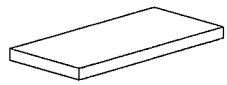
PRELIMINARY

# 16-CHARACTER 3-LINE DOT MATRIX LCD CONTROLLER DRIVER

## ■ GENERAL DESCRIPTION

The NJU6464 is a Dot Matrix LCD controller driver for 16-character 3-line with icon display in single chip.
It contains voltage converter and regulator, bleeder resistance, CR oscillator, microprocessor interface circuits, instruction decoder controller, character generator ROM/RAM, high voltage operation common and segment drivers.
The voltage converter generates high voltage(about 8V) from the supply voltage(3V) and the generated high voltage is regulated by the regulator. The bias level of LCD driving voltage is generated by high value of bleeder resistance and the buffer amplifier converts its impedance. The 16th gray scale contrast control function
is incorporated for its adjustment. Therefore, simple power supply circuit and easy contrast adjustment are available.
The complete CR oscillator is incorporated, therefore no external components for oscillation circuit are required.
The microprocessor interface circuits which operate by 1MHz, can be selected serial, 4 or 8 bits interface.
The character generator ROM consists of 10,080 bits stores 252 kinds of character Font. Each 160 bits CG RAM and Icon display RAM can store 4 kinds of special character displayed on the dot matrix display area or 152 kinds of Icon on the Icon display area.
The 29-common (24 for character, 4 for icon and 1 for static) and 83-segment (80 for character, 2 for icon and 1 for static) drivers operating up to 10.0V drives 16-character 3-line with 152 Icon and static segment LCD display.

## ■ PACKAGE OUTLINE



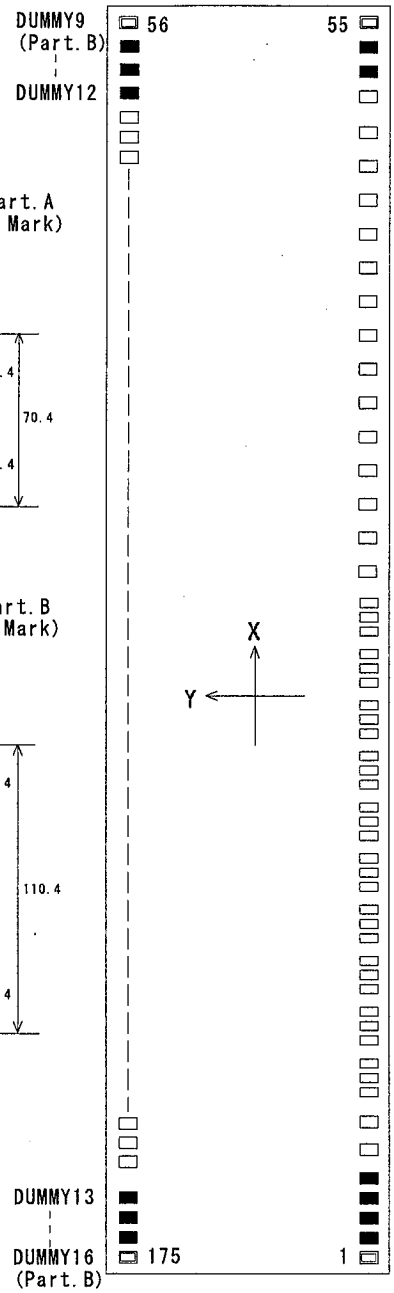
NJU6464CH

## ■ FEATURES

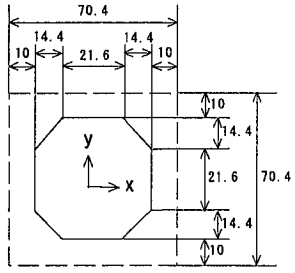
- 16-character 3-line Dot Matrix LCD Controller Driver
- Maximum 152 Icon Display
- Serial, 4 or 8 Bits parallel Direct Interface with Microprocessor
- Display Data RAM - 48 x 8 bits : Maximum 16-character 3-line Display
- Character Generator ROM - 10,080 bits : 252 Characters for 5 x 8 Dots
- Character Generator RAM - 32 x 5 bits : 4 Patterns( 5 x 8 Dots )
- Icon Display RAM - 32 x 5 bits : Maximum 152 Icon
- High Voltage LCD Driver : 29-common / 83-segment
- Duty and Bias Ratio : 1/28 duty and 1/6.3 bias
- Useful Instruction Set : Clear Display, Return Home, Display ON/OFF Cont, Cursor ON/OFF Cont, Display Blink, Cursor Shift, Character Shift
- Common and Segment driver Location order Select Function(Mode A/Mode B)
- Power On Initialization / Hardware Reset
- Voltage Converter and Bleeder Resistance on-chip
- Voltage regulator on-chip
- Software contrast control
- Oscillation Circuit on-chip
- Low Power Consumption
- Operating Voltage --- 2.4 to 3.3 V ( Except LCD Driving Voltage )
- Package Outline --- Bumped Chip
- C-MOS Technology

Feb. 1999
Ver. 0

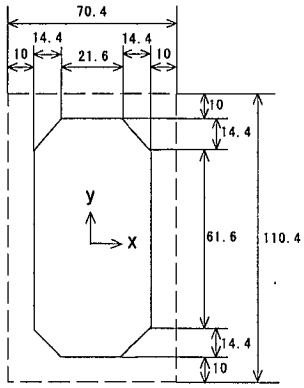
■ PAD LOCATION




Enlarged Figure of Part. A
(Alignment Mark)




Enlarged Figure of Part. B
(Alignment Mark)




Chip Size :9.89 X 1.99 mm
Chip Center : X=0um, Y=0um

Pad Size
No. 2～54、57～174
: 50um X 90um
Bump Size
No. 2～54、57～174
: 63um X 103um

Bump Heigt : 25umTYP.
Bump Material: Au

■ PAD COORDINATES CHIP SIZE 9.89 mm x 1.99 mm ( CHIP CENTER X=0 μm, Y=0 μm )

| PAD No. | PAD NAME | | X=(μm) | Y=(μm) |
|---|---|---|---|---|
| | Mode A | Mode B | | |
| 1 | DUMMY1 | DUMMY1 | -4790 | -837 |
| 2 | DUMMY2 | DUMMY2 | -4695 | -837 |
| 3 | DUMMY3 | DUMMY3 | -4615 | -837 |
| 4 | DUMMY4 | DUMMY4 | -4535 | -837 |
| 5 | DUMMY5 | DUMMY5 | -4455 | -837 |
| 6 | OSC1 | OSC1 | -4168 | -837 |
| 7 | OSC2 | OSC2 | -4008 | -837 |
| 8 | V5 (L) | V5 (L) | -3845 | -837 |
| 9 | V5 (C) | V5 (C) | -3720 | -837 |
| 10 | V5 (R) | V5 (R) | -3595 | -837 |
| 11 | VSS (L) | VSS (L) | -3333 | -837 |
| 12 | VSS (C) | VSS (C) | -3208 | -837 |
| 13 | VSS (R) | VSS (R) | -3083 | -837 |
| 14 | V5OUT (L) | V5OUT (L) | -2911 | -837 |
| 15 | V5OUT (C) | V5OUT (C) | -2786 | -837 |
| 16 | V5OUT (R) | V5OUT (R) | -2661 | -837 |
| 17 | C2⁻ (L) | C2⁻ (L) | -2396 | -837 |
| 18 | C2⁻ (C) | C2⁻ (C) | -2271 | -837 |
| 19 | C2⁻ (R) | C2⁻ (R) | -2146 | -837 |
| 20 | C2⁺ (L) | C2⁺ (L) | -1884 | -837 |
| 21 | C2⁺ (C) | C2⁺ (C) | -1759 | -837 |
| 22 | C2⁺ (R) | C2⁺ (R) | -1634 | -837 |
| 23 | C1⁻ (L) | C1⁻ (L) | -1372 | -837 |
| 24 | C1⁻ (C) | C1⁻ (C) | -1247 | -837 |
| 25 | C1⁻ (R) | C1⁻ (R) | -1122 | -837 |
| 26 | C1⁺ (L) | C1⁺ (L) | -860 | -837 |
| 27 | C1⁺ (C) | C1⁺ (C) | -735 | -837 |
| 28 | C1⁺ (R) | C1⁺ (R) | -610 | -837 |
| 29 | VDD (L) | VDD (L) | -438 | -837 |
| 30 | VDD (C) | VDD (C) | -313 | -837 |
| 31 | VDD (R) | VDD (R) | -188 | -837 |
| 32 | VR (L) | VR (L) | -17 | -837 |
| 33 | VR (C) | VR (C) | 108 | -837 |
| 34 | VR (R) | VR (R) | 233 | -837 |
| 35 | VREG (L) | VREG (L) | 664 | -837 |
| 36 | VREG (C) | VREG (C) | 789 | -837 |
| 37 | VREG (R) | VREG (R) | 914 | -837 |
| 38 | TEST | TEST | 1120 | -837 |
| 39 | SEL | SEL | 1462 | -837 |
| 40 | RESET | RESET | 1636 | -837 |
| 41 | P/S | P/S | 1927 | -837 |
| 42 | RS | RS | 2095 | -837 |
| 43 | R/W | R/W | 2386 | -837 |
| 44 | E/SCL | E/SCL | 2554 | -837 |
| 45 | DB0 | DB0 | 2824 | -837 |
| 46 | DB1 | DB1 | 3049 | -837 |
| 47 | DB2 | DB2 | 3291 | -837 |
| 48 | DB3 | DB3 | 3516 | -837 |
| 49 | DB4 | DB4 | 3757 | -837 |
| 50 | DB5 | DB5 | 3982 | -837 |

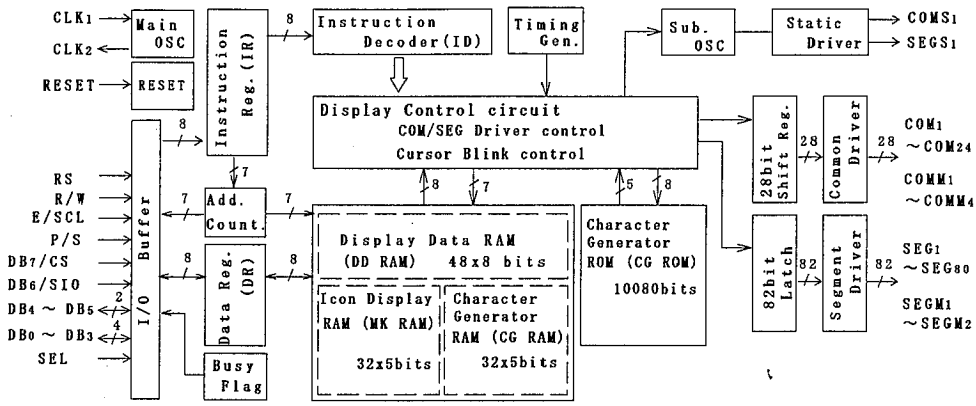
| PAD No. | PAD NAME | | X=(μm) | Y=(μm) |
|---|---|---|---|---|
| | Mode A | Mode B | | |
| 51 | DB6/SIO | DB6/SIO | 4224 | -837 |
| 52 | DB7/CS | DB7/CS | 4449 | -837 |
| 53 | DUMMY6 | DUMMY6 | 4610 | -837 |
| 54 | DUMMY7 | DUMMY7 | 4690 | -837 |
| 55 | DUMMY8 | DUMMY8 | 4788 | -837 |
| 56 | DUMMY9 | DUMMY9 | 4808 | 847 |
| 57 | DUMMY10 | DUMMY10 | 4698 | 847 |
| 58 | DUMMY11 | DUMMY11 | 4618 | 847 |
| 59 | DUMMY12 | DUMMY12 | 4538 | 847 |
| 60 | SEGS1 | SEGS1 | 4458 | 847 |
| 61 | COM9 | COM9 | 4378 | 847 |
| 62 | COM10 | COM10 | 4298 | 847 |
| 63 | COM11 | COM11 | 4218 | 847 |
| 64 | COM12 | COM12 | 4138 | 847 |
| 65 | COM13 | COM13 | 4058 | 847 |
| 66 | COM14 | COM14 | 3978 | 847 |
| 67 | COM15 | COM15 | 3898 | 847 |
| 68 | COM16 | COM16 | 3818 | 847 |
| 69 | SEGM1 | SEGM2 | 3738 | 847 |
| 70 | SEG1 | SEG80 | 3658 | 847 |
| 71 | SEG2 | SEG79 | 3578 | 847 |
| 72 | SEG3 | SEG78 | 3498 | 847 |
| 73 | SEG4 | SEG77 | 3418 | 847 |
| 74 | SEG5 | SEG76 | 3338 | 847 |
| 75 | SEG6 | SEG75 | 3258 | 847 |
| 76 | SEG7 | SEG74 | 3178 | 847 |
| 77 | SEG8 | SEG73 | 3098 | 847 |
| 78 | SEG9 | SEG72 | 3018 | 847 |
| 79 | SEG10 | SEG71 | 2938 | 847 |
| 80 | SEG11 | SEG70 | 2858 | 847 |
| 81 | SEG12 | SEG69 | 2778 | 847 |
| 82 | SEG13 | SEG68 | 2698 | 847 |
| 83 | SEG14 | SEG67 | 2618 | 847 |
| 84 | SEG15 | SEG66 | 2538 | 847 |
| 85 | SEG16 | SEG65 | 2458 | 847 |
| 86 | SEG17 | SEG64 | 2378 | 847 |
| 87 | SEG18 | SEG63 | 2298 | 847 |
| 88 | SEG19 | SEG62 | 2218 | 847 |
| 89 | SEG20 | SEG61 | 2138 | 847 |
| 90 | SEG21 | SEG60 | 2058 | 847 |
| 91 | SEG22 | SEG59 | 1978 | 847 |
| 92 | SEG23 | SEG58 | 1898 | 847 |
| 93 | SEG24 | SEG57 | 1818 | 847 |
| 94 | SEG25 | SEG56 | 1738 | 847 |
| 95 | SEG26 | SEG55 | 1658 | 847 |
| 96 | SEG27 | SEG54 | 1578 | 847 |
| 97 | SEG28 | SEG53 | 1498 | 847 |
| 98 | SEG29 | SEG52 | 1418 | 847 |
| 99 | SEG30 | SEG51 | 1338 | 847 |
| 100 | SEG31 | SEG50 | 1258 | 847 |

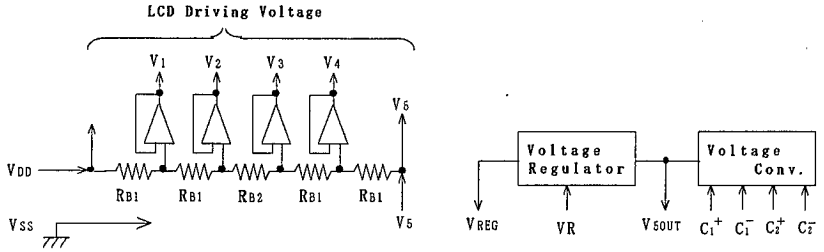
| PAD No. | PAD NAME | | X=(μm) | Y=(μm) |
|---|---|---|---|---|
| | Mode A | Mode B | | |
| 101 | $SEG_{32}$ | $SEG_{49}$ | 1178 | 847 |
| 102 | $SEG_{33}$ | $SEG_{48}$ | 1098 | 847 |
| 103 | $SEG_{34}$ | $SEG_{47}$ | 1018 | 847 |
| 104 | $SEG_{35}$ | $SEG_{46}$ | 938 | 847 |
| 105 | $SEG_{36}$ | $SEG_{45}$ | 858 | 847 |
| 106 | $SEG_{37}$ | $SEG_{44}$ | 778 | 847 |
| 107 | $SEG_{38}$ | $SEG_{43}$ | 698 | 847 |
| 108 | $SEG_{39}$ | $SEG_{42}$ | 618 | 847 |
| 109 | $SEG_{40}$ | $SEG_{41}$ | 538 | 847 |
| 110 | $SEG_{41}$ | $SEG_{40}$ | 458 | 847 |
| 111 | $SEG_{42}$ | $SEG_{39}$ | 378 | 847 |
| 112 | $SEG_{43}$ | $SEG_{38}$ | 298 | 847 |
| 113 | $SEG_{44}$ | $SEG_{37}$ | 218 | 847 |
| 114 | $SEG_{45}$ | $SEG_{36}$ | 138 | 847 |
| 115 | $SEG_{46}$ | $SEG_{35}$ | 58 | 847 |
| 116 | $SEG_{47}$ | $SEG_{34}$ | -22 | 847 |
| 117 | $SEG_{48}$ | $SEG_{33}$ | -102 | 847 |
| 118 | $SEG_{49}$ | $SEG_{32}$ | -182 | 847 |
| 119 | $SEG_{50}$ | $SEG_{31}$ | -262 | 847 |
| 120 | $SEG_{51}$ | $SEG_{30}$ | -342 | 847 |
| 121 | $SEG_{52}$ | $SEG_{29}$ | -422 | 847 |
| 122 | $SEG_{53}$ | $SEG_{28}$ | -502 | 847 |
| 123 | $SEG_{54}$ | $SEG_{27}$ | -582 | 847 |
| 124 | $SEG_{55}$ | $SEG_{26}$ | -662 | 847 |
| 125 | $SEG_{56}$ | $SEG_{25}$ | -742 | 847 |
| 126 | $SEG_{57}$ | $SEG_{24}$ | -822 | 847 |
| 127 | $SEG_{58}$ | $SEG_{23}$ | -902 | 847 |
| 128 | $SEG_{59}$ | $SEG_{22}$ | -982 | 847 |
| 129 | $SEG_{60}$ | $SEG_{21}$ | -1062 | 847 |
| 130 | $SEG_{61}$ | $SEG_{20}$ | -1142 | 847 |
| 131 | $SEG_{62}$ | $SEG_{19}$ | -1222 | 847 |
| 132 | $SEG_{63}$ | $SEG_{18}$ | -1302 | 847 |
| 133 | $SEG_{64}$ | $SEG_{17}$ | -1382 | 847 |
| 134 | $SEG_{65}$ | $SEG_{16}$ | -1462 | 847 |
| 135 | $SEG_{66}$ | $SEG_{15}$ | -1542 | 847 |
| 136 | $SEG_{67}$ | $SEG_{14}$ | -1622 | 847 |
| 137 | $SEG_{68}$ | $SEG_{13}$ | -1702 | 847 |
| 138 | $SEG_{69}$ | $SEG_{12}$ | -1782 | 847 |
| 139 | $SEG_{70}$ | $SEG_{11}$ | -1862 | 847 |
| 140 | $SEG_{71}$ | $SEG_{10}$ | -1942 | 847 |
| 141 | $SEG_{72}$ | $SEG_{9}$ | -2022 | 847 |
| 142 | $SEG_{73}$ | $SEG_{8}$ | -2102 | 847 |
| 143 | $SEG_{74}$ | $SEG_{7}$ | -2182 | 847 |
| 144 | $SEG_{75}$ | $SEG_{6}$ | -2262 | 847 |
| 145 | $SEG_{76}$ | $SEG_{5}$ | -2342 | 847 |
| 146 | $SEG_{77}$ | $SEG_{4}$ | -2422 | 847 |
| 147 | $SEG_{78}$ | $SEG_{3}$ | -2502 | 847 |
| 148 | $SEG_{79}$ | $SEG_{2}$ | -2582 | 847 |
| 149 | $SEG_{80}$ | $SEG_{1}$ | -2662 | 847 |
| 150 | $SEGM_{2}$ | $SEGM_{1}$ | -2742 | 847 |

| PAD No. | PAD NAME | | X=(μm) | Y=(μm) |
|---|---|---|---|---|
| | Mode A | Mode B | | |
| 151 | $COM_{24}$ | $COM_{24}$ | -2822 | 847 |
| 152 | $COM_{23}$ | $COM_{23}$ | -2902 | 847 |
| 153 | $COM_{22}$ | $COM_{22}$ | -2982 | 847 |
| 154 | $COM_{21}$ | $COM_{21}$ | -3062 | 847 |
| 155 | $COM_{20}$ | $COM_{20}$ | -3142 | 847 |
| 156 | $COM_{19}$ | $COM_{19}$ | -3222 | 847 |
| 157 | $COM_{18}$ | $COM_{18}$ | -3302 | 847 |
| 158 | $COM_{17}$ | $COM_{17}$ | -3382 | 847 |
| 159 | $COM_{8}$ | $COM_{8}$ | -3462 | 847 |
| 160 | $COM_{7}$ | $COM_{7}$ | -3542 | 847 |
| 161 | $COM_{6}$ | $COM_{6}$ | -3622 | 847 |
| 162 | $COM_{5}$ | $COM_{5}$ | -3702 | 847 |
| 163 | $COM_{4}$ | $COM_{4}$ | -3782 | 847 |
| 164 | $COM_{3}$ | $COM_{3}$ | -3862 | 847 |
| 165 | $COM_{2}$ | $COM_{2}$ | -3942 | 847 |
| 166 | $COM_{1}$ | $COM_{1}$ | -4022 | 847 |
| 167 | $COMM_{4}$ | $COMM_{4}$ | -4102 | 847 |
| 168 | $COMM_{3}$ | $COMM_{3}$ | -4182 | 847 |
| 169 | $COMM_{2}$ | $COMM_{2}$ | -4262 | 847 |
| 170 | $COMM_{1}$ | $COMM_{1}$ | -4342 | 847 |
| 171 | $COMS_{1}$ | $COMS_{1}$ | -4422 | 847 |
| 172 | $DUMMY_{13}$ | $DUMMY_{13}$ | -4502 | 847 |
| 173 | $DUMMY_{14}$ | $DUMMY_{14}$ | -4582 | 847 |
| 174 | $DUMMY_{15}$ | $DUMMY_{15}$ | -4662 | 847 |
| 175 | $DUMMY_{16}$ | $DUMMY_{16}$ | -4808 | 847 |

Note : Mode A:SEL="L", Mode B:SEL="H"

■ BLOCK DIAGRAM



■ TERMINAL DESCRIPTION

| PAD No | SYMBOL | I/O | FUNCTION |
|---|---|---|---|
| 29, 30, 31<br>10, 11, 12 | $V_{DD}$, $V_{SS}$ | — | Power Source $V_{DD}$ : +3V , $V_{SS}$ : 0V |
| 8, 9, 10 | $V_5$ | — | LCD driving voltage |
| 6 | $OSC_1$ | I | System clock input terminal<br>This terminal should be open for internal clock operation. |
| 7 | $OSC_2$ | O | System clock output terminal<br>This terminal can use for clock frequency monitoring. |
| 41 | P/S | I | Parallel or serial interface selection terminal<br>"0":Serial interface<br>"1":Parallel interface |
| 42 | RS | I | Register selection signal input terminal<br>"0":Instruction register (writing)<br>Busy flag, address counter (reading)<br>"1":Data register (writing / reading) |
| 43 | R/W | I | Read / Write selection signal input terminal<br>"0":Write "1": Read |
| 44 | E | I | Read / Write activation signal input in parallel mode |
| | SCL | I | Sift clock input in serial mode |
| 52 | $DB_7$ | I/O | 3-state data bus for MSB to transfer the Data between MPU and NJU6464 in parallel mode .<br>$DB_7$ is also used for the Busy Flag reading. |
| | CS | I | Chip select signal input in serial mode |
| 51 | $DB_6$ | I/O | 3-state data bus for bit 6 to transfer the Data between MPU and NJU6464 in parallel mode |
| | SIO | I/O | Serial Data I/O in serial mode |
| 49, 50 | $DB_4$, $DB_5$ | I/O | 3-state data bus for bit 4 and 5 to transfer the Data between MPU and NJU6464 in parallel mode .<br>In serial mode, these terminals are not used and should be open. |
| 45～48 | $DB_0$～$DB_3$ | I/O | 3-state data bus for lower 4 bits to transfer the Data between MPU and NJU6464 in parallel mode<br>In serial and 4-bit parallel mode, these terminals are not used and should be open. |
| 61～68<br>151～166 | $COM_1$～$COM_{24}$ | O | LCD common driving signal output terminals |
| 167～170 | $COMM_1$～$COMM_4$ | O | Icon common driving signal output terminals |
| 171 | $COMS_1$ | O | Static driving common signal output terminal<br>When power down mode, $V_{DD}$ or $V_{SS}$ level are output. |
| 70～149 | $SEG_1$～$SEG_{80}$ | O | LCD segment driving signal output terminals |
| 69, 150 | $SEGM_1$, $SEGM_2$ | O | Icon segment driving signal output terminals |
| 60 | $SEGS_1$ | O | Static driving segment signal output terminal<br>When power down mode, $V_{DD}$ or $V_{SS}$ level are output. |

| PAD No | SYMBOL | I/O | FUNCTION |
|---|---|---|---|
| 17～28 | $C_1^+$, $C_1^-$<br>$C_2^+$, $C_2^-$ | I/O | Step up voltage capacitor connecting terminals<br>In case of tripler operation, connect the capacitor between $C_1^+$ and $C_1^-$, $C_2^+$ and $C_2^-$.<br>In case of doubler operation, connect the capacitor between $C_2^+$ and $C_2^-$, connect $C_2^+$ to $C_1^+$, and $C_1^-$ should be open. |
| 14, 15, 16 | $V_{5OUT}$ | O | Step up voltage output terminal |
| 35, 36, 37 | $V_{REG}$ | O | Voltage regulator output terminal<br>Connect the resistor between this terminal and VR Terminal. |
| 32, 33, 34 | VR | I | Reference voltage for voltage regulator input terminal<br>Connect the resistor between this terminal and $V_{DD}$ terminal. |
| 40 | $\overline{RESET}$ | I | Reset Terminal.<br>When the "L" level input over than 1.2ms to this terminal, the system will be reset ( at $f_{OSC}$ 145KHz ). |
| 39 | SEL | I | Common and Segment driver location order select terminal<br>"0":Mode A location ( See the PAD COORDINATES )<br>"1":Mode B location ( See the PAD COORDINATES ) |
| 38 | TEST | I | Maker Testing Terminal ( Pull down )<br>This terminal should be connected to $V_{SS}$ or open. |
| 2～5 | $DUMMY_2$ ～$DUMMY_5$ | — | Dummy terminal<br>These terminals are electrically open. |
| 53, 54 | $DUMMY_6$, $DUMMY_7$ | | |
| 57～59 | $DUMMY_{10}$ ～$DUMMY_{12}$ | | |
| 172～174 | $DUMMY_{13}$ ～$DUMMY_{15}$ | | |
| 1<br>55<br>56<br>175 | $DUMMY_1$<br>$DUMMY_8$<br>$DUMMY_9$<br>$DUMMY_{16}$ | — | Dummy terminal<br>These terminals are electrically open and an alignment pattern is placed beside each terminals. |

■ FUNCTIONAL DESCRIPTION

(1)Description for each block

(1-1)Register

The NJU6464 incorporates two 8-bit registers, an Instruction Register(IR) and a Data Register (DR). The Register(IR) stores instruction codes such as "Clear Display" and "Cursor Shift" or address data for Display Data RAM(DD RAM), Character Generator RAM(CG RAM) and Icon Display RAM (MK RAM).
The MPU can write the instruction code and address data to the Register(IR), but it cannot read out from the Register(IR).
The Register(DR) is a temporary stored register, the data stored in the Register(DR) is written into the DD RAM, CG RAM or MK RAM and read out from the DD RAM, CG RAM or MK RAM.
The data in the Register(DR) written by the MPU is transferred automatically to the DD RAM, CG RAM or MK RAM by internal operation.
When the address data for the DD RAM, CG RAM or MK RAM is written into the Register(IR), the addressed data in the DD RAM, CG RAM or MK RAM is transferred to the Register(DR).
By the MPU read out the data in the Register(DR), the data transmitting process is performed completely.
After reading the data in the Register(DR) by the MPU, the next address data in the DD RAM, CG RAM or MK RAM is transferred automatically to the Register(DR) to provide for the next MPU reading.
These two registers are selected by the selection signal RS as shown below.
Table 1. shows register operation controlled by RS and R/W signals.

Table 1. Register Operation

| RS | R/W | Selected Register | Operation |
|---|---|---|---|
| 0 | 0 | IR | Write |
| 0 | 1 | | Read busy flag($DB_7$) and address counter ($DB_0$~$DB_6$) |
| 1 | 0 | DR | Write (Register(DR) to DD RAM, CG RAM or MK RAM) |
| 1 | 1 | | Read (DD RAM, CG RAM or MK RAM to Register(DR) |

(1-2)Busy Flag (BF)

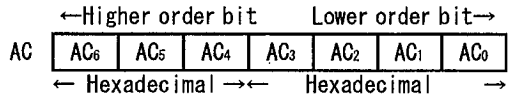
When the internal circuits are in the operation mode, the busy flag(BF) is "1", and any instruction reading is inhibited.
The busy flag(BF) is output at $DB_7$ when RS="0" and R/W="1" as shown in Table 1.
The next instruction should be written after the busy flag(BF) goes to "0".

(1-3)Address Counter (AC)

The address counter(AC) addresses the DD RAM, CG RAM or MK RAM.
When the address setting instruction is written into the Register(IR), the address information is transferred from Register(IR) to the Counter(AC). The selection of either the DD RAM, CG RAM or MK RAM is also determined by this instruction.
After writing (or reading) the display data to (or from) the DD RAM, CG RAM or MK RAM, the Counter(AC) increments (or decrements) automatically.
The address data in the Counter(AC) is output from $DB_6$ ~ $DB_0$ when RS="0" and R/W="1" as shown in Table 1.

(1-4) Display Data RAM (DD RAM)

The display data RAM (DD RAM) consists of 48 x 8 bits stores up to 48-character display data represented in 8-bit code.
The DD RAM address data set in the address counter (AC) is represented in Hexadecimal.




(Example) DD RAM address " 08 "

| 0 | 0 | 0 | 1 | 0 | 0 | 0 |
|---|---|---|---|---|---|---|
| ← | 0 | →← | | 8 | | → |

・3-line Display

The relation between DD RAM address and display position on the LCD is shown below.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | ←Display Position |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1st Line | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | 0F | ←DD RAM Address (Hexadecimal) |
| 2nd Line | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 1A | 1B | 1C | 1D | 1E | 1F | |
| 3rd Line | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 2A | 2B | 2C | 2D | 2E | 2F | |

When the display shift is performed, the DD RAM address changes as follows:

( Left Shift Display )

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (00) ← | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | 0F | 00 |
| (10) ← | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 1A | 1B | 1C | 1D | 1E | 1F | 10 |
| (20) ← | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 2A | 2B | 2C | 2D | 2E | 2F | 20 |

( Right Shift Display )

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0F | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | → (0F) |
| 1F | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 1A | 1B | 1C | 1D | 1E | → (1F) |
| 2F | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 2A | 2B | 2C | 2D | 2E | → (2F) |

Note : The left and right shift performs only in same line, the display data do not change to other line.

(1-5) Character Generator ROM (CG ROM)

The Character Generator ROM (CG ROM) generates 5 x 8 dots character pattern represented in 8-bit character code.
The storage capacity is up to 252 kinds of 5 x 8 dots character pattern (available address is $(04)_H$ through $(FF)_H$).
The correspondence between character code and standard character pattern of NJU6464 is shown in Table 2-1.
User-defined character patterns (Custom Font) are also available by mask option.

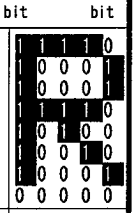
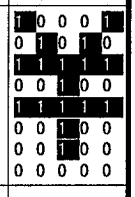
Table 2-1. CG ROM Character Pattern ( ROM version -02 )

| Lower 4bit (Hexadecimal) \ Upper 4bit (Hexadecimal) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | CG RAM (01) |  | |  |  |  |  |  |  |  | |  |  |  |  |  |
| 1 | (02) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 | (03) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 | (04) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7 | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 9 | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| A | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| B | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| C | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| D | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| E | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| F | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

(1-6) Character Generator RAM ( CG RAM )

The character generator RAM ( CG RAM ) can store any kind of character pattern in 5 x 8 dots written by the user program to display user's original character pattern. The CG RAM can store 4 kinds of character in 5 x 8 dots mode.
To display user's original character pattern stored in the CG RAM, the address data $(00)_H$-$(03)_H$ should be written to the DD RAM as shown in Table 2-1.
Table 3. shows the correspondence among the character pattern, CG RAM address and Data.

Table 3. Correspondence of CG RAM address, DD RAM character code and CG RAM character pattern( 5 x 7 dots )

| Character Code (DD RAM Data) | CG RAM Address | | Character Pattern (CG RAM Data) |
|---|---|---|---|
| 7 6 5 4 3 2 1 0 ← → Upperbit Lower bit | 7 6 5 4 3 2 1 0 ← → Upperbit Lower bit | | ← 4 3 2 1 0 → Upper bit Lower bit |
| 0 0 0 0 0 0 0 0 | 0 1 0 0 0 | 0 0 0<br>0 0 1<br>0 1 0<br>0 1 1<br>1 0 0<br>1 0 1<br>1 1 0<br>1 1 1 |  Character Pattern Example(1) ←Cursor Position |
| 0 0 0 0 0 0 0 1 | 0 1 0 0 1 | 0 0 0<br>0 0 1<br>0 1 0<br>0 1 1<br>1 0 0<br>1 0 1<br>1 1 0<br>1 1 1 |  Character Pattern Example(2) ←Cursor Position |
| | | 0 0 0<br>0 0 1 | |
| . . . | . . . | . . . | . . . |
| 0 0 0 0 0 0 1 1 | 0 1 0 1 1 | 1 0 0<br>1 0 1<br>1 1 0<br>1 1 1 | |

Notes : 1. Character code bit 0, 1 correspond to the CG RAM address bit 3, 4 (2bits:4 patterns).
2. CG RAM address 0 to 2 designate character pattern line position. The 8th line is the cursor position and the display is performed by logical OR with cursor. Therefore, in case of the cursor display, the 8th line should be "0". If there is "1" in the 8th line, the bit "1" is always displayed on the cursor position regardless of cursor existence.
3. Character pattern row position correspond to the CG RAM data bits 0 to 4 are shown above.
4. CG RAM character patterns are selected when character code bits 2 to 7 are all "0" and these are addressed by character code bits 0 and 1.
5. "1" for CG RAM data corresponds to display ON and "0" to display OFF.

(1-7) Icon Display RAM (MK RAM)

The NJU6464 can display maximum 152 Icons.
The Icon Display can be controlled by writing the Data in MK RAM corresponds to the Icon.
The relation between MK RAM address and Icon Display position is shown below:

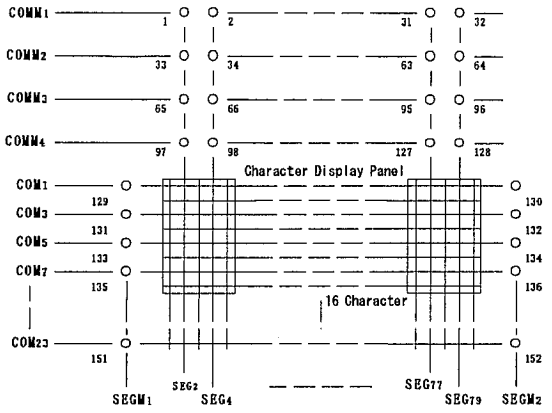



Table 4. Correspondence among Icon Position, MK RAM Address and Data

| MK RAM Address | Bits for Icon Display Position | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | $D_7$ | $D_6$ | $D_5$ | $D_4$ | $D_3$ | $D_2$ | $D_1$ | $D_0$ | |
| $60_H$ | * | * | * | 1 | 2 | 3 | 4 | 129 | COMM1 Line and Both besides of 1st Line (COM1, 3, 5, 7) |
| $61_H$ | * | * | * | 5 | 6 | 7 | 8 | 130 | |
| : | : | | | | | | | | |
| $67_H$ | * | * | * | 29 | 30 | 31 | 32 | 136 | |
| $68_H$ | * | * | * | 33 | 34 | 35 | 36 | 137 | COMM2 Line and Both besides of 2nd Line (COM9, 11, 13, 15) |
| $69_H$ | * | * | * | 37 | 38 | 39 | 40 | 138 | |
| : | : | | | | | | | | |
| $6F_H$ | * | * | * | 61 | 62 | 63 | 64 | 144 | |
| $70_H$ | * | * | * | 65 | 66 | 67 | 68 | 145 | COMM3 Line and Both besides of 3rd Line (COM17, 19, 21, 23) |
| $71_H$ | * | * | * | 69 | 70 | 71 | 72 | 146 | |
| : | : | | | | | | | | |
| $77_H$ | * | * | * | 93 | 94 | 95 | 96 | 152 | |
| $78_H$ | * | * | * | 97 | 98 | 99 | 100 | * | COMM4 Line |
| $79_H$ | * | * | * | 101 | 102 | 103 | 104 | * | |
| : | : | | | | | | | | |
| $7F_H$ | * | * | * | 125 | 126 | 127 | 128 | * | |

*:Don't care

Notes: 1. When the Icon display function using, the system should be initialized by the software initialization because the MK RAM is not initialized by the power turning on and hardware reset.
2. The cross-points between $SEGM_1$, $SEGM_2$ and some of common $COMM_1$ through $COMM_4$, even common likes as $COM_2$, $COM_4$...$COM_{24}$, are always off because of the corresponding RAM does not exist as shown above.
3. In the table 4, the bits $D_5$ to $D_7$ mentioned by * are invalid, therefore both of "0" or "1" can be written but these are no meaning.

(1-8)Timing Generator

The timing generator generates a timing signals for the DD RAM, CG RAM and MK RAM and other internal circuits.
RAM read timing for the display and internal operation timing for MPU access are separately generated, so that they may not interfere with each other.
Therefore, when the data write to the DD RAM for example, there will be no undesirable influence, such as flickering, in areas other than the display area.

(1-9)LCD Driver

LCD Driver consists of 29-common driver and 83-segment driver.
The character pattern data are latched to the addressed Segment-register respectively. This latched data controls display driver to output LCD driving waveform.

(1-10)Cursor Blinking Control Circuit

This circuits controls cursor On/Off and the cursor position character blinks.
The cursor or blinks appear in the digit residing at the DD RAM address set in the address counter (AC).
When the address counter is $(28)_H$, a cursor position is shown as follows:

| | $AC_6$ | $AC_5$ | $AC_4$ | $AC_3$ | $AC_2$ | $AC_1$ | $AC_0$ |
|---|---|---|---|---|---|---|---|
| AC | 0 | 0 | 0 | 1 | 0 | 0 | 0 |

3-Line display

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | ←Display position |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1st Line | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | 0F | ←DD RAM address (Hexadecimal) |
| 2nd Line | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 1A | 1B | 1C | 1D | 1E | 1F | |
| 3rd Line | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 2A | 2B | 2C | 2D | 2E | 2F | |

Cursor position

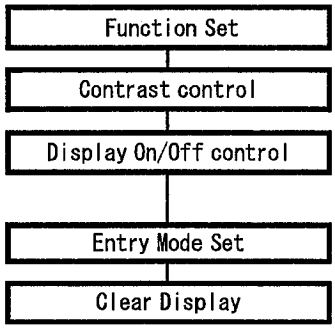
Note : The cursor or blinks also appear when the address counter (AC) selects the CG RAM or the MK RAM. But the displayed cursor and blink are meaningless.
If the AC storing the CG or MK RAM address data, the cursor and blink are displayed in the meaningless position.

(2)Power on Initialization by internal circuits

(2-1)Initialization By Internal Reset Circuits

The NJU6464 is automatically initialized by internal power on initialization circuits when the power is turned on. In the internal power on initialization, following instructions are executed. During the Internal power on initialization, the busy flag (BF) is "1" and this status is kept 7 ms (fosc=145kHz) after $V_{DD}$ rises to 2.4V.

Initialization flow is shown below:




DL=1 :8-bit long interface data
PD=1 :Power down off

Setting $(00)_H$ to the contrast control register

D = 0 :Display Off
C = 0 :Cursor Off
B = 0 :Cursor Blink Off

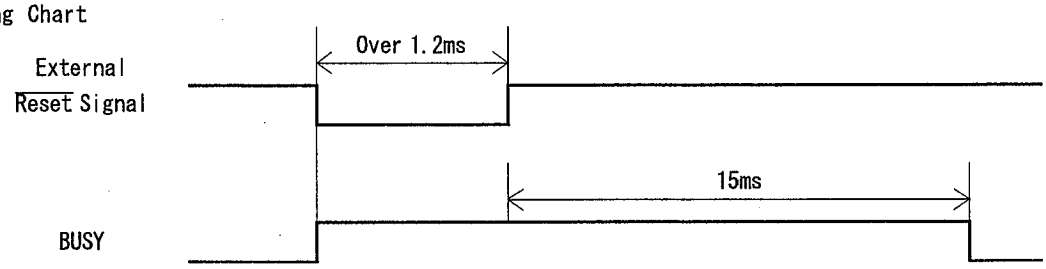
I/D=1 :Increment by 1
S = 0 :No Shift

Note : If the condition of power supply rise time described in the Electrical Characteristics is not satisfied, the internal Power On Initialization Circuits will not operated and initialization will not performed.
In this case the initialization by MPU software is required.

(2-2)Initialization By Hardware

The NJU6464 incorporates $\overline{RESET}$ terminal to initialize the all system. When the "L" level input over 1.2ms to the $\overline{RESET}$ terminal, reset sequence is executed. In this time, busy signal output during 15 ms (fosc=145kHz) after $\overline{RESET}$ terminal goes to "H".

・Timing Chart




(3)Instructions

The NJU6464 incorporates two registers, an Instruction Register (IR) and a Data Register(DR). These two registers store control information temporarily to allow interface between NJU6464 and MPU or peripheral ICs operating different cycles. The operation of NJU6464 is determined by this control signal from MPU. The control information includes register selection signals (RS), read/write signals (R/W) and data bus signals ($DB_0$ to $DB_7$).
Table 5. shows each instruction and its operating time.

Note : The execution time mentioned in Table 5. based on fcp or fosc=145kHz.
If the oscillation frequency is changed, the execution time is also changed.

Table 4. Table of Instructions

| INSTRUCTIONS | CODE RS | R/W | $DB_7$ | $DB_6$ | $DB_5$ | $DB_4$ | $DB_3$ | $DB_2$ | $DB_1$ | $DB_0$ | DESCRIPTION | Execute Time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maker Testing | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | All "0" code is using for maker testing. | — |
| Clear Display | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | Display clear and sets RAM address $(00)_H$ in AC. | 14.13ms |
| Return Home | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | * | Sets RAM address $(00)_H$ in AC and returns display being shifted original position. RAM contents remain unchanged. | 600μs |
| Entry Mode Set | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | I/D | S | Sets cursor move direction and specifies shift of display are performed in data read/write. I/D=1:Increment, I/D=0:Decremen S=1:Accompanies display shift | 0μs |
| Display ON/OFF Control | 0 | 0 | 0 | 0 | 0 | 0 | 1 | D | C | B | Sets of display On/Off(D), cursor On/Off(C) and blink of cursor position character(B). | 0μs |
| Cursor or Display Shift | 0 | 0 | 0 | 0 | 0 | 1 | S/C | R/L | * | * | Moves cursor & shifts display without changing RAM contents S/C=1 : Display shift S/C=0 : Cursor shift R/L=1 : Shift to the right R/L=0 : Shift to the left | cursor: 600μs display: 0μs |
| Function Set | 0 | 0 | 0 | 0 | 1 | DL | * | * | * | PD | Sets interface data length(DL) and power down mode(PD). | PD=0: 0μs PD=1: 200μs |
| Contrast control | 0 | 0 | 0 | 1 | * | * | ←— | Cc | | —→ | Sets data to Contrast Control Register. | 0μs |
| Set RAM Address | 0 | 0 | 1 | ←— | | | $A_R$ | | | —→ | Sets RAM address. After this instruction, the data is transferred to/from RAM. | 600μs |
| Read Busy Flag & AC contents | 0 | 1 | BF | ←— | | | AC | | | —→ | Reads busy flag and AC content BF=1 : Internally operating BF=0 : Can accept instruction | 0μs |
| Write Data to RAM | 1 | 0 | ←— | | | Write Data | | (DD RAM) | | —→ | Writes data into RAM. | 600μs |
| | 1 | 0 | * | * | * | ←— | | (CG RAM) | | —→ | | |
| | 1 | 0 | * | * | * | ←— | | (MK RAM) | | —→ | | |
| Read Data from RAM | 1 | 1 | ←— | | | Read Data | | (DD RAM) | | —→ | Reads data from RAM. | 600μs |
| | 1 | 1 | * | * | * | ←— | | (CG RAM) | | —→ | | |
| | 1 | 1 | * | * | * | ←— | | (MK RAM) | | —→ | | |
| Explanation of Abbreviation | DD RAM : Display data RAM, CG RAM : Character generator RAM, MK RAM : Icon display RAM, $A_R$ : RAM address (both of DD, CG and MK RAM) AC : Address counter used for both of DD, CG and MK RAM | | | | | | | | | | | |

*:Don't care

NOTE1 fosc=145KHz. Change frequency, change execute time too.

(3-1)Description of each instructions

(a)Maker Testing

| | RS | R/W | $DB_7$ | $DB_6$ | $DB_5$ | $DB_4$ | $DB_3$ | $DB_2$ | $DB_1$ | $DB_0$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Code | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

All "0" code in 4-bit length is using for device testing mode ( only for maker ).
Therefore, please avoid all "0" input or no meaning Enable signal input at data "0".
(Especially please check the output condition of Enable signal when the power turns on.)

(b)Clear Display

| | RS | R/W | $DB_7$ | $DB_6$ | $DB_5$ | $DB_4$ | $DB_3$ | $DB_2$ | $DB_1$ | $DB_0$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Code | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

Clear display instruction is executed when the code "1" is written into $DB_0$.
When this instruction is executed, the space code $(20)_H$ is written into every DD RAM address, the DD RAM address $(00)_H$ is set into the address counter and entry mode is set increment.
If the cursor or blink are displayed, they are returned to the left end of the 1st line on the LCD.
The S of entry mode does not change.

Note: The character pattern for character code $(20)_H$ must be blank code in the user-defined character pattern(Custom font).

(c)Return Home

| | RS | R/W | $DB_7$ | $DB_6$ | $DB_5$ | $DB_4$ | $DB_3$ | $DB_2$ | $DB_1$ | $DB_0$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Code | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | * |

* =Don't Care

Return home instruction is executed when the code "1" is written into $DB_1$. When this instruction is executed, the DD RAM address $(00)_H$ is set into the address counter. Display is returned its original position if it is shifted, the cursor or blink are returned to the left end of the 1st line in the LCD if the cursor or blink are on the display.
The DD RAM contents do not change.

(d) Entry Mode Set

| | RS | R/W | $DB_7$ | $DB_6$ | $DB_5$ | $DB_4$ | $DB_3$ | $DB_2$ | $DB_1$ | $DB_0$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Code | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | I/D | S |

Entry mode set instruction which sets the cursor moving direction and display shift On/Off, is executed when the code "1" is written into $DB_2$ and the codes of (I/D) and (S) are written into $DB_1$(I/D) and $DB_0$(S), as shown below.
(I/D) sets the address increment or decrement, and the (S) sets the entire display shift in the DD RAM writing.

| I/D | Function |
|---|---|
| 1 | Address increment: The address of the DD RAM or CG RAM increment (+1) when the read/write, and the cursor or blink move to the right. |
| 0 | Address decrement: The address of the DD RAM or CG RAM decrement (−1) when the read/write, and the cursor or blink move to the left. |

| S | Function |
|---|---|
| 1 | Entire display shift.<br>The shift direction is determined by I/D.: shift to the left at I/D=1 and shift to the right at the I/D=0. The shift is operated only for the character, so that it looks as if the cursor stands still and the display moves.<br>The display does not shift when reading from the DD RAM and writing/reading into/from CG RAM. |
| 0 | The display does not shift. |

(e)Display ON/OFF Control

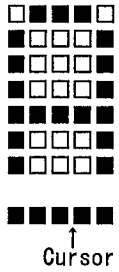
| | RS | R/W | $DB_7$ | $DB_6$ | $DB_5$ | $DB_4$ | $DB_3$ | $DB_2$ | $DB_1$ | $DB_0$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Code | 0 | 0 | 0 | 0 | 0 | 0 | 1 | D | C | B |

Display On/Off control instruction which controls the whole display On/Off, the cursor On/Off and the cursor position character blink, is executed when the code "1" is written into $DB_3$ and the codes of (D), (C) and (B) are written into $DB_2$(D), $DB_1$(C) and $DB_0$(B), as shown below.

| D | Function |
|---|---|
| 1 | Display On. |
| 0 | Display Off. In this mode, the display data remains in the DD RAM so that it is retrieved immediately on the display when the D change to 1. |

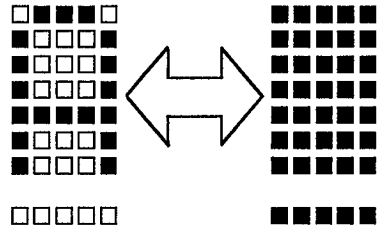
| C | Function |
|---|---|
| 1 | Cursor On. The cursor is displayed by 5 dots on the 8th line. |
| 0 | Cursor Off. Even if the display data write, the I/D etc does not change. |

| B | Function |
|---|---|
| 1 | The cursor position character is blinking. Blinking rate is 600ms at $f_{osc}$=145kHz.<br>The cursor and the blink can be displayed simultaneously. |
| 0 | The character does not blink. |




Character Font 5 x 8 dots

(1)Cursor display example



Alternating display

(2)Blink display example

(f)Cursor/Display Shift

| | RS | R/W | $DB_7$ | $DB_6$ | $DB_5$ | $DB_4$ | $DB_3$ | $DB_2$ | $DB_1$ | $DB_0$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Code | 0 | 0 | 0 | 0 | 0 | 1 | S/C | R/L | * | * | * =Don't Care |

The Cursor/Display shift instruction shifts the cursor position or display to the right or left without writing or reading display data. This function is used to correct or search the display. The cursor moves to the 2nd line when it passes the 16th digit of the 1st line. Notice that the every 1st to 3rd line displays shift at the same time. When the displayed data are shifted repeatedly, each line moves only horizontally.
The 2nd and 3rd line display does not shift into the 1st and 2nd line.
The contents of address counter(AC) does not change by operation of the display shift only.
This instruction is executed when the code "1" is written into $DB_4$ and the codes of (S/C)and (R/L) are written into $DB_3$(S/C) and $DB_2$(R/L), as shown below.

| S/C | R/L | Function |
|---|---|---|
| 0 | 0 | Shifts the cursor position to the left ((AC) is decremented by 1) |
| 0 | 1 | Shifts the cursor position to the right ((AC) is incremented by 1) |
| 1 | 0 | Shifts the entire display to the left and the cursor follows it. |
| 1 | 1 | Shifts the entire display to the right and the cursor follows it. |

(g)Function Set

| | RS | R/W | $DB_7$ | $DB_6$ | $DB_5$ | $DB_4$ | $DB_3$ | $DB_2$ | $DB_1$ | $DB_0$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Code | 0 | 0 | 0 | 0 | 1 | DL | * | * | * | PD | * =Don't Care |

Function set instruction which sets the interface data length and powerdown mode, is executed, when the code "1" is written into $DB_5$ and the code of (DL) and (PD) is written into $DB_4$ (DL) and $DB_0$ (PD), as shown below. In the serial interface operation, the DL is not cared. When the powerdown mode is set, the display is off automatically (D=0). Afterward, when the powerdown mode is reset, the display is off continuously. The display is appeared by the display on (D="1") instruction.

Note : This function set instruction must be performed at the head of the program prior to all other existing instructions(except Busy flag/Address read). This function set instruction can not be executed afterwards unless the interface data length change.

| DL | Function |
|---|---|
| 1 | Set the interface data length of 8-bit (using from $DB_7$ to $DB_0$) in the parallel operation only |
| 0 | Set the interface data length of 4-bit (using from $DB_7$ to $DB_4$) in the parallel operation only the data must be sent or received twice in this mode. |

| PD | Function |
|---|---|
| 1 | Power down mode off (Normal operation) |
| 0 | Power down mode on ( The display goes to off automatically.) |

(h) Contrast Control

| | RS | R/W | $DB_7$ | $DB_6$ | $DB_5$ | $DB_4$ | $DB_3$ | $DB_2$ | $DB_1$ | $DB_0$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Code | 0 | 0 | 0 | 1 | * | * | $C_3$ | $C_2$ | $C_1$ | $C_0$ | * =Don't Care |

Contrast Control instruction which adjusts the contrast of the LCD, is executed when the code "1" is written into $DB_6$ and the codes of $C_3$ to $C_0$ are written into $DB_3$ to $DB_0$ as shown below.
The contrast of LCD can be adjusted one of 16 voltage stage by setting this 4-bit register.
See (5-1) to realize "how to adjust the Contrast of LCD".
Set the binary code "0000" when contrast adjustment is unused.

| contrast | $C_3$ | $C_2$ | $C_1$ | $C_0$ |
|---|---|---|---|---|
| low | 0 | 0 | 0 | 0 |
| | : | : | : | : |
| | : | : | : | : |
| high | 1 | 1 | 1 | 1 |

(i) Set RAM Address

| | RS | R/W | $DB_7$ | $DB_6$ | $DB_5$ | $DB_4$ | $DB_3$ | $DB_2$ | $DB_1$ | $DB_0$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Code | 0 | 0 | 1 | $A_6$ | $A_5$ | $A_4$ | $A_3$ | $A_2$ | $A_1$ | $A_0$ |
| | | | | ←Higher order bit | | | | Lower order bit→ | | |

The RAM address set instruction is executed when the code "1" is written into $DB_7$ and the address is written into $DB_6$ to $DB_0$ as shown above.
The address data ($DB_6$ to $DB_0$) is written into the address counter (AC) by this instruction. After this instruction execution, the data writing/reading is performed into/from the addressed RAM.
The RAM includes DD RAM, CG RAM and MK RAM, and these RAMs are shared by address as shown below.

| | | | RAM address |
|---|---|---|---|
| DD RAM | 1st Line | : | from $(00)_H$ to $(0F)_H$ |
| DD RAM | 2nd Line | : | from $(10)_H$ to $(1F)_H$ |
| DD RAM | 3rd Line | : | from $(20)_H$ to $(2F)_H$ |
| CG RAM | 4characters | : | from $(40)_H$ to $(5F)_H$ |
| MK RAM | 152icon | : | from $(60)_H$ to $(7F)_H$ |

(j) Read Busy Flag & AC contents

| | RS | R/W | $DB_7$ | $DB_6$ | $DB_5$ | $DB_4$ | $DB_3$ | $DB_2$ | $DB_1$ | $DB_0$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Code | 0 | 1 | BF | $A_6$ | $A_5$ | $A_4$ | $A_3$ | $A_2$ | $A_1$ | $A_0$ |
| | | | | ←Higher order bit | | | | Lower order bit→ | | |

This instruction reads out the internal status of the NJU6464. When this instruction is executed, the busy flag (BF) stored in $DB_7$ and the address counter (AC) contents stored in $DB_6$ to $DB_0$ are read out.
The (BF)="1" indicates that internal operation is in progress. The next instruction is inhibited when (BF)="1". Check the (BF) status before the next write operation.

(k)Write Data to RAM

Write Data to RAM instruction is executed when the code "1" is written into (RS) and code "0" is written into (R/W).
By the execution of this instruction, the binary 8-bit data ($A_7$ to $A_0$) are written into the DD RAM, and the binary 5-bit data ($A_4$ to $A_0$) are written into the CG or MK RAM. The selection of RAM is determined by the previous instruction. After this instruction execution, the address increment(+1) or decrement(-1) is performed automatically according to the entry mode set.
And the display shift is also executed according to the previous entry mode set.

·Write Data to DD RAM

| | RS | R/W | $DB_7$ | $DB_6$ | $DB_5$ | $DB_4$ | $DB_3$ | $DB_2$ | $DB_1$ | $DB_0$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Code | 1 | 0 | $D_7$ | $D_6$ | $D_5$ | $D_4$ | $D_3$ | $D_2$ | $D_1$ | $D_0$ |
| | | | ←Higher order bit | | | | | | Lower order bit→ | |

·Write Data to CG or MK RAM

| | RS | R/W | $DB_7$ | $DB_6$ | $DB_5$ | $DB_4$ | $DB_3$ | $DB_2$ | $DB_1$ | $DB_0$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Code | 1 | 0 | * | * | * | $D_4$ | $D_3$ | $D_2$ | $D_1$ | $D_0$ |
| | | | | | | ←Higher order bit | | | Lower order bit→ | |

(l)Read Data from MK RAM

Read Data from RAM instruction is executed when the code "1" is written into (RS) and (R/W).
By the execution of this instruction, the binary 8-bit data ($D_7$ to $D_0$) are read out from the DD RAM, the binary 5-bit data ($D_4$ to $D_0$) are read out from the CG or MK RAM. The selection of RAM is determined by previous instruction. Before executing this instruction, RAM address set must be executed, otherwise the read out data are invalidated.
When this instruction is serially executed, the next address data is normally read from the second read.
The RAM address set instruction is not required if the cursor shift instruction is executed just beforehand (only DD RAM reading). The cursor shift instruction has same function as the DD RAM address set, so that after reading the DD RAM, the address increment or decrement is executed automatically according to the entry mode.
But display shift does not operate regardless of the entry mode.

Note : The address counter(AC) is automatically incremented or decremented by 1 after write instruction to either of the DD RAM, CG RAM or DD RAM. Even if the read instruction is executed after this write instruction, the addressed data can not be read out correctly.
For a correct data read out, either the address set instruction or cursor shift instruction (only with DD RAM) must be implemented just before this instruction or from the second time read out instruction execution if the read out instruction is executed 2 times consecutively.

·Read Data from DD RAM

| | RS | R/W | $DB_7$ | $DB_6$ | $DB_5$ | $DB_4$ | $DB_3$ | $DB_2$ | $DB_1$ | $DB_0$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Code | 1 | 1 | $D_7$ | $D_6$ | $D_5$ | $D_4$ | $D_3$ | $D_2$ | $D_1$ | $D_0$ |
| | | | ←Higher order bit | | | | | | Lower order bit→ | |

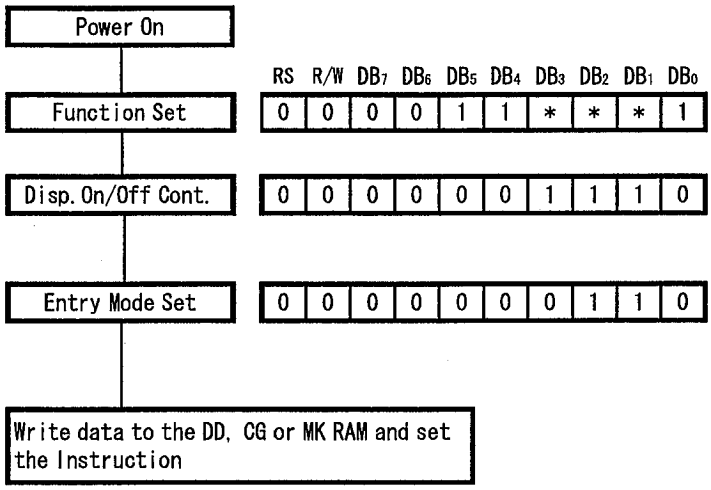
·Read Data from CG or MK RAM

| | RS | R/W | $DB_7$ | $DB_6$ | $DB_5$ | $DB_4$ | $DB_3$ | $DB_2$ | $DB_1$ | $DB_0$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Code | 1 | 1 | * | * | * | $D_4$ | $D_3$ | $D_2$ | $D_1$ | $D_0$ | * =Don't Care |
| | | | | | | ←Higher order bit | | | Lower order bit→ | | |

(3-2) Initialization using the internal reset circuits

(a) 8-bit operation (Using internal reset circuits).

The Function set, Display On/Off Control and Entry Set Instruction must be executed before the data input, as shown below.




Initialized.
No display appears.

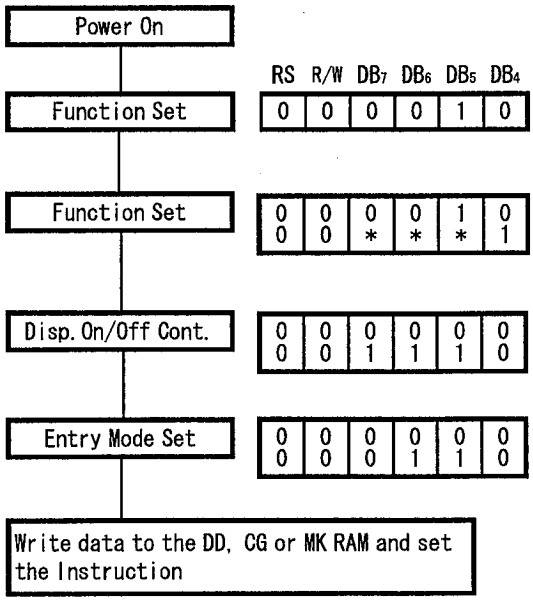
Set the 8-bit operation and Power down mode off.

Turns on display and cursor.
Entire display is in space mode set by the initialization.

Example for set address increment and cursor right shift when the data write to the DD, CG or MK RAM.

(b) 4-bit operation (Using internal reset circuits).

In the 4-bit operation, the function set must be performed by the user programming.
When the power is turned on, 8-bit operation is selected automatically, therefore the first input is performed under 8-bit operation. In this operation, full instruction can not input because of terminals $DB_0$ to $DB_3$ are no connection. Therefore, same instruction must be rewritten on the RS, R/W and $DB_7$ to $DB_4$, as shown below. Since one operation is completed by the two accesses in the 4-bit operation mode, rewrite is required to set the instruction code in full.




Initialized.
No display appears.

Set the 4-bit operation.
This step is executed in 8-bit mode set by the initialization.

Set the 4-bit operation, Power down mode off, 5 x 8 dots Font.
The 4-bit operation starts from this step.

Turn on display and cursor.
Entire display is in space mode set by the initialization.

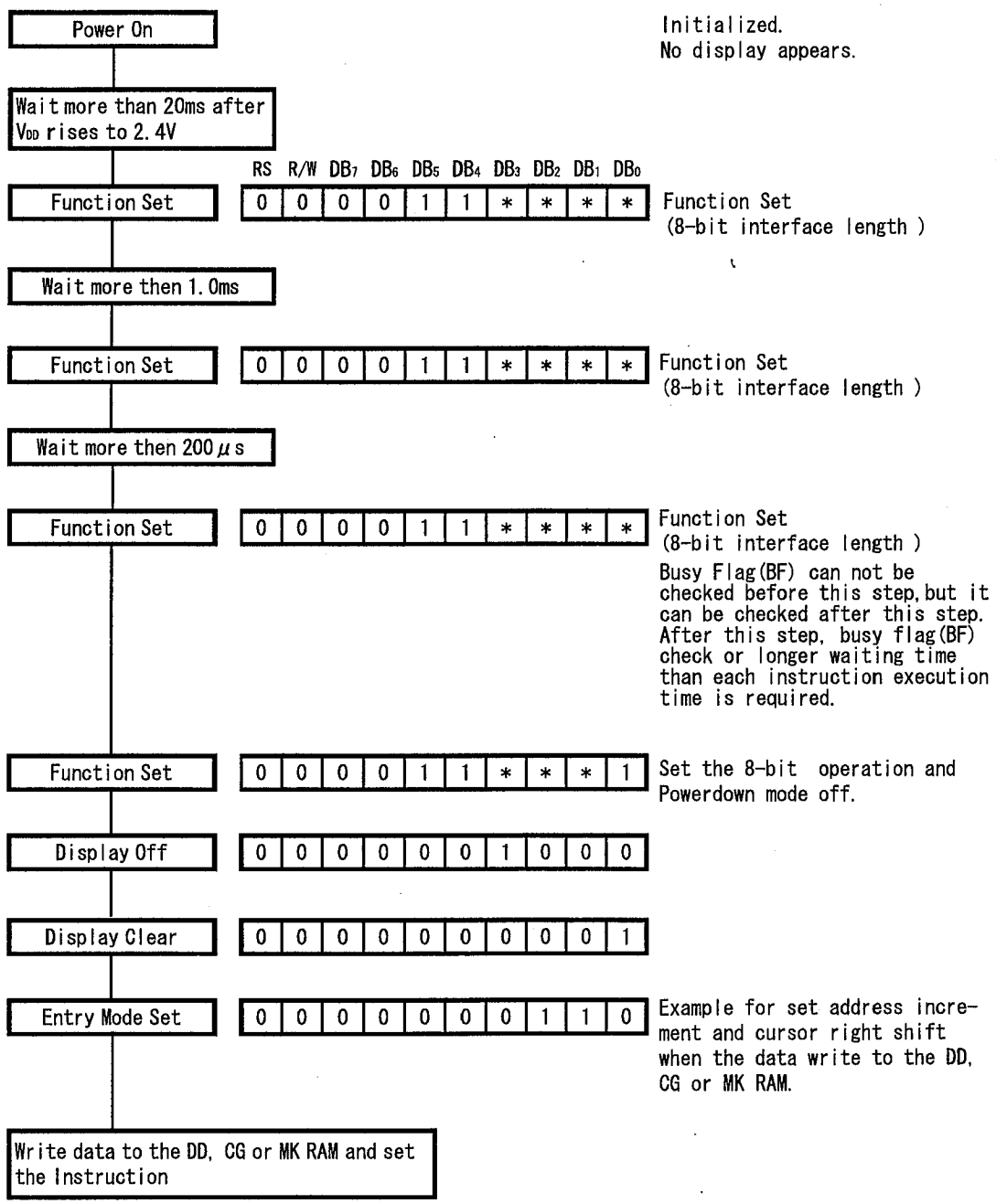
Example for set address increment and cursor right shift when the data write to the DD RAM or CG RAM.

Note : When the Icon display function using, the system should be initialized by software initialization.

(3-3) Initialization by instruction

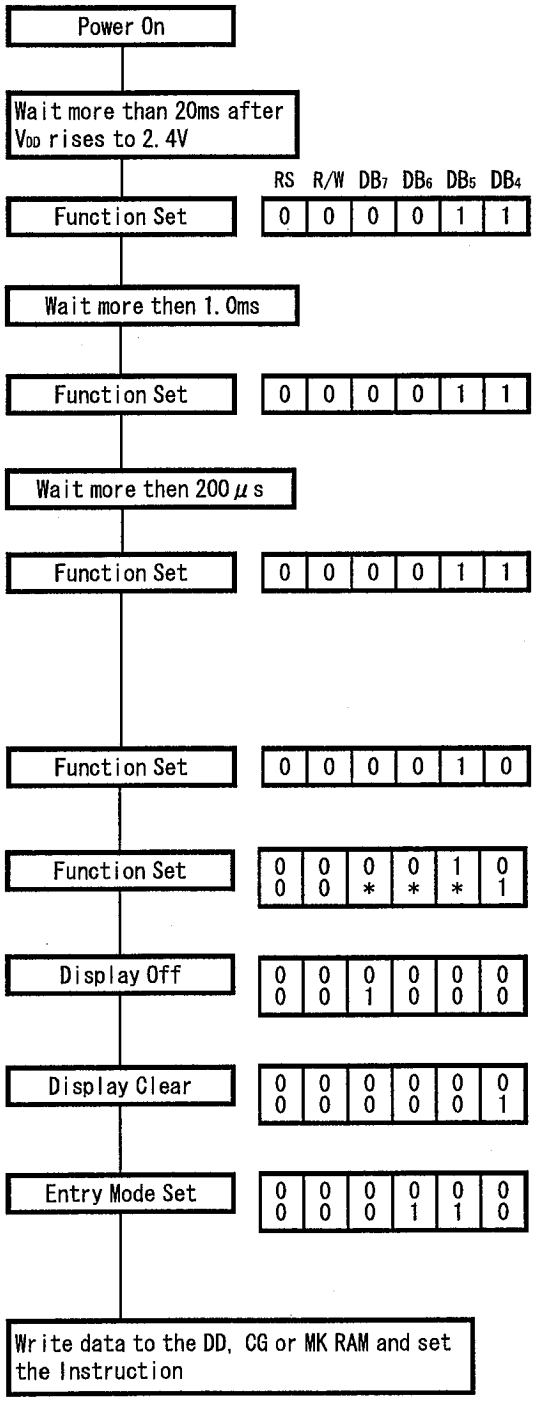
If the power supply conditions for the correct operation of the internal reset circuits are not met, the NJU6464 must be initialized by the instruction.

(a) Initialization by Instruction in 8-bit interface length.




Note : When the Icon display function using, the system should be initialized by software initialization.

(b) Initialization by Instruction in 4-bit interface length




Note : When the Icon display function using, the system should be initialized by software initialization.

(4)Powerdown Function

NJU6464 incorporates the powerdown mode to decrease the operating current.
The powerdown mode can be set/reset by the function set instruction.
In the powerdown mode, all the character display ( 16-character 3-line ) and icon display turn off and only the static display area operates automatically.
The status of internal circuits at the powerdown mode is shown below :

- Main oscillator stops operation and sub oscillator for the static display starts operations.
- Voltage converter, voltage regulator and buffer amplifier for the bleeder resistance stop the operation.
- The contents of DD RAM, CG RAM and MK RAM are kept.

(5)LCD display

(5-1)Power Supply for LCD Driving

NJU6464 incorporates Voltage converter ( tripler or doubler ) to generate the LCD driving high voltage, Voltage regulator to adjust the LCD driving voltage, Bleeder resistance and buffer amplifier.

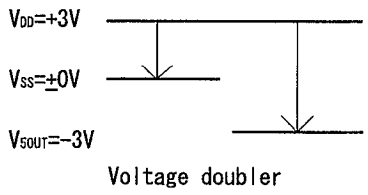
(a)Voltage converter

- Voltage tripler

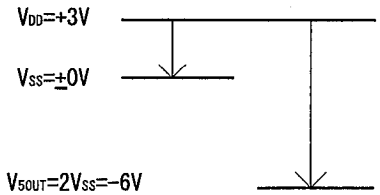
By connecting the capacitor between $C_1^+$ and $C_1^-$, $C_2^+$ and $C_2^-$, $V_{SS}$ and $V_{5OUT}$ respectively, two times negative voltage of $V_{DD}-V_{SS}$ output from $V_{5OUT}$.

- Voltage doubler

By connecting the capacitor between $C_2^+$ and $C_2^-$, $V_{SS}$ and $V_{5OUT}$ respectively, and connecting the $C_1^+$ terminal to $C_2^+$ terminal, and $C_1^-$ terminal being open, negative voltage of $V_{DD}-V_{SS}$ output from $V_{5OUT}$.




Voltage doubler

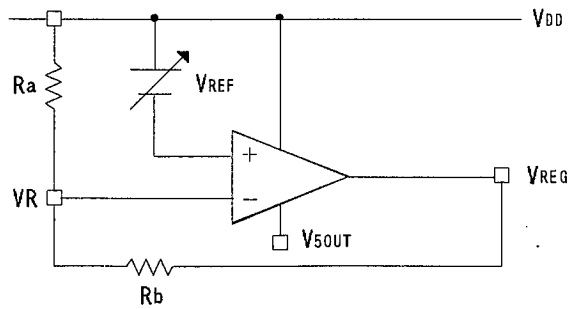



Voltage tripler

(b)Voltage Regulator

Voltage Regulator incorporates a non-inverting OP-AMP which supplied $V_{DD}$ and $V_{5OUT}$, and a reference voltage source.
By setting the VR level by connecting $R_a$ and $R_b$, the regulator which amplifies $V_{REF}$ output the LCD driving voltage to the $V_{REG}$ terminal.
Therefore, the LCD operating voltage can be output between $V_{DD}$ and $V_{REG}$ by setting $V_{REF}$ and the external resistances $R_a$ and $R_b$.

$$V_{REG} = (1+R_b/R_a) \cdot V_{REF} \quad \text{where,} \quad V_{DD} = 0V \quad \text{and} \quad |V_{REG}| < |V_{5OUT}|$$

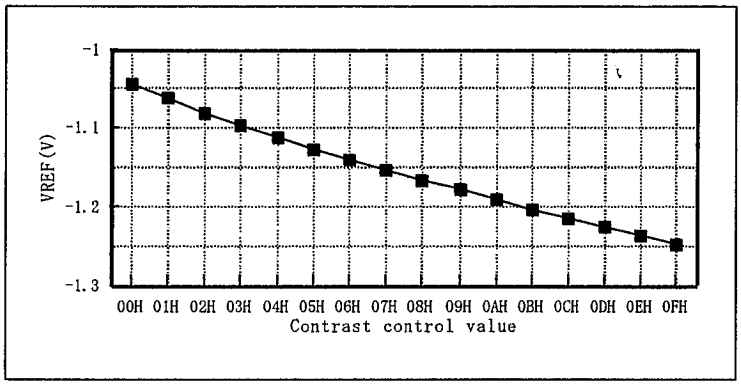


The contrast control function performs $V_{REF}$ value adjustment from 1st step to 16th step by a step setting when the 4-bit data write into the contrast control register by the instruction.

Note : Set the contrast control register to $(00)_H$ when the contrast control function is unused.
Use variable resistances to the external resistances $R_a$, $R_b$ and a thermistor if need due to the voltage reference $V_{REF}$ is changed by the lot and operating temperature.
Take care the Noise input on the $V_R$ terminal because of it designed in high impedance.
Short wiring or sealed wiring are required to avoid the noise input, if necessary.

[ The Voltage Reference VREF characteristics ]

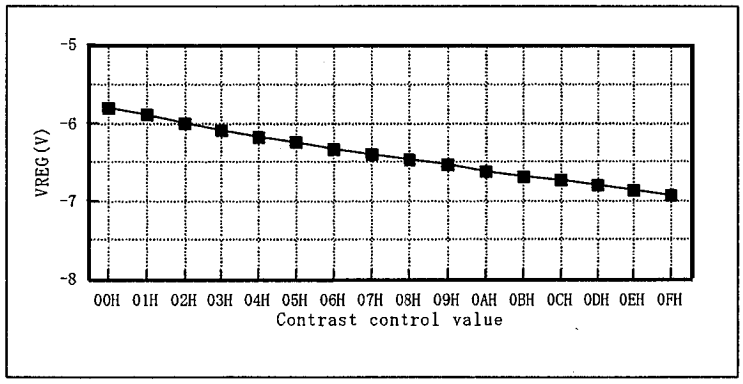
Supply Voltage : $V_{DD}$= 0V, $V_{SS}$= -3V  Temperature : 25°C




[ The LCD Operating Voltage $V_{REG}$ characteristics ]

Supply Voltage : $V_{DD}$= 0V, $V_{SS}$= -3V  Voltage Tripler Output : $V_{5OUT}$= -9V
External Resistances : $R_a$ = 180K Ω, $R_b$ = 820K Ω  Temperature : 25°C

Used Equation : $V_{REG}(xx)_H = ( 1 + 820k\,\Omega / 180k\,\Omega ) \cdot V_{REF}(xx)_H$



(c)Bleeder Resistance

Each LCD driving voltage ( $V_1$, $V_2$, $V_3$, $V_4$ ) is generated by the high impedance bleeder resistance buffered by voltage follower OP-AMP to get a enough display characteristics with low operating current.

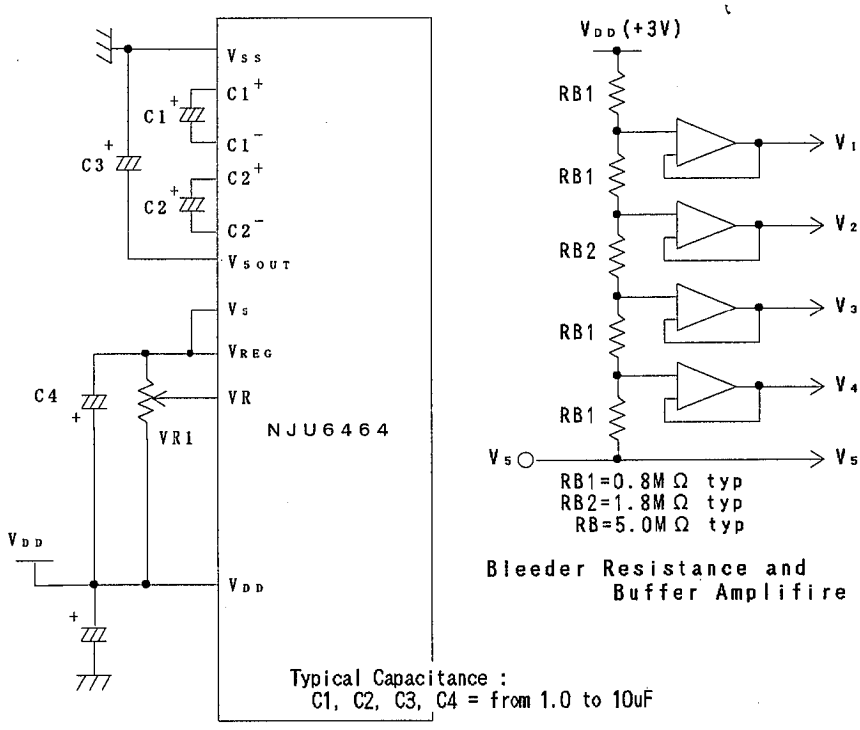
The bleeder resistance is set 1/6.3 bias suitable for 1/28 duty ratio and 5MΩ resistance in total.

The capacitor connected between $V_5$ and $V_{DD}$ is needed for stabilizing $V_5$. The determination of the each capacitance of $C_1$, $C_2$ and $C_3$ generating for LCD operating voltage, is required to operate with the LCD panel actually. The capacitance for the typical application is shown below :

LCD Driving Voltage vs Duty Ratio

| Power supply | Duty Ratio | 1/28 |
|---|---|---|
| | Bias | 1/6.3 |
| $V_{LCD}$ | | $V_{DD} - V_5$ |

$V_{LCD}$ is the maximum amplitude for LCD driving voltage.



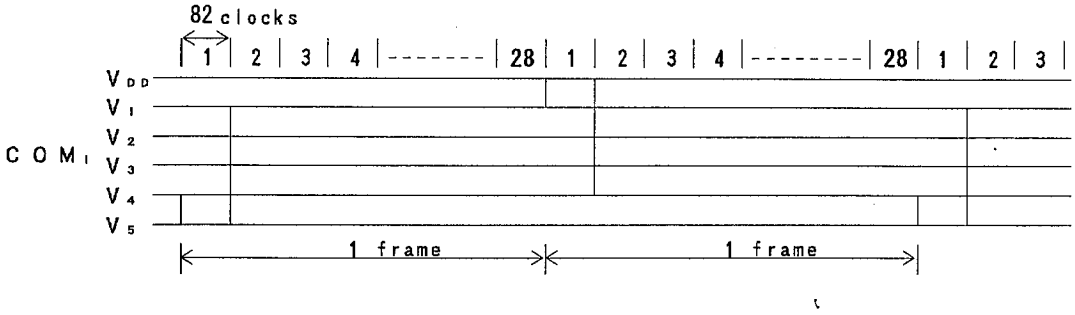

Typical application for LCD operating voltage generation

Note 1 : Take care the Noise input on the $V_R$ terminal as designed in high impedance. Short wiring or sealed wiring are required to avoid the noise input, if necessary.

(5-2) Relation between oscillation frequency and LCD frame frequency

As the NJU6464 incorporate oscillation capacitor and resistor for CR oscillation, 145kHz oscillation is available without any external components.
The LCD frame frequency example mentioned below is based on 145kHz oscillation. (1clock =6.90 $\mu$ s)

1/28 duty ratio



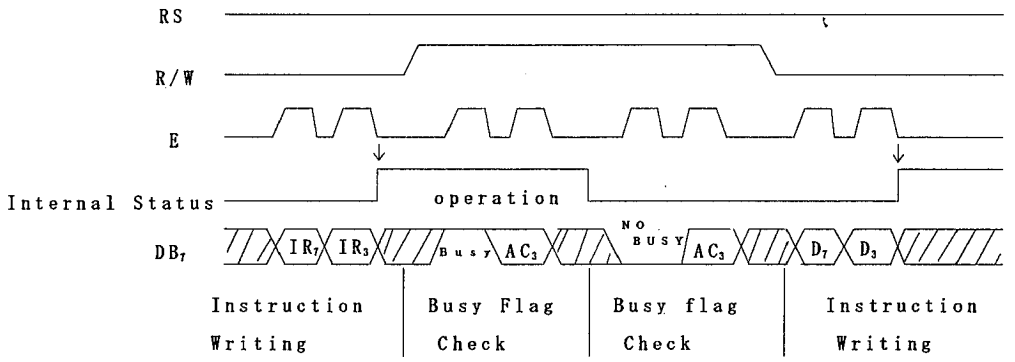

1 frame = 6.90($\mu$ s) x 82 x 28 = 15.84(ms)
Frame frequency = 1 / 15.84(ms) = 63.1(Hz)

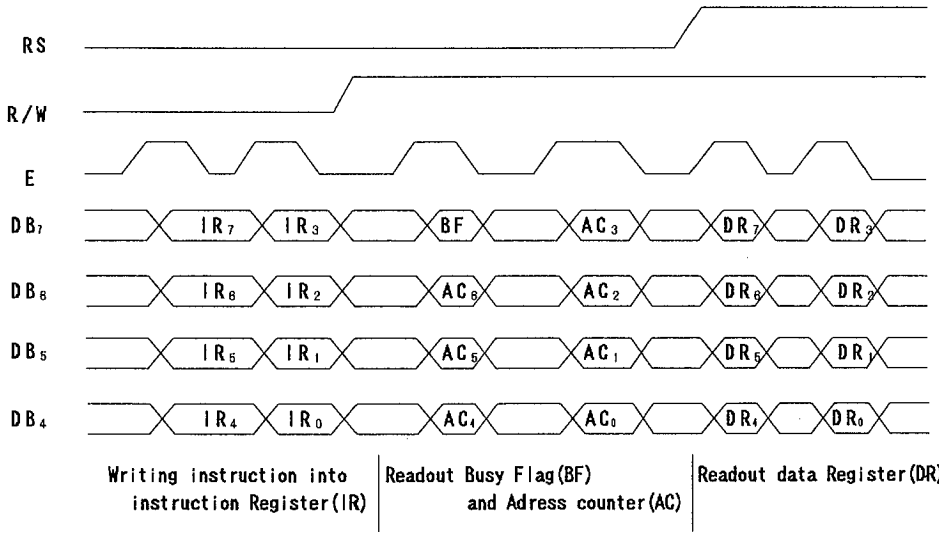
(6) Interface with MPU

Interface circuits of NJU6464 can be connected to serial or 4/8-bit parallel.
NJU6464 can be interfaced with both of 4/8-bit MPU and the two-time 4-bit or one-time 8-bit data transfer is available.

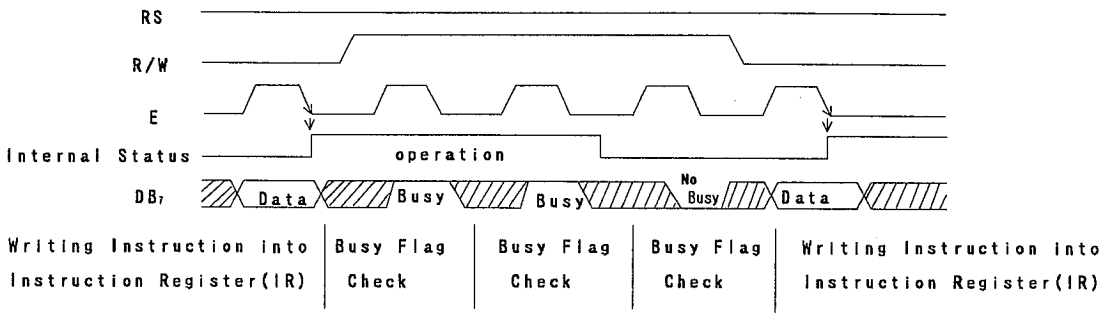
(6-1) 4-bit MPU interface

When the interface length is 4-bit, the data transfer is performed by 4 lines connected to $DB_4$ to $DB_7$ ($DB_0$ to $DB_3$ are not used). The data transfer with the MPU is completed by the two time 4-bit data transfer.
The data transfer is executed in the sequence of upper 4-bit (the data $DB_4$ to $DB_7$ at 8-bit length) and lower 4-bit (the data $DB_0$ to $DB_3$ at 8-bit length).
The busy flag check can be executed after two-time 4-bit data transfer (1 instruction execution by two-time transfer). In this case, the data of busy flag and address counter contents are also output twice.



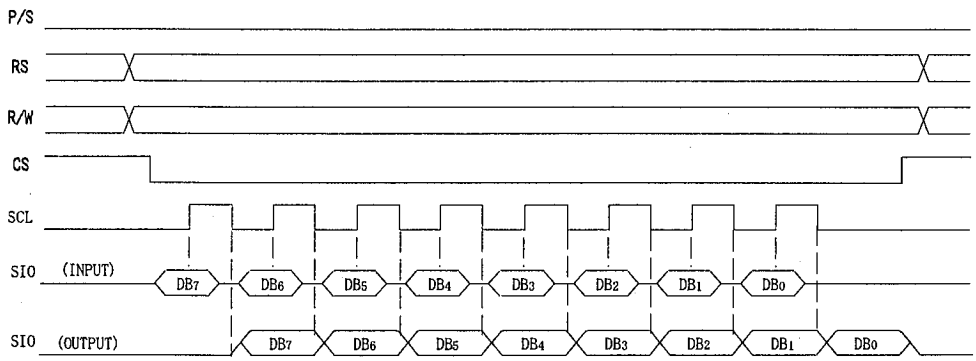
(6-2) 8-bit MPU interface




(6-3) Serial interface

Serial interface circuit is activated when the P/S terminal is set to "L" level then the chip select terminal (CS) goes to "L" level. The data input/output is MSB first like as the order of $DB_7$, $DB_6$ ···· $DB_0$.
The input data is entered into the shift register synchronized at the rise edge of the serial clock SCL. The shift register converted to parallel data at the CS rise edge input.
In case of entering over than 8-bit data, valid data is last 8-bit data.
The output data is exited from the shift register synchronized at the fall edge of the serial clock SCL.
The time chart for the serial interface is shown below.

Note : The level ("L" or "H") of RS and R/W terminals should be set before CS terminal goes to "L" level.



## ■ ABSOLUTE MAXIMUM RATINGS

(Ta=25°C)

| PARAMETER | SYMBOL | RATINGS | UNIT | NOTE |
|---|---|---|---|---|
| Supply Voltage | $V_{DD}$ | -0.3～+7.0 | V | |
| Input Voltage | $V_{IN}$ | -0.3～$V_{DD}$+0.3 | V | |
| Operating Temperature | Topr | -30～+80 | °C | |
| Storage Temperature | Tstg | -55～+125 | °C | |

Note 1 : If the LSI are used on condition above the absolute maximum ratings, the LSI may be destroyed. Using the LSI within electrical characteristics is strongly recommended for normal operation. Use beyond the electric characteristics conditions will cause mal function and poor reliability.
Note 2 : Decoupling capacitor should be connected between $V_{DD}$ and $V_{SS}$ due to the stabilized operation for the Voltage converter.
Note 3 : All voltage values are specified as $V_{SS}$ = 0V
Note 4 : The relation : $V_{DD} > V_{SS}$ , $V_{DD} > V_{SS} \geqq V_{5OUT}$, $V_{SS}$=0V must be maintained.

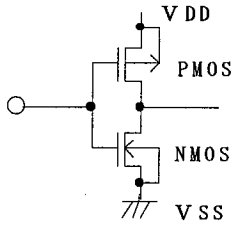
## ■ ELECTRICAL CHARACTERISTICS

($V_{DD}$ =2.4～3.3V、Ta=-20～+75°C)

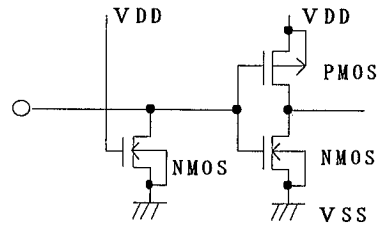
| PARAMETER | | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNIT | NOTE |
|---|---|---|---|---|---|---|---|---|
| Operationg Voltage | | $V_{DD}$ | | 2.4 | 3.0 | 3.3 | V | |
| Input Voltage | | $V_{IH}$ | | 0.8$V_{DD}$ | — | $V_{DD}$ | V | 4 |
| | | $V_{IL}$ | | $V_{SS}$ | — | 0.2$V_{DD}$ | V | 5 |
| Output Voltage | | $V_{OH}$ | $-I_{OH}$=0.205mA、$V_{DD}$=3V | 2.0 | — | — | V | 6 |
| | | $V_{OL}$ | $I_{OL}$=1.6mA、$V_{DD}$=3V | — | — | 0.5 | V | |
| Driver On-resist. (COM) | | $R_{COM}$ | $\pm I_d$=1μA (All com term.) | — | — | 20 | kΩ | 9 |
| Driver On-resist. (SEG) | | $R_{SEG}$ | $\pm I_d$=1μA (All seg term.) | — | — | 30 | kΩ | |
| Input Leakage Current | | $I_{LI}$ | $V_{IN}$=0 or $V_{DD}$ | -1 | — | 1 | μA | 7 |
| Pull-up MOS Current | | $-I_P$ | $V_{DD}$=3V, (All DB terminals) | 10 | 25 | 50 | μA | |
| Operating Current | | $I_{DD1}$ | $V_{DD}$=3V $f_{OSC}$=Internal Osc. $V_5$=-5V, during display | — | 250 | 290 | μA | 8 |
| | | $I_{DD2}$ | $V_{DD}$=3V $f_{OSC}$=Internal Osc. dyuring access, $T_{CYCE}$=5μs | — | — | 500 | μA | |
| | | $I_{DD3}$ | $V_{DD}$=3V, $f_{OSC}$=Internal Osc. during power down mode | — | — | 20 | μA | |
| Voltage Converter (Tripler) | Output Voltage | $V_{5OUT}$ | $V_{DD}$=3V, Ta=25°C, $I_{OUT}$=100μA | -4.6 | -4.8 | — | V | |
| | Voltage Efficiency | $V_{ef}$ | $R_L$=∞ | 90.0 | 95.0 | — | % | |
| Voltage Regulator | Reference Voltage | $V_{REF}$ | Contrast Control $(00)_H$ Ta=25°C | -1.3 | -1.0 | -0.7 | V | |
| | Output Voltage | $V_{REG}$ | $R_L$=∞, $V_{5OUT}$=-10V, $R_{RV}$=1MΩ Contrast Control $((00)_H$ | -10 | — | -1.8 | | |
| Bleeder resistance | | $R_B$ | $V_{DD}$-$V_5$=3V | — | 5.0 | — | MΩ | |
| Oscillation Frequency | | $f_{OSC}$ | $V_{DD}$=3V, Ta=25°C | 110 | 145 | 180 | kHz | |
| LCD Driving Voltage | | $V_{LCD}$ | $V_{LCD}$=$V_{DD}$-$V_5$ | $V_{DD}$-5.0 | — | $V_{DD}$-10.0 | V | 10 |

Note 5 : Input/Output structure except LCD driver are shown below:

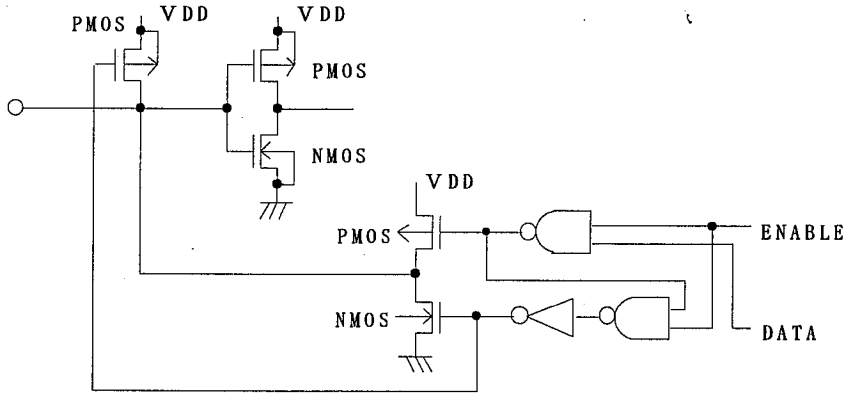
·Input Terminal Structure
E/SCL, RS, R/W, P/S, SEL, $\overline{\text{RESET}}$ Terminals




TEST Terminal (Pull-Down MOS)

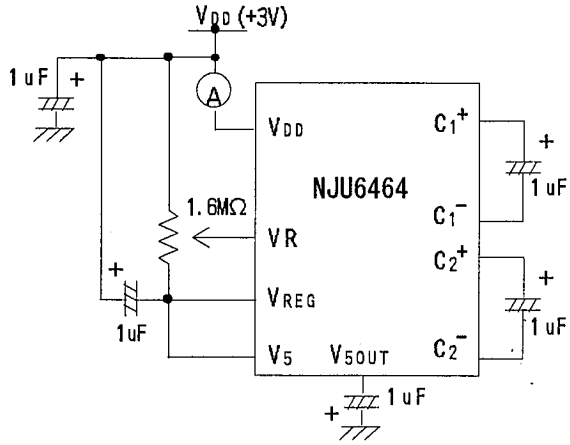



·Input/Output Terminal Structure
$DB_0$ to $DB_7$ Terminals




Note 6 : Apply to the Output and Input/Output Terminals.
Note 7 : Except pull-up resistance current and output driver current.
Note 8 : Except Input/output current but including the current flow on bleeder resistance.
If the input level is medium, current consumption will increase due to the penetration current. Therefore, the input level must be fixed to "H" or "L".

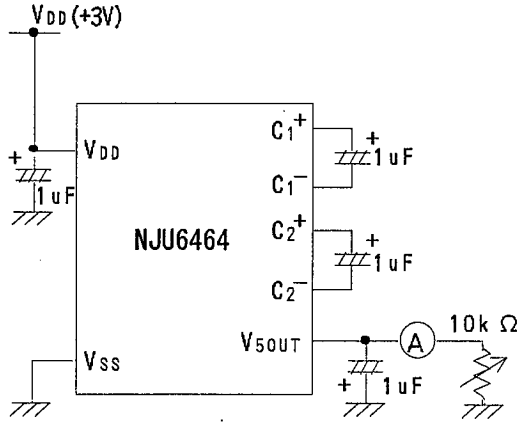
· Operating Current Measurement Circuit



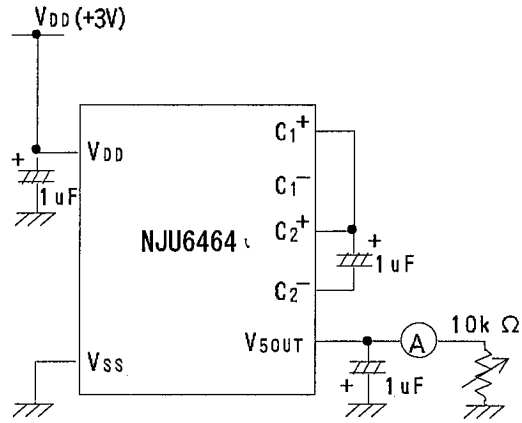
Note 9 : $R_{COM}$ and $R_{SEG}$ are the resistance values between power supply terminals ($V_{DD}$, $V_{5OUT}$) and each common terminal ($COM_1$ to $COM_{24}$, $COMMK_1$ to $COMMK_4$) and supply voltage ($V_{DD}$, $V_{5OUT}$) and each segment terminal ($SEG_1$ to $SEG_{80}$, $SEGM_1$ and $SEGM_2$) respectively, and measured when the current $I_d$ is flown on every common and segment terminals at a same time.

Note 10: Apply to the output voltage from each COM and SEG are less than ±0.15V against the LCD driving constant voltage ($V_{DD}$, $V_{5OUT}$) at no load condition.

Voltage Tripler Measurement Circuit

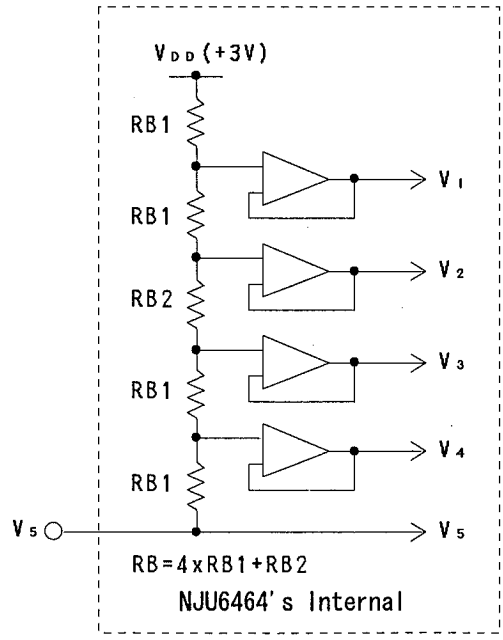



Voltage Doubler Measurement Circuit




Voltage Tripler/Doubler
Operation Clock Frequency = 10kHz

Bleeder Resistance
and Buffer Amplifier



・Bus timing characteristics ($V_{DD}$ = 2.4～3.3V, $V_{SS}$ = 0V, Ta =-20 ～ +75℃)

Write operation ( Write from MPU to NJU6464 )

| PARAMETER | | SYMBOL | MIN. | MAX. | CONDITION | UNIT |
|---|---|---|---|---|---|---|
| Enable cycle time | | $t_{CYCE}$ | 1 | — | fig. 1 | μs |
| Enable pulse width | "1" level | $PW_{EH}$ | 400 | — | | ns |
| Enable rise time, fall time | | $t_{Er}$, $t_{Ef}$ | — | 20 | | |
| Set up time | RS, R/W, E | $t_{AS}$ | 200 | — | | |
| Address hold time | | $t_{AH}$ | 200 | — | | |
| Data set up time | | $t_{DSW}$ | 200 | — | | |
| Data hold Time | | $t_H$ | 200 | — | | |

Timing Characteristics (Write operation)

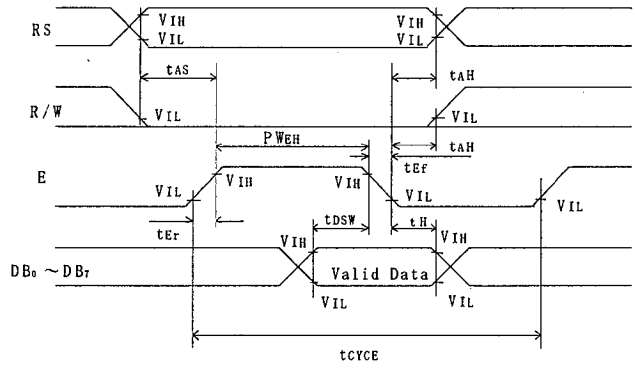



fig. 1

Read operation ( Read from NJU6464 to MPU )

| PARAMETER | | SYMBOL | MIN. | MAX. | CONDITION | UNIT |
|---|---|---|---|---|---|---|
| Enable cycle time | | $t_{CYCE}$ | 1 | — | fig. 2 | μs |
| Enable pulse width | "1" level | $PW_{EH}$ | 600 | — | | ns |
| Enable rise time, fall time | | $t_{Er}$, $t_{Ef}$ | — | 20 | | |
| Set up time | RS, R/W, E | $t_{AS}$ | 200 | — | | |
| Address hold time | | $t_{AH}$ | 200 | — | | |
| Data delay time | | $t_{DDR}$ | — | 500 | | |
| Data hold time | | $t_{DHR}$ | 0 | — | | |

Timing Characteristics (Read operation)

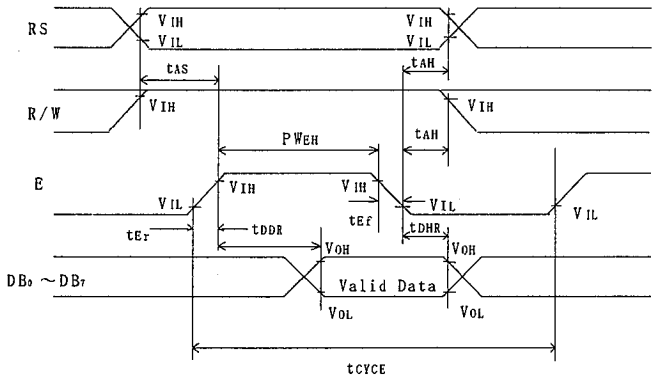



fig. 2

・Serial Interface Sequence

($V_{DD}$ = 2.4 ~ 3.3V , $V_{SS}$ =0V, Ta =-20 ~ +75°C)

| PARAMETER | | SYMBOL | MIN. | MAX. | CONDITION | UNIT |
|---|---|---|---|---|---|---|
| Serial clock cycle time | | $t_{CYCE}$ | 1 | — | fig.3 | μs |
| Serial clock width | "1" level | $t_{SCH}$ | 300 | — | | ns |
| | "0" level | $t_{SCL}$ | 700 | — | | |
| Serial clock rise and fall Time | | $t_{SCr}$, $t_{SCf}$ | — | 20 | | |
| Chip select pulse width | | $PW_{CS}$ | 500 | — | | |
| Chip select set up time | | $t_{CSU}$ | 200 | — | | |
| Chip select hold time | | $t_{CH}$ | 200 | — | | |
| Chip Select rise and fall Time | | $t_{CSr}$, $t_{CSf}$ | — | 20 | | |
| Set up time | RS, R/W - CS | $t_{AS}$ | 200 | — | | |
| Address hold time | CS - RS, R/W | $t_{AH}$ | 200 | — | | |
| Serial input data set up time | | $t_{SISU}$ | 200 | — | | |
| Serial input data hold time | | $t_{SIH}$ | 200 | — | | |
| Serial output data delay time | | $t_{SOD}$ | — | 700 | | |
| Serial output data hold time | | $t_{SOH}$ | 0 | — | | |

Load Condition of $DB_0$ to $DB_7$ : CL=100pF

Serial Interface

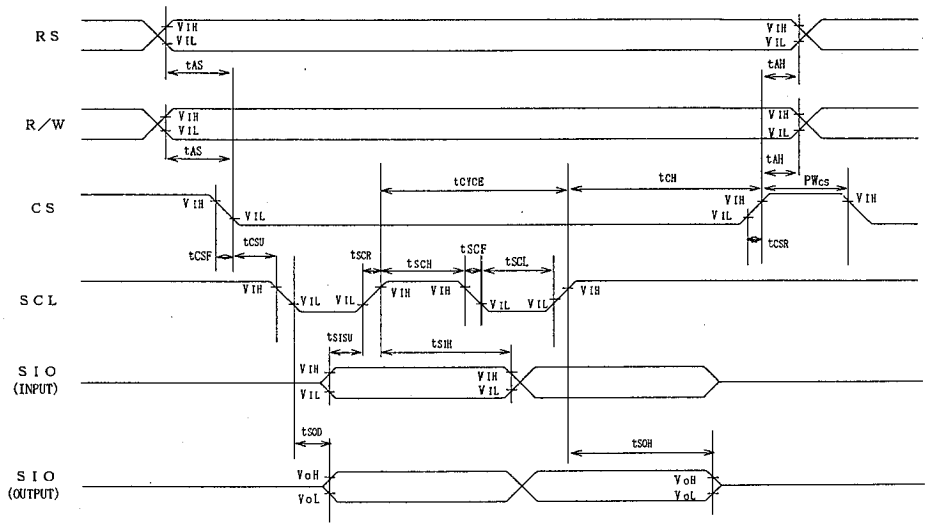
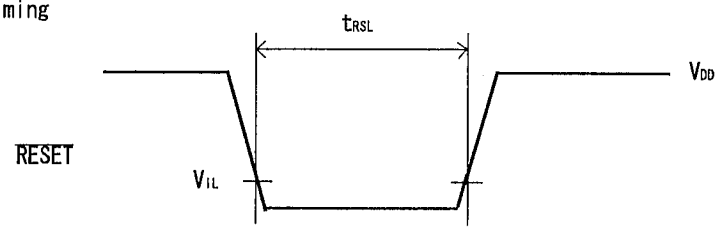



fig. 3

・The Input Condition when using the Hardware Reset Circuit

Input timing



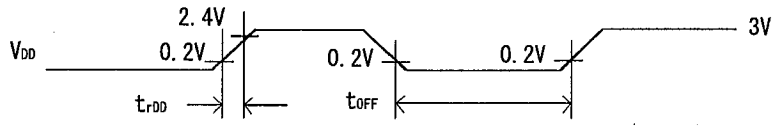

| PARAMETER | SYMBOL | CONDITION | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| Reset input "0" level width | $t_{RSL}$ | $f_{OSC}$=145kHz | 1.2 | — | ms |

・Power Supply Condition when using the internal initialization circuit

(Ta = -20 ～ +75°C)

| PARAMETER | SYMBOL | CONDITION | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| Power supply rise time | $t_{rDD}$ | — | 0.1 | 5 | ms |
| Power supply OFF time | $t_{OFF}$ | — | 1 | — | ms |

Since the internal initialization circuits will not operate normally unless the above conditions are met, in such a case initialize by instruction. (Refer to initialization by the instruction)

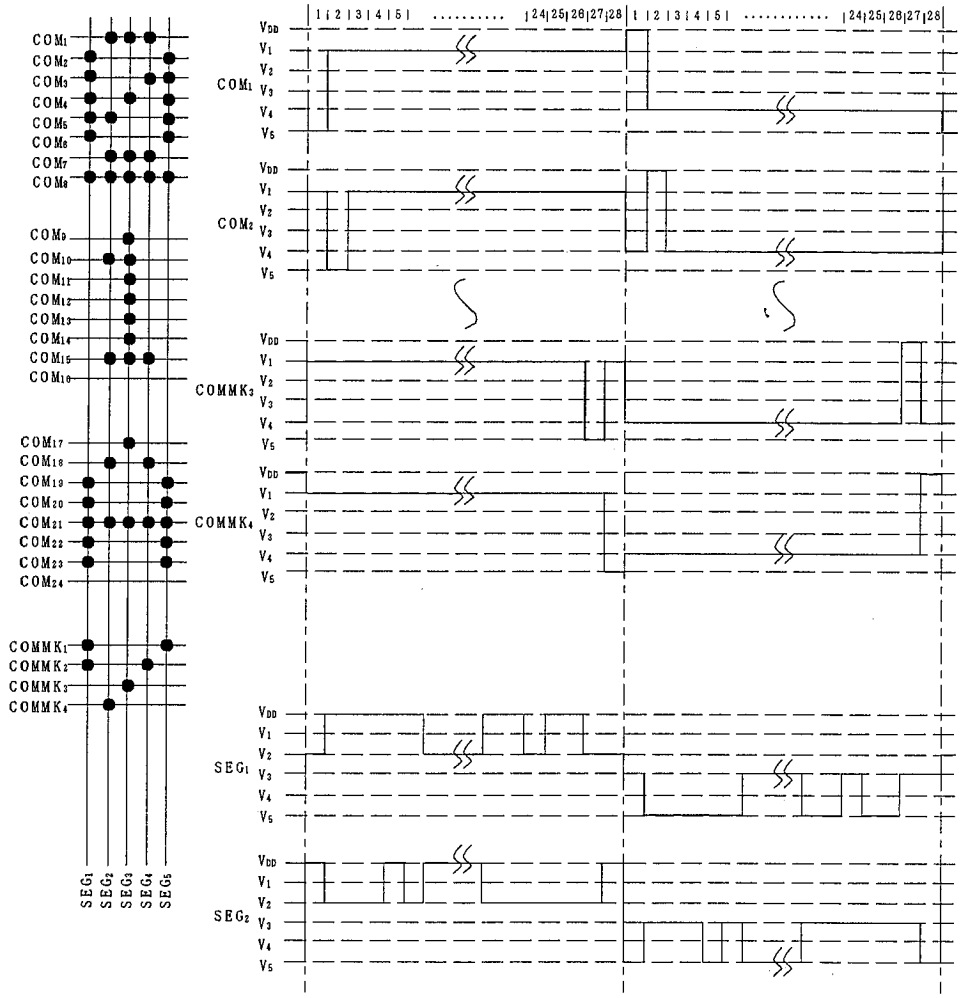



$0.1ms \leqq t_{rDD} \leqq 5ms$ $\quad t_{OFF} \geqq 1ms$

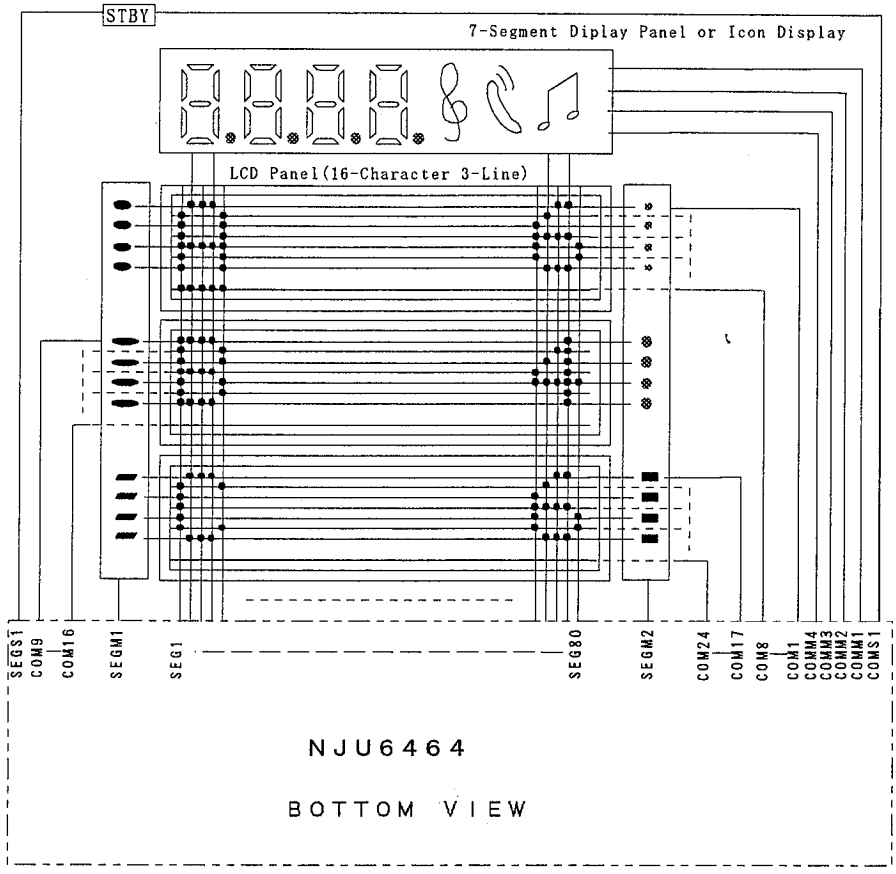
$t_{OFF}$ specifies the power off time in a short period off or cyclical on/off.

■ LCD DRIVING WAVE FORM

1/28 Duty Driving

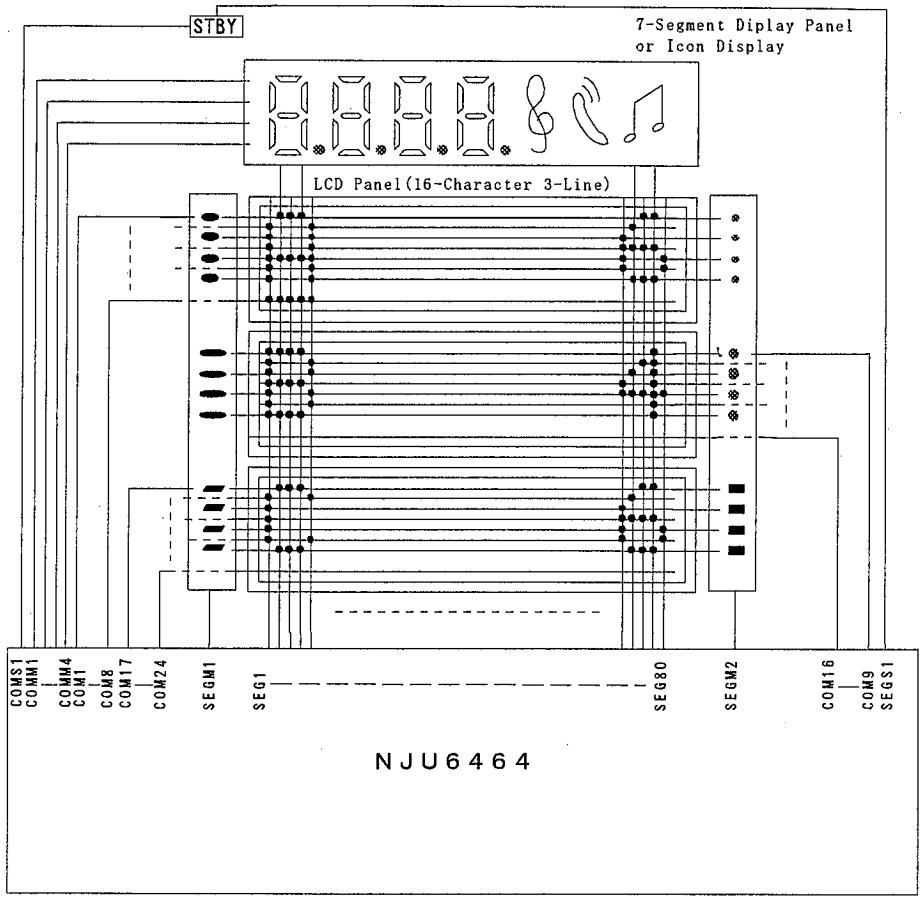


■ APPLICATION CIRCUITS (1)




16-character 3-line Display Example
(The terminal description is "Mode A".)

■ APPLICATION CIRCUITS (2)




16-character 3-line Display Example
(The terminal description is "Mode B".)

MEMO

[CAUTION]
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