YAMAHA LSI

YSS244

SCORE

■ OUTLINE

The YSS244 (SCORE) provides the score of a singer's karaoke performance. The LSI samples pitch and volume of both model vocal (in the karaoke source) and the singer's vocal, then compares the sampled data to determine the score of the singer.
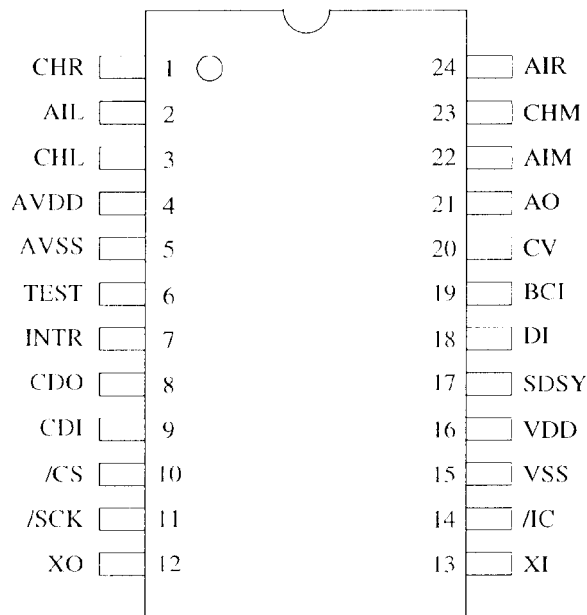
In addition, the LSI has a sound-effect generator that produces desired sound effects such as applause by using internally stored digital data that have been compressed conforming to Adaptive Differential Pulse-Code Modulation (hereafter referred to as "ADPCM").

The YSS244 stores built-in default values of various parameters that can be used to calculate the score through Yamaha's original scoring system. Thus, use of this LSI reduces load on the microprocessor in performing the scoring function and helps to shorten the period for development of the system.

■ FEATURE

- Simultaneously samples pitches of model vocal and singer's vocal.
- Samples pitch in a range of four octaves (65 Hz to 1.3 kHz).
- Completes sampling of pitch within 93 msec. (The time varies according to the pitch.)
- Simultaneously samples volumes of three types of inputs including model vocal, singer's vocal, and accompaniment. The signal of accompaniment is useful for detection of start and end of a music.
- Outputs scores on the basis of 100 points with the use of a simple scoring system that operates on Yamaha's original algorithm.
- The ROM (192 kbits) built in this LSI stores sound data compressed based on ADPCM to be used for generating sound effects.
- Stores fifteen types of sound effects. One type of sound such as an applause can be selected from them at a time. The playback and fade-out time can be specified for the sound selected.
- Sound effects are stored in the built-in ROM sampled with frequency of 8.82 kHz that is one fifth of vocal signal sampling frequency, 44.1 kHz. Thus, instantaneous levels of sound effect between two consecutive sampling moments are determined by using linear interpolation at four equally spaced points between the two values.
- Has one channel of 12-bit floating D/A converter for outputting analog playback.
- Has two channels for digital audio input, other two channels for 8-bit A/D converter that are used for processing model vocal, and one channel for another 8-bit A/D converter that is used for processing singer's vocal.
- Uses serial interface for reading or writing parameters, commands and data on the microprocessor.
- Can generate interrupt signal upon detecting specified data.
- Supports use of analog/digital multiplex karaoke source for model vocal.
- Master clock ; 16.9344 MHz / Sampling frequency ; 44.1 kHz.
- 5 V single, Si-gate CMOS process
- 24 pin SOP (YSS244-M)

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■ PIN CONFIGURATION

```
          ┌─────────∪─────────┐
   CHR ──┤ 1  ○            24 ├── AIR
   AIL ──┤ 2               23 ├── CHM
   CHL ──┤ 3               22 ├── AIM
  AVDD ──┤ 4               21 ├── AO
  AVSS ──┤ 5               20 ├── CV
  TEST ──┤ 6               19 ├── BCI
  INTR ──┤ 7               18 ├── DI
   CDO ──┤ 8               17 ├── SDSY
   CDI ──┤ 9               16 ├── VDD
   /CS ──┤ 10              15 ├── VSS
  /SCK ──┤ 11              14 ├── /IC
    XO ──┤ 12              13 ├── XI
          └───────────────────┘
```

<24pin SOP Top View>

■ PIN FUNCTION

No.	NAME	I/O	FUNCTION
1	CHR	A	Connects sample hold capacitor for R channel input
2	AIL	A	L channel analog audio input
3	CHL	A	Connects sample hold capacitor for L channel input
4	AVDD	-	+5 power supply (For analog system. Connect with VDD.)
5	AVSS	-	Ground (For analog system. Connect with VSS.)
6	TEST	I+	LSI test terminal (To be open at normal operation)
7	INTR	OD	Microprocessor interface　　Interrupt output
8	CDO	O	Microprocessor interface　　Serial data output
9	CDI	I	Microprocessor interface　　Serial data input
10	/CS	I	Microprocessor interface　　Chip select
11	/SCK	I	Microprocessor interface　　Serial clock
12	XO	O	Connects crystal oscillator
13	XI	I	Connects crystal oscillator or inputs external clock signal (16.9344 MHz)
14	/IC	I	Initial clear
15	VSS	-	Ground (For digital system)
16	VDD	-	+5 power supply (For digital system)
17	SDSY	I+	Digital audio input　　Word clock
18	DI	I+	Digital audio input　　Serial data
19	BCI	I+	Digital audio input　　Bit clock
20	CV	OA	ADC center voltage output
21	AO	OA	Analog audio (sampled sound) output
22	AIM	A	Microphone(singer) analog audio input
23	CHM	A	Connects sample hold capacitor for microphone input
24	AIR	A	R channel analog audio input

Note)　I+ : Input terminal with pull up resistor,　A : Analog terminal,　OD : Open drain terminal

YSS244

■ BLOCK DIAGRAM
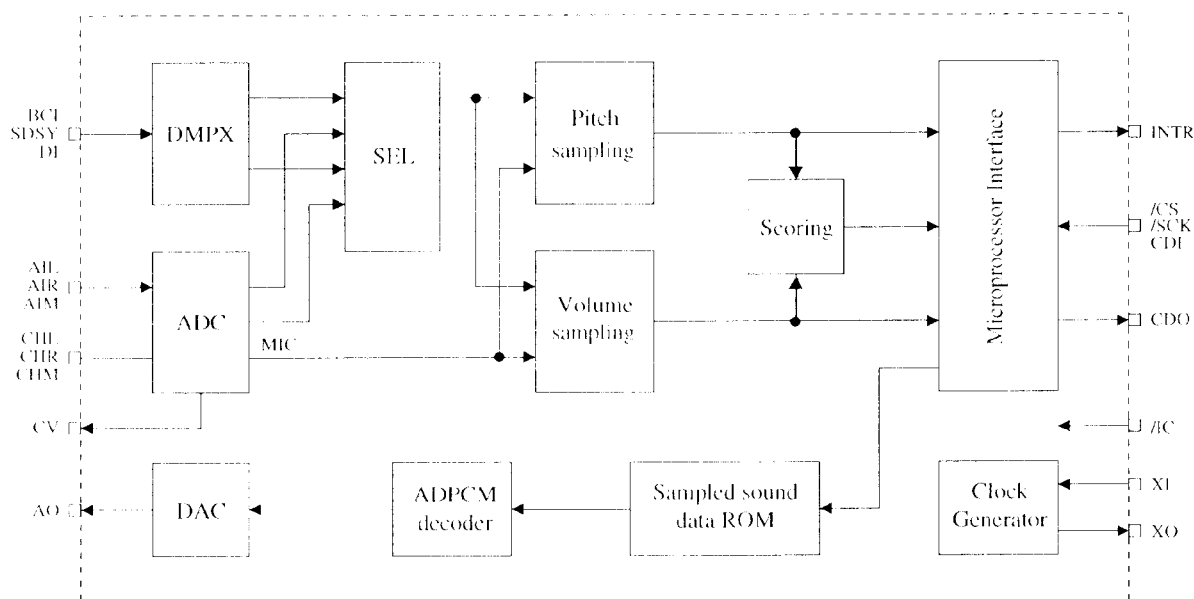
## ■ OUTLINE OF FUNCTIONS

1. Clock signal XI, XO

XI and XO terminals are used to form a crystal oscillation circuit which generates a frequency of 16.9344 MHz. External clock signal can be input through XI terminal.

2. Analog inputs AIL, AIR, AIM, CHL, CHR, CHM, CV

Analog signals from L, R channels and microphone are input to AIL, AIR and AIM terminals respectively.
The sampling for A/D conversion is made at the frequency of 44.1 kHz.
CHL, CHR and CHM terminals are used to connect sample hold capacitors for A/D conversion.
CV is a terminal where center voltage of A/D converter is obtained. Connect a capacitor for stabilizing.
Use this voltage as bias for analog input signal.

3. Digital inputs   BCI, SDSY, DI

Digital audio data are input from BCI, SDSY and DI terminals using the following format.
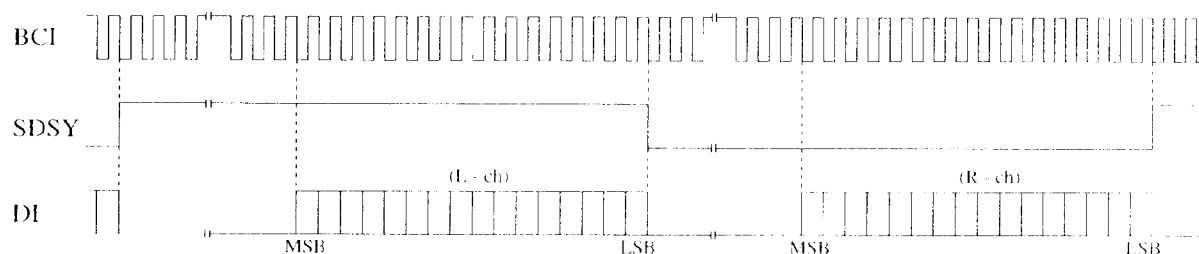

After the digital data has been taken in with 16-bit stereophonic format, upper 12 bits are used for signal processing and lower 4 bits are ignored. BCI, SDSY and DI signals must be synchronized with XI clock.
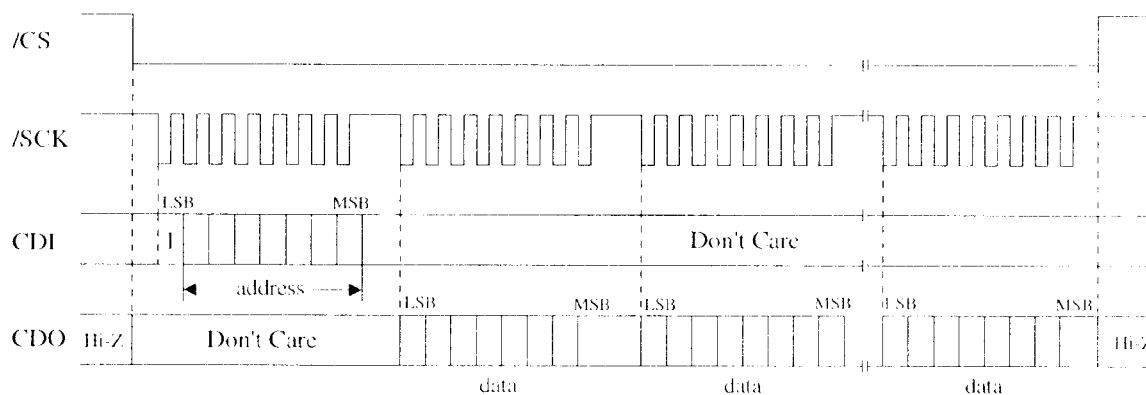
4. Microprocessor interface   /CS, /SCK, CDI, CDO

These terminals are used as 8 bit serial interface that are used to write or read the internal register data. The register data are written or read using the following format.

●   Register data write timing
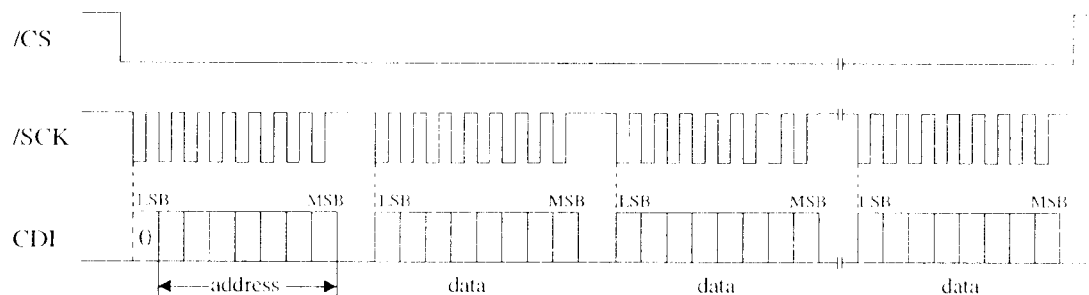
●   Register data read timing

LSB bit of the first byte is used to identify register write/read from the microcomputer.
     0 : Write (W)
     1 : Read (R)
The other seven bits of the first byte are used to set the address. The second and the following bytes are used to set the register data. Addresses 00H to 12H are used to set 8-bit (1 byte) data, and 40H and the following addresses are used to set 16-bit (2 byte) data.

When writing data into or reading data from consecutive addresses, the address is incremented automatically.
For the addresses 00H to 12H, the address is incremented every time one byte of data has been written (or read).
For the addresses 40H and after, the address is incremented every time two bytes of data have been written (or read).

5. Interrupt output   INTR

An interrupt signal is outputted through INTR pin at detection of data. (Active low)
Use the interrupt mask register (05H) to set the type of data to be detected. Two or more types of the data can be set.
When INTR pin has become active, the type of data detected is set into the interrupt register (06H). The interrupt register (06H) is cleared to "0" when the register value has been read. The pin becomes high impedance state at the same time.

6. Analog output   AO

AO is a D/A converter output terminal from which sound effects are outputted.
The sound effect signals are stored in the built-in ROM as ADPCM compressed digital data made with the sampling frequency of 8.82 kHz that is one fifth of the vocal signal sampling frequency, 44.1 kHz.
When playing back a sound effect, the signals are decoded conforming to ADPCM, and then instantaneous levels of sound effect between two consecutive sampling moments are determined by using linear interpolation at four equally spaced points between the two values.
Because voltage signal is outputted from this AO pin, add sample hold capacitor to this pin and input the signal through this pin into a buffer operation amplifier with high input impedance.

No.	Type of sound
1	Snare roll
2	Applause (1)
3	Fanfare
4	Sound of bell, do (One octave higher "do" of No.5)
5	Sound of bell, do
6	Sound of bell, re
7	Sound of bell, mi
8	Sound of bell, fa
9	Sound of bell, so
10	Sound of bell, la
11	Sound of bell, si
12	Hand clapping
13	Finger snapping
14	Funny sound
15	Applause (2)

7. Initial clear   /IC
This LSI requires initial clear when turned on.

8. LSI test terminal   TEST
This terminal is used to test this LSI, which is to be open at normal operation.

■ REGISTERS

Each of addresses 00H to 12H consists of 8 bits (by byte). These addresses are allotted for read only registers (R) and read/write registers (R/W). Each of addresses 40H to 6FH consists of 16 bits (per two bytes), all of which are used as read/write registers. "N" used in explanation of the following addresses are defined as follows for bit j to bit i.

$$N = \sum_{k=i}^{j} \text{bit } k \times 2^{k-i}$$

Address 00H (R/W)

bit 7 (MSB)	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0 (LSB)

bit 7 to bit 4 : Model vocal key control

The pitch adjustment can be made in the range between -800 cents to +700 cents inclusive with resolution of 100 cents.

The pitch of the model vocal that has been corrected is applied to scoring the karaoke singer for his/her pitch.

bit 3 to bit 0 : Selection of tone for sampled sound

N=0 : No sampled sound

N=1 to 15 : Sampled sound is available with 15 types.

Address 01H (R/W)

bit 7 (MSB)	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0 (LSB)

bit 7 to bit 4 : Sampled sound repetition period.

The period can be set between 0 and 6.96 seconds inclusive.

N=0 : Sampled sound is generated once.

N>0 : N x 464 msec

bit 3 to bit 0 : Sampled sound decay time

Time for decaying down to -54 dB (1/512) can be set between 116 milliseconds (msec) and 3.596 seconds inclusive.   (N x 2 + 1) x 116 msec.

Address 02H (R/W)

bit 7 (MSB)	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0 (LSB)

bit 7 to bit 4 : Interval between two consecutive comparisons of model and singer's pitch and volume for scoring (N=1 to 15)

The interval can be set between 14.5 and 217 msec inclusive.

When the scoring condition that is specified at the address 03H has been met at N x 14.5 msec (N=1 to 15), the model and singer's vocals are compared for their pitches and volumes and the scoring counter is activated.

bit 3 : At writing : Don't care, or at reading : "0" is read.

bit 2 to bit 0 : Interval between two consecutive scoring occasions (N=0 to 4).

The result of scoring is updated at every $(2^{(N+4)} - 1)$ x (above mentioned pitch comparison period) seconds where N=0 to 4.

Address 03H (R/W)

bit 7 (MSB)	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0 (LSB)

bit 7 to bit 4 : At writing : Don't care, or at reading : "0" is read.

bit 3 : Scoring starting register

0 : Scoring result is held.

1 : Scoring is started.

bit 2, 1 : Selection of scoring condition (See Note 1 and Note 2.)

(bit 2, bit 1)=(0, 0) : Scoring is made in the period where volume level of model vocal is detected.

(bit 2, bit 1)=(0, 1) : Scoring is made in the period where volume level of model vocal is detected and pitch of model vocal is sampled.

(bit 2, bit 1)=(1, 0) : Scoring is made in the period where volume level of singer's vocal is detected.

(bit 2, bit 1)=(1, 1) : Scoring is made in the period where volume level of singer's vocal is detected and pitch of model vocal is sampled.

bit 0 : Selection of volume comparison condition

0 : Result of scoring is determined as "good" when the difference between volume level of the singer's vocal and that of model vocal is at or over the specified level.

1 : Result of scoring is determined as "good" when the difference between volume level of the singer's vocal and that of model vocal is within the specified range.

YSS244

Address 05H (R/W)

bit 7 (MSB)	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0 (LSB)

Interrupt mask register

0 : Interrupt prohibited, 1 : Interrupt permitted

INTR terminal is set to "low" when an interrupt has occurred in any bit to which "1" has been set.

- bit 7 : At writing : Don't care, or at reading : "0" is read.
- bit 6 : Singer's vocal zero cross interrupt
- bit 5 : Model vocal zero cross interrupt
- bit 4 : Singer's vocal pitch sampling interrupt
- bit 3 : Model vocal pitch sampling interrupt
- bit 2 : Singer's vocal volume level sampling interrupt
- bit 1 : Model vocal volume level sampling interrupt
- bit 0 : Accompaniment volume level sampling interrupt

Address 06H (R)

bit 7 (MSB)	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0 (LSB)

Interrupt register

1 : Interrupt has occurred.

When data of this address has been read, the register is cleared to "0" and the interrupt is canceled.

- bit 7 : "0" is read.
- bit 6 : Singer's vocal zero cross interrupt
- bit 5 : Model vocal zero cross interrupt
- bit 4 : Singer's vocal pitch sampling interrupt
- bit 3 : Model vocal pitch sampling interrupt
- bit 2 : Singer's vocal volume level sampling interrupt
- bit 1 : Model vocal volume level sampling interrupt
- bit 0 : Accompaniment volume level sampling interrupt

Address 07H (R)

bit 7 (MSB)	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0 (LSB)

- bit 7 : Singer's vocal pitch sampling bit.
  This bit is set to "1" when pitch of the singer's vocal has been sampled. While the bit 7 is "1", the pitch data obtained by the sampling is shown by the bits 6 to 0 as described below.
- bit 6 to bit 4 : Octave (by 1200 cents) data of singer's vocal (P)
- bit 3 to bit 0 : Halftone (by 100 cents) data of singer's vocal (Q)

Frequency (f) of the singer's vocal is calculated using the following equation.

$$f \ [Hz] = A \times 2^{(P+Q/12)} \qquad A = 31.77$$

Address 08H (R)

bit 7 (MSB)	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0 (LSB)

- bit 7 : Model vocal pitch sampling bit.
  This bit is set to "1" when pitch of the model vocal has been sampled. While the bit 7 is "1", the pitch data obtained by the sampling is shown by the bits 6 to 0 as described below.
- bit 6 to bit 4 : Octave (by 1200 cents) data of model vocal (P)
- bit 3 to bit 0 : Halftone (by 100 cents) data of model vocal (Q)

Frequency (f) of the model vocal is calculated using the following equation.

$$f \ [Hz] = A \times 2^{(P+Q/12)} \qquad A = 31.77$$

Address 09H (R) | bit 7 (MSB) | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 | bit 0 (LSB) |
bit 7 :   "0" is read.
bit 6 to bit 0 :   Pitch data of singer's vocal (by 10 cents)

Address 0AH (R) | bit 7 (MSB) | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 | bit 0 (LSB) |
bit 7 :   "0" is read.
bit 6 to bit 0 :   Pitch data of model vocal (by 10 cents)

Address 0BH (R) | bit 7 (MSB) | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 | bit 0 (LSB) |
bit 7 to bit 0 :   Singer's vocal volume data

Address 0CH (R) | bit 7 (MSB) | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 | bit 0 (LSB) |
bit 7 to bit 0 :   Model vocal volume data

Address 0DH (R) | bit 7 (MSB) | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 | bit 0 (LSB) |
bit 7 to bit 0 :   Accompaniment volume data

Address 0EH (R) | bit 7 (MSB) | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 | bit 0 (LSB) |
bit 7 :   "0" is read.
bit 6 to bit 0 :   Result of scoring   0 to 100 points

Address 04H, 0FH to 12H
These registers are used for testing, thus should not be used for writing or reading data.

Address 40H to 46H, 6FH (R/W)
Used to set input coefficient and mixing coefficients.

Address 47H to 57H (R/W)
Used to set coefficients for LPF and HPF.

Address 58H to 5AH (R/W)
Used to set criteria for detection of volume levels of singer's vocal, model vocal and accompaniment, and reference value for interrupt.

Address 61H (R/W)
Used to determine criteria for comparison of pitches of singer's vocal and model vocal (volume grading criteria) under which the singer's vocal is scored for the pitch.

Address 62H (R/W)
Used to determine criteria for comparison of volumes of singer's vocal and model vocal (volume grading criteria) under which the singer's vocal is scored for the volume.

Address 63H (R/W)

Used to determine criteria for comparison of volume of singer's vocal and model vocal. The singer's volume is determined "good" when the difference is within the specified range.

Address 64H to 67H (R/W)

Used to set coefficient for scoring. Balances data including pitch, volume and random numbers that are used for scoring.

Address 68H, 69H (R/W)

Fixed value (C61) or internally operated variables (C6A to C6D) is specified here to be used as a pitch grading criteria.
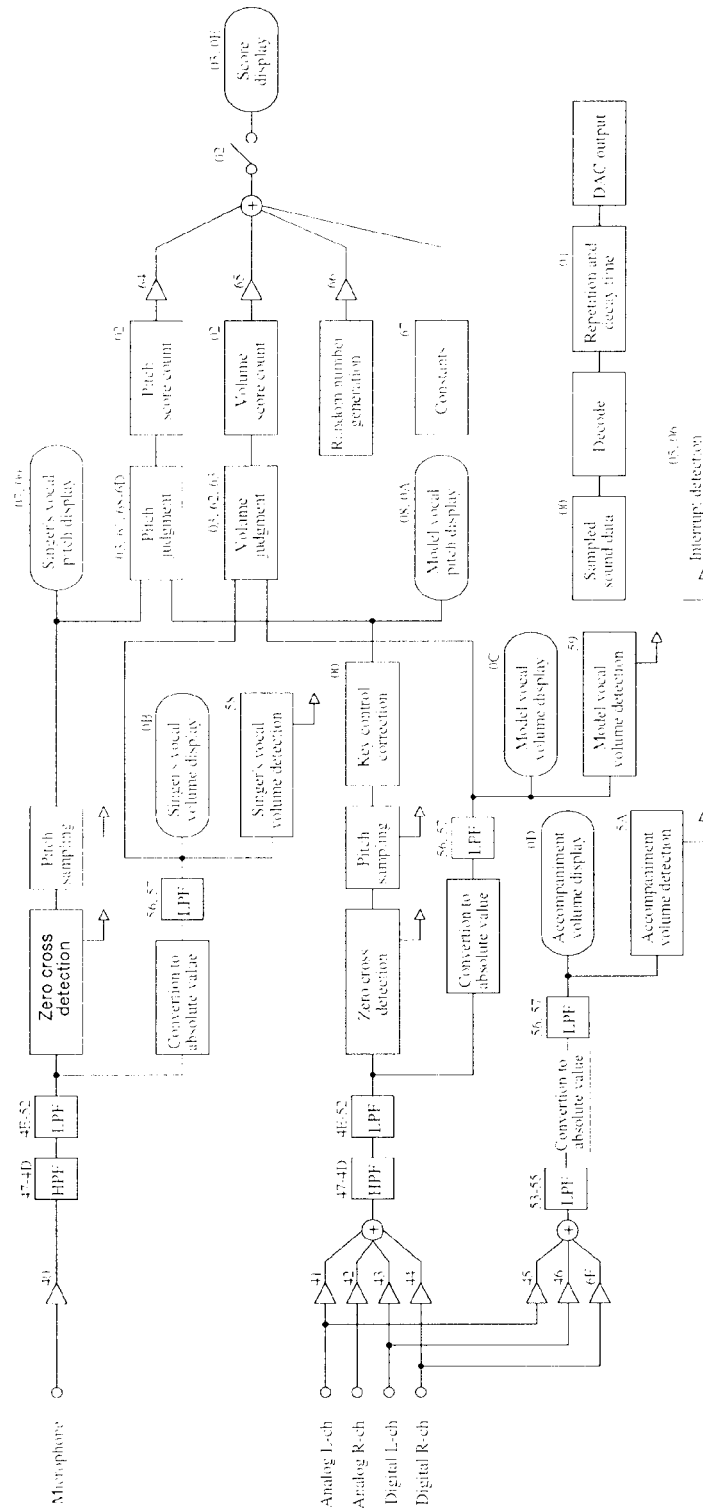
Address 6AH to 6DH (R/W)

Used to calculate pitch grading criteria based on 4 coefficients. It changes by the present score, and it becomes strict as the score goes up.

Address 5BH to 60H, 6EH

These are used for testing, thus should not be used for writing or reading data.

■ SIGNAL FLOW AND REGISTER ADDRESS

■ ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Rating

Item	Code	Rating	Unit
Power Supply Voltage	VDD	-0.3 ~ 7.0	V
Input Voltage	VI	-0.3 ~ VDD+0.5	V
Operating Temperature	Top	0 ~ 70	°C
Storage Temperature	Tstg	-50 ~ 125	°C

2. Recommended Operating Conditions

Item	Code	Min.	Typ.	Max.	Unit
Power Supply Voltage	VDD	4.75	5.00	5.25	V
Operating Temperature	Top	0	25	70	°C

3. DC Characteristics (Conditions: VDD=5.0±0.25V, Ta=25 °C)

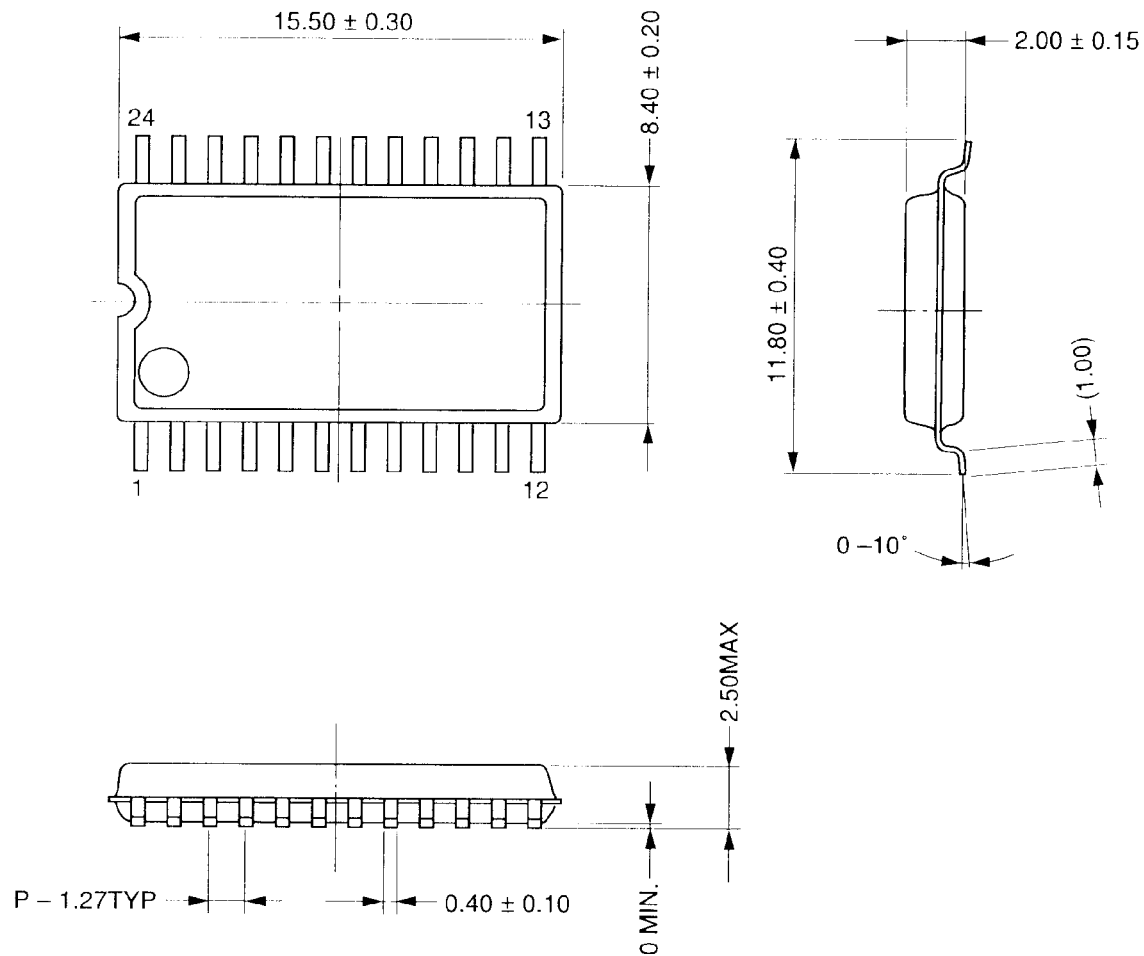| Item	Code	Condition	Min.	Typ.	Max.	Unit
Power supply current	IDD			40		mA
Input voltage H level (1)	VIH1	*1)	2.2			V
Input voltage H level (2)	VIH2	*2)	0.7VDD			V
Input voltage L level (1)	VIL1	*1)			0.8	V
Input voltage L level (2)	VIL2	*2)			0.3VDD	V
Input leakage current	ILI	*3)			10	μA
Output voltage H level	VOH	IOH = -80μA	2.7			V
Output voltage L level	VOL	IOL = 1.6mA			0.4	V
Pull-up resistor	RU		60	200	600	kΩ
Input pin capacitance	CI	f = 1MHz			12	pF
Output pin capacitance	CO	f = 1MHz			12	pF

*1) Applies to input pins except XI and /IC pins.
*2) Applies to XI and /IC pins.
*3) Applies to CDI, /CS, /SCK, XI and /IC pins.

■ EXTERNAL DIMENSIONS

YSS244-M (24pin SOP)

15.50 ± 0.30

8.40 ± 0.20

24

13

1

12

2.00 ± 0.15

11.80 ± 0.40

(1.00)

0 −10°

2.50MAX

P − 1.27TYP

0.40 ± 0.10

0 MIN.

端子厚さ：0.15±0.10
(LEAD THICKNESS)

カッコ内の寸法値は参考値とする
モールド外形寸法はバリを含まない
単位（UNIT）：mm

The figure in the parenthesis (   )
should be used as a reference.
Plastic body dimensions do not
include burr of resin.
UNIT : mm

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