# Sitronix

# ST7624

## 65K Color Dot Matrix LCD Controller/Driver

## 1. INTRODUCTION

The ST7624 is a driver & controller LSI for 65k color graphic dot-matrix liquid crystal display systems. It generates 312 Segment and 104 Common driver circuits. This chip is connected directly to a microprocessor, accepts Serial Peripheral Interface (SPI) or 8-bit/16-bit parallel display data and stores in an on-chip display data RAM. It performs display data RAM read/write operation with no external 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.

## 2. FEATURES

### Driver Output Circuits

- 312 segment outputs / 104 common outputs

### Applicable Duty Ratios

- Various partial display
- Partial window moving & data scrolling

### Gray-Scale Display

- 4FRC & 31 PWM function circuit to display
- 64 gray-scale display.

### On-chip Display Data RAM

- Capacity: 104X104X16 =173,056bits
- 65K colors (RGB)=(565) mode
- Dithered262k colors (RGB)=(666) mode
- Dithered 16M colors (RGB)=(888) mode

### Microprocessor Interface

- 8/16-bit parallel bi-directional interface with 6800-series or 8080-series
- 4-line serial interface (4-line-SIF)
- 3-line serial interface (3-line-SIF)

### On-chip Low Power Analog Circuit

- On-chip oscillator circuit
- Voltage converter (x2, x3, x4, x5, x6, x7, x8)
- Voltage regulator(Temperature gradient= -0.119%/°C +-10%)
- On-chip electronic contrast control function
- Voltage follower (LCD bias: 1/5 to 1/12)

### Operating Voltage Range

- Supply voltage (VDD, VDD1): 2.4 to 3.3V
  (VDD2, VDD3, VDD4, VDD5): 2.4 to 3.3V
- LCD driving voltage (VOP = V0 - VSS): 3.76 to 18.0 V
- Suggested value of V0 is 12V~15V , bias =1/11

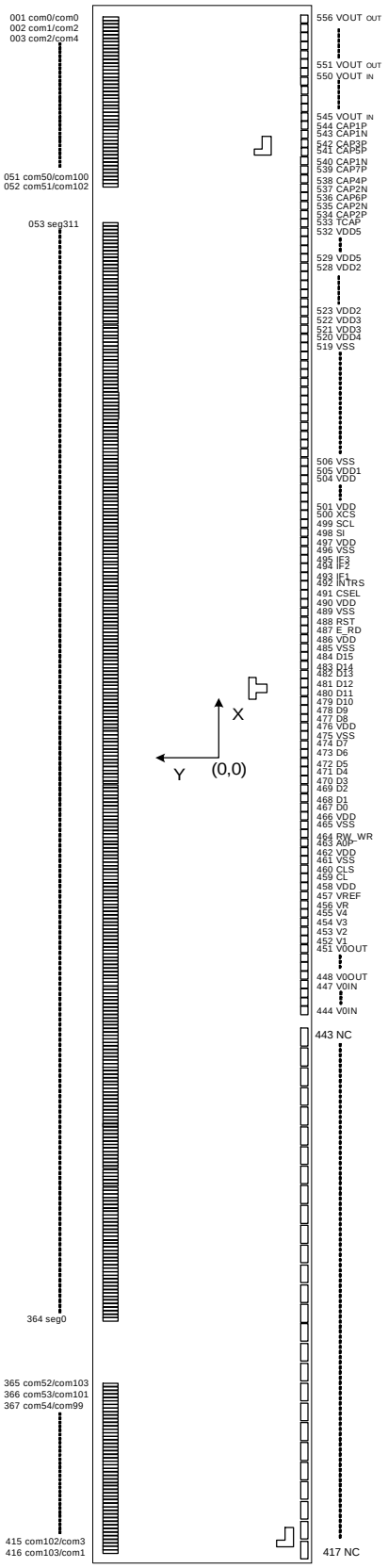
### LCD driving voltage (EEPROM)

- To store contrast adjustment value for better display

### Package Type

- Application for COG

| ST7624 | 6800 , 8080 ,4-Line , 3-Line interface | ST |
|---|---|---|




**Chip Size: 17,390 um x1,544 um**

- **Bump Pitch:**

**PAD NO 1 ~ 416: 40 um (COM/SEG)**

**PAD NO 417~443: 175um(NC)**

**PAD NO 444 ~ 556:110 um (I/O)**

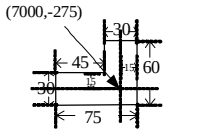
- **Bump size:**

**PAD NO.1~416: 25(x)um X 96(y)um**

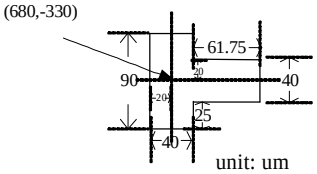
**PAD No. 417~443: 158(x)um X 23(y)um**

**PAD N0. 444~556: 90(x)um X 40(y)um**

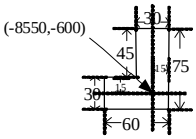
- **Bump Height: 17 um**
- **Chip Thickness: 635um**



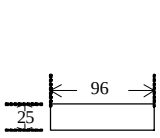

unit: um



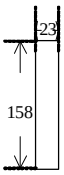

unit: um



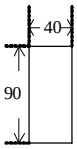

unit: um




Bump size of
PAD 1~416
unit: um




Bump size of
PAD 417~443
unit: um




Bump size of
PAD 444 ~ 556
unit: um

## 4. Pad Center Coordinates

| PAD No. | PIN Name | | X | Y |
|---|---|---|---|---|
| | CSEL=0 | CSEL=1 | | |
| 001 | COM[0] | COM[0] | 8557.0 | 642.5 |
| 002 | COM[1] | COM[2] | 8517.0 | 642.5 |
| 003 | COM[2] | COM[4] | 8477.0 | 642.5 |
| 004 | COM[3] | COM[6] | 8437.0 | 642.5 |
| 005 | COM[4] | COM[8] | 8397.0 | 642.5 |
| 006 | COM[5] | COM[10] | 8357.0 | 642.5 |
| 007 | COM[6] | COM[12] | 8317.0 | 642.5 |
| 008 | COM[7] | COM[14] | 8277.0 | 642.5 |
| 009 | COM[8] | COM[16] | 8237.0 | 642.5 |
| 010 | COM[9] | COM[18] | 8197.0 | 642.5 |
| 011 | COM[10] | COM[20] | 8157.0 | 642.5 |
| 012 | COM[11] | COM[22] | 8117.0 | 642.5 |
| 013 | COM[12] | COM[24] | 8077.0 | 642.5 |
| 014 | COM[13] | COM[26] | 8037.0 | 642.5 |
| 015 | COM[14] | COM[28] | 7997.0 | 642.5 |
| 016 | COM[15] | COM[30] | 7957.0 | 642.5 |
| 017 | COM[16] | COM[32] | 7917.0 | 642.5 |
| 018 | COM[17] | COM[34] | 7877.0 | 642.5 |
| 019 | COM[18] | COM[36] | 7837.0 | 642.5 |
| 020 | COM[19] | COM[38] | 7797.0 | 642.5 |
| 021 | COM[20] | COM[40] | 7757.0 | 642.5 |
| 022 | COM[21] | COM[42] | 7717.0 | 642.5 |
| 023 | COM[22] | COM[44] | 7677.0 | 642.5 |
| 024 | COM[23] | COM[46] | 7637.0 | 642.5 |
| 025 | COM[24] | COM[48] | 7597.0 | 642.5 |
| 026 | COM[25] | COM[50] | 7557.0 | 642.5 |
| 027 | COM[26] | COM[52] | 7517.0 | 642.5 |
| 028 | COM[27] | COM[54] | 7477.0 | 642.5 |
| 029 | COM[28] | COM[56] | 7437.0 | 642.5 |
| 030 | COM[29] | COM[58] | 7397.0 | 642.5 |
| 031 | COM[30] | COM[60] | 7357.0 | 642.5 |
| 032 | COM[31] | COM[62] | 7317.0 | 642.5 |
| 033 | COM[32] | COM[64] | 7277.0 | 642.5 |
| 034 | COM[33] | COM[66] | 7237.0 | 642.5 |

| PAD No. | PIN Name | | X | Y |
|---|---|---|---|---|
| | CSEL=0 | CSEL=1 | | |
| 035 | COM[34] | COM[68] | 7197.0 | 642.5 |
| 036 | COM[35] | COM[70] | 7157.0 | 642.5 |
| 037 | COM[36] | COM[72] | 7117.0 | 642.5 |
| 038 | COM[37] | COM[74] | 7077.0 | 642.5 |
| 039 | COM[38] | COM[76] | 7037.0 | 642.5 |
| 040 | COM[39] | COM[78] | 6997.0 | 642.5 |
| 041 | COM[40] | COM[80] | 6957.0 | 642.5 |
| 042 | COM[41] | COM[82] | 6917.0 | 642.5 |
| 043 | COM[42] | COM[84] | 6877.0 | 642.5 |
| 044 | COM[43] | COM[86] | 6837.0 | 642.5 |
| 045 | COM[44] | COM[88] | 6797.0 | 642.5 |
| 046 | COM[45] | COM[90] | 6757.0 | 642.5 |
| 047 | COM[46] | COM[92] | 6717.0 | 642.5 |
| 048 | COM[47] | COM[94] | 6677.0 | 642.5 |
| 049 | COM[48] | COM[96] | 6637.0 | 642.5 |
| 050 | COM[49] | COM[98] | 6597.0 | 642.5 |
| 051 | COM[50] | COM[100] | 6557.0 | 642.5 |
| 052 | COM[51] | COM[102] | 6517.0 | 642.5 |
| 053 | SEG[311] | | 6352.6 | 642.5 |
| 054 | SEG[310] | | 6312.6 | 642.5 |
| 055 | SEG[309] | | 6272.6 | 642.5 |
| 056 | SEG[308] | | 6232.6 | 642.5 |
| 057 | SEG[307] | | 6192.6 | 642.5 |
| 058 | SEG[306] | | 6152.6 | 642.5 |
| 059 | SEG[305] | | 6112.6 | 642.5 |
| 060 | SEG[304] | | 6072.6 | 642.5 |
| 061 | SEG[303] | | 6032.6 | 642.5 |
| 062 | SEG[302] | | 5992.6 | 642.5 |
| 063 | SEG[301] | | 5952.6 | 642.5 |
| 064 | SEG[300] | | 5912.6 | 642.5 |
| 065 | SEG[299] | | 5872.6 | 642.5 |
| 066 | SEG[298] | | 5832.6 | 642.5 |
| 067 | SEG[297] | | 5792.6 | 642.5 |
| 068 | SEG[296] | | 5752.6 | 642.5 |

| PAD No. | PIN Name | | X | Y |
|---|---|---|---|---|
| | CSEL=0 | CSEL=1 | | |
| 069 | SEG[295] | | 5712.6 | 642.5 |
| 070 | SEG[294] | | 5672.6 | 642.5 |
| 071 | SEG[293] | | 5632.6 | 642.5 |
| 072 | SEG[292] | | 5592.6 | 642.5 |
| 073 | SEG[291] | | 5552.6 | 642.5 |
| 074 | SEG[290] | | 5512.6 | 642.5 |
| 075 | SEG[289] | | 5472.6 | 642.5 |
| 076 | SEG[288] | | 5432.6 | 642.5 |
| 077 | SEG[287] | | 5392.6 | 642.5 |
| 078 | SEG[286] | | 5352.6 | 642.5 |
| 079 | SEG[285] | | 5312.6 | 642.5 |
| 080 | SEG[284] | | 5272.6 | 642.5 |
| 081 | SEG[283] | | 5232.6 | 642.5 |
| 082 | SEG[282] | | 5192.6 | 642.5 |
| 083 | SEG[281] | | 5152.6 | 642.5 |
| 084 | SEG[280] | | 5112.6 | 642.5 |
| 085 | SEG[279] | | 5072.6 | 642.5 |
| 086 | SEG[278] | | 5032.6 | 642.5 |
| 087 | SEG[277] | | 4992.6 | 642.5 |
| 088 | SEG[276] | | 4952.6 | 642.5 |
| 089 | SEG[275] | | 4912.6 | 642.5 |
| 090 | SEG[274] | | 4872.6 | 642.5 |
| 091 | SEG[273] | | 4832.6 | 642.5 |
| 092 | SEG[272] | | 4792.6 | 642.5 |
| 093 | SEG[271] | | 4752.6 | 642.5 |
| 094 | SEG[270] | | 4712.6 | 642.5 |
| 095 | SEG[269] | | 4672.6 | 642.5 |
| 096 | SEG[268] | | 4632.6 | 642.5 |
| 097 | SEG[267] | | 4592.6 | 642.5 |
| 098 | SEG[266] | | 4552.6 | 642.5 |
| 099 | SEG[265] | | 4512.6 | 642.5 |
| 100 | SEG[264] | | 4472.6 | 642.5 |
| 101 | SEG[263] | | 4432.6 | 642.5 |
| 102 | SEG[262] | | 4392.6 | 642.5 |
| 103 | SEG[261] | | 4352.6 | 642.5 |

| PAD No. | PIN Name | | X | Y |
|---|---|---|---|---|
| | CSEL=0 | CSEL=1 | | |
| 104 | SEG[260] | | 4312.6 | 642.5 |
| 105 | SEG[259] | | 4272.6 | 642.5 |
| 106 | SEG[258] | | 4232.6 | 642.5 |
| 107 | SEG[257] | | 4192.6 | 642.5 |
| 108 | SEG[256] | | 4152.6 | 642.5 |
| 109 | SEG[255] | | 4112.6 | 642.5 |
| 110 | SEG[254] | | 4072.6 | 642.5 |
| 111 | SEG[253] | | 4032.6 | 642.5 |
| 112 | SEG[252] | | 3992.6 | 642.5 |
| 113 | SEG[251] | | 3952.6 | 642.5 |
| 114 | SEG[250] | | 3912.6 | 642.5 |
| 115 | SEG[249] | | 3872.6 | 642.5 |
| 116 | SEG[248] | | 3832.6 | 642.5 |
| 117 | SEG[247] | | 3792.6 | 642.5 |
| 118 | SEG[246] | | 3752.6 | 642.5 |
| 119 | SEG[245] | | 3712.6 | 642.5 |
| 120 | SEG[244] | | 3672.6 | 642.5 |
| 121 | SEG[243] | | 3632.6 | 642.5 |
| 122 | SEG[242] | | 3592.6 | 642.5 |
| 123 | SEG[241] | | 3552.6 | 642.5 |
| 124 | SEG[240] | | 3512.6 | 642.5 |
| 125 | SEG[239] | | 3472.6 | 642.5 |
| 126 | SEG[238] | | 3432.6 | 642.5 |
| 127 | SEG[237] | | 3392.6 | 642.5 |
| 128 | SEG[236] | | 3352.6 | 642.5 |
| 129 | SEG[235] | | 3312.6 | 642.5 |
| 130 | SEG[234] | | 3272.6 | 642.5 |
| 131 | SEG[233] | | 3232.6 | 642.5 |
| 132 | SEG[232] | | 3192.6 | 642.5 |
| 133 | SEG[231] | | 3152.6 | 642.5 |
| 134 | SEG[230] | | 3112.6 | 642.5 |
| 135 | SEG[229] | | 3072.6 | 642.5 |
| 136 | SEG[228] | | 3032.6 | 642.5 |
| 137 | SEG[227] | | 2992.6 | 642.5 |
| 138 | SEG[226] | | 2952.6 | 642.5 |

| PAD No. | PIN Name | | X | Y |
|---|---|---|---|---|
| | CSEL=0 | CSEL=1 | | |
| 139 | SEG[225] | | 2912.6 | 642.5 |
| 140 | SEG[224] | | 2872.6 | 642.5 |
| 141 | SEG[223] | | 2832.6 | 642.5 |
| 142 | SEG[222] | | 2792.6 | 642.5 |
| 143 | SEG[221] | | 2752.6 | 642.5 |
| 144 | SEG[220] | | 2712.6 | 642.5 |
| 145 | SEG[219] | | 2672.6 | 642.5 |
| 146 | SEG[218] | | 2632.6 | 642.5 |
| 147 | SEG[217] | | 2592.6 | 642.5 |
| 148 | SEG[216] | | 2552.6 | 642.5 |
| 149 | SEG[215] | | 2512.6 | 642.5 |
| 150 | SEG[214] | | 2472.6 | 642.5 |
| 151 | SEG[213] | | 2432.6 | 642.5 |
| 152 | SEG[212] | | 2392.6 | 642.5 |
| 153 | SEG[211] | | 2352.6 | 642.5 |
| 154 | SEG[210] | | 2312.6 | 642.5 |
| 155 | SEG[209] | | 2272.6 | 642.5 |
| 156 | SEG[208] | | 2232.6 | 642.5 |
| 157 | SEG[207] | | 2192.6 | 642.5 |
| 158 | SEG[206] | | 2152.6 | 642.5 |
| 159 | SEG[205] | | 2112.6 | 642.5 |
| 160 | SEG[204] | | 2072.6 | 642.5 |
| 161 | SEG[203] | | 2032.6 | 642.5 |
| 162 | SEG[202] | | 1992.6 | 642.5 |
| 163 | SEG[201] | | 1952.6 | 642.5 |
| 164 | SEG[200] | | 1912.6 | 642.5 |
| 165 | SEG[199] | | 1872.6 | 642.5 |
| 166 | SEG[198] | | 1832.6 | 642.5 |
| 167 | SEG[197] | | 1792.6 | 642.5 |
| 168 | SEG[196] | | 1752.6 | 642.5 |
| 169 | SEG[195] | | 1712.6 | 642.5 |
| 170 | SEG[194] | | 1672.6 | 642.5 |
| 171 | SEG[193] | | 1632.6 | 642.5 |
| 172 | SEG[192] | | 1592.6 | 642.5 |
| 173 | SEG[191] | | 1552.6 | 642.5 |

| PAD No. | PIN Name | | X | Y |
|---|---|---|---|---|
| | CSEL=0 | CSEL=1 | | |
| 174 | SEG[190] | | 1512.6 | 642.5 |
| 175 | SEG[189] | | 1472.6 | 642.5 |
| 176 | SEG[188] | | 1432.6 | 642.5 |
| 177 | SEG[187] | | 1392.6 | 642.5 |
| 178 | SEG[186] | | 1352.6 | 642.5 |
| 179 | SEG[185] | | 1312.6 | 642.5 |
| 180 | SEG[184] | | 1272.6 | 642.5 |
| 181 | SEG[183] | | 1232.6 | 642.5 |
| 182 | SEG[182] | | 1192.6 | 642.5 |
| 183 | SEG[181] | | 1152.6 | 642.5 |
| 184 | SEG[180] | | 1112.6 | 642.5 |
| 185 | SEG[179] | | 1072.6 | 642.5 |
| 186 | SEG[178] | | 1032.6 | 642.5 |
| 187 | SEG[177] | | 992.6 | 642.5 |
| 188 | SEG[176] | | 952.6 | 642.5 |
| 189 | SEG[175] | | 912.6 | 642.5 |
| 190 | SEG[174] | | 872.6 | 642.5 |
| 191 | SEG[173] | | 832.6 | 642.5 |
| 192 | SEG[172] | | 792.6 | 642.5 |
| 193 | SEG[171] | | 752.6 | 642.5 |
| 194 | SEG[170] | | 712.6 | 642.5 |
| 195 | SEG[169] | | 672.6 | 642.5 |
| 196 | SEG[168] | | 632.6 | 642.5 |
| 197 | SEG[167] | | 592.6 | 642.5 |
| 198 | SEG[166] | | 552.6 | 642.5 |
| 199 | SEG[165] | | 512.6 | 642.5 |
| 200 | SEG[164] | | 472.6 | 642.5 |
| 201 | SEG[163] | | 432.6 | 642.5 |
| 202 | SEG[162] | | 392.6 | 642.5 |
| 203 | SEG[161] | | 352.6 | 642.5 |
| 204 | SEG[160] | | 312.6 | 642.5 |
| 205 | SEG[159] | | 272.6 | 642.5 |
| 206 | SEG[158] | | 232.6 | 642.5 |
| 207 | SEG[157] | | 192.6 | 642.5 |
| 208 | SEG[156] | | 152.6 | 642.5 |

| PAD No. | PIN Name | | X | Y |
|---|---|---|---|---|
| | CSEL=0 | CSEL=1 | | |
| 209 | SEG[155] | | 112.6 | 642.5 |
| 210 | SEG[154] | | 72.6 | 642.5 |
| 211 | SEG[153] | | 32.6 | 642.5 |
| 212 | SEG[152] | | -7.4 | 642.5 |
| 213 | SEG[151] | | -47.4 | 642.5 |
| 214 | SEG[150] | | -87.4 | 642.5 |
| 215 | SEG[149] | | -127.4 | 642.5 |
| 216 | SEG[148] | | -167.4 | 642.5 |
| 217 | SEG[147] | | -207.4 | 642.5 |
| 218 | SEG[146] | | -247.4 | 642.5 |
| 219 | SEG[145] | | -287.4 | 642.5 |
| 220 | SEG[144] | | -327.4 | 642.5 |
| 221 | SEG[143] | | -367.4 | 642.5 |
| 222 | SEG[142] | | -407.4 | 642.5 |
| 223 | SEG[141] | | -447.4 | 642.5 |
| 224 | SEG[140] | | -487.4 | 642.5 |
| 225 | SEG[139] | | -527.4 | 642.5 |
| 226 | SEG[138] | | -567.4 | 642.5 |
| 227 | SEG[137] | | -607.4 | 642.5 |
| 228 | SEG[136] | | -647.4 | 642.5 |
| 229 | SEG[135] | | -687.4 | 642.5 |
| 230 | SEG[134] | | -727.4 | 642.5 |
| 231 | SEG[133] | | -767.4 | 642.5 |
| 232 | SEG[132] | | -807.4 | 642.5 |
| 233 | SEG[131] | | -847.4 | 642.5 |
| 234 | SEG[130] | | -887.4 | 642.5 |
| 235 | SEG[129] | | -927.4 | 642.5 |
| 236 | SEG[128] | | -967.4 | 642.5 |
| 237 | SEG[127] | | -1007.4 | 642.5 |
| 238 | SEG[126] | | -1047.4 | 642.5 |
| 239 | SEG[125] | | -1087.4 | 642.5 |
| 240 | SEG[124] | | -1127.4 | 642.5 |
| 241 | SEG[123] | | -1167.4 | 642.5 |
| 242 | SEG[122] | | -1207.4 | 642.5 |
| 243 | SEG[121] | | -1247.4 | 642.5 |

| PAD No. | PIN Name | | X | Y |
|---|---|---|---|---|
| | CSEL=0 | CSEL=1 | | |
| 244 | SEG[120] | | -1287.4 | 642.5 |
| 245 | SEG[119] | | -1327.4 | 642.5 |
| 246 | SEG[118] | | -1367.4 | 642.5 |
| 247 | SEG[117] | | -1407.4 | 642.5 |
| 248 | SEG[116] | | -1447.4 | 642.5 |
| 249 | SEG[115] | | -1487.4 | 642.5 |
| 250 | SEG[114] | | -1527.4 | 642.5 |
| 251 | SEG[113] | | -1567.4 | 642.5 |
| 252 | SEG[112] | | -1607.4 | 642.5 |
| 253 | SEG[111] | | -1647.4 | 642.5 |
| 254 | SEG[110] | | -1687.4 | 642.5 |
| 255 | SEG[109] | | -1727.4 | 642.5 |
| 256 | SEG[108] | | -1767.4 | 642.5 |
| 257 | SEG[107] | | -1807.4 | 642.5 |
| 258 | SEG[106] | | -1847.4 | 642.5 |
| 259 | SEG[105] | | -1887.4 | 642.5 |
| 260 | SEG[104] | | -1927.4 | 642.5 |
| 261 | SEG[103] | | -1967.4 | 642.5 |
| 262 | SEG[102] | | -2007.4 | 642.5 |
| 263 | SEG[101] | | -2047.4 | 642.5 |
| 264 | SEG[100] | | -2087.4 | 642.5 |
| 265 | SEG[99] | | -2127.4 | 642.5 |
| 266 | SEG[98] | | -2167.4 | 642.5 |
| 267 | SEG[97] | | -2207.4 | 642.5 |
| 268 | SEG[96] | | -2247.4 | 642.5 |
| 269 | SEG[95] | | -2287.4 | 642.5 |
| 270 | SEG[94] | | -2327.4 | 642.5 |
| 271 | SEG[93] | | -2367.4 | 642.5 |
| 272 | SEG[92] | | -2407.4 | 642.5 |
| 273 | SEG[91] | | -2447.4 | 642.5 |
| 274 | SEG[90] | | -2487.4 | 642.5 |
| 275 | SEG[89] | | -2527.4 | 642.5 |
| 276 | SEG[88] | | -2567.4 | 642.5 |
| 277 | SEG[87] | | -2607.4 | 642.5 |
| 278 | SEG[86] | | -2647.4 | 642.5 |

| PAD No. | PIN Name | | X | Y |
|---|---|---|---|---|
| | CSEL=0 | CSEL=1 | | |
| 279 | SEG[85] | | -2687.4 | 642.5 |
| 280 | SEG[84] | | -2727.4 | 642.5 |
| 281 | SEG[83] | | -2767.4 | 642.5 |
| 282 | SEG[82] | | -2807.4 | 642.5 |
| 283 | SEG[81] | | -2847.4 | 642.5 |
| 284 | SEG[80] | | -2887.4 | 642.5 |
| 285 | SEG[79] | | -2927.4 | 642.5 |
| 286 | SEG[78] | | -2967.4 | 642.5 |
| 287 | SEG[77] | | -3007.4 | 642.5 |
| 288 | SEG[76] | | -3047.4 | 642.5 |
| 289 | SEG[75] | | -3087.4 | 642.5 |
| 290 | SEG[74] | | -3127.4 | 642.5 |
| 291 | SEG[73] | | -3167.4 | 642.5 |
| 292 | SEG[72] | | -3207.4 | 642.5 |
| 293 | SEG[71] | | -3247.4 | 642.5 |
| 294 | SEG[70] | | -3287.4 | 642.5 |
| 295 | SEG[69] | | -3327.4 | 642.5 |
| 296 | SEG[68] | | -3367.4 | 642.5 |
| 297 | SEG[67] | | -3407.4 | 642.5 |
| 298 | SEG[66] | | -3447.4 | 642.5 |
| 299 | SEG[65] | | -3487.4 | 642.5 |
| 300 | SEG[64] | | -3527.4 | 642.5 |
| 301 | SEG[63] | | -3567.4 | 642.5 |
| 302 | SEG[62] | | -3607.4 | 642.5 |
| 303 | SEG[61] | | -3647.4 | 642.5 |
| 304 | SEG[60] | | -3687.4 | 642.5 |
| 305 | SEG[59] | | -3727.4 | 642.5 |
| 306 | SEG[58] | | -3767.4 | 642.5 |
| 307 | SEG[57] | | -3807.4 | 642.5 |
| 308 | SEG[56] | | -3847.4 | 642.5 |
| 309 | SEG[55] | | -3887.4 | 642.5 |
| 310 | SEG[54] | | -3927.4 | 642.5 |
| 311 | SEG[53] | | -3967.4 | 642.5 |
| 312 | SEG[52] | | -4007.4 | 642.5 |
| 313 | SEG[51] | | -4047.4 | 642.5 |

| PAD No. | PIN Name | | X | Y |
|---|---|---|---|---|
| | CSEL=0 | CSEL=1 | | |
| 314 | SEG[50] | | -4087.4 | 642.5 |
| 315 | SEG[49] | | -4127.4 | 642.5 |
| 316 | SEG[48] | | -4167.4 | 642.5 |
| 317 | SEG[47] | | -4207.4 | 642.5 |
| 318 | SEG[46] | | -4247.4 | 642.5 |
| 319 | SEG[45] | | -4287.4 | 642.5 |
| 320 | SEG[44] | | -4327.4 | 642.5 |
| 321 | SEG[43] | | -4367.4 | 642.5 |
| 322 | SEG[42] | | -4407.4 | 642.5 |
| 323 | SEG[41] | | -4447.4 | 642.5 |
| 324 | SEG[40] | | -4487.4 | 642.5 |
| 325 | SEG[39] | | -4527.4 | 642.5 |
| 326 | SEG[38] | | -4567.4 | 642.5 |
| 327 | SEG[37] | | -4607.4 | 642.5 |
| 328 | SEG[36] | | -4647.4 | 642.5 |
| 329 | SEG[35] | | -4687.4 | 642.5 |
| 330 | SEG[34] | | -4727.4 | 642.5 |
| 331 | SEG[33] | | -4767.4 | 642.5 |
| 332 | SEG[32] | | -4807.4 | 642.5 |
| 333 | SEG[31] | | -4847.4 | 642.5 |
| 334 | SEG[30] | | -4887.4 | 642.5 |
| 335 | SEG[29] | | -4927.4 | 642.5 |
| 336 | SEG[28] | | -4967.4 | 642.5 |
| 337 | SEG[27] | | -5007.4 | 642.5 |
| 338 | SEG[26] | | -5047.4 | 642.5 |
| 339 | SEG[25] | | -5087.4 | 642.5 |
| 340 | SEG[24] | | -5127.4 | 642.5 |
| 341 | SEG[23] | | -5167.4 | 642.5 |
| 342 | SEG[22] | | -5207.4 | 642.5 |
| 343 | SEG[21] | | -5247.4 | 642.5 |
| 344 | SEG[20] | | -5287.4 | 642.5 |
| 345 | SEG[19] | | -5327.4 | 642.5 |
| 346 | SEG[18] | | -5367.4 | 642.5 |
| 347 | SEG[17] | | -5407.4 | 642.5 |
| 348 | SEG[16] | | -5447.4 | 642.5 |

| PAD No. | PIN Name | | X | Y |
|---|---|---|---|---|
| | CSEL=0 | CSEL=1 | | |
| 349 | SEG[15] | | -5487.4 | 642.5 |
| 350 | SEG[14] | | -5527.4 | 642.5 |
| 351 | SEG[13] | | -5567.4 | 642.5 |
| 352 | SEG[12] | | -5607.4 | 642.5 |
| 353 | SEG[11] | | -5647.4 | 642.5 |
| 354 | SEG[10] | | -5687.4 | 642.5 |
| 355 | SEG[9] | | -5727.4 | 642.5 |
| 356 | SEG[8] | | -5767.4 | 642.5 |
| 357 | SEG[7] | | -5807.4 | 642.5 |
| 358 | SEG[6] | | -5847.4 | 642.5 |
| 359 | SEG[5] | | -5887.4 | 642.5 |
| 360 | SEG[4] | | -5927.4 | 642.5 |
| 361 | SEG[3] | | -5967.4 | 642.5 |
| 362 | SEG[2] | | -6007.4 | 642.5 |
| 363 | SEG[1] | | -6047.4 | 642.5 |
| 364 | SEG[0] | | -6087.4 | 642.5 |
| 365 | COM[52] | COM[103] | -6485.75 | 642.5 |
| 366 | COM[53] | COM[101] | -6525.75 | 642.5 |
| 367 | COM[54] | COM[99] | -6565.75 | 642.5 |
| 368 | COM[55] | COM[97] | -6605.75 | 642.5 |
| 369 | COM[56] | COM[95] | -6645.75 | 642.5 |
| 370 | COM[57] | COM[93] | -6685.75 | 642.5 |
| 371 | COM[58] | COM[91] | -6725.75 | 642.5 |
| 372 | COM[59] | COM[89] | -6765.75 | 642.5 |
| 373 | COM[60] | COM[87] | -6805.75 | 642.5 |
| 374 | COM[61] | COM[85] | -6845.75 | 642.5 |
| 375 | COM[62] | COM[83] | -6885.75 | 642.5 |
| 376 | COM[63] | COM[81] | -6925.75 | 642.5 |
| 377 | COM[64] | COM[79] | -6965.75 | 642.5 |
| 378 | COM[65] | COM[77] | -7005.75 | 642.5 |
| 379 | COM[66] | COM[75] | -7045.75 | 642.5 |
| 380 | COM[67] | COM[73] | -7085.75 | 642.5 |
| 381 | COM[68] | COM[71] | -7125.75 | 642.5 |
| 382 | COM[69] | COM[69] | -7165.75 | 642.5 |
| 383 | COM[70] | COM[67] | -7205.75 | 642.5 |

| PAD No. | PIN Name | | X | Y |
|---|---|---|---|---|
| | CSEL=0 | CSEL=1 | | |
| 384 | COM[71] | COM[65] | -7245.75 | 642.5 |
| 385 | COM[72] | COM[63] | -7285.75 | 642.5 |
| 386 | COM[73] | COM[61] | -7325.75 | 642.5 |
| 387 | COM[74] | COM[59] | -7365.75 | 642.5 |
| 388 | COM[75] | COM[57] | -7405.75 | 642.5 |
| 389 | COM[76] | COM[55] | -7445.75 | 642.5 |
| 390 | COM[77] | COM[53] | -7485.75 | 642.5 |
| 391 | COM[78] | COM[51] | -7525.75 | 642.5 |
| 392 | COM[79] | COM[49] | -7565.75 | 642.5 |
| 393 | COM[80] | COM[47] | -7605.75 | 642.5 |
| 394 | COM[81] | COM[45] | -7645.75 | 642.5 |
| 395 | COM[82] | COM[43] | -7685.75 | 642.5 |
| 396 | COM[83] | COM[41] | -7725.75 | 642.5 |
| 397 | COM[84] | COM[39] | -7765.75 | 642.5 |
| 398 | COM[85] | COM[37] | -7805.75 | 642.5 |
| 399 | COM[86] | COM[35] | -7845.75 | 642.5 |
| 400 | COM[87] | COM[33] | -7885.75 | 642.5 |
| 401 | COM[88] | COM[31] | -7925.75 | 642.5 |
| 402 | COM[89] | COM[29] | -7965.75 | 642.5 |
| 403 | COM[90] | COM[27] | -8005.75 | 642.5 |
| 404 | COM[91] | COM[25] | -8045.75 | 642.5 |
| 405 | COM[92] | COM[23] | -8085.75 | 642.5 |
| 406 | COM[93] | COM[21] | -8125.75 | 642.5 |
| 407 | COM[94] | COM[19] | -8165.75 | 642.5 |
| 408 | COM[95] | COM[17] | -8205.75 | 642.5 |
| 409 | COM[96] | COM[15] | -8245.75 | 642.5 |
| 410 | COM[97] | COM[13] | -8285.75 | 642.5 |
| 411 | COM[98] | COM[11] | -8325.75 | 642.5 |
| 412 | COM[99] | COM[9] | -8365.75 | 642.5 |
| 413 | COM[100] | COM[7] | -8405.75 | 642.5 |
| 414 | COM[101] | COM[5] | -8445.75 | 642.5 |
| 415 | COM[102] | COM[3] | -8485.75 | 642.5 |
| 416 | COM[103] | COM[1] | -8525.75 | 642.5 |
| 417 | NC | | -8534.45 | -679.5 |
| 418 | NC | | -8359.45 | -679.5 |

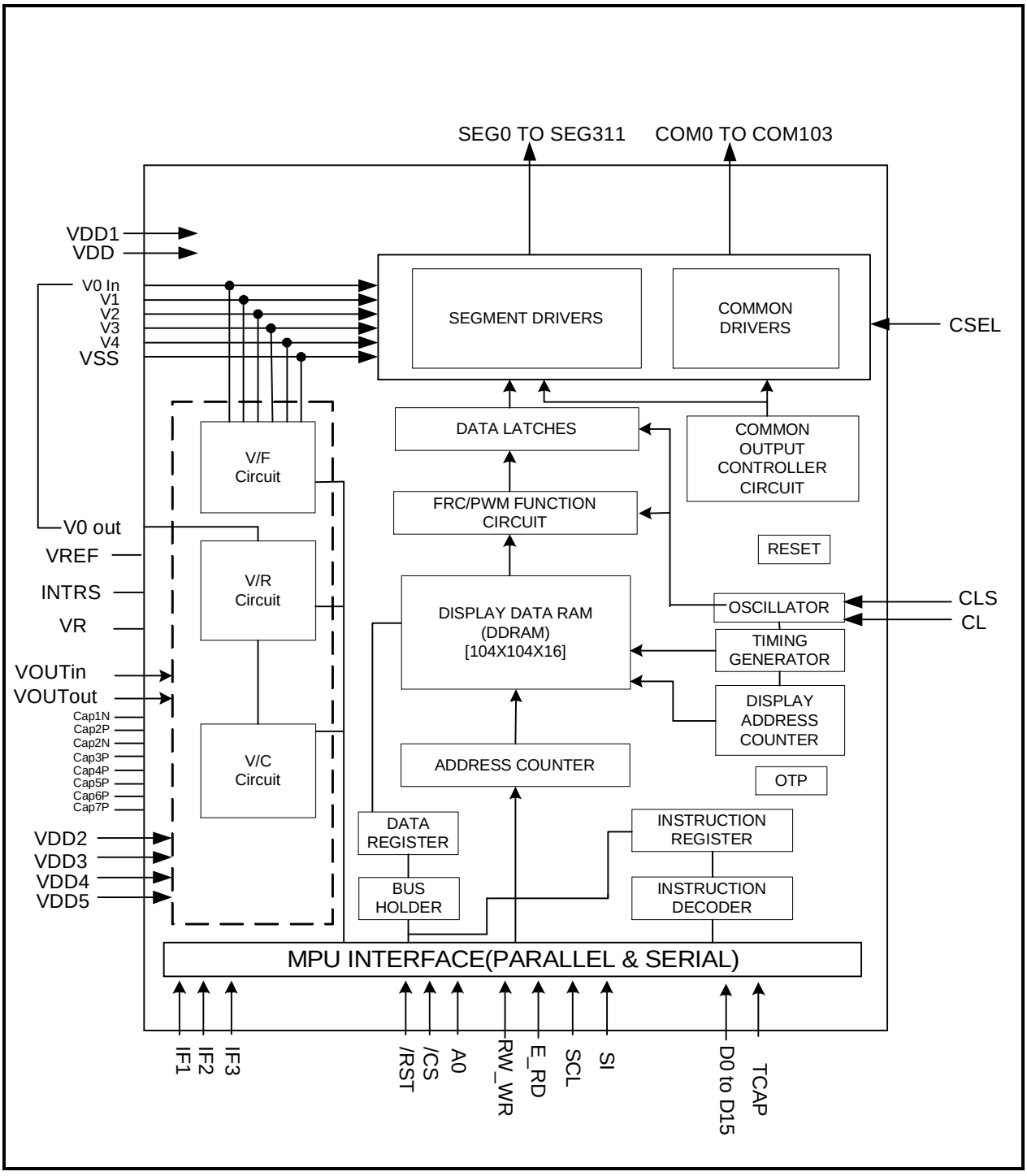
| PAD No. | PIN Name | | X | Y |
|---|---|---|---|---|
| | CSEL=0 | CSEL=1 | | |
| 419 | NC | | -8184.45 | -679.5 |
| 420 | NC | | -8009.45 | -679.5 |
| 421 | NC | | -7834.45 | -679.5 |
| 422 | NC | | -7659.45 | -679.5 |
| 423 | NC | | -7484.45 | -679.5 |
| 424 | NC | | -7309.45 | -679.5 |
| 425 | NC | | -7134.45 | -679.5 |
| 426 | NC | | -6959.45 | -679.5 |
| 427 | NC | | -6784.45 | -679.5 |
| 428 | NC | | -6609.45 | -679.5 |
| 429 | NC | | -6434.45 | -679.5 |
| 430 | NC | | -6259.45 | -679.5 |
| 431 | NC | | -6084.45 | -679.5 |
| 432 | NC | | -5909.45 | -679.5 |
| 433 | NC | | -5734.45 | -679.5 |
| 434 | NC | | -5559.45 | -679.5 |
| 435 | NC | | -5384.45 | -679.5 |
| 436 | NC | | -5209.45 | -679.5 |
| 437 | NC | | -5034.45 | -679.5 |
| 438 | NC | | -4859.45 | -679.5 |
| 439 | NC | | -4684.45 | -679.5 |
| 440 | NC | | -4509.45 | -679.5 |
| 441 | NC | | -4334.45 | -679.5 |
| 442 | NC | | -4159.45 | -679.5 |
| 443 | NC | | -3984.45 | -679.5 |
| 444 | V0IN | | -3795.58 | -671.0 |
| 445 | V0IN | | -3685.58 | -671.0 |
| 446 | V0IN | | -3575.58 | -671.0 |
| 447 | V0IN | | -3465.58 | -671.0 |
| 448 | V0OUT | | -3355.58 | -671.0 |
| 449 | V0OUT | | -3245.58 | -671.0 |
| 450 | V0OUT | | -3135.58 | -671.0 |
| 451 | V0OUT | | -3025.58 | -671.0 |
| 452 | V1 | | -2915.58 | -671.0 |
| 453 | V2 | | -2805.58 | -671.0 |

| PAD No. | PIN Name | | X | Y |
|---|---|---|---|---|
| | CSEL=0 | CSEL=1 | | |
| 454 | V3 | | -2695.58 | -671.0 |
| 455 | V4 | | -2585.58 | -671.0 |
| 456 | VR | | -2475.58 | -671.0 |
| 457 | VREF | | -2365.58 | -671.0 |
| 458 | VDD | | -2255.58 | -671.0 |
| 459 | CL | | -2145.58 | -671.0 |
| 460 | CLS | | -2035.58 | -671.0 |
| 461 | VSS | | -1925.58 | -671.0 |
| 462 | VDD | | -1815.58 | -671.0 |
| 463 | A0 | | -1705.58 | -671.0 |
| 464 | RW_WR | | -1595.58 | -671.0 |
| 465 | VSS | | -1485.58 | -671.0 |
| 466 | VDD | | -1375.58 | -671.0 |
| 467 | D0 | | -1265.58 | -671.0 |
| 468 | D1 | | -1155.58 | -671.0 |
| 469 | D2 | | -1045.58 | -671.0 |
| 470 | D3 | | -935.58 | -671.0 |
| 471 | D4 | | -825.58 | -671.0 |
| 472 | D5 | | -715.58 | -671.0 |
| 473 | D6 | | -605.58 | -671.0 |
| 474 | D7 | | -495.58 | -671.0 |
| 475 | VSS | | -385.58 | -671.0 |
| 476 | VDD | | -275.58 | -671.0 |
| 477 | D8 | | -165.58 | -671.0 |
| 478 | D9 | | -55.58 | -671.0 |
| 479 | D10 | | 54.42 | -671.0 |
| 480 | D11 | | 164.42 | -671.0 |
| 481 | D12 | | 274.42 | -671.0 |
| 482 | D13 | | 384.42 | -671.0 |
| 483 | D14 | | 494.42 | -671.0 |
| 484 | D15 | | 604.42 | -671.0 |
| 485 | VSS | | 714.42 | -671.0 |
| 486 | VDD | | 824.42 | -671.0 |
| 487 | E_RD | | 934.42 | -671.0 |
| 488 | RST | | 1044.42 | -671.0 |

| PAD No. | PIN Name | | X | Y |
|---|---|---|---|---|
| | CSEL=0 | CSEL=1 | | |
| 489 | VSS | | 1154.42 | -671.0 |
| 490 | VDD | | 1264.42 | -671.0 |
| 491 | CSEL | | 1374.42 | -671.0 |
| 492 | INTRS | | 1484.42 | -671.0 |
| 493 | IF1 | | 1594.42 | -671.0 |
| 494 | IF2 | | 1704.42 | -671.0 |
| 495 | IF3 | | 1814.42 | -671.0 |
| 496 | VSS | | 1924.42 | -671.0 |
| 497 | VDD | | 2034.42 | -671.0 |
| 498 | SI | | 2144.42 | -671.0 |
| 499 | SCL | | 2254.42 | -671.0 |
| 500 | /CS | | 2364.42 | -671.0 |
| 501 | VDD | | 2474.42 | -671.0 |
| 502 | VDD | | 2584.42 | -671.0 |
| 503 | VDD | | 2694.42 | -671.0 |
| 504 | VDD | | 2804.42 | -671.0 |
| 505 | VDD1 | | 2914.42 | -671.0 |
| 506 | VSS | | 3024.42 | -671.0 |
| 507 | VSS | | 3134.42 | -671.0 |
| 508 | VSS | | 3244.42 | -671.0 |
| 509 | VSS | | 3354.42 | -671.0 |
| 510 | VSS | | 3464.42 | -671.0 |
| 511 | VSS | | 3574.42 | -671.0 |
| 512 | VSS | | 3684.42 | -671.0 |
| 513 | VSS | | 3794.42 | -671.0 |
| 514 | VSS | | 3904.42 | -671.0 |
| 515 | VSS | | 4014.42 | -671.0 |
| 516 | VSS | | 4124.42 | -671.0 |
| 517 | VSS | | 4234.42 | -671.0 |
| 518 | VSS | | 4344.42 | -671.0 |
| 519 | VSS | | 4454.42 | -671.0 |
| 520 | VDD4 | | 4564.42 | -671.0 |
| 521 | VDD3 | | 4674.42 | -671.0 |
| 522 | VDD3 | | 4784.42 | -671.0 |

| PAD No. | PIN Name | | X | Y |
|---|---|---|---|---|
| | CSEL=0 | CSEL=1 | | |
| 523 | VDD2 | | 4894.42 | -671.0 |
| 524 | VDD2 | | 5004.42 | -671.0 |
| 525 | VDD2 | | 5114.42 | -671.0 |
| 526 | VDD2 | | 5224.42 | -671.0 |
| 527 | VDD2 | | 5334.42 | -671.0 |
| 528 | VDD2 | | 5444.42 | -671.0 |
| 529 | VDD5 | | 5554.42 | -671.0 |
| 530 | VDD5 | | 5664.42 | -671.0 |
| 531 | VDD5 | | 5774.42 | -671.0 |
| 532 | VDD5 | | 5884.42 | -671.0 |
| 533 | TCAP | | 5994.42 | -671.0 |
| 534 | CAP2P | | 6104.42 | -671.0 |
| 535 | CAP2N | | 6214.42 | -671.0 |
| 536 | CAP6P | | 6324.42 | -671.0 |
| 537 | CAP2N | | 6434.42 | -671.0 |
| 538 | CAP4P | | 6544.42 | -671.0 |
| 539 | CAP7P | | 6654.42 | -671.0 |
| 540 | CAP1N | | 6764.42 | -671.0 |
| 541 | CAP5P | | 6874.42 | -671.0 |
| 542 | CAP3P | | 6984.42 | -671.0 |
| 543 | CAP1N | | 7094.42 | -671.0 |
| 544 | CAP1P | | 7204.42 | -671.0 |
| 545 | $VOUT_{IN}$ | | 7314.42 | -671.0 |
| 546 | $VOUT_{IN}$ | | 7424.42 | -671.0 |
| 547 | $VOUT_{IN}$ | | 7534.42 | -671.0 |
| 548 | $VOUT_{IN}$ | | 7644.42 | -671.0 |
| 549 | $VOUT_{IN}$ | | 7754.42 | -671.0 |
| 550 | $VOUT_{IN}$ | | 7864.42 | -671.0 |
| 551 | $VOUT_{OUT}$ | | 7974.42 | -671.0 |
| 552 | $VOUT_{OUT}$ | | 8084.42 | -671.0 |
| 553 | $VOUT_{OUT}$ | | 8194.42 | -671.0 |
| 554 | $VOUT_{OUT}$ | | 8304.42 | -671.0 |
| 555 | $VOUT_{OUT}$ | | 8414.42 | -671.0 |
| 556 | $VOUT_{OUT}$ | | 8524.42 | -671.0 |

## 5. BLOCK DIAGRAM



# 6. PIN DESCRIPTION

## 6.1 POWER SUPPLY

<table>
<tr><th>Name</th><th>I/O</th><th>Description</th></tr>
<tr><td>VDD</td><td>Supply</td><td>Power supply for logic circuit</td></tr>
<tr><td>VDD1</td><td>Supply</td><td>Power supply for OSC circuit</td></tr>
<tr><td>VDD2</td><td>Supply</td><td>Power supply for Booster Circuit</td></tr>
<tr><td>VDD3</td><td>Supply</td><td>Power supply for LCD.</td></tr>
<tr><td>VDD4</td><td>Supply</td><td>Power supply for LCD.</td></tr>
<tr><td>VDD5</td><td>Supply</td><td>Power supply for LCD.</td></tr>
<tr><td>VSS</td><td>Supply</td><td>Ground. Ground system should be connected together.</td></tr>
<tr><td>$VOUT_{OUT}$</td><td>Supply</td><td>If the internal voltage generator is used, the $VOUT_{IN}$ & $VOUT_{OUT}$ must be connected together.<br>If an external supply is used, this pin must be left open.</td></tr>
<tr><td>$VOUT_{IN}$</td><td>Supply</td><td>An external LCD supply voltage can be supplied using the $VOUT_{IN}$ pad. In this case, $VOUT_{OUT}$ has to be left open, and the internal voltage generator has to be programmed to zero. (SET register VC=0)</td></tr>
<tr><td>V0In<br>V0out<br>V1<br>V2<br>V3<br>V4</td><td>I/O</td><td>LCD driver supply voltages<br>The voltage determined by LCD pixel is impedance-converted by an operational amplifier for application.<br>V0In & V0out should be connected together.<br>Voltages should have the following relationship;<br>$V0 \geqq V1 \geqq V2 \geqq V3 \geq V4 \geqq VSS$<br>When the internal power circuit is active, these voltages are generated as following table according to the state of LCD bias.
<table>
<tr><th>LCD bias</th><th>V1</th><th>V2</th><th>V3</th><th>V4</th></tr>
<tr><td>1/N bias</td><td>(N-1) / N x V0</td><td>(N-2) / N x V0</td><td>(2/N) x V0</td><td>(1/N) x V0</td></tr>
</table>
NOTE: N = 5 to 12</td></tr>
</table>

## 6.2 LCD Power Supply Pins

| Pin Name | I/O | Function |
|---|---|---|
| CAP1P | O | DC/DC voltage converter. Connect a capacitor between this terminal and the CAP1N terminal. |
| CAP1N | O | DC/DC voltage converter. Connect a capacitor between this terminal and the CAP1P terminal. |
| CAP2P | O | DC/DC voltage converter. Connect a capacitor between this terminal and the CAP2N terminal. |
| CAP2N | O | DC/DC voltage converter. Connect a capacitor between this terminal and the CAP2P terminal. |
| CAP3P | O | DC/DC voltage converter. Connect a capacitor between this terminal and the CAP1N terminal. |
| CAP4P | O | DC/DC voltage converter. Connect a capacitor between this terminal and the CAP2N terminal. |
| CAP5P | O | DC/DC voltage converter. Connect a capacitor between this terminal and the CAP1N terminal. |

| | | |
|---|---|---|
| CAP6P | O | DC/DC voltage converter. Connect a capacitor between this terminal and the CAP2N terminal. |
| CAP7P | O | DC/DC voltage converter. Connect a capacitor between this terminal and the CAP1N terminal. |
| VREF | O | Reference voltage output for monitor only. Left it open. |

## 6.3 SYSTEM CONTROL

| Name | I/O | Description |
|---|---|---|
| CLS | I | When using internal clock oscillator, connect CLS to VDD.<br>When using external clock oscillator, connect CLS to VSS. |
| CL | I/O | When using internal clock oscillator, it's oscillator output.<br>When using external clock oscillator, it's clock input. |
| INTRS | I | This terminal selects the resistors for the V0 voltage level adjustment.<br>INTRS = "H": Use the internal resistors |
| VR | I | No use. Left it open. |
| CSEL | I | Select Common output direction.<br>CSEL="L", COM0~COM51 is in one side, COM52~COM103 is in the opposite side.<br>CSEL="H", COM2n(even number) is in the one side, COM2n+1 (odd number) is in the opposite side.<br>Reference "Pad Center Coordinates" |
| TCAP | I/O | Test pin. Left it open. |

## 6.4 MICROPROCESSOR INTERFACE

| Name | I/O | Description |
|---|---|---|
| RST | I | Reset input pin<br>When RST is "L", initialization is executed. |
| IF[3:1] | I | Parallel / Serial data input select input |

| IF1 | IF2 | IF3 | MPU interface type |
|---|---|---|---|
| H | H | H | 80 series 16-bit parallel |
| H | H | L | 80 series 8-bit parallel |
| H | L | L | 68 series 16-bit parallel |
| L | H | H | 68 series 8-bit parallel |
| L | L | H | 9-bit serial (3 line) |
| L | L | L | 8-bit serial (4 line) |

| | | |
|---|---|---|
| /CS | I | Chip select input pins<br>Data/instruction I/O is enabled only when /CS is "L". When chip select is non-active, D0 to D15 become high impedance while parallel interface. |
| A0 | I | Register select input pin<br>– A0 = "H": D0 to D15 or SI are display data |

<table>
<tr><td></td><td></td><td>– A0 = "L": D0 to D15 or SI are control data<br>In 3-line interface contact A0 to VSS or VDD, do not let it floating.</td></tr>
<tr><td>RW_WR</td><td>I</td><td>Read / Write execution control pin
<table>
<tr><th>MPU type</th><th>RW_WR</th><th>Description</th></tr>
<tr><td>6800-series</td><td>RW</td><td>Read / Write control input pin<br>RW = “H” : read<br>RW = “L” : write</td></tr>
<tr><td>8080-series</td><td>/WR</td><td>Write enable clock input pin<br>The data on D0 to D15 are latched at the rising edge of the /WR signal.</td></tr>
</table>
When in serial interface, must contact it to VSS or VDD.</td></tr>
<tr><td>E_RD</td><td>I</td><td>Read / Write execution control pin
<table>
<tr><th>MPU Type</th><th>E_RD</th><th>Description</th></tr>
<tr><td>6800-series</td><td>E</td><td>Read / Write control input pin<br>˜ RW = “H”: When E is “H”, D0 to D15 are in an output status.<br>˜ RW = “L”: The data on D0 to D15 are latched at the falling edge of the E signal.</td></tr>
<tr><td>8080-series</td><td>/RD</td><td>Read enable clock input pin<br>When /RD is “L”, D0 to D15 are in an output status.</td></tr>
</table>
When in serial interface, must contact it to VSS or VDD.</td></tr>
</table>

| Name | I/O | Description |
|---|---|---|
| D15 to D0 | I/O | They connect to the standard 8-bit or 16 bit MPU bus via the 8/16 –bit bi-directional bus.<br>When the following interface is selected and the /CS pin is high, the following pins become high impedance.<br>1. 8-bit parallel: D15-D8 are in the state of high impedance, should contact to “H” or “L”level.<br>2. Serial interface: D15-D0 are in the state of high impedance, should contact to “H” or “L”level. |
| SI | I | This pin is used to input serial data when the serial interface is selected.(3 line and 4 line)<br>When not use contact it to VSS or VDD. |
| SCL | I | This pin is used to input serial clock when the serial interface is selected.<br>The data is converted in the rising edge. (3 line and 4 line)<br>When not use contact it to VSS or VDD. |

**NOTE: Microprocessor interface pins should not be floating in any operation mode.**

## 6.6 LCD DRIVER OUTPUTS

<table>
<tr><th>Name</th><th>I/O</th><th>Description</th></tr>
<tr><td>SEG0<br>to<br>SEG311</td><td>O</td><td>LCD segment driver outputs<br>The display data and the M signal control the output voltage of segment driver.
<table>
<tr><th rowspan="2">Display data</th><th rowspan="2">M (Internal)</th><th colspan="2">Segment driver output voltage</th></tr>
<tr><th>Normal display</th><th>Reverse display</th></tr>
<tr><td>H</td><td>H</td><td>V0</td><td>V2</td></tr>
<tr><td>H</td><td>L</td><td>VSS</td><td>V3</td></tr>
<tr><td>L</td><td>H</td><td>V2</td><td>V0</td></tr>
<tr><td>L</td><td>L</td><td>V3</td><td>VSS</td></tr>
<tr><td colspan="2">Power save mode</td><td>VSS</td><td>VSS</td></tr>
</table></td></tr>
<tr><td>COM0<br>to<br>COM103</td><td>O</td><td>LCD common driver outputs<br>The internal scanning data and M signal control the output voltage of common driver.
<table>
<tr><th>Scan data</th><th>M (Internal)</th><th>Common driver output voltage</th></tr>
<tr><td>H</td><td>H</td><td>VSS</td></tr>
<tr><td>H</td><td>L</td><td>V0</td></tr>
<tr><td>L</td><td>H</td><td>V1</td></tr>
<tr><td>L</td><td>L</td><td>V4</td></tr>
<tr><td colspan="2">Power save mode</td><td>VSS</td></tr>
</table></td></tr>
</table>

**ST7624 I/O PIN ITO Resister Limitation**

| PIN Name | ITO Resister |
|---|---|
| **INTRS,IF[3:1],CLS,CSEL** | **No Limitation** |
| **VREF, TCAP** | **Floating** |
| **Vdd, Vdd1~Vdd5, Vss, $VOUT_{IN}$, $VOUT_{OUT}$,V0in,V0out,CL,VR** | **<100Ω** |
| **V0in,V0out,V1,V2, V3, V4**<br>**CAP1P,CAP1N,CAP2P,CAP2N,CAP3P,CAP4P,CAP5P,CAP6P,CAP7P** | **<100Ω** |
| **A0, RW_WR, E_RD, /CS, D0 …D15, SCL, SI** | **<1KΩ** |
| **RST** | **<10KΩ** |

# 7. FUNCTIONAL DESCRIPTION

## 7.1 MICROPROCESSOR INTERFACE

### Chip Select Input

There is /CS pin for chip selection. The ST7624 can interface with an MPU when /CS is "L".In case of serial interface, the internal shift register and the counter are reset.

### 7.1.1 Selecting Parallel / Serial Interface

ST7624 has seven types of interface with an MPU, which are three serial and four parallel interfaces. This parallel or serial interface is determined by IF pin as shown in table 7.1.1**.**

**Table 7.1.1 Parallel / Serial Interface Mode**

| IF1 | IF2 | IF3 | Interface type | /CS | A0 | /RD(E) | /WR(R/W) | D15 to D8 | D7 to D0 | SI | SCL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| H | H | H | 80 serial 16-bit parallel | /CS | A0 | /RD | /WR | D15 to D8 | D7 to D0 | -- | -- |
| H | H | L | 80 serial 8-bit parallel | /CS | A0 | /RD | /WR | -- | D7 to D0 | -- | -- |
| H | L | L | 68 serial 16-bit parallel | /CS | A0 | E | R/W | D15 to D8 | D7 to D0 | -- | -- |
| L | H | H | 68 serial 8-bit parallel | /CS | A0 | E | R/W | -- | D7 to D0 | -- | -- |
| L | L | H | 9-bit SPI mode (3 line) | /CS | -- | -- | -- | -- | | SI | SCL |
| L | L | L | 8-bit SPI mode (4 line) | /CS | A0 | -- | -- | -- | | SI | SCL |

**--:Must be fixed to either H or L.**

NOTE: When these pins are set to any other combination, A0, E_RD, and RW_WR inputs are disabled and D0 to D15 are to be high impedance.

### 7.1.2 8- or 16-bit Parallel Interface

The ST7624 identifies type of the data bus signals according to combinations of A0, /RD (E) and /WR (W/R) signals, as shown in table 7.1.2.

**Table 7.1.2 Parallel Data Transfer**

| Common | 6800-series | | 8080-series | | Description |
|---|---|---|---|---|---|
| A0 | R/W | E | /RD | /WR | |
| H | H | H | L | H | Display data read out |
| H | L | H | H | L | Display data write |
| L | H | H | L | H | Register status read |
| L | L | H | H | L | Writes to internal register (instruction) |

**Relation between Data Bus and Gradation Data**

ST7624 offers the 65K color display, dithered 262K color display, and dithered 16M color display.

When using 65K, 262K, and 16M color, you can specify color for each of R, G, B using the palette function.

Use the command for switching between these modes.

**(1) 65K color display**

*1. 8-bit mode*

D7, D6, D5, D4, D3, D2, D1, D0: RRRRRGGG 1st write

D7, D6, D5, D4, D3, D2, D1, D0: GGGBBBBB 2nd write

A single pixel of data is read after the second write operation as shown, and it is written in the display RAM.

*2. 16-bit mode*

D15, D14, D13, D12, D11, D10, D9, D8, D7, D6, D5, D4, D3, D2, D1, D0: RRRRRGGGGGGBBBBB (16 bits)

Data is acquired through signal write operation and then written to the display RAM.

**(2) 262K color display**

*1. 8-bit mode*

D7, D6, D5, D4, D3, D2, D1, D0: RRRRRRXX 1st write

D7, D6, D5, D4, D3, D2, D1, D0: GGGGGGXX 2nd write

D7, D6, D5, D4, D3, D2, D1, D0: BBBBBBXX 3rd write

A single pixel of data is read after the third write operation as shown, and it is written in the display RAM.

*2. 16 bit mode*

D15, D14, D13, D12, D11, D10, D9, D8, D7, D6, D5, D4, D3, D2, D1, D0: RRRRRRXXGGGGGGXX

D15, D14, D13, D12, D11, D10, D9, D8, D7, D6, D5, D4, D3, D2, D1, D0: BBBBBBXXXXXXXXXXXX

A single pixel of data is read after the second write operation as shown, and it is written in the display RAM.

“XXXX” are dummy bits, and they are ignored for display.

**(3) 16M color display**

*1. 8-bit mode*

D7, D6, D5, D4, D3, D2, D1, D0: RRRRRRRR 1st write

D7, D6, D5, D4, D3, D2, D1, D0: GGGGGGGG 2nd write

D7, D6, D5, D4, D3, D2, D1, D0: BBBBBBBB 3rd write

A single pixel of data is read after the third write operation as shown, and it is written in the display RAM.

*2. 16 bit mode*

D15, D14, D13, D12, D11, D10, D9, D8, D7, D6, D5, D4, D3, D2, D1, D0: RRRRRRRRGGGGGGGG

D15, D14, D13, D12, D11, D10, D9, D8, D7, D6, D5, D4, D3, D2, D1, D0: BBBBBBBBXXXXXXXX

A single pixel of data is read after the second write operation as shown, and it is written in the display RAM.

### 7.1.3 8- and 9-bit Serial Interface

The 8-bit serial interface uses four pins /CS, SI, SCL, and A0 to enter commands and data. Meanwhile, the 9-bit serial interface uses three pins /CS, SI and SCL for the same purpose.

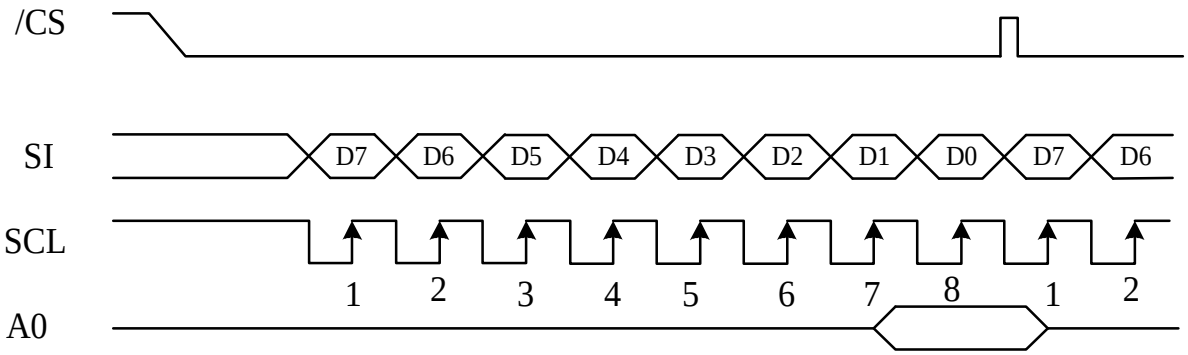
Data read is not available with the serial interface. Data entered must be 8 bits. Refer to the following chart for entering commands, parameters or gray-scale data.

The relation between gray-scale data and data bus in the serial input is the same as that in the 8-bit parallel interface mode at every gradation.

(1) 8-bit serial interface (4 line )

When entering data (parameters): A0= HIGH at the rising edge of the 8th SCL.

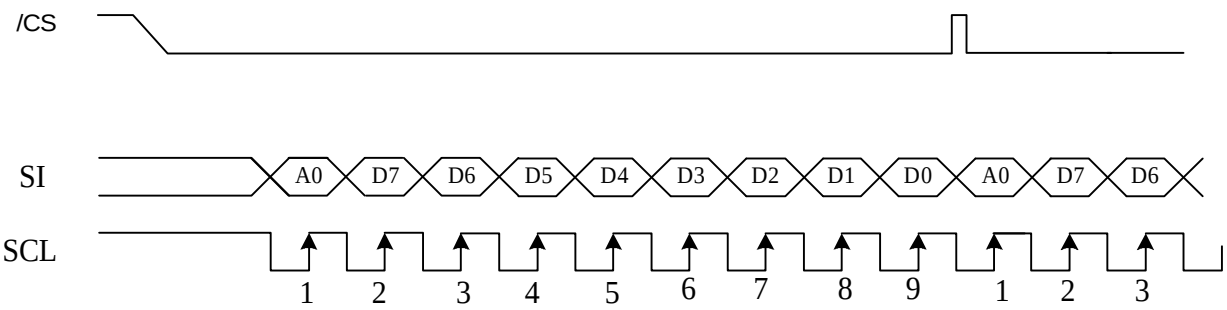
When entering command: A0= LOW at the rising edge of the 8th SCL




(2) 9-bit serial interface (3 line )

When entering data (parameters): SI= HIGH at the rising edge of the 1st SCL.

When entering command: SI= LOW at the rising edge of the 1st SCL.




- If /CS is caused to HIGH before 8 bits from D7 to D0 are entered, the data concerned is invalidated. Before entering succeeding sets of data, you must correctly input the data concerned again.
- In order to avoid data transfer error due to incoming noise, it is recommended to set /CS at HIGH on byte basis to initialize the serial-to-parallel conversion counter and the register.
- When executing the command RAMWR, set /CS to HIGH after writing the last address (after starting the 9th pulse in case of 9-bit serial input or after starting the 8th pulse in case of 8-bit serial input).

## 7-2 ACCESS TO DDRAM AND INTERNAL REGISTERS

ST7624 realizes high-speed data transfer because the access from MPU is a sort of pipeline processing done via the bus holder attached to the internal, requiring the cycle time alone without needing the wait time.

For example, when MPU writes data to the DDRAM, the data is once held by the bus holder and then written to the DDRAM before the succeeding write cycle is started. When MPU reads data from the DDRAM, the first read cycle is dummy and the bus holder holds the data read in the dummy cycle, and then it read from the bus holder to the system bus in the succeeding read cycle. Fig. 7.2.1 illustrates these relations.

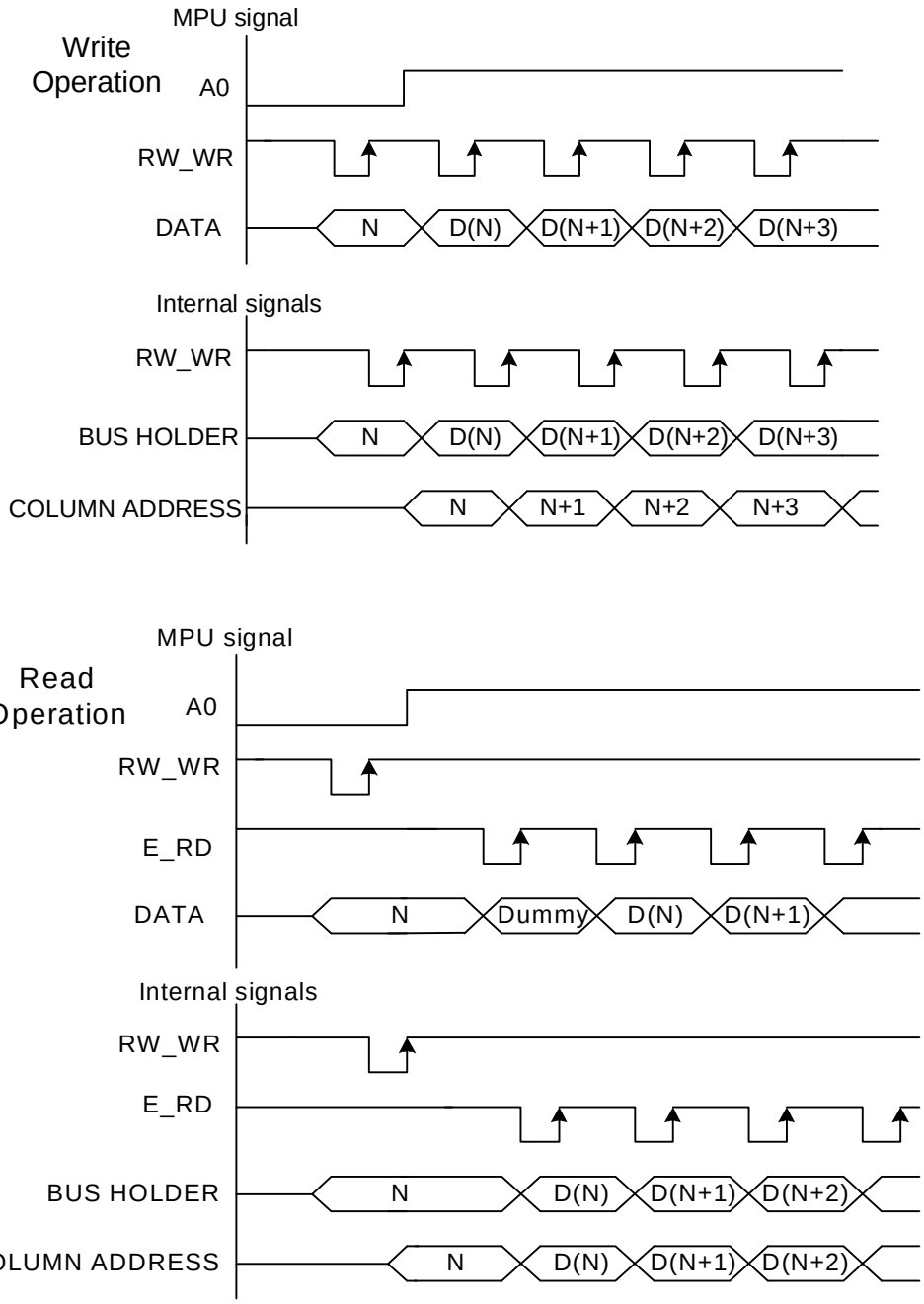



Fig 7.2.1

## 7-3 DISPLAY DATA RAM (DDRAM)

### 7.3.1 DDRAM

It is 104 X 104 X 16 bits capacity RAM prepared for storing dot data. You can access a desired bit by specifying the page address and column address. Since display data from MCU D7 to D0 and D15 to D8 correspond to one or two pixels of RGB, data transfer related restrictions are reduced, realizing the display flexing.

The RAM on ST7624 is separated to a block per 4 lines to allow the display system to process data on the block basis.

MPU's read and write operations to and from the RAM are performed via the I/O buffer circuit; Reading of the RAM for the liquid crystal drive is controlled from another separate circuit. Refer to the following memory map for the RAM configuration.

**Memory Map (When using the 65Kcolor. 8-bit mode,)**

| RGB alignment (Command of data control parameter2=000) | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Data control command (BCH) | | | | Column | | | | | | | | | | | | | | | | | | | |
| LCD read direction | P11:0(DATCTL) | | | 0 | | | 1 | | | | | | | | | | | | | 103 | | | |
| | P11:1(DATCTL) | | | 103 | | | 102 | | | | | | | | | | | | | 0 | | | |
| | Color | | | R | G | B | R | G | B | | | | | | | | | | | R | G | B | |
| | Data / Page | | | D7 | D2 | D4 | D7 | D2 | D4 | | | | | | | | | | | D7 | D2 | D4 | |
| | | | | D6 | D1 | D3 | D6 | D1 | D3 | | | | | | | | | | | D6 | D1 | D3 | |
| Block | P10:0 (DATCTL) | | P10:1 (DATCTL) | D5 | D0 | D2 | D5 | D0 | D2 | | | | | | | | | | | D5 | D0 | D2 | |
| | | | | D4 | D7 | D1 | D4 | D7 | D1 | | | | | | | | | | | D4 | D7 | D1 | |
| | | | | D3 | D6 | D0 | D3 | D6 | D0 | | | | | | | | | | | D3 | D6 | D0 | |
| | | | | | D5 | | | D5 | | | | | | | | | | | | D5 | | |
| 0 | 0 | | 103 | | | | | | | | | | | | | | | | | | | | |
| | 1 | | 102 | | | | | | | | | | | | | | | | | | | | |
| | 2 | | 101 | | | | | | | | | | | | | | | | | | | | |
| | 3 | | 100 | | | | | | | | | | | | | | | | | | | | |
| 1 | 4 | | 99 | | | | | | | | | | | | | | | | | | | | |
| | 5 | | 98 | | | | | | | | | | | | | | | | | | | | |
| | 6 | | 97 | | | | | | | | | | | | | | | | | | | | |
| | 7 | | 96 | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 24 | 96 | | 7 | | | | | | | | | | | | | | | | | | | | |
| | 97 | | 6 | | | | | | | | | | | | | | | | | | | | |
| | 98 | | 5 | | | | | | | | | | | | | | | | | | | | |
| | 99 | | 4 | | | | | | | | | | | | | | | | | | | | |
| 25 | 100 | | 3 | | | | | | | | | | | | | | | | | | | | |
| | 101 | | 2 | | | | | | | | | | | | | | | | | | | | |
| | 102 | | 1 | | | | | | | | | | | | | | | | | | | | |
| | 103 | | 0 | | | | | | | | | | | | | | | | | | | | |
| SEGout | | | | 0 | 1 | 2 | 3 | 4 | 5 | | | | | | | | | | | 309 | 310 | 311 | |

You can change position of R and B with DATCTL command.

**Memory Map (When using the 65K color. 16-bit mode)**

| RGB alignment (Command of data control parameter2=000) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Data control command (BCH) | | | Column | | | | | | | | | | | |
| LCD read direction | P11:0(DATCTL) | | 0 → | | | 1 → | | | | | | 103 → | | |
| | P11:1(DATCTL) | | 103 ← | | | 102 ← | | | | | | 0 ← | | |
| | Color | | R | G | B | R | G | B | | | | R | G | B |
| | Data / Page | | D15 | D10 | D4 | D15 | D10 | D4 | | | | D15 | D10 | D4 |
| | | | D14 | D9 | D3 | D14 | D9 | D3 | | | | D14 | D9 | D3 |
| Block | P10:0 (DATCTL) | P10:1 (DATCTL) | D13 | D8 | D2 | D13 | D8 | D2 | | | | D13 | D8 | D2 |
| | | | D12 | D7 | D1 | D12 | D7 | D1 | | | | D12 | D7 | D1 |
| | | | D11 | D6 | D0 | D11 | D6 | D0 | | | | D11 | D6 | D0 |
| | | | | D5 | | | D5 | | | | | | D5 | |
| 0 | 0 | 103 | | | | | | | | | | | | |
| | 1 | 102 | | | | | | | | | | | | |
| | 2 | 101 | | | | | | | | | | | | |
| | 3 | 100 | | | | | | | | | | | | |
| 1 | 4 | 99 | | | | | | | | | | | | |
| | 5 | 98 | | | | | | | | | | | | |
| | 6 | 97 | | | | | | | | | | | | |
| | 7 | 96 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 24 | 96 | 7 | | | | | | | | | | | | |
| | 97 | 6 | | | | | | | | | | | | |
| | 98 | 5 | | | | | | | | | | | | |
| | 99 | 4 | | | | | | | | | | | | |
| 25 | 100 | 3 | | | | | | | | | | | | |
| | 101 | 2 | | | | | | | | | | | | |
| | 102 | 1 | | | | | | | | | | | | |
| | 103 | 0 | | | | | | | | | | | | |
| SEGout | | | 0 | 1 | 2 | 3 | 4 | 5 | | | | 309 | 310 | 311 |

You can change position of R and B with DATCTL command.

**Memory Map (When using the 262K color. 8-bit mode,)**

| RGB alignment (Command of data control parameter2=000) | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Data control command (BCH) | | | | Column | | | | | | | | | | | | | | | | | | | |
| LCD read direction | P11:0(DATCTL) | | | 0 | | | 1 | | | | | | | | | | | | | 103 | | | |
| | P11:1(DATCTL) | | | 103 | | | 102 | | | | | | | | | | | | | 0 | | | |
| | Color | | | R | G | B | R | G | B | | | | | | | | | | | R | G | B | |
| | Data / Page | | | D7 | D7 | D7 | D7 | D7 | D7 | | | | | | | | | | | D7 | D7 | D7 | |
| | | | | D6 | D6 | D6 | D6 | D6 | D6 | | | | | | | | | | | D6 | D6 | D6 | |
| Block | P10:0 (DATCTL) | | P10:1 (DATCTL) | D5 | D5 | D5 | D5 | D5 | D5 | | | | | | | | | | | D5 | D5 | D5 | |
| | | | | D4 | D4 | D4 | D4 | D4 | D4 | | | | | | | | | | | D4 | D4 | D4 | |
| | | | | D3 | D3 | D3 | D3 | D3 | D3 | | | | | | | | | | | D3 | D3 | D3 | |
| | | | | D2 | D2 | D2 | D2 | D2 | D2 | | | | | | | | | | | D2 | D2 | D2 | |
| 0 | 0 | | 103 | | | | | | | | | | | | | | | | | | | | |
| | 1 | | 102 | | | | | | | | | | | | | | | | | | | | |
| | 2 | | 101 | | | | | | | | | | | | | | | | | | | | |
| | 3 | | 100 | | | | | | | | | | | | | | | | | | | | |
| 1 | 4 | | 99 | | | | | | | | | | | | | | | | | | | | |
| | 5 | | 98 | | | | | | | | | | | | | | | | | | | | |
| | 6 | | 97 | | | | | | | | | | | | | | | | | | | | |
| | 7 | | 96 | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 24 | 96 | | 7 | | | | | | | | | | | | | | | | | | | | |
| | 97 | | 6 | | | | | | | | | | | | | | | | | | | | |
| | 98 | | 5 | | | | | | | | | | | | | | | | | | | | |
| | 99 | | 4 | | | | | | | | | | | | | | | | | | | | |
| 25 | 100 | | 3 | | | | | | | | | | | | | | | | | | | | |
| | 101 | | 2 | | | | | | | | | | | | | | | | | | | | |
| | 102 | | 1 | | | | | | | | | | | | | | | | | | | | |
| | 103 | | 0 | | | | | | | | | | | | | | | | | | | | |
| SEGout | | | | 0 | 1 | 2 | 3 | 4 | 5 | | | | | | | | | | | 309 | 310 | 311 | |

You can change position of R and B with DATCTL command.

**Memory Map (When using the 262K color. 16-bit mode)**

| RGB alignment (Command of data control parameter2=000) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Data control command (BCH) | | | | | Column | | | | | | | | | | | | |
| LCD read direction | P11:0(DATCTL) | | | | 0 → | | | 1 → | | | | | | 103 → | | | |
| | P11:1(DATCTL) | | | | 103 ← | | | 102 ← | | | | | | 0 ← | | | |
| | Color | | | | R | G | B | R | G | B | | | | R | G | B | |
| | Data / Page | | | | D15 | D7 | D15 | D15 | D7 | D15 | | | | D15 | D7 | D15 | |
| | | | | | D14 | D6 | D14 | D14 | D6 | D14 | | | | D14 | D6 | D14 | |
| Block | P10:0 (DATCTL) | | P10:1 (DATCTL) | | D13 | D5 | D13 | D13 | D5 | D13 | | | | D13 | D5 | D13 | |
| | | | | | D12 | D4 | D12 | D12 | D4 | D12 | | | | D12 | D4 | D12 | |
| | | | | | D11 | D3 | D11 | D11 | D3 | D11 | | | | D11 | D3 | D11 | |
| | | | | | D10 | D2 | D10 | D10 | D2 | D10 | | | | D10 | D2 | D10 | |
| 0 | 0 | ↓ | 103 | ↑ | | | | | | | | | | | | | |
| | 1 | | 102 | | | | | | | | | | | | | | |
| | 2 | | 101 | | | | | | | | | | | | | | |
| | 3 | | 100 | | | | | | | | | | | | | | |
| 1 | 4 | | 99 | | | | | | | | | | | | | | |
| | 5 | | 98 | | | | | | | | | | | | | | |
| | 6 | | 97 | | | | | | | | | | | | | | |
| | 7 | | 96 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 24 | 96 | | 7 | | | | | | | | | | | | | | |
| | 97 | | 6 | | | | | | | | | | | | | | |
| | 98 | | 5 | | | | | | | | | | | | | | |
| | 99 | | 4 | | | | | | | | | | | | | | |
| 25 | 100 | | 3 | | | | | | | | | | | | | | |
| | 101 | | 2 | | | | | | | | | | | | | | |
| | 102 | | 1 | | | | | | | | | | | | | | |
| | 103 | | 0 | | | | | | | | | | | | | | |
| SEGout | | | | | 0 | 1 | 2 | 3 | 4 | 5 | | | | 309 | 310 | 311 | |

You can change position of R and B with DATCTL command.

**Memory Map (When using the 16M color. 8-bit mode,)**

| RGB alignment (Command of data control parameter2=000) | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Data control command (BCH) | | | | Column | | | | | | | | | | | | | | | | | | | |
| LCD read direction | P11:0(DATCTL) | | | 0 | | | 1 | | | | | | | | | | | 103 | | | | | |
| | P11:1(DATCTL) | | | 103 | | | 102 | | | | | | | | | | | 0 | | | | | |
| | Color | | | R | G | B | R | G | B | | | | | | | | | R | G | B | | | |
| | Data / Page | | | D7 | D7 | D7 | D7 | D7 | D7 | | | | | | | | | D7 | D7 | D7 | | | |
| | | | | D6 | D6 | D6 | D6 | D6 | D6 | | | | | | | | | D6 | D6 | D6 | | | |
| Block | P10:0 (DATCTL) | | P10:1 (DATCTL) | D5 | D5 | D5 | D5 | D5 | D5 | | | | | | | | | D5 | D5 | D5 | | | |
| | | | | D4 | D4 | D4 | D4 | D4 | D4 | | | | | | | | | D4 | D4 | D4 | | | |
| | | | | D3 | D3 | D3 | D3 | D3 | D3 | | | | | | | | | D3 | D3 | D3 | | | |
| | | | | D2 | D2 | D2 | D2 | D2 | D2 | | | | | | | | | D2 | D2 | D2 | | | |
| | | | | D1 | D1 | D1 | D1 | D1 | D1 | | | | | | | | | D1 | D1 | D1 | | | |
| | | | | D0 | D0 | D0 | D0 | D0 | D0 | | | | | | | | | D0 | D0 | D0 | | | |
| 0 | 0 | | 103 | | | | | | | | | | | | | | | | | | | | |
| | 1 | | 102 | | | | | | | | | | | | | | | | | | | | |
| | 2 | | 101 | | | | | | | | | | | | | | | | | | | | |
| | 3 | | 100 | | | | | | | | | | | | | | | | | | | | |
| 1 | 4 | | 99 | | | | | | | | | | | | | | | | | | | | |
| | 5 | | 98 | | | | | | | | | | | | | | | | | | | | |
| | 6 | | 97 | | | | | | | | | | | | | | | | | | | | |
| | 7 | | 96 | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 24 | 96 | | 7 | | | | | | | | | | | | | | | | | | | | |
| | 97 | | 6 | | | | | | | | | | | | | | | | | | | | |
| | 98 | | 5 | | | | | | | | | | | | | | | | | | | | |
| | 99 | | 4 | | | | | | | | | | | | | | | | | | | | |
| 25 | 100 | | 3 | | | | | | | | | | | | | | | | | | | | |
| | 101 | | 2 | | | | | | | | | | | | | | | | | | | | |
| | 102 | | 1 | | | | | | | | | | | | | | | | | | | | |
| | 103 | | 0 | | | | | | | | | | | | | | | | | | | | |
| SEGout | | | | 0 | 1 | 2 | 3 | 4 | 5 | | | | | | | | | 309 | 310 | 311 | | | |

You can change position of R and B with DATCTL command.

**Memory Map (When using the 16M color. 16-bit mode)**

| RGB alignment (Command of data control parameter2=000) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Data control command (BCH) | | | | Column | | | | | | | | | | |
| LCD read direction | P11:0(DATCTL) | | | 0 | | | 1 | | | | | 103 | | |
| | | | | → | | | | | | | | | | |
| | P11:1(DATCTL) | | | 103 | | | 102 | | | | | 0 | | |
| | | | | ← | | | | | | | | | | |
| | Color | | | R | G | B | R | G | B | | | R | G | B |
| | Data / Page | | | D15 | D7 | D15 | D15 | D7 | D15 | | | D15 | D7 | D15 |
| | | | | D14 | D6 | D14 | D14 | D6 | D14 | | | D14 | D6 | D14 |
| Block | P10:0 (DATCTL) | | P10:1 (DATCTL) | D13 | D5 | D13 | D13 | D5 | D13 | | | D13 | D5 | D13 |
| | | | | D12 | D4 | D12 | D12 | D4 | D12 | | | D12 | D4 | D12 |
| | | | | D11 | D3 | D11 | D11 | D3 | D11 | | | D11 | D3 | D11 |
| | | | | D10 | D2 | D10 | D10 | D2 | D10 | | | D10 | D2 | D10 |
| | | | | D9 | D1 | D9 | D9 | D1 | D9 | | | D9 | D1 | D9 |
| | | | | D8 | D0 | D8 | D8 | D0 | D8 | | | D8 | D0 | D8 |
| 0 | 0 | ↓ | 103 | ↑ | | | | | | | | | | |
| | 1 | | 102 | | | | | | | | | | | |
| | 2 | | 101 | | | | | | | | | | | |
| | 3 | | 100 | | | | | | | | | | | |
| 1 | 4 | | 99 | | | | | | | | | | | |
| | 5 | | 98 | | | | | | | | | | | |
| | 6 | | 97 | | | | | | | | | | | |
| | 7 | | 96 | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 24 | 96 | | 7 | | | | | | | | | | | |
| | 97 | | 6 | | | | | | | | | | | |
| | 98 | | 5 | | | | | | | | | | | |
| | 99 | | 4 | | | | | | | | | | | |
| 25 | 100 | | 3 | | | | | | | | | | | |
| | 101 | | 2 | | | | | | | | | | | |
| | 102 | | 1 | | | | | | | | | | | |
| | 103 | | 0 | | | | | | | | | | | |
| SEGout | | | | 0 | 1 | 2 | 3 | 4 | 5 | | | 309 | 310 | 311 |

You can change position of R and B with DATCTL command.

### 7.3.2 Page Address Control Circuit

This circuit is used to control the address in the page direction when MPU accesses the DDRAM or when reading the DDRAM to display image on the LCD.

You can specify a scope of the page address with page address set command. When the page-direction scan is specified with DATCTL command and the address are incremented from the start up to the end page, the column address is incremented by 1 and the page address returns to start page.

The DDRAM supports up to 104 lines, and thus the total page becomes 104.

In the read operation, as the end page is reached, the column address is automatically incremented by 1 and the page address is returned to start page.

Using the address normal/reverse parameter of DATCTL command allows you to reverse the correspondence between the DDRAM address and command output.

### 7.3.3 Column Address Control Circuit

This circuit is used to control the address in the column direction when MPU accesses the DDRAM. You can specify a scope of the column address using column address set command. When the column-direction scan is specified with DATCTL command and the address are incremented from the start up to the end page, the page address is incremented by 1 and the column address returns to start column.

In the read operation, too, the column address is automatically incremented by 1 and returned to start page as the end column is reached.

Just like the page address control circuit, using the column address normal/reverse parameter of DATCTL command enables to reverse the correspondence between the DDRAM column address and segment output. This arrangement relaxes restrictions in the chip layout on the LCD module.

### 7.3.4 I/O Buffer Circuit

It is the bi-directional buffer used when MPU reads or writes the DDRAM. Since MPU's read or write of DDRAM is performed independently from data output to the display data latch circuit, asynchronous access to the DDRAM while the LCD is turned on does not cause troubles such as flicking of the display images.

### 7.3.5 Block Address Circuit

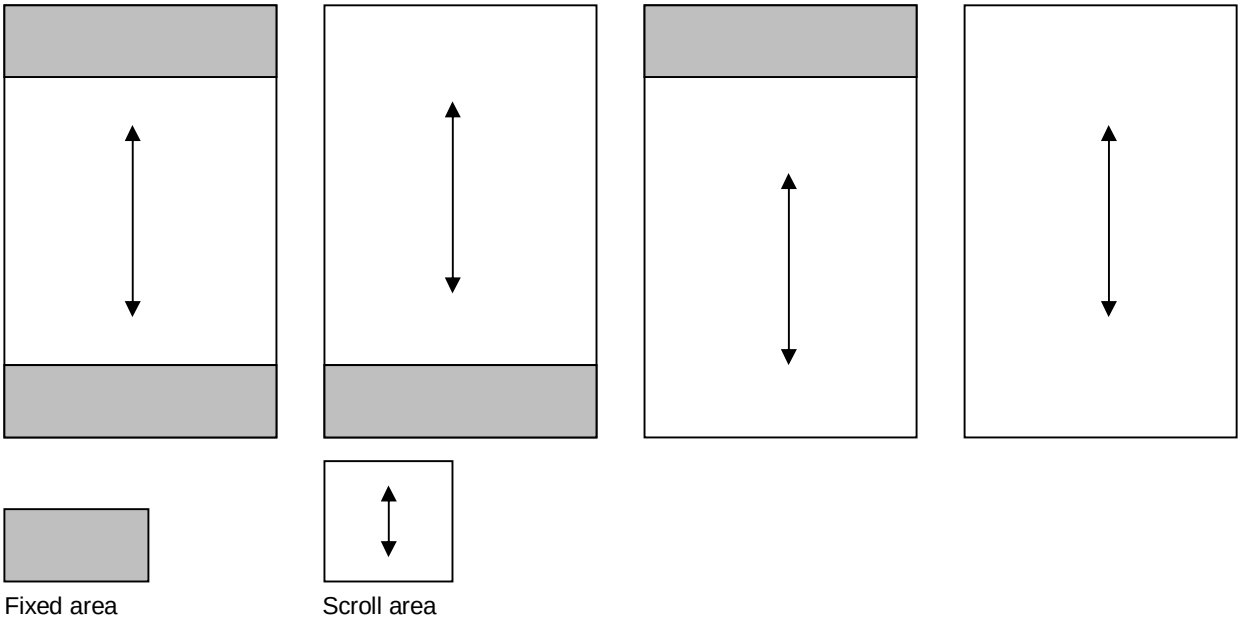
The circuit associates pages on DDRAM with COM output. ST7624 processes signals for the liquid crystal display on 4-page basis. Thus, when specifying a specific area in the area scroll display or partial display, you must designate it in block.

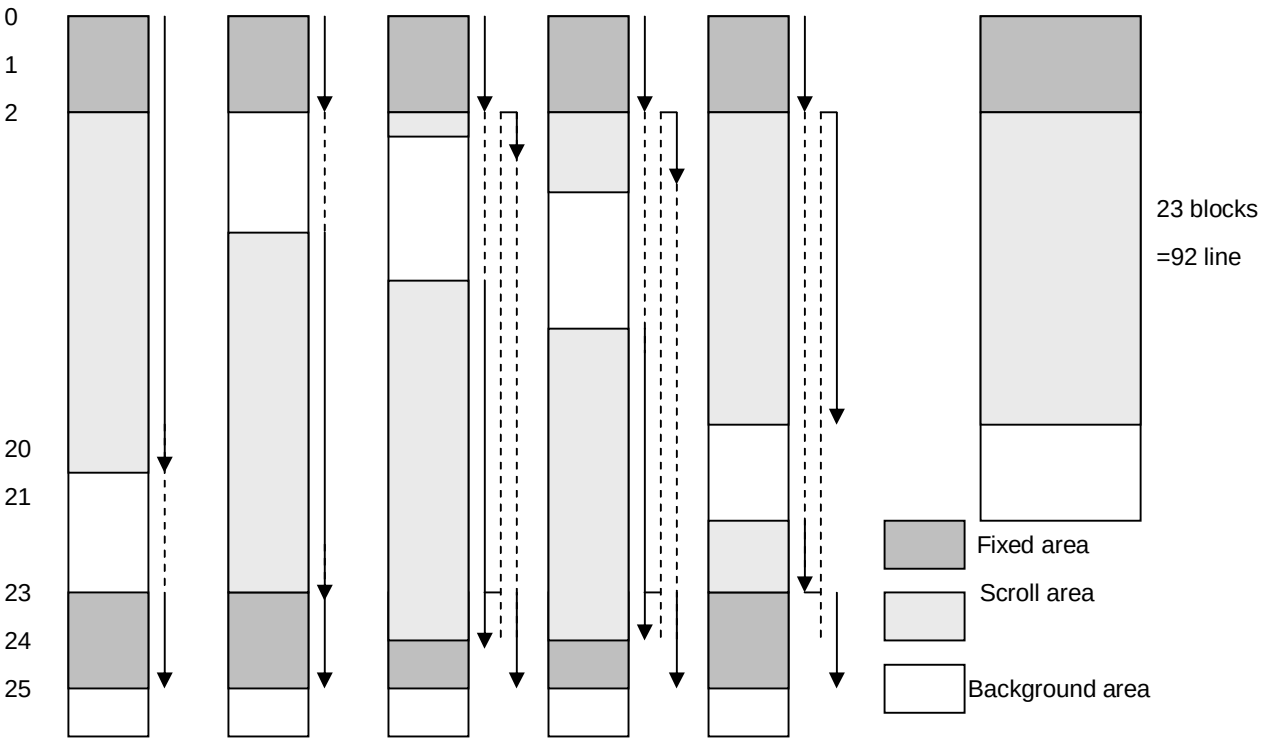
### 7.3.6 Display data Latch Circuit

This circuit is used to temporarily hold display data to be output from the DDRAM to the SEG decoder circuit. Since display normal/inverse and display on/off commands are used to control data in the latch circuit alone, they do not modify data in the DDRAM.

### 7.4 Area Scroll Display

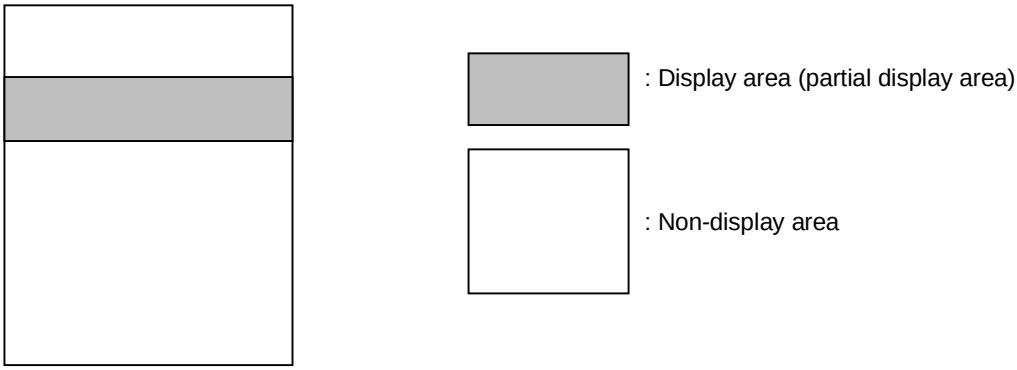
Using area scroll set and scroll start set commands allows you to scroll the display screen partially. You can select any one of the following four scroll patterns.



### 7.5 Partial Display

Using partial in command allows you turn on the partial display (division by line) of the screen. This mode requires less current consumption than the whole screen display, making it suitable for the equipment in the standby state.




If the partial display region is out of the Max. Display range, it would be no operation

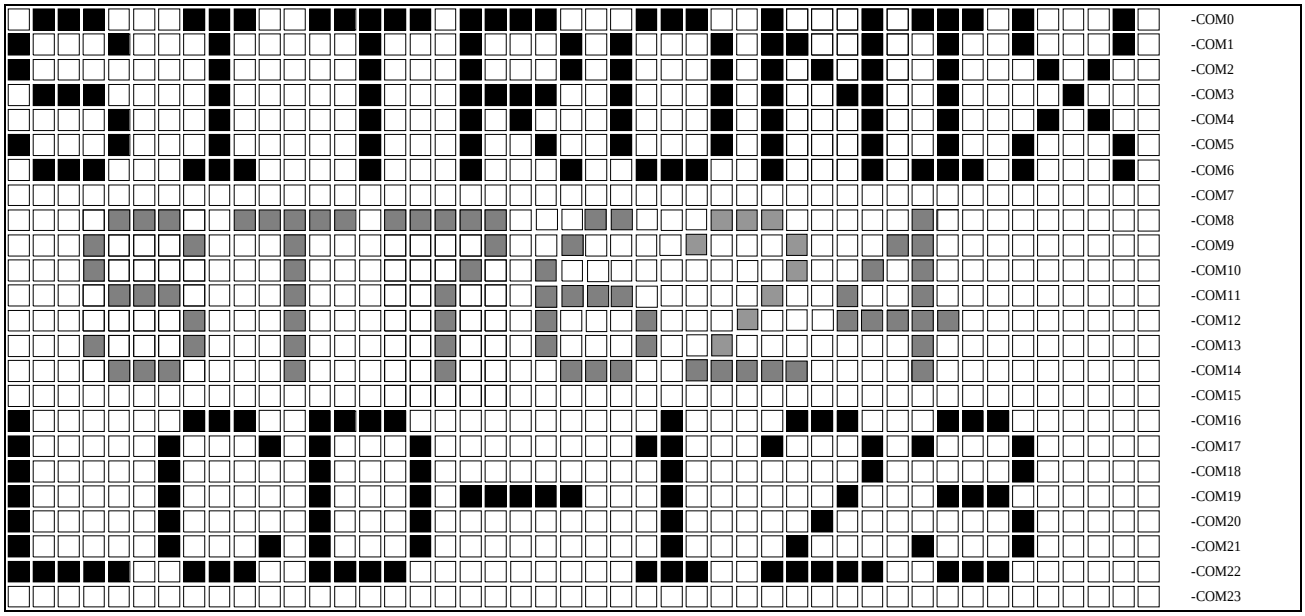



**Figure 7.5.1.Reference Example for Partial Display**

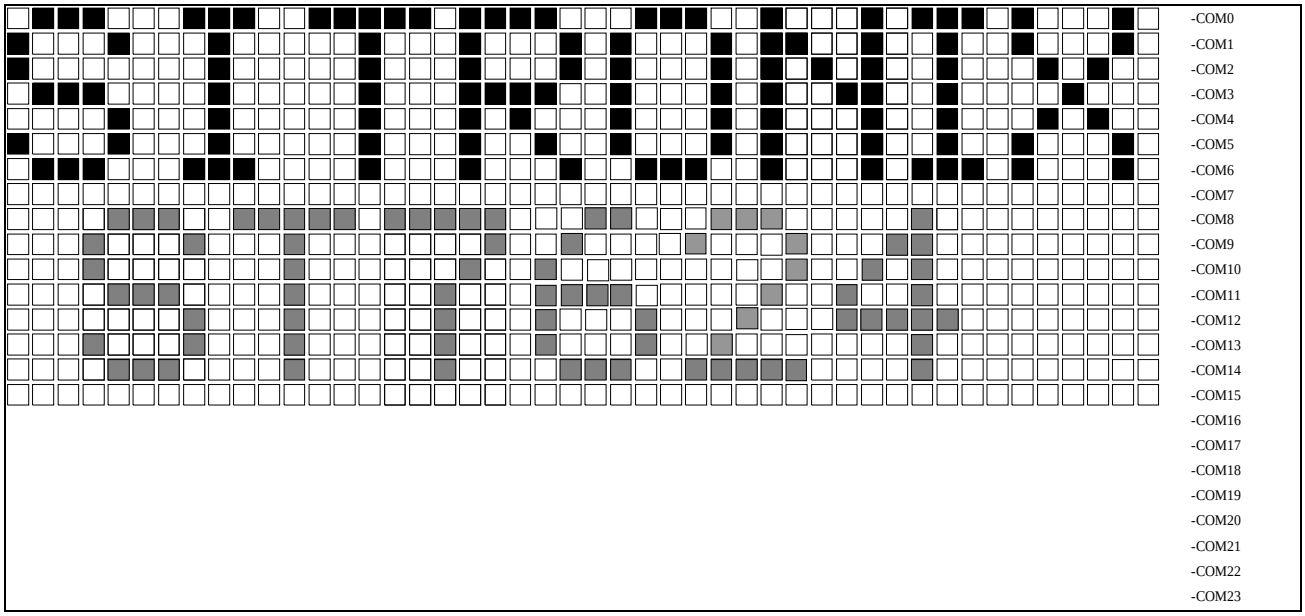



**Figure 7.5.2.Partial Display (Partial Display Duty=16,initial COM0=0)**

### 7.6 Gray-Scale Display

ST7624 incorporates a 4FRC & 31 PWM function circuit to display a 64 gray-scale display.

### 7.7 Oscillation circuit

This is on-chip Oscillator without external resistor. When the internal oscillator is used, CLS must connect to VDD; when the external oscillator is used, CL could be input pin. This oscillator signal is used in the voltage converter and display timing generation circuit.

### 7.8 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 104-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 an 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 7.8.1.

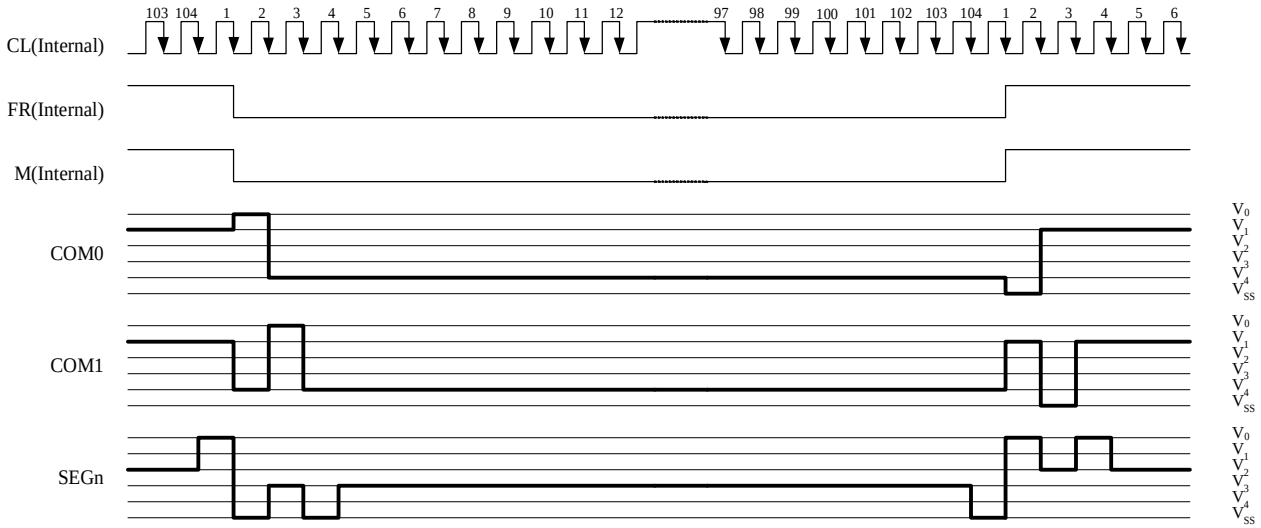



**Figure 7.8.1 2-frame AC Driving Waveform (Duty Ratio: 1/104)**

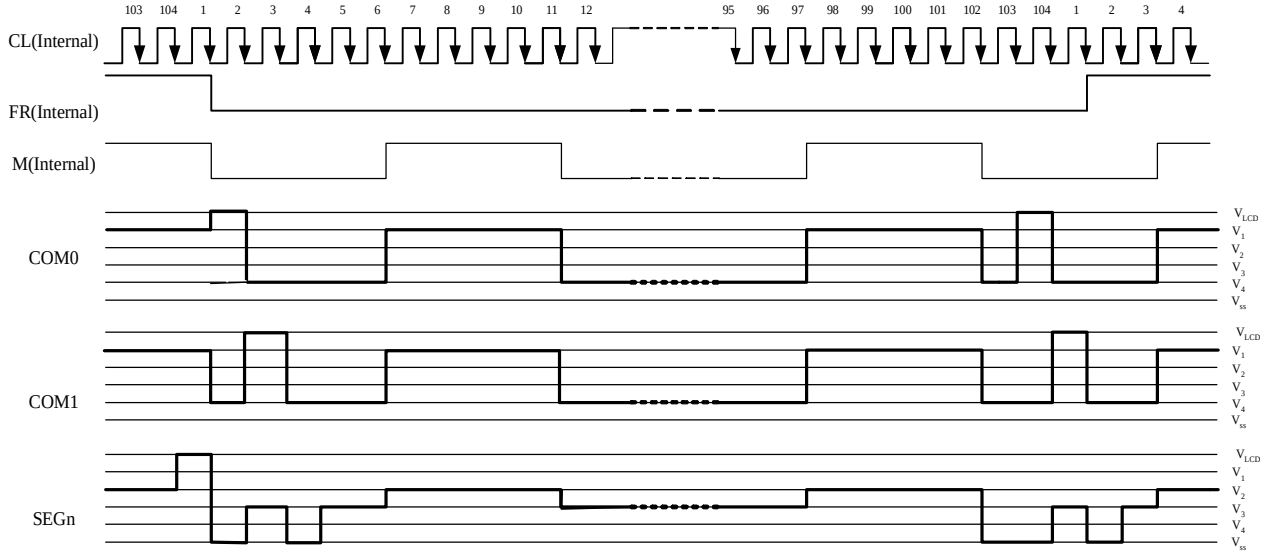
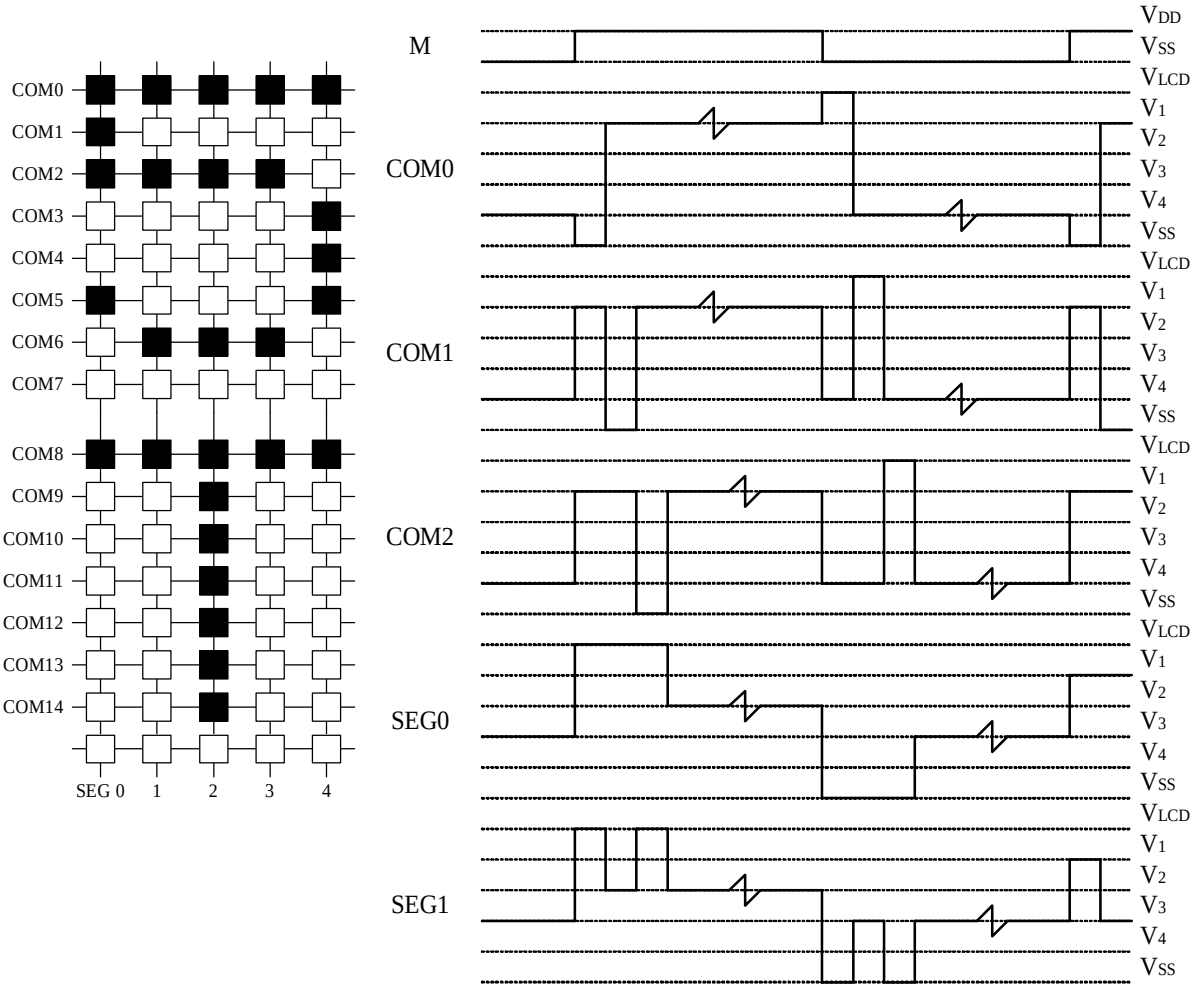



**Figure 7.8.2 N-Line Inversion Driving Waveform (N=5,Duty Ratio=1/104)**

### 7.9 Liquid Crystal drive Circuit

This driver circuit is configured by 104-channel common drivers and 312-channel segment drivers. This LCD panel driver voltage depends on the combination of display data and M signal.


COM0
COM1
COM2
COM3
COM4
COM5
COM6
COM7
COM8
COM9
COM10
COM11
COM12
COM13
COM14
SEG 0
1
2
3
4
M
COM0
COM1
COM2
SEG0
SEG1
VDD
VSS
VLCD
V1
V2
V3
V4
VSS
VLCD
V1
V2
V3
V4
VSS
VLCD
V1
V2
V3
V4
VSS
VLCD
V1
V2
V3
V4
VSS
VLCD
V1
V2
V3
V4
VSS

### 7.10 Liquid Crystal Driver Power Circuit

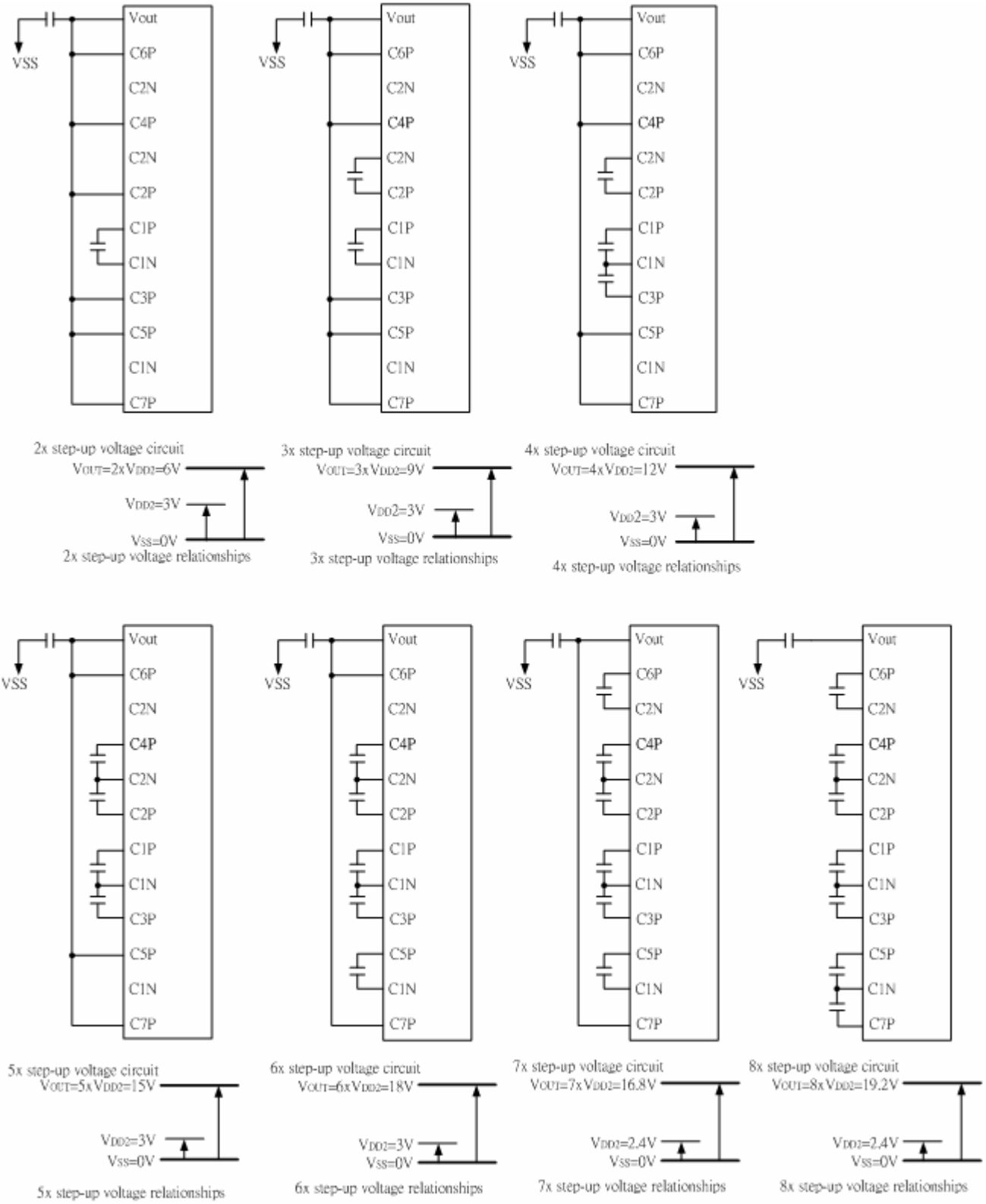
The Power Supply circuits generate the voltage levels necessary to drive liquid crystal driver circuits with low power consumption and the fewest components. There are voltage converter circuits, voltage regulator circuits, and voltage follower circuits. They are controlled by power control instruction. For details, refers to "Instruction Description". Table 7.10.1 shows the referenced combinations in using Power Supply circuits.

**Table 7.10.1 Recommended Power Supply Combinations**

| User setup | Power control (VC VR VF) | V/C circuits | V/R circuits | V/F circuits | VOUT | V0 | V1 to V4 |
|---|---|---|---|---|---|---|---|
| Only the internal power supply circuits are used | 1 1 1 | ON | ON | ON | Open | Open | Open |
| Only the voltage regulator circuits and voltage follower circuits are used | 0 1 1 | OFF | ON | ON | External input | Open | Open |
| Only the voltage follower circuits are used | 0 0 1 | OFF | OFF | ON | Open | External input | Open |
| Only the external power supply circuits are used | 0 0 0 | OFF | OFF | OFF | Open | External input | External input |

### 7.10.1 Voltage Converter Circuits

#### The Step-up Voltage Circuits



### 7.10.2 Voltage Regulator Circuits

SET VOP (SETVOP)

The set VOP function is used to program the optimum LCD supply voltage V0.

**SETVOP**

Reset state of Vop[8:0] is 257DEC = 13.88V.

The VOP value is programmed via the Vop[8:0] register.

**V0=a+( Vop[8:6]Vop[5:0]) · b**

Ex:Vop[5:0]=000001, Vop[8:6]=100

→ Vop [8:0]=100000001

→ 3.6+257x0.04=13.88

- a is a fixed constant value (see table 7.10.2).
- b is a fixed constant value (see table 7.10.2).
- Vop[8:0] is the programmed VOP value. The programming range for Vop[8:0] is 4 to 410 (19Ahex).
- Vop[5:0] is the set contrast value which can be set via the interface and is in two's complement format.(See command VOLUP & VOLDOWN)

Table 7.10.2

| SYMBOL | VALUE | UNIT |
|---|---|---|
| a | 3.6 | V |
| b | 0.04 | V |

The VOP[8:0] value must be in the VLCD programming range as given in Fig.7.10.2. Evaluating equation (1), values outside the programming range indicated in Fig.7.10.2 may result. Calculated values below VOP[8:0]=4 will be mapped to VOP[8:0]=4, resulting VOP values higher than VOP[8:0]=410 will be mapped to VOP[8:0]=410.

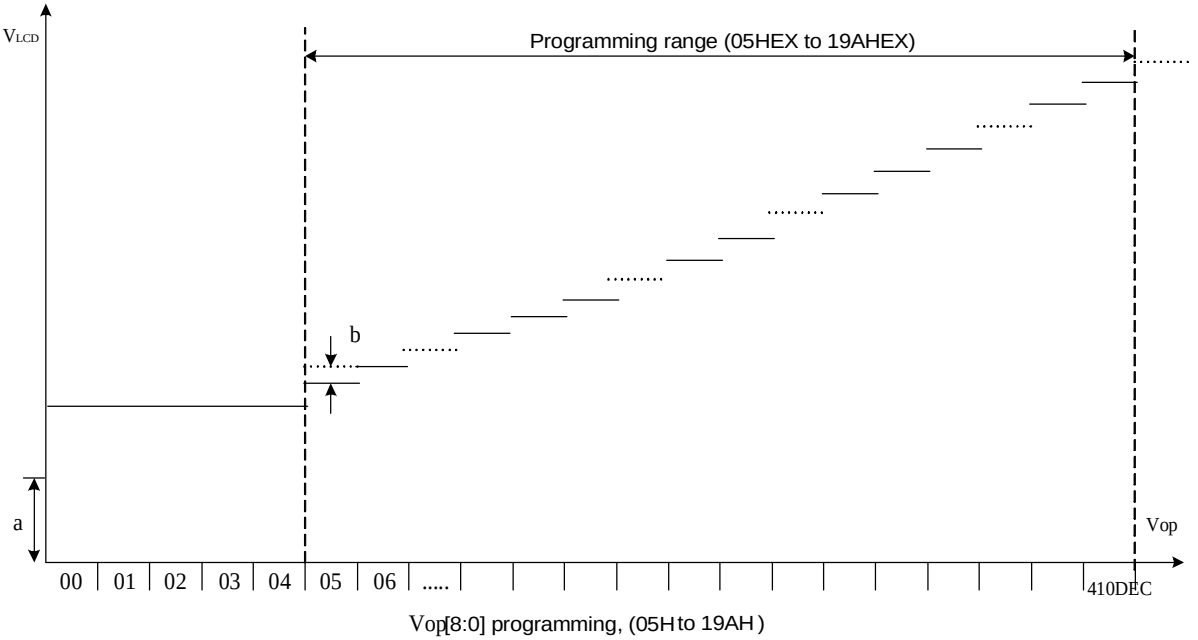



**Fig. 7.10.2 VLCD programming range**

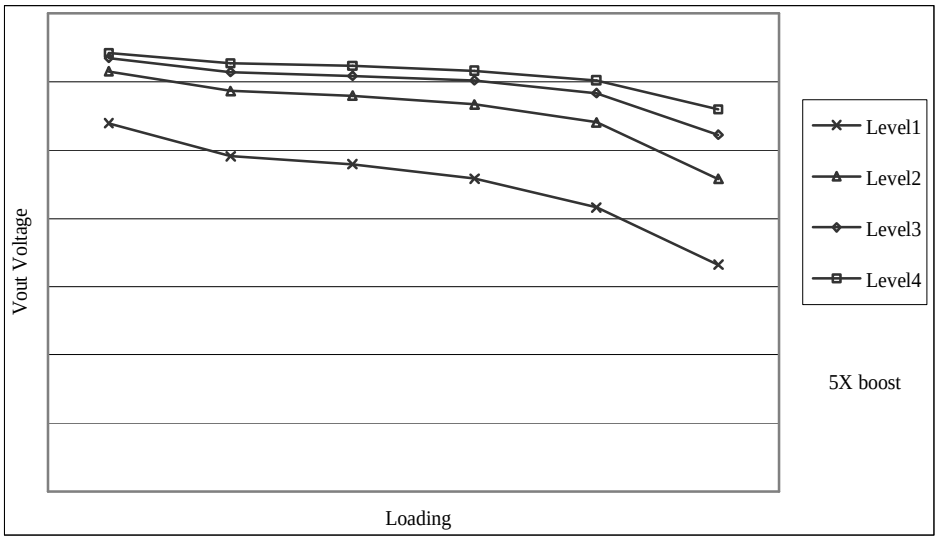
**As the programming range for the internally generated $V_0$ allows values above the max(18V). Allowed $V_0$ (18V) the user has to ensure while setting the VOP register and the temperature compensation, that under all conditions and including all tolerances the $V_0$ remains below 18V.**

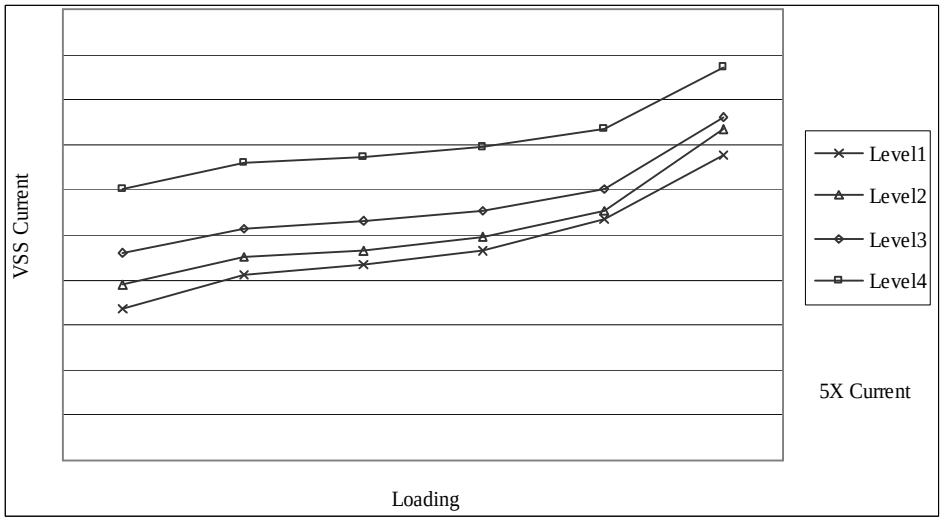
**Booster Efficiency**

By Booster Stages (2X, 3X, 4X, 5X, 6X, 7X, 8X) and Booster Efficiency (Level1~4) commands, we could easily set the best Booster performance with suitable current consumption. If the Booster Efficiency is set to higher level (level4 is higher than level1), The Boost Efficiency is better than lower level, and it just needs few more power consumption current. It could be applied to each multiple voltage Condition.

When the LCD Panel loading is heavier, the performance of Booster will be not in a good working condition. Users could set the BE level to be higher and just need few more current. Never consider to change to higher Booster Stage at beginning stage unless it really necessary.

The Booster Efficiency Command could be used together with Booster Stage Command to choose one best Boost output condition. Users could see the Booster Stage Command as a large scale operation, and see the Booster Efficiency Command as a small scale operation. These commands are very convenient for using.



## RESET CIRCUIT

**When Power is Turned On**

Input power (VDD,VDD1~VDD5)

↓

Be sure to apply POWER-ON RESET (RES = LOW)

↓

| **<Display Setting>** | **<<State after resetting>>** |
|---|---|
| Display control (DISCTL) | |
| Setting clock dividing ratio: | 1 dividing |
| Duty setting: | 1/4 |
| Setting reverse rotation number of line: | 11h reverse rotations |
| Common scan direction (COMSCN) | |
| Setting scan direction: | COM0 -> COM51, COM52 -> COM103 |
| Oscillation ON (OSCON) | Oscillation OFF |

↓

| | |
|---|---|
| Sleep-out (SLIPOUT) | Sleep-in |

↓

| **<Power Supply Setting>** | **<<State after resetting>>** |
|---|---|
| Electronic volume control (VOLCTR) | |
| Setting volume value: | 0 |
| Setting built-in resistance value: | 0 (3.76) |
| Power control (PWRCTR) | |
| Setting operation of power supply circuit: | All OFF |

↓

| **<Display Setting 2>** | **<<State after resetting>>** |
|---|---|
| Normal rotation of display (DISNOR)/Inversion of display (DISINV): Normal rotation of display | |
| Partial-in (PTLIN)/Partial-out (PTLOUT) | Partial-out |
| Setting fix area: | 0 |
| Area scroll set (ASSET) | |
| Setting area scroll region: | 0 |
| Setting area scroll type: | Full-screen scroll |
| Scroll start set (SCSTART) | |
| Setting scroll start address: | 0 |

↓

| **<Display Setting 3>** | **<<State after resetting>>** |
|---|---|
| Data control (DATCTL) | |
| Setting normal rotation/reversion of page address: | Normal rotation |
| Setting normal rotation/reversion of column address: | Normal rotation |
| Setting direction of address scanner: | Column direction |

Setting RGB arrangement: RGB

Setting gradation: 65K

↓

**<RAM Setting>** **<<State after resetting>>**

Page address set (PASET)

Setting start page address: 0

Setting end page address: 0

Column address set (CASET)

Setting start column address: 0

Setting end column address: 0

↓

**<RAM Write>** **<<State after resetting>>**

Memory write command (RAMWR)

Writing displayed data : Repeat as many as the number needed

and exit by entering other command.

↓

**<Waiting (approximately 100ms)>**

Wait until the power supply voltage has stabilized.

Enter the power supply control command first, then wait at least

100ms before entering the display ON command when the built-in

power supply circuit operates.

If you do not wait, an unwanted display may appear on the

liquid crystal panel.

↓

Display ON (DISON): Display OFF

(Note) If changes are unnecessary after resetting, command input is unnecessary.

# 8. COMMANDS

## 8.1 Command table

| Ext=0 | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Command*** | ***A0*** | ***RD*** | ***WR*** | ***D7*** | ***D6*** | ***D5*** | ***D4*** | ***D3*** | ***D2*** | ***D1*** | ***D0*** | ***Function*** | ***Hex*** | ***Parameter*** | ***Index*** |
| DISON | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | Display On | AF | None | 1 |
| DISOFF | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | Display Off | AE | None | 2 |
| DISNOR | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | Normal Display | A6 | None | 3 |
| DISINV | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | Inverse Display | A7 | None | 4 |
| COMSCN | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | Com Scan Direc. | BB | 1 byte | 5 |
| DISCTR | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | Display Control | CA | 3 byte | 6 |
| SLPP | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | Sleep In/Out Preparation | 04 | 1 byte | 7 |
| SLPIN | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | Sleep In | 95 | None | 8 |
| SLPOUT | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | Sleep Out | 94 | None | 9 |
| PASET | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | Page Addr. Set | 75 | 2 byte | 10 |
| CASET | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | Column Addr. Set | 15 | 2 byte | 11 |
| DATCTL | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | Data Scan Direction | BC | 3 byte | 12 |
| RAMWR | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | Writing to Memory | 5C | Data | 13 |
| RAMRD | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | Reading from Memory | 5D | Data | 14 |
| PLTIN | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | Partial display in | A8 | 2 byte | 15 |
| PLTOUT | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | Partial display out | A9 | None | 16 |
| RMWIN | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | Read and Modify Write | E0 | None | 17 |
| RMWOUT | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | RMW end | EE | None | 18 |
| ASCSET | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | Area Scroll Set | AA | 4 byte | 19 |
| SCSTART | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | Scroll Start Set | AB | 1 byte | 20 |
| OSCON | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | Internal OSC on | D1 | None | 21 |
| OSCOFF | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | Internal OSC off | D2 | None | 22 |
| PWRCTL | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | Power Control | 20 | 1 byte | 23 |
| VOLCTR | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | EC control | 81 | 2 byte | 24 |
| VOLUP | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | EC increase 1 | D6 | None | 25 |
| VOLDOWN | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | EC decrease 1 | D7 | None | 26 |
| EPSRRD1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | READ Register1 | 7C | None | 27 |
| EPSRRD2 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | READ Register2 | 7D | None | 28 |
| NOP | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | NOP Instruction | 25 | None | 29 |
| STREAD | 0 | 0 | 1 | Status Read | | | | | | | | Status Read | | | 30 |
| Initial code(1) | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | Initial code(1) | 07 | 1 byte | 31 |
| RESERVED | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | Not Use | 82 | | 32 |

| Ext=1 | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Command*** | ***A0*** | ***RD*** | ***WR*** | ***D7*** | ***D6*** | ***D5*** | ***D4*** | ***D3*** | ***D2*** | ***D1*** | ***D0*** | ***Function*** | ***Hex*** | ***Parameter*** | ***Index*** |
| Red1 Set | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | FRAME 1 Red PWM Set | 20 | 16 byte | 1 |
| Red2 Set | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | FRAME 2 Red PWM Set | 21 | 16 byte | 2 |
| Red3 Set | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | FRAME 3 Red PWM Set | 22 | 16 byte | 3 |
| Red4 Set | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | FRAME 4 Red PWM Set | 23 | 16 byte | 4 |
| Grn1 Set | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | FRAME 1 Grn PWM Set | 24 | 16 byte | 5 |
| Grn2 Set | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | FRAME 2 Grn PWM Set | 25 | 16 byte | 6 |
| Grn3 Set | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | FRAME 3 Grn PWM Set | 26 | 16 byte | 7 |
| Grn4 Set | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | FRAME 4 Grn PWM Set | 27 | 16 byte | 8 |
| Blu1 Set | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | FRAME 1 Blu PWM Set | 28 | 16 byte | 9 |
| Blu2 Set | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | FRAME 2 Blu PWM Set | 29 | 16 byte | 10 |
| Blu3 Set | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | FRAME 3 Blu PWM Set | 2A | 16 byte | 11 |
| Blu4 Set | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | FRAME 4 Blu PWM Set | 2B | 16 byte | 12 |
| ANASET | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | Analog | 32 | 3 byte | 13 |
| DITHOFF | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | Dithering Circuit Off | 34 | None | 14 |
| DITHON | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | Dithering Circuit On | 35 | None | 15 |
| EPCTIN | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | Control EEPROM | CD | 1 byte | 17 |
| EPCOUT | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | Cancel EEPROM | CC | None | 18 |
| EPMWR | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | Write to EEPROM | FC | None | 19 |
| EPMRD | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | Read from EEPROM | FD | None | 20 |

| Ext=1 or Ext=0 | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Command*** | ***A0*** | ***RD*** | ***WR*** | ***D7*** | ***D6*** | ***D5*** | ***D4*** | ***D3*** | ***D2*** | ***D1*** | ***D0*** | ***Function*** | ***Hex*** | ***Parameter*** | ***Index*** |
| Ext In | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | Ext=0 Set | 30 | None | -- |
| Ext Out | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | Ext=1 Set | 31 | None | -- |

## *EXT="0"*

**(1) Display ON (DISON) Command: 1; Parameter: None (AFH)**

It is used to turn the display on. When the display is turned on, segment outputs and common outputs are generated at the level corresponding to the display data and display timing. You can't turn on the display as long as the sleep mode is selected. Thus, whenever using this command, you must cancel the sleep mode first.

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 |

**(2) Display OFF (DISOFF) Command: 1; Parameter: None (AEH)**

As long as the display is turned off, every segment and common outputs are forced to Vss level.

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |

**(3) Normal display (DISNOR) Command: 1; Parameter: None (A6H)**

It is used to normally highlight the display area without modifying contents of the display data RAM.

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |

**(4) Inverse display (DISINV) Command: 1; Parameter: None (A7)**

It is used to inversely highlight the display area without modifying contents of the display data RAM. This command does not invert non-display areas in case of using partial display.

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |

**(5) Common scan (COMSCAN) Command: 1; Parameter: 1 (BBH)**

It is used to specify the direction the common output direction. This command helps increasing degrees of freedom of wiring on the LCD panel.

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | – |
| **Parameter1 (P1)** | 1 | 1 | 0 | * | * | * | * | * | P12 | P11 | P10 | Common Scan direction |

When 1/104 is selected for the display duty, pins and common output are scanned in the order shown below. When CSEL ="H", this function becomes no use.

| P12 | P11 | P10 | Common scan direction | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | COM0 pin | | COM51 pin | COM52 pin | | COM103 pin |
| 0 | 0 | 0 | 0 | **à** | 51 | 52 | **à** | 103 |
| 0 | 0 | 1 | 0 | **à** | 51 | 103 | **à** | 52 |
| 0 | 1 | 0 | 51 | **à** | 0 | 52 | **à** | 103 |
| 0 | 1 | 1 | 51 | **à** | 0 | 103 | **à** | 52 |

**(6) Display control (DISCTL) Command: 1; Parameter: 3 (CAH)**

This command and succeeding parameters are used to perform the display timing-related setups. This command must be selected before using SLPOUT. Don't change this command while the display is turned on.

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | — |
| **Parameter1(P1)** | 1 | 1 | 0 | * | * | * | P14 | P13 | P12 | * | * | CL dividing ratio, |
| **Parameter2(P2)** | 1 | 1 | 0 | 0 | 0 | 0 | P24 | P23 | P22 | P21 | P20 | Drive duty |
| **Parameter3(P3)** | 1 | 1 | 0 | * | * | * | P34 | P33 | P32 | P31 | P30 | FR inverse-set value |

P1: it is used to specify the CL dividing ratio.

P14, P13, P12: CL dividing ratio. They are used to change number of dividing stages of external or internal clock.

| P14 | P13 | P12 | CL dividing ratio |
|---|---|---|---|
| 0 | 0 | 0 | Not divide |
| 0 | 0 | 1 | 2 divisions |
| 0 | 1 | 0 | 4 divisions |
| 0 | 1 | 1 | 8 divisions |

This command Decides the Oscillator frequency(default=7.8KHz),Related Command 32H.

P2: It is used to specify the duty of the module on block basis.

| Duty | * | * | P25 | P24 | P23 | P22 | P21 | P20 | (Numbers of display lines)/4-1 |
|---|---|---|---|---|---|---|---|---|---|
| Example: 1/104 duty | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 104/4-1=25 |

P3: It is used to specify number of lines to be inversely highlighted on LCD panel from P33 to P30 (lines can be inversely highlighted in the range of 2 to 16)

| Inversely highlighted line | * | * | * | P34 | P33 | P32 | P31 | P30 | Inversely highlighted lines-1 |
|---|---|---|---|---|---|---|---|---|---|
| Example: 11H | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 11-1=10 |
| Example: 13H | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 13-1=12 |

In the default, 11H inverse highlight is selected.

P34="0": Inversion occurs every frame. P34="1": Independent from frames.

**(7) Sleep In/Out Preparation (SLPP) Command: 1; Parameter: 1**

Using this command to setup ready status for sleep-in or sleep out.

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | — |
| **Parameter(P1)** | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | P10 | Sleep in/out ready |

P10 =" 1": Ready for sleep in. P10 = "0": Ready for sleep out.

Parameter 3FH is used to initialize sleep-in sequencing, and parameter 3EH is used to initialize sleep-out sequencing.

**(8)Sleep in (SPLIN) Command: 1; Parameter: None (95H)**

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |

**(9)Sleep out (SLPOUT) Command: 1;Parameter: None (94H)**

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |

**(10)Page address set (PASET) Command: 1; Parameter: 2 (75H)**

When MPU makes access to the display data RAM, this command and succeeding parameters are used to specify the page address area. As the addresses are incremented from the start to the end page in the page-direction scan, the column address is incremented by 1 and the page address is returned to the start page. Note that the start and end page must be specified as a pair. Also, the relation “start page <end page” must be maintained.

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | – |
| **Parameter1(P1)** | 1 | 1 | 0 | 0 | P16 | P15 | P14 | P13 | P12 | P11 | P10 | Start page |
| **Parameter2(P2)** | 1 | 1 | 0 | 0 | P26 | P25 | P24 | P23 | P22 | P21 | P20 | End page |

**(11)Column address set (CASET) Command: 1; Parameter: 2 (15H)**

When MPU makes access to the display data RAM, this command and succeeding parameters are used to specify the column address area. As the addresses are incremented from the start to the end column in the column-direction scan, the page address is incremented by 1 and the column address is returned to the start column. Note that the start and end page must be specified as a pair. Also, the relation “start column <end column” must be maintained.

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | – |
| **Parameter1(P1)** | 1 | 1 | 0 | 0 | P16 | P15 | P14 | P13 | P12 | P11 | P10 | Start address |
| **Parameter2(P2)** | 1 | 1 | 0 | 0 | P26 | P25 | P24 | P23 | P22 | P21 | P20 | End address |

**(12)Data control (DATCTL) Command: 1;Parameter: 3 (BCH)**

This command and succeeding parameters are used to perform various setups needed when MPU operates display data stored on the built-in RAM.

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | – |
| **Parameter1(P1)** | 1 | 1 | 0 | * | * | * | * | * | P12 | P11 | P10 | Normal/reverse display of page address and page-address scan direction. |
| **Parameter2(P2)** | 1 | 1 | 0 | * | * | * | * | * | * | * | P20 | RGB arrangement |
| **Parameter3(P3)** | 1 | 1 | 0 | * | * | * | * | * | P32 | P31 | P30 | Gray-scale setup |

P1: It is used to specify the normal or inverse display of the page address and also to specify the page address scanning direction.

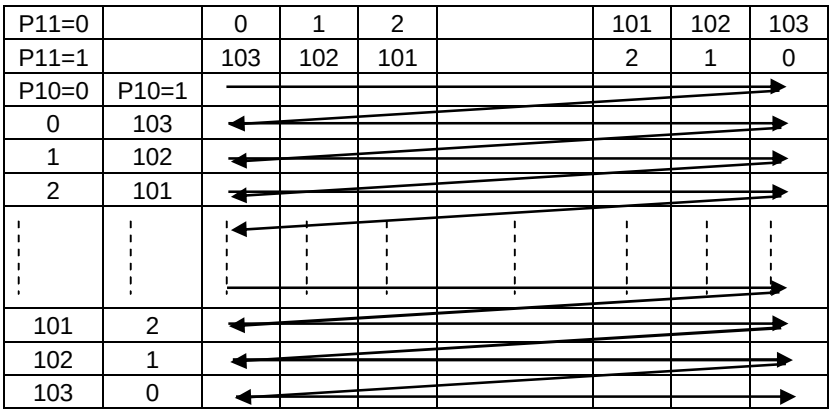
P10: Normal/reverse display of the page address. P10=0: Normal rotation and P10=1: Reverse rotation.

P11: Normal/reverse turn of column address. P11=0: Normal rotation and P11=1: Reverse rotation.

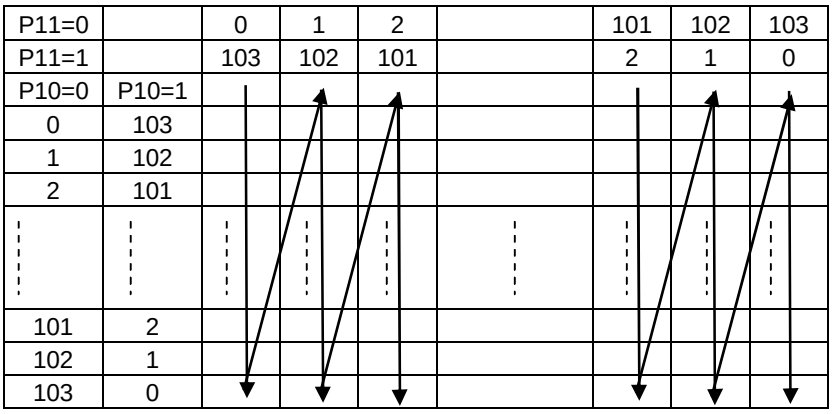
P12: Address-scan direction. P12=0: In the column direction and P12=1: In the page direction.

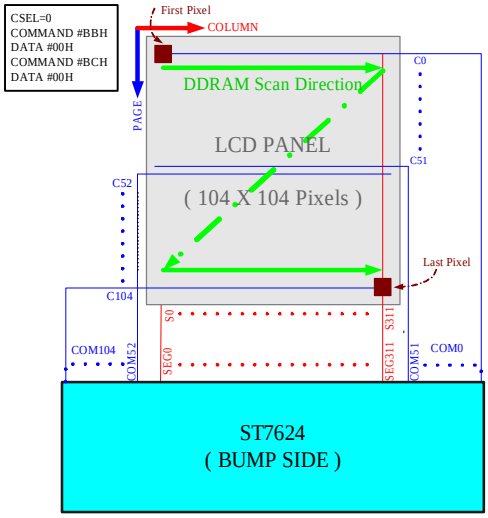
## Page address and page-address scan direction.

P12=0 Column direction

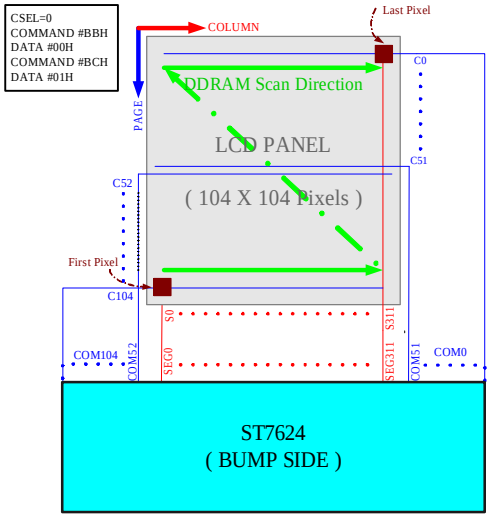



P12=1 Page direction

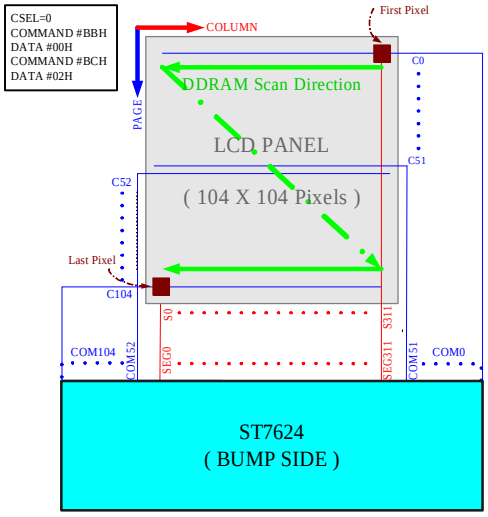




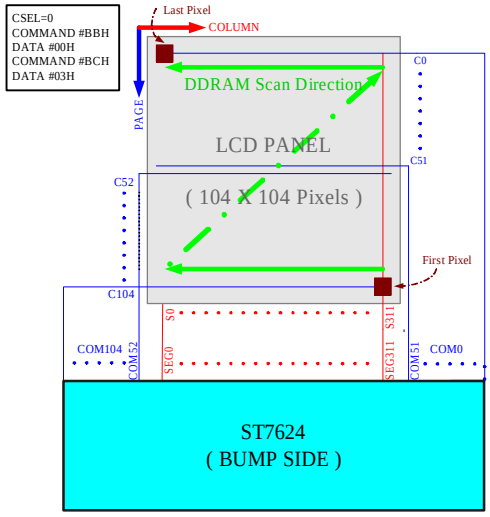

(a) COMMAND #BCH, DATA #00H




(b) COMMAND #BCH, DATA #01H

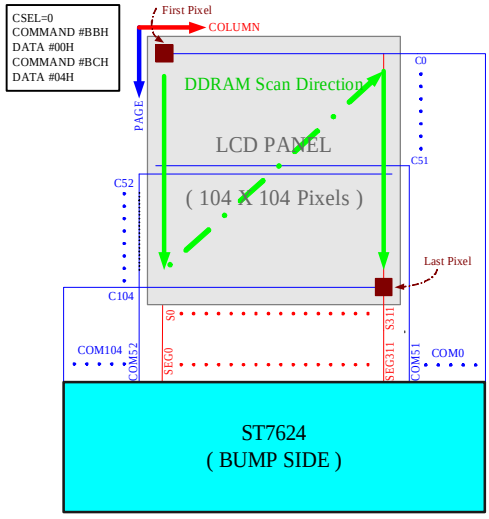



(c) COMMAND #BCH, DATA #02H

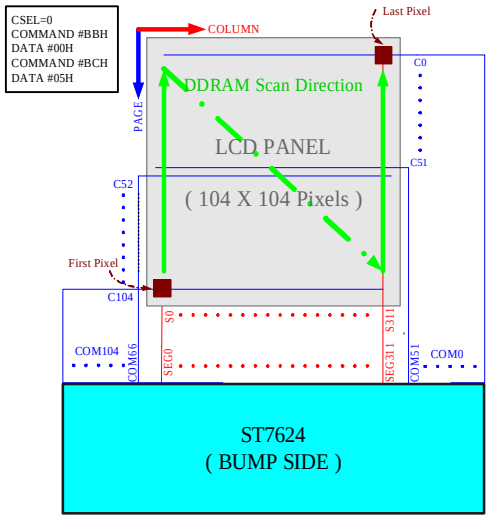



(d) COMMAND #BCH, DATA #03H

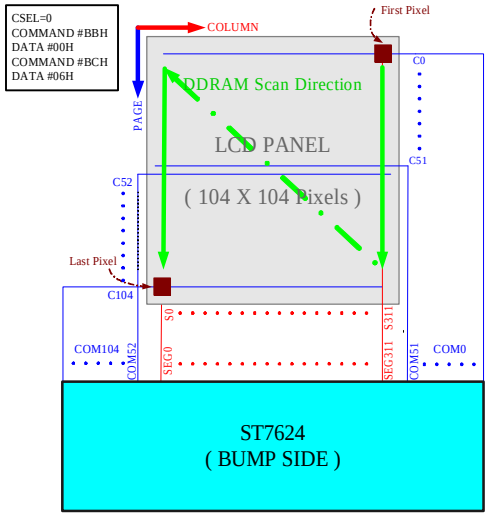
**Figure 8.2.1 Different RAM accessing setup when CSEL=0 under COMMAND #BBH, DATA #00H**
**(a) COMMAND #BCH, DATA #00H**
**(b) COMMAND #BCH, DATA #01H**
**(c) COMMAND #BCH, DATA #02H**
**(d) COMMAND #BCH, DATA #03H**



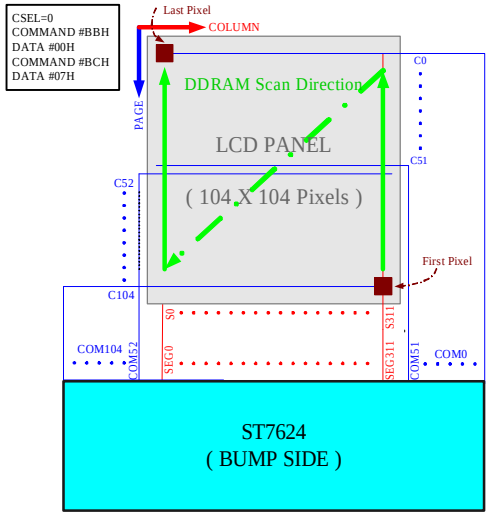

(e) COMMAND #BCH, DATA #04H




(f) COMMAND #BCH, DATA #05H




(g) COMMAND #BCH, DATA #06H




(h) COMMAND #BCH, DATA #07H

**Figure 8.2.3 Different RAM accessing setup when CSEL=0 under COMMAND #BBH, DATA #00H (continue)**
**(e) COMMAND #BCH, DATA #04H**
**(f) COMMAND #BCH, DATA #05H**
**(g) COMMAND #BCH, DATA #06H**
**(h) COMMAND #BCH, DATA #07H**

P2: RGB arrangement. This parameter allows you to change RGB arrangement of data which is going to be written into RAM, and therefore causes the inverse RGB rotation of the segment output of ST7624. You can fit RGB arrangement on the LCD panel according to this parameter setting.

| P20 | Line | SEG0 | SEG1 | SEG2 | SEG3 | SEG4 | SEG5 | SEG6 | SEG7 | … | SEG311 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Even page | R | G | B | R | G | B | R | G | … | B |
| | Odd page | R | G | B | R | G | B | R | G | … | B |
| 1 | 1 | B | G | R | B | G | R | B | G | … | R |
| | 2 | B | G | R | B | G | R | B | G | … | R |

P3: Gray scale setup. Using this parameter, 64 gray-scale display, you can select the 65K, 262K, and 16M display mode depending on the difference in RGB data arrangement.

| P32 | P31 | P30 | Numbers of gray-scale |
|---|---|---|---|
| 0 | 0 | 1 | 64-gray 65K |
| 0 | 1 | 0 | 64-gray 262K |
| 1 | 0 | 0 | 64-gray 16M |

**(13)Memory write (RAMWR) Command: 1;Parameter: Numbers of data written (5CH)**

When MPU writes data to the display memory, this command turns on the data entry mode. Entering this command always sets the page and column address at the start address. You can rewrite contents of the display data RAM by entering data succeeding to this command. At the same time, this operation increments the page or column address as applicable. The write mode is automatically cancelled if any other command is entered.

1. 8-bit bus

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | – |
| **Parameter** | 1 | 1 | 0 | Data to be written | | | | | | | | Data to be written |

2. 16-bit bus

| | A0 | RD | RW | D15 | D14 | … | D9 | D8 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | * | * | … | * | * | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | Memory write |
| **parameter** | 1 | 1 | 0 | Data to be written | | | | | | | | | | | | | Write date |

**(14)Memory read (RAMRD) Command: 1; Parameter: Numbers of data read (5DH)**

When MPU read data from the display memory, this command turns on the data read mode. Entering this command always sets the page and column address at the start address. After entering this command, you can read contents of the display data RAM. At the same time, this operation increments the page or column address as applicable. The data read mode is automatically cancelled if any other command is entered.

1. 8-bit bus

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | -- |
| **Parameter** | 1 | 0 | 1 | Data to be read | | | | | | | | Data to be read |

2. 16-bit bus

| | A0 | RD | RW | D15 | D14 | …. | D9 | D8 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | * | * | * | * | * | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | Memory read |
| **parameter** | 1 | 0 | 1 | Data to be read | | | | | | | | | | | | | Read date |

**(15)Partial in (PTLIN) Command: 1; Parameter: 2 (A8H)**

This command and succeeding parameters specify the partial display area. This command is used to turn on partial display of the screen (dividing screen by lines) in order to save power. Since ST7624 processes the liquid crystal display signal on 4-line basis (block basis), the display and non-display areas are also specified on 4-bit line (block basis).

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | -- |
| **Parameter(P1)** | 1 | 1 | 0 | * | * | 0 | P14 | P13 | P12 | P11 | P10 | Start block address |
| **Parameter(P2)** | 1 | 1 | 0 | * | * | 0 | P24 | P23 | P22 | P21 | P20 | End block address |

A block address that can be specified for the partial display must be the display one (don't try to specify an address not to be displayed when scrolled).

**(16)Partial out (PTLOUT) Command: 1; Parameter: 0 (A9H)**

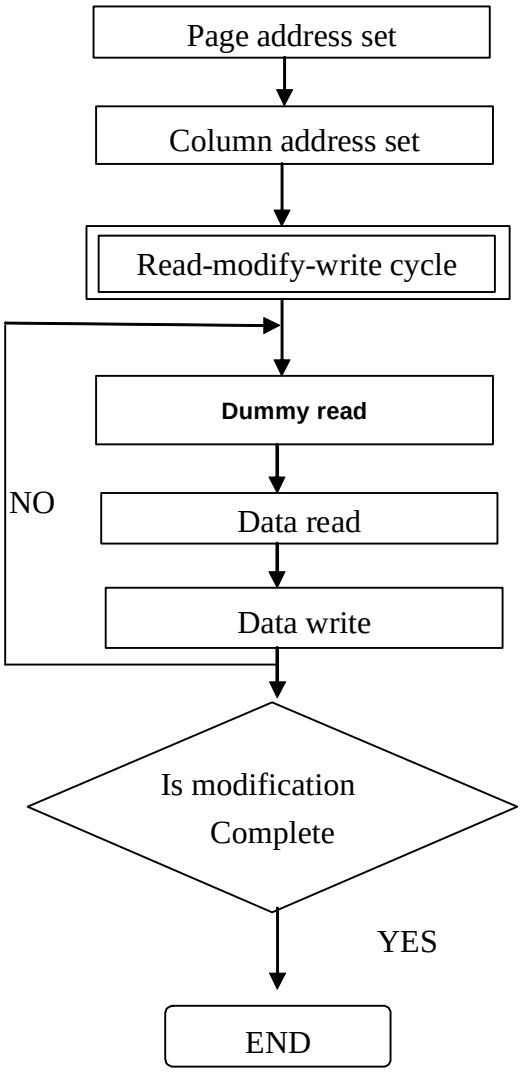
This command is used to exit from the partial display mode.

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |

**(17)Read modify write in (RMWIN) Command: 1; Parameter: 0 (E0H)**

This command is used along with the column address set command, page address set command and read modify write out command. This function is used when frequently modifying data to specify a specific display area such as blinking cursor. First set a specific display area using the column and page address commands. Then, enter this command to set the column and page addresses at the start address of the specific area. When this operation is complete, the column (page) address won't be modified by the display data read command. It is incremented only when the display data write command is used. You can cancel this mode by entering the read modify write out or any other command.

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |




**(18)Read modify write out (RMWOUT) Command: 1; Parameter: 0 (EEH)**

Enter this command cancels the read modify write mode

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |

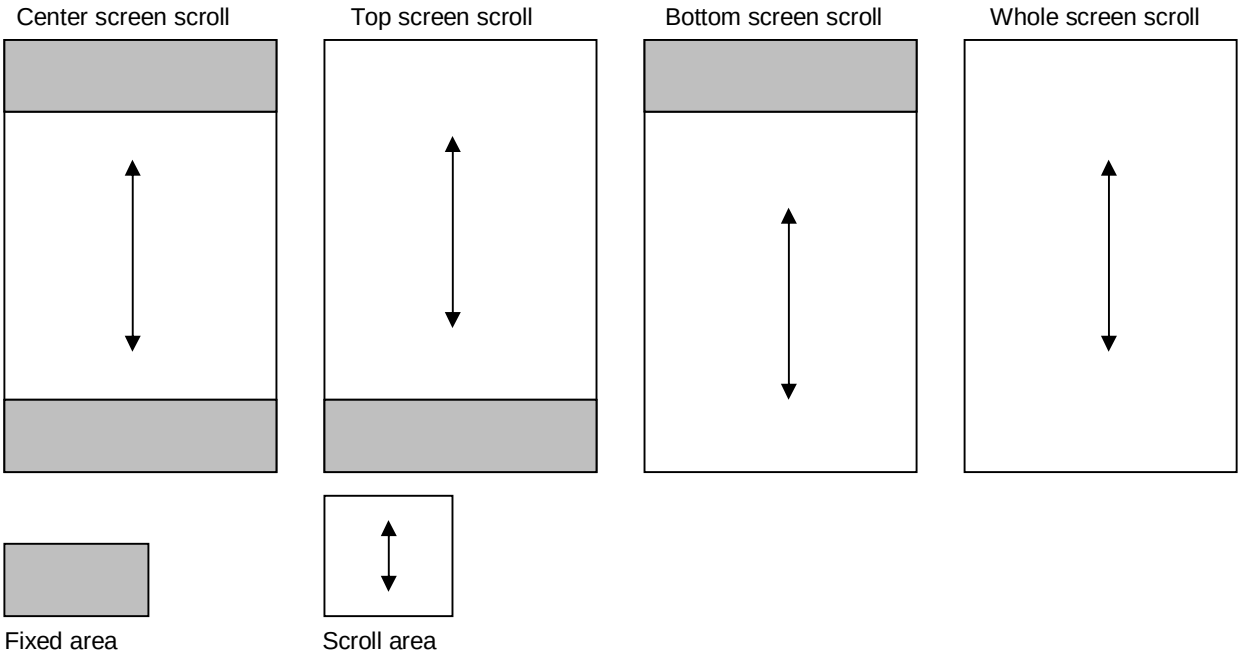
**(19)Area scroll set (ASCSET) Command: 1; Parameter: 4 (AAH)**

It is used when scrolling only the specified portion of the screen (dividing the screen by lines). This command and succeeding parameters specify the type of area scroll, FIX area and scroll area.

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | -- |
| **Parameter(P1)** | 1 | 1 | 0 | * | * | 0 | P14 | P13 | P12 | P11 | P10 | Top block address |
| **Parameter(P2)** | 1 | 1 | 0 | * | * | 0 | P24 | P23 | P22 | P21 | P20 | Bottom block address |
| **Parameter(P3)** | 1 | 1 | 0 | * | * | 0 | P34 | P33 | P32 | P31 | P30 | Number of specified blocks |
| **Parameter(P4)** | 1 | 1 | 0 | * | * | * | * | * | * | P41 | P40 | Area scroll mode |

P4: It is used to specify an area scroll mode.

| P41 | P40 | Type of area scroll |
|---|---|---|
| 0 | 0 | Center screen scroll |
| 0 | 1 | Top screen scroll |
| 1 | 0 | Bottom screen scroll |
| 1 | 1 | Whole screen scroll |




Since ST7624 processes the liquid crystal display signals on the four-line basis (block basis), FIX and scroll areas are also specified on the four-line basis (block basis).

DDRAM address corresponding to the top FIX area is set in the block address incrementing direction starting with 0 block.

DDRAM address corresponding to the bottom FIX area is set in the block address decreasing direction starting with 41st block. Other DDRAM blocks excluding the top and bottom FIX areas are assigned to the scroll + background areas.

P1: It is used to specify the top block address of the scroll+ background areas. Specify the 0th block for the top screen scroll or whole screen scroll.

P2: It specifies the bottom address of the scroll+ background areas. Specify the 32th block for the bottom or whole screen scroll.

Required relation between the start and end blocks (top block address<bottom block address) must be maintained.

P3: It specifies a specific number of blocks {Numbers of (Top FIX area +Scroll area) block-1}. When the bottom scroll or whole screen scroll, the value is identical with P2.

You can turn on the area scroll function by executing the area scroll set command first and then specifying the display start block of the scroll area with the scroll start set command.

*[Area Scroll Setup Example]*

In the center screen scroll of 1/92 duty (display range: 92 lines=23 blocks), if 8 lines=2 blocks and 8 lines=2 blocks are specified for the top and bottom FIX areas, 76 lines =19 blocks is specified for the scroll areas, respectively, 12 lines = 3 blocks on the DDRAM are usable as the background area. Value of each parameter at this time is as shown below.

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **P1** | 1 | 1 | 0 | * | * | 0 | 0 | 0 | 0 | 1 | 0 | Top block address = 2 |
| **P2** | 1 | 1 | 0 | * | * | 0 | 1 | 0 | 1 | 1 | 1 | Bottom block address = 23 |
| **P3** | 1 | 1 | 0 | * | * | 0 | 1 | 0 | 1 | 0 | 0 | Number of specific blocks = 23 |
| **P4** | 1 | 1 | 0 | * | * | * | * | * | * | 0 | 0 | Area scroll mode = center |

**(20)Scroll start address set (SCSTART) Command:1 Parameter: 1 (ABH)**

This command and succeeding parameters are used to specify the start block address of the scroll area. Note that you must execute this command after executing the area scroll set command. Scroll becomes available by dynamically changing the start block address.

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | -- |
| **Parameter(P1)** | 1 | 1 | 0 | * | * | 0 | P14 | P13 | P12 | P11 | P10 | Start block address |

**(21)Internal oscillation on (OSCON) Command: 1; Parameter: 0 (D1H)**

This command turns on the internal oscillation circuit. It is valid only when the internal oscillation circuit of CLS = HIGH is used.

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 |

**(22)Internal oscillation off (OSOFF) Command: 1; Parameter: 0 (D2H)**

It turns off the internal oscillation circuit. This circuit is turned off in the reset mode.

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 |

**(23)Power control set (PWRCTR) Command: 1; Parameter: 1 (20H)**

This command is used to turn on or off the Booster circuit, voltage follower circuit, and voltage regulator circuit.

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Command | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -- |
| Parameter(P1) | 1 | 1 | 0 | * | * | * | * | P13 | * | P11 | P10 | LCD drive power |

P10: It turns on or off the voltage regulator circuit.

P10 = “1”: ON. P10 =” 0”: OFF

P11: It turns on or off the voltage follower circuit.

P11 = “1”: ON. P11 =” 0”: OFF

P13:It turns on or off the Booster.

P13 = “1”: ON. P13 =” 0”: OFF

**(24)Electronic volume control (VOLCTR) Command: 1; Parameter: 2 (81H)**

The command is used to program the optimum LCD supply voltage $V_{LCD}$. Reference to 7.10.2

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | -- |
| **Parameter(P1)** | 1 | 1 | 0 | * | * | P15 | P14 | P13 | P12 | P11 | P10 | Set Vop[5:0] |
| **Parameter(P2)** | 1 | 1 | 0 | * | * | * | * | * | P18 | P17 | P16 | Set Vop[8:6] |

**(25)Increment electronic control (VOLUP) Command: 1; Parameter: 0 (D6H)**

With the VOLUP and VOLDOWN command the $V_{LCD}$ voltage and therewith the contrast of the LCD can be adjusted.

This command increments electronic control value VOP[5:0] of voltage regulator circuit by 1.

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 |

If you set the electronic control value to 111111, the control value is set to 000000 after this command has been executed.

**(26)Decrement electronic control (VOLDOWN) Command: 1; Parameter: 0 (D7H)**

With the VOLUP and VOLDOWN command the $V_{LCD}$ voltage and therewith the contrast of the LCD can be adjusted.

This command decrements electronic control value VOP[5:0] of voltage regulator circuit by 1.

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 |

If you set the electronic control value to 000000, the control value is set to 111111 after this command has been executed.

Table 8.1.1 Possible VOP[5:0] values

| Electronic Control Value | Decimal Equivalent | VLCD Offset |
|---|---|---|
| 111111 | 31 | +1240 mV |
| 111110 | 30 | +1200 mV |
| 111101 | 29 | +1160 mV |
| … | … | … |
| 000010 | 2 | +80 mV |
| 000001 | 1 | +40 mV |
| 000000 | 0 | 0 mV |
| 111111 | -1 | -40 mV |
| 111110 | -2 | -80 mV |
| … | … | … |
| 100010 | -30 | -1200 mV |
| 100001 | -31 | -1240 mV |
| 100000 | -32 | -1280mV |

**(27)Read Register 1 (EPSRRD1) Command: 1; Parameter: 0 (7CH)**

Issue the EPSRRD1 and STREAD (Status Read) commands in succession to read the Electronic Control value.

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Command | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |

Issue the Status Read command immediately after this command. Also, always issue the NOP command after the STREAD (Status Read) command.

**(28)Read Register 2 (EPSRRD2) Command: 1 ;Parameter: 0 (7DH)**

Issue the EPSRRD1 and STREAD (Status Read) commands in succession to read the built-in resistance ratio.

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |

Issue the Status Read command immediately after this command. Also, always issue the NOP command after the STREAD (Status Read) command.

**(29)Non-operating (NOP) Command: 1; Parameter: 0 (25H)**

This command does not affect the operation.

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |

This command, however, has the function of canceling the IC test mode. Thus, it is recommended to enter it periodically to prevent malfunctioning due to noise and such.

**(30)Status read (STREAD) Command: 1; Parameter: None**

It is the command for reading the internal condition of the IC. One status can be displayed depending on the setting.

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 0 | 1 | (7) Status data | | | | | | | |

Status after reset or after NOP operation

| | | |
|---|---|---|
| D7: Area scroll mode | Refer to P41 (ASCSET) | |
| D6: Area scroll mode | Refer to P40 (ASCSET) | |
| D5: RMW on/off | 0 : Out | 1 : In |
| D4: Scan direction | 0 : Column | 1 : Page |
| D3: Display ON/OFF | 0 : OFF | 1 : ON |
| D2: EEPROM access | 0: OutAccess | 1: InAccess |
| D1: Display normal/inverse | 0 : Normal | 1 : Inverse |
| D0: Partial display | 0 : OFF | 1 : ON |

**(31) Initial code –(1) Command: 1; Parameter: 1 (07H)**

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 07H |
| **Parameter(P1)** | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 19H |

This command is used for EEPROM internal ACK signal generating ,suggest using this command before EEPROM read/write operation . This command improve the EEPROM internal ACK signal under unstable power system.

**(32)Reserved (82H)**

Do not use this command

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Command | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |

***EXT="1"***

**(1)Set Red 1 value (Red1 set) Command: 1; Parameter: 16 (20H)**

| Command | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Red1 Set** | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | FRAME 1 Red PWM Set |

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | – |
| **Parameter1(P1)** | 1 | 1 | 0 | * | * | * | P14 | P13 | P12 | P11 | P10 | Set red level 0 and 1st frame |
| **Parameter2(P2)** | 1 | 1 | 0 | * | * | * | P24 | P23 | P22 | P21 | P20 | Set red level 1 and 1st frame |
| | | | | | | | | | | | | |
| **Parameter16(P16)** | 1 | 1 | 0 | * | * | * | P164 | P163 | P162 | P161 | P160 | Set red level 15 and 1st frame |

**(2)Set Red 2 value (Red2 set) Command: 1; Parameter: 16 (21H)**

| Command | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Red2 Set** | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | FRAME 2 Red PWM Set |

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | – |
| **Parameter1(P1)** | 1 | 1 | 0 | * | * | * | P14 | P13 | P12 | P11 | P10 | Set red level 0 and 2nd frame |
| **Parameter2(P2)** | 1 | 1 | 0 | * | * | * | P24 | P23 | P22 | P21 | P20 | Set red level 1 and 2nd frame |
| | | | | | | | | | | | | |
| **Parameter16(P16)** | 1 | 1 | 0 | * | * | * | P164 | P163 | P162 | P161 | P160 | Set red level 15 and 2nd frame |

**(3) Set Red 3 value (Red3 set) Command: 1; Parameter: 16 (22H)**

| Command | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Red3 Set** | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | FRAME 3 Red PWM Set |

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | – |
| **Parameter1(P1)** | 1 | 1 | 0 | * | * | * | P14 | P13 | P12 | P11 | P10 | Set red level 0 and 3rd frame |
| **Parameter2(P2)** | 1 | 1 | 0 | * | * | * | P24 | P23 | P22 | P21 | P20 | Set red level 1 and 3rdframe |
| | | | | | | | | | | | | |
| **Parameter16(P16)** | 1 | 1 | 0 | * | * | * | P164 | P163 | P162 | P161 | P160 | Set red level 15 and 3rd frame |

**(4) Set Red 4 value (Red4 set) Command: 1; Parameter: 16 (23H)**

| Command | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Red4 Set | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | FRAME 4 Red PWM Set |

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Command | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | – |
| Parameter1(P1) | 1 | 1 | 0 | * | * | * | P14 | P13 | P12 | P11 | P10 | Set red level 0 and 4th frame |
| Parameter2(P2) | 1 | 1 | 0 | * | * | * | P24 | P23 | P22 | P21 | P20 | Set red level 1 and 4thframe |
| | | | | | | | | | | | | |
| Parameter16(P16) | 1 | 1 | 0 | * | * | * | P164 | P163 | P162 | P161 | P160 | Set red level 15 and 4th frame |

**The default value of Red level set**

| | RED1SET | RED2SET | RED3SET | RED4SET |
|---|---|---|---|---|
| | FRAM1 | FRAM2 | FRAM3 | FRAME4 |
| red level0 | 00 | 00 | 00 | 00 |
| red level1 | 02 | 02 | 02 | 02 |
| red level2 | 05 | 05 | 05 | 05 |
| red level3 | 07 | 07 | 07 | 08 |
| red level4 | 0A | 0A | 0A | 0B |
| red level5 | 0D | 0D | 0D | 0C |
| red level6 | 0F | 10 | 0F | 10 |
| red level7 | 11 | 12 | 11 | 12 |
| red level8 | 13 | 14 | 13 | 14 |
| red level9 | 16 | 16 | 16 | 15 |
| red level10 | 18 | 18 | 18 | 17 |
| red level11 | 19 | 19 | 19 | 1A |
| red level12 | 1B | 1B | 1B | 1A |
| red level13 | 1C | 1C | 1C | 1D |
| red level14 | 1D | 1D | 1D | 1E |
| red level15 | 1E | 1E | 1E | 1E |

**The modulation range of Red level set**

| | RED1SET | RED2SET | RED3SET | RED4SET |
|---|---|---|---|---|
| | FRAM1 | FRAM2 | FRAM3 | FRAME4 |
| **red level0** | 0 | 0 | 0 | 0 |
| **red level1** | 0-7 | 0-7 | 0-7 | 0-7 |
| **red level2** | 0-F | 0-F | 0-F | 0-F |
| **red level3** | 0-F | 0-F | 0-F | 0-F |
| **red level4** | 8-F | 8-F | 8-F | 8-F |
| **red level5** | 0-1F | 0-1F | 0-1F | 0-1F |
| **red level6** | 0-1F | 0-1F | 0-1F | 0-1F |
| **red level7** | 0-1F | 0-1F | 0-1F | 0-1F |
| **red level8** | 10-17 | 10-17 | 10-17 | 10-17 |
| **red level9** | 10-1F | 10-1F | 10-1F | 10-1F |
| **red level10** | 10-1F | 10-1F | 10-1F | 10-1F |
| **red level11** | 10-1F | 10-1F | 10-1F | 10-1F |
| **red level12** | 10-1F | 10-1F | 10-1F | 10-1F |
| **red level13** | 10-1F | 10-1F | 10-1F | 10-1F |
| **red level14** | 10-1F | 10-1F | 10-1F | 10-1F |
| **red level15** | 18-1F | 18-1F | 18-1F | 18-1F |

**(5) Set Green 1 value (Grn1 set) Command: 1; Parameter: 16 (24H)**

| Command | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Grn 1 Set** | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | FRAME 1 Grn PWM Set |

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | – |
| **Parameter1(P1)** | 1 | 1 | 0 | * | * | * | P14 | P13 | P12 | P11 | P10 | Set green level 0 and 1st frame |
| **Parameter2(P2)** | 1 | 1 | 0 | * | * | * | P24 | P23 | P22 | P21 | P20 | Set green level 1 and 1st frame |
| | | | | | | | | | | | | |
| **Parameter16(P16)** | 1 | 1 | 0 | * | * | * | P164 | P163 | P162 | P161 | P160 | Set green level 15 and 1st frame |

**(6) Set Green 2 value (Grn2 set) Command: 1;Parameter: 16 (25H)**

| Command | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Grn2 Set** | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | FRAME 2 Grn PWM Set |

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | – |
| **Parameter1(P1)** | 1 | 1 | 0 | * | * | * | P14 | P13 | P12 | P11 | P10 | Set green level 0 and 2nd frame |
| **Parameter2(P2)** | 1 | 1 | 0 | * | * | * | P24 | P23 | P22 | P21 | P20 | Set green level 1 and 2nd frame |
| | | | | | | | | | | | | |
| **Parameter16(P16)** | 1 | 1 | 0 | * | * | * | P164 | P163 | P162 | P161 | P160 | Set green level 15 and 2nd frame |

**(7) Set Green 3 value (Grn3 set) Command: 1; Parameter: 16 (26H)**

| Command | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Grn3 Set** | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | FRAME 3 Grn PWM Set |

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | – |
| **Parameter1(P1)** | 1 | 1 | 0 | * | * | * | P14 | P13 | P12 | P11 | P10 | Set green level 0 and 3rd frame |
| **Parameter2(P2)** | 1 | 1 | 0 | * | * | * | P24 | P23 | P22 | P21 | P20 | Set green level 1 and 3rdframe |
| | | | | | | | | | | | | |
| **Parameter16(P16)** | 1 | 1 | 0 | * | * | * | P164 | P163 | P162 | P161 | P160 | Set green level 15 and 3rd frame |

**(8) Set Green 4 value (Grn4 set) Command: 1;Parameter: 16 (27H)**

| Command | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Grn4 Set** | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | FRAME 4 Grn PWM Set |

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | – |
| **Parameter1(P1)** | 1 | 1 | 0 | * | * | * | P14 | P13 | P12 | P11 | P10 | Set green level 0 and 4th frame |
| **Parameter2(P2)** | 1 | 1 | 0 | * | * | * | P24 | P23 | P22 | P21 | P20 | Set green level 1 and 4thframe |
| | | | | | | | | | | | | |
| **Parameter16(P16)** | 1 | 1 | 0 | * | * | * | P164 | P163 | P162 | P161 | P160 | Set green level 15 and 4th frame |

**The default value of Green level set**

| | GRN1SET | GRN2SET | GRN3SET | GRN4SET |
|---|---|---|---|---|
| | **FRAM1** | **FRAM2** | **FRAM3** | **FRAME4** |
| **green level0** | 00 | 00 | 00 | 00 |
| **green level1** | 02 | 02 | 02 | 02 |
| **green level2** | 05 | 05 | 05 | 05 |
| **green level3** | 07 | 07 | 07 | 08 |

| | | | | |
|---|---|---|---|---|
| **green level4** | 0A | 0A | 0A | 0B |
| **green level5** | 0D | 0D | 0D | 0C |
| **green level6** | 0F | 10 | 0F | 10 |
| **green level7** | 11 | 12 | 11 | 12 |
| **green level8** | 13 | 14 | 13 | 14 |
| **green level9** | 16 | 16 | 16 | 15 |
| **green level10** | 18 | 18 | 18 | 17 |
| **green level11** | 19 | 19 | 19 | 1A |
| **green level12** | 1B | 1B | 1B | 1A |
| **green level13** | 1C | 1C | 1C | 1D |
| **green level14** | 1D | 1D | 1D | 1E |
| **green level15** | 1E | 1E | 1E | 1E |

**The modulation range of Green level set**

| | **GRN1SET** | **GRN2SET** | **GRN3SET** | **GRN4SET** |
|---|---|---|---|---|
| | **FRAM1** | **FRAM2** | **FRAM3** | **FRAME4** |
| **green level0** | 0 | 0 | 0 | 0 |
| **green level1** | 0-7 | 0-7 | 0-7 | 0-7 |
| **green level2** | 0-F | 0-F | 0-F | 0-F |
| **green level3** | 0-F | 0-F | 0-F | 0-F |
| **green level4** | 8-F | 8-F | 8-F | 8-F |
| **green level5** | 0-1F | 0-1F | 0-1F | 0-1F |
| **green level6** | 0-1F | 0-1F | 0-1F | 0-1F |
| **green level7** | 0-1F | 0-1F | 0-1F | 0-1F |
| **green level8** | 10-17 | 10-17 | 10-17 | 10-17 |
| **green level9** | 10-1F | 10-1F | 10-1F | 10-1F |
| **green level10** | 10-1F | 10-1F | 10-1F | 10-1F |
| **green level11** | 10-1F | 10-1F | 10-1F | 10-1F |
| **green level12** | 10-1F | 10-1F | 10-1F | 10-1F |
| **green level13** | 10-1F | 10-1F | 10-1F | 10-1F |
| **green level14** | 10-1F | 10-1F | 10-1F | 10-1F |
| **green level15** | 18-1F | 18-1F | 18-1F | 18-1F |

**(9) Set Blue 1 value (Blu 1 set) Command: 1; Parameter: 16 (28H)**

| Command | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grn 1 Set | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | FRAME 1 Blu PWM Set |

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Command | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | – |
| Parameter1(P1) | 1 | 1 | 0 | * | * | * | P14 | P13 | P12 | P11 | P10 | Set blue level 0 and 1st frame |
| Parameter2(P2) | 1 | 1 | 0 | * | * | * | P24 | P23 | P22 | P21 | P20 | Set blue level 1 and 1st frame |
| | | | | | | | | | | | | |
| Parameter16(P16) | 1 | 1 | 0 | * | * | * | P164 | P163 | P162 | P161 | P160 | Set blue level 15 and 1st frame |

**(10) Set Blue 2 value (Blu2 set) Command: 1; Parameter: 16 (29H)**

| Command | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grn2 Set | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | FRAME 2 Blu PWM Set |

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Command | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | – |
| Parameter1(P1) | 1 | 1 | 0 | * | * | * | P14 | P13 | P12 | P11 | P10 | Set blue level 0 and 2nd frame |
| Parameter2(P2) | 1 | 1 | 0 | * | * | * | P24 | P23 | P22 | P21 | P20 | Set blue level 1 and 2nd frame |
| | | | | | | | | | | | | |
| Parameter16(P16) | 1 | 1 | 0 | * | * | * | P164 | P163 | P162 | P161 | P160 | Set blue level 15 and 2nd frame |

**(11) Set Blue 3 value (Blu3 set) Command: 1; Parameter: 16 (2AH)**

| Command | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grn3 Set | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | FRAME 3 Blu PWM Set |

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Command | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | – |
| Parameter1(P1) | 1 | 1 | 0 | * | * | * | P14 | P13 | P12 | P11 | P10 | Set blue level 0 and 3rd frame |
| Parameter2(P2) | 1 | 1 | 0 | * | * | * | P24 | P23 | P22 | P21 | P20 | Set blue level 1 and 3rdframe |
| | | | | | | | | | | | | |
| Parameter16(P16) | 1 | 1 | 0 | * | * | * | P164 | P163 | P162 | P161 | P160 | Set blue level 15 and 3rd frame |

**(12) Set Blue 4 value (Blu4 set) Command: 1; Parameter: 16 (2BH)**

| Command | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grn4 Set | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | FRAME 4 Blu PWM Set |

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Command | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | – |
| Parameter1(P1) | 1 | 1 | 0 | * | * | * | P14 | P13 | P12 | P11 | P10 | Set blue level 0 and 4th frame |
| Parameter2(P2) | 1 | 1 | 0 | * | * | * | P24 | P23 | P22 | P21 | P20 | Set blue level 1 and 4thframe |
| | | | | | | | | | | | | |
| Parameter16(P16) | 1 | 1 | 0 | * | * | * | P164 | P163 | P162 | P161 | P160 | Set blue level 15 and 4th frame |

**The default value of Blue level set**

| | GRN1SET | GRN2SET | GRN3SET | GRN4SET |
|---|---|---|---|---|
| | FRAM1 | FRAM2 | FRAM3 | FRAME4 |
| blue level0 | 00 | 00 | 00 | 00 |
| blue level1 | 02 | 02 | 02 | 02 |
| blue level2 | 05 | 05 | 05 | 05 |
| blue level3 | 07 | 07 | 07 | 08 |
| blue level4 | 0A | 0A | 0A | 0B |
| blue level5 | 0D | 0D | 0D | 0C |
| blue level6 | 0F | 10 | 0F | 10 |
| blue level7 | 11 | 12 | 11 | 12 |
| blue level8 | 13 | 14 | 13 | 14 |
| blue level9 | 16 | 16 | 16 | 15 |
| blue level10 | 18 | 18 | 18 | 17 |
| blue level11 | 19 | 19 | 19 | 1A |
| blue level12 | 1B | 1B | 1B | 1A |
| blue level13 | 1C | 1C | 1C | 1D |
| blue level14 | 1D | 1D | 1D | 1E |
| blue level15 | 1E | 1E | 1E | 1E |

**The modulation range of Blue level set**

| | GRN1SET | GRN2SET | GRN3SET | GRN4SET |
|---|---|---|---|---|
| | FRAM1 | FRAM2 | FRAM3 | FRAME4 |
| **blue level0** | 0 | 0 | 0 | 0 |
| **blue level1** | 0-7 | 0-7 | 0-7 | 0-7 |
| **blue level2** | 0-F | 0-F | 0-F | 0-F |
| **blue level3** | 0-F | 0-F | 0-F | 0-F |
| **blue level4** | 8-F | 8-F | 8-F | 8-F |
| **blue level5** | 0-1F | 0-1F | 0-1F | 0-1F |
| **blue level6** | 0-1F | 0-1F | 0-1F | 0-1F |
| **blue level7** | 0-1F | 0-1F | 0-1F | 0-1F |
| **blue level8** | 10-17 | 10-17 | 10-17 | 10-17 |
| **blue level9** | 10-1F | 10-1F | 10-1F | 10-1F |
| **blue level10** | 10-1F | 10-1F | 10-1F | 10-1F |
| **blue level11** | 10-1F | 10-1F | 10-1F | 10-1F |
| **blue level12** | 10-1F | 10-1F | 10-1F | 10-1F |
| **blue level13** | 10-1F | 10-1F | 10-1F | 10-1F |
| **blue level14** | 10-1F | 10-1F | 10-1F | 10-1F |
| **blue level15** | 18-1F | 18-1F | 18-1F | 18-1F |

**(13) ANASET Command 1; Parameter: 3 (32H)**

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | – |
| **Parameter1(P1)** | 1 | 1 | 0 | * | * | * | * | * | P12 | P11 | P10 | OSC frequency Adjustment |
| **Parameter2(P2)** | 1 | 1 | 0 | * | * | * | * | * | * | P21 | P20 | Booster Efficiency Set |
| **Parameter3(P3)** | 1 | 1 | 0 | * | * | * | * | * | P32 | P31 | P30 | Bias setting |

P1: Oscillator frequency adjustment(CL division ratio ,plz reference “Command CAH”)

| P12 | P11 | P10 | Frame frequency | OSC Frequency CL=X1(KHz) | Note |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 77 ± 5% | 8.09 ± 5% | Default |
| 0 | 0 | 1 | 80 ± 20% | 8.40 ± 20% | |
| 0 | 1 | 0 | 87 ± 20% | 9.14 ± 20% | |
| 0 | 1 | 1 | 100 ± 20% | 10.50 ± 20% | |
| 1 | 0 | 0 | 105 ± 20% | 11.03 ± 20% | |
| 1 | 0 | 1 | 118 ± 20% | 12.39 ± 20% | |
| 1 | 1 | 0 | 133 ± 20% | 13.97 ± 20% | |
| 1 | 1 | 1 | 155 ± 20% | 16.28 ± 20% | |

Frame Frequency = OSC Frequency/(Duty+1)

Example: using 96duty ,(P12,P11,P10)=(000),Frame Frequency=8.085k/(96+1)=83.35Hz

P2: Booster Efficiency set(Suggest using default value)

| P21 | P20 | Frequency(Hz) |
|---|---|---|
| 0 | 0 | Level 1 |
| 0 | 1 | Level 2 (Default) |
| 1 | 0 | Level 3 |
| 1 | 1 | Level 4 |

P3: Select LCD bias ratio of the voltage required for driving the LCD.

| P32 | P31 | P30 | LCD bias |
|---|---|---|---|
| 0 | 0 | 0 | 1/12 |
| 0 | 0 | 1 | 1/11 |
| 0 | 1 | 0 | 1/10 |
| 0 | 1 | 1 | 1/9 |
| 1 | 0 | 0 | 1/8 |
| 1 | 0 | 1 | 1/7 |
| 1 | 1 | 0 | 1/6 |
| 1 | 1 | 1 | 1/5 |

**(14) Color Dither OFF (DITHOFF) Command: 1; Parameter: None (34H)**

Turn off the dithering circuit.

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Command | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |

**(15) Color Dither ON (DITHON) Command: 1; Parameter: None (35H)**

Turn on the dithering circuit.

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |

**(16) Control EEPROM (EPCTIN) Command: 1; Parameter: 1 (CDH)**

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 |
| **Parameter (P1)** | 1 | 1 | 0 | 0 | 0 | P15 | 0 | 0 | 0 | 0 | 0 |

P15: when setting “1” **è** The Write Enable of EEPROM will be opened.

P15: when setting “0” **è** The Read Enable of EEPROM will be opened.

**(17) Cancel EEPROM (EPCOUT) Command: 1;Parameter:None (CCH)**

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |

**(18) Write data to EEPROM (EPMWR) Command: 1; Parameter: None (FCH)**

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |

**(19) Read data from EEPROM (EPMWR) Command: 1; Parameter: None (FDH)**

| | A0 | RD | RW | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |

## EXT="1" or "0"

**(1) Extension instruction disable (EXT IN) Command:1 Parameter: None (30H)**

Use the "Ext=0" command table

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |

**(2) Extension instruction enable (EXT OUT) Command:1 Parameter: None (31H)**

Use the extended command table (EXT="1")

| | A0 | RD | WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |

## 8.5 Referential Instruction Setup Flow

### 8.5.1 EEPROM Setting Flow

The ST7624 chip provide the Write and Read function to write the Electronic Control value and Built-in resistance ratio into and read them from the built-in EEPROM. Using the Write and Read functions, you can store these values appropriate to each LCD panel. This function is very convenient for user in setting from some different panel's voltage. But using this function must attention the setting procedure. Please see the following diagram.

**Note: When "Writing" value to EEPROM, the voltage of $VOUT_{IN}$ must be more than 17V.**

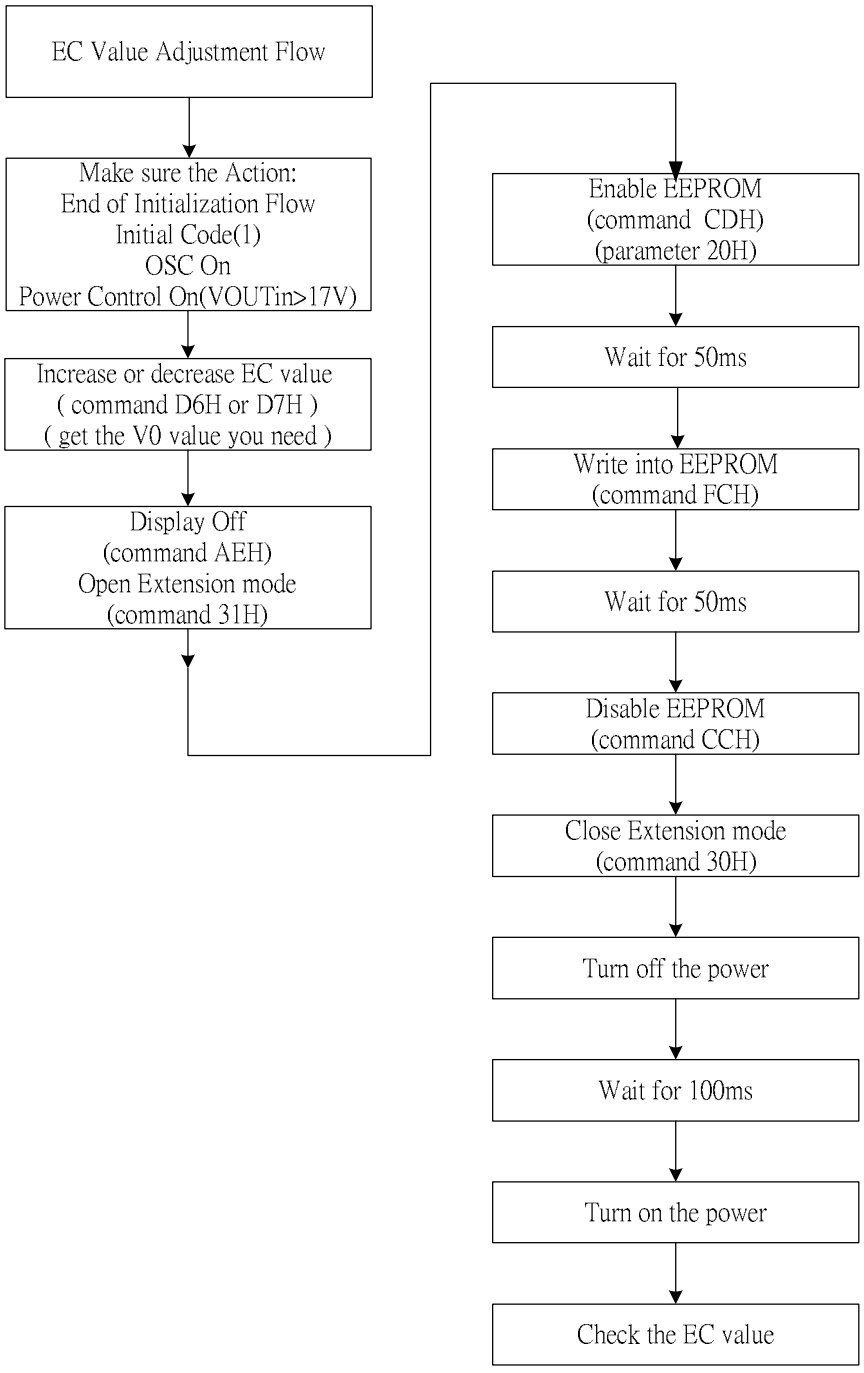



**Figure 8.5.1.1 Flow of EC value adjustment and writing into EEPROM**

**Note: When "Reading" value from EEPROM, the voltage of $VOUT_{IN}$ must be more than 10V.**

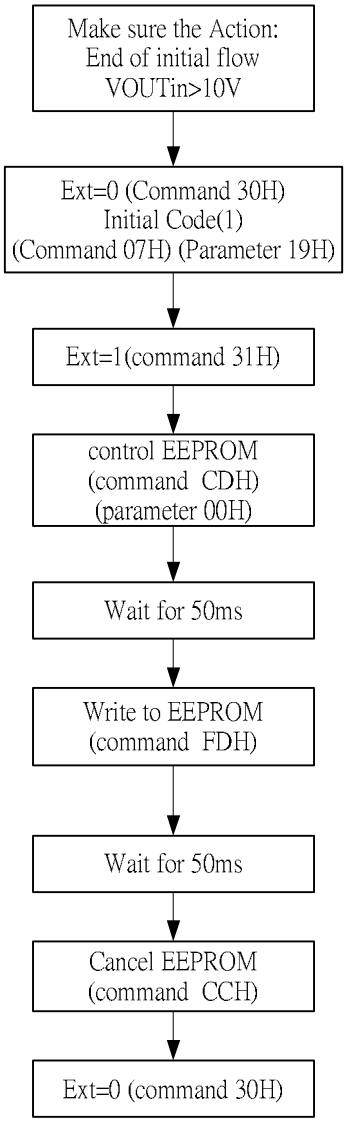



**Figure 8.5.1.2 EEPROM Reading flow**

## Example：EEPROM Read Operation

```
void ReadEEPROM( void )
    {

        Write( COMMAND, 0x0030 );           // Ext = 0
        Write( COMMAND, 0x0007 );           // Initial code (1)
        Write( DATA, 0x0019 );

        Write( COMMAND, 0x0031 );           // Ext = 1
        Write( COMMAND, 0x00CD );           // EEPROM ON
        Write( DATA, 0x0000 );              // Entry "Read Mode"
        Delay( 50ms );                      // Waite for EEPROM Operation ( 50ms )
        Write( COMMAND, 0x00FD );           // Start EEPROM Reading Operation
        Delay( 50ms );                      // Waite for EEPROM Operation ( 50ms )
        Write( COMMAND, 0x00CC );           // Exist EEPORM Mode step.1
        Write( COMMAND, 0x0030 );           // Exist EEPORM Mode step.2

    }
```

## Example：EEPROM Write Operation

```
void WriteEEPROM( void )
    {

        Write( COMMAND, 0x0030 );           // Ext = 0
        Write( COMMAND, 0x0007 );           // Initial code(1)
        Write( DATA, 0x0019 );

        Write( COMMAND, 0x00AE );           //Display Off
        Write( COMMAND, 0x0031 );           // Ext = 1
        Write( COMMAND, 0x00CD );           // EEPROM ON
        Write( DATA, 0x0020 );              // Entry "Write Mode"
        Delay( 50ms );                      // Waite for EEPROM Operation ( 50ms )
        Write( COMMAND, 0x00FC );           // Start EEPROM Writing Operation
        Delay( 50ms );                      // Waite for EEPROM Operation ( 50ms )
        Write( COMMAND, 0x00CC );           // Exist EEPORM Mode step.1
        Write( COMMAND, 0x0030 );           // Exist EEPORM Mode step.2

    }
```

### 8.5.2 Initializing with the Built-in Power Supply Circuits

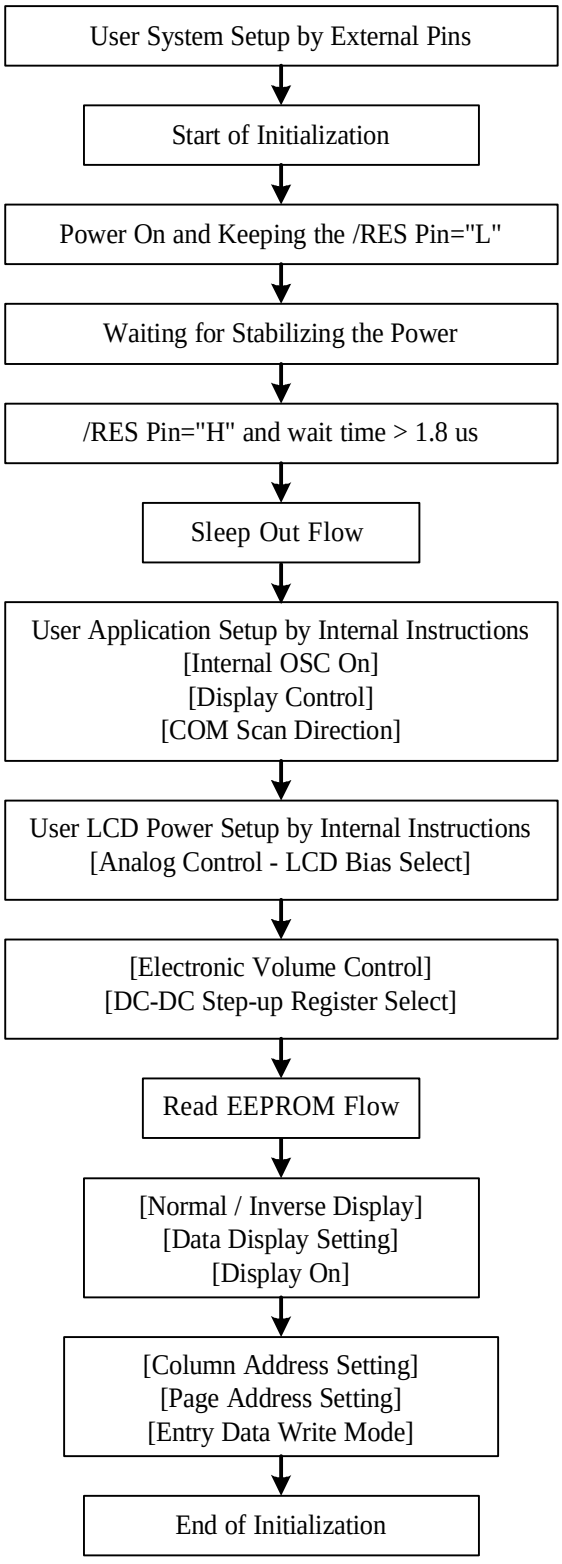



**Figure 8.5.2.1 Initializing with the Built-in Power Supply Circuits**

## Example：Initial code for 96X96

void ST7624_Init( void )

{

| | |
|---|---|
| Write( COMMAND, 0x0030 ); | //Ext = 0 |
| | |
| SleepOut() | //Sleep Out Flow |
| | |
| Write( COMMAND, 0x00D1 ); | //OSC On |
| Write( COMMAND, 0x0020 ); | //Power Control Set |
| Write( DATA, 0x000B ); | //Booster Regulator Follower On |
| | |
| Write( COMMAND, 0x0081 ); | //Electronic Control |
| Write( DATA, 0x0004 ); | //Vop=14.0V |
| Write( DATA, 0x0004 ); | |
| | |
| Write( COMMAND, 0x00CA ); | //Display Control |
| Write( DATA, 0x0000 ); | //CL=X1 |
| Write( DATA, 0x0017 ); | //Duty=96 |
| Write( DATA, 0x0000 ); | //FR Inverse-Set Value |
| | |
| Write( COMMAND, 0x00A6 ); | // Normal Display |
| | |
| Write( COMMAND, 0x00BB ); | //COM Scan Direction |
| Write( DATA, 0x0001 ); | // 0→51 103→52 |
| | |
| Write( COMMAND, 0x00BC ); | //Data Scan Direction |
| Write( DATA, 0x0000 ); | //Normal |
| Write( DATA, 0x0000 ); | //RGB Arrangement |
| Write( DATA, 0x0001 ); | //65K COLOR |
| | |
| Write( COMMAND, 0x0075 ); | // Page Address Set |
| Write( DATA, 0x0000 ); | //Start Page=0 |
| Write( DATA, 0x005F ); | //End Page =95 |
| | |
| Write( COMMAND, 0x0015 ); | //Column Address Set |
| Write( DATA, 0x0000 ); | //Start Column=0 |
| Write( DATA, 0x005F ); | //End Column =95 |
| | |
| Write( COMMAND, 0x0031 ); | //Ext = 1 |
| | |
| Write( COMMAND, 0x0032 ); | //Analog Circuit Set |
| Write( DATA, 0x0000 ); | //OSC Frequency =000 (Default) |
| Write( DATA, 0x0001 ); | //Booster Efficiency=01(Default) |
| Write( DATA, 0x0001 ); | //Bias=1/11 |
| | |
| Write( COMMAND, 0x0034 ); | //Dithering Off |
| | |
| ReadEEPROM(); | //Read EEPROM Flow |
| | |
| Write( COMMAND, 0x00AF ); | //Display On |

}

### 8.5.3 Sleep In/Out

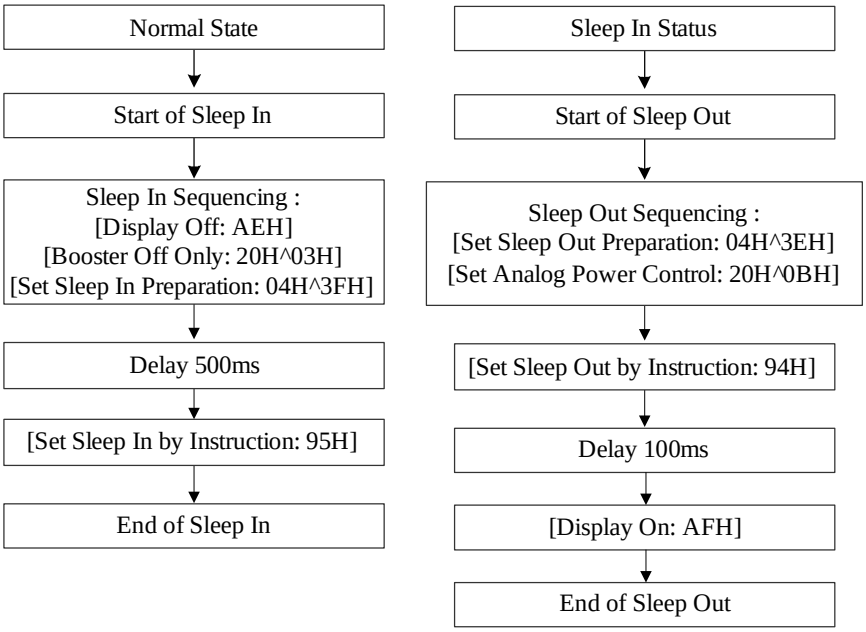



**Fig 8.5.3.1 Sleep In/Out**

### Example：Sleep In Operation

```
void SleepIn( void )
     {

        Write( COMMAND, 0x0030 );          // Ext = 0
        Write( COMMAND, 0x00AE );          // Display Off
        Write( COMMAND, 0x0020);           // Power Control
        Write( DATA, 0x0003 );             // B/F/R = Off/On/On
        Write( COMMAND, 0x0004 );          // Sleep Preparation
        Write( DATA, 0x003F );             // Sleep In Ready
        Delay( 500ms);
        Write( COMMAND, 0x0095 );          // Sleep In

     }
```

### Example：Sleep Out Operation

```
void SleepOut( void )
     {

        Write( COMMAND, 0x0030 );          // Ext = 0
        Write( COMMAND, 0x0004 );          // Sleep Preparation
        Write( DATA, 0x003E );             // Sleep Out Ready
        Write( COMMAND, 0x0020 );          // Power Control
        Write( DATA, 0x000B );             // B/F/R = On/On/On
        Write( COMMAND, 0x0094 );          // Sleep Out
        Delay( 100ms );
        Write( COMMAND, 0x00AF );          // Display On

     }
```

### 8.5.4 Data Displaying

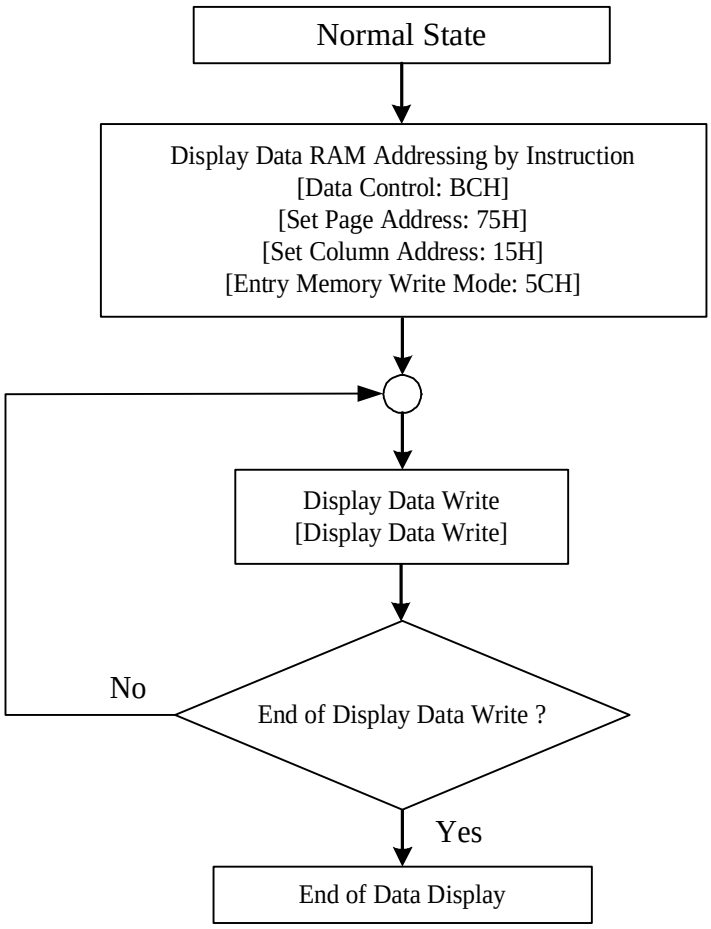



**Figure 8.5.4.1 Data Displaying**

### Example：Display for 104X104

```
void Display( char *pattern )
        {

          unsigned char i, j;

          Write( COMMAND, 0x0030 );                    // Ext = 0
          Write( COMMAND, 0x0015 );                    // Column address set
          Write( DATA, 0 );                            // From column0 to column103
          Write( DATA, 103 );
          Write( COMMAND, 0x0075 );                    // Page address set
          Write( DATA, 0 );                            // From page0 to page103
          Write( DATA, 103 );
          Write( COMMAND, 0x005C )                     // Entry Memory Write Mode
          for( j = 0; j < 104 ; j++ )
              for( i = 0 ; i < 104 ; i++ )
                  Write( DATA, pattern[j*104+i] );     // Display Data Write


        }
```

### 8.5.5 Partial Display In/Out

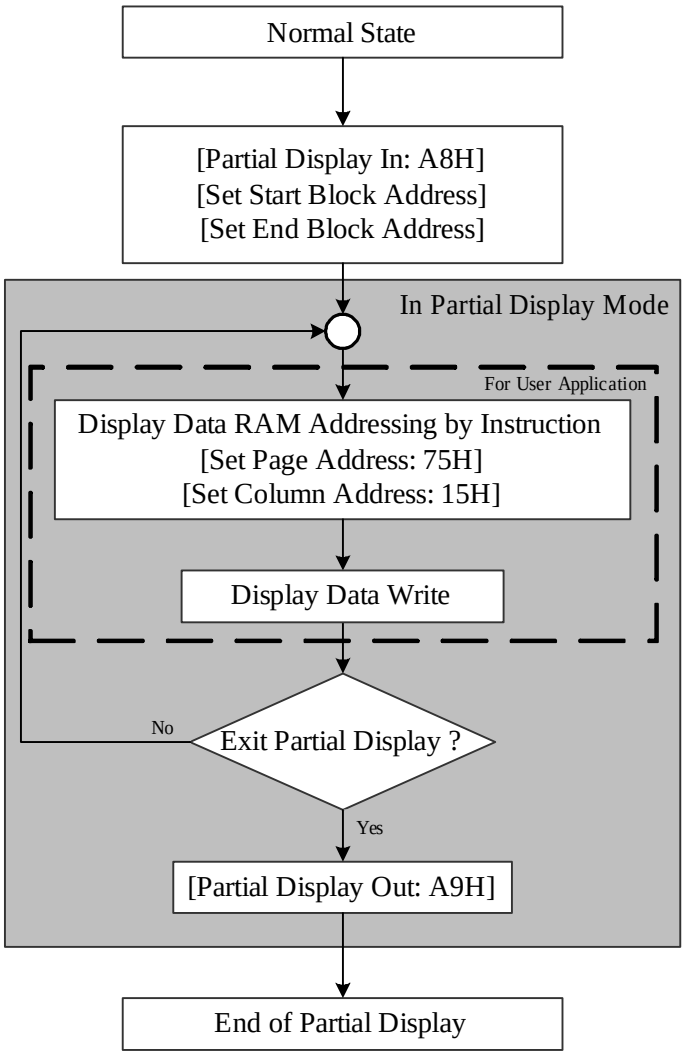



**Figure 8.5.5.1 Partial Display In/Out**

## Example：Partial Display In Operation

```
void PartailIn( unsigned char start_block, unsigned char end_block )
     {
        Write( COMMAND, 0x0030 );              // Ext = 0
        Write( COMMAND, 0x00A8);               // Partial Display In Function
        Write( DATA, start_block );            // Start Block
        Write( DATA, end_block );              // End Block

     }

void PartailOut( void )
     {
        Write( COMMAND, 0x0030 );              // Ext = 0
        Write( COMMAND, 0x00A9 );              // Partial Display Out Function

     }
```

```
extern unsigned char *display_pattern;
void main()
    {

        PartialIn( 11, 18 );                    // entry partial display mode

        Windowing( 0, 11*4, 103, 18*4 );        // set the page and column range
        PartialDisplay( display_pattern );      // Fill the data into partial display area
                .
                .
                .
        PartialOut();                           // Out of partial display mode

    }
```

### 8.5.6 Scroll Display

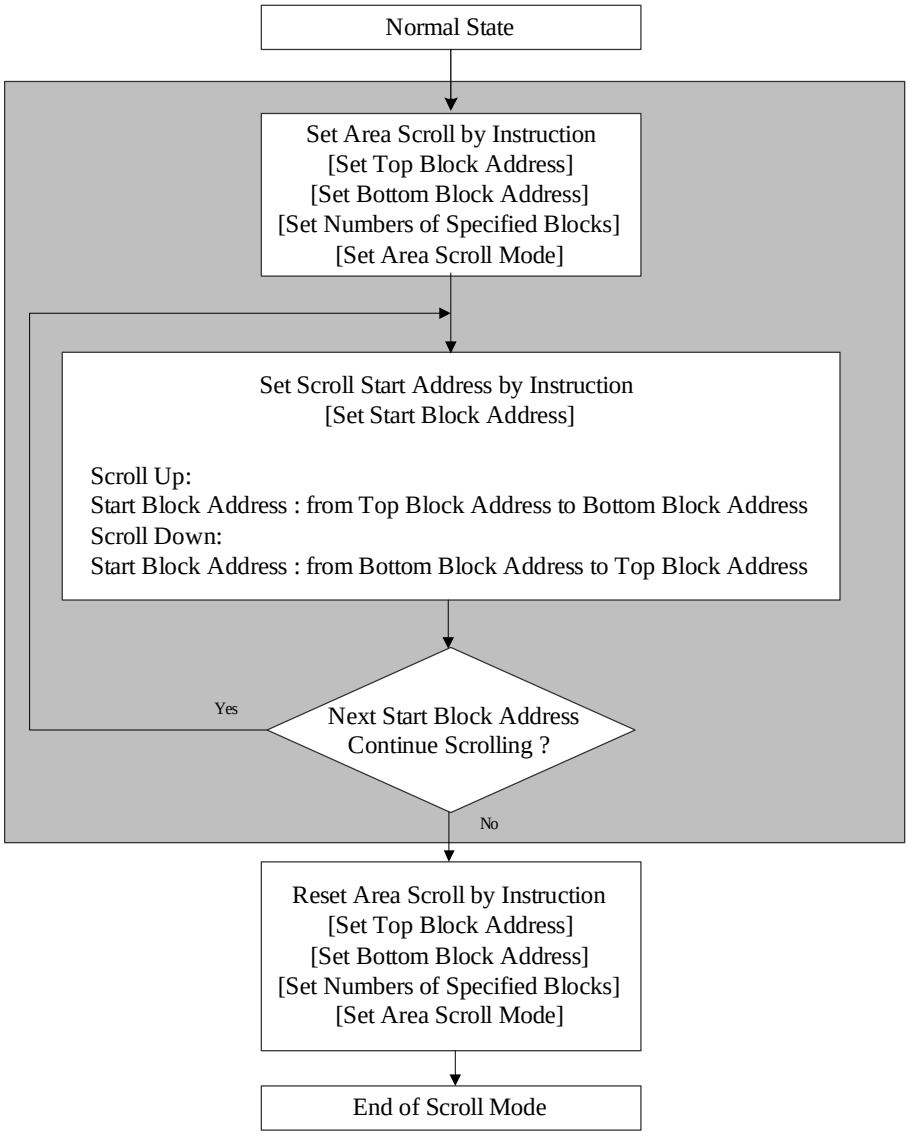



**Figure 8.5.6.1 Scroll Display**

## Example：Screen Scroll Operation

```
void CenterScreenScroll( void )
     {

        Write( COMMAND, 0x0030 );          // Ext = 0
        Write( COMMAND, 0x00AA);           // Partial Display In Function
        Write( DATA, 0x000A );             // Top_Block=10
        Write( DATA, 0x0014 );             // Bottom_Block=20
        Write( DATA, 0x0014 );             // Number of Specified Blocks=Bottom_Block=20
        Write( DATA, 0x0000 );             // Area Scroll Type=Center Screen Scroll

        ScrollUp() or ScrollDown();        // Scroll Up or Scroll Down

     }

void TopScreenScroll( void )
     {

        Write( COMMAND, 0x0030 );          // Ext = 0
        Write( COMMAND, 0x00AA);           // Partial Display In Function
        Write( DATA, 0x0000 );             // Top_Block=0
        Write( DATA, 0x0014 );             // Bottom_Block=20
        Write( DATA, 0x0014 );             // Number of Specified Blocks=Bottom_Block=20
        Write( DATA, 0x0001 );             // Area Scroll Type=Top Screen Scroll

        ScrollUp() or ScrollDown();        // Scroll Up or Scroll Down

     }

void BottomScreenScroll( void )
     {

        Write( COMMAND, 0x0030 );          // Ext = 0
        Write( COMMAND, 0x00AA);           // Partial Display In Function
        Write( DATA, 0x000A );             // Top_Block=10
        Write( DATA, 0x0019 );             // Bottom_Block=25
        Write( DATA, 0x0019 );             // Number of Specified Blocks=Bottom_Block=25
        Write( DATA, 0x0002 );             // Area Scroll Type=Bottom Screen Scroll

        ScrollUp() or ScrollDown();        // Scroll Up or Scroll Down

     }
void WholeScreenScroll( void )
     {

        Write( COMMAND, 0x0030 );          // Ext = 0
        Write( COMMAND, 0x00AA);           // Partial Display In Function
        Write( DATA, 0x0000 );             // Top_Block=0
        Write( DATA, 0x0019 );             // Bottom_Block=25
        Write( DATA, 0x0019 );             // Number of Specified Blocks=Bottom_Block=25
        Write( DATA, 0x0003 );             // Area Scroll Type=Whole Screen Scroll

        ScrollUp() or ScrollDown();        // Scroll Up or Scroll Down

     }
```

```
void ScrollUp( void )
     {

        Write( COMMAND, 0x0030 );          // Ext = 0
        Write( COMMAND, 0x00AB);           // Scroll Start Set
        Write( DATA, Top_Block);           // Start Block Address=Top_Block
        Delay();                           // Delay

        Write( COMMAND, 0x00AB);           // Scroll Start Set
        Write( DATA, Top_Block +1 );       // Start Block Address= Top_Block+1
        Delay();                           // Delay

        Write( COMMAND, 0x00AB);           // Scroll Start Set
        Write( DATA, Top_Block +2 );       // Start Block Address= Top_Block +2
        Delay();                           // Delay
        ……
        ……
        Write( COMMAND, 0x00AB);           // Scroll Start Set
        Write( DATA, Bottom_Block );       // Start Block Address= Bottom_Block
        Delay();                           // Delay

     }

void ScrollDown( void )
     {

        Write( COMMAND, 0x0030 );          // Ext = 0
        Write( COMMAND, 0x00AB);           // Scroll Start Set
        Write( DATA, Bottom_Block);        // Start Block Address= Bottom_Block
        Delay();                           // Delay

        Write( COMMAND, 0x00AB);           // Scroll Start Set
        Write( DATA, Bottom_Block -1 );    // Start Block Address= Bottom_Block -1
        Delay();                           // Delay

        Write( COMMAND, 0x00AB);           // Scroll Start Set
        Write( DATA, Bottom_Block -2 );    // Start Block Address= Bottom_Block -2
        Delay();                           // Delay
        ……
        ……
        Write( COMMAND, 0x00AB);           // Scroll Start Set
        Write( DATA, Top _Block );         // Start Block Address= Top_Block
        Delay();                           // Delay

     }
```

### 8.5.7 Read-Modify-Write Cycle

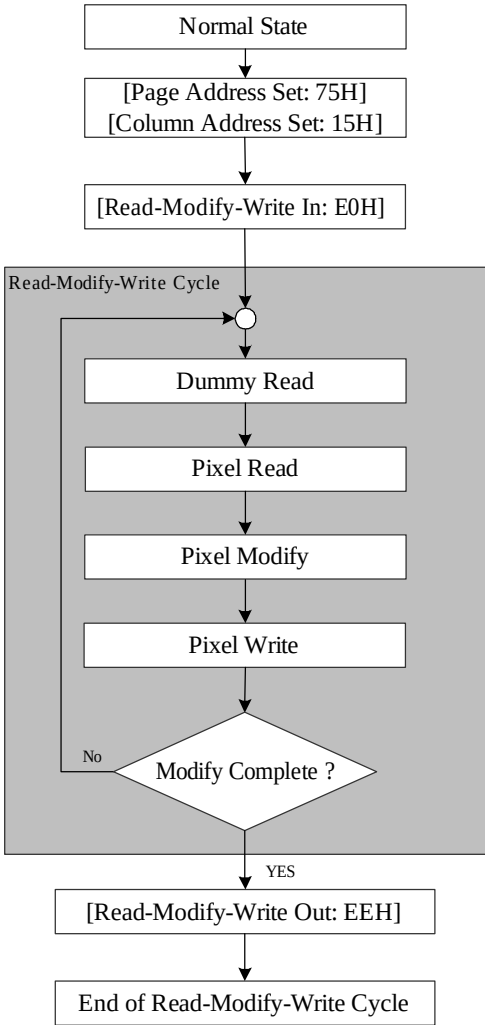



**Figure 8.5.7.1 Read-Write-Modify Cycle**

## Example：Read-Write-Modify Cycle

```
void ReadModifyWriteIn( void )
        {
          Write( COMMAND, 0x0030 );      // Ext = 0
          Write( COMMAND, 0x00E0 );      // Entry the Read-Modify-Write mode
        }

void ReadModifyWriteOut( void )
        {
          Write( COMMAND, 0x0030 );      // Ext = 0
          Write( COMMAND, 0x00EE );      // Out of partial display mode
        }

extern unsigned char *display_pattern;
void main()
    {
        unsigned pixel, i;

        Windowing( 11, 31, 80, 50 );          // set the page and column range
```

```
        ReadModifyWriteIn();                    // entry the Read-Modify-Write mode

        for( i = 0 ; i < 1000 ; i++ )
          {
            Read( DATA );                       // For dummy read
            pixel = Read( DATA );               // Pixel read
            pixel = pixel & 0x07FF;             // Pixel modify: red filter
            Write( DATA, pixel );
          }

        ReadModifyWriteOut();                   // Out of Read-Modify-Write mode

    }
```

### 8.5.8 Display On / OFF

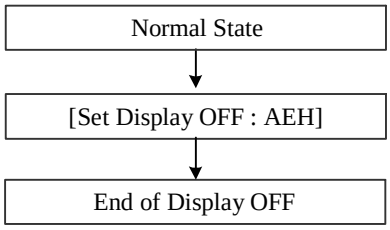



**Figure 8.5.8.1 Display Off**

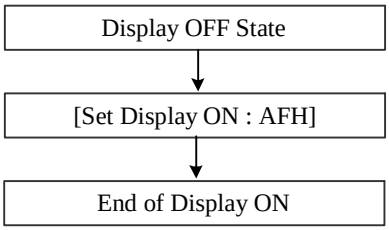



**Figure 8.5.8.2 Display On**

### Example：Display OFF Operation

```
void DisplayOff( void )
    {
```

| | |
|---|---|
| Write( COMMAND, 0x0030 ); | // Ext = 0 |
| Write( COMMAND, 0x00AE ); | // Display Off |

```
    }
```

### Example：Display ON Operation

```
void DisplayOn( void )
    {
```

| | |
|---|---|
| Write( COMMAND, 0x0030 ); | // Ext = 0 |
| Write( COMMAND, 0x00AF ); | // Display On |

```
    }
```

### 8.5.9 Power OFF

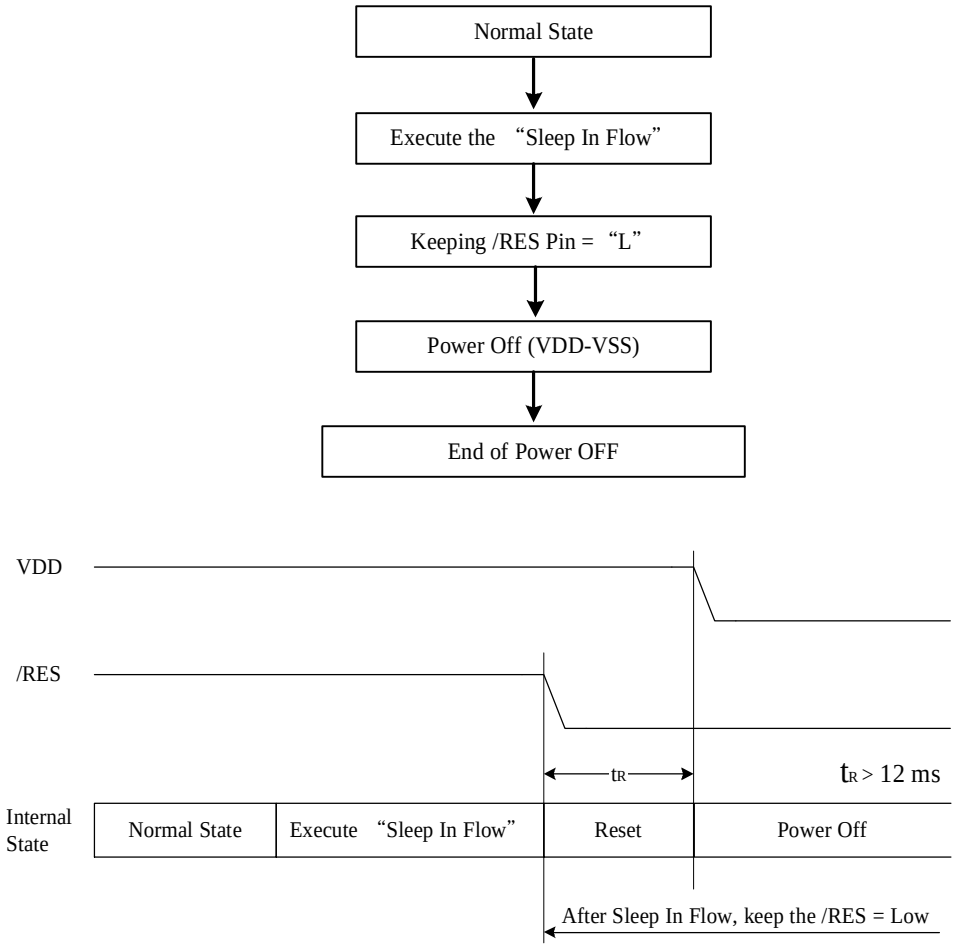


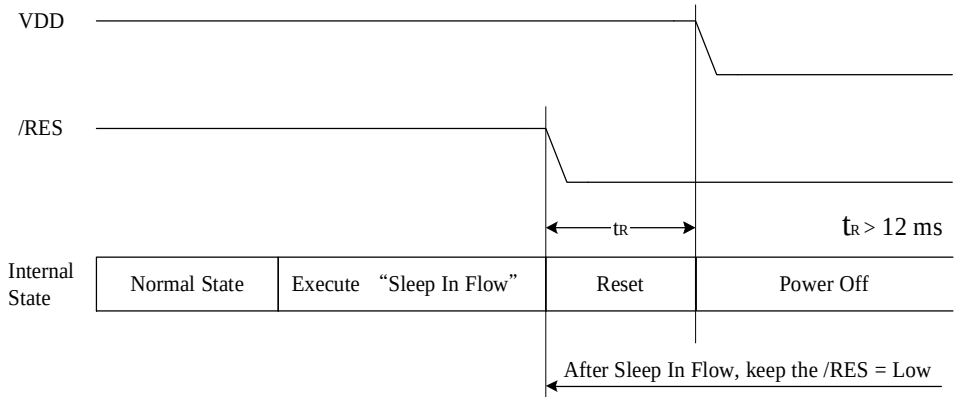

**Figure 8.5.9.1 Power off**

**Note：The sequence is that users must set the VDD to low after keeping the /RES=low time longger than 12ms.**

## 9. LIMITING VALUES

In accordance with the Absolute Maximum Rating System; see notes 1 and 2.

| Parameter | Symbol | Conditions | Unit |
|---|---|---|---|
| Power Supply Voltage | VDD, VDD1~5 | –0.5 ~ +4.0 | V |
| Power supply voltage (VDD standard) | $VOUT_{IN}$ | –0.5 ~ +20 | V |
| Power supply voltage (VDD standard) | V1, V2, V3, V4 | 0.3 to $VOUT_{IN}$ | V |
| Input voltage | VIN | –0.5 to VDD+0.5 | V |
| Output voltage | VO | –0.5 to VDD+0.5 | V |
| Operating temperature (Die) | TOPR | –30 to +85 | °C |
| Storage temperature (Die) | TSTR | –40 to +125 | °C |




**Notes**

1. Stresses above those listed under Limiting Values may cause permanent damage to the device.
2. Parameters are valid over operating temperature range unless otherwise specified. All voltages are with respect to $V_{SS}$ unless otherwise noted.
3. Insure that the voltage levels of V1, V2, V3, and V4 are always such that

   $VOUT_{IN} \geqq V0 \geqq V1 \geqq V2 \geqq V3 \geqq V4 \geqq Vss$

4. V0 tolerance +/- 0.1V

## 10. HANDLING

Inputs and outputs are protected against electrostatic discharge in normal handling. However, to be totally safe, it is desirable to take normal precautions appropriate to handling MOS devices (see “Handling MOS devices”).

## 11. DC CHARACTERISTICS

**$V_{DD}$ = 2.4 V to 3.3V; $V_{SS}$ = 0 V; $V_0$ = 3.76 to 18.0V; $T_{amb}$ = -30℃ to +85℃; unless otherwise specified.**

| Item | | Symbol | Condition | | Rating | | | Units | Applicable Pin |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Min. | Typ. | Max. | | |
| Operating Voltage (1) | | VDD<br>VDD1 | | | 2.4 | — | 3.3 | V | Vss |
| Operating Voltage (2) | | VDD2<br>VDD3<br>VDD4<br>VDD5 | | | 2.4 | — | 3.3 | V | VSS |
| High-level Input Voltage | | VIHC | | | 0.8 x VDD | — | VDD | V | *2 |
| Low-level Input Voltage | | VILC | | | VSS | — | 0.2 x VDD | V | *2 |
| High-level Output Voltage | | VOHC | | | 0.8 x VDD | — | VDD | V | *3 |
| Low-level Output Voltage | | VOLC | | | VSS | — | 0.2 x VDD | V | *3 |
| Input leakage current | | ILI | VIN = VDD or VSS | | –1.0 | — | 1.0 | μA | *4 |
| Output leakage current | | ILO | VIN = VDD or VSS | | –3.0 | — | 3.0 | μA | *5 |
| Liquid Crystal Driver ON Resistance | | RON | Ta = 25°C (Relative To VSS) | $VOUT_{IN}$ = 15.0 V | — | 2.0 | — | KΩ | SEGn COMn *6 |
| | | | | $VOUT_{IN}$ = 8.0 V | — | 3.2 | — | | |
| Oscillator Frequency | Internal Oscillator | fOSC | 1/104 duty | Ta = 25°C<br>31 PWM | — | 8.09 | — | kHz | *7 |
| | External Input | fCL | | | — | 250.79 | — | kHz | OSC |
| | Frame frequency | fFRAME | | | fFRAME=fOSC/(Duty+1) | | | Hz | |

| Item | | Symbol | Condition | Rating | | | Units | Applicable Pin |
|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | | |
| Internal Power | Input voltage | VDD | (Relative To VSS) | 2.4 | — | 3.3 | V | |
| | Supply Step-up output voltage Circuit | $VOUT_{OUT}$ | (Relative To VSS) | — | — | 18 | V | $VOUT_{OUT}$ |
| | Voltage regulator Circuit Operating Voltage | $VOUT_{IN}$ | (Relative To VSS) | — | — | 18 | V | $VOUT_{IN}$ |

Dynamic Consumption Current : During Display, with the Internal Power Supply OFF Current consumed by total ICs when an external power supply is used .

| Test pattern | Symbol | Condition | Rating | | | Units | Notes |
|---|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | | |
| Display Pattern Normal | ISS | VDD = 2.8V, BoosterX7<br>V0 – VSS = 14.0 V, 1/11 Bias | — | 350(die) | — | μA | *8 |
| Power Down | ISS | Ta = 25°C | — | — | 10 | μA | die |

PS.V0 tolerance +/- 0.1V

**Notes to the DC characteristics**

1. The maximum possible $V_{OUT}$ voltage that may be generated is dependent on voltage, temperature and (display) load.
2. Internal clock
3. Power-down mode. During power down all static currents are switched off.
4. If external $V_{OUT}$, the display load current is not transmitted to $I_{DD}$.
5. $V_{OUT}$ external voltage applied to $VOUT_{IN}$ pin; $VOUT_{IN}$ disconnected from $VOUT_{OUT}$

**References for items market with ***

*1 While a broad range of operating voltages is guaranteed, performance cannot be guaranteed if there are sudden fluctuations to the voltage while the MPU is being accessed.

*2 The A0, D0 to D5, D6 (SI), D7 (SCL), D8 to D15, /RD (E), /WR ,/(R/W), /CS, and RESB terminals.

*3 The D0 to D7 terminals.

*4 The A0,/RD (E), /WR ,/(R/W), /CS, and RESB terminals.

*5 Applies when the D0 to D5, D6 (SI), D7 (SCL) terminals are in a high impedance state.

*6 These are the resistance values for when a 0.1 V voltage is applied between the output terminal SEGn or COMn and the various power supply terminals (V1, V2, V3, and V4). These are specified for the operating voltage range.
RON = 0.1 V /ΔI (Where ΔI is the current that flows when 0.1 V is applied while the power supply is ON.)

*7 The relationship between the oscillator frequency and the frame rate frequency.

*8,9It indicates the current consumed on ICs alone when the internal oscillator circuit and display are turned on.

# 12. TIMING CHARACTERISTICS

**Condition：Bare Die**

**System Bus Read/Write Characteristics 1 (For the 8080 Series MPU)**

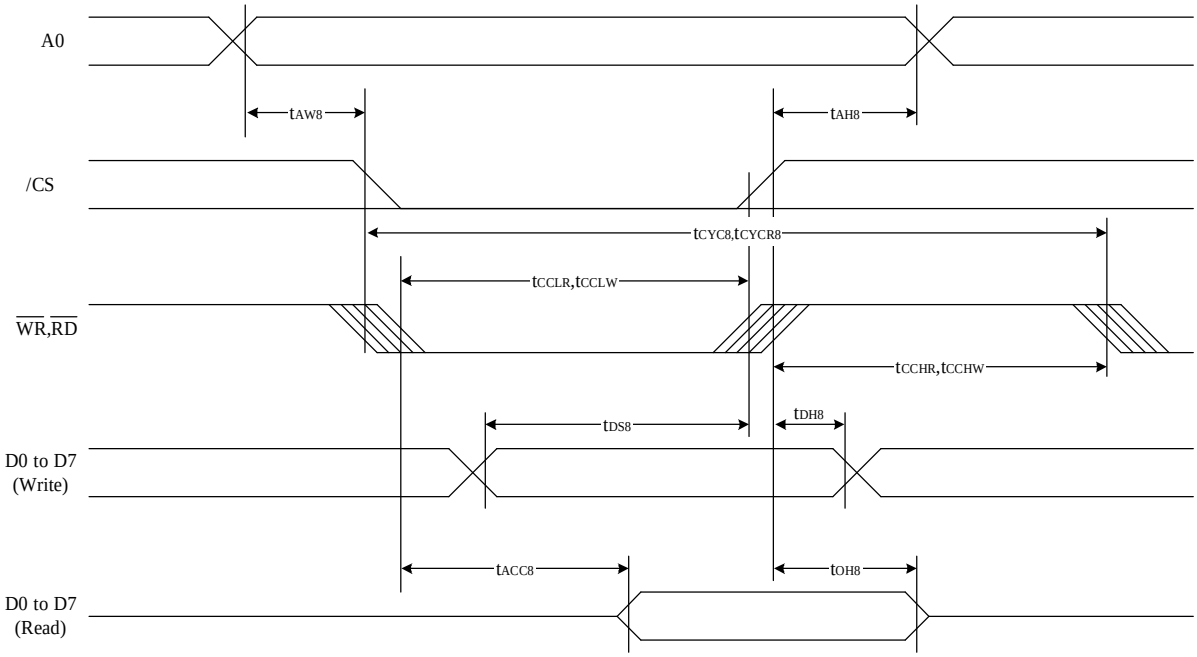



**Figure 39.**

(VDD = 3.3V , Ta =-30°C~85°C, die)

| Item | Signal | Symbol | Condition | Rating | | Units |
|---|---|---|---|---|---|---|
| | | | | Min. | Max. | |
| Address hold time | A0 | tAH8 | | 10 | — | ns |
| Address setup time | | tAW8 | | 10 | — | |
| System cycle time | WR | tCYC8 | | 150 | — | |
| System cycle frequency | | fCYC8 | | 6.67 | — | MHz |
| Enable L pulse width (WRITE) | | tCCLW | | 50 | — | ns |
| Enable H pulse width (WRITE) | | tCCHW | | 100 | — | |
| System cycle time(READ) | RD | tCYCR8 | | 490 | | |
| Enable L pulse width (READ) | | tCCLR | | 140 | — | |
| Enable H pulse width (READ) | | tCCHR | | 350 | — | |
| WRITE data setup time | D0 to D7 | tDS8 | | 70 | — | |
| WRITE data hold time | | tDH8 | | 10 | — | |
| READ access time | | tACC8 | CL = 100 pF | — | 70 | |
| READ Output disable time | | tOH8 | CL = 100 pF | — | 50 | |

(VDD = 2.8 V , Ta =-30°C~85°C, die)

| Item | Signal | Symbol | Condition | Rating | | Units |
|---|---|---|---|---|---|---|
| | | | | Min. | Max. | |
| Address hold time | A0 | tAH8 | | 10 | — | ns |
| Address setup time | | tAW8 | | 10 | — | |
| System cycle time | WR | tCYC8 | | 180 | — | |
| System cycle frequency | | fCYC8 | | 5.56 | — | MHz |
| Enable L pulse width (WRITE) | | tCCLW | | 60 | — | ns |
| Enable H pulse width (WRITE) | | tCCHW | | 120 | — | |
| System cycle time(READ) | RD | tCYCR8 | | 620 | | |
| Enable L pulse width (READ) | | tCCLR | | 190 | — | |
| Enable H pulse width (READ) | | tCCHR | | 420 | — | |
| WRITE data setup time | D0 to D7 | tDS8 | | 80 | — | |
| WRITE data hold time | | tDH8 | | 30 | — | |
| READ access time | | tACC8 | CL = 100 pF | — | 140 | |
| READ Output disable time | | tOH8 | CL = 100 pF | — | 100 | |

*1 The input signal rise time and fall time (tr, tf) is specified at 15 ns or less. When the system cycle time is extremely fast, (tr +tf) $\leqq$ (tCYC8 – tCCLW – tCCHW) for (tr + tf) $\leqq$ (tCYC8 – tCCLR – tCCHR) are specified.

*2 All timing is specified using 20% and 80% of VDD as the reference.

*3 tCCLW and tCCLR are specified as the overlap between /CS being “L” and WR and RD being at the “L” level.

**System Bus Read/Write Characteristics 1 (For the 6800 Series MPU)**

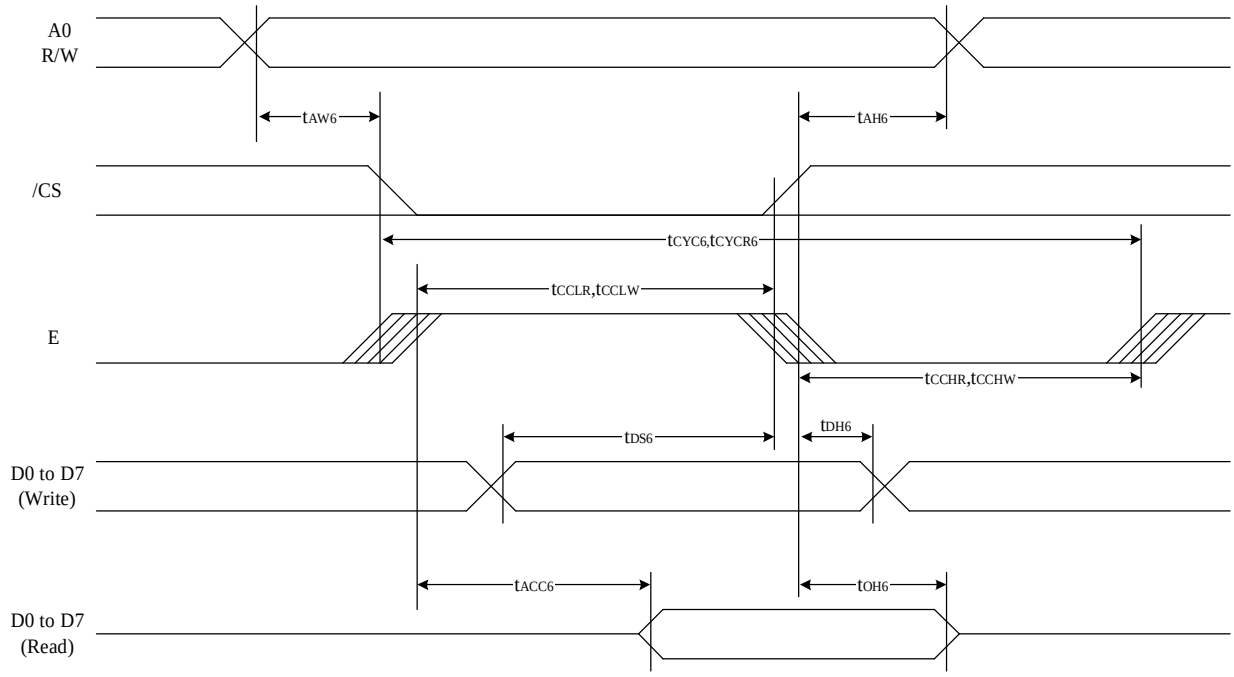



**Figure 40.**

($V_{DD}$ = 3.3 V , Ta =-30°C~85°C , die)

| Item | Signal | Symbol | Condition | Rating | | Units |
|---|---|---|---|---|---|---|
| | | | | Min. | Max. | |
| Address hold time | A0 | tAH6 | | 10 | — | ns |
| Address setup time | | tAW6 | | 10 | — | |
| System cycle time | WR | tCYC6 | | 150 | — | |
| System cycle frequency | | fCYC6 | | 6.67 | — | MHz |
| Enable L pulse width (WRITE) | | tEWLW | | 90 | — | ns |
| Enable H pulse width (WRITE) | | tEWHW | | 60 | — | |
| System cycle time(READ) | RD | tCYCR6 | | 500 | — | |
| Enable L pulse width (READ) | | tEWLR | | 340 | — | |
| Enable H pulse width (READ) | | tEWHR | | 160 | — | |
| WRITE data setup time | D0 to D7 | tDS6 | | 70 | — | |
| WRITE data hold time | | tDH6 | | 10 | — | |
| READ access time | | tACC6 | CL = 100 pF | — | 70 | |
| READ Output disable time | | tOH6 | CL = 100 pF | — | 50 | |

(VDD = 2.8V , Ta =-30°C~85°C , die)

| Item | Signal | Symbol | Condition | Rating | | Units |
|---|---|---|---|---|---|---|
| | | | | Min. | Max. | |
| Address hold time | A0 | tAH6 | | 10 | — | ns |
| Address setup time | | tAW6 | | 10 | — | |
| System cycle time | WR | tCYC6 | | 180 | — | |
| System cycle frequency | | fCYC6 | | 5.56 | — | MHz |
| Enable L pulse width (WRITE) | | tEWLW | | 110 | — | ns |
| Enable H pulse width (WRITE) | | tEWHW | | 70 | — | |
| System cycle time(READ) | RD | tCYCR6 | | 590 | — | |
| Enable L pulse width (READ) | | tEWLR | | 400 | — | |
| Enable H pulse width (READ) | | tEWHR | | 190 | — | |
| WRITE data setup time | D0 to D7 | tDS6 | | 80 | — | |
| WRITE data hold time | | tDH6 | | 10 | — | |
| READ access time | | tACC6 | CL = 100 pF | — | 140 | |
| READ Output disable time | | tOH6 | CL = 100 pF | — | 100 | |

*1 The input signal rise time and fall time (tr, tf) is specified at 15 ns or less. When the system cycle time is extremely fast, (tr +tf) ≦ (tCYC6 – tEWLW – tEWHW) for (tr + tf) ≦ (tCYC6 – tEWLR – tEWHR) are specified.

*2 All timing is specified using 20% and 80% of VDD as the reference.

*3 tEWLW and tEWLR are specified as the overlap between /CS being “L” and E.

**SERIAL INTERFACE(4-Line Interface)**

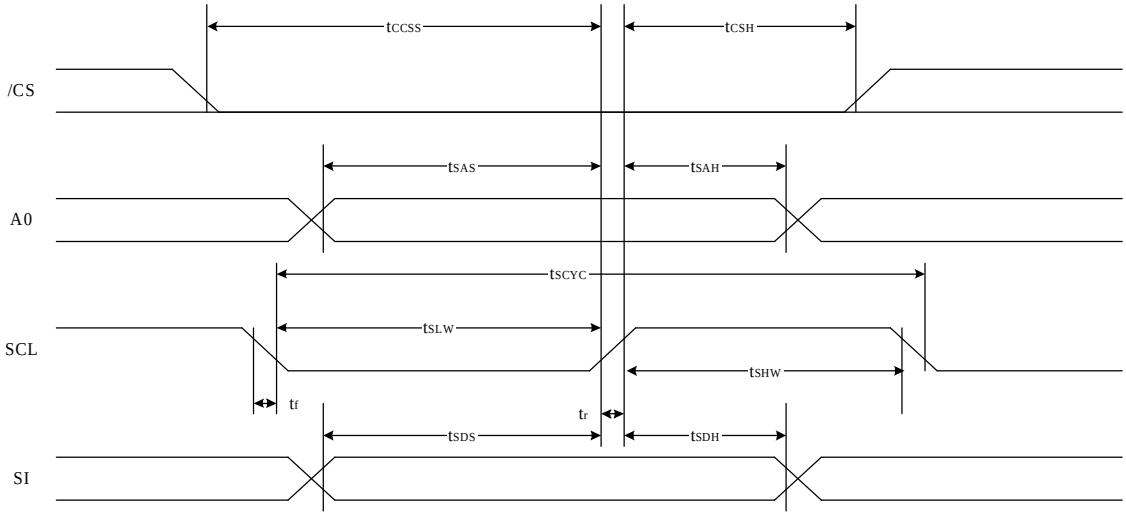



**Fig 41.**

($V_{DD}$=3.3V, Ta =-30°C~85°C, die)

| Item | Signal | Symbol | Condition | Rating | | Units |
|---|---|---|---|---|---|---|
| | | | | Min. | Max. | |
| Serial clock period | SCL | tSCYC | | 100 | — | ns |
| Serial clock frequency | | fSCYC | | 10 | | MHz |
| SCL “H” pulse width | | tSHW | | 70 | — | ns |
| SCL “L” pulse width | | tSLW | | 30 | — | |
| Address setup time | A0 | tSAS | | 20 | — | |
| Address hold time | | tSAH | | 50 | — | |
| Data setup time | SI | tSDS | | 20 | — | |
| Data hold time | | tSDH | | 30 | — | |
| CS-SCL time | /CS | tCSS | | 20 | — | |
| CS-SCL time | | tCSH | | 50 | — | |

($V_{DD}$=2.8V, Ta =-30°C~85°C, die)

| Item | Signal | Symbol | Condition | Rating | | Units |
|---|---|---|---|---|---|---|
| | | | | Min. | Max. | |
| Serial clock period | SCL | tSCYC | | 110 | — | ns |
| Serial clock frequency | | fSCYC | | 9.09 | | MHz |
| SCL “H” pulse width | | tSHW | | 80 | — | ns |
| SCL “L” pulse width | | tSLW | | 30 | — | |
| Address setup time | A0 | tSAS | | 20 | — | |
| Address hold time | | tSAH | | 50 | — | |
| Data setup time | SI | tSDS | | 20 | — | |
| Data hold time | | tSDH | | 30 | — | |
| CS-SCL time | /CS | tCSS | | 20 | — | |
| CS-SCL time | | tCSH | | 60 | — | |

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

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

**SERIAL INTERFACE(3-Line Interface)**

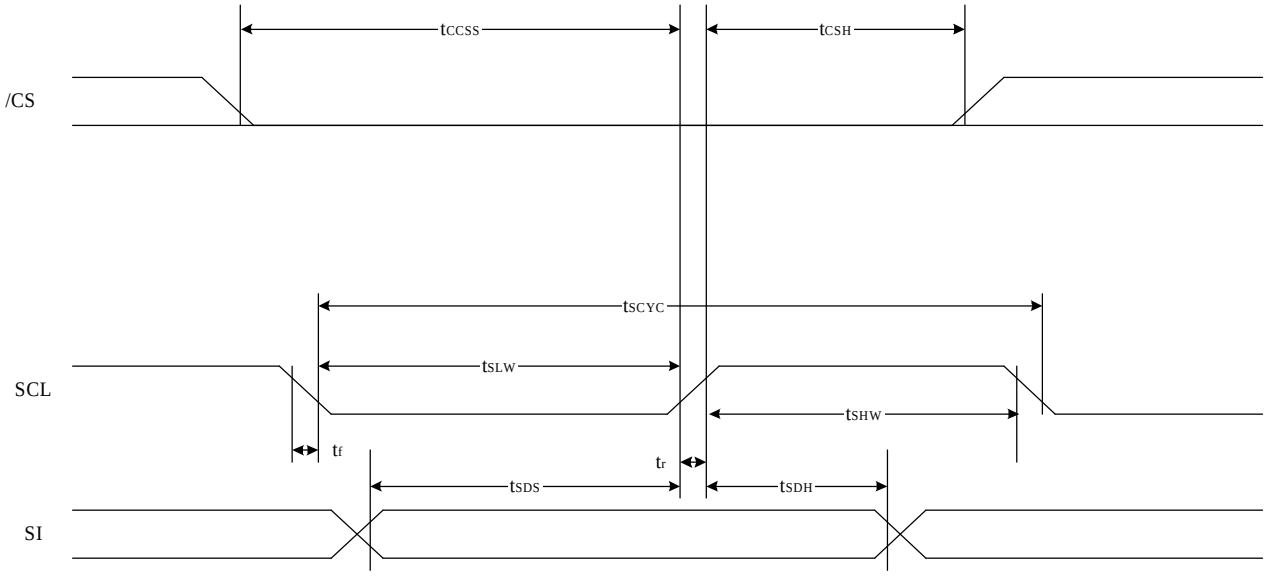



**Fig 42.**

($V_{DD}$=3.3V, Ta =-30°C~85°C, die)

| Item | Signal | Symbol | Condition | Rating | | Units |
|---|---|---|---|---|---|---|
| | | | | Min. | Max. | |
| Serial clock period | SCL | tSCYC | | 100 | — | ns |
| Serial clock frequency | | fSCYC | | 10 | | MHz |
| SCL “H” pulse width | | tSHW | | 70 | — | ns |
| SCL “L” pulse width | | tSLW | | 30 | — | |
| Data setup time | SI | tSDS | | 20 | — | |
| Data hold time | | tSDH | | 30 | — | |
| CS-SCL time | /CS | tCSS | | 20 | — | |
| CS-SCL time | | tCSH | | 60 | — | |

($V_{DD}$=2.8V, Ta =-30°C~85°C, die)

| Item | Signal | Symbol | Condition | Rating | | Units |
|---|---|---|---|---|---|---|
| | | | | Min. | Max. | |
| Serial clock period | SCL | tSCYC | | 110 | — | ns |
| Serial clock frequency | | fSCYC | | 9.09 | | MHz |
| SCL “H” pulse width | | tSHW | | 80 | — | ns |
| SCL “L” pulse width | | tSLW | | 30 | — | |
| Data setup time | SI | tSDS | | 20 | — | |
| Data hold time | | tSDH | | 40 | — | |
| CS-SCL time | /CS | tCSS | | 20 | — | |
| CS-SCL time | | tCSH | | 60 | — | |

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

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

## 13. RESET TIMING

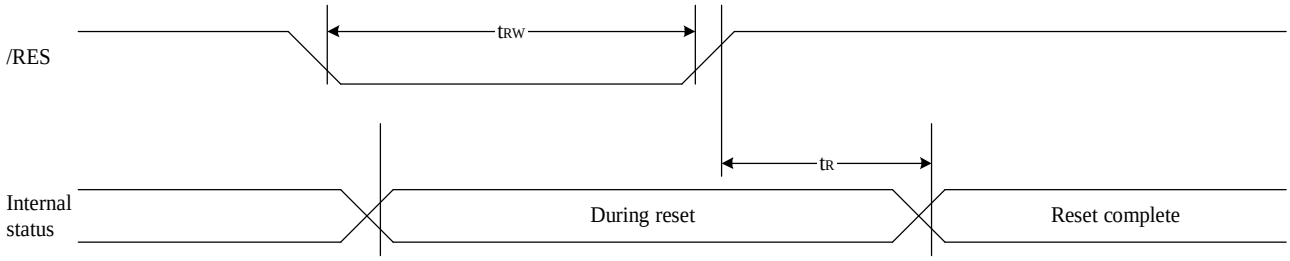



**Fig 43.**

(VDD = 3.3V , Ta = –30 to 85°C, die)

| Item | Signal | Symbol | Condition | Rating | | | Units |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Reset time | | tR | | — | — | 1 | us |
| Reset “L” pulse width | RESB | tRW | | 1 | — | — | us |

(VDD = 2.8V , Ta = –30 to 85°C, die)

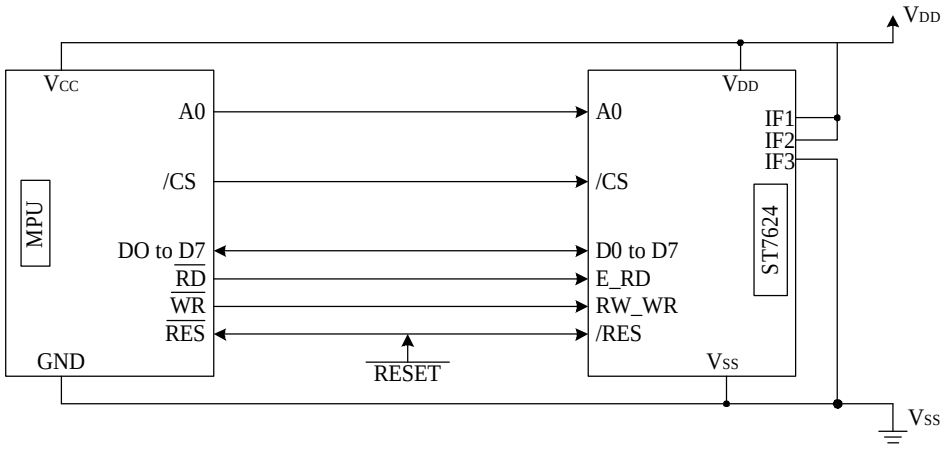
| Item | Signal | Symbol | Condition | Rating | | | Units |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Reset time | | tR | | — | — | 1.5 | us |
| Reset “L” pulse width | RESB | tRW | | 1.5 | — | — | us |

## 14. THE MPU INTERFACE (REFERENCE EXAMPLES)

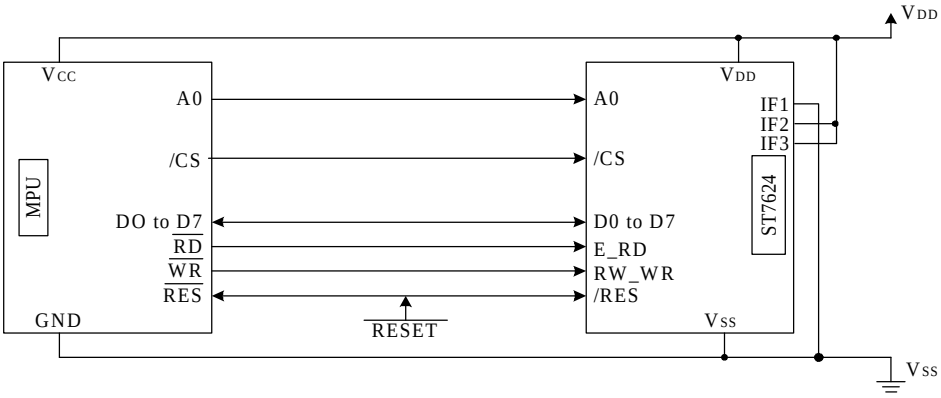
The ST7624 Series can be connected to either 8080 Series MPUs or to 6800 Series MPUs. Moreover, using the serial interface it is possible to operate the ST7624 series chips with fewer signal lines.

The display area can be enlarged by using multiple ST7624 Series chips. When this is done, the chip select signal can be used to select the individual Ics to access.

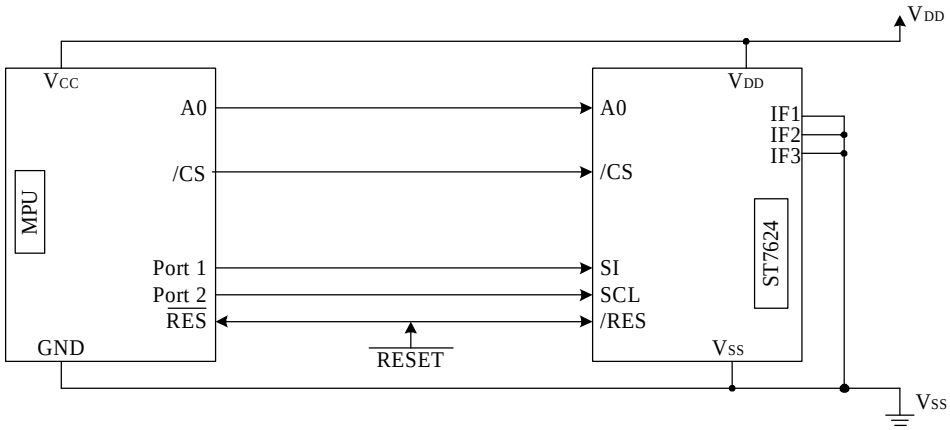
(1) 8080-8bits Series MPUs



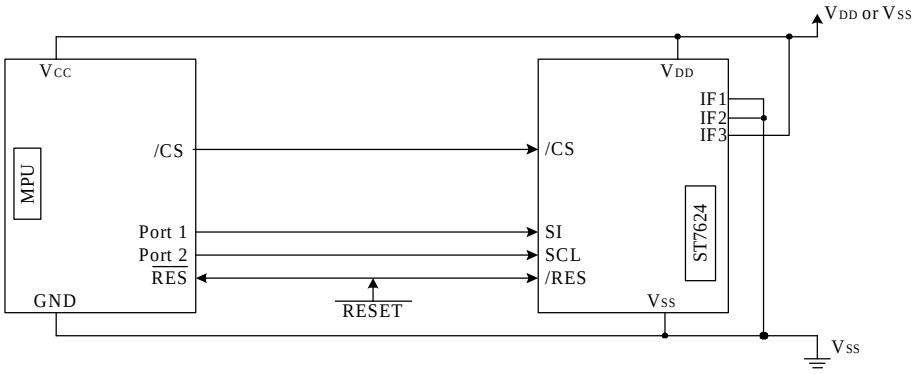
(2) 6800-8bits Series MPUs




(3) Using the Serial Interface (4-line interface)

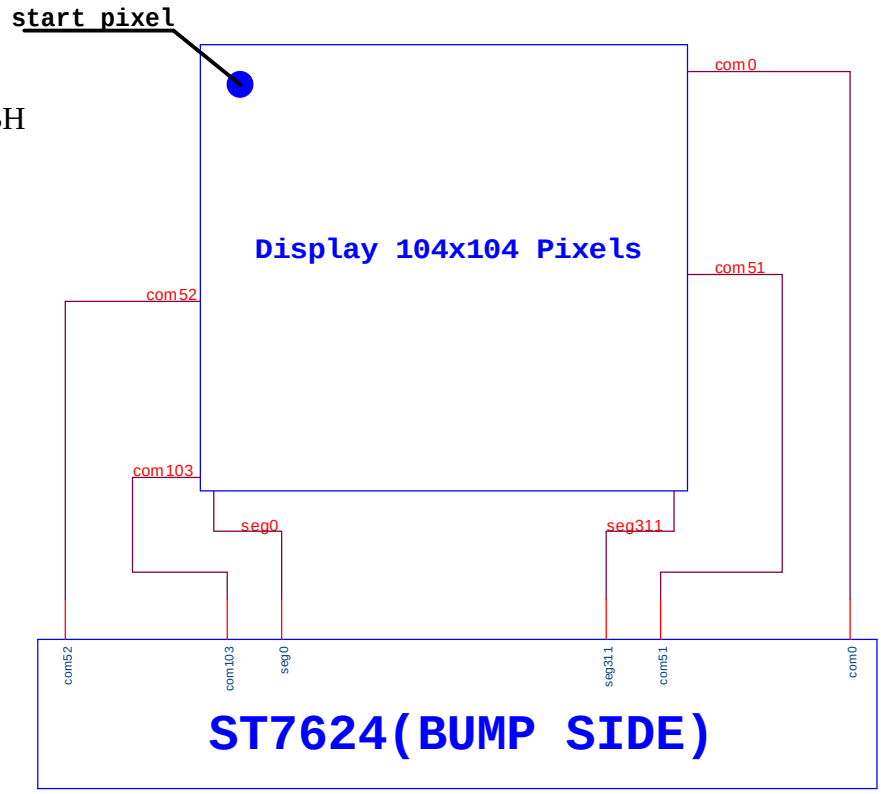



(4) Using the Serial Interface (3-line interface)

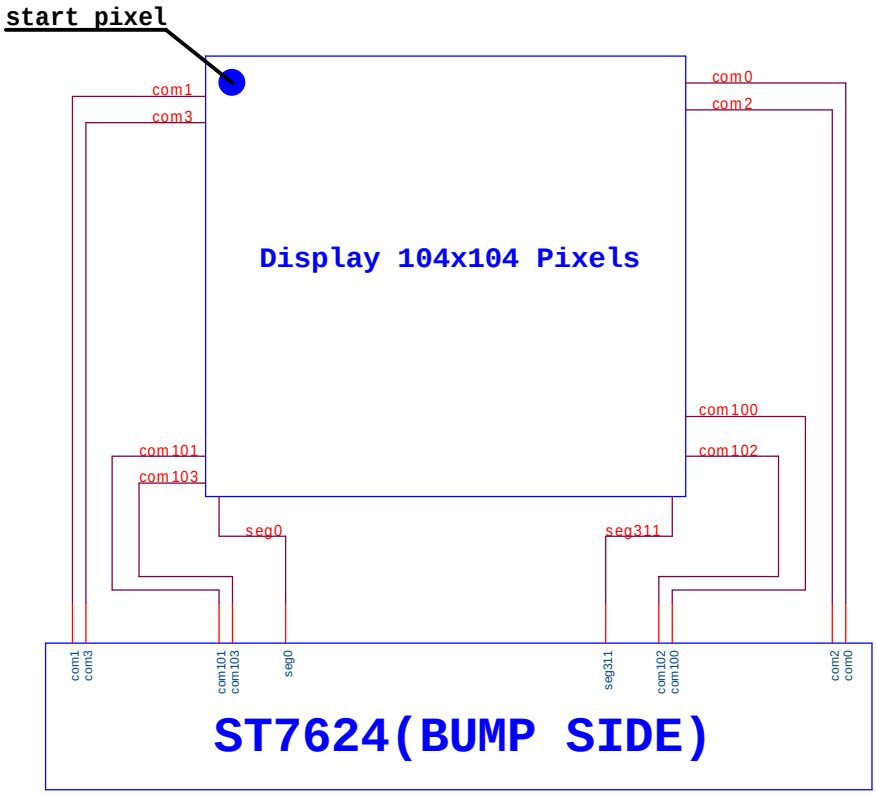


# 15.APPLICATION NOTE

Resolution : 104 X 104 Color
CSEL = L
Common Scan Command : BBH
Parameter : P12,P11,P10=001
(Reference Page 45)

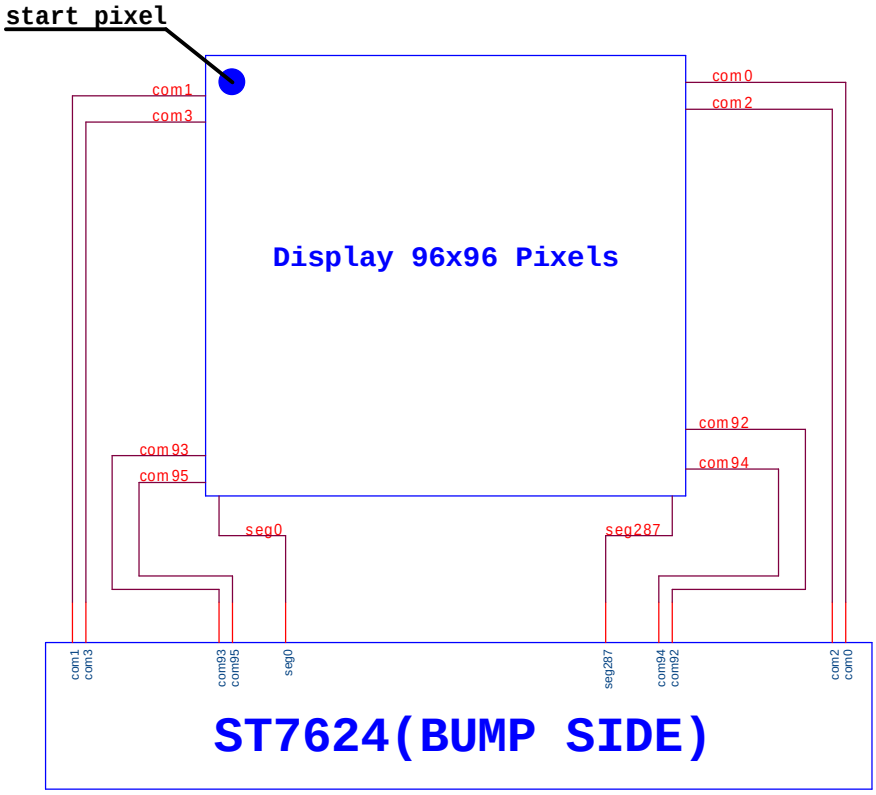



Resolution : 104 X 104 Color
CSEL = H

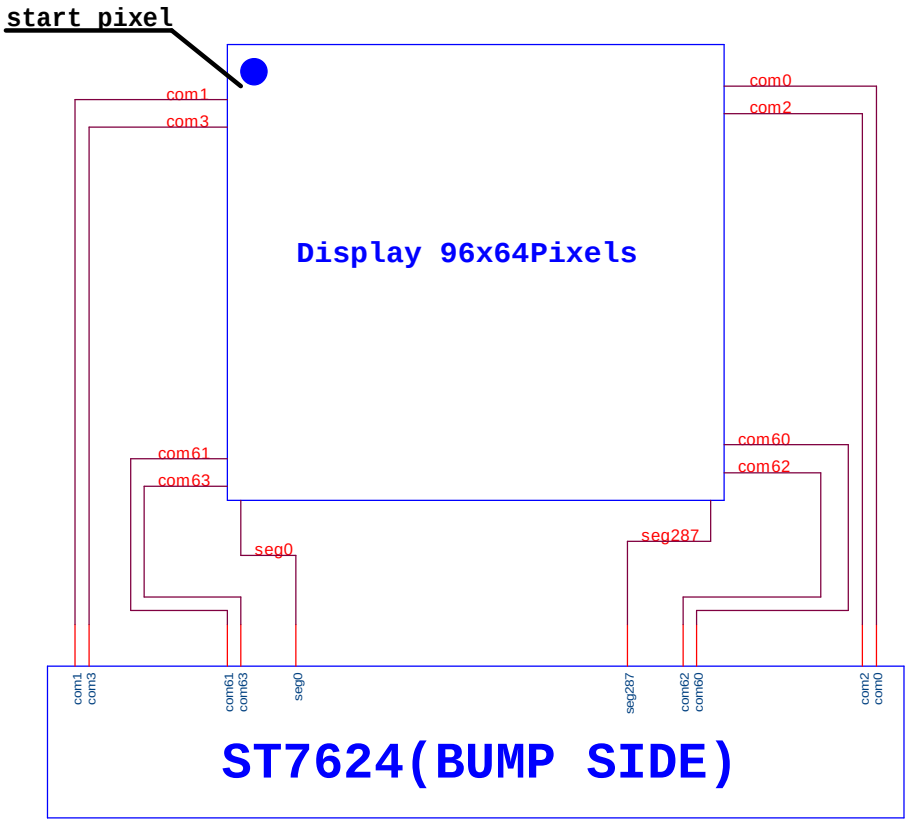



Note : the View Angle of panel can be changed by software(Command BCH)

Resolution : 96 X 96 Color
CSEL = H




Resolution : 96 X 64 Color
CSEL = H




Note : the View Angle of panel can be changed by software(Command BCH)

# ST7624

Interface : 8080series-8bits

VDD,VDD1=2.4V~3.3V

VDD2~VDD5=2.4V~3.3V

Booster : X7

CSEL = H

IF1 = H ; IF2 = H ; IF3 = L

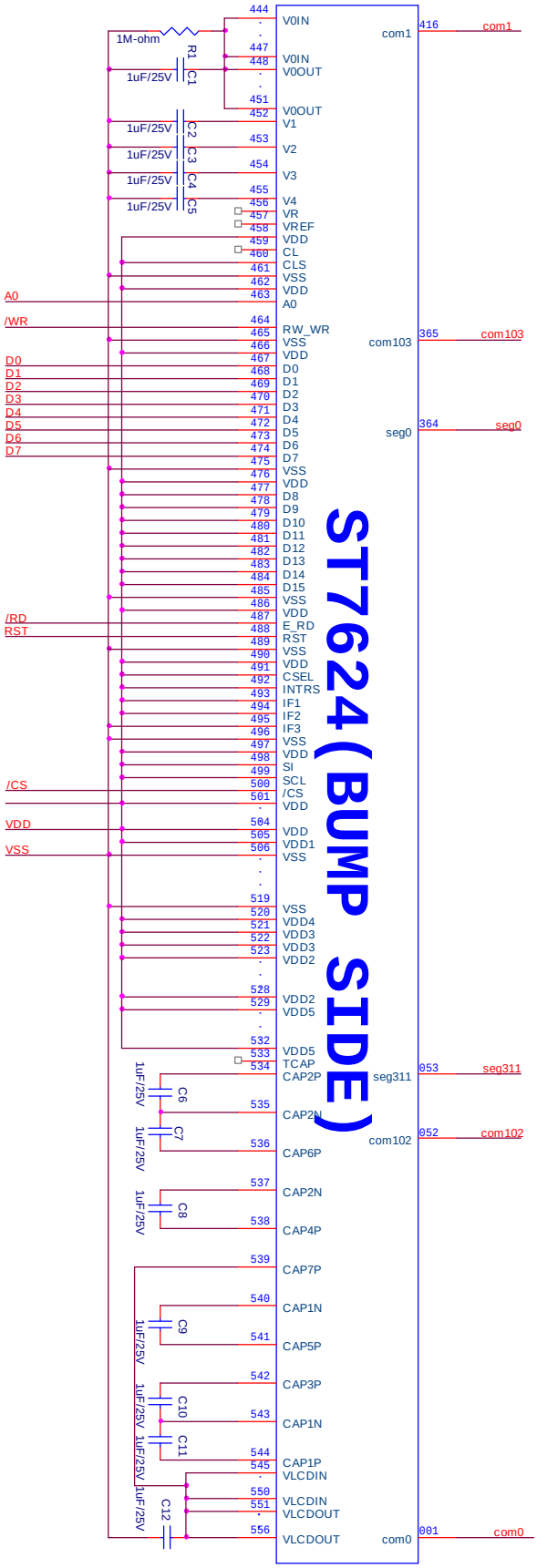
C1~C5 : 0.1uF~1.0uF/25V

C6~C13 : 1.0~2.2uF/25V

Vop = 12~15V

Bias = 1/11(under 1/104 duty)

R1=1M-ohm



# ST7624

Interface : 8080series-16bits

VDD,VDD1=2.4V~3.3V

VDD2~VDD5=2.4V~3.3V

Booster : X7

CSEL = H

IF1 = H ; IF2 = H ; IF3 = H

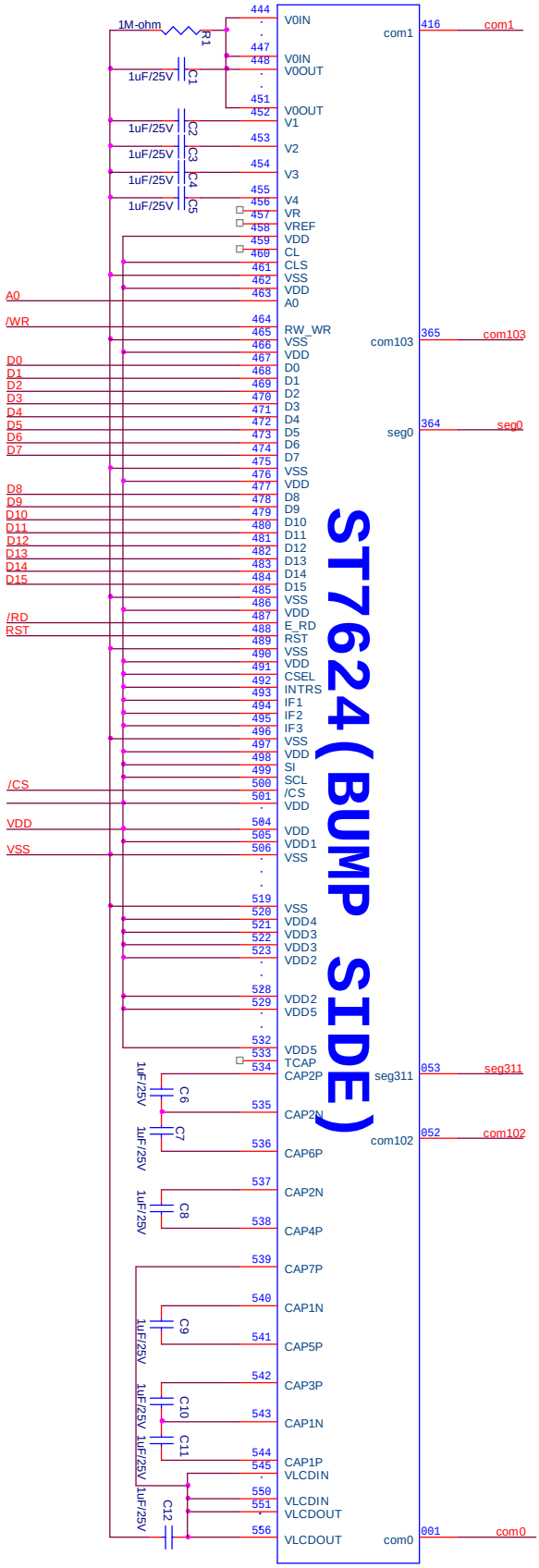
C1~C5 : 0.1uF~1.0uF/25V

C6~C13 : 1.0~2.2uF/25V

Vop = 12~15V

Bias = 1/11(under 1/104 duty)

R1=1M-ohm



# ST7624

Interface : 6800series-8bits

VDD,VDD1=2.4V~3.3V

VDD2~VDD5=2.4V~3.3V

Booster : X7

CSEL = H

IF1 = L ; IF2 = H ; IF3 = H

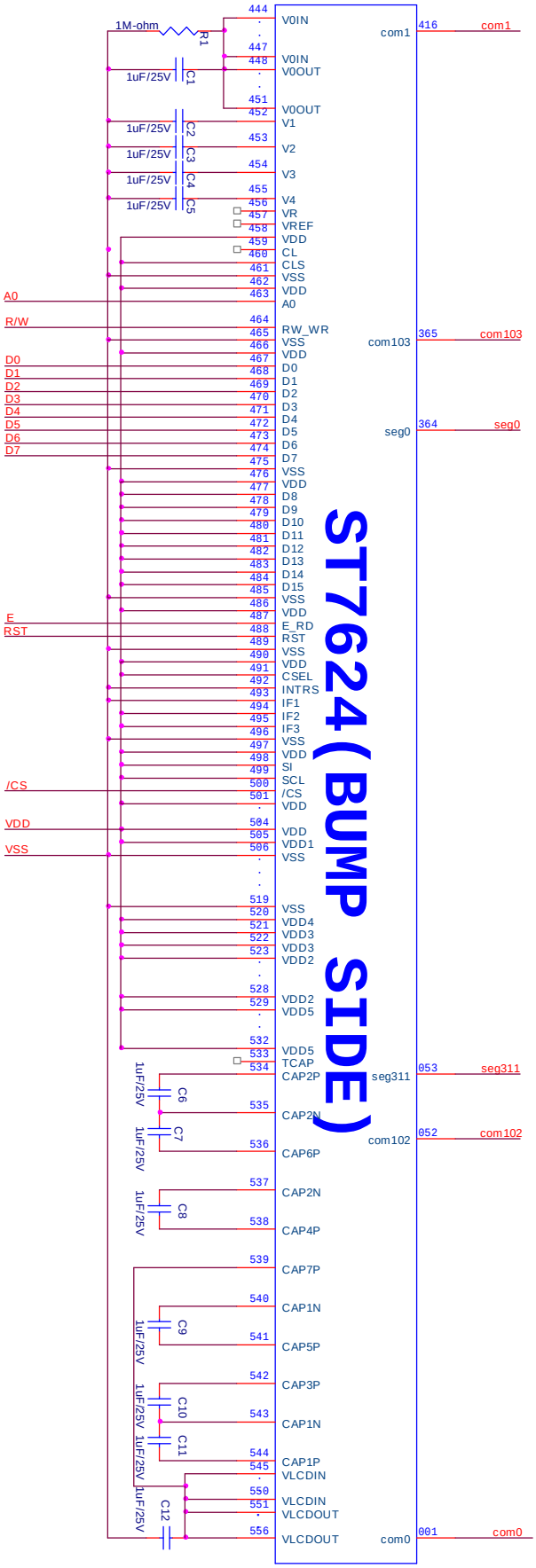
C1~C5 : 0.1uF~1.0uF/25V

C6~C13 : 1.0~2.2uF/25V

Vop = 12~15V

Bias = 1/11(under 1/104 duty)

R1=1M-ohm



# ST7624

Interface : 6800series-16bits

VDD,VDD1=2.4V~3.3V

VDD2~VDD5=2.4V~3.3V

Booster : X7

CSEL = H

IF1 = H ; IF2 = L ; IF3 = L

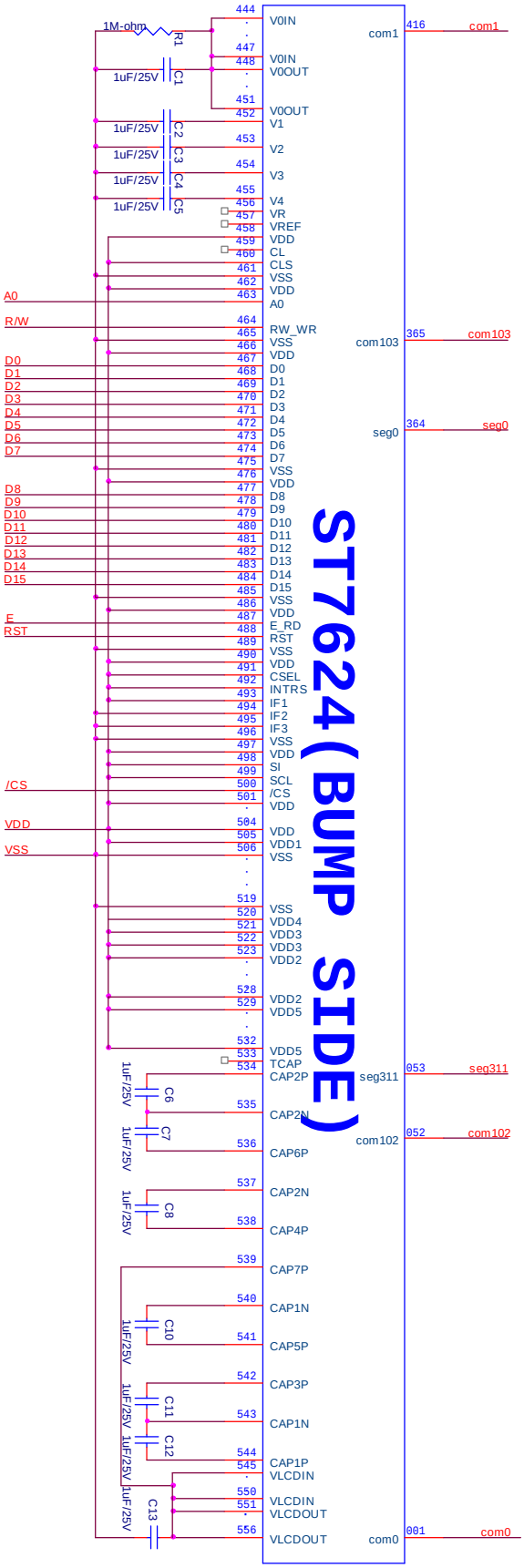
C1~C5 : 0.1uF~1.0uF/25V

C6~C13 : 1.0~2.2uF/25V

Vop = 12~15V

Bias = 1/11(under 1/104 duty)

R1=1M-ohm



# ST7624

Interface : 4-line

VDD,VDD1=2.4V~3.3V

VDD2~VDD5=2.4V~3.3V

Booster : X7

CSEL = H

IF1 = L ; IF2 = L ; IF3 = L

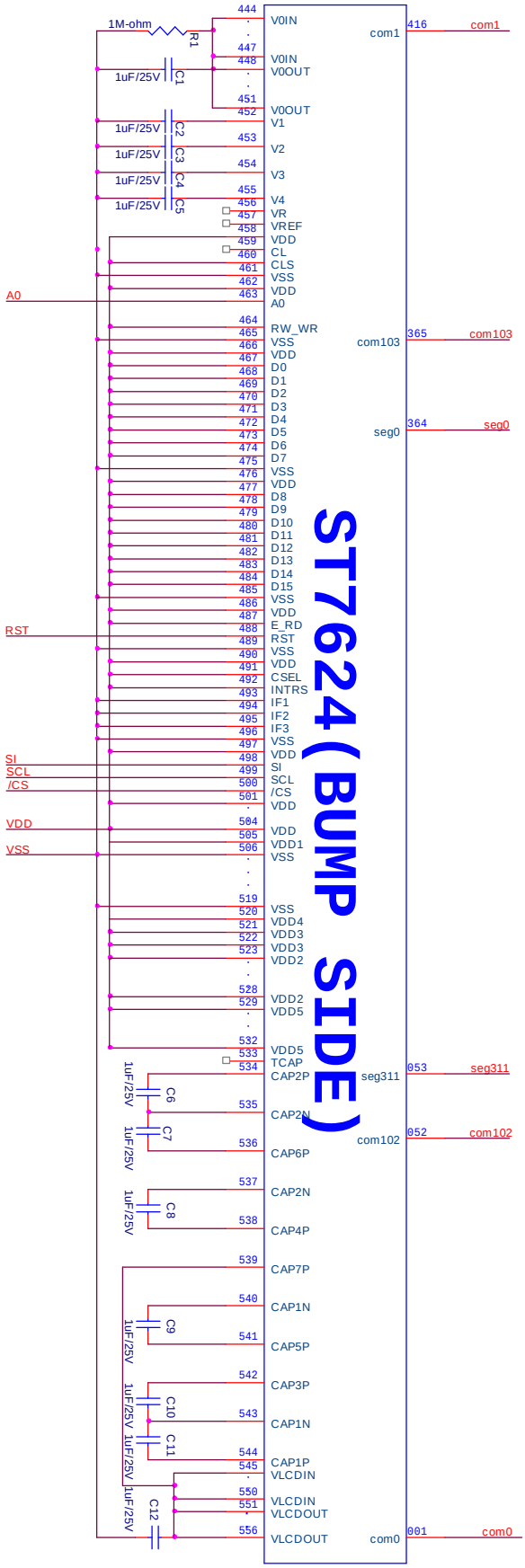
C1~C5 : 0.1uF~1.0uF/25V

C6~C13 : 1.0~2.2uF/25V

Vop = 12~15V

Bias = 1/11(under 1/104 duty)

R1=1M-ohm



# ST7624

Interface : 3-line

VDD,VDD1=2.4V~3.3V

VDD2~VDD5=2.4V~3.3V

Booster : X7

CSEL = H

IF1 = L ; IF2 = L ; IF3 = H

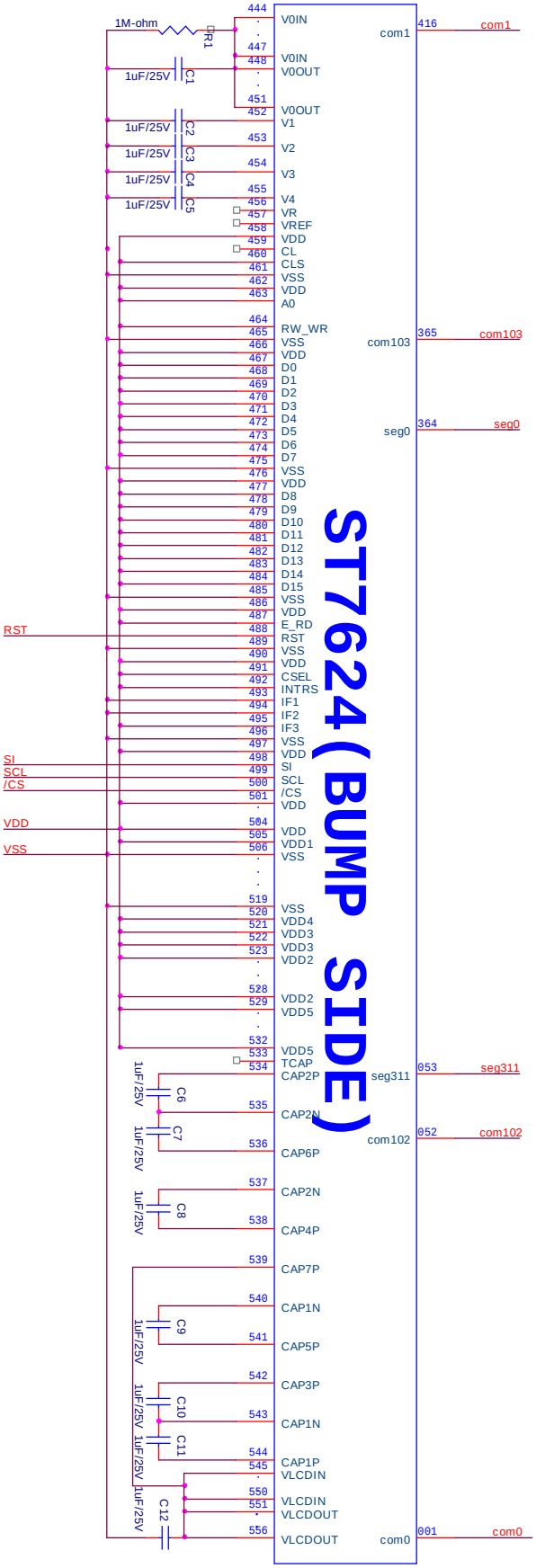
C1~C5 : 0.1uF~1.0uF/25V

C6~C13 : 1.0~2.2uF/25V

Vop = 12~15V

Bias = 1/11(under 1/104 duty)

R1=1M-ohm




**NOTE: Microprocessor interface pins should not be floating in any operation mode.**

| ST7624 Specification Revision History | | |
|---|---|---|
| **Version** | **Date** | **Description** |
| 1.0 | 2004/12/08 | Remove Preliminary and modify Timing Characteristic |
| 1.1 | 2005/01/14 | Correct 8080/6800 interface Timing |
| 1.2 | 2005/03/12 | Modify EEPROM flow and Parallel Timing |
| 1.3 | 2005/05/03 | Remove IIC Interface |
| 1.4 | 2005/05/18 | Modify Program Flow |
| 1.5 | 2005/06/02 | Modify Application Note |
| 1.6 | 2005/09/07 | Modify Limiting Value and DC Characteristic<br>1. Temperature gradient (Add tolerance) on Page1<br>2. supply voltage (no tolerance).<br>3. Bump height on Page2<br>4. Operating and storage temperature. |
| 1.7 | 2005/9/15 | 1. Add die in Temperature Range of Time<br>2. Add die in Display on Current (Typ) |
| 1.8 | 2006/8/15 | Add microprocessor notice item(p.14, p.97). |
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