

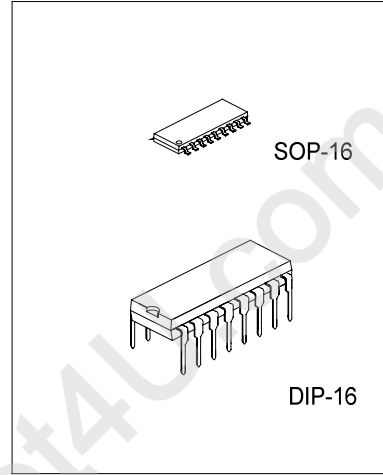
ELECTRONIC VOLUME

DESCRIPTION

The SC9235 and SC9235S are an optimum CMOS IC which has been designed for electronization of volume control of audio equipment, etc.

FEATURES

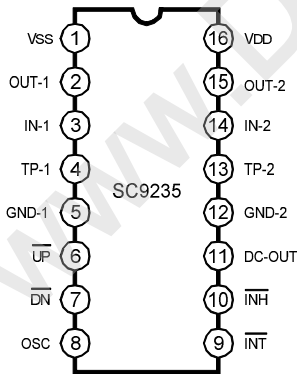
- * Attenuation can be controlled from 0dB to -78dB by up, down input.
- * This IC have 20dB tap for loudness circuit.
- * This IC features a built-in DC output circuit (7 level) for volume level meter.
- * Polysilicon resistors enables low-distortion, high-performance volume systems.
- * Volume level remains in backup mode with low current consumption.
- * Package is DIP16 and SOP16.



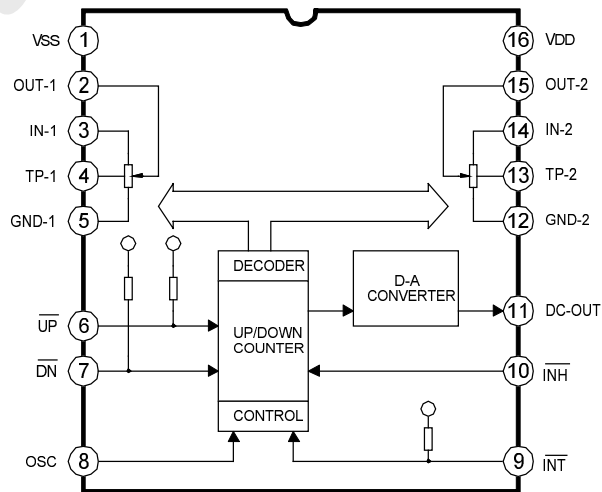
ORDERING INFORMATION

SC9235	DIP-16 Package
SC9235S	SOP-16 Package

PIN CONFIGURATION



BLOCK DIAGRAM



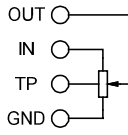
ABSOLUTE MAXIMUM RATINGS($T_a=25^{\circ}\text{C}$)

Characteristic	Symbol	Value	Unit
Supply Voltage	V_{DD}	-0.3 ~ 15	V
Input Voltage	V_{IN}	-0.3V ~ $V_{DD}+0.3\text{V}$	V
Power Dissipation	P_D	300	mW
Operating Temperature	T_{opr}	-40 ~ +85	$^{\circ}\text{C}$
Storage Temperature	T_{stg}	-55 ~ +150	$^{\circ}\text{C}$

ELECTRICAL CHARACTERISTICS(Unless otherwise specified, $T_a = 25^{\circ}\text{C}$, $V_{DD} = 9\text{V}$)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit	
Operating Supply Voltage	V_{DD}	$T_a=-40 \sim 85^{\circ}\text{C}$	4.5	9.0	12	V	
Operating Supply Current	I_{DD}	No load, $f_{osc}=20\text{Hz}$	--	0.3	1.0	μA	
Backup Voltage	V_{QD}	$\overline{\text{INH}}="L"$	2.0	--	12	V	
Backup Current	I_{QD}		--	0.01	1.0	μA	
Input Voltage	"H" Level	V_{IH}	All input pin		0.7 V_{DD}	V	
	"L" Level				V_{IL}		0
Input Current	"H" Level	I_{IH}	$\overline{\text{INH}}$ input pin	$V_{IH}=V_{DD}$	-1	1	μA
	"L" Level			I_{IL}	$V_{IL}=0\text{V}$	-1	
Pull Up Resistor	R_{UP}	$\overline{\text{UP}}, \overline{\text{DN}}, \overline{\text{INT}}$ Input pin	23	47	71	$\text{k}\Omega$	
Volume Resistor	R_{VR}	Between $\text{IN} \rightarrow \text{GND}$ resistor	31	44	58	$\text{k}\Omega$	
Analog Switch ON Resistor	R_{ON}	Analog switch ON resistor	--	500	800	Ω	
Attenuation Error	ΔATT	--	--	0	± 2.0	dB	
Balance Between Left And Right	ΔR_{VR}	Volume resistor error between left and right	--	0	± 3.0	%	
Total Harmonic Distortion	THD	$F_{IN}=1\text{kHz}$	0dB	--	0.01	%	
Maximum Attenuation	ATT_{MAX}	$V_{IN}=1\text{V}_{rms}$	∞dB	--	100	dB	
Cross Talk	C.T	$R_L=100\text{k}\Omega$	0dB	--	100	dB	
Output Noise Voltage	V_N	$R_g=600\Omega$		--	2.0	--	μV_{rms}
OSC Frequency	f_{osc}	$C_x=2.2\mu\text{F}, R_x=33\text{k}\Omega$	--	20	--	Hz	

PIN DESCRIPTION

Pin No.	Symbol	Pin Name	Description
1	V _{SS}	Negative power supply pin	Power Supply terminal
16	V _{DD}	Positive power supply pin	
2	OUT-1	Volume output pins	Volume circuit
15	OUT-2		
3	IN-1	Volume input pins	
14	IN-2		
4	TP-1	Tap output pins for loudness	
13	TP-2		
5	GND-1	Analog ground pins	
12	GND-2		
6	\overline{UP}	Volume up input pin	Volume up, down control input pin. The 1 step / 1 push volume is controlled by pushing the Up or Down key . If the key has been pushed continuously, the continuous volume control. These two input pins have built-in pull-up resistor.
7	\overline{DN}	Volume down input pin	
8	OSC	Oscillation pin	Oscillation pin. Oscillator circuit consist of C.R connection. Oscillation is executed while key is pushed.
9	\overline{INT}	Initializing pin	Input pin for setting initial volume level volume level set to 46dB by "L" input. This input pin has built-in pull-up resistor.
10	\overline{INH}	Inhibit terminal	Back up mode input pin. Internal all operation is stopped by "L" input, and volume level remains with low current consumption.
11	DC-OUT	DC output pin for level meter	DC output pin for volume level meter. DC voltage which is corresponded to volume step is generated.

FUNCTION DESCRIPTION

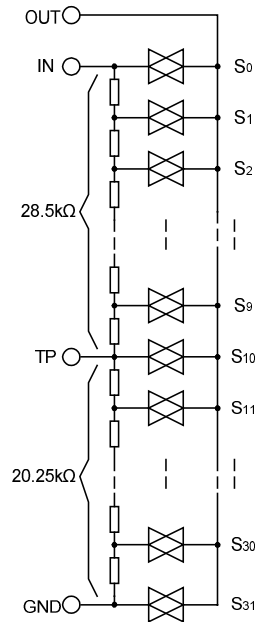
1. VOLUME CIRCUIT

Volume circuit consist of ladder resistor and analog switch.

Tap for loudness is connected to step 10 (20dB).

Attenuation is as follows when resistor (3.9kΩ) is connected between TP pin and pin.

* Equivalence circuit



* Volume step and attenuation

(Attenuation is as follows when resistor (3.9kΩ) is connected between TP pin and GND pin.)

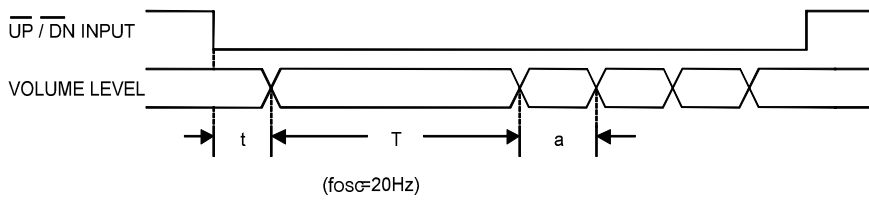
Step	Attenuation	Step	Attenuation
0	0(dB)	16	32(dB)
1	2	17	34
2	4	18	36
3	6	19	38
4	8	20	40
5	10	21	42
6	12	*22	46
7	14	23	50
8	16	24	54
9	18	25	58
10	20	26	62
11	22	27	66
12	24	28	70
13	26	29	74
14	28	30	78
15	30	31	∞

* Step 22 (46dB) initial value.

2. VOLUME UP, DOWN CONTROL CIRCUIT

Volume up, down control is executed by \overline{UP} , \overline{DN} key input.

- * The 1 step / 1 push volume is controlled by "L" level of \overline{UP} , \overline{DN} key.
- * If \overline{UP} , \overline{DN} key is input "L" continuously, volume level is changed continuously.
- * Timing of key input



- Note: t : Prevent time for chattering $\approx 2.2 \times 1/fosc (\approx 110ms)$
- T: Switching time to automatic mode $\approx 10 \times 1/fosc (\approx 500ms)$
- a : Up,Down speed $\approx 2 \times 1/fosc (\approx 100ms)$
- $fosc \approx Cx \cdot Rx (Hz)$: $Rx = 12 \sim 220k \Omega$

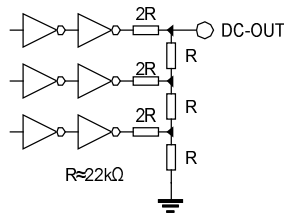
3. DC OUTPUT CIRCUIT FOR VOLUME LEVEL

DC output for volume level meter is internally connected to D-A converter (R/2R type).

8 stage output voltage which is corresponded to volume level is generated.

Because output impedance $\approx 22k\Omega$ (typ.) is high, If input impedance of next setting level meter IC is low, set to Buffer.

- Equivalence circuit



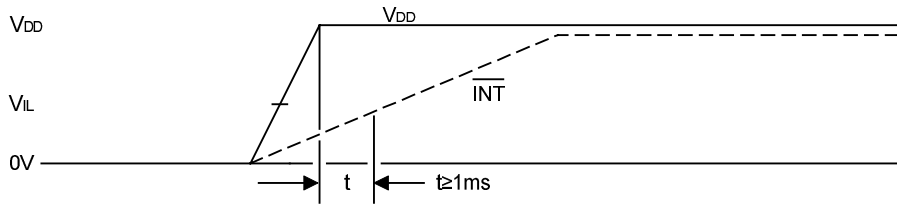
* Volume step and Output voltage

Step	Attenuation(dB)	Output Voltage(V)
0 ~ 3	0 ~ 6	$7/8 V_{DD}$
4 ~ 7	8 ~ 14	$6/8 V_{DD}$
8 ~ 11	16 ~ 22	$5/8 V_{DD}$
12 ~ 15	24 ~ 30	$4/8 V_{DD}$
16 ~ 19	32 ~ 38	$3/8 V_{DD}$
20 ~ 23	40 ~ 50	$2/8 V_{DD}$
24 ~ 27	54 ~ 66	$1/8 V_{DD}$
28 ~ 31	70 ~ ∞	0

4. INITIALIZATION AND BACKUP OPERATION

1) Initialization operation

When power on, volume level is set to initial value (46dB) by setting \overline{INT} pin to "L" level for a while.

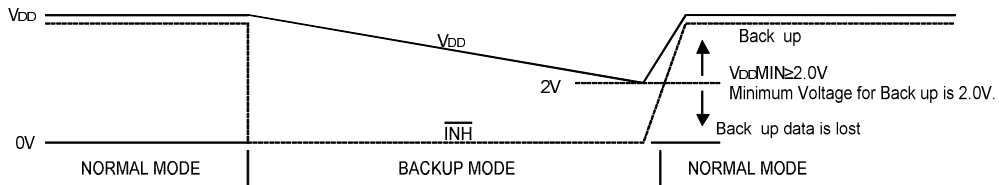


Adjust condenser value which is set \overline{INT} pin to the period while \overline{INT} pin is "L" level is longer than 1ms when Power on.

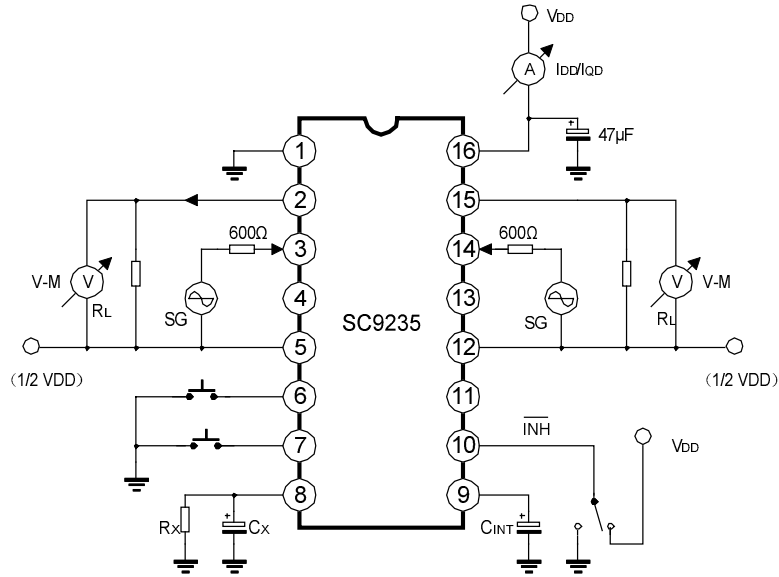
2) Backup operation

Internal operation is all stopped when \overline{INH} pin is "L" level, and prohibit input and output.

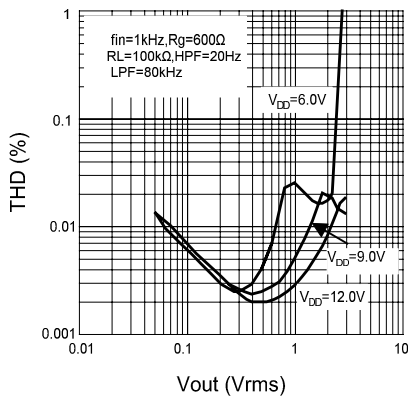
Volume data is remains while Backup mode with low current consumption.



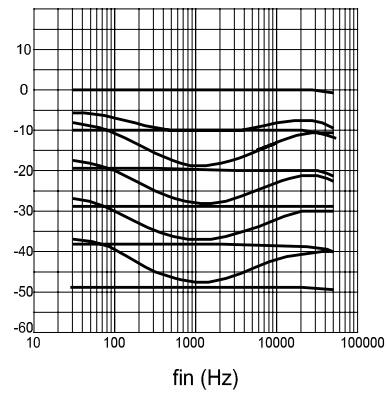
TEST CIRCUITS



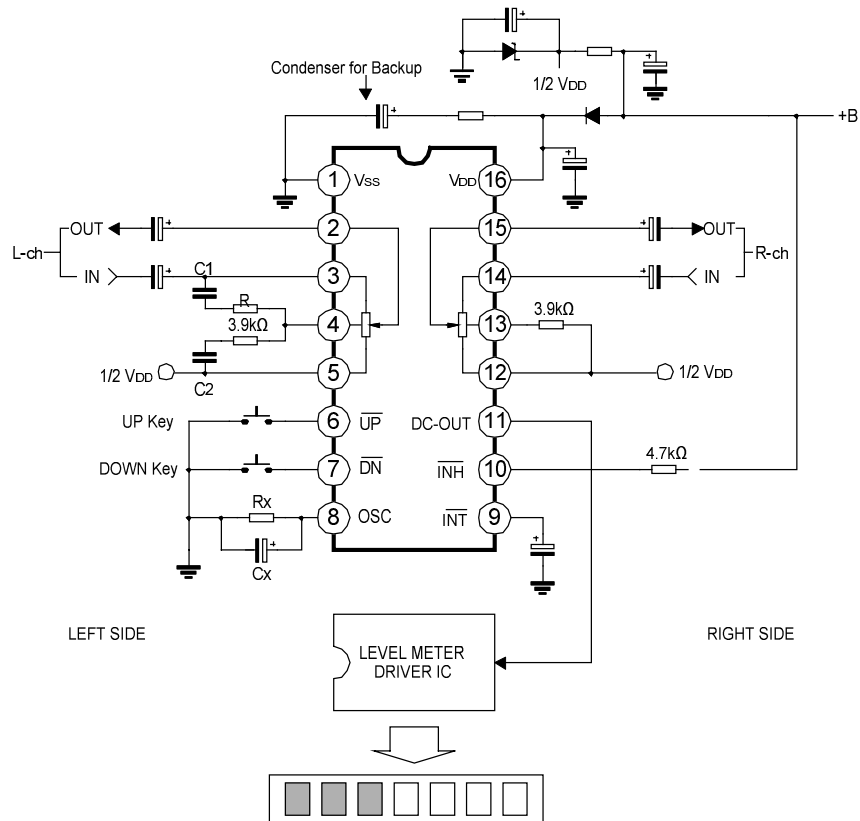
THD —Vout



LD CHARACTERISTIC



TYPICAL APPLICATION CIRCUIT



(Note) Loudness circuit is left side, only volume (without loudness) circuit is right side.

C1=1500pF C2=0.1μF R=8.2kΩ

PACKAGE OUTLINE

