9 Liquid Crystal Display

The LCD is a 16 character x 2 lines module. Internally it is 40 characters x 2 lines. Line 1 ranges from H’00’ to H’27’ and Line 2 ranges from H’40’ to H’67’.

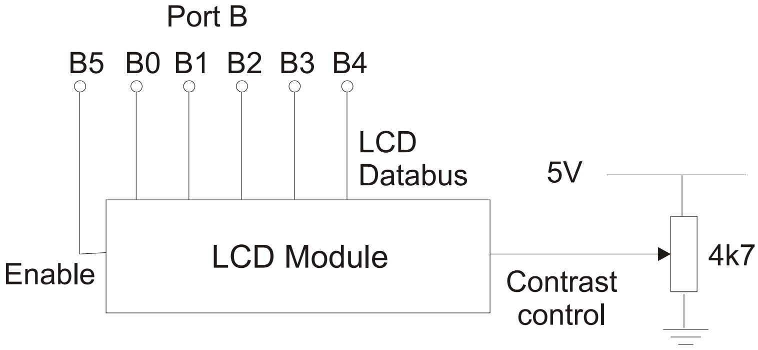
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	20	21	22	23	24	25	26	27
40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F	60	61	62	63	64	65	66	67

Internal [40x2]

Display Window [16x2]

The LCD Module uses a Samsung KS0066U controller, which is similar to the Hitachi HD44780 controller.

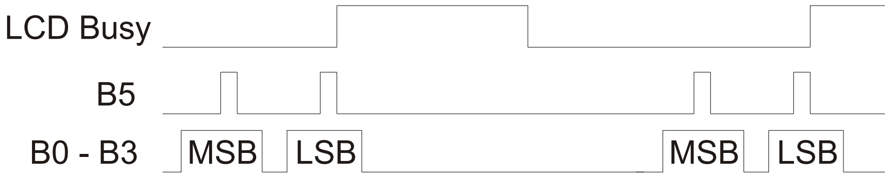
The PICmicro board uses port B [B0 to B5] to program the LCD, as shown in the circuit diagram below. When the PICmicro board is turned on, data can only be sent to it after 30ms, this is the time taken for the LCD to initialize [as it clears all the RAM and sets up the Entry Mode].



LCD Block Diagram

To send a command to the LCD, data must be sent in two steps, the MSB followed by the LSB [byte is data on B0 to B3]. As each byte is sent to the LCD, B5 must be go high then low, for the LCD to acknowledge the byte. After the second byte has been acknowledged the LCD executes the command. The PICmicro board must wait for at least the length of the execution time for that command, before the next command can be sent. A timing diagram of this process is shown below.

Timing Diagram



The first command to be sent to the LCD must be ‘Function Set’ [to setup the LCD], this is usually followed by ‘Display Control’ and then ‘Clear Display’. According to ‘Entry Mode Set’ after each character is sent to the LCD, the position of the cursor changes [by default it is incremented].

LCD Instruction Set

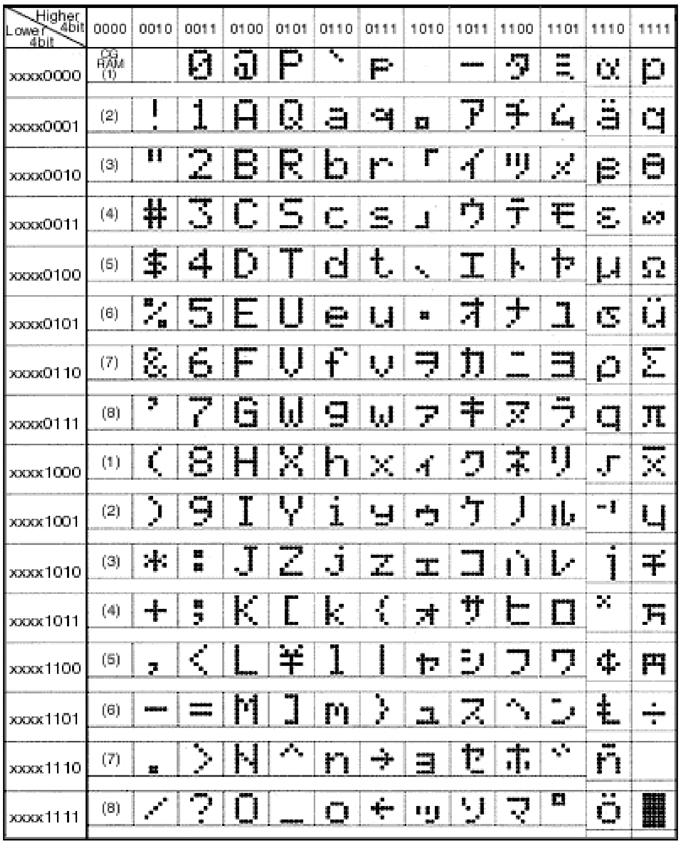
Instruction	Code					Description	Execution Time
MSB LSB	B4	B3	B2	B1	B0		
Clear Display	0	0	0	0	0	Clear all display data. Set DDRAM address to 0. Move cursor to home position. Entry mode set to increment.	1.53 ms
		0	0	0	1		
Return Home	0	0	0	0	0	Set DDRAM address to 0. Move cursor to home position.	1.53 ms
		0	0	1	X		
Entry Mode Set	0	0	0	0	0	Sets cursor move direction (I/D), specifies to shift the display (S). These operations are performed during data read/write.	39 us
		0	1	I/D	SH		
Display Control	0	0	0	0	0	D is Display ON/OFF bit. C is Cursor ON/OFF bit. B is Blink Cursor ON/OFF bit.	39 us
		1	D	C	B		
Cursor/Display Shift	0	0	0	0	1	Sets cursor-move or display-shift (S/C), shift direction (R/L). DDRAM contents remains unchanged.	39 us
		S/C	R/L	X	X		
Function Set	0	0	0	1	0	Configuration data for setting up LCD. [Send First]	39 us
		1	0	X	X		
Set CGRAM Address	0	0	1	A5	A4	Sets the CGRAM address. CGRAM data is sent and received after this setting.	39 us
		A3	A2	A1	A0		
Set DDRAM Address	0	1	A6	A5	A4	Sets the DDRAM address. DDRAM data is sent and received after this setting.	39 us
		A3	A2	A1	A0		
Write Data to RAM	1	D7	D6	D5	D4	Writes data to CGRAM or DDRAM.	43 us
		D3	D2	D1	D0		

DDRAM is Display Data RAM
DDRAM address is location of cursor
CGRAM is Character Generator RAM
X is Don t Care

Bit Name	0	1
I/D	Decrement cursor position	Increment cursor position
SH	No display shift	Display shift
D	Display off	Display on
C	Cursor off	Cursor on
B	Cursor blink off	Cursor blink on
S/C	Move cursor	Shift display
R/L	Shift left	Shift right

Hint
please look at our web
site for examples of code
that shows how to
program the 7-segment
display. (TEST40.ASM
factory test routine.)

LCD Character Set



Lower 4bit \ Higher 4bit	0000	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111
xxxx0000	CG RAM (1)		0	@	P	`	p		ｰ	ﾀ	ﾐ	α	p
xxxx0001	(2)	!	1	A	Q	a	q	｡	ｱ	ﾁ	ﾑ	ä	q
xxxx0010	(3)	"	2	B	R	b	r	｢	ｲ	ﾂ	ﾒ	β	θ
xxxx0011	(4)	#	3	C	S	c	s	｣	ｳ	ﾃ	ﾓ	ε	∞
xxxx0100	(5)	$	4	D	T	d	t	､	ｴ	ﾄ	ﾔ	μ	Ω
xxxx0101	(6)	%	5	E	U	e	u	･	ｵ	ﾅ	ﾕ	σ	ü
xxxx0110	(7)	&	6	F	V	f	v	ｦ	ｶ	ﾆ	ﾖ	ρ	Σ
xxxx0111	(8)	'	7	G	W	g	w	ｧ	ｷ	ﾇ	ﾗ	g	π
xxxx1000	(1)	(	8	H	X	h	x	ｨ	ｸ	ﾈ	ﾘ	√	x̄
xxxx1001	(2)	)	9	I	Y	i	y	ｩ	ｹ	ﾉ	ﾙ	⁻¹	y
xxxx1010	(3)	*	:	J	Z	j	z	ｪ	ｺ	ﾊ	ﾚ	j	千
xxxx1011	(4)	+	;	K	[	k	{	ｫ	ｻ	ﾋ	ﾛ	ˣ	万
xxxx1100	(5)	,	<	L	¥	l	|	ｬ	ｼ	ﾌ	ﾜ	¢	円
xxxx1101	(6)	-	=	M	]	m	}	ｭ	ｽ	ﾍ	ﾝ	£	÷
xxxx1110	(7)	.	>	N	^	n	→	ｮ	ｾ	ﾎ	ﾞ	ñ	
xxxx1111	(8)	/	?	O	_	o	←	ｯ	ｿ	ﾏ	ﾟ	ö	█