



LC75392, 75392M

Single-Chip Electronic Volume Control System



Overview

The LC75392 (DIP-30SD) and the LC75392M (MFP-30S) are electronic volume control ICs that provide input and output switching, volume, and tone control functions controlled by data transferred over a serial interface.

Functions

- Input and output switching: Four inputs and outputs can be switched independently.
- Volume control: A balance function can be implemented by controlling the left and right levels independently. Each channel can be set to 0 to -20 dB in 2 dB steps, -20 to -32 dB in 3 dB steps, -32 to -52 dB in 4 dB steps, -52 dB to -70 dB in 4.5 dB steps, and $-\infty$.
- Tone controls: Internal switches are provided to select between four sets of frequency characteristics. A buffer function can be implemented using external components.

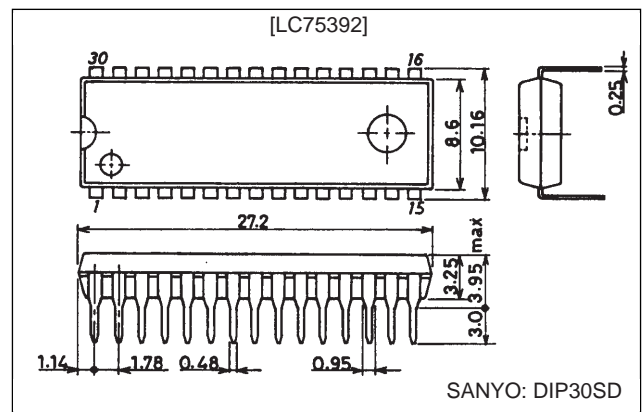
Features

Serial data interface: Support for control and communication in the CCB format.

Package Dimensions

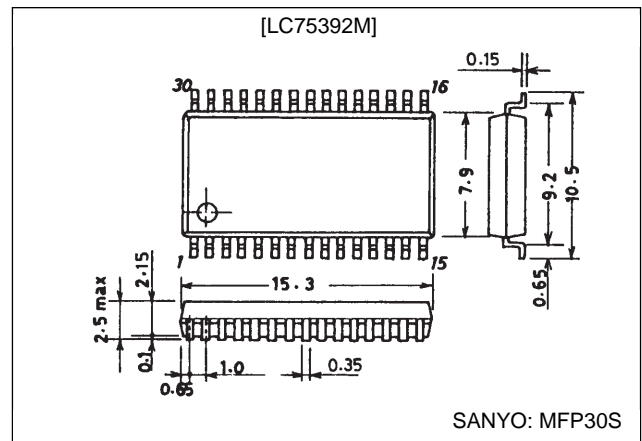
unit: mm

3196-DIP30SD



unit: mm

3216-MFP30S



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}	12	V
Maximum input voltage	$V_{IN\text{ max}}$	CL, DI, CE, L1, L2, L3, L4, R1, R2, R3, R4	$V_{SS} - 0.3$ to $V_{DD} + 0.3$	V
Allowable power dissipation	$Pd\text{ max}$	$T_a \leq 85^\circ\text{C}$	160	mW
Operating temperature	T_{opr}		-40 to +85	$^\circ\text{C}$
Storage temperature	T_{stg}		-50 to +125	$^\circ\text{C}$

- 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.

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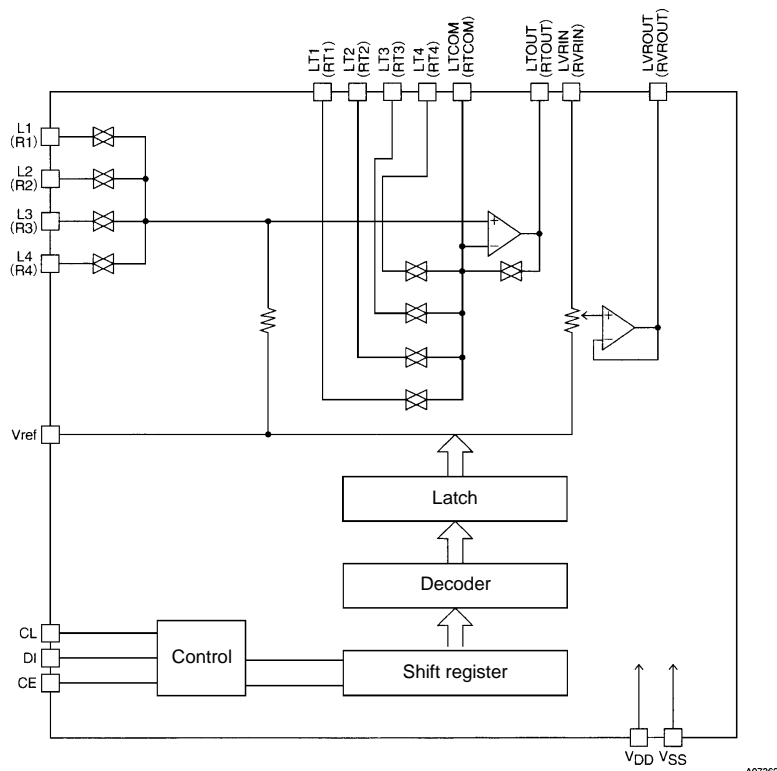
Allowable Operating Ranges at $T_a = 25^\circ\text{C}$, $V_{SS} = 0\text{ V}$

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Supply voltage	V_{DD}	V_{DD}	5.5		11.0	V
Input high-level voltage	V_{IH}	CL, DI, CE	4.0		V_{DD}	V
Input low-level voltage	V_{IL}	CL, DI, CE	V_{SS}		1.0	V
Input voltage amplitude	V_{IN}	L1, L2, L3, L4, R1, R2, R3, R4	V_{SS}		V_{DD}	Vp-p
Input pulse width	t_{pw}	CL	1.0			μs
Setup time	t_{setup}	CL, DI, CE	1.0			μs
Hold time	t_{hold}	CL, DI, CE	1.0			μs
Operating frequency	fopg	CL			500	kHz

Electrical Characteristics at $T_a = 25^\circ\text{C}$, $V_{DD} = 10\text{ V}$, $V_{SS} = 0\text{ V}$

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
[Input Block]						
Input resistance	R_{in}	L1, L2, L3, L4, R1, R2, R3, R4		500		$\text{k}\Omega$
[Overall]						
Total harmonic distortion	THD1	$V_{IN} = 100\text{ mV rms}$, $f = 1\text{ kHz}$, overall, buffer mode off, flat state		0.013		%
	THD2	$V_{IN} = 100\text{ mV rms}$, $f = 20\text{ kHz}$, overall, buffer mode off, flat state		0.013		%
Crosstalk	CT	$V_{IN} = 1\text{ V rms}$, $f = 1\text{ kHz}$, overall, $R_g = 1\text{ k}\Omega$, buffer mode off, flat state		81		dB
Output at maximum attenuation	$V_{O\text{ min}}$	$V_{IN} = 1\text{ V rms}$, $f = 1\text{ kHz}$, main volume set to $-\infty$, buffer mode on		-80		dB
Output noise voltage	V_{N1}	Flat overall (IHF-A), $R_g = 1\text{ k}\Omega$, buffer mode off, flat state		15		μV
	V_{N2}	Flat overall (DIN-AUDIO), $R_g = 1\text{ k}\Omega$, buffer mode off, flat state		22		μV
Current drain	I_{DD}	$V_{DD} - V_{SS} = 11\text{ V}$		7	10	mA
Input high-level current	I_{IH}	CL, DI, CE, $V_{IN} = 10\text{ V}$			10	μA
Input low-level current	I_{IL}	CL, DI, CE, $V_{IN} = 0\text{ V}$	-10			μA

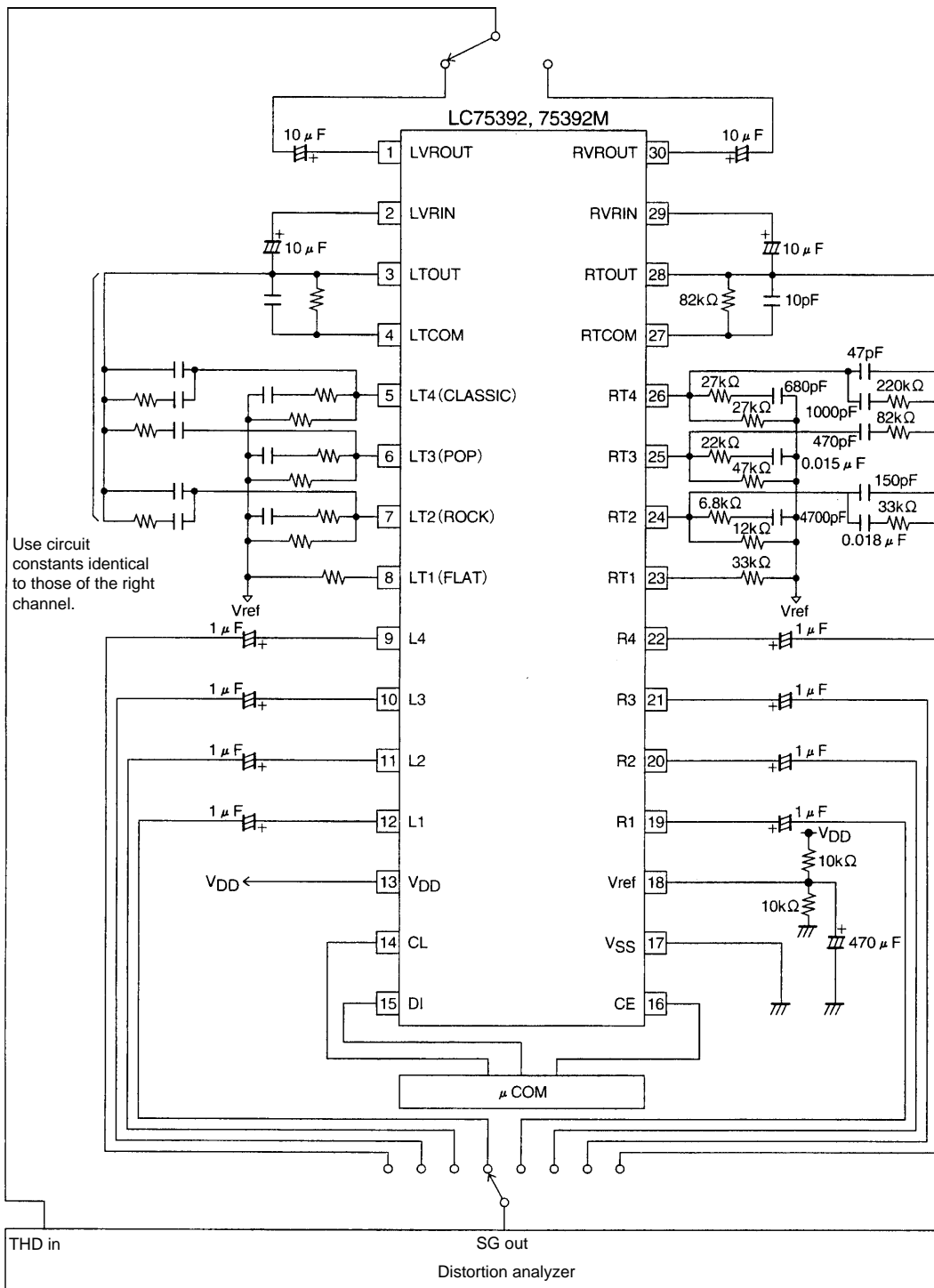
Equivalent Circuit Block Diagram



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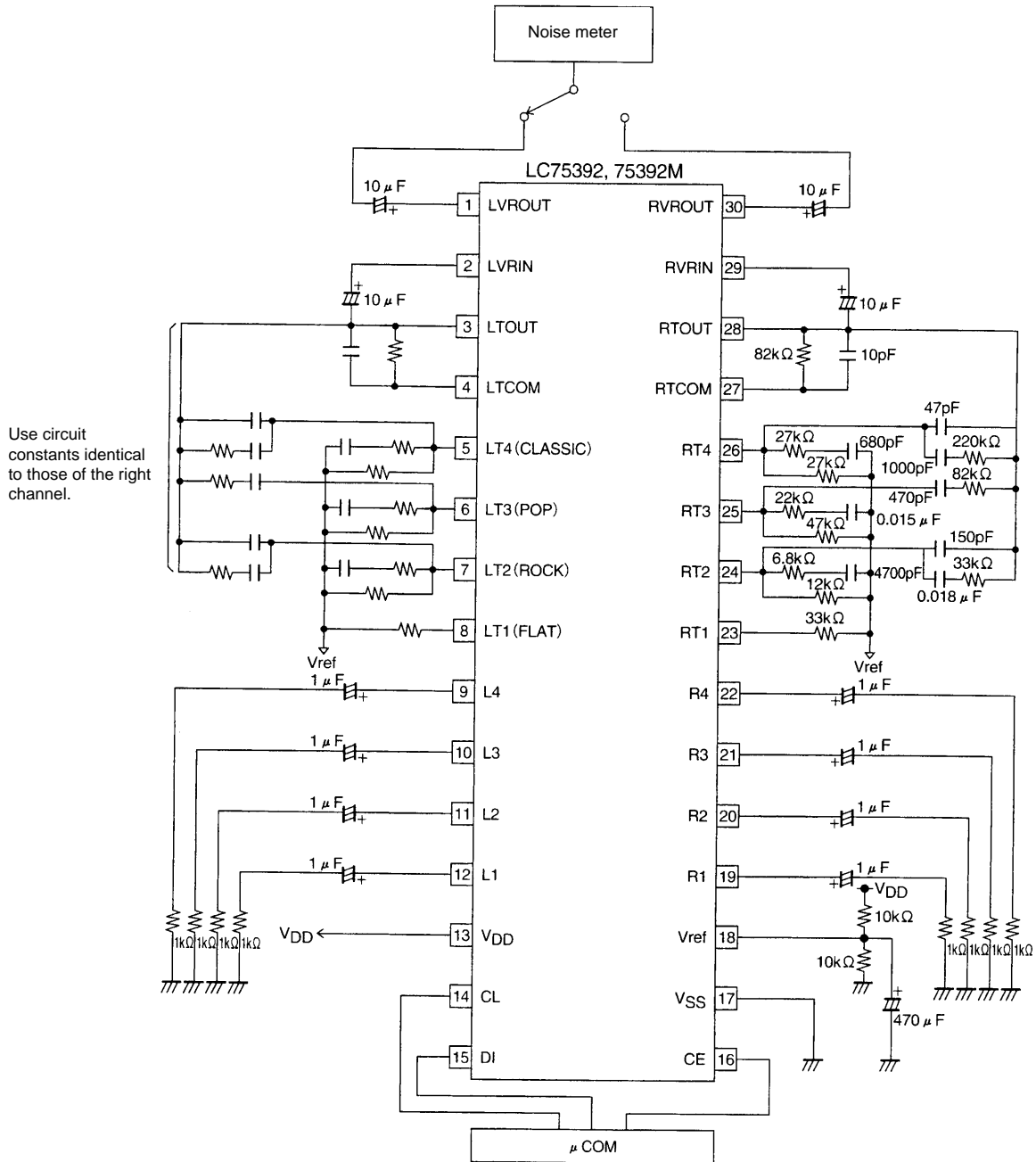
Test Circuit Total Harmonic Distortion



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Output Noise Voltage

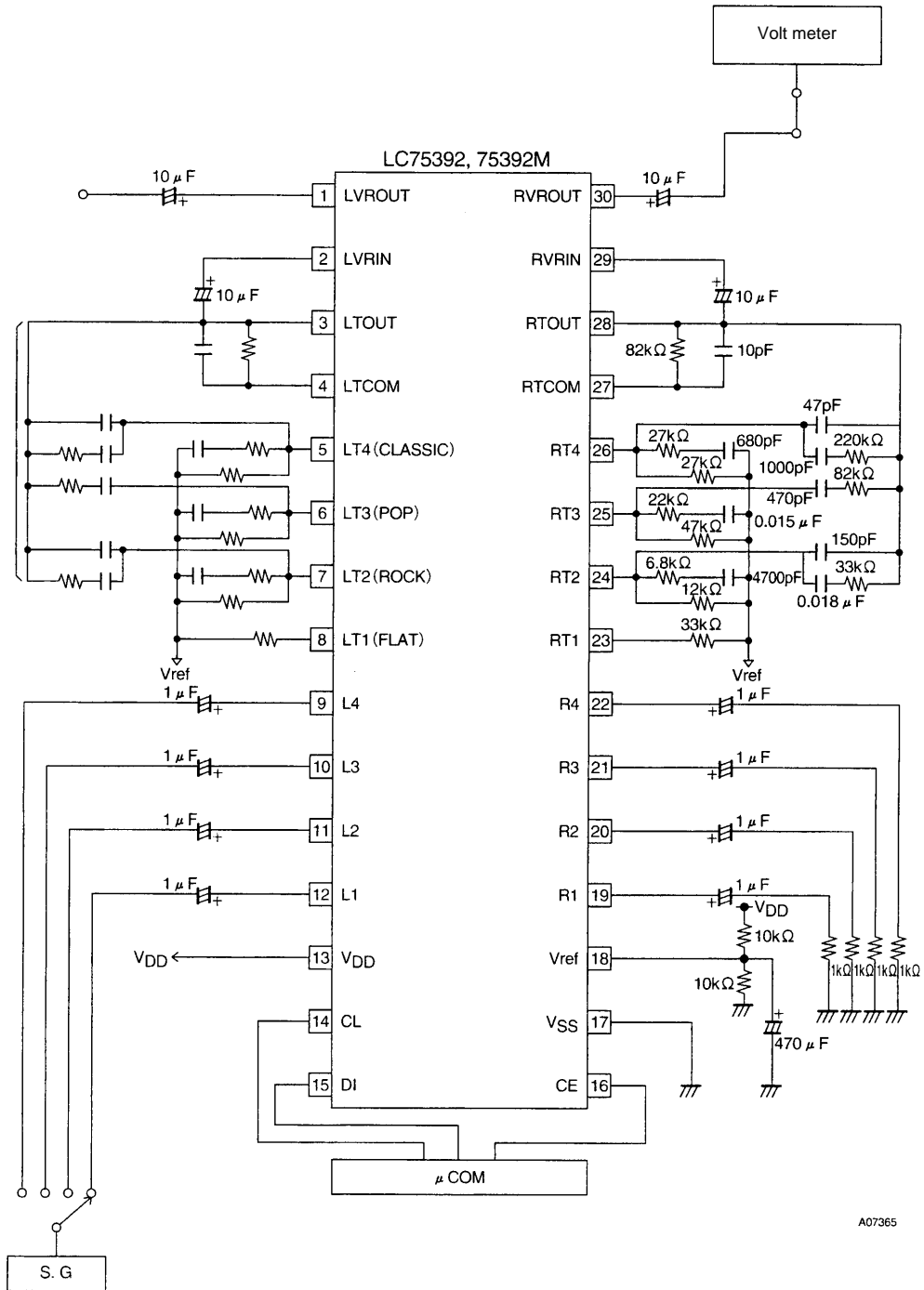


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Crosstalk

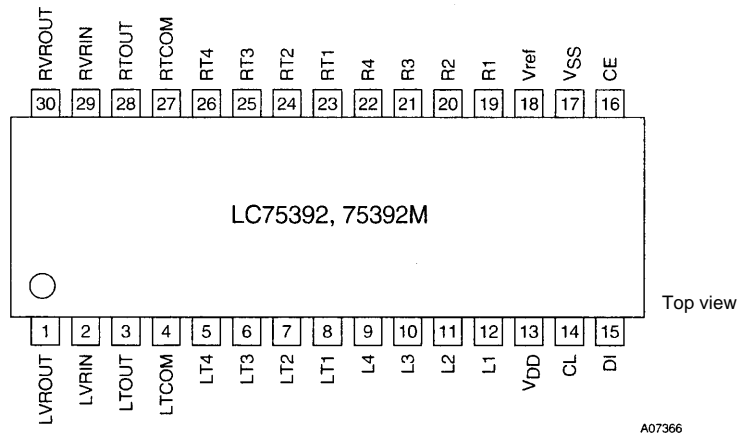
Use circuit constants identical to those of the right channel.



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Pin Assignment



Pin Functions

Pin	Pin No.	Function	Circuit
LVROUT RVROUT	1 30	Volume control outputs	
LVRIN RVRIN	2 29	Volume control inputs	
LTOUT RTOUT	3 28	Tone control circuit outputs	
LTCOM RTCOM	4 27	Tone control circuit operational amplifier inverting inputs	
LT1 LT2 LT3 LT4 RT1 RT2 RT3 RT4	8 7 6 5 23 24 25 26	Connections for the tone control pattern external constants	

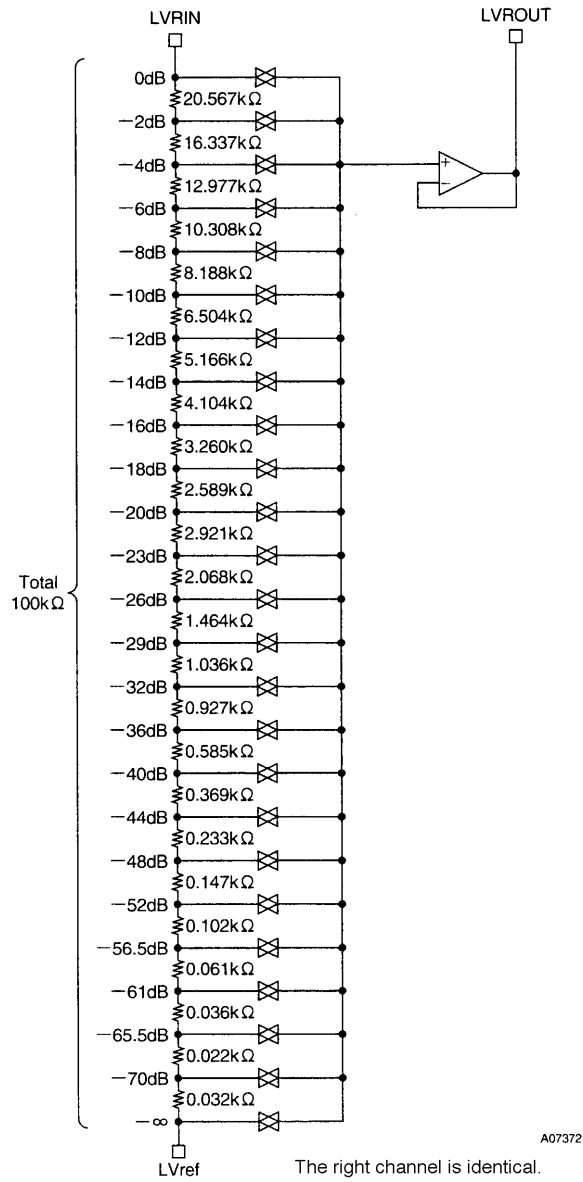
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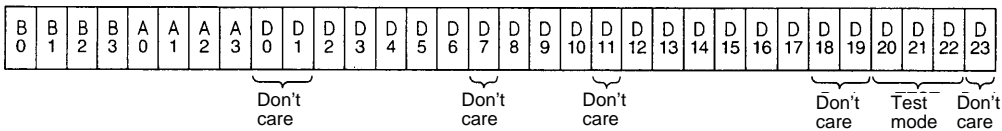
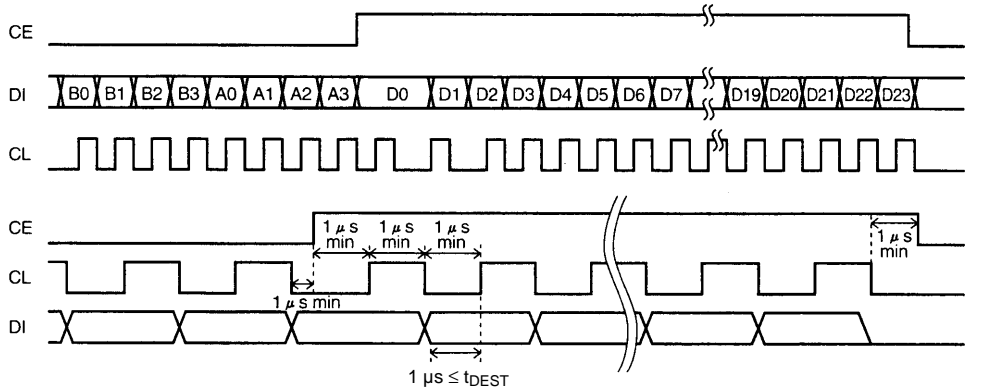
Pin	Pin No.	Function	Circuit
L1 L2 L3 L4 R1 R2 R3 R4	12 11 10 9 19 20 21 22	Audio signal inputs and outputs	
V _{DD}	13	Power supply	
V _{ref}	18	Analog system ground	
V _{SS}	17	Ground	
CL DI	14 15	Serial data and clock inputs for device control	
CE	16	<ul style="list-style-type: none"> • Chip enable • Data is read into an internal latch and the analog switches operate when this pin goes from high to low. • Data transfers are enabled when this pin is high. 	

Volume Control Equivalent Circuit



Control System Timing and Data Format

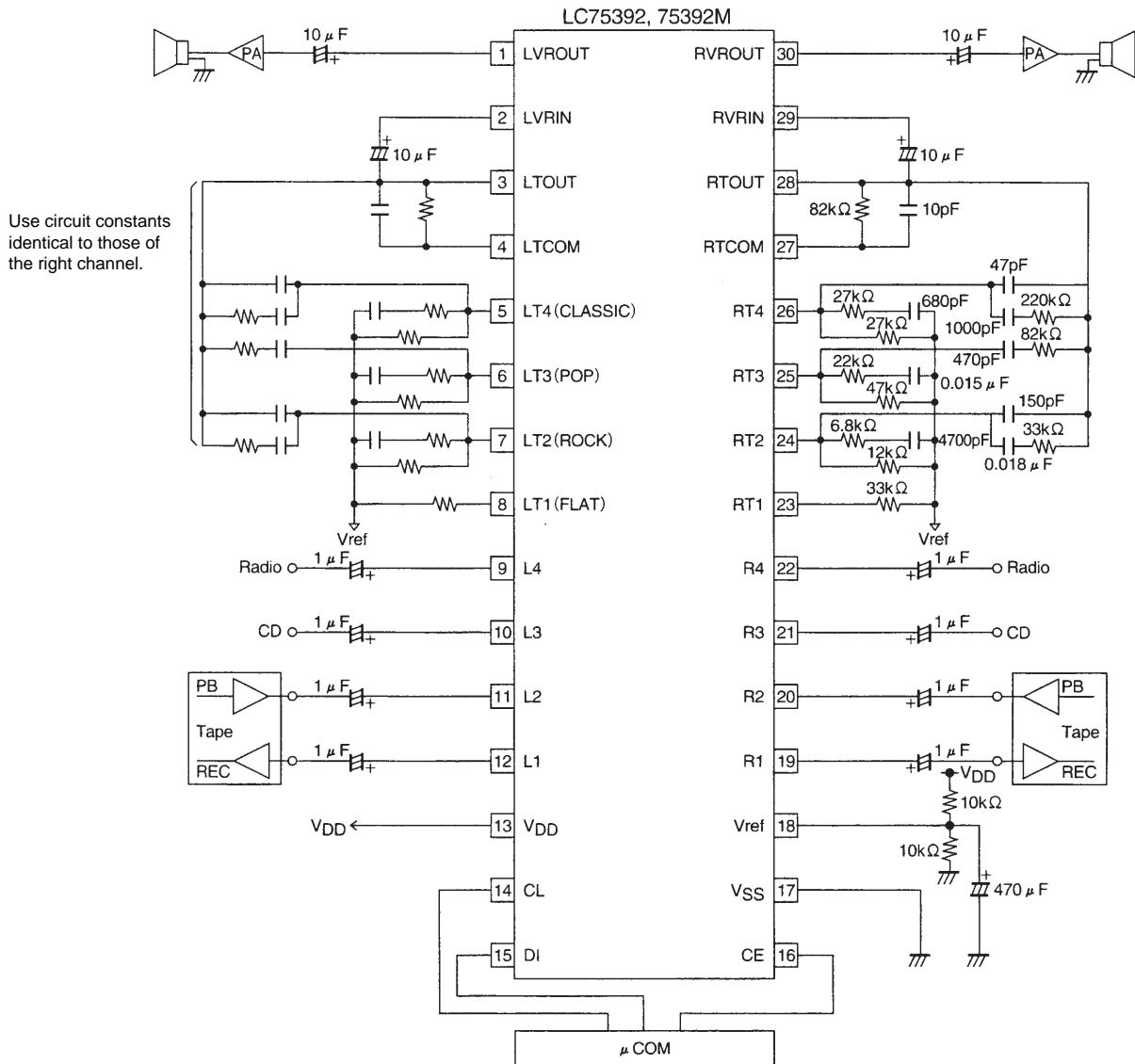
To control the LC75392, applications must apply data in the stipulated format to the CE, CL, and DI pins. This data consists of 32 bits, of which 8 bits are the address and 24 bits are the control data.



Address code				Volume control data				Tone pattern control data		Buffer mode	Function switch control data			
B	B	B	B	D	D	D	D	D	D	D	D	D	D	D
0	1	2	3	2	3	4	5	8	9	10	12	13	14	15
0	1	0	0	00000	∞	0	0	0	0	0	0	0	0	0
1	0	0	0	10000	-70dB	1	0	0	1	1	1	0	0	1
0	1	0	0	01000	-65.5dB	0	1	1	0	0	1	1	0	1
0	0	0	1	11000	-61dB	1	1	1	1	1	0	1	0	0
0	0	1	0	00100	-56.5dB						0	0	0	0
0	1	1	0	10100	-52dB						1	1	0	0
0	1	1	1	01100	-48dB						1	0	1	0
0	1	1	1	11100	-44dB						0	0	1	0
0	0	0	1	00010	-40dB						1	1	0	0
0	0	1	0	10010	-36dB						0	1	0	0
0	1	0	1	01010	-32dB						1	0	1	0
0	1	1	0	11010	-29dB						0	1	1	0
0	0	1	1	00110	-26dB						1	0	0	0
0	1	1	1	10110	-23dB						0	1	1	0
0	1	1	1	01110	-20dB						1	0	0	0
0	0	0	1	11110	-18dB						0	1	1	0
0	0	0	1	00001	-16dB						1	1	0	0
0	0	0	1	10001	-14dB						0	0	1	0
0	1	0	0	01001	-12dB						1	1	1	0
0	1	0	1	11001	-10dB						0	0	0	0
0	0	1	0	00101	-8dB						1	1	0	0
0	1	0	1	10101	-6dB						0	1	1	0
0	1	1	0	01101	-4dB						1	0	0	0
0	1	1	0	11101	-2dB						0	1	1	0
0	0	0	1	00011	0dB						1	1	1	0

Note: The bits D20, D21, and D22 are IC test mode control data. User applications must always set these bits to 0.

Sample Application Circuit (Three-input type)



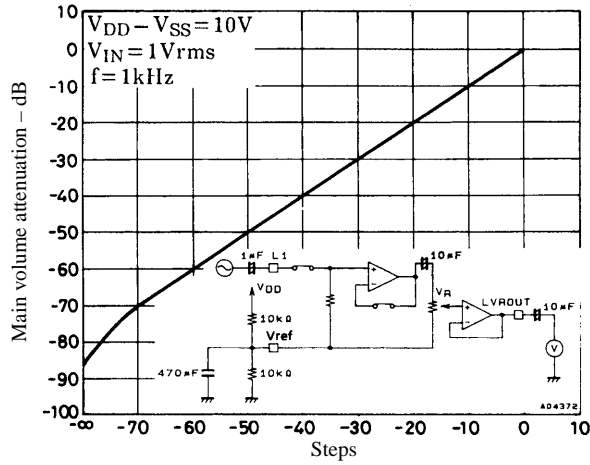
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Usage Notes

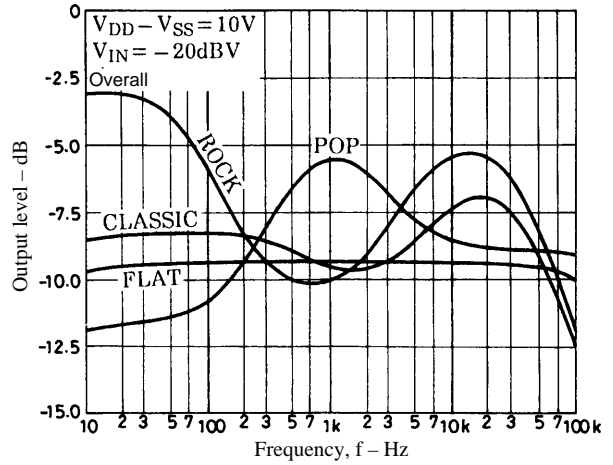
- The states of the internal analog switches are undefined immediately after power is first applied. Applications should apply muting to the outputs of this IC using external circuits until the control data has been set up.
- The CL, DI, and CE pin lines should be shielded by the ground pattern or shielded lines should be used to prevent the high-frequency digital signals that are transmitted over these lines from entering the analog system as noise.
- We recommend that applications use a sequence of several smaller steps to approach the final setting when changing the value of the volume control setting significantly. For example, the sequence shown below should be used when changing from 0 dB to $-\infty$. This can reduce switching noise.

Example: 0 dB \rightarrow -10 dB \rightarrow -20 dB \rightarrow -40 dB \rightarrow -70 dB \rightarrow $-\infty$

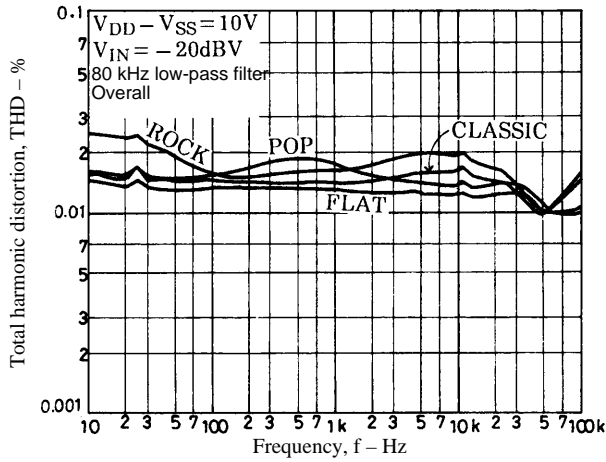
Main Volume Step Characteristics



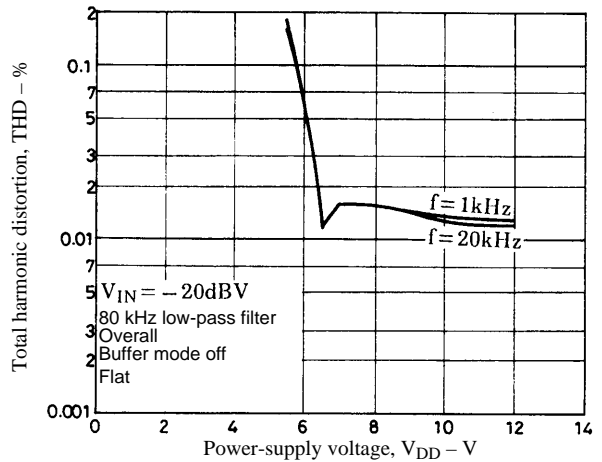
Tone Control Characteristics



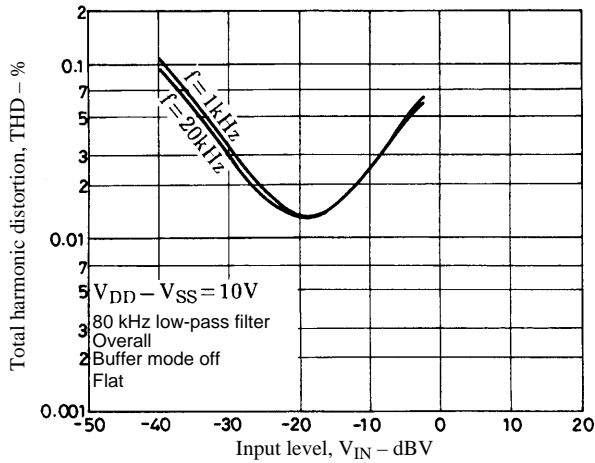
THD vs. Frequency Characteristics



THD vs. Power-Supply Voltage Characteristics



THD vs. Input Level Characteristics



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