



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.

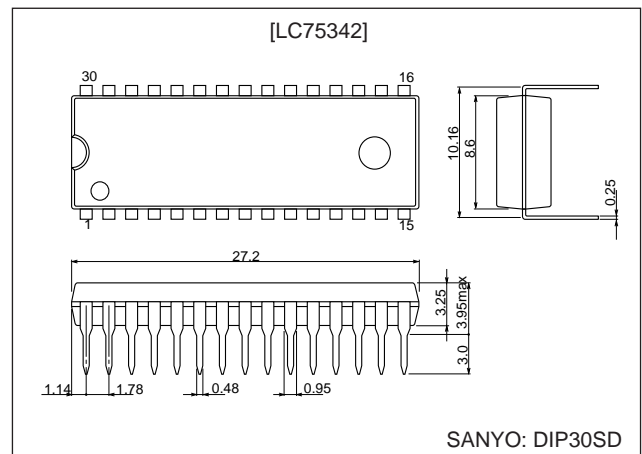
Features

- 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

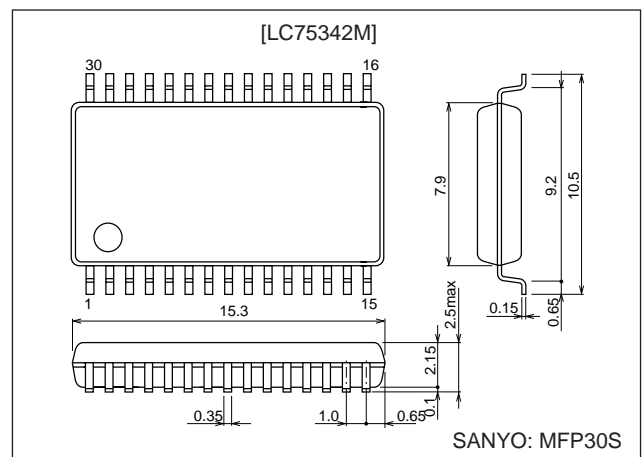
unit: mm

3196-DIP30SD



unit: mm

3216-MFP30S



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SANYO Electric Co., Ltd. Semiconductor Company

TOKYO OFFICE Tokyo Bldg., 1-10, 1 Chome, Ueno, Taito-ku, TOKYO, 110-8534 JAPAN

LC75342, 75342M

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 | | $V_{SS} - 0.3$ to $V_{DD} + 0.3$ | V | |
| Allowable power dissipation | P_{dmax} | | $T_a \leq 75^\circ\text{C}$ | 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: $76.1 \times 114.3 \times 1.6$ mm, printed circuit board material: glass/epoxy resin

Allowable Operating Ranges at $T_a = -30$ 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} | LSEL0, RSEL0 | THD = 1.0%, $f = 1\text{ kHz}$ | | 2.90 | | Vrms |
| Output load resistance | R_l | LSEL0, RSEL0 | | 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

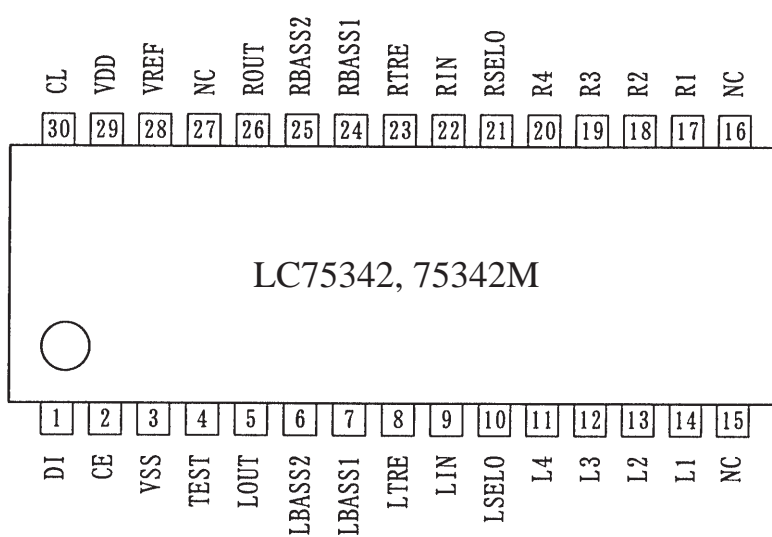
| Parameter | Symbol | Pin | Conditions | Ratings | | | Unit |
|------------------------------|------------|-----|---------------|---------|----------|----------|------------------|
| | | | | min | typ | max | |
| Control range | G_{eq} | | max.boost/cut | ± 8 | ± 10 | ± 12 | dB |
| Step resolution |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

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Overall Characteristics

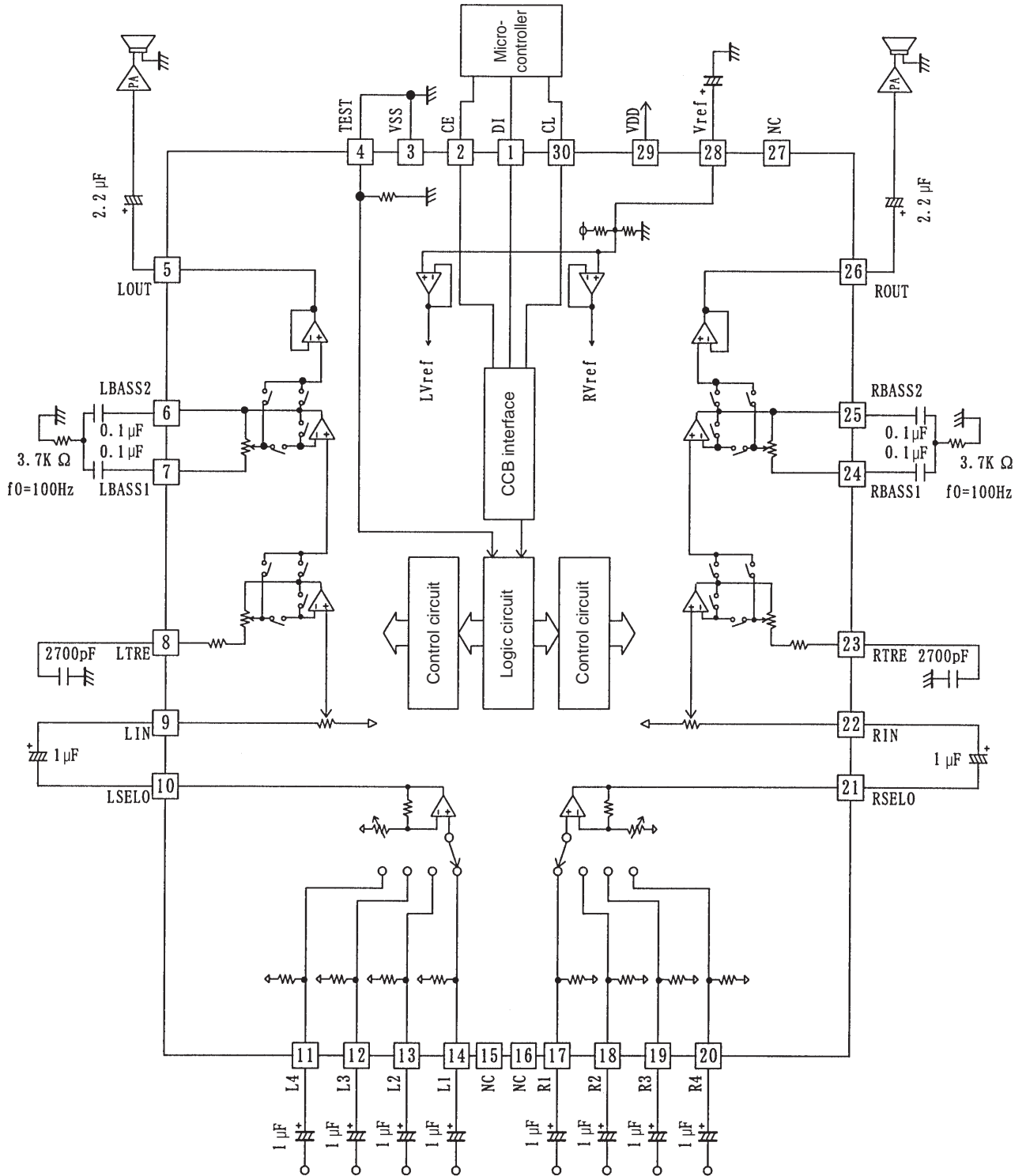
| Parameter | Symbol | Conditions | Ratings | | | Unit |
|---------------------------|----------|---|---------|-----|------|---------------|
| | | | min | typ | max | |
| Total harmonic distortion | THD | $V_{IN} = 1 \text{ V}_{rms}$, $f = 1 \text{ kHz}$, all flat overall | | | 0.01 | % |
| Crosstalk | CT | $V_{IN} = 1 \text{ V}_{rms}$, $f = 1 \text{ kHz}$, $R_g = 1 \text{ k}\Omega$, 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



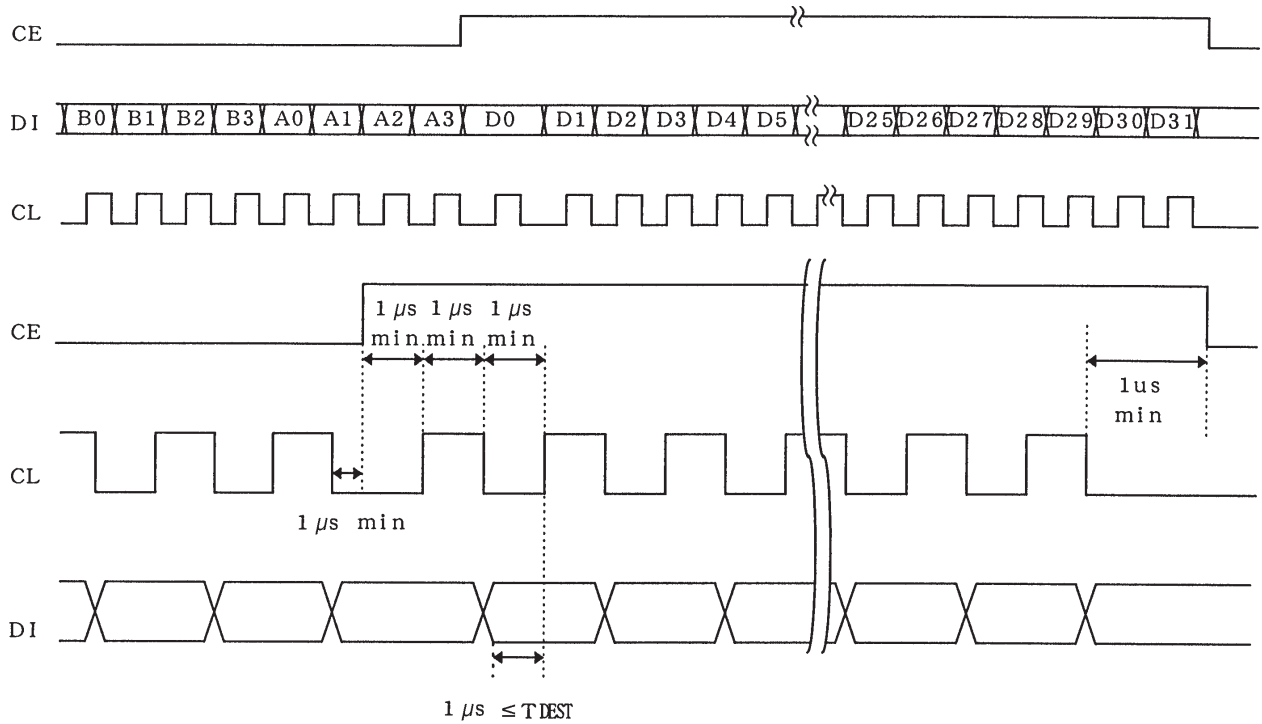
(Top view)

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. | | | | |

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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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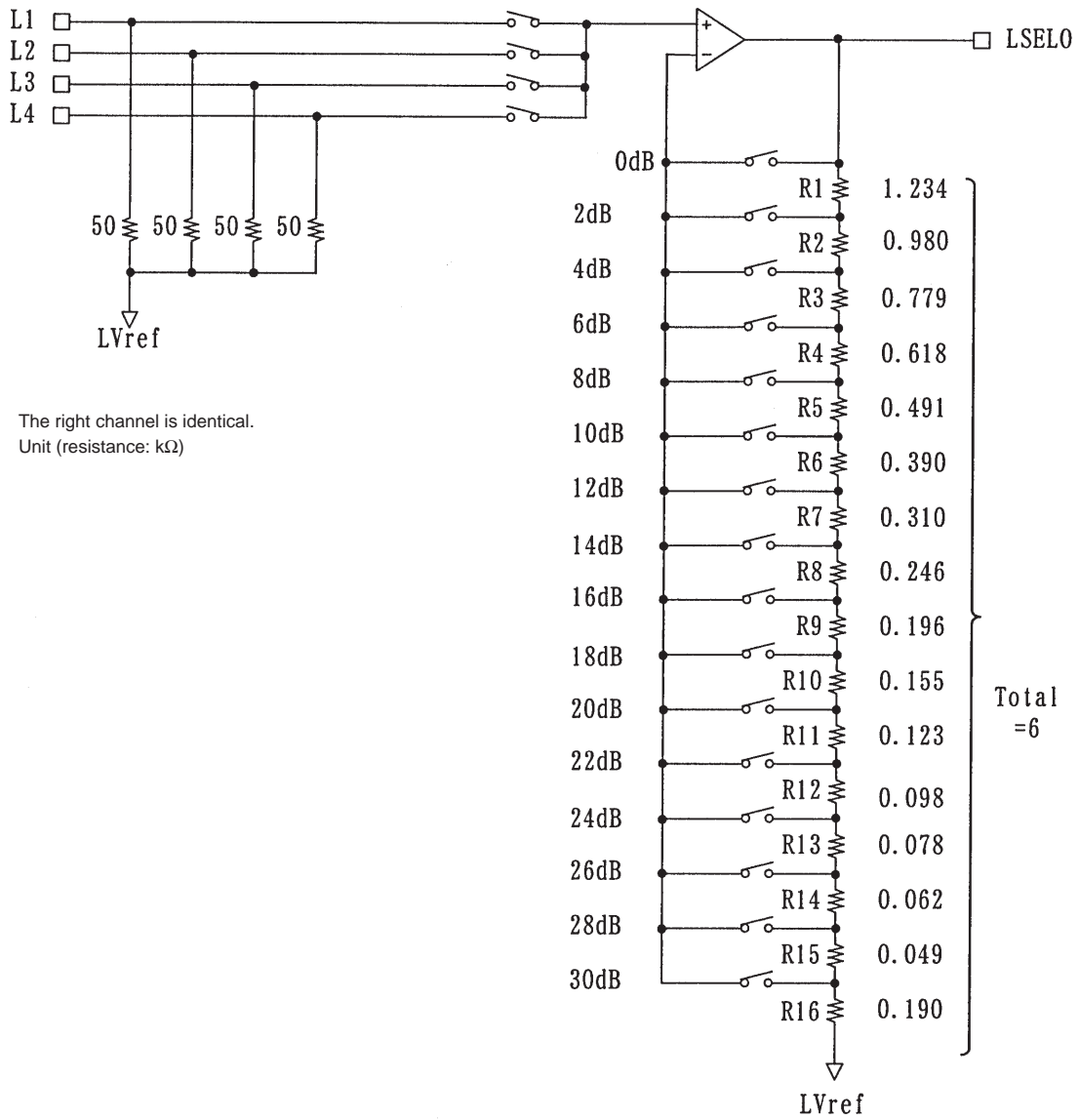
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| Pin No. | Pin | Description | Notes |
|----------------|----------|---|---|
| 28 | Vref | <ul style="list-style-type: none"> • Connection to the $0.5 \times V_{DD}$ voltage generator circuit used as the analog signal ground. • Applications must connect 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. It consists of two resistors connected between V_{DD} and V_{SS}. The output of the divider is connected to the Vref pin. Two protection diodes are connected in series between the Vref pin and V_{SS} to prevent reverse current flow.</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 pull-up resistor connected between V_{DD} and the CE pin. A protection diode is connected between the CE pin and V_{SS} to prevent reverse current flow.</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. | |

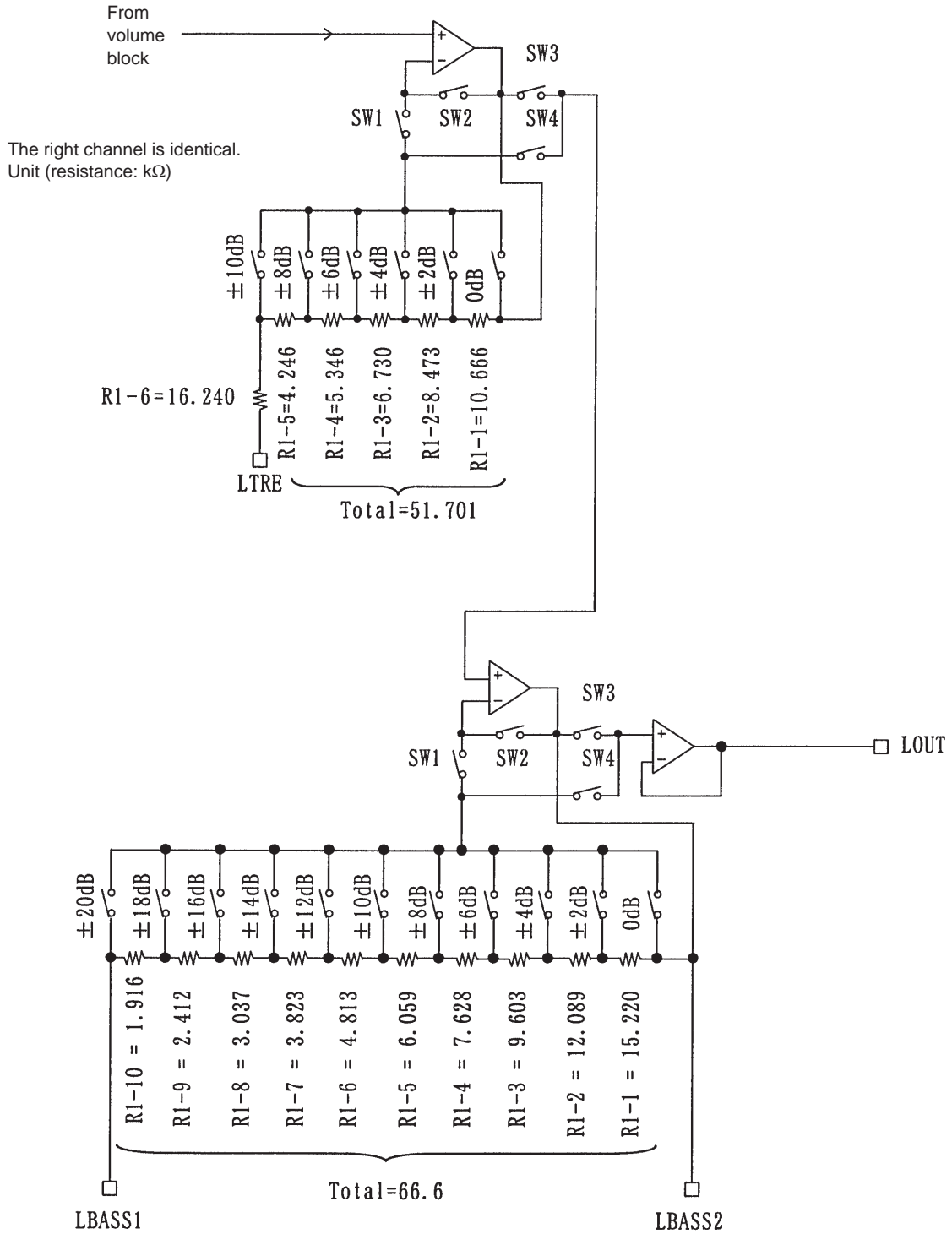
Internal Equivalent Circuits

- Selector block equivalent circuit



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• Treble and bass band block internal equivalent circuit

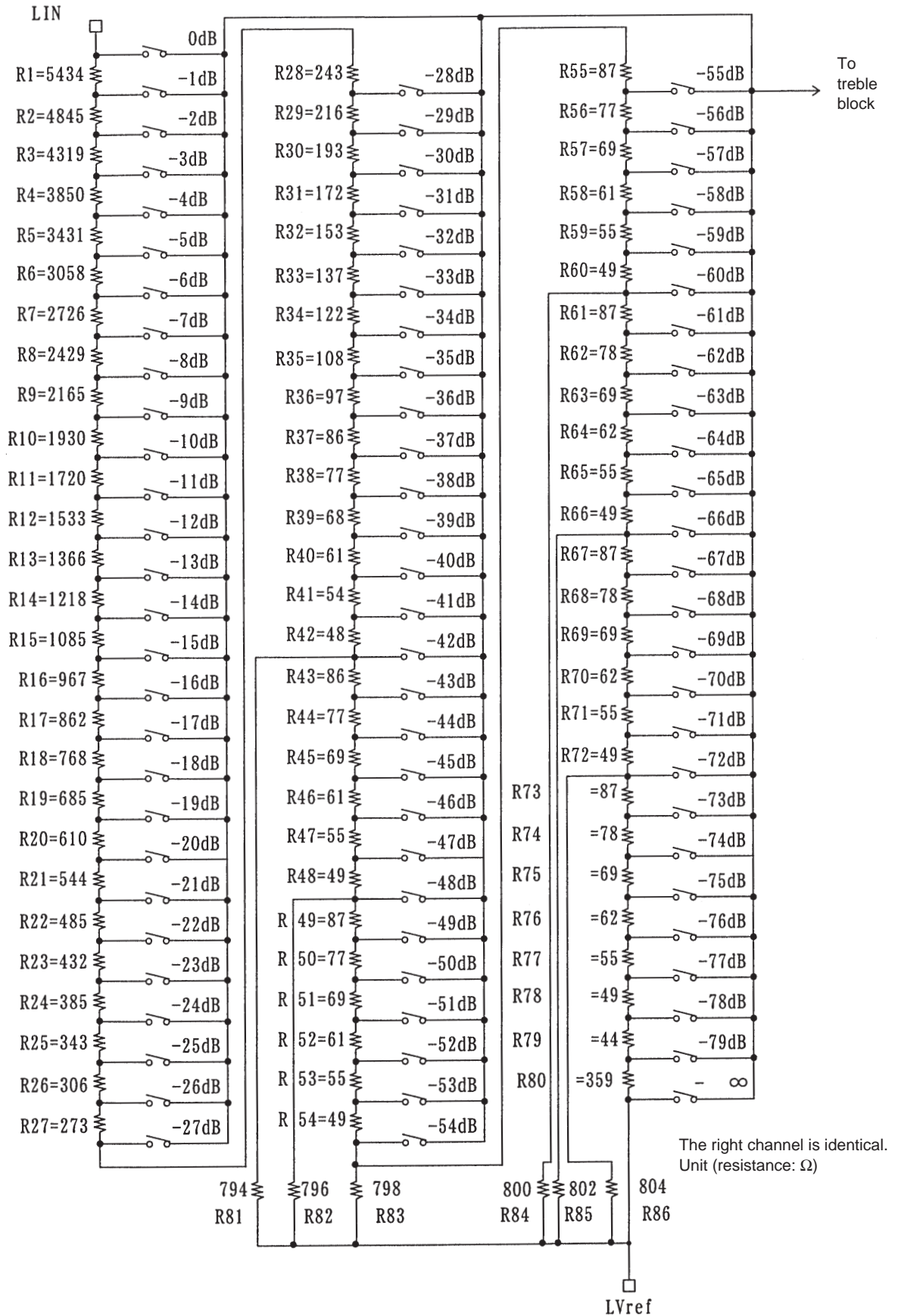


The right channel is identical.
Unit (resistance: k Ω)

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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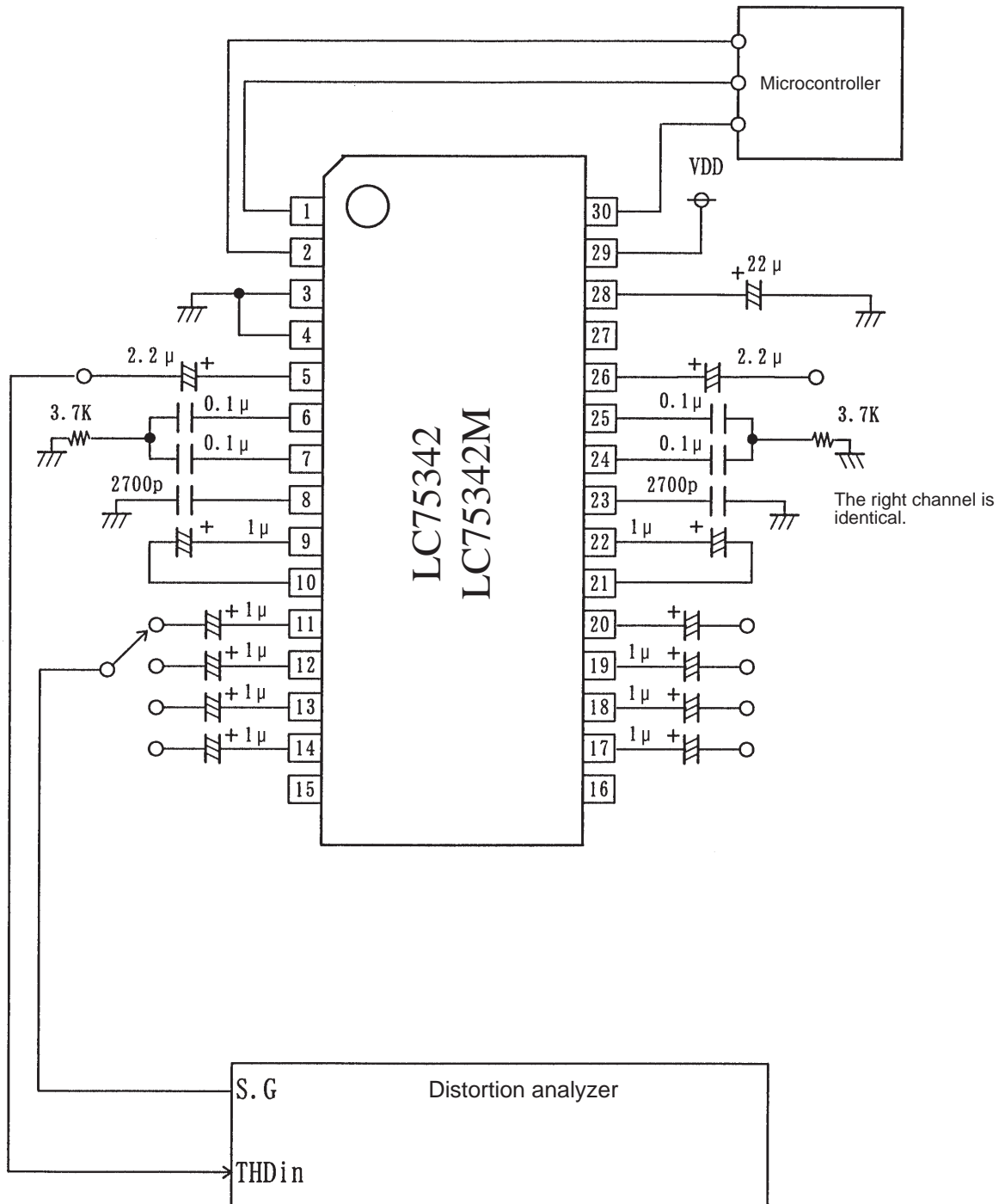
- Volume block internal equivalent circuit



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Test Circuits

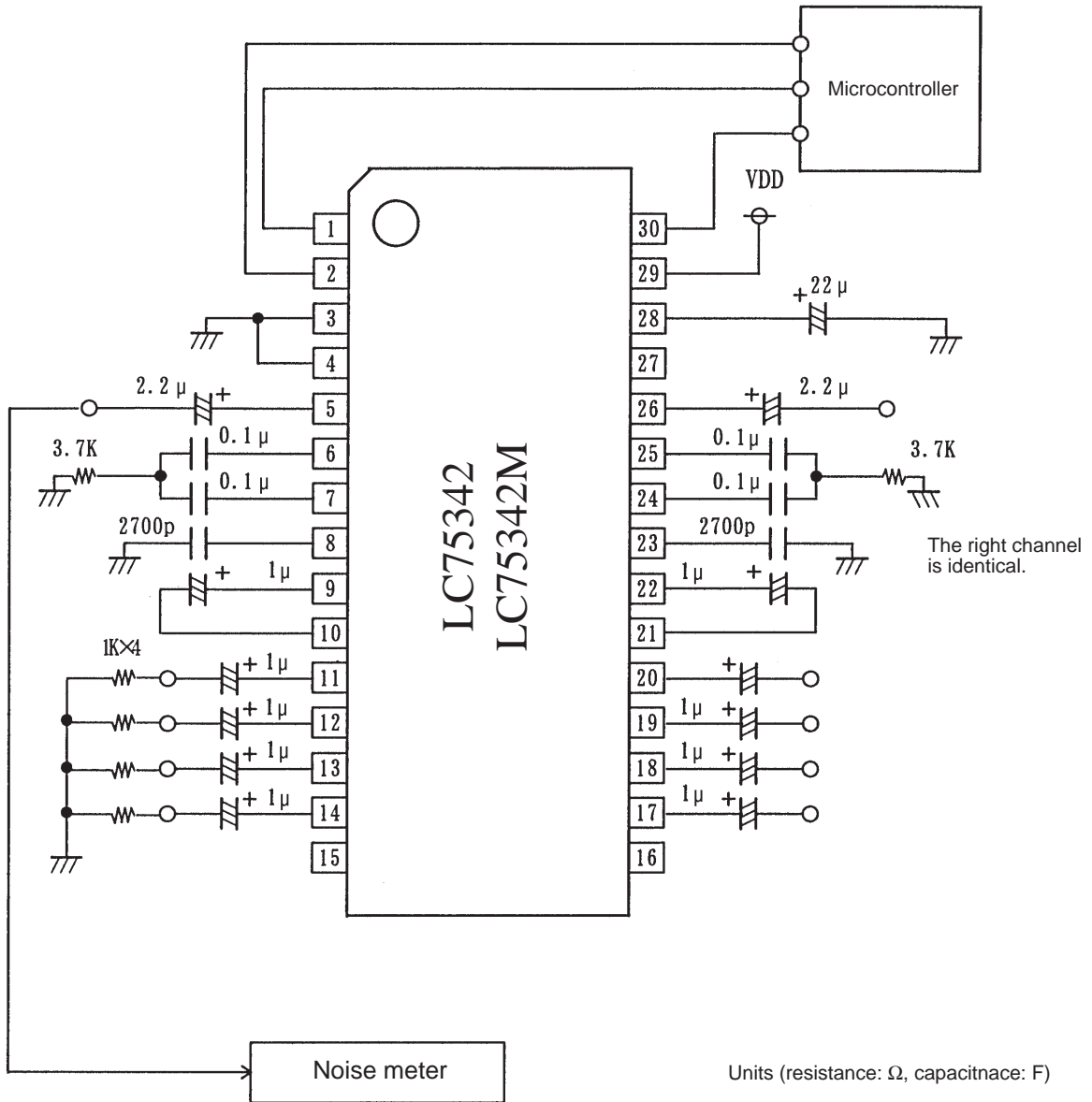
- Total harmonic distortion



Units (resistance: Ω, capacitance: F)

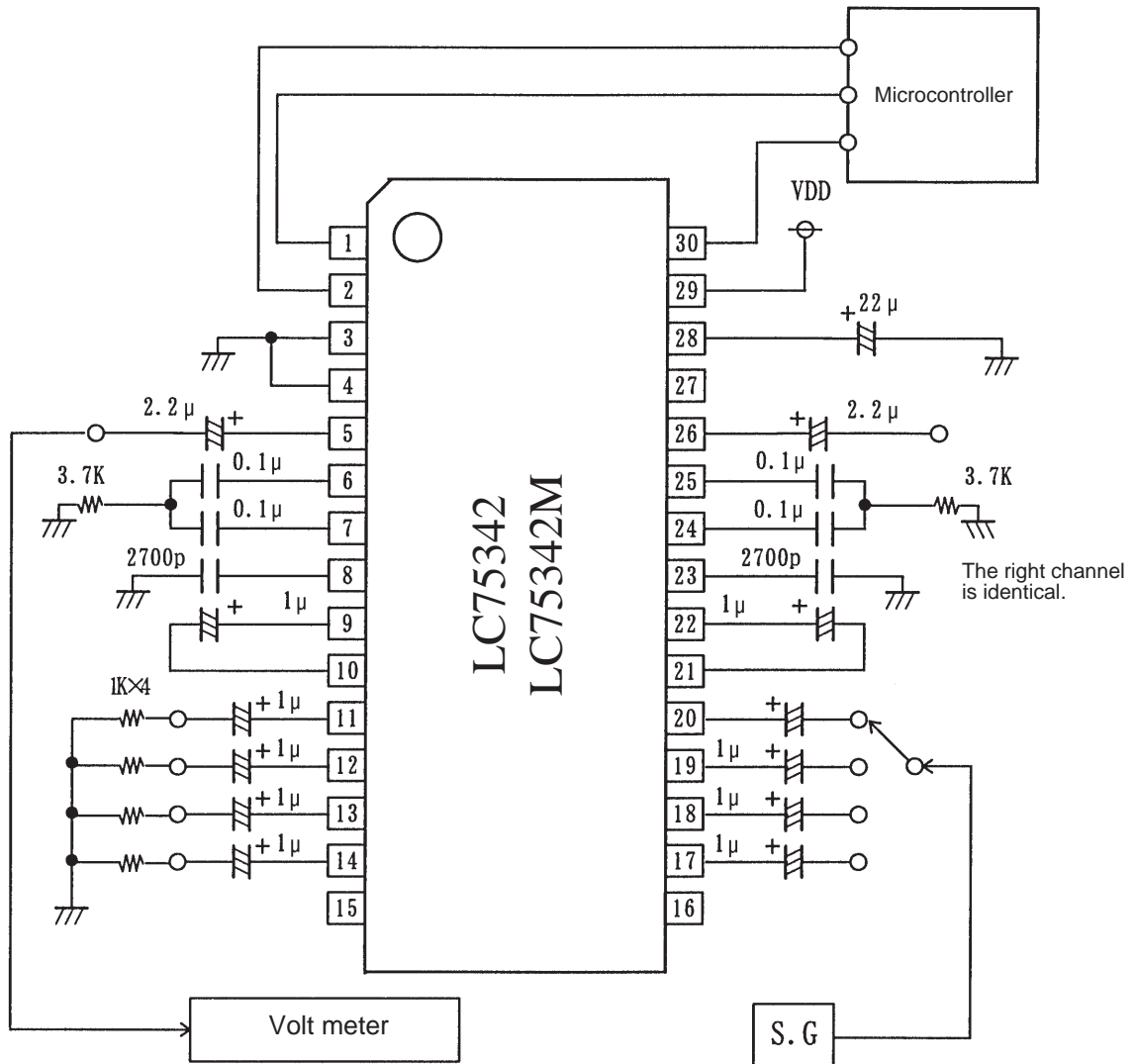
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- Output noise voltage



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- Crosstalk

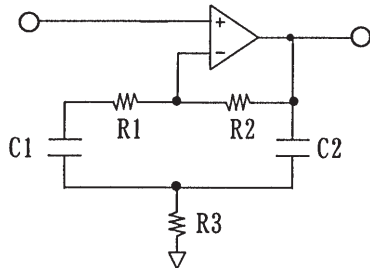


Units (resistance: Ω, capacitance: F)

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 $f_0 = 100 \text{ Hz}$.

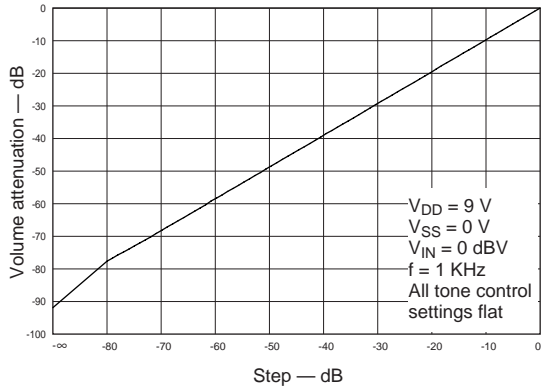
$$f_0 = \frac{1}{2\pi \sqrt{R_3 R_2 C_1 C_2}}$$

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

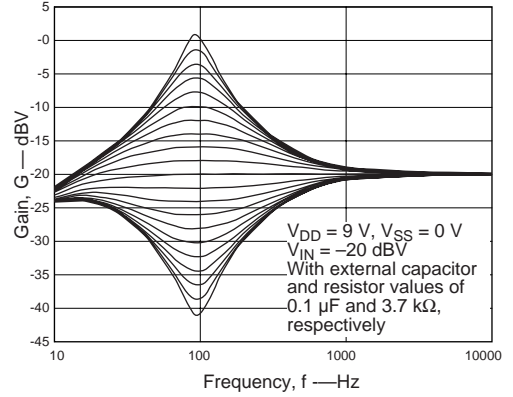
- (3) Determine Q .

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

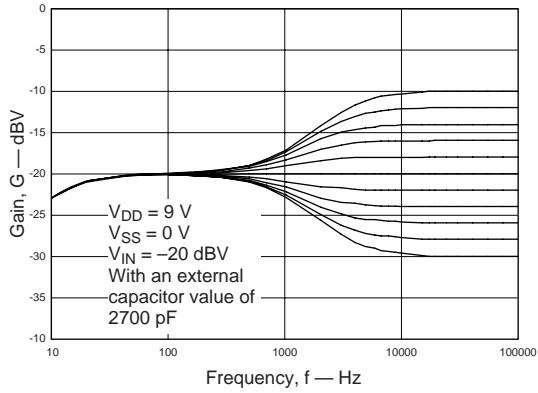
Volume Control Step Characteristics



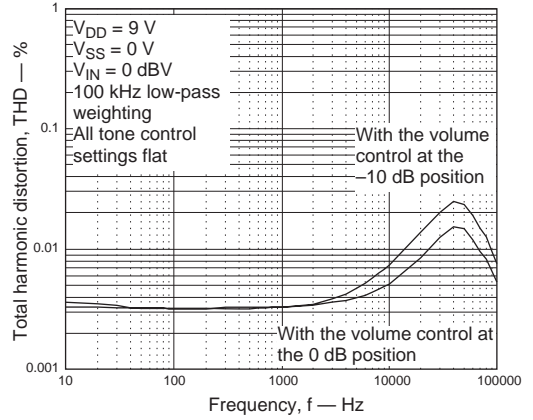
Bass Control Frequency Characteristics



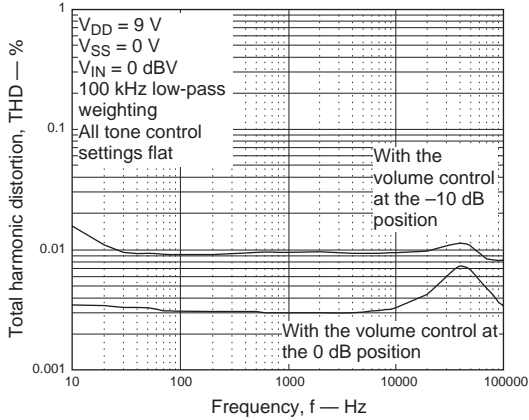
Treble Control Frequency Characteristics



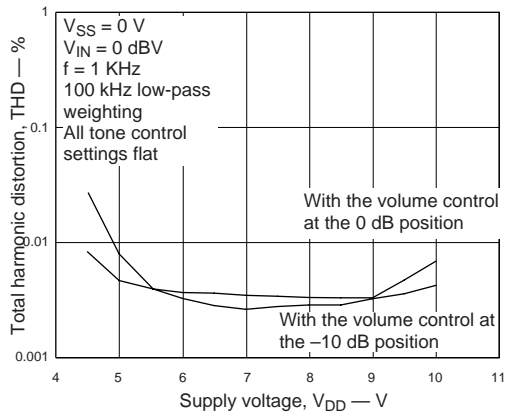
THD - Frequency Characteristics (1)



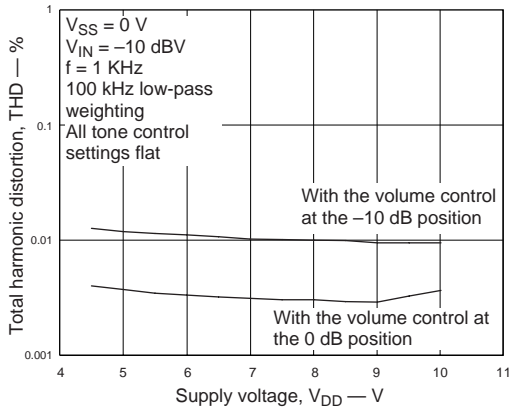
THD - Frequency Characteristics (2)



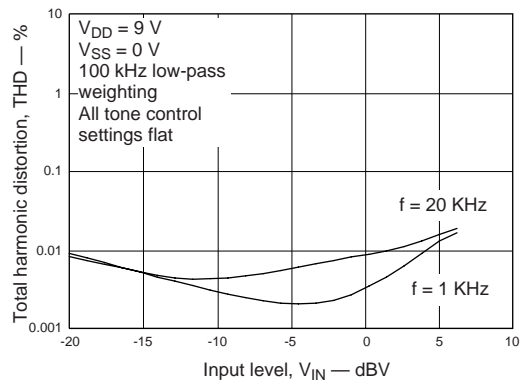
THD - Supply Voltage Characteristics (1)

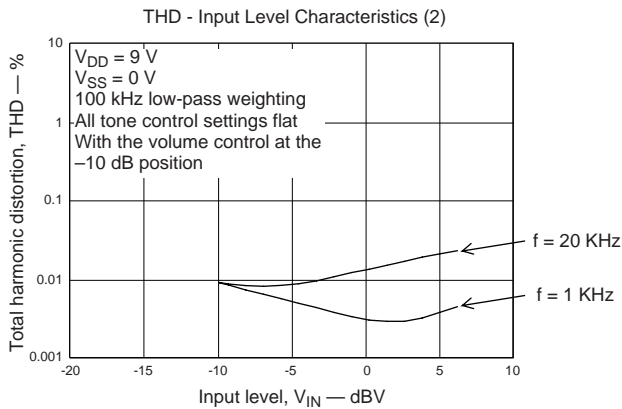


THD - Supply Voltage Characteristics (2)



THD - Input Level Characteristics (1)





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