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Single-Chip, Single-Message Voice Record/Playback Device  
8- to 16-Second Durations

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# ISD1510

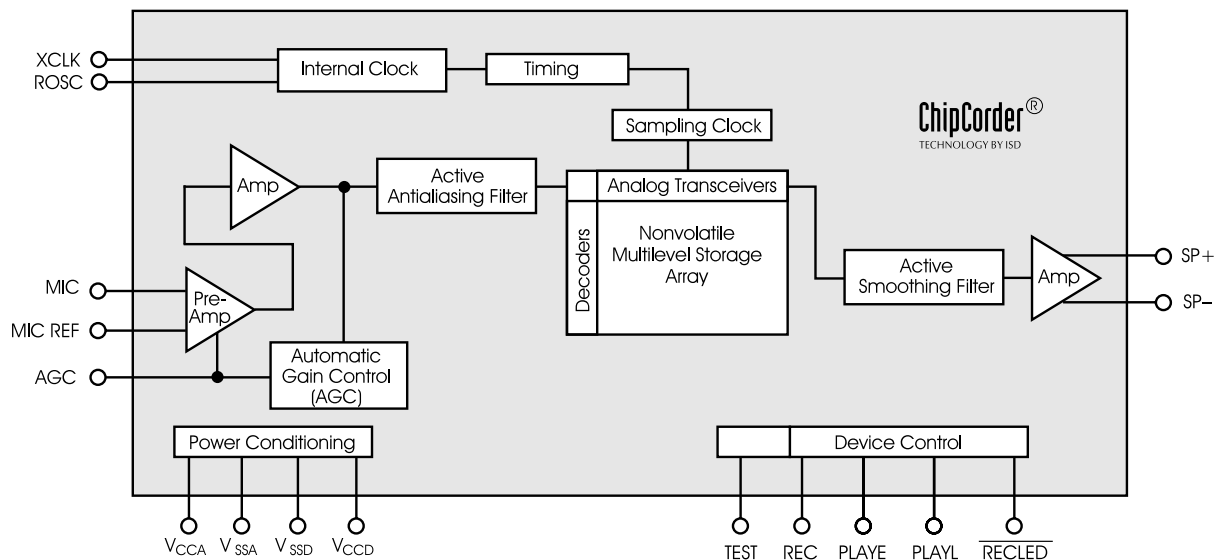
## Single-Chip, Single-Message Voice Record/Playback Device 8- to 16-Second Durations

### GENERAL DESCRIPTION

Information Storage Devices' ISD1510 ChipCorder® provides high-quality, single-chip, single-message, record/playback solution with user-selectable durations of 8 to 16 seconds. The CMOS devices include an on-chip oscillator (with external control), microphone preamplifier, automatic gain control, anti-aliasing 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.

Figure i: ISD1510 Block Diagram



**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 which sets sample rate.
  - 8 KHz sample rate = 8 seconds
  - 6.4 KHz sample rate = 10 seconds
  - 5.3 KHz sample rate = 12 seconds
  - 4.0 KHz sample rate = 16 seconds
- Automatic power-down mode
  - Enters standby mode immediately following a record or playback cycle
  - 0.5  $\mu$ A standby current (typical)
- On-chip 8  $\Omega$  speaker driver
- Zero-power message storage
  - Eliminates battery backup circuits
- 100-year message retention (typical)
- 10,000 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 (for sampling only)

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**Table i: ISD1510 Product Summary**

<b>Part Number</b>	<b>Minimum Duration<sup>1</sup> (Seconds)</b>	<b>Maximum Input Sample Rate (KHz)<sup>1</sup></b>	<b>Typical Filter Upper Pass Band (KHz)<sup>1</sup></b>
ISD1510	10	6.4	2.6

**1.** A resistor value of 100 K $\Omega$  at the ROSC pin provides this specified duration. Only this duration is guaranteed and tested.

## 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.

### DURATION

The ISD1510 devices offer single-chip solutions with 8 to 16 seconds of record/playback duration capacity. Sampling rate and duration are determined by an external resistor connected to the ROSC pin. These specifications apply with the required resistor value for 10-second minimum playback duration.

**NOTE** Only the 10 second duration is guaranteed and tested.

### 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.

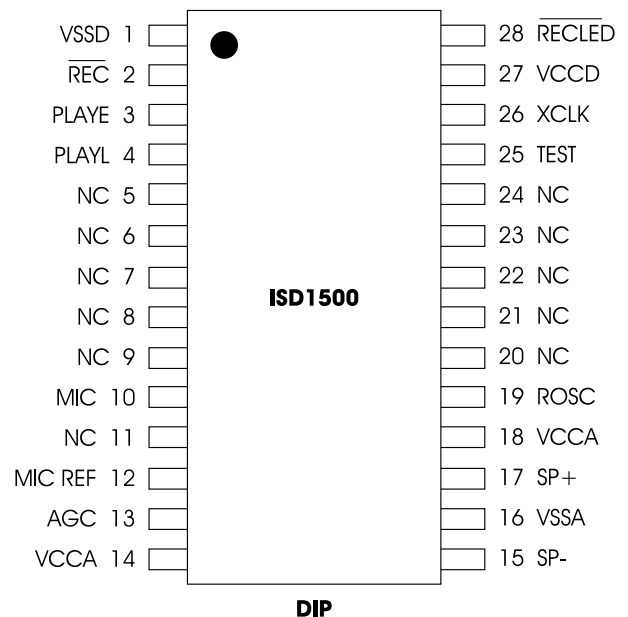
### BASIC OPERATION

The ISD1510 ChipCorder device is controlled by the REC pin, and either of two playback pins, PLAYE (edge-activated playback), and PLAYL (level-activated playback). The ISD1510 parts are configured for design simplicity in a single-message application. Device operation is explained on "Functional Description Example" on page 6.

### AUTOMATIC POWER-DOWN MODE

At the end of a playback or record cycle, the ISD1510 device automatically returns to a low-power standby mode, consuming typically  $0.5\ \mu\text{A}$ , 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 1: ISD1510 Pinouts—For Sampling Only**



**NOTE:** NC means must Not Connect.

## **PIN DESCRIPTIONS**

### **VOLTAGE SUPPLIES ( $V_{CCA}$ , $V_{CCD}$ )**

Analog and digital circuits internal to the ISD1510 device 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 ISD1510 device use separate ground buses to minimize noise. These pins should be tied together as close as possible to the device.

### **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.

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

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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 (EOM) 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 $\Omega$  resistance on this pin, determine the low-frequency cutoff for the ISD1510 passband. Internal AC coupling connects the preamplifier to the amplifier.

**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 6) connected from the AGC pin to V<sub>SSA</sub> 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<sub>SSA</sub> analog ground. Nominal values of 470 K $\Omega$  and 4.7  $\mu$ F give satisfactory results in most cases.

**SPEAKER OUTPUTS (SP+, SP-)**

The SP+ and SP- pins provide direct drive for loudspeakers with impedances as low as 8  $\Omega$ . 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.

**EXTERNAL CLOCK (XCLK)**

The external clock input for the ISD1510 devices has an internal pull-down resistor. This pin is used for test purposes only. Do not bond this pad.

**TEST (TEST)**

The test input for the ISD1510 devices has an internal pull-down resistor. This pin is used for test purposes only. Do not bond this pad.

**RESISTOR CONTROLLED OSCILLATOR (ROSC)**

The resistor controlled oscillator input enables the user to vary the ISD1510 device record and playback duration. The resistor connected between the ROSC pin and V<sub>SS</sub> (R2) determines the sample frequency and the filter upper pass band for the ISD1510 device. ISD recommends an ROSC resistor value of 100 K $\Omega$ .

**SPECIFICATIONS**

**Table 1: Absolute Maximum Ratings<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: Operating Conditions**

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>	0 V

- 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 3: DC Parameters**

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	<sup>(4)</sup> <sup>(5)</sup>
I <sub>I LPD1</sub>	Input Leakage Current			±1	μA	Force V <sub>SS</sub> <sup>(6)</sup>
I <sub>I LPD2</sub>	Input Current HIGH		200	400	μA	Force V <sub>CC</sub> <sup>(7)</sup>
I <sub>I LPD3</sub>	Input Current HIGH			130	μA	Force V <sub>CC</sub> <sup>(8)</sup>
R <sub>EXT</sub>	Output Load Impedance	8			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		42		dB	AGC = 0.0 V
R <sub>AGC</sub>	AGC Output Resistance		5		KΩ	

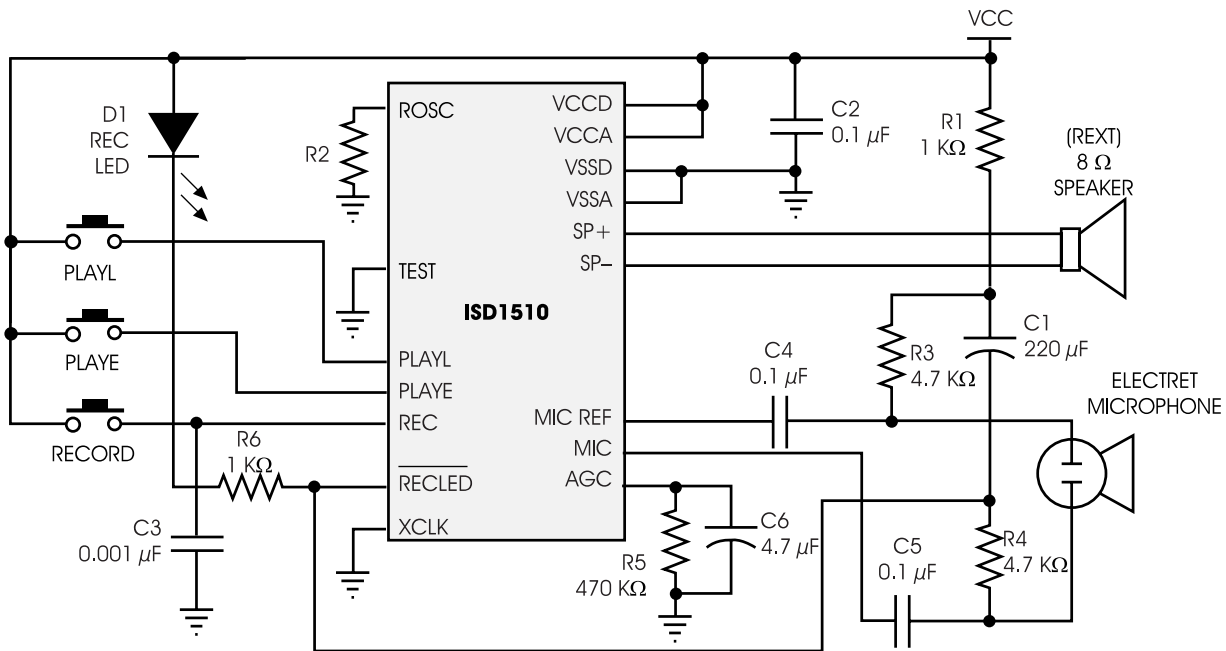
- 1. Typical values @ T<sub>A</sub> = 25°C and 5.0 V.
- 2. All Min/Max limits are guaranteed by ISD via electrical testing or characterization. Not all specifications are 100 percent tested.
- 3. Record LED output, RECLE<sub>D</sub>.
- 4. V<sub>CCA</sub> and V<sub>CCD</sub> connected together.
- 5. REC, PLAYL, PLAYE, XCLK, and TEST must be at V<sub>SSD</sub>.
- 6. REC, PLAYL, and PLAYE.
- 7. REC.
- 8. PLAYL and PLAYE.

Table 4: AC Parameters<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			6.4	KHz	(4)
F <sub>CF</sub>	Filter Pass Band		2.6		KHz	3 dB Roll-Off Point <sup>(5)(6)</sup>
T <sub>REC</sub>	Record Duration	10		11	sec	(4)
T <sub>PLAY</sub>	Playback Duration	10		11	sec	(4)
T <sub>EOM</sub>	EOM Pulse Width		84		msec	
T <sub>DB</sub>	Debounce Time		84		msec	
THD	Total Harmonic Distortion		1		%	@ 1 KHz, V <sub>IN</sub> = 15 mV Peak to Peak
P <sub>OUT</sub>	Speaker Output Power		24.4		mW	R <sub>EXT</sub> = 8 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		15	300	mV	Peak-to-Peak <sup>(7)</sup>

1. These specifications apply with R<sub>OSC</sub> equaling 100 KΩ.
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 percent tested.
4. Oscillator stability may vary as much as ±5 percent 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 to the smoothing filter.
7. Balanced input signal applied between MIC and MIC REF as shown in the application example. Single-ended MIC or MIC REF recommended to be less than 100 mV peak to peak.

Figure 2: ISD1510 Application Example—Design Schematic



## FUNCTIONAL DESCRIPTION EXAMPLE

The following example operating sequence demonstrates the functionality of the ISD1510 devices.

- 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. If REC is held HIGH, the recording continues until the message space has been filled. Once the message space is filled, recording ceases.

- 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

message is played. A subsequent rising edge on PLAYL initiates a new play cycle from the beginning of the memory.

- 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.

- 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.

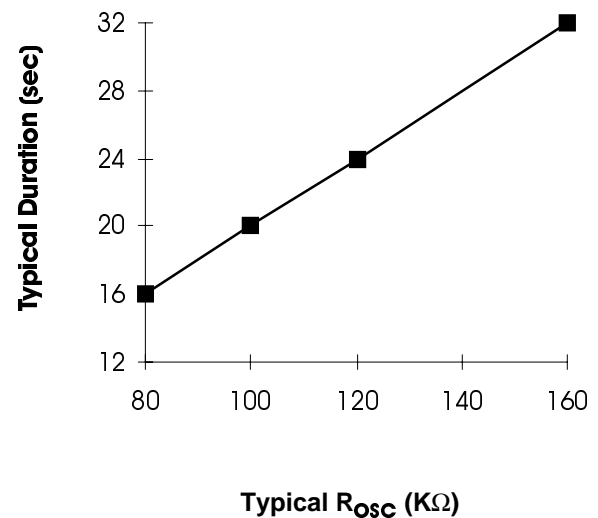
**9. ROSC Operation**

The duration of the device can be varied by changing the value of R2 ( $R_{\text{OSC}}$ ). This means the ISD1510 device can actually be between 8 to 16 seconds duration. See the curve below which charts typical durations when the  $R_{\text{OSC}}$  is varied from 80 K $\Omega$  to 160 K $\Omega$ .

This feature allows frequency shifting where a recorded voice or sound can be played back faster or slower than normal for special effects. For example, use a 100 K $\Omega$  resistor to make the recording and then playback with either an 80 K $\Omega$  resistor for faster "chipmunk" talk or with a 120 K $\Omega$  resistor for a slower, lower voice.

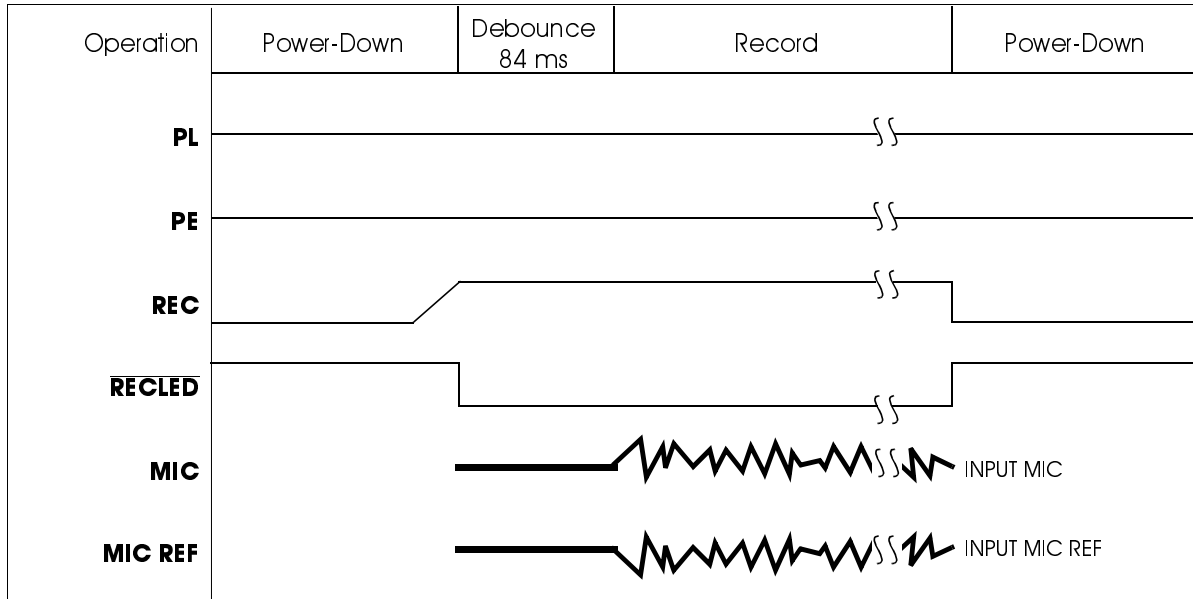
Another feature is a "Pause" or interrupt function that can be done by taking the ROSC resistor to  $V_{\text{CC}}$  to stop playback momentarily, resuming when the resistor is connected back to ground.

**Chart 1: ISD1510 Duration versus  $R_{\text{OSC}}$  at  $T_{\text{A}} = 25^{\circ}\text{C}$  and 5.0 V**



**TIMING DIAGRAMS**

**Figure 3: Record Message Until Record Goes LOW**



**Figure 4: Record Message Until Array is Full**

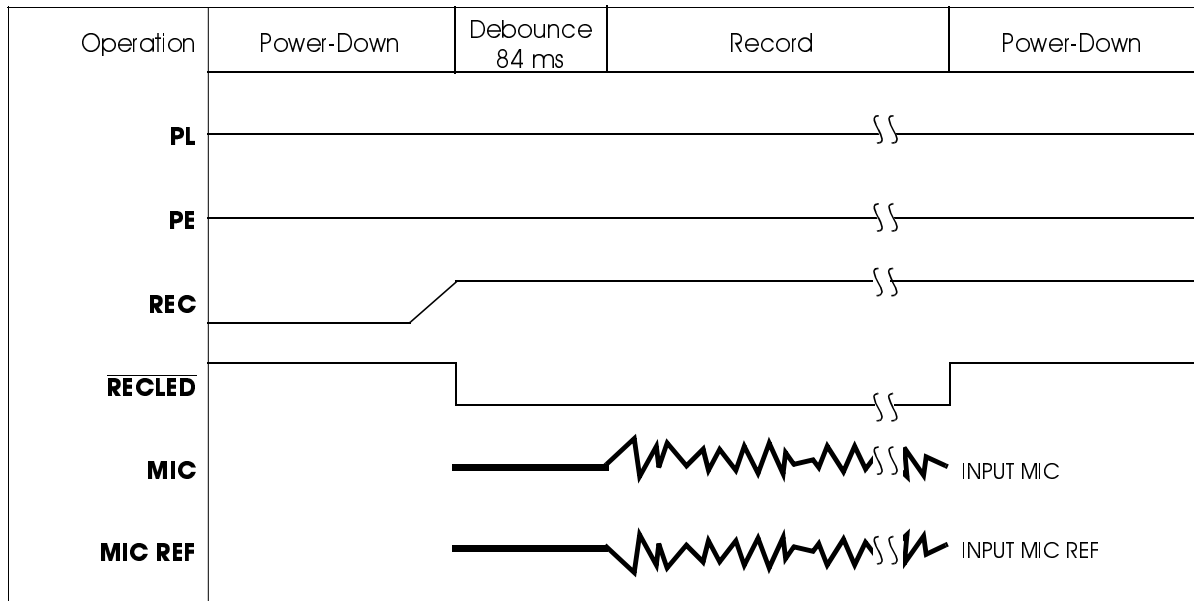


Figure 5: Play Edge (PE) Play Until End of Message

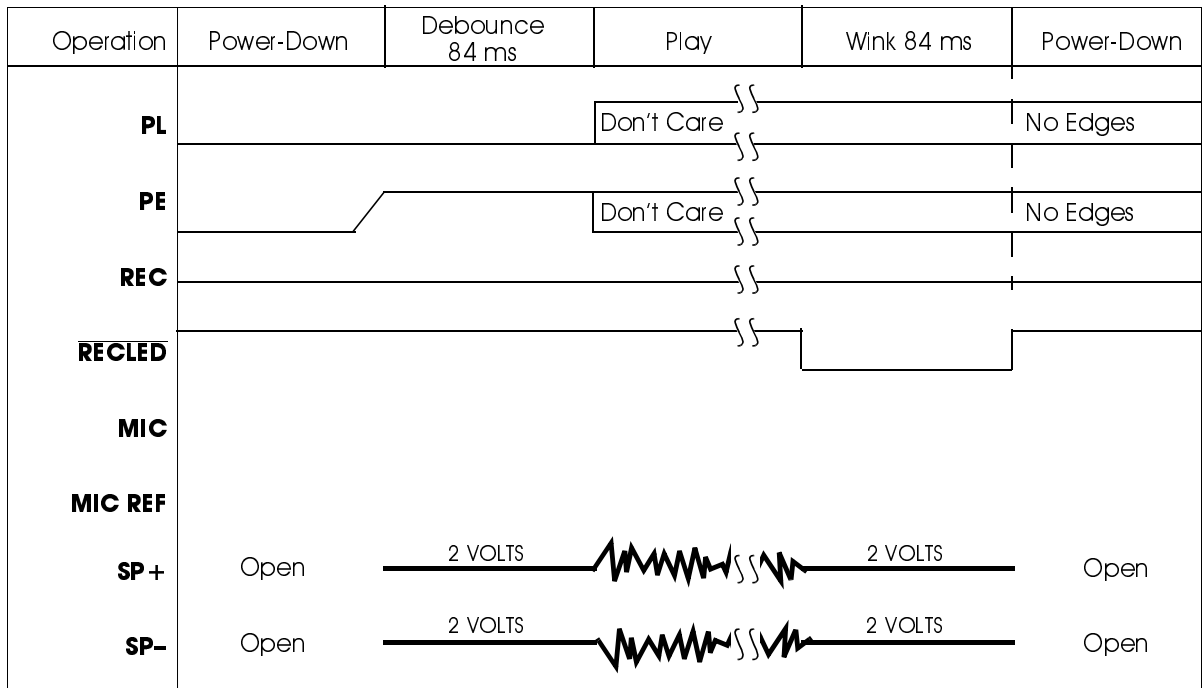


Figure 6: Play Level (PL) Play Until End of Message

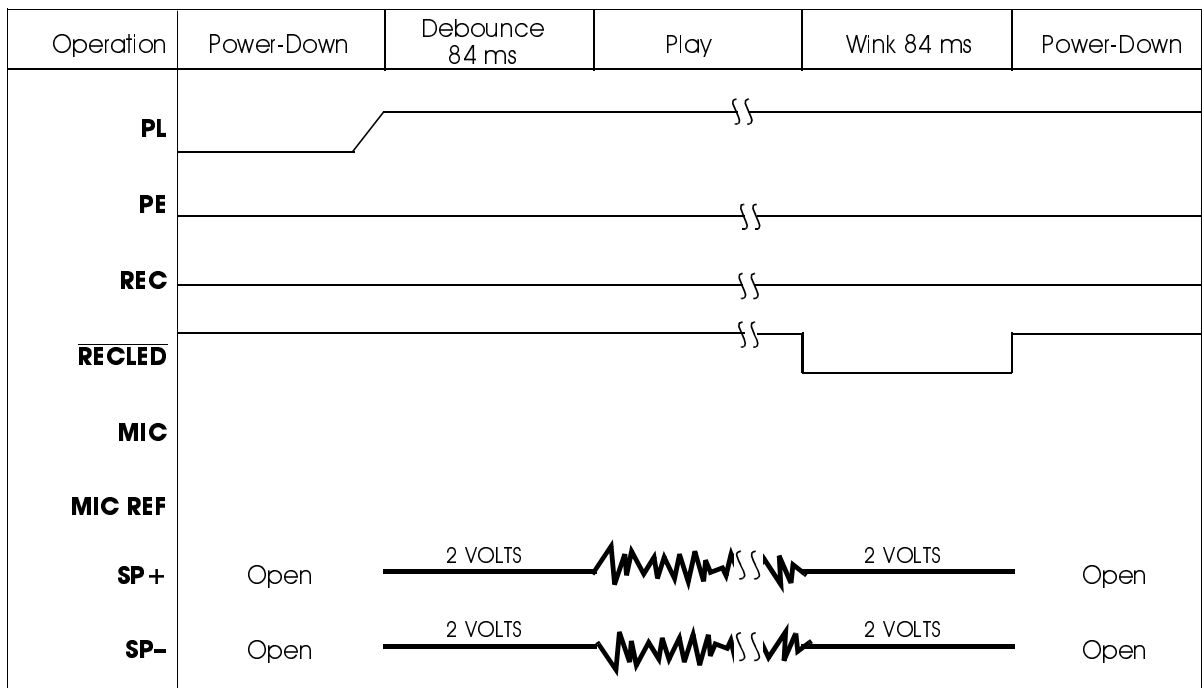


Figure 7: Play Until Play Level (PL) Falls

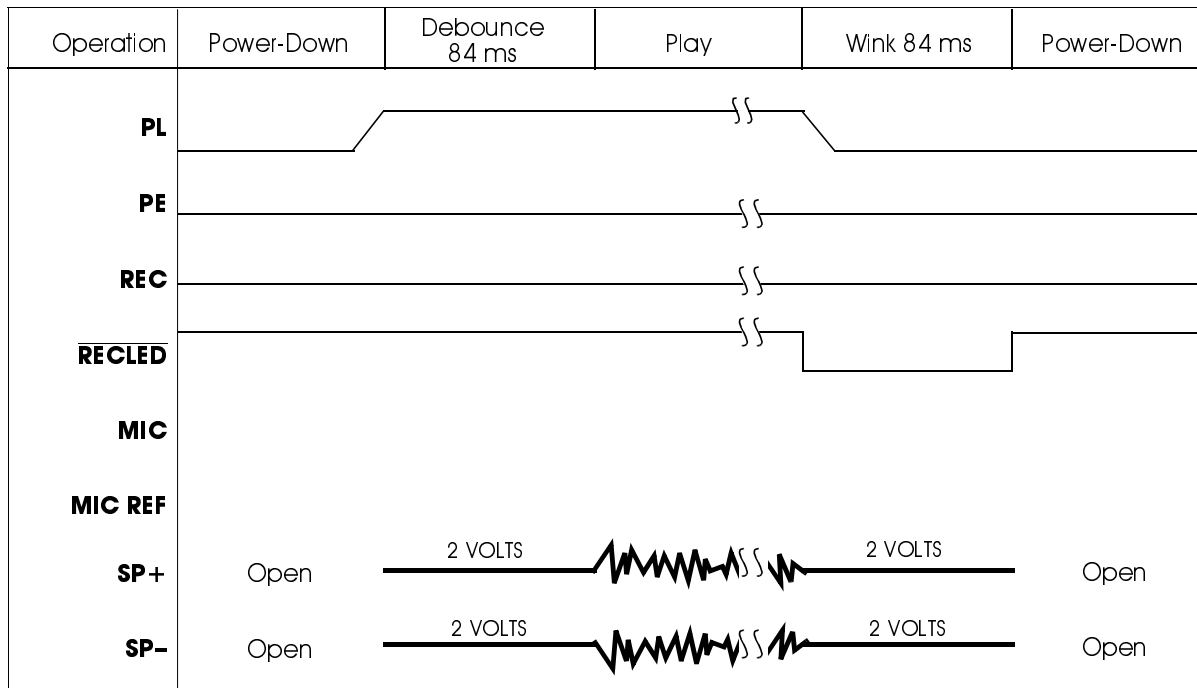
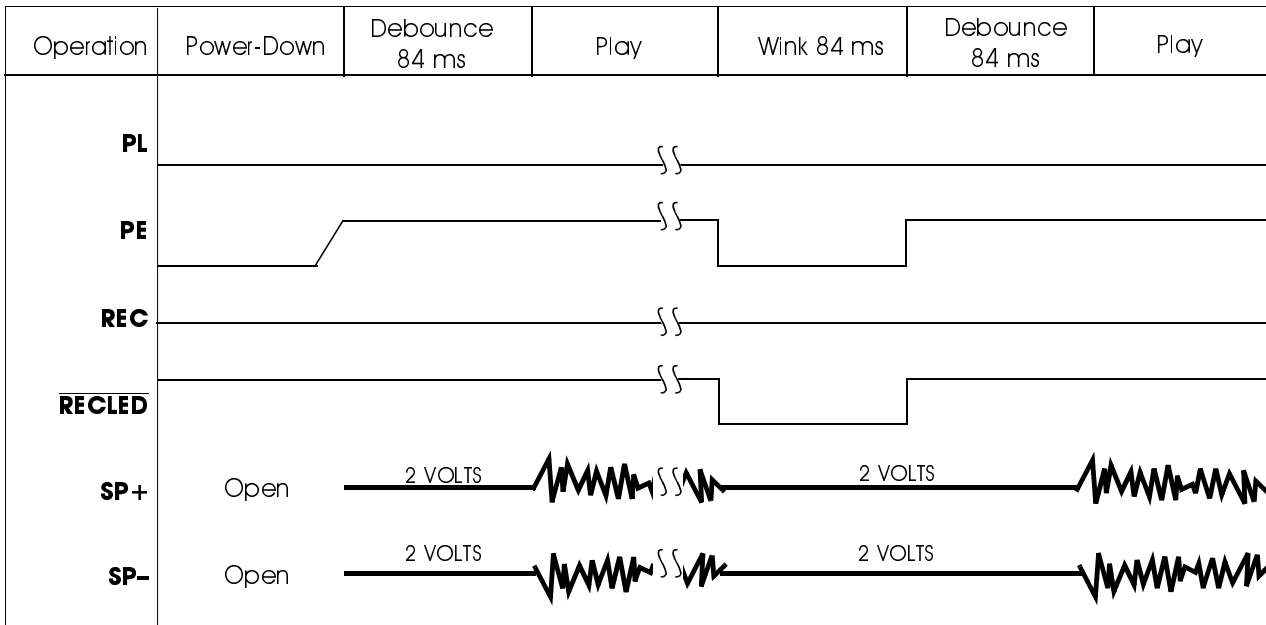


Figure 8: Looping Play, PE to **RECLED**



## DEVICE PHYSICAL DIMENSIONS

Figure 9: ISD1510 Bonding Physical Layout (Unpackaged Die)

### ISD1510

#### I. Die Dimensions

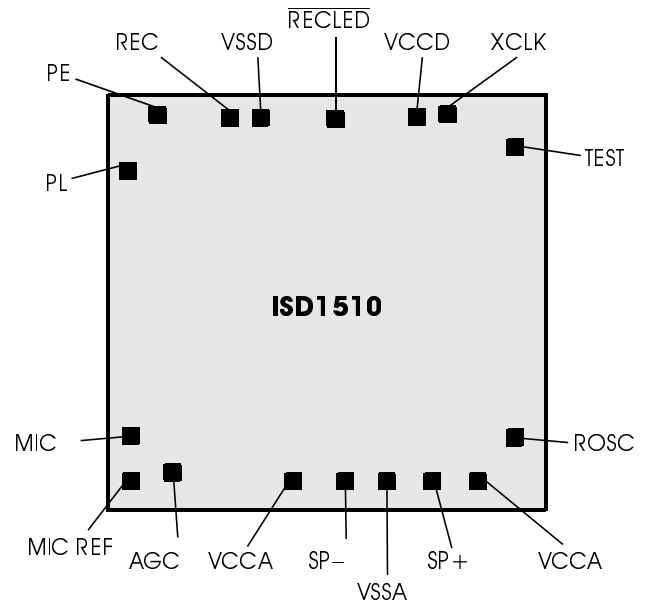
X:	2710	±25.4 microns
	106.7	±1 mil
Y:	3260	±25.4 microns
	128.3	±1 mil

#### II. Die Thickness<sup>2</sup>

11.5 ±0.5 mil (typ)

#### III. PAD Opening

100 microns  
3.9 mils



1. The backside of die is internally connected to  $V_{SS}$ . It **MUST NOT** be connected to any other potential or damage may occur.
2. Die thickness is subject to change, please contact ISD factory for status and availability.

**Table 5: ISD1510 PIN/PAD Designations with Respect to Die Center**

<b>PIN</b>	<b>PIN Name</b>	<b>X Axis (μm)</b>	<b>Y Axis (μm)</b>	<b>X Axis (mil)</b>	<b>Y Axis (mil)</b>
1	VSSD	-342.40	1462.80	-13.48	57.59
2	REC	-579.80	1477.80	-22.83	58.18
3	PE	-1053.40	1477.80	-41.47	58.18
4	PL	-1201.80	1138.00	-47.31	44.80
5	N/C				
6	N/C				
7	N/C				
8	N/C				
9	N/C				
10	MIC	-1197.60	-1212.20	-47.15	-47.72
11	N/C				
12	MIC REF	-1190.40	-1473.00	-46.87	-57.99
13	AGC	-953.00	-1443.00	-37.52	-56.81
14	VCCA	-247.40	-1459.40	-9.74	-57.46
15	SP-	72.40	-1459.40	2.85	-57.46
16	VSSA	392.20	-1459.40	15.44	-57.46
17	SP+	712.00	-1459.40	28.03	-57.46
18	VCCA	1031.80	-1459.40	40.62	-57.46
19	ROSC	1198.00	-1207.20	47.17	-47.53
20	N/C				
21	N/C				
22	N/C				
23	N/C				
24	N/C				
25	TEST	1196.60	1293.35	47.11	50.92
26	XCLK	752.20	1474.20	29.61	58.04
27	VCCD	563.80	1474.20	22.20	58.04
28	RECLD	150.80	1462.80	5.94	57.59

Figure 10: 28-Lead 0.600-Inch Plastic Dual Inline Package (PDIP) (P)—For Sampling Only

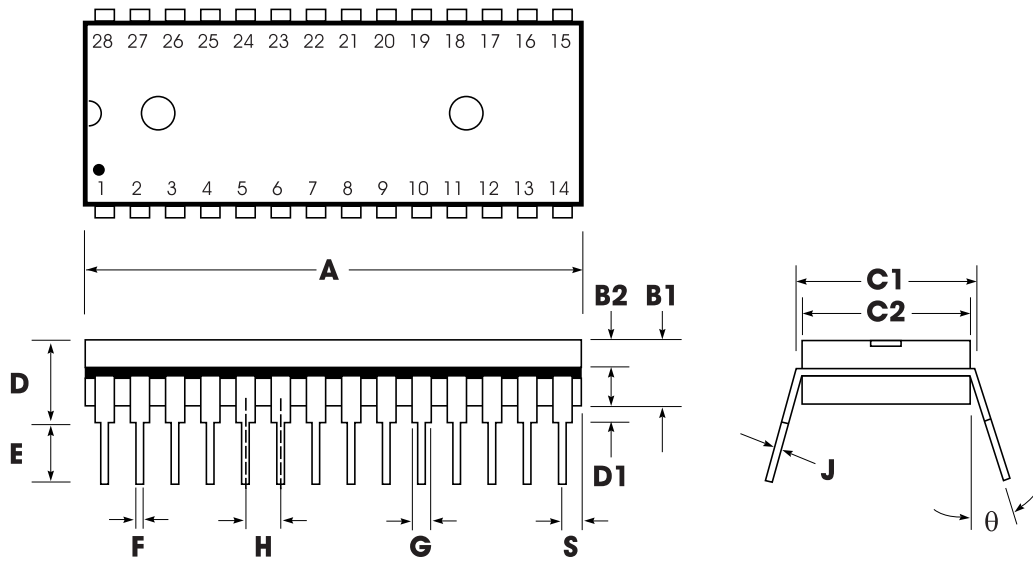


Table 6: Plastic Dual Inline Package (PDIP) (P) Dimensions

	INCHES			MILLIMETERS		
	Min	Nom	Max	Min	Nom	Max
A	1.445	1.450	1.455	36.70	36.83	36.96
B1		0.150			3.81	
B2	0.065	0.070	0.075	1.65	1.78	1.91
C1	0.600		0.625	15.24		15.88
C2	0.530	0.540	0.550	13.46	13.72	13.97
D			0.19			4.83
D1	0.015			0.38		
E	0.125		0.135	3.18		3.43
F	0.015	0.018	0.022	0.38	0.46	0.56
G	0.055	0.060	0.065	1.40	1.52	1.65
H		0.100			2.54	
J	0.008	0.010	0.012	0.20	0.25	0.30
S	0.070	0.075	0.080	1.78	1.91	2.03
q	0°		15°	0°		15°

## ORDERING INFORMATION

### Product Number Descriptor Key

**1510**

**Duration:**

10 = 10 sec minimum duration

**Package Type:**

P = 28-Lead 0.600-Inch Plastic Dual Inline Package (PDIP)—For Sampling Only

W = Wafer

X = Die

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

Part Number
ISD1510P (For Sampling Only)
ISD1510W
ISD1510X

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