



LC75342, 75342M

Single-Chip Volume and Tone Control System

Preliminary



Overview

The LC75342 and LC75342M 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 $-\infty$, 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.

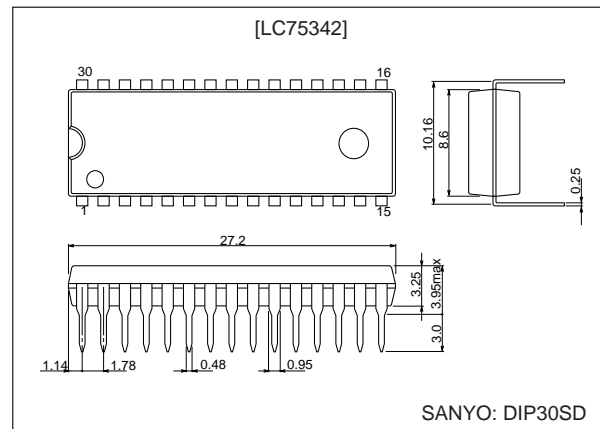
Features

- 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

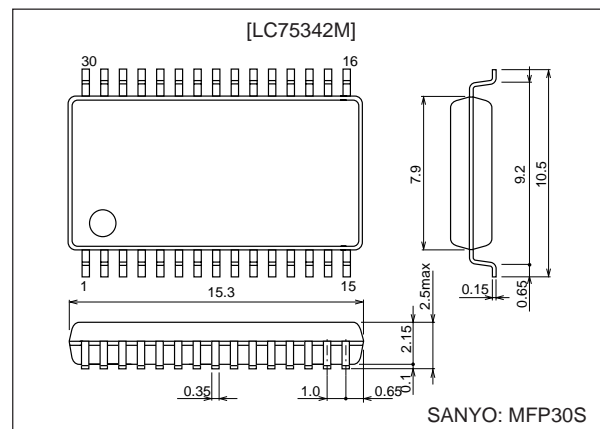
unit: mm

3196-DIP30SD



unit: mm

3216-MFP30S



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D2499RM (OT) No. 6271-1/20

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Specifications

Absolute Maximum Ratings at $T_a = 25^\circ\text{C}$, $V_{SS} = 0\text{ V}$

Parameter	Symbol	Pin	Conditions	Ratings	Unit	
Maximum supply voltage	$V_{DD\text{ max}}$	V_{DD}		11	V	
Maximum input voltage	$V_{IN\text{ max}}$	CE, DI, CL, L1 to L4, R1 to R4, LIN, RIN		$V_{SS} - 0.3\text{ to }V_{DD} + 0.3$	V	
Allowable power dissipation	$P_{d\text{ max}}$		$T_a \leq 75^\circ\text{C}$	LC75342	450	mW
			$T_a \leq 75^\circ\text{C}$ with a PCB*	LC75342M	450	
Operating temperature	T_{opr}			-30 to +75	$^\circ\text{C}$	
Storage temperature	T_{stg}			-40 to +125	$^\circ\text{C}$	

Note: * Printed circuit board size: $76.1 \times 114.3 \times 1.6\text{ mm}$, printed circuit board material: glass/epoxy resin

Allowable Operating Ranges at $T_a = -30\text{ to }+75^\circ\text{C}$, $V_{SS} = 0\text{ V}$

Parameter	Symbol	Pin	Conditions	Ratings			Unit
				min	typ	max	
Supply voltage	V_{DD}	V_{DD}		4.5		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
			$4.5 \leq V_{DD} < 7.5$	V_{SS}		0.8	
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	t_{PW}	CL		1			μs
Setup time	t_{setup}	CL, DI, CE		1			μs
Hold time	t_{hold}	CL, DI, CE		1			μs
Operating frequency	f_{opg}	CL				500	kHz

Electrical Characteristics at $T_a = 25^\circ\text{C}$, $V_{DD} = 9\text{ V}$, $V_{SS} = 0\text{ V}$

Input Block

Parameter	Symbol	Pin	Conditions	Ratings			Unit
				min	typ	max	
Maximum input gain	$G_{in\text{ max}}$				+30		dB
Step resolution	G_{step}				+2		dB
Input resistance	R_{in}	L1, L2, L3, L4 R1, R2, R3, R4			50		$\text{k}\Omega$
Clipping level	V_{cl}	LSELO, RSELO	THD = 1.0%, $f = 1\text{ kHz}$		2.90		V _{rms}
Output load resistance	R_l	LSELO, RSELO		10			$\text{k}\Omega$

Volume Control Block

Parameter	Symbol	Pin	Conditions	Ratings			Unit
				min	typ	max	
Input resistance	R_{in}	L_{IN}, R_{IN}			50		$\text{k}\Omega$

Bass Band Equalizer Control Block

Parameter	Symbol	Pin	Conditions	Ratings			Unit
				min	typ	max	
Control range	G_{eq}		max.boost	± 18	± 20	± 22	dB
Step resolution	E_{step}			1	2	3	dB
Internal feedback resistance	R_{feed}				66.6		$\text{k}\Omega$

Treble Band Equalizer Control Block

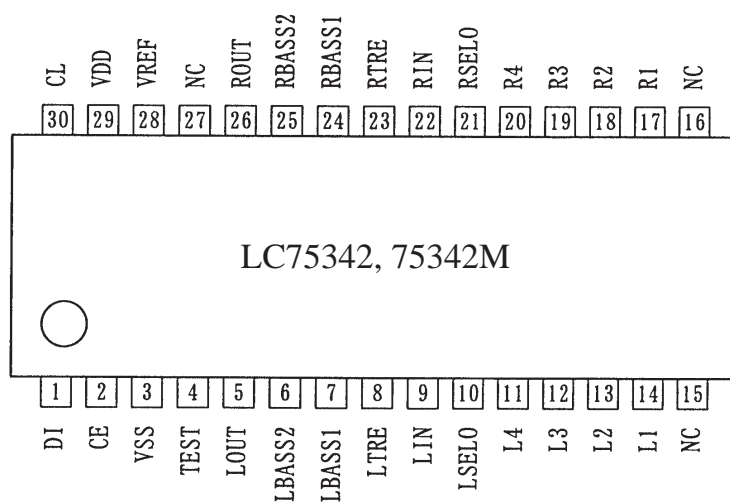
Parameter	Symbol	Pin	Conditions	Ratings			Unit
				min	typ	max	
Control range	G_{eq}		max.boost/cut	± 8	± 10	± 12	dB
Step resolution	E_{step}			1	2	3	dB
Internal feedback resistance	R_{feed}				51.7		$\text{k}\Omega$

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Overall Characteristics

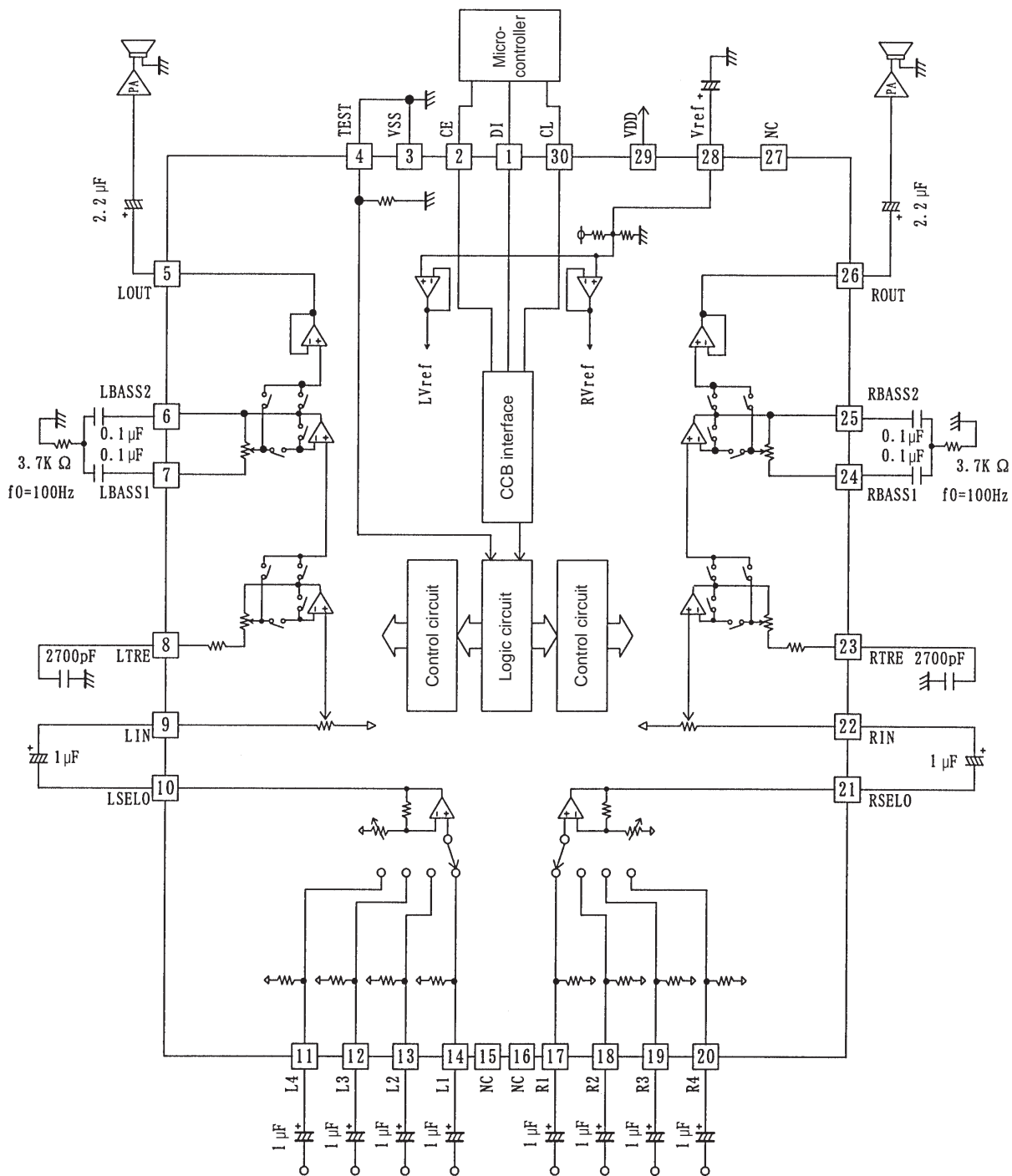
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Total harmonic distortion	THD	$V_{IN} = 1 \text{ Vrms}$, $f = 1 \text{ kHz}$, all flat overall			0.01	%
Crosstalk	CT	$V_{IN} = 1 \text{ Vrms}$, $f = 1 \text{ kHz}$, $R_g = 1 \text{ k}\Omega$, all flat overall	80			dB
Output noise voltage	V_N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

Pin Assignment



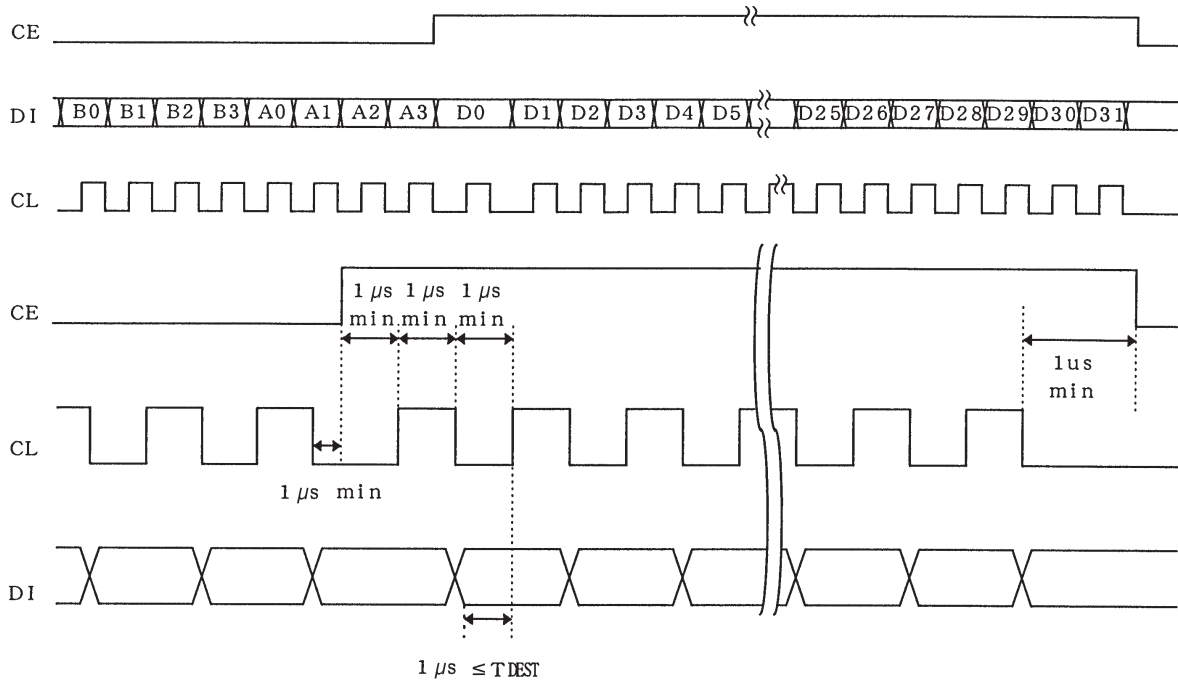
(Top view)

Equivalent Circuit



Control System Timing and Data Format

Applications control the LC75342 and LC75342M 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 LC75342 and LC75342M 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

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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

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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

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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

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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
1	0	0	0	1	0	-2 dB
0	1	0	0	1	0	-4 dB
1	1	0	0	1	0	-6 dB
0	0	1	0	1	0	-8 dB
1	0	1	0	1	0	-10 dB
0	1	1	0	1	0	-12 dB
1	1	1	0	1	0	-14 dB
0	0	0	1	1	0	-16 dB
1	0	0	1	1	0	-18 dB
0	1	0	1	1	0	-20 dB

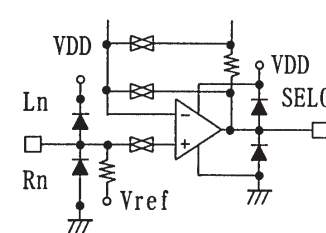
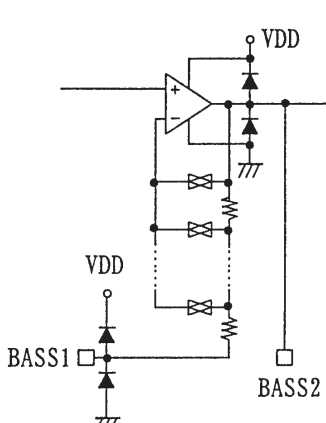
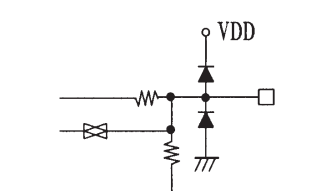
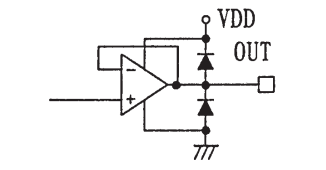
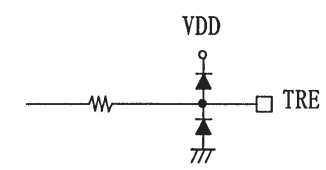
Channel Selection

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

Pin No.	Pin	Description	Notes
14 13 12 11 17 18 19 20	L1 L2 L3 L4 R1 R2 R3 R4	• Input signal connections	
10 21	LSEL0 RSEL0	• Input selector outputs	
7 6 24 25	LBASS1 LBASS2 RBASS1 RBASS2	• Connections for the resistors and capacitors that form the bass band filters.	
9 22	LIN RIN	• Volume control and equalizer input	
5 26	LOUT ROUT	• Volume and equalizer outputs	
8 23	LTRE RTRE	• Connections for the capacitors that form the treble band filters.	

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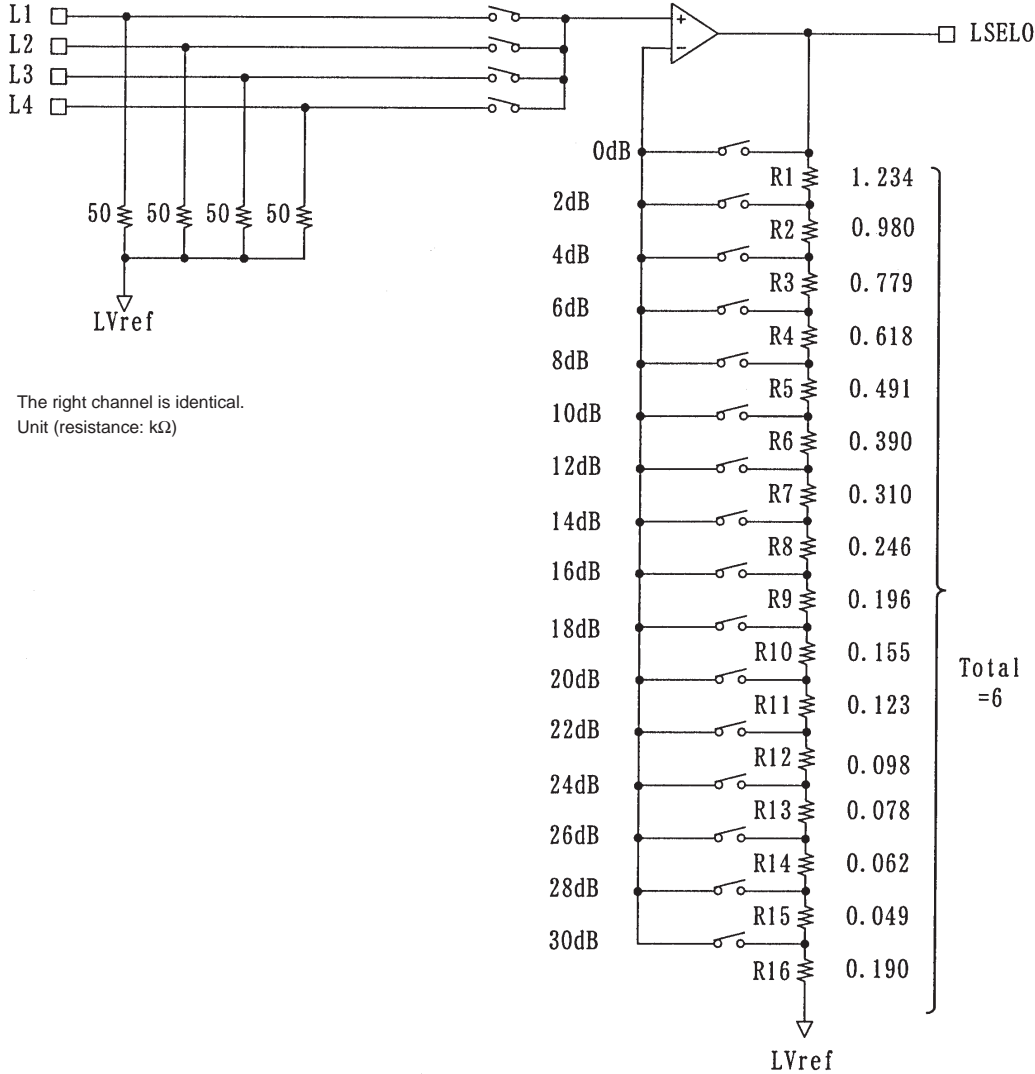
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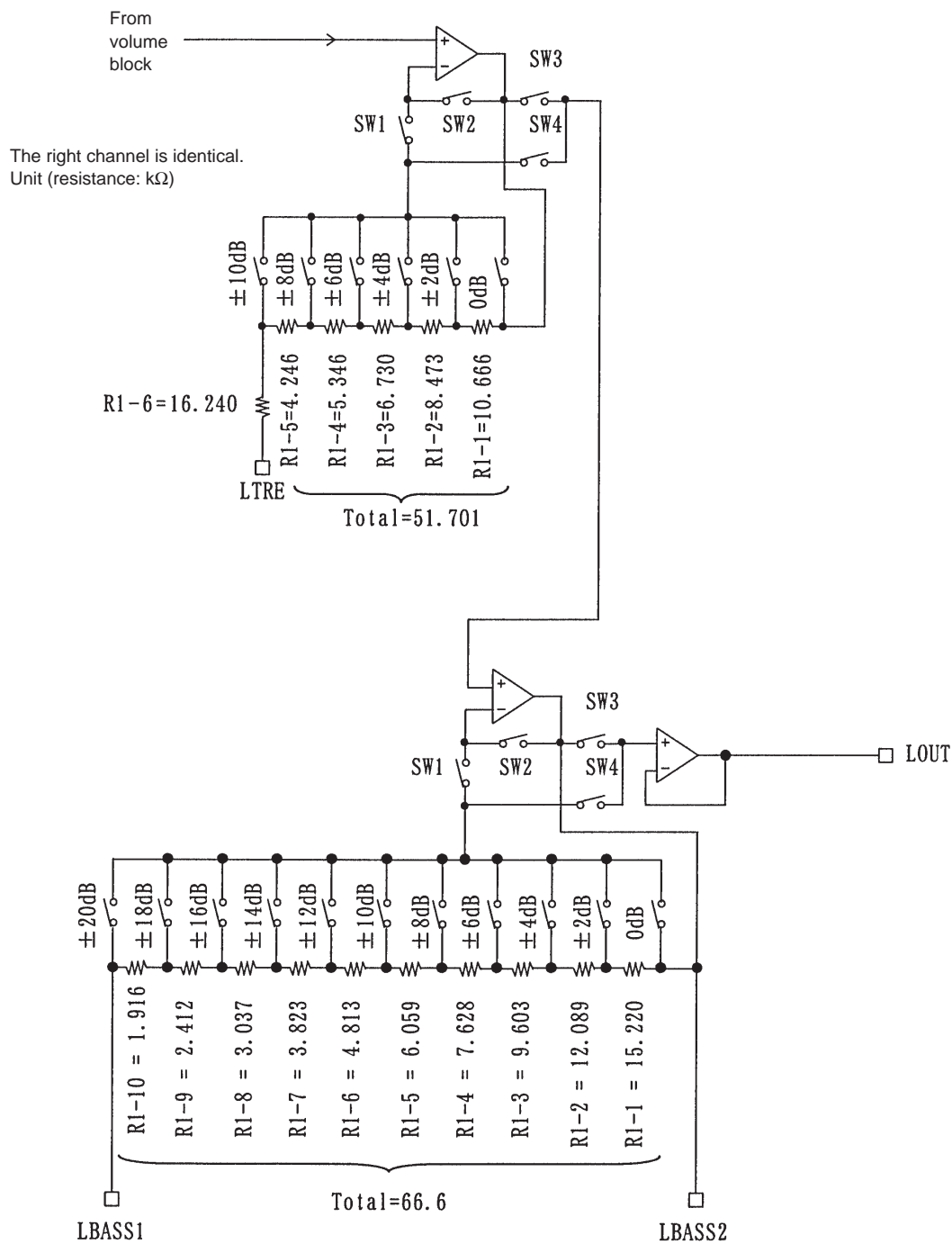
Pin No.	Pin	Description	Notes
28	Vref	<ul style="list-style-type: none"> Connection to the $0.5 \times V_{DD}$ voltage generator circuit used as the analog signal ground. Applications must connect a capacitor of about $10 \mu\text{F}$ between this pin and V_{SS} to exclude power supply ripple. 	<p>The diagram shows an internal voltage divider circuit. A resistor network is connected between VDD and a node labeled Vref. The Vref node is connected to the non-inverting input (+) of an operational amplifier. The op-amp's output is connected to the inverting input (-) and also to a protection diode that is connected to VDD. Another protection diode is connected from the Vref node to ground (GND). The ground symbol is labeled with three diagonal lines (GND).</p>
3	V_{SS}	<ul style="list-style-type: none"> Ground 	
29	V_{DD}	<ul style="list-style-type: none"> Power supply 	
2	CE	<ul style="list-style-type: none"> 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. 	<p>The diagram shows an internal latch circuit. The CE pin is connected to the input of a latch (represented by a triangle with a Z). The latch's output is connected to a protection diode that is connected to VDD. Another protection diode is connected from the CE pin to ground (GND). The ground symbol is labeled with three diagonal lines (GND).</p>
1 30	DI CL	<ul style="list-style-type: none"> Serial data and clock inputs used for IC control. 	
4	V_{SS}	<ul style="list-style-type: none"> Electronic volume and tone control testing This pin must be tied to V_{SS} during normal operation. 	
15 16 27	NC	<ul style="list-style-type: none"> Unused. These pins must be left open or connected to V_{SS} during normal operation. 	

Internal Equivalent Circuits

- Selector block equivalent circuit



• Treble and bass band block internal equivalent circuit

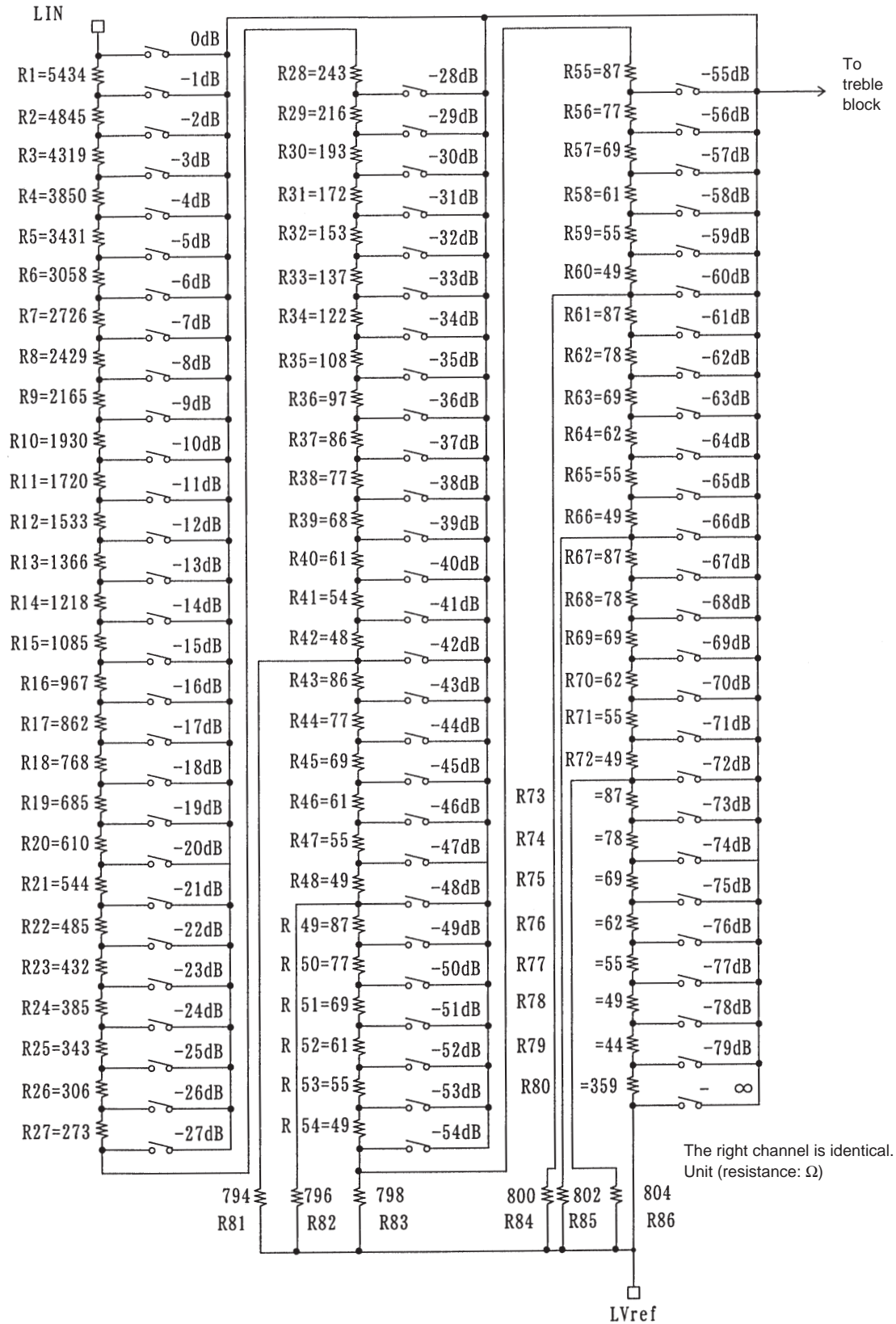


The right channel is identical.
Unit (resistance: kΩ)

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 0dB SW, SW2, and SW3 switches on.

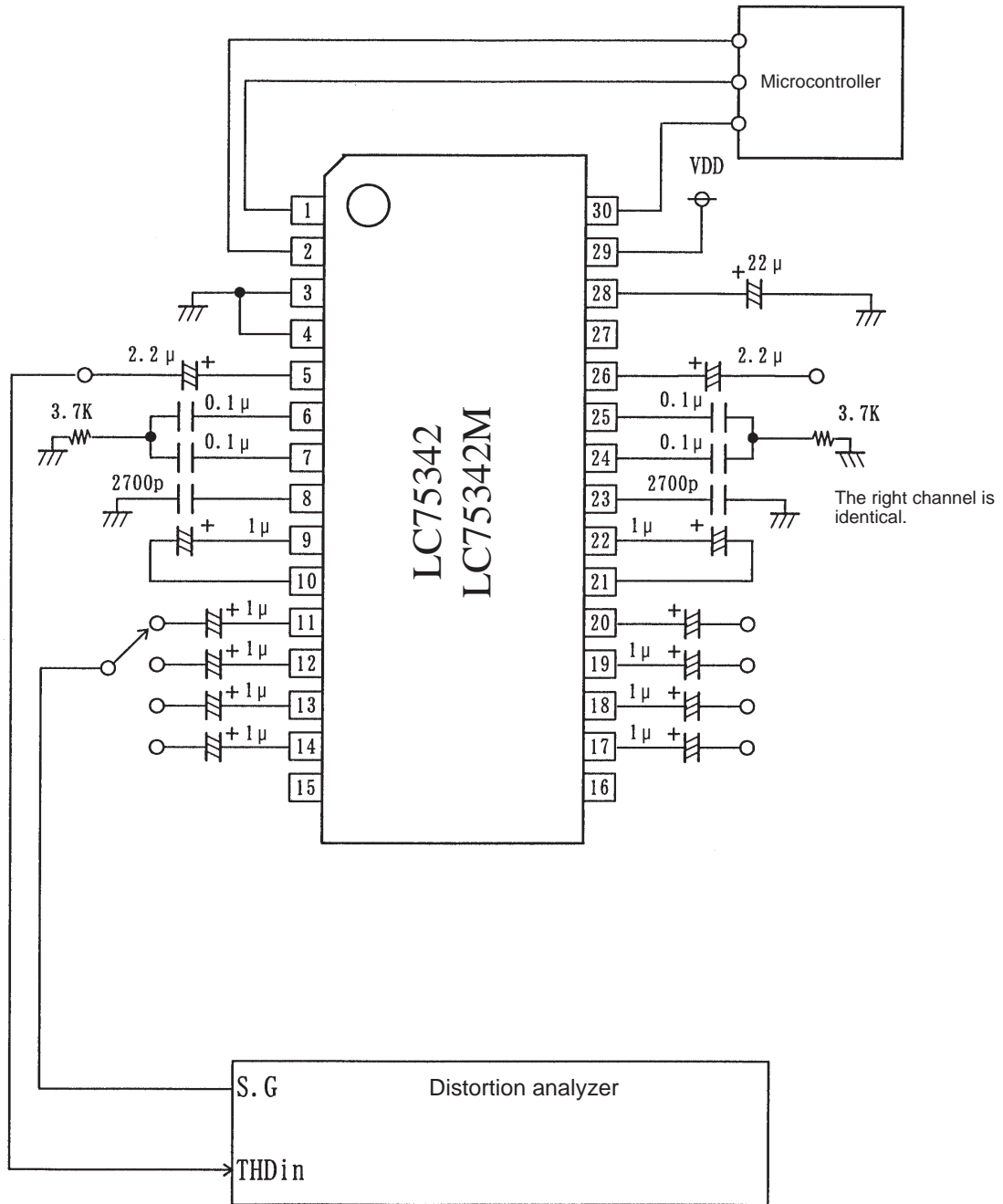
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- Volume block internal equivalent circuit



Test Circuits

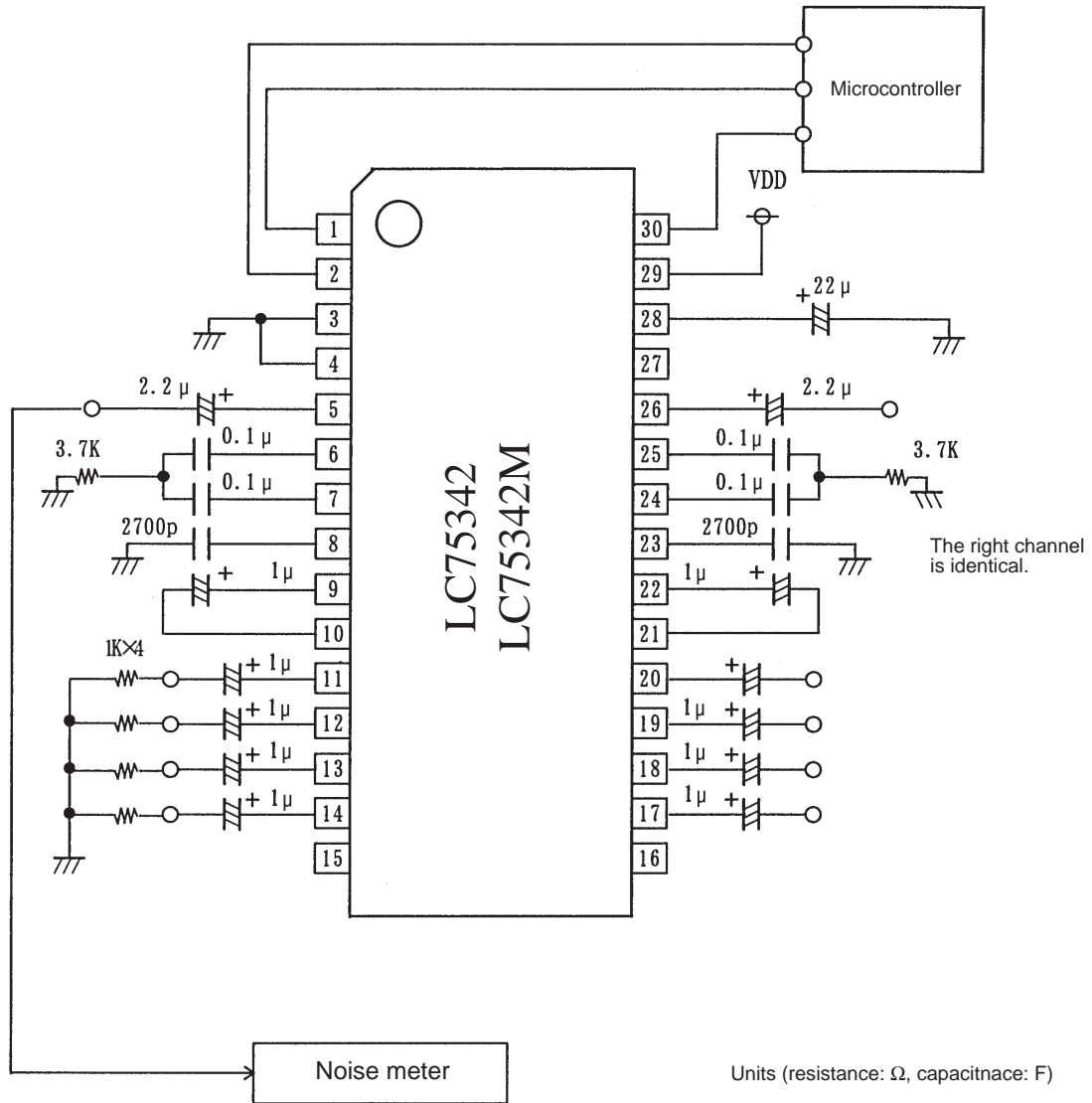
- Total harmonic distortion



Units (resistance: Ω, capacitance: F)

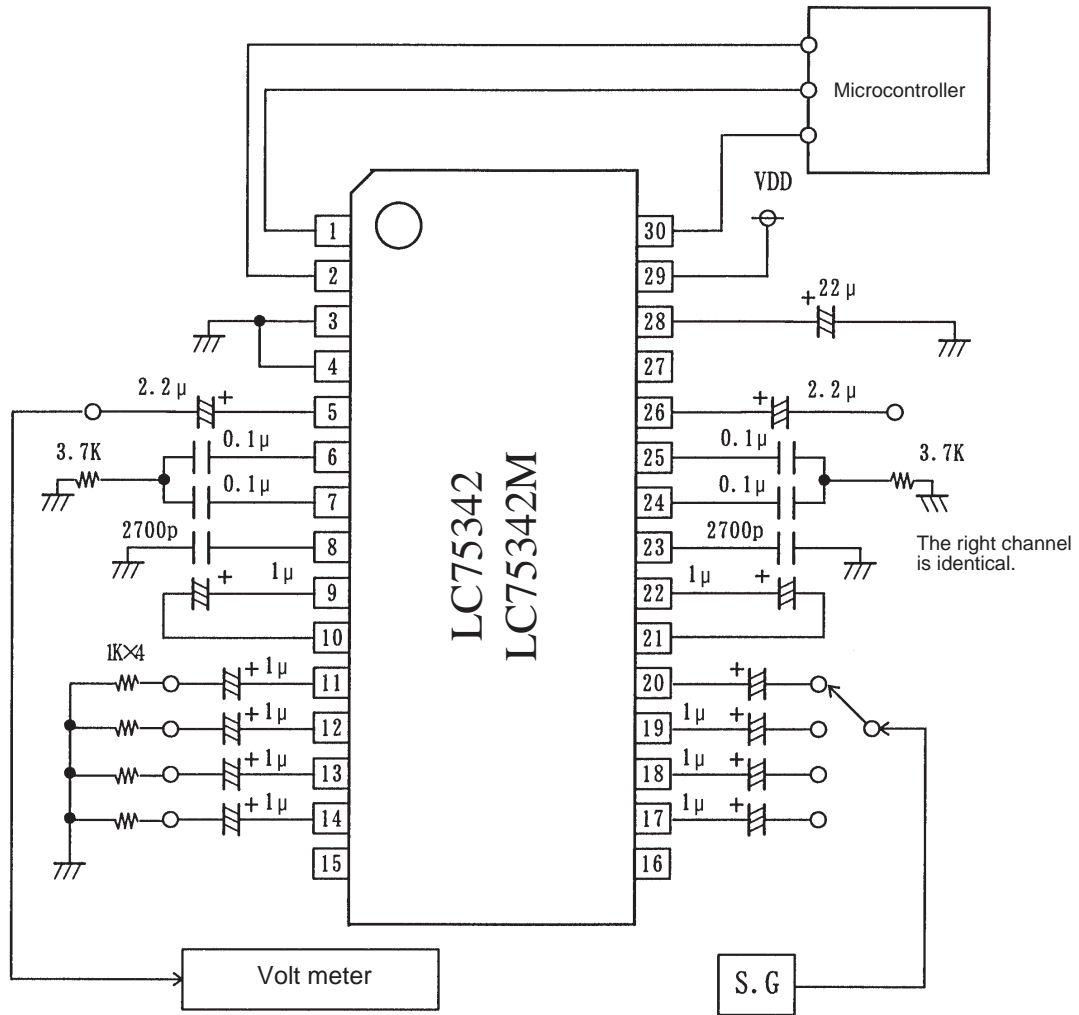
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- Output noise voltage



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- Crosstalk

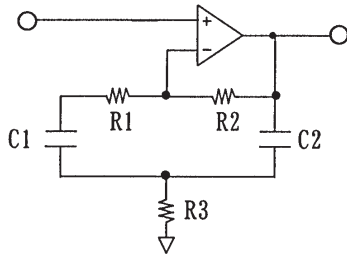


Units (resistance: Ω , capacitance: F)

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: $f_0 = 100 \text{ Hz}$
 Gain at maximum boost: $G = 20 \text{ dB}$
 Let $R_1 = 0$, $R_2 = 66.6 \text{ k}\Omega$, and $C_1 = C_2 = C$.

- (1) Determine R_2 from the fact that $G = 20 \text{ dB}$.

$$G_{+20\text{dB}} = 20 \times \text{LOG}_{10} \left(1 + \frac{R_2}{2R_3} \right)$$

$$R_3 = \frac{R_2}{2 (10^{G_{+20\text{dB}}/20} - 1)} = \frac{66000}{2 \times (10 - 1)} \approx 3.7 \text{ k}\Omega$$

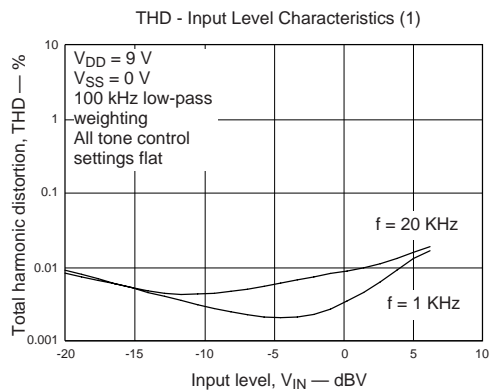
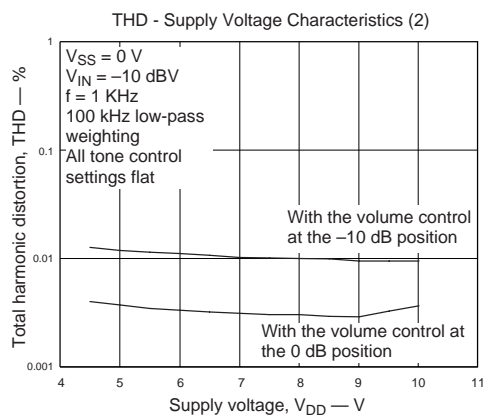
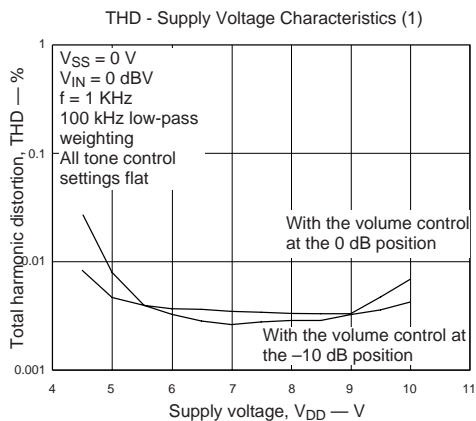
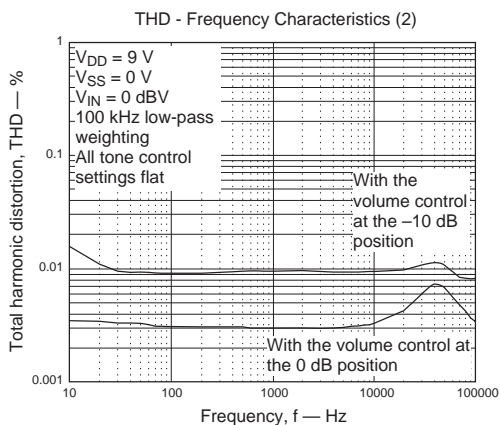
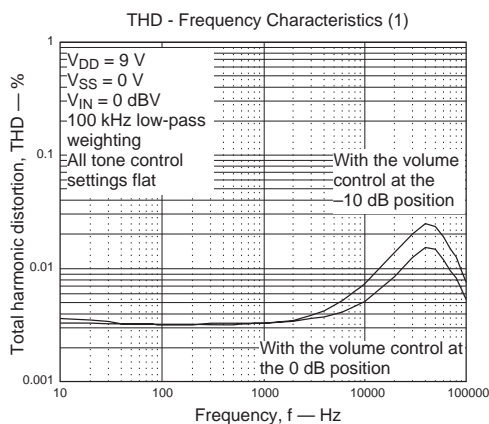
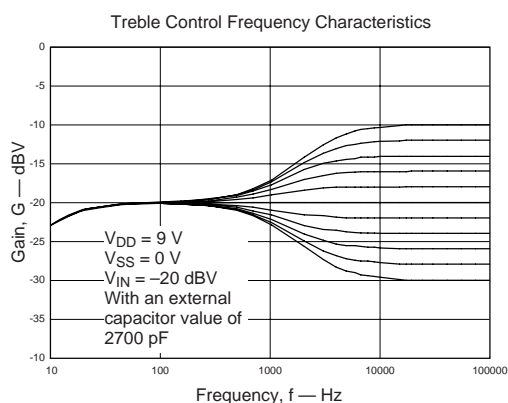
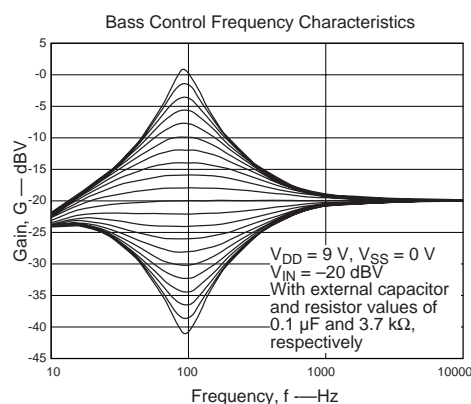
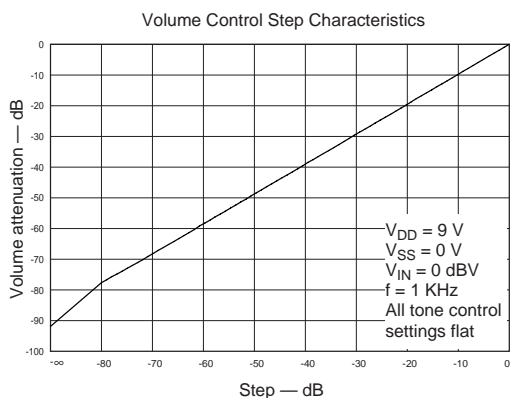
- (2) Determine C from the fact that the center frequency $f_0 = 100 \text{ Hz}$.

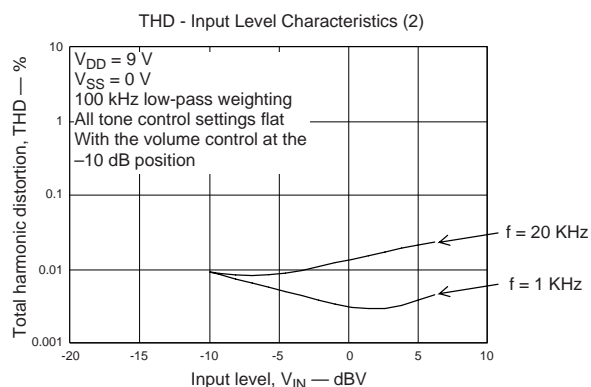
$$f_0 = \frac{1}{2\pi \sqrt{R_3 R_2 C_1 C_2}}$$

$$C = \frac{1}{2\pi f_0 \sqrt{R_3 R_2}} = \frac{1}{2\pi \times 100 \sqrt{66000 \times 3700}} \approx 0.1 \mu\text{F}$$

- (3) Determine Q .

$$Q = \frac{R_3 R_2}{2R_3} \cdot \frac{1}{\sqrt{R_3 R_2}} \approx 2.1$$





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