

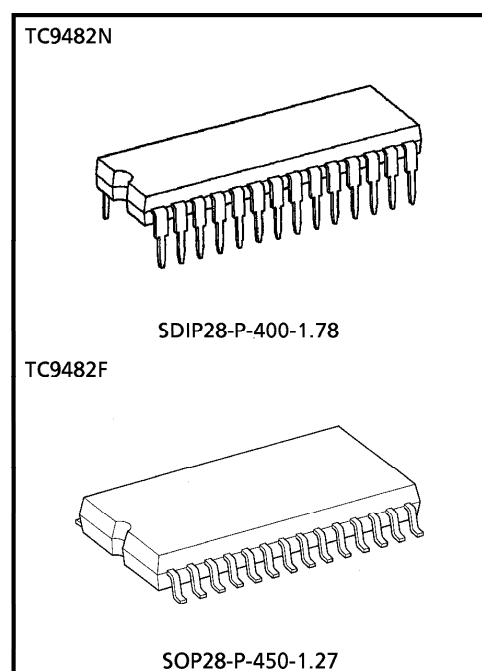
# TC9482N, TC9482F

## SYSTEM ELECTRONIC VOLUME CONTROL

The TC9482N and TC9482F are six-channel electronic volume control ICs developed for Hi-Fi audio equipment. Since all six channels can be individually controlled, the devices are optimum for audio equipment with multiple outputs.

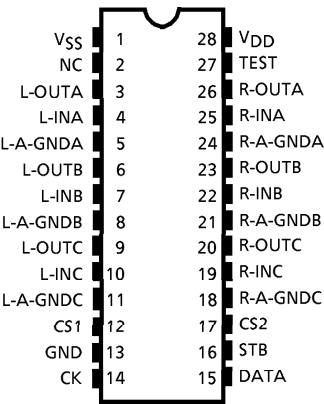
### FEATURES

- Sound volume can be controlled in 97 steps from 0 to -95dB or up to an infinite level in 1dB increments.
- Incorporating six channels of volume control circuits, the device allows independent volume control.
- Can operate with a single or dual power supplies.
- Can control up to 4 chips on the same bus by using chip select input.
- Built-in interface for 5-V microcomputers.
- Thanks to its polysilicon resistor, the device allows you to configure a low-distortion, high-performance volume control system.
- Two packages supported: 28-pin shrink DIP and 28-pin flat package.

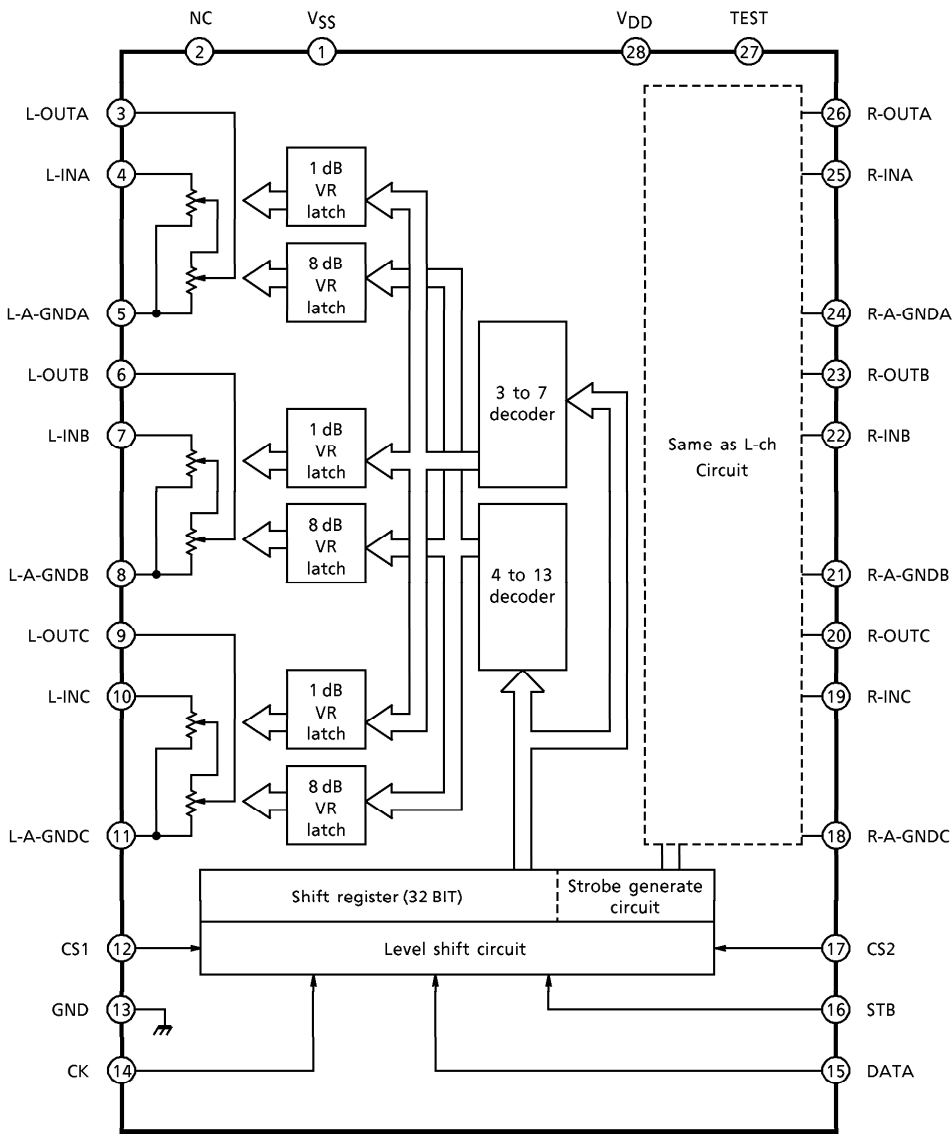


Weight  
SDIP28-P-400-1.78 : 2.2 g (Typ.)  
SOP28-P-450-1.27 : 0.8 g (Typ.)

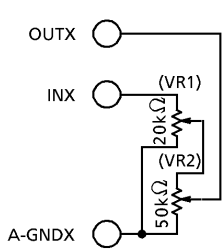
PIN CONNECTIONS



BLOCK DIAGRAM



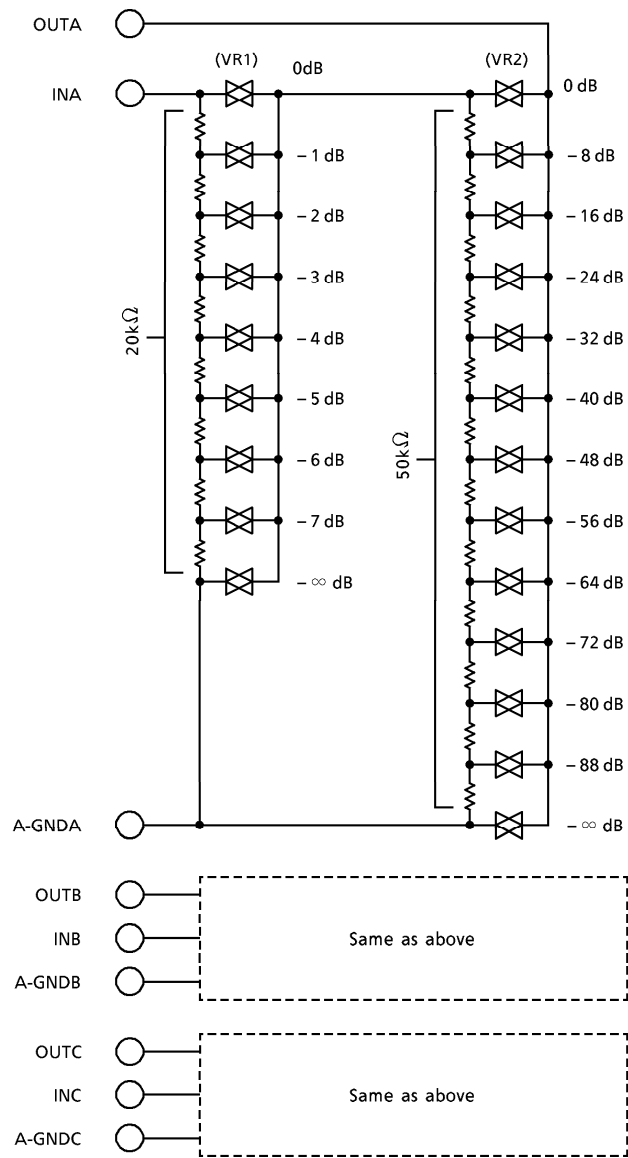
## PIN DESCRIPTION

| PIN No. | SYMBOL          | PIN NAME                  | FUNCTION  | REMARK                        |
|---------|-----------------|---------------------------|---|-------------------------------|
| 1       | V <sub>SS</sub> | Negative power supply pin | ● Power Supply Pins   | —                             |
| 28      | V <sub>DD</sub> | Positive power supply pin |   |                               |
| 3       | L-OUTA          | Volume output pin         | ● Volume circuit<br> | —                             |
| 26      | R-OUTA          |                           |   |                               |
| 6       | L-OUTB          |                           |   |                               |
| 22      | R-OUTB          |                           |   |                               |
| 9       | L-OUTC          |                           |   |                               |
| 19      | R-OUTC          |                           |   |                               |
| 4       | L-INA           | Volume input pin          |   |                               |
| 25      | R-INA           |                           |   |                               |
| 7       | L-INB           |                           |   |                               |
| 22      | R-INB           |                           |   |                               |
| 10      | L-INC           |                           |   |                               |
| 19      | R-INC           |                           |   |                               |
| 5       | L-A-GNDA        | Analog GND pin            |   |                               |
| 24      | R-A-GNDA        |                           |   |                               |
| 8       | L-A-GNDB        |                           |   |                               |
| 21      | R-A-GNDB        |                           |   |                               |
| 11      | L-A-GNDC        |                           |   |                               |
| 18      | R-A-GNDC        |                           |   |                               |
| 12      | CS1             | Chip select input pin     | Up to 4 chips on the same bus can be used by switching over chip select code.                           | —                             |
| 17      | CS2             |                           |   |                               |
| 14      | CK              | Clock input pin           | Inputs clock for serial data transfer.  | Low threshold value input pin |
| 15      | DATA            | Data input pin            | Inputs control data for setting volume.   |                               |
| 16      | STB             | Strobe input pin          | Inputs strobe for writing data.   |                               |
| 13      | GND             | Digital GND pin           | Digital ground pin  | —                             |
| 27      | TEST            | Test Pin                  | Normally connect to V <sub>DD</sub> pin.  | —                             |
| 2       | NC              | No connection             | —   | —                             |

OPERATIONS

1. Volume Control Circuit

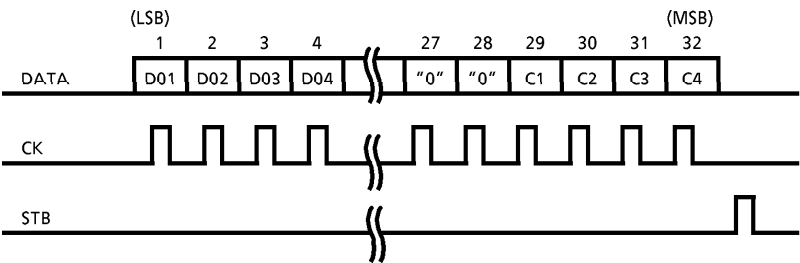
The volume control circuit incorporates two volume controls, each consisting of a resistor array and a CMOS analog switch. VR1 attenuates from 0 to 7 dB in 1-dB steps. VR2 attenuates from 0 to -88 dB in 8-dB steps. In total, volume is controlled from 0 to 95 dB in 1-dB steps.



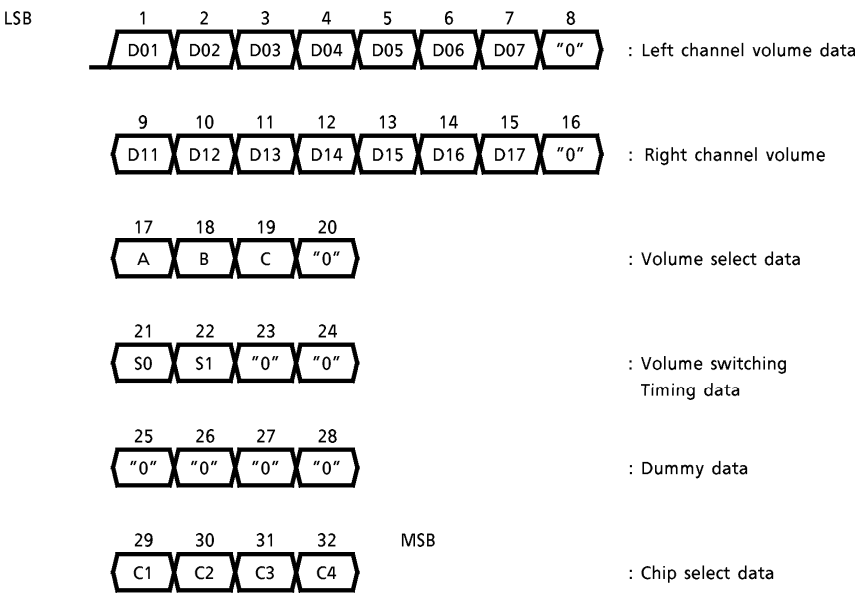
2. Setting up volume value (amount of attenuation)

Serial data consisting of 32 bits is used to set a volume value.

● Data format



(1) Assignment of volume control data



## (2) Volume setup data

The bits "D01" through "D07" are the left channel volume setup data, the bits "D11" through "D17" are the right channel volume setup data. For details, see the tables below.

| STEP    | D01<br>D11 | D02<br>D12 | D03<br>D13 | D04<br>D14 | D05<br>D15 | D06<br>D16 | D07<br>D17 |
|---------|------------|------------|------------|------------|------------|------------|------------|
| 0 dB    | 0          | 0          | 0          | 0          | 0          | 0          | 0          |
| - 1 dB  | 1          | 0          | 0          | 0          | 0          | 0          | 0          |
| - 2 dB  | 0          | 1          | 0          | 0          | 0          | 0          | 0          |
| - 3 dB  | 1          | 1          | 0          | 0          | 0          | 0          | 0          |
| - 4 dB  | 0          | 0          | 1          | 0          | 0          | 0          | 0          |
| - 5 dB  | 1          | 0          | 1          | 0          | 0          | 0          | 0          |
| - 6 dB  | 0          | 1          | 1          | 0          | 0          | 0          | 0          |
| - 7 dB  | 1          | 1          | 1          | 0          | 0          | 0          | 0          |
| - 8 dB  | 0          | 0          | 0          | 1          | 0          | 0          | 0          |
| - 9 dB  | 1          | 0          | 0          | 1          | 0          | 0          | 0          |
| - 10 dB | 0          | 1          | 0          | 1          | 0          | 0          | 0          |
| - 11 dB | 1          | 1          | 0          | 1          | 0          | 0          | 0          |
| - 12 dB | 0          | 0          | 1          | 1          | 0          | 0          | 0          |
| - 13 dB | 1          | 0          | 1          | 1          | 0          | 0          | 0          |
| - 14 dB | 0          | 1          | 1          | 1          | 0          | 0          | 0          |
| - 15 dB | 1          | 1          | 1          | 1          | 0          | 0          | 0          |
| - 16 dB | 0          | 0          | 0          | 0          | 1          | 0          | 0          |
| - 17 dB | 1          | 0          | 0          | 0          | 1          | 0          | 0          |
| - 18 dB | 0          | 1          | 0          | 0          | 1          | 0          | 0          |
| - 19 dB | 1          | 1          | 0          | 0          | 1          | 0          | 0          |
| - 20 dB | 0          | 0          | 1          | 0          | 1          | 0          | 0          |
| - 21 dB | 1          | 0          | 1          | 0          | 1          | 0          | 0          |
| - 22 dB | 0          | 1          | 1          | 0          | 1          | 0          | 0          |
| - 23 dB | 1          | 1          | 1          | 0          | 1          | 0          | 0          |
| - 24 dB | 0          | 0          | 0          | 1          | 1          | 0          | 0          |
| - 25 dB | 1          | 0          | 0          | 1          | 1          | 0          | 0          |
| - 26 dB | 0          | 1          | 0          | 1          | 1          | 0          | 0          |
| - 27 dB | 1          | 1          | 0          | 1          | 1          | 0          | 0          |
| - 28 dB | 0          | 0          | 1          | 1          | 1          | 0          | 0          |
| - 29 dB | 1          | 0          | 1          | 1          | 1          | 0          | 0          |
| - 30 dB | 0          | 1          | 1          | 1          | 1          | 0          | 0          |
| - 31 dB | 1          | 1          | 1          | 1          | 1          | 0          | 0          |
| - 32 dB | 0          | 0          | 0          | 0          | 0          | 1          | 0          |
| - 33 dB | 1          | 0          | 0          | 0          | 0          | 1          | 0          |
| - 34 dB | 0          | 1          | 0          | 0          | 0          | 1          | 0          |
| - 35 dB | 1          | 1          | 0          | 0          | 0          | 1          | 0          |
| - 36 dB | 0          | 0          | 1          | 0          | 0          | 1          | 0          |
| - 37 dB | 1          | 0          | 1          | 0          | 0          | 1          | 0          |
| - 38 dB | 0          | 1          | 1          | 0          | 0          | 1          | 0          |
| - 39 dB | 1          | 1          | 1          | 0          | 0          | 1          | 0          |
| - 40 dB | 0          | 0          | 0          | 1          | 0          | 1          | 0          |
| - 41 dB | 1          | 0          | 0          | 1          | 0          | 1          | 0          |
| - 42 dB | 0          | 1          | 0          | 1          | 0          | 1          | 0          |
| - 43 dB | 1          | 1          | 0          | 1          | 0          | 1          | 0          |
| - 44 dB | 0          | 0          | 1          | 1          | 0          | 1          | 0          |
| - 45 dB | 1          | 0          | 1          | 1          | 0          | 1          | 0          |
| - 46 dB | 0          | 1          | 1          | 1          | 0          | 1          | 0          |
| - 47 dB | 1          | 1          | 1          | 1          | 0          | 1          | 0          |

| STEP    | D01<br>D11 | D02<br>D12 | D03<br>D13 | D04<br>D14 | D05<br>D15 | D06<br>D16 | D07<br>D17 |
|---------|------------|------------|------------|------------|------------|------------|------------|
| - 48 dB | 0          | 0          | 0          | 0          | 1          | 1          | 0          |
| - 49 dB | 1          | 0          | 0          | 0          | 1          | 1          | 0          |
| - 50 dB | 0          | 1          | 0          | 0          | 1          | 1          | 0          |
| - 51 dB | 1          | 1          | 0          | 0          | 1          | 1          | 0          |
| - 52 dB | 0          | 0          | 1          | 0          | 1          | 1          | 0          |
| - 53 dB | 1          | 0          | 1          | 0          | 1          | 1          | 0          |
| - 54 dB | 0          | 1          | 1          | 0          | 1          | 1          | 0          |
| - 55 dB | 1          | 1          | 1          | 0          | 1          | 1          | 0          |
| - 56 dB | 0          | 0          | 0          | 1          | 1          | 1          | 0          |
| - 57 dB | 1          | 0          | 0          | 1          | 1          | 1          | 0          |
| - 58 dB | 0          | 1          | 0          | 1          | 1          | 1          | 0          |
| - 59 dB | 1          | 1          | 0          | 1          | 1          | 1          | 0          |
| - 60 dB | 0          | 0          | 1          | 1          | 1          | 1          | 0          |
| - 61 dB | 1          | 0          | 1          | 1          | 1          | 1          | 0          |
| - 62 dB | 0          | 1          | 1          | 1          | 1          | 1          | 0          |
| - 63 dB | 1          | 1          | 1          | 1          | 1          | 1          | 0          |
| - 64 dB | 0          | 0          | 0          | 0          | 0          | 0          | 1          |
| - 65 dB | 1          | 0          | 0          | 0          | 0          | 0          | 1          |
| - 66 dB | 0          | 1          | 0          | 0          | 0          | 0          | 1          |
| - 67 dB | 1          | 1          | 0          | 0          | 0          | 0          | 1          |
| - 68 dB | 0          | 0          | 1          | 0          | 0          | 0          | 1          |
| - 69 dB | 1          | 0          | 1          | 0          | 0          | 0          | 1          |
| - 70 dB | 0          | 1          | 1          | 0          | 0          | 0          | 1          |
| - 71 dB | 1          | 1          | 1          | 0          | 0          | 0          | 1          |
| - 72 dB | 0          | 0          | 0          | 1          | 0          | 0          | 1          |
| - 73 dB | 1          | 0          | 0          | 1          | 0          | 0          | 1          |
| - 74 dB | 0          | 1          | 0          | 1          | 0          | 0          | 1          |
| - 75 dB | 1          | 1          | 0          | 1          | 0          | 0          | 1          |
| - 76 dB | 0          | 0          | 1          | 1          | 0          | 0          | 1          |
| - 77 dB | 1          | 0          | 1          | 1          | 0          | 0          | 1          |
| - 78 dB | 0          | 1          | 1          | 1          | 0          | 0          | 1          |
| - 79 dB | 1          | 1          | 1          | 1          | 0          | 0          | 1          |
| - 80 dB | 0          | 0          | 0          | 0          | 1          | 0          | 1          |
| - 81 dB | 1          | 0          | 0          | 0          | 1          | 0          | 1          |
| - 82 dB | 0          | 1          | 0          | 0          | 1          | 0          | 1          |
| - 83 dB | 1          | 1          | 0          | 0          | 1          | 0          | 1          |
| - 84 dB | 0          | 0          | 1          | 0          | 1          | 0          | 1          |
| - 85 dB | 1          | 0          | 1          | 0          | 1          | 0          | 1          |
| - 86 dB | 0          | 1          | 1          | 0          | 1          | 0          | 1          |
| - 87 dB | 1          | 1          | 1          | 0          | 1          | 0          | 1          |
| - 88 dB | 0          | 0          | 0          | 1          | 1          | 0          | 1          |
| - 89 dB | 1          | 0          | 0          | 1          | 1          | 0          | 1          |
| - 90 dB | 0          | 1          | 0          | 1          | 1          | 0          | 1          |
| - 91 dB | 1          | 1          | 0          | 1          | 1          | 0          | 1          |
| - 92 dB | 0          | 0          | 1          | 1          | 1          | 0          | 1          |
| - 93 dB | 1          | 0          | 1          | 1          | 1          | 0          | 1          |
| - 94 dB | 0          | 1          | 1          | 1          | 1          | 0          | 1          |
| - 95 dB | 1          | 1          | 1          | 1          | 1          | 0          | 1          |
| - ∞ dB  | 0          | 0          | 0          | 0          | 0          | 1          | 1          |

## (3) Volume control select data

"A", "B", and "C" are data used to select volume controls.

"A" = 1 selects volume control VR-A, "B" = 1 selects volume control VR-B, "C" selects volume control VR-C.

("A" = "B" = "C" = 1 sets all volume controls simultaneously.)

## (4) Volume control switching timing

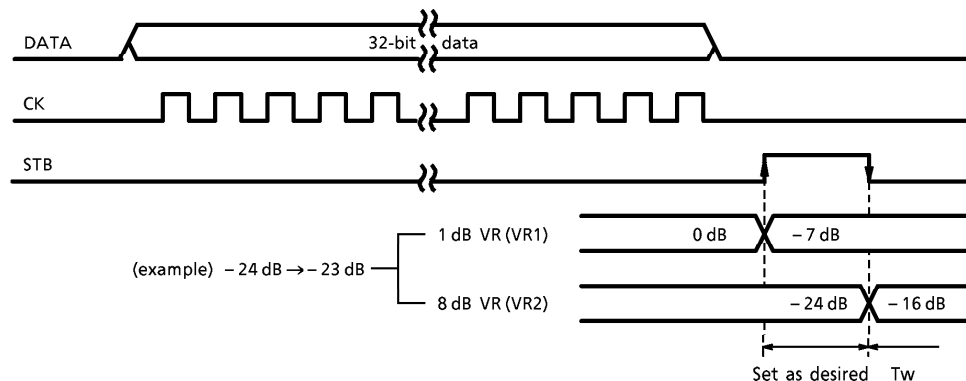
"S0" and "S1" are data used to set the timing of volume control switching.

Depending on the setting of "S0" and "S1", the timing for switching VR1 (1-dB step volume control) and VR2 (8-dB step volume control) can be selected as in sync with either the rise or the fall of the STB signal. Thus, noise generated at switching can be reduced by making the timing of VR1 and VR2 switching asynchronous when increasing or decreasing the volume.

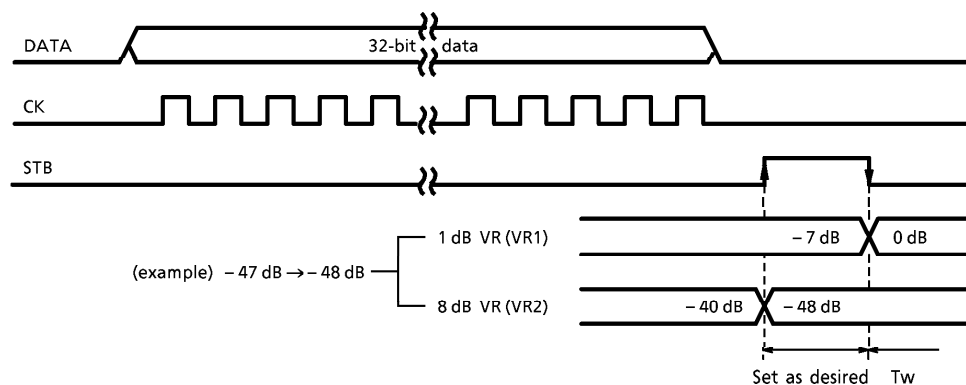
| S0 | S1 | VR1 | VR2 |
|----|----|-----|-----|
| 0  | 0  | ↑   | ↑   |
| 0  | 1  | ↑   | ↓   |
| 1  | 0  | ↓   | ↑   |
| 1  | 1  | ↓   | ↓   |

(\*) ↑ Indicates synchronization with the rise of the STB signal.  
↓ Indicates synchronization with the fall of the STB signal.

- Volume control switching timing at volume up (set "S0" to "0" and "S1" to "1")



- Volume switching timing at volume down (set "S0" to "1" and "S1" to "0")



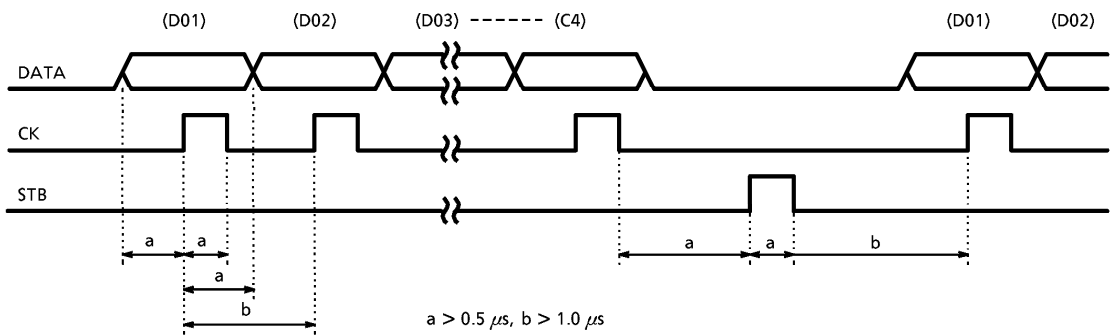
(5) Chip select code (C1 to C4)

Chip select code consists of four bits: "C1", "C2", "C3", and "C4".  
"C3" and "C4" are fixed to "01".  
"C1" and "C2" are variable bits. They are set according to the input level of pins CS1 and CS2.

| CS1 | CS2 | C1 | C2 | C3 | C4 |
|-----|-----|----|----|----|----|
| L   | L   | 0  | 0  | 0  | 1  |
| H   | L   | 1  | 0  | 0  | 1  |
| L   | H   | 0  | 1  | 0  | 1  |
| H   | H   | 1  | 1  | 0  | 1  |

3. Serial data timing

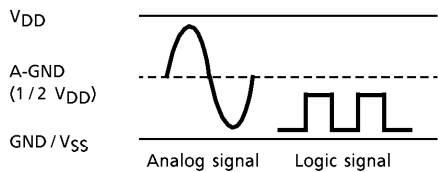
Make sure that CK, DATA and STB are input to the device at the timings shown below.



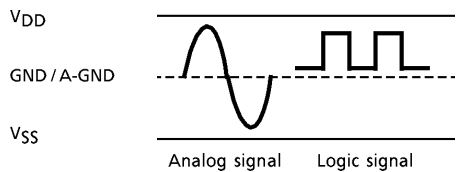
4. Operating with a single or dual power supplies

The TC9482N, TC9482F can operate off either a single power supply or dual power supplies.

● Operation off single power supply



● Operation off dual power supplies





## MAXIMUM RATINGS (Ta = 25°C)

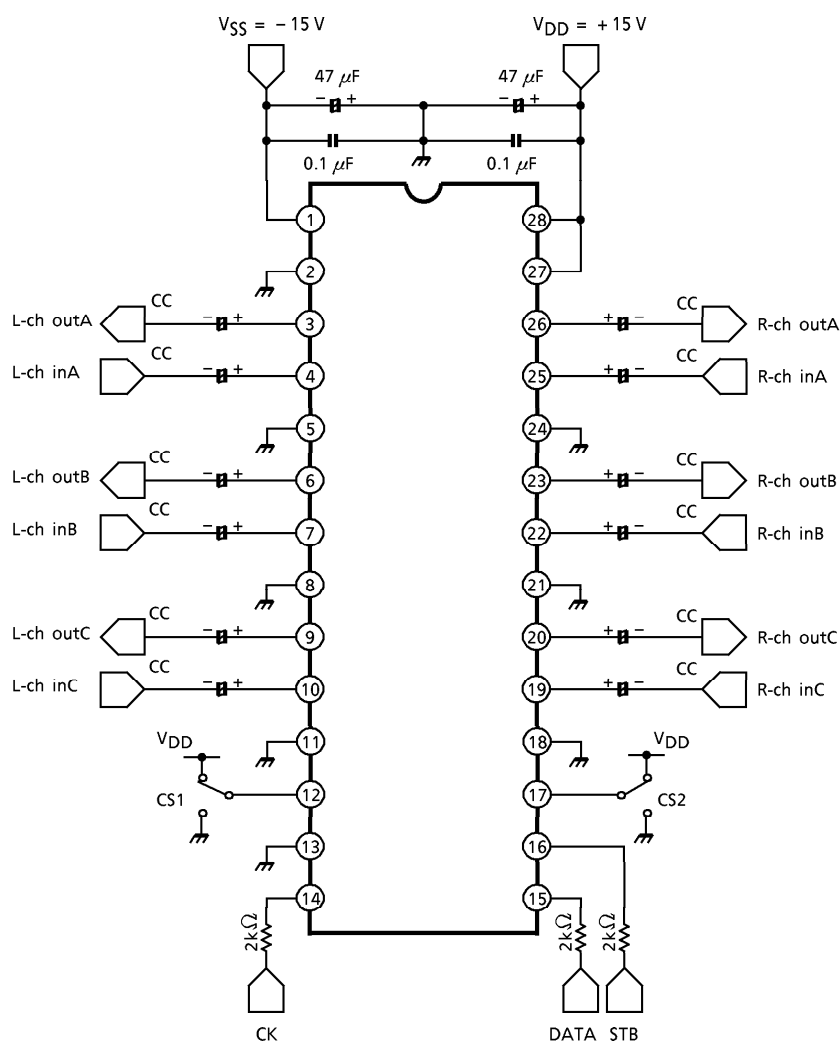
| CHARACTERISTIC          | SYMBOL           | RATING                    | UNIT |
|-------------------------|------------------|---------------------------|------|
| Power Supply Voltage    | V <sub>DD</sub>  | -0.3~36                   | V    |
| GND Block Input Voltage | V <sub>IN</sub>  | -0.3~V <sub>DD</sub> +0.3 | V    |
| Power Dissipation       | P <sub>D</sub>   | 300                       | mW   |
| Operating Temperature   | T <sub>opr</sub> | -40~85                    | °C   |
| Storage Temperature     | T <sub>stg</sub> | -65~150                   | °C   |

## ELECTRICAL CHARACTERISTICS

(Referenced to V<sub>DD</sub> = 15 V, V<sub>SS</sub> = -15 V at Ta = 25°C unless otherwise noted)

| CHARACTERISTIC               |                          | SYMBOL                           | TEST CIRCUIT | TEST CONDITION  | MIN.                 | TYP.  | MAX.                 | UNIT              |
|------------------------------|--------------------------|----------------------------------|--------------|---|----------------------|-------|----------------------|-------------------|
| Operating Supply Voltage (1) |                          | V <sub>DD</sub> -V <sub>SS</sub> | —            | Operating with dual power supplies  | 12.0                 | ~     | 34.0                 | V                 |
| Operating Supply Voltage (2) |                          | V <sub>DD</sub> -GND             | —            | Operating with single power supply  | 6.0                  | ~     | 18.0                 | V                 |
| Operating Supply Current     |                          | I <sub>DD</sub>                  | —            | Non-loaded, no input  | —                    | 6.0   | 12.0                 | mA                |
| Input Current                | "H"レベル                   | I <sub>IH</sub>                  | —            | CK, DATA, STB, V <sub>IN</sub> = V <sub>DD</sub><br>CS1, CS2 pins V <sub>IN</sub> = 0 V   | —                    | —     | 1.0                  | μA                |
|                              | "L"レベル                   | I <sub>IL</sub>                  |              |   | -1.0                 | —     | —                    |                   |
| Input Voltage (1)            | "H"レベル                   | V <sub>IH1</sub>                 | —            | CK, DATA, STB pins<br>V <sub>DD</sub> = 6.0~18.0V   | 4.0                  | ~     | V <sub>DD</sub>      | V                 |
|                              | "L"レベル                   | V <sub>IL1</sub>                 |              |   | 0.0                  | ~     | 1.0                  |                   |
| Input Voltage (2)            | "H"レベル                   | V <sub>IH2</sub>                 | —            | CS1, CS2 pins   | V <sub>DD</sub> ×0.7 | ~     | V <sub>DD</sub>      | V                 |
|                              | "L"レベル                   | V <sub>IL2</sub>                 |              |   | 0.0                  | ~     | V <sub>DD</sub> ×0.3 |                   |
| Resistance                   | VR1<br>Volume Resistance | R <sub>VR1</sub>                 | —            | —   | 14.0                 | 20.0  | 26.0                 | kΩ                |
|                              | VR2<br>Volume Resistance | R <sub>VR2</sub>                 |              |   | 35.0                 | 50.0  | 65.0                 |                   |
| Step Deviation               |                          | ΔV                               | —            | —   | -1.0                 | —     | 1.0                  | dB                |
| Total Harmonic Distortion    |                          | THD                              | —            | V <sub>IN</sub> = 1 V <sub>rms</sub><br>f <sub>IN</sub> = 1 kHz<br>R <sub>g</sub> = 600 Ω, R <sub>L</sub> = 100 kΩ<br>BW = 20 Hz ~ 20 kHz | —                    | 0.005 | —                    | %                 |
| Output Noise Voltage         |                          | V <sub>N</sub>                   |              |   | —                    | 1.2   | —                    | μV <sub>rms</sub> |
| Channel                      |                          | C·T                              |              |   | —                    | 80    | —                    | dB                |
| Maximum Attenuation          |                          | ATT-M                            |              |   | —                    | 100   | —                    | dB                |
| A-SW ON Resistance           |                          | R <sub>ON</sub>                  | —            | All A-SW  | —                    | 350   | 500                  | Ω                 |
| Clock Frequency              |                          | f <sub>CK</sub>                  | —            | CK, DATA, STB pins  | —                    | —     | 1.0                  | MHz               |
| Clock Timing                 |                          | T <sub>CK</sub>                  | —            | CK, DATA, STB pins  | 0.5                  | —     | —                    | μs                |

## EXAMPLE OF APPLICATION CIRCUIT

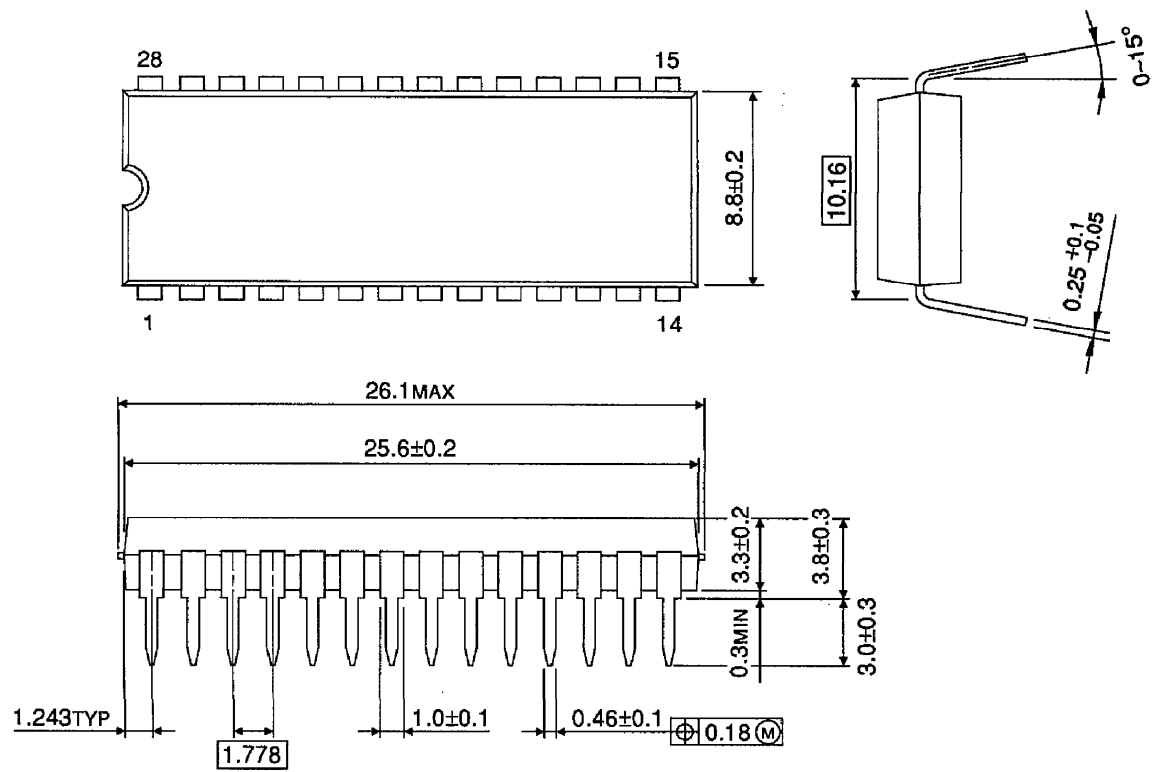


(\*) CC indicates the capacitor from  $1\text{ }\mu\text{F}$  to  $10\text{ }\mu\text{F}$ .

(Note) Since a high-frequency digital signal is input to the CK, DATA and STB pins, corrective measures must be taken to prevent it from getting mixed in the analog circuit to generate noise by, for example, guarding the above signal lines with ground patterns or using shielding wire for these lines.

PACKAGE DIMENSIONS  
SDIP28-P-400-1.78

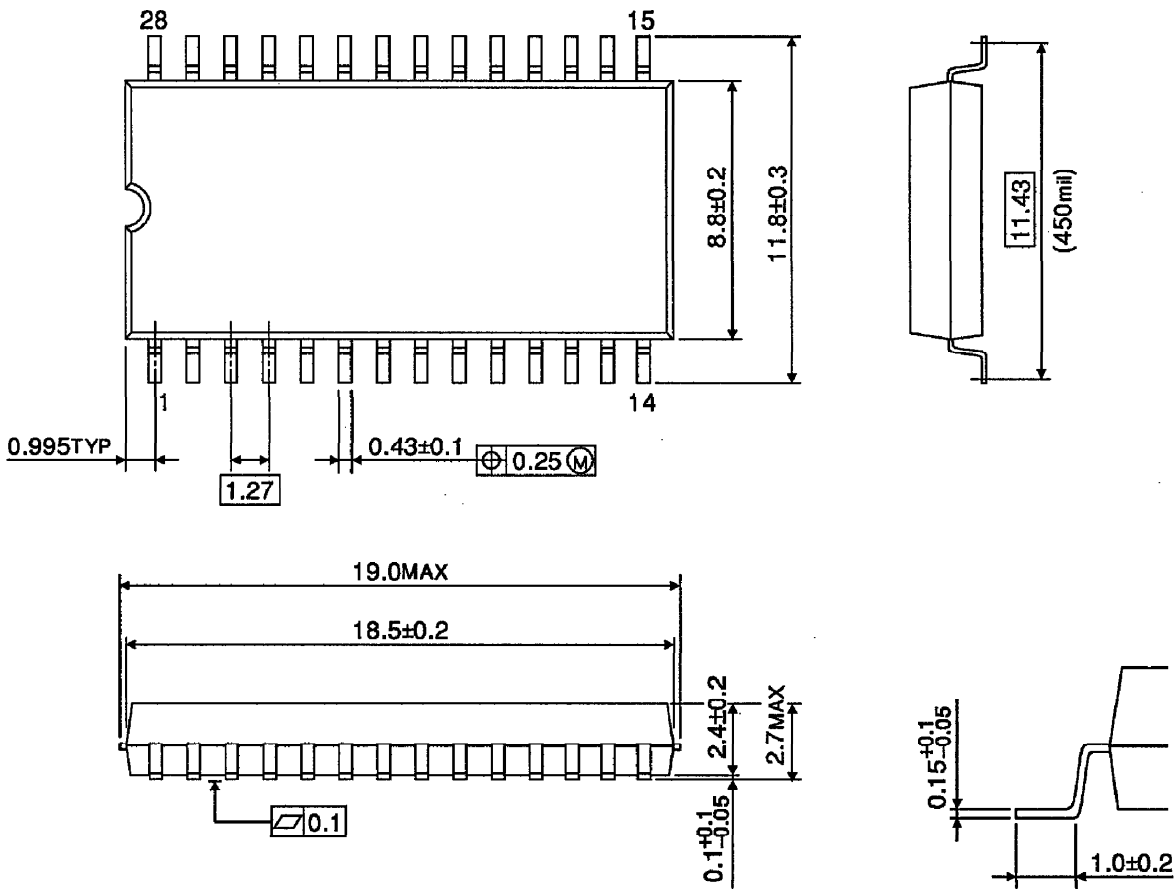
Unit : mm



Weight : 2.2g (Typ.)

PACKAGE DIMENSIONS  
SOP28-P-450-1.27

Unit : mm



Weight : 0.8g (Typ.)

**RESTRICTIONS ON PRODUCT USE**

000707EBA

- TOSHIBA is continually working to improve the quality and 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 comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products 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 TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc..
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk.
- The products described in this document are subject to the 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.