# III. THE V10 BOARD (V10-D)

# III. THE VIO BOARD (VIO-D)

## A. THEORY OF OPERATION

### 1. HARDWARE OVERVIEW

The VIO interfaces to the computer as a 4K byte block of memory. This 4K block includes a 2K byte static video refresh memory, the 2K bytes of VIOROM firmware, and a memory-mapped command port. Figure III-1 indicates the standard VIO memory space configuration. A Block Diagram of the VIO hardware is shown in Figure III-2.

VIO Processes

The operation of the VIO can be broken down into four basic processes: Character storage, display control, refresh display and firmware access.

Character Storage: Characters to be displayed are stored into the video refresh memory by the system CPU. The select and control signals necessary to effect this transfer are generated by the VIO's Bus Interface.

Display Control: The system CPU will assert control over the visual attributes of the screen display by outputting a command byte to the memory-mapped control port of the VIO. This command byte will be latched by the command logic and will specify to the Video Refresh Logic the display parameters (line length, page length, and inverse video).

Refresh Display: The Video Refresh Logic will take characters from the video refresh memory and create the necessary composite video signal to allow the characters to be displayed on an external video monitor device.

Firmware Access: Since the VIO resides in the system memory space, the CPU will execute the VIOROM firmware as if it were a program stored in the system memory. The VIO's Bus Interface allows the CPU to access the VIOROM by providing the necessary select and control signals.

### 2. VIDEO REFRESH MEMORY

The 2K bytes of video refresh memory is implemented with sixteen 2102 memory chips (U11-U18 and U28-U35). Characters to be displayed are stored in this memory in order beginning with the character in the top left screen location and ending with the character which appears in the lower right corner of the display

The video refresh memory is accessible both by the system CPU as well as by the video refresh logic. Therefore, video refresh memory addressing is achieved through the use of a separate MA bus which may be driven by the S-100 address line during a CPU access, or by the video

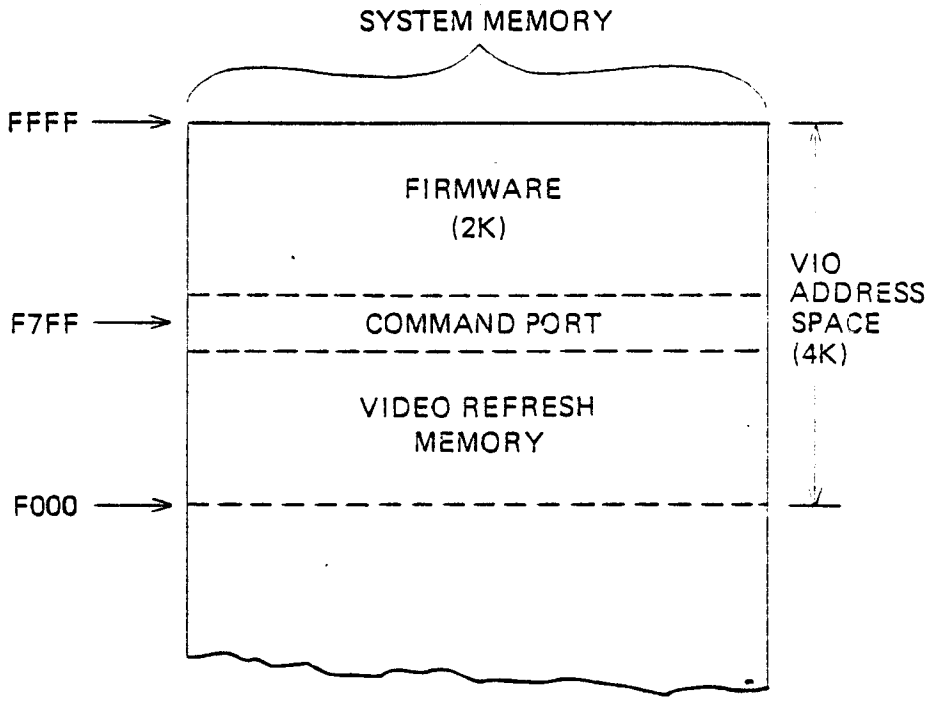



FIGURE III-1 VIO MEMORY SPACE (STANDARD CONFIGURATION)

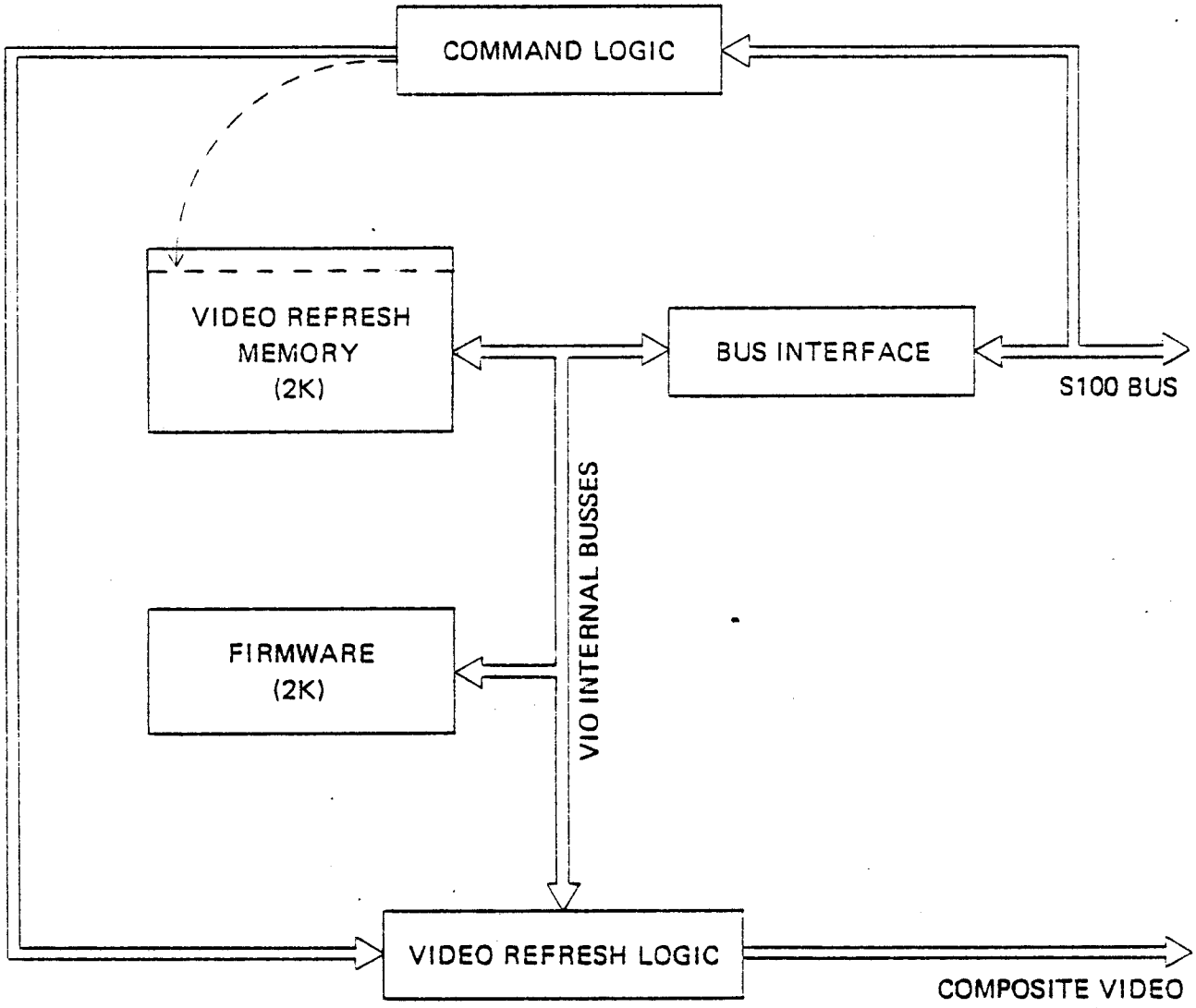



FIGURE III-2 VIO BLOCK DIAGRAM

refresh logic during refresh processes. The necessary multiplexing is achieved with tri-state drivers.

During a CPU write to the refresh memory, data from the system CPU is bussed directly to the data input pins of the memory chips via the S-100 DO bus.

Data out from the video refresh memory appears on the internal PCH bus. During a CPU read of the video refresh memory, the PCH bus drives the internal DB bus which in turn drives the S-100 Data In (DI) bus. During a video refresh, data on the PCH bus is latched by the video refresh logic.

## 3. VIOROM

The VIOROM firmware resides in the ROM at U46. Since the VIOROM is only accessed by the system CPU, its address lines are driven directly by the S-100 address bus.

During a CPU read of the VIOROM, the data from the PROM chip drives the VIO's DB bus which in turn drives the S-100 DI bus through tri-state drivers.

## 4. BUS INTERFACE

The VIO's S-100 bus interface provides the control and select signals necessary to effect a CPU transfer or access.

When the VIO is used in a megabyte address space (with IMM), the occurrence of A16-A19 (high) and /SINP, /SOUT and /SINTA indicates a CPU access in the top page of memory. The resulting signal enables a 74LS85 comparator at U50.

In a 65K address space, the occurrence of /SINP, /SOUT, and /SINTA is used to directly enable the 74LS85 comparator at U50. The comparator then compares A12-A16 to the settings of the address select switches (SW1). The comparator will drive its "=" output high only when a CPU access to the selected 4K block occurs.

This "=" output is further combined with A11 to determine if the CPU access is to the video refresh memory or to the VIOROM. The indication that the VIOROM is being accessed is used to directly drive the signal ROMSEL to enable the VIOROM at U46. The indication that the access is to the video refresh memory is latched at U40 by the user selected edge of the processor status strobe to prevent transients from interfering with the display. The /Q output of the latch U40 is the signal RAMSEL and is used to enable the refresh memory chips.

In addition to the ROMSEL and RAMSEL select signals, the VIO's bus interface must also provide the necessary control signals to effect a memory transfer.

The WRITE control signal is generated by gating /RAMSEL with /PWR at U26. The resulting signal /RAMWR is active low only during a CPU write to the video refresh memory. /RAMWR directly drives the R/W inputs of the memory chips.

If the wait state option has been selected, wait states are generated by reflecting PWAIT on

the PRDY line when the board is selected. The "not ready" signal is extended using a 74LS74 flip flop (U40) clocked by 02.

## 5. COMMAND LOGIC

The command port is memory mapped to the top location of the 2K byte video refresh memory space. A0-A10 is ANDed with RAMWR to detect a CPU write to the command port address. This signal then clocks DO0-DO4 into a 74LS74 latch (U44). The outputs of the four bit latch form the control signals /W80, /L24, MD0, MD1 and VIDREV; and are used by the video refresh logic.

/W80 controls line length; /L24 controls page length; MD0 and MD1 are encoded and select screen blanking, the character set and character-by-character reverse video; and VIDREV controls full screen reverse video.

## 6. VIDEO REFRESH LOGIC

A block diagram of the Video Refresh Logic is shown in Figure III-3. The timing and refresh address logic together generate the sequence of addresses which allow characters to be taken from the Video Refresh Memory. Data from the Refresh Memory (the encoded characters to be displayed) appear at the inputs of the character generator, where they are mapped into the specific pattern of "dots" which will form the visual representation of the characters. The video generation logic then combines the outputs of the character generator with the sync and blanking signals from the Timing Logic to produce the composite video signal required by the video monitor.

### a) Timing Logic

The timing circuitry essentially consists of a 12.2304 MHz oscillator and a modulo-203840 counter chain. The counter chain consists of modulo-7, modulo-112 and modulo-260 sections cascaded to provide the 1.7472 MHz character clock, 15.600 KHz horizontal sweep synchronization and blanking and 60.00 Hz vertical sweep synchronization and blanking. This circuitry also provides outputs which specify the current scan position. A block diagram of this circuitry is shown in Figure III-4 and it is described in detail in the following paragraphs.

1) DOT CLOCK: The dot clock (Figure III-5) is a crystal-controlled oscillator which generates the basic 12.2304 Mhz timing reference DCK1 for video generation. It consists of two sections of a 74LS04 cascaded to form a non-inverting amplifier. A series resonant crystal establishes the feed- back path to cause oscillation. A third section of the 74LS04 buffers the oscillator output. A 74LS74 D-flip-flop divides the 12.2304 Mhz signal by two to produce the 6.1152 Mhz clock signal DCK2 required for generation of double width (40 per-line) characters. The reset input of this flip-flop is connected to the composite sync signal /PCOMPSYNC to ensure that the flip-flop starts each line in the zero state (DCK2=1).

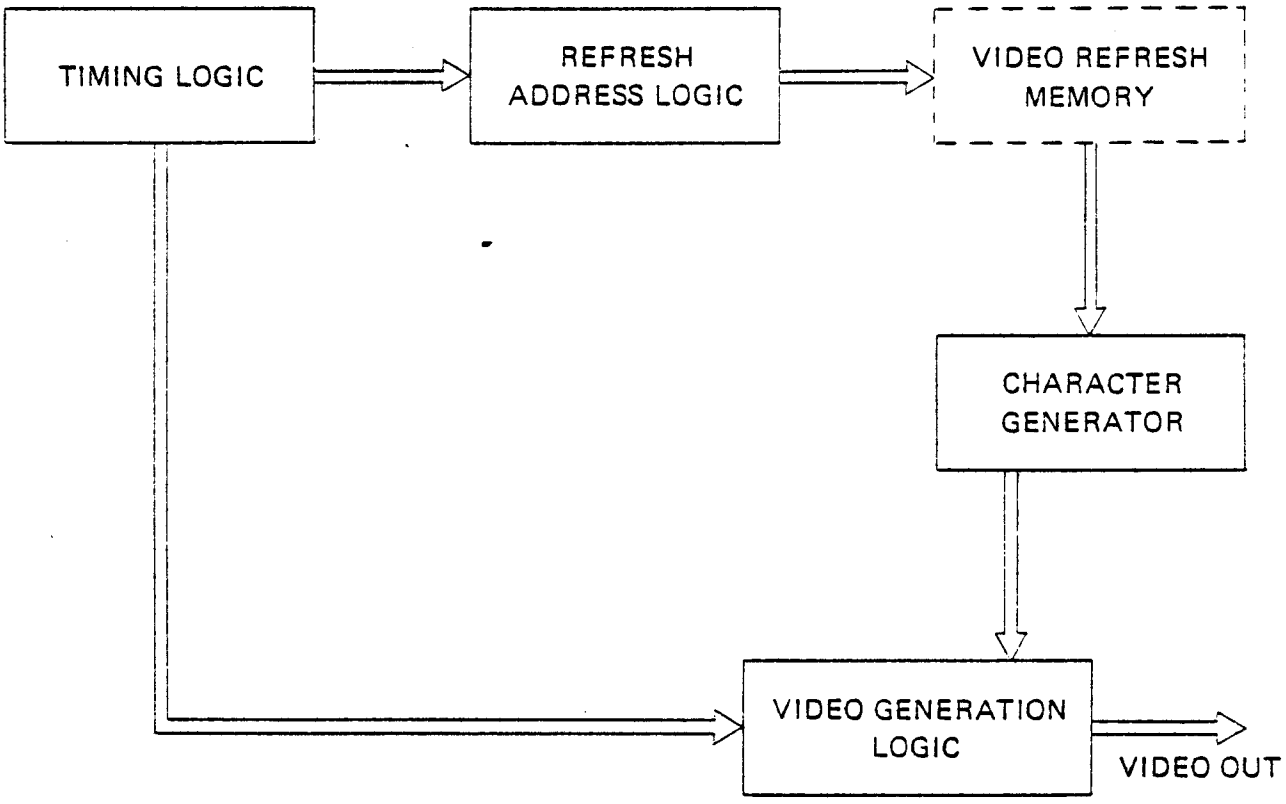



FIGURE III-3 VIDEO REFRESH LOGIC

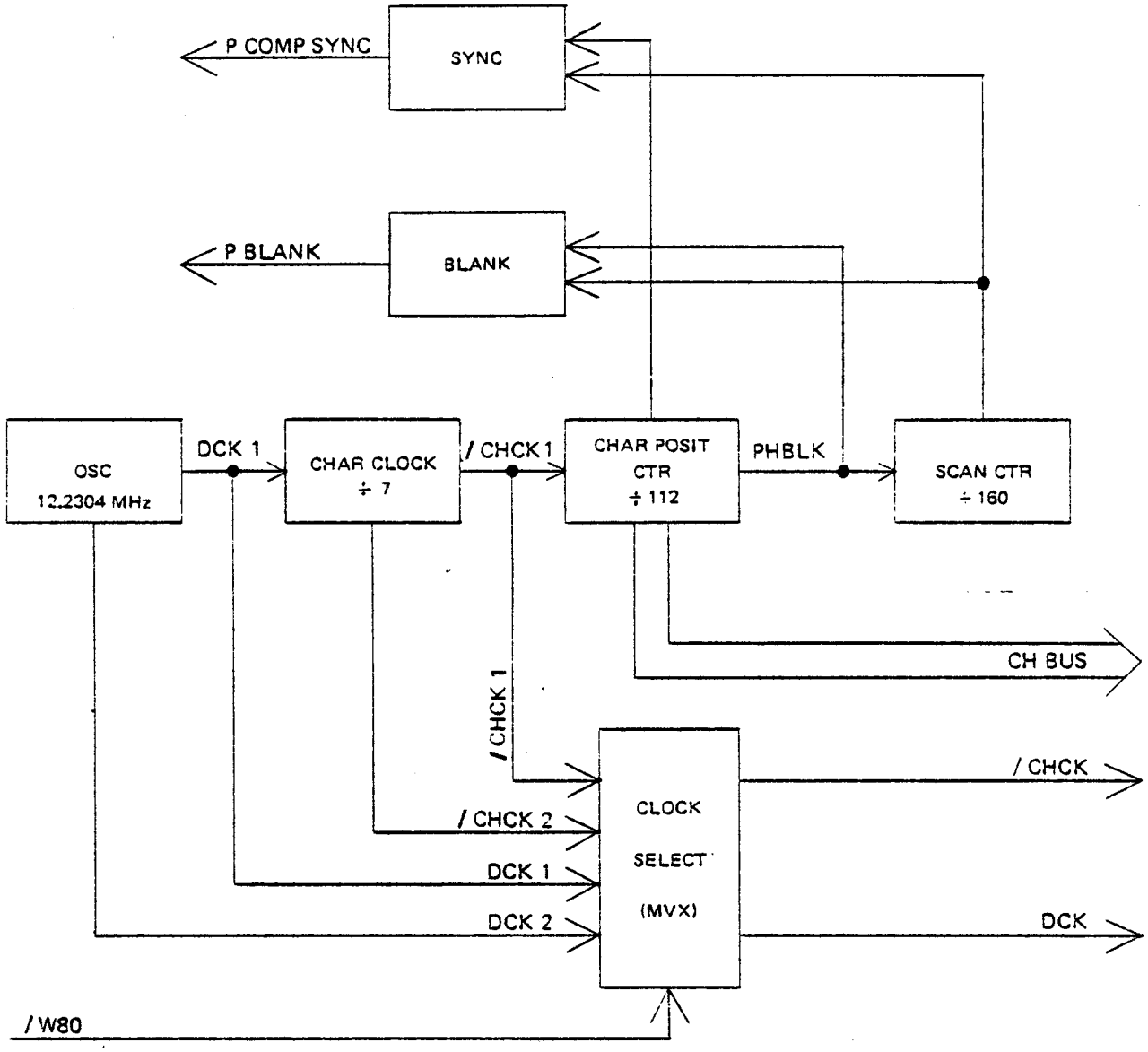



FIGURE III-4 TIMING BLOCK DIAGRAM

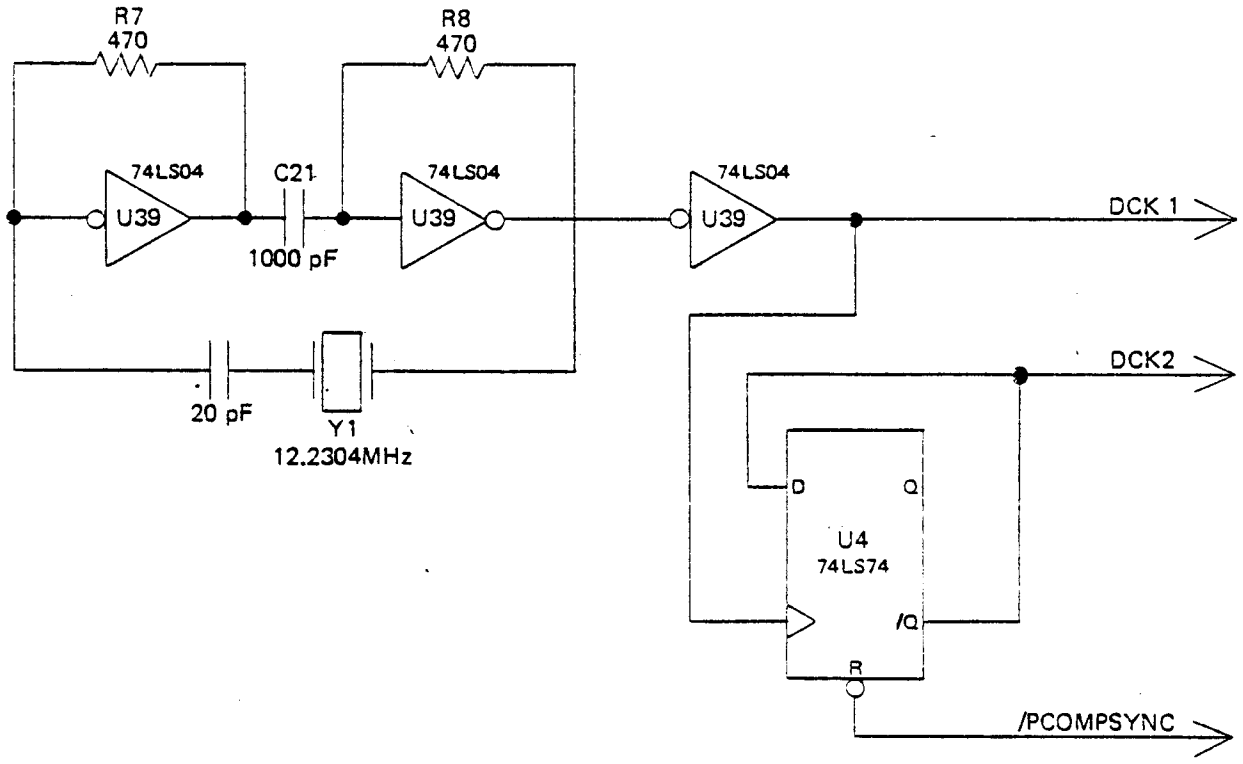



FIGURE III-5 DOT CLOCK

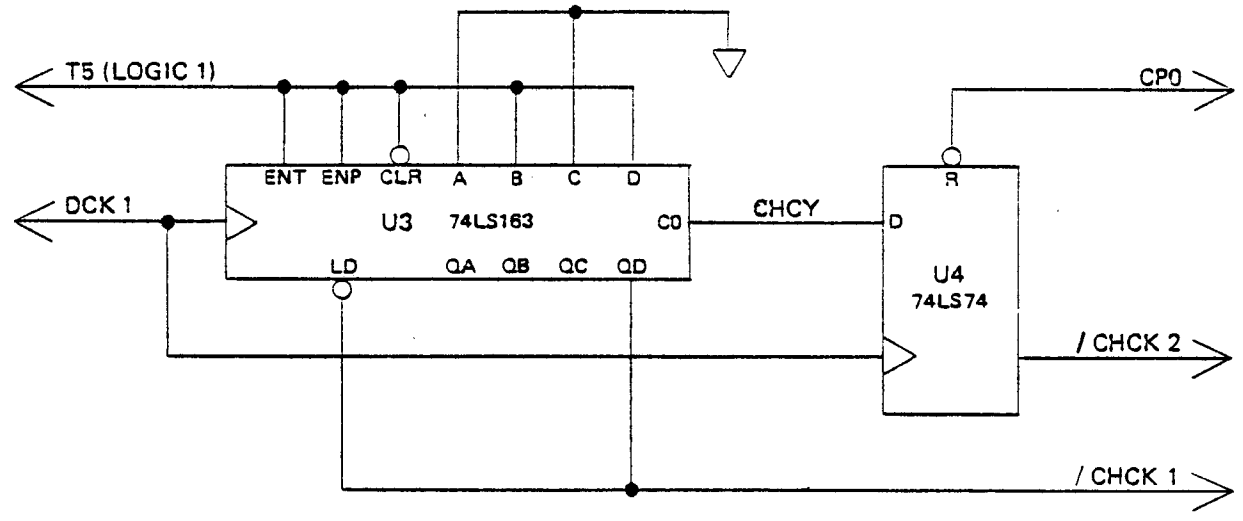



FIGURE III-6 CHARACTER CLOCK

2) CHARACTER CLOCK: The character dot matrix is seven dots wide so the character clock frequency is one-seventh that of the dot clock. It is generated by dividing DCK1 with a 74LS163 configured as a modulo-7 counter (Figure III-6). The counter is pre-loaded with a count of 10 then allowed to count through 15 overflowing to a count of zero. The QD output pulls the /LOAD input low causing a count of 10 to be again loaded. The QD output is high for the first six states and low only for the seventh (zero) state. This is used as the character clock output /CHCK1. A 74LS74 flip-flop generates a signal at half the frequency of /CHCK1, ie., the required character clock for double-wide characters /CHCK2. It is a one-bit shift register which is held in the reset state by CP0 (described in the next paragraph) during the first half of a double wide character. During the second half, the carry output of the 74LS163 CHCY is delayed one period of DCK1 by the 74LS74 to produce /CHCK2. Note that the low-to-high transitions of /CHCK2 are synchronized with the same edge of /CHCK1 and that the leading edge of /CHCK2 has the same timing relationship to DCK2 as /CHCK1 has to DCK1.

3) CHARACTER POSITION COUNTER: The character position counter (Figure III-7) counts the 80 character positions in each scan and generates the timing for blanking during horizontal retrace. It consists of two 74LS163's configured as a modulo-112 counter with input /CHCK1. The states zero through 79 correspond to the 80 character positions. State 79 is decoded by the 74LS11 and the associated inverters. This causes the /LOAD inputs of the 74LS163's to go low during state 79 and 224 to be loaded as the next state. The count continues for 32 states and over-flows back to the zero state. The states 224 through 255 correspond to the horizontal blanking interval. The counter's most significant bit is high only during these states so it's output is used as the horizontal blanking signal PHBLK. The remaining seven outputs drive the character position bus CP0-CP6.

4) SCAN COUNTER: The 240 displayed scans and 20 blanked scans are counted by the modulo-260 counter shown in Figure III-8. It consists of modulo-10 and modulo-26 cascaded counters. The modulo-10 section is a 74LS162 decade counter operating in its fundamental mode. The modulo-26 section consists of two 74LS163's. The counters are loaded with 232 and the states 232 through 255 correspond to the 240 (24 X 10) displayed scans. The counter overflows to the zero state and states zero and one correspond to the twenty blanked states. The one state is decoded by the 74LS00 and its associated inverter. The decoder causes the /LOAD inputs of the counters to be low during the one state and 232 to again be loaded as the next state. The most significant bit is low only during vertical blanking so its inverted output is used as the vertical blanking signal PVLK.

5) SYNC GENERATION: The horizontal and vertical sync pulses are generated by the circuit shown in Figure III-9. The horizontal sync signal PHSYNC is generated by using a 74LS74 flip-flop to essentially AND together CP3, /CP4 and PHBLK. The resulting signal is high only during the second quarter of PHBLK. The vertical sync signal PVSYNC is generated by using another section of a 74LS74 as a one bit shift register. The first half of PVBLK is decoded then phase-shifted by VCK. Note that PVSYNC is longer than one-half the length of PVBLK because of the phase relationship

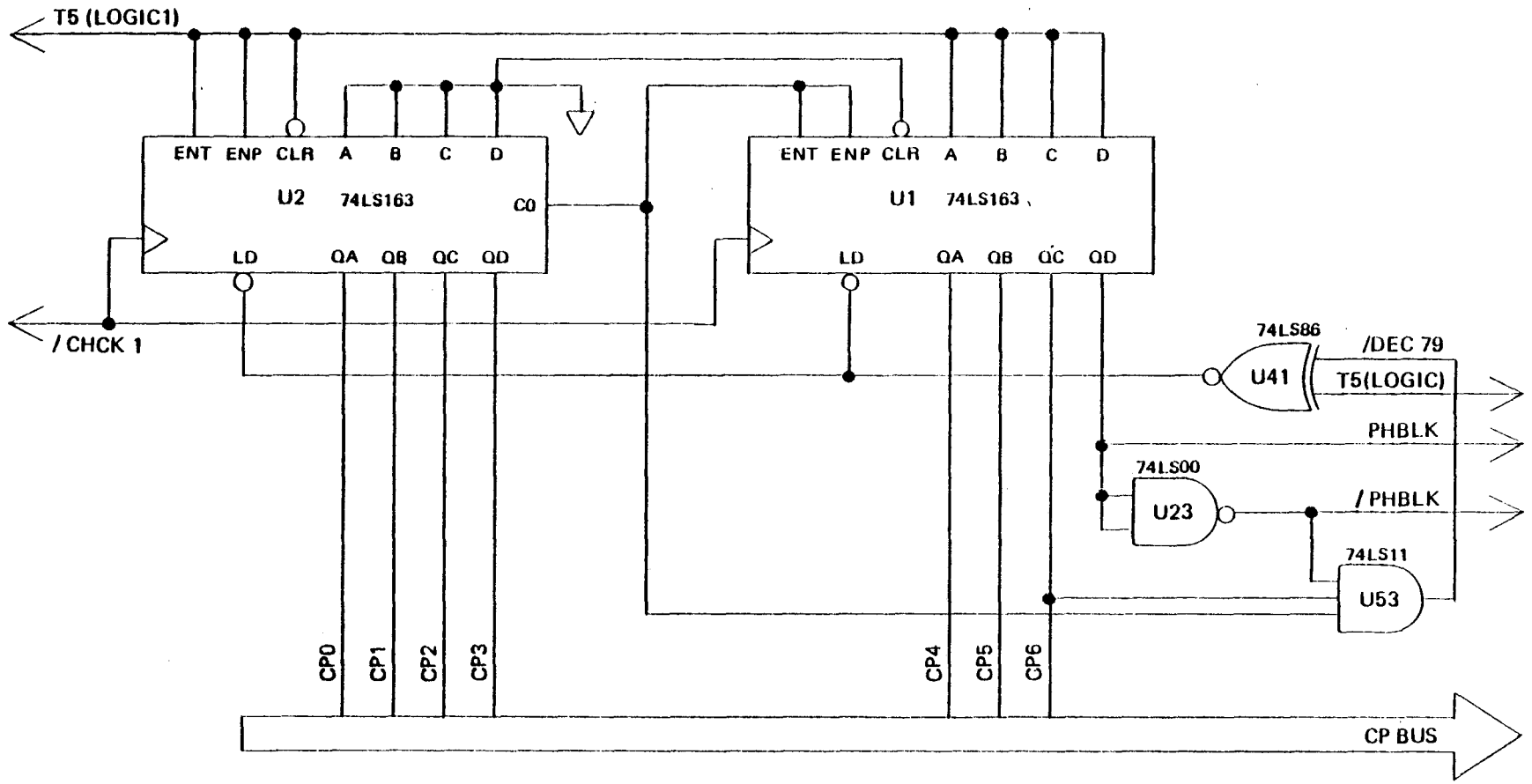



FIGURE III-7 CHARACTER POSITION COUNTER

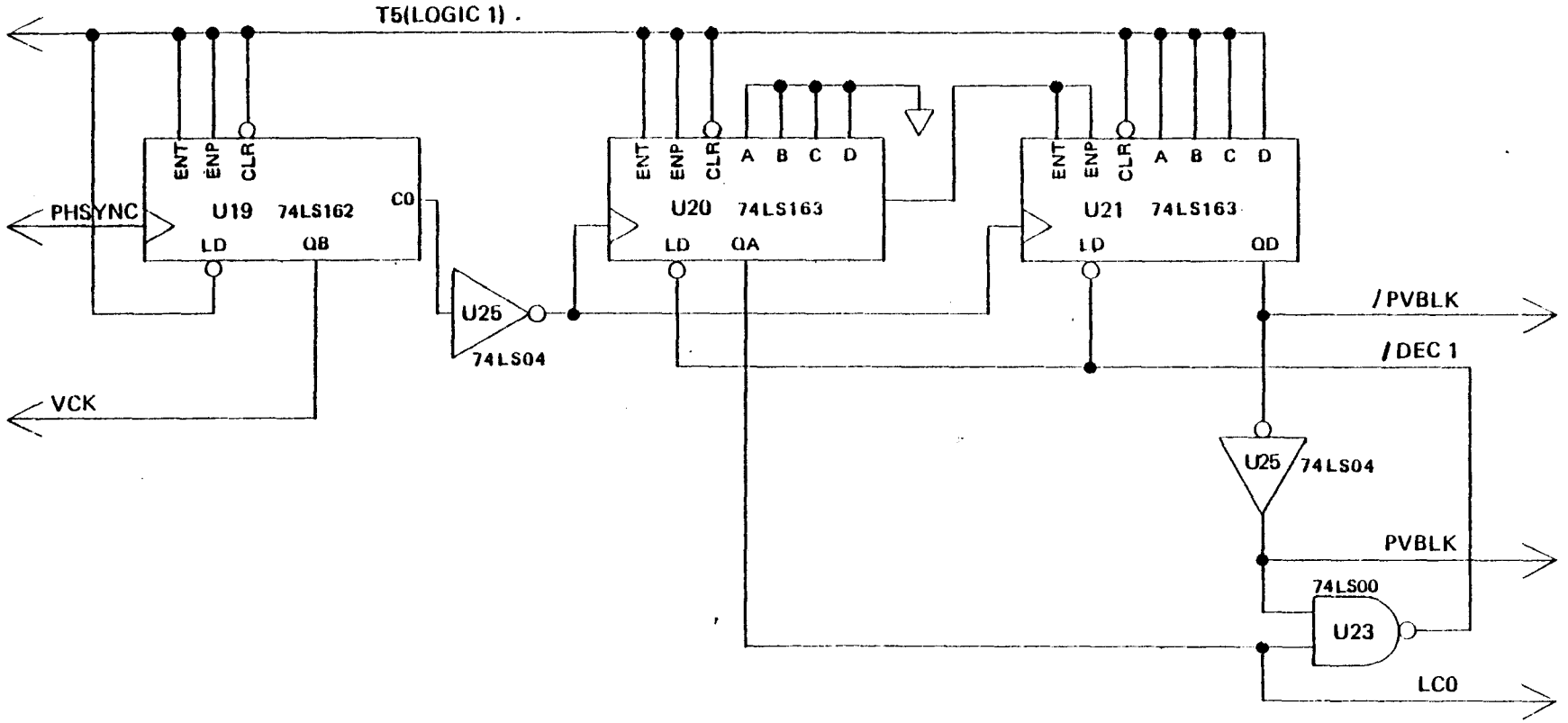



FIGURE III-8 SCAN COUNTER

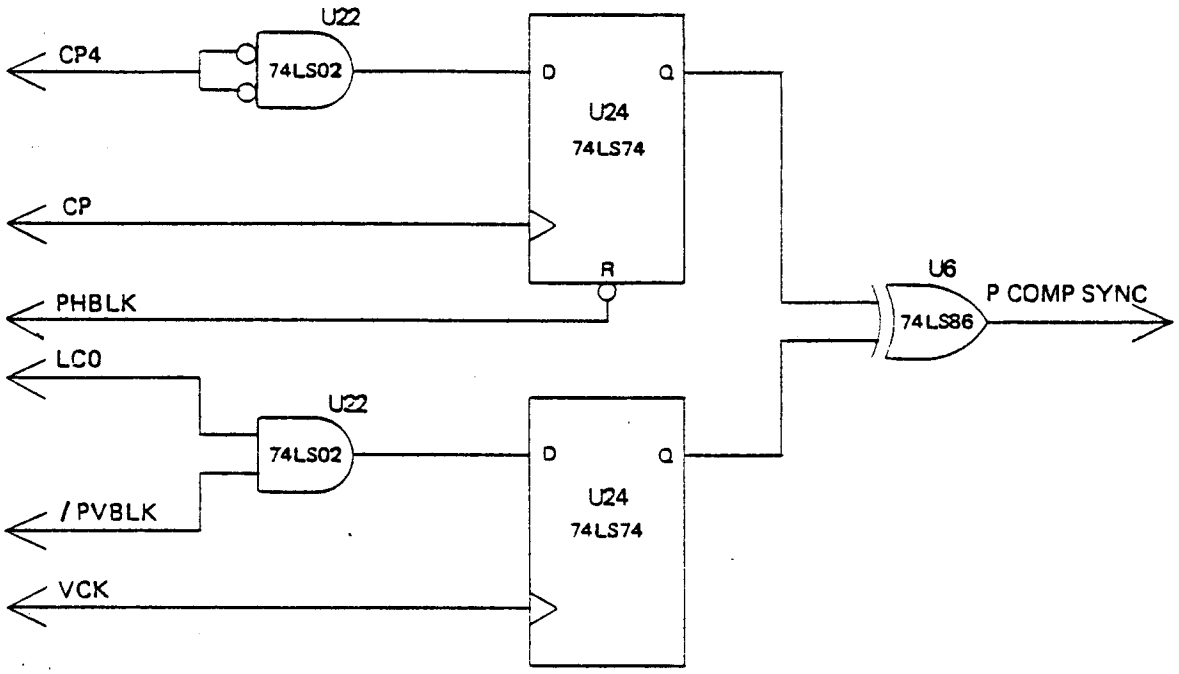



FIGURE III-9 SYNC GENERATION

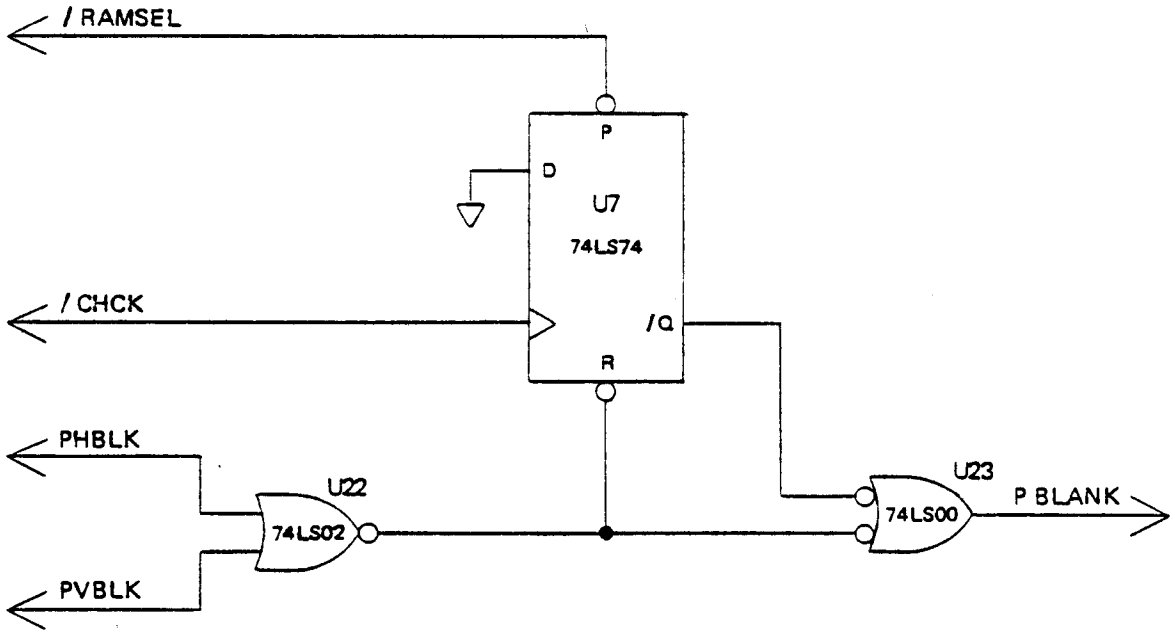



FIGURE III-10 BLANKING GENERATION

between VCK and LC0. The sync pulses are XOR'ed to obtain the composite sync signal PCOMPSYNC. By combining the pulses in this way there is still horizontal sync information available during the vertical sync pulse.

6) BLANKING GENERATION: The horizontal blanking signals (PHBLK and PVBLK) are generated as described above. They are combined in the circuit shown in Figure III-10. In addition this circuit blanks the display when the refresh memory is accessed by the computer. PHBLK and PVBLK are OR'ed with the output of a 74LS74 flip-flop. The flip-flop is set by a computer access of the refresh memory (/RAMSEL low) and is reset by either /CHCK making a low-high transition or by either PHBLK or PVBLK being high. The result is that the circuit output PBLANK is high whenever PHBLK or PVBLK is high and during the short interval when a normally unblanked character is interrupted by a memory access.

b) Refresh Address Circuitry

A significant portion of the VIO's circuitry is associated with providing the refresh memory with appropriate address information via the MA bus. Normally the address provided is the address of the next character to be displayed. The characters are taken in order from memory regardless of screen format. Character addresses are computed from character position in a line, line number and screen format. When the VIO's refresh memory is being accessed by the system, the address on the MA bus is the same as the least significant eleven bits of the system bus. The multiplexing of this address and the character address is obtained using tri-state devices.

1) SCAN/LINE COUNTER: The circuit shown in Figure III-11 is the scan/ line counter. It counts the ten scans in each line and the 12 or 24 lines in each page. The scans are counted by a 74LS162 decade counter operating in its fundamental mode. When a 24 line format is selected the count is advanced once for each raster scan. When a 12 line format is selected the count is prescaled by a 74LS107 J-K flip flop configured as a modulo-2 divider. In this case the count is advanced once for every other raster scan. The outputs of the 74LS162 drive the SCN bus to provide scan number information to the character generator circuitry. The lines of characters on a page are counted by a five bit counter consisting of a 74LS163 and a 74LS107. The outputs of this counter drive the LN bus to provide information for computing character addresses.

2) CHARACTER ADDRESS COMPUTER: The refresh memory address of a character to be displayed is computed from its position in a line, the number of the line and the screen format. The character position counter provides position information via the CP bus. The scan/line counter provides line number information via the LN bus. The screen format is provided by the control signals /L24 and /W80 from the command latch. The four least significant bits of the character address are computed by a linear two to one scaling of the five least significant bits of the CP bus. This is accomplished using 74LS367 tri-state drivers configured as a multiplexor controlled by the line length format (80 or 40 characters). When a 40 character line is selected, bit 3 is inverted for odd numbered lines by XOR'ing this bit with LN0.

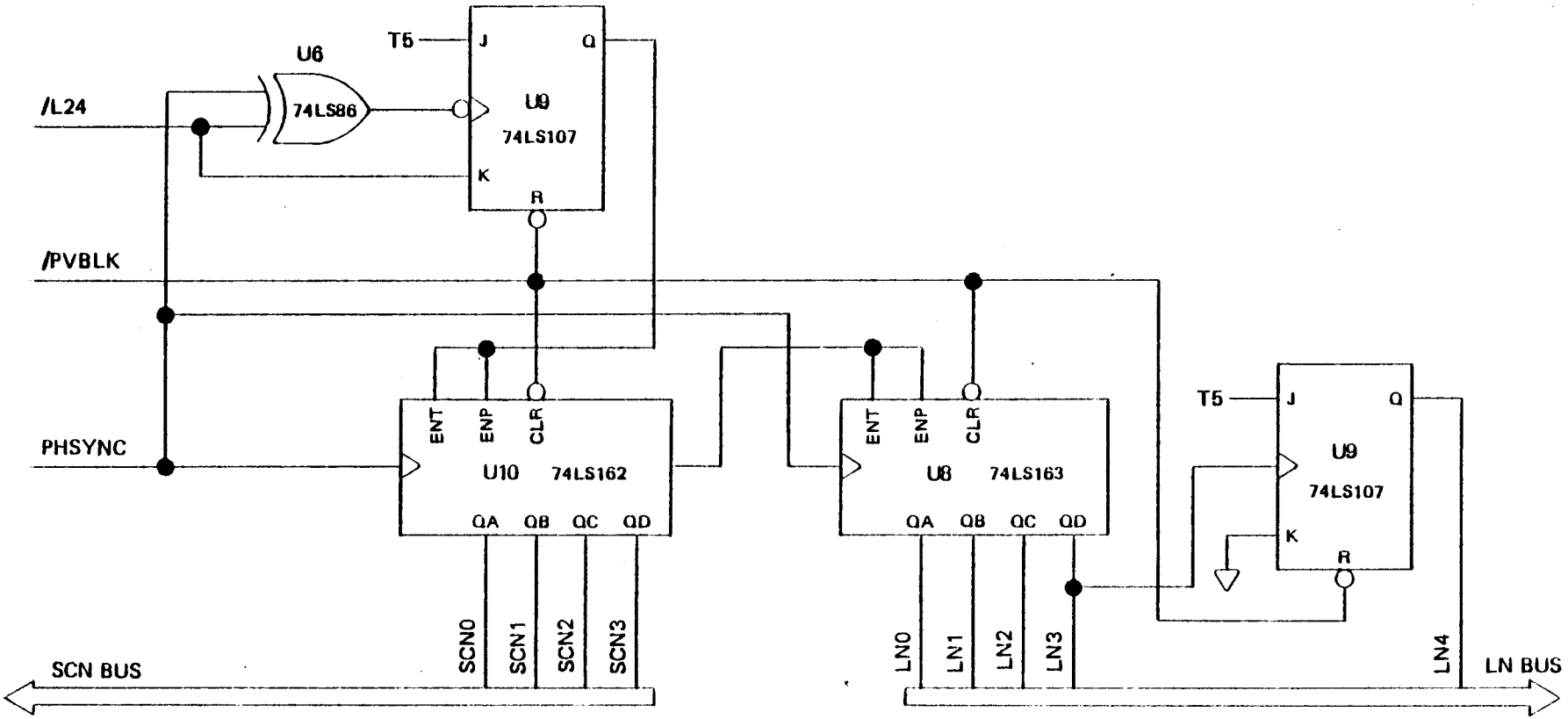



FIGURE III-11 LINE SCAN COUNTER

The high order character address bits are computed using a look-up table implimented in a 512x8 bit PROM.

All of the output structures of the character address computer are tri-state. When the refresh memory is being accessed by the system, all of these outputs are disabled and the MA bus is driven by the system address bus.

### c) CHARACTER GENERATION

The character generation circuitry translates the character codes stored in the refresh memory into the dot patterns which form the desired character. The actual translation is performed using 2308/2708 ROM/EPROM's as look-up tables. The data entered in the table is the encoded character (CH bus) and the matrix row number (SCH bus). The data output is seven bits representing the seven dot positions for a row of that character. The ROM's are configured as a 7x10x256 bit memory with two 74LS32 gate sections and two 74LS04 inverter sections providing select decoding.

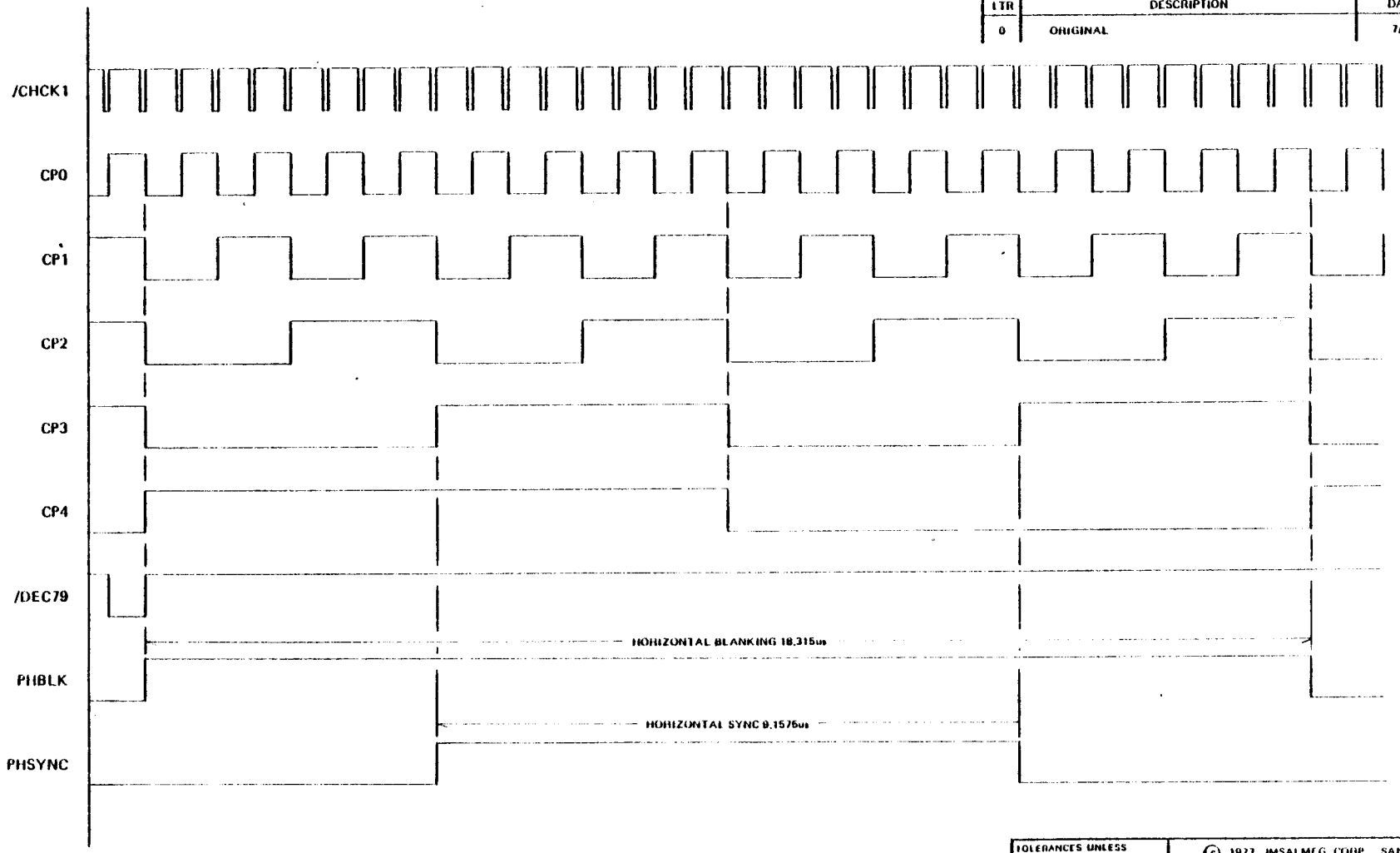
The output of the refresh memory (PCH bus) is first latched in 74LS174 flip-flops. The output of the latch (CH bus) is the encoded character provided to the character generator ROM's. The output of the ROM's is latched by the parallel input of a shift-register (part of video generation circuitry described below). Both latchings are clocked by /CHCK. The intermediate 74LS174 latch is necessary because the total access times of the refresh memory and the ROM's exceed one character time. A side effect of using this technique is that there is a two character time delay from the time when the address of a character is placed on the MA bus to the time when the resulting dot pattern is output by the VIO. As a result, the blanking and sync signals must also be delayed by two character times. This is accomplished using 74LS174 and 74LS74 flip-flops as two bit shift-registers.

### d) VIDEO GENERATION

The video generation circuitry serializes the dot patterns output by the character generation circuitry, combines the resulting video with the blanking and sync signals and outputs the combined video signal to the monitor. The parallel to serial conversion is performed by a 74LS166 shift-register. As described above, the parallel output of the character generator ROM's is latched in the shift-register by /CHCK. The patterns are shifted out, clocked by DCK. This raw-video signal is XOR'ed with CH77, the most significant bit of the encoded character. The resulting signal is used for character-by-character reverse video. The 74LS153 mode data-selector selects either this signal or the raw video. The selected signal is XOR'ed with VIDREV for full-screen reverse video.

The video signal is gated with the blanking signal BLANK by a 74LS32 then combined with the sync signal COMPSYNC in a voltage adder circuict. A common-emmiter 2N3904 amplifier provides the impedance matching for the VIO's 72 ohm output.

| REVISIONS | | | |
|---|---|---|---|
| LTR | DESCRIPTION | DATE | APPROVED |
| 0 | ORIGINAL | 7/77 | |




| TOLERANCES UNLESS OTHERWISE SPECIFIED | |
|---|---|
| FRACTIONS DEC. ANGLES | |
| ± ± ± | |
| APPROVALS | DATE |
| DRAWN | |
| CHECKED | |



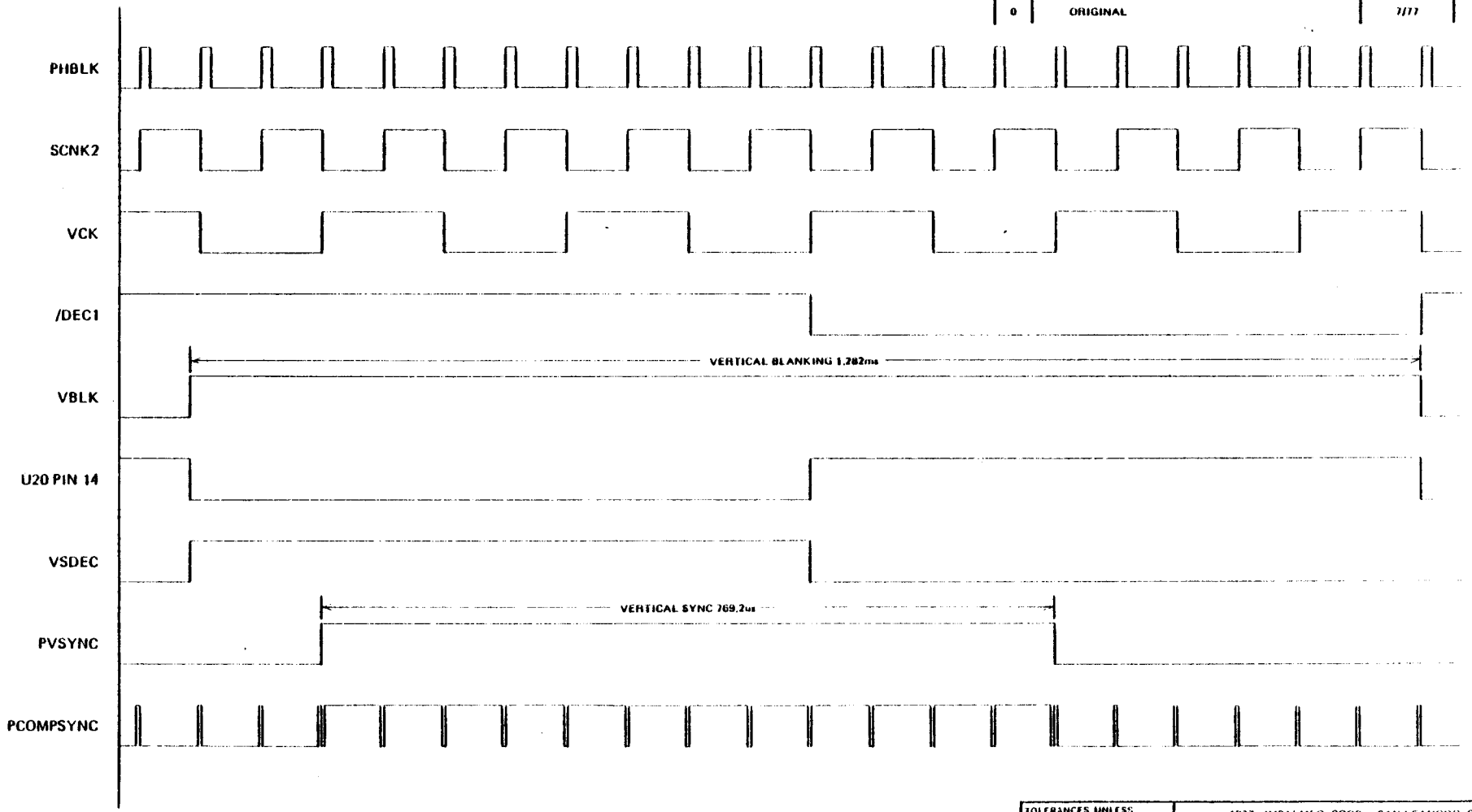
VIO

HORIZONTAL BLANK AND SYNC GENERATION

| SCALE | SIZE | DRAWING NO |
|---|---|---|
| | B | |

DO NOT SCALE DRAWING — SHEET

| REVISIONS | | | |
|---|---|---|---|
| LTR | DESCRIPTION | DATE | APPROVED |
| 0 | ORIGINAL | 7/77 | |




| TOLERANCES UNLESS OTHERWISE SPECIFIED | | |
|---|---|---|
| FRACTIONS | DEC. | ANGLES |
| ± | ± | ± |

| APPROVALS | DATE |
|---|---|
| DRAWN JEB | |
| CHECKED | |



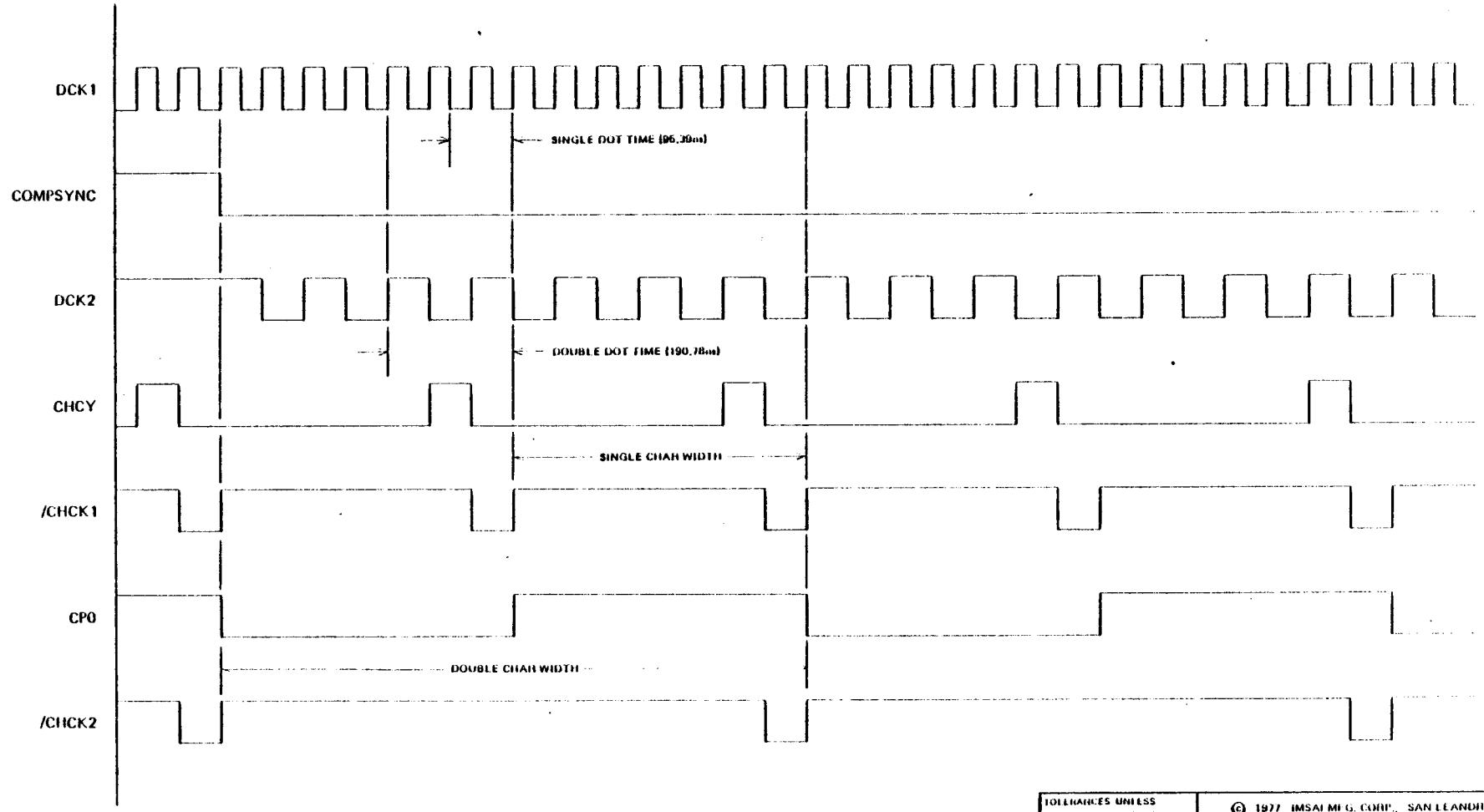
VIO

VERTICAL BLANK AND SYNC GENERATION

| SCALE | SIZE | DRAWING NO. |
|---|---|---|
| | B | |

DO NOT SCALE DRAWING | SHEET

| REVISIONS | | | |
|---|---|---|---|
| LTR | DESCRIPTION | DATE | APPROVED |
| 0 | ORIGINAL | 1177 | |




TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS DEC. ANGLES

| APPROVALS | DATE |
|---|---|
| DRAWN | |
| CHECKED | |



VIO
DOT AND CHARACTER TIMING

| SCALE | SIZE | DRAWING NO. |
|---|---|---|
| | B | |

DO NOT SCALE DRAWING | SHEET

## B. USER GUIDE

### 1. BOARD CONFIGURATION

To properly set-up the VIO board, the board jumpers and switches must be configured for the particular USER application. The board configuration instructions must be followed to insure a properly functioning unit.

SWITCHES 1-8 (SW1)

Switches one through eight are located in position SW1 to the left of U39. Each switch must be set according to the instructions detailed in Steps 1-5 below.

1) Set switches (SW1) 1, 2, 3, and 4 to the OFF position. The VIO board will now occupy the 4K block of memory beginning at address F000 hex.

   NOTE: Switches 1-4 correspond to address bits A12 to A15 respectively. Each switch should be in the OFF position to select a "1", or in the ON position to select a "0" for the appropriate address bit.

2) Set switch 5 (SW1) to the OFF position. The VIOROM firmware is now set to reside in the upper half of the associated 4K block of memory (F800-FFFF).

3) Set SWITCH 6 (SW1) to the ON position. The VIO board will now be selected when either the VIOROM or VIO RAM is being accessed.

TABLE III-1
Address Switches 1-4

| ADDRESS | S1 | S2 | S3 | S4 |
|---|---|---|---|---|
| 0000-0FFF | ON | ON | ON | ON |
| 1000-1FFF | OFF | ON | ON | ON |
| 2000-2FFF | ON | OFF | ON | ON |
| 3000-3FFF | OFF | OFF | ON | ON |
| 4000-4FFF | ON | ON | OFF | ON |
| 5000-5FFF | OFF | ON | OFF | ON |
| 6000-6FFF | ON | OFF | OFF | ON |
| 7000-7FFF | OFF | OFF | OFF | ON |
| 8000-8FFF | ON | ON | ON | OFF |
| 9000-9FFF | OFF | ON | ON | OFF |
| A000-AFFF | ON | OFF | ON | OFF |
| B000-BFFF | OFF | OFF | ON | OFF |
| C000-CFFF | ON | ON | OFF | OFF |
| D000-DFFF | OFF | ON | OFF | OFF |
| E000-EFFF | ON | OFF | OFF | OFF |
| F000-FFFF | OFF | OFF | OFF | OFF |

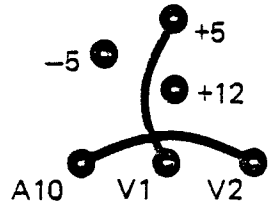



FIGURE III-12 POWER JUMPERS FOR 2316E ROM'S AND 2716/8716 EPROMS

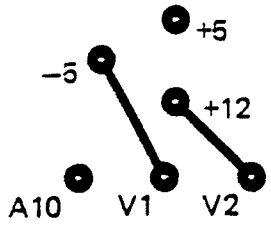



FIGURE III-13 POWER JUMPERS FOR 2308/8308 ROM'S AND 2708/8708 EPROMS

A16/A32/A65

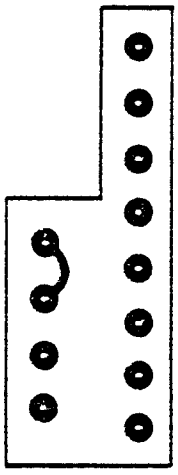
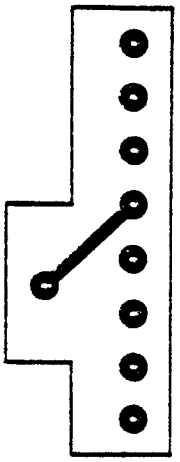


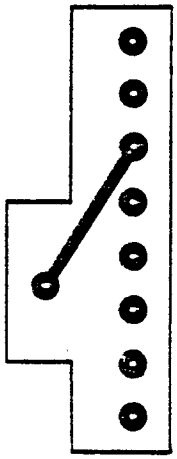
FIGURE III-14 DYNAMIC RAM BOARDS. REMOVE JUMPER FROM A16 TO GROUND <u>ONLY</u> IF USING A16 AS PHANTOM LINE.

FIGURE III-15

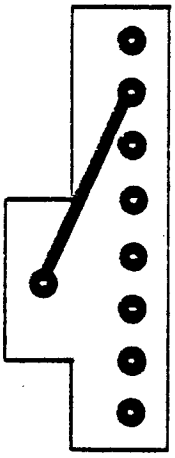
RAM16 B16 JUMPERS



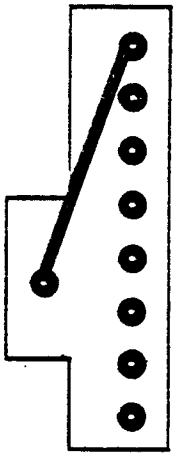
0000-3FFF



4000-7FFF



8000-BFFF

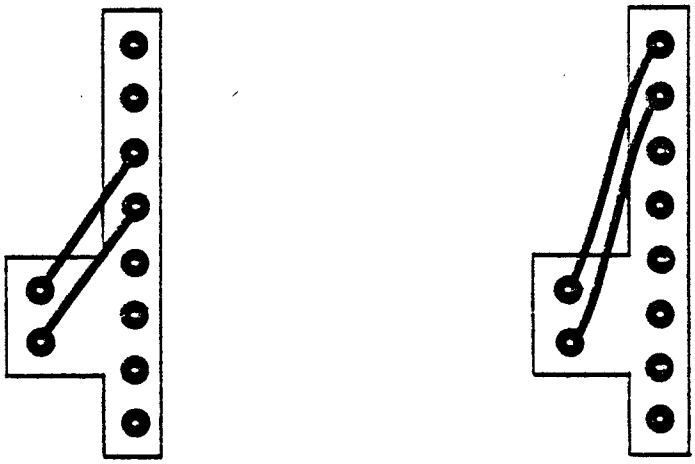


C000-FFFF

NOTE: VIO USING A16 AS PHANTOM LINE MUST BE INSTALLED.

FIGURE III-16

RAM 32 B32 JUMPERS

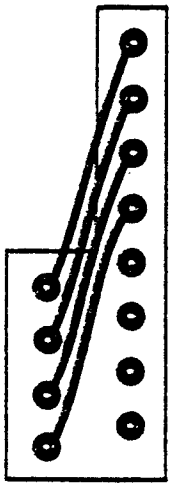


0000-7FFF

8000-FFFF

NOTE: VIO USING A16 AS PHANTOM LINE MUST BE INSTALLED.

FIGURE III-17
RAM 65 865 JUMPERS



0000-FFFF

NOTE: VIO USING A16 AS PHANTOM LINE MUST BE INSTALLED.

4) Set SWITCH 7 (SW1) to the OFF position. The VIO memory will now operate with no WAIT states.

   If it is desired to insert WAIT states into every VIO memory access, set SWITCH 7 to the ON position. Note that the memory devices supplied by IMSAI do not require WAIT states.

5) SWITCH 8 is not used and should be disregarded.

JUMPERS

The board jumper areas are clearly marked both on the board and on the Assembly Diagram. Each jumper area must be configured as required in Steps 6-9 below. Note that assembled VIO's are shipped with the jumpers described in Steps 6 and 7 installed.

6) Connect a jumper between pads "PH" and "B". This will allow the VIO memory to be accessed on the trailing edge of the processor status strobe (as required by 8085 type CPU's).

7) Connect jumpers V1 and V2 as shown in Figures III-12 AND III-13 for the particular type of ROM device used at U46.

   CAUTION!! Incorrect connection of jumpers V1 and V2 may cause damage to the ROM. Make certain that these jumpers are correct for the type of ROM used before applying power to the board. Only the following types of EROM/ROM's may be used at location U46: 2708, 2308, 2716 or 2316E. Do not attempt to use any other types of ROM/EROM devices or damage to the device will result.Ensure that the jumpers do not short to each other, to any board traces, or to any IC pins.

8) If IMSAI RAM-16, RAM-32 or RAM-65 memory boards are not used in the system, leave jumper area "F" open.

   If it is desired to allow the VIO Board to coexist with a full 65K of memory, consisting entirely of RAM-16's, RAM-32's, or a RAM-65 Board, install a jumper in Jumper Area "F", from the pad labelled "F" to the pad labelled "A16". On each memory board, install the jumper shown in Figure III-14, in the A16, A32, or A65 Jumper Area. Re-address each memory board to reside in the second 65K using the jumpers shown in Figures III-15, III-16, and III-17 (B16, B32, or B65 Jumper Areas).

   NOTE: The memory boards are now configured to reside in the second 65K memory space. The VIO will disable the memory boards using address line A16 whenever the VIO is accessed. (A19 may be used in place of A16 if it is so desired). Note that in this configuration, if the VIO is removed from the system, the memory boards will not be accessible unless provision is made to externally drive A16.

9) If an IMSAI IMM board is not being used in the system, Jumper Areas C and D should be disregarded.

If an IMM board is being used, the VIO board may be addressed to reside in the top 65K of the Megabyte Address Space. To do this, cut the two traces connecting the pads labelled "C" and "D" to the pads labelled A15 and A14 respectively. Then install a jumper between the pad labelled "AA15" and the pad labelled "C". Also install a jumper between the pad labelled "AA14" and the pad labelled "D". Install a jumper at location "M".

Refer to the IMSAI IMM Documentation for further details.

## 2. VIO OPERATION WITH VIOROM

The VIOROM contains two separate and distinct programs. The first is a firmware driver which will allow a user program to easily control all VIO functions and screen displays, (new releases of IMSAI Software will include provisions for using the VIOROM Firmware). The second is a complete system monitor program, IMSAI VDP-80, which gives the user a number of extremely useful memory and input/output functions when the VIO and monitor are used with a keyboard or other input device.

Since operation with the VIOROM depends upon the Users application, the User may proceed in one of three ways. If it is desired to use the display functions of the VIO with existing User Software, proceed to "VIO Firmware Driver". If it is desired to exercise the display functions of the VIO and VIOROM Firmware Driver, proceed to "VIO Test Routine". If it is desired to operate the VIO as an Intelligent Video Terminal, proceed to VDP-80 Monitor.

a) VIO Firmware Driver

The VIO firmware driver can be called from the user program whenever it is desired to initialize the VIO, place a character on the screen display, or execute a control sequence.

1) SCREEN INITIALIZATION: To initialize the VIO, the user program should CALL the INITIALIZATION ENTRY POINT at F800 H. The firmware will then

clear the screen
put the cursor in the upper left corner (HOME)
select an 80x24 screen format
select UPPER CASE display (ASCII text mode)
activate the screen scroll mode

Following the initialization routine, control will return to the user's calling program.

2) CHARACTER DISPLAY: To display a character on the screen, the user program must CALL the CHARACTER OUT entry point, F803H, with the character code (for the character to be displayed), in the Accumulator. Prior to the CALL, the stack must contain at least 30 bytes of available STACK SPACE. Once the character has been displayed, control will return to the user's calling program with none of the registers or status bits affected.

A list of character codes appears in Appendix 1.

The characters which may be displayed on the screen will depend entirely on the mode of operation selected by the user: ASCII text mode, extended text mode, or graphic

mode. These modes are selected with the ESCAPE SEQUENCES, described in the next section.

Note: characters may also be displayed by directly accessing the refresh memory (as described in section III-A,6-b).

ASCII TEXT MODE: When the ASCII Text Mode is selected, any of the 96 characters represented by the character codes 20-7F H (see Appendix 1) may be displayed through the firmware. This includes the standard 96 character ASCII set (upper and lower case plus punctuation). Character-by-character reverse video is available and both CONTROL CHARACTER COMMANDS and ESCAPE SEQUENCES will be accepted.

To display a character in the ASCII Text Mode, the User program must CALL the Character Out Entry Point, F803 H. Prior to the CALL, the lower 7 bits of the Accumulator must contain a valid ASCII Text Character Code. Bit 7 of the Accumulator will act as the character-by-character reverse video flag (0=positive video, 1=reverse video).

Displayable ASCII Text Character Codes consist of the lower 7 bits of CODES 20-7F H listed in Appendix 1. Note that these codes correspond to the standard 7 bit ASCII Codes 20-7F H.

For example, if we wanted to display an ASCII "1" in positive video, we would CALL the Character Out Entry Point, F803 H, with the code 31 H in the Accumulator. The same code, with bit 7 "on" would cause the ASCII "1" to be displayed in reverse video. Thus if the Accumulator contained a B1 H, the ASCII "1" would be displayed as a dark character on a light background (reverse video).

Note that character codes 00-1F H are not displayable through the firmware (in the ASCII Text Mode). However, they may be displayed by directly accessing the VIO's refresh memory (III-A,6-b).

In most cases, existing User Software may easily be modified to be used with the VIO.

1. Locate the output driver routine.
2. Substitute a CALL to the Character Out Entry Point (CALL F803 H), for the status port input instruction (directly preceding the output instruction to the terminal device).
3. Ensure that the character to be output, is in the Accumulator prior to the CALL.
4. "NOP" out the rest of the driver up to but not including any RET instruction.

For example, suppose the existing output driver appears as follows:

```
1950  DB 03      TOUT     IN   TTY+1        ;GET STATUS
1952  1F                   RAR               ;TEST IF READY
1953  D2 50 19             JNC  TOUT         ;LOOP IF NOT RDY
1956  F1                   POP  PSW          ;GET CHAR
1957  D3 02                OUT  TTY          ;OUT TO TERMINAL
1959  C9                   RET
```

This driver may be modified to be used with the VIO firmware as follows:

```
1950  F1                   POP  PSW          ;GET CHAR
1951  CA 03 F8             CALL VIO          ;DISPLAY CHAR
1954  00                   NOP
1955  00                   NOP
1956  00                   NOP
1957  00 00                NOP!NOP
1959  C9                   RET
```

EXTENDED TEXT MODE: When the Extended Text Mode is selected, any of the 96 graphic characters, represented by the character codes C0-FFH (see Appendix 1) may be displayed through the firmware. Character-by-character reverse video is available and both CONTROL CHARACTER COMMANDS and ESCAPE SEQUENCES will be accepted.

To display a character in the Extended Text Mode, the User program must CALL the Character Out Entry Point (CALL F803 H). Prior to the CALL, the lower 7 bits of the Accumulator must contain a valid Extended Text Character Code. Bit 7 of the Accumulator will act as the character-by-character reverse video flag (0=positive video, 1=reverse video).

Displayable Extended Text Character Codes consist of the lower 7 bits of Codes A0-FF H listed in Appendix 1. Note that Codes A0-FF H correspond to a partial block drawing and a complete line drawing graphic character set. This set is a subset of the one available in the Graphic Mode, and it is fully explained in the Graphic Mode section (below).

For example, if we wanted to display in positive video, the vertical line segment represented by the Code C5 H in Appendix 1, we would CALL the Character Out Entry Point F803 H, with a 45 H in the Accumulator. The same Code with bit 7 "on" would cause the character to be displayed in reverse video. Thus if the Accumulator contained a C5 H, the vertical line segment would be displayed as a dark character on a light background (reverse video).

Note that Codes 80-9F H are not displayable through the firmware (in the Extended Text Mode). However, they may be displayed by directly accessing the VIO's refresh memory (Section III-b,3).

While the Extended Text Mode currently allows graphic characters to be displayed, it is ideally suited for the display of foreign language fonts. This would require the upper half of the character generator PROM's to be appropriately reprogrammed.

GRAPHIC MODE: When the Graphic Mode is selected, any of 255 ASCII and graphic characters may be displayed (codes 00-1A H and codes 1C-FF H). The character codes appear in Appendix 1.

While this mode allows both ASCII and graphic characters to be displayed, it does not allow the use of character-by-character reverse video. Any new CONTROL CHARACTER COMMANDS will not be accepted. Any CONTROL CHARACTER COMMANDS in effect prior to the entry into the Graphic Mode will remain valid and will still affect character display. ESCAPE sequences will be accepted and provide the only means of control when in the Graphic Mode.

To display a character in the Graphic Mode, the User program must CALL the Character Out Entry Point F803 H. Prior to the CALL, the Accumulator must contain a valid 8 bit Graphic Character Code.

All Codes 00-FF H (listed in Appendix 1) are displayable in the Graphic Mode, with the exception of Code 1B H. The character codes 00-1F H correspond to 32 special characters. The character codes 20-7F H, correspond to the standard ASCII codes 20-7F H. The characters represented by the codes 80-FF H, comprise a complete line drawing and block drawing graphics set.

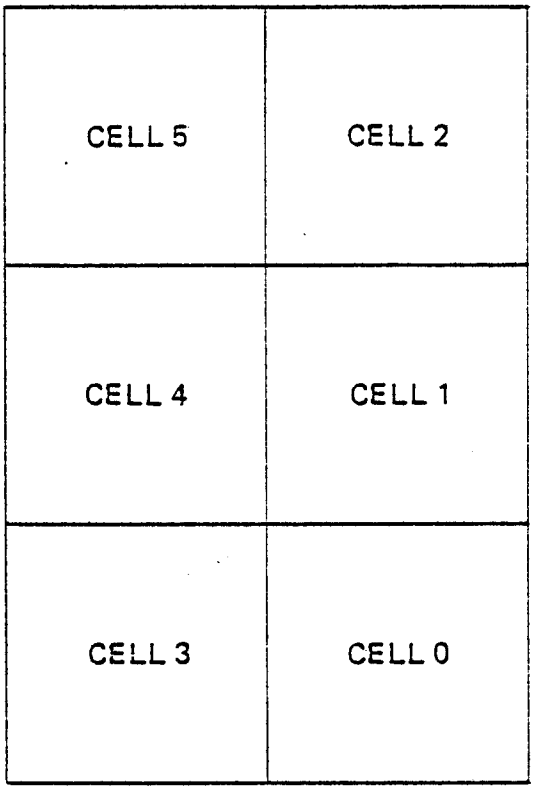
For example, if we wanted to display an ASCII "A", we would CALL the Character Out Entry Point, F803 H, with a 41 H in the Accumulator. Similarly, if we wanted to display the line segment represented by the Code C1 in Appendix 1, we would CALL the Character Out Entry Point F803 H, with a C1 H in the Accumulator.

Note that Character Code 1B H is not displayable through the firmware (in the Graphic Mode). However, it may be displayed by directly accessing the refresh memory (Section III-b,3).

Codes 80-BF H correspond to the Block Drawing Graphic Set. The display grid for this set uses a 7x10 dot matrix font, equally divided into 6 cells or display areas as shown in Figure III-18. The characters in the Block Drawing Set consist of the patterns formed by using these six cells in various combinations. Bits 0-5 of the character codes 80-BF H correspond to the six display cells as shown in Figure III-18. A "one" in any of these bit positions will cause the corresponding cell to be used in the display character. For example, if it is desired to display the character formed by using cell 0 and cell 2, the character code will contain a "1" in bits 0 and 2. Bits 1, 3, 4, and 5 will be "0", since cells 1,3,4, and 5 are not used in the display character. Since bit 6 is a "0" and bit 7 is a "1" for all Block Drawing Characters, the resultant character code is B5 H (10000101).

Codes C0-FF H correspond to the Line Drawing Graphic Set. The display grid for this set uses the 7x10 dot matrix font to create the six line segments shown in Figure

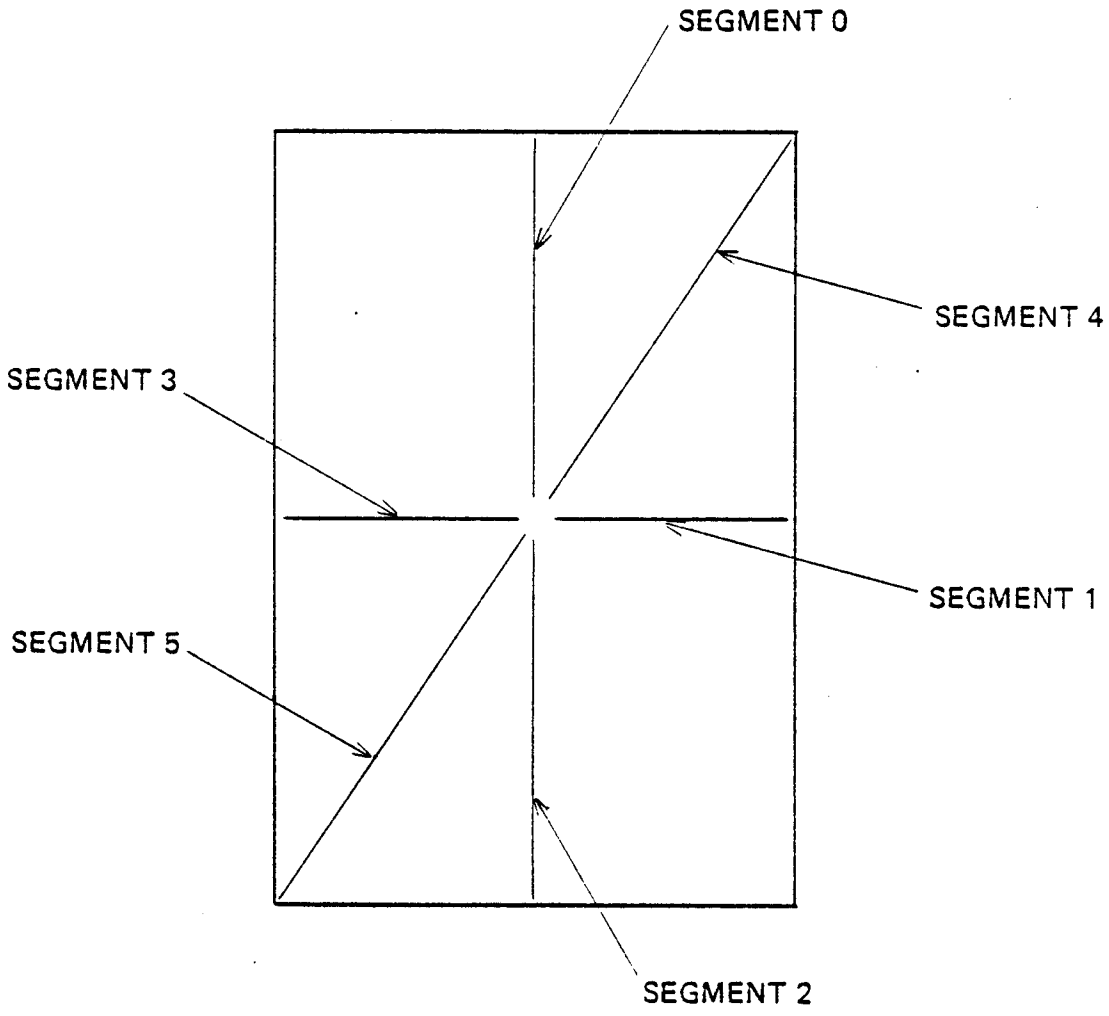
FIGURE III-18 THE CHARACTER CODE – DISPLAY RELATIONSHIP FOR THE BLOCK DRAWING GRAPHIC SET




| 1 | 0 | CELL 5 | CELL 4 | CELL 3 | CELL 2 | CELL 1 | CELL 0 |
|---|---|---|---|---|---|---|---|

CHARACTER CODES 80–BF H.

FIGURE III-19 THE CHARACTER CODE – DISPLAY RELATIONSHIP FOR THE LINE DRAWING GRAPHIC SET




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | 1 | SEGMENT 5 | SEGMENT 4 | SEGMENT 3 | SEGMENT 2 | SEGMENT 1 | SEGMENT 0 |

CHARACTER CODES C0–FF H.

III-19. The characters in the line drawing set consist of the patterns formed by using these six line segments in various combinations. Bits 0-5 of the character codes C1-FF H, correspond to the six display segments as shown in Figure III-19. A "one" in any of these bit positions will cause the corresponding segment to be used in the display character. For example, if it is desired to display the character formed by using segments 1 and 2, the character code will contain a "1" in bits 1 and 2. Bits 0, 3, 4, and 5 will be "0", since segments 0, 3, 4, and 5 are not used in the display character. Since bit 6 is "1" and bit 7 is "1", for all Line Drawing Characters, the resulting character code is C6 H (11000110).

3) CONTROL SEQUENCES: There are two basic methods of controlling or modifying VIO operations: CONTROL CHARACTER COMMANDS and ESCAPE SEQUENCES.

## CONTROL CHARACTER COMMANDS

To execute a CONTROL CHARACTER COMMAND, the user program should CALL the CHARACTER OUT entry point at F803 H, with the desired control character in the Accumulator. Prior to the CALL, the stack must contain at least 30 bytes of available stack space. Following the execution of the command, control will return to the user's calling program with none of the registers or status bits affected. Note that CONTROL CHARACTER COMMANDS will not be accepted when operating in the Graphics Mode.

| | |
|---|---|
| Carriage Return (0DH) | causes the cursor to return to position 1 of the current line and forces the overwrite mode. |
| Line Feed (0AH) | causes the cursor to move one line down in the same column position |
| Up Cursor (0BH or CTRL-K) | causes the cursor to move one line up in the same column position |
| Forward Cursor (0CH or CTRL-L) | causes the cursor to move non-destructively to the right one position. An auto line feed/ carriage return occurs at the end of the line. |
| Back Cursor (08H or CTRL-H) | causes the cursor to move non-destructively to the left one position. The cursor will not move past position 1. |
| Home Cursor (1EH or CTRL- ) | Moves cursor to column 1, row 1 |
| Erase Screen (1AH or CTRL-Z) | Fills screen with blanks and homes cursor. |
| Clear to end of Field (15H or CTRL-U) | Clears the characters from the cursor to the end of the line or until the existence of the first protected character, whichever comes first. |

| | |
|---|---|
| Tab<br>(09H or CTRL-I) | Causes the cursor to move to the next tab stop that is not within a protected field or the first unprotected character following the next protected field or the home position, whichever comes first. |
| Delete Character<br>(7FH or rubout) | Removes the character under the the cursor by shifting the remainder of the line one place to the left. The right-most character is filled with a blank. |
| Insert Mode<br>(14H or CTRL-T) | Toggles the system in and out of the insert mode. In the insert mode, any character entered at the cursor causes the remaining characters of the line to be shifted to the right one place. The last character on the line is lost to the bit bucket. When not in the insert mode, the system is in the overwrite mode. In the overwrite mode any new character output just overwrites any previous character in that position. |
| Delete Line<br>(04H or CTRL-D) | Deletes the current line indicated by the cursor by moving all lines below the current line up one line and filling in the last line with blanks. The cursor is returned to the beginning of the line. |
| Enter Line<br>(05H or CTRL-E) | All lines from the current line to the end of the screen are moved down one line with the last line being lost to the bit bucket. The former current line is then blanked and the cursor returned to position 1. |
| Protect Fields/Unprotect Fields<br>(10H or CTRL-P) | All inverted characters currently existing or subsequently entered are treated as protected fields when the protect mode is active. When inactive, there is no significance to the inverted video other that visual. When protected, these fields will not allow entry of data in most cases and affect such things as Tabs, and cursor control. |

## ESCAPE SEQUENCES

To execute an ESCAPE SEQUENCE, the User program should successively place each Escape Sequence character in the Accumulator and CALL the CHARACTER OUT entry point at F803 H. All Escape Sequences begin with the ESCAPE character 1B H, followed by the appropriate character or characters listed below. Following the execution of the Escape Sequence, control will return to the User program, with none of the registers or status bits affected.

| | |
|---|---|
| Set/Clear Tab (49H or "I") | Set a Tab stop at the current cursor position or clear an existing tab stop at current cursor position. |
| Clear All Tabs (09H or CTRL-I) | Unconditionally clear all all Tab positions |
| ASCII Text Mode (54H or "T") | Standard ASCII Text Mode allows for the display of the 96 character ASCII set (upper and lower case with punctuation). Character codes 20-7F H may be displayed (see Appendix 1). Character-by-character reverse video is available in this mode. |
| Extended Text Mode (45H or "E") | Extended Text mode currently allows for the display of 96 graphic characters but could be used to display foreign language fonts (when the upper half of the character generator ROMs are appro-priately programmed). Character codes A0-FF H may be displayed (see Appendix 1). Character-by-character reverse video is available in this mode. |
| Graphic Mode (47H or "G") | Graphic Mode allows 255 ASCII and graphic characters to be displayed. Codes 00-1AH and Codes 1C-FF H may be displayed (see Appendix 1). Character-by-character reverse is NOT available in this mode. Note that new Control Character Com-mands will not be accepted, however, escape sequences will be accepted. |

| | |
|---|---|
| Scroll Mode Toggle (53H or "S") | Alternately places the screen mode scroll or wrap-around mode. The Text or Extended Text Modes default to the scroll option while the Graphic Mode defaults to the Wrap-around Option. Note that the scroll option may not be used in the Graphic Mode. |
| Upper/Lower Case Toggle (55H or "U") | Alternately selects the Upper case only or Upper/Lower case display. Defaults to Upper Case only. |
| Inverse Video Toggle (56H or "V") | Alternately selects positive video (white characters on a black background) or inverse video (black characters on a white background). Default is positive video (white on black). |
| Lines Per Page Toggle (4CH or "L") | Alternately selects 12 line pages or 24 line pages. Default is 24 line pages. |
| Columns per Line Toggle (43H or "C") | Alternately selects 40 column lines or 80 column lines. Default is 80 column lines. |
| Addressable Cursor (=YX) | Places the cursor at the position defined by y-axis (line number) and X-axis (column number). Y-axis and X-axis position codes may be determined from Appendix 2. |

b) VDP-80 Monitor

The monitor program allows the VIO to operate as an intelligent terminal when used with an ASCII encoded keyboard or other suitable ASCII encoded input device. It allows for keyboard control of all VIO firmware and hardware features and provides a number of extremely useful memory and I/O commands.

1) INPUT DEVICES

The VDP-80 monitor commands allow for the use of a keyboard, cassette recorder and a paper tape reader. It is ideally suited for use with the IMSAI MIO board.

1) To use the monitor, an ASCII encoded keyboard or other suitable ASCII encoded input device must be used. Configure the input interface (MIO) so that input data appears on Port 02H. The input interface (MIO) must also be configured to drive Bit 1 of Port 03H with an input data ready or input data available signal.

2) If the cassette commands are to be used with an IMSAI MIO cassette port, configure the MIO cassette port so that cassette data appears on Port 00H. Configure the cassette status so that Bit 2 of Port 03H is driven by the cassette data ready or cassette data available signal.

3) If the paper tape command is to be used with a Teletype device, configure the input interface (MIO) so that the teletype input data appears on Port 02H. Configure teletype status so that Bit 1 of Port 03H is driven by the input data ready or input data available signal.

2) MONITOR OPERATION

1) The monitor ENTRY POINT is located at F806H. The display will come-up in the default mode:

40x12 screen format
Upper case only
ASCII Text Mode
Screen Scroll Mode

2) Any time a Hex parameter is requested from the user, any number of hex digits will be accepted, but only the last 4 (if a 16 bit value is requested) or the last 2 (if an 8 bit value is requested) will be used. The user may use any type of field delimiter (i.e., ",", "b", ";", etc.).

## 3) MONITOR COMMANDS

The following is a list of valid VDP-80 commands. In all cases the symbol @ represents CARRIAGE RETURN.

### DISPLAY MEMORY

D@
D<start>@
D<start>,<end>@

Display the contents of the memory locations beginning at the start address (or 0 if not specified) and continuing until the end address if specified. If no end address is specified only one single location will be displayed.

### EXAMINE AND MODIFY MEMORY

E<addr>@ [XX]@

Display the contents of memory location addr. The user then has four options:

a. hitting the space bar will display the next successive location;

b. hitting the minus key (-) will display the previous location;

c. hitting carriage return will terminate the operation; or

d. entering 2 or more valid Hex characters (followed by 1, 2, or 3 above) will modify memory as entered and perform 1, 2, or 3 above.

### FILL MEMORY

F<start>,<end>, XX@

Fill memory from starting address through ending address inclusive with specified XX byte.

To Zero all of memory the following could be used (do not zero refresh memory on VIO): F0,EFFF,0@

## MOVE MEMORY

M<start>,<end>,<dest>@

Move the block of memory starting at start address through end address to the destination address. The move occurs byte by byte from low memory to high memory. Hence, the following command will fill memory locations 100-1FF with the same byte that is at location 100:

M100,1FE,101@

## SEARCH MEMORY

S<start>,<end>,<16 bit value>,<16 bit mask>@

Search memory from starting address through ending address for all instances of 16 bit values which, when ANDed with the specified mask yield the 16 bit specified value. If no mask is specified, FFFF is assumed which implies a full 16 bit compare.

EXAMPLE: You have a version of BASIC in memory locations 0-1FFF and wish to locate the status input instructions so you can locate and modify the output driver for use with the VIO.

S0,1FFF,DB03@ will print the address and contents of all memory locations which contain DB03.

It should be noted that specifying less than 4 digits in the value, or mask, might produce unexpected results since all inputted hex values are left padded with zeros.

## VERIFY MEMORY

V<start>,<end>,<dest>@

Do a byte by byte compare from start through end to the destination. Print each pair of bytes which are not identical in the 2 strings.

## PROTECT/UNPROTECT RAM 4A MEMORY

P<start>,<end>@
U<start>,<end>@

Protects all 1K blocks of memory (RAM 4A-4 only) which fall within the specified memory addresses. Any 1K blocks which overlap the boundary will also be protected.

## JUMP TO MEMORY

J<start>@

Jump to memory at location start.

## CALL MEMORY

C<start>@

Push the start address of the monitor on the stack and jump to memory address start. If the program entered does not alter the stack and terminates with a Return instruction, the monitor will be properly re-entered.

## PERFORM DIRECT I/O

I<port #>@
O<port #>,XX@

Input or output from/to the specified port #. If input then display the resulting 8 bit value on the VIO. If output then output the specified value.

This instruction causes an IN (DB) or OUT (D3) instruction with the appropriate port # to be stuffed into RAM in the MPU-B memory and then called.

| Loc | Inst | |
|---|---|---|
| 10FA | DB or D3 | IN or OUT |
| 10FB | XX | Port # |
| 10FC | C9 | RET |

The contents of memory locations 0, 1, and 2 will therefore be destroyed. The following command will change the RAM direct I/O ptr:

Y<addr>@

The address specified will now be used along with addr+1 and addr+2.

## MEMORY DIAGNOSTIC

T@
T<start>,<end>@

Test memory from start address to end address. Every memory cell is cycled through all 256 bit patterns and tested to see if it contains the correct pattern. If all memory within the specified range is good, a prompt "?" will appear. If a bad cell or non-existent cell is located, the following display will occur:

AAAA VV SS

where: AAAA is the bad address
VV is the value in the memory
SS is what the value should be

Using the form T@ begins the memory test at location 0 and continues until the first bad cell, non-existent cell, or ROM memory is found.

The memory diagnostic DOES NOT destroy the contents of the memory tested.

## GENERATE SYNC STREAM

G@

## ADJUST AND ALIGN CASSETTE RECORDER

A@

## EXEC FROM CASSETTE FILE

X@
X<start>,<end>,<exec>@

This command is identical to the Load command except that after the file is loaded it is CALLED at its execution address. If the program called does not change the stack ptr and returns properly, the monitor will be re-entered upon return.

## LOAD INTEL HEX PAPER TAPE

H@

Reads characters from port 2 expecting to find a file in the Intel HEX format. If found, it is loaded at the specified address contained in the file itself. If a checksum error is detected in loading, a "C" will appear. If an

invalid character is detected, a "T" will appear and the operation will be terminated.

The input drivers are set up to read an MIO or SIO jumpered so the status appears on port 3 with bit 1 going high when data is available. The data should appear on port 2. This is the configuration which would be required if a teletype were being used for input.

## LOAD CASSETTE FILE

L@
L<START>,<END>,<EXEC>@

This routine allows the user to load an object file (Type 81H) from cassette. Cassette files generated by IMSAI or by TCOS (Tape Cassette Operating System) may be loaded with this command.

All Type 81H files created by IMSAI or TCOS have a header record in front containing the file name (up to 5 characters), the starting memory address, the ending memory address, and an execution address which is often the same as the starting address. By typing in the L@ command, the user is effectively saying, "Load the next headered file into the memory address specified in the header."

By typing in the "L start, end, exec@" command, the user is saying, "load the next type 81 file whether headered or not using the start, end addresses specified in the command itself.

After the command is entered, the cassette recorder should be started. If a header is encountered, the name of the file to be loaded will be displayed. If no starting and ending addresses were specified, they will be read from the header. If an error is discovered in the header, an "I" initialization error will appear and the operation terminated.

All files created by IMSAI or TCOS block their records into 128 (80H) byte records. As the loader loads the object file, an indicator, "*", is displayed after each record is loaded to indicate a good load or a checksum error, "C", for that particular record.

After the entire file has been loaded, the starting address, ending address, and execution address of the file just loaded will be displayed. If at any point, an incorrect file type is encountered, a "T" for type code error will be displayed and the operation terminated.

CAUTION: DUE TO TIMING CONSIDERATIONS, THE VIO MUST NOT BE ALLOWED TO SCROLL DURING A LOADING FROM CASSETTE. THEREFORE THE SCREEN SHOULD BE ERASED (CTRL-Z) BEFORE KEYING IN THE LOAD COMMAND.

## BOOT FROM FLOPPY DISK

B@

## READ FROM DISKETTE

R<tt,ss,bbbb,u>@

where:

tt = track
ss = sector
bbbb = buffer address
u = unit

Track and sector must be specified; buffer and unit specifications are optional.

If the information contained within the bracket is not specified, the following values are assumed:

track = 00
sector = 01
buffer address = 0000
unit #(master) = 0

## WRITE TO DISKETTE

W@
W<tt,ss,bbbb,u>

## JUMP AND SWITCH-OUT MPU-B

K<x>@

Jump to locattion x and switch off MPU-B ROM and system memory

MPU-B ROM residing at D800 - DBFF
MPU-B RAM residing at D001 - D0FF

SWITCH OUT MPU-B AND JUMP TO VIO MONITOR
(INITIALIZE SCREEN)

Q@

SET BAUD RATE

Z@ (requires two terminals)
Zxxxx (where xxxx is baud rate)

Sets baud rate for MPU-B serial port as 12 and 13 and 4 and S (the system terminal is tied to 2 and 3).

When Z@ is typed, the system will print:

HIT SPACE BAR

The user then hits the space bar on the terminal tied to 12 and 13. the system will print out:

xxxx BAUD SERIAL PORT

## 3. VIO OPERATION WITHOUT VIOROM

When the VIOROM is not used, the VIO functions and modes of operation may be controlled directly from user programs.

It should be noted that operation without the VIOROM is intended primarily for those Users who wish to write a display driver for a particular application, or for those Users who wish to use only very minimal display functions. For most video display applications, it is recommended that the VIOROM be used.

a) VIO Initialization

On power-up or reset, the VIO will default to the following mode of operation:

screen blanked (mode 0)
80x24 screen format

It is then up to the user's program to 1) initialize the VIO's refresh memory for the initial display desired (Part b); and 2) to select the desired VIO mode of operation using the appropriate command byte (Part c).

b) Character Display

To display a character on the screen, the user's program must store the character code for the character to be displayed into the VIO's refresh memory.

Since the VIO's refresh memory consists of 1K or 2K of RAM residing in the system memory space, the user's program may store a character code into the refresh memory using any memory store instruction (e.g., MOV M,R). It is not possible to write into the refresh memory using a front panel Deposit or DMA.

Note that the address of the VIO's refresh memory was set by the user in Section III-B,1, Steps 1 and 2. The position of the displayed character, on the screen, is a function of the location (in the refresh memory) where the character code is stored.

The first memory location in the VIO's refresh memory corresponds to the first display position in the upper left corner of the screen. Each succeeding memory location will correspond to the next display position. Characters are displayed by row, from left to right, with the last display position in the lower right corner of the screen. The relationship between memory locations is shown in Figure III-20.

For example, if the refresh memory were jumpered to reside at F000H (standard address), storing a 31H (ASCII "1") in memory location F000H would cause the character "1" to appear in the upper left hand corner of the screen.

Similarly, a 31H stored in location F028H would cause the character "1" to appear as the 41st character of the first line (if the 80 column option is selected) or as the first character of the second line (if the 40 column option is selected).

A list of the valid character codes appears in Appendix 1. The characters which may be

displayed on the screen depend entirely upon the mode of operation selected by the user: Mode 0, Mode 1, Mode 2, or Mode 3. These modes are selected with the appropriate command byte described in Part c.

MODE 0

When MODE 0 is selected, the screen will be blanked and no characters will be displayed. Display of the characters stored in the VIO's refresh memory will not begin until MODE 0 is terminated.

MODE 1

When MODE 1 is selected, any of the 128 graphic characters represented by character codes 80-FF H (Appendix 1) may be displayed. In MODE 1 bit 7 of the character code acts as the reverse video flag (0=positive video, 1=reverse video).

Note that the character codes listed in Appendix 1 are 8 bits wide. In MODE 1, only the lower 7 bits will be used as the actual character code. The high order bit is used as the reverse video flag.

MODE 2

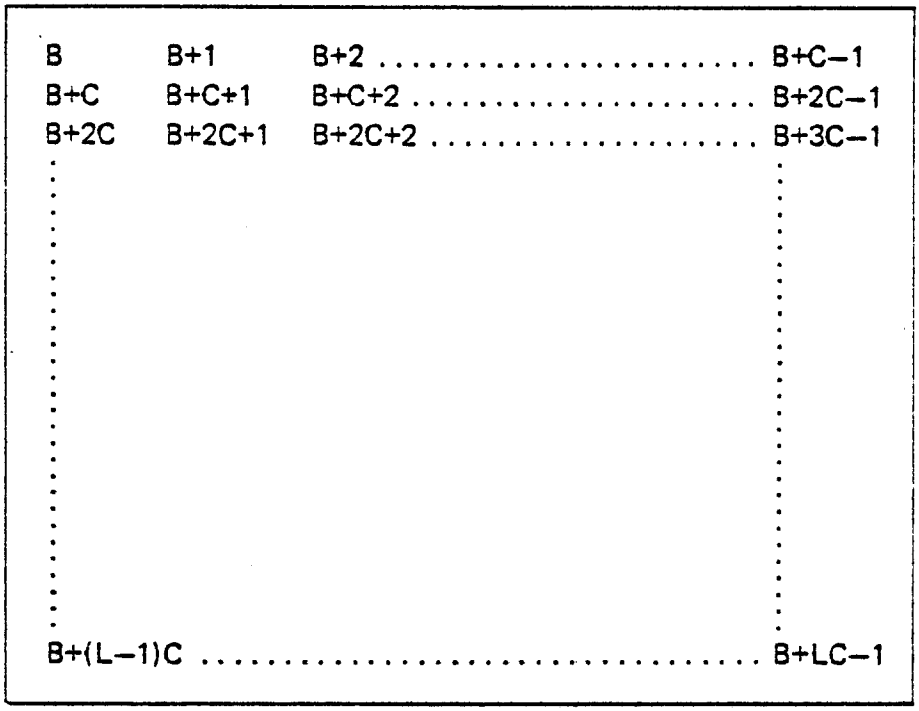
When MODE 2 is selected, any of the 128 characters represented by the character codes 00-7FH (Appendix 1) may be displayed. This includes the standard 96 character ASCII set and 32 graphic characters. In MODE 2, bit 7 of the character code will act as the reverse video flag (0 = positive video, 1 = reverse video).

For example, a 31H (ASCII "1") stored into the refresh memory would cause the character "1" to be displayed in positive video (white character on dark background). The same code, with bit 7 on, would cause the character to be displayed in reverse video. Thus a B1H would cause the character "1" to be displayed as a dark character on a light background.

Note that the character codes listed in Appendix 1 are 8 bits wide. In MODE 2, only the lower 7 bits will be used as the actual character code. The high order bit is used as the reverse video flag.

MODE 3

When MODE 3 is selected, any of the 256 characters represented by character codes 00-FFH (Appendix 1) may be displayed. Note that in MODE 3, character-by-character video is not available. All 8 bits of the character codes listed in Appendix 1 will be used as the actual character codes.




B=BASE ADDRESS OF REFRESH MEMORY
C=NUMBER OF COLUMNS PER LINE
L=NUMBER OF LINES PER PAGE

FIGURE III-20 RELATIONSHIP BETWEEN DISPLAY POSITION AND REFRESH MEMORY LOCATION

c) Command Byte

The top location in the VIO's refresh memory serves as a memory mapped command port. Note that the address of this port is dependent upon the location of the refresh memory (set in Section III-B,1, Steps 1 and 2).

If the refresh memory was set to reside in the top half of the VIO's 4K address space, (Section III-B,1, Step 2), the command port address will be of the form XFFF, where X is equal to the high order address determined in Section III-B,1, Step 1. If the refresh memory was set to reside in the lower half of the VIO's 4K address space, the command port address will be of the form X7FF, where X is equal to the high order address determined in Section III-B,1, Step 1.

The command port address is not affected by the amount of refresh memory (1K or 2K) installed.

The command byte which is stored in the command port location will determine line length, page length, full screen reverse video, and mode of operation, according to the following format:

Bit 0 when equal to 0, produces 80 character lines
when equal to 1, produces 40 character lines

Bit 1 when equal to 0, produces 24 line pages;
when equal to 1, produces 12 line pages.

Bits 2-3 are encoded and control the VIO mode of operation
When equal to 00, activates Mode 0,
video off, screen blanked.

When equal to 01, activates Mode 1. Character codes 80-FF (Appendix 1) may be displayed. Bits 0-6 of codes 80-FF are used as the character code. Bit 7 is used as the character-by-character reverse video flag (0 = positive video, 1 = reverse video).

When equal to 10, activates Mode 2. Character codes 00-7F H (Appendix 1) may be displayed. Bits 0-6 of codes 00-7F H are used as the character code. Bit 7 is used as the character-by-character reverse video flag (0=positive video, 1=reverse video).

When equal to 11, activates Mode 3. Character codes 00-FF (Appendix 1) may be displayed. Character-by-character reverse video is not available in this mode, and all 8 bits of codes 00-FF are used as character code.

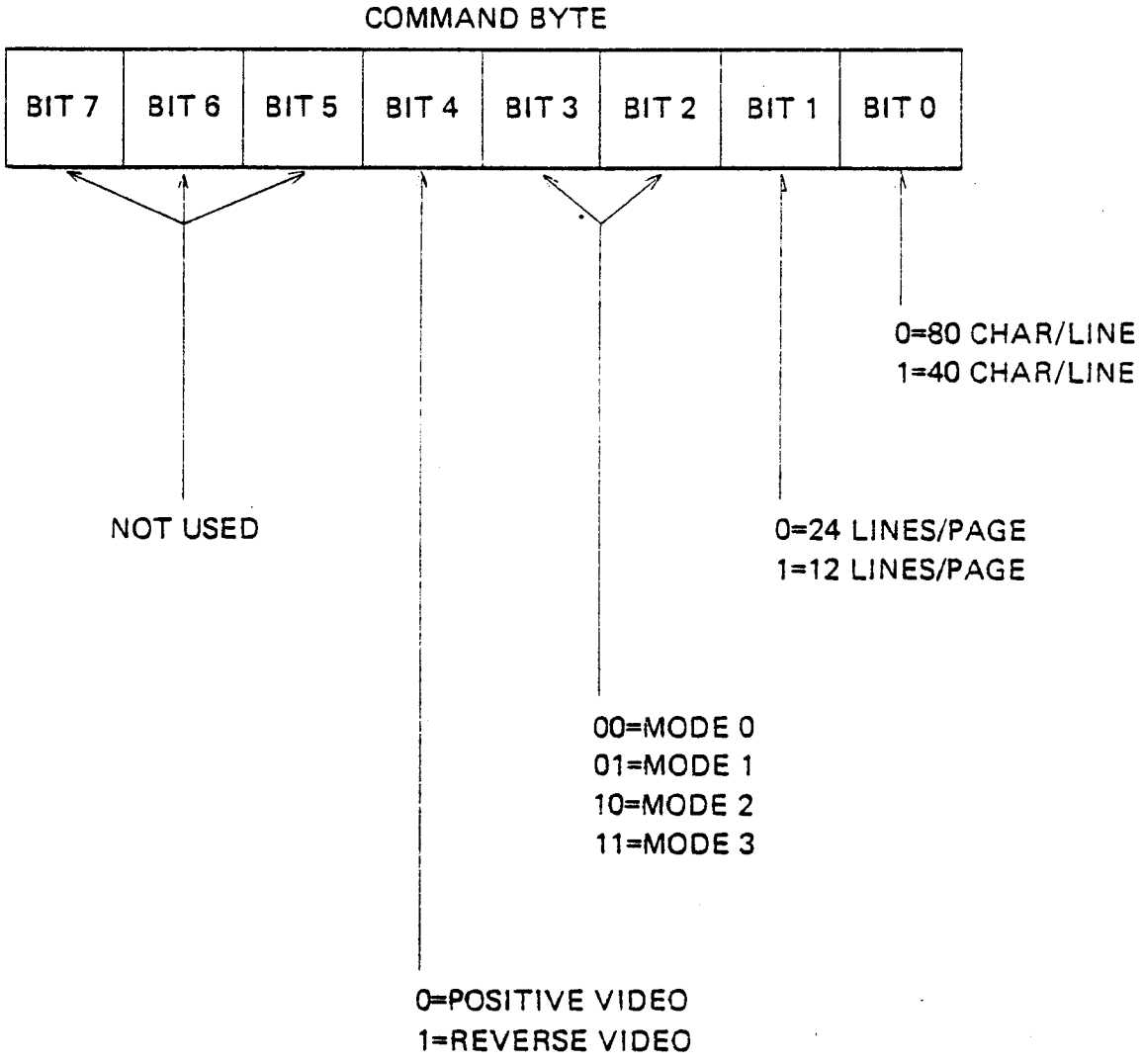



FIGURE III-21 COMMAND BYTE FORMAT

Bit 4 when equal to 0, causes the screen display to appear as positive video (light characters on a dark background).

When equal to 1, causes the screen display to appear as reverse video (dark characters on a light background).

Bits 5-7 are not used.

The command byte format is shown in Figure III-21. On power-up or reset, the command byte will default to 00H (Mode 0) with the screen blanked. The command byte may then be changed using any memory store instruction (e.g., MOV M,R). If the VIO contains a full 2K bytes of refresh memory, the command byte may also be read using any memory read instruction (e.g., MOV R,M). It is not possible to write into the Command Port location using a front panel Deposit or DMA.

NOTE: Reading the command port location after a reset, but prior to writing, will not reflect the default command (00).

For example, if the VIO's refresh memory is set to reside in location F000-F7FF (bottom half of 4K block beginning at F000), we may store the command byte 07H in location F7FF to produce

positive video display
Mode 1
12 lines per page
40 characters per line

Similarly, if the VIO's refresh memory is set to reside in location F800-FFFF (top half of 4K block beginning at F000H), we may store the command byte 08H in location FFFF to produce

positive video display
Mode 2
24 lines per page
80 characters per line

## C. APPENDICES

Appendix 1 — Character Codes

Appendix 2 — X, Y Position Codes

Appendix 3 — Simple VIO Driver Listing

Appendix 4 — Programming the Character Generator ROMs/PROMs

## APPENDIX 1

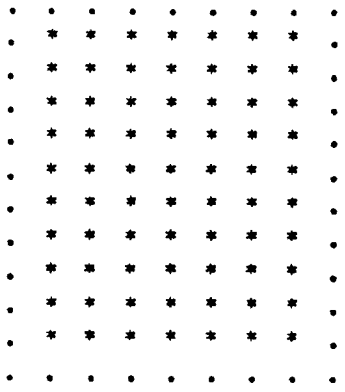
The characters represented by the character codes 00-FF H, comprise the complete 256 character set of the VIO.

Characters which may be displayed depend upon the display mode selected. Codes 20-7F H may be displayed through the firmware, in the ASCII Text Mode. Codes A0-FF H may be displayed through the firmware in the Extended Text Mode. Codes 00-FF H may be displayed through the firmware in the Graphic Mode (with the exception of the character 1B H).

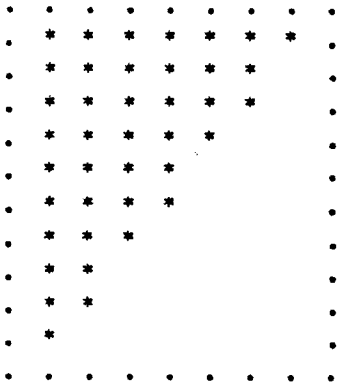
Codes 00-FF H may also be displayed by directly accessing the VIO's refresh memory.

The valid character codes 00-FF are listed in the following pages.

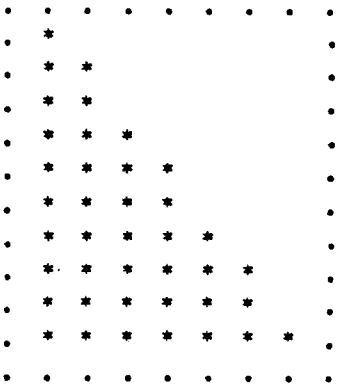
CODE : 00 H



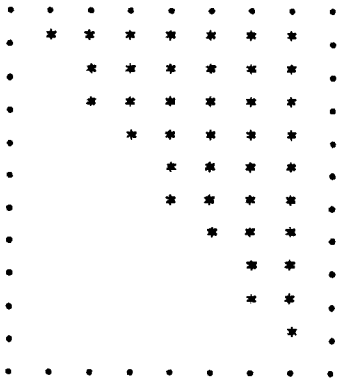
CODE 01 H



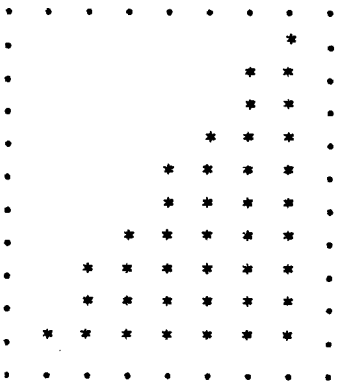
CODE 02 H



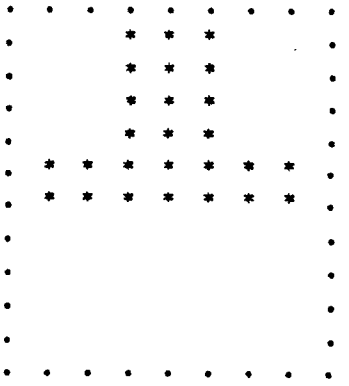
CODE 03 H



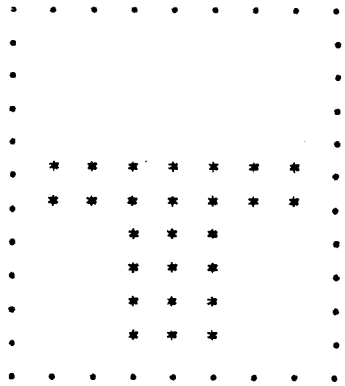
CODE 04 H



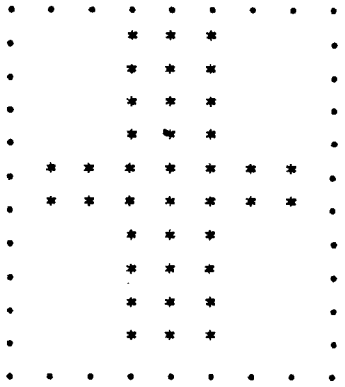
CODE 05 H



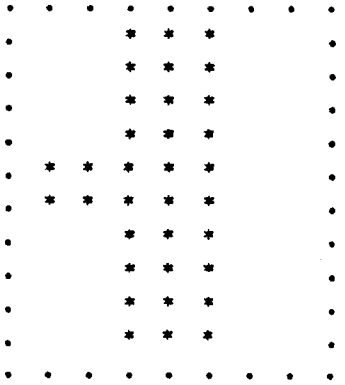
CODE 06 H



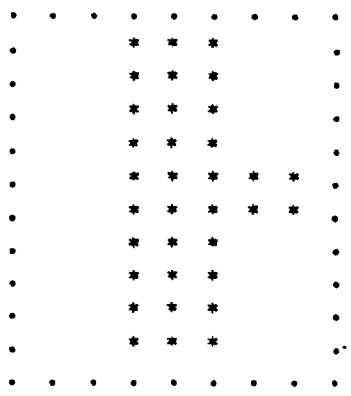
CODE 07 H



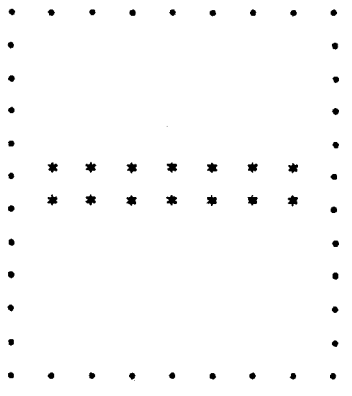
CODE 08 H



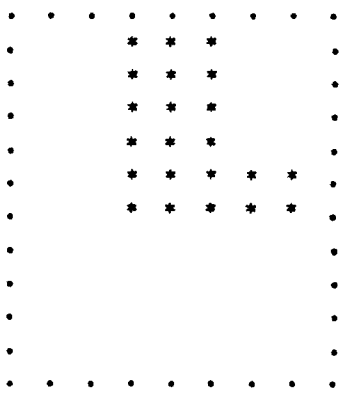
CODE 09 H



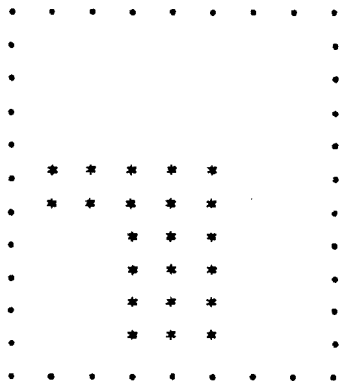
CODE 0C H



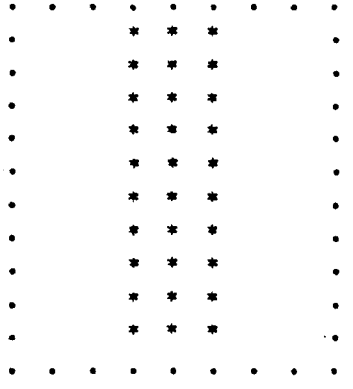
CODE 0F H



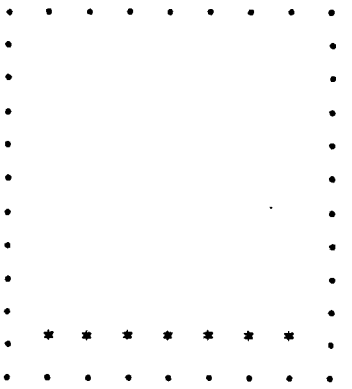
CODE 0A H



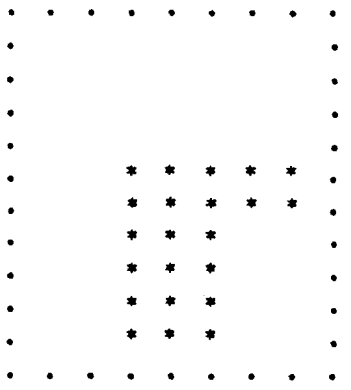
CODE 0D H



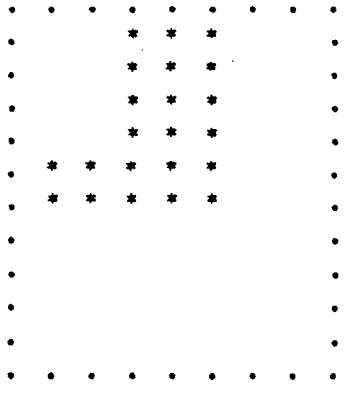
CODE 10 H



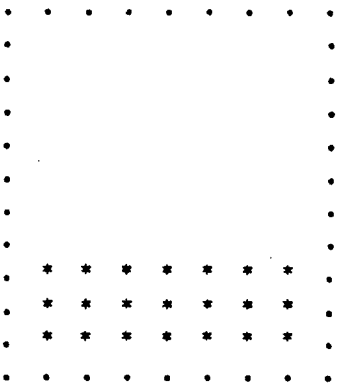
CODE 0B H



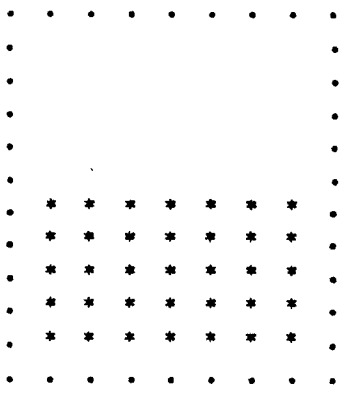
CODE 0E H



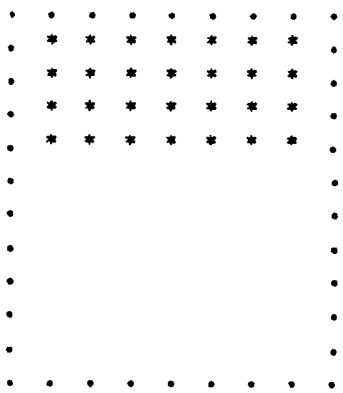
CODE 11 H



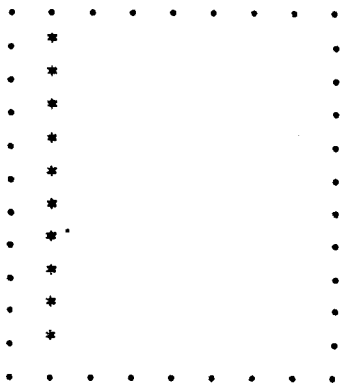
CODE 12 H



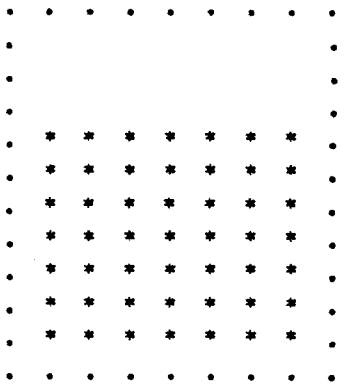
CODE 15 H



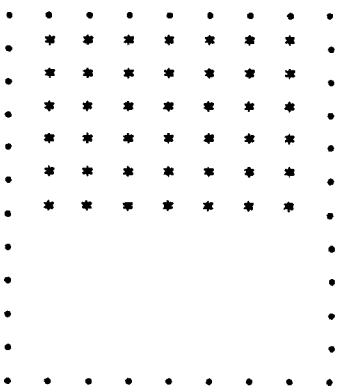
CODE 18 H



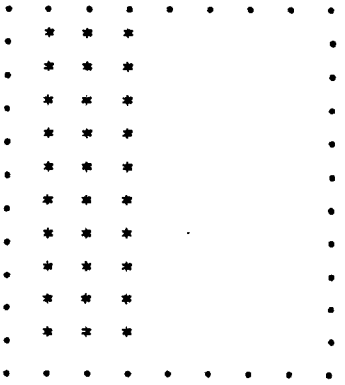
CODE 13 H



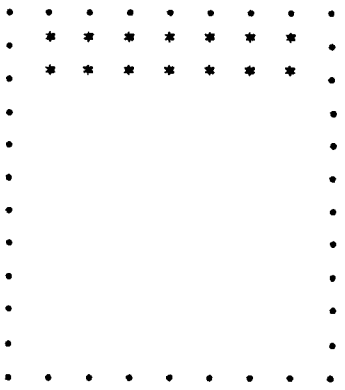
CODE 16 H



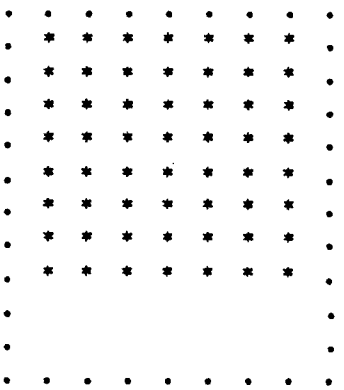
CODE 19 H



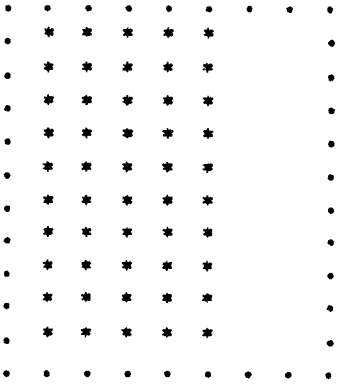
CODE 14 H



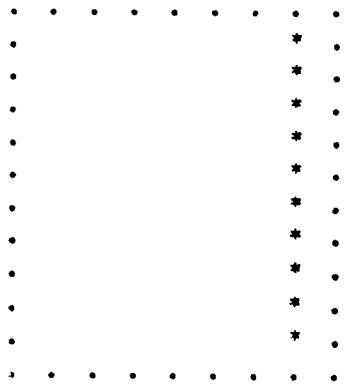
CODE 17 H



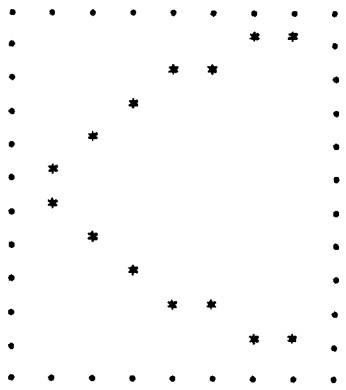
CODE 1A H



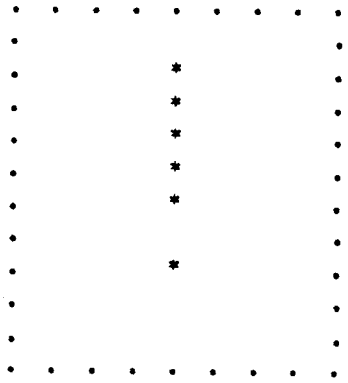
CODE 1B H



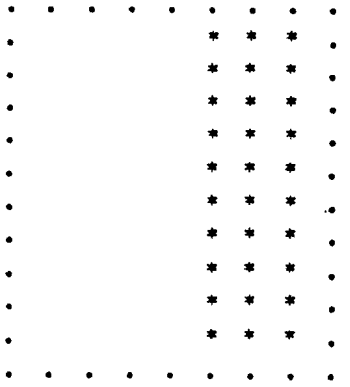
CODE 1E H



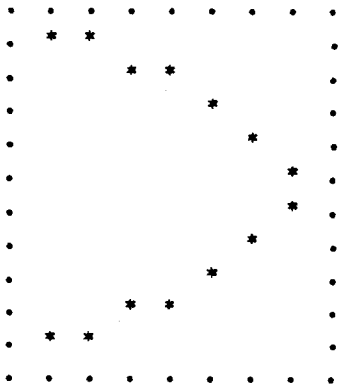
CODE 21 H



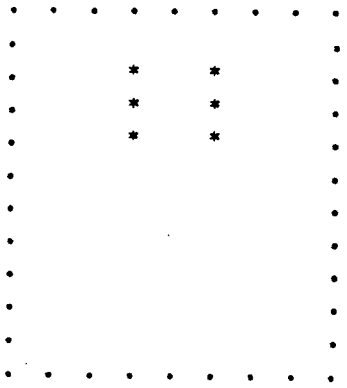
CODE 1C H



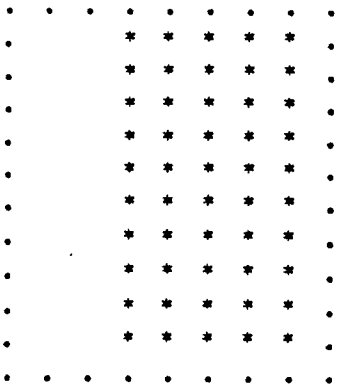
CODE 1F H



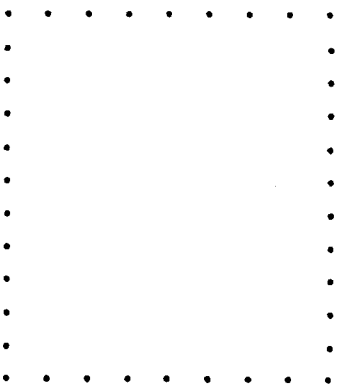
CODE 22 H



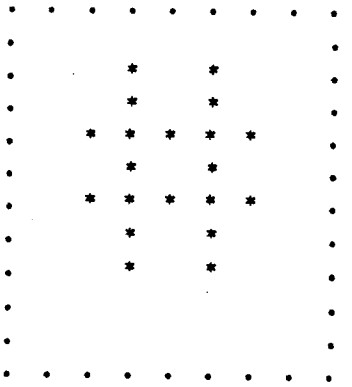
CODE 1D H



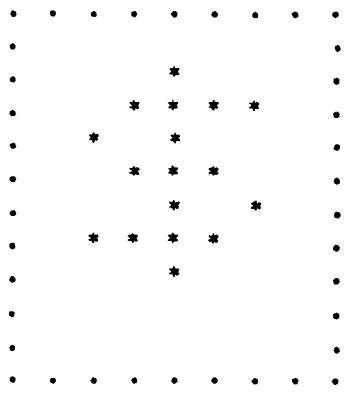
CODE 20 H



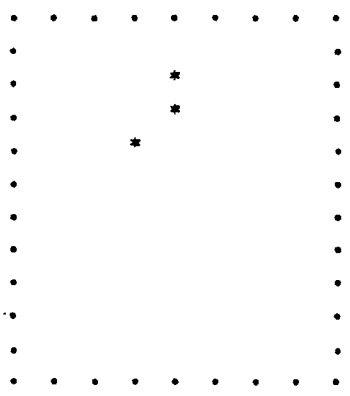
CODE 23 H



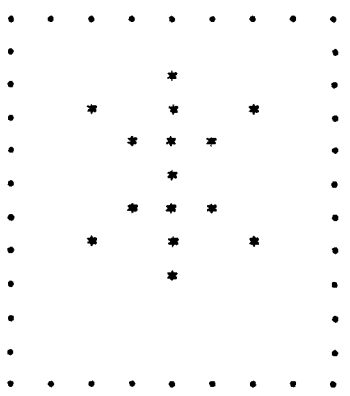
CODE 24 H



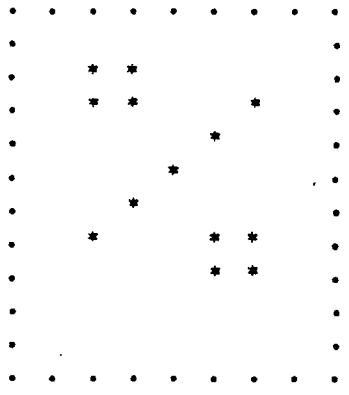
CODE 27 H



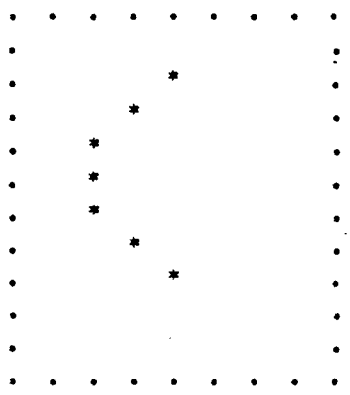
CODE 2A H



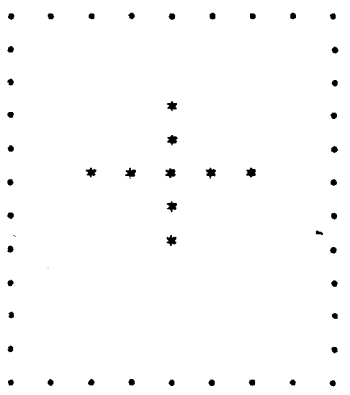
CODE 25 H



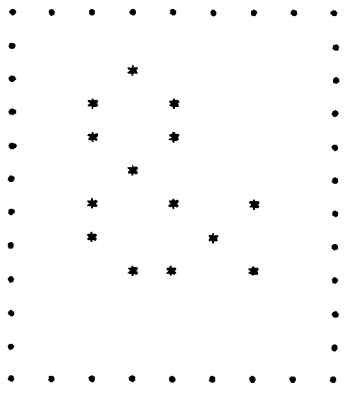
CODE 28 H



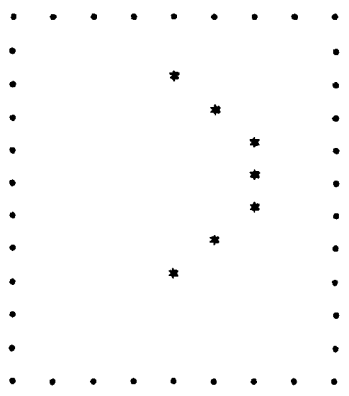
CODE 2B H



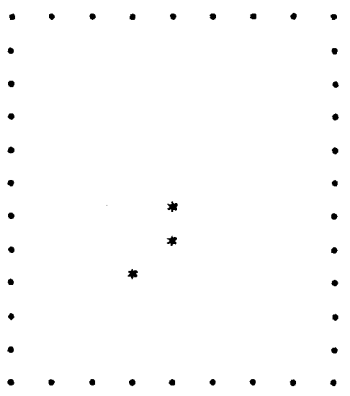
CODE 26 H



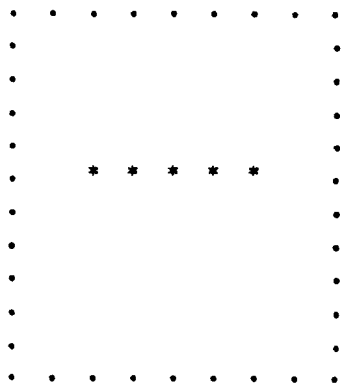
CODE 29 H



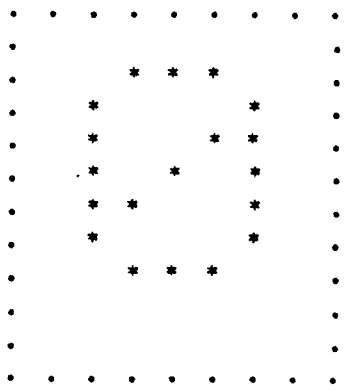
CODE 2C H



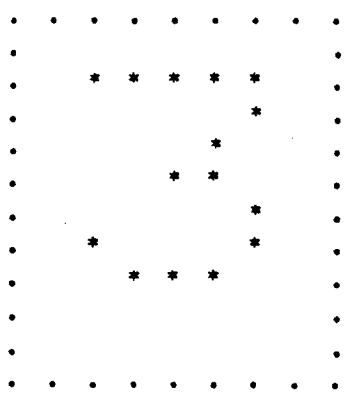
CODE 2D H



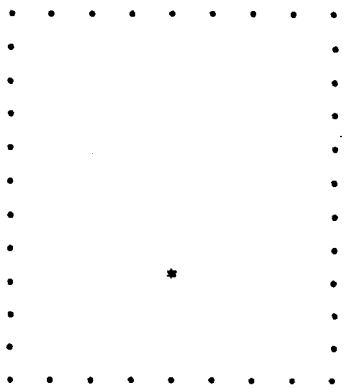
CODE 30 H



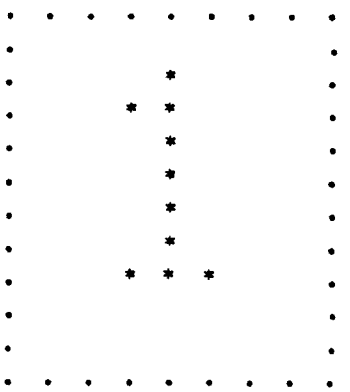
CODE 33 H



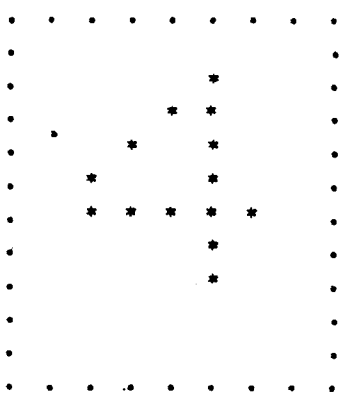
CODE 2E H



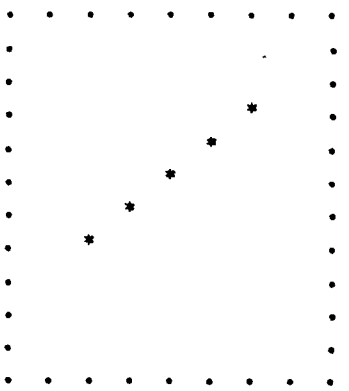
CODE 31 H



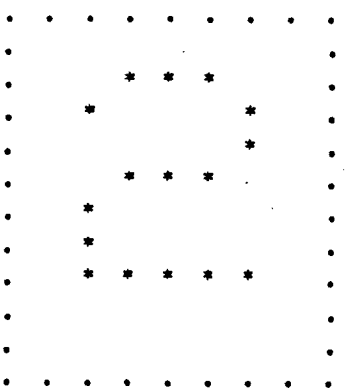
CODE 34 H



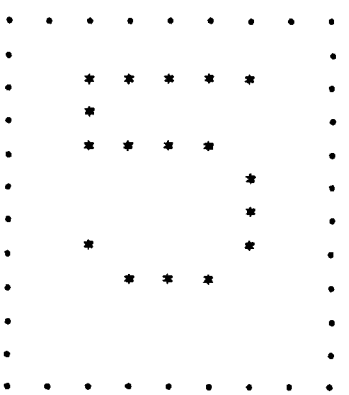
CODE 2F H



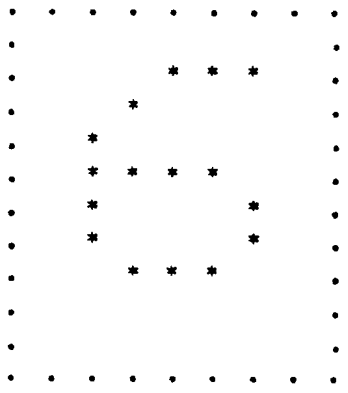
CODE 32 H



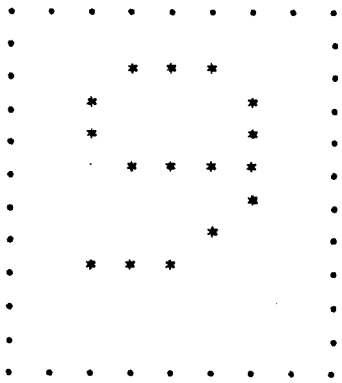
CODE 35 H



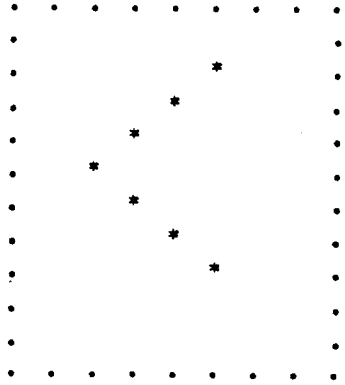
CODE 36 H



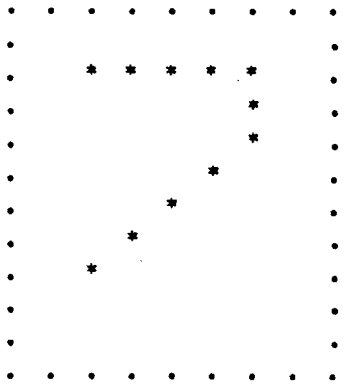
CODE 39 H



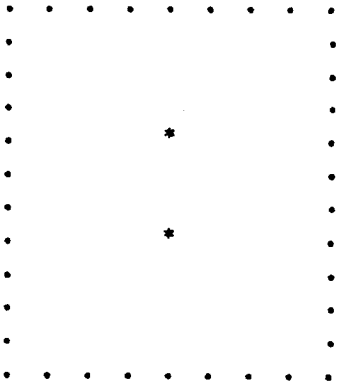
CODE 3C H



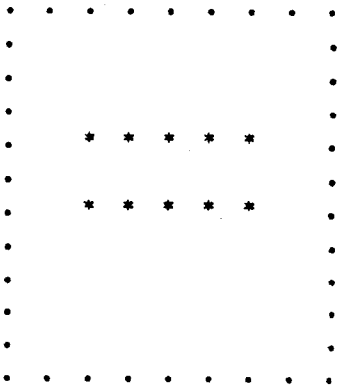
CODE 37 H



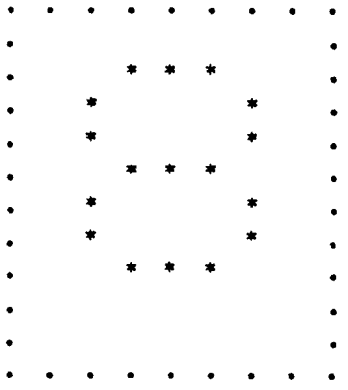
CODE 3A H



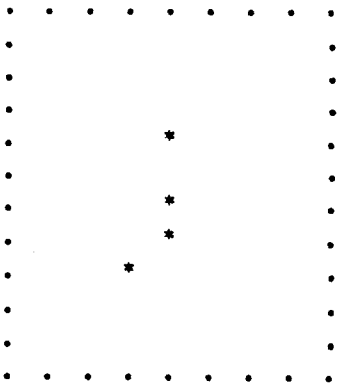
CODE 3D H



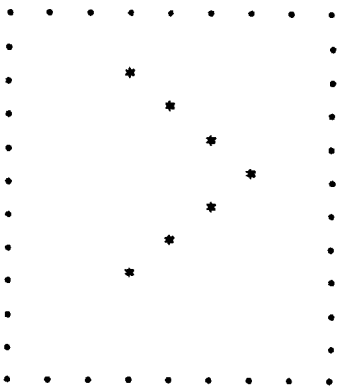
CODE 38 H



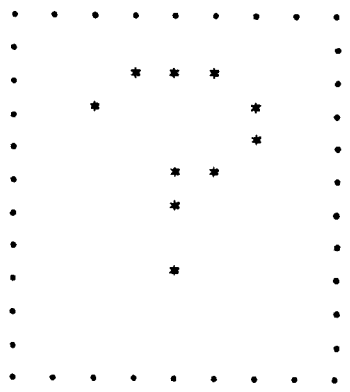
CODE 3B H



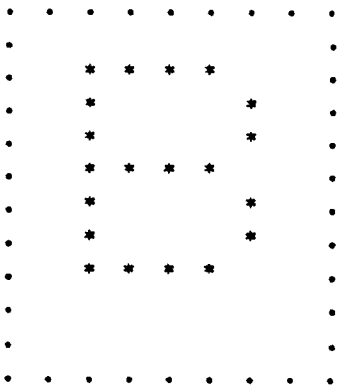
CODE 3E H



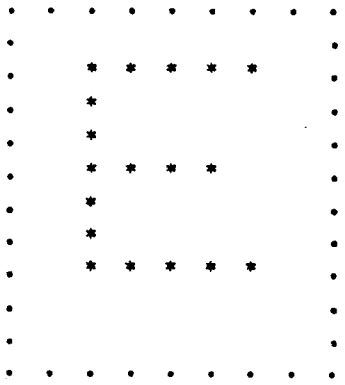
CODE 3F H



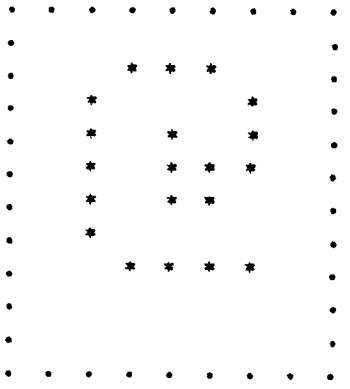
CODE 42 H



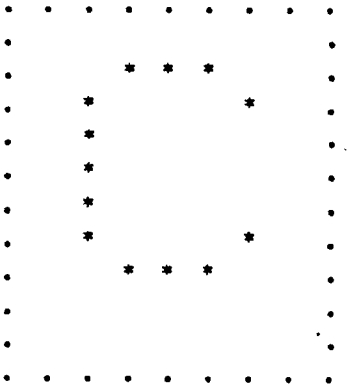
CODE 45 H



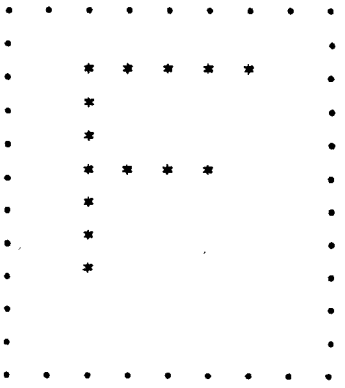
CODE 40 H



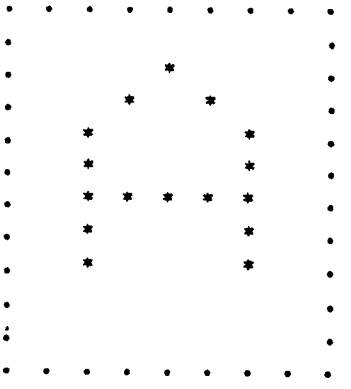
CODE 43 H



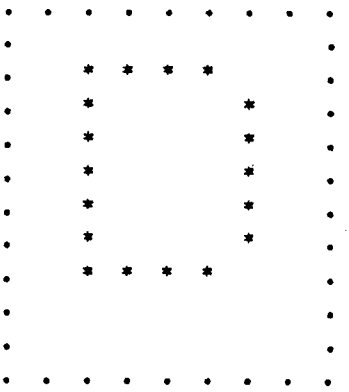
CODE 46 H



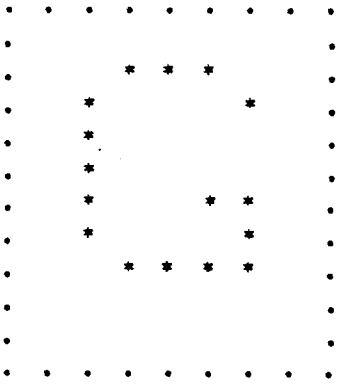
CODE 41 H



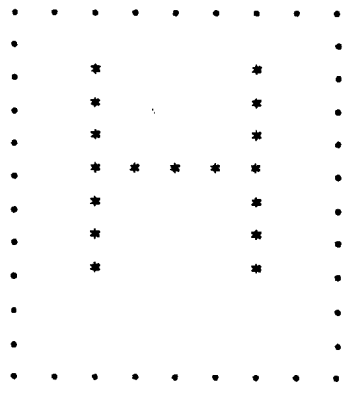
CODE 44 H



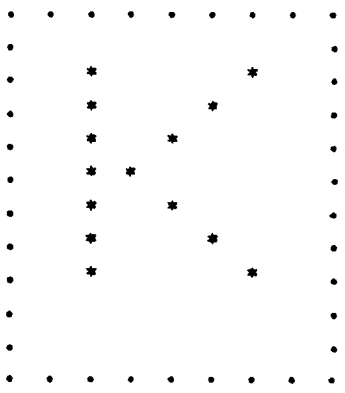
CODE 47 H



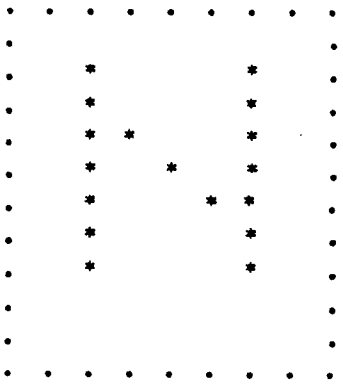
CODE 48 H



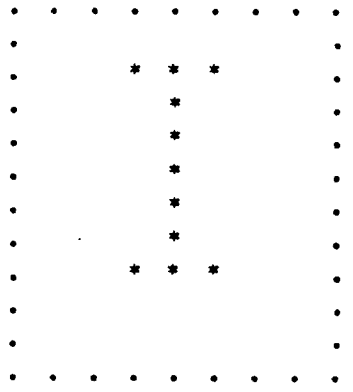
CODE 4B H



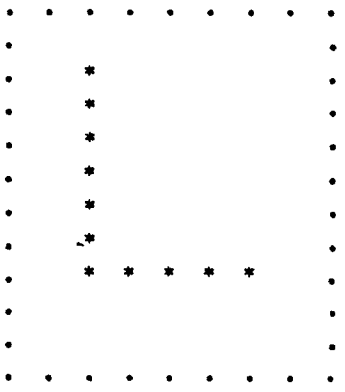
CODE 4E H



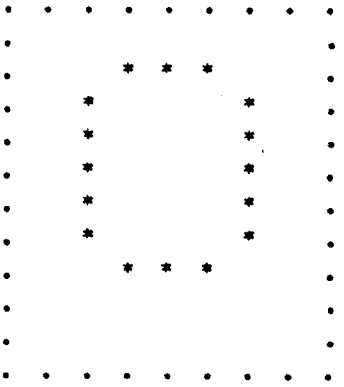
CODE 49 H



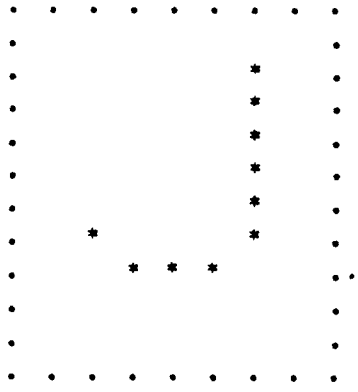
CODE 4C H



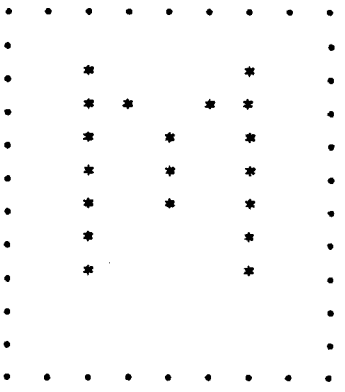
CODE 4F H



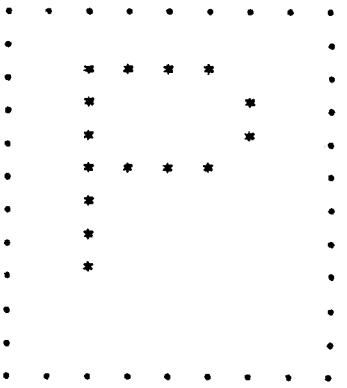
CODE 4A H



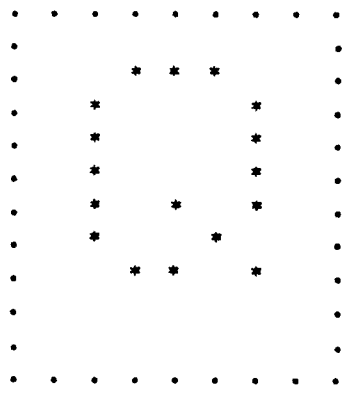
CODE 4D H



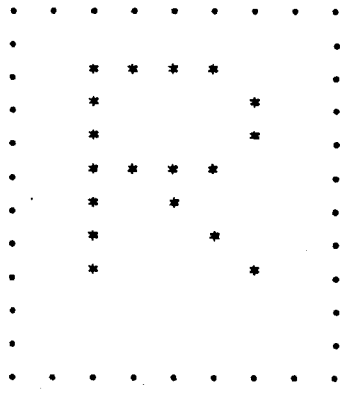
CODE 50 H



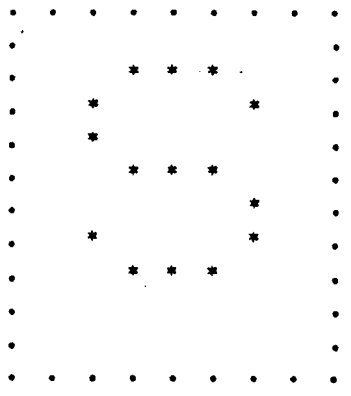
CODE 51 H



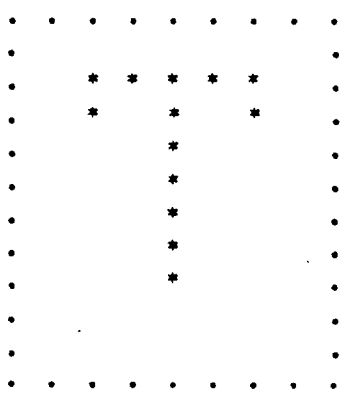
CODE 52 H



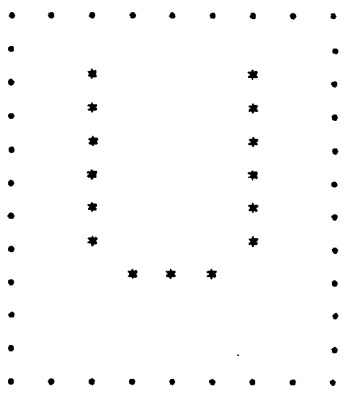
CODE 53 H



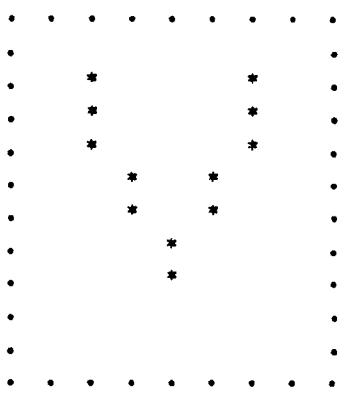
CODE 54 H



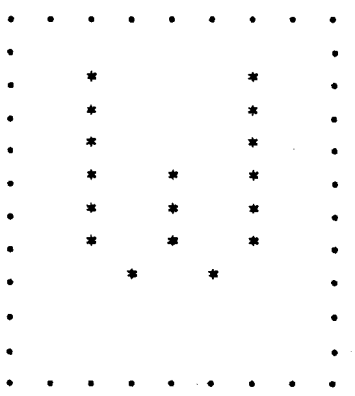
CODE 55 H



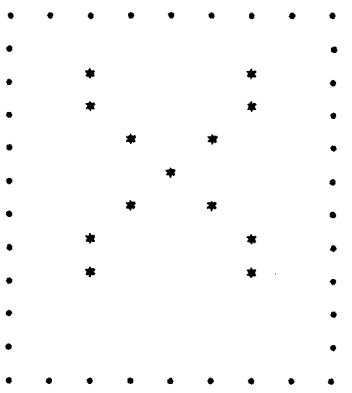
CODE 56 H



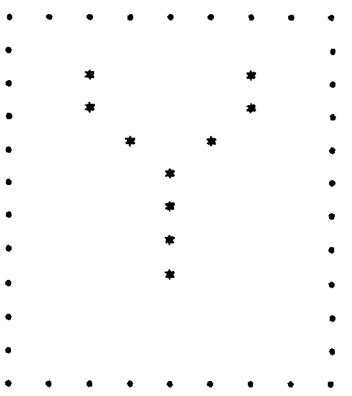
CODE 57 H



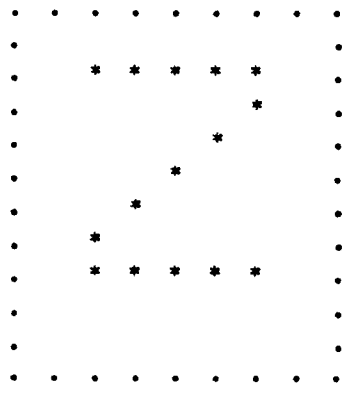
CODE 58 H



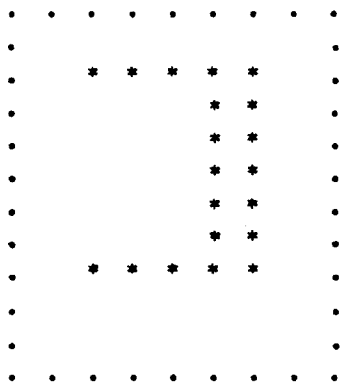
CODE 59 H



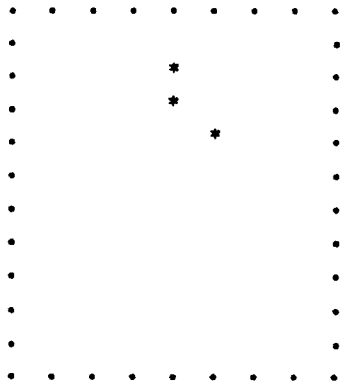
CODE 5A H



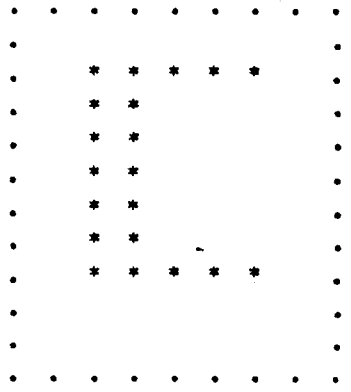
CODE 5D H



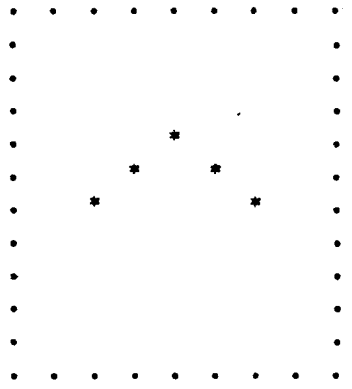
CODE 60 H



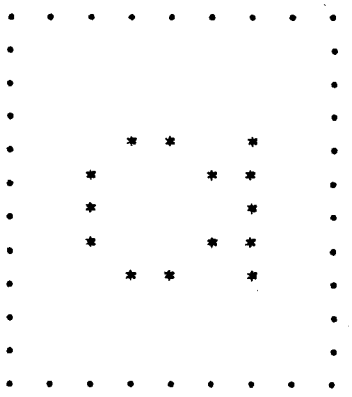
CODE 5B H



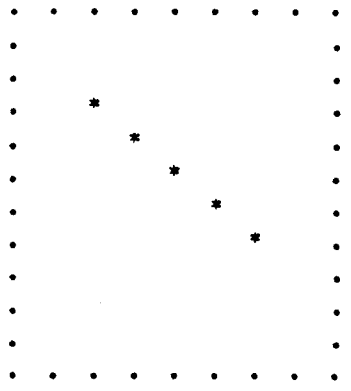
CODE 5E H



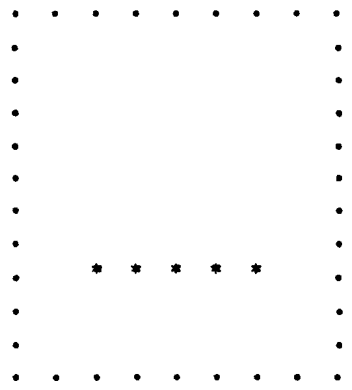
CODE 61 H



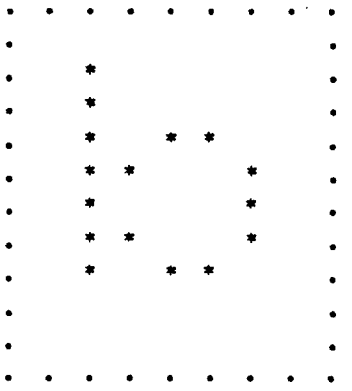
CODE 5C H



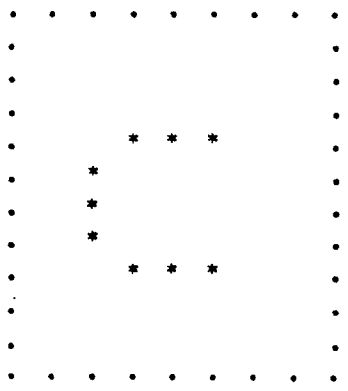
CODE 5F H



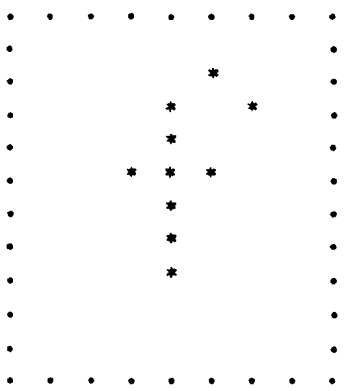
CODE 62 H



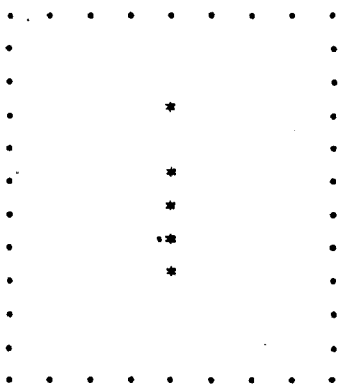
CODE 63 H



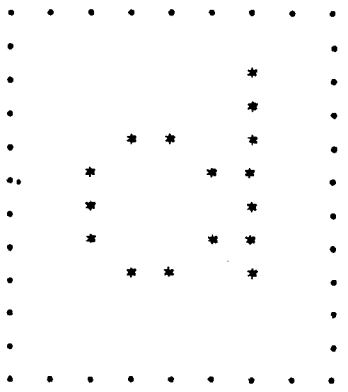
CODE 66 H



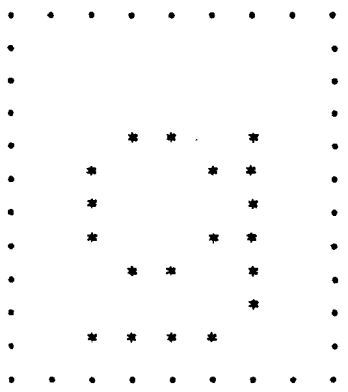
CODE 69 H



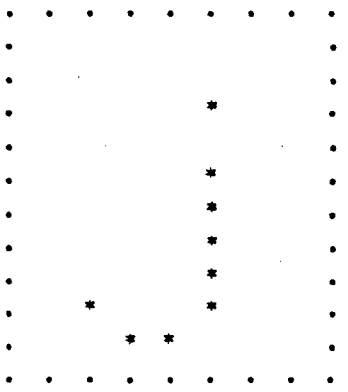
CODE 64 H



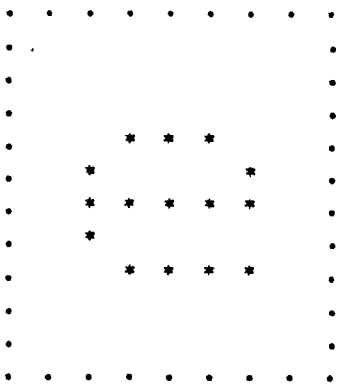
CODE 67 H



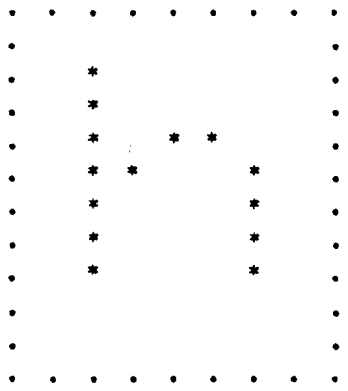
CODE 6A H



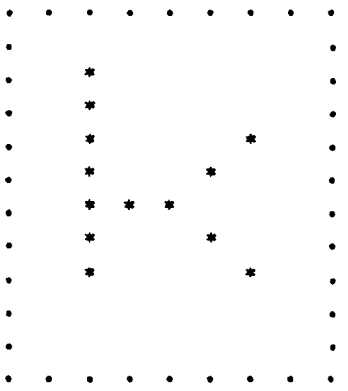
CODE 65 H



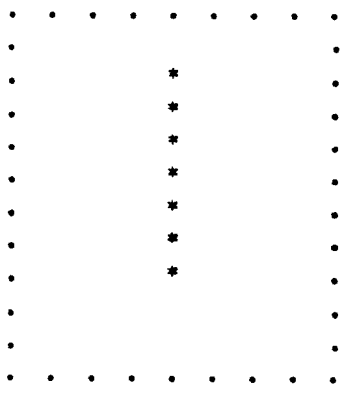
CODE 68 H



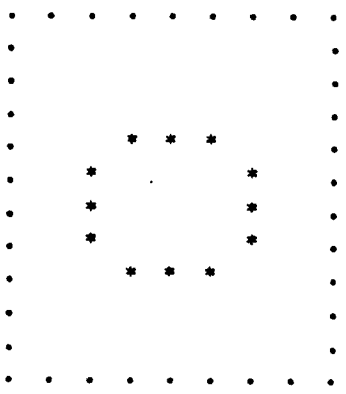
CODE 6B H



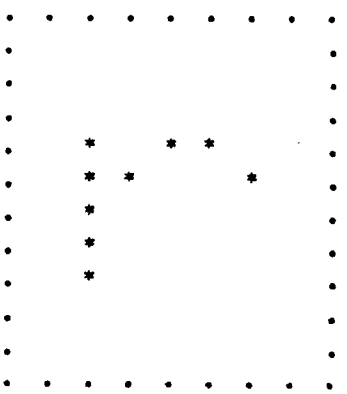
CODE 6C H



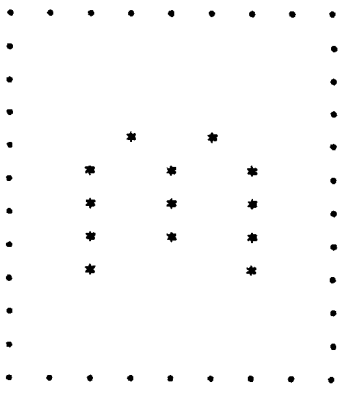
CODE 6F H



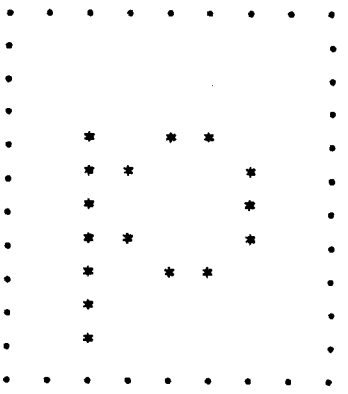
CODE 72 H



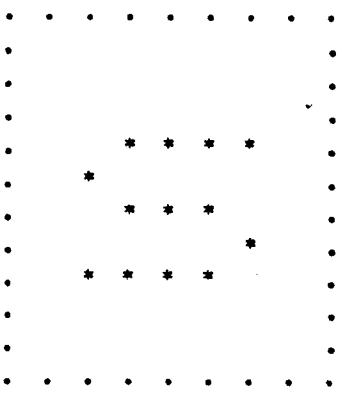
CODE 6D H



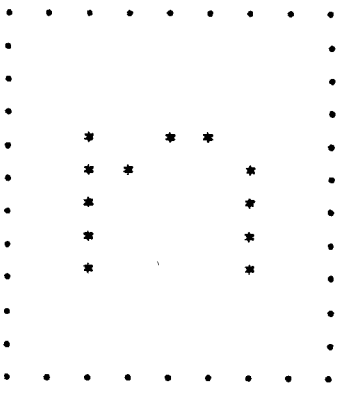
CODE 70 H



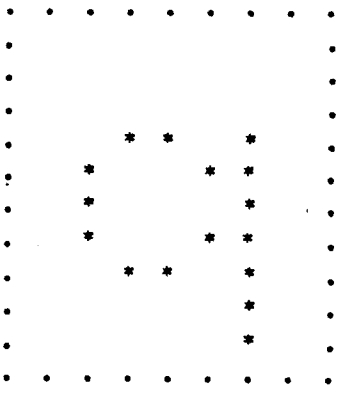
CODE 73 H



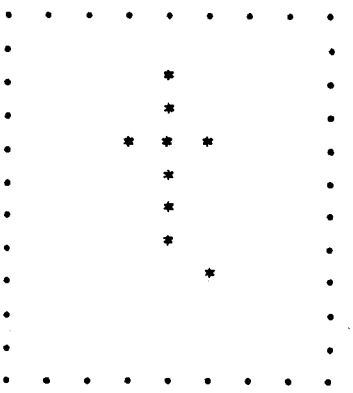
CODE 6E H



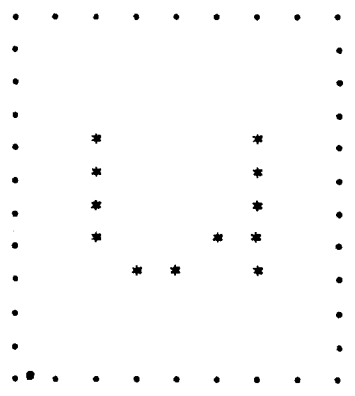
CODE 71 H



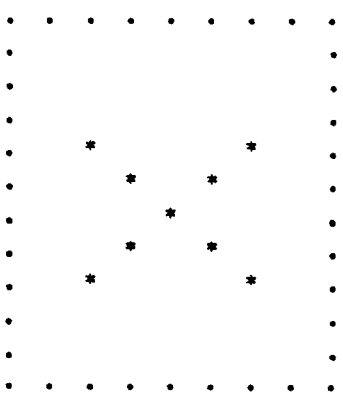
CODE 74 H



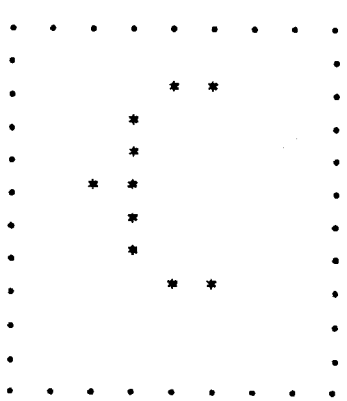
CODE 75 H



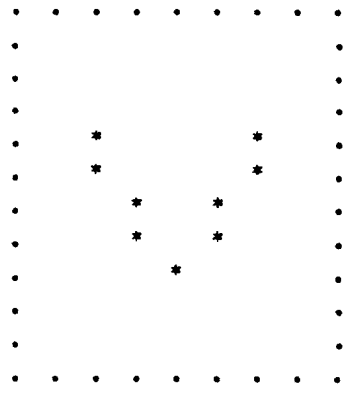
CODE 78 H



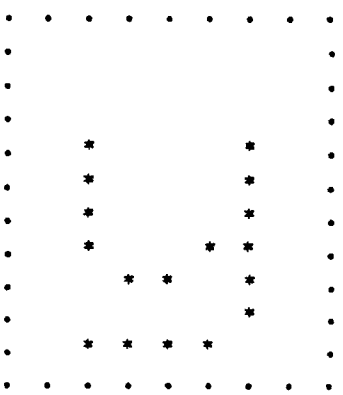
CODE 7B H



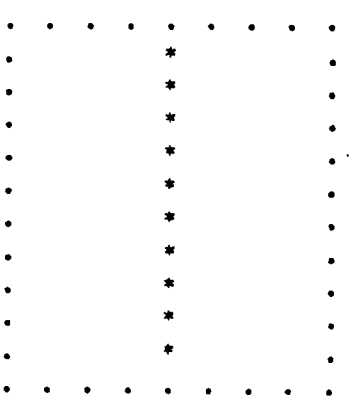
CODE 76 H



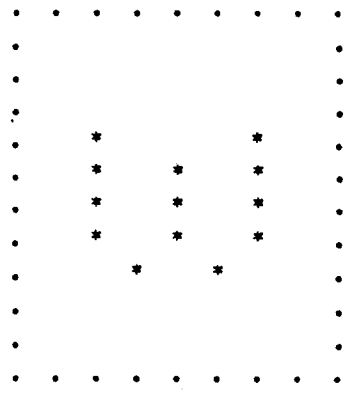
CODE 79 H



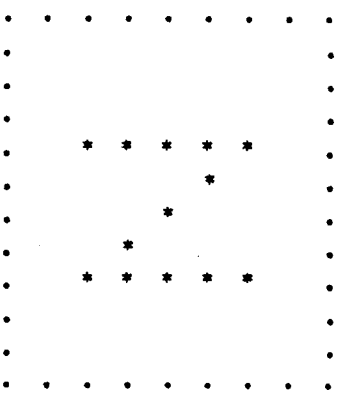
CODE 7C H



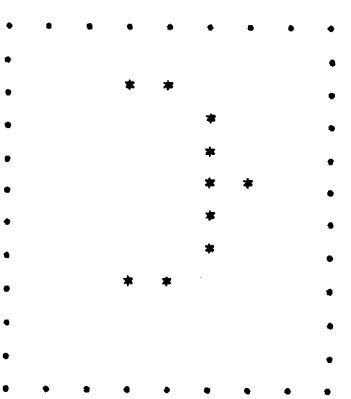
CODE 77 H



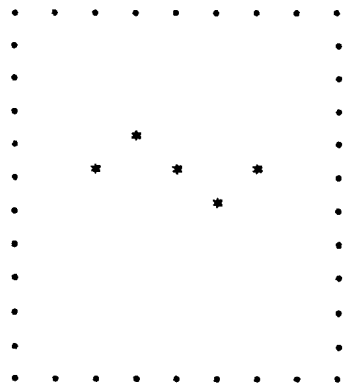
CODE 7A H



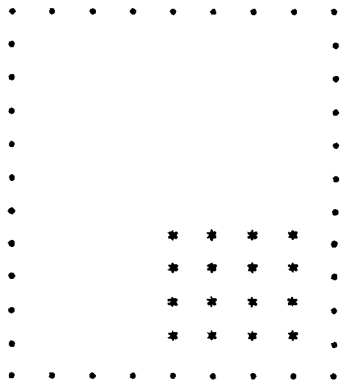
CODE 7D H



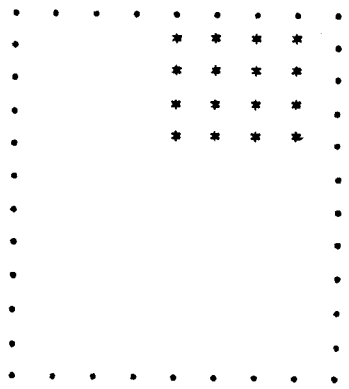
CODE 7E H



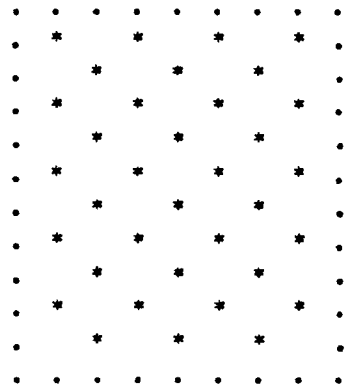
CODE 81 H



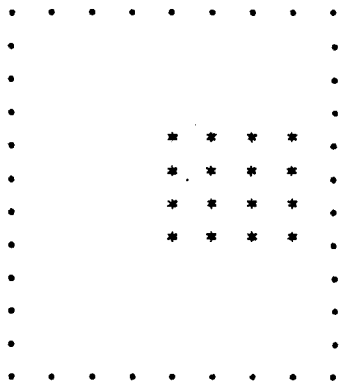
CODE 84 H



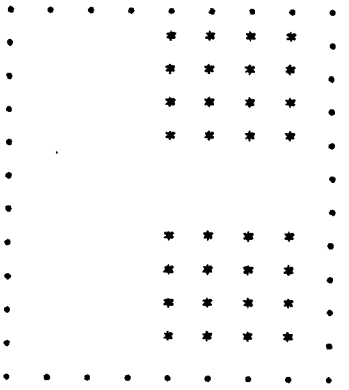
CODE 7F H



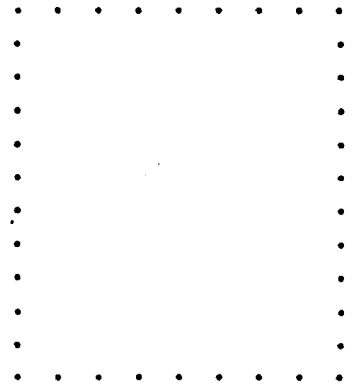
CODE 82 H



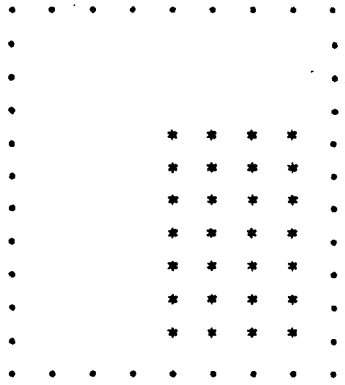
CODE 85 H



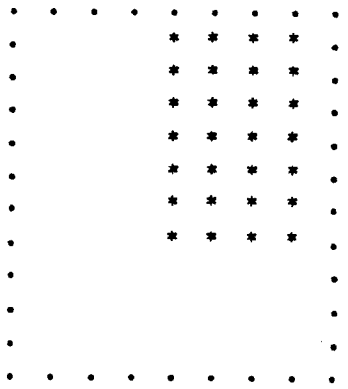
CODE 80 H



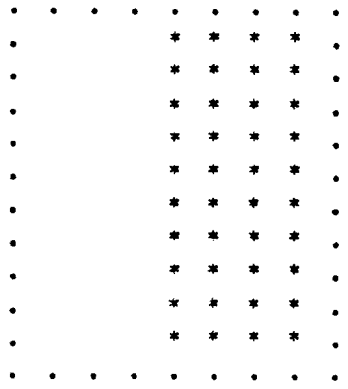
CODE 83 H



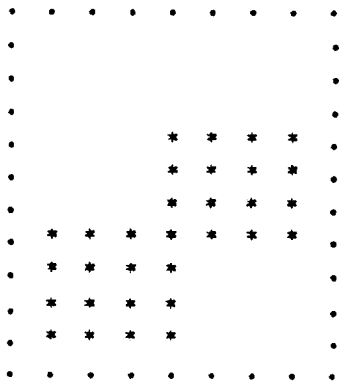
CODE 86 H



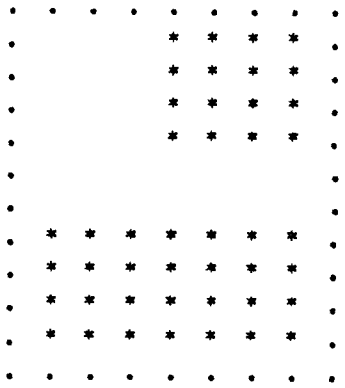
CODE 87 H



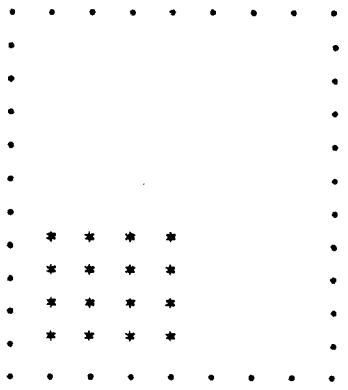
CODE 8A H



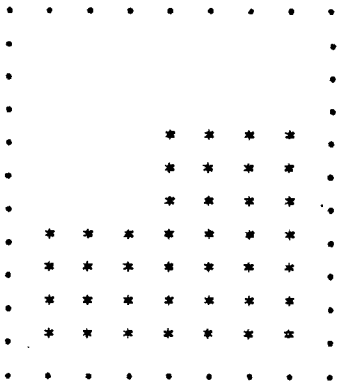
CODE 8D H



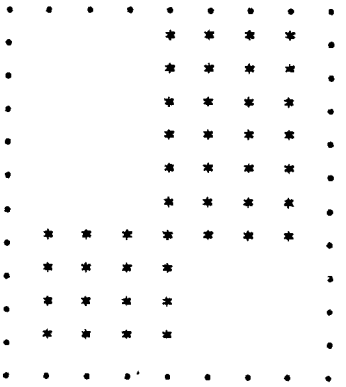
CODE 88 H



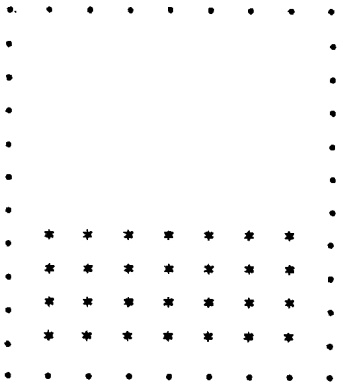
CODE 8B H



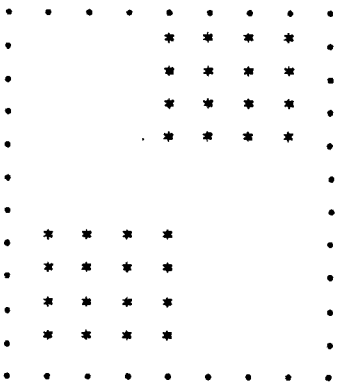
CODE 8E H



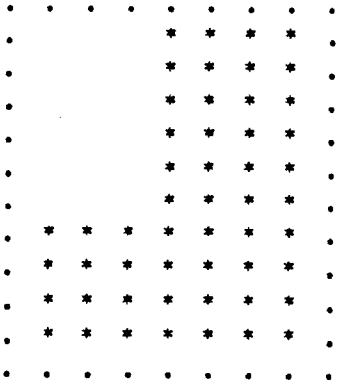
CODE 89 H



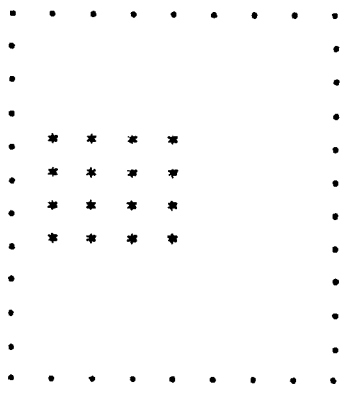
CODE 8C H



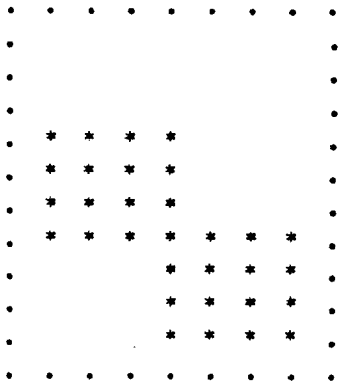
CODE 8F H



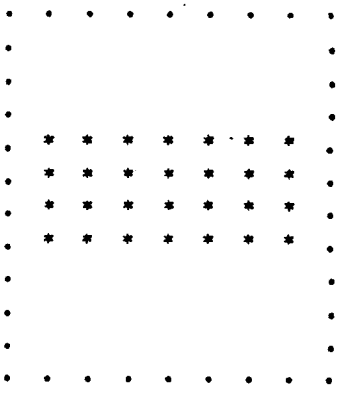
CODE 90 H



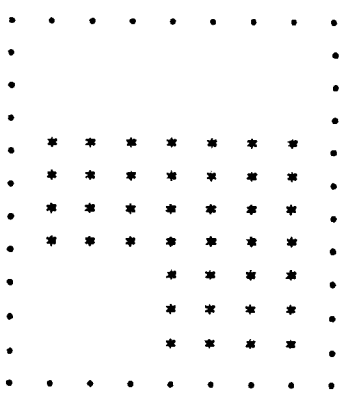
CODE 91 H



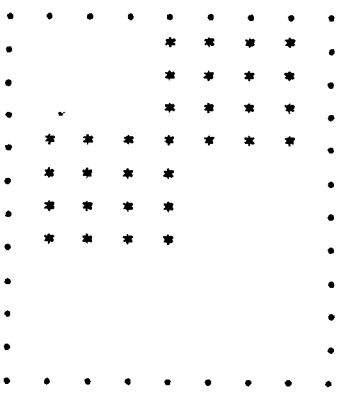
CODE 92 H



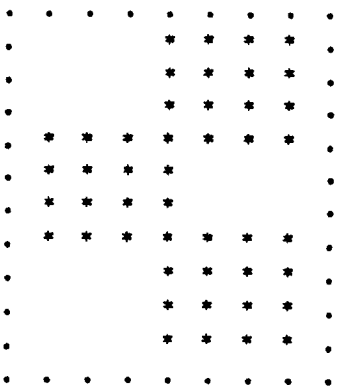
CODE 93 H



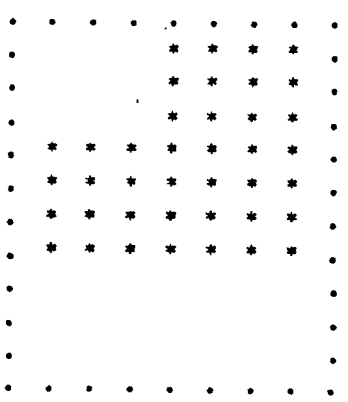
CODE 94 H



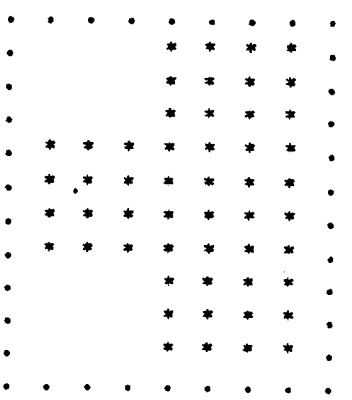
CODE 95 H



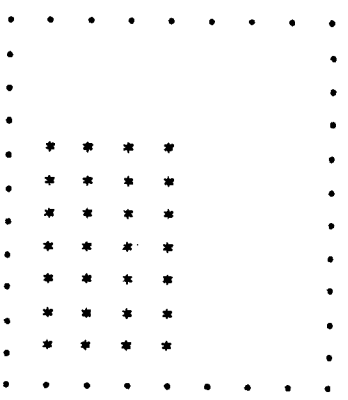
CODE 96 H



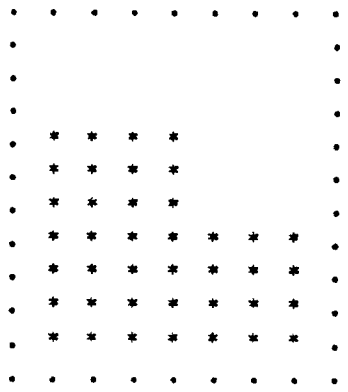
CODE 97 H



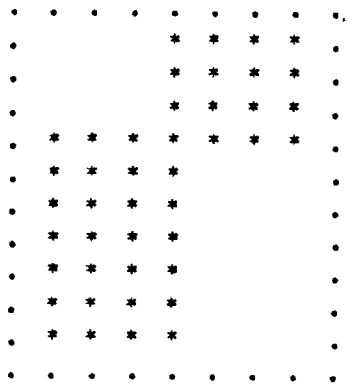
CODE 98 H



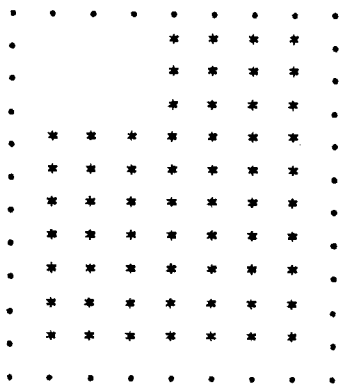
CODE 99 H



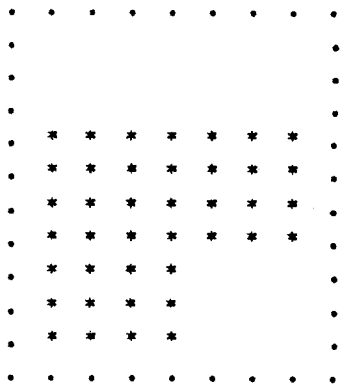
CODE 9C H



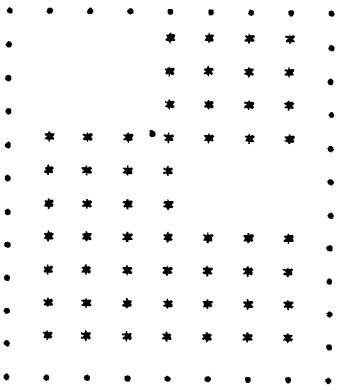
CODE 9F H



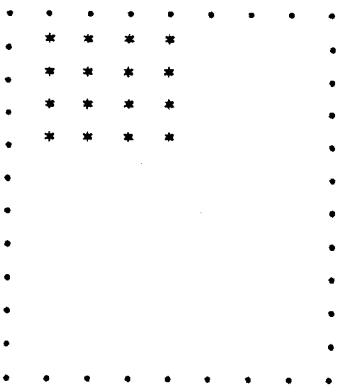
CODE 9A H



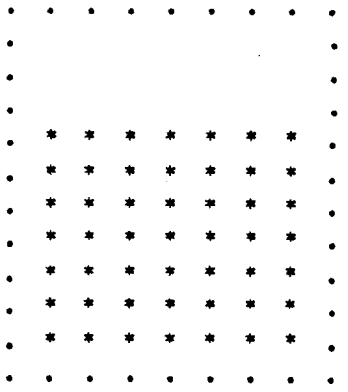
CODE 9D H



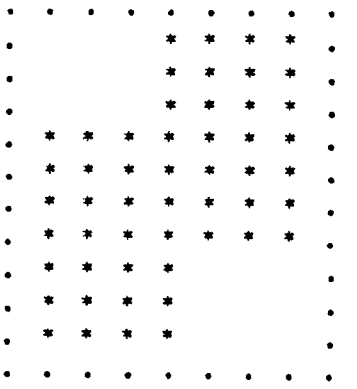
CODE A0 H



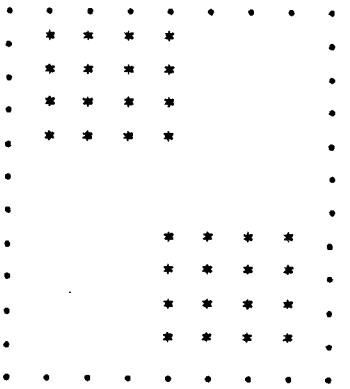
CODE 9B H



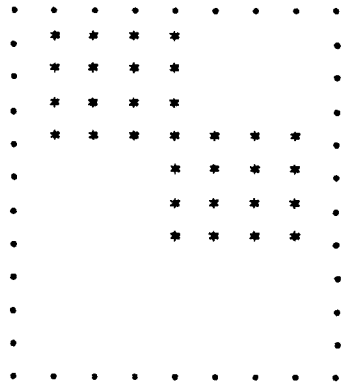
CODE 9E H



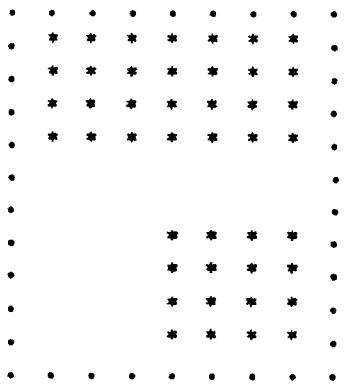
CODE A1 H



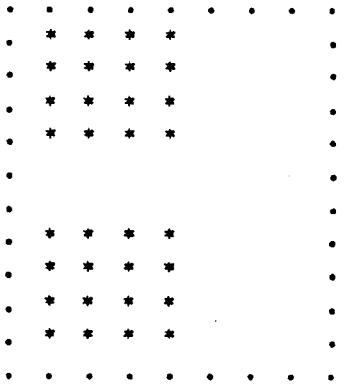
CODE A2 H



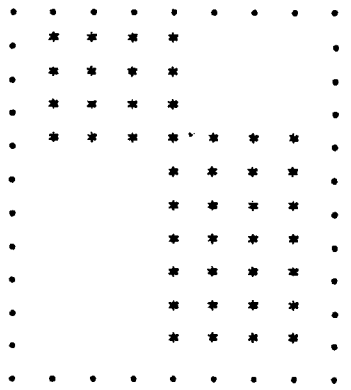
CODE A5 H



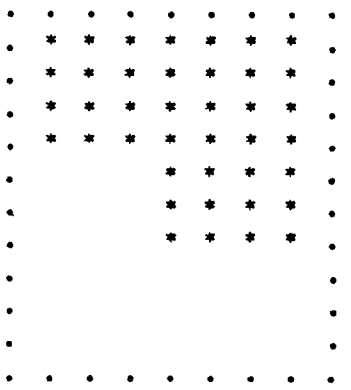
CODE A8 H



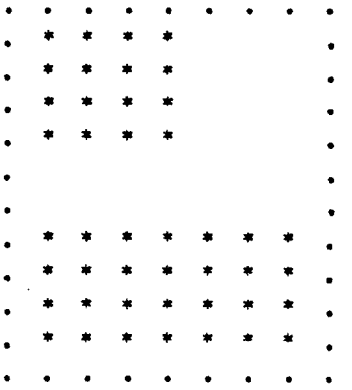
CODE A3 H



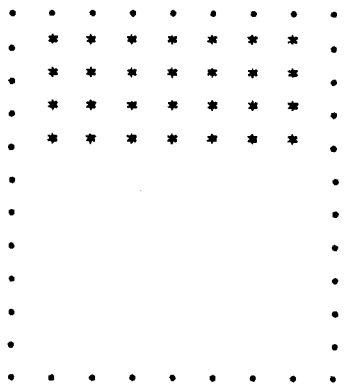
CODE A6 H



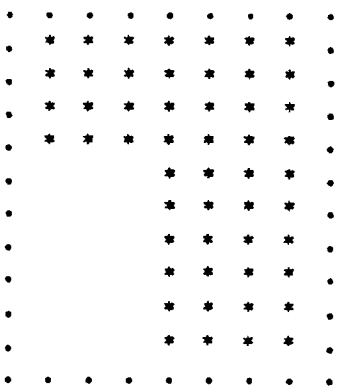
CODE A9 H



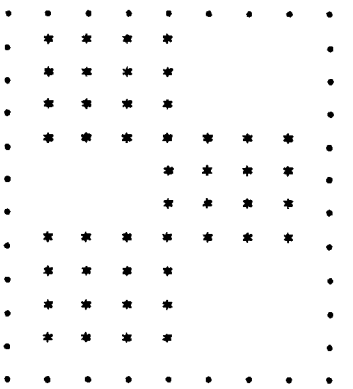
CODE A4 H



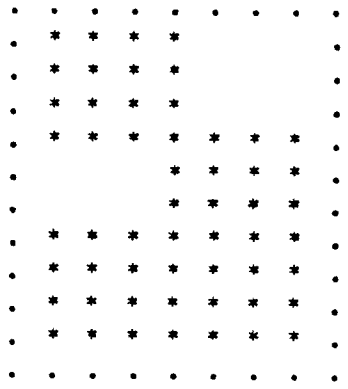
CODE A7 H



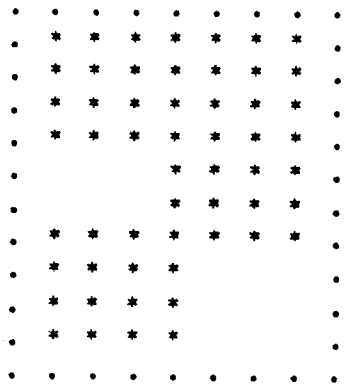
CODE AA H



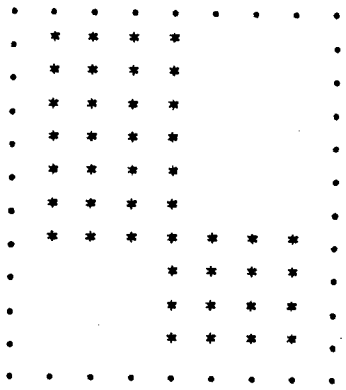
CODE AB H



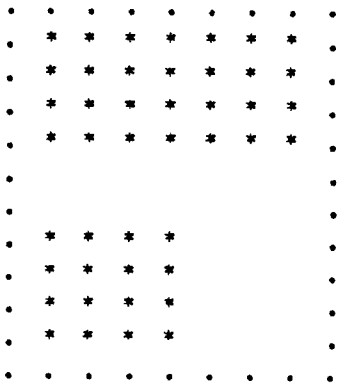
CODE AE H



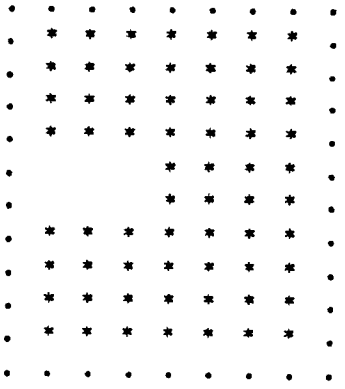
CODE B1 H



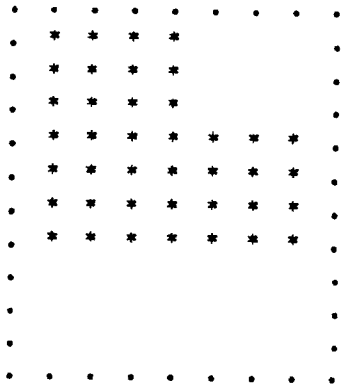
CODE AC H



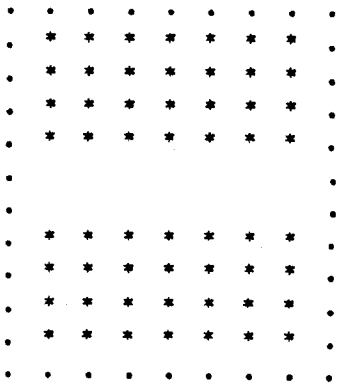
CODE AF H



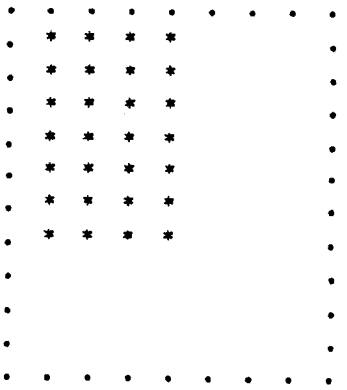
CODE B2 H



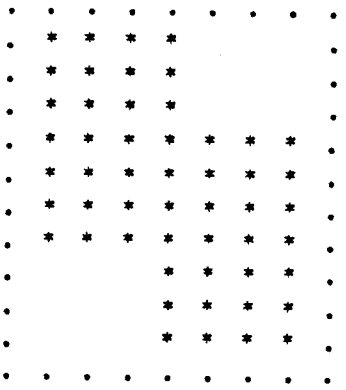
CODE AD H



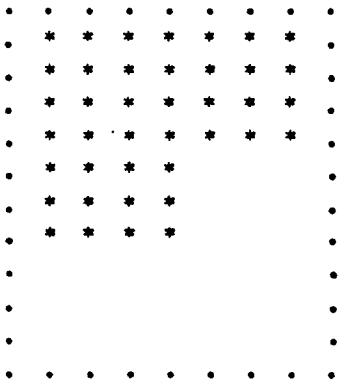
CODE B0 H



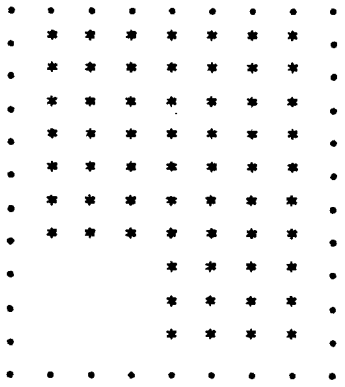
CODE B3 H



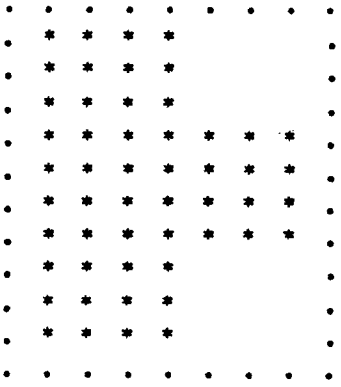
CODE B4 H



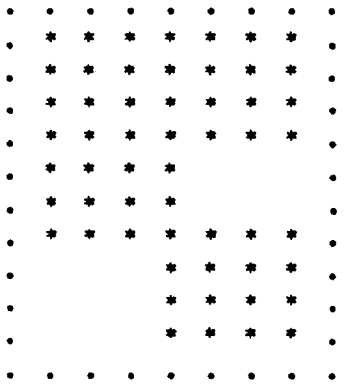
CODE B7 H



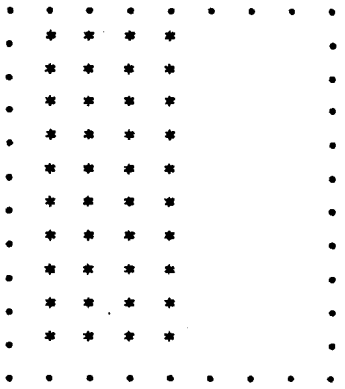
CODE BA H



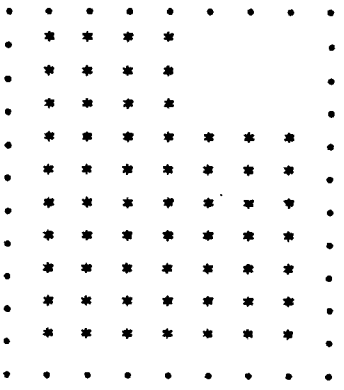
CODE B5 H



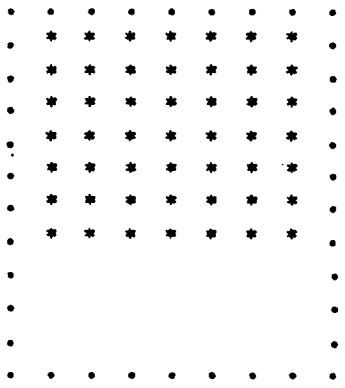
CODE B8 H



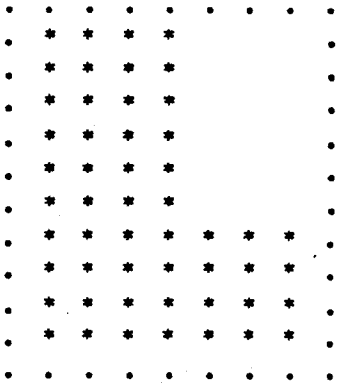
CODE BB H



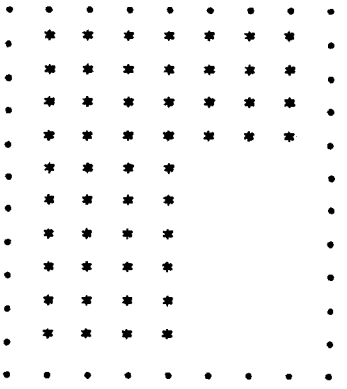
CODE B6 H



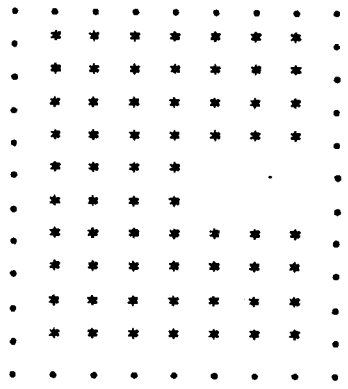
CODE B9 H



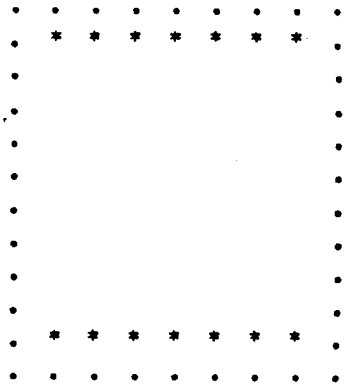
CODE BC H



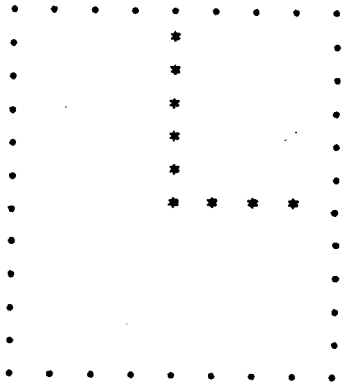
CODE BD H



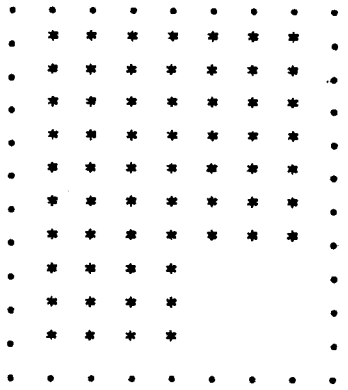
CODE C0 H



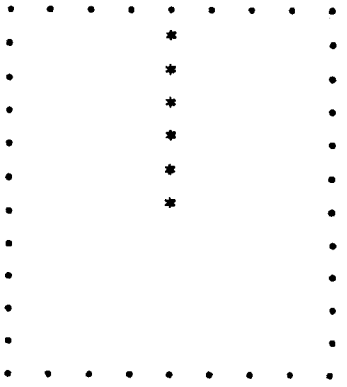
CODE C3 H



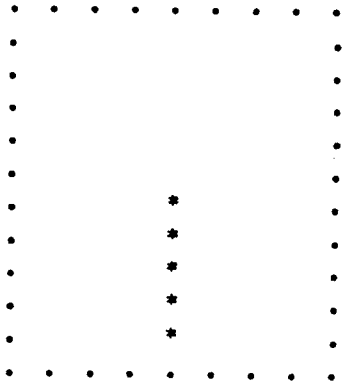
CODE BE H



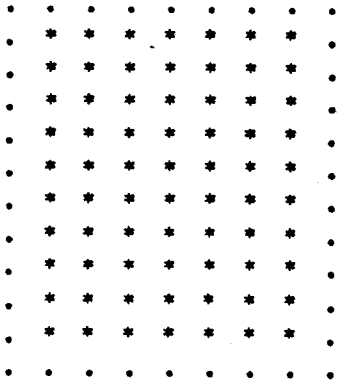
CODE C1 H



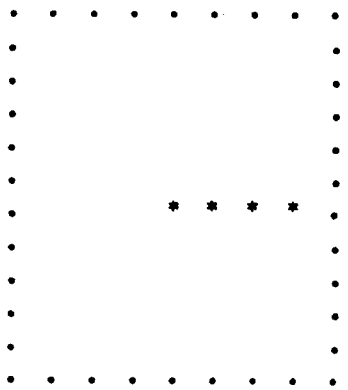
CODE C4 H



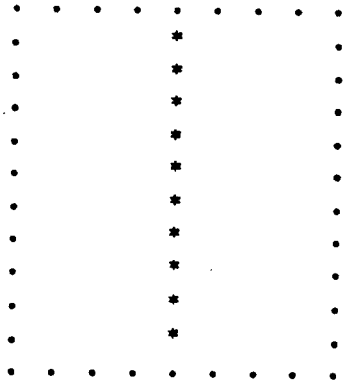
CODE BF H



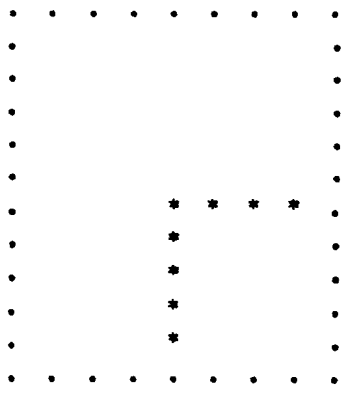
CODE C2 H



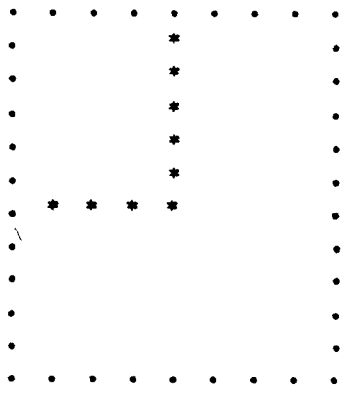
CODE C5 H



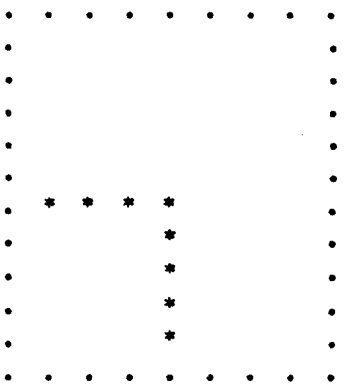
CODE C6 H



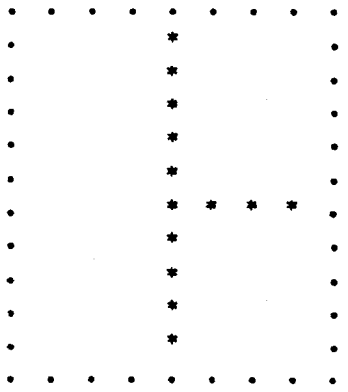
CODE C9 H



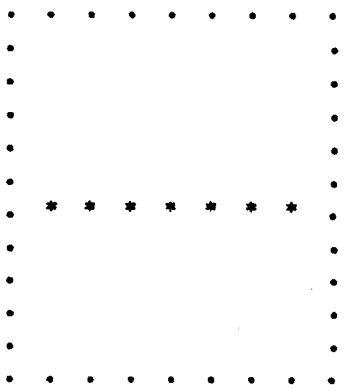
CODE CC H



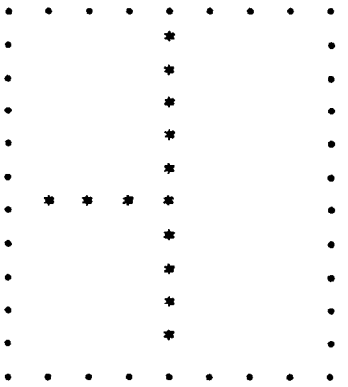
CODE C7 H



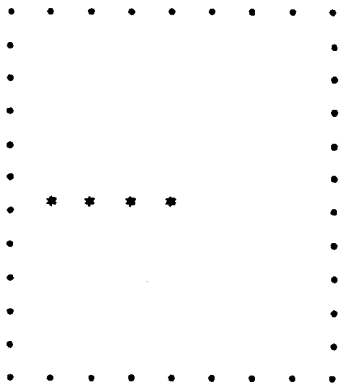
CODE CA H



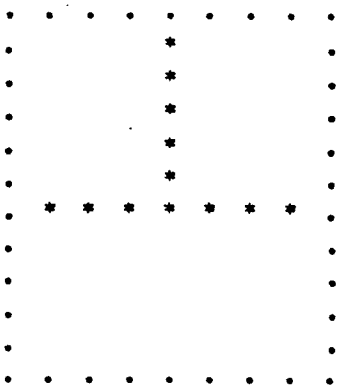
CODE CD H



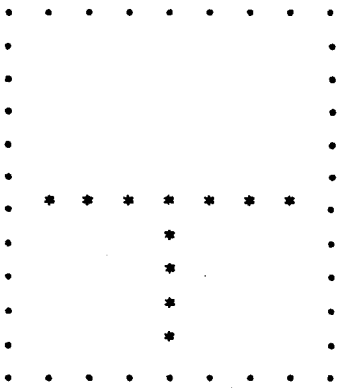
CODE C8 H



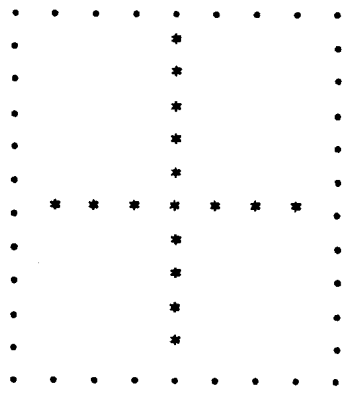
CODE CB H



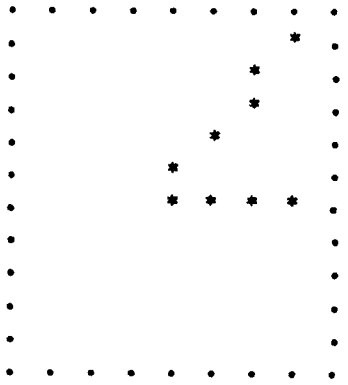
CODE CE H



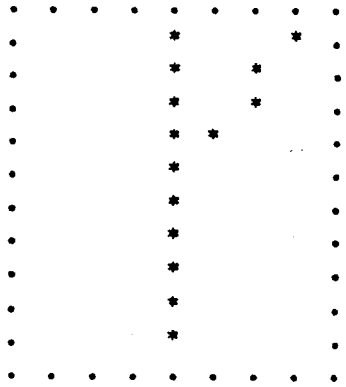
CODE CF H



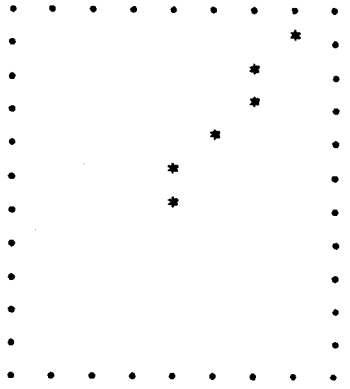
CODE D2 H



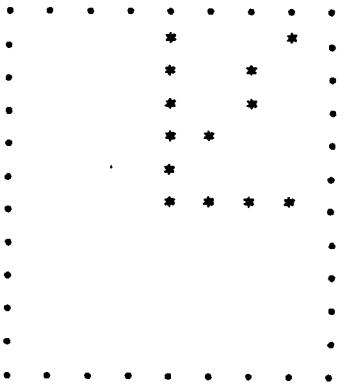
CODE D5 H



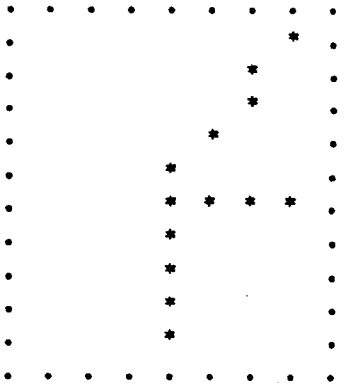
CODE D0 H



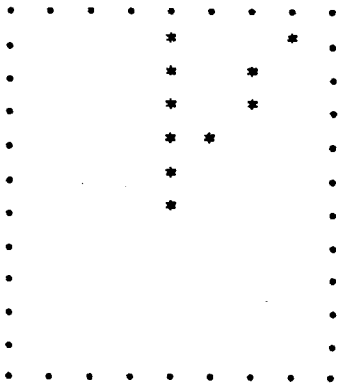
CODE D3 H



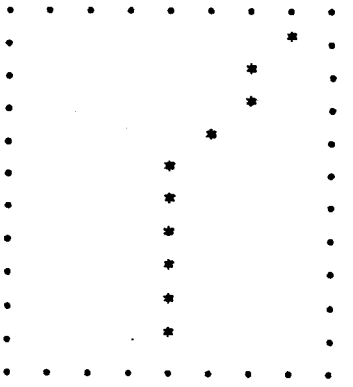
CODE D6 H



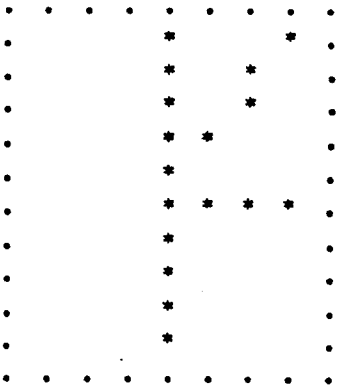
CODE D1 H



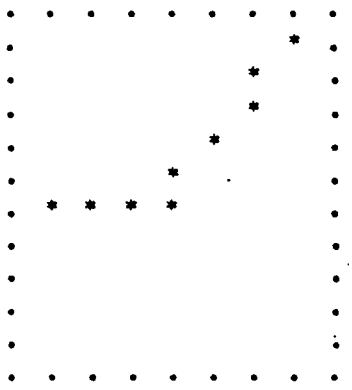
CODE D4 H



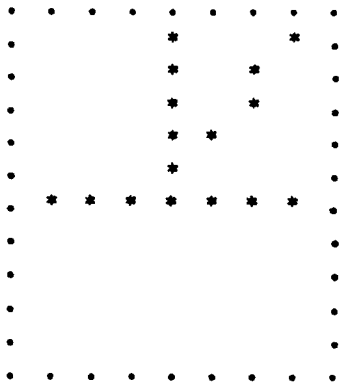
CODE D7 H



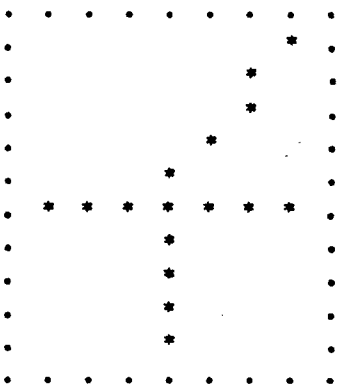
CODE D8 H



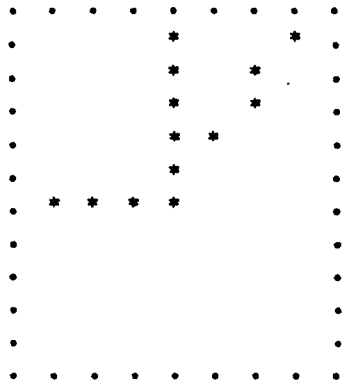
CODE DB H



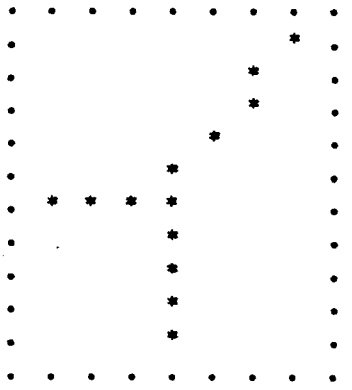
CODE DE H



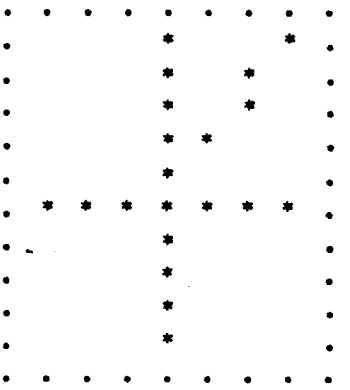
CODE D9 H



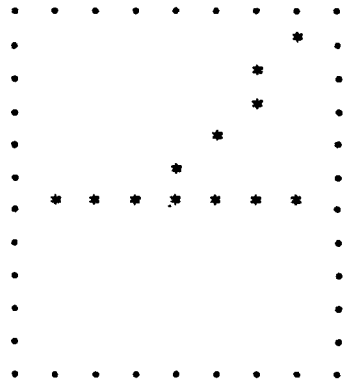
CODE DC H



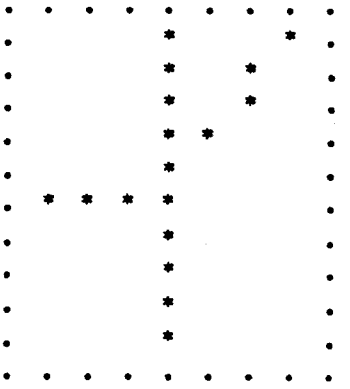
CODE DF H



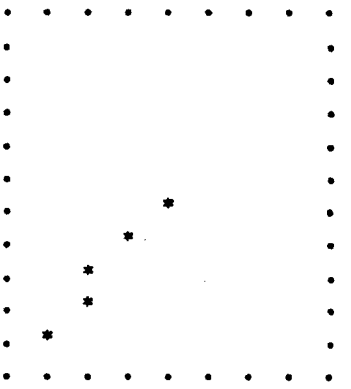
CODE DA H



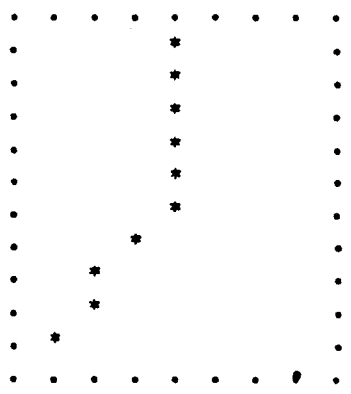
CODE DD H



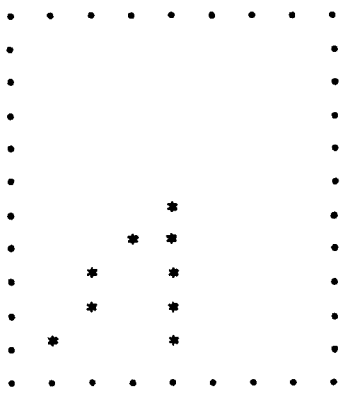
CODE E0 H



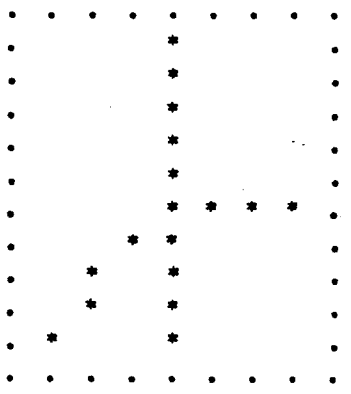
CODE E1 H



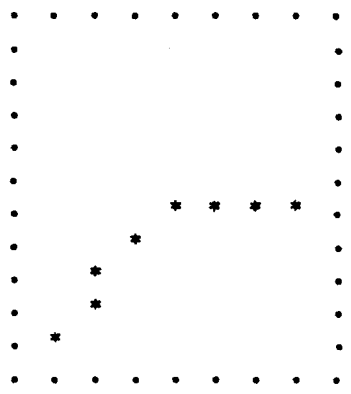
CODE E4 H



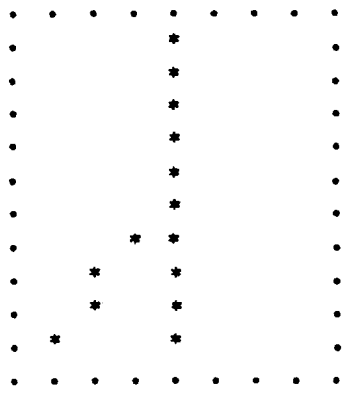
CODE E7 H



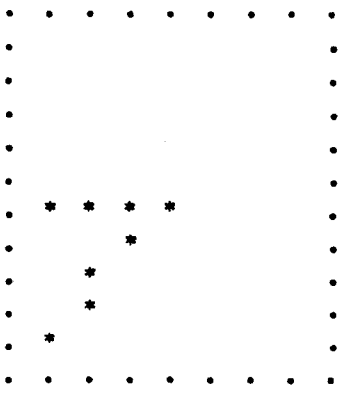
CODE E2 H



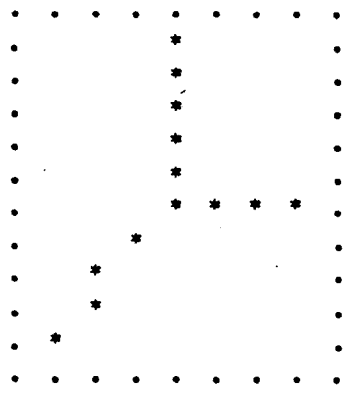
CODE E5 H



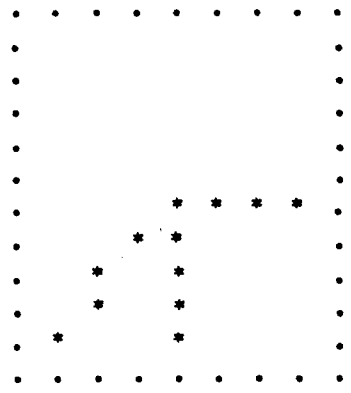
CODE E8 H



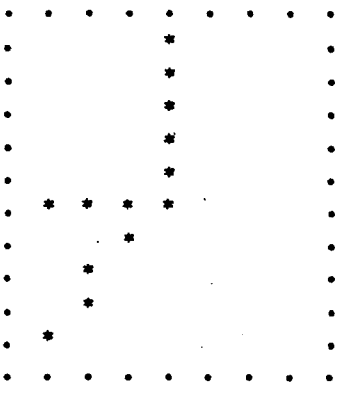
CODE E3 H



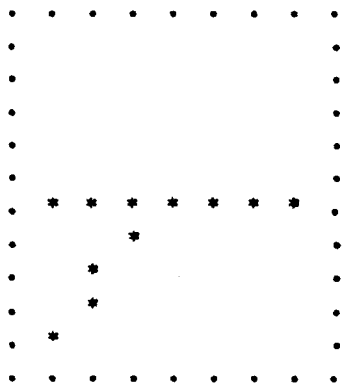
CODE E6 H



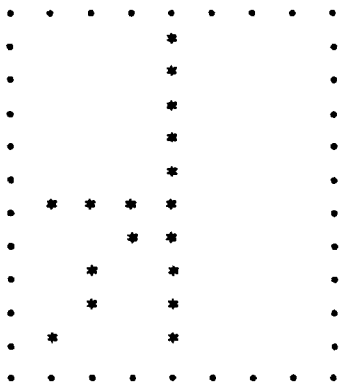
CODE E9 H



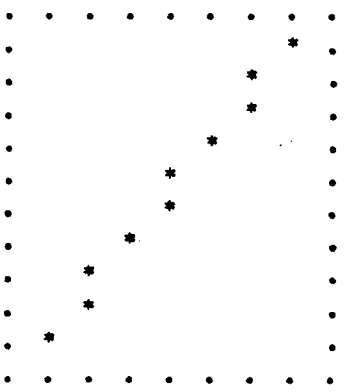
CODE EA H



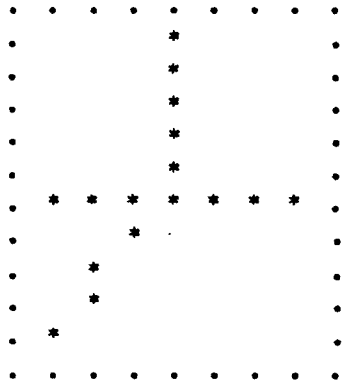
CODE ED H



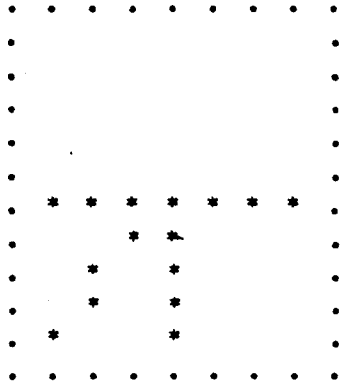
CODE F0 H



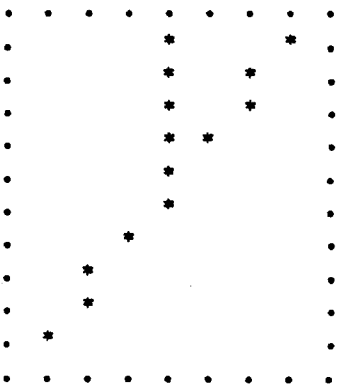
CODE EB H



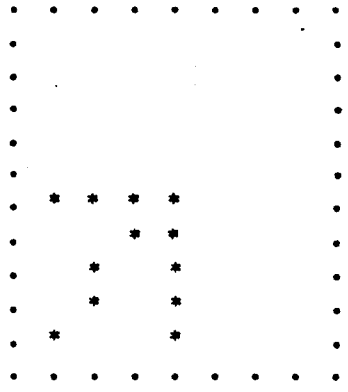
CODE EE H



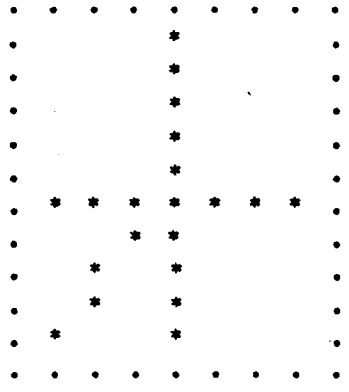
CODE F1 H



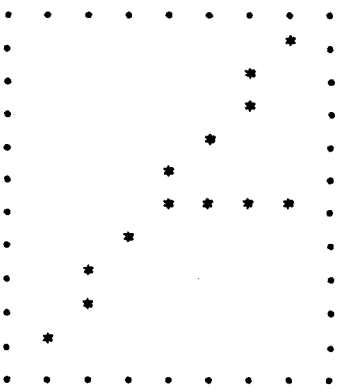
CODE EC H



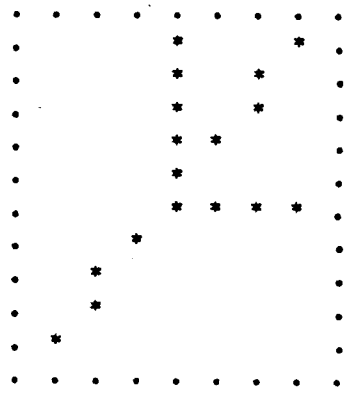
CODE EF H



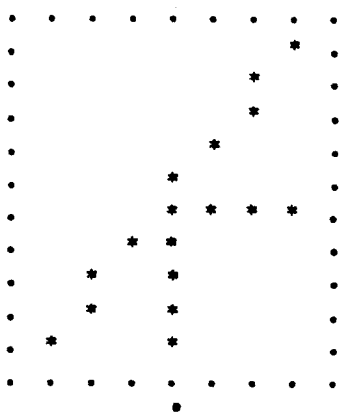
CODE F2 H



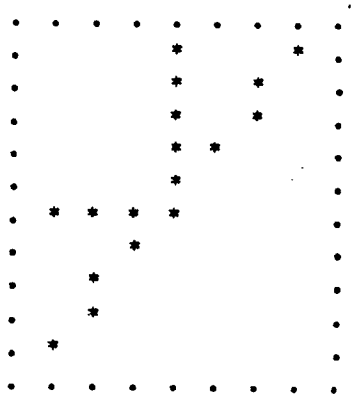
CODE F3 H



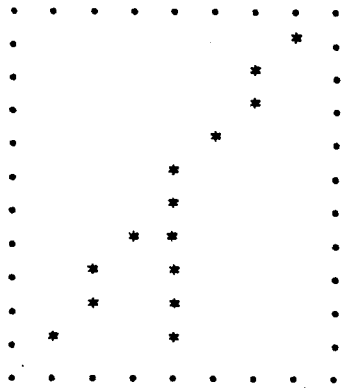
CODE F6 H



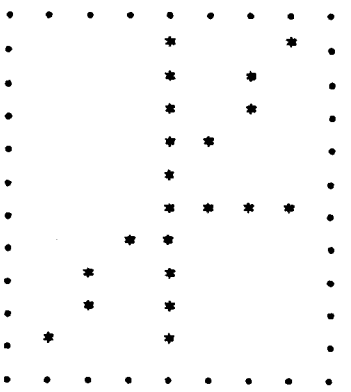
CODE F9 H



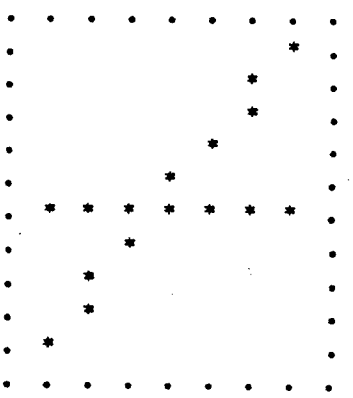
CODE F4 H



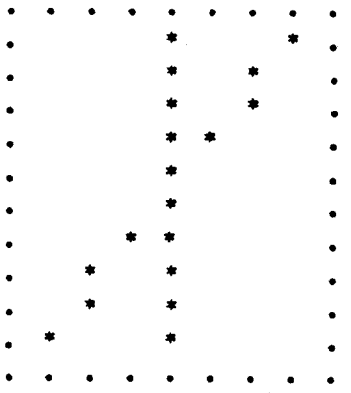
CODE F7 H



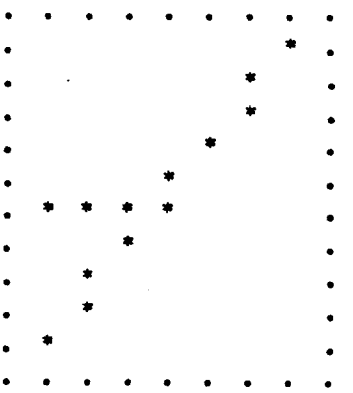
CODE FA H



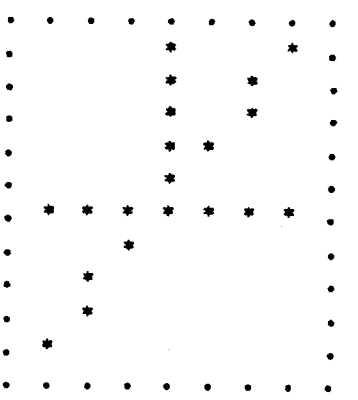
CODE F5 H



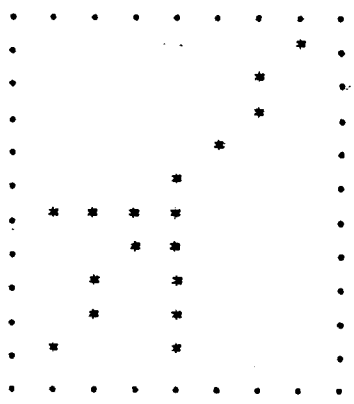
CODE F8 H



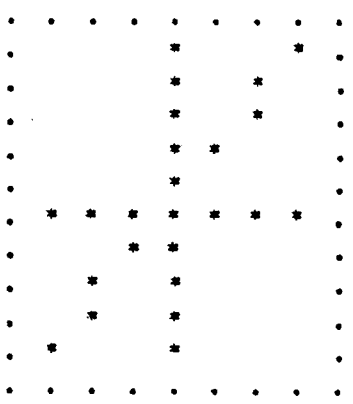
CODE FB H



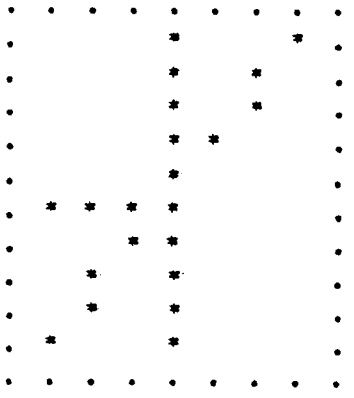
CODE FC H



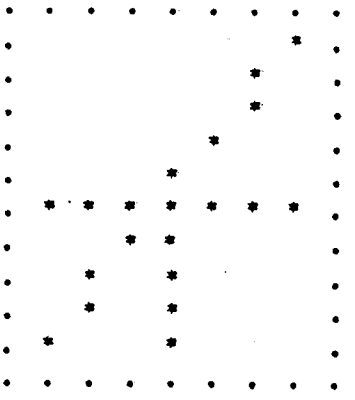
CODE FF H



CODE FD H



CODE FE H



APPENDIX 2 ----------

X,Y POSITION CODES

| Y OR X | CODE | ASCII |
|---|---|---|
| 1 | 20 H | SPACE |
| 2 | 21 H | ! |
| 3 | 22 H | " |
| 4 | 23 H | # |
| 5 | 24 H | $ |
| 6 | 25 H | % |
| 7 | 26 H | & |
| 8 | 27 H | ' |
| 9 | 28 H | ( |
| 10 | 29 H | ) |
| 11 | 2A H | * |
| 12 | 2B H | + |
| 13 | 2C H | ` |
| 14 | 2D H | - |
| 15 | 2E H | . |
| 16 | 2F H | / |
| 17 | 30 H | 0 |
| 18 | 31 H | 1 |
| 19 | 32 H | 2 |
| 20 | 33 H | 3 |
| 21 | 34 H | 4 |
| 22 | 35 H | 5 |
| 23 | 36 H | 6 |
| 24 | 37 H | 7 |
| 25 | 38 H | 8 |
| 26 | 39 H | 9 |
| 27 | 3A H | : |

| X | CODE | ASCII |
|---|---|---|
| 28 | 3B H | ; |
| 29 | 3C H | < |
| 30 | 3D H | = |
| 31 | 3E H | > |
| 32 | 3F H | ? |
| 33 | 40 H | @ |
| 34 | 41 H | A |
| 35 | 42 H | B |
| 36 | 43 H | C |
| 37 | 44 H | D |
| 38 | 45 H | E |
| 39 | 46 H | F |
| 40 | 47 H | G |
| 41 | 48 H | H |
| 42 | 49 H | I |
| 43 | 4A H | J |
| 44 | 4B H | K |
| 45 | 4C H | L |
| 46 | 4D H | M |
| 47 | 4E H | N |
| 48 | 4F H | O |
| 49 | 50 H | P |
| 50 | 51 H | Q |
| 51 | 52 H | R |
| 52 | 53 H | S |
| 53 | 54 H | T |
| 54 | 55 H | U |

| X | CODE | ASCII |
|---|---|---|
| 55 | 56 H | V |
| 56 | 57 H | W |
| 57 | 58 H | X |
| 58 | 59 H | Y |
| 59 | 5A H | Z |
| 60 | 5B H | [ |
| 61 | 5C H | \ |
| 62 | 5D H | ] |
| 63 | 5E H | ^ |
| 64 | 5F H | ← |
| 65 | 60 H | |
| 66 | 61 H | a |
| 67 | 62 H | b |
| 68 | 63 H | c |
| 69 | 64 H | d |
| 70 | 65 H | e |
| 71 | 66 H | f |
| 72 | 67 H | g |
| 73 | 68 H | h |
| 74 | 69 H | i |
| 75 | 6A H | j |
| 76 | 6B H | k |
| 77 | 6C H | l |
| 78 | 6D H | m |
| 79 | 6E H | n |
| 80 | 6F H | o |

## APPENDIX 3

### Simple VIO Driver

This appendix lists a simple VIO driver, assembled to reside at location 0100H. The driver assumes that the refresh memory resides in location F000 - F7FF. It will set-up the display with the following parameters:

40 characters per line
24 lines per page
positive video display
Mode 3 (graphics and ASCII characters may be displayed)

When it is desired to display a character on the screen, the user program should call the driver entry point (0100H) with the character code (for the character to be displayed) in the accumulator. Note that codes 00 - FFH (Appendix 1) may be displayed with the following three exceptions.

CRTL-Z (1AH) will cause the screen to be erased
CR (0DH) will be recognized as a carriage return/line feed.
LF (0AH) will be ignored.

APPENDIX 3 ----------

SIMPLE VIO DRIVER LISTING

```
                ;*********************************************
                ;VIO DRIVER
                ;PUTS SCREEN IN 40/24 FORMAT AND SCROLLS AT
                ;CARRIAGE RETURN/LINE FEED.
                ;RECOGNIZED 1AH AS SCREEN ERASE
                ;RECOGNIZES 0DH AS CARRIAGE RETURN/LINE FEED
                ;IGNORES 0AH (LINE FEED)
                ;*********************************************
F7FF =          CTRPORT EQU 0F7FFH      ;HARDWARE CONTROL PORT
F000 =          REFRESH EQU 0F000H      ;REFRESH MEMORY LOCATION
0100                    ORG 100H
0100 E5         VIODRV  PUSH H
0101 C5                 PUSH B
0102 D5                 PUSH D
0103 F5                 PUSH PSW
0104 21FFF7             LXI H,CTRPORT
0107 36AD               MVI M,0ADH      ;24 BY 40
0109 FE1A               CPI 1AH         ;INIT?
010B C23301             JNZ VIO1
010E 01C003     ERASE   LXI B,960
0111 2100F0             LXI H,REFRESH
0114 3620       ERASE1  MVI M,' '
0116 0B                 DCX B
0117 23                 INX H
0118 78                 MOV A,B
0119 B1                 ORA C
011A C21401             JNZ ERASE1      ;CONTINUE UNTIL SCREEN ERASED
011D 21C0F3     LNER1   LXI H,REFRESH+960       ;LAST LINE
0120 0628               MVI B,40        ;40 CHARS PER LINE
0122 2B         LNER    DCX H
0123 3620               MVI M,' '
0125 05                 DCR B
0126 C22201             JNZ LNER
0129 367F       RETURN  MVI M,7FH       ;CURSOR CHAR
012B 226301             SHLD CURPTR
012E F1                 POP PSW
012F D1                 POP D
0130 C1                 POP B
0131 E1                 POP H           ;RESTORE USER STUFF
```

```
0132 C9                 RET
0133 2A6301    VIO1     LHLD CURPTR
0136 3620               MVI M,' '          ;REMOVE CURSOR
0138 FE0A               CPI 0AH            ;LINE FEED?
013A CA2901             JZ RETURN          ;YES.,IGNORE IT
013D FE0D               CPI 0DH            ;CARRIAGE RETURN?
013F C25801             JNZ VIO2           ;NO,DO INDIVID CHAR
0142 2100F0    SCROLL   LXI H,REFRESH
0145 1128F0             LXI D,REFRESH+40
0148 019803             LXI B,920
014B 1A        SCRL1    LDAX D             ;GET CHAR
014C 77                 MOV M,A            ;MOVE IT
014D 23                 INX H
014E 13                 INX D
014F 0B                 DCX B
0150 78                 MOV A,B
0151 B1                 ORA C
0152 C24B01             JNZ SCRL1
0155 C31D01             JMP LNER1
0158 77        VIO2     MOV M,A            ;PUT CHAR ON SCREEN
0159 23                 INX H              ;BUMP CURSOR
015A 7D                 MOV A,L
015B FEC0               CPI 0C0H           ;END OF LINE?
015D CA4201             JZ SCROLL          ;YES
0160 C32901             JMP RETURN
0163 0000      CURPTR   DW 0               ;CURSOR PTR STORAGE
               ;
0200                    ORG 200H
0200 310002    VIOTEST  LXI SP,200H
0203 DB03               IN 3
0205 E602               ANI 2
0207 CA0302             JZ VIOTEST+3
020A DB02               IN 2
020C CD0001             CALL VIODRV
020F C30302             JMP VIOTEST+3
0212                    END
```

APPENDIX 4 ——————————————

## PROGRAMMING THE CHARACTER GENERATOR ROMS/PROMS

When it is desired to implement other character sets, the VIO's character generator ROMS/PROMS may be appropriately reprogrammed or replaced.

The three 2308/2708 ROMS/PROMs at locations U47, U48, and U49 contain the dot patterns for the entire 256 character set of the VIO. Each character consists of a 7x10 dot matrix which includes inter-character and inter-line spacing. The top eight rows of the 128 character represented by character codes 00-7F H, are stored in U49. The top eight rows of the second group of characters, (represented by codes 80-FF H), are stored in U48. U47 contains the dot patterns for the bottom two rows of the entire 256 character set.

NOTE: If only U49 is installed, the descenders of all lower case letters will be missing.

## CHARACTER GENERATOR EXAMPLE

Figure III-22 shows an example of the ROM/EPROM entries for implimenting the character generator look-up tables. The figure shows a representation of the number "7" in a 5x7 dot format. The VIO uses a 7x10 dot format but this includes the inter-character and inter-line spacing. By including the spacing areas in the character matrix it is possible to form "no gap" graphic characters. Alphanumeric characters are normally limited to the 5x7 dot format.
Each row (seven dots) of each character has its own entry in the look-up table. The "dots" are stored in a "negative logic" format, i.e., a zero corresponds to a dot while a one corresponds to a blank. The left-most dot position in a row corresponds to the least significant bit in the associated look-up table entry.

The ASCII code for the number "7" is HEX 37. The correspondance between codes and ROM/PROM addresses is shown in Tables III-2 and III-3. Since 37 falls in the lower half of the character set, Table III-2 should be used. Note that for this character code, scans (rows) 0-9 correspond to locations 037, 0B7, 137, 1B7, 237, 2B7, 337, 3B7 of U49 and 037, 0B7 of U47.

There are no dots in the zero row. Because of the negative logic format this corresponds to all 7 bits being equal to one. Therefore the entry 7F is made at location 037 of ROM U49.

Row one has dots at all locations except the first and last. This requires an entry of 41 in location 0B7 of U49. Row two has a dot only in position 5. Recall that the left-most dot corresponds to the least significant bit. This pattern therefore corresponds to a 5F entry in location 137 of U49.

The remaining entries are as shown in the figure. It is very important to remember that the entries are in negative logic format and that the left-most dot position corresponds to the least significant bit in the entry.

Users who wish to do extensive character set development may wish to use the program CHARGEN included with this chapter. This program is written in IMSAI Extended BASIC.

CODE=37

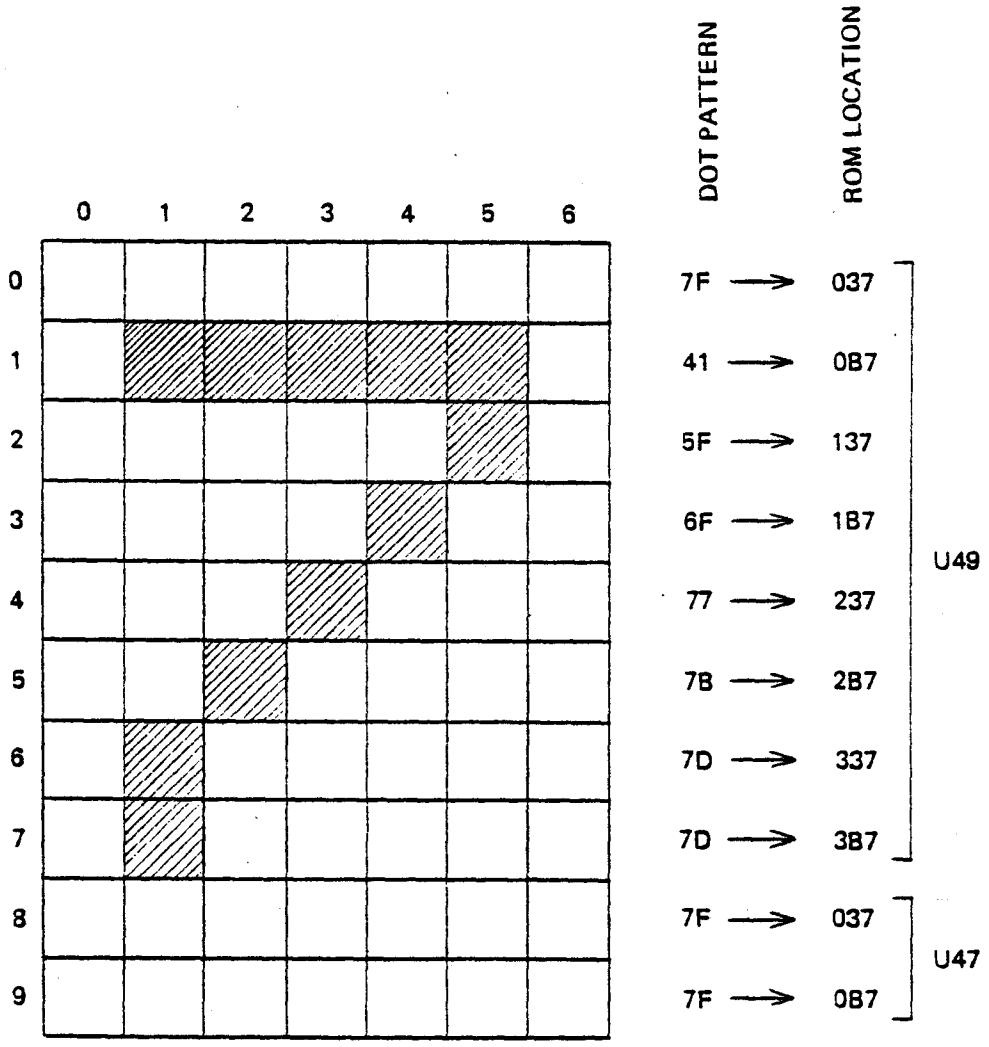



FIGURE III-22 CHARACTER GENERATOR EXAMPLE

TABLE III-2. LOW 128 FONT ROM ADDRESSES

| CODE | ROM ADDRESS (U49) | | | | | | | | | (U47) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | 9 | 10 | SCAN |
| 00 | 000 | 080 | 100 | 180 | 200 | 280 | 300 | 380 | -- | 000 | 080 | |
| 01 | 001 | 081 | 101 | 181 | 201 | 281 | 301 | 381 | -- | 001 | 081 | |
| 02 | 002 | 082 | 102 | 182 | 202 | 282 | 302 | 382 | -- | 002 | 082 | |
| 03 | 003 | 083 | 103 | 183 | 203 | 283 | 303 | 383 | -- | 003 | 083 | |
| 04 | 004 | 084 | 104 | 184 | 204 | 284 | 304 | 384 | -- | 004 | 084 | |
| 05 | 005 | 085 | 105 | 185 | 205 | 285 | 305 | 385 | -- | 005 | 085 | |
| 06 | 006 | 086 | 106 | 186 | 206 | 286 | 306 | 386 | -- | 006 | 086 | |
| 07 | 007 | 087 | 107 | 187 | 207 | 287 | 307 | 387 | -- | 007 | 087 | |
| 08 | 008 | 088 | 108 | 188 | 208 | 288 | 308 | 388 | -- | 008 | 088 | |
| 09 | 009 | 089 | 109 | 189 | 209 | 289 | 309 | 389 | -- | 009 | 089 | |
| 0A | 00A | 08A | 10A | 18A | 20A | 28A | 30A | 38A | -- | 00A | 08A | |
| 0B | 00B | 08B | 10B | 18B | 20B | 28B | 30B | 38B | -- | 00B | 08B | |
| 0C | 00C | 08C | 10C | 18C | 20C | 28C | 30C | 38C | -- | 00C | 08C | |
| 0D | 00D | 08D | 10D | 18D | 20D | 28D | 30D | 38D | -- | 00D | 08D | |
| 0E | 00E | 08E | 10E | 18E | 20E | 28E | 30E | 38E | -- | 00E | 08E | |
| 0F | 00F | 08F | 10F | 18F | 20F | 28F | 30F | 38F | -- | 00F | 08F | |
| 10 | 010 | 090 | 110 | 190 | 210 | 290 | 310 | 390 | -- | 010 | 090 | |
| 11 | 011 | 091 | 111 | 191 | 211 | 291 | 311 | 391 | -- | 011 | 091 | |
| 12 | 012 | 092 | 112 | 192 | 212 | 292 | 312 | 392 | -- | 012 | 092 | |
| 13 | 013 | 093 | 113 | 193 | 213 | 293 | 313 | 393 | -- | 013 | 093 | |
| 14 | 014 | 094 | 114 | 194 | 214 | 294 | 314 | 394 | -- | 014 | 094 | |
| 15 | 015 | 095 | 115 | 195 | 215 | 295 | 315 | 395 | -- | 015 | 095 | |
| 16 | 016 | 096 | 116 | 196 | 216 | 296 | 316 | 396 | -- | 016 | 096 | |
| 17 | 017 | 097 | 117 | 197 | 217 | 297 | 317 | 397 | -- | 017 | 097 | |
| 18 | 018 | 098 | 118 | 198 | 218 | 298 | 318 | 398 | -- | 018 | 098 | |
| 19 | 019 | 099 | 119 | 199 | 219 | 299 | 319 | 399 | -- | 019 | 099 | |
| 1A | 01A | 09A | 11A | 19A | 21A | 29A | 31A | 39A | -- | 01A | 09A | |
| 1B | 01B | 09B | 11B | 19B | 21B | 29B | 31B | 39B | -- | 01B | 09B | |
| 1C | 01C | 09C | 11C | 19C | 21C | 29C | 31C | 39C | -- | 01C | 09C | |
| 1D | 01D | 09D | 11D | 19D | 21D | 29D | 31D | 39D | -- | 01D | 09D | |
| 1E | 01E | 09E | 11E | 19E | 21E | 29E | 31E | 39E | -- | 01E | 09E | |
| 1F | 01F | 09F | 11F | 19F | 21F | 29F | 31F | 39F | -- | 01F | 09F | |
| 20 | 020 | 0A0 | 120 | 1A0 | 220 | 2A0 | 320 | 3A0 | -- | 020 | 0A0 | |
| 21 | 021 | 0A1 | 121 | 1A1 | 221 | 2A1 | 321 | 3A1 | -- | 021 | 0A1 | |
| 22 | 022 | 0A2 | 122 | 1A2 | 222 | 2A2 | 322 | 3A2 | -- | 022 | 0A2 | |
| 23 | 023 | 0A3 | 123 | 1A3 | 223 | 2A3 | 323 | 3A3 | -- | 023 | 0A3 | |
| 24 | 024 | 0A4 | 124 | 1A4 | 224 | 2A4 | 324 | 3A4 | -- | 024 | 0A4 | |
| 25 | 025 | 0A5 | 125 | 1A5 | 225 | 2A5 | 325 | 3A5 | -- | 025 | 0A5 | |
| 26 | 026 | 0A6 | 126 | 1A6 | 226 | 2A6 | 326 | 3A6 | -- | 026 | 0A6 | |
| 27 | 027 | 0A7 | 127 | 1A7 | 227 | 2A7 | 327 | 3A7 | -- | 027 | 0A7 | |
| 28 | 028 | 0A8 | 128 | 1A8 | 228 | 2A8 | 328 | 3A8 | -- | 028 | 0A8 | |
| 29 | 029 | 0A9 | 129 | 1A9 | 229 | 2A9 | 329 | 3A9 | -- | 029 | 0A9 | |
| 2A | 02A | 0AA | 12A | 1AA | 22A | 2AA | 32A | 3AA | -- | 02A | 0AA | |
| 2B | 02B | 0AB | 12B | 1AB | 22B | 2AB | 32B | 3AB | -- | 02B | 0AB | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2C | 02C | 0AC | 12C | 1AC | 22C | 2AC | 32C | 3AC | -- | 02C | 0AC |
| 2D | 02D | 0AD | 12D | 1AD | 22D | 2AD | 32D | 3AD | -- | 02D | 0AD |
| 2E | 02E | 0AE | 12E | 1AE | 22E | 2AE | 32E | 3AE | -- | 02E | 0AE |
| 2F | 02F | 0AF | 12F | 1AF | 22F | 2AF | 32F | 3AF | -- | 02F | 0AF |
| 30 | 030 | 0B0 | 130 | 1B0 | 230 | 2B0 | 330 | 3B0 | -- | 030 | 0B0 |
| 31 | 031 | 0B1 | 131 | 1B1 | 231 | 2B1 | 331 | 3B1 | -- | 031 | 0B1 |
| 32 | 032 | 0B2 | 132 | 1B2 | 232 | 2B2 | 332 | 3B2 | -- | 032 | 0B2 |
| 33 | 033 | 0B3 | 133 | 1B3 | 233 | 2B3 | 333 | 3B3 | -- | 033 | 0B3 |
| 34 | 034 | 0B4 | 134 | 1B4 | 234 | 2B4 | 334 | 3B4 | -- | 034 | 0B4 |
| 35 | 035 | 0B5 | 135 | 1B5 | 235 | 2B5 | 335 | 3B5 | -- | 035 | 0B5 |
| 36 | 036 | 0B6 | 136 | 1B6 | 236 | 2B6 | 336 | 3B6 | -- | 036 | 0B6 |
| 37 | 037 | 0B7 | 137 | 1B7 | 237 | 2B7 | 337 | 3B7 | -- | 037 | 0B7 |
| 38 | 038 | 0B8 | 138 | 1B8 | 238 | 2B8 | 338 | 3B8 | -- | 038 | 0B8 |
| 39 | 039 | 0B9 | 139 | 1B9 | 239 | 2B9 | 339 | 3B9 | -- | 039 | 0B9 |
| 3A | 03A | 0BA | 13A | 1BA | 23A | 2BA | 33A | 3BA | -- | 03A | 0BA |
| 3B | 03B | 0BB | 13B | 1BB | 23B | 2BB | 33B | 3BB | -- | 03B | 0BB |
| 3C | 03C | 0BC | 13C | 1BC | 23C | 2BC | 33C | 3BC | -- | 03C | 0BC |
| 3D | 03D | 0BD | 13D | 1BD | 23D | 2BD | 33D | 3BD | -- | 03D | 0BD |
| 3E | 03E | 0BE | 13E | 1BE | 23E | 2BE | 33E | 3BE | -- | 03E | 0BE |
| 3F | 03F | 0BF | 13F | 1BF | 23F | 2BF | 33F | 3BF | -- | 03F | 0BF |
| 40 | 040 | 0C0 | 140 | 1C0 | 240 | 2C0 | 340 | 3C0 | -- | 040 | 0C0 |
| 41 | 041 | 0C1 | 141 | 1C1 | 241 | 2C1 | 341 | 3C1 | -- | 041 | 0C1 |
| 42 | 042 | 0C2 | 142 | 1C2 | 242 | 2C2 | 342 | 3C2 | -- | 042 | 0C2 |
| 43 | 043 | 0C3 | 143 | 1C3 | 243 | 2C3 | 343 | 3C3 | -- | 043 | 0C3 |
| 44 | 044 | 0C4 | 144 | 1C4 | 244 | 2C4 | 344 | 3C4 | -- | 044 | 0C4 |
| 45 | 045 | 0C5 | 145 | 1C5 | 245 | 2C5 | 345 | 3C5 | -- | 045 | 0C5 |
| 46 | 046 | 0C6 | 146 | 1C6 | 246 | 2C6 | 346 | 3C6 | -- | 046 | 0C6 |
| 47 | 047 | 0C7 | 147 | 1C7 | 247 | 2C7 | 347 | 3C7 | -- | 047 | 0C7 |
| 48 | 048 | 0C8 | 148 | 1C8 | 248 | 2C8 | 348 | 3C8 | -- | 048 | 0C8 |
| 49 | 049 | 0C9 | 149 | 1C9 | 249 | 2C9 | 349 | 3C9 | -- | 049 | 0C9 |
| 4A | 04A | 0CA | 14A | 1CA | 24A | 2CA | 34A | 3CA | -- | 04A | 0CA |
| 4B | 04B | 0CB | 14B | 1CB | 24B | 2CB | 34B | 3CB | -- | 04B | 0CB |
| 4C | 04C | 0CC | 14C | 1CC | 24C | 2CC | 34C | 3CC | -- | 04C | 0CC |
| 4D | 04D | 0CD | 14D | 1CD | 24D | 2CD | 34D | 3CD | -- | 04D | 0CD |
| 4E | 04E | 0CE | 14E | 1CE | 24E | 2CE | 34E | 3CE | -- | 04E | 0CE |
| 4F | 04F | 0CF | 14F | 1CF | 24F | 2CF | 34F | 3CF | -- | 04F | 0CF |
| 50 | 050 | 0D0 | 150 | 1D0 | 250 | 2D0 | 350 | 3D0 | -- | 050 | 0D0 |
| 51 | 051 | 0D1 | 151 | 1D1 | 251 | 2D1 | 351 | 3D1 | -- | 051 | 0D1 |
| 52 | 052 | 0D2 | 152 | 1D2 | 252 | 2D2 | 352 | 3D2 | -- | 052 | 0D2 |
| 53 | 053 | 0D3 | 153 | 1D3 | 253 | 2D3 | 353 | 3D3 | -- | 053 | 0D3 |
| 54 | 054 | 0D4 | 154 | 1D4 | 254 | 2D4 | 354 | 3D4 | -- | 054 | 0D4 |
| 55 | 055 | 0D5 | 155 | 1D5 | 255 | 2D5 | 355 | 3D5 | -- | 055 | 0D5 |
| 56 | 056 | 0D6 | 156 | 1D6 | 256 | 2D6 | 356 | 3D6 | -- | 056 | 0D6 |
| 57 | 057 | 0D7 | 157 | 1D7 | 257 | 2D7 | 357 | 3D7 | -- | 057 | 0D7 |
| 58 | 058 | 0D8 | 158 | 1D8 | 258 | 2D8 | 358 | 3D8 | -- | 058 | 0D8 |
| 59 | 059 | 0D9 | 159 | 1D9 | 259 | 2D9 | 359 | 3D9 | -- | 059 | 0D9 |
| 5A | 05A | 0DA | 15A | 1DA | 25A | 2DA | 35A | 3DA | -- | 05A | 0DA |
| 5B | 05B | 0DB | 15B | 1DB | 25B | 2DB | 35B | 3DB | -- | 05B | 0DB |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5C | 05C | 0DC | 15C | 1DC | 25C | 2DC | 35C | 3DC | -- | 05C | 0DC |
| 5D | 05D | 0DD | 15D | 1DD | 25D | 2DD | 35D | 3DD | -- | 05D | 0DD |
| 5E | 05E | 0DE | 15E | 1DE | 25E | 2DE | 35E | 3DE | -- | 05E | 0DE |
| 5F | 05F | 0DF | 15F | 1DF | 25F | 2DF | 35F | 3DF | -- | 05F | 0DF |
| 60 | 060 | 0E0 | 160 | 1E0 | 260 | 2E0 | 360 | 3E0 | -- | 060 | 0E0 |
| 61 | 061 | 0E1 | 161 | 1E1 | 261 | 2E1 | 361 | 3E1 | -- | 061 | 0E1 |
| 62 | 062 | 0E2 | 162 | 1E2 | 262 | 2E2 | 362 | 3E2 | -- | 062 | 0E2 |
| 63 | 063 | 0E3 | 163 | 1E3 | 263 | 2E3 | 363 | 3E3 | -- | 063 | 0E3 |
| 64 | 064 | 0E4 | 164 | 1E4 | 264 | 2E4 | 364 | 3E4 | -- | 064 | 0E4 |
| 65 | 065 | 0E5 | 165 | 1E5 | 265 | 2E5 | 365 | 3E5 | -- | 065 | 0E5 |
| 66 | 066 | 0E6 | 166 | 1E6 | 266 | 2E6 | 366 | 3E6 | -- | 066 | 0E6 |
| 67 | 067 | 0E7 | 167 | 1E7 | 267 | 2E7 | 367 | 3E7 | -- | 067 | 0E7 |
| 68 | 068 | 0E8 | 168 | 1E8 | 268 | 2E8 | 368 | 3E8 | -- | 068 | 0E8 |
| 69 | 069 | 0E9 | 169 | 1E9 | 269 | 2E9 | 369 | 3E9 | -- | 069 | 0E9 |
| 6A | 06A | 0EA | 16A | 1EA | 26A | 2EA | 36A | 3EA | -- | 06A | 0EA |
| 6B | 06B | 0EB | 16B | 1EB | 26B | 2EB | 36B | 3EB | -- | 06B | 0EB |
| 6C | 06C | 0EC | 16C | 1EC | 26C | 2EC | 36C | 3EC | -- | 06C | 0EC |
| 6D | 06D | 0ED | 16D | 1ED | 26D | 2ED | 36D | 3ED | -- | 06D | 0ED |
| 6E | 06E | 0EE | 16E | 1EE | 26E | 2EE | 36E | 3EE | -- | 06E | 0EE |
| 6F | 06F | 0EF | 16F | 1EF | 26F | 2EF | 36F | 3EF | -- | 06F | 0EF |
| 70 | 070 | 0F0 | 170 | 1F0 | 270 | 2F0 | 370 | 3F0 | -- | 070 | 0F0 |
| 71 | 071 | 0F1 | 171 | 1F1 | 271 | 2F1 | 371 | 3F1 | -- | 071 | 0F1 |
| 72 | 072 | 0F2 | 172 | 1F2 | 272 | 2F2 | 372 | 3F2 | -- | 072 | 0F2 |
| 73 | 073 | 0F3 | 173 | 1F3 | 273 | 2F3 | 373 | 3F3 | -- | 073 | 0F3 |
| 74 | 074 | 0F4 | 174 | 1F4 | 274 | 2F4 | 374 | 3F4 | -- | 074 | 0F4 |
| 75 | 075 | 0F5 | 175 | 1F5 | 275 | 2F5 | 375 | 3F5 | -- | 075 | 0F5 |
| 76 | 076 | 0F6 | 176 | 1F6 | 276 | 2F6 | 376 | 3F6 | -- | 076 | 0F6 |
| 77 | 077 | 0F7 | 177 | 1F7 | 277 | 2F7 | 377 | 3F7 | -- | 077 | 0F7 |
| 78 | 078 | 0F8 | 178 | 1F8 | 278 | 2F8 | 378 | 3F8 | -- | 078 | 0F8 |
| 79 | 079 | 0F9 | 179 | 1F9 | 279 | 2F9 | 379 | 3F9 | -- | 079 | 0F9 |
| 7A | 07A | 0FA | 17A | 1FA | 27A | 2FA | 37A | 3FA | -- | 07A | 0FA |
| 7B | 07B | 0FB | 17B | 1FB | 27B | 2FB | 37B | 3FB | -- | 07B | 0FB |
| 7C | 07C | 0FC | 17C | 1FC | 27C | 2FC | 37C | 3FC | -- | 07C | 0FC |
| 7D | 07D | 0FD | 17D | 1FD | 27D | 2FD | 37D | 3FD | -- | 07D | 0FD |
| 7E | 07E | 0FE | 17E | 1FE | 27E | 2FE | 37E | 3FE | -- | 07E | 0FE |
| 7F | 07F | 0FF | 17F | 1FF | 27F | 2FF | 37F | 3FF | -- | 07F | 0FF |

TABLE III-3. HIGH 128 FONT ROM ADDRESSES

| CODE | ROM ADDRESS (U48) | | | | | | | | | (U47) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | 9 | 10 | SCAN |
| 80 | 000 | 080 | 100 | 180 | 200 | 280 | 300 | 380 | -- | 200 | 280 | |
| 81 | 001 | 081 | 101 | 181 | 201 | 281 | 301 | 381 | -- | 201 | 281 | |
| 82 | 002 | 082 | 102 | 182 | 202 | 282 | 302 | 382 | -- | 202 | 282 | |
| 83 | 003 | 083 | 103 | 183 | 203 | 283 | 303 | 383 | -- | 203 | 283 | |
| 84 | 004 | 084 | 104 | 184 | 204 | 284 | 304 | 384 | -- | 204 | 284 | |
| 85 | 005 | 085 | 105 | 185 | 205 | 285 | 305 | 385 | -- | 205 | 285 | |
| 86 | 006 | 086 | 106 | 186 | 206 | 286 | 306 | 386 | -- | 206 | 286 | |
| 87 | 007 | 087 | 107 | 187 | 207 | 287 | 307 | 387 | -- | 207 | 287 | |
| 88 | 008 | 088 | 108 | 188 | 208 | 288 | 308 | 388 | -- | 208 | 288 | |
| 89 | 009 | 089 | 109 | 189 | 209 | 289 | 309 | 389 | -- | 209 | 289 | |
| 8A | 00A | 08A | 10A | 18A | 20A | 28A | 30A | 38A | -- | 20A | 28A | |
| 8B | 00B | 08B | 10B | 18B | 20B | 28B | 30B | 38B | -- | 20B | 28B | |
| 8C | 00C | 08C | 10C | 18C | 20C | 28C | 30C | 38C | -- | 20C | 28C | |
| 8D | 00D | 08D | 10D | 18D | 20D | 28D | 30D | 38D | -- | 20D | 28D | |
| 8E | 00E | 08E | 10E | 18E | 20E | 28E | 30E | 38E | -- | 20E | 28E | |
| 8F | 00F | 08F | 10F | 18F | 20F | 28F | 30F | 38F | -- | 20F | 28F | |
| 90 | 010 | 090 | 110 | 190 | 210 | 290 | 310 | 390 | -- | 210 | 290 | |
| 91 | 011 | 091 | 111 | 191 | 211 | 291 | 311 | 391 | -- | 211 | 291 | |
| 92 | 012 | 092 | 112 | 192 | 212 | 292 | 312 | 392 | -- | 212 | 292 | |
| 93 | 013 | 093 | 113 | 193 | 213 | 293 | 313 | 393 | -- | 213 | 293 | |
| 94 | 014 | 094 | 114 | 194 | 214 | 294 | 314 | 394 | -- | 214 | 294 | |
| 95 | 015 | 095 | 115 | 195 | 215 | 295 | 315 | 395 | -- | 215 | 295 | |
| 96 | 016 | 096 | 116 | 196 | 216 | 296 | 316 | 396 | -- | 216 | 296 | |
| 97 | 017 | 097 | 117 | 197 | 217 | 297 | 317 | 397 | -- | 217 | 297 | |
| 98 | 018 | 098 | 118 | 198 | 218 | 298 | 318 | 398 | -- | 218 | 298 | |
| 99 | 019 | 099 | 119 | 199 | 219 | 299 | 319 | 399 | -- | 219 | 299 | |
| 9A | 01A | 09A | 11A | 19A | 21A | 29A | 31A | 39A | -- | 21A | 29A | |
| 9B | 01B | 09B | 11B | 19B | 21B | 29B | 31B | 39B | -- | 21B | 29B | |
| 9C | 01C | 09C | 11C | 19C | 21C | 29C | 31C | 39C | -- | 21C | 29C | |
| 9D | 01D | 09D | 11D | 19D | 21D | 29D | 31D | 39D | -- | 21D | 29D | |
| 9E | 01E | 09E | 11E | 19E | 21E | 29E | 31E | 39E | -- | 21E | 29E | |
| 9F | 01F | 09F | 11F | 19F | 21F | 29F | 31F | 39F | -- | 21F | 29F | |
| A0 | 020 | 0A0 | 120 | 1A0 | 220 | 2A0 | 320 | 3A0 | -- | 220 | 2A0 | |
| A1 | 021 | 0A1 | 121 | 1A1 | 221 | 2A1 | 321 | 3A1 | -- | 221 | 2A1 | |
| A2 | 022 | 0A2 | 122 | 1A2 | 222 | 2A2 | 322 | 3A2 | -- | 222 | 2A2 | |
| A3 | 023 | 0A3 | 123 | 1A3 | 223 | 2A3 | 323 | 3A3 | -- | 223 | 2A3 | |
| A4 | 024 | 0A4 | 124 | 1A4 | 224 | 2A4 | 324 | 3A4 | -- | 224 | 2A4 | |
| A5 | 025 | 0A5 | 125 | 1A5 | 225 | 2A5 | 325 | 3A5 | -- | 225 | 2A5 | |
| A6 | 026 | 0A6 | 126 | 1A6 | 226 | 2A6 | 326 | 3A6 | -- | 226 | 2A6 | |
| A7 | 027 | 0A7 | 127 | 1A7 | 227 | 2A7 | 327 | 3A7 | -- | 227 | 2A7 | |
| A8 | 028 | 0A8 | 128 | 1A8 | 228 | 2A8 | 328 | 3A8 | -- | 228 | 2A8 | |
| A9 | 029 | 0A9 | 129 | 1A9 | 229 | 2A9 | 329 | 3A9 | -- | 229 | 2A9 | |
| AA | 02A | 0AA | 12A | 1AA | 22A | 2AA | 32A | 3AA | -- | 22A | 2AA | |
| AB | 02B | 0AB | 12B | 1AB | 22B | 2AB | 32B | 3AB | -- | 22B | 2AB | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AC | 02C | 0AC | 12C | 1AC | 22C | 2AC | 32C | 3AC | -- | 22C | 2AC |
| AD | 02D | 0AD | 12D | 1AD | 22D | 2AD | 32D | 3AD | -- | 22D | 2AD |
| AE | 02E | 0AE | 12E | 1AE | 22E | 2AE | 32E | 3AE | -- | 22E | 2AE |
| AF | 02F | 0AF | 12F | 1AF | 22F | 2AF | 32F | 3AF | -- | 22F | 2AF |
| B0 | 030 | 0B0 | 130 | 1B0 | 230 | 2B0 | 330 | 3B0 | -- | 230 | 2B0 |
| B1 | 031 | 0B1 | 131 | 1B1 | 231 | 2B1 | 331 | 3B1 | -- | 231 | 2B1 |
| B2 | 032 | 0B2 | 132 | 1B2 | 232 | 2B2 | 332 | 3B2 | -- | 232 | 2B2 |
| B3 | 033 | 0B3 | 133 | 1B3 | 233 | 2B3 | 333 | 3B3 | -- | 233 | 2B3 |
| B4 | 034 | 0B4 | 134 | 1B4 | 234 | 2B4 | 334 | 3B4 | -- | 234 | 2B4 |
| B5 | 035 | 0B5 | 135 | 1B5 | 235 | 2B5 | 335 | 3B5 | -- | 235 | 2B5 |
| B6 | 036 | 0B6 | 136 | 1B6 | 236 | 2B6 | 336 | 3B6 | -- | 236 | 2B6 |
| B7 | 037 | 0B7 | 137 | 1B7 | 237 | 2B7 | 337 | 3B7 | -- | 237 | 2B7 |
| B8 | 038 | 0B8 | 138 | 1B8 | 238 | 2B8 | 338 | 3B8 | -- | 238 | 2B8 |
| B9 | 039 | 0B9 | 139 | 1B9 | 239 | 2B9 | 339 | 3B9 | -- | 239 | 2B9 |
| BA | 03A | 0BA | 13A | 1BA | 23A | 2BA | 33A | 3BA | -- | 23A | 2BA |
| BB | 03B | 0BB | 13B | 1BB | 23B | 2BB | 33B | 3BB | -- | 23B | 2BB |
| BC | 03C | 0BC | 13C | 1BC | 23C | 2BC | 33C | 3BC | -- | 23C | 2BC |
| BD | 03D | 0BD | 13D | 1BD | 23D | 2BD | 33D | 3BD | -- | 23D | 2BD |
| BE | 03E | 0BE | 13E | 1BE | 23E | 2BE | 33E | 3BE | -- | 23E | 2BE |
| BF | 03F | 0BF | 13F | 1BF | 23F | 2BF | 33F | 3BF | -- | 23F | 2BF |
| C0 | 040 | 0C0 | 140 | 1C0 | 240 | 2C0 | 340 | 3C0 | -- | 240 | 2C0 |
| C1 | 041 | 0C1 | 141 | 1C1 | 241 | 2C1 | 341 | 3C1 | -- | 241 | 2C1 |
| C2 | 042 | 0C2 | 142 | 1C2 | 242 | 2C2 | 342 | 3C2 | -- | 242 | 2C2 |
| C3 | 043 | 0C3 | 143 | 1C3 | 243 | 2C3 | 343 | 3C3 | -- | 243 | 2C3 |
| C4 | 044 | 0C4 | 144 | 1C4 | 244 | 2C4 | 344 | 3C4 | -- | 244 | 2C4 |
| C5 | 045 | 0C5 | 145 | 1C5 | 245 | 2C5 | 345 | 3C5 | -- | 245 | 2C5 |
| C6 | 046 | 0C6 | 146 | 1C6 | 246 | 2C6 | 346 | 3C6 | -- | 246 | 2C6 |
| C7 | 047 | 0C7 | 147 | 1C7 | 247 | 2C7 | 347 | 3C7 | -- | 247 | 2C7 |
| C8 | 048 | 0C8 | 148 | 1C8 | 248 | 2C8 | 348 | 3C8 | -- | 248 | 2C8 |
| C9 | 049 | 0C9 | 149 | 1C9 | 249 | 2C9 | 349 | 3C9 | -- | 249 | 2C9 |
| CA | 04A | 0CA | 14A | 1CA | 24A | 2CA | 34A | 3CA | -- | 24A | 2CA |
| CB | 04B | 0CB | 14B | 1CB | 24B | 2CB | 34B | 3CB | -- | 24B | 2CB |
| CC | 04C | 0CC | 14C | 1CC | 24C | 2CC | 34C | 3CC | -- | 24C | 2CC |
| CD | 04D | 0CD | 14D | 1CD | 24D | 2CD | 34D | 3CD | -- | 24D | 2CD |
| CE | 04E | 0CE | 14E | 1CE | 24E | 2CE | 34E | 3CE | -- | 24E | 2CE |
| CF | 04F | 0CF | 14F | 1CF | 24F | 2CF | 34F | 3CF | -- | 24F | 2CF |
| D0 | 050 | 0D0 | 150 | 1D0 | 250 | 2D0 | 350 | 3D0 | -- | 250 | 2D0 |
| D1 | 051 | 0D1 | 151 | 1D1 | 251 | 2D1 | 351 | 3D1 | -- | 251 | 2D1 |
| D2 | 052 | 0D2 | 152 | 1D2 | 252 | 2D2 | 352 | 3D2 | -- | 252 | 2D2 |
| D3 | 053 | 0D3 | 153 | 1D3 | 253 | 2D3 | 353 | 3D3 | -- | 253 | 2D3 |
| D4 | 054 | 0D4 | 154 | 1D4 | 254 | 2D4 | 354 | 3D4 | -- | 254 | 2D4 |
| D5 | 055 | 0D5 | 155 | 1D5 | 255 | 2D5 | 355 | 3D5 | -- | 255 | 2D5 |
| D6 | 056 | 0D6 | 156 | 1D6 | 256 | 2D6 | 356 | 3D6 | -- | 256 | 2D6 |
| D7 | 057 | 0D7 | 157 | 1D7 | 257 | 2D7 | 357 | 3D7 | -- | 257 | 2D7 |
| D8 | 058 | 0D8 | 158 | 1D8 | 258 | 2D8 | 358 | 3D8 | -- | 258 | 2D8 |
| D9 | 059 | 0D9 | 159 | 1D9 | 259 | 2D9 | 359 | 3D9 | -- | 259 | 2D9 |
| DA | 05A | 0DA | 15A | 1DA | 25A | 2DA | 35A | 3DA | -- | 25A | 2DA |
| DB | 05B | 0DB | 15B | 1DB | 25B | 2DB | 35B | 3DB | -- | 25B | 2DB |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 05C | 0DC | 15C | 1DC | 25C | 2DC | 35C | 3DC | -- | 25C | 2DC |
| DD | 05D | 0DD | 15D | 1DD | 25D | 2DD | 35D | 3DD | -- | 25D | 2DD |
| DE | 05E | 0DE | 15E | 1DE | 25E | 2DE | 35E | 3DE | -- | 25E | 2DE |
| DF | 05F | 0DF | 15F | 1DF | 25F | 2DF | 35F | 3DF | -- | 25F | 2DF |
| E0 | 060 | 0E0 | 160 | 1E0 | 260 | 2E0 | 360 | 3E0 | -- | 260 | 2E0 |
| E1 | 061 | 0E1 | 161 | 1E1 | 261 | 2E1 | 361 | 3E1 | -- | 261 | 2E1 |
| E2 | 062 | 0E2 | 162 | 1E2 | 262 | 2E2 | 362 | 3E2 | -- | 262 | 2E2 |
| E3 | 063 | 0E3 | 163 | 1E3 | 263 | 2E3 | 363 | 3E3 | -- | 263 | 2E3 |
| E4 | 064 | 0E4 | 164 | 1E4 | 264 | 2E4 | 364 | 3E4 | -- | 264 | 2E4 |
| E5 | 065 | 0E5 | 165 | 1E5 | 265 | 2E5 | 365 | 3E5 | -- | 265 | 2E5 |
| E6 | 066 | 0E6 | 166 | 1E6 | 266 | 2E6 | 366 | 3E6 | -- | 266 | 2E6 |
| E7 | 067 | 0E7 | 167 | 1E7 | 267 | 2E7 | 367 | 3E7 | -- | 267 | 2E7 |
| E8 | 068 | 0E8 | 168 | 1E8 | 268 | 2E8 | 368 | 3E8 | -- | 268 | 2E8 |
| E9 | 069 | 0E9 | 169 | 1E9 | 269 | 2E9 | 369 | 3E9 | -- | 269 | 2E9 |
| EA | 06A | 0EA | 16A | 1EA | 26A | 2EA | 36A | 3EA | -- | 26A | 2EA |
| EB | 06B | 0EB | 16B | 1EB | 26B | 2EB | 36B | 3EB | -- | 26B | 2EB |
| EC | 06C | 0EC | 16C | 1EC | 26C | 2EC | 36C | 3EC | -- | 26C | 2EC |
| ED | 06D | 0ED | 16D | 1ED | 26D | 2ED | 36D | 3ED | -- | 26D | 2ED |
| EE | 06E | 0EE | 16E | 1EE | 26E | 2EE | 36E | 3EE | -- | 26E | 2EE |
| EF | 06F | 0EF | 16F | 1EF | 26F | 2EF | 36F | 3EF | -- | 26F | 2EF |
| F0 | 070 | 0F0 | 170 | 1F0 | 270 | 2F0 | 370 | 3F0 | -- | 270 | 2F0 |
| F1 | 071 | 0F1 | 171 | 1F1 | 271 | 2F1 | 371 | 3F1 | -- | 271 | 2F1 |
| F2 | 072 | 0F2 | 172 | 1F2 | 272 | 2F2 | 372 | 3F2 | -- | 272 | 2F2 |
| F3 | 073 | 0F3 | 173 | 1F3 | 273 | 2F3 | 373 | 3F3 | -- | 273 | 2F3 |
| F4 | 074 | 0F4 | 174 | 1F4 | 274 | 2F4 | 374 | 3F4 | -- | 274 | 2F4 |
| F5 | 075 | 0F5 | 175 | 1F5 | 275 | 2F5 | 375 | 3F5 | -- | 275 | 2F5 |
| F6 | 076 | 0F6 | 176 | 1F6 | 276 | 2F6 | 376 | 3F6 | -- | 276 | 2F6 |
| F7 | 077 | 0F7 | 177 | 1F7 | 277 | 2F7 | 377 | 3F7 | -- | 277 | 2F7 |
| F8 | 078 | 0F8 | 178 | 1F8 | 278 | 2F8 | 378 | 3F8 | -- | 278 | 2F8 |
| F9 | 079 | 0F9 | 179 | 1F9 | 279 | 2F9 | 379 | 3F9 | -- | 279 | 2F9 |
| FA | 07A | 0FA | 17A | 1FA | 27A | 2FA | 37A | 3FA | -- | 27A | 2FA |
| FB | 07B | 0FB | 17B | 1FB | 27B | 2FB | 37B | 3FB | -- | 27B | 2FB |
| FC | 07C | 0FC | 17C | 1FC | 27C | 2FC | 37C | 3FC | -- | 27C | 2FC |
| FD | 07D | 0FD | 17D | 1FD | 27D | 2FD | 37D | 3FD | -- | 27D | 2FD |
| FE | 07E | 0FE | 17E | 1FE | 27E | 2FE | 37E | 3FE | -- | 27E | 2FE |
| FF | 07F | 0FF | 17F | 1FF | 27F | 2FF | 37F | 3FF | -- | 27F | 2FF |

## CHARACTER GENERATOR PROGRAM

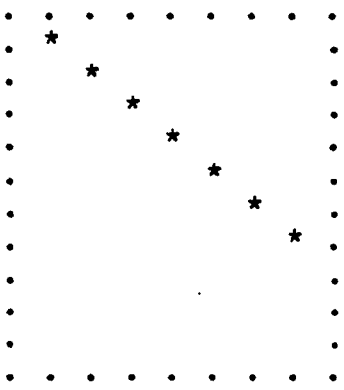
The program CHARGEN.BAS was used to develop the standard character font for the IMSAI VIO. Users who wish to do extensive font development may wish to use this or a similar program of their own design. CHARGEN is written in IMSAI Extended BASIC and requires at least 32K of memory. It allows the user to interactively create fonts and generates HEX files for PROM programming.

The following is a sample session with CHARGEN:

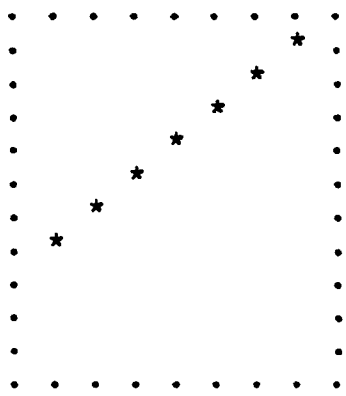
```
        A>RUN-E CHARGEN
BASIC-E INTERPRETER - VER 2.2


NAME OF CHARACTER FILE? PFONT
NEW FILE (Y/N)? Y


ENTER CODE OR COMMAND? 00000000
INPUT CHARACTER MATRIX

LINE 1          .? "
LINE 2          .? " *****
LINE 3          .? " *   *
LINE 4          .? 2
ILLEGAL CHARACTER
LINE 4          .? " *   *
LINE 5          .? " *   *
LINE 6          .? " *   *
LINE 7          .? " *****
LINE 8          .? "
LINE 9          .? "
LINE 10         .? "
```

```
CODE IS 00000000

CHARACTER IS:
. . . . . .
.           .
.   * * * *   .
.   *       *   .
.   *       *   .
.   *       *   .
.   *       *   .
.   * * * * *   .
.               .
.               .
.               .
. . . . . . . . .

CHARACTER OK (Y/N)? Y



ENTER CODE OR COMMAND? 0000001
ENTER 8 BINARY DIGITS


ENTER CODE OR COMMAND? 00000001
INPUT CHARACTER MATRIX

LINE 1          .? "*
LINE 2          .? " *
LINE 3          .? "  *
LINE 4          .? "   *
LINE 5          .? "    *
LINE 6          .? "     *
LINE 7          .? "      *
LINE 8          .? "       *
LINE TOO LONG
LINE 8          .? "
LINE 9          .? "
LINE 10         .? "
```

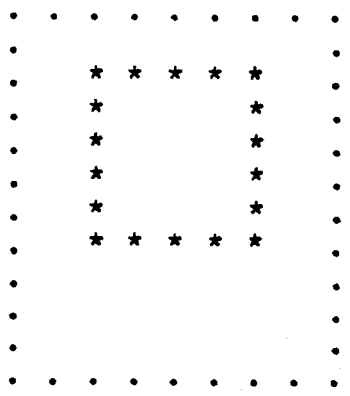
```
CODE IS 00000001

CHARACTER IS:
```



```
CHARACTER OK (Y/N)? N
REENTER CHARACTER
INPUT CHARACTER MATRIX

LINE 1          .? "       *
LINE 2          .? "      *
LINE 3          .? "     *
LINE 4          .? "    *
LINE 5          .? "   *
LINE 6          .? "  *
LINE 7          .? " *
LINE 8          .? "
LINE 9          .? "
LINE 10         .? "

CODE IS 00000001

CHARACTER IS:
```



```
CHARACTER OK (Y/N)? Y


ENTER CODE OR COMMAND? E00000000

CODE IS 00000000

CHARACTER IS:
```



```
CHARACTER OK (Y/N)? Y

ENTER CODE OR COMMAND? Q

A>
```

In this example we are working on a font named PFONT. CHARGEN opens four files. The first three are hex files (PFONT1.HEX, PFONT2.HEX and PFONT3.HEX) corresponding to the character generator ROM's U49, U48 and U47. The fourth file PFONT.CHR can be used to dump a printout of the font.

The "Y" response to "NEW FILE (Y/N)?" causes the hex files to be initialized to all blank characters. After the first session with a new font you should always answer "N" to this prompt to prevent destroying the entries of previous sessions.

The characters may be entered in any order. When prompted by "ENTER CODE OR COMMAND?" type in exactly eight binary digits representing the code for the character you desire to enter. In response to the line prompt, type a double quote followed by seven or fewer spaces and *'s as appropriate for that character. After the tenth line the code and dot matrix will be echoed as a check for proper entry. If you respond "Y" to the "CHARACTER OK (Y/N)?" prompt, the character will be entered into the hex files. Any other response will require that the dot matrix be re-entered.

If you wish to examine a previously entered character, type "E" before the eight bit code. If you wish to change this character, respond "N" to the OK prompt.

There are three valid commands which may be given the program. The command "Q" terminates a session by simply closing all files. The command "DUMP" causes the complete 256 character font to be printed on the terminal and written into the type CHR file. This may take several hours if the terminal speed is low. The command "CKSUM" causes the check sums for all hex files to be updated. These computations require several minutes. The "CKSUM" command is only required when the entry of characters is completed and you are ready to use the hex files for burning PROM's.

As can be noted in the example, CHARGEN will respond with error messages when invalid entries are made. Attempting to operate on uninitiated hex files will cause program termination without any error message. The message "HEX ERROR" indicates a program malfunction and should not be encountered by the user.

The "CKSUM" and "DUMP" commands should not be used unless the user allows them to run to completion. Attempts to abort these commands may cause the file contents to be lost.

The program listing follows:

```
REM
REM       PROGRAM CHARGEN
REM
REM       THIS PROGRAM INTERACTIVELY GENERATES
REM       HEX FILES FOR THE CHARACTER GENERATOR
REM       ROMS FOR THE IMSAI VIO VIDEO BOARD
REM
REM
REM       COPYRIGHT 1977 IMSAI MANAFACTURING CORP.
REM
REM       VERS 1.0 GEE


IF END #1 THEN 9999
IF END #2 THEN 9999
IF END #3 THEN 9999

          HEXCONV$="0123456789ABCDEF"
          DIM LN$(10)
          DIM STAR$(16)
          STAR$(0)="****"
          STAR$(1)=" ***"
          STAR$(2)="* **"
          STAR$(3)="  **"
          STAR$(4)="** *"
          STAR$(5)=" * *"
          STAR$(6)="*  *"
          STAR$(7)="   *"
          STAR$(8)="*** "
          STAR$(9)=" ** "
          STAR$(10)="* * "
          STAR$(11)="  * "
          STAR$(12)="**  "
          STAR$(13)=" *  "
          STAR$(14)="*   "
          STAR$(15)="    "

          INPUT "NAME OF CHARACTER FILE";SFILE$
          DFILE$=LEFT$(SFILE$,1)
          IF LEN(SFILE$)=1 THEN 20
          FOR I=2 TO LEN(SFILE$)
          F$=MID$(SFILE$,I,1)
          IF F$="." THEN 20
          DFILE$=DFILE$+F$
          IF LEN(DFILE$)>6 THEN DFILE$=LEFT$(DFILE$,6)
          NEXT I

20
          DFILE1$=DFILE$+"1.HEX"
```

```
        DFILE2$=DFILE$+"2.HEX"
        DFILE3$=DFILE$+"3.HEX"
        DFILE4$=DFILE$+".CHR"


        FILE DFILE1$(50),DFILE2$(50),DFILE3$(50),DFILE4$

        INPUT "NEW FILE (Y/N)";A$
        IF LEFT$(A$,1)<>"Y" THEN 100

        FOR I=1 TO 64
        N=I-1
        GOSUB 200
        LINE$=":100"+HEX$+"000FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF"
        PRINT #1,I;LINE$
        PRINT #2,I;LINE$
        PRINT #3,I;LINE$
        NEXT I
        LINE$=":00000000000"
        PRINT #1,65;LINE$
        PRINT #2,65;LINE$
        PRINT #3,65;LINE$
100
        PRINT:PRINT:PRINT
        INPUT "ENTER CODE";A$
        DFLAG=0
        IF A$<>"DUMP" THEN 101
        DFLAG=1
        GOTO 700
101
        IF LEFT$(A$,1)="Q" THEN 9999
        IF A$="CKSUM" THEN 999
        EFLAG=0
        IF LEFT$(A$,1)<>"E" THEN 102
        EFLAG=1
        A$=RIGHT$(A$,LEN(A$)-1)
102
        IF LEN(A$)=8 THEN 110
        PRINT "ENTER 8 BINARY DIGITS"
        GOTO 100
110
        V=0
        F=128
        FOR I=1 TO 8
        AA$=MID$(A$,I,1)
        IF (AA$="1") OR (AA$="0") THEN 115
        PRINT "ILLEGAL CHARACTER CODE"
        GOTO 100
115     IF AA$="1" THEN V=V+F
        F=F/2
```

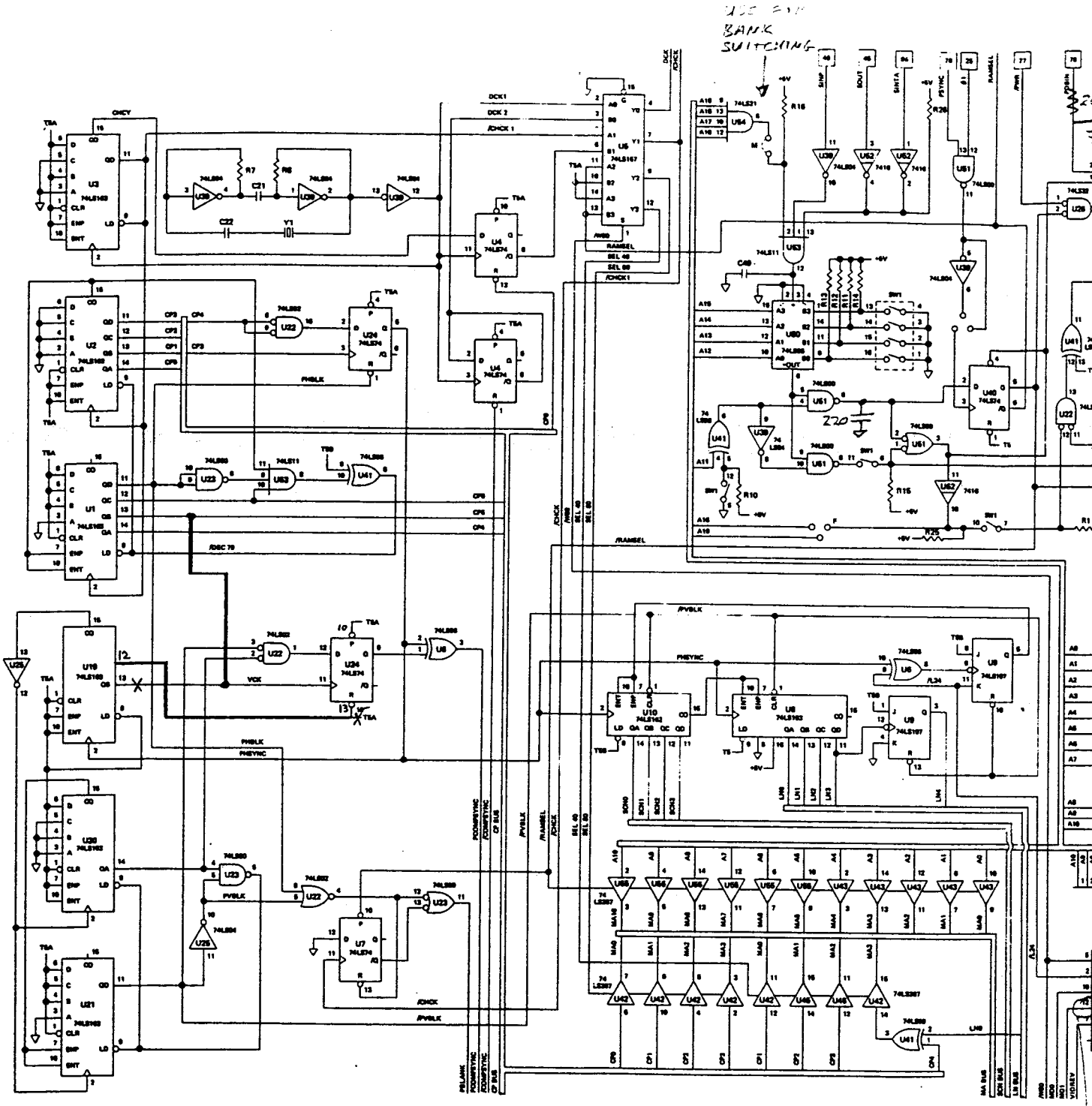
```
        NEXT I

        IF EFLAG=1 THEN 800
120
        PRINT "INPUT CHARACTER MATRIX"
        PRINT
        EFLAG=0
        FOR J=1 TO 10
125
        PRINT "LINE ";J,".";
        INPUT LN$(J)
        IF LEN(LN$(J))<8 THEN 130
        PRINT "LINE TOO LONG"
        GOTO 125
130
        IF LEN(LN$(J))=7 THEN 135
        LN$(J)=LN$(J)+" "
        GOTO 130
135
        FOR K=1 TO 7
        LNN$=MID$(LN$(J),K,1)
        IF (LNN$=" ") OR (LNN$="*") THEN 140
        PRINT "ILLEGAL CHARACTER"
        GOTO 125
140
        NEXT K
        NEXT J
142
        PRINT:PRINT:PRINT "CODE IS ";A$
        PRINT:PRINT "CHARACTER IS:":PRINT ". . . . . ."
        IF DFLAG<>1 THEN 104
        PRINT #4; " "
        PRINT #4; " "
        PRINT #4;"CHARACTER CODE:",A$
        PRINT #4;" "
        PRINT #4;". . . . . ."
104
        FOR J=1 TO 10
        LL$=". "
        FOR K=1 TO 7
        LL$=LL$+MID$(LN$(J),K,1)+" "
        NEXT K
        LL$=LL$+"."
        PRINT LL$
        IF DFLAG=1 THEN PRINT #4;LL$
        NEXT J
        PRINT ". . . . . ."
        IF DFLAG<>1 THEN 106
        PRINT #4;". . . . . ."
        RETURN
```

```
106
        PRINT:PRINT:INPUT "CHARACTER OK (Y/N)";B$
        IF (LEFT$(B$,1)="Y") AND (EFLAG=1) THEN 100
        IF LEFT$(B$,1)="Y" THEN 145
        PRINT "REENTER CHARACTER"
        GOTO 120
145
        FOR J=1 TO 10
        JJ=J-1
        N=0
        F=1
        FOR K=1 TO 7
        IF MID$(LN$(J),K,1)=" " THEN N=N+F
        F=F*2
        NEXT K
        GOSUB 200

        IF V>=128 THEN VV=V-128 ELSE VV=V
        IF JJ>7 THEN 150
        PPOSIT=JJ*128+VV
        LOWADR=INT(PPOSIT/16)+1
        IF V>=128 THEN READ #2,LOWADR;LINE$ ELSE READ #1,LOWADR;LINE$

        POSIT=(PPOSIT-16*LOWADR+16)*2+9
        LINE$=LEFT$(LINE$,POSIT)+HEX$+RIGHT$(LINE$,41-POSIT)
        IF V>=128 THEN PRINT #2,LOWADR;LINE$ ELSE PRINT #1,LOWADR;LINE$
        GOTO 157
150
        IF V>=128 THEN VVV=1 ELSE VVV=0
        PPOSIT=(JJ-8)*128+VVV*512+VV

        LOWADR=INT(PPOSIT/16)+1
        READ #3,LOWADR;LINE$
        POSIT=(PPOSIT-16*LOWADR+16)*2+9
        LINE$=LEFT$(LINE$,POSIT)+HEX$+RIGHT$(LINE$,41-POSIT)
        PRINT #3,LOWADR;LINE$
157
        NEXT J
        PRINT:PRINT
        GOTO 100
800
        FOR J=1 TO 10
        JJ=J-1
        IF V>=128 THEN VV=V-128 ELSE VV=V
        IF JJ>7 THEN 820
        PPOSIT=JJ*128+VV
        LOWADR=INT(PPOSIT/16)+1
        IF V>=128 THEN READ #2,LOWADR;LINE$ ELSE READ #1,LOWADR;LINE$
        GOTO 830
820
```

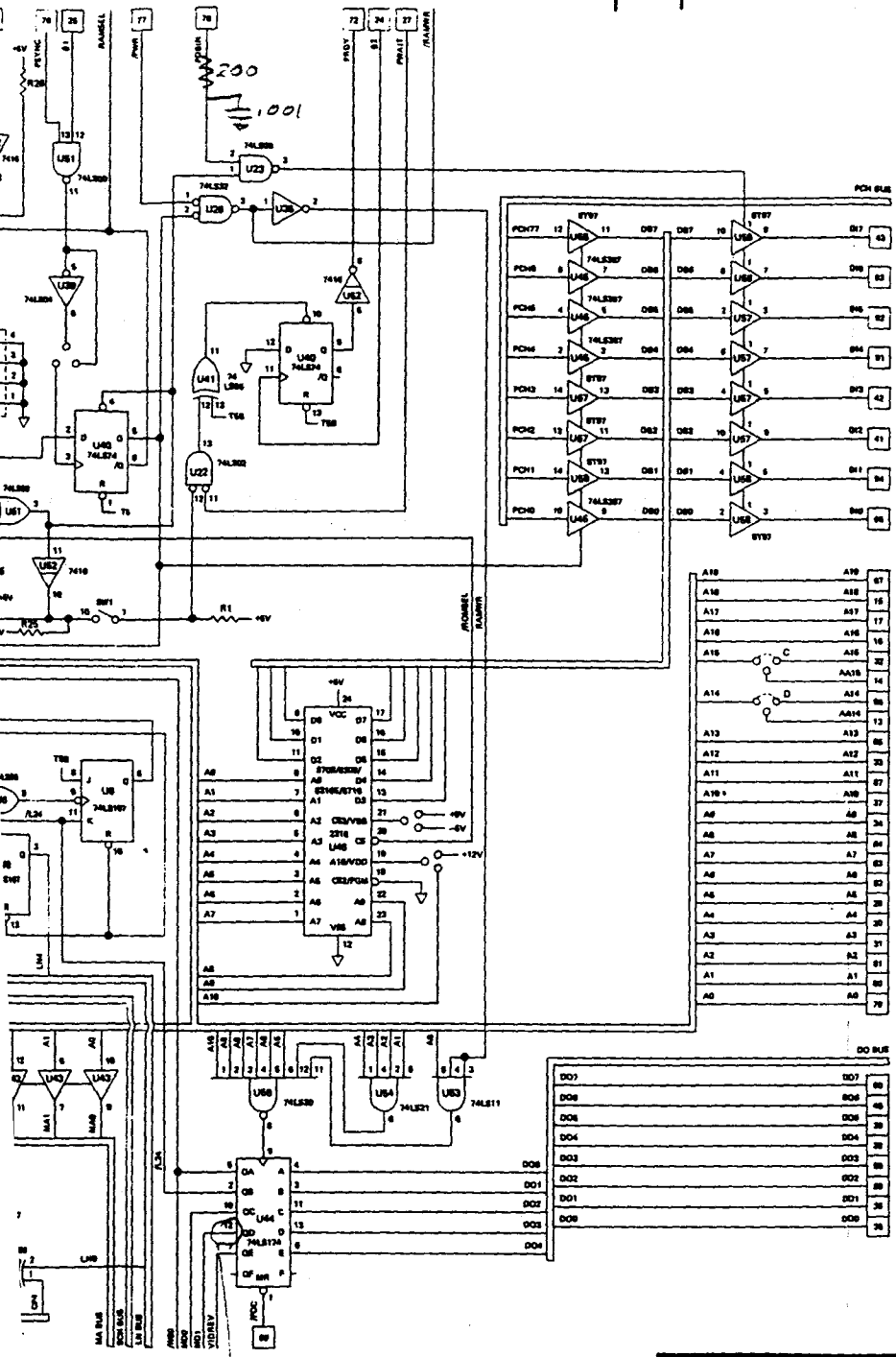
```
        IF V>=128 THEN VVV=1 ELSE VVV=0
        PPOSIT=(JJ-8)*128+VVV*512+VV
        LOWADR=INT(PPOSIT/16)+1
        READ #3,LOWADR;LINE$
830
        POSIT=(PPOSIT-16*LOWADR+16)*2+10
        CK$=MID$(LINE$,POSIT,1)
        GOSUB 500
        LN$(J)=LEFT$(STAR$(M),3)
        CK$=MID$(LINE$,POSIT+1,1)
        GOSUB 500
        LN$(J)=STAR$(M)+LN$(J)
        NEXT J
        GOTO 142



200     HEX16=INT(N/16)
        IF HEX16=16 THEN 250
        HEX=INT(N-HEX16*16)
        H16$=MID$(HEXCONV$,HEX16+1,1)
        H$=MID$(HEXCONV$,HEX+1,1)
        HEX$=H16$+H$
        RETURN
250
        HEX$="00"
        RETURN


400
        N=0
        L=2
410
        CK$=MID$(LINE$,L,1)
        GOSUB 500
420
        N=N+16*M
        L=L+1
        CK$=MID$(LINE$,L,1)
        GOSUB 500
430
        N=N+M
        IF N>=256 THEN N=N-256
        IF N<0 THEN N=0
        L=L+1
        IF L<42  THEN 410
        IF N>=256 THEN N=N-256
        N=ABS(256-N)
        GOSUB 200
        LINE$=LEFT$(LINE$,41)+HEX$
```

```
        RETURN

500     M=0
        IF CK$="0" THEN RETURN
        M=M+1
        IF CK$="1" THEN RETURN
        M=M+1
        IF CK$="2" THEN RETURN
        M=M+1
        IF CK$="3" THEN RETURN
        M=M+1
        IF CK$="4" THEN RETURN
        M=M+1
        IF CK$="5" THEN RETURN
        M=M+1
        IF CK$="6" THEN RETURN
        M=M+1
        IF CK$="7" THEN RETURN
        M=M+1
        IF CK$="8" THEN RETURN
        M=M+1
        IF CK$="9" THEN RETURN
        M=M+1
        IF CK$="A" THEN RETURN
        M=M+1
        IF CK$="B" THEN RETURN
        M=M+1
        IF CK$="C" THEN RETURN
        M=M+1
        IF CK$="D" THEN RETURN
        M=M+1
        IF CK$="E" THEN RETURN
        M=M+1
        IF CK$="F" THEN RETURN
        PRINT "HEX ERROR"
        GOTO 9999

999
        FOR I=1 TO 64
        READ #1,I;LINE$
        GOSUB 400
        PRINT #1,I;LINE$
        READ #2,I;LINE$
        GOSUB 400
        PRINT #2,I;LINE$
        READ #3,I;LINE$
        GOSUB 400
        PRINT #3,I;LINE$
        NEXT I
```

```
        GOTO 9999

700
        P$="0"
        FOR P=0 TO 1
        Q$="0"
        FOR Q=0 TO 1
        R$="0"
        FOR R=0 TO 1
        S$="0"
        FOR S=0 TO 1
        T$="0"
        FOR T=0 TO 1
        U$="0"
        FOR U=0 TO 1
        W$="0"
        FOR W=0 TO 1
        X$="0"
        FOR X=0 TO 1
        A$=P$+Q$+R$+S$+T$+U$+W$+X$
        V=X+2*W+4*U+8*T+16*S+32*R+64*Q+128*P
        GOSUB 800
        X$="1"
        NEXT X
        W$="1"
        NEXT W
        U$="1"
        NEXT U
        T$="1"
        NEXT T
        S$="1"
        NEXT S
        R$="1"
        NEXT R
        Q$="1"
        NEXT Q
        P$="1"
        NEXT P
9999 END
```


BANK
SWITCHING
220
/CHCK
/RAMSEL
/PVBLK
PHSYNC
/CHCK1
DCK1
DCK 2
/DCK 1
VCK
/DSC 70
SEL 40
SEL 80
CP BUS
MA BUS
SCN BUS
LN BUS
VIDKEY

| REVISIONS | | | |
|---|---|---|---|
| LTR | DESCRIPTION | DATE | APPROVE |
| | | | |




R2 ON PDBIN
CAP ON U51-6
2 CUT + JUMP U1/U19

LIFT PIN 12
FOR 08 DEFAULT

TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS DEC. ANGLES
± ± ±

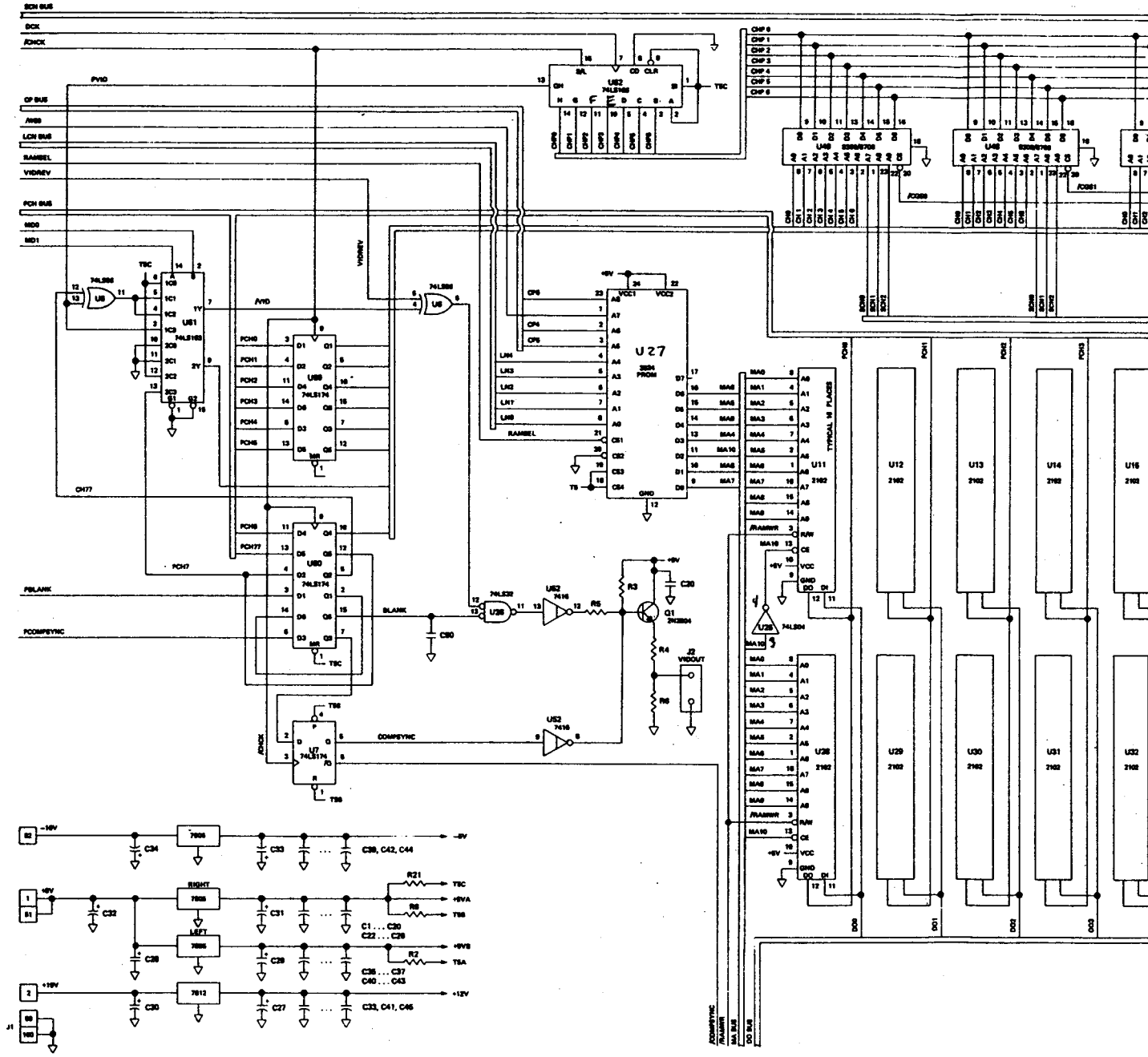
| APPROVALS | DATE |
|---|---|
| DRAWN | |
| CHECKED | |
| | |
| | |



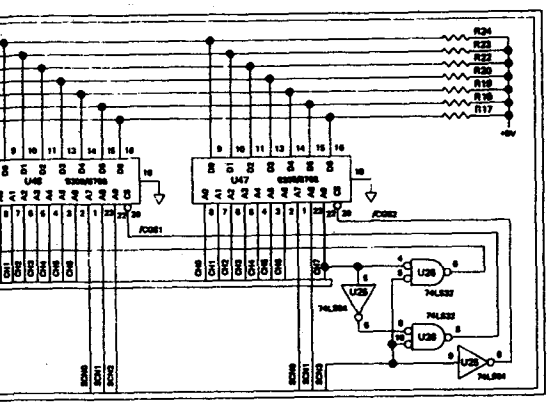
IMSAI SYSTEM
VIO REV. 1
SCHEMATIC DIAGRAM

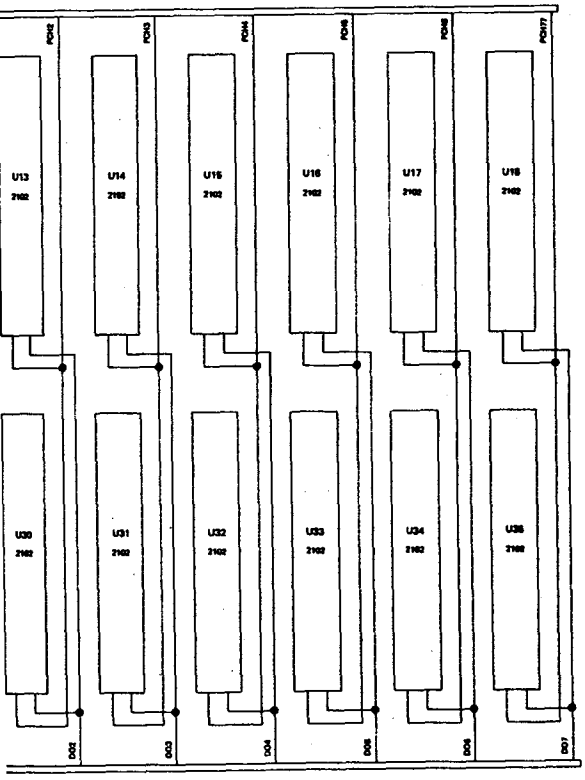
| SCALE | SIZE | DRAWING NO. |
|---|---|---|
| | B | |

DO NOT SCALE DRAWING


SCN BUS
DCK
/DHCK
PV10
CP BUS
/WB
LCN BUS
RAMSEL
VIDREV
PCH BUS
MD0
MD1
TSC
74LS86
U6
74LS163
U51
1V
2V
/VID
PCH0
PCH1
PCH2
PCH3
PCH4
PCH5
PCH6
PCH7
PCH77
U50
U60
U57
74LS174
CH77
VIDREV
74LS86
U6
U27
3604
PROM
CP6
CP4
CP5
LA4
LA3
LA2
LA1
LA0
RAMSEL
+5V
VCC1
VCC2
GND
MA0
MA1
MA2
MA3
MA4
MA5
MA6
MA7
MA8
MA9
MA10
/RAMWR
R/W
CE
VCC
GND
DO
DI
U11
2102
TYPICAL 16 PLACES
U12
U13
U14
U16
U28
U29
U30
U31
U32
74LS04
U35
PBLANK
PCOMPSYNC
BLANK
C50
74LS32
U26
U52
7416
R5
R3
C36
Q1
2N3904
R4
J2
VIDOUT
R6
TSB
TSC
U7
74LS174
/D
DCMPSYNC
U52
7416
-10V
+5V
+10V
J1
82
81
99
100
7905
7905
7912
RIGHT
LEFT
C34
C32
C38
C30
C33
C31
C29
C27
C35, C42, C44
C1 . . . C20
C22 . . . C26
C35 . . . C37
C40 . . . C43
C33, C41, C45
R21
R8
R2
TSA
+12V
DD0
DD1
DD2
DD3
/DCOMPSYNC
/RAMWR
MA BUS
DD BUS

| REVISIONS | | | |
|---|---|---|---|
| LTR | DESCRIPTION | DATE | APPROVED |
| 0 | ORIGINAL REV. 1 | 6/77 | |





| | | | |
|---|---|---|---|
| U1 THRU U3, U8, U20, U21 | 74LS163 | U62 | 74LS166 |
| U4, U7, U24, U40 | 74LS74 | C1 THRU C20, C23 THRU C26, C35, C37 THRU C48 | .1 uF |
| U5 | 74LS157 | | |
| U6, U41 | 74LS86 | C21 C49, C36 | .001 uF |
| U9 | 74LS107 | C22 | 20 pF |
| U10, U19 | 74LS162 | C27 THRU C34 | 2.2 uF 25V |
| U11 THRU U18, U28 THRU U35 | 2102 AL-4 | C50 | 470 pF |
| | | Q1 | 2N3904 |
| U22 | 74LS02 | R1, R10 THRU R16, R25, R26 | 2.2K ¼W |
| U23, U51 | 74LS00 | | |
| U25, U39 | 74LS04 | R2, R9, R21 | 1K ¼W |
| U26 | 74LS32 | | |
| U27 | 3624 W/ VIO MAP | R3, R7, R8 | 470 ¼W |
| U36, U37 | SPARE | R4 | 100 ¼W |
| U42, U43, U45, U55 | 74LS367 | R5, R6 | 150 ¼W |
| U44, U59, U60 | 74LS174 | R17 THRU R20, R22 THRU R24 | 4.7K ¼W |
| U46 | 2316 SMP/80.0 | | |
| U47 THRU U49 | 8308/8708 | S1 | 8 POSITION DIP |
| U50 | 74LS85 | | |
| U52 | 7416 | Y1 | XTAL 12.2304 MHz |
| U53 | 74LS11 | | |
| U54 | 74LS21 | | |
| U56 | 74LS30 | | |
| U57, U58 | 8T97 | | |
| U61 | 74LS153 | | |

TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS DEC. ANGLES
± ± ±



| APPROVALS | DATE |
|---|---|
| DRAWN | |
| CHECKED | |

IMSAI SYSTEM
VIO REV. 1
SCHEMATIC DIAGRAM

| SCALE | SIZE | DRAWING NO. |
|---|---|---|
| | B | |

DO NOT SCALE DRAWING