

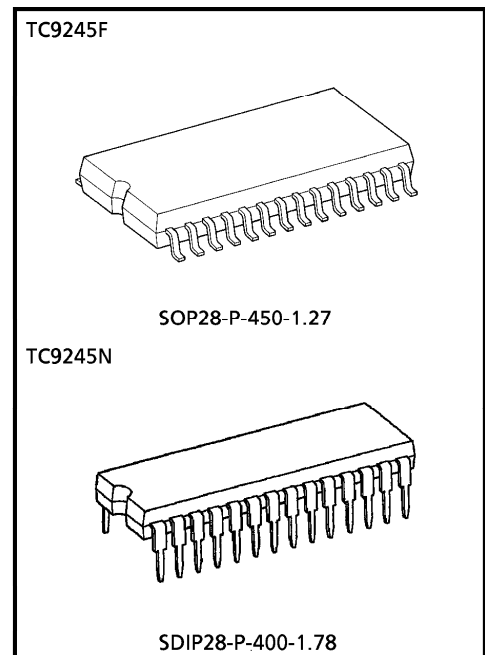
# TC9245F, TC9245N

## RECEIVING DEMODULATION IC FOR DIGITAL AUDIO INTERFACE

TC9245F, TC9245N are a receiving demodulation IC for digital audio interface developed in accordance with EIAJ "CP-340 Standard".

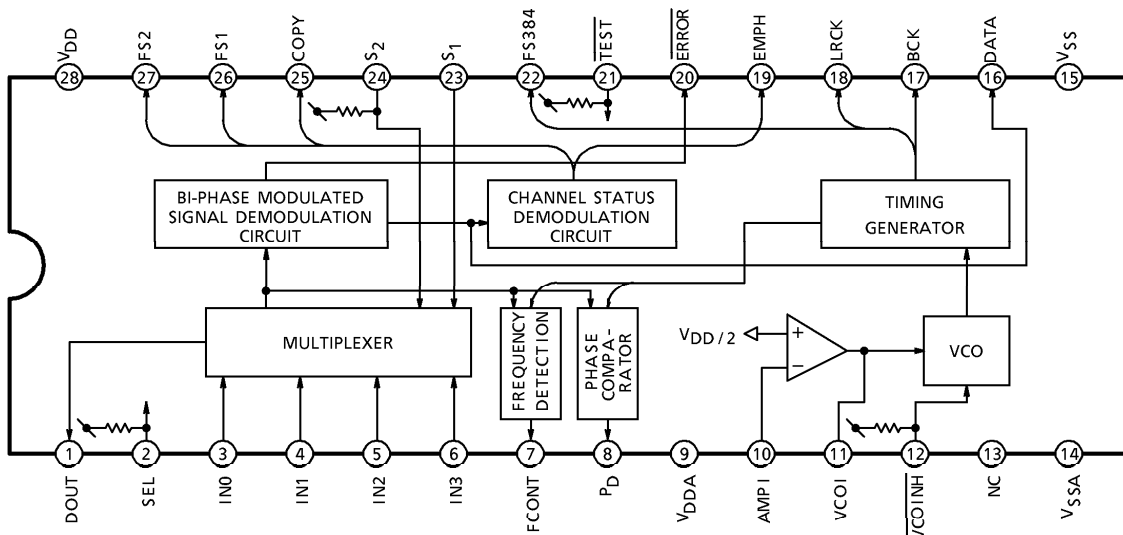
### FEATURES

- Compatible with SCMS (Serial Copy Management System).
- Compatible with 4 inputs including both coaxial and optical inputs.
- Performs 2 kinds of error detection, i.e., synchronizing signal detection and parity check. If an error is detected, output data is muted for a fixed time.
- PLL circuit can be easily constructed by built-in VCO.
- Built-in pseudo-locking preventive function assures positive locking.
- With VCO oscillation stop function.
- CMOS silicon gate construction with low power dissipation.
- 2 kinds of package, 28pin flat package and 28pin DIP shrunk package.



Weight  
 SOP28-P-450-1.27 : 0.8g (Typ.)  
 SDIP28-P-400-1.78 : 2.2g (Typ.)

### BLOCK DIAGRAM



980508EBA2

● TOSHIBA is continually working to improve the quality and the reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to observe standards of safety, and to avoid situations in which a malfunction or failure of a TOSHIBA product could cause loss of human life, bodily injury or damage to property. In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent products specifications. Also, please keep in mind the precautions and conditions set forth in the TOSHIBA Semiconductor Reliability Handbook.

**PIN FUNCTION**

| PIN No. | SYMBOL | FUNCTIONAL DESCRIPTION |                                                                                                                                                                          |     |                                                            | REMARKS                                        |
|---------|--------|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------------------------------------------------------------|------------------------------------------------|
|         |        | I/O                    | PARALLEL MODE                                                                                                                                                            | I/O | SERIAL MODE                                                |                                                |
| 1       | DOUT   | O                      | IN0~IN2 selecting output terminal.<br>When selecting IN3, output is fixed at "L".                                                                                        |     |                                                            | With a pull-down resistor + switch.            |
| 2       | SEL    | I                      | Microcomputer interface mode selecting input terminal.<br>Compatible with the parallel mode when this terminal is at "H" level or open and the serial mode at "L" level. |     |                                                            | With a pull-up resistor.                       |
| 3       | IN0    | I                      | Digital audio data input terminal.                                                                                                                                       |     |                                                            | With a pull-down resistor + switch.            |
| 4       | IN1    |                        |                                                                                                                                                                          |     |                                                            |                                                |
| 5       | IN2    |                        |                                                                                                                                                                          |     |                                                            |                                                |
| 6       | IN3    |                        |                                                                                                                                                                          |     |                                                            |                                                |
| 7       | FCONT  | O                      | PLL mis-lock detection signal output terminal.                                                                                                                           |     |                                                            | 3-state output.                                |
| 8       | PD     | O                      | Phase comparator phase error signal output terminal.                                                                                                                     |     |                                                            | 3-state output.                                |
| 9       | VDDA   | —                      | Analog supply voltage terminal.                                                                                                                                          |     |                                                            | —                                              |
| 10      | AMPI   | I                      | LPF operational amplifier input terminal.                                                                                                                                |     |                                                            | —                                              |
| 11      | VCOI   | O                      | Operation amplifier output terminal.<br>(VCO oscillation control voltage output)                                                                                         |     |                                                            | —                                              |
| 12      | VCOINH | I                      | VCO oscillation stop control input terminal.                                                                                                                             |     |                                                            | —                                              |
| 13      | NC     | —                      | Non connection terminal.                                                                                                                                                 |     |                                                            | —                                              |
| 14      | VSSA   | —                      | Analog ground terminal.                                                                                                                                                  |     |                                                            | —                                              |
| 15      | VSS    | —                      | Digital ground terminal.                                                                                                                                                 |     |                                                            | —                                              |
| 16      | DATA   | O                      | Digital audio data output terminal.                                                                                                                                      |     |                                                            | —                                              |
| 17      | BCK    | O                      | Bit clock output terminal. (32fs)                                                                                                                                        |     |                                                            | —                                              |
| 18      | LRCK   | O                      | LR clock output terminal.<br>L/R-ch polarity fixed.                                                                                                                      | O   | LR clock output terminal.<br>L/R-ch polarity variable.     | —                                              |
| 19      | EMPH   | O                      | Emphasis output terminal. Emphasis is available at "H".                                                                                                                  |     |                                                            | —                                              |
| 20      | ERROR  | O                      | Error detection flag output terminal. Error is detected at "L".                                                                                                          |     |                                                            | —                                              |
| 21      | TEST   | I                      | Test terminal.                                                                                                                                                           |     |                                                            | With a pull-up resistor.                       |
| 22      | FS384  | O                      | 384fs clock output terminal.                                                                                                                                             |     |                                                            |                                                |
| 23      | S1     | I                      | Input selecting terminal.                                                                                                                                                | O   | 192fs or 128fs clock output terminal.                      | —                                              |
| 24      | S2     | I                      | Input selecting terminal.                                                                                                                                                | I   | Microcomputer data input / output mode selecting terminal. | With a pull-up resistor.                       |
| 25      | COPY   | O                      | Copy inhibit flag output terminal.<br>Copy is inhibited at "L".                                                                                                          | I/O | Microcomputer data input / output terminal.                | With a pull-up resistor.<br>Open drain output. |
| 26      | FS1    | O                      | Sampling frequency bit decoding output terminal.                                                                                                                         | I   | Microcomputer data latch pulse input terminal.             |                                                |
| 27      | FS2    | O                      |                                                                                                                                                                          | I   | Microcomputer data transfer clock input terminal.          |                                                |
| 28      | VDD    | —                      | Digital power supply voltage terminal.                                                                                                                                   |     |                                                            | —                                              |

980508EBA2'

- The products described in this document are subject to foreign exchange and foreign trade laws.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.
- The information contained herein is subject to change without notice.

**DESCRIPTION OF OUTLINE**

**1. Mode setting**

The communication modes are set by setting the SEL terminal at "L" or "H" level. The parallel communication mode is set statically and the serial communication mode is set by inputting 3 signals of serial data, transfer clock and latch pulse as shown in Fig.1.

Table.1 Terminal name change table

| PIN NAME       |                  | I/O | FUNCTION IN SERIAL COMMUNICATION MODE                                                                               |
|----------------|------------------|-----|---------------------------------------------------------------------------------------------------------------------|
| PARALLEL       | SERIAL           |     |                                                                                                                     |
| S <sub>1</sub> | CKOUT            | O   | 192fs or 128fs clock is output.                                                                                     |
| S <sub>2</sub> | $\overline{I/O}$ | I   | The output mode when the microcomputer I/O mode selecting terminal is at "H" level and the input mode at "L" level. |
| FS1            | $\overline{LP}$  | I   | $\overline{I/O} = H$ : Data output trigger signal input.<br>$\overline{I/O} = L$ : Data latch pulse input.          |
| FS2            | $\overline{SCK}$ | I   | Data transfer clock input.                                                                                          |
| COPY           | $\mu$ DATA       | I/O | $\overline{I/O} = H$ : Channel status output.<br>$\overline{I/O} = L$ : Internally set serial data input.           |

(a) Parallel communication mode : (SEL = H)

In this mode, sampling frequency is decoded and output by 2 bits of FS1 and FS2 and input data (internally taken in) and DOUT output data by S<sub>1</sub> and S<sub>2</sub> as shown in the following table :

Table.2 Sampling frequency encode table

| FS2 | FS1 | SAMPLING FREQUENCY |
|-----|-----|--------------------|
| L   | L   | 44.1kHz            |
| L   | H   | —                  |
| H   | L   | 48kHz              |
| H   | H   | 32kHz              |

Table.3 Input/Output setting table

| S <sub>2</sub> | S <sub>1</sub> | INTERNAL PROCESS | DOUT PIN |
|----------------|----------------|------------------|----------|
| L              | L              | IN0              | IN0      |
| L              | H              | IN1              | IN1      |
| H              | L              | IN2              | IN2      |
| H              | H              | IN3              | "L" fix  |

(b) Serial communication mode : (SEL = L)

In this mode, S<sub>1</sub> and S<sub>2</sub> are input in the data input mode and channel status signals shown in Table 5 are output to the outside in the data output mode.

The data input and output modes are briefly explained hereinafter.

• Data input mode : ( $\overline{I/O} = L$ )

In this mode, 4 bits of S<sub>1</sub>, S<sub>2</sub>, LRS and 192s can be input. Each of these bits is taken in the IC at the trailing edge of  $\overline{SCK}$  and the internal mode is updated at the trailing edge of  $\overline{LP}$ .

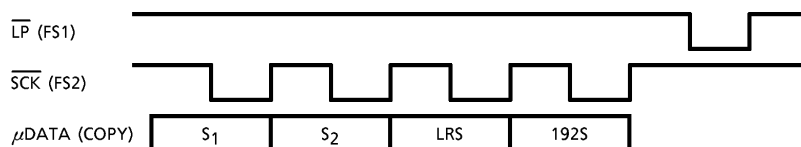


Fig.1 Serial data input timing

Table.4 Internal setting by serial data

| SERIAL DATA                     | FUNCTION DESCRIPTION                                                                           |
|---------------------------------|------------------------------------------------------------------------------------------------|
| S <sub>1</sub> , S <sub>2</sub> | The same operation as S <sub>1</sub> and S <sub>2</sub> terminal in the parallel setting mode. |
| LRS                             | Changes phase of LRCK. L : The same as the parallel mode.<br>H : Inverse output.               |
| 192S                            | "H" : 192fs clock is output through the CKOUT terminal.<br>"L" : 128fs clock is output.        |

- Data output mode : ( $\overline{I/O} = H$ )

In this mode, the channel status bits shown in Table.5 can be monitored.

Each channel status bit is output as serial data.

The serial data output timing is shown in Fig.2.

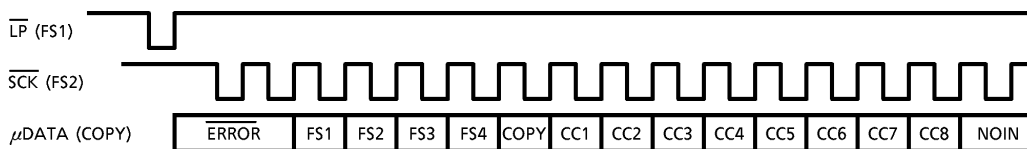


Fig.2 Serial data output timing

Table.5 Contents of serial data output

| SYMBOL                    | CONTENTS                                      |
|---------------------------|-----------------------------------------------|
| $\overline{\text{ERROR}}$ | Error detection result                        |
| COPY                      | Copy flag                                     |
| CC1~8                     | Category bit                                  |
| FS1~4                     | Sampling frequency bit                        |
| NOIN                      | No signal detected at selected input terminal |

(Note 1) In order to cope with SCMS, sampling frequency bits are not decoded.

Further, in the actual serial data output, parity (even parity from the top bit  $\overline{\text{ERROR}}$ ) is output for every data bit as shown in Fig.3.

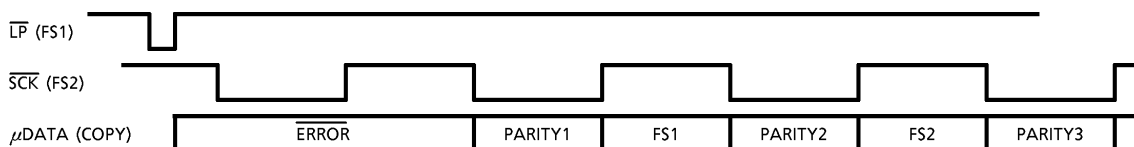


Fig.3 Parity output timing of serial data output mode

2. Detection of error

If an error is detected, the  $\overline{\text{ERROR}}$  terminal is set at "L" level and output data is muted. In addition, the channel status latch operation is inhibited and a preceding value is held. If the no error status continues for times shown in the following table, the  $\overline{\text{ERROR}}$  terminal is set at "H" level, returning to the normal operation.

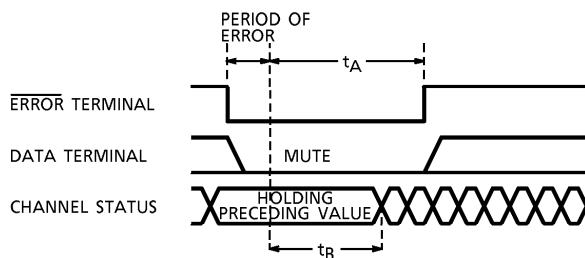


Fig.4 Internal operation timing at error

Table.6 Error detecting operation releasing time

| SAMPLING FREQUENCY (kHz) | $\overline{\text{ERROR}}$ , DATA TERMINAL $t_A$ (ms) | CHANNEL STATUS $t_B$ (ms) |
|--------------------------|------------------------------------------------------|---------------------------|
| 32                       | 384.0                                                | 288.0                     |
| 44.1                     | 278.6                                                | 209.0                     |
| 48                       | 256.0                                                | 192.0                     |

3. Detection of no input

Detecting existence of IN0~3 input signals, oscillation of VCO is automatically suppressed to low if no edge is detected for a fixed time.

Table.7 No input judging time of input data

| SAMPLING FREQUENCY (kHz) | TIME FROM LAST EDGE (ms) |
|--------------------------|--------------------------|
| 32                       | approx. 1000             |
| 44.1                     | approx. 750              |
| 48                       | approx. 700              |

4. Detection of mis-lock

Detecting mis-lock by comparing input signal with oscillation frequency, outputs a signal to escape from the mis-lock through the FCONT terminal.

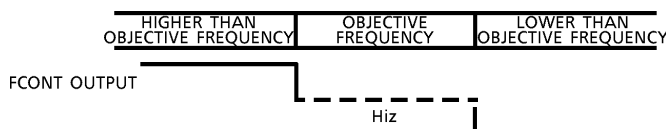


Fig.5 Mis-lock detection timing

5. Digital data input terminal

The configuration of IN0~3 input multiplexer is shown in Fig.6.

Considering crosstalk to other terminals, an unused terminal can be pulled down by resistors through ON/OFF of the internal switch.

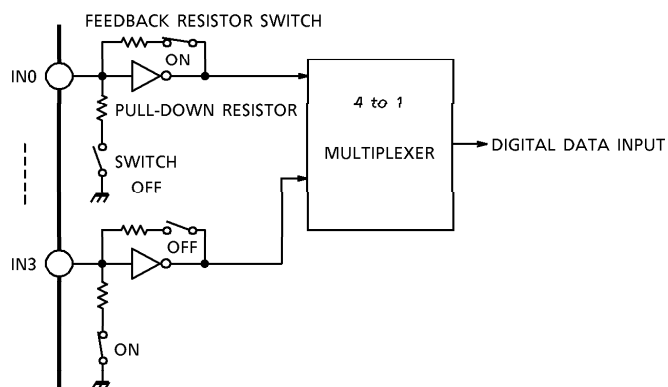


Fig.6 Configuration of input multiplexer

**MAXIMUM RATINGS** (Ta = 25°C)

| CHARACTERISTIC        |         | SYMBOL           | RATING                      | UNIT |
|-----------------------|---------|------------------|-----------------------------|------|
| Supply Voltage        |         | V <sub>DD</sub>  | - 0.3~6.0                   | V    |
| Input Voltage         |         | V <sub>IN</sub>  | - 0.3~V <sub>DD</sub> + 0.3 | V    |
| Power Dissipation     | TC9245F | P <sub>D</sub>   | 600                         | mW   |
|                       | TC9245N |                  | 800                         |      |
| Operating Temperature |         | T <sub>opr</sub> | - 25~75                     | °C   |
| Storage Temperature   |         | T <sub>stg</sub> | - 55~150                    | °C   |

**ELECTRICAL CHARACTERISTICS** (Unless otherwise specified, Ta = 25°C, VDD = 5V)

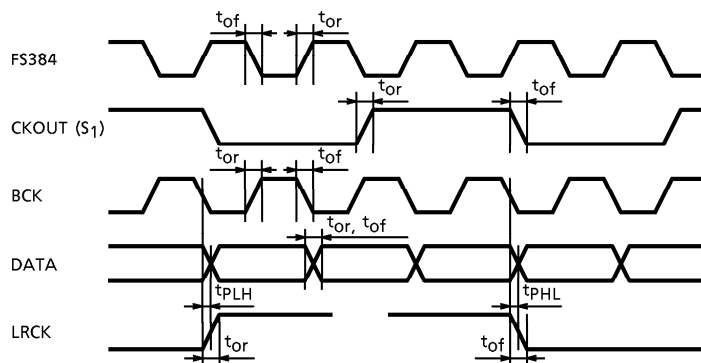
DC characteristics

| CHARACTERISTIC           | SYMBOL    | TEST CIRCUIT | TEST CONDITION                                   | MIN.       | TYP. | MAX. | UNIT |    |
|--------------------------|-----------|--------------|--------------------------------------------------|------------|------|------|------|----|
| Operating Supply Voltage | VDD       | —            | Ta = -25~75°C                                    | 4.75       | 5.00 | 5.25 | V    |    |
| Operating Supply Current | IDD       | —            | —                                                | —          | 15.0 | 25.0 | mA   |    |
| Input Voltage            | "H" Level | VIH          | VCOINH, TEST, S1, S2, SEL, COPY, FS1, FS2, IN0~3 | 4.0        | —    | VDD  | V    |    |
|                          | "L" Level | VIL          |                                                  | 0.0        | —    | 1.0  |      |    |
| Input Amplitude          | VIN       | —            | IN0~3                                            | 0.4        | —    | 5.0  | Vp-p |    |
| Input Current (1)        | "H" Level | IiH (1)      | S1, AMPI                                         | VIH = 5.0V | —    | —    | 1.0  | μA |
|                          | "L" Level | IiL (1)      |                                                  | VIL = 0.0V | -1.0 | —    | —    |    |
| Input Current (2)        | "H" Level | IiH (2)      | IN0~3                                            | VIH = 5.0V | —    | 10   | —    |    |
|                          | "L" Level | IiL (2)      |                                                  | VIL = 0.0V | —    | -10  | —    |    |
| Trystate Leak Current    | "H" Level | ITLH         | FCONT, PD                                        | VIH = 5.0V | —    | —    | 1.0  |    |
|                          | "L" Level | ITLL         |                                                  | VIL = 0.0V | -1.0 | —    | —    |    |
| Output Current (1)       | "H" Level | IOH (1)      | EMPH, ERROR                                      | VOH = 4.5V | —    | —    | -1.0 | mA |
|                          | "L" Level | IOL (1)      |                                                  | VOL = 0.5V | 2.0  | —    | —    |    |
| Output Current (2)       | "H" Level | IOH (2)      | DATA, BCK, LRCK, FS384, DOUT                     | VOH = 4.5V | —    | —    | -2.0 |    |
|                          | "L" Level | IOL (2)      |                                                  | VOL = 0.5V | 4.0  | —    | —    |    |
| Output Current (3)       | "H" Level | IOH (3)      | S1, FCONT, PD                                    | VOH = 4.5V | —    | —    | -4.0 |    |
|                          | "L" Level | IOL (3)      |                                                  | VOL = 0.5V | 8.0  | —    | —    |    |
| Pull-up Resistor         | RUP       | —            | VCOINH, TEST, S2, SEL, COPY, FS1, FS2            | —          | 20   | —    | kΩ   |    |
| Pull-down Resistor       | RDOWN     | —            | IN0~3, DOUT                                      | —          | 1    | —    |      |    |

AC characteristics

(1) Clock system and data output system timing

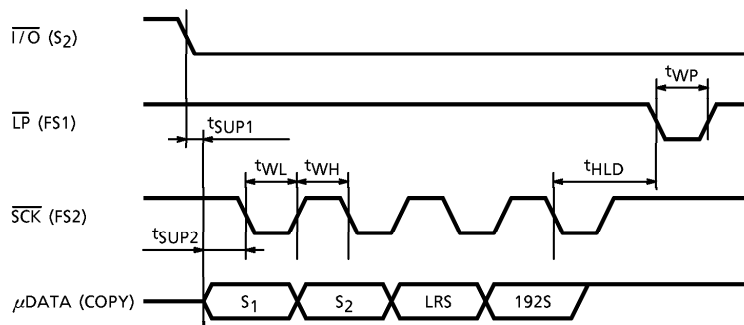
| CHARACTERISTIC   | SYMBOL          | TEST CIRCUIT     | TEST CONDITION         | MIN. | TYP. | MAX. | UNIT |
|------------------|-----------------|------------------|------------------------|------|------|------|------|
| Output Rise Time | t <sub>or</sub> | —                | FS384, BCK, LRCK, DATA | —    | —    | 15   | ns   |
| Output Fall Time | t <sub>of</sub> | —                | CKOUT (S1)             | —    | —    | 15   |      |
| Delay Time       | "H" Level       | t <sub>PHL</sub> | BCK→DATA, LRCK         | —    | —    | 25   | ns   |
|                  | "L" Level       | t <sub>PLH</sub> |                        | —    | —    | 25   |      |



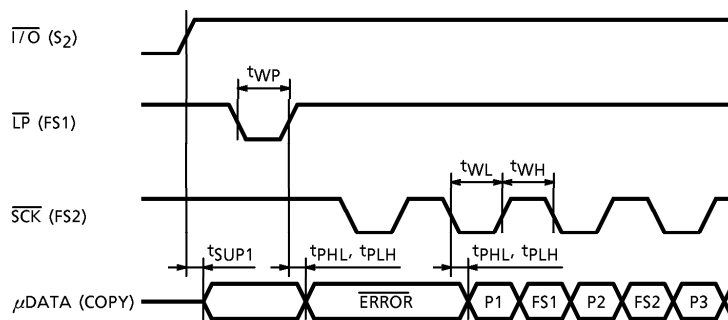
(2) Microcomputer interface system timing (SEL = L : Serial communication mode)

| CHARACTERISTIC     | SYMBOL    | TEST CIRCUIT      | TEST CONDITION                              | MIN. | TYP. | MAX. | UNIT          |
|--------------------|-----------|-------------------|---------------------------------------------|------|------|------|---------------|
| Transfer Time      | "H" Level | t <sub>PHL</sub>  | $\overline{SCK} \rightarrow \mu\text{DATA}$ | —    | —    | 1    | $\mu\text{s}$ |
|                    | "L" Level | t <sub>PLH</sub>  | $\overline{LP} \rightarrow \mu\text{DATA}$  | —    | —    | 0.2  |               |
| Strobe Pulse Width |           | t <sub>WP</sub>   | $\overline{LP}$                             | 0.5  | —    | —    | $\mu\text{s}$ |
| Clock Pulse Width  | "H" Level | t <sub>WH</sub>   | $\overline{SCK}$                            | 1    | —    | —    | $\mu\text{s}$ |
|                    | "L" Level | t <sub>WL</sub>   |                                             | 1    | —    | —    |               |
| Setup Time         |           | t <sub>SUP1</sub> | $\overline{I/O} \rightarrow \mu\text{DATA}$ | 0.2  | —    | —    | $\mu\text{s}$ |
|                    |           | t <sub>SUP2</sub> | $\mu\text{DATA} \rightarrow \overline{SCK}$ | 0.5  | —    | —    |               |
| Hold Time          |           | t <sub>HLD</sub>  | $\overline{SCK} \rightarrow \overline{LP}$  | 0.5  | —    | —    | $\mu\text{s}$ |

• Data input mode ( $\overline{I/O} = L$ ) :



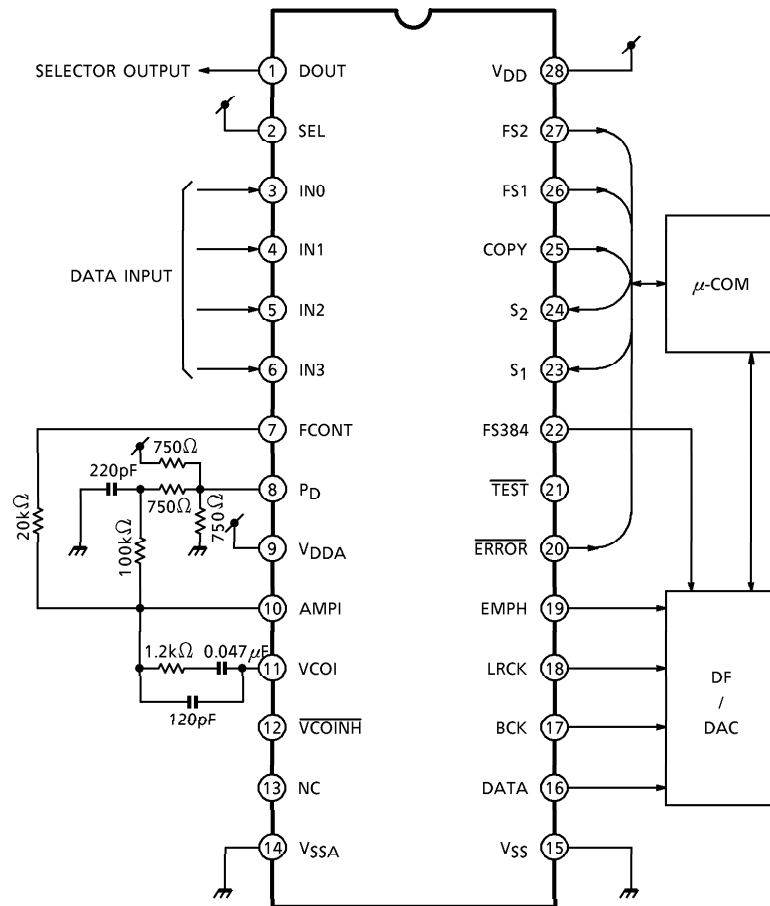
• Data output mode ( $\overline{I/O} = H$ ) :



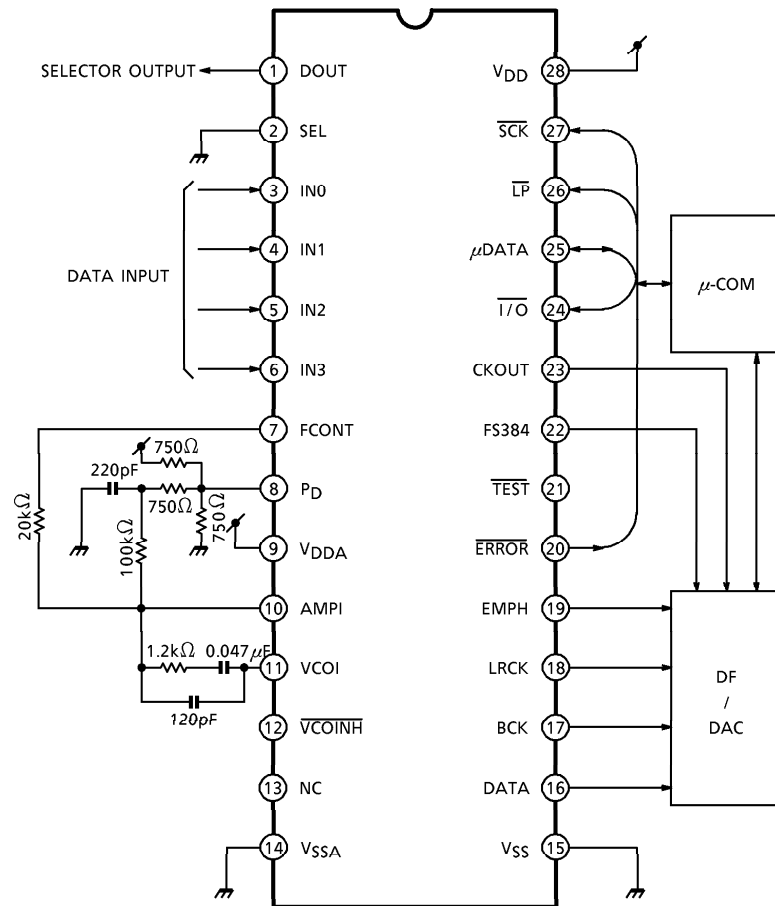


**APPLICATION CIRCUIT**

**1. Parallel setting mode**

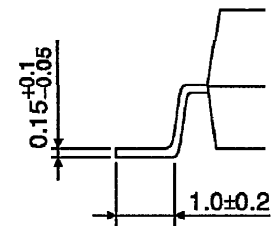
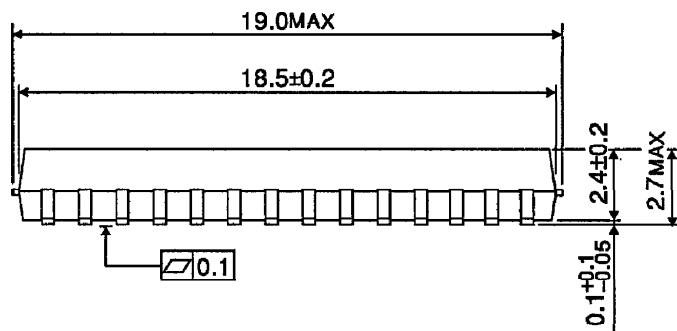
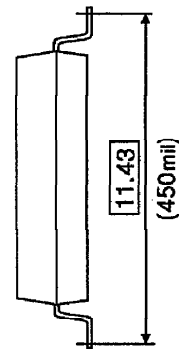
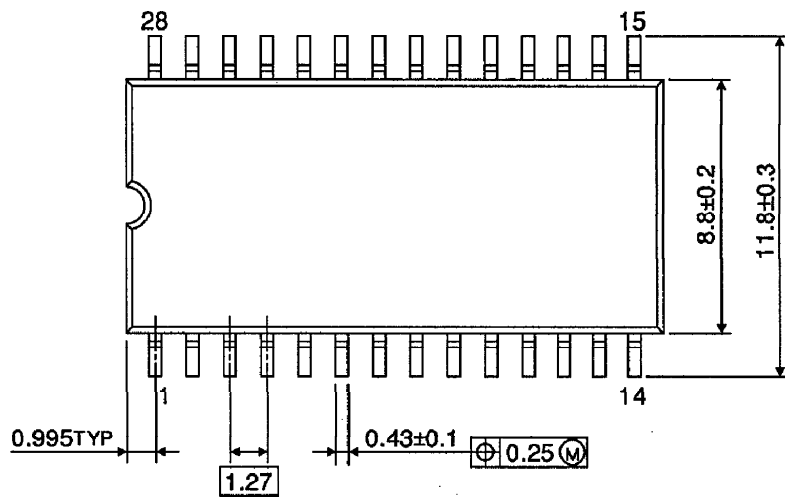


2. Serial communication mode



**OUTLINE DRAWING**  
SOP28-P-450-1.27

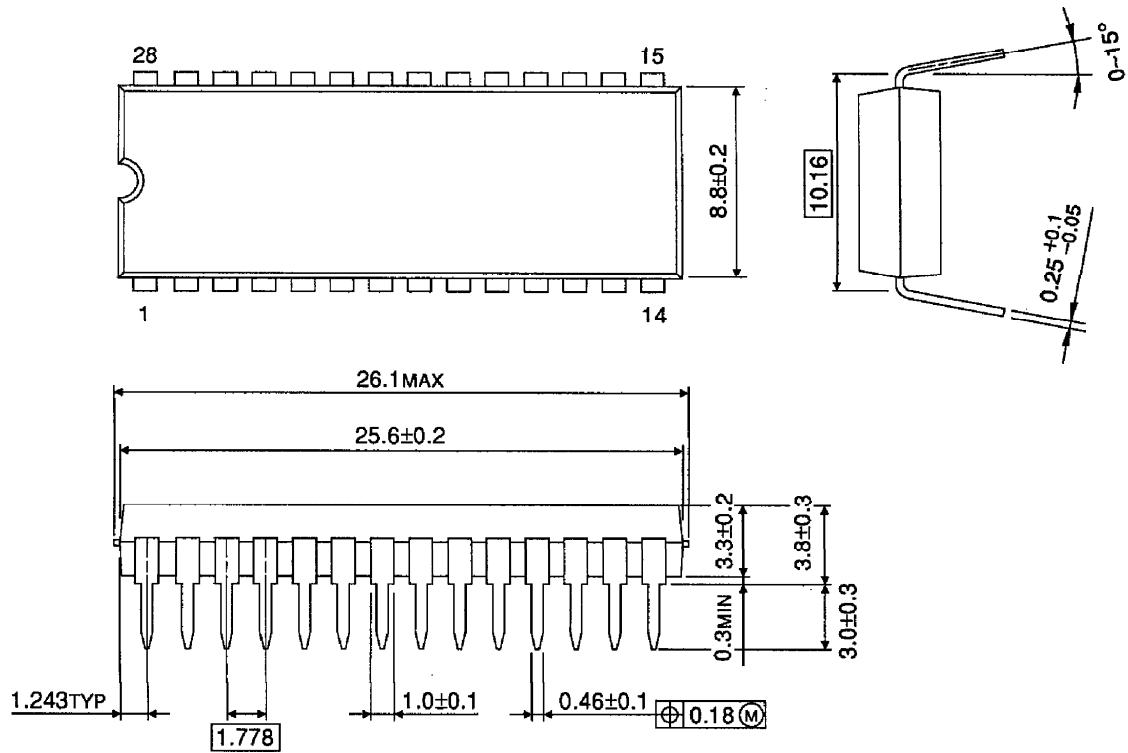
Unit : mm



Weight : 0.8g (Typ.)

**OUTLINE DRAWING**  
SDIP28-P-400-1.78

Unit : mm



Weight : 2.2g (Typ.)