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The S-1460BF/14L60BF is a CMOS 4-bit microcomputer, which integrates ROM, RAM, a timer and I/O ports on a single chip. Since the S-1460BF/14L60BF has a 4K×16-bit ROM, a special terminal for remote control signal output and key-on wake-up functions, it is ideal for infrared remote controller.

Due to its low operating voltage range (1.2V to 3.6V), the S-14L60BF is suitable for single-battery powered devices.

## ■ Features

### *Characteristics*

- Power supply voltage : 2.2 to 6.0 V (S-1460BF)  
1.2 to 3.6 V (S-14L60BF)
- Current consumption
  - S-1460BF : Running : 0.7 mA max. at 1MHz, 3 V operation  
Standby : 0.1  $\mu$ A typ., 2.0  $\mu$ A max.
  - S-14L60BF : Running : 0.3 mA max. at 1MHz, 1.5 V operation  
Standby : 10  $\mu$ A max.

- Operating frequency : 1 MHz
- Instruction execution time : 4.0  $\mu$ s at 1 MHz oscillation

### *Hardware functions*

- ROM : 4K×16 bits
- RAM : 128×4 bits
- Port : 8-bit input, 8-bit output, 4-bit I/O
- Remote control signal output
- Standby counter
- Timer / Counter : 10-bit counter, 8-bit timer
- Watchdog timer
- Key-on wake-up
- Interrupt function: Internal (two)
- Oscillation circuit : Ceramic oscillator is built in
- Standby status : Stops oscillation, holds internal status
- Internal low-voltage detector (only for the S-1460BF)

### *Software*

- Instruction: 35 basic instruction sets (166 if addressing modes are included)
- 16-level subroutine nesting

### *Package*

- 28-pin SOP

### *OTP version*

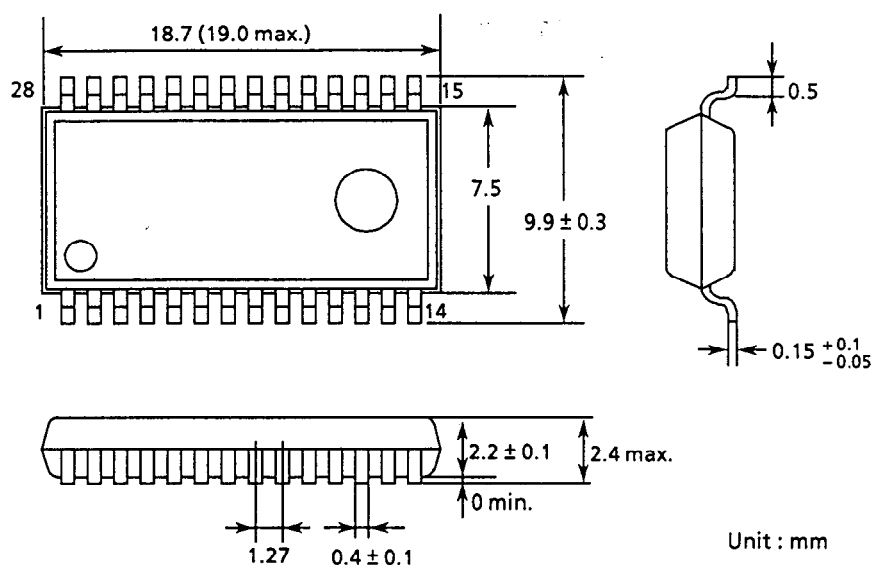
- S-1460BF : S-14P60AF
- S-14L60BF : For software evaluation, use the S-14P60AF

## ■ Applications

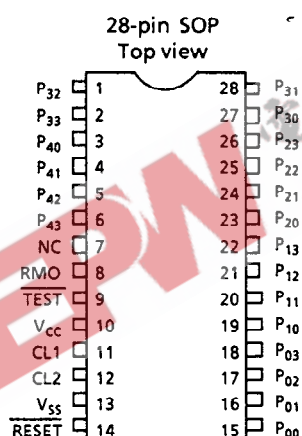
- Remote controller
- Other small-sized control equipment

# CMOS 4-bit 1-chip MICROCOMPUTER S-1460BF/14L60BF

## ■ Dimensions (28-pin SOP)



## ■ Pin Assignment

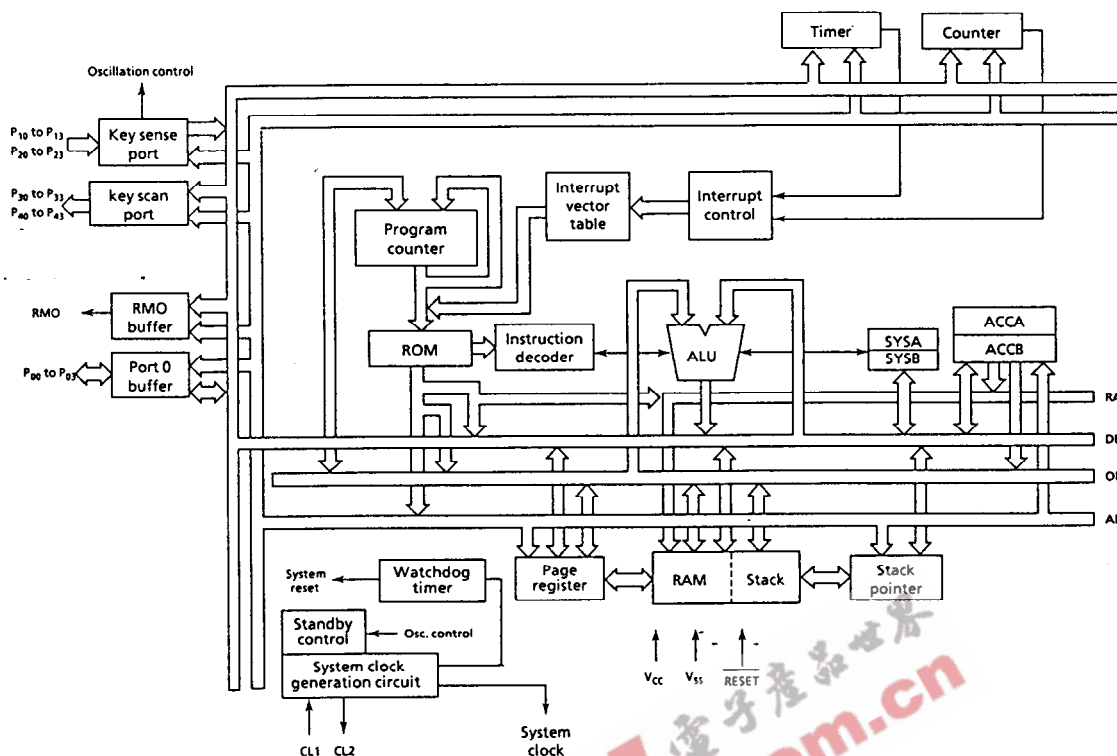


## ■ Terminal Functions

| Name                                                                     | I/O    | Functions                                                                                                                                                     |
|--------------------------------------------------------------------------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| V <sub>CC</sub>                                                          | —      | Positive power supply                                                                                                                                         |
| V <sub>SS</sub>                                                          | —      | GND potential terminal                                                                                                                                        |
| CL1                                                                      | Input  | Oscillation circuit input terminal                                                                                                                            |
| CL2                                                                      | Output | Oscillation circuit output terminal                                                                                                                           |
| RESET                                                                    | Input  | Reset input terminal (pull-up resistor is built in)                                                                                                           |
| TEST                                                                     | Input  | Test input terminal (pull-up resistor is built in)                                                                                                            |
| RMO                                                                      | Output | Remote control signal output terminal                                                                                                                         |
| P <sub>00</sub> to P <sub>03</sub>                                       | I/O    | I/O ports, selectable in bit unit.<br>Built-in pull-up resistor and Nch opendrain output are available in mask option.                                        |
| P <sub>10</sub> to P <sub>13</sub><br>P <sub>20</sub> to P <sub>23</sub> | Input  | Input ports, also used as sense input of key matrix.<br>Standby status is released by inputting low level in standby status.<br>Pull-up resistor is built in. |
| P <sub>30</sub> to P <sub>33</sub><br>P <sub>40</sub> to P <sub>43</sub> | Output | Output ports, also used as scan output of key matrix.<br>Nch opendrain output is also available in mask option.                                               |

## ■ Block Diagram

The S-1460BF/14L60BF blocks connect with a 4-bit data bus(DB), 4-bit address bus(AB), 4-bit RAM address bus(RA) and 12-bit operation bus(OB).



## ■ Absolute Maximum Ratings

| Parameter             | Symbol    | Conditions                            | Ratings                          | Unit |
|-----------------------|-----------|---------------------------------------|----------------------------------|------|
| Storage temperature   | $T_{stg}$ |                                       | -40 to +125                      | °C   |
| Operating temperature | $T_{opr}$ |                                       | -10 to +70                       | °C   |
| Power supply voltage  | $V_{CC}$  | $T_a = 25^\circ\text{C}$<br>S-1460BF  | -0.3 to +7.0                     | V    |
| Power supply voltage  | $V_{CC}$  | $T_a = 25^\circ\text{C}$<br>S-14L60BF | -0.3 to +4.0                     | V    |
| Input voltage         | $V_{IN}$  | $T_a = 25^\circ\text{C}$              | $V_{SS} - 0.3$ to $V_{CC} + 0.3$ | V    |
| Output voltage        | $V_{OUT}$ | $T_a = 25^\circ\text{C}$              | $V_{SS}$ to $V_{CC}$             | V    |
| Power dissipation     | $P_D$     | $T_a = 25^\circ\text{C}$              | 300                              | mW   |

## ■ Recommended Operating Conditions

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

| Parameter              | Symbol    | Conditions                                                                                  | Min. | Typ. | Max.     | Unit |
|------------------------|-----------|---------------------------------------------------------------------------------------------|------|------|----------|------|
| Power supply voltage   | $V_{CC}$  | $f_{osc} = 1\text{ MHz}$<br>S-1460BF                                                        | 2.2  | —    | 6.0      | V    |
| Power supply voltage   | $V_{CC}$  | $f_{osc} = 1\text{ MHz}$<br>S-14L60BF                                                       | 1.2  | —    | 3.6      | V    |
| Input voltage          | $V_{IN}$  |                                                                                             | 0    | —    | $V_{CC}$ | V    |
| System clock frequency | $f_{osc}$ | $V_{CC} = 2.2$ to $6.0\text{ V}$ (S-1460BF)<br>$V_{CC} = 1.2$ to $3.6\text{ V}$ (S-14L60BF) | 0.2  | —    | 1.0      | MHz  |

# CMOS 4-bit 1-chip MICROCOMPUTER

## S-1460BF/14L60BF

### DC Electrical Characteristics

#### 1. S-1460BF

- $V_{CC} = 3\text{ V}$

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

| Parameter                        | Symbol    | Conditions(applicable terminals)                                                                                 | Min.                | Typ. | Max.                | Unit          |
|----------------------------------|-----------|------------------------------------------------------------------------------------------------------------------|---------------------|------|---------------------|---------------|
| Operating current consumption    | $I_{CCO}$ | $f_{OSC} = 1\text{ MHz}$ , no load                                                                               | —                   | 0.25 | 0.7                 | mA            |
| Standby current consumption      | $I_{CCS}$ | OFF mode (When low voltage detection is used)                                                                    | —                   | 0.5  | 2.0                 | $\mu\text{A}$ |
| Standby current consumption      | $I_{CCS}$ | OFF mode (When low voltage detection is not used)                                                                | —                   | 0.1  | 2.0                 | $\mu\text{A}$ |
| High level input voltage         | $V_{IH}$  |                                                                                                                  | $0.8 \times V_{CC}$ | —    | —                   | V             |
| Low level input voltage          | $V_{IL}$  |                                                                                                                  | —                   | —    | $0.2 \times V_{CC}$ | V             |
| High level input leakage current | $I_{LH}$  | All input pins*<br>$V_{IN} = V_{CC}$                                                                             | —                   | —    | 1                   | $\mu\text{A}$ |
| Low level input leakage current  | $I_{LL}$  | Without pull-up resistor<br>$P_{00}$ to $P_{03}$ , $V_{IN} = V_{SS}$                                             | -1                  | —    | —                   | $\mu\text{A}$ |
| High level input current         | $I_{IH}$  | RESET, $V_{IN} = V_{CC} - 0.3\text{V}$                                                                           | -9                  | —    | -0.9                | $\mu\text{A}$ |
| Low level input current 1        | $I_{IL1}$ | With pull-up resistor, $P_{00}$ to $P_{03}$ ,<br>$P_{10}$ to $P_{13}$ , $P_{20}$ to $P_{23}$ , $V_{IN} = V_{SS}$ | -90                 | -30  | -10                 | $\mu\text{A}$ |
| Low level input current 2        | $I_{IL2}$ | RESET, $V_{IN} = V_{SS}$                                                                                         | -6                  | -2   | -0.6                | $\mu\text{A}$ |
| Low level input current 3        | $I_{IL3}$ | TEST, $V_{IN} = V_{SS}$                                                                                          | -30                 | -10  | -3                  | $\mu\text{A}$ |
| High level output current 1      | $I_{OH1}$ | RMO, $V_{OUT} = 2.1\text{ V}$                                                                                    | —                   | —    | -5.0                | mA            |
| High level output current 2      | $I_{OH2}$ | $P_{00}$ to $P_{03}$ , $P_{30}$ to $P_{33}$ , $P_{40}$ to $P_{43}$ ,<br>$V_{OUT} = 2.6\text{ V}$                 | —                   | —    | -100                | $\mu\text{A}$ |
| Low level output current 1       | $I_{OL1}$ | RMO, $V_{OUT} = 0.4\text{ V}$                                                                                    | 250                 | —    | —                   | $\mu\text{A}$ |
| Low level output current 2       | $I_{OL2}$ | $P_{00}$ to $P_{03}$ , $P_{30}$ to $P_{33}$ , $P_{40}$ to $P_{43}$ ,<br>$V_{OUT} = 0.4\text{ V}$                 | 1.0                 | —    | —                   | mA            |
| Schmitt hysteresis width         | $V_{WD}$  |                                                                                                                  | —                   | 1.0  | —                   | V             |

\* TEST, RESET,  $P_{00}$  to  $P_{03}$ ,  $P_{10}$  to  $P_{13}$ ,  $P_{20}$  to  $P_{23}$

- $V_{CC} = 5\text{ V}$

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

| Parameter                        | Symbol    | Conditions(applicable terminals)                                                                                 | Min.                | Typ. | Max.                | Unit          |
|----------------------------------|-----------|------------------------------------------------------------------------------------------------------------------|---------------------|------|---------------------|---------------|
| Operating current consumption    | $I_{CCO}$ | $f_{OSC} = 1\text{ MHz}$ , no load                                                                               | —                   | 0.6  | 1.2                 | mA            |
| Standby current consumption      | $I_{CCS}$ | OFF mode                                                                                                         | —                   | 0.1  | 5.0                 | $\mu\text{A}$ |
| High level input voltage         | $V_{IH}$  |                                                                                                                  | $0.8 \times V_{CC}$ | —    | —                   | V             |
| Low level input voltage          | $V_{IL}$  |                                                                                                                  | —                   | —    | $0.2 \times V_{CC}$ | V             |
| High level input leakage current | $I_{LH}$  | All input pins*<br>$V_{IN} = V_{CC}$                                                                             | —                   | —    | 1                   | $\mu\text{A}$ |
| Low level input leakage current  | $I_{LL}$  | Without pull-up resistor<br>$P_{00}$ to $P_{03}$ , $V_{IN} = V_{SS}$                                             | -1                  | —    | —                   | $\mu\text{A}$ |
| High level input current         | $I_{IH}$  | RESET, $V_{IN} = V_{CC} - 0.3\text{V}$                                                                           | -15                 | —    | -1.5                | $\mu\text{A}$ |
| Low level input current 1        | $I_{IL1}$ | With pull-up resistor, $P_{00}$ to $P_{03}$ ,<br>$P_{10}$ to $P_{13}$ , $P_{20}$ to $P_{23}$ , $V_{IN} = V_{SS}$ | -230                | -90  | -30                 | $\mu\text{A}$ |
| Low level input current 2        | $I_{IL2}$ | RESET, $V_{IN} = V_{SS}$                                                                                         | -15                 | -6   | -2.4                | $\mu\text{A}$ |
| Low level input current 3        | $I_{IL3}$ | TEST, $V_{IN} = V_{SS}$                                                                                          | -75                 | -30  | -12                 | $\mu\text{A}$ |
| High level output current 1      | $I_{OH1}$ | RMO, $V_{OUT} = 4.1\text{ V}$                                                                                    | —                   | —    | -7                  | mA            |
| High level output current 2      | $I_{OH2}$ | $P_{00}$ to $P_{03}$ , $P_{30}$ to $P_{33}$ , $P_{40}$ to $P_{43}$ ,<br>$V_{OUT} = 4.6\text{ V}$                 | —                   | —    | -250                | $\mu\text{A}$ |
| Low level output current 1       | $I_{OL1}$ | RMO, $V_{OUT} = 0.4\text{ V}$                                                                                    | 450                 | —    | —                   | $\mu\text{A}$ |
| Low level output current 2       | $I_{OL2}$ | $P_{00}$ to $P_{03}$ , $P_{30}$ to $P_{33}$ , $P_{40}$ to $P_{43}$ ,<br>$V_{OUT} = 0.4\text{ V}$                 | 1.5                 | —    | —                   | mA            |
| Schmitt hysteresis width         | $V_{WD}$  |                                                                                                                  | —                   | 2.2  | —                   | V             |

\* TEST, RESET,  $P_{00}$  to  $P_{03}$ ,  $P_{10}$  to  $P_{13}$ ,  $P_{20}$  to  $P_{23}$

2. S-14L60BF

- $V_{CC} = 1.5\text{ V}$

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

| Parameter                        | Symbol    | Conditions(applicable terminals)                                                                                 | Min.                | Typ. | Max.                | Unit          |
|----------------------------------|-----------|------------------------------------------------------------------------------------------------------------------|---------------------|------|---------------------|---------------|
| Operating current consumption    | $I_{CCO}$ | $f_{OSC} = 1\text{ MHz}$ , no load                                                                               | —                   | 0.1  | 0.3                 | mA            |
| Standby current consumption      | $I_{CCS}$ | OFF mode                                                                                                         | —                   | 1    | 10                  | $\mu\text{A}$ |
| High level input voltage         | $V_{IH}$  |                                                                                                                  | $0.8 \times V_{CC}$ | —    | —                   | V             |
| Low level input voltage          | $V_{IL}$  |                                                                                                                  | —                   | —    | $0.2 \times V_{CC}$ | V             |
| High level input leakage current | $I_{LH}$  | All input pins*<br>$V_{IN} = V_{CC}$                                                                             | —                   | —    | 1                   | $\mu\text{A}$ |
| Low level input leakage current  | $I_{LL}$  | Without pull-up resistor<br>$P_{00}$ to $P_{03}$ , $V_{IN} = V_{SS}$                                             | -1                  | —    | —                   | $\mu\text{A}$ |
| High level input current         | $I_{IH}$  | RESET, $V_{IN} = V_{CC} - 0.3\text{ V}$                                                                          | -4                  | —    | -1                  | $\mu\text{A}$ |
| Low level input current 1        | $I_{IL1}$ | With pull-up resistor, $P_{00}$ to $P_{03}$ ,<br>$P_{10}$ to $P_{13}$ , $P_{20}$ to $P_{23}$ , $V_{IN} = V_{SS}$ | -30                 | -10  | -3                  | $\mu\text{A}$ |
| Low level input current 2        | $I_{IL2}$ | RESET, $V_{IN} = V_{SS}$                                                                                         | -2                  | -0.6 | -0.2                | $\mu\text{A}$ |
| Low level input current 3        | $I_{IL3}$ | TEST, $V_{IN} = V_{SS}$                                                                                          | -8                  | -2   | -0.5                | $\mu\text{A}$ |
| High level output current 1      | $I_{OH1}$ | RMO, $V_{OUT} = 1.1\text{ V}$                                                                                    | —                   | —    | -2                  | mA            |
| High level output current 2      | $I_{OH2}$ | $P_{00}$ to $P_{03}$ , $P_{30}$ to $P_{33}$ , $P_{40}$ to $P_{43}$ ,<br>$V_{OUT} = 1.1\text{ V}$                 | —                   | —    | -100                | $\mu\text{A}$ |
| Low level output current 1       | $I_{OL1}$ | RMO, $V_{OUT} = 0.4\text{ V}$                                                                                    | 200                 | —    | —                   | $\mu\text{A}$ |
| Low level output current 2       | $I_{OL2}$ | $P_{00}$ to $P_{03}$ , $P_{30}$ to $P_{33}$ , $P_{40}$ to $P_{43}$ ,<br>$V_{OUT} = 0.4\text{ V}$                 | 0.5                 | —    | —                   | mA            |
| Schmitt hysteresis width         | $V_{WD}$  |                                                                                                                  | —                   | 0.4  | —                   | V             |

\* TEST, RESET,  $P_{00}$  to  $P_{03}$ ,  $P_{10}$  to  $P_{13}$ ,  $P_{20}$  to  $P_{23}$

- $V_{CC} = 3\text{ V}$

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

| Parameter                        | Symbol    | Conditions(applicable terminals)                                                                                 | Min.                | Typ. | Max.                | Unit          |
|----------------------------------|-----------|------------------------------------------------------------------------------------------------------------------|---------------------|------|---------------------|---------------|
| Operating current consumption    | $I_{CCO}$ | $f_{OSC} = 1\text{ MHz}$ , no load                                                                               | —                   | 0.5  | 1.0                 | mA            |
| Standby current consumption      | $I_{CCS}$ | OFF mode                                                                                                         | —                   | 1    | 15                  | $\mu\text{A}$ |
| High level input voltage         | $V_{IH}$  |                                                                                                                  | $0.8 \times V_{CC}$ | —    | —                   | V             |
| Low level input voltage          | $V_{IL}$  |                                                                                                                  | —                   | —    | $0.2 \times V_{CC}$ | V             |
| High level input leakage current | $I_{LH}$  | All input pins*<br>$V_{IN} = V_{CC}$                                                                             | —                   | —    | 1                   | $\mu\text{A}$ |
| Low level input leakage current  | $I_{LL}$  | Without pull-up resistor<br>$P_{00}$ to $P_{03}$ , $V_{IN} = V_{SS}$                                             | -1                  | —    | —                   | $\mu\text{A}$ |
| High level input current         | $I_{IH}$  | RESET, $V_{IN} = V_{CC} - 0.3\text{ V}$                                                                          | -8                  | —    | -2                  | $\mu\text{A}$ |
| Low level input current 1        | $I_{IL1}$ | With pull-up resistor, $P_{00}$ to $P_{03}$ ,<br>$P_{10}$ to $P_{13}$ , $P_{20}$ to $P_{23}$ , $V_{IN} = V_{SS}$ | -120                | -50  | -20                 | $\mu\text{A}$ |
| Low level input current 2        | $I_{IL2}$ | RESET, $V_{IN} = V_{SS}$                                                                                         | -10                 | -4   | -1.5                | $\mu\text{A}$ |
| Low level input current 3        | $I_{IL3}$ | TEST, $V_{IN} = V_{SS}$                                                                                          | -40                 | -16  | -6                  | $\mu\text{A}$ |
| High level output current 1      | $I_{OH1}$ | RMO, $V_{OUT} = 2.6\text{ V}$                                                                                    | —                   | —    | -3                  | mA            |
| High level output current 2      | $I_{OH2}$ | $P_{00}$ to $P_{03}$ , $P_{30}$ to $P_{33}$ , $P_{40}$ to $P_{43}$ ,<br>$V_{OUT} = 2.6\text{ V}$                 | —                   | —    | -200                | $\mu\text{A}$ |
| Low level output current 1       | $I_{OL1}$ | RMO, $V_{OUT} = 0.4\text{ V}$                                                                                    | 400                 | —    | —                   | $\mu\text{A}$ |
| Low level output current 2       | $I_{OL2}$ | $P_{00}$ to $P_{03}$ , $P_{30}$ to $P_{33}$ , $P_{40}$ to $P_{43}$ ,<br>$V_{OUT} = 0.4\text{ V}$                 | 1.0                 | —    | —                   | mA            |
| Schmitt hysteresis width         | $V_{WD}$  |                                                                                                                  | —                   | 1.0  | —                   | V             |

\* TEST, RESET,  $P_{00}$  to  $P_{03}$ ,  $P_{10}$  to  $P_{13}$ ,  $P_{20}$  to  $P_{23}$

# CMOS 4-bit 1-chip MICROCOMPUTER S-1460BF/14L60BF

## ■ Instructions

1. Instructions are 16-bit length, and executed in a single instruction cycle(4 clocks).
2. The S-1460BF/14L60BF has 6 addressing modes.
  - 1) Direct addressing modes
  - 2) Relative addressing modes
  - 3) Immediate addressing modes
  - 4) Register addressing modes
  - 5) Accumulator indirect addressing modes
  - 6) Accumulator indexed addressing modes
3. Number of instructions

|                                  | Basic | Including addressing modes |
|----------------------------------|-------|----------------------------|
| Transfer instruction             | 6     | 15                         |
| Arithmetic operation instruction | 9     | 57                         |
| Logical operation instruction    | 8     | 66                         |
| Branch instruction               | 7     | 19                         |
| Rotate/shift instruction         | 2     | 6                          |
| CPU control instruction          | 3     | 3                          |
| Total                            | 35    | 166                        |

## ■ Application Example (S-1460BF)

