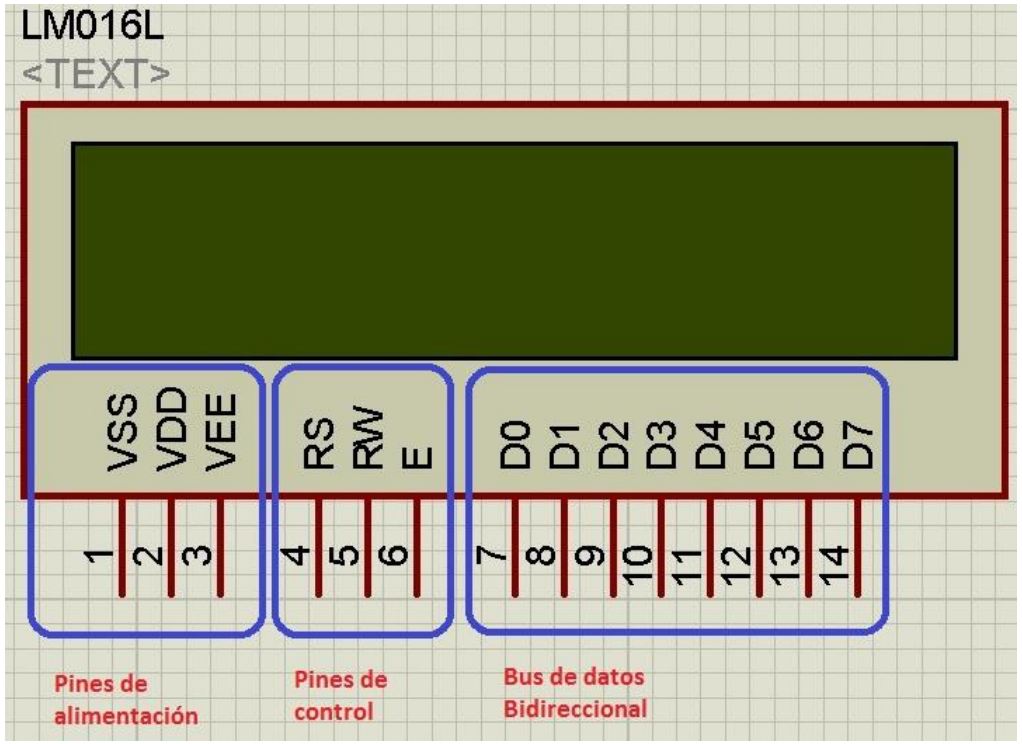
LCD

PINES

- RS
  - 0 – Instrucción
  - 1 – Datos
- RW
  - 0 – Escritura
  - 1 – Lectura
- E
  - Falling edge – Escritura
  - Rising edge – Lectura

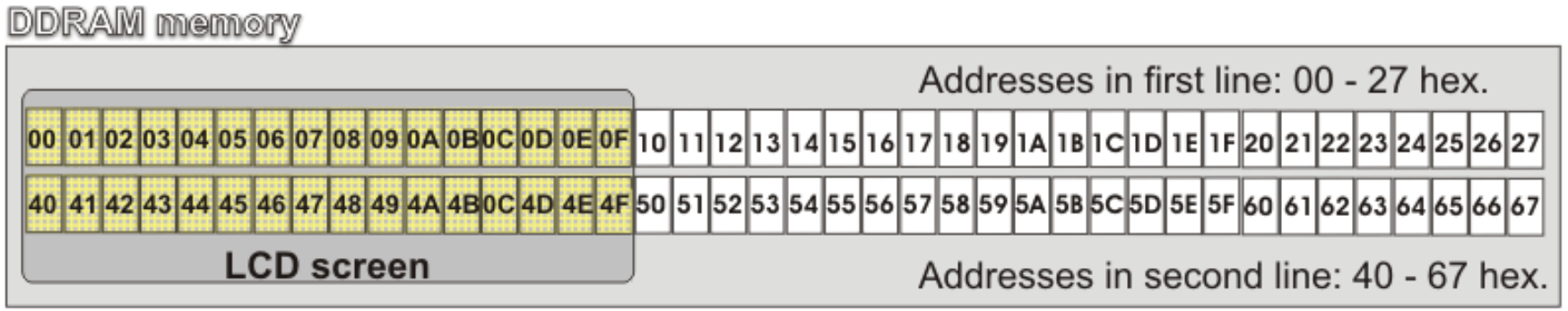


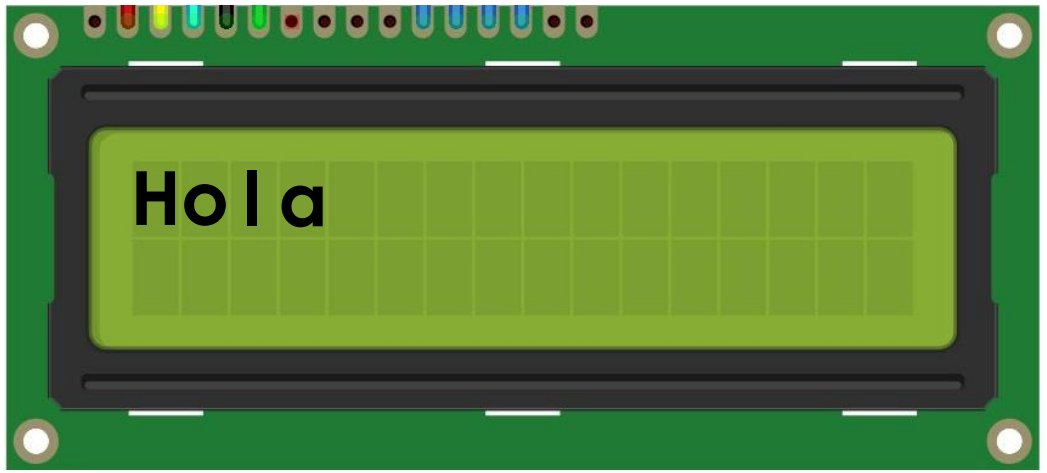
Dec	Hex	Oct	Chr	Dec	Hex	Oct	HTML	Chr	Dec	Hex	Oct	HTML	Chr	Dec	Hex	Oct	HTML	Chr
0	0	000	NULL	32	20	040		Space	64	40	100	@	@	96	60	140	`	`
1	1	001	Start of Header	33	21	041	!	!	65	41	101	A	A	97	61	141	a	a
2	2	002	Start of Text	34	22	042	"	"	66	42	102	B	B	98	62	142	b	b
3	3	003	End of Text	35	23	043	#	#	67	43	103	C	C	99	63	143	c	c
4	4	004	End of Transmission	36	24	044	$	$	68	44	104	D	D	100	64	144	d	d
5	5	005	Enquiry	37	25	045	%	%	69	45	105	E	E	101	65	145	e	e
6	6	006	Acknowledgment	38	26	046	&	&	70	46	106	F	F	102	66	146	f	f
7	7	007	Bell	39	27	047	'	'	71	47	107	G	G	103	67	147	g	g
8	8	010	Backspace	40	28	050	(	(	72	48	110	H	H	104	68	150	h	h
9	9	011	Horizontal Tab	41	29	051	)	)	73	49	111	I	I	105	69	151	i	i
10	A	012	Line feed	42	2A	052	*	*	74	4A	112	J	J	106	6A	152	j	j
11	B	013	Vertical Tab	43	2B	053	+	+	75	4B	113	K	K	107	6B	153	k	k
12	C	014	Form feed	44	2C	054	,	,	76	4C	114	L	L	108	6C	154	l	l
13	D	015	Carriage return	45	2D	055	-	-	77	4D	115	M	M	109	6D	155	m	m
14	E	016	Shift Out	46	2E	056	.	.	78	4E	116	N	N	110	6E	156	n	n
15	F	017	Shift In	47	2F	057	/	/	79	4F	117	O	O	111	6F	157	o	o
16	10	020	Data Link Escape	48	30	060	0	0	80	50	120	P	P	112	70	160	p	p
17	11	021	Device Control 1	49	31	061	1	1	81	51	121	Q	Q	113	71	161	q	q
18	12	022	Device Control 2	50	32	062	2	2	82	52	122	R	R	114	72	162	r	r
19	13	023	Device Control 3	51	33	063	3	3	83	53	123	S	S	115	73	163	s	s
20	14	024	Device Control 4	52	34	064	4	4	84	54	124	T	T	116	74	164	t	t
21	15	025	Negative Ack.	53	35	065	5	5	85	55	125	U	U	117	75	165	u	u
22	16	026	Synchronous idle	54	36	066	6	6	86	56	126	V	V	118	76	166	v	v
23	17	027	End of Trans. Block	55	37	067	7	7	87	57	127	W	W	119	77	167	w	w
24	18	030	Cancel	56	38	070	8	8	88	58	130	X	X	120	78	170	x	x
25	19	031	End of Medium	57	39	071	9	9	89	59	131	Y	Y	121	79	171	y	y
26	1A	032	Substitute	58	3A	072	:	:	90	5A	132	Z	Z	122	7A	172	z	z
27	1B	033	Escape	59	3B	073	;	;	91	5B	133	[	[	123	7B	173	{	{
28	1C	034	File Separator	60	3C	074	<	<	92	5C	134	\	\	124	7C	174			|
29	1D	035	Group Separator	61	3D	075	=	=	93	5D	135	]	]	125	7D	175	}	}
30	1E	036	Record Separator	62	3E	076	>	>	94	5E	136	^	^	126	7E	176	~	~
31	1F	037	Unit Separator	63	3F	077	?	?	95	5F	137	_	_	127	7F	177	&#127;	Del

asciichars.com

Dec	Hex	Oct	HTML	Chr	Dec	Hex	Oct	HTML	Chr
64	40	100	@	@	96	60	140	`	`
65	41	101	A	A	97	61	141	a	a
66	42	102	B	B	98	62	142	b	b
67	43	103	C	C	99	63	143	c	c
68	44	104	D	D	100	64	144	d	d
69	45	105	E	E	101	65	145	e	e
70	46	106	F	F	102	66	146	f	f
71	47	107	G	G	103	67	147	g	g
72	48	110	H	H	104	68	150	h	h
73	49	111	I	I	105	69	151	i	i
74	4A	112	J	J	106	6A	152	j	j
75	4B	113	K	K	107	6B	153	k	k
76	4C	114	L	L	108	6C	154	l	l
77	4D	115	M	M	109	6D	155	m	m
78	4E	116	N	N	110	6E	156	n	n
79	4F	117	O	O	111	6F	157	o	o
80	50	120	P	P	112	70	160	p	p

- Escribir “Hola”
  - H – 0x48 -> 0100 1000
  - o – 0x6F -> 0110 1111
  - l – 0x6C -> 0110 1100
  - a – 0x61 -> 0110 0001





Inicia en dirección 0x00
Se envía la “H”
Puntero se mueve AUTOMATICAMENTE a 0x01
Se envía la “o”
Puntero se mueve AUTOMATICAMENTE a 0x02
Se envía la “l”
Puntero se mueve AUTOMATICAMENTE a 0x03
Se envía la “a”
Puntero se mueve AUTOMATICAMENTE a 0x04

Instruction	Code										Description	Execution time**
	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).	1.64mS
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.	1.64mS
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.	40uS
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).	40uS
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.	40uS
Function set	0	0	0	0	1	DL	N	F	*	*	Sets interface data length (DL), number of display line (N) and character font(F).	40uS
Set CGRAM address	0	0	0	1	CGRAM address						Sets the CGRAM address. CGRAM data is sent or received after this setting.	40uS
Set DDRAM address	0	0	1	DDRAM address							Sets the DDRAM address. DDRAM data is sent or received after this setting.	40uS
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.	0uS
Write to CGRAM or DDRAM	1	0	write data								Writes data to CGRAM or DDRAM.	40uS
Read from CGRAM or DDRAM	1	1	read data								Reads data from CGRAM or DDRAM.	40uS

https://mil.ufl.edu/3744/docs/lcdmanual/commands.html

- I/D (Dirección del **cursor**)
  - 1 – Incrementar (mover a la derecha)
  - 0 – Decrementar (mover a la izquierda)
- S (Movimiento del **display**)
  - 1 – Activo y depende de I/D
  - 0 – Desactivado
- D (encendido del display)
  - 1 – ON
  - 0 – OFF
- C (cursor)
  - 1 – ON
  - 0 – OFF
- B (blink-parpadeo)
  - 1 – ON
  - 0 – OFF
- S/C – R/L (mover cursor y display sin modificar la DDRAM)
  - 00 – Cursor a la izquierda
  - 01 – Cursor a la derecho
  - 10 – Display a la izquierda
  - 11 – Display a la derecho
- DL (longitude de datos)
  - 1 – 8bits
  - 0 – 4bits
- N (número de lineas)
  - 1 – 2 lineas
  - 0 – 1 linea
- F (font)
  - 1 – 5x10 px
  - 0 – 5x7 px

8BITS – 4BITS?

- Para enviar un caracter, por ejemplo “H”
- H – 0x48 -> 0100 1000

4 bits

- Primero se envía NIBBLE superior
- 0100 (DB7-DB4)
- Esperar 40us
- Enviar NIBBLE inferior
- 1000 (DB7-DB4)
- Esperar 40us

8 bits

- Se envian 8 bits
- 0100 1000 (DB7-DB0)
- Esperar 40us

INICIALIZACIÓN (8 BITS)

1. Function set
   - 8 bits, 2 lineas, 5x7 px
     - RS = 0
     - R/W = 0
     - DB = 0011 10xx

Instruction	Code										Description	Execution time**
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Function set	0	0	0	0	1	DL	N	F	*	*	Sets interface data length (DL), number of display line (N) and character font(F).	40uS

2. Display on/off control
   - Display on, cursor on, blink on
     - RS = 0
     - R/W = 0
     - DB = 0000 1111

Instruction	Code										Description	Execution time**
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
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).	40uS

3. Clear display
   - RS = 0
   - R/W = 0
   - DB = 0000 0001

Instruction	Code										Description	Execution time**
	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).	1.64mS

FALTABA...

Instruction	Code										Description	Execution time**
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
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.	40uS

Y PARA CARACTERES?? (8 BITS)

- Señales para escribir la “H”

Instruction	Code										Description	Execution time**
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Write to CGRAM or DDRAM	1	0	write data								Writes data to CGRAM or DDRAM.	40uS

  - RS = 1
  - R/W = 0
  - DB = 0100 1000

Y EL ENABLE?? (8 BITS)

1. Function set
   - **E = 1**
   - RS = 0
   - R/W = 0
   - DB = 0011 10xx

Estado 1

2. Function set
   - **E = 0**
   - RS = 0
   - R/W = 0
   - DB = 0011 10xx

Estado 2

3. Display on/off control
   - **E = 1**
   - RS = 0
   - R/W = 0
   - DB = 0000 1111

Estado 3

4. Display on/off control
   - **E = 0**
   - RS = 0
   - R/W = 0
   - DB = 0000 1111

Estado 4

5. Clear display
   - **E = 1**
   - RS = 0
   - R/W = 0
   - DB = 0000 0001

Estado 5

6. Clear display
   - **E = 0**
   - RS = 0
   - R/W = 0
   - DB = 0000 0001

Estado 6

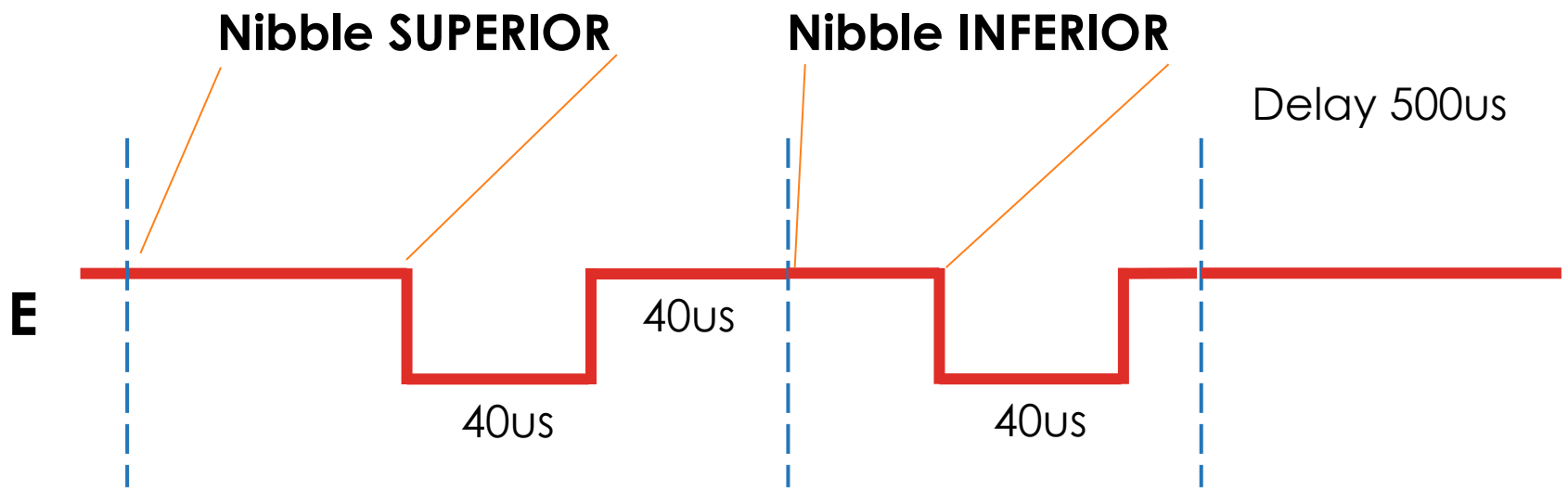
7. Escribir “H”
   - **E = 1**
   - RS = 1
   - R/W = 0
   - DB = 0100 1000

Estado 7

8. Escribir “H”
   - **E = 0**
   - RS = 1
   - R/W = 0
   - DB = 0100 1000

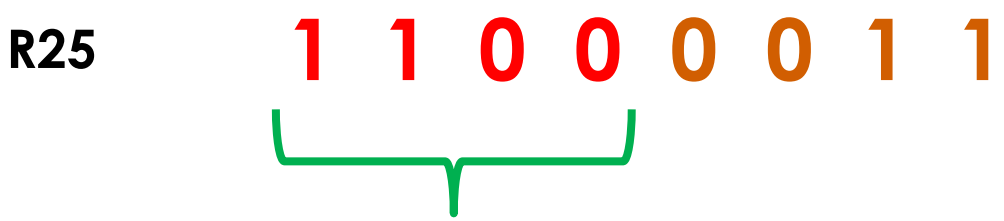
Estado 8

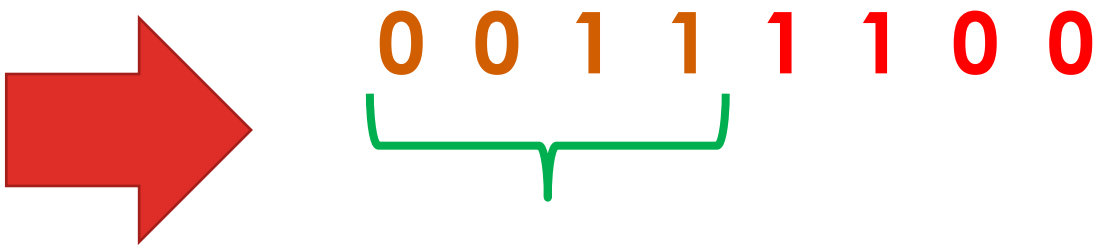
ENVIAR DATOS (4 BITS)



PREPARAR EL DATO

R25 1 1 0 0 0 0 1 1





- https://www.8051projects.net/lcd-interfacing/introduction.php