



SANYO Semiconductors

## DATA SHEET

# LV2283VB — Bi-CMOS IC FM Transmitter IC with Stereo Modulation

## Overview

The LV2283VB is an FM Transmitter IC. MPX block makes stereo modulated, composite signal from L and R sound inputs. RF VCO includes FM modulation function. PLL synthesizer determines RF output frequency with I<sup>2</sup>C control.

## Application

- Portable Memory Player
- Portable HDD Player
- Wireless Headphone

## Features

- (Audio) Pilot tone system stereo modulation, audio attenuation
- (RF) VCO, programmable gain driver amplifier
- (PLL) 70 to 110MHz 100kHz step
- (Bus control) I<sup>2</sup>C bus control
- (Regulator) 2.8V LDO regulator

## Specifications

### Absolute Maximum Ratings at Ta = 25°C

| Parameter                   | Symbol              | Conditions                               | Ratings              | Unit |
|-----------------------------|---------------------|------------------------------------------|----------------------|------|
| Maximum supply voltage      | V <sub>CC</sub> max | Pin 6                                    | 7.0                  | V    |
| Maximum input voltage       | V <sub>IN</sub> max |                                          | V <sub>CC</sub> +0.3 | V    |
| Minimum input voltage       | V <sub>IN</sub> min |                                          | -0.3                 | V    |
| Allowable power dissipation | P <sub>d</sub> max  | Ta ≤ 85°C, Mounted on a specified board* | 500                  | mW   |
| Operating temperature       | T <sub>opr</sub>    |                                          | -40 to +85           | °C   |
| Storage temperature         | T <sub>stg</sub>    |                                          | -55 to +150          | °C   |

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

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## Recommended Operating Conditions at Ta = 25°C

| Parameter                      | Symbol             | Conditions | Ratings    | Unit |
|--------------------------------|--------------------|------------|------------|------|
| Recommended supply voltage     | V <sub>CC</sub>    | Pin 6      | 3.3        | V    |
| Operating supply voltage range | V <sub>CC op</sub> | Pin 6      | 2.8 to 5.5 | V    |

## AC Characteristics Ta = 25°C, V<sub>CC</sub> = 3.3V, I<sup>2</sup>C bits = Default state, L and R input = 1kHz, 450mVrms, unless otherwise noted

| Parameter       | Symbol          | Conditions                                                       | Ratings |     |     | Unit |
|-----------------|-----------------|------------------------------------------------------------------|---------|-----|-----|------|
|                 |                 |                                                                  | min     | typ | max |      |
| Circuit current | I <sub>CC</sub> | No input signal, Pin 6 current                                   |         | 8   | 10  | mA   |
| Standby current | ISTB            | No input signal, I <sup>2</sup> C bit "STB" = "1", Pin 6 current |         |     | 1.0 | μA   |

## Audio and MPX Blocks

| Parameter                         | Symbol    | Conditions                                                            | Ratings |      |     | Unit  |
|-----------------------------------|-----------|-----------------------------------------------------------------------|---------|------|-----|-------|
|                                   |           |                                                                       | min     | typ  | max |       |
| Maximum audio input               | VA max    | Pin 1 and 24 input                                                    |         |      | 900 | mVrms |
| Audio input frequency             | FAF       | Pin 1 and 24 input                                                    | 20      |      | 15k | Hz    |
| Channel separation                | SEP       | Pin 7, composite output, L→R, R→L                                     | 20      | 35   |     | dB    |
| Channel balance                   | CB        | Pin 7, composite output                                               | -2      | 0    | 2   | dB    |
| Total harmonic distortion         | THD       | Pin 7, composite output                                               |         | 0.1  | 0.3 | %     |
| Pilot tone output level           | PMOD      | I <sup>2</sup> C bits "ST" = "1"                                      | 0.5     | 0.85 | 1.2 | mVp-p |
| Composite output level            | MPXOUT    |                                                                       | 3.3     | 3.8  | 4.3 | mVrms |
| Audio mute                        | MUTE      | I <sup>2</sup> C bit "MUTE" = "1"                                     | 30      | 35   |     | dB    |
| Audio attenuation adjustment step | ATTSTEP   | I <sup>2</sup> C bit "ATT2 – ATT0" = "000" to "111", totally 8 steps. | 1.5     | 2    | 2.5 | dB    |
| Crystal oscillator frequency (1)  | FXOSC (1) | Pin 21 and Pin 22                                                     |         | 76   |     | kHz   |

## RF Blocks

| Parameter                 | Symbol | Conditions                                                                                  | Ratings |     |     | Unit |
|---------------------------|--------|---------------------------------------------------------------------------------------------|---------|-----|-----|------|
|                           |        |                                                                                             | min     | typ | max |      |
| RF output                 | RFOUT  | f = 98MHz, I <sup>2</sup> C bit "RF2 - RF0" = "011", Pin 12 output                          | 109     | 112 | 115 | dBμV |
| RF output adjustment step | RFSTEP | I <sup>2</sup> C bit "RF2 – RF0" = "000" to "111", totally 8 steps. Pin 12 relative output. | 0.4     | 0.9 | 1.4 | dB   |
| RF frequency              | FRF    | 100kHz step                                                                                 | 70      |     | 110 | MHz  |

## PLL Blocks

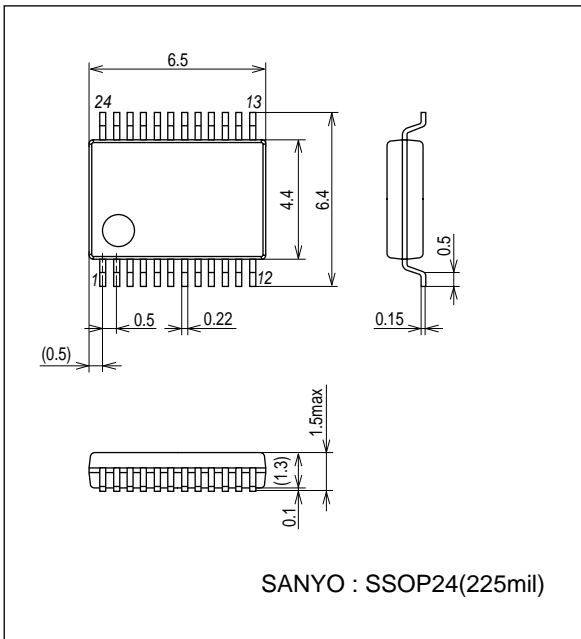
| Parameter                             | Symbol    | Conditions                                                                                                                            | Ratings            |                    |                      | Unit |
|---------------------------------------|-----------|---------------------------------------------------------------------------------------------------------------------------------------|--------------------|--------------------|----------------------|------|
|                                       |           |                                                                                                                                       | min                | typ                | max                  |      |
| I <sup>2</sup> C input "High" voltage | VH        |                                                                                                                                       | 0.8V <sub>CC</sub> |                    | V <sub>CC</sub> +0.3 | V    |
| I <sup>2</sup> C input "Low" voltage  | VL        |                                                                                                                                       | -0.3               |                    | 0.2V <sub>CC</sub>   | V    |
| 19kHz output voltage                  | V19K      | Pin 20. 19kHz output. I <sup>2</sup> C bit "19K" = "1". Load impedance = 47kΩ.                                                        | 0.6V <sub>CC</sub> | 0.8V <sub>CC</sub> |                      | Vp-p |
| RF input frequency                    | FPLL      | Step = 100kHz, See table 1                                                                                                            | 70                 |                    | 110                  | MHz  |
| Crystal oscillator frequency (2)      | FXOSC (2) | Pin 16                                                                                                                                |                    | 16                 |                      | MHz  |
| External clock frequency              | FEXT      | External clock injection to Pin 13 instead of 16MHz crystal oscillation. When the LSI is standby mode, external clock should be stop. | 1                  |                    | 24                   | MHz  |
| CP output current                     | ICP       | CP voltage = 1.4V                                                                                                                     |                    | 30                 |                      | μA   |

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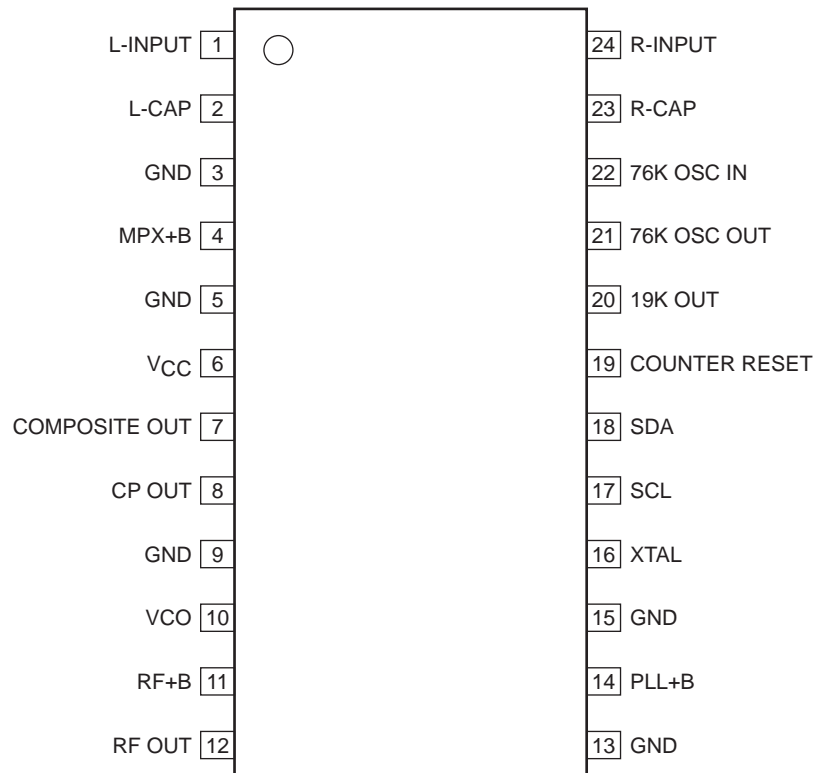
## Package Dimensions

unit : mm (typ)

3287

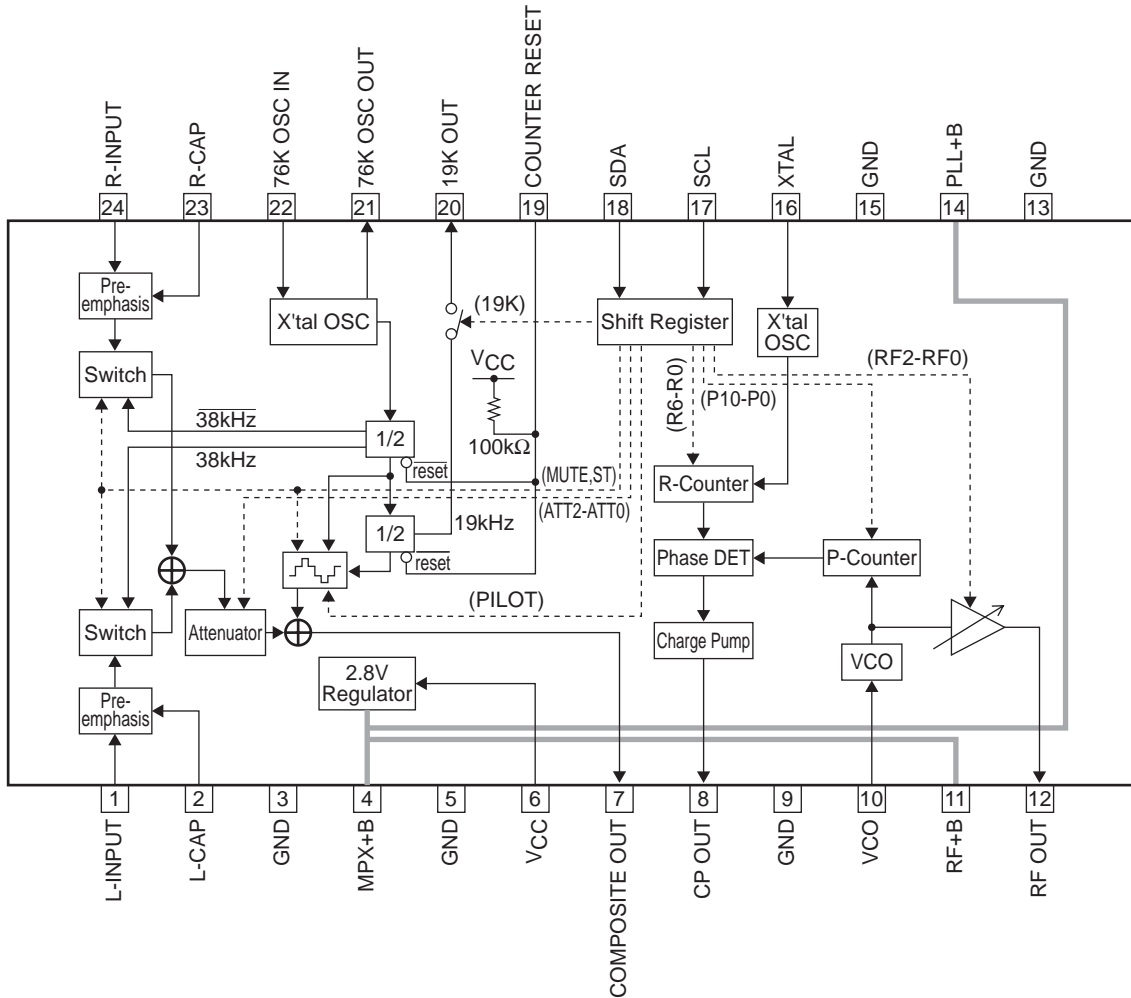


## Pin Assignment

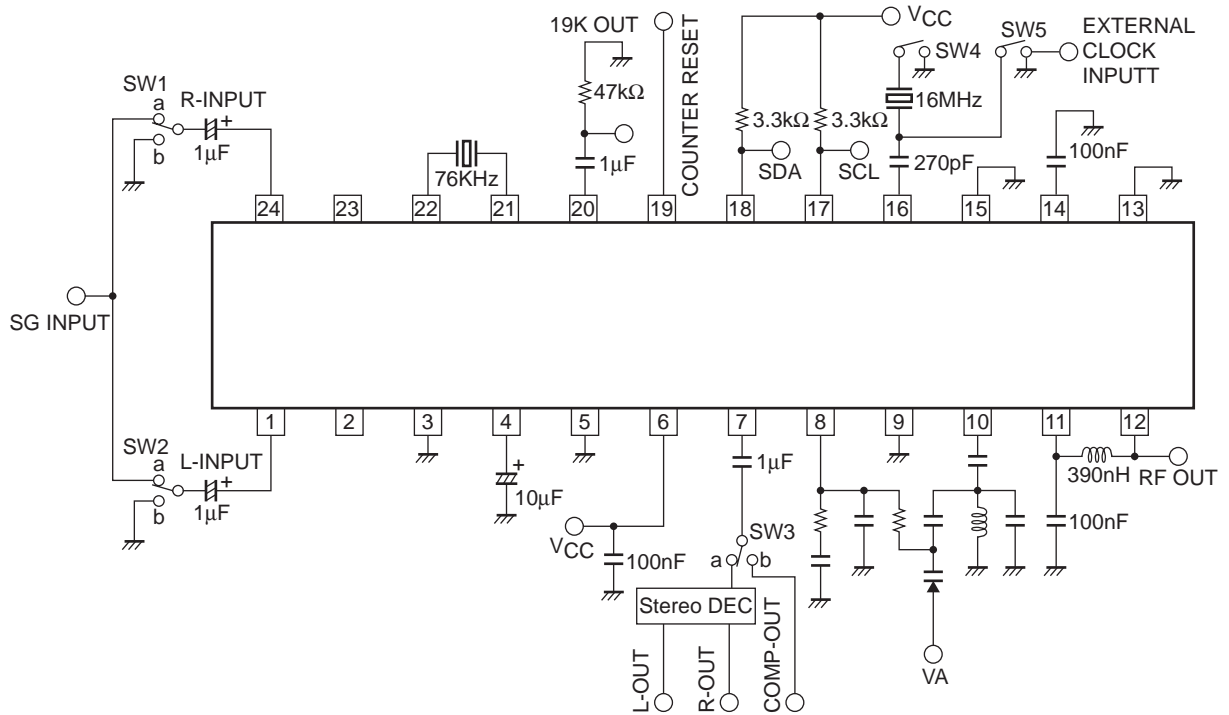


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## Block Diagram



## AC Testing Circuit



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## Pin Description

| Pin No. | Pin Name      | DC Voltage (V) | Description                                                                                                                                                               | Equivalent Circuit |
|---------|---------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| 1       | L-INPUT       | 0              | Left channel input. If audio source DC voltage is not 0V, AC coupling capacitance is required. Pre-emphasis capacitance should be required between pin 1 (24) and 2 (23). |                    |
| 2       | L-CAP         | 0              | See Pin 1                                                                                                                                                                 |                    |
| 3       | GND           | 0              |                                                                                                                                                                           |                    |
| 4       | MPX+B         | 2.8            | LDO regulator output for audio frequency and MPX blocks. External decoupling capacitance is required.                                                                     |                    |
| 5       | GND           | 0              |                                                                                                                                                                           |                    |
| 6       | VCC           | 3.3            |                                                                                                                                                                           |                    |
| 7       | COMPOSITE OUT | 0.05           | Stereo modulated output.                                                                                                                                                  |                    |
| 8       | CP OUT        | -              | Charge pump current output.                                                                                                                                               |                    |
| 9       | GND           | 0              |                                                                                                                                                                           |                    |

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| Pin No. | Pin Name | DC Voltage (V) | Description                                                                                                                              | Equivalent Circuit |
|---------|----------|----------------|------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| 10      | VCO      | 2.2            | Transistor BASE terminal for Colpitz oscillator.                                                                                         |                    |
| 11      | RF+B     | 2.8            | LDO regulator output for RF blocks.                                                                                                      |                    |
| 12      | RF OUT   | 2.8            | Collector output. Inductance should be connected Between pin 11 and pin 12 for getting resonant frequency and making pin12 DC bias 2.8V. |                    |
| 13      | GND      | 0              |                                                                                                                                          |                    |
| 14      | PLL+B    | 2.8            | LDO regulator output for digital blocks.                                                                                                 |                    |
| 15      | GND      | 0              |                                                                                                                                          |                    |

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| Pin No. | Pin Name      | DC Voltage (V) | Description                                                                                                                                                                                                                   | Equivalent Circuit |
|---------|---------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| 16      | XTAL          | 2.0            | 16MHz crystal is needed for PLL reference frequency. If external clock is injected to Pin 16, frequency should be from 1MHz to 24MHz and N (integer) × 200kHz.<br>When the IC is Standby mode, external clock should be stop. |                    |
| 17      | SCL           | -              | I <sup>2</sup> C clock input.                                                                                                                                                                                                 |                    |
| 18      | SDA           | -              | I <sup>2</sup> C data input.                                                                                                                                                                                                  |                    |
| 19      | COUNTER RESET | 3.3            | Usually pin 19 should be kept "Logic High" or opened (pull up 100kΩ makes pin 19 "Logic High" automatically).<br>When pin 19 is "Logic Low" level, internal frequency counter from 76kHz to 19kHz is reset.                   |                    |
| 20      | 19K OUT       | -              | 19kHz output (same phase as pilot tone).<br>When I2C bit "19K"=0, Pin 20 is kept "Logic Low" level.                                                                                                                           |                    |
| 21      | 76K OSC OUT   | 2.0            | For stereo modulator pilot signal and sub carrier. 76kHz crystal should be connected between Pin 21 and Pin 22                                                                                                                |                    |

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| Pin No. | Pin Name   | DC Voltage (V) | Description | Equivalent Circuit |
|---------|------------|----------------|-------------|--------------------|
| 22      | 76K OSC IN | 0.7            | See Pin 21  | See Pin 21         |
| 23      | R-CAP      | 0              | See Pin 1   | See Pin 21         |
| 24      | R-INPUT    | 0              | See Pin 1   | See Pin 21         |

## I<sup>2</sup>C Bus Definition

Table 1. I<sup>2</sup>C Bus Write Data Format

| Name           | Byte | Bit     |      |     |     |     |       |      |      | ACK |
|----------------|------|---------|------|-----|-----|-----|-------|------|------|-----|
|                |      | MSB (1) |      |     |     | LSB |       |      |      |     |
| Address Byte   | 1    | AD7     | AD6  | AD5 | AD4 | AD3 | AD2   | AD1  | R/W  | A   |
|                |      | 1       | 1    | 0   | 1   | 0   | 0     | 0    | 0    |     |
| Control Byte 1 | 2    | P10     | P9   | P8  | P7  | P6  | P5    | P4   | P3   | A   |
|                |      | 0       | 1    | 1   | 1   | 1   | 0     | 1    | 0    |     |
| Control Byte 2 | 3    | P2      | P1   | P0  | 19K | ST  | PILOT | STB  | MUTE | A   |
|                |      | 1       | 0    | 0   | 0   | 1   | 1     | 0    | 0    |     |
| Control Byte 3 | 4    | RES1    | RES0 | RF2 | RF1 | RF0 | ATT2  | ATT1 | ATT0 | A   |
|                |      | 0       | 0    | 1   | 1   | 1   | 0     | 1    | 1    |     |
| Control Byte 4 | 5    | R6      | R5   | R4  | R3  | R2  | R1    | R0   | TEST | A   |
|                |      | 1       | 0    | 1   | 0   | 0   | 0     | 0    | 0    |     |

(1) : MSB is transmitted first.

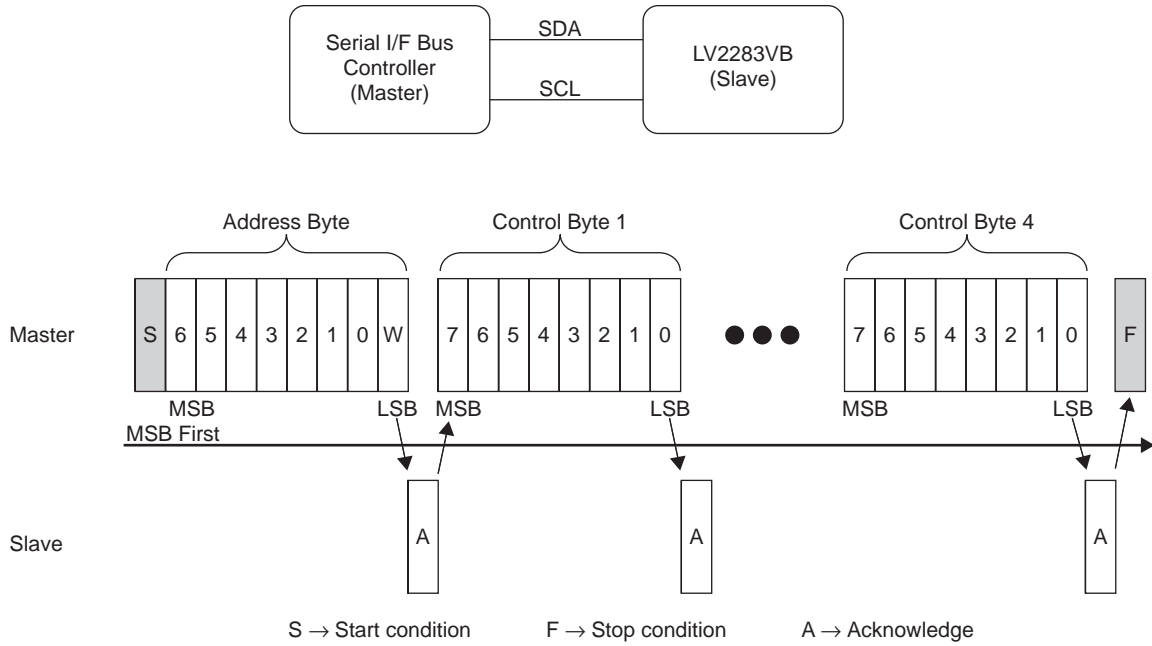
Table 2. I<sup>2</sup>C Write Mode Description

| Bit         | Name                 | Description                                                                                                                                                                                                                                                                             |
|-------------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AD7 – AD1   | Address bit          | LV2283VB requires address bits.                                                                                                                                                                                                                                                         |
| R/W         | Read/Write           | "0" for Write mode (Write mode only).                                                                                                                                                                                                                                                   |
| A           | Acknowledge          |                                                                                                                                                                                                                                                                                         |
| P10 – P0    | Programmable counter | 11 bit Programmable counter. P0 = LSB, P10 = MSB.<br>RF Frequency = $(P10 \times 2^{10} + P9 \times 2^9 + \dots + P1 \times 2^1 + P0) \times 100\text{kHz}$<br>Default state = "01111010100" (980)                                                                                      |
| 19K         | 19kHz output         | 19K OUT (Pin 20) ON / OFF. "19K" = "0" for no output. "1" for 19kHz output (same phase as pilot tone).<br>Default state = "0"                                                                                                                                                           |
| ST          | MONO/ST selection    | Monaural/Stereo transmission mode selection. "ST" is set "0" for monaural mode (no pilot tone), "1" for stereo transmission. Default state = "1"                                                                                                                                        |
| PILOT       | Pilot tone output    | "1" for normal operation (default). "0" for NO pilot tone in composite output even if ST bit = "1" (Stereo mode).                                                                                                                                                                       |
| STB         | Standby              | "1" for standby mode. Default state = "0" for normal operation.                                                                                                                                                                                                                         |
| MUTE        | Audio mute           | "1" for Audio mute. Default state = "0" for normal operation.                                                                                                                                                                                                                           |
| RES1, RES0  | Reserved bits        | Reserved bits. Default state = "00" for normal operation.                                                                                                                                                                                                                               |
| RF2 – RF0   | RF output adjustment | RF output voltage adjustment with 8 degree, 1dB steps. "RF2, RF1, RF0" = "111" for maximum. "000" is minimum RF output. Default state = "111"                                                                                                                                           |
| ATT2 – ATT0 | Audio attenuator     | Audio attenuator for FM modulation fine adjustment is set by "ATT2, ATT1, ATT0" with 8 degree, 2dB steps. "111" is for 0dB attenuation. "000" is for 14dB attenuation. Default state = "011".                                                                                           |
| R6 – R0     | Reference counter    | 7 bit Programmable counter. R0 = LSB, R6 = MSB.<br>Reference frequency should be set 100kHz.<br>$\{\text{Crystal oscillator frequency (Pin 16)}\} / \{(R6 \times 2^6 + R5 \times 2^5 + \dots + R1 \times 2^1 + R0) \times 2\} = 100\text{kHz}$ .<br>Default state = "1010000" (80 x 2). |
| TEST        | Test mode            | For IC testing. Set "0" for normal operation.<br>"1" for counter testing mode. Default state = "0"                                                                                                                                                                                      |



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## I<sup>2</sup>C Bus Operation



## Time chart

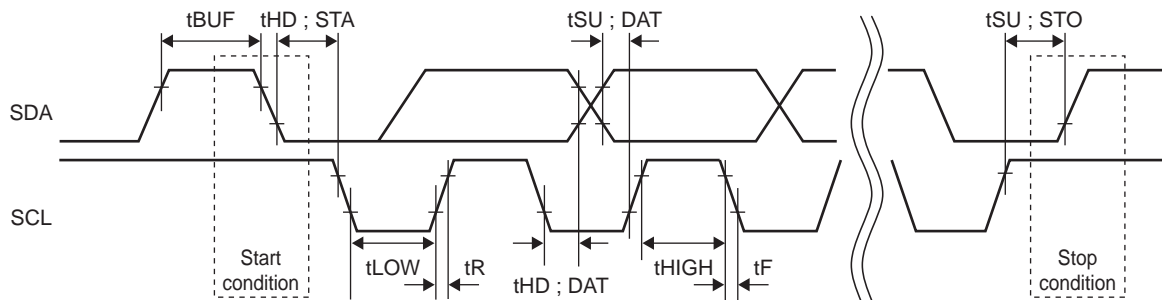


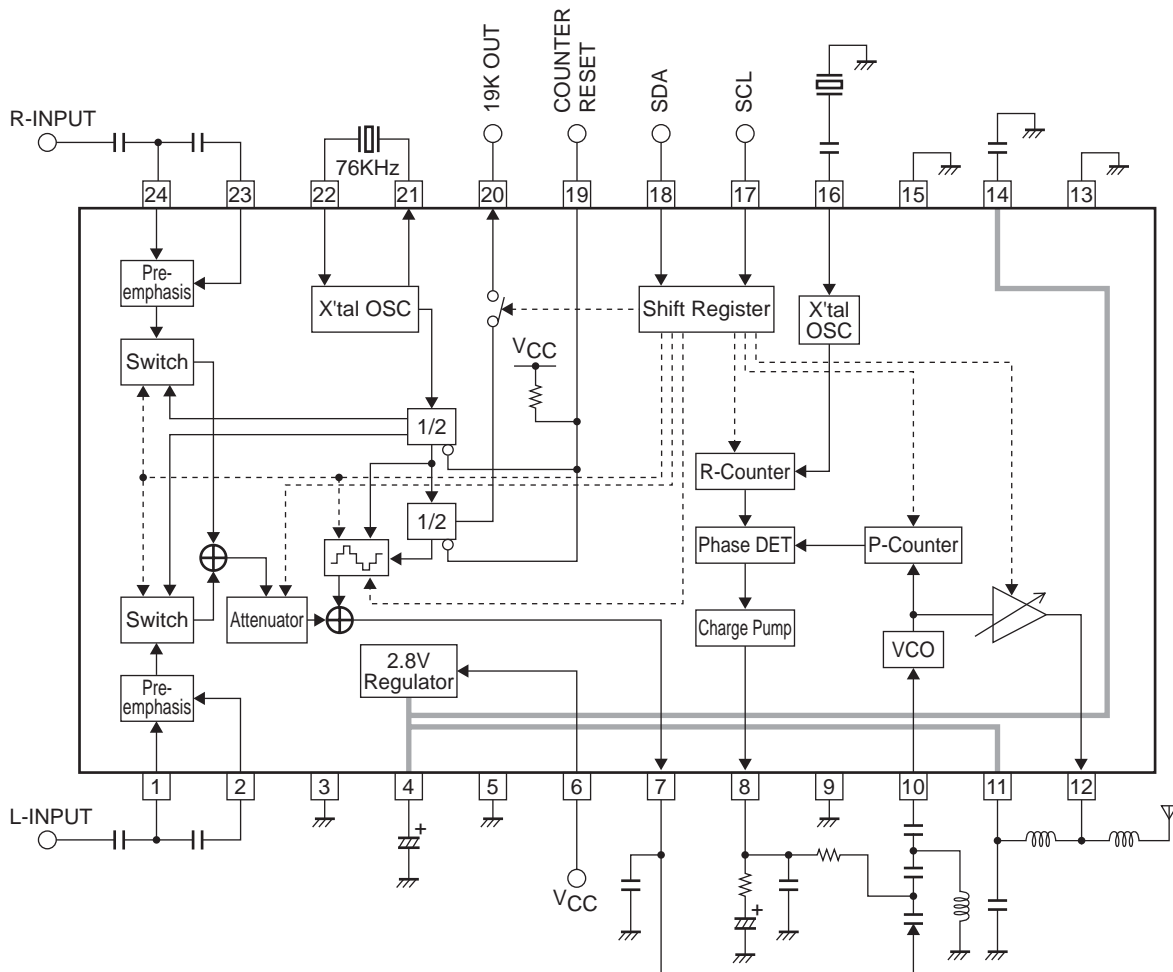
Table 3. Timing specification

| Parameter                                        | Symbol    | Ratings |     |      | Unit |
|--------------------------------------------------|-----------|---------|-----|------|------|
|                                                  |           | min     | typ | max  |      |
| SCL clock frequency                              | fSCL      |         |     | 100  | kHz  |
| Bus free time between a STOP and START condition | tBUF      | 4.7     |     |      | μs   |
| Hold time START condition                        | tHD ; STA | 4.0     |     |      | μs   |
| LOW period of the SCL clock                      | tLOW      | 4.7     |     |      | μs   |
| HIGH period of the SCL clock                     | tHIGH     | 4.0     |     |      | μs   |
| Data hold time                                   | tHD ; DAT | 0.0     |     |      | μs   |
| Data set-up time                                 | tSU ; DAT | 250     |     |      | ns   |
| Rise time of both SDA and SCL signals            | tR        |         |     | 1000 | ns   |
| Fall time of both SDA and SCL signals            | tF        |         |     | 300  | ns   |
| Set-up time for STOP condition                   | tSU ; STO | 4.0     |     |      | μs   |

I<sup>2</sup>C Bus AC Characteristics : Temp=25°C V<sub>CC</sub> = 3.3V

Note : I<sup>2</sup>C Bus is a registered trademark of the Philips Co..

Application Circuit



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