

SANYO

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.

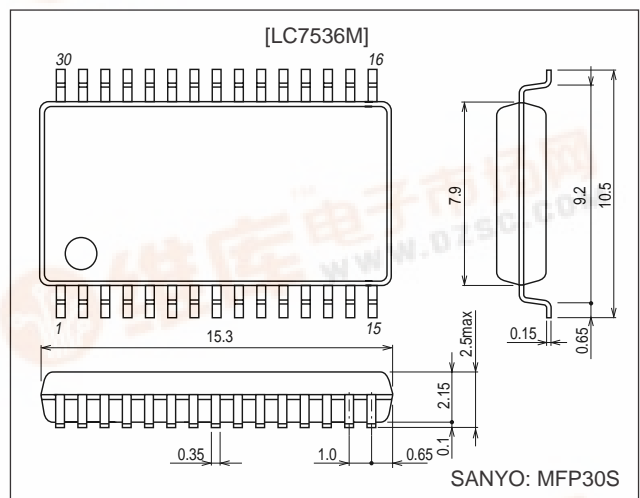
Features

- High voltage handling capability: ± 16 V.

Package Dimensions

unit: mm

3216A-MFP30S



- 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.

- Any and all SANYO products described or contained herein do not have specifications that can handle applications that require extremely high levels of reliability, such as life-support systems, aircraft's control systems, or other applications whose failure can be reasonably expected to result in serious physical and/or material damage. Consult with your SANYO representative nearest you before using any SANYO products described or contained herein in such applications.
- SANYO assumes no responsibility for equipment failures that result from using products at values that exceed, even momentarily, rated values (such as maximum ratings, operating condition ranges, or other parameters) listed in products specifications of any and all SANYO products described or contained herein.



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} to $V_{SS} + 18$	V
	$V_{EE\text{ max}}$	$V_{EE} \leq V_{SS} < V_{CC} < V_{DD}$	$V_{SS} - 18$ to V_{SS}	V
	$V_{CC\text{ max}}$	$V_{EE} \leq V_{SS} < V_{CC} < V_{DD}$	V_{SS} to $V_{SS} + 7$	V
Maximum input voltage	$V_{IN\text{ max1}}$	CL, DI, CE	0 to $V_{CC} + 0.3$	V
	$V_{IN\text{ max2}}$	L5dBIN, R5dBIN, L1dBIN, R1dBIN	$V_{EE} - 0.3$ to $V_{DD} + 0.3$	V
	$V_{IN\text{ max3}}$	S	$V_{CC} - 0.3$ 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 to $+75$	$^\circ\text{C}$
Storage temperature	T_{stg}		-40 to $+125$	$^\circ\text{C}$

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

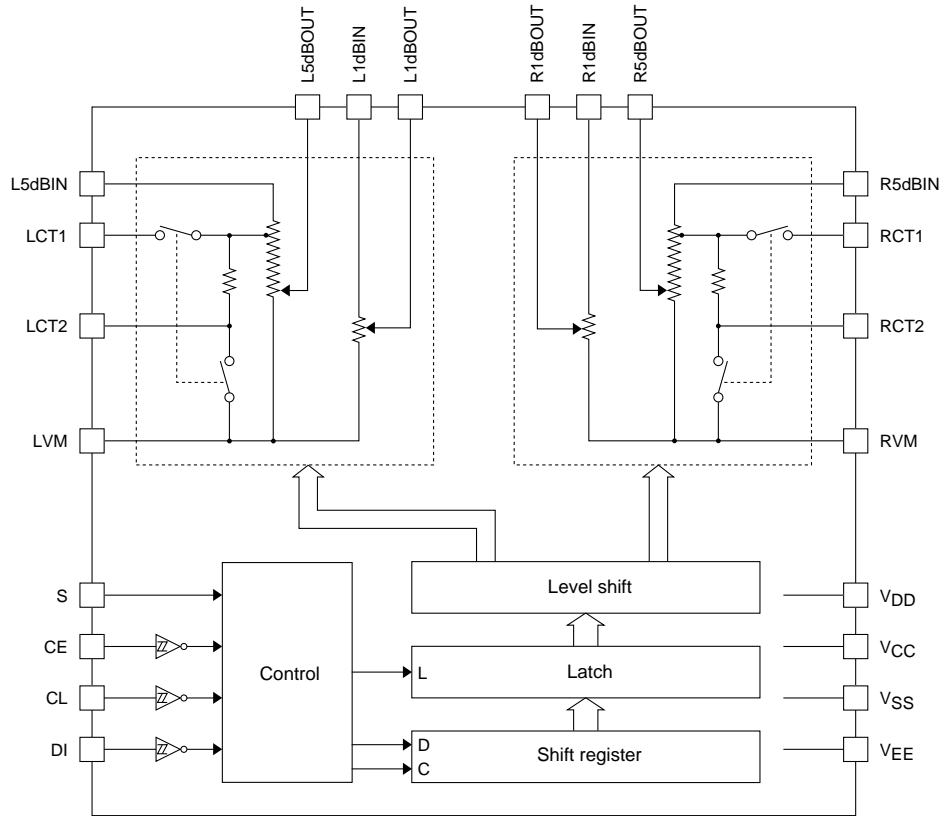
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Supply voltage	V_{DD}	V_{DD}	$V_{CC} + 4.5$		16	V
	V_{EE}	V_{EE}	-16		0	V
	V_{CC}	V_{CC}	4.5	5	5.5	V
High-level input voltage	V_{IH1}	CL, DI, CE	$0.8 V_{CC}$		V_{CC}	V
	V_{IH2}	S	$0.8 \times (V_{DD} - V_{CC}) + V_{CC}$		V_{DD}	V
Low-level input 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

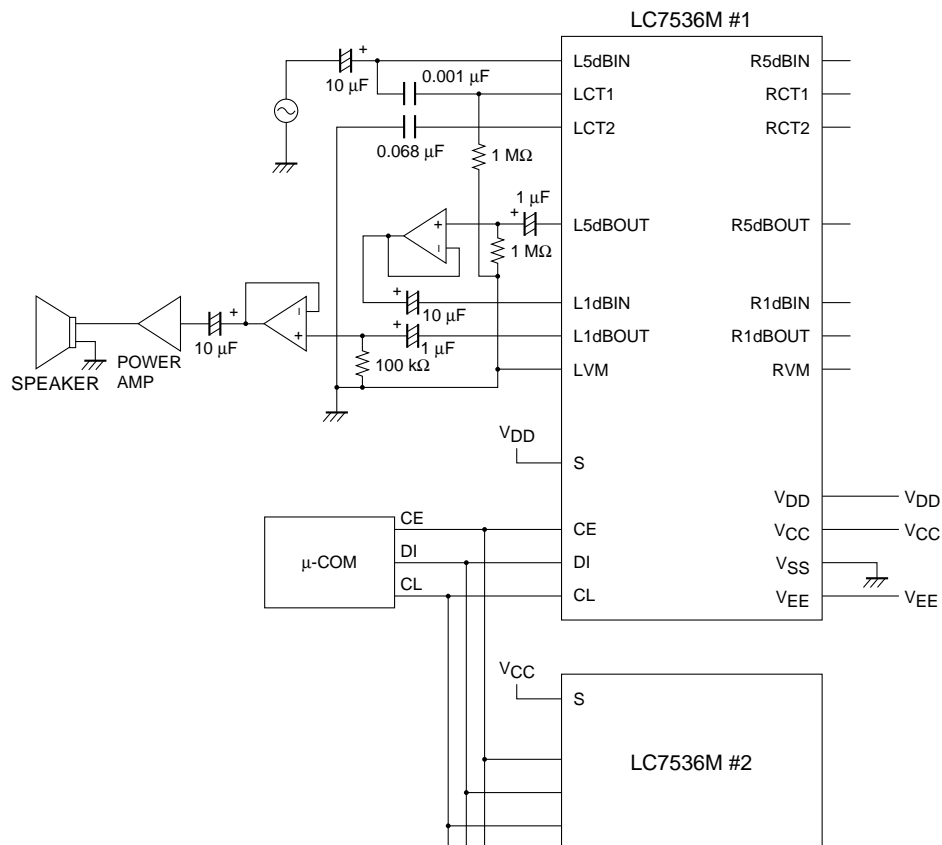
LC7536M

Equivalent Circuit



A11989

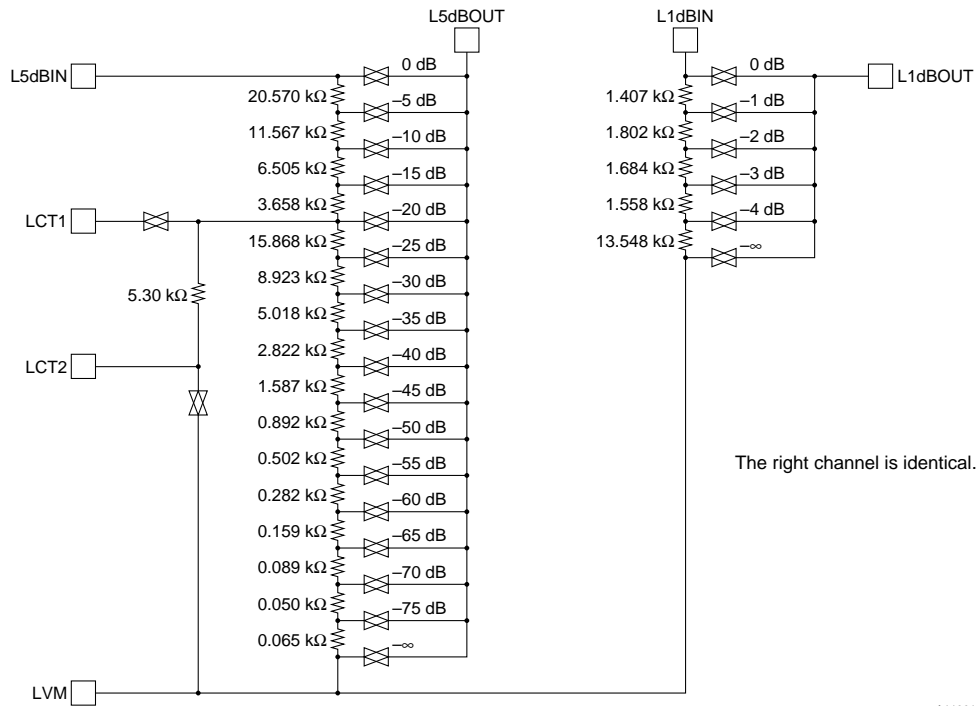
Sample Application Circuit



A11990

LC7536M

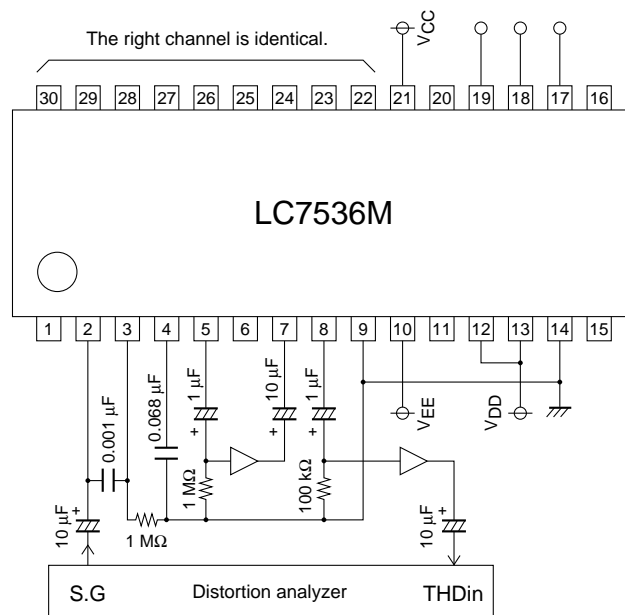
Internal Resistor Equivalent Circuit



A11991

Test Circuit

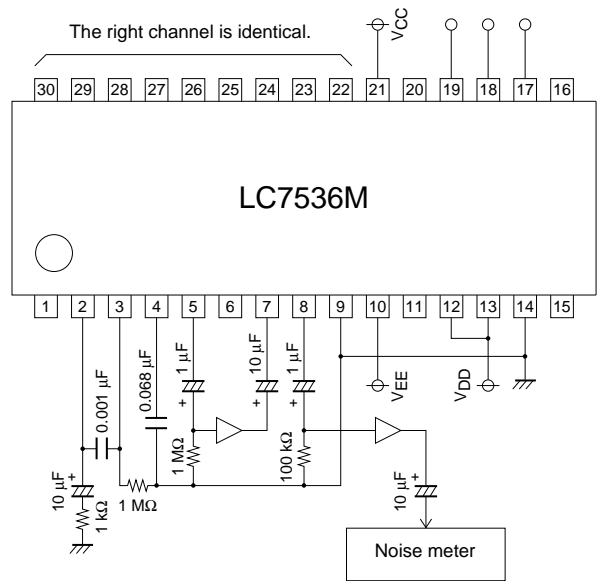
- Total harmonic distortion



A11992

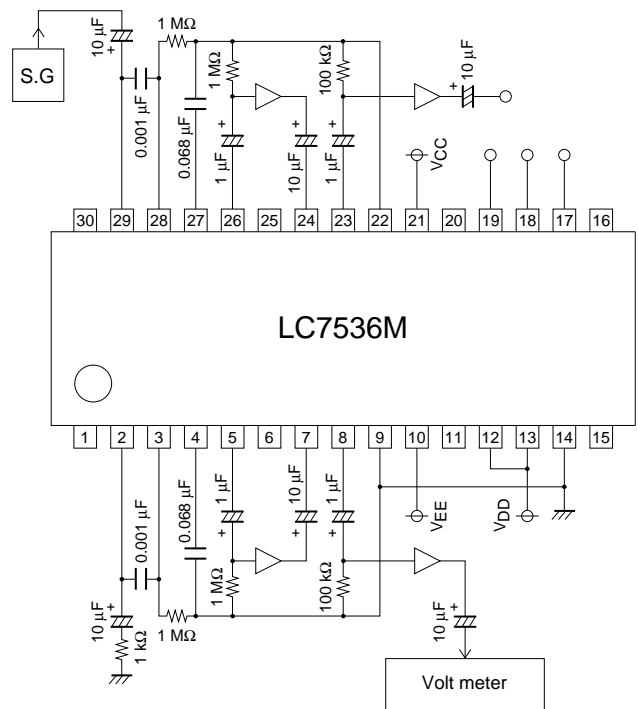
LC7536M

- Output noise voltage



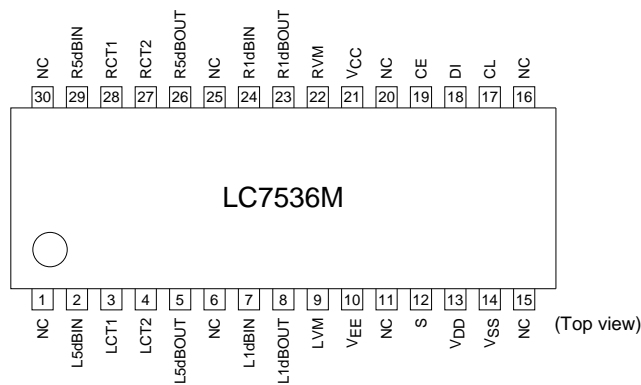
A11993

- Crosstalk



A11994

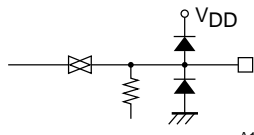
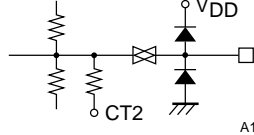
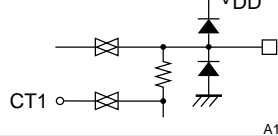
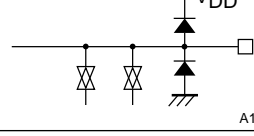
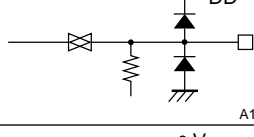
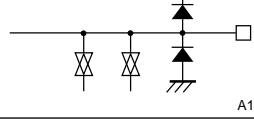
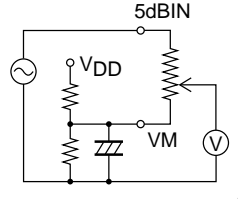
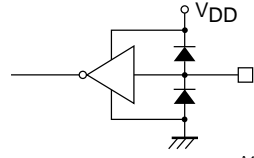
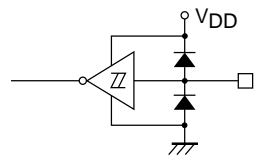
Pin Assignment



A11995

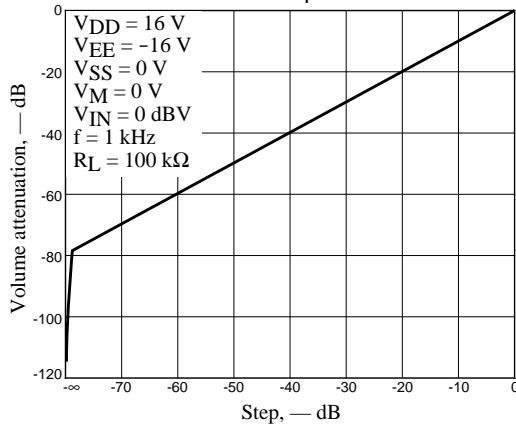
LC7536M

Pin Functions

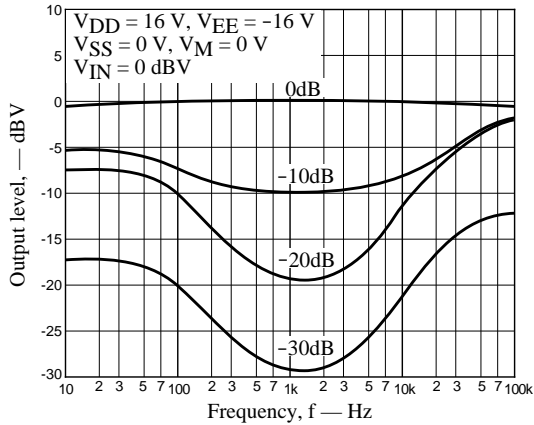
Pin No.	Pin	Function	Equivalent circuit
2	L5dBIN	<ul style="list-style-type: none"> 5-dB step attenuator inputs <p>These inputs must be driven by low-impedance circuits.</p>	 <p style="text-align: right;">A11996</p>
29	R5dBIN		
3	LCT1	<ul style="list-style-type: none"> Loudness circuit connections <p>Connect high-band compensation capacitors between the CT1 and 5dBIN pins, and connect low-band compensation capacitors between the CT2 and VM pins.</p>	 <p style="text-align: right;">A11997</p>
28	RCT1		 <p style="text-align: right;">A11998</p>
4	LCT2		
27	RCT2		
5	L5dBOUT	<ul style="list-style-type: none"> 5-dB step attenuator outputs <p>These signals should be received by loads of about 47 kΩ to 1 MΩ.</p>	 <p style="text-align: right;">A11999</p>
26	R5dBOUT		
7	L1dBIN	<ul style="list-style-type: none"> 1-dB step attenuator inputs <p>These inputs must be driven by low-impedance circuits.</p>	 <p style="text-align: right;">A12000</p>
24	R1dBIN		
8	L1dBOUT	<ul style="list-style-type: none"> 1-dB step attenuator outputs <p>These signals should be received by loads of about 47 kΩ to 1 MΩ.</p>	 <p style="text-align: right;">A12001</p>
23	R1dBOUT		
9	LVM	<ul style="list-style-type: none"> 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. <p>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.</p>	 <p style="text-align: right;">A12002</p>
22	RVM		
12	S	<ul style="list-style-type: none"> 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. 	 <p style="text-align: right;">A12003</p>
17	CL	<ul style="list-style-type: none"> Inputs for the serial data that controls the IC. The input signals must have an amplitude of 0 to 5 V. 	 <p style="text-align: right;">A12004</p>
18	DI		
19	CE		
10	V _{EE}	<ul style="list-style-type: none"> Power supply connections. These pins must be connected to the corresponding power supply. Applications must be designed so that V_{CC} is not applied before V_{DD}. 	
13	V _{DD}		
14	V _{SS}		
21	V _{CC}		
1, 6, 11, 15, 16, 20, 25, 30	NC	<ul style="list-style-type: none"> Unused pins. These pins must be left open. 	

LC7536M

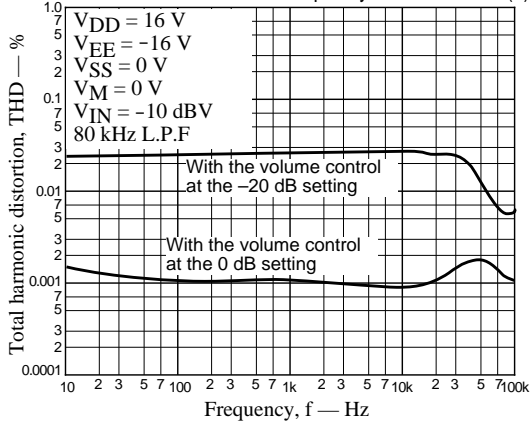
Volume Control Step Characteristics



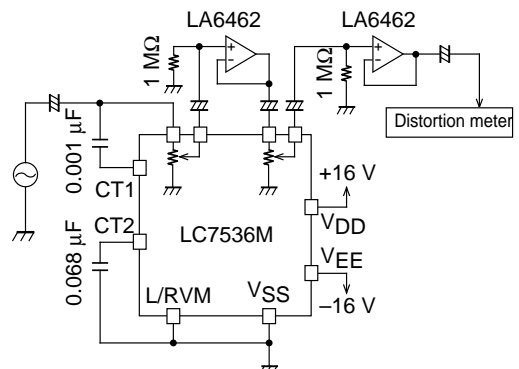
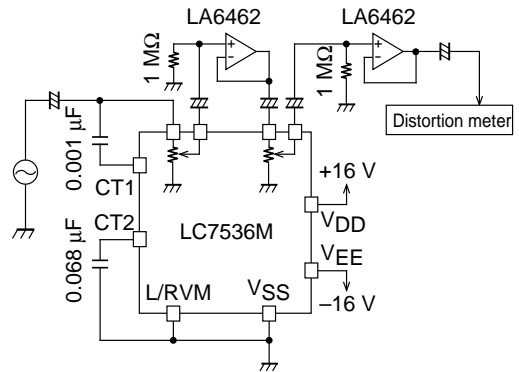
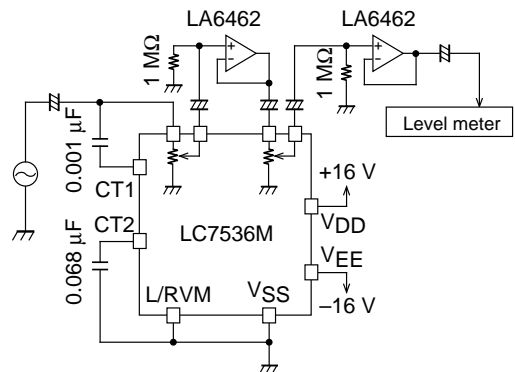
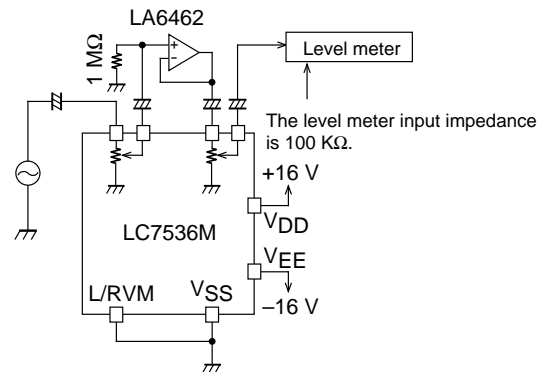
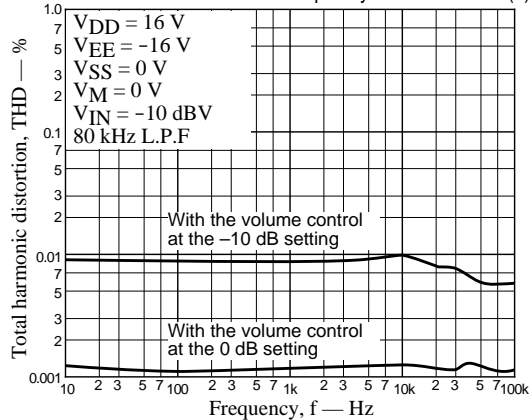
Loudness Characteristics



Total Harmonic Distortion — Frequency Characteristics (1)

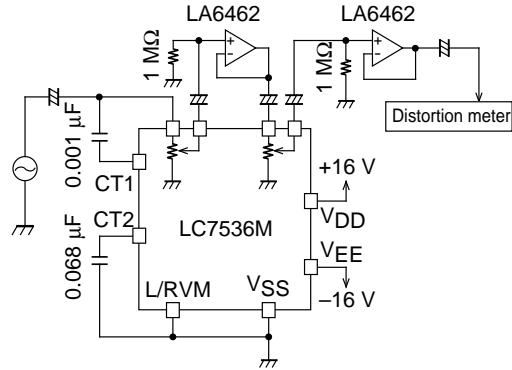
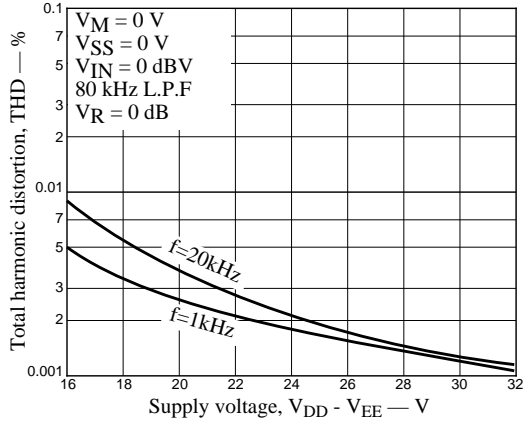


Total Harmonic Distortion — Frequency Characteristics (2)

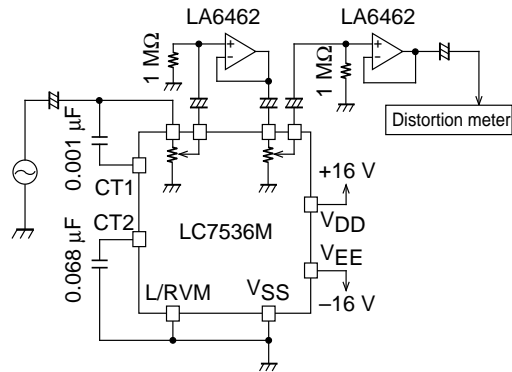
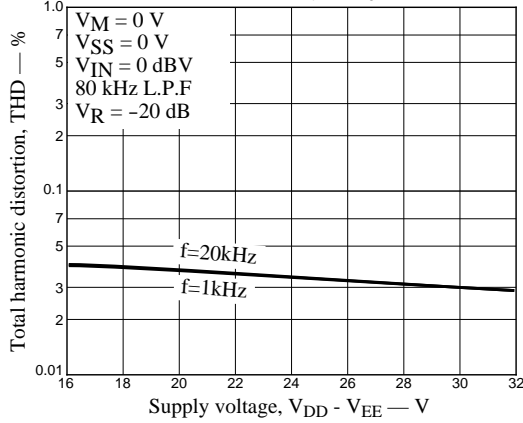


LC7536M

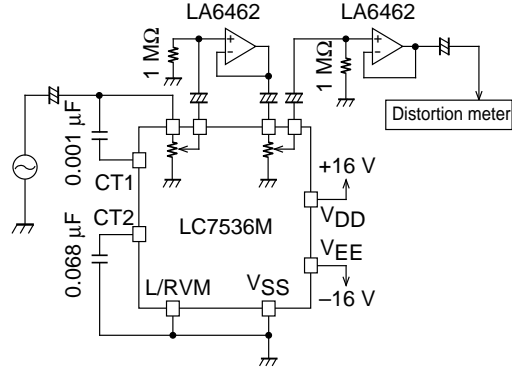
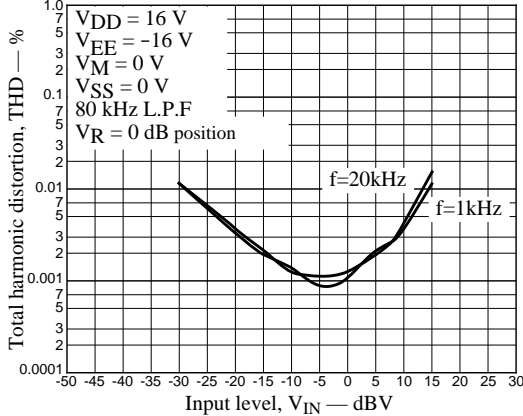
Total Harmonic Distortion — Supply Voltage Characteristics (1)



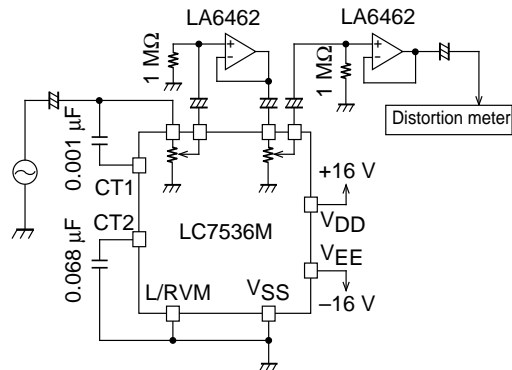
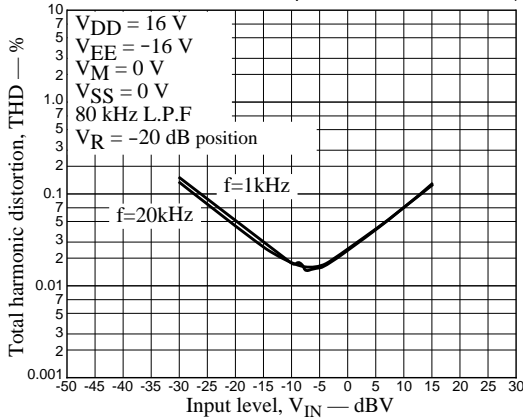
Total Harmonic Distortion — Supply Voltage Characteristics (2)



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.

- Specifications of any and all SANYO products described or contained herein stipulate the performance, characteristics, and functions of the described products in the independent state, and are not guarantees of the performance, characteristics, and functions of the described products as mounted in the customer's products or equipment. To verify symptoms and states that cannot be evaluated in an independent device, the customer should always evaluate and test devices mounted in the customer's products or equipment.
- SANYO Electric Co., Ltd. strives to supply high-quality high-reliability products. However, any and all semiconductor products fail with some probability. It is possible that these probabilistic failures could give rise to accidents or events that could endanger human lives, that could give rise to smoke or fire, or that could cause damage to other property. When designing equipment, adopt safety measures so that these kinds of accidents or events cannot occur. Such measures include but are not limited to protective circuits and error prevention circuits for safe design, redundant design, and structural design.
- In the event that any or all SANYO products (including technical data, services) described or contained herein are controlled under any of applicable local export control laws and regulations, such products must not be exported without obtaining the export license from the authorities concerned in accordance with the above law.
- No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, or any information storage or retrieval system, or otherwise, without the prior written permission of SANYO Electric Co., Ltd.
- Any and all information described or contained herein are subject to change without notice due to product/technology improvement, etc. When designing equipment, refer to the "Delivery Specification" for the SANYO product that you intend to use.
- Information (including circuit diagrams and circuit parameters) herein is for example only; it is not guaranteed for volume production. SANYO believes information herein is accurate and reliable, but no guarantees are made or implied regarding its use or any infringements of intellectual property rights or other rights of third parties.