

THE COMPUTER JOURNAL

For Those Who Interface, Build, and Apply Micros

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Editor's Page

Small Company Comeback?

Back in the seventies — before micros — when people mentioned computers they meant the huge, expensive mainframes. These systems were almost always designed for batch processing where you would punch a card deck for your program, submit it to the data processing department to be run at their convenience, and wait hours or days for a printout of the results. If your program bombed, you had to revise it and reenter the long cycle to try it again. The development of minicomputers with interactive terminals was a great improvement because the programmer could work directly with the computer, but these systems still cost millions of dollars and required a lot of space and tons of air conditioning.

At that time computers were constructed of discrete components using thousands of individual resistors, capacitors, and transistors, and the equipment could not be made small or inexpensive. When the integrated circuit microprocessor was developed people started talking about the possibility of smaller systems, but the manufacturers wouldn't even consider the idea of an individual having a complete computer on their desk. They felt that the future of the computer market was in larger, more expensive systems, with batch type processing or possibly time sharing.

The only way to get your own computer at that time was to build it, so the hardware hackers scrounged around for parts and helped each other get their systems up and running. It wasn't long before small companies offered kits, and it mushroomed into the microcomputer industry of today. It is important to note that the initial development was done by very small, previously unknown businesses. MITS started with an idea and was swamped with orders for kits. Bill Godbout started selling kits out of an old hanger and developed the business into CompuPro. Steve Jobs and Steve Wozniak sold a

VW Van and a HP calculator to start building Apples in a garage. The large, established companies didn't enter the market until long after it had been founded and proven by the pioneers. The spectacular technological advances were made by individuals or small start-up businesses; the big boys just added a few enhancements and a lot of promotional marketing when they decided that the field was ripe for picking.

"...it takes a minimum promotional budget of ten million dollars to bring out a major program in the business market."

The entry of big name companies established the microcomputer as legitimate for the business office environment, and opened the possibility of selling extremely large quantities of micros to a technically unsophisticated audience. These companies built factories for high volume production of a conservatively designed system intended to serve a wide variety of users, and spent millions on promotion. The result was that anyone competing with them in this market had to follow the same plan targeted towards large quantities and high promotional expenditures.

At this point it was no longer possible to start from the garage with a few dollars, at least not if you wanted to battle the big boys for a share of their market. One of the software publishers has said that it takes a minimum promotional budget of ten million dollars to bring out a new major program in the business office market. This means that only programs with
(continued on page 4)

DEBUGGING 8087 CODE

by Lance Rose

Cailing all number crunchers! The good news is that the price of the 8087, Intel's floating point numeric processor, just fell again and it can now be bought for about \$150. (Compare this with its initial price of \$400.) In addition, you can now buy an 8MHz version of the chip (the standard version is rated at 5MHz), although the price is quite a bit steeper (\$275). The bad news is that in order to use the chip, you need an assembler or compiler that will generate the floating point opcodes for it. So far, the compilers available that will do this have a pretty steep price tag attached to them (\$300 and up) and for those of us on a limited budget, it may come down to a choice between buying either the math chip itself or the compiler without the math chip. Since the latter choice doesn't make any sense, we might look at some ways of using the 8087 that don't involve compilers.

I think it's only fair to say here that for math, science or engineering applications, a high level language is much better than assembly language, unless running the program at maximum speed is your primary goal. Debugging applications programs written in assembly language is tedious and frustrating and the program listings tend to be much longer (by about a factor of 5-10 in my experience) than the high level language equivalent. Still, if you don't have unlimited funds this may be your only choice.

My own system uses a Compupro 8085/8088 Dual Processor board which has been modified to incorporate an 8087 floating point processor (see "Add an 8087 Math Chip to Your Dual Processor Board" in Vol. I, No. 3 of *The Computer Journal*). My system runs CP/M-86 which is file compatible with CP/M-80, an important factor if you have a hard disk and want to switch back and forth between systems. CP/M-86 comes with an assembler called ASM86 and a debugger called DDT86. These function much the same as their CP/M-80 counterparts. In addition

there is a macro library of 8087 instructions included with the system so that you can write programs which include floating point operations.

As an aside here, let me warn anyone using this library that it does not entirely agree with Intel's instruction set as far as the function of some instructions go. I have found it useful to fix up the library so as to be compatible with Intel's description of the opcodes as described in the Intel "iAPX 86,88 User's Manual" which is available from Intel Corporation, 3065 Bowers Avenue, Santa Clara, CA 95051. Anyone who is interested in the changes required (they are minimal) can contact me through **The Computer Journal** for more information.

With the macro library available, it is possible to write assembly language applications programs. However, debugging them is another matter, since the DDT86 debugger has no way of examining or modifying the 8087 registers the way it does for the 8086/88 registers. Also, during program tracing all 8087 instructions show simply as ESC instructions with meaningless operands rather than the actual mnemonics (e.g. FADD ST,ST3 or FSQRT). While this latter problem is not very easy to fix, it isn't too hard to allow the display of the 8087's stack of 8 floating point registers as well as the control and status registers.

Modifications

My original plan for incorporating 8087 code debugging into DDT86 was to show all the 8087 registers along with the 8088 registers whenever the latter were displayed. Aside from the complexity of this approach, it would make it awkward to use the debugger for 8088-only code, thereby necessitating two separate debuggers on the disk. After some thought, I decided on a different method.

DDT86, like ordinary DDT, accepts single-letter commands, with or without arguments, to do things like

Display memory, eXamine registers, Set memory and so forth. There is a jump table located within DDT86 that vectors to the proper routine corresponding to the letter of the command entered. Since many of the letters of the alphabet are unused by DDT86, it is a simple matter to appropriate one of them to display the 8087 registers. All that is required is to: (1) patch the jump table at the position of the desired letter code to jump to a new routine, (2) write the display routine and (3) merge it with the original DDT86 to get a new debugger, which I call DDT87.

The additional code necessary to implement the 8087 register display is the program listing shown in Figure 1. It is pretty straightforward and uses the 8087 instructions FSAVE and FRESTOR to put the entire 8087 machine state into memory where it can then be examined and displayed by the 8088. I used the letter Z as the instruction to do this, simply because it is positioned near the 'X' on the keyboard and I'm used to displaying the 8088 registers with the 'X' command. If you prefer a different letter it's a simple matter to patch the corresponding word in the jump table once you know where to find it. (It begins at 0369H relative to the beginning of the DDT86 file). Just make sure you don't choose a letter that's already in use or you will lose one of DDT86's standard functions.

After you have entered the patch program with a text editor or word processor, simply go through the procedure shown in Figure 2. This figure is simply a copy of the console commands required to assemble the patch, merge it with DDT86 and test its function. Once it is known to be working you can remove DDT86 from your working disk (not your archive diskette) and use DDT87 instead. When not examining 8087 registers it will function just as DDT86 would. The only difference is the 'Z' command.

Summary

I have found that the hardest thing in debugging 8087 code is not being able to see the floating point registers. This makes it hard to find floating point stack overflows and the like. This debugger patch rectifies this and makes floating point program debugging much easier. Some additional enhancements that might be nice would be to display the 8087

register values in floating decimal instead of hex, allow alteration of individual 8087 registers and display floating point opcodes with their proper mnemonics. I might decide in the future to add some of these, but the ability to actually examine the 8087 registers seems to solve the majority of the debugging problems. In retrospect, the patch is so simple that I wonder why I didn't add it sooner.

```

; Patch to allow DDT86 display of 8087 registers
; 12/15/84
;
; CSEG
;
; ORG 3660H ;End of DDT86
;
; FSAVE STATE ;Save 8087 state
; FRSTCR STATE ;Now restore it
; MOV DX,OFFSET HDG1
; MOV CL, 9
; I NT 224 ;Display first heading
; CALL SPACE
; MOV AX,STATE
; CALL DISPW ;-Display control word
; CALL SPACE
; MOV AX,STATE+2
; CALL DISPW ;Display status word
; CALL SPACE
; MOV AX,STATE+4
; CALL DISPW ;Display tag word
; CALL SPACE ;Add an additional space
; MOV SI,OFFSET STATE+22
; MOV CX, 3
; CALL DISPPF (Display ST0,ST3,ST6
; MOV DX,OFFSET HDG2
; MOV CL, 9
; I NT 224 (Display second heading
; MOV SI,OFFSET STATE+32
; MOV CX, 3
; CALL DISPPF (Display ST1,ST4,ST7
; MOV DX,OFFSET CRLF
; MOV CL, 9
; I NT 224 (Do a CRLF
; MOV AL,BYTE PTR STATE+9
; MOV CL, 4
; SHR AL, CL
; CALL DISPW (Display high nybble of IP
; MOV AX,STATE+6
; CALL DISPW (Display low word of IP
; CALL SPACE
; MOV AX,STATE+8
; AND AH,07H
; OR AH,0D8H
; CALL DISPW (Display opcode
; CALL SPACE
; MOV AL,BYTE PTR STATE+13
; MOV CL, 4
; SHR AL, CL
; CALL DISPW (Display high nybble of OP
; MOV AX,STATE+10
; CALL DISPW (Display low word of OP
; MOV SI,OFFSET STATE+42
; MOV CX,2 (Display ST2,ST5
DISPPF: PUSH CX
; PUSH SI
; CALL SPACE (One leading space
; POP SI
; MOV CX,5 (Five words per register
DISPF1: STD (Set to decrement

```

continued

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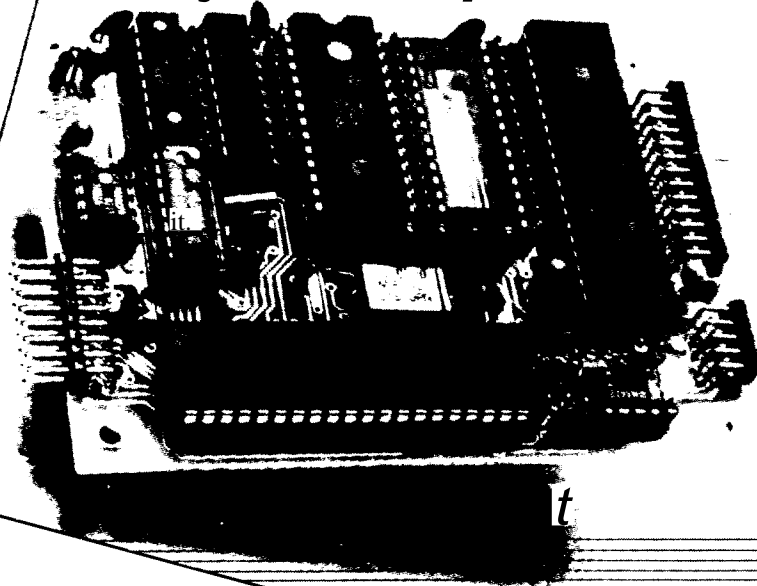
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```

-c
-DDT86 1.1 A>DDT86
-RDDT86.CMD
I          START END
i          2000:0000 2000:367F
          2000:0000 01
          2000:0001 60 79
          2000:0002 03
          2000:0003 00
          2000:0004 00
          2000:0005 66 7F
          2000:0006 03 .
-SIBE
          2000:01BE 36 37
          2000:01BF 20 .
          2000:039B DF 60
          2000:039C 02 36
          2000:039D CD .
-WDDT87.CMD,0,387F
A>DDT87
DDT87 1.1
-Z
          CW          Tw
          03p Sw      1p ^100
          -9000e °C   C °S0
A)

```

```

ST0-ST2          ST3-ST5          ST6-ST7
FFF6D5 555 57 511 5C7 55 5 FFF6D55 5 557511 5C755 5 FFF6D555557511 5C7555
FFF6D555575115C7555 FFF6D5555575115C7555
FFF6D55 5 557 511 5C 7 555 FFF6D55 5 5575115C7555 FFF6D555557511507555

```

USING THE APPLE GAME PORT

by Art Carlson

When Woz designed the Apple® he included a very useful port to interface the joysticks, paddles, and switches used for games, and named it the game port. This port can be used for many other applications, and it is unfortunate that because of its name people do not consider it for other uses.

The game port, which is available from a 16 pin DIP (Dual Inline Package) socket on the motherboard, contains four analog inputs which respond to variable resistance, four one bit outputs called "annunciators" which can be used as an input to some other device, three one bit inputs which can be used to sense the position of a switch or the state of an electronic device, and a strobe output. These features can be used from either assembly language or BASIC and can provide many interfacing functions without the added expense or slot space of a plug-in board.

The pin-out for this connector is shown in Figure I as viewed from the

top of the motherboard. You can make the connections directly to the socket, but for experimental work where you will be changing the parts frequently, it is more convenient to use a 16 conductor jumper cable (Radio Shack #276-1976.A) to bring the connections outside of the computer to a prototyping breadboard (Radio Shack #276-174). This also saves wear and tear on the motherboard socket. A permanent circuit for a small device could be assembled on a 16 pin header and plugged directly into the socket after being tested on the breadboard.

A Simple Starter Project

The first project, as shown in Figure 2, demonstrates the use of the annunciator outputs to control a device. It is a very simple project which almost anyone can do. The experienced hardware hackers can just skim over this section, but if this is your first attempt, roll up your sleeves and get started.

Our philosophy is to have you start at a level where you can succeed and build from there, rather than start you on something way over your head and have you fall flat on your face.

The first step is to acquire a prototyping breadboard, a 16 pin jumper cable, two LEDs, and two 330 ohm resistors. Although I have occasionally used wires poked into the socket with the other end clipped or soldered to the components, I do encourage you to get the breadboard and cable. They can be used over again for other projects, and are a small investment (about \$15) which will make things much more convenient.

It may appear to be overkill to use a computer to flash a couple of LEDs, but they are used here because they are cheap, easy to get, and provide visual feedback on what is happening while avoiding the additional complications involved in driving more demanding devices. In an actual application you would be controlling a motor, relay, heater, or some other device.

The annunciators are controlled by soft switches, with two memory locations assigned to each annunciator. Reading or writing to one location will turn the switch on, and reading or writing to the second location will turn the switch off. The value written to or read from the location is meaningless; it is the action of referencing the location which sets the switch.

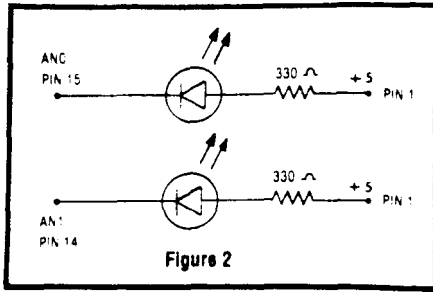
In this example we use ANO to control an LED connected to pin 15 of the game port, and AN1 to control an LED connected to pin 14 (see Figure 1). ANO is turned on from location 49241 (Hex \$C059), and is turned off from location 49240 (Hex \$C058). The Apple uses the \$ symbol to identify a hexadecimal number. AN1 is turned on from 49243 (\$C05B), and off from 49242 (\$C05A).

The annunciator outputs are standard 74LS series TTL (Transistor-Transistor Logic) outputs from a 74LS259 addressable latch on the motherboard, and the Apple reference manual states that the outputs must be buffered if used to drive other than

1-	+5V'	NC	-16
2-	PB0	AN	-15
3-	PB1	ANi	-14
4-	PB2	AN2	-13
5-	STROBE	AN3	-12
6-	GC	GC3	-11
7-	8C2	GC1	-10
8-	GRND	NC	-9

	FUNCTION	HEX	DEC	READ OR WRITE
PB0	FLAGINPUT ZERO	*C061	49249	R
PB1	FLAGINPUT ONE	•C062	49250	R
PB2	FLAGINPUT TWO	•C063	49251	R
AN0	ANN.ZERO OFF	•C058	49240	R/W
AN0	ANN.ZERO ON	C059	49241	R/W
AN1	ANN.ONE OFF	•C05A	49242	R/W
AN1	ANN.ONE ON	\$C5B	49243	R/W
AN2	ANN.TWO OFF	•C05C	49244	R/W
AN2	ANN.TWO ON	•C05D	49245	R/W
AN3	ANN.3 OFF	•C05E	49246	R/W
AN3	ANN.3 ON	•C05F	49247	R/W
GC0	ANALOG INPUT	«C064	49252	R
GC1	ANALOG INPUT	C065	49253	R
GC2	ANALOG INPUT	«C066	49254	R
GC3	ANALOG INPUT	•C067	49255	R
	STROBE	•C040	49216	R
	ANALOG CLEAR	•C070	49264	R/W

Figure 1



TTL inputs. TTL is called *current-sinking* logic because it can absorb or sink current to ground in the low state, but it can source or supply only a very limited current in the high state. The 74LS259 is rated as being able to source 0.4ma in the high state or sink 8ma in the low state. Since common LEDs require about 6ma, you have to either use the current sinking capability of the low state or use a buffer to drive the LED from the high state. Because of my early training on tube type equipment, I have had difficulty adjusting my thinking to turning something on with the logic in the low state, which is normally considered "off." Another alternative would be to use an inverter so that the device would be turned off with the TTL output low, but that also adds more parts for a simple LED driver. I have chosen to use the low state LED driver as shown in Figure 2. For more information on TTL logic, refer to page 7 of **Interfacing Microcomputers to the Real World** by Sargent and Shoemaker, page 6 of **TTL Cookbook** by Lancaster, or page 394 of **The Art of Electronics** by Horowitz and Hill.

The Applesoft BASIC program in Figure 3 will flash the two LEDs with the on and off times determined by the FOR-NEXT delay loops in lines 40 to 50,70 to 80,100 to 110, and 130 to 140. While this demonstrates the use of

```

JLIST
10 REM CYCLE AN0 AND AN1
20 REM 1/16/85
30 POKE 49240,0: REM TURN AN0 OFF
40 FOR I = 1 TO 250
50 NEXT
60 POKE 49241,0: REM TURN AN0 ON
70 FOR I = 1 TO 250
80 NEXT
90 POKE 49242,0: REM TURN AN1 OFF
100 FOR I = 1 TO 250
110 NEXT
120 POKE 49243,0: REM TURN AN1 ON
130 FOR I = 1 TO 250
140 NEXT
150 GOTO 30
    
```

Figure 3

POKE statements to control the annunciators it doesn't have any useful applications. However, by using an analog input to read the value of a variable resistance you can vary the on and off times depending on this resistance.

Assembly Language Programming of the Annunciators

Before tackling the game controller input, I want to cover using the annunciators from assembly language. I know that there were a lot of moans and groans when you saw the frightening words "assembly language," but it is not the intimidating beast that everyone thinks it is, and the speed of assembly language programs will be necessary for real time control in more advanced projects. Another advantage of assembly language programs is that you can place small driver programs in memory below HIMEM and call them from BASIC or other assembly programs.

Most assemblers can use either decimal or HEX addresses, but HEX addresses are much easier to use.

especially since the memory pages break on HEX boundaries. A page in memory is the first byte of a two byte number. In other words, \$0300 to \$03FF is page three and covers \$100 bytes (remember the Apple convention of defining a number preceded by the \$ symbol as a HEX number). The game port soft switches are located in page \$C0 and are shown along with the decimal numbers in Figure 1 so that you can use them without doing any conversions.

The assembly language program in Figure 4 includes a nested delay loop so that the LEDs flash slowly enough for you to see. The HEX dump listing can be entered directly from the monitor if you do not have an assembler. The assembler source code is for the S-C Macro Assembler, but should work with most assemblers by changing the pseudo-opcode directives to suit your assembler. Lines 1050 thru 1080 establish the equates for addressing the four annunciator switches so that you can use the labels instead of the addresses in the source code. The assembler replaces the label with the

```

1000 * -----
1010 *          CYCLE VERSION 1.2
1020 * PROGRAM TO CYCLE AN0 AND AN1
1030 *          1/16/85 RAC
1040 * -----
C05B- 1050 OFF0      .EQ »C05B
C059- 1060 ON0      .EO SC059
C05A- 1070 OFF1     .EO SC05A
C05B- 1080 ON1      .EQ *C05B
0800- BD 58 C      1090 CY0      STA OFF0      TURN AN0 OFF
0803- 20 IB 08     1100          JSR DELAY
0806- 8D 59 C0     1 1 10      STA ON0      TURN AN0 ON
0809- 20 IB 08     1120          JSR DELAY
080C- 8D 5A C0     1130 CY1      STA OFF1     TURN AN1 OFF
080F- 20 IB 08     1140          JSR DELAY
0812- BD 5B C0     1 150       STA ON1      TURN AN1 ON
0815- 20 IB 08     1160          JSR DELAY
0818- 4C 00 08     1170          JMP CY0
081B- A2 FF        1180 DELAY    LDX #»FF
081D- A0 FF        1190 LOOP1    LDY #SFF
081F- 88           1200 LOOP2    DEY
0820- D0 FD        1210          BNE LOOP2
0822- CA           1220          DEX
0823- D0 F8        1230          BNE LOOP1
0825- 60           1240          RTS

SYMBOL TABLE

0800- CY0
0800- CY1          *800.825
081B- DELAY
081D- LOOP1       0800- 8D 58 C0 20 IB 08 8D 59
081F- LOQP2       0808- C0 20 IB 08 8D 5A C0 20
C058- OFF0        0810- IB 08 8D 5B C0 20 IB 08
C05A- OFF1        0818- 4C 00 08 A2 FF A0 FF 88
C059- ON0         0820- D0 FD CA D0 F8 60
C05B- ON1

0000 ERRORS IN ASSEMBLY
    
```

Figure 4

data established by the equate at assembly time as you can see in the HEX code in Figure 4. If you are not familiar with assembler listings, the first column is the target address, the next three columns are the actual HEX data being stored in those locations, the fifth column contains the line numbers used by the assembler for editing purposes (these line numbers are not a part of the program as in BASIC), the sixth column is the label, the seventh column is the op-code, the eighth column is the operand, and anything after that is a comment—similar to a REM statement in Basic.

Lines 1000 thru 1040 are comments to identify the program, and lines 1050 thru 1080 set up the equates. Line 1090, which is the start of the actual program (located at \$800 in this example), uses the op-code STA (STore the Accumulator) to write to \$C058 and turn off ANO. The HEX code for this is in columns two through four, where 8D is the code for STA, and 58 CO is the address. The 6502 CPU used in the Apple stores two byte addressess, with the low byte (58) first followed by the high byte (CO). This is the opposite of the way you enter it in the assembler source code. You don't have to worry about this—the assembler takes care of it for you—but it can be confusing when you look at the HEX code memory dump. Line 1100 uses JSR (Jump to SubRoutine) to transfer operation to the address in the operand field. The assembler very conveniently replaced our DELAY operand with the address for DELAY in the label field. Lines 1180 and 1190 load the X and Y registers with the value \$FF (when the operand is preceded by the symbol # it means load this number instead of the number in this address). Line 1200, DEY (DEcrement the Y register), subtracts one from the Y register. Line 1210, BNE (Branch Not Equal) LOOP2, executes the branch if the preceding operation did not result in zero. If the result is zero, the program continues on to the next line. After the Y register has been decremented to zero line 1220, DEX (DEcrement the X register), subtracts one from the X register, and line 1230 loops back to line 1190 to reload the Y register with \$FF and keeps on repeating this sequence until the X register has been decremented to zero. Then in line 1240, RTS (ReTurn From

Subroutine), the program goes back to where the subroutine was called. After the first delay period, we store the accumulator in \$C059 to turn ANO on, and jump back to the delay loop. I'll leave it to you to follow the rest of the program.

The program is not elegant—for example, the only way to stop it is to use the reset—but it does show how to program the annunciators from assembly language.

Using The Analog Inputs

The four analog inputs were designed to read the position of joysticks by using variable resistance potentiometers attached to the joystick. Each analog input is connected to one section of a 558 quad timer integrated circuit on the motherboard (see the article "555 Timer Breadboard" in issue 12 for information on the timer IC). The reading subroutine simply counts the number of cycles required for the 558 to time out with the time determined by the variable resistance. Woz designed the circuit with a 0.022 microfarad capacitor in each section so that the count can be varied between zero and 255 with a 150 kilohm potentiometer.

To use the input, you connect a resistance between CGO (pin 6) and five volts (pin 1), and read the value from BASIC with the command `Y = PDL(0)`.

Then the value in Y can be used by your program. The BASIC program in Figure 5 shows how a variable resistance, such as a thermistor, can be used to control temperature regulating devices.

One of the problems in controlling temperature is that if you use large heaters to bring the load up to temperature rapidly from a cold start and then switch the heater off when the proper temperature is reached, the temperature will continue to rise past the set point because of the stored energy in the heaters. When the temperature drops below the set point and you switch the heaters back on, the temperature will rise above the set point again. In a typical on-off application the temperature will continue to oscillate above and below the set points, and the fluctuations can be large. In servo control parlance this type of system where the power is either completely on or completely off is called a bang-bang control, and I like to compare it with trying to drive in city traffic with either the accelerator to the floor or the brakes completely locked with no in-between partial control. The program in Figure 5 provides much more advanced control than a simple on-off switch such as a thermostat because it allows you to proportion the response to the amount of

JLIST

```

100 REM CYCLE AN AND AN1 PROPORTIONAL TO ERROR
110 RAC - -1/19/85
120 POKE 49241,0: POKE 49243,0: REM START WITH BOTH LEDS OFF
130 REM THE LEDS ARE OFF WHEN THE ANNUNCIATORS ARE ON
140 X = PDL (0): REM READ GC0
150 PRINT X
160 M = 5: REM MULTIPLIER
170 IF X > 125 GOTO 210
180 IF X < 120 GOTO 300
190 FOR I = 0 TO 500: NEXT I
200 GOTO 140
210 H = M * (X - 125)
220 J = M * (255 - X): PRINT H,J
230 POKE 49240,0: REM TURN ANO OFF
240 FOR I = 0 TO H
250 NEXT I
260 POKE 49241,0: REM TURN ANO ON
270 FOR I = 0 TO J
280 NEXT I
290 GOTO 140
300 L = M * X
310 N = M * <120 - X>: PRINT L,N
320 POKE 49242,0: REM TURN ANI OFF
330 FOR I = 0 TO N
340 NEXT I
350 POKE 49243,0: REM TURN ANI ON
360 FOR I = 0 TO L
370 NEXT I
380 GOTO 140

```

Figure 5

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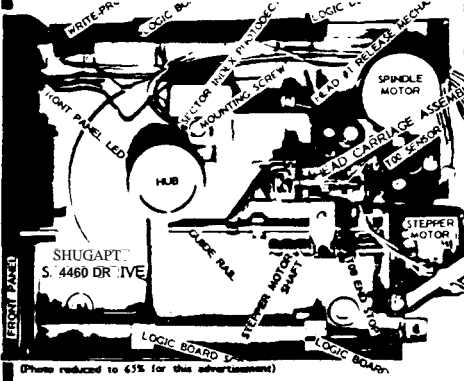
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error.

Line 140 sets X equal to the reading from GCO, and line 150 prints the value to the screen. Line 160 is a multiplier to increase the length of the cycle. In a real world control situation, you will probably want to control from both sides of a set point to correct errors in either direction, so lines 170 and 180 determine if the result is above or below the set point, with a "dead band" created between 120 and 125. This "dead band" means that no control action will take place between 120 and 125, allowing us to avoid rapid cycling from heating to cooling. If the value is between 120 and 125 the program advances to the delay loop in line 190, then returns to line 140 to repeat the cycle.

If the value is above 125 the program goes to line line 210 where we set H equal to M times X minus 125 to establish the ON portion of the cycle. In line 220 we set J equal to M times 255 minus X to establish the OFF portion of the cycle, and print the values of H and J to the screen. The purpose of these two lines is to maintain the total length of the cycle equal to M times 255, but vary the ratio of the ON time to the OFF time with the ON time proportional to the difference between 125 and X. Line 230 POKES location 49240 to turn ANO off, lines 240 and 250 are the delay loop using the value of H determined in line 210. Line 260 POKES location 49241 to turn ANO on, lines 270 and 280 are the delay loop using the value of J determined in line 220, and line 290 returns the program to line 140 to repeat the cycle. I'll let you trace the section of the program for values less than 120 which starts in line 300.

You can tailor the program for your application by making a few minor revisions. For example, if controlling a relay you'll probably want to increase M in order to lengthen the cycle to avoid rapid cycling of the relay. You could raise H and J to some power so that the correction would increase more rapidly than the linear proportional control in the listing. You could also establish additional set points to activate an alarm or initiate some other action if the error exceeded certain limits. This BASIC program is fine for experimenting with the LEDs or for controlling something slow like a

heater, but you'll need to use assembly language to control high speed motors, so fire up your assembler and tackle the next section.

In order to read GCO from machine language, you load X with a number from 0 to 3 to determine which controller to read, and then use the monitor routine PREAD at \$FB1E, which returns with a number between \$00 and \$FF in the Y register. (Note: the contents of the accumulator are scrambled during this process.) The assembly language listing in Figure 6 demonstrates reading GCO and using the value to control an LED attached to ANO. Lines 1060 to 1080 establish the equates for the PREAD routine and the ANO soft switches. Line 1090 calls PREAD to read the controller input, and line 1100 stores the value in a memory location. Line 1110 writes to \$C058 to turn ANO off (which turns the LED on), and line 1120 jumps to the delay routine. Line 1200 loads the value \$FF in to X register, and enters a delay routine similar to that already encountered in Figure 4 except that we use the value in register Y obtained from the PREAD routine.

The portion of the program starting with line 1130 controls the off period of the LED. The first step is to turn the LED off by writing to \$0059. Next we want to get a value equal to the difference between \$FF and the value obtained from PREAD, so we load the ac-

```

1000 | *-----
1010 | *
1020 | * CYCLE.PROP,ML1.6
1030 | * 1/19/05
1040 | *
1050 | *-----
1060 | PREAD .EQ «FB1E
1070 | OFF .EQ «C058
1080 | ON .EQ *C059
1090 | CYCLE JSR PREAD
1100 | STY TEMP
1110 | CYON STA OFF
1120 | JSR DELAY
1130 | CYOFF STA ON
1140 | LDA #SFF
1150 | SEC
1160 | SBC TEMP
1170 | TAY
1180 | JSR DELAY
1190 | JMP CYCLE
1200 | DELAY LDX sFF
1210 | LOOP DEX
1220 | BNE LOOP
1230 | DEY
1240 | BNE DELAY
1250 | RTS
1260 | TEMP .BS 1

```

Figure 6

FB1E-	AD	70 ¹	ce ¹	LDA	»C070
FB21-	Aft	00 ¹		LDY	#00
FB23-	EA			NOP	
FB24-	EA			NOF	
FB25-	BD	64	C0	LDA	*C064.X
FB28-	10	04		BPL	»FB2E
FB2A-	C8			INY	
FB2B-	D0	F8		BNE	*FB25
FB2D-	88			DEY	
FB2E-	60 ¹			RTS	

Figure 7

cumulator with the value \$FF in line 1140, set the carry in line 1150, and then in line 1160 we subtract the value in location TEMP. In line 1170 we transfer the value in the accumulator to register Y, and then jump to the delay routine. We had stored the value obtained from PREAD in the temporary memory location TEMP so that it would be available for use in CYOFF because both the X and Y registers would be decremented in CYON and we needed to load \$FF into the accumulator before the subtraction. There are other ways to accomplish this, but I chose this method because it is simple and easy to follow.

One of the nice things about the Apple is the many subroutines in the monitor which are available for our use. In the above example we just used PREAD without concerning ourselves with how it works, but if you really want to learn assembly language you should examine the routine in order to understand what it does. You can use the monitor to display the routines in ROM by entering the monitor from Applesoft with the command CALL-151. The prompt will change to an asterisk and you can enter FB1EL (you don't enter the \$ symbol because the monitor only understand HEX). This command will disassemble and list 20 memory locations starting with location FB1E as shown in Figure 7, and you can send the listing to your printer by entering the slot number for your printer card followed by a "control P" before the list command.

The first command at \$FB1E is LDA \$C070 which resets bit seven of the four locations \$C064 thru \$C067 to 1. Then it loads the Y register with 00 and follows with two NOP (No Operation) statements to pad out the routine for the desired time. Next it loads the accumulator with the value in location \$C064 indexed by the value in the X register which selects the controller to read. The line BPL FB2E returns to the calling routine if bit seven of the value

continued on IS page

BASE

A Series on How To Design and Write Your Own Database

By E.G. Brooner

Last month we covered the task of defining the file structure to our needs. Now, we can assume that files exist for our custom-designed storage system and we are ready to make some data entries. This is actually the easy part to program and to use. The DATA INPUT portion of the sample program is shown in Listing 1.

It opens by zeroing some arrays into which the program will read some of the housekeeping information that it previously stored, regarding such things as the field names for this data collection. Remember, we are accessing several of these little databases from the same program so it has to 'customize' itself for the files we have chosen each time we use it.

It will then present us (on the screen) with a prompt for the information it wants until the record has been entered in the otherwise conventional manner. It will name the field and tell us what kind and amount of information will be acceptable. The data will be stored in an array until we approve the entry. As is customary with this kind of operation, the program will give us a chance to correct the data, or back out, before filing it on the disk. It's that simple.

Next, we might want to edit an existing record. This section functions much like the data entry portion, except that we are presented with existing data rather than a blank record. We step through the fields in a similar manner, hitting RETURN to leave them unchanged or typing in the new, corrected information where necessary. (Note: Some BASICs do not accept a carriage return as an input variable.)

For simplicity we choose to call up the desired record by its relative number rather than by some key. This is fast and it is possible because if the record exists we probably already know the record number. If we don't, we can find it by other means in the 'search' section of the program; that

will be taken up as our next subject. What is illustrated here is just a method of changing one or more fields of a record that has been called back and displayed on the screen.

There is not a great deal more to say about this section. The program

already knows which base it is dealing with (from the opening section) and can pull out the necessary housekeeping and data files from among whatever else is there on our disk directory. Again, it reconstructs the file names, based on the core name we specified

```

*****
REM      DATA INPUT MODULE*
REM      *****
3000     GOSUB 9999
REM      PREPARE ARRAYS                REM FILL WITH BLANKS
REM      FOR X%=1 TO 12
REM              FIELD.NAMES(X%)=""=
REM              FIELD.LENGTH!XX->0
REM              DATAS(X%) - . )
REM      NEXT XX
REM      FILES- B"+NAMES+*.DEF
REM      OPEN FILES AS 19
REM      IF END *19 THEN 3100
REM      FOR XX-1 TO 12                REM DISPLAY FIELD NAMES
REM              READ W19)FIELD.NAMES<XX),FIELD.LENGTHX(XX)
REM              IF FIELD. LENGTH%(X%) -0 THEN 3100
REM              PRINT XXI "I FIELD.NAMES(XX)>1
REM              PRINT TAB<20>IFIELD.LENGTHX(XX)1 CHAR "1
3050     INPUT LINE DATUMS
REM              IF LENDATUMS) <-FIELD.LENGTH%(X%) THEN 3060
REM              PRINT -DATA TOO LONG FOR FIELD * RE-ENTER*
REM              GOTO 3050
3060     DATA*(X%)-DATUMS REM SAVE IN ARRAY
REM      NEXT x%
3100     CLOSE 19
REM      GOSUB 9999
REM      FOR XX-1 TO 12                REM DISPLAY FOR APPROVAL
REM              IF FIELD. LENGTH%(X%) -0 THEN 3200
REM              PRINT FIELD.NAMES(XX)ITAB120)IDATAS(XX)
REM      NEXT XX
3200     INPUT "APPROVED ? (Y/N)"I APPROVES
REM      IF APPROVES >" Y" THEN 3000                REM FILE IT
REM      FILEXTS—"B""NAMES*+.EXT"
REM      OPEN FILEXTS RECL 5 AS 20
REM      READ M20.1)LASTX                REM PREVIOUS FILE LENGTH
REM      FOR XX-1 TO 12                REM ALL POSSIBLE FIELDS
REM              IF FIELD.LENGTHX(XX)-0 THEN 3500
REM              FILES—" B "+NAMES + STRS (XX) +*.DAT*
REM              OPEN FILES RECL FIELD.LENGTHX(XX)*5 AS XX
REM              PRINTSXX,LASTX+1 IDATAS(XX)
REM              CLOSE XX
REM      NEXT XX                REM DATA FILED
3500     PRINT N20,1)LASTX*1                REM & *EXT* FILE UPDATED
REM      CLOSE 20
REM      CONTINUATION OPTION                REM IF MORE TO BE ENTERED
REM      PRINT "TYPE <M> FOR MAIN MENU, OR <CR> FOR MORE ENTRIES"

```

Listing 1

```

INPUT LINE OPTIONS
IF OPTIONS='M' THEN 1300
GOTO 3000

REM *****
REM *EDIT MODULE*
T 577 7A XAAAAA AAAAA " " " "
4000 GOSUB 9999
FILES='B'+NAMES+'.EXT' REM FIND FILE LENGTH
OPEN FILE' AS 19
READ '191 MAX%: CLOSE:19 REM CALL IT 'MAX'
4050 PRINT "RECORD TO CHANGE - MUST BE BETWEEN 1 AND J MAXX
INPUT REC.NBRX
IF REC.NBRX<1 OR REC.NBR%>MAX% THEN 4050
FILE='B'+NAME+'.DEF' REM DEFINE THE FIELDS
OPEN FILE' AS 19
IF END 419 THEN 4100

FOR x%=1 TO 12 REM & READ THE DETAILS
NBR. OF . FLDS%=X%- 1
READ 4191 FI ELD . NAME' < XX) ,FL%(X%)
IF FLX(XX)>0 THEN 4100
NEXT XX

4100 PRINT "AFTER EACH FIELD IS DISPLAYED:"
PRINT 'IF CORRECT PRESS <CR> OR ENTER NEW DATA':PRINT

FOR XX=1 TO NBR.OF.FLDSX:F.LX-FLX<XX)
PRINT FIELD.NAME'(XX) I TAB(20) I
GOSUB 4200 REM YOUR CHANCE TO CHANGE IT
NEXT XX

PRINT "<CR> - ADDITIONAL CHANGE - <M>- RETURN TO MENU-
INPUT LINE CHOICE"
IF LEN(CHOICE">0 THEN 4100 REM ALL FINISHED?
CLOSE 19:GOTO 1300

4200 FILE='B'+NAME**STR'(XX) + '.DAT'
OPEN FILE' RECL F.LX+5 AS XX
READ #x%, REC, NBRXI DATUM': PRINT DATUMS;
INPUT LINE CHANGE" REM NEW DATA <IF ANY)
IF LEN<CHANGE">0 THEN 4300 REM OR KEEP THE OLD
PRINT wx%: REC.NBRXICHANGE"

4300 CLOSE XX:RETURN

```

Listing 2

before making our main menu choice. See Listing 2.

Reviewing the BASE series to date: after the introductory discussion we covered opening the program, then the definition and creation of the related files and their record structure. In this issue we entered some data into the files that were created earlier, and showed how any portion of any record, in any of our data collections, could be edited or altered after it was already in the file. In the next column we'll take up some of the more database-like features, i.e: searching the files for particular key information. We will be able to relate these searches to any of several criteria that might be part of the record. While many simpler applications retrieve records only by relative number, or by a single 'key' field, we'll construct this program so as to permit 'finding' data by more flexible methods. We may also discuss additional methods just as a subject of interest. As this is a learning project, an attempt has been made to keep the sample program relatively uncomplicated while illustrating other techniques which may sometimes be desirable.

Apple Game Port, *continued*

read in the previous location is zero, which would indicate that the timer has completed its cycle. If bit seven is still one, the next operation (INY) increments the Y register to count the number of cycles, and the following operation (BNE FB25) terminates the loop if the Y register has been incremented past \$FF, which would indicate that the resistance is in excess of 150 kilohms. The following operation (DEY) decrements the Y register so that it will contain the maximum value of IFF if it has been incremented to zero. It may be confusing when we talk about increasing a positive number to zero by adding another positive number to it, but the contents of an eight bit register will overflow and "wrap around" to 00 if one is added to the maximum value of IFF. The final command RTS at FB2E returns control to

the program which called the subroutine, with the value in register Y containing the number of cycles required for the capacitor on the 558 timer to charge.

The assembly language routines should not be considered the best examples of programming practice — I just hacked out something to do what I wanted. I'm sure that Don Lancaster (Synergistics) or Bob Sander-Cederlof (S-C Software) could write much better code! I tried to include enough information on the assembly language routines to help people not familiar with them, but did not write them as a complete tutorial. I need your feedback on how much assembly language detail should be included in future articles.

Going Further

There are many cards available for the Apple which offer more advanced

interfacing capabilities than can be obtained from the game port, but it is an interesting challenge to learn what can be done with the little-used game port. Jan Eugenides is working on an article about using the game port to drive a printer, and others have articles in progress that deal with using it to control stepper motors, DC motors, and other devices. This article has not mentioned the flag inputs or the strobe; I intend to cover both topics in a future article, and would like to include information on what you are doing with the game port. Your articles, letters, and comments are welcome.

References:

- AmteLL Applications by Marvin L. De Jong, published by Howard W. Samt.
- The Art of Eleetronics by Horowitz and Hill published by Cambridge University Press.
- TTL Cookbook by Don Lanauttr, published by Howard W. Samt.

* S-C Meero Assembler sold by S-C Software Corporation, P.O. Box U0300, Dallas, TX 75228.

linear power supplies and many slots for cards.

4. A completely new system can be put together in a matter of minutes by merely swapping a few cards.

On the negative side:

1. The S-100 bus has speed limitations.
2. The assertion levels of some of the signals are wrong.
3. The layout of the signals could be better.

Choosing a 16 Bit CPU

We decided to try one of the newer microprocessors but to continue to use our 8 bit hardware. Two choices were available, the Intel 8088 and the Motorola 68008. The latter was chosen because of its superior architecture. Here is a list of reasons for choosing the 68008:

Hardware considerations:

1. The hardware signals issued by the 68008 are straightforward and systematic.
2. Only a 5 volt supply and a simple, single phase clock are necessary to drive the 68008.

Programming considerations:

1. The chip has 8 address and 8 data registers.
2. The 68008 has two modes of operation; user mode, and supervisor mode. Address register A 7 is used as the stack pointer for both modes. When the 68008 is in user mode A 7 points to the user stack, and when in supervisor mode it points to the supervisor stack.
3. Except for A7 used as both a supervisor and user stack pointer, the address registers do not have special properties; i.e., instructions which use address registers are not tied to a particular address register.
4. Address registers can point to any memory location in the entire 1 megabyte address space of the 68008.
5. The data registers may be used interchangeably; i.e., instructions which use data registers are not tied to a particular data register.
6. A wide range of addressing modes is available.
7. A wide range of opcodes is available.

A 68008 CPU Board Design

In the following paragraphs you will find the the technical details for a 68008

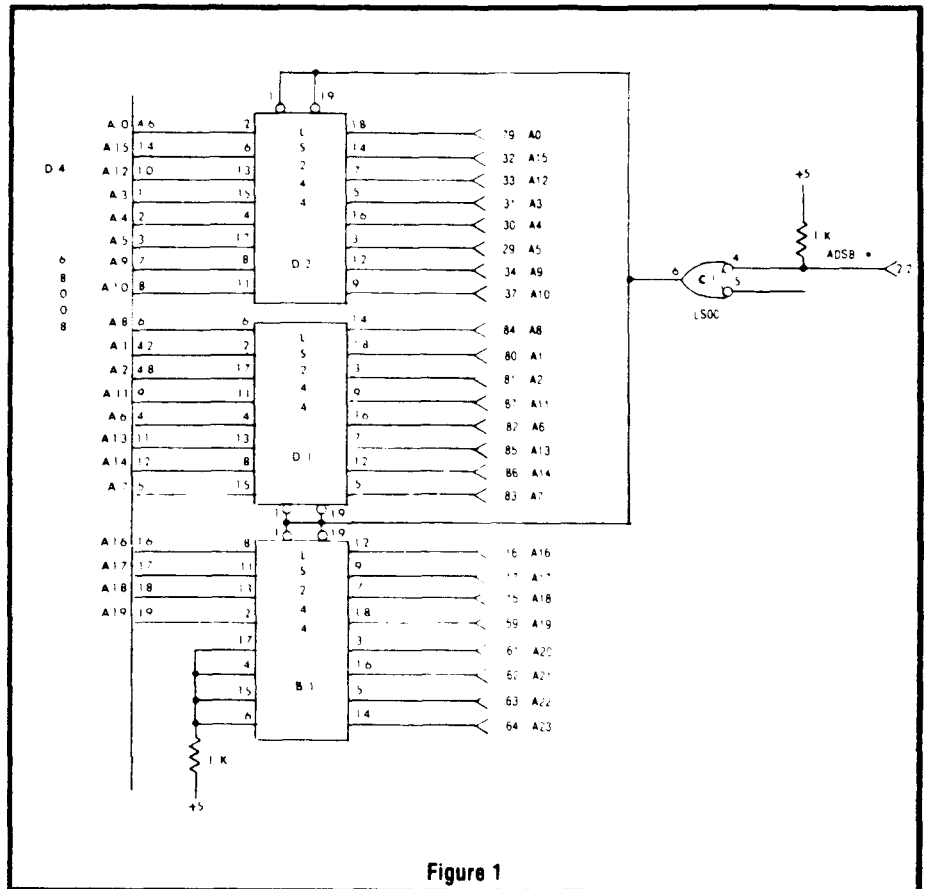


Figure 1

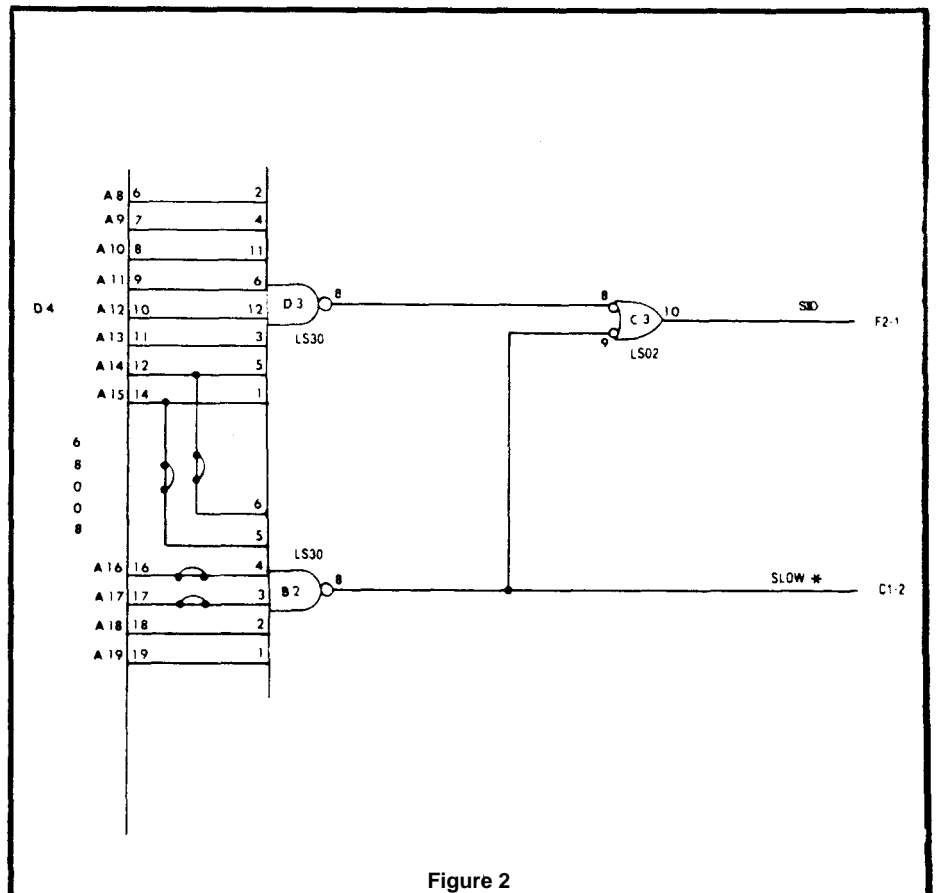


Figure 2

to D7 of the 68008. This LS244 is enabled by EIBUF which is asserted whenever both R and DS (see Figure 5) are asserted by the 68008.

Status Lines SINP, SOUT, SMEMR, SINTA. At the beginning of each bus cycle the 68008 tells us what it wants to do during the next bus cycle by placing a value of 0 to 7 at its function code outputs FC0 to FC2. The only one used on this board is interrupt acknowledge denoted by INT ACK (see Figure 3).

The three signals SIO, R/W and INT ACK are fed to an LS138 whose outputs are the status signals SINP, SOUT, SMEMR and SINTA in inverted form. This LS138 is enabled only when AS is asserted by the 68008 so these signals are asserted only when there is valid address information on the S-100 bus. These signals reach the S-100 bus with proper polarity by passing through half an LS240. This half LS240 is enabled except when SDSB is asserted.

Control Lines PWR, PHLDA, PDBIN. PWR (see Figure 5) is asserted whenever the 68008 asserts both DS and W. PDBIN (see Figure 5) is asserted whenever the 68008 asserts both DS and R. PHLDA (see Figure 6) is asserted whenever the 68008 asserts BG and negates (actually tristates) AS. The three control signals reach the S-100 bus with proper polarity by passing through one half an LS240. The half LS240 is enabled except when CDSB is asserted.

Reset. Whenever the reset switch is depressed a low is delivered to the RESET and HALT (see Figure 7) inputs of the 68008. The low is held for a period determined by the time necessary for the 33uF capacitor to charge through the 10K resistor. The feedback circuit causes some hysteresis to be added but is overly conservative. The 68008 seems to work well enough without it.

Clock. The clock circuit (see Figure 8) has appeared in the literature. The SI 12 was used to achieve sharp rise and fall times as well as a 50 percent duty cycle (see Reference 1 at the conclusion of this article).

Interrupts. Assertion of NMI (see Figure 6) causes the 68008 to see a low at inputs IPL1 and IPL2/0 which it

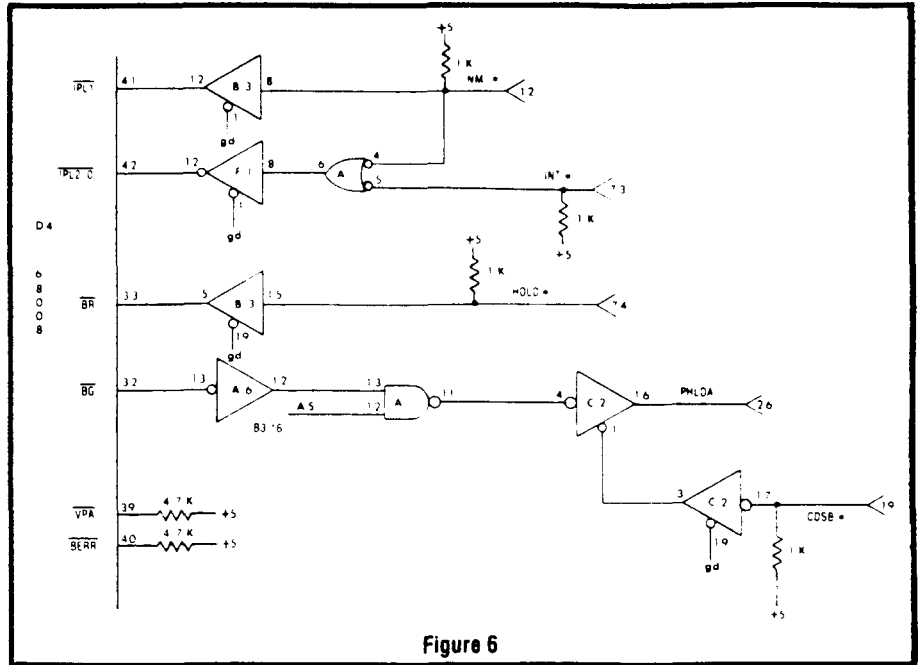


Figure 6

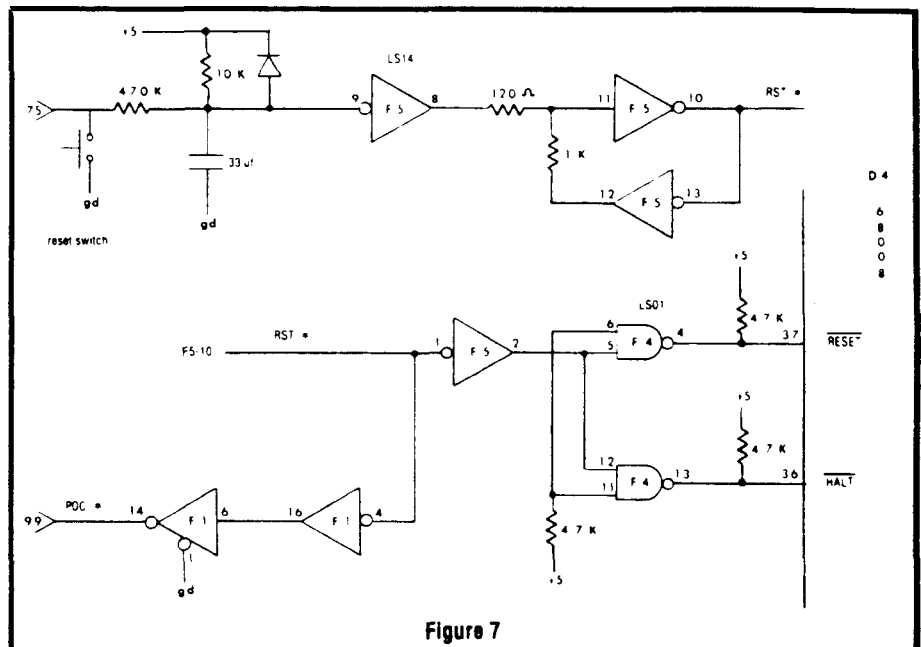


Figure 7

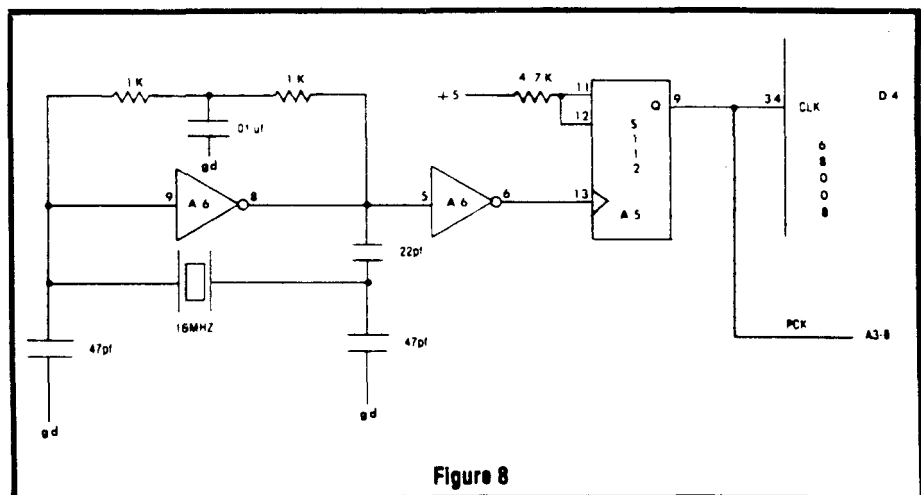


Figure 8

regards as a level 7 interrupt. To the 68008, this is an edge triggered non-maskable interrupt. Assertion of INT causes the 68008 to see a low at its ILP2/0 input, which the 68008 regards as a level 2 interrupt. To enable interrupts set the interrupt mask less than 2. To disable interrupts set the interrupt mask greater than 2.

SLOW and PHANTOM. Assertion of either PHANTOM or SLOW (see Figure 9) forces the insertion of wait states. SLOW (originates in Figure 2) is dependent upon placement of jumpers to determine which of A14 to A17 must be high in order to contribute to the assertion of SLOW. Assume A14, A15, A16, A17 are all connected (i.e. no trace under a jumper has been cut or if it has, jumpers reconnect the cut traces). Memory references to addresses with A14 through A19 all set to 1 will have wait states. The duration of the wait is determined by A, B, C. All other memory references run at the maximum speed of the processor. Thus memory references from \$00000 to \$FC000 run at maximum speed and any reference to the 16K of address space from \$FC000 to \$FFFFFF has the assertion of DTACK delayed by an amount determined by A, B, C. The slow memory space can be increased to 32K by cutting the A14 trace, to 64K by cutting the A14, and A15 traces etc. Whenever PHANTOM is asserted memory references will have wait states, again the number determined by A, B, C.

Our reason for having a slow area of memory is to allow the use of ROM chips which cannot be correctly read by a 68008 running at 8mhz. Also the I/O space is in the slow area of memory because many ICs such as timers, disk controller chips, etc. have slow read/write times.

Memory references to the upper 256 bytes i.e. to \$FFF00 to \$FFFFFF assert SIO which results in the assertion of SINP or SOUT and the negation of SMEMR. Thus references to the I/O space are always slow. If a RAM or ROM board overlaps the I/O space, the overlap becomes write only to those boards that respond to PWR. The signal MWRITE (see Figure 5) is negated by references to the I/O space.

STRT. The assertion of STRT (see

Figure 9) indicates the beginning of a read or write operation. You might expect AS to indicate the beginning of a read or write cycle. It does, but there is

a problem for the read-modify-write cycle. During such a cycle DTACK must be negated following the read portion of the cycle and reasserted

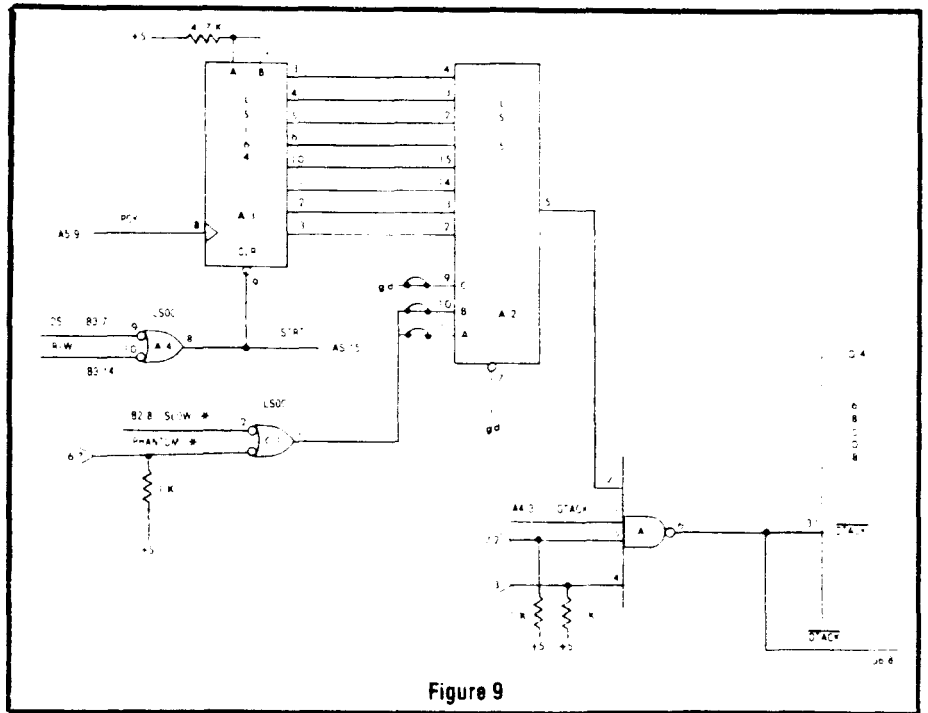


Figure 9

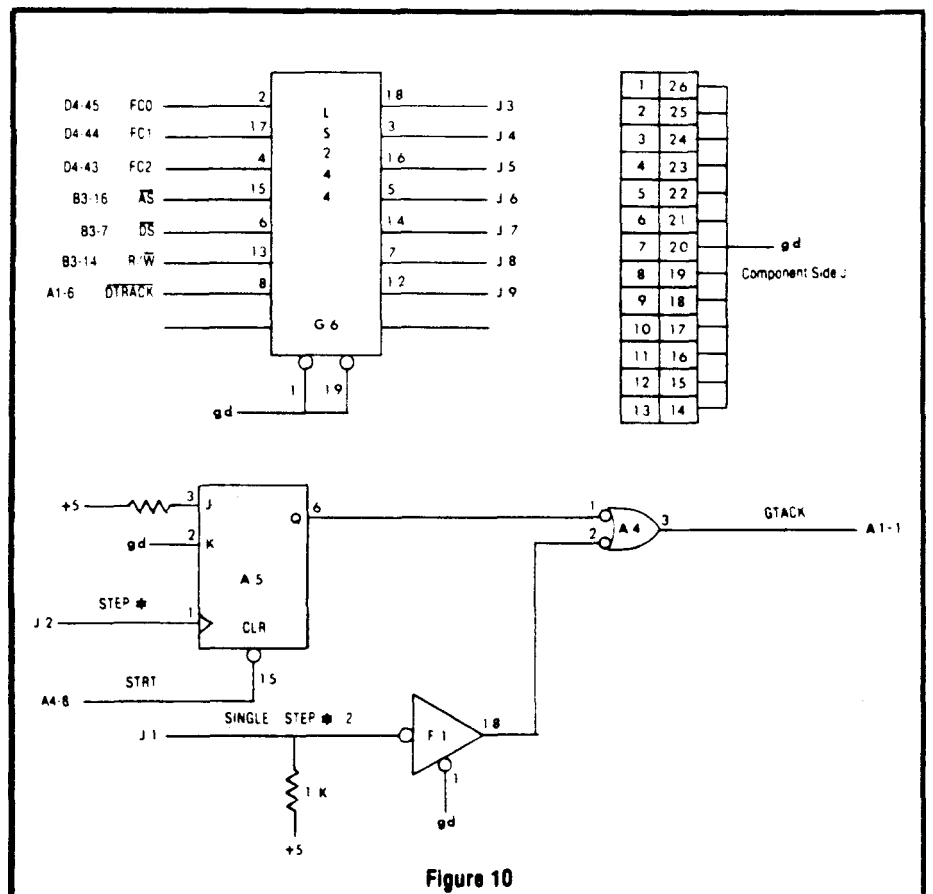


Figure 10

during the write portion of the cycle. If STRT were asserted only when AS was asserted then the read-modify-write cycle would not work properly, because AS is asserted throughout the read modify-write cycle.

STRT is asserted following the assertion of either DS or W. Note that for a read transaction DS is asserted at the beginning of the transaction (same time as AS is asserted) and for a write transaction W is asserted at the beginning of the transaction (same time as AS is asserted). The only write transaction for which AS and W are not asserted at the same time is during a read-modify-write cycle. Until STRT is asserted the shift register is held in the clear state. Following the assertion of STRT each rising edge of the clock sets successive outputs of the shift register high. After a number of clocks a high will appear on pin 5 of the LS151. The exact number of clocks is determined by the A, B, C values. The inputs at A, B, C yield a binary value and the number of shifts required to set pin 5 of the LS151 high is this binary value plus one.

SINGLE STEP. If J1 is grounded, then SINGLE STEP (see Figure 10) is asserted and pin 2 of A4 is high. As long as pin 2 of A4 is high GTACK is the inversion of the Q* output of A5. Now a debounced switch connected to J2 can be used to single step the 68008.

At the beginning of every 68008 bus

transaction STRT is negated so the Q* output of A5 is high and therefore GTACK is negated. The assertion of either DS or W forces the assertion of STRT which removes the low from the clear input of A5. At this time GTACK is still negated so the 68008 is waiting for the assertion of DTACK (see Figure 9).

Now, if the debounced switch is grounded (i.e., STEP is asserted), the Q* output of A5 goes low so GTACK is asserted. This results in the assertion of DTACK. The 68008 performs the read or write and then negates both DS and W so STRT is again negated. This returns the 68008 to the state described at the beginning of the previous paragraph.

Connector J. The LS244 G6 (see Figure 10) buffers a number of the 68008 control signals so that they may be available to another board. We have also built a companion display board which displays these signals, allows single stepping of the 68008 and displays a number of the S-100 signals. The display board shows the S-100 address, data in, data out in hex displays and control signals in discrete LEDs.

Reference 1: "Basu: Circuit-design Techniques Yield Stable Clock Oscillators." by Jim Williams EDN Magazine. August 18, 1983.

Note: A PC card for this 68008 CPU design can be purchased for \$60 from Intellicomp Inc., 293 Lambourne Ave., Worthington OH Ohio 43085

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Interfacing Tips and Troubles

A Column by Neill Bungard I

One of the best ways to interface to any computer is through its serial communication port, especially if speed is not a critical factor. I personally use this method anytime I can because the serial communication port is usually a standard configuration regardless of the type of computer being used. In addition, the serial port can usually be accessed through a higher level language (like BASIC) as opposed to writing machine language drive routines. Even in the cases where machine language routines are required, computer manufacturers are good about documenting the required software for using their serial port.

I said that the good thing about the serial communication port is that it is usually a standard configuration. This is good because you know what to expect when connecting to the computer. But it can also be annoying because the logic level voltage standard for a serial communication port and the logic level voltage values in the interface circuit are usually mismatched. Most computers' serial ports adhere to the RS232C standard. This standard assumes a logic 1 to be between -3 and -15 volts, and a logic 0 to be between +3 and +15 volts. The logic level

voltages in the interface circuit (assuming TTL logic) are 0 volts for a logic 0 and +5 volts for a logic 1.

The discrepancy in logic level voltages between the serial communication port and the interface circuit is eliminated by conditioning the interface signals to agree with the RS232C standards. This typically requires a dual power supply, special driver and receiver ICs, special connectors, etc. After completing several serial interface projects, I decided that I needed a "jelly bean" logic-to-RS232 converter which could be pulled out of my hacker's tool box and placed between any interface circuit and a serial communication port. Figure 1 is such a device. This circuit operates from a single 5 volt supply and conditions TTL logic signals to agree with RS232 standards.

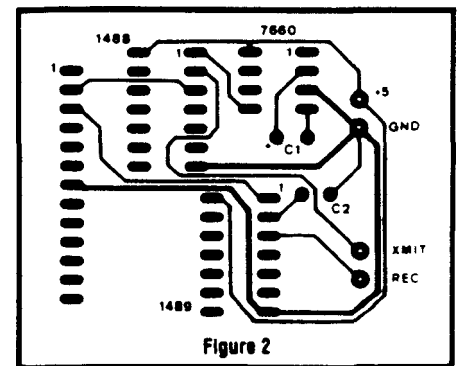
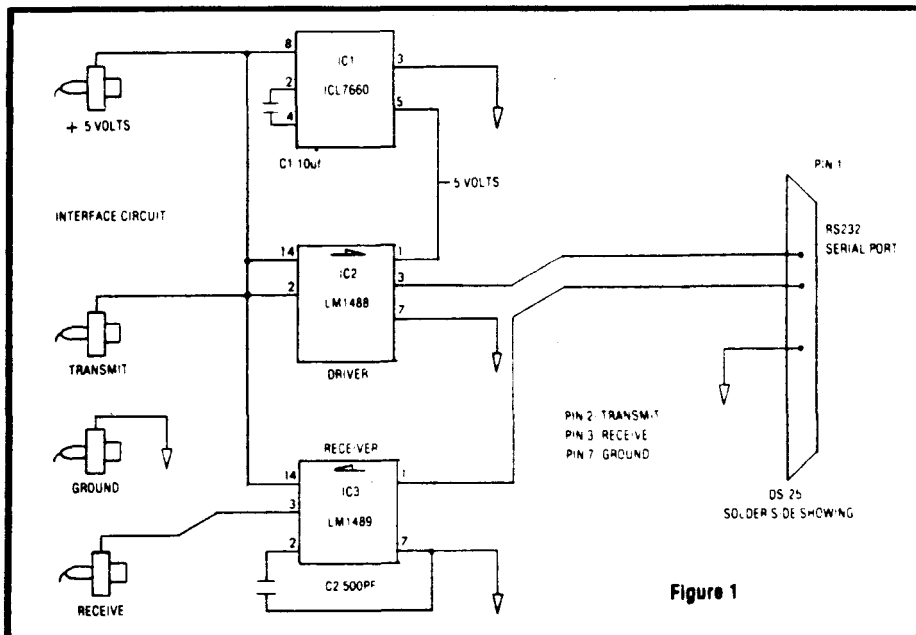
Circuit Description

The logic to RS232 signal conditioning circuit in Figure 1 is extremely straightforward and utilizes an interesting IC manufactured by Intersil Corporation, the ICL7660 (IC1). The ICL7660 is a voltage converter IC which requires only +5 volts to operate, and produces a -5 volts on its output (pin 5). This IC eliminates the

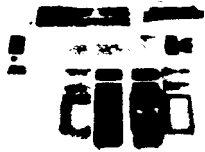
need for a dual power supply, which greatly simplifies this circuit's design. The other two ICs in Figure 1 are the RS232 driver (LM1488, IC2), and the RS232 receiver (LM1489, IC3). For proper operation, the LM1488 requires +3 to +15 volts on pin 14 (which is obtained from the interface circuit), -3 to -15 volts on pin 1 (which is obtained from the ICL7660), and ground on pin 7. The LM1489 only requires +5 volts on pin 14, and ground on pin 7 for its operation.

Serial information being generated by the builder's circuit enters and signal conditioning circuit on pin 2 of the LM1488 (IC2). The signal is conditioned by this IC to meet RS232 standards, and is output to pin 2 of a standard DS-25 connector (This connector is standard on most computer systems). Information coming from a computer's serial interface port enters the conditioning circuit on pin 1 of the LM1489 (IC3), where it is converted to TTL level signals before it is sent to the builder's circuit.

This signal conditioning circuit can easily be wirewrapped, or for convenience and reliability a circuit board can be manufactured. A foil pattern for the signal conditioning circuit is provided in Figure 2 for those who wish to make a circuit board. If you do not wish to manufacture your own board, I have a few and would be glad to send you one for \$10.00. Regardless of whether you produce a board or wirewrap this circuit, I'm sure that you will find this device a worthy addition to your interfacing toolbox.



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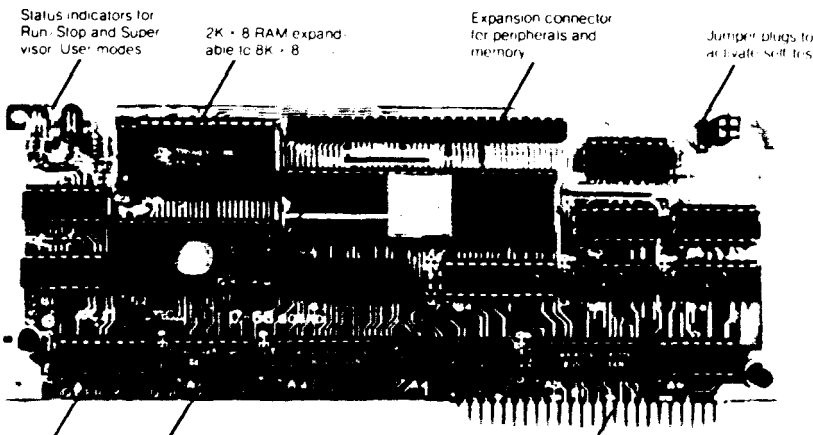
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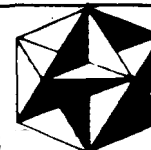
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Books of Interest

Structured Microprocessor Programming

by Morris Krieger, Charles Popper, Robert Radcliffe, and David Ripps.
Published by Yourdon Inc.
1133 Avenue of the Americas
New York, NY 10036
230 pages, 6" x9"

This book is not new (the copyright date is 1979), but it is so unusual that I felt it should be brought to the attention of our readers. Most books on assembly language are either very simple with side-by-side examples of BASIC and assembly language routines, or they are written on a doctoral thesis level and only the experts can understand them. You'd expect a book about structured programming at the CPU level to be difficult to follow, but this book is written for the beginner. On page one they state "We assume no prior knowledge on the part of the reader about programming (structured or otherwise). This book is for the complete novice. It starts at square one."

The book is intended to accompany SMAL/80 (Structured Macro Assembly Language 80) which will be the subject of a separate review, but the detailed programming information will be helpful to anyone programming in assembly language. The contents of the book are as follows:

- **Chapter 1 SMAL/80—An Introduction.** Why Structured Programming.
- **Chapter 2 Structured Programming Principles.** The BEGIN-END Construct; The IF-THEN-ELSE Construct; The LOOP-REPEAT Construct; To GOTO or Not to GOTO; Flowcharts or Pseudo-Coding?
- **Chapter 3 Microcomputer Basics.** Central Processing Unit; Arithmetic and Logic Unit; 8080 and 8085 Microprocessors; Bits, Bytes, and Words; Microprocessor Operation; Instruction Execution; Program Counter.
- **Chapter 4 The Binary Number System.** Binary Numbers; Binary Addition; Binary Subtraction; Positive and Negative Binary Numbers; The Octal and Hexadecimal Number Systems.

- **Chapter 5 Boolean Logic and SMAL/80.** AND Operator; OR Operator; XOR Operator; NOT Operator; Boolean Logic and the CPU; AND Operation; OR Operation; XOR Operation.

- **Chapter 6 Decision Making and the IF-Then-Else.** SMAL/80 Flags; Decision Making; SMAL/80 Coding: Semicolons; SMAL/80 Coding: Writing Small Numbers; SMAL/80 Coding: Transfer Instructions; Controlling Program Flow; SMAL/80 Coding: Increment and Decrement Instructions.

- **Chapter 7 Decision Making and the LOOP-REPEAT.** Loops Within Loops; SMAL/80 Coding: Memory Transfers and the HL Register Pair; Double-Byte Increment and Decrement Instructions; ASCII Coding; Setting Up the Line-Numbering Program; Decision-Making Using a Comparison Instruction; SMAL/80 Coding: More Memory Transfers and the HL Register Pair.

- **Chapter 8 Symbolic Addressing: Addition and the Carry Flag.** Addition and Subtraction in SMAL/80 Programs; The Carry Flag and Addition; Symbolic Addressing; The Transfer of Multi-Byte Numbers; Multi-Byte Arithmetic; SMAL/80 Coding: Addition with Carry; SMAL/80 Coding: Clearing the CPU Registers.

- **Chapter 9 BREAK and NEXT Statements and ASCII Coding.** The ASCII Code (continued); SMAL/80 Coding; The BREAK Statement; SMAL/80 Coding; The NEXT Statement; Pointers and the BC and DE Register Pairs.

- **Chapter 10 Subroutines and the Stack, More ASCII.** The Road from HEX to ASCII; Subroutines: RETURN and CALL Instructions; The Stack; PUSH and POP Instructions; The Stack and Interrupts; CONVERT2 and the Sign Flag; The Conversion Routine; SMAL/80 Coding: ROTATE Instructions.

- **Chapter 11 Files, Counters, and Markers.** COUNTER, Why Negative Addition? Finding the End of the Block; SMAL/80 Coding: Exchange Instruction; SMAL/80 Coding: Complement Instructions.

- **Chapter 12 Storage and Retrieval:**

An Introduction to Tables. Indexed Retrieval; Linear Search Tables; Variations on a Theme; SMAL/80 Coding: Exchange Instructions; SMAL/80 Coding: Program Jump Instruction.

- **Chapter 13 Writing Modular Programs.** A Caveat; An Overview; Walking Through a Program; More on Flag-Setting and Flag-Testing; Prompt Messages; Entering Data; BINARY: An ASCII to Binary Conversion Routine; Pseudo Operations; Program Origin; EQU Statements; RESERVE Statements; BYTES and WORDS; Setting the Stack Pointer.

- **Chapter 14 Input/Output Programming.** Basic Output Programming; Basic Input Programming; Teletypewriter Interface; Cassette Tape Interface; Parity Checking; Checksum Error Detection; Drivers.

- **Chapter 15 The SMAL/80 Macro Processor.** Macros Defined; Simple Replacement Macros; Inventing Instructions; Writing Macros That Have Variables; Writing Conditional Macros; Language Changes.

- **Appendix A** 8080/8085 Condition Flags.

- **Appendix B** Macro Processor Description.

- **Appendix C** 8080/8085, Z-80, and SMAL/80 Instructions Sorted Numerically by Standard Intel Op Code.

- **Appendix D** 8080/8085, Z-80, and SMAL/80 Instructions Organized Alphabetically According to Standard Intel Mnemonics.

The book contains a lot of down-to-earth advice. For example, in chapter 2 on structured programming principles, they state "in structured programming, every statement must always have only one entry point and one exit point." They also advise "When a program segment has more than one entry or exit point, the programmer will very likely find he has lost control of his program."

I found chapter 11 on files, counters, and markers, and chapter 12 on storage and retrieval to be especially helpful on a program I was working with using 8080 code and ASM.

Hew Products

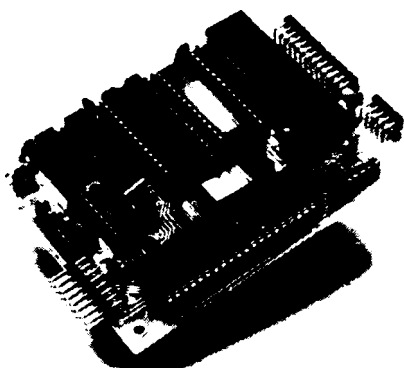
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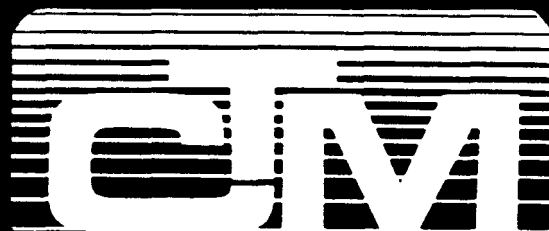
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