Ordering number : ENN*6270

CMOS IC

LC75341, 75341M

Single-Chip Volume and Tone Control System

Preliminary

Overview

The LC75341 and LC75341M are electronic volume and tone control systems that provide volume, balance, a 2-band equalizer, and input switching functions that can be controlled from serially transferred data.

Functions

- Volume: 0 dB to –79 dB (in 1-dB steps) and –∞, for a total of 81 settings.
  The volume can be controlled independently in the left and right channels to implement a balance function.
- Bass boost: Up to +20 dB in 2-dB steps. Peaking characteristics.
- Treble: ±10 dB in 2-dB steps. Shelving characteristics.
- Selector: One of four sets of left/right inputs can be selected.
- Input gain: The input signal can be boosted by from 0 dB to +30 dB in 2-dB steps.

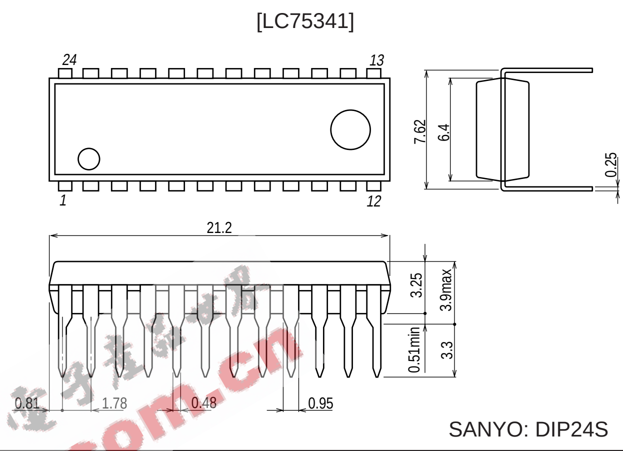
Features

- On-chip buffer amplifiers minimize the number of external components.
- Fabricated in a silicon gate CMOS process to minimize switching noise from internal switches.
- Built-in analog ground reference voltage generation circuit.
- All controls can be set from serially transferred data. Supports the CCB standard.

Package Dimensions

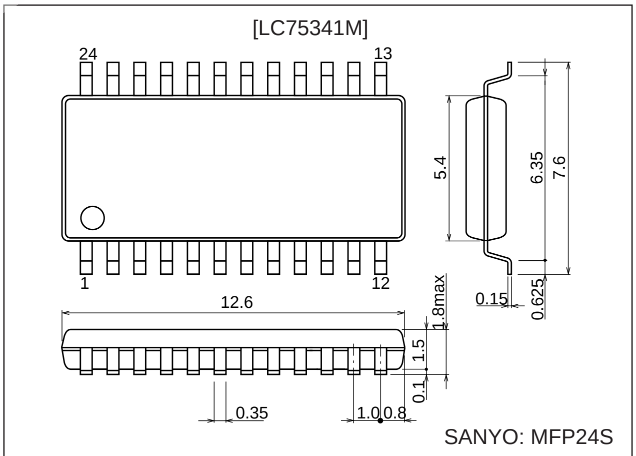
unit: mm

3067-DIP24S



unit: mm

3112-MFP24S



- **CCB is a trademark of SANYO ELECTRIC CO., LTD.**
- **CCB is a SANYO's original bus format and all the bus addresses are controlled by SANYO.**

Specifications

Absolute Maximum Ratings at Ta = 25°C, V_{SS} = 0 V

Parameter	Symbol	Pin	Conditions		Ratings	Unit
Maximum supply voltage	V_{DD} max	V_{DD}			11	V
Maximum input voltage	V_{IN} max	CE, DI, CL, L1 to L4, R1 to R4, LIN, RIN			V_{SS} – 0.3 to V_{DD} + 0.3	V
Allowable power dissipation	Pdmax		Ta ≤ 75°C	LC75341	450	mW
			Ta ≤ 75°C with a PCB*	LC75341M	450	mW
Operating temperature	Topr				–30 to +75	°C
Storage temperature	Tstg				–40 to +125	°C

Note: * Printed circuit board size: 76.1 × 114.3 × 1.6 mm, printed circuit board material: glass/epoxy resin

Allowable Operating Ranges at Ta = –30 to +75°C, V_{SS} = 0 V

Parameter	Symbol	Pin	Conditions	Ratings			Unit
				min	typ	max	
Supply voltage	V_{DD}	V_{DD}		5.0		10	V
High-level input voltage	V_{IH}	CL, DI, CE		2.7		10	V
Low-level input voltage	V_{IL}	CL, DI, CE	$7.5 \leq V_{DD} \leq 10.0$	V_{SS}		1.0	V
			$5.0 \leq V_{DD} < 7.5$	V_{SS}		0.8	V
Input voltage amplitude	V_{IN}	CE, DI, CL, L1 to L4, R1 to R4, LIN, RIN		V_{SS}		V_{DD}	Vp-p
Input pulse width	tøW	CL		1			µs
Setup time	tsetup	CL, DI, CE		1			µs
Hold time	thold	CL, DI, CE		1			µs
Operating frequency	fopg	CL				500	kHz

Electrical Characteristics at Ta = 25°C, V_{DD} = 9 V, V_{SS} = 0 V

Input Block

Parameter	Symbol	Pin	Conditions	Ratings			Unit
				min	typ	max	
Maximum input gain	Gin max				+30		dB
Step resolution	Gstep				+2		dB
Input resistance	Rin	L1, L2, L3, L4 R1, R2, R3, R4			50		kΩ
Clipping level	Vcl	LSEL0, RSEL0	THD = 1.0%, f = 1 kHz		2.90		Vrms
Output load resistance	Rl	LSEL0, RSEL0		10			kΩ

Volume Control Block

Parameter	Symbol	Pin	Conditions	Ratings			Unit
				min	typ	max	
Input resistance	Rin	L_{IN}, R_{IN}			50		kΩ

Bass Band Equalizer Control Block

Parameter	Symbol	Pin	Conditions	Ratings			Unit
				min	typ	max	
Control range	Geq		max.boost	+18	+20	+22	dB
Step resolution	Estep			1	2	3	dB
Internal feedback resistance	Rfeed				66.6		kΩ

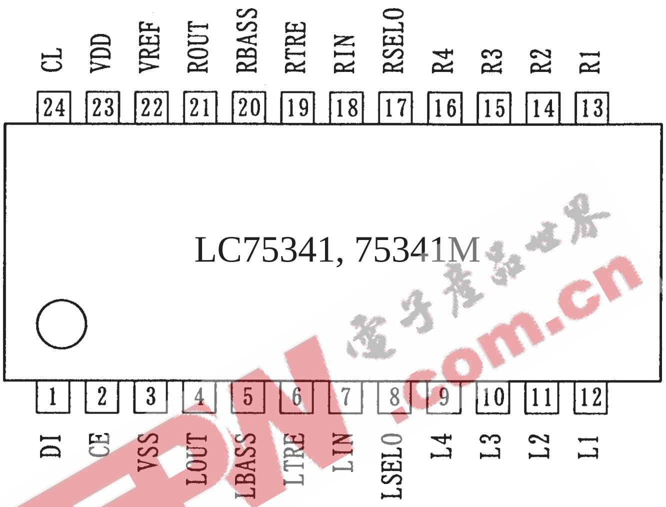
Treble Band Equalizer Control Block

Parameter	Symbol	Pin	Conditions	Ratings			Unit
				min	typ	max	
Control range	Geq		max.boost/cut	±8	±10	±12	dB
Step resolution	Estep			1	2	3	dB
Internal feedback resistance	Rfeed				51.7		kΩ

Overall Characteristics

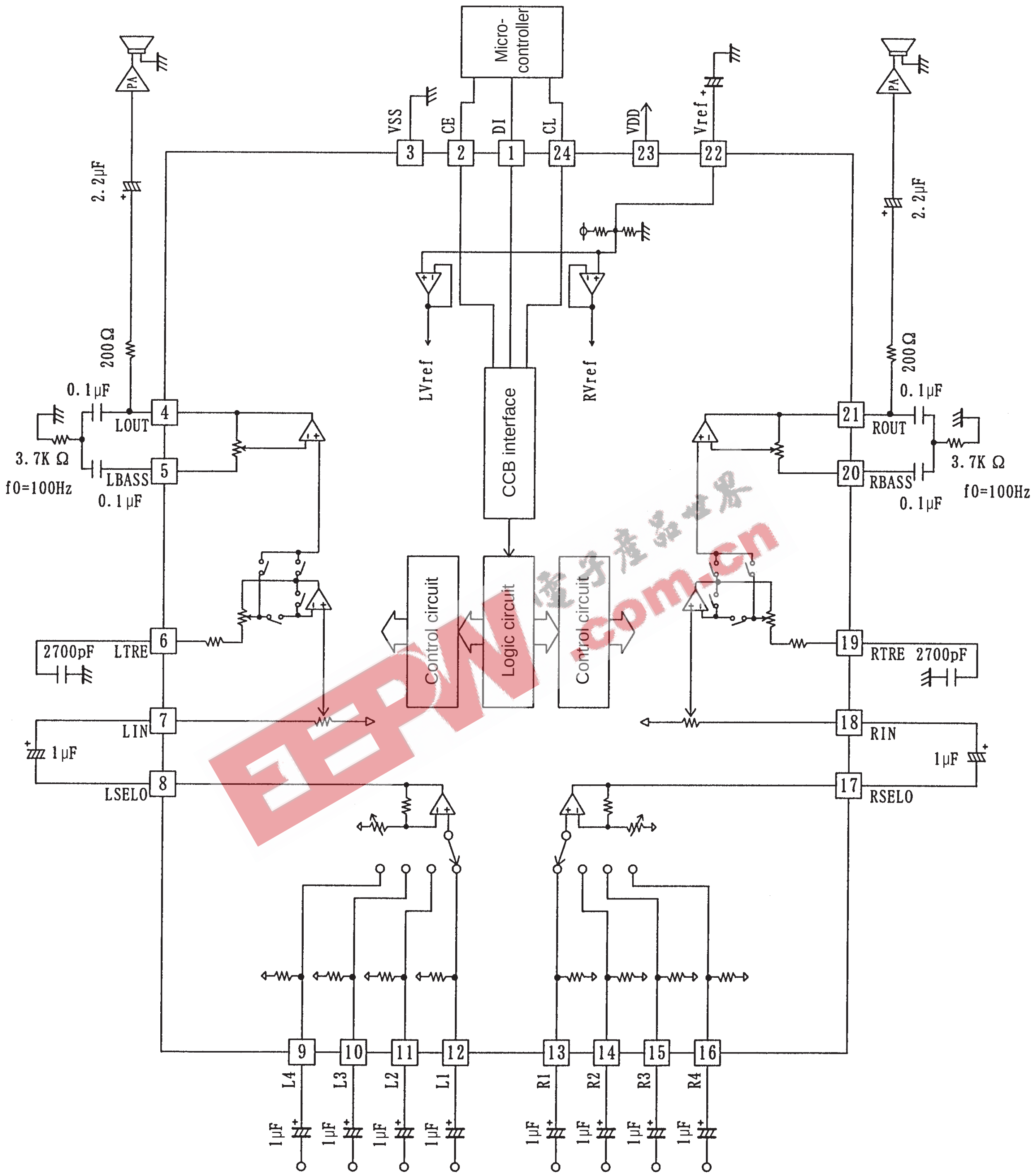
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Total harmonic distortion	THD	V_{IN} = 1 Vrms, f = 1 kHz, all flat overall			0.01	%
Crosstalk	CT	V_{IN} = 1 Vrms, f = 1 kHz, Rg = 1 kΩ, all flat overall	80			dB
Output noise voltage	V_N	All flat overall, 80 kHz, L.P.F		9.3		µV
Maximum attenuation	Vomin	All flat overall, f = 1 kHz		–90		dB
Current drain	I_{DD}	$V_{DD} – V_{SS}$ = +10 V		37		mA
High-level input current	I_{IH}	CL, DI, CE: V_{IN} = 10 V			10	µA
Low-level input current	I_{IL}	CL, DI, CE: V_{IN} = 0 V	–10			µA

Pin Assignment



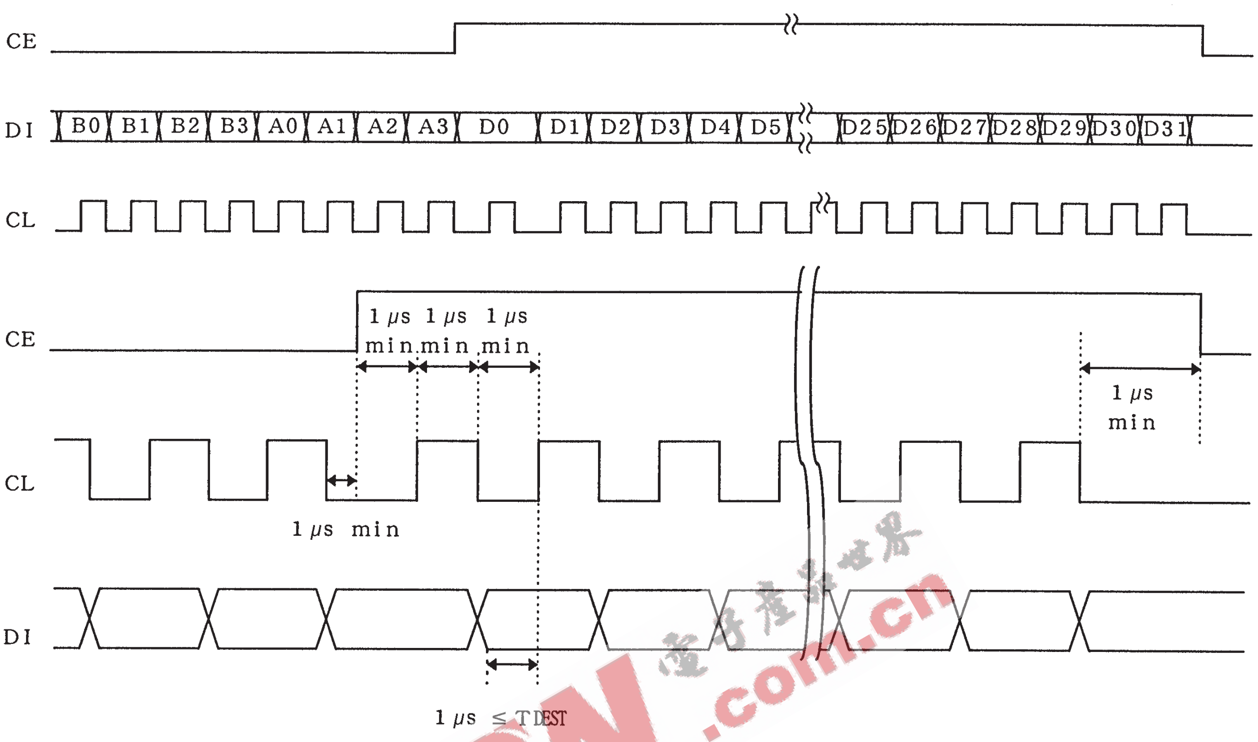
(Top view)

Equivalent Circuit



Control System Timing and Data Format

Applications control the LC75341 and LC75341M by applying the stipulated serial data to the CL, DI, and CE pins. This data consists of a total of 40 bits, of which 8 bits are the address and 32 bits are the data itself.



- Address code (B0 to A3)
  The LC75341 and LC75341M have an 8-bit address code, and can be used together with other ICs that support the Sanyo CCB serial bus format.

Address code (LSB)

B0	B1	B2	B3	A0	A1	A2	A3
0	1	0	0	0	0	0	1

(82HEX)

- Control code allocation

Input switching control (L1, L2, L3, L4, R1, R2, R3, R4)

D0	D1	D2	D3	Operation
0	0	0	0	L1 (R1) ON
1	0	0	0	L2 (R2) ON
0	1	0	0	L3 (R3) ON
1	1	0	0	L4 (R4) ON
0	0	1	0	All switches off
1	0	1	0	All switches off
0	1	1	0	All switches off
1	1	1	0	All switches off

Input Gain Control

D4	D5	D6	D7	Operation
0	0	0	0	0 dB
1	0	0	0	+2 dB
0	1	0	0	+4 dB
1	1	0	0	+6 dB
0	0	1	0	+8 dB
1	0	1	0	+10 dB
0	1	1	0	+12 dB
1	1	1	0	+14 dB
0	0	0	1	+16 dB
1	0	0	1	+18 dB
0	1	0	1	+20 dB
1	1	0	1	+22 dB
0	0	1	1	+24 dB
1	0	1	1	+26 dB
0	1	1	1	+28 dB
1	1	1	1	+30 dB

Volume Control

D8	D9	D10	D11	D12	D13	D14	D15	Operation
0	0	0	0	0	0	0	0	0 dB
1	0	0	0	0	0	0	0	–1 dB
0	1	0	0	0	0	0	0	–2 dB
1	1	0	0	0	0	0	0	–3 dB
0	0	1	0	0	0	0	0	–4 dB
1	0	1	0	0	0	0	0	–5 dB
0	1	1	0	0	0	0	0	–6 dB
1	1	1	0	0	0	0	0	–7 dB
0	0	0	1	0	0	0	0	–8 dB
1	0	0	1	0	0	0	0	–9 dB
0	1	0	1	0	0	0	0	–10 dB
1	1	0	1	0	0	0	0	–11 dB
0	0	1	1	0	0	0	0	–12 dB
1	0	1	1	0	0	0	0	–13 dB
0	1	1	1	0	0	0	0	–14 dB
1	1	1	1	0	0	0	0	–15 dB
0	0	0	0	1	0	0	0	–16 dB
1	0	0	0	1	0	0	0	–17 dB
0	1	0	0	1	0	0	0	–18 dB
1	1	0	0	1	0	0	0	–19 dB
0	0	1	0	1	0	0	0	–20 dB
1	0	1	0	1	0	0	0	–21 dB
0	1	1	0	1	0	0	0	–22 dB
1	1	1	0	1	0	0	0	–23 dB
0	0	0	1	1	0	0	0	–24 dB
1	0	0	1	1	0	0	0	–25 dB
0	1	0	1	1	0	0	0	–26 dB
1	1	0	1	1	0	0	0	–27 dB
0	0	1	1	1	0	0	0	–28 dB
1	0	1	1	1	0	0	0	–29 dB
0	1	1	1	1	0	0	0	–30 dB
1	1	1	1	1	0	0	0	–31 dB
0	0	0	0	0	1	0	0	–32 dB
1	0	0	0	0	1	0	0	–33 dB
0	1	0	0	0	1	0	0	–34 dB
1	1	0	0	0	1	0	0	–35 dB
0	0	1	0	0	1	0	0	–36 dB
1	0	1	0	0	1	0	0	–37 dB
0	1	1	0	0	1	0	0	–38 dB
1	1	1	0	0	1	0	0	–39 dB
0	0	0	1	0	1	0	0	–40 dB
1	0	0	1	0	1	0	0	–41 dB
0	1	0	1	0	1	0	0	–42 dB
1	1	0	1	0	1	0	0	–43 dB
0	0	1	1	0	1	0	0	–44 dB
1	0	1	1	0	1	0	0	–45 dB
0	1	1	1	0	1	0	0	–46 dB
1	1	1	1	0	1	0	0	–47 dB
0	0	0	0	1	1	0	0	–48 dB
1	0	0	0	1	1	0	0	–49 dB
0	1	0	0	1	1	0	0	–50 dB

Volume Control

D8	D9	D10	D11	D12	D13	D14	D15	Operation
1	1	0	0	1	1	0	0	–51 dB
0	0	1	0	1	1	0	0	–52 dB
1	0	1	0	1	1	0	0	–53 dB
0	1	1	0	1	1	0	0	–54 dB
1	1	1	0	1	1	0	0	–55 dB
0	0	0	1	1	1	0	0	–56 dB
1	0	0	1	1	1	0	0	–57 dB
0	1	0	1	1	1	0	0	–58 dB
1	1	0	1	1	1	0	0	–59 dB
0	0	1	1	1	1	0	0	–60 dB
1	0	1	1	1	1	0	0	–61 dB
0	1	1	1	1	1	0	0	–62 dB
1	1	1	1	1	1	0	0	–63 dB
0	0	0	0	0	0	1	0	–64 dB
1	0	0	0	0	0	1	0	–65 dB
0	1	0	0	0	0	1	0	–66 dB
1	1	0	0	0	0	1	0	–67 dB
0	0	1	0	0	0	1	0	–68 dB
1	0	1	0	0	0	1	0	–69 dB
0	1	1	0	0	0	1	0	–70 dB
1	1	1	0	0	0	1	0	–71 dB
0	0	0	1	0	0	1	0	–72 dB
1	0	0	1	0	0	1	0	–73 dB
0	1	0	1	0	0	1	0	–74 dB
1	1	0	1	0	0	1	0	–75 dB
0	0	1	1	0	0	1	0	–76 dB
1	0	1	1	0	0	1	0	–77 dB
0	1	1	1	0	0	1	0	–78 dB
1	1	1	1	0	0	1	0	–79 dB
0	0	0	0	1	0	1	0	–∞ dB

Treble Control

D16	D17	D18	D19	Operation
1	0	1	0	+10 dB
0	0	1	0	+8 dB
1	1	0	0	+6 dB
0	1	0	0	+4 dB
1	0	0	0	+2 dB
0	0	0	0	0 dB
1	0	0	1	–2 dB
0	1	0	1	–4 dB
1	1	0	1	–6 dB
0	0	1	1	–8 dB
1	0	1	1	–10 dB

Bass Control

D20	D21	D22	D23	D24	D25	Operation
0	1	0	1	0	0	+20 dB
1	0	0	1	0	0	+18 dB
0	0	0	1	0	0	+16 dB
1	1	1	0	0	0	+14 dB
0	1	1	0	0	0	+12 dB
1	0	1	0	0	0	+10 dB
0	0	1	0	0	0	+8 dB
1	1	0	0	0	0	+6 dB
0	1	0	0	0	0	+4 dB
1	0	1	0	0	0	+2 dB
0	0	0	0	0	0	0 dB

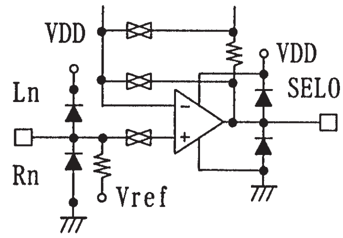
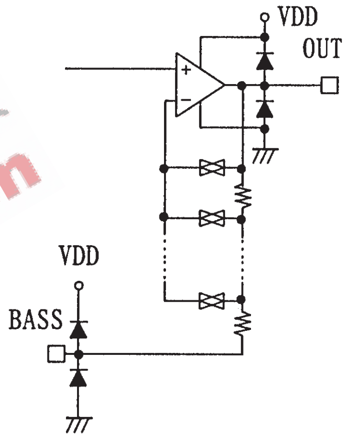
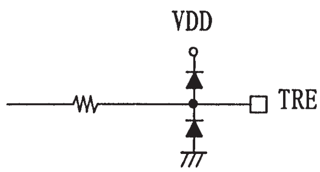
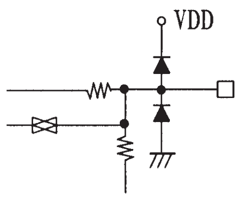
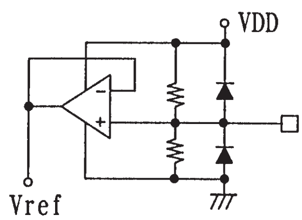
Channel Selection

D26	D27	Operation
0	0	
1	0	RCH
0	1	LCH
1	1	Left and right together

Test Mode

D28	D29	D30	D31	Operation
0	0	0	0	
These bits are used for IC testing and must all be set to 0 during normal operation.				

Pin Functions

<table>
<tr><th>Pin No.</th><th>Pin</th><th>Description</th><th>Notes</th></tr>
<tr><td>12
11
10
9
13
14
15
16</td><td>L1
L2
L3
L4
R1
R2
R3
R4</td><td>• Input signal connections</td><td rowspan="2"></td></tr>
<tr><td>8
17</td><td>LSEL0
RSEL0</td><td>• Input selector outputs</td></tr>
<tr><td>5
20</td><td>LBASS
RBASS</td><td>• Connections for the resistors and capacitors that form the bass band filters.</td><td rowspan="2"></td></tr>
<tr><td>4
21</td><td>LOUT
ROUT</td><td>• These pins are used both as the connections for the resistors and capacitors that form the bass band filters and as the outputs from the bass/treble circuits.</td></tr>
<tr><td>6
19</td><td>LTRE
RTRE</td><td>• Connections for the capacitors that form the treble band filters.</td><td></td></tr>
<tr><td>7
18</td><td>LIN
RIN</td><td>• Volume control and equalizer input</td><td></td></tr>
<tr><td>22</td><td>Vref</td><td>• Connection to the 0.5 × V_{DD} voltage generator circuit used as the analog signal ground.
Applications must connect a capacitor of about 10 µF between this pin and V_{SS} to exclude power supply ripple.</td><td></td></tr>
</table>

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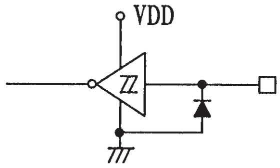
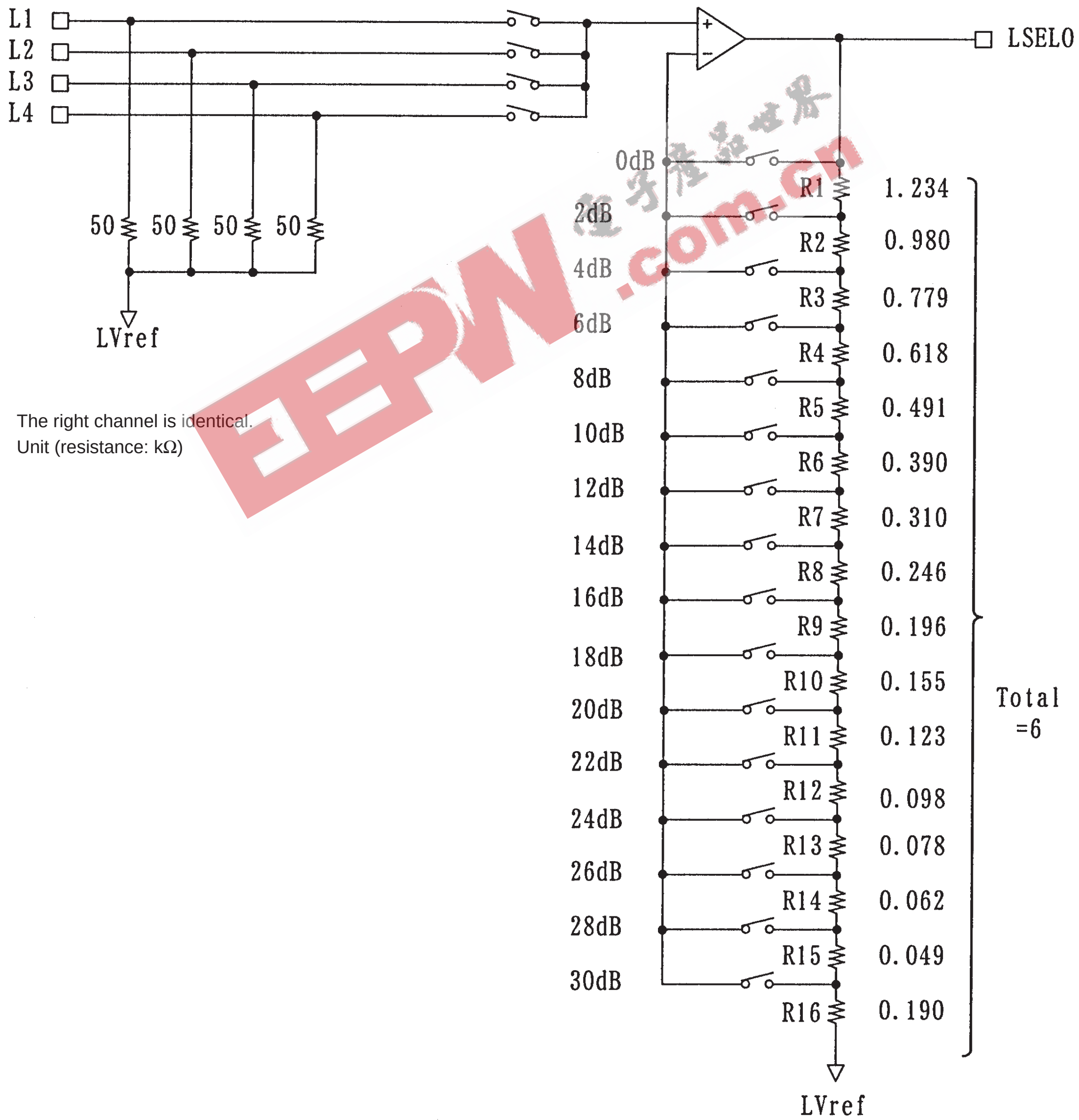
Pin No.	Pin	Description	Notes
3	V_{SS}	• Ground	
23	V_{DD}	• Power supply	
2	CE	• Chip enable Data is written to the internal latch when this pin goes from high to low. The internal analog switches operate at this point. Data transfer is enabled when this pin is high.	
1 24	DI CL	• Serial data and clock inputs used for IC control.	

Internal Equivalent Circuits

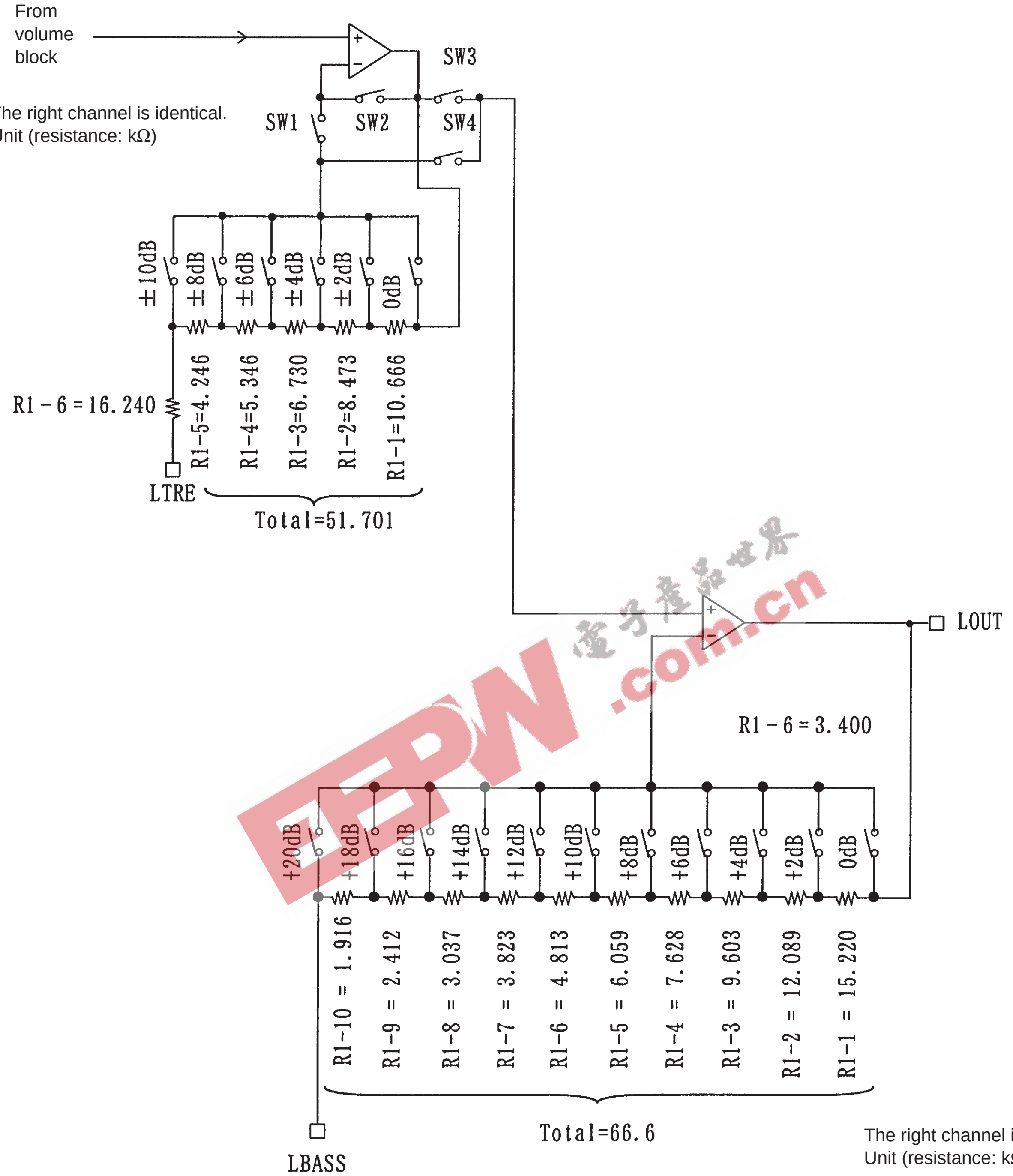
• Selector block equivalent circuit



The right channel is identical.
Unit (resistance: kΩ)

• Treble and bass band block internal equivalent circuit

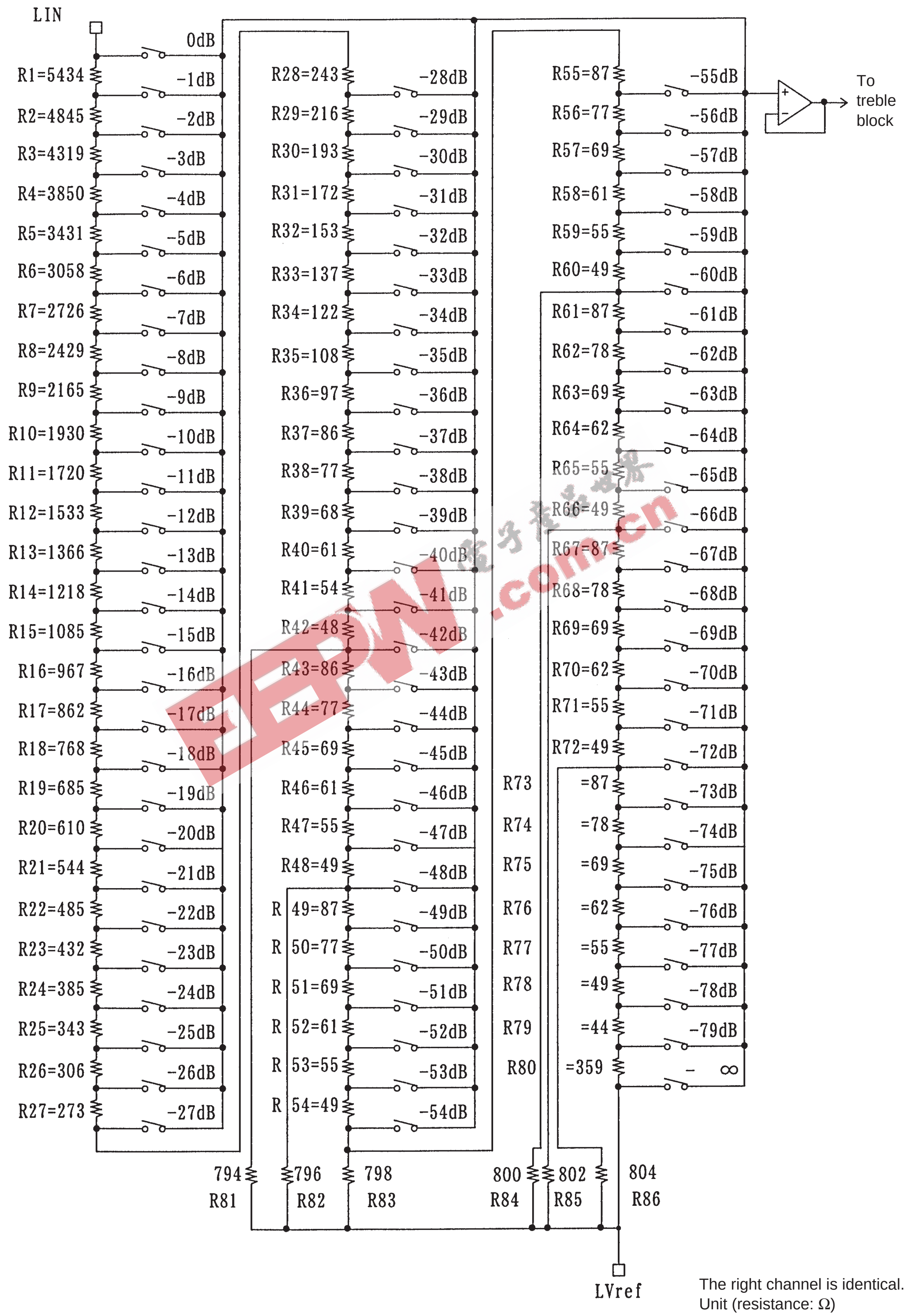
The right channel is identical.
Unit (resistance: kΩ)



The right channel is identical.
Unit (resistance: kΩ)

Set switches SW1 and SW3 to the on position for boost, and set switches SW2 and SW4 to the on position for cut. For a flat (0 dB) response, set the 0dBSW, SW2, and SW3 switches on.

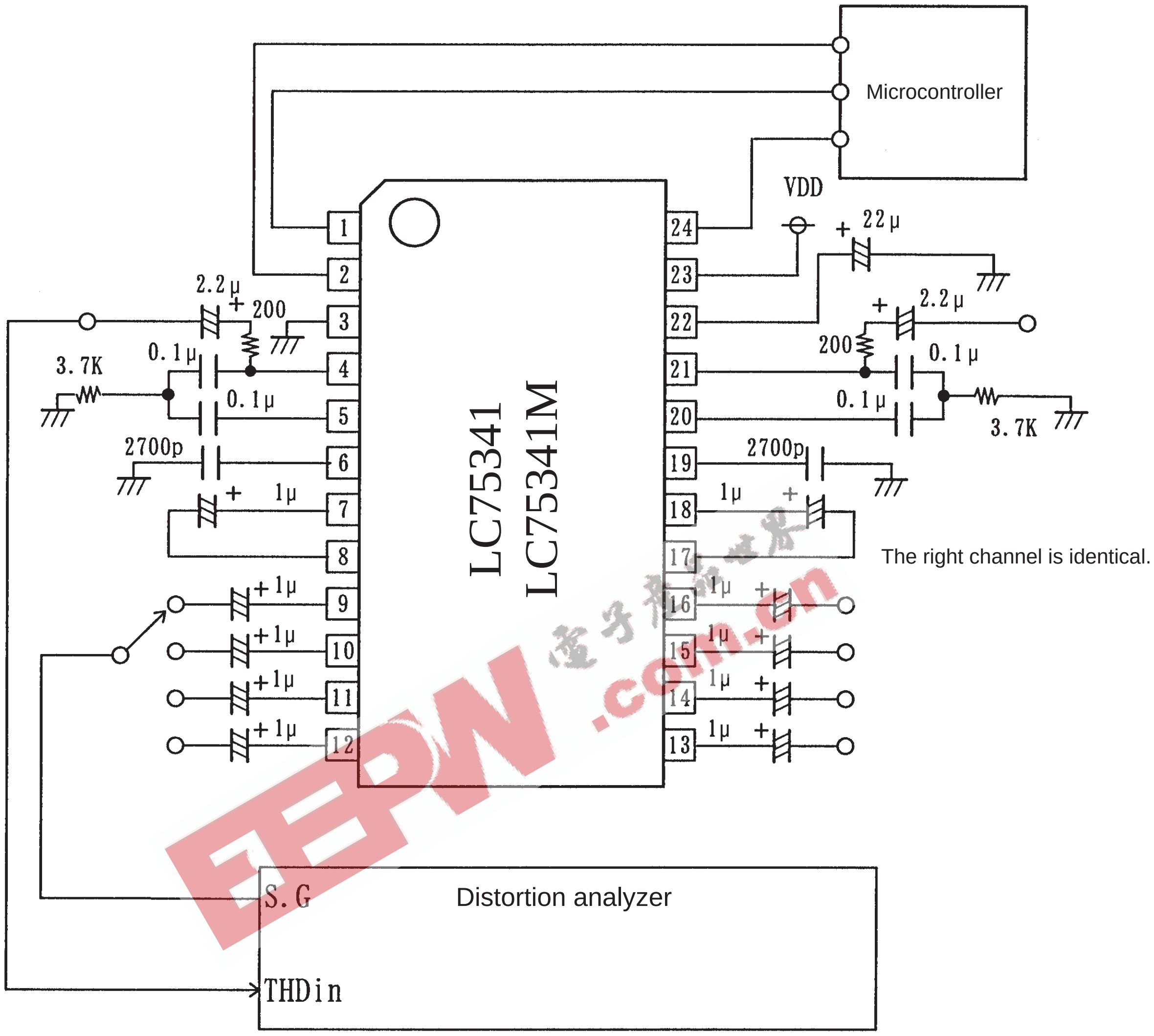
- Volume block internal equivalent circuit



The right channel is identical.
Unit (resistance: Ω)

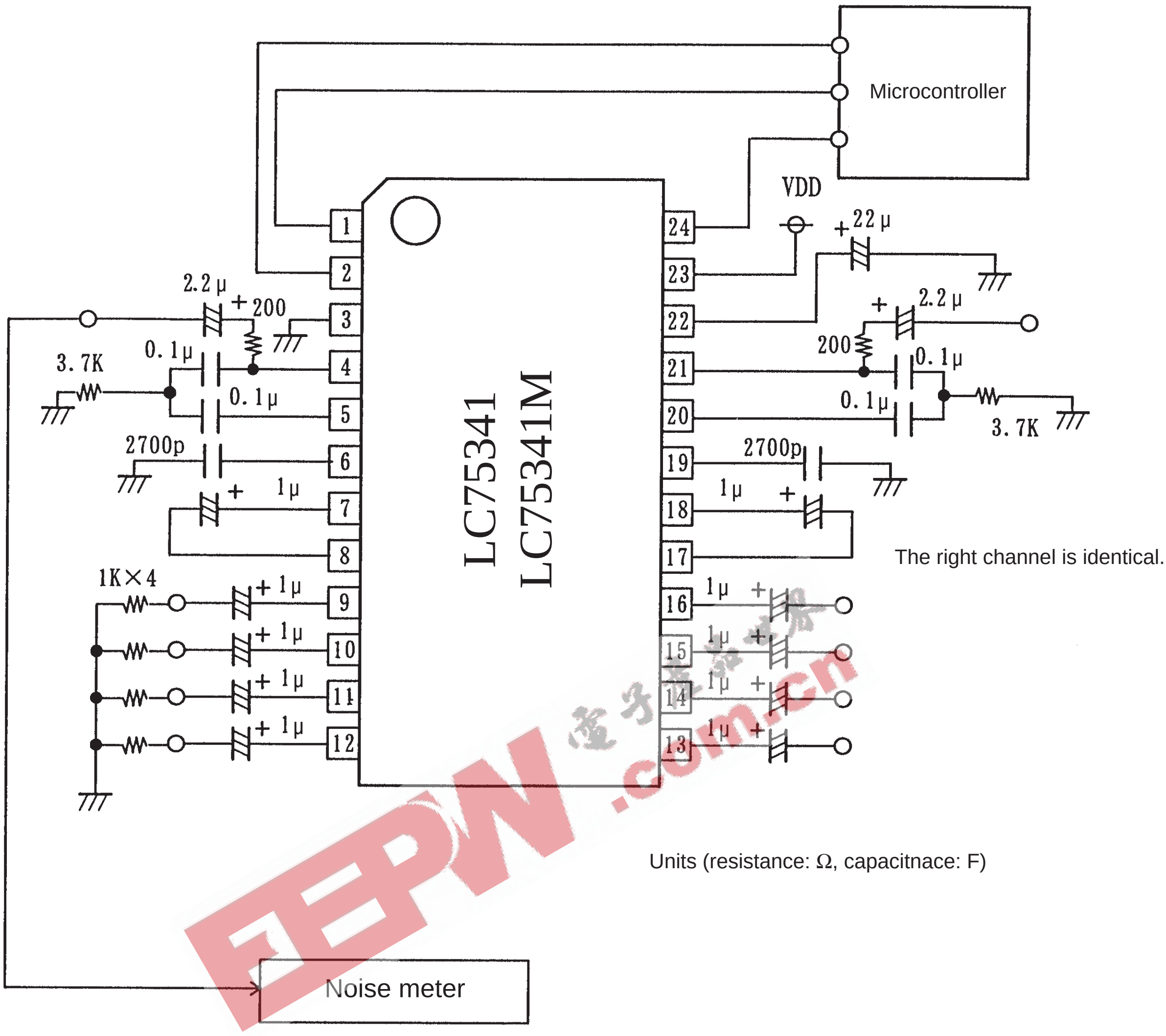
Test Circuits

• Total harmonic distortion

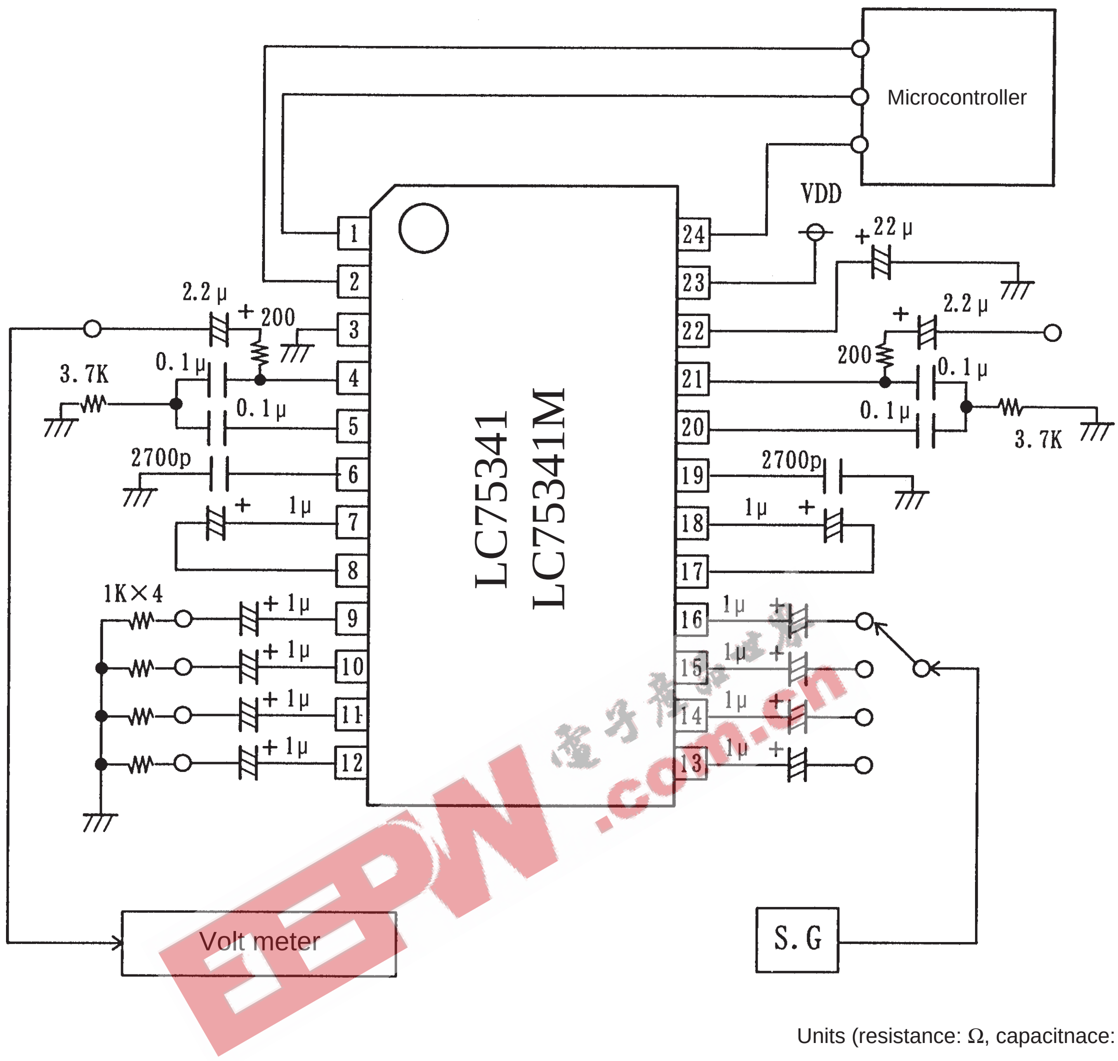


Units (resistance: Ω, capacitnace: F)

• Output noise voltage



• Crosstalk

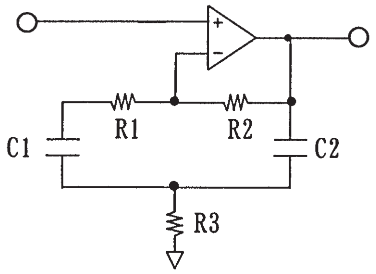


Units (resistance: Ω, capacitnace: F)

Bass Band Circuit

This section presents the equivalent circuit and the calculations for the external capacitors and resistors used to achieve a center frequency of 100 Hz.

- Bass band equivalent circuit



- Sample calculation

  Specifications　　Center frequency: f0 = 100 Hz
  　　　　　　　　Gain at maximum boost: G = 20 dB
  　　　　　　　　Let R1 = 0, R2 = 66.6 KΩ, and C1 = C2 = C.

  (1) Determine R2 from the fact that G = 20 dB.

$$G_{+20dB} = 20 \times LOG_{10}\left(1 + \frac{R2}{2R3}\right)$$

$$R3 = \frac{R2}{2\,(10^{G+20dB/20} - 1)} = \frac{66000}{2 \times (10 - 1)} \neq 3.7\ k\Omega$$

  (2) Determine C from the fact that the center frequency f0 = 100 Hz.

$$f0 = \frac{1}{2\pi\sqrt{R3R2C1C2}}$$

$$C = \frac{1}{2\pi f0\sqrt{R3R2}} = \frac{1}{2\pi \times 100\sqrt{66000 \times 3700}} \neq 0.1\ \mu F$$

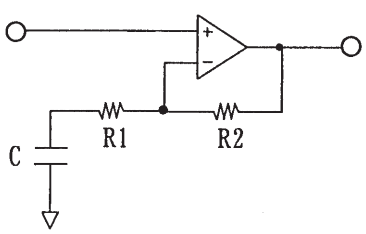
  (3) Determine Q.

$$Q = \frac{R3R2}{2R3} \bullet \frac{1}{\sqrt{R3R2}} \neq 2.1$$

- Treble band circuit

  The treble band circuit provides shelving characteristics.

  This section presents the equivalent circuit in boost mode and the formulas used to calculate the external component values.



- Sample calculation
  Specifications - Set frequency: f = 26,000 Hz
  Gain at maximum boost: G_{+10dB} = 10 dB
  Let R1 = 16.240 kΩ, R2 = 35.461 KΩ,

Substitute the above constants into the following formulas.

$$G = 20 \times LOG_{10}\left(1 + \frac{R2}{\sqrt{R1^2 + (1/\omega C)^2}}\right)$$

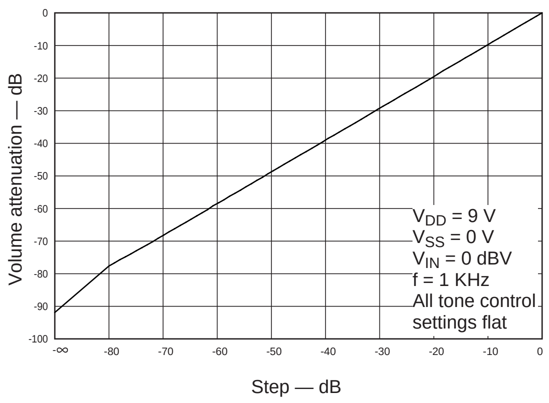
$$C = \frac{1}{2\pi f\sqrt{\left(\frac{R2}{10^{G/20}-1}\right) - R1^2}}$$

$$= \frac{1}{2\pi 26000\sqrt{\left(\frac{35461}{3.16-1}\right)^2 - 16240^2}} \neq 2700\ (pF)$$

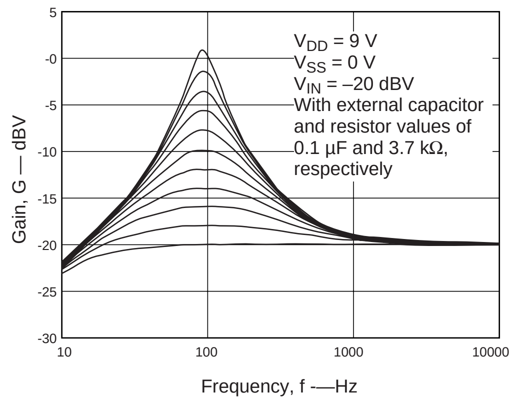
Usage Notes

- When power is first applied, the states of the internal analog switches will be undefined. Applications must provide external muting until the control data has been transferred and the switches set to appropriate states.
- Applications should transfer both the left and right channel initial settings data before releasing the muting function when initializing this IC after first applying power.
- Applications should cover the CL, DI, and CE pin lines with the ground pattern, or should use shielded cables for these lines to prevent the high-frequency digital signals transmitted over these lines from entering analog signal system.
- When the oscillation occurs, connect a resistor of at least 200 Ω to LOUT and ROUT pins.

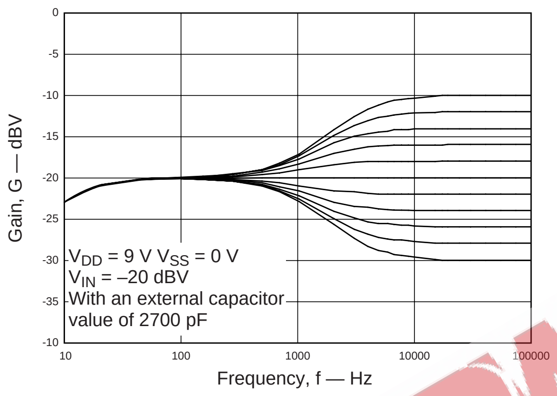
Volume Control Step Characteristics



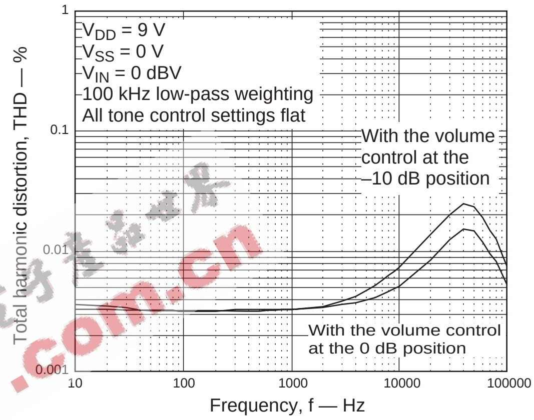
Bass Control Frequency Characteristics



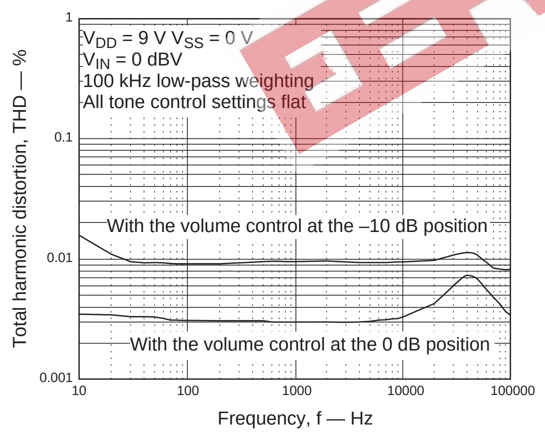
Treble Control Frequency Characteristics



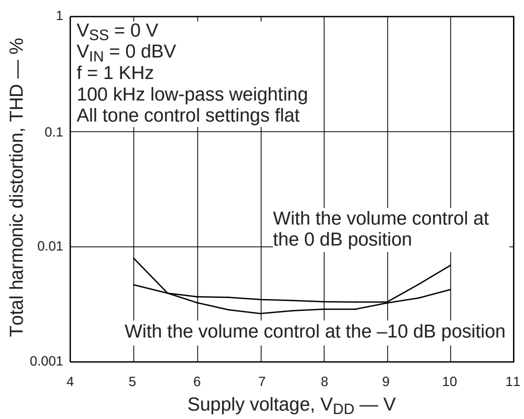
THD - Frequency Characteristics (1)



THD - Frequency Characteristics (2)



THD - Supply Voltage Characteristics (1)



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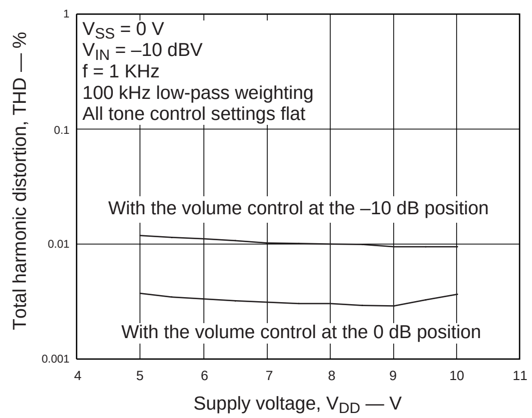
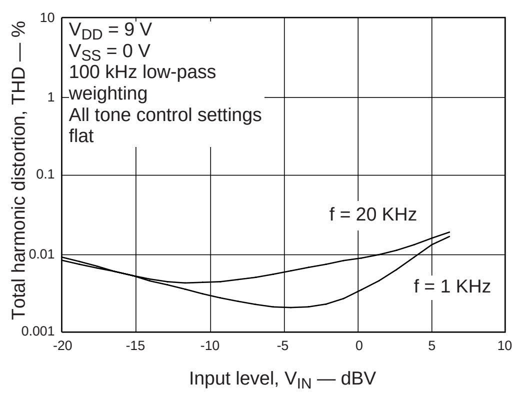
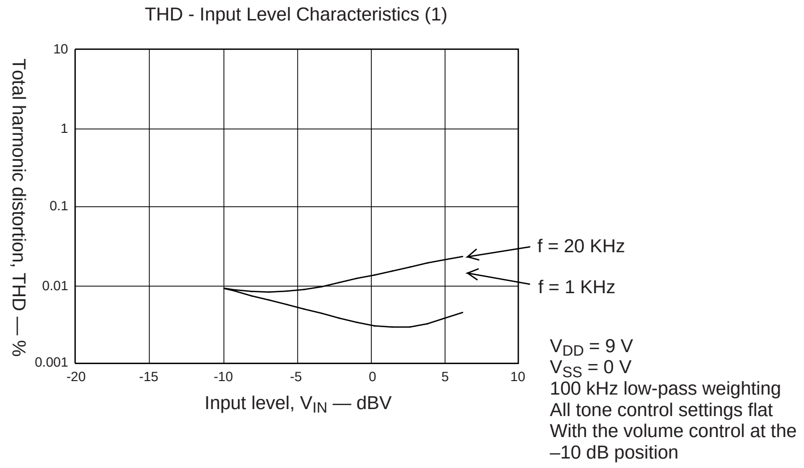


THD - Input Level Characteristics (1)





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