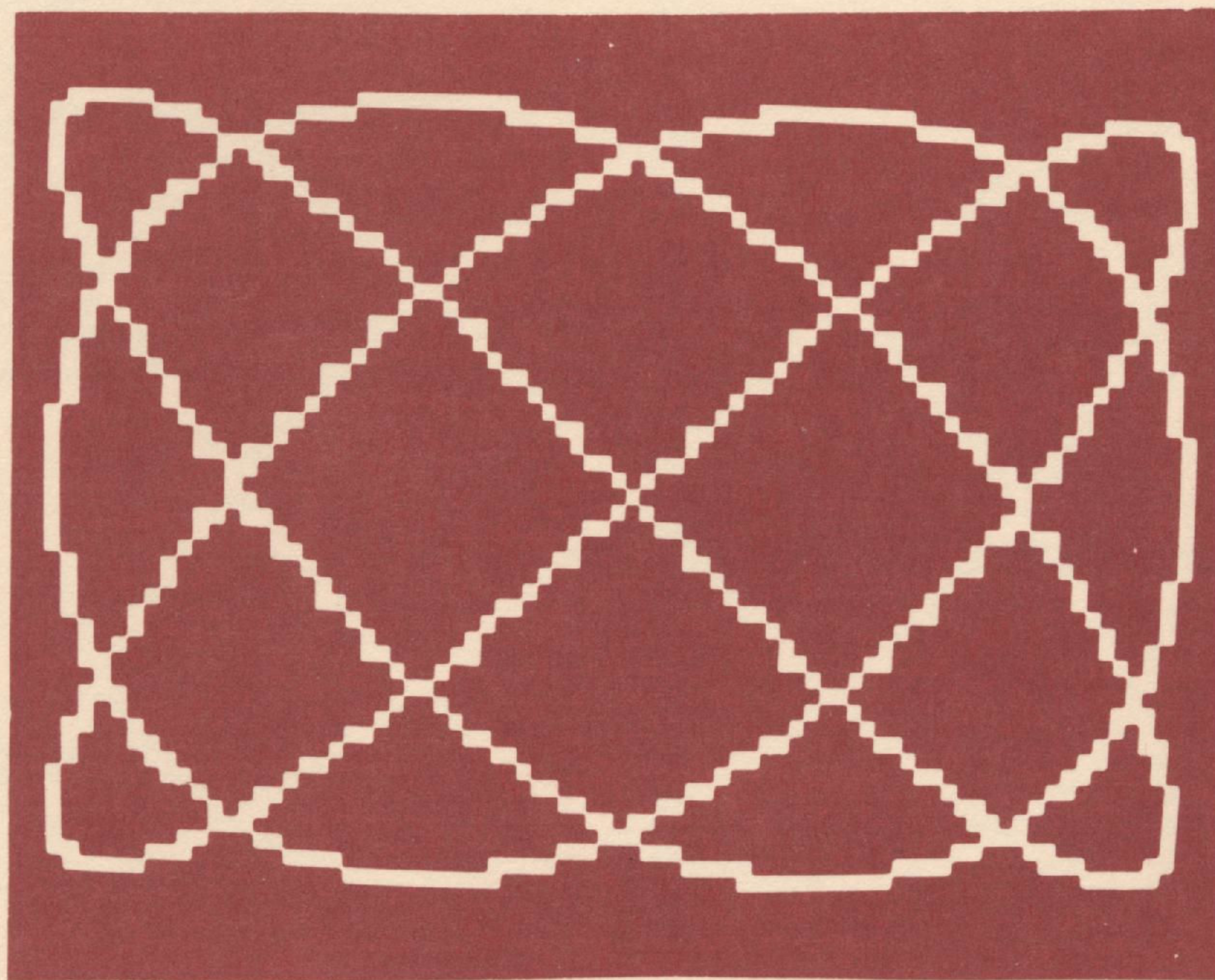


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A SIMPLE 24 HOUR CLOCK FOR THE AIM 65

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The program whose listings are given in the AIM 65 disassembly format is a 24 hour clock that displays the time in hours, minutes, and seconds on the six right-most digits of the 20 character AIM 65 display. AIM 65 owners can load the program directly from the listings using the mini-assembler in the AIM 65 monitor. The program listings were taken directly from the thermal printer on the AIM 65.

The principal reason for writing the program was to experiment with the interval timers on the 6522 VIA. One advantage of the so-called T1 timer on the 6522 is that it can produce equally spaced interrupts, independent of the time necessary to complete an instruction and the time necessary to process the interrupt. SYM-1 owners may also use the program with only minor modifications, since the addresses of the various registers and counters in the 6522 chips are the same for these two computers. SYM-1 owners will have to change the display routines, however.

A brief description of the program follows. The first five instructions set up the interrupt vectors for the AIM 65. The next eight instructions set up the 6522 VIA for the T1 timer in the free running mode, enable the T1 interrupt, and set the time interval to \$C34E = 49,99810 clock cycles. This number, plus the two clock cycles necessary to restart the timer, represent 50,000 clock cycles or 0.05 seconds. Thus, the time between interrupts is exactly 50,000 clock cycles. Twenty interrupts give an interval of 10⁶ clock cycles, or one second with a one MHz clock frequency. Location \$0000 serves as register for the count-to-twenty interrupts process. It starts at \$EC and advances to \$00 before the seconds location is incremented.

The interrupt routine from \$0300 to \$033C is very similar to the clock program by Charles Parsons in THE FIRST BOOK OF KIM. The only difference is that the timers do not need to be restarted in the interrupt routine. Only the interrupt flag needs to be cleared before returning from interrupt. This is accomplished by the LDA A004 instruction at \$0337.

The program from \$0226 to \$0254 is the display routine from the AIM 65. First the seconds, minutes, and hours located in \$0001, \$0002, and \$0003 respectively, are relocated, then converted to ASCII, and finally output to the display by the JSR EF7B. Many kinds of hex to ASCII routines are possible here. I simply rotated nibble after nibble into the low order nibble of location \$0004 and added \$30 to convert to ASCII.

AIM 65 owners may be interested in the output routine. Of all the subroutines mentioned in the "User's Guide" the one I used is not mentioned directly. Basically it takes an ASCII character in the accumulator and outputs it to the display digit between \$00 and \$13 (20 character display) identified by the contents of the X register. It also requires a one in bit seven of the accumulator. Otherwise you get the cursor. So I did a ORA \$80 with the ASCII character in the accumulator before jumping to the subroutine at \$EF7B.

I checked the clock up against WWV and found it was off by about 0.024%, which is substantial if you wish to keep time over the long term. I decreased the \$4E byte location \$0216 to \$42 and now it appears to be off by only 0.00063%. Of course, these timing errors, though small, tend to accumulate giving an error of about 0.5 seconds in 24 hours.

To start the timer, load the hours, minutes, and seconds locations with the time at which you intend to start, wait for this time, then start the program. Of course, there are much more meaningful applications to this program than simply displaying the time. One could record the time at which transistions on the I/O pins occur for example. Have fun.

```

0200 78 SEI
0201 A9 LDA #00
0203 6D STA A404
0206 A9 LDA #03
0208 8D STA A405
020B A9 LDA #C0
020D 8D STA A00E
0210 A9 LDA #40
0212 8D STA A00B
0215 A9 LDA #4E
0217 8D STA A006
021A A9 LDA #C3
021C 8D STA A005
021F A9 LDA #EC
0221 85 STA 00
0223 58 CLI
0224 00 BRK
0225 EA NOP
0226 A5 LDA 01
0228 85 STA 04
022A A5 LDA 02
022C 85 STA 05
022E A5 LDA 03
0230 85 STA 06
0232 A2 LDX #13
0234 8A TXA
0235 48 PHA
0236 A0 LDY #04
0238 A5 LDA 04
023A 29 AND #0F
023C 18 CLC
023D 69 ADC #30
023F 09 ORA #80
0241 20 JSR EF7B
0244 46 LSR 06
0246 66 ROR 05
0248 66 ROR 04
024A 88 DEY
024B D0 BNE 0244
024D 68 PLA
024E AA TAX
024F CA DEX
0250 E0 CPX #0E
0252 B0 BCS 0234
0254 4C JMP 0226

0300 48 PHA
0301 E6 INC 00
0303 D0 BNE 0337
0305 F8 SED
0306 18 CLC
0307 A5 LDA 01
0309 69 ADC #01
030B 85 STA 01
030D C9 CMP #60
030F 90 BCC 0333
0311 A9 LDA #00
0313 85 STA 01
0315 18 CLC
0316 A5 LDA 02
0318 69 ADC #01
031A 85 STA 02
031C C9 CMP #60
031E 90 BCC 0333
0320 A9 LDA #00
0322 85 STA 02
0324 18 CLC
0325 A5 LDA 03
0327 69 ADC #01
0329 85 STA 03
032B C9 CMP #24
032D 90 BCC 0333
032F A9 LDA #00
0331 85 STA 03
0333 A9 LDA #EC
0335 85 STA 00
0337 AD LDA A004
033A D8 CLD
033B 68 PLA
033C 40 RTI

```


24 HOUR AIM CLOCK

BY MARVIN L. DE JONG
FEBRUARY 1979

0200		ORG	\$0200	
0200 78	START	SEI		SET INTERRUPT DISABLE
0201 A9 00		LDAIM \$00		SETUP INTERRUPT VECTORS
0203 8D 04 A4		STA \$A404		FOR 6522
0206 A9 03		LDAIM \$03		POINT TO ADDRESS 0300
0208 8D 05 A4		STA \$A405		
020B A9 C0		LDAIM \$C0		SETUP VIA 6522 FOR TIMER 1
020D 8D 0E A0		STA \$A00E		IN FREE RUNNING MODE
0210 A9 4C		LDAIM \$40		
0212 8D 0B A0		STA \$A00B		
0215 A9 4E		LDAIM \$4E		SET LOW BYTE OF TIMER
0217 8D 06 A0		STA \$A006		
021A A9 C3		LDAIM \$C3		SET HIGH BYTE OF TIMER
021C 8D 05 A0		STA \$A005		
021F A9 EC		LDAIM \$EC		SET 20 INTERRUPT COUNTER
0221 85 00		STA \$0000		IN LOCATION 0000
0223 58		CLI		ENABLE INTERRUPTS
0224 00		BRK		RETURN TO MONITOR
0225 EA		NOP		
0226 A5 01	DISPLY	LDA \$0001		MOVE DIGITS TO BE DISPLAYED
0228 85 04		STA \$0004		FOR SAFE KEEPING
022A A5 02		LDA \$0002		
022C 85 05		STA \$0005		
022E A5 03		LDA \$0003		
0230 85 06		STA \$0006		
0232 A2 13		LDXIM \$13		LOAD DISPLAY POSITION POINTER
0234 8A	LOOP	TXA		PUT X VALUE INTO A
0235 48		PHA		SAVE ON STACK
0236 A0 04		LDYIM \$04		SET TO SHIFT FOUR POSITIONS
0238 A5 04		LDA \$0004		GET LEAST SIGN DIGIT REMAINING
023A 29 0F		ANDIM \$0F		MASK TO SINGLE CHARACTER
023C 18		CLC		CLEAR
023D 69 30		ADCIM \$30		CONVERT 0-9 TO ASCII 0 - 9
023F 09 80		ORAIM \$80		BIT 80 MUST BE ON FOR AIM
0241 20 7B EF		JSR \$EF7B		AIM OUTPUT ROUTINE
0244 46 06	SHIFT	LSR \$0006		SHIFT TO GET HIGH HALF OF
0246 66 05		ROR \$0005		DIGIT INTO POSITION
0248 66 04		ROR \$0004		
024A 88		DEY		DECREMENT FOUR SHIFT COUNTER
024B D0 F7		BNE SHIFT		KEEP ON SHIFTING
024D 68		PLA		RESTORE X FROM STACK
024E AA		TAX		
024F CA		DEX		DECREMENT POSITION POINTER
0250 E0 0E		CPXIM \$0E		TEST 6 DIGITS OUTPUT
0252 B0 E0		BCS LOOP		MORE TO DO
0254 4C 26 02		JMP DISPLY		DONE. NOW START OVER AGAIN.

24 HOUR CLOCK INTERRUPT SERVICE

0300		ORG	\$0300	
0300 48		INTRPT PHA		COME HERE ON TIMER INTERRUPT
0301 E6 00		INC	\$0000	SAVE A REG AND BUMP COUNTER IN 0000
0303 D0 32		BNE	IDONE	DONE WITH INTERRUPT
0305 38		SEC		SET DECIMAL MODE FOR CALCULATIONS
0306 18		CLC		
0307 A5 01		LDA	\$0001	BUMP ONE SECOND COUNTER
0309 69 01		ADCIM	\$01	BY ADDING 1 WITH CARRY
0308 85 01		STA	\$0001	SAVE
030D C9 60		CMPIM	\$60	TEST SIXTY SECONDS
030F 90 22		BCC	NOTMIN	NOT A MINUTE
0311 A9 00		LDAIM	\$00	A MINUTE
0313 85 01		STA	\$0001	ZERO SECOND COUNTER
0315 18		CLC		THEN BUMP MINUTES
0316 A5 02		LDA	\$0002	GET MINUTES COUNTER
0318 69 01		ADCIM	\$01	AND BUMP
031A 85 02		STA	\$0002	SAVE
031C C9 60		CMPIM	\$60	TEST HOUR
031E 90 13		BCC	NOTMIN	NOT AN HOUR YET.
0320 A9 00		LDAIM	\$00	AN HOUR, SO ZERO MINUTES
0322 85 02		STA	\$0002	
0324 18		CLC		THEN FIX HOURS
0325 A5 03		LDA	\$0003	
0327 69 01		ADCIM	\$01	
0329 85 03		STA	\$0003	
032B C9 24		CMPIM	\$24	TEST 24 HOURS
032D 90 04		BCC	NOTMIN	NOT 24 HOURS
032F A9 00		LDAIM	\$00	AT 24 HOURS RESET TO ZERO
0331 85 03		STA	\$0003	
0333 A9 EC	NOTMIN	LDAIM	\$EC	RESET 20 INTERRUPT COUNTER
0335 85 00		STA	\$0000	
0337 AD 04 A0	IDONE	LDA	\$ACC4	RESTART TIMER BY READING
033A D8		CLD		CLEAR DECIMAL MODE
033B 68		PLA		RESTORE A REGISTER
033C 4C		RTI		RETURN FROM INTERRUPT

WRITING FOR MICRO

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