CHARACTER LCD INTERFACING

GROUP 2

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BASIC DEFINITIONS:

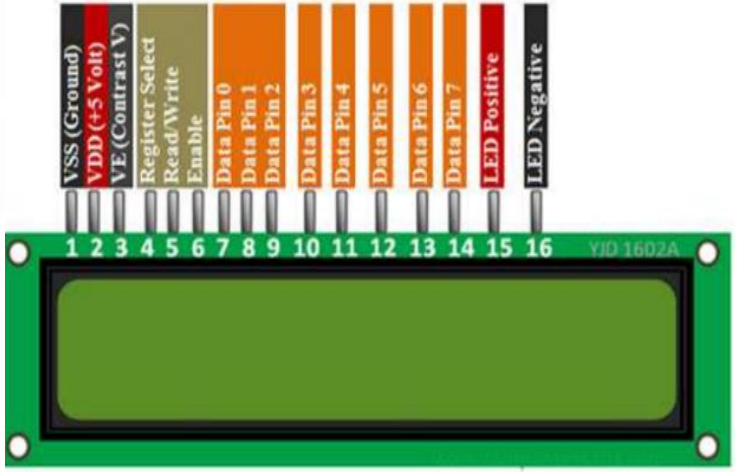
- A character LCD is the most basic form of an electronic display device which is widely used.
- The module will consist of 2 rows each with 16 columns which can display 16 characters.
- Several other LCD modules are also available like 20×4 dimension LCD which can display 20 characters per line and 4 such lines would be available.
- The choice for the module depends on the requirement.

ADVANTAGE OF CLCD:

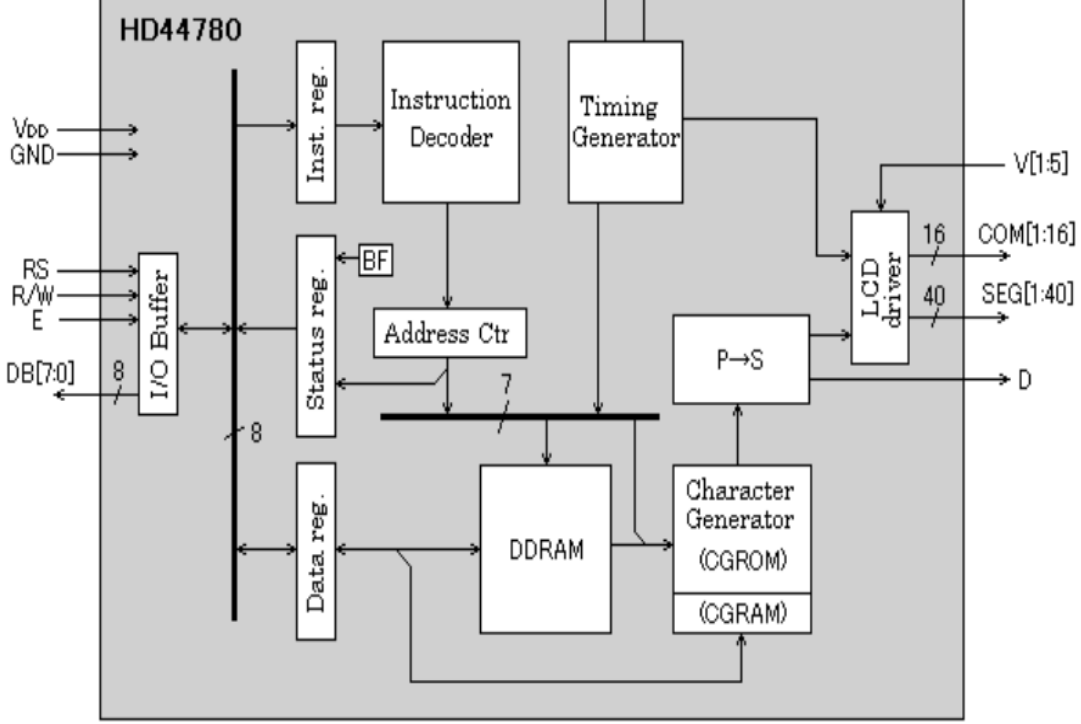
- The main advantage of using a character LCD instead of a seven segment display and other multi-segment leds :
- There is no limitation in displaying special & custom characters animations and so on.
- Most of character LCDs will have (16 Pins)
- It is based on the HD44780 microcontroller (Hitachi)
- It can display all the letters of alphabet, Greek letters, punctuation marks, mathematical symbols etc.
- It is also possible to display symbols made up by the user “Custom Characters”

16 PINS FOR CLCD:

Pin no.	Symbol	Function
1	GND	Power supply ground
2	VCC	+5V supply
3	VEE	Contrast adjustment voltage
4	RS	Register select (H: data, L: instruction)
5	R/$\overline{W}$	Read/Write data (H: LCD -> µC, L: µC -> LCD)
6	E	Enable pulse
7	D0	Data bit 0
8	D1	Data bit 1
9	D2	Data bit 2
10	D3	Data bit 3
11	D4	Data bit 4
12	D5	Data bit 5
13	D6	Data bit 6
14	D7	Data bit 7
15	A	Anode of backlight LED
16	K	Cathode of backlight LED

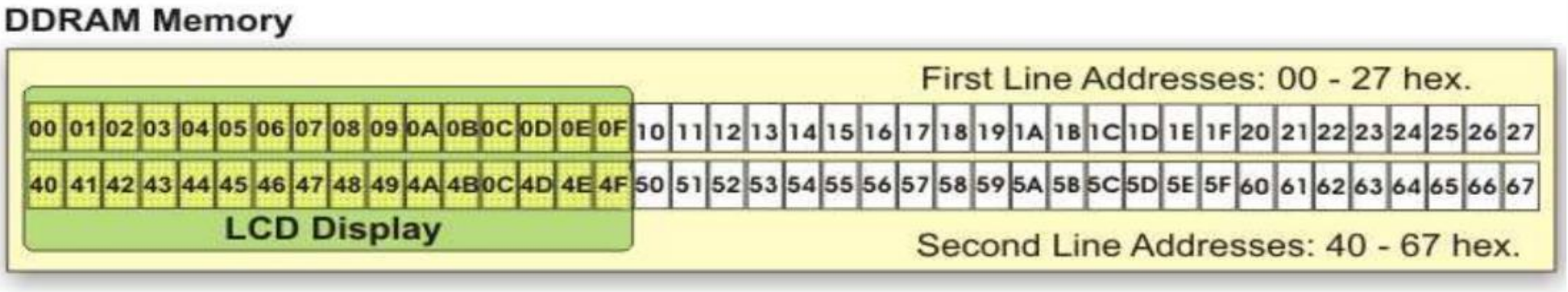


TYPES OF MEMORY IN CLCD:



- LCD display contains three memory blocks :-
- 1) DDRAM Display Data RAM
- 2) CGRAM Character Generator RAM
- 3) CGROM Character Generator ROM
- Instruction Decoder: Processes the instruction code written into the instruction register.
- Address Counter: Holds DDRAM/CGRAM address to be read/written at next data transfer.
- Instruction Register: Holds the commands from the user to be executed
- Data Register: Holds the data from the user to be printed

DISPLAY DATA RAM (DDRAM):



- DDRAM memory is used for storing characters to be displayed.
- The size of this memory is capable of storing 80 characters (4 Rows * 20 Columns).
- All characters sent through lines D0-D7 will be displayed in the message format we are used to- from left to right.
- In this case, displaying starts from the first field of the first line because the initial address is 00 hex.
- If more than 16 characters are sent, then all of them will be memorized (DDRAM), but only the first sixteen characters will be visible.

CHARACTER GENERATOR ROM (CGROM) :

- CGROM memory contains a standard character map with all characters that can be displayed on the screen.
- Each character is assigned to one memory location.
- The addresses of CGROM memory locations match the characters of ASCII.

ASCII TABLE

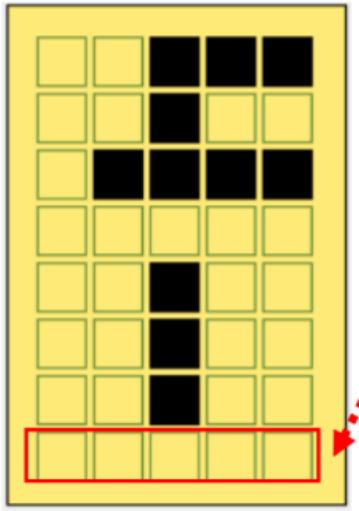
Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char
0	0	[NULL]	32	20	[SPACE]	64	40	@	96	60	`
1	1	[START OF HEADING]	33	21	!	65	41	A	97	61	a
2	2	[START OF TEXT]	34	22	"	66	42	B	98	62	b
3	3	[END OF TEXT]	35	23	#	67	43	C	99	63	c
4	4	[END OF TRANSMISSION]	36	24	$	68	44	D	100	64	d
5	5	[ENQUIRY]	37	25	%	69	45	E	101	65	e
6	6	[ACKNOWLEDGE]	38	26	&	70	46	F	102	66	f
7	7	[BELL]	39	27	'	71	47	G	103	67	g
8	8	[BACKSPACE]	40	28	(	72	48	H	104	68	h
9	9	[HORIZONTAL TAB]	41	29	)	73	49	I	105	69	i
10	A	[LINE FEED]	42	2A	*	74	4A	J	106	6A	j
11	B	[VERTICAL TAB]	43	2B	+	75	4B	K	107	6B	k
12	C	[FORM FEED]	44	2C	,	76	4C	L	108	6C	l
13	D	[CARRIAGE RETURN]	45	2D	-	77	4D	M	109	6D	m
14	E	[SHIFT OUT]	46	2E	.	78	4E	N	110	6E	n
15	F	[SHIFT IN]	47	2F	/	79	4F	O	111	6F	o
16	10	[DATA LINK ESCAPE]	48	30	0	80	50	P	112	70	p
17	11	[DEVICE CONTROL 1]	49	31	1	81	51	Q	113	71	q
18	12	[DEVICE CONTROL 2]	50	32	2	82	52	R	114	72	r
19	13	[DEVICE CONTROL 3]	51	33	3	83	53	S	115	73	s
20	14	[DEVICE CONTROL 4]	52	34	4	84	54	T	116	74	t
21	15	[NEGATIVE ACKNOWLEDGE]	53	35	5	85	55	U	117	75	u
22	16	[SYNCHRONOUS IDLE]	54	36	6	86	56	V	118	76	v
23	17	[ENG OF TRANS. BLOCK]	55	37	7	87	57	W	119	77	w
24	18	[CANCEL]	56	38	8	88	58	X	120	78	x
25	19	[END OF MEDIUM]	57	39	9	89	59	Y	121	79	y
26	1A	[SUBSTITUTE]	58	3A	:	90	5A	Z	122	7A	z
27	1B	[ESCAPE]	59	3B	;	91	5B	[	123	7B	{
28	1C	[FILE SEPARATOR]	60	3C	<	92	5C	\	124	7C	|
29	1D	[GROUP SEPARATOR]	61	3D	=	93	5D	]	125	7D	}
30	1E	[RECORD SEPARATOR]	62	3E	>	94	5E	^	126	7E	~
31	1F	[UNIT SEPARATOR]	63	3F	?	95	5F	_	127	7F	[DEL]

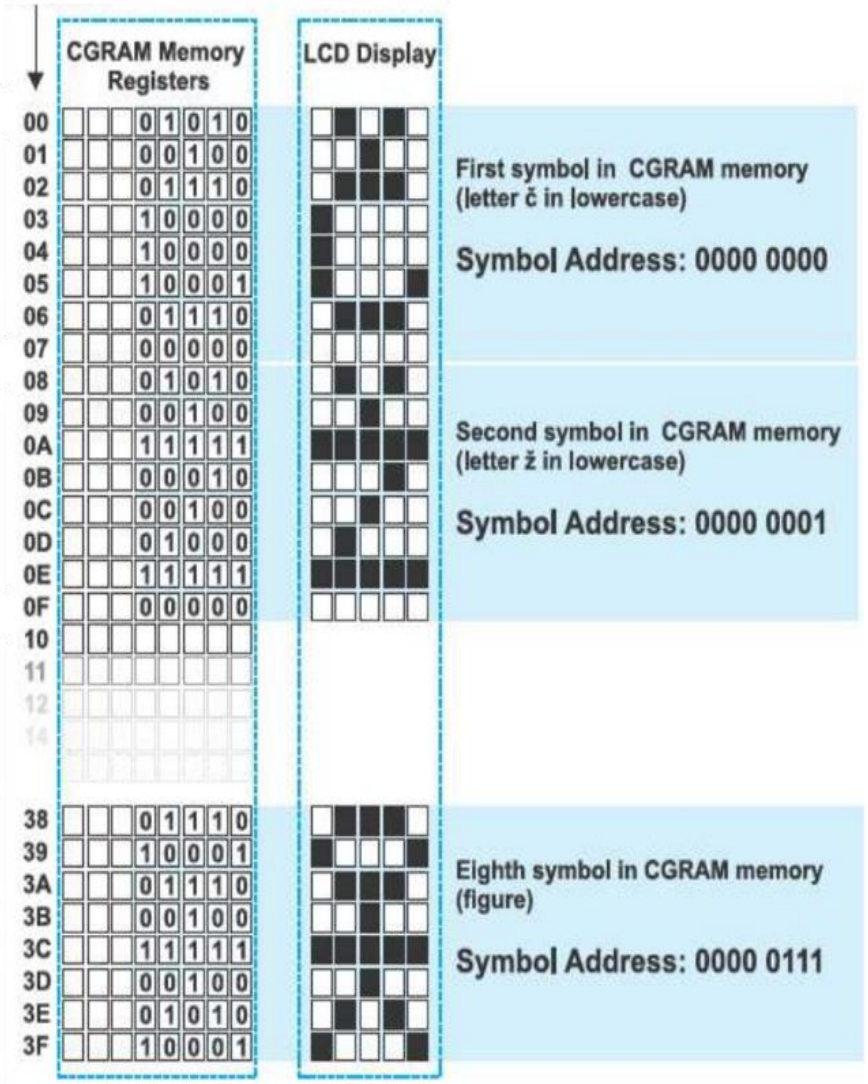
CHARACTER GENERATOR RAM (CGRAM):

- Used to display (User Defined Characters) Custom Characters.
- It can be any symbol in the size of 5x8 pixels.
- 1 Character = 5(Columns) * 8 (Rows)
- CGRAM size = 64 bytes
- 64 / 8Bytes = 8 Characters
- Memory registers are 8 bits wide, but only 5 lower bits are used.

```
const char character[] = { 7,4,15,0,4,4,4,0 };
```

Logic one (1) in every register represents a dimmed **dot**





Instruction	Opcode								Description
	b7	b6	b5	b4	b3	b2	b1	b0	
Clear Display	0	0	0	0	0	0	0	1	Fills DDRAM with 0x20 and set DDRAM address 00h to the address counter.
Cursor Home	0	0	0	0	0	0	1	*	Sets DDRAM address 00h to the address counter. *:Don't care
Entry Mode Set	0	0	0	0	0	1	I/D	S	Sets the direction of address counter and specifies display shift (updating display offset register) on data read/write. I/D=1:Increment, S=1:With display shift
Display ON/OFF	0	0	0	0	1	D	C	B	Sets display, under-line cursor and block cursor on/off. D=1:Display ON, C=1:Under-line cursor ON, B=1:Block cursor ON
Move cursor and Shift display	0	0	0	1	S/C	R/L	*	*	Increment/decremet address counter and display offset register. S/C=1:Shift display, S/C=0:Move cursor, R/L=1:Right shift, R/L=0:Left shift
Function Set	0	0	1	DL	N	F	*	*	Configure operating mode. DL=1:8-bit bus, DL=0:4-bit bus N=1:2-row mode, N=0:1-row mode, F=1:11-line mode, F=0:8-line mode
Address Set (CGRAM)	0	1	Address(00h..3Fh)						Sets CGRAM address to the address counter. After this instruction, CGRAM is accessed via data register
Address Set (DDRAM)	1	Address(00h..67h)							Sets DDRAM address to the address counter. After this instruction, DDRAM is accessed via data register