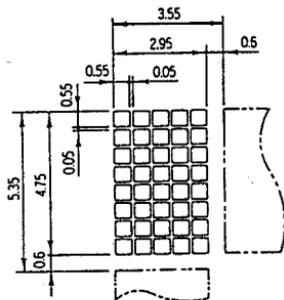
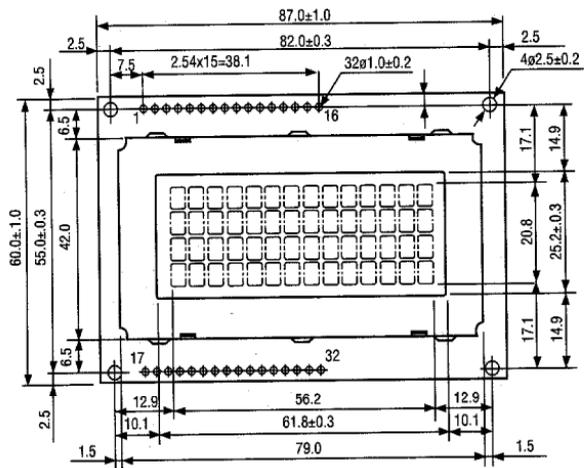


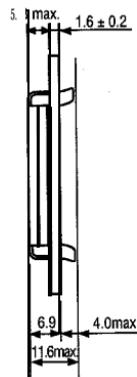
L1662B1J000	L1642B1J000	2 x 16	STN	80.0 x 36.0 x 15.8	35	64.5 x 13.8	2.95 x 3.80	0.50 x 0.55	0.05	420
L1682B1P000	L1642B1L000	2 x 16	WTSTN	80.0 x 36.0 x 15.8	35	64.5 x 13.8	2.95 x 3.80	0.50 x 0.55	0.05	420
L1692B1J200	L1652B1J200	2 x 16	STN	122.0 x 44.0 x 15.8	65	99.0 x 24.0	4.84 x 8.06	0.92 x 1.10	0.06	1000
L1692B1P200	L1652B1L200	2 x 16	WTSTN	122.0 x 44.0 x 15.8	65	99.0 x 24.0	4.84 x 8.06	0.92 x 1.10	0.06	1000
L1634B1J000	L1614B1J000	4 x 16	STN	87.0 x 60.0 x 15.8	65	61.8 x 25.2	2.95 x 4.15	0.50 x 0.55	0.05	590
L1634B1P000	L1614B1L000	4 x 16	WTSTN	87.0 x 60.0 x 15.8	65	61.8 x 25.2	2.95 x 4.15	0.50 x 0.55	0.05	590

# L1634 (4x16) Unit: mm General Tolerance $\pm 0.5$ mm

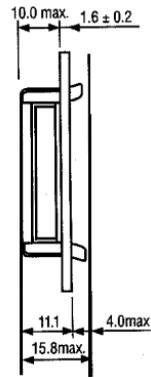


\*LED Powered  
through pins 15 & 16  
or 31 & 32

Reflective/EL Backlight



LED Backlight

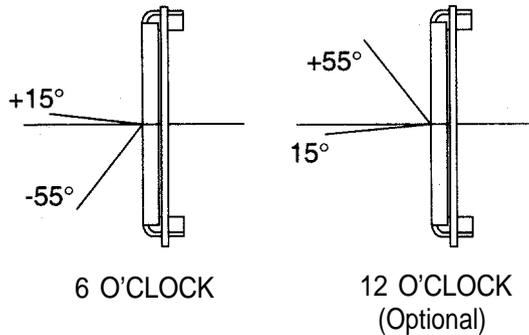


## PIN FUNCTIONS

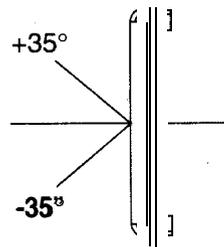
No.	No.	Name	Function
1	17	$V_{SS}$	GND
2	18	$V_{DD}$	Power supply voltage + 5 V
3	19	$V_{LC}$	Liquid crystal driving voltage
4	20	RS	L: Instruction code input. H: Data input
5	21	R/W	L: Data write from MPU to LCM. H: Data read from LCM to MPU
6	22	E	Enable
7	23	DB0	Data bus line
8	24	DB1	Data bus line
9	25	DB2	Data bus line
10	26	DB3	Data bus line
11	27	DB4	Data bus line
12	28	DB5	Data bus line
13	29	DB6	Data bus line
14	30	DB7	Data bus line
15	31	$V_a^*$	Anode
16	32	$V_c^*$	Cathode

# OPTIMUM VIEWING ANGLE / CONTRAST ADJUSTMENT CIRCUIT

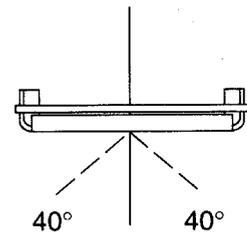
All Super-twist Character Modules Except L1681 & L1692 Series



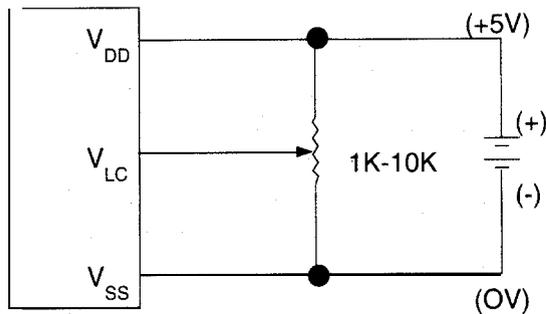
L1681 & L1692 Series (only)



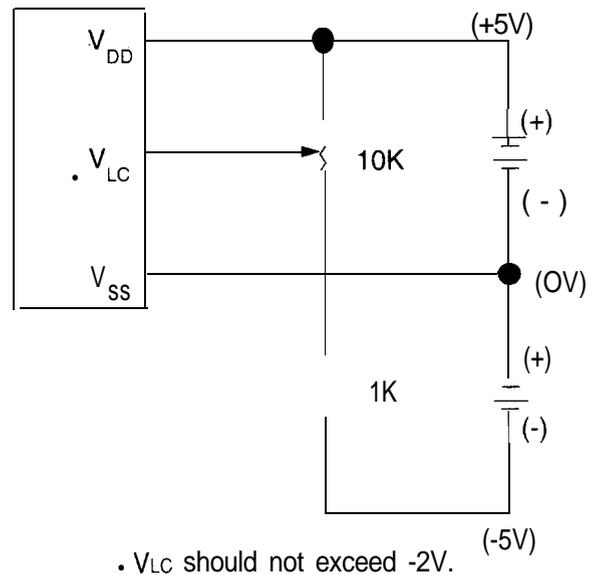
Side Viewing Angles on Supertwist Character Modules



## STANDARD STN & L2022



## WIDE TEMPERATURE STN



- ▶ The above schematic applies to all **Seiko Instruments** standard temperature supertwist character modules except L2022. A variable or fixed resistor must be used on any LCD module as it appears in the above schematic.
- ▶ A variable resistor is advisable, especially for stationary equipment. The variable resistor allows the user to adjust the voltage, to get maximum contrast in relationship to whatever angle the user is viewing the LCD (within the optimum viewing range). A variable also allows the user to adjust the voltage for any temperature fluctuations between 0° and 50°C.
- ▶ A fixed resistor limits the LCD to a finite voltage and therefore a very limited viewing angle. Fixed resistors should be used in those applications where the display can be adjusted to the particular user (i.e., hand-held products).

- ▶ The above schematic applies to all **Seiko Instruments** supertwist character modules with Wide Temperature Fluid. A variable or fixed resistor must be used on any LCD module as it appears in the above schematic.
- ▶ A variable resistor is advisable, especially for stationary equipment. The variable resistor allows the user to adjust the voltage, to get maximum contrast in relationship to whatever angle the user is viewing the LCD (within the optimum viewing range). A variable also allows the user to adjust the voltage for any temperature fluctuations between -20° and 70°C.
- ▶ A fixed resistor limits the LCD to a finite voltage and therefore a very limited viewing angle. Fixed resistors should be used in those applications where the display can be adjusted to the particular user (i.e., hand-held products).

# OPERATING INSTRUCTIONS

## INTRODUCTION

**Seiko instruments** intelligent dot matrix liquid crystal display modules have on-board controller and LSI drivers, which display alpha numerics, Japanese KATA KANA characters and a wide variety of other symbols in either 5 x 7 dot matrix.

The internal operation in the KS0006 controller chip is determined by signals sent from the MPU. The signals

include: 1) Register select RS input consisting of instruction register (IR) when RS = 0 and data register (DR) when RS = 1; 2) Read/write (R/W); 3) Data bus (DB7~DB0); and 4) Enable strobe (E) depending on the MPU or through an external parallel I/O port. Details on instructions data entry, execution times, etc. are explained in the following sections.

## READ AND WRITE TIMING DIAGRAMS AND TABLES

The following timing characteristics are applicable for all of Seiko's LCD dot matrix character modules.

### READ TIMING CHARACTERISTICS

$V_{DD}=5.0V \pm 5\%$ ,  $V_{SS}=0V$ ,  $T_A=0^\circ C$  TO  $50^\circ C$

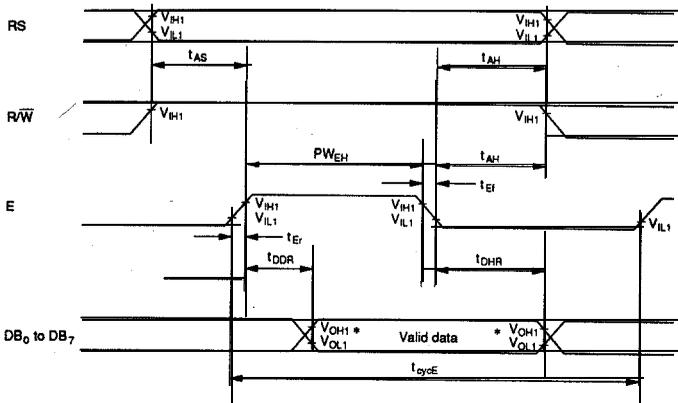
Item	Symbol	Standard		Unit
		Min.	Max.	
Enable cycle time	$t_{CYC}E$	500	—	ns
Enable pulse width High Level	$PW_{EH}$	230	—	ns
Enable rise and fall time	$t_{ER}$ , $t_{EF}$	—	20	ns
Setup time RS,R/W—E	$t_{AS}$	140	—	ns
Address hold time	$t_{AH}$	10	—	ns
Data delay time	$t_{DDR}$	—	160	ns
Data hold time	$t_H$	5	—	ns

### WRITE TIMING CHARACTERISTICS

$V_{DD}=5.0V \pm 5\%$ ,  $V_{SS}=0V$ ,  $T_A=0^\circ C$  TO  $50^\circ C$

Item	Symbol	Standard		Unit
		Min.	Max.	
Enable cycle time	$t_{CYC}E$	500	—	ns
Enable pulse width High Level	$PW_{EH}$	230	—	ns
Enable rise and fall time	$t_{ER}$ , $t_{EF}$	—	20	ns
Setup time RS,R/W—E	$t_{AS}$	140	—	ns
Address hold time	$t_{AH}$	10	—	ns
Data delay time	$t_{DDR}$	80	—	ns
Data hold time	$t_H$	10	—	ns

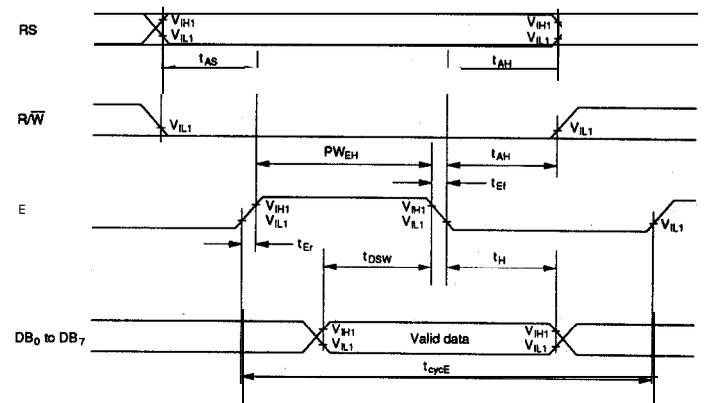
### READ OPERATION



Note: • VOL1 is assumed to be 0.8 V at 2 MHz operation.

DATA READ FROM MODULE TO MPU

### WRITE OPERATION



DATA WRITE FROM MPU TO MODULE

# INSTRUCTION CODES

Instruction	Set		Instruction Code								Description	Execution Time (when $f_{cp}$ or $f_{osc}$ is 250 kHz)	
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0			
Clear Display	0	0	0	0	0	0	0	0	0	0	1	Clears all display memory and returns the cursor to the home position (Address 0).	62 $\mu$ S ~ 1.64ms
Return Home	0	0	0	0	0	0	0	0	0	1	*	Returns the cursor to the home position (Address 0) shifted to the original position. DD RAM contents remain unchanged.	40 $\mu$ S - 1.6ms
Entry Mode Set	0	0	0	0	0	0	0	0	1	I/D	S	Sets the cursor move direction and specifies to or not to shift the display. These operations write and read.	40 $\mu$ S ~ 1.64ms
Display ON/OFF Control	0	0	0	0	0	0	0	1	D	C	B	(D) is display ON/OFF control; memory remains unchanged in OFF condition. (C) cursor ON/OFF (B) blinking cursor.	40 $\mu$ S
Cursor or Display Shift	0	0	0	0	0	0	1	S/C	R/L	*	*	Moves the cursor and shifts the display without changing DD RAM contents.	40 $\mu$ S
Function Set	0	0	0	0	0	1	DL	N	F	*	*	Sets interface data length (DL), number of display lines (N), and character font (F).	40 $\mu$ S
Set CG RAM Address	0	0	0	1	A <sub>CG</sub>						Sets the CG RAM address. CG RAM data is sent and received after this setting.	40 $\mu$ S	
Set DD RAM Address	0	0	1	A <sub>DD</sub>						Sets the DD RAM address. DD RAM data is sent and received after this setting.	40 $\mu$ S		
Read Busy Flag & Address	0	1	BF	AC						Reads Busy Flag (BF) indicating internal operation is being performed and reads address counter contents.	1 $\mu$ S		
Write Data to CG or to DD RAM	1	0	Write Data								Writes data into DD RAM or CG RAM.	40 $\mu$ S	
Read Data from CG or DD RAM	1	1	Read Data								Reads data from DD RAM or CG RAM.	40 $\mu$ S	

\* Doesn't matter

DD RAM:	Display data RAM	I/D = 1:	Increment	C = 1:	Cursor ON	R/L = 1:	Right shift
CG RAM:	Character generator RAM	I/D = 0:	Decrement	c = 0:	Cursor OFF	R/L = 0:	Left shift
A <sub>CG</sub> :	CG RAM address	S = 1:	Display shift	B = 1:	Blink ON	DL = 1:	8 bits
		S = 0:	No display shift	B = 0:	Blink OFF	DL = 0:	4 bits
ADD:	DD RAM address corresponds to cursor address	D = 1:	Display ON	S/C = 1:	Display shift		
		D = 0:	Display OFF	S/C = 0:	Cursor movement		
AC:	Address counter used for both DD RAM and CG RAM address			BF = 1:	Internal operation in progress		
				BF = 0:	Instruction can be accepted	F = 0:	5 x 7 dot matrix

Execution times in the above table indicate the minimum values when operating frequency is 250 kHz.

When  $f_{osc}$  is 270 kHz:  $40\mu\text{s} \times 250/250 = 37\mu\text{s}$

# OPERATING INSTRUCTIONS (CONTINUED)

## INSTRUCTION CODE EXPLANATIONS

The two registers 1) Instruction Register (IR) and the 2) Data Register (DR) in the KS0066 controller chip are directly controlled by the MPU. Control information is temporarily stored in these registers prior to internal operation start. This allows interface to various types of MPUs which operate at different

speeds from that of the KS0066, and allows interface from peripheral control ICs. Internal operations of the KS0066 are determined from the signals sent from the MPU. These signals, including register selection signals (RS), Read/Write (R/W) and data bus signals (DB0 - DB7) are polled instructions.

REGISTER SELECTION		
RS	R/W	Operation
0	0	IR selection, IR write. Internal operation: Display clear
0	1	Busy flag (DB7) and address counter (DB0 to DB6) read
1	0	DR selection, DR write. Internal operation: DR to DD RAM or CG RAM
1	1	DR selection, DR read. Internal operation: DD RAM or CG RAM to DR

### ADDRESS COUNTER (AC)

The counter specifies an address when data is written into DD RAM or CG RAM and the data stored in DD RAM or CG RAM is read out. If an Address Set instruction (for DD RAM or CG RAM) is written in the IR, the address information is transferred from the IR to the AC. When display data is writ-

ten into or read from DD RAM or CG RAM, the AC is automatically incremented or decremented by one according to the Entry Mode Set. The contents of the AC are output to DB0 to DB6; refer to above "Register Selection Table" when RS = 0 and R/W = 1.

### CLEAR DISPLAY

RS	R/W	DB7								DB0				
Code	1	0	1	0	1	0	0	0	0	0	0	0	0	1

Clear all display memory and return the cursor to the

home position. In other words, the cursor returns to the first character block on the first line on all 1, 2, and 4 line character modules except L4044. If the above is entered on E2 (the second controller for lines 3 and 4), the cursor will return to the first character on the third line.

### CURSOR HOME

RS	R/W	DB7								DB0	
Code	0	0	0	0	0	0	0	0	0	1	*

\*Doesn't matter

Returns cursor to home position. First line first character

blocks on all 1, 2 and 4 line display; except L4044 refer "clear display": (Address 0; A,, "80"). The contents of DD RAM remain unchanged.

## RESTRICTIONS ON EXECUTION OF DISPLAY CLEAR AND CURSOR HOME INSTRUCTIONS

Conditions of use	Restrictions
When executing the Display Clear or Cursor Home instruction when the display is shifted (after execution of Display Shift instruction).	The Cursor Home instruction should be executed again immediately after the Display Clear or Cursor Home instruction is executed. Do not leave an interval of a multiple of $400/f_{osc}$ * second after the first execution. <ul style="list-style-type: none"> <li>L4052: <math>f_{osc} = 250</math> kHz</li> <li>The other modules: <math>f_{osc} = 270</math> kHz</li> </ul> <p style="text-align: center;">*<math>f_{osc}</math>: Oscillation frequency</p>
When $23_H$ , $27_H$ , $63_H$ , or $67_H$ is used as a DD RAM address to execute Cursor Home instruction.	Before executing the Cursor Home instruction, the data of the four DD RAM addresses given at the left should be read and saved. After execution, write the data again in DD RAM. (This restriction is necessary to prevent the contents of the DD RAM addresses from being destroyed after the Cursor Home instruction has been executed.)

## ENTRY MODE SET

	RS	R/W	D B 7							DB0
Code	0	0	0	0	0	0	0	1	I/D	S

**I/D:** Increments (I/D = 1) or decrements (I/D = 0) the DD RAM address by one block when writing or reading a character code from DD RAM or CG RAM. The cursor automatically moves to the right when incremented by one or to the left if decremented by one.

**S:** Shifts the entire display to either the right or left when S = 1 (high). When S = 1 and I/D = 1 the display shifts one position to the left. When S = 1 and I/D = 0 the display shifts one position to the right. This right or left shift occurs after each data write to DD RAM. Display is not shifted when reading from DD RAM. Display is not shifted when S = 0.

## DISPLAY AND CURSOR ON/OFF CONTROL

	RS	R/W	DB 7							DB0
Code	0	0	0	0	0	0	1	D	C	B

**D:** Display is turned ON when D = 1 and OFF when D = 0. When display is OFF, display data in DD RAM remains unchanged. Information comes back immediately when D = 1 is entered.

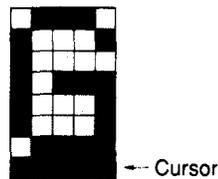
**C:** Cursor is displayed when C = 1 and not displayed when C = 0. If the cursor disappears, function of I/D etc.

does not change during display data write. In a 5 x 7 dot matrix there is an eighth line which functions as the cursor.

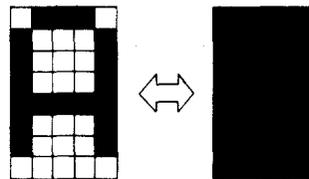
**B:** When B = 1, the character at the cursor position starts blinking. When B = 0 the cursor does not blink. The blink is done by stiching between the all black dot matrix and displayed character at 0.4 second intervals. The cursor and the blink can be set at the same time (fosc = 250 kHz).

## 5 X 7 DOT MATRIX

C = 1 (cursor display)



B = 1 (blinking)



## CURSOR OR DISPLAY SHIFT

	RS	R/W	DB 7							DB0
Code	0	0	0	0	0	1	S/C	R/L	*	*

\* Doesn't Matter

**Cursor/Display Shift** moves the cursor or shifts the display without changing the DD RAM contents.

The cursor position and the AC contents match. This instruction is available for display correction and retrieval because the cursor position or display can be shifted without writing or reading display data. In case of a 2-line display, the

cursor is shifted from character block 40 of line 1 to character block 1 of line 2. Displays of lines 1 and 2 are shifted at the same time. In case of a 4-line display, the cursor does not move continuously from line 2 to line 3. The cursor is shifted from character block 40 of line 3 to character block 1 of line 4. Displays of lines 3 and 4 are shifted at the same time. The display pattern of line 2 or 4 is not shifted to line 1 or 3.

SIC	R/L	Operation
0	0	The cursor position is shifted to the left (the AC decrements one)
0	1	The cursor position is shifted to the right (the AC increments one)
1	0	The entire display is shifted to the left with the cursor
1	1	The entire display is shifted to the right with the cursor



# OPERATING INSTRUCTIONS (CONTINUED)

## 5 x 7 + CURSOR

Relationships between CG RAM addresses and character codes (DD RAM) and character patterns (CG RAM data), (5 x 7 dot matrix).

Character code (DD RAM data)								CG RAM address				Character pattern (CG RAM data)									
7	6	5	4	3	2	1	0	5	4	3	2	10	7	6	5	4	3	2	1	0	
← Upper bit				Lower bit →				← Upper bit		Lower bit →		← Upper bit				Lower bit →					
0 0 0 0 * 0 0 0								0 0 0				0	0	0	* * *	1	1	1	1	0	Example of character pattern (R)
												0	0	1		1	0	0	0	1	
												0	10			1	0	0	0	1	
												0	11			1	1	1	1	0	
												1	0	0		1	0	1	0	0	
												10	1			1	0	0	1	0	
												1	1	0		1	0	0	0	1	
												1	1	1		* * *	0	0	0	0	
0 0 0 0 * 0 0 1								0 01				0	0	0	* * *	1	0	0	0	1	Example of character pattern (¥)
												0	0	1		0	1	0	1	0	
												0	10			1	1	1	1	1	
												0	11			0	0	1	0	0	
												1	0	0		1	1	1	1	1	
												1	0	1		0	0	1	0	0	
												1	1	0		0	0	1	0	0	
												1	1	1		* * *	0	0	0	0	
0 0 0 0 * 1 1 1								1 0 0				0	0	0	* * *						
												0	0	1		1	1	1	* * *		

← Cursor position

- NOTES:
- ▶ In CG RAM data, 1 corresponds to Selection and 0 to Non-selection on the display.
  - ▶ Character code bits 0 to 2 and CG RAM address bits 3 to 5 correspond with each other (three bits, eight types).
  - ▶ CG RAM address bits 0 to 2 specify a line position for a character pattern, Line 8 of a character pattern is the cursor position where the logical sum of the cursor and CG RAM data is displayed. Set the data of line 8 to 0 to display the cursor. If the data is charged to 1, one bit lights, regardless of the cursor.
  - ▶ The character pattern column position corresponds to CG RAM data bits 0 to 4 and bit 4 comes to the left end. CG RAM data bits 5 to 7 are not displayed but can be used as general data RAM.
  - ▶ When reading a character pattern from CG RAM, set to 0 all of character code bits 4 to 7. Bits 0 to 2 determine which pattern will be read out. Since bit 3 is not valid, 00H and 08, select the same character.

3)

## L1634-SERIES (16 characters x 4 lines)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Line 1	80	81	82	83	84	85	86	87	88	89	8A	8B	8C	8D	8E	8F
Line 2	c0	c1	c2	c3	c4	C5	C6	C7	C8	C9	CA	CB	CC	CD	CE	CF
Line 3	90	91	92	93	94	95	96	97	98	99	9A	9B	9C	9D	9E	9F
Line 4	D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	DA	DB	DC	DD	DE	DF

# OPERATING INSTRUCTIONS (CONTINUED)

## PROGRAMMING THE CHARACTER GENERATOR RAM (CG RAM)

The character generator RAM (CG RAM) allows the user to create up to eight custom 5 x 7 characters + cursor (5 x 8). Once programmed, the custom characters or symbols are accessed exactly as if they were in ROM. However since the RAM is a volatile memory, power must be continually maintained. Otherwise, the custom characters/symbols must be programmed into non-volatile external ROM and sent to the display after each display initialization. All dots in the 5 x 8 dot matrix can be programmed, which includes the cursor position.

The modules RAM are divided into two parts: data display RAM (DD RAM) and custom character generator RAM (CG RAM). This is not to be confused programming the custom character generator RAM with the 192 character generator ROM. The CG RAM is located between hex 40 and 7F and is contiguous. Locations 40 thru 47 hold the first custom character (5 x 8), 48 thru 4F hold the second custom character, 50 thru 57 hold the third CG, and so forth to 78 thru 7F for the eighth CG character/symbol.

If during initialization the display was programmed to automatically increment, then only the single initial address, 40, need be sent. Consecutive row data will automatically appear at 41, 42, etc. until the completed character is formed. All eight custom CG characters can be programmed in 64 consecutive "writes" after sending the single initial 40 address.

The CG RAM is 8 bits wide, although only the right-most 5-bits are used for a custom CG character row. The left-most dot of programming the CG RAM character corresponds to D4 in the most significant nibble (XXXD4) of the data bus code, with the remaining 4 dots in the row corresponding to the least significant nibble (D3 thru D0), D0 being the right-most dot. Thus, hex 1F equals all dots on and hex 00 equals all dots off. Examples include hex 15 (10101) equal to 3 dots on the hex 0A (01010) equal 2 dots on. In each case the key 5-bits of the 8-bit code program one row of a custom CG character. When all 7 or 8 rows are programmed, the character is complete. A graphic example is shown below:

RS	R/W	Data	Display	Description
0	0	40	—	addresses 1st row, 1st CG character
1	0	11	* *	result of 11, 1st row
1	0	0A	**	result of 0A, 2nd row
1	0	1F	*****	result of 1F, 3rd row
1	0	04	*	result of 04, 4th row
1	0	1F	*****	result of 1F, 5th row
1	0	04	*	result of 04, 6th row
1	0	04	*	result of 04, 7th row
1	0	00	—	result of 00, 8th row (cursor position)
1	0	15	***	1st row, 2nd CG character. <b>Note:</b> Addressing not now required; hex 48 is next in the sequence.