

TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

TC9422N, TC9422F

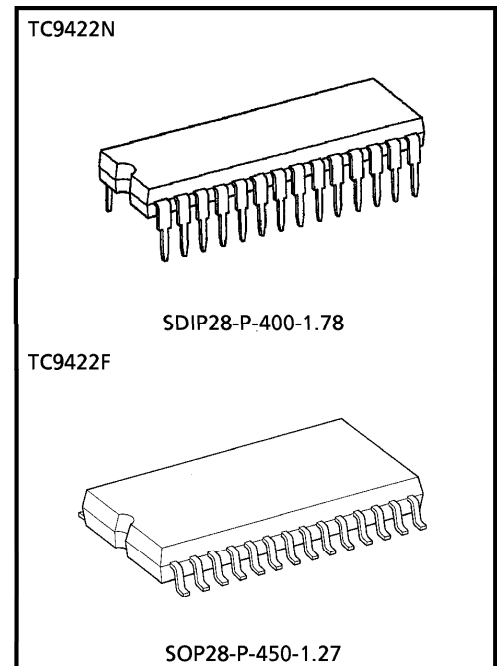
SYSTEM ELECTRONIC VOLUME

TC9422N and TC9422F are single-chip electronic volume IC incorporating an op amp circuit developed for portable audio equipment.

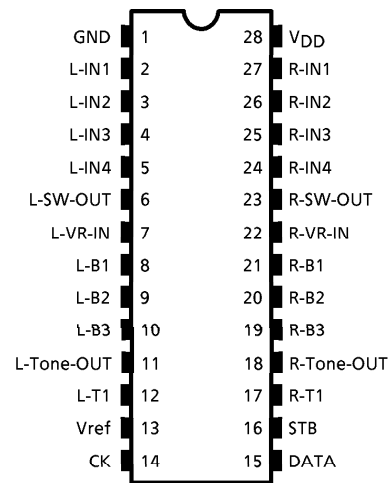
With a few external parts, TC9422N and TC9422F can control a wide range of audio functions, including main volume, balance, fader, bass, treble, loudness, and input switching.

FEATURES

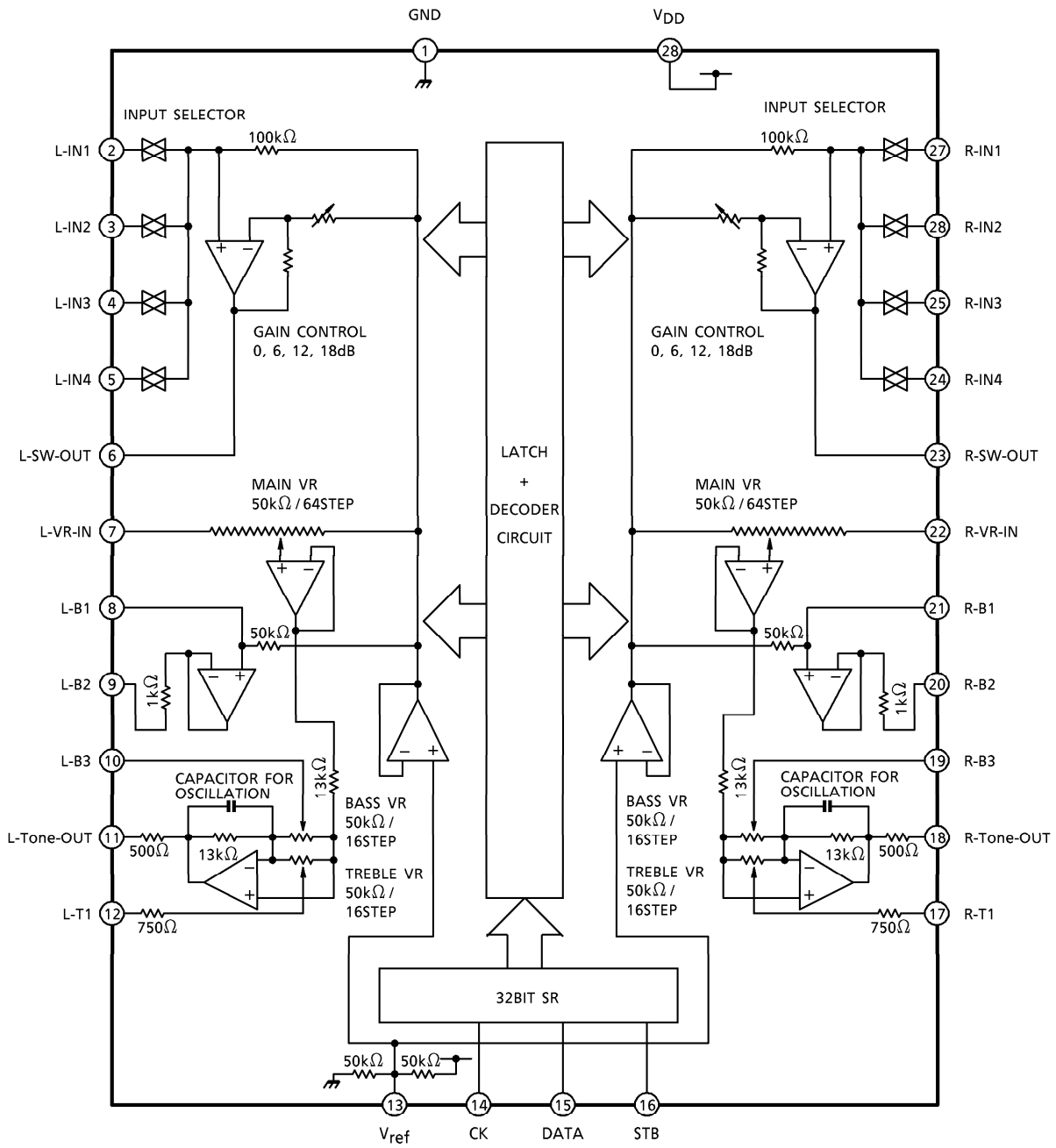
- Tone control : 18dB or -12dB for both bass and treble (16 positions)
- Input selector : Any of four input signals can be amplified with any of four gain options : 0dB, 6dB, 12dB, or 18dB
- Main volume : Offers 64dB positions of separate left and right control over the range 0~ -78dB and ∞ (in 1dB~2dB /steps).
- Incorporates op amp circuit, reducing external parts.
- Incorporates an interface for a 5V-system microcomputer.
- The Si-gate process achieved a high-performance volume system.



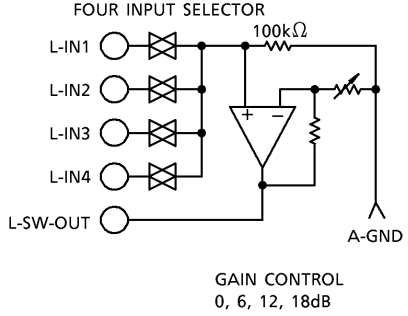
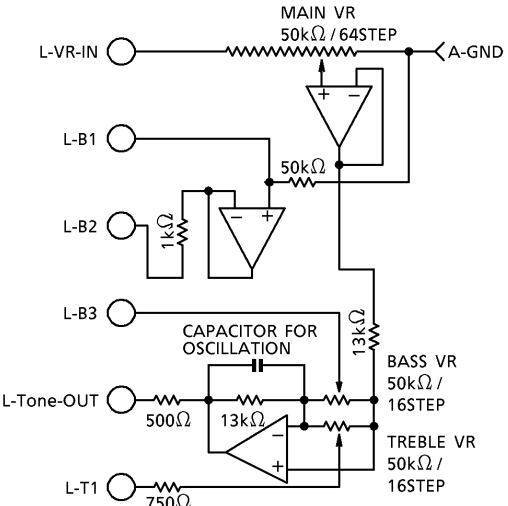
Weight
 SDIP28-P-400-1.78 : 2.2g (Typ.)
 SOP28-P-450-1.27 : 0.8g (Typ.)

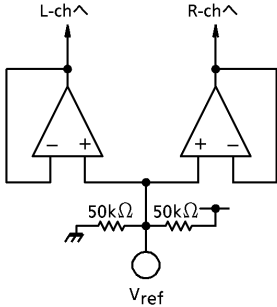
PIN CONNECTION

BLOCK DIAGRAM



DESCRIPTION OF PINS

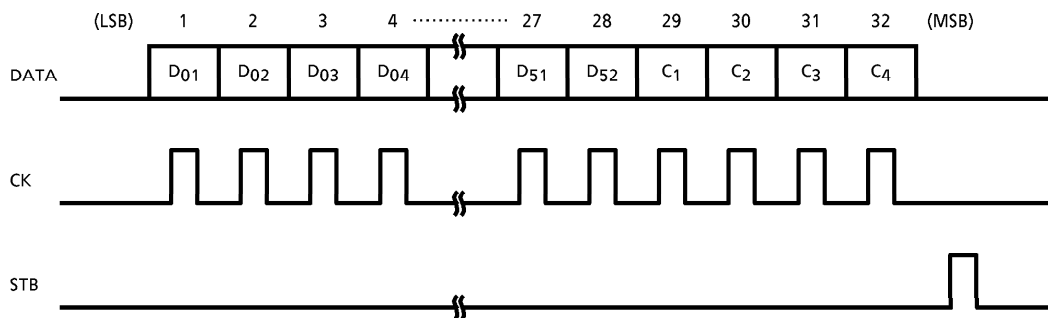
| PIN No. | SYMBOL | PIN NAME | FUNCTION AND OPERATION | REMARKS |
|---------|-----------------|---------------------------------|--|---------|
| 28 | V _{DD} | Power supply voltage pin | <ul style="list-style-type: none"> Power supply pins | — |
| 1 | GND | Ground pin | | |
| 2 | L-IN1 | Audio signal input pins | <ul style="list-style-type: none"> Four input selector circuits Op amp circuit gain can be set to 0dB, 6dB, 12dB, or 18dB  <p>FOUR INPUT SELECTOR</p> <p>GAIN CONTROL 0, 6, 12, 18dB</p> | — |
| 27 | R-IN1 | | | |
| 3 | L-IN2 | | | |
| 26 | R-IN2 | | | |
| 4 | L-IN3 | | | |
| 25 | R-IN3 | | | |
| 5 | L-IN4 | | | |
| 24 | R-IN4 | | | |
| 6 | L-SW-OUT | | | |
| 23 | R-SW-OUT | | | |
| 7 | L-VR-IN | Main volume input pins | <ul style="list-style-type: none"> A main volume circuit and two-band tone control circuits for bass and treble A bass circuit can connect an external capacitor with an operational amplifier in which builds active filter. An external capacitor can connect with a treble circuit.  <p>MAIN VR 50kΩ / 64STEP</p> <p>BASS VR 50kΩ / 16STEP</p> <p>TREBLE VR 50kΩ / 16STEP</p> <p>CAPACITOR FOR OSCILLATION</p> | — |
| 22 | R-VR-IN | | | |
| 8 | L-B1 | Tone control tap pin 1 for bus | | |
| 21 | R-B1 | | | |
| 9 | L-B2 | Tone control tap pin 2 for bus | | |
| 20 | R-B2 | | | |
| 10 | L-B3 | Tone control tap pin 3 for bus | | |
| 19 | R-B3 | | | |
| 11 | L-Tone-OUT | Tone control output pins | | |
| 18 | R-Tone-OUT | | | |
| 12 | L-T1 | Tone control tap pin for treble | | |
| 17 | R-T1 | | | |

| PIN No. | SYMBOL | PIN NAME | FUNCTION AND OPERATION | REMARKS |
|---------|--------|-----------------------------|---|--------------------------------|
| 13 | Vref | Reference voltage input pin | <ul style="list-style-type: none"> Used to determine internal op amp reference voltage (A-GND) Incorporates resistor for dividing voltage between V_{DD} and GND (Typ. V_{REF} = V_{DD} / 2)  | — |
| 14 | CK | Clock input pin | <ul style="list-style-type: none"> Serial data transfer clock input pin | Low threshold value input pins |
| 15 | DATA | Data input pin | <ul style="list-style-type: none"> Control data input pin | |
| 16 | STB | Strobe input pin | <ul style="list-style-type: none"> Data write strobe input pin | |

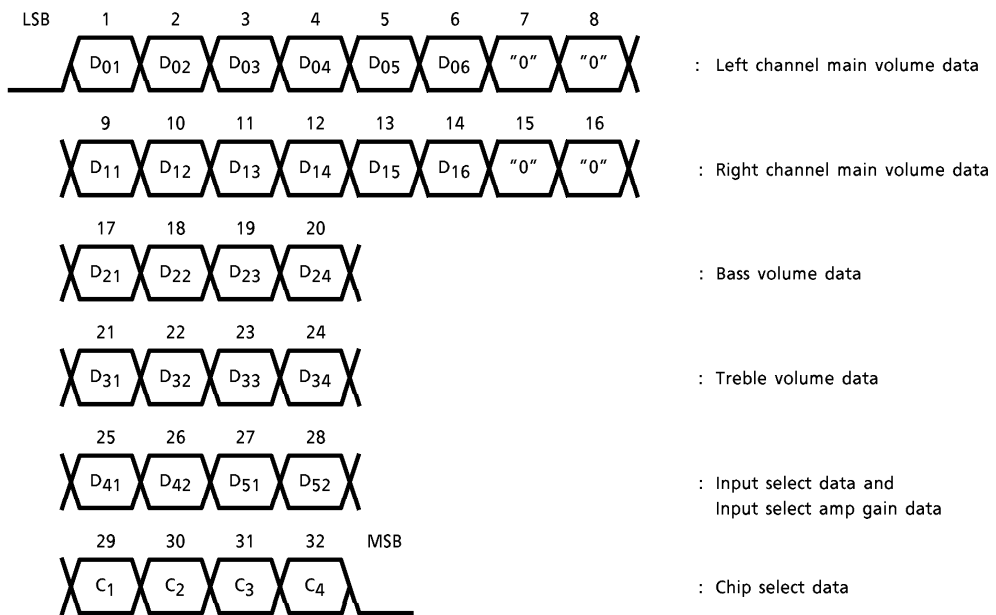
OPERATION

1. Volume data setting

Set volume using serial data input from the CK, DATA, and STB pins. Volume data contain 32 bits.



1) Volume control data assignment



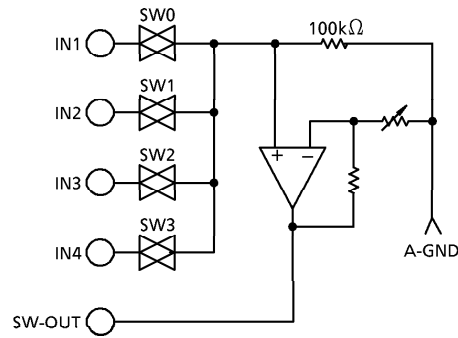
2) Chip select data (C₁~C₄)

Chip select code to enable serial data line to be shared with other ICs.

For TC9422N and TC9422F, set C₁ = "0", C₂ = "1", C₃ = "0", C₄ = "1" (0101 : AH).

2. Input select circuit

1) Equivalent circuit



2) Input select and gain settings

- Input select settings

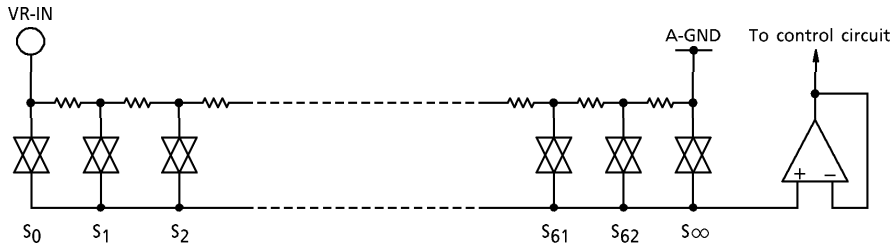
| INPUT DATA | | INPUT SELECT ANALOG SWITCH | | | |
|------------|-----|----------------------------|-----|-----|-----|
| D41 | D42 | SW0 | SW1 | SW2 | SW3 |
| 0 | 0 | ON | OFF | OFF | OFF |
| 1 | 0 | OFF | ON | OFF | OFF |
| 0 | 1 | OFF | OFF | ON | OFF |
| 1 | 1 | OFF | OFF | OFF | ON |

- Gain setting

| INPUT DATA | | GAIN |
|------------|-----|------|
| D51 | D52 | |
| 0 | 0 | 0dB |
| 1 | 0 | 6dB |
| 0 | 1 | 12dB |
| 1 | 1 | 18dB |

3. Main volume circuit

1) Equivalent circuit



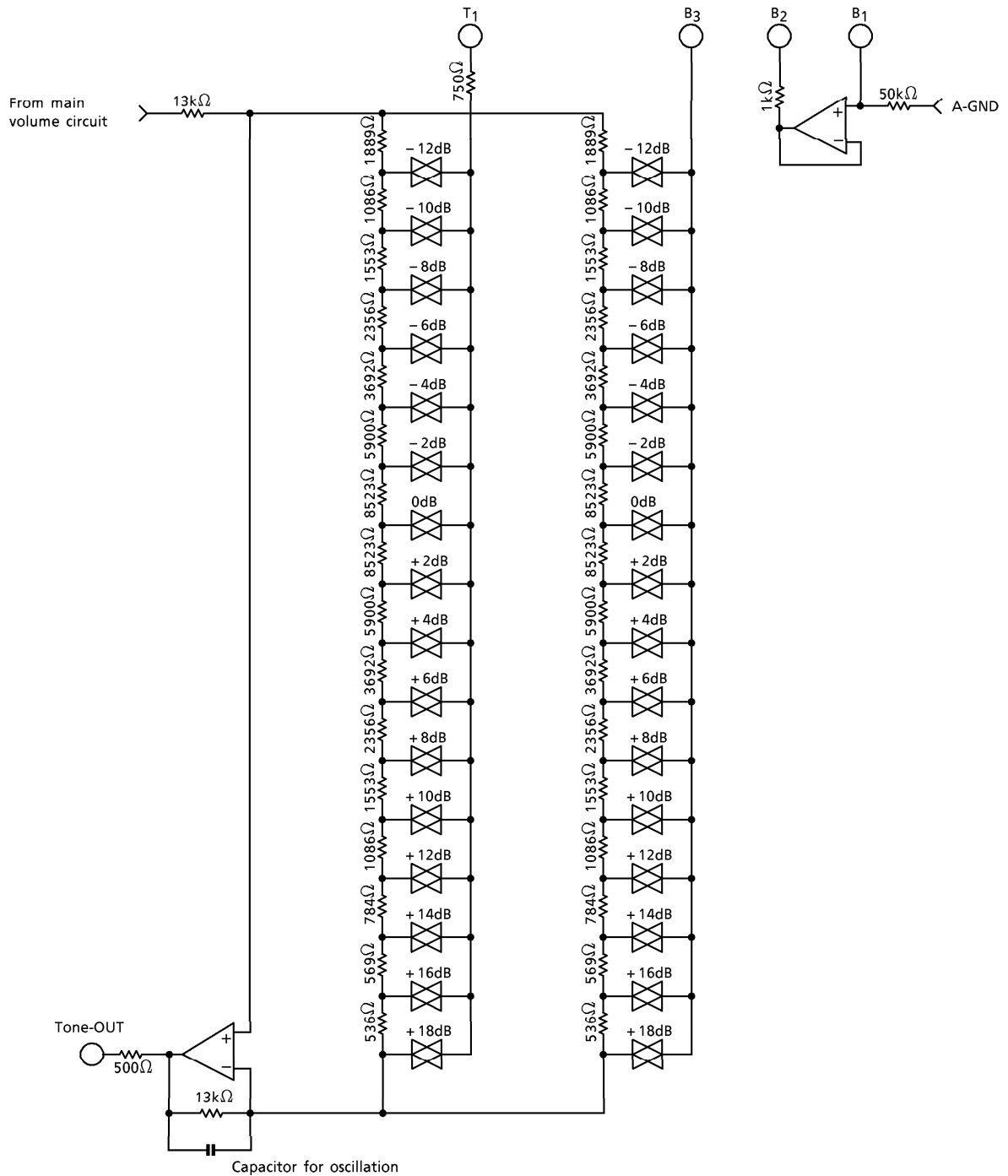
2) Main volume settings

| STEP | D01 D11 | D02 D12 | D03 D13 | D04 D14 | D05 D15 | D06 D16 |
|-------|------------|------------|------------|------------|------------|------------|
| 0dB | 0 | 0 | 0 | 0 | 0 | 0 |
| -1dB | 1 | 0 | 0 | 0 | 0 | 0 |
| -2dB | 0 | 1 | 0 | 0 | 0 | 0 |
| -3dB | 1 | 1 | 0 | 0 | 0 | 0 |
| -4dB | 0 | 0 | 1 | 0 | 0 | 0 |
| -5dB | 1 | 0 | 1 | 0 | 0 | 0 |
| -6dB | 0 | 1 | 1 | 0 | 0 | 0 |
| -7dB | 1 | 1 | 1 | 0 | 0 | 0 |
| -8dB | 0 | 0 | 0 | 1 | 0 | 0 |
| -9dB | 1 | 0 | 0 | 1 | 0 | 0 |
| -10dB | 0 | 1 | 0 | 1 | 0 | 0 |
| -11dB | 1 | 1 | 0 | 1 | 0 | 0 |
| -12dB | 0 | 0 | 1 | 1 | 0 | 0 |
| -13dB | 1 | 0 | 1 | 1 | 0 | 0 |
| -14dB | 0 | 1 | 1 | 1 | 0 | 0 |
| -15dB | 1 | 1 | 1 | 1 | 0 | 0 |
| -16dB | 0 | 0 | 0 | 0 | 1 | 0 |
| -17dB | 1 | 0 | 0 | 0 | 1 | 0 |
| -18dB | 0 | 1 | 0 | 0 | 1 | 0 |
| -19dB | 1 | 1 | 0 | 0 | 1 | 0 |
| -20dB | 0 | 0 | 1 | 0 | 1 | 0 |
| -21dB | 1 | 0 | 1 | 0 | 1 | 0 |
| -22dB | 0 | 1 | 1 | 0 | 1 | 0 |
| -23dB | 1 | 1 | 1 | 0 | 1 | 0 |
| -24dB | 0 | 0 | 0 | 1 | 1 | 0 |
| -25dB | 1 | 0 | 0 | 1 | 1 | 0 |
| -26dB | 0 | 1 | 0 | 1 | 1 | 0 |
| -27dB | 1 | 1 | 0 | 1 | 1 | 0 |
| -28dB | 0 | 0 | 1 | 1 | 1 | 0 |
| -29dB | 1 | 0 | 1 | 1 | 1 | 0 |
| -30dB | 0 | 1 | 1 | 1 | 1 | 0 |
| -31dB | 1 | 1 | 1 | 1 | 1 | 0 |

| STEP | D01 D11 | D02 D12 | D03 D13 | D04 D14 | D05 D15 | D06 D16 |
|-------|------------|------------|------------|------------|------------|------------|
| -32dB | 0 | 0 | 0 | 0 | 0 | 1 |
| -33dB | 1 | 0 | 0 | 0 | 0 | 1 |
| -34dB | 0 | 1 | 0 | 0 | 0 | 1 |
| -35dB | 1 | 1 | 0 | 0 | 0 | 1 |
| -36dB | 0 | 0 | 1 | 0 | 0 | 1 |
| -37dB | 1 | 0 | 1 | 0 | 0 | 1 |
| -38dB | 0 | 1 | 1 | 0 | 0 | 1 |
| -39dB | 1 | 1 | 1 | 0 | 0 | 1 |
| -40dB | 0 | 0 | 0 | 1 | 0 | 1 |
| -41dB | 1 | 0 | 0 | 1 | 0 | 1 |
| -42dB | 0 | 1 | 0 | 1 | 0 | 1 |
| -43dB | 1 | 1 | 0 | 1 | 0 | 1 |
| -44dB | 0 | 0 | 1 | 1 | 0 | 1 |
| -45dB | 1 | 0 | 1 | 1 | 0 | 1 |
| -46dB | 0 | 1 | 1 | 1 | 0 | 1 |
| -48dB | 1 | 1 | 1 | 1 | 0 | 1 |
| -50dB | 0 | 0 | 0 | 0 | 1 | 1 |
| -52dB | 1 | 0 | 0 | 0 | 1 | 1 |
| -54dB | 0 | 1 | 0 | 0 | 1 | 1 |
| -56dB | 1 | 1 | 0 | 0 | 1 | 1 |
| -58dB | 0 | 0 | 1 | 0 | 1 | 1 |
| -60dB | 1 | 0 | 1 | 0 | 1 | 1 |
| -62dB | 0 | 1 | 1 | 0 | 1 | 1 |
| -64dB | 1 | 1 | 1 | 0 | 1 | 1 |
| -66dB | 0 | 0 | 0 | 1 | 1 | 1 |
| -68dB | 1 | 0 | 0 | 1 | 1 | 1 |
| -70dB | 0 | 1 | 0 | 1 | 1 | 1 |
| -72dB | 1 | 1 | 0 | 1 | 1 | 1 |
| -74dB | 0 | 0 | 1 | 1 | 1 | 1 |
| -76dB | 1 | 0 | 1 | 1 | 1 | 1 |
| -78dB | 0 | 1 | 1 | 1 | 1 | 1 |
| -∞ dB | 1 | 1 | 1 | 1 | 1 | 1 |

3. Tone control circuit

1) Equivalent circuit



2) Bass and treble level settings

● Bass level settings

| VOLUME VALUE | D21 | D22 | D23 | D24 |
|--------------|-----|-----|-----|-----|
| + 18dB | 1 | 0 | 0 | 1 |
| + 16dB | 0 | 0 | 0 | 1 |
| + 14dB | 1 | 1 | 1 | 0 |
| + 12dB | 0 | 1 | 1 | 0 |
| + 10dB | 1 | 0 | 1 | 0 |
| + 8dB | 0 | 0 | 1 | 0 |
| + 6dB | 1 | 1 | 0 | 0 |
| + 4dB | 0 | 1 | 0 | 0 |
| + 2dB | 1 | 0 | 0 | 0 |
| + 0dB | 0 | 0 | 0 | 0 |

| VOLUME VALUE | D21 | D22 | D23 | D24 |
|--------------|-----|-----|-----|-----|
| 0dB | 0 | 0 | 0 | 0 |
| - 2dB | 1 | 1 | 1 | 1 |
| - 4dB | 0 | 1 | 1 | 1 |
| - 6dB | 1 | 0 | 1 | 1 |
| - 8dB | 0 | 0 | 1 | 1 |
| - 10dB | 1 | 1 | 0 | 1 |
| - 12dB | 0 | 1 | 0 | 1 |

● Treble level settings

| VOLUME VALUE | D31 | D32 | D33 | D34 |
|--------------|-----|-----|-----|-----|
| + 18dB | 1 | 0 | 0 | 1 |
| + 16dB | 0 | 0 | 0 | 1 |
| + 14dB | 1 | 1 | 1 | 0 |
| + 12dB | 0 | 1 | 1 | 0 |
| + 10dB | 1 | 0 | 1 | 0 |
| + 8dB | 0 | 0 | 1 | 0 |
| + 6dB | 1 | 1 | 0 | 0 |
| + 4dB | 0 | 1 | 0 | 0 |
| + 2dB | 1 | 0 | 0 | 0 |
| + 0dB | 0 | 0 | 0 | 0 |

| VOLUME VALUE | D31 | D32 | D33 | D34 |
|--------------|-----|-----|-----|-----|
| 0dB | 0 | 0 | 0 | 0 |
| - 2dB | 1 | 1 | 1 | 1 |
| - 4dB | 0 | 1 | 1 | 1 |
| - 6dB | 1 | 0 | 1 | 1 |
| - 8dB | 0 | 0 | 1 | 1 |
| - 10dB | 1 | 1 | 0 | 1 |
| - 12dB | 0 | 1 | 0 | 1 |

MAXIMUM RATINGS (Ta = 25°C)

| CHARACTERISTIC | SYMBOL | RATING | UNIT |
|-----------------------|------------------|-----------------------------|------|
| Supply Voltage | V _{DD} | - 0.3~15 | V |
| Input Voltage | V _{IN} | - 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 SPECIFICATIONS (Unless otherwise specified, Ta = 25°C, V_{DD} = 9.0V, GND = 0V)

| CHARACTERISTIC | SYMBOL | TEST CIR-CUIT | TEST CONDITION | MIN. | TYP. | MAX. | UNIT | |
|---------------------------|-------------------|-----------------|---|-----------------------------------|-------|-----------------|------|-----|
| Operating Supply Voltage | V _{DD} | — | Ta = - 40~85°C | 6.0 | 9.0 | 12.0 | V | |
| Operating Supply Current | I _{DD} | 1 | No input, no load | — | 10.0 | 15.0 | mA | |
| Input Voltage | "H" Level | V _{IH} | CK, DATA, STB pins V _{DD} = 6.0~12V | 4.0 | ~ | V _{DD} | V | |
| | "L" Level | V _{IL} | | 0 | ~ | 1.0 | | |
| Input Current | "H" Level | I _{IH} | | V _{IH} = V _{DD} | — | — | 1.0 | μA |
| | "L" Level | I _{IL} | | V _{IL} = 0V | - 1.0 | — | — | |
| Volume Control Resistance | R _{VR} | — | Main volume | 35.0 | 50.0 | 65.0 | kΩ | |
| | T _{VR} | — | Tone volume | 35.0 | 50.0 | 65.0 | | |
| Input Resistance | R _{IN} | — | IN1~IN2 input resistance | 70.0 | 100.0 | 130.0 | | |
| Setup Time | t _{SET} | 2 | CK, DATA, STB signals | 1.0 | — | — | μs | |
| Data Hold Time | t _{HOLD} | | | 1.0 | — | — | | |
| Input Pulse Width | t _W | | | 1.0 | — | — | | |
| Operating Frequency | f _{OP} | | | — | — | 500 | | kHz |

● Input selector block

| CHARACTERISTIC | SYMBOL | TEST CIR-CUIT | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|---------------------|--------------------|-----------------|---|-------|------|-------|------------------|
| Maximum Input Level | V _{INMAX} | — | f _{in} = 1kHz, G _V = 0dB THD = 1%, R _L = 12KΩ | — | 2.0 | — | V _{rms} |
| Input Gain | 1 | G _{V1} | f _{in} = 1kHz, R _g = 600Ω, R _L = 50kΩ | - 1.5 | 0 | + 1.5 | dB |
| | 2 | G _{V2} | | 4.5 | 6.0 | 7.5 | |
| | 3 | G _{V3} | | 10.5 | 12.0 | 13.5 | |
| | 4 | G _{V4} | | 16.5 | 18.0 | 19.5 | |

● Main volume block

| Step Resolution | ΔSTEP | — | 0dB~ - 46dB | 0.5 | 1.0 | 1.5 | dB |
|-----------------|-------|---|--------------|-----|-----|-----|----|
| | | | 45dB~ - 78dB | 1.0 | 2.0 | 3.0 | |

• Tone control block

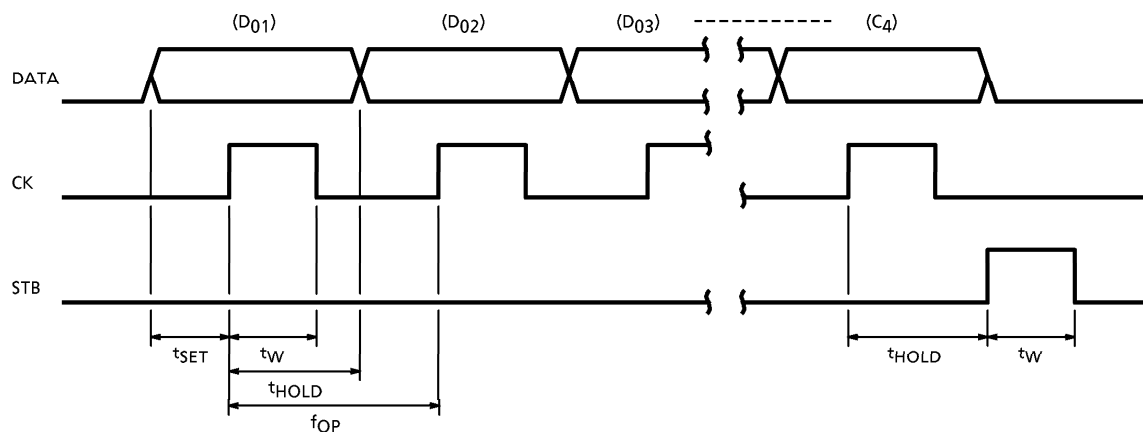
| CHARACTERISTIC | SYMBOL | TEST CIR-CUIT | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|------------------------|----------------|---------------|----------------|--------|--------|--------|------|
| Control Range | GVT (1) | — | Maximum Boost | 16.0 | 18.0 | 21.0 | dB |
| | GVT (2) | | Maximum Cut | - 10.0 | - 12.0 | - 15.0 | |
| Step Resolution | ΔSTEP | | — | 1.0 | 2.0 | 3.0 | |
| Output Load Resistance | R _L | | TONE-OUT pins | 12.0 | — | — | kΩ |

• Overall characteristics

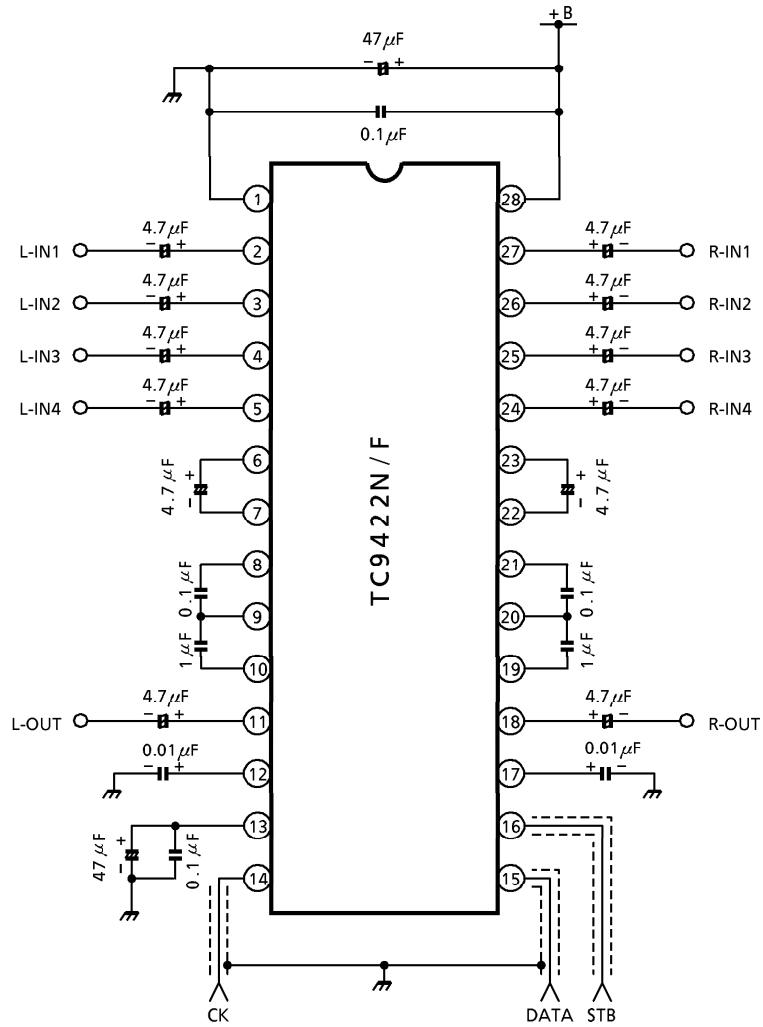
| CHARACTERISTIC | SYMBOL | TEST CIR-CUIT | TEST CONDITIONS | MIN. | TYP. | MAX. | UNIT | |
|-----------------------------------|--------------------|--|---|--|------|-------------------|------|---|
| Overall Harmonic Distortion Ratio | THD (1) | 1 | All set to flat R _g = 600Ω R _L = 33kΩ | f _{in} = 1kHz V _{IN} = 1.0V _{rms} | — | 0.01 | — | % |
| | THD (2) | | | f _{in} = 20kHz V _{IN} = 1.0V _{rms} | — | 0.02 | — | |
| Crosstalk | C·T | | V _{IN} = 1.0V _{rms} , R _g = 600Ω f _{in} = 1kHz, All set to flat | 60 | 80 | — | dB | |
| Maximum Attenuation | ATT _{MAX} | | V _{IN} = 1.0V _{rms} , R _g = 600kΩ f _{in} = 1kHz Main volume ∞ | 60 | 80 | — | dB | |
| Output Noise Voltage | V _N (1) | R _g = 600Ω (IHF-A) All set to flat | — | 5.0 | 12.0 | μV _{rms} | | |
| | V _N (2) | R _g = 600Ω (IHF-A) Bass / treble set to maximum boost Input amp set to + 18dB | — | 50 | 200 | | | |

Test circuit 1 : Application circuit example used

Test circuit 2 : Serial data timing



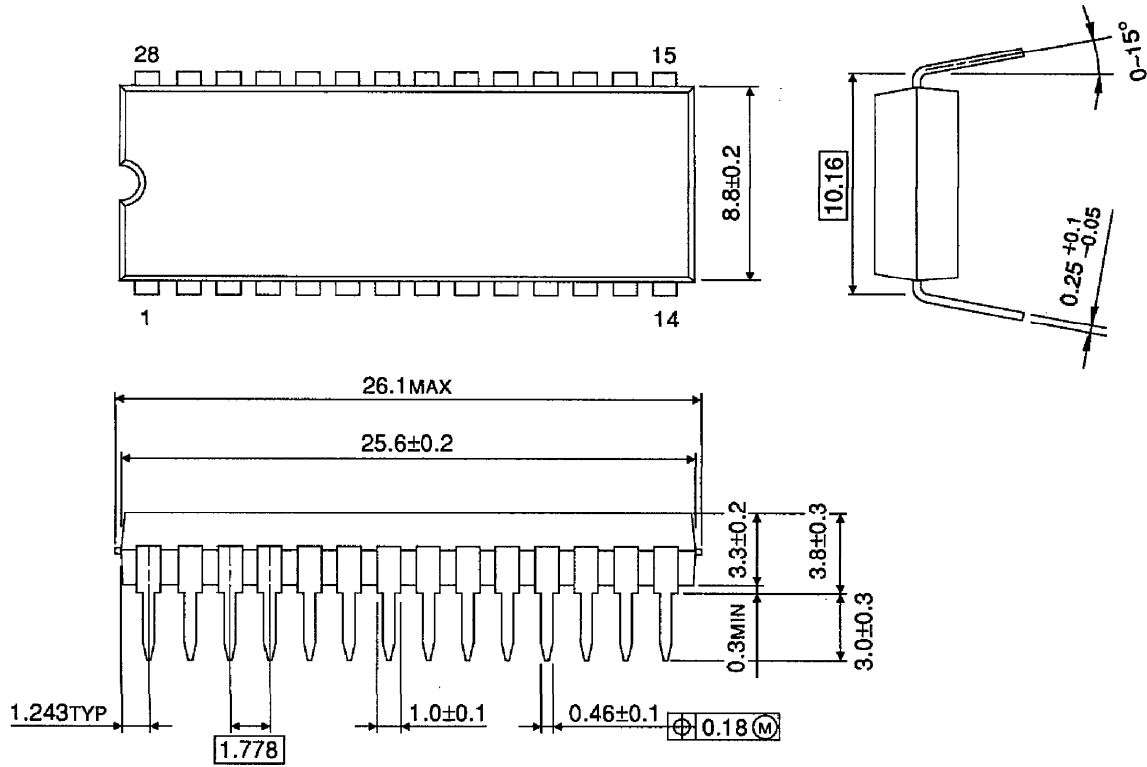
APPLICATION CIRCUIT



(Note) As the CK, DATA, and STB pins receive microcontroller communication digital signals, take measures to prevent digital signals leaking to analog circuits, thus causing noise. For example, use a ground pattern to guard the pins or use a shielded line.

PACKAGE DIMENSIONS
SDIP28-P-400-1.78

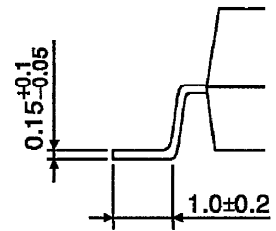
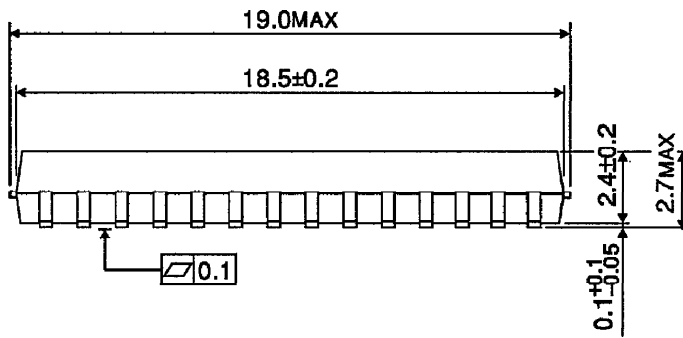
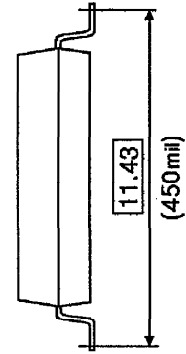
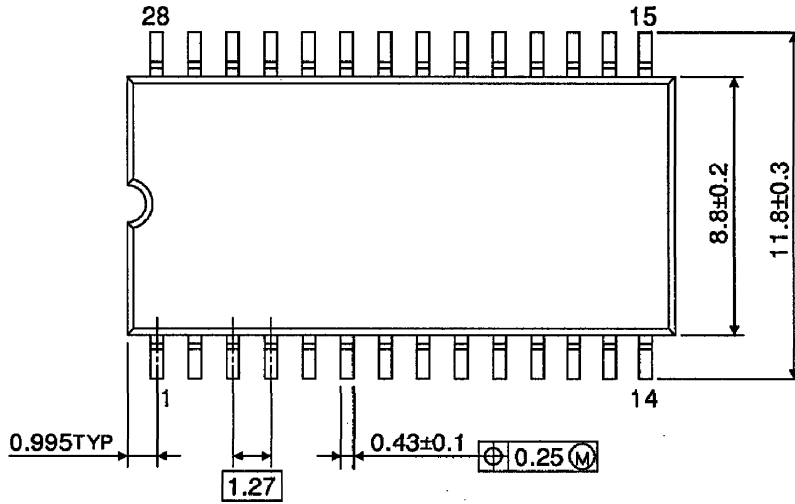
Unit : mm



Weight : 2.2g (Typ.)

PACKAGE DIMENSIONS
SOP28-P-450-1.27

Unit : mm



Weight : 0.8g (Typ.)

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000707EBA

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