

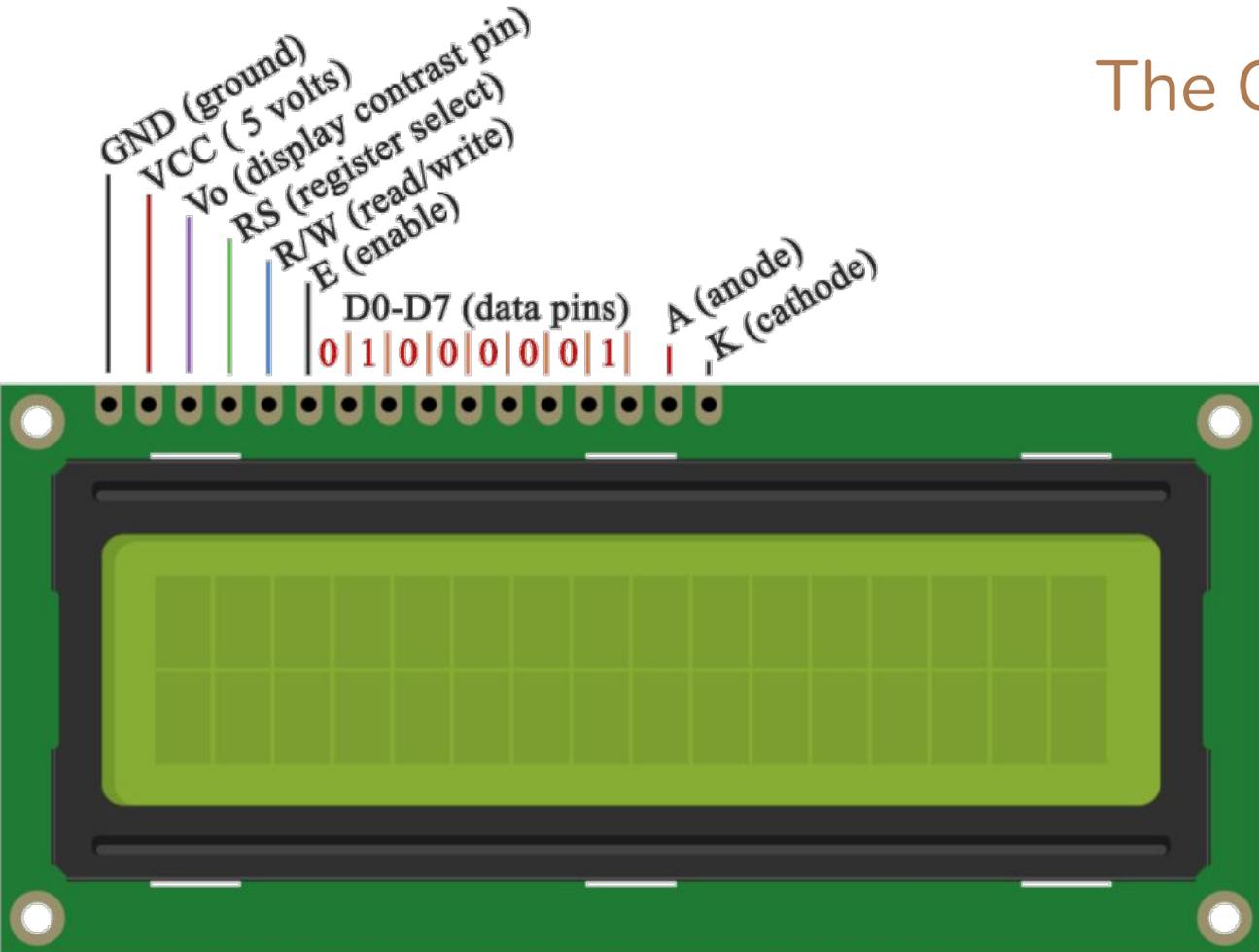


# Dual-Mode LCD Character Entry System

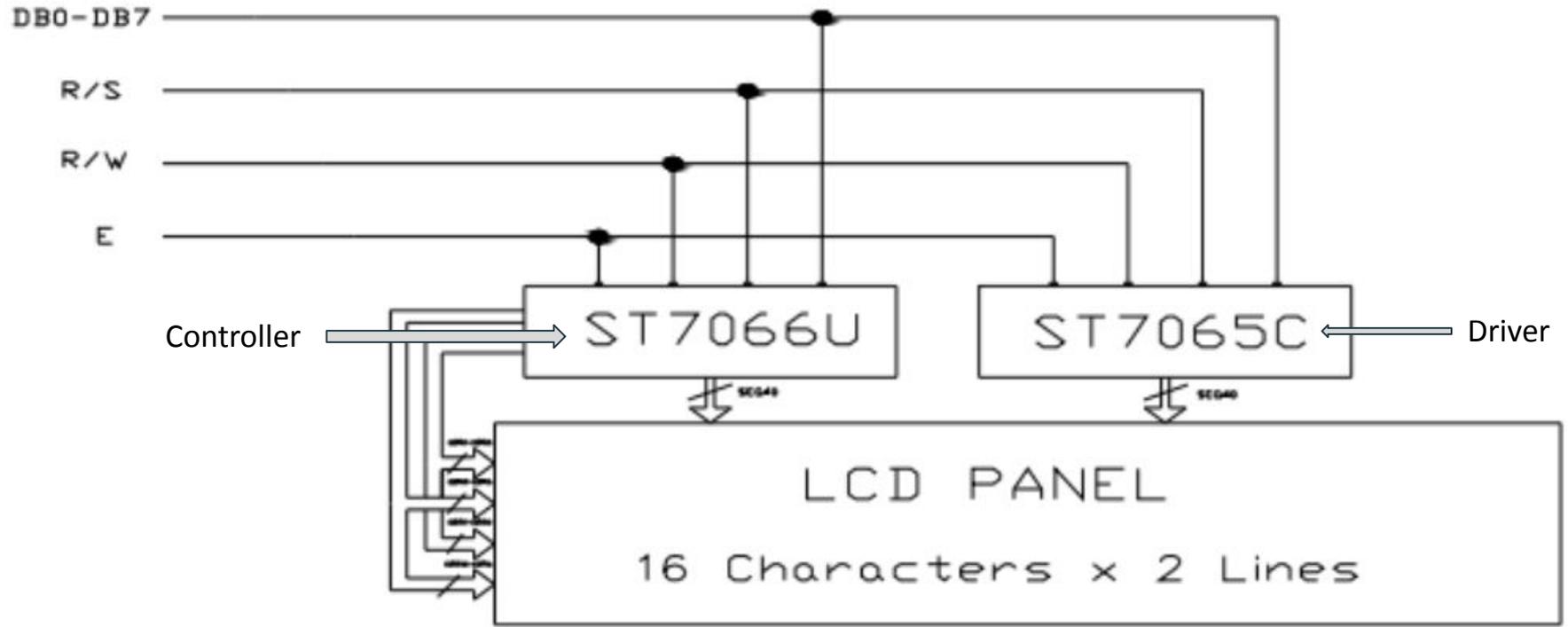
By Remington Davids  
& Bryan Dogariu



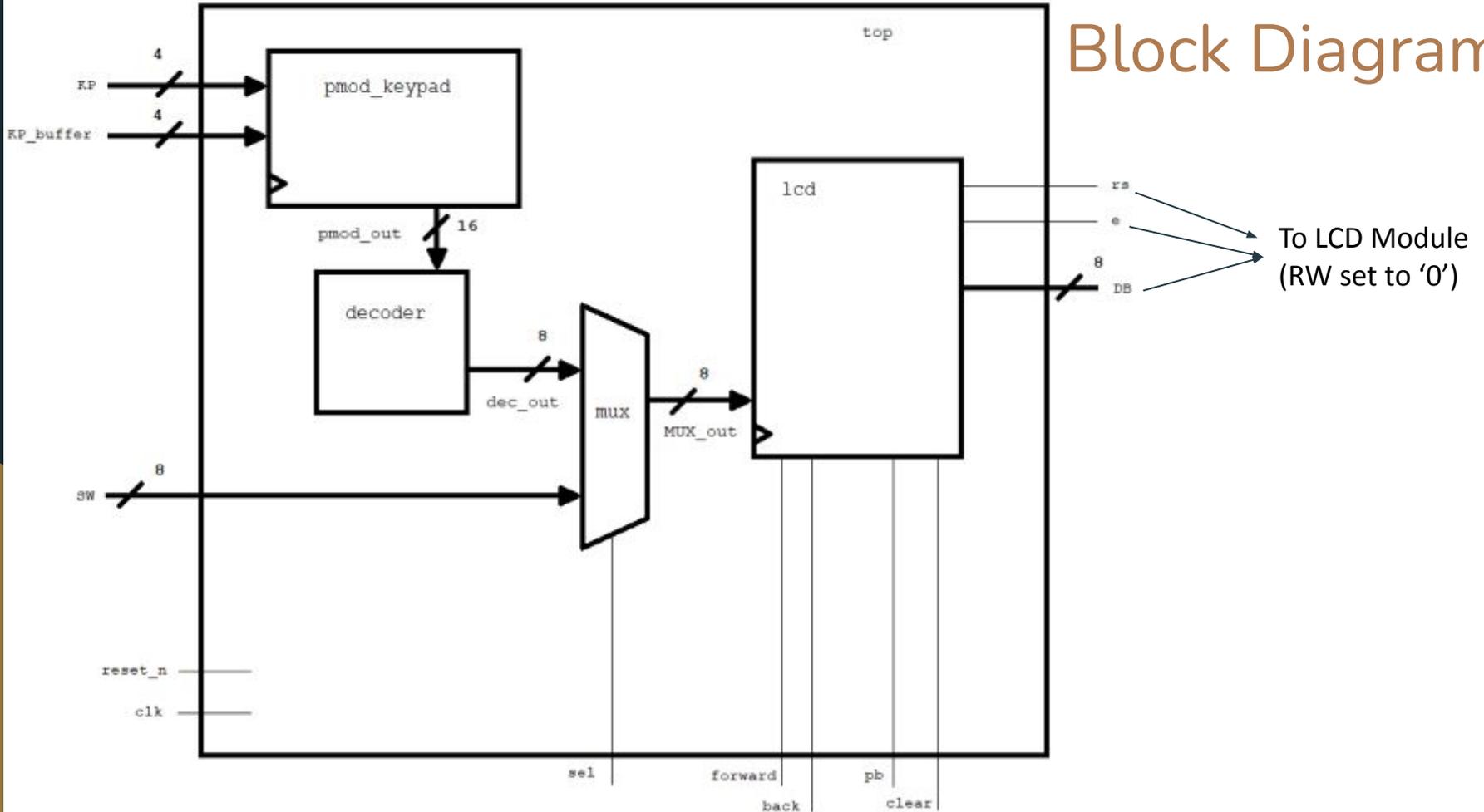
# The Overview



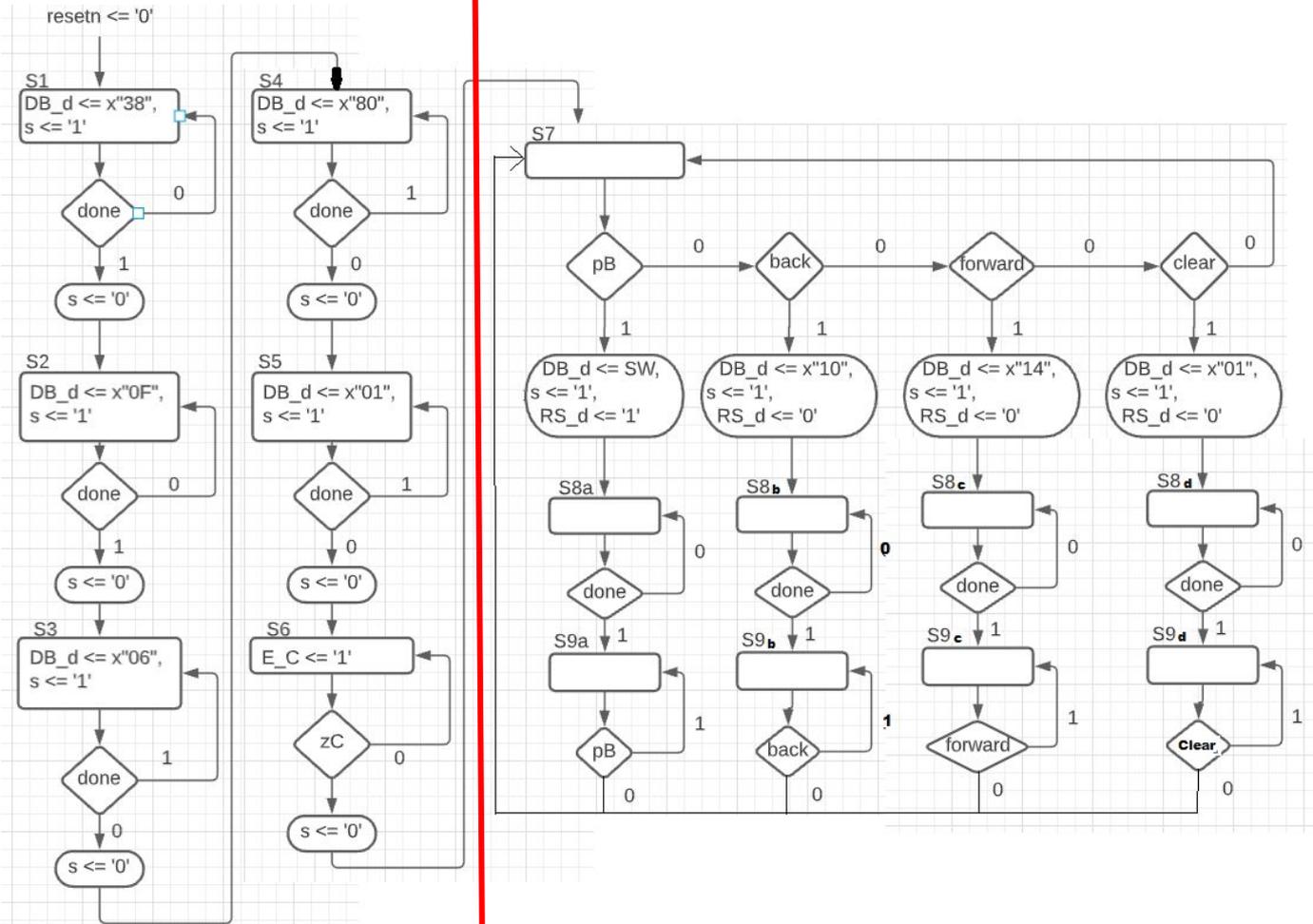
# Inner Workings of the 1602 LCD Module



# Block Diagram



# The Initialization Process and State Machine



# Writing Data

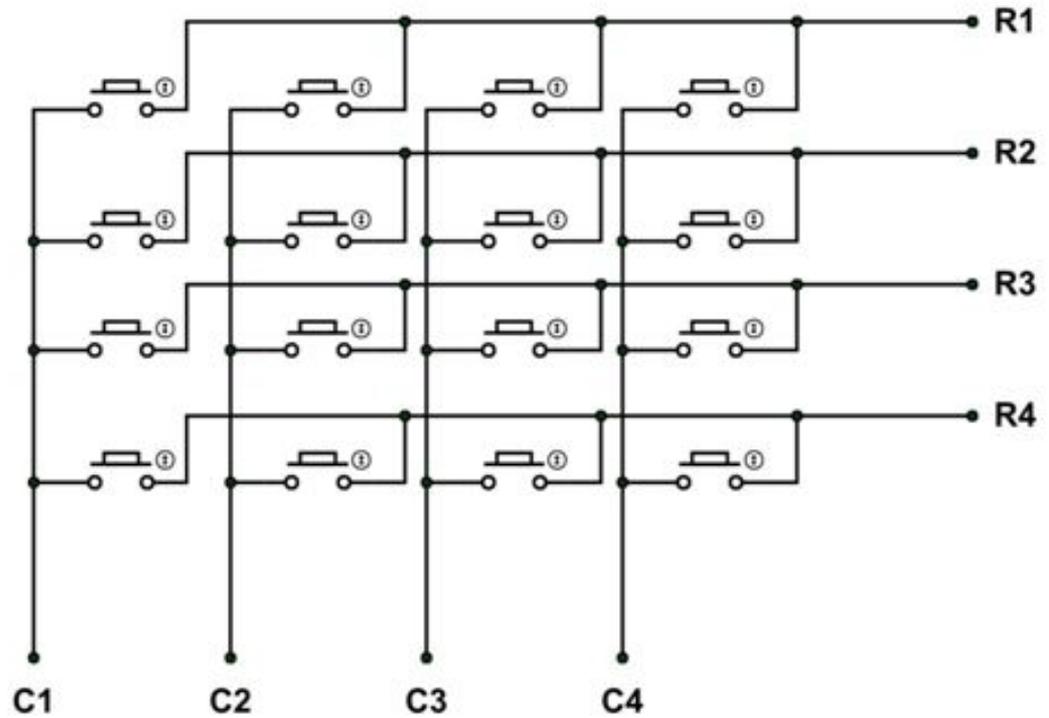
Lower 4 Bits	Upper 4 Bits																			
	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111				
xxxx0000	CG RAM (1)			0@P`P							-	9	3	α	p					
xxxx0001	(2)			!1AQa4							。	7	7	4	ä	q				
xxxx0010	(3)			"2BRbr							「	イ	ツ	×	β	θ				
xxxx0011	(4)			#3CScs							」	ウ	テ	モ	ε	ω				
xxxx0100	(5)			\$4DTdt							、	イ	ト	ト	μ	Ω				
xxxx0101	(6)			%5EUeu							・	オ	ナ	1	ε	Ü				
xxxx0110	(7)			&6FVfv							ヲ	カ	ニ	ヨ	ρ	Σ				
xxxx0111	(8)			'7GWgw							ア	キ	ヌ	ウ	g	π				
xxxx1000	(1)			(8HXhx							イ	ク	ネ	リ	J	Σ				
xxxx1001	(2)			)9IYiy							ウ	ケ	ル		・	y				
xxxx1010	(3)			*:JZjz							エ	コ	ン	レ	j	キ				
xxxx1011	(4)			+;K[k<							オ	サ	ヒ	ロ	*	ア				
xxxx1100	(5)			,<L¥ll							ハ	シ	フ	ワ	Φ	円				
xxxx1101	(6)			-=M]m>							ユ	ズ	ハ	ン	モ	÷				
xxxx1110	(7)			.>N^n→							ヨ	セ	ホ	°	ñ					
xxxx1111	(8)			/?O_oft							ツ	ツ	マ	°	ö	■				

Instruction Table:

Instruction	Instruction Code										Description	Description Time (270KHz)
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear Display	0	0	0	0	0	0	0	0	0	1	Write "20H" to DDRAM, and set DDRAM address to "00H" from AC	1.52 ms
Return Home	0	0	0	0	0	0	0	0	1	x	Set DDRAM address to "00H" from AC and return cursor to its original position if shifted. The contents of DDRAM are not changed.	1.52 ms
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	S	Sets cursor move direction and specifies display shift. These operations are performed during data write and read.	37 us
Display ON/OFF	0	0	0	0	0	0	1	D	C	B	D=1:entire display on C=1:cursor on B=1:cursor position on	37 us
Cursor or Display Shift	0	0	0	0	0	1	S/C	R/L	x	x	Set cursor moving and display shift control bit, and the direction, without changing DDRAM data.	37 us
Function Set	0	0	0	0	1	DL	N	F	x	x	DL:interface data is 8/4 bits N:number of line is 2/1 F:font size is 5x11/5x8	37 us
Set CGRAM address	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address counter	37 us
Set DDRAM address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in address counter	37 us
Read Busy flag and address	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Whether during internal operation or not can be known by reading BF. The contents of address counter can also be read.	0 us
Write data to RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM)	37 us
Read data from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM)	37 us



# The Keypad



# And Now, a Demonstration...

