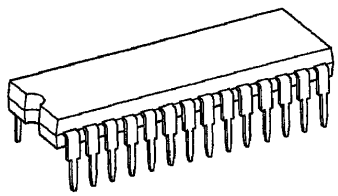
TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

TC9459N, TC9459F

ELECTRONIC VOLUME CONTROL

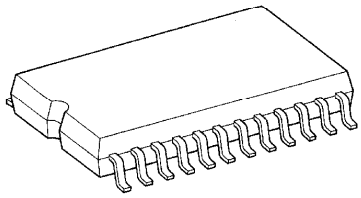
The TC9459N, TC9459F are electronic volume control ICs developed for use in home stereos and other audio equipment.
Using serial data input from external sources, it controls the sound volume, balance and loudness circuits.

TC9459N



SDIP28-P-400-1.78

TC9459F



SOP24-P-450-1.27A

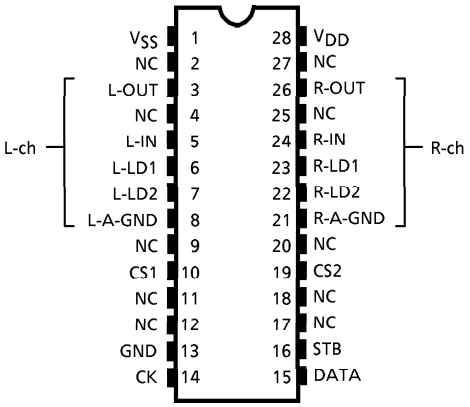
Weight
SDIP28-P-400-1.78 : 2.2g (Typ.)
SOP24-P-450-1.27A : 0.44g (Typ.)

FEATURES

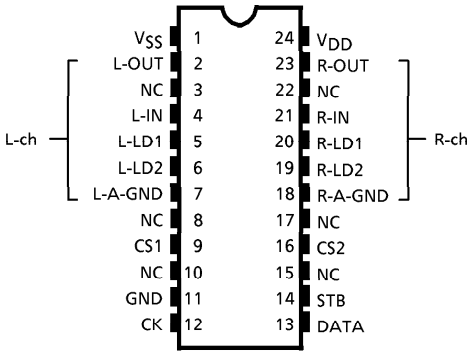
- Sound volume can be controlled in 91 steps from 0 to −89dB or up to an infinite level in 1dB increments.
- Incorporating two channels of volume control circuits, the device allows independent volume control : therefore, it also provides the balancing function.
- A loudness circuit (20dB tap) is built 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.

PIN CONNECTIONS

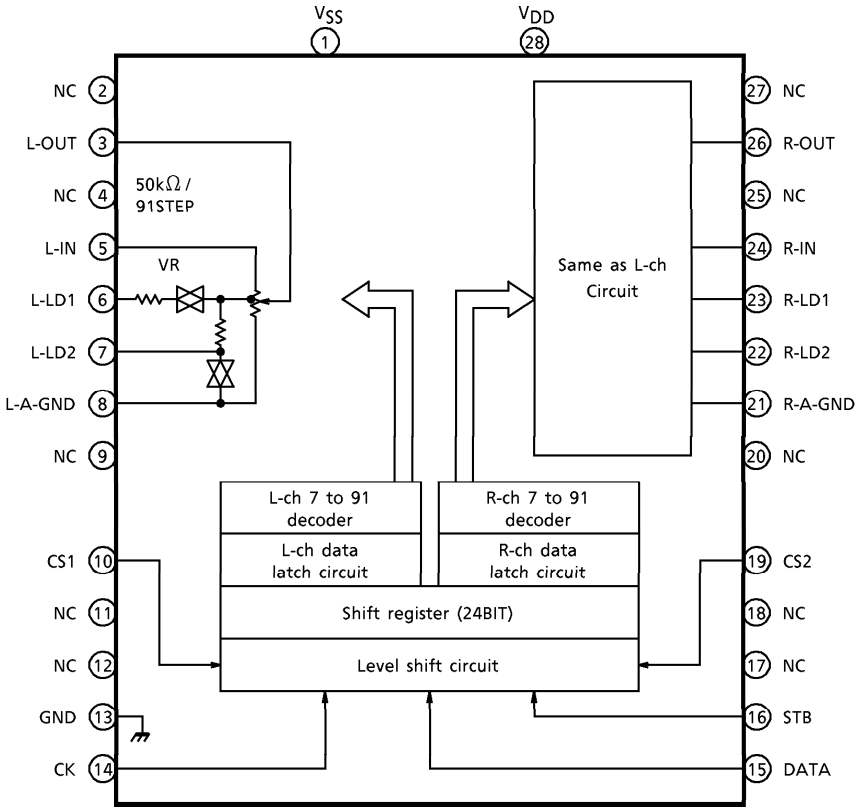
TC9459N



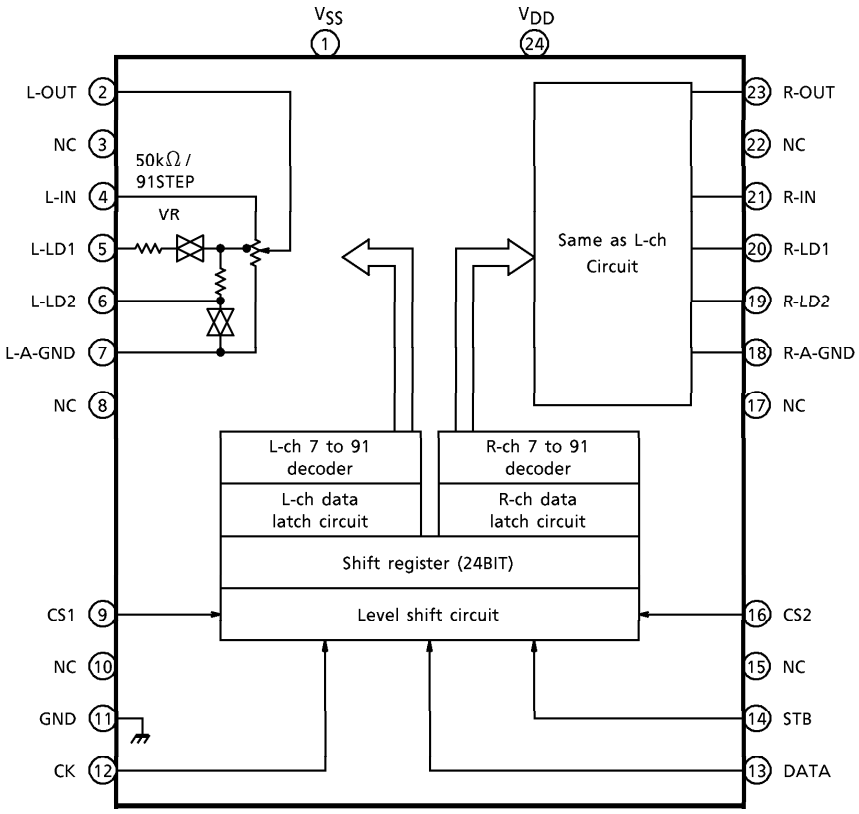
TC9459F



BLOCK DIAGRAM (TC9459N)

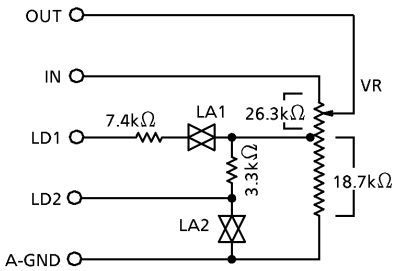


BLOCK DIAGRAM (TC9459F)



PIN DESCRIPTION

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

<table>
<tr><th>PIN No.</th><th>SYMBOL</th><th>PIN NAME</th><th>FUNCTION</th><th>REMARK</th></tr>
<tr><td>1 (1)</td><td>V_{SS}</td><td>Negative power supply pin</td><td rowspan="3">When using dual power supplies
V_{DD} = 6.0~17V
GND = 0V
V_{SS} = – 6.0~ – 17V
When using a single power supply
V_{DD} = 6.0~18V
GND = V_{SS} = 0V</td><td rowspan="3">—</td></tr>
<tr><td>28 (24)</td><td>V_{DD}</td><td>Positive power supply pin</td></tr>
<tr><td>13 (11)</td><td>GND</td><td>Digital GND pin</td></tr>
<tr><td>3 (2)</td><td>L-OUT</td><td rowspan="2">Volume output pin</td><td rowspan="10">• Volume circuit
 

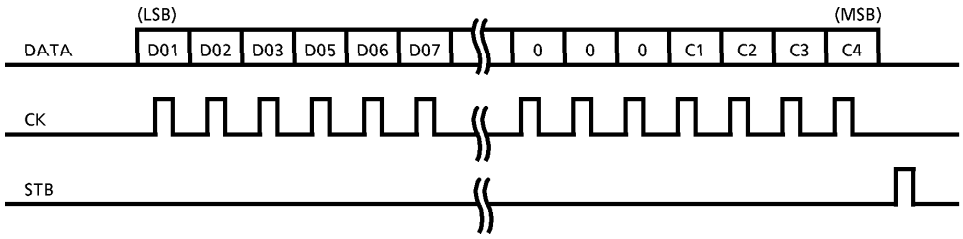
<table>
<tr><th></th><th>LA1</th><th>LA2</th></tr>
<tr><td>LOUDNESS "ON"</td><td>ON</td><td>OFF</td></tr>
<tr><td>LOUDNESS "OFF"</td><td>OFF</td><td>ON</td></tr>
</table></td><td rowspan="10">—</td></tr>
<tr><td>26 (23)</td><td>R-OUT</td></tr>
<tr><td>5 (4)</td><td>L-IN</td><td rowspan="2">Volume input pin</td></tr>
<tr><td>24 (21)</td><td>R-IN</td></tr>
<tr><td>6 (5)</td><td>L-LD1</td><td rowspan="4">Loudness tap output pin</td></tr>
<tr><td>23 (20)</td><td>R-LD1</td></tr>
<tr><td>7 (6)</td><td>L-LD2</td></tr>
<tr><td>22 (19)</td><td>R-LD2</td></tr>
<tr><td>8 (7)</td><td>L-A-GND</td><td rowspan="2">Analog GND pin</td></tr>
<tr><td>21 (18)</td><td>R-A-GND</td></tr>
<tr><td>10 (9)</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>19 (16)</td><td>CS2</td></tr>
<tr><td>14 (12)</td><td>CK</td><td>Clock input pin</td><td>Data transfer clock input</td><td rowspan="3">Low threshold value input pin</td></tr>
<tr><td>15 (13)</td><td>DATA</td><td>Data input pin</td><td>Volume setup serial data input</td></tr>
<tr><td>16 (14)</td><td>STB</td><td>Strobe input pin</td><td>Data write strobe input</td></tr>
<tr><td>2 (3)</td><td rowspan="11">NC</td><td rowspan="11">No connection</td><td rowspan="11">—</td><td rowspan="11">—</td></tr>
<tr><td>27 (22)</td></tr>
<tr><td>4</td></tr>
<tr><td>25</td></tr>
<tr><td>9 (8)</td></tr>
<tr><td>20 (17)</td></tr>
<tr><td>11</td></tr>
<tr><td>18</td></tr>
<tr><td>12 (10)</td></tr>
<tr><td>17 (15)</td></tr>
</table>

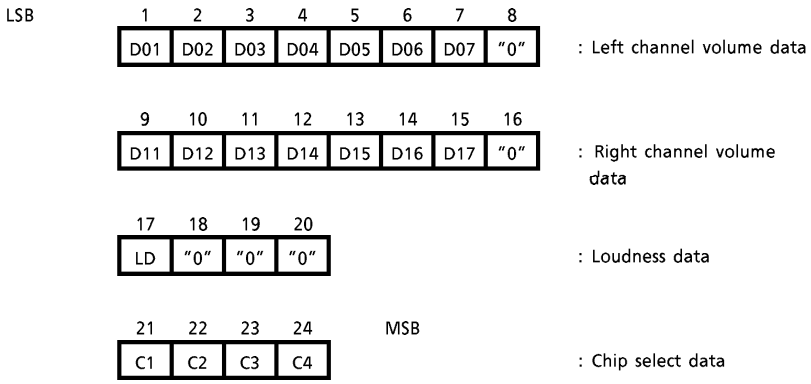
DEVICE OPERATION

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

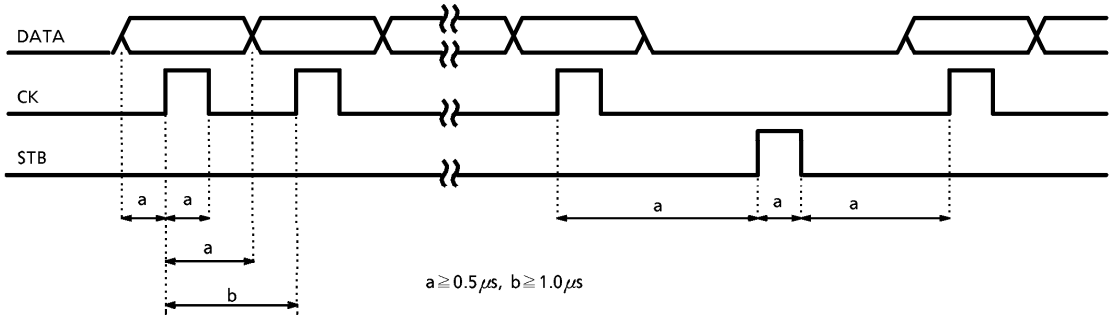
The bits "D01" through "D07" are the left channel volume setup data, the bits "D11" through "D17" are the right channel volume setup data. For details, see the tables below.

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

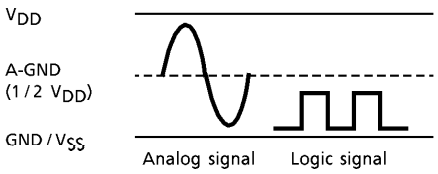
Make sure that CK, DATA and STB are input to the device at the timings shown below.



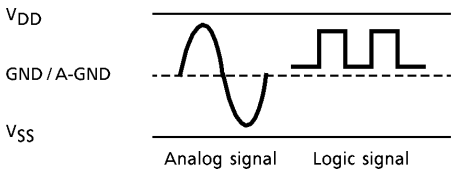
3. Operating with a single or dual power supplies

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



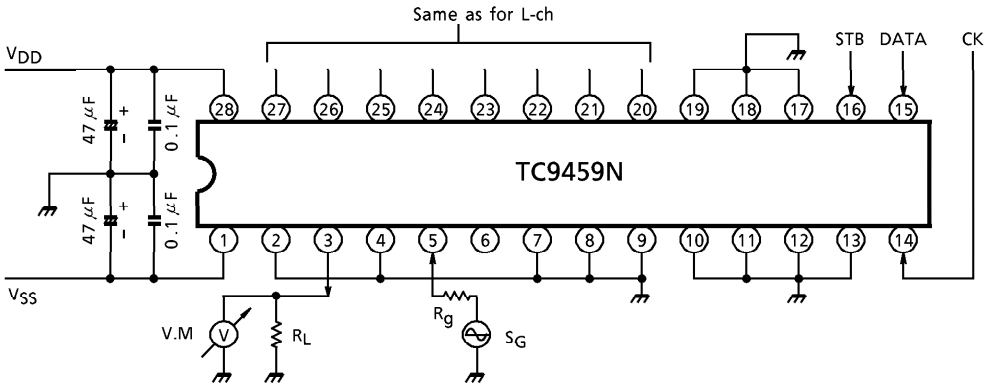
MAXIMUM RATINGS (Ta = 25°C)

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

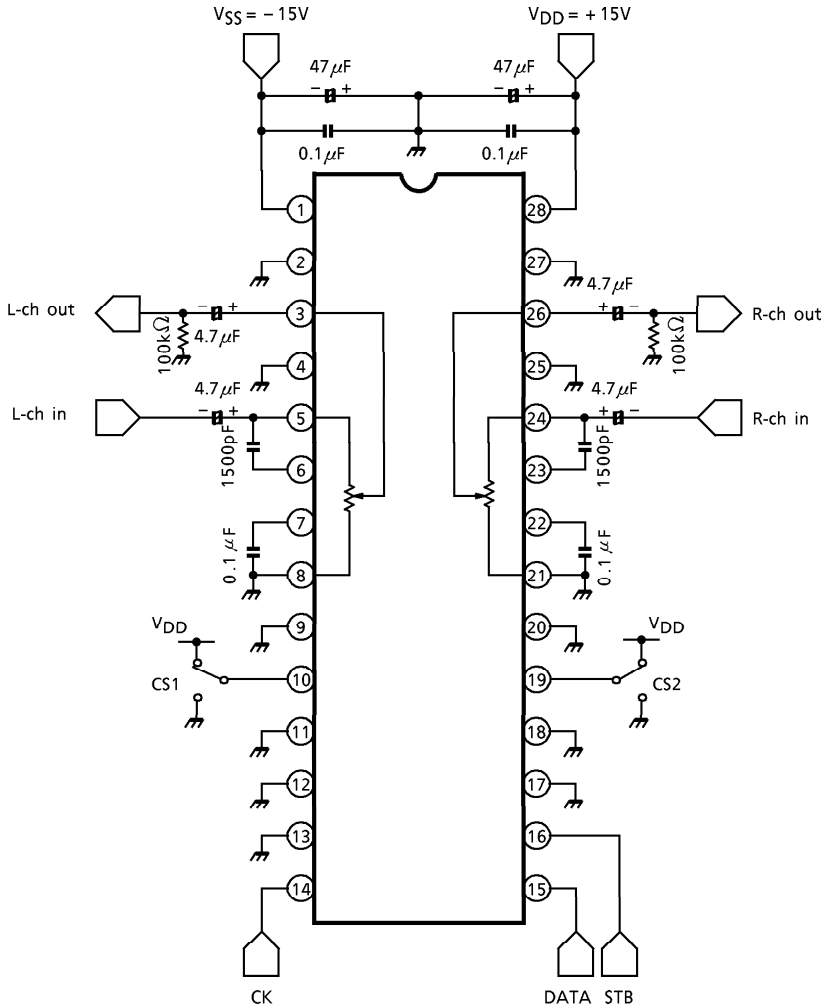
ELECTRICAL CHARACTERISTICS
(Referenced to V_{DD} = 15V, V_{SS} = −15V, GND = 0V at Ta = 25°C unless otherwise noted)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	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		4.0	~	V_{DD}	V
	"L" Level	V_{IL} (1)		V_{DD} = 6.0~18V		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	−1.0	~	1.0	μA
	"L" Level	I_{IL}			V_{IL} = 0V	−1.0	~	1.0	
Operating Frequency		fop	—	CK, DATA, STB pins		0	~	1.0	MHz
Min. Operating Clock Width		Tck				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		—	0.005	—	%
Maximum Attenuation		ATT_{MAX}		V_{IN} = 1Vrms		—	100	—	dB
Output Noise Voltage		V_N		R_g = 600Ω, R_L = 100kΩ		—	1.0	—	μV_{rms}
Crosstalk		C·T		BW = 20Hz~20kHz		—	100	—	dB

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



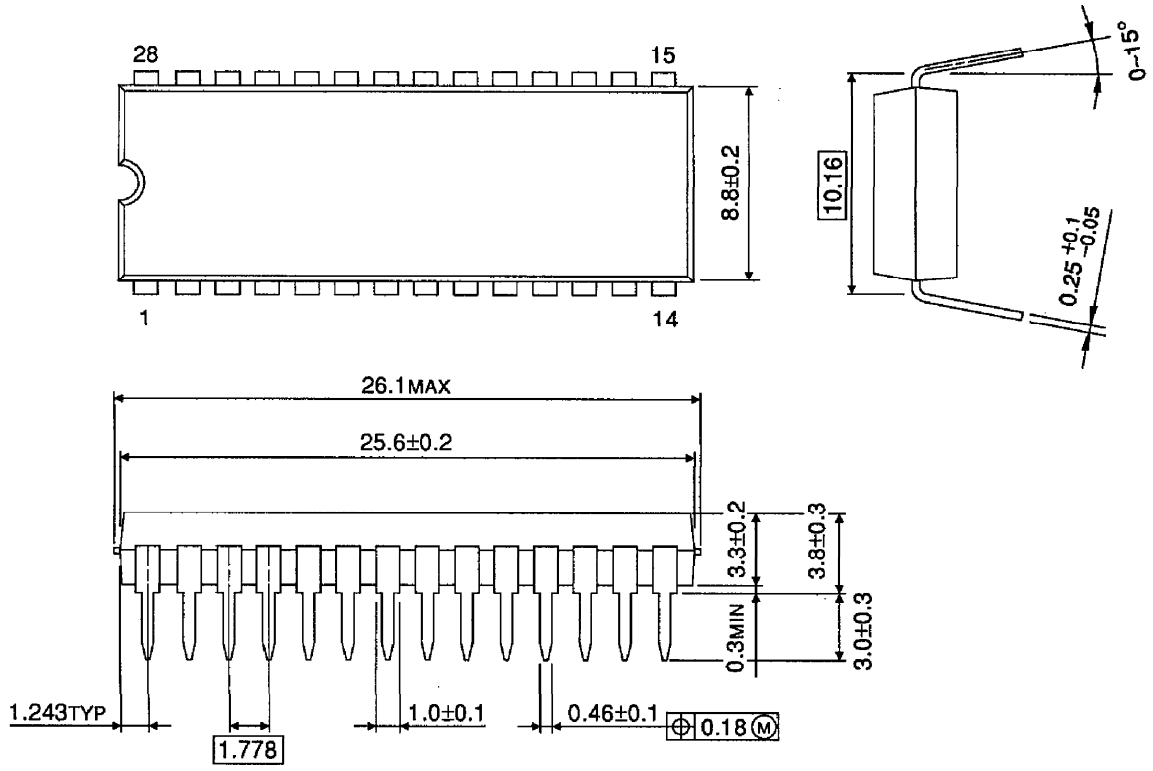
EXAMPLE OF APPLICATION CIRCUIT (TC9459N)



(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

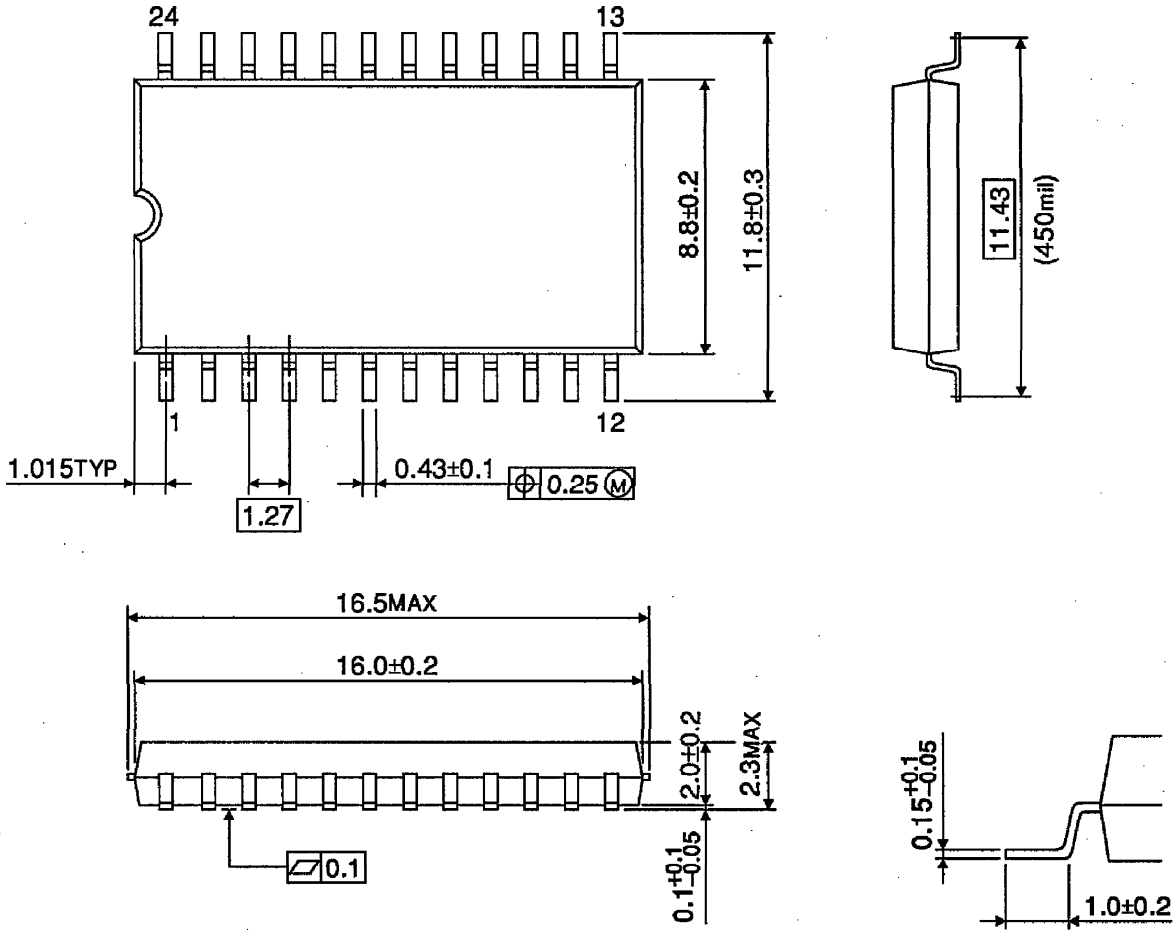


Weight : 2.2g (Typ.)

PACKAGE DIMENSIONS

SOP24-P-450-1.27A

Unit : mm



Weight : 0.44g (Typ.)