

LCD MODULE SPECIFICATION

MODEL NO.

BG240128A series

FOR MESSRS:

ON DATE OF:

APPROVED BY:

C O N T E N T S

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1. Numbering System

| <u>B</u> | <u>C</u> | <u>2004</u> | <u>A</u> | <u>G</u> | <u>P</u> | <u>L</u> | <u>E</u> | <u>B</u> | <u>xxx</u> |
|----------|----------|-------------|----------|----------|----------|----------|----------|----------|------------|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

| | | | | |
|---|---|--|---|--|
| 0 | Brand | | Bolymin | |
| 1 | Module Type | | C= character type G= graphic type P= TAB/TCP type | O= COG type F= COF type |
| 2 | Format | | 2002=20 characters, 4 lines 12232= 122 x 32 dots | |
| 3 | Version No. | | A type | |
| 4 | LCD Color | | G=STN/gray Y=STN/yellow-green C=color STN | B=STN/blue F=FSTN T=TN |
| 5 | LCD Type | | R=positive/reflective P=positive/transflective | M=positive/transmissive N=negative/transmissive |
| 6 | Backlight type/color | | L=LED array/ yellow-green H=LED edge/white R=LED array/red G=LED edge/yellow-green | D=LED edge/blue E=EL/white B=EL/blue C=CCFL/white |
| 7 | CGRAM Font | | J=English/Japanese Font E=English/European Font | C=English/Cyrillic Font H=English/Hebrew Font |
| 8 | View Angle/ Operating Temperature | | B=Bottom/Normal Temperature H=Bottom/Wide Temperature U=Bottom/Ultra wide Temperature | T=Top/Normal Temperature W=Top/Wide Temperature C=9H/Normal Temperature |
| 9 | Special Code | | 3=3 volt logic power supply n=negative voltage for LCD c=cable/connector xxx=to be assigned on data sheet | t=temperature compensation for LCD p=touch panel |



2. General Specification

(1) Mechanical Dimension

| Item | Dimension | Unit |
|--------------------------|--------------------------|------|
| Number of Dots | 240 x 128 | dots |
| Module dimension (L*W*H) | 170.0 x 93.0 x 14.0(MAX) | mm |
| View area | 132.0 x 75.0 | mm |
| Active area | 119.97 x 63.97 | mm |
| Dot size | 0.47 x 0.47 | mm |
| Dot pitch | 0.5 x 0.5 | mm |

(2) Controller IC: T6963C

(3) Temperature Range

| | Normal | Wide |
|-----------|------------|------------|
| Operating | 0 ~+50℃ | -20 ~ +70℃ |
| Storage | -10 ~ +60℃ | -30 ~ +80℃ |

3. Absolute Maximum Ratings

| Item | Symbol | Min | Typ | Max | Unit |
|--------------------------|----------------------------------|-----------------|-----|-----------------|------|
| Operating Temperature | T _{OP} | 0 | — | +50 | ℃ |
| Storage Temperature | T _{ST} | -20 | — | +70 | ℃ |
| Input Voltage | V _I | V _{SS} | — | V _{DD} | V |
| Supply Voltage For Logic | V _{DD} -V _{SS} | -0.3 | — | +7 | V |
| Supply Voltage For LCD | V _{DD} -V ₀ | 0 | — | | V |



4. Electrical Characteristics

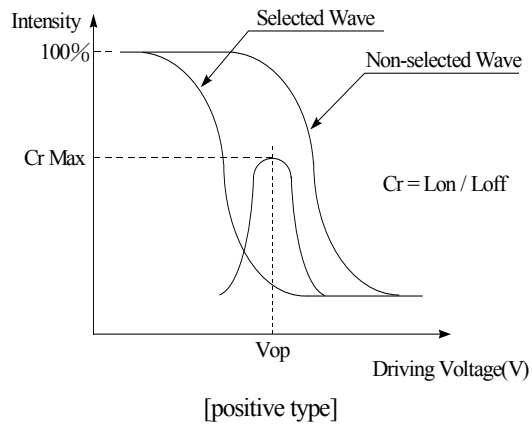
| Item | Symbol | Condition | Min | Typ | Max | Unit |
|--------------------------|-----------------|--------------------------|------|------|----------|------|
| Supply Voltage For Logic | $V_{DD}-V_{SS}$ | — | 4.75 | — | 5.25 | V |
| Supply Voltage For LCD | $V_{DD}-V_0$ | $T_a=25^{\circ}\text{C}$ | — | 19.1 | — | V |
| Input High Volt. | V_{IH} | — | 2.2 | — | V_{DD} | V |
| Input Low Volt. | V_{IL} | — | 0 | — | 0.8 | V |
| Output High Volt. | V_{OH} | — | 2.4 | — | V_{DD} | V |
| Output Low Volt. | V_{OL} | — | 0 | — | 0.4 | V |
| Supply Current | I_{DD} | $V_{DD}=5\text{V}$ | — | 23 | — | mA |

5. Optical Characteristics

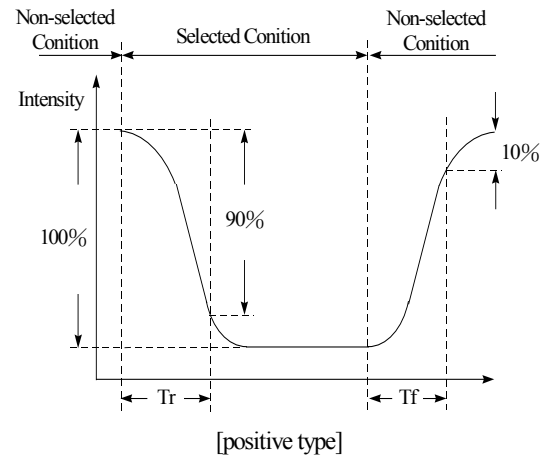
| Item | Symbol | Condition | Min | Typ | Max | Unit |
|----------------|---------------|--------------------------|-----|---------|----------|------|
| View Angle | (V) θ | $CR \geq 2(\text{CCFL})$ | 10 | — | 40(CCFL) | deg |
| | | $CR \geq 5(\text{LED})$ | | | 105(LED) | |
| | (H) φ | $CR \geq 2(\text{CCFL})$ | -30 | — | 30 | deg |
| | | $CR \geq 5(\text{LED})$ | | | | |
| Contrast Ratio | CR | — | — | 5(CCFL) | — | — |
| | | | | 3(LED) | | |
| Response Time | T rise | — | — | 200 | 300 | ms |
| | T fall | — | — | 200 | 300 | ms |



Definition of Operation Voltage (Vop)



Definition of Response Time (Tr , Tf)



Conditions:

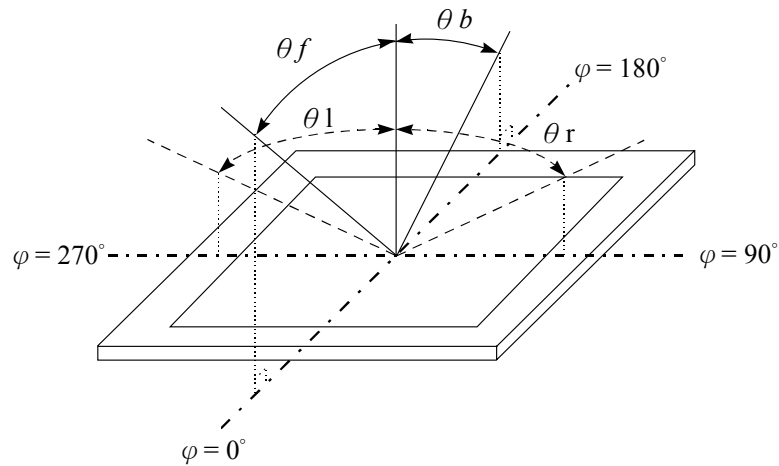
Operating Voltage :Vop

Viewing Angle(θ , φ) : 0° , 0°

Frame Frequency: 64 HZ

Driving Waveform: 1/N duty, 1/a bias

Definition of viewing angle($CR \geq 2$)





6. Interface Description

| Pin No. | Symbol | Level | Description |
|---------|--------|-------|---|
| 1 | FG | — | Frame ground (Connected to bezel) |
| 2 | Vss | — | GND |
| 3 | Vdd | — | Power supply (+5 V) |
| 4 | Vo | — | Power supply for LCD driver |
| 5 | WR | L | Data write. Write data into T6963C when WR = L |
| 6 | RD | L | Data read. Read data from T6963C when RD = L |
| 7 | CE | L | L : Chip enable |
| 8 | C/D | H / L | WR=L , C/D=H : Command Write C/D=L: Data write RD=L , C/D=H : Status Read C/D=L: Data read |
| 9 | NC/Vee | — | No connection/ Negative voltage output |
| 10 | RESET | H / L | H: Normal ; L : Initialize T6963C |
| 11 | DB0 | H / L | Data bus line |
| 12 | DB1 | H / L | Data bus line |
| 13 | DB2 | H / L | Data bus line |
| 14 | DB3 | H / L | Data bus line |
| 15 | DB4 | H / L | Data bus line |
| 16 | DB5 | H / L | Data bus line |
| 17 | DB6 | H / L | Data bus line |
| 18 | DB7 | H / L | Data bus line |
| 19 | FS | MD2 | Pins for selection of font; H : 6 * 8 , L : 8 * 8 |
| 20 | RV | H / L | H:Reverse L:Normal |



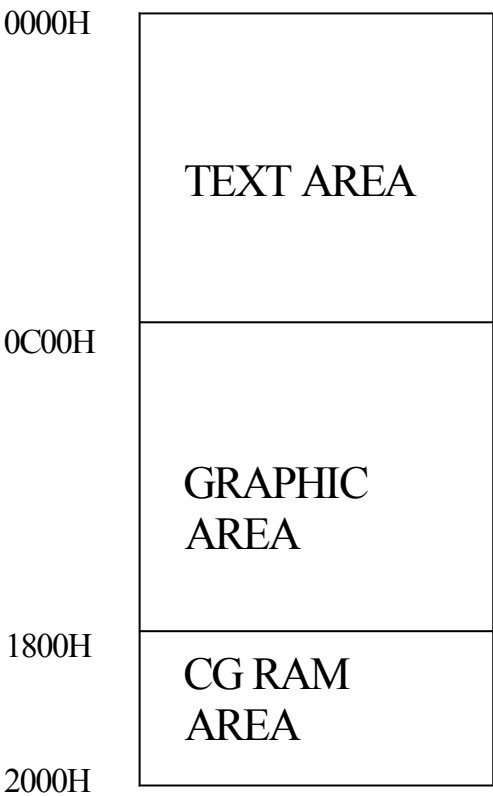
7. Display control instruction

The LCD Module has built in a T6963C LSI controller, It has an 8-bit parallel data bus and control lines for writing or reading through an MPU interface, it has a 128-word character generator ROM (refer to Table 1.), which can control an external display RAM of up to 8K bytes. Allocation of text, graphics and external character generator RAM can be made easily and the display window can be moved freely within the allocated memory range.

•RAM Interface

The external RAM is used to store display data(text, graphic and external CG data). It can be freely allocated to the memory area(8 K byte max).

Recommend



- Flowchart of communications with MPU

(1) Status Read

A status check must be performed before data is read or written.



Status check

The Status of T6963C can be read from the data lines.

| | |
|------------------------|---|
| $\overline{\text{RD}}$ | L |
| $\overline{\text{WR}}$ | H |
| $\overline{\text{CE}}$ | L |
| C/D | H |
| Do to D7 | H |

The T6963C status word format is as follows:

MSB

LSB

| | | | | | | | |
|------|------|------|------|------|------|------|------|
| STA7 | STA6 | STA5 | STA4 | STA3 | STA2 | STA1 | STA0 |
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |

| | | |
|------|--|-----------------------------------|
| STA0 | Check command execution capability | 0:Disable 1:Enable |
| STA1 | Check data read/write Capability | 0:Disable 1:Enable |
| STA2 | Check Auto mode data read capability | 0:Disable 1:Enable |
| STA3 | Check Auto mode data write capability | 0:Disable 1:Enable |
| STA4 | Not used | — |
| STA5 | Check controller operation capability | 0:Disable 1:Enable |
| STA6 | Error flag. Used for Screen Peek and Screen copy commands. | 0:No error 1>Error |
| STA7 | Check the blink condition | 0:Disable off 1:Normal display |

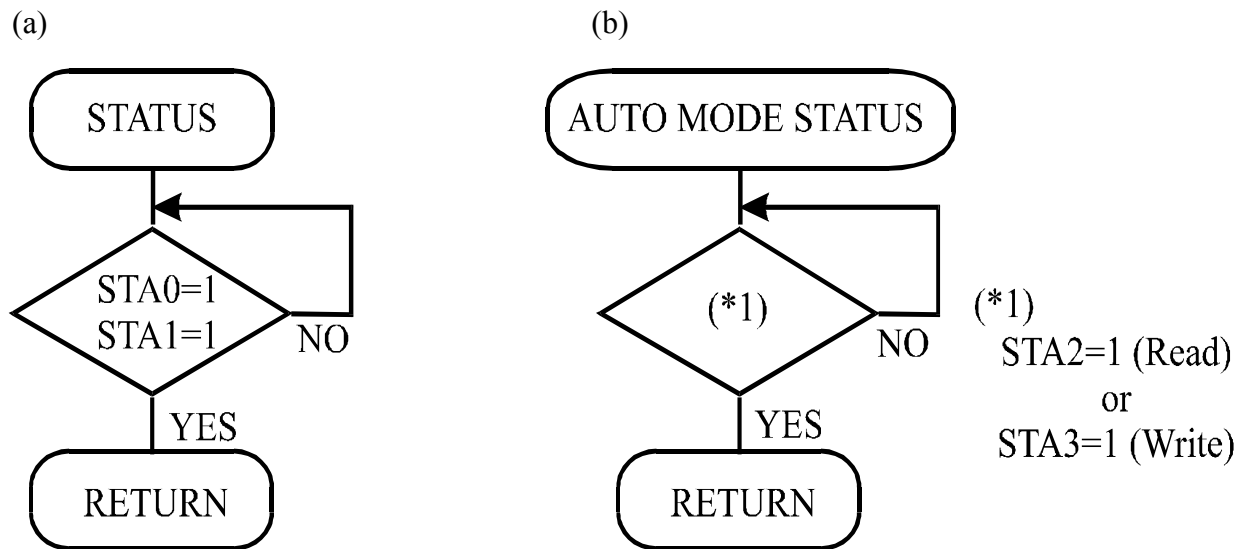
(Note 1) It is necessary to check STA0 and STA1 at the same time.

There is a possibility of erroneous operation due to a hardware interrupt.

(Note 2) For most modes STA0/STA1 are used as a status check.

(Note 3) STA2 and STA3 are valid in Auto mode; STA0 and STA1 are invalid.

Status Checking flow



(Note 4) When using the MSB=0 command, a Status Read must be performed.

If a status check is not carried out, the T6963C cannot operate normally, even after a delay time.

The hardware interrupt occurs during the address calculation period (at the end of each line).

If a MSB=0 command is sent to the T6963C during this period, the T6963C enters Wait status.

If a status check is not carried out in this state before the next command is sent, there is the possibility that the command or data date will not be received.

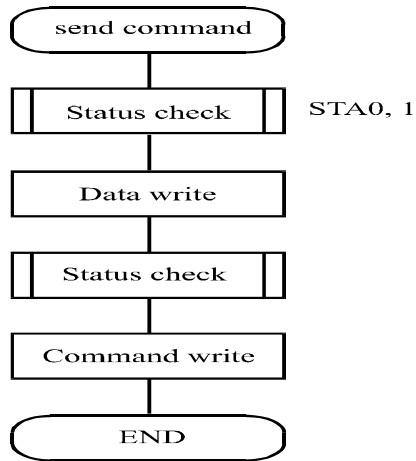


(2) Setting date

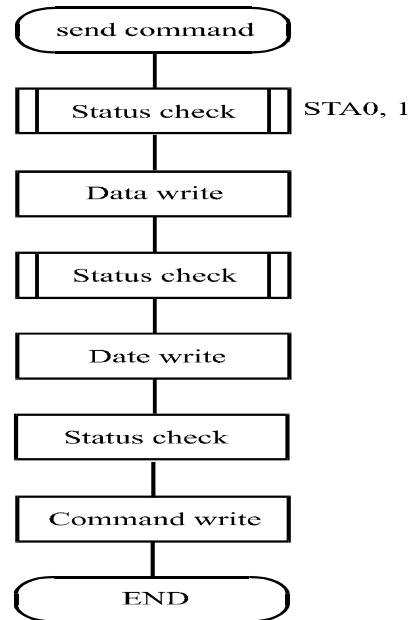
When using the T6963C, first set the data, then set the command.

Procedure for sending a command

(a) The case of 1 date



(b) The case of 2 data



(Note) When sending more than two data, the last datum (or last two data) is valid.

· COMMAND DEFINITIONS



| COMMAND | CODE | D1 | D2 | FUNCTION |
|-----------------------|----------|-------------|--------------|----------------------------------|
| REGISTERS SETTING | 00100001 | X address | Y address | Set Cursor Pointer |
| | 00100010 | Date | 00H | Set Offset Register |
| | 00100100 | Low address | High address | Set Address Pointer |
| SET CONTROL WORD | 01000000 | Low address | High address | Set Text Home Address |
| | 01000001 | Columns | 00H | Set Text Area |
| | 01000010 | Low address | High address | Set Graphic Home Address |
| | 01000011 | Columns | 00H | Set Graphic Area |
| MODE SET | 1000×000 | — | — | OR mode |
| | 1000×001 | — | — | EXOR mode |
| | 1000×011 | — | — | AND mode |
| | 1000×100 | — | — | Text Attribute mode |
| | 10000××× | — | — | Internal CG ROM mode |
| | 10001××× | — | — | External CG RAM mode |
| DISPLAY MODE | 10010000 | — | — | Display off |
| | 1001××10 | — | — | Cursor on, blink off |
| | 1001××11 | — | — | Cursor on, blink on |
| | 100101×× | — | — | Text on, graphic off |
| | 100110×× | — | — | Text off, graphic on |
| | 100111×× | — | — | Text on, graphic on |
| CURSOR PATTERN SELECT | 10100000 | — | — | 1-line cursor |
| | 10100001 | — | — | 2-line cursor |
| | 10100010 | — | — | 3-line cursor |
| | 10100011 | — | — | 4-line cursor |
| | 10100100 | — | — | 5-line cursor |
| | 10100101 | — | — | 6-line cursor |
| | 10100110 | — | — | 7-line cursor |
| | 10100111 | — | — | 8-line cursor |
| DATA AUTO READ/WRITE | 10110000 | — | — | Set Data Auto Write |
| | 10110001 | — | — | Set Data Auto Read |
| | 10110010 | — | — | Auto Reset |
| DATA READ/WRITE | 11000000 | Data | — | Data Write and Increment ADP |
| | 11000001 | — | — | Data Read and Increment ADP |
| | 11000010 | Data | — | Data Write and Decrement ADP |
| | 11000011 | — | — | Data Read and Decrement ADP Data |
| | 11000100 | Data | — | Write and Nonvariable ADP |
| | 11000101 | — | — | Data Read and Nonvariable ADP |
| SCREEN PEEK | 11100000 | — | — | Screen Peek |

X : invalid

| COMMAND | CODE | D1 | D2 | FUNCTION |
|---------------|-----------|----|----|-------------|
| SCREEN COPY | 11101000 | — | — | Screen Copy |
| BIT SET/RESET | 11110××× | — | — | Bit Reset |
| | 11111××× | — | — | Bit Set |
| | 1111× 001 | — | — | Bit 0 (LSB) |
| | 1111× 001 | — | — | Bit 1 |
| | 1111× 010 | — | — | Bit 2 |
| | 1111× 011 | — | — | Bit 3 |
| | 1111× 100 | — | — | Bit 4 |
| | 1111× 101 | — | — | Bit 5 |
| | 1111× 110 | — | — | Bit 6 |
| | 1111× 110 | — | — | Bit 7 (MSB) |

X: invalid



· Setting registers

| CODE | HEX. | FUNCTION | D1 | D2 |
|----------|------|---------------------|----------|-----------|
| 00100001 | 21H | SET CURSOR POINTER | X ADRS | Y ADRS |
| 00100010 | 23H | SET OFFSET REGISTER | DATA | 00H |
| 00100100 | 24H | SET ADDRESS POINTER | LOW ADRS | HIGH ADRS |

(1) Set Cursor Pointer

The position of the cursor is specified by X ADRS and Y ADRS. The cursor position can only be moved by this command. Data read/write from the MPU never changes the cursor pointer. X ADRS and Y ADRS are specified as follows.

X ADRS 00H to 4FH (lower 7 bits are valid)

Y ADRS 00H to 1FH (lower 5 bits are valid)

Single-Scan

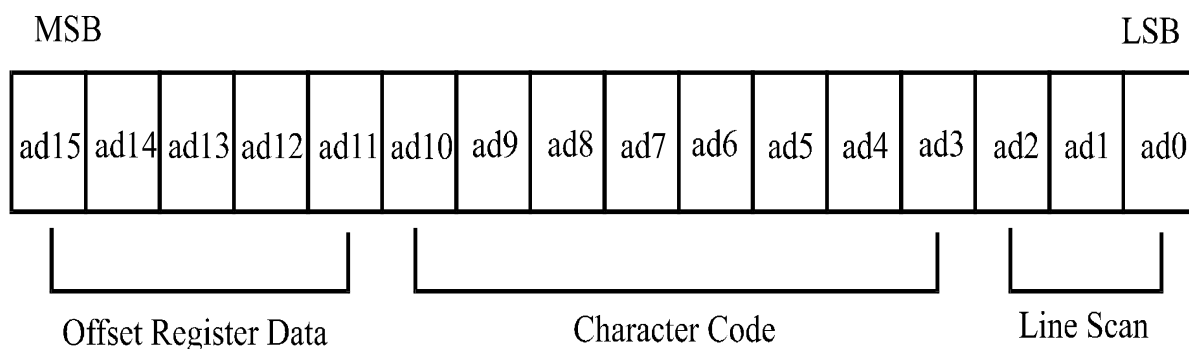
X ADRS 00 to 4FH

Y ADRS 00H to 0FH

(2) Set Offset Register

The offset register is used to determine the external character generator RAM area.

The T6963C has a 16-bit address bus as follows.



T6963C assign External character generator, when character code set 80H TO FFH in using internal character generator. Character code 00H to 80H assign External character generator, when External generator mode.

The senior five bits define the start address in external memory of the CG RAM area. The next eight bits represent the character code of the character. In internal CG ROM, character codes 00H to 7FH represent the predefined “internal” CG ROM characters, and codes 80H to FFH represent the user’s own “external” characters. In external CG ROM mode, all 256



codes from 00H to FFH can be used to represent the user’s own characters. The three least significant bits indicate one of the eight rows of eight dots that define the character’s shape.

The relationship between display RAM address and offset register

| Offset register data | CG RAM hex. address (start to end) |
|----------------------|------------------------------------|
| 00000 | 0000 to 07 FFH |
| 00001 | 0800 to 0FFFH |
| 00010 | 1000 to 17FFH |
| 11100 | E000 to E7FFH |
| 11101 | E800 to EFFFH |
| 11110 | F000 to F7FFH |
| 11111 | F800 to FFFFH |

(Example 1)

| | |
|---------------------------------------|---------------------|
| Offset register | 02H |
| Character code | 80H |
| Character generator RAM start address | 0001 0100 0000 0000 |
| | 1 4 0 0 H |

| | (address) | (data) |
|--|-----------|--------|
| | 1400H | 00H |
| | 1401H | 1FH |
| | 1402H | 04H |
| | 1403H | 04H |
| | 1404H | 04H |
| | 1405H | 04H |
| | 1406H | 04H |
| | 1407H | 00H |

(Example 2) The relationship between display RAM data and display characters



| | (RAM DATA) | (Character) |
|--------------------------------|------------|-------------|
| AB γ DE ζ GHIJKLM | 21H | A |
| . | 22H | B |
| . | 83H | γ |
| . | 24H | D |
| . | 25H | E |
| . | 86H | ζ |
| Display character | | |

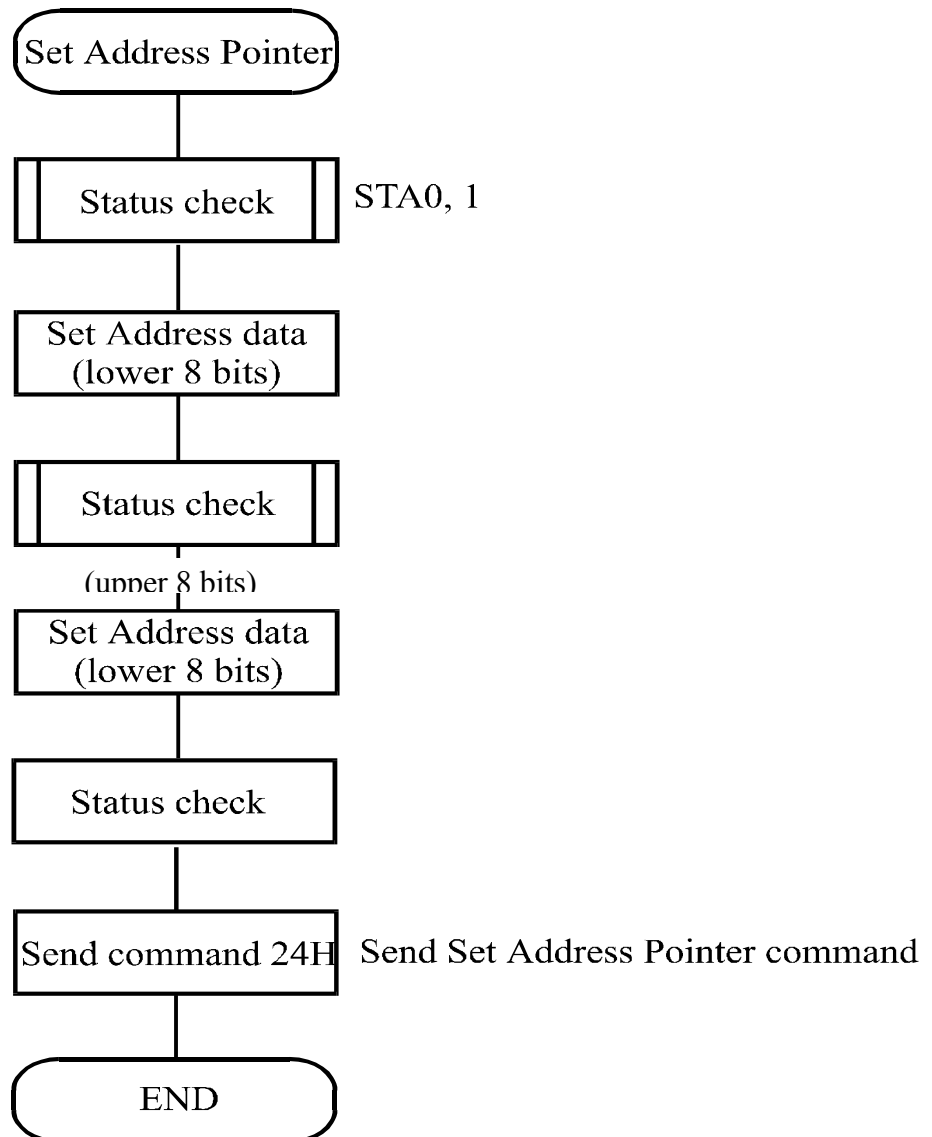
γ and ζ are displayed by character generator RAM.



(3) Set Address Pointer

The Set Address Pointer command is used to indicate the start address for writing to (or reading from) external RAM.

The Flowchart for Set Address Pointer command





· Set Control Word

| CODE | HEX. | FUNCTION | D1 | D2 |
|----------|------|--------------------------|-------------|--------------|
| 01000000 | 40H | Set Text Home Address | Low address | High address |
| 01000001 | 41H | Set Text Area | Columns | 00H |
| 01000010 | 42H | Set Graphic Home Address | Low address | High address |
| 01000011 | 43H | Set Graphic Area | Columns | 00H |

The home address and column size are defined by this command.

(1) Set Text Home Address

The starting address in the external display RAM for text display is defined by this command.

The text home address indicates the leftmost and uppermost position.

The relationship between external display RAM address and display position

| | | |
|-------------|---|----------------|
| TH | — | TH+CL |
| TH+TA | — | TH+TA+CL |
| (TH+TA)+TA | — | TH+2TA+CL |
| (TH+2TA)+TA | — | TH+3TA+CL |
| — | — | — |
| TH+(n-1) TA | — | TH+(n-1) TA+CL |

TH: Text home address

TA: Text area number (columns)

CL: Columns are fixed by hardware (pin-programmable).

(Example)

Text home address : 0000H
Text area : 0020H
: 32 Columns
: 4 Lines

| | | | | |
|-------|-------|---|-------|-------|
| 0000H | 0001H | — | 001EH | 001FH |
| 0020H | 0021H | — | 003EH | 002FH |
| 0040H | 0041H | — | 005EH | 005FH |
| 0060H | 0061H | — | 007EH | 007FH |



(2) Set Graphic Home Address

The starting address of the external display RAM used for graphic display is defined by this command. The graphic home address indicates the leftmost and uppermost position.

The relationship between external display RAM address and display position

| | | |
|-------------|---|----------------|
| GH | — | GH+GL |
| GH+GA | — | GH+GA+CL |
| (GH+GA)+GA | — | GH+2GA+CL |
| (GH+2GA)+GA | — | GH+3GA+CL |
| — | — | — |
| GH+(n-1) GA | — | GH+(n-1) GA+CL |

GH: Graphic home address

GA: Graphic area number (columns)

CL: Columns are fixed by hardware (pin-programmable).



(Example)

Graphic home address : 0000H
 Graphic area : 0020H
 : 32 Columns
 : 2 Lines

| | | | | |
|-------|-------|---|-------|-------|
| 0000H | 0001H | — | 001EH | 001FH |
| 0020H | 0021H | — | 003EH | 003FH |
| 0040H | 0041H | — | 005EH | 005FH |
| 0060H | 0061H | — | 007EH | 007FH |
| 0080H | 0081H | — | 009EH | 009FH |
| 00A0H | 00A1H | — | 00BEH | 00BFH |
| 00C0H | 00C1H | — | 00DEH | 00DFH |
| 00E0H | 00E1H | — | 00FEH | 00FFH |
| 0100H | 0101H | — | 011EH | 011FH |
| 0120H | 0121H | — | 013EH | 013FH |
| 0140H | 0141H | — | 015EH | 014FH |
| 0160H | 0161H | — | 017EH | 017FH |
| 0180H | 0181H | — | 109EH | 019FH |
| 01A0H | 01A1H | — | 01BEH | 01BFH |
| 01C0H | 01C1H | — | 01DEH | 01DFH |
| 01E0H | 01E1H | — | 01FEH | 01FFH |

(3) Set Text Area

The display columns are defined by the hardware Setting. This command can be used to adjust the columns of the display.

(Example)

LCD size 20 columns, 4lines

| | |
|-------------------|-------|
| Text home address | 0000H |
|-------------------|-------|

Text area 0014H

Set 32 columns, 4 Lines

| | | | | | | |
|------|------|-------|------|------|-------|------|
| 0000 | 0001 | ..... | 0013 | 0014 | ..... | 001F |
| 0014 | 0015 | ..... | 0027 | 0028 | ..... | 0033 |
| 0028 | 0029 | ..... | 003B | 003C | ..... | 0047 |
| 003C | 003D | ..... | 004F | 0050 | ..... | 005B |

LCD



The display columns are defined by the hardware setting. This command can be used to adjust the columns of the graphic display.

| | |
|----------------------|--------------------|
| LCD size | 20 columns, 2lines |
| Graphic home address | : 0000H |
| Graphic are | : 0014H |

| | | | | | | |
|------|------|-------|------|-------|-------|-------|
| 0000 | 0001 | ..... | 0013 | 0014 | ..... | 001F |
| 0014 | 0015 | ..... | 0027 | 0028 | ..... | 0033 |
| 0028 | 0029 | ..... | 003B | 003C | ..... | 0047 |
| 003C | 003D | ..... | 004F | 0050 | ..... | 005B |
| 0050 | 0051 | ..... | 0063 | 0064 | ..... | 006F |
| 0064 | 0065 | ..... | 0077 | 0078 | ..... | 0083 |
| 0078 | 0079 | ..... | 008B | 008C | ..... | 0097 |
| 008C | 008D | ..... | 009F | 00A0 | ..... | 00AB |
| 00A0 | 00A1 | ..... | 00B3 | 00B4 | ..... | 00BF |
| 00B4 | 00B5 | ..... | 00C7 | 00C8 | ..... | 00D3 |
| 00C8 | 00C9 | ..... | 00DB | 00DC | ..... | 00E7 |
| 00DC | 00DD | ..... | 00EF | 00F0 | ..... | 00FD |
| 00F0 | 00F1 | ..... | 0103 | 0104 | ..... | 011F |
| 0104 | 0105 | ..... | 0127 | 0128 | ..... | 0123 |
| 0128 | 0129 | ..... | 013B | 0013C | ..... | 00147 |
| 013C | 013D | ..... | 014F | 0150 | ..... | 015B |



If the graphic area setting is set to match the desired number of columns on the LCD, the addressing scheme will be automatically modified so that the start address of each line equals the end address of the previous line +1.

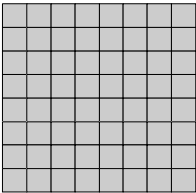
• Mode set

| CODE | FUNCTION | OPERAND |
|----------|-----------------------------------|---------|
| 1000x000 | OR Mode | — |
| 1000x001 | EXOR Mode | — |
| 1000x011 | AND Mode | — |
| 1000x100 | TEXT ATTRIBUTE Mode | — |
| 10000xxx | Internal Character Generator Mode | — |
| 10001xxx | External Character Generator Mode | — |

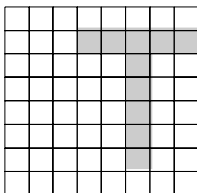
X: invalid

The display mode is defined by this command. The display mode does not change until the next command is sent. The logical OR, EXOR, AND of text or graphic display can be displayed. In Internal Character Generator mode, character codes 00H to 7FH are assigned to the built-in character generator ROM. The character codes 80H to FFH are automatically assigned to the external character generator RAM.

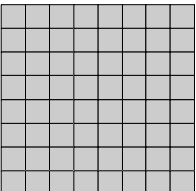
(Example)



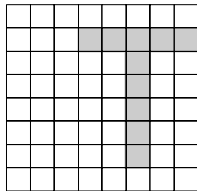
GRAPHIC



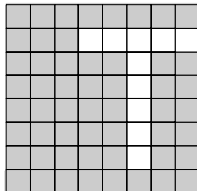
TEXT



“OR”



“AND”



“TXOR”

(Note) Attribute functions can only be applied to text display, since the attribute data is placed in the graphic RAM area.

Attribute function

The attribute operations are Reverse display, Character blink and Inhibit. The attribute data is written into the graphic area which was defined by the Set Control Word command. Only text display is possible in Attribute Function mode; graphic display is automatically disabled. However, the Display Mode command must be used to turn both Text and Graphic on in order for the Attribute function to be available.

The attribute data for each character in the text area is written to the same address in the graphic area.

The Attribute function is defined as follows.

Attribute RAM 1byte

| | | | | | | | | | | | |
|----|----|----|----|--------------------------|---|---|---|----|----|----|----|
| | | | | × | × | × | × | d3 | d2 | d1 | d0 |
| d3 | d2 | d1 | d0 | FUNCTION | | | | | | | |
| 0 | 0 | 0 | 0 | Normal display | | | | | | | |
| 0 | 1 | 0 | 1 | Reverse display | | | | | | | |
| 0 | 0 | 1 | 1 | Inhibit display | | | | | | | |
| 1 | 0 | 0 | 0 | Blink of normal display | | | | | | | |
| 1 | 1 | 0 | 1 | Blink of reverse display | | | | | | | |
| 1 | 0 | 1 | 1 | Blink of inhibit display | | | | | | | |

X: invalid

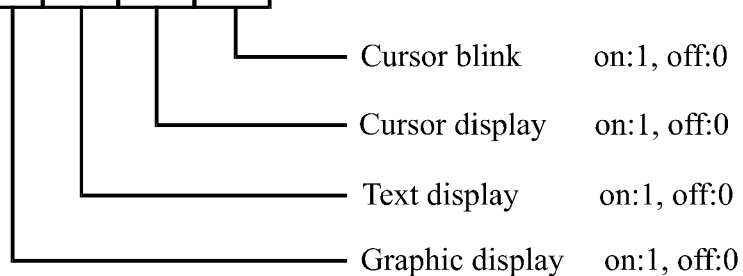
• Display mode



| CODE | FUNCTION | OPERAND |
|----------|----------------------|---------|
| 10010000 | Display off | — |
| 1001xx10 | Cursor on, blink off | — |
| 1001xx11 | Cursor on, blink on | — |
| 100101xx | Text on, graphic off | — |
| 100110xx | Text off, graphic on | — |
| 100111xx | Text on, graphic on | — |

X:invalid

| | | | | | | | |
|---|---|---|---|----|----|----|----|
| 1 | 0 | 0 | 1 | D3 | D2 | D1 | D0 |
|---|---|---|---|----|----|----|----|



(Note) It is necessary to turn on “Text display” and “Graphic display” in the following cases.

- a) Combination of text/graphic display
- b) Attribute function

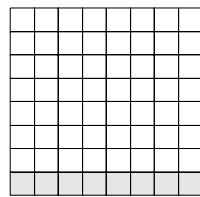
• Cursor pattern select

| CODE | FUNCTION | OPERAND |
|----------|---------------|---------|
| 10100000 | 1-line cursor | — |
| 10100001 | 2-line cursor | — |
| 10100010 | 3-line cursor | — |
| 10100011 | 4-line cursor | — |
| 10100100 | 5-line cursor | — |
| 10100101 | 6-line cursor | — |
| 10100110 | 7-line cursor | — |
| 10100111 | 8-line cursor | — |

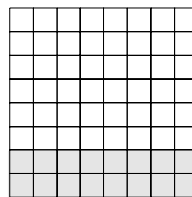
When cursor display is ON, this command selects the cursor pattern in the range 1 line to 8 lines.



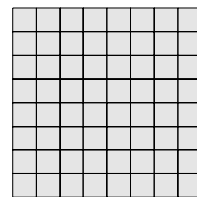
The cursor address is defined by the Cursor Pointer Set command.



1-line cursor



2-line cursor



8-line cursor

- Data Auto Read/Write

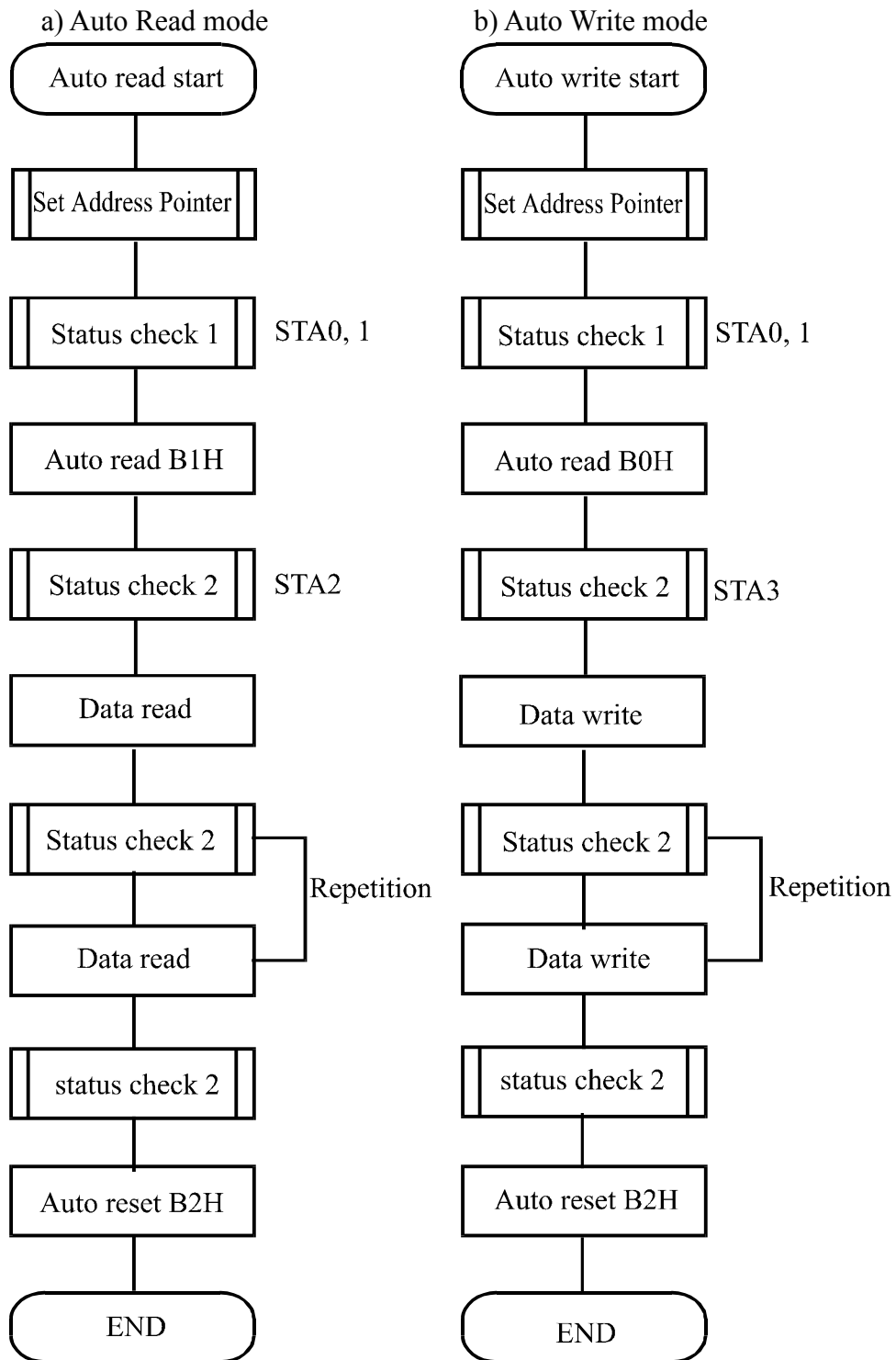
| CODE | HEX. | FUNCTION | OPERAND |
|----------|------|---------------------|---------|
| 10110000 | B0H | Set Data Auto Write | — |
| 10110001 | B1H | Set Data Auto Read | — |
| 10110010 | B2H | Auto Reset | — |

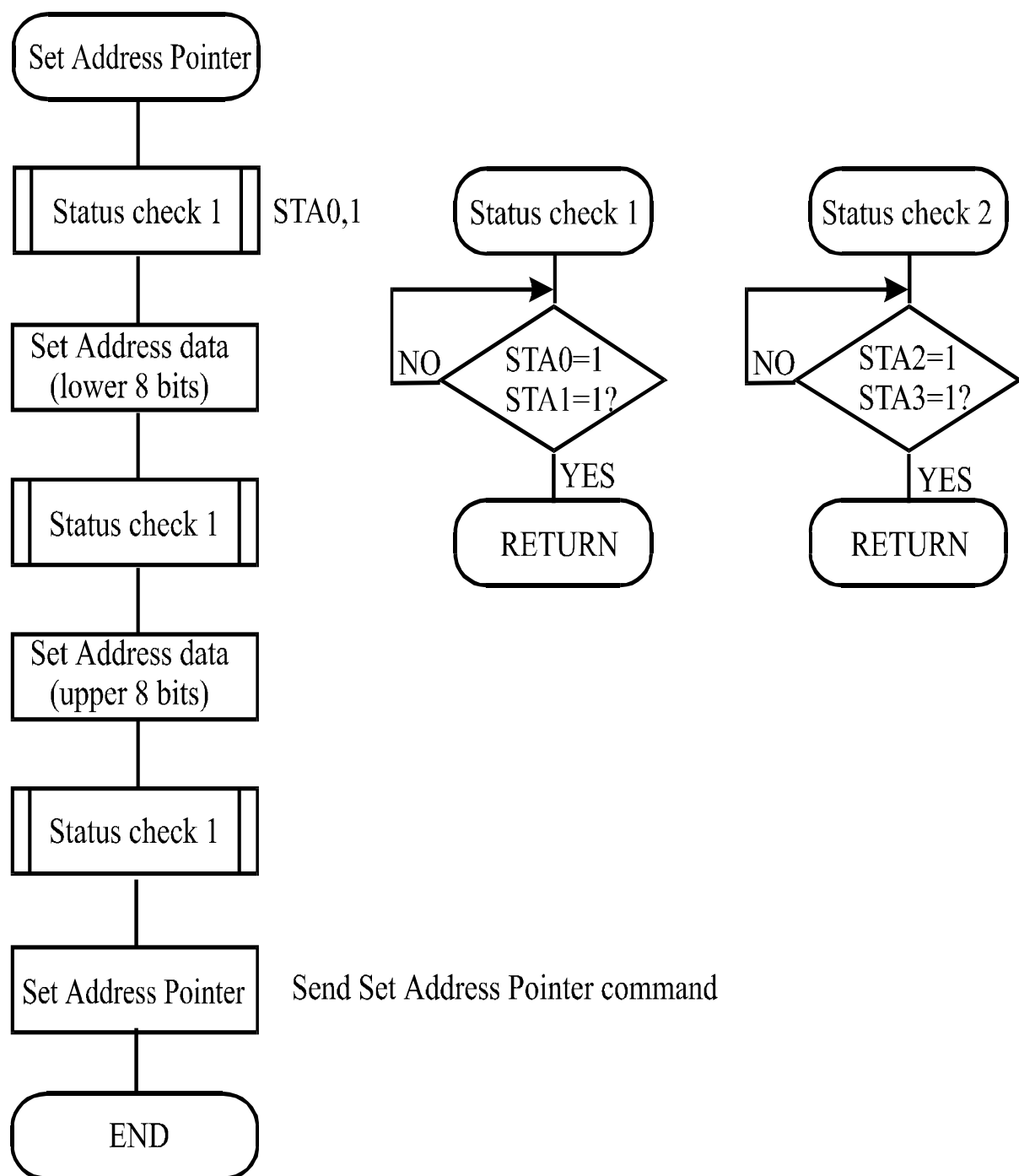
The command is convenient for sending a full screen of data from the external display RAM. After setting Auto mode, a Data Write (or Read) command is need not be sent between each datum. A Data Auto Write (or Read) command must be sent after a Set Address Pointer command. After this command, the address pointer is automatically incremented by 1 after each datum. In Auto mode, the T6963C cannot accept any other commands.

The Auto Reset command must be sent to the T69963C after all data has been sent, to clear Auto mode.

(Note) A Status check for Auto mode

(STA2, STA3 should be checked between sending of each datum. Auto Reset should be performed after checking STA3=1 (STA2=1.) Refer to the following flowchart.







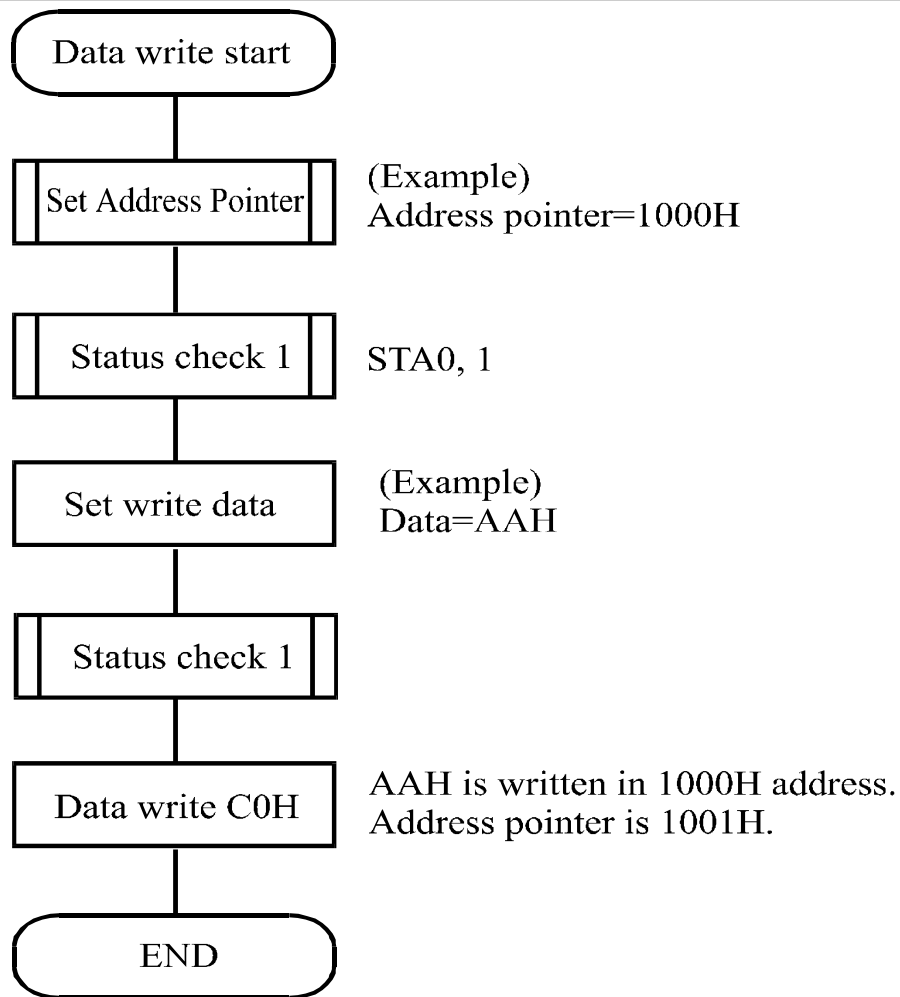
- Date Read/Write

| CODE | HEX. | FUNCTION | OPERAND |
|----------|------|--------------------------------|---------|
| 11000000 | C0H | Data Write and Increment ADP | Data |
| 11000001 | C1H | Data Read and Increment ADP | — |
| 11000010 | C2H | Data Write and Decrement ADP | Data |
| 11000011 | C3H | Data Read and Decrement ADP | — |
| 11000100 | C4H | Data Write and Nonvariable ADP | Data |
| 11000101 | C5H | Data Read and Nonvariable ADP | — |

This command is used for writing data from the MPU to external display RAM, and reading data from external display RAM to the MPU. Data Write/Data Read should be executed after setting address using Set Address Pointer command. The address pointer can be automatically incremented or decremented using this command.

(Note) This command is necessary for each 1-byte datum.

Refer to the following flowchart.



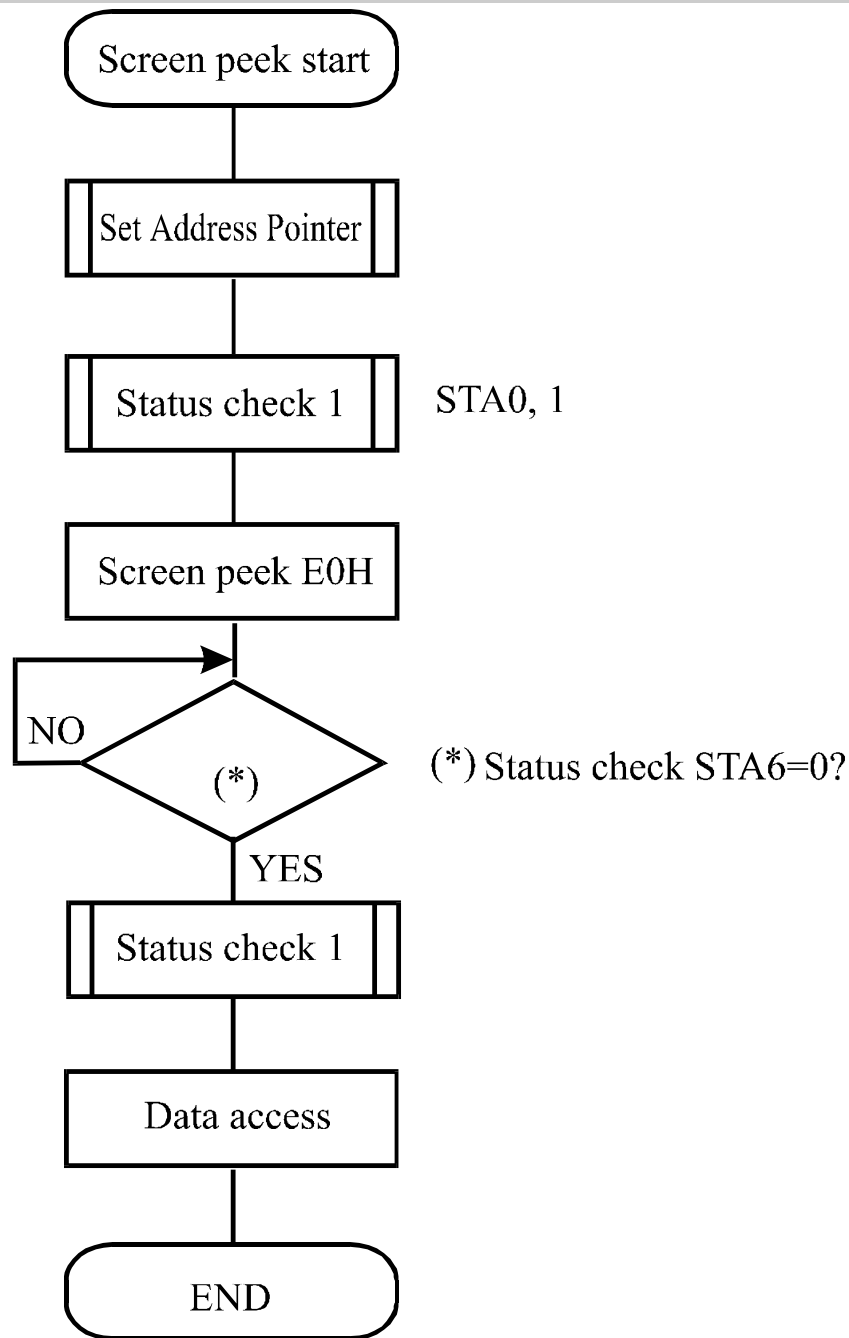
- Screen Peek

| CODE | HEX. | FUNCTION | OPERAND |
|----------|------|-------------|---------|
| 11100000 | E0H | Screen Peek | —e |

This command is used to transfer 1 byte of displayed data to the data stack; this byte can then be read from the MPU by data access. The logical combination of text and graphic display data on the LCD screen can be read by this command.

The status (STA6) should be checked just after the Screen Peek command. If the address determined by the Set Address Pointer command is not in the graphic area, this command is ignored and a status flag (STA6) is set.

Refer to the following flowchart.



- Screen Copy

| CODE | HEX. | FUNCTION | OPERAND |
|----------|------|-------------|---------|
| 11101000 | E8H | Screen Copy | — |

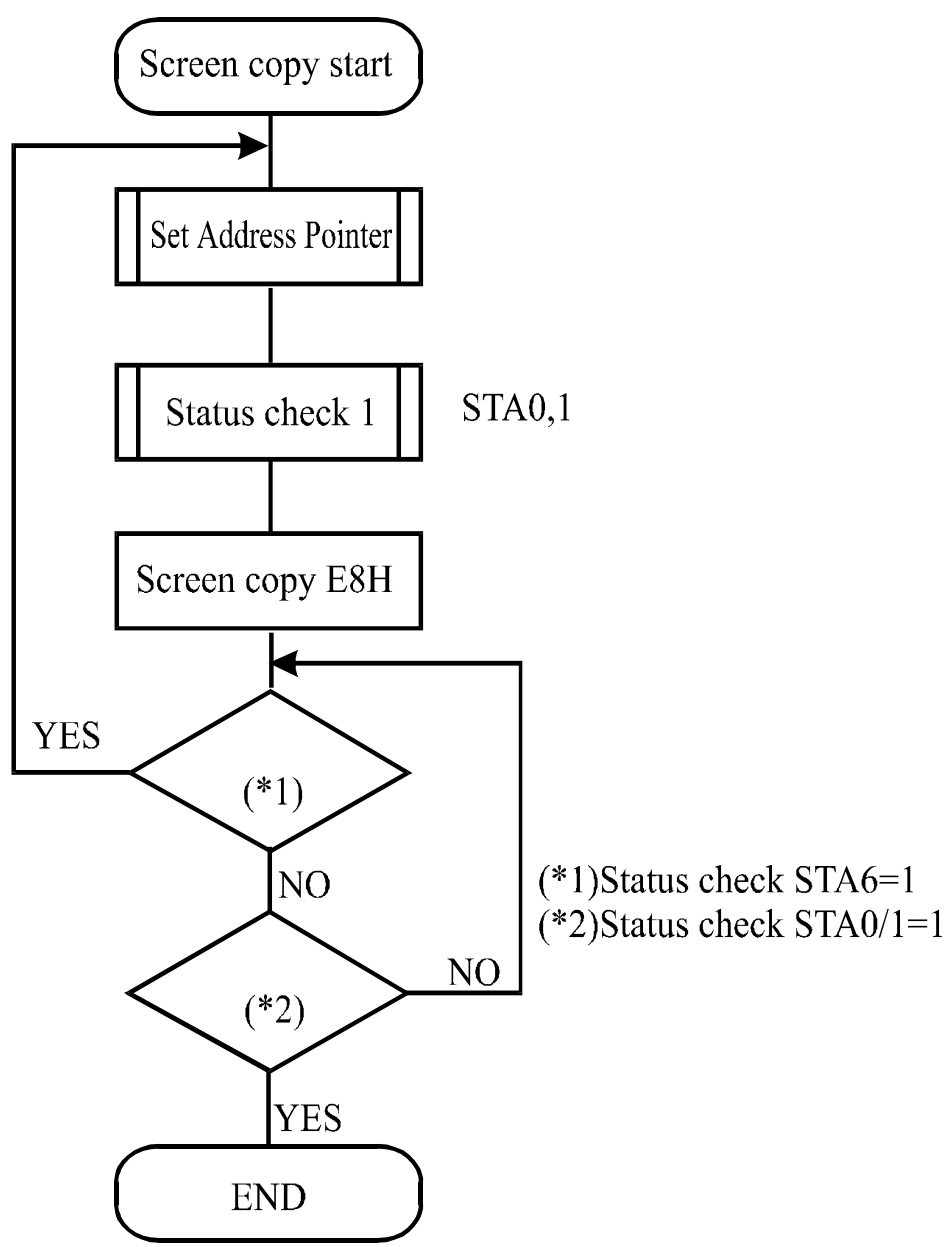
This command copies a single raster line of data to the graphic area.

The start point must be set using the Set Address Pointer command.

(Note 1) If the attribute function is being used, this command is not available.

(With Attribute data is graphic area data.)

Refer to the following flowchart.





- Bit Set/Reset

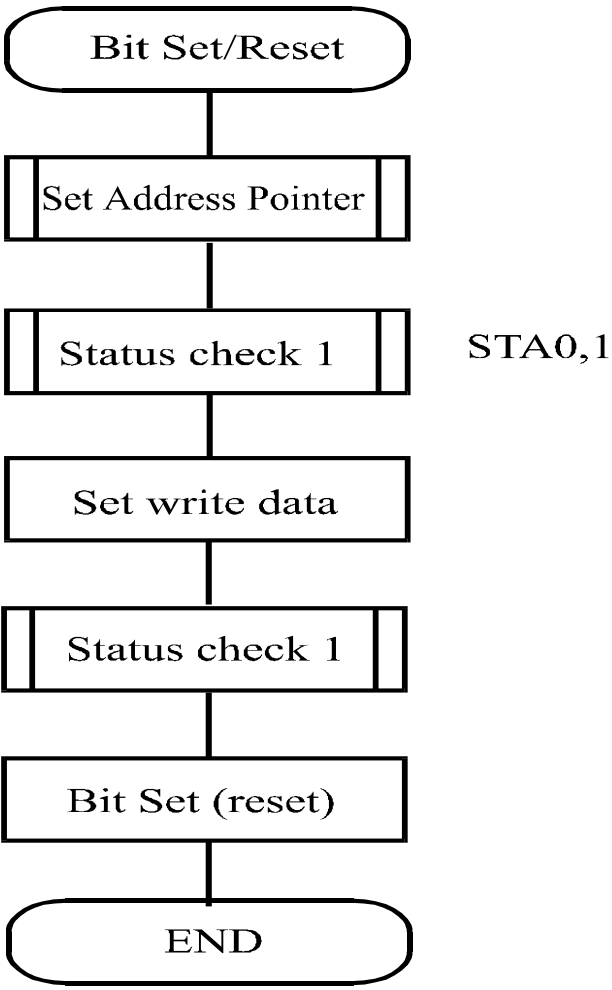
| CODE | FUNCTION | OPERAND |
|----------|-------------|---------|
| 11110xxx | Bit Reset | — |
| 11111xxx | Bit Set | — |
| 1111x000 | Bit 0 (LSB) | — |
| 1111x001 | Bit 1 | — |
| 1111x010 | Bit 2 | — |
| 1111x011 | Bit 3 | — |
| 1111x100 | Bit 4 | — |
| 1111x101 | Bit 5 | — |
| 1111x110 | Bit 6 | — |
| 1111x111 | Bit 7 (MSB) | — |

X: invalid

This command use to set or reset a bit of the byte specified by the address pointer.

Only one bit can be set/reset at a time.

Refer to the following flowchart.





| <div>Upper 4 bit</div> <div>Lower 4 bit</div> | LLLL | LLLH | LLHL | LLHH | LHLL | LHLH | LHHL | LHHH |
|---|------|------|------|------|------|------|------|------|
| LLLL | | O | O | P | ' | 7 | 9 | E |
| LLLH | . | 1 | A | O | a | 7 | C | o |
| LLHL | " | 2 | B | R | b | r | e | E |
| LLHH | # | 3 | C | S | c | s | B | s |
| LHLL | \$ | 4 | D | T | d | t | B | s |
| LHLH | % | 5 | E | U | e | u | B | s |
| LHHL | @ | 6 | F | V | f | v | B | s |
| LHHH | " | 7 | G | W | g | w | B | s |
| HLLL | (| 8 | H | X | h | x | B | s |
| HLLH |) | 9 | I | Y | i | y | B | s |
| HLHL | * | " | J | Z | j | z | B | s |
| HLHH | + | " | K | C | k | c | B | s |
| HHLL | . | < | L | \ | l | \| | S | E |
| HHLH | - | = | M | J | m | j | I | W |
| HHHL | . | > | N | ^ | n | ~ | A | R |
| HHHH | / | ? | O | _ | o | | A | s |



8. Timing Characteristics

Bus Timing

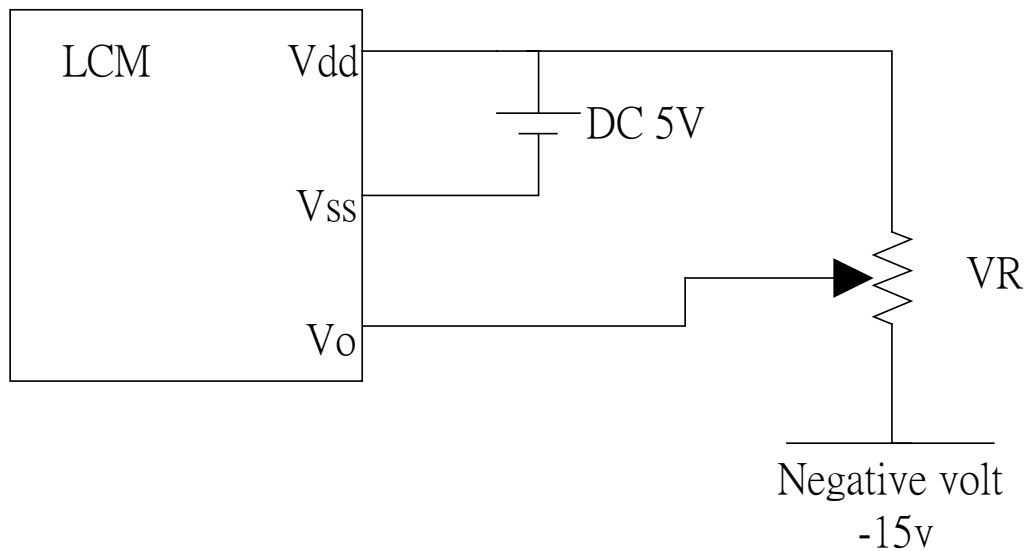
($V_{SS} = 0\text{ V}$, $V_{DD} = 5\text{ V}$)

| Item | Symbol | Min | Typ | Max | Unit |
|------------------------|---------------------------------|-----|-----|-----|------|
| C/D Set-up Time | t_{CDS} | 100 | — | — | ns |
| C/D Hold Time | t_{CDH} | 10 | — | — | ns |
| CE, RD, WR Pulse Width | t_{CDS} , t_{RD} , t_{WR} | 80 | — | — | ns |
| Data Set-up Time | t_{DS} | 80 | — | — | ns |
| Data Hold Time | t_{DH} | 40 | — | — | ns |
| Access Time | t_{ACC} | — | — | 150 | ns |
| Output Hold Time | t_{OH} | 10 | — | 50 | ns |

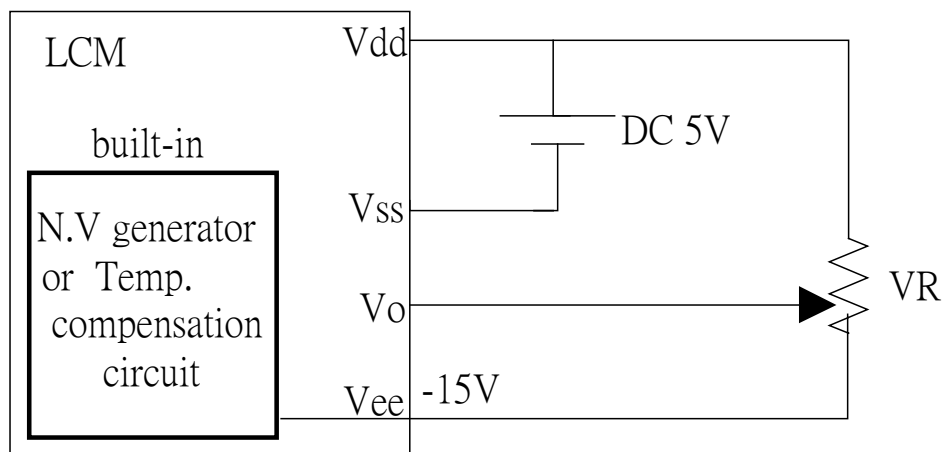


9. Power Supply for LCD Module and LCD Operating Voltage a Adjustment

※(Option) LCM operating on " DC 5V " input with external negative voltage .



※(Option) LCM operating on " DC 5V " input with built-in negative voltage .





10. Backlight Information

10.1 Specification

(1) CCFL/white

No.2 3 4 5 shall be lighted at constant lamp current (IL : 5.0 mA) and shall be measured 3 minutes after the table below. The measurement shall be conducted on the condition that ambient temperature : 25 ± 2 °C humidity : 30 ~ 85%, with no wind.

| NO | Items | Requirements | Remarks |
|----|-------------------------------------|---|---------|
| 1 | Lamp Current (IL) | 5.0 ± 0.5 (mArms) | |
| 2 | Lamp Voltage (VL) | 328 ± 20 (Vrms) | |
| 3 | Lamp Power (P) (Reference Value) | 1.03 (Wrms) | VL * IL |
| 4 | Luminance | 250 min (cd/m ²) | Note 1 |
| 5 | Chromaticity (X) (Y) | 0.308 ± 0.01 0.330 ± 0.01 | Note 2 |
| 6 | Starting Voltage (VS) | 530 MAX (25°C) (Vrms) 650 MAX (0°C) (Vrms) | Note 3 |
| 7 | Life time | 10000 min (h) | Note 4 |

Note 1. The average value is measured though the glass.

Note 2. The tube center / center point shall be measured.

Note 3. All the tubes shall be lighted. Slide in method shall be used for voltage application.

Note 4. Life

Judgment conditions.

A The luminance becomes 50% of the initial luminance.

B Not normal lighting.

C When a severe appearance failure is found.

(2) LED edge/white(a)

| PARAMETER | SYMBOL | MIN | TYP | MAX | UNIT | TEST CONDITION |
|--------------------|------------------|-----|-------|-----|-------------------|-------------------------|
| Supply Current | I _{LED} | — | 240 | 360 | mA | V=3.6V |
| Supply Voltage | V | — | 3.5 | 3.6 | V | — |
| Reverse Voltage | V _R | — | — | 8 | V | — |
| Luminous Intensity | I _V | | 30 | — | CD/M ² | I _{LED} =240mA |
| Wave Length | λ p | — | | — | nm | I _{LED} =240mA |
| Life Time | — | — | 10000 | — | Hr. | V ≤ 3.6V |
| Color | White | | | | | |

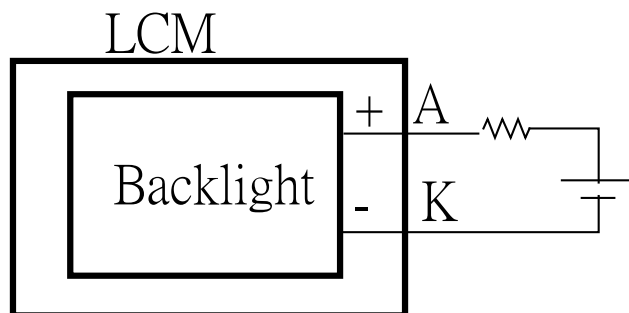


(3) LED edge/white(b)

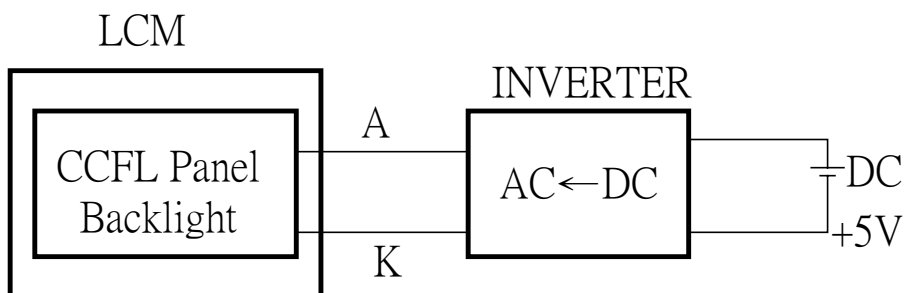
| PARAMETER | SYMBOL | MIN | TYP | MAX | UNIT | TEST CONDITION |
|--------------------|------------------|-----|-------|-----|-------------------|-------------------------|
| Supply Current | I _{LED} | — | 240 | 360 | mA | V=3.2V |
| Supply Voltage | V | — | 3.2 | 3.5 | V | — |
| Reverse Voltage | V _R | — | — | 8 | V | — |
| Luminous Intensity | I _V | | 30 | — | CD/M ² | I _{LED} =240mA |
| Wave Length | λ _p | — | | — | nm | I _{LED} =240mA |
| Life Time | — | — | 10000 | — | Hr. | V ≤ 3.2V |
| Color | White | | | | | |

10.2 Backlight Driving methods

a. LED B/L driven from A.K cable directly



b. CCFL B/L driven from A.K cable directly





10.3 CCFL INVENTER DATA (P/N:IVFL-03)

As shown on next page



1. GENERAL

This specification is applied to driver for CCFT.

2. INPET CHARACTERISTICS

| Parameter | Symbol | Min | Nom | Max | Unit | Remark |
|---------------|-----------------|-----|-----|-----|------|---------------------|
| Input Voltage | V _{in} | 4.5 | 5.0 | 5.5 | V | |
| Input Current | I _{in} | 360 | 410 | 460 | mA | V _{in} =5V |
| Input Power | P _{in} | — | 2.1 | — | W | V _{in} =5V |

3. Output Characteristics

| Parameter | Symbol | Min | Nom | Max | Unit | Remark |
|-------------------|----------------|------|------|------|------------------|-----------------------|
| Output Voltage | V _o | 210 | 260 | 310 | V _{rms} | V _{in} =5.0V |
| Start Voltage | V _v | | 510 | | | |
| Tube Current | I _L | 5.1 | 5.6 | 6.1 | mA | V _{in} =5.0V |
| Working Frequency | f | 38.2 | 43.2 | 48.2 | KHz | |

NOTE: All conditions are at 25°C ambient unless otherwise specified.

4. General Specification

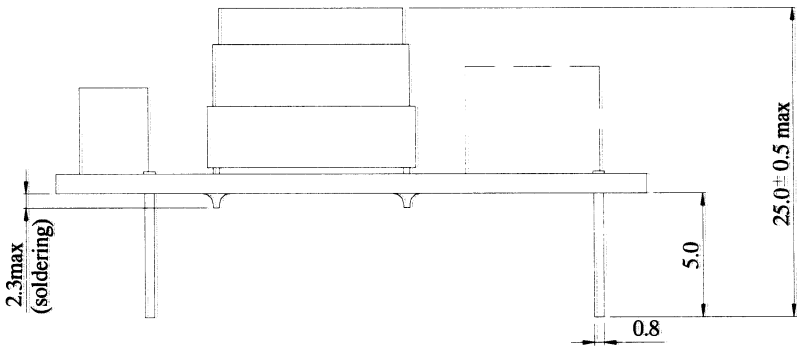
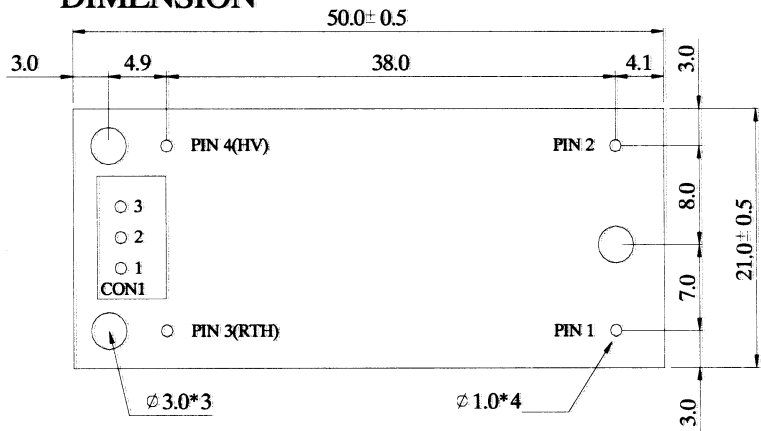
a. Temperature operating : -10~85°C

b. Temperature operating : -20~85°C

C. Humidity operating : -10~95%RH

D. Humidity operating : -20~95%RH

DIMENSION



PIN ASSIGNMENT

UNIT: mm

INPUT CONNECTOR

| PIN NUMBER | FUNCTION |
|------------|----------|
| PIN 1 | VIN |
| PIN 2 | GND |

OUTPUT(CON1) CONNECTOR 2532-03

| PIN NUMBER | FUNCTION |
|------------|----------|
| 1 | RTH |
| 2 | NC |
| 3 | HV |

The non-specified tolerance of dimension is $\pm 0.3\text{mm}$



11. Quality Assurance

Screen Cosmetic Criteria

| No. | Defect | Judgment Criterion | Partition | | | | | | | | | | | | | | | | | | | | |
|--------------------|-------------------------------|--|------------|-------------------------------|--------------|-----------|--------------------|---|--------------------|---|-----------|---|------------|-------------------------------|--------------|-----------|--------------------|---|--------------------|---|-----------|---|-------|
| 1 | Spots | <div><div>A)Clear</div><table><thead><tr><th>Size: d mm</th><th>Acceptable Qty in active area</th></tr></thead><tbody><tr><td>$d \leq 0.1$</td><td>Disregard</td></tr><tr><td>$0.1 < d \leq 0.2$</td><td>6</td></tr><tr><td>$0.2 < d \leq 0.3$</td><td>2</td></tr><tr><td>$0.3 < d$</td><td>0</td></tr></tbody></table><p>Note: Including pin holes and defective dots which must be within one pixel size.</p><div>B)Unclear</div><table><thead><tr><th>Size: d mm</th><th>Acceptable Qty in active area</th></tr></thead><tbody><tr><td>$d \leq 0.2$</td><td>Disregard</td></tr><tr><td>$0.2 < d \leq 0.5$</td><td>6</td></tr><tr><td>$0.5 < d \leq 0.7$</td><td>2</td></tr><tr><td>$0.7 < d$</td><td>0</td></tr></tbody></table></div> <td>Minor</td> | Size: d mm | Acceptable Qty in active area | $d \leq 0.1$ | Disregard | $0.1 < d \leq 0.2$ | 6 | $0.2 < d \leq 0.3$ | 2 | $0.3 < d$ | 0 | Size: d mm | Acceptable Qty in active area | $d \leq 0.2$ | Disregard | $0.2 < d \leq 0.5$ | 6 | $0.5 < d \leq 0.7$ | 2 | $0.7 < d$ | 0 | Minor |
| Size: d mm | Acceptable Qty in active area | | | | | | | | | | | | | | | | | | | | | | |
| $d \leq 0.1$ | Disregard | | | | | | | | | | | | | | | | | | | | | | |
| $0.1 < d \leq 0.2$ | 6 | | | | | | | | | | | | | | | | | | | | | | |
| $0.2 < d \leq 0.3$ | 2 | | | | | | | | | | | | | | | | | | | | | | |
| $0.3 < d$ | 0 | | | | | | | | | | | | | | | | | | | | | | |
| Size: d mm | Acceptable Qty in active area | | | | | | | | | | | | | | | | | | | | | | |
| $d \leq 0.2$ | Disregard | | | | | | | | | | | | | | | | | | | | | | |
| $0.2 < d \leq 0.5$ | 6 | | | | | | | | | | | | | | | | | | | | | | |
| $0.5 < d \leq 0.7$ | 2 | | | | | | | | | | | | | | | | | | | | | | |
| $0.7 < d$ | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Bubbles in Polarize | <div><div>Size: d mm</div><table><thead><tr><th>Size: d mm</th><th>Acceptable Qty in active area</th></tr></thead><tbody><tr><td>$d \leq 0.3$</td><td>Disregard</td></tr><tr><td>$0.3 < d \leq 1.0$</td><td>3</td></tr><tr><td>$1.0 < d \leq 1.5$</td><td>1</td></tr><tr><td>$1.5 < d$</td><td>0</td></tr></tbody></table></div> <td>Minor</td> | Size: d mm | Acceptable Qty in active area | $d \leq 0.3$ | Disregard | $0.3 < d \leq 1.0$ | 3 | $1.0 < d \leq 1.5$ | 1 | $1.5 < d$ | 0 | Minor | | | | | | | | | | |
| Size: d mm | Acceptable Qty in active area | | | | | | | | | | | | | | | | | | | | | | |
| $d \leq 0.3$ | Disregard | | | | | | | | | | | | | | | | | | | | | | |
| $0.3 < d \leq 1.0$ | 3 | | | | | | | | | | | | | | | | | | | | | | |
| $1.0 < d \leq 1.5$ | 1 | | | | | | | | | | | | | | | | | | | | | | |
| $1.5 < d$ | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 3 | Scratch | In accordance with spots cosmetic criteria. When the light reflects on the panel surface, the scratches are not to be remarkable. | Minor | | | | | | | | | | | | | | | | | | | | |
| 4 | Allowable Density | Above defects should be separated more than 30mm each other. | Minor | | | | | | | | | | | | | | | | | | | | |
| 5 | Coloration | Not to be noticeable coloration in the viewing area of the LCD panels. Back-light type should be judged with back-light on state only. | Minor | | | | | | | | | | | | | | | | | | | | |



12. Reliability

Content of Reliability Test

| Environmental Test | | | |
|--------------------------------------|--|---|---------------------|
| Test Item | Content of Test | Test Condition | Applicable Standard |
| High Temperature storage | Endurance test applying the high storage temperature for a long time. | 60℃ 200hrs | — |
| Low Temperature storage | Endurance test applying the high storage temperature for a long time. | -10℃ 200hrs | — |
| High Temperature Operation | Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time. | 50℃ 200hrs | — |
| Low Temperature Operation | Endurance test applying the electric stress under low temperature for a long time. | 0℃ 200hrs | — |
| High Temperature/ Humidity Storage | Endurance test applying the high temperature and high humidity storage for a long time. | 60℃, 90%RH 96hrs | — |
| High Temperature/ Humidity Operation | Endurance test applying the electric stress (Voltage & Current) and temperature / humidity stress to the element for a long time. | 50℃, 90%RH 96hrs | — |
| Temperature Cycle | Endurance test applying the low and high temperature cycle. <div style="text-align: center;"> <p>-10℃ 25℃ 60℃</p> <p>30min 5min 30min</p> <p>1 cycle</p> </div> | -10℃/60℃ 10 cycles | — |
| Mechanical Test | | | |
| Vibration test | Endurance test applying the vibration during transportation and using. | 10~22Hz→ 1.5mmp-p 22~500Hz→1.5G Total 0.5hrs | — |
| Shock test | Constructional and mechanical endurance test applying the shock during transportation. | 50G Half sign wave 11 msdc 3 times of each direction | — |
| Atmospheric pressure test | Endurance test applying the atmospheric pressure during transportation by air. | 115mbar 40hrs | — |
| Others | | | |
| Static electricity test | Endurance test applying the electric stress to the terminal. | VS=800V, RS=1.5k Ω CS=100pF 1 time | — |

***Supply voltage for logic system=5V. Supply voltage for LCD system =Operating voltage at 25℃

