Ordering number : ENN8301

SANYO Semiconductors
DATA SHEET

Bi-CMOS IC

LV23200T — For Home Stereo System 1-chip Tuner IC Incorporating PLL

Overview

The LV23200T is a one-chip tuner IC incorporating PLL for home stereo system.

Functions

- AM tuner — Changeover of the constant in RFAMP, MIX, OSC, IF AMP, DET, AGC, SD, OSC BUFF, IF BUFF, and AGC modes.
- FM tuner — 1stIFAMP, IF limiter AMP, DET (COIL type) , S-METER, SD, AFC, IF BUFF.
- MPX — PLL STEREO DECODER, forced MONO, AUDIO MUTE, function to prevent interference from a neighboring station, PILOT canceling function.
- PLL frequency synthesizer.

Features

- Tuner IC and PLL IC integrated into one chip.
- MPX-VCO incorporated and without need of adjustment.
- FM/AM output level independent setting possible.
- MOS transistor for active LPF incorporated.

Specitications

Maximum Ratings at Ta = 25 °C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V_{CC} max	V_{CC}	7.0	V
	V_{DD} max	V_{DD}	6.0	V
Operating temperature	Topr		-20 to +80	°C
Storage temperature	Tstg		-40 to +125	°C

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Operating Condition at Ta = 25 °C

Parameter	Symbol	Conditions	Ratings	Unit
Recommended supply voltage	V_{CC}		5.0	V
	V_{DD}		3.0	V
Operating supply voltage range	V_{CC} op		4.5 to 6.0	V
	V_{DD} op1	X'tal oscillation = 4.5MHz	2.7 to 3.3	V

* Handle pin 34 with care because its electrostatic voltage at C = 200pF and R = 0Ω is 110 V.

Operating Characteristics at Ta = 25°C, V_{CC} = 5.0V, V_{DD} = 3.0V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
[Current dissipation]						
FM tuner block	I_{CC}FM	No input in FM mode	25	35	45	mA
AM tuner block	I_{CC}AM	No input in AM mode	14	24	34	mA
PLL block	I_{DD}FM	X'tal = 4.5MHz, No input at tuner	2.0	3.0	4.0	mA
[FM-FE characteristics (MPX)] : FM-IF (5PIN) input, fc = 10.7MHz, fm = 1kHz, 75kHzdev (L+R = 90%, Pilot = 10%)						
Demodulation output	V_O	V_{IN} = 100dBμV	450	550	650	mVrms
3dB sensitivity 1	LS1	V_{IN} = 70dBμV reference, input at -3dB *at input of FIFA (pin 1)		28	33	dBμV
3dB sensitivity 2	LS2	V_{IN} = 100dBμV reference, input at -3dB *at input of FMFA (pin 5)		35	40	dBμV
Total harmonic distortion	THD1	V_{IN} = 100dBμV, MONO		0.4	1.5	%
Signal-to-noise ratio	S/N	V_{IN} = 100dBμV	70	76		dB
AM suppression ratio	AMR	V_{IN} = 100dBμV, AM = 30%	36	40		dB
SD sensitivity	SD-1	0%mod, SD sensitivity mode 1	43	50	57	dBμV
Total harmonic distortion	THD2	V_{IN} = 100dBμV, MAIN-MOD		0.5	1.5	%
Separation	SEP	V_{IN} = 100dBμV, L output/R output	30	45		dB
ST sensitivity	VL	V_{IN} = 100dBμV, (L+R)+Pilot		3.0	5.5	%
Mute attenuation	MUTE	V_{IN} = 100dBμV, L output		60		dB
Carrier leakage	CL	V_{IN} = 100dBμV, (L+R)+Pilot	30	40		dB
[AM characteristics] : fc = 999kHz, fm = 1kHz, 30%mod						
Demodulation output 1	V_O1	V_{IN} = 23dBμV, 30%mod, fm = 1kHz	50	80	130	mVrms
Demodulation output 2	V_O2	V_{IN} = 80dBμV, 30%mod, fm = 1kHz	170	240	310	mVrms
Signal-to-noise ratio 1	S/N1	V_{IN} = 23dBμV	15	20		dB
Signal-to-noise ratio 2	S/N2	V_{IN} = 80dBμV	48	54		dB
Total harmonic distortion	THD	V_{IN} = 80dBμV		0.4	1.3	%
SD sensitivity	SD-ON	0%mod (Internally fixed sensitivity)	14	24	34	dBμV
[PLL characteristics]						
Internal return resistance	Rf	XIN		8		MΩ
Built-in output resistance	Rd	XOUT		250		kΩ
Hysteresis width	VHIS	CE, CL, DI		0.1V_{DD}		V
Output high level voltage	V_{OH}	PD ; I_O = -1mA	V_{DD}-1.0			V
Output low level voltage	V_{OL}1	PD ; I_O = 1mA			1.0	V
	V_{OL}2	BO ; I_O = 1mA			0.25	V
		BO ; I_O = 5mA			1.25	V
	V_{OL}3	DO ; I_O = 1mA			0.25	V
	V_{OL}4	AOUT ; I_O = 1mA, AIN = 2.0V			0.5	V
Output high level voltage	I_{IH}1	CE, CL, DI ; VI = 6.0V			5.0	μA
	I_{IH}2	XIN ; VI = V_{DD}	0.16		0.9	μA
	I_{IH}3	AIN ; VI = 6.0V			200	nA
Input high level current	I_{IL}1	CE, CL, DI ; VI = 0V			5.0	μA
	I_{IL}2	XIN ; VI = 0V	0.16		0.9	μA
	I_{IL}3	AIN ; VI = 0V			200	nA

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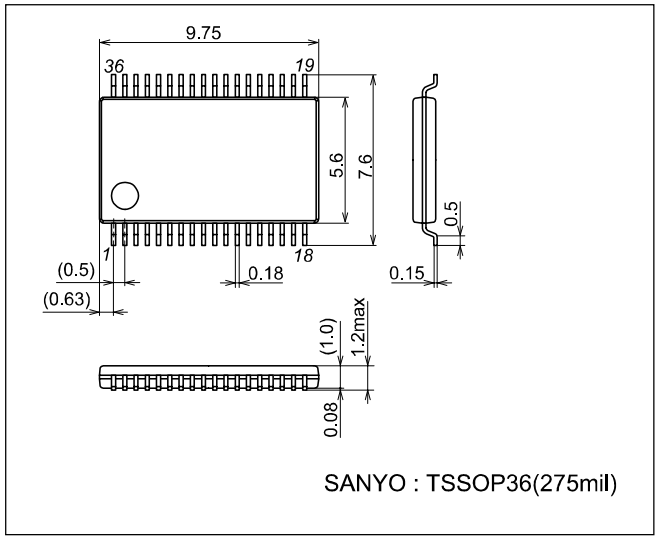
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Output off-leak current	$I_{OFF}1$	BO, AOUT ; V_O = 10V			5.0	µA
	$I_{OFF}2$	DO ; V_O = 6.0V			5.0	µA
"H" level 3-state off-leak current	$I_{OFF}H$	PD ; V_O = 6.0V		0.01	200	nA
"L" level 3-state off-leak current	$I_{OFF}L$	PD ; V_O = 0V		0.01	200	nA

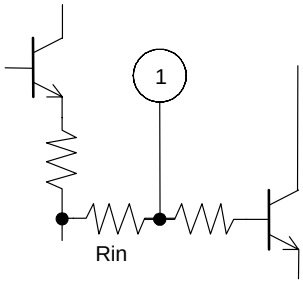
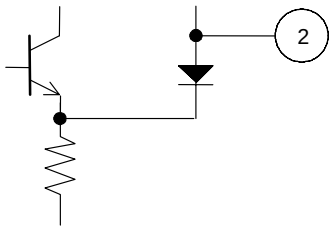
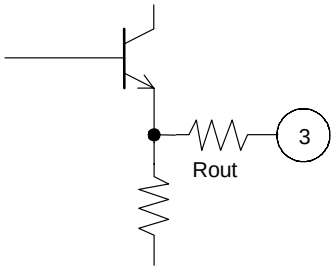
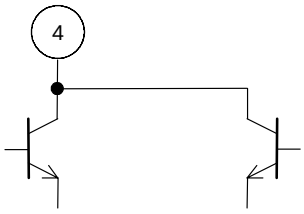
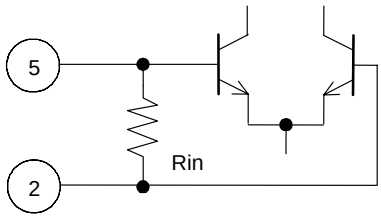
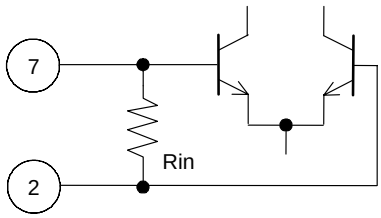
Package Dimensions

unit : mm

3253B



Description of Pin Functions

No.	Functions	Voltage (V)	Internal Equivalent Circuit	Remarks
1	FM 1stIF-AMP input	1.6V		Input impedance ri (Rin). Rin = 330Ω
2	REG	2.2V		Reference voltage of AM/FM IF/MPX block. Vreg = 2.2V
3	FM 1st IF-AMP output	3.0V		Output impedance ro (Rout). Rout = 300Ω
4	AM MIX output	V_{CC}		MIX coil used between pins 4 and 8 (V_{CC} voltage).
5	FM IF input	Vreg		Input impedance ri (Rin). Rin = 330Ω
6	GND	0V		AM/FM IF/MPX block GND
7	AM IF input	2.2V		Input impedance ri (Rin). Rin = 2kΩ
8	V_{CC}	5.0V		AM/FM IF/MPX block V_{CC}

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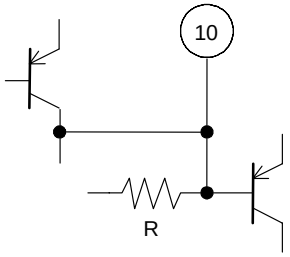
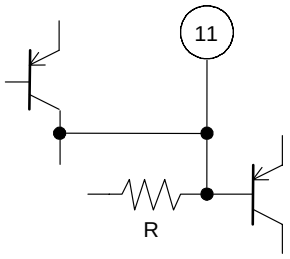
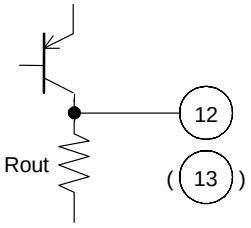
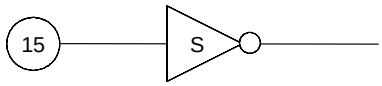
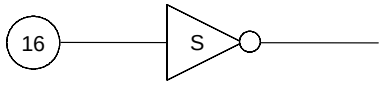
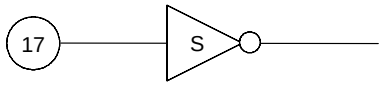
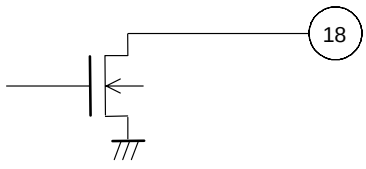
No.	Functions	Voltage (V)	Internal Equivalent Circuit	Remarks
9	FM DET	V_{CC}		Recommended detection coil. 600BCAS–10790Z
10	Phase comparator filter	V_{CC}-1.0V		R = 10kΩ
11	Pilot filter	V_{CC}-1.0V		R = 10kΩ
12 13	L output R output	2.5V		Output impedance ro (Rout). Rout = 7.7kΩ
15	CE	–		Chip enable pin At changeover from “L” to “H”: Address latching. At changeover from “H” to “L”: Data latching.
16	DI	–		Serial data input pin Sets data in synchronization with rise of data clock.
17	CL	–		Data clock input pin.
18	DO	–		Data output pin Outputs various data in synchronization with fall of data clock in the OUT mode.

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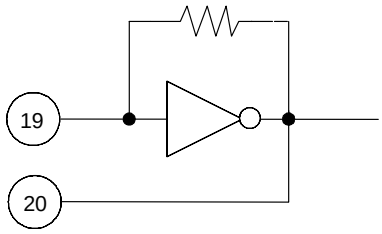
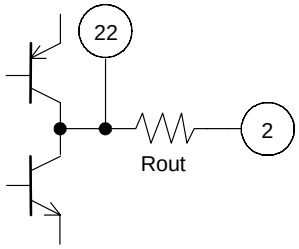
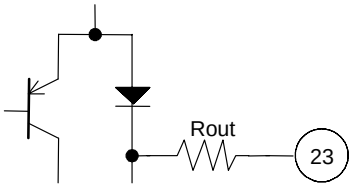
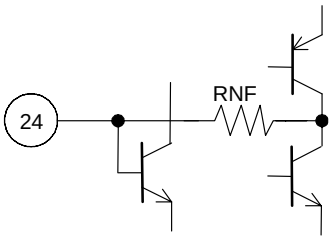
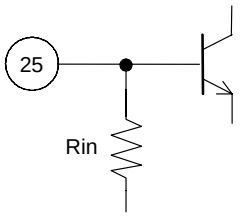
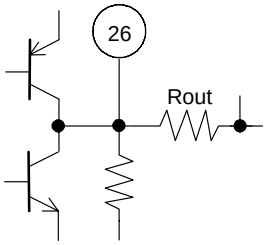
No.	Functions	Voltage (V)	Internal Equivalent Circuit	Remarks
19 20	X IN X OUT	– –		Clock for internal reference Connect a 4.5 MHz crystal oscillator.
21	V_{DD}	3.0V		AM/FM IF/MPX block V_{DD}
22	Pilot canceling output	Vreg		Output impedance ro (Rout). Rout = 30kΩ
23	AM detection output	0.8V (FM) Vreg (AM)		Output impedance ro (Rout). Rout = 10kΩ
24	MPX input	Vreg		MPX inverse input pin. RNF = 20kΩ
25	PLL input	Vreg		Input impedance ri (Rin). Rin = 20kΩ
26	FM detection output	Vreg+0.7V		Output impedance ro (Rout). Rout = 3.3kΩ Adjusts separation using the capacitance value of a section between this pin and GND.

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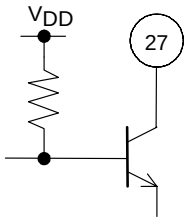
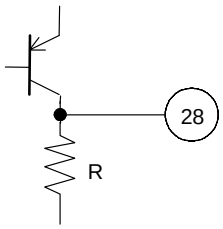
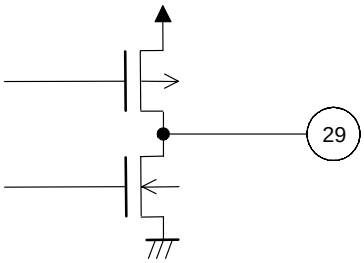
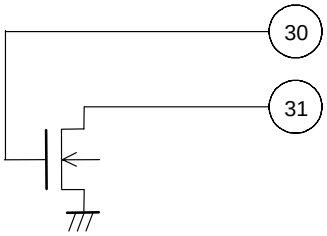
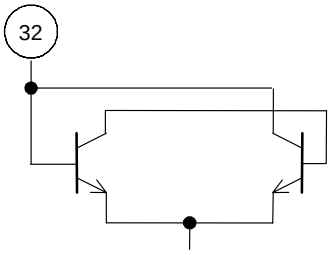
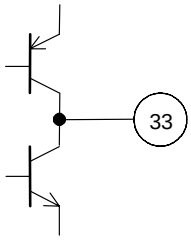
No.	Functions	Voltage (V)	Internal Equivalent Circuit	Remarks
27	SD monitor	V_{DD}		Active “L” Open collector.
28	FMS meter and AM AGC outputs	0.2V (FM) 0.8V (AM)		Internal load resistance R = 13.9kΩ Determines the SD response speed during SEEK by a capacitor externally connected to pin 28.
29	PD	–		PLL charge pump output pin.
30 31	AIN AOUT	– –		Nch MOS transistor for PLL active low pass filter.
32	AM OSC	V_{CC}		OSC coil used between pins 32 and 8 (V_{CC} voltage).
33	AFC	Vreg		Enables adjustment of the FM SD band width by external resistor between pins 33 and 2 (Vreg voltage).

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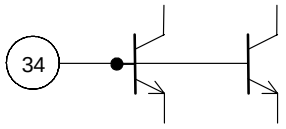
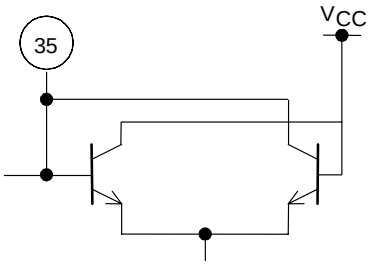
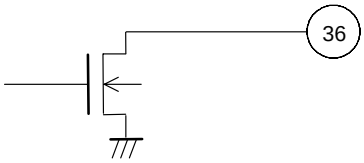
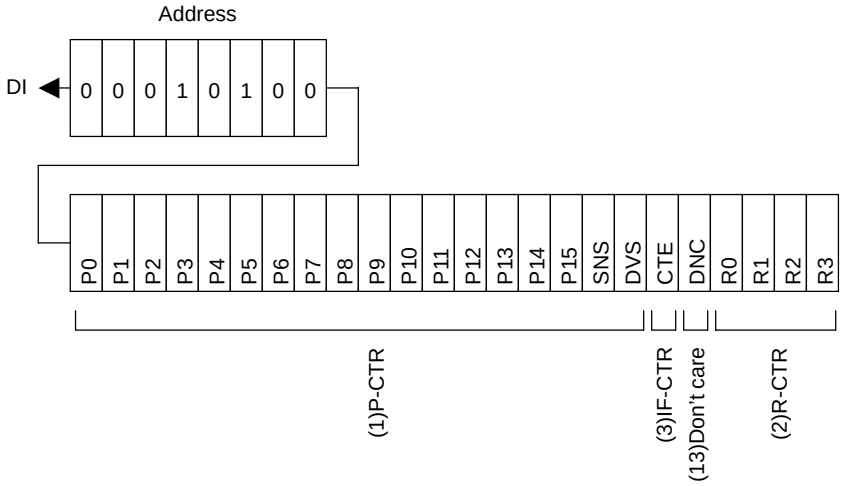
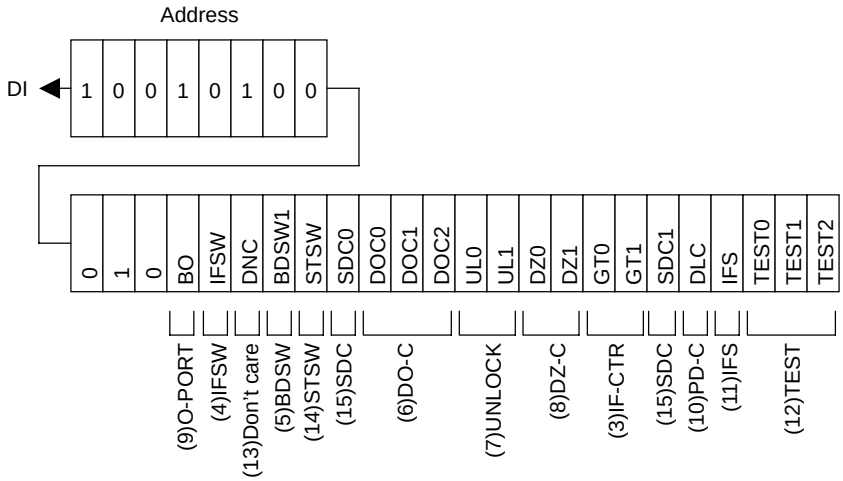
No.	Functions	Voltage (V)	Internal Equivalent Circuit	Remarks
34	AM RF input	Vreg		Use pin 34 with the same potential as for pin 32 (AFC voltage).
35	FM OSC input	V_{CC}		Use pin 35 through pull-up to pin 8 (V_{CC} voltage) by resistance load.
36	BO	–		Pin dedicated for output.

Composition of DI control data (serial data input)

(1) IN1 mode



(2) IN2 mode



Description of DI control Data

No.	Control block data	Description	Related data
(1)	Programmable divider data P0 to P15 DVS, SNS	• Data to set the dividing number of programmable divider Binary value with P15 assumed to be MSB. LSB varies according to DVS and SNS. (* : Don't care) DVS / SNS / LSB / set dividing number (N) / Actual dividing 1 / * / P0 / 272 to 65535 / Twice the set value 0 / 1 / P0 / 272 to 65535 / Set value 0 / 0 / P4 / 4 to 4095 / Set value * P0 to P3 invalid when LSB : P4 • To select the signal input (FMIN, AMIN) to the programmable divider and to change the input frequency range. (* : Don't care) DVS / SNS / Input / Operation frequency range 1 / * / FMIN / 10 to 160MHz 0 / 1 / AMIN / 2 to 40MHz 0 / 0 / AMIN / 0.5 to 10MHz	

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<table>
<tr><th>No.</th><th>Control block data</th><th>Description</th><th>Related data</th></tr>
<tr><td>(2)</td><td>Reference
divider data

R0 to R3</td><td>• Reference frequency (fref) selection data
<table>
<tr><th>R3</th><th>R2</th><th>R1</th><th>R0</th><th>Reference frequency</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>25kHz</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1</td><td>25kHz</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>0</td><td>25kHz</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>1</td><td>25kHz</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>0</td><td>12.5kHz</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>1</td><td>6.25kHz</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>0</td><td>3.125kHz</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>1</td><td>3.125kHz</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td>5kHz</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td><td>5kHz</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>0</td><td>5kHz</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>1</td><td>1kHz</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>0</td><td>3kHz</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>1</td><td>15kHz</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>0</td><td>PLL INHIBIT+X'tal OSC</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>1</td><td>PLL INHIBIT</td></tr>
</table>
* PLL INHIBIT
• The programmable divider and IF counter stop, with FMIN, AMIN, HCTR and LCTR inputs being in the pull-down condition (GND), and the charge pump has the high impedance.</td><td></td></tr>
<tr><td>(3)</td><td>IF counter
control data

CTE
GT0, GT1</td><td>• IF counter counting start data
CTE = 1 : Counting start
= 0 : Counting start
• Determines the counting time of universal counter
<table>
<tr><th>GT1</th><th>GT0</th><th>Counting time</th><th>Wait time</th></tr>
<tr><td>0</td><td>0</td><td>4ms</td><td>3 to 4ms</td></tr>
<tr><td>0</td><td>1</td><td>8ms</td><td>3 to 4ms</td></tr>
<tr><td>1</td><td>0</td><td>16ms</td><td>3 to 4ms</td></tr>
<tr><td>1</td><td>1</td><td>32ms</td><td>3 to 4ms</td></tr>
</table></td><td>IFS</td></tr>
<tr><td>(4)</td><td>MUTE
control data

IFSW</td><td>• Data to determine the output of output port IFSW, controlling the MUTE function.
"Data" = 0 : at receiving
1 : MUTE</td><td></td></tr>
<tr><td>(5)</td><td>FM/AM BAND
selection
control data
BDSW</td><td>• Data to determine the output of output port BDSW, controlling selection of BAND.
"Data" = 0 : AM
1 : FM</td><td></td></tr>
</table>

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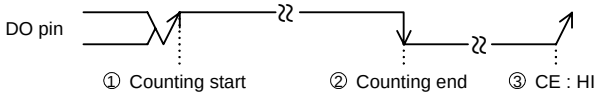
<table>
<tr><th>No.</th><th>Control block data</th><th>Description</th><th>Related data</th></tr>
<tr><td>(6)</td><td>DO pin
control data

DOC0
DOC1
DOC2</td><td>• Data to control DO pin output
<table><tr><th>DOC2</th><th>DOC1</th><th>DOC0</th><th>DO pin condition</th></tr><tr><td>0</td><td>0</td><td>0</td><td>Open</td></tr><tr><td>0</td><td>0</td><td>1</td><td>Low when unlock is detected.</td></tr><tr><td>0</td><td>1</td><td>0</td><td>end-UC (See the item with asterisk below)</td></tr><tr><td>0</td><td>1</td><td>1</td><td>Open</td></tr><tr><td>1</td><td>0</td><td>0</td><td>Open</td></tr><tr><td>1</td><td>0</td><td>1</td><td>Low when SDON</td></tr><tr><td>1</td><td>1</td><td>0</td><td>Low when stereo</td></tr><tr><td>1</td><td>1</td><td>1</td><td>Open</td></tr></table>• The open condition is selected at power ON/reset.
* IF counter counting end check
 
① With end-UC set and IF counter starting (CTE = 0→1), DO pin opens automatically.
② At end of counting of the IF counter, DO pin goes LOW and check on counting end can be made.
③ DO pin opens when serial data is entered/output (CE pin : Hi)
Note : DO pin is always in the open condition during data input (IN1 and IN2 modes, during CE : Hi period), regardless of DO pin control data (DOC0 to 2). In the DO pin condition during data output (OUT mode, CE-Hi period), the content of internal DO serial data is output in synchronization with CL pin signal, regardless of DO pin control data (DOC).</td><td>UL0, UL1
CTE</td></tr>
<tr><td>(7)</td><td>Unlock detection
data

UL0, UL1</td><td>• Phase error (ϕE) detection width selection data to judge if PLL is locked.
Phase error exceeding the detection width is judged to mean that PLL is locked
(* : don't care)
<table><tr><th>UL1</th><th>UL0</th><th>ϕE Detection width</th><th>Detection output</th></tr><tr><td>0</td><td>0</td><td>Stop</td><td>Open</td></tr><tr><td>0</td><td>1</td><td>0</td><td>Direct output of ϕE</td></tr><tr><td>1</td><td>*</td><td>±6.67μs</td><td>ϕE extended by 1 to 2 ms</td></tr></table>* DO pin is LOW. Serial data output : UL = 0.</td><td>DOC0
DOC1
DOC2</td></tr>
<tr><td>(8)</td><td>Phase
comparator
control data

DZ0, DZ1</td><td>• Data to control the dead zone of phase comparator
<table><tr><th>DZ1</th><th>DZ0</th><th>Dead zone mode</th></tr><tr><td>0</td><td>0</td><td>DZA</td></tr><tr><td>0</td><td>1</td><td>DZB</td></tr><tr><td>1</td><td>0</td><td>DZC</td></tr><tr><td>1</td><td>1</td><td>DZD</td></tr></table>Dead zone width : DZA<DZB<DZC<DZD</td><td></td></tr>
<tr><td>(9)</td><td>Output port data

BO</td><td>• Data to determine the output of output ports BO1 and BO2
"Data" = 0 : OPEN
1 : Low</td><td></td></tr>
<tr><td>(10)</td><td>Charge pump
control data

DLC</td><td>• Data to enforce control of charge pump output
<table><tr><th>DLC</th><th>Charge pump output</th></tr><tr><td>0</td><td>Normal</td></tr><tr><td>1</td><td>Forced to LOW</td></tr></table>* In case of dead lock because of VCO oscillation stop when the VCO control voltage (Vtune) is 0V, it is possible to clear dead lock by setting the charge pump output to LOW and V tune to V_{CC}. (Dead lock clear circuit)</td><td></td></tr>
<tr><td>(11)</td><td>IFS</td><td>• Normally, set Data = 1. Setting Data = 0 causes the input sensitivity worsening mode and the sensitivity decreases by about 10 to 30mVrms.</td><td></td></tr>
<tr><td>(12)</td><td>LSI test data

TEST0 to 2</td><td>• LSI test data
TEST0
TEST1] All to be set to "0"
TEST2
All set to zero at power ON/reset</td><td></td></tr>
<tr><td>(13)</td><td>DNC</td><td>• Set data = 0.</td><td></td></tr>
</table>

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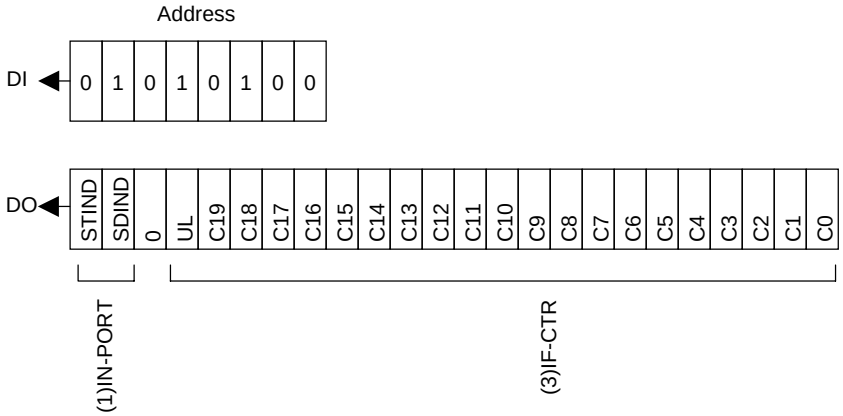
No.	Control block data	Description	Related data
(14)	Forced monaural control data STSW	• Data to determine the output of output port STSW, controlling the forced stereo functions. "Data" = 0 : MONO 1 : STEREO	
(15)	SD sensitivity control data SDC	• Data to determine the output of output ports SDC, controlling the SD sensitivity "Data" = SDC0 : 0, SDC1 : 0 → SD sensitivity 1 = 50dBμV (Typ) SDC0 : 0, SDC1 : 1 → SD sensitivity 2 = 52dBμV (Typ) SDC0 : 1, SDC1 : 0 → SD sensitivity 3 = 57dBμV (Typ) SDC0 : 1, SDC1 : 1 → SD sensitivity 4 = 62dBμV (Typ) * Above data values indicate the difference of SD sensitivity levels and are reference values.	

DO control data (serial data output) composition

(1) OUT mode

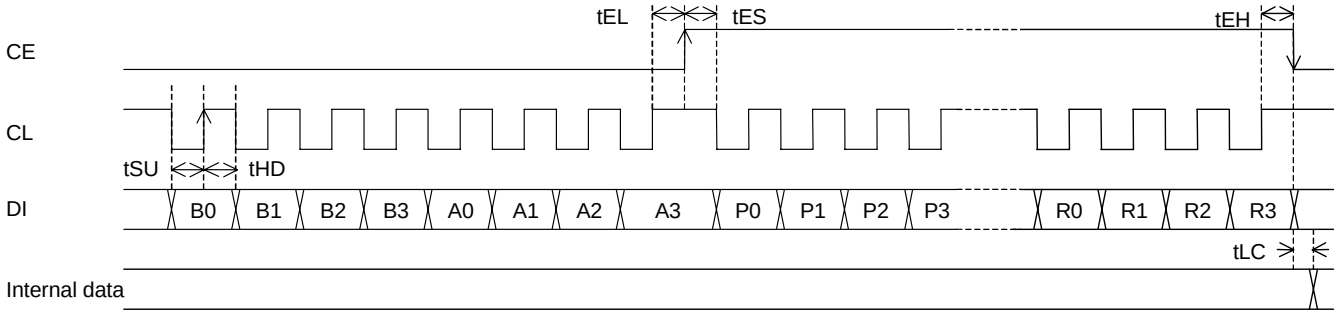


Description of DO output data

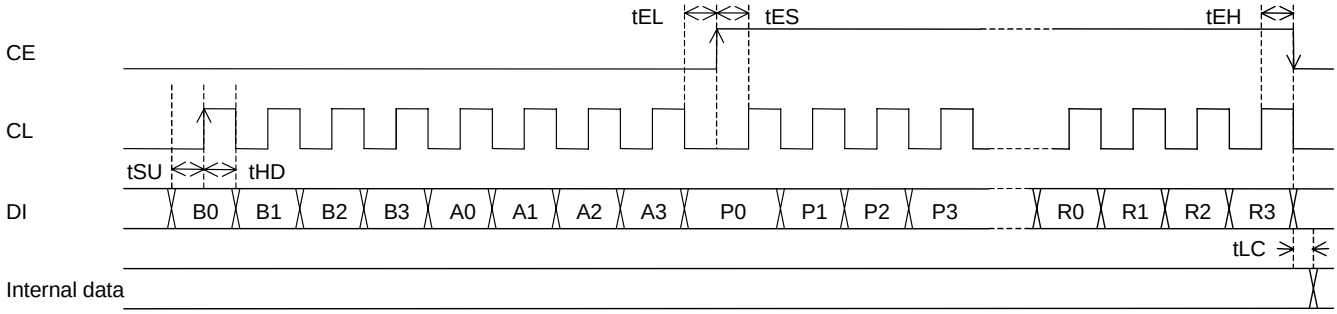
No.	Control block data	Description	Related data
(1)	Stereo and SD indicators control data STIND, SDIND	• Data latching stereo and SD indicator conditions. Latching made in the data output (OUT) mode. SDIND←Stereo indicator condition 0 : ST ON, 1 : ST OFF STIND←SD indicator condition 0 : SD ON, 1 : SD OFF	
(2)	PLL unlock data UL	• Data latching the content of unlock detection circuit UL←0 : At unlock 1 : At lock or in the detection stop mode	UL0 UL1
(3)	IF counter, binary counter C19 to C0	• Data latching the content of IF counter (20-bit binary counter) C19←MSB of binary counter C0 ←LSB of binary counter	CTE GT0 GT1

Serial data input (IN1/IN2) tSU, tHD, tEL, tES, tEH≥0.75µs tLC<0.75µs

CL : Normally Hi

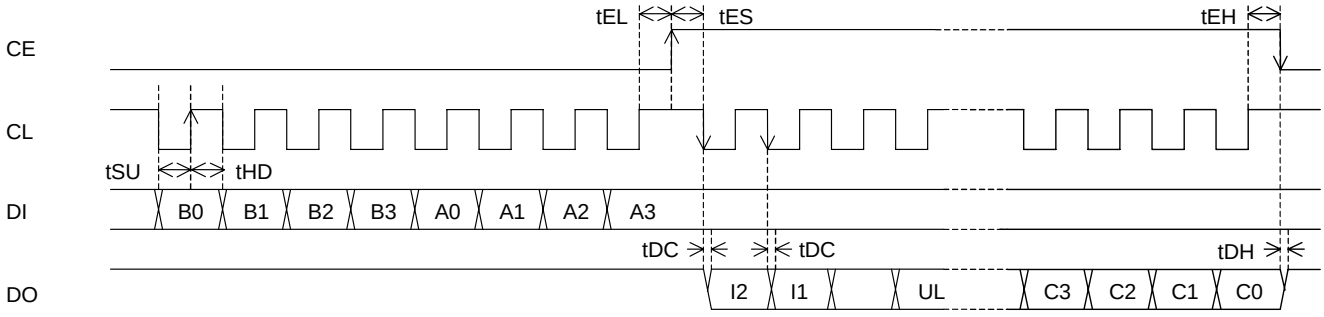


CL : Normally Low

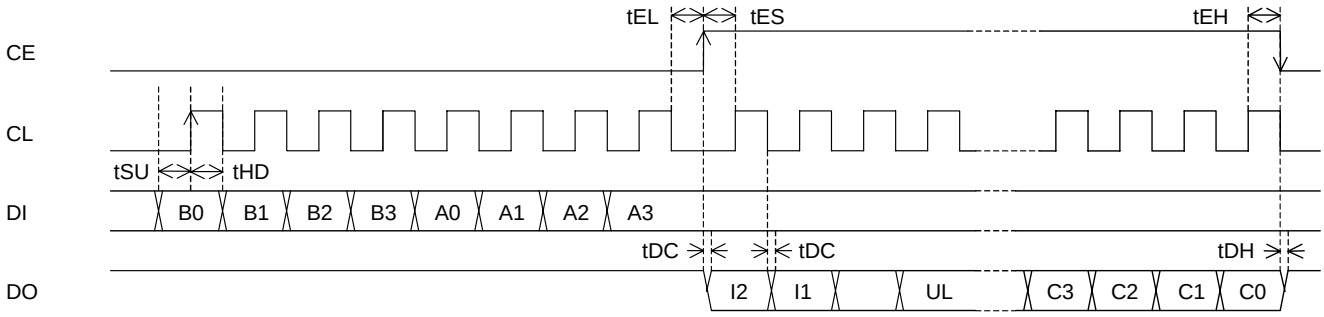


Serial data output (OUT) tSU, tHD, tEL, tES, tEH≥0.75µs tDC, tDH<0.35µs

CL : Normally Hi

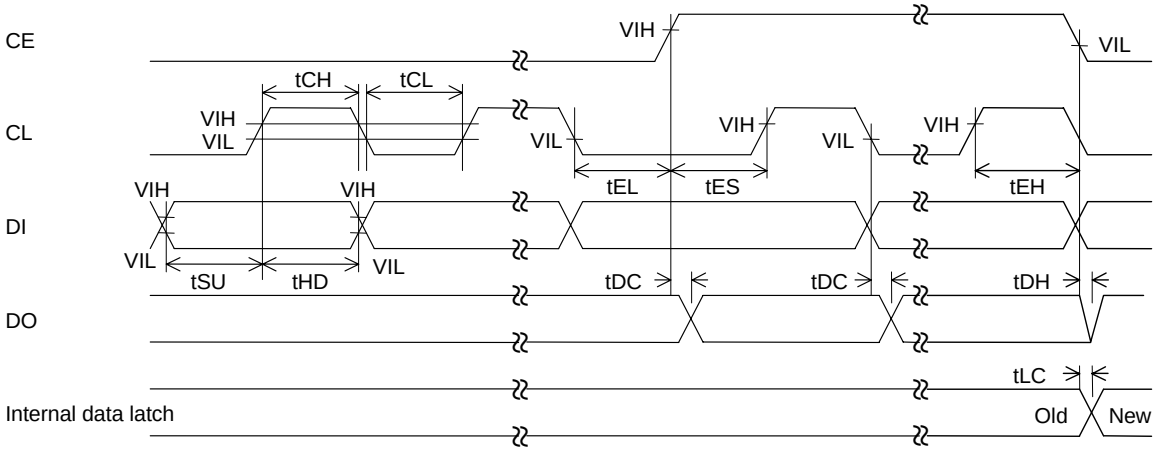


CL : Normally Hi

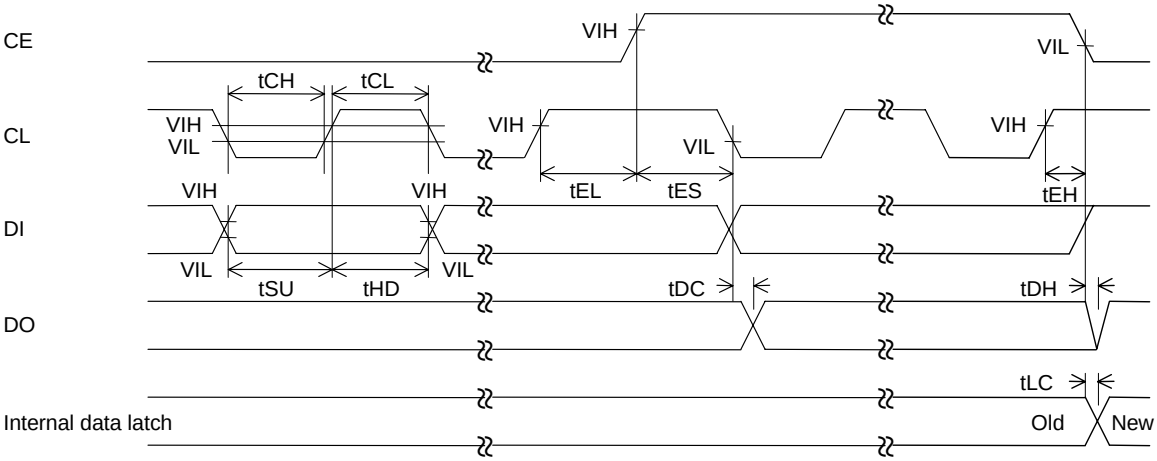


(Note) DO pin is an Nch open drain pin, so that the data varying time (tDC and tDH) differs depending on the pull-up resistance and substrate capacity.

Serial data timing



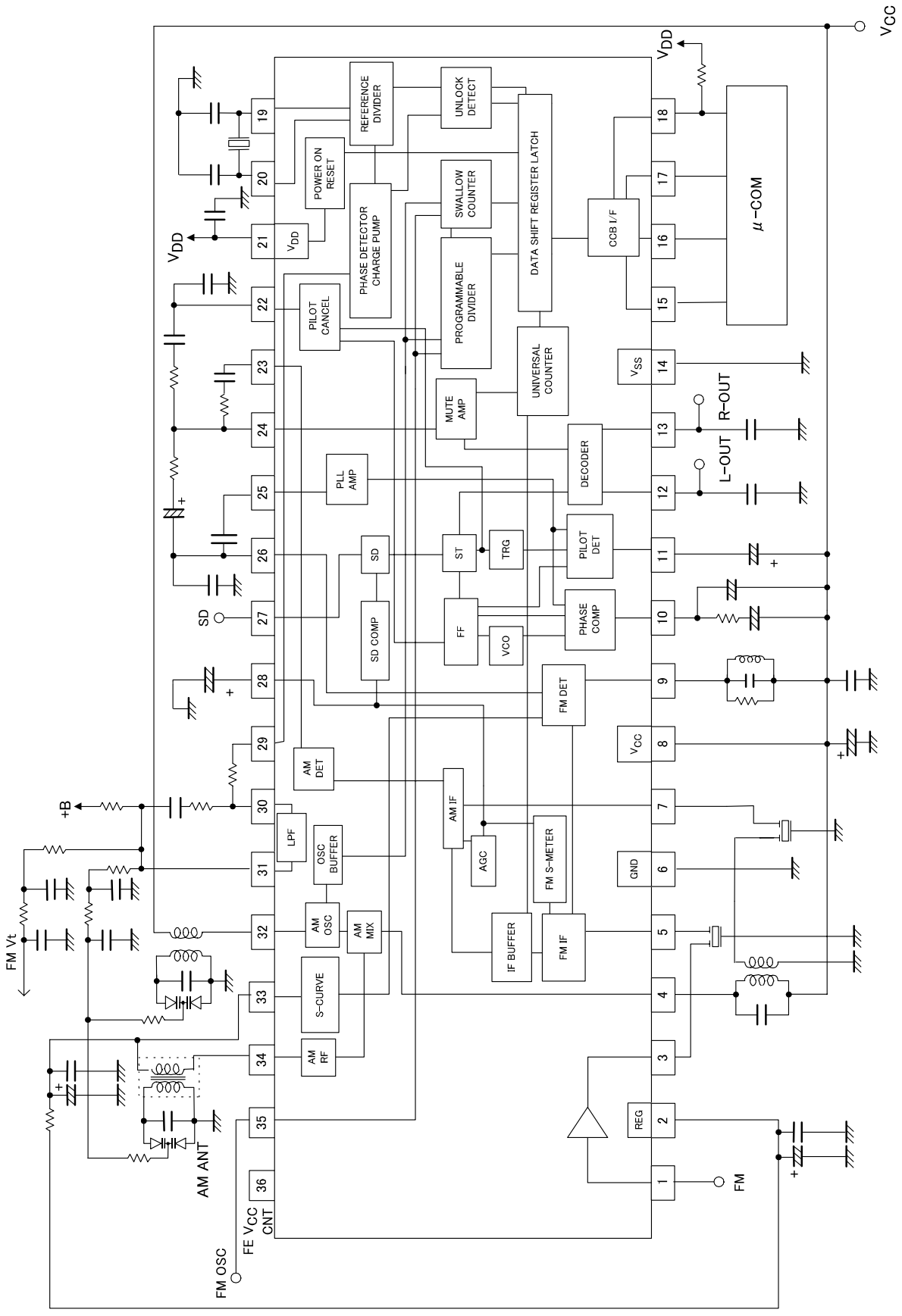
<< When CL stops at the “L” level >>



<< When CL stops at the “H” level >>

Parameter	Symbol	Pin	Conditions	Min	Typ	Max	Unit
Data setup time	tSU	DI, CL		0.75			µs
Data hold time	tHD	DI, CL		0.75			µs
Clock “L” level time	tCL	CL		0.75			µs
Clock “H” level time	tCH	CL		0.75			µs
CE wait time	tEL	CE, CL		0.75			µs
CE setup time	tES	CE, CL		0.75			µs
CE hold time	tEH	CE, CL		0.75			µs
Data latch change time	tLC					0.75	µs
Data output time	tDC	DO, CL	Differs depending on the pull-up resistance and substrate capacity			0.35	µs
	tDH	DO, CE					

Block Diagram



Test Circuit