

**LC7536M**

Serially Controlled Electronic Volume Control that Handles High Voltages



Overview

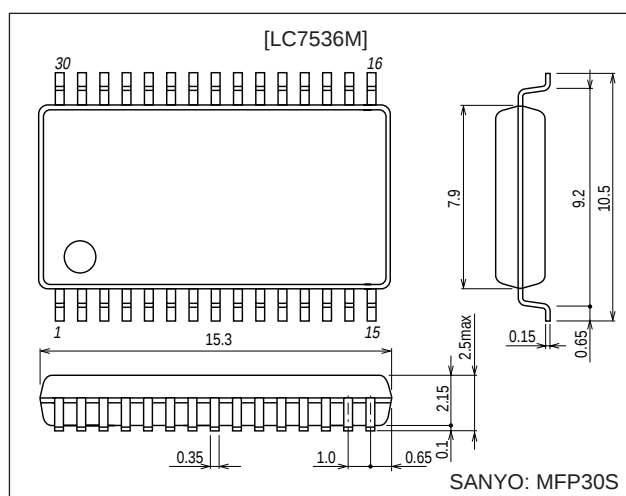
The LC7536M is an electronic volume control that implements volume, balance, and loudness functions with a minimum number of external components, and can be controlled electronically with serial data.

Functions

- Volume: 81 positions from 0 to -79 dB (in 1-dB steps) and $-\infty$. Since the left and right channels can be controlled separately, a balance function can be implemented easily.
- Loudness: A tap is output from the -20 dB position of a 5 dB step volume control resistor ladder. A loudness function can be implemented by connecting an external RC circuit.
- S (select): Up to two LC7536M ICs can be used on the same bus.
- Serial data input: The LC7536M supports control and communication in the CCB format.

Package Dimensions

unit: mm

3216A-MFP30S

Features

- High voltage handling capability: ± 16 V.

- 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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SANYO Electric Co., Ltd. Semiconductor Company

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LC7536M

Specifications

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

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	$V_{DD}\text{ max}$	$V_{EE} \leq V_{SS} < V_{CC} < V_{DD}$	$V_{SS}\text{ to }V_{SS} + 18$	V
	$V_{EE}\text{ max}$	$V_{EE} \leq V_{SS} < V_{CC} < V_{DD}$	$V_{SS} - 18\text{ to }V_{SS}$	V
	$V_{CC}\text{ max}$	$V_{EE} \leq V_{SS} < V_{CC} < V_{DD}$	$V_{SS}\text{ to }V_{SS} + 7$	V
Maximum input voltage	$V_{IN}\text{ max1}$	CL, DI, CE	$0\text{ to }V_{CC} + 0.3$	V
	$V_{IN}\text{ max2}$	L5dBIN, R5dBIN, L1dBIN, R1dBIN	$V_{EE} - 0.3\text{ to }V_{DD} + 0.3$	V
	$V_{IN}\text{ max3}$	S	$V_{CC} - 0.3\text{ to }V_{DD} + 0.3$	V
Allowable power dissipation	$P_d\text{ max}$	$T_a \leq 75^\circ\text{C}$	250	mW
Operating temperature	T_{opr}		$-30\text{ to }+75$	$^\circ\text{C}$
Storage temperature	T_{stg}		$-40\text{ to }+125$	$^\circ\text{C}$

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

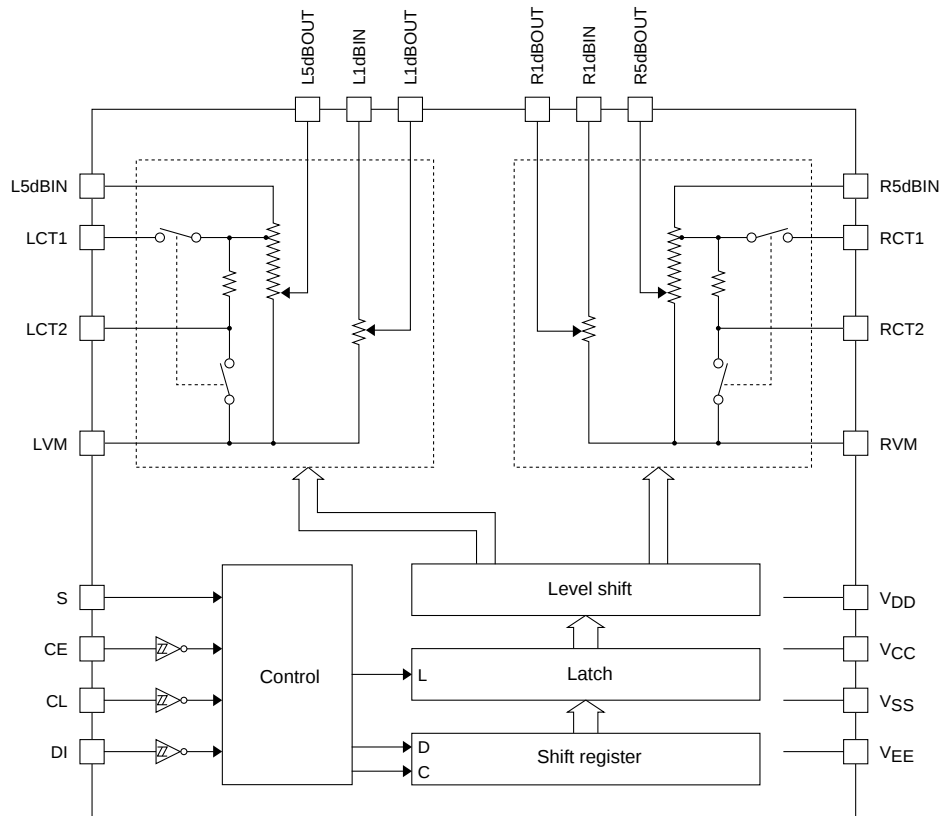
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Supply voltage	V_{DD}	V_{DD}	$V_{CC} + 4.5$		16	V
	V_{EE}	V_{EE}	-16		0	V
	V_{CC}	V_{CC}	4.5	5	5.5	V
High-level input voltage	V_{IH1}	CL, DI, CE	$0.8 V_{CC}$		V_{CC}	V
	V_{IH2}	S	$0.8 \times (V_{DD} - V_{CC}) + V_{CC}$		V_{DD}	V
Low-level input voltage	V_{IL1}	CL, DI, CE	V_{SS}		$0.2 V_{CC}$	V
	V_{IL2}	S	V_{CC}		$0.2 \times (V_{DD} - V_{CC}) + V_{CC}$	V
Input voltage amplitude	V_{IN}	L5dBIN, R5dBIN, L1dBIN, R1dBIN	V_{EE}		V_{DD}	Vp-p
Input pulse width	$t_{\theta W}$	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 $T_a = 25^\circ\text{C}$, $V_{SS} = 0\text{ V}$

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Total harmonic distortion	THD1	$V_{IN} = 1\text{ Vrms}$, $f = 1\text{ kHz}$, all controls flat overall, $V_{DD} - V_{EE} = 32\text{ V}$		0.004		%
	THD2	$V_{IN} = 0.1\text{ Vrms}$, $f = 1\text{ kHz}$, all controls flat overall, $V_{DD} - V_{EE} = 32\text{ V}$		0.02		%
Crosstalk	C_T	$V_{IN} = 1\text{ Vrms}$, $f = 1\text{ kHz}$, $V_{DD} - V_{EE} = 32\text{ V}$, All controls flat overall, $R_g = 1\text{ k}\Omega$		-75	-60	dB
Output at maximum attenuation	$V_o\text{ min}$	$V_{IN} = 1\text{ V rms}$, $f = 20\text{ kHz}$, volume control set at $-\infty$, $V_{DD} - V_{EE} = 32\text{ V}$		-98		dB
Output noise voltage	V_N	All controls flat overall, $R_g = 1\text{ k}\Omega$, IHF-A, $V_{DD} - V_{EE} = 32\text{ V}$		2	10	μV
Total resistance	Rvol1	The 5-dB step volume block		75		$\text{k}\Omega$
	Rvol2	The 1-dB step volume block		20		$\text{k}\Omega$
Output off leakage current	I_{OFF}	L5dBIN, R5dBIN, LCT1, RCT1, LCT2, RCT2, L5dBOUT, R5dBOUT, L1dBIN, R1dBIN, L1dBOUT, R1dBOUT, LVM, RVM	-10		+10	μA
High-level input current	I_{IH}	CL, DI, CE, $V_{IN} = V_{CC}$			+10	μA
Low-level input current	I_{IL}	CL, DI, CE, $V_{IN} = V_{SS}$	-10			μA
Current drain	I_{DD}	$V_{DD} = 16\text{ V}$			1	mA
	I_{CC}	$V_{DD} = 5.5\text{ V}$			1	mA

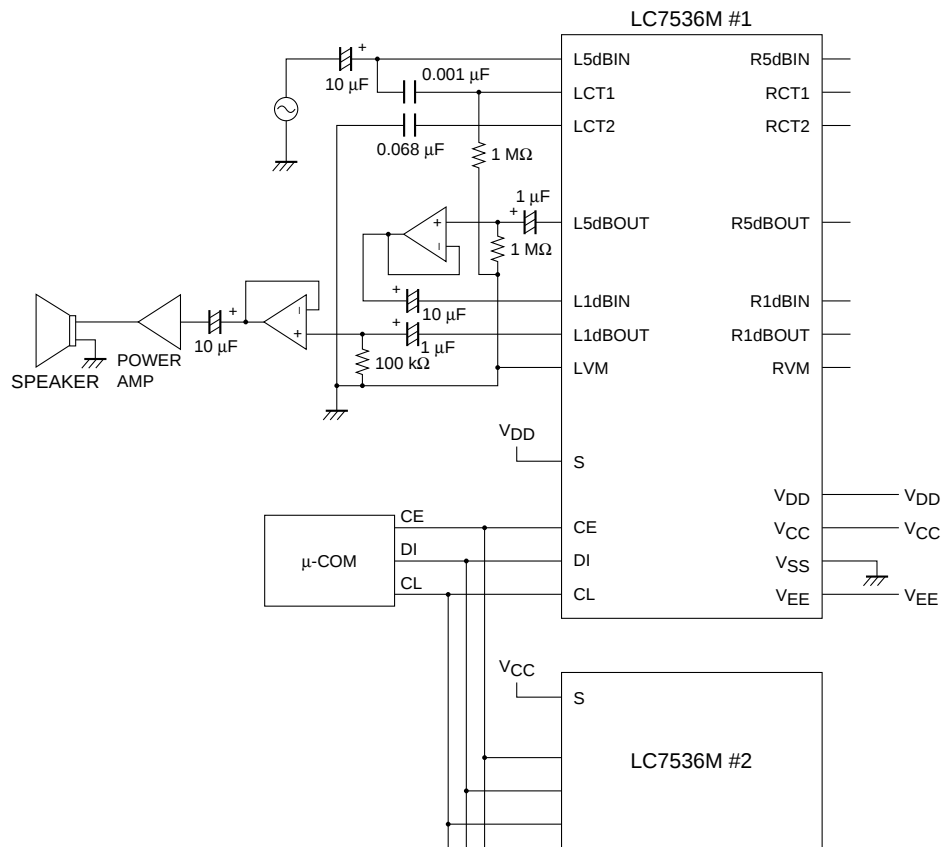
LC7536M

Equivalent Circuit



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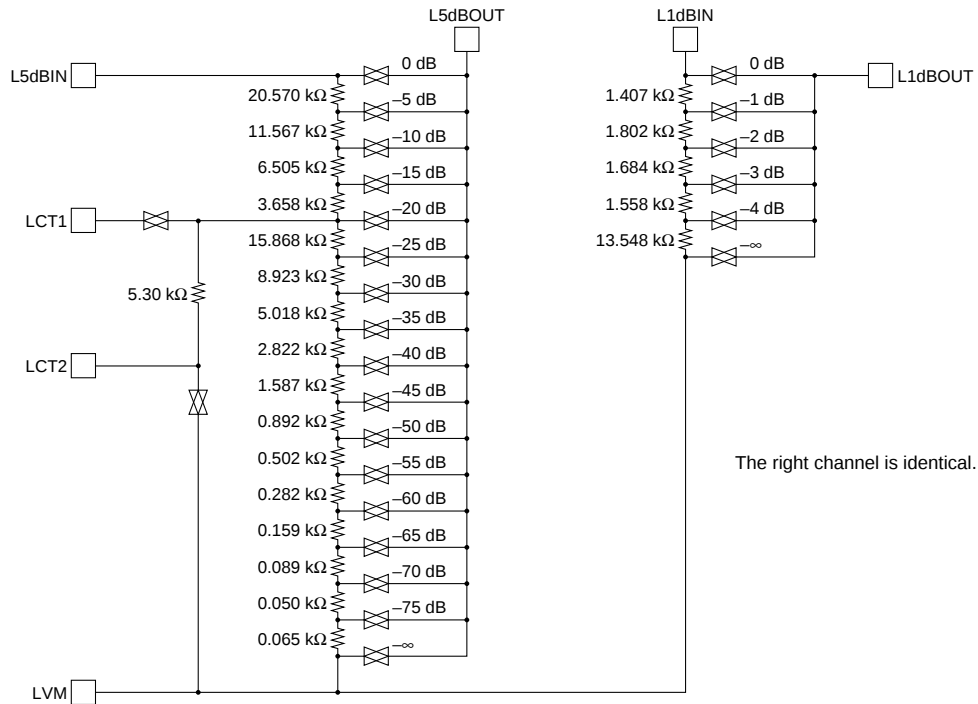
Sample Application Circuit



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LC7536M

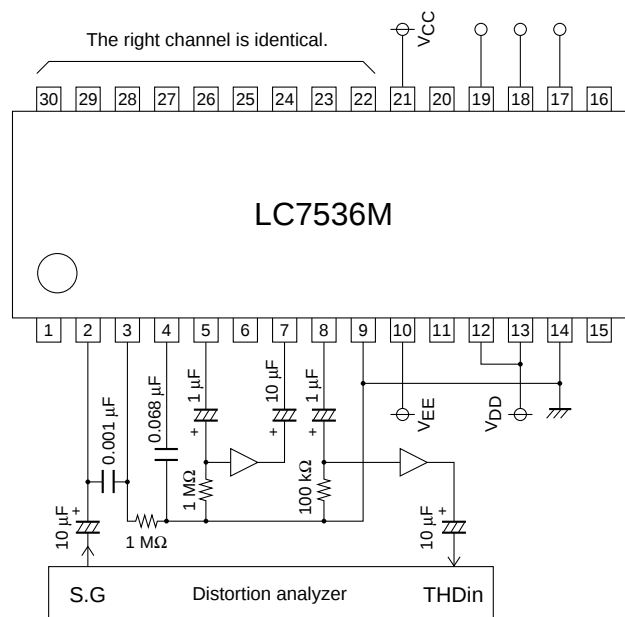
Internal Resistor Equivalent Circuit



A11991

Test Circuit

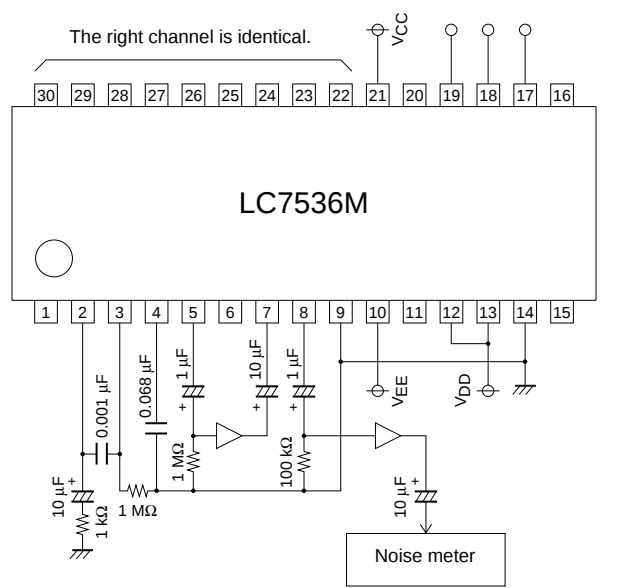
- Total harmonic distortion



A11992

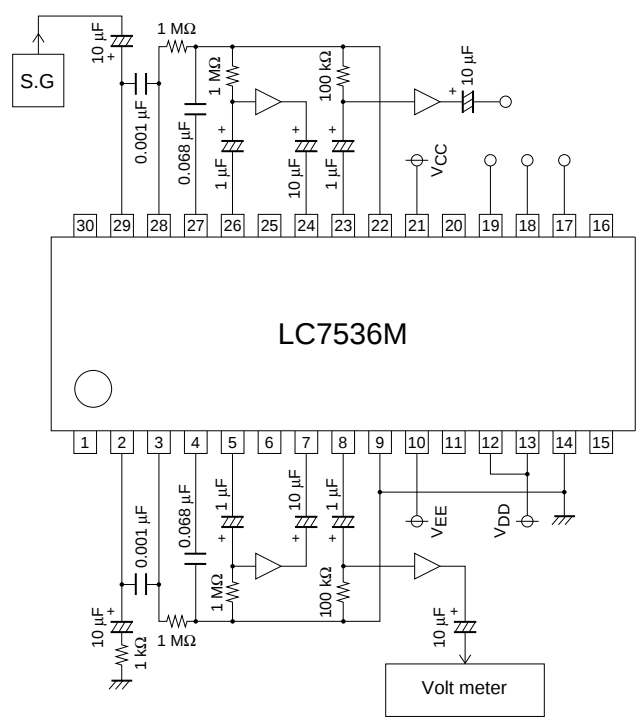
LC7536M

- Output noise voltage



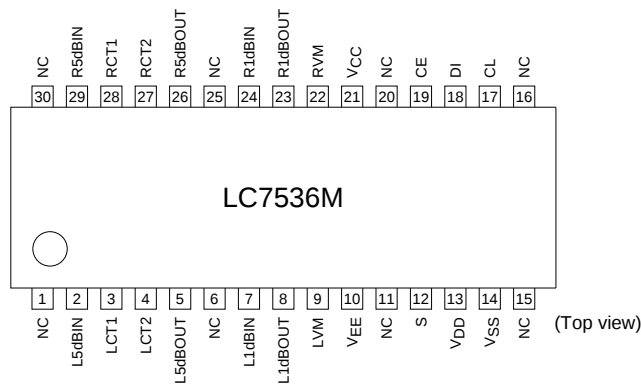
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- Crosstalk



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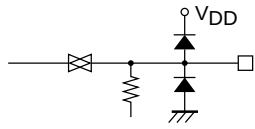
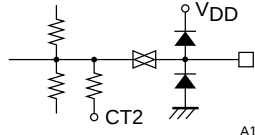
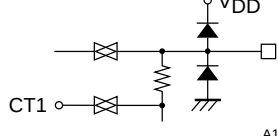
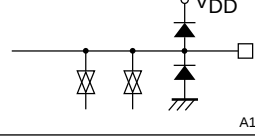
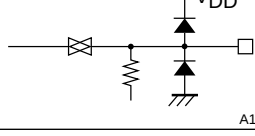
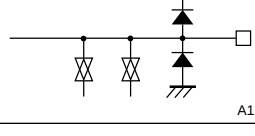
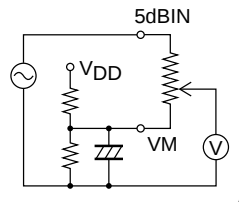
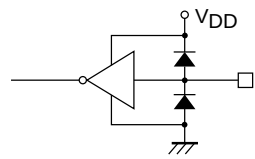
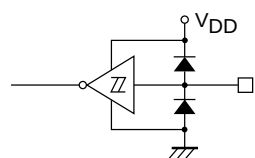
Pin Assignment



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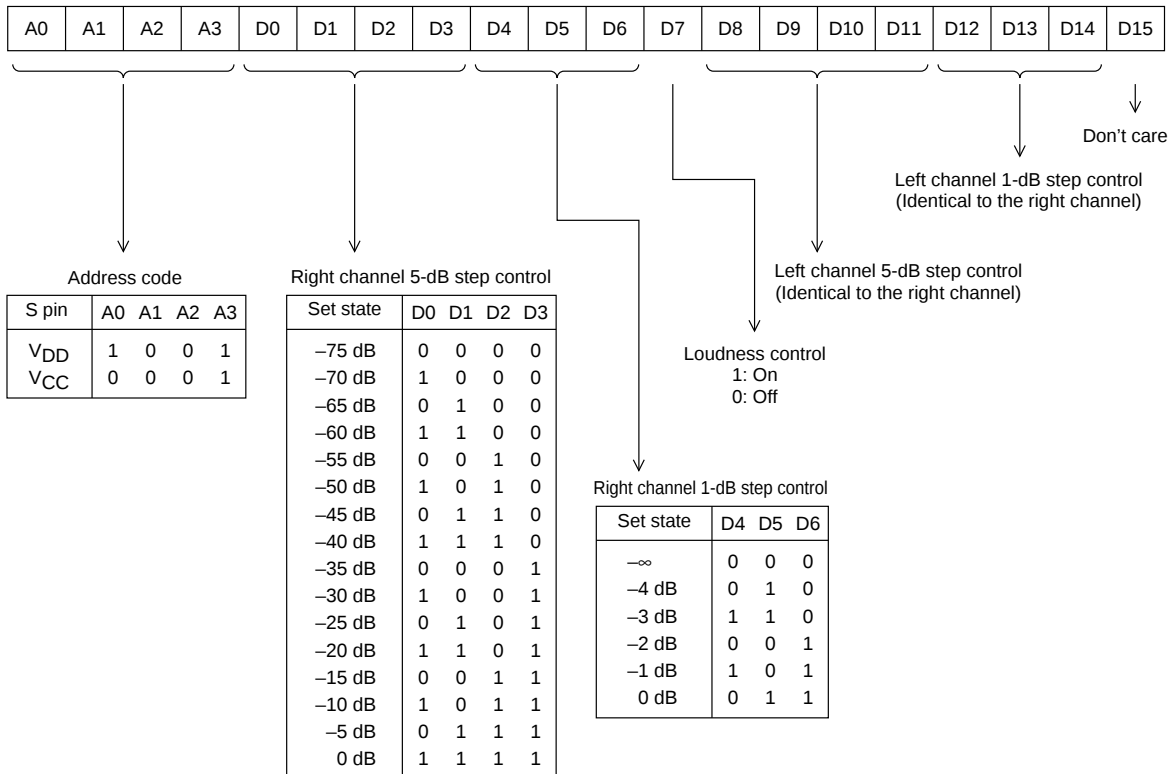
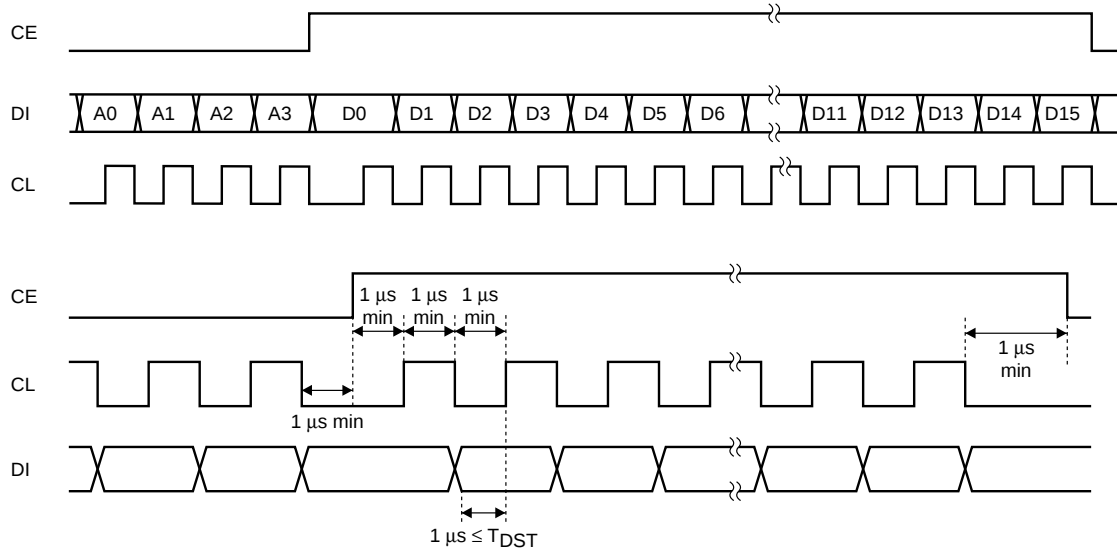
LC7536M

Pin Functions

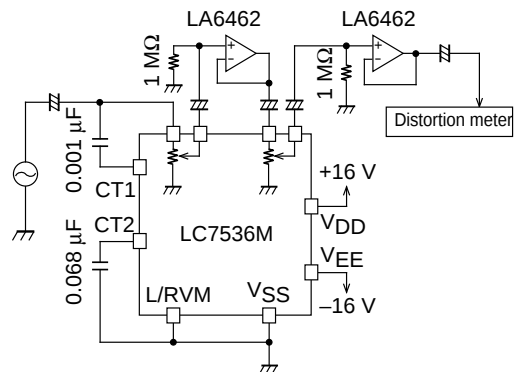
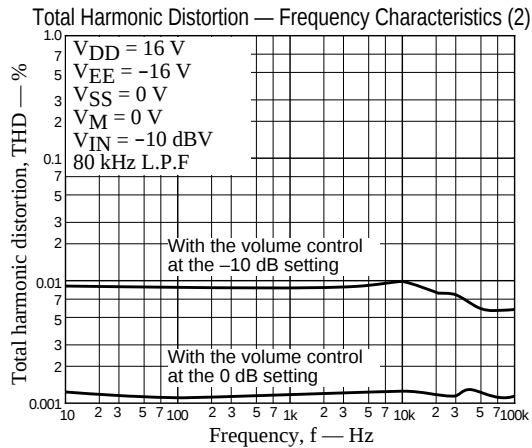
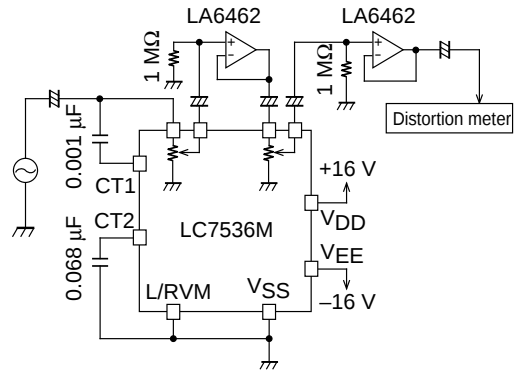
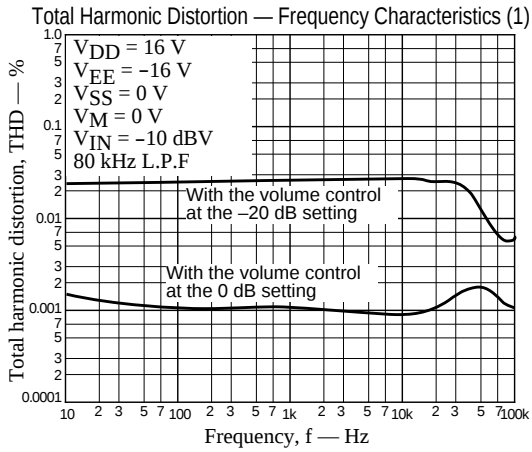
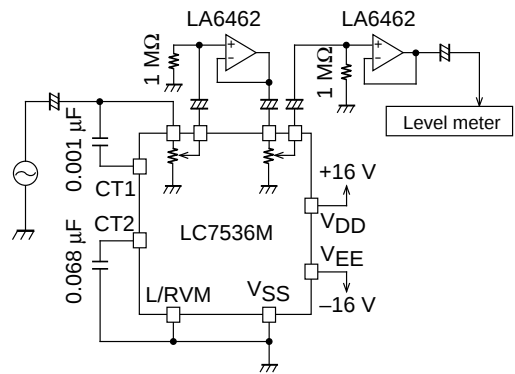
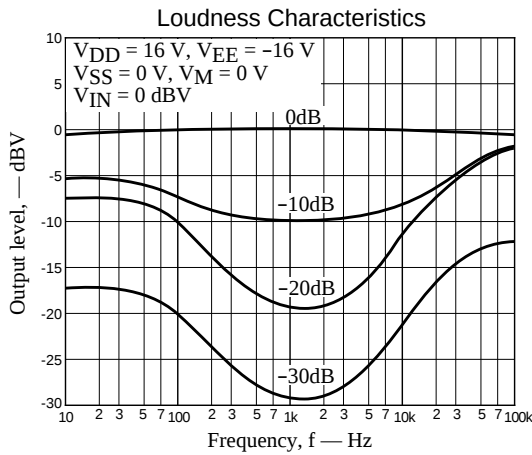
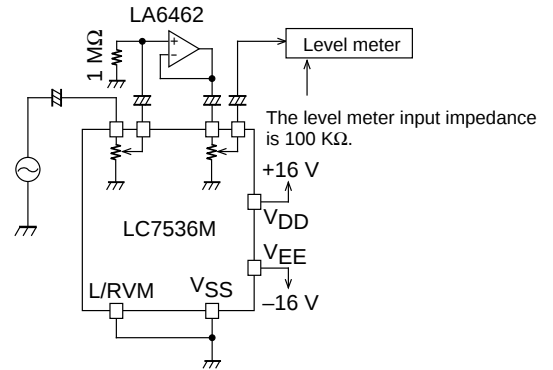
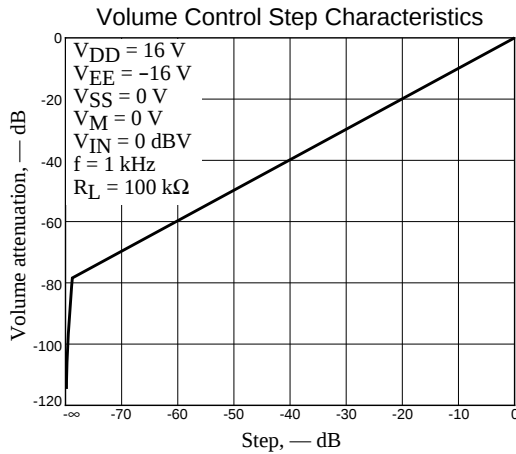
Pin No.	Pin	Function	Equivalent circuit
2	L5dBIN	5-dB step attenuator inputs These inputs must be driven by low-impedance circuits.	 A11996
29	R5dBIN		
3	LCT1	Loudness circuit connections Connect high-band compensation capacitors between the CT1 and 5dBIN pins, and connect low-band compensation capacitors between the CT2 and VM pins.	 A11997
28	RCT1		 A11998
4	LCT2		
27	RCT2		
5	L5dBOUT	5-dB step attenuator outputs These signals should be received by loads of about 47 kΩ to 1 MΩ.	 A11999
26	R5dBOUT		
7	L1dBIN	1-dB step attenuator inputs These inputs must be driven by low-impedance circuits.	 A12000
24	R1dBIN		
8	L1dBOUT	1-dB step attenuator outputs These signals should be received by loads of about 47 kΩ to 1 MΩ.	 A12001
23	R1dBOUT		
9	LVM	Common pins for the volume controls. The printed circuit board pattern for these pins should be designed to have as low an impedance as possible. Since LVM, RVM, and VSS are not connected internally in the IC, they may be connected to separate external circuits that meet their individual specifications. Since the capacitors between the VM pins and the power supply when a single power supply is used become the residual resistance components at maximum attenuation, care is required in determining the values of these capacitors.	 A12002
22	RVM		
12	S	Selects the address code of data during formatted. When this pin is connected to VDD, the IC accepts data when the address code is 9, and when connected to VCC, it accepts data when the address code is 8.	 A12003
17	CL	Inputs for the serial data that controls the IC. The input signals must have an amplitude of 0 to 5 V.	 A12004
18	DI		
19	CE		
10	V _{EE}	Power supply connections. These pins must be connected to the corresponding power supply. Applications must be designed so that VCC is not applied before VDD.	
13	V _{DD}		
14	V _{SS}		
21	V _{CC}		
1, 6, 11, 15, 16, 20, 25, 30	NC	Unused pins. These pins must be left open.	

Control System Timing and Data Format

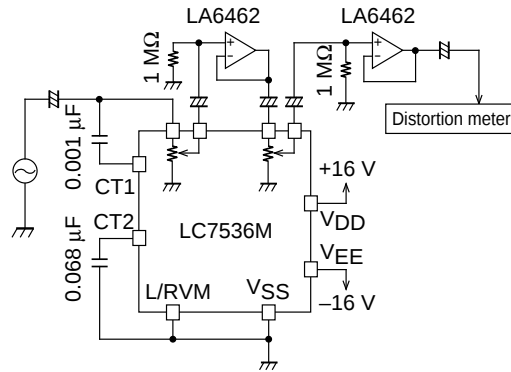
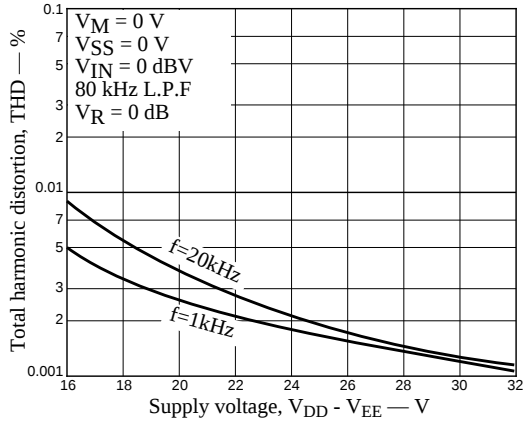
To control the LC7536M, apply the stipulated data signals to the CL, DI, and CE pins. The data consists of 20 bits, of which 4 bits are the address and 16 bits are the data.



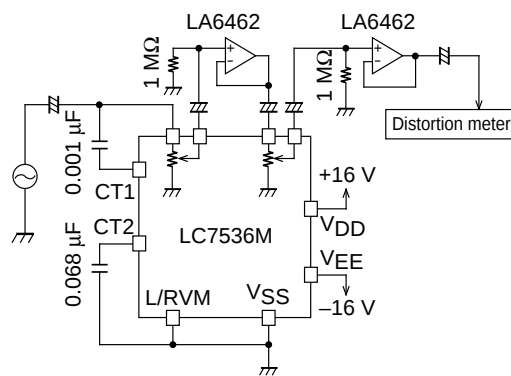
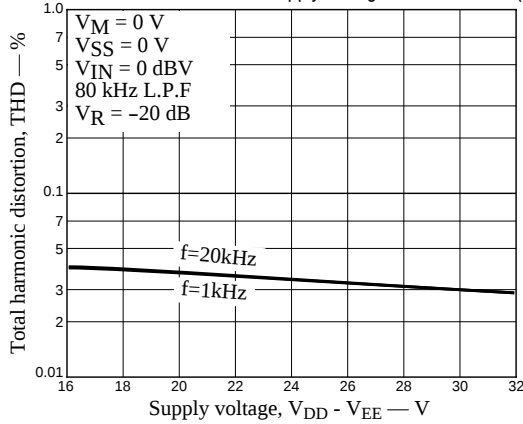
A12005



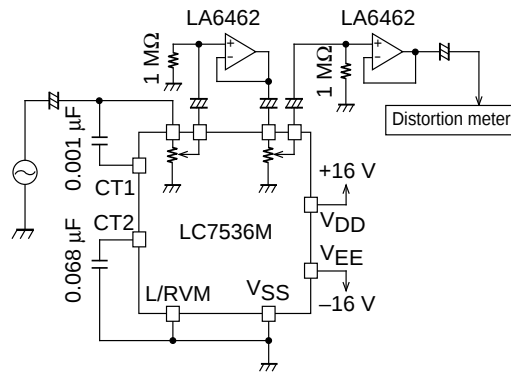
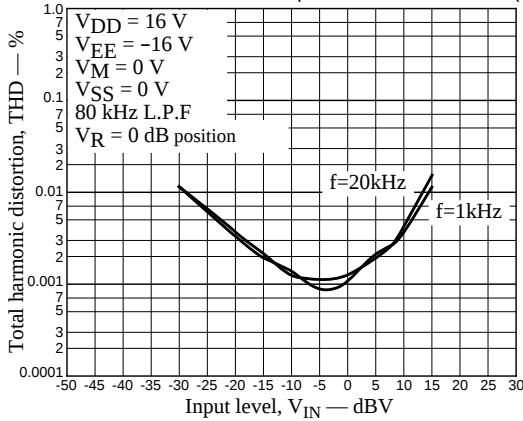
Total Harmonic Distortion — Supply Voltage Characteristics (1)



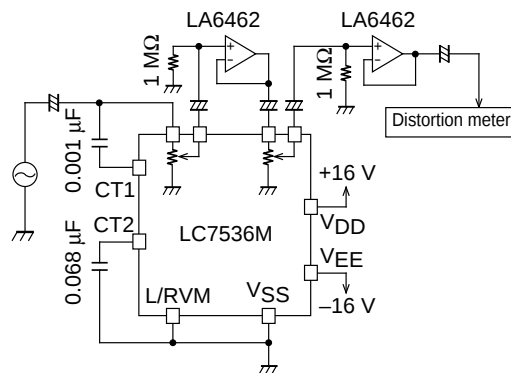
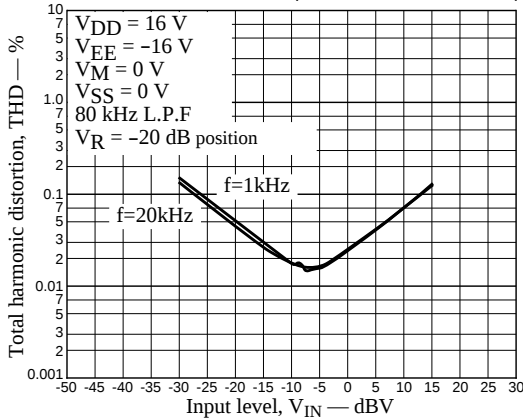
Total Harmonic Distortion — Supply Voltage Characteristics (2)



Total Harmonic Distortion — Input Level Characteristics (1)



Total Harmonic Distortion — Input Level Characteristics (2)



Usage Notes

- The states of the internal analog switches are undefined when power is first applied. Applications should apply muting to the analog signal system externally until control data has been transferred to the IC.
- To prevent noise from the high-frequency digital signals on the CL, DI, and CE pin lines from entering the analog signal system, either shielded lines should be used for these lines, or they should be covered by the ground pattern.

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