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DECEMBER 1997

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

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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:

I just wanted to thank Don Pomery for the debug routine (Reader's Tip in "Electronics Q & A," Nov. '97 issue). I was able to recover a HD that I thought was a gonner for sure. I had done "Fdisk /mbr" twice on the drive each time with a different CMOS setting then written "FUBAR" in pencil on the drive when it wouldn't respond to Fdisk or Format. The drive was headed for the trash when I read Don's Reader's Tip. What did I have to lose? It worked! Thanks Don and thanks *Nuts & Volts*. That more than paid for a year's subscription.

jhonett@pacbell.net

Dear Nuts & Volts:

I like your magazine, but it would be nice if you had more "Ham Radio" stuff. There are a lot of ham radio operators out here.

73 KB0UJC
West Plains, MO

Dear Nuts & Volts:

I have been following the "User's Guide to Audio Power Amplifiers" written by Ray Marston. Ray has written a very good series of articles about audio power amplifier ICs. However, I have difficulty understanding abbreviations of some schematic component values. For example: 510R, is this 510 ohms? Why the R? 100N, is this 100 uF? Why the N? 2R7, I can't guess what resistance value this means. 4R7, same as above. 8R0, from the text I know this means an eight-ohm impedance speaker.

Scattered throughout the many schematic drawings are other puzzling component values.

Perhaps Mr. Marston can be kind enough to help an old tube technician who has not kept pace with solid-state terminology.

James Brendage
Orangevale, CA

Response:

Thanks for your comments about my articles. Regarding the abbreviations commonly used to define schematic component values, these are designed to be as compact as possible, containing no superfluous information and taking up a minimum of schematic space.

When defining the value of a schematic's 47 µF (47 microfarad) capacitor, for example, the 'F' (Farad) part of the notation is obviously superfluous, since the component is clearly drawn as a capacitor and as such inevitably has a value that is related to the Farad; this particular component value can thus be adequately notated as '47µ.'

Similarly, it is usually wasteful to have an 'ohms' notation on a schematic resistor value, or a 'Henrys' notation on a schematic inductor value.

In most modern electronic schematics, resistor values

Continued on page 109

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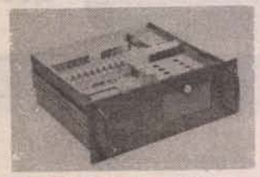

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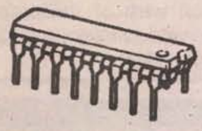

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RS-232 Relays

Computer control of the outside world is a somewhat difficult task for many computer users. I have talked to many people who want to control something with their computer, but lack the knowledge or resources required to actually build the device they need. Like most computer users, I believe programming external devices should be as easy as possible. So, in this article, I intend to simplify the task of hardware and software design by showing what tools can get the job done quickly and effectively.

In the ideal computer-controlled utopia, the user could program external devices to perform simple tasks like opening doors, turning on lights, or just checking the temperature outside. While these needs are simple and the tools are becoming available, integrating these new developments can be an intimidating job. But I think I can show you some clever new tools that will greatly simplify these types of tasks.

RS-232 communications, as you probably know, is nothing new. And because it is so readily available, it only makes sense to use RS-232 for some complicated computer control applications. While RS-422 and other standards boast greater communication distances and speeds, RS-232 typically has the ability to operate over several hundred feet at low baud rates ... perfect for simple control applications like you are about to see.

Explaining RS-232 communications could take a while so I won't do that here ... in fact, I'm going to dodge that topic altogether. Many publications and articles are available on this topic. What is important to understand for our purposes is that you need only two wires to control the devices outlined in the schematic, and that you need only four lines of QBasic code to make these circuits work.

RS-232 Control Network

Have you ever heard of an RS-232 control network? If not, don't worry, it's kind of new. The concept is old and has been around for years. What's new about it is that it is being applied to RS-232 communications for use in low-speed industrial control applications.

An RS-232 control network allows several devices to be attached to a single RS-232/RS-422 serial port and each device can be controlled individually. National Control Devices is among the few companies supporting this type of control network. With it, you can control relays, LCD character displays, LCD graphics displays, hobby servos, and high-power DC motors, and several audio/video control devices ... all from a single RS-232 port.

What makes this type of control network possible is a series of interface processors programmed into common PIC microcontrollers. Here, I would like to introduce you to the NCD-110 interface processor. This processor is the basic element of the NCD RS-232 control network. This processor has a four-bit address that is set using jumpers J1-J4 (see schematic). This processor also has a four-bit data output.

The NCD-110 acts something like a serial-to-parallel converter chip, only instead of giving you eight output bits, it gives you four. It uses what would have been the other four output bits to determine its address.

When a byte of data is received from the serial port of your computer, the NCD-110 breaks the byte into two sections. Each section contains four bits called nibbles. The first nibble (most significant nibble, MSN) is used as the address, the other nibble (least significant nibble, LSN) is the data.

What this means to you is that you can connect 16 of the NCD-110 interface processors to a single RS-232 serial port and have 64 output bits from a single serial port.

Later in this article, I will show you how to interface this processor to a CMOS 4099. This will give you eight output bits for each NCD-110, providing a total of 128 individual output bits that can be controlled from a single RS-232 serial port.

RS-232 Transmission

The RS-232 serial port can send out a maximum of 256 characters. This is illustrated using the QBasic example program shown in Program 1. Note that this program assumes you are using COM2.

If you connected the LED as shown in the "RS-232 Connections" diagram, this program would cause the LED to flash. These flashes represent data traveling from the transmit line of your RS-232 port.

When an NCD-110 is set to address 0 (J1-J4 jumpers removed), the NCD-110B ignores all ASCII characters except for 0-15. See Table 1.

Table 2 tells you how to set the jumpers on the NCD-110. The address number will also be referred to as the device number. The range column is very important. This list shows what ASCII characters the NCD-110 will respond to, depending on the settings of the address jumpers J1-J4.

Controlling Relays with the NCD-110

I chose to control relays in this article because they have a practical application to real-world control systems and they are easy to understand. In the quad relay example, the NCD-110 is directly driving the relay buffer circuitry. And based on what you now know about the NCD-110, a single RS-232 character can be used to control all four relays simultaneously.

```
10 OPEN "com2:9600,N,8,1,CD0,CS0,DS0,OP0" FOR OUTPUT AS #1
20 FOR N = 0 TO 255
30 PRINT #1, CHR$(N);
40 NEXT N
```

PROGRAM 1

When controlling relays, I would advise the use of an optoisolated RS-232 input stage. We omitted this because it is not absolutely necessary and we wanted to simplify the communication to the NCD-110. Note that mechanical relays produce large flyback voltages that are clamped by the use of the 1N4007 diodes. A 47 uF capacitor should also be used across the power supply poles to help absorb the flyback voltages.

A 4 MHz ceramic resonator is used in this design to control the speed of the NCD-110 interface processor. The NCD-110 is based on a PIC 16C54A, and is programmed to operate at 9600 baud without a jumper installed on J5, and at 1200 baud with a jumper installed. High-speed versions of the NCD-110 will be available soon.

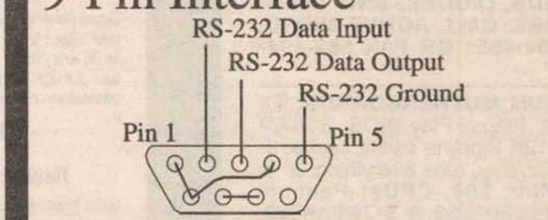
CMOS 4099

The NCD-110 can also be interfaced directly to a CMOS 4099 eight-bit addressable latch. When attached, the user loses the ability to set all the logic levels with a single ASCII character, but gains the ability to individually control eight output bits.

When the NCD-110 is set to address 0, sending ASCII characters 0 to 7 will turn off each of the output bits on the 4099, respectively. Sending ASCII characters 8 to 15 turns on each of the output bits, respectively. When interfaced to relays, a single ASCII character controls a single relay.

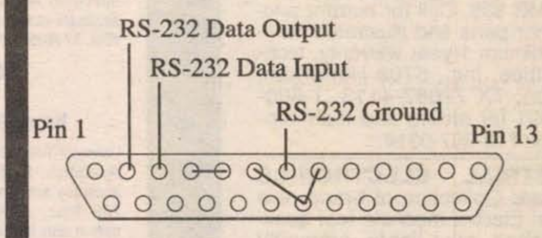
RS-232 Connections

9-Pin Interface



Example Shown Using a DB-9 Female Connector

25-Pin Interface



Example Shown Using a DB-25 Female Connector

You can easily test for data coming from the RS-232 port of your computer by connecting an LED to the ground and data output lines on your serial port. A 4.7K resistor should be used to limit the current driving the LED. Make sure the anode side of the LED is connected to the data output line. Any RS-232 transmission will flash the LED.

Remember, when an NCD-110 is set to address 0, it only listens to ASCII characters 0-15. And when it is set to address 1, the NCD-110 only listens to ASCII characters 16-31. This method of addressing continues up through ASCII character 255. If you are into programming, you can create powerful modules with just a few lines of code. Here are a couple of example relay driver subroutines that handle the entire

RS-232 Networkable Relays

By Ryan Sheldon, National Control Devices, (404) 244-2432, http://members.aol.com/ncdcat/

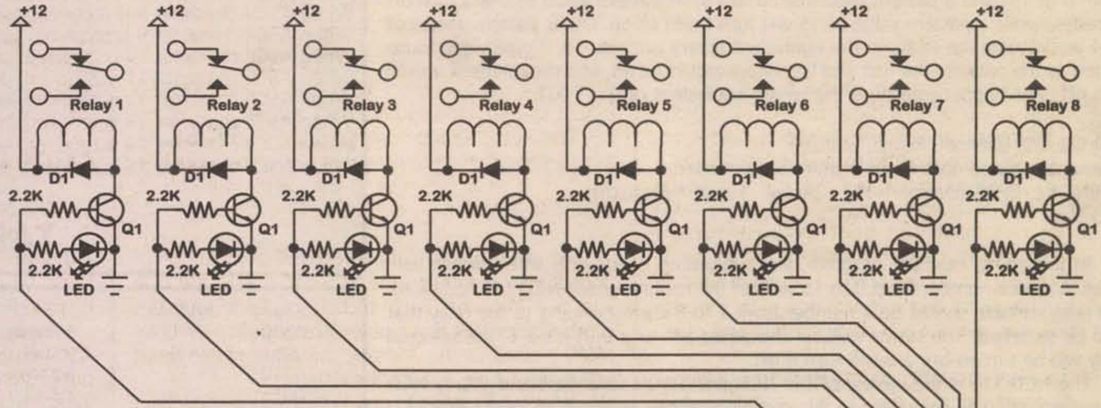
The schematic shows 3 NCD-110 interface processors connected in parallel to a single RS-232 serial port. Each NCD-110 has a set of 4 jumpers that determine its address. When set to address 0, the NCD-110 only responds to ASCII characters 0 to 15. When set to address 1, it only responds to characters 16 to 31. Each subsequent device number defines which set of ASCII characters the NCD-110 responds to.

For example, if you transmit ASCII characters 0 to 47, device 0 will respond first, then device 1, and finally device 2. Note that 255 ASCII characters can be transmitted from a single RS-232 serial port. This allows up 16 NCD-110 interface processors to share a single serial port. Take note of the address jumper setting (J1 to J4) on each device. Four address jumpers have 16 different possible combinations of settings. This method is used to determine each of the 16 addresses.

Device 0 is a quad relay driver that uses the NCD-110 to directly control the relays. This is the easiest type of relay driver to construct.

Device 1 is a simple 4-bit output processor. Using 16 NCD-110 processors enables the user to control 64 logic-level outputs.

Device 2 shows how easy it is to connect the NCD-110 to a CMOS 4099 8-bit addressable latch. This effectively doubles the output capacity of the NCD-110. In this mode, the user can only control the on/off status of the CMOS 4099 1-bit at a time.

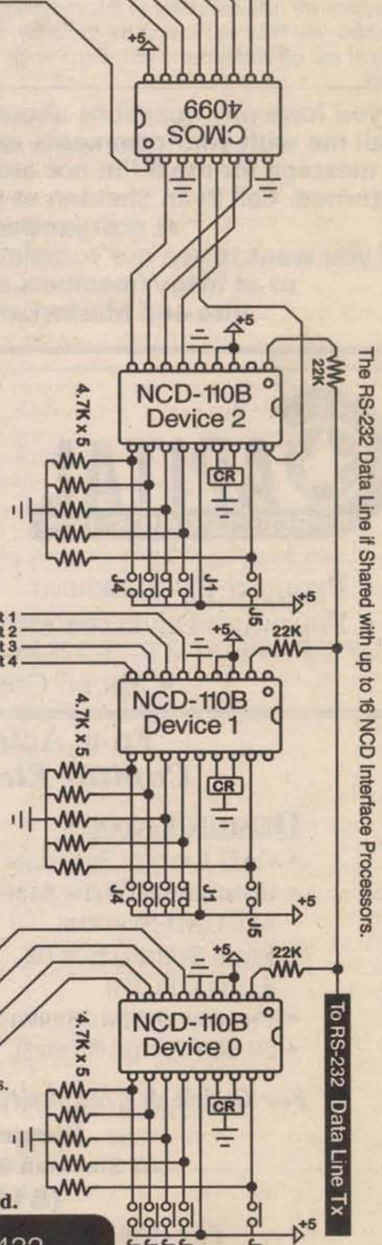


The following ASCII characters only speak to device 1. The outputs present a binary number of 0 to 15 accordingly.

CHR$(16)	Turn Off All Outputs.
CHR$(17)	Turn On Output 1.
CHR$(18)	Turn On Output 2.
CHR$(19)	Turn On Outputs 1 and 2.
CHR$(20)	Turn On Output 3.
CHR$(21)	Turn On Output 1 and 3.
CHR$(22)	Turn On Output 2 and 3.
CHR$(23)	Turn On Outputs 1, 2, and 3.
CHR$(24)	Turn On Output 4.
CHR$(25)	Turn On Outputs 1 and 4.
CHR$(26)	Turn On Outputs 2 and 4.
CHR$(27)	Turn On Outputs 1, 2, and 4.
CHR$(28)	Turn On Outputs 3 and 4.
CHR$(29)	Turn On Outputs 1, 3, and 4.
CHR$(30)	Turn On Outputs 2, 3, and 4.
CHR$(31)	Turn On All Outputs.

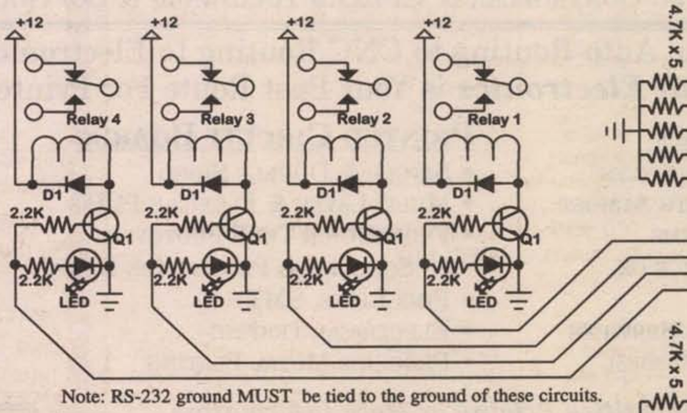
The following ASCII characters only speak to device 2, the 8-relay driver.

CHR$(32)	Turn Off Relay 1.
CHR$(33)	Turn Off Relay 2.
CHR$(34)	Turn Off Relay 3.
CHR$(35)	Turn Off Relay 4.
CHR$(36)	Turn Off Relay 5.
CHR$(37)	Turn Off Relay 6.
CHR$(38)	Turn Off Relay 7.
CHR$(39)	Turn Off Relay 8.
CHR$(40)	Turn On Relay 1.
CHR$(41)	Turn On Relay 2.
CHR$(42)	Turn On Relay 3.
CHR$(43)	Turn On Relay 4.
CHR$(44)	Turn On Relay 5.
CHR$(45)	Turn On Relay 6.
CHR$(46)	Turn On Relay 7.
CHR$(47)	Turn On Relay 8.



The following ASCII characters only speak to device 0, the quad relay driver.

CHR$(0)	Turn Off All Relays.
CHR$(1)	Turn On Relay 1.
CHR$(2)	Turn On Relay 2.
CHR$(3)	Turn On Relays 1 and 2.
CHR$(4)	Turn On Relay 3.
CHR$(5)	Turn On Relays 1 and 3.
CHR$(6)	Turn On Relays 2 and 3.
CHR$(7)	Turn On Relays 1, 2, and 3.
CHR$(8)	Turn On Relay 4.
CHR$(9)	Turn On Relays 1 and 4.
CHR$(10)	Turn On Relays 2 and 4.
CHR$(11)	Turn On Relays 1, 2, and 4.
CHR$(12)	Turn On Relays 3 and 4.
CHR$(13)	Turn On Relays 1, 3, and 4.
CHR$(14)	Turn On Relays 2, 3, and 4.
CHR$(15)	Turn On All Relays.



Note: RS-232 ground MUST be tied to the ground of these circuits.

Diodes (D1) - 1N4007
Transistors (Q1) - 2N2222 NPN
CR - 4 MHz Ceramic Resonator
J5 - Baud Rate Select. Remove for 9600 baud, install for 1200 baud.

RS-232 Relay Driver Boards Available, Contact Ryan Sheldon (404) 244-2432 communication in one wack:

```
SUB RELAY4 (Device!, Pattern!)
  'Compute and send output for a four-relay controller.
  PRINT #1, CHR$((Device * 16) + Pattern);
END SUB
```

In the above example, the RELAY4 subroutine needs only a device number (from 0 to 15) and a pattern (also from 0 to 15). A pattern value of 0 will turn off all relays, while a pattern value of 15 will turn them all on. Other pattern values of 1-14 will actuate the relays in the equivalent binary pattern. So, if nine were transmitted as the pattern, the first and last relays would be on, and the middle 2 would turn off. This happens because the binary equivalent of 9 is 1001.

```
SUB RELAY8 (Device!, Relay!, Status!)
 'Send computed data to an eight-relay controller.
 PRINT #1, CHR$((Device * 16) + (Relay - 1 + (8 * Status)));
END SUB
```

In the above example program, the subroutine needs only three simple variables. A device number from 0 to 15 will tell the routine which NCD-110 to talk to. The relay variable should be a number from 1 to 8 corresponding to the relay that is to be switched. The status variable should be a 1 or a 0. If it's a 1, the selected relay will be turned on; a 0 will turn it off.

The NCD-110 is the easiest of the NCD processors to understand. Many NCD processors are fully compliant to this communications protocol. In future articles, I will show you how you can share this relay driver with our graphics display and many of our other devices ... all using a single serial port on your computer. **NV**

If you have any questions about this article, feel free to call me with your comments and ideas. Please leave a message for me if I'm not around; your call will be returned. Call Ryan Sheldon at (404) 244-2432 or E-Mail at ncdryan@aol.com

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	O4	O3	O2	O1
When ASCII character 0 is received, outputs are	0	0	0	0
When ASCII character 1 is received, outputs are	0	0	0	1
When ASCII character 2 is received, outputs are	0	0	1	0
When ASCII character 3 is received, outputs are	0	0	1	1
When ASCII character 4 is received, outputs are	0	1	0	0
When ASCII character 5 is received, outputs are	0	1	0	1
When ASCII character 6 is received, outputs are	0	1	1	0
When ASCII character 7 is received, outputs are	0	1	1	1
When ASCII character 8 is received, outputs are	1	0	0	0
When ASCII character 9 is received, outputs are	1	0	0	1
When ASCII character 10 is received, outputs are	1	0	1	0
When ASCII character 11 is received, outputs are	1	0	1	1
When ASCII character 12 is received, outputs are	1	1	0	0
When ASCII character 13 is received, outputs are	1	1	0	1
When ASCII character 14 is received, outputs are	1	1	1	0
When ASCII character 15 is received, outputs are	1	1	1	1

0 = Off 1 = On

TABLE 1

Binary	Address	J1	J2	J3	J4	Range
0000	0	Remove	Remove	Remove	Remove	0-15
0001	1	Install	Remove	Remove	Remove	16-31
0010	2	Remove	Install	Remove	Remove	32-47
0011	3	Install	Install	Remove	Remove	48-63
0100	4	Remove	Remove	Install	Remove	64-79
0101	5	Install	Remove	Install	Remove	80-95
0110	6	Remove	Install	Install	Remove	96-111
0111	7	Install	Install	Install	Remove	112-127
1000	8	Remove	Remove	Remove	Install	128-143
1001	9	Install	Remove	Remove	Install	144-159
1010	10	Remove	Install	Remove	Install	160-175
1011	11	Install	Install	Remove	Install	176-191
1100	12	Remove	Remove	Install	Install	192-207
1101	13	Install	Remove	Install	Install	208-223
1110	14	Remove	Install	Install	Install	224-239
1111	15	Install	Install	Install	Install	240-255

TABLE 2

COMPUTER HARDWARE *cont.*

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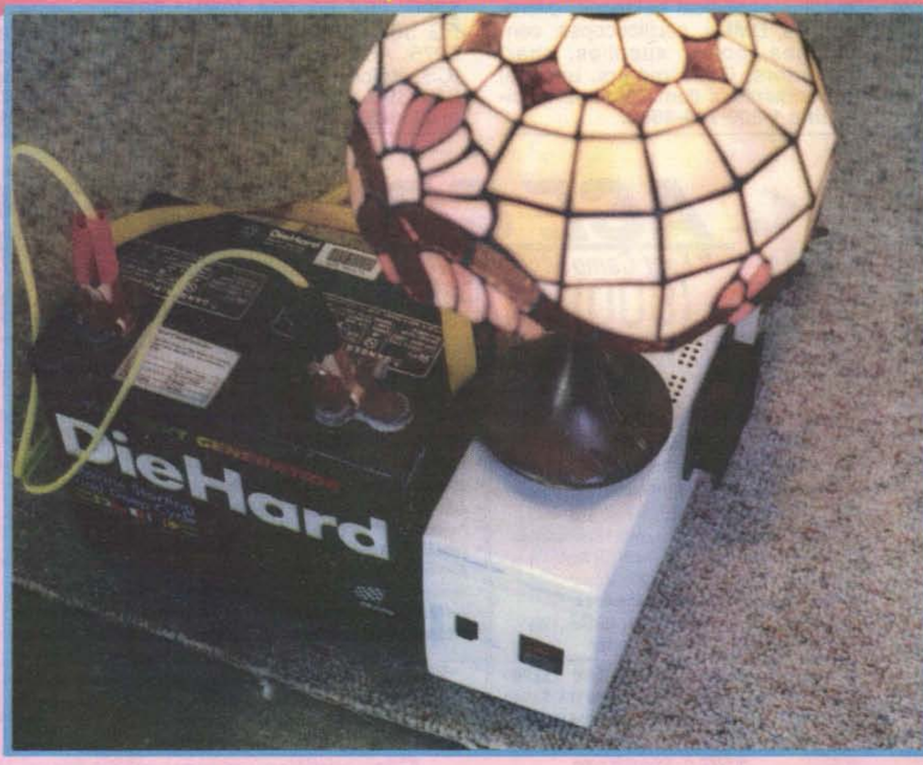
INEXPENSIVE POWER INVERTER CONVERSION PROJECT

by Kenton Chun



Getting Started

With the cost of solar arrays coming down, many experimenters are wondering how they can get in on harvesting free energy from the sun. If you have investigated this topic, you probably realize that solar energy is far from free. After pricing an 80-watt solar panel at $400-$500, it is difficult to look at a 500-watt modified sinewave inverter costing yet another $500.00. Add a good quality deep cycle lead-acid battery and the total cost of a small photovoltaic system can set you back well over a $1,000.00!

This project suggests a low-cost alternative to purchasing an expensive new inverter and yet produces quality modified sinewave power for your household appliances. All but the most sensitive of electronic equipment may be run, including televisions and computers.

By retro-fitting an ordinary UPS (Uninterruptible Power Supply, typically sold for backing up computers) with a larger battery, and making some minor modifications, you can effectively turn it into a low-cost power inverter. It is inexpensive and it works.

It is important to realize up front that certain appliances do not lend themselves well to photovoltaic power. Capacitor-start inductive motors are an example. A capacitor-start motor may require more than twice the run power to get started under load. Refrigerators, washing machines, dishwashers, and air conditioners fall into this category. Other devices simply require too much energy to be solar-powered practically. Full house heaters, oven ranges, and water heaters fall into this category. This still leaves a surprising number of devices that consume significant amounts of power, most less than 500 watts. They include: stereo systems, radios, televisions, computers, and home lighting.

Small amounts of power consumption eventually add up to large amounts. A 100-watt light bulb left burning 24 hours a day will consume 2.4 kilowatts per day. In an average month, this adds up to 72 kilowatts. At the typical rate of 20 cents a kilowatt-hour, this one light bulb will cost monthly over $14.00 to burn day and night! No wonder we try to turn off lights when we aren't using them.

However, if you are an average tech-hound, you probably own quite a few things that never get turned off – maybe a fax machine, a personal computer, or a radio. Try this experiment and just add up all of the wall warts plugged in – the wall transformers that power your portable telephone(s), battery chargers, caller ID boxes, answering machines, and so on. I was surprised to find almost 60 watts worth of these alone in my home!

It is difficult to cut costs on a solar panel. While amorphous silicon construction has dropped prices significantly, the lower limit on cost is fairly constant across the board. It is difficult to find bargain basement prices on solar panels capable of producing the several amps of current necessary to charge an automobile battery. Small, cheap panels just will not be sufficient to replace the charge taken from the battery by even a tiny load.

If you are serious about employing alternative energy sources, it is likely you will end up paying a lot for a decent quality solar array. You will have to try to cut costs elsewhere.

During recent forays to hamfests and computer shows, it became apparent that a large number of used UPSs were hitting the tables at bargain prices. Nothing more was wrong with them except that the internal batteries had worn out, but the former owners were simply not interested in repairing them. This was not surprising considering the batteries inside the units were usually small 6 or 12-volt, 7 amp-hour, lead-acid gel-cell batteries made by Yuasa-Exide or Matsushita Electric, costing half as much as replacing the entire UPS! No wonder no one wanted to repair them.

The computer UPS is an example of technology where function follows form, instead of vice versa. The size and shape of the batteries inside these units are determined by ergonomics instead of physics. They are simply too small. After all, nobody wants to stash a car battery under their mahogany desk next to their personal computer. This is why the UPS ratings are so tiny.

FIGURE 1
REMOVING THE CASE.

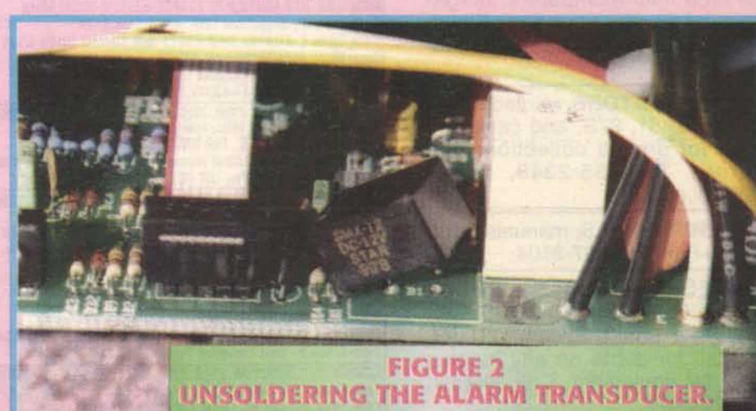


FIGURE 2
UNSOLDERING THE ALARM TRANSDUCER.

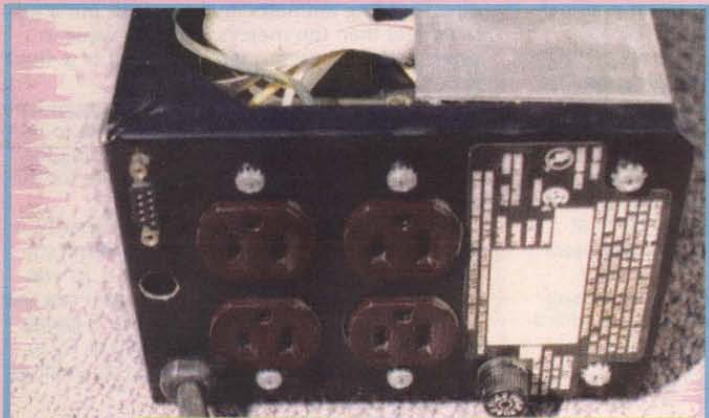


FIGURE 3
DRILL THE HOLE FOR THE NEW POWER CABLES, AND INSTALL A GROMMET.

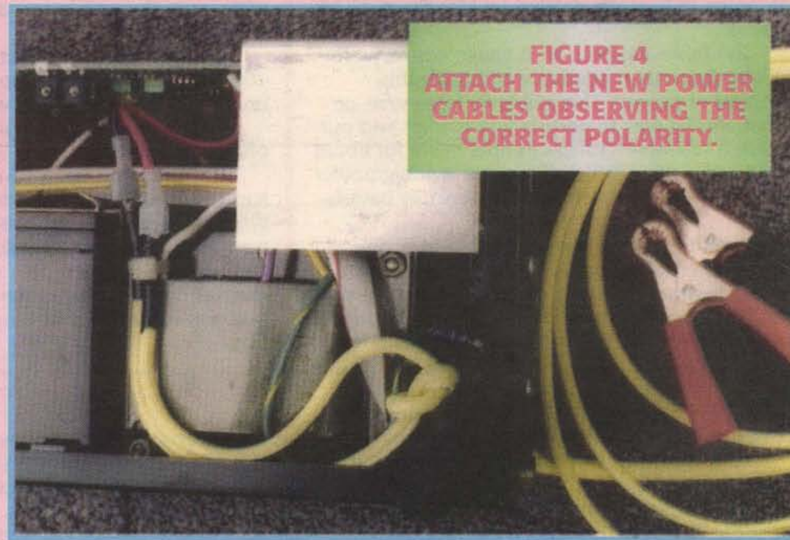


FIGURE 4
ATTACH THE NEW POWER CABLES OBSERVING THE CORRECT POLARITY.

A 500 VA UPS is rated for only a few minutes at this output, not because the circuitry can't take it, but because the teeny gel-cell packed into the UPS box is only rated at 7 amp-hours. Under a 500-watt load, this battery is having over 40 amps sucked out of it. No wonder it only lasts five minutes! This probably also accounts for why so many of these units are going to the trash pile.

Lead-acid batteries dislike being discharged fast and deep – they often do not recover well from this kind of treatment. After only a few power outages, the battery is probably on its way out. This is where you – the experimenter – can take over.

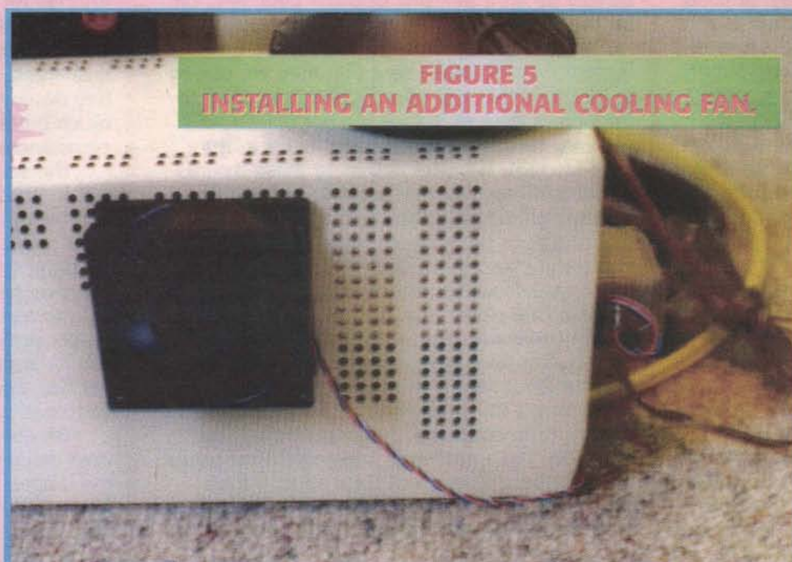


FIGURE 5
INSTALLING AN ADDITIONAL COOLING FAN.

Shopping for a Used UPS

When shopping for a used UPS, be prepared to test it and to open it up. Most "dead" UPSs will have enough charge capacity left in the battery to switch into invert mode when the plug is pulled from the wall. You can usually perform this test yourself at the computer show or the hamfest. If the UPS will hold any kind of a load at all, so much the better, although this is not necessary for a successful conversion.

It is a good thing when hunting for a used UPS to keep a little six-watt night light in your pocket to use as a test load – it is enough to test the inverter section of the UPS, and it is not so much as to bring a weak battery to its knees in two milliseconds.

Plug the unit in and turn it on. There should be an indicator light on somewhere. If not, check the fuse, but be suspicious. A blown fuse may be a simple fix or it may mean that the unit was severely overloaded. Carry around a two-amp slow blow fuse to test units, if necessary. If the switch light comes on, plug in your test night light and pull the plug.

If it lights, and the unit starts alarming and gives off a 60-cycle buzz – even for a few seconds or so – you probably have a winner. If the seller will allow you to pop the unit open, you can also verify that it is a 12-volt model. The vast majority of them are.

Most of the newer UPS units have standardized on 12 volts as the primary power supply. Some older units out there use six volts and I have also seen some that use 24 volts. There are efficiency advantages to using higher primary supply voltages, but for lowest cost and ease of conversion, try to stick with the 12-volt models. Our conversion project will use a Kensington Power Backer 520. It only cost us $40.00 at the local flea hamfest.

The Conversion Process

Make sure the unit is unplugged and powered off. Start by unscrewing the case screws. Usually the case is a shell type. You should not have to undo screws for the feet or the back of the unit, although individual units vary (Figure 1). Slip the shell off toward the back of the unit, being careful not to tear any cardboard spacers or short any power lugs.

If the unit has any battery power, turn it on and try to identify the location of the alarm on the main circuit board. It will usually be a small black cylindrical or square object with a hole in the middle, or small grille holes. Once you have identified the alarm transducer, turn the UPS off. Carefully unsolder one leg of this transducer, taking care not to break or burn any of the traces on the circuit board. Bend the transducer up and away from the circuit board (Figure 2). There may be other ways to silence the alarm, but we have found this to be the simplest and most reliable method.

Identify the batteries. They will probably occupy most of the space in the UPS. The configuration may vary, so look at them carefully. If there is only a single battery and the voltage is marked on the side of it, then all you need to do is to carefully label the battery leads positive and negative and then disconnect the battery.

In multiple battery configurations, note if there is a single short jumper going between the two batteries. If so, then they are connected in series. If the two batteries are six volts, then the unit is a 12-volt unit. If the batteries are 12 volts, then the unit is a 24-volt unit.

The two batteries may also be wired in parallel. If this is the case, then there will be jumpers on both sides of the batteries connecting them together positive to positive and negative to negative.

After you have correctly labeled the power leads, feel free to remove the batteries. Although you can leave them in the UPS without affecting the conversion, there is a risk of eventual acid leakage and damage to the unit. Please discard them in an environmentally-safe fashion.

In order to supply power to the inverter, we will have to drill a hole in the case. Carefully drill a 3/8" hole, preferably in a place that is not removable (like the shell). We drilled our hole in the back of the unit. Make sure there are no other components near the hole location and do not drive the drill into the circuit board or other sensitive locations inside the unit. Carefully remove any metal chips produced by the drilling process with a vacuum or a small brush. Install a rubber or vinyl grommet in the hole (Figure 3).

You must choose a power cable gauge depending on the power capacity of the UPS you are converting. To figure out the necessary size wire for your unit, divide the maximum power rating (in watts or VA) by the battery supply voltage (6,12,24), and then look up the wire size nearest to your final current draw in amps (Table 1). Our Kensington drew a maximum of about

45 amps (520 watts divided by 12 volts = 43.33 amps).

The table suggests an 8-gauge copper wire will be more than adequate to supply this amount of current. This is a fairly large wire, so what we did was to go to a flea market and purchase a "cheapie" 10' car jumper cable for about $8.00. By cutting it in half, we got two big power supply cables complete with heavy-duty battery clips!

Five feet will be plenty of cable to connect our inverter to the battery. Bear in mind that increasing the distance between the battery and the inverter will require heavier gauges of wire to cut resistance losses. Small losses in this power cable will amount to big losses in the overall efficiency of the power conversion. For example, increasing the distance from 5' to 50' from the battery to the inverter will require that we go from 8-gauge wire to #4/0 cable to keep the voltage drop inside two percent!

Try to keep the battery as near to the unit as possible. If you wish to place the project in a remote location i.e., the garage, laundry, or shed, etc., remember that it is far more efficient to run the AC output longer distances with less losses in smaller gauge wire than the DC power supply.

Feed the power wires through the grommet and tie a knot. This will be a strain relief in the event that the wires are accidently jerked. Solder spade lug mates to the power wires in the unit and attach them making sure to observe the correct polarity (Figure 4). The red clip should be positive and the black clip should be negative. Accidently reversing these may destroy the UPS. Finally, wrap the connections with electrical tape and tie-wrap the cable ends to something solid inside the unit to prevent them from shifting around.

Testing the Unit

Connect the battery clips to a good car battery, make sure the polarity is correct, and switch the unit on. Do not plug the unit into the wall. It should be in invert mode humming or buzzing. Connect a load, like your test night light. It should be on. If you have a multimeter that will measure AC and/or a frequency counter, you can make sure the unit is operating within nominal specs.

Increase the load to the inverter by adding a 100-watt trouble light or some desk lamps. The unit should carry the load without complaint.

If everything checks out okay, turn everything off, disconnect the battery, and close the unit up.

The 100% design load capacity of a consumer-grade UPS is sometimes hard to estimate. We have torture-tested good quality UPSs at near load capacity for weeks without any problems. However, if you plan on running your inverter continuously under high loads, we suggest you make the following additional modification.

Additional Cooling Modification

Expensive, high-end inverters tend to have aluminum cases with heatsink area all over the unit to allow the output devices to run as cool as possible. When your unit is open, look inside for the location of the output devices. These will usually be on a heatsink of some kind, possibly on the frame itself.

If the outer shell has ventilation holes, inspect them to make sure that they are placed in locations that will offer a good flow of air to the output devices. If they are not placed well, you may have to drill additional holes in the shell to create a better airflow to these devices.

In addition, you may want to bolt a high-quality muffin fan to the case to force air over the interior of the inverter. Monitor your inverter in a torture test. If the case gets warm to the touch, you should consider adding forced-air cooling. One clever trick is to plug a 115-volt muffin cooling fan into one of the inverter's own outlets. This way, the fan is only on when the inverter is running (Figure 5.)

Connect the solar panel either directly to the battery, or through any charge controller you may have. An ammeter is the single most useful measurement instrument for a photovoltaic installation. It must be comfortably rated at least twice what your solar panel is capable of charging the battery at.

The ammeter should be placed in series with the solar panel and the battery. If it is a direct-reading ammeter, make sure to put a fuse rated less than the meter's full-scale value in series with it to protect it in the event of a short circuit.

If the ammeter is a shunt measurement type, try to keep the shunt as large as possible to minimize the series resistance in your charging load. You will not need to use as heavy a wire for the charging circuit of your system.

If the solar panel has an 80-watt capacity, it will produce between 4 and 5 amps in full sunlight into a battery charging load. For a 20' run from the solar panel to your battery, you can use 10-gauge wire. At 40', you are back to 8-gauge wire again. Remember, it is important to try to keep the DC distances in the project as small as possible.

How Much Power Can I Draw?

If your unit has reasonable thermal dissipation, you can draw the inverter's full rated output until your battery runs out. When Hurricane Andrew hit in 1992, we ran our 27" Sony XBR for about six hours. It consumed 225 watts drawing almost 20 amps on an ordinary, partially-charged car battery. A deep cycle marine battery designed for this type of service will offer much better performance under the same circumstances.

The sustainability of the system is more difficult to predict and depends primarily on the rate at which you can recharge the battery off the solar panel. Using the figures above for the panel charging specs, and assuming a six-hour average charging period in a day at this rate, you will be able to replace about 30 amp-hours of battery power per sunny day. This means that breakeven will be around 360 watt-hours of consumption per day, equivalent to running a couple hundred watt load for a couple of hours a day.

We could, for example, run our 60-watt wall wart assortment for about six hours a day. On the longest days of the year, when we receive 12 hours or more of good charging sun, we may be able to run our wall wart assortment for an equal amount of time in the evening. You could also run a 15-watt light bulb continuously, or a combination of higher-powered loads on an intermittent basis.

Conclusion

Although it is not yet economically advantageous to cut utility power service and switch entirely to solar power, a thrifty experimenter can create a portable, environmentally-safe electrical power source with a high peak load capacity for less than one might think.

The principles outlined in this article are intended to provide some direction for those who have ideas, and an interest in developing the virtually untapped resource of solar energy. Happy Hunting! NV

Kenton Chun is an Information Systems Consultant living in Miami, FL. He has a Master's Degree in English and Technical Writing from the University of Miami. He has spent over 10 years working in the computer and electronics fields. His wife's name is Sandra and he has one son Carrington, who is three months old.

TABLE 1

Max. distance for 2% voltage drop for various wire gauges and currents.

Amps	Wire Size									
	#14	#12	#10	#8	#6	#4	#2	#1/0	#2/0	#4/0
1	45	70	115	180	290					
2	22.5	35	57.5	90	145	228				
4	10	17.5	27.5	45	72.5	114	200			
6	7.5	12	17.5	30	47.5	75	120	193		
8	5.5	8.5	11.5	22.5	35.5	57	90	145	190	
10	4.5	7	11.5	18	28.5	45.5	72.5	115	155	195
15	3	4.5	5.5	12	19	30	48	76.5	110	150
20	2	3.5	4.5	9	14.5	22.5	36	57.5	85	116
25	1.8	2.8	3.5	7	11.5	18	29	46	65	92
30	1.5	2.4	2.8	6	9.5	15	24	38.5	55	77
40			2.3	4.5	7	11.5	18	29	39	56
50				3.6	5.5	9	14.5	23	32	46
100					2.9	4.6	7.2	11.5	15	23
150							4.8	7.7	10	15
200							3.6	5.8	7.5	11

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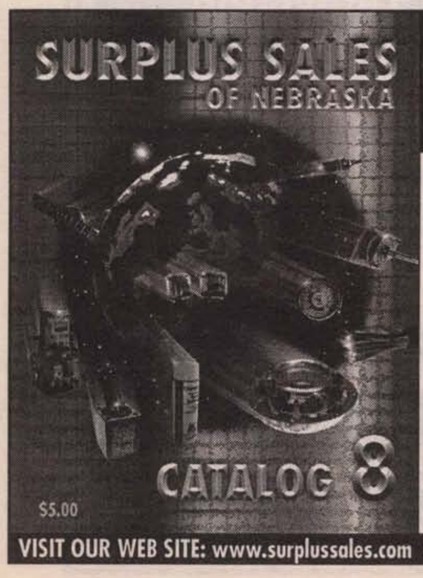

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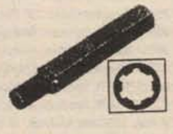

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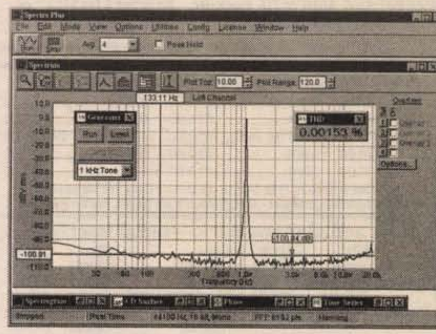

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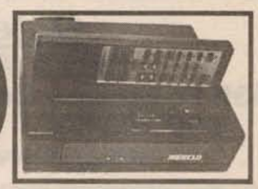

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USER'S GUIDE TO AUDIO POWER AMPLIFIER ICs

Part 5

by Ray Marston

Ray Marston describes practical IC-based audio power amplifier circuit design techniques in this final episode of the series.

Parts 1 to 4 of this series have explained various audio power amplifier IC operating principles and presented a large selection of practical application circuits based on popular audio power amplifier ICs with maximum output power ratings in the range of 325mW tp 68W.

Between them, these various articles have covered many practical aspects of audio power amplifier IC usage. There are, however, still several important details of audio power amplifier IC usage that have not yet been covered, and included among them are the matters of loudspeaker selection, power amplifier sensitivity, power supply parameter selection, IC power dissipation, heatsink selection, and practical audio power amplifier design techniques.

All of these subjects are dealt with in this final part of the series.

LOUDSPEAKER SELECTION

The loudspeaker is the final and perhaps weakest link in the audio signal communication chain. In each channel of a hi-fi system, the speaker unit is normally connected (directly or via an isolating capacitor) between the amplifier's output and the ground (common) line.

The speaker unit may take the form of a single full-range loudspeaker, as shown in the basic 'single-ended power supply' amplifier circuit of Figure 1, but more often takes the form of two or more speakers that are driven via a passive crossover filter, as shown in the simple example in Figure 2.

In Figure 2, one speaker handles the bass frequencies and the other (called a tweeter) handles the treble tones; the diagram shows typical component values for a 6dB/octave filter that drives a pair of 8R0 speakers and has a crossover frequency of 5KHz.

Note that the unit is designed to give an input impedance equal to that of a single speaker (8R0 in this case), and thus appears to the amplifier as a single speaker load.

The most important basic parameter of a loudspeaker is (ignoring its frequency response and its power handling capacity) its input or coil impedance. Modern loudspeakers have standard impedances or 8R0, 6R0, or 16R (but sometimes 64R in very-low-power types) in most domestic or music-system applications, or 4R0 in low-voltage units such as in-car entertainment systems (which operate at a nominal 14.4V under actual running conditions).

Often, in in-car systems, two 4R0 speakers are wired in parallel to form a high-power 2R0 unit. To obtain the maximum possible output power from an audio system, it is necessary to correctly match the effective speaker load impedance to the operating characteristics of the audio power amplifier.

All audio power amplifier ICs have specific supply-voltage and load-current handling and power dissipation limits, and these greatly influence the maximum power that can be safely fed to speakers with particular values of load impedance. The following formulas define the relationships between speaker load impedance, voltage, current, and power:

$$(1)\quad I=\sqrt{\frac{W}{R}} \qquad (2)\quad E=\sqrt{RW}$$

$$(3)\quad W=\frac{E^2}{R} \qquad (4)\quad W=I^2R$$

where E = load voltage in rms volts, I = load current in rms amps, R = load impedance in ohms, and W = load power dissipation in rms watts. Thus: from (1) and (2) it can be deduced that an 8R0 load operating at a 10W power level consumes 1.12A at 8.94V; from (3) that an amplifier that produces an output of 10V rms generates 12.5W in an 8R0 load; and from (4) that an amplifier that can produce a maximum output of 1.2A can generate a maximum of 11.52W in an 8R0 speaker.

In practice, IC drive-current limits are usually specified in terms of I_{peak}, and their output voltage swing limits (which are typically about 10% less than their supply voltage values) are specified in V_{pk} terms in split-supply applications or in $V_{pk\text{-}pk}$ (V_{pp}) in single-ended-supply applications. The following formulas show the relationships between rms (rms), peak (pk), and peak-to-peak (pp) voltage or current values:

$$(5)\quad I_{pk}=I_{rms}\sqrt{2} \qquad (6)\quad I_{rms}=\frac{I_{pk}}{\sqrt{2}}$$

$$(7)\quad V_{rms}=\frac{V_{pk}}{\sqrt{2}}=\frac{V_{pp}}{2\sqrt{2}} \qquad (8)\quad V_{pk}=V_{rms}\sqrt{2}$$

$$(9)\quad V_{pp}=2V_{rms}\sqrt{2}$$

Thus, from (6), (4), (2), and (9) it can be deduced that an IC that can supply an I_{peak} of 3.5A can supply a maximum I_{rms} of 2.47A and generate a maximum of 49W in an 8R0 speaker at a drive voltage of 19.8V_{rms} or 56V_{pp}, thus requiring a typical supply voltage of at least 62V from a single-ended power unit or ±31V from a split-supply unit.

The same IC could generate a maximum of only 24.5W (at 9.9V_{rms}) in a 4R0 speaker, but a pair of ICs could generate 98W in a 16R speaker (or a pair of series-wired 8R0 types) when connected in the bridge-drive mode (in which they effectively double the speaker's drive voltage).

Thus, the first step in designing an IC audio power amplifier system for a particular application is to select a suitable IC and speaker, using the basic data given above.

Figure 3, for example, lists the actual voltage and current values of five different speakers when they are operating at 10W power levels. At low operating voltages, low impedance (2R0 or 4R0) speakers must be used to obtain a good power output.

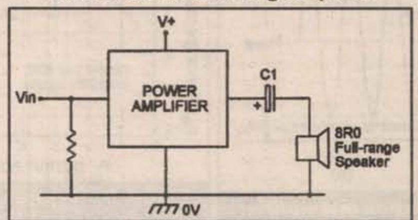

Figure 1. A power amplifier, operated from a single-ended supply, driving a single full-range loudspeaker.

At reasonable high voltages, 8R0 or 16R speakers can be used.

Note, when making calculations of the types described in this section, that if you do not have access to precise data concerning an IC's I_{peak} limit, the data can often be inferred from the manufacturer's application circuits, which are usually designed to show the product operating close to its performance limits.

Thus, the LM3886 circuit of last month's Figure 22, which can generate 68W in a 4R0 load, implies — using formulas (2) and (5) — that the IC can comfortably generate output currents of at least 4.12A_{rms} or 5.8A_{pk}.

POWER AMPLIFIER SENSITIVITY

A power amplifier's 'sensitivity' value defines the magnitude of rms input signal voltage needed to produce a particular output power level from the amplifier. Commercial hi-fi units usually specify the sensitivity at both a standard 1W output level and at the full-rated output power level. The 'standard' (1W) sensitivities of commercial units vary between roughly 25mV and 200mV; a good compromise value is 100mV.

The power amplifier's output power level is proportional to the square of the input voltage, thus, if the amplifier has a basic 100mV sensitivity, it intrinsically gives an output of 4W at 200mV, 16W at 400mV, 36W at 600mV, and 40W at 632mV.

The basic formulas that link an amplifier's output power, standard sensitivity, and actual sensitivity are:

$$(10)\quad W_{out}=\left(\frac{V_{input}}{V_{sens}}\right)^2$$

$$(11)\quad V_{input}=V_{sens}\sqrt{W_{out}}$$

where V_{sens} and V_{input} are in millivolts and W_{out} is in watts.

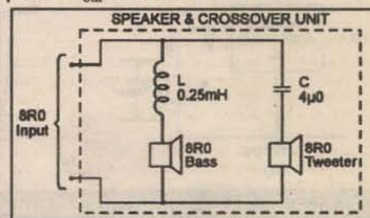

Figure 2. A speaker unit consisting of two loudspeakers and a simple (6dB) cross-over filter unit.

The amplifier's sensitivity is determined by its voltage gain (A_V), speaker impedance (R), and output power level (W), using the formulas:

$$(12)\quad A_V=\frac{V_{out}}{V_{input}}=\frac{\sqrt{RW}}{V_{sens}}$$

Speaker impedance	V_{rms}	I_{rms}	$V_{pk\text{-}pk}$	I_{pk}
16R	12.65V	0.79A	35.8V	1.12A
8R0	8.94V	1.12A	25.3V	1.58A
6R0	7.75V	1.29A	21.9V	1.82A
4R0	6.32V	1.58A	17.9V	2.23A
2R0	4.47V	2.24A	12.6V	3.16A

Figure 3. Voltage and current values of various speakers at 10W power levels.

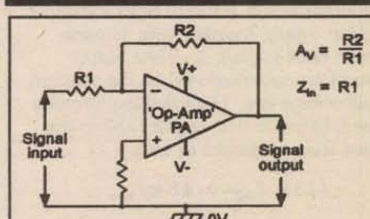

Figure 4. Basic circuit and formula for setting the A_V (and hence sensitivity) value of a modern inverting 'op-amp' type of power amplifier (PA) circuit.

In practice, 4R0 and 8R0 speaker loads absorb 2.0V and 2.83V of drive respectively at 1W power levels. Thus, to give a standard sensitivity value of 100mV, the amplifier needs an A_V of x20 with a 4R0 load or x28.3 with an

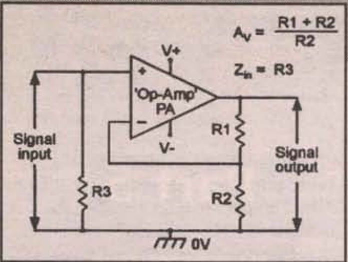

Figure 5. Basic circuit and formula for setting the A_V (and hence sensitivity) value of a modern non-inverting 'op-amp' type of power amplifier (PA) circuit.

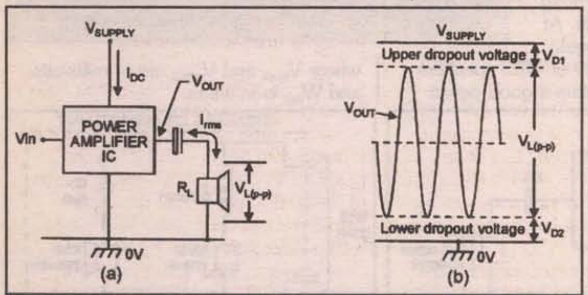

Figure 6. Basic details of an audio power amplifier IC circuit operated from a single-ended supply (a), and its sinewave output waveform when driving maximum power into a speaker load (b).

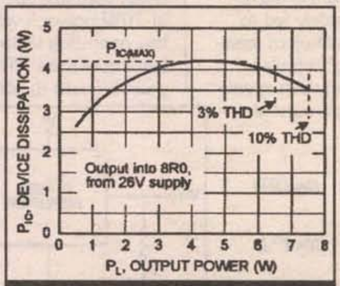

Figure 7. Typical P_{IC} versus P_L curve of an LM384-based 6.5W amplifier driving an 8R0 load from a 26V supply.

8R0 load. Most modern audio power amplifier ICs function like high-power op-amps that are used in either the inverting or non-inverting mode, and their A_V (and hence sensitivity) values can thus be set to any desired values by selecting their R1 and R2 feedback resistor values in the basic ways shown in Figures 4 and 5.

POWER SUPPLY REQUIREMENTS

An audio power amplifier IC's power supply is a critical part of the audio system and, if poorly specified or designed, can have a highly detrimental effect on the audio power amplifier IC's operating efficiency and power dissipation.

Figure 6 illustrates some important audio power amplifier IC characteristics that are relevant to power supply design. The diagram shows a basic amplifier that is powered from a single-ended supply, together with its maximum peak-to-peak sinewave output waveform superimposed on the supply's half-voltage line. The following formulas are relevant to this diagram and to the next few paragraphs of text:

$$(13)\quad I_{DC}=0.45 \times I_{rms}$$

$$(14)\quad P_{INPUT}=V_{SUPPLY} \times I_{DC}$$

$$(15)\quad Efficiency=\frac{P_{OUT}}{P_{INPUT}}$$

$$(16)\quad P_{IC}=P_{INPUT}-P_{OUT}$$

Regarding these formulas — which all assume that the IC is a single (rather than a dual) type — formula (13) defines the IC's power supply current (I_{DC}) as a function of the IC's load (speaker) current, I_{rms} (see formula (1)), but ignores the effects of the IC's quiescent currents, which are usually relatively small.

Formula (14) defines the total power input into the IC, in terms of supply voltage and current (I_{DC}). Formula (15) defines the power amplifier IC's power conversion efficiency in terms of P_{OUT} (to the speaker load) versus P_{INPUT}. Finally, formula (16) defines the actual power dissipated across the IC as P_{INPUT} minus P_{OUT}.

Returning now to Figure 6, note that in an ideal class-AB power amplifier, the load's sinewave output voltage would be able to swing fully between the two supply rail levels (0V and V_{SUPPLY}) without clipping. Such an amplifier would — at maximum power output — operate with an efficiency of 78.5%.

If this ideal amplifier is driving 10W into an 8R0 load at its maximum output level, V_{SUPPLY} will have a value of 25.28V (the load's V_L peak-to-peak voltage value), the IC will consume a supply current (I_{DC}) of 0.504A (= 0.45 times the load's 1.12A rms signal current), a total of 12.74W (= 25.28V x 0.504A) will be consumed from the power supply, and 2.74W of this will be developed across the IC and 10W across the load.

In a real-life class-AB power amplifier IC, significant voltage losses occur in the IC's output driver stages, and in Figure 6 these are represented by two 'dropout' voltages, V_{D1} and V_{D2}, and to compensate for these, the above 10W amplifier needs a minimum supply voltage of V_L+V_{D1}+V_{D2}.

Suppose that this combination calls for a minimum V_{SUPPLY} value of 30V. In this case, a total of 15.12W (= 30V x 0.504A) will be consumed from the supply at 10W output, and 5.12W of this is generated across the IC, which thus operates with an efficiency of only 66.1% (= P_{OUT}/P_{IN}). (Note that dropout voltage values are often given in manufacturer's data sheets, but if this information is not readily available it can — if the IC is fitted with an adequate heatsink — easily be ascertained from practical power amplifier tests with the aid of an oscilloscope.)

Suppose now that, in the above 10W amplifier circuit, the power supply is a badly designed unregulated type that — at the nominal AC power line voltage — gives an actual output of 35V at full load. In this case, a total of 17.64W (= 35V x 0.504A) will be consumed from the supply at 10W output, and 7.64W of this is developed across the IC, which thus operates with an efficiency of only 56.7% at full output.

If the AC power line voltage subsequently rises to its permitted 'nominal+10%' upper limit, the IC power dissipation will rise to 9.4W at 10W output, and the IC will operate with an efficiency of only 51.5%. Good power supply design is thus vital.

From the above, it can be seen that the ideal power supply should be a low ripple type that, at the designed maximum audio power output level, produces a per-channel output current of I_{DC} (see formula (13)) and a voltage of V_L+V_{D1}+V_{D2} if the supply is a single-ended type, or ± half of this value if it is a split type.

Note that — if the supply is an unregulated type — the supply voltage will (depending on the supply's actual regulation factor) typically rise by 15% under very-low-load conditions and by a further 10% if the AC power line voltage rises to its maximum permitted value.

This worst-case voltage must not exceed the IC's supply voltage limit. If the IC is operating close to its critical supply voltage or power dissipation levels, a regulated power supply should be used.

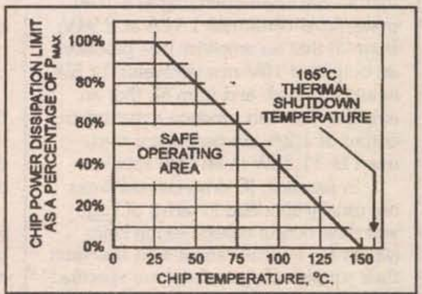

Figure 8. Graph showing the relationship between chip temperature and chip power dissipation limits.

IC POWER DISSIPATION

The previous few paragraphs outlined some basic principles concerning power dissipation in audio power amplifier ICs. A good understanding of this subject is important in practical applications, since IC power dissipation generates heat in the IC and must — if the IC is to function correctly — be kept under control (usually with the aid of a suitable heatsink). This section provides additional information on the subject, as follows.

If the sinewave input signal voltage to an IC audio power amplifier circuit is progressively increased from zero to maximum, the circuit's load (speaker) voltage and current both increase proportionately, and the load power thus increases in proportion to the square of the input voltage.

The power dissipation of the actual IC, however, varies in a rather different way, since any increase in input voltage causes an increase in the IC's supply current, but a decrease in the volt drop across the IC's power-driving output stages. Initially, the IC's power dissipation increases as the input voltage is increased, but eventually a point is reached where the power dissipation reaches a peak value, and any further increase in input voltage results in a *decrease* in the IC's power dissipation.

The IC's peak power dissipation point ($P_{IC(MAX)}$) occurs when V_L (the load's peak-to-peak signal voltage) equals 63.7% of V_S (the IC's supply voltage), at which point $P_{IC(MAX)}$ has, in theory, a value of:

$$(16)\quad P_{IC(MAX)}=\frac{(V_S)^2}{20R_L}$$

Note, however, that this widely quoted, but slightly simplified, theoretical figure assumes the use of an electronically perfect IC that (among other things) is perfectly linear and generates zero signal distortion. In practice, actual $P_{IC(MAX)}$ figures may be as much as 20% higher than given in formula (16), particularly if very low impedance (2R0 or 4R0) speaker loads are used.

Thus, in the well-designed 10W, 30V, 8R0 amplifier mentioned previously, the IC has a theoretical $P_{IC(MAX)}$ value of 5.62W but, in practice, has a probable value of about 6.2W.

If the IC's sinewave input signal voltage is increased beyond the $P_{IC(MAX)}$ point, a level is eventually reached where the load is operating at its designed maximum power level, and any further increase in input voltage generates a clipped (square shaped if severely clipped) output signal that has a greater power content than a simple sinewave; the IC's power dissipation decreases sharply under this condition.

As a consequence of the various factors described above, *all* analogue audio power amplifier ICs generate a P_{IC} versus P_L curve that follows the basic form shown in Figure 7, in which — as the P_L value is increased from zero to maximum — the P_{IC} value rises exponentially from zero to a peak value that occurs at the $P_{IC(MAX)}$ point, and then starts to fall again as the P_L value heads towards the signal-clipping point.

Note that the above $P_{IC(MAX)}$ figures apply to 'single' ICs. In dual (two-channel) ICs, or in single types that form one half of a bridge-type amplifier, the above $P_{IC(MAX)}$ figures must be doubled.

HEATSINK CALCULATIONS

The heart of any IC is its solid-state chip, and it is this that becomes heated when power is generated within the IC. By industry-wide convention, an IC chip's recommended safe maximum power handling capacity is normally specified at a chip temperature of 25°C, and — in commercial ICs that use a plastic package — the chip's recommended maximum allowable operating temperature is limited to 150°C, at which temperature its spare power handling capacity is deemed to be zero.

The chip's power handling capacity is inversely proportional to the chip temperature, and is 40% of maximum at 100°C. Most modern audio power amplifier IC chips incorporate thermal protection circuitry that automatically cuts off the chip's power feed at a chip temperature of 165°C, thus protecting the IC against catastrophic power-induced overtemperature damage.

Figure 8 presents the above data in graphic form, with the chip's power

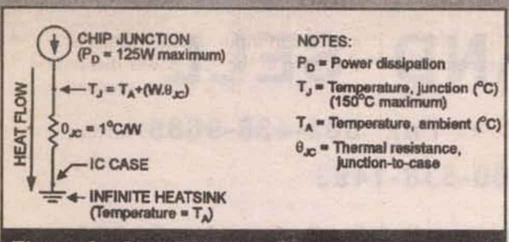

Figure 9. Simple thermal resistance model of a power amplifier IC that has its case bonded to an infinite heatsink.

handling capacity presented as a percentage of the maximum figure attainable at the 25°C value. Thus, if the chip can handle a maximum of 10W at 25°C, its temperature must be kept below 100°C if it is to be used in an application where its maximum power dissipation ($P_{IC(MAX)}$) is expected to reach 4W.

This temperature control is normally exercised via an external heatsink, which helps the internally power-generated heat to flow away and be absorbed by the ambient conditions.

Heat flow is best modeled in terms of thermal resistance, where a 'thermal resistance' represents the thermal conductor's input-to-output temperature drop divided by the power dissipated by the conductor, in °C/W. The symbol used to represent thermal resistance is q (theta), and is usually followed by a subscript that denotes the direction of heat flow. Thus, the symbol q_{JC} denotes the thermal resistance that exists between the IC's junction (chip) and case.

Figure 9 shows a simple thermal resistance model of an audio power amplifier IC that has a power dissipation limit of 125W at a chip temperature of 25°C, has a q_{JC} value of 1°C/W, and has its case bonded to an infinite heatsink that is operating at an ambient temperature of T_A °C.

It is fairly obvious from this model that, at a chip power dissipation value of W, the chip's junction temperature (T_J) equals T_A + (W.q_{JC}). Thus, if T_A is 25°C, the T_J value works out at 35°C at 10W, 75°C at 50W, or 150°C at 125W, and if T_A is 45°C the T_J value works out at 55°C at 10W, 95°C at 50W, or 150°C at 105W, and so on.

In the real world, the point of union between the case and heatsink inevitably has a certain thermal resistance value, and this is given the symbol q_{CS} (case-to-sink) and has a typical value of 0.2°C/W if the union is a bolted type made via a good *modern* heat transfer compound.

Also, the heatsink is inevitably finite, and is represented by the symbol q_{SA} (sink-to-ambient), and has a value of X°C/W.

The *total* thermal resistance between the chip junction and the ambient temperature is represented by the symbol q_{JA} (junction-to-ambient) and is equal to the sum of these three thermal resistance values. Thus, $q_{JA} = q_{JC} + q_{CS} + q_{SA}$.

Figure 10 shows a thermal resistance model of a real-world version of the Figure 9 audio power amplifier IC, bolted to a finite heatsink that has a q_{SA} value of 2°C/W and is operating at an ambient temperature of 25°C.

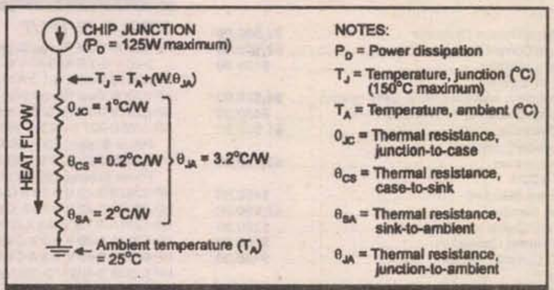

Figure 10. Real-world thermal model of a power amplifier IC that has its case bolted to a finite heatsink.

The IC again has a power dissipation limit of 125W at a chip temperature of 25°C, and has a q_{JC} value of 1°C/W. The total thermal resistance, q_{JA}, between the chip junction and ambient thus equals 1°C/W + 0.2°C/W + 2°C/W, i.e., 3.2°C/W. Consequently, in this example, the IC's T_J value equals T_A + (W.q_{JA}), and works out at 57°C at 10W, or 121°C at 30W.

In practice, the two most valuable pieces of data that can be gleaned from a real-world thermal model of the Figure 10 type are, first, the maximum power dissipation limit ($P_{IC(MAX)}$) of an IC at a given q_{JA} value, and second, the *minimum* heatsink value (q_{SA}) needed to dissipate a known value of IC power, P_{IC}. The following two formulas, in which $T_{J(MAX)}$ has a value of 150°C in normal commercial ICs, define this data.

$$(17)\quad P_{IC(MAX)} = \frac{T_{J(MAX)} - T_A}{\theta_{JA}}$$

$$(18)\quad \theta_{SA} = \frac{T_{J(MAX)} - T_A}{P_{IC}} - (\theta_{JC} + \theta_{CS})$$

Thus, from (17) it can be seen that, when using the q_{JA} value of 3.2°C/W shown in Figure 10, the IC can dissipate a maximum of 39W, and — from (18) — that, for the IC to dissipate 50W, the heatsink needs a *maximum* q_{SA} value of 1.3°C/W.

HEATSINK PRACTICALITIES

When using formula (18) it is always wise to use a realistic (rather than optimistic) worst-case T_A figure, such as 30°C rather than 25°C.

The vital q_{JC} value used in the formula is usually given in the IC's data sheet.

It is important to note that formula (18) indicates the theoretical *absolute maximum* size of heatsink q_{SA} value that should be used in a particular application, and that in practice a heatsink with a somewhat lower q_{SA} value should actually be used.

In the case of the Figure 10 50W amplifier given above, for example, where the formula gives a maximum q_{SA} value of 1.3°C/W, a heatsink with an actual value of 1°C/W should be used. Note, however, that the physical size (and cost) of a heatsink is inversely proportional to its q_{SA} value, and a 1°C/W heatsink is thus physically larger and more expensive than a 1.3°C/W type.

Heatsinks are readily available in a wide range of q_{SA} values.

When selecting an actual heatsink size after completing the formula (18) calculations, some thought should be given to two conflicting theories in the subject. These can be called the 'real life audio' and the 'IC reliability' theories.

The first of these theories states that real life audio systems deal primarily with music or speech signals, and these — at full volume — have a mean power output that is typically less than one-third of the maximum continuous sinewave value used in the formula (18) calculation.

This theory concludes that — in hi-fi types of audio application — there is no practical advantage in using a heatsink that is physically larger than the minimum value indicated by formula (18).

The alternative 'IC reliability' theory is based on IC failure rate studies that show that failure rates are exponentially proportion to the IC's junction temperature, and under worst-case conditions increase by a factor of three for every 10°C rise in junction temperature.

When these failure rate studies are applied to the above-mentioned 50W audio amplifier, they show that — when the IC is operating under worst-case conditions at full (50W) sinewave power — the IC's failure rate is reduced by a factor of five by using a heatsink with a q_{SA} value of 1°C/W, rather than the 1.3°C/W value indicated by formula (14), and that under typical full-volume (16.6W average output power) music conditions, the failure rate is almost halved by using the 1°C/W heatsink.

BASIC AUDIO POWER AMPLIFIER DESIGN

To conclude this final episode of the 'Audio ICs' series, this final section shows how the information so-far presented in this episode can be used to design a complete and reliable basic audio power amplifier system.

The first step in creating such a design is to draw up a specification that includes per-channel details such as: (a) maximum power output; (b) output load impedance; (c) input impedance; (d) input sensitivity; and (e) a basic amplifier description, and to then select a specific IC for use in the design.

Suppose that this basic specification is as follows:

(a). Maximum power output = 30W.
(b). Load (speaker) impedance = 8R0.
(c). Input impedance = 47K.
(d). Input sensitivity (at 1W output) = 100mV.
(e). Amplifier type = non-inverting; powered from a split supply.

The procedure for designing such an amplifier is as follows:

Regarding specifications (a) and (b), formulas (2), (8), (1), and (5) in the LOUDSPEAKER SELECTION section of this article show that the power amplifier must supply the 8R0 load with a peak voltage of 21.9V and a peak current of 2.74A at the 30W power level. These values are well within the capabilities of the LM3875 IC (see Part 4 of this series).

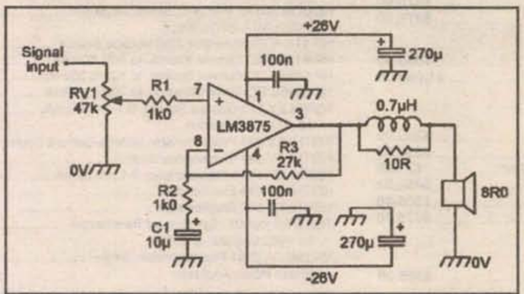

Figure 11. Design example of a 30W non-inverting amplifier powered from a split (dual) supply (see text for design procedure).

This IC's data sheet shows that the IC's upper and lower dropout voltage each have values of 4V under the specified maximum load driving conditions, and the split (dual) power supply must thus generate an output of ±26V at (from formulas (1) and (13)) 0.87A under full load conditions.

The worst-case off-load voltage, assuming a 15% regulation factor in the power supply and a +10% voltage rise in the AC supply line, is thus ±32.5V, and is well within the operating limits of the LM3875.

Regarding specification (e), this calls for a basic amplifier design of the type shown in Figure 11 (which is based on the Figure 18 circuit shown last month).

In this design, specification (c) can be met by giving volume control RV1 a value of 47K. Specification (d) can, as described in the POWER AMPLIFIER SENSITIVITY section of this article, be met by giving the amplifier an A_V value of (ideally) x28.3, and in the Figure 11 circuit this is achieved by giving R3 a value of 27K.

The final step in the amplifier design exercise is that of selecting a suitable heatsink. From formula (16), it can be seen that in this circuit the IC's maximum power dissipation is (remembering that the IC is using a dual — rather than single-ended — supply) 16.9W.

The LM3875 IC has a q_{JA} value of 1°C/W, and the q_{CS} value is typically 0.2°C/W. Consequently, formula (18) shows that, at an ambient temperature of 30°C, the heatsink needs a maximum q_{SA} value of 5.9°C/W.

In practice, a heatsink with a somewhat lower q_{SA} value should be used. **NV**

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L.C.R.

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HP 11683A Range Calibrator, for HP 435/6/7/8 ..... $700.00
HP 432A/8478B Power Meter, -25 to $450.00
+10 dBm, 10 MHz-18 GHz
HP 435A/8481A Power Meter, ... $1,000.00
10 MHz-18 GHz, -30 to +20 dBm
HP 435A/8482A Power Meter, ... $1,000.00
0.1-4200 MHz, -30 to +20 dBm
HP 435A/8482H Power Meter, ... $1,150.00
0.1-4200 MHz, -10 to +34 dBm
HP 8477A Power Meter Calibrator, for HP 432 series $500.00
HP Q8486A Power Sensor, ... $1,500.00
33.0-50.0 GHz, WR22, for 435/6/7/8
HP R486A WR28 Thermistor Mount, ... $350.00
26.5-40 GHz, for 432 series

RF MILLIVOLTMETERS

BOONTON 9200A-01 RF Millivoltmeter, ... $900.00
10 kHz-1.2 GHz, GPIB
RACAL 9303 TRMS Level Meter, ... $875.00
10 kHz-2 GHz, -77 to +23 dBm, GPIB

AMPLIFIERS, MISCELLANEOUS

BOONTON 82AD-opt.01A Modulation Meter, ... $900.00
AM, FM, 10-1200 MHz, GPIB
HP 465A Amplifier, 20/40 dB, 5 Hz-1 MHz, 1/2 Watt/50 Ohms $125.00
HP 8447A-001 Dual Amplifier, 0.1-400 MHz $450.00
HP 8447E Amplifier, 22 dB, 0.1-1300 MHz, +13 dBm output $750.00
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz $3,750.00
HP 8901B-001 Modulation Analyzer, ... $6,750.00
150 kHz-1300 MHz, rear panel input
HP 8970A Noise Figure Meter $6,000.00
HUGHES 1177H01F000 TWT Amplifier, ... $1,500.00
2.0-4.0 GHz, 10 Watts output
HUGHES 1177H02F000 TWT Amplifier, ... $1,500.00
4.0-8.0 GHz, 10 Watts output
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
MICROWAVE SEMI.CORP. MC5112 Noise $325.00
Source, 25.5 dB ENR, 1.0-12.4 GHz, N(m), +28 VDC
ROHDE & SCHWARTZ ESH2 Test Receiver, 9 kHz-30 MHz $6,000.00

COAXIAL & WAVEGUIDE

AMERICAN NUCLEONICS AM-432 Cavity $95.00
Backed Spiral Antenna,LHC, 2-18 GHz,TNC(f) *NEW*
FXR/MICROLAB S3-02N Triple Stub Tuner, ... $125.00
200-1000 MHz, 100 Watts max., N(m/f)
GR 874-LTL Constant Impedance Trombone $400.00
Line, 0-44 cm, DC-2 GHz
GR 900-Q GR900 14mm Interseries Adapters $125.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7 ..... $450.00
HP 11612A Bias Network, 45 MHz-26.5 GHz, APC3.5 ..... $550.00
HP 11691D Directional Coupler, 22 dB, 2-18 GHz $450.00
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz $800.00
HP 11721A Freq. Doubler, 50-1300 MHz in/100-2600 MHz out $400.00
HP 11904B APC2.4(f) x K(f) Adapter, DC-40 GHz $225.00
HP 774D Dual Directional Coupler, 20 dB, 215-450 MHz $275.00
HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz $275.00
HP 8470B Crystal Detector, 10 MHz-18 GHz, neg. pol., APC7 ..... $250.00
HP 8491A-030 30 dB Attenuator, ... $50.00
DC-12.4 GHz, 2 Watts, N(m/f)
HP 8494G-002 Programmable Step $400.00
Attenuator, 0-11 dB, DC-4 GHz, SMA
HP 8495G-002 Programmable Step Attenuator, ... $300.00
0-70 dB, DC-4 GHz, SMA
HP 8495H-002 Programmable Step Attenuator, ... $400.00
0-70 dB, DC-18 GHz, SMA
HP 8497K-004 Programmable Step Attenuator, ... $750.00
0-90 dB, DC-26.5 GHz
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 K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz $275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz $425.00
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 GHz $500.00
HP R752A WR28 Directional Coupler, 3 dB, 26.5-40 GHz $450.00
HP R752D WR28 Directional Coupler, 20 dB, 26.5-40 GHz $450.00
HP R914B WR28 Moving Load, 26.5-40 GHz $300.00
HP V365A WR15 Isolator, 25 dB, 50-75 GHz $900.00
HP V752D WR15 Directional Coupler, 20 dB, 50-75 GHz $650.00
HP X870A WR90 Slide Screw Tuner $150.00
HUGHES 45111H-2000 WR28 Isolator, 25 dB, 26.5-40 GHz $450.00
HUGHES 45113H-1000 WR19 Isolator, 25 dB, 40-60 GHz $650.00
HUGHES 45712H-1000 WR22 Frequency Meter, 33-50 GHz $900.00
HUGHES 47316H-1111 WR10 Tuneable Detector, ... $750.00
75-110 GHz, positive polarity
HUGHES 47323H-1211 WR19 Flat Broadband $650.00
Detector, negative, 40-60 GHz
HUGHES 47974H-1000 WR15 SPST PIN Switch, ... $375.00
250 MHz speed, 60-62 GHz response
INSULATED WIRE SPRR-175-78 Low Loss $45.00
Coaxial Cable, 78 in., DC-18 GHz, SMA(m/ram)
KAY 442D Step Attenuator, 0-101 dB, 75 ohms, BNC $100.00
KRYTAR 1818 Directional Coupler, 16 dB, 2-18 GHz, SMA(f) $200.00
M/A-COM 3-19-300/10 WR19 Directional $450.00
Coupler, 10 dB, 40-60 GHz
MIDWEST MICROWAVE 3537 DC Block, ... $40.00
0.1-12.4 GHz, SMA(m/f) *NEW*
MINI-CIRCUITS ZFDC-20-4 Directional Coupler, ... $25.00
19.5 dB, 1-1000 MHz, SMA(f)
NARDA 25171 Level Set Attenuator, 0-17 dB, 2-8 GHz, SMA(f) $100.00
NARDA 26298 20 dB Attenuator, 150 Watts, DC-1 GHz, N(f/f) $200.00
NARDA 3000-SERIES Directional Couplers $150.00
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz $300.00
NARDA 3090-SERIES Precision High Directivity Couplers $225.00
NARDA 368NM Coaxial High Power Load, ... $400.00
500 Watts, 2.0-12.4 GHz, N(m)
NARDA 369BNF High Power Termination, ... $325.00
175 Watts, 0.7-18 GHz, N(f)
NARDA 3753B Coaxial Phase Shifter, ... $1,250.00
0-55 deg./GHz, 3.5-12.4 GHz
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 4245-10 Directional Coupler, 10 dB, 4-12 GHz, SMA(f) $100.00
NARDA 4799 Level Set Attenuator, 0-15 dB, 4-18 GHz, SMA(f) $135.00
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 766-10 10 dB Attenuator, 20 Watts, DC-4 GHz, N(m/f) $100.00
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
OMNI-SPECTRA 2085-6010-00 Crystal Detector, ... $50.00
1-18 GHz, negative polarity, SMA(m/f)
PAMTECH KYG1014 WR42 Junction Circulator, 18.0-26.5 GHz $250.00
SONOMA SCIENTIFIC 21A3 WR42 Circulator, ... $125.00
20 dB, 20.6-24.8 GHz
SPACEK LABS DQ-1 WR22 Flat Broadband Detector, 33-50 GHz $400.00
TRG B528 WR22 Direct Reading Phase Shifter, ... $1,250.00
0-360 deg.,33-50 GHz
TRG V551 WR15 Frequency Meter, 50-75 GHz $600.00
TRG W551 WR10 Frequency Meter, 75-110 GHz $750.00
WAVELINE 100080 WR28 Terminated $250.00
Crossguide Coupler, 30 dB
WEINSCHEL 1515 Power Divider, 2-Way, DC-18 GHz, SMA(m/f/f) $125.00
WEINSCHEL 45-30-43 30 dB Attenuator, ... $250.00
250 Watts, DC-1.5 GHz, N(f/m)
WILTRON 4612K Programmable Step Attenuator, ... $800.00
0-70 dB, DC-40 GHz
WILTRON 60NF50 SWR Bridge, 5-2000 MHz, ... $450.00
40 dB directivity, N(f/f/f)

LOGIC

HP 10343B/10269C SCSI Bus Preprocessor, ... $300.00
w/probe intfc., for 1630 series
HP 5005A Signature Multimeter $350.00
HP 8170A-002 Logic Pattern Generator, ... $1,200.00
2 MB/s, address driver option
TEK 1240D2/1D 10-channel 50 MHz D/A $50.00
Module for 1240, without probes
TEK 30DM08 80286 Probe, for Tek Prism $50.00
TEK DP186P 80186 / 80188 Probe, for Tek 1230 ..... $50.00
TEK DP286P 80286 Probe, for Tek 1230 ..... $50.00
TEK DPHC11 68HC11 Probe, for Tek 1230 ..... $50.00
TEK P6454 100 MHz Clock Probe, for DAS $50.00

COMMUNICATIONS

HP 4972A LAN Protocol Analyzer $1,500.00
HP 59401A HPIB Bus Analyzer $700.00
TEK 1410R NTSC Gen., w/SPG2 sync. $1,000.00
generator, TSG7 color bars
TEK 1411R PAL Gen.,w/SPG12 sync; $1,000.00
TSG11 color bars;TSG13 linearity
TEK 1411R PAL Test Gen., ... $1,400.00
w/SPG12,TSG11,TSG13,TSG15,TSG16
TEK 1411R PAL Test Gen., ... $1,600.00
w/SPG12,TSG11,TSG12,TSG13,TSG15,TSG16
TEK 1411R-opt.04 PAL Test Gen.,w/
SPG12,TSG11,TSP11,TSG13,TSG15,TSG16 ..... $1,900.00
TEK 147A NTSC Test Signal Generator, with noise test signal $800.00
TEK 148 PAL Insertion Test Signal Generator $800.00
TEK 1750 NTSC Waveform / Vector Monitor $2,750.00
TEK 520A NTSC Vectorscope $750.00
TEK 521A PAL Vectorscope $750.00

MISCELLANEOUS

KEITHLEY 706/ 7055 x12 Scanner,w/(12) 7055 ..... $1,000.00
General Purpose Relay Scanner cards
P.A.R. 5205-94,95,96,98 Lock-In Amp, ... $2,000.00
20 Hz-20 kHz, int. osc., lin/log, GPIB
P.A.R. 5206 Two-Phase Lock-In Amplifier, 2 Hz-200 kHz $1,750.00
P.A.R. 5208-92,94,97,98 Two Phase Lock-In Amp., ... $2,500.00
5 Hz-20 kHz or 200 kHz, GPIB
TEK TM5006 5000-series 6-slot Programmable Power Module $600.00
TEK TM504 500-series 4-slot Power Module $175.00
TEK TM506 500-series 6-slot Power Module $250.00
TEK TM515 500-series 5-slot Traveller Power Module $275.00

Write In 182 on Reader Service Card.

TEST EQUIPMENT *cont.*

WANTED: LATE model TEST EQUIPMENT and test equipment MANUALS, HP, Tektronix, and others. Fax your for sale list to 410-750-1192 or mail to US Surplus, PO Box 37, Ellicott City, MD 21041, Attn: Ron Baublitz. Phone # 410-750-1083, E-Mail: ussurplu@clark.net

IFR1500 SERVICE monitor, excellent condition $5,900. Many more at: http://www.madbbs.com/amtronix 716-763-9104 or 716-661-9964.

WANTED: WESTERN electric test equipment. Tube-type only please. Freq. measuring sets, oscillators, amplifiers, parts, tubes, etc. 1-800-251-5454.

NEW HEWLETT-PACKARD 141T CRTs. $195 EACH. We have quantities available. These are double boxed, unopened with 1985 date code, guaranteed. Price is $195 each plus shipping. Contact Brian at Kentronix. 732-681-3229 or FAX 732-681-3312. Mailing: PO Box 2444, Farmingdale, NJ 07727 or E-Mail brian@kentronix.com

FEITEK HAS the test equipment you want at reasonable prices. We buy, sell, and trade HP, Tek, GR, etc. Call or fax Monday thru Friday, 9 to 5, 314-423-1770, or write us at Box 3423, St. Louis, MO 63143.

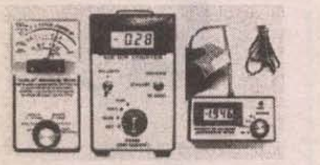
FEITEK PROVIDES repair, calibration and certification on many makes of test equipment. We also have a large selection of used equipment. Send large SASE envelope for list. VISA and MasterCard accepted. Feitek Inc., 2752 Walton Road, St. Louis, MO 63114, 314-423-1770.

QUALITY TEST EQUIPMENT: HP 3488A switch/control mainframe $850 (cards available). **HP 59306A** relay actuator (6-SPDT) $200. **HP 59307A** dual VHF switch (2-SP4T) $200. **HP 8161A/020** 100MHz HP-IB dual channel pulse generator $3,100. **HP 5334A** 100MHz counter (rise/fall time, HP-IB, etc.) $850. **HP 5335A/20,40** 200MHz counter (rise/fall time, statistics, HP-IB, etc.) $1,200. **Stanford Research SR 510** lock-in amplifier $1,400. **HP 339A** distortion analyzer $1,600. **Tek 222A** handheld battery-operated digital storage scope $1,250 (many accessories available). **HP 11869A** adapter (for 8350B) $350. **HP 8502A/H26** transmission/reflection test set $950. **HP 8748A/H26** S-parameter test set $1,550. **HP 436A/022, 8481A** RF power meter, sensor $1,775. Excellent condition! All with warranty. Pepper Systems, 214-353-0257 (FAX 214-902-9511).

28 ITEMS of test equipment, plus miscellaneous parts and equipment. 1. Astron RM35A power supply $30. 2. Bird #4431 wattmeter kit, with case and slugs $100. 3. Bird 82 500W dummy load $75. 4. Boonton 230A RF power amplifier 2 ea., one not operating $150/pair. 5. Boonton 250A RX meter $175. 6. Exact 124 multigenerator $15. 7. Fluke 8800 5.5 digit multimeter $45. 8. Fluke 8050A 4.5 digit multimeter $40. 9. Helper #801 RF millivoltmeter with probe $125. 10. HP 302A wave analyzer $125. 11. HP 310A wave analyzer $175. 12. HP 427A electronic multimeter $25. 13. HP 432A power meter with thermistor mount, inoperative. 14. HP 803A VHF bridge $15. 15. HP 3466A 4.5 digit multimeter, not operating $25. 16. HP 5302A 50 MHz, counter with display $25. 17. HP 34701A digital voltmeter with display $20. 18. HP 600 ohm attenuator 0-110 dB DC-1 MHz $10. 19. HP 4800A vector impedance meter $200. 20. Lambda 28V, 30A, power supply $40. 21. Logimetrics 921 signal generator 50 KHz-80 MHz $150. 22. Military ME30F/U, equivalent to HP 400 series AC voltmeter $35. 23. Millen 90651-A grid dip meter, with case and all coils, like new $40. 24. Military USM223 multimeter $5. 25. Modular devices 0-500V, 100mA power supply $15. 26. Simpson AC wattmeter 5KW and 10KW scales $40. 27. Simpson 604 multicorder, strip chart recording multimeter $40. 28. Squires-Sander BSSG-1 spectrum generator, not operating $10. Other items: Green #106 engraver, no fonts $125. Approx. 25,000 ft. #24/#26 wire in 4 colors $75. Sola constant voltage transformer, 120VA $3. Assorted variable voltage transformers (variac type). Assorted power supplies. Weller soldering stations W-TCP and WTCPN $5-10, 3.125" square, 12VDC, fans, have 22 $2 ea. also 2" and 4". Pick up only, all prices FIRM. Dan 714-444-2228 (Costa Mesa). After 11am.

SALE BOONTON 1120 audio analyzer $650, 2 available SCIENTIFIC ATLANTA 4651B DS3 transmitter, 4654A error analyzer, 4657A/B DS3 error analyzer 5 units available @ 150 ea., offers. **Psitech Plus** 707-745-4804, Fax 707-747-5277 E-Mail: apeas@ix.netcom.com

QUALITY TEST EQUIPMENT: HP 8082A 250MHz pulse generator $995. **HP 8016A** ECL/TTL word generator $295. **HP 8161A/030** 100MHz programmable precision dual channel pulse generator $3,100. **HP 4274A** LCR meter (5-1/2 digit, 100Hz-100KHz, HP-IB) $3,900. **HP 339A** distortion analyzer $1,650. **HP 7595A** DraftMaster I (sizes A-E) $1,675. **HP 7475A** plotter $220. **HP 7090A** measuring plotter $1,500. **HP 5334A** 100MHz counter (rise/fall time, HP-IB, etc.) $850. **HP 5335A/20,40** 200MHz counter (rise/fall time, statistics, HP-IB, etc.) $1,200. **HP 5345A** 500MHz counter $400, with HP-IB $675. **HP 5370A** 100MHz time interval counter (oven time base) $1,200. **HP 3488A** switch/control mainframe $850 (cards available). **HP 59306A** relay actuator (6 SPDT, HP-IB and lighted pushbutton) $200. **HP 59307A** dual VHF switch (2-SP4T, HP-IB and lighted pushbutton) $200. **HP 59401A** HP-IB bus analyzer $250. We also can provide HP-IB programming services and custom ATE systems.) **Fluke 540B** transfer standard $750. **Tek 390AD** digitizer $475. **Tek P6201** 900MHz active probe $325. **Tek 520A** NTSC vectorscope $750. **Stanford Research SR 510** lock-in amplifier $1,400. Excellent condition! All with warranty. Pepper Systems, 214-353-0257 Fax 214-902-9511.



ELECTROMAGNETIC DETECTORS, including **Trifield® broadband meter** (analog) reads field strength of 10-1000 V/M at 100KHz-2.5GHz, also independently reads magnetic (3-axis) and electric fields, below 100KHz. (0.2-100 milliGauss, and .5-100 KV/M, at 60 Hz). Ideal general detection tool for both AC power and RF work $170 postpaid. **Atmospheric ion counter** (digital) reads both polarities 10-2,000,000 ions/cc. (Atmosphere is typically 300-5000 positive and 200-3000 negative. Depends on weather, etc.) **For the first time, under $4,000 for a true ion counter!** $580 postpaid. **DC Gaussmeter** (digital) includes compact Hall probe (.01-20,000 Gauss) **and** differential coil probe (.01 milliGauss - 20 Gauss). Complete $265 postpaid. All above have 1 year warranty and include 9-volt batteries. Made in USA by Alphalab Inc., 1280 South 300 West, Salt Lake City, UT 84101. Tel. 1-800-769-3754 or 801-487-9492. Free catalog.

HP 1744A oscilloscope $300; HP 432C power meter $175; HP 432A $75; HP 86632A $100; HP 86602A $100; HP 86601A $300; Tek TM504 $60; Tek FG504 $200; Tek 508A $200; Tek DC 503 $100; Tek 321 oscilloscope $100; HP 2225A printer HP-IB interface $75; Tek TM506 $60; JDR 2000 oscilloscope $150; Tek P6452, P6455 data acquisition $25; Simpson multimeter 461 $40. Call 714-827-7345

WANTED: HI-voltage power supplies and hi-pot testers. Jennings JHP-70A, Von's C-1, hi-potronics, Spellman. Also looking for VDF 2.8pF Jennings capacitors and hi-voltage calibration resistors for units. Youngson's, Inc., 6701 Melrose Ave., Louisville, KY 40216. 502-448-6228.

TEKTRONIX SCOPE sale, 453 454 $75; 465 465B $350; 475 $450. Sold as is. Ty Miller, South Coast Surplus 714-830-9170.

WANTED! TEST equipment. We pay top dollar for used scopes, generators, analyzers from HP, Tektronix, and others. Call Charles at Metric for immediate quotation. 1-800-432-3424.

AFFORDABLE HP power sensor repair! Most 8481As repaired for $230 or less. We also handle 478As and many others. Call or fax for more information. Willamette RF, Inc., 541-754-7226, FAX 541-753-4629.

MICRODYNE 1100, 1200, 1400 series receivers all bands, FM and PM demods, SDU, IF filters. Aydin, Schlumberger, monitor systems bit syncs. 805-934-2058.

SELL: BIRD 8141 250W RF load DC-2.5 GHz, $200; Bird 8322 in line attenuator, 30dB, 200W, DC-1GHz, $400; Boonton 260A q meter, $300; Bird 694 wattmeter, RF load 1KW 2-30MHz, $300; HP 7225B XY plotter A size single pen, HPIB, $150; A-Comm Electronics 303-290-8012.

Bearcat Intercepts Trunked Radio

COMMUNICATIONS ELECTRONICS INC.

New...Bearcat Trunktracking radios

Get your Bearcat 235XLT for only $199.95 or Bearcat 895XLT for only $239.95

when you order our package deal. To get your **free fax-on-demand catalog**, call 313-663-8888 from the telephone handset on your fax machine and follow the recorded voice prompts. Get many free benefits such as extended warranty coverage on new Bearcat scanners when you use your Communications Electronics Platinum Plus Master Card® issued by MBNA. No annual fee. Call 1-800-523-7666 anyitme and mention offer Q3KI to request yours today.

Get your **Bearcat 895XLT for only $239.95** when you order package deal **#UNI8PD**. Our package deal includes mobile mounting bracket **#MB001** $14.95; Cigarette lighter power cord **#PS001** $14.95; external speaker **#EX711** $19.95 and mag-mount mobile antenna with 12 feet cable **#ANTMMBNC** $29.95; plus $29.00 shipping. Total package deal price is $348.75. Hurry offer expires 1/31/98.

Bearcat®895XLT-A Radio Scanner

Mfg. suggested list price $729.95/**Special $319.95**
300 Channels • 10 banks • Built-in CTCSS • S Meter
Size: 10-1/2" Wide x 7-1/2" Deep x 3-3/8" High
Frequency Coverage: 29.000-54.000 MHz., 108.000-174 MHz., 216.000-512.000 MHz., 806.000-823.995 MHz., 849.0125–868.995 MHz., 894.0125-956.000 MHz.

The Bearcat 895XLT is superb for intercepting trunked communications transmissions (see BC235XLT description) with features like TurboScan™ to search VHF channels at 100 steps per second. This base and mobile scanner is also ideal for intelligence professionals because it has a Signal Strength Meter, RS232C Port to allow computer-control of your scanner via optional hardware and 30 trunking channel indicator annunciators to show you real-time trunking activity for an entire trunking system. Other features include *Auto Store*– Automatically stores all active frequencies within the specified bank(s). *Auto Recording*– This feature lets you record channel activity from the scanner onto a tape recorder. *CTCSS Tone Board* (Continuous Tone Control Squelch System) which allows the squelch to be broken during scanning only when a correct CTCSS tone is received. For maximum scanning enjoyment, order the following optional accessories: **PS001** Cigarette lighter power cord for temporary operation from your vehicle's cigarette lighter $14.95; **PS002** DC power cord - enables permanent operation from your vehicle's fuse box $14.95; **MB001** Mobile mounting bracket $14.95; **EX711** External speaker with mounting bracket & 10 feet of cable with plug attached $19.95. The BC895XLT comes with AC adapter, telescopic antenna, owner's manual and one year limited Uniden warranty. Save $80.00...order the package deal above.

Bearcat®3000XLT-A Radio Scanner

Mfg. suggested list price $699.95/**Special $329.95**
FREE - Get an extra BP2500 battery pack, a $51.95 value when you order a Bearcat 3000XLT. Hurry...offer expires 1/31/98.
400 Channels • 20 banks • Twin Turbo Search/Scan
Frequency Transfer • VFO Control • Automatic Store
10 Priority Channels • Selectable Mode • Data Skip
Frequency step resolution 5, 12.5 & 25 KHz.
Size: 2-3/4" Wide x 1-1/2" Deep x 7-3/8" High
Frequency Coverage:
25.000-549.995 MHz., 760.000-823.995 MHz., 849.0125–868.995 MHz., 894.0125-1,300.000 MHz.

The Bearcat 3000XLT is the ideal handheld radio scanner for communications professionals. This handheld scanner scans at 100 channels per second and searches at a rate up to 300 steps per second. A selectable attenuator eliminates annoying intermodulation from adjacent frequencies in highly populated areas. Selectable AM, Wide FM and Narrow FM modes allow you to change the default receiving mode of the BC3000XLT. For maximum scanning pleasure, order the following optional accessories: **UA502** Cigarette lighter power cord for temporary operation from your vehicle's cigarette lighter $14.95; **LC3000** Deluxe swivel leather carrying case $49.95; **BP2500** rechargeable nickel-cadmium battery pack for up to five hours of dependable use $39.95; **ANTMMBNC** Magnetic mount scanner antenna with BNC jack and 12 feet of cable $29.95. **ANTSGBNC** Glass mount scanner antenna with BNC cable $29.95. The BC3000XLT comes with AC adapter, belt clip, flexible rubber antenna, earphone, owner's manual and one year limited Uniden warranty. Order today.

TrunkTracking Radio

Get your **Bearcat 235XLT for only $199.95** when you order package deal **#UNI2PD**. Our package deal includes deluxe swivel belt loop leather carrying case **#LC235** $49.95; Cigarette lighter power cord **#UA502** $14.95; and mag-mount mobile antenna with 12 feet cable **#ANTMMBNC** $29.95; plus $29.00 shipping. Total package deal price is $323.80. Hurry offer expires 1/31/98.

Bearcat®235XLT-A TrunkTracker

Mfg. suggested list price $429.95/**CEI price $269.95**
300 Channels • 10 banks • Trunk Scan and Scan Lists
Trunk Lockout • Trunk Delay• Extra battery & charger
10 Priority Channels • Programmed Service Search
Size: 2-1/2" Wide x 1-3/4" Deep x 6" High
Frequency Coverage:
29.000-54,000 MHz., 108-174 MHz., 406-512 MHz., 806-823.995 MHz., 849.0125-868.995 MHz., 894.0125-956.000 MHz.

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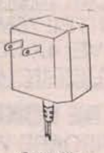
Input: 117 Vac 50/60 Hz. Outputs Available.



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NEW ADAPTEC AHA-1540CF ISA SCSI CONTROLLER CARD WITH EZ-SCSI V 2.0 SOFTWARE
Adaptec 1540CF SCSI-2 ISA card with external high density SCSI-2 port (up to 7 devices). On board BIOS set-up and diagnostics, jumperless configuration. Kit comes with card, cable for two devices, manual, and software. Originally packages for NCR Corp. Note: No floppy support on this model. Adaptec 1540CF KIT ....$99.95 Ea.

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Brand New True 256 Gray Scale Hand Scanner.
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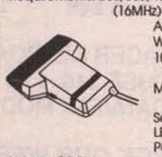
Scan Width: 4.2 In. Scan Length: 11 In.
Interface: 16 Bit high speed (ISA) card, 64K SRAM. System Requirements: 286/386/486 PC Compatible (16MHz).



Available 16-Bit Interface slot, Windows 3.1, 4 Meg RAM, 10 Meg of Available HD space (Min.), Mouse or Other pointing device.
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NEW TANDY SUPER VGA 1 MEG DRAM
(16-Bit ISA Bus Type)

This board is your basic super VGA video board with 1 meg of DRAM type memory. (ISA BUS TYPE.) Core Logic Chip: WD90C31-ZS-00-02. Resolution/Color: 640x480/256C, 800x600/256C, 1024x768/256C, 1024x1024/16C. Note: Software drivers included with board. Windows 3.1, VESA, Autocad, etc.

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NEW 300W BABY SWITCHING POWER SUPPLY UL & CSA RATED 110-220VAC
Input voltage: 110-220VAC 50Hz/60Hz UL & CSA. Output voltage: +12VDC @ 12 amp/-12VDC @ 0.5 amp; +5VDC @ 30 amp/-5VDC @ 0.5 amp.

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New retail box Intel math co-processor comes complete with used guide, utility and diagnostic software. Great price on a hard-to-find part for 286 laptops. (Chip package 44 pin PLCC.)

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Requires one lithium coin battery (BR2325/CR2325).
Note: Battery not included.
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New Standard 1.44 Meg 3.5" floppy disk drive. Manufactured by Teac, Model #FD-235HG. Face plate color: Beige. 34 pin interface connector with 4 pin power.

FD-235HG Teac 1.44M ....$32.95 Ea.

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SDP5-10 SUNDISK ....$124.95 Ea.

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New Pentium 60/66 heatsink 12VDC fan combo for cooling the older, hotter, CPUs. Low profile type with seven inch wires. Can be used on other CPUs if you have the physical space..

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FF-3101/700 Combo ....$69.99 Ea.

Write In 168 on Reader Service Card.

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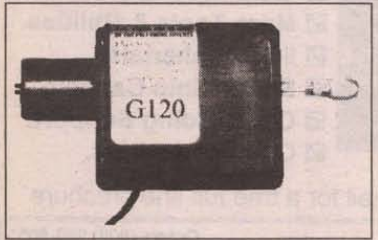

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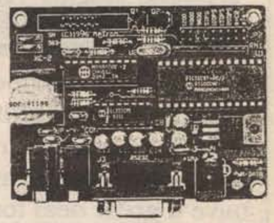

The New **MoTron XC-2** is a versatile bi-directional DTMF to ASCII transceiver. DTMF digits are decoded from the audio line, converted to ASCII, and transmitted out through the serial port. ASCII data is received from the serial port, converted to DTMF digits and transmitted on the audio line. The **XC-2** uses the RS-232C serial communications protocol and includes a PTT output, which can be used to control a radio transmitter. The **XC-2** is user-configurable--select either 1200, 4800 or 9600 baud for the serial port and 5, 10, 15 or 20 cps DTMF transmission rate. Additional jumpers can be used to set DTMF "#" to generate an ASCII "CR", and to control an open-collector output with DTMF "*" (on) and "#" (off). Audio connection options allow combined audio signals, or separate audio input and output via standard 3.5mm jacks. A standard DE-9S is used for serial communications. The **XC-2** is a fully assembled and tested printed circuit board, requires +8 to +17 VDC @ 200ma, and is only 2-1/2" x 3-1/2". OEM and Quantity discounts are available.

XC-2 Bi-Directional DTMF to ASCII Transceiver PCB **$99.00** Plus Shipping

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FIRST

The Competition

Could Engineering be an Olympic Event?

The folks at FIRST (For Inspiration and Recognition of Science and Technology) have devised an exciting way to expose high school kids to engineering and technology. The program is the brainchild of Dean Kamen, a physicist, engineer, and entrepreneur from New Hampshire. His personal goal, and that of FIRST, is to show high school students how much fun engineering can be, encouraging them to pursue a career in technology.

Each year, Mr. Kamen and Professor Woodie Flowers of MIT, create a game in which student teams compete with a radio-controlled robot. The game in 1997 was called "Toroid Terror" and the goal was to place colored inner tubes on a rotating goal.

On the surface, maybe that sounds a little dull. But, when three robots are in play at once, all competing against the clock and cheered on by an excited crowd, you have the makings for a pretty wild time. Teams are encouraged to create stickers, buttons (for trading with other teams), tee shirts, hats, noisemakers, and whatever else contributes to team identity.

The students learn something about mechanical, electrical, electromechanical, pneumatic, and control systems as their volunteer sponsors build a competitive machine. Students and sponsors form cohesive teams very quickly.

The teams have only six weeks to construct a machine of their own design from a box of parts supplied by FIRST. There is a tremendous amount of design latitude afforded by the variety of parts, as long as weight and dimensional restrictions aren't violated.

The robot isn't as much a robot as it is a giant RC model. It even uses some RC components. FIRST provides two three-axis joysticks, eight rocker switches, and two potentiometers for the control station. Teams can use any or all of these controls, but the joysticks can't be altered. No machine can have a footprint larger than three by three feet, nor can it stand more than four feet high. Quite a design challenge when the goal is twice that high!

The fun doesn't end with tubes, gears, motors, switches, sheets, shafts, and wire. For the first time in 1997, the controller supplied by FIRST was programmable! The receive end of the control system has at its core, what amounts to a Parallax Stamp II. There are lots of synchronous serial peripherals that drive relays and RC speed controllers. Other peripherals read switch states and proportional inputs. FIRST supplies a default program which functions perfectly well for those who don't want to write their own code.

The example code, authored by Eric Rasmussen, was well annotated and easy to follow so most teams felt confident in writing custom functions for their controllers. Some were very creative with their programming. At least one team used position sensors on rotating members for feedback to the controller which held a preset position. Very creative!

Competitions

Regional competitions are held across the US beginning in March. All the teams learn a lot about strategy which prepares them for the finals at EPCOT Center in mid-April. Both events are open to the public. FIRST could not have picked a better place than EPCOT for the three-day event.

Disney and FIRST are about technology, fun, and the rewards of hard work. Students, teachers, technologists, and engineers learn from each other and have a great time doing it. All the teams show gracious sportsmanship, some even share tools, parts, and talent to get a competitor's machine battle-ready.

Awards

The Honeywell Leadership in Control Award goes to the team with the most unique control system. The team with the most robust design gets the Motorola Quality Award. Johnson and Johnson offers a Sportsmanship Award. Chrysler shows how much they value team efforts by presenting a Team Spirit Award. The Procter and Gamble Creativity Award is very broad, encompassing design and play criteria.

Other awards are: Best Play of the Day, Number One Seed, Outstanding Defense, Most Photogenic, Best Offensive Round, Featherweight in the Finals, and Rookie All-Star. A highly qualified body of judges determines which teams receive awards.

Of the 17 awards possible, the Chairman's Award is the most prestigious. This award has nothing to do with winning the game. It has to do with student involvement, teamwork, creativity, and the level of cooperation between school and sponsor.

The Founder's Award is presented by Dean Kamen to the person or organization which best promotes the goals of FIRST. The Autodesk Award goes to the team whose computer animation presents creative design solutions for The Competition. The Woodie Flowers Award goes to the individual who excels in teaching math, science, engineering, and creative design. All the teams have an opportunity to vote on which team will receive the Worcester Polytechnic Institute Design Innovation Scholarship.

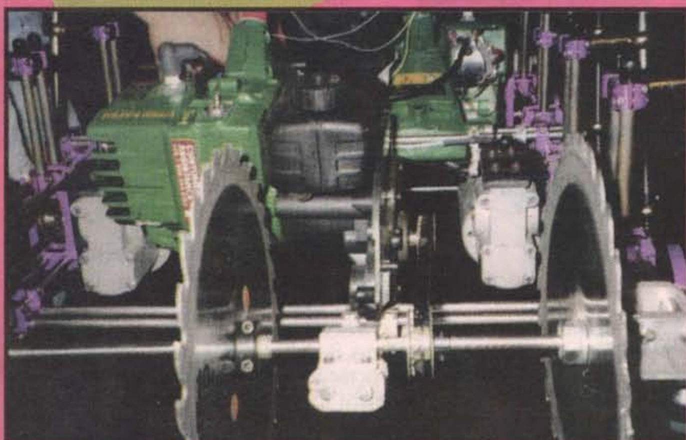
The 1998 game won't be announced until January 10, so there's really no way to anticipate what kind of parts will be available or what the objective will be. That way, no team has a time advantage. Can your company or University sponsor a FIRST team? The hours can be long, but the rewards are great. It's worth every minute.

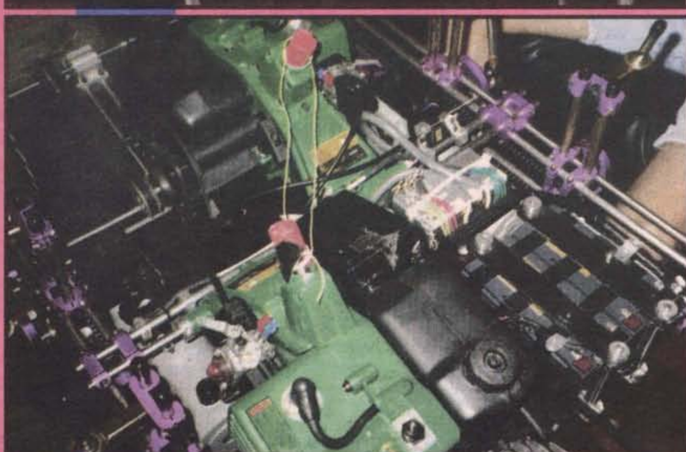
Want more information? Watch for a TV movie to be aired sometime this winter. Don't wait for the movie if you want to be a sponsor.

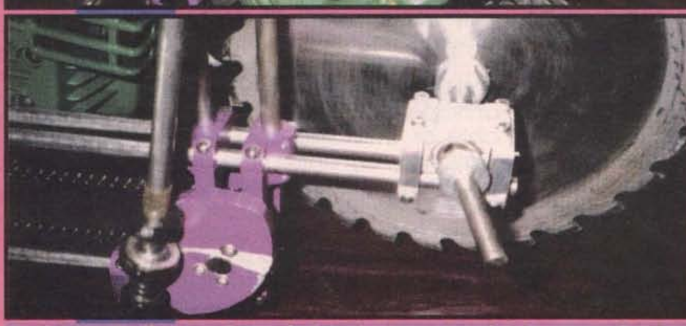
Visit the FIRST web site (www.usfirst.org).

Robot Wars 1997: Pretty Hate Machine

by Dan Danknick







Christian Carlberg can be reached on the Internet at christian@aceweb.net
For more information on the event, you can visit the Robot Wars website at http://www.robotwars.com/
A comprehensive analysis of the last two events is also available on competitor Andrew Lindsey's website at http://www.cybercomm.net/~alindsey/

"It was originally going to be called 'Grinder' or 'Mangler' before the aluminum parts came back from the anodizer with their purple coating," explains Christian Carlberg as he relaxes into his black leather sofa in an unassuming North Hollywood apartment. "Everyone kept saying 'It looks so pretty.' So, I settled on the name 'Pretty Hate Machine.'" And pretty it is, this 100-pound, eight-legged walking robot that competed at Robot Wars 1997 in San Francisco. But he is quick to add "I wanted something that looked mean." I wonder to myself if the 10" saw blades spinning at 14,000 RPM would qualify for that, as the 27-year-old movie special effects mechanic puts me to work helping to uncrate his robot.

As we pick Styrofoam packing material from its driveline (from a recent trip back to San Francisco, this time to become part of an ad for WebTV), Christian describes how it all started. "I made a lot of little Lego things to investigate walking and climbing mechanics. I thought about the design for 16 months. Construction was 700 hours of work over eight straight months." Schooled at Cornell and sporting a masters in mechanical engineering, Christian certainly has the background for a design of this complexity. Now sufficiently de-foamed, I groan as we lift the walker onto his coffee table for a better look at the design. At 30" wide by 54" long by 12" high, I realize: this is no small robot.

A single high torque wheelchair motor on each side moves the feet through a chain drive. Gliding in a set of spherical bearings, the legs attach through adjustable clamps (the purple parts) to a steel space frame, upon which the weapon system also rides. A pair of gel-cell batteries powers the motors, controlled smoothly through proportional H-bridges from a standard RC radio link.

Two bright green 21 cc gas engines pump 1.5 hp of destruction into independent arrays of saw blades, one fore and the other aft. The preferred attack mode is simple: walk the blades right into the target. "They originally had carbide tips on them, but the safety judges were afraid a tip might crack, fly off, and hurt someone." The jagged edge of tool steel that remains looks even more effective to me.

But with all this clever engineering, perhaps the most startling part is the feet. They're racquetballs. "I was the most disappointed with the feet; in some cases, the rubber sheared right off." Odd, considering they carried a 100-pound robot around to rain spinning death upon 50-pound foes.

To encourage the construction of walking entries, the Robot Wars organizers give a major concession to walkers, allowing them to compete in the next lower weight class. "The walkers weight advantage is a big plus," and he credits this incentive as one of the reasons he built a walker instead of a more common rolling entry. Well, that in addition to thinking the competition was "really cool."

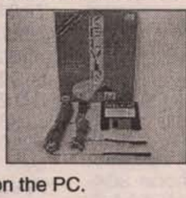
If you're unfamiliar, Robot Wars plays yearly to sold-out crowds. Attended by all manner of engineers, artists, hobbyists, and the just plain curious, many guests go on to become entrants with their own designs. The goal of the competition is simple: disable the opposing robot, while inflicting maximum damage to the entertainment of the cheering crowd. In short, it's a bloodsport.

For fairness, the robots group by weight, from 25 pounds in the featherweights to 175 pounds in the heavyweights. Audience safety prohibits a few design elements: flames, chemicals, electrical discharges, radio jamming, expanding foam, and explosives. Many feel the kinetic energy mechanical weapons that remain make for a better show, as well as the fact they force the entrants to become more clever in their designs. In the words of event creator Marc Thorpe, "The cool tend to dominate."

Though PHM didn't glean a trophy this year, the audience cheer factor indicated it was a winner. What does he have planned for 1998? "I'm going to fix PHM at least. And I'm thinking about a 175-pound walker to compete in the middleweights." What would he build, given unlimited resources? "A 300-pound walking robot. Or a fully powered exoskeleton suit. Though nano-size insect robots might be cool, too." NV

Point Six, Inc. Data Acquisition Products based on Dallas Semiconductor 1-Wire™ Technology

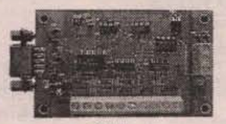
Kelvin® Dual Channel Temperature Monitor



The software has real-time and historical graphing as well as numerical display modes. The program runs under Windows® 95 , 3.1 and 3.11.
- Probes have digital outputs.
- No external power required.
- Connects to 9 pin RS232 port on the PC.
- Weight 1.0 lb. • One-year warranty

Item	Description	Price
DCTM01	Dual Channel Monitor	99.95

Eight Channel PC Interfaced Data Acquisition Card

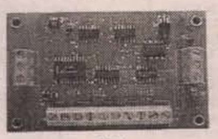


T8AH

Data acquisition card with eight channels that can be individually configured as a **12 bit analog** input, a digital input, or a digital output. It has built in RS232 to 1-Wire™ converter and is supplied with the OneSix™ DDE Server.
- Built-in multi-drop controller.
- Unique device addressing.
- Analog inputs are 0-5V.
- 1-Wire™ drives 2000' net and 200 devices.
- No external power required.
- Connects to 9 pin RS232 port on the PC.
- Size 2.110W X 3.825L
- Weight 1.0 lb. • One-year warranty

Item	Description	Price
T8ADH	Analog And Digital Card	119.95
T8AH	Analog Only Card	99.95
T8DH	Digital Only Card	89.95

Eight Channel Data Acquisition Card



T8A

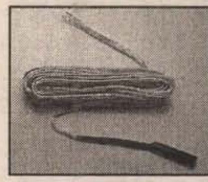
Data acquisition card with eight channels that can be individually accessed as a **12 bit analog** input, a digital input, or a digital output. It is supported by OneSix™ DDE Server.
- Built-in multi-drop controller.
- Unique device addressing.
- Analog inputs are 0-5V.
- Two 1-Wire™ Ports for net expansion.
- Requires Host Adapter or existing network.
- Size 2.110W X 3.375L
- Weight 1.0 lb. • One-year warranty

Item	Description	Price
T8AD	Analog and Digital Card	109.95
T8A	Analog Only Card	89.95
T8D	Digital Only Card	79.95

To Place An Order Contact Us At
Phone: 606-271-1744
FAX: 606-271-4695
E-Mail: sales@pointsix.com

For application specific information contact Applications Engineering or visit our website at www.pointsix.com.

1-Wire™ Probes



STP010

Our probe designs are based on 1-Wire™ protocol devices all probes are multi-dropable and supported by OneSix™ DDE Server Software.
- Digital Data Output.
- Built-in multi-drop controllers.
- Unique device addressing.
- No external power required.
- Standard Temperature Range -30 to +182˚F.
- Requires Host Adapter or existing network.
- Weight 1.0 lb. • One-year warranty

Item	Description	Price
STP010	Standard Temperature /W 10' Lead	14.95
STP025	Standard Temperature /W 25' Lead	16.95
ATP006	Acrylic Temperature 6" Waterproof	18.95
ATP010	Acrylic Temperature 10" Waterproof	19.95
FRP001	Fast Response Temperature /W 25' Lead	23.95
HTP001	High Temperature -30 to +225˚F	24.95
PRP001	Pressure Probe 0-30 PSI	159.95
PHP001	pH Probe	159.95
CDP001	Conductivity Probe	159.95
HMP001	Humidity Probe	159.95
FCP001	1500g Force Probe	179.95

I/O Backplanes

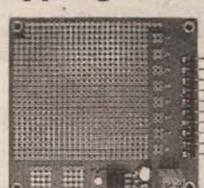
T2SSM

T1SS

One and two position cascading backplanes accept industry standard miniature I/O modules to allow monitoring and control of high voltage/current applications. Both are supported by OneSix™ DDE Server.
- Built-in multi-drop controller.
- Unique device addressing.
- 4000VAC Isolation.
- Requires Host Adapter or existing network.
- Size (T1) 3.37W X 0.75L, (T2) 3.37W X 1.25L
- Weight 1.0 lb. • One-year warranty.

Item	Description	Price
T1SS	Digital I/O Card	29.95
T2SSM	Digital I/O Card	39.95
IAC5	AC Input Module	9.00
OAC5	AC Output Module	9.00
IDC5	DC Input Module	9.00
ODC5	DC Output Module	9.00

T8 Design Prototyping Card



The prototyping card connects to any T8ADH, T8AH, T8AD, or T8A to allow easy prototyping of I/O and analog conditioning circuits.
- On board power regulation.
- Size 3.375W X 3.375L
- Weight 1.0 lb.
- One-year warranty

Item	Description	Price
T8BDB	T8 Prototype Card	49.95

1-Wire™

1-Wire™ is a communication protocol developed by Dallas Semiconductor which allows 1-Wire™ devices to communicate on a two wire network with bi-directional data CRC checking.

OneSix™ DDE Server Software Driver

A software server driver for Windows® 95 , 3.1 and 3.11 that allows easy interface of 1-Wire™ devices and Point Six products to applications via DDE links. This eliminates the need for low level device communication programming.
- Searches network, adds and auto configures all new devices found.
- Copy and paste links to Office® products like Excel®, Word® and many other DDE capable applications.
- Works with HMI interface software such as Wonderware®, LabView®, and TestPoint®.
- Includes complete help.
- Includes an HA3 Host Adapter.
- Weight 0.5 lb. • One-year warranty

Item	Description	Price
ONESIX	DDE Server Software	69.95

PC Host Adapter

RS232 to 1-Wire™ protocol host adapter interface. Converts standard PC serial port to a 1-Wire™ network. All interface components are contained inside the DB9 shroud. The HA3 supports all Point Six Products.
- No external power required.
- Includes OneSix™ DDE Server Software.
- Connects to 9 pin RS232 port on the PC.
- 2000 ' Network and 200 1-Wire™ devices.
- Weight 0.5 lb. • One-year warranty.

Item	Description	Price
HA3	Host Adapter	69.95

Isolated PC Host Adapter

Isolated RS232 to 1-Wire™ protocol host adapter interface. Converts standard PC serial port to an Isolated 1-Wire™ network. Supports all Point Six Products.
- Includes OneSix™ DDE Server.
- 2000 ' Network and 200 1-Wire™ devices.
- 2000VAC Isolation from the 1-Wire™ Net.
- Connects to 9 pin RS232 port on the PC.
- Size 2.375W X 3.875L
- Weight 0.5 lb. • One-year warranty

Item	Description	Price
HA4	Host Adapter	139.95

Digital Thermometer

A simple easy way to access temperatures from a 1-Wire™ network. Supported by OneSix™ DDE Server.
- Built-in multi-drop controller.
- Unique device addressing.
- Temperature range -67 to +257˚F.
- Can be powered for faster operation.
- 200 Devices per network.
- Requires Host Adapter or existing network.
- Weight 0.5 lb. • One-year warranty

Item	Description	Price
DS1820	Digital Thermometer Chip	3.49

Point Six, Inc. • 138 East Reynolds Road • Lexington KY • 40517 • 606-271-1744 • http://www.pointsix.com

TEST EQUIPMENT *cont.*

AM-FM SERVICE MONITORS bought & sold. IFR, Motorola, Wavetek, Marconi, Triplet, HP. **FOR QUOTE CALL TEST-TRONICS. Full calibration & repair, reasonable rates.** A division of Communications Signalling Inc. **1-888-423-2565, 805-251-2244, Fax 805-252-3100.**

ATLAS MISSILE E/F/H telemetry package flight certified. 2243.5MHz 10.6 watts PAM/FM/FM. 2 commutators, 20 VCOs. All tech data. 805-934-2058.

SENCORE CG-169 $90, CR-143 $110; CR-168 $180; RC-144 $10; TF-151 $60; TF-30 $70; EICO 369 $50, 715 $30; Nicolet Zeta 824A-CS $125; Narda 3042-20 $40; 3096 $50 new; 4031C $30; HP P281B-OPT 013 $50; P424A $30; P752A $50; P752C $50; P934A $40, 934A $40; 3300ID $40; 8447E $150; 8709 $75. G&G 210-674-8771.

HP 8640B option 3 signal generator $800. **Fluke 5200A** AC voltage calibrator $1,000. **Fluke 5205A** amplifier $800. Amadeus Surplus 810-465-1844 evenings.

OSCILLOSCOPES: TEKTRONIX, 5110, quadruple channel, 20 megahertz. Dual channel, 40 megahertz. $300. 360-262-9099 (Washington State).

6 MFD 3000VDC capacitors $10; HP 1980B scope w/2 plug-ins $300; HP 7035 XY recorder $50; HP 5325 counter $50; HP 400D VTVM $50; HP 180A scope $100. All plus shipping. SASE gets list. John Bartholomew, 519 Lower Terrace, Huntington, WV 25705. Phone 304-525-8793 E-Mail: PEHL52A@PRODIGY.COM

TEK-SALE: 1241 color logic analyzer $300; TM5006 frame $275; MI-5010 program. Multifunction interface $200 7A13 $135; 7A16A $40; 7A16P $75; 7A18 $50; 7A22 $100; 7A24 $125; 7A26 $53; 7B53A $64; 7B80 $70; 7B85 $75; 7B87 $125; 7B92A $125. 7D12 $100; 7D13 $100; 7D15 $250; DL-502 latch $50; DD-501 $85; DM-501 multimeter $100; 7S11 $150; PG-501 $125; SI-5010 $500; TM-503 frame $50; all with 30 day warranty; call **Psitech Plus** 707-745-4804 request bi-monthly fax listings Fax 707-747-5277, E-Mail: apeas@ix.netcom.com

TEK 577/D2/177 curve tracer $850 in good condition. **CUSHMAN CE-24** selective level meter 1KHz-3.2MHz, -80 to 20dBm input $150. **TEK 2236** 100MHz oscilloscope with built-in DMM and frequency counter $790. 10 day money back guarantee. For more great deals on test equipment please call 650-244-9438 or visit our web site: http://www.odulo.com/corp/equiptek

SELL: HP 141T, 8552A, 8553B, SPEC. ANA., $1,300; HP 141T, 8552B, 8554B, $1,800. HP 141T, 8552B, 8555A, $2,000; HP 8690B, $200; PLUG-INS CALL FOR LOW COST PLUG-INS; HP 5340A, $1,200; EIP 371 source locking counter, $1,200; HP 8683B signal generator, $2,500; HP 432A, 8478A, power meter, $450; Bird 4430, Thruline wattmeter and six slugs, $500; Clarostat 240C decade power resistor, $200; Cabletron TDR 5000 time domain reflectometer, $800; HP 11729B carrier noise test set; HP 1725A 265MHz dual ch. scope, $500; HP 7475A six pen plotter, $250; HP 7550A, 8 pen graphics plotter, $400, Matrix 3000 color graphics recorder, $1,000; HP 5423A structural dynamics analyzer, $4,000; HP 3575A phase meter, $800, HP 3437A system voltmeter, $400; A-Comm Electronics 303-290-8012 Sales@A-comm.com

CALIBRATORS: FLUKE 335A $425; FLUKE 515A $575; FLUKE 5100B $2,750; FLUKE 5100B/03/05 $3,250. AST GLOBAL ELECTRONICS. Voice: 1-888-216-7159; Fax: 814-398-1176; E-Mail: astmrktg@toolcity.net

OPTICAL IMPULSE GENERATOR (UNUSED) TEK OIG-502 $3,500. AST GLOBAL ELECTRONICS. Voice: 1-888-216-7159; Fax: 814-398-1176; E-Mail: astmrktg@toolcity.net

FLUKE 6071A-1000MHz signal generator, complete but not working units $850/ea.; HP 853A/8559A 21GHz spectrum analyzer $4,200; Safco SMRTSAM cellular 500T analyzer (new) $475; HP 8901B $3,800; Marconi 2957 $3,200; Tektronix OF150 OTDR $450; Fluke 6060A $2,400; Marconi 2022A $1,800; HP 8657A $4,200. http://www.madbbs.com/amtronix 716-763-9104, fax 716-763-0371.

EQUIPMENT SALE Hewlett Packard 1122A probe supply $75; 36037A repeater $75; 37203A HP-IB extender $65; 59308 timing generator $50; 59501A power supply programmer (as new) $60; 59401A HP-IB bus analyzer $200. 435A power meter $150; 5420A w/10920A digital signal analyzer $300; late model 8170A $300; 8740A transmission test set $175; 8742A reflection test set $200; 1630G logic analyzer with acc. $500; **Psitech Plus** 707-745-4804 request twice-monthly fax listings Fax 707-747-5277. E-Mail: apeas@ix.netcom.com

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VIDEO SALE! Phillips PM5565 waveform monitor $350; Tek 1480C $475; Tek 1485C $525. AST GLOBAL ELECTRONICS. Voice: 1-888-216-7159; Fax: 814-398-1176; E-Mail: astmrktg@toolcity.net

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SELL: TRACOR 599K, VLF tracking receiver, $500, Wavetek SAM I-450 signal analyzer, $500; C-COR 4329E wide band solid state amplifier 20dB, 10Hz-70MHz 250MW output, $150; HP 4328A milliohmmeter, $800; HP 3400A, true RMS meter, $300; Rockland 1022F dual filter, $300; Tektronix 1410 NTSC gen. with SP-G2; TSG-2, TSG-3, $800, HP 8660A, 86634A, 86603A, $3,000; Fluke 893A diff voltmeter, $200; Kepco 188-030 power supply 0-1000V, 20mA, $150; Hickok DP170 ohm meter and frame, $150; HP 428B current meter and probe, $300; power designs 1556C 0-6KV power supply, $600; A-Comm Electronics 303-290-8012, http://www.A-COMM.COM

AUDIO TEST EQUIPMENT: HP 339A distortion analyzer $1,600. **HP 3580A** 5Hz-50KHz, 1Hz RBW, adaptive sweep, tracking generator: $790 (mech), $1,250 (LED). **Tek 7L5/L3** spectrum analyzer plug-in, 20Hz-5MHz, 10Hz RBW $1,400; with tracking generator $1,900. **Audio Precision System One + DSP** (SYS-222G) dual generator/analyzer with DSP, MEM, GPIB $8,200. Excellent condition, with warranty. Pepper Systems, 214-353-0257 Fax 214-902-9511.

Write in 147 on Reader Service Card.

Write in 186 on Reader Service Card.

Write in 108 on Reader Service Card.

GOOD DEALS: HP 3455A $250; HP 3581C $100; HP 8015A $150; HP 8556A $150; HP 86601A $100; Bruel Kjaer 4145, 4134 microphones $150, $200 each. Call Jeff for list, 508-533-5944.

METER SPECIALS: FLUKE 893A $45; FLUKE 8000 3-1/2 DIGITS $75; FLUKE 8050A 4-1/2 DIGITS $145; FLUKE 8502A OPT 02/03/09 6-1/2 DIGIT $450; HP 3455 5-1/2 OR 6-1/2 DIGIT $325. AST GLOBAL ELECTRONICS. Voice: 1-888-216-7159; Fax: 814-398-1176; E-Mail: astmrktg@toolcity.net

TEST EQUIPMENT for sale/wanted: RF, Microwave, video and fiber optic. Broadcast TV, satellite and related industries. Wavetek, Tektronix, Hewlett Packard and other manufacturers. Spectrum analyzers, signal level meters, sweep systems, TDRs, OTDRs, and much more. PTL Cable Service. Phone 561-747-3647 FAX 561-575-4635.

WANTED HP 86603-60043 attenuator assembly or 86601/86602/86603 RF head with a good attenuator assembly. Amadeus Surplus 810-465-1844 evenings.

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POWER SUPPLIES, ETC.: HP 6237B triple output: 0-18V, 1A; 0-20V, .5A dual tracking $375. **HP 6253A** 0-20V, 3A dual tracking $325. **HP 6255A** 0-40V, 1.5A dual tracking $325. **HP 6443B** 0-120V, 2.5A $350. **Tek PS 503A** triple output $175. **Xentek** extreme isolation transformers for clean power: 5 KVA, 2.5 KVA, etc., starting at $150. Excellent condition, warranty. Pepper Systems, 214-353-0257 Fax 214-902-9511.

Events CALENDAR

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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Events Calendar
430 Princeland Court
Corona, CA 91719
Phone 909-371-8497
Fax 909-371-3052
E-mail events@nutsvolts.com

DECEMBER 1997

DECEMBER 6

AL - DOTHAN - Wiregrass ARC Hamfest. Mark Childre KE4OYU. 334-702-7406. Web: http://www.qsl.net/warc
AZ - MESA - Superstition ARC Hamfest. Gary Roberts AB7MX, 602-827-2195
CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
FL - OKEECHOBEE - ARC Hamfest. Al Berryman AD4RZ, 941-467-0516. E-Mail: ad4rz@juno.com
IL - JACKSONVILLE - Superfest. Jonathan Turner Jr. High School, 664 S. Lincoln Ave. 8am-2pm. Kaye Green KB9KHQ, 217-245-6778
LA - MINDEN - ARA Hamfest. Lowell A. "Dusty" Collins KB5WFE, 318-371-0636 dustyc@prysm.net
MI - LIVONIA - Super Computer Sale. Livonia Elks Lodge Hall. 31117 Plymouth Rd., 10am-3pm. Computers And You 313-283-1754
MN - GOLDEN VALLEY - Courage Handi Ham System Hamfest. Chris Peterson KG0PB, 612-520-0515
NC - GREENSBORO - Hamfest. Greensboro Coliseum Complex, 1921 W. Lee St. 910-851-1676
NH - SALEM - Computer Show. Rockingham Park Race Track. Northern Computer Shows 978-744-8440
NY - WHITE PLAINS - Computer Show. Westchester County Ctr. 9:30am-4pm. MarketPro 201-825-2229
OH - CLEVELAND - Computer Show. Cuyahoga Co. Fairgrounds. 10am-3pm. Peter Trapp Shows 603-272-5008. www.petertrapp.com

DECEMBER 6-7

CA - SACRAMENTO - Computer Show. Cal Expo. 10am-5pm. MarketPro 415-456-6730
NC - CHARLOTTE - Computer Show. Charlotte Merchandise Mart. 9:30am-4pm. MarketPro 201-825-2229

DECEMBER 7

CA - FULLERTON - Computer Show. Sequoia Conference Center. 1535 Deerpark Ave. Paul Martinez 619-295-1221
CA - LIVERMORE - Swapmeet. Las Positas College. Noel Anklam 510-447-3857
CA - SAN DIEGO - Computer Show. Scottish Rite Center. 10am-5pm. MarketPro 415-456-6730
MA - TAUNTON - Computer Show. Holiday Inn. Northern Computer Shows. 978-744-8440
MI - HAZEL PARK - ARC Swap & Shop. Hazel Park High School, 23400 Hughes St. 8am-2pm. Tom Austin N8TMQ. 810-293-7398
MI - SOUTHFIELD - Super Computer Sale. Southfield Pavilion, 26000 Evergreen. 10am-4pm. Computers And You 313-283-1754
NY - POUGHKEEPSIE - Computer Show. Mid-Hudson Civic Center. 9:30am-4pm. MarketPro 201-825-2229
OH - AKRON - Computer Show. Tadmor Shrine Temple. 10am-3pm. Peter Trapp Shows 603-272-5008. www.petertrapp.com

DECEMBER 12-13-14

MI - TAYLOR - Computer & Technology Show. Gibraltar Trade Center, 15525 Racho Rd. 313-287-2000

DECEMBER 13

CA - DALY CITY - Computer Show. Cow Palace, Gate #5, Geneva & Santos. Robert Austin Corp. 1-800-243-7041, Web: http://www.robertaustin.com
CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
CA - FRESNO - Computer Show. Fresno Fairgrounds. 10am-5pm. MarketPro 415-456-6730
FL - LAKE CITY - Hamfest & Computer Show. National Guard Armory. 8am-4pm. Colin Boutwell WA5RKR, 904-755-7969 1-800-752-7969. E-Mail: wa5rkr@isgroup.net
IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center. 3655 E. Raymond St. 10am-4pm. 317-299-8827. E-Mail: agi@surf-ici.com Web: http://www.surf-ici.com/agi
ME - PORTLAND - Computer Show. Portland Expo. Northern Computer Shows. 978-744-8440
NY - SYRACUSE - Computer Show. NY State Fairgrounds. 10am-5pm. Peter Trapp Shows 603-272-5008 www.petertrapp.com
SC - UNION - Hamfest. Union National Guard Armory. 8am-3pm. Roger Gregory KD4YFB. 864-427-1462

DECEMBER 14

CA - LANCASTER - Computer Show. Antelope Valley Frgnds. 10am-5pm. MarketPro 415-456-6730
CA - SAN DIEGO - Computer Show. Scottish Rite Ctr. Paul Martinez 619-295-1221 Fax 619-295-7726
CA - SANTA ROSA - Computer Show. Sonoma Co. Fairgrounds. 10am-5pm. MarketPro 415-456-6730
IN - KOKOMO - AGI Computer Fair. Ramada Inn, 1709 E. Lincoln. 10am-3pm. 317-299-8827. E-Mail: agi@surf-ici.com Web: http://www.surf-ici.com/agi
NH - DURHAM - Computer Show. Whitemore Arena UNH. Northern Computer Shows. 978-744-8440
NY - HEMPSTEAD - Computer Show. Best Western. 9:30am-4pm. MarketPro 201-825-2229

DECEMBER 20

CA - OAKLAND - Computer Show. Oakland Convention Center, Broadway @ 10th St. 1-800-243-7041 Web: http://www.robertaustin.com
CA - SACRAMENTO - Computer Show. Scottish Rite Center. 10am-5pm. MarketPro 415-456-6730
CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
MI - FLINT - Super Computer Sale. IMA Arena, 3501 Lapeer Rd. 10am-3pm. Computers And You 313-283-1754
NH - SEABROOK - Computer Show. Seabrook Greyhound Park. Northern Computer Shows. 978-744-8440
NY - BUFFALO - Computer Show. Hamburg Fairgrounds. 9:30am-4pm. MarketPro 201-825-2229
PA - YORK - Computer Show. York Fairgrounds, Old Main Bldg. 10am-3pm. Peter Trapp Shows 603-272-5008 www.petertrapp.com

DECEMBER 20-21

CA - VENTURA - Computer Show. Ventura Fairgrounds. 10am-5pm. MarketPro 415-456-6730
GA - KENNESAW - Computer Show. Outlet Mall, I-75 @ Exit 117. Georgia Mountain Productions 706-838-4827
NY - STONY BROOK - Computer Show. SUNY Stony Brook. 9:30am-4pm. MarketPro 201-825-2229

DECEMBER 21

CA - RICHMOND - Computer Show. Memorial Auditorium. 10am-5pm. MarketPro 415-456-6730
CA - STOCKTON - Computer Show. Civic Auditorium. 10am-5pm. MarketPro 415-456-6730
MI - DEARBORN - Super Computer Sale. Dearborn Civic Center, 15801 Michigan Ave. 10am-4pm. Computers And You 313-283-1754
MI - FLINT - Computer Show. Holiday Inn, Gateway Centre, US 23 @ Hill Rd. Exit. Five Star Productions 810-890-0988
NY - ROCHESTER - Computer Show. The Dome Center. 9:30am-4pm. MarketPro 201-825-2229
PA- BETHLEHAM - Computer Show. Stabler Arena, Lehigh Univ. 10am-4pm. Peter Trapp Shows 603-272-5008. www.petertrapp.com

DECEMBER 26-27-28

MI - MT. CLEMENS - Computer & Technology Show. Gibraltar Trade Center, 237 N. River Rd. 810-465-6440

DECEMBER 26

MA - ROCKLAND - Computer Show. Sons of Italy Hall. Northern Computer Shows. 978-744-8440

DECEMBER 27

CA - BAKERSFIELD - Computer Show. Kern Co. Fairgrounds. 10am-5pm. MarketPro 415-456-6730
MI - TAYLOR - Super Computer Sale. Democratic Club Hall, 23400 Wick Rd. 10am-3pm. Computers And You 313-283-1754
NH - MANCHESTER - Computer Show. Center of NH Expo. Northern Computer Shows. 978-744-8440

DECEMBER 27-28

CA - SAN DIEGO - Computer Show. Scottish Rite Center. 10am-5pm. MarketPro 415-456-6730
CA - VALLEJO - Computer Show. Solano Co. Fairgrounds. 10am-5pm. MarketPro 415-456-6730
NJ - PARSIPPANY - Computer Show. Parsippany Hilton. 9:30am-4pm. MarketPro 201-825-2229
OH - AKRON - Computer Show. Summit Co. Frgnds, Tallmadge. Sat: 10am-4pm, Sun: 10am-3pm. Peter Trapp Shows 603-272-5008. www.petertrapp.com

DECEMBER 28

MI - MADISON HEIGHTS - Super Computer Sale. UF&CW Hall, 876 Horace Brown Dr. 10am-4pm. Computers And You 313-283-1754
NH - WORCESTER - Computer Show. Worcester's Centrum Centre. Northern Computer Shows. 978-744-8440

JANUARY 1998

JANUARY 2-3-4

MN - ROCHESTER - Super Computer Sale. Mayo Civic Center. Blue Star Productions 612-788-1901. Web: http://www.supercomputersale.com

JANUARY 3-4

FL - FT. MYERS - ARC Hamfest. Colleen Sammons KQ4TR. 941-936-1431. E-Mail: csammons@juno.com

JANUARY 3

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
MI - LIVONIA - Super Computer Sale. Livonia Elks Lodge Hall, 31117 Plymouth Rd. 10am-3pm. Computers And You 313-283-1754
NH - NASHUA - Computer Show. Sheraton Tara Hotel. Northern Computer Shows. 978-744-8440
TN - MORRISTOWN - Lakeway ARC Hamfest. Perry Hensley N4PH, 423-828-4848

JANUARY 4

CA - LIVERMORE - Swapmeet. Las Positas College. Noel Anklam 510-447-3857
IN - SOUTH BEND - Hamfest and Computer Expo. The Century Center. Bob Denniston KA9WNR. 219-291-0252
MA - HYANNIS - Computer Show. Tara Hyannis Hotel. Northern Computer Shows. 978-744-8440
MI - SOUTHGATE - Super Computer Sale. Crystal Gardens, 16703 Fort St. 10am-4pm. Computers And You 313-283-1754

JANUARY 9-10-11

WI - LA CROSSE - Super Computer Sale. La Crosse Civic Center. Blue Star Productions 612-788-1901. Web: http://www.supercomputersale.com

JANUARY 10

AZ - GLENDALE - WestFest Hamfest. Glendale Community College, 6000 W. Olive. Mark Fellhauer KC7BXS, 602-931-1204. sparkfel@primenet.com
CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
CO - LOVELAND - ARC Superfest. Larimer County Fairgrounds. 700 Railroad Ave. 9am-3pm. 970-352-5304
IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center. 3655 E. Raymond St. 10am-4pm. 317-299-8827. E-Mail: agi@surf-ici.com Web: http://www.surf-ici.com/agi
NE - KEARNEY - Midway ARC Hamfest. Jerry Ramsey W0PXD, 308-237-7539
NY - MARATHON - Skyline ARC Hamfest. Barbara Mudge KB2TIK, 607-849-6751

JANUARY 11

IN - NOBLESVILLE - AGI Computer Fair. Hamilton Co. Fairgrounds, 2003 E. Pleasant. 10am-3pm. 317-299-8827. E-Mail: agi@surf-ici.com Web: http://www.surf-ici.com/agi
WI - WAUKESHA - West Allis RAC Hamfest. Phil Gural W9NAW, 414-425-3649

JANUARY 16-17-18

MN - SHAKOPEE - Super Computer Sale. Canterbury Park. 1100 Canterbury Rd. Blue Star Productions 612-788-1901. Web: http://www.supercomputersale.com

JANUARY 17

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
LA - HAMMOND - S.E. LA ARC Hamfest. Jack Stang N5XVJ. 504-542-7605.
MO - ST. JOSEPH - Hamfest. Ramada Inn. 9am-4pm. Jean Pearson KC0GB, PO Box 8547, St. Joseph, MO 64508

JANUARY 18

FL - ST. PETERSBURG - Hamfest. Jean Endicott KC4KZU. 813-525-5178
NY - YONKERS - Flea Market. Lincoln High School. Kneeland Ave. 9am-3pm. Otto Supliski WB2SLQ, 914-969-1053
OH - NELSONVILLE - Sunday Creek AR Federation Hamfest. Russell Ellis N8MWK, 614-767-2226
VA - RICHMOND - Frostfest. The Showplace, 3000 Mechanicsville Tpke. 8:30am-3:30pm. 804-739-2269. E-Mail: frostfest@rats.net Web: http://www.frostfest.rats.net

JANUARY 23-24-25

KS - WICHITA - Super Computer Sale. Century 2 Conv. Ctr. 225 W. Douglas. Blue Star Productions 612-788-1901. Web: http://www.supercomputersale.com

JANUARY 24

MO - ST. CHARLES - St. Louis Repeater Hamfest. James E. Welby WB0ZJW. 6059 Sutherland, St. Louis, MO 63109-2247
TN - GALLATIN - Hamfest & Computer Show. Gallatin Civic Center. 8am-2pm. TN Valley Amateur Radio Network. Bill Ferrell N4SSB, 615-451-5992

JANUARY 25

CA - SANTA ANA - Swapmeet. ACP parking lot. Mary Russo 714-558-8813
IL - VILLA PARK - Wheaton Community Radio Amateurs Hamfest. Don Motz N9NYX, 630-665-7757. E-Mail: donlin@xnet.com
MD - ODENTON - Hamfest. Odenton Vol. Fire Dept. Hall, 1425 Annapolis Rd. Bill Ziegler KA6TYY. 410-987-2384. E-Mail: ka6tyy@juno.com
OH - DOVER - Hamfest. OH Nat'l Guard Armory, 2800 No. Wooster Ave. 8am-1pm. Howard Blind KD8KF. 330-364-5258

JANUARY 30-31-FEBRUARY 1

WI - MADISON - Super Computer Sale. Dane Co. Expo Center. 1881 Expo Hall E., Blue Star Productions. 612-788-1901. Web: http://www.supercomputersale.com

JANUARY 31

AL - GREENVILLE - RACES Hamfest. Bob W4MPQ. E-Mail: w4mpq@alaweb.com

FEBRUARY 1998

FEBRUARY 1

CA - LIVERMORE - Swapmeet. Las Positas College. Noel Anklam 510-447-3857

FEBRUARY 2

AZ - SUN CITY - Amateur radio equipment auction. St. Clement Social Hall, 15800 Del Webb Blvd. 7pm. George N7JSA, 602-933-0854. E-Mail: watgl@juno.com

FEBRUARY 6-7-8

IL - PEORIA - Super Computer Sale. Peoria Civic Center. 201 S.W. Jefferson St. Blue Star Productions 612-788-1901. Web: http://www.supercomputersale.com

FEBRUARY 7

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
SC - NORTH CHARLESTON - ARS Hamfest. Jenny Myers WA4NGV, 803-747-2324. E-Mail: WA4USN@amsat.org

FEBRUARY 7-8

FL - MIAMI - Hamboree. Dade Co. Fair & Expo Center, SW 112th Ave. & Coral Way. Evelyn 305-642-4139. E-Mail: edg@elink.net Web: http:// hamboree.org
MO - ST. CHARLES - Computer Show & Sale. St. Charles Exposition Hall, St. Charles Center, I-70 & 5th St. Sat: 10am-4pm, Sun: 11am-3pm. Computer Central Shows 888-296-6066. E-Mail: computershow.chicago@mcimail.com
MS - JACKSON - State Convention. Ron Brown AB5WF, 601-956-1448, 601-982-0101. E-Mail: ab5wf@juno.com

FEBRUARY 8

OH - MANSFIELD - Mid*Winter hamfest. Richland Co. Fairgrounds. Pat Ackerman N8YOB, 419-589-7133 eves.
PA - LATROBE - Hamfest & computer show. American Legion, 1811 Ligonier St. 8am-3pm. Andrew Michalovicz KE3YU, 412-539-0468. Chris Weiss K3JDU, 412-537-6068

FEBRUARY 13-14-15

IN - INDIANAPOLIS - IN Convention RCA Dome. 100 S. Capital. Blue Star Productions 612-788-1901. Web: http://www.supercomputersale.com
FL - ORLANDO - Northern FL Section Convention. Tim Starr AE4NJ, 407-850-9258. E-Mail: AE4NJ@AOL.COM Web: http://www.oarc.org

FEBRUARY 14

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
MA - MARLBOROUGH - Flea Market. Middle School. 10am-2pm. Ann Weldon 508-481-4988
MN - BLAINE - Ham and computer show. National Sports Center. 7:30am-3pm. Susan Baker N0JND, 612-537-1722

FEBRUARY 15

IL - ROCK ISLAND - Hamfest & Computer Show. QCCA Expo Center, 2621 4th Ave. Kent Williams K9UQI, 309-796-0718. E-Mail: k9uqi@arcsupport.com

FEBRUARY 20-21-22

KS - KANSAS CITY - Super Computer Sale. Overland Park Trade Ctr. 6800 W. 115th St. Blue Star Productions. 612-788-1901. Web: http://www.supercomputersale.com

FEBRUARY 21

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
NC - ELKIN - Briarpatch and Foothills ARCs Hamfest. Jimmy Holbrook KB4GKI, 910-957-3820. E-Mail: jholbro363@aol.com
OR - RICKREALL - Hamfair. Polk Co. Fairgrounds. 9am-3:30pm. Evan Burroughs N7IFJ, 503-585-5924

FEBRUARY 21-22

IN - INDIANAPOLIS - AGI Computer Fair. National Guard Armory, 3912 W. Minnesota. 10am-5pm. 317-299-8827. E-Mail: agi@surf-ici.com Web: http://www.surf-ici.com/agi
OH - CINCINNATI - Great Lakes Div. Convention. Cincinnati Gardens Exhibition Center, 2250 Seymour Ave. 8:30am-5pm. Bill Tittle KA8LAY, 513-661-1805. E-Mail: BOBGARFIELD@JUNO.COM

FEBRUARY 22

MI - DEARBORN - Swap 'n Shop. Civic Center. 8am-3pm. 313-261-5486. Web: www.larc.mi.org
OH - CUYAHOGA FALLS - Hamfest. Emidio's Party Ctr., 48 Bath Rd. 8am-2pm. Dan Adkinson KC8CFJ, 330-923-9045. hamfest@neo.lrun.com
PA - PITTSBURGH - South Hills ARC Hamfest. Steve Lane N3RNY, 412-341-1043. E-Mail: slane@sgi.net
WV - FAYETTEVILLE - Plateau ARA Hamfest. Richard M. Roy KB8SMC, 304-469-3292, 304-465-1911

FEBRUARY 27-28-29

CO - DENVER - Super Computer Sale. National Western Complex. 4655 Humboldt St. Blue Star Productions 612-788-1901. Web: http://www.supercomputersale.com

MARCH 1998

MARCH 1

CA - LIVERMORE - Swapmeet. Las Positas College. Noel Anklam 510-447-3857

MARCH 6-7-8

NE - NORFOLK - Nebraska State Convention. Fred Wiebelhaus N0VLX. 402-379-1929

MARCH 7-8

NC - CHARLOTTE - Mecklenburg ARS Hamfest. Tim Slay WO4G, 704-948-7373. http://www.w4bfb.org

MARCH 7

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
NJ - PARSIPPANY - Split Rock ARA Hamfest. Mark Turner KB2VKO, 973-347-3195. E-Mail: mlturner@bellatlantic.net Web: http://home.hsix.com/sara/hamfest.html

MARCH 8

IN - INDIANAPOLIS - Morgan Co. Repeater Assn. Hamfest. Brian Elliott N9JPX, 317-342-7236. E-Mail: belliott@surf-ici.com
NY - LINDENHURST - Hamfest. Walter Wenzel KA2RGI, 516-457-0218. E-Mail: Tom Carrubba: ka2d@li.net Web: http://www.li.net/~tom car/hamfest.htm
OH - CONNEAUT - ARC Hamfest. Clarence Baugher W8FAS, 440-593-3038
WI - WAUKESHA - SEWFARS ARC Hamfest. Mary J. Adams KB9IFF, 414-358-1003. E-Mail: mjadams@execpc.com

MARCH 13-14-15

NE - OMAHA - Super Computer Sale. Omaha Civic Auditorium. 1804 Capital Ave. Blue Star Productions 612-788-1901. Web: http://www.supercomputersale.com

MARCH 14

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
FL - SEBRING - Highlands Co. ARC Hamfest. Dennis Koranda KF4JTM. 941-382-9560. E-Mail: kf40stra to.net Web: http://www.strato.net/~hamradio/
MO - KANSAS CITY - Ararat Shrine ARC Hamfest. Steve Dowdy WJ0I, 816-941-0620

MARCH 14-15

TX - MIDLAND - West TX State Conv. Beverley Harwood KC5BNT, 915-686-1841. E-Mail: sham rock@apex2000.net

MARCH 15

IL - STERLING - Hamfest. High School Field House, 1608 4th Ave. Lloyd Sherman KB9APW, 815-336-2434. E-Mail: lsherman@essexl.com
OH - MAUMEE - Toledo Mobile Radio Assn. Hamfest. Brenda Krukowski KB8IUP. 419-866-5928
WV - CHARLESTON - Hamfest & Computer Show. Jimmie Hewlett WD8MKS, 304-768-9788

MARCH 20-21-22

FL - FT. WALTON BEACH - Playground ARC Hamfest. Clyde Gowdy KE4FLC, 850-314-3337. E-Mail: parcfest@aol.com
WI - WEST ALLIS - Super Computer Sale. WI State Fairgrounds. 8100 W. Greenfield Ave. Blue Star Productions 612-788-1901. Web: http://www.supercomputersale.com

MARCH 21

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

MARCH 22

NC - KINSTON - Down East Hamfest. Doug Burt W4OFO. 919-524-5724
NY - YONKERS - Westchester Emergency Comm. Assn. Hamfest. Thomas Raffaelli WB2NHC, 914-741-6606

MARCH 28

KY - ELIZABETHTOWN - Lincoln Trail ARC Hamfest. Harold Bennett AF4AC. 502-351-9599. E-Mail: hbennett@bbtel.com
OR - EUGENE - Hamfest. John Brambora KB7SXS. 541-747-2898

MARCH 28-29

MD - TIMONIUM - Maryland State Convention. William Dobson N3WD. 410-HAM-FEST. E-Mail: gbhc@concentric.net Web: http://www.concentric.net/~gbhc

MARCH 29

CA - SANTA ANA - Swapmeet. ACP parking lot. Mary Russo 714-558-8813
IL - TAYLORVILLE - Christian County Hamfest. David E. Nation, Sr. KA9JHW, 214-824-3707. E-Mail: ka9jhw@mindless.com

APRIL 1998

APRIL 4

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
NC - MORGANTON - Catawba Valley Hamfest and Computer Fair. Thomas Taylor KC4QPR. 704-433-6205. E-Mail: kc4qpr@vistatech.net
PA - FREDERICKSBURG - Appalachian AR Group Hamfest. Paul Felty WB3HEC. 717-566-2606
WA - VANCOUVER - Clark Co. Hamfest. Luther Brisky KC7KVL. 360-896-8909

APRIL 5

IA - DELOIT - Denison Repeater Assn. Hamfest. John Amdor KD6MXL. 712-748-8162. E-Mail: john mxl@netins.net Web: http://www.netins.net/showcase/johnmxl/deloit98. html
NC - RALEIGH - North Carolina State Convention. Wilbur Goss WD4RDT. 919-266-9335
WI - MADISON - Madison Area Repeater Assn. Hamfest. Jeremy Charles N9VHT. 608-245-8890

APRIL 10-11

MS - TUPELO - Tupelo, Booneville and Union Co. ARCs Hamfest. Jack Ellis KI5QV. 601-842-7255

APRIL 11

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
OK - LAWTON - Lawton Ft. Sill ARC Hamfest. Bob Morford KA5YED, 405-355-6120, 405-353-8074

APRIL 18

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
MO - JOPLIN - ARC Hamfest. Andy Gabbert KA0TUD. 417-673-8371. E-Mail: agabbertka0tud@hotmail.com

APRIL 18-19

AL - BIRMINGHAM - Southeastern Div. Conv. Bill Levey WA4FAT, 205-97-0622. E-Mail: barc@bro.net Web: http://bro.net/barc

APRIL 19

MA - CAMBRIDGE - Flea Market. Kendall Square area. MIT. Nick Alternbernd KA1MQX, 617-253-3776

APRIL 24-25

AR - LITTLE ROCK - Hamfest. Jim Blackmon KB5IFV. 501-246-6736. E-Mail: 1rhamfest@usa.net Web: http://www.aristotle.net/~n5xay/lrh98.html

APRIL 25

IA - DES MOINES - RAA Hamfest. Ron Hobbs N0XWI. 515-255-4020
OR - KLAMATH FALLS - Keno ARC Hamfest. Tom Hamilton WD6EAW. 541-883-2736. E-Mail: wjonesjr@cdsnet.net Web: http://home.cdsnet.net/~wjonesjr/kenoarc.htm
PA - BLOOMSBURG - Columbia-Montour ARC Hamfest. Dave Schack WC3A. 717-752-6851

MAY 1998

MAY 2

AZ - SIERRA VISTA - Hamfest. Ronald Slominski KC7QXJ. 520-378-3018
CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
KY - OWENSBORO - ARC Hamfest. George Stokes KD4CKT, 502-683-2169. E-Mail: w4nho@occ-uky.campus.mci.net

MAY 3

MD - HAGERSTOWN - Antietam Radio Assn. Hamfest. Donald Jones KB8WHW. 304-728-7769. E-Mail: kb8zqm@intrepid.net
NY - YONKERS - Flea Market. Lincoln High School. Kneeland Ave. 9am-3pm. Otto Supliski WB2SLQ. 914-969-1053
PA - WRIGHTSTOWN - Warminster ARC Hamfest. Tony Simek N3YNH, 215-674-5218
WV - RIPLEY - Jackson Co. ARC Hamfest. Gary Casto AG8RY, 304-372-2849

MAY 8-9

NH - ROCHESTER - HOSSTRADERS Hamfest. Joe Demaso K1RQG. 207-469-3492. E-Mail: k1rqg@aol.com

Continued on page 97

TEST EQUIPMENT *cont.*

DESOLDERING STATIONS: Hakko $225, Pace MP-1 $300, MBT101 $300, MBT200 $375, older Pace $200, Ungar 4924 $450, Weller DS1000 $300, Hart 200A $800. Soldering stations: Weller $50-$150, Hexacon $45. Jim 310-515-2058.

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TEST EQUIPMENT *cont.*

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WANTED: USED TEST EQUIPMENT. CONTACT: AST GLOBAL ELECTRONICS, 24529 State Highway 408, Cambridge Springs, PA 16403. Voice: 1-888-216-7159; Fax: 814-398-1176; E-Mail: astmrktg@toolcity.net

TEXSCAN VSM-2C portable spectrum analyzer, 4-1,000MHz, 12VDC operation, very clean, $475. Precision 505-988-5233, E-Mail: jbau@dsrt.com

POCKET TESTBENCH - Handheld, inexpensive, RS232 virtual instrument. Digital, analog, serial protocol displays. High-speed counting. Sinewave, squarewave, PWM, binary outputs. Oricom Technologies, 303-444-9776, www.sni.net/~oricom

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BIM-4XX-F................ $87.36

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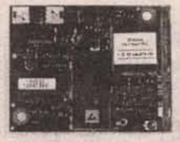

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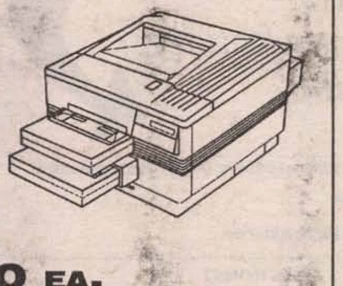

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The brand new Raytheon radar has an impressive LCD high-contrast screen.

BOATERS SEE BIG IMPROVEMENTS IN RADARS

by Gordon West

Slotted waveguide antennas offer increased resolution to a cluster of small targets.

The first radar was developed in the mid-20s by the British. The British were bouncing very high frequency waves into the ionosphere and then measuring the time delay of the echo. Since the velocity of radio waves is approximately 300 million meters per second (the same as the speed of light), the British could determine the height of the ionosphere by timing the echo.

A radio wave will travel one nautical mile every 6.2 microseconds. When they measured a layer of the ionosphere up 100 miles, the time delay was 1,240 microseconds. This works out to be 620 microseconds up, and 620 microseconds back, for a total of 1,240 microseconds of up-and-back journey.

In the 30s, the British developed a shore-based radar that was able to detect aircraft in flight. They found signals in the VHF and UHF spectrum suitable for this purpose with up to 60 miles detection range possible. Although crude — massive and lacking the high degree of accuracy desired — this early VHF/UHF radar system was the foundation of early warning that later made a decisive contribution in winning the Battle of Britain in 1940.

The term RADAR stands for RAdio Detection And Ranging.

In the 40s, British scientists Boot and Randall at Birmingham University successfully operated the first resonant cavity magnatron which generated high-powered microwave signals near 10,000 MHz which had such a short wavelength, that aiming them and concentrating them into a tight beam was easily possible with a relatively small parabolic reflector antenna.

After the war, early microwave radar equipment began to show up in war surplus stores, and were quickly scooped up by commercial boaters who wanted to be able to see what was happening out there ahead of them in the fog. The early radar A-SCOPES would show an oscilloscope-type readout with a horizontal line representing zero time delay to time delays up to 20 miles. The rotatable antenna was usually left in the forward position, and the mariner would peer at the scope and look for telltale "blips" that indicated something ahead that was reflecting the radar wave back a few microseconds later.

While this type of one-direction radar worked okay for boaters, it wasn't until the planned position indicator came along that radar really became a hit out on the water.

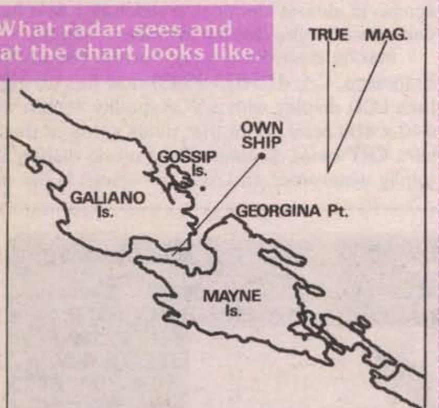
Some of the very first planned position indicating radars were from Decca, and two of the first inexpensive marine radars on the market were the Decca 101 and Decca 202. These radars offered up to 20-mile omnidirectional coverage at X-band frequencies 9415 MHz - 9475 MHz, 3.2 cm wavelength.

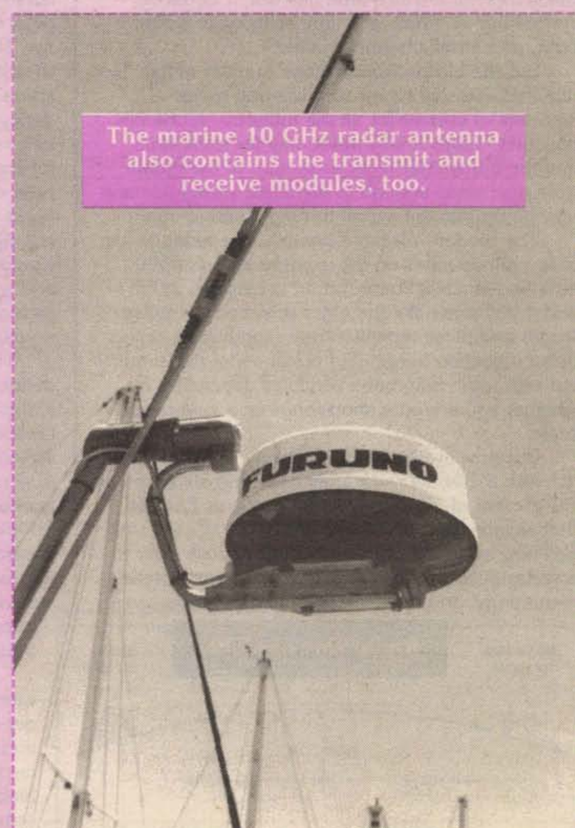
The antenna was an end-fed slotted waveguide array, four feet in length, and revolving at 24 revolutions per minute. This relatively small four-foot antenna offered a tight two-degree horizontal beam width (at -3 dB points half power), with side lobes down at least 23 dB. The vertical beam width was a comfortable 27 degrees which would allow the radar to work quite nicely on a small boat that might be pitching or rolling in moderate seas.

Transmitter power output was 3 KW peak power, with .1 microsecond nominal pulse length with a pulse repetition rate of 1,000 pulses per second.

The six-inch cathode ray tube for the earlier radars was similar to the construction of oscilloscope tubes — a phosphorous screen which would show a black background, and a relatively bright

What radar sees and what the chart looks like.

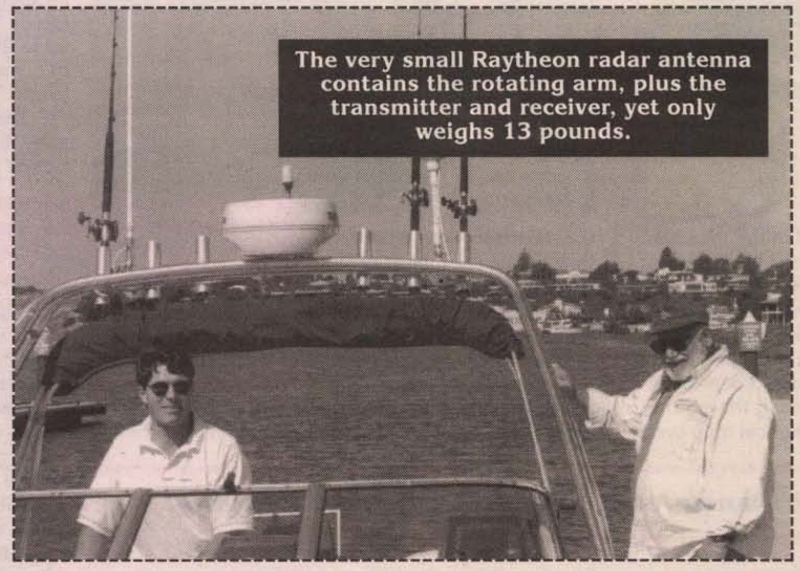




The marine 10 GHz radar antenna also contains the transmit and receive modules, too.

The radar transponder to improve target size on the screen.

Some X band antennas use slotted waveguides. Others use a printed circuit board (front right).



The very small Raytheon radar antenna contains the rotating arm, plus the transmitter and receiver, yet only weighs 13 pounds.

orange indication of echoes, as well as the orange straight-line sweep indicating the position of the antenna.

When echoes were received, they would be classified as "targets," going back to the early days of early warning radar in Britain. We still use the term "targets" today.

The phosphorous scope where the boat showed up in the center was called a planned position indicator. It indicated both target bearing, as well as target distance. And you could judge the size of the target by the intensity of the phosphorous target indication on the scope. If it was a big fat blob, chances are you were looking at a big steel-hulled vessel a few miles away. If it was a little tiny dot, it could be something as small as a little sailboat or power boat, or a small channel marker.

But the big phosphor scope in older radars required massive power supplies and major amounts of current for all the tubes inside the display unit. Tubes finally made way for transistors, and the transmitter receiver section of the radars were now small enough to eliminate waveguide and now go up into the actual turning antenna unit.

The modern pleasure boat marine radar of today still operates on those same X-band 9500 MHz frequencies. Power output is between 2,000 and 4,000 watts like the older sets, and the pulse length and pulse repetition rate (sometimes called pulse repetition frequency) is still about the same, but with more automatic variables depending on whether you are on a short-range or a long-range scale.

But now everything is relatively "battery friendly," with a 24-mile radar only requiring six amps of DC current at 12 volts, and an antenna T/R unit that weighs less than 50 pounds. The display unit has now switched from a phosphor scope over to a rectangular cathode ray tube using raster scan technology, and echo strength can be displayed either as bigger blob monochrome targets, or even color-coded targets with color CRTs available.

The switch from the old phosphor screen over to raster scan went almost unnoticed except for some old-time radar experts that liked the slow decay qualities of the old phosphor screen. The new raster scan displays needed small and powerful computer circuits to quantify the level of brightness of the displayed echoes. Four levels of display intensity were good, but eight were better. Small targets would show up as one tiny pixel, and a large target could consume as many as eight pixels in their relationship to the returned echo.

The capability of a CRT to define small targets with high resolution is dependent on their horizontal and vertical pixel capabilities. A 15-inch cathode ray tube radar display could provide as many as 480 horizontal and 640 vertical pixels, for a total of 307,200 pixels which is considered quite detailed and approaching the capabilities of what we originally had with an older phosphor screen which was not bound by pixel counts.

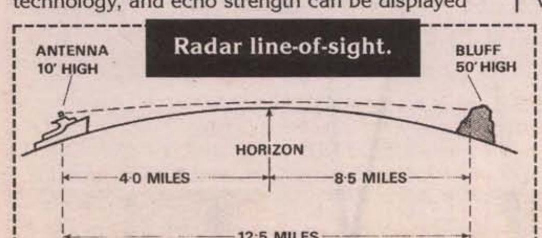
Most small boat radars feature either a green or orange target display, along with range rings and the heading mark plus cursor, all indicated over a black background. The raster scan display had a much better "look" when it came to nice sharp definitions over the older phosphor display, yet the older phosphor displays could still show some extremely small targets that the bigger raster scan display might consider as false echoes, and ignore.

About five years ago, a company called Apelco introduced a small boat marine radar with a liquid crystal display. It was an amazing performer, yet many radar "experts" felt that the LCD display could never have near the resolution as a CRT. And there were several years that a few pleasure boat marine radar manufacturers dabbled in LCD radar displays, only to find the review of their products mixed by boaters who had tried them in the sunlight, liked them at first, and then found that the display ultimately began to turn black as the sunlight heated up the LCD plate.

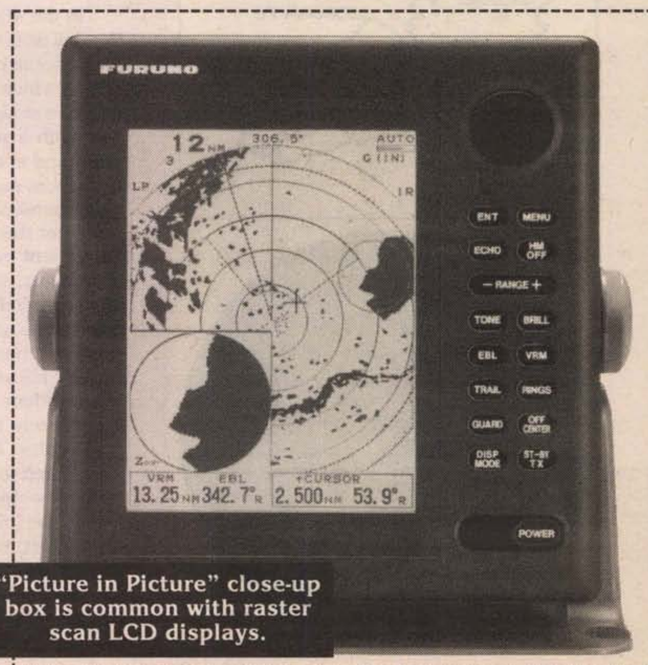
But one thing for sure — the LCD did a lot better job in the sunlight than the green or amber cathode ray tube. The CRT display had no place in the sun at all.

As LCD technology continued to produce improved plates that were much more tolerant to high temperatures, pixel counts on the LCD display plates for radars began to grow. You can now find a small six-inch diagonal screen using LCD technology to resolve 240 horizontal by 320 vertical pixels. The eight-inch LCD can show 480 horizontal by 640 vertical dots, for a total of 307,200 pixels, and the screen is almost identical in resolution to a larger cathode ray tube display for radar imaging.

Marine electronics giant Furuno (South San Francisco, CA; 415-873-9393) now has an eight-inch LCD display with a VGA-quality screen with 640 x 480 pixel count that rivals some of their present CRT radar displays. The Furuno display is totally waterproof and may be viewed in the direct



Radar line-of-sight.



"Picture in Picture" close-up box is common with raster scan LCD displays.

sunlight without turning dark. Furuno has also introduced an open-array antenna with this LCD display where other manufacturers were only offering a smaller antenna inside a radome.

The Furuno 41-inch rotating antenna has 4 KW of power driving it, and a 48 nautical mile range that allows you to see distant headlands, and plenty of power for the small commercial lobster boat to see his floating traps up to one-half mile away out on flat water.

Most pleasure boat radars operate between 2,000 watts and 4,000 watts output, so mariners are advised never to stand directly in line with the rotating antenna. Approximately five feet away is the recommended close-in safe distance. If the radar is well above their heads, all the better.

Radar range is line-of-sight to the horizon and objects beyond the ocean horizon. The calculations 1.22h allows you to calculate the radar horizon; h = the height of the radar antenna above the water. But you can do this in your head by simply taking the height of the radar antenna and figuring the square root for a distance to the horizon.

If the antenna is up 36 feet, it will see about six miles to the distant waves at the edge of the radar horizon. If a land mass is 500 feet tall, the square root of 500 is about 22 miles. Add 22 miles to the six miles of range you have to the horizon, and you have a total effective range to that distant land mass of just under 30 miles. If the radar you are using has a 24-mile range, you should begin to see the land show up at the maximum of its range.

But if you're running radar to stay away from other small boats, you could get as close as two or three miles to that other boat before it would show up on the screen. And when you run radar and look for breakwaters, the irregular rocks will many times scatter the signal, so you won't see the complete line of rocks on your radar scope until you are about three miles away.

On calm days, a properly running pleasure boat marine radar should be able to pick up big birds sitting on the water. I have even seen turtles floating in the water at about 1/8th of a mile away on radar in flat seas. But when the seas get rough, wave return will cause "popcorn" on the screen, and any small echoes will now blend in with all of the interference, and you won't know what is wave return from something really out there.

Radar reflectors will dramatically help return as much radar energy as possible as an echo because of the 90-degree corners. Small boats should always fly a radar reflector to intensify their signal on another radar scope.

The United States Coast Guard runs radar transponders on certain harbor approach buoys and bridges. These are known as RACONs, and they show up as an intensified target with Morse Code dots and dashes emanating out from the target for positive ID. Mariners would look on their marine charts and identify the Morse Code seen on the screen with a specific RACON listed with that same Morse Code identifier. But the radar must be in the full sensitivity mode with all interference filters turned off in order to get this special radar echo.

Another type of radar transponders found out on the water are called search and rescue transponders (SART). When these transponders sense radar X-band reception, they intensify their own target echo with the transmitted signal along with a series of dots emanating out from the SART activation. The SART is intended for man-overboard or sinking situations where rescue boats are trying to home in on faint targets seen on the radar scope. The telltale sign of SART reception would be the six dots seen going away from the actual radar target on the screen.

And brand new for the boating community is the active radar intensifier transponder called RTE (radar target enhancer). This European device is manufactured by McMurdo (Portsmouth, Hampshire, United Kingdom; 44(0)1705 775044). It operates between 9300 and 9500 MHz X-band radar frequencies, and has a typical conversion gain of 58 dB with a radiated power output of .8 watts typical. This device electronically amplifies the radar echo, thus imitating a much larger vessel. When compared to a passive radar reflector, this radar transponder may sometimes lead to reception range of up to 10 miles, whereas the reflector might only be seen up to five miles.

The device consists of an antenna unit that goes atop a sailboat or power boat antenna or mast, and an indicator unit which sounds off when radar activity is detected within 10 miles or more. Or less. You know when this unit detects radar because it automatically swings onto the transponder mode.

Many major harbors in the United States are also served by the radar vessel traffic system. Shore-based radars will monitor the shipping activity around a busy port, and will announce ship movements over the VHF marine channels, usually Channels 12 or 14. If the vessel traffic system detects an impending collision, it will closely watch their radar screens while guiding commercial shipping onto a safer course. Recreational vessels are encouraged to tune into the vessel traffic system frequencies, too.

Although mariners don't have the sophisticated transponders that private pilots now have, it appears that marine radar and marine radar systems are getting more sophisticated for the water. It's long overdue, and radar is certainly one way to find out what's happening all around you when the fog sets in, and visibility drops to zero zero. **NV**

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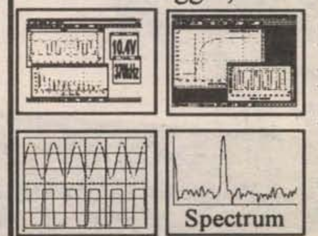

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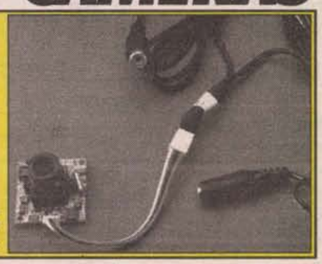

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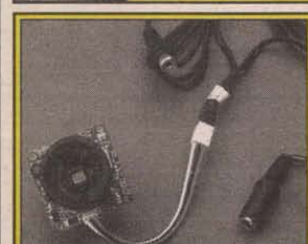

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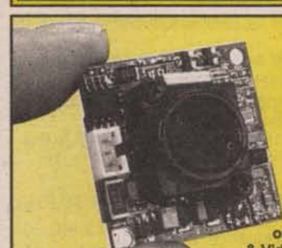

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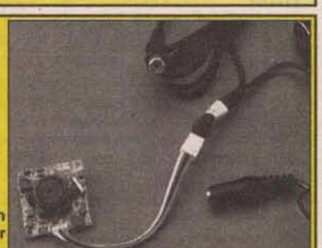

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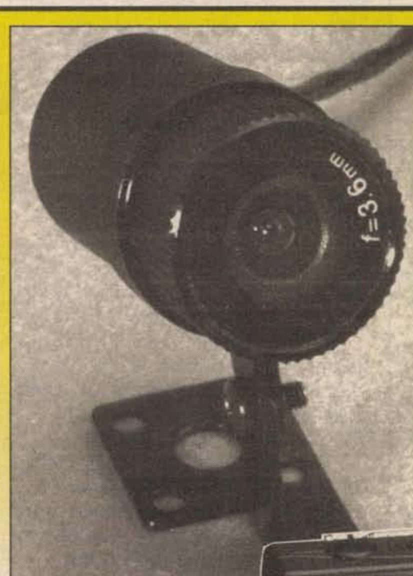

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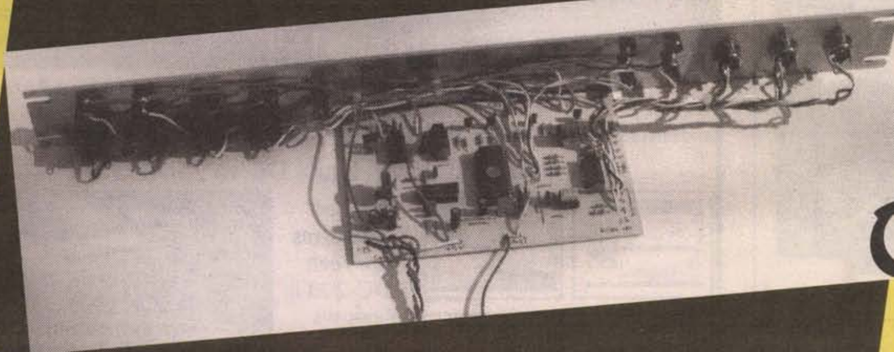

Build Your Own MIDI-to-Synthesizer Interface

Flip through any music or recording magazine and you'll find constant reference to the fact that we're in the midst of an analog synthesizer revival. Indeed, more and more musicians are dusting off their favorite instruments of yesteryear and hauling them into the studio or onto the stage again.

The claim is that these old analog synthesizers have a richer and warmer sound than their modern digital counterparts. The only trouble, though, is that analog units are voltage-controlled, whereas virtually all modern recording and performing equipment is MIDI based.

MIDI is a standard protocol that permits the interconnection of a broad range of musical devices, and then lets them communicate with each other via a digital bit stream.

Well, don't give up on your analog synthesizer just yet, for here's the MTS-100! The MTS-100 is an inexpensive monophonic MIDI-to-Synthesizer interface which lets you add digital control. With it, it's a snap to connect a modern music keyboard or a personal computer running sequencer software to your dinosaur.

The MIDI messages coming down the pike are converted to standard control voltage, gate and trigger formats, perfect for taming most older equipment. And just check out these features:

- MIDI IN and THRU jacks
- 1V/octave control voltage output
- Pitch bend (pitch wheel) control voltage output
- Independent gate and trigger outputs for full retriggerability
- Omni on or off switch and indicator
- Channel switch and indicator
- Recognizes a variety of MIDI Channel Mode messages
- Octave transpose switch extends response with short keyboards
- Fits behind an industry standard 1U rack panel (1-3/4" by 19")

But if you really want to know what the MTS-100 can do, then check out its Implementation Chart in Figure 1. By custom, each piece of MIDI gear is supposed to be provided with just such a chart. It's really nothing more than a standardized way to explain what MIDI features are available, what messages are recognized, etc. Take a moment to review it. After you get a feel for what to expect, then read on to see how the MTS-100 works.

CIRCUIT DESCRIPTION

Since the MTS-100 is really little else than a glorified digital-to-analog converter (DAC), it's convenient to split the schematic into two main parts. In broad terms, Figure 2 depicts the digital side of things, while Figure 3 shows the analog portion.

Refer to Figure 2 now. If you're getting a sense of deja vu, there's a reason! You might recall my ADV-MIDI project which appeared in the Oct. '97 issue of *Nuts & Volts Magazine*.

The purpose of that circuit was to convert incoming MIDI messages to triggers suitable for firing analog drum sets. As it turns out, quite a bit of the input circuitry can be copied over directly. So, we can really buzz through the explanation now. The basics will be described here, but if you need more details or want to refresh your knowledge of MIDI, refer back to the article just mentioned.

A source of MIDI messages (coming from a music keyboard, sequencer, personal computer, etc.) is applied to jack J5. Optocoupler IC1 isolates and translates the electrical signal as required by the MIDI specification. A suitable replica of the bit stream is generated at output pin 6 of IC1.

One path conducts this bit stream directly to input port line PA7 of the MC68705P3 microprocessor. (For brevity, this chip will be referred to as the 68705 from now on.) The bits roll in to the microprocessor one at a time and are properly reassembled into a complete byte under control of the firmware residing within the chip.

Function		Transmitted	Recognized	Remarks
Basic	Default	***	1	
Channel	Channel	***	1-16	note 1
	Default	***	Mode 4	
Mode	Messages	X	Modes 2 or 4	note 2
	Altered	***	Modes 2 or 4	note 3
Note		X	O	
Number	True Voice	***	0-127	note 4
Velocity	Note ON	X	X	
	Note OFF	X	X	
Aftertouch	Key	X	X	
	Channel	X	X	
Pitch Bend		X	O	
Controllers		X	O	note 5
Program		X	X	
Change	True #	***	***	
System Exclusive		X	X	
System	SPP	X	X	
Common	Song Select	X	X	
	Tune Request	X	X	
System	Clock	X	X	
Realtime	Commands	X	X	
Aux	Local ON/OFF	X	***	
	All Notes Off	X	O	note 6
	Active Sensing	X	X	
	Reset	X	O	note 7

Notes:

1. At power-up or during reset, switch S2 can set the MTS-100 to receive on any channel (1-16).
2. The MTS-100 can be set to Omni Off or Omni On either by front panel switch S1, or by an appropriate Channel Mode Message.
3. The MTS-100 is a monophonic device, but is compatible with any MIDI keyboard even if polyphonic. In this case, it simply responds to the most recent Note On message.
4. The MTS-100 can convert all 128 MIDI notes. If using a short keyboard, switch S3 can transpose notes up or down by one octave to extend the output range.
5. The following Channel Mode messages are recognized: Reset All Controllers, All Notes Off, Omni Off, and Omni On. Reset All Controllers sets the pitch bend output to its midposition value.
6. Sending the Omni Off or Omni On commands also turns all notes off, as required by the MIDI 1.0 spec.
7. The current channel can be changed during the Reset sequence, if desired.

Mode 1: Omni On, Poly	Mode 2: Omni On, Mono	O: Yes
Mode 3: Omni Off, Poly	Mode 4: Omni Off, Mono	X: No

Figure 1 — The MTS-100 Implementation Chart

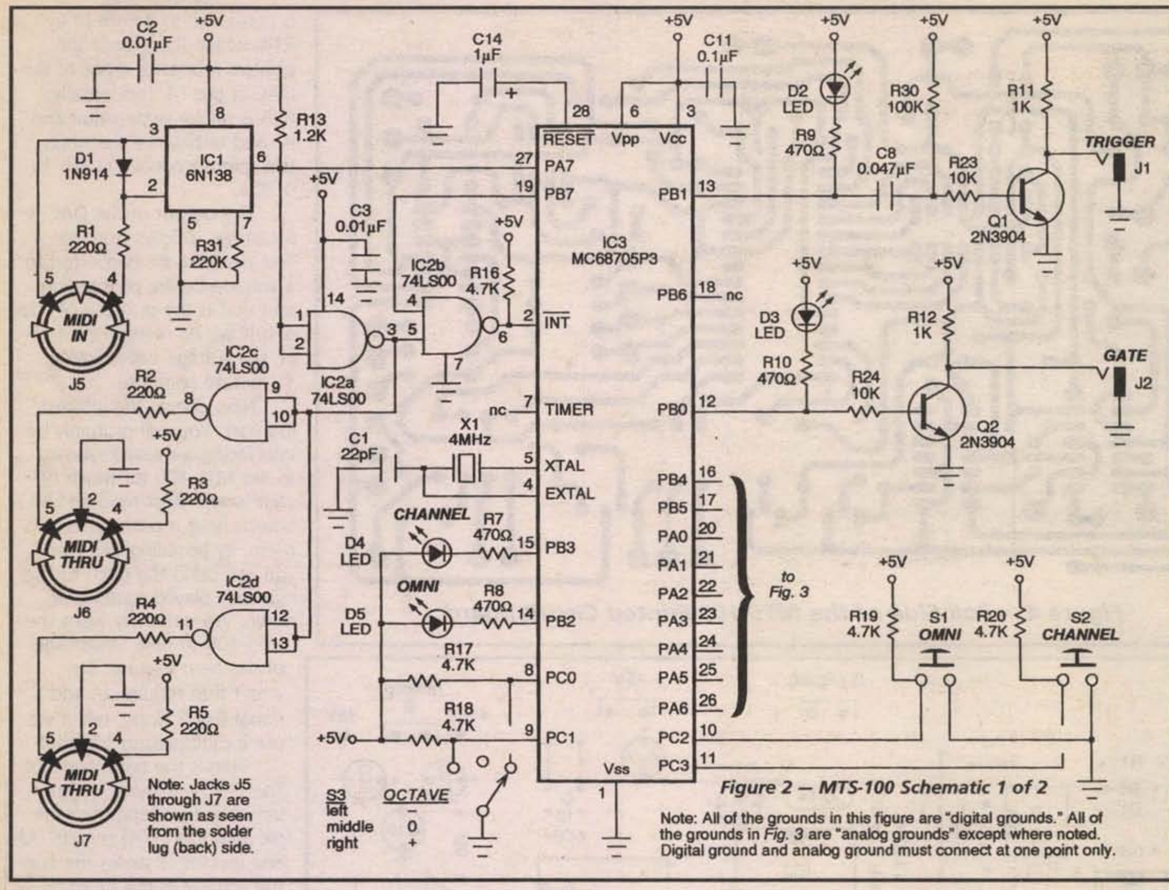

Figure 2 — MTS-100 Schematic 1 of 2

Note: All of the grounds in this figure are "digital grounds." All of the grounds in *Fig. 3* are "analog grounds" except where noted. Digital ground and analog ground must connect at one point only.

Pin 6 of IC1 also feeds MIDI THRU jacks J6 and J7 by means of the buffers configured around IC2c and IC2d. Again, this is a standard arrangement described in the MIDI specification. The MIDI THRU jacks can be used to daisy chain other equipment to the MTS-100.

Since the MIDI messages are asynchronous in nature (i.e., can occur at any time), microprocessor interrupts are used to dictate when data is to be read in. Once a message is rolling in, it is important that the 68705 not be further interrupted. Thus, IC2b is used to pass or block external interrupts to pin 2 of the 68705, as required.

Switch S1 and LED D5 work in tandem to let the user turn Omni mode on or off from the front panel. Port line PC2 of the 68705 is normally high. Tapping pushbutton S1 once causes this line to momentarily drop low. The microprocessor senses the change and toggles the condition of the Omni status, as well as LED D5.

Obviously when the LED is shining, Omni mode is on, and when it is dark Omni mode is off. By the way, you can also turn Omni on or off by sending the standard MIDI Channel Mode message. The LED will still respond as just described.

S2 and D4 also work as a team, in this case to set or test the current channel. At power-up or during reset, the channel defaults to 1. But you can change it to any legal value (1-16) in the following way.

First, with power to the MTS-100 off, press and hold pushbutton S2. Now turn the power on. LED D4 will begin flashing, about once per second. Simply release the pushbutton after witnessing the desired number of blinks, representing the channel. For example, to set the MTS-100 to channel 5, hold S2 closed then turn the power on. After five blinks, release S2.

Once you're up and running, you can also use pushbutton S2 to check what the current channel is, in case you've forgotten it in the meanwhile. Simply tap the switch once. The LED will flash the number of times representing the current channel number. This is a very simple, yet effective method to set or test the channel. And best of all, it uses very little front panel real estate!

Switch S3, which connects to the 68705 port lines PC0 and PC1, can be used to transpose the currently played note up or down by one octave. This is handy if you are driving the MTS-100 with a smaller keyboard which spans less than the 128 notes of the standard MIDI scheme.

If the lowest note on your keyboard is number 36, for instance, then by flipping S3 to the minus position, the internal firmware automatically subtracts 12 (a one octave difference) and spits out the number 24 to the

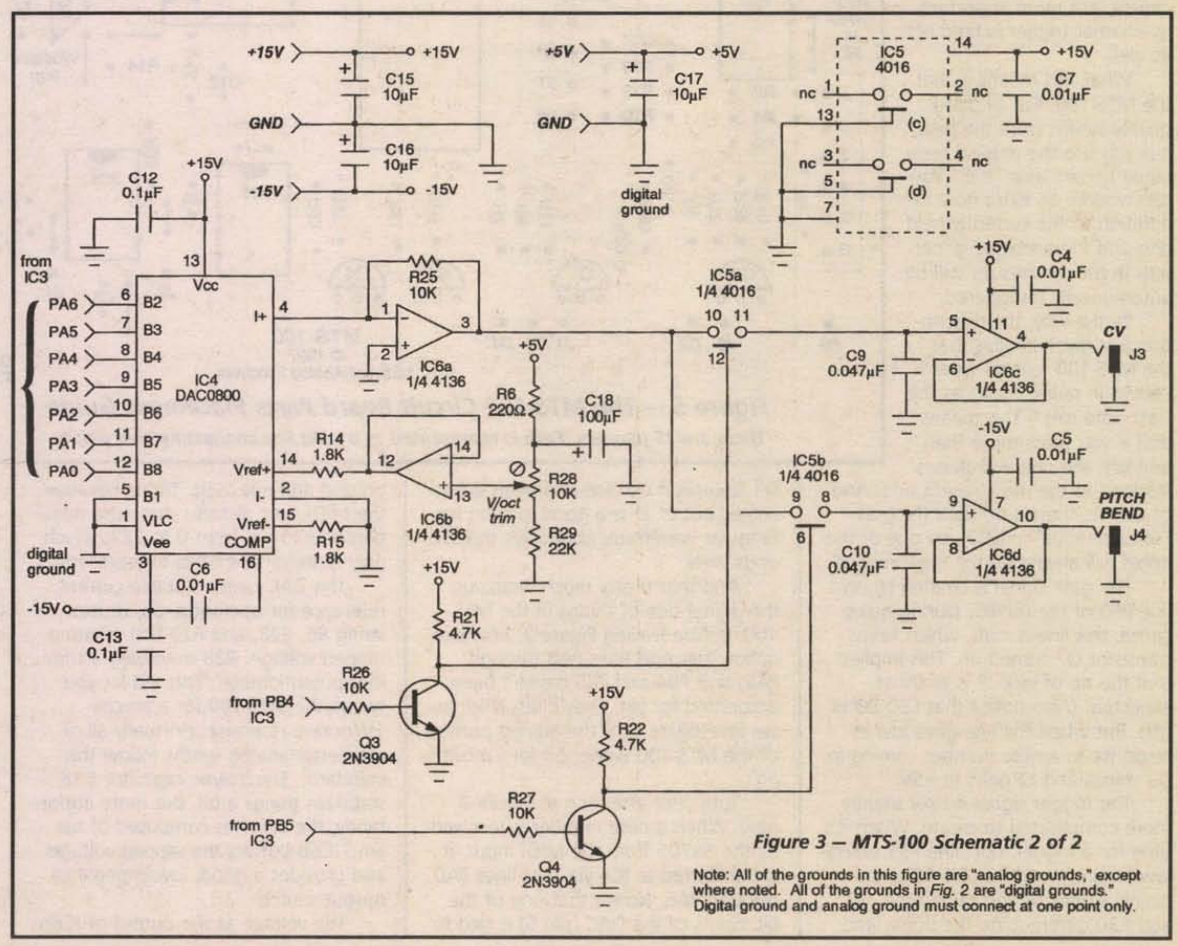

Figure 3 — MTS-100 Schematic 2 of 2

Note: All of the grounds in this figure are "analog grounds," except where noted. All of the grounds in *Fig. 2* are "digital grounds." Digital ground and analog ground must connect at one point only.

DAC.

In a similar way, putting S3 to the plus position will add 12. In effect, your short keyboard has now gained an octave on both the low and high ends. By the way, the firmware takes care of any potential goofiness should you attempt to transpose a note out of range. In this case, it's simply left as is and passed on to the DAC unchanged.

The envelope generators in an analog synthesizer require a source of keyboard gate and trigger signals. A gate should normally be at 0V, but swing to +5V and stay there whenever a note is to be sounded. On the other hand, a trigger is a 0V to +5V pulse, several milliseconds wide. It is generated at the outset of a note, and can also be retriggered under certain other conditions.

For example, suppose you have pressed a key on a music keyboard for the first time. A trigger is created. Now imagine that you keep that key depressed and play another one in addition to it. The current note number is updated to the new value of course, but more importantly, another trigger is fired off as well.

What this means is that the MTS-100, like all good quality synths from the past, lets you use the musical technique known as a "trill." You can twiddle an extra note in addition to the currently held one and the envelope generator in the synthesizer will be automatically retriggered.

By the way, the description just given implies that the MTS-100 follows what is known in music circles as the "last note rule." This means that if you press more than one key, the unit will always respond to the most recent one. And of course, there's no such thing as "simultaneous" in MIDI, so one of the notes will always be the most recent!

The gate signal is created by port line PB0 of the 68705. During quiescence, this line is high, which keeps transistor Q2 turned on. This implies that the tip of jack J2 is at 0V as expected. (Also notice that LED D3 is off). But when the line goes low in response to a note number coming in, D3 shines and J2 goes to +5V.

The trigger signal is only slightly more complicated to create. When it's time for a trigger, port line PB1 swings low long enough for LED D2 to be plainly visible. At the same time, C8 and R30 differentiate the pulse, and

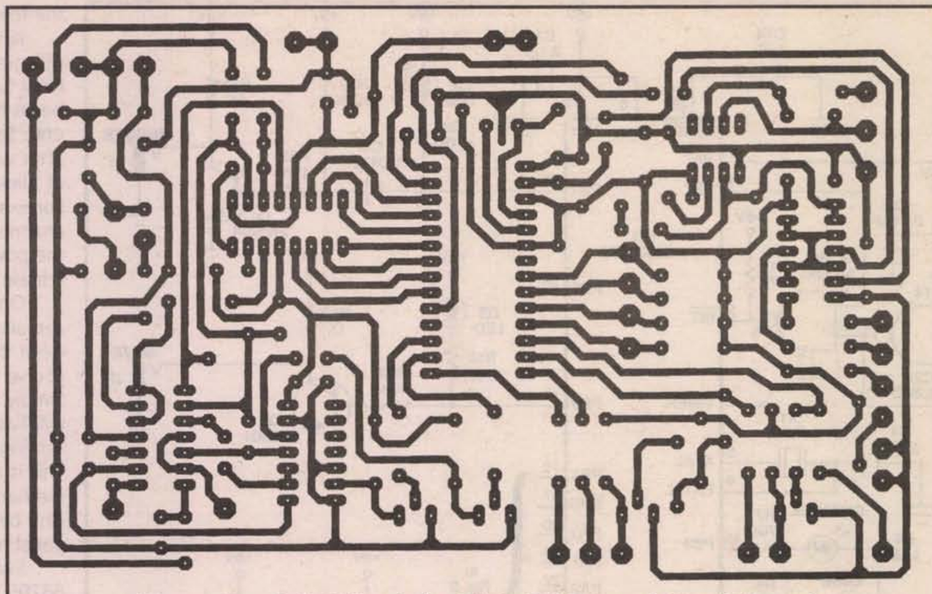

Figure 4 — Foil Side of the MTS-100 Printed Circuit Board

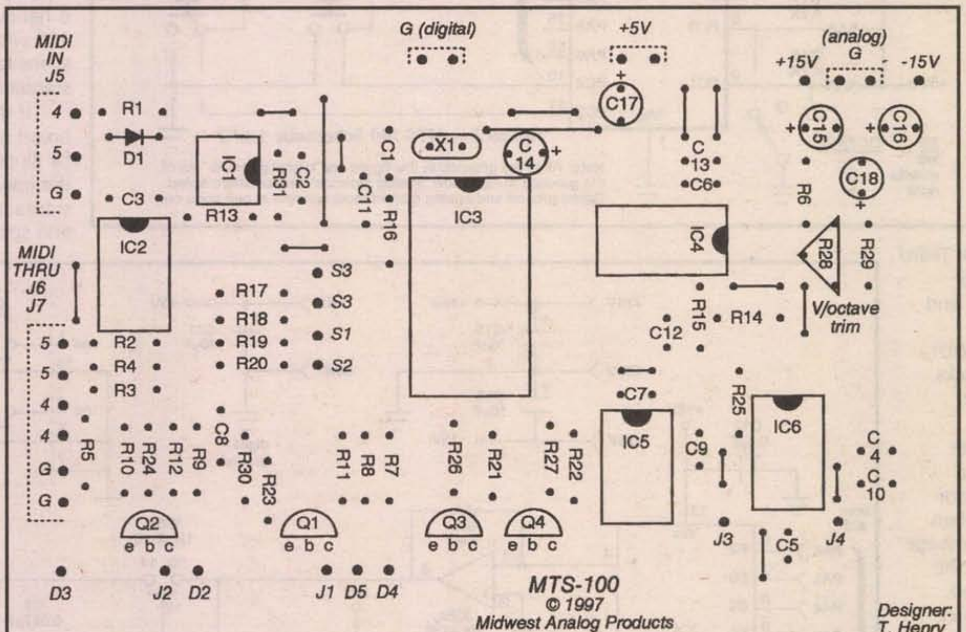

Figure 5 — The MTS-100 Circuit Board Parts Placement Guide

There are 15 jumpers. Each is represented as a solid line connecting two points.

Q1 squares it up nice and neat. What comes out of J1 is a good looking rectangular waveform, about five milliseconds wide.

And that pretty much wraps up the digital side of things in the MTS-100. Before leaving Figure 2, however, notice that port lines PA0 through PA6, and PB4 and PB5 haven't been accounted for yet. They'll resurface as we investigate how the analog portion of the MTS-100 works. So let's move on.

Turn your attention to Figure 3 now. When a note number is received by the 68705 from the MIDI input, it is transferred to IC4 via port lines PA0 through PA6. Notice that one of the bit inputs of the DAC (pin 5) is tied to ground and not used. This is because the MIDI spec dictates that note numbers should run from 0 to 127, which only requires seven bits to represent.

The DAC needs a stable current reference for operation. So, resistor string R6, R28, and R29 first create a tapped voltage. R28 is actually a trimmer potentiometer. This will let you tweak the MTS-100 for a precise 1V/octave response. (Virtually all of the better analog synths follow this standard). Electrolytic capacitor C18 stabilizes things a bit. But more importantly, the follower composed of op-amp IC6b buffers the tapped voltage and provides a good, low-impedance output source.

The voltage at the output of IC6b is converted to a current by R14, which then feeds the positive reference input of the DAC at pin 14. Incidentally, R15 is of the same value and is used to balance the negative reference input at pin 15 of IC4.

The output of the DAC is a current; it flows from pin 4. This needs to be converted to a voltage before proceeding and that is the purpose of R25 and IC6a. As mentioned earlier, the voltage will follow a 1V/octave response.

Now comes the interesting part. You will probably be interfacing a music keyboard to the MTS-100 for much of your work. Most modern keyboards have a pitch wheel on them. By bobbling this wheel, you can bend the pitch of the currently played note up or down. We definitely want the MTS-100 to take advantage of this neat feature. But won't that require an additional DAC? Nope, not if we use a multiplexing scheme!

Here's the basic concept. The DAC will share its time between two separate sample-and-hold (S/H) circuits. At one instant, it stores the control voltage in the first S/H, and in the next instant it stores the pitch bend voltage in the second. Then the process starts over again. Since the multiplexing is happening at such a rapid rate (about 100 microseconds per cycle), the S/H capacitors never have a chance to drop or lose their stored charges. The net effect? The DAC appears to have two separate outputs. Let's look into the details.

The output voltage of the DAC is found at pin 3 of IC6a, the op-amp follower. This signal splits in two now, going to analog switches IC5a and IC5b. When switch IC5a is closed, the DAC voltage is applied to the S/H configured around C9 and IC6c. The buffered voltage is then presented to jack J3, the control voltage output. On the other hand, if IC5b is closed then the DAC's output is instead routed to C10 and IC6d. The buffered pitch bend voltage is available at jack J4.

In case you're wondering, the firmware within the 68705 makes certain that only one of these analog switches is closed at any given moment. Another thing to note is that the CMOS switches need to operate off of a +15V power supply. This is because the voltage from the DAC ranges on up to +10.58V (note number 127). So transistors Q3 and Q4,

Figure 6 — Front Panel

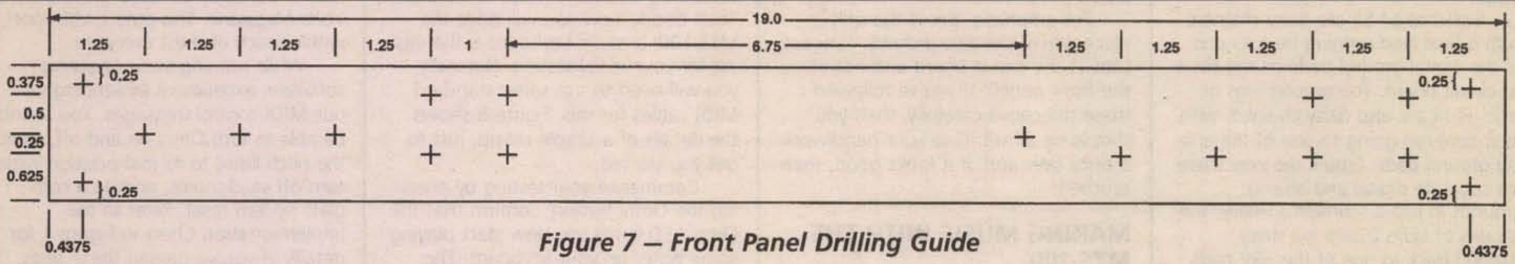

Figure 7 — Front Panel Drilling Guide

along with their associated resistors, translate the TTL control signals from the 68705 to a suitable +15V level.

To wrap things up, notice that there have been numerous capacitors not mentioned in the circuit description so far. Most of these are decoupling, bypass, or compensation caps. In general, these caps are used to stabilize the operation of the various chips. Even though they don't seem to do anything very glamorous, all of them are essential for proper performance.

Well, you're probably sick of circuit descriptions, so let's move on now and see how to actually construct the MTS-100!

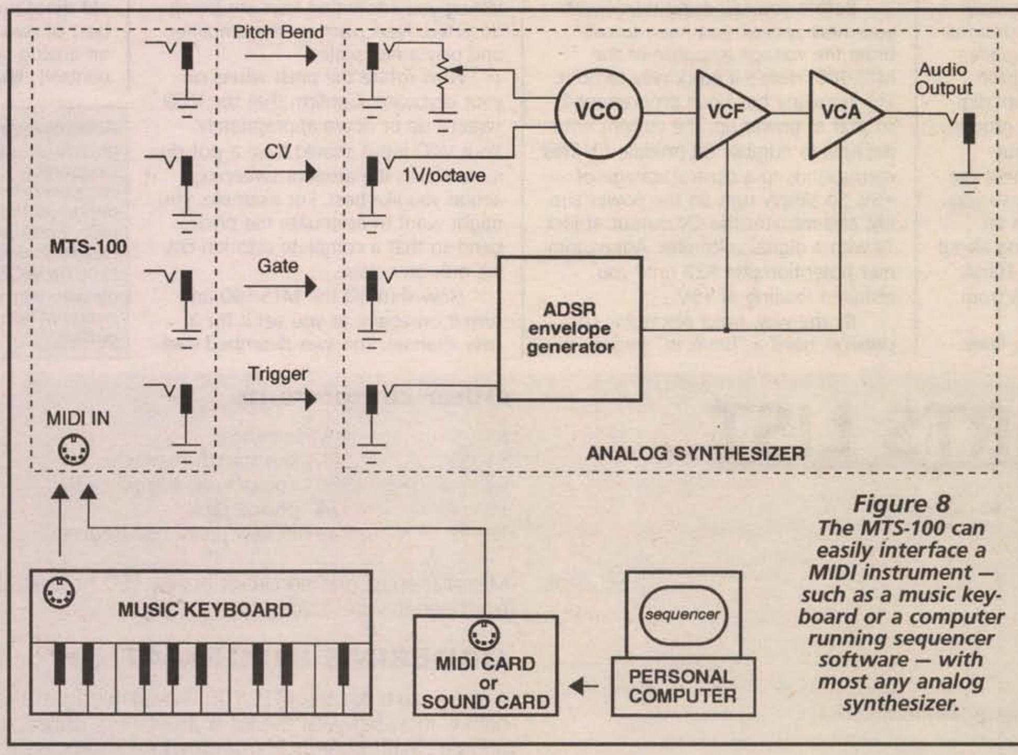

Figure 8
The MTS-100 can easily interface a MIDI instrument — such as a music keyboard or a computer running sequencer software — with most any analog synthesizer.

BUILD IT!

Besides the hardware just described, it also takes firmware to put the MTS-100 through its paces. If you'd like to try a complete homebrew approach, then first obtain a blank 68705 chip. Jameco Electronics (1355 Shoreway Road, Belmont, CA 94002) is a good source for the part, and has them for under $15.00.

Next, you'll need to get your hands on the program for the firmware. Even though the object code is quite short (about 700 bytes), it's still too long to appear in this article. However, the complete annotated assembler source code is available free of charge for download on the World Wide Web. See the Parts List for details.

Next, you'll need to assemble the code and burn it into your chip. There are dozens of excellent freeware and shareware cross-assemblers available on the Internet; try your favorite search engine and see! As for programming the microprocessor, get your hands on a 68705 Motorola manual. You'll find complete directions for programming the internal EPROM.

But if the thought of hassling around with software doesn't appeal to you, then you might want to consider purchasing the kit of parts which includes a programmed 68705. Refer to the Parts List for ordering information.

All of the other components in the MTS-100 are available from a variety of sources. A quick check of the ads in this magazine or the catalogs of some of the better mail order houses will fill in the gaps almost immediately.

After gathering the parts together, ponder what method of construction you will employ. Most of the project is non-critical, but keep in mind that the S/H circuits, as well as the crystal oscillator, demand neatness. (Stray capacitance and the like can wreak havoc.) So, if you decide to handwire it, be sure you keep everything nice and tidy.

The best approach by far, however, is to use a printed circuit board. This is much more fun to put together, looks pretty, and will probably minimize any potential wiring errors. Many hobbyists are becoming old hands at etching their own boards nowadays using a laser printer and iron-on transfer material. If you'd like to give it whirl, refer to Figure 4 which shows the 1:1 positive artwork for the foil side. Conveniently, it all fits on a 4" by 6" board, which is a standard copper clad size.

See Figure 5 for the parts placement guide. Loading the board is pretty straightforward as long as you obey the usual rules. For example, be sure to observe the orientations of all of the polarized components. Diode D1 is marked with a standard schematic symbol. A plus sign indicates the positive lead of electrolytic capacitors C14-C18. The emitter, base, and collector leads of Q1-Q4 are called out with their initial letters.

Finally, don't forget to install the 15 jumpers. These are indicated as straight lines connecting pairs of points on the diagram.

After loading the printed circuit board, you can then proceed to the final wiring of the front panel. A rack-mounted unit is perhaps best, since most pro equipment comes that way nowadays.

The MTS-100 fits nicely behind a standard 1U rack panel (1-3/4" by 19"). Figure 6 shows a sample design, while Figure 7 gives the related drilling guide. The circuit board mounts behind the panel on standoffs or little angles, using #4 hardware to secure things.

To connect the circuit board to the panel, notice that all of the relevant pads are labeled on the parts placement guide in Figure 5. Even so, here are a few additional tips. For best results, twisted triples should be used to connect up jacks J5-J7. The schematic in Figure 2 shows the pin arrangement of these jacks, as seen from the solder lug side. Notice that G, the ground wire of the triple going to the MIDI input, does not connect to J5. Clip if off, and let it float.

The purpose of this wire is simply to provide a degree of shielding for the other two wires in the triple. It is left unconnected at the panel side to avoid ground loop problems.

On the other hand, G does connect to MIDI THRU jacks J6 and J7. Solder the respective ground wire of each triple directly to pin 2 of each of these.

Switches S1-S3 are daisy chained, with a final lead running back to one of the digital ground pads on the printed circuit board. The ground lugs of jacks J1-J4 are also daisy chained, with their final run going to one of the analog ground pads. (You'll see why there are separate digital and analog grounds in just a moment.) Finally, the anodes of LEDs D2-D5 are daisy chained back to one of the +5V pads.

The remaining connections to the switches, LEDs, and jacks are trivial, and easily identified from the designations on the parts placement guide.

At this point, you should have only five more pads to hook up: digital ground, +5V, -15V, analog ground, and +15V. They connect to your power supplies. Notice that these are standard synthesizer voltages, so you may be able to tap them from an existing supply. Plan on drawing about 120mA from the +5V supply, 10mA from the -15V side, and 15mA from the +15V side.

Connect up these last five lines. Now here is an easily overlooked, but vital point to remember. In any hybrid analog/digital circuit, it is essential that digital ground and analog ground connect at one point only! This helps to minimize interference and other gremlins. So, complete the hook-up by joining digital ground to analog ground right at the output of the power supplies.

For emphasis, this is the only place where the two grounds connect (not at the circuit board and not at the front panel). If you've followed these directions carefully, then you should be all set. Give your handiwork a once over and, if it looks good, then proceed!

MAKING MUSIC WITH THE MTS-100

Before you can make music with your new system, you need to calibrate the voltage response of the MTS-100. Here's a quick way to do it. The firmware has been programmed so that at power up, the current note defaults to number 60 (middle C). This corresponds to a control voltage of +5V. So simply turn on the power supply, and monitor the CV output at jack J3 with a digital voltmeter. Adjust trimmer potentiometer R28 until you obtain a reading of +5V.

By the way, most electronic components need a "break in" period, so you might want to tweak this up several hours later after the parts have aged a little.

That's it; you're all set to go! So, dig out your analog synthesizer and connect it up to an audio amplifier. Next, patch in the MTS-100 using 1/4" phone plug cables. Depending on the modules in your synthesizer, there may be several ways to do this. Then decide how you will drive the MTS-100; a music keyboard is the easiest for your initial testing. Naturally, you will need to use some standard MIDI cables for this. Figure 8 shows the details of a simple set-up, just to get you started.

Commence your testing by pressing the Omni button; confirm that the Omni LED lights up. Now start playing some notes on your keyboard. The Gate and Trigger LEDs should flash, letting you know that keys are being detected. Next, turn up the amplifier and play a few scales.

Now rotate the pitch wheel on your keyboard. Confirm that the VCO sweeps up or down appropriately. Your VCO input should have a pot on it, so dial in the amount sweeping action you like best. For example, you might want to attenuate the pitch bend so that a complete rotation covers only an octave.

Now shut off the MTS-100 and turn it on again, as you set it for a new channel. This was described earlier in the article. Follow this by pressing the Channel button one more time to confirm that the LED properly indicates the number you just chose.

Lastly, hook up your personal computer to the MTS-100. Of course, you'll need a MIDI port on the PC to do this. But remember that I described a do-it-yourself Sound Blaster 16 to MIDI interface in the April '97 issue of *Nuts & Volts Magazine*. This puts a MIDI port within reach of most everyone.

While running some sequencer software, experiment by sending various MIDI control messages. You should be able to turn Omni on and off, reset the pitch bend to its mid position value, turn off stuck notes, and do a complete system reset. Refer to the Implementation Chart in Figure 1 for details. If you've passed these tests, then you're all set to resuscitate that old dinosaur. You will now have the best of two worlds: the fat sound of an analog synthesizer, all under MIDI control! **NV**

Acknowledgments: *I am extremely grateful to John Simonton of PAiA Electronics, whose pioneering work in computers and synthesizers made this design all that much easier to accomplish. I also wish to thank Bernie Hutchins, publisher of the legendary ELECTRONOTES newsletter, for putting up with way too many questions, and patiently helping me track down circuit goblins.*

PARTS LIST

All resistors are 1/4-watt, 5% values.

R1 - R6	220 ohms
R7 - R10	470 ohms
R11, R12	1K
R13	1.2K
R14, R15	1.8K
R16 - R22	4.7K
R23 - R27	10K
R28	10K trimmer potentiometer
R29	22K
R30	100K
R31	220K

All capacitors are 16V.

C1	22 pF dipped silver mica
C2 - C7	0.01 mfd disc
C8 - C10	0.047 mfd mylar
C11 - C13	0.1 mfd disc
C14	1 mfd electrolytic
C15 - C17	10 mfd electrolytic
C18	100 mfd electrolytic

Semiconductors

D1	1N914 or 1N4148 diode
D2 - D5	Red LED
Q1 - Q4	2N3904 NPN transistor
IC1	6N138 optocoupler
IC2	74LS00 quad NAND gate
IC3	MC68705P3 MPU (programmed)
IC4	DAC0800 D-to-A converter
IC5	4016 quad SPST switch
IC6	4136 quad op-amp

Other components

X1	4 MHz crystal
S1, S2	SPST pushbutton switch
S3	SPDT (on-off-on) toggle switch
J1 - J4	1/4" phone jack
J5 - J7	Five-pin DIN jack (180 degrees)

Miscellaneous: printed circuit board, LED holders, IC sockets, front panel, wire, solder, etc.

ORDERING INFORMATION

A kit of parts for the MTS-100 is available from the source below. Included with the kit is an etched, drilled, and tinned printed circuit board, programmed microprocessor, all resistors, capacitors, semiconductors, crystal, switches, jacks, LED holders, sockets, and Assembly Guide. Does not include front panel, wire, or solder.

- MTS-100 Kit (#K210)-$69.95

US and Canadian orders add $5.00 shipping and handling. E-Mail or write for shipping information to other countries.

Prices shown in USA dollars. Remit US funds only. Money orders and checks only. MN residents add 6.5% sales tax. Prices and terms subject to change without notice.

Order from: **Midwest Analog Products**
P.O. Box 2101
N. Mankato, MN 56003

The complete source code for the MTS-100 firmware may be downloaded free of charge from the WWW homepage of Midwest Analog Products.

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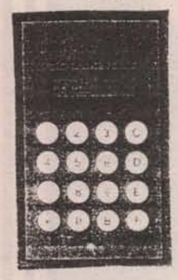

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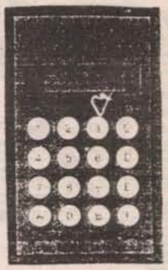

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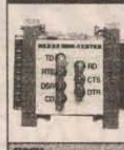

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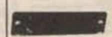

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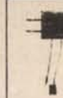

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AMATEUR ROBOTICS

by Karl Lunt

Last month, I started my design of a fire-fighting robot. I had selected the New Micros' NMIX-0332 single-board computer (SBC) as my robot brain, and set out to design my robot software in C. Unfortunately, things haven't worked out, and I've had to shift gears. I'm still using the New Micros' board, but now I'm writing my robot code in Forth.

I gave it my best shot, though. The Software Development System (SDS) compiler, described last month, is excellent and, even though I was using a "demo" version, it included all the tools I would have needed for my project. It even has a nifty utility for splitting a large object file into two halves, suitable for burning into the upper and lower EPROMs common to 16-bit microcontroller (MCU) systems.

But after several days of effort, and a couple of calls to the technical desk at New Micros, I threw in the towel. I simply could not write even a simple assembly language program, burn it into the two EPROMs, and have the MCU execute my program on power-up. I've always agreed with the old maxim that it's a poor craftsman who blames his tools, but the New Micros "documentation" for this board truly sucks.

The most glaring example of this is page 26 from the NMIX-0332 Hardware Manual; except for the heading of "Programming Examples," the page is TOTALLY BLANK! This same hardware manual includes page 17, titled "Memory Map," which contains one paragraph describing where the 68332's 1K of internal RAM appears on power-up, but instead of a memory map, the page carries a table of miscellaneous jumpers.

Even this paragraph bothers me, since the 68332 has 2K of internal RAM, normally used by the Time Processor Unit (TPU), and that memory comes out of reset disabled. I invite any reader who was able to get a custom C or assembly program to execute on this board to contact me; I'd like to find out what I missed.

So there I sat one Saturday evening, having wasted far more time than I should have on getting a small program, any program, to run on my new board. Reluctantly, I reinstalled the original EPROMs in their sockets, strapped the NMIX board so it booted up in Max-FORTH, and hit the switch. Even if I couldn't get C to run, I could at least dabble a bit in Forth.

What a difference a language makes! In just four hours of hacking, I had most of the low-level timing routines written and tested. This, despite having never used the 68332's powerful TPU — the microcoded engine at the heart of the MCU's timing system. Forth has always been my language of choice, and the New Micros' 32-bit version of this power tool makes designing software so easy, it's fun.

Yes, I got more done in Forth because New Micros did the painful integration work up front, and I only had to use the finished tool. But the language itself plays a large part in the productivity boost; Forth is simply a strong, tight language for software development.

The bottom line: You are going to get a few lessons in developing Forth software. Those of you who have never seen the language before would do well to pick up one of the classic Forth texts — Leo Brodie's wonderful *Starting Forth* — published some years ago by Prentice-Hall. The book has been out of print for a few years now, but finding it is well worth the hunt.

Be sure you get the second edition, as the original work dealt with an old dialect of the language seldom in use any more. Even the second edition is behind the times, but his marvelous explanations of the core words still apply, and the book is both entertaining and educational.

Rather than bog down this article with a full explanation of Forth's inner workings, I'll settle for many examples with lots of comments. After all, this is an article about robotics, not about Forth. I will have to hit a few high points, though, so bear with me.

Forth is a stack-based language, similar to the Hewlett-Packard calculators. Whenever you want to perform an operation in Forth, you first push onto a data stack all the arguments that function (called a word) will need, then you invoke the word. When the word you've selected executes, it pulls its arguments from the stack, processes them, pushes any results back onto the stack, then exits.

A quick example should help. The Forth word for addition is + (pronounced "plus"). The Forth word for displaying an argument on the screen, similar to Basic's PRINT, is a period (pronounced "dot"). Thus, to display the sum of 7 and 82, you would enter the command:

```
7 82 + .
```

The Forth processor, called the interpreter, pushes 7 onto the stack, pushes 82 onto the stack, then invokes the word +. + adds the two arguments together and leaves the sum, 89, on the stack. The interpreter then invokes the word ., which pulls an argument off the stack (89, in this case) and displays it on the screen.

But the interpreter only processes your keystrokes; if you don't type, it doesn't execute anything. This is great for dabbling with the underlying hardware, since you can change I/O registers and memory contents, then watch what happens.

However, when you finally get around to writing a finished program, you need to compile your program so it will run later. For that, you need the Forth compiler, named : (pronounced "colon").

The colon compiler lets you create a new Forth word that performs whatever operation you want. Once defined, this word becomes an extension of the Forth system, as much an element of the language as any of the original words. Given the above example, we can create a word that displays the sum of the two original numbers by entering:

```
: SUM
7 82 + .
;
```

This isn't too useful in and of itself, but it illustrates a point. We have created a Forth word, called SUM, that does just what our first, interactive example does, only this word is compiled. We can execute it at any time by simply typing:

```
SUM
```

There, in a nutshell, is the essence of the Forth language; a stack-based, extensible, compiler-interpreter development system. These simple core elements, used properly, will (I hope) get my robot running by March. But it's a long road, and the first step to take involves the 68332's TPU. I hope the code I've developed for controlling this subsystem will also help you appreciate Forth's power in developing programs.

The 68332 TPU

My old favorite, the 68hc11, has a timing subsystem that eases the pain of developing precise timing elements. I've clocked pulses, generated frequencies, driven pulse-width modulation (PWM) electronics, and blinked more LEDs than I can recall, all using this wonderful little I/O subsystem. But as powerful as the 68hc11's timers are, they pale in comparison to the 68332's TPU.

The TPU contains a separate microprocessor dedicated to servicing timing instructions from the host 68332 core. Communications between the two processors occurs through a set of I/O registers and a bank of dual-ported RAM. Based on instructions provided by the 68332, the TPU can perform complex timing functions on any of 16 timing channels. Each channel has its own I/O pin, which your program can use to drive electronics or read signals. The TPU can provide functions such as PWM, servo step-pulse generation, input capture, output compare, period measurement with missing-pulse detection, position-synchronized pulse generation, and others.

It also supports a wide range of interrupts, allowing the CPU to get updates on timing activities, if necessary. And all of these functions take place with zero CPU impact, other than interrupts. Your code simply loads up a function, triggers its execution, and leaves the TPU to do the rest.

The TPU is so complex that Motorola has printed a separate book on its use. You can order a copy of the TPU Reference Manual (TPURM/AD) by calling your nearest Motorola office, or hitting the Motorola web site: www.mcu.motsps.com — I just received Rev. 3 of the manual, along with other books such as the *MC68332 User's Manual* (MC68332UM/AD), the *CPU32 Reference Manual* (CPU32RM/AD), the *System Integration Module Reference Manual* (SIMRM/AD), and the *Queued Serial Module Reference Manual* (QSMRM/AD). I expect to need all of these manuals at some point in the development, so I went ahead and got them early.

I also picked up a super collection of application notes for the TPU. This two-inch stack of documentation contains details on using many of the different TPU functions. For example, application note TPUPN00/D, titled "Using the TPU Function Library and TPU Emulation Mode," covers the basics of the TPU and the use of its underlying microcode engine.

The document includes information on setting up your own functions in the TPU's microcode, and even includes instructions on using TPUASM, Motorola's FREEWARE TPU assembler. You can find both the TPUASM assembler and the source code for the examples in this application note on the Motorola FREEWARE web site at: www.mcu.motsps.com:80/freeweb/

Other application notes in this collection cover topics such as designing an asynchronous serial port (UART) using a pair of TPU channels, using the TPU frequency measurement function, and generating sophisticated PWM signal sequences. If you want to get the full value out of the 68332's TPU, this set of notes ranks as "must-have."

But before I could get started using the TPU, I first had to decide what timing functions my robot would require. I already know I'm going to have to generate stepper motor signals, but since I'm using Bill Bailey's terrific little stepper motor driver boards, I don't need the complicated four-wire step signals.

Instead, I can get by with just a direction line and a step-pulse line for each of two motors. The direction lines will be simple digital outputs, but the two step-pulse signals will be timer output lines controlled by the TPU.

Navigation will be a key element in the robot's design, and that means my program must be able to count pulses generated by an outside source, such as wheel encoders. Therefore, I'll also need some form of pulse-counting ability on at least two inputs.

I'll also need to generate one or more 40 KHz 50% duty-cycle squarewaves, for use with an IR object detection system. The TPU will save me a chip or two here, since I can set up a simple PWM output with the proper time period and duty-cycle, then let the microcode engine do the work. Finally, I expect to need at least one PWM signal for driving a hobby R/C servo motor. I'll attach a mechanism to this servo for controlling whatever fire-extinguishing system I design.

As of now, that's all I can foresee needing. Granted, these requirements won't begin to strain the TPU's capabilities, but they make an excellent starting point for exploring the power of this subsystem.

I first had to apply power to the board and hook up the PC. You can find some of the neatest little wall-wart power supplies in mail-order catalogs these days, and a first-rate multiple-output power supply for small SBCs shouldn't set you back more than $5.00. I'm using an old AT&T wall-wart that generates +5, +12, and -12 VDC, which I picked up ages ago at a surplus store. I cut the 15-pin connector off the end of the cable, then installed three two-pin connectors, one on each voltage and ground combination.

Now I can simply plug whatever voltage I need into the board and I'm ready to go. If you follow a similar course, be sure to label each connector so you don't accidentally plug -12 VDC into the +5 VDC input on your board; that'll hurt!

I connected the serial cable, supplied by New Micros, to my PC's serial port, then fired up an old copy of Crosstalk. Just about any communications program will work; I use Crosstalk because I can customize scripts for several different boards.

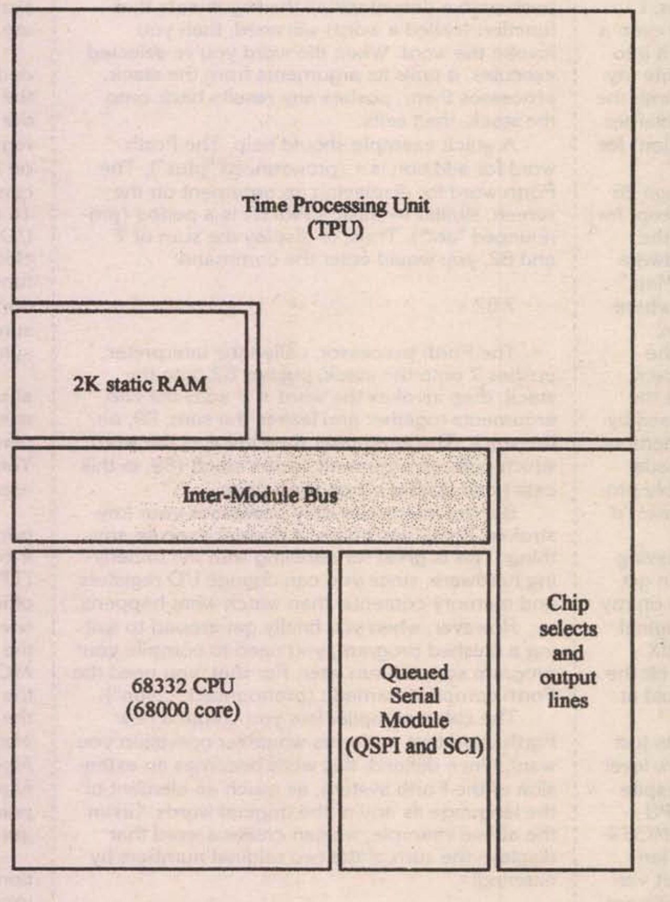
One feature you will need on your comm program is the ability to pace lines of text during an ASCII download. You will be sending source lines to the Forth compiler over the serial port, and each line must wait until the compiler signals that it is done with the previous line. I set Crosstalk to wait for an echo on each character and an echo on each line.

After finishing the set-up (9600 baud, 8N1), I was ready to hit the switch. My NMIX-0332 board responded with the Forth prompt. I started by tackling the 40 KHz signal generation, since that seemed the most straightforward. In the 68hc11, this type of function would be done with the timer output-compare function and some interrupt service request (ISR) code. Oddly enough, this knowledge of "how it's done" tripped me up, and I spent about an hour trying to use the TPU's output-compare function for this simple task. Finally, a talk with Kevin Ross, president of the Seattle Robotics Society, put me on the right track and I turned to the PWM function.

All TPU functions are set up using the same basic format. You must first decide which of the 16 available TPU channels you will assign to a task. Next, your software sets up that channel by writing the necessary information to various I/O registers and parameter RAM locations related to that channel.

Finally, your software enables the channel, allowing it to begin processing its assigned function. In general, a channel set-up uses the following sequence:

1. Write the function code you want to use to the proper TPU channel function select register (FSR).



Simplified 68332 Block Diagram

2. Write any necessary parameters to the area of TPU RAM assigned to that channel.

3. Write the appropriate host service request (HSR) to the section of the HSR registers assigned to that channel.

4. Write a priority value to the section of the channel priority registers (CPR) assigned to that channel.

At this point, the TPU should be executing your function. While all of this looks complicated, it actually reduces to a mere six lines of Forth code. Refer to the accompanying listing of 40khz.txt for details.

My example starts with some Forth housekeeping chores. HEX tells Forth to use hexadecimal as the default radix. FORGET TASK causes Forth to erase all known words back to and including the word TASK, if it exists. Finally, the third line defines an empty word named TASK, which I use to mark the beginning of my work space.

I then define a word called TPU-INIT, that does whatever low-level set-up is needed on the TPU. In this case, the only task I need to do is define the TPU's clock rate. I chose a value of $00c0; writing this value to address $fffe00 (TPUMCR) sets the TPU's clock prescaler to divide-by-4. This means that each TPU clock cycle is 250 nsec, given the standard 68332 system clock of 16 MHz.

Writing a 16-bit value to a memory location requires two stack values and the store word, H! (pronounced "H-store"). Notice that the order of the values is important; the value to write always appears first, then the address to modify, followed by the word that actually performs the store operation.

Next up, I define the word 40KHZ, which actually configures a TPU channel to generate a fixed 40 KHz signal. In this example, I've chosen TPU channel 0 for my 40 KHz output. The first line of code in the definition writes the PWM function ($09) to the proper section of the appropriate channel function select register (CFSR3).

There are four channel function select registers in the TPU, and each register supports four TPU channels. The section of a CFSR assigned to any one TPU channel spans four bits, leaving room for 16 available TPU functions, $00 through $0f. As you can see here, the value $09 selects the PWM timer function. You can also see that the low four bits of address $fffe12 are used by the TPU logic to hold the function assigned to TPU channel 0.

The TPU design uses a section of dual-ported RAM as a parameter area. Both the host CPU (68332) and the TPU can read/write addresses in this RAM. During TPU function set-up, your software writes any required parameters to the area of this RAM dedicated to the selected TPU channel. If necessary, your software can later examine addresses within this RAM to determine the state of a selected TPU channel.

Each TPU channel is assigned a block of eight words in TPU RAM for holding parameters. For channels 0 through 13, only the first six words in these blocks are really RAM; the last two words aren't actually implemented.

The second line of code in my little program writes the value $0091 to parameter 0 for channel 0. This value tells the TPU to use timer 1 (the TPU internal clock source) as the time base and to pull the output line for TPU channel high at the start of each PWM cycle. I don't need to write anything to parameter 1, since that is reserved as an output location for the TPU PWM function.

My next line of code writes the value $0032 to parameter 2, which gives the number of TPU clock cycles to hold the output pin in its assigned state. Recall that TPU-INIT set the TPU clock to 250 nsecs per period. Thus, this parameter means that the output pin will remain high for $32 (or 50) 250 nsec clocks, or 12.5 usecs.

The fourth line of code in this function writes the value $0064 to parameter 3. This gives the number of TPU clock cycles in the entire PWM period, again measured in 250 nsec clocks. This works out to 100 clocks, or 25 usecs. The net result of parameters 3 and 4 is to create a pulse stream of 40 KHz frequency with a 50% duty-cycle.

The fifth line of code issues a command, known as a host service request (HSR), to the TPU. An HSR takes up two bits, and the HSR field for TPU channel 0 is the low two bits of address $fffe1a, the second of two HSRs (HSRR1). By writing the value %10 to this field, my code instructs the TPU to initialize TPU channel 0, using the values I've previously written to the parameter areas of RAM.

We are nearly done. The only remaining tasks are to enable the TPU processing of channel 0 and to assign a priority for that processing. Both of these tasks are handled by the last line of my little program, which writes the value $0003 to address $fffe1e, the second channel priority register (CPR1).

The priority value for any channel fits in two bits, and by using a value of %11 for TPU channel 0's priority, I'm assigning it high priority. Writing a value other than %00 to this field tells the TPU that the parameters are stable and that it can begin performing the assigned function.

The final phase of this program takes place in the word MAIN. Executing MAIN invokes the TPU-INIT word to set up the TPU, then invokes the 40KHZ word to set up and start TPU channel 0. MAIN then ends, returning control to the Forth interpreter. However, since the TPU has started the PWM function on channel 0, the desired 40 KHz signal appears on channel 0's output pin without any support from the 68332.

This first program fits the bill as a learning tool; by simply typing MAIN at the Forth prompt, I can generate a 40 KHz signal on timer pin 0. But the program needs some work before it can be used as part of robot firmware.

The biggest problem is that this code clobbers any values previously stored in several of the TPU I/O registers. To be truly useful, this and routines like it should leave previous values intact, changing only those fields assigned to functions of interest.

The second program, stepper.txt, carries the concepts of the previous example farther. This code begins with the customary removal of TASK, then sets the Forth dictionary pointer to a special RAM address, which will later be used by the New Micros start-up sequence; more on this in a later article. This file also includes the TPU-INIT word, just like the previous example.

The next word, HOR! (pronounced "H-O-R-store"), lets my software modify only selected bits within a 16-bit memory address. The technique uses some of the simpler Forth stack-manipulation words, and provides a good example of how to define and set up words that need several arguments. Using the comments in the definition, try to work out for yourself how the word does what it does; you can check later lines in the program for examples on using HOR!.

The next word, INIT-STEPPERS, sets up TPU channel 1 to generate a PWM pulse stream. As with the previous example, the code must modify several memory addresses. Those addresses in the range $fffexx are TPU registers, shared by other TPU channels. Thus, my code invokes HOR! so only the bits associated with channel 1 are modified.

Addresses in the range $ffffxx belong in the TPU parameter RAM and are dedicated solely to a specific channel. Therefore, my code can modify the entire word without trashing parameters belonging to another channel. The second half of

```
HEX
FORGET TASK
: TASK ;
: TPU-INIT
 00C0 FFFE00 H! ( USE 250 NS RATE FOR TCR1 (PSCK=1)
;

(
( 40KHZ    ( - )
( Use the TPU to generate a 40 KHz output on TP0.
(
( This requires that the TPU be initialized to use a
( /4 prescaler (PSCK = 1)
(
: 40KHZ
 0009 FFFE12 H! ( CHNL 0 FUNCTION SELECT = PWM
 0091 FFFF00 H! ( TCR1, FORCE OUTPUT HIGH, TIMER CH 0
 0032 FFFF04 H! ( PWMHI = 12.5 USECS
 0064 FFFF06 H! ( PWMPER = 25.0 USECS
 0002 FFFE1A H! ( HSR FOR CHNL 0 = %10 (INIT)
 0003 FFFE1E H! ( PRIORITY FOR CHNL 0 = HIGH
;

: MAIN
 TPU-INIT
 40KHZ
 CR CR ." Done!" CR
;
```

Program for generating 40 KHz pulses using the TPU

```
 FORGET TASK
HEX
0 8000 !
8100 DP !
: TASK ;

0 CONSTANT RMTR
1 CONSTANT LMTR
: INIT-TPU
 00C0 FFFE00 H! ( USE 250 NS RATE FOR TCR1 (PSCK=1)
;
: HOR!  ( data addr mask - )
 OVER H@      ( get current word in addr
 AND          ( clear bits based on AND-mask
 ROT          ( get data on TOS
 OR           ( now add new bits
 SWAP H!      ( and write new value to addr
;

: INIT-STEPPERS
 0090 FFFE12 FF0F HOR! ( CHNL 1 FUNCTION SELECT = PWM
 0092 FFFF10 H!    ( TCR1, OUTPUT LOW, TIMER CH 1
 0000 FFFF14 H!    ( PWMHI = 0 USECS
 1F40 FFFF16 H!    ( PWMPER = 2.0 MSECS
 0008 FFFE1A FFF3 HOR! ( HSR FOR CHNL 1 = INIT
 0004 FFFE1E FFF3 HOR! ( PRIORITY FOR CHNL 1 = MEDIUM
 0900 FFFE12 F0FF HOR! ( CHNL 2 FUNCTION SELECT = PWM
 0092 FFFF20 H!    ( TCR1, OUTPUT LOW, TIMER CH 2
 0000 FFFF24 H!    ( PWMHI = 0 USECS
 7FFF FFFF26 H!    ( PWMPER = 8.19 MSECS = 122 HZ
 0020 FFFE1A FFCF HOR! ( HSR FOR CHNL 2 = INIT
 0010 FFFE1E FFCF HOR! ( PRIORITY FOR CHNL 2 = MEDIUM
;

: INIT-PULSE-COUNTER
 A000 FFFE12 0FFF HOR! ( CHNL 3 FUNCTION = TRANS CNTR
 000D FFFF30 H!    ( DETECT FALLING EDGES
 000E FFFF32 H!    ( NO LINKS, INCR DUMMY LOC
 2000 FFFF34 H!    ( NUMBER OF PULSES TO COUNT
 0000 FFFE16 FF3F HOR! ( NO LINK, SNGL MODE, HOST SEQ
 0040 FFFE1A FF3F HOR! ( HSR FOR CHNL 3 = INIT
 0080 FFFE1E FF3F HOR! ( PRIORITY FOR CHNL 3 = MEDIUM
;

: SET-STEPPER-RATE   ( MTR PERIOD - )
 SWAP
 RMTR = IF       ( DOING RIGHT MOTOR?
   FFFF16 H!     ( USE TOS AS PERIOD
 ELSE
   FFFF26 H!     ( USE TOS AS PERIOD
 THEN
;

: START-STEPPERS
 0091 FFFF10 H!    ( TCR1, FORCE OUTPUT HI, CH 1
 0190 FFFF14 H!    ( PWMHI = 100 USECS
 0004 FFFE1A FFF3 HOR! ( HSR FOR CHNL 1 = UPDATE
 0004 FFFE1E FFF3 HOR! ( PRIORITY FOR CHNL 1 = MEDIUM
 0091 FFFF20 H!    ( TCR1, FORCE OUTPUT HI, CH 2
 0190 FFFF24 H!    ( PWMHI = 100 USECS
 0010 FFFE1A FFCF HOR! ( HSR FOR CHNL 2 = UPDATE
 0010 FFFE1E FFCF HOR! ( PRIORITY FOR CHNL 2 = MEDIUM
;

: STOP-STEPPERS
 0092 FFFF10 H!    ( TCR1, FORCE OUTPUT LOW, CH 1
 0000 FFFF14 H!    ( PWMHI = 0 USECS
 0004 FFFE1A FFF3 HOR! ( HSR FOR CHNL 1 = UPDATE
 0004 FFFE1E FFF3 HOR! ( PRIORITY FOR CHNL 1 = MEDIUM
 0092 FFFF20 H!    ( TCR1, FORCE OUTPUT LOW, CH 2
 0000 FFFF24 H!    ( PWMHI = 0 USECS
 0010 FFFE1A FFCF HOR! ( HSR FOR CHNL 2 = UPDATE
 0010 FFFE1E FFCF HOR! ( PRIORITY FOR CHNL 2 = MEDIUM
;

: MAIN
 INIT-TPU
 INIT-STEPPERS
 INIT-PULSE-COUNTER
 CR ." Press a key..."
 KEY DROP
 RMTR 2000 SET-STEPPER-RATE
 LMTR 2000 SET-STEPPER-RATE
 START-STEPPERS
 CR CR ." Counting..."
 BEGIN
  FFFF34 H@      ( GET NUMBER OF PULSES TO COUNT
  FFFF36 H@      ( GET PULSES COUNTED SO FAR
  =              ( DONE WHEN THESE MATCH
 UNTIL
 STOP-STEPPERS
 ." done!" CR
;
```

Program for Generating Stepper Pulses and Counting Pulses

the INIT-STEPPERS word sets up TPU channel 2 to generate another PWM pulse stream; you can see how this block of code mimics the first half.

The word INIT-PULSE-COUNTER sets up TPU channel 3 as a pulse counter, to count the number of pulses applied to the I/O pin associated with that channel. I won't go into the details of this set-up, but instead refer you to the TPU manual. With this example and the manual, you shouldn't have any trouble figuring out how the transition or pulse counter function works.

START-STEPPERS and STOP-STEPPERS perform obvious functions. Note how these routines first modify selected areas in the parameter RAM and TPU registers, then execute a host service request called UPDATE. This HSR tells the TPU that the parameter RAM and I/O registers for this channel have been modified and a new function or new parameters are available. For START-STEPPERS, the new parameters assign a pulse width value and tell the TPU to generate active-high pulses.

For STOP-STEPPERS, the new parameters call for a pulse width of 0 nsecs and an active-low output. This latter combination essentially shuts off all pulse activity, stopping the motors.

The whole design comes together in the word MAIN. This code sets up the TPU, then sets up the three TPU channels using the words defined earlier. Next, the program sets the stepping rate for both motors and starts the motors running. The code then enters a loop that checks the values of two parameters in the RAM assigned to channel 3, which I'm using as a pulse-counter.

The TPU updates the value in address $ffff36 with the number of pulses counted since the last update or initialization, and the INIT-PULSE-COUNTER word loaded the desired pulse count in $ffff34.

When these two addresses hold the same value, the pulse counter has detected the desired number of pulses. At this point, the BEGIN-UNTIL loop terminates, MAIN prints out a useful message, and control returns to the Forth interpreter. For testing purposes, I connected a jumper between the output of channel 2 and the input of channel 3. Thus, channel 3 is used to count the number of pulses issued by channel 2.

In conclusion ...

This article has provided a brief look at both the Forth language as implemented by New Micros and the powerful Time Processing Unit built into the Motorola 68332. Hopefully, you will find my examples clear enough at least to get started with this high-octane microcontroller.

Be sure to hit the Motorola web site for more information on the 68332 chip. Also contact Motorola directly for the literature you will need to start out with this chip.

And now, I have to get back to my robot design. See you next month ... **NV**

As always, you can reach me at:
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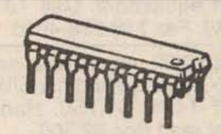

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More Radio Direction Finding

Open Channel

by Joseph J. Carr
K4IPV

Last month, we looked at the more basic forms of radio direction finding systems. Those RDFs were based on either loop or loopstick antennas. This month, we are going to look at some additional types of antenna and receiver systems used for RDF activity.

Sense Antenna Circuit

Last month, I discussed the type of radio direction finding (RDF) system in which a loop or loopstick bidirectional antenna is made unidirectional by adding a "sense antenna" to the circuit. Unfortunately, later I realized that I forgot to tell you how to make the circuit (sorry). Figure 1 shows a method for summing together the sense and loop signals. The two terminals of the loop are connected to the primary of an RF transformer. This primary (L1A) is center-tapped and the center-tap is grounded. The secondary of the transformer (L1B) is resonated by a variable capacitor, C1. The dots on the transformer coils indicate the 90-degree phase points.

The top of L1B is connected to the sense circuit, and to the receiver antenna input. The phasing control is a potentiometer (R1). The value of this pot is usually 10 Kohm to 100 Kohm, with 25 Kohm being a commonly seen value. Switch S1 is used to take the sense antenna out of the circuit. The reason for this switch is that the nulls of the loop or loopstick are typically a lot deeper than the null on the cardioid pattern.

The null is first located with the switch open. When the switch is closed, you can tell by the receiver S-meter whether or not the correct null was used. If not, then reverse the direction of the antenna and try again.

Adcock Antennas

The Adcock antenna has been around since 1919 when it was patented by F. Adcock. Figure 2 shows the basic Adcock RDF array. This antenna consists of two center-fed non-resonant (but identical) vertical radiators. Each side of each element is at least 0.1λ long, but need not be resonant (which means the antenna can be used over a wide band). The elements are spaced from 0.1λ to 0.75λ, although the example shown here is spaced 0.125λ.

The Adcock antenna is vertically polarized, so it will respond to the vertically polarized wave very much like loop or phased array antennas of similar size. The horizontally polarized wave, however, affects all elements the same, so the currents are essentially cancelled, resulting in no pattern. This characteristic makes the Adcock antenna suitable for high-frequency shortwave RDFing.

The pattern for an Adcock antenna is shown in Figure 3. This pattern was generated using Nec-Win Basic. The example antenna is a 10 MHz (30-meter band) Adcock that uses 1.455-meter elements (total 2.91 meters on each side), spaced four meters apart. The pattern is a traditional "figure-8" with deep nulls at 0 degrees and 180 degrees. The antenna can be rotated to find a null in the same manner as a loop.

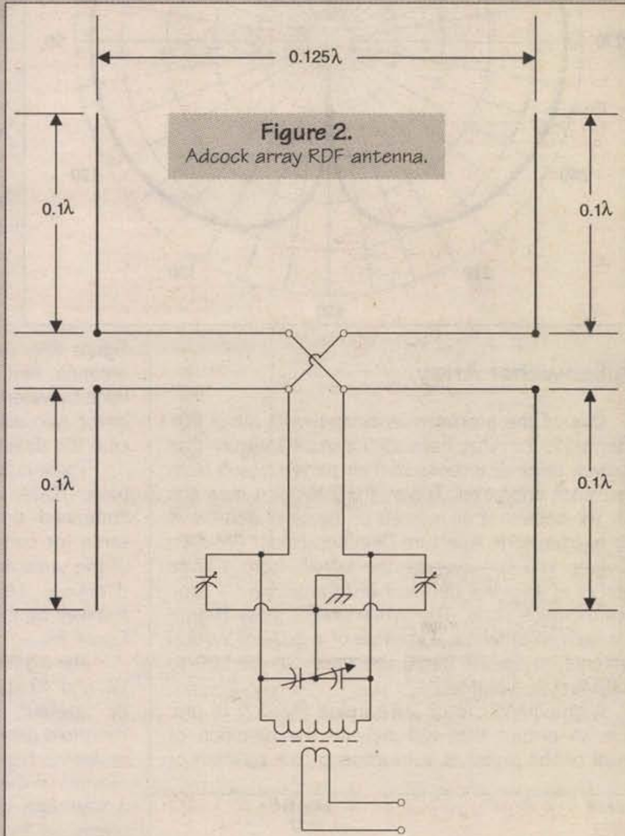

Figure 2.
Adcock array RDF antenna.

Watson-Watt Adcock Array

Figure 4 shows the Watson-Watt Adcock RDF array. It consists of two Adcock arrays arranged orthogonally to each other. It is common practice to arrange one Adcock in the east-west direction and the other in the north-south direction. These are fed to identical receivers that are controlled by a common local oscillator (LO). The outputs of the receivers are balanced, and are used to drive the vertical and horizontal plates of a cathode ray oscilloscope (CRO).

Figure 5 shows the patterns achieved by signals of various phases arriving at the Watson-Watt array. The patterns of Figure 5A and Figure 5B are made from signals 180 degrees out of phase, while the signal of Figure 5C is a 90-degree phase difference.

Doppler RDF Antennas

Figure 6 shows the basic concept of a Doppler RDF antenna. The Doppler effect was discovered in the nineteenth century. A practical example of the Doppler effect is seen when an ambulance wailing siren is approaching you, and then passes you and heads out away from you. The wailing pitch will rise as the sound source approaches, and then falls as the sound source recedes in the opposite direction.

In a radio system, when the antenna and signal source move with respect to each other, a Doppler shift is generated. This shift is proportional to the relative speed difference. The Doppler RDF antenna of Figure 6 uses a rotating antenna. The signal approaches from a single direction, so there will be a predictable Doppler shift at any point on the circular path of the antenna. The magnitude of the phase shift is:

$$S = \frac{R \omega F_c}{c}$$

Where:
S is the Doppler shift in hertz (Hz)
R is the radius of rotation in meters
ω is the angular velocity of the antenna in radians per second (rad/s)
F_c is the carrier frequency of the incoming signal in hertz (Hz)
c is the velocity of light (3×10^8 m/s)

In theory, this antenna works nicely, but in practice there are problems. One of the big problems is getting a large enough Doppler shift to easily measure. Unfortunately, the rotational speed required of the antenna is very high ... too high for practical use. However, the effect can be simulated using a number of antennas arranged in a circle that are sequentially scanned. The result is a piecewise approximation of the effect seen when the antenna is rotated at high speed.

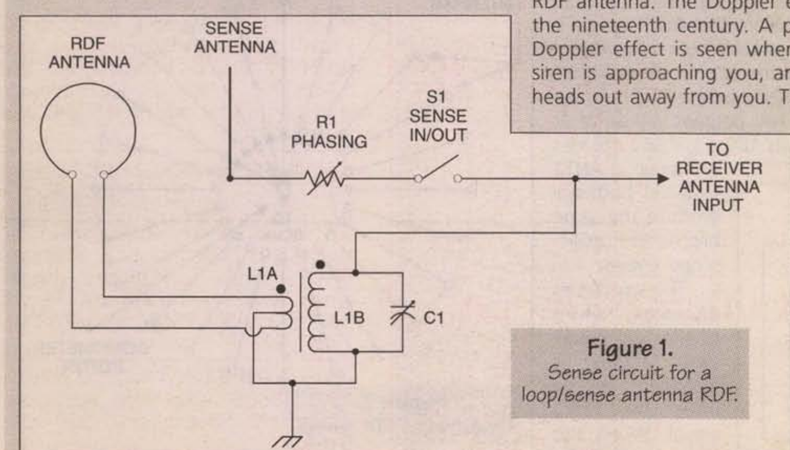

Figure 1.
Sense circuit for a loop/sense antenna RDF.

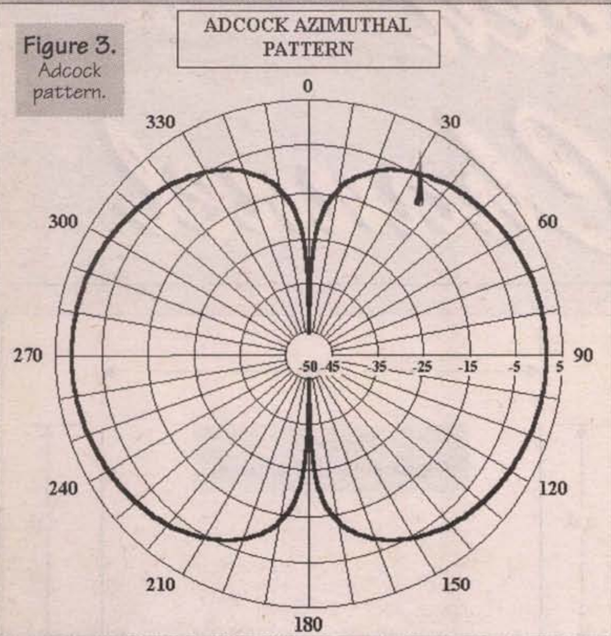

Figure 3. Adcock pattern.

Wullenweber Array

One of the problems associated with small RDF antennas is that they have such a small aperture that relatively large distortions of their pattern result from even small anomalies. Follow that? What it means is that the pattern is all messed up by small defects. If you build a Wide Aperture Direction Finder (WADF), however, you can average the signals from a large number of antenna elements distributed over a large circumference circle. The Wullenweber array (Figure 7) is such an antenna. It consists of a circle of vertical elements. In the HF band, the circle can be 500 to 2,000 feet in diameter.

A goniometer rotor spins inside the ring to produce an output that will indicate the direction of arrival of the signal as a function of the position of the goniometer. The theoretical resolution of the Wullenweber array is on the order of 0.1 degrees, although practical resolutions of about 2.8 degrees is commonly seen.

Time Difference of Arrival (TDOA) Array

If you erect two antennas with a distance, d, apart, then arriving signals can be detected by examining the time-of-arrival difference. Figure 8A shows an example signal. If the advancing wavefront is parallel to the line between the antennas, then it will arrive at both antennas at the same time. The TDOA is zero in that case. But if the signal arrives at an angle (as in Figure 8A), it will arrive at one antenna first. From the difference between the time of arrival at the two antennas, we can discern the direction of arrival.

There is an ambiguity in the basic TDOA array in that the combined output will be the same for conjugate angles, i.e., at the same angle from opposite directions. This problem can be resolved by the system shown in Figure 8B.

The signals from ANT1 and ANT2 are designated V1 and V2, respectively. These signals are detected by receivers (RCVR1 and RCVR2), and are then threshold detected in order to prevent signal-to-noise problems from interfering with the operation. The outputs of the threshold detectors are used to trigger a sawtooth generator that controls the horizontal sweep on an oscilloscope.

The two signals are then delayed, and one is inverted. The reason for inverting one signal is to allow the operator to distinguish them on the CRT screen. The reason why this is necessary is the ambiguity. If the antennas in Figure 8A are arrayed east-to-west, then the line perpendicular to the line between them is north-to-south.

If we designate north as zero degrees, then the signal shown arrives at an angle of 330 degrees. That means it will arrive at ANT1 before it arrives at ANT2. A signal arriving from a bearing of 30 degrees will produce the same output signal, even though it arrives at ANT2 before ANT1. All signals of bearing $0 \leq x < 180$ degrees will arrive at ANT2 first, while all signals $180 \leq x < 360$ degrees will arrive at ANT1 first. Yet both will produce the same blip on the oscilloscope screen.

The solution to discerning which of the two conjugate angles is intended is to invert the ANT1 signal. When this is done, the ANT1 signal falls below the baseline on the CRT screen, while the ANT2 signal is above the baseline. By noting the time difference between the pulses, and their relative position, we can determine the bearing of the arriving signal.

Switched Pattern RDF Antennas

Suppose we have a unidirectional pattern such as the cardioid shown in Figure 9. If we can rapidly switch the pattern back and forth between two directions that are 180 degrees apart, then we can-

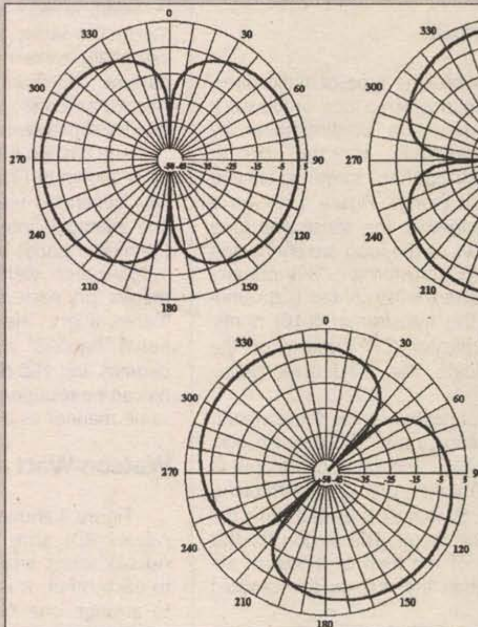

Figure 5. Patterns for different signals on the Watson-Watt array.

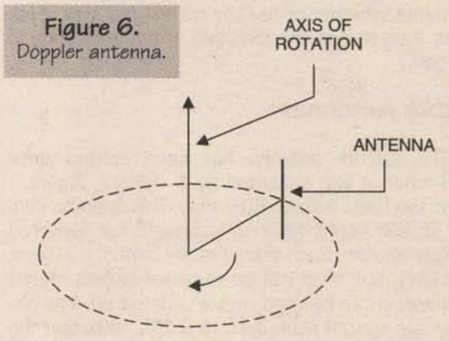

Figure 6. Doppler antenna.

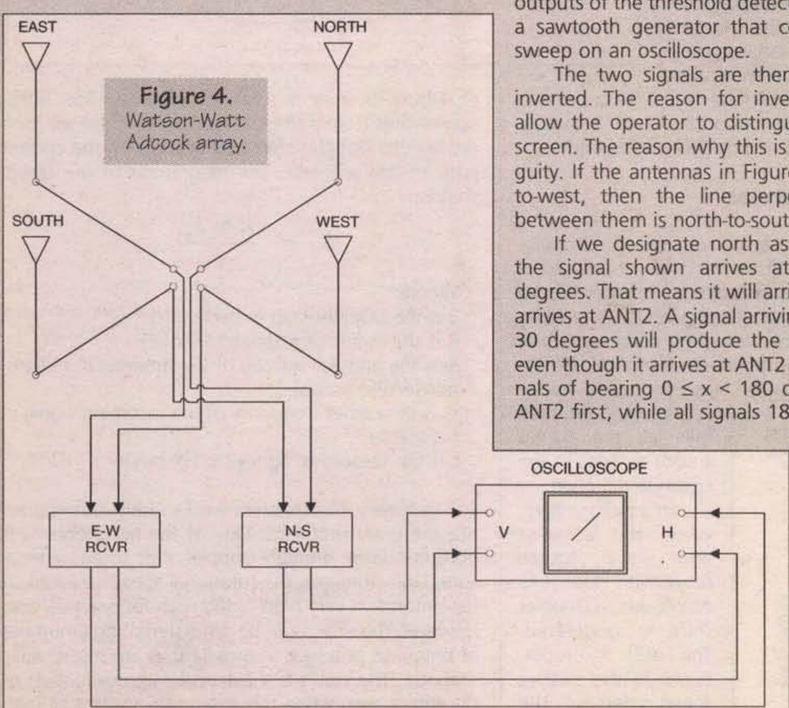

Figure 4. Watson-Watt Adcock array.

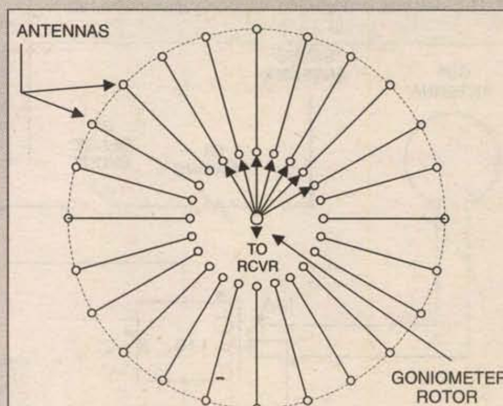

Figure 7. Wellenweber RDF array.

not only discern direction, but tell whether an off-axis signal is left or right. This feature is especially useful for mobile and portable direction finding.

In Figure 9 we have three different positions for a signal source. When the signal source is at point A, it will affect the pattern to the left more than the pattern to the right, so the meter will read "LEFT." If the signal source is at point B, on the other hand, the signal affects both pattern positions equally, so the meter reads zero. Finally, if the signal arrives from point C, it affects the right hand pattern more than the left hand pattern, so the meter reads "RIGHT."

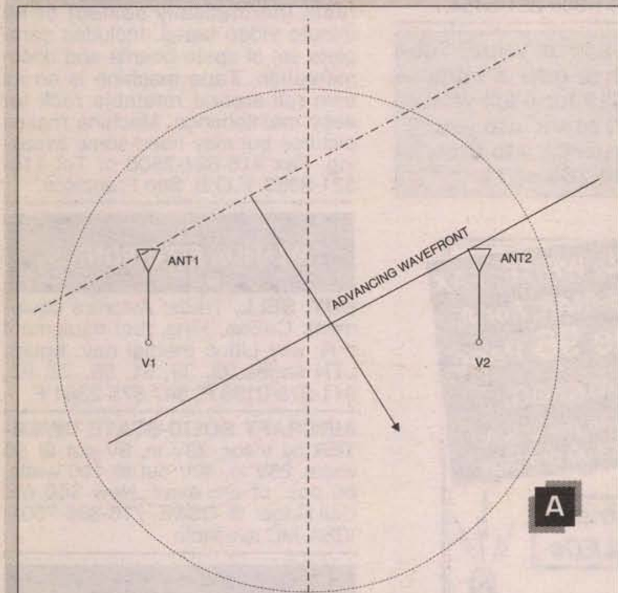

Figure 10 shows how such a system can be constructed. This system has been used by amateur radio operators using "rubber ducky" VHF antennas and a single receiver, where it is commonly called the "Double-Ducky Direction Finder" (DDDF). The antennas are spaced from 0.25λ to 1λ apart over a good ground plane (such as the roof of a car or truck). If no ground plane exists, then a sheet metal ground plane should be provided.

In Figure 10, we see the antennas are fed from a common transmission to the receiver. In order to keep them electrically the same distance apart, a pair of identical half wavelength sections of transmission line are used to couple to the antennas.

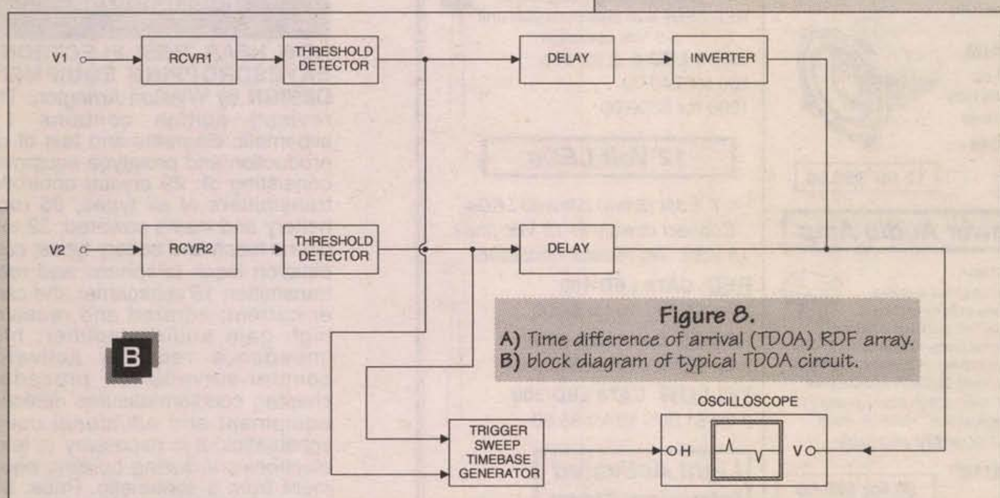

Figure 8.
A) Time difference of arrival (TDOA) RDF array.
B) block diagram of typical TDOA circuit.

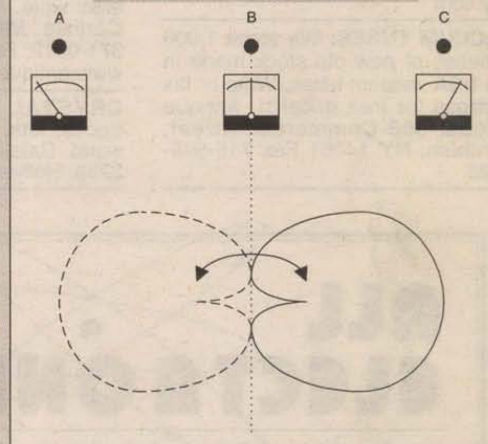

Figure 9.
Switched pattern RDF system.

Switching is accomplished by using a bipolar squarewave and pin diodes. The bipolar squarewave (see inset to Figure 10) has a positive peak voltage and a negative peak voltage on opposite halves of the cycle. The pin diodes (D1 and D2) are connected in opposite polarity to each other. Diode D1 will conduct on negative excursions of the squarewave, while D2 conducts on positive excursions. The antenna connected to the conducting diode is the one that is connected to the receiver, while the other one is parasitic. The active antenna therefore switches back and forth between ANT-1 and ANT-2.

This antenna is coupled to the receiver through a small value capacitor (C1) so that the squarewave does not enter the receiver. This allows us to use the transmission line for both the RF signal and the switching signal. An RF choke (RFC3) is used to keep RF from the antenna from entering the squarewave generator.

The DDDF antenna produces a phase modulation of the incoming signal that has the same frequency as the squarewave. This signal can be heard in the receiver output. When the signal's direction of arrival is perpendicular to the line between the two antennas, the phase difference is zero, so the audio tone disappears.

The pattern of the DDDF antenna is bidirectional, so there is the same ambiguity problem as exists with loop antennas. The ambiguity can be resolved by either of two methods. First, a reflector can be placed λ/4 behind the antennas. This is attractive, but it tends to distort the antenna pattern a little bit. The other method is to rotate the antenna through 90 degrees (or walk an L-shaped path).

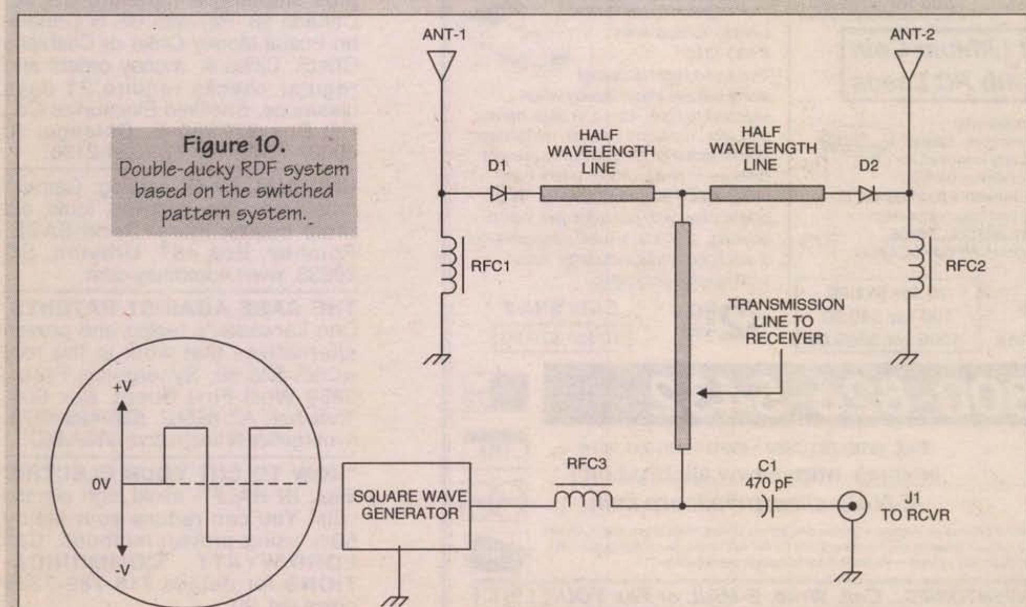

Figure 10.
Double-ducky RDF system based on the switched pattern system.

Conclusion

Radio direction finding can be very useful for locating RF noise sources, illegal stations, and other RF sources. It can also be used to locate yourself if you can get bearings on at least two stations. The lines of bearing will cross at a location approximately where you are standing ... try it, you'll like it. **NV**

Connections ...
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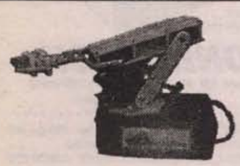

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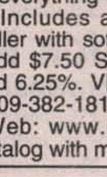

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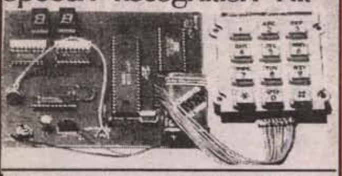

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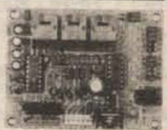

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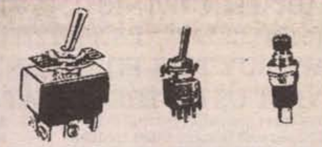

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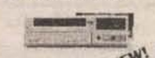

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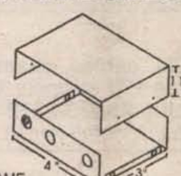

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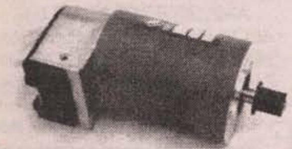

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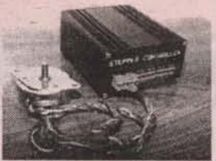

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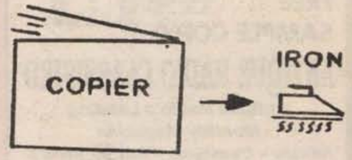

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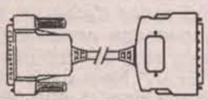

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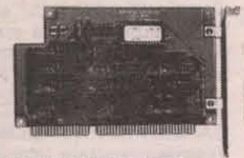

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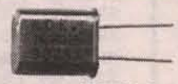

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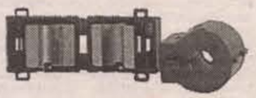

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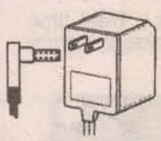

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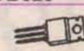

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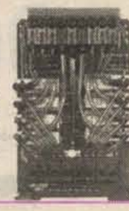

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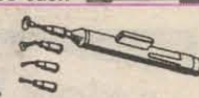

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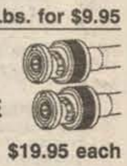

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Stamp Applications!

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

by Jon Williams

Last month, we built a working alarm clock with the Stamp 2 and the Dallas Semiconductor DS1302. While I've been able to port the heart of that code to the Stamp 1, there just isn't enough program space left to do anything practical. This month, we'll create an alarm clock with the Stamp 1 by using a recent addition to the list of serial saviors: the Pocket Watch B (PWB) from Solutions Cubed. And, of course, we'll call on our old friend — the Scott Edwards' serial LCD backpack — to provide the display for the clock.

It's Time To Get Real – Part 2

The Pocket Watch B is a pin-for-pin replacement of the original Pocket Watch that Scott reviewed in this column in April '97. Improvements include:

- Factory calibrated timebase
- User accessible timebase
- User calibration of timebase
- Three advanced alarms: single-shot, short astable, and long astable
- Year 2000 compliance
- PCB insertable SIP connector
- Streamlined communications protocol

Physically, the Pocket Watch B is a one-inch-squared circuit board with a five-pin SIP connector on one edge. I found the arrangement of the SIP connector very handy; I simply plugged the PWB into a solderless breadboard and started experimenting. In a permanent project, you could use Scott Edwards' connéctamúndos header-post jumper wires (I love those things!). Refer to the Oct. '95 installment of Stamp Applications for instructions on building your own connéctamúndos-type jumper wires.

The connections to the PWB are +5 volts, ground, transmit, receive, and alarm. Don't be worried about the separate transmit and receive pins. These pins are never active at the same time, so we can tie them together for use with the Stamp. The alarm output from the PWB is a real help in conserving our I/O resources. Last month, we used eight pins. This month, we only need five.

How It Works

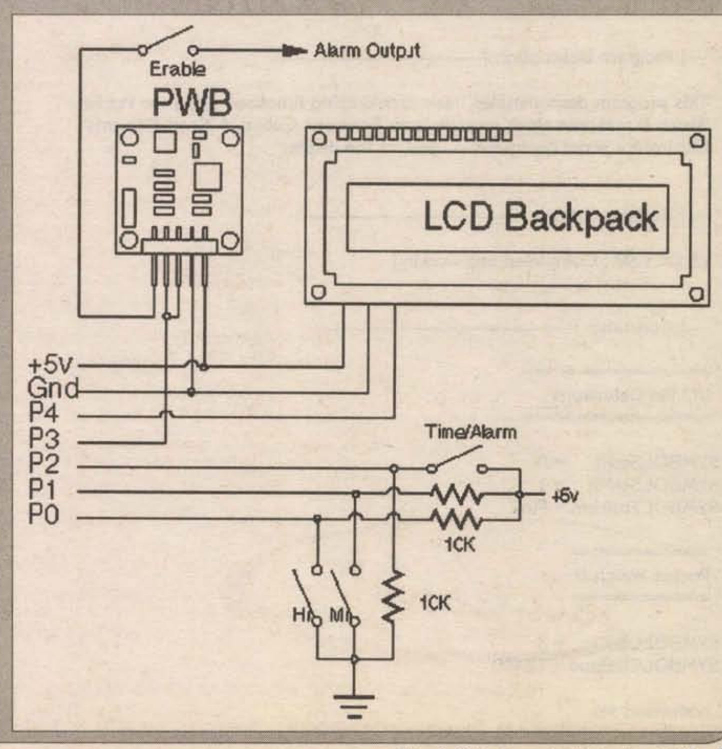
The PWB is a stand-alone, time-keeping module with advanced alarm features. It contains separate registers for the time and alarm values. Last month, we were forced to synthesize an alarm with the DS1302. The PWB conveniently handles all those details for us. The PWB also differs from the DS1302 in that the registers are transmitted in straight binary. We don't need to worry about BCD conversions when using the PWB.

Like the LCD backpack, the PWB communicates with the Stamp through an asynchronous serial connection. When you examine the code, you'll notice that each command sequence begins with $55. This byte is necessary for the PWB to detect the baud rate being used. And, while 4800 and 9600 baud are supported, the standard speed of the Stamp 1 limits us to 2400 baud.

The PWB uses two different time modes: standard and extended. In extended mode, two bytes are used for the year. The high byte of the year contains the century value (i.e., 19). If you need year-2000 compliance, or want to use one of the advanced alarms, use extended mode. And keep in mind that the PWB operates strictly in 24-hour mode. That is, the hours will always be from zero to 23. In order to save space, we'll stick with that format for this project. If you'd like to have a 12-hour clock, refer to last month's code for the conversion routine.

In addition to the physical alarm output, the PWB has four distinct alarm types: standard, single-short, short astable, and long astable. The standard alarm is the easiest to understand, and yet, the least convenient to use. Once the standard alarm trips, it will not reset unless the PWB power is cycled or an "alarm off" command is sent to the PWB. Either case requires the Stamp to monitor the alarm output, using up another precious pin.

The single-shot alarm output causes the alarm output to be on for a user-specified number of seconds. The PWB accepts values $0000 to $FFFE (65,534) allowing for very long outputs (greater than 18 hours). A possible down side to the single-shot mode is that it is not automatically re-enabled once fired. This means that you have to reset the alarm after the single-shot output has activated. One last note: The PWB automatically adds one second to the time you download. Keep this in mind for precision applications.



As I pointed out earlier, the PWB has two astable alarms: short and long. They are similar in that you download a repetition rate and duration for the alarm output. In short mode ($17), repetition is specified in minutes, and duration is specified in seconds. In long mode ($18), repetition is specified in hours, and output is in minutes. And just as with the single-shot mode, the PWB increments each register (repetition and time) by one. Since our project is a standard alarm clock, we tell the PWB to turn on the alarm output for one minute every 24 hours with this command:

```
SEROUT ClkIO, ClkBaud, ($55, $18, 23, 0)
```

Our BS1 Alarm Clock

Aside from the different RTC and LCD hardware, our BS1 alarm clock is structurally similar to the BS2 version we built last month. The features of the PWB certainly simplify the code, allowing it to fit into the slim resources of the Stamp 1. Examining Listing 1, you'll see that the code reads the PWB, displays the time just read, and checks the time-set buttons. If either time-set button was pressed, the raw time value is updated and the clock is reset with that value. Since the PWB handles the alarm processing, we simply need to connect our circuit to it.

There are no new tricks used in this program, however, there is one area that I feel could use a bit more explanation: the use of I/O pins as variables. If you look very carefully, you'll see that this program does not actually know what it's reading or setting (time or alarm). The program simply deals with a time value. What this value represents is determined by the state of the Time/Alarm input.

Within our definitions, we have a variable called TmAlrm that tracks the state of pin 2. This pin is normally pulled low through a 10K resistor. With the Time/Alarm switch in the Time position (open), a read of TmAlrm will return a value of zero. When the switch is in the Alarm position (closed), a read of TmAlrm will return a value of one. The value of TmAlrm is refreshed every time we use it since it is referencing pin 2.

Last month, we used this input (albeit inverted) as an array index for our rawTime variable. Since the PWB contains separate time and alarm registers, this month we're using TmAlrm variable to determine which set of registers are being retrieved or set. To read the time registers (standard mode is suitable for our project) from the PWB, we need to issue the command byte of $02. To read the alarm time registers, we need to issue a command byte of $03. No problem; we simply add the value of TmAlrm to $02 and use this as our command byte.

We use the same technique when setting the time or alarm. There is a bit of extra code in the SetTm routine to set up the long astable alarm and to enable the alarm output.

The PWB command set made the technique I just described pretty easy. But what would you do if the commands were, say, $03 and $15? This is still not a problem; it just requires a little extra math. If the code for "get time" was $03, and the code for "get alarm" was $15, we'd rewrite our command line like this:

```
temp1 = $12 * TmAlarm + $03
```

Run through the math so you understand how this works. Note that the order is important. Remember that the Stamp 1 evaluates math strictly from left to right — parenthesis are not allowed and there are no operator precedents. Do keep this one in your bag of tricks. It'll save you a couple of lines of code, which is always important when working with the Stamp 1.

True to our word, we built an alarm clock with the Stamp 1. It's not particularly fancy, but it is very functional and there's enough space left for a few bells and whistles. If you connect the PWB to a Stamp 2, you'll have plenty of code space to work with the date registers. Give it a try.

Once again, I'd like to thank those of you who have sent E-Mail. I sincerely appreciate your kind comments and your thoughtful ideas. And I'd like to thank the good folks at *Nuts & Volts* and my friend Scott Edwards for their faith in my first stint as a columnist. To each of you reading this, may God bless you, your families, and loved ones through this holiday season, and the coming new year. I'll see you in 1998! **NV**

Sources

For more information on the BASIC Stamp, contact:

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

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```
' Listing 1
' Stamp Applications: Nuts & Volts, December 1997

' —[ Title ]———————————————
'
' File...... BS1CLOCK.BAS
' Purpose... Stamp 1-based Alarm Clock
' Author.... Jon Williams
' E-mail.... jonwms@aol.com
' WWW....... http://members.aol.com/jonwms
' Started... 25 OCT 97
' Updated... 26 OCT 97


' —[ Program Description ]—————————
'
' This program demonstrates basic timekeeping functions using the Pocket
' Watch B real-time clock module from Solutions Cubed. A Scott Edwards'
' Electronics serial backpack is used for the display


' —[ Revision History ]———————————
'
' 26 OCT 97 : Completed and working


' —[ Constants ]———————————————
'
' ==================
' I/O Pin Definitions
' ==================
'
SYMBOLSetHr   = 0
SYMBOLSetMn   = 1
SYMBOLTmAlrm = Pin2

' ==============
' Pocket Watch B
' ==============
'
SYMBOLClkIO    = 3
SYMBOLClkBaud = T2400

' command set
SYMBOLWrTime  = $00        ' write time – standard
SYMBOLWrAlrm  = $01        ' write alarm – standard
SYMBOLRdTime  = $02        ' read time – standard
SYMBOLRdAlrm  = $03        ' read alarm – standard
SYMBOLAlrm1   = $04        ' alarm on
SYMBOLAlrm0   = $05        ' alarm off
SYMBOLWrXTm   = $10        ' write time – extended
SYMBOLWrXAlrm= $11         ' write alarm – extended
SYMBOLRdXTm   = $12        ' read time – extended
SYMBOLRdXAlrm= $13         ' read alarm – extended
SYMBOLAlrm1X  = $14        ' alarm on – extended
SYMBOLAlrm0X  = $15        ' alarm off – extended
SYMBOLSSAlrm  = $16        ' single-shot alarm
SYMBOLSAAlrm  = $17        ' short astable alarm
SYMBOLLAAlrm  = $18        ' long astable alarm
SYMBOLGetAlrm = $19        ' get alarm characteristics


' ======================
' SEE Serial Backpack LCD
' ======================
'
SYMBOLLcdIO    = 4
SYMBOLLcdBaud= N2400

SYMBOL I       = $FE       ' backpack instruction toggle
SYMBOL ClrLCD  = $01       ' clear the LCD
SYMBOL CrsrHm  = $02       ' move cursor to home position
SYMBOL CrsrLf  = $10       ' move cursor left
SYMBOL CrsrRt  = $14       ' move cursor right
SYMBOL DispLf  = $18       ' shift displayed chars left
SYMBOL DispRt  = $1C       ' shift displayed chars right
SYMBOL DDRam   = $80       ' Display Data Ram control
SYMBOL CGRam   = $40       ' Char Gen Ram control


SYMBOLBtnDly   = 35        ' delay for BUTTON loop


' —[ Variables ]———————————————

SYMBOLsecs     = B0
SYMBOLmins     = B1
SYMBOLhrs      = B2
```

Stamp

```
SYMBOLxx       = B3              ' space holder for date registers
SYMBOLtemp1    = B4
SYMBOLtemp2    = B5
SYMBOLbutn     = B6              ' BUTTON workspace
SYMBOLrawTm    = W4              ' raw time (minutes past midnight)

' —[ EEPROM Data ]————————————
'

' —[ Initialization ]———————————
'
Init:   Dirs = %00011000
        Pins = %00001000
        PAUSE 1000               ' let clock and LCD initialize

' —[ Main Code ]————————————
'
Start:  GOSUB GetTm              ' get the clock
        GOSUB ShowTm             ' show clock on backpack lcd

        butn = 0
ChkHr:  BUTTON SetHr,0,150,10,butn,0,ChkMn    ' is Set Hours pressed?
        GOSUB GetTm                           ' yes, get the clock
        rawTm = rawTm + 60 // 1440
        GOSUB SetTm                           ' set new time
        GOSUB ShowTm                          ' display the change
        PAUSE BtnDly                          ' pause between changes
        GOTO ChkHr                            ' still pressed?

ChkMn:  BUTTON SetMn,0,150,10,butn,0,Start    ' is Set Minutes pressed?
        GOSUB GetTm                           ' yes, get the clock
        rawTm = rawTm + 1 // 1440
        GOSUB SetTm                           ' set new time
        GOSUB ShowTm                          ' display the change
        PAUSE BtnDly                          ' pause between changes
        GOTO ChkMn                            ' still pressed?

        GOTO Start

' —[ Subroutines ]————————————
'
GetTm:  temp1 = $02 + TmAlrm                  ' time ($02) or alarm ($03)
        SEROUT ClkIO,ClkBaud,($55,temp1)
        ' note that we ignore day, month and year
        SERIN  ClkIO,ClkBaud,secs,mins,hrs,xx,xx,xx
        rawTm = hrs * 60 + mins               ' update raw time value
        RETURN

SetTm:  hrs = rawTm / 60                      ' get hours from raw time
        mins = rawTm // 60                    ' get minutes from raw time
        ' set the clock time
        ' (alarm if "TmAlrm" input is high)
        temp1 = $10 + TmAlrm                  ' calculate command code
        SEROUT ClkIO,ClkBaud,($55,temp1,0,mins,hrs,10,18,97)
        IF TmAlrm = 0 THEN Done
        ' reset the alarm output duration
        ' every 24 hours for 1 minute
        ' (the Pocket Watch B increments each value by 1)
        SEROUT ClkIO,ClkBaud,($55,LAAlrm,23,0)
        ' enable the alarm
        SEROUT ClkIO,ClkBaud,($55,Alrm1X)
Done:   RETURN

ShowTm:         SEROUT LcdIO,LCDBaud,(I,ClrLCD)       ' clear the lcd
        temp1 = hrs / 10                      ' get the hours 10s digit
        temp2 = hrs // 10                     ' get the hours 1s digit
        SEROUT LcdIO,LCDBaud,(#temp1,#temp2,":")
        temp1 = mins / 10                     ' get the mins 10s digit
        temp2 = mins // 10                    ' get the mins 1s digit
        SEROUT LcdIO,LCDBaud,(#temp1,#temp2)
        ' remove next 3 lines to conserve code space
        temp1 = secs / 10                     ' get the secs 10s digit
        temp2 = secs // 10                    ' get the secs 1s digit
        SEROUT LcdIO,LCDBaud,(":",#temp1,#temp2)
        RETURN
```

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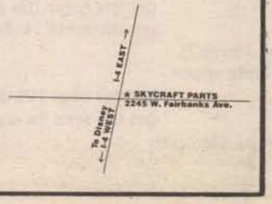

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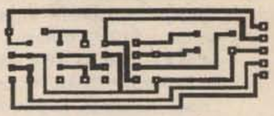

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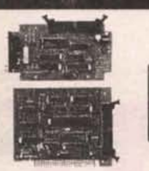

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ELECTRONICS Q & A

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

What's Up:

Thanks for the lost memories: the story of a virus infection, two readers looking for part replacements, and specs on old monitors. A more ambitious telephone off-hook circuit, a sensitive IR detector, and a turntable vacuum tube preamplifier. Finally, two programs that convert Internet files to text.

Virus Concerns

Q. Will you shed some light on a subject that comes up around here quite often? Is it possible for a computer to become infected with a virus by merely reading an E-Mail message?

Charles E. Heisler K3VDB
via Internet

A. Not that I'm aware of. To become infected you need to download a file of *some kind — something that has encoding, such an EXE or MS-Word file. E-Mail messages are done in ASCII, which a virus can't attach to.*

While we're on the subject, I'd like to thank that reader who infected my system with a virus. As you know, I try my best to respond to your needs as quickly as possible, which is why my E-Mail box is always open. However, this open-door policy also leaves me vulnerable to all kinds of trash — including viruses. Well, this month, a reader slipped a StealthBoot.c virus through my defenses, with devastating consequences. StealthBoot is a very infectious virus that's undetectable by many virus checkers. Moreover, the longer it lingers, the more damage it does. Imagine an earth worm eating through your brain, gobbling up brain cells as it tunnels. That's StealthBoot. So, if you're the person who purposely infected me with that phoney "drawing" file, this is your 15 minutes of fame. I know who you are and if you try it again, expect a lawsuit and possible arrest.

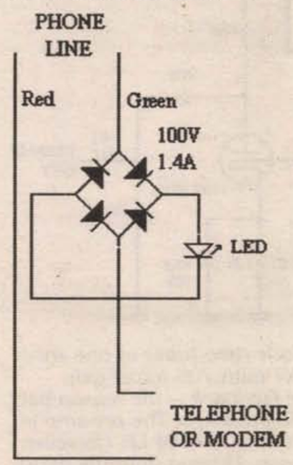
I know what your next question is, so let me tell you how I discovered and rid myself of this virus. Because this particular strain is stealth and new, it was able to penetrate my first line of defense: a virus checker from Microsoft that I should have upgraded three years ago. All the really good virus-detection programs have some form of scheduled upgrading (usually quarterly) that adds new virus patterns to their scanning process. Well, I made a copy of a file and gave it to my girlfriend to print out. Guarding the gates of her computer is the Norton AntiVirus program. While it didn't identify the virus correctly, it flashed a message that the disk was infected. Puzzled, I ran a virus search and destroy (clean) operation using her virus program, only to discover that Norton had lost it. Oops! Big trouble! I took the diskette back to my PC and gave it a thorough screening. It wasn't until I downloaded the latest version of Dr. Solomon (http://www.drsolomon.com) that I discovered the true nature of the infection. A subsequent check with the newest version of McAfee VirusScan (http://www.mcafee.com) also located the virus. However, I used Dr. Solomon for the innoculation process, just because. This isn't to say McAfee VirusScan or Norton Anti-Virus are inferior. What I'm saying is that viruses are always a moving target. Like the hundreds of strains of Asian flu that plague us every year, no one vaccine works for all. From now on, I'll do my scheduled upgrades and daily scour my system for slimy bugs.

Are You Busy?

Q. On page 93 of the Oct. '97 issue you show how to build a line-in-use indicator for readers who have two phone lines. I built the indicator section of the circuit using parts from Radio Shack, but the light comes on only when the phone to which it is connected goes off-hook. If my wife picks up the extension in the next room, the light won't light. Is there a way to make your schematic work with extension phones, too, other than buying the Radio Shack "In-use Indicator" for $12.99 (plus a nine-volt battery)?

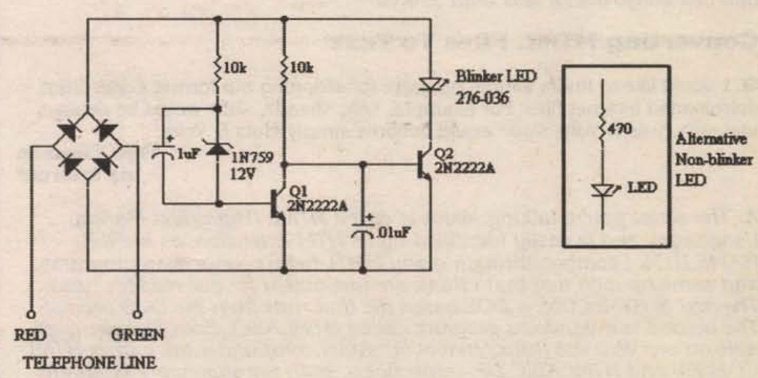
Bill Stitzer
Atascadero, CA

A. *The reason you can only detect your phone off-hook and not the extension is because the circuit is current operated. In other words, voltage is generated across the bridge rectifier only when current flows through the diodes — current triggered by your phone or any other device (fax, modem, etc.) going off-hook.*



When your wife picks up the extension, no current flows through your line, and the LED won't light. You need to insert this circuit in a line that feeds both phones, such as the building's main junction box, which isn't always practical. The solution is a voltage-sensitive off-hook detector, like the one below.

This circuit works by sensing the voltage status of the phone line. When the phone is on-hook, the line voltage is about 48 volts. This condition causes current to flow through the zener diode and turns on Q1 which, in turn, shunts the bias current of Q2 to ground and turns Q2 off. When the line goes off-hook, the voltage drops to 10 volts, which is below the triggering point of the zener. Q1 turns off, and restores bias current to Q2, which now turns on and lights the LED. If you have trouble detecting the off-hook, increase the value of the zener from 12 volts to 15 or 20 volts. The beauty of this device is that you can place it in any room and know if the line is being used by any device in the building — and you don't have to break the line. The disadvantage is the circuit has a higher part count and costs more to build.



Looking For A Substitute Part

Q. If you have your NTE cross-reference handy, could you please tell me what I can substitute for an NTE 379? I have one in an ancient Macintosh 512 power supply that has overheated and failed. I think it's a silicon power transistor, and I may have something in my attic that I could use — if I knew what to look for. However, my Radio Shack references don't show NTE numbers.

Miki Karner
via Internet

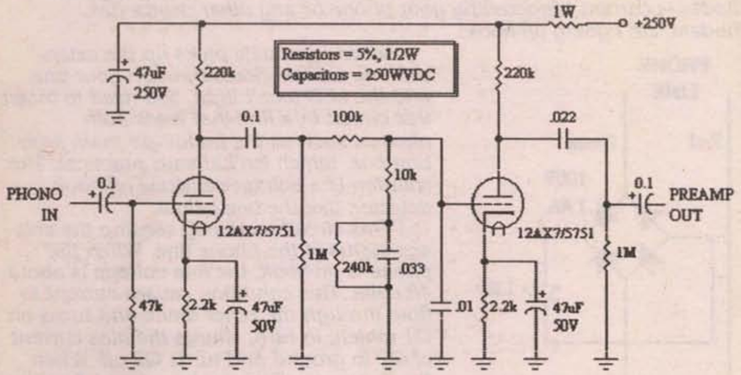
A. *Hmm, according to my crystal ball this is a very expensive ($8.00) silicon NPN power transistor with 12A @ 700V ratings in a TO220 case. The power dissipation is 100W. Let me see what Radio Shack has that's close ... how about a 2SC4274 (RSU 11426145). This is a special order part (via mail only) that lists for $5.39. Before you replace the transistor, though, make sure the diodes in the low-voltage section aren't shorted, or you'll be ordering another transistor. BTW, you can cross-reference NTE parts yourself from their Web site at http://www.nteinc.com*

Tube Preamp

Q. My friend recently gave me an old Pioneer PL-200 turntable, that sounds pretty amazing — but only after I run it through my four-track recorder before plugging it into the AUX input of my stereo. I would like to build a preamplifier to replace the tape recorder. After looking through several magazines, I noticed that old-style tube amps seem to be popular, but are way out of my price range. Are there any books or articles out there that show you how to build a reasonably-priced tube amp for my turntable?

Dave Whiteford
via Internet

A. *There's no such thing as a cheap tube amp because the parts that go into making it are expensive. For example, a 12AX7 tube will cost you $10.00, not counting the socket. And the high-voltage capacitors cost many times more than their solid-state counterparts. Still interested? Then here's a typical turntable pre-amp that'll cost you about $20.00 per channel (you need two for stereo), plus the cost of a chassis, ventilated cabinet, and a power supply (about $40.00, minimum).*



The circuit is built around a 5751 twin-triode (two tubes in one envelope). This tube is a premium, low-noise 12AX7 with 70% lower gain which all but eliminates the need for negative feedback — the reason vacuum tubes are highly prized in high-end audio pre-amps. The pre-amp is RIAA-compensated to match the sound profile of a 33-RPM LP. However, the circuit isn't complete, as you see, on purpose. Missing from the drawing is the power supply, tube pin-outs, and the filament connections. If you don't know how to do this, get help from a local HAM radio operator. The high voltages and open construction can be a deadly combination. Good luck! Are you sure you don't want the op amp equivalent which you can construct for less than $20.00?

Converting HTML Files To Text

Q. I would like to find a simple program for stripping out format codes from downloaded Internet files. For example, <A>, <head>, <h5> would be deleted, and <ul> Nuts & Volts <\ul> would become simply Nuts & Volts.

Fred Chesson
via Internet

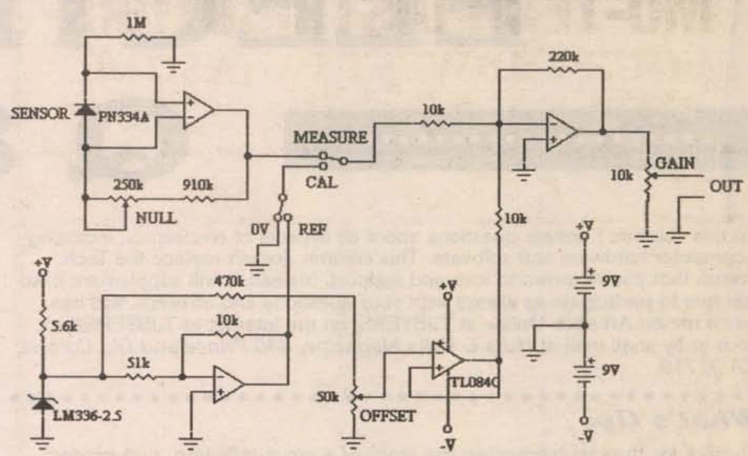
A. *The script you're talking about is called HTML (HyperText Markup Language), and is easily identified by its HTM extension, as in FILENAME.HTM. I combed through many HMTL-to-text conversion programs, and came up with two that I think are well-suited for our reader's needs. The first is HTMLCOM, a DOS-based file that runs from the DOS prompt. The second is a Windows program called HTMLASCI. Both files are available on our Web site (http://www.nutsvolts.com) under the names HTMLCOM.ZIP and HTMLASIC.ZIP, respectively. Both are shareware programs ($7.00 and $20.00), which you can try for free, and both are zipped files that need to be expanded using PKUNZIP (also available on our Web site under PKUNZIP.EXE for DOS and PK250W16.EXE for Windows). Be aware, these are conversion programs only; they won't let you edit HTML files. But you can edit the resulting ASCII files using any text editor or word processor.*

Future Scientist Needs Part

Q. I'm a junior at Greenwich High School currently working on an independent science research project. I'm trying to build an electronic circuit that I found in an article published in the *Journal of Chemical Education*. The detector in the schematic is a TIL413, which is no longer in production. I noticed your article on page 133 of the July '97 issue where you mentioned an infrared detector. Could this detector be substituted for the TIL413? If not, could you please suggest another detector that could be used in place of it?

Melissa Otero
via Internet

A. *You've taken on a very ambitious project, trying to measure vivo chlorophyll fluorescence. I wish you luck. The detector you seek has long ago been replaced with faster and more sensitive PIN diodes. An excellent replacement is the PN334PA PIN diode from Panasonic. This part is available from Digi-Key (800-344-4539; http://www.digikey.com) for just $1.40. While you're at it, I'd substitute a TL084C op amp for the LM324 shown in the original design, and move a couple of the controls so that the circuit is more stable. Here's the modified schematic.*



This circuit can also be used to measure other low-level infrared events. Detection of the weak IR light is achieved by amplifying the output from the PN334PA photodiode. This sensor has a response time of two nanoseconds and a peak sensitivity at 900 nanometers. To set the NULL, short out the sensor diode and adjust the 250K pot so that the output of IC1A is zero. The OFFSET control is used to position the recorder's pen, and the GAIN control is used to limit the pen's swing so that it doesn't bang against the sides.

Scratchy CD Drive

Q. I need help with my CD-ROM, which is rather dirty. Every time I play my CDs, the drive ends up leaving scratches on the disk. I paid only $29.00, but that was three months ago, so I can't return it. I'd like to convert the CD music files to MP3 or WAV format to save them from further damage. Any suggestions?

Alex Bel
via Internet

A. *Only $29.00? The CDs this drive is destroying cost more than that! Toss it and buy a new one. As for converting your music tracks to WAV files, most of today's sound cards and video capture boards have the ability to capture CD-quality audio and save them to a file. While we're on the subject, the video capture cards can capture both synchronized sound and graphics, but you'll probably want to edit both to refine them and then re-synchronize them. To do this, look into Animator (Autodesk) or Premiere (Adobe). These are two completely different types of software. Animator is for 2-D animation, paint, and sound synchronization. Premiere handles video editing and special effects. In Animator, you can create or alter digital video sequences and synchronize the sound. In Premiere, you can also edit video, create custom transitions and special effects, and even remix audio into a finalized playback sequence. Be careful, though, this hobby can be addictive.*

EGA Monitor Lives?

Q. I have a used color monitor that I purchased surplus, and I need to get more information on it. I wrote the company (Mitsubishi), and got nowhere. The monitor is an XC1412C. I believe it is an EGA or CGA monitor, but I'm not sure. It has a DB-9 connector, and I'd like to get it to work with a Tandy RSX computer (386SX), which has a DB-15 connector and an AVGA2 video card running DOS 5.0. I also have an old PC-XT that I'd like to upgrade for use with this monitor, too, and need to know what I have to add.

Dave Raycroft
va3rj@hotmail.com

A. *I can't find anything on this monitor either, but if memory serves me, it's an EGA monitor. Unfortunately, your Tandy PC has a VGA video controller, and the PC-XT has a monochrome or CGA adapter. So your first task is finding an EGA video card, which won't be easy. They disappeared from the planet over 10 years ago. You might still be able to find one at a hamfest or parking-lot sale. Or maybe one of our readers has one gathering dust, which is why I'm including your E-Mail address. If you locate one of these dinosaurs, make sure you get the cable, too. Now all you have to do is plug the card into an empty slot and plug in the monitor. You may have to change a switch on the PC-XT from mono to color; it's located somewhere in the middle of the motherboard. I wouldn't waste too much time or money on this project. For a couple hundred dollars you can put together a 486DX system with a 14-inch SVGA (super-VGA) monitor that'll run circles around either.*

More Old Monitors

Q. I have a little AT&T monitor which I suspect is monochrome. I don't know what PC it came off, but it has a single cable coming out of it terminating in a

(Continued on page 109)

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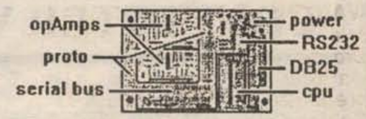

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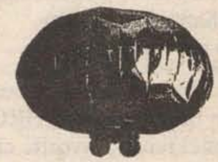

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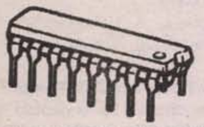

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Questions & Answers

TECH FORUM

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

QUESTIONS

Does anyone know how I can modify my Radio Shack DX-390 digital shortwave radio so that it doesn't mute while tuning?

12971 **Mike Elcsisin**
Winters, CA

I would like to make a 50 LED panel controlled by a number pad where the LED will come on when the respective number is pressed in on the number pad. I want to use high emitting green LEDs.

12972 **Sal Lieata**
Brooklyn, NY

I need a schematic/parts list to build a good bandpass filter and I need to pass 42 to 50 MHz on a receive antenna.

12973 **KF6NID**
Essex, CA

I need to get as much information as I can on kits for music. Such as drum machines or drum tone boards, synthesizer modules, tone generators, electronic bass emulators, sounders, and etc. It doesn't matter if it is company producers and schematics or person-built emulators, etc., resources, web sites, magazines, books, schematics, copies of these things of information will help me in educating myself.

12974 **Troy Thomas Day**
Longwood, FL

I am looking for a supplier of SMPTE time code generator and reader ICs. Does anyone know if PIC source code is available for this purpose?

12975 **Mike Uschak**
Loyalhanna, PA

In the past few years, I have designed several analog type measurement instruments that operate through the parallel port (with ADCs of course). These have all used QBASIC as the programming language. QBASIC addresses the port with the simple OUT- - - - for output on the port's eight output lines/pins, or INP- - - - for input so as to look at whatever is present on at least four of the port's input lines/pins.

I just purchased the PRO version of VISUAL BASIC 5 and discovered that it will not respond to "OUT- - - -" and "INP- - - -," even though it does respond to other QBASIC words. Actually it does respond with the dreaded "Compile error - - - Sub or Function not defined," but does not do anything useful.

My question boils down to: What commands (or words or lines or routines or something) are equivalent to "OUT - - - "and "INP - - - ?"

12976 **Richard Schroeder**
r.f.schroeder@juno.com

I'm making lighthouse models for gifts. I need a flashing light to operate off a nine-volt battery, flashing three to five seconds or so, with a switch.

Can you suggest a circuit? Where can I get the components? Is it possible to keep the cost to $1.00 or less (without the battery)? I will need about 125-150 total.

12977 **Andy Osborne**
South Walpole, MA

I have an AM/FM broadcast band radio aboard my boat. I find that the safety rails (attached to the fiberglass deck) make a fairly good reception aerial for it and the small portable TV. How can I make a better set-up using both rails (about 12 feet long each)? A hookey jumper works fair, but would like other and better ideas.

12978 **Cliff Steele**
Rockford, IL

My problem is finding any service information, schematic, or similar circuitry for a ADC model LT 60 linear tracking turntable. Maybe 10-years-old or more. The company address was 71 Chapel St., Newton, MA. This was made in Taiwan. If possible maybe a place to get service, arm travels only backwards to home. Would like schematic if possible.

12979 **James Marvel**
Rensselaer, NY

How can I make a battery operated TV using a signal amplifier (small but strong)? I have a TV set with regular rabbit ears for reception, and because of my location my reception is poor.

129710 **Anthony E. Smith**
Camden, NJ

I would like to get information on a good and reliable school-to-train in the field of RF technician.

129711 **Luis Diaz**
Paterson, NJ

I need to build a count down counter with a three or four digit LCD display keyed with a microswitch or reed switch. Then at "0" key, a relay to shut the system off. Maybe thumb wheel or rotary switches to set each digit, or maybe a key pad. Cost is important so I must build one. I need a schematic and parts list. This is to help our local school.

129712 **Mel Goodwin**
Terrell, TX

I have a IC-2F and IC-3P made by Inoue Communication Equipment of Oaska, Japan. I need information on two diodes D11 and D12 in IC-2F, manufactured in 1970. The diode is marked TCG110. What is the JEDEC number or what is the replacement number? Is this the first ICOM equipment made and sold in the USA?

129713 **Jerome F. Musialowski**
Cheektowaga, NY

I have a Toshiba T3100 model PA7037U laptop computer with a non-working screen. I would like to attach an outboard monitor to this computer, but I don't know how to toggle from the computer's built-in screen to the outboard monitor.

129714 **Ray Gilbert**
Sequim, WA

I was given a Hewlett Packard printer model number 2934A. It also has four plug-in slots in the back. In one of the slots is a module Courier 92188A. What is that for?

I would like to connect it to my Directwave PT 5M166B Pentium PC with Windows 95. In my printer wizard under HP selection, there are no choices for that model number. And I don't have a disk for it. What do I need to do to connect and make it work on my PC? I have called many different departments at "HP" and the best they could do is to give me another number to find out how much of a trade-in allowance I would get if I purchased a new HP printer. I have a good laser printer. I would like to use this one, because it has the wide carriage to run business forms.

129715 **Albin Bauer**
via Internet

A friend of mine bought a used 486SX computer from one of the local dealers. We (and I helped) could not get the 1.4 meg drive to format, coming back with the "Invalid media or track 0 bad - disk unusable. When I put the disk in my machine it would give me an empty directory and a serial number of 0000-0000. I put a NEW 1.44 MHz drive in and received the same results.

Both of the drives would format a 720K, giving the serial number 0000-0000. The dealer thought it was a defective power supply, but after a few days replaced the machine, with a 486 DXL4 100 MHz with an Award Modular Bios V4.50G. Same thing. The drive will format a 720K disk with no problem, giving it the same serial number, 0000-0000! The 5-1/2 drive works okay on both 360 and 1.2 Meg disks, giving the same serial #0000-0000.

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.
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- Due to space limitations, we can not reprint the original questions with the answer. The question number and the issue it appeared in are printed above the answer.
- Unanswered questions from a past issue may still be responded to.

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

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- Selected questions will be printed one time on a space available basis.
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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.

ANSWER TO #109713 - OCT. 1997

CAUTION! Timing lights can have up to 1 KV inside them. Use a shorting lead with a 50 ohm, 2W resistor in series on all high voltage capacitors inside the light as soon as you open it, and each time you make changes if you test it while opened up.

I am assuming the light runs off the vehicle 12V and has a third trigger wire that has to be directly connected to a spark plug wire. Some of the parts you need can be found in a junked photoflash unit trigger coil, SCR, small high-voltage film capacitor. The inductive pickup itself can be made from a ferrite U-1 core set with 10 turns of #26 wire on the "u." I used Ferroxcube (now called Phillips) 376U250 and 376B250 cores when I converted an old Sears timing light. There will be a lot of mechanical work involved:

1. Wrap a thin trigger wire around the flashtube, three-five turns of fine wire (#28-34 GA will do) wound over the length of the tube except the last 1/4"-3/8" near each end. **2.** Make a clamp housing for the inductive pickup cores. It will have a hinged, spring-loaded jaw with the "1" core in it and an opening big enough to pass the largest wire you want it to fit. The cable from the pickup to the timing light can be several feet of coaxial cable. The coax enters the light housing the same way the "direct connected" HV wire did. **3.** Add a small circuit board inside the timing light to hold the trigger cirucuit and possibly some added circuitry to be discussed below.

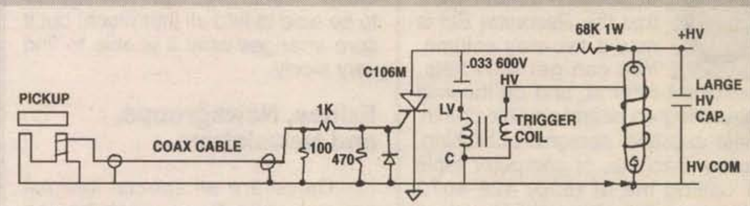
The trigger circuit is fairly simple.

The +HV and ground connections are to the two ends of the large high- voltage film capacitor which is wired across the ends of the flashtube. USE THE SHORTING WIRE before touching this part. It can have high voltage on it.

What is not simple is that the +HV varies a lot with engine RPM and can get very high if the timing light is turned on when no trigger is present. Usually all that happens is that the trigger circuit "free runs" as a relaxation oscillator. If it does this at low RPM (setting timing at idle speed, etc.) a high-voltage regulator circuit will have to be added to limit voltage at the SCR. This can be done various ways. The most efficient way controls the converter circuit that makes the high voltage. The simplest way is to stack up 300-500V of zeners in series and connect them across the SCR. Use a 68K 2W resistor instead of the 68K 1W shown in the drawing if this is done. If a better SCR is needed, try a C106M or any other 600V sensitive gate SCR.

Timing lights are fairly cheap, so I assume this is being done for fun. If so, trace the voltage converter circuit and find a way to add a controller to make it regulate. Set it for 80% of the voltage rating on the large high-voltage film capacitor.

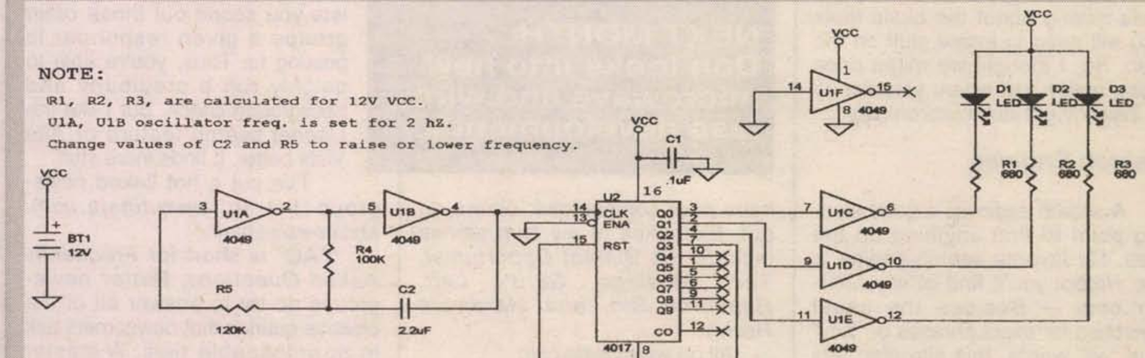
Jonathan Wexler
Los Angeles, CA



ANSWER TO #109715 OCT. 1997

The circuit you requested is easily implemented using a 4017 CMOS decade counter and a 4049 inverter to drive the LEDs. The 4000 series CMOS will operate between 3 to 18 volts and are ideally suited to the battery power as they use very little current.

Kevin Goodwin
Oceanside, CA



When using another format utility, it would format the disk and give a directory, both in this machine and mine. I cannot understand how this could happen. Could you enlighten me?

129716 **B. J. Baum**
Decatur, IL

I have an LCD clock and thermometer module that can be set on any given temperature within specified limits. (High or low.) If for example, I set the high limit for 75 degrees and when the ambient temperature reaches 75 degrees, the module opens one output port for connecting additional circuitry for an alarm buzzer, etc. This output offers a 1.5 volt positive. What simple circuit could I use to energize a 12-volt relay?

129717 **Mike McFarlane**
via Internet

Is there a machine that allows you to copy cartridges like Genesis or Nintendo 64?

129718 **Internet**

I have an old, small multi-band (3 to 30 MHz) "adapter" for an automobile radio (similar to many sold over the years by Blaupunkt, Phillips, Telefunken, Grundig, etc., but this one is a Japanese copy). It has push buttons for different meter bands; a 12-volt power connection, is solid-state, has an on-off push button, and connects between the antenna and the car radio. Once the band is selected, then the car radio's analog tuning knob tunes that band. It is a quite-satisfactory-at-night poor man's automobile shortwave receiver. (My income is limited to my monthly social security check.)

Is there a way to use this little gadget with newer digital (PLL) automobile radios? (They seem to be limited to the frequency spacing of regular US AM

Continued on page 100

Don Lancaster's

RESOURCE BIN

number seventy one

My secrets of web-based research

Our usual reminder here that the *Resource Bin* is now a two-way column. You can get tech help, consultant referral, 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.

Web Research Secrets

I sure do get a lot of helpline calls asking about the basic tools you will need to locate stuff on the web. So, I thought we might once again review just where you can go to instantly get stuff electronically ...

Search Engines

A *search engine* is a good starting point to find anything on the web. My favorite search engine is the *Hotbot* you'll find at www.hotbot.com — Besides the usual searches for exact phrases or "any" and "all" words, this site also lets you find people and even links to your own website.

The latter sure is a great ego trip. Finding out who knows about you is one useful way to see how well your web promotion efforts are working. Url links are also a means to find out what others think about a site.

Or to find related sites on a linked list third party collection.

Another popular search engine is *Alta Vista* at *www.altavista.digital.com*

This one appears to find almost as much as Hotbot almost as well. But Hotbot lets me view more results at once. And lets you restrict by date. The "find url" feature on Alta Vista is somewhat hidden. You have to prefix your search with *link:*.

As in *link:www.tinaja.com*

A hint: To find an exact phrase or a name, put the words in quotes. This will miss a lot and give you less hits, but can be fast and accurate.

Some 70 or so of the popular search engines are gathered together at *www.wp.com/resch/search.htm* — One brand new *inference* engine is offered at *www.inference.com/infind* — This one does not appear to be able to find all that much, but it sure arranges what it is able to find very nicely.

Ezines, Newsgroups, and Newsletters

These are all special interest online publications, each having their own strengths and weaknesses.

An *ezine* could be any electronically published magazine. Some have print companions; others do not. Examples of my own ezines include the *Blatant Opportunist*, *Tech Musings*, *Guru's Lair*, *Resource Bin*, and *Hardware Hacker*.

NEXT MONTH: Don looks into new microwave and wireless developments.

All on *www.tinaja.com*

The best ezine directory seems to be John Labovitz's *www.meer.net/~johnle-zine-list* — Some other useful locators are found at *www.dominis.com/Zines* or *www.edoc.com/ejournal*

My favorite printed zine and web ezine commentary is Seth Friedman's *Factsheet Five* at *www.well.com/conf/f5/f 5index2.html* — There's something here to offend everyone.

A *NewsGroup* is a Usenet forum to which anyone can post and anyone can subscribe. There are many tens of thousands of these which target most any imaginable special interest topic. The nice thing about newsgroups is that you might visit these only when and where you want, actually reading only those threads and the authors of current interest to you.

The bad thing about newsgroups is that their quality can get really poor. Many newsgroups are not moderated, so anyone can say anything. There's a lot of naive and misinformed posting here, scads of hidden agendas, plus great heaping bunches of invective insults. So much so that all the real experts in most fields won't put up with such time-wasting nonsense.

And are promptly driven away.

Newsgroups are also the home of *trolls.* A troll is an life-challenged and clue-challenged individual who posts in such a tone as to totally infuriate the other users into making irrational responses. Troll skill levels can range from immature juvenile newbies to diabolical fiends. Your surest way to spot any troll is whenever they flame *themselves* on slow days. Some even conjure carefully crafted *Sock Puppet* alter egos. Needless to say, you *never* respond to any troll in any manner. Ignore them and they'll go away.

Or else Bozo filter them.

You can access these newsgroups through the *news server* at your local ISP. Most include news access in their basic rate; others will charge a little extra. The news service will include a listing and a search service.

The usual starting point to find out all about newsgroups is *Deja News* at *www.dejanews.com/home_ps.shtml* — This one also lets you scope out those *other* groups a given responder is posting to. Thus, you're able to quickly run a credibility and background check. But I like the *Usenet* search feature of *Alta Vista* better. It finds more stuff.

I've put a hot linked newsgroup list to *www.tinaja.com/text/newslist.html*

"FAQ" is short for *Frequently Asked Questions.* Better newsgroups do try to answer all of the obvious queries that newcomers ask in downloadable files. A master directory for the FAQ sites appears as *www.faqlib.com*

Three newsgroup rules: *Always lurk before you post.* Preferably for several weeks. Always carefully read *all* the other responses before posting. And *never* post anything to a newsgroup without *at least* a 24 hour delay for thinking out your message.

A *newsletter* (or *mailing list*) can be thought of as a "subscription only" newsgroup. The postings are usually moderated, thoroughly stomping all the garbage, the flames, and the trolls. The people here are usually far more knowledgeable, infinitely more polite, and the content quality is often much higher. Membership might be strictly limited, and charges may apply.

You've got a choice of receiving dozens (and possibly hundreds) of E-Mail newsletter messages daily. Or of receiving a few humongous and hard to search *digest* files. Either way, newsgroups could provide you with useful information and contacts. But normally do so in an annoying and obnoxiously intrusive way.

A FEW USEFUL WEB RESEARCH SITES

Acrobat newsgroup	comp.text.pdf
Adobe Acrobat Reader	www.adobe.com/prodindex/acrobat/readstep.html
Alta Vista search engine	www.altavista.digital.com
Alternate ezine directory	www.dominis.com/Zines
Alternate ezine directory	www.edoc.com/ejournal
Basic Stamp support	www.parallaxinc.com
Bed and breakfast directory	www.homearts.com/affil/ahi/main/ahihome.htm
Best book info	www.amazon.com
Best ezine directory	www.meer.net/~johnl/e-zine-list
Bizarre Pseudoscience	www.tinaja.com/scweb01.html
Black Range Lodge	www.zianet.com/blackrange/lodge.html
Blond Aggie redneck lawers	www.winn.com/pwinn/humor/index/html
Car trader	www.traderonline.com
Cattle Moo Tillations	www.qtm.net/~geibdan/framest.html
Church of the SubGenius	sunsite/unc.edu/subegnius
Classified shopper	www.classifieds2000.com
Dilbert and Dogbert	www.unitedmedia.com/comics/dilbert
Don Lancaster's Guru's Lair	www.tinaja.com
Emory University MedWeb	www.gen.emory.edu/medweb
Factsheet Five on zines	www.well.com/conf/f5/f5index2.html
FM radio station finder	wmbr.mit.edu/stations/locate.html
Four11 people finder	www.Four11.com
Free catalogs	catalog.savvy.com
Free energy forum	www.eskimo.com/~bilb/freenrg/frng
Free Medline medical info	www.healthy.net
Electronic auctions	www.bentleysauction.com
Electronic engineer links	www.tinaja.com/eeweb01.html
Hotbot search engine	www.hotbot.com
Inference search engine	www.inference.com/infind
InfoPack research services	www.tinaja.com/info01.html
Interesting site links	www.persiankitty.com
Internet country codes	www.Four11.com/cgi-bin/Four11Main?Country
Internet Service Providers	thelist.iworld.com
Jerry Decker's Keelynet	www.keelynet.com
Job listing links	www.datamation.com/PlugIn/jobs/jobs.html
Kelly Blue Book	www.kbb.com
Lindsay Publications	www.keynet.net/~lindsay
Lookup USA phone directory	www.lookupusa.com
Ma Bell 800 numbers	attnet/dir800
Mapquest map drawing site	www.mapquest.com
Master FAQ directory	www.faqlib.com
Master PIC directory	www.tinaja.com/pic500
Meta search engine site	www.wp.com/resch/search.htm
Microchip Technology	www.microchip.com
Mo Hotta Mo Betta	www.mohotta.com
More Acrobat support	www.tinaja.com/acrob01.html
Movie reviews & info	us.imdb.com
Online published books	www.cs.cmu.edu/books.html
Oxbridge Media Finder	www.mediafinder.com
PAML newsletter directory	www.NeoSoft.com/Internet/paml
Patent repository	patent/womplex.ibm.com
Periodical elements table	www2.shef.ac.uk/~chem?web-elements
PIC reprints & support	www.tinaja.com/picup01.html
Random cyberspace jump	www.yahoo.com/bin/top2?122.25
Real time Arizona floods	wwwdaztcn.wr.usgs.gov/rt-cgi/gen_tbl_pg
Saucer Smear magazine	www.mcs.com/~kvg/smear.htm
Scott Edwards	www.seetron.com
Science Hobbyist	www.eskimo.com/~billb
Shepard Engineering	home.att.net/~dennis.shepard
Surplus bargains	www.tinaja.com/barg01.html
Switchboard phone directory	www.switchboard.com/cgiqa.dll?MG=
Technical electronics	techweb.cmp.com/eet/docs
US Government surplus	131.87.1.51
USPS zip code directory	www.usps.gov/ncsc
Volkswagen Van newsletter	Vanagon@gerry.sdsc.edu
Wall Street investment net	wsm.com
Web site free promotion	www2com.com/~upfront/launch
Web site free promotion	www.ep.com/faq/webannounce.html
Web site name finder	www.internic.net/cgi-bin/whois
Web site registration	www.internic.net
Webmastering secrets	www.tiaja.com/weblib01.html
WhoWhere people finder	www.whowhere.com

Newsgroups are tightly targeted. E-Mail *Vanagon@gerry.sdsc.edu* with a message of *subscribe vanagon* or else *subscribe vanagon digest*, and you'll be placed on their fine mailing list for a newsletter on 1987 Synchro 4WD vans with diff locks.

You subscribe to other newsgroups in pretty much the same manner. By E-Mailing them your requests. *PAML* is one newsletter directory service.

At *www.NeoSoft.com/Internet/paml*

Finding People

Online phone directories are your obvious place to start people finding. These do include *Lookup USA* at, of all places, *www.lookupusa.com*; competitor *Switchboard* at *www.switchboard.com/cg iqa.dll?MG=*; and the Ma Bell toll free 800 number directory *attnet/dir800.*

Lookup USA also can provide maps. A second useful map site is *Mapquest* at *www.mapquest.com*

If the individual is active online, try finding them by way of *WhoWhere* at *www.whowhere.com* or else use *Four11* at *www.Four11.com*

If the person you are looking for is active in newsgroups, Deja News is once again a powerful access choice.

Basic Research Tools

Here is one quick rundown of the research sites on the web that I use most for my own consulting:

Books in Print does not seem to be online just yet. But *Amazon Books* at *www.amazon.com* is a useful alternate that works even better. Similarly, that *Ulrich's Periodicals Dictionary* also does not seem to be available online. Their *Oxbridge Media Finder* competitor is now completely blowing them out of the water at *www.mediafinder.com*

Surprisingly, the complete and free *Thomas Registry of Manufacturers* is now available online at *www.thomasre gister.com/index.html* — You do have to register and remember a password. This is a great place to go to find out stuff about old line companies who are not yet web-literate.

A great selection of technical books (many involving historical or "lost" art) can be located through *Lindsay* at *www.keynet.net/~lindsay/* — A directory of online published books is available through *www.cs.cmu.edu/books.html*

I've got a whole page of electrical engineering links uploaded for you at *www.tinaja.com/eeweb01.html* — Other superb electronics access can be found at *techweb.cmp.com/eet/docs*

Government surplus electronics are found at *131.87.1.51*, while one leading surplus electronics auction house is Bentley at *www.bentleysauction.com*

Other surplus bargains can often be gotten at *www.tinaja.com/barg01.html*

A USPS zip code directory can be found at *www.usps.gov/ncsc*

A great periodical table of the elements is at www2.shef.ac.uk/~chem?web-elements

A fully searchable patent repository resides at the *patent/womplex.ibm.com* — But do remember that winners appear in the marketplace and losers appear in the patent directories. More on this in my *Case Against Patents* package or at *www.tinaja.com/patnt01.html*

You can find the darndest stuff on the web if you dig deep enough. For instance, you can track Arizona floods real-time with the live stream gauge satellite monitors at wwwdaztcn.wr.usgs.gov/rt-cgi/gen_tbl_pg

Betcha you don't already have this one bookmarked.

Investments, Medicine, Jobs, and Movies

Let's quickly look at a few of my favorite non-technical sites. The best investment links I've found are the superb *Wall Street Research Network* at *wsm.com*

The place doctors go to get info is the fee-based *Medline* service. One free medline link is *www.healthy.net*

Another very useful medical link is *www.gen.emory.edu/medweb*

One extensive job listing source is *www.datamation.com/plugin/jobs*

A leading movie review site is the *Internet Movie Database* at /us.imdb.com

Places to buy and sell stuff include *www.classifieds2000.com* and the *Trader Online* people at *www.traderonline.com*

Car apprasial is best done through the *Kelly Blue Book* at *www.kbb.com*

Thousands of free catalogs are now offered by *catalog.savvy.com*

Essential hacker nutrients are at *Mo Hotta Mo Betta* (*www.mohotta.com*) One good bed and breakfast directory is *www.homearts.com/affil/ahi/main/ahihome.htm* while our favorite B & B is the *Black Range Lodge* at *www.zianet.com/blackrange/lodge.html*

A really great FM station finder is at *wmbr.mit.edu/stations/locate.html*

Check this one out.

Adobe Acrobat

Typical web technical information (especially electronic data sheets) is now presented in *Adobe Acrobat* or .PDF format. In *one* fast-loading single file, Acrobat can give you a "perfect" camera ready image, having exactly and only what your provider wants you to see in precisely the way they want you to see it. With all fonts and artwork and images and text fully and perfectly preserved. Magnifiable, and with text smoothing, even.

If you know the secret insider trick, Acrobat gives you instant online and hot linked *full screen* displays. Just click on your PDF selection and let it autoload into Netscape. Then enter ctrl-shift-L followed by ctrl-K. Presto. Your full screen "just like the printed page" display. Easily navigated with the usual keys or mouse moves. And printable on any newer printer.

A hint: Set your Acrobat full screen preferences to activate escape, apply vertical wipe, set cursor hidden after delay, and use loop wraparound. But unclick your auto advance.

You can get the latest free Acrobat 3.01 reader from *www.adobe.com/prodindex/acrobat/readstep.html* — Always do install Netscape first and Acrobat 3.01 second, so your plug-ins get properly placed into your browser.

There's an acrobat newsgroup at *comp.text.pdf* and more Acrobat info at *www.tinaja.com/acrob01.html*

Web-Related

Your usual place to go to register your personal website is Internic at *www.internic.net* — They also have their *whois* at *www.internic.net/cgi-bin/whois* that lets you find if a domain name is in use and who owns it.

Useful locations to promote your website at no charge now do include *www2com.com/~upfront/launch* plus *www.ep.com/faq/webannounce.html*

A handy listing for the internet country codes appears at *www.Four11.com/cgi-bin/Four11Main?Country*, while the master directory of ISP *Internet Service Providers* is at *thelist.iworld.com*

A few more webmastering access tools: /www.tinaja.com/webwb01.html

PIC-Related

The horse's whatever on PIC info is *Microchip* at *www.microchip.com* — Other great PIC sites include the *BASIC Stamp* people at *www.parallaxinc.com*, *Shepard Engineering* at *home.att.net/~dennis.shepard*, or the Scott Edwards Electronics at *www.seetron.com*

A master directory of PIC websites is at *www.tinaja.com/pic500*, while PIC reprints and other useful content are found both at my */picup01.html* and at */picwb01.html* on the same site.

Pseudoscience

One of my very favorite activities is pseudoscience bashing. Besides being mesmerizingly awful fiction, this can give me unique directions to present fundamental electronic, chemical, and physical principles.

I also have this goal of piling up all of pseudoscience in the middle of a big stage somewhere, shining a bright light on it, and getting all of you to conclude "Yup, that sure is a really big pile allright."

Only tiny problem is that a lot of it keeps leaking out of the bottom.

My favorite source for this sort of thing is *www.keelynet.com* — Bill Beatty runs his superb *Science Hobbyist* site at *www.eskimo.com/~billb* which combines both real science and pseudoscience file downloads. He also hosts a bizarre free energy forum at *www.eskimo.com/~bilb/freenrg/frng*. But watch out for all the "not even wrong" labwork here.

And, of course, Mosley's old *Saucer Smear* at *www.mcs.com/~kvg/smear.htm* uses "in your face" journalism to slam UFO friend and foe alike. Now in their 43rd year!

Cattle *Moo Tillations* are covered by *www.qtm.net/~geibdan/framest.html*

Lots more pseudoscience site links are at *www.tinaja.com/scweb01.html*

Just For Fun

Those Guru's and Swami's Union local #204 rules do demand that all technical Internet sites have a Dilbert and Dogbert link. You'll find them at *www.unitedmedia.com/comics/dilbert* — To pick up all of the latest blonde Aggie redneck lawer jokes, try *www.winn.c om/pwinn/humor/index/html* — I really do like the one here where Wiley Coyote is filing a product liability suit against *Acme* manufacturing.

An interesting variety of site links is offered by *www.persiankitty.com*

If you want to go completely off the planet in your web explorations, do check out the *Church of the SubGenius* at *sunsite/unc.edu/subgenius*

One ultimate for-fun venture is to make a random jump somewhere in cyberspace and see where you land. One good way to do this is by using *www.yahoo.com/bin/top2?122.25* — Since this link is now "hidden" by its host, it might not stay around forever.

For More Help

The best way to find things on the web is to jump in with both feet and start doing it. If you do not yet have a web account with the local ISP, try borrowing a friend's Internet access. Or go to your local library to begin picking up experience. Or sign up for a community college course.

Hands-on is everything!

Hot links to all of these mentioned research tools appear on my *Guru's Lair* website at *www.tinaja.com* — Start with all of those *Web Related Links* at *www.tinaja.com/webwb01.html* — Then try those seven other link buttons.

Additional insider web tricks and techniques in the *Webmaster Library* at *www.tiaja.com/weblib01.html* — The hot linked version of this column is up at *http://www.tinaja.com/glib/resbn71.pdf* — Just click on any blue text to instantly go anywhere mentioned. By using Acrobat's online full screen feature.

Finally, if you don't want to do your own web research, I'd be most happy to do most of it for you. Full details all about my unique *InfoPack* consulting service can now be found at *www.tinaja.com/info01.html*

This Month's Contest

For our contest this month, just tell me about any useful and unusual web site I don't already know about. Tell me what it does. And why you like it.

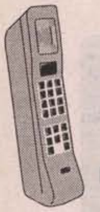
There should be a largish pile of my new *Incredible Secret Money Machine II* books going to the dozen or so better entries, plus an all-expense-paid (FOB Thatcher, AZ) *tinaja quest* for two that will go to the very best of all.

Send all your *written* entries to me here at *Synergetics*, rather than to *Nuts & Volts* editorial. **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 offers a free catalog full of his unique products and resource secrets. The 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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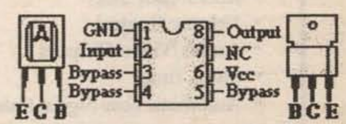

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Events CALENDAR

Continued from page 39

MAY 9

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

MAY 15-16-17

OH - DAYTON - HamVention. Dick Miller N8CBU, 937-276-6930. E-Mail: chair@hamvention.org Web: http://www.hamvention.org/

MAY 16

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

MAY 17

MA - CAMBRIDGE - Flea Market. Kendall Square area. MIT. Nick Alternbernd KA1MQX, 617-253-3776

MAY 29-30

NE - SOUTH SIOUX CITY - Midwest/Dakota Div. Convention. Mike Nickolaus NF0N, 402-494-6070

MAY 29-30-31

NY - ROCHESTER - Atlantic Division Convention. Harold Smith K2HC. 716-424-7184. E-Mail: rochfst@frontiernet.net Web: http://www.rochesterhamfest.org

OR - SEASIDE - Northwestern Division Convention. Randy Stimson KZ7T. 503-297-1175

MAY 31

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

JUNE 1998

JUNE 6

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

JUNE 7

IL - PRINCETON - Starved Rock RC Hamfest. Debbie Burton N9DRU, 815-795-2201

JUNE 12-13

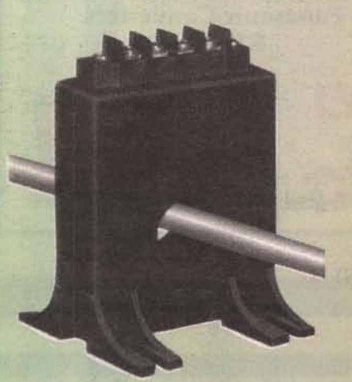
GA - ALBANY - ARC Hamfest. Arthur Shipley N4GPJ, 912-439-7055

New Product News

Our readers are always looking for new and interesting electronic items. Showcase your NEW PRODUCTS here to help stimulate your product's success. Submit all news releases, product information, and/or photos to:

NUTS & VOLTS MAGAZINE
NEW PRODUCT EDITOR,
430 PRINCELAND CT., CORONA, CA 91719

250CT CURRENT TRANSDUCER



Ideal for industrial monitoring and control, Shoreline Electronics introduces the 250CT, an AC/DC current transducer. The 250CT monitors both AC and DC current with ±1.0% accuracy at 20°C ±5°C and ±2.0% accuracy at 45°C. This Hall-Effect current sensor allows a user simply to place a positive or negative cable through the sensor and measures up to 250 amps.

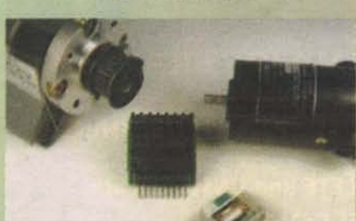
Requiring merely a single DC 10-12 volt power supply, the 250CT has a rise time of <3 microS, operates up to 400 Hz, and weighs <100G. Packed into a sleek 58 x 91 x 45 mm frame, the 250CT operates over a wide temperature range (-10° to 55° C) with 0.5% linearity over 0 to 250 amps.

Pricing begins at $59.95.

For more information, contact:

SHORELINE ELECTRONICS
2098B WALSH AVE., DEPT NV
SANTA CLARA, CA 95050
408-987-7733 FAX: 408-987-7735
E-MAIL: ShoreElec@aol.com

MOTOR MIND B



Motor control is simplified to a serial communication stream with the Motor Mind B. Serial commands can be sent via a one- or two-wire interface. The short instruction set designed into the Motor Mind B allows the user to implement complex control algorithms quickly and with little effort. Bi-directional or uni-directional DC motors with operating voltages as great as 30 VDC, can be used with the Motor Mind B.

This module can handle peak currents as large as 3.5 amps and continuous currents of 2 amps. Package power dissipation must not be exceeded during use.

Features include the ability to read a motor's tachometer frequency (0-65,528 Hz), automated speed control, 254 discrete steps of speed control, and motor direction changes.

The Motor Mind B comes complete with a watchdog timer to eliminate the possibility of a system firmware failure.

The Motor Mind B's small size and connection scheme allow the device to be inserted directly into circuit boards for production runs, or into breadboards for easy prototyping. Complete data sheets and application notes are available at "www.solutions-cubed.com"

The Motor Mind B comes in a 1.2" x 1.3" SIP module, and sells for $29.95.

For more information, contact:

SOLUTIONS CUBED
3029 ESPLANADE STE. F
DEPARTMENT NV
CHICO, CA 95973
530-891-8045 FAX: 530-891-1643
E-MAIL:
lon@solutionscubed.com
URL: www.solutions-cubed.com

CIRCULAR CONNECTOR

Hirose offers the JR-W series of high-performance water-proof circular connectors, developed for interfaces of a variety of electronic equipment, including machine tools and communications equipment.

The JR-W connector was also developed to be corrosion resistant in order to be utilized even in adverse environments.

Plated with black chromium, the JR-W series offers smooth connections, provided by five guide points, and is provided in variable shell sizes and core numbers.

Cost of the JR-W is $33.50 in lots of 500.

For more information, contact:

HIROSE ELECTRIC, INC.
2688 WESTHILLS CT., DEPT. NV
SIMI VALLEY, CA 93065
805-522-7958 FAX: 805-522-3217

PEI FILTER PROBE

This new and unique probe is designed to locate phone, data, security, and alarm, HVAC and building control, and de-energized electrical wiring without picking up the hum generated by AC wiring.

It works with any PEI tone generator and speeds cable tracing.

It has volume control, a conductive tip, momentary on-switch, and terminals for connection to a test set.

It is weather-resistant and has an easy access battery compartment.

For more information, contact:

JENSEN TOOLS INC.
7815 S. 46TH ST., DEPT. NV
PHOENIX, AZ 85044-5399
602-968-6241 FAX: 602-438-1690

BNC T-CONNECTORS

Trompeter Electronics has added a BNC coaxial T-connector to its telecom, and audio and video broadcast lines in two versions: a 50-ohm connector (BN23) and a 75-ohm version (UBN23).

The new BNC T-adapters include Teflon dielectric and beryllium copper contacts, at a cost of $5.00 at 100 quantity.

For more information, contact:

TROMPETER ELECTRONICS
31186 LABAYA DR., DEPT. NV
WESTLAKE VILLAGE, CA 91362
818-707-2020 FAX: 818-706-1040
1-800-982-2629
www.trompeter.electronics.industry.net

NX1 PC CARD FRAME KITS

Hirose Electric, Inc., provides NX1 snap-together-type PC card frame kits, ideal for a wide variety of PC card I/O applications. Versions for standard 16-bit and CardBus are available.

The NX1 reduces the number of steps needed for PC card frame assembly eliminating the need for heat fusion and cooling of covers.

With the NX1, assembly of the frame kit is possible with a simple jig tool. The NX1's two-piece construction enables fast, efficient assembly. The spring quality of the metal also maintains stable conduction between the panels of the NX1.

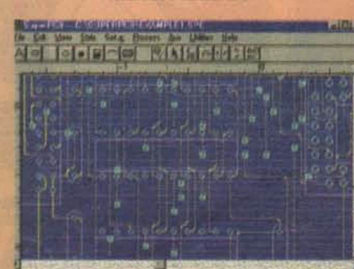
The frame kits are available with board offsets of 0.3 mm and 0.9 mm. Back connectors with 15, 25 and 32 contacts are available.

Costs of the NX1 for 15 positions is $1.99 in lots of 1,000 or more.

For more information, contact:

HIROSE ELECTRIC, INC.
2688 WESTHILLS CT. DEPT. NV
SIMI VALLEY, CA 93065
805-522-7958 FAX: 805-522-3217

MENTALMAX™



Selling for $549.00, mentalMAX is a new all-in-one circuit design package featuring schematic entry, printed circuit board layout with autorouting, and both analog (SPICE) and digital simulation.

The package is designed for small companies, individual engineers, students, and others who want a complete design capability for a very low cost.

MentalMAX includes the easy-to-use SuperCAD schematic entry software. This software allows you to draw circuit diagrams on A through E size sheets which can be printed on any Windows compatible printer. SuperCAD has nearly 2,000 part symbols including most TTL and CMOS logic, op amps, discrete symbols, and others, plus you can easily add custom symbols. SuperCAD serves as the front end to the other mentalMAX software and seamlessly interfaces to them directly through menus and display windows, including the oscilloscope window for SPICE and the analyzer window for digital simulation. Output from SuperCAD includes a netlist report and a bill of materials. You can also output drawings to AutoCAD®.

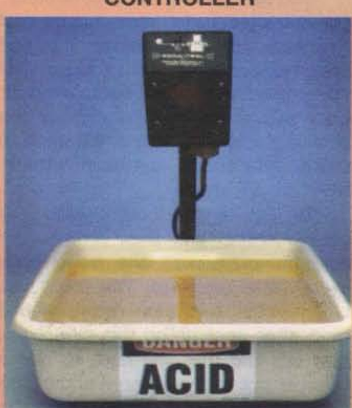
MentalMAX comes with the popular SuperPCB program for doing layouts on printed circuit boards up to 32" x 32". SuperPCB features 1 mil (.001") resolution, four signal layers, silkscreen, paste, and solder mask layers. It includes industry-standard Gerber and Excellon outputs, and you can print your artwork on laser and other printers.

The mentalMAX tools will run under Windows 3.1, 3.11, Windows 95, and Windows NT. You need about 10M of disk space and at least 4M of memory.

For more information, contact:

MENTAL AUTOMATION, INC.
5415 136TH PL., S.E., DEPT. NV
BELLEVUE, WA 98006
425-641-2141 FAX: 425-649-0767
http://www.mentala.com

ULTRASONIC LEVEL CONTROLLER



The SONA-TROL® Ultrasonic Level Controller features a sensor head which can detect changes down to .006" over a 48" distance or within 1" up to 20' over the surface. Eliminating floats, switches, and hardware subject to wear and corrosion, this non-contacting level controller can provide digital or analog readouts, 0 to 10 VDC or 4 to 20 mA outputs, and be equipped with circuits to detect false signals and compensate for surface rippling.

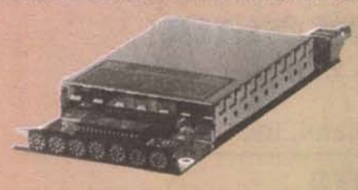
Ideal for use with liquids, slurries, and solids, the SONA-TROL® Ultrasonic Level Controller has a electrically isolated sensor, adjustable gain and receiver sensitivity, and distance zero offset. Incorporating a standard oil-tight JIC enclosure, sensors can be constructed from stainless steel or fiberglass and be equipped with a purge box for hazardous environments.

The SONA-TROL® Ultrasonic Level Controller is priced from $799.00 (list).

For more information, contact:

WADDINGTON ELECTRONICS, INC.
25 WEBB ST., DEPT. NV
CRANSTON, RI 02920
401-781-3904 FAX: 401-781-1650
E-MAIL: johnwn@ids.net

HIGH-PERFORMANCE RECEIVER



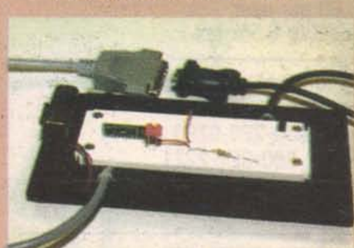
Neulink is now shipping its DCL-VHF-RX and DCL-UHF-RX, a high-performance, synthesized, digital receiver operating in the VHF band, 153 MHz to 173 MHz and 450 MHz to 470 MHz band, respectively. They are currently being used in the National Broadcast Emergency Alert Systems and Law Enforcement applications.

The receivers support digital data, and have excellent audio output that out-performs many high-end commercial radios. The band spread is 10 MHz in the receivers and can be tuned to any frequency in the selected band.

For more information, contact:

RF NEULINK
7610 MIRAMAR RD., DEPT. NV
SAN DIEGO, CA 92126
619-549-6340 FAX: 619-549-6345
1-800-233-1728
E-MAIL: rfneulink@aol.com

PROTOTYPING SYSTEM



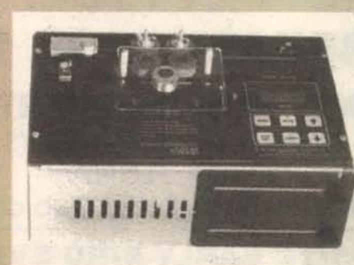
AWC announces the ASP-1 prototyping system for developing hardware based on Parallax's BASIC Stamp microcontrollers. The system consists of a high-quality solderless breadboard, a power source, and two integrated programming cables (one for the Stamp I and another for the Stamp II).

Using this system, designers can easily try circuits, tear them apart, and try something different. There is no soldering or wirewrapping required. The ASP-1 is perfect for professional designers, hobbyists, and it is ideal for educational use, too.

For more information, contact:

AWC
310 IVY GLEN CT., DEPT. NV
LEAGUE CITY, TX 77573
281-334-4341
alw@al-williams.com

AUTOMATIC WIRE CUTTER

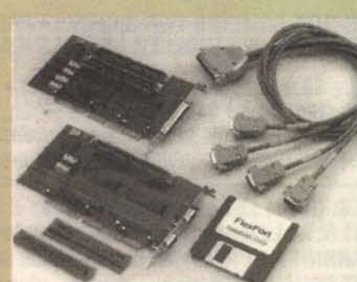


RF Industries announces the release of the RFA-4090, automatic wire and tubing cutter. Lengths from .01" to 9999" and cuts up to 9,999 pieces can be programmed and stored into the microprocessor. Pieces will run out of the calibrated machine, pre-measured and cut at the rate of 1,000 feet per hour.

For more information, contact:

RF INDUSTRIES
7610 MIRAMAR RD., DEPT. NV
SAN DIEGO, CA 92126-4202
619-549-6340 FAX: 619-549-6345
1-800-233-1728
E-MAIL: rfi@rfindustries.com

FLEXPORT™ MODULAR SERIAL I/O SYSTEM



Dataforth Corporation introduces the new FlexPort™ PC5000 Series of high-performance, serial input/output boards, and accessories for industrial PC/XT/AT ISA bus applications.

The PC5000 Series makes it easy to interface RS-232 and/or RS-485 data acquisition, control, or data lines.

The new FlexPort PC5000 System consists of two main boards that plug into the PC/XT/AT ISA bus and provide two or four serial ports; two "daughter" interface SimmPort™ modules that plug into SIMM sockets on the main cards and provide two channels each of RS-232 or RS-485 communications; RS-485 transmit and receive lines are transient protected to ANSI/IEEE C37.90-1-1989; a software driver compatible with Windows 3.1; and a special connector cable for four-channel configurations.

Prices for PC5000 FlexPort Serial I/O Systems start at $166.00.

For more information, contact:

DATAFORTH CORP.
3331 E. HEMISPHERE LOOP
DEPARTMENT NV
TUCSON, AZ 85706
520-741-1404 FAX: 520-741-0762
1-800-444-7644
E-MAIL: techinfo@dataforth.com
WEB: www.dataforth.com

WIRELESS REMOTE DATA ACQUISITION AND CONTROL SYSTEMS

Skyline base stations and remote platforms contain high speed, two watts, synthesized, transceiver modems that have 65,000 unique ID codes, error detection/correction, 64 programmable RF channels, and a repeater capability. Skyline comes in both UHF and VHF versions and has its own propriety over-the-air protocol with several options that can be configured by the user. This over-the-air protocol is transparent to the devices on either end and is configured by hooking the Skyline up to a computer through the RS232 serial port.

Continued on page 110

Continued from page 91

520-1710 KHz band, which I think is 10 KHz instead of the 5 KHz or less spacing of the shortwave bands.)

129719 **Bernard A. McIlhany**
Lebanon, GA

ANSWERS

ANSWER TO #11971 - NOV. 1997

What you mentioned will not work without some major modifications. The original pulse width for the throttle body injectors that you mentioned are computed by that analog computer and are calibrated by pulse width for a given motor and its unique conditions.

Its mixture is a formulae made up from varied input signals such as motor temperature, RPM, vacuum, oxygen sensor, and throttle settings. If this set-up comes off an eight-cylinder, two-injector throttle body set up, and you direct the signal to eight separate injectors without any pulse width modification, then the fuel pulse duration will be four times too long, making your mixture far too rich to run. Even if your computer assembly is from a four-cylinder engine. The signal length, hence the mixture quantity, will still be incorrect for any V-8 engine.

If you have a gas analyzer and scope, and add an optical sensor to your motor with four positions firing each sequence into two opposing cylinder injectors at the same time, one of the cylinders being at the intake position of the firing sequence and the other at its exhaust sequence (that cylinder will have a closed intake valve and this injection will act as a precharge), you will still need to modify all of the sensor inputs and the pulse width inside the computer so that the injector's "On Time" is correct for the exact amounts of fuel necessary for that motors exact requirements. The value variance of each input signal coming from such things as the throttle sensor or temperature gauge may also not be compatible with that computer.

Most computers are linked to an oxygen sensor that compensates for incorrect mixtures, but according to federal law they are only allowed to compensate for a minute amount of error of around two to five percent overall mixture which won't compensate for all of the errors you will run into by mismatching the motor to that computer.

It can be done, but basically you will need to completely overhaul the entire system just to get it to operate. A better way might be to start with a eight-cylinder computer off of a newer car and slightly modify it to suit your needs.

Chris
Bieber, CA

ANSWER TO #11973 - NOV. 1997

If you were able to calibrate successfully two variacs to give you a perfect out- put, then it should be easy for you to modify two commercial light dimmers to simplify your needs.

Using a double gang rotary switch you replace both of the potentiometers that normally control the light dimmer circuit with matched and calibrated value precision resistors.

You set up using the original potentiometers and reach your desired goal or phase/voltage on each dimmer and then measure each of the values off of the potentiometer on each dimmer. Copy that down because each of the dimmers potentiometers will have a slight variance between them. Measure accurately.

Do this at the three positions of your choosing and then replace the potentiometers with the switch and exact value resistors. You must use one percent tolerance resistors and even after assembling this circuit you may still find that you have to add a trimmer pot to one or more of the positions on the switch to fine tune the slight error that still occurs. The overall variance shouldn't exceed two percent depending on load, or overheating will occur.

Chris
Bieber, CA

ANSWER TO #11972 - NOV. 1997

The connection you need can be across the tip/ring connection, or

Continued on page 102

TECH FORUM

Continued from page 100

direct connect to the microphone in the handset.

In either case, get an audio transformer from Radio Shack. The transformer should be impedence 8-ohm to 600-ohm.

Optionally, get a 2-MFD capacitor, this should be a Mylar or other non-polarized (not an electrolytic, tantilum, etc., do not use a capacitor with + or - labeled). Then connect the 8-ohm side to the audio output of your voice device. Place the 2-MFD capacitor in series with the 600-ohm output. This will give you a 600-ohm output with DC blocking so it can connect directly across the phone line, or can be connected to the handset microphone.

You will also need a way to keep the line "off Hook." This can be the phone itself, but doing this, the phone handset may pick up ambient noise in the room. Also, if you use it directly across the phone line, disconnect the device when not in use.

The 2-MFD capacitor and the DC resistance of the transformer across the phone line will cause the circuit to answer an incoming call. The 20 Hz ringing voltage will cause the 2-MFD capacitor to conduct ringing voltage, and will exceed the ring trip current, and go off hook for the duration of the ring cycle. The phone will ring part of one time, then the line would go back on hook.

The effect to the caller would be picking up the phone during the first ring, and immediatly putting it back on hook.

You could optionally place a 220-ohm, 2-watt resistor in parallel with the 2-MFD capacitor.

This would provide a DC path for the line current, and the circuit would provide off-hook conditions, and audio coupling into the phone line. It would act as a telephone in this configuration.

Ed Pruitt
Keller, TX

ANSWER TO #11979 - NOV. 1997

Home Shop Machinist magazine had a six-part series (ending with the Mar./Apr. '96 issue) on building one that included circuit diagrams and parts lists. However, its stepper motor was not computer-controlled like you want. *Nuts & Volts* had an excellent article on building a three-axis stepper motor controller rig that was computer-controlled about three years ago (I've got it, but it is loaned out), more recently, *Electronics Now* had one called "Build the PC Drill" in the Feb. and Mar. '97 issues that uses two-axis computer-controlled stepper motors.

If you can't locate someone who has the HSM issues, the series has been reprinted in a single volume as "Build an EDM" by Robert Langlois. It is a bit pricey at $17.00 plus $4.50 shipping. Their address is **Village Press Publications**, P.O. Box 629, Traverse City, MI 49685-0629 or call **1-800-447-7367**. I have the issues (around here some place) if you want to correspond. Hope this helps.

Frank Nally
Louisville, KY

Continued on page 109

(Part 3)

Encyclopedia of Electronic Circuits: PCB Layout

by TJ Byers

This unique CD-ROM contains 1,000 circuits that can be knitted together to create virtually any project imaginable. In this three-part series, I show you how to use this CD to go from concept to copper, and build a karaoke amplifier in the process.

In case you missed the first two parts of this series, let me bring you up to speed. It began with an innocent enough query from readers like you who asked, "Where do you get the answers for your Electronics Q & A column?" Well, some of the answers come from years of experience, but mostly they're the result of searching through countless stacks of trade journals and application notes. One of my many sources is the "Encyclopedia of Electronic Circuits," which I refer to as the CD-ROM of 1,000 circuits. You can buy this CD-ROM from any well-stocked software house for just $99.00.

In addition to sporting over 1,000 circuits, the CD-ROM contains the entire catalog of EDA (Electronic Design Automation) software from Mental Automation. The software lets you import a circuit from the CD-ROM and convert it into a printed circuit board. Well, that's what this series is about — going from schematic to copper clad to finished project using the CD-ROM. For this tutorial, I chose a karaoke amplifier as an example. So far, we've covered circuit capture, project design, and design modification. All this was done using SuperCAD ($99.00), the schematic capture program.

In this installment, I'll show you how to convert our schematic (Figure 1) into a printed circuit board.

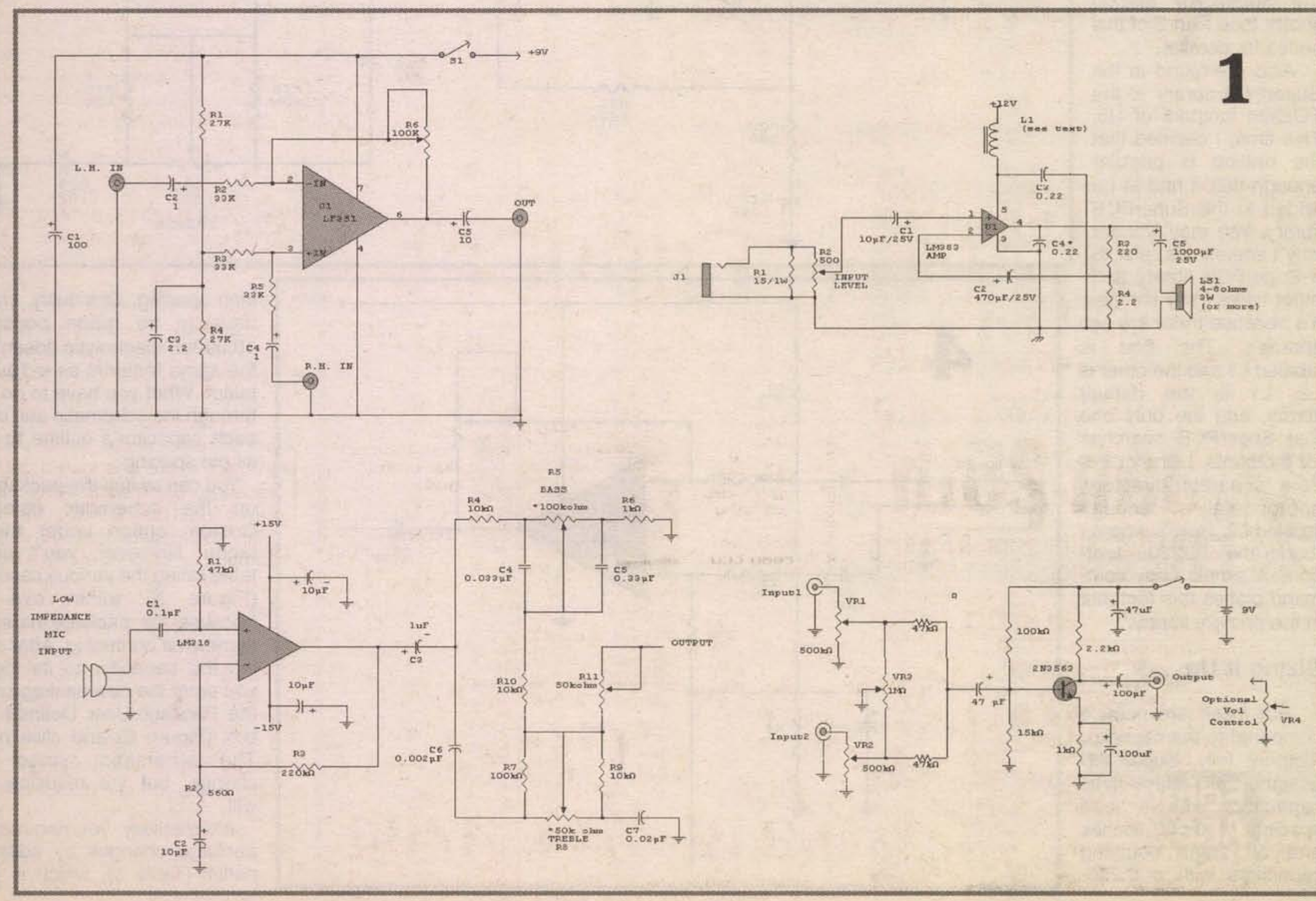
Parsing The Pieces

Once you have a SuperCAD schematic on the screen, it's usually a simple process to convert it into a circuit board using the SuperPCB software. However, the transfer from schematic to copper clad isn't always seamless. For example, our schematic won't translate into a functional circuit board the way it stands. Changes have to be made to the drawing — changes that translate it from a schematic to a bill of materials drawing, so to speak.

Let's start with the power supply. First off, I don't want to have 110VAC applied to any part of the board. It presents a shock hazard, and it's not a good engineering practice to mix line voltage with low voltage. So let's remove S1, F1, T1, and the power cord from the schematic. This way they won't appear in the netlist — or on the circuit board. Instead, these parts are mounted in the cabinet and hand-wired together. In place of T1, we install a five-pin berg connector. The Power LED (D3) needs to be replaced with a berg connector, too (Figure 2).

The microphone also needs to be removed and replaced with an audio jack (Figure 3). While we're at it, let's replace J1 and J2 with a stereo phone jack (Figure 4), which will let you patch into the earphone jack of your CD, stereo, or boombox. Finally, we need to replace the speaker with a berg connector.

The potentiometers can be replaced with berg connectors, too, because (except for one) they're not on the circuit board either. They mount on the front panel. However, this isn't a wise thing to do because the symbol changes from a potentiometer to a connector — which is quite unacceptable. Fortunately, the hole spacing is identical to that of a berg con-



nector — 0.100 inches — so we can leave the symbol as-is.

Missing Footprints

The next order of business is to see if SuperCAD's component outlines are available in SuperPCB. Not all schematic symbols have a physical equivalent in SuperPCB. For example, SuperCAD assigns a TO5B outline to the LM383 chip — an outline that's specific to National Semiconductor and not listed in the SuperPCB library.

When the CD-ROM was cobbled, the editors had to draw the circuits by hand from the pages of the book so that they ended up in SuperCAD format. However, several of the circuits use parts that weren't in the SuperCAD component libraries at the time — parts that had to be created from scratch. Obviously, some of the editors drew their information from National Semiconductor data sheets, unaware that the TO5B outline wasn't in the SuperPCB libraries. Since most data sheets list this package as a TO220a5, I went back to SuperCAD, gave the LM383 a new outline, and saved it in the SuperCAD analog library (see Part 2 of this series for details).

Also not found in the SuperPCB library is the TO220u footprint of U3. This time, I decided that the outline is popular enough that it had to be added to the SuperPCB library. You may wonder why I sometimes refer to a SuperPCB library and other times I say libraries. It's because there are two libraries. The first is labeled L1 and the other is L2. L1 is the default library, and the only one that SuperPCB searches for footprints. Library L2 is in a separate directory, appropriately enough labeled L2. Here's where I found the TO220u footprint. A simple copy command places this footprint in the primary library.

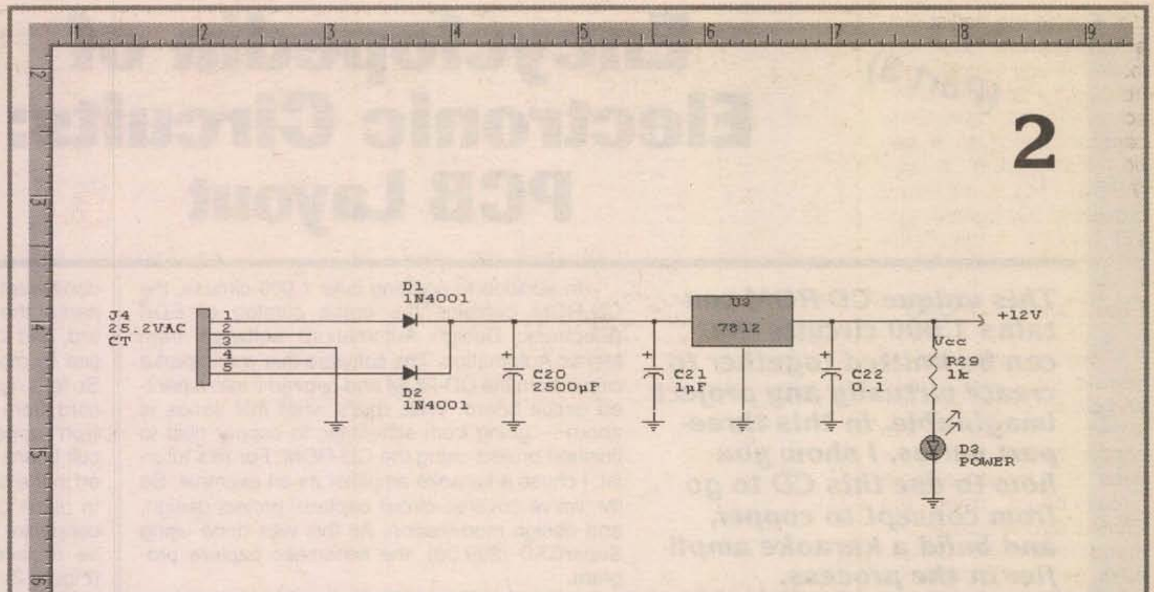
Sizing It Up

But these are nothing compared to the capacitor footprint folly. SuperCAD assigns all electrolytic capacitors with a lead spacing of 0.600 inches and all small coupling capacitors with a 0.250-inch spacing. Obviously, changes have to be made because a 10,000uF electrolytic doesn't have the same footprint as a 10uF tantalum. What you have to do is sort through the schematic and change each capacitor's outline to match its pin spacing.

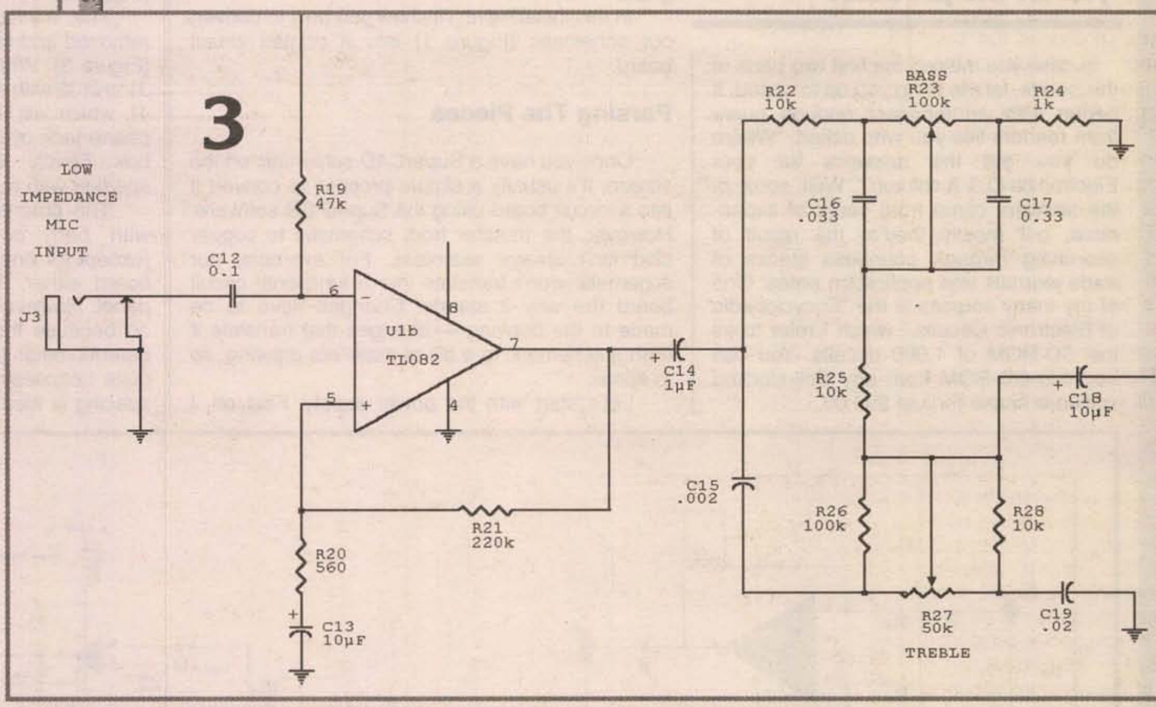
You can switch the package type on the schematic using the Custom option under the Edit menu. However, you'll need a table listing the various case styles (Figure 5) within eye shot, because the package names are somewhat confusing. After matching the capacitor to its footprint, you enter the new package style in the Package/User Defined dialog box (Figure 6) and click on OK. The schematic symbol won't change, but the resulting netlist will.

Alternatively, you can make the package changes by editing the netlist (Table 1), which is what I

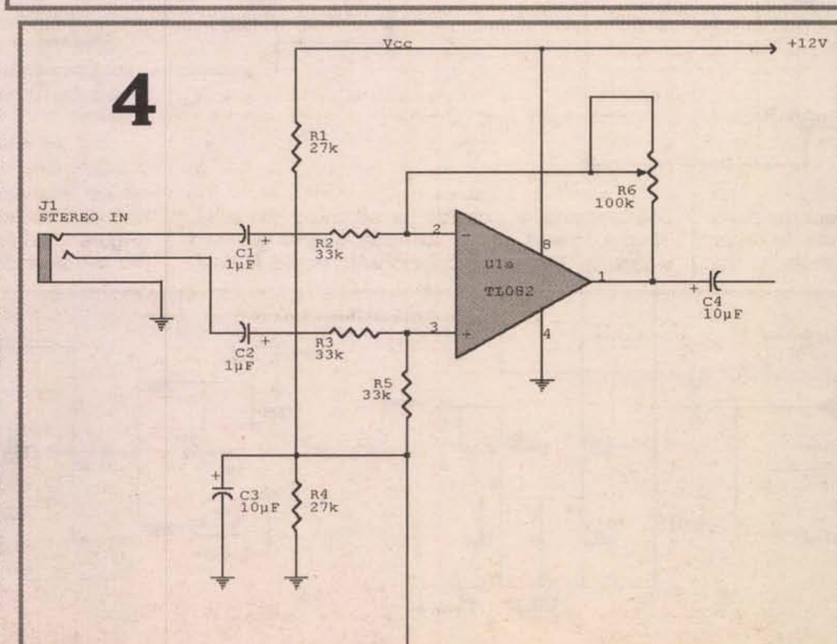
2



3



4



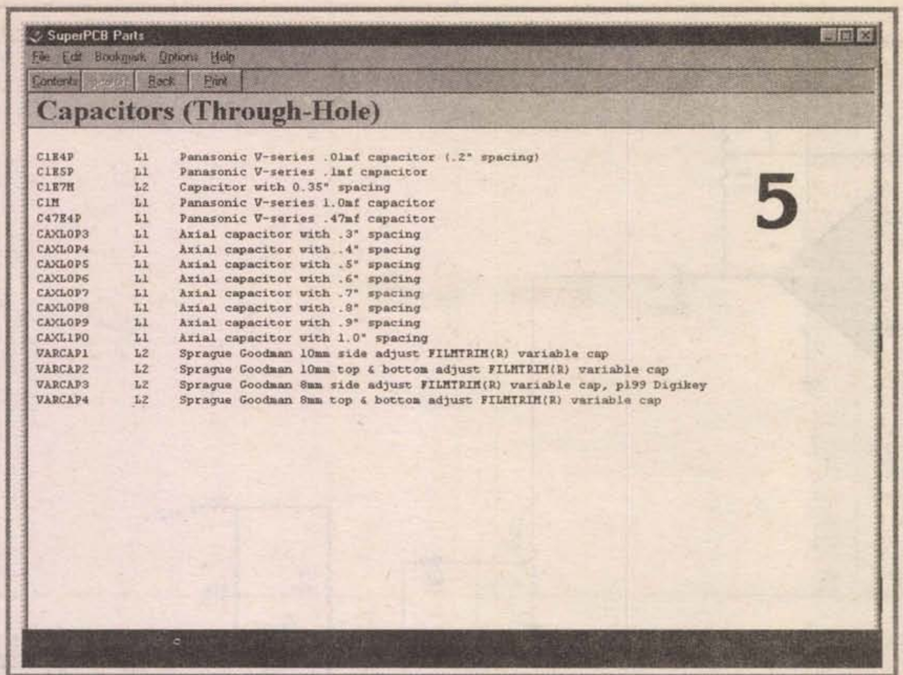
did. Editing the netlist (listed under *filename*.ref) is a lot faster and simpler than hopping around the schematic from capacitor to capacitor, because it can be done using a text (ASCII) editor or word processor. Of course, you still need a copy of the package outline list.

From Ink To Copper

We are now ready to convert the squiggly lines and circles on the modified schematic (Figure 7) into copper traces and solder pads. Start by generating a circuit board using the Printed Circuit Board command under the Utilities menu (Figure 8). The dialog box gives you several options. If this is the first attempt, check the "Generate new netlist option." After that, you'll want to turn this option off, otherwise it'll overwrite any changes you may have made to the netlist.

There are three versions of the SuperPCB program to accommodate users with different needs. Table 2 lists the differences between the versions.

For this project, I used the full version of SuperPCB ($499.00) because it has an autorouter and automatic parts placement. The decision was made on the size of the project and the component count. A smaller project, such as a wireless microphone or digital thermometer, doesn't require this much power, and can be easily fabricated using one of the cheaper versions of SuperPCB.



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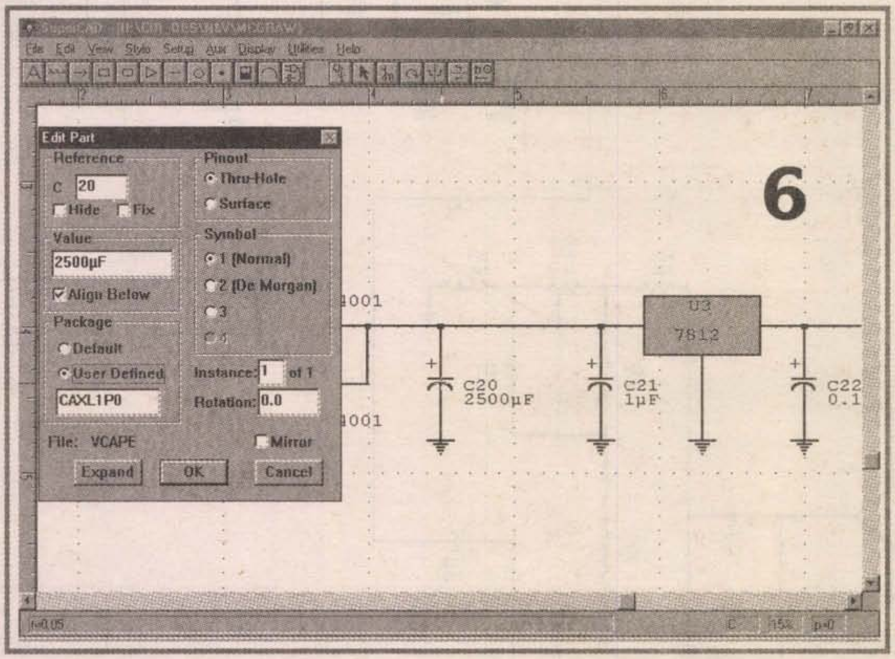


6

Part Placement

With my version of SuperPCB, the parts are placed on the circuit board in what it thinks is a logical pattern (Figure 9). It never is. Notice how the autoplace algorithm placed C20 atop U1. The other versions of SuperPCB simply stack the parts in a big heap that you have to distribute. In either case, you're gonna shuffle around most of the parts by hand before you find a layout that works.

What I did first is move the jacks and berg connectors to the edge of the circuit board, where they belong. In fact, it's always a good idea to move wires and cables to the perimeter of the board whenever possible for servicing purposes. Then I looked at the schematic, and guessed where the remaining components would fit best.

When moving parts, pay careful attention to the placement of the bypass capacitors — they must be kept as close as possible to their respective IC.

A useful tool for part placement is a *ratsnest* — which is listed as Rats Nest under the Process menu. This utility draws lines — not traces — between all the parts on the circuit board. If you see a long line connecting two parts, it means they should be closer together than they are (Figure 10).

Unfortunately, SuperPCB's ratsnest isn't the best I've used. It doesn't have rubber-banding — a feature that lets the lines move as the part moves. With SuperPCB, you have to move the part, erase the lines, and generate a new ratsnest. Another annoyance, albeit a common complaint with PCB layout software and not exclusive to SuperPCB, is that Rats Nest can't find the shortest path between common links, such as ground wires. What looks like a long reach may actually be a short hop.

Design Verification

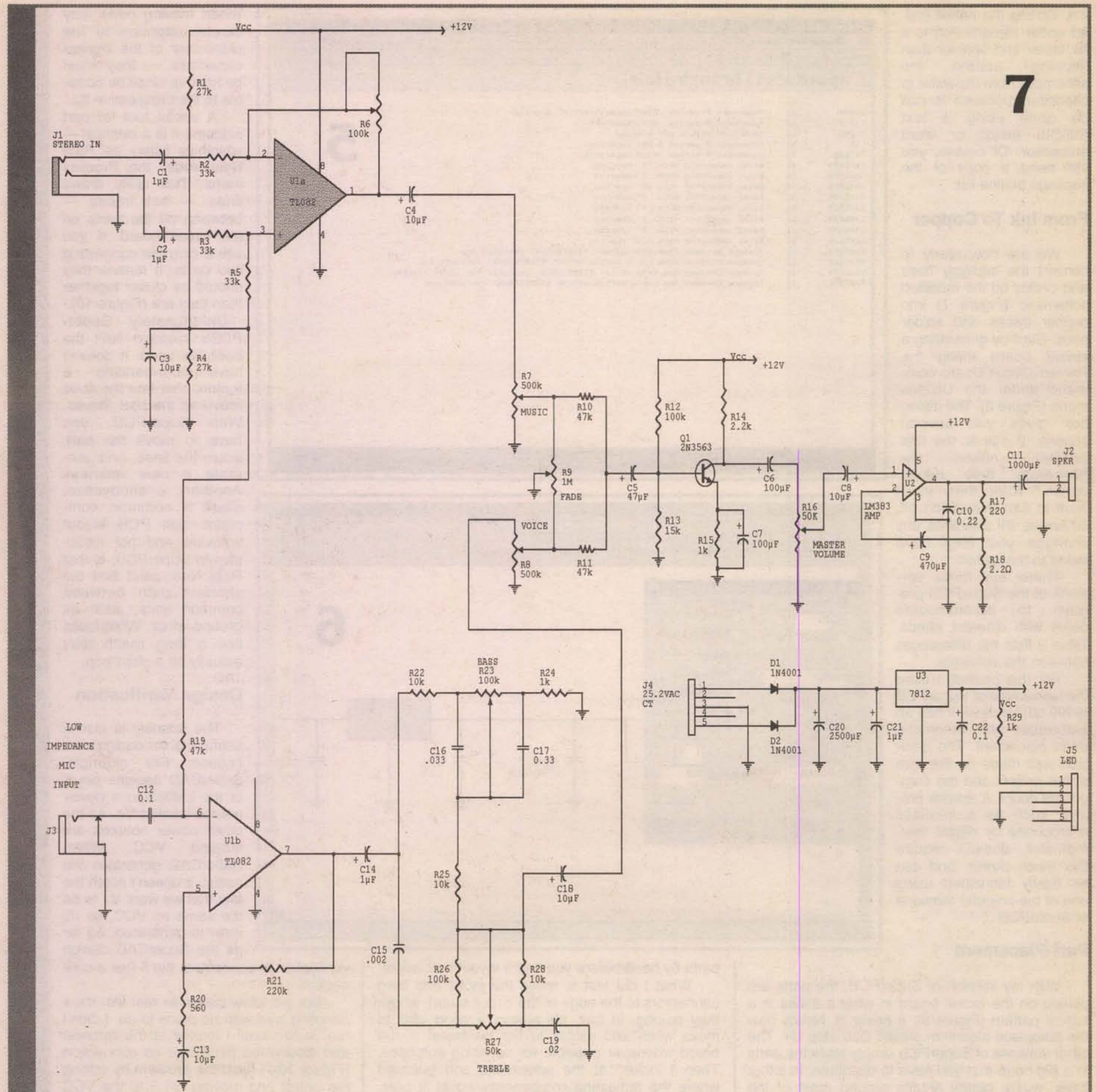
The ratsnest is also a useful tool for design verification. For example, SuperCAD assigns pin 5 of the LM383 to a power source labeled V+. All the other power sources are labeled VCC. When SuperCAD generates the netlist, it doesn't catch the fact that we want V+ to be the same as VCC, so no error is generated. As far as the SuperCAD design verification is concerned, pin 5 has a connection.

But we know better. In real life, it's a dangling lead with no place to go. I didn't realize this until I looked at the ratsnest and discovered pin 5 had no connection (Figure 10). I fixed the problem by editing the netlist and moving pin 5 to the VCC

TABLE 1. Karaoke Netlist

u2 ANALOG\LM383 1 TO220a5
c9 HCAPE 1 CAXL0P6
c10 VCAP 1 C47E4P
r17 VRES 1 RES4W
r18 VRES 1 RES4W
c11 VCAPE 1 CAXL0P6
r16 DEVICE\VAR_RES 1 B3292W
c8 HCAPE 1 CAXL0P6
r10 HRES1 1 RES4W
r11 HRES1 1 RES4W
r12 VRES 1 RES4W
r13 VRES 1 RES4W
q1 NPN 1 TO92
r14 VRES 1 RES4W
r15 VRES 1 RES4W
c7 VCAPE 1 CAXL0P6
r8 DEVICE\VAR_RES 1 B3292W
r7 DEVICE\VAR_RES 1 B3292W
r9 DEVICE\VAR_RES 1 B3292W
r19 VRES 1 RES4W
r21 HRES 1 RES4W
c13 VCAPE 1 CAXL0P6
c16 VCAP 1 C47E4P
r27 DEVICE\VAR_RES 1 B3292W
r20 VRES 1 RES4W
c14 HCAPE 1 CAXL0P6
c15 VCAP 1 C47E4P
r23 DEVICE\VAR_RES 1 B3292W
r25 VRES 1 RES4W
r26 VRES 1 RES4W
r28 VRES 1 RES4W
c19 HCAP 1 C47E4P
r22 HRES 1 RES4W
r24 HRES 1 RES4W
c17 VCAP 1 C47E4P
c12 HCAP 1 C47E4P
r2 HRES 1 RES4W
r6 DEVICE\VAR_RES 1 B3292W
c1 HCAPE 1 CAXL0P6
r1 VRES 1 RES4W
r5 VRES 1 RES4W
r4 VRES 1 RES4W
c3 VCAPE 1 CAXL0P6
c4 HCAP 1 C47E4P
r3 HRES 1 RES4W
c2 HCAPE 1 CAXL0P6
c18 HCAPE 1 CAXL0P6
d1 DIODE 1 DO7
d2 DIODE 1 DO7
c20 VCAPE 1 CAXL1P0
c21 VCAPE 1 CAXL0P6
c22 VCAPE 1 CAXL0P6
c5 HCAPE 1 CAXL0P6
c6 HCAPE 1 CAXL0P6
r29 VRES 1 RES4W
u3 7812 1 TO220u
u1 TL082 2 DIP8
j4 CONN5 1 WSIP5
j1 DEVICE\PJACK3 1 pjack
j2 CONN2 1 WSIP2
j5 CONN5 1 WSIP5
j3 DEVICE\PJACK 1 pjack

7



line. I've since made a change to the SuperCAD library, so it won't happen again. However, you can see the trouble I would have had if it weren't for the ratsnest.

Making Tracks

The next task is to replace the ratsnest with copper tracks, or traces. Yes, you can do this by hand one track at a time, if you have the patience, but why? Spend the extra bucks and buy one of the versions that has a batch router.

Batch routing, commonly called

SuperPCB Features

	SuperPCB/I	SuperPCB/R	SuperPCB (full)
Version	MA8500	MA8505	MA8510
Signal Layers	2	2	16
Router	incremental	incremental/batch	incremental/batch
Placement	manual	manual	manual/automatic
Library Parts	90	90	320
Verify Checking	manual	manual	manual/batch
Net Selection	no	no	yes
Netlist Extraction	no	no	yes
Grids	Cartesian	Cartesian	Cartesian and Polar
Max. Work Area	8" x 8"	16" x 8"	32" x 32"
Drawing Elements (traces, vias, parts)	16,000	16,000	32,000
Price	$149.00	$299.00	$499.00

You can update at any time from SuperPCB/I/R to the SuperPCB package by paying the price difference plus shipping.

autorouting, is supported by two of the three SuperPCB programs. In the batch operation, the traces are automatically routed on one or more layers. If the router hits a roadblock, it looks for an alternate path. Sometimes it's successful, and sometimes it's not. The rate of success depends on component density, track width, and pad size and shape. In really tight spots, you can use the necking feature. Necking down is the process of narrowing a trace skinny enough to squeak between the pads of an IC's footprint.

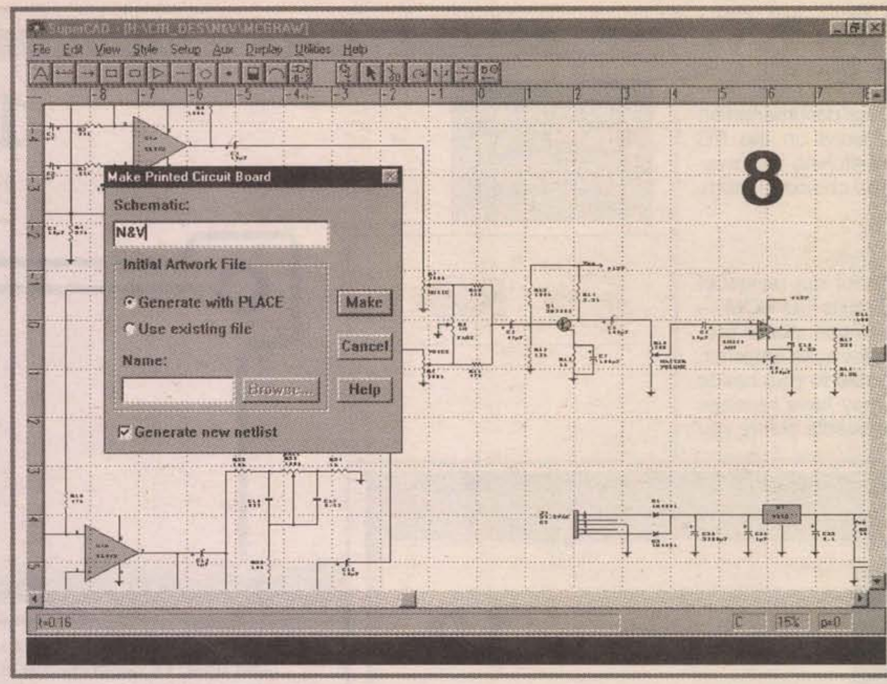
A board can be routed using a 25-, 50-, or 100-mil grid, and component pads don't have to fall on the grid (1 mil is a thousandth of an inch). However, traces follow the grid pattern as closely as possible. So even though there may be a more direct path between two pads, the traces will hug the grid the best they can, which results in traces like you see in Figure 11. As tracks are added, they stack one atop the other, separated by a space defined in the Setup table, usually 10 mils.

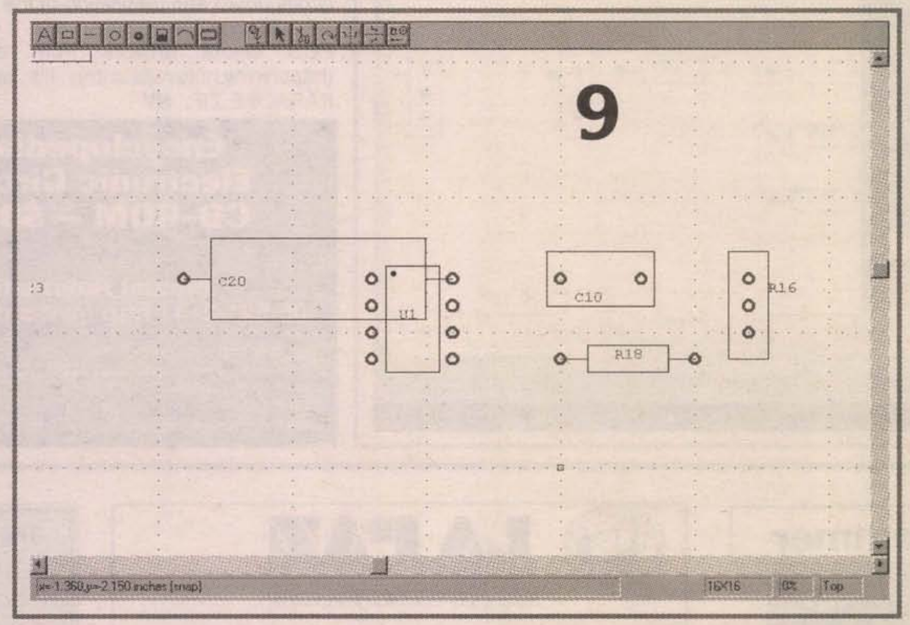
In general, if you're routing a board with mostly DIP packages, then a 50-mil grid is adequate. However, I find the 50-mil grid too coarse for most layouts. My preference is 25 mils, which, oddly enough, happens to be the default spacing.

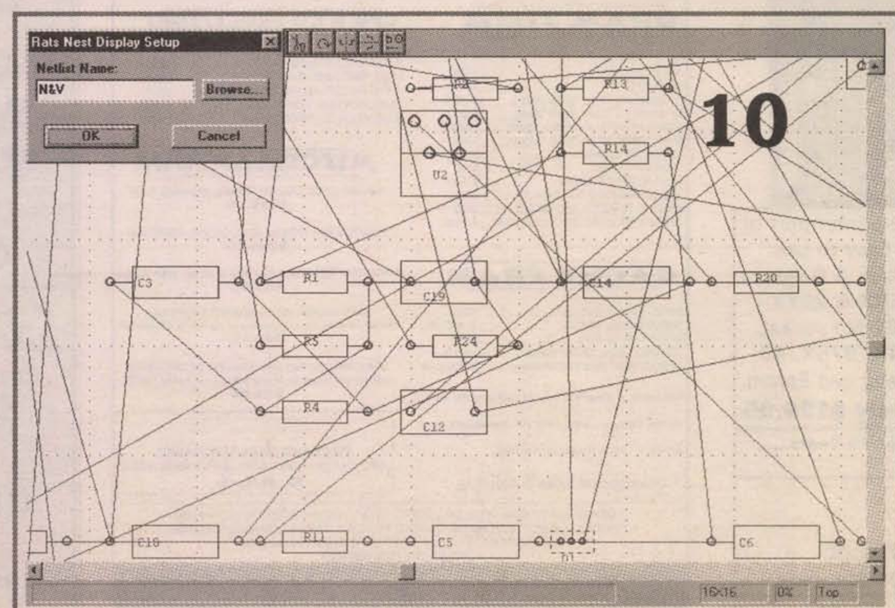
The default trace width is just 8 mils, which I find too narrow for hobby use. Instead, I prefer to use 20 mils for the track width because it's easier to work with using home etching methods.

Autorouting

To autoroute a board, click on the Batch Route option in the Process menu. A dialog box will appear (Figure 12), from which you set the trace width, routing grid, and the active layers. The Max length option (measured in mils) is used to







control the maximum length of traces on a board, which is useful for high-frequency layouts. After the router parameters are set, click on the Route button and watch the traces magically appear as the algorithm ripples through the possible combinations.

The autorouter relies heavily on vias to achieve 100 percent completion. A via is a "jumper" wire that connects the trace from one layer to another. Vias are useful for getting around roadblocks, such as an existing track. Think of them as tunnels or freeway underpasses. Unfortunately, vias are prone to failure because the hole has to be filled with a metal plating to make the connection — metal plating that's subject to physical and thermal stress. So the fewer vias you have, the better. The Optimize utility under the Process menu scours a routed board and removes unnecessary vias.

Because most readers don't have access to through-hole metal plating, my goal was to design a PC board with no vias, which I was able to do after much trial and error. All my layer-to-layer connections are made through component leads.

A Smoothing Massage

Once the traces are in place, the corners should be rounded, a process called smoothing. The smooth operation replaces 90-degree trace bends with either arcs or 45-degree bends. Smoothing has two benefits: it improves PC board yield because there's less risk of shorted traces, and it reduces RFI radiation (sharp corners are notorious for emitting noise).

The smooth operation is applied only after a board has been both routed and optimized. To initiate the smoothing, click on Smooth under the Process menu and select the type of smoothing (Figure 11).

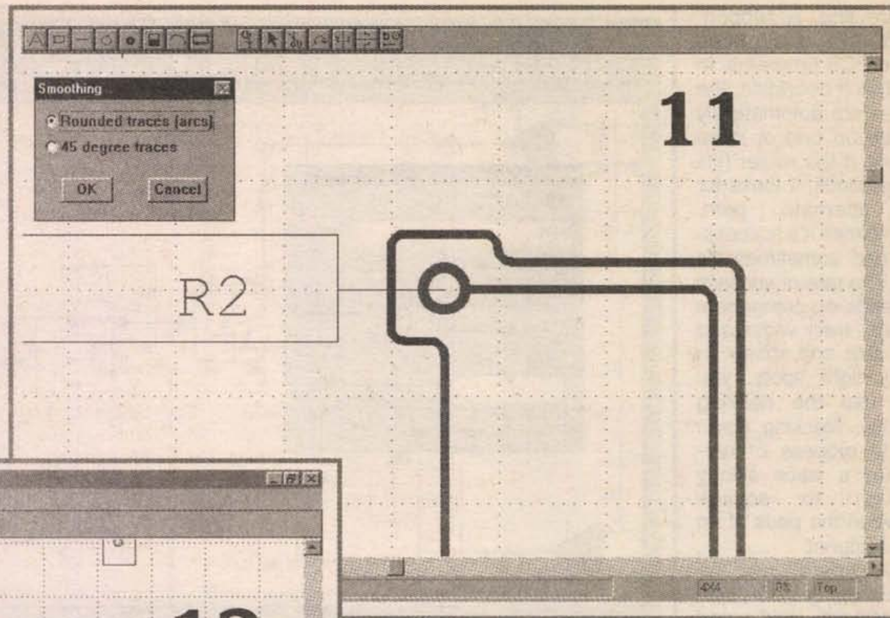
A Sound Message

The last item on this long list of things to do is to identify the components for both fabrication and repair. Fortunately, every component has a built-in reference — the same reference found on the schematic. However, I took it a step further, and so should you.

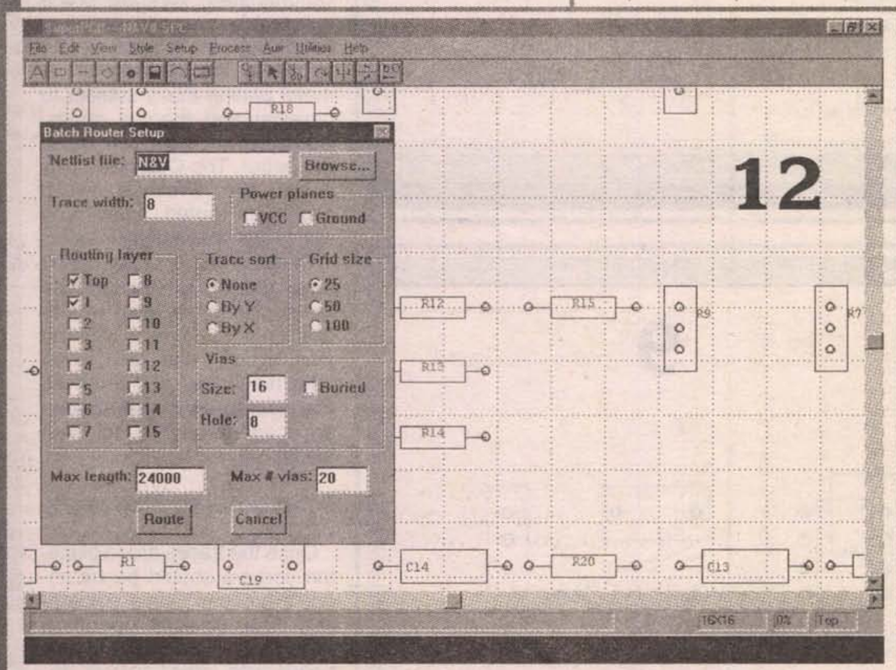
This project, for example, has quite a few sound processing controls, specifically several tone and volume adjustments. To make things clearer, I used the Draw Text feature to identify the purpose of these potentiometers on the PC board. Other nomenclature can be added to the board as well, such as the project's name, the date, and, most importantly, settings of DIP switches. The more information you put on the board, the less documentation it needs. The nomenclature is placed on the PC board via a silkscreen mask or by etching the message directly into a copper layer; the choice is yours.

It's A Wrap

That does it for this project, and for our review of the Encyclopedia of Electronics Circuits CD-ROM — the CD-ROM of 1,000 circuits. Of course, not all projects have to be as complex as the karaoke amplifier. I'm sure you'll find many of them suited to your needs as is. But like I pointed out, you may have to make adjustments to the artwork or components before you can turn it into a finished project.



11



12

Next time, I'll describe the construction of the circuit board and fabrication of the karaoke amplifier. Meanwhile, you can download the PCB layout artwork from our Web site (http://www.nutsvolts.com); it's under the name KARAOKE.ZIP. **NV**

Encyclopedia of Electronic Circuits: CD-ROM — $99.00

Available from:
Mental Automation
206-641-2141 http://www.mentala.com

Includes the viewer needed to *display* the schematics on the screen. To edit the circuits or make a printed circuit board, you need the Mental Automation CAD software, which is also on the CD-ROM, but requires the purchase of a password to unlock. *(Also available at major CD-ROM outlets.)*

DB-25 male connector. By any chance, do you have the pinouts for it so I can make an adapter? Also, I have an old Amiga 1000 with what is supposed to be an RGB output on the back of it. The problem is it uses a DB-23 (yes, I said 23 pins) connector. I would like to use it with a nine-pin RGB from my PC. I don't regularly subscribe to *Nuts & Volts Magazine*, so an E-Mail reply would be appreciated.

Gary Depietro
FL

A. What, you aren't a regular subscriber! Why not? Fortunately, you don't have to be a subscriber to get answers, and here they are (your answer is in the E-Mail, too).

AT&T PC6300

Pin	Function	Comment
1	Horizontal sync	
2	ID0 (monitor ID)	Logic high for color; nothing for mono
3	Vertical sync	
4	Red	
5	Green	
6	Blue	
7	???	
8, 9	N/C	
10	ID1 (monitor ID)	Logic high for color; nothing for mono
11	Mode 0	
12	N/C	
13	-Degauss	I'd use a push button
14-21	GND	
22, 23	N/C	
24, 25	+15V	

Amiga *500, 1000, 2200, 2500, 3000, 3500, 4000*

Pin	Function
3	Red
4	Green
5	Blue
11	Horizontal sync
12	Vertical sync
16-20	GND

MAILBAG

In reading your response in the Oct. '97 Electronics Q & A column regarding the 400-volt vacuum tube power supply, I noted your concern that it might be difficult to locate a two-megohm, two-watt resistor. Indeed, it might — but the resistor in the circuit shown can't dissipate more than 0.08 watts at 400 volts (or 0.125 watts at 500), so a one-watt, or even a one-half watt resistor should be plenty. I suspect you specified a two-watt resistor because of its higher insulation breakdown voltage — actually a longer leakage path and more space between leads. But this is clearly overkill. In circuits operating at up to 500 volts, one watt composition resistors are routinely used, and one-half watt resistors are not uncommon with 300-400 volt drops across them. I have a suggestion which may satisfy all requirements without requiring a two-megohm, two-watt resistor: Use two one-megohm, one-half-watt resistors in series.

Michael
via Internet

Response:
I wholeheartedly agree with this conclusion. I remember when one-half watt resistors were 3/4 inches long, not the puny 1/4 inches they measure today. Nice analysis!

TJ Byers
Q & A Editor

TECH FORUM

Continued from page 102

ANSWER TO #11974 - NOV. 1997

To provide DC power to a camera is pretty simple. You can build the following circuit at the TV where you wish to monitor the activity in the baby's room, and run RG 59 or RG 6. Use RG 6 for longer runs over 100'. You will need a capactor. Typically, .001 will work fine, and a 100 Uh choke. The choke is placed in series with typically, the positive side of your 12-volt supply the other end of the choke is connected to the center conductor of the RG 59 or RG 6. The other lead of the power supply will be connected to the shield of the coax. This will provide the needed 12-volts on the line with center conductor positive, if you need opposite polarity reverse the power leads. Then connect the .001 MFD capacitor from the same point as the choke, and then to the connection to the TV. The capacitor will be a DC block to keep the DC voltage from flowing into the TV. The capacitor will provide a path for the video on channel three or four to pass. Many of these cameras have this same circuit built-in the design to allow a power/video connection in one. If your camera requires separate DC input, then build an identical circuit for the camera end of the coax, and connect the DC out at the choke.

Ed Pruitt
Keller, TX

ANSWER TO #11978 - NOV. 1997

To put video into the computer, you need a video capture board. The board can have either a composite video hack, or some have tuners that allow you to tune any channel available. You can watch the video on screen typically with any super VGA monitor, 1 meg or more.

The capture is typically any frame. rather than full motion video. The storage of full motion video takes so much space it is not practical for most computers. Even storing it on CD-ROM 650 MB you could likely get 10-15 minutes of full motion video. There are DVD Players on the market, They use CD-ROM-type media, and have typically two or more hours per DVD Disk. Currently, I am not aware of any writeable CD drives that can handle the density required for the DVD Technology. With developments in the industry, it should be available in the near future.

Ed Pruitt
Keller, TX

ANSWER TO #11975 - NOV. 1997

James Waite may already have all the stuff he needs to get a stereo theater in his living room. If he has a cable that broadcasts stereo, a TV with mono audio, a stereo amplifier, and an MTS stereo VCR.

Take the channel three out of the cable box for premiums to stereo VCR, feed the left and right audio to the stereo amplifier and the channel three RF to the TV with mono audio. For non-premiums, the cable can go directly to the cable ready MTS VCR. Place the stereo speakers on either side of the TV to suit and adjust the volume controls to suit. The TV audio can be used to fill the middle or turned down as one prefers.

In the event that one inserts a splitter in the cable and feeds the extra output to the antenna input of the FM of the stereo system, most cable companies have a whole spectrum of FM stereo programming that this arrangement will play. Just leave the TV off.

Travis Brackeen
Fayetteville, GA

reader FeedBack

Continued from page 5

are notated with the aid of multiplier values of R (= Resistance 'units' or 'ohms'), K (= 1000 ohms), or M (= 1000,000 ohms); if the component's value contains a decimal point, the point is replaced by the appropriate multiplier symbol in the actual abbreviation. For example, 510R (= 510 ohms), 47K (= 47,000 ohms), 4K7 (=4.7K = 4,700 ohms), 4M7 (= 4.7M = 4,700,000 ohms), 8R0 (= 8.0 ohms), 2R7 (= 2.7 ohms), 0R1 (= 0.1R = 0.1 ohms).

Schematic capacitance values are usually notated with the aid of multiplier values of µ (pronounced micro-farad, = 1 millionth of a Farad), N (pronounced nano-farad, = 1 thousandth of a microfarad), or P (pronounced picofarad, but usually abbreviated to 'puff,' = 1 thousandth of a nonofarad). Thus, 1N0 = 1000P = 0.001µ, and 1 µ0 = 1000N = 1,000,000P.

Typical examples of capacitance values are 100P (= 0N1 = 0.1N = 0.0001µ), 47N (= 47,000P = 0.047µ), 0µ1 (= 100N = 100,000P = 0.1 µF), and 47µ (= 47,000N = 47,000,000P).

Schematic inductance values are usually notated with the aid of multiplier values of µ (pronounced microhenry, = 1 millionth of a Henry), M (pronounced millihenry, = 1 thousandth of a Henry, or H (= 1 inductive unit or 'Henry'). Thus, 1M0 = 1000µ = 0.001H.

Ray Marston

Dear Nuts & Volts:

I really enjoyed the article by Brian Mork on Disposable Cameras. I have torn everything else apart to salvage parts and to learn how they are constructed. This was a great article.

John B. Stuart
via Internet

Dear Nuts & Volts:

I was suprised to open my latest issue of N & V today and find the same article it took me two hours to search for on the Internet last night.

The article on disposable cameras was excellent. I've been hobbying in robotics for the past several months and one of the articles suggested getting the cameras for their 160 uF caps. I've been meaning to stop by the camera store for weeks. When I finally did, they gave me six or seven the first day. I was astounded to find all the useful components in something that would have been thrown away. At first, I was going to just tear out the caps and trash the rest, but my curiousity got the better of me and since I'm more of a digital electronics tech I was curious to find out how the circuit worked. Brian's article not only showed me how a flash circuit worked, he also enlightened me in the basics of charge pump power supplies. Great work. Thanks for an excellent magazine.

Biff Wheeler
via Internet

Continued from page 99

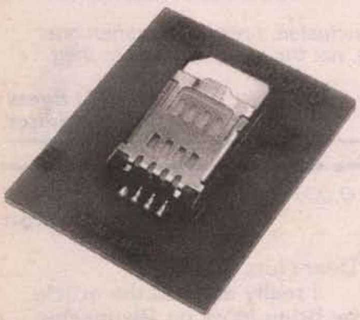
New Product News

Skyline can be used to monitor and control physical devices through a variety of I/O modules. These modules inside digital I/O, analog I/O, and various of I/O relay configurations. Up to eight I/O modules can be connected to a single remote Skyline platform. Skyline can also be configured to mimic an operation.

For more information, contact:

RF NEULINK
7610 MIRAMAR RD., DEPT. NV
SAN DIEGO, CA 92126
619-549-6340 FAX: 619-549-6345
1-800-233-1728
E-MAIL: rfneulink@aol.com

ID1 SOCKET SERIES



Hirose introduces the surface mount ID1 socket series for SIM (Subscriber Identity Module) cards.

Ultra-compact and thin, the ID1 is the world's smallest socket for SIM cards: only 2.75 mm in height, 30.6 mm in length, and 17.4 mm in width.

The ID1 series of sockets complies with the requirements of plug-in SIM cards meeting the GSM Standard. Applications include GSM Standard portable terminals and portable equipment.

The sockets are available in standard tray packaging or embossed type packaging for automatic mounting. The cost of the ID1 is $1.39 in lots of more than 500.

For more information, contact:

HIROSE ELECTRIC, INC.
2688 WESTHILLS CT., DEPT. NV
SIMI VALLEY, CA 93065
805-522-7958 FAX: 805-522-3217

COMPACT POWER SUPPLY CONNECTORS

Hirose introduces the MQ172 series of compact power supply connectors that also doubles as an I/O connector for small handheld devices.

Applications for the three-position MQ172 series include handheld devices such as cellular phones, handheld computers, and PDAs.

The lightweight MQ172 is not only space-saving (it is about 60% smaller than a typical pin jack connector), it also uses a stable two-point mating contact and a snap latch with a positive "click" connection. Durability is assured through 5,000 insertions. S-shape spring contacts prevent stressing of solder joints.

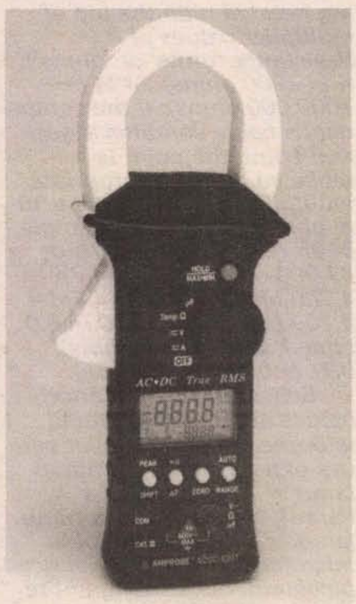
The contacts have 3 amp capacity and accommodate 24-32 AWG wiring and a choice of three keyings. Tape and reel packaging are available.

Cost of the MQ172 series is $1.20 per mated pair in lots of 1,000.

For more information, contact:

HIROSE ELECTRIC, INC.
2688 WESTHILLS CT., DEPT. NV
SIMI VALLEY, CA 93065
805-522-7958 FAX: 805-522-3217
1-800-879-8071

ACDC-620T CLAMP-ON METER



Amprobe Instrument, announces the release of their new Clamp-On meter, model ACDC-620T. The ACDC-620T is the first clamp-on meter to contain true RMS AC and DC amperage, true RMS AC and DC voltage, temperature and differential temperature, capacitance, and resistance measurement capabilities.

The circuitry allows recording to maximum, minimum, and average values of all parameters possible.

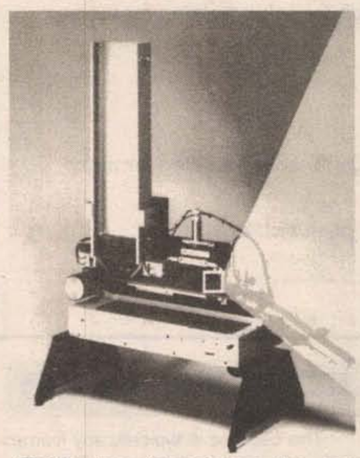
Peak values of AC voltage and current can also be measured, typically for motor inrush current applications.

The ACDC-620T comes complete with DTL-3000 test leads, CC-ACDC carrying case, MN-1604 nine-volt battery, and instruction manual.

For more information, contact:

AMPROBE INSTRUMENT
630 MERRICK RD., P.O. BOX 329
DEPARTMENT NV
LYNBROOK, NY 11563
516-593-5600 FAX: 516-593-5682

MICRO POSITIONING SYSTEM



CST, Inc. introduces the new Micro Positioning System (patents pending) for its DM718 Automatic SIMM/DIMM Handler.

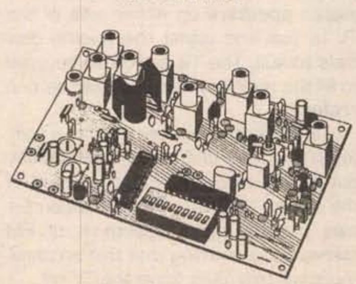
This system assures a perfect match between contactors and the module tabs and helps eliminate costly retest and quality uncertainty.

This new Micro Positioning System references the modules to the JEDEC specified tooling holes instead of the variable outer edges. The module is first carried to the test site and stopped at this proximity. The center-seeking micro positioning pins lower into the two tooling holes on the module to perfectly align the module tabs to the contactors. The Micro Position is the only way to eliminate fallout on automatic memory module testing.

For more information, contact:

CST, INC.
2336 LU FIELD RD., DEPT. NV
DALLAS, TX 75229
214-241-2662 FAX: 214-241-2661
E-MAIL: cst_inc@ix.netcom.com
WEB: http://www.simmtester.com

VHF FM EXCITERS AND RECEIVERS



Hamtronics® has a new line of VHF FM transmitters and receivers.

The new T301 exciter and R301 receiver provide high-quality NBFM and FSK operation on 144-148 MHz (and 148-174 MHz for export and government services). Features include DIP switch frequency selection, low-noise synthesizer for repeater service, commercial grade TCXO for tight frequency accuracy in wide range of environmental conditions, and fast delivery with no wait for channel crystals.

The T301 exciter has exceptional modulation for voice and sub-audible tones. It uses direct FM modulation, which allows FSK transmission of data up to 9600 baud. Power output is 2-3 watts and it is rated for continuous duty in demanding applications, such as repeater service.

The T301 and R301 are available either in kit form or factory wired and tested. The T301 exciter is only $109.00 for the kit or $189.00 wired/tested. The R301 receiver is $139.00 for the kit or $209.00 wired/tested. Kits use a crystal (supplied) to generate the reference frequency, and a TCXO is optional at $40.00. Factory built units include a TCXO as standard equipment.

For more information, contact:

HAMTRONICS, INC.
65-N MOUL RD., DEPT. NV
HILTON, NY 14468-9535
716-392-9430 FAX: 716-392-9420
E-MAIL: jv@hamtronics.com
WEB: http://www.hamtronics.com

DIGITAL PAGING TRANSMITTERS

Sonik Technologies Corporation announces the introduction of its new PagePro family of low-powered digital paging transmitters. These units are designed for low-powered on-site and local area paging and are also ideal for use as exciters with high-powered power amplifiers to provide wide area coverage.

The PagePro family provides synthesized coverage in the 136-174, 218-230, 260-280, 450-470, and 470-490 MHz frequency bands. Output power is adjustable at 1-5 watts in the 136-174 MHz band and 0.5-2 watts in the other bands.

The PagePro units are packaged in compact fully-shielded metal OEM enclosures with a large heatsink to permit continuous duty operation. Rack mounting is available as an option. An RS-232 port provides convenient programming of the operating frequency and other parameters.

For more information, contact:

SONIK TECHNOLOGIES
310 VIA VERA CRUZ, STE. 111
DEPARTMENT NV
SAN MARCOS, CA 92029
760-752-1011 FAX: 760-752-1411
E-MAIL: sales@sonik.com
WEB: http://www.sonik.com

HOW TO PLACE A CLASSIFIED AD

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

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

RATE PER WORD

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

WORDS IN BOLD AND/OR ALL CAPS

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

PHOTOS, DRAWINGS, AND BOXES

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

FAXING IN AD COPY

You may fax in ad copy or changes before the closing date (5:00pm on the 10th) at 909-371-3052 using MasterCard or Visa. Include credit card expiration date, the name that appears on the card, a daytime phone number, and your *Nuts & Volts* account number. Ads without credit card information will not be listed as received until payment is received in full. **WE DO NOT CALL OR FAX BACK VERIFICATION OR QUOTES OF FAXED-IN ADS.** For verification of faxed-in ads, please call 909-371-8497.

DEADLINE

Prepaid ads received by 5:00pm on the closing date (10th of the month) will appear in the following month's issue. Ads postmarked through the 10th, but received after the closing date, will be placed in the next available issue. No cancellations or changes after the 10th. Cancellations and changes must be submitted in writing.

IMPORTANT INFORMATION

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

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

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

ADVERTISER'S INDEX

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FIND what you need... FAST by PRODUCT OR CATEGORY

NUTS & VOLTS MAGAZINE
430 PRINCELAND COURT
CORONA, CA 91719

ADDRESS CORRECTION REQUESTED

BULK RATE
U.S. POSTAGE
PAID
V.Q.S.
ENTERPRISES