



## ISD1500 Series

### Single-Chip, Single-Message Voice Record/Playback Devices 6-, 10-, and 20-Second Durations

#### GENERAL DESCRIPTION

Information Storage Devices' ISD1500 ChipCorder® Series provides high-quality, single-chip, single-message, record/playback solutions. The CMOS devices include an on-chip oscillator (with external control), microphone preamplifier, automatic gain control, antialiasing filter, multilevel storage array, smoothing filter, and speaker amplifier. A minimum record/playback subsystem can be configured with a microphone, a speaker, several passive components, two push-buttons, and a power source.

Recordings are stored in on-chip nonvolatile memory cells, providing zero-power message storage. This unique, single-chip solution is made possible through ISD's patented multilevel storage technology. Voice and audio signals are stored directly into memory in their natural form, providing high-quality, solid-state voice reproduction.

#### FEATURES

- Easy-to-use single-chip, single-message voice Record/Playback solution
- High-quality, natural voice/audio reproduction
- Push-button interface
  - Playback can be edge- or level-activated
- Variable Record/Playback duration controlled by external resistor selection
- Automatic power-down mode
  - Enters standby mode immediately following a Record or Playback cycle
  - 0.5  $\mu$ A standby current (typical)
- Zero-power message storage
  - Eliminates battery backup circuits

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Table 2-50: ISD1500 Series Summary

| Part Number | Minimum Duration <sup>1</sup> (Seconds) | Maximum Input Sample Rate (KHz) <sup>1</sup> | Typical Filter Upper Pass Band (KHz) <sup>1</sup> |
|-------------|---|--|---|
| ISD1506     | 6                                       | 6.4  | 2.6   |
| ISD1510     | 10                                      | 6.4  | 2.6   |
| ISD1520     | 20                                      | 6.4  | 2.6   |

1. Indicates with the specified resistor value of 100 K $\Omega$  at the ROSC pin to provide these specified durations.

- 100-year message retention (typical)
- 10 K record cycles (typical)
- On-chip oscillator
- No algorithm development required
- Single +5 volt power supply
- Available in wafer form, die form, and 28 pin 600 mil DIP

## DETAILED DESCRIPTION

### Speech/Sound Quality

ISD's patented ChipCorder technology provides natural Record and Playback. The input voice signals are stored directly in nonvolatile EEPROM cells and are reproduced without the synthetic effect often heard with digital solid-state speech solutions. A complete sample is stored in a single cell, minimizing the memory necessary to store a single message.

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### Duration

Sampling rate and duration are determined by an external resistor connected to the ROSC pin.

### EEPROM Storage

One of the benefits of ISD's ChipCorder technology is the use of on-chip nonvolatile memory, providing zero-power message storage. The message is retained for up to 100 years without power. In addition, the device can be re-recorded typically over 10,000 times.

### Basic Operation

The ISD1500 ChipCorder Series devices are controlled by the REC pin, and either of two Playback pins, PLAYE (edge-activated Playback), and PLAYL (level-activated Playback). The ISD1500 Series parts are configured for design simplicity in a single-message application. Device operation is explained on page 2-87.

### Automatic Power-Down Mode

At the end of a Playback or Record cycle, the ISD1500 Series devices automatically return to a low-power standby mode, consuming typically 0.5  $\mu$ A, provided that PLAYE, PLAYL, REC, XCLK and TEST pins are low (see DC parameters). During a Playback cycle, the device powers down automatically at the end of the message. During a Record cycle, the device powers down immediately after REC is released LOW.

Figure 2-21: ISD1500 Series Block Diagram

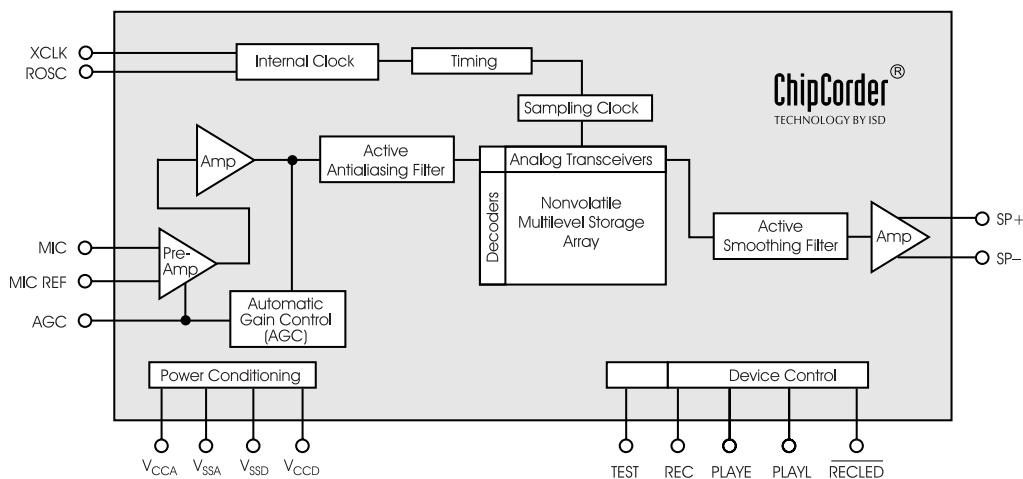
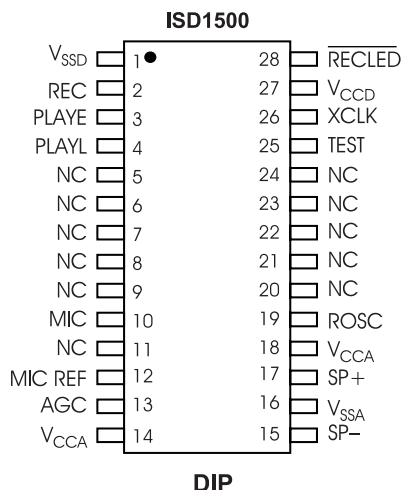


Figure 2-22: ISD1500 Series Pinouts



## PIN DESCRIPTIONS

### Voltage Supplies ( $V_{CCA}$ , $V_{CCD}$ )

Analog and digital circuits internal to the ISD1500 Series devices use separate power buses to minimize noise on the chip. These power buses are brought out to separate pins on the package and should be tied together as close to the supply as possible. It is important that the power supply be decoupled as close as possible to the package.

### Ground Supplies ( $V_{SSA}$ , $V_{SSD}$ )

Similar to  $V_{CCA}$  and  $V_{CCD}$ , the analog and digital circuits internal to the ISD1500 Series devices use separate ground buses to minimize noise. These pins should be tied together as close as possible to the device. The backside of the die is connected to  $V_{SS}$  through the substrate resistance. In a chip-on-board design the die attach area must be connected to  $V_{SS}$  or left floating.

### Record (REC)

The REC input is an active-HIGH Record signal. The device records whenever REC is HIGH. This pin must remain HIGH for the duration of the Recording. REC takes precedence over either Playback (PLAYE or PLAYL) signal. If REC is pulled HIGH during a Playback cycle, the playback immediately ceases and Recording begins.

**NOTE** The REC signal is internally debounced on the rising edge to prevent a false retriggering from a push-button switch.

A Record cycle is completed when REC is pulled LOW. An end-of-message (EOM) marker is internally recorded, enabling a subsequent Playback cycle to terminate appropriately. The device automatically powers down to standby mode when REC goes LOW. This pin has an internal pull-down device. Holding this pin HIGH will increase standby current consumption.

### Playback, Edge-Activated (PLAYE)

When a HIGH-going transition is detected on this input pin, a Playback cycle begins. Playback continues until an end-of-message marker is encountered or the end of the memory space is reached. Upon completion of the Playback cycle, the device automatically powers down into standby mode. Taking PLAYE LOW during a Playback cycle will not terminate the current cycle. This pin has an internal pull-down device. Holding this pin HIGH will increase standby current consumption.

### Playback, Level-Activated (PLAYL)

When this input pin transitions from LOW to HIGH, a Playback cycle is initiated. Playback continues until PLAYL is pulled LOW, an end-of-message marker is detected, or the end of the memory space is reached. The device automatically powers down to standby mode upon completion of the playback cycle. This pin has an internal pull-down device. Holding this pin HIGH will increase standby current consumption.

**Record LED Output ( $\overline{\text{RECLED}}$ )**

The  $\overline{\text{RECLED}}$  output is LOW during a Record cycle. It can be used to drive an LED to provide feedback that a Record cycle is in progress. In addition,  $\overline{\text{RECLED}}$  pulses LOW momentarily when an end-of-message or end-of-memory marker is encountered in a Playback cycle.

**Microphone Input (MIC)**

The microphone input transfers its signal to the on-chip preamplifier. An on-chip Automatic Gain Control (AGC) circuit controls the gain of the preamplifier. An external microphone should be AC coupled to this pin via a series capacitor. The capacitor value, together with the internal 10 K ohm resistance on this pin, determine the low-frequency cutoff for the ISD1500 Series passband.

**Microphone Reference (MIC REF)**

The MIC REF input is the inverting input to the microphone preamplifier. This provides input noise-cancellation, or common-mode rejection, when the microphone is connected differentially to the device.

**Automatic Gain Control (AGC)**

The AGC dynamically adjusts the gain of the preamplifier to compensate for the wide range of microphone input levels. The AGC allows the full range of sound, from whispers to loud sounds, to be recorded with minimal distortion. The "attack" time is determined by the time constant of a 5 K $\Omega$  internal resistance and an external capacitor (C6 on the schematic on page 2-87) connected from the AGC pin to  $V_{SSA}$  analog ground. The "release" time is determined by the time constant of an external resistor (R5) and an external capacitor (C6) connected in parallel between the AGC pin and  $V_{SSA}$  analog ground. Nominal values of 470 K $\Omega$  and 4.7  $\mu\text{F}$  give satisfactory results in most cases.

**External Clock (XCLK)**

The external clock input for the ISD1500 Series devices has an internal pull-down resistor. This pin is used for test purposes only. For die, do not bond this pad. For packages, this pin should be connected to ground.

**Test (TEST)**

The test input for the ISD1500 series devices has an internal pull-down resistor. This pin is used for test purposes only. For die, do not bond this pad. For packages, this pin should be connected to ground.

**Resistor Controlled Oscillator (ROSC)**

The resistor controlled oscillator input enables the user to vary the ISD1500 Series device Record and Playback duration. The resistor connected between the ROSC pin and  $V_{SS}$  (R2) determines the sample frequency and the filter upper pass band for the ISD1500 Series device. ISD recommends an ROSC resistor value of 100 K $\Omega$ .

**Speaker Outputs (SP+, SP-)**

The SP+ and SP- pins provide direct drive for loudspeakers with impedances as low as 16 ohms. A single output may be used, but, for direct-drive loudspeakers, the two opposite-polarity outputs provide an improvement in output power of up to four times over a single-ended connection. Furthermore, when SP+ and SP- are used, a speaker coupling capacitor is not required. A single-ended connection will require an AC-coupling capacitor between the SP pin and the speaker.

The SP+ pin and the SP- pin are internally connected through a 50 K $\Omega$  resistance. When not in Playback mode, they are floating.

**Table 2-51: Absolute Maximum Ratings**  
(Packaged Parts)<sup>1</sup>

| Condition                                 | Value  |
|---|--|
| Junction temperature                      | 150°C  |
| Storage temperature range                 | –65°C to +150°C  |
| Voltage applied to any pin                | (V <sub>SS</sub> – 0.3 V) to (V <sub>CC</sub> + 0.3 V) |
| Lead temperature (soldering – 10 seconds) | 300°C  |
| V <sub>CC</sub> – V <sub>SS</sub>         | –0.3 V to +7.0 V                                       |

1. Stresses above those listed may cause permanent damage to the device. Exposure to the absolute maximum ratings may affect device reliability. Functional operation is not implied at these conditions.

**Table 2-52: Operating Conditions**  
(Packaged Parts)

| Condition                                      | Value            |
|--|------------------|
| Operating temperature range <sup>1</sup>       | 0°C to +70°C     |
| Supply voltage (V <sub>CC</sub> ) <sup>2</sup> | +4.5 V to +5.5 V |
| Ground voltage (V <sub>SS</sub> ) <sup>3</sup> | 0 V              |

1. Case temperature.

2. V<sub>CC</sub> = V<sub>CCA</sub> = V<sub>CCD</sub>.

3. V<sub>SS</sub> = V<sub>SSA</sub> = V<sub>SSD</sub>.

**Table 2-53: DC Parameters (Packaged Parts)**

| Symbol             | Parameters                          | Min <sup>2</sup> | Typ <sup>1</sup> | Max <sup>2</sup> | Units | Conditions  |
|--------------------|-------------------------------------|------------------|------------------|------------------|-------|---|
| V <sub>IL</sub>    | Input Low Voltage                   |                  |                  | 0.8              | V     |   |
| V <sub>IH</sub>    | Input High Voltage                  | 2.0              |                  |                  | V     |   |
| V <sub>OL</sub>    | Output Low Voltage                  |                  |                  | 0.4              | V     | I <sub>OL</sub> = 4.0 mA <sup>3</sup>                     |
| V <sub>OH</sub>    | Output High Voltage                 | 2.4              |                  |                  | V     | I <sub>OH</sub> = –1.6 mA <sup>3</sup>                    |
| I <sub>CC</sub>    | V <sub>CC</sub> Current (Operating) |                  |                  | 30               | mA    | V <sub>CC</sub> = 5.5 V <sup>4</sup> , R <sub>EXT</sub> ∞ |
| I <sub>SB</sub>    | V <sub>CC</sub> Current (Standby)   |                  | 0.5              | 10               | μA    | 4, 5  |
| I <sub>ILPD1</sub> | Input Leakage Current               |                  |                  | ±1               | μA    | Force V <sub>SS</sub> <sup>6</sup>                        |
| I <sub>ILPD2</sub> | Input Current HIGH                  |                  | 200              | 400              | μA    | Force V <sub>CC</sub> <sup>7</sup>                        |
| I <sub>ILPD3</sub> | Input Current HIGH                  |                  |                  | 130              | μA    | Force V <sub>CC</sub> <sup>8</sup>                        |
| R <sub>EXT</sub>   | Output Load Impedance               | 16               |                  |                  | Ω     | Speaker Load, SP+ to SP–                                  |

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**Table 2-53: DC Parameters (Packaged Parts)**

| Symbol                                 | Parameters              | Min <sup>2</sup> | Typ <sup>1</sup> | Max <sup>2</sup> | Units      | Conditions  |
|--|-------------------------|------------------|------------------|------------------|------------|-------------|
| R <sub>MIC</sub> , R <sub>MICREF</sub> | Preamp Input Resistance |                  | 10               |                  | K $\Omega$ |             |
| A <sub>MSP</sub>                       | MIC SP+/- Gain          |                  | 46               |                  | dB         | AGC = 0.0 V |
| R <sub>AGC</sub>                       | AGC Output Resistance   |                  | 5                |                  | K $\Omega$ |             |

1. Typical values @  $T_A = 25^\circ\text{C}$  and 5.0 V.
2. All Min/Max limits are guaranteed by ISD via electrical testing or characterization. Not all specifications are 100% tested.
3. Record LED output, RECLEd.
4.  $V_{CCA}$  and  $V_{CCD}$  connected together.
5. REC, PLAYL, PLAYE, XCLK, and TEST must be at  $V_{SSD}$ .
6. REC, PLAYL, and PLAYE.
7. REC.
8. PLAYL and PLAYE.

**Table 2-54: AC Parameters (Packaged Parts)<sup>1</sup>**

| Symbol            | Characteristic                                  | Min <sup>3</sup> | Typ <sup>2</sup> | Max <sup>3</sup> | Units | Conditions                          |
|-------------------|---|------------------|------------------|------------------|-------|-------------------------------------|
| F <sub>S</sub>    | Sampling Frequency ISD15XX                      |                  |                  | 6.4              | KHz   | 4                                   |
| F <sub>CF</sub>   | Filter Pass Band ISD15XX                        |                  | 2.6              |                  | KHz   | 3 dB Roll-Off Point <sup>5, 6</sup> |
| T <sub>REC</sub>  | Record Duration ISD1506<br>ISD1510<br>ISD1520   | 6<br>10<br>20    |                  |                  | sec   | 7<br>7<br>7                         |
| T <sub>PLAY</sub> | Playback Duration ISD1506<br>ISD1510<br>ISD1520 | 6<br>10<br>20    |                  |                  | sec   | 4, 7<br>4, 7<br>4, 7                |
| T <sub>EOM</sub>  | EOM Pulse Width ISD15XX                         |                  | 84               |                  | msec  |                                     |
| T <sub>DB</sub>   | Debounce Time                                   |                  | 84               |                  | msec  |                                     |
| THD               | Total Harmonic Distortion                       |                  | 1                |                  | %     | @ 1 KHz                             |
| P <sub>OUT</sub>  | Speaker Output Power                            |                  | 12.2             |                  | mW    | R <sub>EXT</sub> = 16 $\Omega$      |
| V <sub>OUT</sub>  | Voltage Across Speaker Pins                     |                  | 1.25             | 2.5              | V p-p | R <sub>EXT</sub> = 600 $\Omega$     |
| V <sub>IN</sub>   | MIC Input Voltage                               |                  | 3                | 300              | mV    | Peak-to-Peak                        |

1. These specifications apply with ROSC equalling 100 K $\Omega$ . Only these specifications are guaranteed and tested.
2. Typical values @  $T_A = 25^\circ\text{C}$  and 5.0 V.
3. All Min/Max limits are guaranteed by ISD via electrical testing or characterization. Not all specifications are 100% tested.
4. Oscillator stability may vary as much as  $\pm 5\%$  over the operating temperature and voltage ranges.
5. Low-frequency cutoff depends upon value of external capacitors (see Pin Descriptions).
6. Filter specification applies to the antialiasing filter and the smoothing filter.
7. These specifications apply to usage of a 100K  $\Omega$  ideal resistor.

**Table 2-55: Absolute Maximum Ratings (Die)<sup>1</sup>**

| Condition                         | Value  |
|-----------------------------------|--|
| Junction temperature              | 150°C  |
| Storage temperature range         | –65°C to +150°C  |
| Voltage applied to any pad        | (V <sub>SS</sub> – 0.3 V) to (V <sub>CC</sub> + 0.3 V) |
| V <sub>CC</sub> – V <sub>SS</sub> | –0.3 V to +7.0 V                                       |

1. Stresses above those listed may cause permanent damage to the device. Exposure to the absolute maximum ratings may affect device reliability. Functional operation is not implied at these conditions.

**Table 2-56: Operating Conditions (Die)**

| Condition                                      | Value            |
|--|------------------|
| Operating temperature range                    | 0°C to +50°C     |
| Supply voltage (V <sub>CC</sub> ) <sup>1</sup> | +4.5 V to +6.5 V |
| Ground voltage (V <sub>SS</sub> ) <sup>2</sup> | 0V               |

1. V<sub>CC</sub> = V<sub>CCA</sub> = V<sub>CCD</sub>.

2. V<sub>SS</sub> = V<sub>SSA</sub> = V<sub>SSD</sub>.

**Table 2-57: DC Parameters (Die)**

| Symbol                                 | Parameters                          | Min <sup>2</sup> | Typ <sup>1</sup> | Max <sup>2</sup> | Units | Conditions  |
|--|-------------------------------------|------------------|------------------|------------------|-------|---|
| V <sub>IL</sub>                        | Input Low Voltage                   |                  |                  | 0.8              | V     |   |
| V <sub>IH</sub>                        | Input High Voltage                  | 2.0              |                  |                  | V     |   |
| V <sub>OL</sub>                        | Output Low Voltage                  |                  |                  | 0.4              | V     | I <sub>OL</sub> = 4.0 mA <sup>3</sup>                     |
| V <sub>OH</sub>                        | Output High Voltage                 | 2.4              |                  |                  | V     | I <sub>OH</sub> = –1.6 mA <sup>3</sup>                    |
| I <sub>CC</sub>                        | V <sub>CC</sub> Current (Operating) |                  |                  | 30               | mA    | V <sub>CC</sub> = 5.5 V <sup>4</sup> , R <sub>EXT</sub> ∞ |
| I <sub>SB</sub>                        | V <sub>CC</sub> Current (Standby)   |                  | 0.5              | 10               | μA    | 4, 5  |
| I <sub>ILPD1</sub>                     | Input Leakage Current               |                  |                  | ±1               | μA    | Force V <sub>SS</sub> <sup>6</sup>                        |
| I <sub>ILPD2</sub>                     | Input Current HIGH                  |                  | 200              | 400              | μA    | Force V <sub>CC</sub> <sup>7</sup>                        |
| I <sub>ILPD3</sub>                     | Input Current HIGH                  |                  |                  | 130              | μA    | Force V <sub>CC</sub> <sup>8</sup>                        |
| R <sub>EXT</sub>                       | Output Load Impedance               | 16               |                  |                  | Ω     | Speaker Load, SP+ to SP–                                  |
| R <sub>MIC</sub> , R <sub>MICREF</sub> | Preamplifier Input Resistance       |                  | 10               |                  | KΩ    |   |
| A <sub>MSP</sub>                       | MIC SP+/- Gain                      |                  | 46               |                  | dB    | AGC = 0.0 V   |
| R <sub>AGC</sub>                       | AGC Output Resistance               |                  | 5                |                  | KΩ    |   |

1. Typical values @ T<sub>A</sub> = 25°C and 5.0 V.

2. All Min/Max limits are guaranteed by ISD via electrical testing or characterization. Not all specifications are 100% tested.

3. Record LED output, RECLED.

4. V<sub>CCA</sub> and V<sub>CCD</sub> connected together.

5. REC, PLAYL, PLAYE, XCLK, and TEST must be at V<sub>SSD</sub>.

6. REC, PLAYL, and PLAYE.

7. REC.

8. PLAYL and PLAYE.

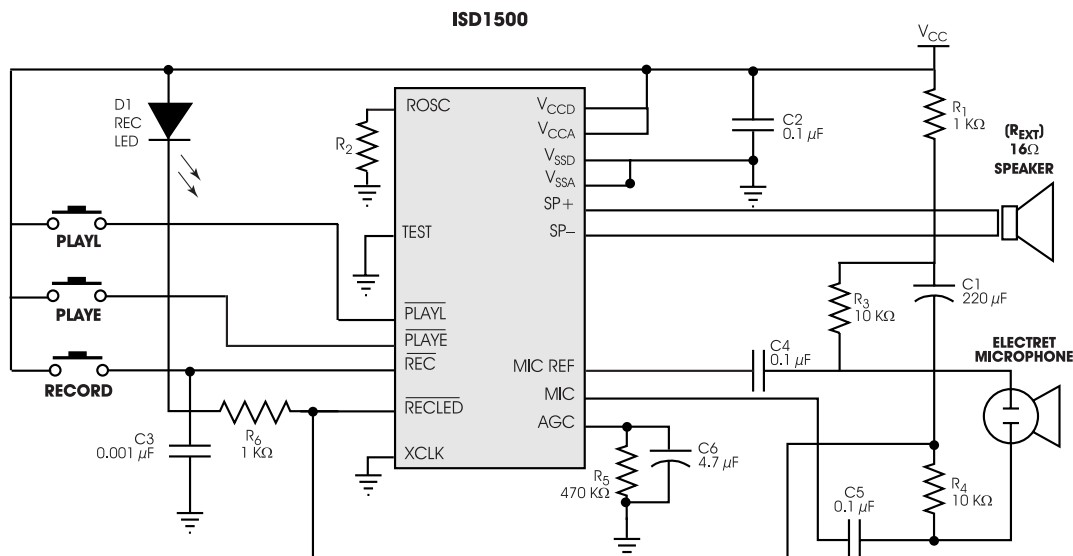
Table 2-58: AC Parameters (Die)<sup>1</sup>

| Symbol            | Characteristic                                  | Min <sup>3</sup> | Typ <sup>2</sup> | Max <sup>3</sup> | Units | Conditions  |
|-------------------|---|------------------|------------------|------------------|-------|---|
| F <sub>S</sub>    | Sampling Frequency ISD15XX                      |                  |                  | 6.4              | KHz   | <sup>4</sup>  |
| F <sub>CF</sub>   | Filter Pass Band ISD15XX                        |                  | 2.6              |                  | KHz   | 3 dB Roll-Off Point <sup>5, 6</sup>                   |
| T <sub>REC</sub>  | Record Duration ISD1506<br>ISD1510<br>ISD1520   | 6<br>10<br>20    |                  | TBD              | sec   | <sup>7</sup><br><sup>7</sup><br><sup>7</sup>          |
| T <sub>PLAY</sub> | Playback Duration ISD1506<br>ISD1510<br>ISD1520 | 6<br>10<br>20    |                  | TBD              | sec   | <sup>4, 7</sup><br><sup>4, 7</sup><br><sup>4, 7</sup> |
| T <sub>EOM</sub>  | EOM Pulse Width ISD15XX                         |                  | 84               |                  | msec  |   |
| T <sub>DB</sub>   | Debounce Time                                   |                  | 84               |                  | msec  |   |
| THD               | Total Harmonic Distortion                       |                  | 1                |                  | %     | @ 1 KHz   |
| P <sub>OUT</sub>  | Speaker Output Power                            |                  | 12.2             |                  | mW    | R <sub>EXT</sub> = 16 Ω                               |
| V <sub>OUT</sub>  | Voltage Across Speaker Pins                     |                  | 1.25             | 2.5              | V p-p | R <sub>EXT</sub> = 600 Ω                              |
| V <sub>IN</sub>   | MIC Input Voltage                               |                  | 3                | 300              | mV    | Peak-to-Peak  |

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1. These specifications apply with ROSC equalling 100 kΩ. Only these specifications are guaranteed and tested.
2. Typical values @ T<sub>A</sub> = 25°C and 5.0 V.
3. All Min/Max limits are guaranteed by ISD via electrical testing or characterization. Not all specifications are 100% tested.
4. Oscillator stability may vary as much as ±5% over the operating temperature and voltage ranges. For greater accuracy, an external clock can be utilized (see Pin Descriptions).
5. Low-frequency cutoff depends upon value of external capacitors (see Pin Descriptions).
6. Filter specification applies to the antialiasing filter and to the smoothing filter.
7. These specifications apply to usage of a 100 kΩ ideal resistor.

### Figure 2-23: Application Example



## 2

## FUNCTIONAL DESCRIPTION EXAMPLE

The following example operating sequence demonstrates the functionality of the ISD1500 Series devices.

1. Record a message filling the memory.

Pulling the REC pin HIGH initiates a Record cycle from the beginning of the message space. The device will automatically power down after REC is released LOW. An EOM marker is written at the end of message or end of memory. If REC is held HIGH, the recording continues until the message space has been filled. Once the message space is filled, recording ceases.

- ## 2. Edge-activated playback.

Pulling the PLAYE pin HIGH initiates a Playback cycle from the beginning of the message space. The falling edge of PLAYE has no effect on operation. When the device reaches the EOM marker, it automatically powers down. If a Recording has filled the message space, the entire

- ### 3. Level-activated playback.

Pulling the PLAYL pin HIGH initiates a Playback cycle from the beginning of the message space. When the device reaches the EOM marker, it automatically powers down. If Recording has filled the message space, the entire message is played. A subsequent rising edge on PLAYL initiates a new play cycle from the beginning of the memory.

4. Level-activated playback (truncated).

If PLAYL is pulled LOW any time during the Playback cycle, the device stops playing and enters the power-down mode. A subsequent rising edge on PLAYL initiates a new play cycle from the beginning of memory.

5. Record (interrupting playback).

The REC pin takes precedence over other operations. Any HIGH-going transition on REC initiates a new Record operation from the beginning of the memory, regardless of any current operation in progress.

6. Record a message, partially filling the memory.

A Record operation need not fill the entire memory. Releasing the REC pin LOW before filling the message space causes the recording to stop and an EOM marker to be placed. The device powers down automatically.

7. Play back a message that partially fills the memory.

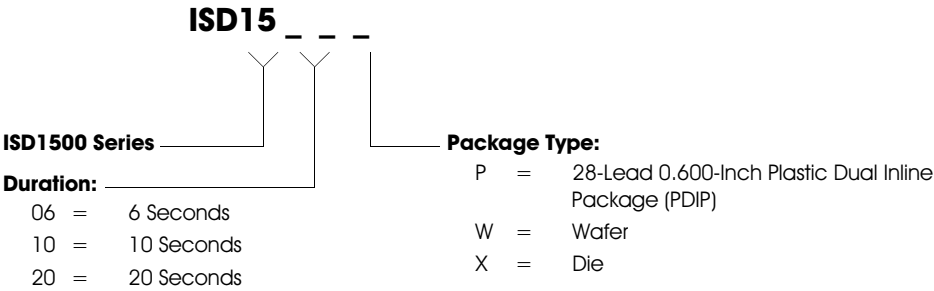
Pulling the PLAYE or PLAYL pin HIGH initiates a Playback cycle. The Playback cycle ceases when the EOM marker is encountered and the device then powers down.

8.  $\overline{\text{RECLED}}$  operation.

The  $\overline{\text{RECLED}}$  output pin provides an active-LOW signal which can be used to drive an LED as a "Record-in-progress" indicator. It returns to a HIGH state when the REC pin is released LOW or when the recording is completed due to the memory being filled. This pin also pulses LOW to indicate the end of a message has been played.

ORDERING INFORMATION

Product Number Descriptor Key



When ordering ISD1500 Series devices, please refer to the following part numbers which are planned to be supported in volume for this product series. Consult the local ISD Sales Representative or Distributor for availability information.

| Part Number | Part Number | Part Number |
|-------------|-------------|-------------|
| ISD1506P    | ISD1510P    | ISD1520P    |
| ISD1506W    | ISD1510W    | ISD1520W    |
| ISD1506X    | ISD1510X    | ISD1520X    |

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For the latest product information, access ISD’s worldwide website at <http://www.isd.com>.

