

CL6017S

|  |                                             |                   |                   |
|--|---------------------------------------------|-------------------|-------------------|
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|  | <b>Product: Broadcast FM Radio Receiver</b> |                   | <b>Page #: 23</b> |

# CL6017S Datasheet

(For Strategic Customers)

## Product Description

The CL6017S is a single-chip FM stereo radio for portable application with fully integrated digital low-IF selectivity and demodulation. The radio is completely adjustment-free and only requires a minimum of small and low-cost external components. The radio can tune to worldwide FM bands.

## Application

MP3/MP4  
Portable radios  
PDAs  
Notebook PCs

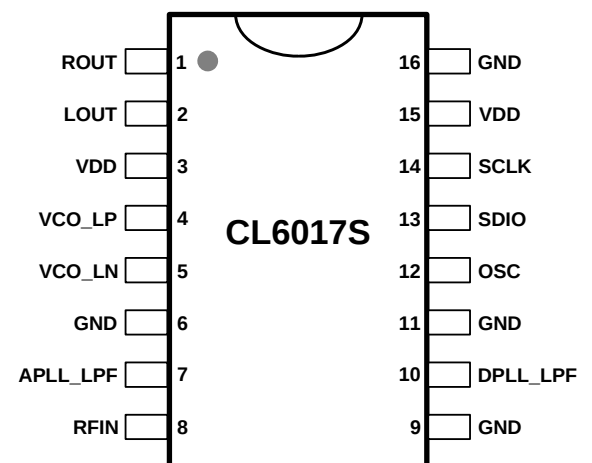
## Technology

- RF CMOS Process
- SSOP16 Package

## Features

- Worldwide FM Bands (70 MHz to 108 MHz)
- Digital Low-IF Receiver
- 32.768KHz/13MHz Reference Clock
- Frequency Synthesizer with Integrated VCO
- Automatic Frequency Control (AFC)
- Automatic Gain Control (AGC)
- DSP MPX Stereo Decoder
- DSP FM Demodulator
- Adaptive Noise Cancellation
- MONO/Stereo Blend
- High Cut
- Software Mute
- Programmable De-emphasis
- Bass Boost
- Integrated LDO Regulator
- Supply Voltage Ranges from 2.5 V to 5.0 V

## Pin Assignment



## CONTENTS

|     |                                      |    |
|-----|--------------------------------------|----|
| 1   | ELECTRICAL SPECIFICATIONS .....      | 4  |
| 1.1 | ABSOLUTE MAXIMUM RATINGS.....        | 4  |
| 1.2 | SPECIFICATIONS .....                 | 4  |
| 1.3 | CONTROL INTERFACE TIMING .....       | 7  |
| 2   | APPLICATION SCHEMATIC .....          | 8  |
| 3   | BOM .....                            | 8  |
| 4   | FUNCTIONAL DESCRIPTION .....         | 9  |
| 4.1 | OVERVIEW .....                       | 9  |
| 4.2 | STEREO DECODER .....                 | 9  |
| 4.3 | AUDIO PROCESSING .....               | 10 |
| 4.4 | TUNING AND SEEKING FUNCTION .....    | 11 |
| 4.5 | REFERENCE CLOCK .....                | 12 |
| 4.6 | CONTROL INTERFACE .....              | 12 |
| 4.7 | RESET, POWER-UP AND POWER-DOWN ..... | 12 |
| 4.8 | POWER SEQUENCE .....                 | 13 |
| 5   | REGISTERS DEFINITION .....           | 14 |
| 5.1 | REGISTER OVERALL DESCRIPTION.....    | 14 |
| 5.2 | REGISTER WORD DESCRIPTION .....      | 15 |
| 5.3 | REGISTER WORD DESCRIPTION .....      | 15 |
| 6   | PIN DESCRIPTIONS .....               | 22 |
| 7   | PACKAGE OUTLINE.....                 | 23 |

# 1 Electrical Specifications

## 1.1 Absolute Maximum Ratings

| Parameter             | Symbol   | Value        | Units           |
|-----------------------|----------|--------------|-----------------|
| Supply Voltage        | V        | - 0.5 to 5.8 | V               |
| Input Current         | $I_{IN}$ | +/-10        | mA              |
| Operating Temperature | TOP      | - 40 to 85   | °C              |
| Storage Temperature   | TSTG     | - 55 to 150  | °C              |
| RF Input Level        |          | 0.8          | V <sub>PP</sub> |

## 1.2 Specifications

(V<sub>DD</sub> = 2.5 to 5.0 V, T<sub>A</sub> = - 20 to 85 °C)

| Parameter                                       | Condition                                                                                                                        | Min.                 | Typ. | Max.                 | Unit   |
|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|----------------------|------|----------------------|--------|
| <b>Basic Parameters</b>                         |                                                                                                                                  |                      |      |                      |        |
| Power Supply                                    | V <sub>DD</sub>                                                                                                                  | 2.5                  | 3.0  | 5.0                  | V      |
| Low Level Input Voltage <sup>1</sup>            |                                                                                                                                  | ---                  | ---  | 0.3*V <sub>DD</sub>  | V      |
| High Level Input Voltage <sup>1</sup>           |                                                                                                                                  | 0.7* V <sub>DD</sub> | ---  | ---                  | V      |
| Low Level Output Voltage <sup>2</sup>           |                                                                                                                                  | ---                  | ---  | 0.2* V <sub>DD</sub> | V      |
| High Level Output Voltage <sup>2</sup>          |                                                                                                                                  | 0.8* V <sub>DD</sub> | ---  | ---                  | V      |
| Ambient Temperature                             |                                                                                                                                  | -20                  | 25   | 85                   | °C     |
| <b>Power Consumption</b>                        |                                                                                                                                  |                      |      |                      |        |
| Work Current Consumption <sup>3</sup>           | Maximum Volume Output                                                                                                            | ---                  | 21   | ---                  | mA     |
| Idle Current Consumption                        | V <sub>DD</sub> = 3V                                                                                                             | ---                  | 50   | ---                  | uA     |
| <b>Receiver Characteristics</b>                 |                                                                                                                                  |                      |      |                      |        |
| Frequency Range (f <sub>FM</sub> ) <sup>4</sup> |                                                                                                                                  | 70                   | ---  | 108                  | MHz    |
| LNA Input Impedance (R <sub>IN</sub> )          | Z <sub>IN_LNA</sub> = 0                                                                                                          | ---                  | 50   | ---                  | Ω      |
|                                                 | Z <sub>IN_LNA</sub> = 1 (Default)                                                                                                | ---                  | 120  | ---                  | Ω      |
| LNA Input Capacitance (C <sub>IN</sub> )        |                                                                                                                                  | ---                  | 4    | ---                  | pF     |
| Sensitivity                                     | f <sub>TUNE</sub> =70~108MHz f <sub>DEV</sub> =22.5kHz;<br>f <sub>MOD</sub> =1kHz; SINAD=26dB; L=R;<br>BAF=200Hz ~15kHz; MONO=ON | ---                  | 1.7  | ---                  | uV EMF |
| In-band Input IP3 (IIP3 <sub>INBAND</sub> )     | Δf1=200kHz; Δf2=400kHz;                                                                                                          | ---                  | 66   | ---                  | dBuV   |

*Broadcast FM Radio Receiver CL6017S*

|                                                  |                                                                                                                                                                                                               |     |      |     |             |
|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|-----|-------------|
|                                                  | $f_{TUNE} = 70 \sim 108 \text{MHz}$                                                                                                                                                                           |     |      |     | EMF         |
| Out-band Input IP3<br>( $IIP3_{OUTBAND}$ )       | $\Delta f = 1 \text{MHz};$<br>$f_{TUNE} = 76 \sim 108 \text{MHz}$                                                                                                                                             | 90  | 92   | --- | dBuV<br>EMF |
| AM Suppression( $AM_{SP}$ )                      | $V_{RF}=60\text{dBuV}$<br>FM: $f_{DEV}=22.5\text{kHz}; f_{MOD}=1\text{kHz};$<br>AM: $m=0.3; f_{MOD}=1\text{kHz};$<br>BAF=200Hz $\sim 15\text{kHz}; \text{MONO}=\text{ON}$                                     | 50  | 52   | --- | dB          |
| Adjacent Channel Selectivity<br>( $ACS_{200}$ )  | $\Delta f=\pm 200\text{kHz}; f_{TUNE} = 70 \sim 108 \text{MHz}$<br>$\text{SINAD}>26\text{dB}$                                                                                                                 | 39  | 42   | --- | dB          |
| Alternate Channel Selectivity<br>( $ACS_{400}$ ) | $\Delta f=\pm 400\text{kHz}; f_{TUNE} = 70 \sim 108 \text{MHz}$<br>$\text{SINAD}>26\text{dB}$                                                                                                                 | 40  | 50   | --- | dB          |
| Spurious Response<br>Rejection                   | $\Delta f>\pm 1\text{MHz}; f_{TUNE} = 70 \sim 108 \text{MHz}$<br>$\text{SINAD}>26\text{dB}$                                                                                                                   | 60  | ---  | --- | dB          |
| Audio Output Voltage <sup>5</sup>                | $V_{RF}=60\text{dBuV};$<br>$f_{TUNE}=70 \sim 108 \text{MHz}; f_{DEV} = 22.5\text{kHz};$<br>$f_{MOD} = 1\text{kHz}; \text{BAF}=200\text{Hz} \sim 15\text{kHz};$<br>$\text{MONO}=\text{ON}; \text{MAX. Volume}$ | --- | 110  | --- | mV RMS      |
| Audio Output L/R Imbalance                       | $V_{RF}=60\text{dBuV};$<br>$f_{TUNE}=70 \sim 108 \text{MHz}; f_{DEV} = 22.5\text{kHz};$<br>$f_{MOD}=1\text{kHz}; \text{BAF}=200\text{Hz} \sim 15\text{kHz};$                                                  | --- | 0.1  | --- | dB          |
| Audio Stereo Separation                          | $V_{RF}=60\text{dBuV};$<br>$f_{TUNE} = 70 \sim 108 \text{MHz}; f_{DEV} = 30\%;$<br>$f_{MOD}=1\text{kHz}; L=1; R=0; \text{Pilot } 10\%$<br>$\text{BAF}=200\text{Hz} \sim 15\text{kHz};$                        | 34  | 35   | --- | dB          |
| Audio Mono SINAD <sup>6</sup>                    | $V_{RF}=60\text{dBuV};$<br>$f_{TUNE} = 70 \sim 108 \text{MHz}; f_{DEV} = 75\text{kHz};$<br>$f_{MOD} = 1\text{kHz}; \text{BAF}=200\text{Hz} \sim 15\text{kHz};$<br>$\text{MONO}=\text{ON}$                     | --- | 62   | --- | dB          |
| Audio Stereo SINAD <sup>6</sup>                  | $V_{RF}=60\text{dBuV};$<br>$f_{TUNE} = 70 \sim 108 \text{MHz}; f_{DEV} = 75\text{kHz};$<br>$f_{MOD} = 1\text{kHz}; \text{BAF}=200\text{Hz} \sim 15\text{kHz};$<br>$\text{Stereo}=\text{ON}$                   | --- | 62   | --- | dB          |
| Audio THD                                        | $V_{RF}=60\text{dBuV};$<br>$f_{TUNE} = 70 \sim 108 \text{MHz}; f_{DEV} = 75\text{kHz};$<br>$f_{MOD} = 1\text{kHz}; \text{BAF}=200\text{Hz} \sim 15\text{kHz};$<br>$\text{MONO}=\text{ON}$                     | --- | 0.07 | 0.1 | %           |
| De-emphasis Time Constant                        | DE=0                                                                                                                                                                                                          | --- | 75   | --- | us          |

*Broadcast FM Radio Receiver CL6017S*

|                                                                              |                                        |                    |     |      |            |
|------------------------------------------------------------------------------|----------------------------------------|--------------------|-----|------|------------|
|                                                                              | DE=1                                   | ---                | 50  | ---  |            |
| Seek Time                                                                    |                                        | ---                | 50  | ---  | ms/C       |
| Power-up Time                                                                |                                        | ---                | --- | 1    | s          |
| <b>External Reference Clock Mode (In Addition to 32.768kHz Crystal Mode)</b> |                                        |                    |     |      |            |
| Reference Clock Frequency                                                    | Support Two Clock Frequency            | 32.768kHz or 13MHz |     |      |            |
| Jitter                                                                       | For Audio SNR > 40dB                   | ---                | --- | 1    | ns         |
| MIN. Voltage of Reference Clock                                              | Support Both Square-wave and Sine-wave | -200               | --- | 400  | mV         |
| MAX. Voltage of Reference Clock                                              | Support Both Square-wave and Sine-wave | 1200               | --- | 1800 | mV         |
| <b>32.768kHz Crystal Characteristics</b>                                     |                                        |                    |     |      |            |
| Series Oscillating Impedance                                                 |                                        | ---                | --- | 100  | K $\Omega$ |
| Reference Frequency Tolerance                                                |                                        | -50                | --- | 50   | ppm        |

Notes:

1. For input pins SCLK,SDIO.
2. For Output pin SDIO.
3. All values are tested at VDD = 3.0V and 25°C.
4. Support more wide frequency range through change the software.
5. External audio amplifier output.
6. Input reference clock is 13MHz.

### 1.3 Control Interface Timing

Control bus supports standard I2C protocol with a maximum frequency of 400 kHz.

| Parameter                       | Symbol | Condition | Standard-Mode |      |     | Fast-Mode |     |     | Units |
|---------------------------------|--------|-----------|---------------|------|-----|-----------|-----|-----|-------|
|                                 |        |           | MIN           | TYP  | MAX | MIN       | TYP | MAX |       |
| SCLK Period                     | Tclk   |           | ---           | 10.0 | --- | ---       | 2.5 | --- | us    |
| SCLK High Time                  | Thigh  |           | ---           | 4.0  | --- | ---       | 1.0 | --- | us    |
| SCLK Low Time                   | Tlow   |           | ---           | 4.7  | --- | ---       | 1.4 | --- | us    |
| SDIO Input, SEN to SCLK ↑ Setup | Ts     |           | ---           | 50   | --- | ---       | 50  | --- | ns    |
| SDIO Input, SEN to SCLK ↑ Hold  | Th     |           | ---           | 5    | --- | ---       | 1.2 | --- | us    |
| Start Condition Hold            | Tsh    |           | ---           | 4.7  | --- | ---       | 1.4 | --- | us    |
| Stop Condition Setup            | Tsu    |           | ---           | 4.0  | --- | ---       | 1.0 | --- | us    |
| SCLK ↑ to SDIO Output Valid     | Tcdv   | Read      | ---           | 2    | --- | ---       | 2   | --- | ns    |
| SCLK ↑ to SDIO Output High Z    | Tcdz   | Read      | ---           | 2    | --- | ---       | 2   | --- | ns    |

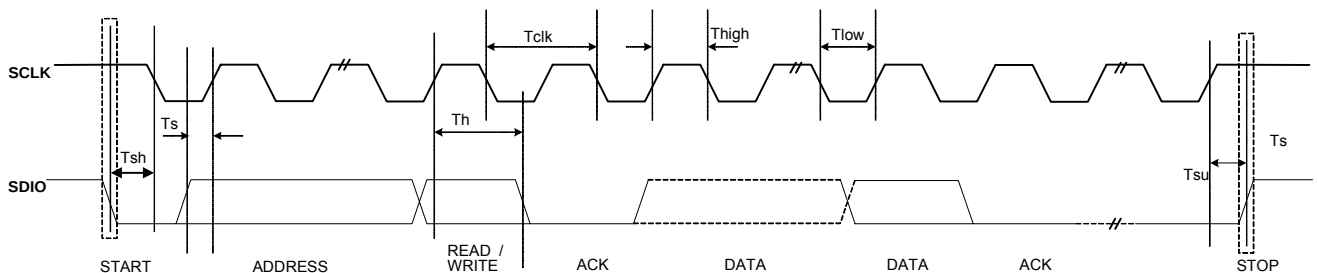


Figure 1. I<sup>2</sup>C Control Interface Write Timing

## 2 Application Schematic

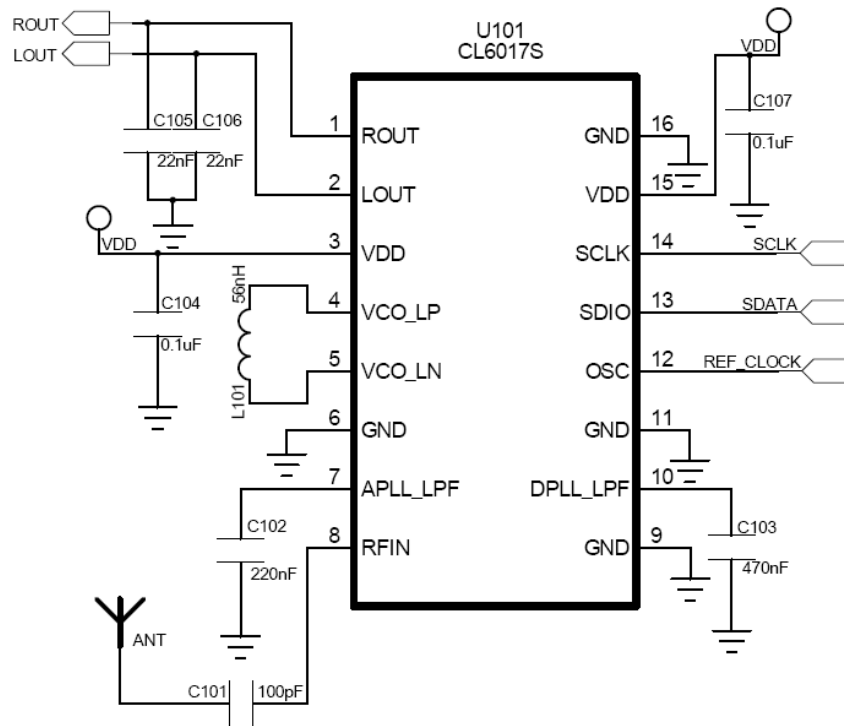


Figure 2. Application Schematic

Note: Please note the CL6017S On-Board design guide for details of different applications.

## 3 BOM

| Component Type | Designation | Value (Description)            | Number |
|----------------|-------------|--------------------------------|--------|
| Capacitors     | C101        | 100pF $\pm 10\%$               | 1      |
|                | C102        | 220nF $\pm 10\%$               | 1      |
|                | C103        | 470nF $\pm 10\%$               | 1      |
|                | C104 C107   | 0.1uF                          | 2      |
|                | C105 C106   | 22nF $\pm 10\%$                | 2      |
| Inductor       | L101        | 56nH $\pm 5\%$ (LQW15AN56NJ00) | 1      |

## 4 Functional Description

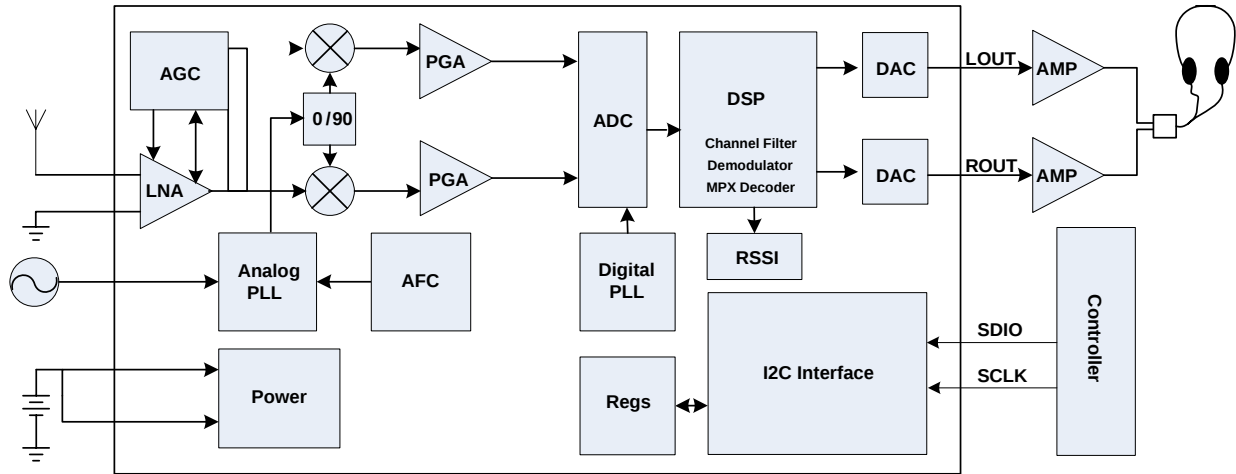


Figure 3. Block Diagram

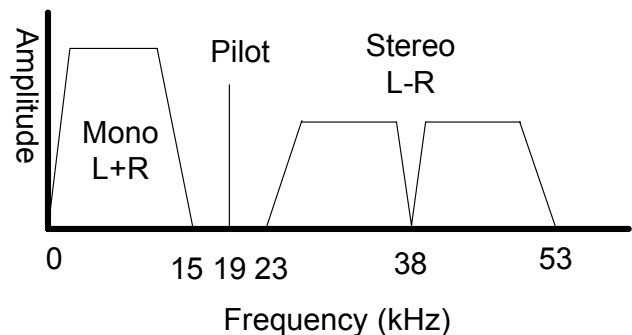
### 4.1 Overview

The CL6017S is a single-chip FM stereo radio for portable application with fully integrated digital low-IF selectivity and demodulation. The radio is completely adjustment-free and only requires a minimum of small, low-cost external components. The radio can tune to worldwide FM bands.

With digital low intermediate frequency (low-IF) architecture and frequency synthesizer technology, CL6017S delivers superior RF performance and can be utilized to provide optimum sound quality. The improved digital processing and power management assure the low power consumption with a supply voltage range from 2.5 V to 5.0 V. The highly integrated single-chip solution makes CL6017S easier to its applications in handset, MP3 and other portable products.

### 4.2 Stereo Decoder

The output of the FM demodulator is a stereo multiplexed (MPX) signal. The MPX standard was developed in 1961, and is used worldwide. Today's MPX signal format consists of Left + Right (L + R) audio, Left - Right (L - R) audio and a 19 kHz pilot tone as shown in figure.



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The CL6017S integrated stereo decoder automatically decodes the MPX signal using DSP techniques. The 0 to 15 kHz (L + R) signal is the mono output of the FM tuner. Stereo is generated from the (L + R), (L - R), and a 19 kHz pilot tone. The pilot tone is used as a reference to recover the (L - R) signal. Output left and right channels are obtained by adding and subtracting the (L + R) and (L - R) signals respectively.

### 4.3 Audio Processing

Pre-emphasis and De-emphasis is a technique used by FM broadcasters to improve the signal-to-noise ratio of FM receivers by reducing the effects of high frequency interference and noise. When the FM signal is transmitted, a pre-emphasis filter is applied to accentuate the high audio frequencies. All FM receivers incorporate a de-emphasis filter which attenuates high frequencies to restore a flat frequency response. Two time constants are used in various regions. The de-emphasis time constant is programmable to 50 or 75  $\mu$ s with the DE bit. The CL6017S de-emphasis filter and compensation effect is shown in below figure.

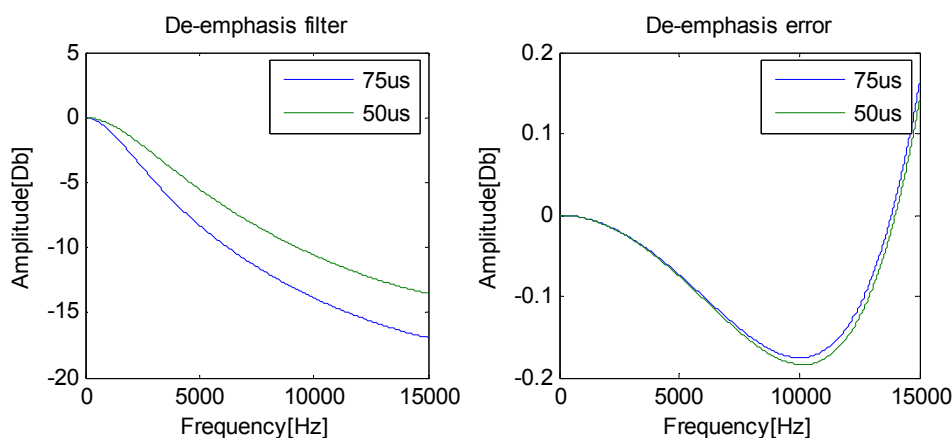


Figure 4. De-emphasis Filter

CL6017S has a bass boost filter to enhance low frequency.

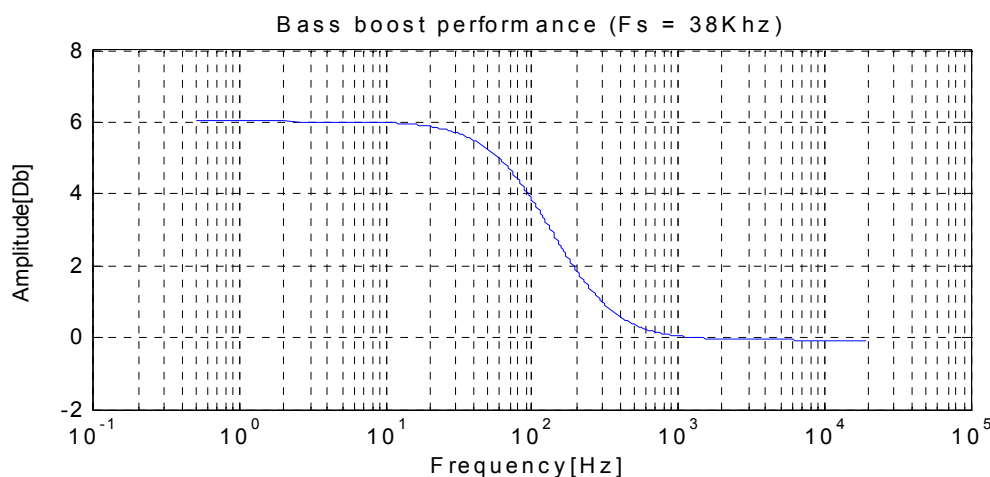


Figure 5. Bass Boost Filter

#### 4.4 Tuning and Seeking function

Tuning needs only to update bits CHAN[9:0], then trigger it by bit Tune rising edge (from 0 to 1). The whole process requires approximately 50mS. After tuning process is completed, three values are given in read-only registers: 8-bit RSSI for signal strength, 6-bit ENVELOP\_NUM for signal-to-noise ratio and 8-bit FD\_NUM for frequency deviation. These values are in format of two's complement. The suggested criteria of radio station are  $(RSSI \geq 176) \& (ENVELOP\_NUM \leq 38) \& (Abs(FD\_NUM) \leq 14)$ .

Hardware seeking function is integrated within CL6017S with less than 10 second to find a radio station. The trigger condition is control bit SEEK rising edge, i.e. bit SEEK from 0 to 1. When seeking is completed, bit STC will be sent to as 1, and the chip is tuned to new radio station frequency, if there is no station, it returns to starting frequency. STC value can be tracked to read the register through I2C. Control bit SF is the indicator of radio station, if SF=0, the current stop is a radio station, if SF=1, STC=1, it means there is no station across FM radio frequency band. Radio station frequency can be acquired from control bit READCHAN[9:0] and the tuning frequency is defined as

$$\text{Frequency (MHz)} = 50 \text{ kHz} * \text{READCHAN}[9:0] + 70\text{MHz}$$

READCHAN[9:0] is 0 for 70MHz.

Seeking can be triggered again with bit SEEK rising edge to find the next radio station after it is completed.

## 4.5 Reference Clock

The CL6017S can be used with 32.768 kHz crystal, the required frequency stability is less than +/- 50ppm in the working temperature range. Also it accepts a 32.768 kHz or 13MHz reference clock, the required jitter is less than 1ns.

## 4.6 Control Interface

Two-wire slave-transceiver (I2C interface) is provided for the controller IC to read and write the control registers. Registers may be written and read when the VDD supply is applied regardless of the state of the VDD supplies.

For two-wire operation, a transfer begins with the START condition. The control word is latched internally on rising SCLK edges. The device acknowledges the address by setting SDIO low on the next falling SCLK edge.

For write operations, the device acknowledge is followed by an eight bit data word latched internally on rising edges of SCLK. The device always acknowledges the data by setting SDIO low on the next falling SCLK edge.

For read operations, the device acknowledge is followed by an eight bit data word shifted out on falling SCLK edges. The controller IC returns an acknowledge if additional data will be transferred. The transfer ends with the STOP conditions regardless of the state of the acknowledge.

## 4.7 RESET, Power-up and Power-down

First of all, power supply to the CL6017S, with 100ns (minimum) delay, digital part circuit reset automatically.

Then, IC can be powered on with set bit "Disable", analog part circuit will be powered on with this bit control.

With action bit "Disable" was toggled to "0", 5ms latter, DSP power on reset will be active and clock will be output 0.8s latter than POR.

## 4.8 Power Sequence

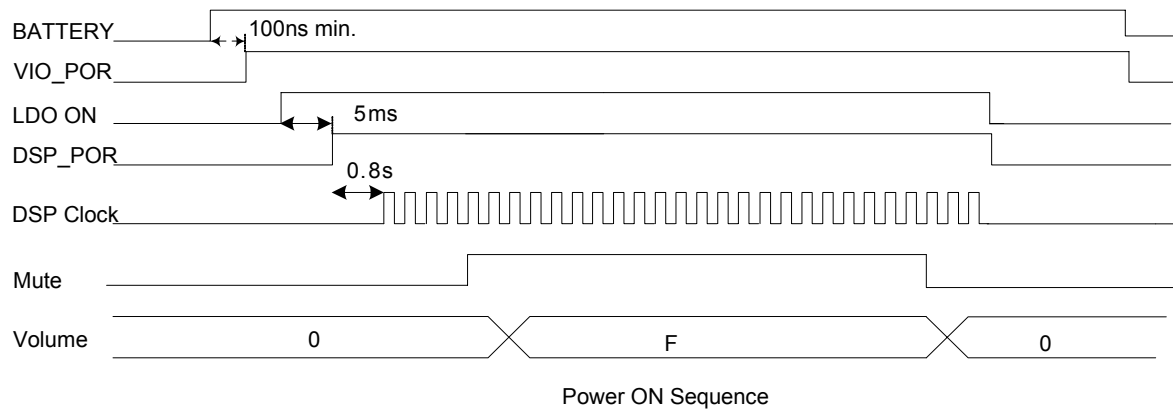


Figure 6. Power Sequence

### Power-up Sequence:

1. Power supply the IC with battery;
2. POR of I2C startup at least 100ns later after power on;
3. Toggle the bit "Disable=0" come to work mode and enable the LDO for both digital and analog;
4. Last action will trigger the DSP part power on rest action, and this action will be done in 5ms;
5. Refer to "Disable=0", crystal oscillator will start to oscillate and DSP clock should be ready in 800ms;
6. Set the MUTE and volume bit by I<sup>2</sup>C to enable audio output.

### Power-down Sequence:

1. Set the MUTE bit low to disable the audio output
2. Set the bit "Disable" to 1 to power down the device
3. Remove power supply

## 5 Registers Definition

### 5.1 Register Overall Description

The IC address is 0010 000b. This means that the first byte to be transmitted to the CL6017S should be “0x20” for a WRITE operation or “0x21” for READ operation.

Note: Address 1100 000b is used for P-Mode.

#### Register map

| Reg. | Name           | D15            | D14      | D13     | D12    | D11       | D10    | D9     | D8       | D7        | D6      | D5         | D4     | D3    | D2    | D1        | D0   |
|------|----------------|----------------|----------|---------|--------|-----------|--------|--------|----------|-----------|---------|------------|--------|-------|-------|-----------|------|
| 00h  | StatusRSSI     | Mode           | Reserved |         |        | HLSi_Flag | STC    | SF     | ST       | RSSI      |         |            |        |       |       |           |      |
| 01h  | ReadChan       | Envelop_Number |          |         |        |           |        |        | ReadCHAN |           |         |            |        |       |       |           |      |
| 02h  | QOS            | DeviceID       |          |         |        |           |        |        |          | FD_Number |         |            |        |       |       |           |      |
| 03h  | Function       | Disable        | DSP      | Mute    | LMute  | RMute     | SMute  | Tune   | Seek     | Seek_up   | MONO    | Stereo     | HCC_EN | BB_EN | ---   | HLSI_CTRL | HLSi |
| 04h  | Channel Volume | Reserved       |          | Volume  |        |           |        | CHAN   |          |           |         |            |        |       |       |           |      |
| 05h  | SysConfig      | Band           |          | Space   |        | DEEN      | DE     | AFC_EN | AFC_Pol  | CHK       | RSSI_EN | Reserved   |        |       |       |           |      |
| 06h  | APLLN          | ---            | Xtal_Sel | Xtal_EN | ON_LNA | ZIN_LNA   | RSSITU |        |          |           | NK_Sel  | APLLN      |        |       |       |           |      |
| 07h  | APLLK          | APLLK          |          |         |        |           |        |        |          |           |         |            |        |       |       |           |      |
| 08h  | Seek_TH        | Seek_TH        |          |         |        |           |        |        |          | PGA_RD_TH |         | Envelop_TH |        |       | FD_TH |           |      |
| 09h  | Reserved       |                |          |         |        |           |        |        |          |           |         |            |        |       |       |           |      |
| 0Ah  | Reserved       |                |          |         |        |           |        |        |          |           |         |            |        |       |       |           |      |
| 0Bh  | Reserved       |                |          |         |        |           |        |        |          |           |         |            |        |       |       |           |      |
| 0Ch  | Reserved       |                |          |         |        |           |        |        |          |           |         |            |        |       |       |           |      |
| 0Dh  | Reserved       |                |          |         |        |           |        |        |          |           |         |            |        |       |       |           |      |
| 0Eh  | Reserved       |                |          |         |        |           |        |        |          |           |         |            |        |       |       |           |      |

## 5.2 Register Word Description

| Register | Default | Type | Function        |
|----------|---------|------|-----------------|
| 00h      | 0x0800  | R    | StatusRSSI      |
| 01h      | 0x02F8  | R    | ReadChan        |
| 02h      | 0xA700  | R    | QOS, DeviceID   |
| 03h      | 0xE481  | R/W  | Function        |
| 04h      | 0x3EF8  | R/W  | Channel, Volume |
| 05h      | 0x1F40  | R/W  | SysConfig       |
| 06h      | 0x385A  | R/W  | APLLN           |
| 07h      | 0xE8AC  | R/W  | APLLK           |
| 08h      | 0xB0F1  | R/W  | Seek Threshold  |
| 09h      | 0x8BAA  | R/W  | Reserved        |
| 0Ah      | 0xC604  | R/W  | Reserved        |
| 0Bh      | 0x6D25  | R/W  | Reserved        |
| 0Ch      | 0xFFFC  | R/W  | Reserved        |
| 0Dh      | 0x120F  | R/W  | Reserved        |
| 0Eh      | 0x451D  | R/W  | Reserved        |

## 5.3 Register Word Description

| Bit               | Word | Bit | Type | Default | Function Description                                         |
|-------------------|------|-----|------|---------|--------------------------------------------------------------|
| <b>StatusRSSI</b> |      |     |      |         |                                                              |
| Mode_SEN          | 00h  | 15  | R    | 0       | I2C Mode Indicator<br>0---C-Mode<br>1---P-Mode               |
| HLSi_FLAG         | 00h  | 11  | R    | 1       | HLSi status indicator in auto mode<br>0---Low side injection |

*Broadcast FM Radio Receiver CL6017S*

|                 |     |       |   |               |                                                                                                                                                                                                                               |
|-----------------|-----|-------|---|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                 |     |       |   |               | 1---High side injection                                                                                                                                                                                                       |
| STC             | 00h | 10    | R | 0             | Seek/Tune Complete<br>0---Not complete<br>1---Complete<br>STC flag is set when seek or tune operation completes. Set the SEEK or TUNE bit low (both of TUNE and SEEK are low) will clear STC.                                 |
| SF              | 00h | 9     | R | 0             | Seek Fail<br>0---Seek successful<br>1---Seek failure<br>The seek fail flag is set when the seek operation fails to find a channel with $RSSI[7:0] \geq \{SEEKTH[7:0]\}$ (before map). Setting the SEEK bit low will clear SF. |
| ST              | 00h | 8     | R | 0             | Stereo Indicator<br>0---Mono<br>1---Stereo                                                                                                                                                                                    |
| RSSI            | 00h | 7:0   | R | 0x00          | Received Signal Strength Indicator (RSSI)<br>RSSI scale is logarithmic, 1db/step                                                                                                                                              |
| <b>ReadChan</b> |     |       |   |               |                                                                                                                                                                                                                               |
| Envelop_NUM     | 01h | 15:10 | R | 0             | Envelop detection                                                                                                                                                                                                             |
| ReadCHAN        | 01h | 9:0   | R | 760<br>108MHz | Current Channel No<br>Channel Frequency=50kHz*ReadCHAN + 70MHz<br>ReadCHAN is updated according to CHAN in the beginning of tune operation, or updated during seek operation.                                                 |
| <b>QOS</b>      |     |       |   |               |                                                                                                                                                                                                                               |
| DeviceID        | 02h | 15:8  | R | 0xA7          |                                                                                                                                                                                                                               |
| FD_NUM          | 02h | 7:0   | R | 0x00          | Frequency deviation                                                                                                                                                                                                           |
| <b>Function</b> |     |       |   |               |                                                                                                                                                                                                                               |

*Broadcast FM Radio Receiver CL6017S*

|           |     |    |     |   |                                                                                                                                                                                                                       |
|-----------|-----|----|-----|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Disable   | 03h | 15 | R/W | 1 | Power Down control<br>0---Work mode<br>1---Power down mode (Only I2C supply is on for digital control access.)                                                                                                        |
| Reset_DSP | 03h | 14 | R/W | 1 | DSP reset software control<br>0---Reset DSP<br>1---Normal operation                                                                                                                                                   |
| Mute      | 03h | 13 | R/W | 1 | Mute<br>1---Mute L/R channel<br>0---Normal operation                                                                                                                                                                  |
| LMute     | 03h | 12 | R/W | 0 | Left Mute<br>1---Mute<br>0---Normal operation                                                                                                                                                                         |
| RMute     | 03h | 11 | R/W | 0 | Right Mute<br>1---Mute<br>0---Normal operation                                                                                                                                                                        |
| SMute     | 03h | 10 | R/W | 1 | Soft Mute Disable<br>0---Mute (if RSSI<RSSI_MUTE then mute L/R)<br>1---Normal operation(do not mute)                                                                                                                  |
| Tune      | 03h | 9  | R/W | 0 | Tune Enable<br>0---Disable<br>1---Enable<br>The tune operation begins when the TUNE bit is set high. The STC bit is set high when the tune operation completes. Set TUNE=0 (1->0) (by i2c), will clear STC registers. |
| Seek      | 03h | 8  | R/W | 0 | Seek Enable<br>0---Disable<br>1---Enable                                                                                                                                                                              |
| SeekUp    | 03h | 7  | R/W | 1 | Seek process<br>0---Seek down<br>1---Seek up                                                                                                                                                                          |
| MONO      | 03h | 6  | R/W | 0 | Mono Selection<br>0---Auto mode<br>1---Force in mono mode                                                                                                                                                             |
| Stereo    | 03h | 5  | R/W | 0 | Force in stereo mode<br>0---No force (means Stereo Noise Canceling On)                                                                                                                                                |

*Broadcast FM Radio Receiver CL6017S*

|                       |     |       |     |               |                                                                                                                                                                                                                                                                                                                                            |
|-----------------------|-----|-------|-----|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                       |     |       |     |               | 1---If detect pilot, then force to stereo<br>(means Stereo Noise Canceling Off)                                                                                                                                                                                                                                                            |
| HCC_EN                | 03h | 4     | R/W | 0             | High Cut Enable<br>0---Bypass high cut filter<br>1---Enable high cut filter<br>The hccen signal to other digital part is decided by HCCEN, RSSIEN, RSSI(before map), RSSI_HCC registers.<br>If HCCEN=1, hccen=1;<br>If HCCEN=0 and RSSIEN=0, hccen=0;<br>If HCCEN=0 and RSSIEN=1,<br>If RSSI<={ RSSI_HCC,00 00}, hccen=1;<br>else hccen=0. |
| BB_EN                 | 03h | 3     | R/W | 0             | Bass Boost Enable<br>0---Disable<br>1---Enable                                                                                                                                                                                                                                                                                             |
| HLSi_CTRL             | 03h | 1     | R/W | 0             | High-Low side injection control<br>0---Manually control<br>1---Automatically control                                                                                                                                                                                                                                                       |
| HLSi                  | 03h | 0     | R/W | 1             | High/Low side injection in manual mode<br>0---Low side injection<br>1---High side injection                                                                                                                                                                                                                                                |
| <b>Channel Volume</b> |     |       |     |               |                                                                                                                                                                                                                                                                                                                                            |
| Volume                | 04h | 13:10 | R/W | 1111          | Volume<br>0000---Min. volume<br>1111---Max. volume                                                                                                                                                                                                                                                                                         |
| CHAN                  | 04h | 9:0   | R/W | 760<br>108MHz | Channel Selection<br>Frequency = 50kHz*CHAN + 70MHz<br>CHAN is updated every tune                                                                                                                                                                                                                                                          |
| <b>SysConfig</b>      |     |       |     |               |                                                                                                                                                                                                                                                                                                                                            |
| Band                  | 05h | 15:14 | R/W | 00            | Band Select<br>00---87.5MHz~108MHz (US/Europe, China)<br>10---76MHz~90MHz(Japan)<br>11---70MHz~108MHz                                                                                                                                                                                                                                      |
| Space                 | 05h | 13:12 | R/W | 01            | Channel Spacing<br>00---200kHz                                                                                                                                                                                                                                                                                                             |

*Broadcast FM Radio Receiver CL6017S*

|              |     |    |     |   |                                                                                                                                                                                                                                                                                                 |
|--------------|-----|----|-----|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              |     |    |     |   | 01---100kHz (Europe, Japan)<br>10---50kHz (USA)                                                                                                                                                                                                                                                 |
| DEEN         | 05h | 11 | R/W | 1 | De-emphasis enable.<br>0---Disable<br>1---Enable                                                                                                                                                                                                                                                |
| DE           | 05h | 10 | R/W | 1 | De-emphases<br>0---75 $\mu$ s (USA)<br>1---50 $\mu$ s (China)                                                                                                                                                                                                                                   |
| AFC_EN       | 05h | 9  | R/W | 1 | AFC mode selection<br>0---No AFC<br>1---in Tune module                                                                                                                                                                                                                                          |
| AFC_Polarity | 05h | 8  | R/W | 1 | AFC Polarity Selection in tuning module<br>0---Low LO, + AFCIN; high LO, -AFCIN<br>1---Low LO, - AFCIN; high LO, +AFCIN                                                                                                                                                                         |
| QOS_CHK      | 05h | 7  | R/W | 0 | Quality of Signal check method                                                                                                                                                                                                                                                                  |
| RSSI_EN      | 05h | 6  | R/W | 1 | Enable RSSI result update RSSITU.<br>0---RSSI disable, tuning module use<br>RSSITU written by bus as rssi value.<br>1---RSSI enable, tuning module use RSSI<br>generated in FM demodulator as rssi value.<br>It is also related to DMUTE and HCCEN.<br>See DMUTE and HCCEN register definition. |
| <b>APLLN</b> |     |    |     |   |                                                                                                                                                                                                                                                                                                 |
| Xtal_Sel     | 06h | 14 | R/W | 0 | Crystal selection<br>0---32.768kHz<br>1---13MHz                                                                                                                                                                                                                                                 |
| Xtal_EN      | 06h | 13 | R/W | 1 | Internal crystal oscillator enable signal<br>0---Disable oscillator circuit and enable<br>differential pair as buffer but<br>will not use it as buffer<br>1---Enable oscillator circuit, it can support<br>XTAL, but also use it as<br>13.768kHz and 13MHz buffer                               |
| ON_LNA       | 06h | 12 | R/W | 1 | LNA ON/bypass control when AGC PD<br>0---Low gain (bypass LNA)<br>1---High gain (LNA active)                                                                                                                                                                                                    |

*Broadcast FM Radio Receiver CL6017S*

|                |     |      |     |       |                                                                                                                                                                                                                               |
|----------------|-----|------|-----|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ZIN_LNA        | 06h | 11   | R/W | 1     | LNA input impedance<br>0---50ohm input impedance<br>1---120ohm input impedance                                                                                                                                                |
| RSSITU         | 06h | 10:7 | R/W | 0000  | RSSI value written by I2C for Tuning module.<br>RSSITU is written by bus.<br>If RSSIEN=0, tuning module use RSSITU as rssi value. If RSSIEN=1, tuning module use the rssi generated in FM demodulator, and RSSITU is ignored. |
| APLL_NK_SEL    | 06h | 6    | R/W | 1     | APLL N/K mode selection<br>0---N/K value used in APLL is APLLN and APLLK (registers) set by I2C<br>1---N/K value used in APLL is generated in tuning module                                                                   |
| APLLN          | 06h | 5:0  | R/W | 26    | N to APLL when APLL_NK_SEL=0                                                                                                                                                                                                  |
| <b>APLLK</b>   |     |      |     |       |                                                                                                                                                                                                                               |
| APLLK          | 07h | 15:0 | R/W | 59564 | K to APLL when APLL_NK_SEL=0                                                                                                                                                                                                  |
| <b>Seek_TH</b> |     |      |     |       |                                                                                                                                                                                                                               |
| SeekTH         | 08h | 15:8 | R/W | 176   | Seek Threshold<br>11001001---201<br>11111111---Max. RSSI<br>RSSI scale is logarithmic.                                                                                                                                        |
| PGA_RD_TH      | 08h | 7:6  | R/W | 11    | PGA range detector switching threshold<br>00---35000<br>01---30000<br>10---25000<br>11---20000                                                                                                                                |
| Envelop_TH     | 08h | 5:3  | R/W | 110   | Envelop detection threshold<br>000---224 (14)<br>001---288 (18)<br>010---352 (22)<br>011---416 (26)<br>100---480 (30)<br>101---544 (34)<br>110---608 (38)                                                                     |

*Broadcast FM Radio Receiver CL6017S*

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|       |     |     |     |     |                                                                                                                                         |
|-------|-----|-----|-----|-----|-----------------------------------------------------------------------------------------------------------------------------------------|
|       |     |     |     |     | 111---672 (42)                                                                                                                          |
| FD_TH | 08h | 2:0 | R/W | 001 | Frequency deviation detection threshold<br>000---12<br>001---14<br>010---16<br>011---18<br>100---20<br>101---22<br>110---24<br>111---26 |

## 6 PIN Descriptions

| PIN | Name     | Description                                           |
|-----|----------|-------------------------------------------------------|
| 1   | ROUT     | Right Audio Output                                    |
| 2   | LOUT     | Left Audio Output                                     |
| 3   | VDD      | Power Supply                                          |
| 4   | VCO_LP   | Noinverting port for external inductor for Analog VCO |
| 5   | VCO_LN   | Inverting port for external inductor for Analog VCO   |
| 6   | GND      | Ground                                                |
| 7   | APLL_LPF | Analog PLL LPF                                        |
| 8   | RFIN     | RF Single-end input                                   |
| 9   | GND      | Ground                                                |
| 10  | DPLL_LPF | Digital PLL LPF                                       |
| 11  | GND      | Ground                                                |
| 12  | OSC      | Crystal Single-end Input                              |
| 13  | SDIO     | I2C Data                                              |
| 14  | SCLK     | I2C Clock                                             |
| 15  | VDD      | Power Supply                                          |
| 16  | GND      | Ground                                                |

# 7 Package Outline

SSOP 16 Pin 6 X 5 X 1.4 mm

