

DEFINITION OF TERMINALS

PIN NO.	SYMBOL	FUNCTION
1.	Vss	Ground terminal of module.
2.	Vdd	Supply terminal of module, +5V.
3.	Vo	Power supply for Liquid Crystal Drive
4.	RS	Register Select RS = 0... Instruction Register. RS = 1... Data Register.
5.	R/W	Read/Write R/W = 1...Read R/W = 0...Write
6.	E	Enable
7-14.	DB0-DB7	Bi-directional Data Bus. Data Transfer is performed once, thru DB0-DB7, in the case of interface data length is 8-bits; and twice, thru DB4-DB7, in the case of interface data length is 4-bits. Upper four bits first then lower four bits.
15.	LAMP- (L-)	LED or EL lamp power supply terminals
16.	LAMP+ (L+)	

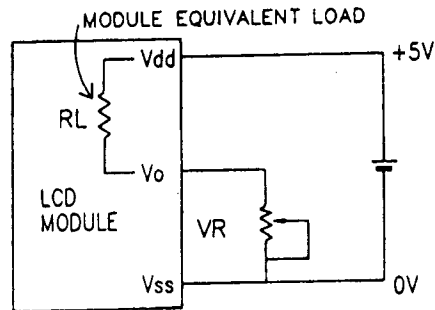
*ALL LED BACKLIGHT MODELS HAVE A BUILT-IN LIMITING RESISTOR EXCEPT CR2011 - CR 2014.

OPERATING SPECIFICATIONS

	STANDARD TEMP	WIDE TEMP
Operating temperature range	0°C to +50°C	-20°C to +70°C
Storage temperature range	-40°C to +70°C	-40°C to +85°C
Operating relative humidity	90% MAX	90% MAX

POWER SUPPLY REQUIREMENTS

- Wide Temperature Range Version
- Standard
- Super Twist Display Version



When $RL=23.5K$, $VR=10\sim20K$
 $RL=5K$, $VR=2\sim5K$

USE 3.3kΩ

This circuit shows the typical power supply connection for all dot matrix modules. The display Voltage (V_{LCD}) is slightly different for different versions. (eg. standard, wide temp and supertwists) Recommend end user to use **VARIABLE RESISTOR** as shown in the circuit for optimum V_{LCD} ($V_{DD} - V_o$) adjustment to obtain best display contrast and viewing angle.

ELECTRICAL CHARACTERISTICS ($T_a = +25^\circ C$)

PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
Supply Voltage	VDD		4.5	5.0	5.5	V
LCD Drive Voltage	VDD-Vo (V _{LCD})		4.2	4.5*	4.8	V
Normal Temp Model (TN/STN)		4.4	4.7*	5.0	V	
Wide Temp Model (TN)		6.4	6.8*	7.5	V	
Supply Current ¹	IDD	VDD = 5V Vo = 0V MIN	-	1.0	2.0	mA
1x16 DMM			-	1.0	3.0	mA
2x16 DMM			-	1.5	3.0	mA
1x20, 2x20, 2x24 DMM			-	2.5	4.0	mA
4x20, 2x40, 1x40 DMM 4x16 DMM			-	4.5	5.5	mA
Input Voltage ²	V _L V _H		0 2.2	- -	0.6 VDD	V V
Output Voltage ³	V _{OL} V _{OH}	I _{OL} = 1.6 mA I _{OH} = 0.2 mA	- 2.4	- -	0.4 -	V V
LED Current ⁴	I _{LED}	L+ - L- = 5V	-	40	60	mA
1x16, 2x16 DMM			-	60	80	mA
2x24, 2x20 DMM			-	150	250	mA
1x20, 1x40, 2x40, 4x20 DMM			-	-	-	-

DRIVE VOLTAGE (V_{LCD}) IS NOT IDENTICAL FOR LCD MODULES. MANUFACTURER'S ACCEPTABLE RESULTS CAN BE OBTAINED BY ADJUSTING V_{LCD} . IF THIS DOES NOT WORK, CRYSTALOID CAN MODIFY DISPLAY TO MEET CUSTOM NEEDS. CONSULT THE FACTORY.

- NOTE:
1. Applies to DB0-DB7, E, RS and R/W.
 2. Applies to DB0-DB7.
 3. Supply current may slightly exceed MAX. rating if SAMSUNG controller is used without pull-up resistor for DB0-DB7.
 4. For CR2011-CR2014, an external limiting resistor of 6.8 - 10Ω is required.



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ALPHANUMERIC DOT MATRIX MODULES WITH BACKLIGHTS

ELECTROLUMINESCENT BACKLIGHTING

ELECTRICAL CHARACTERISTICS

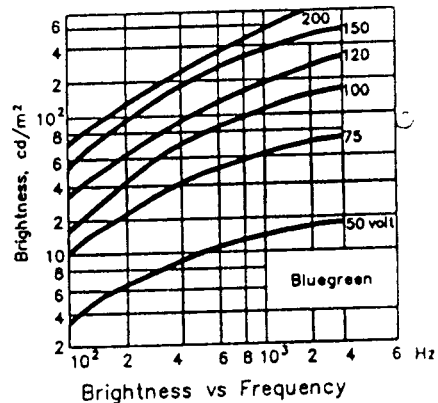
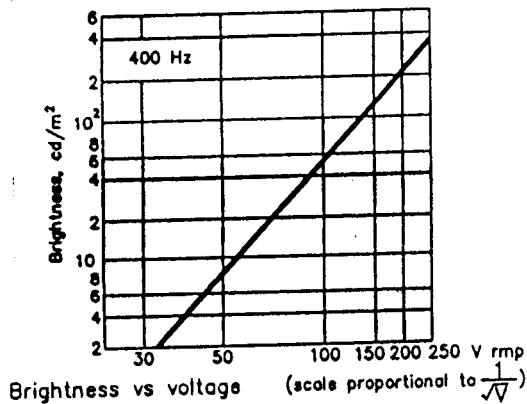
PARAMETER	TYP.	GENERAL OPERATING CONDITION	UNIT
VOLTAGE	115	100~150	V
FREQUENCY	400	50~1000	HZ
CURRENT	0.20	0.05~0.60	mA/cm ²
WATTAGE	5.90	1~10	mW/cm ²
BRIGHTNESS	70	10~100	cd/m
LIFE *	3000	SEE NOTE	hrs
COLOR	-	BLUE-GREEN	-

OPERATING CONDITION

TEMPERATURE	0~50°C
HUMIDITY	< 95%RH
STORAGE CONDITION	20°, < 60%RH, DARK ROOM.

*NOTE: 3000 HOURS LIFE IS WITH CRYSTALOID CONVERTER (DA50, DA51 AND DA52). WITH OTHER UNSTABLE POWER SUPPLY LIFE MAY BE TYPICALLY 1000 HOURS.

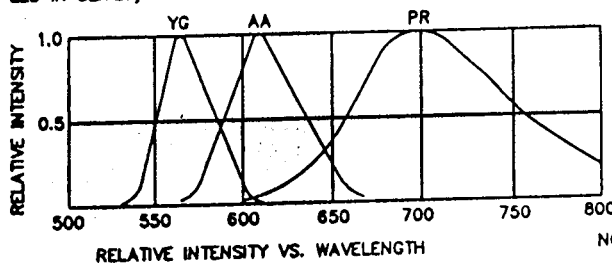
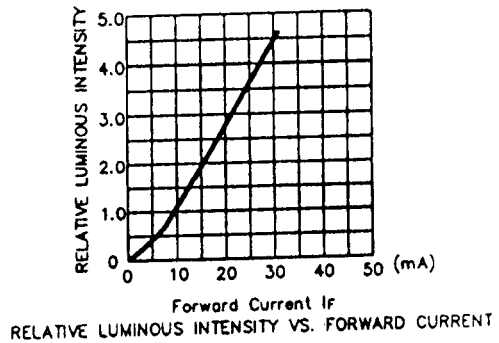
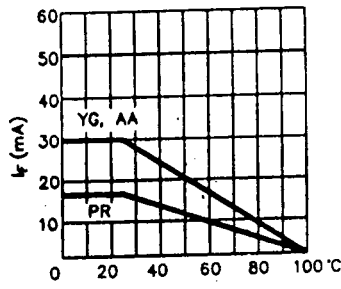
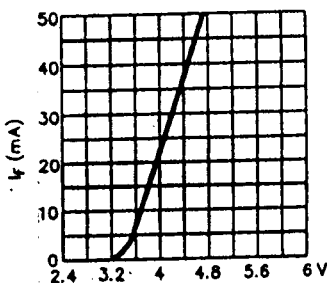
BRIGHTNESS



LIGHT EMITTING DIODE BACKLIGHTING

FEATURES:

- NO NOISE INTERFERENCE.
- LONG LIFE, TYPICALLY 100,000 HOURS.
- LOW VOLTAGE DC DRIVE - 5V (10 VOLT OPTIONAL ON SOME MODULES)
- YELLOW-GREEN BACKLIGHTING STANDARD (PURE RED AND AMBER OPTIONAL)



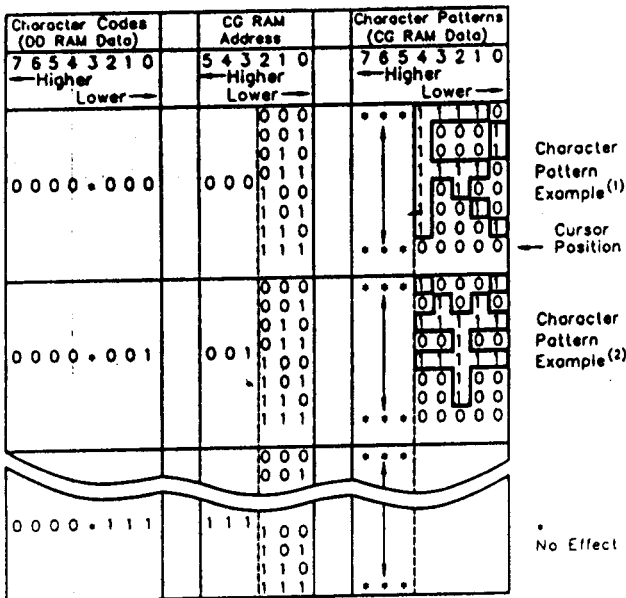
PR : PURE RED
YG : YELLOW-GREEN
AA : AMBER

WAVELENGTH NANOMETERS
T_a = 25°C

NOTE : SENSITIVITY OF EYE IS MAXIMUM AT 550nm.

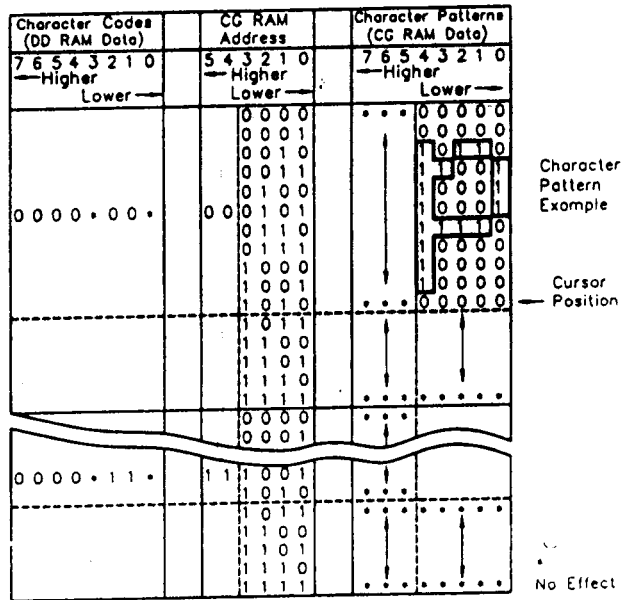
DOT CHARACTER PATTERNS

For 5x7 Dot Character Patterns



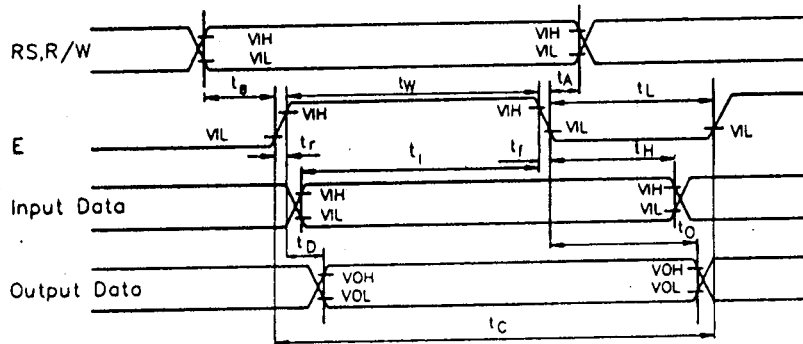
NOTE:
Character code bits 0,2 correspond to CG RAM address bits 3,5 (3 bits : 8 types)

For 5x10 Dot Character Patterns



NOTE:
Character code bits 1,2 correspond to CG RAM address bits 4,5 (2 bits : 4 types)

TIMING DIAGRAM



TIMING CHARACTERISTICS FOR ALL COMPATIBLE CONTROLLER CHIPS

PARAMETERS	CONTROLLERS CHIPS	SAMSUNG KS0066	HITACHI HD44780	SANYO LC7985 NA	EPSON SED1278	OKI MSM6222	RECOMMENDED TIMING	UNIT
Enable Cycle Time	t_c (min)	1000	1000	1000	500	667	1000	nS
Enable Pulse Width	High Level	t_w (min)	450	450	450	220	450	nS
	Low Level	t_l (min)	450	450	450	280	450	nS
E Raise Time	t_r (max)	25	25	25	25	25	25	nS
E Fall Time	t_f (max)	25	25	25	25	25	25	nS
Set-up Time	t_b (min)	140	140	140	40	140	140	nS
Data Set-up Time	t_i (min)	195	195	195	60	180	195	nS
Data Delay Time	t_d (max)	320	320	320	120	220	320	nS
Address Hold Time	t_a (max)	10	10	10	10	10	10	nS
Hold Time	Input Data	t_h (min)	10	10	10	10	10	nS
	Output Data	t_o (min)	20	20	20	20	20	nS

NOTE:

- INITIALIZATION BY POWER-ON RESET INVOLVES MANY UNSTABLE FACTORS CAUSED BY POWER SUPPLY FLUCTUATIONS. THEREFORE, INITIALIZING BY INSTRUCTIONS IS STRONGLY RECOMMENDED.
- MODULE INITIALIZATION IS NOT AFFECTED BY USING HD44100 OR KS0066, OR LC7930, OR MSM5839, OR MSM5260 DRIVER CHIPS.

INSTRUCTION	CODE										DESCRIPTION	TYPICAL EXECUTION TIME
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear display	0	0	0	0	0	0	0	0	0	1	Clears display and returns the cursor to home position (Address 0). Sets I/D=1 of Entry Mode.	1.64 ms
Return home	0	0	0	0	0	0	0	0	1	●	Return the cursor to the home position (Address 0). Also returns the display being shifted to the original position. DD RAM contents remain unchanged. Set DD RAM addresses to zero.	1.64 ms
Entry mode set	0	0	0	0	0	0	0	1	I/D	S	Set the cursor move direction and specifies or not to shift the display. These operations are performed during data write and read of DD RAM/CG RAM. FOR NORMAL OPERATION, SET S TO 0	40ms
Display ON/OFF control	0	0	0	0	0	0	1	D	C	B	Sets ON/OFF all display (D), cursor ON/OFF (C), and blink of cursor position character (B).	40ms
Cursor or display shift	0	0	0	0	0	1	S/C	R/L	●	●	Moves the cursor and shifts the display without changing DD RAM contents.	40ms
Function set	0	0	0	0	1	DL	N	F	●	●	Sets interface data length (DL) number of display lines (N) and character font (F).	40ms
Set the CG RAM address	0	0	0	1	MSB	ACG				LSB	Sets the CG RAM address. CG RAM data is sent and received after this setting.	40ms
Set the DD RAM address	0	0	1	MSB	ADD				LSB	Sets the DD RAM address. DD RAM data is sent and received after this setting.	40ms	
Read busy flag & address	0	1	BF	MSB	AC				LSB	Reads Busy flag (BF) indicating internal operation is being performed and reads address counter contents.	40ms	
Write data to CG or DD RAM	1	0	MSB							LSB	Writes data into DD RAM or CG RAM.	40ms
Read data from CG or DD RAM	1	1	MSB							LSB	Reads data from DD RAM or CG RAM.	40ms
	S = 1: Accompanies display shift when data is written. For normal operation, set to 0 I/D=1: Increment DL=1: 8 bits I/D=0: Decrement DL=0: 4 bits S/C=1: Display shift N=1: 2 (1) line S/C=0: Cursor move N=0: 1 line R/L=1: Shift to the right F=1: 5x10 dots R/L=0: Shift to the left F=0: 5x7 dots BF=1: Internally operating BF=0: Can accept instruction										DD RAM : Display data RAM CG RAM : Character generator RAM ACG : CG RAM address ADD : DD RAM address corresponds to cursor address AC : Address counter used for both DD and CG RAM address B : 1=ON 0=OFF (Blinking cursor) C : 1=ON 0=OFF (Cursor) D : 1=ON 0=OFF (Display) ● Don't Care	

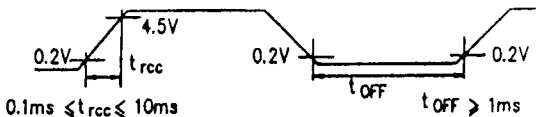
INITIALIZATION

The module automatically performed initialization when powered on (using internal reset circuit). The following instructions are executed during initialization :-

- CLEAR DISPLAY**
The Busy Flag is kept in the Busy State (BF=1) unit initialization ends. The time is 15 ms.
- Function Set** ----- DL= 1: 8-bits long interface data
N = 0 : 1 Line display
- DISPLAY ON/OFF CONTROL**---- D = 0 : Display OFF
C = 0 : Cursor OFF
B = 0 : Blink OFF
- ENTRY MODE SET** ----- I/D= 1 : +1(INCREMENT)
S = 0 : NO SHIFT
- DD RAM IS SELECTED**

Power On initialization depends on rise time of the supply when it is turned on. The following time relationship must be satisfied.

ITEM	SYMBOL	STANDARD TIME			UNIT
		MIN	TYP	MAX	
Power Supply Rise Time	t _{rc}	0.1	-	10	ms
Power Supply Off Time	t _{off}	1.0	-	-	ms



Power On Timing Diagram

NOTE :

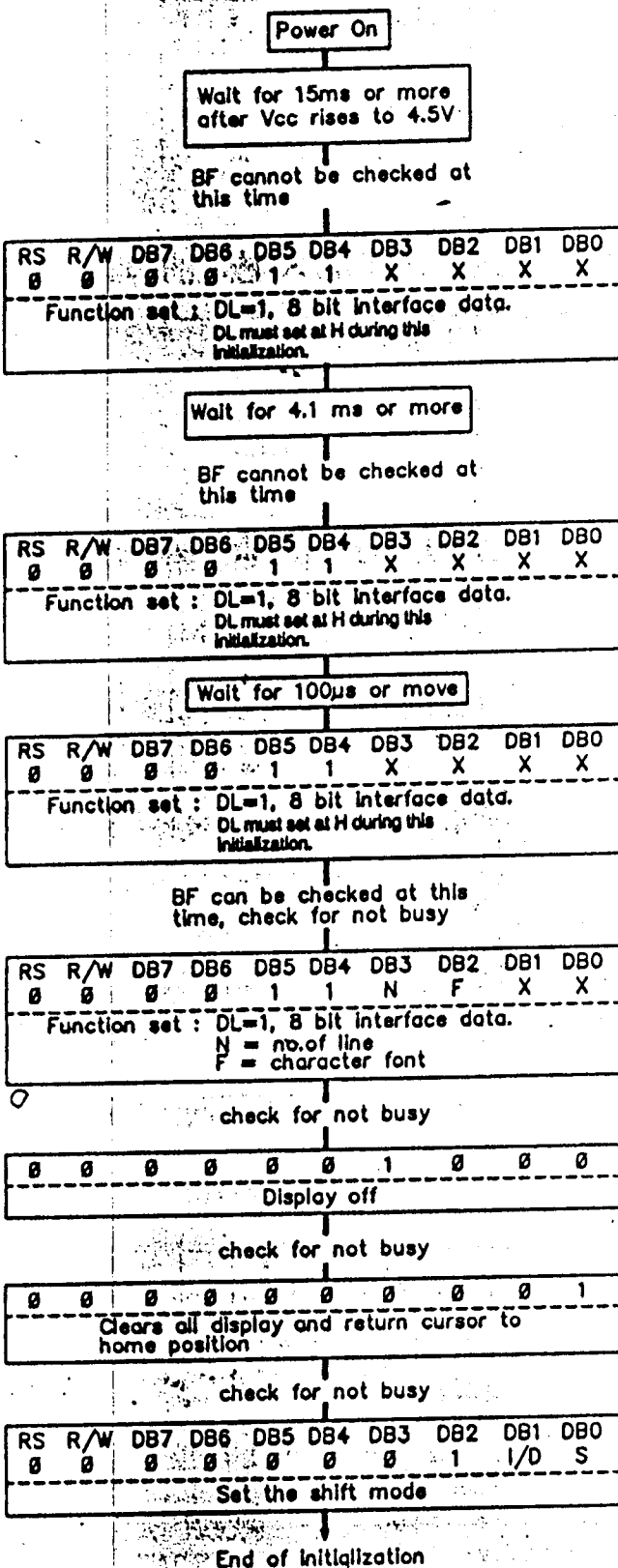
When the above power supply condition is not satisfied, the internal reset circuitry does not operate correctly. In this case, perform the needed initialization by sending function set instructions thrice from MPU after turning the power on. For example, to designate a 8-bits data length, send the following instructions thrice.

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	1	●	●	●	●
0	0	0	0	1	1	●	●	●	●
0	0	0	0	1	1	●	●	●	●

When this ends, the module enters 8-bits data length mode without fail. Then enter 4-bits data length instruction for 4-bits data length interface.

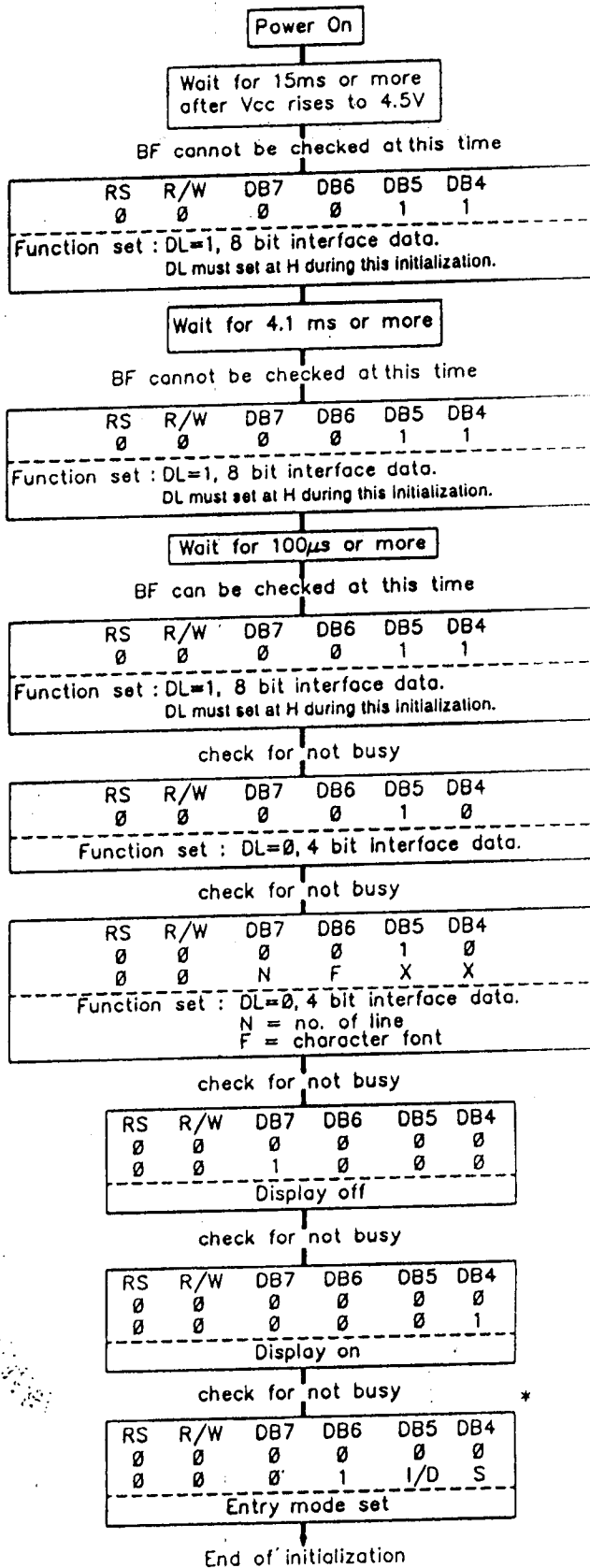
INITIALIZATION

For 8 bit data interfacing



* NOTE : IN NORMAL OPERATION, SET S TO 0

For 4 bit data interfacing



CHARACTER CODE MAP

		Higher 4 bit (D4 to D7) of Character Code (Hexadecimal)															
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Lower 4 bit (D0 to D3) Character Code (Hexadecimal)	0	CG RAM (1)															
	1	CG RAM (2)															
	2	CG RAM (3)															
	3	CG RAM (4)															
	4	CG RAM (5)															
	5	CG RAM (6)															
	6	CG RAM (7)															
	7	CG RAM (8)															
	8	CG RAM (1)															
	9	CG RAM (2)															
	A	CG RAM (3)															
	B	CG RAM (4)															
	C	CG RAM (5)															
	D	CG RAM (6)															
	E	CG RAM (7)															
	F	CG RAM (8)															

NOTE 1: SOME PATTERNS WITH CHARACTER ABOVE "E0H" (11100000) ARE FOR 5 X 10 DOT CHARACTERS FONT AND ARE APPLICABLE ONLY TO CR2021 AND CR2140 IN 1/11 MULTIPLEX MODE.

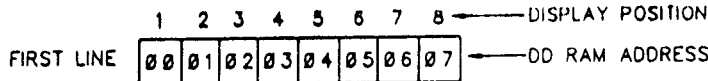
NOTE 2: CUSTOM FONT ROM MASK CAN BE TOOLED ON SPECIAL REQUEST.

DISPLAY CHARACTER POSITION AND DD RAM ADDRESS

1x8 DMM, 1/8 MUX

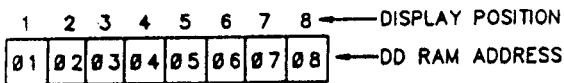
N=0 : 1-LINE DISPLAY

F=0 : 5X7 DOTS

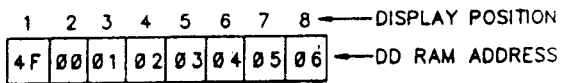


WHEN THE DISPLAY SHIFT OPERATION IS PERFORMED, THE DD RAM ADDRESS MOVED AS FOLLOWS:

AFTER THE LEFT SHIFT INSTRUCTION



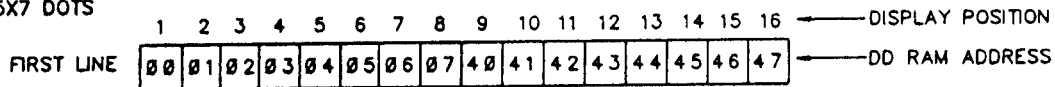
AFTER THE RIGHT SHIFT INSTRUCTION



1x16 DMM, 1/16 MUX

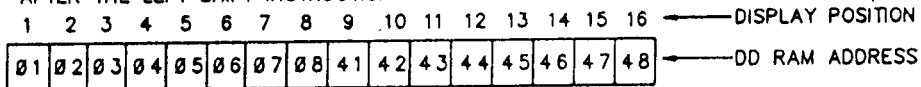
N=1 : 2-LINE DISPLAY

F=0 : 5X7 DOTS

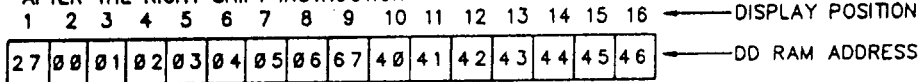


WHEN THE DISPLAY SHIFT OPERATION IS PERFORMED, THE DD RAM ADDRESS MOVED AS FOLLOWS:

AFTER THE LEFT SHIFT INSTRUCTION



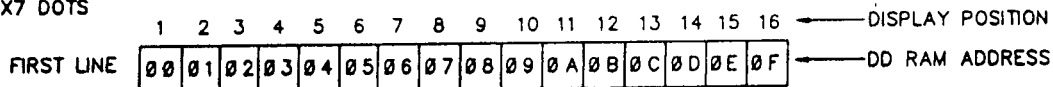
AFTER THE RIGHT SHIFT INSTRUCTION



1x16 DMM, 1/8 MUX

N=0 : 1-LINE DISPLAY

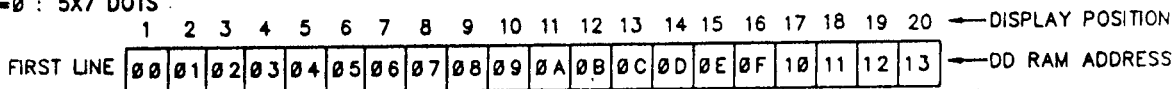
F=0 : 5X7 DOTS



1x20 DMM, 1/8 MUX

N=0 : 1-LINE DISPLAY

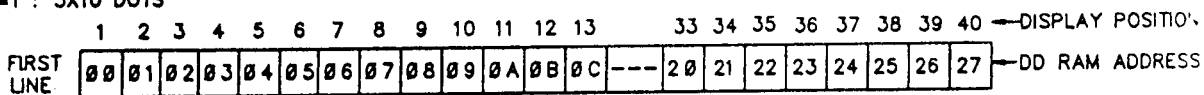
F=0 : 5X7 DOTS

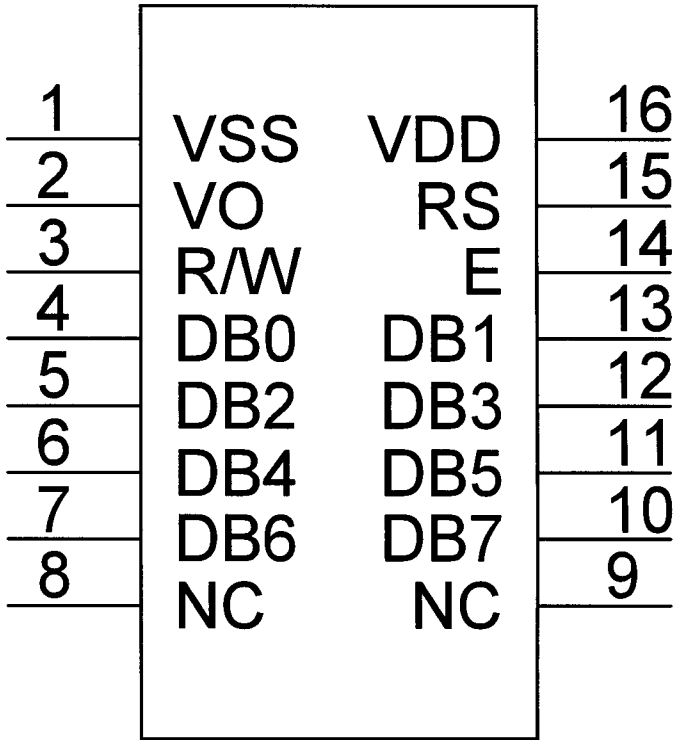


1x40 DMM, 1/11 MUX

N=0 : 1-LINE DISPLAY

F=1 : 5X10 DOTS





Part Name	HEADER
Library	LCD
Reference Prefix	U
Description	Part No 2011 TNLDNORN-TC

Addendum to Documentation for 20 character Matrix Display
PN TNLDORN-TC

The initialization sequence given in the manufacturers docs does not seem to work
This initialization is known to work. It will :

- 1) Init the display
- 2) Set it to autoincrement. This means the next characters will go into RAM sequentially. I.E first character will go into address 0, the next character entered will go into address 1, etc.

- 3) Turn off the visible cursor, and set the cursor to the home position
- NOTE: it is still necessary to follow the timing constrains given which is a cycle time of 1000ns at a 50% duty cycle for the Enable signal.

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	hex
0	0	0	0	1	1	0	0	0	0	0x30
0	0	0	0	1	1	0	0	0	0	0x30
0	0	0	0	1	1	0	0	0	0	0x30
0	0	0	0	1	1	0	0	0	0	0x30
0	0	0	0	1	1	0	0	0	0	0x30
0	0	0	0	0	1	1	0	0	0	0x0c
0	0	0	0	0	0	1	1	0	0	0x06
0	0	1	0	0	0	0	0	0	0	0x80

Function
init for 8 bit interface
Wait 4.1ms or more
init for 8 bit interface
wait 100us or more
init for 8 bit interface
no lines, char font
display on, cursor off, no blink
move the cursor, do not shift the display
set the cursor position to address 0 (home)

10 R Reach across Back light