ISD1600 SERIES

SINGLE-MESSAGE

SINGLE-CHIP

6.6- TO 40-SECOND DURATION

VOICE RECORD/PLAYBACK DEVICE

1. GENERAL DESCRIPTION

Winbond's ISD1600 Series ChipCorder® is a single-message, single chip, record/playback solution with selectable durations from 6.6 to 40 seconds. The CMOS device includes an on-chip oscillator (via external control), microphone preamplifier, automatic gain control, anti-aliasing filter, Multi-Level Storage (MLS) array, smoothing filter, PWM Class D speaker amplifier for standard 8Ω speaker or buzzer, plus an extra current output. Recording is stored into the embedded Flash memory cells, providing zero-power message storage. This unique single-chip solution ultilizes Winbond's patented MLS technology. Therefore, voice or audio data are stored directly into the memory in their natural form without any compressions alike digital approach, providing high-quality, solid-state audio reproduction. The device enters into standby mode automatically once an operation is completed for power saving purposes.

Moreover, a minimum record/playback subsystem can be configured with a microphone, a speaker or buzzer, several passive components, two push buttons, and a power source.

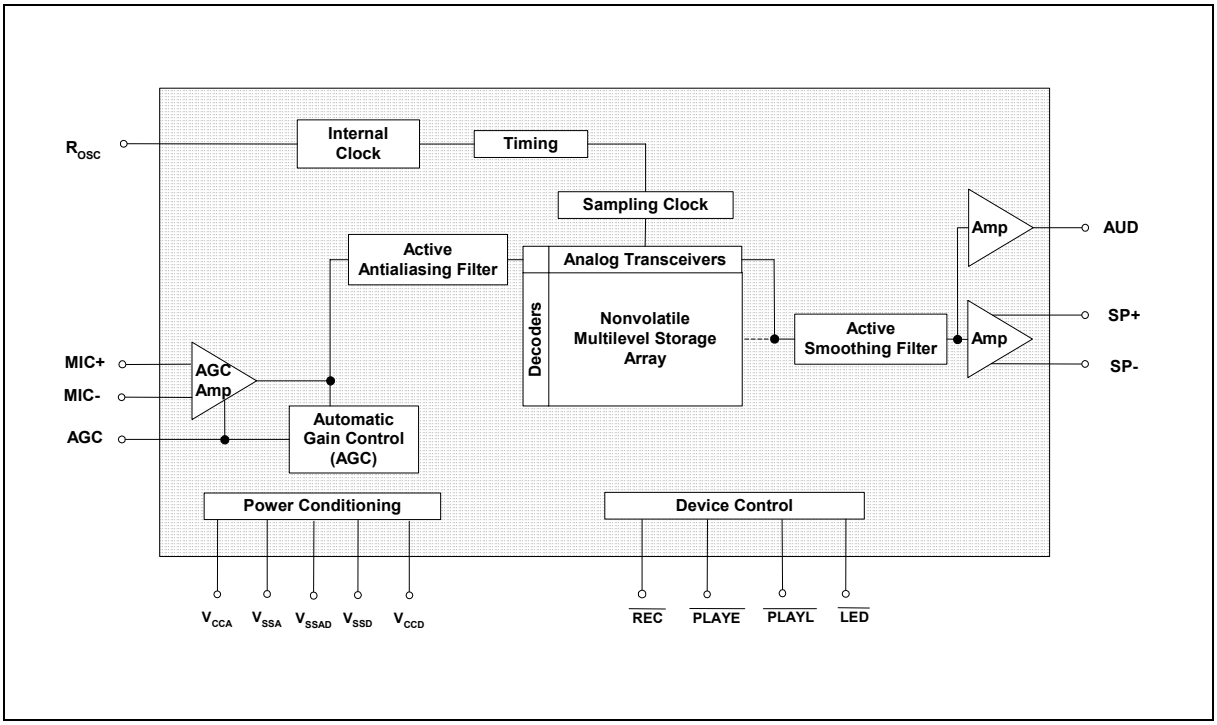
2. FEATURES

- User-friendly single-chip, single-message voice record/playback solution
- Wide operating voltage range: 2.4V to 5.5V
- Push-button interface
  - Playback is either edge- or level-triggered
  - Record is level-triggered
- Variable duration selected by external oscillator resistor

Sample Rate	12 KHz	8 KHz	6.4 KHz	5.3 KHz	4 HKz
Rosc	60 kΩ	80 kΩ	100 kΩ	120 kΩ	160 kΩ
ISD1610	6.6 secs	10 secs	12.5 secs	15 secs	20 secs
ISD1612	8 secs	12 secs	15 secs	18 secs	24 secs
ISD1616	10.6 secs	16 secs	20 secs	24 secs	32 secs
ISD1620	13.3 secs	20 secs	25 secs	30 secs	40 secs

- Automatic power-down mode
  - Enters standby mode immediately after a record or playback cycle
  - 1μA standby current (maximum) at room temperature
- PWM Class D speaker amplifier and AUD output driver simultaneously
  - Direct drive an 8Ω speaker or typical buzzer
  - AUD current output to drive external power transistor
- High-quality, natural voice/audio reproduction
- Zero-power message storage
  - Eliminates battery backup circuits
- 100-year message retention (typical)
- 10,000 record cycles (typical)
- On-chip oscillator
- Available in die, 16L 150mil SOIC and 16L 300mil PDIP
- Temperature options:
  - Commercial: 0°C to +50°C (Die); 0°C to +70°C (Packaged)
  - Industrial: -40°C to +85°C (Packaged)

3. BLOCK DIAGRAM



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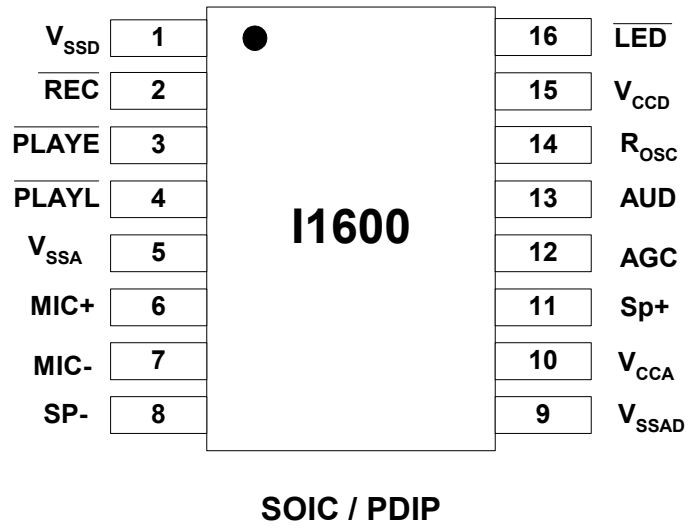
5. PIN CONFIGURATION



SOIC / PDIP

6. PIN DESCRIPTION

PIN NAME	SOIC / PDIP PIN NO.	FUNCTIONS
V_{SSD}, V_{SSA}, V_{SSAD}	1, 5, 9	**Ground**: V_{SSD} is the ground for digital circuits. V_{SSA} is the ground for analog circuits, whereas V_{SSAD} is the ground for PWM speaker driver. They should be separate ground paths connecting to ground of power supply to minimize noises.
$\overline{REC}$ [1]	2	**Record**: The device starts recording whenever REC transits from HIGH to LOW and stays at LOW. Recording stops when the signal returns to HIGH. This pin has an internal pull-up device[2].
$\overline{PLAYE}$ [1]	3	**Edge-trigger Playback**: A playback operation starts when this input detects a LOW going signal exceeding the specified debounced time. This pin has an internal pull-up device[2].
$\overline{PLAYL}$ [1]	4	**Level-trigger Playback**: A playback operation begins when this input detects a LOW going signal and remains at LOW. Playback stops when the signal returns to HIGH. This pin has an internal pull-up device[2].
MIC+	6	**Microphone Positive Input**: The input transfers the signals to the preamplifier. The internal 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 an internal 10 KΩ resistance on this pin, determines the low-frequency cutoff for the ISD1600 passband.
MIC-	7	**Microphone Negative Input**: This is the inverting input to the microphone preamplifier. It provides input noise-cancellation, or common-mode rejection, when the microphone is connected differentially to the device.
SP-	8	**Speaker Negative** : The SP-, Class D PWM output, provide a differential output with SP+ pin to drive 8Ω speaker or buzzer. During power down or recording, this pin is tri-stated.
V_{CCA}, V_{CCD}	10, 15	**Supply Voltages**: Internal analog and digital circuits use separate power busses to minimize noises inside the chip. These power busses are brought out to separate pads and should be tied together as close to the power supply as possible. It is important that the power supplies are decoupled as close as possible to the device.
SP+	11	**Speaker Positive** : The SP+, Class D PWM output, provide a differential output with SP- pin to drive an 8Ω speaker or buzzer directly. During power down or recording, this pin is tri-stated.

PIN NAME	SOIC / PDIP PIN NO.	FUNCTIONS
AGC	12	**Automatic Gain Control**: The AGC dynamically adjusts the gain of the preamplifier to compensate the wide range of microphone input levels. The AGC allows the full range of signal to be recorded with minimal distortion. Nominal values of 4.7 µF give satisfactory results in most cases. Connecting this pin to ground provides maximum gain to the preamplifier circuitry. Conversely, connecting this pin to power supply provides minimum gain to the preamplifier circuitry.
AUD	13	**AUD**: The AUD provides a single-ended current output to drive an external amplifier. During standby or recording, this pin is tri-stated.
R_{OSC}	14	**Oscillator Resistor**: This enables the user to vary the record and/or playback duration of the device. A resistor connected between the R_{OSC} pin and V_{SS} determines the sample frequency for the ISD1600 device. Please refer to the Duration Section in Section 7.1.
$\overline{LED}$	16	**$\overline{LED}$** : This output is LOW during a record cycle and blinks during playback cycle. It can be used to drive an LED to indicate either a record or playback cycle is in progress.

Note: [1] The REC and Play signal are internally debounced on the falling edge to prevent a false re-triggering from a push-button switch.

[2] The internal pull-up resistors are 600kΩ (typical).

7. FUNCTIONAL DESCRIPTION

7.1. DETAILED DESCRIPTION

Audio Quality

Winbond's patented ChipCorder® MLS technology provides natural high quality record and playback solution on a single chip. The input audio signals are stored directly into the non-volatile memory and are reproduced in its natural form without any compression artifacts caused by the digital speech solutions. A complete sample is stored in a single cell, minimizing the memory needed to store a single message.

Duration

The ISD1600 series offer single-chip solution with record/playback duration from 6.6 seconds to 40 seconds. Sampling rate and duration are determined by an external resistor connected to the Rosc pin.

Sample Rate	Rosc	ISD1610	ISD1612	ISD1616	ISD1620
12 KHz	60 kΩ	6.6 secs	8 secs	10.6 secs	13.3 secs
8 KHz	80 kΩ	10 secs	12 secs	16 secs	20 secs
6.4 KHz	100 kΩ	12.5 secs	15 secs	20 secs	25 secs
5.3 KHz	120 kΩ	15 secs	18 secs	24 secs	30 secs
4 KHz	160 kΩ	20 secs	24 secs	32 secs	40 secs

Flash Storage

The ISD1600 product utilizes the on-chip Flash 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 ISD1600 ChipCorder® device is controlled by either the REC pin, or one of the two playback modes, PLAYE and PLAYL. The ISD1600 parts are configured for design simplicity in a single-message application. Device operation is explained in Section 7.2.

Automatic Power-Down Mode

At the end of a playback or record cycle, the ISD1600 device automatically enters into a low-power standby mode, consuming typically 0.5µA, provided that PLAY and REC pins are HIGH (see DC parameters, Section 10). 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 to HIGH.

7.2. Functional Description Example

The following example operating sequences demonstrate the functionality of the ISD1600 series.

1. Record a message

The device starts recording from the beginning of the memory when REC transits from HIGH to LOW and stays at LOW. A record cycle is completed when REC is pulled to HIGH or entire memory is filled up. Then an End-of-Message (EOM) marker is written at the end of message, enabling a subsequent playback cycle to terminate appropriately. Hence, the device automatically enters into standby mode.

REC takes precedence over any playback operations. If REC is pulled LOW during a playback cycle, the playback immediately halts and recording starts from the beginning of the memory.

The REC pin has an internal pull-up device[2]. Holding this pin LOW after recording cycle will increase standby current consumption.

2. Edge-trigger playback

A playback operation starts from the beginning of the memory when PLAYE detects a LOW going signal exceeding the specified debounced time. Playback continues until an EOM marker is encountered. Upon completion of a playback cycle, the device automatically powers down and enters into standby mode.

During playback, a subsequent LOW going signal will terminate the current playback operation.

This pin has an internal pull-up device[2]. Holding this pin LOW after playback operation will increase standby current consumption.

3. Level- trigger playback

When PLAYL switches from HIGH to LOW and stays at LOW, a playback starts from the beginning of the memory until either an EOM marker is reached, then it automatically powers down.

If PLAYL is pulled HIGH any time during playback, the playback operation stops immediately and the device enters into the power-down mode.

4. $\overline{\text{LED}}$ operation

The $\overline{\text{LED}}$ output pin provides an active-LOW signal during recording, which is used to turn on an LED as a “record-in-progress” indicator. However, during playback, the LED blinks a few times per second to indicate a “playback-in-progress” operation. It returns to a HIGH state when operation stops.

5. R_{OSC} operation

The duration of the device can be varied by changing the value of R_{OSC}. This means the designer has the flexibility to choose different sampling frequency, up to 12 KHz, depending upon the needs.

This feature allows frequency shifting where a recorded audio can be played back faster or slower than normal for special sound effects.

Another feature is a “Pause” function that can be activated by taking the R_{OSC} resistor to V_{CC} to stop playback momentarily, and to resume when the resistor is switched back to ground.

8. TIMING DIAGRAMS

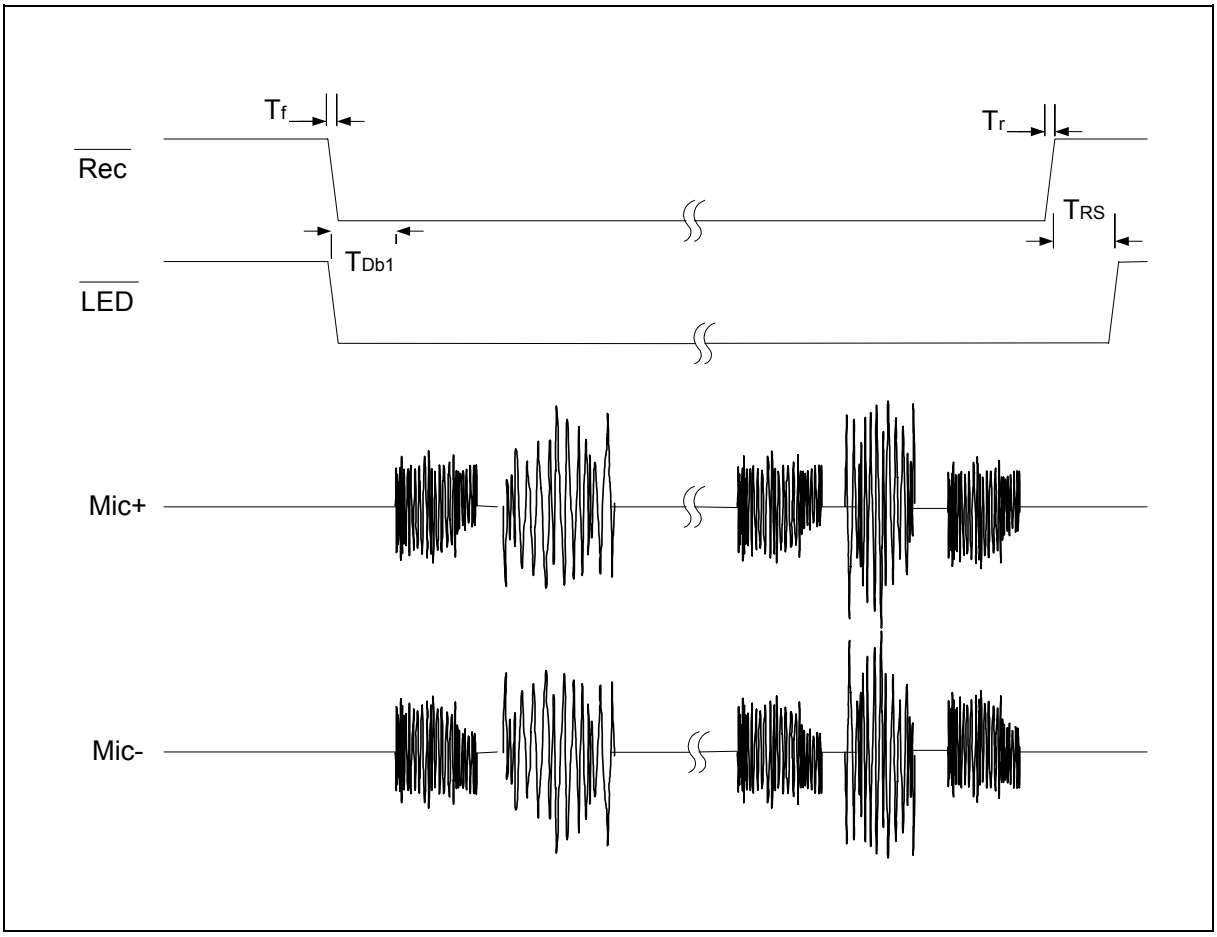


FIGURE 1: RECORD OPERATION

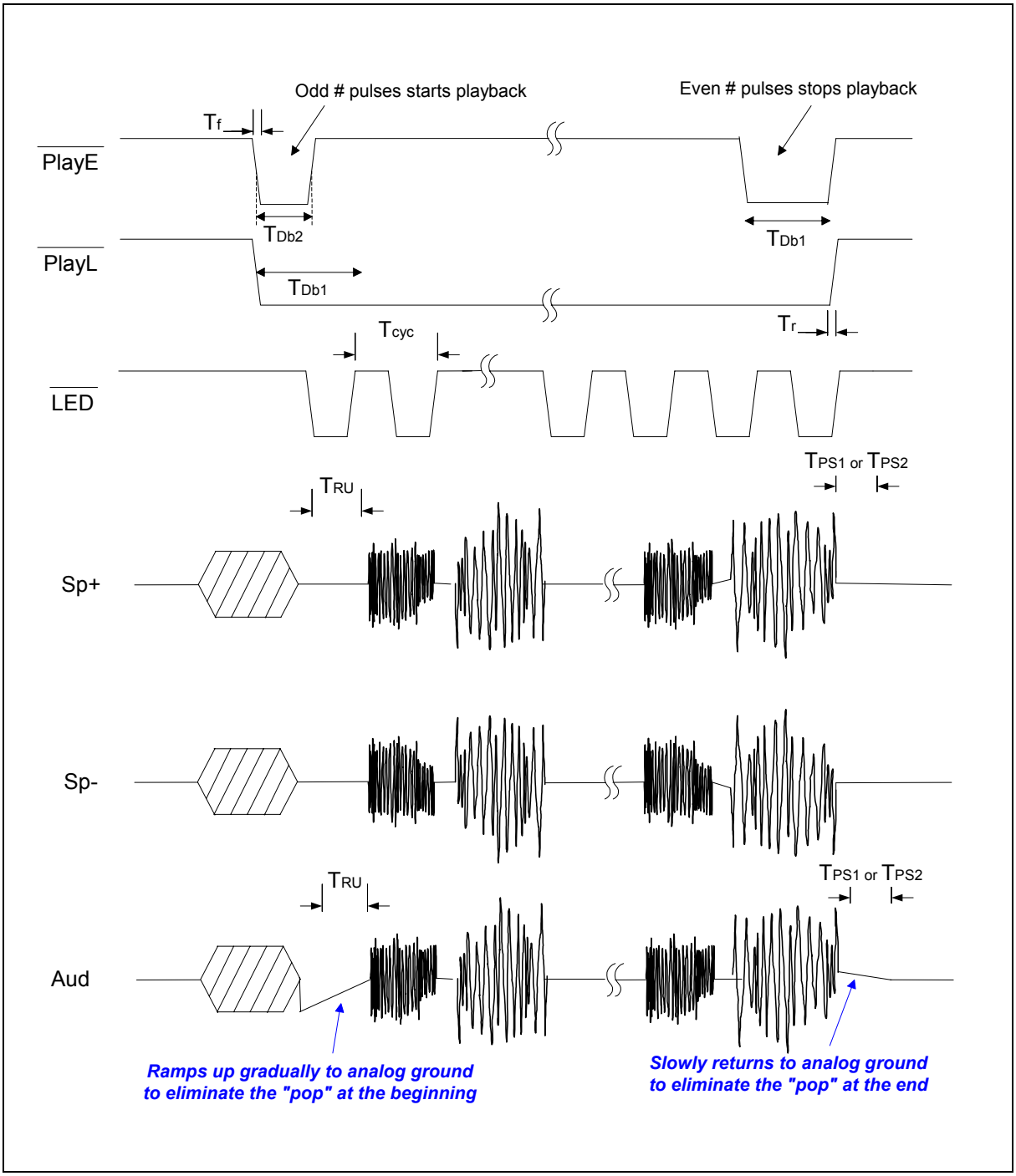


FIGURE 2: PLAYBACK OPERATION

9. ABSOLUTE MAXIMUM RATINGS [1]

ABSOLUTE MAXIMUM RATINGS (DIE)

CONDITIONS	VALUES
Junction temperature	150°C
Storage temperature range	-65°C to +150°C
Voltage applied to any pins	(V_{SS} –0.3V) to (V_{DD} +0.3V)
Power supply voltage to ground potential	-0.3V to +7.0V

ABSOLUTE MAXIMUM RATINGS (PACKAGED PARTS)

CONDITIONS	VALUES
Junction temperature	150°C
Storage temperature range	-65°C to +150°C
Voltage applied to any pins	(V_{SS} –0.3V) to (V_{DD} +0.3V)
Lead temperature (Soldering – 10 sec)	300°C
Power supply voltage to ground potential	-0.3V to +7.0V

[1] 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.

9.1 OPERATING CONDITIONS

OPERATING CONDITIONS (DIE)

CONDITIONS	VALUES
Operating temperature range	0°C to +50°C
Supply voltage (V_{DD}) [1]	+2.4V to +5.5V
Ground voltage (V_{SS}) [2]	0V
Input voltage (V_{DD}) [1]	0V to 5.5V
Voltage applied to any pins	(V_{SS} –0.3V) to (V_{DD} +0.3V)

OPERATING CONDITIONS (PACKAGED PARTS)

CONDITIONS	VALUES
Operating temperature range (Case temperature)	-40°C to +85°C
Supply voltage (V_{DD}) [1]	+2.4V to +5.5V
Ground voltage (V_{SS}) [2]	0V
Input voltage (V_{DD}) [1]	0V to 5.5V
Voltage applied to any pins	(V_{SS} –0.3V) to (V_{DD} +0.3V)

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

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

10. ELECTRICAL CHARACTERISTICS

10.1. DC PARAMETERS

PARAMETER	SYMBOL	MIN	TYP [1]	MAX	UNITS	CONDITIONS
Supply Voltage	V_{DD}	2.4		5.5	V	
Input Low Voltage	V_{IL}	V_{SS}-0.3		0.3xV_{DD}	V	
Input High Voltage	V_{IH}	0.7xV_{DD}		V_{DD}	V	
Output Low Voltage	V_{OL}	V_{SS}-0.3		0.3xV_{DD}	V	I_{OL} = 4.0 mA[2]
Output High Voltage	V_{OH}	0.7xV_{DD}		V_{DD}	V	I_{OH} = -1.6 mA[2]
Record Current	I_{DD_Record}			20	mA	V_{DD} = 5.5V, No load, Sampling freq = 12 kHz
Playback Current	$I_{DD\_Playback}$			20	mA	
Standby Current	I_{SB}		0.5	1	µA	V_{DD} = 5.5V, T=25°C [3] [4] [7]
Input Leakage Current	I_{ILPD1}			±1	µA	Force V_{DD} [5]
Input Current HIGH	I_{ILPD2}	-3		-10	µA	Force V_{SS} [5]
Preamp Input Resistance	R_{MIC+},R_{MIC-}		20		KΩ	Across both pins
MIC Input Voltage	V_{IN}		15	300	mV	Peak-to-Peak[6]
Gain from MIC to SP+/-	A_{MSP}	6		40	dB	V_{IN} = 15 to 300mV, AGC = 4.7µF, V_{DD} = 2.4V to 5.5V
Output Load Impedance	R_{EXT}	8			Ω	Speaker Load
Speaker Output Power	Pout		670		mW	V_{DD} = 5.5V; 15mVp-p 1kHz freq sinewave, R_{EXT} = 8Ω;
			313		mW	V_{DD} = 4.4V
			117		mW	V_{DD}= 3V
			49		mW	V_{DD}= 2.4V
Speaker Output Voltage	Vout		V_{DD}		V	R_{EXT} = 8Ω (Speaker), 70mH-160Ω (Buzzer)
AUD	I_{AUD}		-3.0		mA	V_{DD} =4.5V, R_{EXT}= 100Ω
Total Harmonic Distortion	THD		1		%	15mV p-p 1KHz sinewave, Cmessage weighted

Notes:

[1] Conditions: V_{CC} = 4.5V, 8kHz sampling frequency and T_A = 25°C, unless otherwise stated.

[2] LED output during Record operation.

[3] V_{CCA} and V_{CCD} are connected together. V_{SSA}, V_{SSAD} and V_{SSD} are connected together.

[4] REC, PLAYL, PLAYE must be at V_{CCD}.

[5] REC, PLAYL and PLAYE are forced to specified condition.

[6] Balanced input signal applied between MIC and MIC REF as shown in the applications example. Single-ended MIC or MIC REF recommended to be less than 100 mV peak to peak.

[7] For industrial grade, the maximum limit is 10µA.

10.2. AC PARAMETERS

CHARACTERISTIC	SYMBOL	MIN	TYP [1]				MAX	UNITS	CONDITIONS	
Sampling Frequency [2]	F_S	4					12	KHz	Vcc=2.4V~5.5V	
Duration [3]	Dur		**I1610**	**I1612**	**I1616**	**I1620**				
			6.6	8	10.6	13.3		Sec	SF=12kHz	Vcc=2.4 V~5.5V
			10	12	16	20		Sec	SF=8kHz	
			12.5	15	20	25		Sec	SF=6.4kHz	
			15	18	24	30		Sec	SF=5.3kHz	
			20	24	32	40		Sec	SF=4kHz	
Rising time	T_r	0					100	nsec		
Falling Time	T_f	0					100	nsec		
Debounce Time (Record & PlayL)	T_{Db1}		26.6	26.6	26.6	26.6		msec	SF=12kHz	Vcc=2.4 V~5.5V
			40	40	40	40		msec	SF=8kHz	
			50	50	50	50		msec	SF=6.4kHz	
			60.4	60.4	60.4	60.4		msec	SF=5.3kHz	
			80	80	80	80		msec	SF=4kHz	
Debounce Time (PlayE)	T_{Db2}		13.3	13.3	13.3	13.3		msec	SF=12kHz	Vcc=2.4 V~5.5V
			20	20	20	20		msec	SF=8kHz	
			25	25	25	25		msec	SF=6.4kHz	
			30.2	30.2	30.2	30.2		msec	SF=5.3kHz	
			40	40	40	40		msec	SF=4kHz	
Signal Ramp Up Time	T_{RU}	100						msec	Vcc=2.4V~5.5V	
Record Stop Time	T_{RS}		2 Sample Clock						Vcc=2.4V~5.5V	
PlayL Stop Time	T_{PS1}		T_{Db1}					msec	Vcc=2.4V~5.5V	
PlayE Stop Time	T_{PS2}		2 X T_{Db1}					msec	Vcc=2.4V~5.5V	
LED Cycle frequency	T_{Cyc}	1					6	Hz	Playback at any SF	

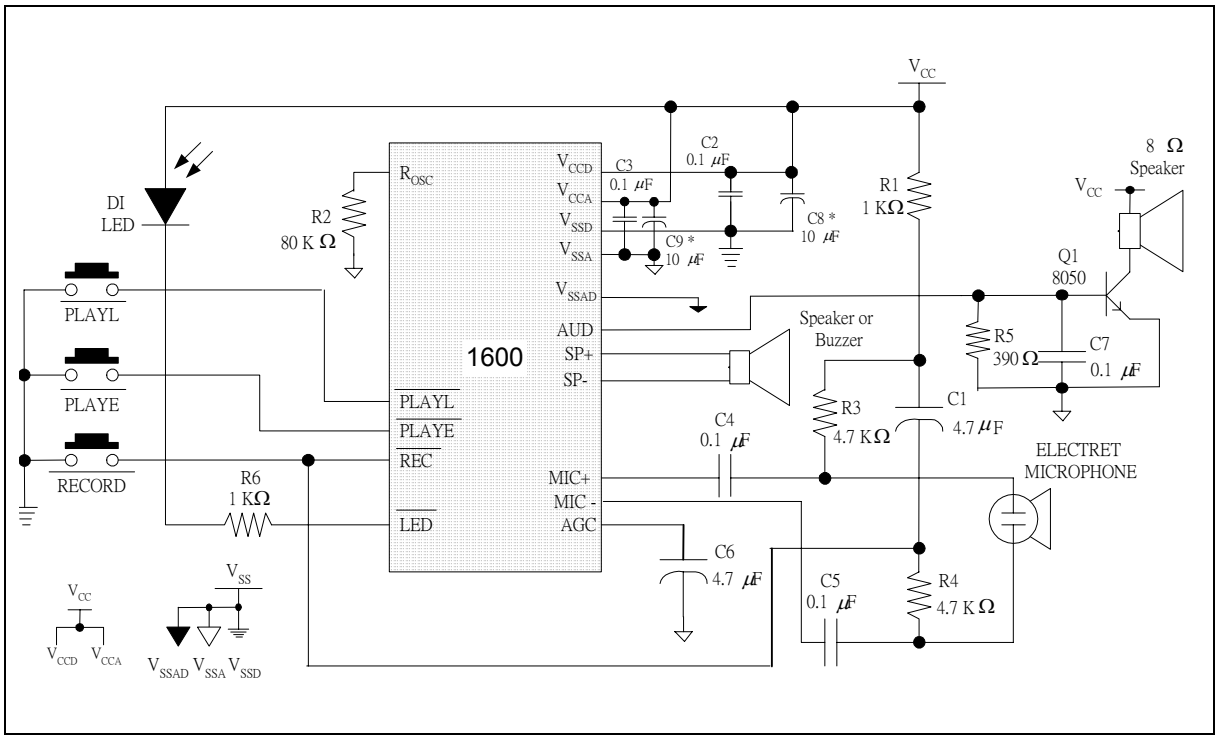
Notes:

[1] Typical values : V_{CC} = 4.5V, SF = 8 kHz and @ T_A = 25°C, unless otherwise stated.

[2] Sampling Frequency can vary as much as ±2.25 percent over the commercial temperature and voltage ranges, and –6/+4 percent over the industrial temperature and voltage ranges.

[6] Duration can vary as much as ±2.25 percent over the commercial temperature and voltage ranges, and –6/+4 percent over the industrial temperature and voltage ranges.

11. TYPICAL APPLICATION CIRCUIT



Schematic shows both speaker and AUD outputs

* C8 and C9 may be needed in order to optimize for the best voice quality, which is also depended upon the layout of the PCB. Please refer to ChipCorder Applications section or consult Winbond for layout advice.

The above example represents a typical implementation of ISD1600 in most applications.

In addition, it is important to have a separate path for each ground (V_{SSD}, V_{SSA} & V_{SSAD}) back to the ground terminal of power source to minimize the noises. Please refer to the ChipCorder Applications section in our website.

Good Audio Design Practices

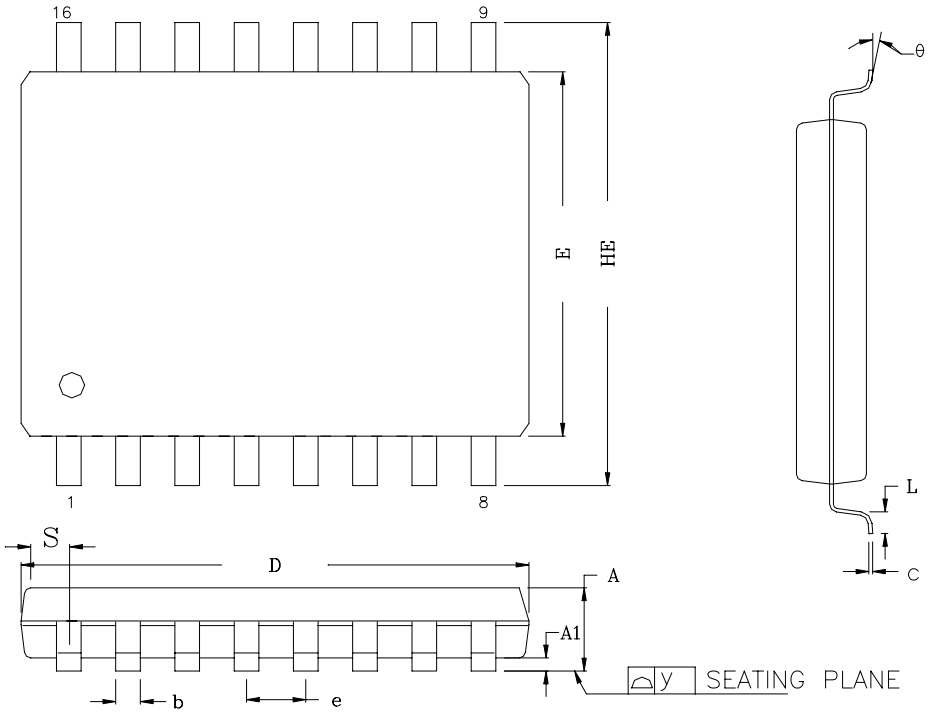
Winbond products are very high-quality single-chip voice recording and playback systems. To ensure the highest quality voice reproduction, it is important that good audio design practices on layout and power supply decoupling be followed. See Application Information or below links for details.

Good Audio Design Practices
http://www.winbond-usa.com/products/isd_products/chipcorder/applicationinfo/apin11.pdf

Single-Chip Board Layout Diagrams
http://www.winbond-usa.com/products/isd_products/chipcorder/applicationinfo/apin12.pdf

12. PACKAGE DRAWING AND DIMENSIONS

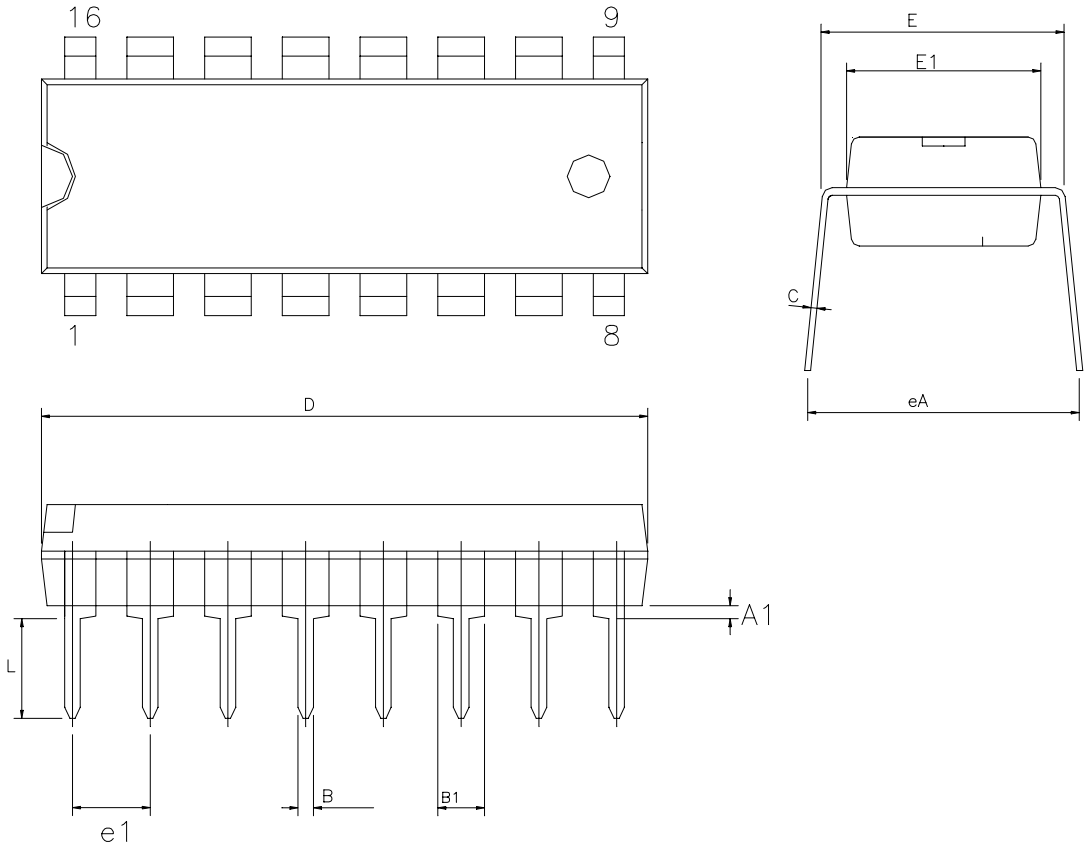
12.1. 16-LEAD 150MIL SMALL OUTLINE IC (SOIC) PACKAGE



COTROL DIMENSIONS ARE IN MILLIMETERS.

SYMBOL	MILLIMETER			INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	1.35	——	1.75	0.053	——	0.069
A1	0.10	–	0.25	0.004	–	0.010
b	0.33	–	0.51	0.013	–	0.020
c	0.19	–	0.25	0.008	–	0.010
D	9.8	–	10.00	0.386		0.394
E	3.8	–	4.0	0.150		0.157
e	1.27 BASIC			0.050 BASIC		
HE	5.8	–	6.20	0.228	–	0.244
θ	0°	–	8°	0°	–	8°
L	0.40	–	1.27	0.016	–	0.050
S	0.394	–	0.648	0.0155	–	0.0255
y	–	–	0.10	–	–	0.004

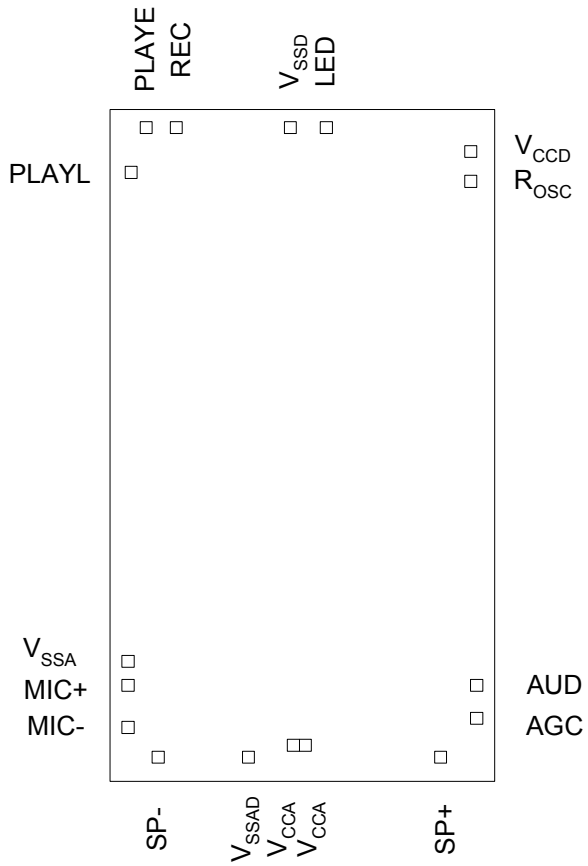
12.2. 16-Lead 300mil Plastic Dual Inline Package (PDIP)



Symbol	Dimension in inch			Dimension in mm		
	Min	Nom	Max	Min	Nom	Max
A1	0.015	–	–	0.381	–	–
B	0.016	0.018	0.020	0.406	0.457	0.508
B1	0.055	0.060	0.065	1.397	1.524	1.651
c	–	0.010	–	–	0.25	–
D	0.740	0.750	0.760	18.796	19.05	19.304
E	0.300	0.312	0.324	7.62	7.925	8.230
E1	0.246	0.250	0.254	6.25	6.35	6.45
e1	0.1BSC			2.54BSC		
L	0.115	–	–	2.921	–	–
eA	0.330	0.350	0.370	8.382	8.89	9.398

12.3. DIE PHYSICAL LAYOUT

ISD1610 / 1612 / 1616 / 1620

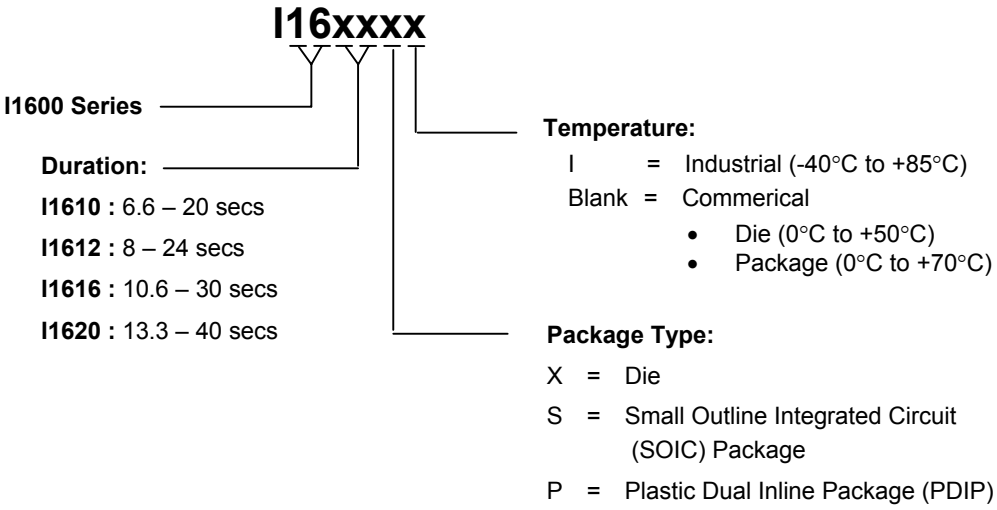


Notes:

[1] The backside of die is internally connected to V_{SS}. It **MUST NOT** be connected to any other potential or damage may occur.

13. ORDERING INFORMATION

Product Number Descriptor Key



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

Die / Package	Ordering Part Number			
Die	I1610X	I1612X	I1616X	I1620X
PDIP	I1610P	I1612P	I1616P	I1620P
	I1610PI	I1612PI	I1616PI	I1620PI
SOIC	I1610S	I1612S	I1616S	I1620S
	I1610SI	I1612SI	I1616SI	I1620SI

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

14. VERSION HISTORY

VERSION	DATE	DESCRIPTION
0.1	July 2004	Initial draft
1	Nov. 2004	Revise Ground description Revise application diagram Revise die information

The contents of this document are provided only as a guide for the applications of Winbond products. Winbond makes no representation or warranties with respect to the accuracy or completeness of the contents of this publication and reserves the right to discontinue or make changes to specifications and product descriptions at any time without notice. No license, whether express or implied, to any intellectual property or other right of Winbond or others is granted by this publication. Except as set forth in Winbond's Standard Terms and Conditions of Sale, Winbond assumes no liability whatsoever and disclaims any express or implied warranty of merchantability, fitness for a particular purpose or infringement of any Intellectual property.

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Application examples and alternative uses of any integrated circuit contained in this publication are for illustration only and Winbond makes no representation or warranty that such applications shall be suitable for the use specified.

The 100-year retention and 10K record cycle projections are based upon accelerated reliability tests, as published in the Winbond Reliability Report, and are neither warranted nor guaranteed by Winbond. This product incorporates SuperFlash® technology.

Information contained in this Winbond ChipCorder® datasheet supersedes all data for the ISD® ChipCorder® products published by ISD® prior to August, 1998.

This datasheet and any future addendum to this data sheet is(are) the complete and controlling ISD® ChipCorder® product specifications. In the event any inconsistencies exist between the information in this and other product documentation, or in the event that other product documentation contains information in addition to the information in this, the information contained herein supersedes and governs such other information in its entirety.

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