# ISD1400 SERIES

## SINGLE-CHIP

## VOICE RECORD/PLAYBACK DEVICES

## 16- AND 20-SECOND DURATION

*Publication Release Date: November 16, 2005*

Winbond Electronics Corp.

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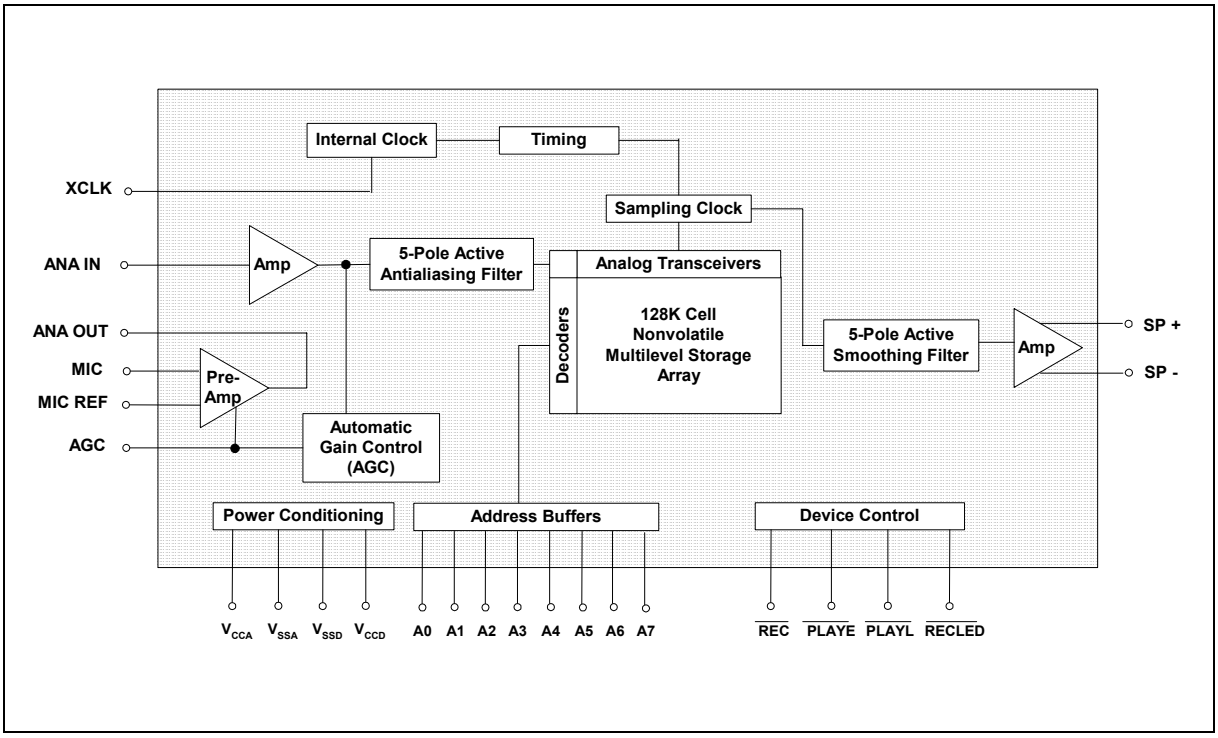
## 1. GENERAL DESCRIPTION

Winbond's ISD1400 ChipCorder® series provide high-quality, single-chip, Record/Playback solutions to short-duration messaging applications. The CMOS devices include an on-chip oscillator, microphone preamplifier, automatic gain control, anti-aliasing filter, 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 into on-chip non-volatile memory cells, providing zero-power message storage. This unique, single-chip solution is made possible through Winbond's patented Multi-Level Storage (MLS) technology. Voice and audio signals are stored directly into memory in their natural form, providing high-quality, solid-state voice reproduction.

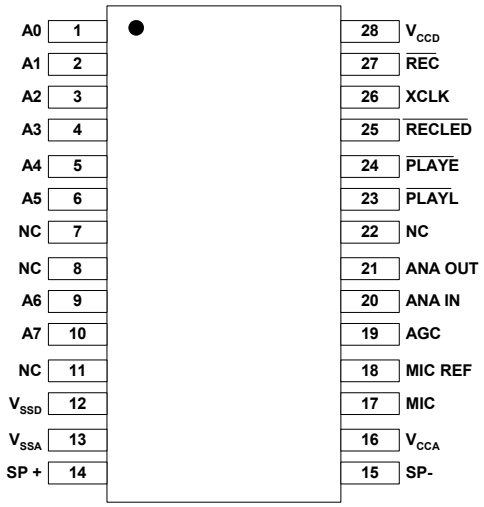
## 2. FEATURES

- Single +5 volt power supply
- Duration: 14 and 20 seconds.
- Easy-to-use single-chip, voice record/playback solution
- High-quality, natural voice/audio reproduction
- Manual switch or microcontroller compatible Playback can be edge- or level-activated
- Directly cascadable for longer durations
- Automatic power-down (push-button mode)
    - Standby current 1 µA (typical)
- Zero-power message storage
    - Eliminates battery backup circuits
- Fully addressable to handle multiple messages
- 100-year message retention (typical)
- 100,000 record cycles (typical)
- On-chip oscillator
- Programmer support for play-only applications
- Packaged types: Leaded and Lead-Free
- Available in die, PDIP and SOIC
- Temperature:
    - Commercial - Packaged unit : 0°C to 70°C, Die : 0°C to 50°C
    - Industrial - Packaged unit : -40°C to 85°C

## 3. BLOCK DIAGRAM



## 4. PIN CONFIGURATION




SOIC / PDIP

Note: NC means must be No connect

## 5. PIN DESCRIPTION

| PIN NAME | PIN NO | FUNCTION |
|---|---|---|
| A0-A7 | 1-6, 9, 10 | **Address Inputs**: The address inputs have two functions, depending on the level of the two Most Significant Bits (MSB) of the address.<br>If either or both of the two MSBs are LOW, the inputs are all interpreted as address bits and are used as the start address for the current record or playback cycle. The address pins are inputs only and do not output internal address information as the operation progresses. Address inputs are latched by the falling edge of $\overline{\text{PLAYE}}$, $\overline{\text{PLAYL}}$, or $\overline{\text{REC}}$.<br>If both A6 & A7 are HIGH, then the device is in special operational modes. Please refer to operational modes section for details. |
| NC | 7, 8, 11, 22 | **NC:** No Connect |
| $V_{SSD}$, $V_{SSA}$ | 12, 13 | **Ground**: Similar to $V_{CCA}$ and $V_{CCD}$, the analog and digital circuits internal to the ISD1400 series use separate ground buses to minimize noise. These pins should be tied together as close as possible to the device. |
| SP+, SP- | 14, 15 | **Speaker Outputs**: The SP+ and SP- pins provide direct drive for loudspeakers with impedances as low as 16 Ω. 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. Forthermore, when SP+ and SP- are used, a speakercoupling capacitor is not required. A single-ended connection will require an AC-coupling capacitor between the SP pin and the speaker. The speaker outputs are in a high-impedance state during a record cycle, and held at $V_{SSA}$ during power down. |
| $V_{CCA}$, $V_{CCD}$ | 16, 28 | **Supply Voltage**: Analog and digital circuits internal to the ISD1400 series use separate power buses to minimize noise on the chip. These voltage 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 to the package as possible. |
| MIC | 17 | **Microphone**: The microphone input transfers its signal to the on-chip preamplifier. An on-chip Automatic Gain Control (AGC) circuit controls the gain of this preamplifier from –15 to 24dB. An external microphone should be AC coupled to this pin via a series capacitor. The capacitor value, together with the internal 10 KΩ resistance on this pin, determines the low-frequency cutoff for the ISD1400 series passband. See Winbond's Application Information for additional information on low-frequency cutoff calculation. |

| PIN NAME | PIN NO | FUNCTION |
|---|---|---|
| MIC REF | 18 | **Microphone Reference**: The MIC REF input is the inverting input to the microphone preamplifier. This provides a noise-canceling or common-mode rejection input to the device when connected to a differential microphone. |
| AGC | 19 | **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 KΩ internal resistance and an external capacitor (C6 on the schematic of section 11, Figure 5) 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 KΩ and 4.7 µF give satisfactory results in most cases. |
| ANA IN | 20 | **Analog Input**: The analog input pin transfers its signal to the chip for recording. For microphone inputs, the ANA OUT pin should be connected via an external capacitor to the ANA IN pin. This capacitor value, together with the 3.0 KΩ input impedance of ANA IN, is selected to give additional cutoff at the low-frequency end of the voice passband. If the desired input is derived from a source other than a microphone, the signal can be fed, capacitively coupled, into the ANA IN pin directly. |
| ANA OUT | 21 | **Analog Output**: This pin provides the preamplifier output to the user. The voltage gain of the preamplifier is determined by the voltage level at the AGC pin. |
| $\overline{\text{PLAYL}}$ [2] | 23 | **Playback, Level-Activated**: When this input signal is held LOW, a playback cycle is initiated, and playback continues until $\overline{\text{PLAYL}}$ is pulled HIGH, or an EOM marker is detected. The device automatically powers down and enters into standby mode upon completion of a playback cycle. |
| $\overline{\text{PLAYE}}$ [2] | 24 | **Playback, Edge-Activated**: When a LOW-going transition is input to this pin, a playback cycle begins. Taking $\overline{\text{PLAYE}}$ HIGH during a playback cycle will not terminate the current cycle. Playback continues until an EOM is encountered. Upon completion of a playback cycle, the device automatically powers down and enters into standby mode. |

| PIN NAME | PIN NO | FUNCTION |
|---|---|---|
| $\overline{\text{RECLED}}$ | 25 | **Record LED**: The $\overline{\text{RECLED}}$ output is LOW during a record cycle. It can be used to drive an LED to indicate a record cycle is in progress. In addition, $\overline{\text{RECLED}}$ pulses LOW momentarily when an end-of-message is encountered in a playback operation. |
| XCLK | 26 | **External Clock**: The input has an internal pull-down device. The ISD1400 is configured at the factory with an internal sampling clock frequency that guarantees its minimum nominal record/playback time. For instance, an ISD1420 operating within specification will be observed to always have a minimum of 20 seconds of recording time. The sampling frequency is then maintained to a variation of ±2.25 percent over the commercial temperature and operating voltage ranges, while still maintaining the minimum specified recording duration. This will result in some devices having a few percent more than nominal recording time.<br><br>The Internal clock has a ±5 percent tolerance over the industrial temperature and voltage range. A regulated power supply is recommended for industrial temperature parts. If greater precision is required, the device can be clocked through the XCLK pin as follows:<br><br>**EXTERNAL CLOCK SAMPLE RATES**<br><br>**Part Number** / **Sample Rate** / **Required Clock**<br>ISD1416 / 8.0 kHz / 1024 kHz<br>ISD1420 / 6.4 kHz / 819.2 kHz<br><br>These recommended clock rates should not be varied because the antialiasing and smoothing filters are fixed, and aliasing problems can occur if the sample rate differs from the one recommended. The duty cycle on the input clock is not critical, as the clock is immediately divided by two. **If the XCLK is not used, this input must be connected to ground.** |

| PIN NAME | PIN NO | FUNCTION |
|---|---|---|
| $\overline{\text{REC}}$ | 27 | **Record Input**: The $\overline{\text{REC}}$ input is an active-LOW record signal. The device records whenever $\overline{\text{REC}}$ is LOW. This signal must remain LOW for the duration of the recording. $\overline{\text{REC}}$ takes precedence over either playback ( $\overline{\text{PLAYE}}$ or $\overline{\text{PLAYL}}$ ) signal. If $\overline{\text{REC}}$ is pulled LOW during a playback cycle, the playback immediately ceases and recording begins.<br><br>A record cycle is completed when $\overline{\text{REC}}$ is pulled HIGH or the memory space is filled.<br><br>And end-of-message marker (EOM) is internally recorded, enabling a subsequent playback cycle to terminate appropriately. The device automatically powers down to standby mode when $\overline{\text{REC}}$ goes HIGH. |

Notes:

[1] The $\overline{\text{REC}}$ signal is debounced for 50 ms on the rising edge to prevent a false retriggering from a push-button switch.

[2] During playback, if either $\overline{\text{PLAYE}}$ or $\overline{\text{PLAYL}}$ is held LOW during EOM or OVF, the device will still enter into standby mode and the internal oscillator and timing generator will stop. However, the rising edge of $\overline{\text{PLAYE}}$ and $\overline{\text{PLAYL}}$ are not debounced and any subsequent falling edge (particularly switch bounce) present on the input pins will initiate another playback.

# 6. FUNCTIONAL DESCRIPTION

## 6.1. DETAILED DESCRIPTION

### Speech/Sound Quality

The Winbond's ISD1400 series offer 6.4 and 8.0 kHz sampling frequencies, allowing the user a choice of speech quality options. The speech samples are stored directly into on-chip non-volatile memory without the digitization and compression associated with other solutions. Direct analog storage provides a very true, natural sounding reproduction of voice, music, tones, and sound effects not available with most solidstate digital solutions.

### Duration

To meet end system requirements, the ISD1400 series offer single-chip solutions at 16 and 20 seconds.

**TABLE 1: ISD1400 SERIES SUMMARY**

| Part Number | Duration (Seconds) | Input Sample Rate (kHz) | Typical Filter Pass Band* (kHz) |
|---|---|---|---|
| ISD1416 | 16 | 8.0 | 3.3 |
| ISD1420 | 20 | 6.4 | 2.6 |

* 3dB roll-off-point

### EEPROM Storage

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

### Basic Operation

The ISD1400 ChipCorder® series are controlled by a single control signal, $\overline{\text{REC}}$, $\overline{\text{PLAYE}}$ (edge-activated playback) or $\overline{\text{PLAYL}}$ (level-activated playback). The ISD1400 parts are configured for simplicity of design in a single/multiple-message application. Using the address lines will allow multiple message applications.

### Automatic Power-Down Mode

At the end of a playback or record cycle, the ISD1400 series automatically return to a low-power standby mode, consuming typically 0.5 µA. After a playback cycle, the device powers down automatically at the end of the message. After a record cycle, the device powers down immediately after $\overline{\text{REC}}$ is pulled to HIGH.

**Addressing**

In addition to providing single message application, the ISD1400 series provide a full addressing capability.

The ISD1400 series have 160 distinct addressable segments, providing the below resolutions. See Application Information for ISD1400 address tables.

**TABLE 2: DEVICE PLAYBACK/RECORD DURATIONS**

| Part Number | Minimum Duration (Seconds) |
|---|---|
| ISD1416 | 100 ms |
| ISD1420 | 125 ms |

## 6.2. OPERATIONAL MODES

The ISD1400 series have several built-in operational modes providing maximum functionality with a minimal additional components. The operational modes use the address pins, but are mapped to outside the normal address range. When the two Most Significant Bits (MSBs), A6 and A7, are HIGH, the remaining address signals are interpreted as mode bits and not as address bits. Therefore, operational modes and direct addressing are not compatible and cannot be used simultaneously.

There are two important considerations for using operational modes. Firstly, all operations begin initially at address 0, which is the beginning address. Later operations can begin at other address locations, depending on the operational mode(s) chosen. In addition, the address pointer is reset to 0 when the device is changed from record to playback but not from playback to record when A4 is HIGH in Operational Mode.

Secondly, an Operational Mode is executed when any of the control inputs, $\overline{\text{PLAYE}}$, $\overline{\text{PLAYL}}$ or $\overline{\text{REC}}$, goes LOW and the two MSBs are HIGH. This Operational Mode remains in effect until the next LOW-going control input signal, at which point the current address/mode levels are sampled and executed.

### 6.2.1. Operational Modes Description

The Operational Modes can be used in conjunction with a microcontroller, or they can be hardwired to provide the desired system operation.

**A0 – Message Cueing**

Message Cueing allows the user to skip through messages, without knowing the actual physical addresses of each message. Each LOW pulse causes the internal address pointer to skip to the next message. This mode is used for playback only and typically used with the A4 Operational Mode.

### A1 – Delete $\overline{\text{EOM}}$ Markers

The A1 Operational Mode allows recording messages sequentially and playback as a single message with only one $\overline{\text{EOM}}$ set at the end of the final message.

### A2 – Unused

### A3 – Message Looping

The A3 Operational Mode allows repeating playback a message continuously from the beginning of the memory. A message can completely fill the ISD1400 device and will loop from beginning to end. Pulsing $\overline{\text{PLAYE}}$ will start the playback and pulsing $\overline{\text{PLAYL}}$ will end the playback.

### A4 – Consecutive Addressing

During normal operation, the address pointer will reset when a message is played through to an $\overline{\text{EOM}}$ marker. The A4 Operational Mode inhibits the address pointer reset, allowing messages to be recorded or played back consecutively. When the device is in a static state; i.e., not recording or playback, momentarily taking this pin LOW will reset the address counter to zero.

### A5 – Unsued

**TABLE 3: OPERATIONAL MODES**

| Mode | Function | Typical Use | Jointly Compatible [1] |
|---|---|---|---|
| **A0** | Message cueing | Fast-forward through messages | A4 |
| A1 | Delete $\overline{\text{EOM}}$ markers | Position $\overline{\text{EOM}}$ marker at the end of the last message | A3, A4 |
| A2 | Unused | | |
| A3 | Looping | Continuous playback from Address 0 | A1 |
| A4 | Consecutive addressing | Record/playback multiple consecutive messages | A0, A1 |
| A5 | Unused | | |

[1] Additional Operational Modes can be used simultaneously with the given mode.

## 7. TIMING DIAGRAMS

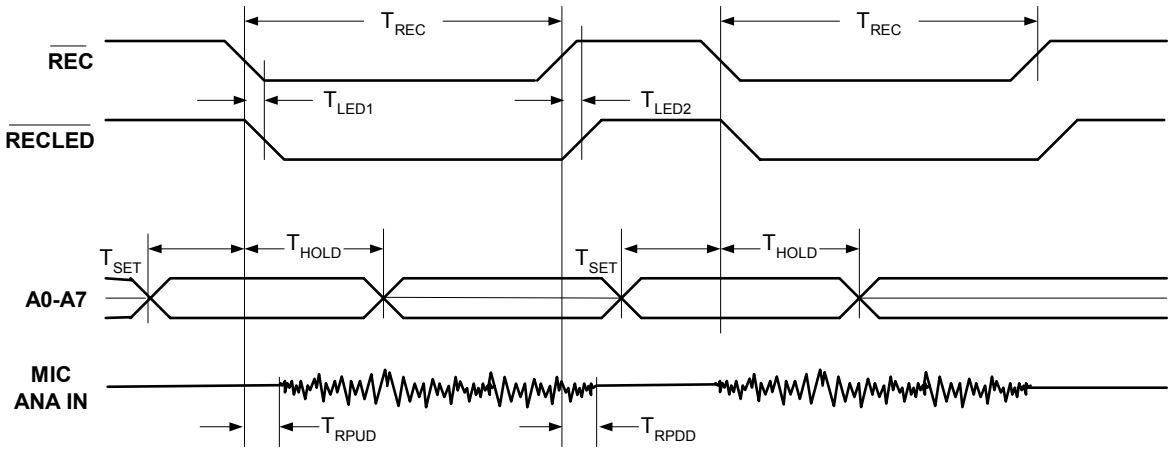
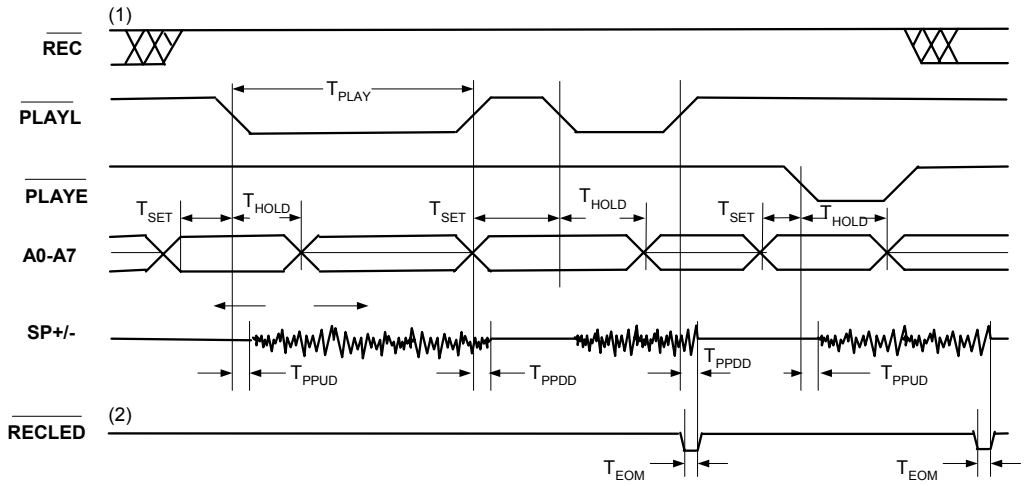



**FIGURE 1: RECORD**




**1.** $\overline{\text{REC}}$ must be HIGH for the entire duration of a playback cycle.

**2.** $\overline{\text{RECLED}}$ funstions as an EOM playback.

**FIGURE 2: PLAYBACK**

## 8. ABSOLUTE MAXIMUM RATINGS[2]

**TABLE 4: ABSOLUTE MAXIMUM RATINGS (PACKAGED PARTS)**

| CONDITIONS | VALUES |
|---|---|
| Junction temperature | 150ºC |
| Storage temperature range | -65ºC to +150ºC |
| Voltage applied to any pin | ($V_{SS}$ – 0.3V) to ($V_{CC}$ + 0.3V) |
| Voltage applied to any pin (Input current limited to ±20 mA) | ($V_{SS}$ – 1.0V) to ($V_{CC}$ + 1.0V) |
| Lead temperature (Soldering – 10sec) | 300ºC |
| $V_{CC}$ – $V_{SS}$ | -0.3V to +7.0V |

**TABLE 5: ABSOLUTE MAXIMUM RATINGS (DIE)**

| CONDITIONS | VALUES |
|---|---|
| Junction temperature | 150ºC |
| Storage temperature range | -65ºC to +150ºC |
| Voltage applied to any pad | ($V_{SS}$ – 0.3V) to ($V_{CC}$ + 0.3V) |
| Voltage applied to any pad (Input current limited to ±20mA) | ($V_{SS}$ – 1.0V) to ($V_{CC}$ + 1.0V) |
| Lead Temperature (soldering 10 seconds) | 330º C |
| $V_{CC}$ – $V_{SS}$ | -0.3V to +7.0V |

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

## 8.1 OPERATING CONDITIONS

**TABLE 6: OPERATING CONDITIONS (PACKAGED PARTS)**

| CONDITIONS | VALUES |
|---|---|
| Commercial operating temperature range (Case temperature) | 0ºC to +70ºC |
| Industrial operating temperature (Case temperature) | -40ºC to +85ºC |
| Supply voltage ($V_{CC}$) [1] | +4.5V to +5.5V |
| Ground voltage ($V_{SS}$) [2] | 0V |

**TABLE 7: OPERATING CONDITIONS (DIE)**

| CONDITIONS | VALUES |
|---|---|
| Commercial operating temperature range | 0ºC to +50ºC |
| Supply voltage ($V_{CC}$) [1] | +4.5V to +6.5V |
| Ground voltage ($V_{SS}$) [2] | 0V |

[1] $V_{CC} = V_{CCA} = V_{CCD}$

[2] $V_{SS} = V_{SSA} = V_{SSD}$

# 9. ELECTRICAL CHARACTERISTICS

## 9.1. PARAMETERS FOR PACKAGED PARTS

**TABLE 8: DC PARAMETERS**

| PARAMETERS | SYMBOLS | MIN[2] | TYP[1] | MAX[2] | UNITS | CONDITIONS |
|---|---|---|---|---|---|---|
| Input Low Voltage | $V_{IL}$ | | | 0.8 | V | |
| Input High Voltage | $V_{IH}$ | 2.4 | | | V | |
| Output Low Voltage | $V_{OL}$ | | | 0.4 | V | $I_{OL}$ = 4.0 mA |
| Output High Voltage | $V_{OH}$ | 2.4 | | | V | $I_{OH}$ = -1.6 mA |
| $V_{CC}$ Current (Operating) | $I_{CC}$ | | 15 | 30 | mA | $V_{CC}$ = 5.5V[3], $R_{EXT}$ = ∞ |
| $V_{CC}$ Current (Standby) | $I_{SB}$ | | 0.5 | 10 | µA | [3] [4] |
| Input Leakage Current | $I_{IL}$ | | | ±1 | µA | |
| Input Current HIGH w/Pull Down | $I_{ILPD}$ | | | 130 | µA | Force $V_{CC}$ [5] |
| Output Load Impedance | $R_{EXT}$ | 16 | | | Ω | Speaker Load |
| Preamp IN Input Resistance | $R_{MIC}$ | 4 | 9 | 17 | KΩ | Pins 17, 18 |
| ANA IN Input Resistance | $R_{ANA\ IN}$ | 2.5 | 3 | 5 | KΩ | |
| Preamp Gain 1 | $A_{PRE1}$ | 20 | 23 | 26 | dB | AGC = 0.0V |
| Preamp Gain 2 | $A_{PRE2}$ | | -45 | -15 | dB | AGC = 2.5V |
| ANA IN to SP+/- Gain | $A_{ARP}$ | 20 | 22 | 25 | dB | |
| AGC Output Resistance | $R_{AGC}$ | 2.5 | 5 | 9.5 | KΩ | |
| Preamp Out Source | $I_{PREH}$ | | -2 | | mA | @ $V_{OUT}$ = 1.0V |
| Preamp In Sink | $I_{PREL}$ | | 0.5 | | mA | @ $V_{OUT}$ = 2.0V |

[1] Typical values @ $T_A$ = 25º and 5.0V.

[2] All Min/Max limits are guaranteed by Winbond via electronical testing or characterization. Not all specifications are 100 percent tested.

[3] $V_{CCA}$ and $V_{CCD}$ connected together.

[4] $\overline{REC}$, $\overline{PLAYL}$, and $\overline{PLAYE}$ must be at $V_{CCD}$.

[5] XCLK pin .

**TABLE 9: AC PARAMETERS**

| CHARACTERISTICS | SYMBOLS | MIN[2] | TYP[1] | MAX[2] | UNITS | CONDITIONS |
|---|---|---|---|---|---|---|
| Sampling Frequency<br>ISD1416<br>ISD1420 | $F_S$ | | | 8.0<br>6.4 | <br>kHz<br>kHz | <br>[5]<br>[5] |
| Filter Pass Band<br>ISD1416<br>ISD1420 | $F_{CF}$ | | <br>3.3<br>2.6 | | <br>kHz<br>kHz | <br>3 dB Roll-Off Point[3][6]<br>3 dB Roll-Off Point[3][6] |
| Record Duration<br>ISD1416<br>ISD1420 | $T_{REC}$ | <br>16<br>20 | | | <br>sec<br>sec | |
| Playback Duration<br>ISD1416<br>ISD1420 | $T_{PLAY}$ | <br>16<br>20 | | | <br>sec<br>sec | <br>[5]<br>[5] |
| $\overline{\text{RECLED}}$ ON Delay | $T_{LED1}$ | | 5 | | msec | |
| $\overline{\text{RECLED}}$ OFF Delay<br>ISD1416<br>ISD1420 | $T_{LED2}$ | 30<br>40 | 38.9<br>48.6 | 95<br>110 | msec<br>msec | |
| Address Setup Time | $T_{SET}$ | 300 | | | nsec | |
| Address Hold Time | $T_{HOLD}$ | 0 | | | nsec | |
| Record Power-Up Delay<br>ISD1416<br>ISD1420 | $T_{RPUD}$ | | <br>26<br>32 | | <br>msec<br>msec | |
| Record Power-Down Delay<br>ISD1416<br>ISD1420 | $T_{RPDD}$ | | <br>26<br>32 | | <br>msec<br>msec | |
| Play Power-Up Delay<br>ISD1416<br>ISD1420 | $T_{PPUD}$ | | <br>26<br>32 | | <br>msec<br>msec | |
| Play Power-Down Delay<br>ISD1416<br>ISD1420 | $T_{PPDD}$ | | 6.5<br>8.1 | | <br>msec<br>msec | |

| CHARACTERISTICS | SYMBOLS | MIN[2] | TYP[1] | MAX[2] | UNITS | CONDITIONS |
|---|---|---|---|---|---|---|
| $\overline{EOM}$ Pulse Width<br>ISD1416<br>ISD1420 | $T_{EOM}$ | | <br>12.5<br>15.625 | | <br>msec<br>msec | |
| Total Harmonic Distortion | THD | | 1 | 3 | % | @ 1 kHz |
| Speaker Output Power | $P_{OUT}$ | | 12.2 | | mW | $R_{EXT}$ = 16 Ω |
| Voltage Across Speaker Pins | $V_{OUT}$ | | 1.25 | 2.5 | V p-p | $R_{EXT}$ = 600 Ω |
| MIC Input Voltage | $V_{IN1}$ | | | 20 | mV | Peak-to-Peak[5] |
| ANA IN Input Voltage | $V_{IN2}$ | | | 50 | mV | Peak-to-Peak |

Notes:

[1] Typical values @ $T_A$ = 25° and 5.0V.

[2] All Min/Max limits are guaranteed by Winbond via electronical testing or characterization. Not all specifications are 100 percent tested.

[3] Low-frequency cutoff depends upon the value of external capacitors (see Pin Descriptions)

[4] With 5.1 K Ω series resistor at ANA IN.

[5] Sampling Frequency and playback duration can vary as much as ±2.25 percent over the commercial temperature and voltage rangs. It may vary as much as ±5 percent over the industrial temperature and voltage ranges. All devices will meet the maximum sampling frequency and minimum playback duration parameters. For greater stability, an external clock can be utilized (see Pin Descriptions)

[6] Filter specification applies to the anti-aliasing filter and the smoothing filter. Typical Parameter Variation with Voltage and Temperature. This parameter is not checked during production testing and may vary due to process variations and other factors. Therefore, the customer should not rely upon this value for testing purposes.

### 9.1.1. Typical Parameter Variation with Voltage and Temperature

**Chart 1: Record Mode Operating Current ($I_{CC}$)**

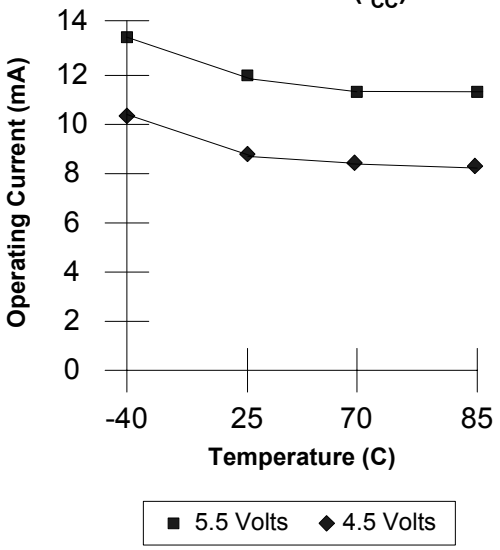



**Chart 3: Standby Current ($I_{SB}$)**

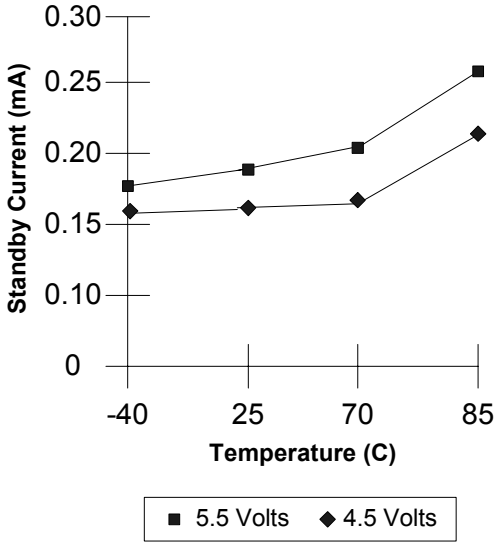



**Chart 2: Total Harmonic Distortion**

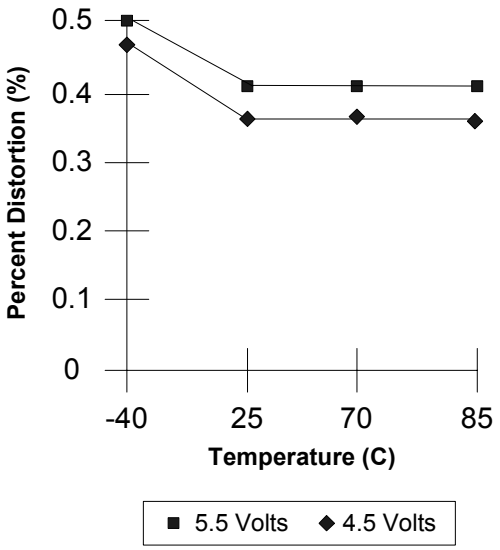
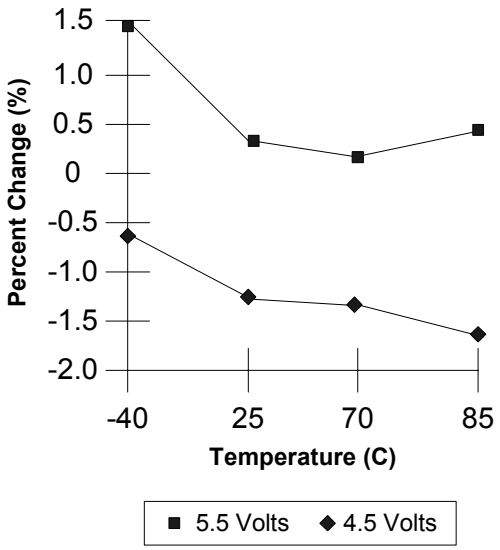



**Chart 4: Oscillator Stability**



### 9.2. PARAMETERS FOR DIE

**TABLE 10: DC PARAMETERS**

| PARAMETERS | SYMBOLS | MIN[2] | TYP[1] | MAX[2] | UNITS | CONDITIONS |
|---|---|---|---|---|---|---|
| Input Low Voltage | $V_{IL}$ | | | 0.8 | V | |
| Input High Voltage | $V_{IH}$ | 2.4 | | | V | |
| Output Low Voltage | $V_{OL}$ | | | 0.4 | V | $I_{OL}$ = 4.0 mA |
| Output High Voltage | $V_{OH}$ | 2.4 | | | V | $I_{OH}$ = -1.6 mA |
| $V_{CC}$ Current (Operating) | $I_{CC}$ | | 15 | 30 | mA | $V_{CC}$ = 5.5V[3], $R_{EXT}$ = ∞ |
| $V_{CC}$ Current (Standby) | $I_{SB}$ | | 0.5 | 10 | µA | [3] [4] |
| Input Leakage Current | $I_{IL}$ | | | ±1 | µA | |
| Input Current HIGH w/Pull Down | $I_{ILPD}$ | | | 130 | µA | Force $V_{CC}$ [5] |
| Output Load Impedance | $R_{EXT}$ | 16 | | | Ω | Speaker Load |
| Preamp IN Input Resistance | $R_{MIC}$ | 4 | 9 | 17 | KΩ | Pads 17,18 |
| ANA IN Input Resistance | $R_{ANA\ IN}$ | 2.5 | 3 | 5 | KΩ | |
| Preamp Gain 1 | $A_{PRE1}$ | 20 | 23 | 26 | dB | AGC = 0.0V |
| Preamp Gain 2 | $A_{PRE2}$ | | -45 | -15 | dB | AGC = 2.5V |
| ANA IN to SP+/- Gain | $A_{ARP}$ | 20 | 22 | 25 | dB | |
| AGC Output Resistance | $R_{AGC}$ | 2.5 | 5 | 9.5 | KΩ | |
| Preamp Out Source | $I_{PREH}$ | | -2 | | mA | @ $V_{OUT}$ = 1.0V |
| Preamp In Sink | $I_{PREL}$ | | 0.5 | | mA | @ $V_{OUT}$ = 2.0V |

[1] Typical values @ $T_A$ = 25° and 5.0V.

[2] All Min/Max limits are guaranteed by Winbond via electronical testing or characterization. Not all specifications are 100 percent tested.

[3] $V_{CCA}$ and $V_{CCD}$ connected together.

[4] $\overline{REC}$, $\overline{PLAYL}$, and $\overline{PLAYE}$ must be at $V_{CCD}$.

[5] XCLK pin.

**TABLE 11: AC PARAMETERS**

| CHARACTERISTICS | SYMBOLS | MIN[2] | TYP[1] | MAX[2] | UNITS | CONDITIONS |
|---|---|---|---|---|---|---|
| Sampling Frequency | $F_S$ | | | | | |
| ISD1416 | | | 8.0 | | kHz | [5] |
| ISD1420 | | | 6.4 | | kHz | [5] |
| Filter Pass Band | $F_{CF}$ | | | | | |
| ISD1416 | | | 3.3 | | kHz | 3 dB Roll-Off Point[3][6] |
| ISD1420 | | | 2.6 | | kHz | 3 dB Roll-Off Point[3][6] |
| Record Duration | $T_{REC}$ | | | | | |
| ISD1416 | | 16 | | | sec | |
| ISD1420 | | 20 | | | sec | |
| Playback Duration | $T_{PLAY}$ | | | | | |
| ISD1416 | | 16 | | | sec | |
| ISD1420 | | 20 | | | sec | |
| $\overline{\text{RECLED}}$ ON Delay | $T_{LED1}$ | | 5 | | msec | |
| $\overline{\text{RECLED}}$ OFF Delay | $T_{LED2}$ | | | | | |
| ISD1416 | | 30 | 38.9 | 95 | msec | |
| ISD1420 | | 40 | 48.6 | 110 | msec | |
| Address Setup Time | $T_{SET}$ | 300 | | | nsec | |
| Address Hold Time | $T_{HOLD}$ | 0 | | | nsec | |
| Power-Up Delay | $T_{RPUD}$ | | | | | |
| ISD1416 | | | 26 | | msec | |
| ISD1420 | | | 32 | | msec | |
| PD Pulse Width (Record) | $T_{RPUD}$ | | | | | |
| ISD1416 | | | 26 | | msec | |
| ISD1420 | | | 32 | | msec | |
| PD Pulse Width (Play) | $T_{PPUD}$ | | | | | |
| ISD1416 | | | 6.5 | | msec | |
| ISD1420 | | | 8.1 | | msec | |
| Play Power-Down Delay | $T_{PPDD}$ | | | | | |
| ISD1416 | | | 6.5 | | msec | |
| ISD1420 | | | 8.1 | | msec | |

| CHARACTERISTICS | SYMBOLS | MIN[2] | TYP[1] | MAX[2] | UNITS | CONDITIONS |
|---|---|---|---|---|---|---|
| $\overline{EOM}$ Pulse Width<br>ISD1416<br>ISD1420 | $T_{EOM}$ | | <br>12.5<br>15.625 | | <br>msec<br>msec | |
| Total Harmonic Distortion | THD | | 1 | 3 | % | @ 1 kHz |
| Speaker Output Power | $P_{OUT}$ | | 12.2 | | mW | $R_{EXT}$ = 16 Ω[4] |
| Voltage Across Speaker Pins | $V_{OUT}$ | | 1.25 | 2.5 | V p-p | $R_{EXT}$ = 600 Ω |
| MIC Input Voltage | $V_{IN1}$ | | | 20 | mV | Peak-to-Peak[4] |
| ANA IN Input Voltage | $V_{IN2}$ | | | 50 | mV | Peak-to-Peak |

Notes:

[1] Typical values @ $T_A$ = 25° and 5.0V.

[2] All Min/Max limits are guaranteed by Winbond via electronical testing or characterization. Not all specifications are 100 percent tested.

[3] Low-frequency cutoff depends upon the value of external capacitors (see Pin Descriptions)

[4] With 5.1 K Ω series resistor at ANA IN.

[5] Sampling Frequency and playback duration can vary as much as ±2.25 percent over the commercial temperature and voltage rangs. It may vary as much as ±5 percent over the industrial temperature and voltage ranges. All devices will meet the maximum sampling frequency and minimum playback duration parameters. For greater stability, an external clock can be utilized (see Pin Descriptions)

[6] Filter specification applies to the anti-aliasing filter and the smoothing filter. Typical Parameter Variation with Voltage and Temperature. This parameter is not checked during production testing and may vary due to process variations and other factors. Therefore, the customer should not rely upon this value for testing purposes.

### 9.2.1. Typical Parameter Variation with Voltage and Temperature

**Chart 5: Record Mode Operating Current ($I_{CC}$)**

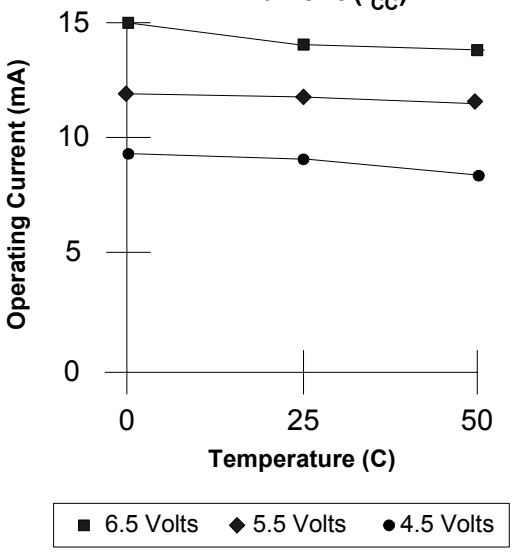



**Chart 7: Standby Current ($I_{SB}$)**

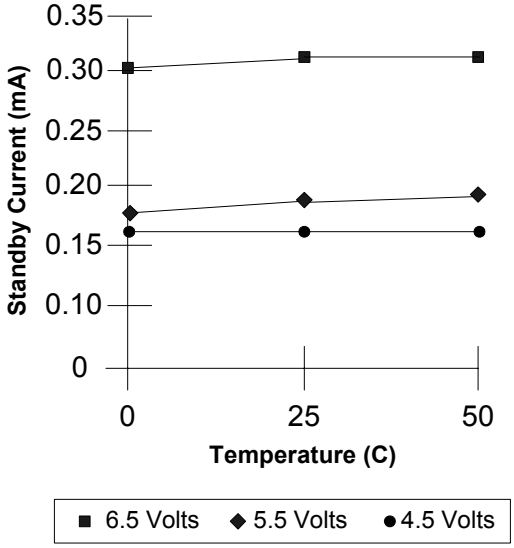



**Chart 6: Total Harmonic Distortion**

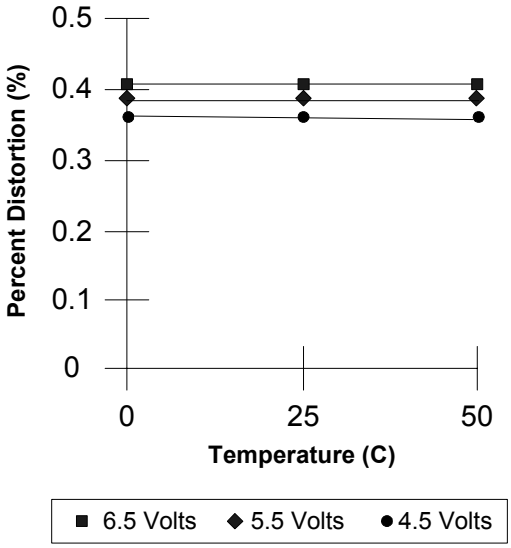
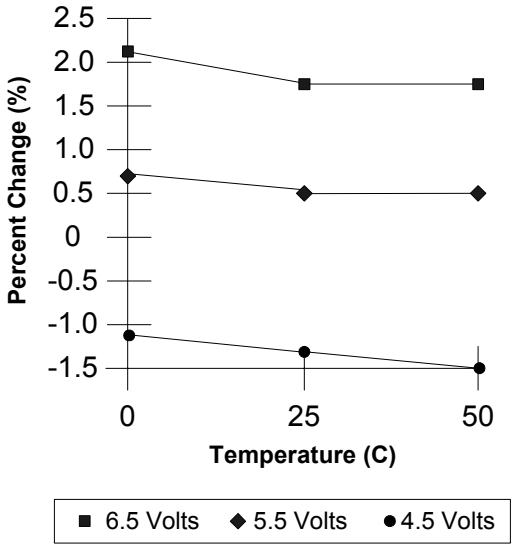



**Chart 8: Oscillator Stability**



## 10. TYPICAL APPLICATION CIRCUIT

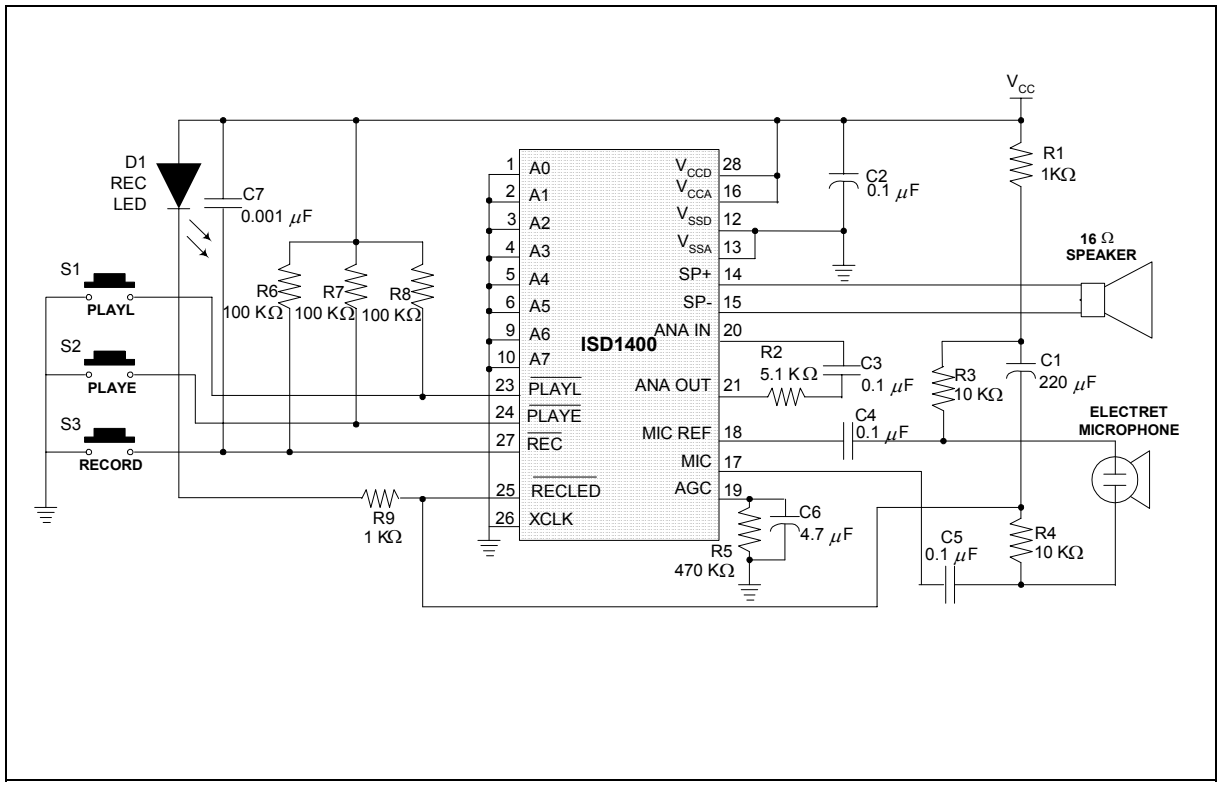



**FIGURE 5: DESIGN SCHEMATIC**

**Functional Description Example**

The following operating examples demonstrate the functionality of the ISD1400 series.

1. Record a message:

   Pulling the $\overline{\text{REC}}$ signal LOW initiates a record cycle from current location. When $\overline{\text{REC}}$ is held LOW, the recording continues. Until the memory array is filled up or when $\overline{\text{REC}}$ is pulled HIGH, recording ceases. An EOM marker is written at the end of message. Then the device will automatically power down.

2. Edge-activated playback:

   Pulling the $\overline{\text{PLAYE}}$ signal LOW initiates a playback cycle from the beginning of the message until the entire message is played. The rising edge of $\overline{\text{PLAYE}}$ has no effect on operation. When the EOM marker is encountered, the device automatically powers down. A subsequent falling edge on $\overline{\text{PLAYE}}$ initiates a new playback operation from the beginning of the message.

3. Level-activated playback:

   Holding the $\overline{\text{PLAYL}}$ signal LOW initiates a playback cycle from the beginning of the message, until $\overline{\text{PLAYL}}$ is pulled HIGH or when the EOM marker is encountered, playback operation stops and the device automatically powers down.

4. Record (interrupting playback).

   The $\overline{\text{REC}}$ signal takes precedence over playback operation. Holding $\overline{\text{REC}}$ LOW initiates a new record operation from current location, regardless of any current operation in progress.

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

   During record, 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 $\overline{\text{REC}}$ pin is pulled HIGH or when the recording is completed due to the memory being filled. However, during playback, this pin also pulses LOW to indicate an EOM at the end of a message.

### Applications Note

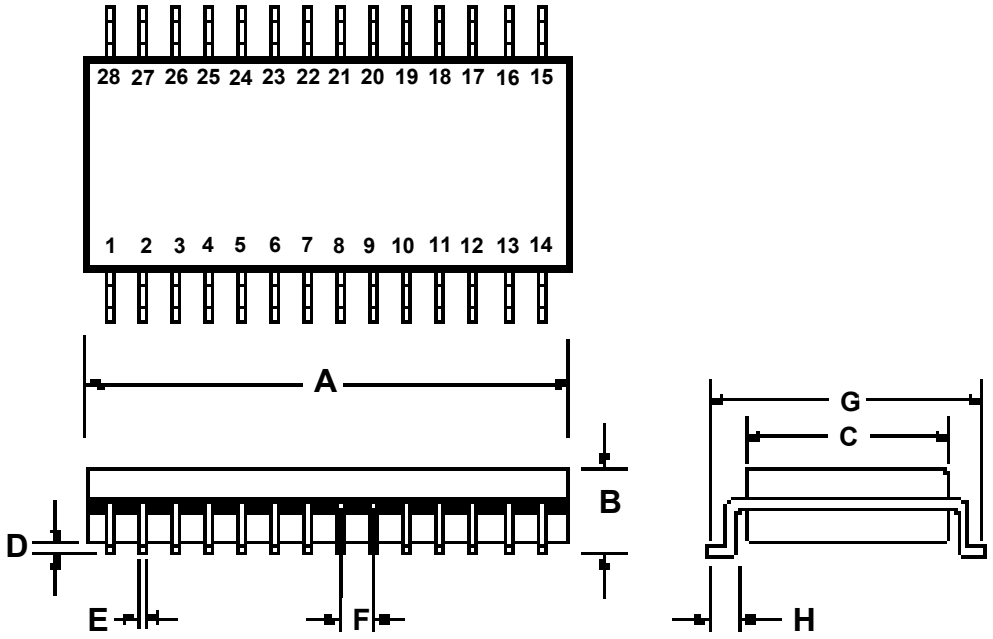
Some users may experience an unexpected recording taking place when their circuit is powered up, or the batteries are changed and $V_{CC}$ rises faster than $\overline{REC}$. This undesired recording prevents playback of the previously recorded message. A spurious End Of Message (EOM) marker appears at the very beginning of the memory, preventing access to the original message, and nothing is played.

To prevent this occurrence, place a capacitor (approx. 0.001 µF) between the control pin ($\overline{REC}$) and $V_{CC}$. This pulls the control pin voltage up with $V_{CC}$ as it rises. Once the voltage is HIGH, the pull-up device will keep the pin HIGH until intentionally pulled LOW, preventing the false EOM marker.

Since this anomaly depends on factors such as the capacitance of the user's printed circuit board, not all circuit designs will exhibit the spurious marker. However, it is recommended that the capacitor is included for design reliability. A more detailed explanation and resolution of this occurrence is described in Application Information.

## 11. PACKAGE DRAWING AND DIMENSIONS

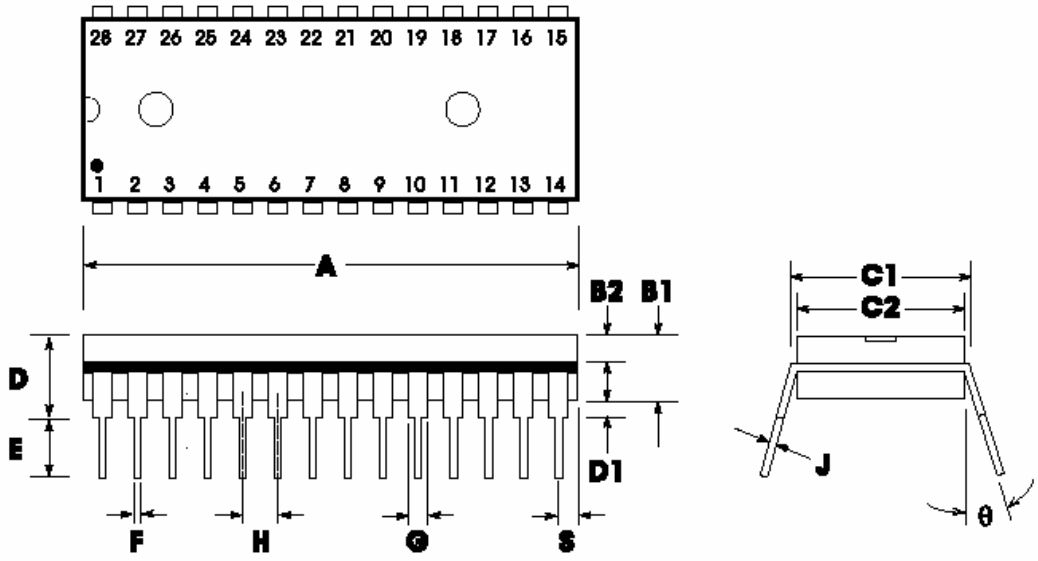
### 11.1. 28-LEAD 300 MIL PLASTIC SMALL OUTLINE IC (SOIC)




| | INCHES | | | MILLIMETERS | | |
|---|---|---|---|---|---|---|
| | Min | Nom | Max | Min | Nom | Max |
| A | 0.701 | 0.706 | 0.711 | 17.81 | 17.93 | 18.06 |
| B | 0.097 | 0.101 | 0.104 | 2.46 | 2.56 | 2.64 |
| C | 0.292 | 0.296 | 0.299 | 7.42 | 7.52 | 7.59 |
| D | 0.005 | 0.009 | 0.0115 | 0.127 | 0.22 | 0.29 |
| E | 0.014 | 0.016 | 0.019 | 0.35 | 0.41 | 0.48 |
| F | | 0.050 | | | 1.27 | |
| G | 0.400 | 0.406 | 0.410 | 10.16 | 10.31 | 10.41 |
| H | 0.024 | 0.032 | 0.040 | 0.61 | 0.81 | 1.02 |

Note: Lead coplanarity to be within 0.004 inches.

### 11.2. 28-LEAD 600 MIL PLASTIC DUAL INLINE PACKAGE (PDIP)

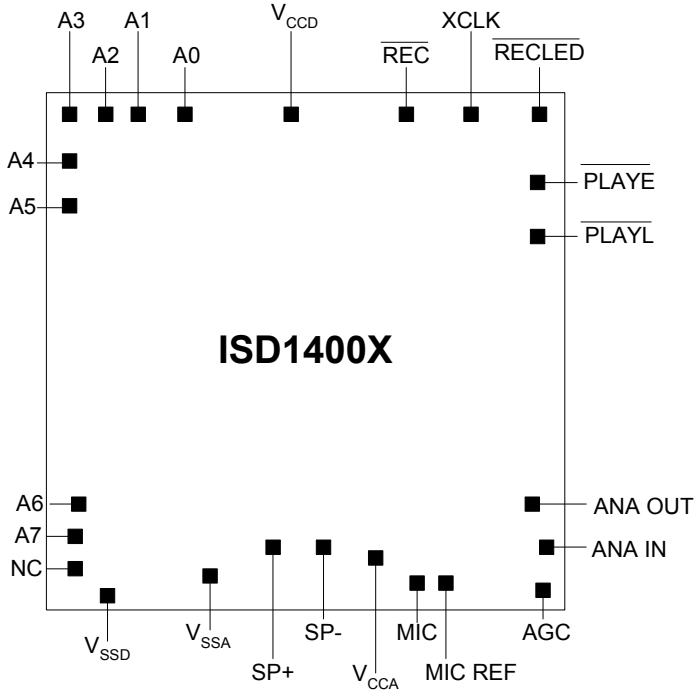



| | INCHES | | | MILLIMETERS | | |
|---|---|---|---|---|---|---|
| | Min | Nom | Max | Min | Nom | Max |
| A | 1.445 | 1.450 | 1.455 | 36.70 | 36.83 | 36.96 |
| B1 | | 0.150 | | | 3.81 | |
| B2 | 0.065 | 0.070 | 0.075 | 1.65 | 1.78 | 1.91 |
| C1 | 0.600 | | 0.625 | 15.24 | | 15.88 |
| C2 | 0.530 | 0.540 | 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 | 1.62 |
| 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° |

### 11.3. DIE PHYSICAL LAYOUT [1]

**ISD1400x**

- Die Dimensions
  X: 172.2 ± 1 mils
  Y: 168.5 ± 1 mils
- Die Thickness[2]
  17.5 ± 1 mils
- Pad Opening
  100 x 112 microns
  3.9 x 4.4 mils




Notes:

[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 Winbond factory for status and availability.

### ISD1400 SERIES PAD DESIGNATIONS

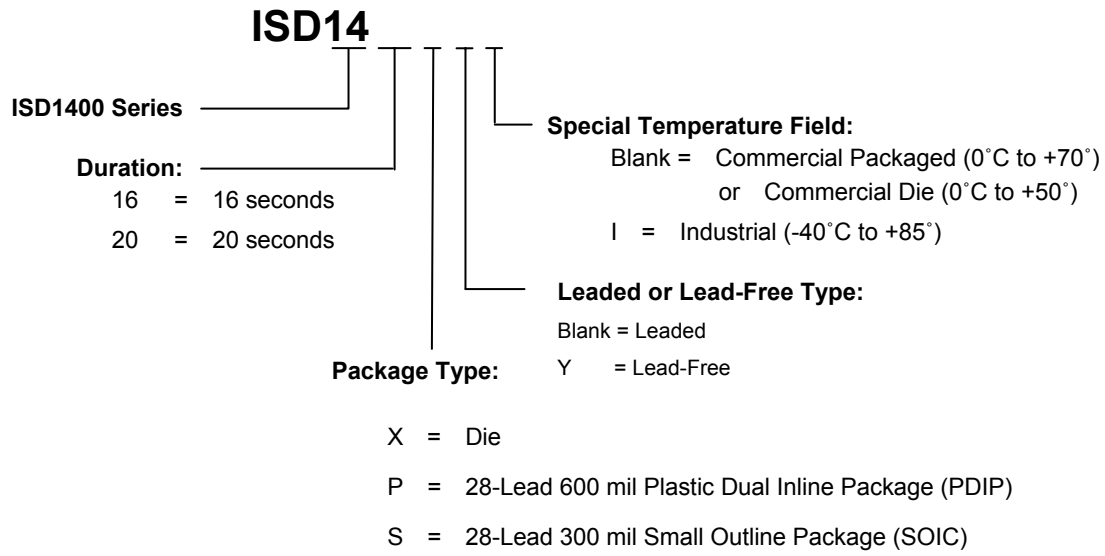
(with respect to die center)

| Pad | Pad Name | X Axis (µm) | Y Axis (µm) |
|---|---|---|---|
| A0 | Address 0 | -1332.5 | 1973.8 |
| A1 | Address 1 | -1628.9 | 1973.8 |
| A2 | Address 2 | -1808.9 | 1973.8 |
| A3 | Address 3 | -2014.1 | 1910.2 |
| A4 | Address 4 | -2014.1 | 1722.6 |
| A5 | Address 5 | -2014.1 | 1519.8 |
| A6 | Address 6 | -2014.1 | -1214.6 |
| A7 | Address 7 | -2014.1 | -1399.8 |
| NC | No Connect | -2014.1 | -1745.4 |
| $V_{SSD}$ | Digital Ground | -1894.1 | -1971.8 |
| $V_{SSA}$ | Analog Ground | -358.1 | -1971.8 |
| SP+ | Speaker Output + | -17.7 | -1896.6 |
| SP- | Speaker Output - | 411.9 | -1896.6 |
| $V_{CCA}$ | Analog Power Supply | 779.5 | -1936.2 |
| MIC | Microphone Input | 991.5 | -1973.8 |
| MIC REF | Microphone Reference | 1168.7 | -1973.8 |
| AGC | Automatic Gain Control | 1977.9 | -1910.6 |
| ANA IN | Analog Input | 2005.1 | -1580.2 |
| ANA OUT | Analog Output | 1990.7 | -1379.0 |
| $\overline{\text{PLAYL}}$ | Level-Activated Playback | 2013.9 | 1608.6 |
| $\overline{\text{PLAYE}}$ | Edge-Activated Playback | 2013.9 | 1777.0 |
| $\overline{\text{RECLED}}$ | Record LED Output | 2011.9 | 1971.8 |
| XCLK | External Clock | 1580.7 | 1973.8 |
| $\overline{\text{REC}}$ | Record | 752.3 | 1973.8 |
| $V_{CCD}$ | Digital Power Supply | -48.5 | 1929.4 |

Note: Die dimensions and pad positions may be subjected to change. Please contact Winbond Sales Offices or Representatives to verify current or future specifications.

## 12. ORDERING INFORMATION

**Product Number Descriptor Key**




When ordering the devices, please refer to the following valid order numbers. For the shaded part numbers, please contact the local Winbond Sales Representatives for availability information.

| Type | Duration | 16-Second | | 20-Second | |
|---|---|---|---|---|---|
| | Package | Part # | Order # | Part # | Order # |
| Leaded | Die | ISD1416X C5006 | I1416X5006 | ISD1420X C5006 | I1420X5006 |
| | PDIP | ISD1416P C5006 | I1416P5006 | ISD1420P C5006 | I1420P5006 |
| | | ISD1416PI C5006 | I1416PI5006 | ISD1420PI C5006 | I1420PI5006 |
| | SOIC | ISD1416S C5006 | I1416S5006 | ISD1420S C5006 | I1420S5006 |
| | | ISD1416SI C5006 | I1416SI5006 | ISD1420SI C5006 | I1420SI5006 |
| Lead-Free | PDIP | ISD1416PY | I1416PY | ISD1420PY | I1420PY |
| | | ISD1416PYI | I1416PYI | ISD1420PYI | I1420PYI |
| | SOIC | ISD1416SY | I1416SY | ISD1420SY | I1420SY |
| | | ISD1416SYI | I1416SYI | ISD1420SYI | I1420SYI |

**For the latest product information, access Winbond's worldwide website at**
**http://www.winbond-usa.com**

## 13. VERSION HISTORY

| VERSION | DATE | DESCRIPTION |
|---|---|---|
| 0 | Before 2004 | Initial issue. |
| 1.0 | March 2004 | Reformat the document.<br>Revise footnote for Filter Passband in Tables 1, 9 & 11.<br>Revise Functional Description Example section.<br>Revise die picture.<br>Revise ordering information. |
| 1.1 | Apr 2005 | Revise the disclaim section. |
| 1.2 | Jun 2005 | Revise the part number for I1420 device in Ordering section. |
| 1.3 | Nov 2005 | Add Pb-free info |

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- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения «**JONHON**», а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов «**FORSTAR**».

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