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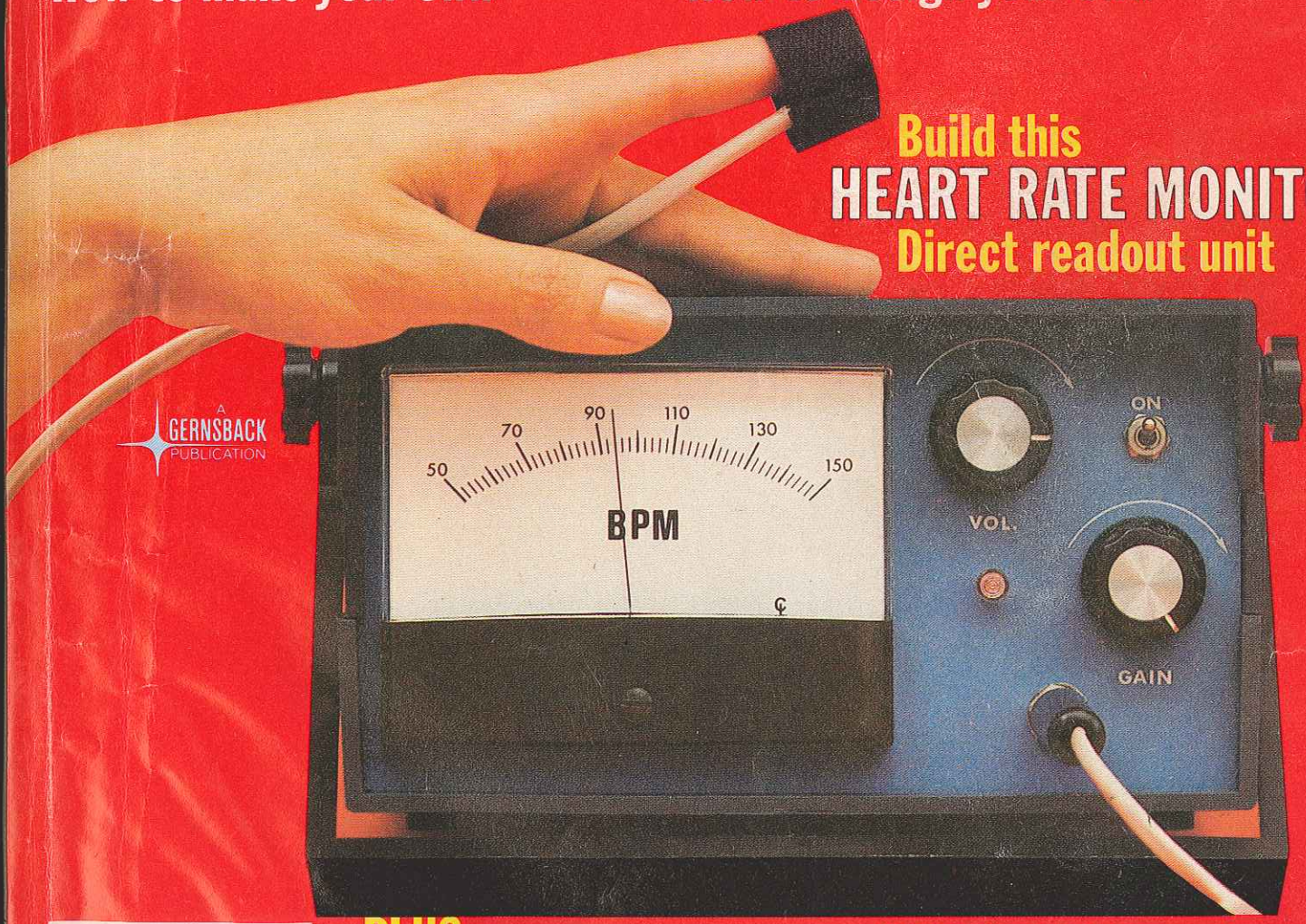

Build this HEART RATE MONITOR
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is also available. It looks like an ordinary wall switch, operates like one, installs like one, but can also be remotely controlled.

When we first looked at the unit, we wondered what would happen if we had one, an upstairs neighbor had one, or the guy next door had one; if his units would turn mine on, and if my units would turn his on. Obviously, if our signal gets into his apartment, it will. But BSR is just one little step ahead of us. There are 16 separate ranges that will automatically prevent overlap. A simple dial selector on the unit codes the letters A through P for those noninterfering signals.

I can't think of an easier way to remotely control electrical functions in anyone's home or apartment, and the price is surprisingly reasonable for what the equipment can do. This is one of those products among the many we've tested that I am going to want for myself.

The *System ×10* is available from Advanced Electronics, 54 W. 45 St., New York, NY 10036. **R-E**

RCA CDP18S020 COSMAC Evaluation Kit

THE RCA 1800 SERIES COSMAC MICROPROCESSOR and its associated family of devices have a couple of unique characteristics. First, because they are COS/MOS devices, the power drain is low, starting at the milliwatt level. Single-IC standby memory power is also in the low milliwatt range.

Second, the 1800 family tolerates an unusually wide power supply range—3 to 12 volts for the CDP1802 with a 3.2-MHz clock. And the operating temperature range for the full-speed processor and certain memory products covers the full −55 to 125°C temperature range. This is important if your microprocessor-controlled gadget will form part of an automotive system.

CIRCLE 103 ON FREE INFORMATION CARD

The processor instruction set is based on a 16- × 16-bit scratch-pad organization that provides good programming flexibility.

The RCA CDP18S020 Evaluation Kit is a relatively inexpensive tool with which to learn about the RCA 1802, prototype a microcomputer system, or develop software. A 20-mA loop or RS232C terminal is normally required to use the Evaluation Kit, although a simple keyboard or switch interface can be designed. Board dimensions are 14 × 9.7 inches, including fully decoded prewired locations for expansion to 4096 bytes of random-access memory (RAM), and a 6- × 4-inch user area wired to accept standard DIP packages.

Three edge connectors provide access to the microprocessor pins and the user input-output (I/O) area, and connect to external power sources and peripheral devices. The kit comes with a 2-MHz crystal which, for the 16- and 24-clock-period instructions, calculates to 8-μs or 12-μs execution times. A 6.4- MHz oscillator reduces these values to 2.5 and 3.75 μs.

A 512-byte ROM is assigned address space from 8000 to 81FF and permanently stores the UT4 monitor program. A 32-word RAM starting at 8C00 is used by the utility program to store register contents. Two supplied RAM IC's fit into the first two locations in the 4K memory area for an initial 256-word user programming space.

System operation is controlled by three pushbuttons and a toggle switch. The RESET pushbutton intializes the CPU and control logic: RUN U (*R*un *U*tility) gives control to the ROM monitor program by starting execution at 8000. The RUN P (*R*un *P*rogram) pushbutton starts program execution at 0000, where the first user's program instruction is usually entered. The CONTINUOUS/STEP toggle switch lets the user choose between the normal clocked mode or single-cycle operation, where individual program steps can be dissected down to 2 machine or 3 machine cycles-per-instruction.

A series of 29 LED's display the status of the 16-bit memory address bus, the 8-bit data bus, the S0 and S1 processor state codes, the $\overline{\text{CLEAR}}$ and $\overline{\text{WAIT}}$ control signals, and the processor's Q flip-flop.

Bidirectional communications to a data terminal are provided by interface circuits that use the Q flip-flop for output and the $\overline{\text{EF4}}$ flag to input the serial data. Detailed instructions show how to hook up to current loop terminals such as *Teletypes,* and to EIA RS232C interfaces such as Texas Instruments' *Silent 700* terminal. Parallel 8-bit input and output ports are included in the kit.

External power supplies are required—of 5 volts at 600 mA, or 10 volts at 200 mA with a separate 5-volt 400-mA supply for the LED's.

Assembly

Kit assembly was pleasantly uneventful with the help of a high-quality, double-sided PC board with plated-through holes. Close PC runs are necessity on microcomputer boards, and careful soldering and inspection techniques are a must. Sockets are provided for the microprocessor and utility ROM IC's, but, as always, I recommend using additional sockets or *Molex* pins to mount some or all of the remaining 22 circuits.

The checkout procedures consists of measuring the resistance of the supply input leads, and loading and executing a four-instruction program that sets and resets flip-flop Q.

Figure 1 demonstrates the writing of data to memory, the reading of data from memory, and starting programs. The UT4 program recognizes three commands corresponding to each of these functions.

After pressing the RESET and RUN U pushbuttons, type either a carriage return or a line feed depending on whether your terminal is connected for full-duplex or half-duplex operation. Full-duplex operation requires the computer to echo back characters typed on the keyboard to the printer, since the two terminal functions are completely isolated. Based on the first character typed, the utility program sets up to echo or not, and calculates the bit timing necessary to talk and listen to the terminal.

Figure 1 shows how the three-command repertoire works. First, you enter a program either from the keyboard or from punched paper or magnetic tape. The command !M is the write-memory command, which is immediately followed by the address where the input should be entered—in this case, 0 or 0000. The space after the 0 separates the address from the data. Next, the program instructions or data are entered in hexadecimal format, with each two characters accounting for a single memory word. In hexadecimal or base 16 format, additional symbols are needed for numbers between 10 to 15. Letters from A through F are used to represent 10 through 15 with a single symbol.

Spaces can be imbedded between words if desired. At the end of the line, you have a number of choices. In Fig. 1 the first line is terminated by a semicolon. This told the machine I wasn't finished yet, and that I will give a new address and more input. Everything else was ignored until the next hexadecimal digit. I then added an extra line feed to make the printout more legible. On the second line I started to type 10 but decided I really wanted to enter more data starting at address 20. The system (being forgiving) only pays attention to the last four numbers entered, so I typed 0020 (or I could have typed 020 since one 0 was already there from the 10). I then hit the space bar and typed in the data.

This time I hit a comma at the end of the line that told the machine I still had more data to enter but wanted to continue on the next line. With the comma the data continues in sequence and a new address is not given.

At the end of the third line I decided to go back and fill in data starting at 000F; so I used the semicolon again.

Finally, at the end of line 4, I simply used a

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```
*M0 1122334455667788 99AABBCCDDEEFF;

100020 123456789ABCDE,
1029384756;
000F AFBECD
*?M0 30
0000 1122 3344 5566 7788 99AA BBCC DDEE FFAF;
0010 BECD 0000 0000 0000 0000 0000 0000 0000;
0020 1234 5678 9ABC DE10 2938 4756 0000 0000
*?M20 10
0020 1234 5678 9ABC DE10 2938 4756 0000 0000
*?M8C00 20
8C00 D0D0 8C02 FF00 814F 9401 804A BD00 EF82;
8C10 FA24 FF66 FF02 7F00 80EF 0000 2800 8000
*$P

*$P0100
```

FIG. 1

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carriage return, indicating I was through, and the machine responded with the prompt asterisk on the following line.

At this point, you're ready to check by reading out memory contents with the ?M command. Again, you use 0 as the starting address; however, the 30 is not data but the number of words in hexadecimal format to be typed out—$30_{16} = 3 \times 16 = 48_{10}$ words. The next three lines represent the response to that command. The first four columns display the starting address for each line followed by 16 words grouped by two's. The last byte on the 0000 line is the AF that I inserted at address 000F on line 4.

Note the format that the machine uses to output memory contents. The first two lines begin with addresses and end with semicolons, and the third line starts with an address (0020) and ends with a carriage return. This allows the data to be stored on tape in this format and then later be read back in using the compatible !M command.

The next group of lines demonstrate a memory dump of 10_{16} or 16_{10} words starting at 0020.

The UT4 monitor program uses a 32-byte RAM starting at 8C00 to store the 16 scratchpad microprocessor registers. This feature is helpful in troubleshooting, but care must be used since certain registers are modified by the system. The program cannot be restarted from an intermediate point after being interrupted by inserting an idle instruction unless the registers are restored.

The next three lines in Fig. 1 show how the register RAM is printed out with the ?M8C00 20 command. Characters R0 and R7 are displayed on the line prefixed by 8C00, and R8 through RF on the line starting with 8C10.

Command $P starts program execution. If no address is given, execution begins wherever the program counter is set, usually at 0000. Otherwise, the program is started at the address typed immediately after $P.

A large loose-leaf binder comes with the kit. It includes detailed sections on kit assembly, design and operation of the system, the utility program (including listing), application notes on I/O and control, software and memory.

The CDP18S20 evaluation Kit is priced at $249 and is available from RCA Solid State Division, Somerville, NJ 08876, or from RCA Solid State distributors. **R-E**

"No matter what the project he's working on is supposed to be—it ends up being a light dimmer."