

TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

TC9459N, TC9459F

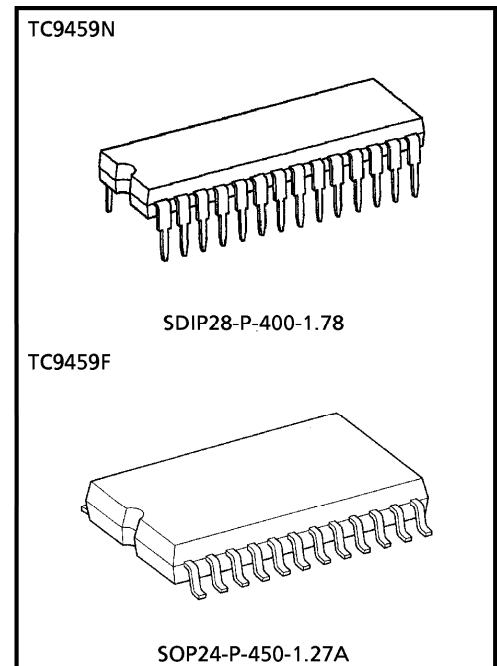
ELECTRONIC VOLUME CONTROL

The TC9459N, TC9459F are electronic volume control ICs developed for use in home stereos and other audio equipment.

Using serial data input from external sources, it controls the sound volume, balance and loudness circuits.

FEATURES

- Sound volume can be controlled in 91 steps from 0 to -89dB or up to an infinite level in 1dB increments.
- Incorporating two channels of volume control circuits, the device allows independent volume control : therefore, it also provides the balancing function.
- A loudness circuit (20dB tap) is built in.
- Can operate with a single or dual power supplies.
- Can control up to 4 chips on the same bus by using chip select input.
- Thanks to its polysilicon resistor, the device allows you to configure a low-distortion, high-performance volume control system.

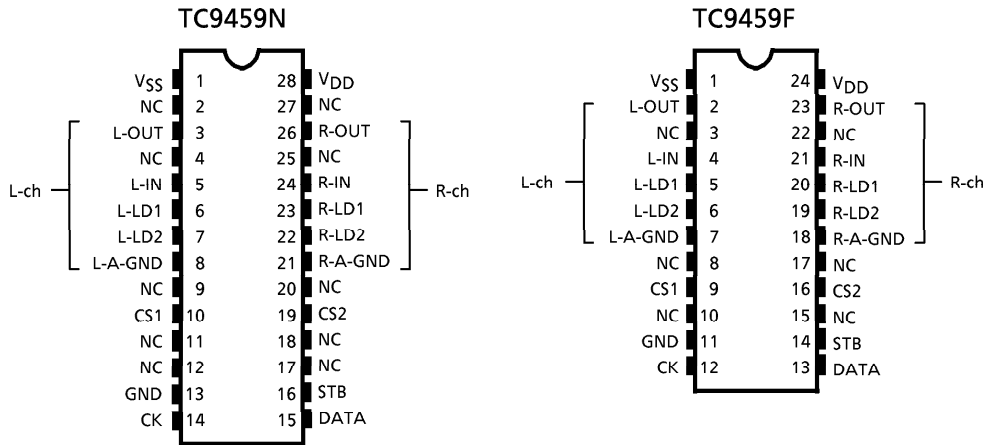


Weight

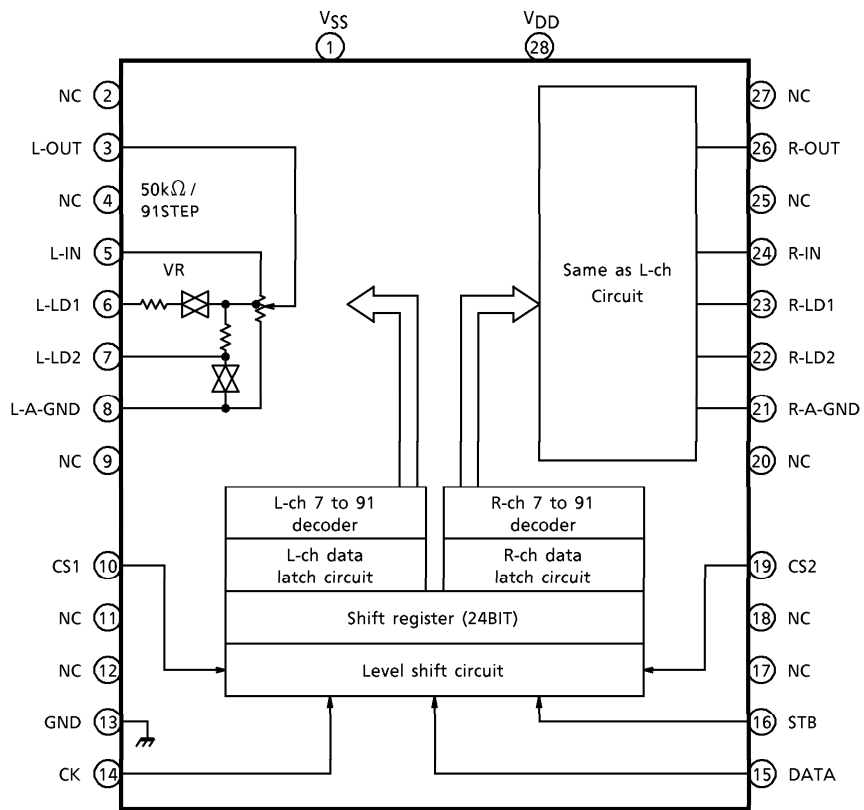
SDIP28-P-400-1.78 : 2.2g (Typ.)

SOP24-P-450-1.27A : 0.44g (Typ.)

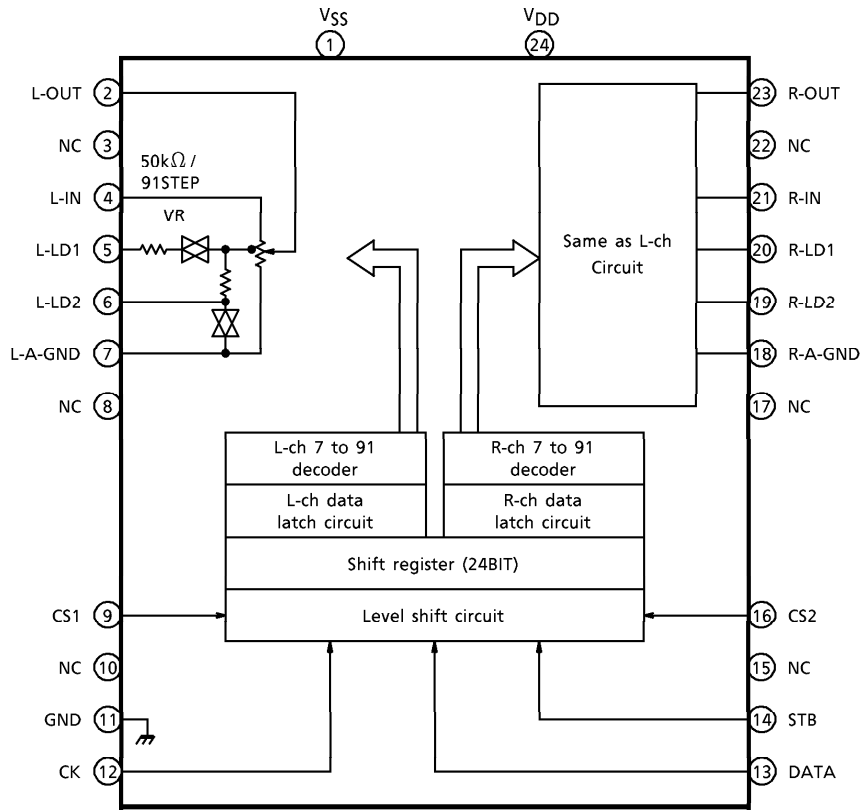
PIN CONNECTIONS



BLOCK DIAGRAM (TC9459N)



BLOCK DIAGRAM (TC9459F)



PIN DESCRIPTION

Numeral in () means the pin No. of TC9459F.

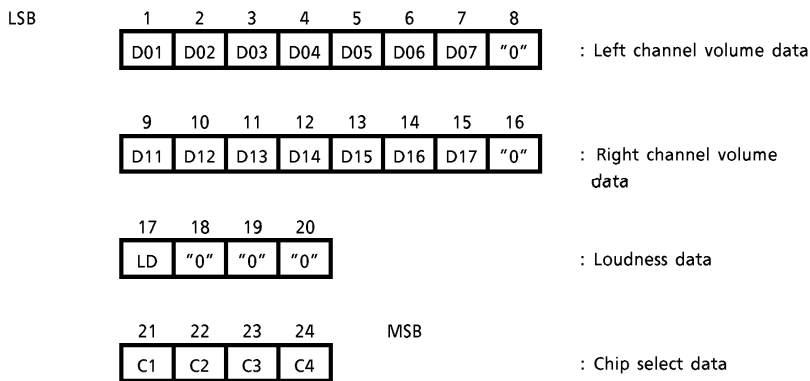
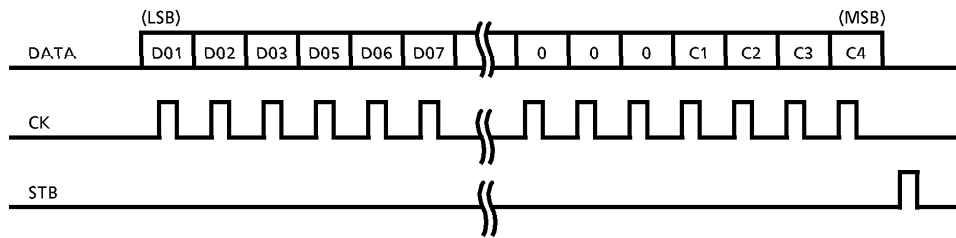
| PIN No. | SYMBOL | PIN NAME | FUNCTION | REMARK | | | | | | | | | | |
|----------------|-----------------|---------------------------|--|-------------------------------|--|-----|-----|-----|---------------|----|-----|----------------|-----|----|
| 1 (1) | V _{SS} | Negative power supply pin | When using dual power supplies <ul style="list-style-type: none"> V_{DD} = 6.0~17V GND = 0V V_{SS} = -6.0~-17V When using a single power supply <ul style="list-style-type: none"> V_{DD} = 6.0~18V GND = V_{SS} = 0V | — | | | | | | | | | | |
| 28 (24) | V _{DD} | Positive power supply pin | | | | | | | | | | | | |
| 13 (11) | GND | Digital GND pin | | | | | | | | | | | | |
| 3 (2) | L-OUT | Volume output pin | • Volume circuit | — | | | | | | | | | | |
| 26 (23) | R-OUT | | | | | | | | | | | | | |
| 5 (4) | L-IN | Volume input pin | | | | | | | | | | | | |
| 24 (21) | R-IN | | | | | | | | | | | | | |
| 6 (5) | L-LD1 | Loudness tap output pin | | | <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td style="width: 50%;"></td> <td style="width: 25%;">LA1</td> <td style="width: 25%;">LA2</td> </tr> <tr> <td>LOUDNESS "ON"</td> <td>ON</td> <td>OFF</td> </tr> <tr> <td>LOUDNESS "OFF"</td> <td>OFF</td> <td>ON</td> </tr> </table> | | LA1 | LA2 | LOUDNESS "ON" | ON | OFF | LOUDNESS "OFF" | OFF | ON |
| | LA1 | | | | | LA2 | | | | | | | | |
| LOUDNESS "ON" | ON | | | | | OFF | | | | | | | | |
| LOUDNESS "OFF" | OFF | | | | | ON | | | | | | | | |
| 23 (20) | R-LD1 | | | | | | | | | | | | | |
| 7 (6) | L-LD2 | | | | | | | | | | | | | |
| 22 (19) | R-LD2 | | | | | | | | | | | | | |
| 8 (7) | L-A-GND | Analog GND pin | | | | | | | | | | | | |
| 21 (18) | R-A-GND | | | | | | | | | | | | | |
| 10 (9) | CS1 | Chip select input pin | Up to 4 chips on the same bus can be used by switching over chip select code. | — | | | | | | | | | | |
| 19 (16) | CS2 | | | | | | | | | | | | | |
| 14 (12) | CK | Clock input pin | Data transfer clock input | Low threshold value input pin | | | | | | | | | | |
| 15 (13) | DATA | Data input pin | Volume setup serial data input | | | | | | | | | | | |
| 16 (14) | STB | Strobe input pin | Data write strobe input | | | | | | | | | | | |
| 2 (3) | NC | No connection | — | — | | | | | | | | | | |
| 27 (22) | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | |
| 9 (8) | | | | | | | | | | | | | | |
| 20 (17) | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | |
| 12 (10) | | | | | | | | | | | | | | |
| 17 (15) | | | | | | | | | | | | | | |

DEVICE OPERATION

1. Setting up volume value (amount of attenuation)

Serial data consisting of 24bits is used to set a volume value.

- Data format



(1) Chip select data

The bits "C1" through "C4" are the chip select code data. These bits set the code data that corresponds to the CS1 and CS2 inputs.

| 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 |

(2) Loudness setting

The bit "LD" is the loudness setup data. Loudness is turned on when LD = 1.

(3) Volume setup data

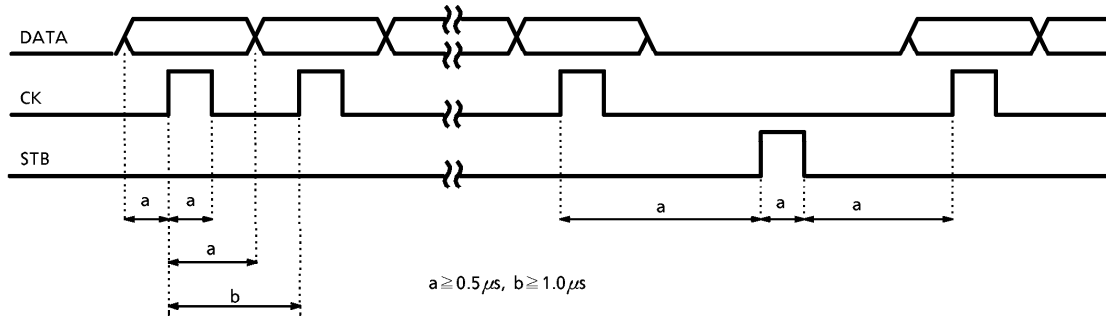
The bits "D01" through "D07" are the left channel volume setup data, the bits "D11" through "D17" are the right channel volume setup data. For details, see the tables below.

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

| VOLUME VALUE | D01 D11 | D02 D12 | D03 D13 | D04 D14 | D05 D15 | D06 D16 | D07 D17 |
|--------------|---------|---------|---------|---------|---------|---------|---------|
| -46dB | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| -47 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| -48 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| -49 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| -50 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| -51 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| -52 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| -53 | 1 | 0 | 1 | 0 | 1 | 1 | 0 |
| -54 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| -55 | 1 | 1 | 1 | 0 | 1 | 1 | 0 |
| -56 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| -57 | 1 | 0 | 0 | 1 | 1 | 1 | 0 |
| -58 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| -59 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |
| -60 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |
| -61 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |
| -62 | 0 | 1 | 1 | 1 | 1 | 1 | 0 |
| -63 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| -64 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| -65 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| -66 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| -67 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| -68 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| -69 | 1 | 0 | 1 | 0 | 0 | 0 | 1 |
| -70 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| -71 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| -72 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| -73 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| -74 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| -75 | 1 | 1 | 0 | 1 | 0 | 0 | 1 |
| -76 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |
| -77 | 1 | 0 | 1 | 1 | 0 | 0 | 1 |
| -78 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| -79 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |
| -80 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| -81 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| -82 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
| -83 | 1 | 1 | 0 | 0 | 1 | 0 | 1 |
| -84 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| -85 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| -86 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |
| -87 | 1 | 1 | 1 | 0 | 1 | 0 | 1 |
| -88 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| -89 | 1 | 0 | 0 | 1 | 1 | 0 | 1 |
| -∞ | 0 | 1 | 0 | 1 | 1 | 0 | 1 |

2. Serial data timing

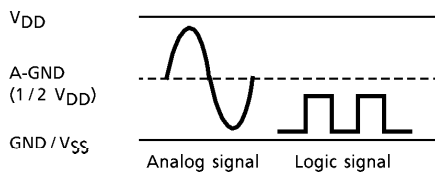
Make sure that CK, DATA and STB are input to the device at the timings shown below.



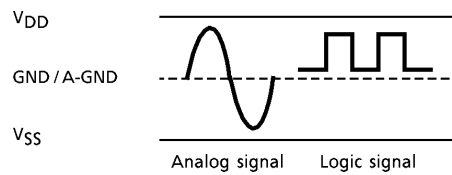
3. Operating with a single or dual power supplies

The TC9459N, TC9459F can operate with either a single power supply or dual power supplies.

● Operation with single power supply



● Operation with dual power supplies



MAXIMUM RATINGS (Ta = 25°C)

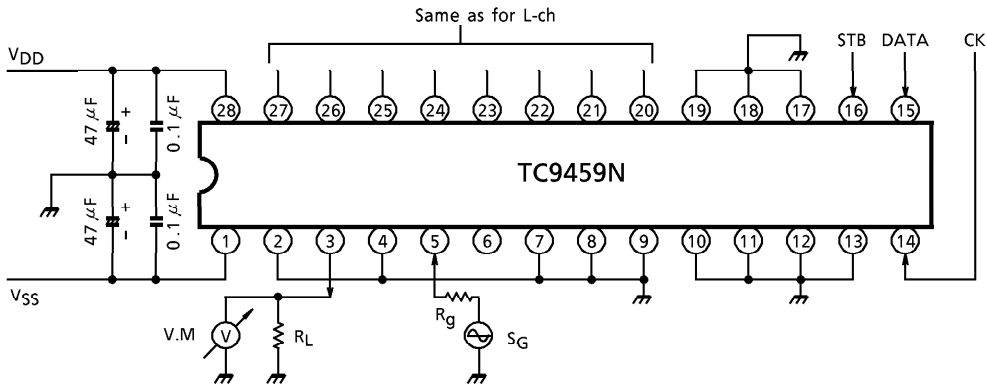
| CHARACTERISTIC | SYMBOL | RATING | UNIT |
|-------------------------------------|----------------------------------|---|------|
| Supply Voltage (1) | V _{DD} -V _{SS} | -0.3~36 | V |
| Supply Voltage (2) | V _{DD} -GND | -0.3~20 | V |
| GND Block Input Voltage | V _{IN} (1) | -0.3~V _{DD} + 0.3 | V |
| V _{SS} Block Input Voltage | V _{IN} (2) | V _{SS} - 0.3~V _{DD} + 0.3 | V |
| Power Dissipation | P _D | 300 | mW |
| Operating Temperature | T _{opr} | -40~85 | °C |
| Storage Temperature | T _{stg} | -65~150 | °C |

ELECTRICAL CHARACTERISTICS

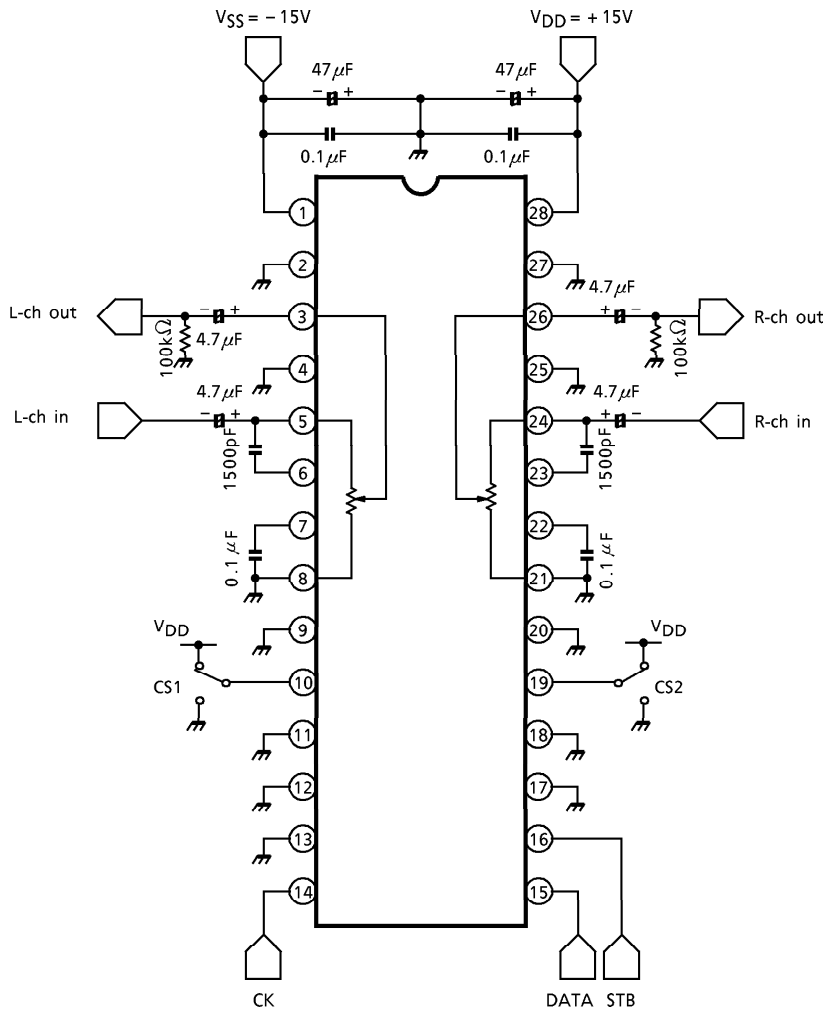
(Referenced to V_{DD} = 15V, V_{SS} = -15V, GND = 0V at Ta = 25°C unless otherwise noted)

| CHARACTERISTIC | SYMBOL | TEST CIRCUIT | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|-------------------------------|----------------------------------|---------------------|---|-----------------------|-------|-----------------------|-------------------|
| Operating Supply Voltage (1) | V _{DD} -V _{SS} | — | Operating with dual power supplies | 12 | ~ | 34 | V |
| Operating Supply Voltage (2) | V _{DD} -GND | — | Operating with single power supply | 6.0 | ~ | 18 | V |
| Operating Supply Current | I _{DD} | 1 | Non-loaded, no input | — | 0.5 | 2.0 | mA |
| Input Voltage | "H" Level | V _{IH} (1) | CK, DATA, STB pins V _{DD} = 6.0~18V | 4.0 | ~ | V _{DD} | V |
| | "L" Level | V _{IL} (1) | | GND | ~ | 1.0 | |
| Input Voltage | "H" Level | V _{IH} (2) | CS1 and CS2 pins | V _{DD} × 0.7 | ~ | V _{DD} | V |
| | "L" Level | V _{IL} (2) | | GND | ~ | V _{DD} × 0.3 | |
| Input Current | "H" Level | I _{IH} | CK, DATA, STB, CS1, CS2 pins V _{IH} = 15V V _{IL} = 0V | -1.0 | ~ | 1.0 | μA |
| | "L" Level | I _{IL} | | -1.0 | ~ | 1.0 | |
| Operating Frequency | f _{op} | — | CK, DATA, STB pins | 0 | ~ | 1.0 | MHz |
| Min. Operating Clock Width | T _{ck} | — | | 0.5 | — | — | μs |
| Volume Resistance | R _{VR} | — | When loudness OFF | 20.5 | 29.3 | 38.2 | kΩ |
| Step Deviation | ΔVR | — | Deviation between volume steps | -1.2 | ~ | 1.2 | dB |
| Analog Switch ON-Resistance | R _{ON} (1) | — | Analog switch LA2 only | — | 350 | — | Ω |
| | R _{ON} (2) | — | All analog switch except for LA2 | — | 750 | 1500 | |
| Analog Switch Leakage Current | I _{OFF} | — | Internal analog switch | -0.1 | ~ | 0.1 | μA |
| Total Harmonic Distortion | THD | 1 | f _{IN} = 1kHz V _{IN} = 1V _{rms} R _g = 600Ω, R _L = 100kΩ BW = 20Hz~20kHz | — | 0.005 | — | % |
| Maximum Attenuation | ATT _{MAX} | | | — | 100 | — | dB |
| Output Noise Voltage | V _N | | | — | 1.0 | — | μV _{rms} |
| Crosstalk | C-T | | | — | 100 | — | dB |

TEST CIRCUIT 1 (I_{DD} /THD/ATT_{MAX}/V_N/CT)



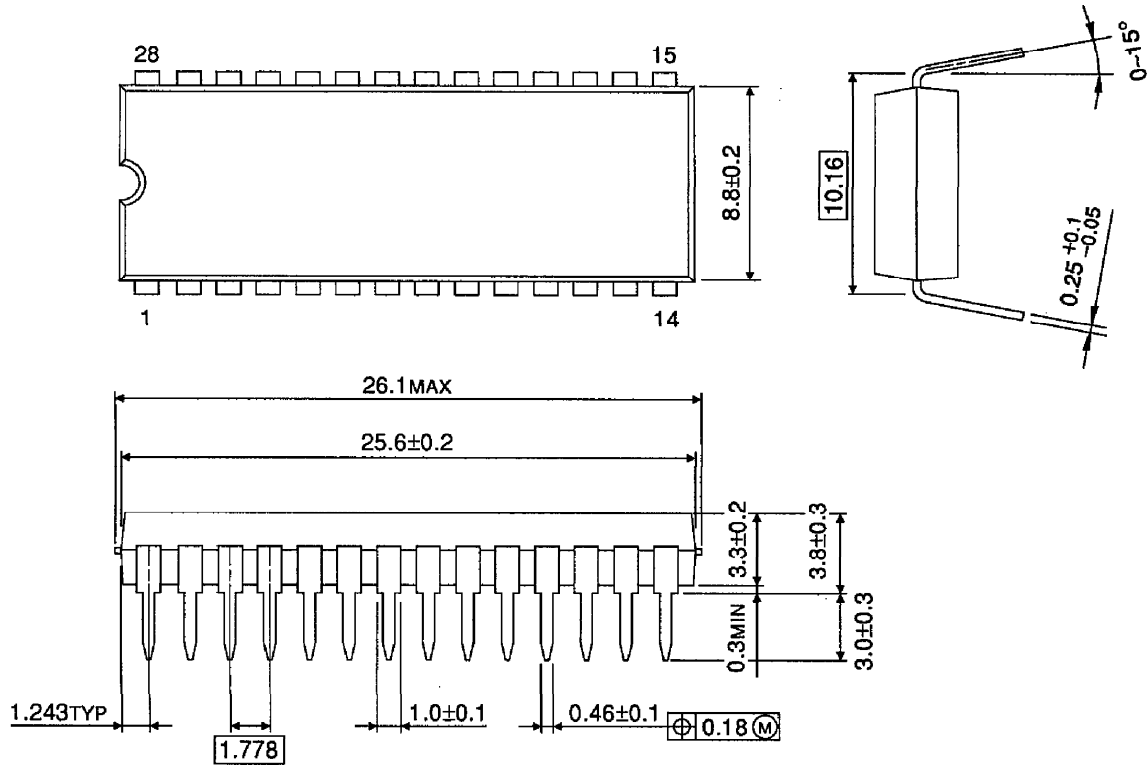
EXAMPLE OF APPLICATION CIRCUIT (TC9459N)



(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

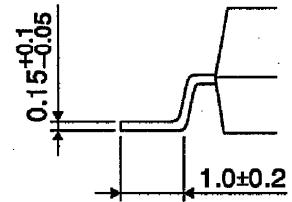
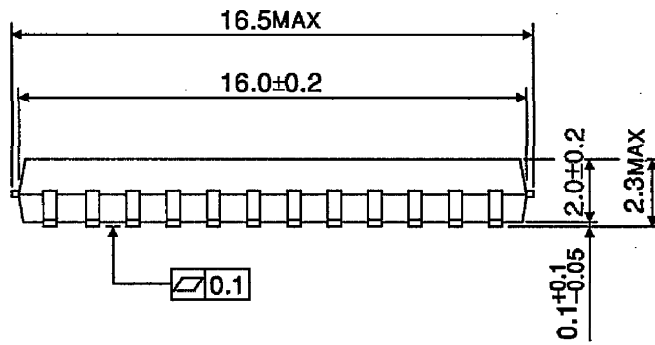
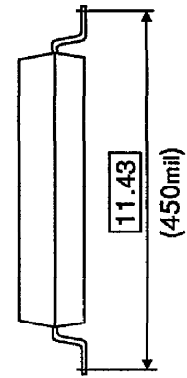
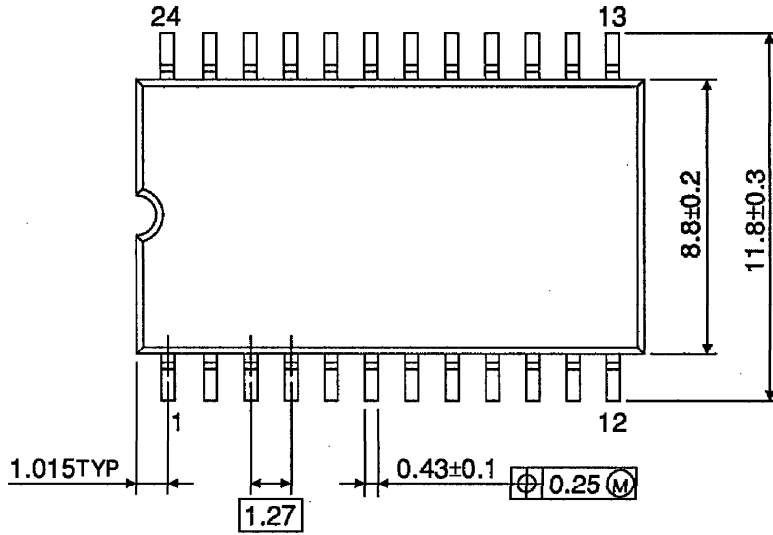
Unit : mm



Weight : 2.2g (Typ.)

PACKAGE DIMENSIONS
SOP24-P-450-1.27A

Unit : mm



Weight : 0.44g (Typ.)

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000707EBA

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