



ON Semiconductor®

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# CCB LC75344MD

CMOS LSI

## Two-Channel Electronic Volume Control System

### Overview

The LC75344MD is a two-channel electronic volume control IC that is controlled by data input over a serial interface.

### Functions

- Volume control: 0 dB to -50 dB in 1 dB steps, -52 dB to -78 dB in 2 dB steps, and  $-\infty$ , for a total of 66 positions. A balance function can be implemented by controlling the left and right channels independently.

### Features

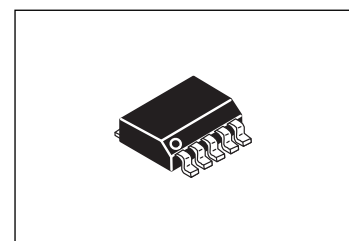
- Built-in buffer amplifiers minimize the number of external components required.
- Fabricated in a silicon gate CMOS process to minimize the switching noise generated by internal switches.
- Built-in reference voltage generation circuit for the analog ground level.
- All settings are controlled by data input over a serial interface that conforms to the CCB specifications.

### 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
Input voltage	$V_{IN\text{ max}}$	CE, CL, DI	-0.3 to +11.0	V
		LIN, RIN	$V_{SS} - 0.3$ to $V_{DD} + 0.3$	
Output voltage	$V_{OUT1}$	OSC	-0.3 to $V_{DD} + 0.3$	V
	$V_{OUT2}$	S1 to S87, COM1 to COM4, P1 to P8	-0.3 to $V_{LCD} + 0.3$	
Allowable power dissipation	$P_d\text{ max}$	$T_a \leq 75^\circ\text{C}$ *1: When mounted on a PCB.	300	mW
Operating temperature	$T_{opr}$		-30 to +75	$^\circ\text{C}$
Storage temperature	$T_{stg}$		-40 to +125	$^\circ\text{C}$

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.



SOIC-10 NB

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### ORDERING INFORMATION

See detailed ordering and shipping information on page 13 of this data sheet.

# LC75344MD

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

Parameter	Symbol	Pin Name	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		2.0		10	V
Low-level input voltage	$V_{IL}$	CL, DI, CE	$7.5 \leq V_{DD} \leq 10$	$V_{SS}$		0.8	V
		CL, DI, CE	$4.5 \leq V_{DD} \leq 7.5$	$V_{SS}$		0.3	V
Input voltage amplitude	$V_{IN}$	LIN, RIN		$V_{SS}$		$V_{DD}$	Vp-p
Input pulse width	$t_{\text{PW}}$	CL		1			$\mu\text{s}$
Setup time	$t_{\text{setup}}$	CL, DI, CE		1			$\mu\text{s}$
Hold time	$t_{\text{hold}}$	CL, DI, CE		1			$\mu\text{s}$
Operating frequency	$f_{\text{opg}}$	CL				500	kHz

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

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

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

## Overall Characteristics

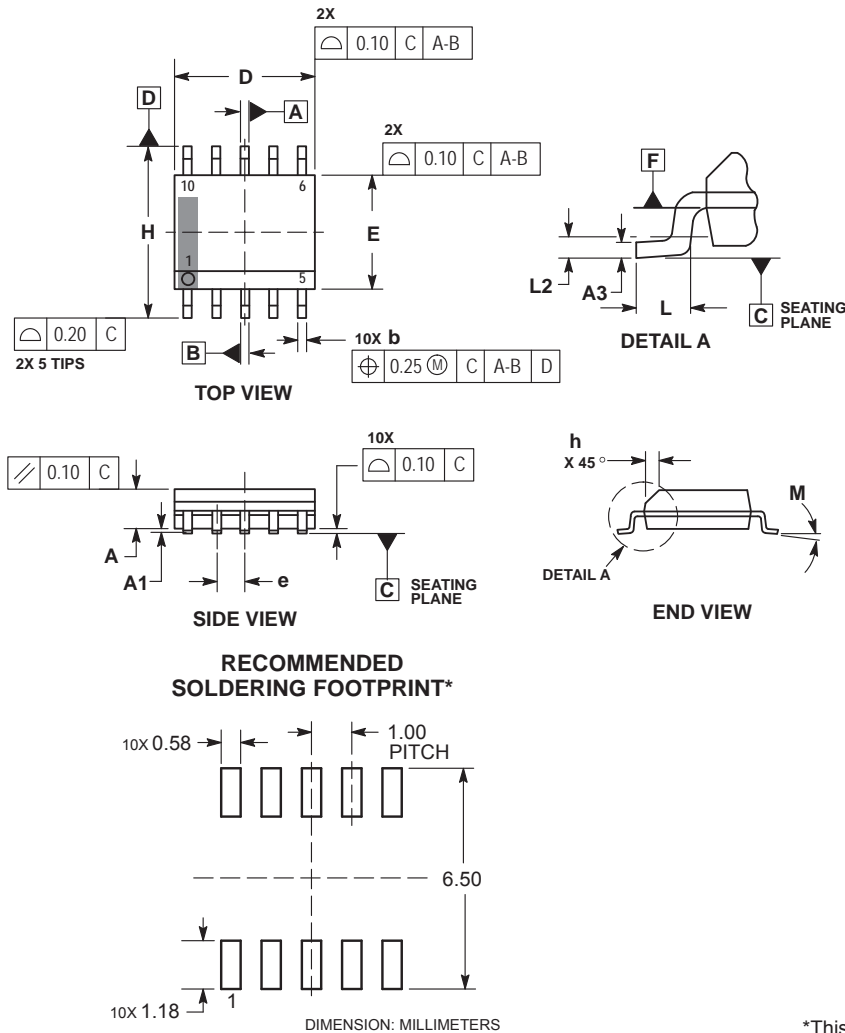
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Total harmonic distortion	THD	$V_{IN} = 1\text{ Vrms}$ , $f = 1\text{ kHz}$ With all settings flat overall		0.002	0.01	%
		$V_{IN} = 1\text{ Vrms}$ , $f = 20\text{ kHz}$ With all settings flat overall		0.003		%
Crosstalk	CT	$V_{IN} = 1\text{ Vrms}$ , $f = 1\text{ kHz}$ , $R_g = 1\text{ k}\Omega$ With all settings flat overall	90			dB
Output noise voltage	$V_N$	80 kHz L.P.F, $R_g = 1\text{ k}\Omega$ With all settings flat overall		6.0		$\mu\text{V}$
Maximum attenuation	$V_{\text{omin}}$	$V_{IN} = 1\text{ Vrms}$ , $f = 1\text{ kHz}$ With all settings flat overall		-92		dB
Current drain	$I_{DD}$	$V_{DD} - V_{SS} = +9\text{ V}$		12		mA
High-level input current	$I_{IH}$	CL, DI, CE: $V_{IN} = 10\text{ V}$ , $V_{DD} = 10\text{ V}$			10	$\mu\text{A}$
Low-level input current	$I_{IL}$	CL, DI, CE: $V_{IN} = 0\text{ V}$ , $V_{DD} = 10\text{ V}$	-10			$\mu\text{A}$

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

## Package Dimensions

unit : mm

**SOIC-10 NB**  
CASE 751BQ  
ISSUE B

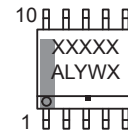


### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.10mm TOTAL IN EXCESS OF 'b' AT MAXIMUM MATERIAL CONDITION.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.15mm PER SIDE. DIMENSIONS D AND E ARE DETERMINED AT DATUM F.
5. DIMENSIONS A AND B ARE TO BE DETERMINED AT DATUM F.
6. A1 IS DEFINED AS THE VERTICAL DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT ON THE PACKAGE BODY.

MILLIMETERS		
DIM	MIN	MAX
A	1.25	1.75
A1	0.10	0.25
A3	0.17	0.25
b	0.31	0.51
D	4.80	5.00
E	3.80	4.00
e	1.00 BSC	
H	5.80	6.20
h	0.37 REF	
L	0.40	0.80
L2	0.25 BSC	
M	0°	8°

### GENERIC MARKING DIAGRAM\*



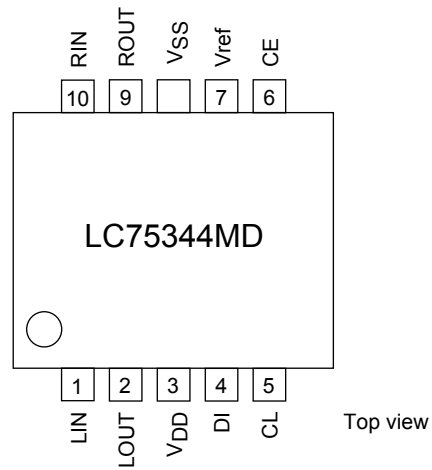
- XXXXX = Specific Device Code  
A = Assembly Location  
L = Wafer Lot  
Y = Year  
W = Work Week  
■ = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G", may or not be present.

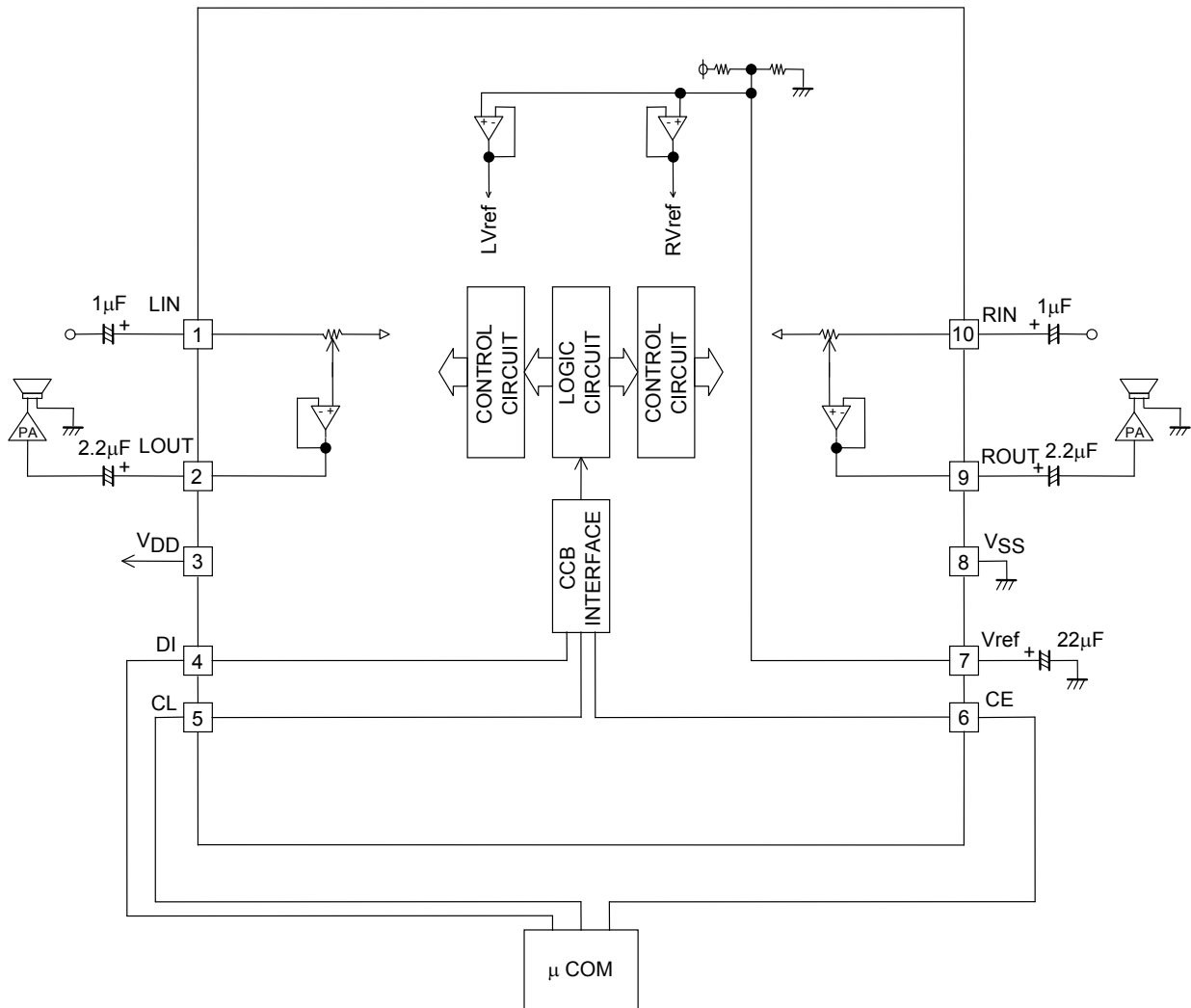
\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# LC75344MD

## Pin Arrangement

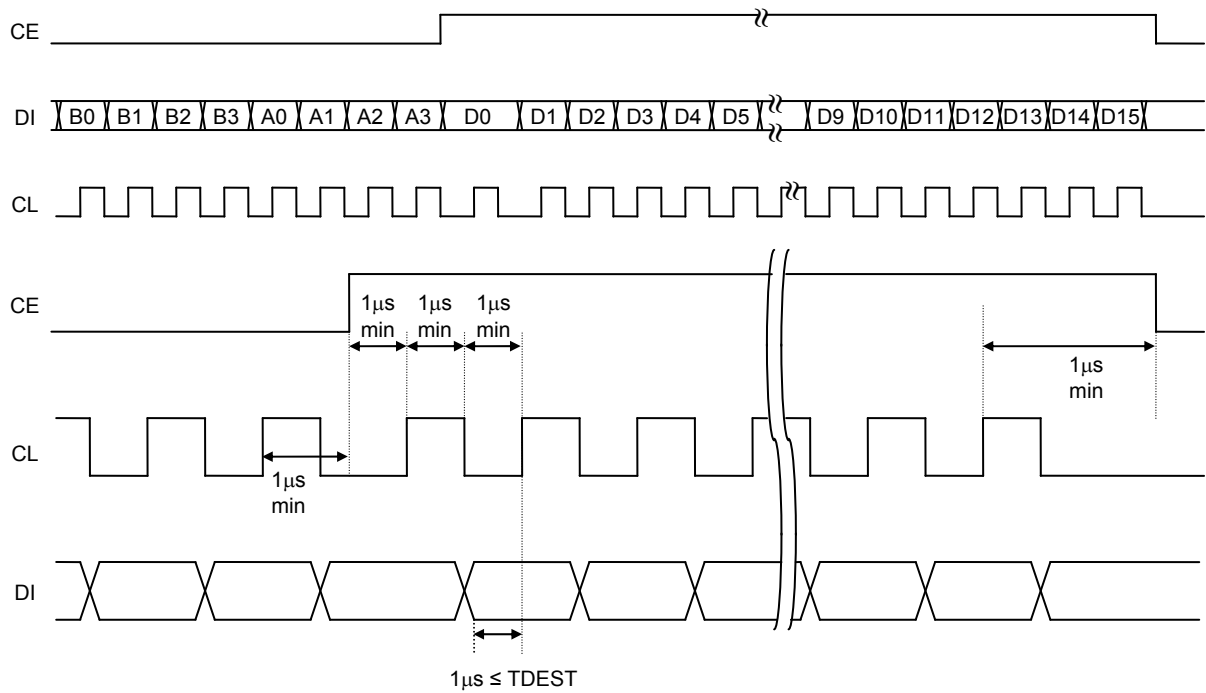


## Equivalent Circuit



# Control System Timing and Data Format

The LC75344MD is controlled by inputting the stipulated data serially to the CL, DI, and CE pins. The data consists of a total of 24 bits, of which 8 bits are the address and 16 bits are the data.



- Address Code (B0 to A3)  
The data has an 8-bit address field, and conforms to the CCB serial bus specifications.

Address code (LSB)	B0	B1	B2	B3	A0	A1	A2	A3	(88HEX)
	0	0	0	1	0	0	0	1	

# LC75344MD

## • Control Code Allocations

### Volume control

D0	D1	D2	D3	D4	D5	D6	D7	Operation
0	0	0	0	0	0	0	0	0dB
1	0	0	0	0	0	0	0	-1dB
0	1	0	0	0	0	0	0	-2dB
1	1	0	0	0	0	0	0	-3dB
0	0	1	0	0	0	0	0	-4dB
1	0	1	0	0	0	0	0	-5dB
0	1	1	0	0	0	0	0	-6dB
1	1	1	0	0	0	0	0	-7dB
0	0	0	1	0	0	0	0	-8dB
1	0	0	1	0	0	0	0	-9dB
0	1	0	1	0	0	0	0	-10dB
1	1	0	1	0	0	0	0	-11dB
0	0	1	1	0	0	0	0	-12dB
1	0	1	1	0	0	0	0	-13dB
0	1	1	1	0	0	0	0	-14dB
1	1	1	1	0	0	0	0	-15dB
0	0	0	0	1	0	0	0	-16dB
1	0	0	0	1	0	0	0	-17dB
0	1	0	0	1	0	0	0	-18dB
1	1	0	0	1	0	0	0	-19dB
0	0	1	0	1	0	0	0	-20dB
1	0	1	0	1	0	0	0	-21dB
0	1	1	0	1	0	0	0	-22dB
1	1	1	0	1	0	0	0	-23dB
0	0	0	1	1	0	0	0	-24dB
1	0	0	1	1	0	0	0	-25dB
0	1	0	1	1	0	0	0	-26dB
1	1	0	1	1	0	0	0	-27dB
0	0	1	1	1	0	0	0	-28dB
1	0	1	1	1	0	0	0	-29dB
0	1	1	1	1	0	0	0	-30dB
1	1	1	1	1	0	0	0	-31dB
0	0	0	0	0	1	0	0	-32dB
1	0	0	0	0	1	0	0	-33dB
0	1	0	0	0	1	0	0	-34dB
1	1	0	0	0	1	0	0	-35dB
0	0	1	0	0	1	0	0	-36dB
1	0	1	0	0	1	0	0	-37dB
0	1	1	0	0	1	0	0	-38dB
1	1	1	0	0	1	0	0	-39dB
0	0	0	1	0	1	0	0	-40dB

Continued on next page.

## LC75344MD

Continued from preceding page.

### Volume control

D0	D1	D2	D3	D4	D5	D6	D7	Operation
1	0	0	1	0	1	0	0	−41dB
0	1	0	1	0	1	0	0	−42dB
1	1	0	1	0	1	0	0	−43dB
0	0	1	1	0	1	0	0	−44dB
1	0	1	1	0	1	0	0	−45dB
0	1	1	1	0	1	0	0	−46dB
1	1	1	1	0	1	0	0	−47dB
0	0	0	0	1	1	0	0	−48dB
1	0	0	0	1	1	0	0	−49dB
0	1	0	0	1	1	0	0	−50dB
0	0	1	0	1	1	0	0	−52dB
0	1	1	0	1	1	0	0	−54dB
0	0	0	1	1	1	0	0	−56dB
0	1	0	1	1	1	0	0	−58dB
0	0	1	1	1	1	0	0	−60dB
0	1	1	1	1	1	0	0	−62dB
0	0	0	0	0	0	1	0	−64dB
0	1	0	0	0	0	1	0	−66dB
0	0	1	0	0	0	1	0	−68dB
0	1	1	0	0	0	1	0	−70dB
0	0	0	1	0	0	1	0	−72dB
0	1	0	1	0	0	1	0	−74dB
0	0	1	1	0	0	1	0	−76dB
0	1	1	1	0	0	1	0	−78dB
0	0	0	0	1	0	1	0	−∞

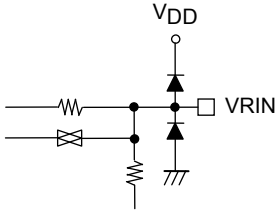
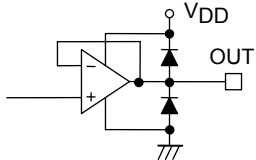
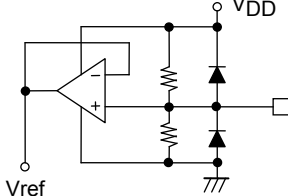
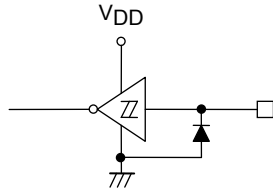
### Channel selection

D8	D9	Operation
0	0	Normally not used
1	0	RCH
0	1	LCH
1	1	Left and right channels together

### Test mode

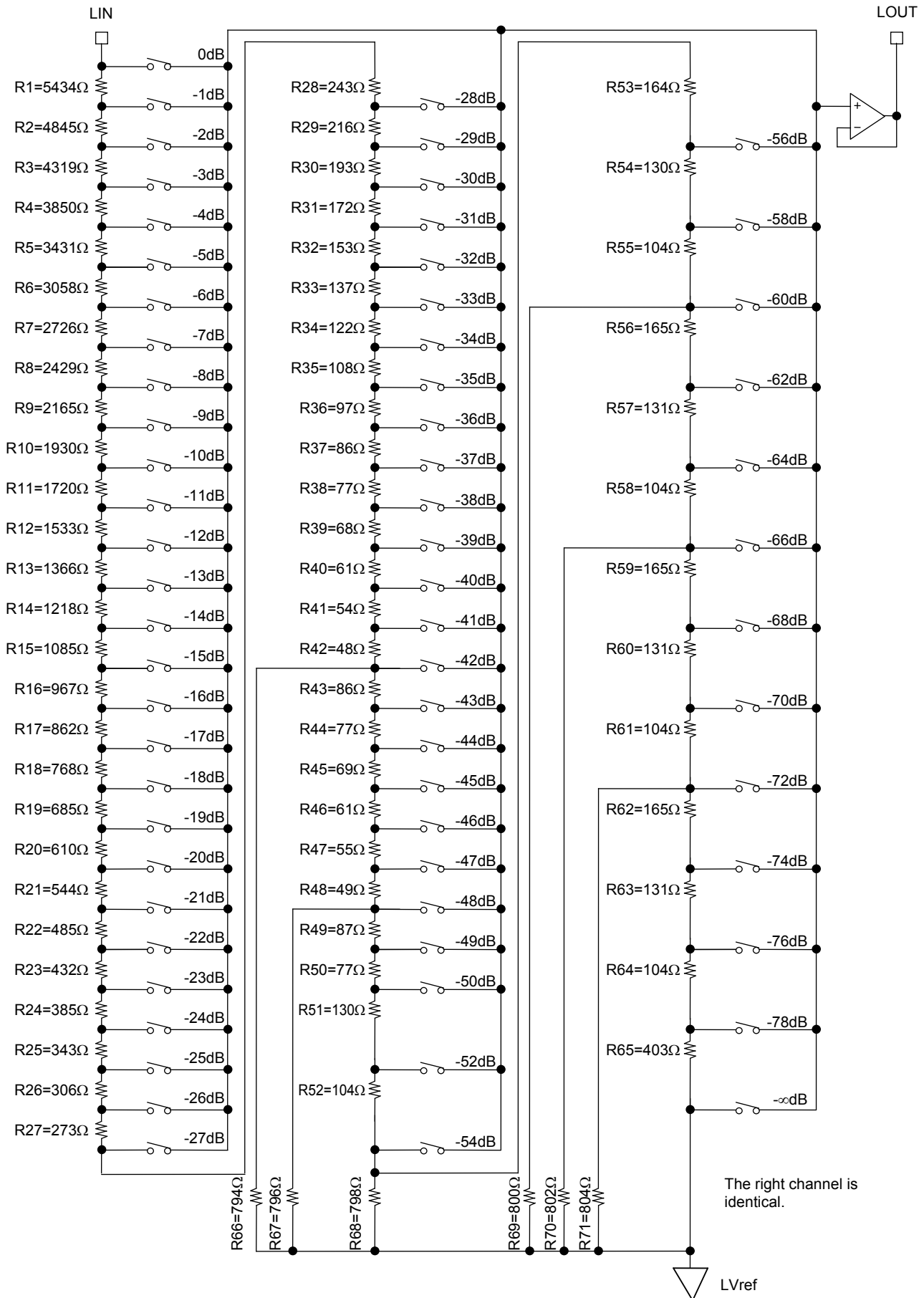
D10	D11	D12	D13	D14	D15	Operation
0	0	0	0	0	0	
These bits specify the IC test mode. They must be set to zero for normal operation.						

Pin Functions

Pin name	Pin No.	Function	Notes
LIN RIN	1 10	Volume control inputs	
LOUT ROUT	2 9	Volume control outputs	
Vref	7	VDD × 0.5 voltage generator block for the analog ground level. A capacitor with a value a few times 10 μF must be inserted between Vref and AVSS (VSS) to minimize power supply ripple.	
VSS	8	Ground	
VDD	3	Power supply	
CE	6	Chip enable The internal latch data is written and the analog switches operate at the point this pin goes from high to low. Data transfer is enabled when this pin is at the high level.	
DI CL	4 5	Serial data and clock inputs for IC control.	

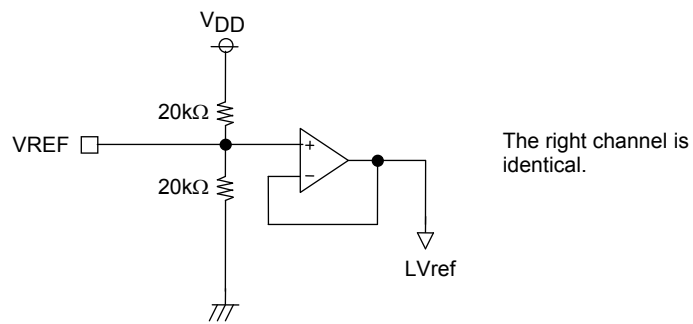


## Equivalent Circuit



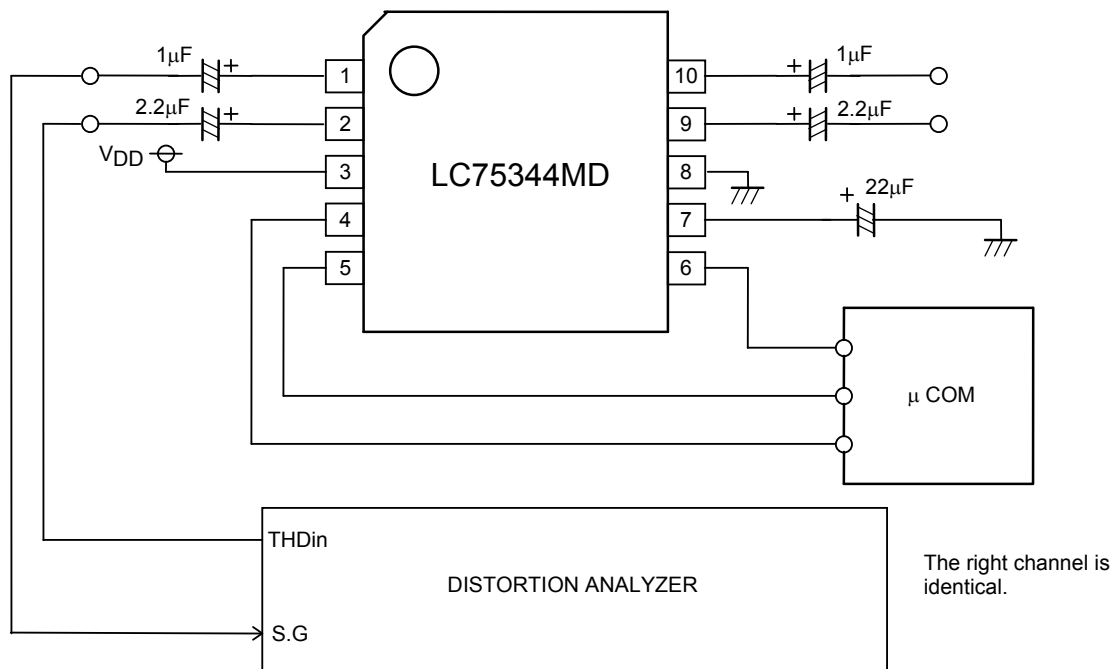
## LC75344MD

### Reference Voltage Generator Equivalent Circuit



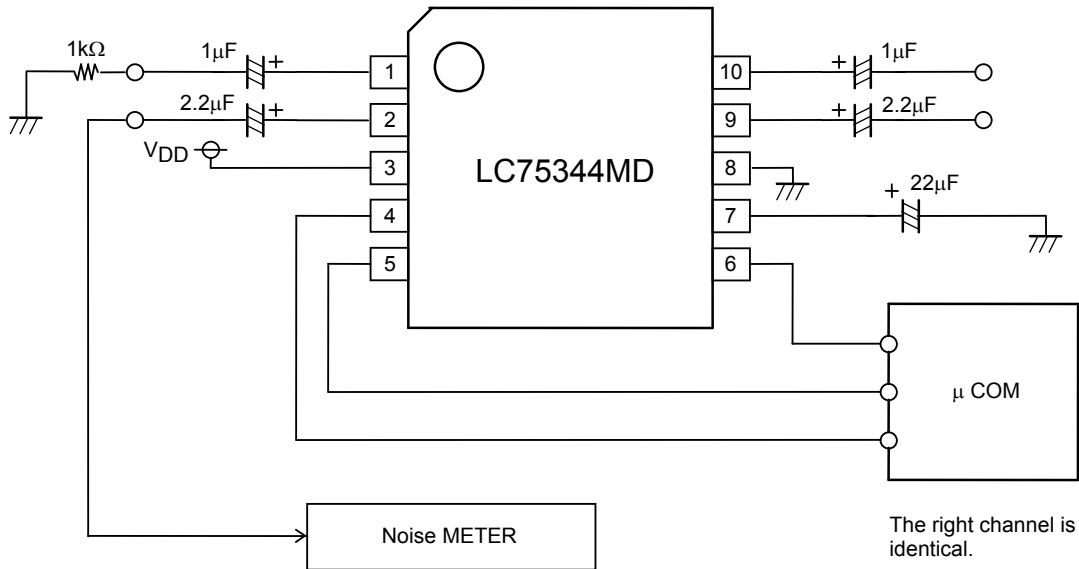
### Test Circuit

- Total harmonic distortion

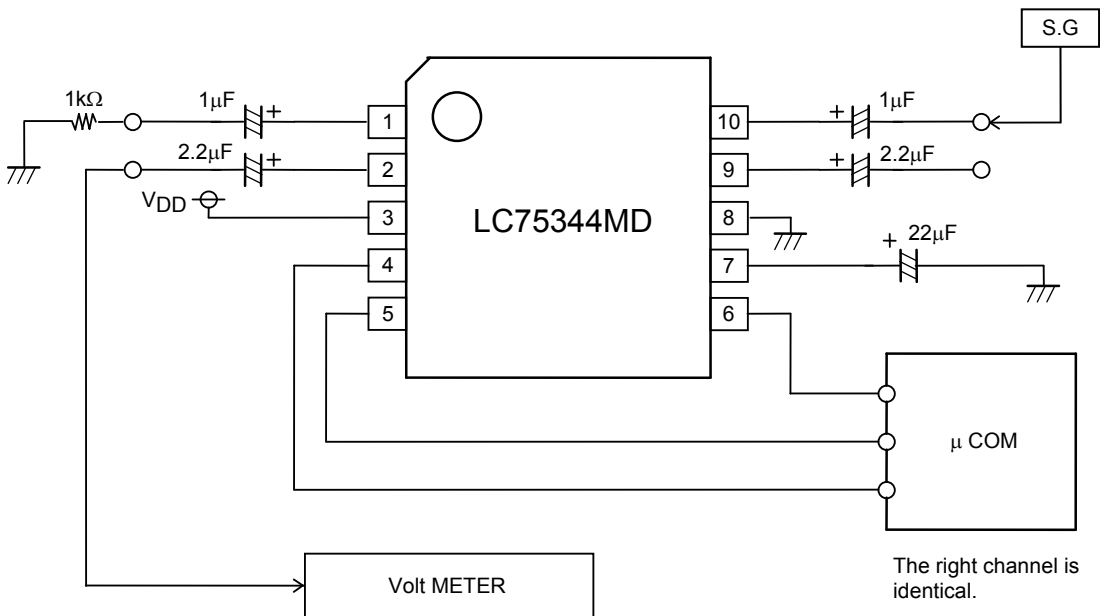


## LC75344MD

### • Output noise voltage



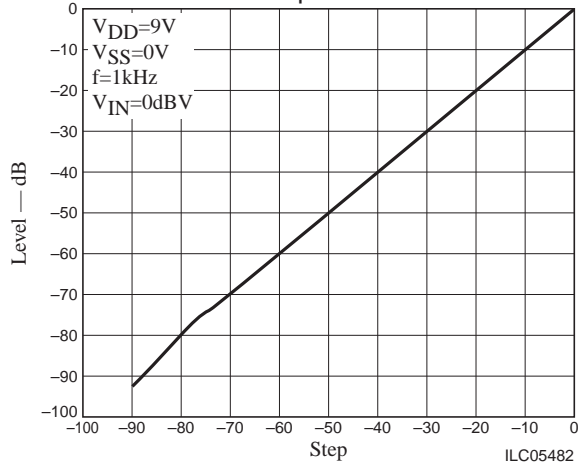
### • Crosstalk



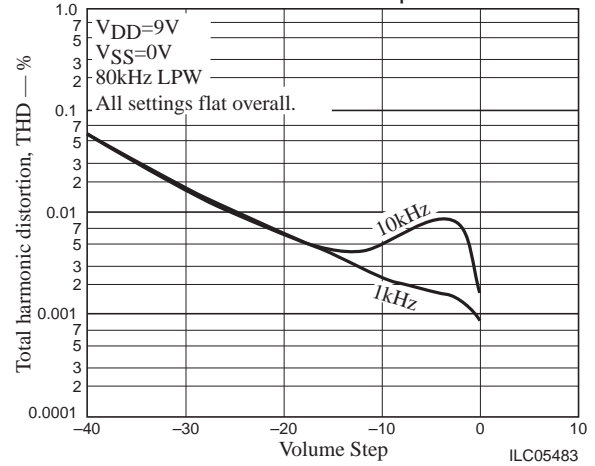
### Usage Notes

- The states of the internal analog switches are undefined after power is first applied. Muting must be applied externally until the control data has been sent.
- When performing the initial settings after power is first applied, both the left and right channel initial settings data must be sent before releasing the external mute.
- Either cover the CL, DI, and CE lines with the ground pattern or use shielded lines to prevent high-frequency digital noise from entering the analog signal system from these lines.

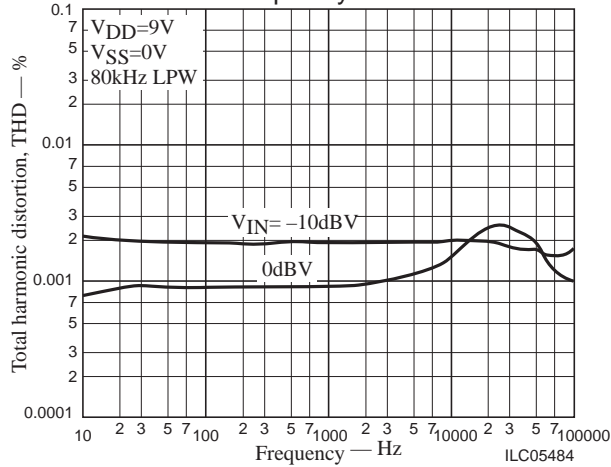
## Volume Step Characteristics



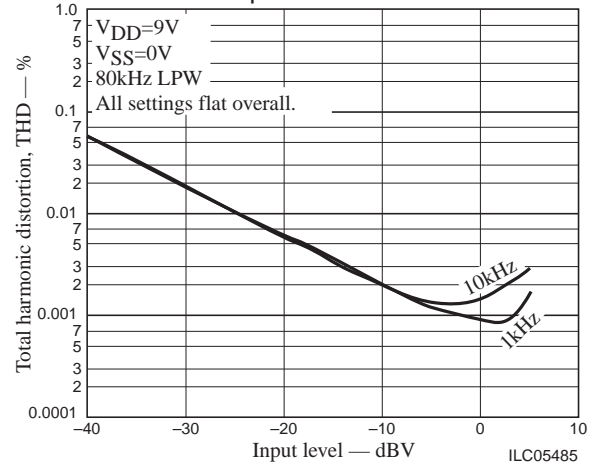
## THD vs. Volume Control Step Characteristics



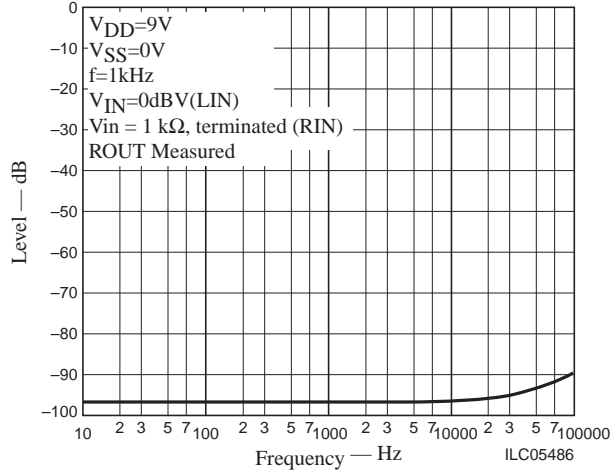
## THD vs. Frequency Characteristics



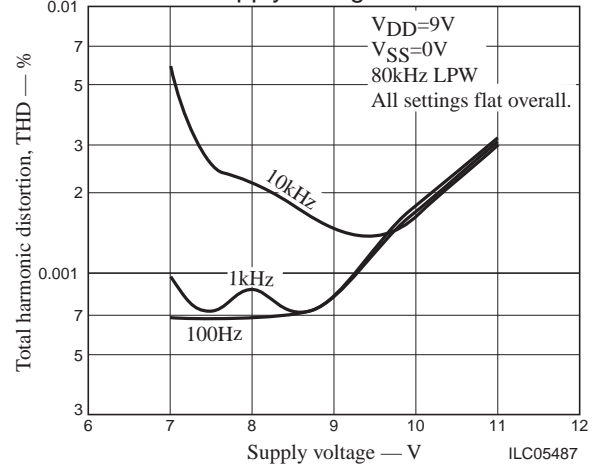
## THD vs. Input Level Characteristics



## Crosstalk Characteristics



## THD vs. Supply Voltage Characteristics



## ORDERING INFORMATION

Device	Package	Shipping (Qty / Packing)
LC75344MD-AH	SOIC-10 NB (Pb-Free / Halogen Free)	2500 / Tape & Reel

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