



LC75385NE-R

Electronic Volume and Tone Control for Car Stereo Systems



Overview

The LC75385NE-R is an electronic volume and tone control IC that can implement volume, balance, fader, bass/treble, loudness, input switching, and input gain control functions with a minimum number of external components.

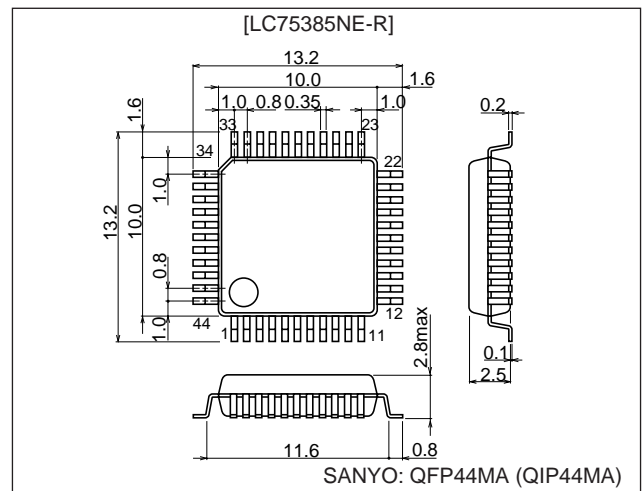
Features

- Volume: 81 positions: from 0 dB to -79 dB in 1-dB steps and $-\infty$
A balance function can be implemented by controlling the left and right volume settings independently.
- Fader: Either the rear or front outputs can be attenuated over 16 positions. (16 positions: From 0 dB to -2 dB in 1-dB steps, from -2 dB to -20 dB in 2-dB steps, from -20 to -30 dB in one 10-dB step, -45 dB, -60 dB, and $-\infty$)
- Bass/treble: Control over ± 12 dB in 2-dB steps in each band.
- Input gain: The input signal can be amplified by from 0 to $+18.75$ dB in 1.25 dB steps.
- Input switching: One of four signals can be selected for each of the left and right channels.
- Loudness: Taps are output from a 2-dB step volume control ladder resistor starting at the -32 -dB position. A loudness function can be implemented by attaching external capacitors and resistors.
- On-chip buffer amplifiers minimize the number of required external components.
- Minimal switching noise when no input signals are present due to fabrication in a silicon gate CMOS process that minimizes the noise generated by internal switches.
- Use of zero-cross switching circuits for internal switches minimizes switching noise when signals are present.
- Built-in $V_{DD}/2$ reference voltage generator circuit
- All controls can be set from serial input data transferred over a CCB interface.

Package Dimensions

unit: mm

3148-QFP44MA



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- CCB is SANYO's original bus format and all the bus addresses are controlled by SANYO.

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LC75385NE-R

Specifications

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

| Parameter | Symbol | Conditions | Ratings | Unit |
|-----------------------------|---------------------|---|----------------------------------|------------------|
| Maximum supply voltage | $V_{DD\text{ max}}$ | V_{DD} | 11 | V |
| Maximum input voltage | $V_{IN\text{ max}}$ | All input pins | $V_{SS} - 0.3$ to $V_{DD} + 0.3$ | V |
| Allowable power dissipation | $Pd\text{ max}$ | $T_a \leq 85^\circ\text{C}$, when mounted on a printed circuit board | 720 | mW |
| Operating temperature | $Topr$ | | -40 to +85 | $^\circ\text{C}$ |
| Storage temperature | $Tstg$ | | -50 to +125 | $^\circ\text{C}$ |

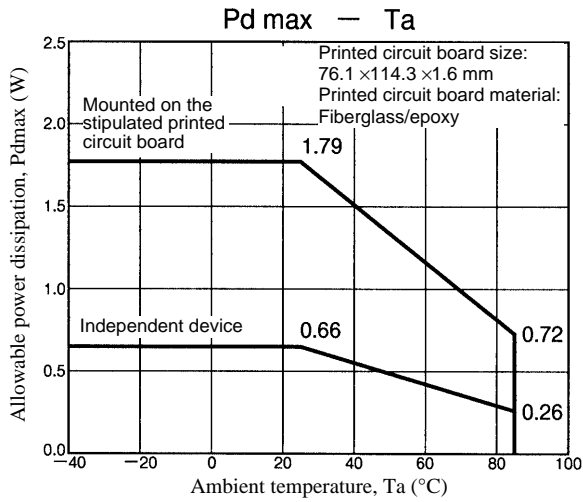
Allowable Operating Ranges at $T_a = 25^\circ\text{C}$, $V_{SS} = 0\text{ V}$

| Parameter | Symbol | Conditions | Ratings | | | Unit |
|--------------------------|--------------------|------------|----------|-----|----------|---------------|
| | | | min | typ | max | |
| Supply voltage | V_{DD} | V_{DD} | 6.0 | | 10.5 | V |
| High-level input voltage | V_{IH} | CL, DI, CE | 4.0 | | V_{DD} | V |
| Low-level input voltage | V_{IL} | CL, DI, CE | V_{SS} | | 1.0 | V |
| Input voltage amplitude | V_{IN} | | 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 | fopg | CL | | | 500 | kHz |

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

| Parameter | Symbol | Pins | Conditions | Ratings | | | Unit |
|--------------------------|---------------------|----------------------------|------------------|---------|----------|-----------|------------|
| | | | | min | typ | max | |
| [Input Block] | | | | | | | |
| Input resistance | R_{in} | L1 to L4, R1 to R4 | | 30 | 50 | 70 | k Ω |
| Minimum input gain | $G_{in\text{ min}}$ | L1 to L4, R1 to R4 | | -1 | 0 | +1 | dB |
| Maximum input gain | $G_{in\text{ max}}$ | | | +16.5 | +18.75 | +21 | dB |
| Inter-step setting error | A_{Terr} | | | | | ± 0.6 | dB |
| Left/right balance | BAL | | | | | ± 0.5 | dB |
| [Volume Block] | | | | | | | |
| Input resistance | R_{vr} | LVRIN, RVRIN, loudness off | | 113 | 226 | 339 | k Ω |
| Inter-step setting error | A_{Terr} | | | | | ± 0.5 | dB |
| Left/right balance | BAL | | | | | ± 0.5 | dB |
| [Tone Control Block] | | | | | | | |
| Inter-step setting error | A_{Terr} | | | | | ± 1.0 | dB |
| Bass control range | G_{bass} | | max. boost/cut | ± 9 | ± 12 | ± 15 | dB |
| Treble control range | G_{tre} | | max. boost/cut | ± 9 | ± 12 | ± 15 | dB |
| Left/right balance | BAL | | | | | ± 0.5 | dB |
| [Fader Block] | | | | | | | |
| Input resistance | R_{fed} | LFIN, RFIN | | 25 | 50 | 100 | k Ω |
| Inter-step setting error | A_{Terr} | | 0 dB to -2 dB | | | ± 0.5 | dB |
| | | | -2 dB to -20 dB | | | ± 1 | dB |
| | | | -20 dB to -30 dB | | | ± 2 | dB |
| | | | -30 dB to -60 dB | | | ± 3 | dB |
| Left/right balance | BAL | | | | | ± 0.5 | dB |

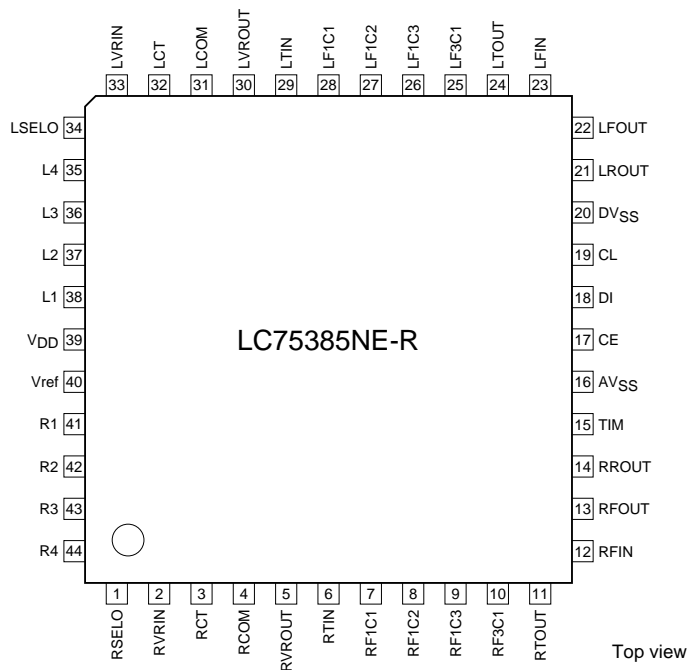
LC75385NE-R



Overall Characteristics

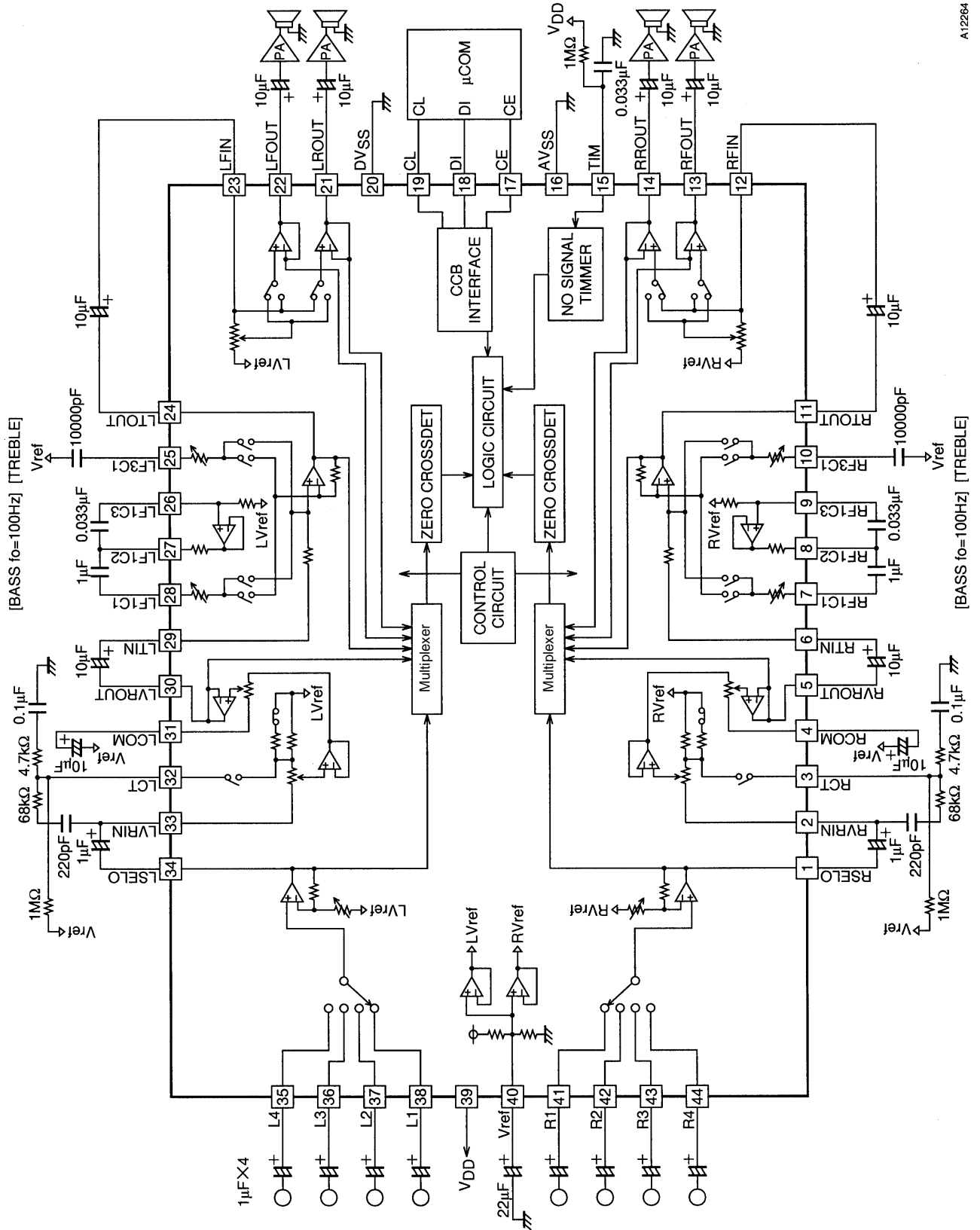
| Parameter | Symbol | Conditions | Ratings | | | Unit |
|------------------------------|------------------------|---|---------|-------|-----|---------|
| | | | min | typ | max | |
| Total harmonic distortion | THD 1 | $V_{IN} = -10$ dBV, $f = 1$ kHz | | 0.004 | | % |
| | THD 2 | $V_{IN} = -10$ dBV, $f = 10$ kHz | | 0.006 | | % |
| Inter-input crosstalk | CT | $V_{IN} = 1$ Vrms, $f = 1$ kHz | 80 | 88 | | dB |
| Left/right channel crosstalk | CT | $V_{IN} = 1$ Vrms, $f = 1$ kHz | 80 | 88 | | dB |
| Maximum attenuation | $V_{O \text{ min } 1}$ | $V_{IN} = 1$ Vrms, $f = 1$ kHz | 80 | 88 | | dB |
| | $V_{O \text{ min } 2}$ | $V_{IN} = 1$ Vrms, $f = 1$ kHz, INMUTE, with the fader set to $-\infty$ | 90 | 95 | | dB |
| Output noise voltage | $V_N 1$ | All controls flat, with the IHF-A filter | | 5 | 10 | μ V |
| | $V_N 2$ | All controls flat, with a 20 Hz to 20 kHz bandpass filter | | 7 | 15 | μ V |
| Current drain | I_{DD} | | | 33 | 40 | mA |
| High-level input current | I_{IH} | CL, DI, CE, $V_{IN} = 9$ V | | | 10 | μ A |
| Low-level input current | I_{IL} | CL, DI, CE, $V_{IN} = 0$ V | -10 | | | μ A |
| Maximum input voltage | V_{CL} | THD = 1 %, $R_L = 10$ k Ω , all controls flat, $f_{IN} = 1$ kHz | 2.5 | 2.9 | | Vrms |

Pin Arrangement

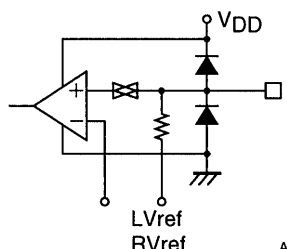
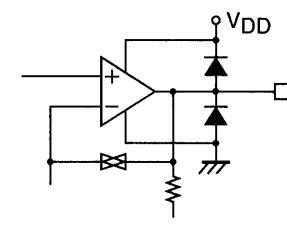
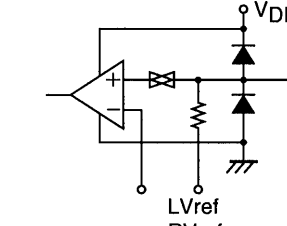
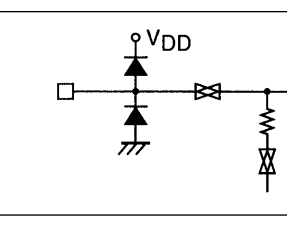
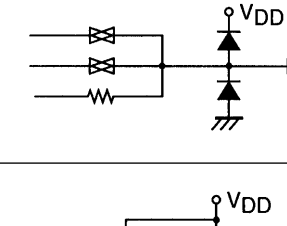
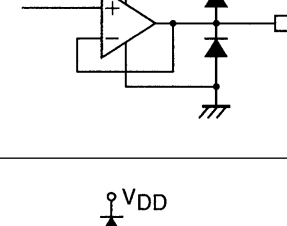
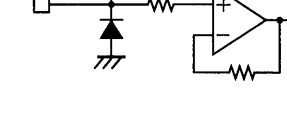


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Equivalent Circuit and Sample Application Circuit Diagram



Pin Functions

| Pin No. | Pin | Function | Notes |
|--|--|---|---|
| 38 37 36 35 41 42 43 44 | L1 L2 L3 L4 R1 R2 R3 R4 | <ul style="list-style-type: none"> • Single end inputs |  <p>A12265</p> |
| 34 1 | LSELO RSELO | <ul style="list-style-type: none"> • Input selector outputs |  <p>A12266</p> |
| 33 2 | LVRIN RVRIN | <ul style="list-style-type: none"> • Inputs for the 2-dB step volume control • These inputs must be driven from low-impedance circuits. |  <p>A12267</p> |
| 32 3 | LCT RCT | <ul style="list-style-type: none"> • Loudness function pins. Connect the high-band compensation RC circuits between the LCT (RCT) and the LVRIN (RVRIN) pins and connect the low-band compensation RC circuits between the LCT (RCT) and Vref. |  <p>A12268</p> |
| 31 4 | LCOM RCOM | <ul style="list-style-type: none"> • 2-dB step volume control outputs • To reduce switching noise, each of these pins should be connected to Vref through a capacitor. |  <p>A12269</p> |
| 30 5 | LVROUT RVROUT | <ul style="list-style-type: none"> • Output from the 1-dB step volume control |  <p>A12270</p> |
| 29 6 | LTIN RTIN | <ul style="list-style-type: none"> • Tone control circuit inputs |  <p>A12271</p> |

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LC75385NE-R

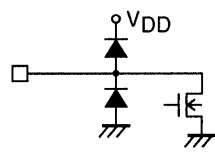
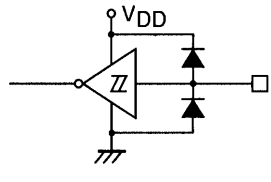
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| Pin No. | Pin | Function | Equivalent circuit |
|-------------------------------|--|--|--|
| 28 27 26 7 8 9 | LF1C1 LF1C2 LF1C3 RF1C1 RF1C2 RF1C3 | <ul style="list-style-type: none"> • Tone control circuit low band filter capacitor connections <p>The low band compensation capacitors must be connected between the following pins: LF1C1 (RF1C1) and LF1C2 (RF1C2) LF1C2 (RF1C2) and LF1C3 (RF1C3)</p> | <p style="text-align: right;">A12272</p> |
| 39 10 | LF3C1 RF3C1 | <ul style="list-style-type: none"> • Tone control circuit high band filter capacitor connections <p>The high band compensation capacitors must be connected between LF3C1 (RF3C1) and Vref.</p> | <p style="text-align: right;">A12273</p> |
| 24 11 | LTOUT RTOUT | <ul style="list-style-type: none"> • Tone control circuit outputs | <p style="text-align: right;">A12274</p> |
| 23 12 | LFIN RFIN | <ul style="list-style-type: none"> • Fader block inputs • These inputs must be driven from low-impedance circuits. | <p style="text-align: right;">A12275</p> |
| 22 21 13 14 | LFOUT LROUT RFOUT RROUT | <ul style="list-style-type: none"> • Fader block outputs. The front and rear outputs can be attenuated independently. The attenuation is the same in the left and right channels. | <p style="text-align: right;">A12276</p> |
| 40 | Vref | <ul style="list-style-type: none"> • $V_{DD}/2$ voltage generator block. A capacitor with a value of about $10\ \mu\text{F}$ must be inserted between Vref and AV_{SS} (V_{SS}) to reduce power supply ripple. | <p style="text-align: right;">A12277</p> |
| 39 | V_{DD} | <ul style="list-style-type: none"> • Power supply | |
| 20 | DV_{SS} | <ul style="list-style-type: none"> • Logic system ground | |
| 16 | AV_{SS} | <ul style="list-style-type: none"> • Analog system ground | |

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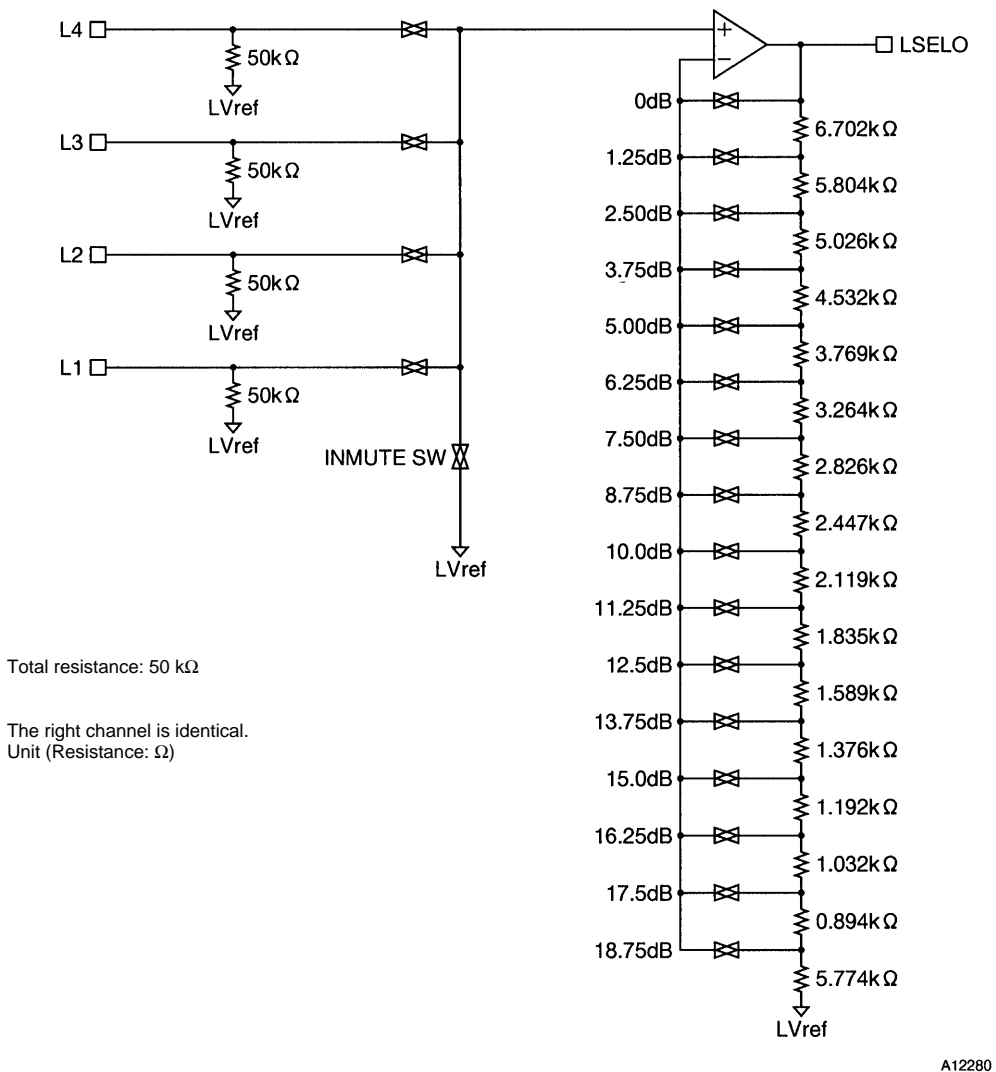
LC75385NE-R

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| Pin No. | Pin | Function | Equivalent circuit |
|----------|----------|---|---|
| 15 | TIM | <ul style="list-style-type: none"> Used for the zero cross circuit no-signal timer function. If a zero cross signal does not occur between the point when data is loaded and the point when the timer times out, the data will be stored forcibly when the timer times out. |  <p>A12278</p> |
| 19 18 | CL DI | <ul style="list-style-type: none"> Serial data and clock inputs used for device control |  <p>A12279</p> |
| 17 | CE | <ul style="list-style-type: none"> Chip enable input. Data is written to the internal latch when this pin goes from high to low. The analog switches then operate. Data transfers are enabled when this pin is high. | |

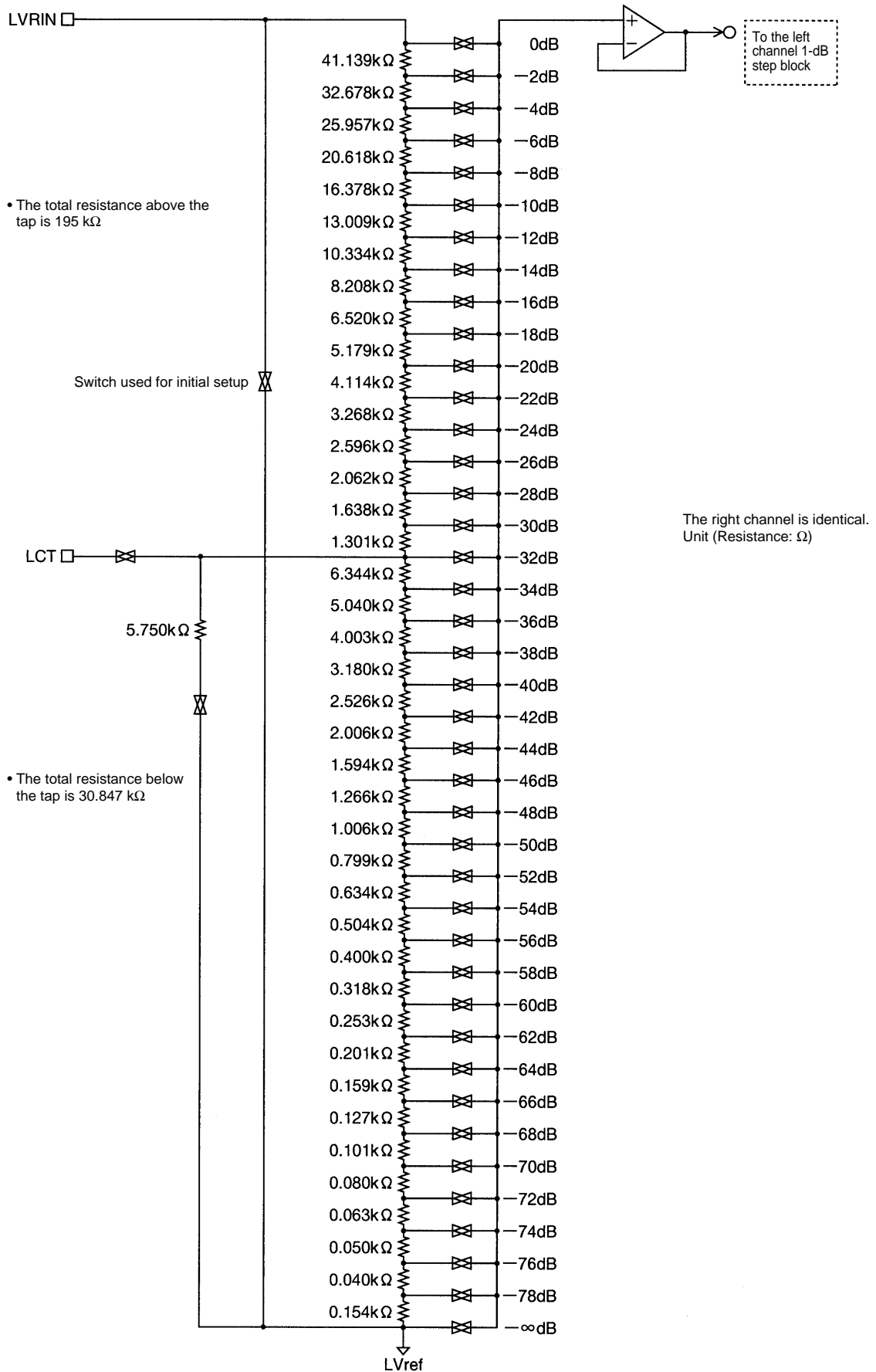
Internal Equivalent Circuits

Selector Block Equivalent Circuit



LC75385NE-R

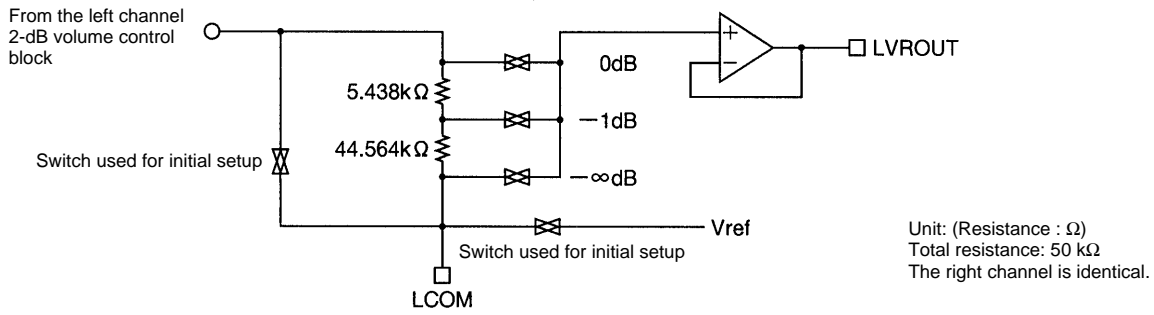
2-dB Step Volume Control Block Equivalent Circuit



A12281

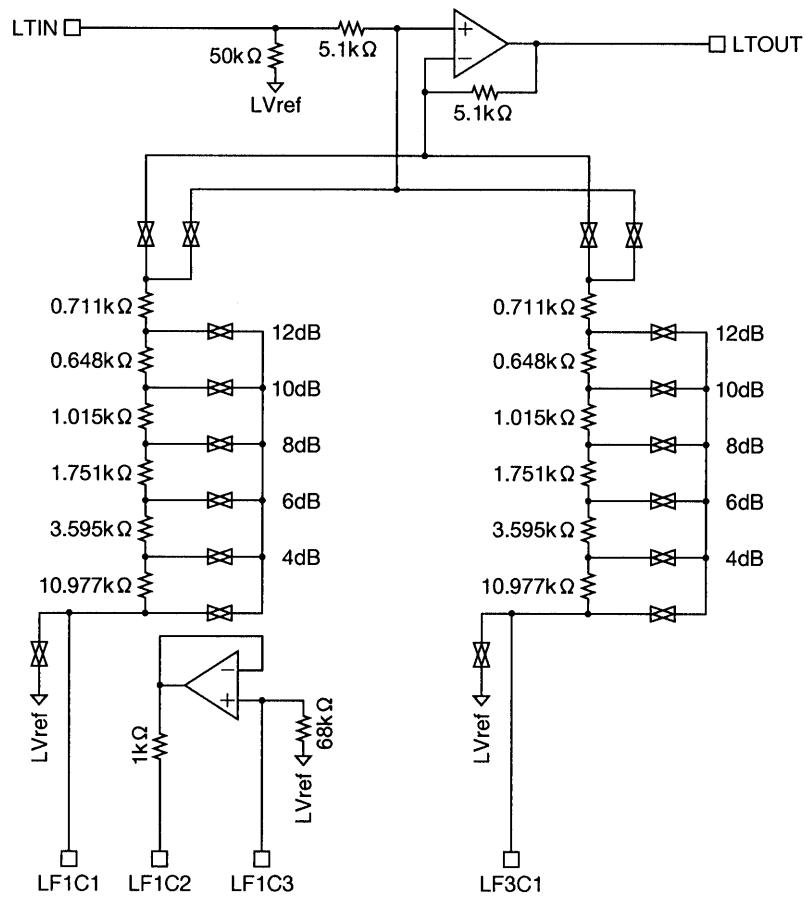
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1-dB Step Volume Control Block Equivalent Circuit



A12282

Tone Control Block Equivalent Circuit

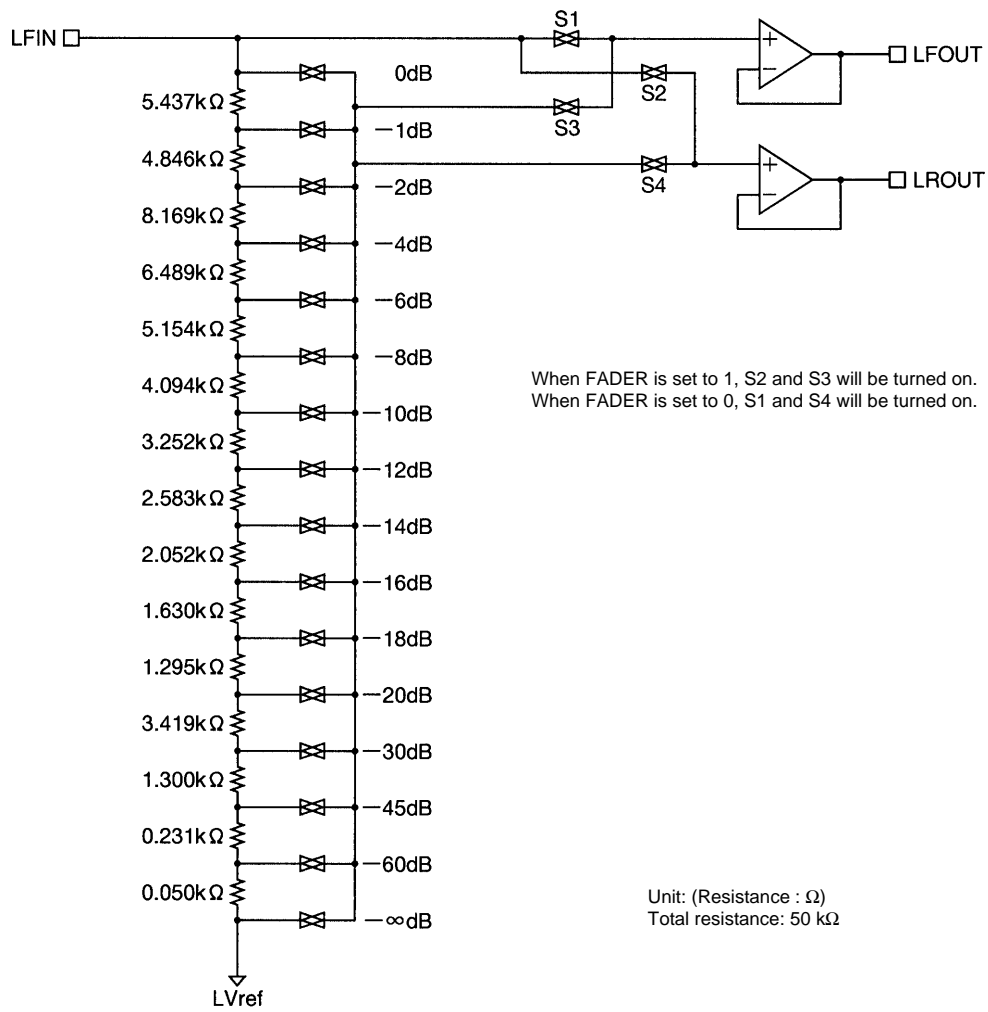


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Unit: (Resistance : Ω)

LC75385NE-R

Fader Volume Control Block Equivalent Circuit

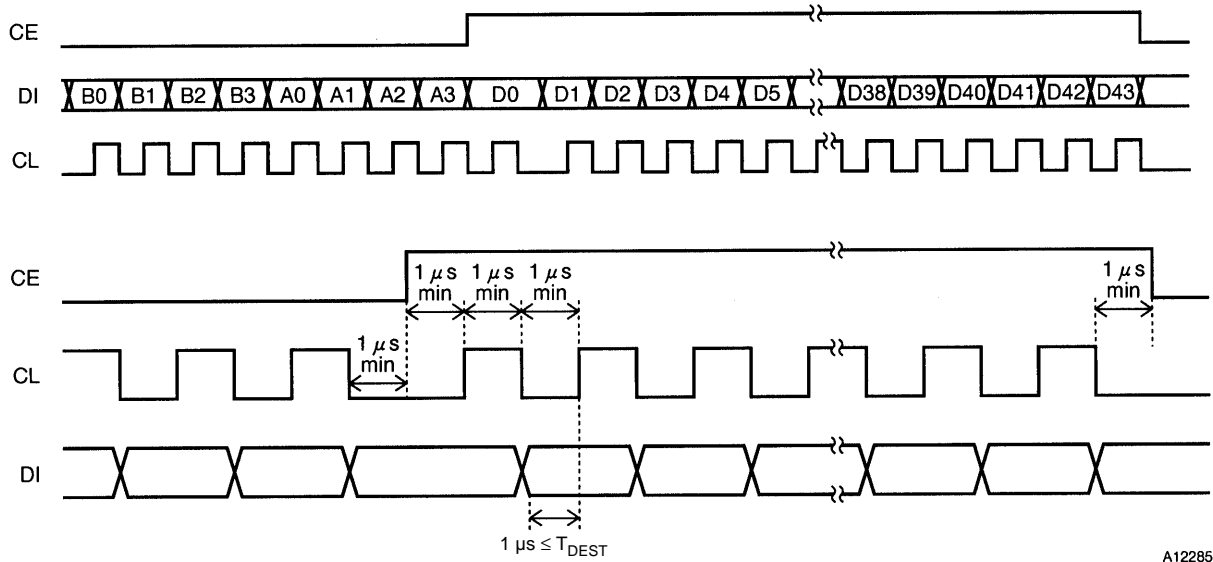


A12284

If data that sets the main volume control 1-dB step circuit to $-\infty$ is sent to the device, switches S1 and S2 will be opened (off) and switches S3 and S4 will be closed (on).

Control System Timing and Data Format

The LC75385NE-R is controlled by applying the stipulated data to the CL, DI, and CE pins. The data consists of a total of 52 bits, of which 8 bits are the device address and 44 bits are the actual control data.



A12285

• Address code (B0 to A3)

The LC75385NE-R has an 8-bit address code, and can be used along with other ICs that support the Sanyo CCB serial bus.

Address code

| | | | | | | | | | |
|-------|----|----|----|----|----|----|----|----|---------|
| (LSB) | B0 | B1 | B2 | B3 | A0 | A1 | A2 | A3 | (81HEX) |
| | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |

• Control code allocation

Input switching control

| | | | | |
|----|----|----|---------|--|
| D0 | D1 | D2 | | |
| 0 | 0 | 0 | L1 (R1) | |
| 1 | 0 | 0 | L2 (R2) | |
| 0 | 1 | 0 | L3 (R3) | |
| 1 | 1 | 0 | L4 (R4) | |
| 0 | 1 | 1 | | IC test values. These values must not be used during normal operation. |
| 1 | 1 | 1 | | |

| | |
|----|---|
| D3 | IC test bit. This bit must be set to 0 during normal operation. |
|----|---|

LC75385NE-R

Input gain control

| D4 | D5 | D6 | D7 | |
|----|----|----|----|-----------|
| 0 | 0 | 0 | 0 | 0 dB |
| 1 | 0 | 0 | 0 | +1.25 dB |
| 0 | 1 | 0 | 0 | +2.50 dB |
| 1 | 1 | 0 | 0 | +3.75 dB |
| 0 | 0 | 1 | 0 | +5.00 dB |
| 1 | 0 | 1 | 0 | +6.25 dB |
| 0 | 1 | 1 | 0 | +7.50 dB |
| 1 | 1 | 1 | 0 | +8.75 dB |
| 0 | 0 | 0 | 1 | +10.0 dB |
| 1 | 0 | 0 | 1 | +11.25 dB |
| 0 | 1 | 0 | 1 | +12.5 dB |
| 1 | 1 | 0 | 1 | +13.75 dB |
| 0 | 0 | 1 | 1 | +15.0 dB |
| 1 | 0 | 1 | 1 | +16.25 dB |
| 0 | 1 | 1 | 1 | +17.5 dB |
| 1 | 1 | 1 | 1 | +18.75 dB |

LC75385NE-R

Volume Control

| D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 | |
|----|----|-----|-----|-----|-----|-----|-----|-----------|
| | | | | | | | | 1 dB STEP |
| 0 | | | | | | | | 0 dB |
| 1 | | | | | | | | -1 dB |
| | | | | | | | | 2 dB STEP |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 dB |
| | 1 | 0 | 0 | 0 | 0 | 0 | 0 | -2 dB |
| | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -4 dB |
| | 1 | 1 | 0 | 0 | 0 | 0 | 0 | -6 dB |
| | 0 | 0 | 1 | 0 | 0 | 0 | 0 | -8 dB |
| | 1 | 0 | 1 | 0 | 0 | 0 | 0 | -10 dB |
| | 0 | 1 | 1 | 0 | 0 | 0 | 0 | -12 dB |
| | 1 | 1 | 1 | 0 | 0 | 0 | 0 | -14 dB |
| | 0 | 0 | 0 | 1 | 0 | 0 | 0 | -16 dB |
| | 1 | 0 | 0 | 1 | 0 | 0 | 0 | -18 dB |
| | 0 | 1 | 0 | 1 | 0 | 0 | 0 | -20 dB |
| | 1 | 1 | 0 | 1 | 0 | 0 | 0 | -22 dB |
| | 0 | 0 | 1 | 1 | 0 | 0 | 0 | -24 dB |
| | 1 | 0 | 1 | 1 | 0 | 0 | 0 | -26 dB |
| | 0 | 1 | 1 | 1 | 0 | 0 | 0 | -28 dB |
| | 1 | 1 | 1 | 1 | 0 | 0 | 0 | -30 dB |
| | 0 | 0 | 0 | 0 | 1 | 0 | 0 | -32 dB |
| | 1 | 0 | 0 | 0 | 1 | 0 | 0 | -34 dB |
| | 0 | 1 | 0 | 0 | 1 | 0 | 0 | -36 dB |
| | 1 | 1 | 0 | 0 | 1 | 0 | 0 | -38 dB |
| | 0 | 0 | 1 | 0 | 1 | 0 | 0 | -40 dB |
| | 1 | 0 | 1 | 0 | 1 | 0 | 0 | -42 dB |
| | 0 | 1 | 1 | 0 | 1 | 0 | 0 | -44 dB |
| | 1 | 1 | 1 | 0 | 1 | 0 | 0 | -46 dB |
| | 0 | 0 | 0 | 1 | 1 | 0 | 0 | -48 dB |
| | 1 | 0 | 0 | 1 | 1 | 0 | 0 | -50 dB |
| | 0 | 1 | 0 | 1 | 1 | 0 | 0 | -52 dB |
| | 1 | 1 | 0 | 1 | 1 | 0 | 0 | -54 dB |
| | 0 | 0 | 1 | 1 | 1 | 0 | 0 | -56 dB |
| | 1 | 0 | 1 | 1 | 1 | 0 | 0 | -58 dB |
| | 0 | 1 | 1 | 1 | 1 | 0 | 0 | -60 dB |
| | 1 | 1 | 1 | 1 | 1 | 0 | 0 | -62 dB |
| | 0 | 0 | 0 | 0 | 0 | 1 | 0 | -64 dB |
| | 1 | 0 | 0 | 0 | 0 | 1 | 0 | -66 dB |
| | 0 | 1 | 0 | 0 | 0 | 1 | 0 | -68 dB |
| | 1 | 1 | 0 | 0 | 0 | 1 | 0 | -70 dB |
| | 0 | 0 | 1 | 0 | 0 | 1 | 0 | -72 dB |
| | 1 | 0 | 1 | 0 | 0 | 1 | 0 | -74 dB |
| | 0 | 1 | 1 | 0 | 0 | 1 | 0 | -76 dB |
| | 1 | 1 | 1 | 0 | 0 | 1 | 0 | -78 dB |
| | | | | | | | | MUTE |
| | 1 | 1 | 1 | 1 | 1 | 1 | 0 | ∞ |
| | 0 | 1 | 1 | 1 | 1 | 1 | 0 | INMUTE |

Tone Control

| D16 | D17 | D18 | D19 | Bass |
|-----|-----|-----|-----|--------|
| D24 | D25 | D26 | D27 | Treble |
| 0 | 1 | 1 | 0 | +12 dB |
| 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 |
| 0 | 1 | 1 | 1 | -12 dB |

| D20 | D21 | D22 | D23 | |
|-----|-----|-----|-----|-----------------------------|
| 0 | 0 | 0 | 0 | These bits must be set to 0 |

Fader Volume Control

| D28 | D29 | D30 | D31 | |
|-----|-----|-----|-----|--------|
| 0 | 0 | 0 | 0 | 0 dB |
| 1 | 0 | 0 | 0 | -1 dB |
| 0 | 1 | 0 | 0 | -2 dB |
| 1 | 1 | 0 | 0 | -4 dB |
| 0 | 0 | 1 | 0 | -6 dB |
| 1 | 0 | 1 | 0 | -8 dB |
| 0 | 1 | 1 | 0 | -10 dB |
| 1 | 1 | 1 | 0 | -12 dB |
| 0 | 0 | 0 | 1 | -14 dB |
| 1 | 0 | 0 | 1 | -16 dB |
| 0 | 1 | 0 | 1 | -18 dB |
| 1 | 1 | 0 | 1 | -20 dB |
| 0 | 0 | 1 | 1 | -30 dB |
| 1 | 0 | 1 | 1 | -45 dB |
| 0 | 1 | 1 | 1 | -60 dB |
| 1 | 1 | 1 | 1 | -∞ |

Channel Selection Control

| D32 | D33 | |
|-----|-----|--|
| 0 | 0 | Left and right together. This is the mode set up initially |
| 1 | 0 | RCH |
| 0 | 1 | LCH |
| 1 | 1 | Left and right together |

Fader Rear/Front Control

| D34 | |
|-----|-------|
| 0 | Rear |
| 1 | Front |

Loudness Control

| | |
|-----|-----|
| D35 | |
| 0 | off |
| 1 | on |

Zero Cross Control

| | | |
|-----|-----|---|
| D36 | D37 | |
| 0 | 0 | Data is written when a zero cross is detected |
| 1 | 1 | The zero cross detection operation is disabled and data is written on the falling edge of the CE signal |

Zero Cross Signal Detection Block Control

| | | | | |
|-----|-----|-----|-----|----------|
| D38 | D39 | D40 | D41 | |
| 0 | 0 | 0 | 0 | Selector |
| 1 | 0 | 0 | 0 | Volume |
| 0 | 1 | 0 | 0 | Tone |
| 1 | 1 | 0 | 0 | Feder |

Test Mode Control

| | | |
|-----|-----|--|
| D42 | D43 | |
| 0 | 0 | These IC test mode control bits must be set to 0 |

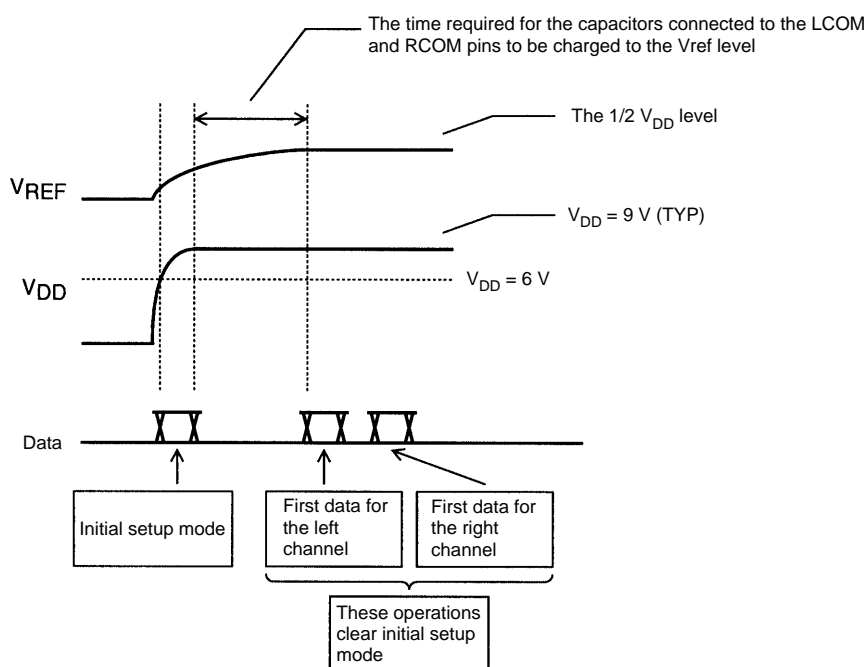
Usage Notes

Data Transmission after Power Is First Applied

- When power is first applied, the state of the internal analog switches will be undefined. Applications that use this IC must include external circuits to provide muting until control data has been transferred to the IC.
- After power is first applied, applications should send initial setup data to stabilize the bias levels in each of the IC circuit blocks in a short time.

1. The time between initial setup mode and the first actual data settings

- Applications should send the initial setup data as soon as V_{DD} rises above 6 V.
- After the LCOM and RCOM pins have stabilized at the V_{ref} level, applications should send the first data settings.



A12286

2. Procedure for setting up initial setup mode

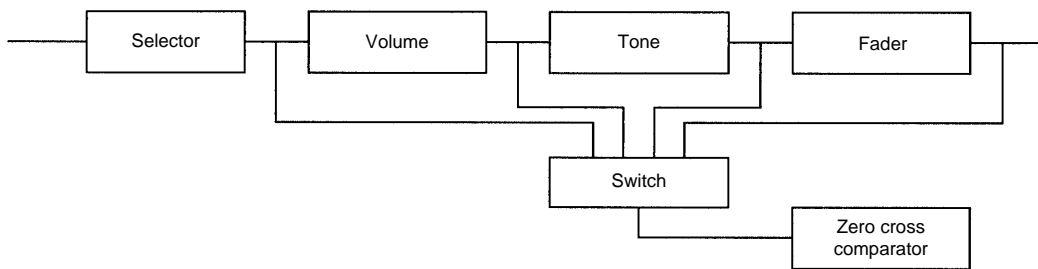
- When D32 and D33 are set to 00, the IC's internal initial setup switch is turned on and the IC goes to quick charge mode. At this time the other data (D0 to D31 and D34 to D43) will also be set up for the left and right channels at the same time. This means that applications can set up the states of the various blocks at the same time as specifying initial setup mode.

3. Procedure for clearing initial setup mode

- Initial setup mode is cleared by setting D32 and D33 to any value other than 00. In other words, any normal left or right channel specification will turn the internal initial setup switch off and clear quick charge mode.

Zero Cross Switching Circuit Operating Principles

- The LC75385NE-R includes a function for switching the place where the zero cross comparator operates and thus allows applications to select the optimal detection location for the block for which the control data is updated. Basically, switching noise will be minimized if the signal immediately following the block for which the control data is updated is input to the zero cross comparator. Thus the detection location must be changed for each data update operation. Another issue is the point that if the signal amplitude is lower than the detection sensitivity (a few mV rms) of the zero cross comparator (for example if the volume is set to a low level), the switching noise can be minimized further by selecting a point before the volume control block, namely the selector block output, as the zero cross detection point than by simply waiting for the data write to occur due to the overflow of the zero cross timer. For example, if the volume block input is 1 V rms, and the volume is set to -40 dB or lower, the output will be under 10 mV rms. In this case, detecting at the selector output block will result in lower switching noise.



A12287

Zero Cross Detection Circuit

Zero Cross Switching Control Procedure

- The zero cross switching control procedure consists of first setting the zero cross detection mode with the zero cross control bits (D36 and D37 = 0) and then, after specifying the detection block (with bits D38, D39, D40, and D41), sending the control data. Since these control bits are latched first immediately after the data is sent, i.e. on the falling edge of the CE signal, it is possible to both set the IC mode as well as specify zero cross switching operation in a single data transfer, even when updating the volume and other data. The following presents an example of the control operation when updating the volume block data.

| D36 | D37 | D38 | D39 | D40 | D41 |
|-----|-----|-----|-----|-----|-----|
| 0 | 0 | 1 | 0 | 0 | 0 |

Zero cross detection mode specification
Volume block setting

Zero Cross Timer Setting

- When the input signal has a level lower than the sensitivity of the zero cross comparator, or consists only of extremely low frequencies, the zero cross detection circuit will remain in the state in which it cannot detect a zero cross and the data will not be latched during that period. The zero cross timer specifies a time after which the data will be latched forcibly in states where a zero crossing cannot be detected. The time is determined by the lowest frequency for which a zero cross can be detected reliably.

For example, if the timer is set to 25 ms:

$$T = 0.69 CR$$

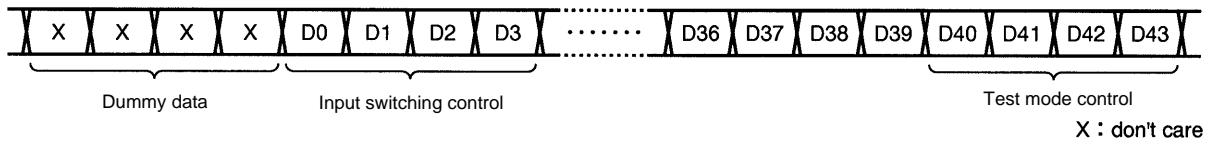
If C is taken to be 0.033 μF, then R will be:

$$R = \frac{25 \times 10^{-3}}{0.69 \times 0.033 \times 10^{-6}} \approx 1.1 \text{ M}\Omega$$

Notes on Serial Data Transfer

- The CL, DI, and CE pin signal lines must be covered (and thus shielded) by the ground pattern or formed from shielded cable to prevent the high-frequency digital signals on those lines from entering the analog system.
- The LC75385NE-R data format consists of 8 bits of address and 44 bits of data. When the data is sent in units of 8 bits each (i.e. 48 bits are actually sent), use the data transfer technique shown in figure 1.

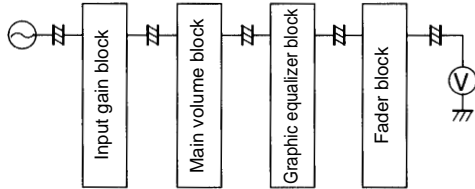
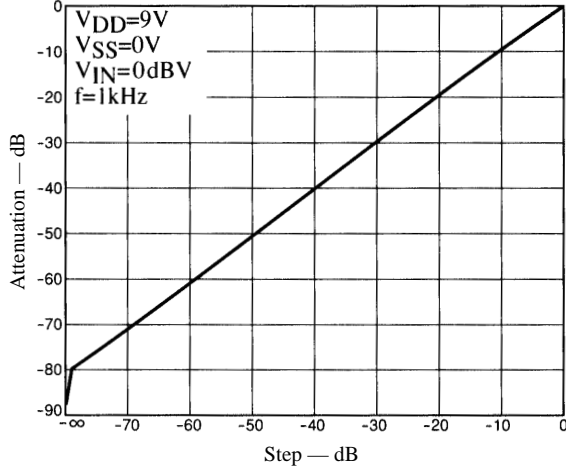
LC75385NE-R data reception in 8-bit units



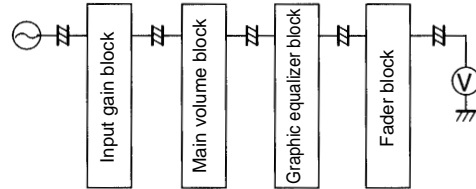
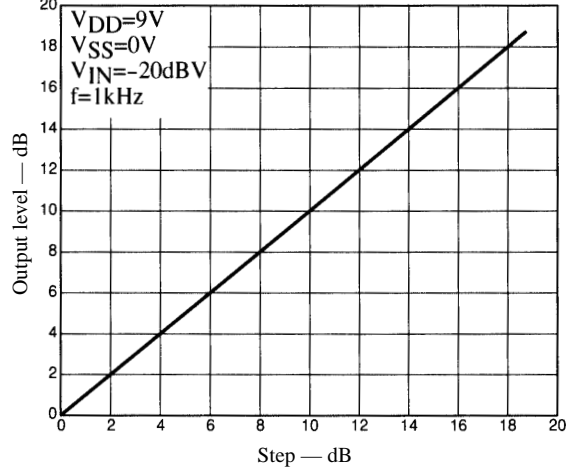
A12288

- During CCB transfers, this IC detects address matches on the rising edge of the CE signal. Therefore, applications must set the CL signal low and then set it high at this time.

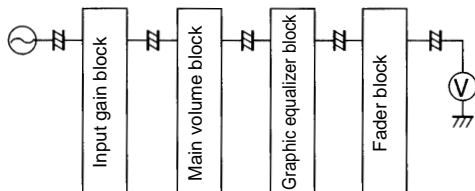
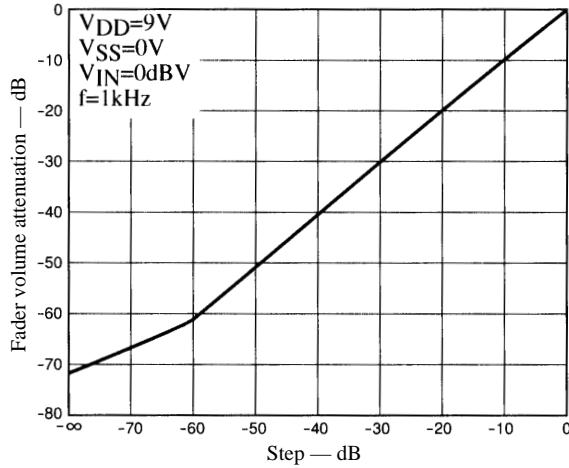
Main Volume Step Characteristics



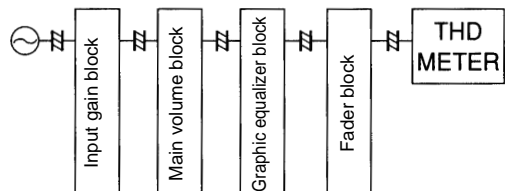
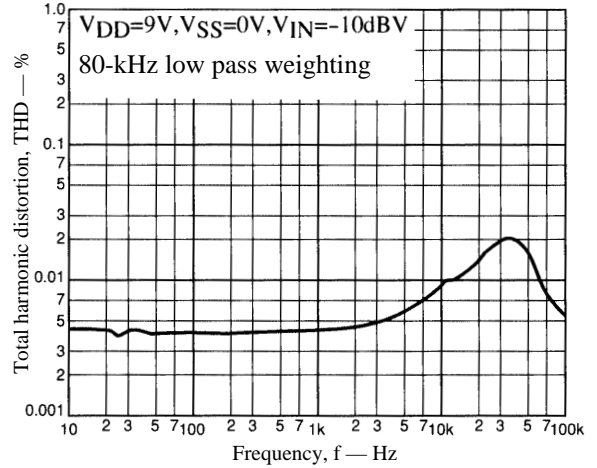
Gain Step Characteristics



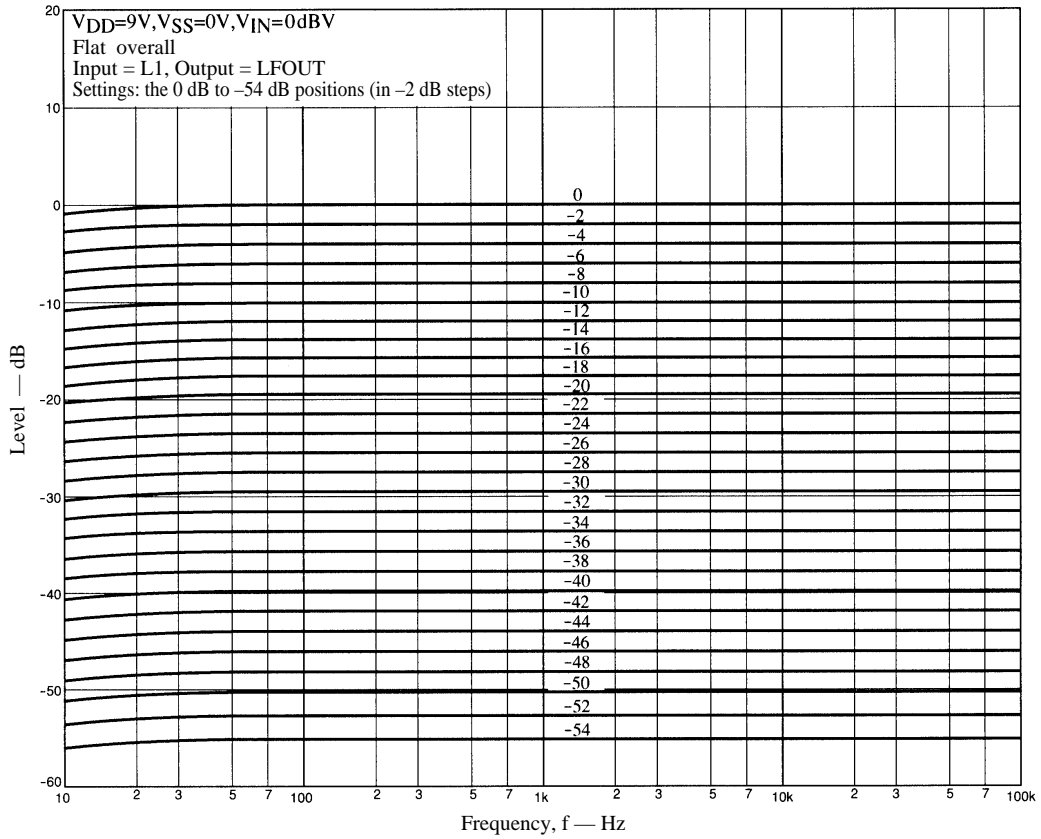
Fader Volume Step Characteristics



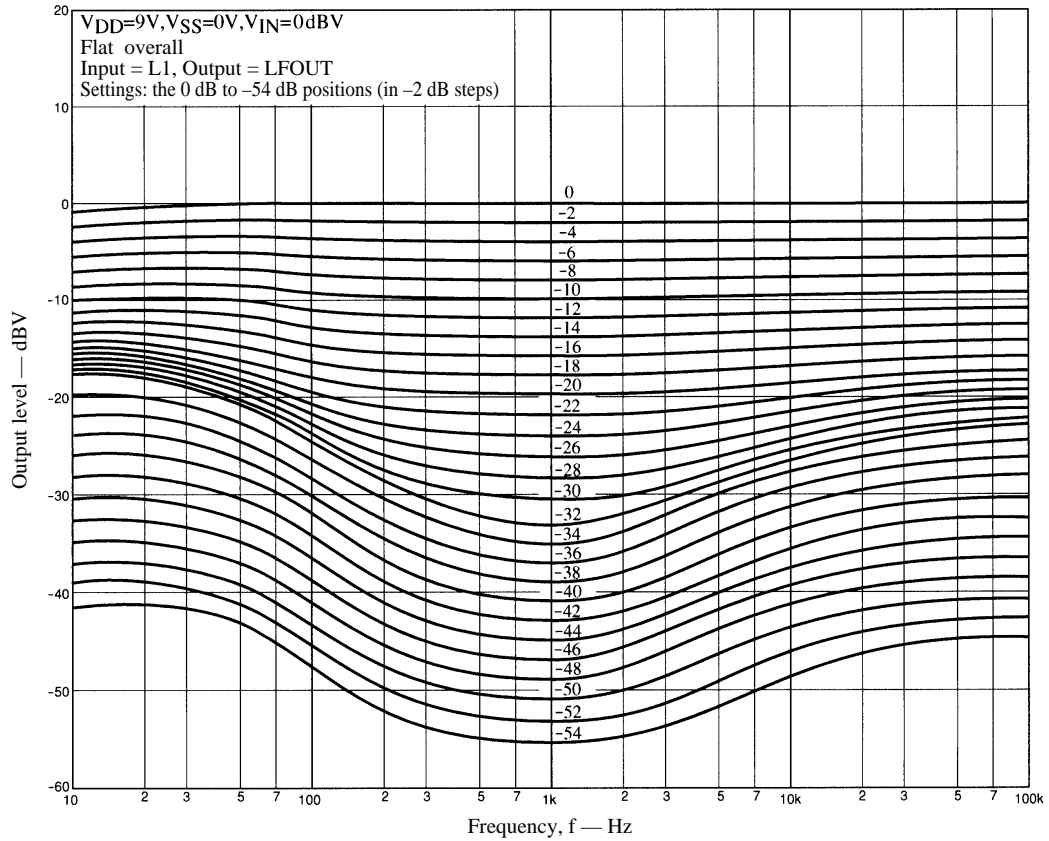
THD – Frequency Characteristics



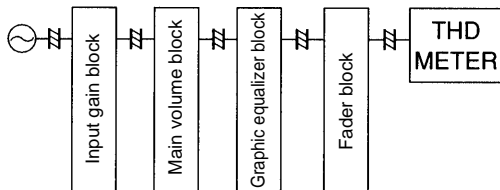
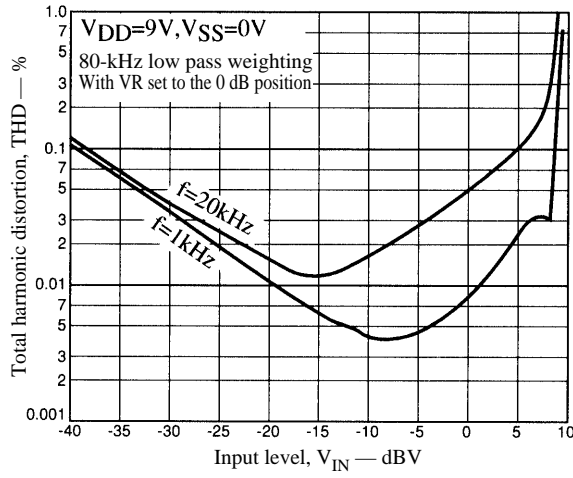
Output Level Characteristics



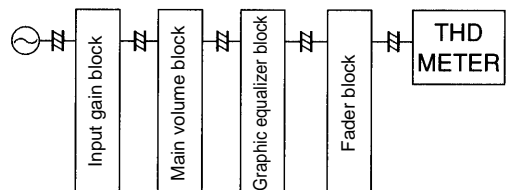
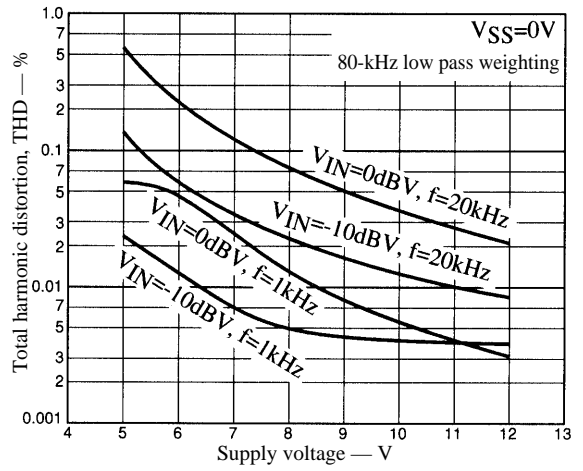
Loudness Characteristics



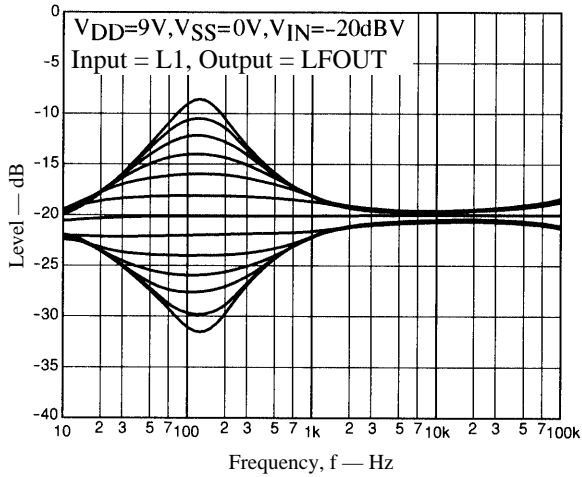
THD – Input Level Characteristics



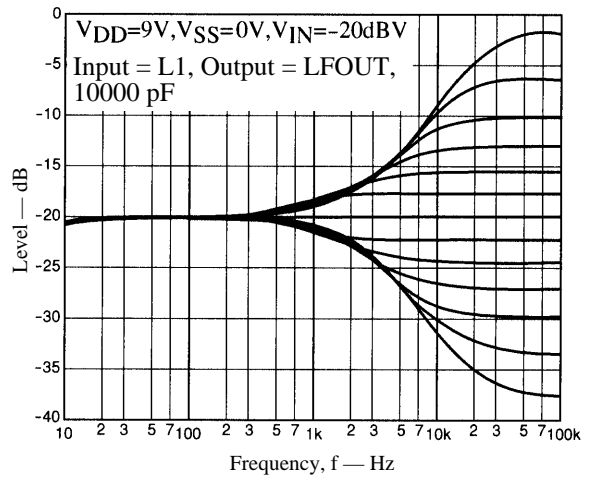
THD – Supply Voltage Characteristics



Bass Control Characteristics



Treble Control Characteristics



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