LSI/CSI
Since 1969
LS3404 SERIES

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MUSIC BOX QUALITY MELODY GENERATORS

Sept. 1993

FEATURES:
- Realistic Chime-Like Sound
- Mask Programmable 255-Note Capacity ROM
- Excellent Pitch Resolution and Duration Range
- Drives Piezo Transducer directly
- Drives Dynamic Speaker with Single-Transistor Buffer
- Auto Turn-off
- Low Standby Current
- 4.5V to 15V Operation (Vss - VDD)
- Inexpensive Custom Programming offered
- Selection of Pre-Programmed Melodies (See Table 1)
- 8 Pin Plastic DIP (See Figure 1)
- Waffle-Packed Dice and Probed Wafers available.

PIN ASSIGNMENT - TOP VIEW
STANDARD 8 PIN PLASTIC MINI-DIP

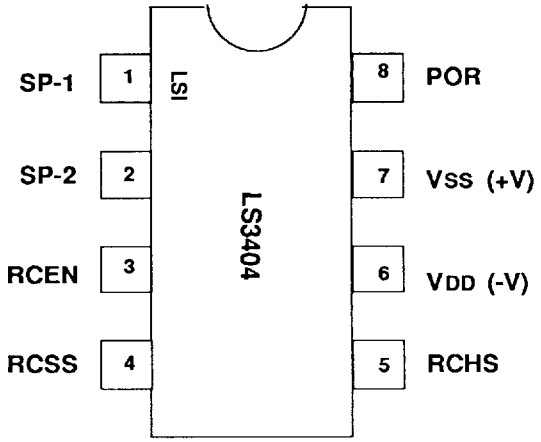

FIGURE 1

APPLICATIONS:
Music Boxes, Musical Ornaments, Musical Teddy Bears, etc. - where sound quality is as critical as low cost.

GENERAL DESCRIPTION:
The LS3404 Series are monolithic MOS Integrated Circuits designed to generate musical sounds. The ICs are mask-programmable and can hold 255 notes in ROM. Each note consists of 7-Bits of data. Pitch data is 4-Bits and Duration data is 3-Bits.
The 4-Bit Pitch data allows 15 different pitches out of a possible 511 pitches to be programmed in each font. The sixteenth possible selection is always devoted to a "Rest" note.
The 3-Bit Duration data allows 8 different durations out of a possible 16 durations to be programmed in each font.
Resolution of Note Pitch is 0.8% at 2KHz Pitch and 1.2% at 3KHz Pitch. (Based upon a 500KHz Pitch Clock - See I/O Description, Pin 5).
The Note Duration ranges from 125 msec for a 1/16th note to 2.0 sec for a full note. (Based upon an 8Hz Duration Clock-See I/O Description, Pin 4).
An external R-C is used to generate an Exponential Decay Envelope (See I/O Description, Pin 3) which is controlled to begin with the start of each note and decay for the duration of the note. The Decay Envelope is combined with each note's Audio-Frequency in two OP-Amps which drive the Speaker Outputs in opposite phase. (See I/O Description, Pins 1 and 2.) These two Outputs are used to directly drive a Piezoelectric Speaker in a Push-Pull configuration. (See Figure 2) A transistor-buffered Dynamic Speaker need only be driven in a Single-Ended configuration which requires only one Output to be used. (See Figure 3)

Upon application of Vss (+V), the IC starts to play after a small time delay caused by Power-On-Reset. (See I/O Description, Pin 8.) Play automatically terminates when an End-of-Play (EOP) Signal is generated after all notes have been sequenced. When EOP occurs, the IC goes into Standby Mode drawing very little current.

The Exponential Decay Envelope imposed on each note along with the range of pitch and duration available accounts for the uniquely realistic musical sound produced by the LS3404 Series of ICs.

INPUT/OUTPUT DESCRIPTION:

SP-1 OUTPUT (Pin 1), SP-2 OUTPUT (Pin 2)
Outputs containing Audio-frequency for the duration of each note, modulated by an exponential decay envelope. Both outputs contain the same information but are configured 180° out-of-phase for push-pull direct drive of a Piezoelectric capacitive type speaker. The typical Piezo transducer has a 27MM diameter with a capacitance of 20,000 pF.

RCEN INPUT (Pin 3)
An external R-C network connected to this input controls the exponential decay envelope which modulates each note. (See Figure 2).

RCSS INPUT (Pin 4)
An external R-C ntetwork connected to this input controls the frequency of the Duration Clock Oscillator. Always connect RD to VDD (-V) and CD to Vss (+V) to ensure proper initialization. (See Figure 2) The Duration Clock Period and the Duration ROM Bits determine the duration of each note.

RCHS INPUT (Pin 5)
An external R-C network connected to this input controls the frequency of the Pitch Clock Oscillator. (See Figure 2) The Pitch Clock Frequency and the Pitch ROM Bits determine the Audio frequency of each note.

VDD (Pin 6)
Supply voltage negative terminal.

Vss (Pin 7)
Supply voltage positive terminal.

POR INPUT (Pin 8)
An external capacitor connected to this input controls the Power-On-Reset time which is used to initialize the circuit. (See Figure 2)

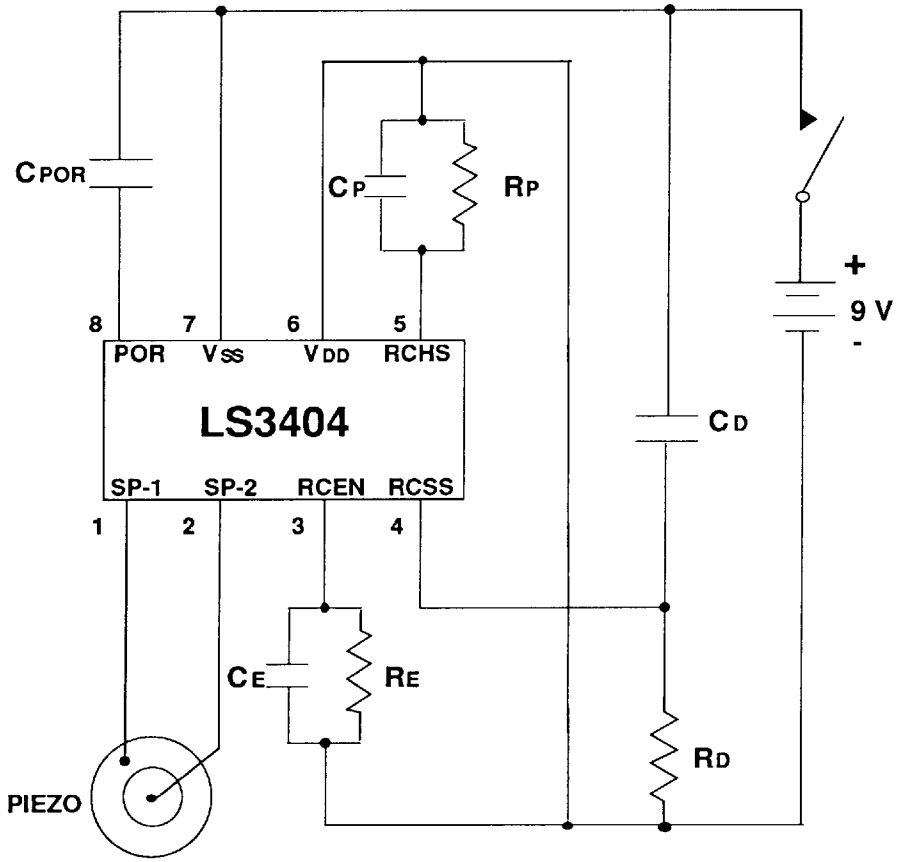

FIGURE 2. Typical Piezo Transducer Schematic

TYPICAL VALUES

RP = 15KΩ
CP = 100pF
RD = 2.2MΩ
CD = 0.1µF
RE = 3.3MΩ
CE = 0.1µF
CPOR = 0.01µF

3404-091493-2

ABSOLUTE MAXIMUM RATINGS (All voltages referenced to V_{DD})

PARAMETER	SYMBOL	VALUE	UNIT
DC Supply Voltage	V_{SS}	+18	V
Any Input Voltage	V_{IN}	0 to V_{SS} +0.5	V
Operating Temperature	T_A	0 to +70	°C
Storage Temperature	T_{STG}	-65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 0 to +70°C. All voltages referenced to V_{DD})

PARAMETER	SYMBOL	MIN	TYPICAL	MAX	UNITS	CONDITION
Supply Voltage	Vss	+4.5	-	+15	V	-
Standby Current	Iss	-	-	15	µA	V_{SS}=6V, R_D=2.2MΩ
At End of Play				25	µA	V_{SS}=10V, R_D=2.2MΩ
Operating Current	Iss	-	4	-	mA	V_{SS}=6V, driving Piezo
(During play)	Iss	-	5	-	mA	V_{SS}=10V, driving Piezo
Pitch Clock Frequency	f_P	425	500	575	KHz	R_P=15KΩ, C_P=100 pF
Duration Clock Frequency	f_P	-	8	-	Hz	R_D=2.2 MΩ, C_D=0.1µF
Duration Clock Frequency Range	f_D	2	-	30	Hz	-
Envelope Resistance	R_E	-	3.3	-	MΩ	-
Envelope Capacitance	C_E	-	0.1	-	µF	-
POR Capacitance	C_P	.01	-	-	µF	-
Speaker Output peak-peak	V_O	4.5	-	-	V	Vss = 6V, f_P=1KHz
voltage	V_O	8.0	-	-	V	Vss = 10V, f_P =1KHz
Tracking of output	V_T	-2.0	-	+0.4	V	Vss = 6V
to the envelope	V_T	-2.5	-	+0.4	V	Vss = 10V

FONT	SONG
3404-02	Christmas Medley
3404-03	"Somewhere My Love"
3404-04	"As Time Goes By"
3404-05	"Let Me Call You Sweetheart"
3404-08	"I'm In The Mood For Love"
3404-09	"Wedding March"
3404-10	"Happy Birthday I"
3404-11	"Zip-A-Dee-Doo-Dah"
3404-12	"Brahm's Lullabye"
3404-14	"Santa Claus Is Coming To Town"
3404-15	Christmas Angel Medley
3404-16	"We Wish You A Merry Christmas"
3404-17	"Walking In A Winter Wonderland"
3404-18	"Jingle Bells"
3404-19	"Joy To The World"
3404-20	"Love Makes The World Go Round"

FONT	SONG
3404-21	"My Favorite Things"
3404-22	"What The World Needs Now"
3404-23	"I'd Do Anything"
3404-24	"Hail To The Chief"
3404-25	"Thanks For The Memories"
3404-26	"Gonna Fly Now" (Rocky)
3404-27	"Lazy Crazy Hazy Days of Summer"
3404-28	"For He's A Jolly Good Fellow"
3404-29	"Pomp & Circumstance"
3404-30	"More"
3404-31	"Ain't She Sweet"
3404-32	"You Are The Sunshine Of My Life"
3404-33	Nursery Rhyme Medley
3404-34	"Happy Birthday II"
3404-35	Brahms/Mozart Lullabye Medley

TABLE 1. Listing of the 31 Available Melodies

Note: Contact Harry Fox Agency, N.Y., N.Y. to determine if a Song Royalty Fee is required.

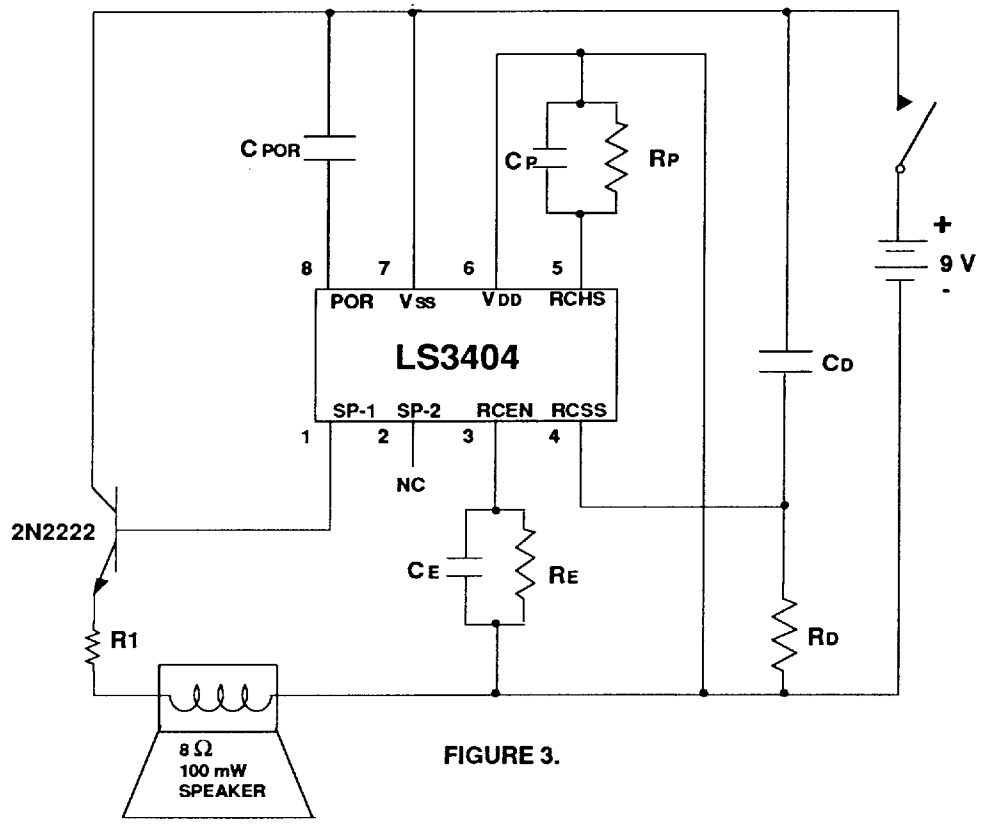

FIGURE 3.

TYPICAL VALUES

R_P = 15KΩ
C_P = 100pF
R_D = 2.2MΩ
C_D = 0.1μF
R_E = 3.3MΩ
C_E = 0.1μF
C_{POR} = 0.01μF

Typical 8 Ohm speaker connection. In this configuration only SP-1 is used to drive the external 8 ohm speaker in a single ended mode. Resistor R1 is used as a volume control and can be omitted for maximum volume.