

MS211

Simple SPI Recorder IC With Voice Changer Datasheet

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General Description

MS211 is a build in high quality voice compress and decompress logic ,also with voice mixing and voice change effects.MS211 IC that can be used for all kinds of sound recording applications. It build in class D amplifier, maximum out 0.6W with high efficiency. Recording Microphone input to connected SPI flash memory, very low cost solution , With different SPI flash memory connected, All data kept when power is OFF, it can record sound up to 35 minutes with good MIC amplifier input circuit for long distance with lossless sound quality.

Features

- Operating from 2.6 ~ 4.5V.
- 1 MBIT SPI flash may record 30 seconds of speech with 8 KHz sample rate¹.
- Recording Length from 30 Sec to 35mins(64 M Bit),vary SPI Flash size for different recording Length. with 8 KHz sample rate.
- 14 Bit high quality Audio ADC input,14 Bit DAC Output .
- Support μ -LAW² / ADPCM/ PCM format .
- Play the recorded sound directly from the SPI flash memory to 8 ohm speaker.
- Sample-rate is adjusted by external resistor.³,from 6KHz to 16KHz
- Class D Amplifier, Direct drive 8 ~ 32 ohm speaker, maximum output 0.6 W.
- Sleep power consumption < 10 uA with FLASH memory.
- Key button inputs
 - ◆ PLAE, edge trigger to play the recorded sound.
 - ◆ PLAL, level-hold to play the recorded and preload sound.
 - ◆ RECE, edge trigger to start recording.
 - ◆ RECL, level hold to start recording. And RECL can interrupt PLAL operation, suitable for card applications.
- Pre-Load Audio on SPI Flash with special options. It can play or mix with recording voice . will not be erased when recording new sound.
- Preload FLASH Options are as follows:
 - ◆ Preload music playing order, first or second.
 - ◆ ADPCM or μ -LAW format recording.
 - ◆ Preload music playing with double sample rate.
 - ◆ Preload music playing mixed with recorded speech.
 - ◆ Quieter volume for power saving.
- Auto-repeat function select by PIN connection.
- Voice-Changer Capability when playing recorded voices:
 - Robot
 - Child (Pitch shift)
- Long Distance recording, sensitivity can be adjusted by hardware, Maximum reach 3M ~ 5M
- Playing/Recording LED Indicator.
- Act as band-limited amplifier if TEST and SPIMISO connect to GND, and PLAE connect to LEDBZ.
- BEEP prompt for recording.

¹ The length is in ADPCM Format.

² U-LAW recording needs faster SPI flash due to internal RAM size limit. Check MSHINE Technologies Corp for further information.

³ For recording applications with ADPCM format, sample rate is limited by $2400/[\text{Flash sector-erase-time}]$. Recording sample will missing if recording-sample rate is greater than $2400/[\text{Flash sector-erase-time}]$. Pre-record sound segment has no such limit. For μ -LAW recording, sample rate is limited by $1200/[\text{Flash sector-erase-time}]$.

Block Diagram

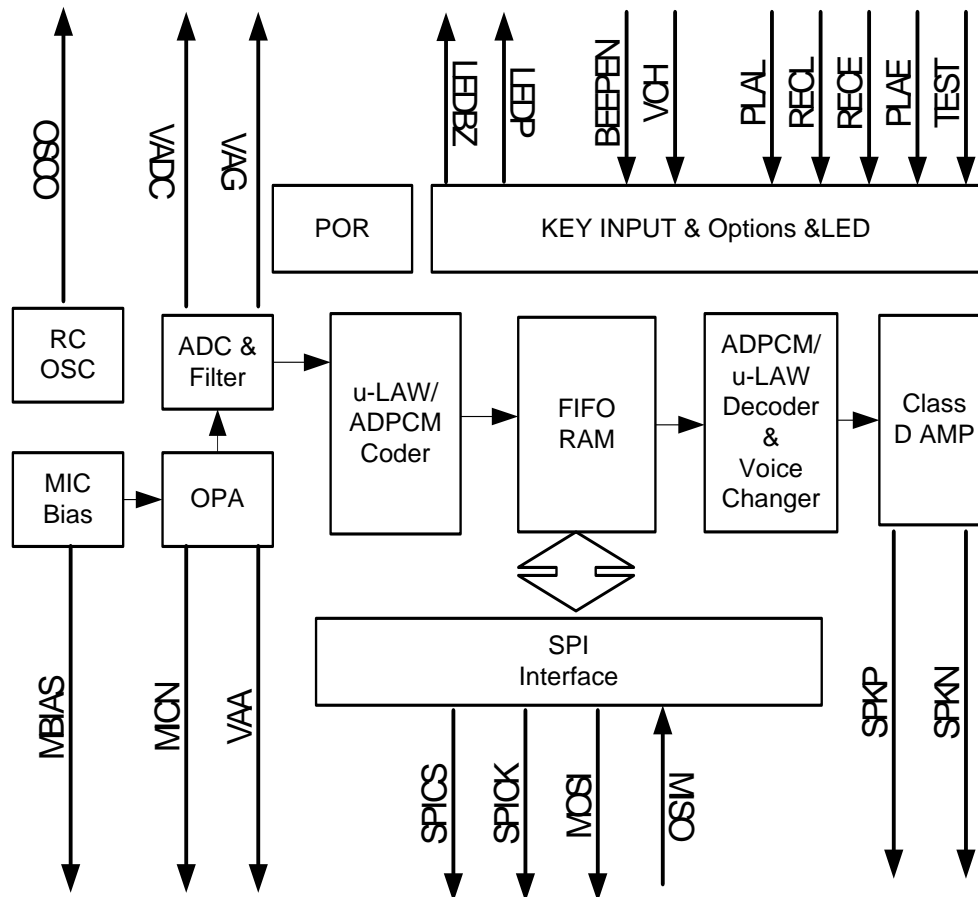


Figure 1. MS211 Block Diagram.

Application

- Sound recording toys, Greeting cards, Soft and Hard toys, Gift box ,Key Chains and other applications.

Package

- SSOP28.

PAD Configuration (Draft)

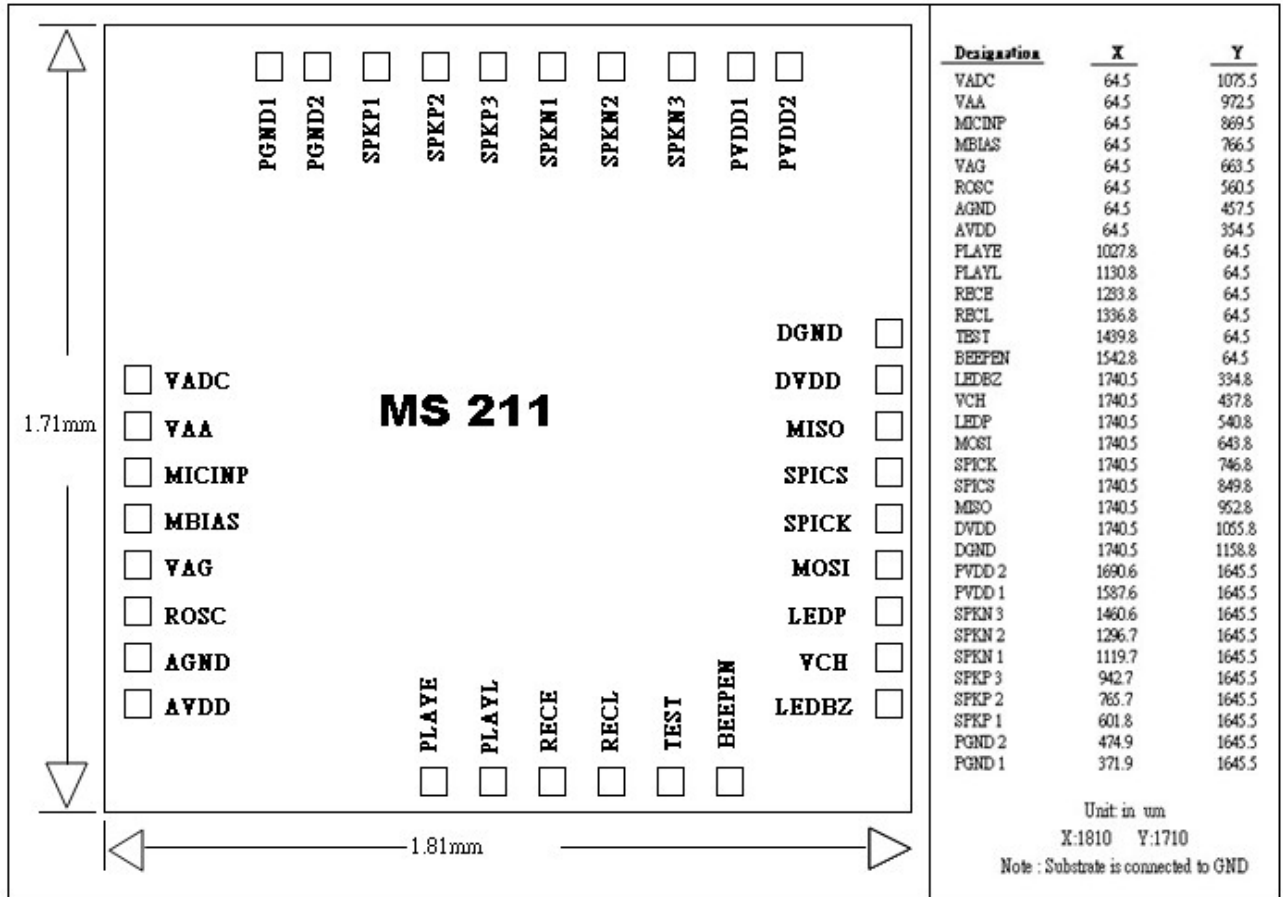


Figure 2. MS211 Dice PAD Configuration

SSOP 28 Pins Configuration

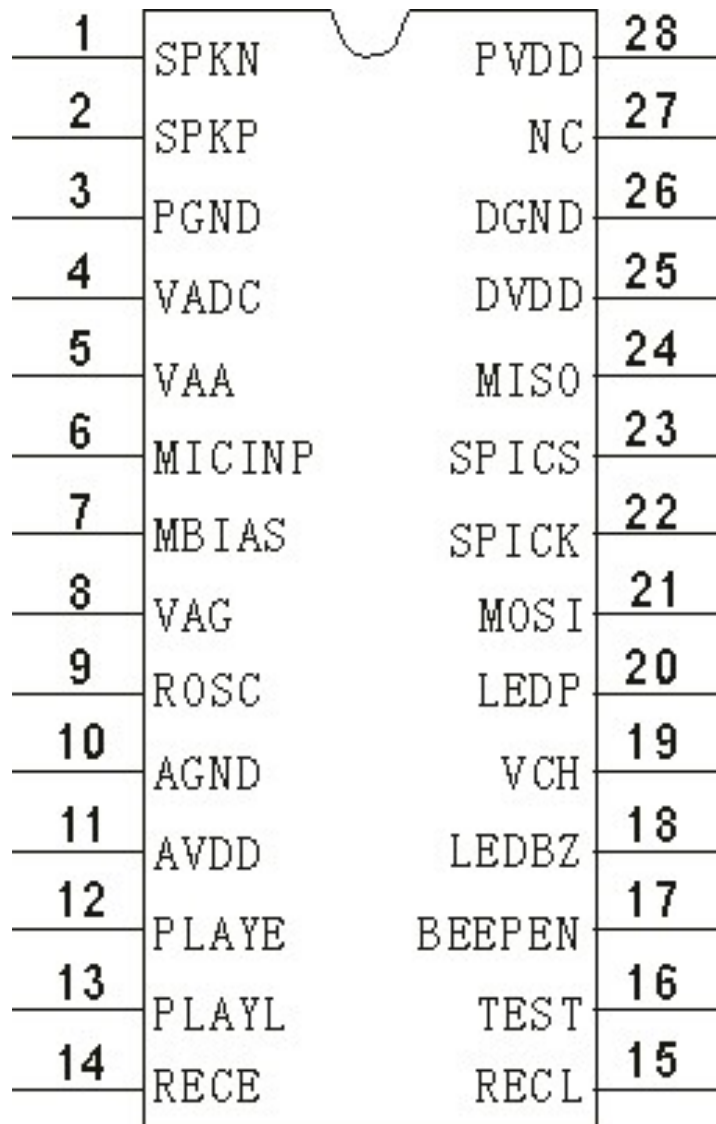


Figure 3. MS211 SSOP28 Package configuration.

Pin Descriptions

| Pin No. | Notation | TYPE | Functional Description |
|----------------------------------|----------|-----------------|--|
| Power Pins | | | |
| *4 | DVDD | Power | VDD power source of digital circuits. |
| * | DVSS | Power | GND power of digital circuits. |
| * | AVDD | Power | Analog/SPK Power VDD |
| * | AVSS | Power | Analog/SPK Power GND |
| * | PVDD | Power | Power Amplifier Supply |
| * | PVSS | Power | Power Amplifier GND. |
| Special Pins | | | |
| * | OSCO | O | External resistor to DVSS |
| * | TEST | IU | Input low for test mode. |
| Key buttons & Options | | | |
| * | PLAE | IU ⁵ | Play button input. Edge Trigger. If the data is not played over, playing will stop at the second trigger. In 1-segment mode, only 1 segment will played. In 2 segment mode, 2 segment of voices will be played. |
| * | RECE | IU | Record start input. Edge Trigger. Second trigger will stop the record process. |
| * | PLAL | IU | Play, level hold input, low active. |
| * | RECL | IU | Record, level trigger, low active. |
| * | VCH | IU | Voice Changer option, |

⁴ * means To be defined later.

⁵ IU means input with pull up resistor inside.

| | | | <table border="1"> <tr> <th>Connection</th> <th>Effect</th> </tr> <tr> <td>Floating</td> <td>None</td> </tr> <tr> <td>Short to LEDP</td> <td>Robot</td> </tr> <tr> <td>Short to LEDBZ</td> <td>Pitch-shift</td> </tr> </table> | Connection | Effect | Floating | None | Short to LEDP | Robot | Short to LEDBZ | Pitch-shift | | | | | | | |
|----------------------------|--------------------|------------|---|------------|--------|-----------------|-----------------|----------------------|--------------|-----------------------|--------------------|------------|----------------------|------------|-----------|-----------------------|-----------|------------|
| Connection | Effect | | | | | | | | | | | | | | | | | |
| Floating | None | | | | | | | | | | | | | | | | | |
| Short to LEDP | Robot | | | | | | | | | | | | | | | | | |
| Short to LEDBZ | Pitch-shift | | | | | | | | | | | | | | | | | |
| * | BEEPEN | IU | <p>Beep & Repeat Option. Normally Beep frequency is 1.0 KHz at 8.0 KHz sample rate. The operation is as following table.</p> <table border="1"> <tr> <th>Connection</th> <th>Beep</th> <th>Repeat</th> </tr> <tr> <td>Floating</td> <td>ON</td> <td>OFF</td> </tr> <tr> <td>Short to GND</td> <td>OFF</td> <td>OFF</td> </tr> <tr> <td>Short to LEDP</td> <td>OFF</td> <td>ON</td> </tr> <tr> <td>Short to LEDBZ</td> <td>ON</td> <td>OFF</td> </tr> </table> | Connection | Beep | Repeat | Floating | ON | OFF | Short to GND | OFF | OFF | Short to LEDP | OFF | ON | Short to LEDBZ | ON | OFF |
| Connection | Beep | Repeat | | | | | | | | | | | | | | | | |
| Floating | ON | OFF | | | | | | | | | | | | | | | | |
| Short to GND | OFF | OFF | | | | | | | | | | | | | | | | |
| Short to LEDP | OFF | ON | | | | | | | | | | | | | | | | |
| Short to LEDBZ | ON | OFF | | | | | | | | | | | | | | | | |
| LED Pins | | | | | | | | | | | | | | | | | | |
| * | LEDP | O | Output low when playing. | | | | | | | | | | | | | | | |
| * | LEDBZ | O | Output 3 Hz when playing and output low when recording. | | | | | | | | | | | | | | | |
| SPI Pins | | | | | | | | | | | | | | | | | | |
| * | SPICS | O | SPI Chip Select (Low active) | | | | | | | | | | | | | | | |
| * | SPICK | O | SPI clock signal. | | | | | | | | | | | | | | | |
| * | MOSI | O | Master data/command output. | | | | | | | | | | | | | | | |
| * | MISO | I | Master data input. | | | | | | | | | | | | | | | |
| Mic and Analog pins | | | | | | | | | | | | | | | | | | |
| * | VAG | O | Analog virtual ground. Capacitor of 1 uF to AVSS is required. This pin is also the positive input of the OP-AMP. A resistor 100K to MBIAS shall be connected for 3-battery (>3.6V) applications. | | | | | | | | | | | | | | | |
| * | VAA | O | Anti-Alias filter PAD. It is also the output of the OP-AMP. | | | | | | | | | | | | | | | |

| | | | |
|----------------------|-------|---|---|
| * | MBIAS | O | Microphone bias voltage source. A capacitor 1 uF to AVSS is required. |
| * | MICNP | I | Negative input of internal OP-AMP. A feed back resistor and capacitor is required to connect VAA, and a resistor is used to connect the microphone. |
| * | VADC | O | A PAD for ADC voltage reference. A capacitor 1 uF is required to connect this pin to AVSS. |
| Speaker Driving Pins | | | |
| * | SPKP | O | Speaker output. High-Z when not playing. |
| * | SPKN | O | Speaker output. High-Z when not playing. |

Table 1. MS211 Pins Description.

General Functional Description

MS211 is a simple chip that can record the voice from microphone/Speaker to SPI memory, and play the voice from SPI memory directly. It built in high-quality ADPCM/ μ -LAW engine that can compress the voice data from ADC to 8-bit per sample.

When recording, sound are compressed to 8-bit per sample, and then stored to flash memory. While erasing sectors on SPI flash memory, MS211 will store the compressed speech data in its own RAM. After the sector is erased, the compressed data will be written to the SPI memory as soon as possible. Also, it will overwrite the old record data and replaced by the new one whenever a voice is recorded.

Before start recording a short Beep prompt will be on the speaker. And 2 short “beep” will out after recording stopped. Beep function can be disabled with BEEPEN short to GND.

In 1-segment mode, MS211 will record the speech from the beginning of the SPI flash. In 2-segment mode, MS211 will record (overwrite) the speech of high-address voice segment.

When playing, MS211 will read the content from the SPI memory and decode with ADPCM/ μ -LAW decoder, and perform the voice-changer function as required. In 1-segment mode, MS211 will play just one voice segment. In 2-segment mode, MS211 will play 2 segments of voices one by one or mixed together. Which one should be played first is defined by preload FLASH option. After the sound segments are played, it will toggle LED pins to check if repeat is required. If BEEPEN is short to LEDBZ or LEDP, MS211 will repeat playing again. For mix-mode and Sound-Detect Mode, repeating has special options, and will be described in later sections.

MS211 playing is through Class D Amplifier that has very good power efficiency and sound quality.

If TEST is low and SPIMISO is low, with PLAE connect to LEDBZ, MS211 will be act as band-limited amplifier.

Recording Function Description

MS211 can record the signal of microphone to the SPI Flash Memory. The following sub-sections will describe the detailed information.

Record Timing

When recording in normal operation, MS211 has input signals and LED output like the figure below. Note that LEDP3 and LEDBZ can be used for recording indicator.

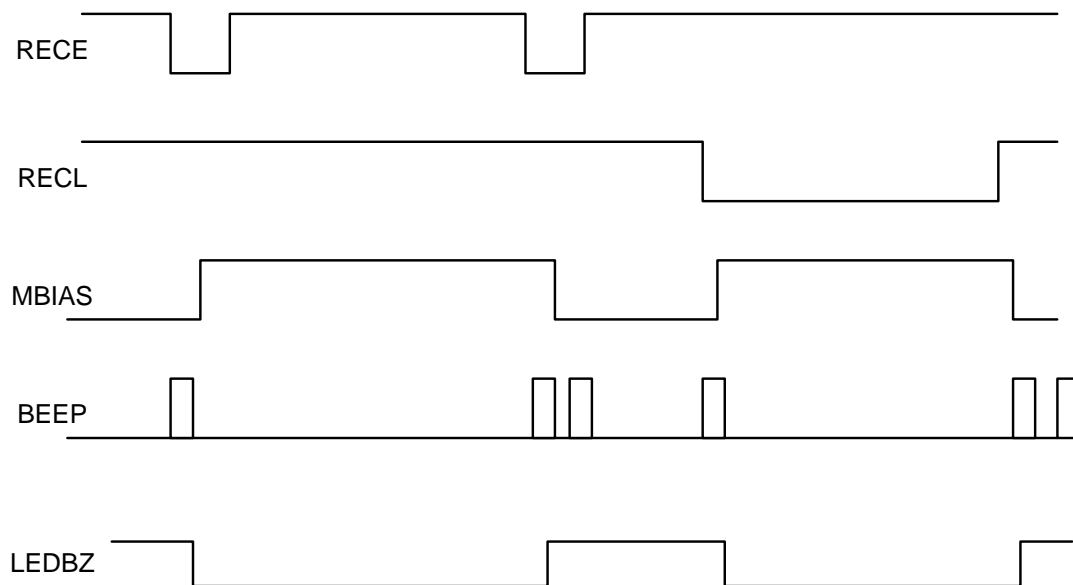


Figure 1. Record Timing Diagram.

In Sound-Detect Mode, recording will start by sound level, and will be described in the later section.

Playing Function Description

MS211 can play the recorded sound from the SPI Flash memory. The following subsections will describe the playing function in detail.

Playing Timing Diagram, 1-SEG Mode

When PLAE or PLAL pressed, MS211 will start to play. The LED and sound segment timing is as the following figure, if there is no preload music.

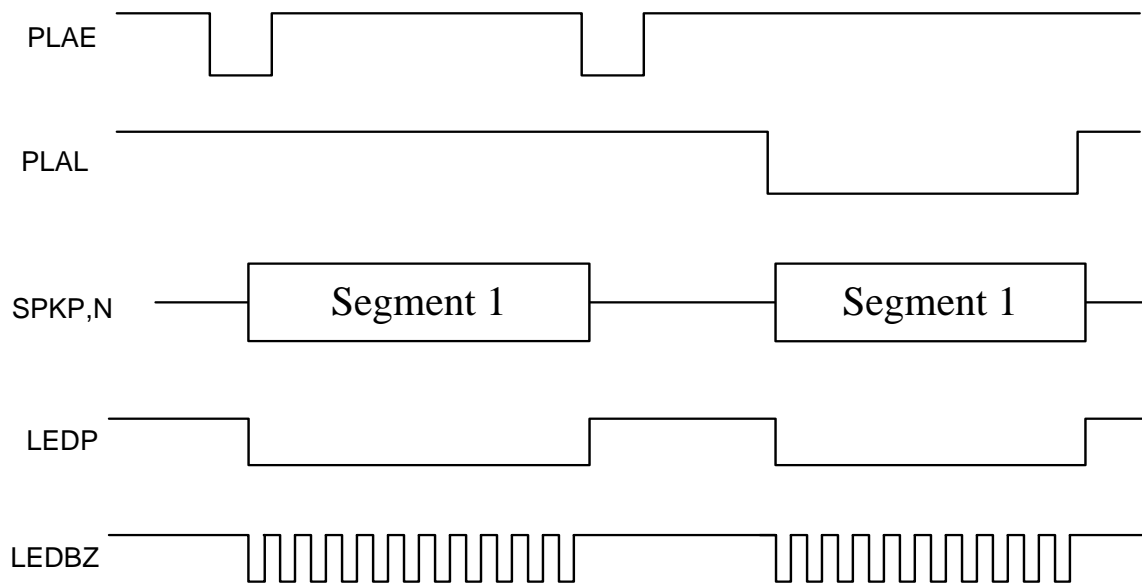


Figure 2. Playing Timing Diagram.

Playing Timing of 2-SEGMENT Mode

Also, MS211 can play 2 segments with a segment fixed. The timing is as Figure and Figure.

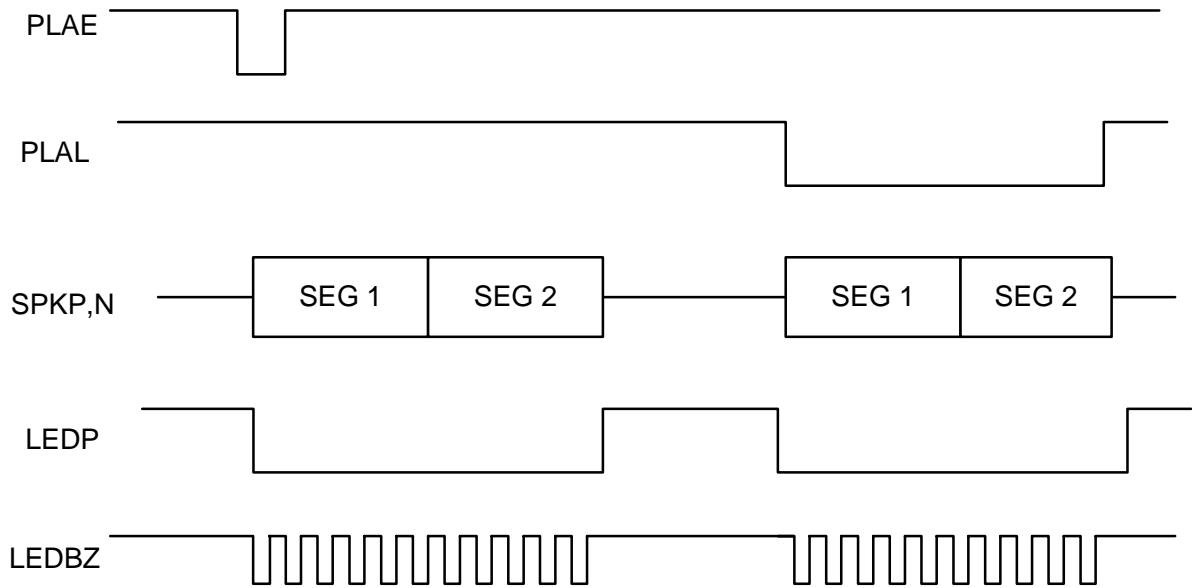


Figure 3. Playing 2-segment Mode. (Low address first)

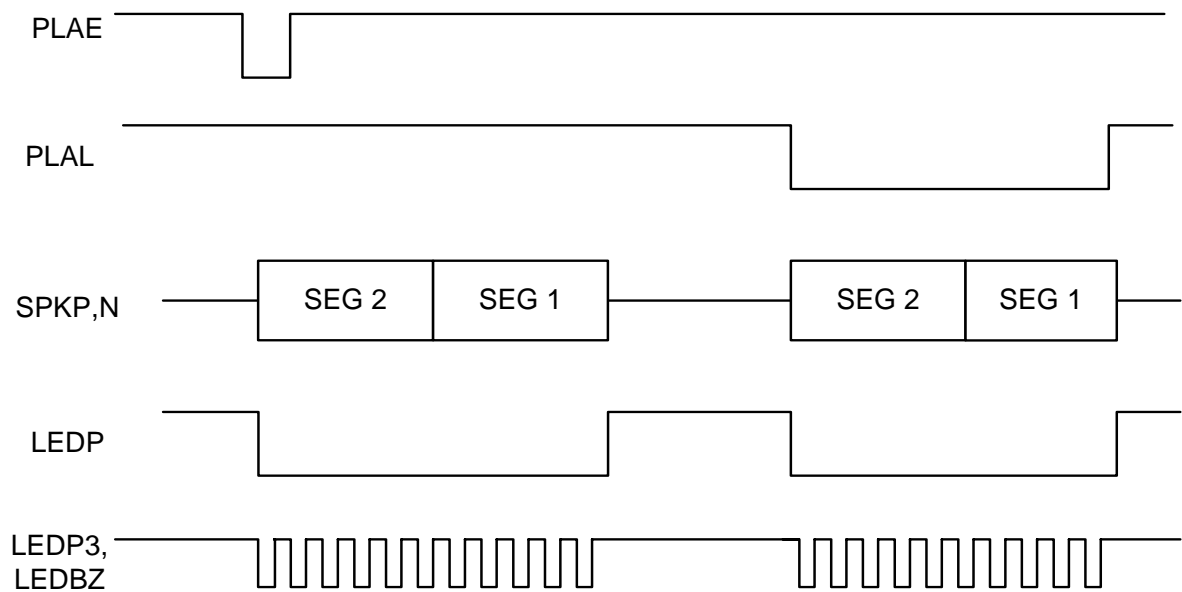


Figure 4. Playing 2-segment Mode. (High address first)

RECL over PLAL

MS211 has a special function about the key buttons that PLAL function can be interrupted by RECL. That is, when PLAL and RECL are low at the same time, RECL function will always overtake PLAL function. The function is suitable for card applications that external photo resistor is only required at PLAL pad.

That is, if PLAL is low, PLAE and RECE keys will have no function. However, if RECL is low, MS211 will change to recording mode, and when RECL is released, MS211 will play again the newly record segment. After the new segment is played, MS211 will enter sleep mode even PLAL is low.

The timing diagram is as below:

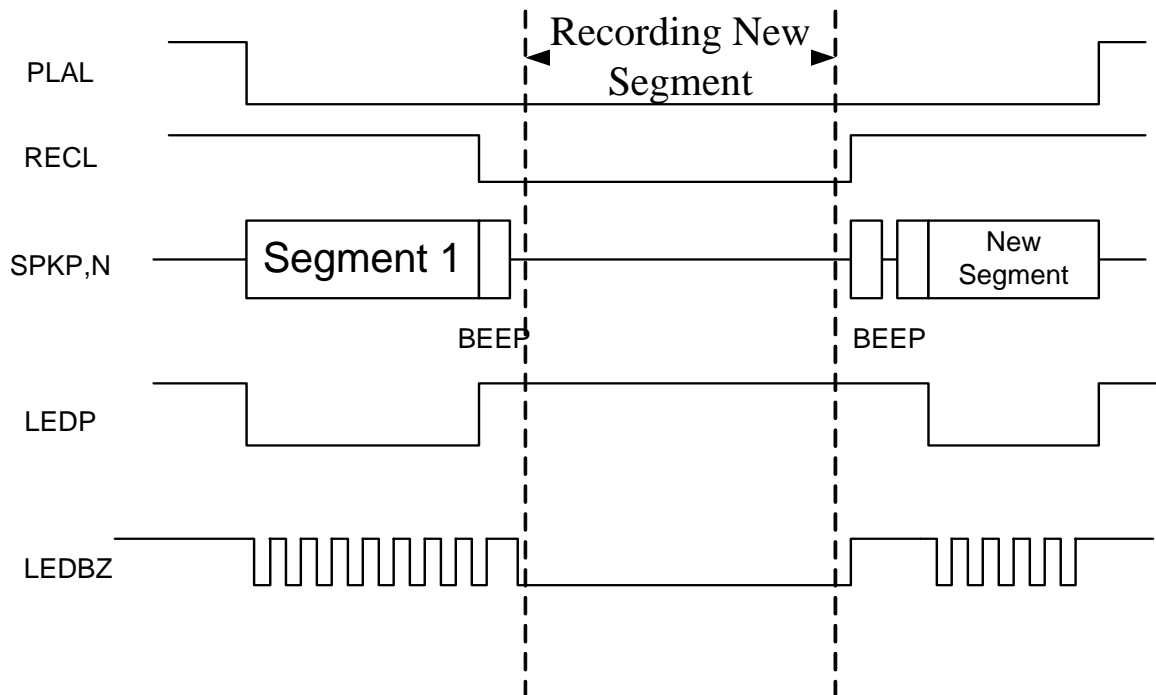


Figure 5. RECL interrupt PLAL function.

Playing-Stop Condition & Auto-Repeat

When playing, MS211 will check the following condition to stop playing:

1. If PLAE pressed, it will stop when any other button pressed.
2. If PLAL pressed, it will stop when PLAL released.
3. If MS211 found 0xFF for 8 times, it think it is the end-code, and will stop playing.
4. If entire flash played, it will also stop.

MS211 will also check if BEEPEN pin is connected to PLED or LEDBZ. Either of them will make MS211 to restart playing again. The configuration is like Figure.

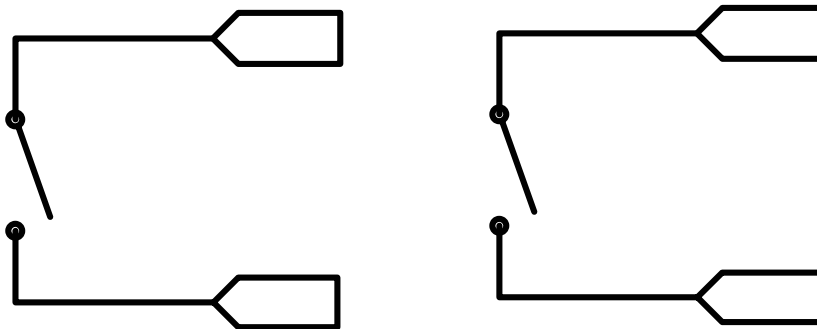


Figure 6. Auto repeat configuration.

Mixed Playing Mode

MS211 support mixed playing mode that can mix the pre-load music and the recorded sound playing together. It does not support ROBOT effect and has special configuration for auto-repeat function and gain settings. The data flow is as follows.

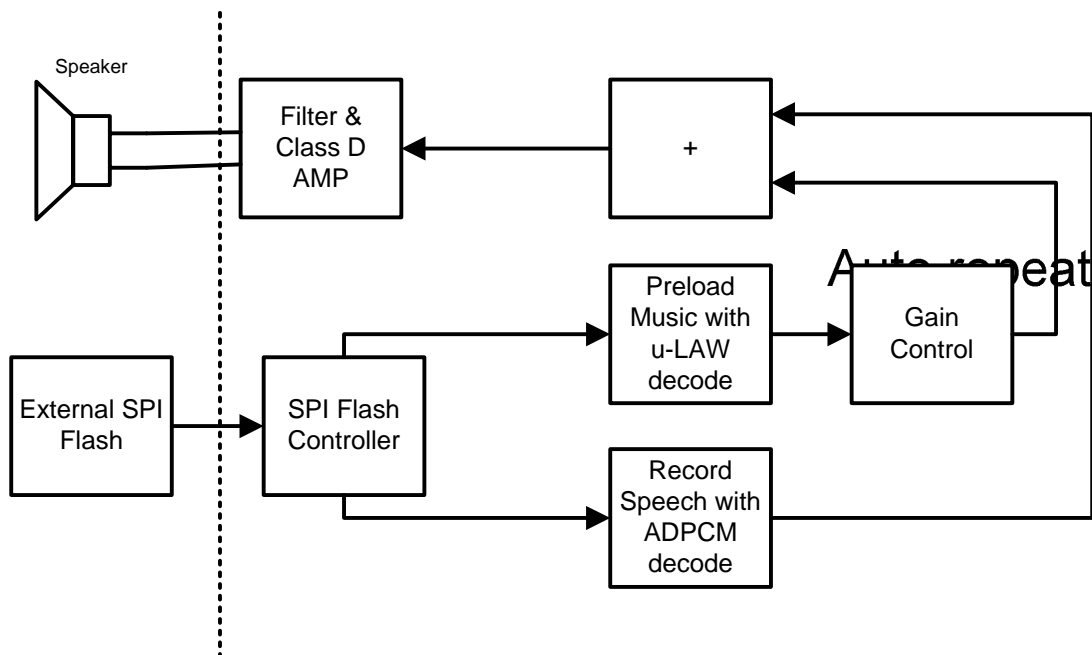


Figure 6. Mixed playing mode concept.

Because preload music may different length from the recorded speech, and auto-repeat may be used, the playing sequence is like the following figure.

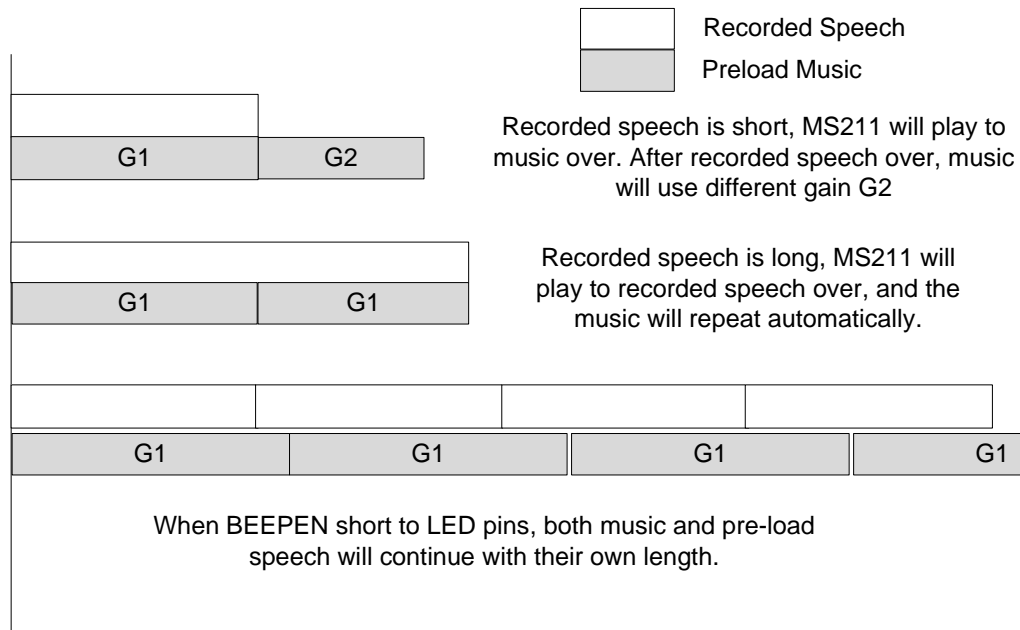


Figure 7. Mixed playing mode playing sequence.

Voice Changer Function

MS211 has 2 voice changer function option. When enabled, it will have the sound effect when playing. When VCH connect to LEDBZ, MS211 will have Pitch-shift effect that playing frequency will be 150% of recording frequency. The entire signal flow has no change.

When VCH connect to LEDP, MS211 will have “ROBOT” effect. The ROBOT effect is repeating the recorded sound with short time periods, or short time echoes. The effect usually listened best under 8~12 KHz sample rate.

Sample Rate and Resistor Value

For different sample rate, resistor of correct value should connect to OSCO pin. The recommend value is as below (At 3.6V):

| SAMPLE RATE (KHZ) | 6 K HZ | 8 K HZ | 10 K HZ | 11 K HZ | 12 K HZ | 16 K HZ |
|---------------------------|--------|--------|---------|---------|---------|---------|
| Typical Resistor (K Ohms) | 120K | 91 K | 73 K | 68 K | 62 K | 47 K |

Typical Application Circuits

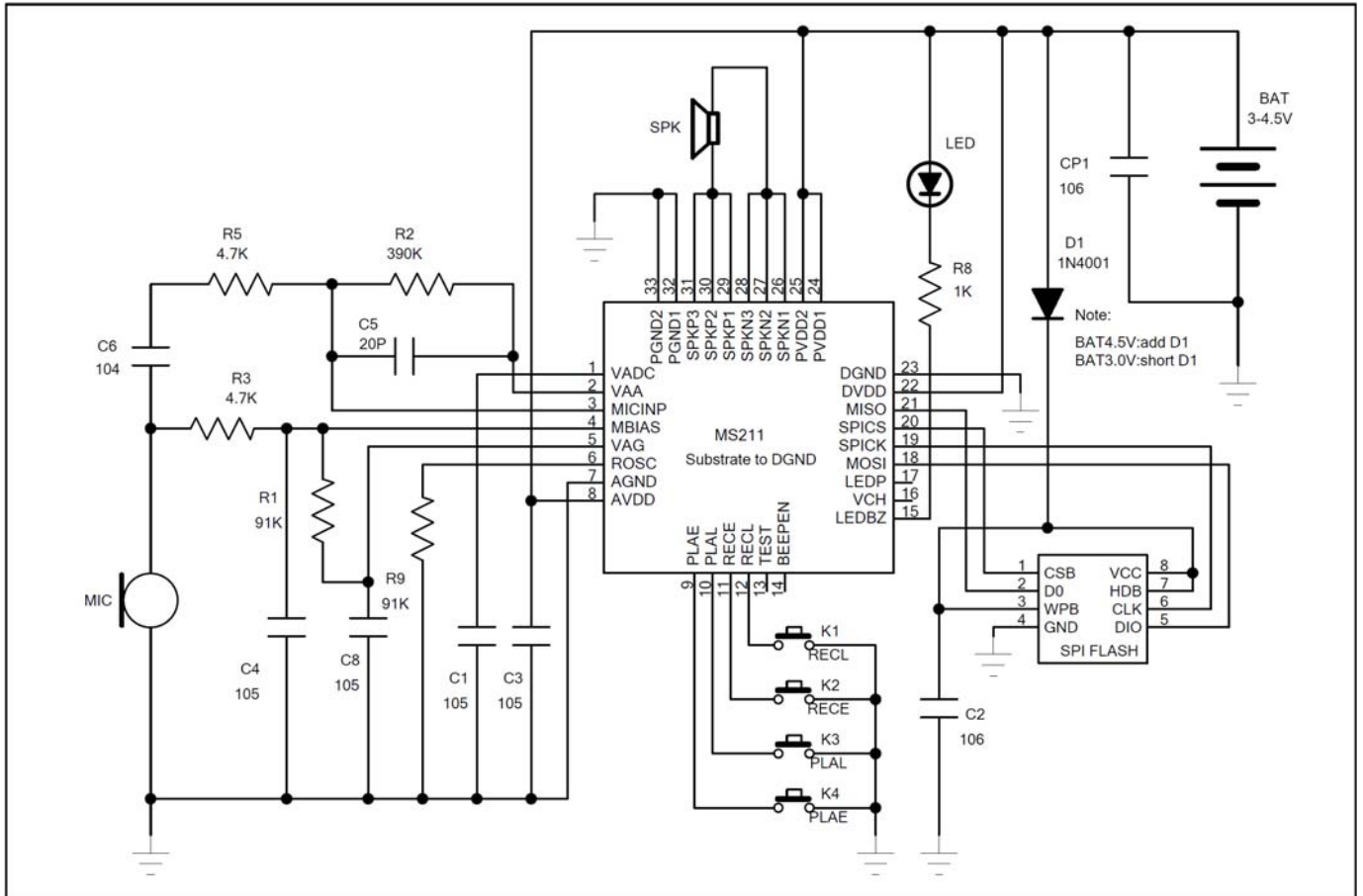


Figure 8. Typical Application Circuit for Recording Application.

Absolute Maximum Ratings

Comments

DC Supply Voltage.....-0.5V to + 4.8V
 Input Voltage.....-0.5V to VDD + 0.5V
 Output Voltage.....-0.5V to VDD + 0.5V
 Operating Temperature.....-40° to 85° C
 Storage Temperature.....-70° to 150° C

Never allow a stress to exceed the values listed under “Absolute Maximum Ratings”, otherwise the device would suffer from a permanent damage. Nor is a stress at the listed value be allowed to persist over a period, since an extended exposure to the absolute maximum rating condition may also affect the reliability of the device, if not causing a damage thereof.

AC & DC Electrical Characteristics

DC Characteristics

| Parameters | Conditions | Symbol | Min. | Typ. | Max. | Unit |
|----------------------------|--|--------------------------------------|---------------------|--------------|----------------------|------|
| Supply voltage | With SPI flash working at 4.5V | V _{DD} | 2.6 ⁶ | 3.3 | 4.5 ⁷ | V |
| Supply Current | 8KHz, recording, VDD=3.0V | I _{REC} | | 13 | | mA |
| | 8KHz, playing, VDD=3.0V, 8-Ohm speaker | I _{PLA} | | 30 | | mA |
| | Power-Down Mode, 3.0V ⁸ | I _{DD1} | | 5 | 8 | uA |
| | Power-Down Mode, 3.6V | I _{DD2} | | 7 | | uA |
| | Power-Down Mode, 4.5V | I _{DD3} | | | 10 | uA |
| Output voltage | I _{OH} =1, Push-pull pins. | V _{OH1} | VDD-0.2 | - | - | V |
| | I _{OL} =2 mA, push-pull pins | V _{OL1} | 0.2 | - | - | V |
| Input voltage ⁹ | All Input Pins | V _{IH1} | 0.8 V _{DD} | - | V _{DD} +0.3 | V |
| | All Input Pins | V _{IL1} | -0.3 | - | 0.2 V _{DD} | V |
| Output current | LED pins, VOL=0.5V, VOH=VDD-0.5V | I _{OL1} I _{OH1} | 8 | | -8 | mA |
| | AMP pins, 8-ohm speaker connected | I _{OL2} I _{OH2} | | -100 +100 | | mA |
| | KEY pulled high input at 4.5V | I _{PH} | | -0.04 | | mA |
| | KEY pulled high input at 3.6V | I _{PH} | | -0.03 | | mA |
| MBIAS Output Current | VDD=3.3V | Imbo | | 3 | | mA |
| MBIAS Output CVoltage | VDD=3.3V | | | 2.2 | | V |
| VAG output Voltage | VDD=3.3V | Vag | | 1.1 | | V |

⁶ The supply voltage MUST be greater than the working voltage of the SPI Flash Memory.

⁷ When VDD>=3.3V, some 8-ohm speaker need to connected with a resistor and an inductor.

⁸ SPI Flash's power is not included.

⁹ Schmitter Trigger level around 2VDD/5, 3VDD/5 is implemented for all input pins except MISO.

| | | | | | | |
|---------------------|------------|------|--|-----|--|---|
| POR Release voltage | Temp=23° C | Vpor | | 2.3 | | V |
|---------------------|------------|------|--|-----|--|---|

Table 2. DC Characteristics of MS211.

AC Characteristics

| Parameters | Conditions | Symbol | Min. | Typ. | Max. | Unit |
|-------------------------------|--------------------------------|---------------------|------|------------------|------|------|
| Key button De-bounce time | Sample Rate = 8.0 KHz | Tkd | | 30 | | ms |
| ADC Input Range ¹⁰ | VDD=2.3~4.5V | Vadi | 0.25 | | 2.1 | VDC |
| External RC Frequency | VDD=4.5V, ROSC=91K OHMS | Frc | 3.8 | 4.2 | 4.6 | MHz |
| Sample Rate variation #1 | VDD 4.6V → 3.6V, ROSC=91K ohms | FR1 | | +4% | | |
| Sample Rate variation #2 | VDD 4.6V → 3.6V, ROSC=91K ohms | FR2 | | -4% | | |
| ADC Sample rate ¹¹ | VDD=3.0V | FS | 6 | 8 | 16 | KHz |
| Speech Signal SNR | VDD=3.0V | ADC _{SNR} | | 60 ¹² | | DB |
| Speech Dynamic Range | VDD=3.0V | ADC _{SNDR} | | 70 | | DB |
| MBIAS Driving Current | VDD=3.0V | IMBIAS | | 2 | | MA |
| ADC POWER NOISE REJECT | VDD=3.0V | PSRR | | 50 | | DB |
| ADC COMMON MODE REJECT | VDD=3.0V | CMRR | | 40 | | DB |
| Input OPA Open loop gain | VDD=3.0v | G _{OL} | 70 | | | DB |
| OPA Input offset | VDD=3.0V | Oop | | | 10 | mV |
| OPA Unit gain bandwidth | VDD=3.0V | BWuni | | 1 | | MHz |

¹⁰ ADC input will be DC offset to VAG by OPA inside, which is usually 0.1V.

¹¹ ADC Sample rate is limited by the sector-erase time with the memory since higher frequency needs more data stored at RAM when SPI is under sector-erase. The sample rate limit is [2400/sector-erase-time]. That is, sound sample will be dropped while recording if sample rate is greater than [2400/sector-erase-time].

¹² Input signal is around 100 Hz sine wave.

| | | | | | | |
|--------------------------------------|----------------------|--------|--|----|--|----|
| MBIAS Power Noise Reject Ratio | VDD=3.3V,load=2.0 mA | PSRRmb | | 40 | | db |
|--------------------------------------|----------------------|--------|--|----|--|----|

Table 3. AC Characteristics.

Package Outline

