Ordering number : ENN6868

CMOS IC

LC75345M

Electronic Volume Control System on-Chip

Overview

The LC75345M is an electronic volume system that can control the volume, balance, 2-band equalizer, super bass, and input switching functions by serial data input.

Functions

- Volume: 0 dB to –78 dB (1-dB step) and –∞ (64 positions)
  0 dB to –50 dB (1-dB step), –50 dB to –70 dB (2-dB step), –70-dB to –78 dB (4-dB step)
  Balance function with separate L/R control
- Treble: ±10-dB control in 2-dB steps is possible. Shelving characteristic.
- Bass: ±10-dB control in 2-dB steps is possible. Peaking characteristics.
- Super bass: +10-dB control in 2-dB steps is possible. Peaking characteristics.
- Selector: 5 input signals can be selected both for L and R
- Input gain: 0 dB to +30 dB (2-dB step) amplification is possible for the input signal.
- General-purpose amp (ATT): 2 on-chip general-purpose amplifiers

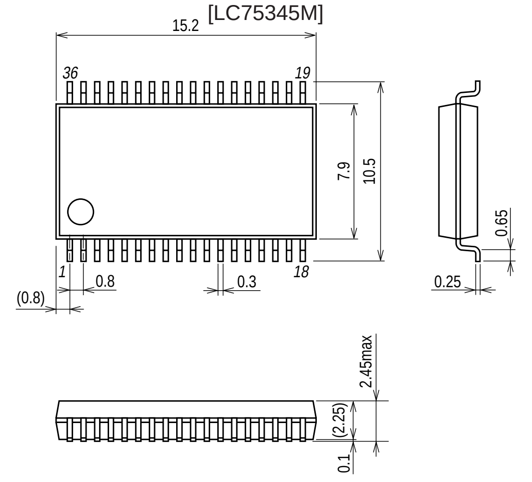
Features

- On-chip buffer amplifier cuts down number of external components
- Low switching noise generated by on-chip switch due to use of silicon gate CMOS process
- On-chip reference voltage circuit for analog ground
- Controls performed with serial data input (CCB)

Package Dimensions

unit: mm

3263-MFP36SDJ (375 mil)

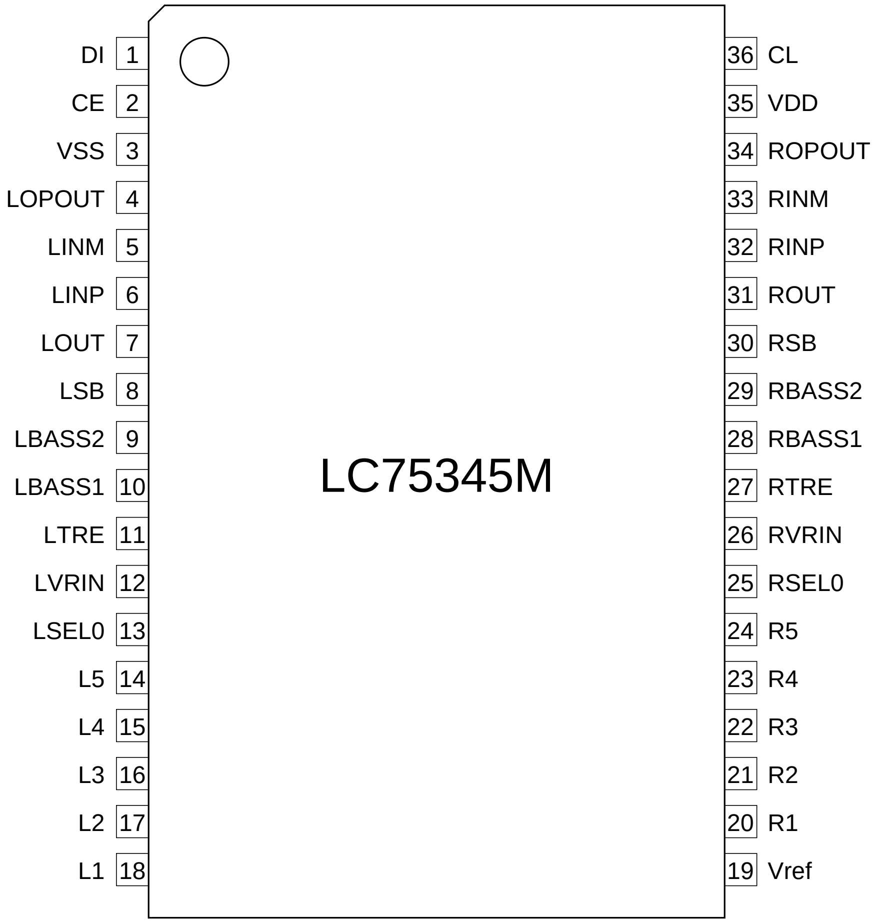


SANYO: MFP36SDJ (375 mil)

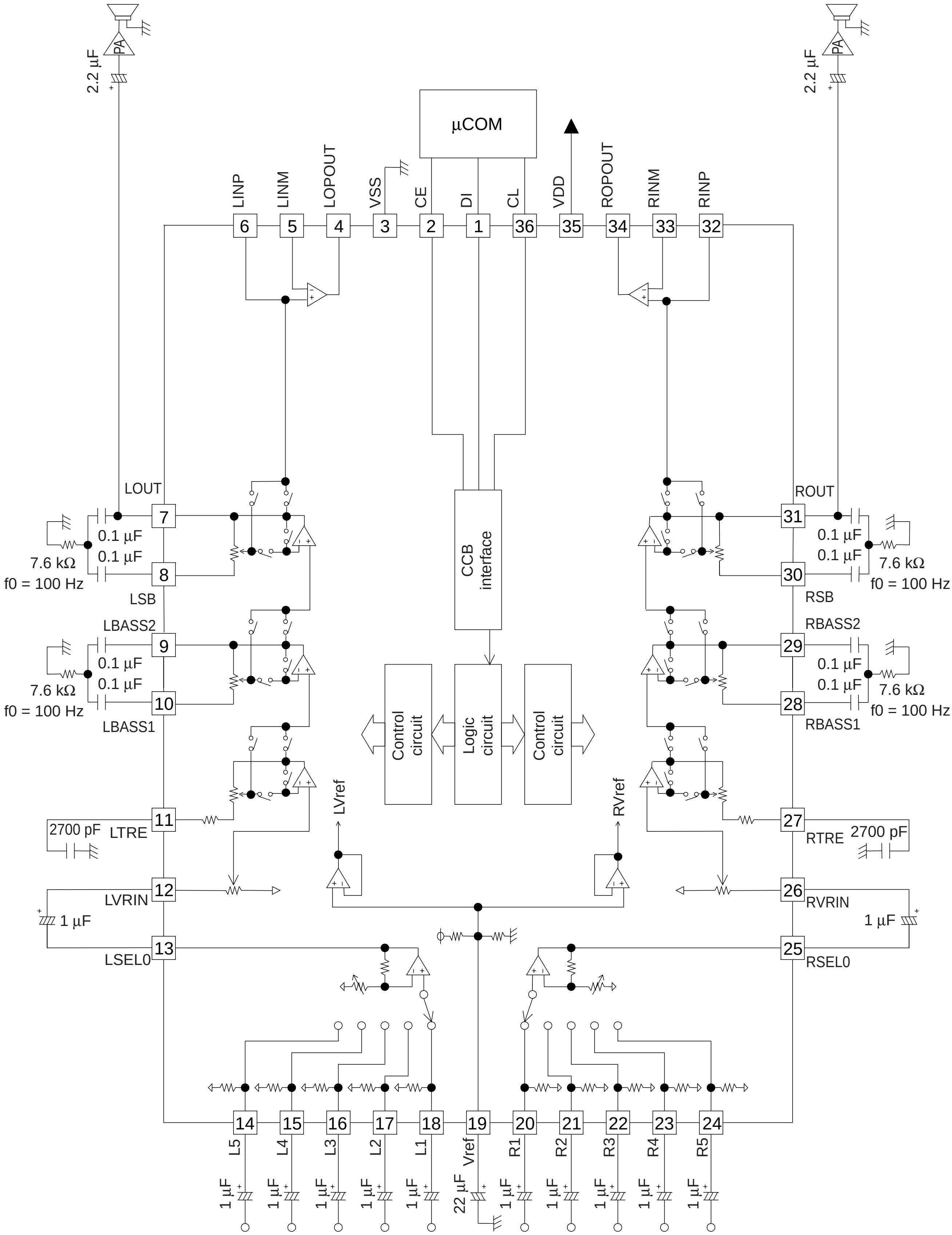
- **CCB is a trademark of SANYO ELECTRIC CO., LTD.**
- **CCB is SANYO's original bus format and all the bus addresses are controlled by SANYO.**

SANYO Electric Co.,Ltd. Semiconductor Company
TOKYO OFFICE Tokyo Bldg., 1-10, 1 Chome, Ueno, Taito-ku, TOKYO, 110-8534 JAPAN

Pin Assignment



Sample Application Circuit



Note: When a general-purpose amp is not used, leave the LINP (RINP) open and connect the LINM (RINM) with the LOPOUT (ROPOUT).

Specifications

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

Parameter	Symbol	Pin Name	Conditions	Ratings	Unit
Maximum supply voltage	V_{DD} max	V_{DD}		10.5	V
Maximum input voltage	V_{IN} max	CE, DI, CL		–0.3 to 10.5	V
		L1 to L5, R1 to R5, LVRIN, RVRIN, LINP, RINP, LINM, RINM		V_{SS} – 0.3 to V_{DD} + 0.3	V
Allowable power dissipation	Pdmax		*1 Ta ≤75°C, independent IC	520	mW
Operating temperature	Topr			–30 to +75	°C
Storage temperature	Tstg			–40 to +125	°C

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

Parameter	Symbol	Pin Name	Conditions	Ratings			Unit
				min	typ	max	
Supply voltage	V_{DD}	V_{DD}		4.5		9	V
Input high-level voltage	V_{IH}	CL, DI, CE		2.0		9	V
Input low-level voltage	V_{IL}	CL, DI, CE	7.5 ≤ V_{DD} ≤ 9	V_{SS}		0.8	V
			4.5 ≤ V_{DD} ≤ 7.5	V_{SS}		0.3	
Input amplitude voltage	V_{IN}	L1 to L5, R1 to R5, LVRIN, RVRIN, LINP, RINP, LINM, RINM		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} = 8 V, V_{SS} = 0 V

Input block

Parameter	Symbol	Pin Name	Conditions	Ratings			Unit
				min	typ	max	
Maximum input gain	Ginmax				+30		dB
Step resolution	Gstep				+2		dB
Input resistance	Rin	L1, L2, L3, L4, L5 R1, R2, R3, R4, R5			50		kΩ
Clipping level	Vcl	LSEL0, RSEL0	THD = 1.0%, f = 1 kHz		2.50		Vrms
Output load resistance	Rl	LSEL0, RSEL0		10			kΩ

Volume block

Parameter	Symbol	Pin Name	Conditions	Ratings			Unit
				min	typ	max	
Input resistance	Rin	LIN, RIN			50		kΩ

Treble band equalizer control block

Parameter	Symbol	Pin Name	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

Bass band equalizer control block

Parameter	Symbol	Pin Name	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				33.1		kΩ

Super bass band equalizer control block

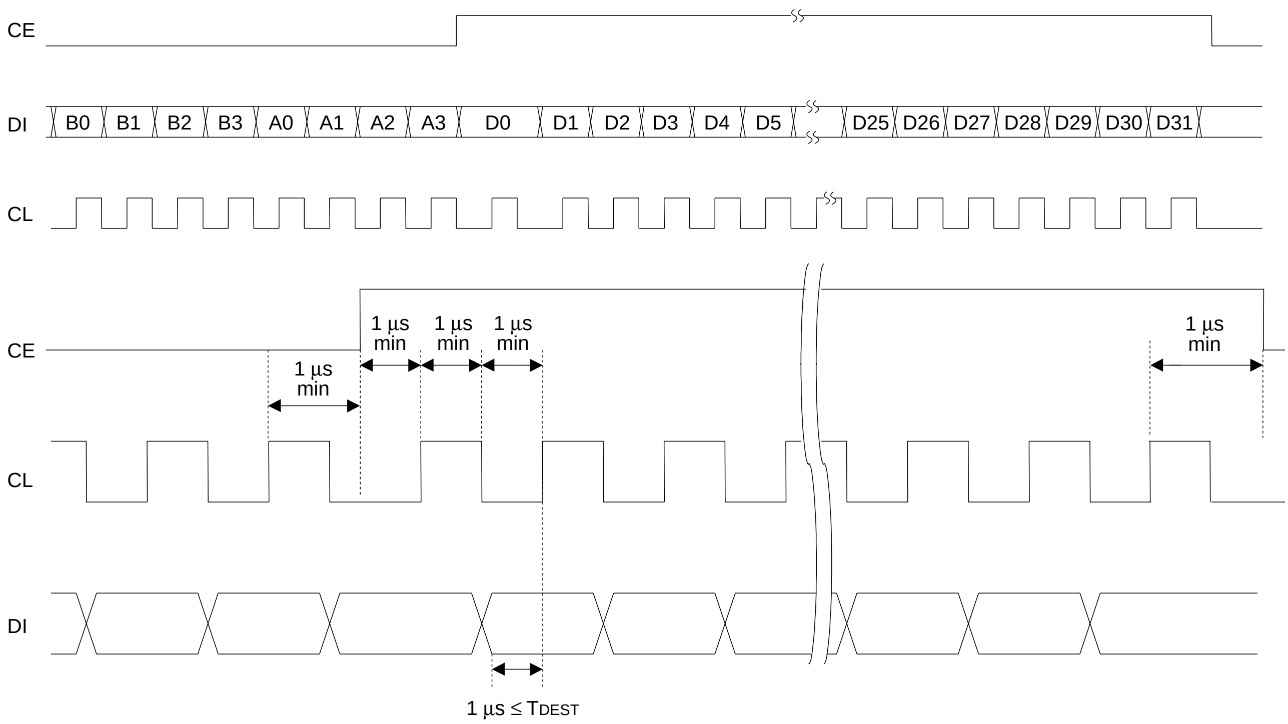
Parameter	Symbol	Pin Name	Conditions	Ratings			Unit
				min	typ	max	
Control range	Geq		max. boost	+8	+10	+12	dB
Step resolution	Estep			1	2	3	dB
Internal feedback resistance	Rfeed				33.1		kΩ

General

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Total harmonic distortion	THD	V_{IN} = 1 Vrms, f = 1 KHz, total flat overall			0.01	%
Crosstalk	CT	V_{IN} = 1 Vrms, f = 1 KHz, Rg = 1 kΩ, total flat overall	80			dB
Output noise voltage	VN	Flat overall, 80 kHz L.P.F	9.3		µV	
Maximum attenuated output	Vomin	Flat overall, f = 1 kHz		–90		dB
Current drain	I_{DD}	V_{DD} – V_{SS} = +9 V		40		mA
Input high-level current	I_{IH}	CL, DI, CE: V_{IN} = 9 V			10	µA
Input low-level current	I_{IL}	CL, DI, CE: V_{IN} = 0 V	–10			µA

Control Timing and Data Format

To control the LC75345M, input specified serial data to the CL, DI, and CE pins. The data configuration consists of a total of 40 bits broken down into 8 address bits and 32 data bits.



• Address Code (B0 to A3)

The LC75345M has an 8-bit address code and common specifications with a SANYO serial bus CCB IC are possible.

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, L5, R1, R2, R3, R4, R5)

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	L5 (R5) on
1	0	1	0	Analog ground connection
0	1	1	0	Test mode Must not be used in normal operation.
1	1	1	0	

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

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D8	D9	D10	D11	D12	D13	Operation
1	1	0	0	1	1	–52 dB
0	0	1	0	1	1	–54 dB
1	0	1	0	1	1	–56 dB
0	1	1	0	1	1	–58 dB
1	1	1	0	1	1	–60 dB
0	0	0	1	1	1	–62 dB
1	0	0	1	1	1	–64 dB
0	1	0	1	1	1	–66 dB
1	1	0	1	1	1	–68 dB
0	0	1	1	1	1	–70 dB
1	0	1	1	1	1	–74 dB
0	1	1	1	1	1	–78 dB
1	1	1	1	1	1	–∞ dB

Channel selection

D14	D15	Operation
1	0	Right channel
0	1	Left channel
1	1	L/R simultaneous

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	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

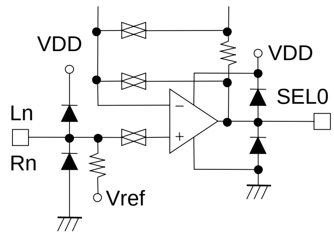
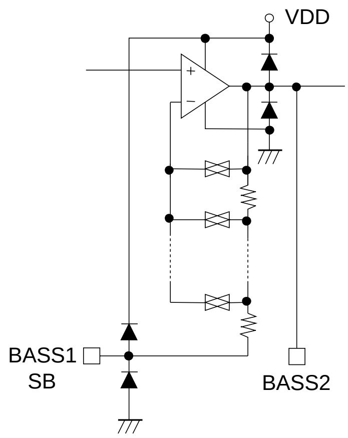
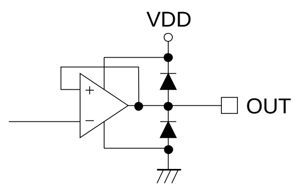
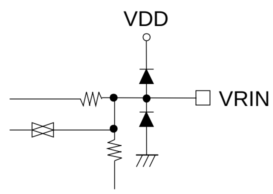
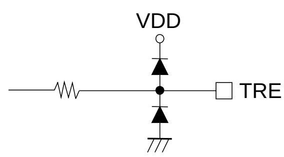
Super bass control

D24	D25	D26	D27	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

D28 to D31 test mode
(Fixed to 0)

D28	D29	D30	D31	Operation
0	0	0	0	

Pin Functions

Pin No.	Pin Name	Function	Equivalent circuit
18 17 16 15 14 20 21 22 23 24	L1 L2 L3 L4 L5 R1 R2 R3 R4 R5	• Input signal pins	
13 25	LSEL0 RSEL0	• Input selector output pins	
10 9 28 29 8 30	LBASS1 LBASS2 RBASS1 RBASS2 LSB RSB	• Capacitor and resistor connection pins for configuring filter, used for bass and super bass band	
7 31	LOUT ROUT	• ATT + equalizer output pins/Capacitor connection pins used to configure super bass filter	
12 26	LVRIN RVRIN	• Volume input pins	
11 27	LTRE RTRE	• Capacitor connection pins for configuring treble band filter	

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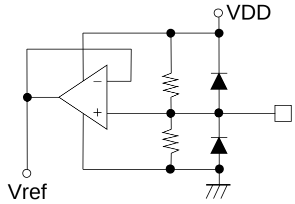
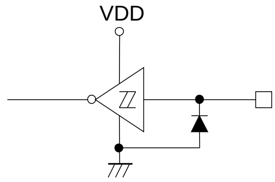
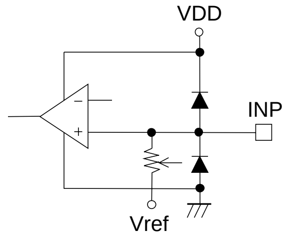
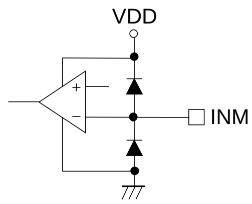
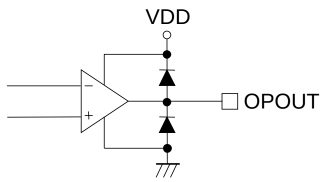
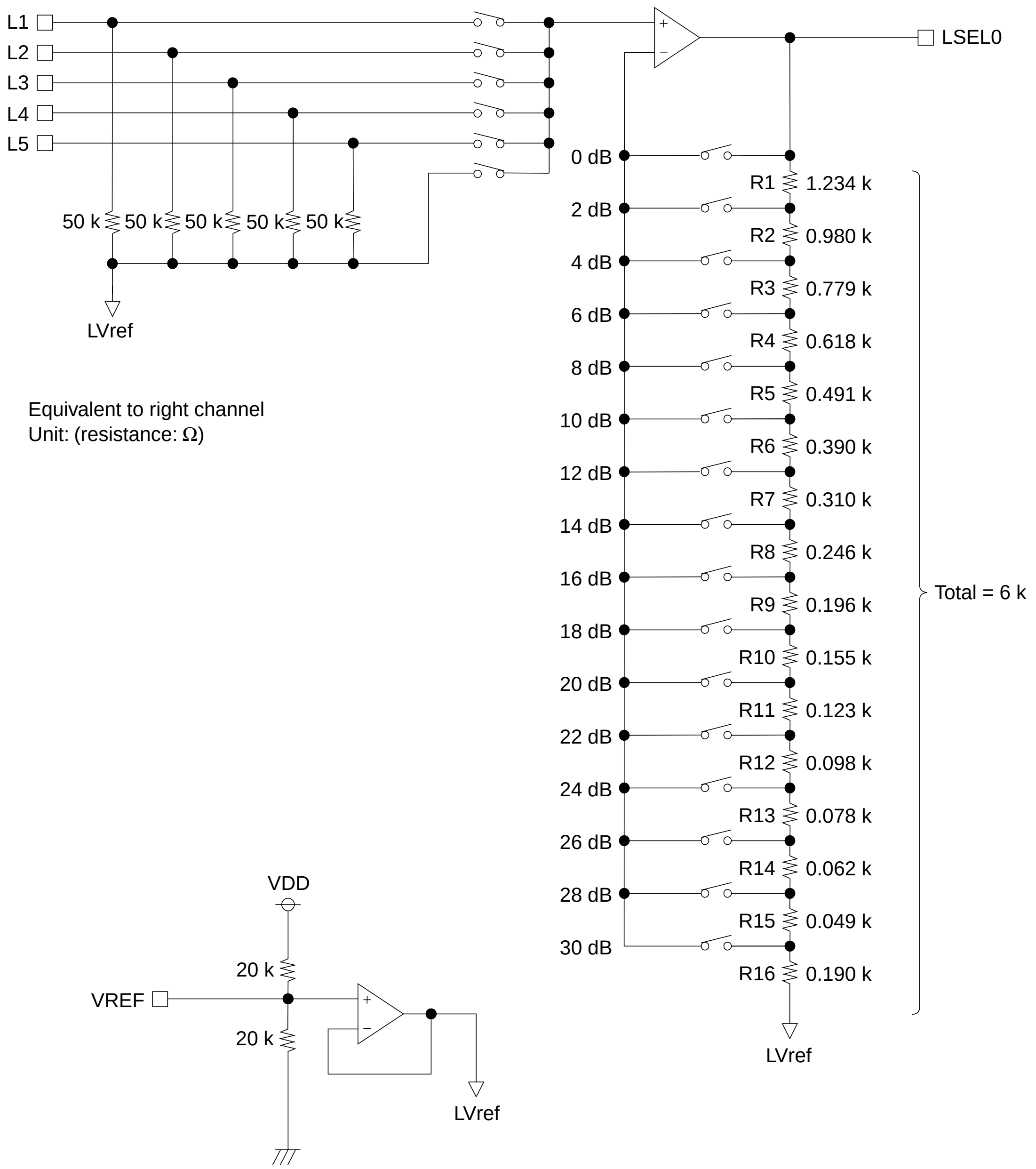
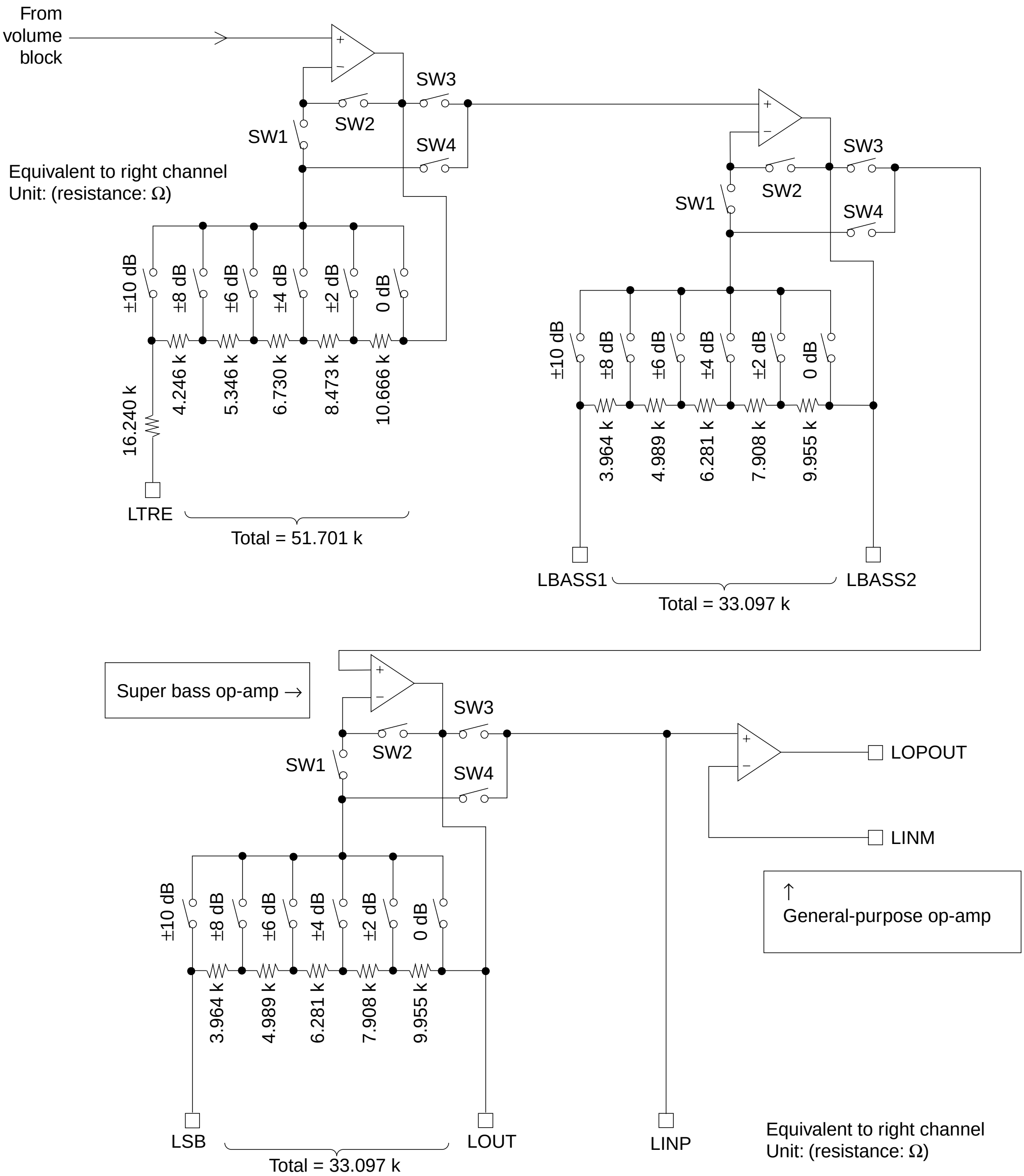
Pin No.	Pin Name	Function	Equivalent circuit
19	Vref	• Connect a capacitor of a few tens of µF between Vref and AV_{SS} (V_{SS}) as a analog ground 0.5 × V_{DD} voltage generator, current ripple countermeasure.	
3	V_{SS}	• Ground pin	
35	V_{DD}	• Power supply pin	
2	CE	• Chip enable pin Data is written to the internal latch and the analog switches are operated when the level changes from high to low. Data transfer is enabled when the level is high.	
1 36	DI CL	• Serial data pins and clock input pin for control	
6 32	LINP RINP	Non-inverted input pins of general-purpose op-amp When not used, leave open.	
5 33	LINM RINM	Inverted input pins of general-purpose op-amp. When not used, connect these pins to the L(R) OPOUT Pins. (Connected between pin 5 and pin 4) (Connected between pin 33 and pin 34)	
4 34	LOPOUT ROPOUT	General-purpose op-amp output pins. When not used, connect these pins to the L(R) INM pins. (Connected between pin 5 and pin 4) (Connected between pin 33 and pin 34)	

Equivalent Circuit

• Selector Block/Reference Voltage Generator



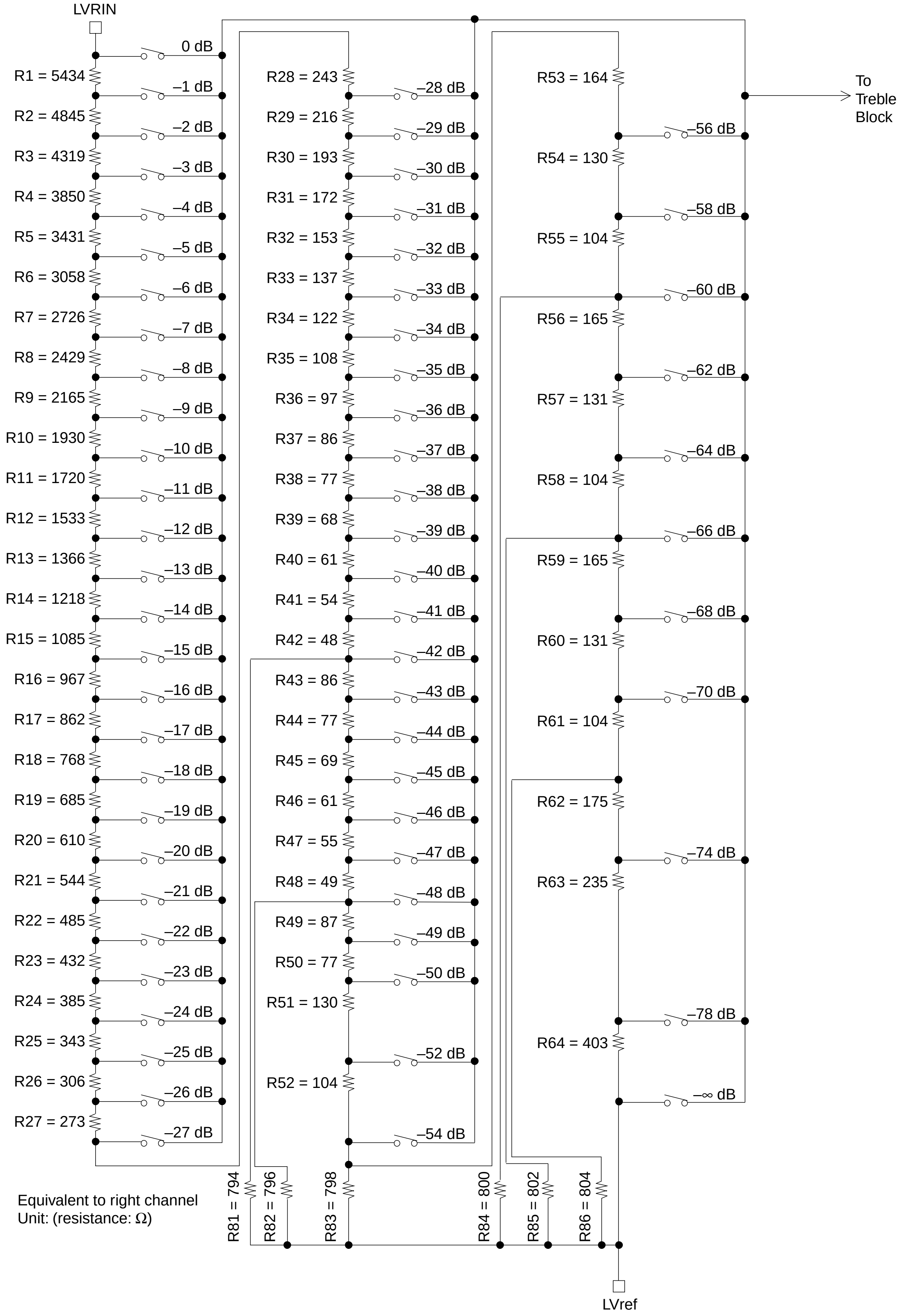
• Treble/Bass/Super Bass Band Multi-Purpose Op Amp



During boost, SW1 and SW3 are on, during cut, SW2 and SW4 are on, when 0 dB, 0dBSW and SW2 and SW3 are on.

SW3, SW4 of super bass block are always off.

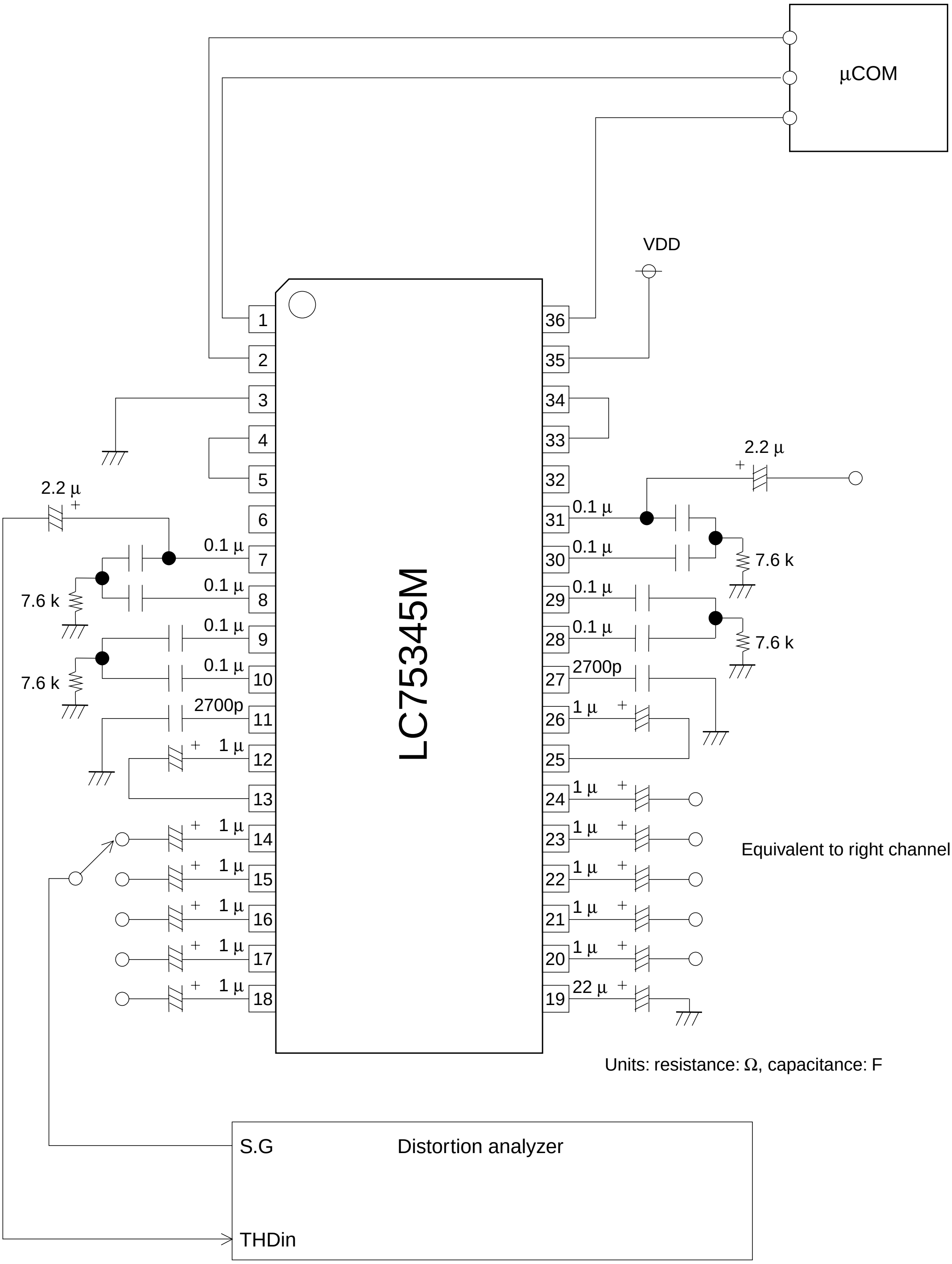
• Volume Block



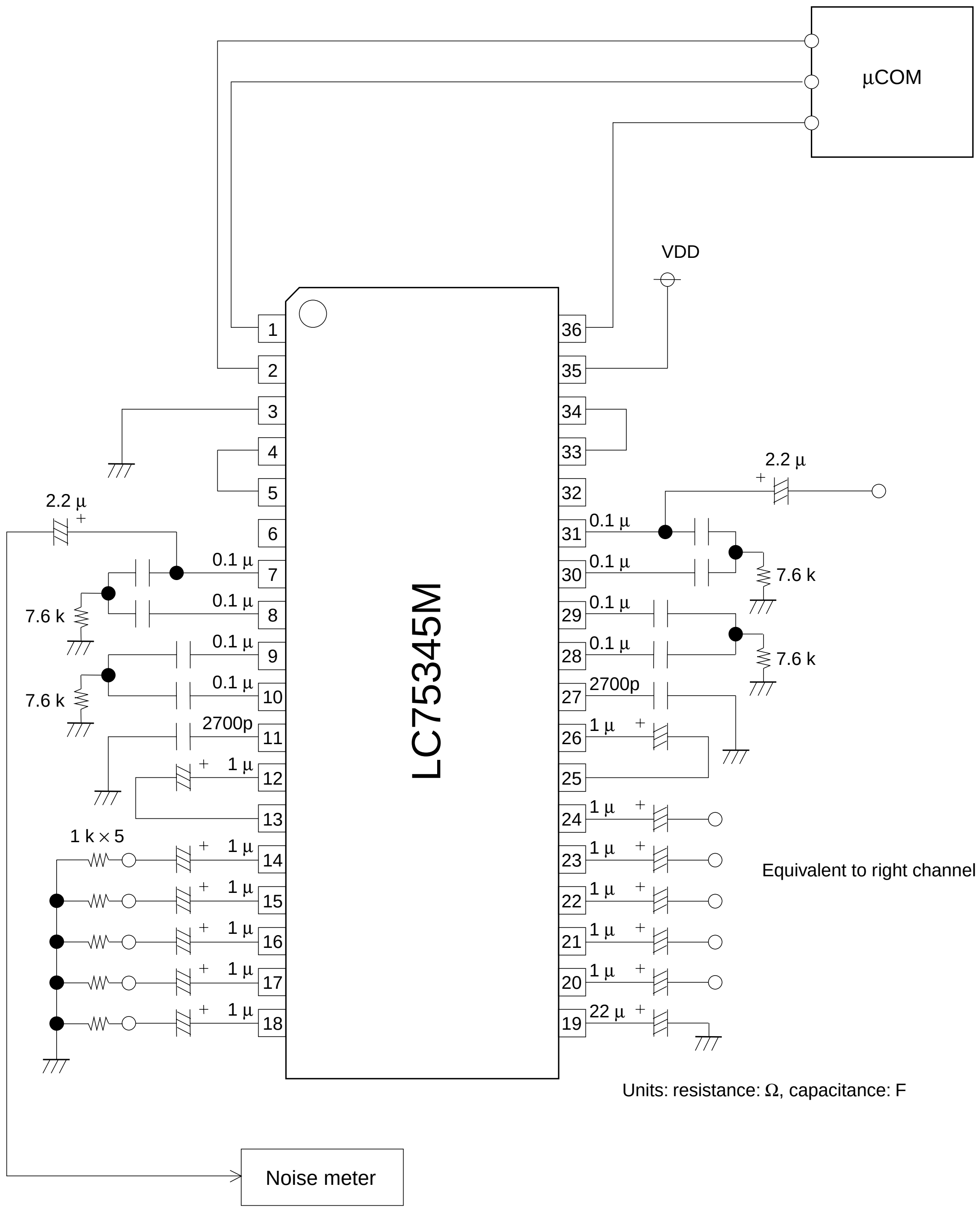
Equivalent to right channel
Unit: (resistance: Ω)

Test Circuit

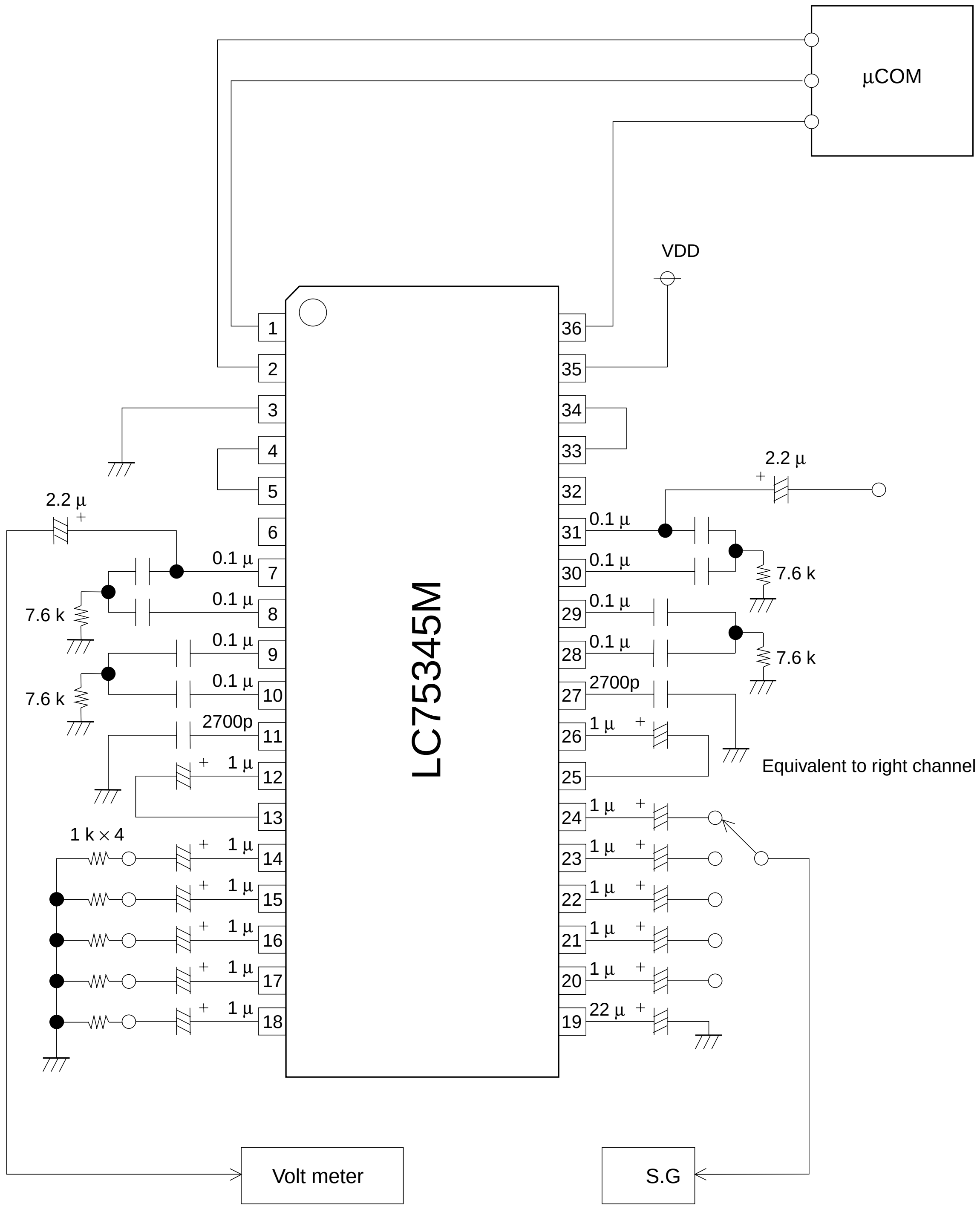
• Total Harmonic Distortion



• Output Noise Voltage



• Crosstalk



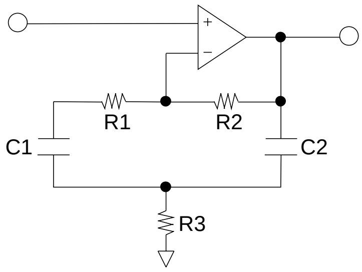
Units: resistance: Ω, capacitance: F

Calculation of External Equalizer Constant

Bass/Super Bass Circuit

The equivalent circuit and the formula for calculating the external RC with a mean frequency of 100 Hz are shown below.

- Bass/super bass band equivalent circuit block diagram



- Calculation example

Specification Mean frequency: f0 = 100 Hz
Gain during maximum boost: G = 10 dB
Using R1 = 0, R2 = 33.097 kΩ, and C1 = C2 = C,

We obtain R2 from G = 10 dB.

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

$$R3 = \frac{R2}{2\left(10^{G+10dB/20} - 1\right)} = \frac{33097}{2 \times (3.162 - 1)} \neq 7.6\ K\Omega$$

We obtain C from mean frequency f0 = 100 Hz.

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

$$C = \frac{1}{2\pi f0\sqrt{R3R2}} = \frac{1}{2\pi \times 100\sqrt{33097 \times 7600}} \neq 0.01\ \mu F$$

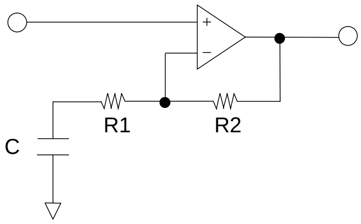
We obtain Q.

$$Q = \frac{R3R2}{2R3}\ \frac{1}{\sqrt{R3R2}} \neq 1.04$$

Treble Band Circuit

The shelving characteristics can be obtained for the treble band.

The equivalent circuit and calculation formula during boost are indicated below.



- Calculation example

Specification Set frequency: f = 26000 Hz

Gain during maximum boost: $G_{+10\ dB}$ = 10 dB

Using R1 = 16.240 kΩ and R2 = 35.461 kΩ, and inserting the above values in the following formula, we

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

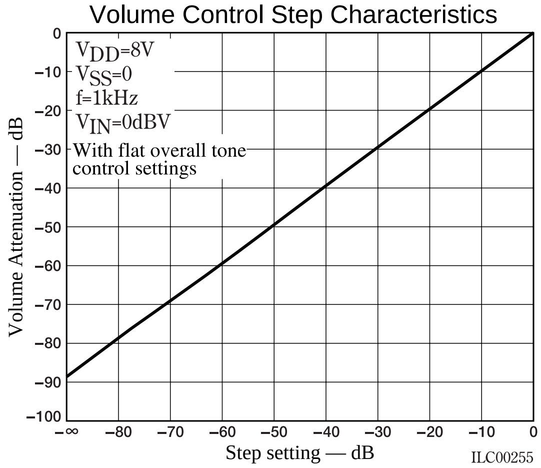
$$C = \frac{1}{2\pi f \sqrt{(\frac{R2}{10^{G/20} - 1})^2 - R1^2}}$$

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

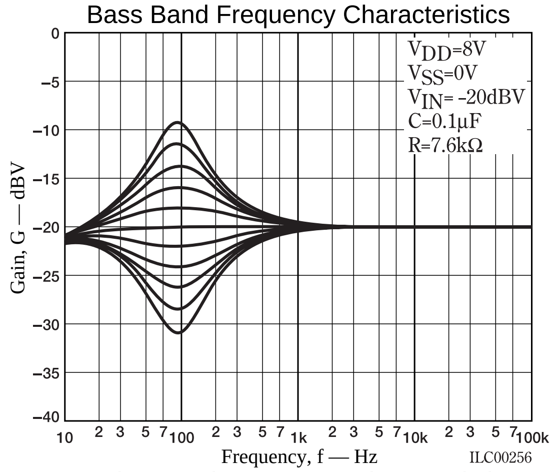
Usage Cautions

- Upon power application, the internal analog switch status is undefined. Use an external countermeasure such as muting until data is set.
- When performing initial setting after applying power, send the initial setting data for the left and right channels prior to canceling mute.
- To ensure that the high-frequency digital signals sent to the CL, DI, and CE pins do not spill over to the analog signal block, either guard these signal lines with a ground pattern, or perform transmission using shielded wires.

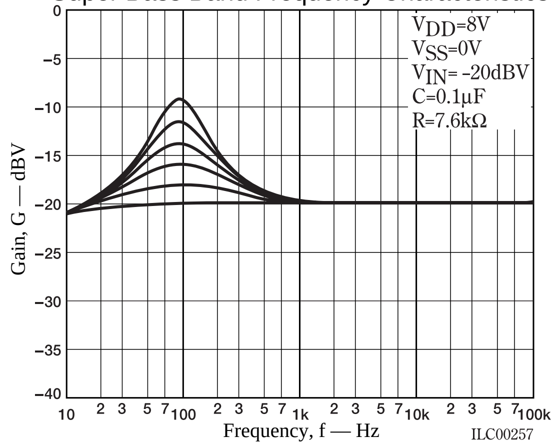
Volume Control Step Characteristics



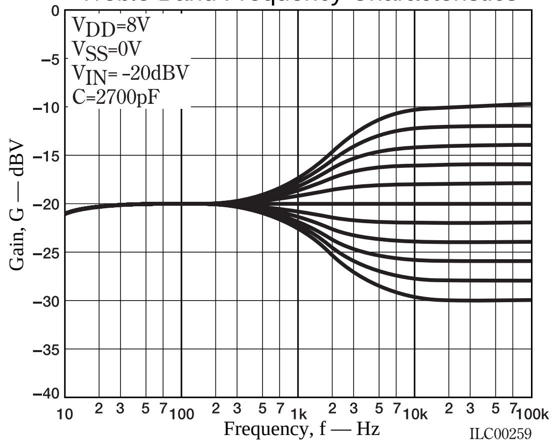
Bass Band Frequency Characteristics



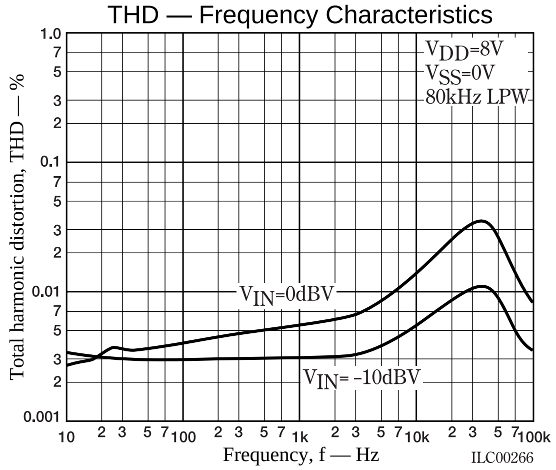
Super Bass Band Frequency Characteristics



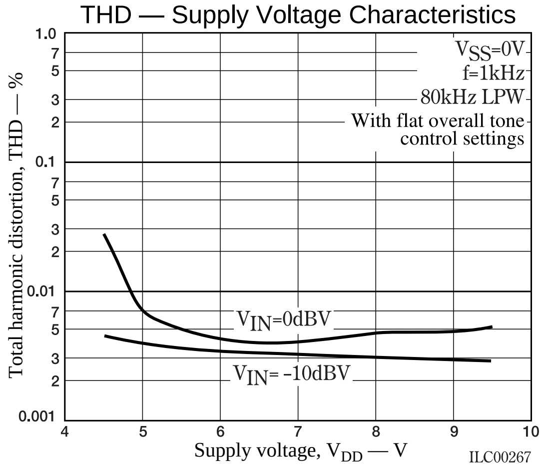
Treble Band Frequency Characteristics



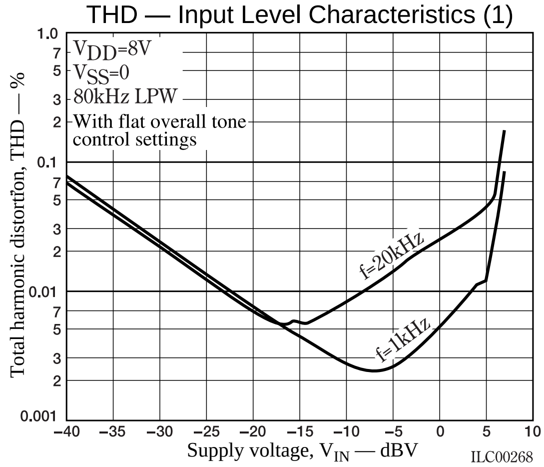
THD — Frequency Characteristics



THD — Supply Voltage Characteristics



THD — Input Level Characteristics (1)



This catalog provides information as of February, 2001. Specifications and information herein are subject to change without notice.