



Sitronix

ST7036

Dot Matrix LCD Controller/Driver

■ Features

- 5 x 8 dot matrix possible
- Low power operation support:
-- 2.7 to 5.5V
- Range of LCD driver power
-- 3.0 to 7.0V
- 4-bit, 8-bit, serial or I²C-bus MPU interface enabled
- 80 x 8-bit display RAM (80 characters max.)
- 10,240-bit character generator ROM for a total of 256 character fonts(max)
- 64 x 8-bit character generator RAM(max)
- Support two display mode:
16-com x 100-seg and 80 ICON
24-com x 80-seg and 80 ICON
- 16 x 5 –bit ICON RAM(max)
- Wide range of instruction functions:
Display clear, cursor home, display on/off, cursor on/off, display character blink, cursor shift, display shift, double height font
- Automatic reset circuit that initializes the controller/driver after power on and external reset pin
- Internal oscillator(Frequency=540kHz) and external clock
- Built-in voltage booster and follower circuit (low power consumption)
- COM/SEG direction selectable
- Multi-selectable for CGRAM/CGROM size
- Instruction compatible to ST7066U and KS0066U and HD44780
- Available in COG type

■ Description

The ST7036 dot-matrix liquid crystal display controller can display alphanumeric, Japanese kana characters, and symbols. It can be configured to drive a dot-matrix liquid crystal display under the control of a 4/ 8-bit with 6800-series, serial or fast I²C interface microprocessor. Since all the functions such as display RAM, character generator ROM/RAM and liquid crystal driver, required for driving a dot-matrix liquid crystal display are internally provided on one chip, a minimal system can be used with this controller/driver.



The ST7036 character generator ROM size is 256 5x8dot bits which can be used to generate 256 different character fonts (5x8dot).

The ST7036 is suitable for low voltage supply (2.7V to 5.5V) and is perfectly suitable for any portable product which is driven by the battery and requires low power consumption.

The display resolution of ST7036 dot-matrix_LCD driver can be either 1-line x 20 characters, 2-line x 20 characters or 3-line x 16 characters with 80 bit ICON.

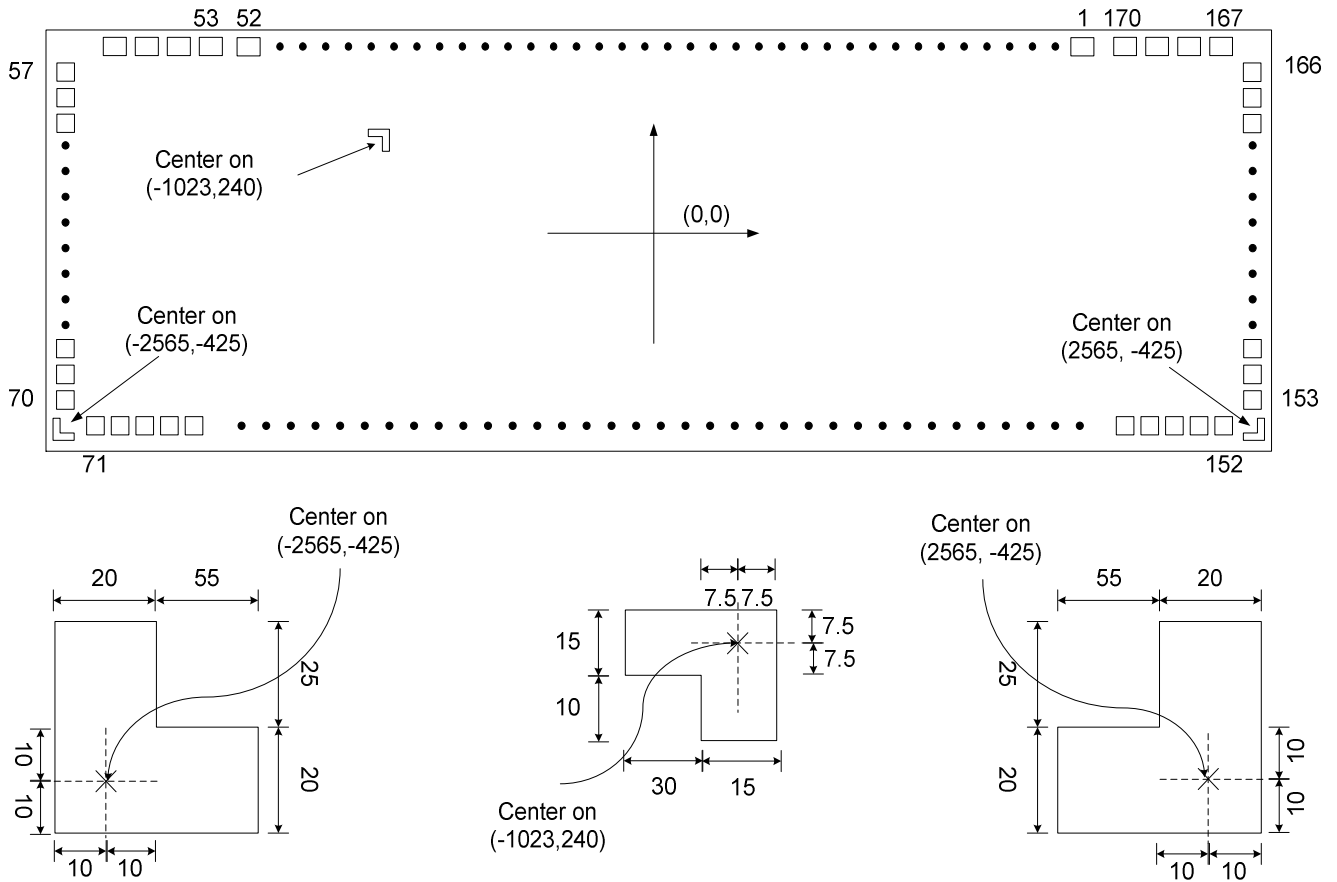
The ST7036 dot-matrix LCD driver does not need extra cascaded drivers.

product Name	Character generator ROM Size	OPR1	OPR2	Support Character
ST7036-0A	256	1	1	English / Japan/Europe
-	-	-	-	-

ST7036	6800-4bit / 8bit,4-Line interface (without IIC interface)	
ST7036i	IIC interface	

ST7036 Serial Specification Revision History		
Version	Date	Description
0.1a	2003/04/28	1. 1 st Edition
0.1b	2003/06/03	1. PAD Dimension: 2. Modify IC L mark location 3. Modify Chip Size X/Y
0.2a	2003/09/01	1. Include ST7036i
1.0	2003/10/24	1. Add application circuit for 3 line display 2. Modify 4 bit interface program example
1.1	2003/12/24	1. Remove the instruction of frequency adjust. 2. Add the detail of CGRAM/CGROM arrangement.
1.2	2004/05/13	1. Remove 'Preliminary'.
1.3	2004/05/26	1. Correct the I/O pad configuration. 2. Add comments for I ² C application.
1.4	2004/10/20	1. Modify icon RAM mapping. (P.24)
1.5	2005/06/13	1. Modify operating temperature range Ta=-35°C to 85°C
1.6	2005/10/17	1. Modify Operating Temperature Range Ta=-30°C to 85°C 2. Modify Storage Temperature Range Ta=-65°C to 150°C 3. Modify the VLCD voltage Range 3.0v~7.0v 4. Modify the limiting values -0.3v~+6.0v 5. Add Chip Thickness: 635 um
1.7	2006/07/10	1. Modify Chip Thickness: 480 um
1.7a	2007/10/17	1. Add the description of 4-line interface in cover page
1.8	2011/10/03	1. Modify the sequence of internal power supply reset.
1.8a	2013/05/15	1. Add the description of the recommended ITO resistance limitation
1.8b	2013/05/15	1. Modify wrong typing

■ Pad Dimensions



- **Chip Size: 5190.0 X 910.0 μm**
- **Chip Thickness: 480 μm**
- **Bump Pitch : 55 μm (min)**
- **Bump Height : 17 μm (typ.)**
- **Bump Size :**
 - **Pad No.1~52 : 56 x 72 μm**
 - **Pad No.53~170 : 35 x 101 μm**

■ Pad Location Coordinates(N3=0 1 line/2 line)

Pad No.	Function	X	Y
1	XRESET	1859	393
2	OSC	1783	393
3	VDD	1707	393
4	RS	1631	393
5	CSB	1555	393
6	RW	1479	393
7	E	1403	393
8	DB0	1327	393
9	DB1	1251	393
10	DB2	1175	393
11	DB3	1099	393
12	DB4	1023	393
13	DB5	947	393
14	DB6	871	393
15	DB7	795	393
16	VSS	719	393
17	VSS	643	393
18	VSS	567	393
19	OPF1	491	393
20	OPF2	415	393
21	OPR1	339	393
22	OPR2	263	393
23	SHLC	187	393
24	SHLS	111	393
25	N3	35	393
26	TEST1	-41	393
27	VDD	-117	393
28	VDD	-193	393
29	VDD	-269	393
30	VIN	-345	393
31	VIN	-421	393
32	VOUT	-497	393
33	VOUT	-573	393
34	PSB	-649	393
35	VSS	-725	393
36	PSI2B	-801	393
37	CAP1P	-877	393
38	CAP1P	-953	393
39	EXT	-1029	393
40	VSS	-1105	393

Pad No.	Function	X	Y
41	CLS	-1181	393
42	CAP1N	-1257	393
43	CAP1N	-1333	393
44	VOUT	-1409	393
45	VOUT	-1485	393
46	V0	-1561	393
47	V0	-1637	393
48	V1	-1713	393
49	V2	-1789	393
50	V3	-1865	393
51	V4	-1941	393
52	NC	-2017	393
53	COM[8]	-2125	378
54	COM[7]	-2180	378
55	COM[6]	-2235	378
56	COM[5]	-2290	378
57	COM[4]	-2518	365
58	COM[3]	-2518	310
59	COM[2]	-2518	255
60	COM[1]	-2518	200
61	COMI1	-2518	145
62	SEG[1]	-2518	90
63	SEG[2]	-2518	35
64	SEG[3]	-2518	-20
65	SEG[4]	-2518	-75
66	SEG[5]	-2518	-130
67	SEG[6]	-2518	-185
68	SEG[7]	-2518	-240
69	SEG[8]	-2518	-295
70	SEG[9]	-2518	-350
71	SEG[10]	-2253	-378
72	SEG[11]	-2198	-378
73	SEG[12]	-2143	-378
74	SEG[13]	-2088	-378
75	SEG[14]	-2033	-378
76	SEG[15]	-1978	-378
77	SEG[16]	-1923	-378
78	SEG[17]	-1868	-378
79	SEG[18]	-1813	-378
80	SEG[19]	-1758	-378

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Pad No.	Function	X	Y
81	SEG[20]	-1703	-378
82	SEG[21]	-1648	-378
83	SEG[22]	-1593	-378
84	SEG[23]	-1538	-378
85	SEG[24]	-1483	-378
86	SEG[25]	-1428	-378
87	SEG[26]	-1373	-378
88	SEG[27]	-1318	-378
89	SEG[28]	-1263	-378
90	SEG[29]	-1208	-378
91	SEG[30]	-1153	-378
92	SEG[31]	-1098	-378
93	SEG[32]	-1043	-378
94	SEG[33]	-988	-378
95	SEG[34]	-933	-378
96	SEG[35]	-878	-378
97	SEG[36]	-823	-378
98	SEG[37]	-768	-378
99	SEG[38]	-713	-378
100	SEG[39]	-658	-378
101	SEG[40]	-603	-378
102	SEG[41]	-548	-378
103	SEG[42]	-493	-378
104	SEG[43]	-438	-378
105	SEG[44]	-383	-378
106	SEG[45]	-328	-378
107	SEG[46]	-273	-378
108	SEG[47]	-218	-378
109	SEG[48]	-163	-378
110	SEG[49]	-108	-378
111	SEG[50]	-53	-378
112	SEG[51]	2	-378
113	SEG[52]	57	-378
114	SEG[53]	112	-378
115	SEG[54]	167	-378
116	SEG[55]	222	-378
117	SEG[56]	277	-378
118	SEG[57]	332	-378
119	SEG[58]	387	-378
120	SEG[59]	442	-378

Pad No.	Function	X	Y
121	SEG[60]	497	-378
122	SEG[61]	552	-378
123	SEG[62]	607	-378
124	SEG[63]	662	-378
125	SEG[64]	717	-378
126	SEG[65]	772	-378
127	SEG[66]	827	-378
128	SEG[67]	882	-378
129	SEG[68]	937	-378
130	SEG[69]	992	-378
131	SEG[70]	1047	-378
132	SEG[71]	1102	-378
133	SEG[72]	1157	-378
134	SEG[73]	1212	-378
135	SEG[74]	1267	-378
136	SEG[75]	1322	-378
137	SEG[76]	1377	-378
138	SEG[77]	1432	-378
139	SEG[78]	1487	-378
140	SEG[79]	1542	-378
141	SEG[80]	1597	-378
142	SEG[81]	1652	-378
143	SEG[82]	1707	-378
144	SEG[83]	1762	-378
145	SEG[84]	1817	-378
146	SEG[85]	1872	-378
147	SEG[86]	1927	-378
148	SEG[87]	1982	-378
149	SEG[88]	2037	-378
150	SEG[89]	2092	-378
151	SEG[90]	2147	-378
152	SEG[91]	2202	-378
153	SEG[92]	2518	-350
154	SEG[93]	2518	-295
155	SEG[94]	2518	-240
156	SEG[95]	2518	-185
157	SEG[96]	2518	-130
158	SEG[97]	2518	-75
159	SEG[98]	2518	-20
160	SEG[99]	2518	35

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Pad No.	Function	X	Y
161	SEG[100]	2518	90
162	COM[9]	2518	145
163	COM[10]	2518	200
164	COM[11]	2518	255
165	COM[12]	2518	310
166	COM[13]	2518	365
167	COM[14]	2290	378
168	COM[15]	2235	378
169	COM[16]	2180	378
170	COMI2	2125	378

Pad No.	Function	X	Y

■ Pad Location Coordinates(N3=1 3 line)

Pad No.	Function	X	Y
1	XRESET	1859	393
2	OSC	1783	393
3	VDD	1707	393
4	RS	1631	393
5	CSB	1555	393
6	RW	1479	393
7	E	1403	393
8	DB0	1327	393
9	DB1	1251	393
10	DB2	1175	393
11	DB3	1099	393
12	DB4	1023	393
13	DB5	947	393
14	DB6	871	393
15	DB7	795	393
16	VSS	719	393
17	VSS	643	393
18	VSS	567	393
19	OPF1	491	393
20	OPF2	415	393
21	OPR1	339	393
22	OPR2	263	393
23	SHLC	187	393
24	SHLS	111	393
25	N3	35	393
26	TEST1	-41	393
27	VDD	-117	393
28	VDD	-193	393
29	VDD	-269	393
30	VIN	-345	393
31	VIN	-421	393
32	VOUT	-497	393
33	VOUT	-573	393
34	PSB	-649	393
35	VSS	-725	393
36	PSI2B	-801	393
37	CAP1P	-877	393
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42	CAP1N	-1257	393
43	CAP1N	-1333	393
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45	VOUT	-1485	393
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47	V0	-1637	393
48	V1	-1713	393
49	V2	-1789	393
50	V3	-1865	393
51	V4	-1941	393
52	NC	-2017	393
53	COM[12]	-2125	378
54	COM[11]	-2180	378
55	COM[10]	-2235	378
56	COM[9]	-2290	378
57	COM[8]	-2518	365
58	COM[7]	-2518	310
59	COM[6]	-2518	255
60	COM[5]	-2518	200
61	NC	-2518	145
62	COM[4]	-2518	90
63	COM[3]	-2518	35
64	COM[2]	-2518	-20
65	COM[1]	-2518	-75
66	COMI1	-2518	-130
67	NC	-2518	-185
68	NC	-2518	-240
69	NC	-2518	-295
70	NC	-2518	-350
71	NC	-2253	-378
72	SEG[1]	-2198	-378
73	SEG[2]	-2143	-378
74	SEG[3]	-2088	-378
75	SEG[4]	-2033	-378
76	SEG[5]	-1978	-378
77	SEG[6]	-1923	-378
78	SEG[7]	-1868	-378
79	SEG[8]	-1813	-378
80	SEG[9]	-1758	-378

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Pad No.	Function	X	Y
81	SEG[10]	-1703	-378
82	SEG[11]	-1648	-378
83	SEG[12]	-1593	-378
84	SEG[13]	-1538	-378
85	SEG[14]	-1483	-378
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87	SEG[16]	-1373	-378
88	SEG[17]	-1318	-378
89	SEG[18]	-1263	-378
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92	SEG[21]	-1098	-378
93	SEG[22]	-1043	-378
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95	SEG[24]	-933	-378
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101	SEG[30]	-603	-378
102	SEG[31]	-548	-378
103	SEG[32]	-493	-378
104	SEG[33]	-438	-378
105	SEG[34]	-383	-378
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108	SEG[37]	-218	-378
109	SEG[38]	-163	-378
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113	SEG[42]	57	-378
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119	SEG[48]	387	-378
120	SEG[49]	442	-378

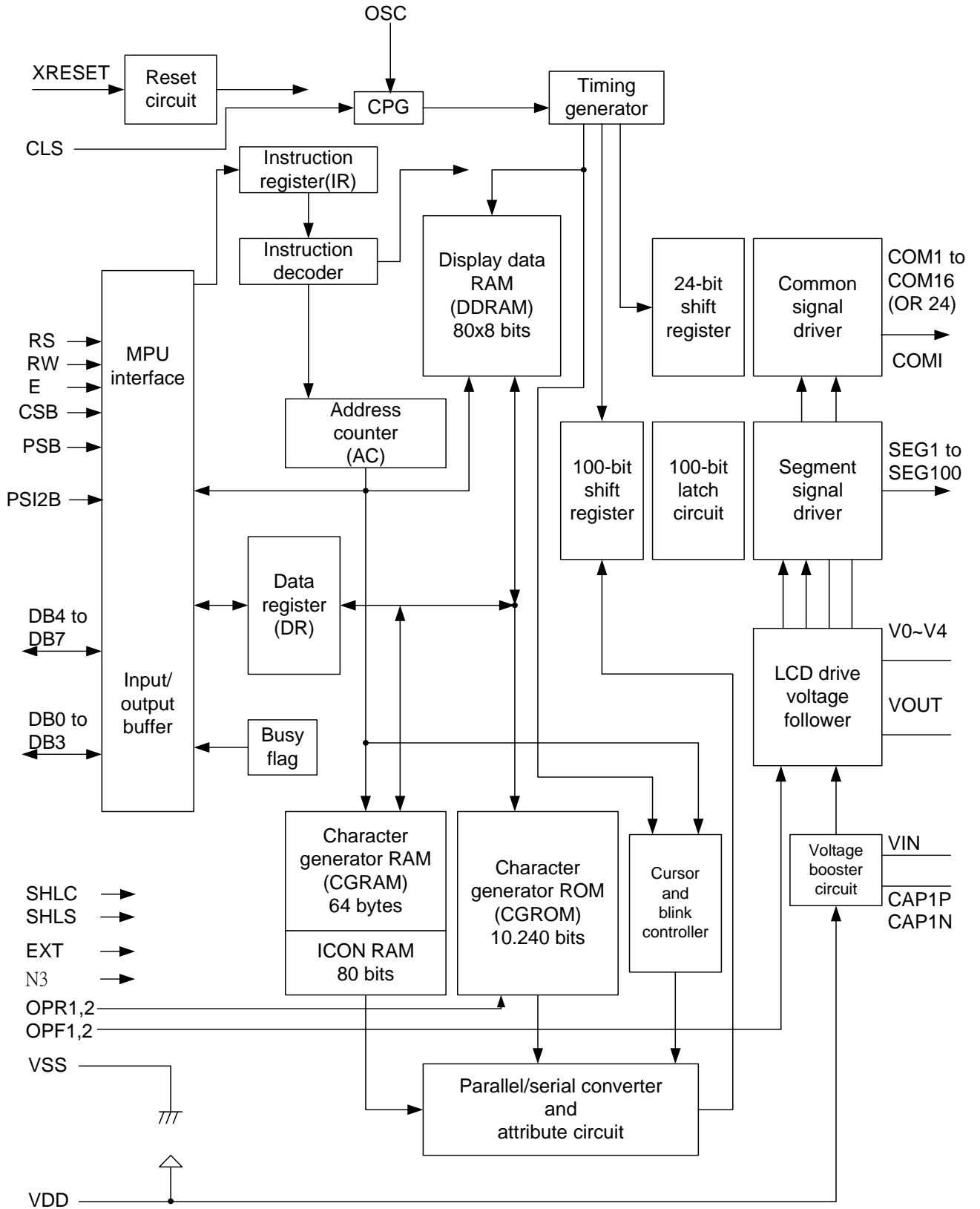
Pad No.	Function	X	Y
121	SEG[50]	497	-378
122	SEG[51]	552	-378
123	SEG[52]	607	-378
124	SEG[53]	662	-378
125	SEG[54]	717	-378
126	SEG[55]	772	-378
127	SEG[56]	827	-378
128	SEG[57]	882	-378
129	SEG[58]	937	-378
130	SEG[59]	992	-378
131	SEG[60]	1047	-378
132	SEG[61]	1102	-378
133	SEG[62]	1157	-378
134	SEG[63]	1212	-378
135	SEG[64]	1267	-378
136	SEG[65]	1322	-378
137	SEG[66]	1377	-378
138	SEG[67]	1432	-378
139	SEG[68]	1487	-378
140	SEG[69]	1542	-378
141	SEG[70]	1597	-378
142	SEG[71]	1652	-378
143	SEG[72]	1707	-378
144	SEG[73]	1762	-378
145	SEG[74]	1817	-378
146	SEG[75]	1872	-378
147	SEG[76]	1927	-378
148	SEG[77]	1982	-378
149	SEG[78]	2037	-378
150	SEG[79]	2092	-378
151	SEG[80]	2147	-378
152	NC	2202	-378
153	NC	2518	-350
154	NC	2518	-295
155	NC	2518	-240
156	NC	2518	-185
157	NC	2518	-130
158	COM[13]	2518	-75
159	COM[14]	2518	-20
160	COM[15]	2518	35

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Pad No.	Function	X	Y
161	COM[16]	2518	90
162	COM[17]	2518	145
163	COM[18]	2518	200
164	COM[19]	2518	255
165	COM[20]	2518	310
166	COM[21]	2518	365
167	COM[22]	2290	378
168	COM[23]	2235	378
169	COM[24]	2180	378
170	COMI2	2125	378

Pad No.	Function	X	Y

■ Block Diagram



■ Pin Function

Name	Number	I/O	Interfaced with	Function															
XRESET	1	I	MPU	External reset pin. Only if the power on reset be used, the XRESET pin could be fixed to VDD. Low active.															
RS	1	I	MPU	Select registers. 0: Instruction register (for write) Busy flag & address counter (for read) 1: Data register (for write and read)															
R/W	1	I	MPU	Select read or write(In parallel mode). 0: Write 1: Read															
E	1	I	MPU	Starts data read/write. (<u>"E" must connect to "VDD" when serial mode is selected.</u>)															
CSB	1	I	MPU	Chip select in parallel mode and serial interface(Low active). When the CSB in falling edge state (in serial interface), the shift register and the counter are reset.															
DB0 to DB7	8	I/O	MPU	DB0~DB3 are four low order bi-directional data bus pins. DB0~DB3 are used for data transfer and receive between the MPU and the ST7036. These pins are not used during 4-bit operation and must connect to VDD. DB4~DB7 are four high order bi-directional data bus pins. DB4~DB7 are used for data transfer and receive between the MPU and the ST7036. DB7 can be used as a busy flag. In serial interface mode DB7 is SI(input data),DB6 is SCL(serial clock). In I ² C interface DB7 is slave address A1, DB6 is slave address A0, DB5 DB4 DB3 are SDA –out, DB2 DB1 are SDA-in and D0 is SCL. SDA and SCL must connect to I ² C bus (I ² C bus means that connecting a resister between SDA/SCL and the power of I ² C bus).															
Ext	1	I	ITO option	Extension instruction select: 0:enable extension instruction(add contrast/ICON/double height font/ extension instruction) 1:disable extension instruction(compatible to ST7066U, but without 5x11dot font)															
PSB	1	I	ITO option	Interface selection 0:serial mode (<u>"E" must connect to "VDD" when serial mode is selected.</u>) 1:parallel mode(4/8 bit) In I ² C interface PSB must connect to V _{DD}															
PSI2B	1	I	ITO option	<table border="1"> <thead> <tr> <th>PSB</th> <th>PSI2B</th> <th>Interface</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>No use</td> </tr> <tr> <td>0</td> <td>1</td> <td>4-line SPI</td> </tr> <tr> <td>1</td> <td>0</td> <td>I²C</td> </tr> <tr> <td>1</td> <td>1</td> <td>Parallel 68</td> </tr> </tbody> </table>	PSB	PSI2B	Interface	0	0	No use	0	1	4-line SPI	1	0	I ² C	1	1	Parallel 68
PSB	PSI2B	Interface																	
0	0	No use																	
0	1	4-line SPI																	
1	0	I ² C																	
1	1	Parallel 68																	

Name	Number	I/O	Interfaced with	Function				
OPR1,OPR2	2	I	ITO option	Character generator select:				
				OPR1	OPR2	CGROM	CGRAM	
				0	0	240	8	
				0	1	250	6	
				1	0	248	8	
SHLC	1	I	ITO option	Common signals direction select:				
				0:Com1~24←Row address 23~0(Invert)				
				1:Com1~24←Row address 0~23(Normal)				
				Segment signals direction select:				
				0:Seg1~100←Column address 99~0(Invert)				
COM1 to COM16	16	O	LCD	Common signals that are not used are changed to non-selection waveform. COM9 to COM16 are non-selection waveforms at 1/8 or 1/9 duty factor				
				COM12 COM11	1	O	LCD	ICON common signals
				Seg1~Seg10 Seg91~Seg100	21	O	LCD	Select "N3" pin for common or segment waveform output (follow up table 2 defined)
				N3	1	I	ITO option	1 line/2 line or 3 line select : 0:1 line/2 line SEG0~SEG100:normal 1:3 line COM1,SEG1~SEG5,SEG97~SEG100 re-defined
				SEG11 to SEG90	80	O	LCD	Segment signals
OPF1,OPF2	2	I	ITO option	The built-in voltage follower circuit selection				
				OPF1	OPF2	Bias select		
				0	0	Built-in voltage follower(only use at EXT=0)		
				0	1	Built-in bias resistor(3.3K Ω)		
				1	0	Built-in bias resistor(9.6K Ω)		
1	1	External bias resistor select						
CAP1P	2	-	Power supply	For voltage booster circuit(VDD-VSS) External capacitor about 0.1u~4.7uf				
CAP1N	2	-	Power supply					
VIN	2	-	Power supply		Input the voltage to booster			
VOUT	4	-	Power supply	DC/DC voltage converter. Connect a capacitor between this terminal and VIN when the built-in booster is used.				
V0 to V4	6	-	Power supply	Power supply for LCD drive V0-Vss = 7V (Max) Built-in/external Voltage follower circuit				
VDD,VSS	4,5	-	Power supply	VDD: 2.7V to 5.5V, VSS: 0V				
CLS	1	I	ITO option	Internal/External oscillation select 0:external clock 1:internal oscillation				
OSC	1	I	Oscillation	When the pin input is an external clock, it must be input to OSC. When the on-chip oscillator is used, it must be connected to VDD.				
TEST1	1	I/O	Test pin	TEST1 must connect to VDD.				

■ EXT option pin difference table

Difference \ Mode	Normal mode (EXT=1) (Instruction compatible to ST7066U)	Extension mode (EXT=0)
Booster	Always OFF	ON/OFF controlled by instruction
Bias (V0~V4)	Can't use the follower circuit Only use external resistor or internal resistor(1/5 bias)	Follower or internal/external resistor selectable
Contrast adjust	Control by external VR	1. Controlled by instruction with follower 2. Controlled by external VR with internal/external resistor
ICON RAM	Can't be use	RAM size has 80 bit width(S1~S80).
Instruction	Control normal instruction similar to ST7066U.	Control extension instruction for low power consumption.
Double height font	Only 5x8 font	Can set 5x8 or 5x16 font

■ Recommended ITO Resistance Limitation

PIN Name	ITO Resistance
Power Pin: VDD, VSS, VIN, Vout, CAP1P, CAP1N	< 100 Ω
Follower Pin: V0, V1, V2, V3, V4	< 300 Ω
Control Pin: CSB, RS, RW, E, DB0~DB7	< 1 K Ω
Option Pin: OPFx, OPRx, SHLx, PSB, PSI2B, TESTx, EXT, CLS, N3	< 5 K Ω
Reset Pin: XRESET	1K~3K Ω

Notes:

1. If using I2C interface mode, the resistance of SDA signal should be lower than 100Ω .
2. The RSTB pin has the most priority over other control signals. It is important to prevent the ESD pulse or external noise flow into this pin. By adding a series resistor externally or increase the ITO resistance at this pin, the unexpected reset condition can be solved. The recommended resistance is between 1K and 3KΩ (the optimized value depends on the LCD module and application system).
3. This table defines the actual ITO resistance. The ITO tolerance and ITO-layout bottle-neck should be considered.

■ Function Description

● System Interface

This chip has all four kinds of interface type with MPU: 4-bit bus, 8-bit bus, serial and fast I²C interface. 4-bit bus or 8-bit bus is selected by DL bit in the instruction register.

During read or write operation, two 8-bit registers are used. One is data register (DR), the other is instruction register(IR).

The data register(DR) is used as temporary data storage place for being written into or read from DDRAM/CGRAM/ICON RAM, target RAM is selected by RAM address setting instruction. Each internal operation, reading from or writing into RAM, is done automatically. So to speak, after MPU reads DR data, the data in the next DDRAM/CGRAM/ICON RAM address is transferred into DR automatically. Also after MPU writes data to DR, the data in DR is transferred into DDRAM/CGRAM/ICON RAM automatically.

The Instruction register(IR) is used only to store instruction code transferred from MPU. MPU cannot use it to read instruction data.

To select register, use RS input pin in 4-bit/8-bit bus mode.

RS	R/W	Operation
L	L	Instruction Write operation (MPU writes Instruction code into IR)
L	H	Read Busy Flag(DB7) and address counter (DB0 ~ DB6)
H	L	Data Write operation (MPU writes data into DR)
H	H	Data Read operation (MPU reads data from DR)

Table 1. Various kinds of operations according to RS and R/W bits.

I²C interface

**It just only could write Data or Instruction to ST7036 by the IIC Interface.
It could not read Data or Instruction from ST7036 (except Acknowledge signal).**

SCL: serial clock input

SDA_IN: serial data input

SDA_OUT: acknowledge response output

Slaver address could set from "0111100" to "0111111".

The I²C interface send RAM data and executes the commands sent via the I²C Interface. It could send data in to the RAM. The I²C Interface is two-line communication between different ICs or modules. The two lines are a Serial Data line (SDA) and a Serial Clock line (SCL). Both lines must be connected to a positive supply via a pull-up resistor. Data transfer may be initiated only when the bus is not busy.

BIT TRANSFER

One data bit is transferred during each clock pulse. The data on the SDA line must remain stable during the HIGH period of the clock pulse because changes in the data line at this time will be interpreted as a control signal. Bit transfer is illustrated in Fig.1.

START AND STOP CONDITIONS

Both data and clock lines remain HIGH when the bus is not busy. A HIGH-to-LOW transition of the data line, while the clock is HIGH is defined as the START condition (S). A LOW-to-HIGH transition of the data line while the clock is HIGH is defined as the STOP condition (P). The START and STOP conditions are illustrated in Fig.2.

SYSTEM CONFIGURATION

The system configuration is illustrated in Fig.3.

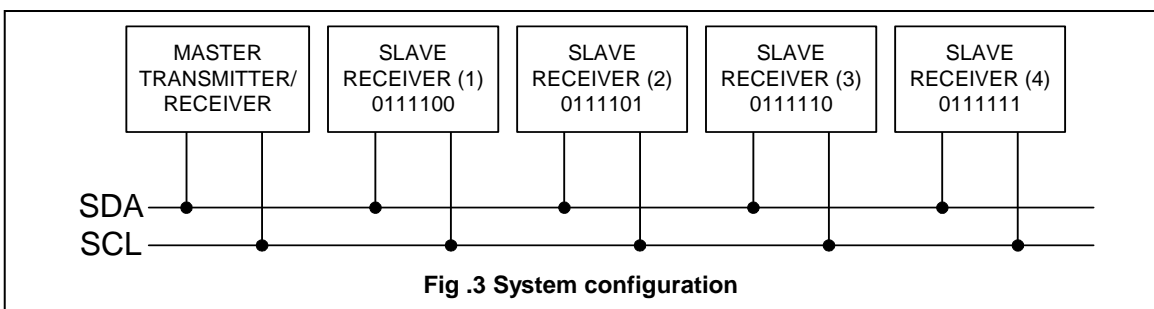
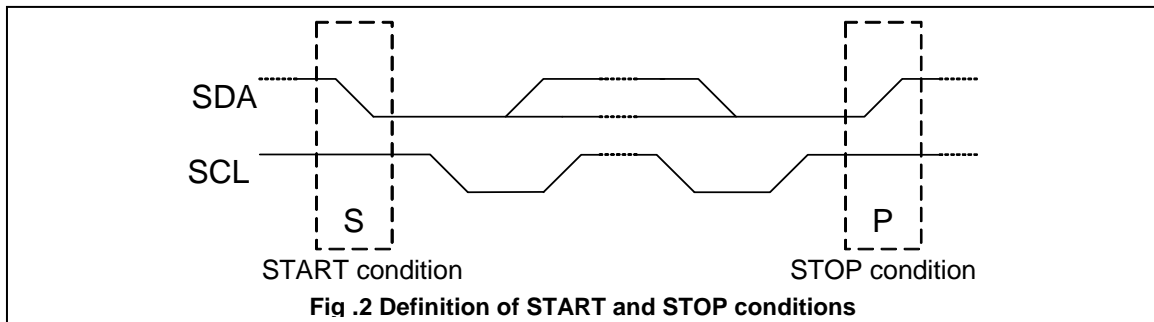
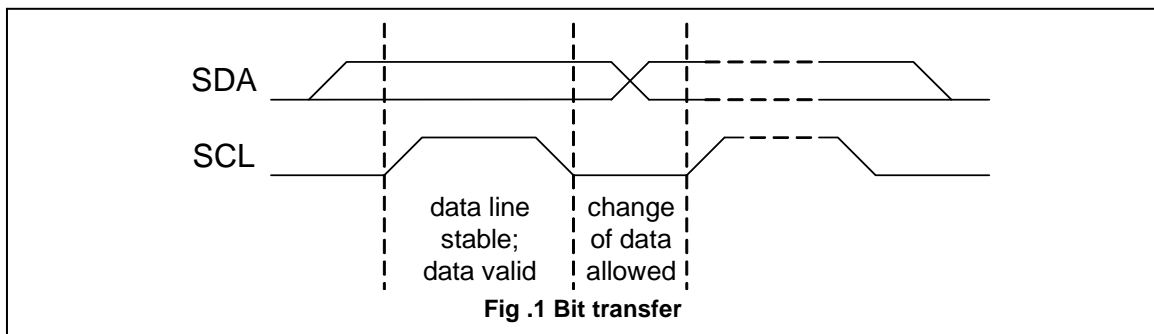
- Transmitter: the device, which sends the data to the bus
- Master: the device, which initiates a transfer, generates clock signals and terminates a transfer
- Slave: the device addressed by a master
- Multi-Master: more than one master can attempt to control the bus at the same time without corrupting the message

- Arbitration: procedure to ensure that, if more than one master simultaneously tries to control the bus, only one is allowed to do so and the message is not corrupted
- Synchronization: procedure to synchronize the clock signals of two or more devices.

ACKNOWLEDGE

Acknowledge signal (ACK) is not BF signal in parallel interface.

Each byte of eight bits is followed by an acknowledge bit. The acknowledge bit is a HIGH signal put on the bus by the transmitter during which time the master generates an extra acknowledge related clock pulse. A slave receiver which is addressed must generate an acknowledge after the reception of each byte. A master receiver must also generate an acknowledge after the reception of each byte that has been clocked out of the slave transmitter. The device that acknowledges must pull-down the SDA line during the acknowledge clock pulse, so that the SDA line is stable LOW during the HIGH period of the acknowledge related clock pulse (set-up and hold times must be taken into consideration). A master receiver must signal an end-of-data to the transmitter by not generating an acknowledge on the last byte that has been clocked out of the slave. In this event the transmitter must leave the data line HIGH to enable the master to generate a STOP condition. Acknowledgement on the I²C Interface is illustrated in Fig.4.



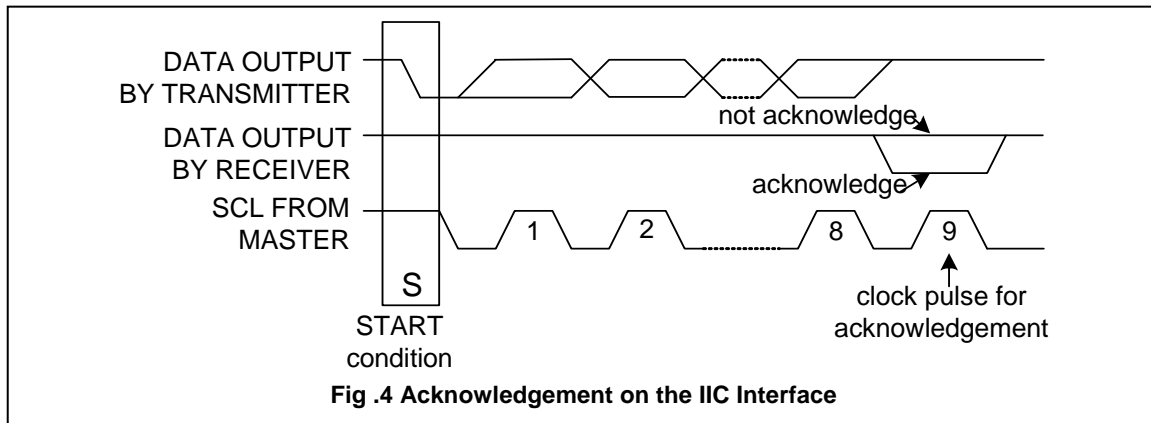


Fig .4 Acknowledgement on the IIC Interface

I²C Interface protocol

The ST7036 supports command, data write addressed slaves on the bus.

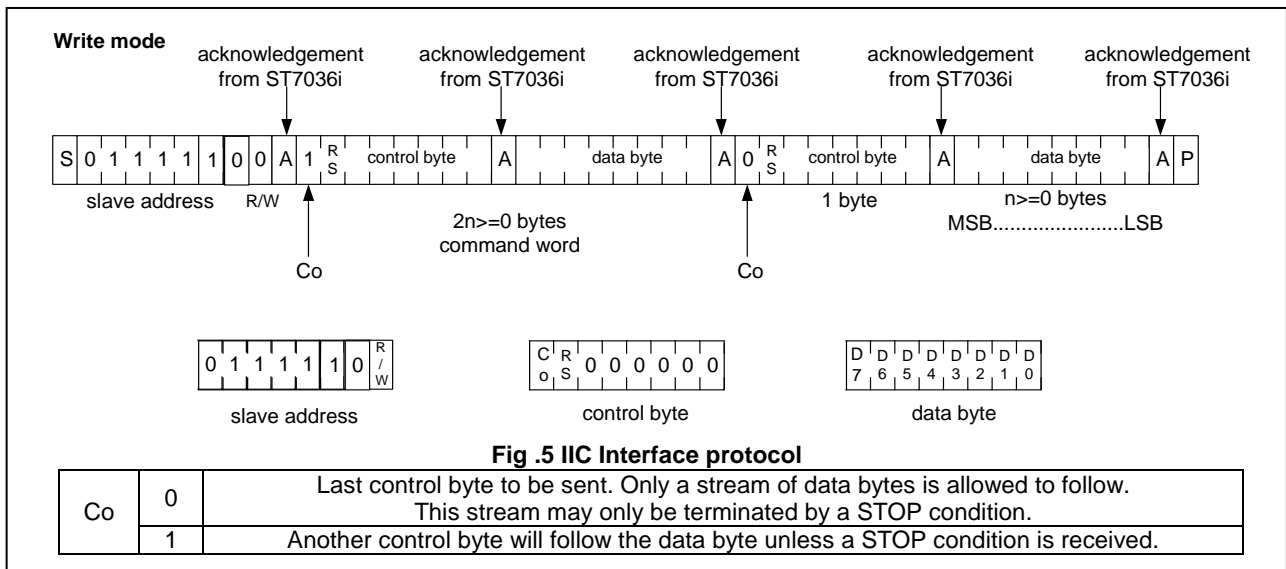
Before any data is transmitted on the I²C Interface, the device, which should respond, is addressed first. Four 7-bit slave addresses (0111100 to 0111111) are reserved for the ST7036. The R/W is assigned to 0 for Write only.

The I²C Interface protocol is illustrated in Fig.5.

The sequence is initiated with a START condition (S) from the I²C Interface master, which is followed by the slave address. All slaves with the corresponding address acknowledge in parallel, all the others will ignore the I²C Interface transfer. After acknowledgement, one or more command words follow which define the status of the addressed slaves.

A command word consists of a control byte, which defines Co and RS, plus a data byte.

The last control byte is tagged with a cleared most significant bit (i.e. the continuation bit Co). After a control byte with a cleared Co bit, only data bytes will follow. The state of the RS bit defines whether the data byte is interpreted as a command or as RAM data. All addressed slaves on the bus also acknowledge the control and data bytes. After the last control byte, depending on the RS bit setting; either a series of display data bytes or command data bytes may follow. If the RS bit is set to logic 1, these display bytes are stored in the display RAM at the address specified by the data pointer. The data pointer is automatically updated and the data is directed to the intended ST7036i device. If the RS bit of the last control byte is set to logic 0, these command bytes will be decoded and the setting of the device will be changed according to the received commands. Only the addressed slave makes the acknowledgement after each byte. At the end of the transmission the I²C INTERFACE-bus master issues a STOP condition (P).



During write operation, two 8-bit registers are used. One is data register (DR), the other is instruction register(IR).

The data register(DR) is used as temporary data storage place for being written into DDRAM/CGRAM/ICON RAM, target RAM is selected by RAM address setting instruction. Each internal operation, writing into RAM, is done automatically. So to speak, after MPU writes data to DR, the data in DR is transferred into DDRAM/CGRAM/ICON RAM automatically.

The Instruction register(IR) is used only to store instruction code transferred from MPU. MPU cannot use it to read instruction data.

To select register, use RS bit input in IIC interface.

RS	R/W	Operation
L	L	Instruction Write operation (MPU writes Instruction code into IR)
H	L	Data Write operation (MPU writes data into DR)

Table 2. Various kinds of operations according to RS and R/W bits.

● **Busy Flag (BF)**

When BF = "High", it indicates that the internal operation is being processed. So during this time the next instruction cannot be accepted. BF can be read, when RS = Low and R/W = High (Read Instruction Operation), through DB7 port. Before executing the next instruction, be sure that BF is not High.

● **Address Counter (AC)**

Address Counter(AC) stores DDRAM/CGRAM/ICON RAM address, transferred from IR. After writing into (reading from) DDRAM/CGRAM/ICON RAM, AC is automatically increased (decreased) by 1. When RS = "Low" and R/W = "High", AC can be read through DB0 ~ DB6 ports.

● **Display Data RAM (DDRAM)**

Display data RAM (DDRAM) stores display data represented in 8-bit character codes. Its extended capacity is 80 x 8 bits, or 80 characters. The area in display data RAM (DDRAM) that is not used for display can be used as general data RAM. See Figure 6 for the relationships between DDRAM addresses and positions on the liquid crystal display.

The DDRAM address (A_{DD}) is set in the address counter (AC) as hexadecimal.

➤ **1-line display (N3=0,N = 0) (Figure 7)**

When there are fewer than 80 display characters, the display begins at the head position. For example, if using only the ST7036, 20 characters are displayed. See Figure 7.

When the display shift operation is performed, the DDRAM address shifts. See Figure 8.

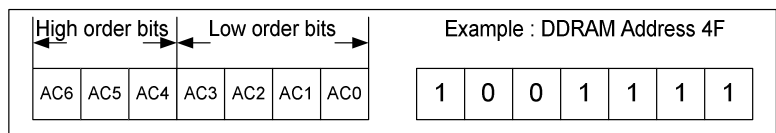


Fig. 6 DDRAM Address

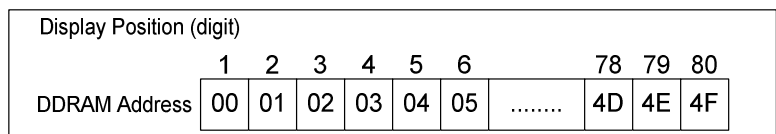


Fig. 7 1-Line Display

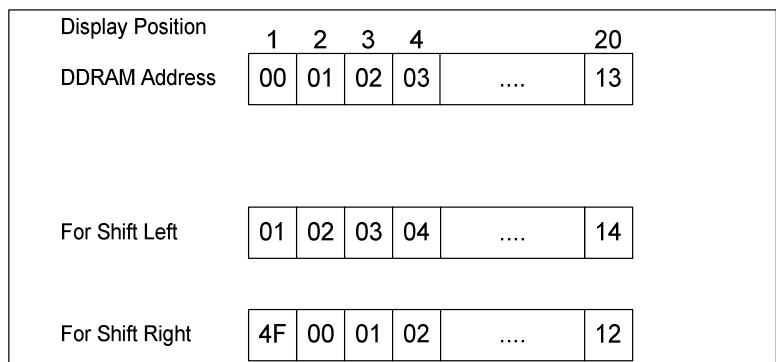


Fig. 8 1-Line by 20-Character Display Example

➤ **2-line display (N3=0,N = 1) (Figure 9)**

Case 1: When the number of display characters is less than 40 x 2 lines, the two lines are displayed from the head. Note that the first line end address and the second line start address are not consecutive. For example, when just the ST7036 is used, 20 characters x 2 lines are displayed. See Figure 9. When display shift operation is performed, the DDRAM address shifts. See Figure 10.

Display Position										
	1	2	3	4	5	6	.....	38	39	40
DDRAM Address	00	01	02	03	04	05	.....	25	26	27
(hexadecimal)	40	41	42	43	44	45	.....	65	66	67

Fig. 9 2-Line Display

Display Position	1	2	3	4	5	6	7	8	.....	17	18	19	20
DDRAM Address	00	01	02	03	04	05	06	07	.....	10	11	12	13
	40	41	42	43	44	45	46	47	.....	50	51	52	53
For Shift Left	01	02	03	04	05	06	07	08	.....	11	12	13	14
	41	42	43	44	45	46	47	48	.....	51	52	53	54
For Shift Right	27	00	01	02	03	04	05	06	.....	0F	10	11	12
	67	40	41	42	43	44	45	46	.....	4F	50	51	52

Fig. 10 2-Line by 20-Character Display Example

➤ **3-line display (N3=1,N =1) (Figure 11)**

Case 1: When the number of display characters is less than 16 x 3 lines, the three lines are displayed from the head. For example, when just the ST7036 is used, 16 characters x 3 lines are displayed. See Figure 11. When display shift operation is performed, the DDRAM address shifts. See Figure 12.

Display Position		1	2	3	4	5	6		14	15	16
DDRAM Address (hexadecimal)		00	01	02	03	04	05	.....	0D	0E	0F
		10	11	12	13	14	15	.....	1D	1E	1F
		20	21	22	23	24	25	.....	2D	2E	2F

Fig. 11 3-Line Display

Display Position		1	2	3	4	5	6		14	15	16
DDRAM Address (hexadecimal)		00	01	02	03	04	05	.....	0D	0E	0F
		10	11	12	13	14	15	.....	1D	1E	1F
		20	21	22	23	24	25	.....	2D	2E	2F
For Shift Left		1	2	3	4	5	6		14	15	16
		01	02	03	04	05	06	.....	0E	0F	00
		11	12	13	14	15	16	.....	1E	1F	10
		21	22	23	24	25	26	.....	2E	2F	20
For Shift Right		1	2	3	4	5	6		14	15	16
		0F	00	01	02	03	04	.....	0C	0D	0E
		1F	10	11	12	13	14	.....	1C	1D	1E
		2F	20	21	22	23	24	.....	2C	2D	2E

Fig. 12 3-Line Display

● **Character Generator ROM (CGROM)**

The character generator ROM generates 5 x 8 dot character patterns from 8-bit character codes. It can generate 240/250/248/256 5 x 8 dot character patterns(select by OPR1/2 ITO pin). User-defined character patterns are also available by mask-programmed ROM.

● **Character Generator RAM (CGRAM)**

In the character generator RAM, the user can rewrite character patterns by program. For 5 x 8 dots, eight character patterns can be written.

Write into DDRAM the character codes at the addresses shown as the left column of Table 5 to show the character patterns stored in CGRAM.

See Table 5 for the relationship between CGRAM addresses and data and display patterns. Areas that are not used for display can be used as general data RAM.

● **ICON RAM**

In the ICON RAM, the user can rewrite icon pattern by program.

There are totally 80 dots for icon can be written.

See Table 6 for the relationship between ICON RAM address and data and the display patterns.

● **Timing Generation Circuit**

The timing generation circuit generates timing signals for the operation of internal circuits such as DDRAM, CGROM and CGRAM. RAM read timing for display and internal operation timing by MPU access are generated separately to avoid interfering with each other. Therefore, when writing data to DDRAM, for example, there will be no undesirable interference, such as flickering, in areas other than the display area.

● **LCD Driver Circuit(N3=0)**

LCD Driver circuit has 17 common and 100 segment signals for LCD driving. Data from CGRAM/CGROM/ICON is transferred to 100 bit segment latch serially, and then it is stored to 100 bit shift latch. When each common is selected by 17 bit common register, segment data also output through segment driver from 100 bit segment latch. In case of 1-line display mode, COM1 ~ COM8(with COMI) have 1/9 duty, and in 2-line mode, COM1 ~ COM16(with COMI) have 1/17 duty ratio.

● **LCD Driver Circuit(N3=1)**

LCD Driver circuit has 25 common and 80 segment signals for LCD driving. Data from CGRAM/CGROM/ICON is transferred to 80 bit segment latch serially, and then it is stored to 80 bit shift latch. When each common is selected by 25 bit common register, segment data also output through segment driver from 80 bit segment latch. In case of 3-line display mode, COM1 ~ COM24(with COMI) have 1/25 duty.

COM/SEG Output pins

N3	COMI1	COM [1:8]	SEG [1:5]	SEG [6:10]	SEG [11:90]	SEG [91:96]	SEG [97:100]	COM [9:16]	COMI2
VSS	COMI1	COM [1:8]	SEG [1:5]	SEG [6:10]	SEG [11:90]	SEG [91:96]	SEG [97:100]	COM [9:16]	COMI2
VDD	NC	COM [5:12]	COM[4:1] + COMI1	NC	SEG [1:80]	NC	COM [13:16]	COM [17:24]	COMI2

Table 3. COM/SEG output define

● **Cursor/Blink Control Circuit**

It can generate the cursor or blink in the cursor/blink control circuit. The cursor or the blink appears in the digit at the display data RAM address set in the address counter.

Table 4 Correspondence between Character Codes and Character Patterns

ST7036-0A (ITO option OPR1=1, OPR2=1)

b7-b4 b3-b0	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0000	0	1	2	3	4	5	6	7	8	9	.	/	:	;	<	>
0001	J	T	L	I	A	O	a	n	Q	o	w	F	F	L	A	.
0010	0	1	2	3	4	5	6	7	8	9	.	/	:	:	:	.
0011	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2
0100	4	7	8	4	0	T	d	t	a	o	v	E	K	P	o	.
0101	↑	↓	↔	↕	↖	↗	↘	↙	↚	↛	↜	↝	↞	↠	↡	↣
0110	↓	0	0	6	F	V	V	V	a	0	7	0	2	3	4	5
0111	+	A	P	7	B	U	9	W	S	U	7	F	X	7	R	X
1000	+	E	C	0	H	X	h	X	A	0	+	0	0	U	0	+
1001	7	T	7	9	T	Y	i	w	A	0	o	7	7	U	i	3
1010	7	E	8	8	T	Z	a	Z	A	0	o	7	0	U	A	3
1011	L	P	+	+	K	L	K	K	I	A	N	9	U	0	3	0
1100	L	0	.	<	L	7	l	l	3	N	P	9	7	7	0	0
1101	.	7	-	-	N	J	n	+	3	0	7	7	7	0	0	+
1110	0	0	.	>	N	^	n	+	A	0	7	7	7	0	0	T
1111	0	0	/	?	0	L	0	+	A	0	U	7	7	0	0	7

(0,0)				(0,1)				(1,0)				(1,1)			
b7-b4	0000	0001	...	b7-b4	0000	0001	...	b7-b4	0000	0001	...	b7-b4	0000	0001	...
b3-b0				b3-b0				b3-b0				b3-b0			
0000			...	0000			...	0000			...	0000			...
0001			...	0001			...	0001			...	0001			...
0010			...	0010			...	0010			...	0010			...
0011			...	0011			...	0011			...	0011			...
0100			...	0100			...	0100			...	0100			...
0101			...	0101			...	0101			...	0101			...
0110			...	0110			...	0110			...	0110			...
0111			...	0111			...	0111			...	0111			...
1000			...	1000			...	1000			...	1000			...
1001			...	1001			...	1001			...	1001			...
1010			...	1010			...	1010			...	1010			...
1011			...	1011			...	1011			...	1011			...
1100			...	1100			...	1100			...	1100			...
1101			...	1101			...	1101			...	1101			...
1110			...	1110			...	1110			...	1110			...
1111			...	1111			...	1111			...	1111			...

Character Code (DDRAM Data)								CGRAM Address						Character Patterns (CGRAM Data)									
b7	b6	b5	b4	b3	b2	b1	b0	b5	b4	b3	b2	b1	b0	b7	b6	b5	b4	b3	b2	b1	b0		
0	0	0	0	-	0	0	0	0	0	0	0	0	0	-	-	-	1	1	1	1	1		
					0	0	0				0	0	0				0	0	0				
					0	0	0				0	0	0				1	0	0	0	0	0	0
					0	0	0				0	0	0				0	1	1	0	0	0	0
					0	0	0				0	0	0				1	0	0	0	0	0	0
					0	0	0				0	0	0				1	0	1	0	0	0	0
					0	0	0				0	0	0				1	1	0	0	0	0	0
					0	0	0				0	0	0				1	1	1	0	0	0	0
					0	0	0				0	0	0				0	0	0	0	0	0	0
0	0	0	0	-	0	0	1	0	0	1	0	0	0	-	-	-	1	1	1	1	0		
					0	0	1				0	0	1				0	0	1	0	1		
					0	0	1				0	1	0				0	0	1	0	1	0	1
					0	0	1				0	1	1				0	1	1	0	0	0	0
					0	0	1				0	1	1				0	0	0	0	0	0	0
					0	0	1				0	1	1				0	1	0	1	0	0	0
					0	0	1				0	1	1				1	0	0	0	0	0	1
					0	0	1				0	1	1				1	0	0	0	0	0	1
					0	0	1				0	1	1				1	1	0	0	0	0	0

Table 5 Relationship between CGRAM Addresses, Character Codes (DDRAM) and Character patterns (CGRAM Data)

Notes:

1. Character code bits 0 to 2 correspond to CGRAM address bits 3 to 5 (3 bits: 8 types).
2. CGRAM address bits 0 to 2 designate the character pattern line position. The 8th line is the cursor position and its display is formed by a logical OR with the cursor. Maintain the 8th line data, corresponding to the cursor display position, at 0 as the cursor display. If the 8th line data is 1, 1 bits will light up the 8th line regardless of the cursor presence.
3. Character pattern row positions correspond to CGRAM data bits 0 to 4 (bit 4 being at the left).
4. As shown Table 5, CGRAM character patterns are selected when character code bits 4 to 7 are all 0. However, since character code bit 3 has no effect, the T display example above can be selected by either character code 00H or 08H.
5. "1" for CGRAM data corresponds to display selection and "0" to non-selection, "-" Indicates no effect.
6. Different OPR1/2 ITO option can select different CGRAM size.

When ICON RAM data is filled the corresponding position displayed is described as the following table.

When SHLS=1, ICON RAM map refer below table

ICON Address	ICON RAM bits										
	D7~D5	D4		D3		D2		D1		D0	
		N3 = 0	N3 = 1	N3 = 0	N3 = 1	N3 = 0	N3 = 1	N3 = 0	N3 = 1	N3 = 0	N3 = 1
00H	-	S1/S81	S1	S2/S82	S2	S3/S83	S3	S4/S84	S4	S5/S85	S5
01H	-	S6/S86	S6	S7/S87	S7	S8/S88	S8	S9/S89	S9	S10/S90	S10
02H	-	S11/S91	S11	S12/S92	S12	S13/S93	S13	S14/S94	S14	S15/S95	S15
03H	-	S16/S96	S16	S17/S97	S17	S18/S98	S18	S19/S99	S19	S20/S100	S20
04H	-	S21	S21	S22	S22	S23	S23	S24	S24	S25	S25
05H	-	S26	S26	S27	S27	S28	S28	S29	S29	S30	S30
06H	-	S31	S31	S32	S32	S33	S33	S34	S34	S35	S35
07H	-	S36	S36	S37	S37	S38	S38	S39	S39	S40	S40
08H	-	S41	S41	S42	S42	S43	S43	S44	S44	S45	S45
09H	-	S46	S46	S47	S47	S48	S48	S49	S49	S50	S50
0AH	-	S51	S51	S52	S52	S53	S53	S54	S54	S55	S55
0BH	-	S56	S56	S57	S57	S58	S58	S59	S59	S60	S60
0CH	-	S61	S61	S62	S62	S63	S63	S64	S64	S65	S65
0DH	-	S66	S66	S67	S67	S68	S68	S69	S69	S70	S70
0EH	-	S71	S71	S72	S72	S73	S73	S74	S74	S75	S75
0FH	-	S76	S76	S77	S77	S78	S78	S79	S79	S80	S80

When SHLS=0, ICON RAM map refer below table

ICON Address	ICON RAM bits										
	D7~D5	D4		D3		D2		D1		D0	
		N3 = 0	N3 = 1	N3 = 0	N3 = 1	N3 = 0	N3 = 1	N3 = 0	N3 = 1	N3 = 0	N3 = 1
00H	-	S100/S20	S80	S99/S19	S79	S98/S18	S78	S97/S17	S77	S96/S16	S76
01H	-	S95/S15	S75	S94/S14	S74	S93/S13	S73	S92/S12	S72	S91/S11	S71
02H	-	S90/S10	S70	S89/S9	S69	S88/S8	S68	S87/S7	S67	S86/S6	S66
03H	-	S85/S5	S65	S84/S4	S64	S83/S3	S63	S82/S2	S62	S81/S1	S61
04H	-	S80	S60	S79	S59	S78	S58	S77	S57	S76	S56
05H	-	S75	S55	S74	S54	S73	S53	S72	S52	S71	S51
06H	-	S70	S50	S69	S49	S68	S48	S67	S47	S66	S46
07H	-	S65	S45	S64	S44	S63	S43	S62	S42	S61	S41
08H	-	S60	S40	S59	S39	S58	S38	S57	S37	S56	S36
09H	-	S55	S35	S54	S34	S53	S33	S52	S32	S51	S31
0AH	-	S50	S30	S49	S29	S48	S28	S47	S27	S46	S26
0BH	-	S45	S25	S44	S24	S43	S23	S42	S22	S41	S21
0CH	-	S40	S20	S39	S19	S38	S18	S37	S17	S36	S16
0DH	-	S35	S15	S34	S14	S33	S13	S32	S12	S31	S11
0EH	-	S30	S10	S29	S9	S28	S8	S27	S7	S26	S6
0FH	-	S25	S5	S24	S4	S23	S3	S22	S2	S21	S1

Table 6 ICON RAM map

■ Instructions

There are four categories of instructions that:

- Designate ST7036 functions, such as display format, data length, etc.
- Set internal RAM addresses
- Perform data transfer with internal RAM
- Others

➤ instruction table at “Normal mode”

(when “EXT” option pin connect to VDD, the instruction set follow below table)

Instruction	Instruction Code										Description	Instruction Execution Time			
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		OSC=380kHz	OSC=540kHz	OSC=700kHz	
Clear Display	0	0	0	0	0	0	0	0	0	1	Write "20H" to DDRAM. and set DDRAM address to "00H" from AC	1.08 ms	0.76 ms	0.59 ms	
Return Home	0	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.	1.08 ms	0.76 ms	0.59 ms
Entry Mode Set	0	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.	26.3 μs	18.5 μs	14.3 μs
Display ON/OFF	0	0	0	0	0	0	0	1	D	C	B	D=1:entire display on C=1:cursor on B=1:cursor position on	26.3 μs	18.5 μs	14.3 μs
Cursor or Display Shift	0	0	0	0	0	0	1	S/C	R/L	X	X	S/C and R/L: Set cursor moving and display shift control bit, and the direction, without changing DDRAM data.	26.3 μs	18.5 μs	14.3 μs
Function Set	0	0	0	0	0	1	DL	N	X	X	X	DL: interface data is 8/4 bits N: number of line is 2/1	26.3 μs	18.5 μs	14.3 μs
Set CGRAM	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address counter	26.3 μs	18.5 μs	14.3 μs	
Set DDRAM Address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in address counter	26.3 μs	18.5 μs	14.3 μs	
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	0	0	
Write Data to RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM)	26.3 μs	18.5 μs	14.3 μs	
Read Data from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM)	26.3 μs	18.5 μs	14.3 μs	

Note:

Be sure the ST7036 is not in the busy state (BF = 0) before sending an instruction from the MPU to the ST7036. If an instruction is sent without checking the busy flag, the time between the first instruction and next instruction will take much longer than the instruction time itself. Refer to Instruction Table for the list of each instruction execution time.

➤ instruction table at “Extension mode”

(when “EXT” option pin connect to VSS, the instruction set follow below table)

Instruction	Instruction Code										Description	Instruction Execution Time		
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		OSC=380kHz	OSC=540kHz	OSC=700kHz
Clear Display	0	0	0	0	0	0	0	0	0	1	Write "20H" to DDRAM. and set DDRAM address to "00H" from AC	1.08 ms	0.76 ms	0.59 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.	1.08 ms	0.76 ms	0.59 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.	26.3 μs	18.5 μs	14.3 μs
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	26.3 μs	18.5 μs	14.3 μs
Function Set	0	0	0	0	1	DL	N	DH	IS2	IS1	DL: interface data is 8/4 bits N: number of line is 2/1 DH: double height font IS[2:1]: instruction table select	26.3 μs	18.5 μs	14.3 μs
Set DDRAM Address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in address counter	26.3 μs	18.5 μs	14.3 μs
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	0	0
Write Data to RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM/ICONRAM)	26.3 μs	18.5 μs	14.3 μs
Read Data from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM/ICONRAM)	26.3 μs	18.5 μs	14.3 μs

Instruction table 0(IS[2:1]=[0,0])														
Cursor or Display Shift	0	0	0	0	0	1	S/C	R/L	X	X	S/C and R/L: Set cursor moving and display shift control bit, and the direction, without changing DDRAM data.	26.3 μs	18.5 μs	14.3 μs
Set CGRAM	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address counter	26.3 μs	18.5 μs	14.3 μs

Instruction table 1(IS[2:1]=[0,1])														
Bias Set	0	0	0	0	0	1	BS	1	0	FX	BS=1:1/4 bias BS=0:1/5 bias FX: fixed on high in 3-line application and fixed on low in other applications.	26.3 μs	18.5 μs	14.3 μs
Set ICON Address	0	0	0	1	0	0	AC3	AC2	AC1	AC0	Set ICON address in address counter.	26.3 μs	18.5 μs	14.3 μs
Power/ICON Control/ Contrast Set	0	0	0	1	0	1	Ion	Bon	C5	C4	Ion: ICON display on/off Bon: set booster circuit on/off C5,C4: Contrast set for internal follower mode.	26.3 μs	18.5 μs	14.3 μs
Follower Control	0	0	0	1	1	0	Fon	Rab2	Rab1	Rab0	Fon: set follower circuit on/off Rab2~0: select follower amplified ratio.	26.3 μs	18.5 μs	14.3 μs
Contrast Set	0	0	0	1	1	1	C3	C2	C1	C0	Contrast set for internal follower mode.	26.3 μs	18.5 μs	14.3 μs

Instruction table 2(IS[2:1]=[1,0])														
Double Height Position Select	0	0	0	0	0	1	UD	X	x	x	UD: Double height position select	26.3 μs	18.5 μs	14.3 μs
Reserved	0	0	0	1	X	X	X	X	X	X	Do not use (reserved for test)	26.3 μs	18.5 μs	14.3 μs

Instruction table 3(IS[2:1]=[1,1]):Do not use (reserved for test)

■ Instruction Description

- **Clear Display**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	0	0	1

Clear all the display data by writing "20H" (space code) to all DDRAM address, and set DDRAM address to "00H" into AC (address counter). Return cursor to the original status, namely, bring the cursor to the left edge on first line of the display. Make entry mode increment (I/D = "1").

- **Return Home**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	0	1	X

Return Home is cursor return home instruction. Set DDRAM address to "00H" into the address counter. Return cursor to its original site and return display to its original status, if shifted. Contents of DDRAM does not change.

- **Entry Mode Set**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	1	I/D	S

Set the moving direction of cursor and display.

- **I/D : Increment / decrement of DDRAM address (cursor or blink)**
 When I/D = "High", cursor/blink moves to right and DDRAM address is increased by 1.
 When I/D = "Low", cursor/blink moves to left and DDRAM address is decreased by 1.
 * CGRAM operates the same as DDRAM, when read from or write to CGRAM.
- **S: Shift of entire display**
 When DDRAM read (CGRAM read/write) operation or S = "Low", shift of entire display is not performed. If S = "High" and DDRAM write operation, shift of entire display is performed according to I/D value (I/D = "1" : shift left, I/D = "0" : shift right).

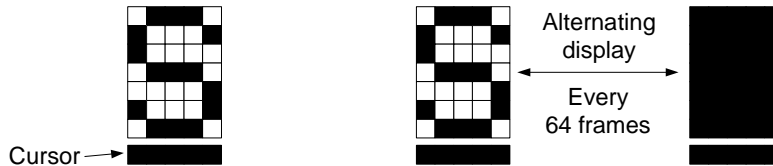
S	I/D	Description
H	H	Shift the display to the left
H	L	Shift the display to the right

● **Display ON/OFF**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	1	D	C	B

Control display/cursor/blink ON/OFF 1 bit register.

- **D : Display ON/OFF control bit**
When D = "High", entire display is turned on.
When D = "Low", display is turned off, but display data is remained in DDRAM.
- **C : Cursor ON/OFF control bit**
When C = "High", cursor is turned on.
When C = "Low", cursor is disappeared in current display, but I/D register remains its data.
- **B : Cursor Blink ON/OFF control bit**
When B = "High", cursor blink is on, that performs alternate between all the high data and display character at the cursor position.
When B = "Low", blink is off.



● **Cursor or Display Shift**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	1	S/C	R/L	X	X

- **S/C: Screen/Cursor select bit**
When S/C="High", Screen is controlled by R/L bit.
When S/C="Low", Cursor is controlled by R/L bit.
 - **R/L: Right/Left**
When R/L="High", set direction to right.
When R/L="Low", set direction to left.
- Without writing or reading of display data, shift right/left cursor position or display. This instruction is used to correct or search display data. During 2-line mode display, cursor moves to the 2nd line after 40th digit of 1st line. Note that display shift is performed simultaneously in all the line. When displayed data is shifted repeatedly, each line shifted individually. When display shift is performed, the contents of address counter are not changed.

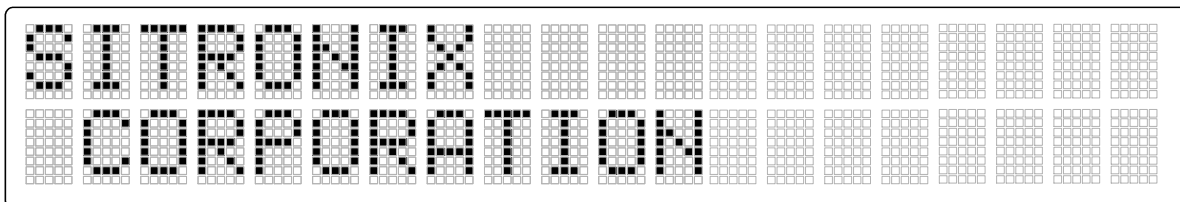
S/C	R/L	Description	AC Value
L	L	Shift cursor to the left	AC=AC-1
L	H	Shift cursor to the right	AC=AC+1
H	L	Shift display to the left. Cursor follows the display shift	AC=AC
H	H	Shift display to the right. Cursor follows the display shift	AC=AC

● **Function Set**

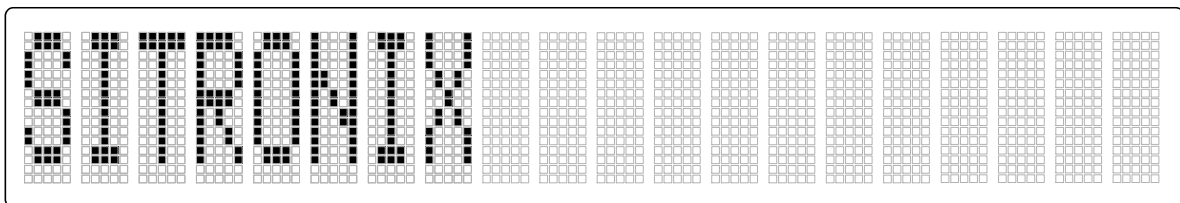
RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	DL	N	DH	IS2	IS1

- **DL : Interface data length control bit**
 When DL = "High", it means 8-bit bus mode with MPU.
 When DL = "Low", it means 4-bit bus mode with MPU. So to speak, DL is a signal to select 8-bit or 4-bit bus mode.
 When 4-bit bus mode, it needs to transfer 4-bit data by two times.
- **N : Display line number control bit**
 When N = "High", 2-line display mode is set.
 When N = "Low", it means 1-line display mode.
 When "N3" option pin connect to VDD, N must set "N=1".
- **DH : Double height font type control bit**
 When DH = " High " and N= "Low", display font is selected to double height mode(5x16 dot),RAM address can only use 00H~27H.
 When DH= "High" and N= "High", it is forbidden.
 When DH = " Low ", display font is normal (5x8 dot).

N	DH	EXT option pin connect to high		EXT option pin connect to low	
		Display Lines	Character Font	Display Lines	Character Font
L	L	1	5x8	1	5x8
L	H	1	5x8	1	5x16
H	L	2	5x8	2	5x8
H	H	2	5x8	Forbidden	



2 line mode normal display (DH=0/N=1)



1 line mode with double height font (DH=1/N=0)

➤ **IS[2:1]: instruction table select**

When IS[2:1]=(0,0): normal instruction be selected(refer instruction table 0)

When IS[2:1]=(0,1):extension instruction be selected(refer instruction table 1)

When IS[2:1]=(1,0):extension instruction be selected(refer instruction table 2)

When IS[2:1]=(1,1):Do not use (reserved for test)

● **Double height position set: IS[2:1]=(1,0)**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	1	UD	X	X	X

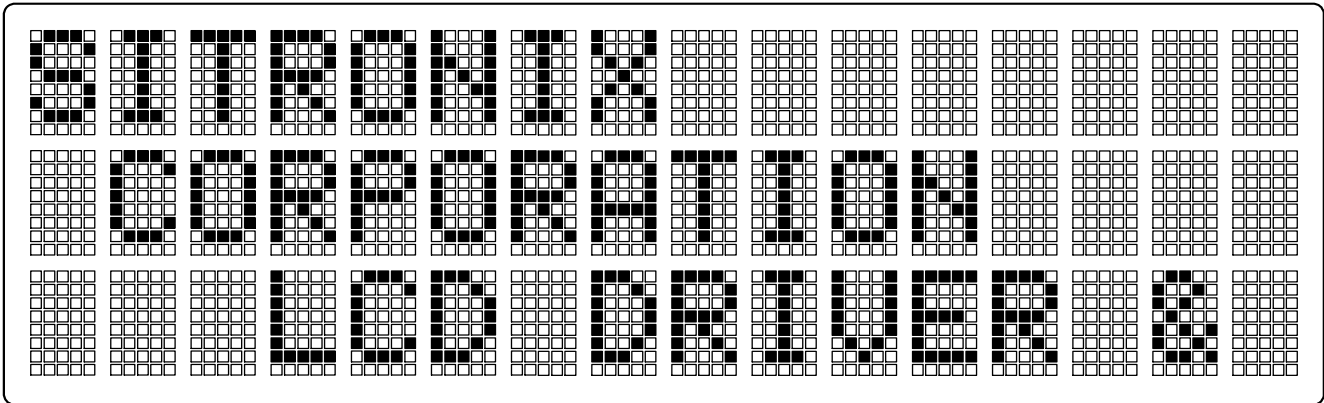
➤ **UD: Select double height font display position of screen.(N3=VDD)**

When UD = "High", double height font is show on Com1~Com16.

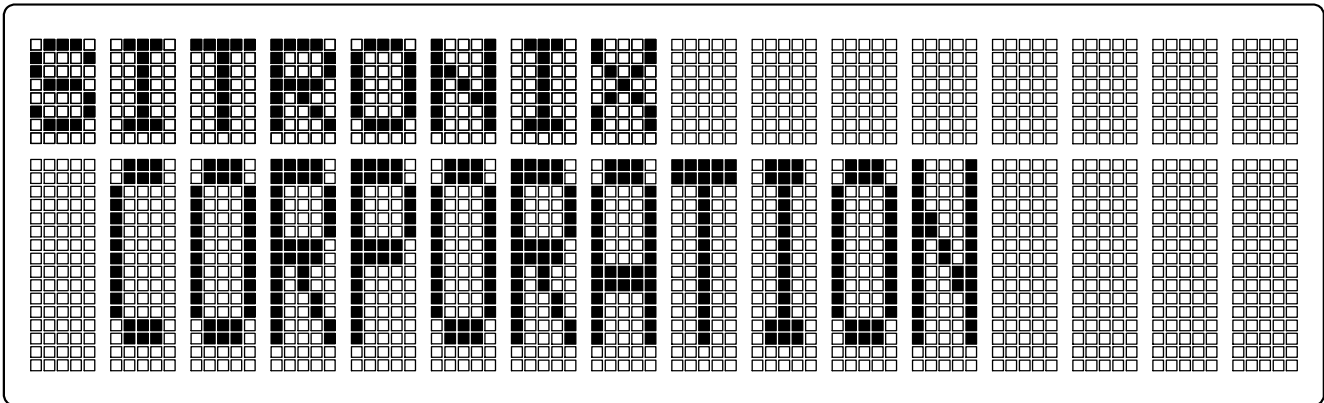
RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	0	0	AC3	AC2	AC1	AC0

When UD = "Low", double height font is show on Com9~Com24.

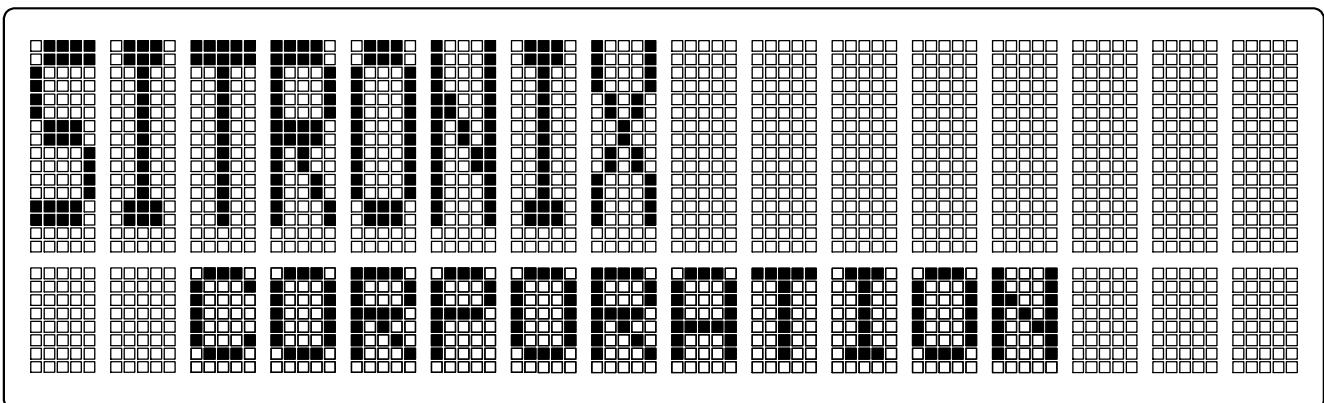
DH	UD	2 LINES(N3=VSS)	3 LINES(N3=VDD)
H	H	Com1~Com16 Double Height	Com1~Com16 Double Height Com17~Com24 Normal Display
H	L	Com1~Com16 Double Height	Com1~Com8 Normal Display Com9~Com24 Double Height
L	X	Normal Display	Normal Display



3 Line mode normal display (DH = 0 / N = 1 / UD = don't care)



COM1 ..8 is normal , COM9 .. 24 is a double height font (DH = 1 / N = 1 / UD = 0)



COM17 ..24 is normal , COM1 .. 16 is a double height font (DH = 1 / N = 1 / UD = 1)

● **Set CGRAM Address**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0

Set CGRAM address to AC.

This instruction makes CGRAM data available from MPU.

● **Set DDRAM Address**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0

Set DDRAM address to AC.

This instruction makes DDRAM data available from MPU.

When 1-line display mode (N = 0), DDRAM address is from "00H" to "4FH".

In 2-line display mode (N = 1), DDRAM address in the 1st line is from "00H" to "27H", and DDRAM address in the 2nd line is from "40H" to "67H".

In 3-line display mode (N3=1, N=1), DDRAM address in the 1st line is from "00H" to "0FH", DDRAM in the 2nd line is from "10H" to "1FH", and DDRAM in the 3rd line is from "20H" to "2FH".

● **Read Busy Flag and Address**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0

When BF = "High", indicates that the internal operation is being processed. So during this time the next instruction cannot be accepted.

The address Counter (AC) stores DDRAM/CGRAM addresses, transferred from IR.

After writing into (reading from) DDRAM/CGRAM, AC is automatically increased (decreased) by 1.

● **Write Data to CGRAM,DDRAM or ICON RAM**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	0	D7	D6	D5	D4	D3	D2	D1	D0

Write binary 8-bit data to **CGRAM,DDRAM or ICON RAM**

The selection of RAM from DDRAM, CGRAM or ICON RAM, is set by the previous address set instruction : DDRAM address set, CGRAM address set, ICON RAM address set. RAM set instruction can also determine the AC

direction to RAM.

After write operation, the address is automatically increased/decreased by 1, according to the entry mode.

● Read Data from CGRAM,DDRAM or ICON RAM

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	1	D7	D6	D5	D4	D3	D2	D1	D0

Read binary 8-bit data from DDRAM/CGRAM./ICON RAM

The selection of RAM is set by the previous address set instruction. If address set instruction of RAM is not performed before this instruction, the data that read first is invalid, because the direction of AC is not determined. If you read RAM data several times without RAM address set instruction before read operation, you can get correct RAM data from the second, but the first data would be incorrect, because there is no time margin to transfer RAM data.

● Bias Set

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	1	BS	1	0	FX

➤ **BS: bias selection**

When BS="High", the bias will be 1/4

When BS="Low", the bias will be 1/5

BS will be invalid when external bias resistors are used(OPF1=1,OPF2=1)

➤ **FX:** must be fixed on high in 3-line application and fixed on low in other applications.

● Set ICON RAM address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	0	0	AC3	AC2	AC1	AC0

Set ICON RAM address to AC.

This instruction makes ICON data available from MPU.

When IS=1 at Extension mode,

The ICON RAM address is from "00H" to "0FH".

● **Power/ICON control/Contrast set(high byte)**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	0	1	ION	BON	C5	C4

➤ **Ion: set ICON display on/off**

When Ion = "High", ICON display on.

When Ion = "Low", ICON display off.

➤ **Bon: switch booster circuit**

Bon can only be set when internal follower is used (OPF1=0,OPF2=0).

When Bon = "High", booster circuit is turn on.

When Bon = "Low", booster circuit is turn off.

➤ **C5,C4 : Contrast set(high byte)**

C5,C4,C3,C2,C1,C0 can only be set when internal follower is used (OPF1=0,OPF2=0).They can more precisely adjust the input reference voltage of V0 generator. The details please refer to the supply voltage for LCD driver.

● **Follower control**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	1	0	FON	Rab 2	Rab 1	Rab 0

➤ **Fon: switch follower circuit**

Fon can only be set when internal follower is used (OPF1=0,OPF2=0).

When Fon = "High", internal follower circuit is turn on.

When Fon = "Low", internal follower circuit is turn off.

Note that Fon must be set to "Low" if (OPF1, OPF2) is not (0,0).

➤ **Rab2,Rab1,Rab0 : V0 generator amplified ratio**

Rab2,Rab1,Rab0 can only be set when internal follower is used (OPF1=0,OPF2=0).They can adjust the amplified ratio of V0 generator. The details please refer to the supply voltage for LCD driver.

● **Contrast set(low byte)**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	1	1	C3	C2	C1	C0

➤ **C3,C2,C1,C0:Contrast set(low byte)**

C5,C4,C3,C2,C1,C0 can only be set when internal follower is used (OPF1=0,OPF2=0).They can more precisely adjust the input reference voltage of V0 generator. The details please refer to the supply voltage for LCD driver.

■ Reset Function

Initializing by Internal Reset Circuit

An internal reset circuit automatically initializes the ST7036 when the power is turned on. The following instructions are executed during the initialization. The busy flag (BF) is kept in the busy state (BF = 1) until the initialization ends. The busy state lasts for 40 ms after VDD rises to stable.

1. Display clear
2. Function set:
 - DL = 1; 8-bit interface data
 - N = 0; 1-line display
 - DH=0; normal 5x8 font
 - IS[2:1]=(0,0); use instruction table 0
3. Display on/off control:
 - D = 0; Display off
 - C = 0; Cursor off
 - B = 0; Blinking off
4. Entry mode set:
 - I/D = 1; Increment by 1
 - S = 0; No shift
5. 3 line: FX=1
1/2 line: FX=0
6. ICON control
 - Ion=0; ICON off
7. Power control
 - BS=0; 1/5bias
 - Bon=0; booster off
 - Fon=0; follower off
 - (C5,C4,C3,C2,C1,C0)=(1,0,0,0,0,0)
 - (Rab2,Rab1,Rab0)=(0,1,0)
8. Double Height Position Select
 - UD=0, double height font is show on Com9~Com24.

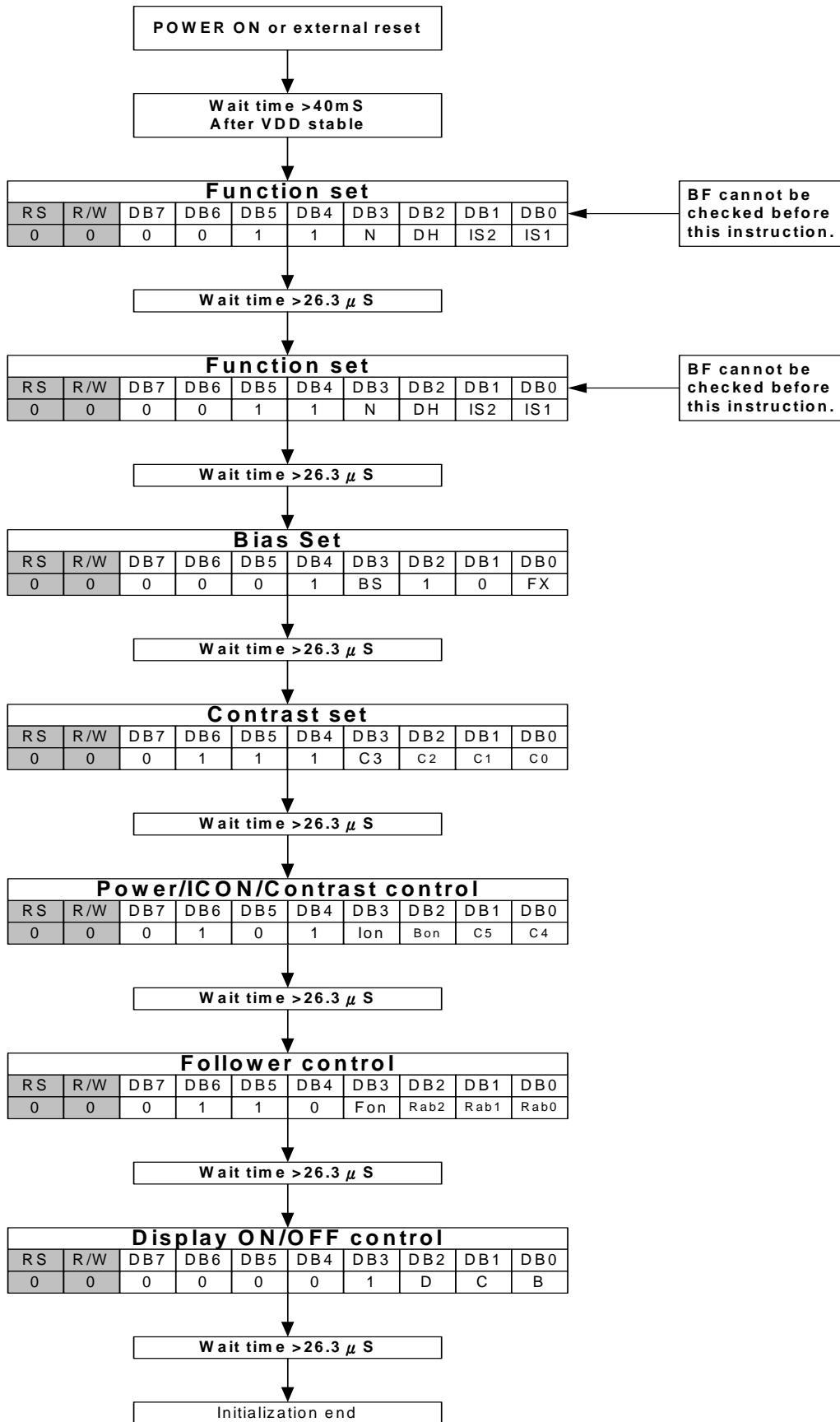
Note:

If the electrical characteristics conditions listed under the table Power Supply Conditions Using Internal Reset Circuit are not met, the internal reset circuit will not operate normally and will fail to initialize the ST7036.

When internal Reset Circuit not operate, ST7036 can be reset by XRESET pin from MPU control signal.

■ Initializing by Instruction

- 8-bit Interface (fosc=380kHz)



➤ **Initial Program Code Example For 8051 MPU(8 Bit Interface):**

```

;-----
INITIAL_START:
    CALL  DELAY40mS
    MOV   A,#38H           ;FUNCTION SET
    CALL  WRINS_NOCHK     ;8 bit, N=1,5*7dot
    CALL  DELAY30uS
    MOV   A,#38H           ;FUNCTION SET
    CALL  WRINS_NOCHK     ;8 bit, N=1,5*7dot
    CALL  DELAY30uS
    MOV   A,#14H          ;set bias
    CALL  WRINS_CHK
    CALL  DELAY30uS
    MOV   A,#78H          ;Contrast set adjustment
    CALL  WRINS_CHK
    CALL  DELAY30uS
    MOV   A,#5EH          ;Power/ICON/Contrast control
    CALL  WRINS_CHK
    CALL  DELAY30uS
    MOV   A,#6AH          ;Follower control
    CALL  WRINS_CHK
    CALL  DELAY30uS
    MOV   A,#0CH          ;DISPLAY ON
    CALL  WRINS_CHK
    CALL  DELAY30uS
    MOV   A,#01H          ;CLEAR DISPLAY
    CALL  WRINS_CHK
    CALL  DELAY2mS
    MOV   A,#06H          ;ENTRY MODE SET
    CALL  WRINS_CHK       ;CURSOR MOVES TO RIGHT
    CALL  DELAY30uS

```

```

;-----
MAIN_START:
    XXXX
    XXXX
    XXXX
    XXXX

```

```

;-----
WRINS_CHK:
    CALL  CHK_BUSY
WRINS_NOCHK:
    CLR   RS               ;EX: Port 3.0
    CLR   RW               ;EX: Port 3.1
    SETB  E                ;EX:Port 3.2
    MOV   P1,A             ;EX:Port 1=Data Bus
    CLR   E
    MOV   P1,#FFH         ;For Check Busy Flag
    RET

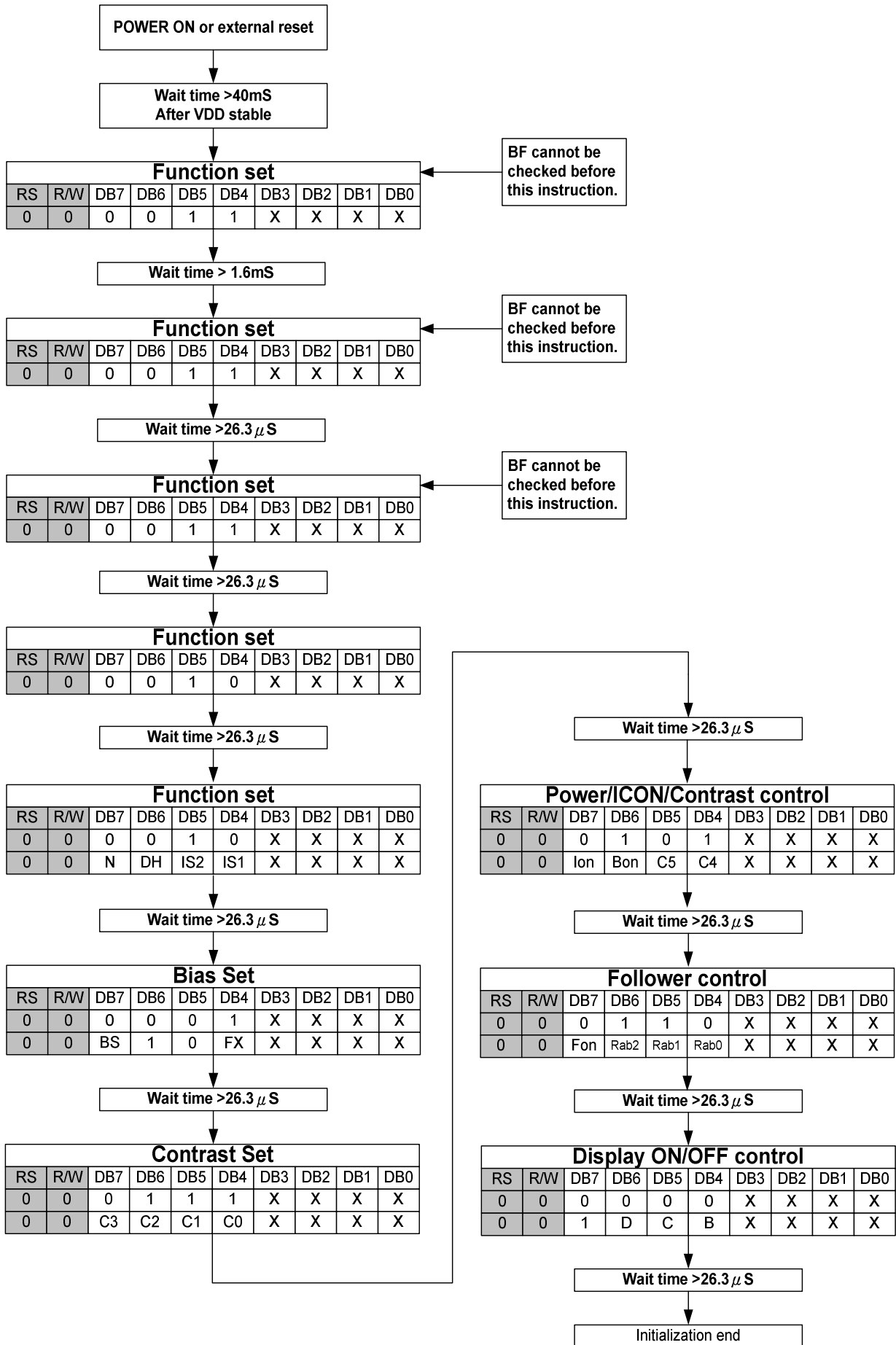
```

```

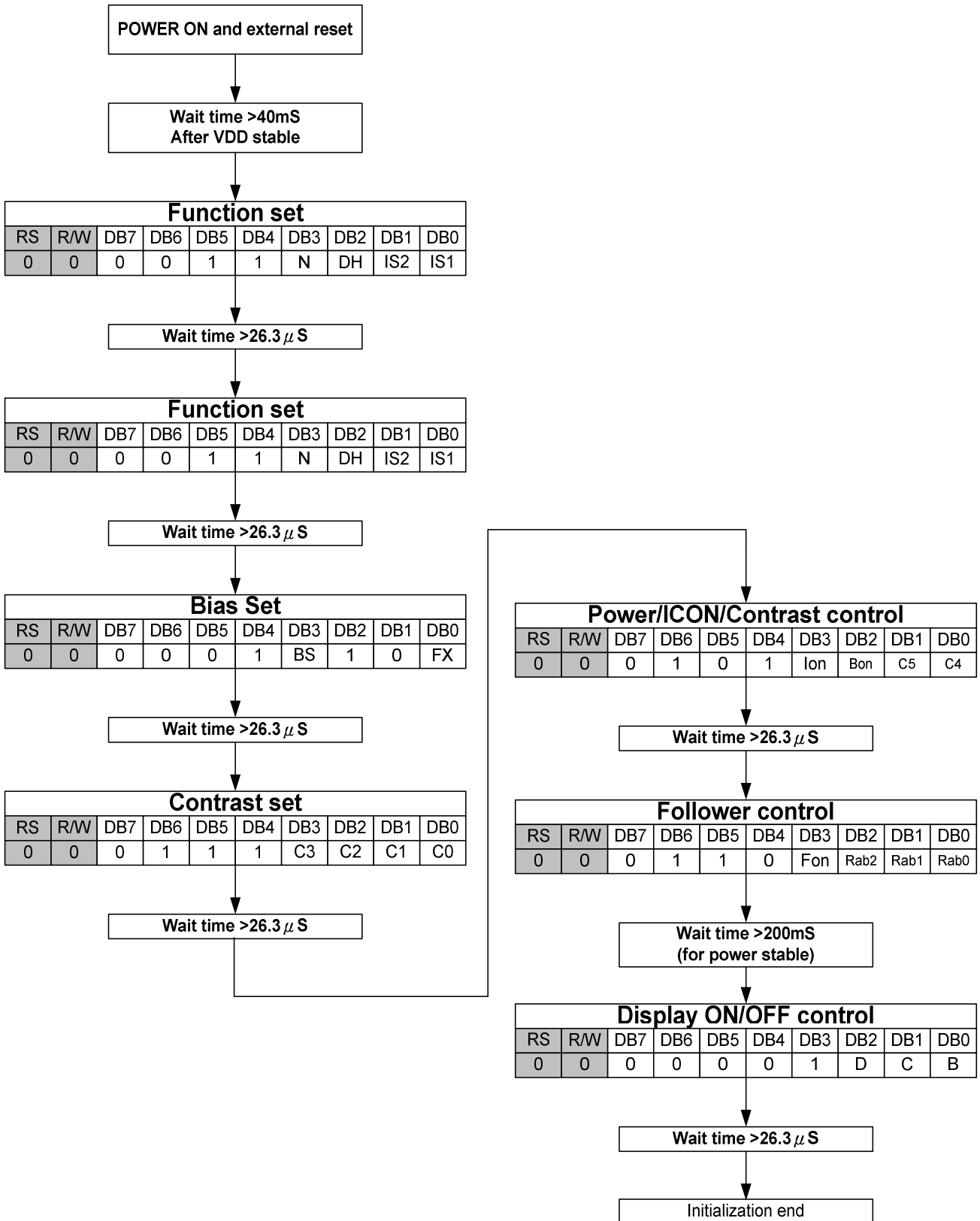
;-----
CHK_BUSY:                               ;Check Busy Flag
    CLR   RS
    SETB  RW
    SETB  E
    JB    P1.7,$
    CLR   E
    RET

```

● 4-bit Interface (fosc=380kHz)



● Serial interface & IIC interface (fosc = 380kHz)



➤ **Initial Program Code Example For 8051 MPU (Serial Interface) :**

INITIAL_START:

```

CALL  HARDWARE_RESET
CALL  DELAY40mS
MOV   A,#38H           ;FUNCTION SET
CALL  WRINS_NOCHK     ;8 bit, N=1,5*7dot
CALL  DELAY30uS
MOV   A,#39H           ;FUNCTION SET
CALL  WRINS_NOCHK     ;8 bit, N=1,5*7dot,IS=1
CALL  DELAY30uS
MOV   A,#14H           ;bias
CALL  WRINS_NOCHK
CALL  DELAY30uS
MOV   A,#78H           ;Contrast set
CALL  WRINS_NOCHK
CALL  DELAY30uS
MOV   A,#5EH           ;Power/ICON/Contrast control
CALL  WRINS_NOCHK
CALL  DELAY30uS
MOV   A,#6AH           ;Follower control
CALL  WRINS_NOCHK
CALL  DELAY200mS      ;for power stable
MOV   A,#0CH           ;DISPLAY ON
CALL  WRINS_NOCHK
CALL  DELAY30uS
MOV   A,#01H           ;CLEAR DISPLAY
CALL  WRINS_NOCHK
CALL  DELAY2mS
MOV   A,#06H           ;ENTRY MODE SET
CALL  WRINS_NOCHK    ;CURSOR MOVES TO RIGHT
CALL  DELAY30uS

```

MAIN_START:

```

XXXX
XXXX
XXXX
XXXX
.
.
.

```

WRINS_NOCHK:

```

PUSH  1
MOV   R1,#8
CLR   RS
$1
RLC   A
MOV   SI,C
SETB  SCL
NOP
CLR   SCL
DJNZ  R1,$1
POP   1

CALL  DLY1.5mS
RET

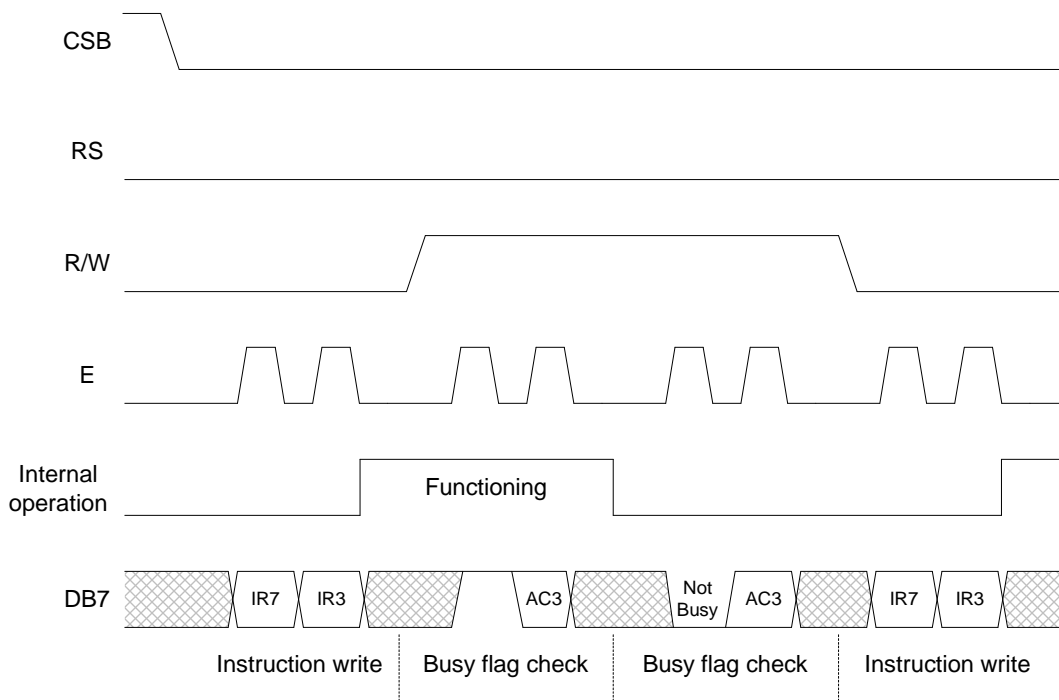
```

■ Interfacing to the MPU

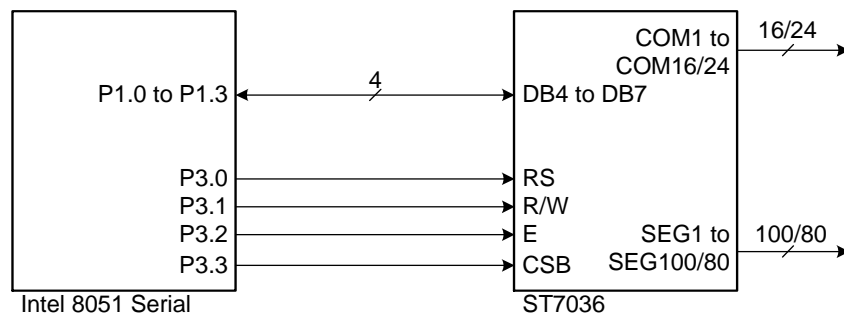
The ST7036 can send data in two 4-bit operations/one 8-bit operation, serial 1 bit operation or fast I²C operation, thus allowing interfacing with 4-bit, 8-bit or I²C MPU.

- **For 4-bit interface data, only four bus lines (DB4 to DB7) are used for transfer.** Bus lines DB0 to DB3 are disabled. The data transfer between the ST7036 and the MPU is completed after the 4-bit data has been transferred twice. As for the order of data transfer, the four high order bits (for 8-bit operation, DB4 to DB7) are transferred before the four low order bits (for 8-bit operation, DB0 to DB3). The busy flag must be checked (one instruction) after the 4-bit data has been transferred twice. Two more 4-bit operations then transfer the busy flag and address counter data.

➤ Example of busy flag check timing sequence

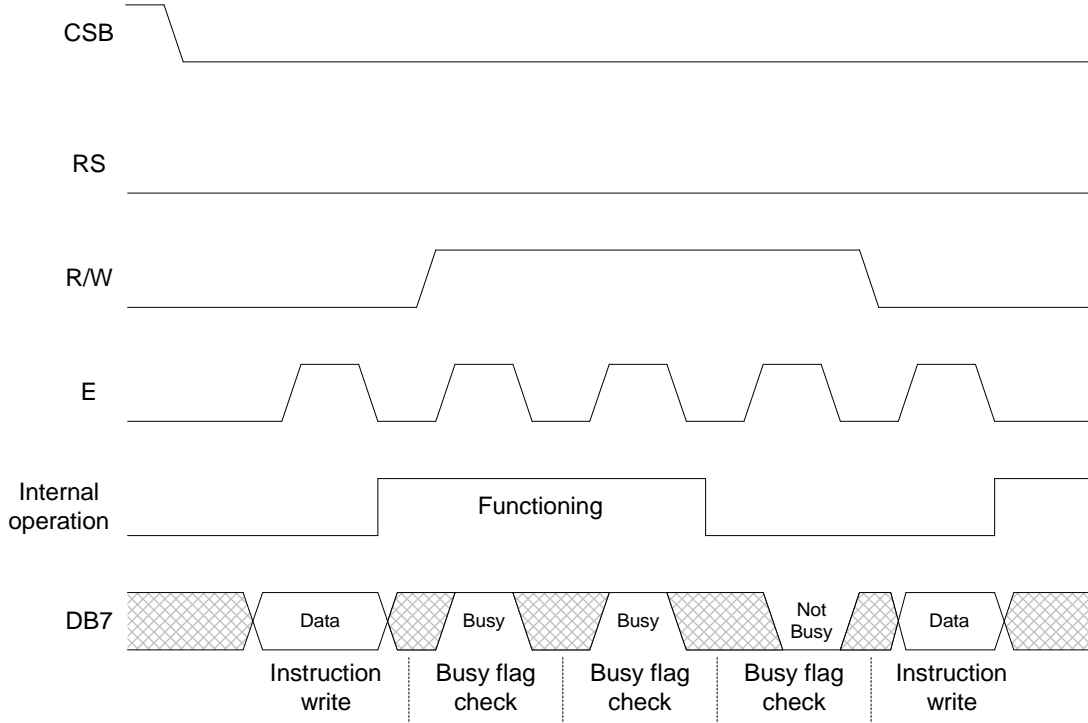


➤ Intel 8051 interface(4 Bit)

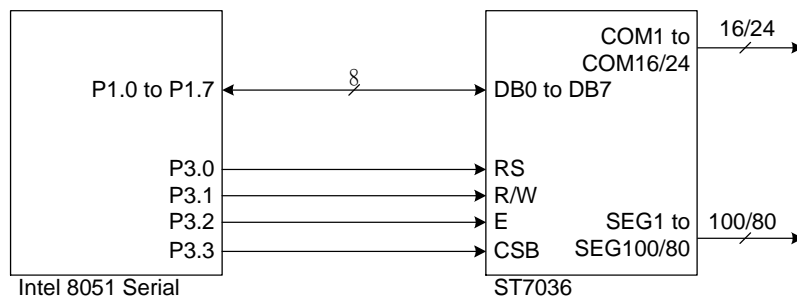


- For 8-bit interface data, all eight bus lines (DB0 to DB7) are used.

➤ Example of busy flag check timing sequence

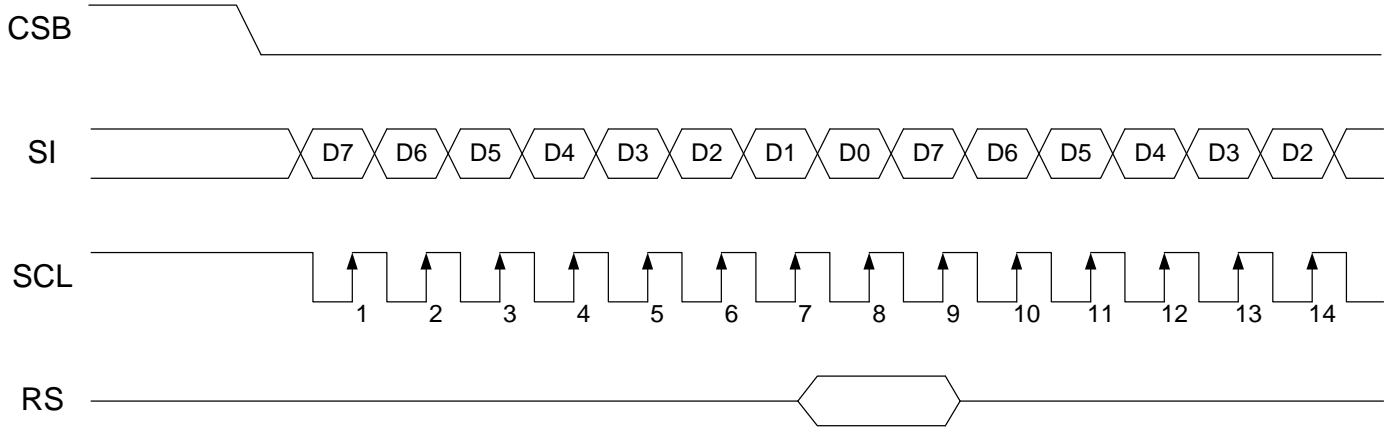


➤ Intel 8051 interface(8 Bit)

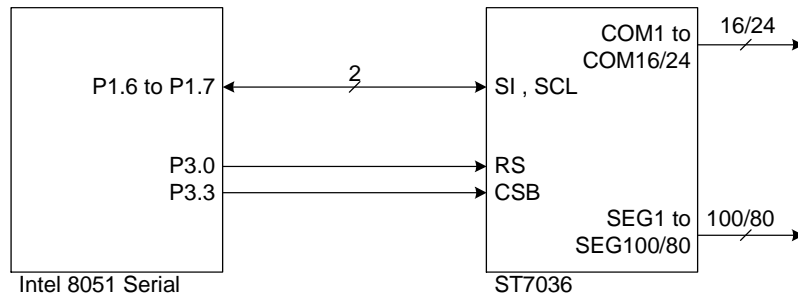


- For serial interface data, only two bus lines (DB6 to DB7) are used.

➤ Example of timing sequence

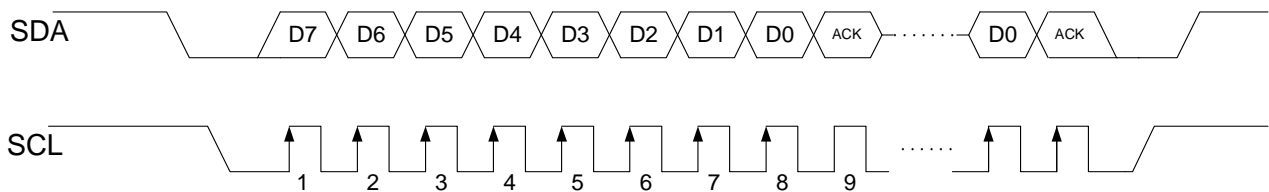


➤ Intel 8051 interface (Serial 4-line)

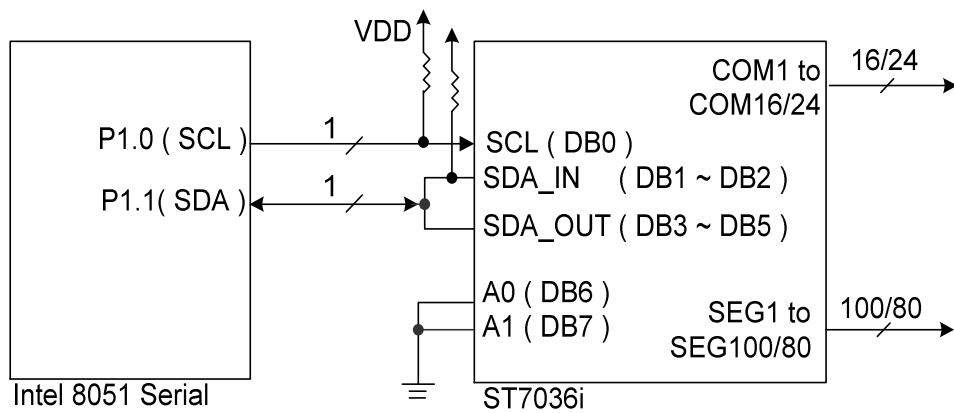


- For I²C interface data, all eight bus lines (DB0 to DB7) are used.

➤ Example of timing sequence

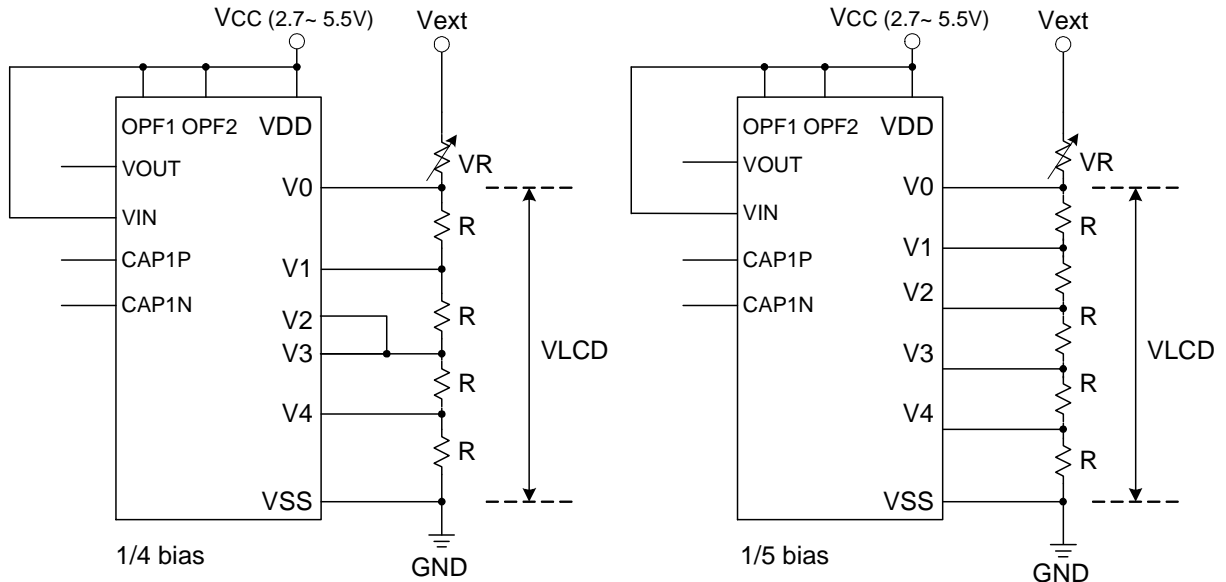


➤ Intel 8051 interface (I²C interface)

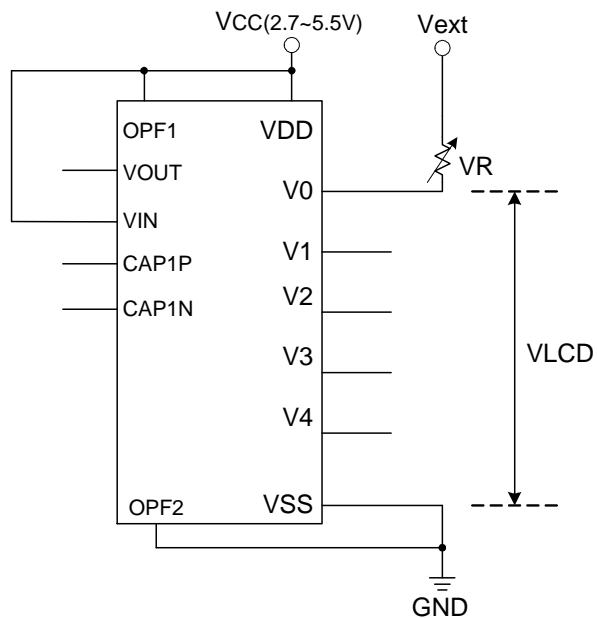


Supply Voltage for LCD Drive

- When external bias resistors are used
(OPF1=1,OPF2=1)

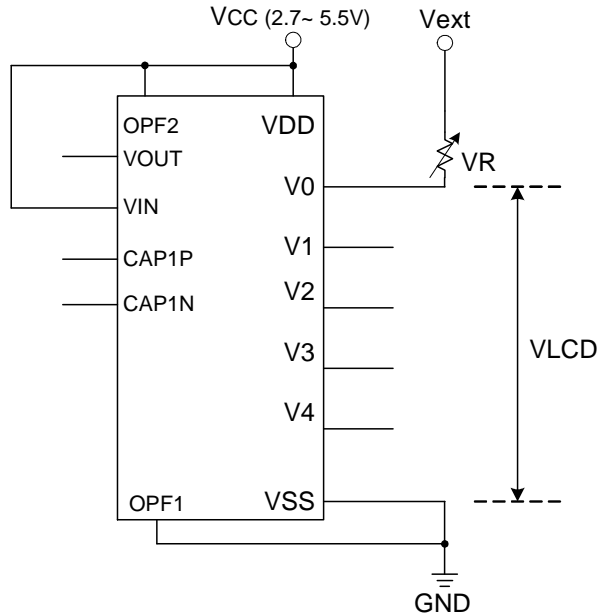


- When built-in bias resistors(9.6KΩ) are used
(OPF1=1,OPF2=0)



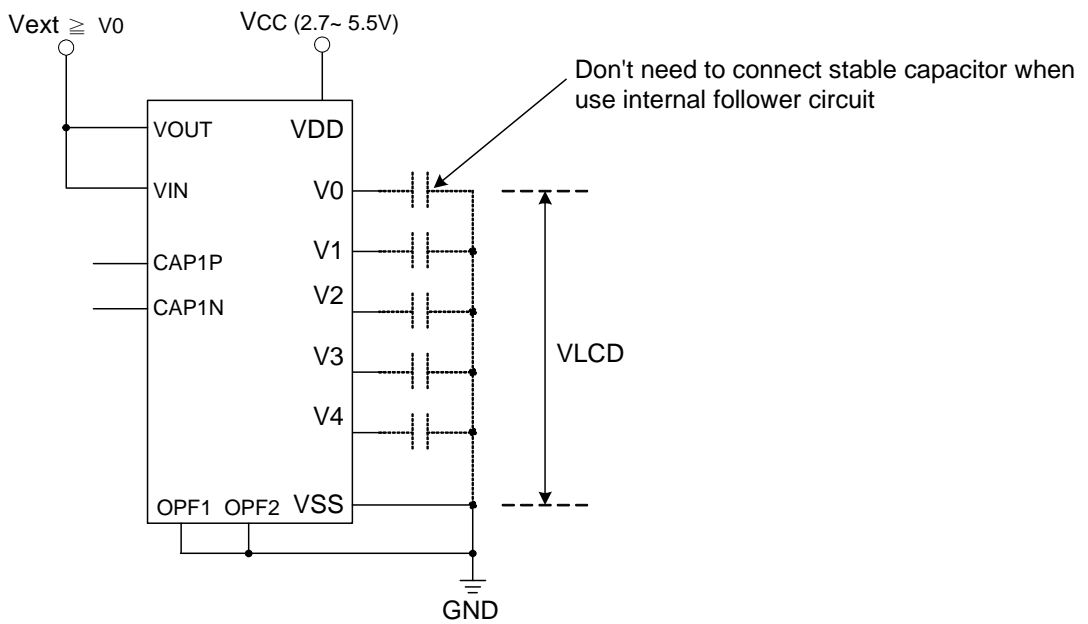
Note: Do not use built-in booster while built-in bias resistors are used.

- When built-in bias resistors(3.3KΩ) are used
(OPF1=0,OPF2=1)

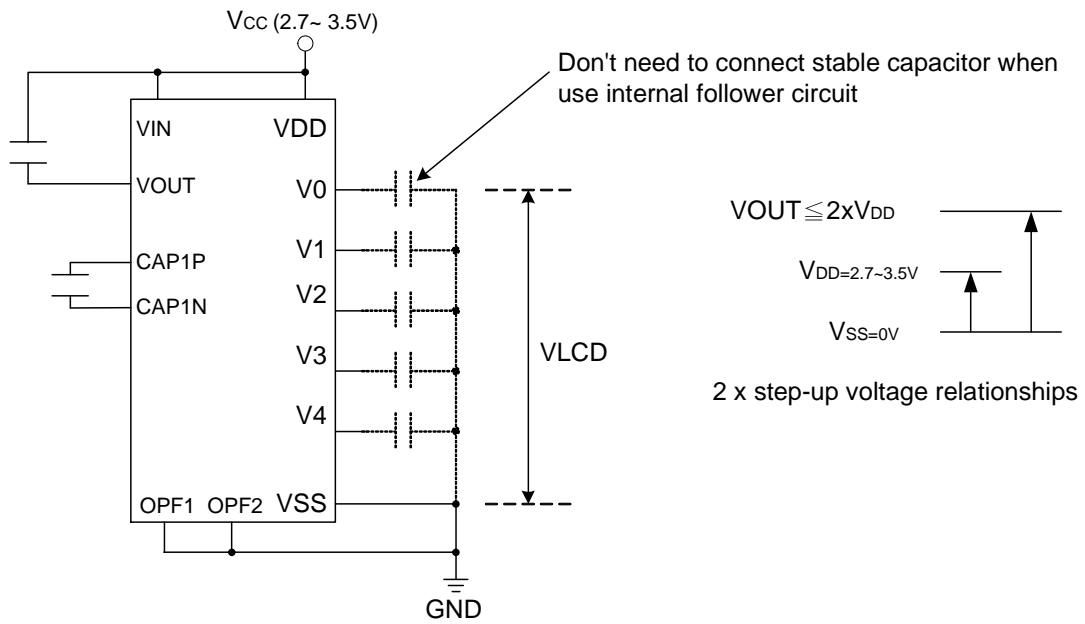


Note: Do not use built-in booster while built-in bias resistors are used.

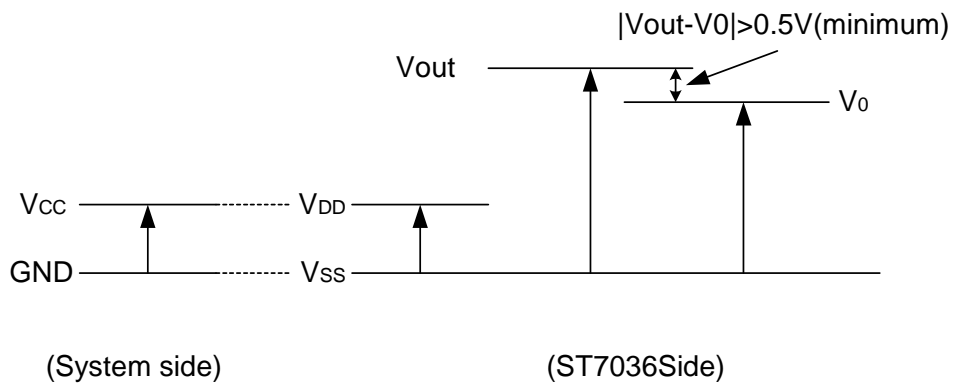
- When built-in voltage followers with external Vout are used
(OPF1=0,OPF2=0 and instruction setting Bon=0,Fon=1)



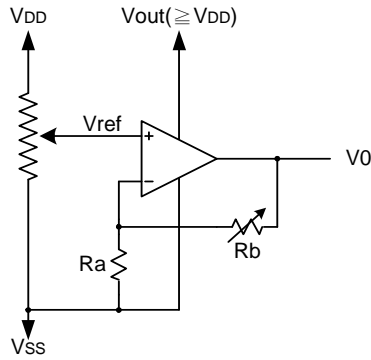
- When built-in booster and voltage followers are used(OPF1=0,OPF2=0)



Note:
Ensure V0 level stable, that must let $|V_{out}-V_0|$ over 0.5V(if panel size over 4.5",the $|V_{out}-V_0|$ propose over 0.8V).



➤ **V0 voltage follower value calculation**

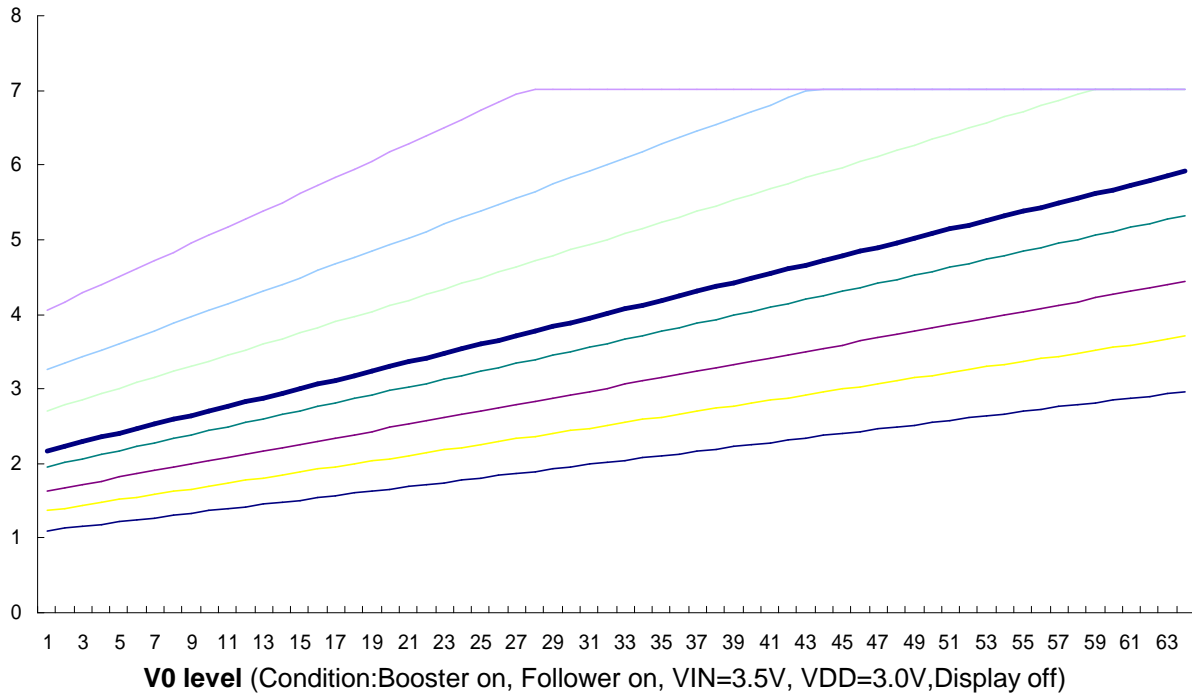


$$V0 = \left(1 + \frac{Rb}{Ra}\right) \times Vref$$

While $Vref = VDD \times \left(\frac{\alpha + 36}{100}\right)$

C5	C4	C3	C2	C1	C0	α
0	0	0	0	0	0	0
0	0	0	0	0	1	1
0	0	0	0	1	0	2
		:				:
		:				:
1	1	1	1	0	1	61
1	1	1	1	1	0	62
1	1	1	1	1	1	63

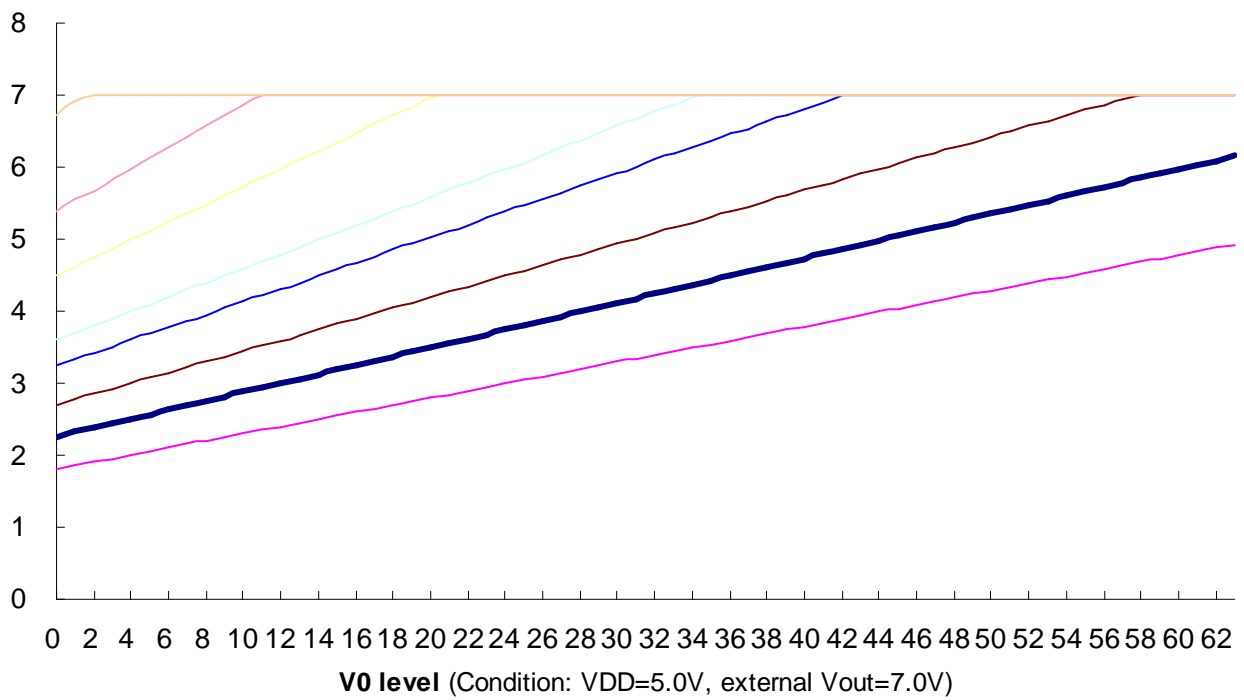
Rab2	Rab1	Rab0	$1 + Rb/Ra$
0	0	0	1
0	0	1	1.25
0	1	0	1.5
0	1	1	1.8
1	0	0	2
1	0	1	2.5
1	1	0	3
1	1	1	3.75



The recommended curve: follower = 04H

Notes:

1. $Vout \geq V0 \geq V1 \geq V2 \geq V3 \geq V4 \geq Vss$ must be maintained.
2. If the calculation value of V0 is higher than Vout, the real V0 value will saturate to Vout.
3. internal built-in booster can only be used when OPF1=0, OPF2=0.



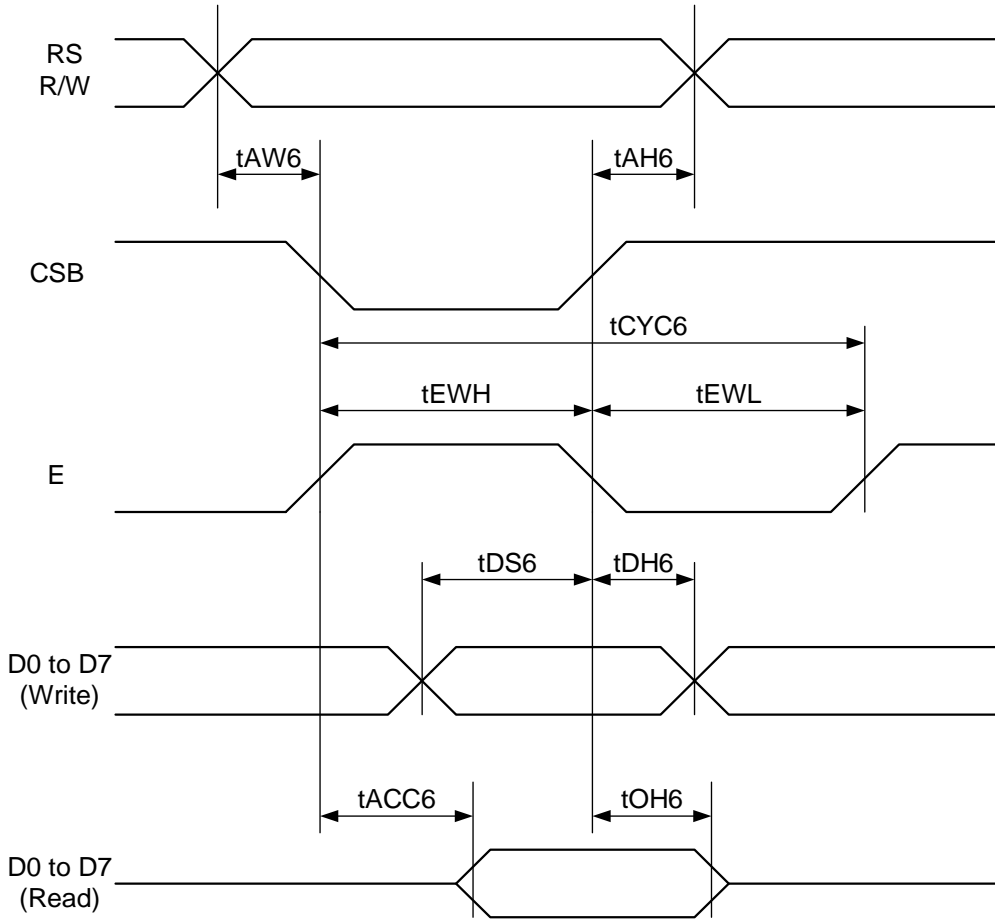
The recommended curve: followe=01H

Notes:

1. $V_{out} \geq V_0 \geq V_1 \geq V_2 \geq V_3 \geq V_4 \geq V_{ss}$ must be maintained.
2. If the calculation value of V_0 is higher than V_{out} , the real V_0 value will saturate to V_{out} .
3. internal built-in booster can only be used when $OPF1=0, OPF2=0$.

■ AC Characteristics

● 68 Interface

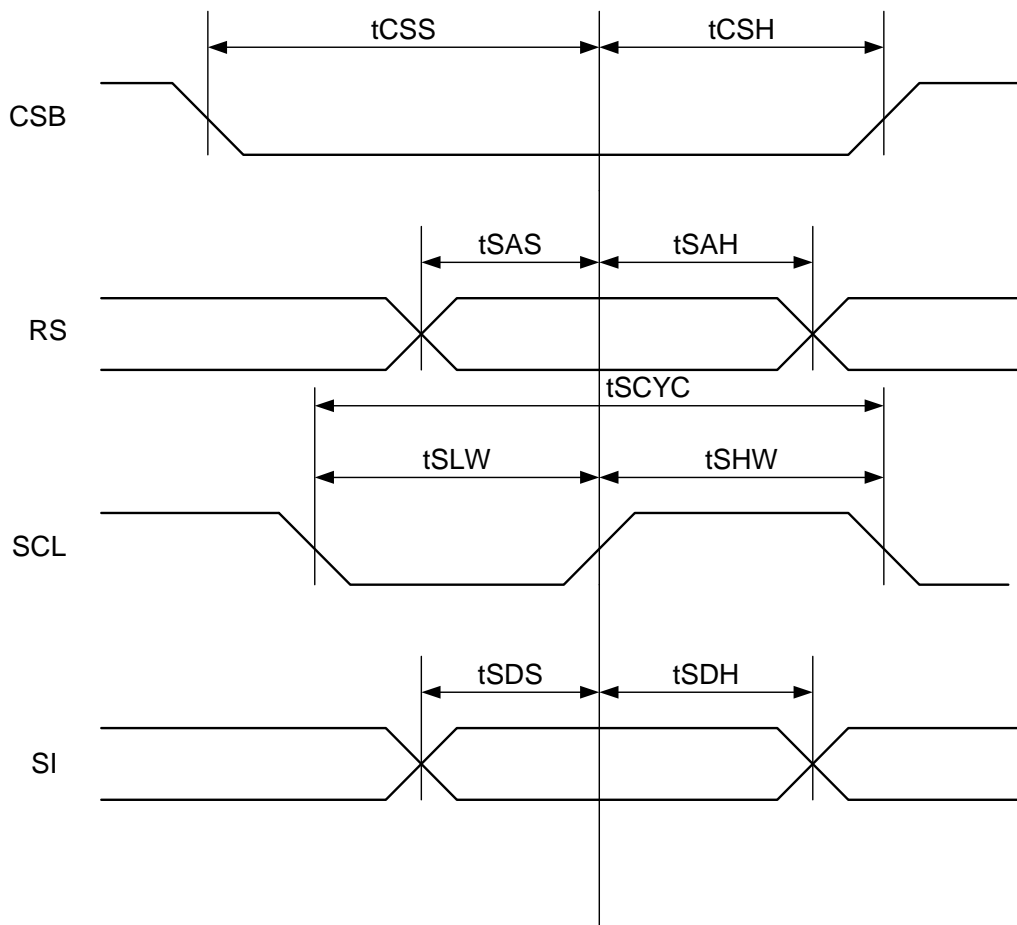


(Ta = -35°C to 85°C)

Item	Signal	Symbol	Condition	VDD=2.7 to 4.5V Rating		VDD=4.5 to 5.5V Rating		Units
				Min.	Max.	Min.	Max.	
Address hold time	RS	t_{AH6}	—	20	-	20	-	ns
Address setup time	RS	t_{AW6}		20	-	20	-	
System cycle time	RS	t_{CYC6}	—	400	-	280	-	ns
Data setup time	D0 to D7	t_{DS6}	—	100	-	80	-	ns
Data hold time	D0 to D7	t_{DH6}		40	-	20	-	
Access time	D0 to D7	t_{ACC6}	CL = 100 pF	-	500	-	400	ns
Output disable time	D0 to D7	t_{OH6}		300	-	150	-	
Enable H pulse time	E	t_{EWH}	—	200	-	120	-	ns
Enable L pulse time	E	t_{EWL}	—	150	-	130	-	ns

Note: All timing is specified using 20% and 80% of VDD as the reference.

● Serial Interface

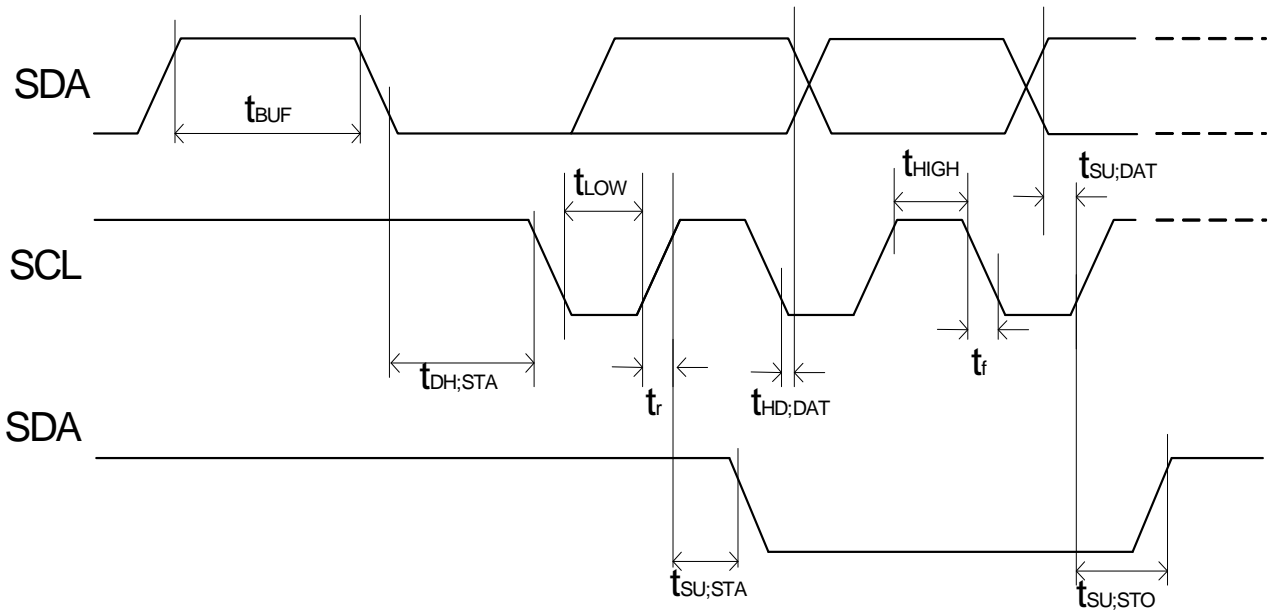


(Ta = -35°C to 85°C)

Item	Signal	Symbol	Condition	VDD=2.7 to 4.5V Rating		VDD=4.5 to 5.5V Rating		Units
				Min.	Max.	Min.	Max.	
Serial Clock Period	SCL	tSCYC	—	200	-	100	-	ns
SCL "H" pulse width		tSHW		20	-	20	-	
SCL "L" pulse width		tSLW		160	-	120	-	
Address setup time	RS	tsAS	—	10	-	10	-	ns
Address hold time		tSAH		250	-	150	-	
Data setup time	SI	tSDS	—	10	-	10	-	ns
Data hold time		tSDH		10	-	20	-	
CS-SCL time	CS	tCSS	—	20	-	20	-	ns
		tCSH		350	-	200	-	

*1 All timing is specified using 20% and 80% of VDD as the standard.

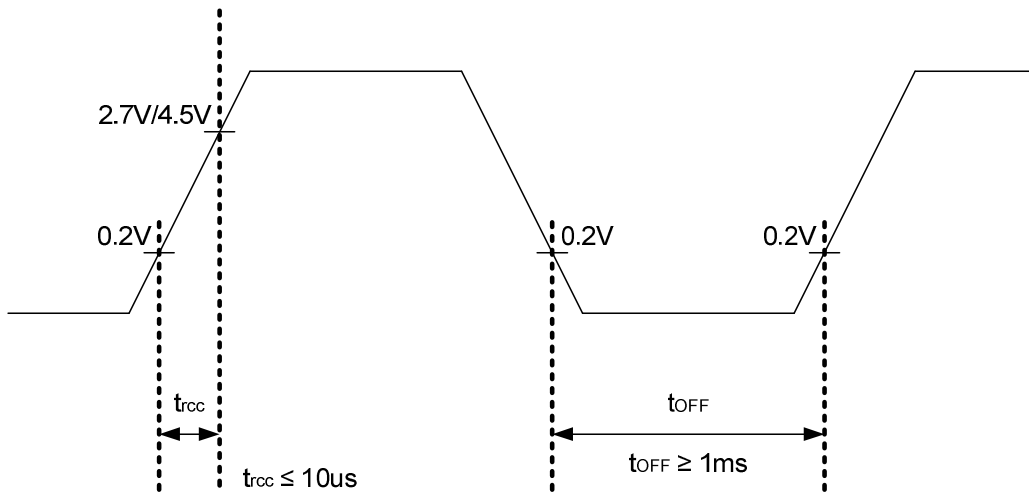
● I2C interface



(Ta = -35°C to 85°C)

Item	Signal	Symbol	Condition	VDD=2.7 to 4.5V Rating		VDD=4.5 to 5.5V Rating		Units
				Min.	Max.	Min.	Max.	
SCL clock frequency	SCL	f_{SCLK}	—	DC	300K	DC	400	kHz
SCL clock low period		t_{LOW}	—	2.5	—	1.3	—	μ s
SCL clock high period		t_{HIGH}	—	0.6	—	0.6	—	
Data set-up time	SDA	$t_{SU;DAT}$	—	1800	—	700	—	ns
Data hold time		$t_{HD;DAT}$	—	0	—	0	0.5	μ s
SCL,SDA rise time	SCL, SDA	t_r	—	20+0.1C _b	300	20+0.1C _b	300	ns
SCL,SDA fall time		t_f	—	20+0.1C _b	300	20+0.1C _b	300	
Capacitive load represent by each bus line		C _b	—	—	400	—	400	pf
Setup time for a repeated START condition	SDA	$t_{SU;STA}$	—	0.6	—	0.6	—	μ s
Start condition hold time		$t_{HD;STA}$	—	1.8	—	1.0	—	μ s
Setup time for STOP condition		$t_{SU;STO}$	—	0.6	—	0.6	—	μ s
Bus free time between a Stop and START condition	SCL	t_{BUF}	—	1.3	—	1.3	—	μ s

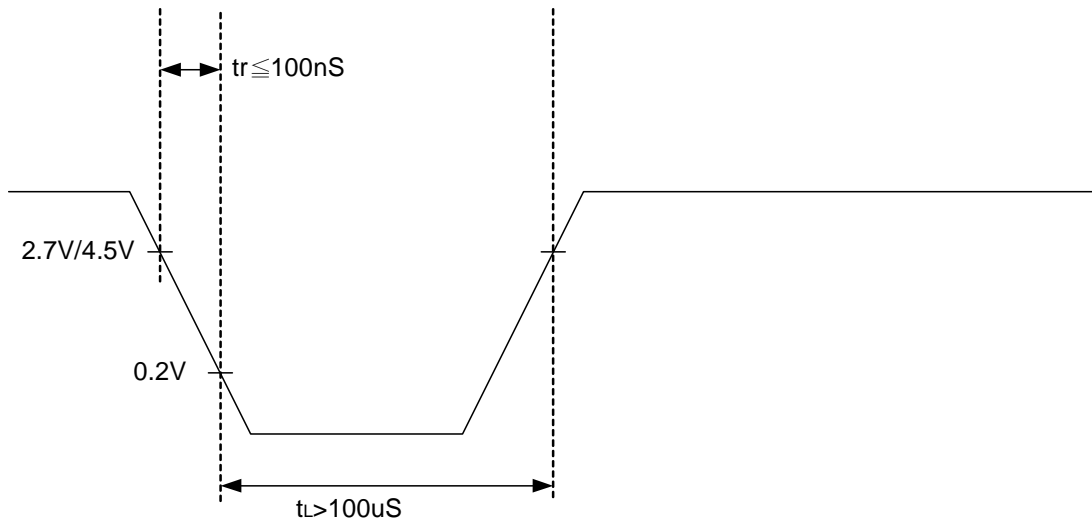
● Internal Power Supply Reset



Note:

- t_{off} compensates for the power oscillation period caused by momentary power supply oscillation.
- Specified at 4.5V for 5V operation, and at 2.7V for 3V operation.
- For if 2.7V/4.5V is not reached during 3V/5V operation, internal reset circuit will not operate normally.
- Different ITO layout pattern will cause some different between external power supply and internal power of IC. Power level, power rising time and power falling time are the different points between external power and internal power.

● Hardware reset(XRESET)



■ Absolute Maximum Ratings

Characteristics	Symbol	Value
Power Supply Voltage	VDD	-0.3 to +6.0
LCD Driver Voltage	V _{LCD}	7.0- V _{SS} to -0.3+V _{SS}
Input Voltage	V _{IN}	-0.3 to VDD+0.3
Operating Temperature	T _A	-30°C to + 85°C
Storage Temperature	T _{STO}	-65°C to + 150°C

■ DC Characteristics

(VDD = 2.7 V, TA = -35°C to 85°C)

Symbol	Characteristics	Test Condition	Min.	Typ.	Max.	Unit
VDD	Operating Voltage	-	2.7	-	4.5	V
V _{LCD}	LCD Voltage	V0-V _{SS}	2.7	-	7.0	V
V _{IN}	Power Supply	-	-	-	3.5	V
I _{DD}	Power Supply Current	VDD=3.0V (Use internal booster/follower circuit)	-	160	230	uA
V _{IH1}	Input High Voltage (Except OSC1)	-	0.7 VDD	-	VDD	V
V _{IL1}	Input Low Voltage (Except OSC1)	-	- 0.3	-	0.8	V
V _{IH2}	Input High Voltage (OSC1)	-	0.7 VDD	-	VDD	V
V _{IL2}	Input Low Voltage (OSC1)	-	-	-	0.2 VDD	V
V _{OH}	Output High Voltage (DB0 - DB7)	I _{OH} = -1.0mA	0.7 VDD	-	-	V
V _{OL}	Output Low Voltage (DB0 - DB7)	I _{OL} = 1.0mA	-	-	0.8	V
R _{COM}	Common Resistance	V _{LCD} = 4V, I _d = 0.05mA	-	2	20	KΩ
R _{SEG}	Segment Resistance	V _{LCD} = 4V, I _d = 0.05mA	-	2	30	KΩ
I _{LEAK}	Input Leakage Current	V _{IN} = 0V to VDD	-1	-	1	μA
I _{PUP}	Pull Up MOS Current	VDD = 3V	20	30	40	μA
fOSC	Oscillation frequency	VDD = 3V, 1/17duty	350	540	1100	kHz

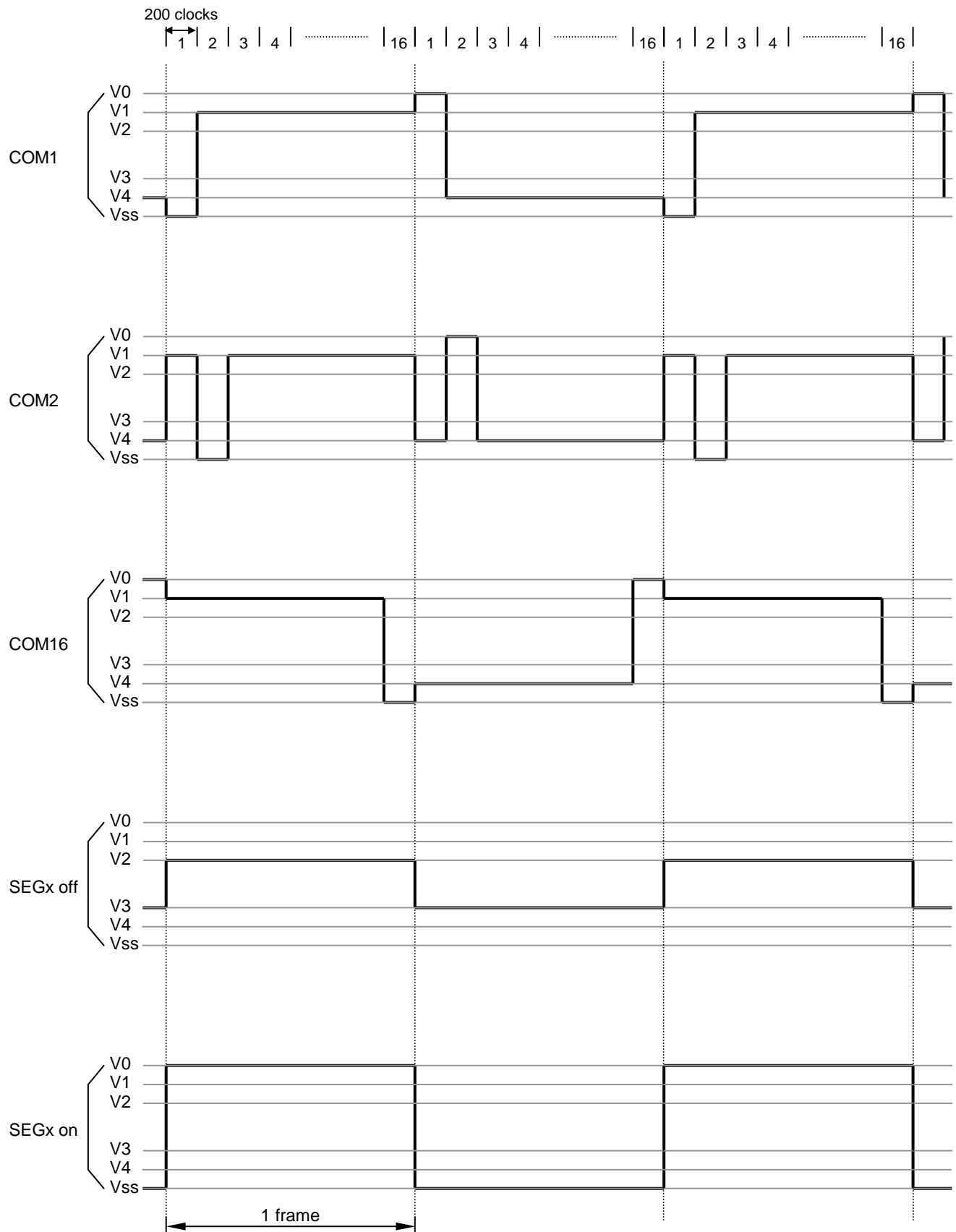
■ DC Characteristics

(VDD = 4.5 V ,TA = -35°C to 85°C)

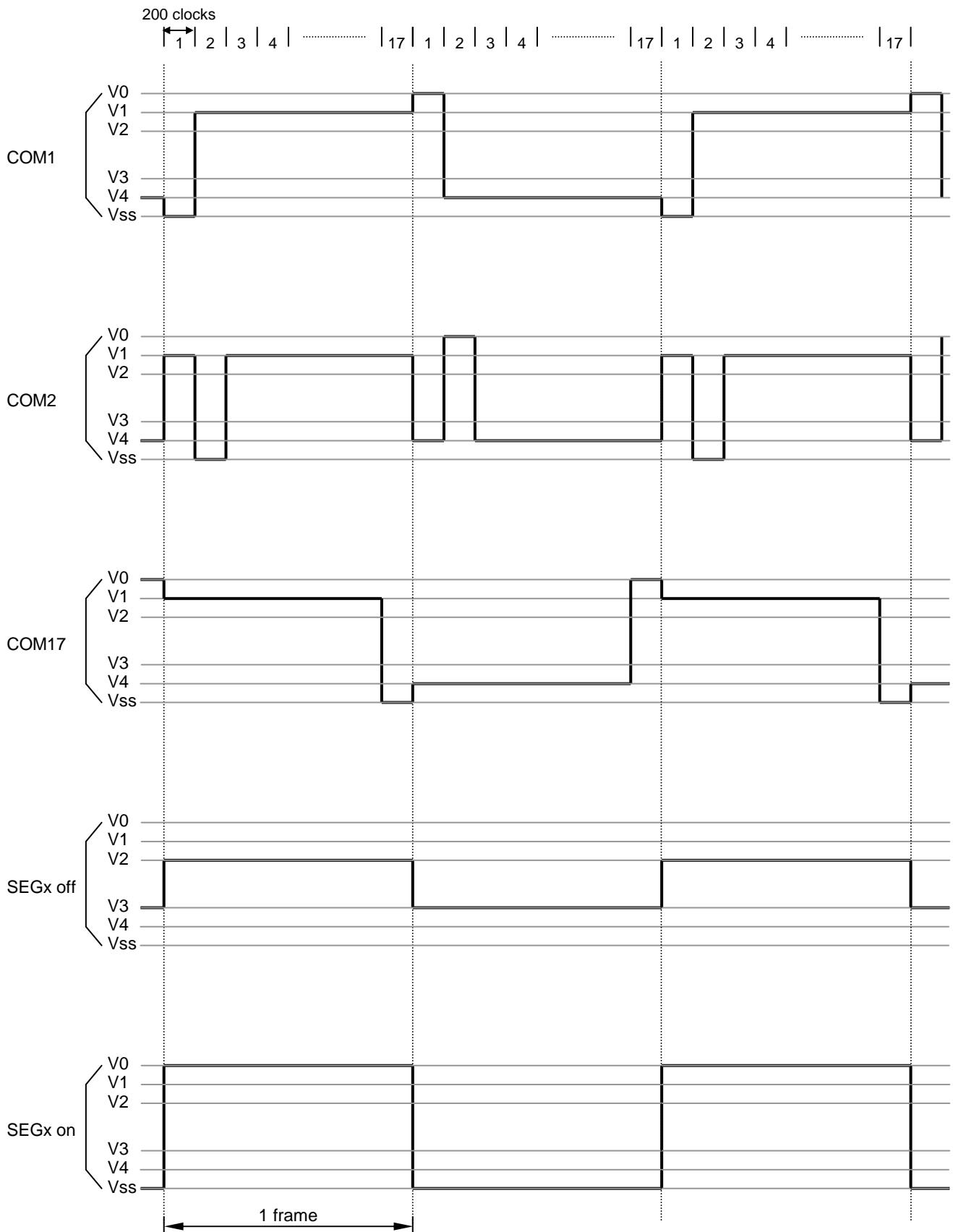
Symbol	Characteristics	Test Condition	Min.	Typ.	Max.	Unit
VDD	Operating Voltage	-	4.5	-	5.5	V
V _{LCD}	LCD Voltage	V ₀ -V _{ss}	2.7	-	7.0	V
V _{IN}	Power Supply	-	-	-	3.5	V
I _{DD}	Power Supply Current	VDD=5.0V (Use internal booster/follower circuit)	-	240	340	μA
V _{IH1}	Input High Voltage (Except OSC1)	-	0.7 VDD	-	VDD	V
V _{IL1}	Input Low Voltage (Except OSC1)	-	-0.3	-	0.8	V
V _{IH2}	Input High Voltage (OSC1)	-	0.7 VDD	-	VDD	V
V _{IL2}	Input Low Voltage (OSC1)	-	-	-	1.0	V
V _{OH}	Output High Voltage (DB0 - DB7)	I _{OH} = -1.0mA	0.8 VDD	-	VDD	V
V _{OL}	Output Low Voltage (DB0 - DB7)	I _{OL} = 1.0mA	-	-	0.8	V
R _{COM}	Common Resistance	V _{LCD} = 4V, I _d = 0.05mA	-	2	20	KΩ
R _{SEG}	Segment Resistance	V _{LCD} = 4V, I _d = 0.05mA	-	2	30	KΩ
I _{LEAK}	Input Leakage Current	V _{IN} = 0V to VDD	-1	-	1	μA
I _{PUP}	Pull Up MOS Current	VDD = 5V	65	95	125	μA
f _{OSC}	Oscillation frequency	VDD = 5V, 1/17duty	350	540	1100	kHz

■ LCD Frame Frequency

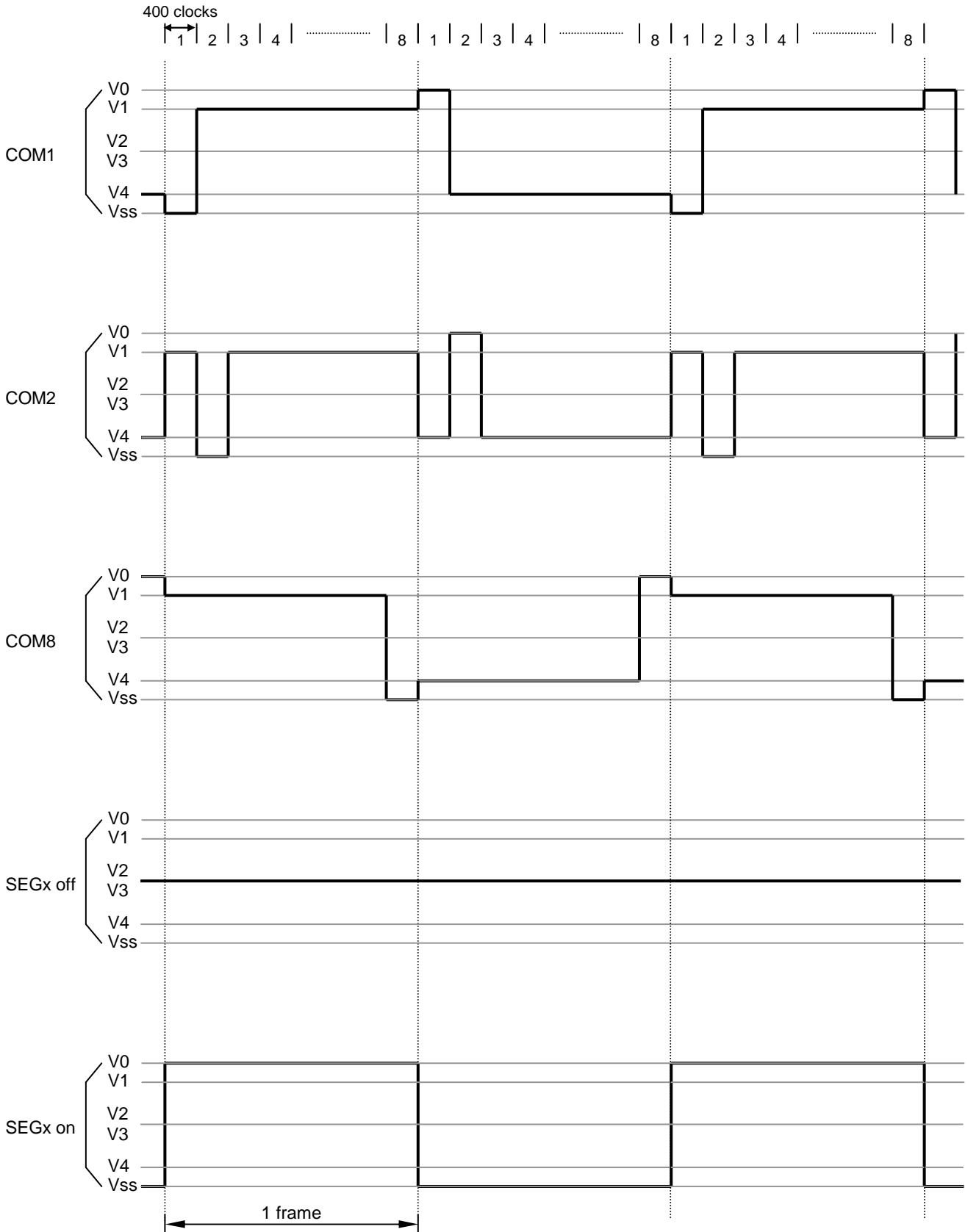
- 1/16 Duty(ST7066U normal mode); Assume the oscillation frequency is 540KHZ, 1 clock cycle time = 1.85us, 1/16 duty; 1/5 bias, 1 frame = 1.85us x 200 x 16 = 5.92ms=168.9Hz(SHLC and SHLS connect to High)



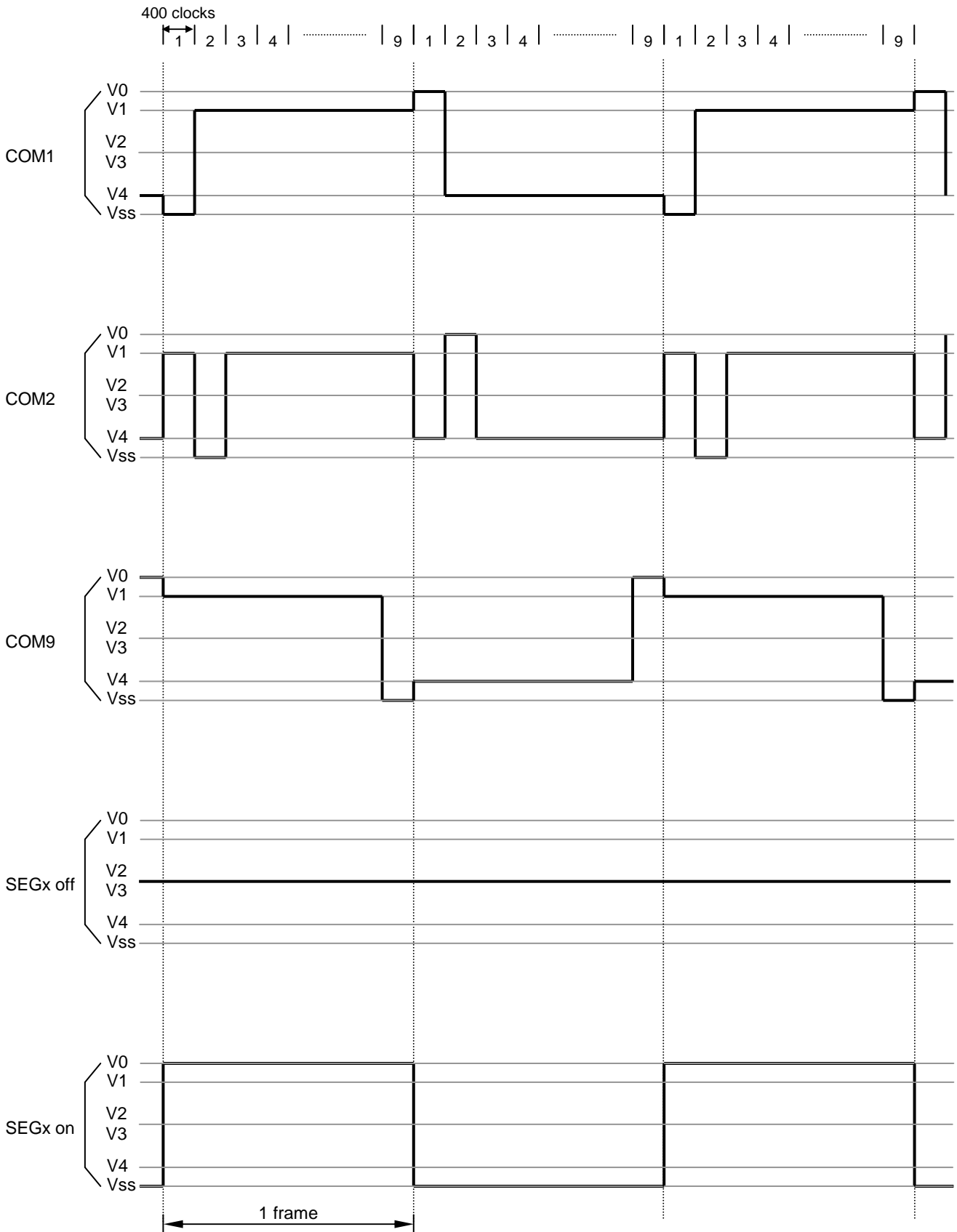
- 1/17 Duty(Extension mode); Assume the oscillation frequency is 540KHZ, 1 clock cycle time = 1.85us, 1/17 duty; 1/5 bias, 1 frame = 1.85us x 200 x 17 = 6.29ms=159Hz(SHLC and SHLS connect to High)



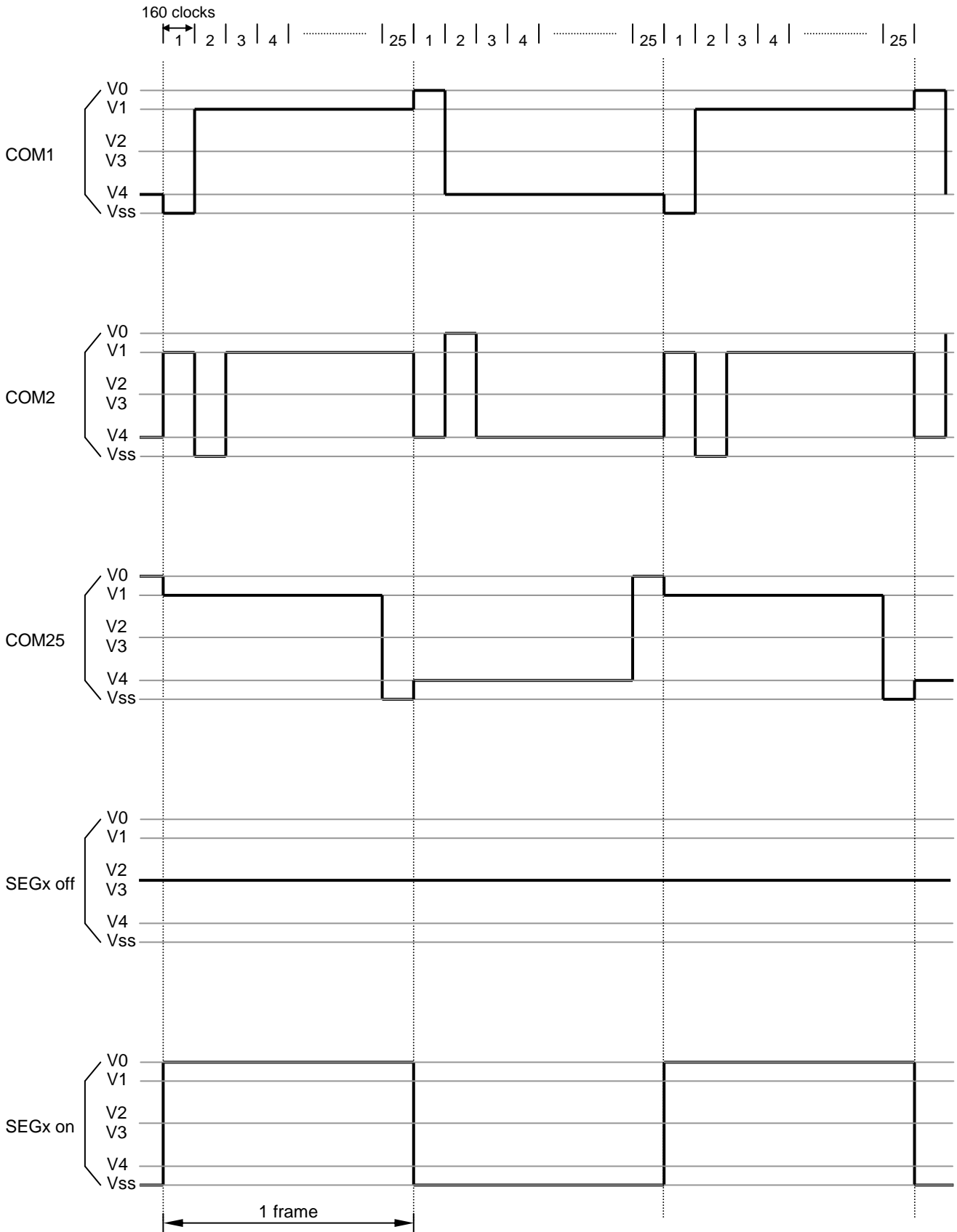
- 1/8 Duty(ST7066U normal mode); Assume the oscillation frequency is 540KHZ, 1 clock cycle time = 1.85us, 1/8 duty; 1/4 bias,1 frame = 1.85us x 400 x 8 = 5.92ms=168.9Hz(SHLC and SHLS connect to High)



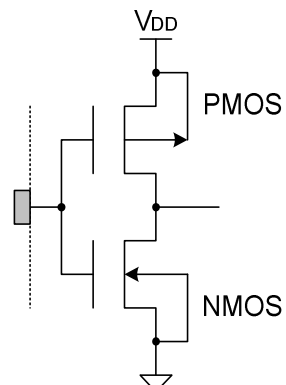
- 1/9 Duty(Extension mode); Assume the oscillation frequency is 540KHZ, 1 clock cycle time = 1.85us, 1/9 duty; 1/4 bias,1 frame = 1.85us x 400 x 9 = 6.66ms=150Hz(SHLC and SHLS connect to High)



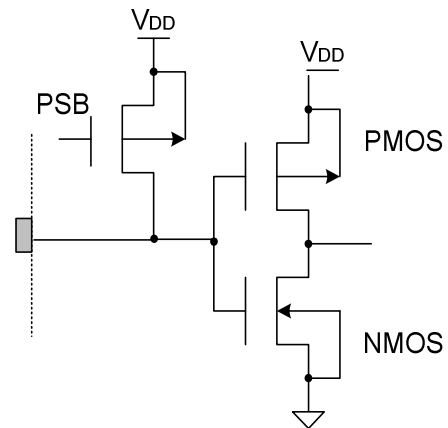
- 1/25 Duty(Extension mode and 3-line); Assume the oscillation frequency is 540KHZ, 1 clock cycle time = 1.85us, 1/25 duty; 1/4 bias,1 frame = 1.85us x 160 x 25 = 7.40ms=135.1Hz(SHLC and SHLS connect to High)



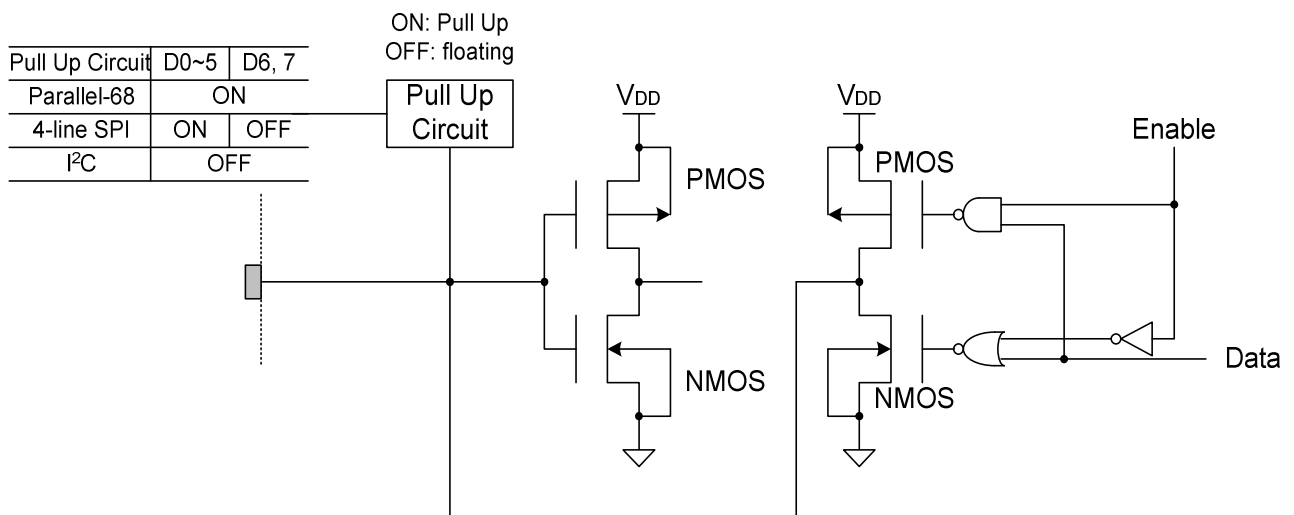
I/O Pad Configuration



Input PAD (No Pull up):
 RS, R/W, XRESET, CSB,
 PSB, PSI2B, OPFx,
 OPRx, SHLx, CLS, EXT



PSB=1==>E(Floating)
 PSB=0==>E(Pull up)

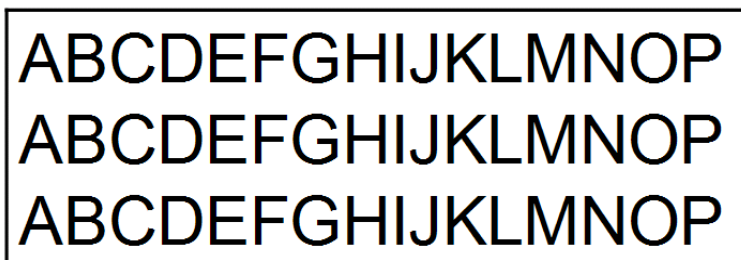


I/O PAD: DB0-DB7

■ **LCD and ST7036 Connection**

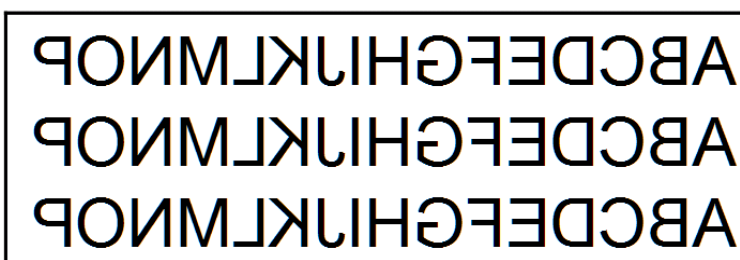
SHLC/SHLS ITO option pin can select at different direction for LCD panel

- Com normal direction/Seg normal direction



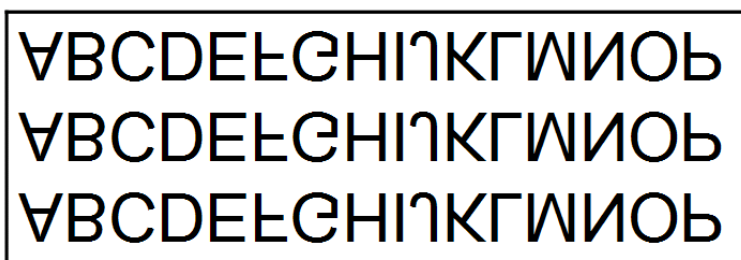
3 line x 16 characters, SHLC=1 SHLS=1

- Com normal direction/Seg reverse direction



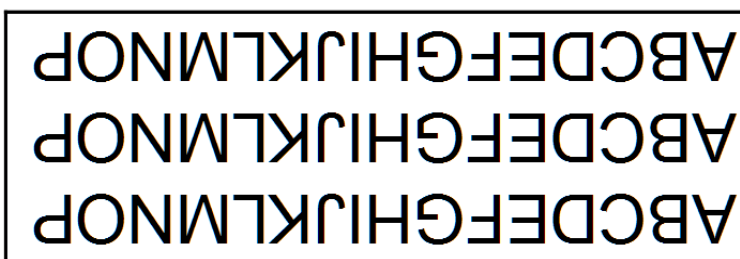
3 line x 16 characters, SHLC=1, SHLS=0

- Com reverse direction/Seg normal direction



3 line x 16 characters, SHLC=0, SHLS=1

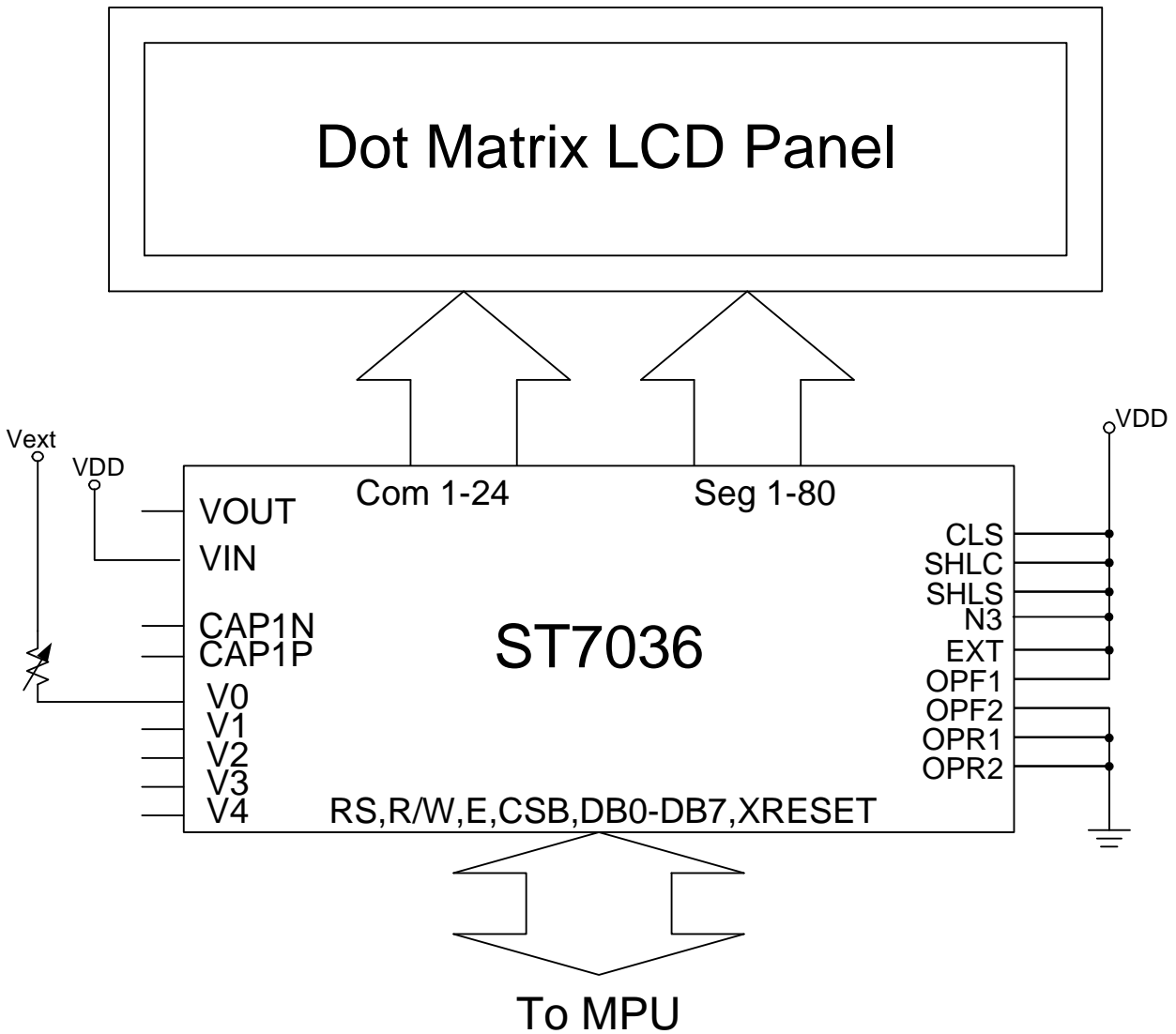
- Com reverse direction/Seg reverse direction



3 line x 16 characters, SHLC=0, SHLS=0

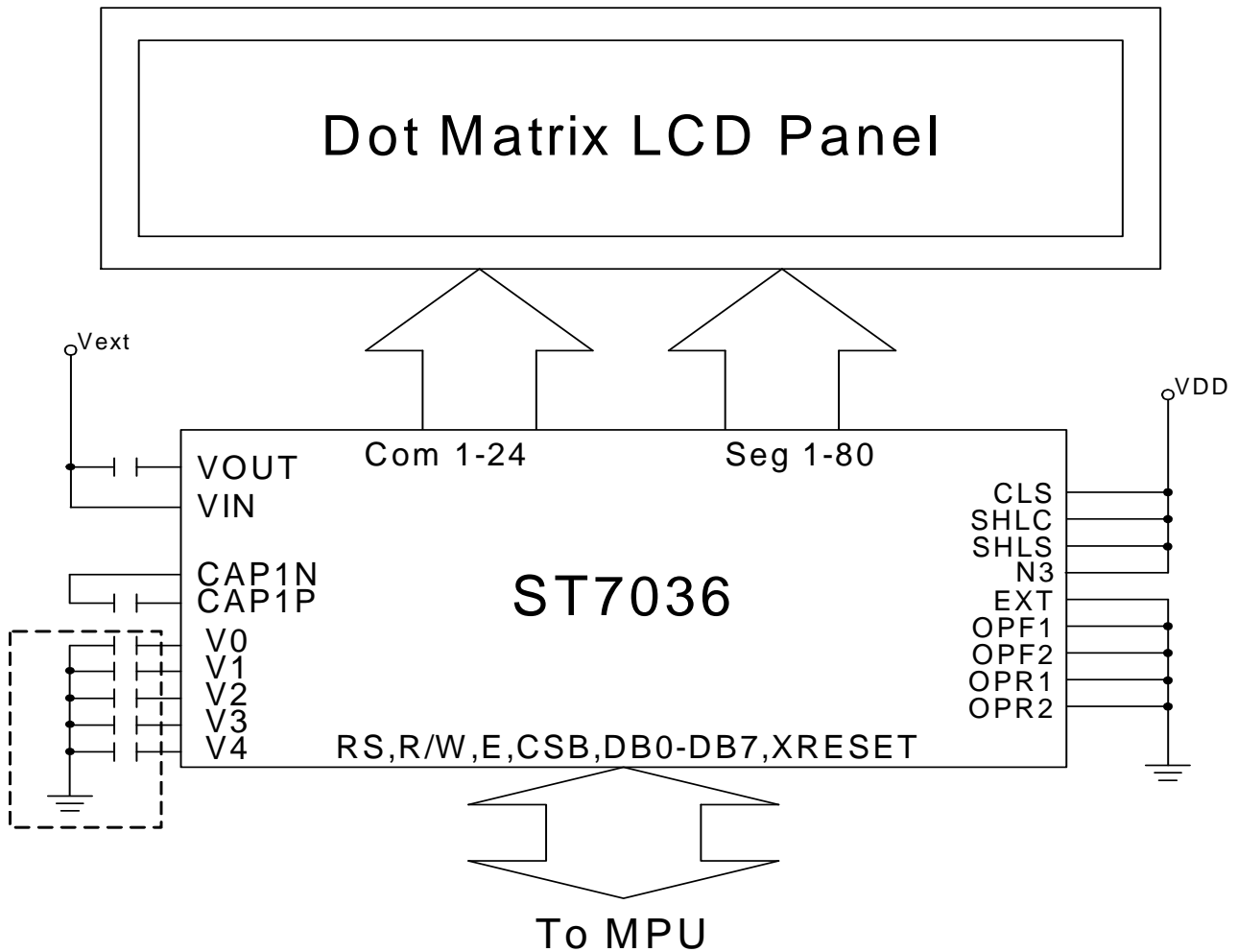
■ **Application Circuit (Normal mode)**

- Use internal resistor(9.6K ohm) and contrast adjust with external VR.
- Booster always off.
- Has 240 character of CGROM.
- Internal oscillator.



■ **Application Circuit(Extension mode)**

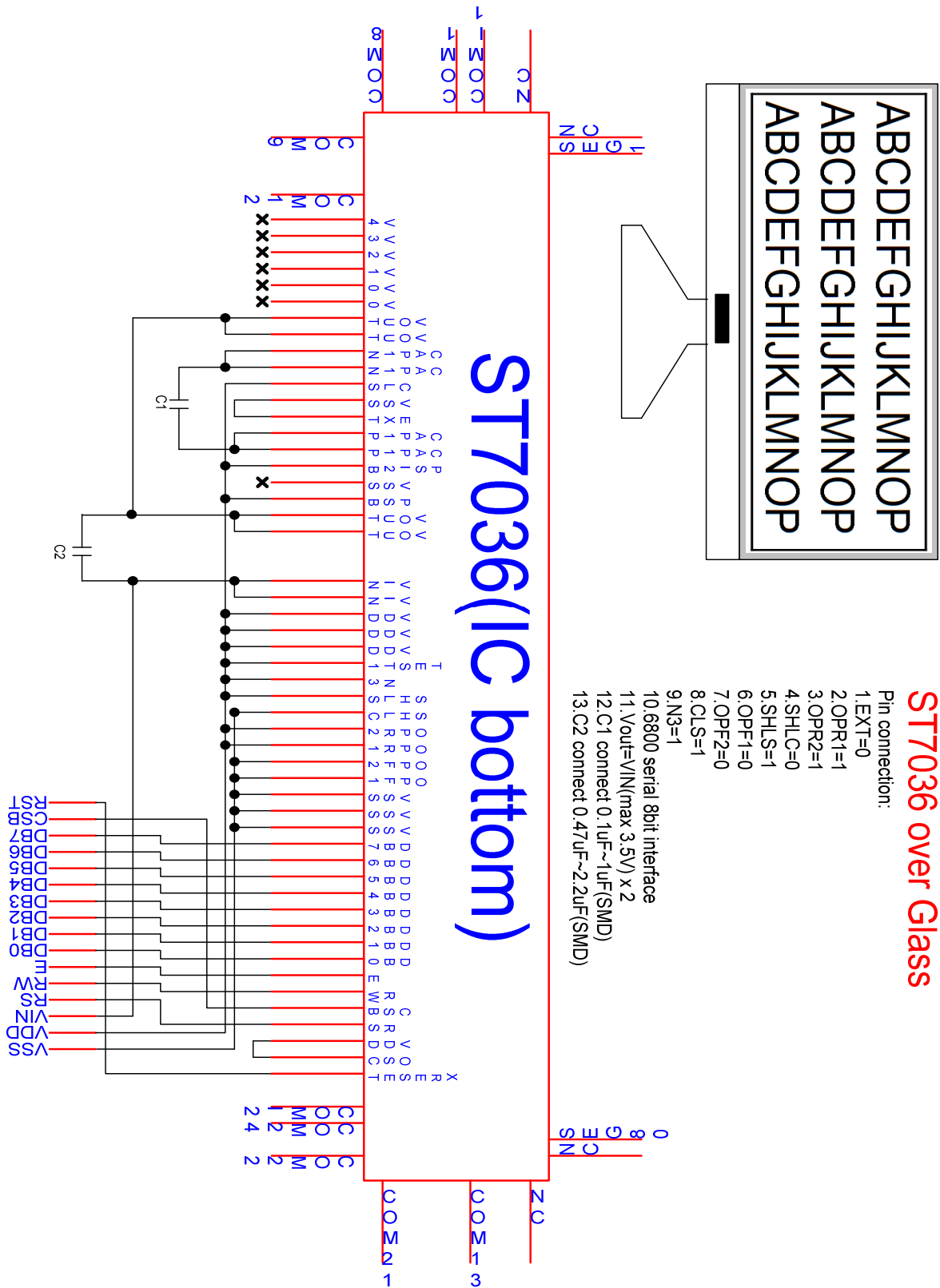
- Use internal follower circuit.
- Booster has 2 times pump.
- Has 240 character of CGROM.
- Internal oscillator.



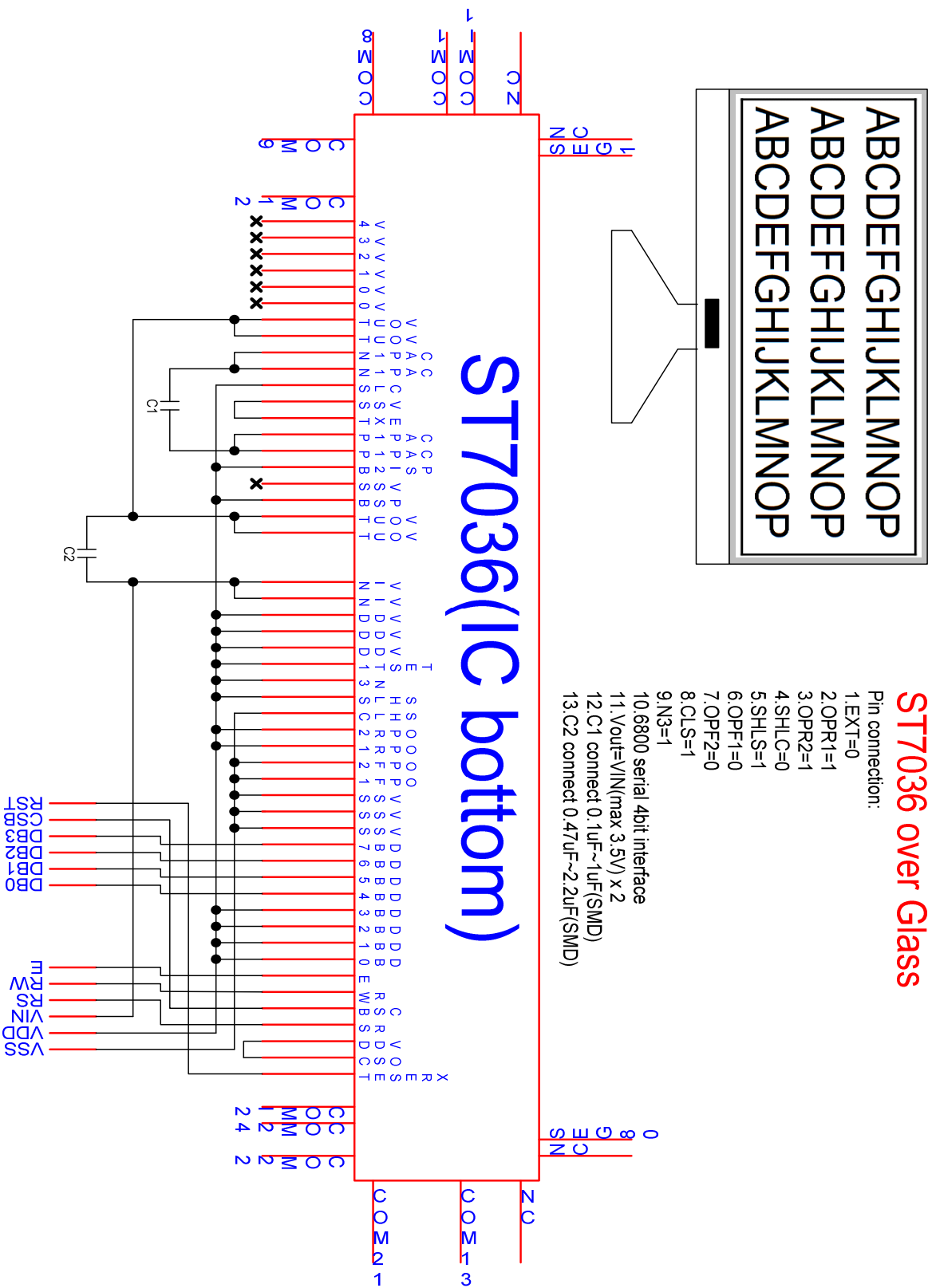
- When the heavy load is applied, the dotted line part could be added.

■ Application Circuit (for glass layout)

- ST7036 over Glass,6800 serial 8bit interface, with booster and follower circuit on



- ST7036 over Glass, 6800 serial 4bit interface, with booster and follower circuit on



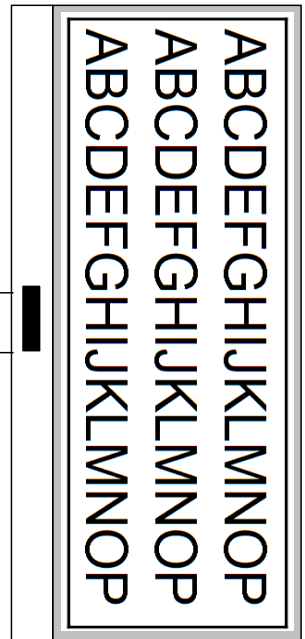
ABCDEFGHIJKLMNOP
 ABCDEFGHIJKLMNOP
 ABCDEFGHIJKLMNOP

ST7036 over Glass

Pin connection:

- EXT=0
- OPR1=1
- OPR2=1
- SHLC=0
- SHLS=1
- OPF1=0
- OPF2=0
- CLS=1
- N3=1
- 6800 serial 4bit interface
- Vout=VIN(max 3.5V) x 2
- C1 connect 0.1uF~1uF(SMD)
- C2 connect 0.47uF~2.2uF(SMD)

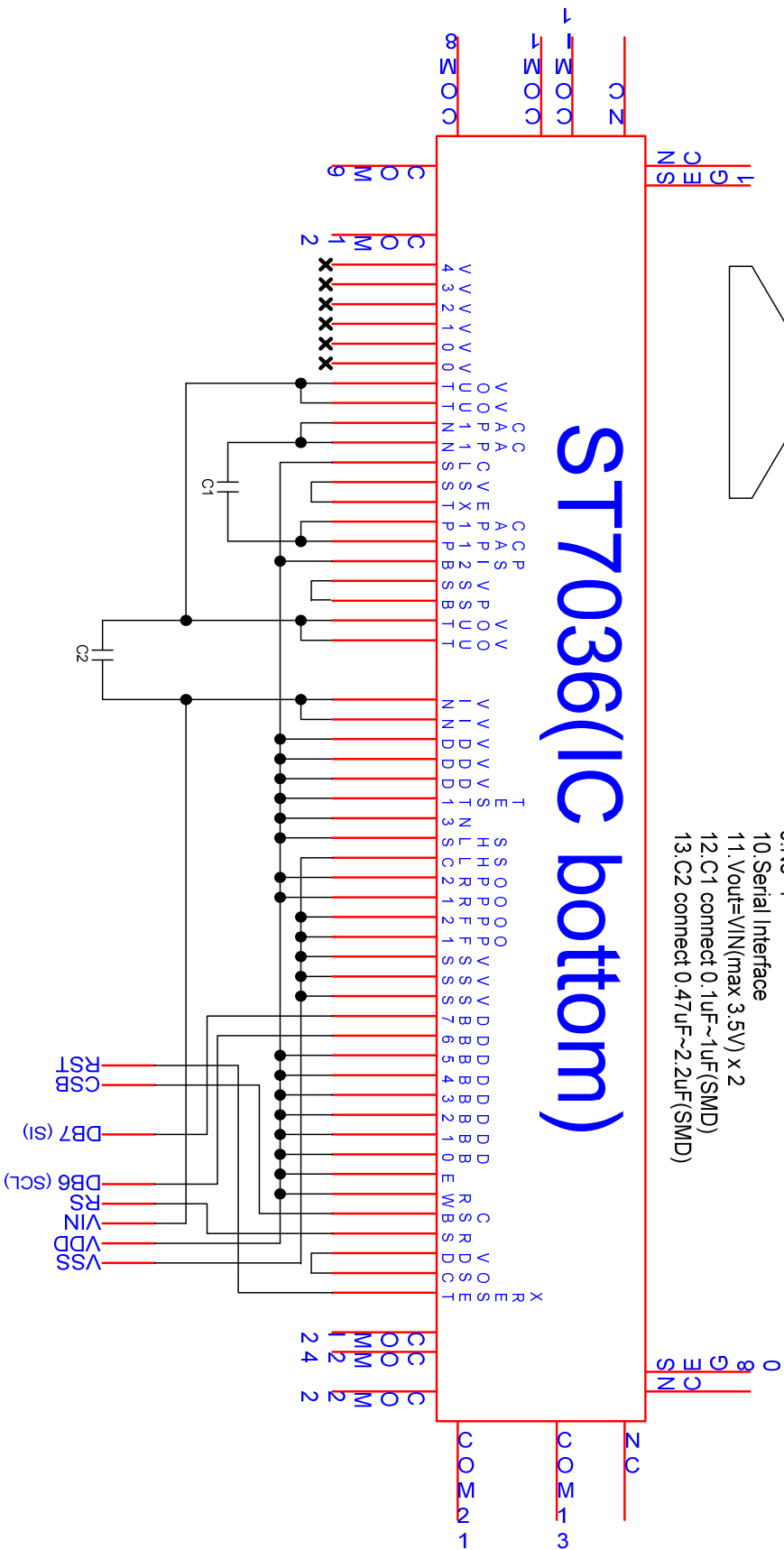
- ST7036 over Glass, serial interface, with booster and follower circuit on



ST7036 over Glass

Pin connection:

1. EXT=0
2. OPR1=1
3. OPR2=1
4. SHLC=0
5. SHLS=1
6. OPF1=0
7. OPF2=0
8. CLS=1
9. N3=1
10. Serial Interface
11. Vout=VIN(max 3.5V) x 2
12. C1 connect 0.1uF~1uF(SMD)
13. C2 connect 0.47uF~2.2uF(SMD)



● **ST7036 over Glass, I²C interface, with booster and follower circuit on**

In I2C application, note that the impedance of SDAs and GNDs should be keep in the POWER PIN LEVEL.

