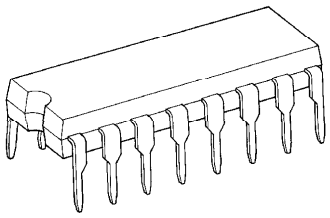
TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

TC9260P, TC9260F

ELECTRONIC VOLUME

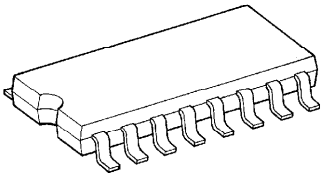
The TC9260P and TC9260F are an optimum CMOS which has been designed for electronization of volume control of audio equipment, etc.

TC9260P



DIP16-P-300-2.54A

TC9260F



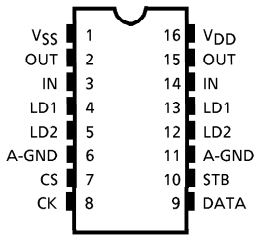
SOP16-P-300-1.27

Weight
DIP16-P-300-2.54A : 1.0g (Typ.)
SOP16-P-300-1.27 : 0.16g (Typ.)

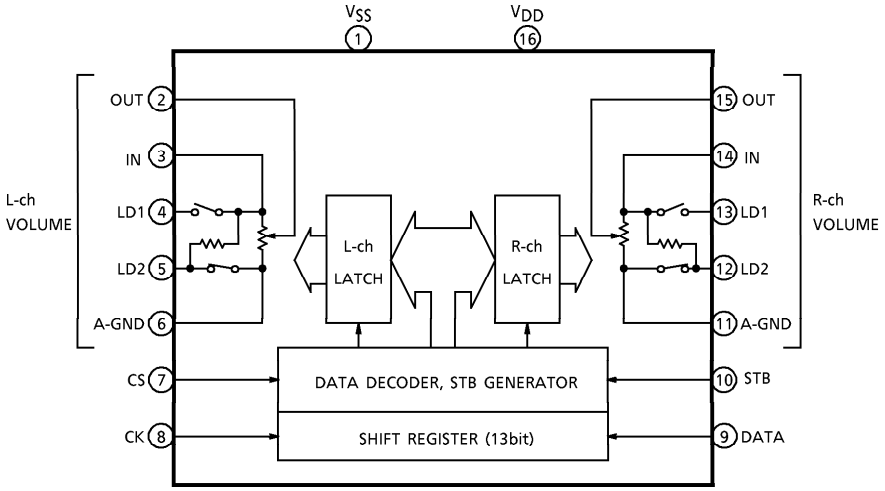
FEATURES

- Attenuation can be controlled from 0dB to −78dB by 2dB / step.
- This ICs feature a built-in loudness circuit. (20dB tap)
- The volume, balance and loudness circuits can be controlled by serial data.
- Chip select input allows control of up to 2 of these chip on the same bus.
- Polysilicon resistors enables low-distortion, high-performance volume system.
- Package is DIP16 and SOP16.

PIN CONNECTION

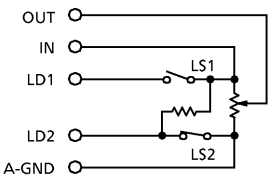


BLOCK DIAGRAM



980508EBA2

PIN FUNCTION

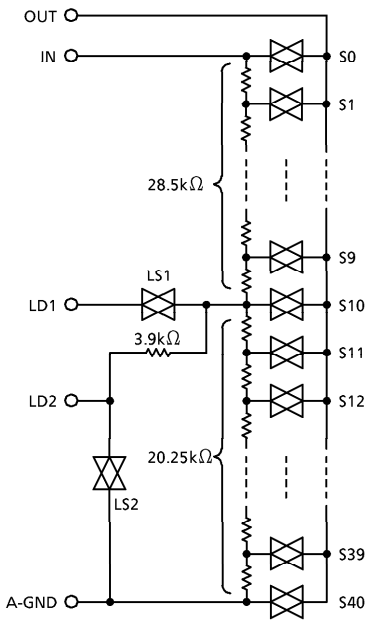
PIN No.	SYMBOL	PIN NAME	FUNCTION AND OPERATION	NOTE
1	V_{SS}	Digital ground pin	—	—
16	V_{DD}	Power supply pin		
2	L-OUT	Volume output pin	● Volume circuit  ● Loudness ON : LS1 = ON, LS2 = OFF	—
15	R-OUT			
3	L-IN	Volume input pin		
14	R-IN			
4	L-LD1	Tap output pins for loudness (1)		
13	R-LD1			
5	L-LD2	Tap output pins for loudness (2)		
12	R-LD2			
6	L-GND	Analog ground pins		
11	R-GND			
7	CS	Chip select input pin	● Input pin for designating chip select code. This pin correspond to bit "C1" which is chip select bit in serial data. When CS = "1" and C1 = "1", Data is valid. When CS = "0" and C1 = "0", Data is valid.	—
8	CK	Clock input pin	Clock input for data transfer.	Low threshold value input pins
9	DATA	Data input pin	Attenuation channel selection data input terminal. Data consists of 13 bits and input by CK signal.	
10	STB	Strobe input pin	Attenuation setting signal take from DATA and CK terminals are latched when this terminal is placed at "H" level.	

OPERATION

1. Volume circuit

Volume circuit consist of ladder resistor and analog switch.
Tap for loudness is connected to step 10 (20dB). Loudness operation is controlled by LS1 / LS2 switches.

- Equipment circuit



- Volume step and attenuation

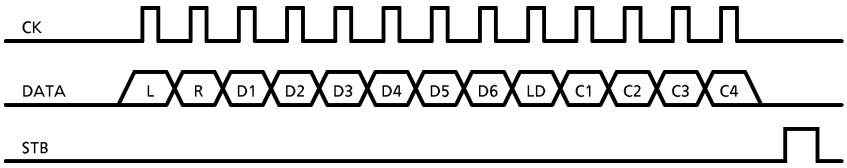
STEP	ATTEN-UATION	STEP	ATTEN-UATION
S0	0 (dB)	S21	42
S1	2	S22	44
S2	4	S23	46
S3	6	S24	48
S4	8	S25	50
S5	10	S26	52
S6	12	S27	54
S7	14	S28	56
S8	16	S29	58
S9	18	S30	60
S10	20	S31	62
S11	22	S32	64
S12	24	S33	66
S13	26	S34	68
S14	28	S35	70
S15	30	S36	72
S16	32	S37	74
S17	34	S38	76
S18	36	S39	78
S19	38	S40	∞
S20	40		

- Loudness ON : LS1 = ON, LS2 = OFF
- Loudness OFF : LS1 = OFF, LS2 = ON

2. Setting volume values

Optional attenuation data is input through the DATA, CK and STB terminals.
Data consists of 18 bits as follows.

(1) Serial data format



(2) Chip select code (C1~C4)

Chip select code is set to use serial bus line in common with other ICs.
Data C2, C3, C4 is fixed 0, 1, 1 in TC9260P, TC9260F.
When level of CS input pin (7pin) correspond to C1 bit, data is valid.

CS	C1	C2	C3	C4
"1"	1	0	1	1
"0"	0	0	1	1

Fixed

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

(4) LD is loudness setting data
When LD = "0", loudness is OFF (LS1 = OFF, LS2 = ON)
When LD = "1", loudness is ON (LS1 = ON, LS2 = OFF)

(5) Volume setting data (D1~D6)

List of volume data and step

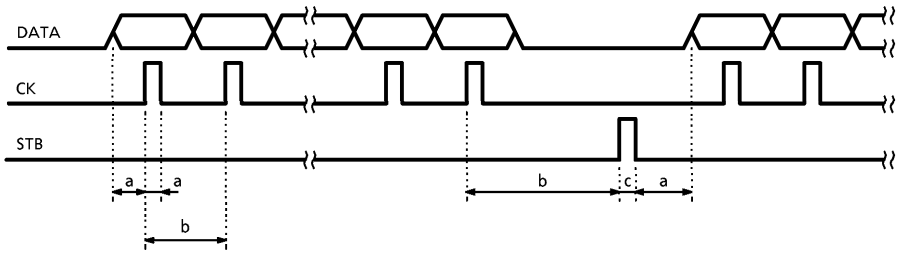
VOLUME VALUE	D1	D2	D3	D4	D5	D6
0dB	0	0	0	0	0	0
2	1	0	0	0	0	0
4	0	1	0	0	0	0
6	1	1	0	0	0	0
8	0	0	1	0	0	0
10	1	0	1	0	0	0
12	0	1	1	0	0	0
14	1	1	1	0	0	0
16	0	0	0	1	0	0
18	1	0	0	1	0	0
20	0	1	0	1	0	0
22	1	1	0	1	0	0
24	0	0	1	1	0	0
26	1	0	1	1	0	0
28	0	1	1	1	0	0
30	1	1	1	1	0	0
32	0	0	0	0	1	0
34	1	0	0	0	1	0
36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

(6) Serial data timing

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



a>1μs, b>2μs, c>2μs

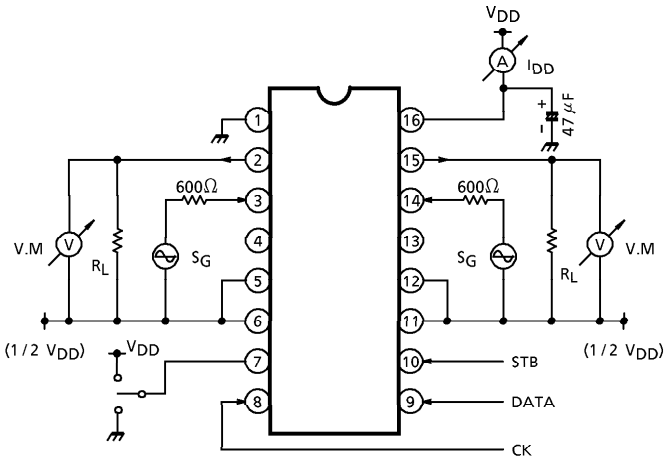
MAXIMUM RATINGS (Ta = 25°C)

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}	−55~150	°C

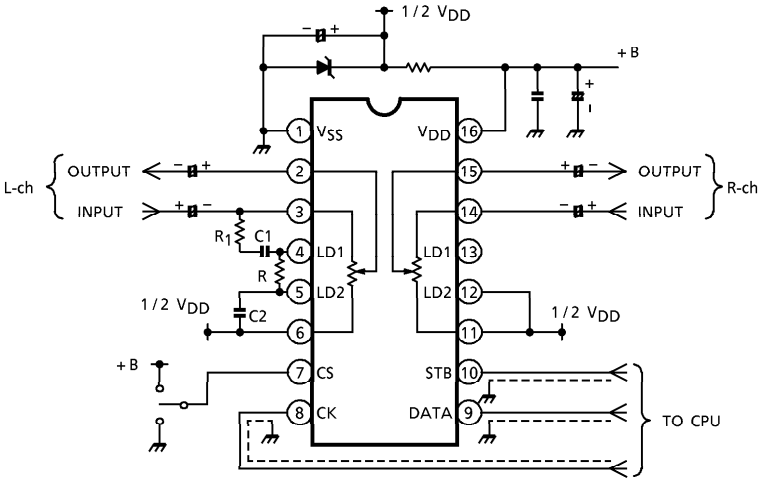
ELECTRICAL CHARACTERISTICS (Unless otherwise specified, Ta = 25°C, V_{DD} = 9V)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Operating Supply Voltage		V_{DD}	—	Ta = −40~85°C		4.5	9.0	12	V
Operating Supply Current		I_{DD}	1	No load		—	0.3	1.0	mA
Input Voltage	"H" Level	V_{IH} (1)	—	CK, DATA, STB input pin V_{DD} = 4.5~12V		4.0	~	V_{DD}	V
	"L" Level	V_{IL} (1)				0	~	1.0	
Input Voltage	"H" Level	V_{IH} (2)	—	CS input pin		V_{DD} × 0.7	~	V_{DD}	V
	"L" Level	V_{IL} (2)				0	~	V_{DD} × 0.3	
Input Current	"H" Level	I_{IH}	—	All input pin	$V_{IH} = V_{DD}$	−1	—	1	μA
	"L" Level	I_{IL}			V_{IL} = 0V	−1	—	1	
Volume Resistance Value		R_{VR}	—	Loudness "OFF"		20	28	37	kΩ
Analog Switch ON Resistance		R_{ON}	—	—		—	250	600	Ω
Attenuation Error		ΔATT	—			—	0	±2	dB
Volume Balance Between Left And Right		ΔR_{VR}	—	Volume error between left and right		—	0	±3	%
Total Harmonic Distortion		THD	1	f_{IN} = 1kHz V_{IN} = 1V_{rms} R_L = 100kΩ R_g = 600Ω	0dB	—	0.01	—	%
Maximum Attenuation		ATTM	1		∞dB	—	100	—	dB
Cross Talk		CT	1		0dB	—	100	—	dB
Output Noise Voltage		V_N	1			—	2.0	—	μV_{rms}
Operation Frequency		f_{op}	—	CK, DATA, STB		—	—	500	kHz
Minimum Pulse Width		T_{CK}	—	CK input		—	0.5	1.0	μs
		T_{STB}		STB input		—	1.0	2.0	

TEST CIRCUIT 1

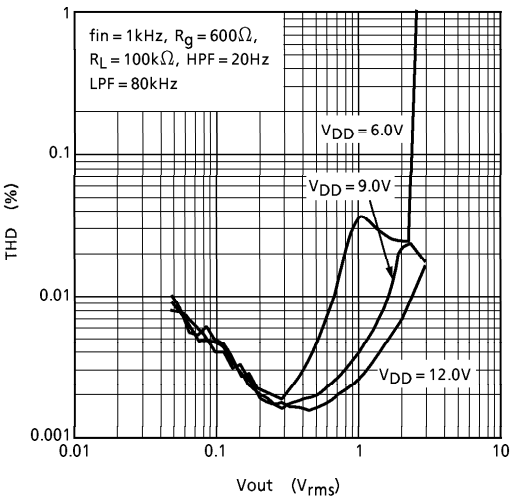


APPLICATION CIRCUIT

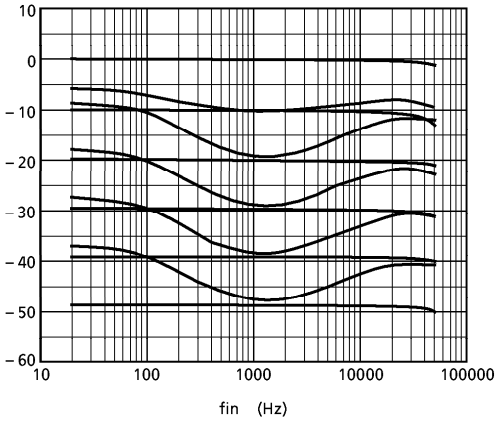


(Note)
- L-ch circuit is loudness operation, R-ch circuit is without loudness.
  $R_1 = 8.2k\Omega$, C1 = 1500pF, C2 = 0.1μF
- For preventing noise when loudness is turned on or off. R = 220kΩ~470kΩ
- High-frequency digital signals are input to pins CK, DATA and STB. Since these signals may cause noise 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.

THD – Vout



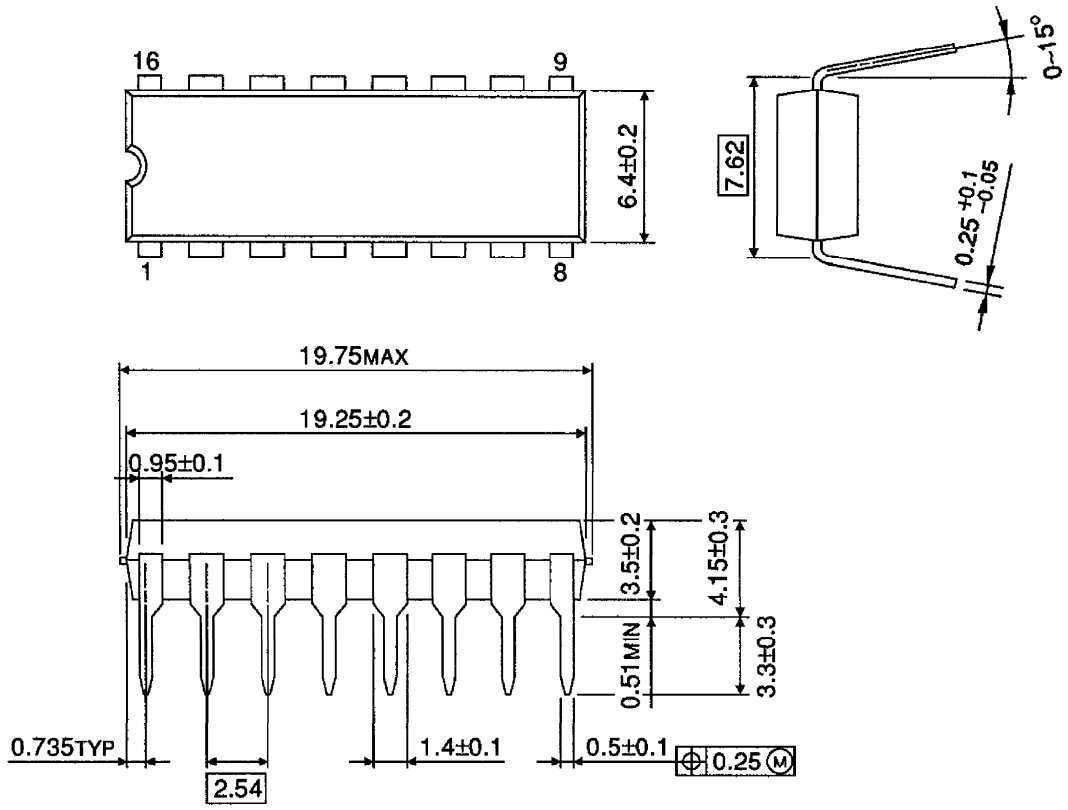
LD Characteristics



OUTLINE DRAWING

DIP16-P-300-2.54A

Unit : mm

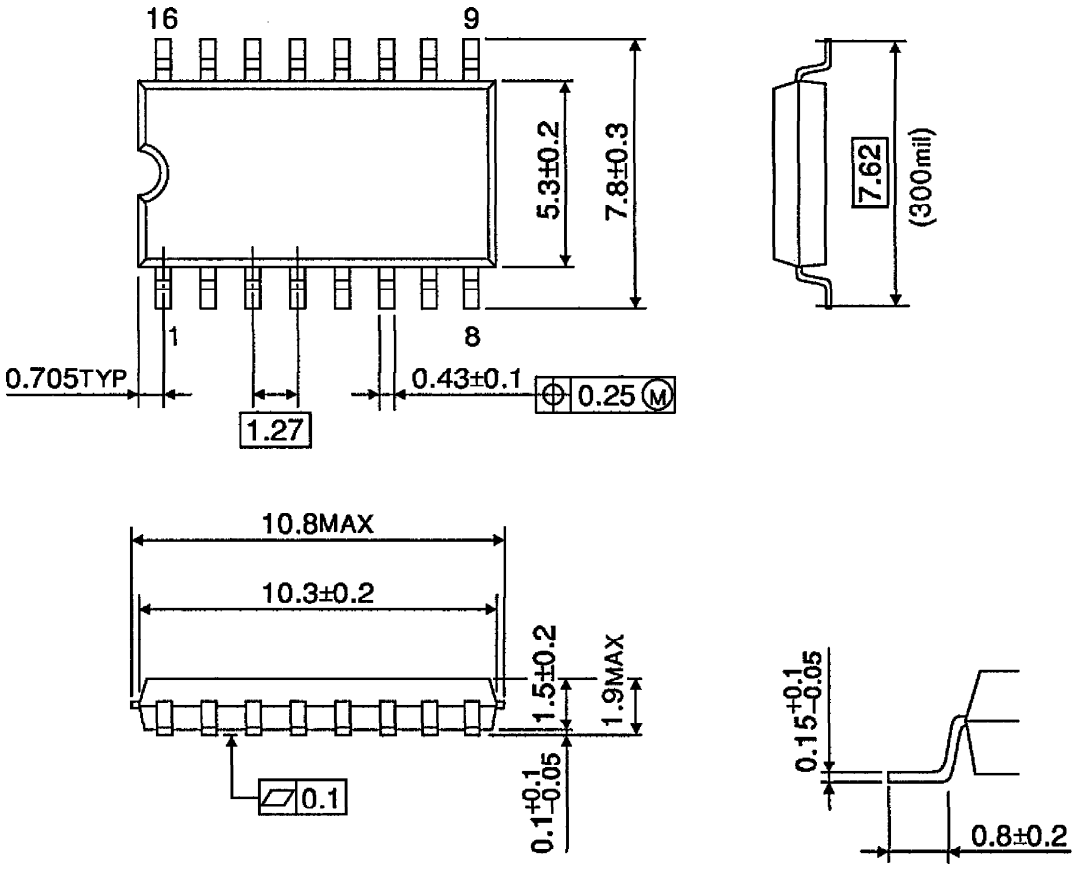


Weight : 1.0g (Typ.)

OUTLINE DRAWING

SOP16-P-300-1.27

Unit : mm



Weight : 0.16g (Typ.)