

**SANYO**

No.3379A

**LC5732N****4-Bit Microcomputer with LCD Driver****Overview**

The LC5732N is a CMOS 4-bit microcomputer that operate on low voltage, very low current and contain LCD drivers. They also contain a 4-bit parallel processing ALU, a program memory ROM, many LCD segment outputs, a prescaler, an oscillator.

The LC5732N is especially suited for use in high-grade timepieces, time controllers, electronic calculators, LCD games with timepiece.

**Hardware Features**

- Supply voltage :  
1.5V or 3.0V typ. (mask option-selectable)
- Very low current dissipation :  
3.0 $\mu$ A typ. (Ag battery version, 32kHz crystal oscillation, during timekeeping operation)  
1.5 $\mu$ A typ. (Li battery version, 32kHz crystal oscillation, during timekeeping operation)
- Crystal oscillator for timekeeping (32.768kHz crystal connected externally) or CR oscillator (CR connected externally)
- Many output pins for LCD panel drive (27 pins)
 

| Drivable LCD panel |          | Number of drivable LCD segments |
|--------------------|----------|---------------------------------|
| 1/2 bias           | 1/3 duty | 81 segments                     |
| 1/2 bias           | 1/2 duty | 54 segments                     |
| Static             |          | 27 segments                     |
- On-chip melody function : 3 octaves (The melody length is software-controlled. One musical note requires one byte.)
- Input/output pins
  - Input pins : 8 pins
  - Control output pins : 3 pins (Output dedicated to alarm : 2 pins, general-purpose output : 1 pin)
- Possible to use LCD panel drive output pins as output-only ports (mask option-selectable)
- ROM : 2048  $\times$  8 bits
- RAM : 48  $\times$  4 bits
- Cycle time : 122 $\mu$ sec. for 32.768kHz crystal
- On-chip step-up circuit/step-down circuit
- Shipping style : Chip

**Software Features**

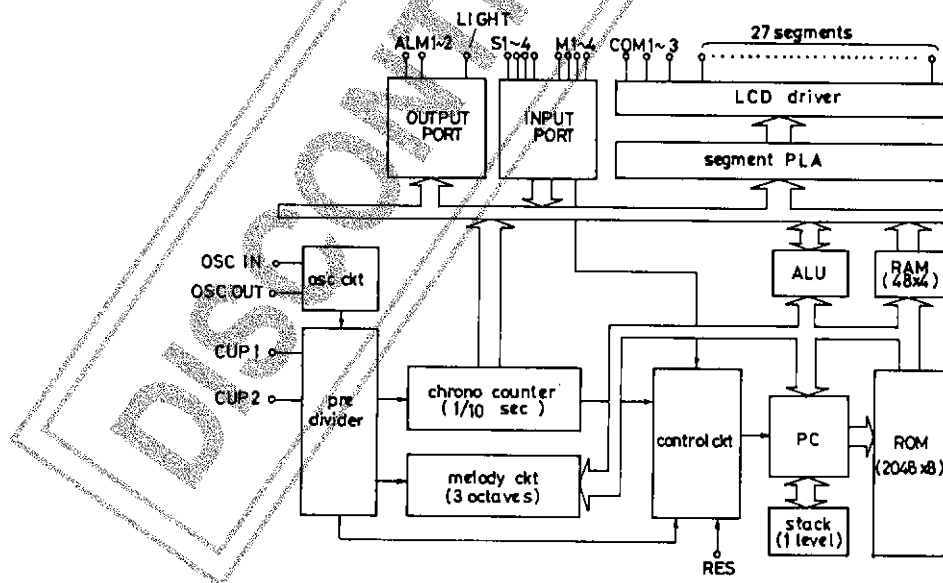
- Powerful instruction set : 92 instructions
- Table read instruction
- 1-level subroutine nesting
- On-chip 15-bit divider for timekeeping (delivers an overflow signal every 32ms or 64ms/100ms/500ms when a 32.768kHz crystal is used.)
- HALT function

**SANYO Electric Co., Ltd. Semiconductor Business Headquarters**  
TOKYO OFFICE Tokyo Bldg., 1-10, 1 Chome, Ueno, Taito-ku, TOKYO, 110 JAPAN

**Application Development Support System**

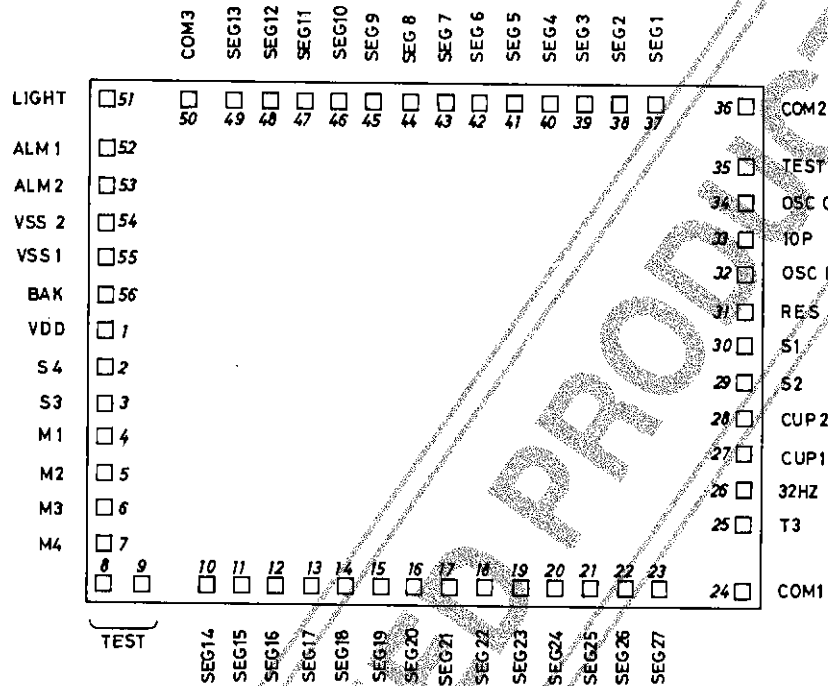
- Evaluation chip (LC5797) is available for application development and the dedicated equipment is available as the application development tools.
- Tools for developing the LC5732N application programs
  - ① · MS-DOS machine
    - Cross Assembler : LC5732.EXE
    - Mask Option selections program : SU5732.EXE
  - ② · SDS-410 system
    - Cross-Assembler : LC5732.COM
    - Mask Option selections program : SU5732.COM
- EVA-510 + TB-5734 + DCB-1 (Rev 2.0V or greater) + Application evaluation board + LC5797  
By connecting to the SDS-410 or MS-DOS machine, application development program data correction and debugging may be done.
- TB-5734 + DCB-1 (Rev 2.0V or greater) + Application evaluation board + LC5797  
By using the EPROM (2732) with application development program data written in, mounting evaluation may be done.

- Note 1
- The application evaluation board is constructed by the user.
  - LEDs or LCDs may be used for display.
  - The EVA-510 is a modified version of the EVA-410 whose monitor ROM is replaced by the SCR-5734.
- Note 2
- Since the evaluation chip LC5797 and the LC5732N differ in RAM capacity, check the ROM capacity when developing or debugging programs.  
LC5732N :  $48 \times 4$  bits  
LC5797 :  $256 \times 4$  bits
  - If the DPH value on a program is other than 0, 1, 2, the LC5732N will malfunction in actual applications.
  - When developing programs, take care of the DPH value. The usable DPH values are "0", "1", "2" only.
  - We will be free from any blame even if you use DPH = other than 0 to 2 to develop programs.
  - User's Manual : "LC5732/32H, 5733/33H, 5734/34H User's Manual"  
Refer to the LC5732 section of this User's Manual.
  - Development Tool Manual : "LC5730 Series Development Tool Manual"  
Refer to the LC5732 section of this Development Tool Manual.

**Equivalent Circuit Block Diagram**

## Pad Assignment of LSI Chip

Chip size : 3.72mm×3.11mm  
 Chip thickness : 480μm  
 Pad size : 120μm×120μm



(Note) SEG14 to SEG27 can be used for output ports. (mask option-selectable)

## Pad Name and Coordinates

| Pad No | Pin Name | X ( $\mu\text{m}$ ) | Y ( $\mu\text{m}$ ) | Pad No | Pin Name | X ( $\mu\text{m}$ ) | Y ( $\mu\text{m}$ ) |
|--------|----------|---------------------|---------------------|--------|----------|---------------------|---------------------|
| 1      | VDD      | -1665               | 90                  | 29     | S 2      | 1665                | -260                |
| 2      | S 4      | -1665               | -90                 | 30     | S 1      | 1665                | -55                 |
| 3      | S 3      | -1665               | -295                | 31     | RES      | 1665                | 150                 |
| 4      | M 1      | -1665               | -500                | 32     | OSCIN    | 1665                | 410                 |
| 5      | M 2      | -1665               | -700                | 33     | 10P      | 1665                | 635                 |
| 6      | M 3      | -1665               | -905                | 34     | OSCOUT   | 1665                | 840                 |
| 7      | M 4      | -1665               | -1110               | 35     | TEST     | 1665                | 1045                |
| 8      | TEST     | -1665               | -1360               | 36     | COM 2    | 1665                | 1360                |
| 9      | TEST     | -1340               | -1360               | 37     | SEG 1    | 1150                | 1360                |
| 10     | SEG14    | -1100               | -1360               | 38     | SEG 2    | 970                 | 1360                |
| 11     | SEG15    | -920                | -1360               | 39     | SEG 3    | 790                 | 1360                |
| 12     | SEG16    | -740                | -1360               | 40     | SEG 4    | 610                 | 1360                |
| 13     | SEG17    | -560                | -1360               | 41     | SEG 5    | 430                 | 1360                |
| 14     | SEG18    | -380                | -1360               | 42     | SEG 6    | 250                 | 1360                |
| 15     | SEG19    | -200                | -1360               | 43     | SEG 7    | 70                  | 1360                |
| 16     | SEG20    | -20                 | -1360               | 44     | SEG 8    | -110                | 1360                |
| 17     | SEG21    | 160                 | -1360               | 45     | SEG 9    | -290                | 1360                |
| 18     | SEG22    | 340                 | -1360               | 46     | SEG10    | -470                | 1360                |
| 19     | SEG23    | 520                 | -1360               | 47     | SEG11    | -650                | 1360                |
| 20     | SEG24    | 700                 | -1360               | 48     | SEG12    | -830                | 1360                |
| 21     | SEG25    | 880                 | -1360               | 49     | SEG13    | -1010               | 1360                |
| 22     | SEG26    | 1060                | -1360               | 50     | COM 3    | -1190               | 1360                |
| 23     | SEG27    | 1240                | -1360               | 51     | LIGHT    | -1665               | 1360                |
| 24     | COM 1    | 1665                | -1360               | 52     | ALM 1    | -1665               | 990                 |
| 25     | T 3      | 1665                | -1075               | 53     | ALM 2    | -1665               | 810                 |
| 26     | 32Hz     | 1665                | -875                | 54     | VSS 2    | -1665               | 630                 |
| 27     | CUP 1    | 1665                | -670                | 55     | VSS 1    | -1665               | 450                 |
| 28     | CUP 2    | 1665                | -465                | 56     | BAK      | -1665               | 270                 |

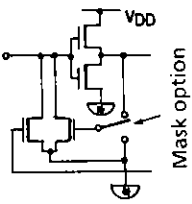
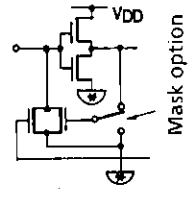
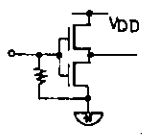
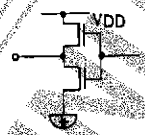
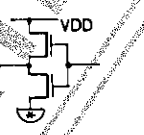
The pad coordinates are such that the chip center is taken as the origin and the values for (X, Y) represent the coordinates of the center point of each pad.

## Pin Description

| Pad No. | Pin Name | Input/Output | Circuit Configuration | Function                                                                                                                                               |
|---------|----------|--------------|-----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| 32      | OSCIN    | Input        |                       | Crystal OSC mode<br>32.768kHz crystal is connected across OSCIN and OSCOUT for oscillation.<br>Used as reference clock for timepiece and system clock. |
| 34      | OSCOUT   | Output       |                       | CR OSC mode<br>R and C are connected across OSCIN and OSCOUT for oscillation.<br>Used as system clock.                                                 |
| 33      | 10P      |              |                       | Connected to OSCOUT and used as OSC phase compensation capacitor.                                                                                      |

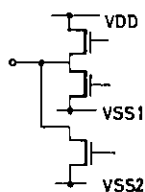
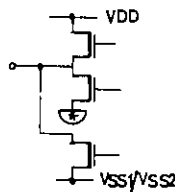
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| Pad No.            | Pin Name                             | Input/Output | Circuit Configuration                                                               | Function                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |             |  |             |  |           |  |        |          |        |          |        |          |                 |  |  |  |  |  |  |                  |  |  |  |  |  |  |                  |  |  |  |  |  |  |
|--------------------|--------------------------------------|--------------|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-------------|--|-------------|--|-----------|--|--------|----------|--------|----------|--------|----------|-----------------|--|--|--|--|--|--|------------------|--|--|--|--|--|--|------------------|--|--|--|--|--|--|
| 30<br>29<br>3<br>2 | S1<br>S2<br>S3<br>S4                 | Input        |    | Input-only port.<br>LSI system is reset by applying V <sub>DD</sub> to S1 to S4 simultaneously.<br>Note (Operating from Li battery, the RES pin must be used in both.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |             |  |             |  |           |  |        |          |        |          |        |          |                 |  |  |  |  |  |  |                  |  |  |  |  |  |  |                  |  |  |  |  |  |  |
| 4<br>5<br>6<br>7   | M1<br>M2<br>M3<br>M4                 | Input        |    | Input pins for placing data in LSI.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |             |  |             |  |           |  |        |          |        |          |        |          |                 |  |  |  |  |  |  |                  |  |  |  |  |  |  |                  |  |  |  |  |  |  |
| 31                 | RES                                  | Input        |    | Input pin for resetting LSI system.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |             |  |             |  |           |  |        |          |        |          |        |          |                 |  |  |  |  |  |  |                  |  |  |  |  |  |  |                  |  |  |  |  |  |  |
| 56                 | BAK                                  |              |                                                                                     | (-) power supply pin for logic unit inside the LSI.<br>For Li battery version, a capacitor must be connected across BAK and V <sub>DD</sub> to prevent logic unit from malfunctioning.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |             |  |             |  |           |  |        |          |        |          |        |          |                 |  |  |  |  |  |  |                  |  |  |  |  |  |  |                  |  |  |  |  |  |  |
| 51                 | LIGHT                                | Output       |  | Output-only pin<br>Suited for driving transistor for light.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |             |  |             |  |           |  |        |          |        |          |        |          |                 |  |  |  |  |  |  |                  |  |  |  |  |  |  |                  |  |  |  |  |  |  |
| 52<br>53           | ALM1<br>ALM2                         | Output       |  | Output-only pin<br>Used to deliver *4kHz, 2kHz, 1kHz modulation signal with instruction.<br>Also used to deliver non-modulation signal.<br>Used to deliver melody signal of 3 octaves with instruction.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |             |  |             |  |           |  |        |          |        |          |        |          |                 |  |  |  |  |  |  |                  |  |  |  |  |  |  |                  |  |  |  |  |  |  |
| 1                  | V <sub>DD</sub>                      |              |                                                                                     | (+) power supply pin.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |             |  |             |  |           |  |        |          |        |          |        |          |                 |  |  |  |  |  |  |                  |  |  |  |  |  |  |                  |  |  |  |  |  |  |
| 54<br>55           | V <sub>SS2</sub><br>V <sub>SS1</sub> |              |                                                                                     | (-) power supply pin.<br>Ag battery version, Li battery version, EXT-V version : mask option selectable.<br>Also used as power supply for LCD drive.<br>The following Table shows how to connect external parts in each case.<br><table border="1" data-bbox="924 1771 1351 1928"><thead><tr><th rowspan="2"></th><th colspan="2">Ag bat. use</th><th colspan="2">Li bat. use</th><th colspan="2">EXT-V use</th></tr><tr><th>static</th><th>1/2 bias</th><th>static</th><th>1/2 bias</th><th>static</th><th>1/2 bias</th></tr></thead><tbody><tr><td>V<sub>DD</sub></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>V<sub>SS1</sub></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>V<sub>SS2</sub></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></tbody></table> |        | Ag bat. use |  | Li bat. use |  | EXT-V use |  | static | 1/2 bias | static | 1/2 bias | static | 1/2 bias | V <sub>DD</sub> |  |  |  |  |  |  | V <sub>SS1</sub> |  |  |  |  |  |  | V <sub>SS2</sub> |  |  |  |  |  |  |
|                    | Ag bat. use                          |              | Li bat. use                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        | EXT-V use   |  |             |  |           |  |        |          |        |          |        |          |                 |  |  |  |  |  |  |                  |  |  |  |  |  |  |                  |  |  |  |  |  |  |
|                    | static                               | 1/2 bias     | static                                                                              | 1/2 bias                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | static | 1/2 bias    |  |             |  |           |  |        |          |        |          |        |          |                 |  |  |  |  |  |  |                  |  |  |  |  |  |  |                  |  |  |  |  |  |  |
| V <sub>DD</sub>    |                                      |              |                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |             |  |             |  |           |  |        |          |        |          |        |          |                 |  |  |  |  |  |  |                  |  |  |  |  |  |  |                  |  |  |  |  |  |  |
| V <sub>SS1</sub>   |                                      |              |                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |             |  |             |  |           |  |        |          |        |          |        |          |                 |  |  |  |  |  |  |                  |  |  |  |  |  |  |                  |  |  |  |  |  |  |
| V <sub>SS2</sub>   |                                      |              |                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |             |  |             |  |           |  |        |          |        |          |        |          |                 |  |  |  |  |  |  |                  |  |  |  |  |  |  |                  |  |  |  |  |  |  |
| 27<br>28           | CUP1<br>CUP2                         |              |                                                                                     | Pins for connecting voltage step-up (step-down) capacitor.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |             |  |             |  |           |  |        |          |        |          |        |          |                 |  |  |  |  |  |  |                  |  |  |  |  |  |  |                  |  |  |  |  |  |  |

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| Pad No.                              | Pin Name             | Input/Output | Circuit Configuration                                                             | Function                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |  |        |          |          |      |   |   |   |      |   |   |   |      |   |   |   |                       |      |      |      |
|--------------------------------------|----------------------|--------------|-----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--------|----------|----------|------|---|---|---|------|---|---|---|------|---|---|---|-----------------------|------|------|------|
| 24<br>36<br>50                       | COM1<br>COM2<br>COM3 | Output       |  | <p>Output pins for LCD panel common plate.<br/>The following pin is used in each case.</p> <table><tr><th></th><th>Static</th><th>1/2 duty</th><th>1/3 duty</th></tr><tr><td>COM1</td><td>○</td><td>○</td><td>○</td></tr><tr><td>COM2</td><td>○</td><td>○</td><td>○</td></tr><tr><td>COM3</td><td>○</td><td>○</td><td>○</td></tr><tr><td>Alternating frequency</td><td>64Hz</td><td>32Hz</td><td>43Hz</td></tr></table> <p>(Alternating frequency is for 32.768kHz crystal OSC application.)</p> |  | Static | 1/2 duty | 1/3 duty | COM1 | ○ | ○ | ○ | COM2 | ○ | ○ | ○ | COM3 | ○ | ○ | ○ | Alternating frequency | 64Hz | 32Hz | 43Hz |
|                                      | Static               | 1/2 duty     | 1/3 duty                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |        |          |          |      |   |   |   |      |   |   |   |      |   |   |   |                       |      |      |      |
| COM1                                 | ○                    | ○            | ○                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |        |          |          |      |   |   |   |      |   |   |   |      |   |   |   |                       |      |      |      |
| COM2                                 | ○                    | ○            | ○                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |        |          |          |      |   |   |   |      |   |   |   |      |   |   |   |                       |      |      |      |
| COM3                                 | ○                    | ○            | ○                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |        |          |          |      |   |   |   |      |   |   |   |      |   |   |   |                       |      |      |      |
| Alternating frequency                | 64Hz                 | 32Hz         | 43Hz                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |        |          |          |      |   |   |   |      |   |   |   |      |   |   |   |                       |      |      |      |
| 10<br>to<br>23<br><br>37<br>to<br>49 | Segment driver       | Output       |  | <p>Output pins for LCD panel segments.<br/>Mask option permits Seg 14 to Seg 27 (pad No.10 to 23) to be used as output ports.</p>                                                                                                                                                                                                                                                                                                                                                                |  |        |          |          |      |   |   |   |      |   |   |   |      |   |   |   |                       |      |      |      |
| 26<br>25<br>35<br>8<br>9             | 32Hz<br>T3<br>TEST   | Test         |                                                                                   | Test pins (not used by user)                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  |        |          |          |      |   |   |   |      |   |   |   |      |   |   |   |                       |      |      |      |

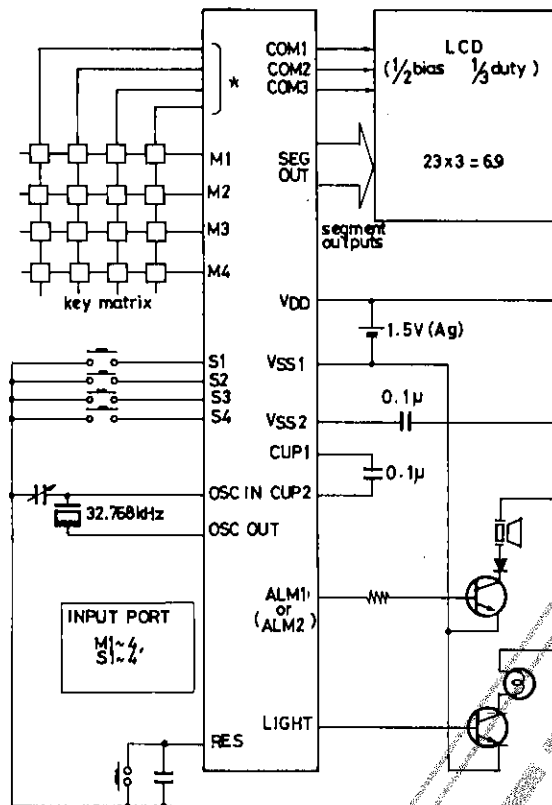
(Note) For Ag battery power supply,  $\oplus$  is connected to  $V_{SS1}$ ; for Li battery/EXT-V power supply, connected to  $V_{SS2}$ .

\* 4kHz, 2kHz, 1kHz : For 32.768kHz crystal OSC application, proportional to OSC frequency.

## Sample Application Circuits

## (1) Ag Battery used application

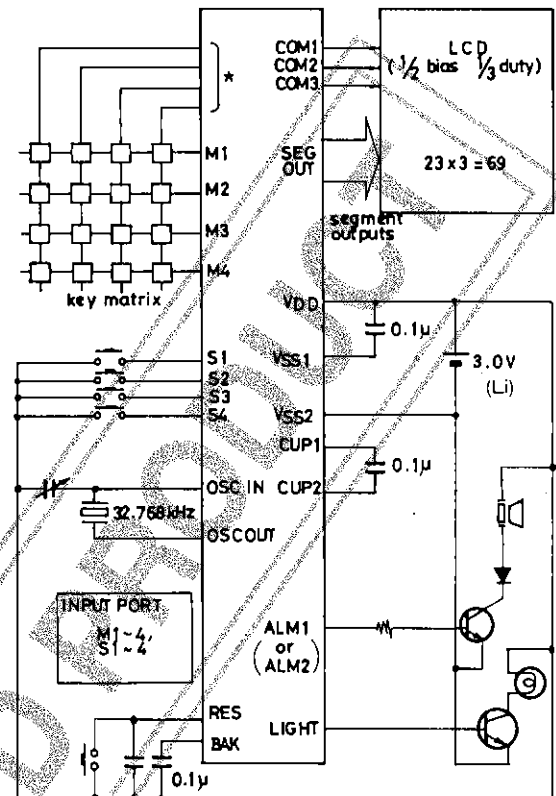
(1/2 bias 1/3 duty) \*: 4 segment outputs are used for output ports.



Crystal OSC (Power supply : Ag battery version)

## (2) Li Battery used application

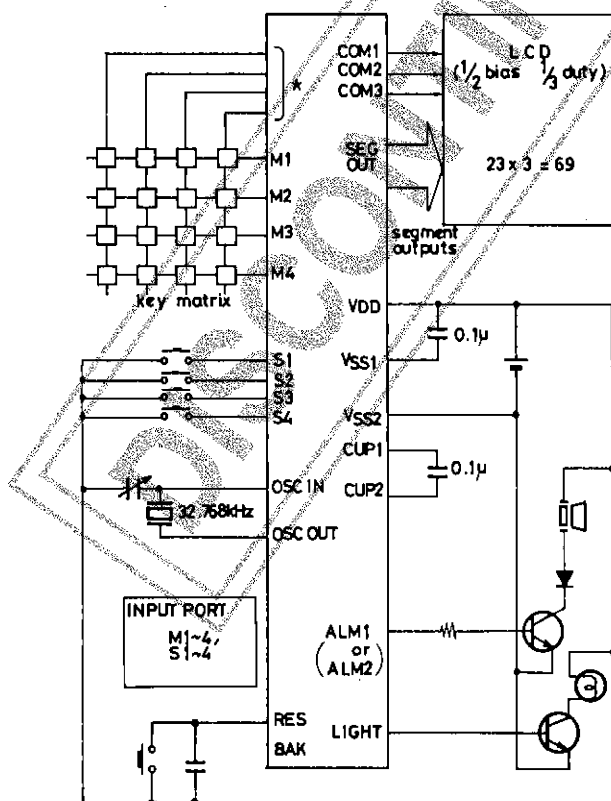
(1/2 bias 1/3 duty) \*: 4 segment outputs are used for output ports.



Crystal OSC (Power supply : Li battery version)

## (3) EXT-V used application

(1/2 bias 1/3 duty) \*: 4 segment outputs are used for output ports.



Crystal OSC (Power supply : EXT-V version)

Unit ( capacitance : F )

# ● Ag Battery Version

Absolute Maximum Ratings at  $T_a = 25 \pm 2^\circ\text{C}$ ,  $V_{DD} = 0\text{V}$

|                        |            |                                 |                         | unit             |
|------------------------|------------|---------------------------------|-------------------------|------------------|
| Maximum Supply Voltage | $V_{SS1}$  |                                 | -4.0 to +0.3            | V                |
|                        | $V_{SS2}$  |                                 | -4.0 to +0.3            | V                |
| Maximum Input Voltage  | $V_{IN}$   | S1-4, M1-4, TEST, OSCIN, RES    | $V_{SS1} - 0.3$ to +0.3 | V                |
| Maximum Output Voltage | $V_{OUT1}$ | CUP2, OSCOUT, ALM1, ALM2, LIGHT | $V_{SS1} - 0.3$ to +0.3 | V                |
|                        | $V_{OUT2}$ | SEGOUT, COM1, COM2, COM3, CUP1  | $V_{SS2} - 0.3$ to +0.3 | V                |
| Operating Temperature  | $T_{opr}$  |                                 | -10 to +65              | $^\circ\text{C}$ |
| Storage Temperature    | $T_{stg}$  |                                 | -30 to +125             | $^\circ\text{C}$ |

Allowable Operating Conditions at  $T_a = 25 \pm 2^\circ\text{C}$ ,  $V_{DD} = 0\text{V}$

|                                                                                              |            |                                                                                   | min       | typ    | max             | unit |
|----------------------------------------------------------------------------------------------|------------|-----------------------------------------------------------------------------------|-----------|--------|-----------------|------|
| Supply Voltage                                                                               | $V_{SS1}$  |                                                                                   | -1.65     |        | -1.30           | V    |
|                                                                                              | $V_{SS2}$  |                                                                                   | -3.3      |        | -2.4            | V    |
| Input 'H'-Level Voltage                                                                      | $V_{IH}$   | S1-4, M1-4, RES                                                                   | -0.2      |        | 0               | V    |
| Input 'L'-Level Voltage                                                                      | $V_{IL}$   | S1-4, M1-4, RES                                                                   | $V_{SS1}$ |        | $V_{SS1} + 0.2$ | V    |
| Operating Frequency                                                                          | $f_{opg1}$ | $T_a = -10$ to $+65^\circ\text{C}$ , crystal OSC (recommended OSC circuit Fig. 7) | 32        |        | 33              | kHz  |
|                                                                                              | $f_{opg2}$ | $T_a = -10$ to $+65^\circ\text{C}$ , CR OSC (recommended OSC circuit Fig. 8)      |           | 32.768 |                 | kHz  |
| (Recommended external CR constant: $C_{ext} = 33\text{pF}$ , $R_{ext} = 510\text{k}\Omega$ ) |            |                                                                                   |           |        |                 |      |

Electrical Characteristics at  $T_a = 25 \pm 2^\circ\text{C}$ ,  $V_{DD} = 0\text{V}$

|                                      |            |                                                                                                                                                     | min             | typ              | max   | unit             |
|--------------------------------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|------------------|-------|------------------|
| Input Resistance                     | $R_{IN1A}$ | $V_{SS1} = -1.55\text{V}$ , $V_{IL} = V_{SS1} + 0.2\text{V}$ , 'L' level hold $t_r$ , *1, Fig. 1                                                    | 200             |                  | 2000  | $\text{k}\Omega$ |
|                                      | $R_{IN1B}$ | $V_{SS1} = -1.55\text{V}$ , 'L' level pull-in $t_r$ , *1, Fig. 1                                                                                    | 200             |                  | 2000  | $\text{k}\Omega$ |
|                                      | $R_{IN2}$  | $V_{SS1} = -1.55\text{V}$ , TEST, RES                                                                                                               | 10              |                  | 300   | $\text{k}\Omega$ |
| Output 'H'-Level Voltage             | $V_{OH1}$  | $V_{SS1} = -1.55\text{V}$ , $I_{OH} = -0.4\mu\text{A}$ , *2                                                                                         | -0.2            |                  |       | V                |
| Output 'L'-Level Voltage             | $V_{OL1}$  | $V_{SS1} = -1.55\text{V}$ , $I_{OL} = 0.4\mu\text{A}$ , *2                                                                                          |                 | $V_{SS2} + 0.2$  |       | V                |
| Output 'H'-Level Voltage             | $V_{OH2}$  | $V_{SS1} = -1.55\text{V}$ , $I_{OH} = -4\mu\text{A}$ , COM1, COM2, COM3                                                                             | -0.2            |                  |       | V                |
| Output 'M'-Level Voltage             | $V_{OM}$   | $V_{SS1} = -1.55\text{V}$ , $I_{OH} = -4\mu\text{A}$ , $I_{OL} = 4\mu\text{A}$ , COM1, COM2, COM3                                                   | $V_{SS1} - 0.2$ | $V_{SS1} + 0.2$  |       | V                |
| Output 'L'-Level Voltage             | $V_{OL2}$  | $V_{SS1} = -1.55\text{V}$ , $I_{OL} = 4\mu\text{A}$ , COM1, COM2, COM3                                                                              |                 | $V_{SS2} + 0.2$  |       | V                |
| Output 'H'-Level Voltage             | $V_{OH3}$  | $V_{SS1} = -1.35\text{V}$ , $I_{OH} = -250\mu\text{A}$ , ALM1, ALM2, LIGHT                                                                          | -0.65           |                  |       | V                |
| Output 'L'-Level Voltage             | $V_{OL3}$  | $V_{SS1} = -1.35\text{V}$ , $I_{OL} = 150\mu\text{A}$ , ALM1, ALM2, LIGHT                                                                           |                 | $V_{SS1} + 0.65$ |       | V                |
| Output 'H'-Level Voltage             | $V_{OH4}$  | $V_{SS1} = -1.55\text{V}$ , $I_{OH} = -20\mu\text{A}$ , *3                                                                                          | -0.2            |                  |       | V                |
| Output 'L'-Level Voltage             | $V_{OL4}$  | $V_{SS1} = -1.55\text{V}$ , $I_{OL} = 20\mu\text{A}$ , *3                                                                                           |                 | $V_{SS1} + 0.2$  |       | V                |
| Output Voltage                       | $V_{SS2}$  | $V_{SS1} = -1.35\text{V}$ , $C1 = C2 = 0.1\mu\text{F}$ , $f_{opg} = 32.768\text{kHz}$ , Fig. 2                                                      | -3.3            |                  | -2.5  | V                |
| Current Dissipation                  | $I_{DD1}$  | $V_{SS1} = -1.55\text{V}$ , $C1 = C2 = 0.1\mu\text{F}$ , $C_g = 20\text{pF}$ , crystal OSC ( $C_I \leq 25\text{k}\Omega$ ), Fig. 2, backup flag OFF |                 | 2.0              |       | $\mu\text{A}$    |
|                                      | $I_{DD2}$  | HALT mode                                                                                                                                           |                 |                  |       |                  |
|                                      |            | ROM continue mode                                                                                                                                   |                 | 5.0              |       | $\mu\text{A}$    |
| Oscillation Start Voltage            | $V_{stt}$  | $C_g = 20\text{pF}$ , crystal OSC ( $C_I \leq 25\text{k}\Omega$ ), Fig. 3                                                                           | -1.35           |                  |       | V                |
| Oscillation Hold Voltage             | $V_{HOLD}$ | $C_g = 20\text{pF}$ , crystal OSC ( $C_I \leq 25\text{k}\Omega$ ), Fig. 3                                                                           |                 |                  | -1.30 | V                |
| Oscillation Start Time               | $t_{stt}$  | $V_{SS1} = -1.35\text{V}$ , $C_g = 20\text{pF}$ , crystal OSC ( $C_I \leq 25\text{k}\Omega$ ), Fig. 3                                               |                 |                  | 10    | s                |
| Oscillation Compensation Capacitance | 10P        | External pin                                                                                                                                        | 8               | 10               | 12    | pF               |

## ● Li Battery Version

Absolute Maximum Ratings at  $T_a = 25 \pm 2^\circ\text{C}$ ,  $V_{DD} = 0\text{V}$ 

|                        |                                                              |                         | unit             |
|------------------------|--------------------------------------------------------------|-------------------------|------------------|
| Maximum Supply Voltage | $V_{SS1}$                                                    | -4.0 to +0.3            | V                |
|                        | $V_{SS2}$                                                    | -4.0 to +0.3            | V                |
| Maximum Input Voltage  | $V_{IN1}$ OSCIN                                              | $V_{SS1} - 0.3$ to +0.3 | V                |
|                        | $V_{IN2}$ S1-4, M1-4, TEST, RES                              | $V_{SS2} - 0.3$ to +0.3 | V                |
| Maximum Output Voltage | $V_{OUT1}$ CUP2, OSCOUT                                      | $V_{SS1} - 0.3$ to +0.3 | V                |
|                        | $V_{OUT2}$ SEGOUT, COM1, COM2, COM3, CUP1, LIGHT, ALM1, ALM2 | $V_{SS2} - 0.3$ to +0.3 | V                |
| Operating Temperature  | $T_{opr}$                                                    | -10 to +65              | $^\circ\text{C}$ |
| Storage Temperature    | $T_{stg}$                                                    | -30 to +125             | $^\circ\text{C}$ |

Allowable Operating Conditions at  $T_a = 25 \pm 2^\circ\text{C}$ ,  $V_{DD} = 0\text{V}$ 

|                         |                                                                                             | min  | typ       | max             | unit |
|-------------------------|---------------------------------------------------------------------------------------------|------|-----------|-----------------|------|
| Supply Voltage          | $V_{SS1}$                                                                                   | -3.6 |           | -1.3            | V    |
|                         | $V_{SS2}$                                                                                   | -3.6 |           | -2.0            | V    |
| Input 'H'-Level Voltage | $V_{IH}$ S1-4, M1-4, RES                                                                    | -0.4 |           | 0               | V    |
| Input 'L'-Level Voltage | $V_{IL}$ S1-4, M1-4, RES                                                                    |      | $V_{SS2}$ | $V_{SS2} + 0.4$ | V    |
| Operating Frequency     | $f_{opg1}$ $T_a = -10$ to $+65^\circ\text{C}$ , crystal OSC (recommended OSC circuit Fig.7) | 32   |           | 33              | kHz  |

Electrical Characteristics at  $T_a = 25 \pm 2^\circ\text{C}$ ,  $V_{DD} = 0\text{V}$ 

|                                      |                                                                                                               | min               | typ               | max   | unit          |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------|-------------------|-------------------|-------|---------------|
| Input Resistance                     | $R_{IN1A}$ $V_{SS2} = -2.9\text{V}$ , $V_{IL} = V_{SS2} + 0.4\text{V}$ , 'L' level hold tr., *1, Fig.4        | 200               |                   | 2000  | k $\Omega$    |
|                                      | $R_{IN1B}$ $V_{SS2} = -2.9\text{V}$ , 'L' level pull-in tr., *1, Fig.4                                        | 100               |                   | 2000  | k $\Omega$    |
|                                      | $R_{IN2}$ $V_{SS2} = -2.9\text{V}$ , TEST, RES                                                                | 10                |                   | 300   | k $\Omega$    |
| Output 'H'-Level Voltage             | $V_{OH1}$ $V_{SS2} = -2.9\text{V}$ , $I_{OH} = -0.4\mu\text{A}$ , *2                                          | -0.2              |                   |       | V             |
| Output 'L'-Level Voltage             | $V_{OL1}$ $V_{SS2} = -2.9\text{V}$ , $I_{OL} = 0.4\mu\text{A}$ , *2                                           |                   | $V_{SS2} + 0.2$   |       | V             |
| Output 'H'-Level Voltage             | $V_{OH2}$ $V_{SS2} = -2.9\text{V}$ , $I_{OH} = -4\mu\text{A}$ , COM1, COM2, COM3                              | -0.2              |                   |       | V             |
| Output 'M'-Level Voltage             | $V_{OM}$ $V_{SS2} = -2.9\text{V}$ , $I_{OH} = -4\mu\text{A}$ , $I_{OL} = 4\mu\text{A}$ , COM1, COM2, COM3     | $V_{SS2}/2 - 0.2$ | $V_{SS2}/2 + 0.2$ |       | V             |
| Output 'L'-Level Voltage             | $V_{OL2}$ $V_{SS2} = -2.9\text{V}$ , $I_{OL} = 4\mu\text{A}$ , COM1, COM2, COM3                               |                   | $V_{SS2} + 0.2$   |       | V             |
| Output 'H'-Level Voltage             | $V_{OH3}$ $V_{SS2} = -2.4\text{V}$ , $I_{OH} = -250\mu\text{A}$ , ALM1, ALM2                                  | -0.65             |                   |       | V             |
| Output 'L'-Level Voltage             | $V_{OL3}$ $V_{SS2} = -2.4\text{V}$ , $I_{OL} = 250\mu\text{A}$ , ALM1, ALM2                                   |                   | $V_{SS2} + 0.65$  |       | V             |
| Output 'H'-Level Voltage             | $V_{OH4}$ $V_{SS2} = -2.4\text{V}$ , $I_{OH} = -150\mu\text{A}$ , LIGHT                                       | -1.5              |                   |       | V             |
| Output 'L'-Level Voltage             | $V_{OL4}$ $V_{SS2} = -2.4\text{V}$ , $I_{OL} = 150\mu\text{A}$ , LIGHT                                        |                   | $V_{SS2} + 1.5$   |       | V             |
| Output 'H'-Level Voltage             | $V_{OH5}$ $V_{SS2} = -2.9\text{V}$ , $I_{OH} = -40\mu\text{A}$ , *3                                           | -0.4              |                   |       | V             |
| Output 'L'-Level Voltage             | $V_{OL5}$ $V_{SS2} = -2.9\text{V}$ , $I_{OL} = 40\mu\text{A}$ , *3                                            |                   | $V_{SS2} + 0.4$   |       | V             |
| Output Voltage (halver)              | $V_{SS1}$ $V_{SS2} = -2.8\text{V}$ , $C1 = C2 = 0.1\mu\text{F}$ , $f_{opg} = 32.768\text{kHz}$ , Fig.5        |                   |                   | -1.35 | V             |
| Current Dissipation                  | $I_{DD1}$ $V_{SS2} = -2.9\text{V}$ , $C1 = C2 = 0.1\mu\text{F}$ , crystal OSC HALT mode                       |                   | 0.8               |       | $\mu\text{A}$ |
|                                      | $I_{DD2}$ $(C1 \leq 25\text{k}\Omega)$ , $C_g = 20\text{pF}$ , Fig.5, backup flag OFF ROM continue mode       |                   | 2.0               |       | $\mu\text{A}$ |
| Oscillation Start Voltage            | $V_{stt}$ $C_g = 20\text{pF}$ , crystal OSC ( $C1 \leq 25\text{k}\Omega$ ), Fig.6                             | -1.35             |                   |       | V             |
| Oscillation Hold Voltage             | $V_{HOLD}$ $C_g = 20\text{pF}$ , crystal OSC ( $C1 \leq 25\text{k}\Omega$ ), Fig.6                            |                   |                   | -1.3  | V             |
| Oscillation Start Time               | $t_{stt}$ $V_{SS2} = -1.35\text{V}$ , $C_g = 20\text{pF}$ , crystal OSC ( $C1 \leq 25\text{k}\Omega$ ), Fig.6 |                   |                   | 10    | s             |
| Oscillation Compensation Capacitance | 10P External pin                                                                                              | 8                 | 10                | 12    | pF            |

## ● EXT-V Version

Absolute Maximum Ratings at  $T_a = 25 \pm 2^\circ\text{C}$ ,  $V_{DD} = 0\text{V}$ 

|                        |           |                                                                                                  | unit             |
|------------------------|-----------|--------------------------------------------------------------------------------------------------|------------------|
| Maximum Supply Voltage | $V_{SS1}$ | -4.0 to +0.3                                                                                     | V                |
|                        | $V_{SS2}$ | -4.0 to +0.3                                                                                     | V                |
| Maximum Input Voltage  | $V_{IN}$  | OSCIN,<br>S1-4,M1-4,TEST,RES<br>$V_{SS2} - 0.3$ to +0.3                                          | V                |
| Maximum Output Voltage | $V_{OUT}$ | CUP2, OSCOUT,<br>SEGOUT, COM1, COM2, COM3, CUP1,<br>LIGHT, ALM1, ALM2<br>$V_{SS2} - 0.3$ to +0.3 | V                |
| Operating Temperature  | $T_{opr}$ | -30 to +70                                                                                       | $^\circ\text{C}$ |
| Storage Temperature    | $T_{stg}$ | -40 to +125                                                                                      | $^\circ\text{C}$ |

Allowable Operating Conditions at  $T_a = 25 \pm 2^\circ\text{C}$ ,  $V_{DD} = 0\text{V}$ 

|                         |            |                                                                                                                                                                      | min       | typ             | max | unit |
|-------------------------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------------|-----|------|
| Supply Voltage          | $V_{SS1}$  |                                                                                                                                                                      | -3.6      | -1.3            |     | V    |
|                         | $V_{SS2}$  |                                                                                                                                                                      | -3.6      | -2.0            |     | V    |
| Input 'H'-Level Voltage | $V_{IH}$   | S1-4,M1-4,RES                                                                                                                                                        | -0.4      | 0               |     | V    |
| Input 'L'-Level Voltage | $V_{IL}$   | S1-4,M1-4,RES                                                                                                                                                        | $V_{SS2}$ | $V_{SS2} + 0.4$ |     | V    |
| Operating Frequency     | $f_{opg1}$ | $T_a = -30$ to $+70^\circ\text{C}$ , crystal OSC (recom-<br>mended OSC circuit Fig.7)                                                                                | 32        |                 | 33  | kHz  |
|                         | $f_{opg2}$ | $T_a = -30$ to $+70^\circ\text{C}$ , CR OSC (recom-<br>mended OSC circuit Fig.8)<br>(Recommended external CR constant: $C = 27\text{pF}$ , $R = 680\text{k}\Omega$ ) |           | 32.768          |     | kHz  |

Electrical Characteristics at  $T_a = 25 \pm 2^\circ\text{C}$ ,  $V_{DD} = 0\text{V}$ 

|                            |            |                                                                                                     | min               | typ               | max  | unit             |
|----------------------------|------------|-----------------------------------------------------------------------------------------------------|-------------------|-------------------|------|------------------|
| Input Resistance           | $R_{IN1A}$ | $V_{SS2} = -2.9\text{V}$ , $V_{IL} = V_{SS2} + 0.4\text{V}$ ,<br>'L' level hold tr., *1, Fig.4      | 200               |                   | 2000 | $\text{k}\Omega$ |
|                            | $R_{IN1B}$ | $V_{SS2} = -2.9\text{V}$ ,<br>'L' level pull-in tr., *1, Fig.4                                      | 100               |                   | 2000 | $\text{k}\Omega$ |
|                            | $R_{IN2}$  | $V_{SS2} = -2.9\text{V}$ , TEST, RES                                                                | 10                |                   | 300  | $\text{k}\Omega$ |
| Output 'H'-Level Voltage   | $V_{OH1}$  | $V_{SS2} = -2.9\text{V}$ , $I_{OH} = -0.4\mu\text{A}$ , *2                                          | -0.2              |                   |      | V                |
| Output 'L'-Level Voltage   | $V_{OL1}$  | $V_{SS2} = -2.9\text{V}$ , $I_{OL} = 0.4\mu\text{A}$ , *2                                           |                   | $V_{SS2} + 0.2$   |      | V                |
| Output 'H'-Level Voltage   | $V_{OH2}$  | $V_{SS2} = -2.9\text{V}$ , $I_{OH} = -4\mu\text{A}$ ,<br>COM1, COM2, COM3                           | -0.2              |                   |      | V                |
| Output 'M'-Level Voltage   | $V_{OM}$   | $V_{SS2} = -2.9\text{V}$ , $I_{OH} = -4\mu\text{A}$ ,<br>$I_{OL} = 4\mu\text{A}$ , COM1, COM2, COM3 | $V_{SS2}/2 - 0.2$ | $V_{SS2}/2 + 0.2$ |      | V                |
| Output 'L'-Level Voltage   | $V_{OL2}$  | $V_{SS2} = -2.9\text{V}$ , $I_{OL} = 4\mu\text{A}$ ,<br>COM1, COM2, COM3                            |                   | $V_{SS2} + 0.2$   |      | V                |
| Output 'H'-Level Voltage   | $V_{OH3}$  | $V_{SS2} = -2.4\text{V}$ , $I_{OH} = -250\mu\text{A}$ ,<br>ALM1, ALM2                               | -0.65             |                   |      | V                |
| Output 'L'-Level Voltage   | $V_{OL3}$  | $V_{SS2} = -2.4\text{V}$ , $I_{OL} = 250\mu\text{A}$ ,<br>ALM1, ALM2                                |                   | $V_{SS2} + 0.65$  |      | V                |
| Output 'H'-Level Voltage   | $V_{OH4}$  | $V_{SS2} = -2.4\text{V}$ , $I_{OH} = -150\mu\text{A}$ , LIGHT                                       | -1.5              |                   |      | V                |
| Output 'L'-Level Voltage   | $V_{OL4}$  | $V_{SS2} = -2.4\text{V}$ , $I_{OL} = 150\mu\text{A}$ , LIGHT                                        |                   | $V_{SS2} + 1.5$   |      | V                |
| Output 'H'-Level Voltage   | $V_{OH5}$  | $V_{SS2} = -2.9\text{V}$ , $I_{OH} = -40\mu\text{A}$ , *3                                           | -0.4              |                   |      | V                |
| Output 'L'-Level Voltage   | $V_{OL5}$  | $V_{SS2} = -2.9\text{V}$ , $I_{OL} = 40\mu\text{A}$ , *3                                            |                   | $V_{SS2} + 0.4$   |      | V                |
| Output Voltage<br>(halver) | $V_{SS1}$  | $V_{SS2} = -2.8\text{V}$ ,<br>$C1 = C2 = 0.1\mu\text{F}$ , $f_{opg} = 32.768\text{kHz}$ , Fig.5     |                   | -1.35             |      | V                |
| Current Dissipation        | $I_{DD1}$  | $V_{SS2} = -2.9\text{V}$ , $C1 =$<br>$C2 = 0.1\mu\text{F}$ , crystal OSC                            |                   | 5.0               |      | $\mu\text{A}$    |
|                            | $I_{DD2}$  | ( $C1 \leq 25\text{k}\Omega$ ),<br>$C_g = 20\text{pF}$ , Fig.5                                      |                   | 12.5              |      | $\mu\text{A}$    |
|                            |            | HALT mode                                                                                           |                   |                   |      |                  |
|                            |            | ROM continue mode                                                                                   |                   |                   |      |                  |
| Oscillation Start Voltage  | $V_{stt}$  | $C_g = 20\text{pF}$ , crystal OSC ( $C1 \leq 25\text{k}\Omega$ ),<br>Fig.6                          | -2.2              |                   |      | V                |
| Oscillation Hold Voltage   | $V_{HOLD}$ | $C_g = 20\text{pF}$ , crystal OSC ( $C1 \leq 25\text{k}\Omega$ ),<br>Fig.6                          |                   | -2.0              |      | V                |

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Continued from preceding page.

|                                      |                  |                                                                                                           |     |     |     |        |
|--------------------------------------|------------------|-----------------------------------------------------------------------------------------------------------|-----|-----|-----|--------|
| Oscillation Start Time               | $t_{\text{stt}}$ | $V_{\text{SS2}} = -2.2\text{V}, C_g = 20\text{pF},$<br>crystal OSC ( $C_I \leq 25\text{k}\Omega$ ), Fig.6 | min | typ | max | unit   |
|                                      |                  |                                                                                                           |     |     |     | 10 sec |
| Oscillation Compensation Capacitance | 10P              | External pin                                                                                              | 8   | 10  | 12  | pF     |

- ※1 S1, S2, S3, S4 ; M1, M2, M3, M4
- ※2 LCD driver output pins out of SEGOUT14 to 27, SEGOUT1 to 13
- ※3 Output pins (used as output port) of SEGOUT14 to 27

Table 1 Constants Guaranteed for Crystal OSC

| Oscillator Type                     | Supplier        | Oscillator                      | Power Supply   | Cg   |
|-------------------------------------|-----------------|---------------------------------|----------------|------|
| 32.768kHz<br>crystal<br>oscillation | Daiwa<br>Shinku | DT-38, 32.768kHz<br>(CL=12.5pF) | Ag/Li<br>EXT-V | 15pF |
|                                     | Kyocera         | KF-38G, 32.768kHz<br>(CL=13pF)  | Ag/Li          | 20pF |
|                                     |                 |                                 | EXT-V          | 18pF |

Cg tolerance :  $\pm 5\%$ 

(Note) Since the circuit pattern affects the oscillation frequency, place the oscillation-related parts as close to the oscillation pins as possible with the shortest possible pattern length.

If oscillators other than shown above are used, the characteristics cannot be guaranteed.

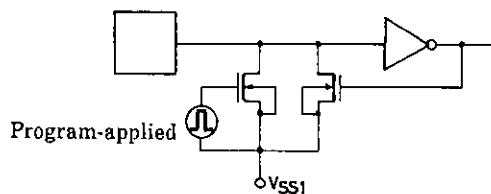


Fig.1 Input configuration of S1-4, M1-4

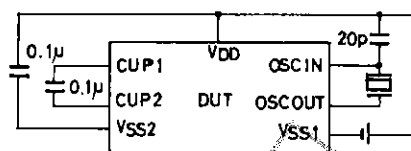


Fig.2 Current dissipation, output voltage test circuit

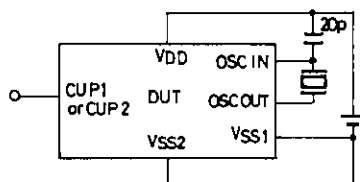


Fig.3 Oscillation start voltage, oscillation start time, frequency stability, oscillation hold voltage test circuit

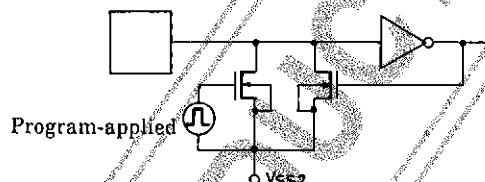


Fig.4 Input configuration of S1-4, M1-4

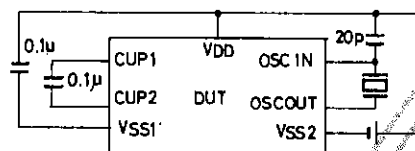


Fig.5 Current dissipation, output voltage test circuit

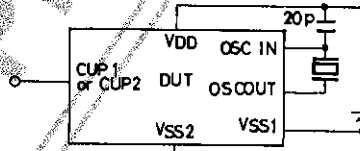


Fig.6 Oscillation start voltage, oscillation start time, frequency stability, oscillation hold voltage test circuit

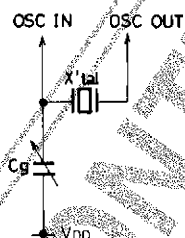


Fig.7 Recommended crystal oscillation circuit

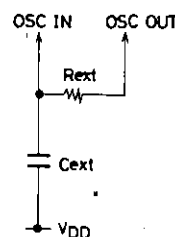


Fig.8 Recommended CR oscillation circuit

Unit (capacitance: F)

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