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CMOS 4-bit  
1-chip MICROCOMPUTER

S-1340AF/13L40AF

The S-1340AF/13L40AF 4-bit microcomputer integrates 8-bit programmable timer, watch dog timer, carry output circuit, etc., on one chip. As it can be driven by batteries, this microcomputer is ideal for various compact portable equipment.

In particular, S-13L40AF, which is a low-voltage operation version of S-1340AF, is designed to be driven by one battery (1.5 V).

■ Feature

- Si gate CMOS process
- Low power consumption
- Single power supply : 1.8 V min.(for S-1340AF, 500 KHz)  
1.2 V min.(for S-13L40AF, 500 KHz)
- High-speed operation : 500 KHz max.
- ROM: 512×8 bits
- RAM: 16×4 bits
- 6 input lines and 6 output lines
- 2 timers: 8-bit programmable timer and delay timer
- Watch dog timer
- Interrupt function
- Standby function (STOP, HALT)
- Instruction execution time: 8  $\mu$  SEC /Inst min. (at 500 KHz)
- Instructions: 79 types (114 including addressing modes)  
5-level subroutine nesting
- 20-pin SOP (terminal distance: 1.27 mm)

■ Applications

- Infrared remote controller
- Compact portable equipment, others

■ Dimensions (20-pin SOP)

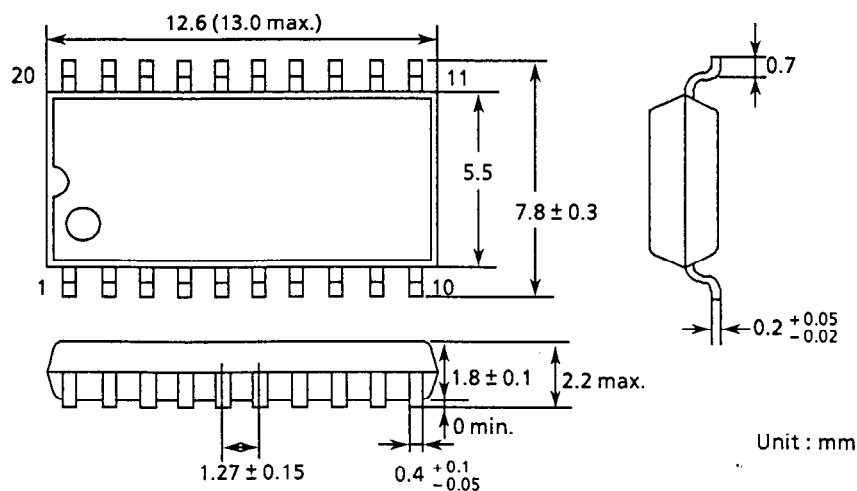


Figure 1

CMOS 4-bit 1-chip MICROCOMPUTER  
S-1340AF/13L40AF

Pin Assignments

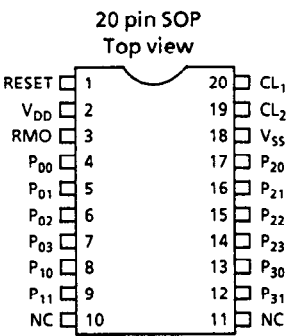


Figure 2

Terminal Functions

Table 1

| Name                               | I/O    | Functions                                                                                                                                                                      |
|------------------------------------|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| V <sub>DD</sub>                    | —      | Positive power terminal                                                                                                                                                        |
| V <sub>SS</sub>                    | —      | GND potential terminal                                                                                                                                                         |
| RESET                              | Input  | Reset input terminal (Schmitt trigger input)<br>Active level can be selected with mask option<br>· Active low: with pull-up resistor<br>· Active high: with pull-down resistor |
| CL <sub>1</sub><br>CL <sub>2</sub> | I/O    | Ceramic oscillator connection terminal                                                                                                                                         |
| RMO                                | Output | Carrier output terminal                                                                                                                                                        |
| P <sub>00</sub> to P <sub>03</sub> | Output | Output port (Nch open drain output and CMOS output can be selected with mask option)                                                                                           |
| P <sub>10</sub> to P <sub>11</sub> | Output | Output port (Nch open drain output and CMOS output can be selected with mask option)                                                                                           |
| P <sub>20</sub> to P <sub>23</sub> | Input  | Input port (pull-up resistor can be built in with mask option)                                                                                                                 |
| P <sub>30</sub> to P <sub>31</sub> | Input  | Input port (pull-up resistor can be built in with mask option)                                                                                                                 |
| N.C                                | —      | Leave open                                                                                                                                                                     |

# CMOS 4-bit 1-chip MICROCOMPUTER S-1340AF/13L40AF

## ■ Block Diagram

S-1340/13L40AF is connected by 4-bit data bus (DB), 12-bit address bus (AB), control signals, etc., and controls the memories (ROM, RAM), registers, I/O ports, logic circuits (ALU), timers, etc.

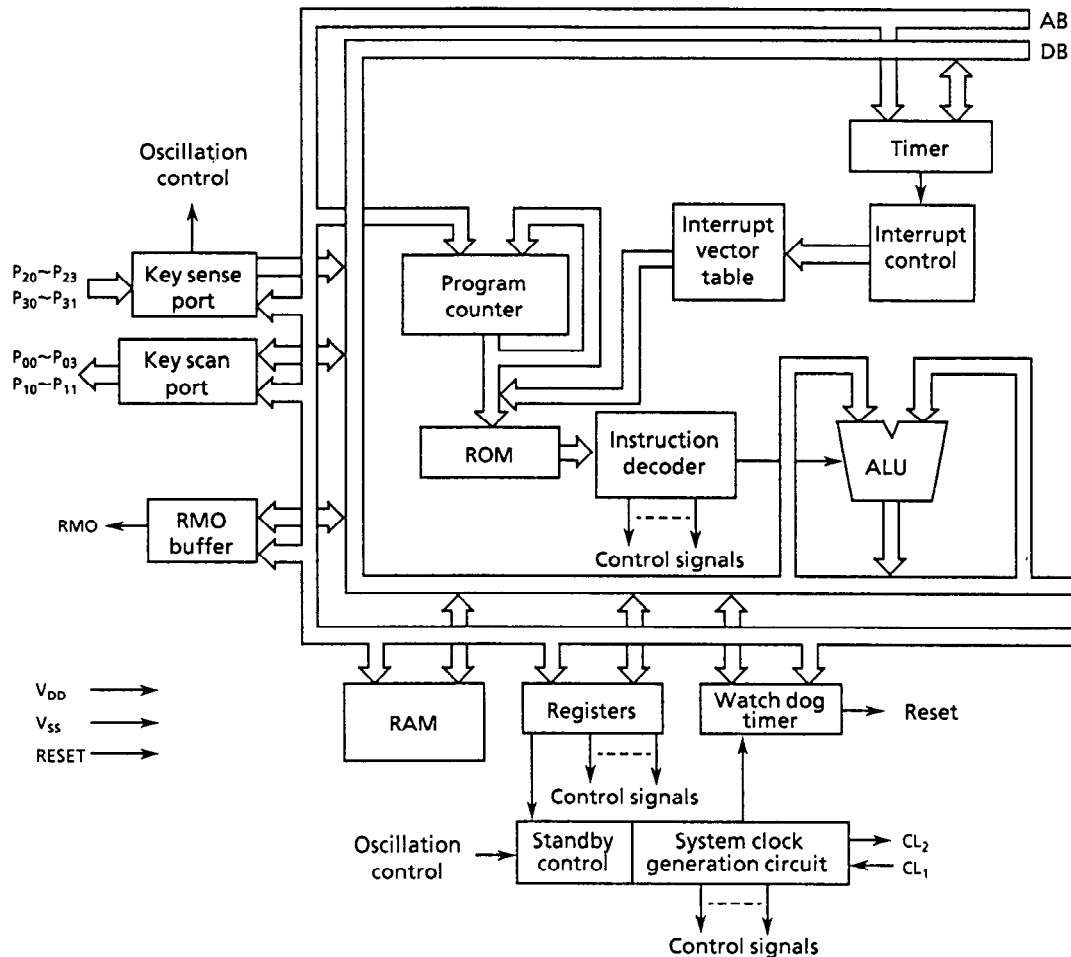


Figure 3

## ■ Absolute Maximum Ratings

Table 2

| Item                  | Symbol    | Conditions               | Rating                       | Unit |
|-----------------------|-----------|--------------------------|------------------------------|------|
| Storage temperature   | $T_{stg}$ |                          | -40 to +125                  | °C   |
| Operating temperature | $T_{opr}$ |                          | -10 to +70                   | °C   |
| Power supply voltage  | $V_{DD}$  | $T_a = 25^\circ\text{C}$ | S-1340AF: -0.3 to +7.0       | V    |
|                       |           |                          | S-13L40AF: -0.3 to +4.0      | V    |
| Input voltage         | $V_{IN}$  | $T_a = 25^\circ\text{C}$ | $V_{SS}-0.3$ to $V_{DD}+0.3$ | V    |
| Output voltage        | $V_{OUT}$ | $T_a = 25^\circ\text{C}$ | $V_{SS}$ to $V_{DD}$         | V    |
| Power dissipation     | $P_d$     | $T_a = 25^\circ\text{C}$ | 300                          | mW   |

## ■ Recommended Operating Conditions

Table 3

( $T_a = -10^\circ\text{C}$  to  $+70^\circ\text{C}$ )

| Item                   | Symbol    | Conditions                                                                    | Min. | Typ. | Max.     | Unit |
|------------------------|-----------|-------------------------------------------------------------------------------|------|------|----------|------|
| Power supply voltage   | $V_{DD}$  | System clock: 500 kHz<br>for S-1340AF                                         | 1.8  | —    | 6.0      | V    |
|                        |           | System clock: 500 kHz<br>for S-13L40AF                                        | 1.2  | —    | 3.6      | V    |
| Input voltage          | $V_{IN}$  |                                                                               | 0    | —    | $V_{DD}$ | V    |
| System clock frequency | $f_{sys}$ | $V_{DD} = 1.8$ to $6.0$ V (S-1340AF)<br>$V_{DD} = 1.2$ to $3.6$ V (S-13L40AF) | 200  | —    | 500      | KHz  |

# CMOS 4-bit 1-chip MICROCOMPUTER

## S-1340AF/13L40AF

### DC Characteristics

#### 1. S-1340AF ( $V_{DD} = 3\text{ V}$ )

Table 4

( $T_a = -10^\circ\text{C}$  to  $+70^\circ\text{C}$ ,  $V_{DD} = 3.0\text{ V}$ )

| Item                             | Symbol    | Conditions                                                              | Min.                | Typ. | Max.                | Unit          |
|----------------------------------|-----------|-------------------------------------------------------------------------|---------------------|------|---------------------|---------------|
| Operating current consumption    | $I_{CCO}$ | System clock : 455 KHz                                                  | —                   | 0.12 | 0.25                | mA            |
| Standby current consumption      | $I_{CCS}$ | At STOP mode                                                            | —                   | 0.4  | 1                   | $\mu\text{A}$ |
| High level input voltage         | $V_{IH}$  |                                                                         | $0.8 \times V_{DD}$ | —    | —                   | V             |
| Low level input voltage          | $V_{IL}$  |                                                                         | —                   | —    | $0.2 \times V_{DD}$ | V             |
| High level input leakage current | $I_{IH}$  | All input terminals<br>$V_{IN} = V_{DD}$                                | —                   | —    | 1                   | $\mu\text{A}$ |
| Low level input leakage current  | $I_{IL}$  | Without pull-up resistor,<br>$V_{IN} = V_{SS}$                          | -1                  | —    | —                   | $\mu\text{A}$ |
| High level input current         | $I_{IH}$  | RESET terminal:<br>When active high<br>$V_{IN} = V_{DD}$                | 0.6                 | 2    | 6                   | $\mu\text{A}$ |
|                                  |           | RESET terminal:<br>When active low<br>$V_{IN} = V_{DD} - 0.3\text{ V}$  | -9                  | —    | -0.9                | $\mu\text{A}$ |
| Low level input current 1        | $I_{IL1}$ | With pull-up resistor,<br>$V_{IN} = V_{SS}$                             | -90                 | -30  | -10                 | $\mu\text{A}$ |
| Low level input current 2        | $I_{IL2}$ | RESET terminal:<br>When active high<br>$V_{IN} = V_{SS} + 0.3\text{ V}$ | 0.9                 | —    | 9                   | $\mu\text{A}$ |
|                                  |           | RESET terminal:<br>When active low<br>$V_{IN} = V_{SS}$                 | -6                  | -2   | -0.6                | $\mu\text{A}$ |
| High level output current 1      | $I_{OH1}$ | RMO terminal, $V_{OUT} = 2.1\text{ V}$                                  | —                   | —    | -5.0                | mA            |
| High level output current 2      | $I_{OH2}$ | Output port, $V_{OUT} = 2.6\text{ V}$                                   | —                   | —    | -100                | $\mu\text{A}$ |
| Low level output current 1       | $I_{OL1}$ | RMO terminal, $V_{OUT} = 0.4\text{ V}$                                  | 250                 | —    | —                   | $\mu\text{A}$ |
| Low level output current 2       | $I_{OL2}$ | Output port, $V_{OUT} = 0.4\text{ V}$                                   | 1.0                 | —    | —                   | mA            |
| Schmitt hysteresis width         | $V_{WD}$  |                                                                         | —                   | 0.7  | —                   | V             |

#### 2. S-1340AF ( $V_{DD} = 5\text{ V}$ )

Table 5

( $T_a = -10^\circ\text{C}$  to  $+70^\circ\text{C}$ ,  $V_{DD} = 5\text{ V}$ )

| Item                             | Symbol    | Conditions                                                              | Min.                | Typ. | Max.                | Unit          |
|----------------------------------|-----------|-------------------------------------------------------------------------|---------------------|------|---------------------|---------------|
| Operating current consumption    | $I_{CCO}$ | System clock : 455 KHz                                                  | —                   | 0.4  | 0.7                 | mA            |
| Standby current consumption      | $I_{CCS}$ | At STOP mode                                                            | —                   | 0.5  | 5                   | $\mu\text{A}$ |
| High level input voltage         | $V_{IH}$  |                                                                         | $0.8 \times V_{DD}$ | —    | —                   | V             |
| Low level input voltage          | $V_{IL}$  |                                                                         | —                   | —    | $0.2 \times V_{DD}$ | V             |
| High level input leakage current | $I_{IH}$  | All input terminals<br>$V_{IN} = V_{DD}$                                | —                   | —    | 1                   | $\mu\text{A}$ |
| Low level input leakage current  | $I_{IL}$  | Without pull-up resistor,<br>$V_{IN} = V_{SS}$                          | -1                  | —    | —                   | $\mu\text{A}$ |
| High level input current         | $I_{IH}$  | RESET terminal:<br>When active high<br>$V_{IN} = V_{DD}$                | 2                   | 7    | 20                  | $\mu\text{A}$ |
|                                  |           | RESET terminal:<br>When active low<br>$V_{IN} = V_{DD} - 0.3\text{ V}$  | -13.5               | —    | -1.5                | $\mu\text{A}$ |
| Low level input current 1        | $I_{IL1}$ | With pull-up resistor,<br>$V_{IN} = V_{SS}$                             | -270                | -90  | -30                 | $\mu\text{A}$ |
| Low level input current 2        | $I_{IL2}$ | RESET terminal:<br>When active high<br>$V_{IN} = V_{SS} + 0.3\text{ V}$ | 1.5                 | —    | 15                  | $\mu\text{A}$ |
|                                  |           | RESET terminal:<br>When active low<br>$V_{IN} = V_{SS}$                 | -20                 | -6.5 | -2                  | $\mu\text{A}$ |
| High level output current 1      | $I_{OH1}$ | RMO terminal, $V_{OUT} = 4.1\text{ V}$                                  | —                   | —    | -8.0                | mA            |
| High level output current 2      | $I_{OH2}$ | Output port, $V_{OUT} = 4.6\text{ V}$                                   | —                   | —    | -250                | $\mu\text{A}$ |
| Low level output current 1       | $I_{OL1}$ | RMO terminal, $V_{OUT} = 0.4\text{ V}$                                  | 500                 | —    | —                   | $\mu\text{A}$ |
| Low level output current 2       | $I_{OL2}$ | Output port, $V_{OUT} = 0.4\text{ V}$                                   | 2.0                 | —    | —                   | mA            |
| Schmitt hysteresis width         | $V_{WD}$  |                                                                         | —                   | 1.6  | —                   | V             |

# CMOS 4-bit 1-chip MICROCOMPUTER S-1340AF/13L40AF

## 3. S-13L40AF ( $V_{DD} = 1.5V$ )

Table 6

( $T_a = -10^\circ C$  to  $+70^\circ C$ ,  $V_{DD} = 1.5 V$ )

| Item                             | Symbol    | Conditions                                                       | Min.                | Typ. | Max.                | Unit    |
|----------------------------------|-----------|------------------------------------------------------------------|---------------------|------|---------------------|---------|
| Operating current consumption    | $I_{CCO}$ | System clock : 455 KHz                                           | —                   | 0.05 | 0.1                 | mA      |
| Standby current consumption      | $I_{CCS}$ | At STOP mode                                                     | —                   | 0.5  | 10.0                | $\mu A$ |
| High level input voltage         | $V_{IH}$  |                                                                  | $0.8 \times V_{DD}$ | —    | —                   | V       |
| Low level input voltage          | $V_{IL}$  |                                                                  | —                   | —    | $0.2 \times V_{DD}$ | V       |
| High level input leakage current | $I_{IH}$  | All input terminals<br>$V_{IN} = V_{DD}$                         | —                   | —    | 1                   | $\mu A$ |
| Low level input leakage current  | $I_{IL}$  | Without pull-up resistor,<br>$V_{IN} = V_{SS}$                   | -1                  | —    | —                   | $\mu A$ |
| High level input current         | $I_{IH}$  | RESET terminal:<br>When active high<br>$V_{IN} = V_{DD}$         | 0.6                 | 2    | 6                   | $\mu A$ |
|                                  |           | RESET terminal:<br>When active low<br>$V_{IN} = V_{DD} - 0.3 V$  | -9                  | —    | -0.9                | $\mu A$ |
| Low level input current 1        | $I_{IL1}$ | With pull-up resistor,<br>$V_{IN} = V_{SS}$                      | -90                 | -30  | -10                 | $\mu A$ |
| Low level input current 2        | $I_{IL2}$ | RESET terminal:<br>When active high<br>$V_{IN} = V_{SS} + 0.3 V$ | 0.9                 | —    | 9                   | $\mu A$ |
|                                  |           | RESET terminal:<br>When active low<br>$V_{IN} = V_{SS}$          | -6                  | -2   | -0.6                | $\mu A$ |
| High level output current 1      | $I_{OH1}$ | RMO terminal, $V_{OUT} = 1.1 V$                                  | —                   | —    | -2.0                | mA      |
| High level output current 2      | $I_{OH2}$ | Output port, $V_{OUT} = 1.1 V$                                   | —                   | —    | -100                | $\mu A$ |
| Low level output current 1       | $I_{OL1}$ | RMO terminal, $V_{OUT} = 0.4 V$                                  | 200                 | —    | —                   | $\mu A$ |
| Low level output current 2       | $I_{OL2}$ | Output port, $V_{OUT} = 0.4 V$                                   | 1.0                 | —    | —                   | mA      |
| Schmitt hysteresis width         | $V_{WD}$  |                                                                  | —                   | 0.2  | —                   | V       |

## 4. S-13L40AF ( $V_{DD} = 3V$ )

Table 7

( $T_a = -10^\circ C$  to  $+70^\circ C$ ,  $V_{DD} = 3.0 V$ )

| Item                             | Symbol    | Conditions                                                       | Min.                | Typ.  | Max.                | Unit    |
|----------------------------------|-----------|------------------------------------------------------------------|---------------------|-------|---------------------|---------|
| Operating current consumption    | $I_{CCO}$ | System clock : 455 KHz                                           | —                   | 0.2   | 0.4                 | mA      |
| Standby current consumption      | $I_{CCS}$ | At STOP mode                                                     | —                   | 0.5   | 10.0                | $\mu A$ |
| High level input voltage         | $V_{IH}$  |                                                                  | $0.8 \times V_{DD}$ | —     | —                   | V       |
| Low level input voltage          | $V_{IL}$  |                                                                  | —                   | —     | $0.2 \times V_{DD}$ | V       |
| High level input leakage current | $I_{IH}$  | All input terminals<br>$V_{IN} = V_{DD}$                         | —                   | —     | 1                   | $\mu A$ |
| Low level input leakage current  | $I_{IL}$  | Without pull-up resistor,<br>$V_{IN} = V_{SS}$                   | -1                  | —     | —                   | $\mu A$ |
| High level input current         | $I_{IH}$  | RESET terminal:<br>When active high<br>$V_{IN} = V_{DD}$         | 4                   | 12    | 36                  | $\mu A$ |
|                                  |           | RESET terminal:<br>When active low<br>$V_{IN} = V_{DD} - 0.3 V$  | -20                 | —     | -2.5                | $\mu A$ |
| Low level input current 1        | $I_{IL1}$ | With pull-up resistor,<br>$V_{IN} = V_{SS}$                      | -500                | -170  | -60                 | $\mu A$ |
| Low level input current 2        | $I_{IL2}$ | RESET terminal:<br>When active high<br>$V_{IN} = V_{SS} + 0.3 V$ | 2.5                 | —     | 20                  | $\mu A$ |
|                                  |           | RESET terminal:<br>When active low<br>$V_{IN} = V_{SS}$          | -35                 | -12.5 | -4                  | $\mu A$ |
| High level output current 1      | $I_{OH1}$ | RMO terminal, $V_{OUT} = 2.6 V$                                  | —                   | —     | -4.0                | mA      |
| High level output current 2      | $I_{OH2}$ | Output port, $V_{OUT} = 2.6 V$                                   | —                   | —     | -250                | $\mu A$ |
| Low level output current 1       | $I_{OL1}$ | RMO terminal, $V_{OUT} = 0.4 V$                                  | 400                 | —     | —                   | $\mu A$ |
| Low level output current 2       | $I_{OL2}$ | Output port, $V_{OUT} = 0.4 V$                                   | 2.0                 | —     | —                   | mA      |
| Schmitt hysteresis width         | $V_{WD}$  |                                                                  | —                   | 0.7   | —                   | V       |

# CMOS 4-bit 1-chip MICROCOMPUTER S-1340AF/13L40AF

## ■ Instructions

### 1. 1-byte and 2-byte instructions

Byte 1 is called "op code", which indicates kinds of instruction.

Byte 2 is called "operand", which indicates objects of instruction.

### 2. Ten types of addressing modes

1) Absolute addressing mode: ABS

2) Relative addressing mode: REL

3) Zero page addressing mode: (ZPG)

4) Register indirect addressing mode: (X)

5) Post-increment register indirect addressing mode: (X + )

6) Pre-decrement register indirect addressing mode: (-X)

7) Register addressing mode: REG

8) 4-bit immediate addressing mode: IMM4

9) 8-bit immediate addressing mode: IMM8

10) Implied addressing mode: IMP

### 3. Number of instructions

Table 8

|                                  | Basic | Including addressing modes |
|----------------------------------|-------|----------------------------|
| Transfer instruction             | 13    | 27                         |
| Arithmetic operation instruction | 34    | 47                         |
| Logical operation instruction    | 7     | 13                         |
| Branch instruction               | 21    | 21                         |
| Shift instruction                | 2     | 4                          |
| CPU control instruction          | 2     | 2                          |
| Total                            | 79    | 114                        |

## ■ Application Example (S-1340AF)

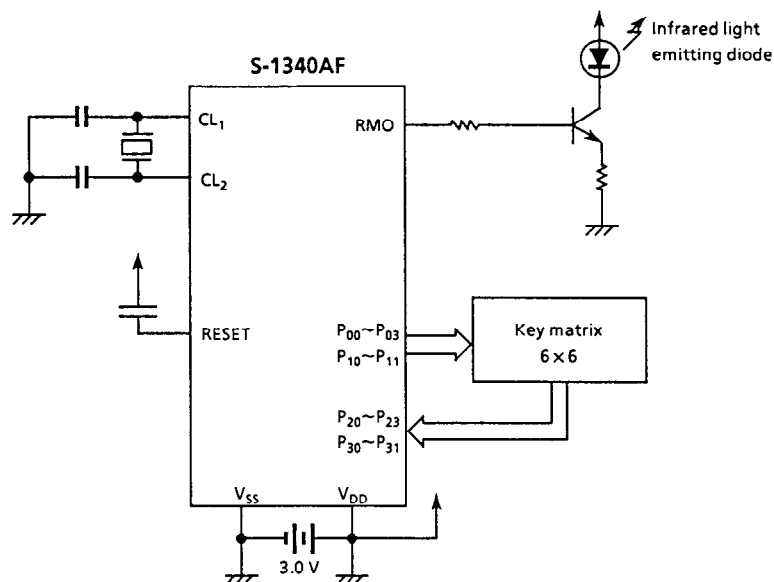


Figure 4