



SANYO Semiconductors

DATA SHEET

LV2285VB — Bi-CMOS IC FM transmitter IC with Stereo Modulation, Auto Sleep Function

Overview

The LV2285VB is IC for FM transmitter. This IC is chiefly composed of the following block. MPX block for stereo modulation, RFVCO block for FM modulation, and PLL block for RF output frequency. At the result, this IC achieves FM transmitter with low power consumption by 1chip.

Additionally, the auto sleep function is installed. This function automatically switches the standby and active according to the state of the audio input. It is possible to achieve a more dynamic electric power reduction as a result.

Feature

- The function necessary for FM transmission has been integrated into 1chip.
- The best low current consumption operation for portable application
- The auto sleep function to reduce more dynamic current consumption
- General I²C I/F and, SANYO original audio control I/F is installed

Functions

- Audio: Stereo modulation using pilot tone system, Audio attenuation
- RF: VCO, programmable gain driver amplifier
- Bus control: I²C I/F, Audio control I/F
- PLL: 70MHz to 110MHz 100kHz step
- Regulator: 2.8V LDO regulator, Auto sleep function

Specifications

Maximum Ratings at Ta = 25°C

| Parameter | Symbol | Conditions | Ratings | Unit |
|-----------------------------|---------------------|---|-----------------------|------|
| Maximum supply voltage | V _{CC} max | Pin 6 | 7.0 | V |
| Maximum input voltage | V _{in} max | | V _{CC} + 0.3 | V |
| Minimum input voltage | V _{in} min | | -0.3 | V |
| Allowable power dissipation | P _d max | Ta ≤ 85°C, Mounted on a specified board.* | 500 | mW |
| Operating temperature | Topr | | -10 to 85 | °C |
| Storage temperature | Tstg | | -55 to 150 | °C |

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

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Recommended Operating Conditions at Ta = 25°C

| Parameter | Symbol | Conditions | Ratings | Unit |
|----------------------------|--------------------|------------|------------|------|
| Recommended Supply voltage | V _{CC} | Pin 6 | 3.3 | V |
| Operating supply voltage | V _{CC op} | Pin 6 | 2.8 to 5.5 | V |

Electrical Characteristics at Ta = 25°C, V_{CC} = 3.3V, L/R input = 1kHz, 425mVrms, I²C bits = Initial

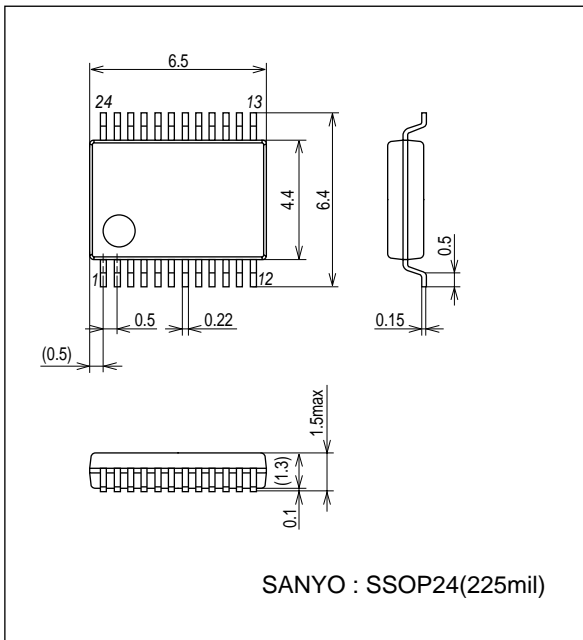
| Parameter | Symbol | Conditions | Ratings | | | Unit |
|---------------------------------------|----------------------|--|--------------------|------|----------------------|-------|
| | | | min | typ | max | |
| Circuit current | I _{CC} | Pin 6 (No signal) | | 8 | 10 | mA |
| Standby current | I _{STB} | Pin 6 (No signal, I ² C"EN"="0") | | 40 | 60 | μA |
| Audio and MPX Block | | | | | | |
| Minimum audio input | V _A MIN | Pin 1 and 24 input | 30 | | | mVrms |
| Maximum audio input | V _A 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 | 40 | | 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 ² C bits "ST"="1", "PILOT"="1" | 0.5 | 0.85 | 1.2 | mVpp |
| Composite output level | MPXOUT | | 2.9 | 3.8 | 4.6 | mVrms |
| Audio mute | MUTE | I ² C bit "MUTE"="1" | 30 | 35 | | dB |
| Audio attenuation step | ATT(1) | ATT[2:0] = "111" – "110" | | 2.3 | | dB |
| | ATT(2) | ATT[2:0] = "110" – "101" | | 2.2 | | dB |
| | ATT(3) | ATT[2:0] = "101" – "100" | | 2.8 | | dB |
| | ATT(4) | ATT[2:0] = "100" – "011" | | 2.3 | | dB |
| | ATT(5) | ATT[2:0] = "011" – "010" | | 4.3 | | dB |
| | ATT(6) | ATT[2:0] = "010" – "001" | | 3.3 | | dB |
| | ATT(7) | ATT[2:0] = "001" – "000" | | 1.6 | | dB |
| Crystal Oscillator Frequency(1) | FXOSC(1) | Pin 21 and Pin22 | | 76 | | kHz |
| Audio control Block | | | | | | |
| Audio Control Frequency | F _{CONT} | Pin 2 and 23 input | | 7.5 | | kHz |
| Audio Control input | V _{CONT} | Pin 2 and 23 input | | 1.2 | | Vp-p |
| Auto sleep Block | | | | | | |
| Turn-off time | T _{OFF} | The time from no signal to turn-off. If the V _{CC} voltage is supplied, LV2285VB maintains I ² C data. Ctc (Pin 20) = 2.2μF | 45 | 70 | 300 | sec |
| PLL Block | | | | | | |
| I ² C input "High" voltage | V _H | | 0.8V _{CC} | | V _{CC} +0.3 | V |
| I ² C input "Low" voltage | V _L | | -0.3 | | 0.2V _{CC} | V |
| RF input frequency | F _{PLL} | Step = 100kHz, See table 2 | 70 | | 110 | MHz |
| Crystal Oscillator frequency | FXOSC(2) | Pin 16 | | 16 | - | MHz |
| External Clock Frequency | F _{EXT} | <ul style="list-style-type: none"> External clock injection to Pin 16 instead of 16MHz crystal oscillation. When the LSI is standby mode, external clock should be stop. | 1 | | 24 | MHz |
| CP output current | I _{CP} | CP voltage = 1.4V | | 30 | | μA |
| RF Block | | | | | | |
| RF output | R _F OUT | f = 98MHz, RF[2:0] = "011", Pin 12 output | 109 | 112 | 115 | dBμV |
| RF output adjustment step | R _F STEP | RF[2:0] = "000" to "111", totally 8 steps. | 0.3 | 0.9 | 1.4 | dB |
| RF frequency | F _{RF} | 100kHz step | 70 | | 110 | MHz |
| I²C Block | | | | | | |
| I ² C input switch | I ₂ CSW * | Input to Pin 2/23 : Audio control I/F | -0.3 | | 0.2V _{CC} | V |
| | | Input to Pin 17/18 : I ² C I/F | 0.8V _{CC} | | V _{CC} +0.3 | V |

* Use case (I²C I/F) : Please set Pin 19 = High.

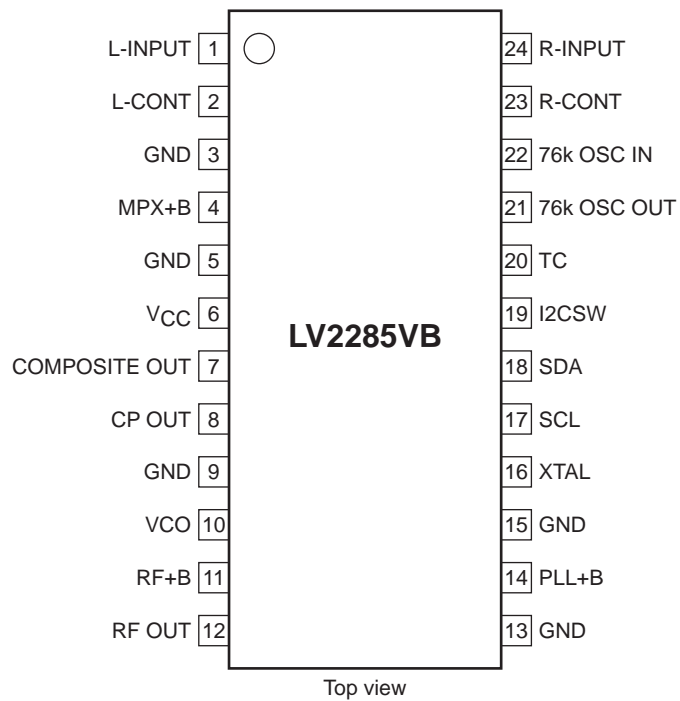
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Package Dimensions

unit : mm (typ)
3287

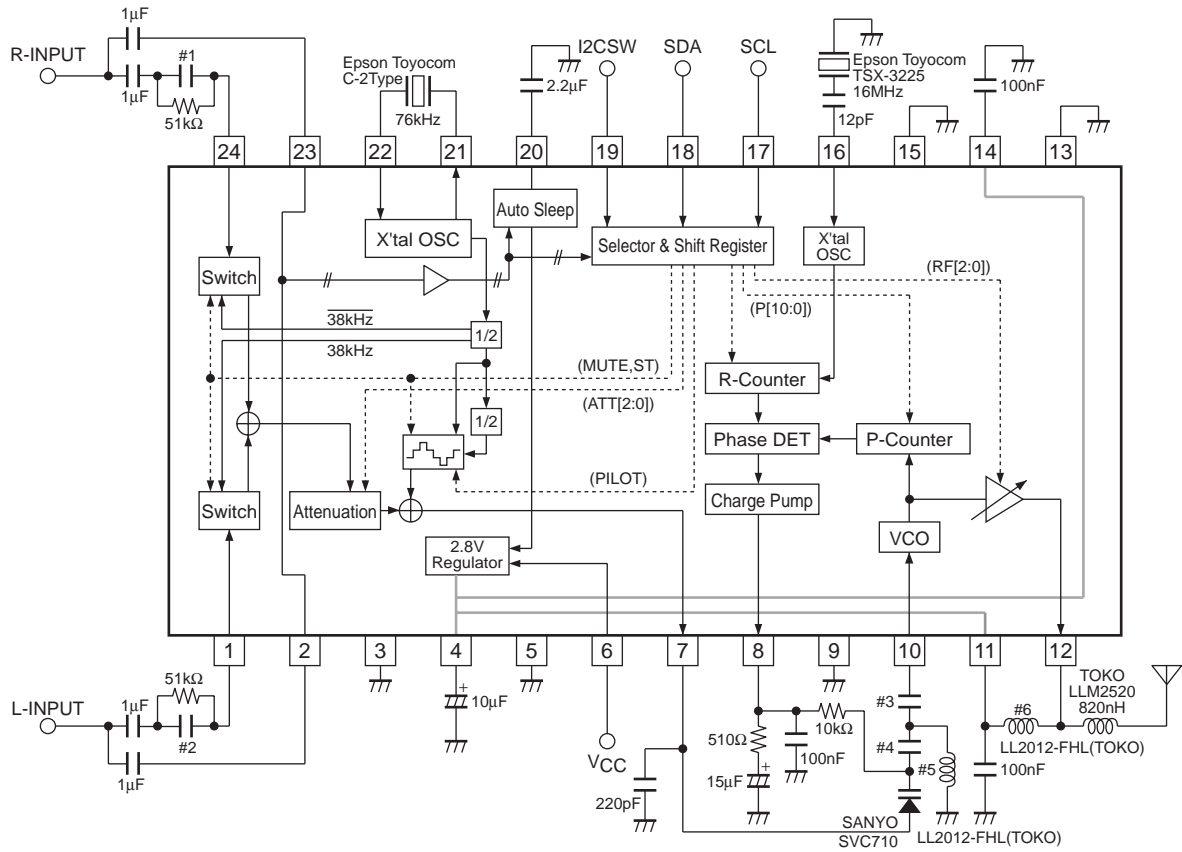


Pin Assignment



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Block Diagram and Application Circuit Example



#Notice (Pre-emphasis)

50µs case : #1 = #2 = 1nF

75µs case : #1 = #2 = 1.5nF

#Notice (RF Frequency range)

76~90MHz : #3=180pF #4=56pF #5=150nH #6=470nH

88~108MHz : #3=270pF #4=82pF #5=100nH #6=330nH

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Pin Function

| Pin No. | Pin name | DC voltage (V) | Function | 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 and resistance should be required. | |
| 2 | L-CONT | 1.2 | Data input pin for Audio control. External coupling capacitance is required. | |
| 3 | GND | 0 | | |
| 4 | MPX+B | 2.8 | LDO regulator output. External decoupling capacitance is required. | |
| 5 | GND | 0 | | |
| 6 | VCC | 3.3 | | |
| 7 | COMPOSITE OUT | | Stereo modulated output. | |
| 8 | CP OUT | | Charge pump current output. | |
| 9 | GND | 0 | | |

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| Pin No. | Pin name | DC voltage (V) | Function | Equivalent circuit |
|---------|----------|----------------|---|--------------------|
| 10 | VCO | 2.2 | Transistor BASE pin 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 pin 12 DC bias 2.8V. | |
| 13 | GND | 0 | | |
| 14 | PLL+B | 2.8 | LDO regulator output for digital blocks. | |
| 15 | GND | 0 | | |
| 16 | XTAL | | 16MHz crystal is needed for PLL reference frequency. If external clock is injected to pin 16. Frequency should be from 1MHz to 24MHz and $N(\text{integer}) \times 200\text{kHz}$. | |
| 17 | SCL | | I ² C clock input. | |

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| Pin No. | Pin name | DC voltage (V) | Function | Equivalent circuit |
|---------|-------------|----------------|--|--------------------|
| 18 | SDA | | I ² C data input. | |
| 19 | I2CSW | | The change switch of the I ² C data input pin. When Pin 19 = GND case, Audio control I/F is selected (Pin 2/23). In one side, when Pin 19 = V _{CC} case, I ² C I/F is selected (Pin 17/18). | |
| 20 | TC | 2.8 | Connect capacitance. Turn-off time is in proportion to this capacity value. | |
| 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. | |
| 22 | 76k OSC IN | 0.7 | See pin 21. | See pin 21. |
| 23 | R-CONT | 1.2 | Clock Input for Audio Control. See Pin 2 | See pin 2. |
| 24 | R-INPUT | 0 | See pin 1. | See pin 1. |

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I²C Bus Definition

Table 1 : I²C Register map

| 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 | RES2 | ST | PILOT | EN | MUTE | A |
| | | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | |
| Control Byte 3 | 4 | RES1 | RES0 | RF2 | RF1 | RF0 | ATT2 | ATT1 | ATT0 | A |
| | | *2 | *2 | 0 | 1 | 1 | 0 | 1 | 0 | |
| 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.

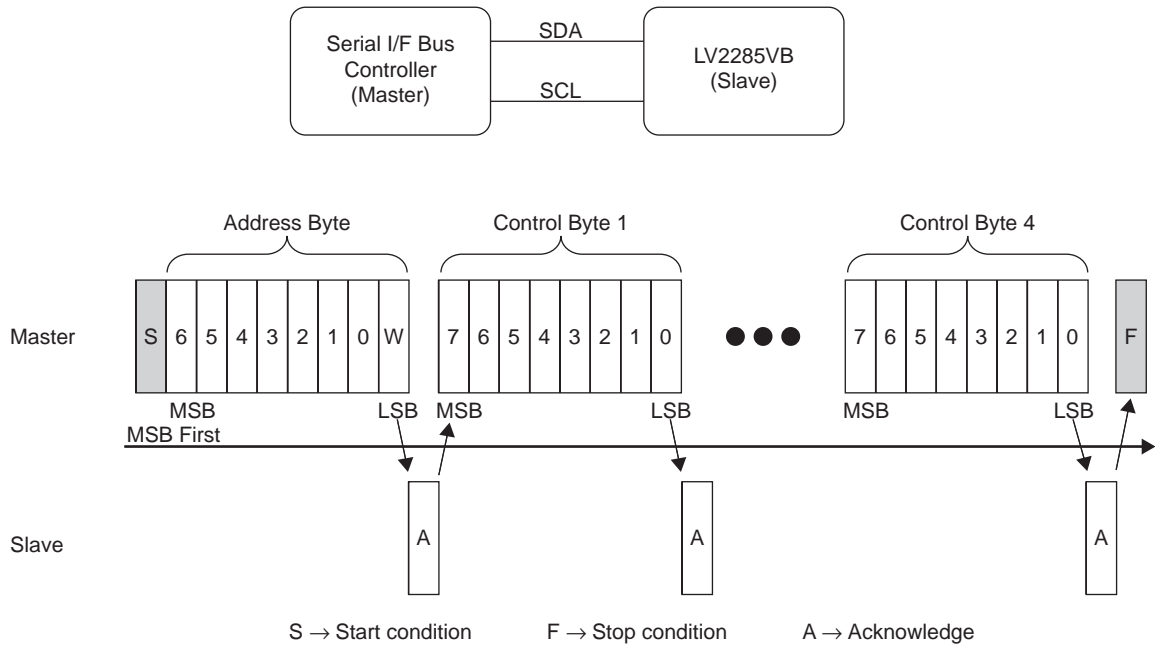
*2 : Don't care

Table 2 : I²C Register map description

| Bit | Name | Initial | Description |
|----------|----------------------|---------------|---|
| AD[7:0] | Address bit | 1101 000 | LV2285VB I ² C 7bit address |
| R/W | Read / Write | 0 | Write mode only |
| A | Acknowledge | | |
| P[10:0] | Programmable counter | 0111 1010 100 | 11bit Programmable counter. RF frequency=(P10 × 2 ¹⁰ + P9 × 2 ⁹ + ... P1 × 2 ¹ + P0) × 100kHz |
| RES2 | Reserved bit | 0 | |
| ST | MONO / Stereo | 1 (stereo) | Stereo modulation control. "ST"="0" : Monaural mode, "ST"="1" : Stereo mode. |
| PILOT | Pilot tone output | 1 | Pilot signal control. "PILOT"="0" : No pilot, "PILOT"="1" : with Pilot |
| EN | Enable | 0 (Standby) | Internal LDO control. "EN"="1" : Active, "EN"="0" : Standby |
| MUTE | Mute | 0 | Audio mute control. "MUTE"="1" : Enable, "MUTE"="0" : Disable |
| RES[1:0] | Reserved bits | 00 | |
| RF[2:0] | RF output adjustment | 011 | RF output level control. RF[2:0]="111" : Maximum, RF[2:0]="000" : Minimum |
| ATT[2:0] | Audio attenuator | 010 | This attenuator is used to adjust FM modulation level."111" is Minimum (0dB)."000" is Maximum (19dB). See Audio and MPX Block specification. |
| R[6:0] | Reference counter | 1010 000 | 7bit reference counter. Reference frequency should be set 100kHz. {Crystal oscillator frequency(Pin 16)}/{(R6 × 2 ⁶ + R5 × 2 ⁵ + ... + R1 × 2 ¹ + R0) × 2} = 100kHz |
| TEST | Reserved bit | 0 | |

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I²C Bus Operation



Time chart

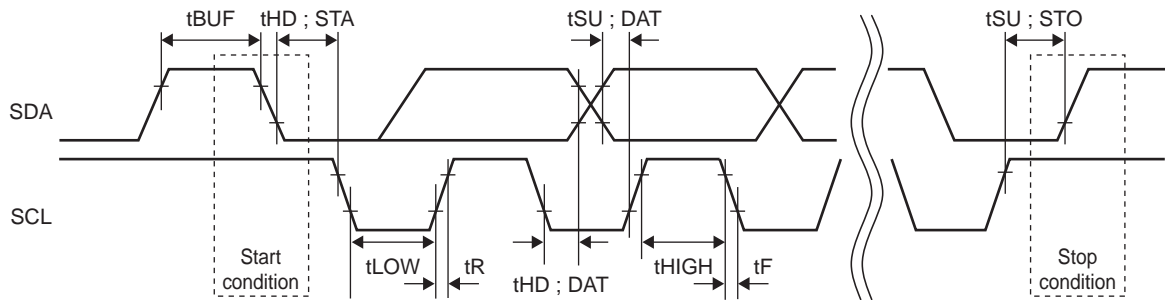


Table 3 : Timing specification

| 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 | | | μs |
| 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 |

I²C Bus AC characteristics: Temp = 25°C, V_{CC} = 3.3V

Note: I²C Bus is registered trademark of the Philips Co..

Usage note

Stereo modulation

In generally, How to generate stereo modulating signals explain below figure 1. LV2285VB generate composite signal like below figure 2. And it is possible to control sub signals at register [ST]. Pilot signal is controlled at register [PILOT]

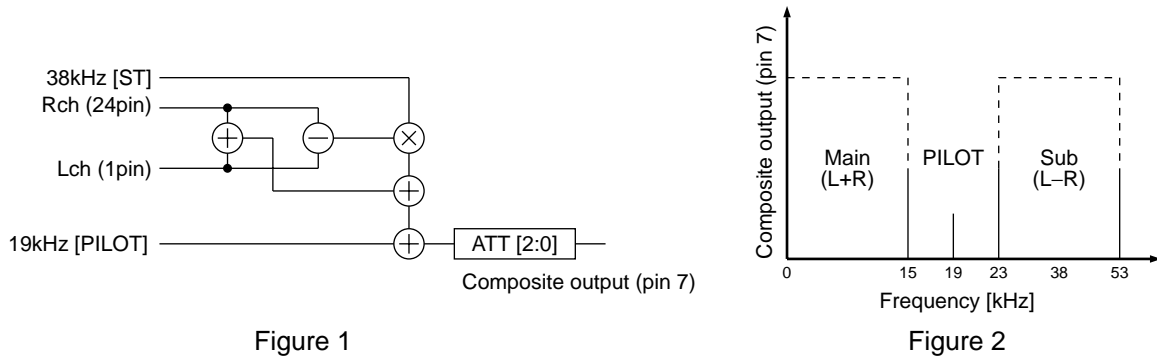


Figure 1

Figure 2

FM modulation

The LV2285VB have best performance of FM modulation at $\pm 75\text{kHzdev}$.

FM modulation level changes in proportion to composite output level (pin 7)

In LV2285VB composed of recommended parts, Table 1 is shown relationship that set ATT [2:0] value against audio input signal level.

Table 1

| Audio input signal level V.S ATT[2:0] setting | | |
|---|-----|------------------------------|
| Large attenuation | 000 | L , R input level = 780mVrms |
| | 001 | L , R input level = 640mVrms |
| | 010 | L , R input level = 425mVrms |
| | 011 | L , R input level = 260mVrms |
| | 100 | L , R input level = 190mVrms |
| | 101 | L , R input level = 140mVrms |
| | 110 | L , R input level = 110mVrms |
| Small attenuation | 111 | L , R input level = 80mVrms |

Please refer to Table 1 to obtain better audio quality.

