Introduction to Electric Vehicles

Midterm project

Joonki Hong
Dept. of Electrical Engineering
Korea Advanced Institute of Science and Technology
joonki@cad4x.kaist.ac.kr

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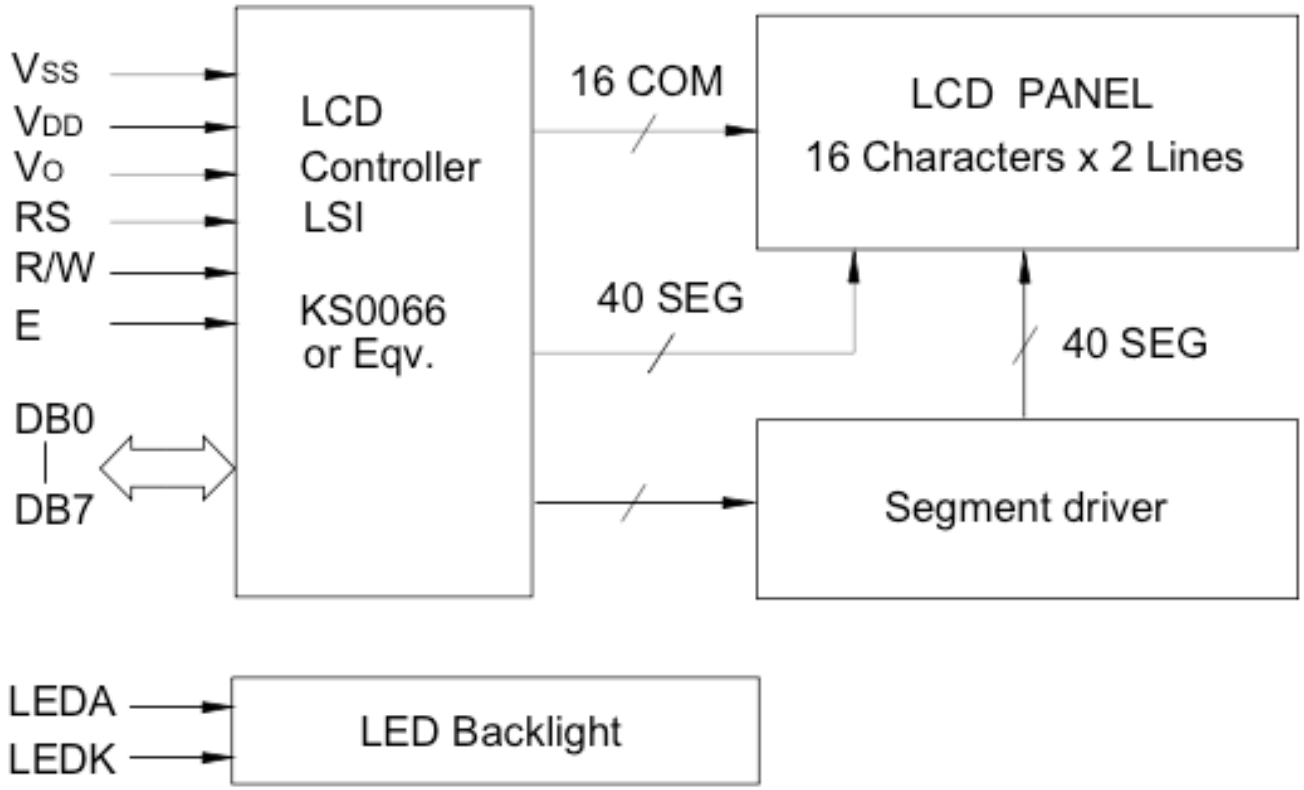
Midterm project

- Using display control instructions
  - 8 bit data mode
  - Display ON/OFF control
  - Cursor ON
  - Blinking cursor
  - 2 line display mode
  - Using cursor shift
  - Read busy flag
- Writing words
  - “Hello World! >.<”
- Clear display

Character display

- LC1628-BMDWH6
  - Mount LCD to your Universal board

LCD block diagram



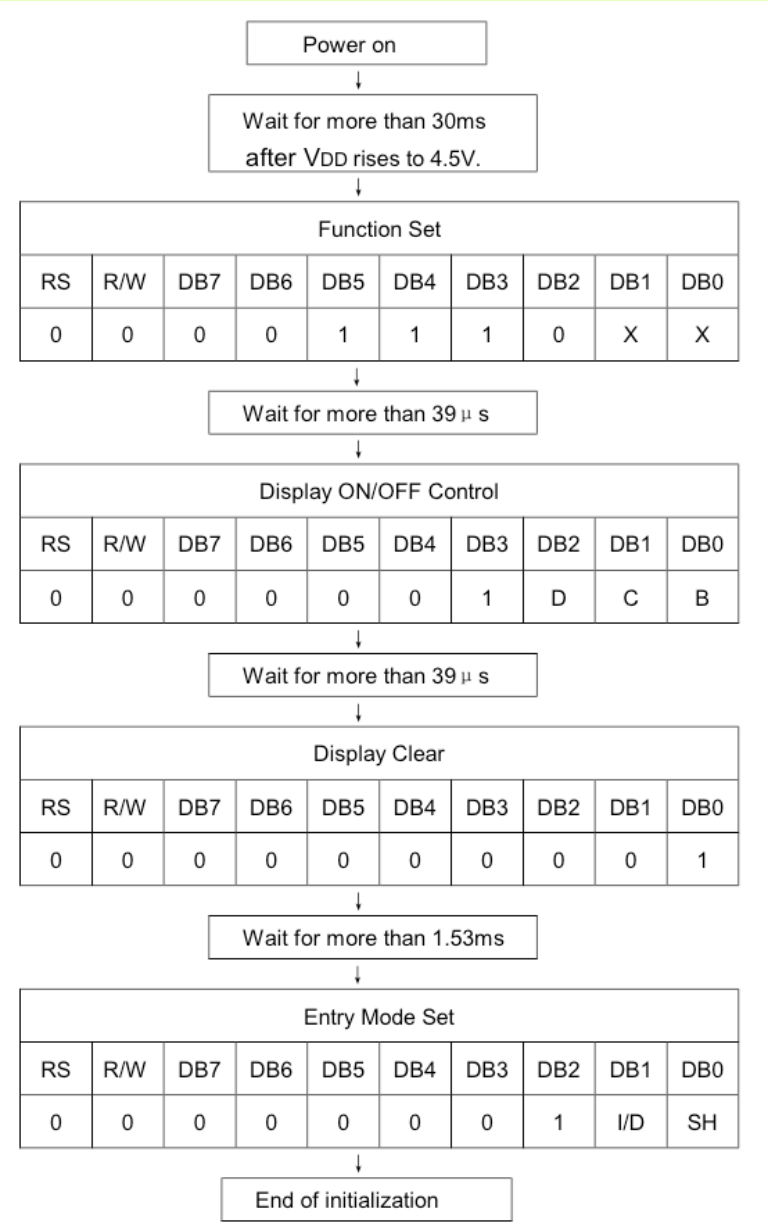
Configurations

- UART
- Timer interrupt
  - To give some delays to the function
- GPIO
  - Data bits, LCD display configuration

Terminal functions

Pin No.	Symbol	Level	Function
1	VSS	0V	Ground
2	VDD	+3 to 5V	Power supply for logic (refer to section 3.4)
3	VO	--	Operating voltage for LCD (contrast adjusting)
4	RS	H/L	Data or instruction selection H: Display data L: Instruction code
5	R/W	H/L	Read or write selection H: Read operation L: Write operation
6	E	H, H→L	Enable signal In read mode (R/W="H"), data appears at DB0 to DB7 while E is "H". In write mode (R/W="L"), data of DB0 to DB7 is latched at the falling edge of E
7	DB0	H/L	In 8-bit mode, used as low order bi-directional data bus. In 4-bit mode, open these terminals.
8	DB1	H/L	
9	DB2	H/L	
10	DB3	H/L	
11	DB4	H/L	In 8-bit mode, used as high order bi-directional data bus. In 4-bit mode, used as both high and low order data bus.
12	DB5	H/L	
13	DB6	H/L	
14	DB7	H/L	
15	LEDA	+5V	Power supply for LED backlight Refer to section 3.3, 3.5
16	LEDK	0V	

8 bit initialization



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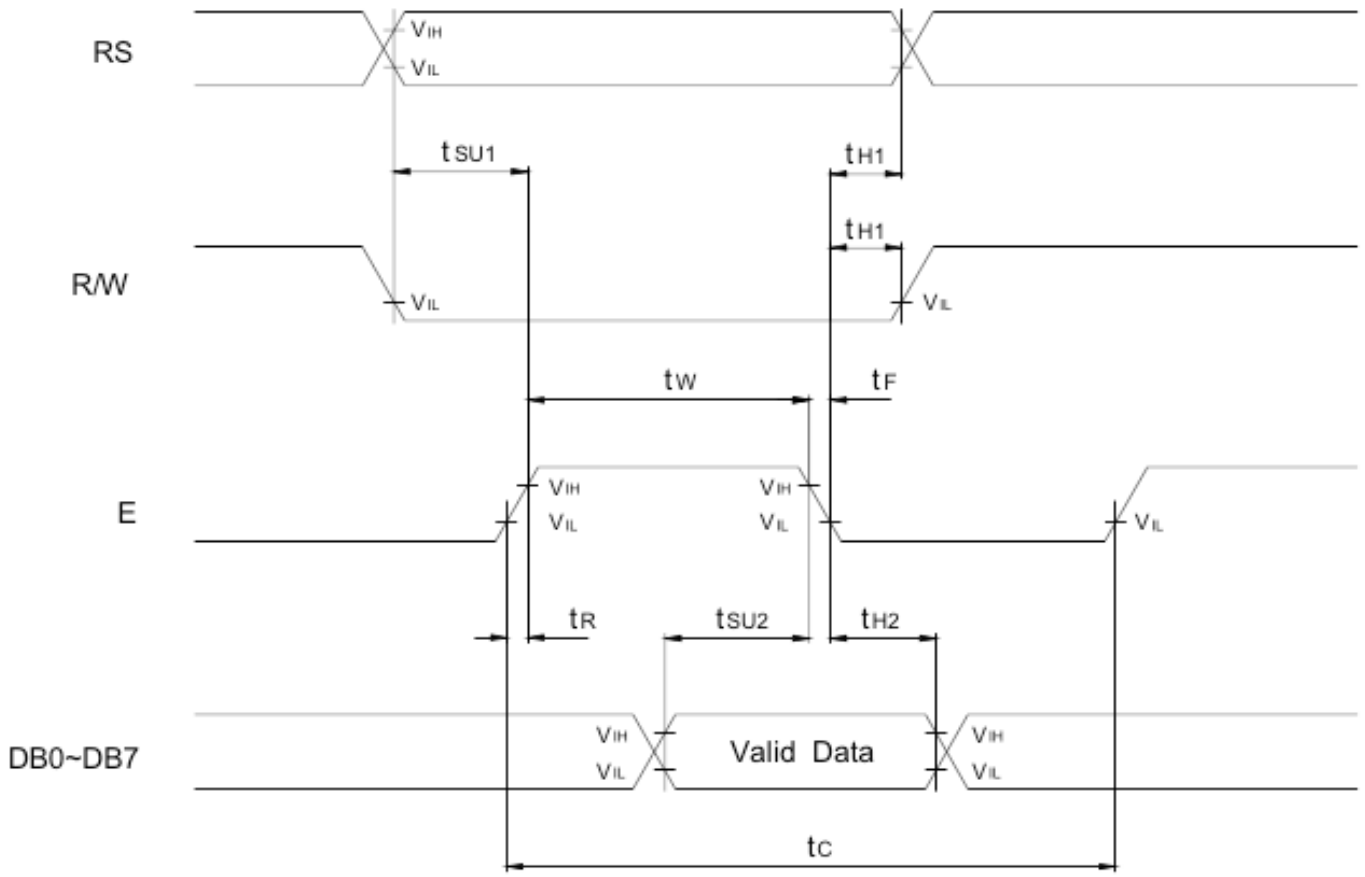
MCU reading/writing timing

- RS
  - Data or instruction selection
- R/W
  - Read or write selection
- E
  - Enable signal

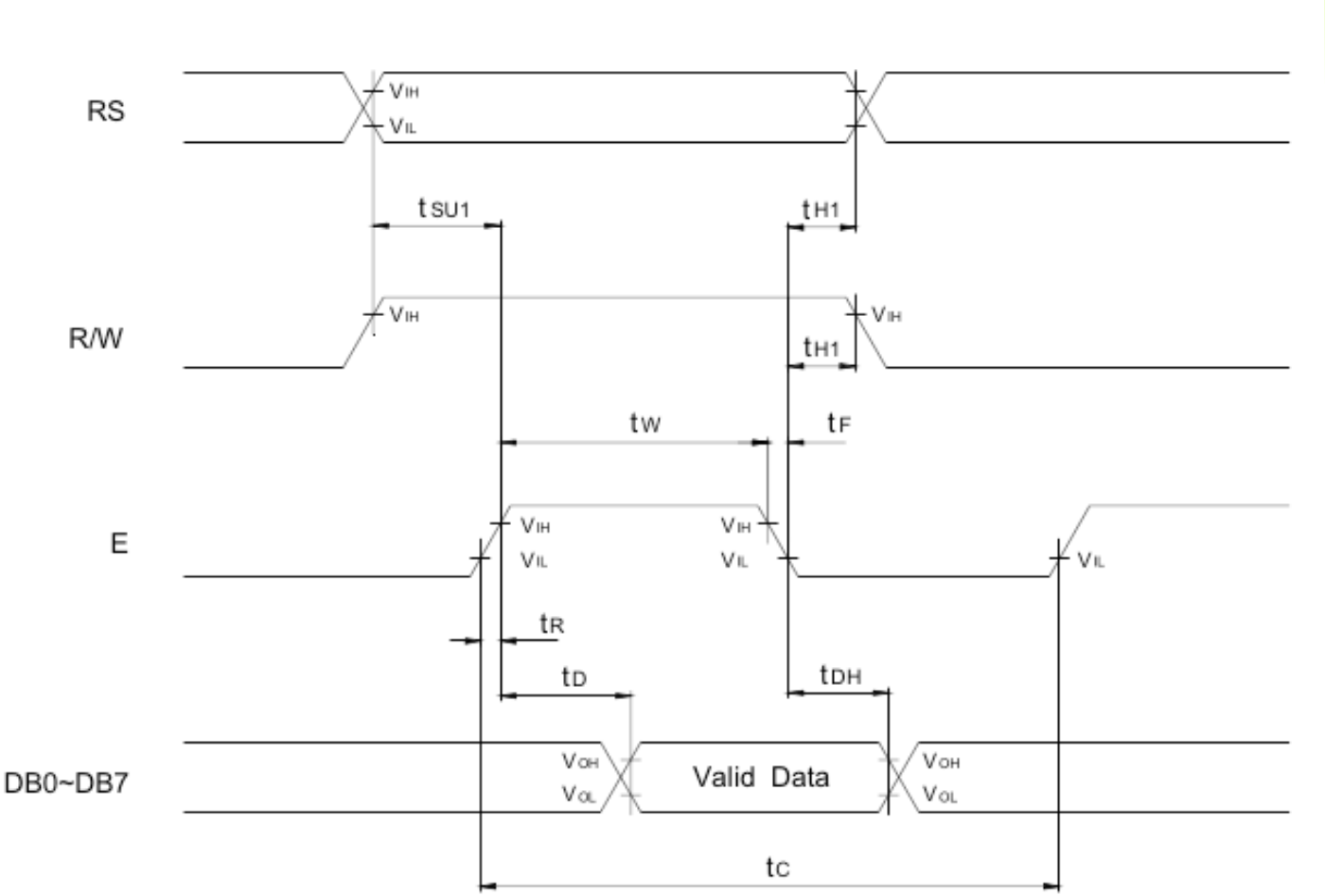
- Change RS, and R/W value for desired operation
- Enable signal (min 230ns)
- Data bit hold time

MCU write timing



MPU Write Timing

MCU read timing

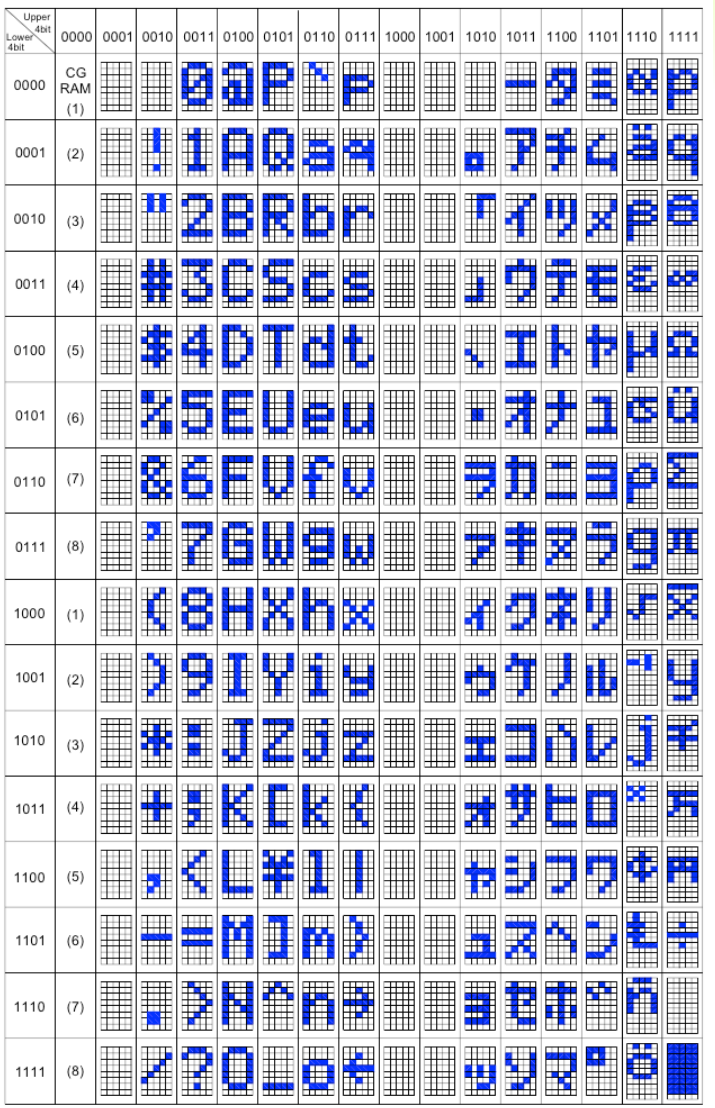


MPU Read Timing

Interface timing chart

Mode	Characteristic	Symbol	Min.	Typ.	Max.	Unit
Write Mode (Refer to MPU Write Timing)	E Cycle Time	t_C	500	--	--	ns
	E Rise/Fall Time	t_R, t_F	--	--	20	
	E Pulse Width (High,Low)	t_W	230	--	--	
	R/W and RS Setup Time	t_{SU1}	40	--	--	
	R/W and RS Hold Time	t_{H1}	10	--	--	
	Data Setup Time	t_{SU2}	80	--	--	
	Data Hold Time	t_{H2}	10	--	--	
Read Mode (Refer to MPU Read Timing)	E Cycle Time	t_C	500	--	--	ns
	E Rise/Fall Time	t_R, t_F	--	--	20	
	E Pulse Width (High,Low)	t_W	230	--		
	R/W and RS Setup Time	t_{SU}	40	--		
	R/W and RS Hold Time	t_H	10	--		
	Data Output Delay Time	t_D	--	--	120	
	Data Hold Time	t_{DH}	5	--	--	

Character code table



Display control instructions

Instruction	Instruction code										Description	Execution time (fosc=270KHz)
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear Display	0	0	0	0	0	0	0	0	0	1	Clears entire display and sets DDRAM address to 00H.	1.53ms
Return Home	0	0	0	0	0	0	0	0	1	-	Sets DDRAM address to 00H in AC and returns shifted display to its original position. The contents of DDRAM remain unchanged.	1.53ms
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	SH	Sets cursor move direction and enable the shift of entire display. These operations are performed during data write and read.	39 μ s
Display ON/ OFF Control	0	0	0	0	0	0	1	D	C	B	Set ON/OFF of entire display (D), cursor ON/OFF(C), and blinking of cursor position character (B).	39 μ s
Cursor or Display Shift	0	0	0	0	0	1	S/C	R/L	-	-	Moves cursor and shifts display without changing DDRAM contents.	39 μ s
Function Set	0	0	0	0	1	DL	N	F	-	-	Sets interface data length (DL: 8-bit/4-bit), numbers of display line (N: 2-line/1-line), and display font type (F: 5x11dots/5x8dots)	39 μ s
Set CGRAM Address	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address counter.	39 μ s
Set DDRAM Address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in address Counter.	39 μ s
Read Busy Flag and Address	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Reads busy flag (BF) indicating internal operation is being performed and reads address counter contents.	0 μ s
Write data to CG or DD RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM).	43us
Read data from CG or DD RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM).	43us