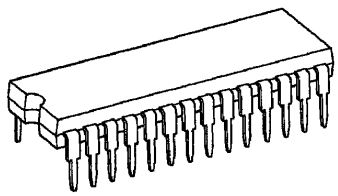
TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

TC9482N, TC9482F

SYSTEM ELECTRONIC VOLUME CONTROL

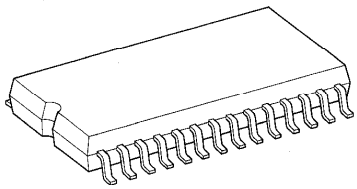
The TC9482N and TC9482F are six-channel electronic volume control ICs developed for Hi-Fi audio equipment. Since all six channels can be individually controlled, the devices are optimum for audio equipment with multiple outputs.

TC9482N



SDIP28-P-400-1.78

TC9482F



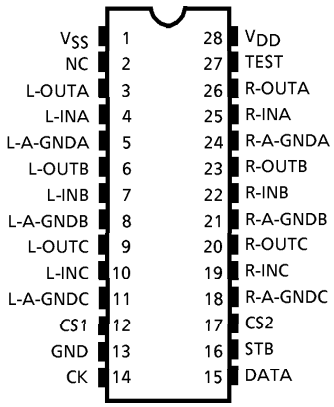
SOP28-P-450-1.27

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

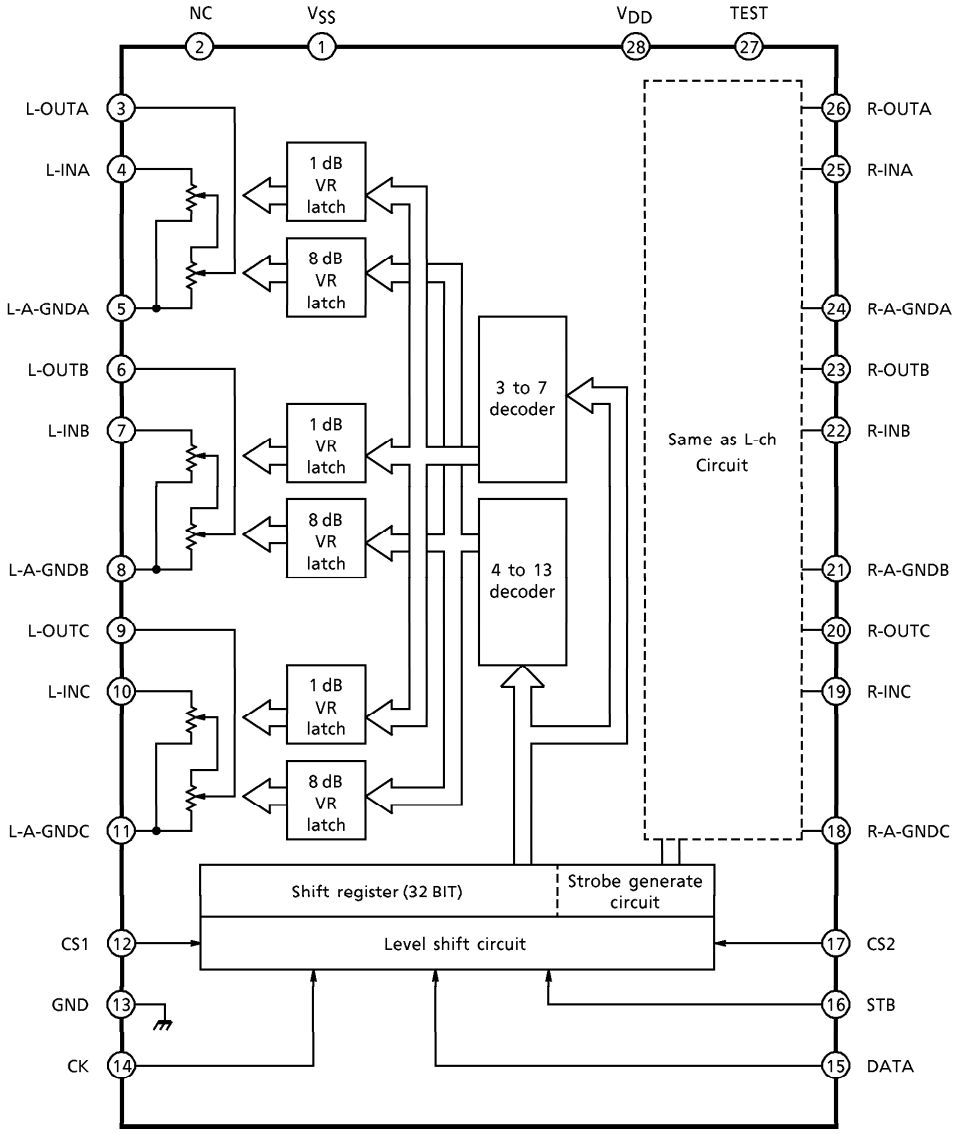
FEATURES

- 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.

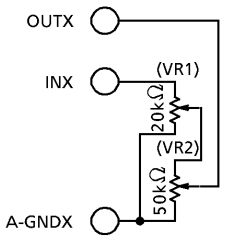
PIN CONNECTIONS



BLOCK DIAGRAM



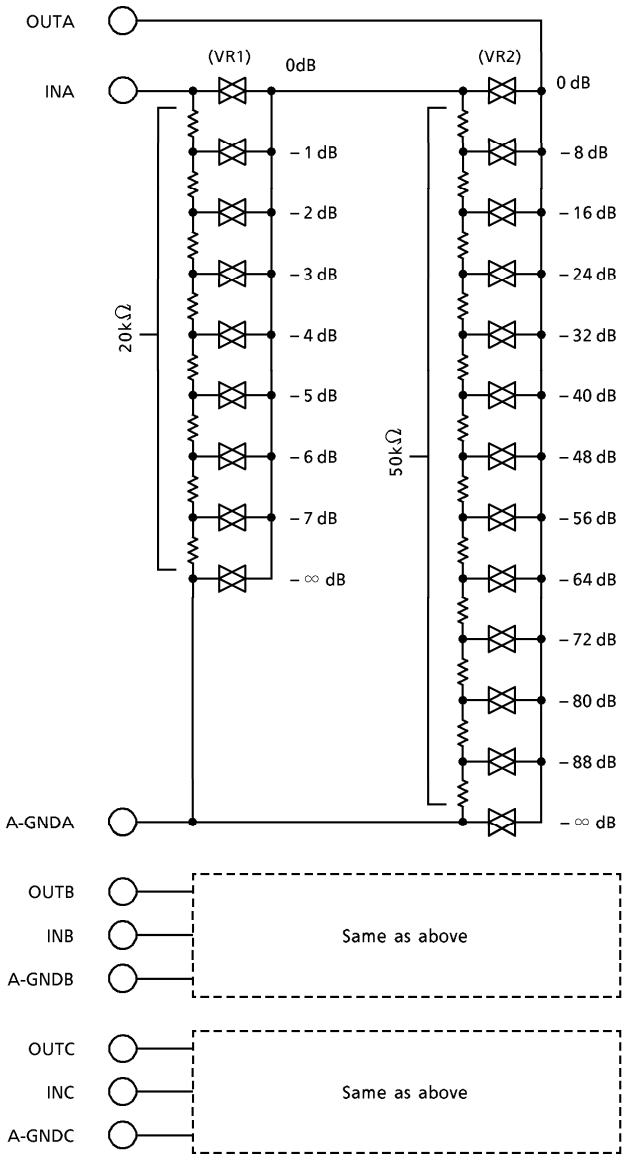
PIN DESCRIPTION

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

OPERATIONS

1. Volume Control Circuit

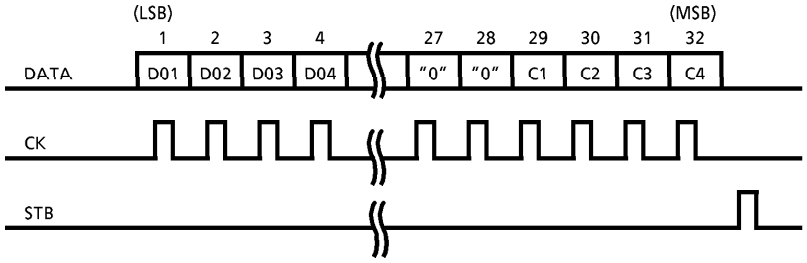
The volume control circuit incorporates two volume controls, each consisting of a resistor array and a CMOS analog switch.
VR1 attenuates from 0 to 7 dB in 1-dB steps. VR2 attenuates from 0 to – 88 dB in 8-dB steps.
In total, volume is controlled from 0 to 95 dB in 1-dB steps.



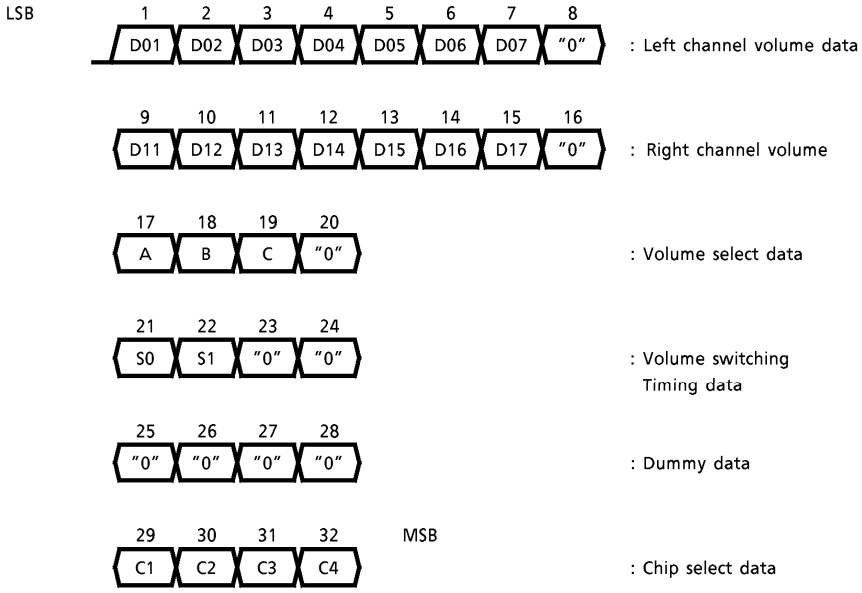
2. Setting up volume value (amount of attenuation)

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 D11	D02 D12	D03 D13	D04 D14	D05 D15	D06 D16	D07 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 D11	D02 D12	D03 D13	D04 D14	D05 D15	D06 D16	D07 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.)

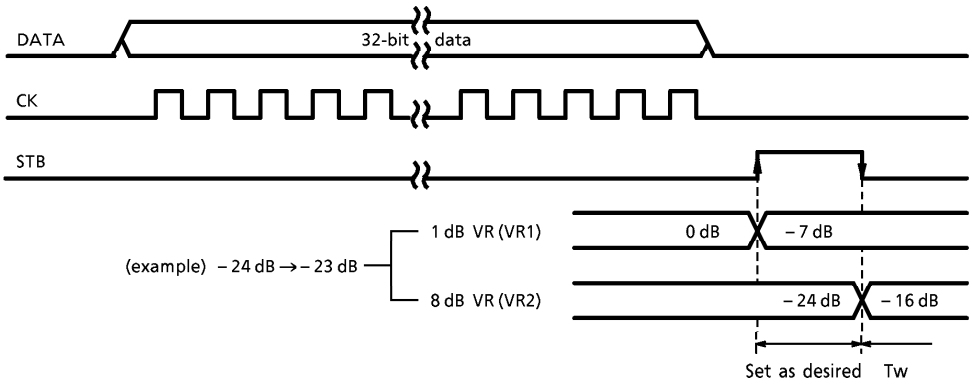
(4) Volume control switching timing

"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.

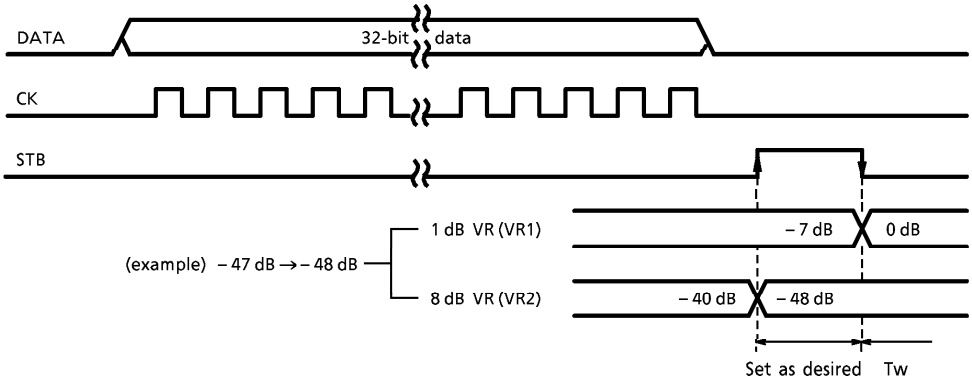
S0	S1	VR1	VR2
0	0	↑	↑
0	1	↑	↓
1	0	↓	↑
1	1	↓	↓

(*) ↑ 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")



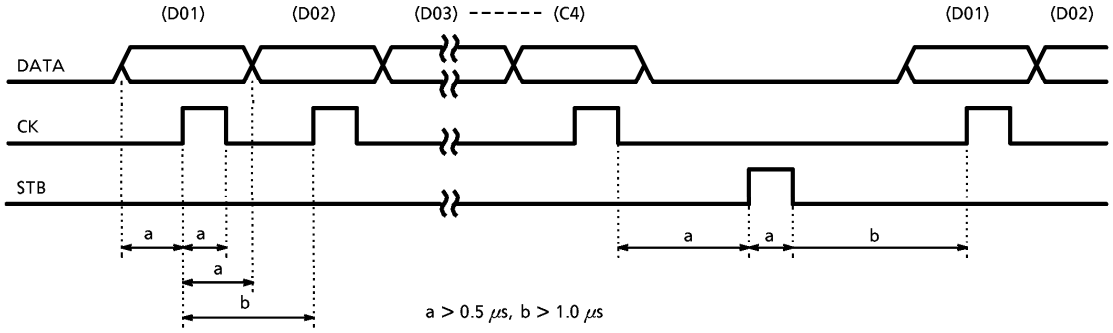
(5) Chip select code (C1 to C4)

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

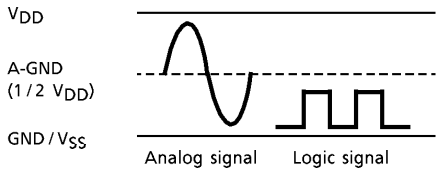
Make sure that CK, DATA and STB are input to the device at the timings shown below.



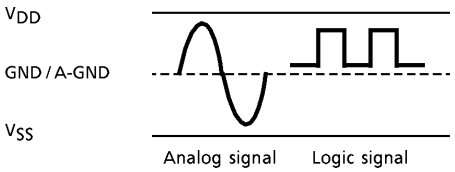
4. Operating with a single or dual power supplies

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



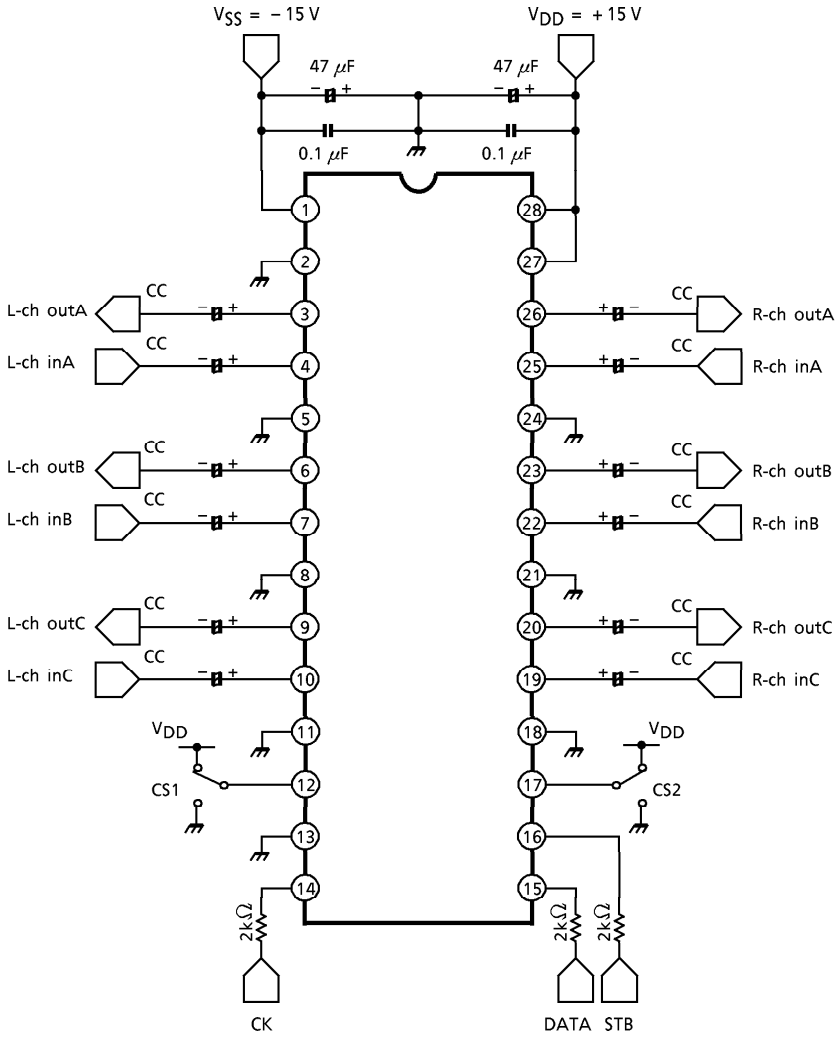
MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Power Supply Voltage	V_{DD}	−0.3~36	V
GND Block 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 CHARACTERISTICS
(Referenced to V_{DD} = 15 V, V_{SS} = −15 V at Ta = 25°C unless otherwise noted)

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

EXAMPLE OF APPLICATION CIRCUIT

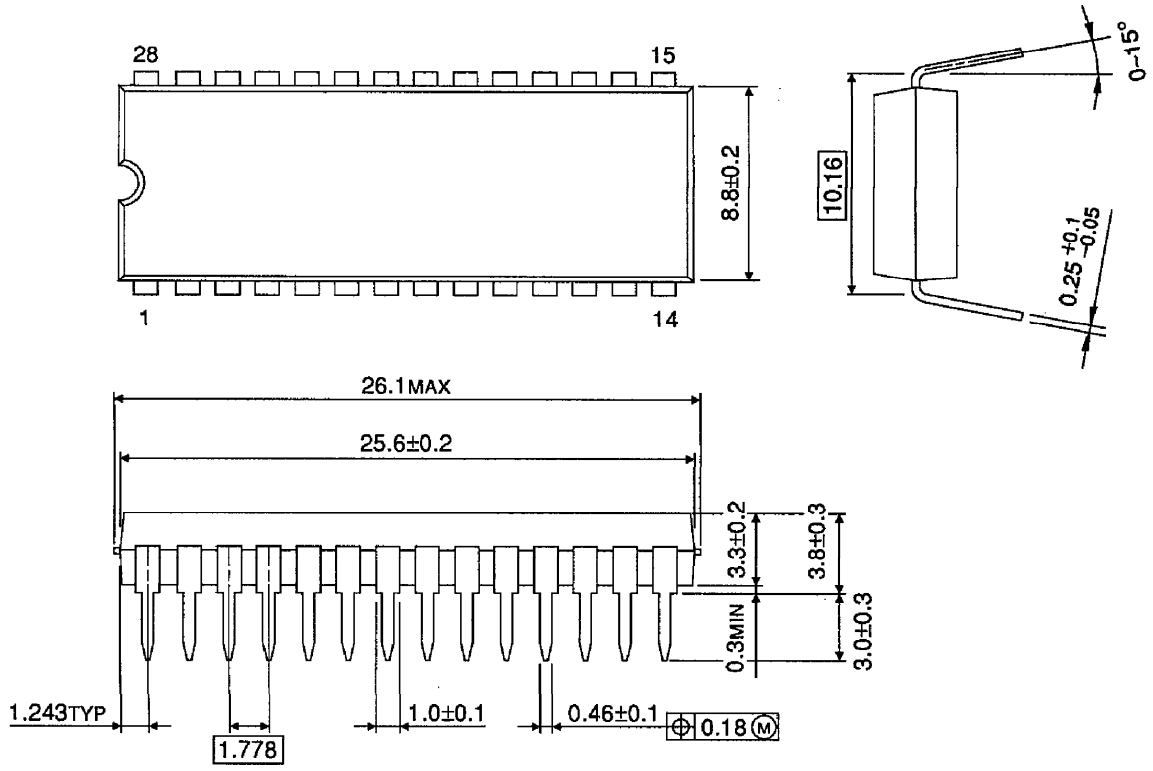


(*) CC indicates the capacitor from 1 μF to 10 μF.

(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

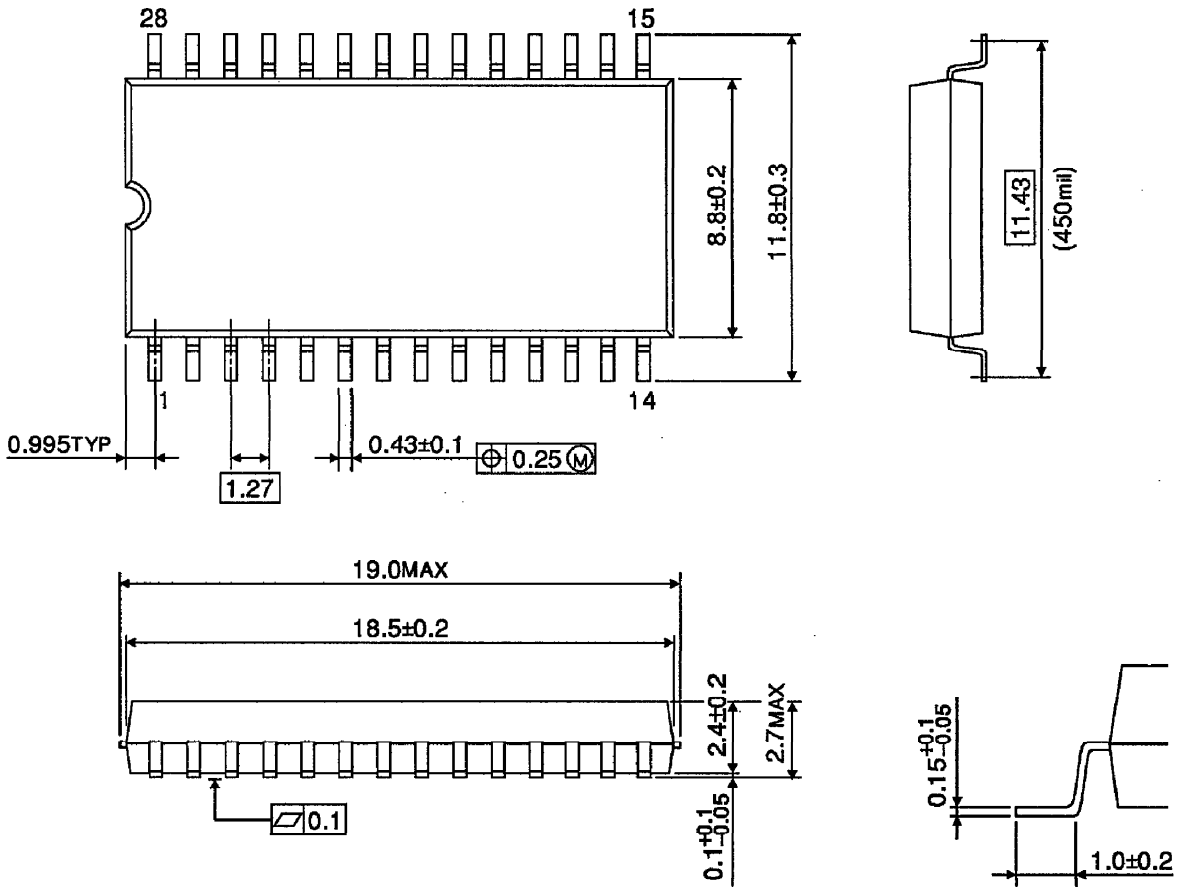


Weight : 2.2g (Typ.)

PACKAGE DIMENSIONS

SOP28-P-450-1.27

Unit : mm



Weight : 0.8g (Typ.)