

TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

# TC9422N, TC9422F

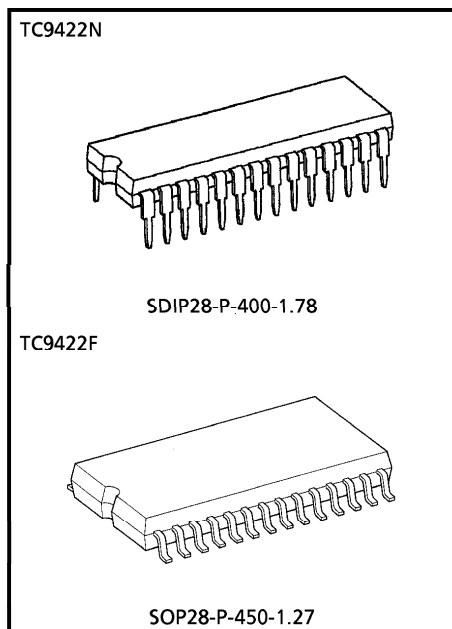
## SYSTEM ELECTRONIC VOLUME

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

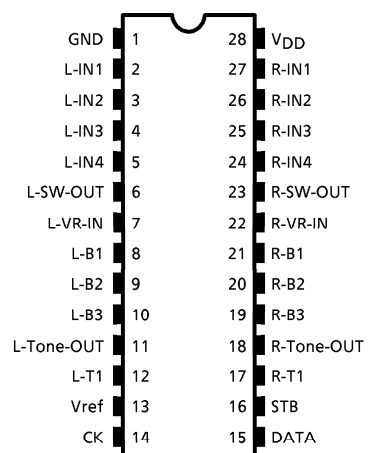
With a few external parts, TC9422N and TC9422F can control a wide range of audio functions, including main volume, balance, fader, bass, treble, loudness, and input switching.

### FEATURES

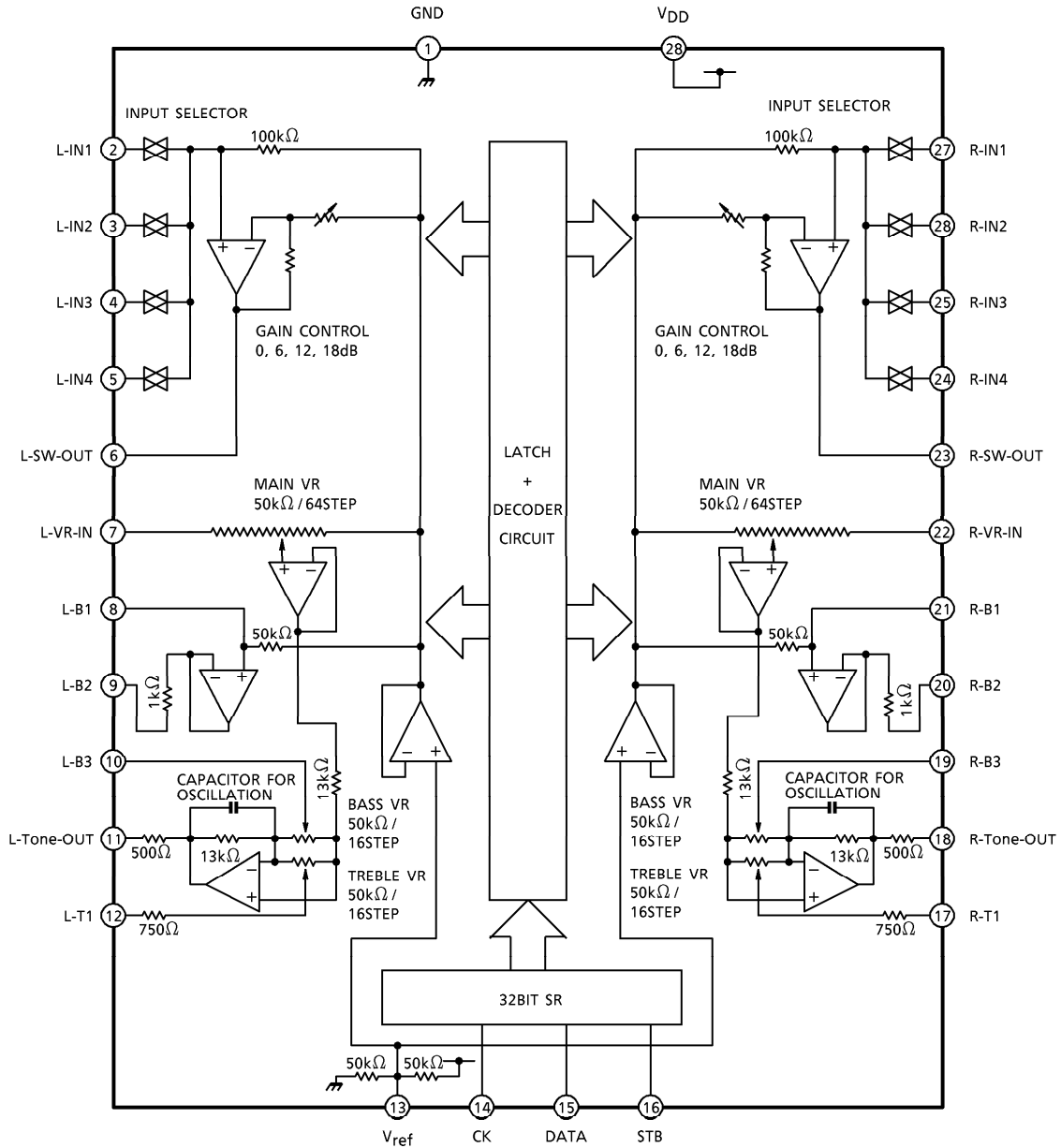
- Tone control : 18dB or -12dB for both bass and treble (16 positions)
- Input selector : Any of four input signals can be amplified with any of four gain options : 0dB, 6dB, 12dB, or 18dB
- Main volume : Offers 64dB positions of separate left and right control over the range 0~ -78dB and  $\infty$  (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.)

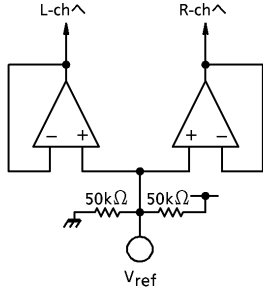
**PIN CONNECTION**

BLOCK DIAGRAM



DESCRIPTION OF PINS

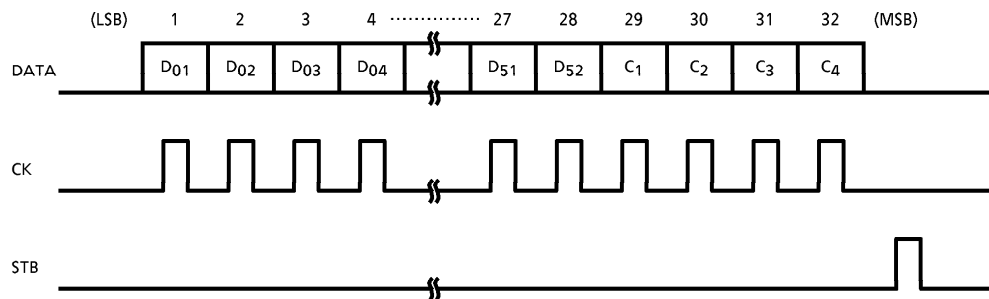
PIN No.	SYMBOL	PIN NAME	FUNCTION AND OPERATION	REMARKS
28	V <sub>DD</sub>	Power supply voltage pin	<ul style="list-style-type: none"> <li>Power supply pins</li> </ul>	—
1	GND	Ground pin		
2	L-IN1	Audio signal input pins	<ul style="list-style-type: none"> <li>Four input selector circuits</li> <li>Op amp circuit gain can be set to 0dB, 6dB, 12dB, or 18dB</li> </ul>	—
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"> <li>A main volume circuit and two-band tone control circuits for bass and treble</li> <li>A bass circuit can connect an external capacitor with an operational amplifier in which builds active filter.</li> <li>An external capacitor can connect with a treble circuit.</li> </ul>	—
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	V <sub>ref</sub>	Reference voltage input pin	<ul style="list-style-type: none"> <li>Used to determine internal op amp reference voltage (A-GND)</li> <li>Incorporates resistor for dividing voltage between V<sub>DD</sub> and GND (Typ. V<sub>REF</sub> = V<sub>DD</sub> / 2)</li> </ul> 	—
14	CK	Clock input pin	<ul style="list-style-type: none"> <li>Serial data transfer clock input pin</li> </ul>	Low threshold value input pins
15	DATA	Data input pin	<ul style="list-style-type: none"> <li>Control data input pin</li> </ul>	
16	STB	Strobe input pin	<ul style="list-style-type: none"> <li>Data write strobe input pin</li> </ul>	

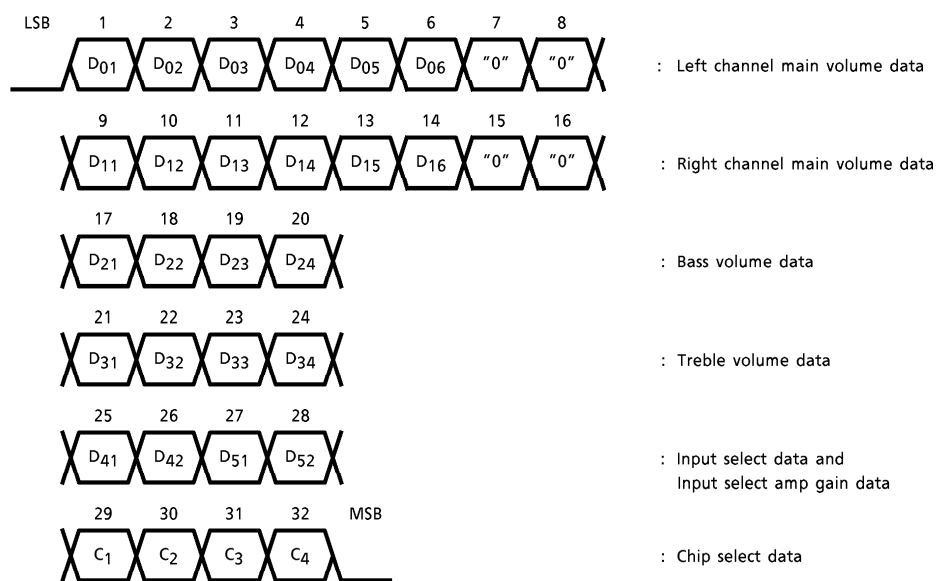
**OPERATION**

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



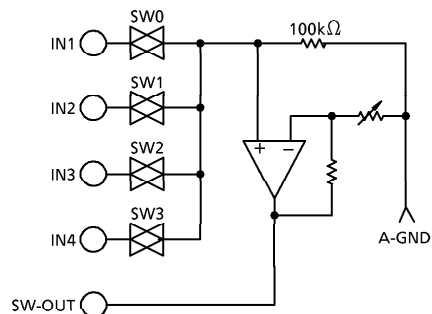
2) Chip select data (C<sub>1</sub>~C<sub>4</sub>)

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

For TC9422N and TC9422F, set C<sub>1</sub> = "0", C<sub>2</sub> = "1", C<sub>3</sub> = "0", C<sub>4</sub> = "1" (0101 : AH).

2. Input select circuit

1) Equivalent circuit



2) Input select and gain settings

• Input select settings

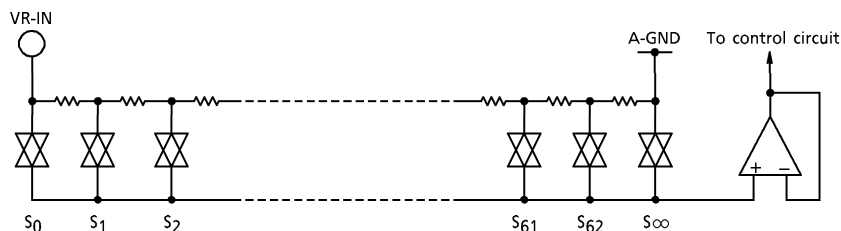
INPUT DATA		INPUT SELECT ANALOG SWITCH			
D <sub>41</sub>	D <sub>42</sub>	SW <sub>0</sub>	SW <sub>1</sub>	SW <sub>2</sub>	SW <sub>3</sub>
0	0	ON	OFF	OFF	OFF
1	0	OFF	ON	OFF	OFF
0	1	OFF	OFF	ON	OFF
1	1	OFF	OFF	OFF	ON

• Gain setting

INPUT DATA		GAIN
D <sub>51</sub>	D <sub>52</sub>	
0	0	0dB
1	0	6dB
0	1	12dB
1	1	18dB

3. Main volume circuit

1) Equivalent circuit



2) Main volume settings

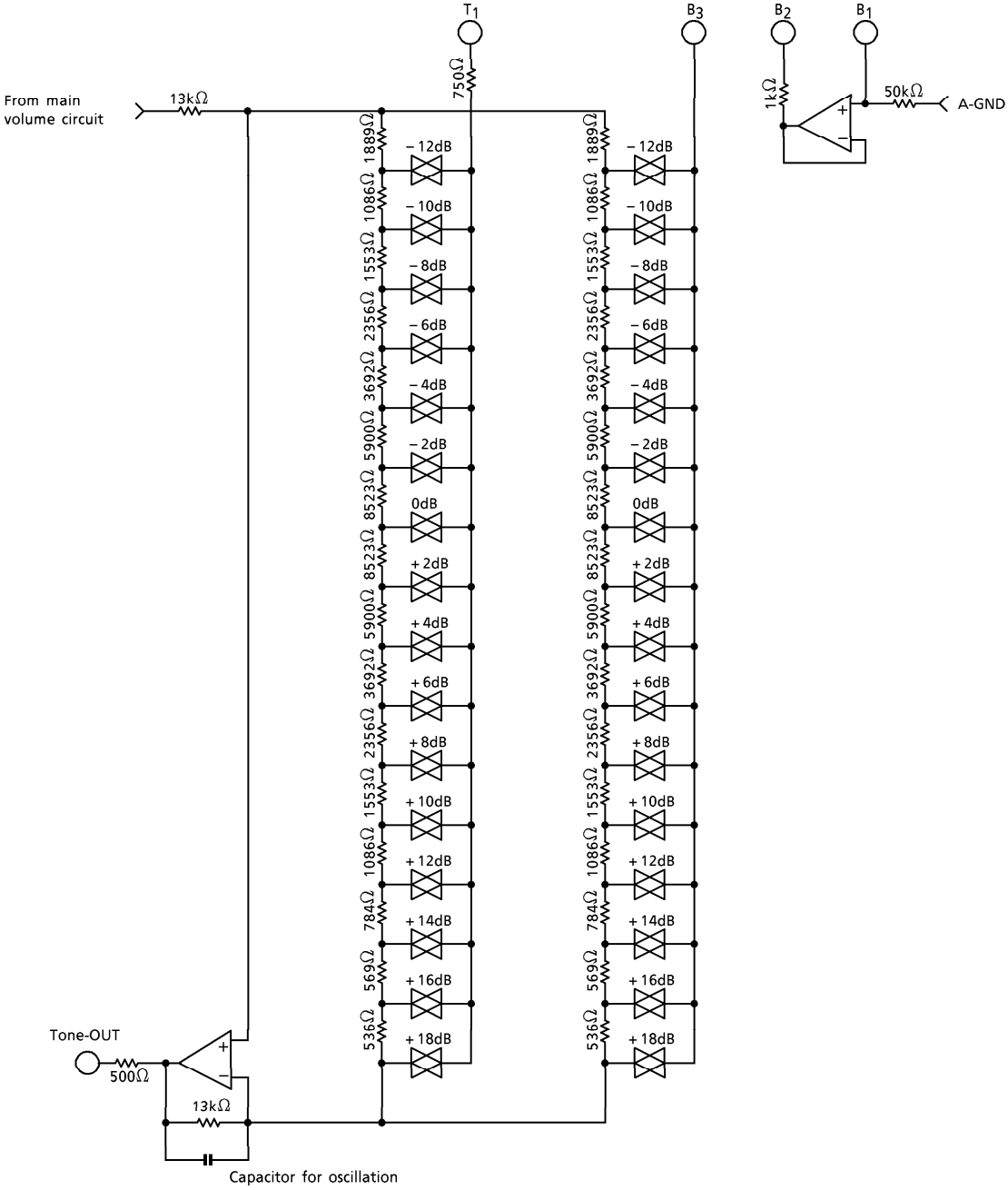
STEP	D01 D11	D02 D12	D03 D13	D04 D14	D05 D15	D06 D16
0dB	0	0	0	0	0	0
-1dB	1	0	0	0	0	0
-2dB	0	1	0	0	0	0
-3dB	1	1	0	0	0	0
-4dB	0	0	1	0	0	0
-5dB	1	0	1	0	0	0
-6dB	0	1	1	0	0	0
-7dB	1	1	1	0	0	0
-8dB	0	0	0	1	0	0
-9dB	1	0	0	1	0	0
-10dB	0	1	0	1	0	0
-11dB	1	1	0	1	0	0
-12dB	0	0	1	1	0	0
-13dB	1	0	1	1	0	0
-14dB	0	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 <sub>DD</sub>	- 0.3~15	V
Input Voltage	V <sub>IN</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 SPECIFICATIONS (Unless otherwise specified, Ta = 25°C, V<sub>DD</sub> = 9.0V, GND = 0V)

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

## ● Input selector block

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
Maximum Input Level	V <sub>INMAX</sub>	—	f <sub>in</sub> = 1kHz, G <sub>V</sub> = 0dB THD = 1%, R <sub>L</sub> = 12kΩ	—	2.0	—	V <sub>rms</sub>	
Input Gain	1		G <sub>V1</sub>	f <sub>in</sub> = 1kHz, R <sub>G</sub> = 600Ω, R <sub>L</sub> = 50kΩ	- 1.5	0	+ 1.5	dB
	2		G <sub>V2</sub>		4.5	6.0	7.5	
	3		G <sub>V3</sub>		10.5	12.0	13.5	
	4		G <sub>V4</sub>		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

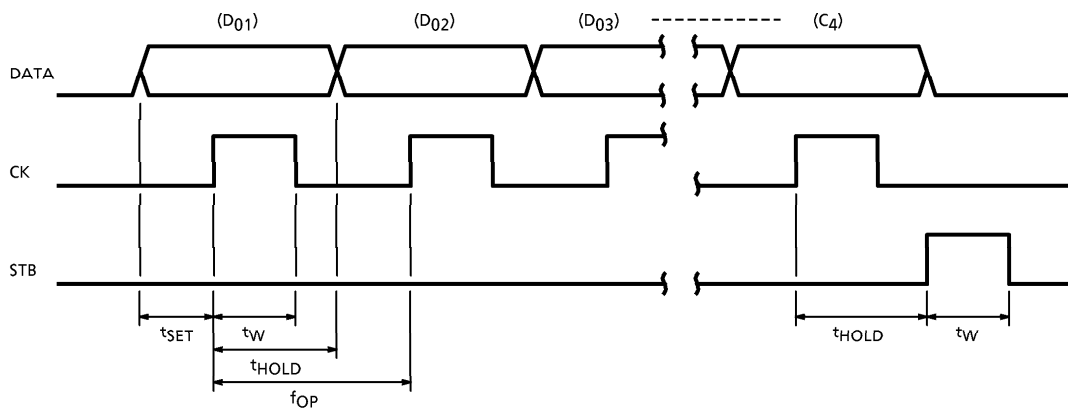
CHARACTERISTIC	SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Control Range	G <sub>VT</sub> (1)	—	Maximum Boost	16.0	18.0	21.0	dB
	G <sub>VT</sub> (2)		Maximum Cut	- 10.0	- 12.0	- 15.0	
Step Resolution	ΔSTEP		—	1.0	2.0	3.0	
Output Load Resistance	R <sub>L</sub>		TONE-OUT pins	12.0	—	—	kΩ

● Overall characteristics

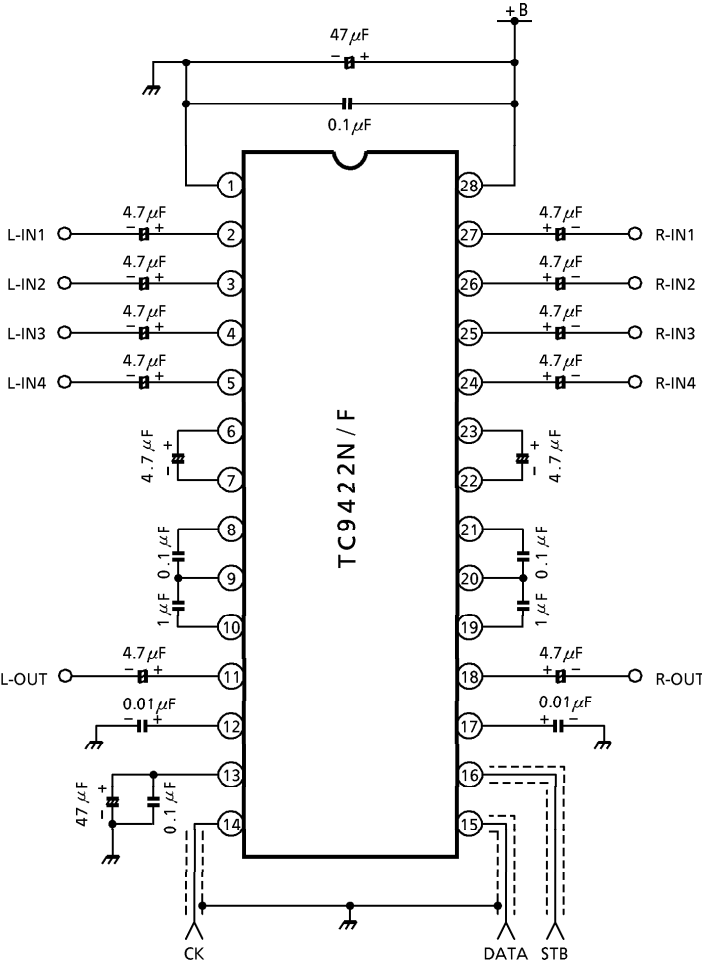
CHARACTERISTIC	SYMBOL	TEST CIRCUIT	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT	
Overall Harmonic Distortion Ratio	THD (1)	1	All set to flat R <sub>g</sub> = 600Ω R <sub>L</sub> = 33kΩ	f <sub>in</sub> = 1kHz V <sub>IN</sub> = 1.0V <sub>rms</sub>	—	0.01	—	%
	THD (2)			f <sub>in</sub> = 20kHz V <sub>IN</sub> = 1.0V <sub>rms</sub>	—	0.02	—	
Crosstalk	C·T		V <sub>IN</sub> = 1.0V <sub>rms</sub> , R <sub>g</sub> = 600Ω f <sub>in</sub> = 1kHz, All set to flat	60	80	—	dB	
Maximum Attenuation	ATT <sub>MAX</sub>		V <sub>IN</sub> = 1.0V <sub>rms</sub> , R <sub>g</sub> = 600kΩ f <sub>in</sub> = 1kHz Main volume ∞	60	80	—	dB	
Output Noise Voltage	V <sub>N</sub> (1)		R <sub>g</sub> = 600Ω (IHF-A) All set to flat	—	5.0	12.0	μV <sub>rms</sub>	
	V <sub>N</sub> (2)	R <sub>g</sub> = 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



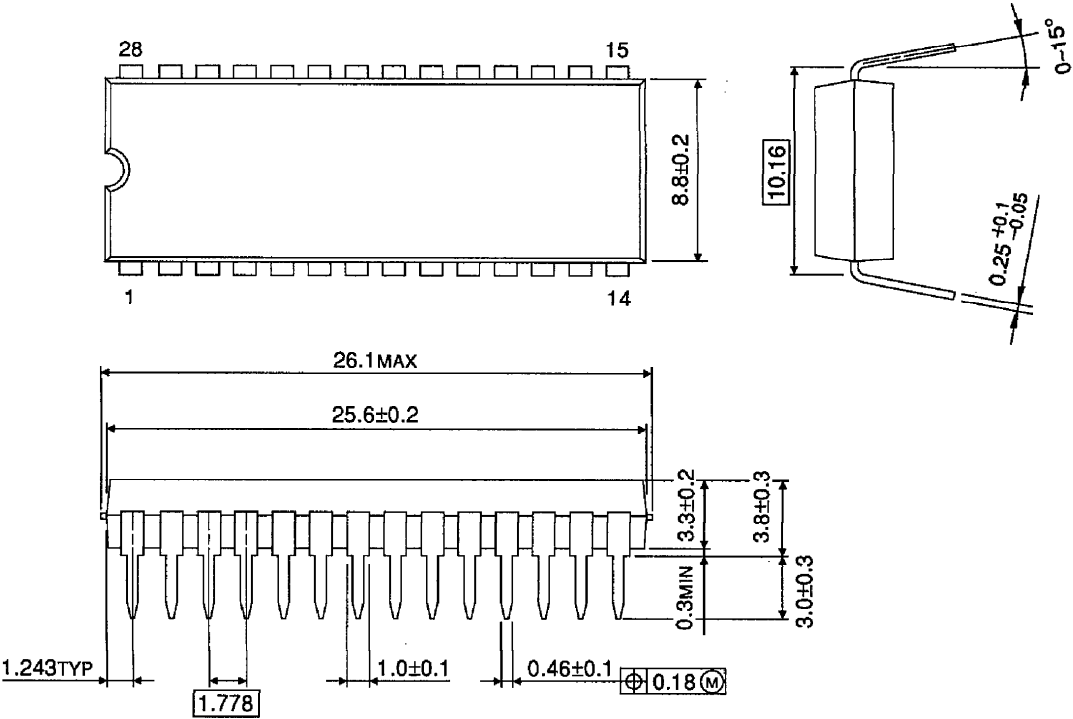
APPLICATION CIRCUIT



(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

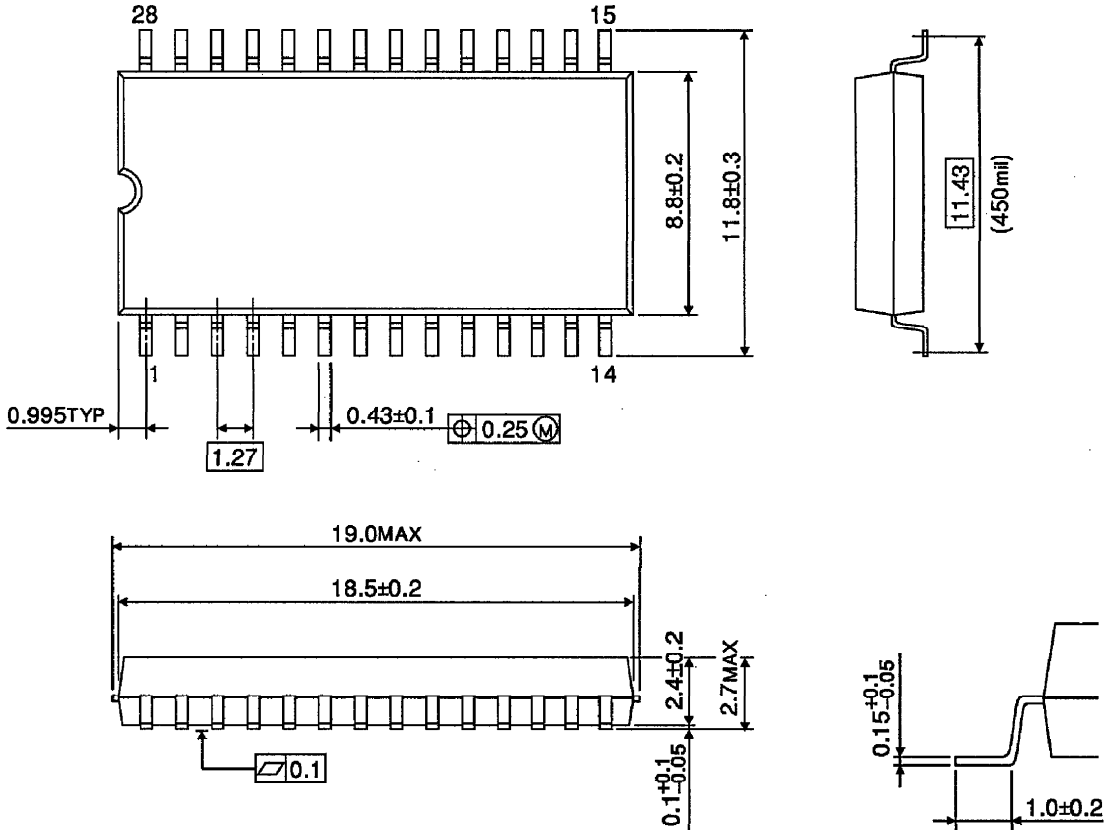
Unit : mm



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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