SANYO

SANYO Semiconductors

DATA SHEET

An ON Semiconductor Company

Bi-CMOS LSI

CCB **LV3329PE** — **For Car Audio Systems**
Electronic Volume IC

Overview

The LV3329PE is an electronic volume and tone IC that implements a rich set of audio control functions with a minimal number of external components. Functions include input selection switching, an input gain, volume, loudness, balance, fader, bass/mid/treble control, and fixed equalizer.

Features

- It is possible to eliminate from the external components of equalizer control block by SCF technology.
- Zero-cross switching circuits, soft steps (bass block and mid 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 controls performed using serial data input (CCB).

Functions

- Input selector :
  Four of the input systems are single-end inputs, one uses differential inputs.
- Input gain control :
  The input gain can be amplified by 0 to +19dB (0 to 5dB/1.25dB steps, 5 to 11dB/1.5dB steps, 11 to 19dB/2dB steps)
- Loudness control :
  Taps are output starting at the -32dB position of the ladder resistor and a loudness function implemented with external capacitor and resistor components.
- Volume control : 0dB to -79dB/-∞ (1dB steps)
  L/R independent control.

- CCB is a registered trademark of SANYO Electric Co., Ltd.
- CCB is SANYO Semiconductor's original bus format. All bus addresses are managed by SANYO Semiconductor for this format.

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- Bass control:

    The bass control gain can be maximum boost +15dB position and maximum cut -15dB position
    (0dB/±1.25dB/±2.75dB/±4.75dB/±7dB/±9.5dB/±12.25dB/±15dB) SCF.
    The bass control center frequency 60Hz/80Hz/100Hz/200Hz can be selected.
    The bass control quality factor 1.0/1.25/1.5/2.0 can be selected.

- Middle control:

    The middle control gain can be maximum boost +12.25dB position and maximum cut -12.25dB position.
    (0dB/±1.25dB/±2.75dB/±4.75dB/±7dB/±9.5dB/±12.25dB) SCF.
    The middle control center frequency 600Hz/800Hz/1kHz/2kHz can be selected.
    The middle control quality factor 1.0/1.25/1.5/2.0 can be selected.

- Treble control:

    The treble control gain can be maximum boost +12.25dB position and maximum cut -12.25dB position.
    (0dB/±1.25dB/±2.75dB/±4.75dB/±7dB/±9.5dB/±12.25dB) SCF.
    The treble control center frequency 8kHz/10kHz/12.5kHz/15kHz can be selected.
    The treble control quality factor 1.0/1.25/1.5/2.0 can be selected.

- Fader control: 0dB to -79dB/-∞ (1dB steps)

    Independent control each four channels output

- Mute
- FIXED EQ SCF

LOW CUT	fo	: 40Hz/50Hz
LOW	G	: ±12dB (2dB steps)
	fo	: 60Hz/80Hz/125Hz/160Hz/250Hz
	Q	: 0.5/1.0/2.0/4.0
MID	G	: ±12dB (2dB steps)
	fo	: 500Hz/800Hz/1kHz/2kHz/4kHz
	Q	: 0.5/1.0/2.0/4.0
HIGH	G	: ±12dB (2dB steps)
	fo	: 5kHz/6.3kHz/8kHz/10kHz/16kHz
	Q	: 0.5/1.0/2.0/4.0
HIGH CUT	fo	: 20kHz

    Note: High cut is used to eliminate SCF clock, so SCF cannot be used.

Specifications

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

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 × 1.6mm^3 : glass epoxy board

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

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	4.5		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			μsec
Setup time	Tsetup	CL, DI, CE	1			μsec
Hold time	Thold	CL, DI, CE	1			μsec
Operating frequency	fopg	CL			500	kHz

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

Parameter	Symbol	Conditions	Ratings min	Ratings typ	Ratings max	Unit
Input block						
Input resistance	Rin	L1-L4, R1-R4		50		kΩ
Minimum input gain	Gin min	L1-L4, R1-R4	-1	0	+1	dB
Maximum input gain	Gin max		+18	+19	+20	dB
Inter-step setting error	ATerr		-1.0		+1.0	dB
Left/Right balance	BAL		-0.5		+0.5	dB
Volume block						
Input resistance	Rvr1	LVRIN, RVRIN: Loudness OFF		200		kΩ
	Rvr2	LVRIN, RVRIN: Loudness ON		226		kΩ
Inter-step setting error	ATerr	0dB to -40dB	-0.5		+0.5	dB
Left/Right balance	BAL		-0.5		+0.5	dB
Tone block: Bass block						
Maximum gain setting	Gb max	max. boost/cut	±12	±15	±18	dB
Inter-step setting error	ATerr	0dB to ±4.75dB	-0.6		+0.6	dB
		±7dB to ±12.25dB	-1.25		+1.25	dB
Left/Right balance	BAL		-0.5		+0.5	dB
Center frequency	f01	GAIN = ±15dB		60		Hz
	f02			80		Hz
	f03			100		Hz
	f04			200		Hz
Quality Factor	Q1	GAIN = ±15dB		1.0		
	Q2			1.25		
	Q3			1.5		
	Q4			2.0		
Mid block						
Maximum gain setting	Gb max	max. boost/cut	±9.25	±12.25	±15.25	dB
Inter-step setting error	ATerr	0dB to ±4.75dB	-0.6		+0.6	dB
		±7dB to ±12.25dB	-1.25		+1.25	dB
Left/Right balance	BAL		-0.5		+0.5	dB
Center frequency	f01	GAIN = ±12.25dB		600		Hz
	f02			800		Hz
	f03			1		kHz
	f04			2		kHz
Quality Factor	Q1	GAIN = ±12.25dB		1.0		
	Q2			1.25		
	Q3			1.5		
	Q4			2.0		
Treble block						
Maximum gain setting	Gb max	max. boost/cut	±9.25	±12.25	±15.25	dB
Inter-step setting error	ATerr	0dB to ±4.75dB	-0.6		+0.6	dB
		±7dB to ±12.25dB	-1.25		+1.25	dB
Left/Right balance	BAL		-0.5		+0.5	dB
Center frequency	f01	GAIN = ±12.25dB		8		kHz
	f02			10		kHz
	f03			12.5		kHz
	f04			15		kHz
Quality Factor	Q1	GAIN = ±12.25dB		1.0		
	Q2			1.25		
	Q3			1.5		
	Q4			2.0		

Continued from preceding page.

Parameter	Symbol	Conditions	Ratings min	Ratings typ	Ratings max	Unit
Fader block						
Input resistance	Rfed			50		kΩ
Inter-step setting error	ATerr	0dB to -40dB	-0.5		+0.5	dB
Left/Right balance	BAL	0dB to -30dB	-0.5		+0.5	dB
Fixed equalizer: LOW CUT						
Center frequency	f01			40		Hz
	f02			50		Hz
LOW						
Maximum gain setting	Gb max	max. boost/cut	±10	±12	±14	dB
Inter-step setting error	ATerr	-10dB to +10dB	-1.0		+1.0	dB
Center frequency	f01	GAIN = ±12dB		60		Hz
	f02			80		Hz
	f03			125		Hz
	f04			160		Hz
	f05			250		Hz
Quality Factor	Q1	GAIN = ±12dB		0.5		
	Q2			1.0		
	Q3			2.0		
	Q4			4.0		
MID						
Maximum gain setting	Gb max	max. boost/cut	±10	±12	±14	dB
Inter-step setting error	ATerr	-10dB to +10dB	-1.0		+1.0	dB
Center frequency	f01	GAIN = ±12dB		500		Hz
	f02			800		Hz
	f03			1		kHz
	f04			2		kHz
	f05			4		kHz
Quality Factor	Q1	GAIN = ±12dB		0.5		
	Q2			1.0		
	Q3			2.0		
	Q4			4.0		
HIGH						
Maximum gain setting	Gb max	max. boost/cut	±10	±12	±14	dB
Inter-step setting error	ATerr	-10dB to +10dB	-1.0		+1.0	dB
Center frequency	f01	GAIN = ±12dB		5		kHz
	f02			6.3		kHz
	f03			8		kHz
	f04			10		kHz
	f05			16		kHz
Quality Factor	Q1	GAIN = ±12dB		0.5		
	Q2			1.0		
	Q3			2.0		
	Q4			4.0		

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

Parameter	Symbol	Conditions	Ratings min	Ratings typ	Ratings max	Unit
A loss of insertion	ATT		-1.0		+1.0	dB
Total harmonic distortion	THD	V_{IN} = 1Vrms, f = 1kHz		0.01		%
Inter-input crosstalk	CT	V_{IN} = 1Vrms, f = 1kHz		80		dB
Left/Right channel crosstalk	CT	V_{IN} = 1Vrms, f = 1kHz		80		dB
Maximum attenuation	V_O min	V_{IN} = 1Vrms, f = 1kHz		80		dB
Output noise voltage	VN	all controls flat, IHF-A, Input 1kΩ terminator		34		μV
Current drain	I_{DD}			30		mA
Input high-level current	I_{IH}	CL, DI, CE, V_{IN} = 5.5V			10	μA
Input low-level current	I_{IL}	CL, DI, CE, V_{IN} = 0V	-10			μA
Maximum input voltage	VCL	THD = 1% RL = 10kΩ all controls flat, f_{IN} = 1kHz		2.2		Vrms
Common-mode rejection ratio	CMRR	V_{IN} = 0dBV, f = 1kHz		50		dB

Package Dimensions

unit : mm (typ)

3148A

SANYO : QIP44M(10X10)

Pin Assignment

Top view

LV3329PE

Pin	Name
33	L3
32	L4
31	L5M
30	L5P
29	LSELO
28	LVRIN
27	LCT
26	LCOM
25	LVROUT
24	LFIN
23	LFOUT

Pin	Name
34	L2
35	L1
36	VREG
37	V_DD
38	MUTE
39	TEST2
40	TIM
41	TEST1
42	VREF
43	R1
44	R2

Pin	Name
22	LROUT
21	AV_SS
20	CE
19	DI
18	CL
17	OSC
16	TEST3
15	TEST4
14	TEST5
13	DV_SS
12	RROUT

Pin	Name
1	R3
2	R4
3	R5M
4	R5P
5	RSELO
6	RVRIN
7	RCT
8	RCOM
9	RVROUT
10	RFIN
11	RFOUT
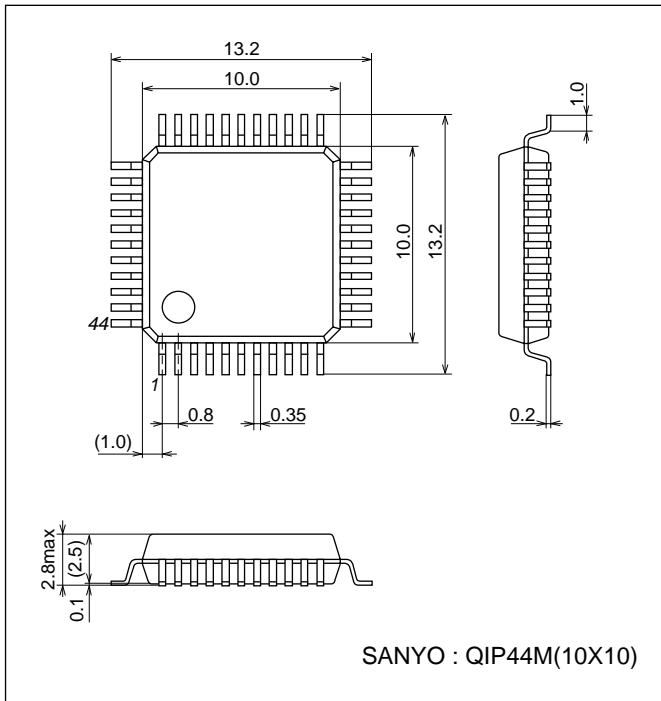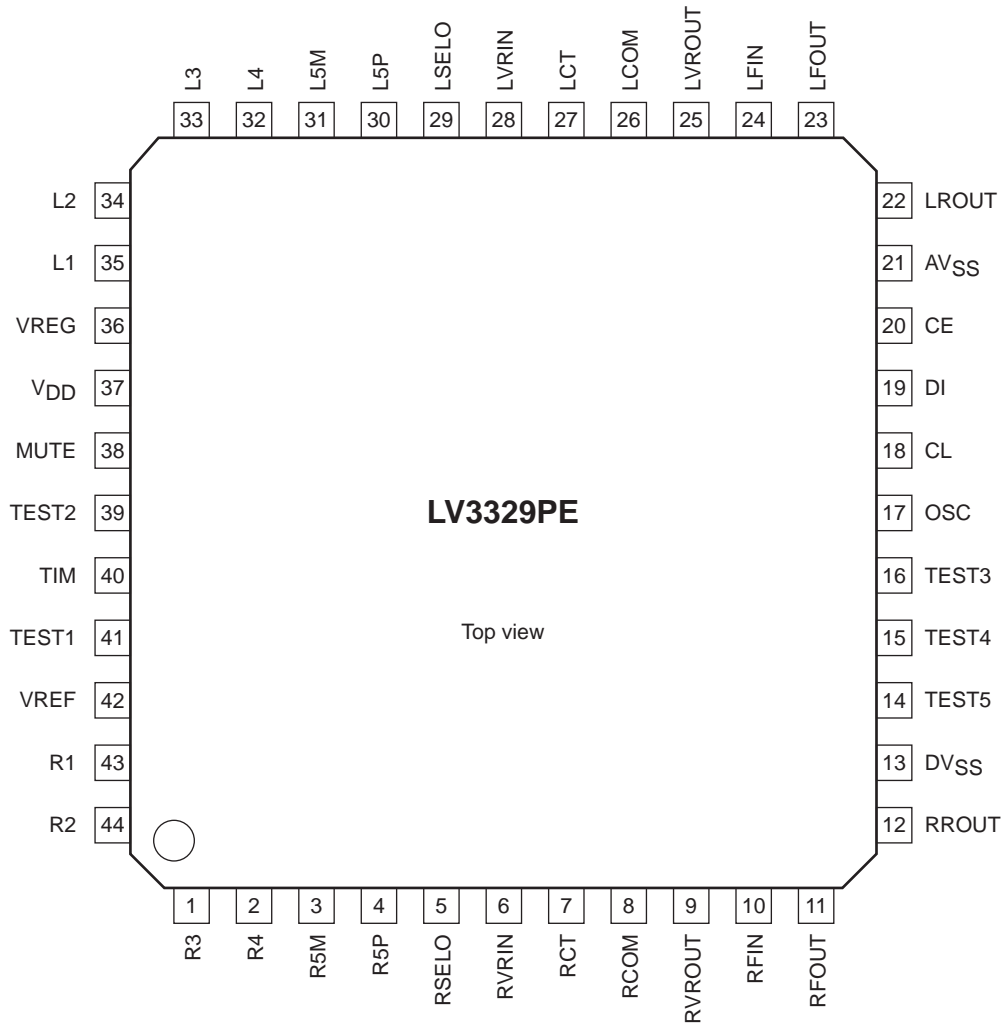
Block Diagram
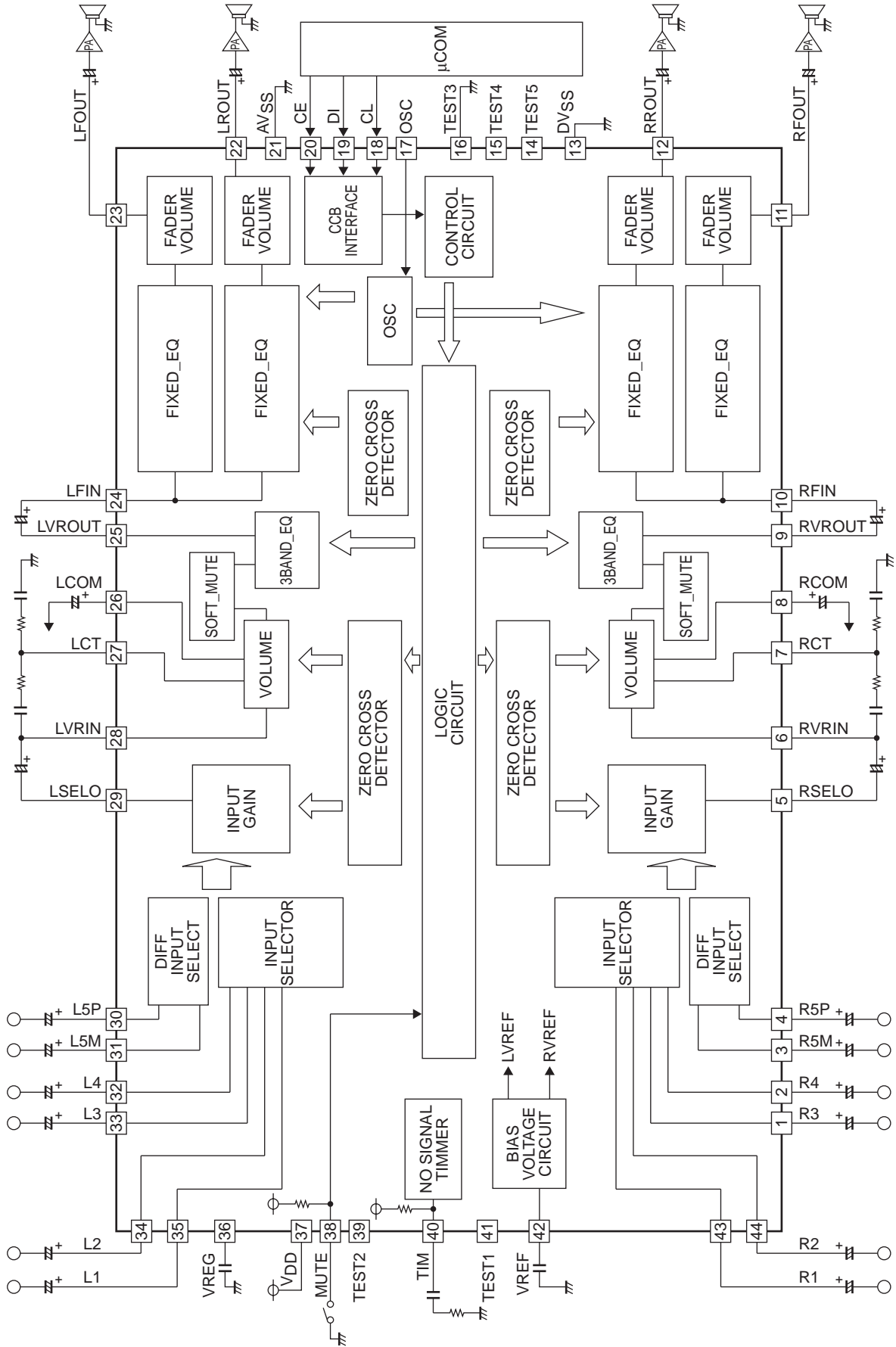
Pin Functions

Pin No.	Pin name	Function	Equivalent Circuit
35 34 33 32 43 44 1 2	L1 L2 L3 L4 R1 R2 R3 R4	Single end input pins.	
31 30 3 4	L5M L5P R5M R5P	Differential input pins.	
29 5	LSELO RSELO	Input selector output pins.	
28 6	LVRIN RVRIN	Main volume input pins.	
27 7	LCT RCT	Loudness function pins.	
26 8	LCOM RCOM	Volume block common pins.	
25 9	LVROUT RVROUT	Tone output pins.	
24 10	LFIN RFIN	Fader block input pins. Drive at low impedance.	

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Pin No.	Pin name	Function	Equivalent Circuit
23 22 11 12	LFOUT LROUT RFOUT RROUT	Fader output pins.Attenuation is possible separately for the front end and rear end.	
42	Vref	Connect a capacitor of a few tens of μF between Vref and AV$_{SS}$ (V$_{SS}$) as a $0.5 \times$ V$_{DD}$ voltage generator, current ripple countermeasure.	
36	VREG	Internal logic voltage pin.	
37	V$_{DD}$	Power supply pin.	
13	DV$_{SS}$	Logic ground pin.	
21	AV$_{SS}$	Analog ground pin.	
38	MUTE	External muting control pin. Setting this pin to V$_{SS}$ level sets forcibly fader volume block to -∞ level.	
40	TIM	Timer pin when there is no signal in the zero cross circuit.Forcibly set data when there is no zero cross signal, from the time the data is set until the timer ends.	
18 19	CL DI	Input pin for serial data and clock used for control.	
20	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.	
16	TEST3	Connect to V$_{SS}$	
15 14	TEST4 TEST5	Normally this pin is OPEN.	
41 39	TEST1 TEST2	IC test pin. Normally this pin is OPEN.	
17	OSC	External oscillat input pin.	

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Control System Timing and Data Format

The LV3329PE is controlled by applying the stipulated data to the CL, DI and CE pins.

The data consists of 8 address bits, 12 data bits for each command, and 4 command register bits.
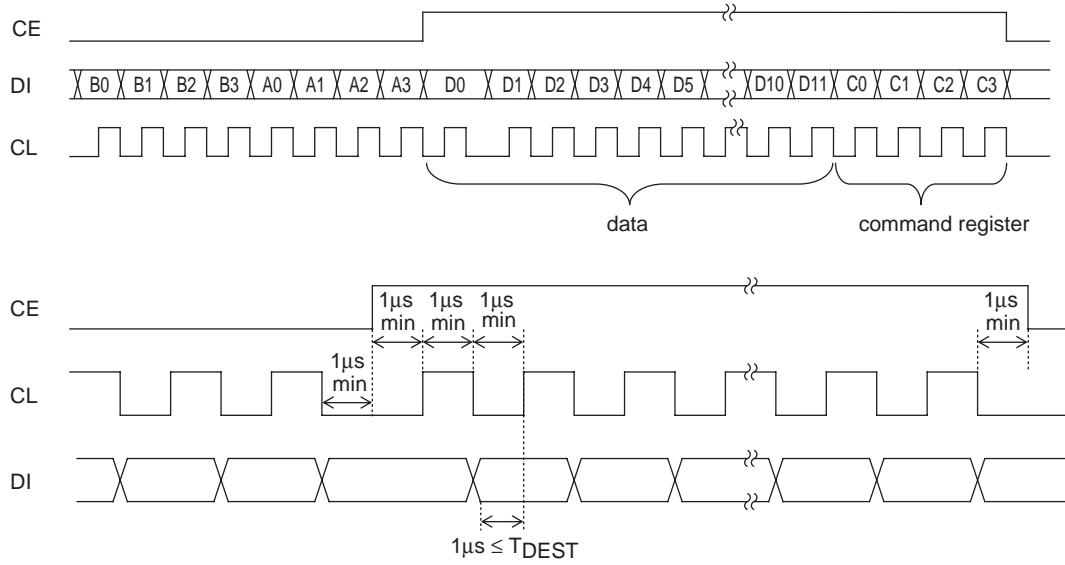
Send to data

Address code	data (12bit)	command register
B0 to B3, A0 to A3	D0 to D11	C0 to C3 REG0 to REG15
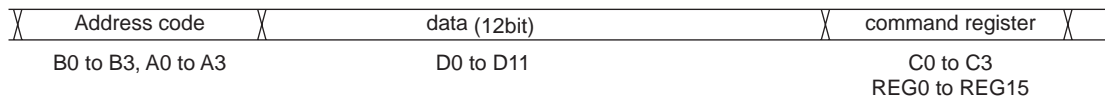
Address code

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

Command register summary (REG0 to REG15)

C0	C1	C2	C3	Register
0	0	0	0	REG0 (Input selector select, input gain related)
1	0	0	0	REG1 (Main volume related)
0	1	0	0	REG2 (Loudness related)
1	1	0	0	REG3 (Tone block_Bass)
0	0	1	0	REG4 (Tone block_Mid)
1	0	1	0	REG5 (Tone block_Treble)
0	1	1	0	REG6 (Fader related)
1	1	1	0	REG7 (Zero cross related)
0	0	0	1	REG8 (FIXED_EQ block LOW CUT)
1	0	0	1	REG9 (FIXED_EQ block LOW)
0	1	0	1	REG10 (FIXED_EQ block MID)
1	1	0	1	REG11 (FIXED_EQ block HIGH)
0	0	1	1	REG12 (Soft mute related)
1	0	1	1	REG13 (Bass block/Mid block soft step on/off select)
0	1	1	1	REG14 (Other settings)
1	1	1	1	REG15 (Test mode related)

Data setting

REG0 (Command register 0000)

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)
1	0	1	L5 (R5)

D3
0

Input gain control

D4	D5	D6	D7	Operation
0	0	0	0	0dB
1	0	0	0	+1.25dB
0	1	0	0	+2.5dB
1	1	0	0	+3.75dB
0	0	1	0	+5dB
1	0	1	0	+6.5dB
0	1	1	0	+8dB
1	1	1	0	+9.5dB
0	0	0	1	+11dB
1	0	0	1	+13dB
0	1	0	1	+15dB
1	1	0	1	+17dB
0	0	1	1	+19dB

D8	D9
0	0

Lch/Rch switching

D10	D11	Operation
0	0	Lch/Rch active simultaneously.
1	0	Only Lch active.
0	1	Only Rch active.

REG1 (Command register 1000)

Volume control (0dB to -39dB)

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

Volume control (-40dB to -∞)

D0	D1	D2	D3	D4	D5	D6	Operation
0	0	0	1	0	1	0	-40dB
1	0	0	1	0	1	0	-41dB
0	1	0	1	0	1	0	-42dB
1	1	0	1	0	1	0	-43dB
0	0	1	1	0	1	0	-44dB
1	0	1	1	0	1	0	-45dB
0	1	1	1	0	1	0	-46dB
1	1	1	1	0	1	0	-47dB
0	0	0	0	1	1	0	-48dB
1	0	0	0	1	1	0	-49dB
0	1	0	0	1	1	0	-50dB
1	1	0	0	1	1	0	-51dB
0	0	1	0	1	1	0	-52dB
1	0	1	0	1	1	0	-53dB
0	1	1	0	1	1	0	-54dB
1	1	1	0	1	1	0	-55dB
0	0	0	1	1	1	0	-56dB
1	0	0	1	1	1	0	-57dB
0	1	0	1	1	1	0	-58dB
1	1	0	1	1	1	0	-59dB
0	0	1	1	1	1	0	-60dB
1	0	1	1	1	1	0	-61dB
0	1	1	1	1	1	0	-62dB
1	1	1	1	1	1	0	-63dB
0	0	0	0	0	0	1	-64dB
1	0	0	0	0	0	1	-65dB
0	1	0	0	0	0	1	-66dB
1	1	0	0	0	0	1	-67dB
0	0	1	0	0	0	1	-68dB
1	0	1	0	0	0	1	-69dB
0	1	1	0	0	0	1	-70dB
1	1	1	0	0	0	1	-71dB
0	0	0	1	0	0	1	-72dB
1	0	0	1	0	0	1	-73dB
0	1	0	1	0	0	1	-74dB
1	1	0	1	0	0	1	-75dB
0	0	1	1	0	0	1	-76dB
1	0	1	1	0	0	1	-77dB
0	1	1	1	0	0	1	-78dB
1	1	1	1	0	0	1	-79dB
0	0	0	0	1	0	1	-∞

D7	D8	D9	Operation
0	0	0	Step mode off
0	1	0	Step mode on

Lch/Rch switching

D10	D11	Operation
0	0	Lch/Rch active simultaneously.
1	0	Only Lch active.
0	1	Only Rch active.

REG2 (Command register 0100)

Loudness control

D0	D1	D2	D3	D4	D5	D6	D7	Operation
0	0	0	0	0	0	0	0	

D8	Operation
0	External loudness off
1	External loudness on

D9
0

Lch/Rch switching

D10	D11	Operation
0	0	Lch/Rch active simultaneously.
1	0	Only Lch active.
0	1	Only Rch active.

REG3 (Command register 1100)

Tone block

Bass

GAIN	D0	D1	D2	D3	Operation
	1	1	1	1	+15dB
	0	1	1	1	+12.25dB
	1	0	1	1	+9.5dB
	0	0	1	1	+7dB
	1	1	0	1	+4.75dB
	0	1	0	1	+2.75dB
	1	0	0	1	+1.25dB
	0	0	0	0	0dB
	1	0	0	0	-1.25dB
	0	1	0	0	-2.75dB
	1	1	0	0	-4.75dB
	0	0	1	0	-7dB
	1	0	1	0	-9.5dB
	0	1	1	0	-12.25dB
	1	1	1	0	-15dB

D4	D5
0	0

f0	D6	D7	Operation
	0	0	60Hz
	1	0	80Hz
	0	1	100Hz
	1	1	200Hz

Q	D8	D9	Operation
	0	0	1.00
	1	0	1.25
	0	1	1.50
	1	1	2.00

Lch/Rch switching

D10	D11	Operation
0	0	Lch/Rch active simultaneously.
1	0	Only Lch active.
0	1	Only Rch active.

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REG4 (Command register 0010)

Tone block

Mid

GAIN	D0	D1	D2	D3	Operation
	0	1	1	1	+12.25dB
	1	0	1	1	+9.5dB
	0	0	1	1	+7dB
	1	1	0	1	+4.75dB
	0	1	0	1	+2.75dB
	1	0	0	1	+1.25dB
	0	0	0	0	0dB
	1	0	0	0	-1.25dB
	0	1	0	0	-2.75dB
	1	1	0	0	-4.75dB
	0	0	1	0	-7dB
	1	0	1	0	-9.5dB
	0	1	1	0	-12.25dB

D4	D5
0	0

f0	D6	D7	Operation
	0	0	600Hz
	1	0	800Hz
	0	1	1kHz
	1	1	2kHz

Q	D8	D9	Operation
	0	0	1.00
	1	0	1.25
	0	1	1.50
	1	1	2.00

Lch/Rch switching

D10	D11	Operation
0	0	Lch/Rch active simultaneously.
1	0	Only Lch active.
0	1	Only Rch active.

REG5 (Command register 1010)

Tone block

Treble

GAIN	D0	D1	D2	D3	Operation
	0	1	1	1	+12.25dB
	1	0	1	1	+9.5dB
	0	0	1	1	+7dB
	1	1	0	1	+4.75dB
	0	1	0	1	+2.75dB
	1	0	0	1	+1.25dB
	0	0	0	0	0dB
	1	0	0	0	-1.25dB
	0	1	0	0	-2.75dB
	1	1	0	0	-4.75dB
	0	0	1	0	-7dB
	1	0	1	0	-9.5dB
	0	1	1	0	-12.25dB

D4	D5
0	0

f0	D6	D7	Operation
	0	0	8kHz
	1	0	10kHz
	0	1	12.5kHz
	1	1	15kHz

Q	D8	D9	Operation
	0	0	1.00
	1	0	1.25
	0	1	1.50
	1	1	2.00

Lch/Rch switching

D10	D11	Operation
0	0	Lch/Rch active simultaneously.
1	0	Only Lch active.
0	1	Only Rch active.

REG6 (Command register 0110)

Fader block (0dB to -39dB)

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

Fader block (-40dB to -∞)

D0	D1	D2	D3	D4	D5	D6	Operation
0	0	0	1	0	1	0	-40dB
1	0	0	1	0	1	0	-41dB
0	1	0	1	0	1	0	-42dB
1	1	0	1	0	1	0	-43dB
0	0	1	1	0	1	0	-44dB
1	0	1	1	0	1	0	-45dB
0	1	1	1	0	1	0	-46dB
1	1	1	1	0	1	0	-47dB
0	0	0	0	1	1	0	-48dB
1	0	0	0	1	1	0	-49dB
0	1	0	0	1	1	0	-50dB
1	1	0	0	1	1	0	-51dB
0	0	1	0	1	1	0	-52dB
1	0	1	0	1	1	0	-53dB
0	1	1	0	1	1	0	-54dB
1	1	1	0	1	1	0	-55dB
0	0	0	1	1	1	0	-56dB
1	0	0	1	1	1	0	-57dB
0	1	0	1	1	1	0	-58dB
1	1	0	1	1	1	0	-59dB
0	0	1	1	1	1	0	-60dB
1	0	1	1	1	1	0	-61dB
0	1	1	1	1	1	0	-62dB
1	1	1	1	1	1	0	-63dB
0	0	0	0	0	0	1	-64dB
1	0	0	0	0	0	1	-65dB
0	1	0	0	0	0	1	-66dB
1	1	0	0	0	0	1	-67dB
0	0	1	0	0	0	1	-68dB
1	0	1	0	0	0	1	-69dB
0	1	1	0	0	0	1	-70dB
1	1	1	0	0	0	1	-71dB
0	0	0	1	0	0	1	-72dB
1	0	0	1	0	0	1	-73dB
0	1	0	1	0	0	1	-74dB
1	1	0	1	0	0	1	-75dB
0	0	1	1	0	0	1	-76dB
1	0	1	1	0	0	1	-77dB
0	1	1	1	0	0	1	-78dB
1	1	1	1	0	0	1	-79dB
0	0	0	0	1	0	1	-∞

D7	D8
0	0

Channel select

D9	D10	D11	Operation
1	0	0	Simultaneous control (LF, LR, RF, RR)
0	0	0	LFOUT
0	1	0	LROUT
0	0	1	RFOUT
0	1	1	RROUT

REG7 (Command register 1110)

Zero cross control

D0	D1	D2	D3	Operation
0	0	0	0	Zero cross detection off
1	0	0	0	Zero cross detection on

Zero cross detection

D4	D5	D6	D7	Operation
0	0	0	0	Input gain (LSELO)
0	1	0	0	Input gain (RSELO)
0	0	1	0	Main volume (LVROUT)
0	1	1	0	Main volume (RVROUT)
0	0	0	1	Fader (LFOUT)
0	1	0	1	Fader (RFOUT)
0	0	1	1	Fader (LROUT)
0	1	1	1	Fader (RROUT)

D8	D9	D10	D11
0	0	0	0

REG8 (Command register 0001)

FIXED EQ block
LOW_CUT

D0	D1	D2	D3	Operation
0	0	0	0	OFF
1	0	0	0	ON

D4	D5	D6	D7	D8	D9	Operation
0	0	0	0	0	0	40Hz
0	1	0	0	0	0	50Hz

Channel select

D10	D11	Operation
0	0	LFOUT
1	0	LROUT
0	1	RFOUT
1	1	RROUT

REG9 (Command register 1001)

FIXED EQ block

LOW

GAIN

D0	D1	D2	D3	Operation
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

D4
0

f0

D5	D6	D7	Operation
0	0	0	60Hz
1	0	0	80Hz
0	1	0	125Hz
1	1	0	160Hz
0	0	1	250Hz

Q

D8	D9	Operation
0	0	0.5
1	0	1.0
0	1	2.0
1	1	4.0

Channel select

D10	D11	Operation
0	0	LFOUT
1	0	LROUT
0	1	RFOUT
1	1	RROUT

REG10 (Command register 0101)

FIXED EQ block

MID

GAIN

D0	D1	D2	D3	Operation
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

D4
0

f0

D5	D6	D7	Operation
0	0	0	500Hz
1	0	0	800Hz
0	1	0	1kHz
1	1	0	2kHz
0	0	1	4kHz

Q

D8	D9	Operation
0	0	0.5
1	0	1.0
0	1	2.0
1	1	4.0

Channel select

D10	D11	Operation
0	0	LFOUT
1	0	LROUT
0	1	RFOUT
1	1	RROUT

REG11 (Command register 1101)

FIXED EQ block

HIGH

GAIN

D0	D1	D2	D3	Operation
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

D4
0

f0

D5	D6	D7	Operation
0	0	0	5kHz
1	0	0	6.3kHz
0	1	0	8kHz
1	1	0	10kHz
0	0	1	16kHz

Q

D8	D9	Operation
0	0	0.5
1	0	1.0
0	1	2.0
1	1	4.0

Channel select

D10	D11	Operation
0	0	LFOUT
1	0	LROUT
0	1	RFOUT
1	1	RROUT

REG12 (Command register 0011)

Soft step/Soft mute control

D0	Operation
0	Soft mute off
1	Soft mute on

D1	D2	D3
0	0	0

Soft step/Soft mute settling time select control

D4	D5	Operation
0	0	mute time 0.64ms
1	0	mute time 5.12ms
0	1	mute time 40ms
1	1	mute time 80ms

D6	D7	Operation
0	0	Bass block/Mid block Soft step time 10ms
1	0	Bass block/Mid block Soft step time 20ms

D8	D9	D10	D11
0	0	0	0

REG13 (Command register 1011)

Soft step on/off select

D0	D1	D2	D3	Contents
0	0	0	0	-
1	0	0	0	-
0	1	0	0	-
1	1	0	0	-
0	0	1	0	-
1	0	1	0	-
0	1	1	0	-
1	1	1	0	-
0	0	0	1	-
1	0	0	1	-
0	1	0	1	-
1	1	0	1	-
0	0	1	1	-
1	0	1	1	-
0	1	1	1	Bass block/Mid block Soft step off
1	1	1	1	Bass block/Mid block Soft step on

D4	D5
0	0

D6	D7	D8	D9	D10	D11
0	0	0	0	0	0

REG14 (Command register 0111)

Other settings

D0	Operation
0	mute off
1	mute on

D1	Operation
0	normal mode
1	test mode

D2	D3	D4	D5	D6	D7	D8	D9	D10	D11
0	0	0	0	0	0	0	0	0	0

REG15 (Command register 1111)

Test mode block

D0	D1	D2	D3	D4	D5	D6	D7
0	0	0	0	0	0	0	0

D8	D9	D10	D11
0	0	0	0

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 LV3329PE 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.
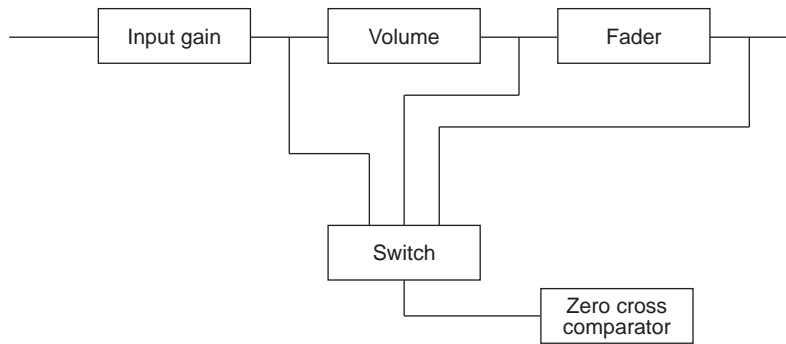
LV3329PE zero cross detection circuit

- Zero cross switching operates at the timing (rising edge and falling edge) when the signal crosses the reference voltage.

(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.

(4) Zero cross timer setting
If the input signal becomes lower than the zero cross comparator detection sensitivity, or if only low-frequency signals are input, zero cross detection continues to be impossible, and data is not latched during this time. The zero cross timer can set a time for forcible latch during such a status when zero cross detection is not possible.
The method of obtaining the timer time is shown below.
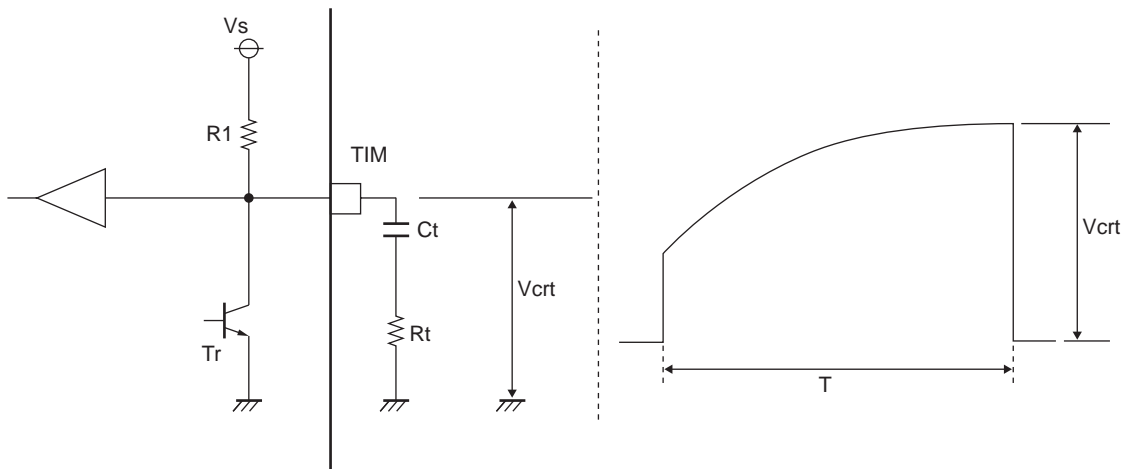
$$T = -Ct \times (R1 + Rt) \times 1n \frac{Vs - Vcrt}{Vs \times (1 - \frac{Rt}{R1 + Rt})} \cdots [1]$$

Calculation example)
- V_{DD} = 8V, Vs = 4V
- Vctr = 1.75V
- R1 = 930kΩ (TIM pin internal resistance)
- Ct = 0.022μF (External Ct)
- Rt = 150kΩ (External Rt)

The timer time "T" is obtained by formula [1] above.

In this example, T = 10.1ms.

(5) Bass/mid-range block soft step operation

The LV3329PE has a soft step function at bass and mid-range blocks to minimize switching noise.
The soft step time for the bass and mid-range blocks is 10ms or 20ms and can be selected using serial data.
When set to soft step on, a soft step function for the bass or mid-range block can be implemented at the minimum resolution step intervals.
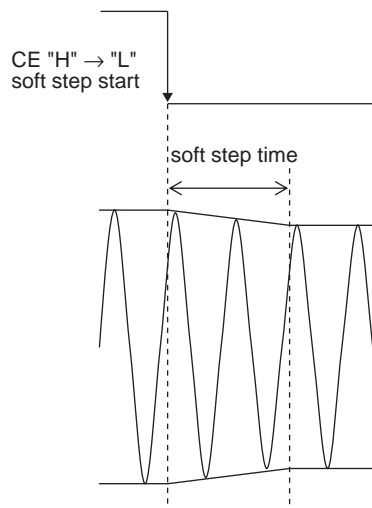
(6) Soft mute operation

The LV3329PE 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. (0.6ms, 5ms, 40ms, 80ms)
A soft mute function can be implemented by set to soft mute on. (Set to mute on/off)
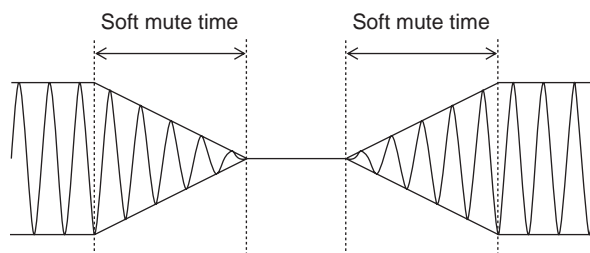
(7) Step mode operation

In step mode, when the main volume is switched between 0dB and -32dB in 2-dB steps, the volume is first set to the midpoint level of before and after the setting, and then to the final value.

The volume is set at the zero cross operation timing.

(Condition: Set to zero cross mode.)

This operation further reduces the switching noise, in addition to the effects of countermeasures against switching noise due to zero cross operation.

(8) Notes during data control

1) Notes when transmitting data continuously
   (1) Transmit the initial data once at power ON. (REG0, D0 to D11 = ALL "0")
       Set each register thereafter, but be sure to set REG7 (zero cross setting "ON") last.
   (2) Do not transmit data during soft mute operation. Wait until soft step operation is finished before transmitting the data. (It is recommended to set the data transmission interval of approximately twice the soft mute setting time.)
   (3) Do not transmit data during soft step operation. Wait until soft step operation is finished before transmitting the data. (It is recommended to set the data transmission interval of approximately twice the soft step setting time.)
   (4) Do not transmit soft mute or soft step operation data during zero cross operation (when data is set while zero cross is set to "ON").
       Wait until zero cross operation is finished before transmitting soft mute or soft step data. Set the data transmission interval to be equal or longer that the zero cross timer setting time.
       (Recommended interval: Zero cross timer setting time +10ms)
   (5) When performing BASS control or MID control in soft step mode, transmit data with the step level interval set to the minimum resolution possible.

2) Notes when setting the mode
   (1) When performing soft step control, always set REG12 (soft step setting time) and REG13 (soft step operation "ON") before transmitting the BASS control and MID control step data.
       (The soft step setting time and soft step operation setting data are transmitted one time in the initial stage, and the soft step mode is maintained thereafter until the power is turned off or the soft step setting time or soft step operation setting is changed. Therefore, there is no need to repeatedly transmit the soft step setting time or soft step operation setting data.)
   (2) When performing zero cross control, always set REG7 (zero cross detection "ON," zero cross detection block selection) before transmitting the input selection switching control, input gain control, main volume control, treble control and fader control step data.

       (The zero cross detection and zero cross detection block selection setting data are transmitted one time in the initial stage, and the zero cross detection mode is maintained thereafter until the power is turned off or the zero cross detection or zero cross detection block selection setting is changed. Therefore, there is no need to repeatedly transmit the zero cross detection or zero cross detection block selection setting data.)

Application Circuit Example