The Gemini MultiBoard Microsystem

MULTI-I/O

80-BUS MULTIPLE
INPUT/OUTPUT BOARD

Installation Manual
and User Guide

GM816
Issue 2
22/12/83

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1. Introduction

The Gemini GM816 is an Input/Output board for use in Gemini MultiBoard and Nascom microcomputer systems utilising the 80-BUS/Nasbus bus structures. The board provides three Z80 PIOs, a Z80 CTC and a 58174 Real Time Clock with battery back up. Flexible I/O port decoding is provided to allow more than one board to be used in a single system.

A special feature of the GM816 is its ability to have a daughter board attached in a "piggy-back" fashion. This is made possible by an on-board I/O bus that provides the necessary buffered address, data and control lines along with a number of I/O port decodes provided by the main board logic. Available daughter boards include a proto-typing board and a dual-channel serial I/O board.

This manual contains all of the information necessary to implement the GM816 and provides programming examples for using the Real Time Clock. MK3881 PIO and MK3882 CTC manuals are supplied separately.

1.1. Guarantee

Your GM816 I/O board is guaranteed by the supplier (your Dealer) for one year from the date of purchase. However, being a system module, any faults attributable to the incorrect implementation of the board within your system will be fully chargeable as to both parts and labour. The guarantee extends as far as the original hardware as supplied and no work on GM816 I/O boards modified in any way will be carried out.

Any queries regarding the implementation and operation of your GM816 I/O board should be directed at your Gemini dealer.

2. Installation

Carefully unpack your GM816 and examine it for any mechanical damage. In the event of any damage please inform your dealer immediately.

Your GM816 will have been shipped to you fully tested and working. However, to prolong the life of the clock back-up battery the 58174 clock chip has been removed. This should be inserted into the IC18 position on the board, taking care to ensure that it is inserted the correct way round and that all the pins enter the socket correctly. All that should now be required is for the board to be plugged into the bus. However, as there are a number of link options on the GM816 it should prove useful to read through this manual carefully first.

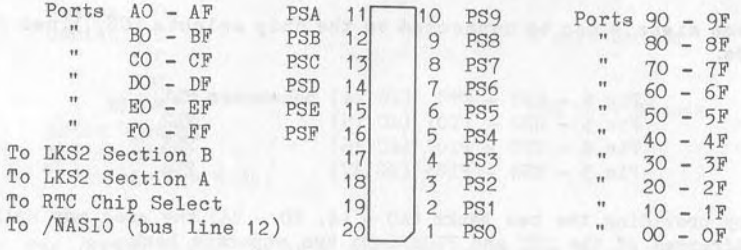
When plugging the GM816 into the bus please take great care, excessive force should not be required, any difficulty that is encounted will in all probability be due to the keyway of the edge connector not slotting accurately into the slot in the edge of the board. Ensure that the board is plugged in with the edge connector going in first and the correct way around, it should not be possible to plug the board in the incorrect way around because of the keyway. Power is connected to the board through the bus - refer to the 80-BUS or Nasbus specification for further details.

2.1. I/O Port Addressing

The two link blocks, LKS1 and LKS2, are used for setting up the Z80 I/O ports that the GM816 board's devices will occupy. The 58174 Real Time Clock (RTC) requires 16 I/O ports, and the CTC and three PIOs each require 4 I/O ports.

2.2. LKS1

LKS1 provides 16 decodes of 16 ports each. There are also 4 outputs from LKS1 to provide the necessary chip selects via LKS2 to the GM816s I/O devices.



Pin 20 provides a block decode onto line 12 of the bus. This line is /NASIO and is only required by a Nascom (see below).

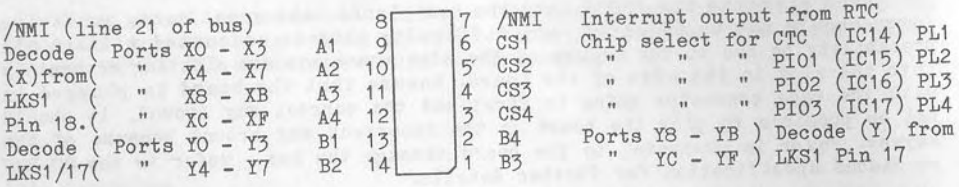
Pin 19 provides a block decode for the RTC. The GM816 has been shipped with this pin connected to pin 3 (PS2). This places the RTC at ports 20H to 2FH in the I/O map.

Pin 18 provides a block decode to section A of LKS2 for the CTC and PIOs. The GM816 has been shipped with this pin connected to pin 2 (PS1). In conjunction with the linking of LKS2, this places the:

CTC at ports 10 - 13
PIO1 " " 14 - 17
2 " " 18 - 1B
3 " " 1C - 1F

Pin 17 provides an alternative block decode to section B of LKS2 for the CTC and PIOs. The GM816 has been shipped with no connection to this pin.

2.3. LKS2



LKS2 provides the individual 4-port decodes required by the CTC and each PIO. There are two input sections to LKS2. Section A provides 4 x 4-port decodes derived from the 16-port decode fed into pin 18 on LKS1. Section B provides 4 x 4-port decodes derived from the 16-port decoded connected to pin 17 on LKS1.

If the decode provided to section A is XO-XF, and that to section B is YO-YF, then the following 4-port decodes will be available at LKS2.

Pin No.	Decode	Address	Pin No.	Decode	Address
9	A1	XO - X3	13	B1	YO - Y3
10	A2	X4 - X7	14	B2	Y4 - Y7
11	A3	X8 - XB	1	B3	Y8 - YB
12	A4	XC - XF	2	B4	YC - YF

In turn these signals can be connected to the chip selects (CS) lines of CTC and the PIOs.

Pin 6 - CS1 - CTC (IC 14) connector PL1
Pin 5 - CS2 - PIO1 (IC 15) " PL2
Pin 4 - CS3 - PIO2 (IC 16) " PL3
Pin 3 - CS4 - PIO3 (IC 17) " PL4

Note that by providing the two banks (AO - A4, BO - B4) the user may split the I/O port addresses of the CTC and PIOs into two separate banks.

The two remaining pins on LKS2 enable the RTC interrupt output (pin 7 of LKS2) to be connected to the bus NMI line (line 21 of the bus, buffered from pin 8 of LKS2). The RTC can be programmed to interrupt every 0.5 secs, 5 secs or 60 secs, or the interrupts can be disabled. The GM816 has been shipped with the NMI line fitted so that the user may program for interrupts or no interrupts as required. (Note that with the CP/M or RP/M operating systems NMIs cannot be used.)

2.4. Standard Port Addresses

The GM816 is supplied with the links set to provide the following port decodes:

Device	Ports
/NASIO	00 - 0F
CTC	10 - 13
PIO1	14 - 17
PIO2	18 - 1C
PIO3	1C - 1F
RTC	20 - 2F

2.5. Implementing /NASIO on a Nascom system

If the GM816 board is to be used with a Nascom then a /NASIO signal must be provided to the Nascom. This is because the Nascom I/O ports are not fully decoded.

With Nascom 1 the I/O internal/external link (LK1) should be set to external and, because of a decoding error on Nascom 1, the on-board PIO (IC 35) must be removed.

With Nascom 2 the I/O internal/external switch (LSW2/8) should be set for external operation.

There are a number of 80-BUS/Nasbus expansion boards that can supply a /NASIO signal, but only some boards provide a full decode. If there is more than one board with a /NASIO output in the system then only the board with the most complete implementation should supply the signal, and the other boards should have this line disconnected.

The following list shows a number of boards from the fullest implementation of /NASIO to the least:

Board	/NASIO implementation
EV IEEE488	Open collector, 4 or 8 port decode
Nascom I/O	" "
Gemini I/O	" 8 port decode
" IVC	" "
" FDC	" "
" EPROM	" 128 port decode
Arfon Speech	" "
Nascom RAM B (with Page Mode)	" "

Note: The /NASIO signal is only required by Nascom Microcomputers as the I/O on these boards is not fully decoded. In a system controlled by a Gemini GM811 or GM813 CPU board the /NASIO signal is not required and may be omitted.

3. Connectors

There are four I/O connectors on the GM816 board edge for the three PIOs (PL2, 3 & 4) and the CTC (PL1). In addition there are two connectors for expansion of the I/O board (PL5 & 6).

3.1. PIO Connectors (PL2, 3 & 4)

The PIO (Parallel Input/Output Controller) has two eight bit data ports, one known as A and one as B, so the I/O bits are numbered A0 to A7 and B0 to B7. A0 and B0 represent the least significant bits, A7 and B7 represent the most significant bits. In addition each port has two handshake lines, one for input and one for output.

Below are the details of the connectors on GM816. +5 volts and ground are provided on the connector to drive a small amount of external circuitry. However, users should beware of drawing excessive currents. Full details on the operation of the PIOs can be found in the MK 3881 PIO manual supplied.

B5	1		2	B4
B6	3		4	B3
B7	5		6	B2
ARDY	7		8	B1
/BSTB	9		10	B0
/ASTB	11		12	BRDY
A0	13		14	N.C.
A1	15		16	GND
A2	17		18	GND
A3	19		20	+5V
A4	21		22	+5V
A5	23		24	A7
A6	25		26	N.C.

Note : On the GM816 pins 14 and 26 are 'No Connection'. This is different to the Gemini GM811 and GM813 boards. These lines are freed to allow the user to run additional signals along the PIO cable if required.

3.2. CTC connector (PL1)

The CTC four-channel counter/timer can be programmed by system software for a broad range of counting and timing applications. The four independently programmable channels of the Z80A CTC satisfy most common microcomputer system requirements for event counting, interrupt and interval timing, and general clock rate generation.

Bus clock	1		2	N.C.
N.C.	3		4	N.C.
ZC/TO2	5		6	N.C.
ZC/TO0	7		8	ZC/TO1
GND	9		10	CLK/TRG0
CLK/TRG1	11		12	CLK/TRG2
CLK/TRG3	13		14	N.C.
N.C.	15		16	+5V

3.3. Expansion Connectors (PL 5 &6)

The Gemini GM816 I/O board is capable of accepting a daughter board "piggy-backed" onto the main board. There is an on-board I/O bus that provides the necessary buffered address, data and control lines along with a number of I/O port decodes provided by the main board logic.

PL5

+5V	1		2	+12V
-12V	3		4	POWER FAIL
-5V	5		6	WR
D7	7		8	CLOCK
D6	9		10	SEL
D5	11		12	BUSY
D4	13		14	ON
D3	15		16	M1
D2	17		18	IORQ
D1	19		20	RD
DO	21		22	IEI
DBDR	23		24	IEO
PSE	25		26	INT
PSD	27		28	PSA
PSC	29		30	PS9
PSB	31		32	PS8
A3	33		34	PS7
A2	35		36	PS6
A1	37		38	PS5
AO	39		40	PS4
A7	41		42	PS3
A6	43		44	PS2
A5	45		46	PS1
A4	47		48	PSO
GND	49		50	GND

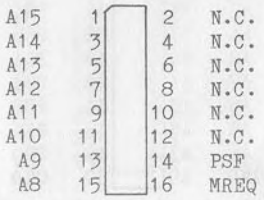
The signals have the following specifications:

Signal name	To/from daughter board	Description
DO - D7	T/F	Z80 data bus.
AO - A7	T	Z80 address signals.
PSO - PSE	T	Port select decodes. (Note PSF is present on PL6)
DBDR	T	When high the GM816s data buffer is enabled from the bus into the I/O board, when low data from GM816 is output to the bus.
Clock	T	Bus master clock.
RD	T	Z80 read signal.
WR	T	Z80 write signal.
IEI	T	Interrupt daisy chain input.
IEO	F	Interrupt daisy chain output.
INT	F	Z80 interrupt line.
IORQ	T	Z80 I/O request signal.

Signal name	To/from daughter board	Description
M1	T	Z80 M1 signal, gated with the bus RESET line.
Power Fail	T	Bus power fail warning line.
SEL	F	Signal from daughter board indicating that on-board devices are selected.
BUSY	T	Signal indicating that devices on I/O board or daughter board are selected.
ON	F	Activates I/O board wait state generator.
+12v) + 5v) GND) - 5V) -12V)	T	Power supply lines for daughter board.

PL6 connector

The PL5 connector described above provides all the necessary signals for the user to implement any I/O requirement on the daughter board. PL6 provides the remaining bus address lines (A8 to A15) and the Z80 memory request signal (/MREQ) should the user wish to add memory devices to the board. Note that these signals are direct from the bus and any load should meet the relevant 80-BUS/Nasbus specification.

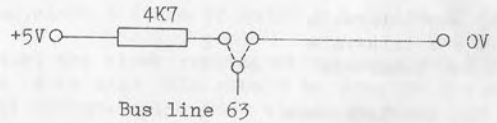


4. The Real-Time-Clock

A trimmer capacitor (C5) is provided for fine adjustment of the clock. This should be adjusted over a period of time for minimum error.

Circuitry is provided on the GM816 to switch the read, write and chip select signals during power-on and power-off of the board. Should it be found that the clock data corrupts then it may be necessary to implement the bus power-fail warning line (bus line 63). This may be done in several ways:

1. A switch on bus line 63 to switch the line between +5V and ground.



The switch should be turned on prior to switching off the computer system, and switched off after the computer has been turned on again.

2. Some power supplies, especially switch mode types, have a TTL compatible Ready line that goes high to indicate that all voltages have reached their correct values, and goes low to indicate that one or more power lines are dropping. This line can be connected to bus line 63.

3. With linear power supplies a comparator can be fitted prior to the reservoir capacitors to detect a failing supply and provide an output to bus line 63.

5. Using the Real-Time-Clock

The MM58174 real time clock provides clock and calendar functions with a battery back-up facility. An interrupt timer is included which can be programmed to have one of three interrupt frequencies or alternatively data can be directly read from the clock registers by polling.

The internal registers are arranged as 4-bit nibbles, these occupying the lower 4 bits only of the 8 bit bytes which constitute the Z80 I/O ports for the clock. For registers which do not require all 4 bits (e.g. day of week uses only three bits) the unused bits are not recognised during a write operation and are logical '0' during a read operation. However, the upper nibble of the Z80 I/O port contains random data and must be ignored during read operations.

5.1. Loading the Clock

Data can be loaded as follows:

1. Switch off the clock by outputting 0 to register 14. This also has the effect of zeroing the ten, units, and tenths of seconds counts (these registers are read only and cannot be loaded directly).

2. Set non-test mode by outputting 0 to register 0. Test mode is used in production testing of the clock chip and for normal operation the clock chip must be in non-test mode.

3. Set interrupt mode. Interrupts are controlled by the interrupt latches in register 15. Register 15 in write mode enables the interrupt output and dictates the frequency of interrupts.

FUNCTION	DATA
No interrupt	0 or 8
Single interrupt at 0.5 sec intervals	1
Single interrupt at 5.0 sec intervals	2
Single interrupt at 60 sec intervals	4
Repeated interrupt at 0.5 sec intervals	9
Repeated intervals at 5.0 sec intervals	A
Repeated interrupt at 60 sec intervals	C

All interrupt frequencies are +/- 16.6 mS.

If a single interrupt mode has been selected the timer is reset at the completion of the selected timing period and must be set by software if a subsequent interrupt is required. Setting a repeated interrupt mode allows automatic repeated timer inputs starting after the next clock chip read following an interrupt status read. Interrupts should be initialised by applying the reset condition and reading register 15 three times.

Reading register 15 gives the interrupt status, D3 set to 1 (giving a value greater than 4) indicates that an interrupt has occurred, and D3 is then reset to 0 by the reading process. The next clock chip read automatically restarts the interrupt timer if in continuous mode.

INTERRUPT STATUS	REGISTER 15 DATA
No interrupts	0
0.5 sec	1 or 9
5.0 sec	2 or A
60 sec	4 or C

4. Load the date and time registers with the appropriate information.

Register 13 (write only) is the year status register. This is used to hold leap year information and is loaded as follows:

YEAR	DATA LOADED
Leap year	8
Leap year + 1	4
Leap year + 2	2
Leap year + 3	1

Any data loaded other than the values above can cause spurious operation. The year status is updated every year on the 31st December.

Registers 12 (tens of months) & 11 (units of months) are the month counters, the month being in the range 1 - 12.

Register 10 is the day of week counter and is in the range 1 - 7.

Registers 9 (tens of days) & 8 (units of days) are the days counters. These counters count up to 28, 29, 30 or 31 days depending on the month counters and year status register.

Registers 7 (tens of hours) & 6 (units of hours) are the hours counters. Both count in 24 hour mode.

Registers 5 (tens of mins) & 4 (units of mins) are the minutes counters.

5. Start the clock running at the required time by outputting 1 to register 14. Note that this should be done at the start of the required minute as the seconds count will always be zero (see paragraph 1 above).

5.2. Reading the Clock

The date and time may be obtained by reading the appropriate registers including the tens of seconds (register 3), units of seconds (register 2) and tenths of seconds (register 1). However, when a register has been updated all data outputs from the clock are set to a '1' indicating that the clock value has changed since it was last read. This data changed indicator is reset by any clock read operation. Upon reading back a data changed indicator (F Hex.) it is necessary to re-read not only that register but ALL the registers required, since the change may have affected more than one register (i.e. consider updating 23:59:59.9 on Friday 31st December !). These data changed indicators occur every tenth of a second so the software which is reading the clock must either guarantee to read all the registers it needs within that time or it must only attempt to read a register when it knows it cannot update (e.g. the software has up to 1 minute to read the units of minutes register immediately after it has just altered). This problem is particularly apparent when using a high-level interpreted language which tend to be slow anyway - a possible solution here is to use a machine code subroutine if the language itself is not fast enough.

Note that since only the lower 4 bits of the data bus are used by the chip the top 4 must be masked out since they are invalid. This can be achieved by ANDing the byte read back from the clock chip with OFH or by MODing it with 16 (divide by 16 and the remainder of the division is the value required).

If a register trys to update during a read operation the data is prevented from updating and a subsequent read will return the data changed indicator (15 Hex.). This means that the clock could be slowed down by reading it very frequently as could happen if the software was sitting in a machine code loop reading the clock constantly.

5.3. Register Summary

REG	USE	MODE
0	Test only	Write only
1	Tenths of sec	Read only
2	Units of secs	Read only
3	Tens of secs	Read only
4	Units of mins	Read / Write
5	Tens of mins	Read / Write
6	Units of hours	Read / Write
7	Tens of hours	Read / Write
8	Units of days	Read / Write
9	Tens of days	Read / Write
10	Day of week	Read / Write
11	Units of months	Read / Write
12	Tens of months	Read / Write
13	Year status	Write only
14	Stop / Start	Write only
15	Interrupt and status	Read / Write

5.4. Examples of Use

The following examples are intended as a guide to the use of the clock chip. They assume a 4MHz system with or without wait states, and the standard port decoding of 20H, but this can easily be altered as described in the listings. Please note that all of the 'read clock' routines, being fairly simple, sit in a loop waiting for the clock to update. If the clock is not present in the system or, more likely, if the clock has stopped as a result of the battery running down or incorrect programming, it will not update and the software will hang up, necessitating a system reset. If this occurs the clock must be started and the time set-up again. This can be performed using the SET machine code program or the BASIC program. More sophisticated software could use some form of time-out loop to detect that the clock is not running.

```
10 '            ************************************************************
20 '            ************************************************************
30 '            ****                                                    ****
40 '            ****   PROGRAM TO SET AND/OR DISPLAY TIME AND DATE      ****
50 '            ****            FOR GEMINI GM816 I/O CARD               ****
60 '            ****                                                    ****
70 '            ****  The  program will prompt whether to set a new     ****
80 '            ****  time, or just  display  existing  time.  Type     ****
90 '            ****  Y  or N as appropriate. The program will then     ****
100 '           ****  prompt for the current time and date.             ****
110 '           ****                                                    ****
120 '           ****  Written for use with Microsoft MBASIC             ****
130 '           ****                                    DRH 01/12/83    ****
140 '           ****                                                    ****
150 '           ************************************************************
160 '           ************************************************************
170 '
180 '
190 '           ************************************************************
200 '           **                  THE FIXED VARIABLES                   **
210 '           ************************************************************
220 '
230 CLKIO = 32      : '       Clock port base address
240 CLS$ = CHR$(26): '        Clear screen
250 YEAR$ = "1984" : '        Current year
260 YR = 8          : '       Current year status (leap year     = 8)
270 '                                             (leap year + 1 = 4)
280 '                                             (leap year + 2 = 2)
290 '                                             (leap year + 3 = 1)
300 '
310 '           ************************************************************
320 '           **        LOAD UP THE MACHINE CODE READ ROUTINE           **
330 '           ************************************************************
340 '
350 ' MC$ is the workspace.
360 MC$="*****************************************": ' 41 Spaces workspace
370 '
380 ' The machine code clock read routine
390 DATA 0E,00      : ' START: LD E,00          ; Clock base address
400 DATA 06,0C      : '        LD B,12          ; 12 registers to read
410 DATA 21,00,00   : '        LD HL,0000       ; Point HL at data area
420 DATA 0C         : ' READ:  INC C            ; Point to next port
430 DATA ED,A2      : '        INI              ; Get the data into (HL)
440 DATA 20,FB      : '        DJNZ READ        ; Do until finished
450 DATA 06,0C      : '        LD B,12          ; 12 Registers to test
460 DATA 21,00,00   : '        LD HL,0000       ; Point HL at data area
470 DATA 7E         : ' SCAN:  LD A,(HL)        ; Get the value
480 DATA E6,0F      : '        AND 0FH          ; Mask top nibble
490 DATA FE,0F      : '        CP 0FH           ; Update indicator
500 DATA 28,E8      : '        JR Z,START       ; Yes, try again
510 DATA 77         : '        LD (HL),A        ; Resave it
520 DATA 23         : '        INC HL           ; Point to next
530 DATA 10,F5      : '        DJNZ SCAN        ; Do until finished
540 DATA C9         : '        RET              ; Return to basic
```

```
550 '
560 ' Calculate the address of MC$ and POKE in the machine code program
570 MC=PEEK(VARPTR(MC$)+1)+256*PEEK(VARPTR(MC$)+2)
580 FOR J=0 TO 28: READ X$: POKE MC+J,VAL("&H"+X$): NEXT
590 '
600 ' POKE the address dependant bytes into the program
610 ADDR=MC+29: POKE MC+1,CLKIO
620 POKE MC+5,ADDR-INT(ADDR/256)*256: POKE MC+6,INT(ADDR/256)
630 POKE MC+15,ADDR-INT(ADDR/256)*256: POKE MC+16,INT(ADDR/256)
640 '
650 '          ************************************************************
660 '          **                START OF MAIN ROUTINE                   **
670 '          ************************************************************
680 '
690 ' Clear any clock test and interrupt mode
700 OUT CLKIO+0,0: OUT CLKIO+15,0
710 '
720 ' Select time set and/or display
730 GOSUB 1280
740 INPUT "Set new time (Y/N) ";I$
750 IF I$ = "Y" OR I$ = "y" THEN 810 ELSE 1020
760 '
770 '          ************************************************************
780 '          **                  SET TIME AND DATE                     **
790 '          ************************************************************
800 '
810 GOSUB 1280
820 PRINT "Note: colons and leading zeros significant"
830 PRINT
840 INPUT "Enter time (hh:mm) ";I1$
850 INPUT "Enter day-of-week, date, month (d:dd:mm) ";I2$
860 '
870 ' Convert inputs into a binary output string
880 I$=CHR$(VAL(MID$(I1$,5,1))) + CHR$(VAL(MID$(I1$,4,1)))
890 I$=I$+CHR$(VAL(MID$(I1$,2,1))) + CHR$(VAL(MID$(I1$,1,1)))
900 I$=I$+CHR$(VAL(MID$(I2$,4,1))) + CHR$(VAL(MID$(I2$,3,1)))
910 I$=I$+CHR$(VAL(MID$(I2$,1,1))) + CHR$(VAL(MID$(I2$,7,1)))
920 I$=I$+CHR$(VAL(MID$(I2$,6,1))) + CHR$(YR) + CHR$(15)
930 '
940 ' Stop the clock, output the string and restart the clock
950 OUT CLKIO+14,0
960 FOR J=1 TO LEN(I$): OUT CLKIO+J+3,ASC(MID$(I$,J,1)): NEXT
970 '
980 '          ************************************************************
990 '          **                 READ TIME AND DATE                     **
1000 '         ************************************************************
1010 '
1020 GOSUB 1280
1030 DAY$="SunMonTueWedThuFriSat"
1040 MTH$="JanFebMarAprMayJunJulAugSepOctNovDec"
1050 CALL MC: ' Read the clock
1060 '
1070 ' Get the data from the workspace and build an output string
1080 T$="The time is --->     "
```

```
1090 I=PEEK(ADDR+6)*10 + PEEK(ADDR+5): GOSUB 1330: T$=T$ + I$ + ":"
1100 I=PEEK(ADDR+4)*10 + PEEK(ADDR+3): GOSUB 1330: T$=T$ + I$ + ":"
1110 I=PEEK(ADDR+2)*10 + PEEK(ADDR+1): GOSUB 1330: T$=T$ + I$ + "."
1120 T$=T$ + RIGHT$(STR$(PEEK(ADDR)),1) + "    "
1130 T$=T$ + MID$(DAY$,3*(PEEK(ADDR+9))-2,3) + " "
1140 I=PEEK(ADDR+8)*10 + PEEK(ADDR+7): GOSUB 1330: T$=T$ + I$ + " "
1150 I=PEEK(ADDR+11)*10 + PEEK(ADDR+10)
1160 T$=T$ + MID$(MTH$,3*I-2,3) + " " + YEAR$
1170 '
1180 ' Print the string and leave the system
1190 PRINT T$
1200 PRINT: PRINT: PRINT: PRINT: PRINT: PRINT: PRINT: PRINT: PRINT
1210 SYSTEM
1220 '
1230 '          ************************************************************
1240 '          **                      SUBROUTINES                       **
1250 '          ************************************************************
1260 '
1270 ' Clear the screen and move half way down the screen
1280 PRINT CLS$; TAB(20); "GM816 CLOCK DISPLAY/TIME SET ROUTINE"
1290 FOR J=1 TO 11: PRINT: NEXT
1300 RETURN
1310 '
1320 ' Convert a digit into string and add leading 0 if required
1330 IF I<=9 THEN I$="0"+RIGHT$(STR$(I),1): RETURN
1340 I$=RIGHT$(STR$(I),2): RETURN
1350 END
```

```
"Set"   MACRO-80 3.4        PAGE    1

                            title "Set"

                            .z80

0000'                       aseg

                            org 100h

0001                        true    equ 1
0000                        false   equ 0

                            .comment \

                            ********************************************
                            * This routine sets the clock time to      *
                            * hh:mm where hh is the number of hours    *
                            * and mm the number of minutes.            *
                            *                                          *
                            * For CP/M or RP/M - program starts at 100h.*
                            * Assemble it into a file SET.COM and      *
                            * execute as SET hh:mm. There should be    *
                            * only one space between SET and hh:mm.    *
                            *                                          *
                            * For Nas-Sys - The program starts at C80h. *
                            * Execute C80h and the cursor will appear  *
                            * on a blank line type in hh:mm. There     *
                            * should be no leading spaces before hh:mm. *
                            ********************************************

                            \

                            ;Define the operating system
0001                        cpm     equ true

                            ife cpm
                                    .phase 0c80h
                            endif

                            if cpm
0005                        bdos    equ 5           ;CP/M BDOS entry point
0082                        args    equ 0082h       ;command tail arguments
                            else
                            scal    equ 18h         ;Nas-Sys subroutine call
                            mret    equ 5bh         ;Nas-Sys return routine
                            inlin   equ 63h         ;Nas-Sys line input
                            endif

0020                        clock   equ 20h         ;base address of clock
```

```
"Set"   MACRO-80 3.4                    PAGE    1-1

                                        ;Initialisation

0100    AF                      init:   xor a           ;zero it
0101    D3 2E                           out (clock+14),a ;stop the clock
0103    D3 20                           out (clock+0),a ;set non-test mode
0105    D3 2F                           out (clock+15),a ;no interrupts
                                if cpm
0107    21 0082                         ld hl,args      ;pointer to arguments
                                else
                                        rst scal        ;get hours & mins
                                        defb inlin
                                        ex de,hl        ;pointer to args in HL
                                endif

                                ;Load the clock registers

010A    0E 27                           ld c,clock+7    ;pointer to registers
010C    CD 011E                         call load       ;load hours
010F    CD 011E                         call load
0112    23                              inc hl
0113    CD 011E                         call load       ;load mins
0116    CD 011E                         call load
0119    3E 01                           ld a,1
011B    D3 2E                           out (clock+14),a ;start clock
                                if cpm
011D    C9                              ret             ;and return to CCP
                                else
                                        rst scal        ;return
                                        defb mret       ; to Nas-Sys
                                endif

                                ;Subroutine to load ASCII data at (HL) in register C

011E    7E                      load:   ld a,(hl)       ;get ASCII
011F    D6 30                           sub 30h         ;into binary
0121    ED 79                           out (c),a       ;load the reg
0123    0D                              dec c           ;next register
0124    23                              inc hl          ;next ASCII value
0125    C9                              ret

                                end

"Set"   MACRO-80 3.4                    PAGE    S

Macros:

Symbols:
ARGS    0082    BDOS    0005    CLOCK   0020    CPM     0001
FALSE   0000    INIT    0100    LOAD    011E    TRUE    0001

No  Fatal error(s)
```

```
"Time"  MACRO-80 3.4                PAGE    1


                                    title "Time"

                                    .z80
0000'                               aseg

                                    org 100h

0001                                true    equ 1
0000                                false   equ 0

                                    .comment \

                                    ********************************************
                                    * This program prints the clock time as    *
                                    * hh:mm:ss.                                *
                                    *                                          *
                                    * For CP/M or RP/M - program starts at 100h.*
                                    * Assemble it into a file TIME.COM and     *
                                    * execute TIME to print up the time.       *
                                    *                                          *
                                    * For Nas-Sys - The program starts at C80h. *
                                    * Assemble it and execute C80h to print    *
                                    * up the time.                             *
                                    ********************************************

                                    \

                                    ;Define the operating system
0001                                cpm     equ true

                                    ife cpm
                                            .phase 0c80h
                                    endif

                                    ;Equates

                                    if cpm
0005                                bdos    equ 5           ;CP/M BDOS entry point
                                    else
                                    rout    equ 30h         ;Nas-Sys output routine
                                    scal    equ 18h         ;Nas-Sys subroutine call
                                    mret    equ 5bh         ;Nas-Sys monitor return
                                    crlf    equ 6ah         ;Nas-Sys carriage return
                                    endif

0006                                nmrreg  equ 6           ;number of registers to re
0020                                clock   equ 20h         ;clock chip base address

0100    C3 0109                             jp start
```

```
"Time"  MACRO-80 3.4                PAGE    1-1

  0103                              regs:   defs 6          ;temp storage for registers

                                    ;Read in the clock registers

  0109    0E 21                     start:  ld c,clock+1    ;first register
  010B    06 06                             ld b,nmrreg     ;no to read
  010D    21 0103                           ld hl,regs      ;start of storage
  0110    0C                        read:   inc c           ;point to next port
  0111    ED A2                             ini             ;put value into (HL)
  0113    20 FB                             jr nz, read     ;do the rest

                                    ;Scan the values for any update indicators

  0115    06 06                             ld b,nmrreg     ;no to scan
  0117    21 0103                           ld hl,regs      ;start of storage
  011A    7E                        scan:   ld a,(hl)       ;get value
  011B    E6 0F                             and 0fh         ;mask top nibble
  011D    FE 0F                             cp 0fh          ;update indicator?
  011F    28 E8                             jr z,start      ;yes, try again
  0121    77                                ld (hl),a       ;resave it
  0122    23                                inc hl          ;point to next one
  0123    10 F5                             djnz scan       ;and repeat

                                    ;Output the time to the console

  0125    21 0108                           ld hl,regs+nmrreg-1 ;end of storage
  0128    CD 0138                           call outnum     ;hours
  012B    CD 014D                           call colon      ;delimiter
  012E    CD 0138                           call outnum     ;mins
  0131    CD 014D                           call colon      ;delimiter
  0134    CD 0138                           call outnum     ;secs
                                    if cpm
  0137    C9                                ret             ;and exit to CCP
                                    else
                                            rst scal        ;output CR
                                            defb crlf
                                            rst scal        ;return
                                            defb mret       ; to Nas-Sys
                                    endif

                                    ;Subroutine to output register values

  0138    CD 0141                   outnum: call outasc     ;output hi byte
  013B    2B                                dec hl          ;get lo byte
  013C    CD 0141                           call outasc     ;output it
  013F    2B                                dec hl
  0140    C9                                ret

                                    ;Subroutine to output A as a digit

  0141    7E                        outasc: ld a,(hl)       ;get value
  0142    C6 30                             add a,30h       ;convert to ASCII
```

```
"Time"  MACRO-80 3.4                    PAGE    1-2

                                        if cpm
0144    5F                                      ld e,a
0145    0E 02                                   ld c,2          ;console output
0147    E5                                      push hl
0148    CD 0005                                 call bdos       ;throw it out
014B    E1                                      pop hl
                                        else
                                                rst rout        ;output it
                                        endif

014C    C9                                      ret

                                        ;Subroutine to output a colon

                                        if cpm
014D    1E 3A                           colon:  ld e,":"        ;ASCII colon
014F    0E 02                                   ld c,2          ;console output
0151    E5                                      push hl
0152    CD 0005                                 call bdos
0155    E1                                      pop hl
0156    C9                                      ret
                                        else
                                        colon:  ld a,":"        ;ASCII colon
                                                rst rout
                                                ret
                                        endif

                                        end

"Time"  MACRO-80 3.4                    PAGE    S

Macros:

Symbols:
BDOS    0005    CLOCK   0020    COLON   014D    CPM     0001
FALSE   0000    NMBREG  0006    OUTASC  0141    OUTNUM  0138
READ    0110    REGS    0103    SCAN    011A    START   0109
TRUE    0001

No Fatal error(s)
```

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