

S6B0756

65COM / 96 SEG DRIVER & CONTROLLER FOR STN LCD

July. 2002.

Ver. 2.5

Prepared by Jae Ho Park

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0.0	.Initial version	Dec.2000
0.1	.Reference circuit examples(Page 26) corrected .Enter Calibration mode instruction deleted .OTP calibration mode changed	Jan.2001
0.2	.Enter Micro Processor Interface Protocol (Page 9)	Mar.2001
1.0	.Eliminated X5 boost.(Page 1) .Added VCI range (Page 1) .Changed Block Diagram for integrated Booster Capacitors(Page 3) .Added OTPG / OTPD pin(Page 3,5) .Changed Reference Circuit Examples(Page 27) .Changed Reset Mode initial operation(Page 29) .Added Frame Frequency command(Page 30,39) .Changed Operating Current(Page 54)	Mar.2001
1.1	.Changed block Diagram (Page 3) .Changed LCD Driver Supply (Page 4) .Changed System Control (Page 5) .Changed Voltage Regulator Circuits (Page 24) .Deleted " In Case of Using External Resisters, Ra and Rb" (Page 26) .Changed Reference Circuit Examples (Page 27) .Changed instruction : Read Status (Page 32) .Added instructions concerned with OTP : Calibration Mode EN (Page 40) , OTP Write Enable(Page 41), Set OV Register (Page 45) .Added OTP operation (Page 64)	Apr.2001
2.0	.Added instruction concerned with OTP : OTP Mode ON/OFF .Added OTP operation .Changed V0 to VOUT	May.2001
2.1	.Pad configuration .Pad center coordinates	June.2001
2.2	.Changed LCD driving voltage	Dec.2001
2.3	.Fix key coordinates and adjust VSS pin number	Feb.2002
2.4	.Added Display Example(Page 42)	May.2002
2.5	.Changed Icon(Page 42) function.	July.2002

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INTRODUCTION

The S6B0756 is a driver & controller LSI for graphic dot-matrix liquid crystal display systems. It contains 65 common and 96 segment driver circuits. This chip is connected directly to a microprocessor, accepts serial or 8-bit parallel display data and stores in an on-chip display data RAM of 65 x 96 bits. It provides a highly flexible display section due to 1-to-1 correspondence between on-chip display data RAM bits and LCD panel pixels. And it performs display data RAM read/write operation with no externally operating clock to minimize power consumption. In addition, because it contains power supply circuits necessary to drive liquid crystal, it is possible to make a display system with the fewest components.

FEATURES

Driver Output Circuits

- 65 common outputs / 96 segment outputs

Applicable Duty Ratios

Programmable duty ratio	Applicable LCD bias	Maximum display area
1/17 to 1/65	1/4 to 1/9	65 × 96

- Various partial display
- Partial window moving & data scrolling

On-chip Display Data RAM

- Capacity: 65 x 96 = 6,240 bits
- Bit data "1": a dot of display is illuminated. Bit data "0": a dot of display is not illuminated.

Microprocessor Interface

- 8-bit parallel bi-directional interface with 6800-series or 8080-series.
- SPI (Serial Peripheral Interface) available. (only write operation)

On-chip Low Power Analog Circuit

- On-chip oscillator circuit
- Voltage converter (x2, x3, x4)
- Voltage regulator (temperature coefficient: -0.05%/°C or external input)
- On-chip electronic contrast control function (64 steps)
- Voltage follower (LCD bias: 1/4 to 1/9)
- On-chip bias / boosting capacitor

OTP(One-Time Programmable) method for VOUT calibration

On-chip EPROM(Erasable and Programmable ROM) for setting the offset voltage into LCD panel.

Operating Voltage Range

- Supply voltage (VDD): 1.8 to 3.3 V
- Voltage for DC/DC Converter (VCI): 2.4 to 4.5 V
- LCD driving voltage (VLCD = VOUT - VSS): 4.0 to 12.0 V

Low power Consumption

- TBD (Internal power supply on and display OFF)

Package Type

- COG (Gold bumped chip)

This chip is not designed for resistance to radiation or light.

BLOCK DIAGRAM

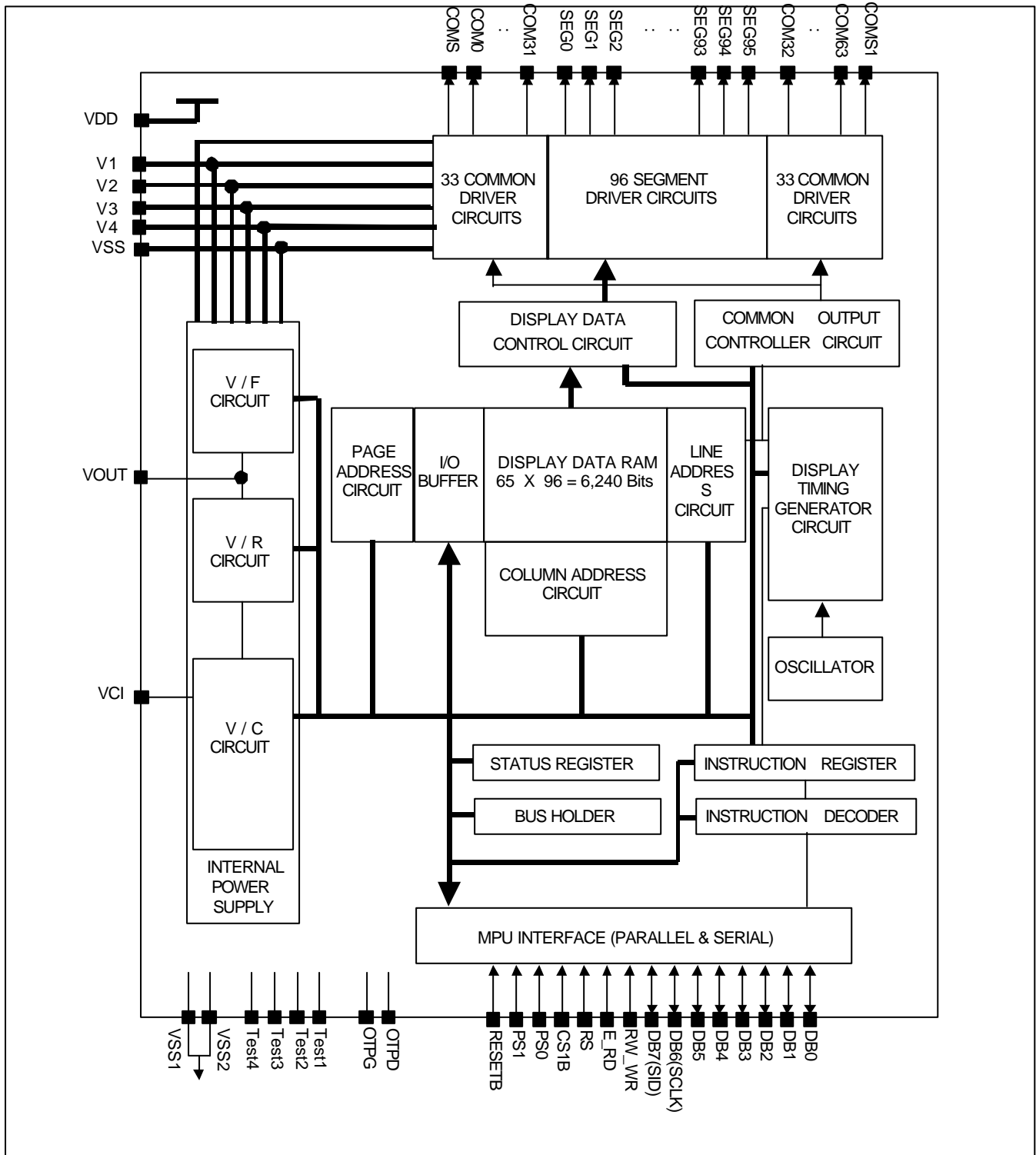


Figure 1. Block Diagram

PAD CONFIGURATION

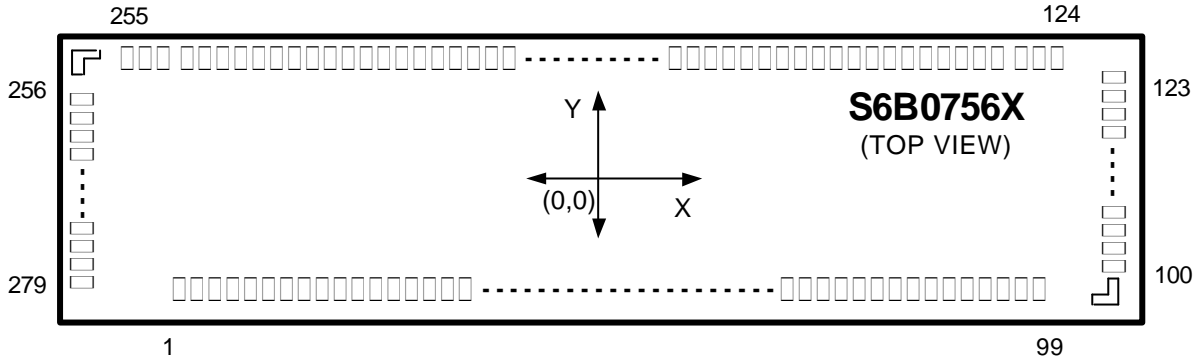
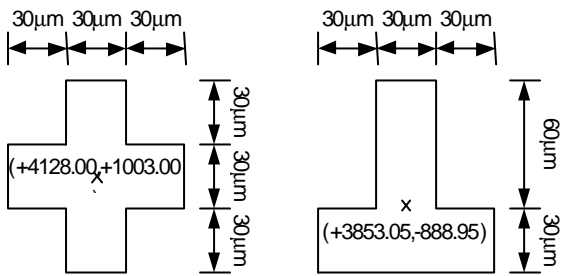


Figure 2. S6B0756 Chip Configuration

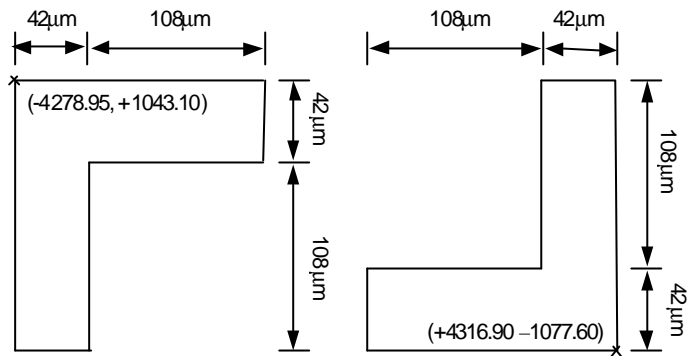
Table 1. S6B0756 Pad Dimensions

Item	Pad NO.	Size		Unit
		X	Y	
Chip Size	-	8780	2300	um
Pad Pitch	1 to 3	80		
	3 to 97	70		
	97 to 99	80		
	100 to 102	80		
	102 to 120	60		
	120 to 123	80		
	124 to 126	80		
	126 to 253	60		
	253 to 255	80		
	256 to 259	80		
259 to 277	60			
277 to 279	80			
Bumped pad Size (Top)	1,2,98,99 124,125,254,255	60	110	um
	3 to 97	50	100	
	100,101,121,122,123, 256,257,258,278,279	110	60	
	102 to 120 259 to 277	110	40	
	126 to 253	40	110	
Bumped pad height	All pad	14(Typ.)		

COG Align Key Coordinate



ILB Align Key Coordinate



When designing COG pattern, ITO pattern must be prohibited on this area (ILB align key). if ITO pattern is used for routing over this area, it can be happened pattern-short through bumped pattern on ILB align key

PAD CENTER COORDINATES

Table 2. Pad Center Coordinates

[Unit: μm]

NO	NAME	X	Y	NO	NAME	X	Y	NO	NAME	X	Y
1	DUMMY1	-3585.35	-1035	51	VCI(VCI3)	-65.35	-1035	101	DUMMY6	4243	-577.55
2	DUMMY2	-3505.35	-1035	52	VCI(VCI3)	4.65	-1035	102	COM31	4243	-497.55
3	TEST(PAD-CK)	-3425.35	-1035	53	VCI(VCI3)	74.65	-1035	103	COM30	4243	-437.55
4	TEST(TEST CL)	-3355.35	-1035	54	VCI(VCI3)	144.65	-1035	104	COM29	4243	-377.55
5	TEST3	-3285.35	-1035	55	VCI(VCI3)	214.65	-1035	105	COM28	4243	-317.55
6	TEST4	-3215.35	-1035	56	VCI(VCI3)	284.65	-1035	106	COM27	4243	-257.55
7	VSS	-3145.35	-1035	57	VCI(VCI3)	354.65	-1035	107	COM26	4243	-197.55
8	PS0	-3075.35	-1035	58	VSS(VSS0)	424.65	-1035	108	COM25	4243	-137.55
9	VDD1	-3005.35	-1035	59	VSS(VSS1)	494.65	-1035	109	COM24	4243	-77.55
10	PS1	-2935.35	-1035	60	VSS(VSS1)	564.65	-1035	110	COM23	4243	-17.55
11	VSS	-2865.35	-1035	61	VSS(VSS1)	634.65	-1035	111	COM22	4243	42.45
12	CS1B	-2795.35	-1035	62	VSS(VSS1)	704.65	-1035	112	COM21	4243	102.45
13	CS1B	-2725.35	-1035	63	VSS(VSS1)	774.65	-1035	113	COM20	4243	162.45
14	VDD1	-2655.35	-1035	64	VSS(VSS2)	844.65	-1035	114	COM19	4243	222.45
15	RESETB	-2585.35	-1035	65	VSS(VSS2)	914.65	-1035	115	COM18	4243	282.45
16	RS	-2515.35	-1035	66	VSS(VSS2)	984.65	-1035	116	COM17	4243	342.45
17	RS	-2445.35	-1035	67	VSS(VSS2)	1054.65	-1035	117	COM16	4243	402.45
18	RS	-2375.35	-1035	68	VSS(VSS2)	1124.65	-1035	118	COM15	4243	462.45
19	VSS	-2305.35	-1035	69	VSS(VSS2)	1194.65	-1035	119	COM14	4243	522.45
20	RW_WR	-2235.35	-1035	70	VSS(VSS2)	1264.65	-1035	120	COM13	4243	582.45
21	RW_WR	-2165.35	-1035	71	VSS(VSS2)	1334.65	-1035	121	DUMMY7	4243	642.45
22	E_RD	-2095.35	-1035	72	VSS(VSS2)	1404.65	-1035	122	DUMMY8	4243	702.45
23	E_RD	-2025.35	-1035	73	INT(VR)	1474.65	-1035	123	DUMMY9	4243	762.45
24	VDD1	-1955.35	-1035	74	INT(VR)	1544.65	-1035	124	DUMMY10	3969.9	1003
25	DB0	-1885.35	-1035	75	VOUT	1614.65	-1035	125	DUMMY11	3889.9	1003
26	DB1	-1815.35	-1035	76	VOUT	1684.65	-1035	126	COM12	3809.9	1003
27	DB2	-1745.35	-1035	77	VOUT	1754.65	-1035	127	COM11	3749.9	1003
28	DB3	-1675.35	-1035	78	VOUT	1824.65	-1035	128	COM10	3689.9	1003
29	DB4	-1605.35	-1035	79	VOUT	1894.65	-1035	129	COM9	3629.9	1003
30	DB5	-1535.35	-1035	80	VOUT	1964.65	-1035	130	COM8	3569.9	1003
31	DB6	-1465.35	-1035	81	VOUT	2034.65	-1035	131	COM7	3509.9	1003
32	DB6	-1395.35	-1035	82	VOUT	2104.65	-1035	132	COM6	3449.9	1003
33	DB7	-1325.35	-1035	83	V1	2174.65	-1035	133	COM5	3389.9	1003
34	DB7	-1255.35	-1035	84	V1	2244.65	-1035	134	COM4	3329.9	1003
35	VDD(VDD1)	-1185.35	-1035	85	V2	2314.65	-1035	135	COM3	3269.9	1003
36	VDD(VDD1)	-1115.35	-1035	86	V2	2384.65	-1035	136	COM2	3209.9	1003
37	VDD(VDD1)	-1045.35	-1035	87	V3	2454.65	-1035	137	COM1	3149.9	1003
38	VDD(VDD1)	-975.35	-1035	88	V3	2524.65	-1035	138	COM0	3089.9	1003
39	VDD(VDD2)	-905.35	-1035	89	V4	2594.65	-1035	139	COMS	3029.9	1003
40	VDD(VDD2)	-835.35	-1035	90	V4	2664.65	-1035	140	DUMMY12	2969.9	1003
41	VDD(VDD2)	-765.35	-1035	91	OTPG	2734.65	-1035	141	DUMMY13	2909.9	1003
42	VCI(VCI1)	-695.35	-1035	92	OTPG	2804.65	-1035	142	SEG0	2849.9	1003
43	VCI(VCI1)	-625.35	-1035	93	OTPD	2874.65	-1035	143	SEG1	2789.9	1003
44	VCI(VCI1)	-555.35	-1035	94	OTPD	2944.65	-1035	144	SEG2	2729.9	1003
45	VCI(VCI1)	-485.35	-1035	95	DUMMY	3014.65	-1035	145	SEG3	2669.9	1003
46	VCI(VCI2)	-415.35	-1035	96	DUMMY	3084.65	-1035	146	SEG4	2609.9	1003
47	VCI(VCI2)	-345.35	-1035	97	DUMMY	3154.65	-1035	147	SEG5	2549.9	1003
48	VCI(VCI2)	-275.35	-1035	98	DUMMY3	3224.65	-1035	148	SEG6	2489.9	1003
49	VCI(VCI2)	-205.35	-1035	99	DUMMY4	3314.65	-1035	149	SEG7	2429.9	1003
50	VCI(VCI3)	-135.35	-1035	100	DUMMY5	4243	-657.55	150	SEG8	2369.9	1003

Table 2. Pad Center Coordinates (Continued)

[Unit: μm]

NO	NAME	X	Y	NO	NAME	X	Y	NO	NAME	X	Y
151	SEG9	2309.9	1003	201	SEG59	-690.1	1003	251	COM43	-3690.1	1003
152	SEG10	2249.9	1003	202	SEG60	-750.1	1003	252	COM44	-3750.1	1003
153	SEG11	2189.9	1003	203	SEG61	-810.1	1003	253	COM45	-3810.1	1003
154	SEG12	2129.9	1003	204	SEG62	-870.1	1003	254	DUMMY16	-3890.1	1003
155	SEG13	2069.9	1003	205	SEG63	-930.1	1003	255	DUMMY17	-3970.1	1003
156	SEG14	2009.9	1003	206	SEG64	-990.1	1003	256	DUMMY18	-4243	822.45
157	SEG15	1949.9	1003	207	SEG65	-1050.1	1003	257	DUMMY19	-4243	742.45
158	SEG16	1889.9	1003	208	SEG66	-1110.1	1003	258	DUMMY20	-4243	662.45
159	SEG17	1829.9	1003	209	SEG67	-1170.1	1003	259	COM46	-4243	582.45
160	SEG18	1769.9	1003	210	SEG68	-1230.1	1003	260	COM47	-4243	522.45
161	SEG19	1709.9	1003	211	SEG69	-1290.1	1003	261	COM48	-4243	462.45
162	SEG20	1649.9	1003	212	SEG70	-1350.1	1003	262	COM49	-4243	402.45
163	SEG21	1589.9	1003	213	SEG71	-1410.1	1003	263	COM50	-4243	342.45
164	SEG22	1529.9	1003	214	SEG72	-1470.1	1003	264	COM51	-4243	282.45
165	SEG23	1469.9	1003	215	SEG73	-1530.1	1003	265	COM52	-4243	222.45
166	SEG24	1409.9	1003	216	SEG74	-1590.1	1003	266	COM53	-4243	162.45
167	SEG25	1349.9	1003	217	SEG75	-1650.1	1003	267	COM54	-4243	102.45
168	SEG26	1289.9	1003	218	SEG76	-1710.1	1003	268	COM55	-4243	42.45
169	SEG27	1229.9	1003	219	SEG77	-1770.1	1003	269	COM56	-4243	-17.55
170	SEG28	1169.9	1003	220	SEG78	-1830.1	1003	270	COM57	-4243	-77.55
171	SEG29	1109.9	1003	221	SEG79	-1890.1	1003	271	COM58	-4243	-137.55
172	SEG30	1049.9	1003	222	SEG80	-1950.1	1003	272	COM59	-4243	-197.55
173	SEG31	989.9	1003	223	SEG81	-2010.1	1003	273	COM60	-4243	-257.55
174	SEG32	929.9	1003	224	SEG82	-2070.1	1003	274	COM61	-4243	-317.55
175	SEG33	869.9	1003	225	SEG83	-2130.1	1003	275	COM62	-4243	-377.55
176	SEG34	809.9	1003	226	SEG84	-2190.1	1003	276	COM63	-4243	-437.55
177	SEG35	749.9	1003	227	SEG85	-2250.1	1003	277	COMS1	-4243	-497.55
178	SEG36	689.9	1003	228	SEG86	-2310.1	1003	278	DUMMY21	-4243	-577.55
179	SEG37	629.9	1003	229	SEG87	-2370.1	1003	279	DUMMY22	-4243	-657.55
180	SEG38	569.9	1003	230	SEG88	-2430.1	1003				
181	SEG39	509.9	1003	231	SEG89	-2490.1	1003				
182	SEG40	449.9	1003	232	SEG90	-2550.1	1003				
183	SEG41	389.9	1003	233	SEG91	-2610.1	1003				
184	SEG42	329.9	1003	234	SEG92	-2670.1	1003				
185	SEG43	269.9	1003	235	SEG93	-2730.1	1003				
186	SEG44	209.9	1003	236	SEG94	-2790.1	1003				
187	SEG45	149.9	1003	237	SEG95	-2850.1	1003				
188	SEG46	89.9	1003	238	DUMMY14	-2910.1	1003				
189	SEG47	29.9	1003	239	DUMMY15	-2970.1	1003				
190	SEG48	-30.1	1003	240	COM32	-3030.1	1003				
191	SEG49	-90.1	1003	241	COM33	-3090.1	1003				
192	SEG50	-150.1	1003	242	COM34	-3150.1	1003				
193	SEG51	-210.1	1003	243	COM35	-3210.1	1003				
194	SEG52	-270.1	1003	244	COM36	-3270.1	1003				
195	SEG53	-330.1	1003	245	COM37	-3330.1	1003				
196	SEG54	-390.1	1003	246	COM38	-3390.1	1003				
197	SEG55	-450.1	1003	247	COM39	-3450.1	1003				
198	SEG56	-510.1	1003	248	COM40	-3510.1	1003				
199	SEG57	-570.1	1003	249	COM41	-3570.1	1003				
200	SEG58	-630.1	1003	250	COM42	-3630.1	1003				

PIN DESCRIPTION

POWER SUPPLY

Table 3. Power Supply Pins

Name	I/O	Description				
VDD1 VDD2	Supply	Power supply				
VSS0 VSS1 VSS2	Supply	Ground NOTE: VSS0, VSS1 and VSS2 must be shorted to external wire.				
VOUT V1 V2 V3 V4	I/O	LCD driver supply voltages These voltages are determined by LCD pixel is impedance, and converted by operational amplifiers for application. Voltages should have the following relationship; $VOUT \geq V1 \geq V2 \geq V3 \geq V4 \geq VSS$ When the internal power circuit is active, these voltages are generated as following table according to the state of LCD bias.				
		LCD bias	V1	V2	V3	V4
		1/N bias	$(N-1) / N \times VOUT$	$(N-2) / N \times VOUT$	$(2/N) \times VOUT$	$(1/N) \times VOUT$
		NOTE: N = 4 to 9				

LCD DRIVER SUPPLY

Table 4. LCD Driver Supply Pins

Name	I/O	Description
VOUT	I/O	Voltage converter input/output pin Connect this pin to VSS through capacitor.
VCI1 VCI2 VCI3	I	Voltage converter input voltage pin and Power supply pins for Analog block Voltages should have the following relationship: $VDD \leq VCI \leq VOUT$

SYSTEM CONTROL**Table 5. System Control Pins**

Name	I/O	Description
OTPG	I	Gate Voltage for OTP programming
OTPD	I	Drain Voltage for OTP programming
TEST1 to TEST4	I	Test pins Don't use these pins.

MICROPROCESSOR INTERFACE

Table 6. Microprocessor Interface Pins

Name	I/O	Description					
RESETB	I	Reset the input pin When RESETB is "L", initialization is executed.					
PS0	I	Parallel/Serial data input select input					
		PS0	Interface Mode	Data/ Instruction	Data	Read / Write	Serial Clock
		H	Parallel	RS	DB0 to DB7	E_RD RW_WR	-
		L	Serial	RS or None	SID(DB7)	Write only	SCLK(DB6)
*NOTE: When PS is "L", DB0 to DB5 are high impedance and E_RD and RW_WR must be fixed to either "H" or "L".							
PS1	I	Microprocessor interface select input pin <ul style="list-style-type: none"> - PS0 = "H" , PS1 = "H": 6800-series parallel MPU interface - PS0 = "H" , PS1 = "L": 8080-series parallel MPU interface - PS0 = "L" , PS1 = "H": 4 Pin-SPI serial MPU interface - PS0 = "L" , PS1 = "L": 3 Pin-SPI serial MPU interface 					
CS1B	I	Chip select input pins Data/instruction I/O is enabled only when CS1B is "L" . When chip select is non-active, DB0 to DB7 may be high impedance.					
RS	I	Register select input pin <ul style="list-style-type: none"> - RS = "H": DB0 to DB7 are display data - RS = "L": DB0 to DB7 are control data 					
RW_WR	I	Read / Write execution control pin					
		PS1	MPU Type	RW_WR	Description		
		H	6800-series	RW	Read/Write control input pin <ul style="list-style-type: none"> - RW = "H": read - RW = "L": write 		
		L	8080-series	/WR	Write enable clock input pin The data on DB0 to DB7 are latched at the rising edge of the /WR signal.		

Table 6 (Continued)

Name	I/O	Description			
E_RD	I	Read / Write execution control pin			
		PS1	MPU Type	E_RD	Description
		H	6800-series	E	Read/Write control input pin – RW = "H": When E is "H", DB0 to DB7 are in an output status. – RW = "L": The data on DB0 to DB7 are latched at the falling edge of the E signal.
		L	8080-series	/RD	Read enable clock input pin When /RD is "L", DB0 to DB7 are in an output status.
DB0 to DB7	I/O	8-bit bi-directional data bus that is connected to the standard 8-bit microprocessor data bus. When the serial interface selected (PS0 = "L"); – DB0 to DB5: high impedance – DB6: serial input clock (SCLK) – DB7: serial input data (SID) When chip select is not active, DB0 to DB7 may be high impedance.			

LCD DRIVER OUTPUTS

Table 7. LCD Driver Outputs Pins

Name	I/O	Description			
SEG0 to SEG95	O	LCD segment driver outputs The display data and the M signal control the output voltage of segment driver.			
		Display data	M (Internal)	Segment driver output voltage	
				Normal display	Reverse display
		H	H	VOUT	V2
		H	L	VSS	V3
		L	H	V2	VOUT
		L	L	V3	VSS
		Power save mode		VSS	VSS
COM0 to COM63	O	LCD common driver outputs The internal scanning data and M signal control the output voltage of common driver.			
		Scan data	M (Internal)	Common driver output voltage	
		H	H	VSS	
		H	L	VOUT	
		L	H	V1	
		L	L	V4	
Power save mode		VSS			
COMS (COMS1)	O	Common output for the icons The output signals of two pins are same. When not used, these pins should be left open.			

NOTE: **DUMMY** – These pins should be opened (floated).

FUNCTIONAL DESCRIPTION

MICROPROCESSOR INTERFACE

Chip Select Input

There are CS1B for chip selection. The S6B0756 can interface with an MPU only when CS1B is "L". Otherwise RS, E_RD, and RW_WR inputs are disabled and DB0 to DB7 are to be high impedance. And, in case of serial interface, the internal shift register and the counter are reset.

Parallel / Serial Interface

S6B0756 has four types of interface with an MPU, which are two serial and two parallel interface. This parallel or serial interface is determined by PS 0 pin as shown in Table 8.

Table 8. Parallel / Serial Interface Mode

PS0	Type	CS1B	PS1	Interface mode
H	Parallel	CS1B	H	6800-series MPU mode
			L	8080-series MPU mode
L	Serial	CS1B	H	4 Pin-SPI MPU mode
			L	3 Pin-SPI MPU mode

Parallel Interface (PS0 = "H")

The 8-bit bi-directional data bus is used in parallel interface and the type of MPU is selected by PS1 as shown in Table 9. The type of data transfer is determined by signals at RS, E_RD and RW_WR as shown in Table 10.

Table 9. Microprocessor Selection for Parallel Interface

PS1	CS1B	RS	E_RD	RW_WR	DB0 to DB7	MPU bus
H	CS1B	RS	E	RW	DB0 to DB7	6800-series
L	CS1B	RS	/RD	/WR	DB0 to DB7	8080-series

Table 10. Parallel Data Transfer

Common	6800-series		8080-series		Description
RS	E_RD (E)	RW_WR (RW)	E_RD (/RD)	RW_WR (/WR)	
H	H	H	L	H	Display data read out
H	H	L	H	L	Display data write
L	H	H	L	H	Register status read
L	H	L	H	L	Writes to internal register (instruction)

NOTE: When E_RD pin is always pulled high for 6800-series interface, it can be used CS1B for enable signal. In this case, interface data is latched at the rising edge of CS1B and the type of data transfer is determined by signals at RS, RW_WR as in case of 6800-series mode.

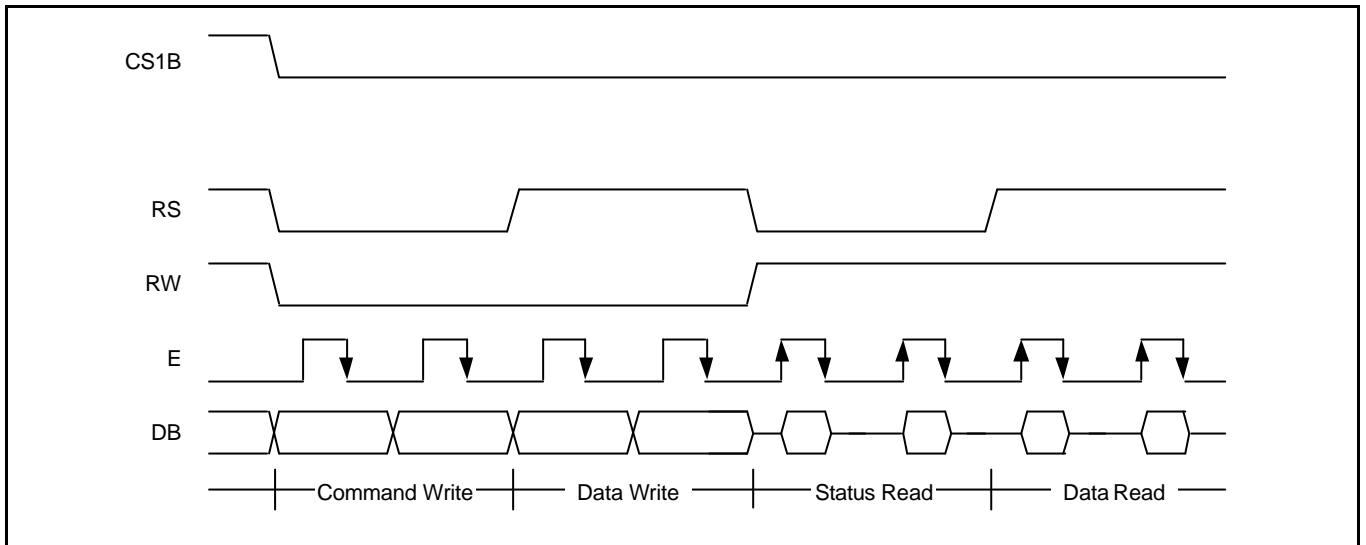


Figure 3. 6800-Series MPU Interface protocol (PS="H", MI="H")

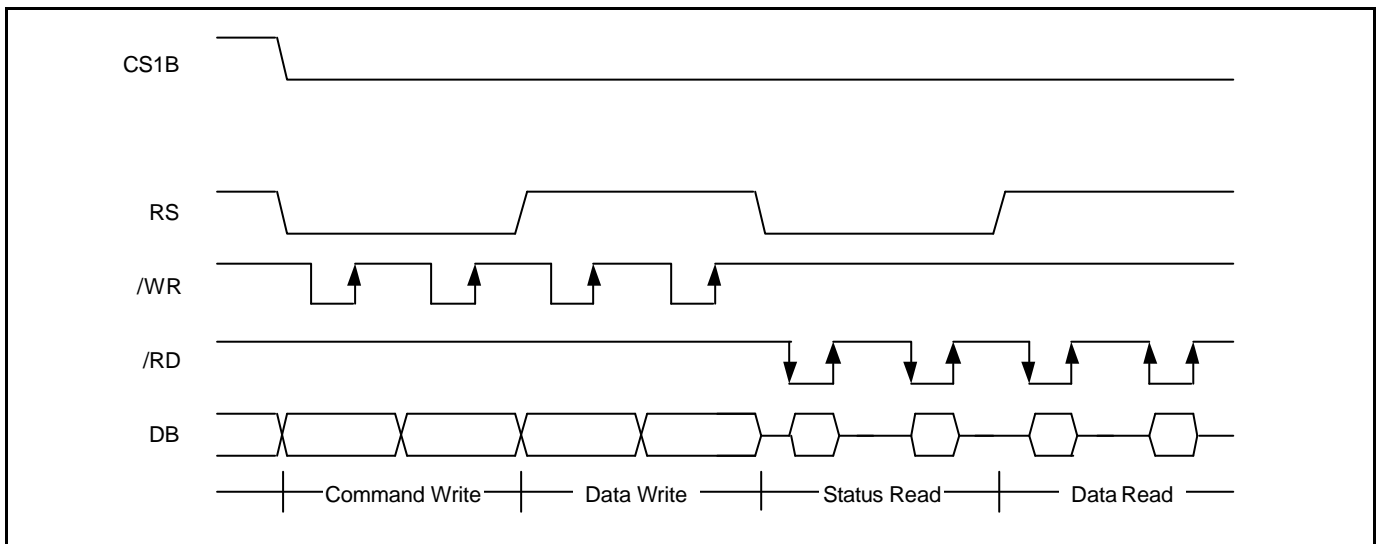


Figure 4 . 8080-Series MPU Interface Protocol (PS="H", MI="L")

Serial Interface (PS0 = "L")

When the S6B0756 is active (CS1B="L"), serial data (DB7) and serial clock (DB6) inputs are enabled. And not active, the internal 8-bit shift register and the 3-bit counter are reset. The display data/command indication may be controlled either via software or the Register Select (RS) Pin, based on the setting of PS1. When the RS pin is used (PS1 = "H"), data is display data when RS is high, and command data when RS is low. When RS is not used (PS1 = "L"), the LCD Driver will receive command from MPU by default. If messages on the data pin are data rather than command, MPU should send Data Direction command (11101000) to control the data direction and then one more command to define the number of data bytes will be write. After these two continuous commands are send, the following messages will be data rather than command. Serial data can be read on the rising edge of serial clock going into DB6 and processed as 8-bit parallel data on the eighth serial clock. And the DDRAM column address pointer will be increased by one automatically. The next bytes after the display data string is handled as command data.

Serial Mode	PS0	PS1	CS1B	RS
Serial-mode with RS pin	L	H	CS1B	Used
Serial-mode with software command	L	L	CS1B	Not used

4 Pin-SPI Interface (PS0 = "L" , PS1 = "H")

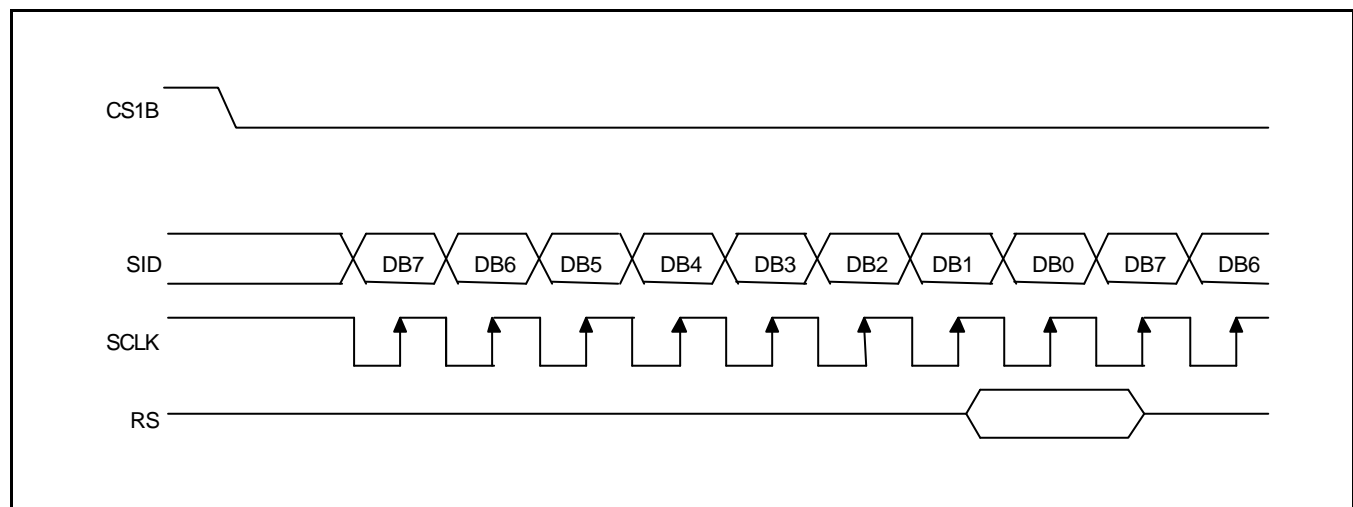


Figure 5. 4 Pin SPI Timing (RS is used)

3 Pin-SPI Interface (PS0 = "L" , PS1 = "L")

To write data to the DDRAM, send Data Direction Command in 3-Pin SPI mode. Data is latched at the rising edge of SCLK. And the DDRAM column address pointer will be increased by one automatically.

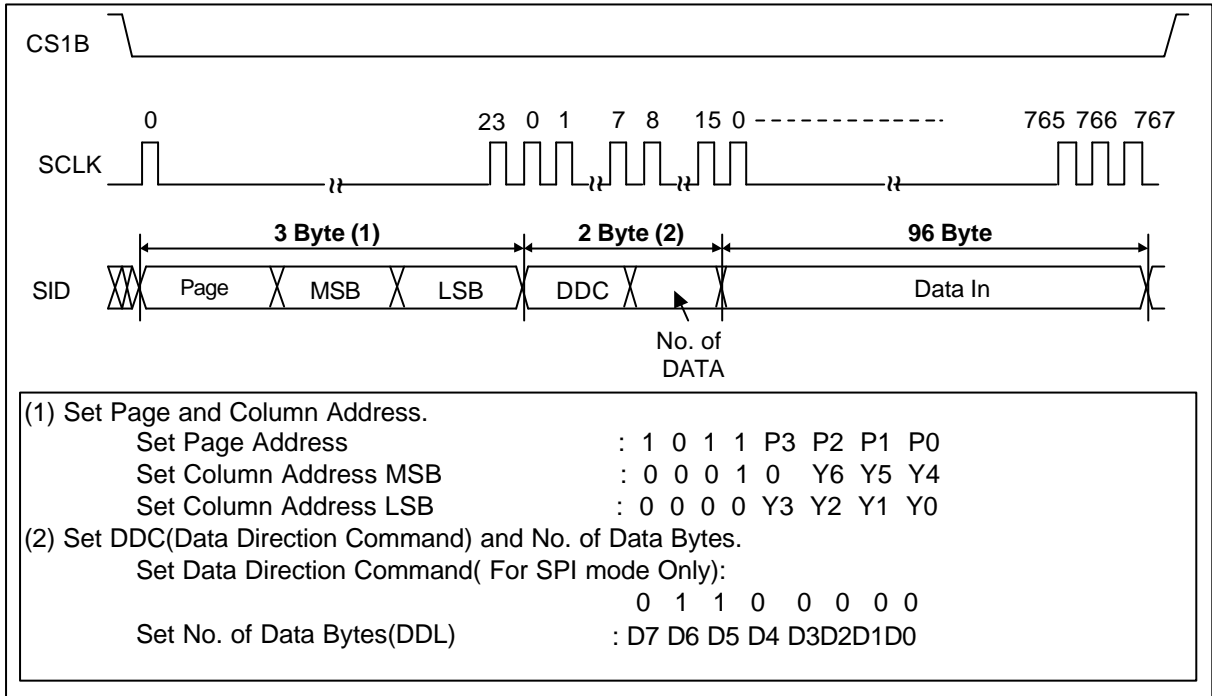


Figure 6. 3 Pin SPI Timing (RS is not used)

This command is used in 3-Pin SPI mode only. It will be two continuous commands, the first byte controls the data direction and informs the LCD driver the second byte will be number of data bytes will be write. After these two commands sending out, the following messages will be data. If data is stopped in transmitting, it is not valid data. New data will be transferred serially with most significant bit first.

Notes:

- In spite of transmission of data, if CS1B will be disable, state terminates abnormally. Next state is initialized.
- DDL Register value "0" → "1" , "95" → "96". (decimal value)

Busy Flag

The Busy Flag indicates whether the S6B0756 is operating or not. When DB7 is "H" in read status operation, this device is in busy status and will accept only read status instruction. If the cycle time is correct, the microprocessor needs not to check this flag before each instruction, which improves the MPU performance.

Data Transfer

The S6B0756 uses bus holder and internal data bus for Data Transfer with the MPU. When writing data from the MPU to on-chip RAM, data is automatically transferred from the bus holder to the RAM as shown in Figure 7. And when reading data from on-chip RAM to the MPU, the data for the initial read cycle is stored in the bus holder (dummy read) and the MPU reads this stored data from bus holder for the next data read cycle as shown in Figure 8. This means that a dummy read cycle must be inserted between each pair of address sets when a sequence of address sets is executed. Therefore, the data of the specified address cannot be output with the read display data instruction right after the address sets, but can be output at the second read of data.

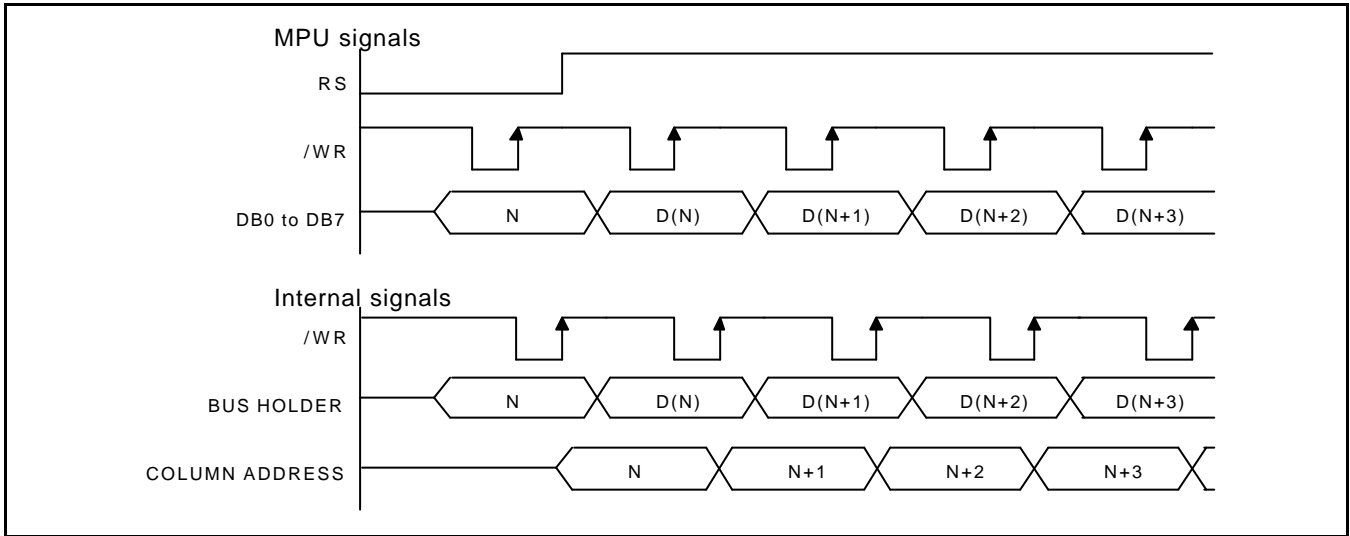


Figure 7. Write Timing

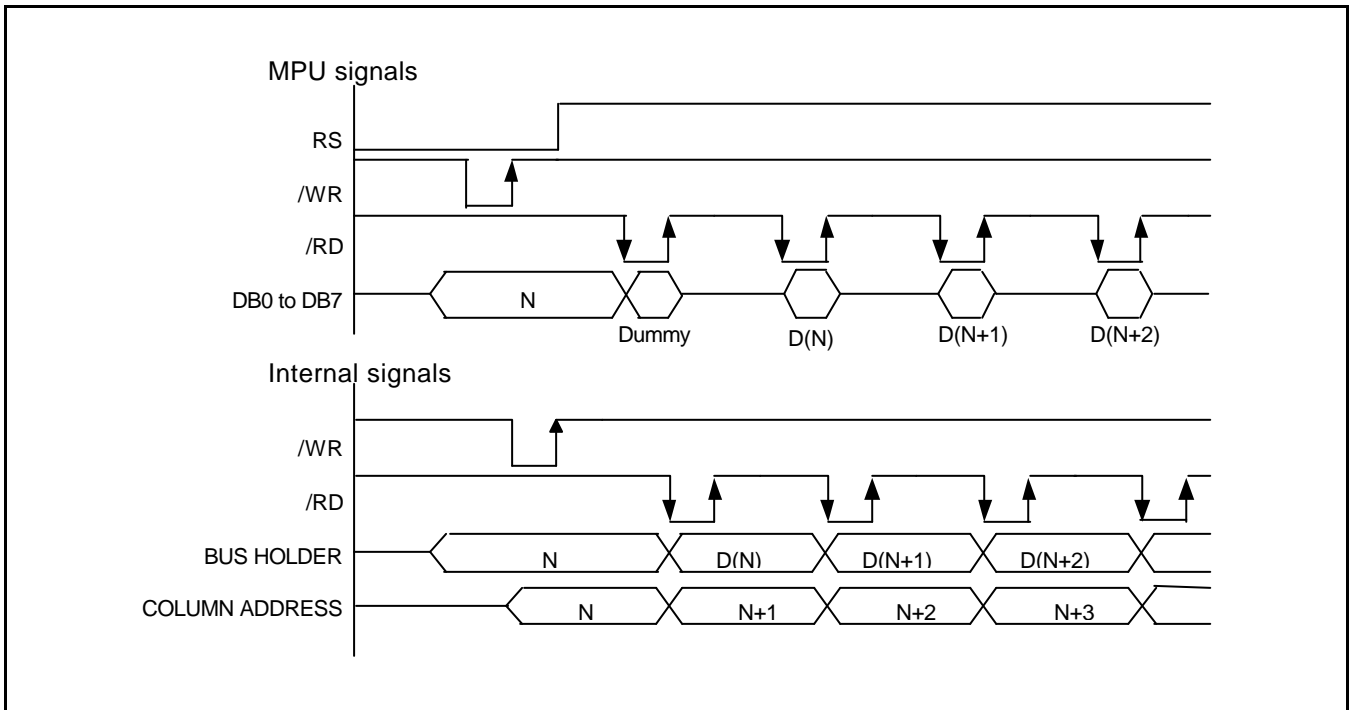


Figure 8. Read Timing

DISPLAY DATA RAM (DDRAM)

The Display Data RAM stores pixel data for the LCD. It is 65-row by 96-column addressable array. Each pixel can be selected when the page and column addresses are specified. The 65 rows are divided into 8 pages of 8 lines and the 9th page with a single line (DB0 only). Data is read from or written to the 8 lines of each page directly through DB0 to DB7. The display data of DB0 to DB7 from the microprocessor correspond to the LCD common lines as shown in Figure 9. The microprocessor can read from and write to RAM through the I/O buffer. Since the LCD controller operates independently, data can be written into RAM at the same time as data is being displayed without causing the LCD flicker.

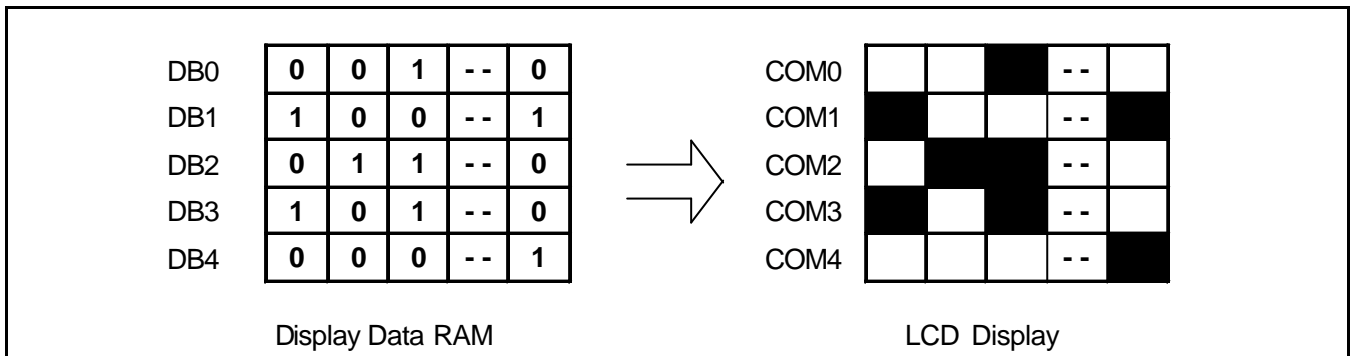


Figure 9. RAM-to-LCD Data Transfer

Page Address Circuit

This circuit is for providing a Page Address to Display Data RAM shown in Figure 11. It incorporates 4-bit Page Address register changed by only the "Set Page" instruction. Page Address 8 (DB3 is "H", DB2, DB1 and DB0 is "L") is a special RAM area for the icons and display data DB0 is only valid.

Line Address Circuit

This circuit assigns DDRAM a Line Address corresponding to the first line (COM0) of the display. Therefore, by setting line address repeatedly, it is possible to realize the screen scrolling and page switching without changing the contents of on-chip RAM as shown in Figure 9. It incorporates 7-bit Line Address register changed by only the initial display line instruction and 7-bit counter circuit. At the beginning of each LCD frame, the contents of register are copied to the line counter which is increased by CL signal and generates the Line Address for transferring the 96-bit RAM data to the display data latch circuit. However, display data of icons are not scrolled because the MPU can not access Line Address of icons.

Column Address Circuit

Column address circuit has a 7-bit preset counter that provides column address to the Display Data RAM as shown in **Figure 11**. When set Column Address MSB / LSB instruction is issued, 7-bit [Y6:Y0] is updated. And, since this address is increased by 1 each a read or write data instruction, microprocessor can access the display data continuously. And the Column Address counter is independent of page address register.

ADC Select instruction makes it possible to invert the relationship between the column address and the segment outputs. It is necessary to rewrite the display data on built-in RAM after issuing ADC Select instruction. Refer to the following Figure 10.

SEG output	SEG 0	SEG 1	SEG 2	SEG 3	SEG 92	SEG 93	SEG 94	SEG 95
Column address [Y6:Y0]	00H	01H	02H	03H	5CH	5DH	5EH	5FH
Display data	1	0	1	0		1	1	0	0
LCD panel display (ADC = 0)								
LCD panel display (ADC = 1)								

Figure 10. The Relationship between the Column Address and the Segment Outputs

Segment Control Circuit

This circuit controls the display data by the Display ON / OFF, reverse display ON / OFF and entire display ON / OFF instructions without changing the data in the display data RAM.

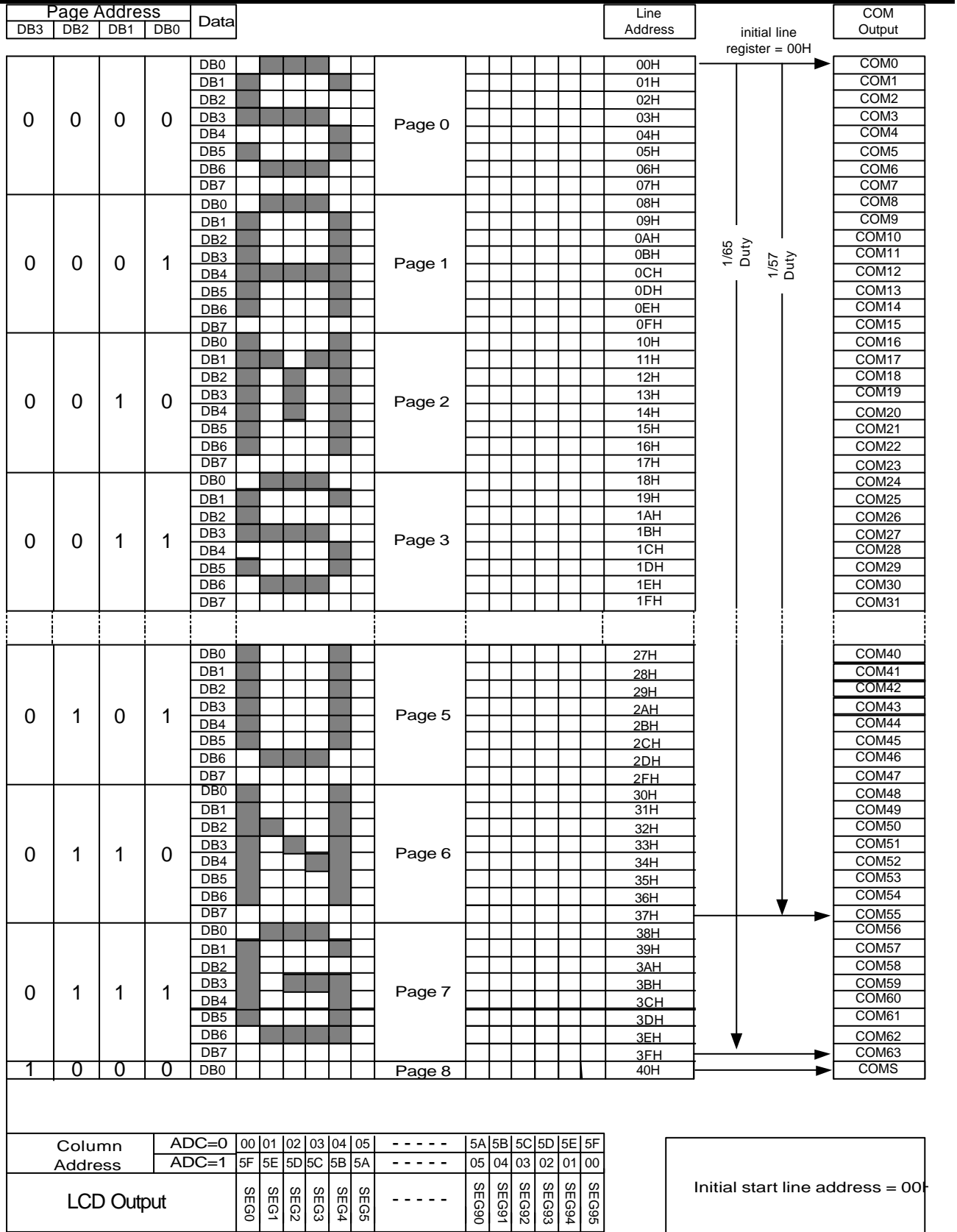


Figure 11. Display Data RAM Map (Initial Line Address = 00H)

LCD DISPLAY CIRCUITS

Oscillator

This is completely on-chip Oscillator and its frequency is nearly independent of V_{DD} . This Oscillator signal is used in display timing generation circuit.

Display Timing Generator Circuit

This circuit generates some signals to be used for displaying LCD. The display clock, CL(internal), generated by oscillation clock, generates the clock for the line counter and the signal for the display data latch. The line address of on-chip RAM is generated in synchronization with the display clock and the display data latch circuit latches the 96-bit display data in synchronization with the display clock. The display data, which is read to the LCD driver, is completely independent of the access to the display data RAM from the microprocessor. The display clock generates an LCD AC signal (M) which enables the LCD driver to make a AC drive waveform, and also generates an internal common timing signal and start signal to the common driver. The frame signal or the line signal changes the M by setting internal instruction. Driving waveform and internal timing signal are shown in Figure 12.

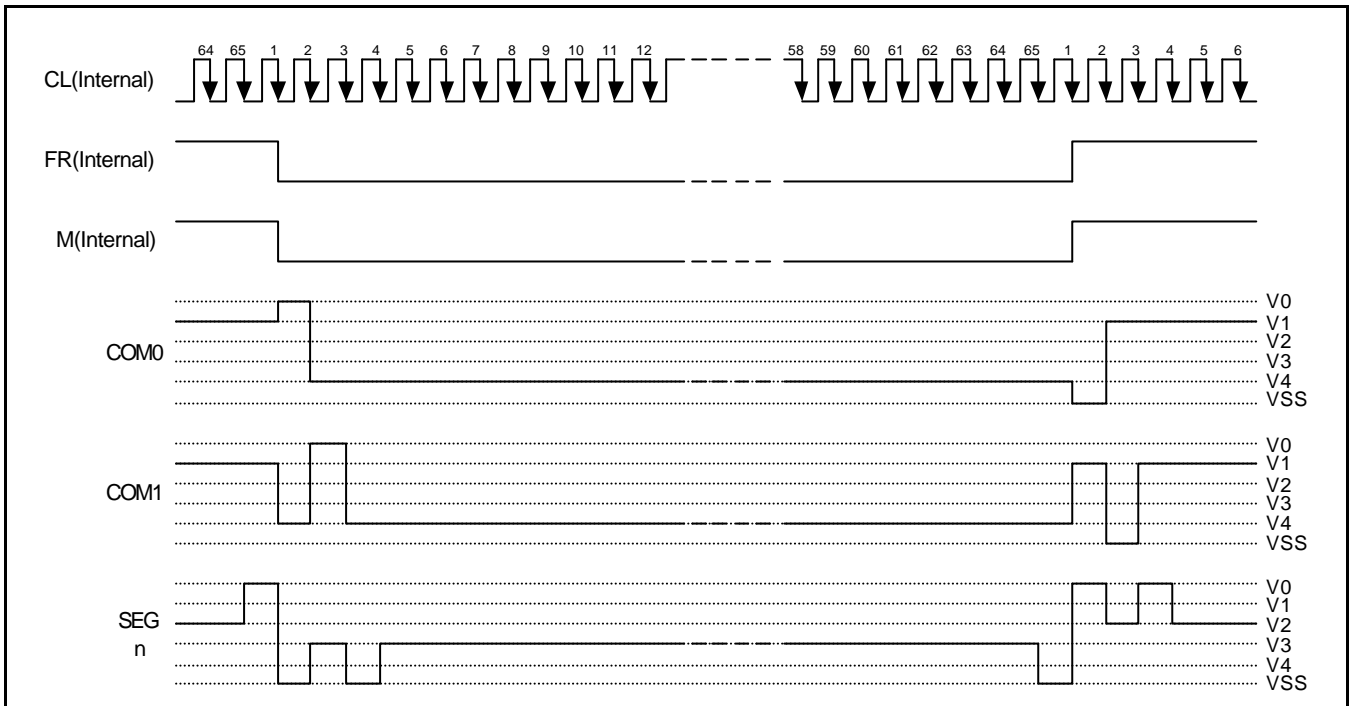


Figure 12. 2-frame AC Driving Waveform (Duty Ratio = 1/65)

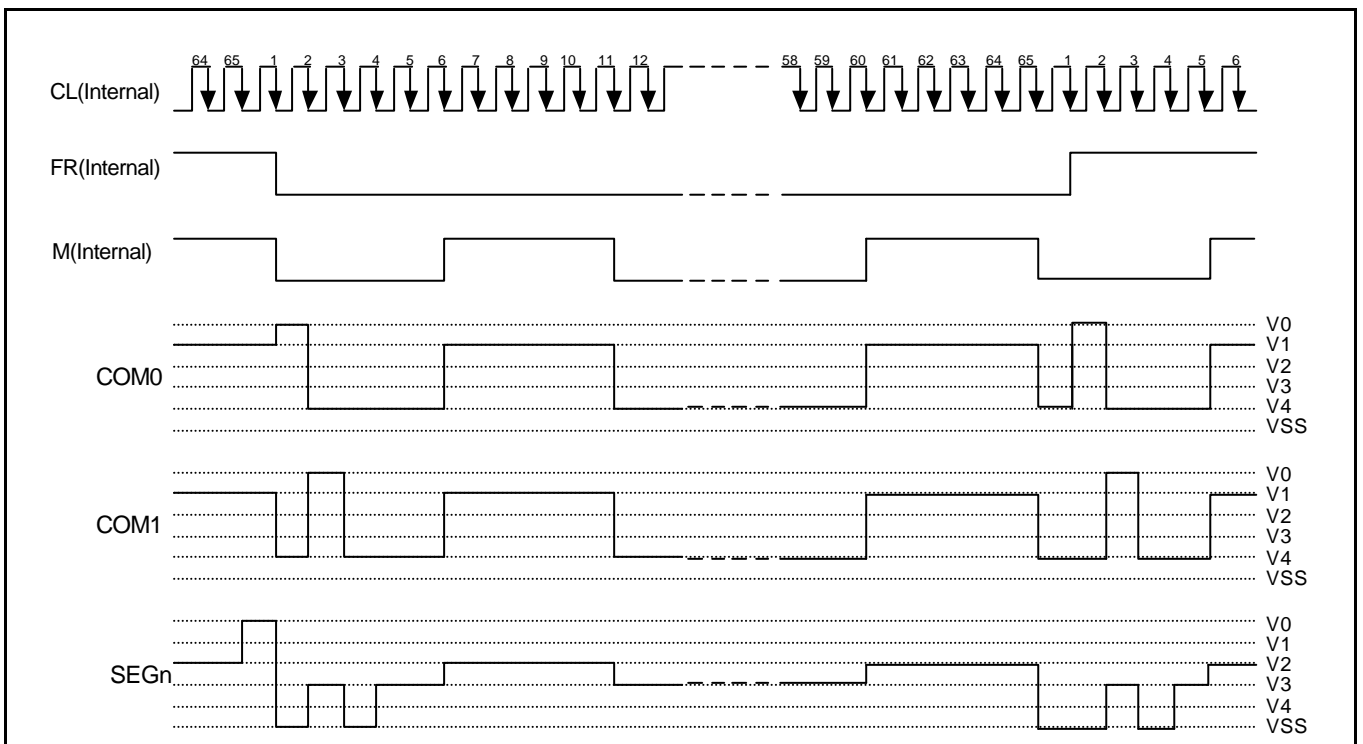


Figure 13. N-line Inversion Driving Waveform (N = 5 , Duty Ratio = 1/65)

LCD DRIVER CIRCUIT

65-channel common driver and 96-channel segment driver configure this driver circuit. This LCD panel driver voltage depends on the combination of display data and M(internal) signal.

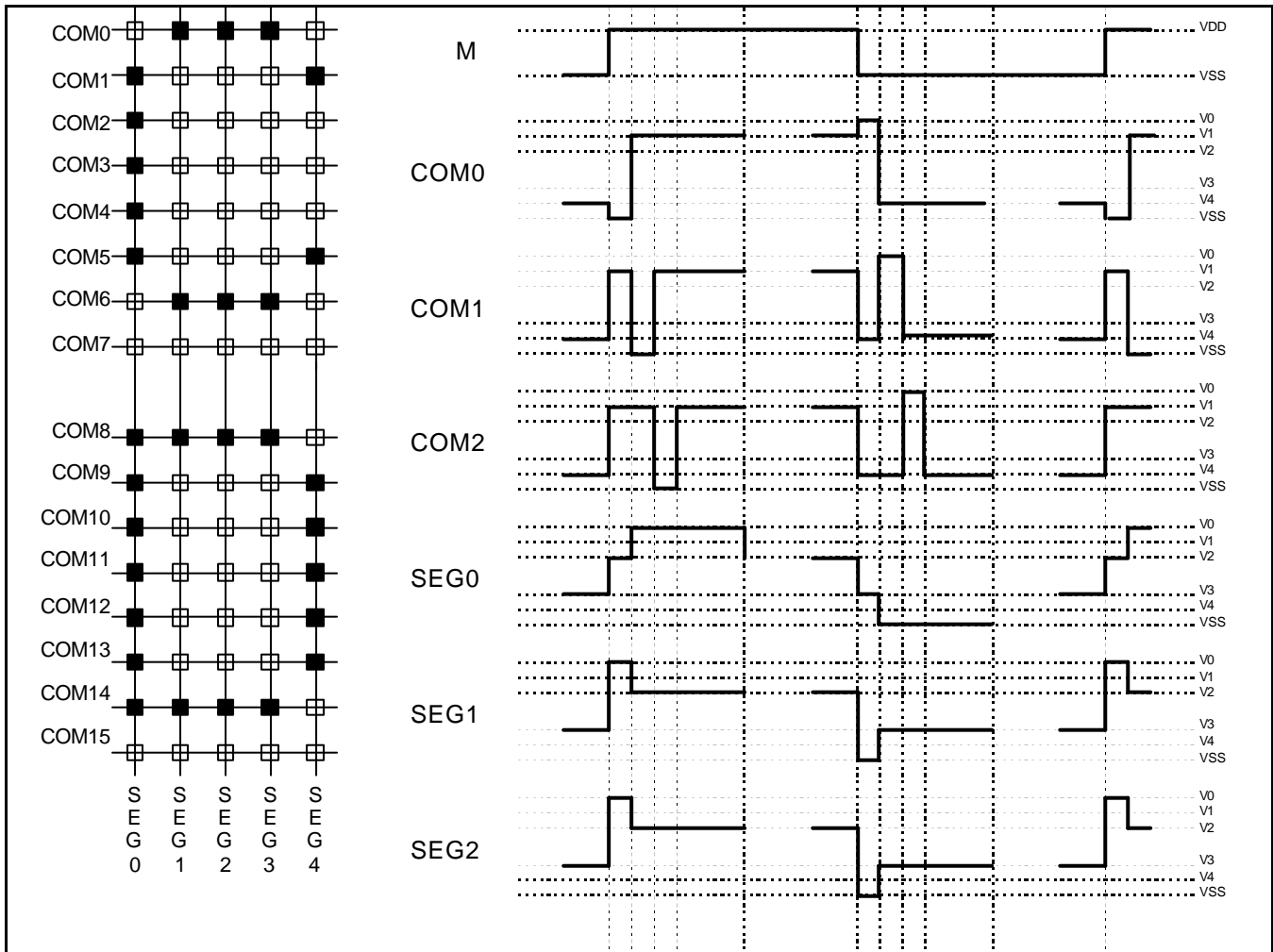


Figure 14. Segment and Common Timing

Partial Display on LCD

The S6B0756 realizes the Partial Display function on LCD with low-duty driving for saving power consumption and showing the various display duty. To show the various display duty on LCD, LCD driving duty and bias are programmable via the instruction. And, built-in power supply circuits are controlled by the instruction for adjusting the LCD driving voltages

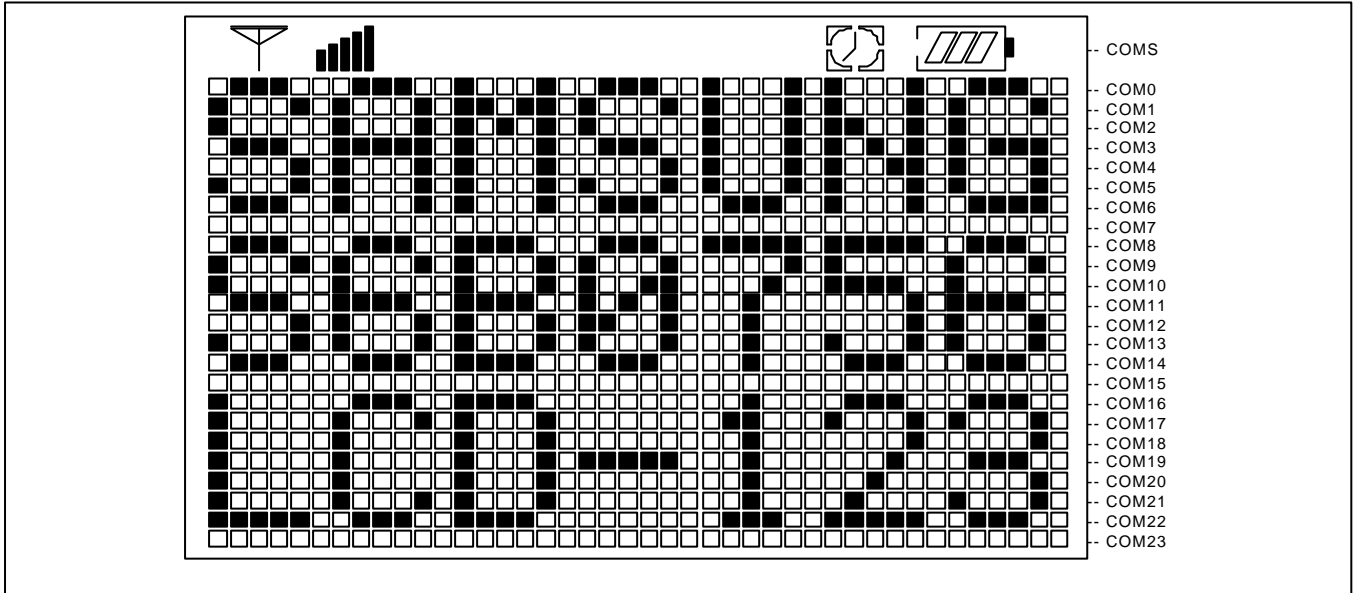


Figure 15. Reference Example for Partial Display (Display Duty = 25)

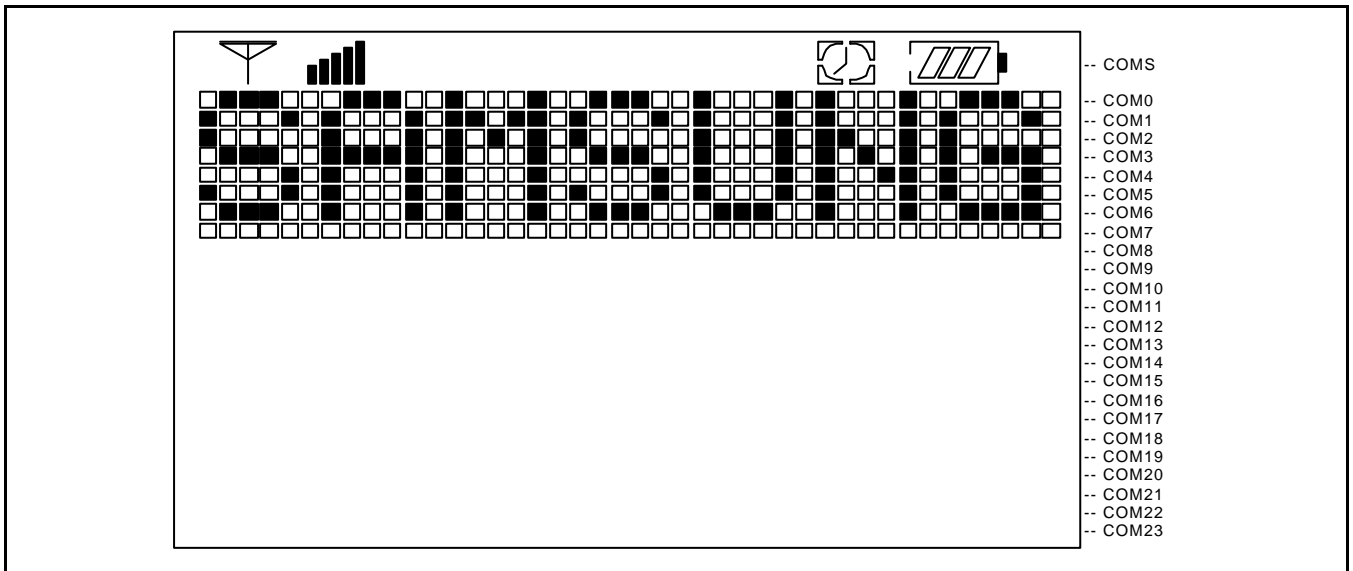


Figure 16. Partial Display (Partial Display Duty = 9, Initial COM0 = 0)

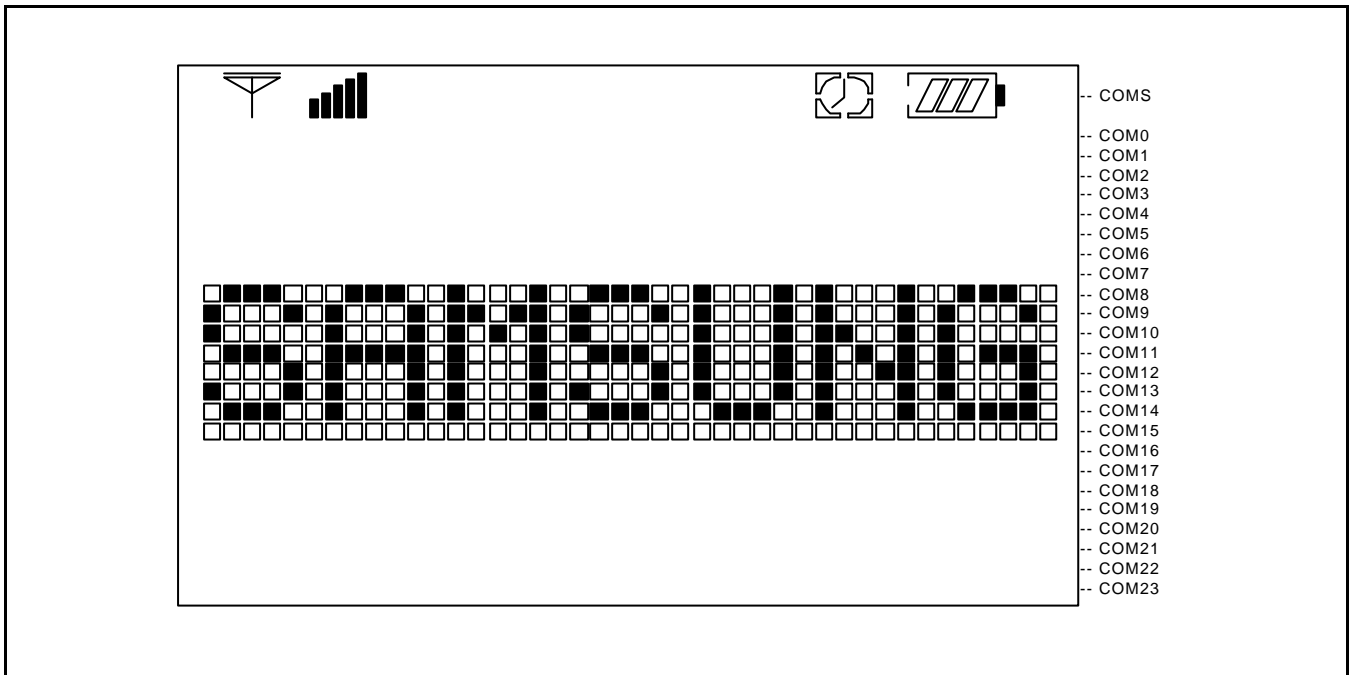


Figure 17. Moving Display (Partial Display Duty = 9, Initial COM0 = 8)

POWER SUPPLY CIRCUITS

The Power Supply circuits generate the voltage levels necessary to drive liquid crystal driver circuits with low-power consumption and the fewest components. There are voltage converter circuits, voltage regulator circuits, and voltage follower circuits. They are valid only in master operation and controlled by power control instruction. For details, refers to "Instruction Description". Table 11 shows the referenced combinations in using Power Supply circuits.

Table 11. Recommended Power Supply Combinations

User setup	Power control (VC VR VF)	V/C circuits	V/R circuits	V/F circuits	VOUT	V1 to V4
Only the internal power supply circuits are used	1 1 1	ON	ON	ON	Open	Open
Only the voltage regulator circuits and voltage follower circuits are used	0 1 1	OFF	ON	ON	*External input	Open
Only the voltage follower circuits are used	0 0 1	OFF	OFF	ON	External input	Open
Only the external power supply circuits are used	0 0 0	OFF	OFF	OFF	External input	External input

* : When only the voltage regulator circuits and voltage follower circuits are used, External VOUT should be the same voltage to operate LCD panel(VLCD). So, voltage regulator circuit operation doesn't cause any effect.

Voltage Converter Circuits

These circuits boost up the electric potential between V_{CI} and V_{SS} to 2, 3, 4 times toward positive side and boosted voltage is outputted from V_{OUT} pin. It is possible to select the lower boosting level in any boosting circuit by "Set DC-DC Step-up" instruction. When the higher level is selected by instruction, V_{OUT} voltage is not valid.

[$C1 = 1.0$ to $4.7 \mu\text{F}$]

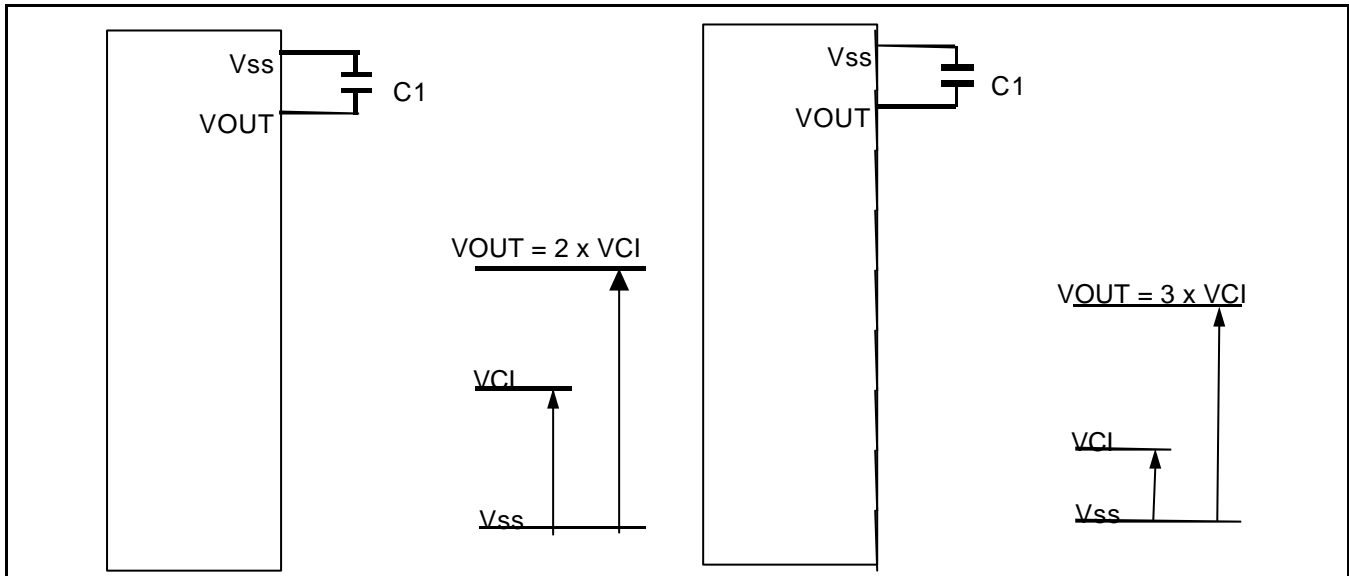


Figure 18. Two Times Boosting Circuit

Figure 19. Three Times Boosting Circuit

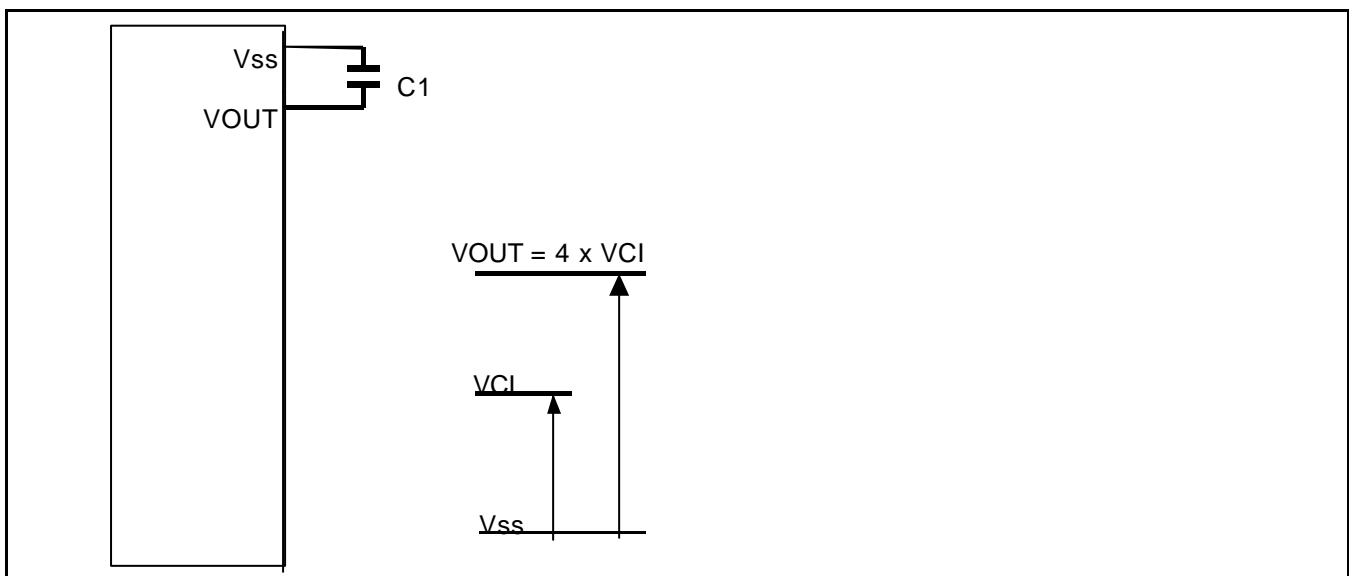


Figure 20. Four Times Boosting Circuit

Voltage Regulator Circuits

The function of the internal Voltage Regulator circuits is to determine liquid crystal operating voltage, VOUT, by adjusting resistors, Ra and Rb. Because VOUT is the operating voltage of operational-amplifier circuits shown in Figure 21, it is necessary to be applied internally.

For the Eq. 1, we determine VOUT by Ra, Rb and VEV. The Ra and Rb are connected internally. And VEV called the voltage of electronic volume is determined by Eq. 2, where the parameter α is the value selected by instruction, "Set Reference Voltage Register", within the range 0 to 63. VREF voltage at Ta= 25°C is shown in Table 12 (Abbreviated OTP calibration in VEV expression (Eq.2), see "OTP calibration mode" section for more information)

$$V_{OUT} = \left(1 + \frac{R_b}{R_a} \right) \times V_{EV} \text{ [V] ----- (Eq. 1)}$$

$$V_{EV} = \left(1 - \frac{(63 - (\alpha \pm OV/2))}{210} \right) \times V_{REF} \text{ [V] ----- (Eq. 2)}$$

Table 12. . VREF Voltage at Ta = 25°C

Temp. coefficient	VREF [V]
-0.05% / °C	2.1

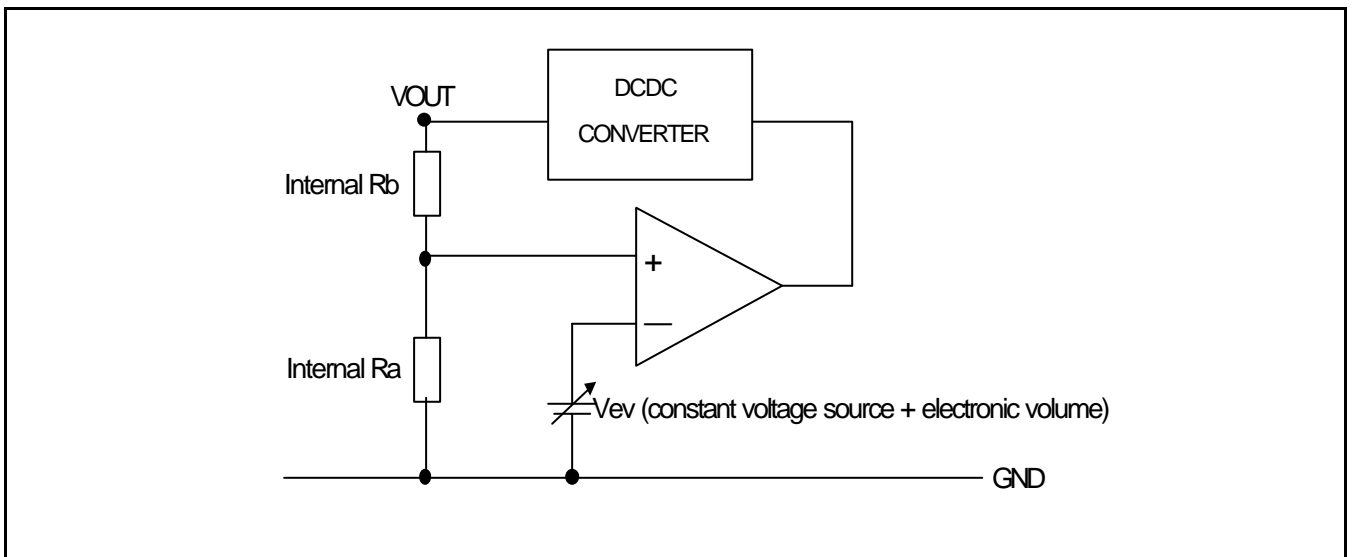


Figure 21. Internal Voltage Regulator Circuit

In Case of Using Internal Resistors, Ra and Rb

Resistor Ra is connected internally between VR pin and VSS, and Rb is connected between VOUT and VR. We determine VOUT by two instructions, "Regulator Resistor Select" and "Set Reference Voltage".

Table 13. Internal Rb / Ra Ratio depending on 3-bit Data (R2 R1 R0)

	3-bit data settings (R2 R1 R0)							
	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
1 + (Rb / Ra)	2.3	3.0	3.7	4.4	5.1	5.8	6.5	7.2

Figure 22 Shows VOUT voltage measured by adjusting internal regulator register ratio (Rb / Ra) and 6-bit electronic volume registers for each temperature coefficient at Ta = 25 °C.

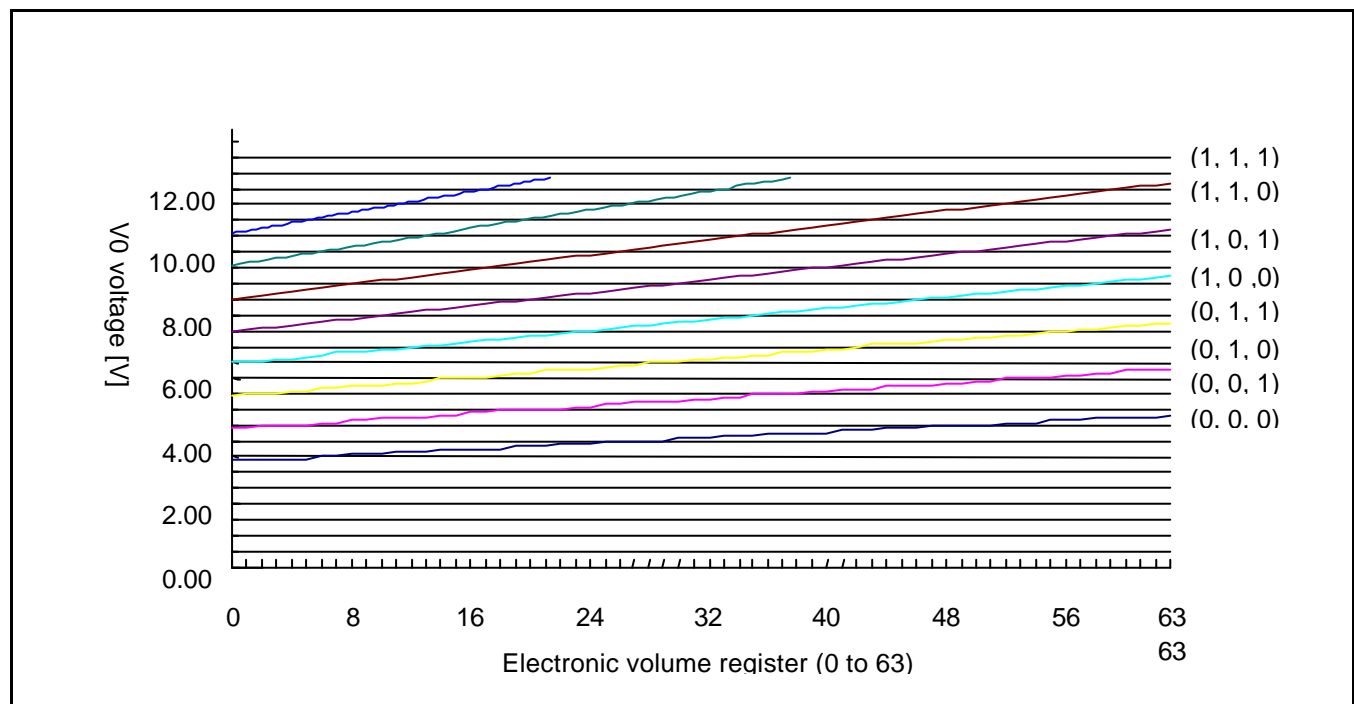


Figure 22. Electronic Volume Level (Temp. Coefficient = -0.05% / °C)

Voltage Follower Circuits

VLCD voltage (VOUT) is resistively divided into four voltage levels (V1, V2, V3 and V4), and those output impedance are converted by the Voltage Follower for increasing drive capability. Table 14 shows the relationship between V1 to V4 level and each duty ratio.

Table 14

LCD bias	V1	V2	V3	V4	Remarks
1/N	$(N-1)/N \times V_{OUT}$	$(N-2)/N \times V_{OUT}$	$2/N \times V_{OUT}$	$1/N \times V_{OUT}$	N = 4 to 9

REFERENCE CIRCUIT EXAMPLES

[C1= 1.0 to 4.7 [μ F]]

Using internal regulator resistors

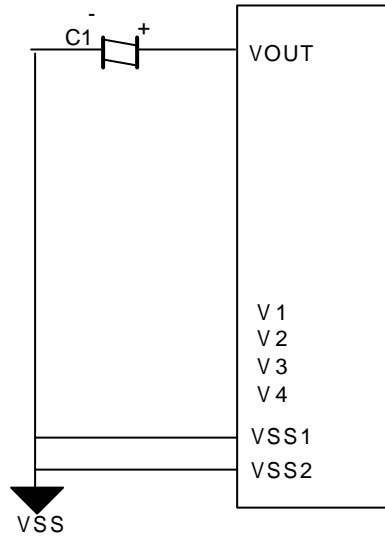


Figure 23. When Using all LCD Power Circuits (V/C: ON, V/R: ON, V/F: ON)

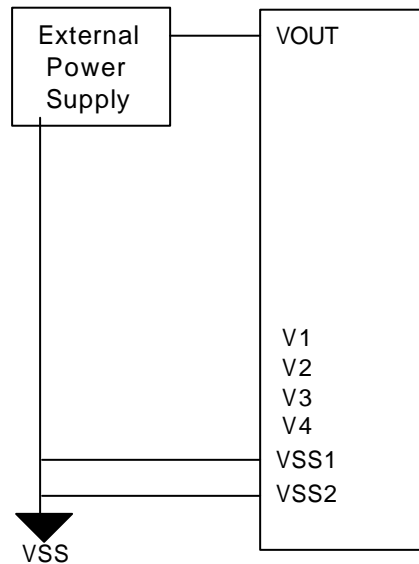


Figure 24. When Using only Voltage Follower Circuit (V/C: OFF, V/R: ON, V/F: ON)

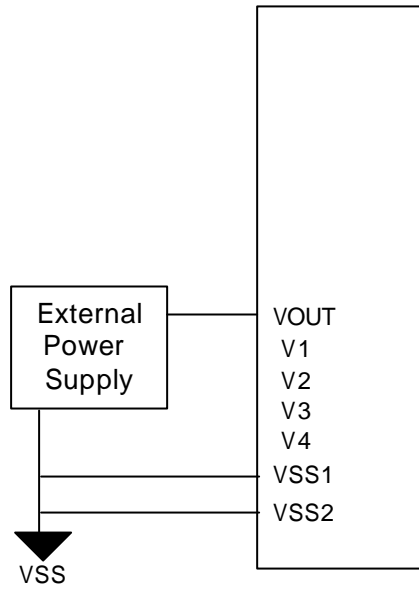


Figure 25. When Using only Voltage Follower Circuit (V/C: OFF, V/R: OFF, V/F: ON)

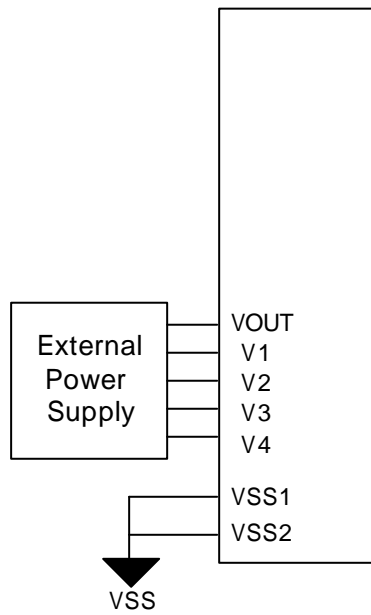


Figure 26. When Not Using all LCD Power Circuits (V/C: OFF, V/R: OFF, V/F: OFF)

RESET CIRCUIT

Setting RESETB to "L" or Reset instruction can initialize internal function.
When RESETB becomes "L", following procedure is occurred.

Page address: 0
 Column address: 0
 Modify-read: OFF
 Display ON / OFF: OFF
 Initial display line: 0 (first)
 Initial COM0 register: 0 (COM0)
 Partial display duty ratio: 1/64
 Icon enable/disable : 0 (disable)
 Reverse display ON / OFF: OFF (normal)
 n-line inversion register: 0 (disable)
 Entire display ON / OFF: OFF (normal)
 OTP_Mode ON/OFF : ON (normal)
 Power control register (VC, VR, VF) = (0, 0, 0)
 DC-DC step up: 2 times converter circuit = (1, 1)
 Regulator resistor select register: (R2, R1, R0) = (0, 0, 0)
 Reference voltage control register: (EV5, EV4, EV3, EV2, EV1, EVOUT) = (1, 0, 0, 0, 0, 0)
 Offset voltage control register (OV4, OV3, OV2, OV1, OVOUT) = (0, 0, 0, 0, 0)
 LCD bias ratio: 1/9
 SHL select: OFF (normal)
 ADC select: OFF (normal)
 Oscillator status: OFF
 Power save mode: release
 Frame Frequency : 75Hz

When RESET instruction is issued, following procedure is occurred.

Page address: 0
 Column address: 0
 Modify-read: OFF
 Initial display line: 0 (First)
 Regulator resistor select register: (R2, R1, R0) = (0, 0, 0)
 Reference voltage control register (EV5, EV4, EV3, EV2, EV1, EVOUT) = (1, 0, 0, 0, 0, 0)
 Other instruction registers : Not Changed

While RESETB is "L" or reset instruction is executed, no instruction except read status can be accepted. Reset status appears at DB5. After DB5 becomes "L", any instruction can be accepted. RESETB must be connected to the reset pin of the MPU, and initialize the MPU and this LSI at the same time. The initialization by RESETB is essential before use.

INSTRUCTION DESCRIPTION

Table 15. Instruction Table

×: Don't care

Instruction	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Description
Read display data	1	1	Read data								Read data from DDRAM
Write display data	1	0	Write data								Write data into DDRAM
Read status	0	1	BUSY	ON	RES	OPRT	0	0	0	0	Read the internal status
Set page address	0	0	1	0	1	1	P3	P2	P1	P0	Set page address
Set column address MSB	0	0	0	0	0	1	0	Y6	Y5	Y4	Set column address MSB
Set column address LSB	0	0	0	0	0	0	Y3	Y2	Y1	Y0	Set column address LSB
Set modify-read	0	0	1	1	1	0	0	0	0	0	Set modify-read mode
Reset modify-read	0	0	1	1	1	0	1	1	1	0	Release modify-read mode
Display ON / OFF	0	0	1	0	1	0	1	1	1	D	D = 0: display OFF D = 1: display ON
Set initial display line register	0	0	0	1	0	0	0	0	×	×	2-byte instruction to specify the initial display line to realize vertical scrolling
	0	0	×	S6	S5	S4	S3	S2	S1	S0	
Set initial COM0 register	0	0	0	1	0	0	0	1	×	×	2-byte instruction to specify the initial COM0 to realize window scrolling
	0	0	×	×	C5	C4	C3	C2	C1	C0	
Set partial display duty ratio	0	0	0	1	0	0	1	0	×	×	2-byte instruction to set partial display duty ratio
	0	0	×	D6	D5	D4	D3	D2	D1	D0	
Frame Frequency	0	0	1	1	0	1	1	F2	F1	F0	Programmable Frame Frequency
Set n-line inversion	0	0	0	1	0	0	1	1	×	×	2-byte instruction to set n-line inversion register
	0	0	×	×	×	N4	N3	N2	N1	N0	
Release n-line inversion	0	0	1	1	1	0	0	1	0	0	Release n-line inversion mode
Reverse display ON / OFF	0	0	1	0	1	0	0	1	1	REV	REV = 0: normal display REV = 1: reverse display
Icon enable/disable	0	0	1	0	1	0	0	0	1	I	I = 0: Icon disable I = 1: Icon enable
Entire display ON / OFF	0	0	1	0	1	0	0	1	0	EON	EON = 0: normal display EON = 1: entire display ON

Table 17. Instruction Table (Continued)

Instruction	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Description
Power control	0	0	0	0	1	0	1	VC	VR	VF	Control power circuit operation
Select DC-DC step-up	0	0	0	1	1	0	0	1	DC1	DC0	Select the step-up of the internal voltage converter
Select regulator resistor	0	0	0	0	1	0	0	R2	R1	R0	Select internal resistance ratio of the regulator resistor
Set electronic volume register	0	0	1	0	0	0	0	0	0	1	2-byte instruction to specify the electronic volume register
	0	0	x	x	EV5	EV4	EV3	EV2	EV1	EV0	
Set offset volume register	0	0	1	1	1	0	1	0	1	0	2-byte instruction to specify the offset volume register
	0	0	x	x	x	OV4	OV3	OV2	OV1	OV0	
Select LCD bias	0	0	0	1	0	1	0	B2	B1	B0	Select LCD bias
OTP_Mode ON	0	0	1	1	1	0	1	1	0	OTON	OTP_mode ON/OFF
OTP write enable	0	0	1	1	1	0	1	1	1	1	OTP write enable
SHL select	0	0	1	1	0	0	SHL	×	×	×	COM bi-directional selection SHL = 0: normal direction SHL = 1: reverse direction
ADC select	0	0	1	0	1	0	0	0	0	ADC	SEG bi-directional selection ADC = 0: normal direction ADC = 1: reverse direction
Set Data Direction & Display Data Length(DDL)	×	×	1	1	1	0	1	0	0	0	2-byte Instruction to specify the number of data bytes(SPI Mode).
	×	×	D7	D6	D5	D4	D3	D2	D1	D0	
Oscillator ON start	0	0	1	0	1	0	1	0	1	1	Start the built-in oscillator
Set power save mode	0	0	1	0	1	0	1	0	0	P	P = 0: standby mode P = 1: sleep mode
Release power save mode	0	0	1	1	1	0	0	0	0	1	Release power save mode
Reset	0	0	1	1	1	0	0	0	1	0	Initialize the internal functions
NOP	0	0	1	1	1	0	0	0	1	1	<u>No operation</u>
Test instruction	0	0	1	1	1	1	×	×	×	×	<u>Don't use this instruction.</u>

Read Display Data

8-bit data from Display Data RAM specified by the column address and page address can be read by this instruction. As the column address is incremented by 1 automatically after each this instruction, the microprocessor can continuously read data from the addressed page. A dummy read is required after loading an address into the column address register. Display Data cannot be read through the serial interface.

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	1	Read data							

Write Display Data

8-bit data of display data from the microprocessor can be written to the RAM location specified by the column address and page address. The column address is incremented by 1 automatically so that the microprocessor can sequentially write data to the addressed page. During auto-increment, the column address wraps to 0 after the last column is written.

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	0	Write data							

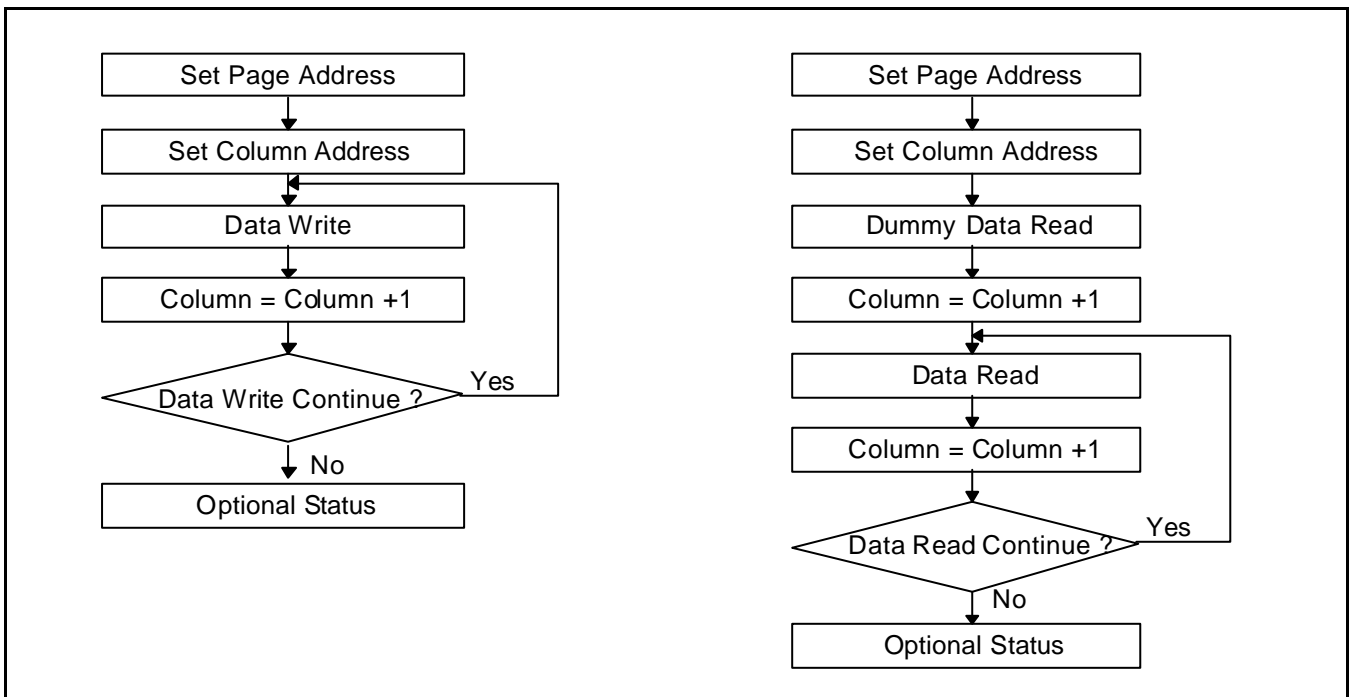


Figure 27. Sequence for Writing Display Data

Figure 28. Sequence for Reading Display Data

Read Status

Indicates the internal status of the S6B0756

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	1	BUSY	ON	RES	OPRT	0	0	0	0

Flag	Description
BUSY	The device is busy when internal operation or reset. Any instruction is rejected until BUSY goes Low. 0: chip is active, 1: chip is being busy.
ON	Indicates display ON / OFF status. 0: display ON, 1: display OFF
RES	Indicates the initialization is in progress by RESETB signal. 0: chip is active, 1: chip is being reset.
OPRT	Indicates OTP status. 0: OTP is programmable, 1: OTP is programmed.

Set Page Address

Sets the Page Address of display data RAM from the microprocessor into the Page Address register. Any RAM data bit can be accessed when its Page Address and column address are specified. Along with the column address, the Page Address defines the address of the display RAM to write or read display data. Changing the Page Address doesn't effect to the display status.

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	0	1	1	P3	P2	P1	P0

P3	P2	P1	P0	Selected page	Description
0	0	0	0	0	Accessible pages for displaying dot-matrix display data
0	0	0	1	1	
0	0	1	0	2	
:	:	:	:	:	
0	1	1	1	7	
1	0	0	0	8	Accessible page for displaying icons
:	:	:	:	:	Not accessible page. Do not use these pages.
1	1	0	0	12	
1	1	0	1	13	
1	1	1	0	14	
1	1	1	1	15	

Set Column Address

Sets the Column Address of display RAM from the microprocessor into the column address register. Along with the Page Address, the column address defines the address of the display RAM to write or read display data. When the microprocessor reads or writes display data to or from display RAM, Column Addresses are automatically incremented.

Set Column Address MSB

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	1	0	Y6	Y5	Y4

Set Column Address LSB

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	Y3	Y2	Y1	Y0

Y6	Y5	Y4	Y3	Y2	Y1	Y0	Selected column address
0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	1
0	0	0	0	0	1	0	2
:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:
1	0	1	1	1	0	1	93
1	0	1	1	1	1	0	94
1	0	1	1	1	1	1	95
1	1	x	x	x	x	x	Not used

Set Modify-Read

This instruction stops the automatic increment of the column address by the read display data instruction, but the column address is still increased by the Write display data instruction. And it reduces the load of microprocessor when the data of a specific area is repeatedly changed during cursor blinking or others. This mode is canceled by the reset Modify-read instruction.

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	1	1	0	0	0	0	0

Reset Modify-Read

This instruction cancels the Modify-read mode, and makes the column address return to its initial value just before the set Modify-read instruction is started.

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	1	1	0	1	1	1	0

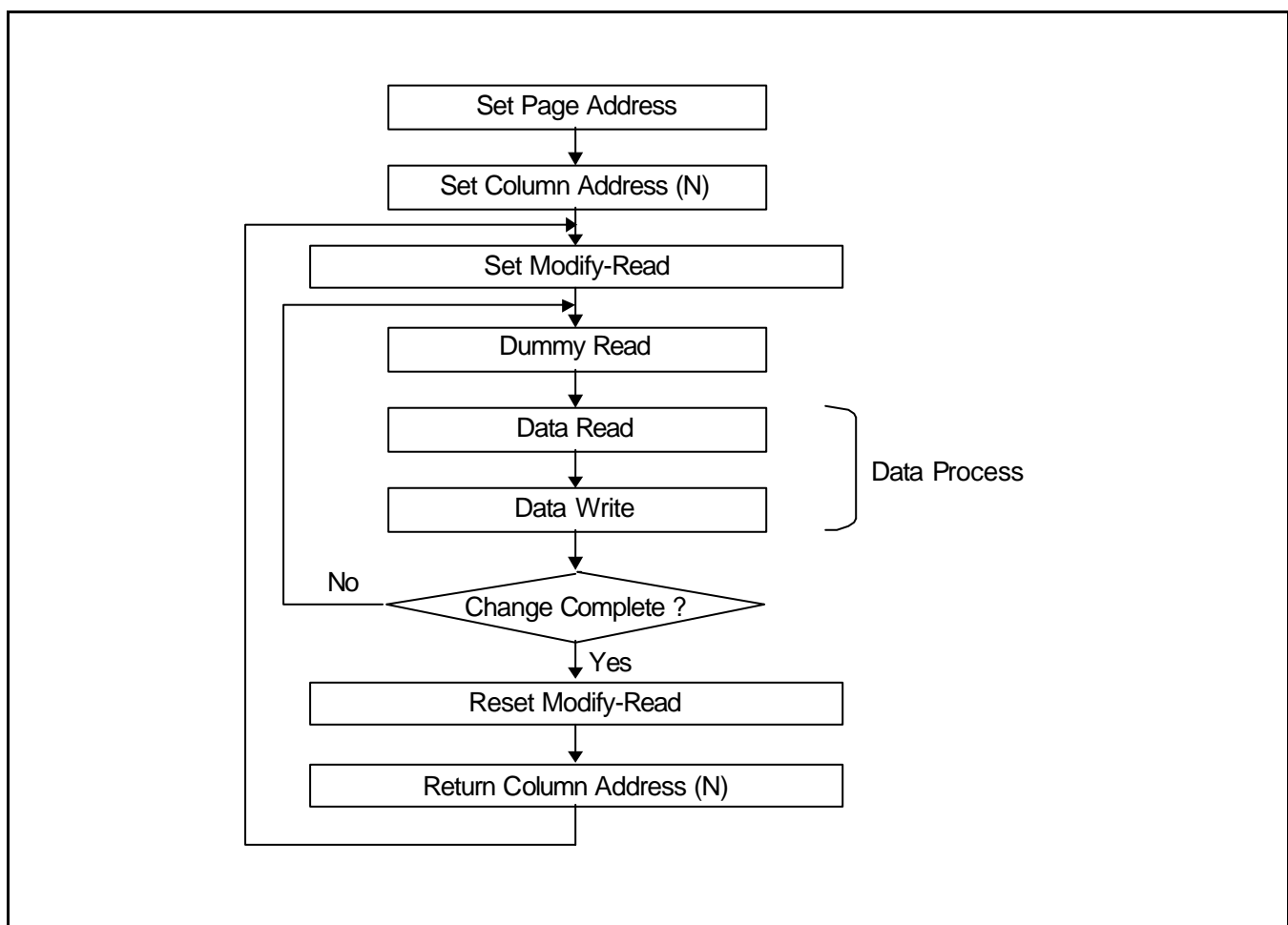


Figure 29. Sequence for Cursor Display

Display ON / OFF

Turns the display ON or OFF.

This command has priority over Entire Display On/Off and Reverse Display On/Off. Commands are accepted while the display is off, but the visual state of the display does not change.

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	0	1	0	1	1	1	D

D = 1: display ON

D = 0: display OFF

Set Initial Display Line Register

Sets the line address of display RAM to determine the initial display line using 2-byte instruction. The RAM display data is displayed at the top row (COM0) of LCD panel.

The 1st Instruction

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	0	0	0	0	×	×

The 2nd Instruction

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	×	S6	S5	S4	S3	S2	S1	S0

S6	S5	S4	S3	S2	S1	S0	Selected line address
0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	1
:	:	:	:	:	:	:	:
0	1	1	1	1	1	0	62
0	1	1	1	1	1	1	63
1	0	0	0	0	0	0	No operation
:	:	:	:	:	:	:	
1	1	1	1	1	1	1	

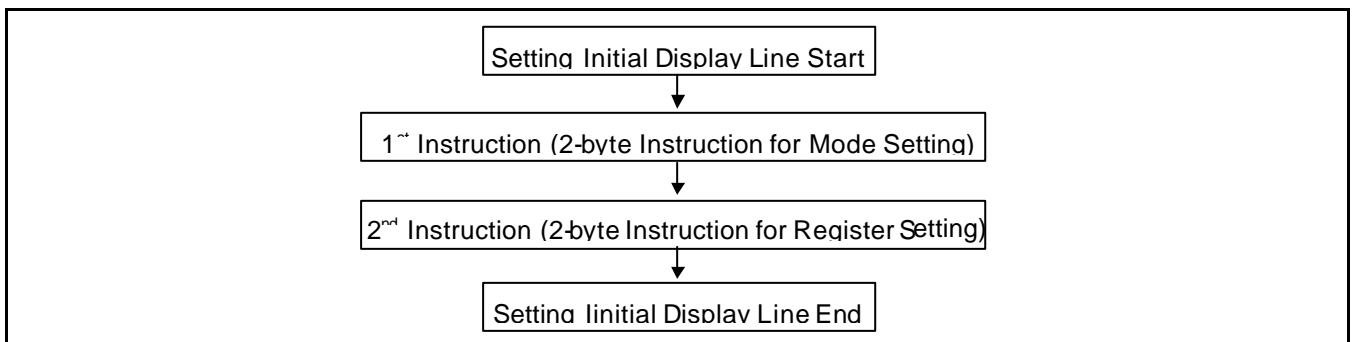


Figure 30. The Sequence for Setting the Initial Display Line

Set Initial COM0 Register

Sets the initial row (COM0) of the LCD panel using the 2-byte instruction. By using this instruction, it is possible to realize the window moving without the change of display data.

The 1st Instruction

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	0	0	0	1	×	×

The 2nd Instruction

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	×	×	C5	C4	C3	C2	C1	C0

C5	C4	C3	C2	C1	C0	Initial COM0
0	0	0	0	0	0	COM0
0	0	0	0	0	1	COM1
0	0	0	0	1	0	COM2
0	0	0	0	1	1	COM3
:	:	:	:	:	:	:
1	1	1	1	0	0	COM60
1	1	1	1	0	1	COM61
1	1	1	1	1	0	COM62
1	1	1	1	1	1	COM63

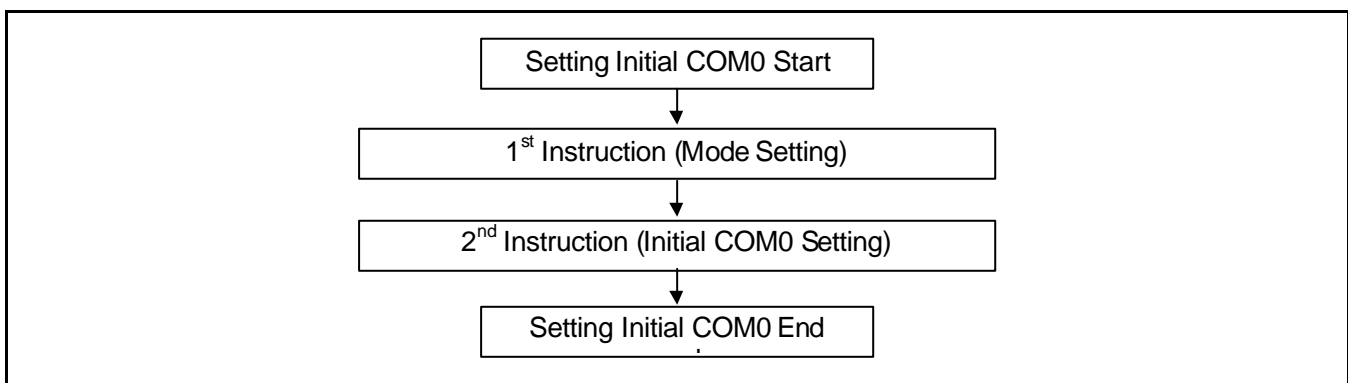


Figure 31. Sequence for Setting the Initial COM0

Set Partial Display Duty Ratio

When the icon mode is disable, Sets the duty ratio within range of 16 to 64 to realize partial display by using the 2-byte instruction. When the icon mode is enable, Sets the duty ratio within range of 17 to 65 to realize partial display by using the 2-byte instruction.

The 1st Instruction

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	0	0	1	0	×	×

The 2nd Instruction

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	×	D6	D5	D4	D3	D2	D1	D0

Icon Enable/Disable Bit = 0

D6	D5	D4	D3	D2	D1	D0	Selected partial duty ratio
0	0	0	0	0	0	0	No operation
:	:	:	:	:	:	:	
0	0	1	0	0	0	0	
0	0	1	0	0	0	0	1/16
0	0	1	0	0	0	1	1/17
0	0	1	0	0	1	0	1/18
0	0	1	0	0	1	1	1/19
:	:	:	:	:	:	:	:
0	1	1	1	1	0	1	1/61
0	1	1	1	1	1	0	1/62
0	1	1	1	1	1	1	1/63
1	0	0	0	0	0	0	1/64
1	0	0	0	0	1	0	No operation
:	:	:	:	:	:	:	
1	1	1	1	1	1	1	

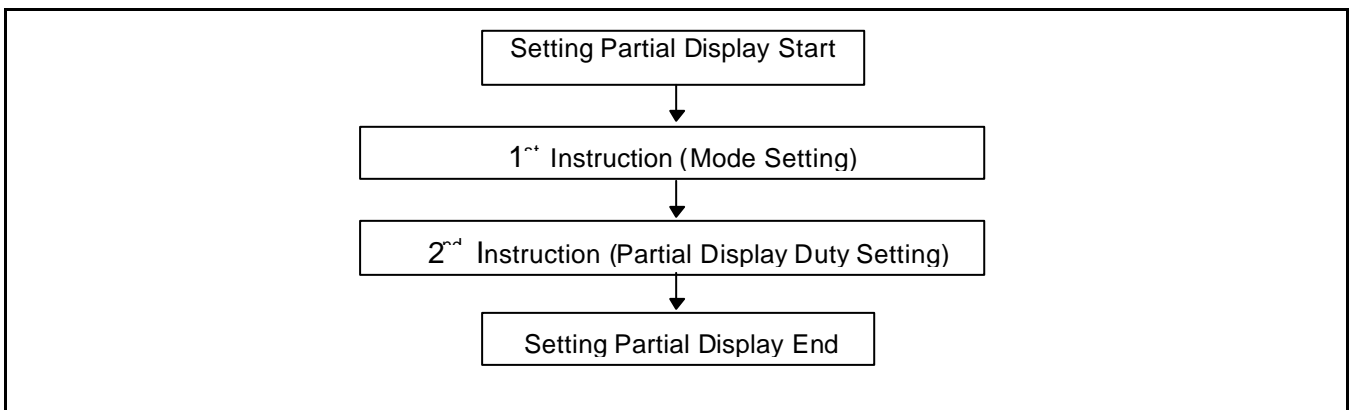


Figure 32. Sequence for Setting Partial Display

Icon Enable/Disable Bit = 1

D6	D5	D4	D3	D2	D1	D0	Selected partial duty ratio
0	0	0	0	0	0	0	No operation
:	:	:	:	:	:	:	
0	0	1	0	0	0	0	
0	0	1	0	0	0	1	1/17
0	0	1	0	0	1	0	1/18
0	0	1	0	0	1	1	1/19
0	0	1	0	1	0	0	1/20
:	:	:	:	:	:	:	:
0	1	1	1	1	1	0	1/62
0	1	1	1	1	1	1	1/63
1	0	0	0	0	0	0	1/64
1	0	0	0	0	0	1	1/65
1	0	0	0	0	1	0	No operation
:	:	:	:	:	:	:	
1	1	1	1	1	1	1	

Partial Duty Ratio = 1/64

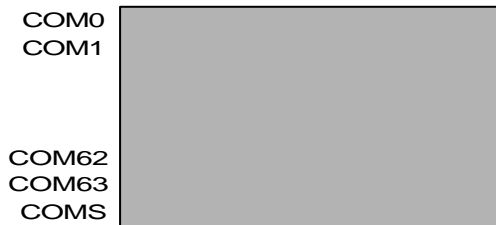


ICON OFF



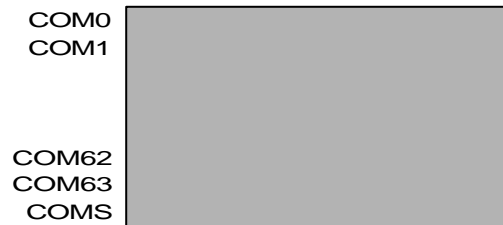
ICON ON

Partial Duty Ratio = 1/65



ICON OFF

Not Available



ICON ON

Figure 33. Display example When ICON is On or Off

Note : once COMS is used, ICON can be turned off only by using memory data.

Programmable Frame Frequency

Sets the frame frequency to compensate LCD flicking

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	1	0	1	1	F2	F1	F0

F2	F1	F0	Frame Frequency
0	0	0	69Hz
0	0	1	73Hz
0	1	0	75Hz(default Value)
0	1	1	81Hz
1	0	0	85Hz
1	0	1	89Hz
1	1	0	93Hz
1	1	1	97Hz

Set N-line Inversion Register

Sets the inverted line number within range of 3 to 33 to improve the display quality by controlling the phase of the internal LCD AC signal (Internal M) by using the 2-byte instruction.

The DC-bias problem could be occurred if K is even number. So, we recommend customers to set K to be odd number. K : D/N

D : The number of display duty ratio (D is selectable by customers)

N : N for N-line inversion (N is selectable by customers).

The 1st Instruction

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	0	0	1	1	×	×

The 2nd Instruction

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	×	×	×	N4	N3	N2	N1	N0

N4	N3	N2	N1	N0	Selected n-line inversion
0	0	0	0	0	0-line inversion (frame inversion)
0	0	0	0	1	3-line inversion
0	0	0	1	0	4-line inversion
:	:	:	:	:	:
1	1	1	0	1	31-line inversion
1	1	1	1	0	32-line inversion
1	1	1	1	1	33-line inversion

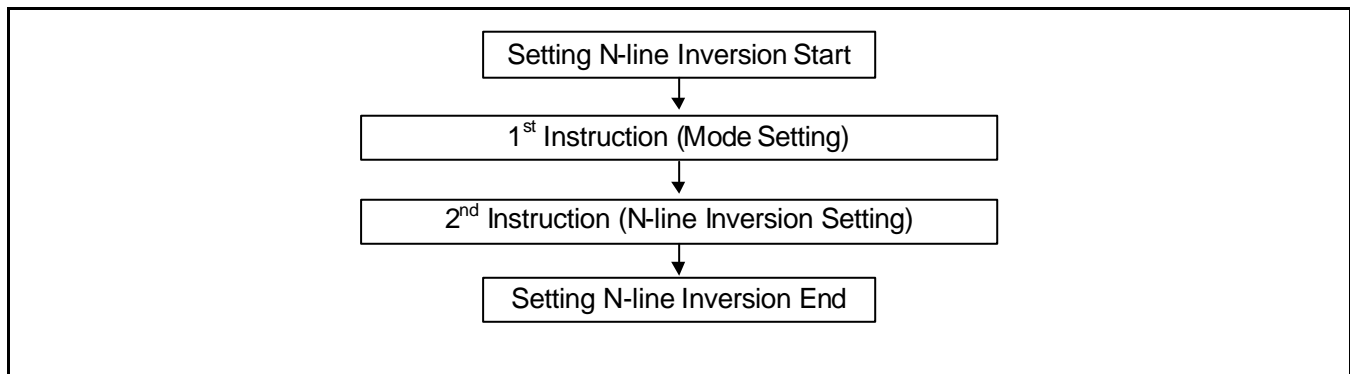


Figure 34. Sequence for Setting Partial Display

Release N-line Inversion

Returns to the frame inversion condition from the n-line inversion condition.

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	1	1	0	0	1	0	0

Reverse Display ON / OFF

Reverses the display status on LCD panel without rewriting the contents of the display data RAM.

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	0	1	0	0	1	1	REV

REV	RAM bit data = "1"	RAM bit data = "0"
0 (normal)	LCD pixel is illuminated	LCD pixel is not illuminated
1 (reverse)	LCD pixel is not illuminated	LCD pixel is illuminated

Icon enable / Disable

Allows the icon driver circuit to be enabled or disabled, thus changing the duty ratio setting.

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	0	1	0	0	0	1	I

I	Duty Range
0 (disable)	1/16 ~ 1/64
1 (enable)	1/17 ~ 1/65

Entire Display ON / OFF

Forces the whole LCD points to be turned on regardless of the contents of the display data RAM. At this time, the contents of the display data RAM are held. This instruction has priority over the reverse display ON / OFF instruction.

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	0	1	0	0	1	0	EON

EON	RAM bit data = "1"	RAM bit data = "0"
0 (normal)	LCD pixel is illuminated	LCD pixel is not illuminated
1 (entire)	LCD pixel is illuminated	LCD pixel is illuminated

OTP_Mode On/Off

Allows module maker to be able to calibrate. Because initial value is On, Mode is changed to Off for calibration. In OTP_mode_off, offset volume is changable. After calibration, calibration offset volume is stored as OTP offset volume by OTP Write Enable.

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	1	1	0	1	1	0	OMON

OMON = 1 : OTP_Mode On

OMON = 0 : OTP_Mode Off

OTP Write Enable

Allow OTP offset volume, which is determined as suitable value, to be programmed on OTP cell. Once programmed, an OTP cell can not be reprogrammed.

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	1	1	0	1	1	1	1

Power Control

Selects one of eight power circuit functions by using 3-bit register. An external power supply and part of internal power supply functions can be used simultaneously.

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	0	1	VC	VR	VF

VC	VR	VF	Status of internal power supply circuits
0 1			Internal voltage converter circuit is OFF Internal voltage converter circuit is ON
	0 1		Internal voltage regulator circuit is OFF Internal voltage regulator circuit is ON
		0 1	Internal voltage follower circuit is OFF Internal voltage follower circuit is ON

Select DC-DC Step-up

Selects one of 4 DC-DC step-up to reduce the power consumption by this instruction. It is very useful to realize the partial display function.

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	1	0	0	1	DC1	DC0

DC1	DC0	Selected DC-DC converter circuit
0	0	3 times boosting circuit
0	1	4 times boosting circuit
1	0	Not used
1	1	2 times boosting circuit

Regulator Resistor Select

Selects resistance ratio of the internal resistor used in the internal voltage regulator. See voltage regulator section in power supply circuit. Refer to Table 13.

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	0	0	R2	R1	R0

R2	R1	R0	[Rb / Ra] ratio
0	0	0	Small
0	0	1	:
:	:	:	:
1	1	0	:
1	1	1	Large

Set Electronic Volume Register

Consists of 2-byte instruction

The 1st instruction sets electronic volume mode, the 2nd one updates the contents of electronic volume register. After second instruction, electronic volume mode is released.

The 1st Instruction

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	0	0	0	0	0	0	1

The 2nd Instruction

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	×	×	EV5	EV4	EV3	EV2	EV1	EV0

EV5	EV4	EV3	EV2	EV1	EVOUT	Reference voltage (a)
0	0	0	0	0	0	0
0	0	0	0	0	1	1
:	:	:	:	:	:	:
:	:	:	:	:	:	:
1	1	1	1	1	0	62
1	1	1	1	1	1	63

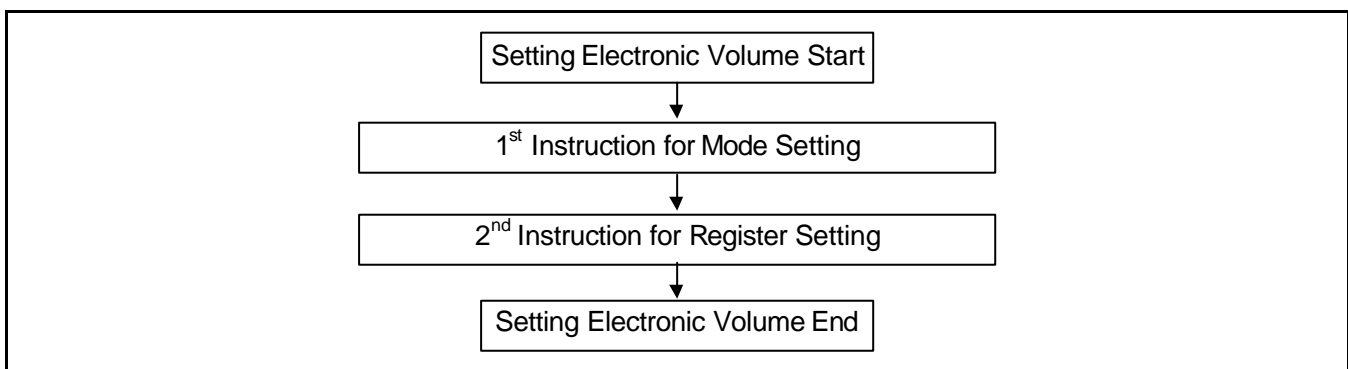


Figure 35. Sequence for Setting the Electronic Volume

Set Offset Volume Register

Consists of 2-byte instruction

The 1st instruction sets offset volume mode, the 2nd one updates the contents of offset volume register. After second instruction, offset volume mode is released.

The 1st Instruction

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	1	1	0	1	0	1	0

The 2nd Instruction

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	×	×	x	OV4	OV3	OV2	OV1	OV0

EV4	EV3	EV2	EV1	EVOUT	Reference voltage (x)
0	1	1	1	1	15
0	1	1	1	0	14
:	:	:	:	:	:
:	:	:	:	:	:
0	0	0	0	1	1
0	0	0	0	0	0
1	1	1	1	1	-1
1	1	1	1	0	-2
1	1	1	0	1	-3
:	:	:	:	:	:
:	:	:	:	:	:
1	0	0	0	1	-15
1	0	0	0	0	-16

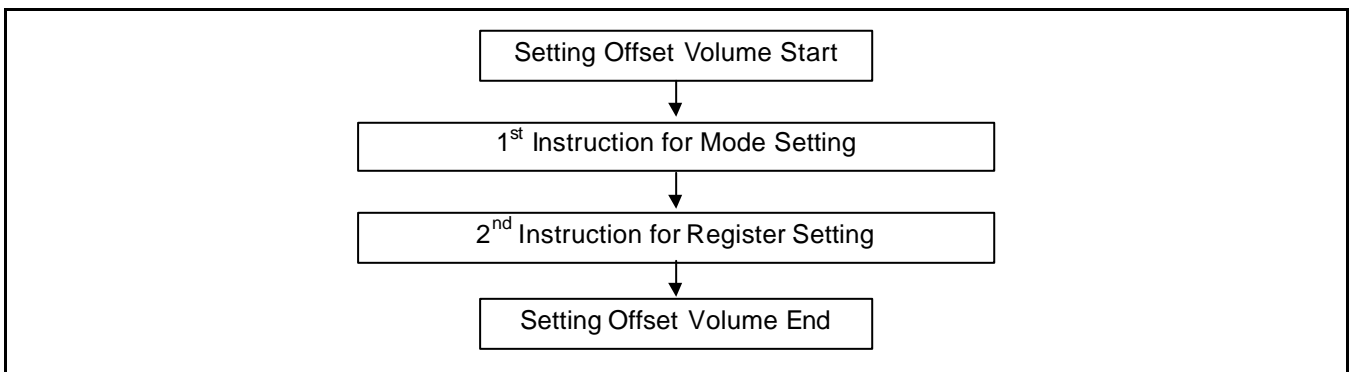


Figure 36. Sequence for Setting the Offset Volume

Select LCD Bias

Selects LCD Bias ratio of the voltage required for driving the LCD.

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	0	1	0	B2	B1	B0

B2	B1	B0	Selected LCD bias
0	0	0	1/4
0	0	1	1/5
0	1	0	1/6
0	1	1	1/7
1	0	0	1/8
1	0	1	1/9
1	1	0	1/9
1	1	1	1/9

SHL Select

COM output scanning direction is selected by this instruction which determines the LCD driver output status.

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	1	0	0	SHL	×	×	×

SHL = 0: normal direction (COM0 → COM63)

SHL = 1: reverse direction (COM63 → COM0)

ADC Select

Changes the relationship between RAM column address and segment driver. The direction of segment driver output pins could be reversed by software. This makes IC layout flexible in LCD module assembly.

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	0	1	0	0	0	0	ADC

ADC = 0: normal direction (SEG0 → SEG95)

ADC = 1: reverse direction (SEG95 → SEG0)

Set Data Direction & Display Data Length (3-Pin SPI Mode)

Consists of two bytes instruction.

This command is used in 3-Pin SPI mode only(PS0 = "L" and PS1 = "L"). It will be two continuous commands, the first byte control the data direction(write mode only) and inform the LCD driver the second byte will be number of data bytes will be write. When RS is not used, the Display Data Length instruction is used to indicate that a specified number of display data bytes are to be transmitted. The next byte after the display data string is handled as command data.

The 1st Instruction: Set Data Direction (Only Write Mode)

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
x	x	1	1	1	0	1	0	0	0

The 2nd Instruction: Set Display Data Length (DDL) Register

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
x	x	D7	D6	D5	D4	D3	D2	D1	D0

D7	D6	D5	D4	D3	D2	D1	D0	Display Data Length
0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1	2
0	0	0	0	0	0	1	0	3
:	:	:	:	:	:	:	:	:
1	1	1	1	1	1	0	1	254
1	1	1	1	1	1	1	0	255
1	1	1	1	1	1	1	1	256

Oscillator ON Start

This instruction enables the built-in oscillator circuit.

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	0	1	0	1	0	1	1

Reset

This instruction resets initial display line, column address, page address, and common output status select to their initial status, but dose not affect the contents of display data RAM. This instruction cannot initialize the LCD power supply, which is initialized by the RESETB pin.

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	1	1	0	0	0	1	0

Power Save

The S6B0756 enters the Power Save status to reduce the power consumption to the static power consumption value and returns to the normal operation status by the following instructions.

Set Power Save Mode

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	0	1	0	1	0	0	P

P = 0: standby mode

P = 1: sleep mode

Release Power Save Mode

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	1	1	0	0	0	0	1

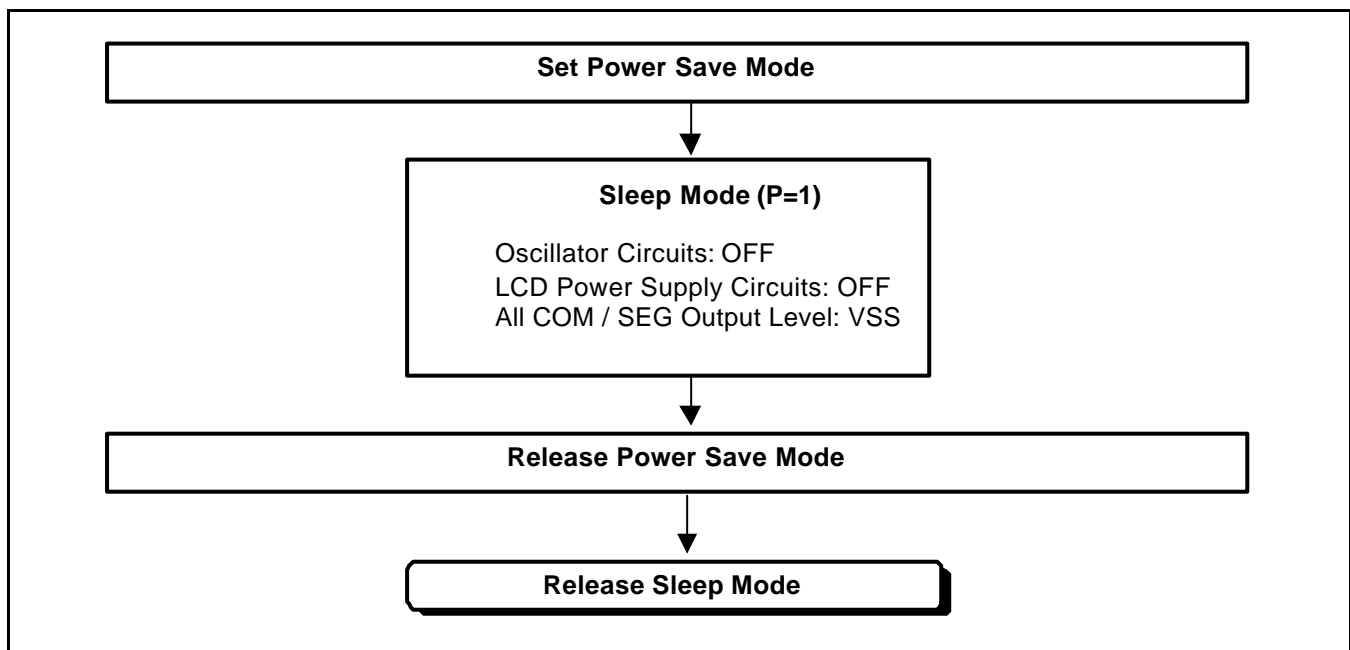


Figure 37. Power Save Routine

NOP

No Operation Instruction

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	1	1	0	0	0	1	1

Test Instruction

This instruction is for test only. Please do not use it.

RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	1	1	1	×	×	×	×

Referential Instruction Setup Flow: Initializing with the Built-in Power Supply Circuits

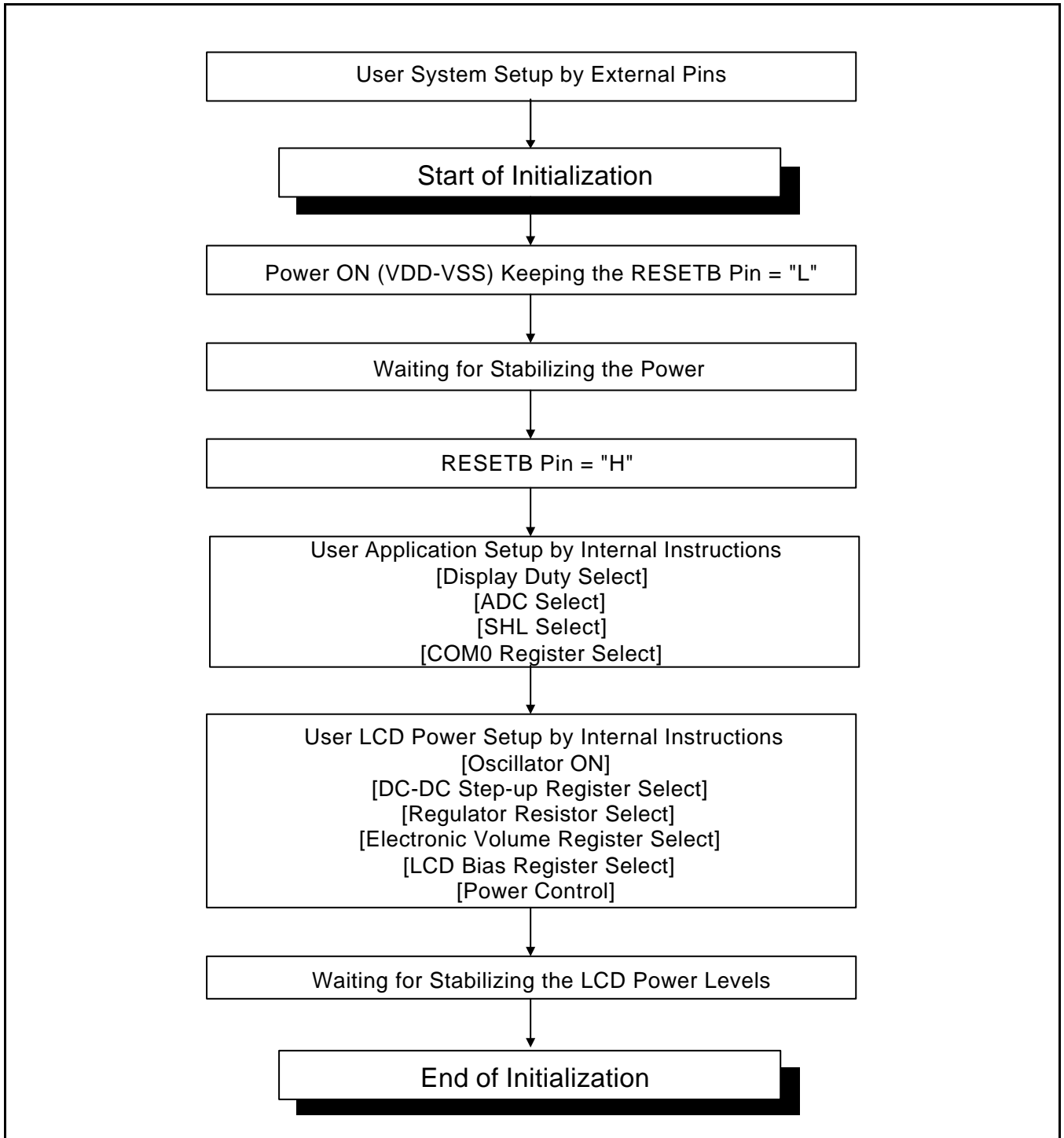


Figure 38. Initializing with the Built-in Power Supply Circuits

Referential Instruction Setup Flow: Initializing without the Built-in Power Supply Circuits

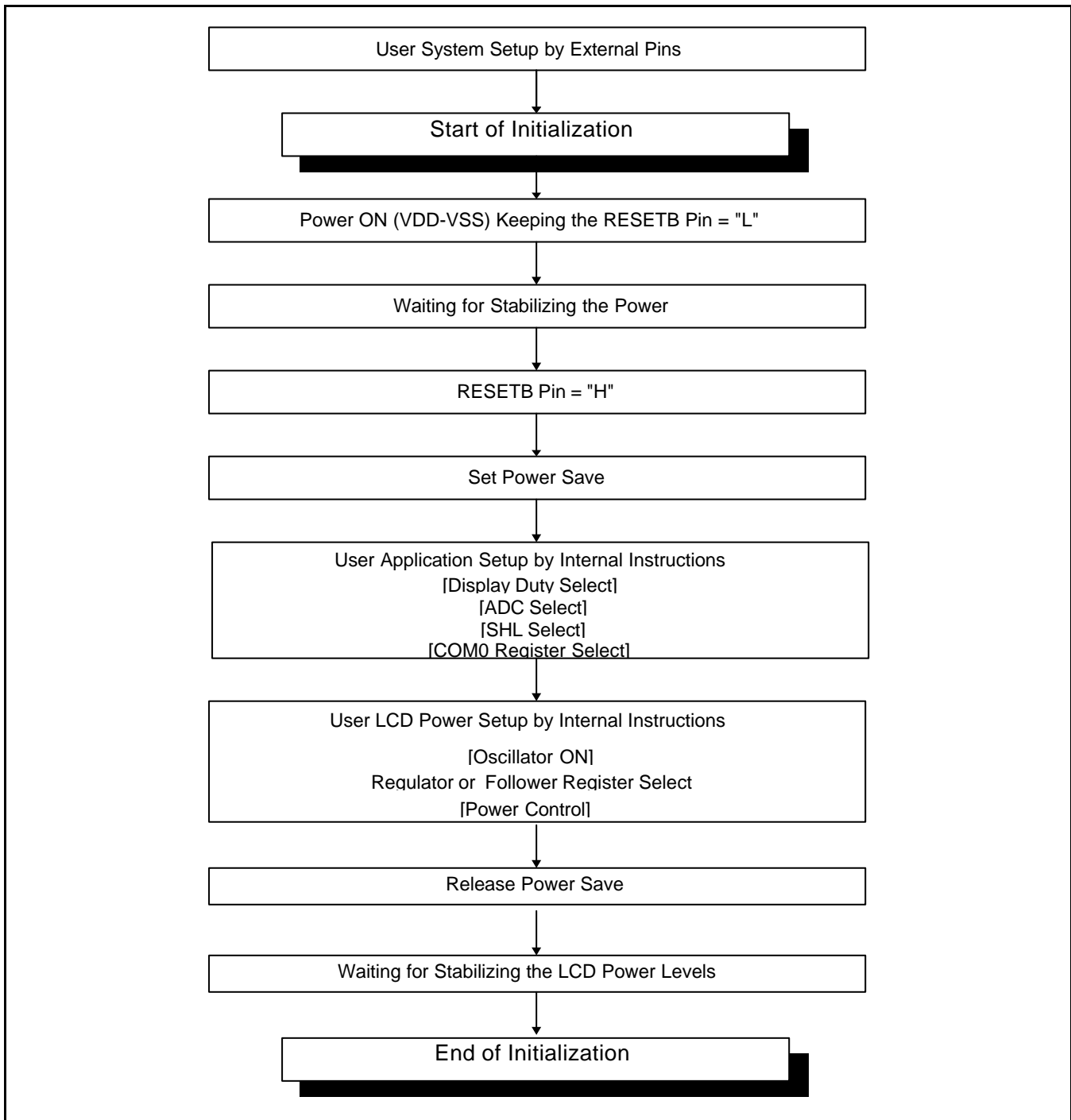


Figure 39. Initializing without the Built-in Power Supply Circuits

Referential Instruction Setup Flow: Data Displaying

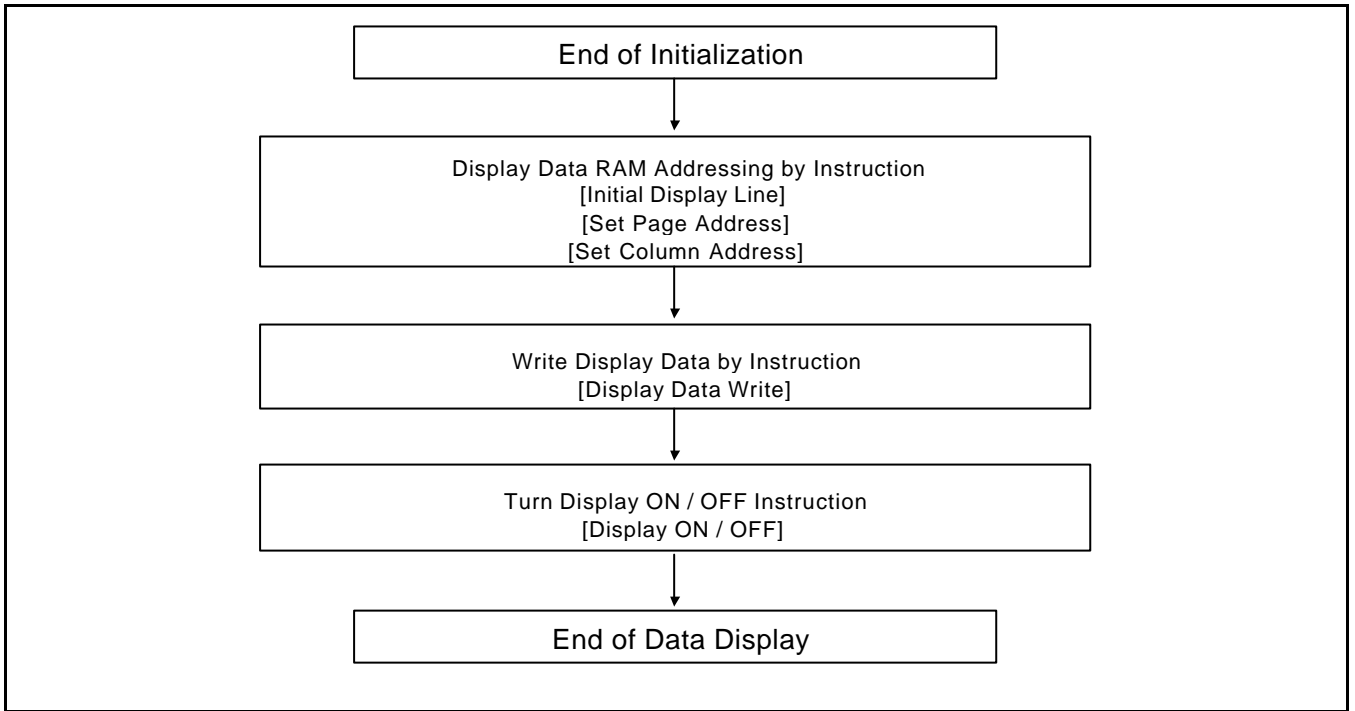


Figure 40. Data Displaying

Referential Instruction Setup Flow: Power OFF

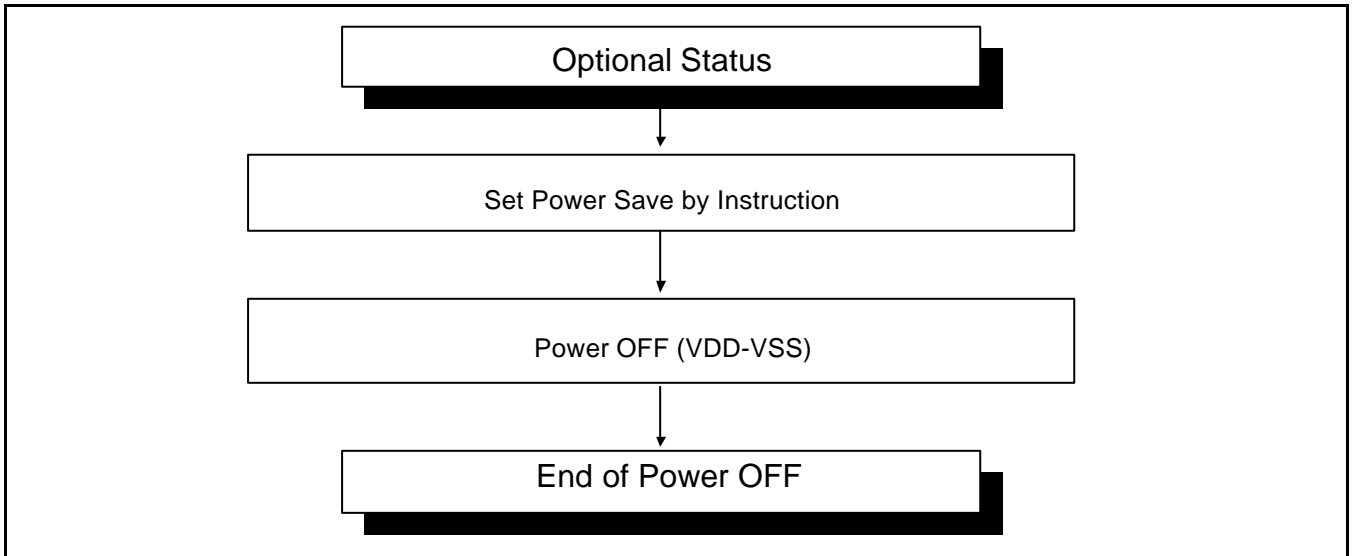


Figure 41. Power OFF

Referential Instruction Setup Flow: Partial Duty Changing

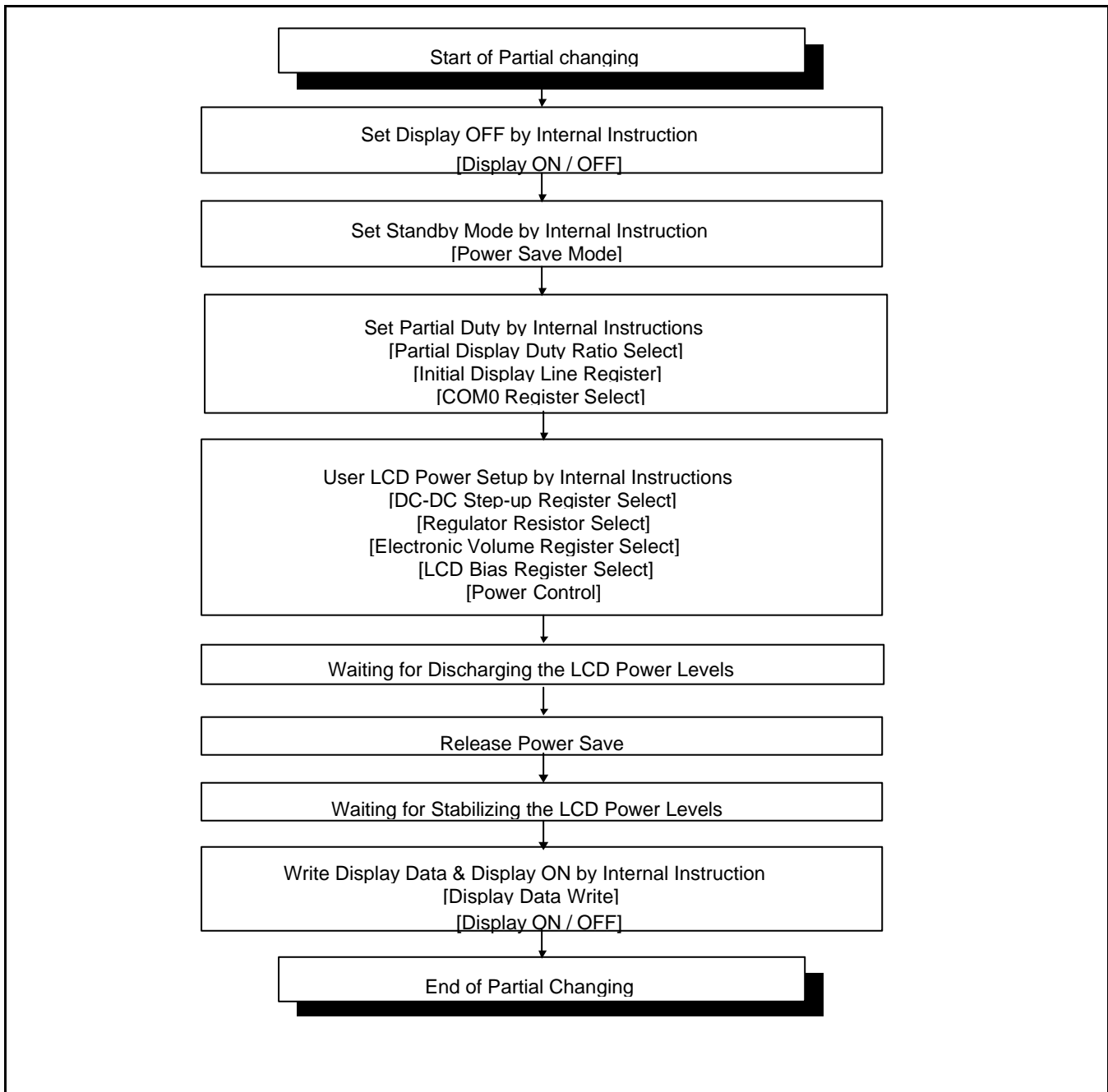


Figure 42. Partial Duty Changing

NOTE:1. Partial COM0 register setting for COM H/W half: $[64 - (\text{user duty})] / 2$

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Table 16. Absolute Maximum Ratings

(VSS = 0V)

Parameter	Symbol	Rating	Unit
Supply voltage range	V _{DD}	- 0.3 ~ + 4.0	V
	V _{OUT}	- 0.3 ~ + 13.5	V
	V ₁ , V ₂ , V ₃ , V ₄	- 0.3 ~ V _{OUT} + 0.3	V
Input voltage range	V _{IN}	- 0.3 ~ V _{DD} + 0.3	V
Operating temperature range	T _{OPR}	- 20 ~ + 70	°C
Storage temperature range	T _{STR}	- 20 ~ + 70	°C

NOTES:

1. V_{DD}, V_{OUT}, V₁ to V₄, V_{EXT} and V_{CI} are based on V_{SS} = 0V.
2. Voltage V_{OUT} ≥ V₁ ≥ V₂ ≥ V₃ ≥ V₄ ≥ V_{SS} must always be satisfied.
3. If supply voltage exceeds its absolute maximum range, this LSI may be damaged permanently. It is desirable to use this LSI under electrical characteristic conditions during general operation. Otherwise, this LSI may malfunction or reduced LSI reliability may result.

DC CHARACTERISTICS

Table 17. DC Characteristics

(V_{SS} = 0V, V_{DD} = 1.8~3.3V, Ta=-20~70°C)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Pin used
Operating voltage (1)	V _{DD}		1.8	-	3.3	V	VDD *1
Operating voltage (2)	V _{OUT}		4.0	-	12.0	V	VOUT, *2
Input voltage	High	V _{IH}	0.8V _{DD}	-	V _{DD}	V	*3
	Low	V _{IL}	V _{SS}	-	0.2V _{DD}		
Output voltage	High	V _{OH}	I _{OH} = -0.5mA	0.8V _{DD}	-	V _{DD}	*4
	Low	V _{OL}	I _{OL} = 0.5mA	V _{SS}	-	0.2V _{DD}	
Input leakage current	I _{IL}	V _{IN} = V _{DD} or V _{SS}	- 1.0	-	+ 1.0	μA	*3
Output leakage current	I _{OZ}	V _{IN} = V _{DD} or V _{SS}	- 3.0	-	+ 3.0	μA	*5
LCD driver ON resistance	R _{ON}	Ta = 25°C, V _{OUT} = 8V	-	2.0	3.0	kΩ	SEg _n COM _n *6
Frame frequency	f _{FR}	Ta = 25°C	65	75	100	Hz	*7

Table 18. DC Characteristics

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Pin used
Voltage converter circuit output voltage	V _{OUT}	×2 / ×3 / ×4 voltage conversion (no-load)	95	99	-	%	VOUT
Voltage regulator circuit operating voltage	V _{OUT}		4.0	-	12.0	V	VOUT
Voltage follower circuit operating voltage	V _{OUT}		4.0	-	12.0	V	VOUT *8
Reference voltage	V _{REF}	Ta = 25°C	2.04	2.10	2.16	V	*9

Dynamic Current Consumption (1) when an External Power Supply is used.**Table 19. Dynamic Current 1 (External Power)** $(V_{DD} = 2.4V, T_a = 25^{\circ}C)$

Item	Symbol	Condition	Min	Typ	Max	Unit	Pin used
Dynamic current consumption (1)	I _{DD1}	V _{OUT} -V _{SS} =9.0V, duty = 1/65 No Load (Display Off)	-	-	20	μA	*10
		V _{OUT} -V _{SS} = 9.0V, duty = 1/65 No Load (Display On , Checker Pattern)	-	-	20	μA	*10

Dynamic Current Consumption (2) when The Internal Power Supply is ON**Table 20. . Dynamic Current 2 (Internal Power)** $(V_{DD} = 2.4V, T_a = 25^{\circ}C)$

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Pin used
Dynamic current consumption (2)	I _{DD2}	V _{CI} =2.75V, x4 boosting, duty = 1/65, EV=32, RR=3, No Load (Display Off)	-	100	150	μA	*10
		V _{CI} =2.75V, x4 boosting, duty = 1/65, EV=32, RR=3 No Load (Display On , Checker Pattern)	-	100	150	μA	*10

Current Consumption during Power Save Mode**Table 21. Power Save Mode Current** $(V_{DD} = 2.4V, T_a = 25^{\circ}C)$

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Pin used
Sleep mode current	I _{DD51}	During sleep	-	2	9	μA	*10

Table 22. The Relationship between Oscillation Frequency and Frame Frequency

Duty ratio	Item	fCL	fosc
1/N	On-chip oscillator circuit is used	$f_{FR} \times N$	$f_{FR} \times 4 \times N$

(fOSC: oscillation frequency, fCL: display clock frequency, fFR: frame frequency, N = 17 to 65)

[* Remark Solves]

- *1. Though the wide range of operating voltages is guaranteed, a spike voltage change may affect the voltage assurance during access from the MPU.
- *2. In case of external power supply is applied.
- *3. CS1B, RS, DB0 to DB7, E_RD, RW_WR, RESETB, PS1, PS0
- *4. DB0 to DB7
- *5. Applies when the DB0 to DB7 pins are in high impedance.
- *6. Resistance value when -0.1[mA] is applied during the ON status of the output pin SEGn or COMn.
 $R_{ON} [k\Omega] = \Delta V[V] / 0.1[mA]$ (ΔV : voltage change when -0.1[mA] is applied in the ON status.)
- *7. See Table 22 for the relationship between oscillation frequency and frame frequency.
- *8. The voltage regulator circuit adjusts V_{OUT} within the voltage follower operating voltage range.
- *9. On-chip reference voltage source of the voltage regulator circuit to adjust V_{OUT} .
- *10. Applies to the case where the on-chip oscillation circuit is used and no access is made from the MPU.
 The current consumption, when the built-in power supply circuit is ON or OFF.
 The current flowing through voltage regulation resistors(R_b and R_a) is not included.
 It does not include the current of the LCD panel capacity, wiring capacity, etc.

AC CHARACTERISTICS

Read / Write Characteristics (8080-series MP)

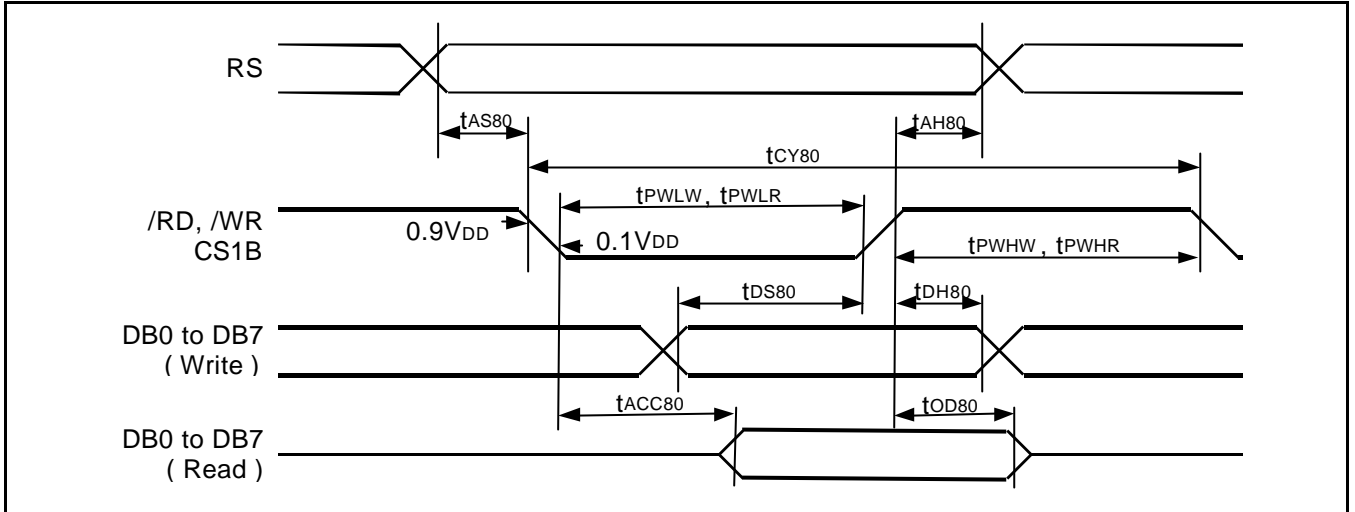


Figure 43. Read / Write Characteristics (8080-series MPU)

Table 23

(V_{DD} = 1.8~ 3.3V, T_a = -20 ~ +70°C)

Item	Signal	Symbol	Condition	Min.	Max.	Unit
Address setup time	RS	t _{AS80}		0	-	ns
Address hold time		t _{AH80}		0	-	ns
System cycle time		t _{CY80}		500	-	ns
Pulse width low for write	RW_WR (/WR)	t _{PWLW}		120	-	ns
Pulse width high for write		t _{PWHW}		120	-	ns
Pulse width low for read	E_RD (/RD)	t _{PWLR}		240	-	ns
Pulse width high for read		t _{PWHR}		120	-	ns
Data setup time	DB0 to DB7	t _{DS80}		80	-	ns
Data hold time		t _{DH80}		30	-	ns
Read access time	DB0 to DB7	t _{ACC80}	CL = 100 pF	-	280	ns
Output disable time		t _{OD80}		10	200	

NOTE: *1. The input signal rise time and fall time (tr, tf) is specified at 15 ns or less.

(tr + tf) < (t_{CY80} - t_{PWLW} - t_{PWHW}) for write, (tr + tf) < (t_{CY80} - t_{PWLR} - t_{PWHR}) for read

Read / Write Characteristics (6800-series Microprocessor)

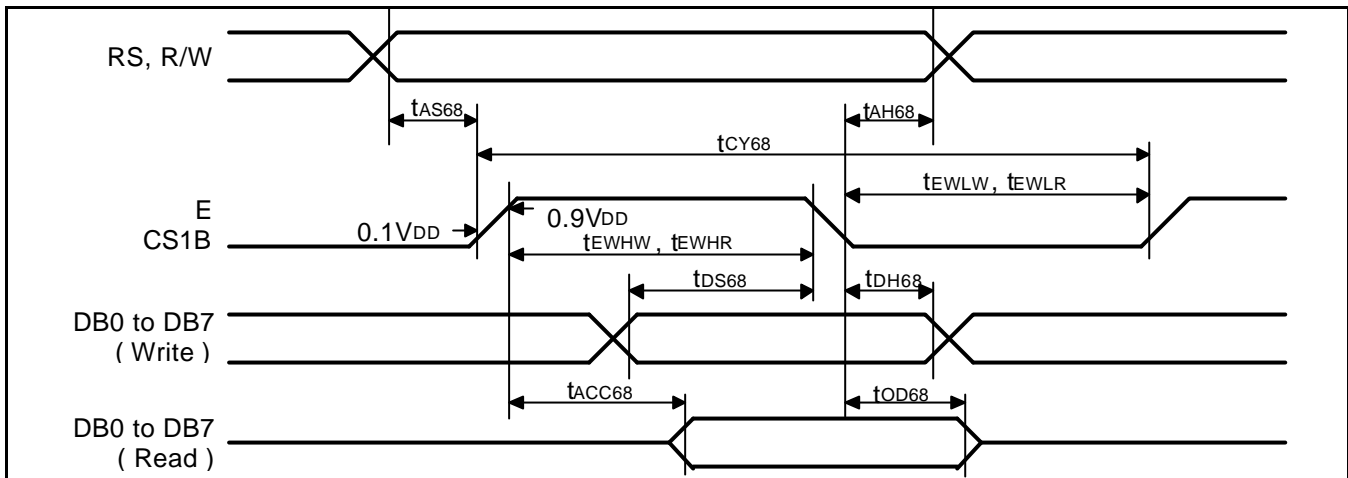


Figure 44. Read / Write Characteristics (6800-series Microprocessor)

Table 24

 $(V_{DD} = 1.8 \sim 3.3V, T_a = -20 \sim +70^{\circ}C)$

Item	Signal	Symbol	Condition	Min.	Max.	Unit
Address setup time	RS	tAS68		0	-	ns
Address hold time	RW	tAH68		0	-	ns
System cycle time		tCY68		500	-	ns
Enable width high for write	E_RD	tEHLW		120	-	ns
Enable width low for write	(E)	tEHLR		120	-	ns
Enable width high for read	E_RD	tEHLW		240	-	ns
Enable width low for read	(E)	tEHLR		120	-	ns
Data setup time	DB0 to DB7	tDS68		30	-	ns
Data hold time		tDH68		5	-	ns
Read access time	DB0 to DB7	tACC68	CL = 100 pF	-	60	ns
Output disable time		tOD68		10	50	

NOTE: *1. The input signal rise time and fall time (tr, tf) is specified at 15 ns or less.

(tr + tf) < (tCY68 - tEHLW - tEHLR) for write, (tr + tf) < (tCY68 - tEHLW - tEHLR) for read

Serial Interface Characteristics

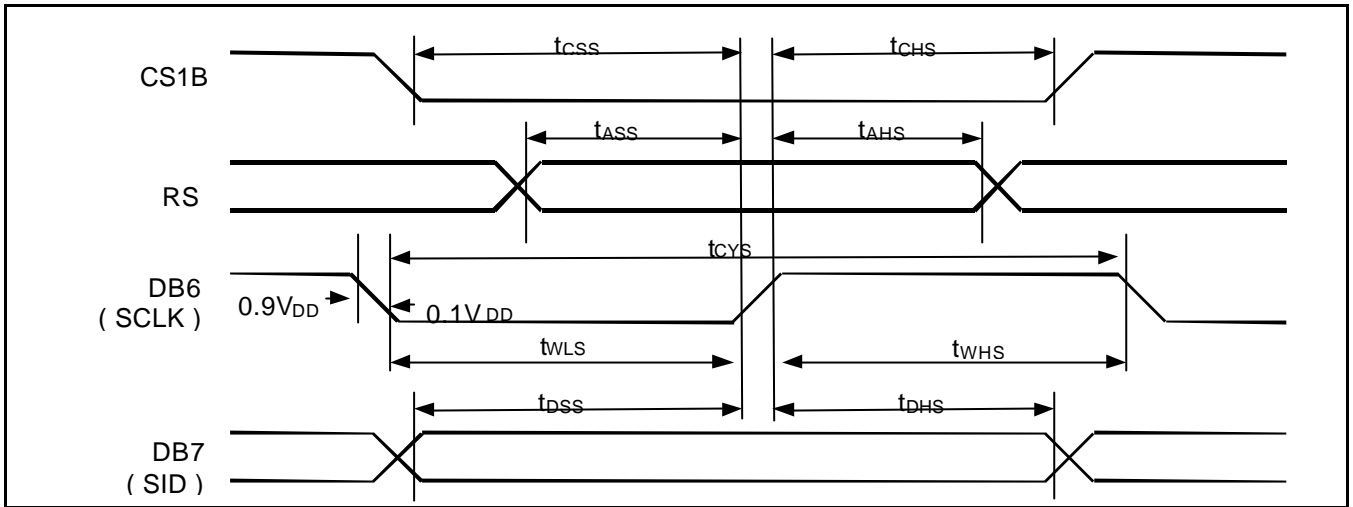


Figure 45

Table 25

($V_{DD} = 1.8V$, $T_a = -20 \sim +70^{\circ}C$)

Item	Signal	Symbol	Condition	Min.	Max.	Unit
Serial clock cycle	DB6 (SCLK)	t_{CYS}		111	-	ns
SCLK high pulse width		t_{SHW}		60	-	
SCLK low pulse width		t_{SLW}		60	-	
Address setup time	RS	t_{ASS}		60	-	ns
Address hold time		t_{AHS}		60	-	
Data setup time	DB7 (SID)	T_{DSS}		60	-	ns
Data hold time		t_{DHS}		60	-	
CS1B setup time	CS1B	T_{CSS}		60	-	ns
CS1B hold time		t_{CHS}		60	-	

($V_{DD} = 2.7V$, $T_a = -20 \sim +70^{\circ}C$)

Item	Signal	Symbol	Condition	Min.	Max.	Unit
Serial clock cycle	DB6 (SCLK)	t_{CYS}		58.8	-	ns
SCLK high pulse width		t_{SHW}		30	-	
SCLK low pulse width		t_{SLW}		30	-	
Address setup time	RS	t_{ASS}		30	-	ns
Address hold time		t_{AHS}		30	-	
Data setup time	DB7 (SID)	T_{DSS}		30	-	ns
Data hold time		t_{DHS}		30	-	
CS1B setup time	CS1B	T_{CSS}		30	-	ns
CS1B hold time		t_{CHS}		30	-	

NOTE: *1. The input signal rise time and fall time (t_r , t_f) is specified at 15 ns or less.

Reset Input Timing

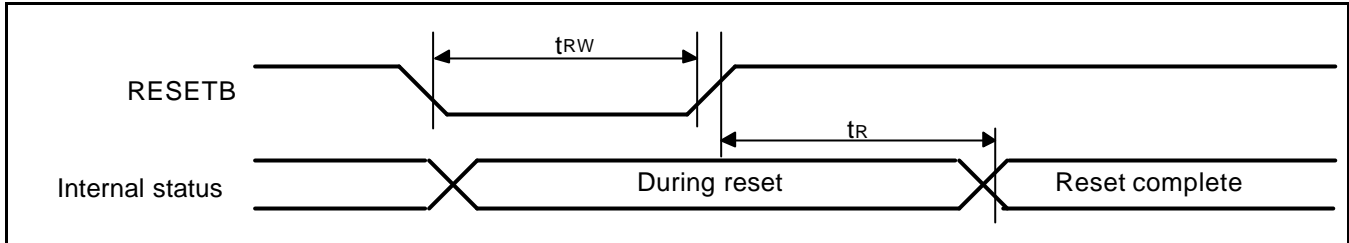


Figure 46

Table 26

 $(V_{DD} = 1.8 \sim 3.3V, T_a = -20 \sim +70^{\circ}C)$

Item	Signal	Symbol	Condition	Min.	Max.	Unit
Reset low pulse width	RESETB	t_{RW}		1000	-	ns
Reset time	-	t_R		-	1000	ns

REFERENCE APPLICATIONS

MICROPROCESSOR INTERFACE

In Case of Interfacing with 6800-series (PS0 = "H", PS1 = "H")

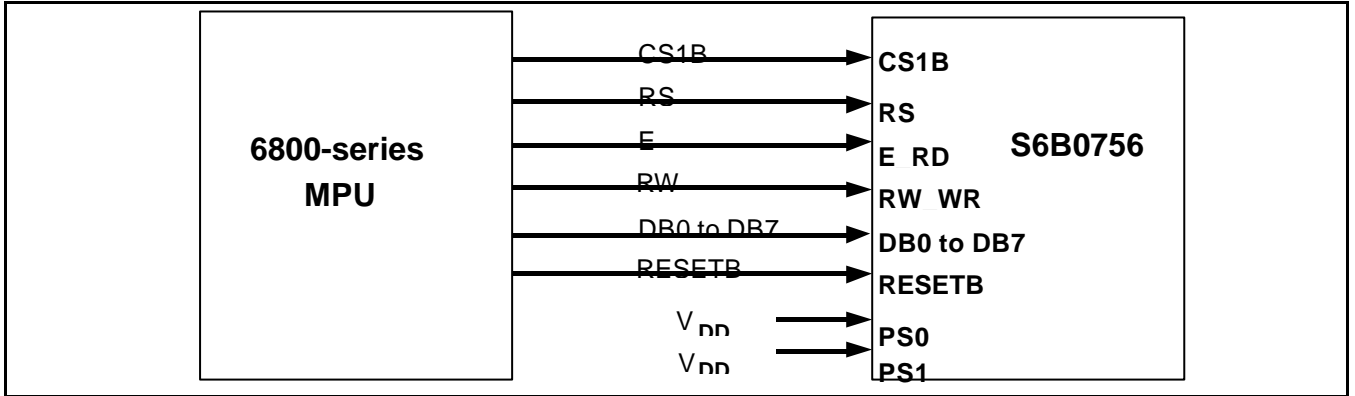


Figure 47. Interfacing with 6800-series

In Case of Interfacing with 8080-series (PS0 = "H", PS1 = "L")

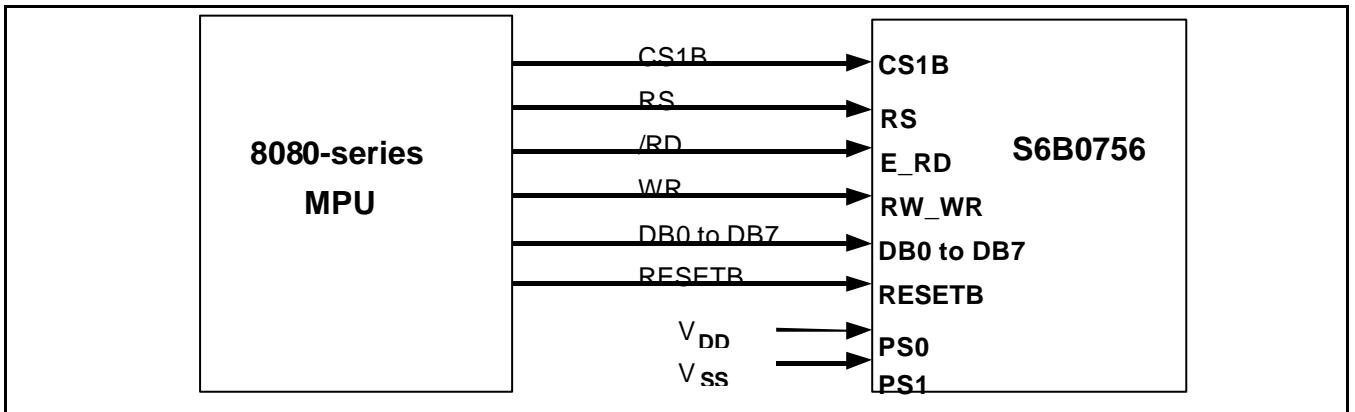


Figure 48. Interfacing with 8080-series

In Case of Serial Peripheral Interface with RS Pin (PS0 = "L" , PS1 = "H")

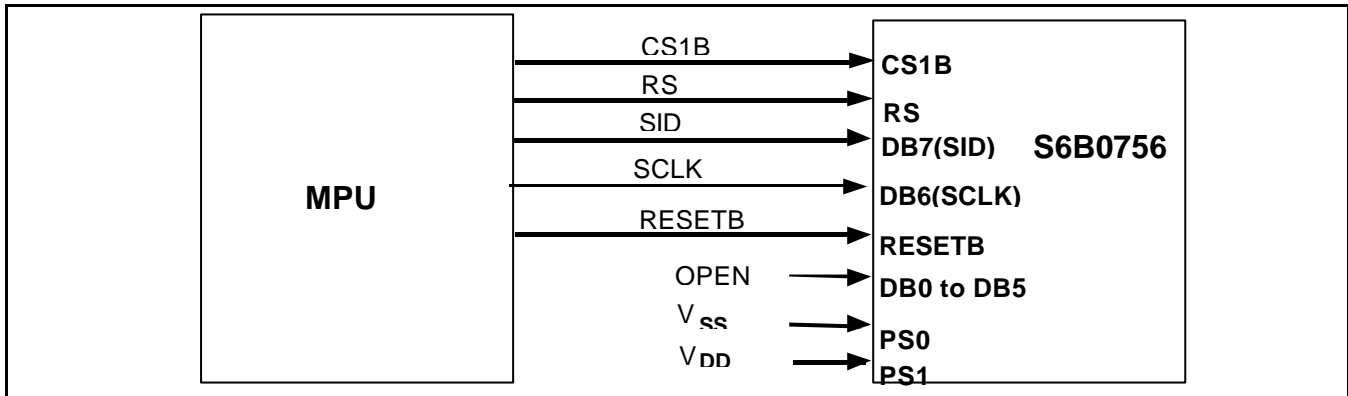


Figure 49. Serial Interface

In Case of Serial Peripheral Interface with software command (PS0 = "L" , PS1 = "L")

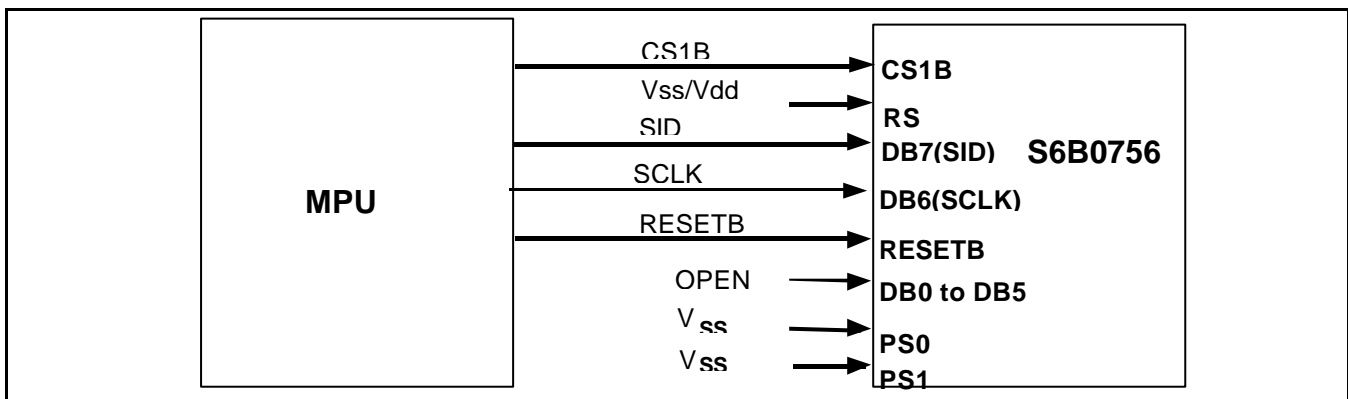


Figure 50. Serial Interface

CONNECTIONS BETWEEN S6B0756 AND LCD PANEL

Single Chip Configurations (1/65 Duty)

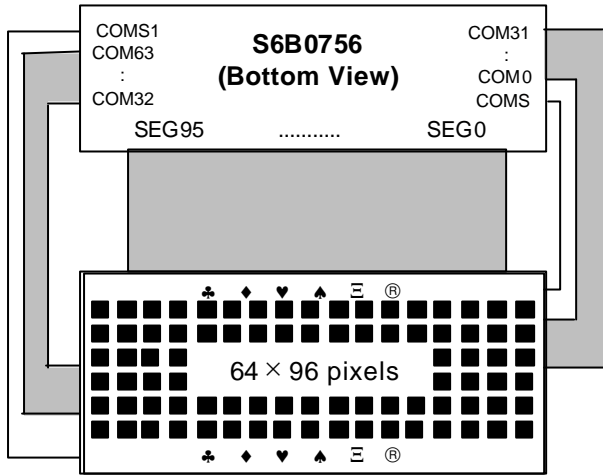


Figure 51. SHL = 0, ADC = 1

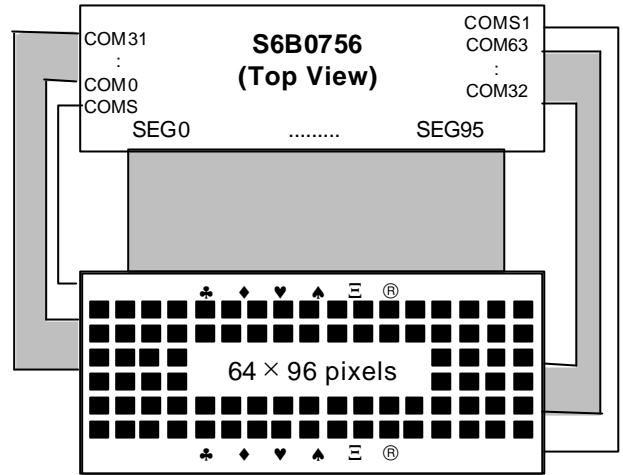


Figure 52. SHL = 0, ADC = 0

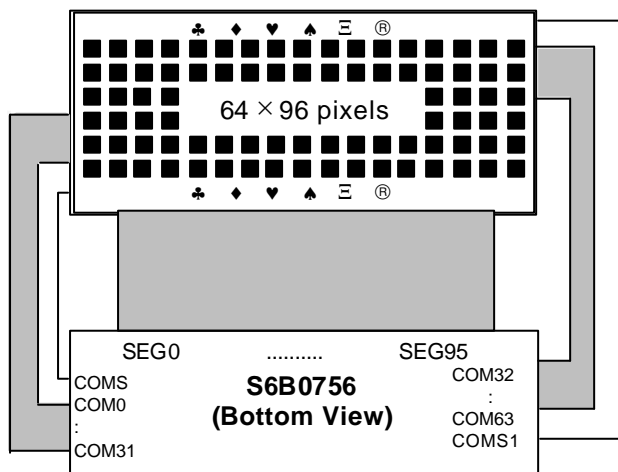


Figure 53. SHL = 1, ADC = 0

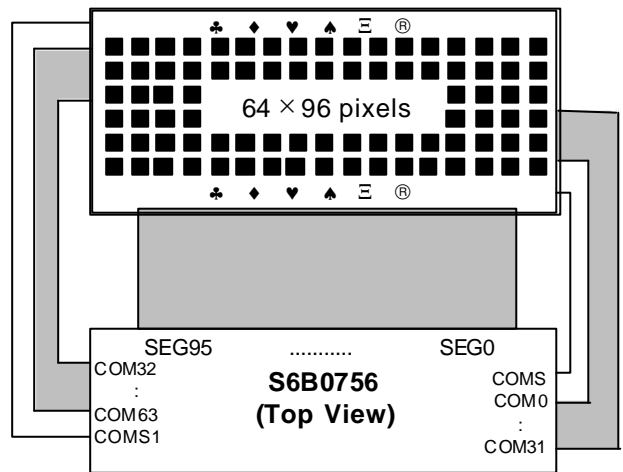


Figure 54. SHL = 1, ADC = 1

OTP CALIBRATION MODE

SEQUENCE FOR SETTING THE MODIFIED ELECTRONIC VOLUME

- Next figure is a Block Diagram of Sequence for Setting the Modified Electronic Volume.

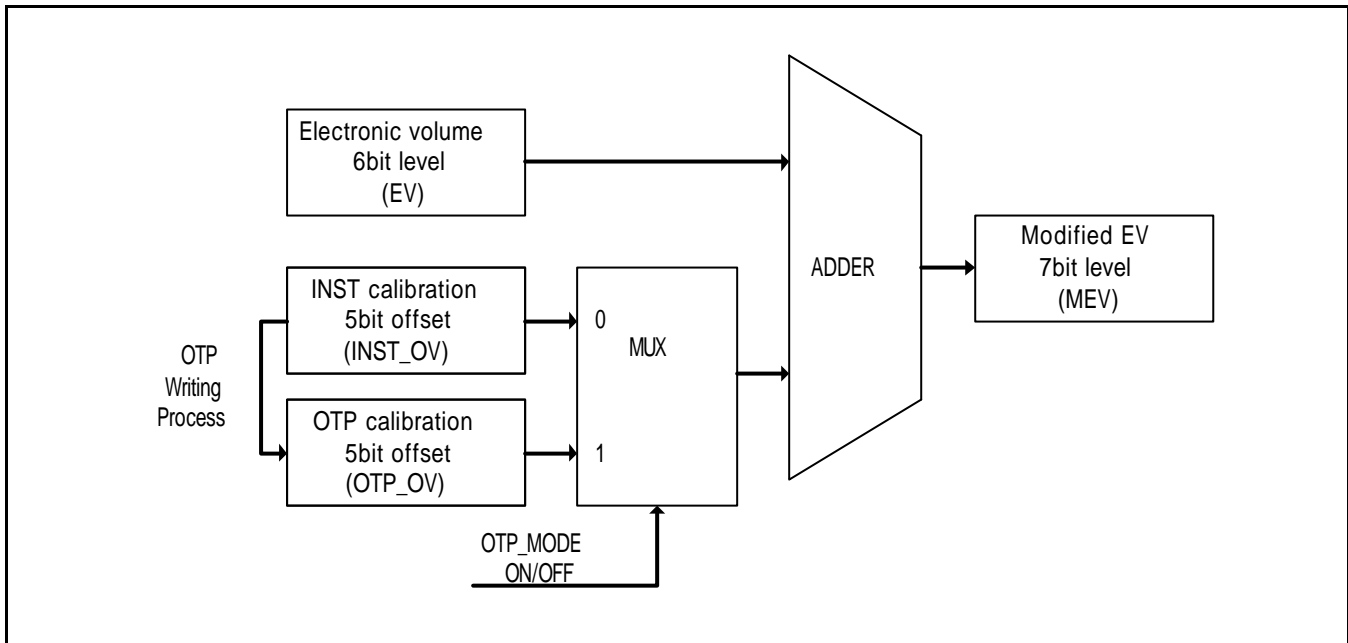


Figure 55. Sequence for Setting the Modified Electronic Volume

Initially, OTP cell is not programmed and has 5'b00000 value. When the external reset is applied, OTP_mode is On. MEV is $EV + OTP_OV$. Since OTP_OV is 5'b00000, MEV is EV. For VOUT calibration The instruction "OTP_mode_off" is executed, and then MEV is $EV + OV$ and user can adjust MEV value using the instruction "Set offset volume register". When MEV overflows or underflows, MEV will be saturated. Repeat this step until end of the calibration. If VOUT calibration is suitable, OTP_writing process is executed, and then OTP cell is programmed and OTP_OV is programmed with OV. Finally, VOUT calibration process is finished. Again, when the external reset is applied, OTP_mode is ON. MEV is $EV + OTP_OV$. Accordingly MEV is the EV which has always the offset with OTP_OV value. But if programmed OTP_OV is unlike, the instruction "OTP_mode off" can be executed and then MEV will be $EV + OV$. Accordingly OV can be adjusted with instructions although OTP cell is programmed.

EPROM CELL STRUCTURE

OTP(One Time Programmable) has been implemented on the S6B0756. The EPROM stores the offset volume for VOUT calibration after the device has been assembled and calibrated on a LCD module. For OTP programming, OTPD pin and OTPG pin are used. Those pins should be made available on the module glass

The OTP block of the S6B0756 consists of 6 bits. 1 bit is used for OTP mode protection bit(OPRT), and 5 bits are used for VOUT calibration(OV4~OV0).

EPROM block

MSB						LSB	
OPRT	OV4	OV3	OV2	OV1	OV0		

Description -.

OPRT : The Offset Volume(OV) can be written to EPROM only when OPRT bit = ' 0

OV4~OV0 : The OV is used for calibrating the VOUT voltage as an offset to the
EV register value.

VOUT CALIBRATION FLOW

VOUT may be calibrated with OTP in the following order.(ex : EX = 32, OV=-3)

STEP	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Description
1.											Apply external reset
2	0	0	1	0	0	0	0	0	0	1	Set electronic volume by using instruction(EV = 32)
	0	0	x	x	1	0	0	0	0	0	
3	0	0	1	1	1	0	1	1	0	0	OTP_mode_off by using the instruction
4.	0	0	1	1	1	0	1	0	1	0	Set offset volume by using the instruction(OV = -3)
	0	0	x	x	x	1	1	1	0	1	
5.											Repeat STEP 4. Until the end of the calibration
6.	0	0	1	0	1	0	1	0	0	1	Set power save mode(P=1)
7.	0	0	1	1	1	0	1	1	1	1	OTP write Enable (Only when OPRT = 0)
8.											Apply programming voltages for OTP programming (OTPG, OTPD)
9.											Cut off programming voltages for OTP programming(OTPG,OTPD)
10.											Apply external reset

After the external reset, the calibrated data are automatically transferred to the 5-bit reference voltage control register.

*Step 6,7,8,9,10 is OTP_WRITING PROCESS.

*OTP_WRITING PROCESS is available when OPRT is zero (if OPRT = 1, OTP cell is not programmed).

VOLTAGES AND WAVEFORMS FOR OTP PROGRAMMING

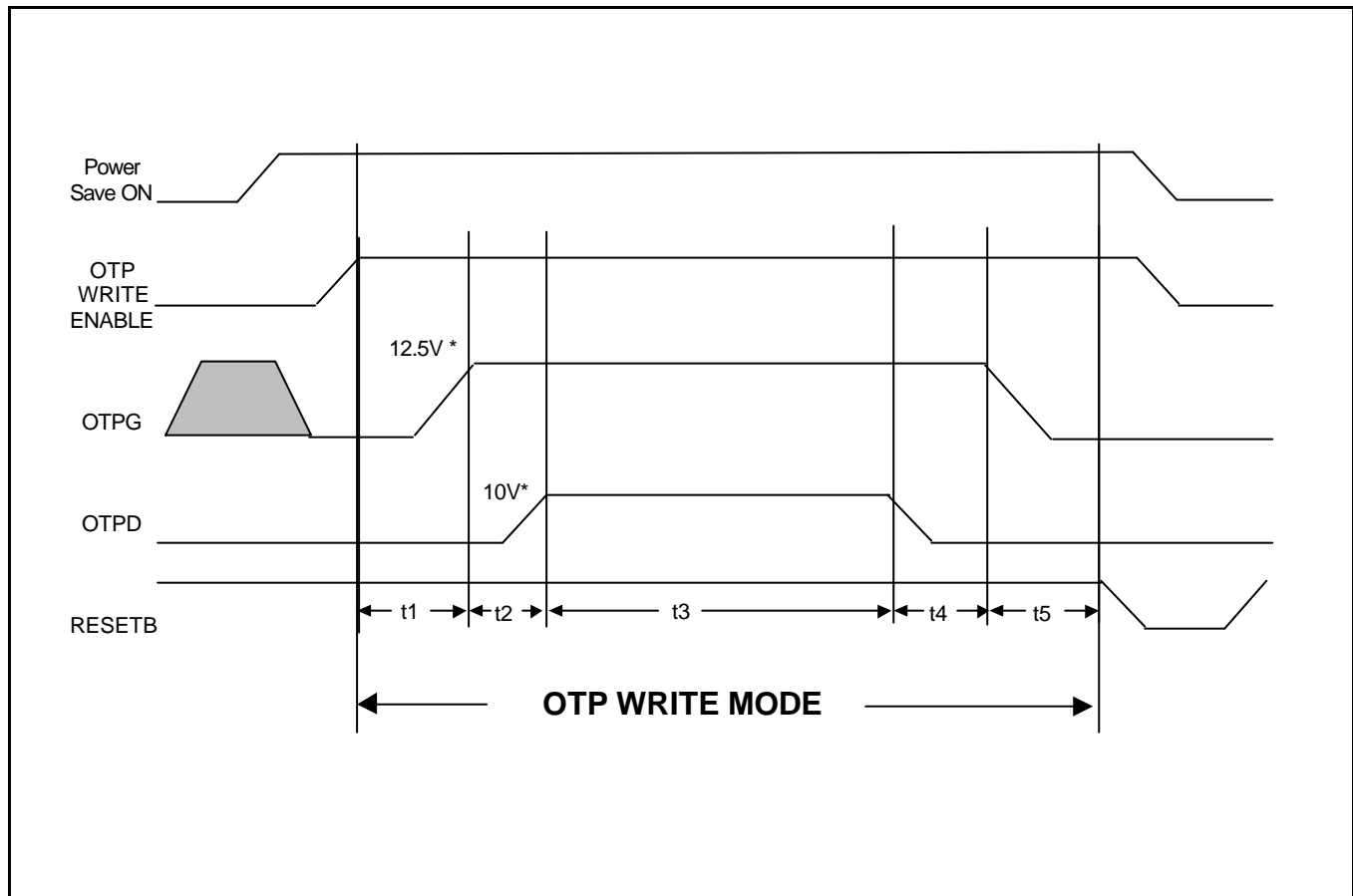


Figure 56. Voltages and waveforms for OTP programming(OTP_Writing Process)

* Note : Voltages for OTPG and OTPD may be changed.

Specific timings(t1~t5)

Timing	Min	Max
t1,t2, t4, t5	100uS	-
t3	100mS	-