

TC9422N, TC9422F

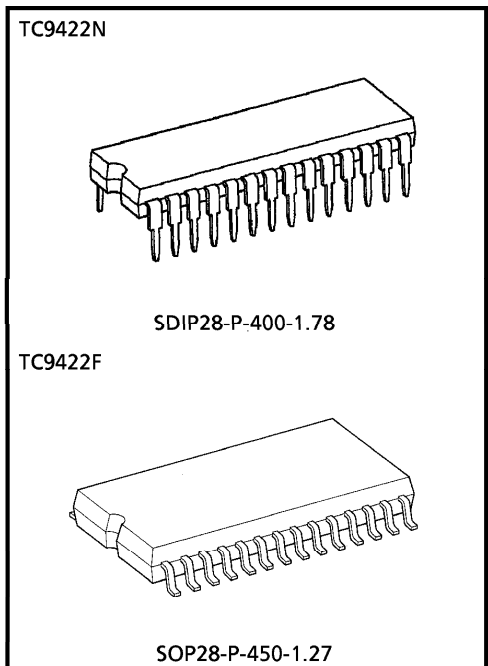
SYSTEM ELECTRONIC VOLUME

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

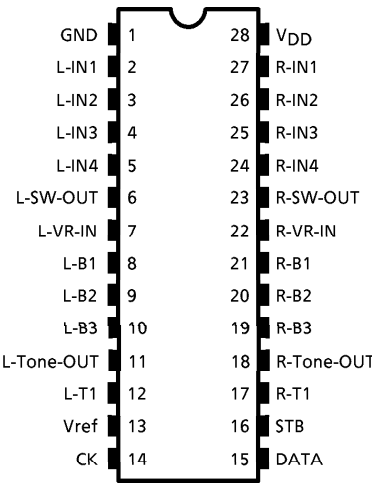
- Tone control : 18dB or -12dB for both bass and treble (16 positions)
- Input selector : Any of four input signals can be amplified with any of four gain options : 0dB, 6dB, 12dB, or 18dB
- Main volume : Offers 64dB positions of separate left and right control over the range 0~ -78dB and ∞ (in 1dB~2dB/steps).
- 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.



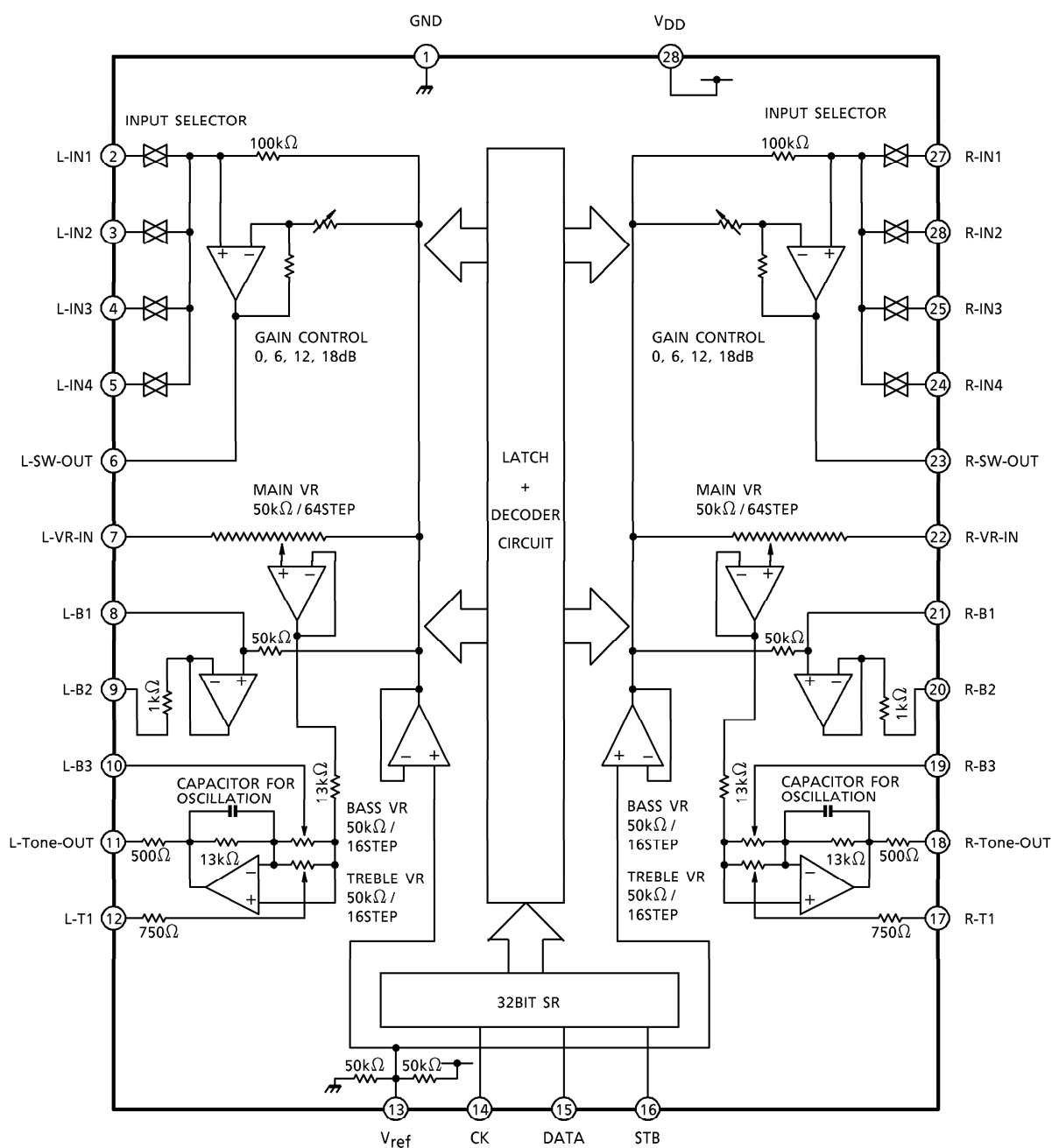
Weight

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

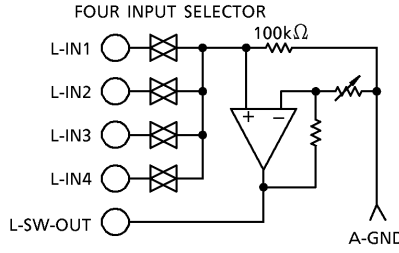
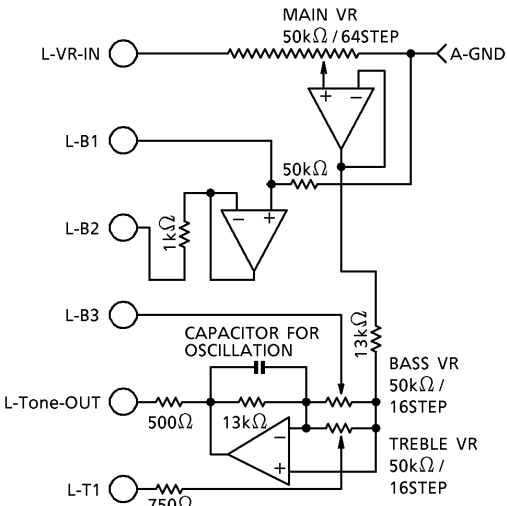
PIN CONNECTION

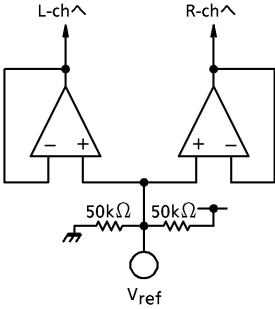


BLOCK DIAGRAM



DESCRIPTION OF PINS

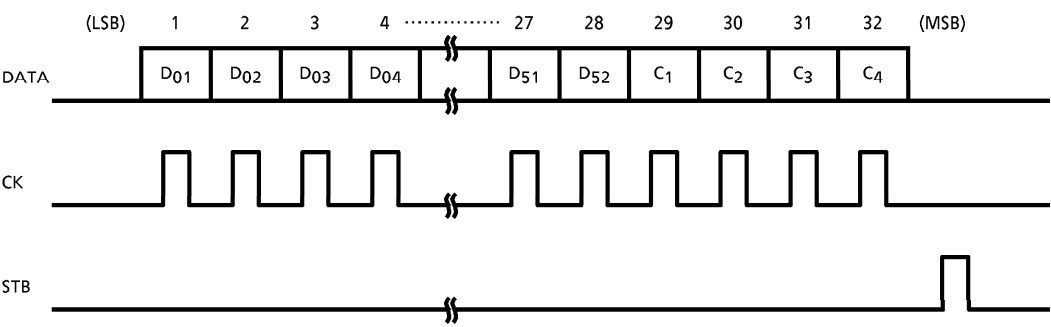
PIN No.	SYMBOL	PIN NAME	FUNCTION AND OPERATION	REMARKS
28	V _{DD}	Power supply voltage pin	Power supply pins	—
1	GND	Ground pin		
2	L-IN1	Audio signal input pins	- Four input selector circuits - Op amp circuit gain can be set to 0dB, 6dB, 12dB, or 18dB FOUR INPUT SELECTOR  L-SW-OUT A-GND GAIN CONTROL 0, 6, 12, 18dB	—
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	- 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.  MAIN VR 50kΩ / 64STEP A-GND L-VR-IN L-B1 L-B2 L-B3 L-Tone-OUT L-T1 500Ω 13kΩ 750Ω 13kΩ 50kΩ 1kΩ 50kΩ 100kΩ 13kΩ 50kΩ / 16STEP 50kΩ / 16STEP 50kΩ / 64STEP 13kΩ 750Ω 1kΩ 50kΩ 13kΩ 50kΩ 13kΩ 750Ω 1kΩ 50kΩ 1	

PIN No.	SYMBOL	PIN NAME	FUNCTION AND OPERATION	REMARKS
13	V _{ref}	Reference voltage input pin	- 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	Serial data transfer clock input pin	Low threshold value input pins
15	DATA	Data input pin	Control data input pin	
16	STB	Strobe input pin	Data write strobe input pin	

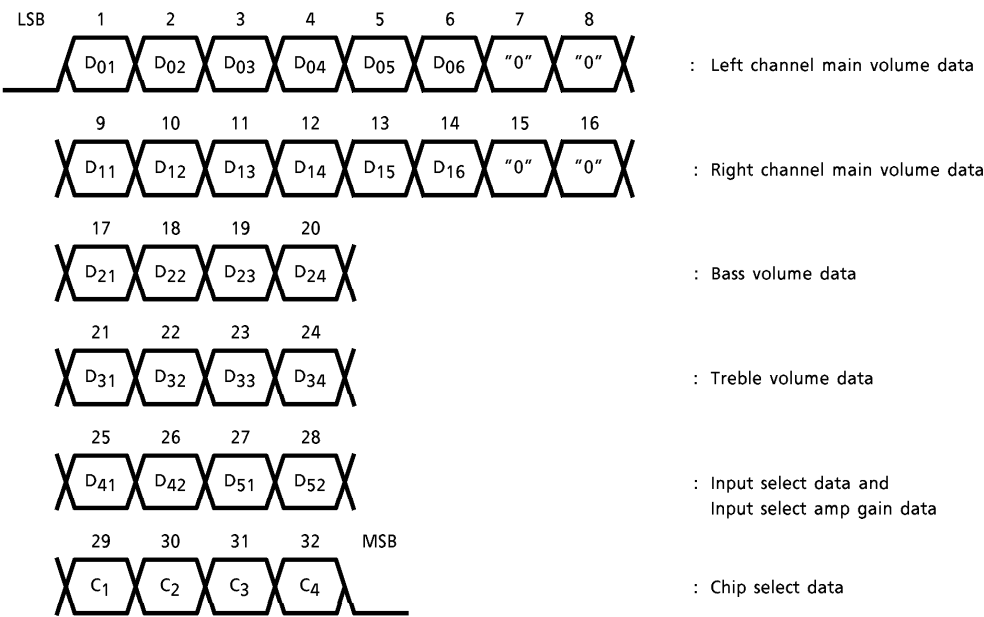
OPERATION

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

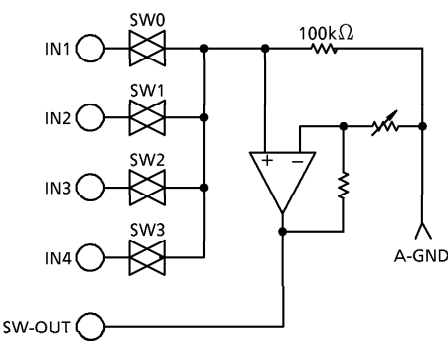


2) Chip select data (C₁~C₄)

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

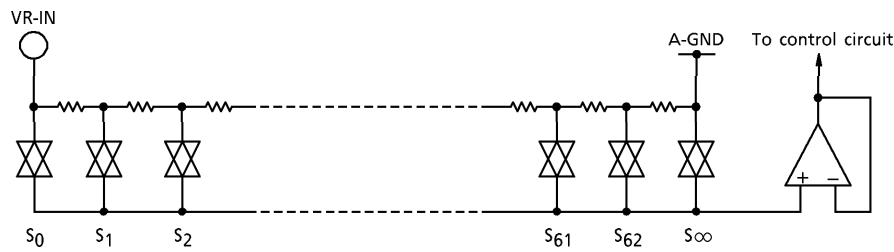
INPUT DATA		INPUT SELECT ANALOG SWITCH			
D41	D42	SW0	SW1	SW2	SW3
0	0	ON	OFF	OFF	OFF
1	0	OFF	ON	OFF	OFF
0	1	OFF	OFF	ON	OFF
1	1	OFF	OFF	OFF	ON

• 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



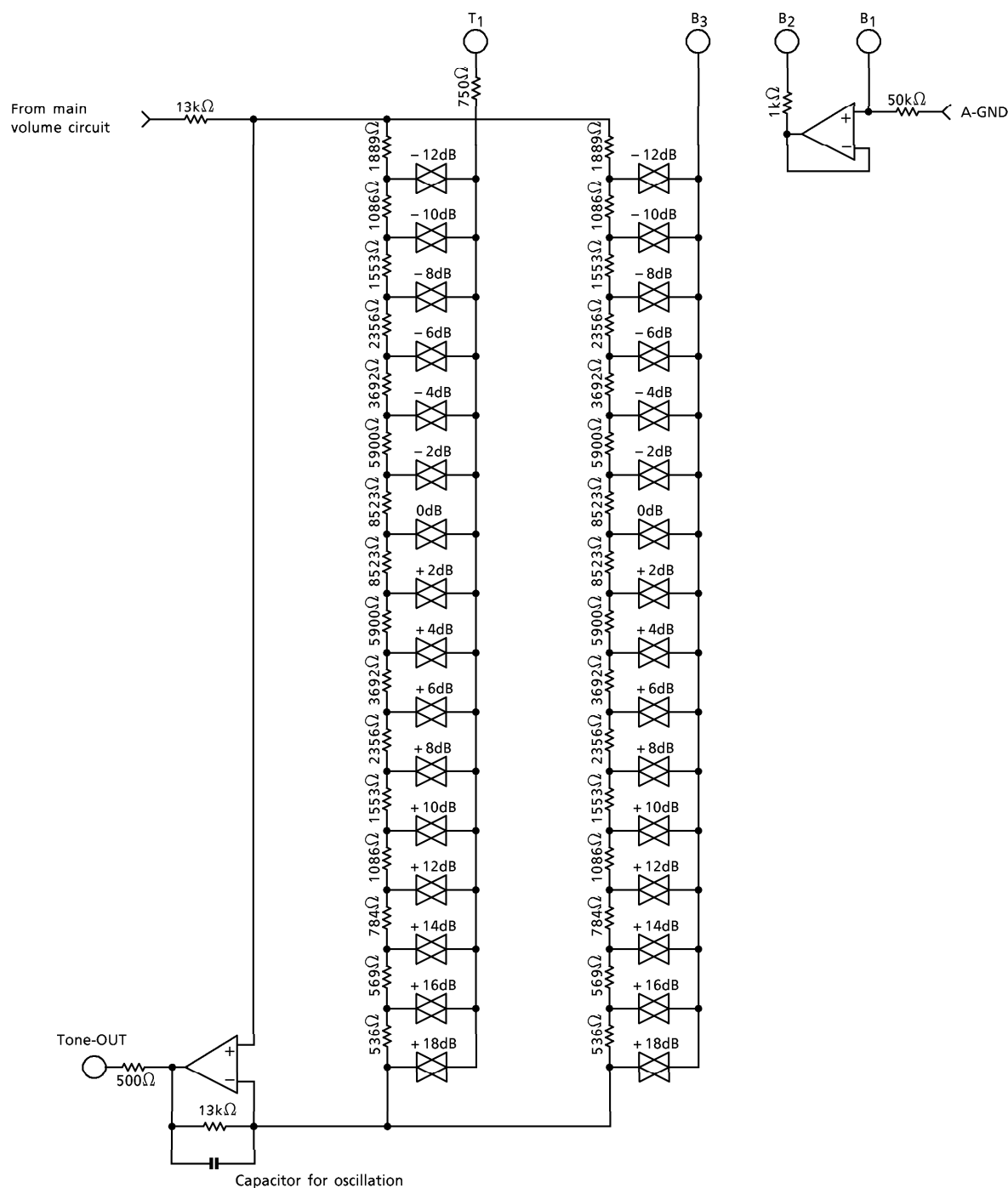
2) Main volume settings

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}		—	—	1.0	μA
	"L" Level	I _{IL}		- 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}		CK signals	—	—	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

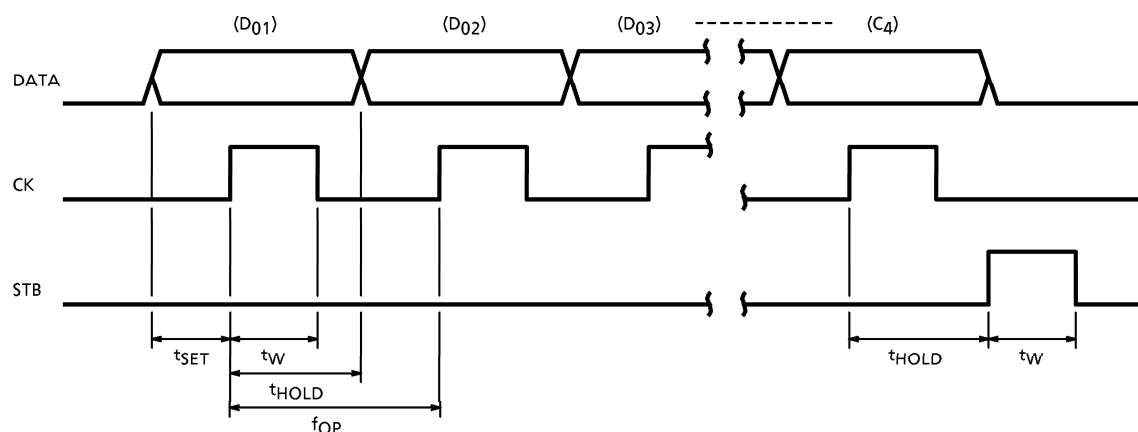
CHARACTERISTIC	SYMBOL	TEST CIR- CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Control Range	$G_{VT} (1)$	—	Maximum Boost	16.0	18.0	21.0	dB
	$G_{VT} (2)$		Maximum Cut	- 10.0	- 12.0	- 15.0	
Step Resolution	$\Delta STEP$		—	1.0	2.0	3.0	
Output Load Resistance	R_L		TONE-OUT pins	12.0	—	—	k Ω

- Overall characteristics

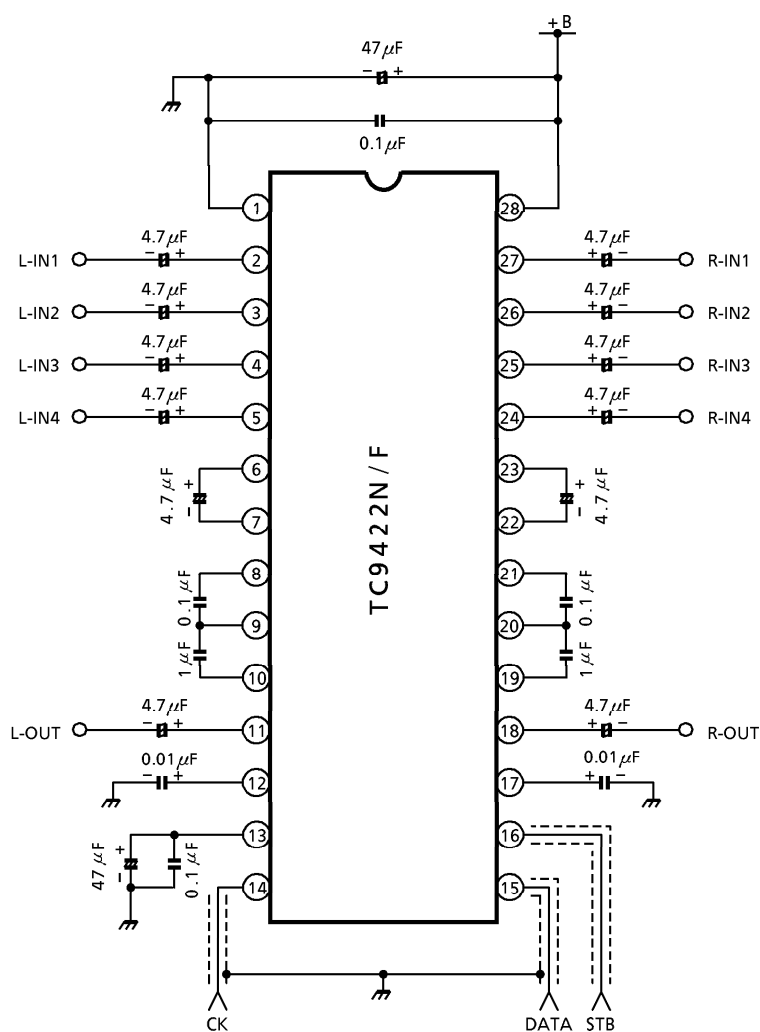
CHARACTERISTIC	SYMBOL	TEST CIR- CUIT	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Overall Harmonic Distortion Ratio	THD (1)	1	All set to flat $R_g = 600\Omega$ $R_L = 33k\Omega$	$f_{in} = 1kHz$ $V_{IN} = 1.0V_{rms}$	—	0.01	%
	THD (2)			$f_{in} = 20kHz$ $V_{IN} = 1.0V_{rms}$	—	0.02	
Crosstalk	C-T		$V_{IN} = 1.0V_{rms}$, $R_g = 600\Omega$ $f_{in} = 1kHz$, All set to flat	60	80	—	dB
Maximum Attenuation	ATT_{MAX}		$V_{IN} = 1.0V_{rms}$, $R_g = 600k\Omega$ $f_{in} = 1kHz$ Main volume ∞	60	80	—	dB
Output Noise Voltage	$V_N (1)$		$R_g = 600\Omega$ (IHF-A) All set to flat	—	5.0	12.0	μV_{rms}
	$V_N (2)$		$R_g = 600\Omega$ (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



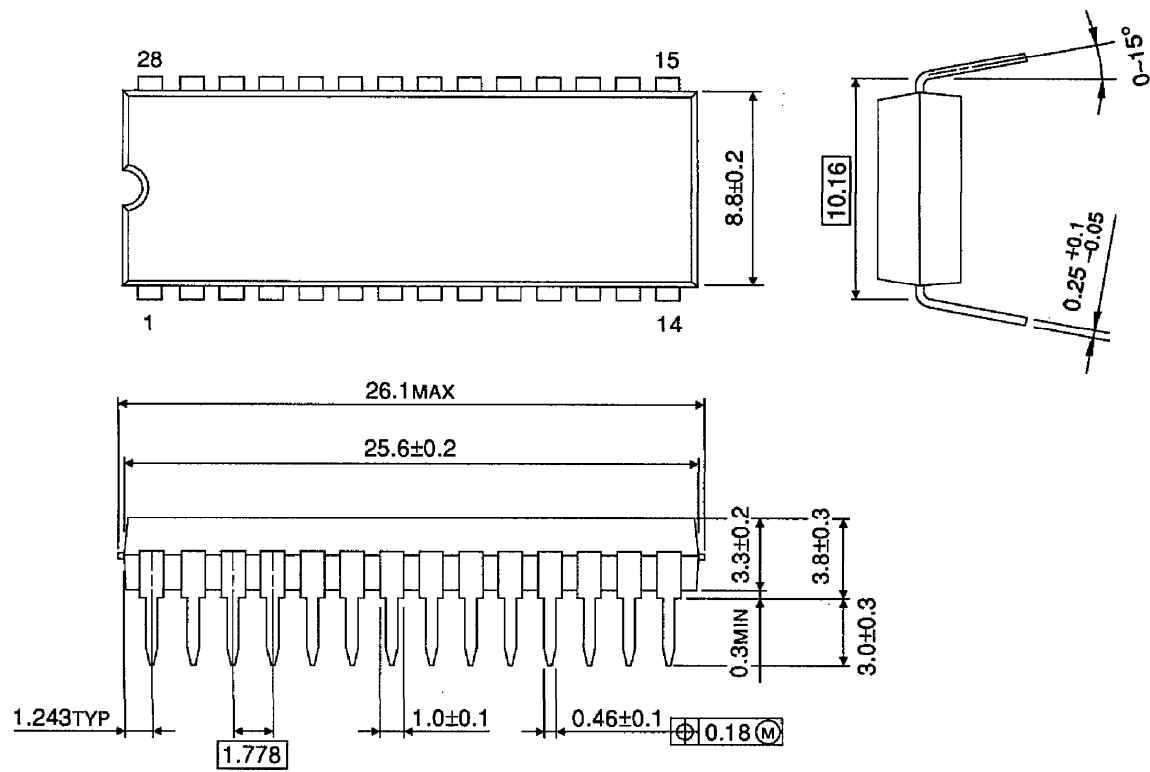
APPLICATION CIRCUIT



(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

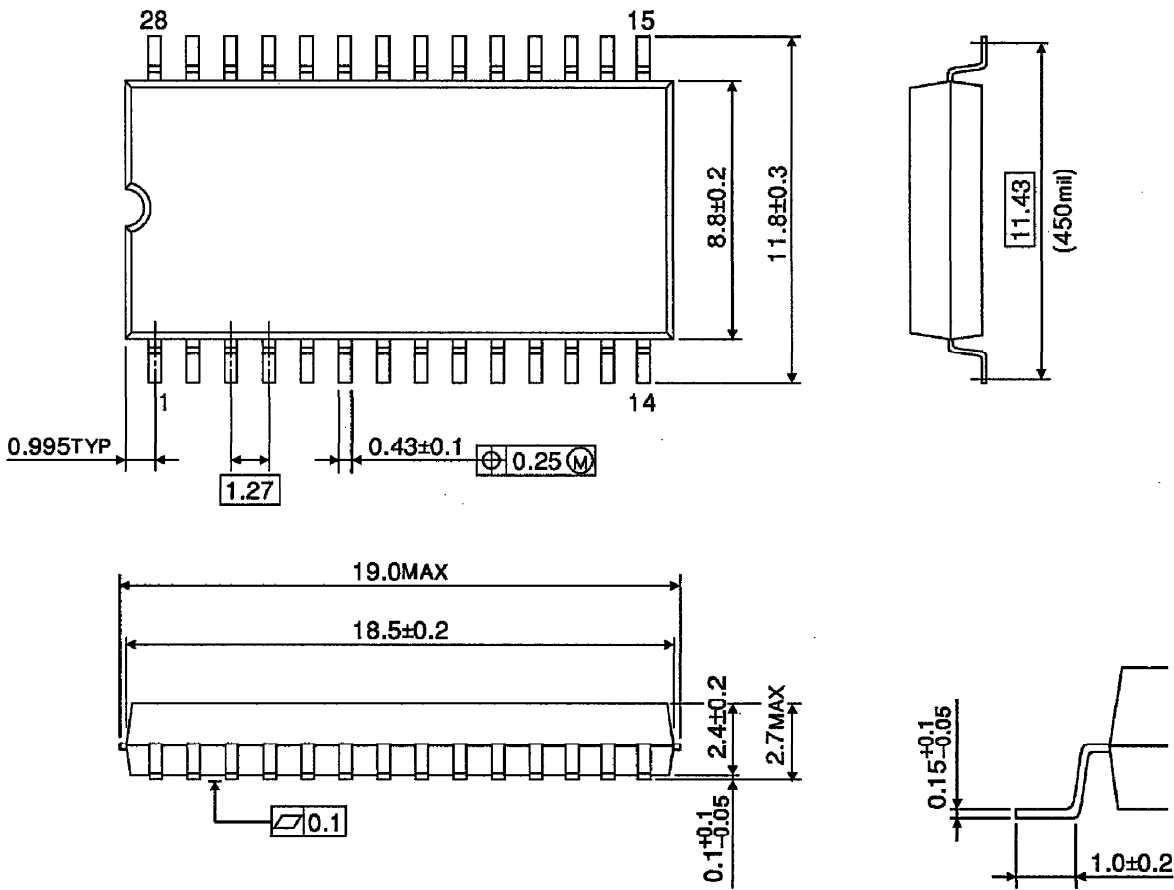
Unit : mm



Weight : 2.2g (Typ.)

PACKAGE DIMENSIONS
SOP28-P-450-1.27

Unit : mm



Weight : 0.8g (Typ.)

RESTRICTIONS ON PRODUCT USE

000707EBA

- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property. In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc..
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk.
- The products described in this document are subject to the foreign exchange and foreign trade laws.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.
- The information contained herein is subject to change without notice.