

## MSC7110-01/7112-01

12-Segment × 16-Digit or 16-Segment × 12-Digit Display Controller/Driver

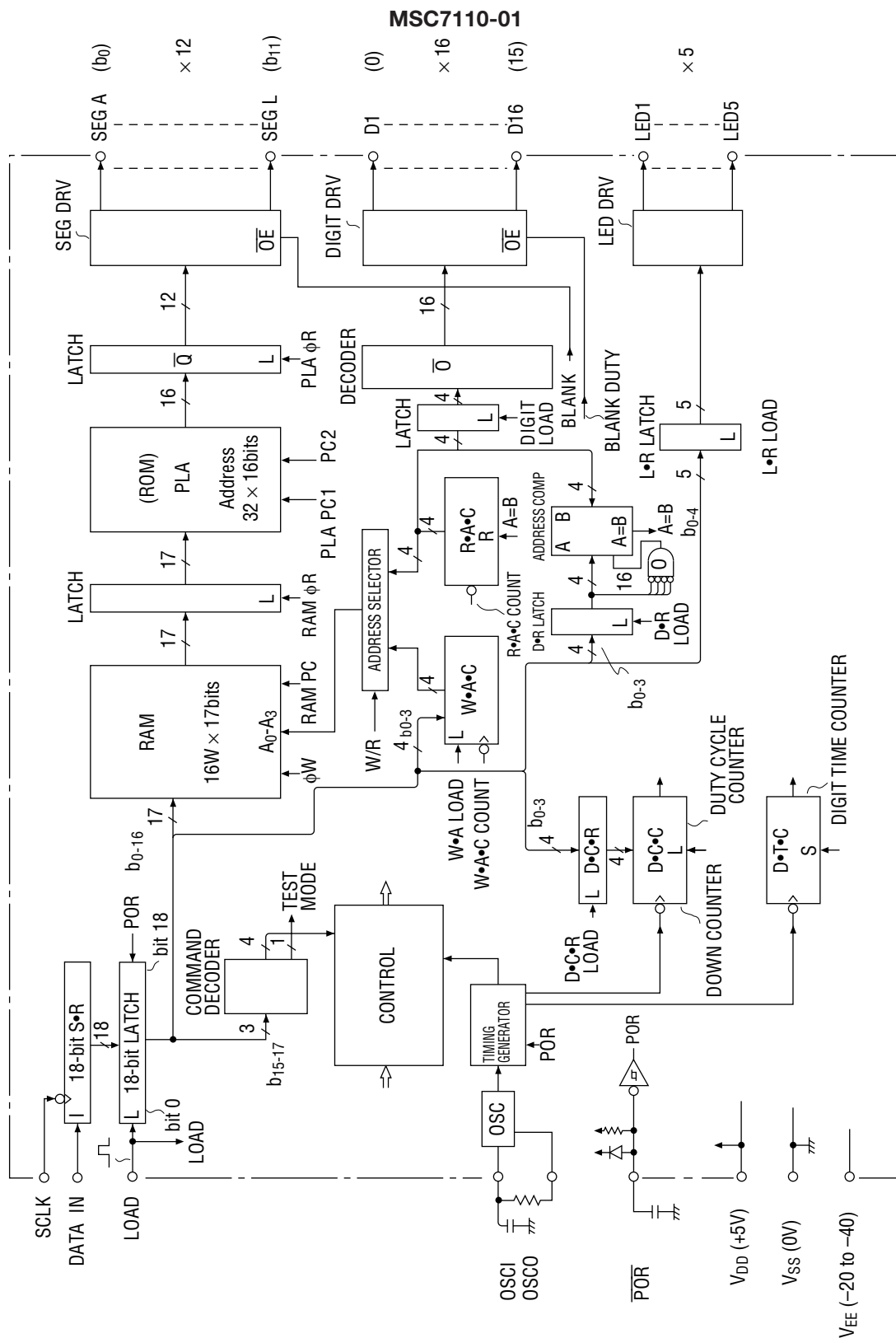
### GENERAL DESCRIPTION

The MSC7110-01 / MSC7112-01 is a display controller to display the timer of video tape recorder, channel operation, and other information by a vacuum fluorescent display tube. Display data is input by serial transfer from microcontroller.

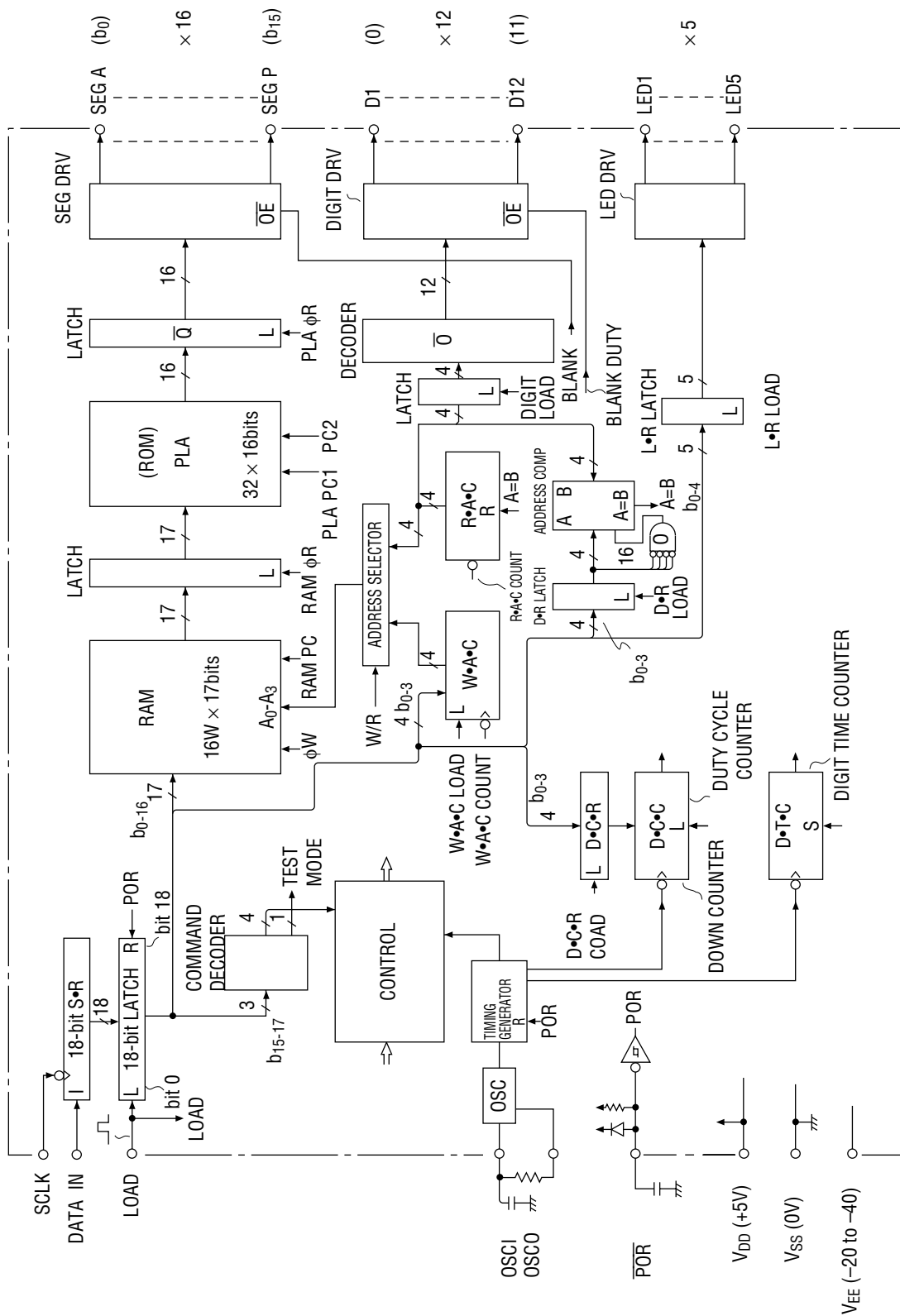
### FEATURES

- Provides the interface with a microcontroller by three signal lines. : DATA IN, CLOCK, and LOAD
- Driver output can directly be connected to a vacuum fluorescent display tube without a pull-down resistor.
- Display is turned on by dynamic drive mode.
- The number of display digits are programmable in the range of : 1 to 12 digits (MSC7112-01)  
1 to 16 digits (MSC7110-01)
- 12-segment driver output : 16 driver outputs (MSC7112-01)  
12 driver outputs (MSC7110-01)
- The LED drivers can turn on 5 outputs statically.
- RAM data can directly be displayed.
- The brightness adjustment is programmable and brightness can be adjusted every 1/15 step.
- Built-in power-on-reset circuit
- The vacuum fluorescent display tube driver outputs high withstand voltage :  $V_{DD}-V_{EE}=45V$  (max).
- Logic supply voltage :  $V_{DD}=5V \pm 10\%$
- Package options:
  - 42-pin plastic SDIP (SDIP42-P-600-1.778) : (Product name : MSC7112-01SS)
  - 44-pin plastic QFP (QFP44-P-910-0.80-2K) : (Product name : MSC7110-01GS-2K/MSC7112-01GS-2K)

## BLOCK DIAGRAM

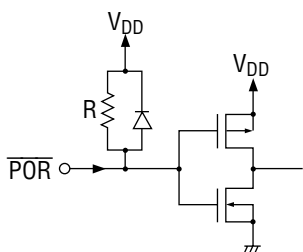
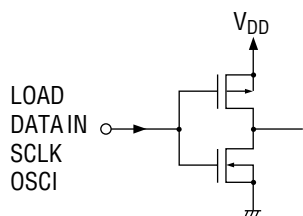


## MSC7112-01

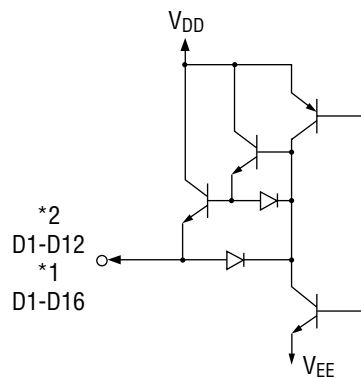
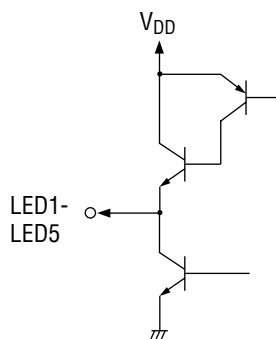
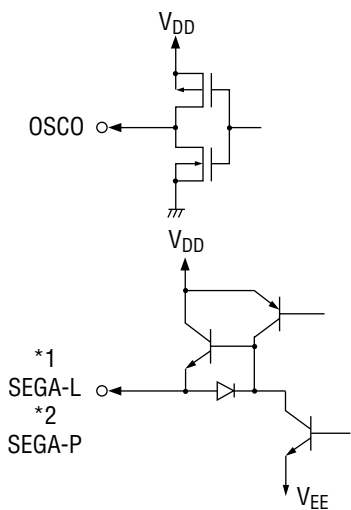


## INPUT AND OUTPUT CONFIGURATION

### Input Pin



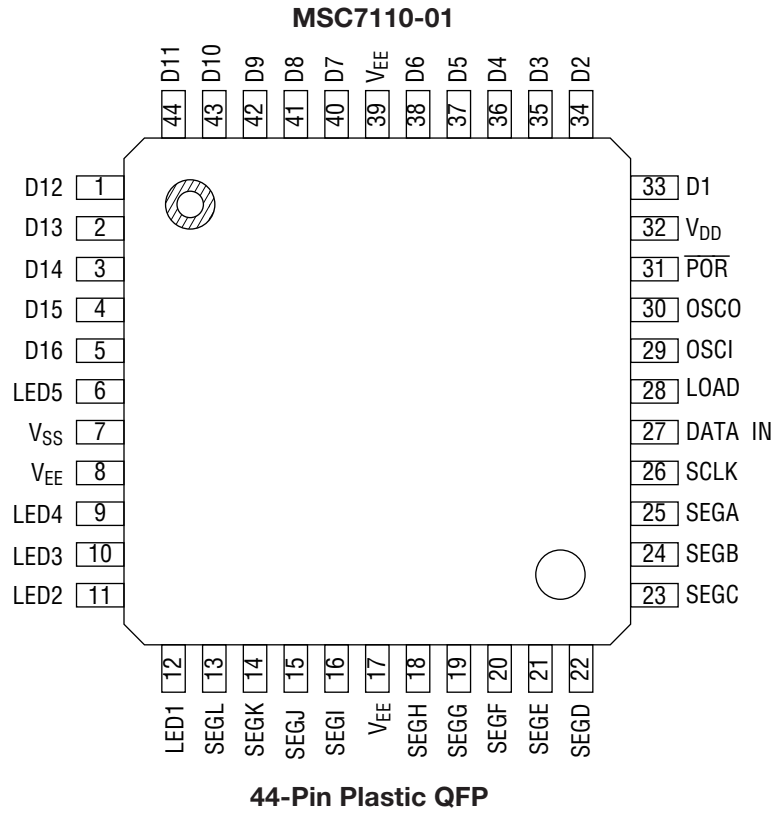
### Output Pin



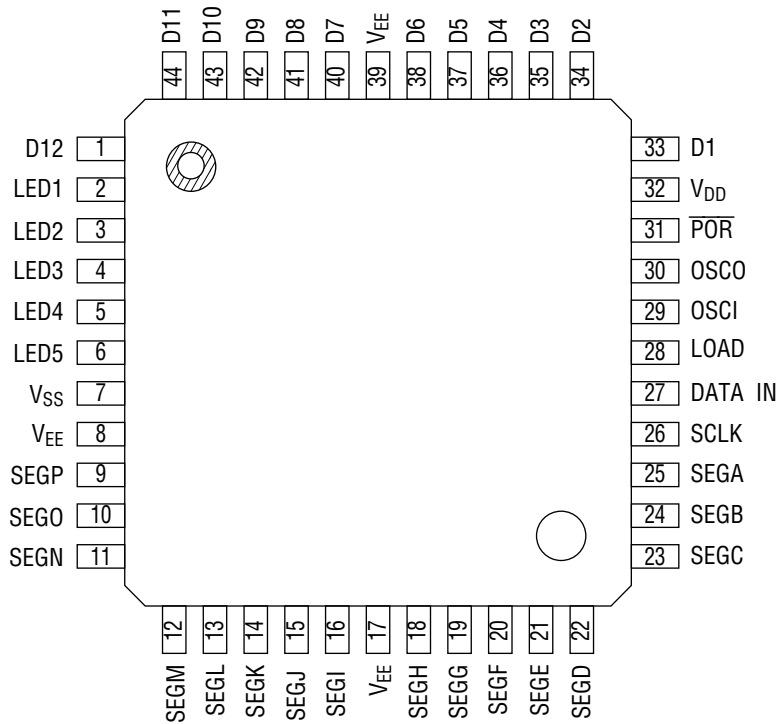
\*1 MSC7110-01

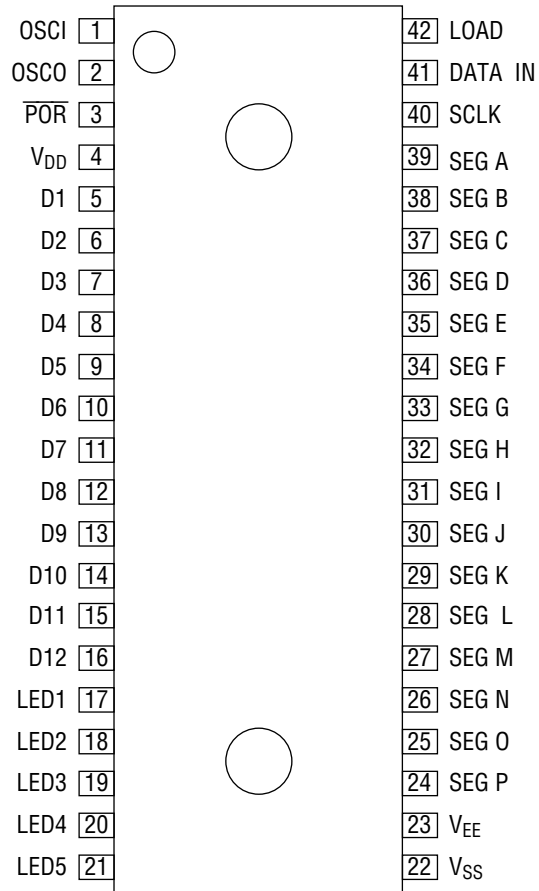
\*2 MSC7112-01

## PIN CONFIGURATION (TOP VIEW)



## MSC7112-01



**MSC7112-01****42-PIN PLASTIC SDIP**

Note: The product name actually printed on the product is "C7112-01".

## PIN DESCRIPTION

| Symbol                  | Number of Pins | Type                                               | Connected to                  | Description                                                                                                                                                                                                                                                                                                                                      |
|-------------------------|----------------|----------------------------------------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| V <sub>DD</sub>         | 1              | —                                                  | Power source                  | V <sub>DD</sub> -V <sub>SS</sub> : Supply voltage for internal logic                                                                                                                                                                                                                                                                             |
| V <sub>SS</sub>         | 1              | —                                                  |                               | V <sub>DD</sub> -V <sub>EE</sub> : Supply voltage for VF display tube driving circuit logic                                                                                                                                                                                                                                                      |
| V <sub>EE</sub>         | 1              | —                                                  |                               |                                                                                                                                                                                                                                                                                                                                                  |
| DATA IN                 | 1              | I                                                  | Microcontroller               | Input of display data of the shift register<br>Input from the MSB (positive logic).                                                                                                                                                                                                                                                              |
| SCLK                    | 1              | I                                                  |                               | Shift clock of the shift register.<br>Data is shifted at the falling edge of SCLK.                                                                                                                                                                                                                                                               |
| LOAD                    | 1              | I                                                  |                               | Latch clock input for display data.<br>When this pin is at a "H" level, the data is not latched to pass through the latch circuit.<br>When the pin is at a "L" level, the data when the pin is at the "H" level is latched.                                                                                                                      |
| $\overline{\text{POR}}$ | 1              | I<br><br>Schmitt with pull-up resistor using diode | —                             | Internal logic reset input upon power-on.<br>During reset, the 18-bit internal latch, duty cycle register, digital register, LED register, and write/read address register are all reset, and the outputs of SEGA to SEGP(*a), D1 to D12 (*b), and LED1 to LED5 go off.<br>Connecting of an external capacitor to the pin allows power-on reset. |
| OSC I                   | 1              | I                                                  | —                             | Input for oscillation circuit<br>When an external resistor and a capacitor are connected, an oscillation circuit is formed.<br>C=100pF, R=47k $\Omega$<br>f <sub>OSC</sub> =235kHz $\pm$ 20%                                                                                                                                                     |
| OSC O                   | 1              | O                                                  |                               |                                                                                                                                                                                                                                                                                                                                                  |
| SEGA-L                  | 12 *1          | O                                                  | Anode side of VF display tube | Output for driving anode electrodes of VF display tube.<br>The output is complementary.                                                                                                                                                                                                                                                          |
| SEGA-P                  | 16 *2          |                                                    |                               |                                                                                                                                                                                                                                                                                                                                                  |
| D1-D12                  | 12 2           | O                                                  | Grid side of VF display tube  | Output for driving grid electrodes of VF display tube.<br>The output is complementary.                                                                                                                                                                                                                                                           |
| D1-D16                  | 16 *1          |                                                    |                               |                                                                                                                                                                                                                                                                                                                                                  |
| LED1-LED5               | 5              | O                                                  | LED                           | LED driving output. The output is complementary.                                                                                                                                                                                                                                                                                                 |

\*a SEGA to SEGL in case of MSC7110-01

\*b D1 to D16 in case of MSC7110-01

\*1 In case of MSC7110-01

\*2 In case of MSC7112-01

## ABSOLUTE MAXIMUM RATINGS

| Parameter           | Symbol          | Condition                   | Range                | Unit             |
|---------------------|-----------------|-----------------------------|----------------------|------------------|
| Supply Voltage (1)  | $V_{DD}$        | —                           | -0.3 to +6.5         | V                |
| Supply Voltage (2)  | $V_{DD}-V_{EE}$ | —                           | 0 to 50              | V                |
| Input Voltage       | $V_I$           | —                           | -0.3 to $V_{DD}+0.3$ | V                |
| Power Dissipation   | $P_D$           | $T_a \leq 25^\circ\text{C}$ | to 500               | mW               |
| Storage Temperature | $T_{STG}$       | —                           | -55 to +150          | $^\circ\text{C}$ |
| Output Current      | $I_{O1}$        | All SEG output              | -10                  | mA               |
|                     | $I_{O2}$        | All DIGIT output            | -60                  | mA               |
|                     | $I_{O3}$        | LED1-LED5                   | -20                  | mA               |

## RECOMENDED OPERATING CONDITIONS

| Parameter             | Symbol          | Condition | Range      | Unit             |
|-----------------------|-----------------|-----------|------------|------------------|
| Supply Voltage (1)    | $V_{DD}$        | —         | 4.5 to 5.5 | V                |
| Supply Voltage (2)    | $V_{DD}-V_{EE}$ | —         | 25 to 45   | V                |
| Oscillation Frequency | $f_{OSC}$       | —         | 200 to 500 | kHz              |
| Operating Temperature | $T_{OP}$        | —         | -20 to +75 | $^\circ\text{C}$ |

## ELECTRICAL CHARACTERISTICS

## DC Characteristics

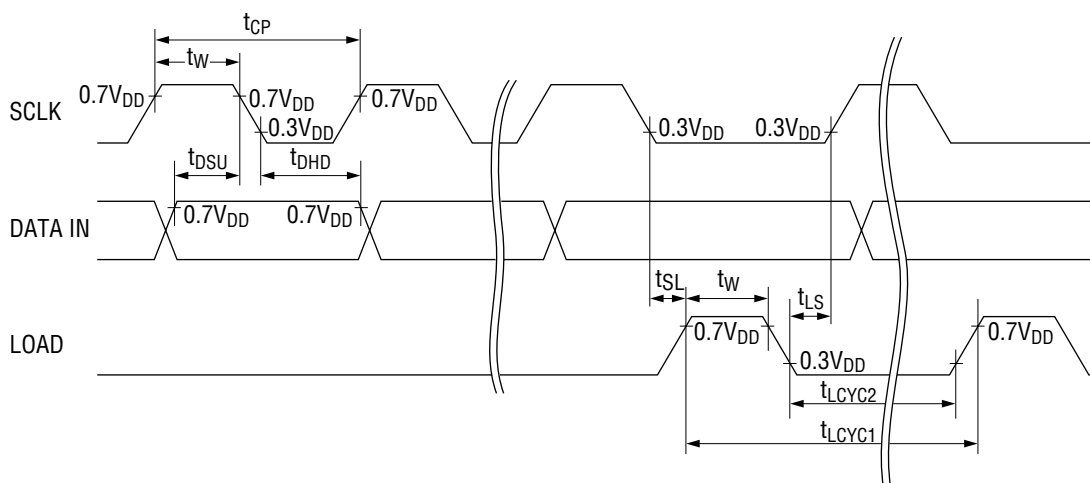
(V<sub>DD</sub>-V<sub>EE</sub>=45V, V<sub>DD</sub>=5V±10%, T<sub>a</sub>=-20 to +75°C)

| Parameter                     | Symbol    | Condition                                                  | Min.                 | Typ.                 | Max.                 | Unit | Applicable pin       |
|-------------------------------|-----------|------------------------------------------------------------|----------------------|----------------------|----------------------|------|----------------------|
| High Level Input Voltage      | $V_{IH}$  | —                                                          | 0.7V <sub>DD</sub>   | —                    | —                    | V    | All input            |
| Low Level Input Voltage       | $V_{IL}$  | —                                                          | —                    | —                    | 0.3V <sub>DD</sub>   | V    | All input            |
| High Level Input Current      | $I_{IH}$  | V <sub>DD</sub> =5.5V, V <sub>I</sub> =V <sub>DD</sub>     | —                    | —                    | 1                    | μA   | All input            |
| Low Level Input Current (1)   | $I_{IL1}$ | V <sub>DD</sub> =5.5V, V <sub>I</sub> =0V                  | —                    | —                    | -1                   | μA   | All input except POR |
| Low Level Input Current (2)   | $I_{IL2}$ | V <sub>DD</sub> =5.5V, V <sub>I</sub> =0V                  | -27                  | -55                  | -110                 | μA   | POR                  |
| High Level Output Voltage (1) | $V_{OH1}$ | V <sub>DD</sub> =4.5, I <sub>OH</sub> =-6mA                | V <sub>DD</sub> -2.2 | V <sub>DD</sub> -1.5 | —                    | V    | All SEG output       |
| Low Level Output Voltage (1)  | $V_{OL1}$ | V <sub>DD</sub> =4.5, I <sub>OL</sub> =0.2mA               | —                    | V <sub>EE</sub> +0.8 | V <sub>EE</sub> +1.3 | V    | All SEG output       |
| High Level Output Voltage (2) | $V_{OH2}$ | V <sub>DD</sub> =4.5, I <sub>OH</sub> =-30mA               | V <sub>DD</sub> -2.9 | V <sub>DD</sub> -2.3 | —                    | V    | All DIGIT output     |
| Low Level Output Voltage (2)  | $V_{OL2}$ | V <sub>DD</sub> =4.5, I <sub>OL</sub> =0.2mA               | —                    | V <sub>EE</sub> +0.8 | V <sub>EE</sub> +1.3 | V    | All DIGIT output     |
| High Level Output Voltage (3) | $V_{OH3}$ | V <sub>DD</sub> =4.5, I <sub>OH</sub> =-10mA               | V <sub>DD</sub> -1.5 | —                    | —                    | V    | LED1-LED5            |
| Low Level Output Voltage (3)  | $V_{OL3}$ | V <sub>DD</sub> =4.5, I <sub>OL</sub> =0.1mA               | —                    | —                    | 0.5                  | V    | LED1-LED5            |
| Current Consumption           | $I_{DD}$  | V <sub>DD</sub> =5.5V, No load<br>f <sub>OSC</sub> =245kHz | —                    | 8.5                  | 15                   | mA   | —                    |

## AC Characteristics

(V<sub>DD</sub>=5V±10%, T<sub>a</sub>=-20 to +75°C)

| Parameter              | Symbol             | Condition                | Min. | Typ. | Max. | Unit |
|------------------------|--------------------|--------------------------|------|------|------|------|
| SCLK Cycle Time        | t <sub>CP</sub>    | —                        | 2    | —    | —    | μs   |
| SCLK, LOAD Pulse Width | t <sub>W</sub>     | —                        | 1    | —    | —    | μs   |
| Data Setup Time        | t <sub>DSU</sub>   | —                        | 500  | —    | —    | ns   |
| Data Hold Time         | t <sub>DHD</sub>   | —                        | 500  | —    | —    | ns   |
| SCLK-LOAD Time         | t <sub>SL</sub>    | —                        | 2    | —    | —    | μs   |
| LOAD-SCLK Time         | t <sub>LS</sub>    | —                        | 2    | —    | —    | μs   |
| LOAD Cycle Time 1*     | t <sub>LCYC1</sub> | f <sub>OSC</sub> =245kHz | 205  | —    | —    | μs   |
| LOAD Cycle Time 2      | t <sub>LCYC2</sub> | f <sub>OSC</sub> =245kHz | 200  | —    | —    | μs   |

\* t<sub>LCYC1</sub>>16/f<sub>OSC</sub> must be satisfied.

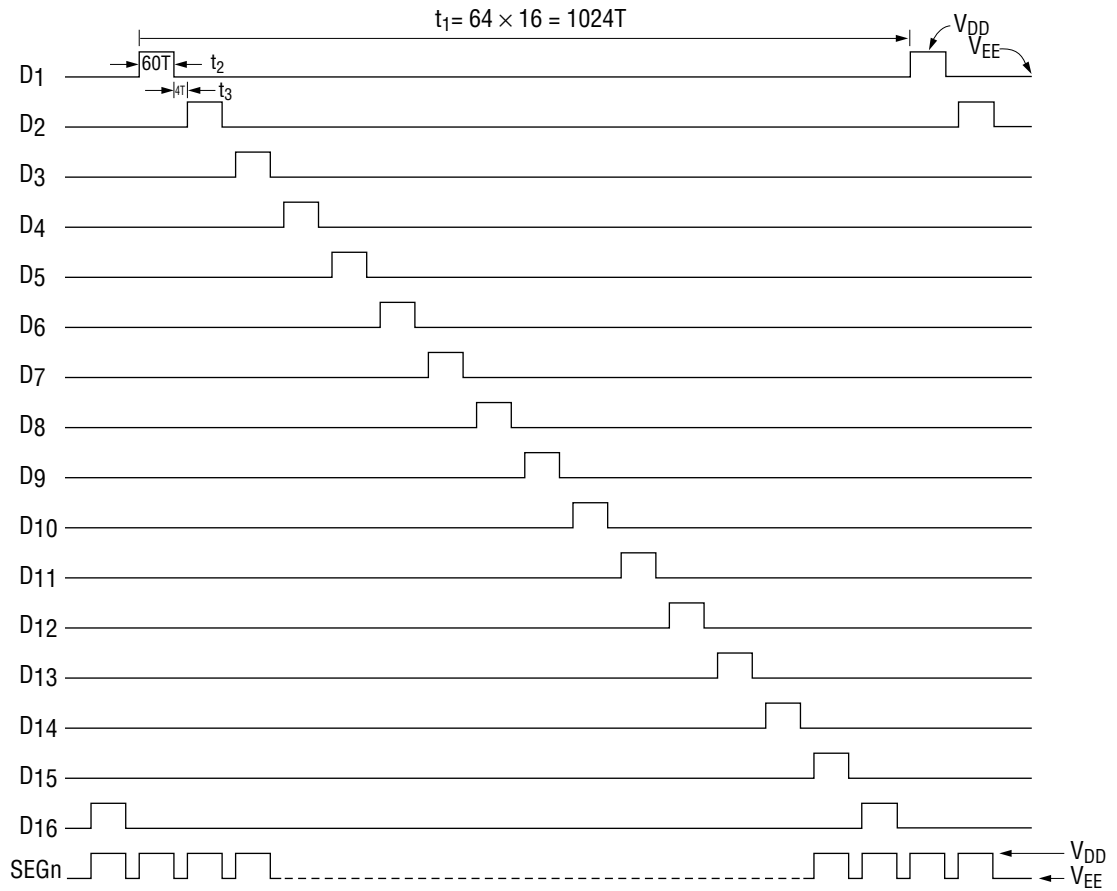
## Oscillation Characteristics

(V<sub>DD</sub>=5V, V<sub>DD</sub>-V<sub>EE</sub>=25V to 45V, T<sub>a</sub>=-20 to +75°C)

| Parameter             | Symbol           | Condition       | Min. | Typ. | Max. | Unit | Applicable pin |
|-----------------------|------------------|-----------------|------|------|------|------|----------------|
| Oscillation Frequency | f <sub>OSC</sub> | C=100pF, R=47kΩ | 188  | 235  | 282  | kHz  | OSCI, OSCO     |

## TIMING DIAGRAM

## 16-digit display



$t_1$ =Frame cycle  
 $t_2$ =Display timing  
 $t_3$ =Blank timing

$f_{OSC}=245\text{kHz}$   
 $t_1=4.096\text{ms}$   
 $t_2=240\mu\text{s}$   
 $t_3=16\mu\text{s}$   
 $T=1/f_{OSC}$

## FUNCTION DESCRIPTION

## Command Description

| Command      | Function                                                                                     | Input data             |                 |                 |                 |                 |                 |                 |                 |                |                |                |                |                |                |                |                |                |                       |
|--------------|----------------------------------------------------------------------------------------------|------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|-----------------------|
|              |                                                                                              | MSB<br>b <sub>17</sub> | b <sub>16</sub> | b <sub>15</sub> | b <sub>14</sub> | b <sub>13</sub> | b <sub>12</sub> | b <sub>11</sub> | b <sub>10</sub> | b <sub>9</sub> | b <sub>8</sub> | b <sub>7</sub> | b <sub>6</sub> | b <sub>5</sub> | b <sub>4</sub> | b <sub>3</sub> | b <sub>2</sub> | b <sub>1</sub> | LSB<br>b <sub>0</sub> |
| DATA DISPLAY | The RAM data is output directly to the SEGAs to SEGPs pins (Positive logic)                  | 0                      | 0               | *1<br>SEGP      | *1<br>SEGO      | *1<br>SEGN      | *1<br>SEGM      | SEGL            | SEKG            | SEGJ           | SEGI           | SEGH           | SEGG           | SEGF           | SEGE           | SEGD           | SEGC           | SEGB           | SEGA                  |
| L.R LOAD     | Display data is set in the LED register and output to the LED1 to LED5 pins (Positive logic) | 1                      | 0               | 0               | ×               | ×               | ×               | ×               | ×               | ×              | ×              | ×              | ×              | ×              | LED5           | LED4           | LED3           | LED2           | LED1                  |
| D.R LOAD     | The number of digits is set in the digit register.                                           | 1                      | 0               | 1               | 0               | ×               | ×               | ×               | ×               | ×              | ×              | ×              | ×              | ×              | ×              | 2 <sup>3</sup> | 2 <sup>2</sup> | 2 <sup>1</sup> | 2 <sup>0</sup>        |
| W.A.C LOAD   | The write address is set in the write address counter. (The write position is set.)          | 1                      | 1               | 0               | ×               | ×               | ×               | ×               | ×               | ×              | ×              | ×              | ×              | ×              | ×              | 2 <sup>3</sup> | 2 <sup>2</sup> | 2 <sup>1</sup> | 2 <sup>0</sup>        |
| D.C.R LOAD   | The duty value is set in the duty cycle register.                                            | 1                      | 1               | 1               | ×               | ×               | ×               | ×               | ×               | ×              | ×              | ×              | ×              | ×              | ×              | ×              | 2 <sup>3</sup> | 2 <sup>2</sup> | 2 <sup>0</sup>        |
| TEST MODE    | The TEST mode is set.                                                                        | 1                      | 0               | 1               | 1               | ×               | ×               | ×               | ×               | ×              | ×              | ×              | ×              | ×              | ×              | ×              | ×              | ×              | ×                     |

× : Don't Care

\*1: Ignored in the case of MSC7110-01.

## Relation between write address and digit output

| Write address count        | 0  | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9   | A   | B   | C         | D         | E         | F         |
|----------------------------|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----------|-----------|-----------|-----------|
| Corresponding digit output | D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 | D12 | *1<br>D13 | *1<br>D14 | *1<br>D15 | *1<br>D16 |

\*1: Ignored in the case of MSC7112-01

## Inputting Display Data

### LED display

Display data is output to the LED1 to LED5 pins in correspondence with each bit by executing the L. RLOAD command. Input data uses positive logic. When the data is 1, the LED lights. When the data is 0, the LED goes off.

### VF display (RAM direct display)

Set optional data in the digit register and the duty register, and execute the W.A.C LOAD command to set the display digit position. Execute the DATA DISPLAY command to write the b0 to b15 (\*1) display data in the RAM. The write address counter is incremented by one. The write address counter counts sequentially 0, 1, 2, -----, 14, 15, 0, 1, ----- regardless of the value of the digit register.

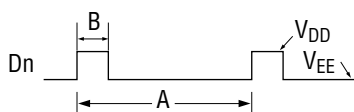
\*1 : b<sub>0</sub> to b<sub>11</sub> display data in the case of MSC7110-01.

## Brightness Adjustment

The brightness can be adjusted by using the values of the duty cycle register (D.C.R) and the digit register (D.R). The value of the duty cycle register changes the pulse width (B) at the D1 to D16 output pins, and the value of the digit register changes the cycle (A).

The table below gives the relation between the value of the duty cycle register and the duty. When all the values of the duty cycle register are 0 (in the case of 16-digit display), the display is blank.

| D.C.R          |                |                |                | DUTY    | D.C.R          |                |                |                | DUTY    | D.C.R          |                |                |                | DUTY    | D.C.R          |                |                |                | DUTY    |
|----------------|----------------|----------------|----------------|---------|----------------|----------------|----------------|----------------|---------|----------------|----------------|----------------|----------------|---------|----------------|----------------|----------------|----------------|---------|
| b <sub>3</sub> | b <sub>2</sub> | b <sub>1</sub> | b <sub>0</sub> | B/A     | b <sub>3</sub> | b <sub>2</sub> | b <sub>1</sub> | b <sub>0</sub> | B/A     | b <sub>3</sub> | b <sub>2</sub> | b <sub>1</sub> | b <sub>0</sub> | B/A     | b <sub>3</sub> | b <sub>2</sub> | b <sub>1</sub> | b <sub>0</sub> | B/A     |
| 0              | 0              | 0              | 0              | —       | 0              | 1              | 0              | 0              | 16/1024 | 1              | 0              | 0              | 0              | 32/1024 | 1              | 1              | 0              | 0              | 48/1024 |
| 0              | 0              | 0              | 1              | 4/1024  | 0              | 1              | 0              | 1              | 20/1024 | 1              | 0              | 0              | 1              | 36/1024 | 1              | 1              | 0              | 1              | 52/1024 |
| 0              | 0              | 1              | 0              | 8/1024  | 0              | 1              | 1              | 0              | 24/1024 | 1              | 0              | 1              | 0              | 40/1024 | 1              | 1              | 1              | 0              | 56/1024 |
| 0              | 0              | 1              | 1              | 12/1024 | 0              | 1              | 1              | 1              | 28/1024 | 1              | 0              | 1              | 1              | 44/1024 | 1              | 1              | 1              | 1              | 60/1024 |



$$A = 64 \times n = 64 \times 16 = 1024$$

n : Number of display digits

## Number of Display Digits

The number of display digits is set by the digit register. The number of display digits ranges from 1 to 16 (\*1). The value of the digit register and the number of digits are as follows:

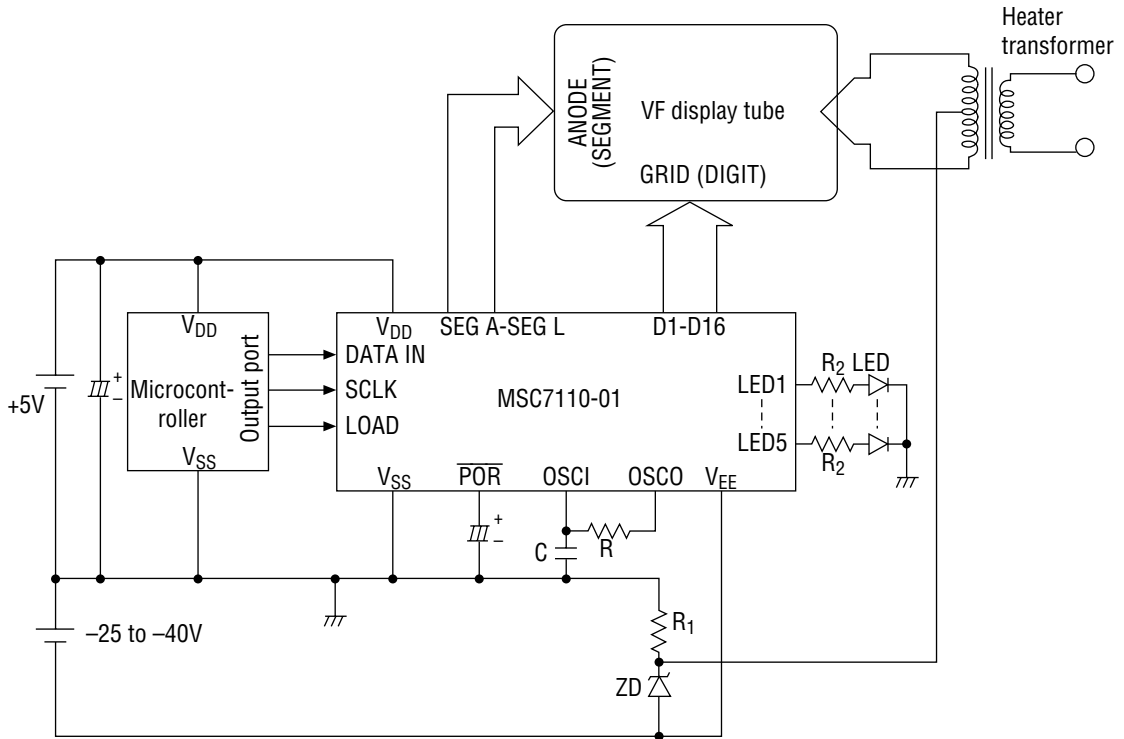
| D.R            |                |                |                | Control                 | D.R            |                |                |                | Control | D.R            |                |                |                | Control | D.R            |                |                |                | Control                 |
|----------------|----------------|----------------|----------------|-------------------------|----------------|----------------|----------------|----------------|---------|----------------|----------------|----------------|----------------|---------|----------------|----------------|----------------|----------------|-------------------------|
| b <sub>3</sub> | b <sub>2</sub> | b <sub>1</sub> | b <sub>0</sub> | digit                   | b <sub>3</sub> | b <sub>2</sub> | b <sub>1</sub> | b <sub>0</sub> | digit   | b <sub>3</sub> | b <sub>2</sub> | b <sub>1</sub> | b <sub>0</sub> | digit   | b <sub>3</sub> | b <sub>2</sub> | b <sub>1</sub> | b <sub>0</sub> | digit                   |
| 0              | 0              | 0              | 0              | <sup>*2</sup><br>D1-D16 | 0              | 1              | 0              | 0              | D1-D4   | 1              | 0              | 0              | 0              | D1-D8   | 1              | 1              | 0              | 0              | D1-D12                  |
| 0              | 0              | 0              | 1              | D1-D1                   | 0              | 1              | 0              | 1              | D1-D5   | 1              | 0              | 0              | 1              | D1-D9   | 1              | 1              | 0              | 1              | <sup>*2</sup><br>D1-D13 |
| 0              | 0              | 1              | 0              | D1-D2                   | 0              | 1              | 1              | 0              | D1-D6   | 1              | 0              | 1              | 0              | D1-D10  | 1              | 1              | 1              | 0              | <sup>*2</sup><br>D1-D14 |
| 0              | 0              | 1              | 1              | D1-D3                   | 0              | 1              | 1              | 1              | D1-D7   | 1              | 0              | 1              | 1              | D1-D11  | 1              | 1              | 1              | 1              | <sup>*2</sup><br>D1-D15 |

\*1 1 to 12 digits in the case of the MSC7112-01

\*2 Ignored in the case of the MSC7112-01

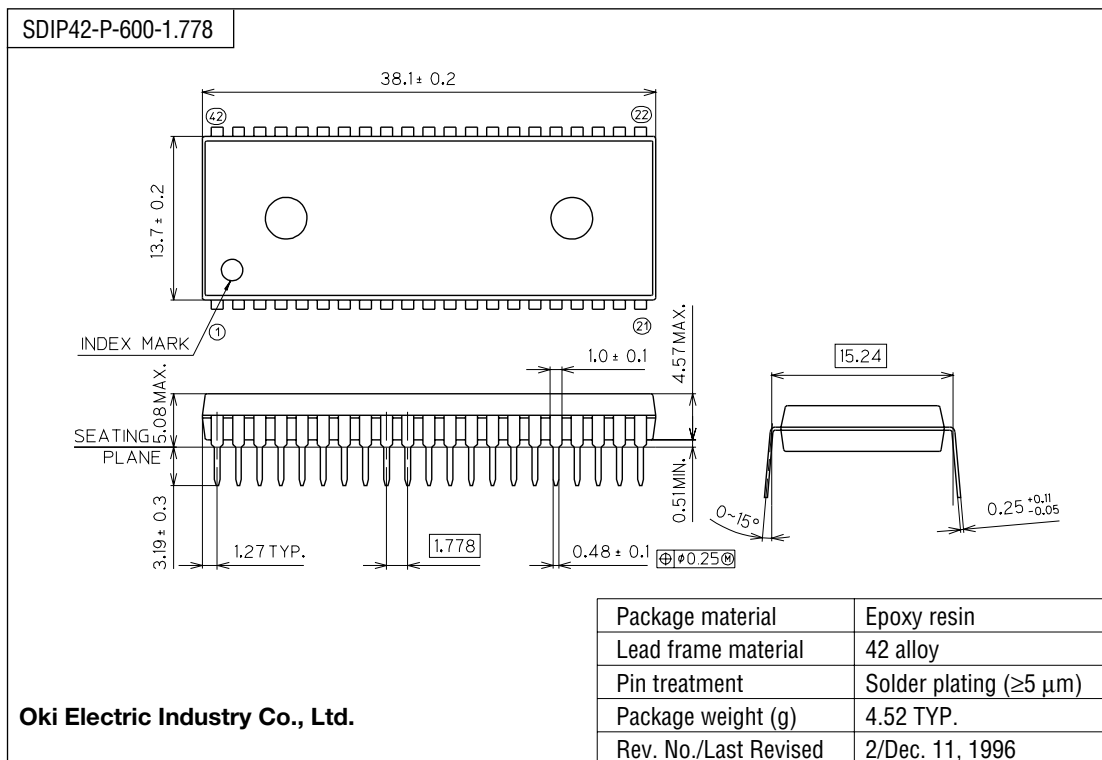
## APPLICATION CIRCUIT

## MSC7110-01



## PACKAGE DIMENSIONS

(Unit : mm)

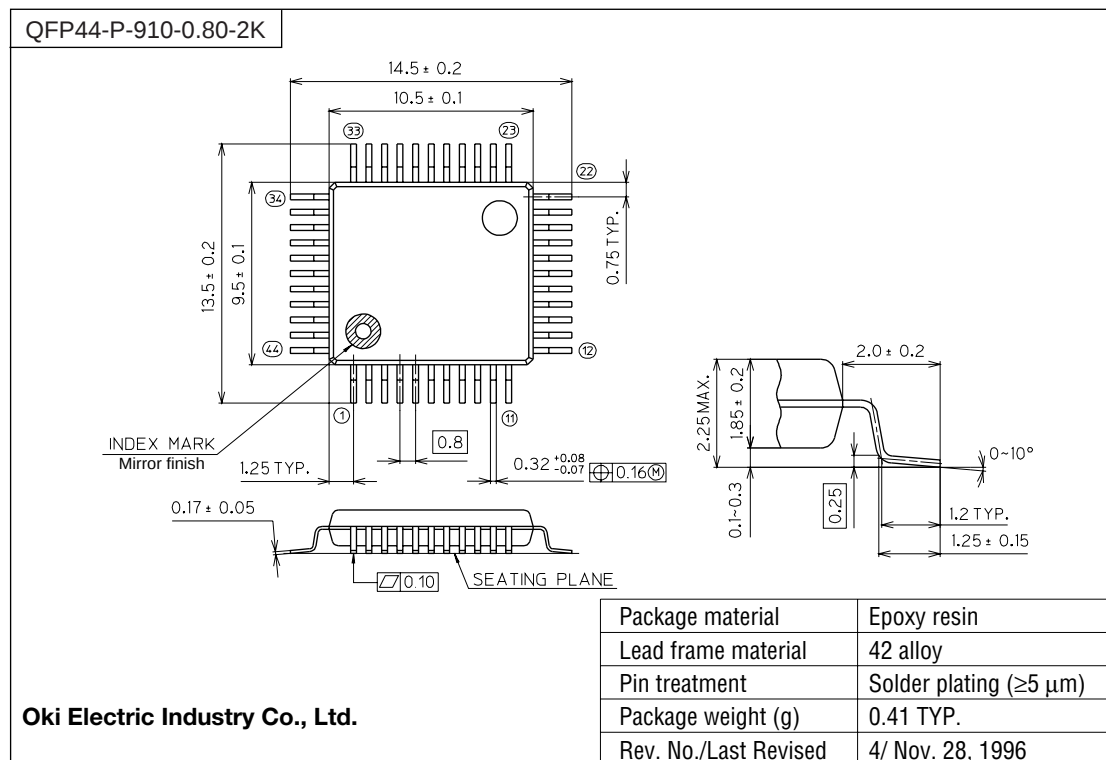


## Notes for Mounting the Surface Mount Type Package

The SOP, QFP, TSOP, SOJ, QFJ (PLCC), SHP and BGA are surface mount type packages, which are very susceptible to heat in reflow mounting and humidity absorbed in storage.

Therefore, before you perform reflow mounting, contact Oki's responsible sales person for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

(Unit : mm)



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## NOTICE

1. The information contained herein can change without notice owing to product and/or technical improvements. Before using the product, please make sure that the information being referred to is up-to-date.
2. The outline of action and examples for application circuits described herein have been chosen as an explanation for the standard action and performance of the product. When planning to use the product, please ensure that the external conditions are reflected in the actual circuit, assembly, and program designs.
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