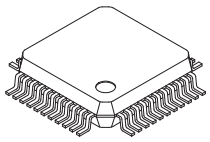
LV3313PM

Electronic Volume for Car Audio Systems

ON Semiconductor®

www.onsemi.com



PQFP44 10x10 / QIP44M

Overview

The LV3313PM is an electronic volume IC that implements a rich set of audio control functions including input selection switching function, an input gain, volume, loudness, balance, fader, and bass/treble control.

Features

- Zero-cross switching circuits (Input gain control block and Volume control block) can switch signal detection location automatically.
- Zero-cross switching circuits (Input gain control block and Volume control block) and soft mute circuits used for low noise even when input signals are present.
- Low power consumption due to the use of BiMOS process.
- All functions are controlled using serial data (CCB*).

Functions

- Input selector :
  Four input signals can be selected (three single-ended inputs and one differential input).
- Input gain control :
  The input signal can be amplified by 0 dB to +18 dB (1 dB steps).
- Loudness control :
  Taps are output starting at the −32 dB position of the ladder resistor and a loudness function implemented with external capacitor and resistor components.
- Volume control : +10 dB to −79 dB / −∞ (1 dB steps)
  L/R independent control.
- Bass control : +12 dB to −12 dB in 2 dB steps
- Treble control : +12 dB to −12 dB in 2 dB steps
- Fader control :
  The fader volume can be attenuations by one of 16 levels. Independent control each four channels. (A total of 16 settings with attenuations of 0 dB to −2 dB in 1 dB steps, −2 dB to −20 dB in 2 dB steps, and −30 dB, −45 dB, −60 dB and −∞ dB settings.)
- Mute

* Computer Control Bus (CCB) is an ON Semiconductor's original bus format and the bus addresses are controlled by ON Semiconductor.

ORDERING INFORMATION

See detailed ordering and shipping information on page 19 of this data sheet.

July 2017 - Rev. 1

Publication Order Number :
LV3313PM/D

Specifications

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

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V_{DD} max	V_{DD}	9.5	V
Maximum input voltage	V_{IN} max	All input pins	V_{SS}−0.3 to V_{DD}	V
Allowable power dissipation	Pd max	Ta ≤ 85°C, when mounted on a printed circuit board *	600	mW
Operating temperature	Topr		−40 to +85	°C
Storage temperature	Tstg		−50 to +125	°C

* Specified circuit board : 114.3 × 76.1 × 1.6 mm : glass epoxy board

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.

Allowable Operating Ratings at Ta = 25°C, V_{SS} = 0 V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Supply voltage	V_{DD}	V_{DD}	7.0	8.0	9.0	V
High-level input voltage	V_{IH}	CL, DI, CE	3.0		5.5	V
Low-level input voltage	V_{IL}	CL, DI, CE	V_{SS}		1.0	V
Input voltage amplitude	V_{IN}		V_{SS}		V_{DD}	Vp-p
Input pulse width	TϕW	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
Rising time	tr	CL, DI, CE			0.1/fopg	s
Falling time	tf					

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 Ta = 25°C, V_{DD} = 8 V, V_{SS} = 0 V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Input block						
Input resistance	Rin	L1-L3, R1-R3	35	50	65	kΩ
Minimum input gain	Gin min	L1-L3, R1-R3	−1.0	0	+1.0	dB
Maximum input gain	Gi max		+17	+18	+19	dB
Inter-step setting error	ATerr		−1.0		+1.0	dB
Left/Right balance	BAL		−0.5		+0.5	dB
Volume block						
Input resistance	Rvr	LVRIN, RVRIN	35	50	65	kΩ
Inter-step setting error	ATerr	+10 dB to −40 dB	−0.5		+0.5	dB
Left/Right balance	BAL		−0.5		+0.5	dB
Bass block						
Bass control range	Gb max	max. boost/cut	±10	±12	±14	dB
Inter-step setting error	ATerr	−10 dB to +10 dB	−0.5		+0.5	dB
Left/Right balance	BAL		−0.5		+0.5	dB
Treble block						
Treble control range	Gb max	max. boost/cut	±10	±12	±14	dB
Inter-step setting error	ATerr	−10 dB to +10 dB	−0.5		+0.5	dB
Left/Right balance	BAL		−0.5		+0.5	dB
Fader block						
Input resistance	Rfed		35	50	65	kΩ
Inter-step setting error	ATerr	0 dB to −2 dB	−0.5		+0.5	dB
		−4 dB to −20 dB	−1.0		+1.0	dB
		−30 dB	−2.0		+2.0	dB
		−45 dB	−3.0		+3.0	dB
Left/Right balance	BAL	0 dB to −30 dB	−0.5		+0.5	dB

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.

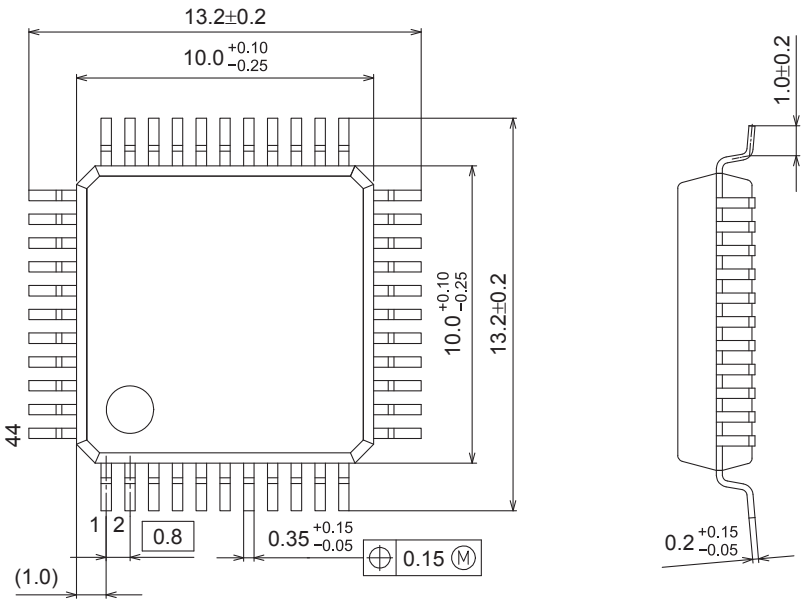
Overall Characteristics at Ta = 25°C, V_{DD} = 8 V, V_{SS} = 0 V

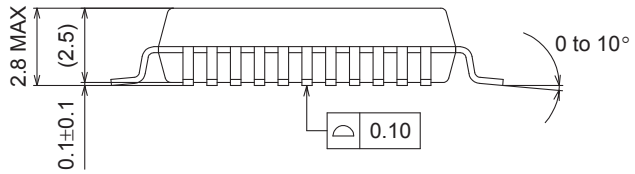
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
A loss of insertion	ATT		−1.0		+1.0	dB
Total harmonic distortion	THD	V_{IN} = 1 Vrms, f = 1 kHz		0.004	0.01	%
Inter-input crosstalk	CT	V_{IN} = 1 Vrms, f = 1 kHz	80	88		dB
Left/Right channel crosstalk	CT	V_{IN} = 1 Vrms, f = 1 kHz	80	88		dB
Maximum attenuation	V_O min	V_{IN} = 1 Vrms, f = 1 kHz	80	88		dB
Output noise voltage	VN			10	25	μV
Current drain	I_{DD}			16	23	mA
Input high-level current	I_{IH}	CL, DI, CE, V_{IN} = 5.5 V			10	μA
Input low-level current	I_{IL}	CL, DI, CE, V_{IN} = 0 V	−10			μA
Maximum input voltage	VCL	THD = 1% RL = 10 kΩ all controls flat, f_{IN} = 1 kHz		2.2		Vrms
Common-mode rejection ratio	CMRR	V_{IN} = 1 Vrms, f = 1 kHz		50		dB

Package Dimensions

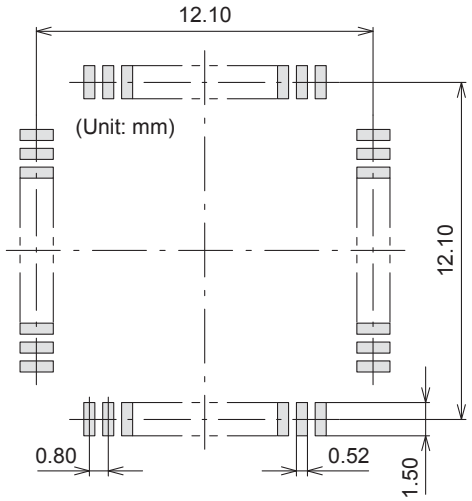
unit : mm

PQFP44 10x10 / QIP44M
CASE 122BK
ISSUE A

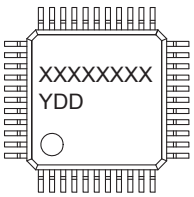




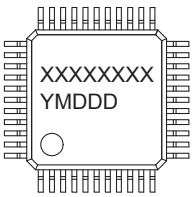
SOLDERING FOOTPRINT*



GENERIC MARKING DIAGRAM*



XXXXX = Specific Device Code
Y = Year
DD = Additional Traceability Data



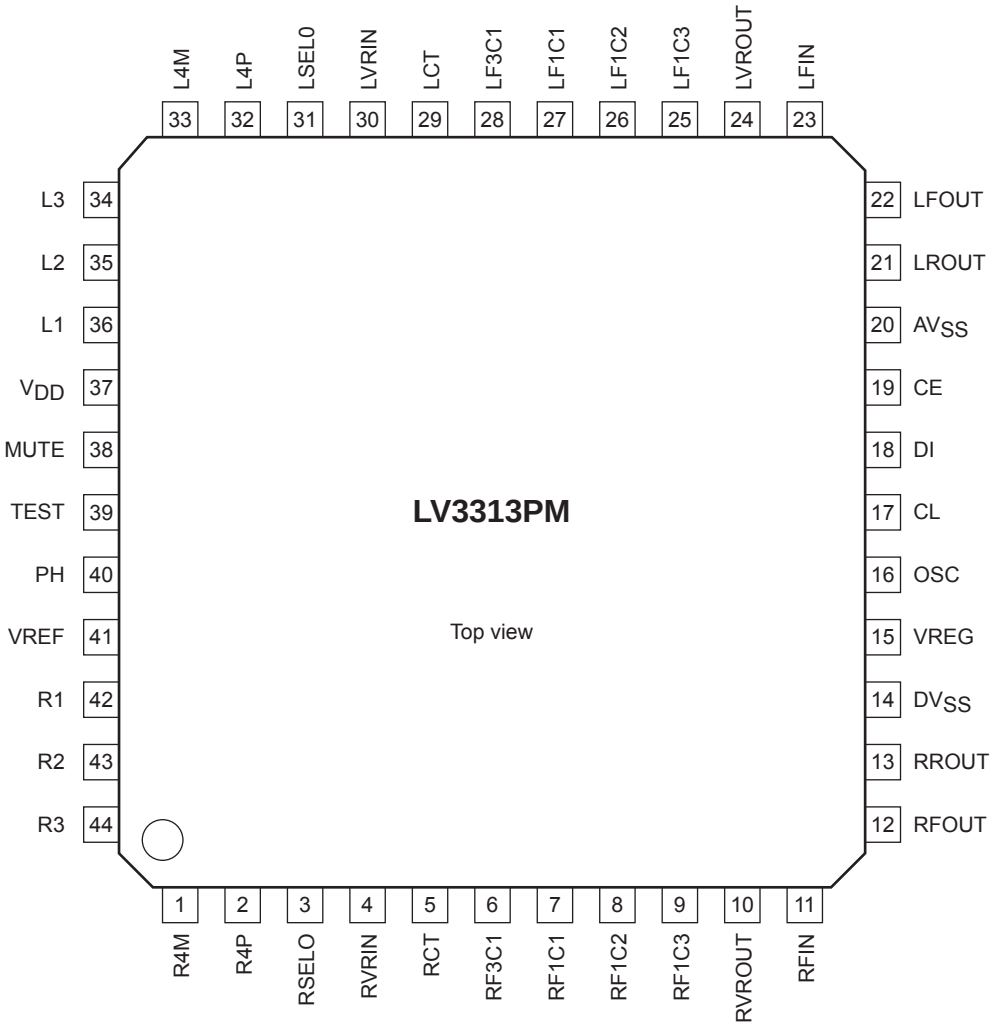
XXXXX = Specific Device Code
Y = Year
M = Month
DDD = Additional Traceability Data

*This information is generic.
Pb-Free indicator, “G” or microdot “ ▪”,
may or may not be present.

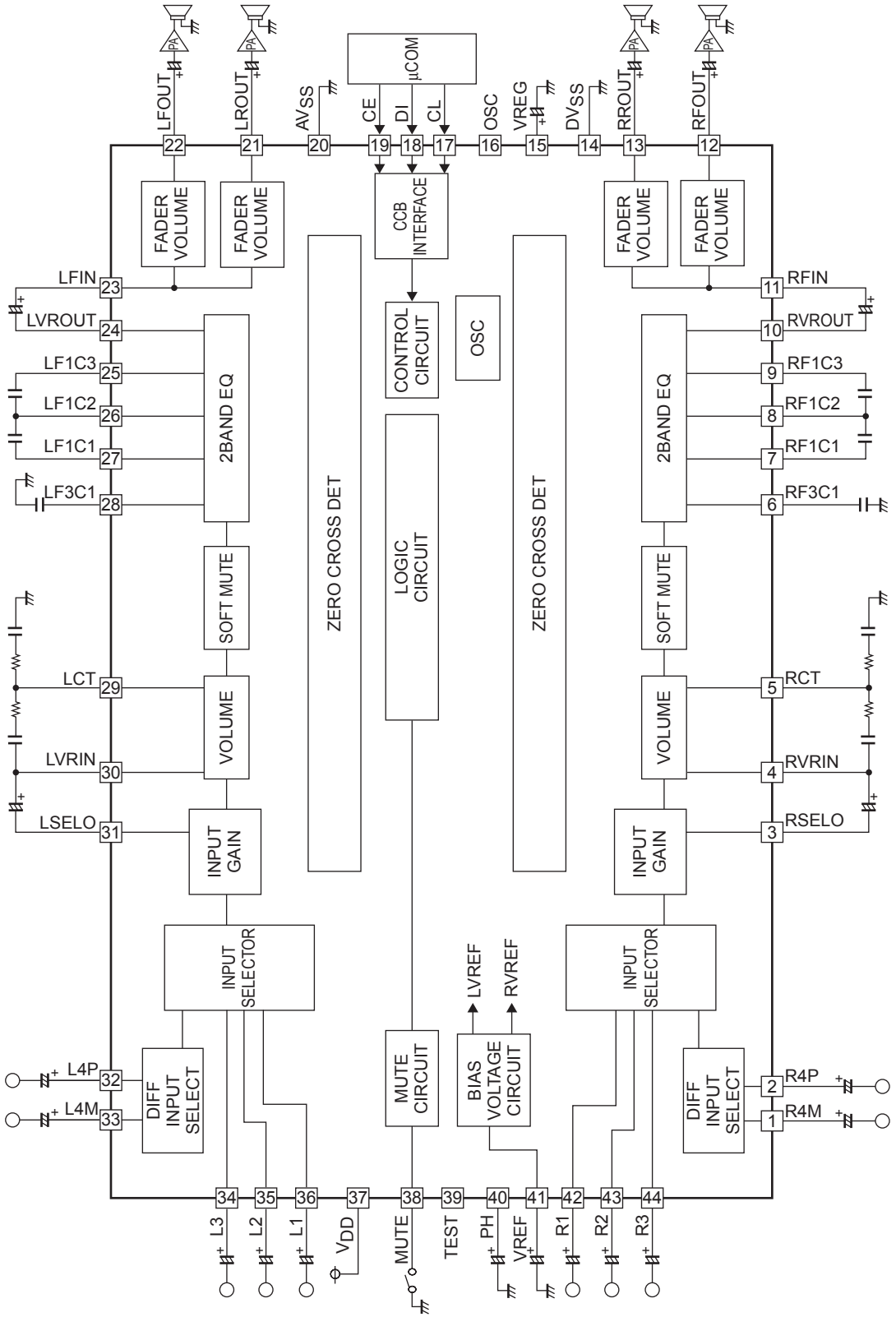
NOTE: The measurements are not to guarantee but for reference only.

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

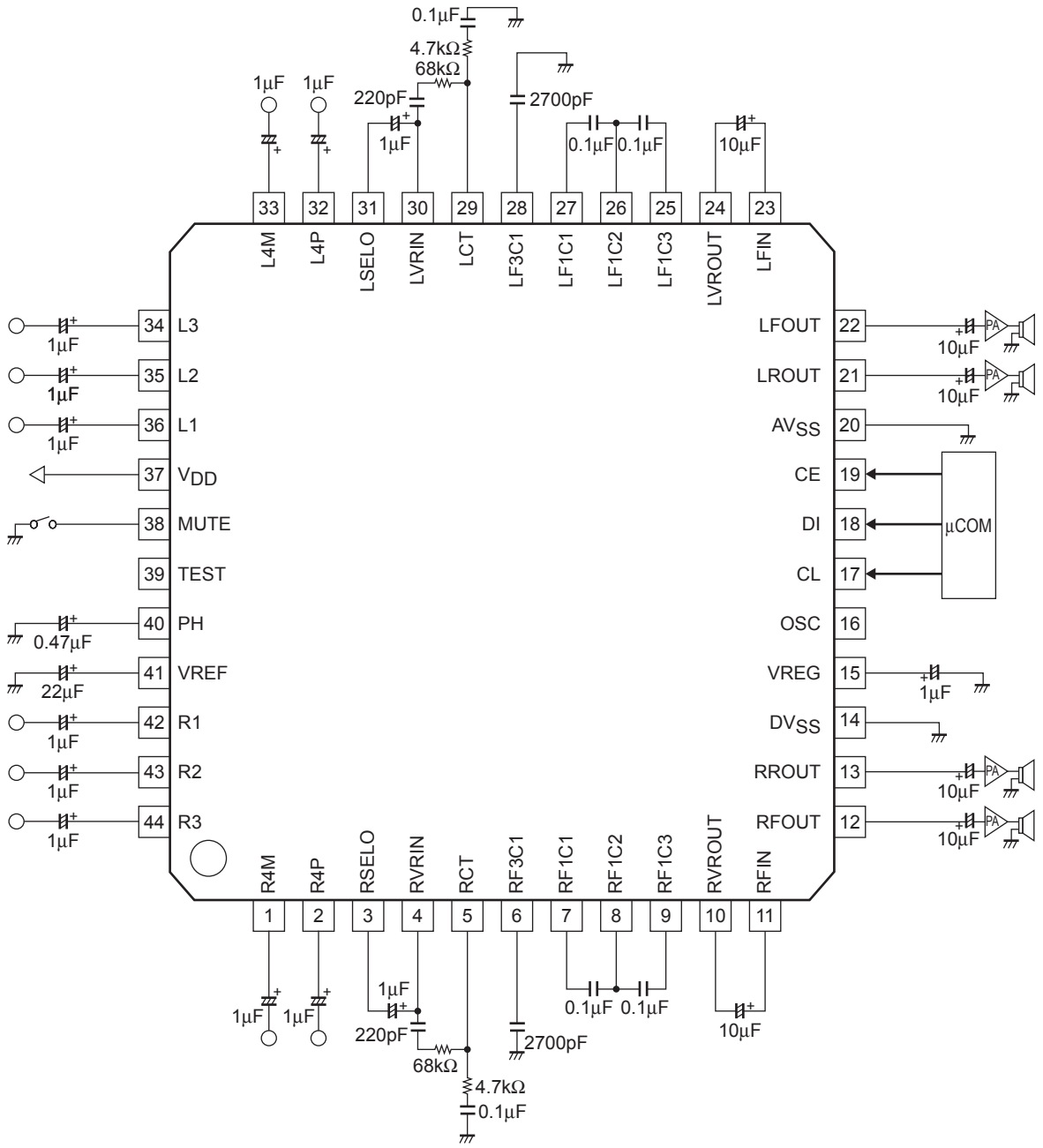
Pin Assignment



Block Diagram

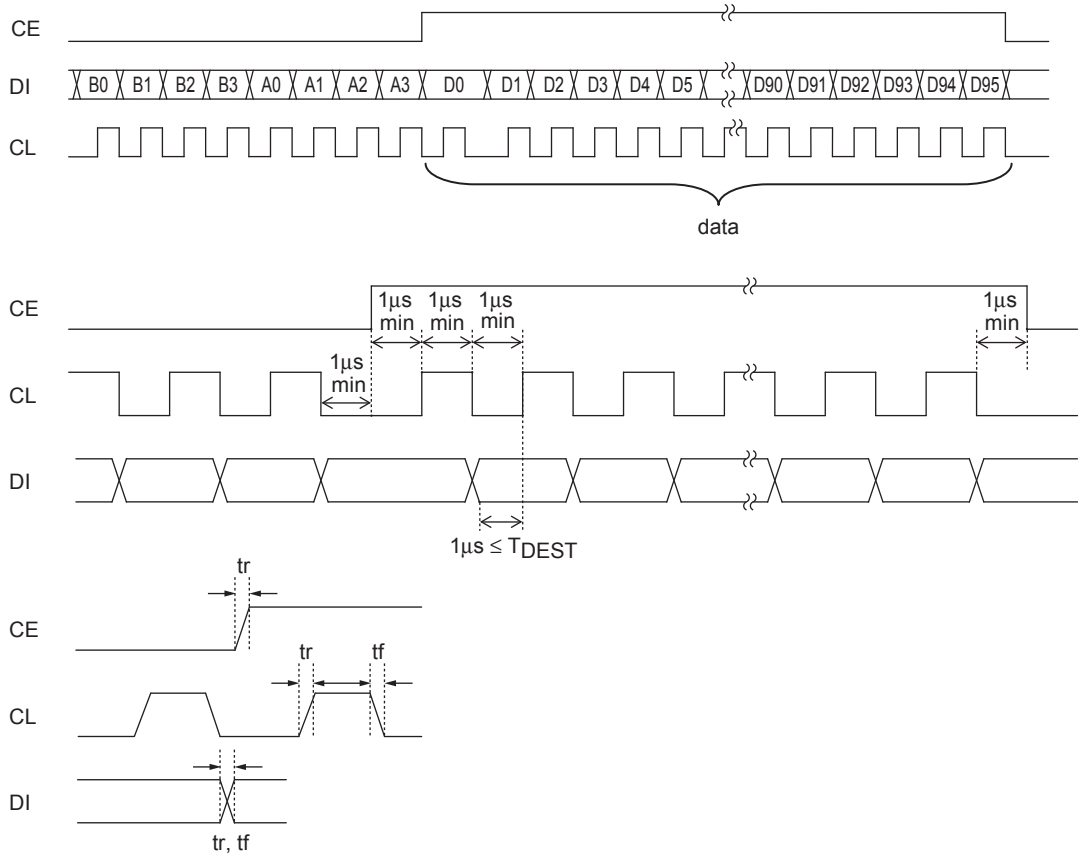


Application Circuit

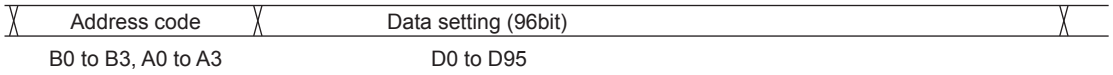


Control System Timing and Data Format

The LV3313PM is controlled by applying the stipulated data to the CL, DI and CE pins. The data consists of a total of 104 bits, of which 8 bits are the device address, 96 bits are the control data.



Send to data



Address code

B0	B1	B2	B3	A0	A1	A2	A3
1	0	0	0	0	0	0	1

Data setting

Input switching control

D0	D1	D2	Operation
0	0	0	INIT
1	0	0	L1 (R1)
0	1	0	L2 (R2)
1	1	0	L3 (R3)
0	0	1	L4 (R4)

Input gain control

D3	D4	D5	D6	D7	Lch
D8	D9	D10	D11	D12	Rch
0	0	0	0	0	0dB
1	0	0	0	0	+1dB
0	1	0	0	0	+2dB
1	1	0	0	0	+3dB
0	0	1	0	0	+4dB
1	0	1	0	0	+5dB
0	1	1	0	0	+6dB
1	1	1	0	0	+7dB
0	0	0	1	0	+8dB
1	0	0	1	0	+9dB
0	1	0	1	0	+10dB
1	1	0	1	0	+11dB
0	0	1	1	0	+12dB
1	0	1	1	0	+13dB
0	1	1	1	0	+14dB
1	1	1	1	0	+15dB
0	0	0	0	1	+16dB
1	0	0	0	1	+17dB
0	1	0	0	1	+18dB

Volume control (10 dB to –43 dB)

D13	D14	D15	D16	D17	D18	D19	D20	Lch
D21	D22	D23	D24	D25	D26	D27	D28	Rch
0	1	1	0	1	1	1	0	10dB
1	1	1	0	1	1	1	0	9dB
0	0	0	1	1	1	1	0	8dB
1	0	0	1	1	1	1	0	7dB
0	1	0	1	1	1	1	0	6dB
1	1	0	1	1	1	1	0	5dB
0	0	1	1	1	1	1	0	4dB
1	0	1	1	1	1	1	0	3dB
0	1	1	1	1	1	1	0	2dB
1	1	1	1	1	1	1	0	1dB
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
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

Volume control (–44 dB to –∞)

D13	D14	D15	D16	D17	D18	D19	D20	Lch
D21	D22	D23	D24	D25	D26	D27	D28	Rch
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
1	1	0	0	1	1	0	0	-51dB
0	0	1	0	1	1	0	0	-52dB
1	0	1	0	1	1	0	0	-53dB
0	1	1	0	1	1	0	0	-54dB
1	1	1	0	1	1	0	0	-55dB
0	0	0	1	1	1	0	0	-56dB
1	0	0	1	1	1	0	0	-57dB
0	1	0	1	1	1	0	0	-58dB
1	1	0	1	1	1	0	0	-59dB
0	0	1	1	1	1	0	0	-60dB
1	0	1	1	1	1	0	0	-61dB
0	1	1	1	1	1	0	0	-62dB
1	1	1	1	1	1	0	0	-63dB
0	0	0	0	0	0	1	0	-64dB
1	0	0	0	0	0	1	0	-65dB
0	1	0	0	0	0	1	0	-66dB
1	1	0	0	0	0	1	0	-67dB
0	0	1	0	0	0	1	0	-68dB
1	0	1	0	0	0	1	0	-69dB
0	1	1	0	0	0	1	0	-70dB
1	1	1	0	0	0	1	0	-71dB
0	0	0	1	0	0	1	0	-72dB
1	0	0	1	0	0	1	0	-73dB
0	1	0	1	0	0	1	0	-74dB
1	1	0	1	0	0	1	0	-75dB
0	0	1	1	0	0	1	0	-76dB
1	0	1	1	0	0	1	0	-77dB
0	1	1	1	0	0	1	0	-78dB
1	1	1	1	0	0	1	0	-79dB
0	0	0	0	1	0	1	0	-∞

Tone block

Treble

GAIN	D29	D30	D31	D32	Lch
	D33	D34	D35	D36	Rch
	0	1	1	1	+12dB
	1	0	1	1	+10dB
	0	0	1	1	+8dB
	1	1	0	1	+6dB
	0	1	0	1	+4dB
	1	0	0	1	+2dB
	0	0	0	0	0dB
	1	0	0	0	-2dB
	0	1	0	0	-4dB
	1	1	0	0	-6dB
	0	0	1	0	-8dB
	1	0	1	0	-10dB
	0	1	1	0	-12dB

Bass

GAIN	D37	D38	D39	D40	Lch
	D41	D42	D43	D44	Rch
	0	1	1	1	+12dB
	1	0	1	1	+10dB
	0	0	1	1	+8dB
	1	1	0	1	+6dB
	0	1	0	1	+4dB
	1	0	0	1	+2dB
	0	0	0	0	0dB
	1	0	0	0	-2dB
	0	1	0	0	-4dB
	1	1	0	0	-6dB
	0	0	1	0	-8dB
	1	0	1	0	-10dB
	0	1	1	0	-12dB

Fader block

D45	D46	D47	D48	D49	D50	LFOUT
D51	D52	D53	D54	D55	D56	LROUT
D57	D58	D59	D60	D61	D62	RFOUT
D63	D64	D65	D66	D67	D68	RROUT
0	0	0	0	0	0	0dB
1	0	0	0	0	0	-1dB
0	1	0	0	0	0	-2dB
1	1	0	0	0	0	-4dB
0	0	1	0	0	0	-6dB
1	0	1	0	0	0	-8dB
0	1	1	0	0	0	-10dB
1	1	1	0	0	0	-12dB
0	0	0	1	0	0	-14dB
1	0	0	1	0	0	-16dB
0	1	0	1	0	0	-18dB
1	1	0	1	0	0	-20dB
0	0	1	1	0	0	-30dB
1	0	1	1	0	0	-45dB
0	1	1	1	0	0	-60dB
1	1	1	1	0	0	-∞

Loudness control

D69	Operation
0	off
1	on

Zero cross control

D70	Operation
0	off
1	on

Zero cross signal detection block control

D71	Operation
0	Input gain
1	Volume

D72	Operation
0	Manual detection
1	Automatic detection

D73	D74
0	0

Zero-cross signal detection timer overflow settings

D75	D76	Operation
0	0	Timer time 10 ms
1	0	Timer time 20 ms
0	1	Timer time 40 ms
1	1	Timer time 80 ms

Soft mute control

D77	Operation
0	Soft mute mode off
1	Soft mute mode on

D78	Operation
0	mute set off
1	mute set on

D79	D80	Operation
0	0	normal mode
1	0	test mode

Soft mute settling time select control

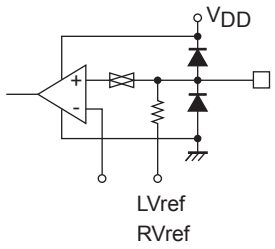
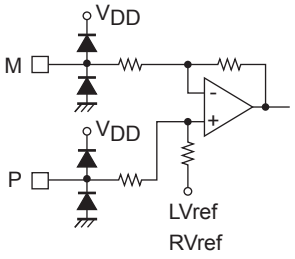
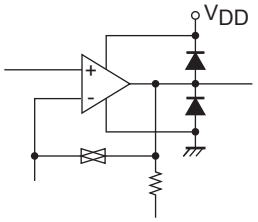
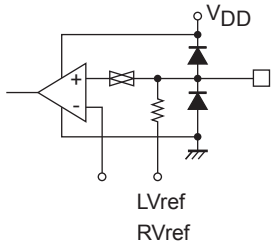
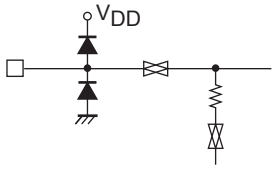
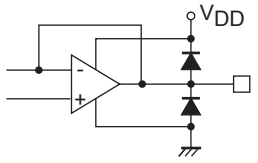
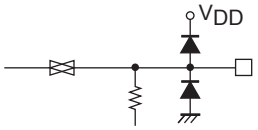
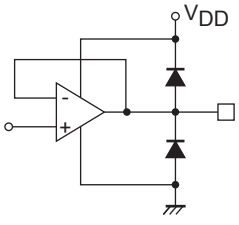
D81	D82	Operation
0	0	mute time 0.64 ms
1	0	mute time 5.12 ms
0	1	mute time 40 ms
1	1	mute time 80 ms

D83	D84	D85	D86	D87
0	0	0	0	0

Test mode block

D88	D89	D90	D91	D92	D93	D94	D95
0	0	0	0	0	0	0	0

Pin Functions

Pin No.	Pin name	Function	Equivalent Circuit
36 35 34 42 43 44	L1 L2 L3 R1 R2 R3	Single end input pins.	
33 32 1 2	L4M L4P R4M R4P	Differential input pins.	
31 3	LSELO RSELO	Input selector output pins.	
30 4	LVRIN RVRIN	Main volume input pins.	
29 5	LCT RCT	Loudness function pins.	
24 10	LVROUT RVROUT	Tone output pins.	
23 11	LFIN RFIN	Fader block input pins. Drive at low impedance.	
22 21 12 13	LFOUT LROUT RFOUT RROUT	Fader output pins.Attenuation is possible separately for the front end and rear end.	

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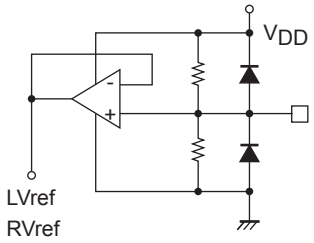
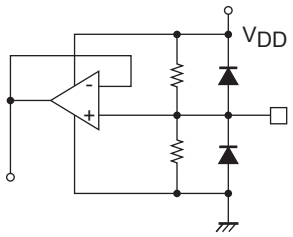
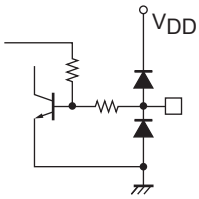
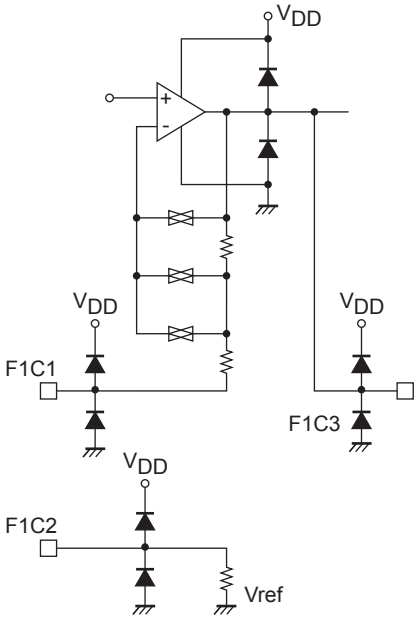
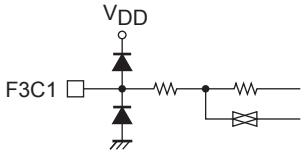
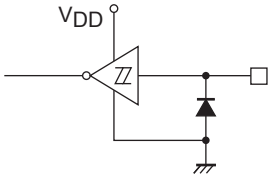
Pin No.	Pin name	Function	Equivalent Circuit
41	Vref	Connect a capacitor of a few tens of uF between Vref and AV_{SS} (V_{SS}) as a 0.55 × V_{DD} voltage generator, current ripple countermeasure.	
15	VREG	Internal logic voltage pin.	
37	V_{DD}	Power supply pin.	
20	AV_{SS}	Ground pin.	
38	$\overline{MUTE}$	External muting control pin. Setting this pin to V_{SS} level sets forcibly fader volume block to -∞ level.	
27 26 25 7 8 9	LF1C1 LF1C2 LF1C3 RF1C1 RF1C2 RF1C3	Capacitor connection pins for configuring equalizer bass band filter. Connect a capacitor between LF1C1 (RF1C1) and LF1C2 (RF1C2), and between LF1C2 (RF1C2) and LF1C3 (RF1C3).	
28 6	LF3C1 RF3C1	Capacitor connection pins for configuring equalizer treble band filter. Connect a high band compensation capacitor between LF3C1 (RF3C1) and V_{SS}.	
17 18	CL DI	Input pin for serial data and clock used for control.	
19	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.	

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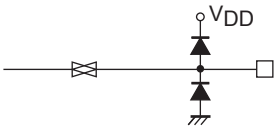
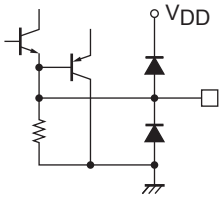
Pin No.	Pin name	Function	Equivalent Circuit
39	TEST	IC test pin. Normally this pin is OPEN.	
14	DV_{SS}	Logic system ground pin.	
16	OSC	External oscillat input pin. Normally this pin is OPEN.	
40	PH	Automatic zero cross detection pin.	

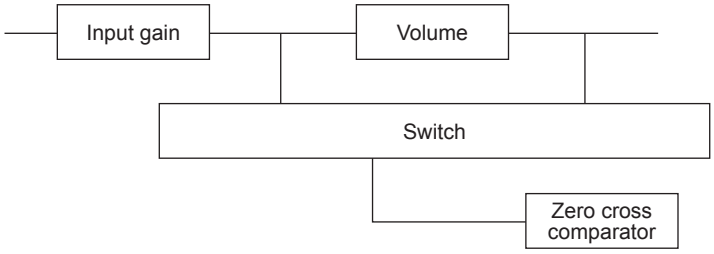
Usage Cautions

(1) Data Transmission at power on

- The status of internal analog switches is unstable at power on. Therefore, perform muting or some other countermeasure until the data has been set.
- At power on, initial setting data must be sent once in order to stabilize the bias of each block in a short time.

(2) Description of zero cross switching circuit operation

The LV3313PM have a function to switch zero cross comparator signal detection locations, enabling the selection of the optimum detection location for blocks whose data is to be updated.Basically, the switching noise can be minimized by inputting the signal immediately following the block whose data is to be updated to the zero cross comparator, so it is necessary to switch the detection location every time.



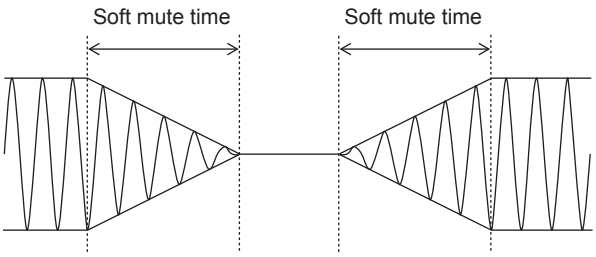
LV3313PM zero cross detection circuit

(3) Zero Cross Switching Control method

The zero cross switching control method consists of setting the zero cross control bits to the zero cross detection mode, and specifying the detection blocks before transmitting the data. These control bits are latched immediately following data transfer, that is to say beforehand in sync with the falling edge of CE, so when updating data of volumes, etc., it is possible to perform mode setting and zero cross switching with one data transfer.

(4) Soft mute operation

The LV3313PM have a soft mute function for low switching noise, when this mute function set operation.
(mute/unmute function select)
The Soft mute time can be selected by send to CCB control. (0.6 ms, 5 ms, 40 ms, 80 ms)
A soft mute function can be implemented by set to soft mute on. (Set to mute on/off)



ORDERING INFORMATION

Device	Package	Shipping (Qty / Packing)
LV3313PM-TLM-E	PQFP44 10x10 / QIP44M (Pb-Free)	1000 / Tape & Reel

† For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D. http://www.onsemi.com/pub_link/Collateral/BRD8011-D.PDF