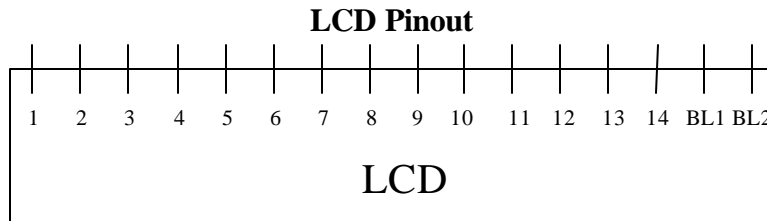


LCD Interface Notes



Note1: Verify that your LCD has Pin #1 on the left. Some LCDs may have Pin #1 on the right. Pinouts on various LCDs are the same, just a different order (right to left instead of left to right).

Note2: BL1 and BL2 can be left open (un-connected) in the design.

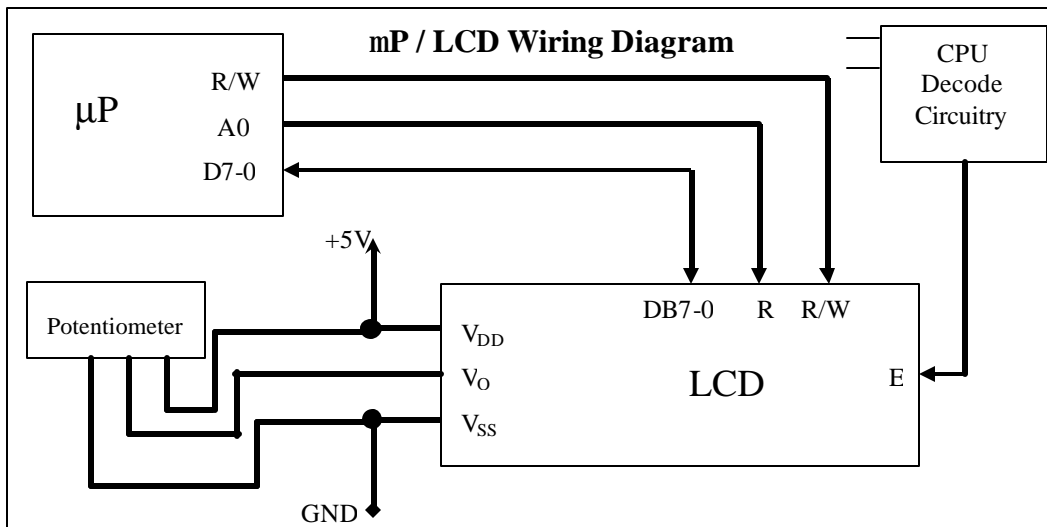
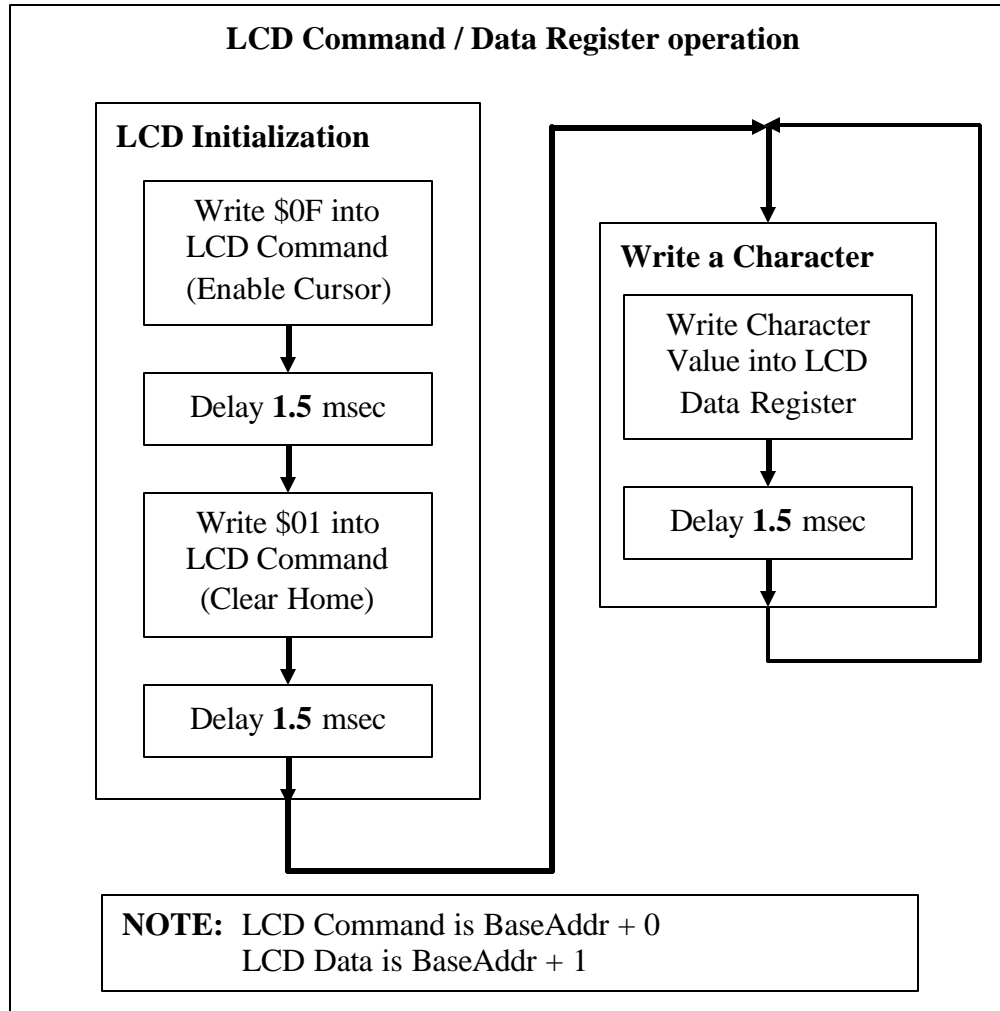
Note3: The RS (register select) signal is used to select between commands and data (0 and 1 respectively). It can be considered an address bit, selecting between the two addressable registers called Command (with address 0) and Data (with address 1). This pin can be connected directly to the CPU address line A0. In this case the address of the LCD command register is ends in 0 and the address of the LCD data register ends in 1.

Note4: E is the enable or chip select (CS) for the LCD. You must create a CS signal for enabling/disabling the LCD using the appropriate address and control lines as you would for any memory-mapped device.

Note5: Bit 7 of the LCD command register can be read. This pin is then known as the BUSY flag. Bit 7 can be tested before any command updates to verify that the previous command is completed. If this is done the delays in the below flow chart are unnecessary.

LCD Pin assignments			
Adapted from the Densitron LM2022 LCD SpecSheet			
Pin No.	Symbol	I/O	Function
1	V _{SS}	-	Ground (0V)
2	V _{DD}	-	Logic Supply Voltage (+5V)
3	V _O	-	LC Drive voltage for contrast adjustment
4	RS	I	Register Select 0: Command Register 1: Data Register
5	R/W	I	Read/Write 0: Data Write (Module ← MPU) 1: Data Read (Module → MPU)
6	E	I	Enable Signal Active High
7	DB0	I/O	Bi-directional data bus line 0 (LSB)
8	DB1	I/O	Bi-directional data bus line 1
9	DB2	I/O	Bi-directional data bus line 2
10	DB3	I/O	Bi-directional data bus line 3
11	DB4	I/O	Bi-directional data bus line 4
12	DB5	I/O	Bi-directional data bus line 5
13	DB6	I/O	Bi-directional data bus line 6
14	DB7	I/O	Bi-directional data bus line 7 (MSB)
BL1	V _{EL}	-	EL Backlight input voltage (from output of DC-AC inverter)
BL2	V _{EL}	-	EL Backlight input voltage (from output of DC-AC inverter)

LCD Interface Notes



LCD Interface Notes

Higher 4bit Lower 4bit	0000	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111
xxxx0000		0	a	P	`	P		-	9	E	o	p	
xxxx0001		!	1	A	Q	a	9	.	7	7	4	3	q
xxxx0010		"	2	B	R	b	r	[	Y	W	x	p	o
xxxx0011		#	3	C	S	c	s	]	0	T	E	e	w
xxxx0100		\$	4	D	T	d	t	{	I	k	k	u	o
xxxx0101		%	5	E	U	e	u	|	o	+	1	o	O
xxxx0110		&	6	F	V	f	v	~	0	=	3	p	Z
xxxx0111		'	7	G	W	g	w	^	+	x	7	q	π
xxxx1000		(	8	H	X	h	x	_	o	*	U	J	X
xxxx1001		)	9	I	Y	i	y	`	o	1	u	'	U
xxxx1010		*	:	J	Z	j	z	~	o	n	k	i	F
xxxx1011		+	:	K	L	k	l	(	*	o	o	°	A
xxxx1100		,	<	L	l								
xxxx1101		-	=	M	I	m	i	)	u	z	^	o	÷
xxxx1110		.	>	N	^	n	^	→	o	e	o	°	n
xxxx1111		/	?	O	_	o	←		u	Y	z	"	o

LCD Character Codes¹

¹ Schwartz, Eric M. "EEL 4744: Microprocessor Applications." LCD Character Set. 28 Feb. 2002.
<http://mil.ufl.edu/4744/docs/lcdmanual/characterset.html>.

LCD Interface Notes

SUMMARY OF LCD COMMANDS

Instruction	Code										Description	
	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 cursor to the home position (address 0).	
Cursor home	0	0	0	0	0	0	0	0	1	*	Returns cursor to home position (address 0). Also returns display being shifted to the original position. DDRAM contents remains unchanged.	
Entry mode set	0	0	0	0	0	0	0	1	I/D	S	Sets cursor move direction (I/D), specifies to shift the display (S). These operations are performed during data read/write.	
Display On/Off control	0	0	0	0	0	0	1	D	C	B	Sets On/Off of all display (D), cursor On/Off (C) and blink of cursor position character (B).	
Cursor/display shift	0	0	0	0	0	1	S/C	R/L	*	*	Sets cursor-move or display-shift (S/C), shift direction (R/L). DDRAM contents remains unchanged.	
Function set	0	0	0	0	1	DL	N	F	*	*	Sets interface data length (DL), number of display line (N) and character font(F).	
Set CGRAM address	0	0	0	1	CGRAM address					Sets the CGRAM address. CGRAM data is sent or received after this setting.		
Set DDRAM address	0	0	1	DDRAM address							Sets the DDRAM address. DDRAM data is sent or received after this setting.	
Read busy-flag and address counter	0	1	BF	DDRAM address							Reads Busy-flag (BF) indicating internal operation is being performed and reads address counter contents.	
Write to CGRAM or DDRAM	1	0	write data								Writes data to CGRAM or DDRAM.	
Read from CGRAM or DDRAM	1	1	read data								Reads data from CGRAM or DDRAM.	

²Schwartz, Eric M. "EEL 4744: Microprocessor Applications." LCD Commands. 17 Mar. 2002. <<http://mil.ufl.edu/4744/docs/lcdmanual/commands.html>>.

Notes:

- DDRAM = Display Data RAM.
- CGRAM = Character Generator RAM.
- DDRAM address corresponds to cursor position.
- Address Counter is used for both DDRAM and CGRAM.
- *= Don't care.
- DL: 0 = 4-bit interface; 1 = 8-bit interface
- N: 0 = 1 line; 1 = 2 lines
- F: 0 = 5x7 dots; 1 = 5x10 dots
- For more info, see link above.

LCD Interface Notes

MORE LCD COMMANDS³

Command	Code	Delay
Clear Display, Cursor to Home	\$01	1.65ms
Cursor to Home	\$02	1.65ms
Entry Mode:		
Cursor Decrement, Shift off	\$04	40us
Cursor Decrement, Shift on	\$05	40us
Cursor Increment, Shift off	\$06	40us
Cursor Increment, Shift on	\$07	40us
Display Control:		
Display, Cursor, and Cursor Blink off	\$08	40us
Display on, Cursor and Cursor Blink off	\$0C	40us
Display and Cursor on, Cursor Blink off	\$0E	40us
Display, Cursor, and Cursor Blink on	\$0F	40us
Cursor / Display Shift: (nondestructive move)		
Cursor shift left	\$10	40us
Cursor shift right	\$14	40us
Display shift left	\$18	40us
Display shift right	\$1C	40us
Display Function (default 2x40 size)	\$3C	40us
Character Generator Ram Address set	\$40-\$7F	40us
Display Ram Address set	\$80-\$FF	40us

³ Schwartz, Eric M. "EEL 4744: Microprocessor Applications." *Axiom CME11E9-EVU Development board's LCD Command Codes*, page 22. <<http://mil.ufl.edu/4744/docs/cme11e9-evbu-m.pdf>>.