SSD1351

Advance Information

128 RGB x 128 Dot Matrix
OLED/PLED Segment/Common Driver with Controller

Appendix: IC Revision history of SSD1351 Specification

Version	Change Items	Effective Date
0.10	1. 1st release	10-Jun-08
1.0	1. Change to Advance Info 2. Revise die thickness tolerance from ±25um to ±15um 3. Revise table 12-1 DC characteristic 4. Revise tables 13 AC characteristic 5. Revise command table 6. Revise V_{CC} voltage range	12-Dec-08
1.1	1. Revised section 8.1 MCU interface	19-Feb-09
1.2	1 Change "Gold Bump Die" to "COG" for SSD1351Z in Table 3-1 Ordering information 2 Revise typo in Figure 5 1: SSD1351Z Die Drawing (position of L, T alignment mark) 3 Revise typo in P.45 : 10.1.9 Set Function selection (ABh) 4 Add Note 2 in application example Fig 14-1	31-Aug-09
1.3	1 Added +/- 0.05mm tolerance for Die Size (after sawing) in Section 5 – P.9 2 Added command C1h in the description of command FDh – P.37 3 Revised typo error on the description of command C1h – P.46 4 Updated the $I_{SLP\ VCI}$ sleep mode current section of Table 12-1 (Max = 50uA when internal V_{DD} is enabled) – P.49 5 Revised declaimer	27-Oct-09

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TABLES

FIGURES

1 GENERAL DESCRIPTION

The SSD1351 is a CMOS OLED/PLED driver with 384 segments and 128 commons output, supporting up to 128RGB x 128 dot matrix display. This chip is designed for Common Cathode type OLED/PLED panel.

The SSD1351 has embedded Graphic Display Data RAM (GDDRAM). It supports with 8, 16, 18 bits 8080 / 6800 parallel interface, Serial Peripheral Interface. It has 256-step contrast and 262K color control, giving vivid color display on OLED panels.

2 FEATURES

- Resolution: 128 RGB x 128 dot matrix panel
- 262k color depth supported by embedded 128x128x18 bit SRAM display buffer
- Power supply
  - V_{DD} = 2.4V – 2.6V (Core V_{DD} power supply, can be regulated from V_{CI})
  - V_{DDIO} = 1.65V – V_{CI} (MCU interface logic level)
  - V_{CI} = 2.4V – 3.5V (Low voltage power supply)
  - V_{CC} = 10.0V – 18.0V (Panel driving power supply)
  - When V_{CI} is lower than 2.6V, V_{DD} should be supplied by external power source
- Segment maximum source current: 200uA
- Common maximum sink current: 70mA
- 256 step brightness current control for the each color component plus 16 step master current control
- Pin selectable MCU Interfaces:
  - 8/16/18 bits 6800-series parallel interface
  - 8/16/18 bits 8080-series parallel interface
  - 3 –wire and 4-wire Serial Peripheral Interface
- Support various color depths
  - 262k color (6:6:6)
  - 65k color (5:6:5)
- Gamma Look Up Tables (GLUT) with 8 bit entry
- Row re-mapping and Column re-mapping
- Vertical and horizontal scrolling
- Programmable Frame Rate and Multiplexing Ratio
- On-Chip Oscillator
- Color Swapping Function (RGB – BGR), arranged in RGB sequence when reset
- Slim chip layout for COF
- Operating temperature range -40°C to 85°C.

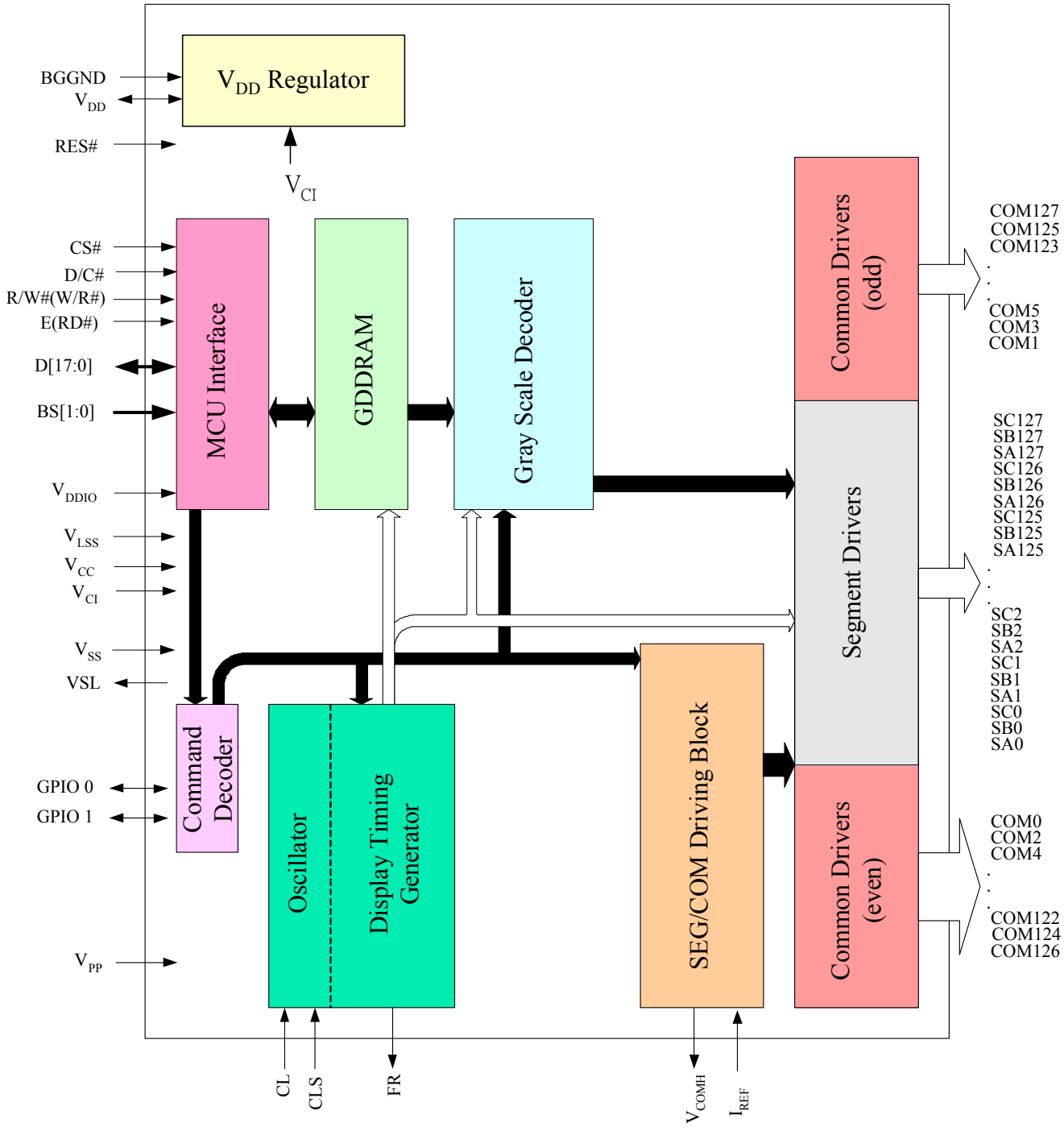
3 ORDERING INFORMATION

Table 3-1 : Ordering Information

Ordering Part Number	SEG	COM	Package Form	Reference	Remark
SSD1351Z	128RGB	128	COG	9 , 57	• Min SEG pad pitch: 25um • Min COM pad pitch: 35um • Die thickness : 300 +/- 15um
SSD1351UR1	128RGB	128	COF	12 , 56	• 48mm film, 4 sprocket hole • Hot bar type COF • 8/16/18-bit 80/68/SPI interface • SEG lead pitch: 0.050x0.999=0.04995mm • COM lead pitch: 0.06x0.999=0.05994mm

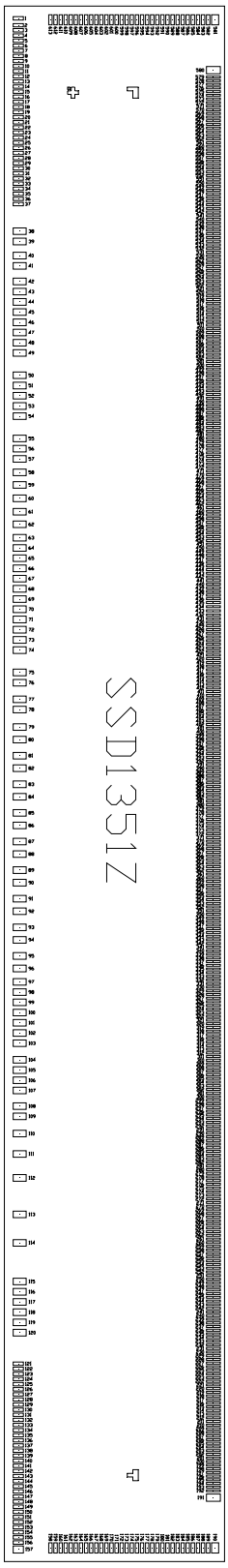
4 BLOCK DIAGRAM

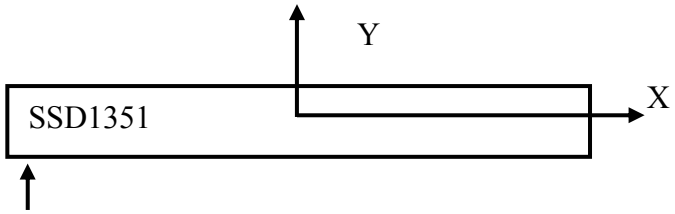
Figure 4-1 Block Diagram



5 DIE PAD FLOOR PLAN

Figure 5-1: SSD1351Z Die Drawing





Pad 1,2,3,->613
Gold Bumps face up

Die size (after sawing)	10.7mm ± 0.05mm x 1.5mm ± 0.05mm
Die Thickness	300 +/- 15um
Min I/O pad pitch	70um
Min SEG pad pitch	25um
Min COM pad pitch	35um

Bump height	Nominal 15um
Bump size	
Pad 1, 157	49um x 70um
Pad 2-37, 121-156	23um x 70um
Pad 38-120	45um x 90um
Pad 158-189, 582-613	70um x 23um
Pad 192-579	13um x 96um
Pad 190,581	70um x 49um
Pad 191,580	50um x 96um

Alignment mark		
L shape	(-4736.35, 126.58)	75um x 75um
T shape	(4736.35, 126.58)	75um x 75um
+ shape	(-4736.35, -284.77)	75um x 75um

Table 5-1: SSD1351Z Bump Die Pad Coordinates

Pad #	Pad Name	X-Axis	Y-Axis	Pad #	Pad Name	X-Axis	Y-Axis	Pad #	Pad Name	X-Axis	Y-Axis	Pad #	Pad Name	X-Axis	Y-Axis
1	NC	-5245.12	-662.08	81	D2	-193.30	-651.82	161	COM28	5234.62	-335.04	241	SB16	3618.00	681.25
2	COM94	-5197.62	-662.08	82	D3	-107.30	-651.82	162	COM27	5234.62	-300.04	242	SC16	3593.00	681.25
3	COM95	-5162.62	-662.08	83	D4	2.70	-651.82	163	COM26	5234.62	-265.04	243	SA17	3568.00	681.25
4	COM96	-5127.62	-662.08	84	D5	88.70	-651.82	164	COM25	5234.62	-230.04	244	SB17	3543.00	681.25
5	COM97	-5092.62	-662.08	85	D6	198.70	-651.82	165	COM24	5234.62	-195.04	245	SC17	3518.00	681.25
6	COM98	-5057.62	-662.08	86	D7	284.70	-651.82	166	COM23	5234.62	-160.04	246	SA18	3493.00	681.25
7	COM99	-5022.62	-662.08	87	D8	394.70	-651.82	167	COM22	5234.62	-125.04	247	SB18	3468.00	681.25
8	COM100	-4987.62	-662.08	88	D9	480.70	-651.82	168	COM21	5234.62	-90.04	248	SC18	3443.00	681.25
9	COM101	-4952.62	-662.08	89	D10	590.70	-651.82	169	COM20	5234.62	-55.04	249	SA19	3418.00	681.25
10	COM102	-4917.62	-662.08	90	D11	676.70	-651.82	170	COM19	5234.62	-20.04	250	SB19	3393.00	681.25
11	COM103	-4882.62	-662.08	91	D12	786.70	-651.82	171	COM18	5234.62	14.96	251	SC19	3368.00	681.25
12	COM104	-4847.62	-662.08	92	D13	872.70	-651.82	172	COM17	5234.62	49.96	252	SA20	3343.00	681.25
13	COM105	-4812.62	-662.08	93	D14	982.70	-651.82	173	COM16	5234.62	84.96	253	SB20	3318.00	681.25
14	COM106	-4777.62	-662.08	94	D15	1068.70	-651.82	174	COM15	5234.62	119.96	254	SC20	3293.00	681.25
15	COM107	-4742.62	-662.08	95	D16	1178.70	-651.82	175	COM14	5234.62	154.96	255	SA21	3268.00	681.25
16	COM108	-4707.62	-662.08	96	D17	1264.70	-651.82	176	COM13	5234.62	189.96	256	SB21	3243.00	681.25
17	COM109	-4672.62	-662.08	97	VSS	1356.70	-651.82	177	COM12	5234.62	224.96	257	SC21	3218.00	681.25
18	COM110	-4637.62	-662.08	98	BGGND	1426.70	-651.82	178	COM11	5234.62	259.96	258	SA22	3193.00	681.25
19	COM111	-4602.62	-662.08	99	VSL	1496.70	-651.82	179	COM10	5234.62	294.96	259	SB22	3168.00	681.25
20	COM112	-4567.62	-662.08	100	VSL	1566.70	-651.82	180	COM9	5234.62	329.96	260	SC22	3143.00	681.25
21	COM113	-4532.62	-662.08	101	CLS	1636.70	-651.82	181	COM8	5234.62	364.96	261	SA23	3118.00	681.25
22	COM114	-4497.62	-662.08	102	VDDIO	1706.70	-651.82	182	COM7	5234.62	399.96	262	SB23	3093.00	681.25
23	COM115	-4462.62	-662.08	103	VDDIO	1776.70	-651.82	183	COM6	5234.62	434.96	263	SC23	3068.00	681.25
24	COM116	-4427.62	-662.08	104	VSS	1890.70	-651.82	184	COM5	5234.62	469.96	264	SA24	3043.00	681.25
25	COM117	-4392.62	-662.08	105	VLSS	1960.70	-651.82	185	COM4	5234.62	504.96	265	SB24	3018.00	681.25
26	COM118	-4357.62	-662.08	106	VCOMH	2030.70	-651.82	186	COM3	5234.62	539.96	266	SC24	2993.00	681.25
27	COM119	-4322.62	-662.08	107	VCOMH	2100.70	-651.82	187	COM2	5234.62	574.96	267	SA25	2968.00	681.25
28	COM120	-4287.62	-662.08	108	VCC	2207.70	-651.82	188	COM1	5234.62	609.96	268	SB25	2943.00	681.25
29	COM121	-4252.62	-662.08	109	VCC	2277.70	-651.82	189	COM0	5234.62	644.96	269	SC25	2918.00	681.25
30	COM122	-4217.62	-662.08	110	TR0	2395.70	-651.82	190	NC	5234.62	692.96	270	SA26	2893.00	681.25
31	COM123	-4182.62	-662.08	111	VCI1	2535.70	-651.82	191	VLSS	4890.00	681.25	271	SB26	2868.00	681.25
32	COM124	-4147.62	-662.08	112	TR1	2699.70	-651.82	192	SA0	4843.00	681.25	272	SC26	2843.00	681.25
33	COM125	-4112.62	-662.08	113	TR2	2949.70	-651.82	193	SB0	4818.00	681.25	273	SA27	2818.00	681.25
34	COM126	-4077.62	-662.08	114	TR3	3144.70	-651.82	194	SC0	4793.00	681.25	274	SB27	2793.00	681.25
35	COM127	-4042.62	-662.08	115	TR4	3409.70	-651.82	195	SA1	4768.00	681.25	275	SC27	2768.00	681.25
36	VLSS	-4007.62	-662.08	116	VSS1	3479.70	-651.82	196	SB1	4743.00	681.25	276	SA28	2743.00	681.25
37	VLSS	-3972.62	-662.08	117	VLSS	3549.70	-651.82	197	SC1	4718.00	681.25	277	SB28	2718.00	681.25
38	VLSS	-3786.30	-651.82	118	VLSS	3619.70	-651.82	198	SA2	4693.00	681.25	278	SC28	2693.00	681.25
39	VSS	-3716.30	-651.82	119	VSS	3689.70	-651.82	199	SB2	4668.00	681.25	279	SA29	2668.00	681.25
40	VCC	-3619.30	-651.82	120	VSS	3759.70	-651.82	200	SC2	4643.00	681.25	280	SB29	2643.00	681.25
41	VCC	-3549.30	-651.82	121	VLSS	3972.62	-662.08	201	SA3	4618.00	681.25	281	SC29	2618.00	681.25
42	VCOMH	-3442.30	-651.82	122	VLSS	4007.62	-662.08	202	SB3	4593.00	681.25	282	SA30	2593.00	681.25
43	VLSS	-3372.30	-651.82	123	COM63	4042.62	-662.08	203	SC3	4568.00	681.25	283	SB30	2568.00	681.25
44	VLSS	-3302.30	-651.82	124	COM62	4077.62	-662.08	204	SA4	4543.00	681.25	284	SC30	2543.00	681.25
45	VSS	-3232.30	-651.82	125	COM61	4112.62	-662.08	205	SB4	4518.00	681.25	285	SA31	2518.00	681.25
46	VSS	-3162.30	-651.82	126	COM60	4147.62	-662.08	206	SC4	4493.00	681.25	286	SB31	2493.00	681.25
47	VSL	-3092.30	-651.82	127	COM59	4182.62	-662.08	207	SA5	4468.00	681.25	287	SC31	2468.00	681.25
48	VCI	-3022.30	-651.82	128	COM58	4217.62	-662.08	208	SB5	4443.00	681.25	288	SA32	2443.00	681.25
49	VCI	-2952.30	-651.82	129	COM57	4252.62	-662.08	209	SC5	4418.00	681.25	289	SB32	2418.00	681.25
50	VDD	-2799.30	-651.82	130	COM56	4287.62	-662.08	210	SA6	4393.00	681.25	290	SC32	2393.00	681.25
51	VDD	-2729.30	-651.82	131	COM55	4322.62	-662.08	211	SB6	4368.00	681.25	291	SA33	2368.00	681.25
52	VDD	-2659.30	-651.82	132	COM54	4357.62	-662.08	212	SC6	4343.00	681.25	292	SB33	2343.00	681.25
53	VDD	-2589.30	-651.82	133	COM53	4392.62	-662.08	213	SA7	4318.00	681.25	293	SC33	2318.00	681.25
54	VDD	-2519.30	-651.82	134	COM52	4427.62	-662.08	214	SB7	4293.00	681.25	294	SA34	2293.00	681.25
55	VDDIO	-2366.30	-651.82	135	COM51	4462.62	-662.08	215	SC7	4268.00	681.25	295	SB34	2268.00	681.25
56	VDDIO	-2296.30	-651.82	136	COM50	4497.62	-662.08	216	SA8	4243.00	681.25	296	SC34	2243.00	681.25
57	VLSS	-2226.30	-651.82	137	COM49	4532.62	-662.08	217	SB8	4218.00	681.25	297	SA35	2218.00	681.25
58	GPIO0	-2134.30	-651.82	138	COM48	4567.62	-662.08	218	SC8	4193.00	681.25	298	SB35	2193.00	681.25
59	GPIO1	-2048.30	-651.82	139	COM47	4602.62	-662.08	219	SA9	4168.00	681.25	299	SC35	2168.00	681.25
60	IREF	-1956.30	-651.82	140	COM46	4637.62	-662.08	220	SB9	4143.00	681.25	300	SA36	2143.00	681.25
61	FR	-1864.30	-651.82	141	COM45	4672.62	-662.08	221	SC9	4118.00	681.25	301	SB36	2118.00	681.25
62	CL	-1778.30	-651.82	142	COM44	4707.62	-662.08	222	SA10	4093.00	681.25	302	SC36	2093.00	681.25
63	VSS	-1686.30	-651.82	143	COM43	4742.62	-662.08	223	SB10	4068.00	681.25	303	SA37	2068.00	681.25
64	RES#	-1616.30	-651.82	144	COM42	4777.62	-662.08	224	SC10	4043.00	681.25	304	SB37	2043.00	681.25
65	D/C#	-1546.30	-651.82	145	COM41	4812.62	-662.08	225	SA11	4018.00	681.25	305	SC37	2018.00	681.25
66	CS#	-1476.30	-651.82	146	COM40	4847.62	-662.08	226	SB11	3993.00	681.25	306	SA38	1993.00	681.25
67	VSS	-1406.30	-651.82	147	COM39	4882.62	-662.08	227	SC11	3968.00	681.25	307	SB38	1968.00	681.25
68	BS1	-1336.30	-651.82	148	COM38	4917.62	-662.08	228	SA12	3943.00	681.25	308	SC38	1943.00	681.25
69	VDDIO	-1266.30	-651.82	149	COM37	4952.62	-662.08	229	SB12	3918.00	681.25	309	SA39	1918.00	681.25
70	BS0	-1196.30	-651.82	150	COM36	4987.62	-662.08	230	SC12	3893.00	681.25	310	SB39	1893.00	681.25
71	VSS	-1126.30	-651.82	151	COM35	5022.62	-662.08	231	SA13	3868.00	681.25	311	SC39	1868.00	681.25
72	R/W# (WR#	-1056.30	-651.82	152	COM34	5057.62	-662.08	232	SB13	3843.00	681.25	312	SA40	1843.00	681.25
73	E(RD#)	-986.30	-651.82	153	COM33	5092.62	-662.08	233	SC13	3818.00	681.25	313	SB40	1818.00	681.25
74	VDDIO	-916.30	-651.82	154	COM32	5127.62	-662.08	234	SA14	3793.00	681.25	314	SC40	1793.00	681.25
75	VCI	-763.30	-651.82	155	COM31	5162.62	-662.08	235	SB14	3768.00	681.25	315	SA41	1768.00	681.25
76	VDD	-693.30	-651.82	156	COM30	5197.62	-662.08	236	SC14	3743.00	681.25	316	SB41	1743.00	681.25
77	VPP	-579.30	-651.82	157	NC	5245.12	-662.08	237	SA15	3718.00	681.25	317	SC41	1718.00	681.25
78	VPP	-509.30	-651.82	158	VLSS	5234.62	-440.04	238	SB15	3693.00	681.25	318	SA42	1693.00	681.25
79	D0	-389.30	-651.82	159	VLSS	5234.62	-405.04	239	SC15	3668.00	681.25	319	SB42	1668.00	681.25
80	D1	-303.30	-651.82	160	COM29	5234.62	-370.04	240	SA16	3643.00	681.25	320	SC42	1643.00	681.25

Pad #	Pad Name	X-Axis	Y-Axis
321	SA43	1618.00	681.25
322	SB43	1593.00	681.25
323	SC43	1568.00	681.25
324	SA44	1543.00	681.25
325	SB44	1518.00	681.25
326	SC44	1493.00	681.25
327	SA45	1468.00	681.25
328	SB45	1443.00	681.25
329	SC45	1418.00	681.25
330	SA46	1393.00	681.25
331	SB46	1368.00	681.25
332	SC46	1343.00	681.25
333	SA47	1318.00	681.25
334	SB47	1293.00	681.25
335	SC47	1268.00	681.25
336	SA48	1243.00	681.25
337	SB48	1218.00	681.25
338	SC48	1193.00	681.25
339	SA49	1168.00	681.25
340	SB49	1143.00	681.25
341	SC49	1118.00	681.25
342	SA50	1093.00	681.25
343	SB50	1068.00	681.25
344	SC50	1043.00	681.25
345	SA51	1018.00	681.25
346	SB51	993.00	681.25
347	SC51	968.00	681.25
348	SA52	943.00	681.25
349	SB52	918.00	681.25
350	SC52	893.00	681.25
351	SA53	868.00	681.25
352	SB53	843.00	681.25
353	SC53	818.00	681.25
354	SA54	793.00	681.25
355	SB54	768.00	681.25
356	SC54	743.00	681.25
357	SA55	718.00	681.25
358	SB55	693.00	681.25
359	SC55	668.00	681.25
360	SA56	643.00	681.25
361	SB56	618.00	681.25
362	SC56	593.00	681.25
363	SA57	568.00	681.25
364	SB57	543.00	681.25
365	SC57	518.00	681.25
366	SA58	493.00	681.25
367	SB58	468.00	681.25
368	SC58	443.00	681.25
369	SA59	418.00	681.25
370	SB59	393.00	681.25
371	SC59	368.00	681.25
372	SA60	343.00	681.25
373	SB60	318.00	681.25
374	SC60	293.00	681.25
375	SA61	268.00	681.25
376	SB61	243.00	681.25
377	SC61	218.00	681.25
378	SA62	193.00	681.25
379	SB62	168.00	681.25
380	SC62	143.00	681.25
381	SA63	118.00	681.25
382	SB63	93.00	681.25
383	SC63	68.00	681.25
384	SA64	43.00	681.25
385	SB64	18.00	681.25
386	SC64	-7.00	681.25
387	SA65	-32.00	681.25
388	SB65	-57.00	681.25
389	SC65	-82.00	681.25
390	SA66	-107.00	681.25
391	SB66	-132.00	681.25
392	SC66	-157.00	681.25
393	SA67	-182.00	681.25
394	SB67	-207.00	681.25
395	SC67	-232.00	681.25
396	SA68	-257.00	681.25
397	SB68	-282.00	681.25
398	SC68	-307.00	681.25
399	SA69	-332.00	681.25
400	SB69	-357.00	681.25

Pad #	Pad Name	X-Axis	Y-Axis
401	SC69	-382.00	681.25
402	SA70	-407.00	681.25
403	SB70	-432.00	681.25
404	SC70	-457.00	681.25
405	SA71	-482.00	681.25
406	SB71	-507.00	681.25
407	SC71	-532.00	681.25
408	SA72	-557.00	681.25
409	SB72	-582.00	681.25
410	SC72	-607.00	681.25
411	SA73	-632.00	681.25
412	SB73	-657.00	681.25
413	SC73	-682.00	681.25
414	SA74	-707.00	681.25
415	SB74	-732.00	681.25
416	SC74	-757.00	681.25
417	SA75	-782.00	681.25
418	SB75	-807.00	681.25
419	SC75	-832.00	681.25
420	SA76	-857.00	681.25
421	SB76	-882.00	681.25
422	SC76	-907.00	681.25
423	SA77	-932.00	681.25
424	SB77	-957.00	681.25
425	SC77	-982.00	681.25
426	SA78	-1007.00	681.25
427	SB78	-1032.00	681.25
428	SC78	-1057.00	681.25
429	SA79	-1082.00	681.25
430	SB79	-1107.00	681.25
431	SC79	-1132.00	681.25
432	VCC	-1158.00	681.25
433	VCC	-1186.00	681.25
434	VCC	-1214.00	681.25
435	VCC	-1242.00	681.25
436	SA80	-1268.00	681.25
437	SB80	-1293.00	681.25
438	SC80	-1318.00	681.25
439	SA81	-1343.00	681.25
440	SB81	-1368.00	681.25
441	SC81	-1393.00	681.25
442	SA82	-1418.00	681.25
443	SB82	-1443.00	681.25
444	SC82	-1468.00	681.25
445	SA83	-1493.00	681.25
446	SB83	-1518.00	681.25
447	SC83	-1543.00	681.25
448	SA84	-1568.00	681.25
449	SB84	-1593.00	681.25
450	SC84	-1618.00	681.25
451	SA85	-1643.00	681.25
452	SB85	-1668.00	681.25
453	SC85	-1693.00	681.25
454	SA86	-1718.00	681.25
455	SB86	-1743.00	681.25
456	SC86	-1768.00	681.25
457	SA87	-1793.00	681.25
458	SB87	-1818.00	681.25
459	SC87	-1843.00	681.25
460	SA88	-1868.00	681.25
461	SB88	-1893.00	681.25
462	SC88	-1918.00	681.25
463	SA89	-1943.00	681.25
464	SB89	-1968.00	681.25
465	SC89	-1993.00	681.25
466	SA90	-2018.00	681.25
467	SB90	-2043.00	681.25
468	SC90	-2068.00	681.25
469	SA91	-2093.00	681.25
470	SB91	-2118.00	681.25
471	SC91	-2143.00	681.25
472	SA92	-2168.00	681.25
473	SB92	-2193.00	681.25
474	SC92	-2218.00	681.25
475	SA93	-2243.00	681.25
476	SB93	-2268.00	681.25
477	SC93	-2293.00	681.25
478	SA94	-2318.00	681.25
479	SB94	-2343.00	681.25
480	SC94	-2368.00	681.25

Pad #	Pad Name	X-Axis	Y-Axis
481	SA95	-2393.00	681.25
482	SB95	-2418.00	681.25
483	SC95	-2443.00	681.25
484	SA96	-2468.00	681.25
485	SB96	-2493.00	681.25
486	SC96	-2518.00	681.25
487	SA97	-2543.00	681.25
488	SB97	-2568.00	681.25
489	SC97	-2593.00	681.25
490	SA98	-2618.00	681.25
491	SB98	-2643.00	681.25
492	SC98	-2668.00	681.25
493	SA99	-2693.00	681.25
494	SB99	-2718.00	681.25
495	SC99	-2743.00	681.25
496	SA100	-2768.00	681.25
497	SB100	-2793.00	681.25
498	SC100	-2818.00	681.25
499	SA101	-2843.00	681.25
500	SB101	-2868.00	681.25
501	SC101	-2893.00	681.25
502	SA102	-2918.00	681.25
503	SB102	-2943.00	681.25
504	SC102	-2968.00	681.25
505	SA103	-2993.00	681.25
506	SB103	-3018.00	681.25
507	SC103	-3043.00	681.25
508	SA104	-3068.00	681.25
509	SB104	-3093.00	681.25
510	SC104	-3118.00	681.25
511	SA105	-3143.00	681.25
512	SB105	-3168.00	681.25
513	SC105	-3193.00	681.25
514	SA106	-3218.00	681.25
515	SB106	-3243.00	681.25
516	SC106	-3268.00	681.25
517	SA107	-3293.00	681.25
518	SB107	-3318.00	681.25
519	SC107	-3343.00	681.25
520	SA108	-3368.00	681.25
521	SB108	-3393.00	681.25
522	SC108	-3418.00	681.25
523	SA109	-3443.00	681.25
524	SB109	-3468.00	681.25
525	SC109	-3493.00	681.25
526	SA110	-3518.00	681.25
527	SB110	-3543.00	681.25
528	SC110	-3568.00	681.25
529	SA111	-3593.00	681.25
530	SB111	-3618.00	681.25
531	SC111	-3643.00	681.25
532	SA112	-3668.00	681.25
533	SB112	-3693.00	681.25
534	SC112	-3718.00	681.25
535	SA113	-3743.00	681.25
536	SB113	-3768.00	681.25
537	SC113	-3793.00	681.25
538	SA114	-3818.00	681.25
539	SB114	-3843.00	681.25
540	SC114	-3868.00	681.25
541	SA115	-3893.00	681.25
542	SB115	-3918.00	681.25
543	SC115	-3943.00	681.25
544	SA116	-3968.00	681.25
545	SB116	-3993.00	681.25
546	SC116	-4018.00	681.25
547	SA117	-4043.00	681.25
548	SB117	-4068.00	681.25
549	SC117	-4093.00	681.25
550	SA118	-4118.00	681.25
551	SB118	-4143.00	681.25
552	SC118	-4168.00	681.25
553	SA119	-4193.00	681.25
554	SB119	-4218.00	681.25
555	SC119	-4243.00	681.25
556	SA120	-4268.00	681.25
557	SB120	-4293.00	681.25
558	SC120	-4318.00	681.25
559	SA121	-4343.00	681.25
560	SB121	-4368.00	681.25

Pad #	Pad Name	X-Axis	Y-Axis
561	SC121	-4393.00	681.25
562	SA122	-4418.00	681.25
563	SB122	-4443.00	681.25
564	SC122	-4468.00	681.25
565	SA123	-4493.00	681.25
566	SB123	-4518.00	681.25
567	SC123	-4543.00	681.25
568	SA124	-4568.00	681.25
569	SB124	-4593.00	681.25
570	SC124	-4618.00	681.25
571	SA125	-4643.00	681.25
572	SB125	-4668.00	681.25
573	SC125	-4693.00	681.25
574	SA126	-4718.00	681.25
575	SB126	-4743.00	681.25
576	SC126	-4768.00	681.25
577	SA127	-4793.00	681.25
578	SB127	-4818.00	681.25
579	SC127	-4843.00	681.25
580	VLSS	-4890.00	681.25
581	NC	-5234.62	692.96
582	COM64	-5234.62	644.96
583	COM65	-5234.62	609.96
584	COM66	-5234.62	574.96
585	COM67	-5234.62	539.96
586	COM68	-5234.62	504.96
587	COM69	-5234.62	469.96
588	COM70	-5234.62	434.96
589	COM71	-5234.62	399.96
590	COM72	-5234.62	364.96
591	COM73	-5234.62	329.96
592	COM74	-5234.62	294.96
593	COM75	-5234.62	259.96
594	COM76	-5234.62	224.96
595	COM77	-5234.62	189.96
596	COM78	-5234.62	154.96
597	COM79	-5234.62	119.96
598	COM80	-5234.62	84.96
599	COM81	-5234.62	49.96
600	COM82	-5234.62	14.96
601	COM83	-5234.62	-20.04
602	COM84	-5234.62	-55.04
603	COM85	-5234.62	-90.04
604	COM86	-5234.62	-125.04
605	COM87	-5234.62	-160.04
606	COM88	-5234.62	-195.04
607	COM89	-5234.62	-230.04
608	COM90	-5234.62	-265.04
609	COM91	-5234.62	-300.04
610	COM92	-5234.62	-335.04
611	COM93	-5234.62	-370.04
612	VLSS	-5234.62	-405.04
613	VLSS	-5234.62	-440.04

6 PIN ARRANGEMENT

6.1 SSD1351UR1 pin assignment

Figure 6-1: SSD1351UR1 Pin Assignment

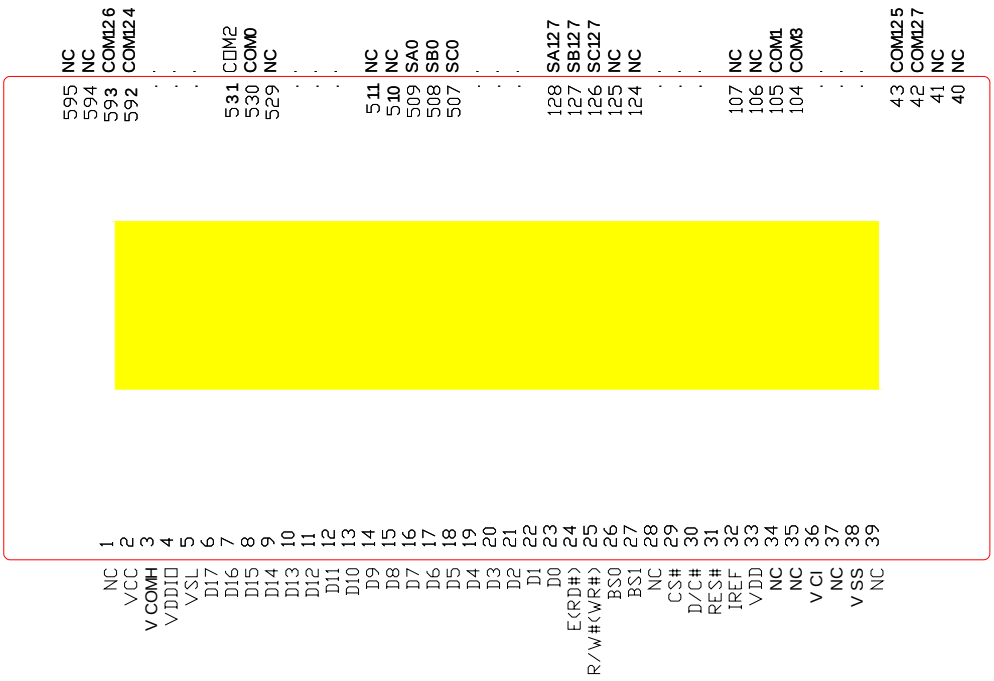


Table 6-1: SSD1351UR1 Pin Assignment Table

Pad#	Pad Name	Pad#	Pad Name	Pad#	Pad Name	Pad#	Pad Name
1	NC	81	COM88	161	SA116	241	SB89
2	VCC	82	COM87	162	SC115	242	SA89
3	VCOMH	83	COM86	163	SB115	243	SC88
4	VDDIO	84	COM85	164	SA115	244	SB88
5	VSL	85	COM84	165	SC114	245	SA88
6	D17	86	COM83	166	SB114	246	SC87
7	D16	87	COM82	167	SA114	247	SB87
8	D15	88	COM81	168	SC113	248	SA87
9	D14	89	COM80	169	SB113	249	SC86
10	D13	90	COM79	170	SA113	250	SB86
11	D12	91	COM78	171	SC112	251	SA86
12	D11	92	COM77	172	SB112	252	SC85
13	D10	93	COM76	173	SA112	253	SB85
14	D9	94	COM75	174	SC111	254	SA85
15	D8	95	COM74	175	SB111	255	SC84
16	D7	96	COM73	176	SA111	256	SB84
17	D6	97	COM72	177	SC110	257	SA84
18	D5	98	COM71	178	SB110	258	SC83
19	D4	99	COM70	179	SA110	259	SB83
20	D3	100	COM69	180	SC109	260	SA83
21	D2	101	COM68	181	SB109	261	SC82
22	D1	102	COM67	182	SA109	262	SB82
23	D0	103	COM66	183	SC108	263	SA82
24	E (RD#)	104	COM65	184	SB108	264	SC81
25	R/W# (WR#)	105	COM64	185	SA108	265	SB81
26	BS0	106	NC	186	SC107	266	SA81
27	BS1	107	NC	187	SB107	267	SC80
28	NC	108	NC	188	SA107	268	SB80
29	CS#	109	NC	189	SC106	269	SA80
30	D/C#	110	NC	190	SB106	270	SC79
31	RES#	111	NC	191	SA106	271	SB79
32	IREF	112	NC	192	SC105	272	SA79
33	VDD	113	NC	193	SB105	273	SC78
34	NC	114	NC	194	SA105	274	SB78
35	NC	115	NC	195	SC104	275	SA78
36	VCI	116	NC	196	SB104	276	SC77
37	NC	117	NC	197	SA104	277	SB77
38	VSS	118	NC	198	SC103	278	SA77
39	NC	119	NC	199	SB103	279	SC76
40	NC	120	NC	200	SA103	280	SB76
41	NC	121	NC	201	SC102	281	SA76
42	COM127	122	NC	202	SB102	282	SC75
43	COM126	123	NC	203	SA102	283	SB75
44	COM125	124	NC	204	SC101	284	SA75
45	COM124	125	NC	205	SB101	285	SC74
46	COM123	126	SC127	206	SA101	286	SB74
47	COM122	127	SB127	207	SC100	287	SA74
48	COM121	128	SA127	208	SB100	288	SC73
49	COM120	129	SC126	209	SA100	289	SB73
50	COM119	130	SB126	210	SC99	290	SA73
51	COM118	131	SA126	211	SB99	291	SC72
52	COM117	132	SC125	212	SA99	292	SB72
53	COM116	133	SB125	213	SC98	293	SA72
54	COM115	134	SA125	214	SB98	294	SC71
55	COM114	135	SC124	215	SA98	295	SB71
56	COM113	136	SB124	216	SC97	296	SA71
57	COM112	137	SA124	217	SB97	297	SC70
58	COM111	138	SC123	218	SA97	298	SB70
59	COM110	139	SB123	219	SC96	299	SA70
60	COM109	140	SA123	220	SB96	300	SC69
61	COM108	141	SC122	221	SA96	301	SB69
62	COM107	142	SB122	222	SC95	302	SA69
63	COM106	143	SA122	223	SB95	303	SC68
64	COM105	144	SC121	224	SA95	304	SB68
65	COM104	145	SB121	225	SC94	305	SA68
66	COM103	146	SA121	226	SB94	306	SC67
67	COM102	147	SC120	227	SA94	307	SB67
68	COM101	148	SB120	228	SC93	308	SA67
69	COM100	149	SA120	229	SB93	309	SC66
70	COM99	150	SC119	230	SA93	310	SB66
71	COM98	151	SB119	231	SC92	311	SA66
72	COM97	152	SA119	232	SB92	312	SC65
73	COM96	153	SC118	233	SA92	313	SB65
74	COM95	154	SB118	234	SC91	314	SA65
75	COM94	155	SA118	235	SB91	315	SC64
76	COM93	156	SC117	236	SA91	316	SB64
77	COM92	157	SB117	237	SC90	317	SA64
78	COM91	158	SA117	238	SB90	318	SC63
79	COM90	159	SC116	239	SA90	319	SB63
80	COM89	160	SB116	240	SC89	320	SA63

Pad#	Pad Name
321	SC62
322	SB62
323	SA62
324	SC61
325	SB61
326	SA61
327	SC60
328	SB60
329	SA60
330	SC59
331	SB59
332	SA59
333	SC58
334	SB58
335	SA58
336	SC57
337	SB57
338	SA57
339	SC56
340	SB56
341	SA56
342	SC55
343	SB55
344	SA55
345	SC54
346	SB54
347	SA54
348	SC53
349	SB53
350	SA53
351	SC52
352	SB52
353	SA52
354	SC51
355	SB51
356	SA51
357	SC50
358	SB50
359	SA50
360	SC49
361	SB49
362	SA49
363	SC48
364	SB48
365	SA48
366	SC47
367	SB47
368	SA47
369	SC46
370	SB46
371	SA46
372	SC45
373	SB45
374	SA45
375	SC44
376	SB44
377	SA44
378	SC43
379	SB43
380	SA43
381	SC42
382	SB42
383	SA42
384	SC41
385	SB41
386	SA41
387	SC40
388	SB40
389	SA40
390	SC39
391	SB39
392	SA39
393	SC38
394	SB38
395	SA38
396	SC37
397	SB37
398	SA37
399	SC36
400	SB36
401	SA36
402	SC35
403	SB35
404	SA35
405	SC34
406	SB34
407	SA34
408	SC33
409	SB33
410	SA33
411	SC32
412	SB32
413	SA32
414	SC31
415	SB31
416	SA31
417	SC30
418	SB30
419	SA30
420	SC29
421	SB29
422	SA29
423	SC28
424	SB28
425	SA28
426	SC27
427	SB27
428	SA27
429	SC26
430	SB26
431	SA26
432	SC25
433	SB25
434	SA25
435	SC24
436	SB24
437	SA24
438	SC23
439	SB23
440	SA23
441	SC22
442	SB22
443	SA22
444	SC21
445	SB21
446	SA21
447	SC20
448	SB20
449	SA20
450	SC19
451	SB19
452	SA19
453	SC18
454	SB18
455	SA18
456	SC17
457	SB17
458	SA17
459	SC16
460	SB16
461	SA16
462	SC15
463	SB15
464	SA15
465	SC14
466	SB14
467	SA14
468	SC13
469	SB13
470	SA13
471	SC12
472	SB12
473	SA12
474	SC11
475	SB11
476	SA11
477	SC10
478	SB10
479	SA10
480	SC9
481	SB9
482	SA9
483	SC8
484	SB8
485	SA8
486	SC7
487	SB7
488	SA7
489	SC6
490	SB6
491	SA6
492	SC5
493	SB5
494	SA5
495	SC4
496	SB4
497	SA4
498	SC3
499	SB3
500	SA3
501	SC2
502	SB2
503	SA2
504	SC1
505	SB1
506	SA1
507	SC0
508	SB0
509	SA0
510	NC
511	NC
512	NC
513	NC
514	NC
515	NC
516	NC
517	NC
518	NC
519	NC
520	NC
521	NC
522	NC
523	NC
524	NC
525	NC
526	NC
527	NC
528	NC
529	NC
530	COM0
531	COM1
532	COM2
533	COM3
534	COM4
535	COM5
536	COM6
537	COM7
538	COM8
539	COM9
540	COM10
541	COM11
542	COM12
543	COM13
544	COM14
545	COM15
546	COM16
547	COM17
548	COM18
549	COM19
550	COM20
551	COM21
552	COM22
553	COM23
554	COM24
555	COM25
556	COM26
557	COM27
558	COM28
559	COM29
560	COM30
561	COM31
562	COM32
563	COM33
564	COM34
565	COM35
566	COM36
567	COM37
568	COM38
569	COM39
570	COM40
571	COM41
572	COM42
573	COM43
574	COM44
575	COM45
576	COM46
577	COM47
578	COM48
579	COM49
580	COM50
581	COM51
582	COM52
583	COM53
584	COM54
585	COM55
586	COM56
587	COM57
588	COM58
589	COM59
590	COM60
591	COM61
592	COM62
593	COM63
594	NC
595	NC

7 PIN DESCRIPTIONS

Key:

I = Input	NC = Not Connected
O =Output	Pull LOW= connect to Ground
I/O = Bi-directional (input/output)	Pull HIGH= connect to V_{DDIO}
P = Power pin	

Table 7-1 : SSD1351 Pin Description

Pin Name	Pin Type	Description
V_{DD}	P	Power supply pin for core logic operation. V_{DD} can be supplied externally (within the range of 2.4V to 2.6V) or regulated internally from V_{CI}. A capacitor should be connected between V_{DD} and V_{SS} under all circumstances. Refer to Section 8.10 for details.
V_{DDIO}	P	Power supply for interface logic level. It should match with the MCU interface voltage level and must be connected to external source.
V_{CI}	P	Low voltage power supply V_{CI} must always be equal to or higher than V_{DD} and V_{DDIO}. Refer to Section 8.10 for details.
V_{CC}	P	Power supply for panel driving voltage. This is also the most positive power voltage supply pin. It is supplied by external high voltage source.
V_{PP}	P	Reserved pin. It must be connected to V_{DD}.
V_{SS}	P	Ground pin
V_{LSS}	P	Analog system ground pin
V_{COMH}	P	COM signal deselected voltage level. A capacitor should be connected between this pin and V_{SS}.
BGGND	P	It should be connected to Ground.
GPIO0	I/O	Detail refer to Command B5h
GPIO1	I/O	Detail refer to Command B5h
VSL	P	This is segment voltage reference pin. External VSL is set as default. This pin has to connect with resistor and diode to ground. (details depend on application) Refer to Command B4h for details.

<table>
<tr><th>Pin Name</th><th>Pin Type</th><th>Description</th></tr>
<tr><td>BS[1:0]</td><td>I</td><td>MCU bus interface selection pins. Select appropriate logic setting as described in the following table. BS3 and BS2 are command programmable (by command ABh). [reset = 00]. BS1 and BS0 are pin select.

Table 7-2 : Bus Interface selection
<table><tr><td>BS[3:0]</td><td>Interface</td></tr><tr><td>XX00</td><td>4 line SPI</td></tr><tr><td>XX01</td><td>3 line SPI</td></tr><tr><td>0011</td><td>8-bit 6800 parallel</td></tr><tr><td>0010</td><td>8-bit 8080 parallel</td></tr><tr><td>0111</td><td>16-bit 6800 parallel</td></tr><tr><td>0110</td><td>16-bit 8080 parallel</td></tr><tr><td>1111</td><td>18-bit 6800 parallel</td></tr><tr><td>1110</td><td>18-bit 8080 parallel</td></tr></table>Note
(1) 0 is connected to V_{SS}
(2) 1 is connected to V_{DDIO}</td></tr>
<tr><td>I_{REF}</td><td>I</td><td>This pin is the segment output current reference pin.
A resistor should be connected between this pin and V_{SS}.</td></tr>
<tr><td>CL</td><td>I</td><td>External clock input pin.

When internal clock is enable (i.e. pull HIGH in CLS pin), this pin is not used and should be connected to Ground.
When internal clock is disable (i.e. pull LOW is CLS pin), this pin is the external clock source input pin.</td></tr>
<tr><td>CLS</td><td>I</td><td>Internal clock selection pin.

When this pin is pulled HIGH, internal oscillator is enabled (normal operation).
When this pin is pulled LOW, an external clock signal should be connected to CL.</td></tr>
<tr><td>CS#</td><td>I</td><td>This pin is the chip select input connecting to the MCU.

The chip is enabled for MCU communication only when CS# is pulled LOW.</td></tr>
<tr><td>RES#</td><td>I</td><td>This pin is reset signal input.

When the pin is pulled LOW, initialization of the chip is executed.
Keep this pin pull HIGH during normal operation.</td></tr>
<tr><td>D/C#</td><td>I</td><td>This pin is Data/Command control pin connecting to the MCU.

When the pin is pulled HIGH, the data at D[17:0] will be interpreted as data.
When the pin is pulled LOW, the data at D[17:0] will be interpreted as command.</td></tr>
<tr><td>R/W# (WR#)</td><td>I</td><td>This pin is read / write control input pin connecting to the MCU interface.

When 6800 interface mode is selected, this pin will be used as Read/Write (R/W#) selection input. Read mode will be carried out when this pin is pulled HIGH and write mode when LOW.

When 8080 interface mode is selected, this pin will be the Write (WR#) input. Data write operation is initiated when this pin is pulled LOW and the chip is selected.

When serial interface is selected, this pin R/W (WR#) must be connected to V_{SS}.</td></tr>
</table>

Pin Name	Pin Type	Description
E (RD#)	I	This pin is MCU interface input. When 6800 interface mode is selected, this pin will be used as the Enable (E) signal. Read/write operation is initiated when this pin is pulled HIGH and the chip is selected. When 8080 interface mode is selected, this pin receives the Read (RD#) signal. Read operation is initiated when this pin is pulled LOW and the chip is selected. When serial interface is selected, this pin E(RD#) must be connected to V_{SS}.
D[17:0]	I/O	These pins are bi-directional data bus connecting to the MCU data bus. Unused pins are recommended to tie LOW. (Except for D2 pin in SPI mode)
FR	O	This pin is reserved pin. No connection is necessary and should be left open individually.
TR[4:0]	O	These are reserved pins. No connection is necessary and should be left open individually.
V_{SS1}	P	This pin is reserved pin. It should be connected to V_{SS}.
V_{CI1}	P	This pin is reserved pin. No connection is necessary and should be left open individually.
SA[127:0] SB[127:0] SC[127:0]	O	These pins provide the OLED segment driving signals. These pins are V_{SS} state when display is OFF. The 384 segment pins are divided into 3 groups, SA, SB and SC. Each group can have different color settings for color A, B and C.
COM[127:0]	I/O	These pins provide the Common switch signals to the OLED panel.

8 FUNCTIONAL BLOCK DESCRIPTIONS

8.1 MCU Interface

SSD1351 MCU interface consist of 18 data pin and 5 control pins. The pin assignment at different interface mode is summarized in Table 8-1. Different MCU mode can be set by hardware selection on BS[1:0] pins and software command on BS[3:0].(refer to Table 7-2 for BS[3:0] setting)

Table 8-1 : MCU interface assignment under different bus interface mode

Pin Name / Bus Interface	Data / Command Interface																Control Signal				
	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	E	R/W#	CS#	D/C#	RES#
8b / 8080	Tie Low										D[7:0]								RD#	WR#	CS#	D/C#	RES#
8b / 6800	Tie Low										D[7:0]								E	R/W#	CS#	D/C#	RES#
16b / 8080	Tie Low										D[15:0]								RD#	WR#	CS#	D/C#	RES#
16b / 6800	Tie Low										D[15:0]								E	R/W#	CS#	D/C#	RES#
18b / 8080	D[17:0]																		RD#	WR#	CS#	D/C#	RES#
18b / 6800	D[17:0]																		E	R/W#	CS#	D/C#	RES#
SPI 4-wire	Tie Low															NC	SDIN	SCLK	Tie Low		CS#	D/C#	RES#
SPI 3-Wire	Tie Low															NC	SDIN	SCLK	Tie Low		CS#	Tie Low	RES#

Table 8-2 : Data bus selection modes

	6800 – series Parallel Interface	**8080 – series Parallel Interface**	**3-wire Serial Interface or 4-wire Serial Interface**
Data Read	18-/16-/8-bits	18-/16-/8-bits	No
Data Write	18-/16-/8-bits	18-/16-/8-bits	8-bits
Command Read	Yes. Refer to section 9	Yes. Refer to section 9	No
Command Write	Yes	Yes	Yes

8.1.1 MCU Parallel 6800-series Interface

The parallel interface consists of 18 bi-directional data pins (D[17:0]), R/W#, D/C#, E and CS#.

A LOW in R/W# indicates WRITE operation and HIGH in R/W# indicates READ operation.
A LOW in D/C# indicates COMMAND read/write and HIGH in D/C# indicates DATA read/write.
The E input serves as data latch signal while CS# is LOW. Data is latched at the falling edge of E signal.

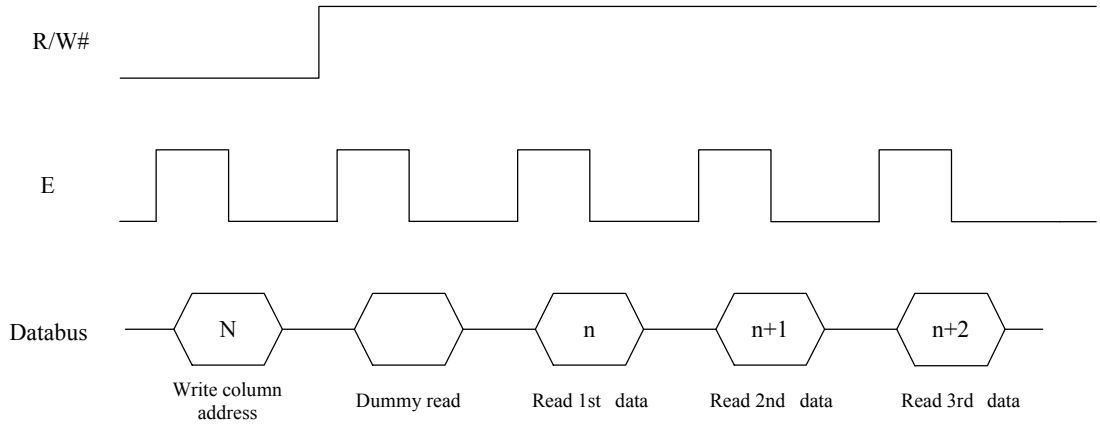
Table 8-3 : Control pins of 6800 interface

Function	**E**	**R/W#**	**CS#**	**D/C#**
Write command	↓	L	L	L
Read status	↓	H	L	L
Write data	↓	L	L	H
Read data	↓	H	L	H

Note
(1) ↓ stands for falling edge of signal
(2) H stands for HIGH in signal
(3) L stands for LOW in signal

In order to match the operating frequency of display RAM with that of the microprocessor, some pipeline processing is internally performed which requires the insertion of a dummy read before the first actual display data read. This is shown in Figure 8-1.

Figure 8-1 : Data read back procedure - insertion of dummy read



8.1.2 MCU Parallel 8080-series Interface

The parallel interface consists of 18 bi-directional data pins (D[17:0]), RD#, WR#, D/C# and CS#.

A LOW in D/C# indicates COMMAND read/write and HIGH in D/C# indicates DATA read/write.
A rising edge of RD# input serves as a data READ latch signal while CS# is kept LOW.
A rising edge of WR# input serves as a data/command WRITE latch signal while CS# is kept LOW.

Figure 8-2 : Example of Write procedure in 8080 parallel interface mode

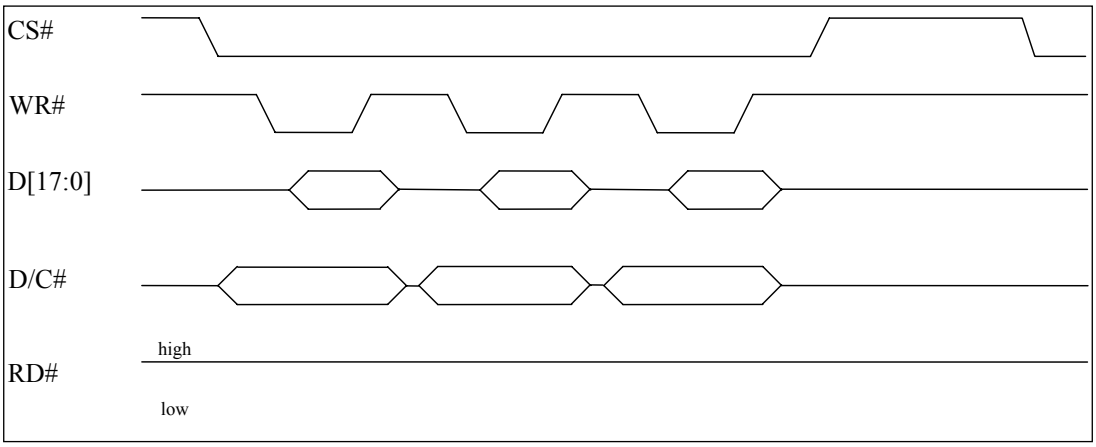


Figure 8-3 : Example of Read procedure in 8080 parallel interface mode

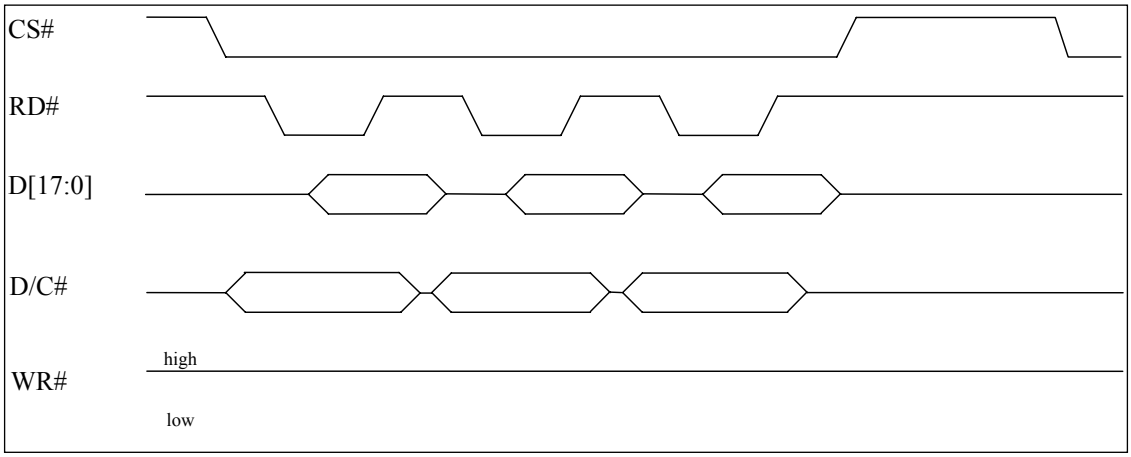


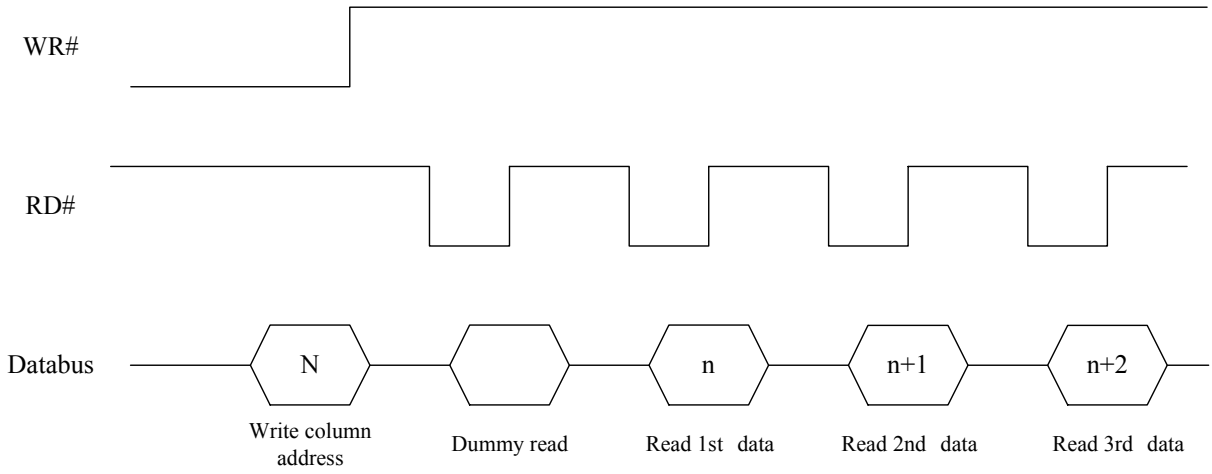
Table 8-4 : Control pins of 8080 interface

Function	RD#	WR#	CS#	D/C#
Write command	H	↑	L	L
Read status	↑	H	L	L
Write data	H	↑	L	H
Read data	↑	H	L	H

Note
(1) ↑ stands for rising edge of signal
(2) H stands for HIGH in signal
(3) L stands for LOW in signal

In order to match the operating frequency of display RAM with that of the microprocessor, some pipeline processing is internally performed which requires the insertion of a dummy read before the first actual display data read. This is shown in Figure 8-4.

Figure 8-4 : Display data read back procedure - insertion of dummy read



8.1.3 MCU Serial Interface (4-wire SPI)

The 4-wire serial interface consists of serial clock: SCLK, serial data: SDIN, D/C#, CS#. In 4-wire SPI mode, D0 acts as SCLK, D1 acts as SDIN. For the unused data pins, D2 should be left open. The pins from D3 to D17and E can be connected to an external ground.

Table 8-5 : Control pins of 4-wire Serial interface

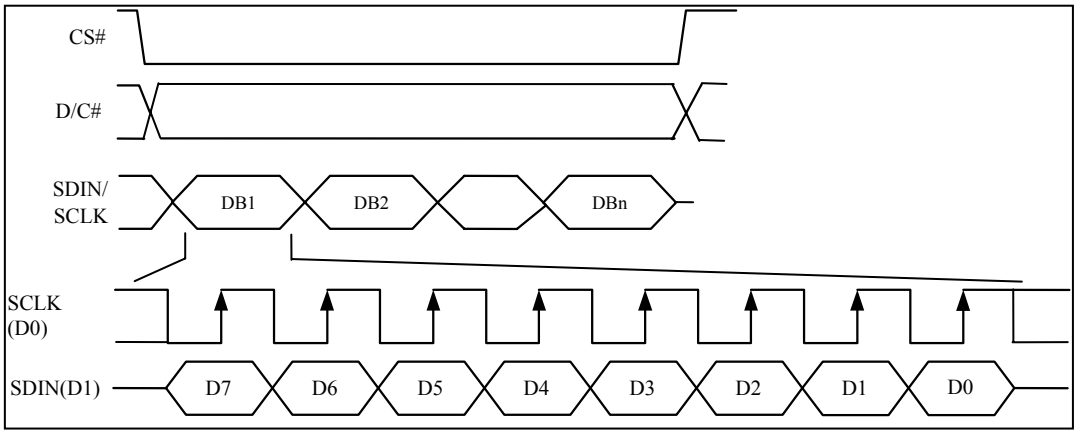
Function	E	CS#	D/C#
Write command	Tie LOW	L	L
Write data	Tie LOW	L	H

Note
(1) H stands for HIGH in signal
(2) L stands for LOW in signal

SDIN is shifted into an 8-bit shift register on every rising edge of SCLK in the order of D7, D6, ... D0. D/C# is sampled on every eighth clock and the data byte in the shift register is written to the Graphic Display Data RAM (GDDRAM) or command register in the same clock.

Under serial mode, only write operations are allowed.

Figure 8-5 : Write procedure in 4-wire Serial interface mode



8.1.4 MCU Serial Interface (3-wire SPI)

The 3-wire serial interface consists of serial clock SCLK, serial data SDIN and CS#.
In 3-wire SPI mode, D0 acts as SCLK, D1 acts as SDIN. For the unused data pins, D2 should be left open. The pins from D3 to D17, R/W# (WR#), E(RD#) and D/C# can be connected to an external ground.

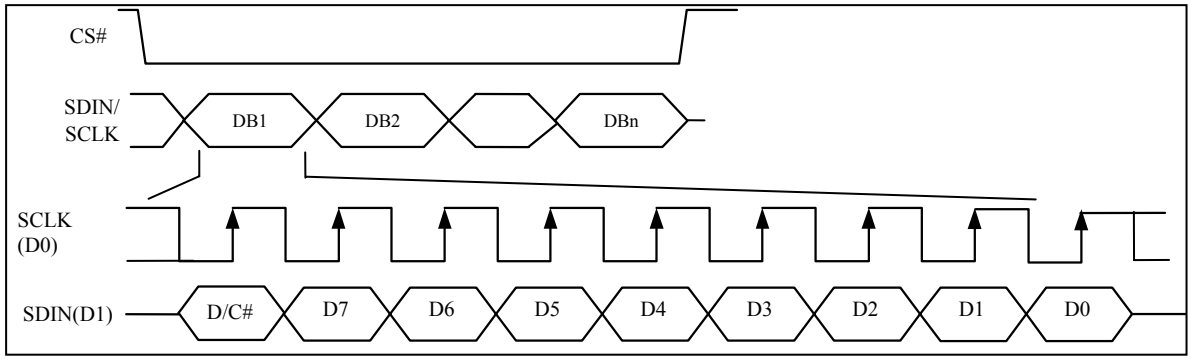
The operation is similar to 4-wire serial interface while D/C# pin is not used. There are altogether 9-bits will be shifted into the shift register on every ninth clock in sequence: D/C# bit, D7 to D0 bit. The D/C# bit (first bit of the sequential data) will determine the following data byte in the shift register is written to the Display Data RAM (D/C# bit = 1) or the command register (D/C# bit = 0). Under serial mode, only write operations are allowed.

Table 8-6 : Control pins of 3-wire Serial interface

Function	E(RD#)	R/W#(WR#)	CS#	D/C#	D0
Write command	Tie LOW	Tie LOW	L	Tie LOW	↑
Write data	Tie LOW	Tie LOW	L	Tie LOW	↑

Note
(1) L stands for LOW in signal

Figure 8-6 : Write procedure in 3-wire Serial interface mode



8.2 Reset Circuit

When RES# input is pulled LOW, the chip is initialized with the following status:

1. Display is OFF
2. 128 MUX Display Mode
3. Normal segment and display data column address and row address mapping (SEG0 mapped to address 00h and COM0 mapped to address 00h)
4. Display start line is set at display RAM address 0
5. Column address counter is set at 0
6. Normal scan direction of the COM outputs
7. Command A2h,B1h,B3h,BBh,BEh are locked by command FDh

8.3 GDDRAM

8.3.1 GDDRAM structure

The GDDRAM is a bit mapped static RAM holding the pattern to be displayed. The RAM size is 128 x 128 x 18bits. For mechanical flexibility, re-mapping on both Segment and Common outputs can be selected by software. Each pixel has 18-bit data. Each sub-pixels for color A, B and C have 6 bits. The arrangement of data pixel in graphic display data RAM is shown in Table 8-7

Table 8-7 : 262k Color Depth Graphic Display Data RAM Structure

Segment	Normal	0			1			2	.....	.....	126	127			
Address	Remapped	127			126			125	.....	.....	1	0			
Color		A	B	C	A	B	C	A			C	A	B	C	
Data Format / Common Address		A5	B5	C5	A5	B5	C5	A5	.....	.....	C5	A5	B5	C5	
		A4	B4	C4	A4	B4	C4	A4	.....	.....	C4	A4	B4	C4	
		A3	B3	C3	A3	B3	C3	A3	.....	.....	C3	A3	B3	C3	
		A2	B2	C2	A2	B2	C2	A2	.....	.....	C2	A2	B2	C2	
		A1	B1	C1	A1	B1	C1	A1	.....	.....	C1	A1	B1	C1	
		A0	B0	C0	A0	B0	C0	A0	.....	.....	C0	A0	B0	C0	Common output
Normal	Remapped														
0	127	6	6	6	6	6	6	6	.....	.....	6	6	6	6	COM0
1	126	6	6	6	6	6	6	6	.....	.....	6	6	6	6	COM1
2	125	6	6	6	6	6	6	6	.....	.....	6	6	6	6	COM2
3	124	6	6	6	6	6	6	6	.....	.....	6	6	6	6	COM3
4	123	6	6	6	6	6	6	6	.....	.....	6	6	6	6	COM4
5	122	6	6	6	6	6	6	6	.....	.....	6	6	6	6	COM5
6	121	6	6	no of bits in this cell			6	6	.....	.....	6	6	6	6	COM6
7	120								.....	.....	6	6	6	6	COM7
:	:	:	:	:	:	:	:	:	.....	.....	:	:	:	:	:
:	:	:	:	:	:	:	:	:	.....	.....	:	:	:	:	:
:	:	:	:	:	:	:	:	:	.....	.....	:	:	:	:	:
123	4	6	6	6	6	6	6	6	.....	.....	6	6	6	6	:
124	3	6	6	6	6	6	6	6	.....	.....	6	6	6	6	COM124
125	2	6	6	6	6	6	6	6	.....	.....	6	6	6	6	COM125
126	1	6	6	6	6	6	6	6	.....	.....	6	6	6	6	COM126
127	0	6	6	6	6	6	6	6	.....	.....	6	6	6	6	COM127

SEG output	SA0	SB0	SC0	SA1	SB1	SC1	SA2	.....	.....	SC126	SA127	SB127	SC127

8.3.2 Data bus to RAM mapping under different input mode

Table 8-8 : Write Data bus usage under different bus width and color depth mode

Write Data			Data bus																	
Bus width	**Color Depth**	**Input order**	**D17**	**D16**	**D15**	**D14**	**D13**	**D12**	**D11**	**D10**	**D9**	**D8**	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
8 bits/Serial	**65k**	**1st**	X	X	X	X	X	X	X	X	X	X	C_4	C_3	C_2	C_1	C_0	B_5	B_4	B_3
		2nd	X	X	X	X	X	X	X	X	X	X	B_2	B_1	B_0	A_4	A_3	A_2	A_1	A_0
8 bits/Serial	**262k**	**1st**	X	X	X	X	X	X	X	X	X	X	X	X	C_5	C_4	C_3	C_2	C_1	C_0
		2nd	X	X	X	X	X	X	X	X	X	X	X	X	B_5	B_4	B_3	B_2	B_1	B_0
		3rd	X	X	X	X	X	X	X	X	X	X	X	X	A_5	A_4	A_3	A_2	A_1	A_0
16 bits	**65k**		X	X	C_4	C_3	C_2	C_1	C_0	B_5	B_4	B_3	B_2	B_1	B_0	A_4	A_3	A_2	A_1	A_0
16 bits	**262k format 1**	**1st**	X	X	X	X	X	X	X	X	X	X	X	X	C_5	C_4	C_3	C_2	C_1	C_0
		2nd	X	X	X	X	B_5	B_4	B_3	B_2	B_1	B_0	X	X	A_5	A_4	A_3	A_2	A_1	A_0
16 bits	**262k format 2**	**1st**	X	X	X	X	$C1_5$	$C1_4$	$C1_3$	$C1_2$	$C1_1$	$C1_0$	X	X	$B1_5$	$B1_4$	$B1_3$	$B1_2$	$B1_1$	$B1_0$
		2nd	X	X	X	X	$A1_5$	$A1_4$	$A1_3$	$A1_2$	$A1_1$	$A1_0$	X	X	$C2_5$	$C2_4$	$C2_3$	$C2_2$	$C2_1$	$C2_0$
		3rd	X	X	X	X	$B2_5$	$B2_4$	$B2_3$	$B2_2$	$B2_1$	$B2_0$	X	X	$A2_5$	$A2_4$	$A2_3$	$A2_2$	$A2_1$	$A2_0$
18 bits	**262k**		C_5	C_4	C_3	C_2	C_1	C_0	B_5	B_4	B_3	B_2	B_1	B_0	A_5	A_4	A_3	A_2	A_1	A_0

Table 8-9 : Read Data bus usage under different bus width and color depth mode

Read Data			Data bus																	
Bus width	**Color Depth**	**Input order**	**D17**	**D16**	**D15**	**D14**	**D13**	**D12**	**D11**	**D10**	**D9**	**D8**	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
8 bits	**65k**	**1st**	X	X	X	X	X	X	X	X	X	X	C_4	C_3	C_2	C_1	C_0	B_5	B_4	B_3
		2nd	X	X	X	X	X	X	X	X	X	X	B_2	B_1	B_0	A_4	A_3	A_2	A_1	A_0
8 bits	**262k**	**1st**	X	X	X	X	X	X	X	X	X	X	X	X	C_5	C_4	C_3	C_2	C_1	C_0
		2nd	X	X	X	X	X	X	X	X	X	X	X	X	B_5	B_4	B_3	B_2	B_1	B_0
		3rd	X	X	X	X	X	X	X	X	X	X	X	X	A_5	A_4	A_3	A_2	A_1	A_0
16 bits	**65k**		X	X	C_4	C_3	C_2	C_1	C_0	B_5	B_4	B_3	B_2	B_1	B_0	A_4	A_3	A_2	A_1	A_0
16 bits	**262k format 1**	**1st**	X	X	X	X	X	X	X	X	X	X	X	X	C_5	C_4	C_3	C_2	C_1	C_0
		2nd	X	X	X	X	B_5	B_4	B_3	B_2	B_1	B_0	X	X	A_5	A_4	A_3	A_2	A_1	A_0
16 bits	**262k format 2**	**1st**	X	X	X	X	$C1_5$	$C1_4$	$C1_3$	$C1_2$	$C1_1$	$C1_0$	X	X	$B1_5$	$B1_4$	$B1_3$	$B1_2$	$B1_1$	$B1_0$
		2nd	X	X	X	X	$A1_5$	$A1_4$	$A1_3$	$A1_2$	$A1_1$	$A1_0$	X	X	$C2_5$	$C2_4$	$C2_3$	$C2_2$	$C2_1$	$C2_0$
		3rd	X	X	X	X	$B2_5$	$B2_4$	$B2_3$	$B2_2$	$B2_1$	$B2_0$	X	X	$A2_5$	$A2_4$	$A2_3$	$A2_2$	$A2_1$	$A2_0$
18 bits	**262k**		C_5	C_4	C_3	C_2	C_1	C_0	B_5	B_4	B_3	B_2	B_1	B_0	A_5	A_4	A_3	A_2	A_1	A_0

8.4 Command Decoder

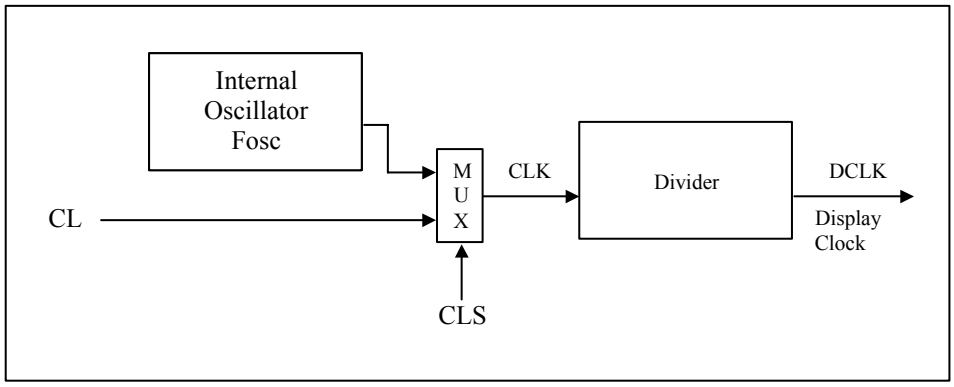
This module determines whether the input should be interpreted as data or command based upon the input of the D/C# pin.

If D/C# pin is HIGH, data is written to Graphic Display Data RAM (GDDRAM). If it is LOW, the inputs at D0-D17 are interpreted as a Command and it will be decoded and be written to the corresponding command register.

8.5 Oscillator & Timing Generator

8.5.1 Oscillator

Figure 8-7 : Oscillator Circuit



This module is an On-Chip low power RC oscillator circuitry (Figure 8-7). The operation clock (CLK) can be generated either from internal oscillator or external source CL pin by CLS pin. If CLS pin is HIGH, internal oscillator is selected. If CLS pin is LOW, external clock from CL pin will be used for CLK. The frequency of internal oscillator F_{OSC} can be programmed by command B3h.

The display clock (DCLK) for the Display Timing Generator is derived from CLK. The division factor "D" can be programmed from 1 to 16 by command B3h.

$$DCLK = F_{OSC} / D$$

The frame frequency of display is determined by the following formula:

$$F_{FRM} = \frac{F_{osc}}{D \times K \times \text{No. of Mux}}$$

where

- D stands for clock divide ratio. It is set by command B3h A[3:0]. The divide ratio has the range from 1 to 1024 .
- K is the number of display clocks per row. The value is derived by
  K = Phase 1 period +Phase 2 period + X
  X = DCLKs in current drive period. Default X = 134
  Default K is 5 + 8 + 134 = 147
- Number of multiplex ratio is set by command CAh. The reset value is 127 (i.e. 128MUX).
- F_{osc} is the oscillator frequency. It can be changed by command B3h A[7:4]. The higher the register setting results in higher frequency.

If the frame frequency is set too low, flickering may occur. On the other hand, higher frame frequency leads to higher power consumption on the whole system.

8.6 SEG/COM Driving block

This block is used to derive the incoming power sources into the different levels of internal use voltage and current.

- V_{CC} is the most positive voltage supply.
- V_{COMH} is the Common deselected level. It is internally regulated.
- V_{LSS} is the ground path of the analog and panel current.
- I_{REF} is a reference current for segment current drivers I_{SEG}. The relationship between reference current and segment current of a color is:

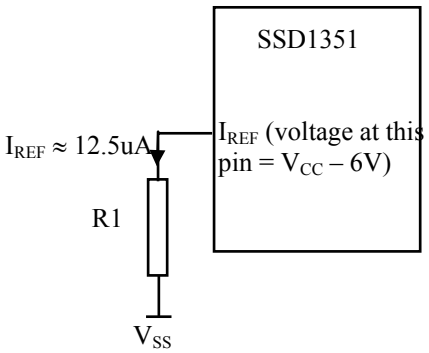
  I_{SEG} = Contrast / 256 * I_{REF} * scale factor

  in which
  the contrast is set by Set Contrast command (C1h); and
  the scale factor (1 ~ 16) is set by Master Current Control command (C7h).

A resistor should be connected between I_{REF} pin and V_{SS} pin.

For example, in order to achieve I_{SEG} = 200uA at maximum contrast 255, I_{REF} is set to around 12.5uA. This current value is obtained by connecting an appropriate resistor from I_{REF} pin to V_{SS} as shown in Figure 8-8.

Figure 8-8 : I_{REF} Current Setting by Resistor Value



Since the voltage at I_{REF} pin is V_{CC} – 6V, the value of resistor R1 can be found as below:

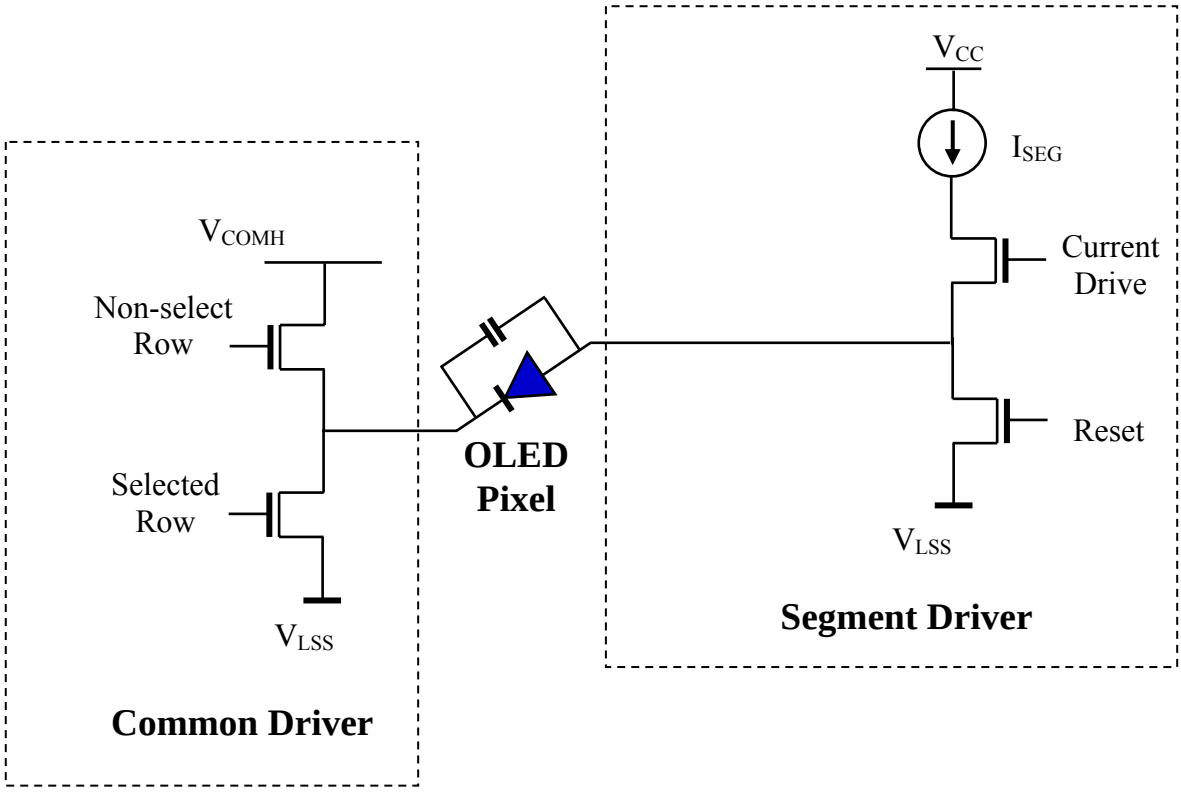
For I_{REF} = 12.5uA, V_{CC} =16V:

R1 = (Voltage at I_{REF} – V_{SS}) / I_{REF}
≈ (16 – 6) / 12.5uA
≈ 800KΩ

8.7 SEG / COM Driver

Segment drivers consist of 384 (128 x 3 colors) current sources to drive OLED panel. The driving current can be adjusted from 0 to 200uA with 256 steps by contrast setting command (C1h). Common drivers generate scanning voltage pulse. The block diagrams and waveforms of the segment and common driver are shown as follow.

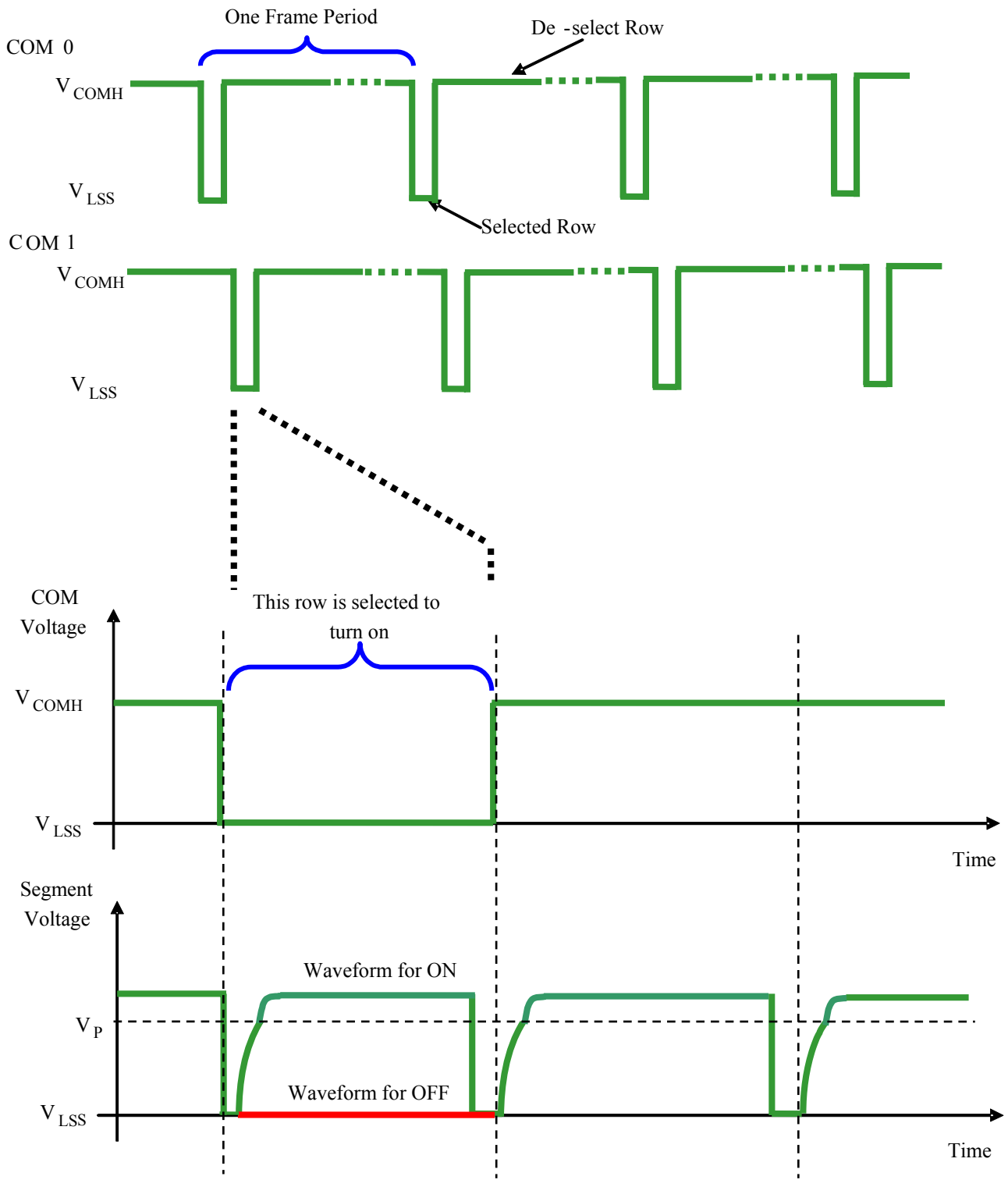
Figure 8-9 : Segment and Common Driver Block Diagram



The commons are scanned sequentially, row by row. If a row is not selected, all the pixels on the row are in reverse bias by driving those commons to voltage V_{COMH} as shown in Figure 8-10.

In the scanned row, the pixels on the row will be turned ON or OFF by sending the corresponding data signal to the segment pins. If the pixel is turned OFF, the segment current is disabled and the Reset switch is enabled. On the other hand, the segment drives to I_{SEG} when the pixel is turned ON.

Figure 8-10 : Segment and Common Driver Signal Waveform



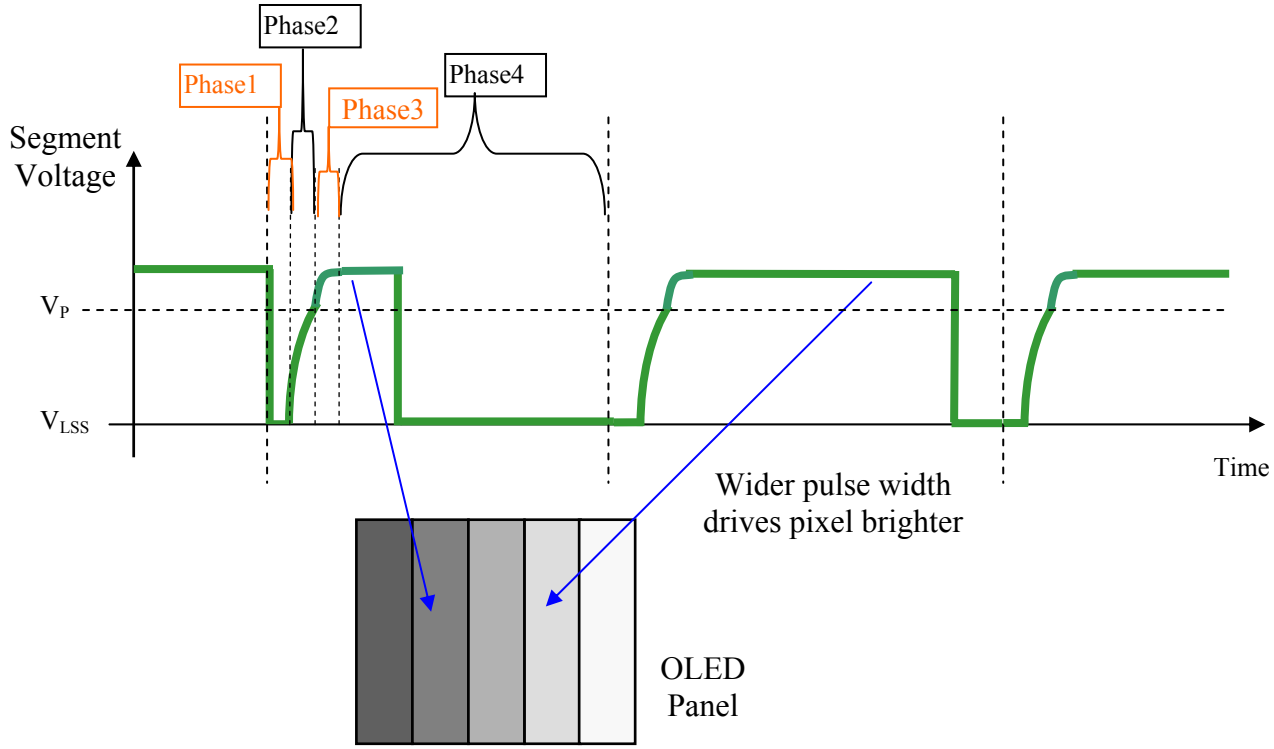
There are four phases to driving an OLED a pixel. In phase 1, the pixel is reset by the segment driver to V_{LSS} in order to discharge the previous data charge stored in the parasitic capacitance along the segment electrode. The period of phase 1 can be programmed by command B1h A[3:0]. An OLED panel with larger capacitance requires a longer period for discharging.

In phase 2, first pre-charge is performed. The pixel is driven to attain the corresponding voltage level V_P from V_{LSS}. The amplitude of V_P can be programmed by the command BBh. The period of phase 2 can be programmed by command B1h A[7:4]. If the capacitance value of the pixel of OLED panel is larger, a longer period is required to charge up the capacitor to reach the desired voltage.

In phase 3, the OLED pixel is driven to the targeted driving voltage through second pre-charge. The second pre-charge can control the speed of the charging process. The period of phase 3 can be programmed by command B6h.

Last phase (phase 4) is current drive stage. The current source in the segment driver delivers constant current to the pixel. The driver IC employs PWM (Pulse Width Modulation) method to control the gray scale of each pixel individually. The gray scale can be programmed into different Gamma settings by command B8h/B9h. The bigger gamma setting in the current drive stage results in brighter pixels and vice versa (Details refer to Section 8.8). This is shown in the following figure.

Figure 8-11: Gray Scale Control in Segment



After finishing phase 4, the driver IC will go back to phase 1 to display the next row image data. This four-step cycle is run continuously to refresh image display on OLED panel.

The length of phase 4 is defined by command B8h "Look Up Table for Gray Scale Pulse width" or B9h "Use Built-in Linear LUT". In the table, the gray scale is defined in incremental way, with reference to the length of previous table entry.

8.8 Gray Scale Decoder

The gray scale effect is generated by controlling the segment current in current drive phase. The segment current is controlled by the Gamma Settings (Setting 0~ Setting 180) through command B8h. The larger the setting, the brighter the pixel will be. The Gray Scale Table stores the corresponding Gamma Setting of the 64 gray scale levels (GS0~GS63) through the software commands B8h or B9h. Three programmable Gray Scale Tables (Gamma Look Up table) support the three colors A, B and C.

As shown in Figure 8-12, color A, B, C sub-pixel RAM data has 6 bits, represent the 64 gray scale level from GS0 to GS63.

Figure 8-12 : Relation between GDDRAM content and Gray Scale table entry for three colors in 262K color mode (under command B9h Use Built-in Linear LUT)

Color A, B or C GDDRAM data (6 bits)	Gray Scale Table	Default Gamma Setting (Command B9h Linear Gamma Look Up Table)
000000	GS0	Setting 0
000001	GS1	Setting 0
000010	GS2	Setting 2
000011	GS3	Setting 4
000100	GS4	Setting 6
:	:	:
111101	GS61	Setting 120
111110	GS62	Setting 122
111111	GS63	Setting 124

In command B8h, there are total 180 Gamma Settings (Setting 0 to Setting 180) available for the Gray Scale table. GS0 has no pre-charge and current drive stages so it is in Gamma Setting 0. GS1 can be set as only pre-charge but no current drive stage by input Gamma Setting 0.

When setting the Gray Scale Table (by B8h command) , the rules below must follow:

1) All Gamma Settings (i.e. GS1, GS2, GS3,.....GS63) are entered after command B8h.

2) The gray scale is defined in incremental way, with reference to the length of previous table entry:

Setting of GS1 has to be >= 0
Setting of GS2 has to be > Setting of GS1 +1
Setting of GS3 has to be > Setting of GS2 +1
:
Setting of GS63 has to be > Setting of GS62 +1

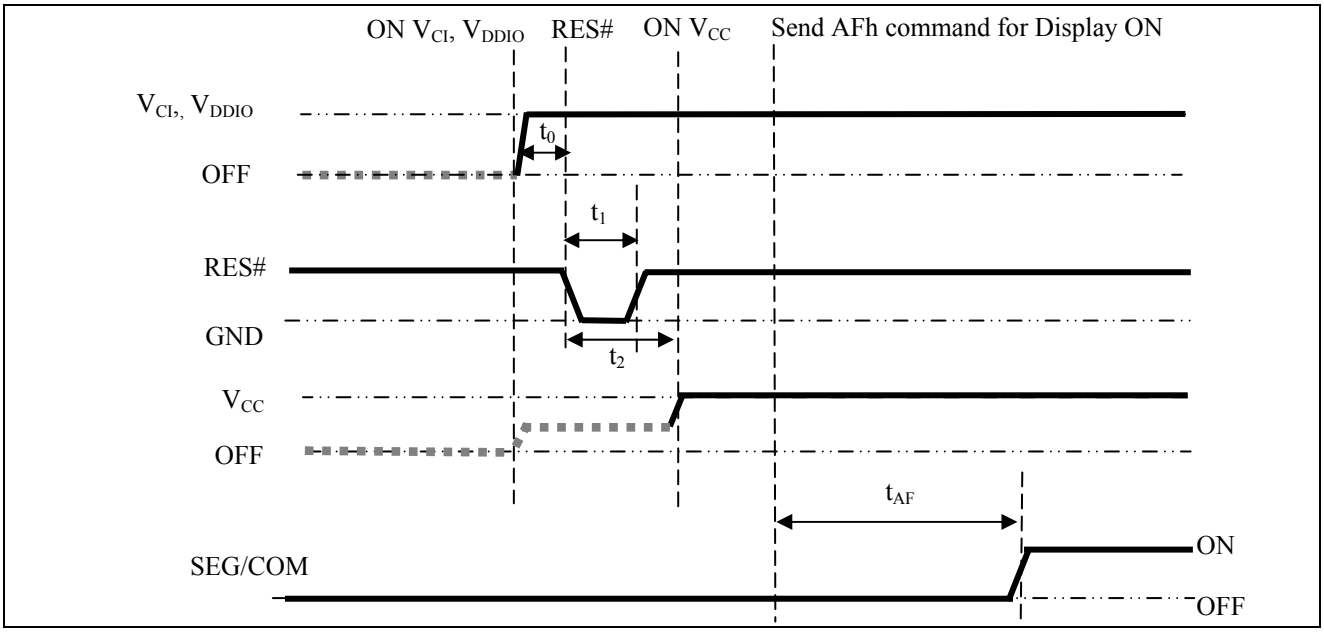
8.9 Power ON and OFF sequence

The following figures illustrate the recommended power ON and power OFF sequence of SSD1351 (assume V_{CI} and V_{DDIO} are at the same voltage level and internal V_{DD} is used).

Power ON sequence:

1. Power ON $V_{CI,}$ $V_{DDIO.}$
2. After V_{CI}, V_{DDIO} become stable, set wait time at least 1ms (t_0) for internal V_{DD} become stable. Then set RES# pin LOW (logic low) for at least 2us (t_1) [4] and then HIGH (logic high).
3. After set RES# pin LOW (logic low), wait for at least 2us (t_2). Then Power ON $V_{CC.}$ [1]
4. After V_{CC} become stable, send command AFh for display ON. SEG/COM will be ON after 200ms (t_{AF}).

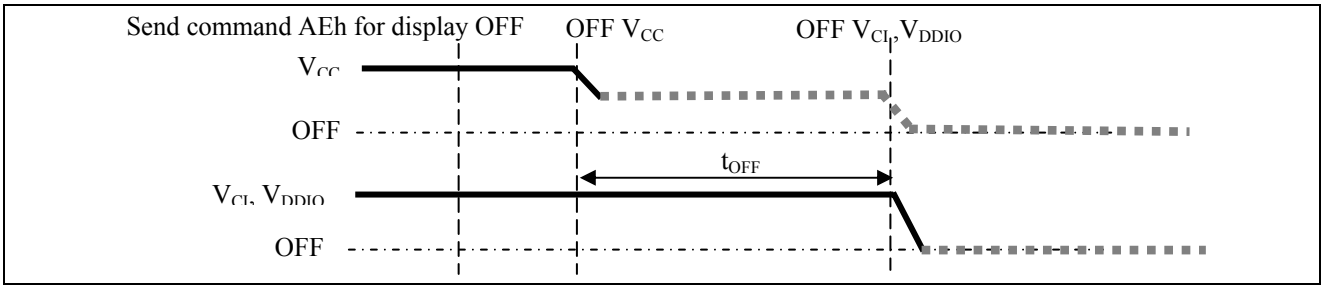
Figure 8-13 : The Power ON sequence.



Power OFF sequence:

1. Send command AEh for display OFF.
2. Power OFF $V_{CC.}$ [1], [2]
3. Wait for t_{OFF}. Power OFF $V_{CI,}$ $V_{DDIO.}$ (where Minimum t_{OFF}=0ms [3], Typical t_{OFF}=100ms)

Figure 8-14 : The Power OFF sequence



Note:

[1] Since an ESD protection circuit is connected between V_{CI}, V_{DDIO} and V_{CC}, V_{CC} becomes lower than V_{CI} whenever V_{CI}, V_{DDIO} is ON and V_{CC} is OFF as shown in the dotted line of V_{CC} in Figure 8-13 and Figure 8-14.

[2] V_{CC} should be kept float (disable) when it is OFF.

[3] V_{CI}, V_{DDIO} should not be Power OFF before V_{CC} Power OFF.

[4] The register values are reset after t_1.

[5] Power pins (V_{CI}, V_{DDIO} and V_{CC}) can never be pulled to ground under any circumstance.

8.10 V_{DD} Regulator

In SSD1351, the power supply pin for core logic operation: V_{DD}, can be supplied by external source or internally regulated through the V_{DD} regulator.

When the command ABh, bit A[0] is set to 1b, the internal V_{DD} regulator is enabled. V_{CI} should be larger than 2.6V when using the internal V_{DD} regulator.

When the command ABh, bit A[0] is set to 0b, external V_{DD} should be used. (external V_{DD} range : 2.4V~2.6V)

It should be notice that, no matter V_{DD} is supplied by external source or internally regulated, V_{CI} must always be equal or higher than V_{DD} and V_{DDIO}.

The following figure shows the V_{DD} regulator pin connection scheme:

Figure 8-15 V_{CI} > 2.6V, V_{DD} regulator enable : pin connection scheme

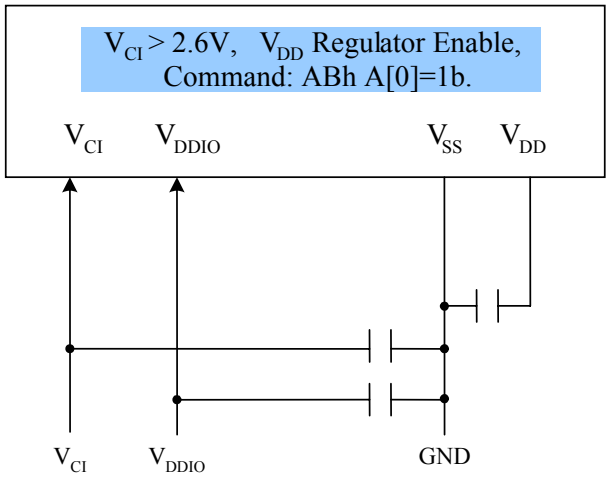
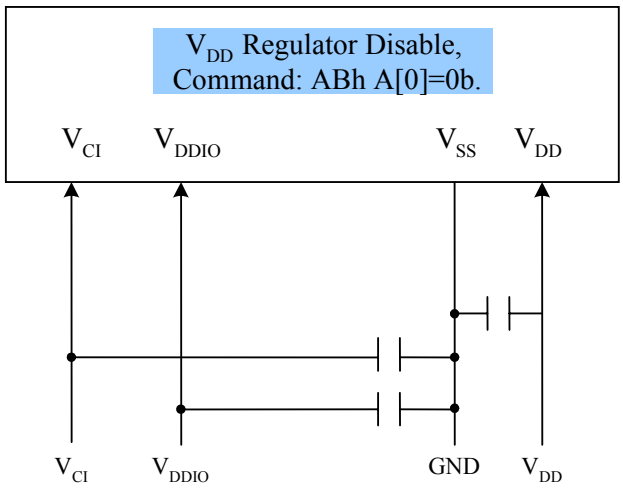


Figure 8-16 V_{DD} regulator disable : pin connection scheme



8.10.1 V_{DD} Regulator in Sleep Mode

Power can be saved by disable the internal V_{DD} regulator during Sleep mode. The following figures show the corresponding command sequence:

Figure 8-17 : Case 1 - Command sequence for just entering/ exiting sleep mode

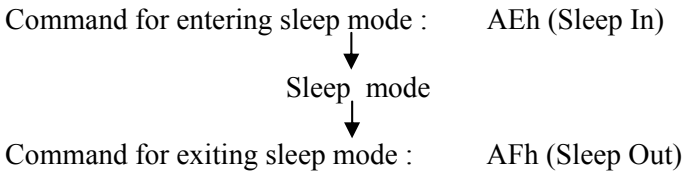
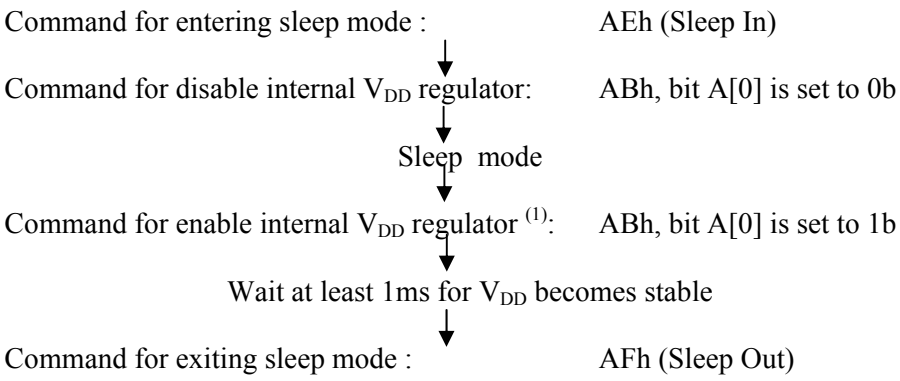


Figure 8-18 : Case 2 - Command sequence for disabling internal V_{DD} regulator during sleep mode



In the above two cases, the RAM content can also be kept during the sleep mode.

Note:
(1) It should be noted that the internal V_{DD} regulator should be enabled before exiting sleep mode (issuing command AFh).
(2) No RAM access through MCU interface when there is no external/ internal V_{DD}.

9 COMMAND

9.1 Basic Command List

Table 9-1 : Command table

(D/C# = 0, R/W#(WR#)= 0, E(RD#) = 1) unless specific setting is stated
Single byte command (D/C# = 0), Multiple byte command (D/C# = 0 for first byte, D/C# = 1 for other bytes)

Fundamental Command Table											
D/C#	**Hex**	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D2**	**D0**	**Command**	**Description**
0 1 1	15 A[6:0] B[6:0]	0 * *	0 A_6 B_6	0 A_5 B_5	1 A_4 B_4	0 A_3 B_3	1 A_2 B_2	0 A_1 B_1	1 A_0 B_0	Set Column Address	A[6:0]: Start Address. [reset=0] B[6:0]: End Address. [reset=127] Range from 0 to 127
0 1 1	75 A[6:0] B[6:0]	0 * *	1 A_6 B_6	1 A_5 B_5	1 A_4 B_4	0 A_3 B_3	1 A_2 B_2	0 A_1 B_1	1 A_0 B_0	Set Row Address	A[6:0]: Start Address. [reset=0] B[6:0]: End Address. [reset=127] Range from 0 to 127
0	5C	0	1	0	1	1	1	0	0	Write RAM Command	Enable MCU to write Data into RAM
0	5D	0	1	0	1	1	1	0	1	Read RAM Command	Enable MCU to read Data from RAM
0 1	A0 A[7:0]	1 A_7	0 A_6	1 A_5	0 A_4	0 A_3	0 A_2	0 A_1	0 A_0	Set Re-map / Color Depth (Display RAM to Panel)	A[0]=0b, Horizontal address increment [reset] A[0]=1b, Vertical address increment A[1]=0b, Column address 0 is mapped to SEG0 [reset] A[1]=1b, Column address 127 is mapped to SEG0 A[2]=0b, Color sequence: A → B → C [reset] A[2]=1b, Color sequence is swapped: C → B → A A[3]=0b, Reserved A[3]=1b, Reserved A[4]=0b, Scan from COM0 to COM[N –1] [reset] A[4]=1b, Scan from COM[N-1] to COM0. Where N is the Multiplex ratio. A[5]=0b, Disable COM Split Odd Even A[5]=1b, Enable COM Split Odd Even [reset] A[7:6] Set Color Depth, 00b / 01b: 65k color [reset] 10b: 262k color 11b 262k color, 16-bit format 2 Refer to Table 8-8 for details

Fundamental Command Table											
D/C#	**Hex**	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D2**	**D0**	**Command**	**Description**
0 1	A1 A[6:0]	1 *	0 A_6	1 A_5	0 A_4	0 A_3	0 A_2	0 A_1	1 A_0	Set Display Start Line	Set vertical scroll by RAM from 0~127. [reset=00h]
0 1	A2 A[6:0]	1 *	0 A_6	1 A_5	0 A_4	0 A_3	0 A_2	1 A_1	0 A_0	Set Display Offset	Set vertical scroll by Row from 0-127. [reset=60h] **Note** (1) This command is locked by Command FDh by default. To unlock it, please refer to Command FDh.
0	A4~A7	1	0	1	0	0	1	X_1	X_0	Set Display Mode	A4h: All OFF A5h: All ON (All pixels have GS63) A6h : Reset to normal display [reset] A7h: Inverse Display (GS0 -> GS63, GS1 -> GS62, ...)
0 1	AB A[7:0]	1 A_7	0 A_6	1 0	0 0	1 0	0 0	1 0	1 A_0	Function Selection	A[0]=0b, Select external V_{DD} A[0]=1b, Enable internal V_{DD} regulator [reset] A[7:6]=00b, Select 8-bit parallel interface [reset] A[7:6]=01b, Select 16-bit parallel interface A[7:6]=11b, Select 18-bit parallel interface
0	AD	1	0	1	0	1	1	0	1	NOP	Command for no operation.
0	AE~AF	1	0	1	0	1	1	1	X_0	Set Sleep mode ON/OFF	AEh = Sleep mode On (Display OFF) AFh = Sleep mode OFF (Display ON)
0	B0	1	0	1	1	0	0	0	0	NOP	Command for no operation.
0 1	B1 A[7:0]	1 A_7	0 A_6	1 A_5	1 A_4	0 A_3	0 A_2	0 A_1	1 A_0	Set Reset (Phase 1) / Pre-charge (Phase 2) period	A[3:0] Phase 1 period of 5~31 DCLK(s) clocks [reset=0010b] A[3:0]: 0-1 invalid 2 = 5 DCLKs 3 = 7 DCLKs : 15 = 31DCLKs A[7:4] Phase 2 period of 3~15 DCLK(s) clocks [reset=1000b] A[7:4]: 0-2 invalid 3 = 3 DCLKs 4 = 4 DCLKs : 15 =15DCLKs Note (1) 0 DCLK is invalid in phase 1 & phase 2 (2)This command is locked by Command FDh by default. To unlock it, please refer to Command FDh.

Fundamental Command Table

D/C#	Hex	D7	D6	D5	D4	D3	D2	D2	D0	Command	Description
0	B2	1	0	1	1	0	0	1	0	Display Enhancement	A[7:0] = 00h, B[7:0] = 00h, C[7:0] = 00h normal [reset] A[7:0] = A4h, B[7:0] = 00h, C[7:0] = 00h enhance display performance
1	A[7:0]	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
1	B[7:0]	0	0	0	0	0	0	0	0		
1	C[7:0]	0	0	0	0	0	0	0	0		
0	B3	1	0	1	1	0	0	1	1	Front Clock Divider (DivSet)/ Oscillator Frequency	A[3:0] [reset=0001], divide by DIVSET where A[3:0] = 0000: divide by 1 0001: divide by 2 0010: divide by 4 0011: divide by 8 0100: divide by 16 0101: divide by 32 0110: divide by 64 0111: divide by 128 1000: divide by 256 1001: divide by 512 1010: divide by 1024 >=1011: invalid A[7:4] Oscillator frequency, frequency increases as level increases [reset=1101b] **Note** (1) This command is locked by Command FDh by default. To unlock it, please refer to Command FDh.
1	A[7:0]	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
0	B4	1	0	1	1	0	1	0	0	Set Segment Low Voltage (VSL)	A[1:0]=00 External VSL [reset] A[1:0]=01,10,11 are invalid **Note** (1) When external VSL is enabled, in order to avoid distortion in display pattern, an external circuit is needed to connect between VSL and V_{SS} as shown in Figure 14-1.
1	A[7:0]	1	0	1	0	0	0	A_1	A_0		
1	B[7:0]	1	0	1	1	0	1	0	1		
1	C[7:0]	0	1	0	1	0	1	0	1		
0	B5	1	0	1	1	0	1	0	1	Set GPIO	A[1:0] GPIO0: 00 pin HiZ, Input disabled 01 pin HiZ, Input enabled 10 pin output LOW [reset] 11 pin output HIGH A[3:2] GPIO1: 00 pin HiZ, Input disabled 01 pin HiZ, Input enabled 10 pin output LOW [reset] 11 pin output HIGH
1	A[3:0]	*	*	*	*	A_3	A_2	A_1	A_0		
0	B6	1	0	1	1	0	1	0	0	Set Second Pre-charge Period	A[3:0] Set Second Pre-charge Period 0000b invalid 0001b 1 DCLKS 0010b 2 DCLKS .... 1000 8 DCLKS [reset] .... 1111 15 DCLKS
1	A[3:0]	*	*	*	*	A_3	A_2	A_1	A_0		

Fundamental Command Table

D/C#	Hex	D7	D6	D5	D4	D3	D2	D2	D0	Command	Description
0	B8	1	0	1	1	1	0	0	0	Look Up Table for Gray Scale Pulse width	The next 63 data bytes define Gray Scale (GS) Table by setting the gray scale pulse width in unit of DCLK's (ranges from 0d ~ 180d) A1[7:0]: Gamma Setting for GS1, A2[7:0]: Gamma Setting for GS2, : A62[7:0]: Gamma Setting for GS62, A63[7:0]: Gamma Setting for GS63 **Note** (1) 0 ≤ Setting of GS1 < Setting of GS2 < Setting of GS3..... < Setting of GS62 < Setting of GS63 (2) GS0 has only pre-charge but no current drive stages. (3) GS1 can be set as only pre-charge but no current drive stage by input gamma setting for GS1 equals 0.
1	A1[7:0]	$A1_7$	$A1_6$	$A1_5$	$A1_4$	$A1_3$	$A1_2$	$A1_1$	$A1_0$		
1	A2[7:0]	$A2_7$	$A2_6$	$A2_5$	$A2_4$	$A2_3$	$A2_2$	$A2_1$	$A2_0$		
1	.	.	.	.	.	.	.	.	.		
1	.	.	.	.	.	.	.	.	.		
1	.	.	.	.	.	.	.	.	.		
1	A62[7:0]	$A62_7$	$A62_6$	$A62_5$	$A62_4$	$A62_3$	$A62_2$	$A62_1$	$A62_0$		
1	A63[7:0]	$A63_7$	$A63_6$	$A63_5$	$A63_4$	$A63_3$	$A63_2$	$A63_1$	$A63_0$		
0	B9	1	0	1	1	1	0	0	1	Use Built-in Linear LUT [reset= linear]	Reset to default Look Up Table: GS1 = 0 DCLK GS2 = 2 DCLK GS3 = 4 DCLK GS4 = 6 DCLK ... GS62 = 122 DCLK GS63 = 124 DCLK
0	BB	1	0	1	1	1	0	1	1	Set Pre-charge voltage	Set pre-charge voltage level.[reset = 17h] **Note** (1)This command is locked by Command FDh by default. To unlock it, please refer to Command FDh.
1	A[4:0]	0	0	0	A_4	A_3	A_2	A_1	A_0		
0	BE	1	0	1	1	1	1	1	0	Set V_{COMH} Voltage	Set COM deselect voltage level [reset = 05h] **Note** (1)This command is locked by Command FDh by default. To unlock it, please refer to Command FDh.
1	A[2:0]	0	0	0	0	0	A_2	A_1	A_0		

A[4:0]	Hex code	pre-charge voltage
00000	00h	0.20 x V_{CC}
:	:	:
11111	1Fh	0.60 x V_{CC}

A[2:0]	Hex code	V_{COMH}
000	00h	0.72 x V_{CC}
:	:	:
101	05h	0.82 x V_{CC} [reset]
:	:	:
111	07h	0.86 x V_{CC}

Fundamental Command Table											
D/C#	**Hex**	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D2**	**D0**	**Command**	**Description**
0 1 1 1	C1 A[7:0] B[7:0] C[7:0]	1 A_7 B_7 C_7	1 A_6 B_6 C_6	0 A_5 B_5 C_5	0 A_4 B_4 C_4	0 A_3 B_3 C_3	0 A_2 B_2 C_2	0 A_1 B_1 C_1	1 A_0 B_0 C_0	Set Contrast Current for Color A,B,C	A[7:0] Contrast Value Color A [reset=10001010b] B[7:0] Contrast Value Color B [reset=01010001b] C[7:0] Contrast Value Color C [reset=10001010b]
0 1	C7 A[3:0]	1 *	1 *	0 *	0 *	0 A_3	1 A_2	1 A_1	1 A_0	Master Contrast Current Control	A[3:0] : 0000b reduce output currents for all colors to 1/16 0001b reduce output currents for all colors to 2/16 .... 1110b reduce output currents for all colors to 15/16 1111b no change [reset]
0 1	CA A[6:0]	1 0	1 A_6	0 A_5	0 A_4	1 A_3	0 A_2	1 A_1	0 A_0	Set MUX Ratio	A[6:0] MUX ratio 16MUX ~ 128MUX, [reset=127], (Range from 15 to 127)
0	D1	1	0	1	0	1	1	0	1	NOP	Command for No Operation
0	E3	1	1	1	0	0	0	1	1	NOP	Command for No Operation
0 1	FD A[7:0]	1 A_7	1 A_6	1 A_5	1 A_4	1 A_3	1 A_2	0 A_1	1 A_0	Set Command Lock	A[7:0]: MCU protection status [reset = 12h] A[7:0] = 12b, Unlock OLED driver IC MCU interface from entering command [reset] A[7:0] = 16b, Lock OLED driver IC MCU interface from entering command A[7:0] = B0b, Command A2,B1,B3,BB,BE,C1 inaccessible in both lock and unlock state [reset] A[7:0] = B1b, Command A2,B1,B3,BB,BE,C1 accessible if in unlock state **Note** (1) The locked OLED driver IC MCU interface prohibits all commands and memory access except the FDh command.

Note
(1) "*" stands for "Don't care".

Table 9-2: SSD1351 Graphic Acceleration Command List

Set (GAC) (D/C# = 0, R/W#(WR#)= 0, E(RD#) = 1) unless specific setting is stated
Single byte command (D/C# = 0), Multiple byte command (D/C# = 0 for first byte, D/C# = 1 for other bytes)

Graphic acceleration command											
D/C#	**Hex**	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D2**	**D0**	**Command**	**Description**
0	96	1	0	0	1	0	1	1	0	Horizontal Scroll	A[7:0] = 00000000b No scrolling A[7:0] = 00000001b to 00111111b Scroll towards SEG127 with 1 column offset A[7:0] = 01000000b to 11111111b Scroll towards SEG0 with 1 column offset B[6:0] : start row address C[7:0] : number of rows to be H-scrolled B+C <= 128 D[6:0] : Reserved (reset=00h) E[1:0] : scrolling time interval 00b test mode 01b normal 10b slow 11b slowest **Note** (1) Operates during display ON.
1	A[7:0]	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
1	B[6:0]	0	B_6	B_5	B_4	B_3	B_2	B_1	B_0		
1	C[7:0]	C_7	C_6	C_5	C_4	C_3	C_2	C_1	C_0		
1	D[6:0]	0	D_6	D_5	D_4	D_3	D_2	D_1	D_0		
1	E[1:0]	0	0	0	0	0	0	E_1	E_0		
0	9E	1	0	0	1	1	1	1	0	Stop Moving	Stop horizontal scroll **Note** (1) After sending 9Eh command to stop the scrolling action, the ram data needs to be rewritten
0	9F	1	0	0	1	1	1	1	1	Start Moving	Start horizontal scroll

Note
(1) After executed the graphic command, waiting time is required for update GDDRAM content.
V_{CI} =2.4~3.5V, waiting time = 500ns/pixel.

(2) "*" stands for "Don't care".

10 COMMAND

10.1.1 Set Column Address (15h)

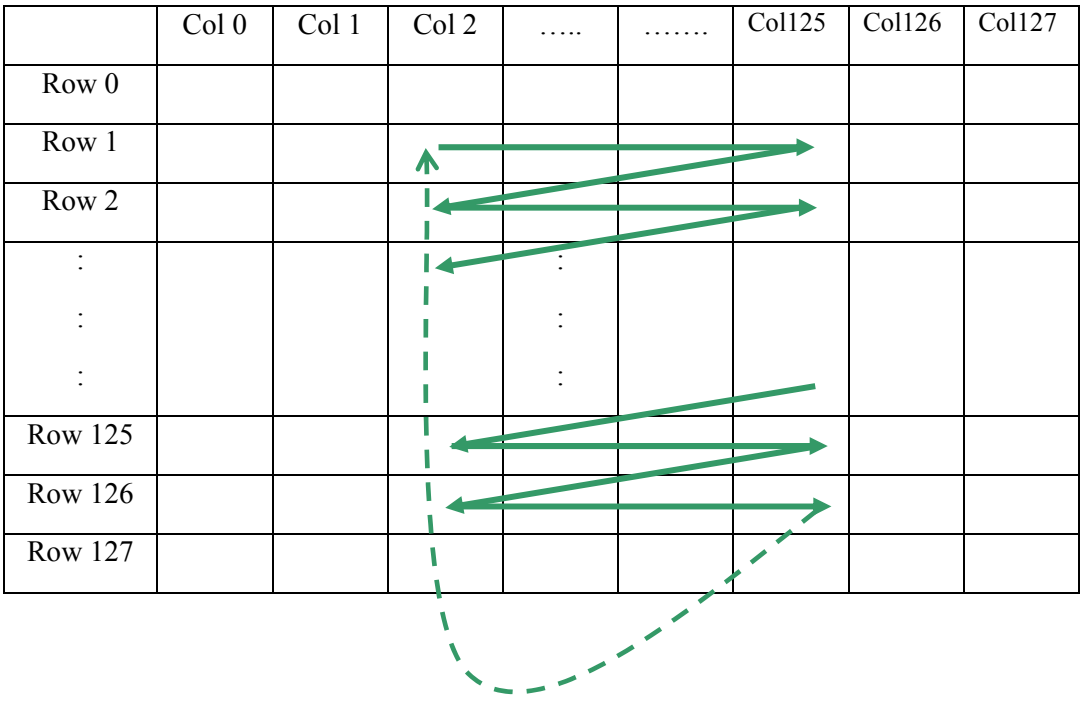
This triple byte command specifies column start address and end address of the display data RAM. This command also sets the column address pointer to column start address. This pointer is used to define the current read/write column address in graphic display data RAM. If horizontal address increment mode is enabled by command A0h, after finishing read/write one column data, it is incremented automatically to the next column address. Whenever the column address pointer finishes accessing the end column address, it is reset back to start column address and the row address is incremented to the next row.

10.1.2 Set Row Address (75h)

This triple byte command specifies row start address and end address of the display data RAM. This command also sets the row address pointer to row start address. This pointer is used to define the current read/write row address in graphic display data RAM. If vertical address increment mode is enabled by command A0h, after finishing read/write one row data, it is incremented automatically to the next row address. Whenever the row address pointer finishes accessing the end row address, it is reset back to start row address.

For example, column start address is set to 2 and column end address is set to 125, row start address is set to 1 and row end address is set to 126. Horizontal address increment mode is enabled by command A0h. In this case, the graphic display data RAM column accessible range is from column 2 to column 125 and from row 1 to row 126 only. In addition, the column address pointer is set to 2 and row address pointer is set to 1. After finishing read/write one pixel of data, the column address is increased automatically by 1 to access the next RAM location for next read/write operation(*solid line in Figure 10-1*). Whenever the column address pointer finishes accessing the end column 125, it is reset back to column 2 and row address is automatically increased by 1(*solid line in Figure 10-1*). While the end row 126 and end column 125 RAM location is accessed, the row address is reset back to 1 and the column address is reset back to 2(*dotted line in Figure 10-1*).

Figure 10-1 : Example of Column and Row Address Pointer Movement



10.1.3 Write RAM Command (5Ch)

After entering this single byte command, data entries will be written into the display RAM until another command is written. Address pointer is increased accordingly. This command must be sent before write data into RAM.

10.1.4 Read RAM Command (5Dh)

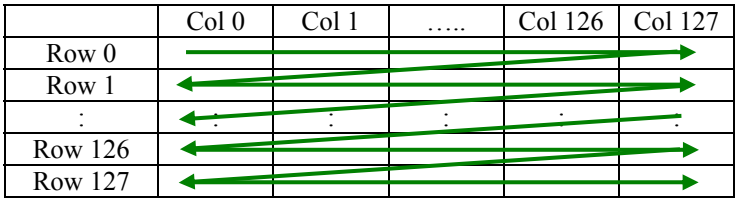
After entering this single byte command, data is read from display RAM until another command is written. Address pointer is increased accordingly. This command must be sent before read data from RAM.

10.1.5 Set Re-map & Dual COM Line Mode (A0h)

This command has multiple configurations and each bit setting is described as follows:

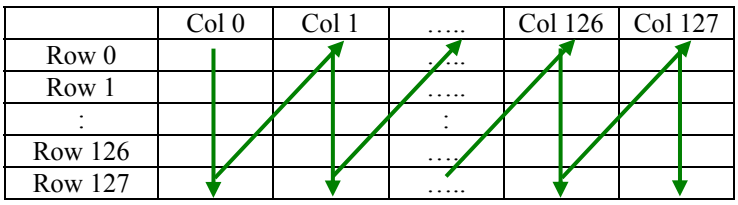
- Address increment mode (A[0])
  When A[0] is set to 0, the driver is set as horizontal address increment mode. After the display RAM is read / written, the column address pointer is increased automatically by 1. If the column address pointer reaches column end address, the column address pointer is reset to column start address and row address pointer is increased by 1. The sequence of movement of the row and column address point for horizontal address increment mode is shown in Figure 10-2.

Figure 10-2 : Address Pointer Movement of Horizontal Address Increment Mode



When A[0] is set to 1, the driver is set to vertical address increment mode. After the display RAM is read / written, the row address pointer is increased automatically by 1. If the row address pointer reaches the row end address, the row address pointer is reset to row start address and column address pointer is increased by 1. The sequence of movement of the row and column address point for vertical address increment mode is shown in Figure 10-3.

Figure 10-3: Address Pointer Movement of Vertical Address Increment Mode



- Column Address Remap (A[1])
  This command bit is made for increasing the layout flexibility of segment signals in OLED module with segment arranged from left to right (when A[1] is set to 0) or vice versa (when A[1] is set to 1), as demonstrated in Figure 10-4.
  A[1] = 0 (reset): RAM Column 0 ~ 127 maps to Col0~Col127
  A[1] = 1: RAM Column 0 ~ 127 maps to Col127~Col0

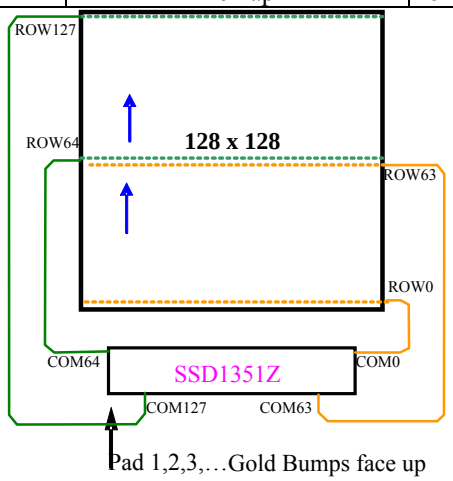
- Color Remap (A[2])
  A[2] = 0 (reset): color sequence A → B → C
  A[2] = 1: color sequence C → B → A

- COM scan direction Remap (A[4])
  This command bit determines the scanning direction of the common for flexible layout of common signals in OLED module either from up to down or vice versa.
  A[1] = 0 (reset): Scan from up to down
  A[1] = 1: Scan from bottom to up
  Details of pin arrangement can be found in Figure 10-4.

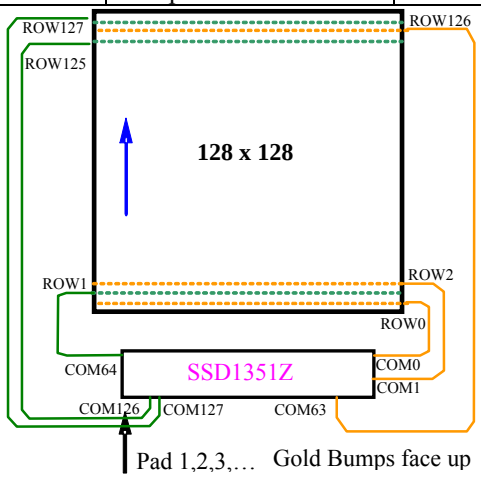
- Odd even split of COM pins (A[5])
  This command bit can set the odd even arrangement of COM pins.
  A[5] = 0 (reset): Disable COM split odd even, pin assignment of common is in sequential as
  COM127 COM126...COM 65 COM64...SEG479...SEG0...COM0 COM1...COM62 COM63
  A[5] = 1: Enable COM split odd even, pin assignment of common is in odd even split as
  COM127 COM125...COM3 COM1...SEG479...SEG0...COM0 COM2...COM124 COM126
  Details of pin arrangement can be found in Figure 10-4.

Figure 10-4 : COM Pins Hardware Configuration (MUX ratio: 128)

A[0] =0	A[1]=0	A[7]=0
Disable Odd Even Split of COM pins	Disable COM Left / Right Remap	COM Scan Direction : from COM0 to COM127



A[0] =1	A[1]=0	A[7]=0
Enable Odd Even Split of COM pins	Disable COM Left / Right Remap	COM Scan Direction : from COM0 to COM127



- Display color mode (A[7:6])
  Select either 262k, 65k or 256 color mode.

10.1.6 Set Display Start Line (A1h)

This command is used to set Display Start Line register to determine starting address of display RAM to be displayed by selecting a value from 0 to 127. Figure 10-5 shows an example of using this command when MUX ratio = 128 and MUX ratio = 100 and Display Start Line = 28. In there, "Row" means the graphic display data RAM row.

Figure 10-5 : Example of Set Display Start Line with no Remap

	128	128	100	100	MUX ratio (CAh)
COM Pin	0	28	0	28	Display start line (A1h)
COM0	Row0	Row28	Row0	Row28	
COM1	Row1	Row29	Row1	Row29	
COM2	Row2	Row30	Row2	Row30	
COM3	Row3	Row31	Row3	Row31	
COM4	Row4	Row32	Row4	Row32	
COM5	Row5	Row33	Row5	Row33	
COM6	Row6	Row34	Row6	Row34	
:	:	:	:	:	
:	:	:	:	:	
:	:	:	:	:	
:	:	:	:	:	
COM95	Row95	Row123	Row95	Row124	
COM96	Row96	Row124	Row96	Row125	
COM97	Row97	Row125	Row97	Row126	
COM98	Row98	Row126	Row98	Row127	
COM99	Row99	Row127	Row99	Row0	
COM100	Row100	Row0	-	-	
COM101	Row101	Row1	-	-	
COM102	Row102	Row2	-	-	
COM103	Row103	Row3	-	-	
COM104	Row104	Row4	-	-	
COM105	Row105	Row5	-	-	
COM106	Row106	Row6	-	-	
COM107	Row107	Row7	-	-	
COM108	Row108	Row8	-	-	
COM109	Row109	Row9	-	-	
COM110	Row110	Row10	-	-	
COM111	Row111	Row11	-	-	
COM112	Row112	Row12	-	-	
COM113	Row113	Row13	-	-	
COM114	Row114	Row14	-	-	
COM115	Row115	Row15	-	-	
COM116	Row116	Row16	-	-	
COM117	Row117	Row17	-	-	
COM118	Row118	Row18	-	-	
COM119	Row119	Row19	-	-	
COM120	Row120	Row20	-	-	
COM121	Row121	Row21	-	-	
COM122	Row122	Row22	-	-	
COM123	Row123	Row23	-	-	
COM124	Row124	Row24	-	-	
COM125	Row125	Row25	-	-	
COM126	Row126	Row26	-	-	
COM127	Row127	Row27	-	-	
Display example	 (a)	 (b)	 (c)	 (d)	 (GDDARAM)	

10.1.7 Set Display Offset (A2h)

This command specifies the mapping of display start line (it is assumed that COM0 is the display start line, display start line register equals to 0) to one of COM0-127. For example, to move the COM16 towards the COM0 direction for 16 lines, A[7:0] should be given by 00010000. The figure below shows an example of this command. In there, "Row" means the graphic display data RAM row.

Figure 10-6 : Example of Set Display Offset with no Remap

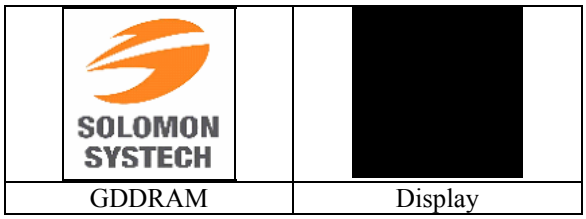
	a	b	c	Case
	128	96	96	MUX ratio (CAh)
	0	0	32	Display offset (A2h A[7:0])
COM0	Row0	Row0	Row32	
COM1	Row1	Row1	Row33	
COM2	Row2	Row2	Row34	
.	.	.	.	
COM61	Row61	Row61	Row93	
COM62	Row62	Row62	Row94	
COM63	Row63	Row63	Row95	
COM64	Row64	Row64	-	
COM65	Row65	Row65	-	
COM66	Row66	Row66	-	
:	:	:	:	
COM93	Row93	Row93	-	
COM94	Row94	Row94	-	
COM95	Row95	Row95	-	
COM96	Row96	-	Row0	
COM97	Row97	-	Row1	
COM98	Row98	-	Row2	
:	:	:	:	
COM125	Row125	-	Row29	
COM126	Row126	-	Row30	
COM127	Row127	-	Row31	
Display example	 (a)	 (c)	 (d)	 (GDDARAM)

10.1.8 Set Display Mode (A4h ~ A7h)

These are single byte command and they are used to set Normal Display, Entire Display ON, Entire Display OFF and Inverse Display.

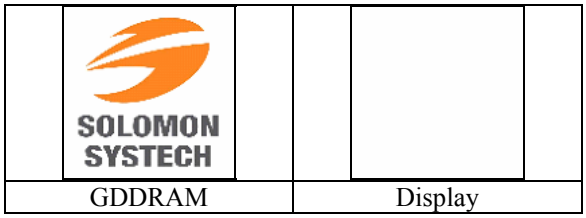
- All OFF (A4h)
  Force the entire display to be at gray scale level "GS0" regardless of the contents of the display data RAM as shown in Figure.

Figure 10-7 : Example of Entire Display OFF



- Set Entire Display ON (A5h)
  Force the entire display to be at gray scale "GS63" regardless of the contents of the display data RAM as shown in Figure 10-8.

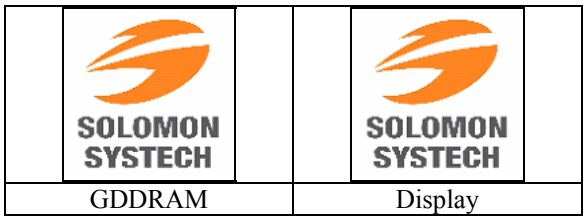
Figure 10-8 : Example of Entire Display ON



- Set Entire Display OFF (A6h)

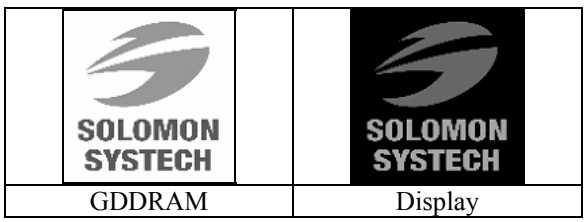
  Reset the above effect and turn the data to ON at the corresponding gray level. Figure 10-9 shows an example of Normal Display.

Figure 10-9 : Example of Normal Display



- Inverse Display (A7h)
  The gray level of display data are swapped such that "GS0" ↔ "GS63", "GS1" ↔ "GS62", …
  Figure 10-10 shows an example of inverse display.

Figure 10-10 : Example of Inverse Display



10.1.9 Set Function selection (ABh)

This double byte command is used to enable or disable the V_{DD} regulator.
Internal V_{DD} regulator is selected when the bit A[0] is set to 1b, while external V_{DD} is selected when A[0] is set to 0b.

10.1.10 Set Sleep mode ON/OFF (AEh / AFh)

These single byte commands are used to turn the OLED panel display ON or OFF.
When the display is OFF (command AEh), the segment is in V_{SS} state and common is in high impedance state.

10.1.11 Set Phase Length (B1h)

This double byte command sets the length of phase 1 and 2 of segment waveform of the driver.

- Phase 1 (A[3:0]): Set the period from 5 to 31 in the unit of 2 DCLKs. A larger capacitance of the OLED pixel may require longer period to discharge the previous data charge completely.
- Phase 2 (A[7:4]): Set the period from 3 to 15 in the unit of DCLKs. A longer period is needed to charge up a larger capacitance of the OLED pixel to the target voltage V_P.

10.1.12 Display Enhancement (B2h)

This four byte command enhancement display performance.

10.1.13 Set Front Clock Divider / Oscillator Frequency (B3h)

This double byte command consists of two functions:

- Front Clock Divide Ratio (A[3:0])
  Set the divide ratio to generate DCLK (Display Clock) from CLK. The divide ratio is from 1 to 16, with reset value = 1. Please refer to Section 8.5 for the detail relationship of DCLK and CLK.

- Oscillator Frequency (A[7:4])
  Program the oscillator frequency Fosc which is the source of CLK if CLS pin is pulled HIGH. The 4-bit value results in 16 different frequency settings being available.

10.1.14 Set GPIO (B5h)

This double byte command is used to set the states of GPIO0 and GPIO1 pins. Refer to Table 9-1 for details.

10.1.15 Set Second Pre-charge period (B6h)

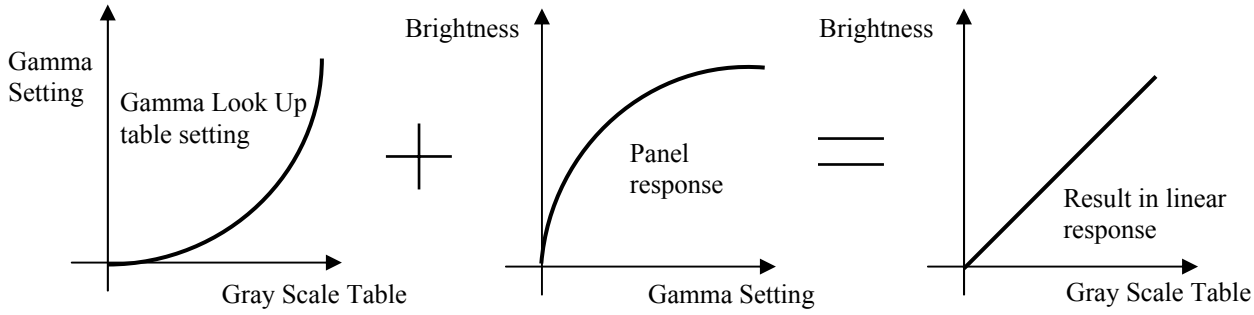
This double byte command is used to set the phase 3 second pre-charge period. The period of phase 3 can be programmed by command B6h and it is ranged from 1 to 15 DCLK's. Please refer to Table 9-1 for the detail information.

10.1.16 Look Up Table for Gray Scale Pulse width (B8h)

This command is used to set each individual gray scale level for the display. Except gray scale levels GS0 that has no pre-charge and current drive, each gray scale level is programmed in the length of current drive stage pulse width with unit of DCLK. The longer the length of the pulse width, the brighter the OLED pixel when it's turned ON. Following the command B8h, the user has to set the gray scale setting for GS1, GS2, …, GS62, GS63 one by one in sequence. GS1 can be set as gamma setting 0, which means there is only pre-charge phase but no current drive phase. Refer to Section 8.8 for details.

The setting of gray scale table entry can perform gamma correction on OLED panel display. Since the perception of the brightness scale shall match the image data value in display data RAM, appropriate gray scale table setting like the example shown below (Figure 10-11) can compensate this effect.

Figure 10-11 : Example of Gamma correction by Gamma Look Up table setting



10.1.17 Use Built-in Linear LUT (B9h)

This single byte command reloads the preset linear Gray Scale table as GS0 =Gamma Setting 0, GS1 = Gamma Setting 0, GS2 = Gamma Setting 2, GS3 = Gamma Setting 4,... GS62 = Gamma Setting 122, GS63 = Gamma Setting 124. Refer to Section 8.8 for details.

10.1.18 Set Pre-charge voltage (BBh)

This double byte command sets the first pre-charge voltage (phase 2) level of segment pins. The level of pre-charge voltage is programmed with reference to V_{CC}. Refer to Table 9-1 for details.

10.1.19 Set V_{COMH} Voltage (BEh)

This double byte command sets the high voltage level of common pins, V_{COMH}. The level of V_{COMH} is programmed with reference to V_{CC}. Refer to Table 9-1 for details.

10.1.20 Set Contrast Current for Color A,B,C (C1h)

This command is used to set Contrast Setting of the display. The chip has 256 contrast steps from 00h to FFh. The segment output current I_{SEG} increases linearly with the contrast step, which results in brighter display.

10.1.21 Master Contrast Current Control (C7h)

This double byte command is to control the segment output current by a scaling factor. The chip has 16 master control steps, with the factor ranges from 1 [0000b] to 16 [1111b – default]. The smaller the master current value, the dimmer the OLED panel display is set.
For example, if original segment output current is 160uA at scale factor = 16, setting scale factor to 8 would reduce the current to 80uA.

10.1.22 Set Multiplex Ratio (CAh)

This double byte command switches default 1:128 multiplex mode to any multiplex mode from 16 to 128. For example, when multiplex ratio is set to 16, only 16 common pins are enabled. The starting and the ending of the enabled common pins are depended on the setting of "Display Offset" register programmed by command A2h. Figure 10-5 and Figure 10-6 show examples of setting the multiplex ratio through command CAh.

10.1.23 Set Command Lock (FDh)

This command is used to lock the OLED driver IC from accepting any command except itself. After entering FDh 16h (A[2]=1b), the OLED driver IC will not respond to any newly-entered command (except FDh 12h A[2]=0b) and there will be no memory access. This is call "Lock" state. That means the OLED driver IC ignore all the commands (except FDh 12h A[2]=0b) during the "Lock" state.

Entering FDh 12h (A[2]=0b) can unlock the OLED driver IC. That means the driver IC resume from the "Lock" state. And the driver IC will then respond to the command and memory access.

11 MAXIMUM RATINGS

Table 11-1 : Maximum Ratings

(Voltage Reference to V_{SS})

Symbol	Parameter	Value	Unit
V_{DD}	Supply Voltage	-0.5 to 2.75	V
V_{CC}		-0.5 to 19.0	V
V_{DDIO}		-0.5 to V_{CI}	V
V_{CI}		-0.3 to 4.0	V
V_{SEG}	SEG output voltage	0 to V_{CC}	V
V_{COM}	COM output voltage	0 to 0.9*V_{CC}	V
V_{in}	Input voltage	Vss-0.3 to V_{DDIO}+0.3	V
T_A	Operating Temperature	-40 to +85	ºC
T_{stg}	Storage Temperature Range	-65 to +150	ºC

*Maximum Ratings are those values beyond which damage to the device may occur. Functional operation should be restricted to the limits in the Electrical Characteristics tables or Pin Description.

*This device may be light sensitive. Caution should be taken to avoid exposure of this device to any light source during normal operation. This device is not radiation protected.

12 DC CHARACTERISTICS

Conditions (Unless otherwise specified):

Voltage referenced to V_{SS}

V_{CI} = 2.4 to 3.5V (V_{CI} must be larger than or equal to V_{DD})

T_A = 25°C

Table 12-1 : DC Characteristics

Symbol	Parameter	Test Condition			Min	Typ	Max	Unit
V_{CC}	Operating Voltage	-			10	16	18	V
V_{DD}	Logic Supply Voltage	-			2.4	-	2.6	V
V_{CI}	Low voltage power supply	-			2.4	-	3.5	V
V_{DDIO}	Power Supply for I/O pins	-			1.65	-	V_{CI}	V
V_{OH}	High Logic Output Level	Iout =100uA			0.9*V_{DDIO}	-	V_{DDIO}	V
V_{OL}	Low Logic Output Level	Iout =100uA			0	-	0.1*V_{DDIO}	V
V_{IH}	High Logic Input Level	-			0.8*V_{DDIO}	-	V_{DDIO}	V
V_{IL}	Low Logic Input Level	-			0	-	0.2*V_{DDIO}	V
I_{SLP_VDD}	V_{DD} Sleep mode Current	V_{CI} = V_{DDIO} =2.8V, V_{CC} =16V V_{DD}(external) = 2.5V, Display OFF, No panel attached			-	-	10	uA
I_{SLP_VDDIO}	V_{DDIO} Sleep mode Current	V_{CI} = V_{DDIO} =2.8V, V_{CC} =16V Display OFF, No panel attached	External V_{DD} = 2.5V		-	-	10	uA
			Internal V_{DD}		-	-	10	uA
I_{SLP_VCC}	V_{CC} Sleep mode Current	V_{CI} = V_{DDIO} =2.8V, V_{CC} =16V Display OFF, No panel attached	External V_{DD} = 2.5V		-	-	10	uA
			Internal V_{DD}		-	-	10	uA
I_{SLP_VCI}	V_{CI} Sleep mode Current	V_{CI} = V_{DDIO} =2.8V, V_{CC} =16V Display OFF, No panel attached	External V_{DD} = 2.5V		-	-	10	uA
			Enable Internal V_{DD} during Sleep mode		-	-	50	uA
			Disable Internal V_{DD} during Sleep mode		-	-	10	uA
I_{DD}	V_{DD} Supply Current	V_{CI} = V_{DDIO} =3.5V, V_{CC} = 16V, External V_{DD} = 2.=6V, Display ON, No panel attached, contrast = FF			-	170	190	uA
I_{DDIO}	V_{DDIO} Supply Current	V_{CI} = V_{DDIO} =, 3.5V, V_{CC} = 16V, Display ON, No panel attached, contrast = FF	External V_{DD} = 2.6V		-	0.5	10	uA
			Internal V_{DD}		-	0.5	10	uA
I_{CI}	V_{CI} Supply Current	V_{CI} = V_{DDIO} =, 3.5V, V_{CC} = 16, Display ON, No panel attached, contrast = FF	External V_{DD} = 2.6V		-	60	70	uA
			Internal V_{DD}		-	255	280	uA
I_{CC}	V_{CC} Supply Current	V_{CI} = V_{DDIO} =, 3.5V, V_{CC} = 16, Display ON, No panel attached, contrast = FF	External V_{DD} = 2.6V		-	1.15	1.26	mA
			Internal V_{DD}		-	1.15	1.26	mA
I_{SEG}	Segment Output Current Setting V_{CC} = 16 at I_{REF} = 12.5uA	Contrast = FFh			-	200	-	uA
		Contrast = 7Fh			-	100	-	uA
		Contrast = 3Fh			-	50	-	uA
Dev	Segment (SA, SB, SC) output current uniformity (contrast = FF)	Dev = (I_{Sn} – I_{MID})/I_{MID} I_{MID} = (I_{MAX} + I_{MIN})/2 I_{Sn} = Segment n current . e.g. For n=A, then I_{Sn} = I_{SA} = SA current		n = A	-3	-	3	%
				n = B	-3	-	3	
				n = C	-3	-	3	
Adj. Dev	Adjacent pin output current uniformity (contrast = FF)	Adj Dev = (I_{Sn}[m]-I_{Sn}[m+1]) / (I_{Sn} [m]+ I_{Sn} [m+1]) e.g. For n=A, m=3, then I_{Sn}[m]= I_{SA}[3] = SA[3] current		n = A	-2	-	2	%
				n = B	-2	-	2	
				n = C	-2	-	2	

13 AC CHARACTERISTICS

Conditions (Unless otherwise specified):

Voltage referenced to V_{SS}

T_A = 25°C

Table 13-1 : AC Characteristics

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
F_{OSC} (1)	Oscillation Frequency of Display Timing Generator	V_{CI} = 2.8V	2.5	2.8	3.1	MHz
F_{FRM}	Frame Frequency for 128 MUX Mode	128x128 Graphic Display Mode, Display ON, Internal Oscillator Enabled	-	F_{OSC} * 1/(D*K*128) (2)	-	Hz
t_{RES}	Reset low pulse width (RES#)	-	2000	-	-	ns

Note

(1) F_{OSC} stands for the frequency value of the internal oscillator and the value is measured when command B3h A[7:4] is in default value, and B3h A[3:0] is in [0001].

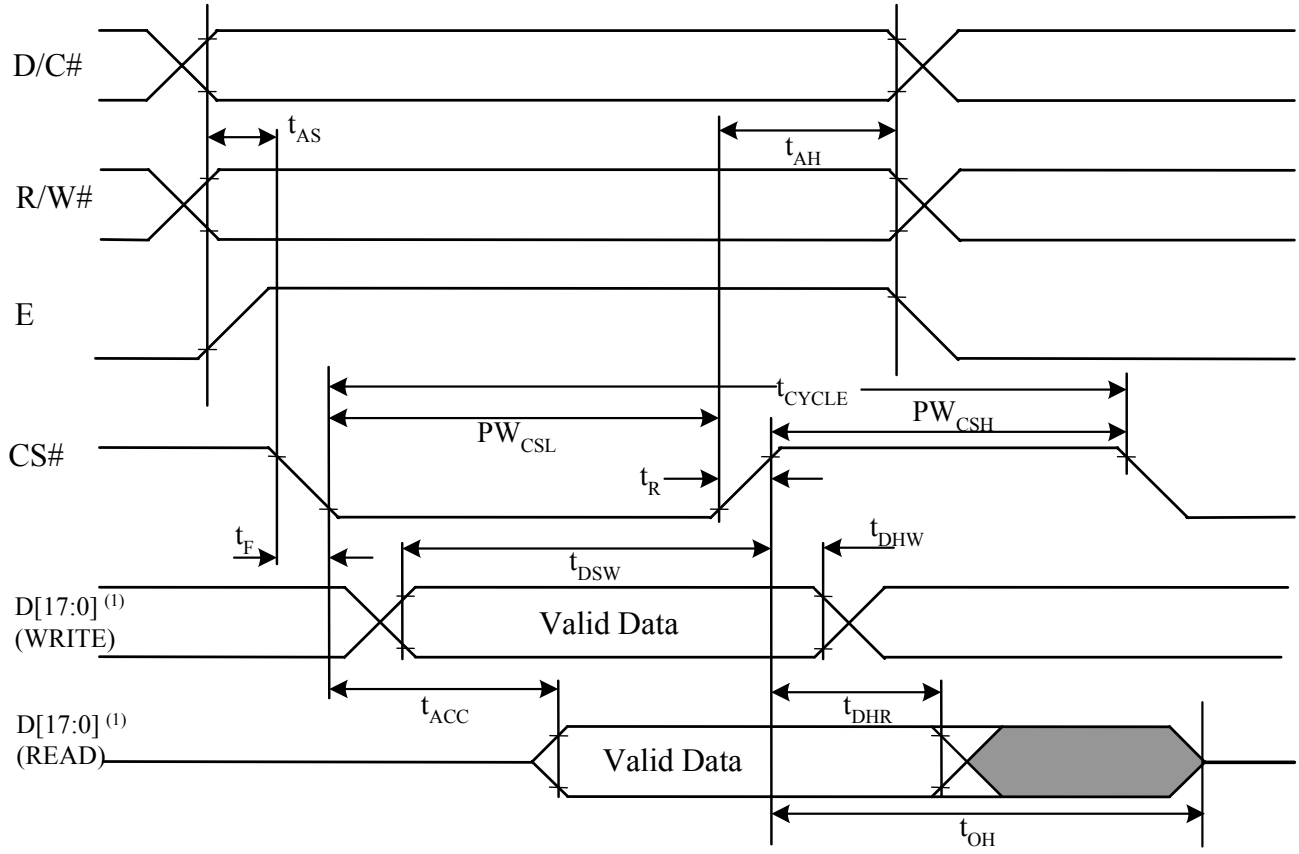
(2) D: divide ratio set by command B3h A[3:0]
K: Phase 1 period +Phase 2 period + X
X: DCLKs in current drive period

Table 13-2 : 6800-Series MCU Parallel Interface Timing Characteristics

(V_{DDIO}- V_{SS} =1.65V- V_{CI}, V_{CI} - V_{SS} = 2.4-3.5V, T_A = 25°C)

Symbol	Parameter	Min	Typ	Max	Unit
t_{CYCLE}	Clock Cycle Time	300	-	-	ns
t_{AS}	Address Setup Time	10	-	-	ns
t_{AH}	Address Hold Time	0	-	-	ns
t_{DSW}	Write Data Setup Time	40	-	-	ns
t_{DHW}	Write Data Hold Time	7	-	-	ns
t_{DHR}	Read Data Hold Time	20	-	-	ns
t_{OH}	Output Disable Time	-	-	70	ns
t_{ACC}	Access Time	-	-	140	ns
PW_{CSL}	Chip Select Low Pulse Width (read) Chip Select Low Pulse Width (write)	120 60	-	-	ns
PW_{CSH}	Chip Select High Pulse Width (read) Chip Select High Pulse Width (write)	60 60	-	-	ns
t_R	Rise Time	-	-	15	ns
t_F	Fall Time	-	-	15	ns

Figure 13-1 : 6800-series MCU parallel interface characteristics



Note

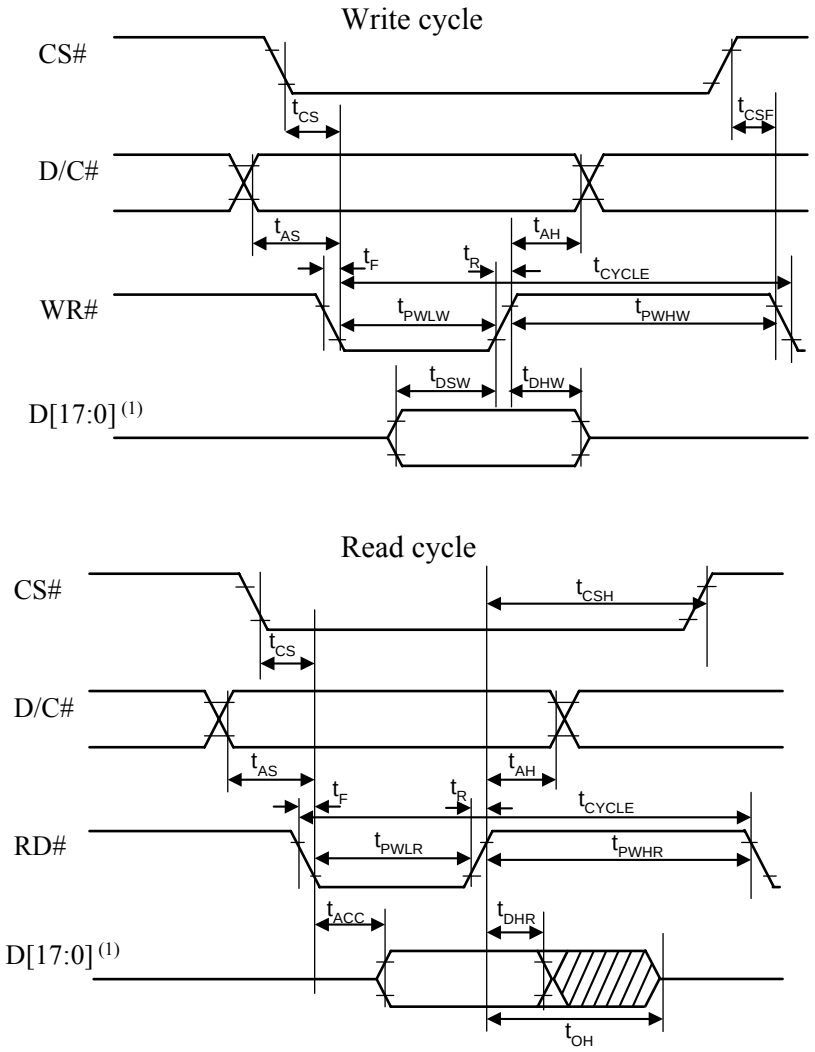
(1) when 8 bit used: D[7:0] instead; when 16 bit used: D[15:0] instead; when 18 bit used: D[17:0] instead.

Table 13-3 : 8080-Series MCU Parallel Interface Timing Characteristics

(V_{DDIO}- V_{SS} =1.65V- V_{CI}, V_{CI} - V_{SS} = 2.4-3.5V, T_A = 25°C)

Symbol	Parameter	Min	Typ	Max	Unit
t_{CYCLE}	Clock Cycle Time	300	-	-	ns
t_{AS}	Address Setup Time	10	-	-	ns
t_{AH}	Address Hold Time	0	-	-	ns
t_{DSW}	Write Data Setup Time	40	-	-	ns
t_{DHW}	Write Data Hold Time	7	-	-	ns
t_{DHR}	Read Data Hold Time	20	-	-	ns
t_{OH}	Output Disable Time	-	-	70	ns
t_{ACC}	Access Time	-	-	140	ns
t_{PWLR}	Read Low Time	150	-	-	ns
t_{PWLW}	Write Low Time	60	-	-	ns
t_{PWHR}	Read High Time	60	-	-	ns
t_{PWHW}	Write High Time	60	-	-	ns
t_R	Rise Time	-	-	15	ns
t_F	Fall Time	-	-	15	ns
t_{CS}	Chip select setup time	0	-	-	ns
t_{CSH}	Chip select hold time to read signal	0	-	-	ns
t_{CSF}	Chip select hold time	20	-	-	ns

Figure 13-2 : 8080-series MCU parallel interface characteristics



Note

(1) when 8 bit used: D[7:0] instead; when 16 bit used: [15:0] instead; when 18 bit used: D[17:0] instead.

Table 13-4 : Serial Interface Timing Characteristics (4-wire SPI)

(V_{DDIO}- V_{SS} =1.65V- V_{CI}, V_{CI} - V_{SS} = 2.4-3.5V, T_A = 25°C)

Symbol	Parameter	Min	Typ	Max	Unit
t_{cycle}	Clock Cycle Time	50	-	-	ns
t_{AS}	Address Setup Time	15	-	-	ns
t_{AH}	Address Hold Time	15	-	-	ns
t_{CSS}	Chip Select Setup Time	20	-	-	ns
t_{CSH}	Chip Select Hold Time	10	-	-	ns
t_{DSW}	Write Data Setup Time	15	-	-	ns
t_{DHW}	Write Data Hold Time	15	-	-	ns
t_{CLKL}	Clock Low Time	20	-	-	ns
t_{CLKH}	Clock High Time	20	-	-	ns
t_R	Rise Time	-	-	15	ns
t_F	Fall Time	-	-	15	ns

Figure 13-3 : Serial interface characteristics (4-wire SPI)

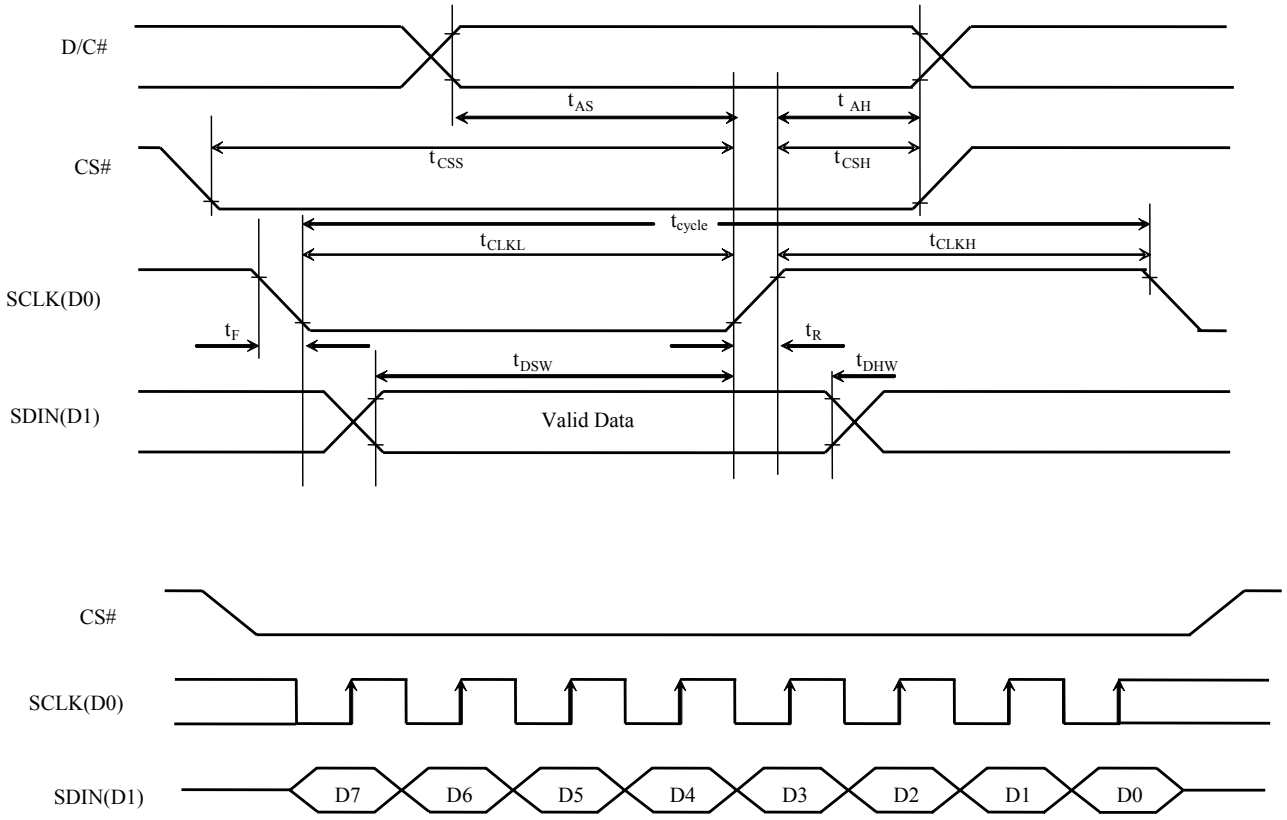
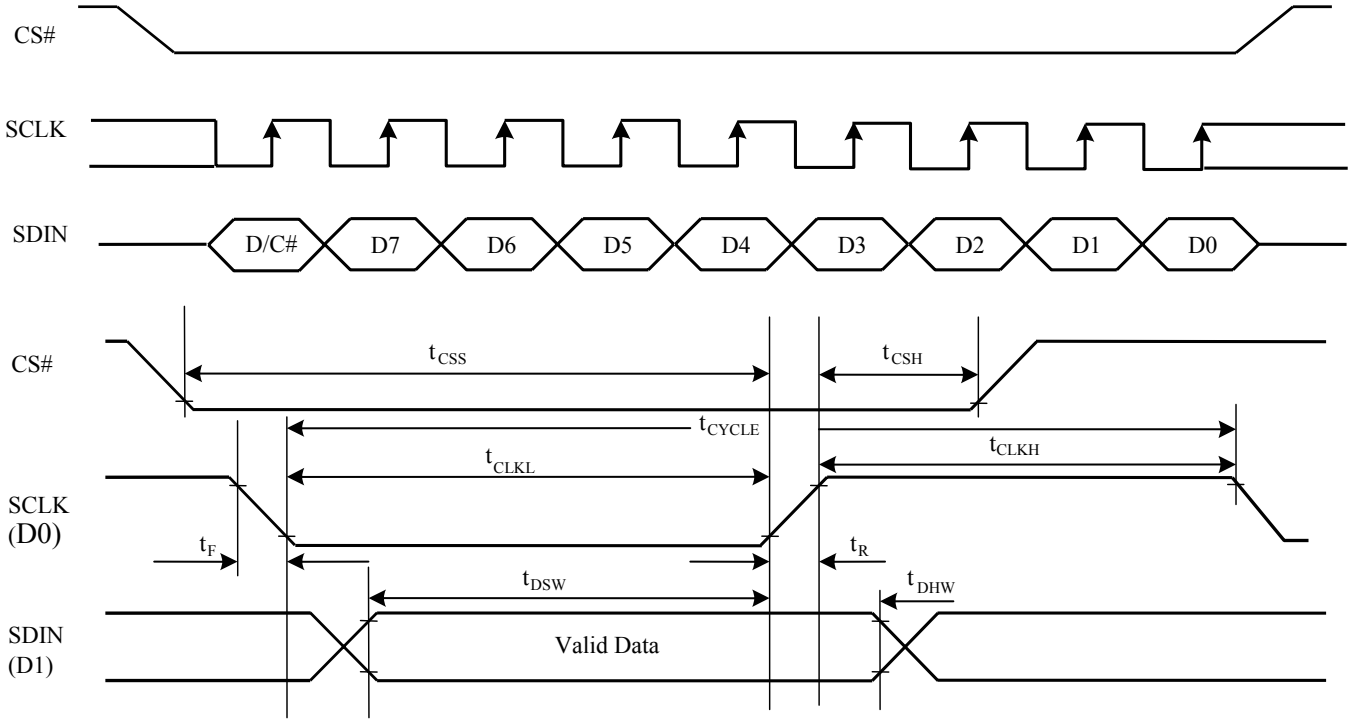


Table 13-5 : Serial Interface Timing Characteristics (3-wire SPI)

(V_{DDIO}- V_{SS} =1.65V- V_{CI}, V_{CI} - V_{SS} = 2.4-3.5V, T_A = 25°C)

Symbol	Parameter	Min	Typ	Max	Unit
t_{cycle}	Clock Cycle Time	50	-	-	ns
t_{CSS}	Chip Select Setup Time	20	-	-	ns
t_{CSH}	Chip Select Hold Time	10	-	-	ns
t_{DSW}	Write Data Setup Time	15	-	-	ns
t_{DHW}	Write Data Hold Time	15	-	-	ns
t_{CLKL}	Clock Low Time	20	-	-	ns
t_{CLKH}	Clock High Time	20	-	-	ns
t_R	Rise Time	-	-	15	ns
t_F	Fall Time	-	-	15	ns

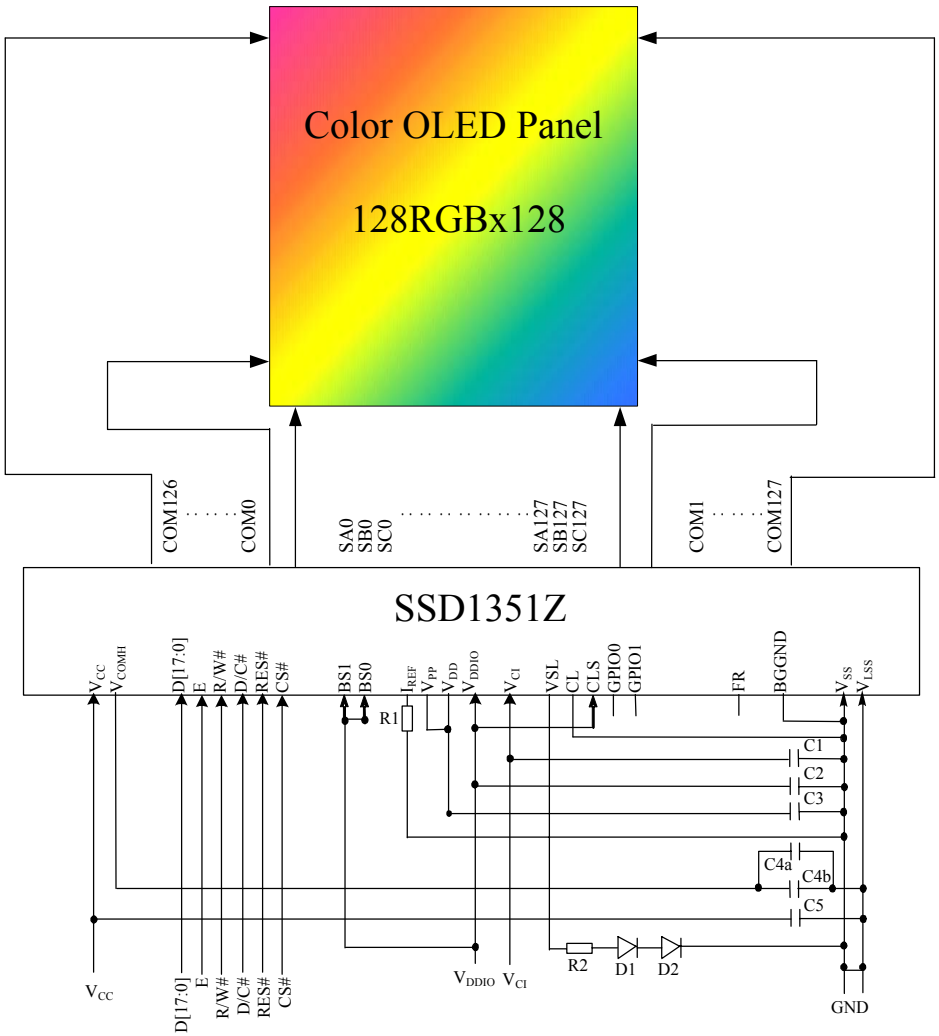
Figure 13-4 : Serial interface characteristics (3-wire SPI)



14 APPLICATION EXAMPLE

Figure 14-1 : SSD1351Z application example for 18-bit 6800-parallel interface mode (Internal regulated V_{DD})

The configuration for 18-bit 6800-parallel interface mode is shown in the following diagram:
(V_{CI} = 3.3V (V_{CI} must be > 2.6V), Internal regulated V_{DD} , V_{DDIO} = 1.8V, external V_{CC} = 16V, I_{REF} = 12.5uA, BS[3:2] are set to 11b through command A0h)



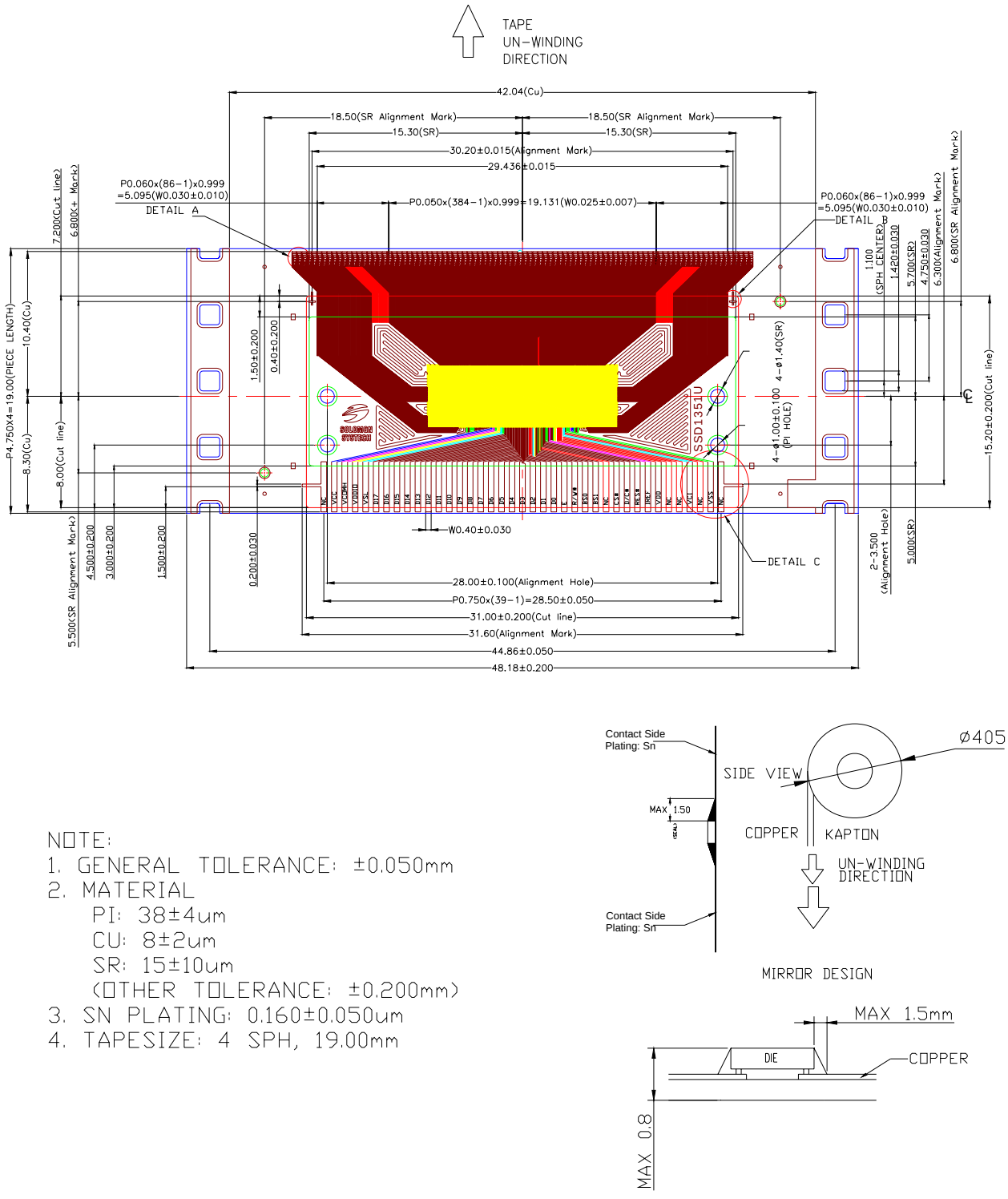
Voltage at I_{REF} = V_{CC} – 6V. For V_{CC} = 16V, I_{REF} = 12.5uA:
R1 = (Voltage at I_{REF} - V_{SS}) / I_{REF}
= (16-6) / 12.5u
= 800KΩ
R2 = 50Ω, 1/8W (1)
D1 ~ D2: V_{th}=0.7V, 1N4148 (1)
C1 ~ C3: 1uF, C4a, C5: 4.7uF, C4b: 0.1uF (1)

Note
(1) The values are recommended value. Select appropriate value against module application.
(2) It is recommended to tie V_{LSS} and V_{SS} at one common ground point to minimize circulating ground noise.

15 PACKAGE INFORMATION

15.1 SSD1351UR1 detail dimension

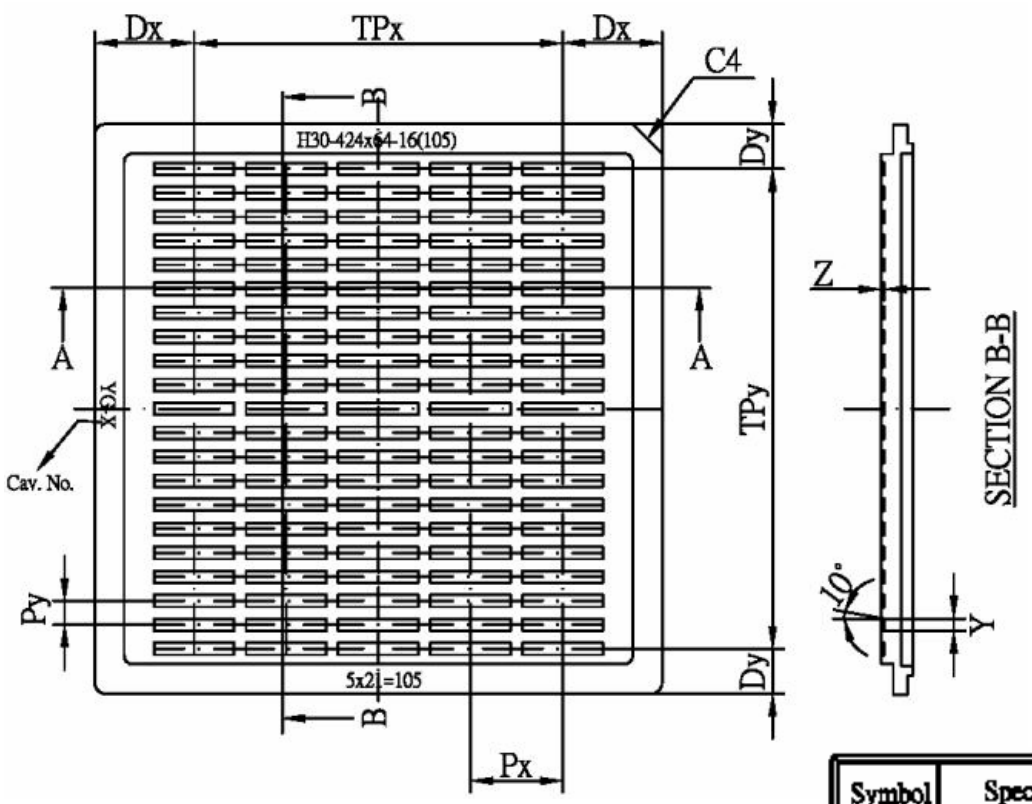
Figure 15-1: SSD1351UR1 Detail Dimension

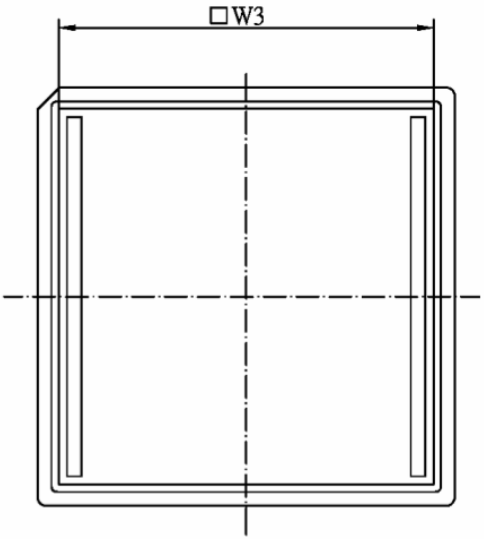


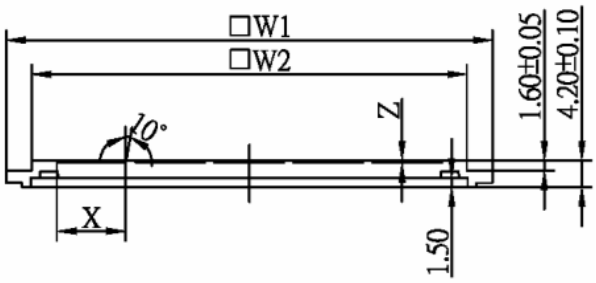
NOTE:
1. GENERAL TOLERANCE: ±0.050mm
2. MATERIAL
   PI: 38±4um
   CU: 8±2um
   SR: 15±10um
   (OTHER TOLERANCE: ±0.200mm)
3. SN PLATING: 0.160±0.050um
4. TAPESIZE: 4 SPH, 19.00mm

15.2 SSD1351Z Die Tray Information

Figure 15-2: SSD1351UR1 Die Tray Information







SECTION A-A

Symbol	Spec (mm)	(mil)
W1	76.00±0.10	(2992)
W2	68.00±0.10	(2677)
W3	68.30±0.10	(2689)
Dx	13.32±0.10	(524)
TPx	49.36±0.10	(1943)
Dy	6.00±0.10	(236)
TPy	64.00±0.10	(2520)
Px	12.34±0.05	(486)
Py	3.20±0.05	(126)
X	10.76±0.05	(424)
Y	1.62±0.05	(64)
Z	0.40±0.05	(16)
N	105(pocket number)	

The product(s) listed in this datasheet comply with Directive 2002/95/EC of the European Parliament and of the council of 27 January 2004 on the restriction of the use of certain hazardous substances in electrical and electronic equipment and People’s Republic of China Electronic Industry Standard SJ/T 11363-2006 “Requirements for concentration limits for certain hazardous substances in electronic information products (电子信息产品中有毒有害物质的限量要求)”. Hazardous Substances test report is available upon request.

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