

TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

# TC9210P, TC9211P

## ELECTRONIC VOLUME CONTROL IC

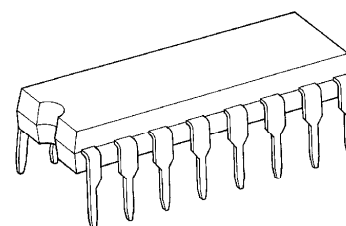
TC9210P and TC9211P are electronic volume control ICs developed for use in audio equipment such as home stereo sets.

The volume, balance and loudness circuits can be controlled by serial data which are input externally.

### FEATURES

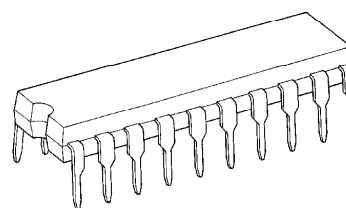
- Forty-level volume control in 2dB steps from 0dB to 78dB,  $\infty$  dB.
- The volume circuit features 2 built-in channels which can be controlled independently, thus controlling balance.
- TC9211P features a built-in loudness circuit (20dB tap).
- Single and dual power supply operation.
- Chip select input allows control of up to four of these chips on the same bus.
- Polysilicon resistors enables low-distortion, high-performance volume systems.

TC9210P



DIP16-P-300-2.54A

TC9211P

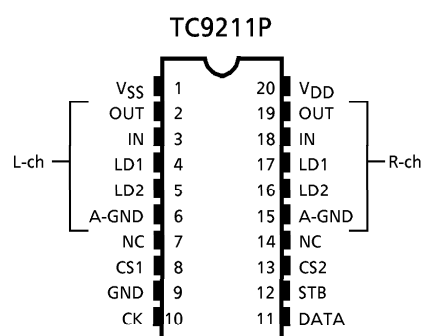
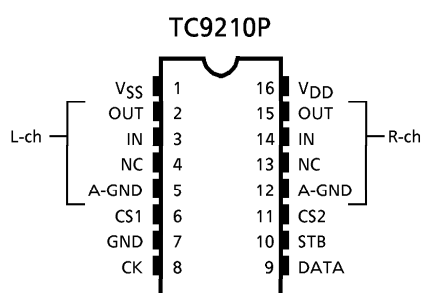


DIP20-P-300-2.54A

### Weight

DIP16-P-300-2.54A : 1.0g (Typ.)  
DIP20-P-300-2.54A : 1.4g (Typ.)

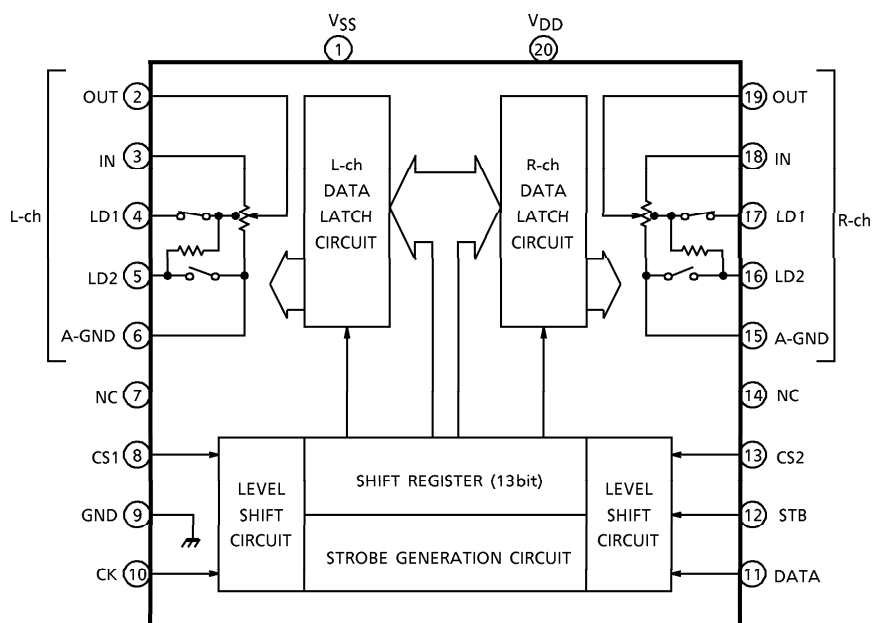
### PIN CONNECTION



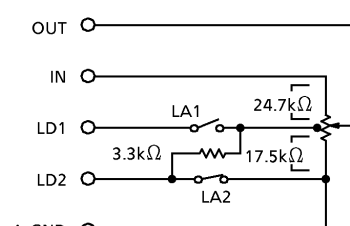
980508EBA2

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### BLOCK DIAGRAM (TC9211P)



## PIN FUNCTION NUMBERS IN PARENTHESES APPLY TO TC9210P

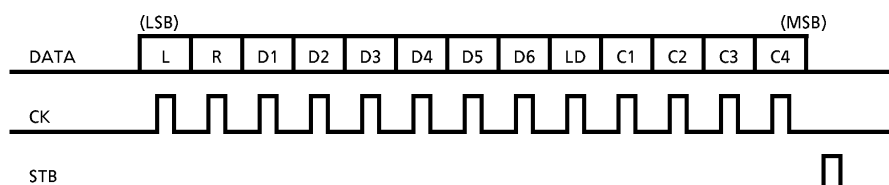
| PIN NUMBER     | SYMBOL          | PIN NAME                     | FUNCTION AND OPERATION                                                                                                                                                                                                                                                                                                                                                 | NOTE                           |     |     |               |    |     |                |     |    |   |
|----------------|-----------------|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|-----|-----|---------------|----|-----|----------------|-----|----|---|
| 1 ( 1 )        | V <sub>SS</sub> | Negative power supply pin    | Dual power supply <div><div>V<sub>DD</sub> = 6.0~17V</div><div>GND = 0V</div><div>V<sub>SS</sub> = - 6.0~ - 17V</div></div><br>Single power supply <div><div>V<sub>DD</sub> = 6.0~18V</div><div>GND = V<sub>SS</sub> = 0V</div></div>                                                                                                                                  | —                              |     |     |               |    |     |                |     |    |   |
| 9 ( 7 )        | GND             | Digital ground pin           |                                                                                                                                                                                                                                                                                                                                                                        |                                |     |     |               |    |     |                |     |    |   |
| 20 ( 16 )      | V <sub>DD</sub> | Positive power supply pin    |                                                                                                                                                                                                                                                                                                                                                                        |                                |     |     |               |    |     |                |     |    |   |
| 2 ( 2 )        | L-OUT           | Volume output pins           | <div>● Volume circuit (TC9211P)</div>  <table border="1" data-bbox="908 916 1211 1050"><thead><tr><th></th><th>LA1</th><th>LA2</th></tr></thead><tbody><tr><td>Loudness "ON"</td><td>ON</td><td>OFF</td></tr><tr><td>Loudness "OFF"</td><td>OFF</td><td>ON</td></tr></tbody></table> |                                | LA1 | LA2 | Loudness "ON" | ON | OFF | Loudness "OFF" | OFF | ON | — |
|                | LA1             |                              |                                                                                                                                                                                                                                                                                                                                                                        | LA2                            |     |     |               |    |     |                |     |    |   |
| Loudness "ON"  | ON              | OFF                          |                                                                                                                                                                                                                                                                                                                                                                        |                                |     |     |               |    |     |                |     |    |   |
| Loudness "OFF" | OFF             | ON                           |                                                                                                                                                                                                                                                                                                                                                                        |                                |     |     |               |    |     |                |     |    |   |
| 19 ( 15 )      | R-OUT           |                              |                                                                                                                                                                                                                                                                                                                                                                        |                                |     |     |               |    |     |                |     |    |   |
| 3 ( 3 )        | L-IN            | Volume input pins            |                                                                                                                                                                                                                                                                                                                                                                        |                                |     |     |               |    |     |                |     |    |   |
| 18 ( 14 )      | R-IN            |                              |                                                                                                                                                                                                                                                                                                                                                                        |                                |     |     |               |    |     |                |     |    |   |
| 4 ( — )        | L-LD1           | Tap output pins for loudness |                                                                                                                                                                                                                                                                                                                                                                        |                                |     |     |               |    |     |                |     |    |   |
| 17 ( — )       | R-LD1           |                              |                                                                                                                                                                                                                                                                                                                                                                        |                                |     |     |               |    |     |                |     |    |   |
| 5 ( — )        | L-LD2           |                              |                                                                                                                                                                                                                                                                                                                                                                        |                                |     |     |               |    |     |                |     |    |   |
| 16 ( — )       | R-LD2           |                              |                                                                                                                                                                                                                                                                                                                                                                        |                                |     |     |               |    |     |                |     |    |   |
| 6 ( 5 )        | L-A-GND         | Analog ground pins           |                                                                                                                                                                                                                                                                                                                                                                        |                                |     |     |               |    |     |                |     |    |   |
| 15 ( 12 )      | R-A-GND         |                              |                                                                                                                                                                                                                                                                                                                                                                        |                                |     |     |               |    |     |                |     |    |   |
| 8 ( 6 )        | CS1             | Chip select input pins       | Switching chip select code allows control of up to 4 chips simultaneously on one bus.                                                                                                                                                                                                                                                                                  | —                              |     |     |               |    |     |                |     |    |   |
| 13 ( 11 )      | CS2             |                              |                                                                                                                                                                                                                                                                                                                                                                        |                                |     |     |               |    |     |                |     |    |   |
| 10 ( 8 )       | CK              | Clock input pin              | Clock input for data transfer                                                                                                                                                                                                                                                                                                                                          | Low threshold value input pins |     |     |               |    |     |                |     |    |   |
| 11 ( 9 )       | DATA            | Data input pin               | Serial data input for setting volume                                                                                                                                                                                                                                                                                                                                   |                                |     |     |               |    |     |                |     |    |   |
| 12 ( 10 )      | STB             | Strobe input pin             | Strobe input for writing data                                                                                                                                                                                                                                                                                                                                          |                                |     |     |               |    |     |                |     |    |   |
| 7, 14 (4, 13)  | NC              | Not connected                |                                                                                                                                                                                                                                                                                                                                                                        | —                              |     |     |               |    |     |                |     |    |   |

## OPERATIONAL DESCRIPTION

### 1. Setting volume values (attenuation)

The volume values are set using 13bit serial data.

- Data format



1) L is left-channel select data ; R is right-channel select data.

When L = 1, left-channel volume is set ; when R = 1, right-channel volume is set. (When R = L = 1, both channel volumes are set simultaneously).

2) LD is loudness setting data. When LD = 1, loudness is on. (Only for TC9211P. Set to 0 for TC9210P.)

3) D1-D6 are volume value setting data.

| VOLUME VALUE | D1 | D2 | D3 | D4 | D5 | D6 |
|--------------|----|----|----|----|----|----|
| 0dB          | 0  | 0  | 0  | 0  | 0  | 0  |
| 2            | 1  | 0  | 0  | 0  | 0  | 0  |
| 4            | 0  | 1  | 0  | 0  | 0  | 0  |
| 6            | 1  | 1  | 0  | 0  | 0  | 0  |
| 8            | 0  | 0  | 1  | 0  | 0  | 0  |
| 10           | 1  | 0  | 1  | 0  | 0  | 0  |
| 12           | 0  | 1  | 1  | 0  | 0  | 0  |
| 14           | 1  | 1  | 1  | 0  | 0  | 0  |
| 16           | 0  | 0  | 0  | 1  | 0  | 0  |
| 18           | 1  | 0  | 0  | 1  | 0  | 0  |
| 20           | 0  | 1  | 0  | 1  | 0  | 0  |
| 22           | 1  | 1  | 0  | 1  | 0  | 0  |
| 24           | 0  | 0  | 1  | 1  | 0  | 0  |
| 26           | 1  | 0  | 1  | 1  | 0  | 0  |
| 28           | 0  | 1  | 1  | 1  | 0  | 0  |
| 30           | 1  | 1  | 1  | 1  | 0  | 0  |
| 32           | 0  | 0  | 0  | 0  | 1  | 0  |
| 34           | 1  | 0  | 0  | 0  | 1  | 0  |
| 36           | 0  | 1  | 0  | 0  | 1  | 0  |
| 38           | 1  | 1  | 0  | 0  | 1  | 0  |

| VOLUME VALUE | D1 | D2 | D3 | D4 | D5 | D6 |
|--------------|----|----|----|----|----|----|
| 40dB         | 0  | 0  | 1  | 0  | 1  | 0  |
| 42           | 1  | 0  | 1  | 0  | 1  | 0  |
| 44           | 0  | 1  | 1  | 0  | 1  | 0  |
| 46           | 1  | 1  | 1  | 0  | 1  | 0  |
| 48           | 0  | 0  | 0  | 1  | 1  | 0  |
| 50           | 1  | 0  | 0  | 1  | 1  | 0  |
| 52           | 0  | 1  | 0  | 1  | 1  | 0  |
| 54           | 1  | 1  | 0  | 1  | 1  | 0  |
| 56           | 0  | 0  | 1  | 1  | 1  | 0  |
| 58           | 1  | 0  | 1  | 1  | 1  | 0  |
| 60           | 0  | 1  | 1  | 1  | 1  | 0  |
| 62           | 1  | 1  | 1  | 1  | 1  | 0  |
| 64           | 0  | 0  | 0  | 0  | 0  | 1  |
| 66           | 1  | 0  | 0  | 0  | 0  | 1  |
| 68           | 0  | 1  | 0  | 0  | 0  | 1  |
| 70           | 1  | 1  | 0  | 0  | 0  | 1  |
| 72           | 0  | 0  | 1  | 0  | 0  | 1  |
| 74           | 1  | 0  | 1  | 0  | 0  | 1  |
| 76           | 0  | 1  | 1  | 0  | 0  | 1  |
| 78           | 1  | 1  | 1  | 0  | 0  | 1  |
| ∞            | 0  | 0  | 0  | 1  | 0  | 1  |

(Note) Note that if data other than those listed above are input, volume values are undefined.

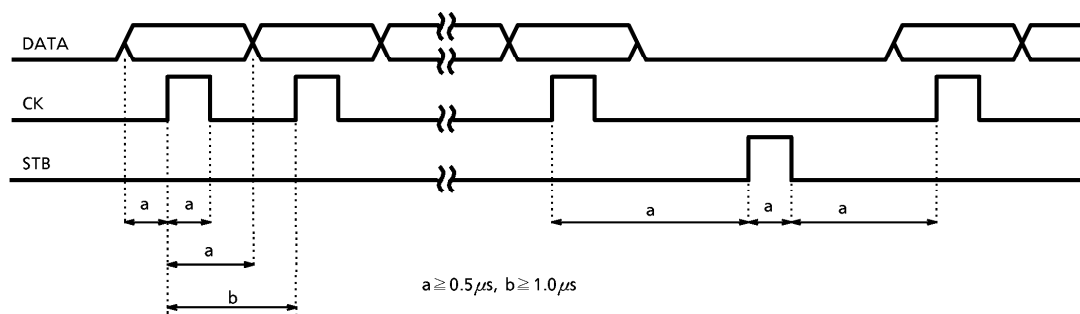
4) C1-C4 are chip select code data.

Code data are set according to CS1 and CS2 input.

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

## 2. Serial data timing

Input CK, DATA and STB according to the following timing.

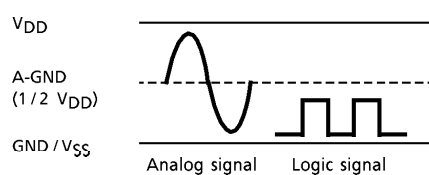


## 3. Single and dual power supply operation

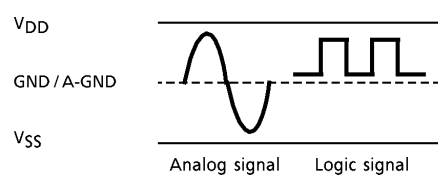
TC9210P and TC9211P can operate with single or dual power supplies.

With single or dual power supply, serial data logic level can be 0-5V.

### • Single power supply operation



### • Dual power supply operation



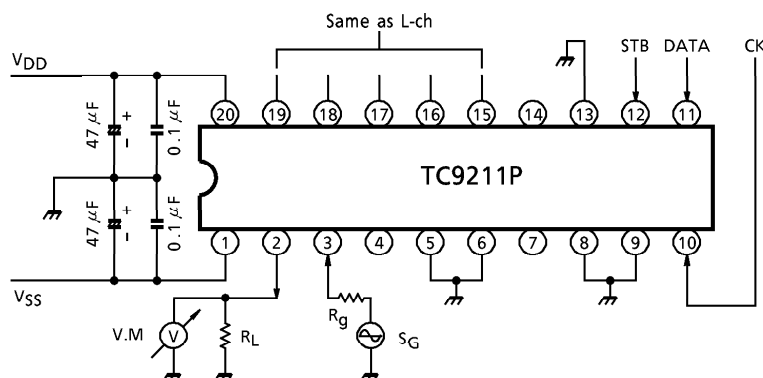
## MAXIMUM RATINGS (Ta = 25°C)

| CHARACTERISTIC                | SYMBOL                           | RATING                                      | UNIT |
|-------------------------------|----------------------------------|---------------------------------------------|------|
| Power Supply Voltage (1)      | V <sub>DD</sub> -V <sub>SS</sub> | - 0.3~36                                    | V    |
| Power Supply Voltage (2)      | V <sub>DD</sub> -GND             | - 0.3~20                                    | V    |
| GND Input Voltage             | V <sub>IN</sub> (1)              | - 0.3~V <sub>DD</sub> + 0.3                 | V    |
| V <sub>SS</sub> Input Voltage | V <sub>IN</sub> (2)              | V <sub>SS</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   |

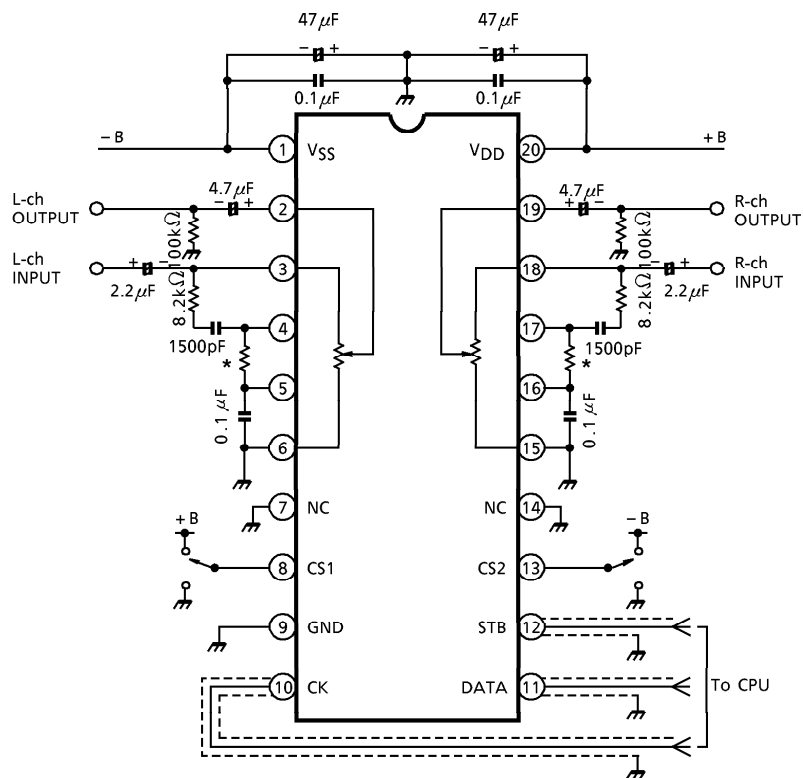
ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V<sub>DD</sub> = 15V, V<sub>SS</sub> = - 15V, GND = 0V, Ta = 25°C)

| CHARACTERISTIC                 | SYMBOL                           | TEST CIR-CUIT       | TEST CONDITION                                                                                                                    | MIN.                           | TYP.  | MAX.                  | UNIT              |
|--------------------------------|----------------------------------|---------------------|-----------------------------------------------------------------------------------------------------------------------------------|--------------------------------|-------|-----------------------|-------------------|
| Operating Supply Voltage (1)   | V <sub>DD</sub> -V <sub>SS</sub> | —                   | Dual power supply operation                                                                                                       | 12                             | ~     | 34                    | V                 |
| Operating Supply Voltage (2)   | V <sub>DD</sub> -GND             | —                   | Single power supply operation                                                                                                     | 6.0                            | ~     | 18                    | V                 |
| Operating Supply Current       | I <sub>DD</sub>                  | 1                   | No load, No input                                                                                                                 | —                              | 0.5   | 1.0                   | mA                |
| Input Voltage                  | "H" Level                        | V <sub>IH</sub> (1) | CK, DATA, STB terminal<br>V <sub>DD</sub> = 6.0~18V                                                                               | 4.0                            | ~     | V <sub>DD</sub>       | V                 |
|                                | "L" Level                        | V <sub>IL</sub> (1) |                                                                                                                                   | GND                            | ~     | 1.0                   |                   |
| Input Voltage                  | "H" Level                        | V <sub>IH</sub> (2) | CS1, CS2 terminal                                                                                                                 | V <sub>DD</sub> × 0.7          | ~     | V <sub>DD</sub>       | V                 |
|                                | "L" Level                        | V <sub>IL</sub> (2) |                                                                                                                                   | GND                            | ~     | V <sub>DD</sub> × 0.3 |                   |
| Input Current                  | "H" Level                        | I <sub>IH</sub>     | CK, DATA, STB, CS1, CS2 terminal                                                                                                  | V <sub>IH</sub> = 15V<br>- 1.0 | ~     | 1.0                   | μA                |
|                                | "L" Level                        | I <sub>IL</sub>     |                                                                                                                                   | V <sub>IL</sub> = 0V<br>- 1.0  | ~     | 1.0                   |                   |
| Operating Frequency Range      | f <sub>op</sub>                  | —                   | CK, DATA, STB terminal                                                                                                            | 0                              | ~     | 1.0                   | MHz               |
| Minimum Clock Frequency        | T <sub>ck</sub>                  | —                   |                                                                                                                                   | 0.5                            | —     | —                     | μs                |
| Volume Resistance Value        | R <sub>VR</sub>                  | —                   | Loudness "OFF"                                                                                                                    | 18.5                           | 27.5  | 36.5                  | kΩ                |
| Step Deviation                 | ΔVR                              | —                   | Volume step deviation                                                                                                             | - 1.2                          | ~     | 1.2                   | dB                |
| Analog Switch ON Resistance    | R <sub>ON</sub>                  | —                   | Internal analog switch                                                                                                            | —                              | 350   | 600                   | Ω                 |
| Analog Switch OFF Leak Current | I <sub>OFF</sub>                 |                     |                                                                                                                                   | - 0.1                          | ~     | 0.1                   | μA                |
| Total Harmonic Distortion      | THD                              | 1                   | f <sub>IN</sub> = 1kHz<br>V <sub>IN</sub> = 1V <sub>rms</sub><br>R <sub>g</sub> = 600Ω, R <sub>L</sub> = 100kΩ<br>BW = 20Hz~20kHz | —                              | 0.005 | —                     | %                 |
| Maximum Attenuation            | ATT <sub>MAX</sub>               |                     |                                                                                                                                   | —                              | 100   | —                     | dB                |
| Output Noise Voltage           | V <sub>N</sub>                   |                     |                                                                                                                                   | —                              | 1.0   | —                     | μV <sub>rms</sub> |
| Cross Talk                     | C·T                              |                     |                                                                                                                                   | —                              | 100   | —                     | dB                |

### TEST CIRCUIT 1 ( $I_{DD}/THD/ATT_{MAX}/V_N/C\cdot T$ )



## APPLICATION CIRCUIT (TC9211P)

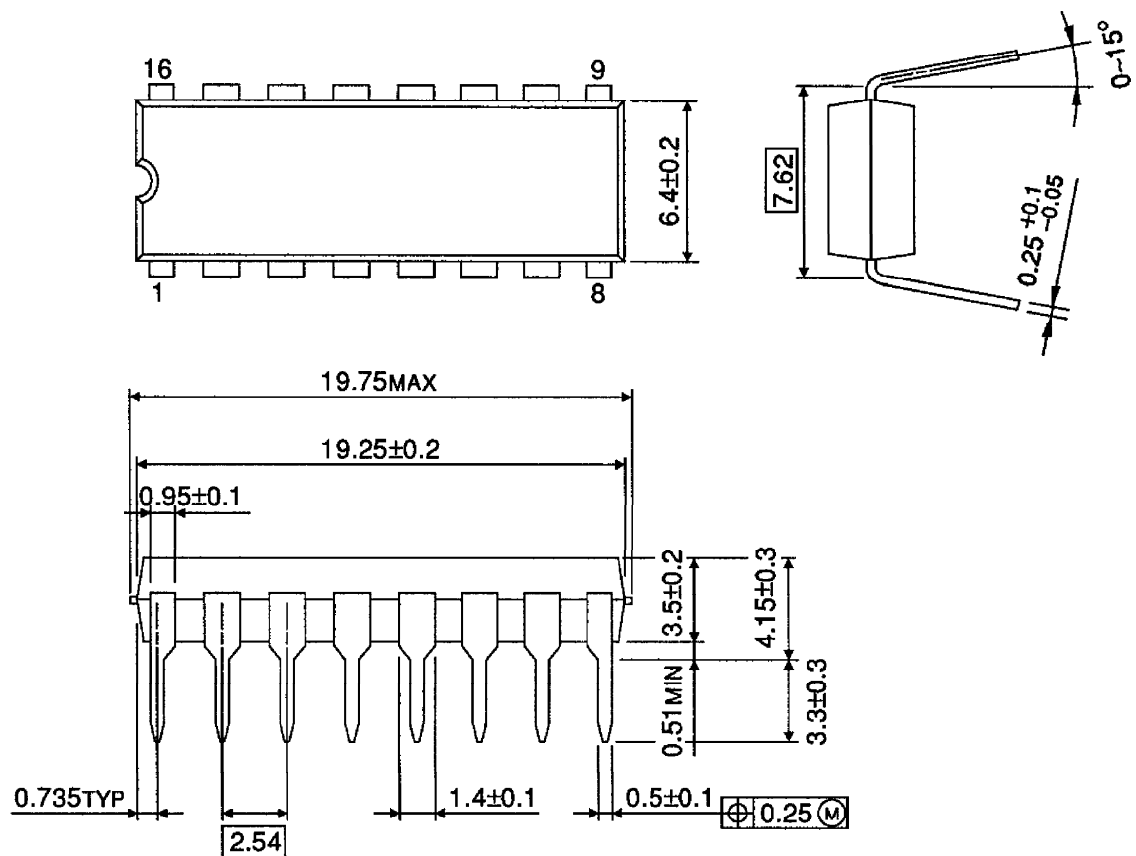


\* For preventing noise when loudness is turned on or off. R=220kΩ~470kΩ

(Note) High-frequency digital signals are input to pins CK, DATA and STB. Since these signals may cause noise in analog circuits, either use shield wire for CK, DATA, and STB signal lines, or design the pattern so that these signal lines are protected by the ground line.

OUTLINE DRAWING  
DIP16-P-300-2.54A

Unit : mm

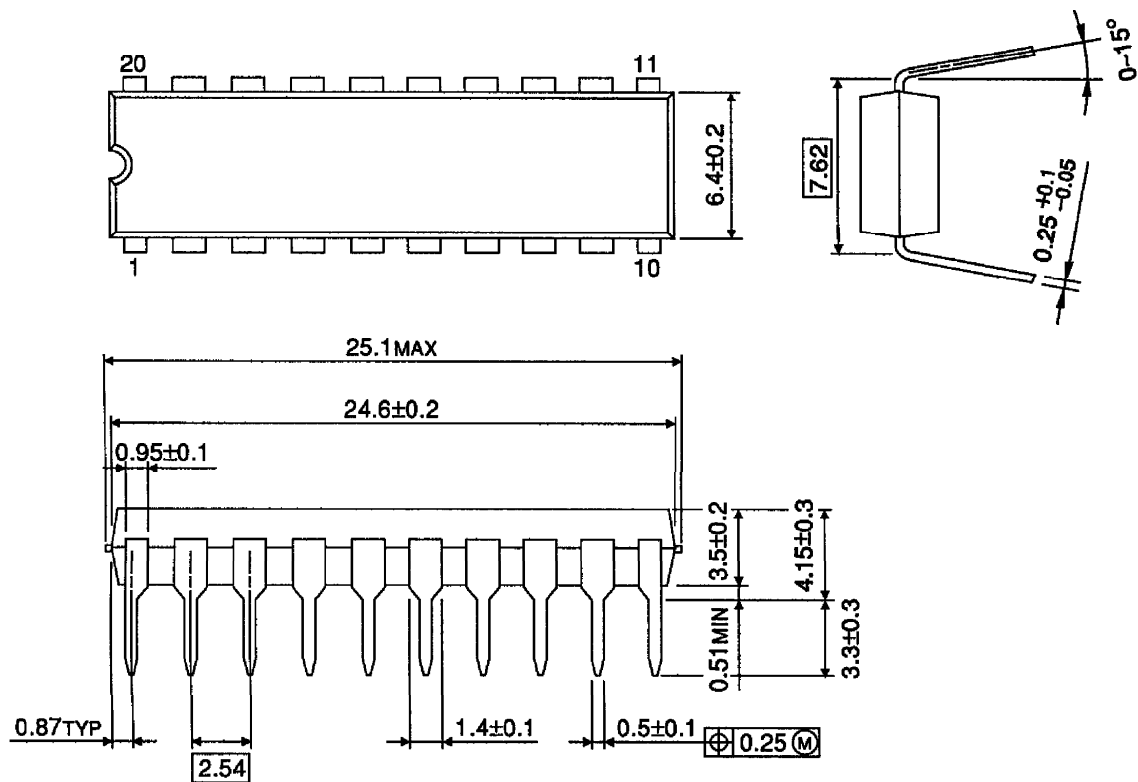


Weight : 1.0g (Typ.)



**OUTLINE DRAWING**  
DIP20-P-300-2.54A

Unit : mm



Weight : 1.4g (Typ.)