measures breathing rate in breaths per second. (If you are interested in how these medical devices work, see my book *Introduction to Biomedical Equipment Technology — 2nd Edition*, co-authored with John M. Brown, and published by Prentice-Hall.)

There is a certain commonality among non-digital tachometer circuits. It doesn't matter whether the rate is audio or sub-audio, or even above the audio rate, the basic circuit design is the same.

Figure 7 shows the basic tachometer circuit in block diagram form. Not all of the stages will be present in all circuits, but some of them are basic to the problem so are universally found. The AC amplifier and Schmitt Trigger will be used only when needed. These stages are used for input signal conditioning, so they are used only where such conditioning is needed. The one-shot circuit and the Miller integrator are basic to the design, however, so are therefore used for all such circuits.

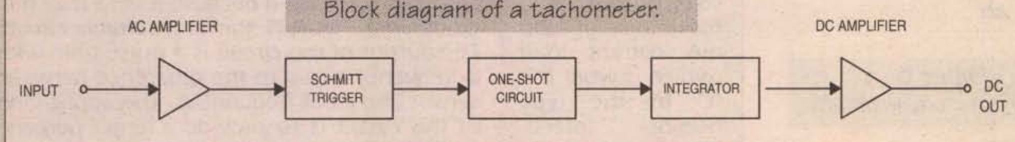
The idea is to convert a frequency or repetition rate to an analog voltage. This is done by first converting the signal to pulse form. The AC input amplifier is used only if it is necessary to scale the input signal to a level where it will drive a Schmitt Trigger or other squaring circuit. The purpose of the following stage is to produce a squarewave output signal at the same frequency as the input signal.

The purpose of the stages in Figure 7 is to produce a DC voltage output that is proportional to the input frequency or pulse repetition rate. The integrator is designed to produce an output voltage that is the time-average of the input signal. That is, the integrator output is proportional to the area under the input signal. The job of the tachometer designer is to create a situation in which the only variable is the frequency or repetition rate of the input signal. Variation in other factors obscures the results.

The output pulse of a one-shot circuit has a constant amplitude and constant duration. The area under the pulse is the product of the amplitude and duration, so from pulse to pulse, the area does not change. If the one-shot is constantly retriggered by the input signal, the total area under the resultant pulse train is a function of only the number of pulses. Therefore, the time-average of the integrator output will be a DC voltage that is proportional to the input frequency.

Figure 8 shows a practical application of the tachometer principle based on the 555 IC timer chip. The circuit was used to demodulate the audio frequency modulated signal

Figure 7
Block diagram of a tachometer.



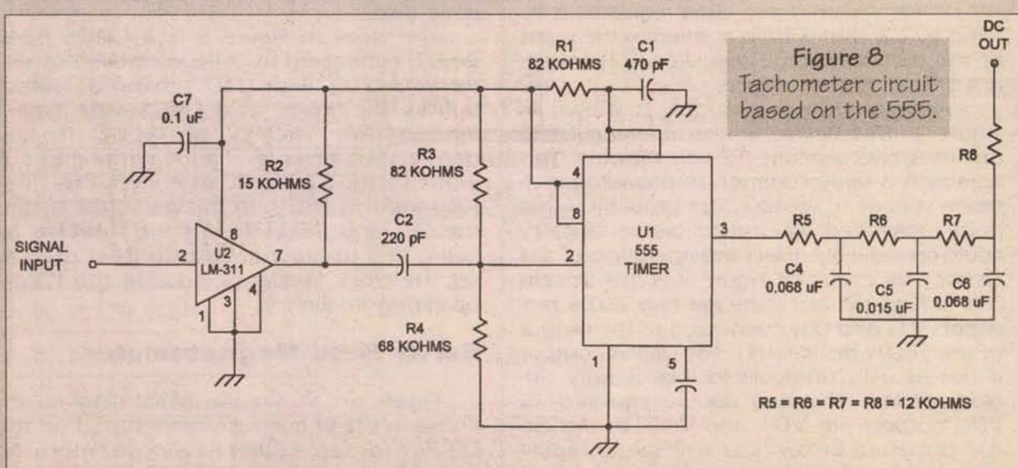


Figure 8
Tachometer circuit based on the 555.

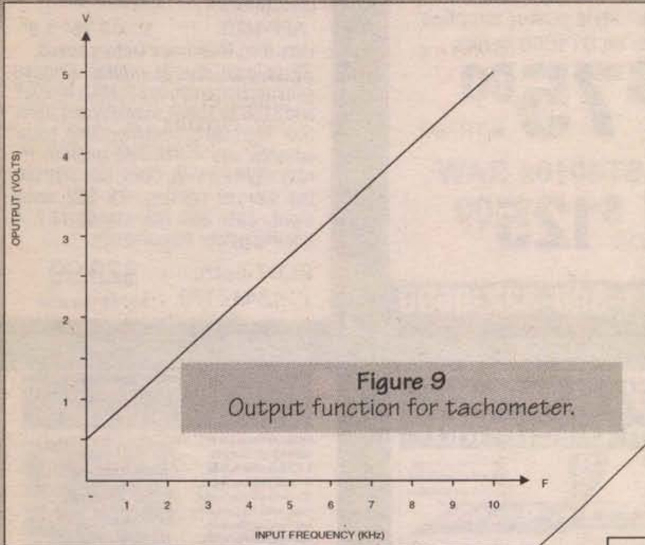


Figure 9
Output function for tachometer.

from an instrumentation telemetry set. A similar circuit (but not based on the 555) was once popular as a coil-less FM detector in communications and broadcast receivers. These pulse counting detectors operated at 10.7 MHz (a commonly used FM IF frequency in receivers). The circuit shown in Figure 8 was used to demodulate a human electrocardiograph (ECG) signal transmitted over telephone lines. The ECG is an analog voltage waveform, and was used to frequency modulate an audio voltage controlled oscillator (VCO) at the transmit end. Normally, the ECG has too low a Fourier frequency content (0.05 Hz to 100 Hz) to pass over the restricted passband of the telephone lines (300 Hz to 3000 Hz). But when used to frequency modulate a 1500 Hz carrier, however, the signal passed easily over telephone circuits.

The input waveshaping function is performed by an LM-311 voltage comparator. The job of the LM-311 is to square the 200 mV peak-to-peak sinewave input signal so that it is capable of triggering the 555 (U2). In this mode, the LM-311 is operating basically as a zero-crossing detector circuit.

The output of the 555 is a pulse train that has constant amplitude and duration. These pulses vary only in repetition rate, which is the same as the frequency of the input signal. The 555 output pulses are integrated in a passive RC integrator (R5-R7/C4-C6). The output of the integrator is a DC voltage that is a linear function of input frequency (see Figure 9). This DC voltage can be scaled, if necessary, to any desired level.

A related circuit is shown in Figure 10. This 555-based tachometer is used to measure audio frequency over four ranges: DC to 50 Hz, DC to 500 Hz, DC to 5000 Hz, and DC to 500 KHz. The circuit uses the same form of input signal conditioning as the previous circuit, and uses a 555 as the one-shot circuit. The integration function is taken up by the combination of RC network R4/C4 and the mechanical inertia of the meter (M1) movement.

Conclusion

The FGM-3 magnetic sensor is an interesting device that can be used in a lot of different scientific and electronic instruments. Try it, you'll like it. **NV**

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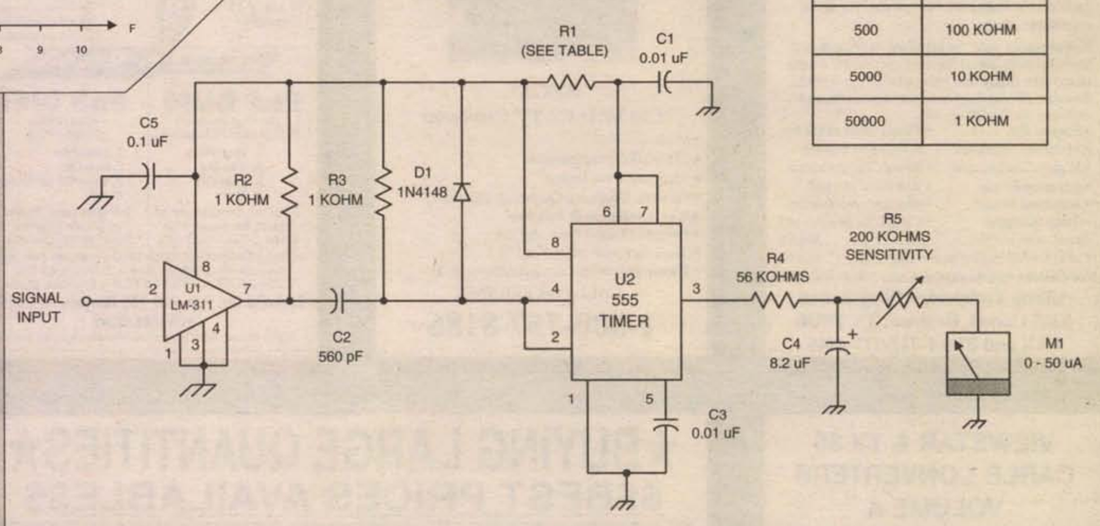
Figure 10
Analog frequency meter.

RANGE (Hz)	R1 VALUE
50	1 MEGOHM
500	100 KOHM
5000	10 KOHM
50000	1 KOHM



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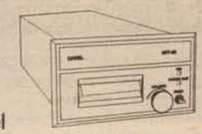

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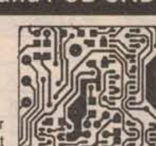

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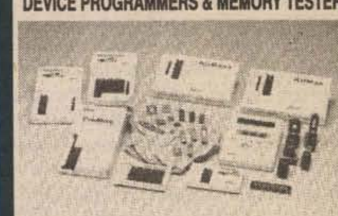

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TECH FORUM

Continued from page 29

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Len Powell
Finksburg, MD

ANSWER TO #7963 - JULY 1996

To try and modify an existing VCR timer so that power remains on would be a difficult task. But the problem as stated in the magazine was not quite clear. Is the reader wanting to have a priority timer list and have higher priority programs interrupt other recordings? Or is the reader using the VCR as a tuner and would want the timer to take over for pre-programmed events/recordings? In either case, the problem can be solved by using a VCR PLUS remote control.

VCR PLUS remotes are used to "program" VCRs by a multi-digit code found in TV listings. Some of these remotes can also be programmed in the conventional manner (i.e., by time and date). Most have more than enough memory for a week's worth of programming. They work by sending IR remote control codes in sequence (POWER, CHANNEL NUMBER, RECORD, STOP, POWER) at the proper time. This causes the VCR to turn on, select the channel number, start the recording, and shut off the VCR. If I understand the reader's question, he or she would like to have the VCR automatically switch channels, recording some programs, but not recording others. By certain tricks, this can be accomplished as follows:

Assume that the VCR is off, and an erasable tape is in the VCR. The programs to be watched and recorded are entered in the VCR PLUS remote to start and stop at the appropriate times. This can be done by using the VCR PLUS codes or times and channel number. (Be sure that the VCR PLUS remote you get can be programmed both ways!) The VCR PLUS remote will power on the VCR and select the proper channels and start the recording at the appropriate times. If the reader is present and does not wish to record the show, he or she simply hits stop on the VCR's regular remote. If the reader only wants to watch programs and not record any, simply make sure that there is no tape in the VCR. This will cause the VCR to ignore the RECORD command.

Priority will be based on the reader's own preference. The programs of less importance should be set to shut off just before the start of higher priority programs. If the reader is channel surfing and the VCR suddenly turns off, he or she should check the display on the VCR PLUS remote to see if it is in the process of getting ready to record another show or is stopping at the end of current programming.

Some things need to be considered though. If the VCR is always left on, the VCR PLUS remote will not work properly. The command sequence is POWER, CHANNEL NUMBER, RECORD, STOP, POWER. It sends these codes to the VCR just like someone using a standard remote control would, except it does everything automatically. If the VCR is on, the first POWER command will shut off the VCR and the other codes will be ignored. At the end of the record time (when the remote should be powering down the VCR) it will turn it back on. I have seen several different types of these timer remote controls. Some can only be programmed with the VCR PLUS codes as seen in the TV listings; others can be programmed both ways. Also, the VCR must be infrared remote controlled. Be sure that the VCR PLUS remote purchased can be programmed to control your VCR. Also, your VCR should have direct entry for selecting its channel numbers.

Tim Naami
Cary, IL

ANSWER TO #7964 - JULY 1996

Over the airwaves Internet? Yes, it's the amateur radio packet system, and it's open to any licensed ham. You will need a two-meter or 70 cm radio, a TNC (Terminal Node Controller), and a simple computer (a 286 will do fine). Once you're up, it's a simple matter to find the frequency and address of a local ham who has set-up an Internet connect to his home station and away you go! Here in the Philadelphia area we use W3JOE at 145.090 with a data rate of 1200 baud. 70-cm radios enjoy a data rate of 9600 baud due to their greater bandwidth.

It's time to go for that radio amateur ticket, isn't it?

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THE SOLDERLESS BREADBOX

by Donald Wilcher

LEGOs and DC Circuits

I've always enjoyed constructing models using LEGO Building Bricks because of their user-friendly mechanical locking and stacking capabilities. On the Internet, there are a ton of folks out there who are LEGOMANIACs. This special breed of hobbyists have invested time and energy to create web pages to show off their creations and resources to those interested individuals.

The LEGO information that is contained on these web pages ranges from construction tips to science-engineering applications. Full color pictures are available online for printing the finished models. Also, information on the history of construction toys, including LEGOs, can be found on some of the web sites, as well. One thing I noticed missing from some of these LEGO homepages was how to connect LEGOs to simple DC circuits. With small motors and incandescent light bulbs, LEGOs can open a world of electrical opportunities for the electronics hacker.

In this month's column, we will examine some basic DC circuits using an electromechanical DC generator constructed out of LEGOs. This generator will be used to power simple electrical resistive circuits. Ohms Law will be revisited via series/parallel circuits, along with some transistor driver applications. In addition to DC circuits, instruments and measurements will be discussed briefly by using the example circuits in this column. So, let's begin our discussion on the construction and operation of a LEGO DC generator.

LEGO DC Generator

To build a DC generator using LEGOs is quite easy. The components needed to build this device are two LEGO motors and a few supporting building blocks. Figure 1 shows all of the LEGO bricks needed to build the generator. Figure 2 shows the completed unit. This model is a good introduction to DC generator electromechanics. The symbol shown in Figure 3 of the DC generator illustrates the two motors mechanically coupled. Theoretically speaking, one of the motors takes the electrical energy from the voltage source and converts it to mechanical motion. The second motor takes this rotary motion and converts it to an electrical output.

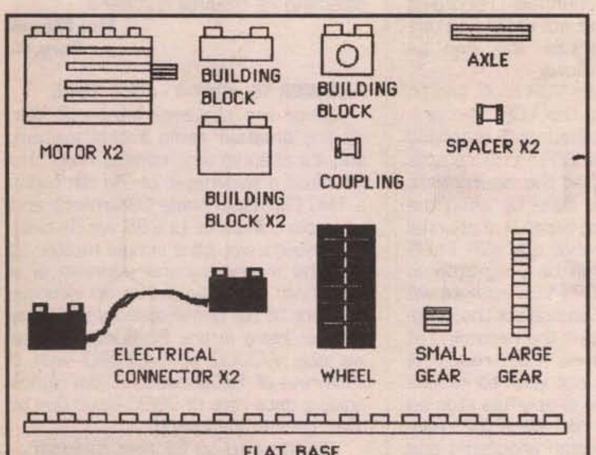

Figure 1
Inventory of LEGO blocks needed to build DC generator

The operation of the our generator quite simply works on the electromechanical theory discussed. By applying voltage to motor #1, its mechanical energy is coupled to motor #2. The output leads of motor #2 will then have an output voltage proportional to its rotational speed. The generator's voltage can increase or decrease respectively by increasing or decreasing motor #1 speed. The engineering concepts behind this mechanical model can be explained by examining the following equation:

$$Vt = Eg + Ia \times Ra$$

where:
Vt = Total supply voltage
Ia = Armature current (motor winding current)
Ra = Armature resistance (motor winding resistance)
Eg = Internal generated voltage

To calculate the LEGO generator DC output voltage, we use:

$$VGEN = Ia \times Ra$$

If the armature resistance and current are measured from the DC generator circuit, the internal generated voltage can be calculated. This numeric value can be compared to the measured value for further circuit analysis. The output voltage measured from the generator using a nine-volt power supply is 2.68V. The measured armature resistance of the LEGO is 20 ohms, therefore, its associated armature current is

$$Ia = VGEN / Ra$$
$$Ia = 2.62V / 20 \text{ ohms}$$
$$Ia = 134 \text{ mA}$$

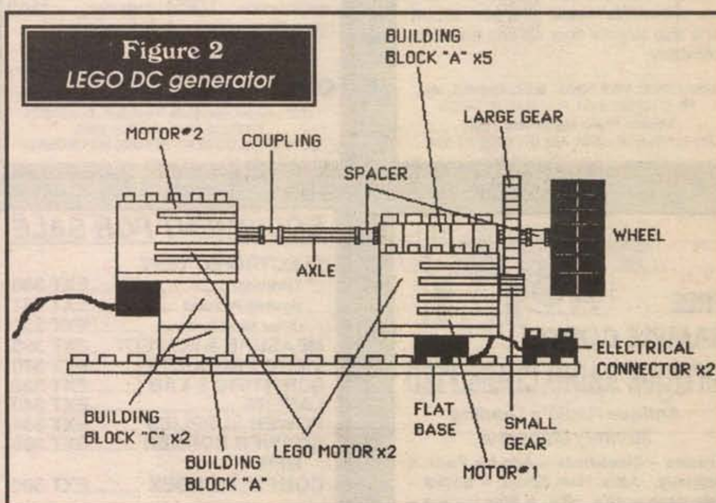

Figure 2
LEGO DC generator

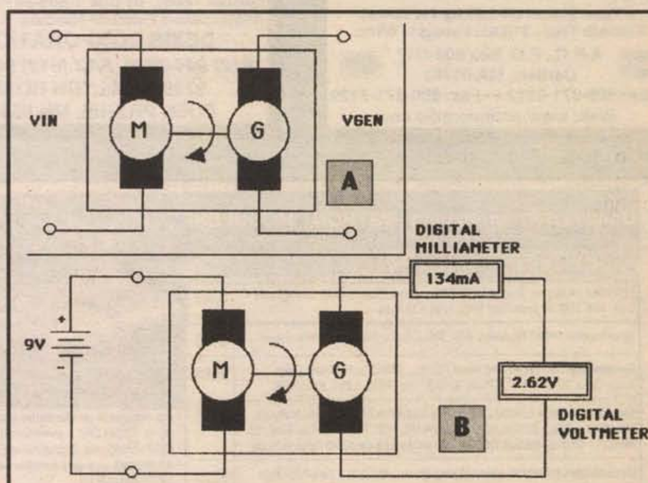

Figure 3
A - Electrical symbol for DC generator
B - Measuring current and voltage of DC generator

Figure 3 shows the electrical schematic for making the DC output and current measurement of the generator. This circuit set-up will be used for the following projects, so set it aside. Next, we will take a look at using the LEGO generator to power up a resistive network. This project will demonstrate how our generator can power an electrical voltage divider network and how to analyze it using a scientific calculator.

Voltage Dividers and LEGOs

The circuit in Figure 4 will be our test fixture for checking out the performance of the LEGO generator. As one can see, the voltage divider is a simple series resistive network. R1 and R2, noted by resistors 10K and 22K, will divide the applied voltage into proportionate levels. The ratio of divided voltage from the network circuit is "5/11." The 22K resistor will have a voltage drop of 1.85V with a 0.825V drop across the 10K component. To calculate these voltages, the voltage divider equation is

$$Vx = (Vapp. \times R1) / (R1 + R2)$$

where:
Vx = the unknown voltage across the resistor of interest
$Vapp$ = the voltage applied to the resistive network circuit

To see this equation in action, breadboard the circuit in Figure 4. With the circuit wired, turn on the 9V supply and note the readings on DVM 1 and 2. Now calculate VR1 (equals DVM 1 reading) and VR2 (equals DVM 2 reading). Figure 5 shows the calculator key sequence for a CASIO fx-7700 GB Graphics calculator. This same sequence should work for most scientific calculators. If you are using a different unit, consult your user's manual for the appropriate calculator key substitutions.

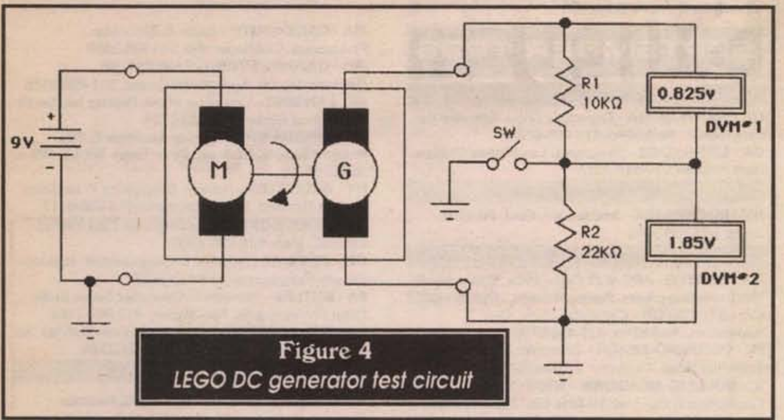

Figure 4
LEGO DC generator test circuit

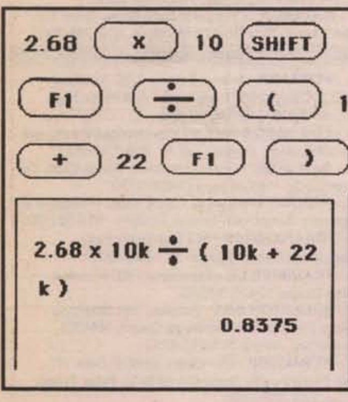

Figure 5
Calculator key sequence for Casio fX-7700GB Power Graphic Calculator

Apply voltage to the circuit. If the voltages are not within 10% of the calculated values, recheck your wiring and try the circuit again. As you observe the readings, note the relationship of the large voltage drop across the big resistor. The reason for this large voltage drop is the electrons have to work really hard to flow through a large amount of resistance. Therefore, the product of the current multiplied by a large resistor equals a big voltage drop across it.

Try different resistor values and compare measured versus calculated voltages. Create a table and record your data for future analysis and circuit verification.

The last experiment to conduct on our test fixture is the activation of the switch. If switch "SW" is closed, DVM 2 = 0V and DVM 1 equals the applied DC generator voltage. Why do you think the DC generator supply voltage is across the 10K resistor when the switch is closed? The reason is the summation of voltages in a series circuit must equal the applied voltage. All the voltage drops in the DC circuit of Figure 4 must equal or total to 2.68V. Therefore, by closing the switch, the 22K resistor is shorted out and all of the current flows through the 10K resistor to ground. Basically, the 22K resistor was replaced with a zero ohm resistor. Current flows through the path of least resistance therefore, the wire is chosen over the 22K component as the new electron path. With the 10K resistor in parallel with the DC generator, VGEN = DVM 1 which equals 2.68V. Even though I used digital multimeters for measuring the voltage drops, volt-ohm-milliammeters (VOM) can be substituted quite easily. Now let's take our generator and use it to turn on a transistor LED driver circuit.

DC Generator-Controlled Transistor Switch

This project demonstrates some basic concepts about series DC circuits and how they can be applied to model all types of complex electronic circuits. To begin our DC generator controlled transistor switch discussion, let's take a look at the physical experimental circuit. Figure 6 shows a transistor LED driver circuit controlled by our LEGO DC generator. The analysis of this circuit can be carried out by first redrawing the circuit as shown in Figure 6b. As can be seen in this circuit, our transistor/DC generator switch is no more than a series DC circuit. The important electrical DC parameters we are interested in will be the base current (IB) and the base voltage (VB). To begin our analysis, let's calculate "VB." The base voltage can be determined by

VB = V470 = VGEN - VBE

where:
VGEN = the LEGO DC generator voltage
VBE = the base-to-emitter junction voltage

For silicon transistors, the VBE junction voltage is typically 0.7V. The value I measured was 0.72V. Therefore, VB equals

VB = 2.45V - 0.72V
VB = 1.73V

The base current is determined by

IB = VB / 470
IB = 1.73 / 470
IB = 3.68 mA

The measured "IB" value from the breadboard circuit with the switch closed was 3.6 mA. At this time, the LED should turn on. If your current measurement was lower or higher than this value, or the LED is not on, recheck the wiring and make another circuit activation for "IB" measurement.

Try using different values of base resistance and note the current and voltage associated with the resistor value. As the base resistance increases, the current and voltage should decrease to a point that the generator will not be able to turn on the transistor.

Another interesting fact about this circuit is the reduction of generator output voltage. The DC generator voltage measured without a load was 2.68V. In our transistor analysis exercise, we had a 2.45V value. The reason for this slight decrease in voltage is our generator has no output regulation. Typically, DC generators have voltage regulation to maintain a constant DC output. This slight drop in voltage will not have an effect on the circuit because, to turn on the transistor, the base voltage must be greater than VBE.

To complete our data analysis of the transistor switch, the collector current (IC) measured was 21.8 mA. This circuit is not limited to just driving LEDs, it can be used to switch relays for controlling larger loads, like motors and incandescent lamps. If a direct solution is desired, a power transistor such as a TIP31 NPN device can be used to drive these loads directly.

Further Thoughts and Experimentation

DC circuits are simple in design, but can provide solutions to big problems. In the automotive field, we use DC circuits for creating test boxes for major electronic systems such as body controllers, airbag modules, ABS units, and engine controllers. These resistive networks in the test boxes simulate sensors and electrical loads that the module will encounter in the vehicle. With these test boxes, engineers can verify problems within the module or the system that it interfaces to.

An example of using a voltage divider network is in the fuel tank. The fuel tank sending unit is responsible for measuring how much gasoline is inside of the fuel tank. A resistor card with an adjustable wiper arm provides a range of resistor values that produce a spectrum of voltages. Depending on where the wiper arm is in relation to the resistor card, an associated voltage is established for that arm position.

The fuel gauge is a simple voltmeter that reads the output voltages from the divider. The fuel gauge is calibrated in gallons for the driver so they know how much gasoline is available in the tank.

Some ideas for further investigation of the DC generator that come to mind are driving digital circuits, a small night light, science fair project, science classroom demonstrations, a relay tester, and a transistor tester. The science fair project and classroom demonstrations would relate to illustrating the electromechanics of the generator.

These circuits can be wired using the solderless breadboard modules or Radio Shack's Science Fair Electronic Project Kits. Yours truly used the 200-in-1 Kit for developing and testing the circuits in the column.

Whatever method fits your pocket book, use it! Those of you who have children, this LEGO generator will make an excellent science fair project.

In addition to using this generator to test components, a DC generator tester could be created for checking the LEGO motors. Let me know what you think of these suggestions via E-Mail. Well, enuf said, see ya next month in the breadbox!!! **NV**

E-Mail address: MrDON@AOL.COM

Figure 6a
A - LEGO DC generator-controlled transistor LED driver circuit

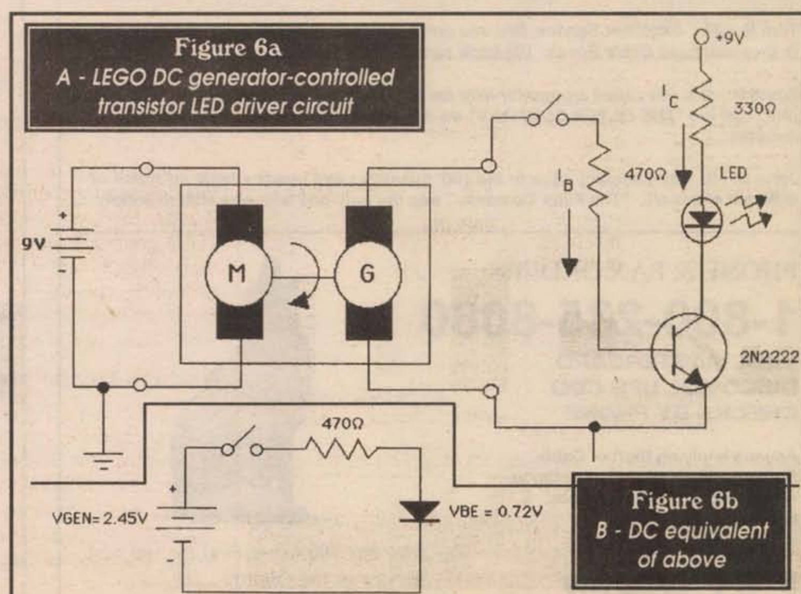

Figure 6b
B - DC equivalent of above

Events CALENDAR

continued from page 46

SEPTEMBER 1996

SEPTEMBER 1

CA - SANTA ROSA - Computer Show. Sonoma Co. Fairgrounds. MarketPro. 415-456-6730
CA - LIVERMORE - Swapmeet. Las Positas College. Noel Anklam 510-447-3857

SEPTEMBER 4-5-6-7

NY - ROCHESTER - Antique WA Conf. Marriott. Joyce 607-739-5443

SEPTEMBER 7

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
CA - STOCKTON - Computer Show. Civic Auditorium. MarketPro. 415-456-6730
FL - POMPANO BEACH - Computer Show & Sale. Palm-Aire Hotel. Narisaam 1-800-436-6707
IL - ROLLING MEADOWS - W9DXCC DX Convention & Banquet. Holiday Inn. 708-343-1696
IN - SPENCER - Owen Co. ARA Hamfest. Kathryn Smith 812-829-2140
IN - SUMMIT CITY - Hamfest. Allen Co. Fairgrounds. Fort Wayne RC. Bill or Becky 219-471-5657
KS - TOPEKA - NE Kansas ARC Hamfest. Robert Nall 913-267-9399
MA - WILMINGTON - Computer Show. Shriner's. KGP Productions 908-297-2526
MA - FALMOUTH - FARA Auction. Methodist Church. Jo 508-548-1121
ME - WINDSOR - Ham/Electronic Flea Market. Fairgrounds. Frank 207-623-9217
MI - SOUTHFIELD - Computer Show. Southfield Pavilion. 313-283-1754
PA - ALLENTOWN - Computer Show & Sale. Merchant's Square. Peter Trapp Shows. 607-369-2796
PA - ERIE - Hamfest '96. Radio Assn. of Erie. Chris Robson 814-474-1211

SEPTEMBER 7-8

AL - HUNTSVILLE - Computer Show. Von Braun Civic Center. ComputerShow 770-907-6225
CANADA - MANITOBA - AUSTIN - Hamfest. Manitoba Amateur Radio Museum. 204-728-2463
CA - OAKLAND - Robert Austin Computer Show. Convention Center. 1-800-346-0100
CA - VENTURA - Computer Show. Ventura Fairgrounds. MarketPro. 415-456-6730
KY - LOUISVILLE - Hamfest, Computer Show, & State Convention. Kentucky Fair & Exposition Center. 812-294-4905

SEPTEMBER 8

CA - SACRAMENTO - Computer Show. Scottish Rite Center. MarketPro. 415-456-6730
IA - DUBUQUE - Hamfest/Radiofest/Computer Expo. Dubuque Co. Fairgrounds. Loren Heber 319-556-5755
IL - JOLIET - Hamfest '96. Inwood Recreation Center. Bolingbrook ARS. 708-759-7005
FL - WEST PALM BEACH - Computer Show & Sale. Palm Beach Airport Hilton. Narisaam 1-800-436-6707
MA - DARTMOUTH - Radio & Electronic Fleamarket. Clubhouse. Bill 508-996-2969
MD - GAITHERSBURG - FARFEST '96. Montgomery Co. Agricultural Center. 301-490-3188
MI - LANSING - Computer Show. Holiday Inn South Convention Center. 313-283-1754
NY - BINGHAMTON - Computer Show & Sale. Kalurah Temple, Endicott. Peter Trapp Shows. 607-369-2796
NY - BREWSTER - Putnam Emergency & Repeater League Hamfest. Shirley Dahlgren 914-736-0717
NY - WOODBURY - Ham/Electronic Flea Market. LIMARC. Mark 516-796-2366
OH - FINDLAY - Hamfest & Computerfest. Hancock County Fairgrounds. 419-423-3402
PA - BUTLER - Hamfest & Computer Show. Butler Farm Showgrounds, Roe Airport. 412-282-1183
PA - PHILADELPHIA - Computer Show. Holiday Inn Sports Complex. Micro-Mart 609-924-2344

SEPTEMBER 13-14-15

IL - PEORIA - Superfest 1996, ARRL National Convention. Downtown Peoria Civic Center. Peoria Area Amateur Radio Club. 309-692-3378
WI - MADISON - Computer Sale/Show. Dane Co. Expo Center. Blue Star Productions. 612-788-1901

SEPTEMBER 14

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
CA - LOS ALTOS HILLS - Electronics Flea Market. Foothill College, Parking Lot A. 408-734-4453
CA - SAN JOSE - Computer Show. Santa Clara Co. Fairgrounds. MarketPro. 415-456-6730
CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center. 317-299-8827
LA - PRAIRIEVILLE - Ascension ARC Hamfest. Shane Dugas 504-673-8396
NY - BALLSTON SPA - Hamfest '96. Saratoga County Fairgrounds. Saratoga County RACES Association. Lenny 518-885-4933
NY - SYRACUSE - Computer Show & Sale. NY State Fairgrounds, Horticultural Bldg. Peter Trapp Shows. 607-369-2796
OH - CLEVELAND - Computer Show & Sale. Cloverleaf Trading Center. Peter Trapp Shows. 607-369-2796

SEPTEMBER 14-15

CA - SAN FRANCISCO - Robert Austin Computer Show. Cow Palace. 1-800-346-0100

SEPTEMBER 15

CA - LANCASTER - Computer Show. Antelope Valley Fairgrounds. MarketPro. 415-456-6730
CA - MODESTO - Computer Show. Centre Plaza at Red Lion. MarketPro. 415-456-6730
CT - NEWTOWN - Western CT Hamfest. Edmond Town Hall. Candlewood ARA. John 203-438-6782
IL - ORLAND PARK - Orland Park Computer Show. Civic Center. 24-Hour Hotline 708-974-3123
MA - CAMBRIDGE - MIT RS & Harvard Wireless Club Hamfest. Nick Alternburnd 617-253-3776
MI - MT. CLEMENS - L'Anse Creuse ARC Hamfest.

Events CALENDAR

Ralph Irish 810-731-6760
NE - OMAHA - AK-SAR-BEN ARC Hamfest. Dave 402-592-4930
NJ - HAMILTON TWP. - Fallfest '96. Tall Cedars of Lebanon picnic grove. DVRA. 609-882-2240
OH - AKRON - Computer Show & Sale. Tadmor Shrine Temple. Peter Trapp Shows. 607-369-2796
OH - CINCINNATI - Greater Cincinnati ARA Hamfest. Joseph Phillips 513-874-0006
WV - WHEELING - Triple States RAC Hamfest. Ralph McDonough 614-546-3930

SEPTEMBER 17

OH - TOLEDO - Computer Show. Masonic Great Hall. 1-800-893-SHOW

SEPTEMBER 20

NJ - PISCATAWAY - Ham & Electronics Auction. North Stelton Firehouse. Piscataway ARC. Marty 908-574-2873

SEPTEMBER 20-21-22

WA - SEATTLE - Digital Communications Conference. Quality Inn Seattle Airport. ARRL & TAPR. 817-383-0000
WI - WAUSAU - Computer Sale/Show. Wausau/Marathon Co. Park. Blue Star Productions. 612-788-1901

SEPTEMBER 21

AR - MOUNTAIN HOME - Twin Lakes ARC Hamfest. Phil Waters 501-425-7406
CA - BAKERSFIELD - Computer Show. Red Lion Inn. MarketPro. 415-456-6730
CA - SEBASTOPOL - Swapmeet/Auction. Holy Ghost Hall. Sonoma County Radio Amateurs. Rick 707-575-4455
ME - LINCOLN - Hamfest. Ella Burr School. BARC. Sylvia Cockburn 207-732-5185
NE - LEXINGTON - Consignment Auction. Knights of Columbus Hall. Randy 308-987-2312
NJ - PENNSAUKEN - Computer Show. South Jersey Expo Center. KGP Productions 908-297-2526
NY - HAMBURG - Western NY Section Convention. Harold Smith 716-424-7184
OR - PORTLAND - Ham Fair. Pay N Pak Building, Delta Park. 503-257-4822
RI - FORESTDALE - Ham/Electronic Flea Market & Auction. VFW Hall. Rick 401-725-7595
VT - RANDOLPH CENTER - Central VT ARC Hamfest. Tom Girardi 802-244-7836

SEPTEMBER 21-22

AK - ANCHORAGE - Hamfest. Kincaid Park Outdoor Center. ARRL. Robert Wilson 907-271-5304
CA - VALLEJO - Computer Show. Solano Co. Fairgrounds. MarketPro. 415-456-6730
IL - GRAYSLAKE - Radio Expo '96. Lake County Fairgrounds. Chicago FM Club. 708-457-0966
VA - VIRGINIA BEACH - Hamfest. Virginia Beach Pavilion. 804-HAM-FEST

SEPTEMBER 22

MI - ADRIAN - Adrian ARC Hamfest. Brian Sarkisian 517-265-1537
MO - COTTLEVILLE - Swapfest. St. Charles Co. Community College. St. Peters ARC. 314-723-4200
NJ - MT. HOLLY - Hamfest/Computer Show. Mt. Holly Armory. South Jersey Radio Association. 609-596-7749
OH - CLEVELAND - Hamfest Assn. of Cleveland Hamfest. 1-800-CLE-FEST

SEPTEMBER 27-28

KS - WICHITA - Hamfest. Wichita ARC State Convention. Sonjia Cowart-Clover 316-284-0262

SEPTEMBER 27-28-29

WA - WALLA WALLA - Hamfest. SE. WA Section Convention. Walla Walla Valley ARC. 509-525-2529

SEPTEMBER 28

AL - ANNISTON - Hamfest. City Meeting Center. AAERC. Harold 205-435-4833
CA - CONCORD - Computer Show. Centre Concord. MarketPro. 415-456-6730
CA - SAN DIEGO - Computer Show. Scottish Rite Center. MarketPro. 415-456-6730
CA - YUBA CITY - Computer Show. Yuba-Sutter Fair. MarketPro. 415-456-6730
LA - ALEXANDRIA - Hamfest. Central LA ARC. Jon Kissick 318-487-0971
MI - HUDSONVILLE - Hamfest. Grand Rapids ARA. Dave Devos 616-698-7022
MN - CHISHOLM - Hamfest. Midrange ARC. Dan Weinberger 218-492-4501
NY - HORSEHEADS - Elmira International Hamfest/Computerfest. Chemung County Fairgrounds. Elmira ARA. Dave 607-589-7495
TN - COOKEVILLE - Hamfest. Cookeville Rptr. Assn. & TN Tech ARS. Rich King 615-526-7171

SEPTEMBER 28-29

AL - MOBILE - Hamfest. Mobile ARC. Bill Cleveland 334-661-3892
KY - LOUISVILLE - Computer Fair. Kentucky Fair & Expo Center. 513-263-3378
NC - CHARLOTTE - Computer Show. Metrolina Expo Center. ComputerShow 770-907-6225
NJ - MORRISTOWN - Computer Show. National Guard Armory. KGP Productions 908-297-2526

SEPTEMBER 29

CA - ANTIOCH - Computer Show. Contra Costa Fairgrounds. MarketPro. 415-456-6730
CA - OXNARD - Computer Show. Community Center. MarketPro. 415-456-6730
CA - SANTA ANA - Swapmeet. ACP Parking Lot. Mary Russo 714-558-8813
IL - GLEN ELLYN - Computer Show & Sale. College of DuPage. 708-940-7547
MA - FRAMINGHAM - Fleamarket & Exams. Framingham High School. FARA. 508-435-0564
NY - YONKERS - Electronic Flea Market. Lincoln High School. Metro 70cm Network. 914-969-1053

OCTOBER 1996

OCTOBER 1

OH - FINDLAY - Computer Show. Hancock Recreation Center. 1-800-893-SHOW

Events CALENDAR

OCTOBER 4-5

CANADA - ONTARIO - OTTAWA - QCWA International Convention. Keith Bedal 613-828-1870

OCTOBER 4-5-6

IL - QUAD CITY - Computer Sale/Show. QCCA Expo Center. Blue Star Productions. 612-788-1901

OCTOBER 5

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
FL - MIAMI - Tailgate Swap Meet. University of Miami Parking Lot #2. The Flamingo Net. Bill, 73 Palm Ave., Miami Beach, FL 33139
IN - PERU - Hamfest. Miami Co. & Cass Co. ARCs. Gary Donaldson 219-382-2203
MO - WARRENSBURG - Hamfest. Warrensburg Area ARC. Denise Haye 816-429-5909
SC - ROCK HILL - Hamfest. York County ARS. George Trunk 803-327-4344
TX - BELTON - Ham Expo. Bell Co. Expo Center. Temple ARC. Mike LeFan 817-773-3590

OCTOBER 5-6

CA - SAN FRANCISCO - Robert Austin Computer Show. Cow Palace. 1-800-346-0100
GA - NORCROSS - Computer Show. North Atlanta Trade Center. ComputerShow 770-907-6225
MA - BOXBORO - ARRL Convention. Boxborough Woods Hotel & Conference Center. 617-334-5770

OCTOBER 6

CA - LIVERMORE - Swapmeet. Las Positas College. Noel Anklam 510-447-3857
IN - HUNTINGTON - Hamfest. Huntington County ARS. Ray Tackett 219-786-0057
NY - WOODBURY - Hamfest. Long Island Mobile ARC. Mark Nadel 516-796-2366
OH - SPRINGFIELD - Hamfest. Clark Co. Fairgrounds. Independent Radio Assn. 513-568-4070

OCTOBER 11-12-13

AZ - MESA - ARRL Convention. Sheraton Mesa Hotel & Conference Center. Scottsdale ARC. 602-837-6492
CA - BAKERSFIELD - Hamfest. Bakersfield ARA. Ed Harlander 805-589-4163
MN - ST. PAUL - Computer Sale/Show. State Fairgrounds. Blue Star Productions. 612-788-1901
TX - HOUSTON - South Texas Section Convention. Darrell Glueck 713-544-4829

OCTOBER 12

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
ID - NAMPA - Hamfest & Computer Fair. Nampa Civic Center. Jay Dyer 208-467-3245
IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center. 317-299-8827
GA - AUGUSTA - Hamfest & Computer Show. Evans Middle School. ARC of Augusta. 706-860-3828
MI - ALPENA - Hamfest. Thunder Bay ARC. Tom Twite 517-354-2469
WA - BREMERTON - Hamfest. North Kitsap ARC. Robert Tomas 360-638-1659

OCTOBER 12-13

KY - LEXINGTON - Computer Fair. Heritage Hall. Trade Show Productions, Inc. 513-263-3378
TN - MEMPHIS - MemFest. Shelby Farms Show Place Arena. Mary Moore 901-758-0661

OCTOBER 13

CT - DURHAM - State Convention. Bill Wawrzeniak 203-269-8252
IL - OAK BROOK TERRACE - Hamfest. Oak Brook Terrace. Chicago ARC. George 312-545-3622
MD - COLUMBIA - Hamfest. Howard County Fairgrounds. Columbia ARA. 410-964-4378
MI - MASON - Ham Fair. Ingham Co. Fairgrounds. LCDRA & CMARC. Jeff Oberg 517-393-4713
NJ - LINCROFT - Shore Area Hamfest & State Convention. Al Allen 908-495-3246
NY - QUEENS - Hall of Science ARC Hamfest. NY Hall of Science parking lot. Arnie 718-343-0172
OH - LIMA - Hamfest. Northwest Ohio ARC. 419-647-6321

OCTOBER 15

OH - TOLEDO - Computer Show. Masonic Great Hall. 1-800-893-SHOW

OCTOBER 18-19

FL - STARKE - Hamfest. Bradford Area ARC. Lev Francis 352-473-3511

OCTOBER 18-19-20

CA - CONCORD - PACIFICON '96. Mt. Diablo ARC. Richard Schulze 510-932-6125
GA - ATLANTA - Grove Communications Expo. Larry Van Horn 704-837-9200

OCTOBER 19

CA - OAKLAND - Robert Austin Computer Show. Convention Center. 1-800-346-0100
CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

OCTOBER 19-20

AL - HUNTSVILLE - ComputerShow. Von Braun Civic Center. 707-907-6225
FL - WEST PALM BEACH - Hamfest. South Florida Fairg Expo Center. Vi Kiekenapp 407-585-9074
MA - MARLBOROUGH - Computer Show. Royal Plaza Trade Center. KGP Productions. 908-297-2526

Electronics Q & A *Continued from page 61*

power. I understand that this was/is a common problem. Any help will be greatly appreciated.

Sean Foley
Midlothian, IL

A. It sounds like a heat problem. Make sure the instrument is clean and well ventilated. You can obtain a service manual for the HP 3465 by calling Hewlett-Packard directly at **800-452-2844**. Ask for part number 03465-90008.

MAILBAG

"All About Floppies" Feedback

Either you're too young to remember or there's too much aluminum in your diet. The PC/XT never had a configurable CMOS. The number of floppies is controlled by a pair of DIP switches on the motherboard. Michael needs to look at Switch Block 1. For two floppies he needs switch 7 off, and switch 8 on.

Steve Mann
via Internet

Hopefully someone's told you this already, but if not, here goes. The IBM PC/XT model set the number of drives with DIP switches. Switch positions 7 and 8 on switch 1 sets the number of drives accordingly.

Floppy Configuration	Switch 7	Switch 8
One floppy	ON	ON
Two floppies	OFF	ON
Three floppies	ON	OFF

With two floppy drives and a drive cable with the twist in it, both drives would be set to Drive Select 0 (depending on the drive either by a switch or jumper on the drive). If the cable does not have a twist in it, the 'A' drive would be set as Drive 0, and the 'B" drive would be set and Drive 1. This information came from the *Pocket PCRef* guide by Thomas Glover & Millie Young, Third Edition, page 50.

John Czupowski
via Internet

Hate to be a butt-in-ski, but:

1) The PC/XT machine did not use a CMOS chip to determine configuration. It is handled by a jumper block or switch set; therefore, set-up software is inappropriate for loading a configuration.

2) The 720K drive is probably set by loading driver.sys in the CONFIG.SYS file. Boot drive should be a 360K or hard drive, if the machine is so equipped.

Ernst C. Land, Jr.
via Internet

For the question "All About Floppies" in your Electronics Q & A column, could you have been thinking of the AT? All configuration of the PC and the XT was done by DIP switches on the motherboard. Also, the BIOS of the PC/XT did not support high density disks. You can try to use the DOS DriveParm in the CONFIG.SYS to get around this, but it usually doesn't work.

Anthony Olszewski
COMPUTERCRAFT

I think it's wonderful that you provide hints for computer tyros. But I'm sure I'm among many who will post to you that the PC/XT EPROM is not a CMOS. Floppy disk programming in this system is done by jumpers on the motherboard or interface card. Thanks for publishing an E-Mail address, otherwise I'd not have replied. Great work!

Will Jordan
via Internet

Response:

My reply to this question generated a lot of reader response; the above is just a sampling. I'm mostly red-faced, but defensive, too, about my answer, as you'll see. In every case, you pointed out that the PC/XT used DIP switches to set the number of floppy drives. My first "real" PC (as in, not an Atari) was a true blue IBM PC, and, yes, it used DIP switches, not CMOS. And it had only 64K of RAM – a whopping amount for 1982. This I soon replaced with an IBM 512MB version of the same many times over, all with DIP switch setups. In 1985, though, I bought a PC clone (8088 powered) from Blackship which had only two DIP switches: one for memory size and one for color/mono monitor. All the other set-up data was contained in a CMOS which was programmed from a diagnostic diskette. Since then I've looked at and tested hundreds, if not thousands, of PCs ranging from 8088 systems to DEC workstations.

After carefully reading Mr. Keller's letter (which I edited for content, so you didn't see the whole picture), I noticed two facts. First, his only floppy drive was 3.5", which didn't exist until 1986 – about the same time CMOS set-up was becoming commonplace. Second, he made no mention of changing any motherboard switches or modifying his CONFIG.SYS or AUTOEXEC.BAT files. This and the fact that his 3.5" drive quit working in the middle of the upgrade lead me to suspect his PC/XT clone had a CMOS set-up, and therein was the problem. This is why I stressed the difference between the A: and B: cable connectors, and how the set-up table must match the drive type.

I'm sorry for the confusion. I really should have included the more popular DIP-switch-based PC/XT motherboards, too. Such an oversight by a technical editor is inexcusable. I'll be more careful in the future. I wish to thank those keen-eyed readers who took the time to set the record straight.

TJ Byers
Q & A Editor

Dear Nuts & Volts:

Congratulations on the *Nuts & Volts* Electronics Q & A feature! An interesting range of questions with well considered answers. It's such a contrast to the Q & A column in another well-known publication. Keep up the good work!

Just a comment on the Delayed Action schematic from June and July. This type of simple RC delay is much improved by adding a diode across the timing resistor so that the discharge is much faster than the charge (anode to the R1,C1,D2 junction in this case). This goes a long way to ensuring a full timing cycle if the circuit is quickly retriggered.

Stephen Parry
via Internet

Dear TJ Byers:

I enjoy your Electronics Q & A column. In the July '96 issue, in reply to a reader's letter, you mention using "CircuitMaker," a circuit simulation program. I am looking for a "moderately" priced circuit simulator for simulating pretty simple mixed signal circuits (say a few op amps and a few digital logic ICs). I would very much appreciate it if you would give me your recommendation for a circuit simulation software package, and where to purchase.

Steve Roberts
via Internet

Response:

There's plenty of inexpensive circuit simulation software, but few that do both analog and digital simulations. My recommendations are CircuitMaker (800-419-4242) and Electronics Workbench (800-263-5552). Both sell for $299.00. Watch for an upcoming article where I take a hard look at a number of low-cost circuit simulators.

TJ Byers
Q & A Editor

Dear Nuts & Volts:

I feel that TJ Byers left out a few details about using Netscape with AOL. Please allow me to fill in the gaps.

1) After loading AOL, you do not have to establish an Internet link before loading Netscape. You just have to be in a pay area. I know! I couldn't get a network connection on Netscape one day after using it several times before. After I got out of the free area, I had no more trouble. Yep, there's such thing as a free lunch. BTW, the WINSOCK.DLL is the TCP/IP stack for the AOL connection; also, no dialer is needed. AOL takes care of that.

2) Only the browser part works. If you are on a web page which allows E-Mail responses, you must go back to AOL and use their browser to respond (I believe it has something to do with AOL keeping tight reins on their E-Mail server).

3) In the interest of keeping AOL use as problem-free as possible, I recommend downloading the WINSOCK.DLL which AOL recommends and placing it in the AOL directory. Then, if there are any proprietary extensions in that WINSOCK.DLL or another WINSOCK.DLL, they won't conflict as long as you only load one or the other during any Windows session and you restart Windows if you need to change WINSOCK.DLLs.

4) Lastly, the latest public version of AOL is 3.0 (not yet in the snail mail, I just received another version 2.5 at home and at work). The latest version of Netscape available from Netscape's download site is 2.02 (it fixes some bugs in version 2.01). Get the 2.02 and play with the right mouse button!

Just had to add my two cents worth!

P.E. Burke, Sr.
Craftamics
Nashville, TN

Response:

Actually, your input is worth more than two cents because I wasn't aware you had to be in a pay area before Netscape worked. On reflection, though, I can see why – AOL has to keep the meter running to make money! Most of the of the other details you mention, including the WINSOCK.DLL warning, are included in the Netscape README.TXT file. As to lastly (4), both AOL and Netscape are downloading versions 3.0 of their software, which lets the two work together better than before. (If you haven't checked out Netscape Navigator 3.0 yet, do it now. You'll like it a lot.) A large part of my response to Ms. Goodman's question was to let her know that there are other ways to establish a Netscape connection without having to incur the astronomical expenses AOL and CompuServe charge for the privilege (hence, the dialer mention). My latest figures show that if you use AOL's or CompuServe's Internet connection for eight hours a day, the bill comes to over $1,000.00 a month. AT&T and her daughter Bells charge only $24.95 for a month of unlimited use.

TJ Byers
Q & A Editor

Reader's Tip

Hey, guys! I can't do it all by myself. Your input is much needed, and will be recognized and rewarded ($25.00). Come on. I help you, so help me! Give me a good tip on how to make your computer's hardware or software work better, a unique circuit design, maybe an extremely useful PC or ham utility or peripheral you've run across, or anything else that has reader appeal, and I'll publish it.

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