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About the change in the name such as "Oki Electric Industry Co. Ltd." and "OKI" in documents to OKI Semiconductor Co., Ltd.

The semiconductor business of Oki Electric Industry Co., Ltd. was succeeded to OKI Semiconductor Co., Ltd. on October 1, 2008. Therefore, please accept that although the terms and marks of "Oki Electric Industry Co., Ltd.", "Oki Electric", and "OKI" remain in the documents, they all have been changed to "OKI Semiconductor Co., Ltd.". It is a change of the company name, the company trademark, and the logo, etc. , and NOT a content change in documents.

October 1, 2008
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OKI Semiconductor

FEDL6722-05

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MSM6722

Pitch Control IC for The Speech Signal

GENERAL DESCRIPTION

The MSM6722 converts in real-time the pitch of the speech signal in a range of one octave upward or downward.

Two pitch control methods can be selected. One is to change the pitch in 17 steps by two switch inputs, and the other is to select one of 16 steps by four binary input lines.

Since a microphone preamplifier and a low-pass filter are built in, the pitch conversion set can easily be configured by connecting a microphone, amplifier, and speaker in the peripheral circuit. The MSM6722 is functionally compared to the MSM6322, as described below.

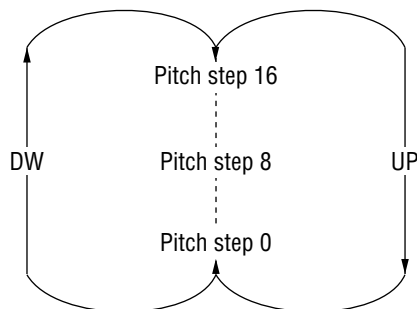
1. Method of resetting the speech pitch step (UP/DW mode)

MSM6322 PRST pin only

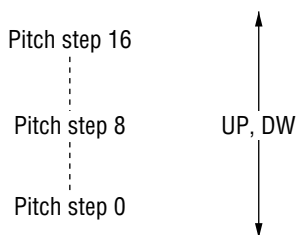
MSM6722 Two methods are available. One is to reset by the PRST pin only, and the other is to reset using the UPC and DWC pins concurrently.

2. Change in pitch

MSM6322 Speech pitch is changeable in 17 steps.



MSM6722 The pitch step does not change if a signal is input to the UPC (DWC) pin when the pitch step is 16 or 0.



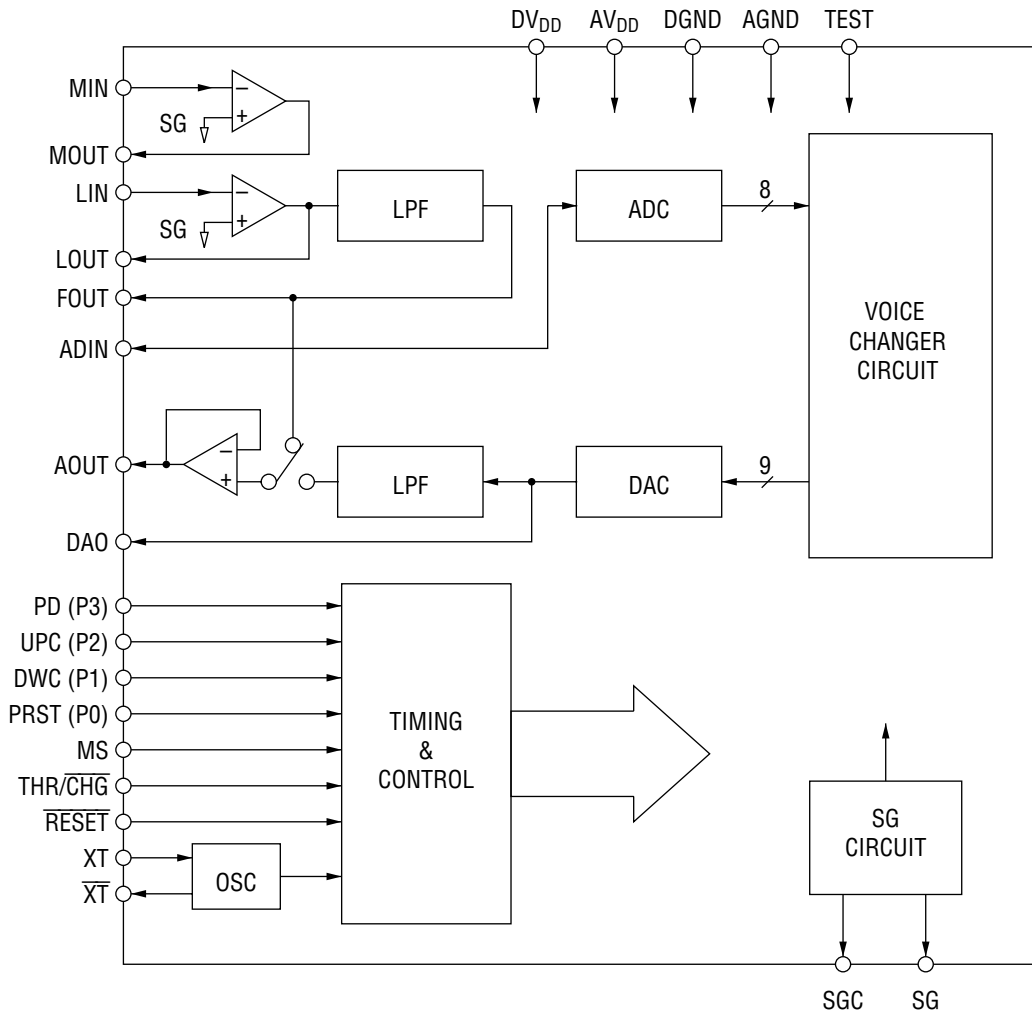
3. Additional THR/ $\overline{\text{CHA}}$ pin

This pin outputs a voice signal without passing the pitch conversion circuit including ADC•DAC.

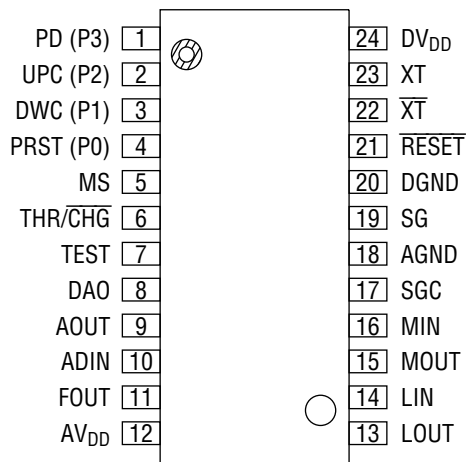
FEATURES

- Built-in microphone preamplifier
- Built-in low-pass filters
- Built-in 8-bit AD converter
- Built-in 9-bit DA converter
- Speech pitch alterable in 17 steps (including the no pitch change step)
- Master clock frequency at 4 MHz
- 5 V single power supply
- Package : 24-pin plastic SOP (SOP24-P-430-1.27-K) (MSM6722GS-K)
Chip

BLOCK DIAGRAM



PIN CONFIGURATION (TOP VIEW)



24-Pin Plastic SOP

PIN DESCRIPTIONS

Common to UP/DOWN Mode and BINARY Mode

Pin	Symbol	Type	Description
24	DV _{DD}	—	Digital power supply pin. Insert a bypass capacitor of 0.1 μF or more between this pin and DGND.
20	DGND	—	Digital ground pin.
12	AV _{DD}	—	Analog power supply pin. Insert a bypass capacitor of 0.1 μF or more between this pin and AGND.
18	AGND	—	Analog ground pin.
16	MIN	I	Inverting input pins for the built-in OP amplifier. The non-inverting input pin is connected internally to SG.
14	LIN		
15	MOUT	O	MOUT and LOUT are output pins of the built-in OP amplifier for MIN and LIN respectively.
13	LOUT		
10	ADIN	I	Input pin for the built-in 8-bit AD converter.
11	FOUT	O	Output pin from the built-in LPF. Connect to ADIN Pin.
9	AOUT	O	Output pin from built-in LPF. This pin is used to output speech signals and to connect the amplifier for driving speaker.
8	DAO	O	Output pin from built-in 9-bit DA converter.
21	$\overline{\text{RESET}}$	I	The IC enters the initial state when this pin is at the "L" level. At this time, the oscillation stops and the DA converter output (DAO) and audio output (AOUT) fall to the GND level. Then the IC returns to the initial state. The IC has a built-in power-on-reset circuit. For normal power-on reset operation, supply the power within 1 msec. If power cannot be supplied within 1 msec, apply a $\overline{\text{RESET}}$ pulse after the power is switched on.
6	THR/ $\overline{\text{CHG}}$	I	Select pin for the pitch control or non-pitch control. With a "H" level input, the IC outputs a normal speech signal from the AOUT pin through the built-in OP amplifier. With a "L" level input, the IC outputs a pitch controlled speech signal from the AOUT pin.
7	TEST	I	Test pin to be fixed to "L" level.
23	XT	I	Crystal oscillator connecting pin. When using the external clock, use this pin as the input.
22	$\overline{\text{XT}}$	O	Crystal oscillator connecting pin. When using the external clock, this pin must be left OPEN.
19	SG	O	These pins output the reference voltage (signal ground (SG)) of the analog circuit. The output is approximately 1/2 the AV _{DD} level.
17	SGC		

UP/DOWN Mode Only

Pin	Symbol	Type	Description
5	MS	I	Mode select pin. This pin must always be tied low.
2	UPC	I	Pins for raising or lowering the pitch by one step at a time. The pitch changes by one step upward (or downward) each time a "H" level pulse is input to the UPC (or DWC) pin. The circuit enters the "no pitch change" state when an "H" level pulse is input to these pins simultaneously.
3	DWC		
1	PD	I	Power-down pin. All clocks, including the internal oscillator circuit, are stopped when the PD pin is set to the "H" level.
4	PRST	I	Pitch reset pin. The circuit enters the "no pitch change" state when this pin is set to the "H" level.

Binary Mode Only

Pin	Symbol	Type	Description
5	MS	I	Mode select pin. This pin must always be tied high.
1	P3	I	The pitch step is directly set by 4 pins (bits) of P3 (MSB) to P0 (LSB). One of the 16 steps from step 0 (P3=P2=P1=P0="L") to step 15 (P3=P2=P1=P0="H") can be set.
2	P2		
3	P1		
4	P0		

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Condition	Rating	Unit
Power-supply voltage	V_{DD}	$T_a = 25^\circ\text{C}$	-0.3 to +7.0	V
Input voltage	V_{IN}	$T_a = 25^\circ\text{C}$	-0.3 to $V_{DD} + 0.3$	V
Storage temperature	T_{STG}	—	-55 to +150	$^\circ\text{C}$

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Condition	Range	Unit
Power-supply voltage	V_{DD}	DGND = AGND = 0 V	4.5 to 5.5	V
Operating temperature	T_{op}	—	-10 to +70	$^\circ\text{C}$
Master clock frequency	f_{OSC}	—	4 to 4.5	MHz

ELECTRICAL CHARACTERISTICS

DC Characteristics

($T_a = -10$ to $+70^\circ\text{C}$, $DV_{DD} = AV_{DD} = 4.5$ V to 5.5 V, DGND = AGND = 0 V)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
"H" input voltage	V_{IH}	—	$0.8 \times V_{DD}$	—	—	V
"L" input voltage	V_{IL}	—	—	—	$0.2 \times V_{DD}$	V
"H" input current *1	I_{IH1}	$V_{IH} = V_{DD}$	—	—	10	μA
"H" input current *2	I_{IH2}	$V_{IH} = V_{DD}$	—	—	20	μA
"H" input current *4	I_{IH3}	$V_{IH} = V_{DD}$	20	—	650	μA
"L" input current *3	I_{IL1}	$V_{IL} = \text{GND}$	-10	—	—	μA
"L" input current *2	I_{IL2}	$V_{IL} = \text{GND}$	-20	—	—	μA
Operating current consumption (1)	I_{DD}	$f_{OSC} = 4$ MHz, no load	—	6	12	mA
Operating current consumption (2)	I_{PD}	At power down, no load $T_a = -40$ to $+70^\circ\text{C}$	—	—	10	μA
		At power down, no load $T_a = -40$ to $+85^\circ\text{C}$	—	—	50	μA

*1 Applies to all input pins excluding the XT pin.

*2 Applies to the XT pin.

*3 Applies to all the input pins without pull-down resistors, excluding the XT pin (i.e., pins 1, 5-7, 10, 14, 16, 21; however pin 1 is applied only during UP/DOWN mode).

*4 Applies to the input pins with pull-down resistors, excluding the XT pin (i.e., pins 1, 2, 3, 4; however, pin 1 is applied only during BINARY mode).

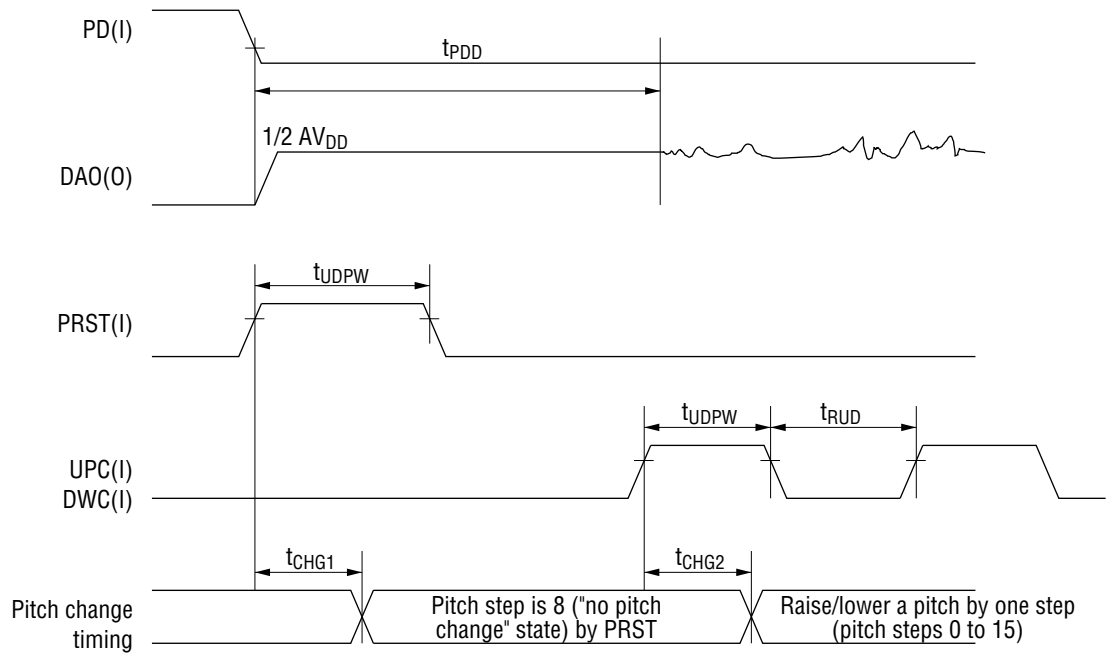
Analog Characteristics(Ta = -10 to +70°C, DV_{DD} = AV_{DD} = 4.5 V to 5.5 V, DGND = AGND = 0 V)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
DA output relative error	V _{DAE}	No load	—	—	40	mV
AD output relative error	V _{ADE}	No load	—	—	40	mV
SCF allowable input voltage range	V _{FIN}	—	1	—	V _{DD} -1	V
SCF input impedance	R _{FIN}	—	1	—	—	MΩ
OP amplifier open loop gain	G _{OP}	f _{IN} = 0 to 4 kHz	40	—	—	dB
OP amplifier input impedance	R _{INA}	—	1	—	—	MΩ
OP amplifier load resistance	R _{OUTA}	—	200	—	—	kΩ
AOUT load resistance	R _{AOUT}	—	50	—	—	kΩ

AC Characteristics(Ta = -10 to +70°C, f_{OSC} = 4 MHz, DV_{DD} = AV_{DD} = 4.5 V to 5.5 V, DGND = AGND = 0 V)

Parameter	Symbol	Condition	Min	Max	Unit
DAO output delay from falling edge of PD	t _{PDD}	f _{OSC} = 4 MHz	—	16	ms
Pulse width of PRST, UPC, and DWC pulses	t _{UDPW}	f _{OSC} = 4 MHz	62	—	ms
Time between UPC and DWC pulses	t _{RUD}	f _{OSC} = 4 MHz	31	—	ms
Pitch change delay from rising edge of PRST	t _{CHG1}	f _{OSC} = 4 MHz	62	—	ms
Pitch change delay from rising edge of UPC and DWC	t _{CHG2}	f _{OSC} = 4 MHz	31	—	ms

TIMING DIAGRAM

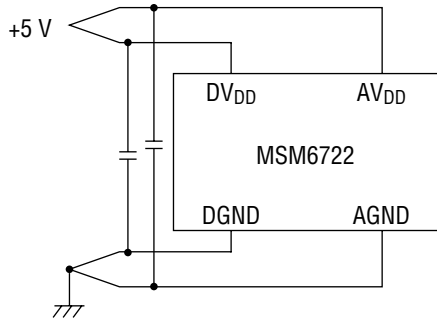


FUNCTIONAL DESCRIPTION

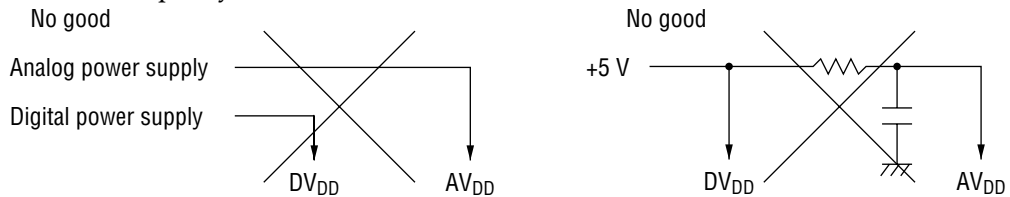
Power Supply Wiring

As shown in the diagram below, supply the power to this IC from the same power source, but separate the wiring for the analog and the logic sections.

To improve the electrical characteristics, insert a bypass capacitor of 0.1 μF or more between DV_{DD} and DGND and between AV_{DD} and AGND .

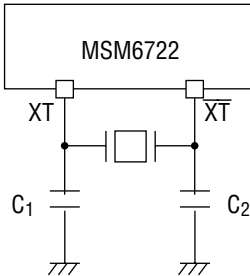


Do not supply the power to the analog section and the logic section from separate power sources; otherwise latch-up may occur.



Connecting an Oscillator

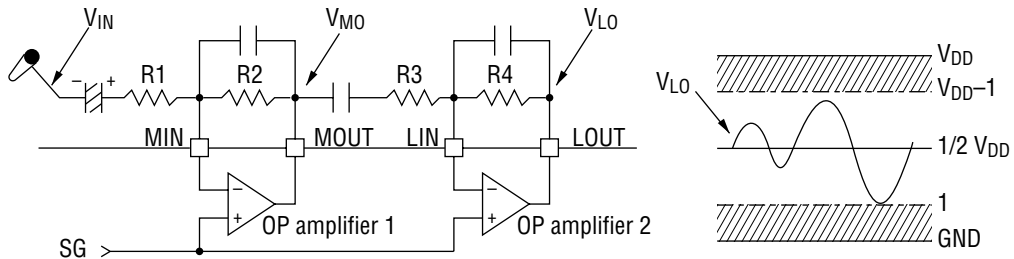
Connect ceramic or crystal oscillators to the XT and \overline{XT} pins as shown below. The characteristics of recommended ceramic oscillators of MURATA MFG. and KYOCERA CORPORATION are shown below for reference.



Maker	Ceramic oscillator		Optimal load Capacity		Supply voltage range(V)	Operating temperature range(°C)
	Type	Frequency (MHz)	C1(pF)	C2(pF)		
MURATA MFG.	CSTLS4M00G53-B0 (with capacitor) CSTCR4M00G53-R0 (with capacitor)	4.0	—	—	4.5 to 5.5	-10 to +70
KYOCERA CORPORATION	KBR-4.0MSA KBR-4.0MKS PBRC4.00B	4.0	33	33	4.5 to 5.5	-10 to +70

Analog Input Amplifier Circuit

The MSM6722 has two built-in operational amplifiers for amplifying the microphone output. Each output amplifier is provided with an inverting input pin and output pin. The analog circuit reference voltage SG (signal ground) is connected internally to the non-inverting input of each output amplifier. For amplification, form an inverting amplifier circuit and adjust the amplification ratio by using external resistors, as shown below.

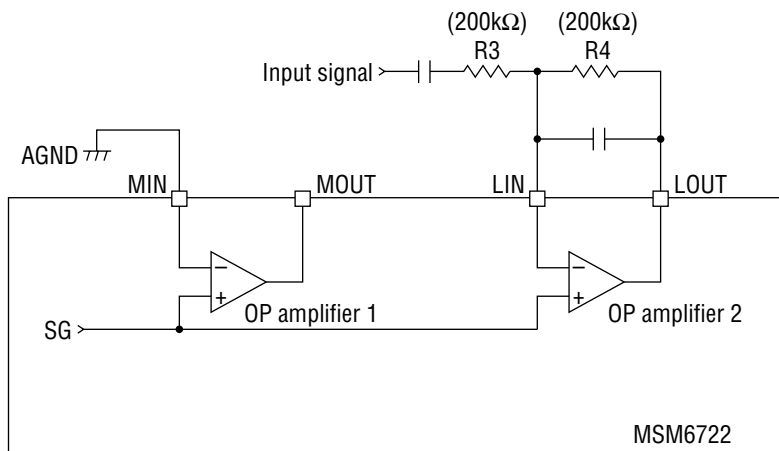


$$V_{LO} = \frac{R_4}{R_3} V_{M0} = \frac{R_2 \cdot R_4}{R_1 \cdot R_3} V_{IN} \text{ (V)}$$

The output V_{LO} of output amplifier 2 is connected to the input F_{IN} of the built-in LPF. The F_{IN} allowable input voltage (V_{FIN}) ranges from 1 V to $(V_{DD}-1)$ V. Therefore, the amplification ratio must be adjusted so that the V_{LO} amplitude can be within the F_{IN} allowable input voltage range. For example, if $V_{DD} = 5$ V, V_{LO} becomes 3 V_{p-p} max. If V_{LO} exceeds the F_{IN} allowable input voltage range, the output of the LPF will be a clipped waveform. The load resistance R_{OUTA} of the OP amplifier is 200 k Ω or more. Therefore, the feedback resistors R_2 and R_4 of the inverting amplifier circuit must be 200 k Ω or more.

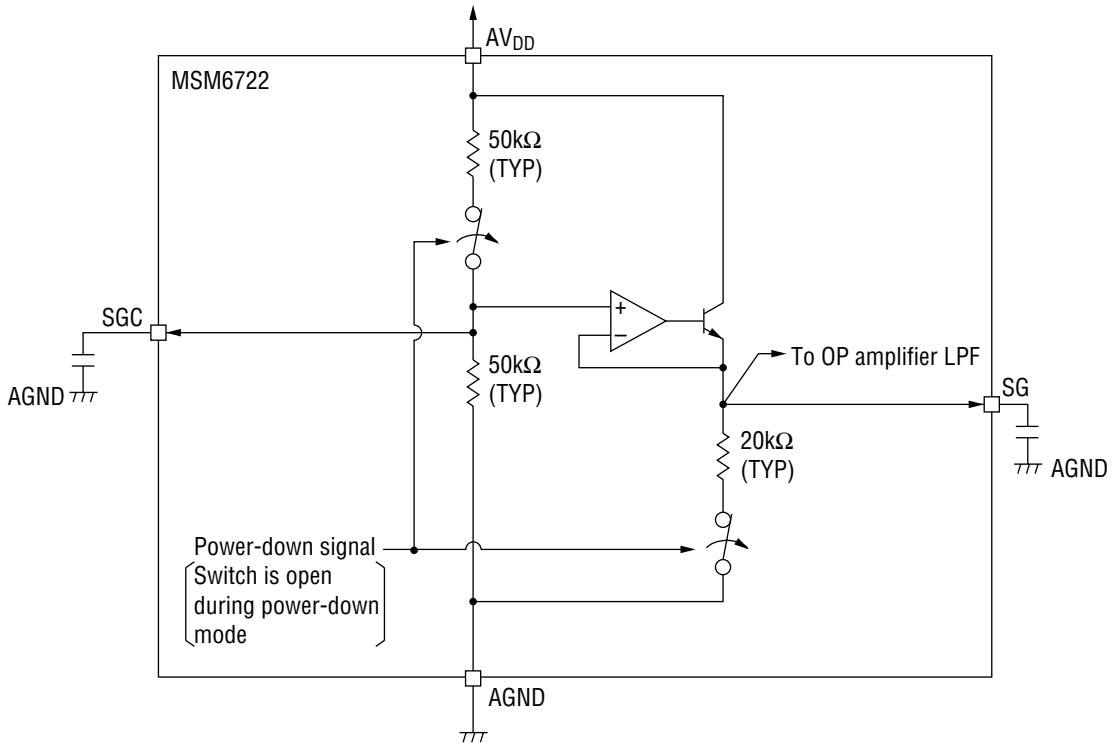
Analog Input Amplifier Circuit

The output V_{LO} of OP amplifier 2 is connected to the input FIN of the built-in LPF. The allowable FIN input voltage V_{FIN} ranges from 1 V to $(V_{DD} - 1)$ V. Therefore, the amplification factor must be adjusted so that the V_{FIN} amplitude can be within the allowable FIN input voltage range. For example, if $V_{DD} = 5$ V, V_{LO} becomes 3 V_{P-P} max. If V_{LO} exceeds the allowable FIN input voltage range, the output of the LPF will be a clipped waveform. The load resistance R_{OUTA} of the OP amplifier is 200 k Ω or more. Therefore, the feedback resistors R2 and R4 must be 200 k Ω or more. When OP amplifier 1 is not used and OP amplifier 2 is used, the MIN pin must be connected to AGND or AVDD, and the MOUT pin must be open. Even if amplification is unnecessary, OP amplifier 2 must be always used. Below is an example of an analog input amplifier circuit when the amplification factor is 1.



Configuring SGC and SG pins

The internal equivalent circuit around the SGC and SG pins is shown below.



The SG signal is reference voltage (signal ground) for internal OP amplifiers and LPF. Install a capacitor between the SGC pin and AGND and between the SG pin and AGND respectively in order to make the SG signal noiseless. It is recommended to install an approx. 1μ capacitor, which should be determined after evaluating the tone quality.

It takes several ten msec until the DC levels such as the SG level of the analog circuit is stabilized after the power-down mode is cancelled. The larger capacitance of a capacitor connected to SGC or SG requires the longer time for stabilizing. After the power-down mode is cancelled, enter voices after the DC levels for the analog circuit has been stabilized.

When the device is in power-down mode, the output voltage of the SG pin becomes unstable. Therefore, SG must not be supplied to external circuits. Otherwise, power supply current may be leaked via the internal SG circuit. Same is true for the SGC pin.

Pitch-Control Circuit

[BINARY mode] (P3, P2, P1, P0)

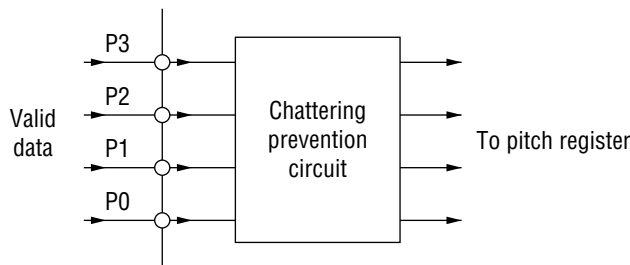
As shown in the diagram below, this IC has an internal prevention circuit for approximately 62 ms of chattering. Therefore, hold these pins at "H" level for 62 ms or more. P3, P2, P1, and P0 pins are used to directly set the pitch steps.

Sixteen pitch steps are provided, but step 16 cannot be set.

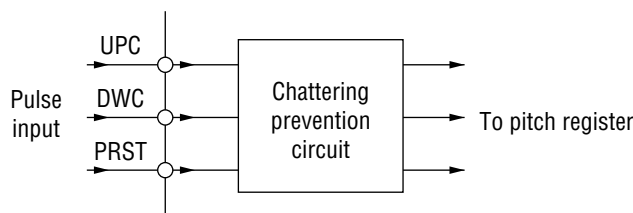
[UP/DOWN mode] (UPC, DWC, PRST)

As shown in the diagram below, this IC has an internal prevention circuit for approximately 62 ms of chattering. Therefore, hold these pins at "H" level for 62 ms or more.

[BINARY mode]



[UP/DOWN mode]

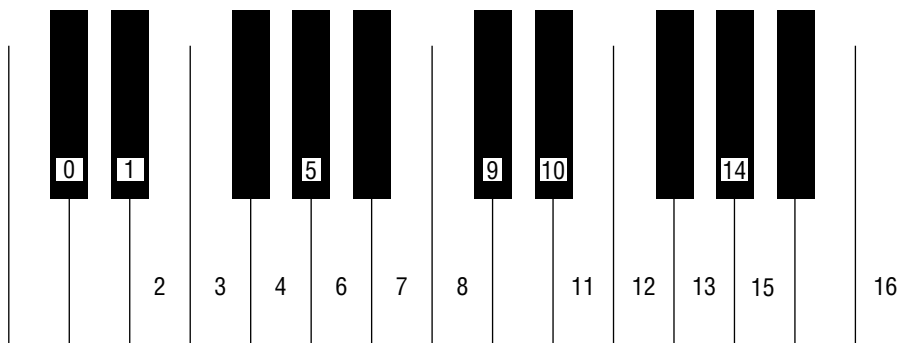


Pitch-Control Circuit

Inputting a "H" level pulse to the UPC pin raises the pitch by one step, and inputting a "H" level pulse to the DWC pin lowers the pitch by one step. Inputting a "H" level pulse to the PRST pin or to the UPC and DWC pins at the same time sets the no-pitch change state (pitch step 8).

A pitch shifts in a range of about one octave upward or downward, centered at pitch step 8. The pitch shift is illustrated in the following keyboard diagram and the following table via corresponding frequencies.

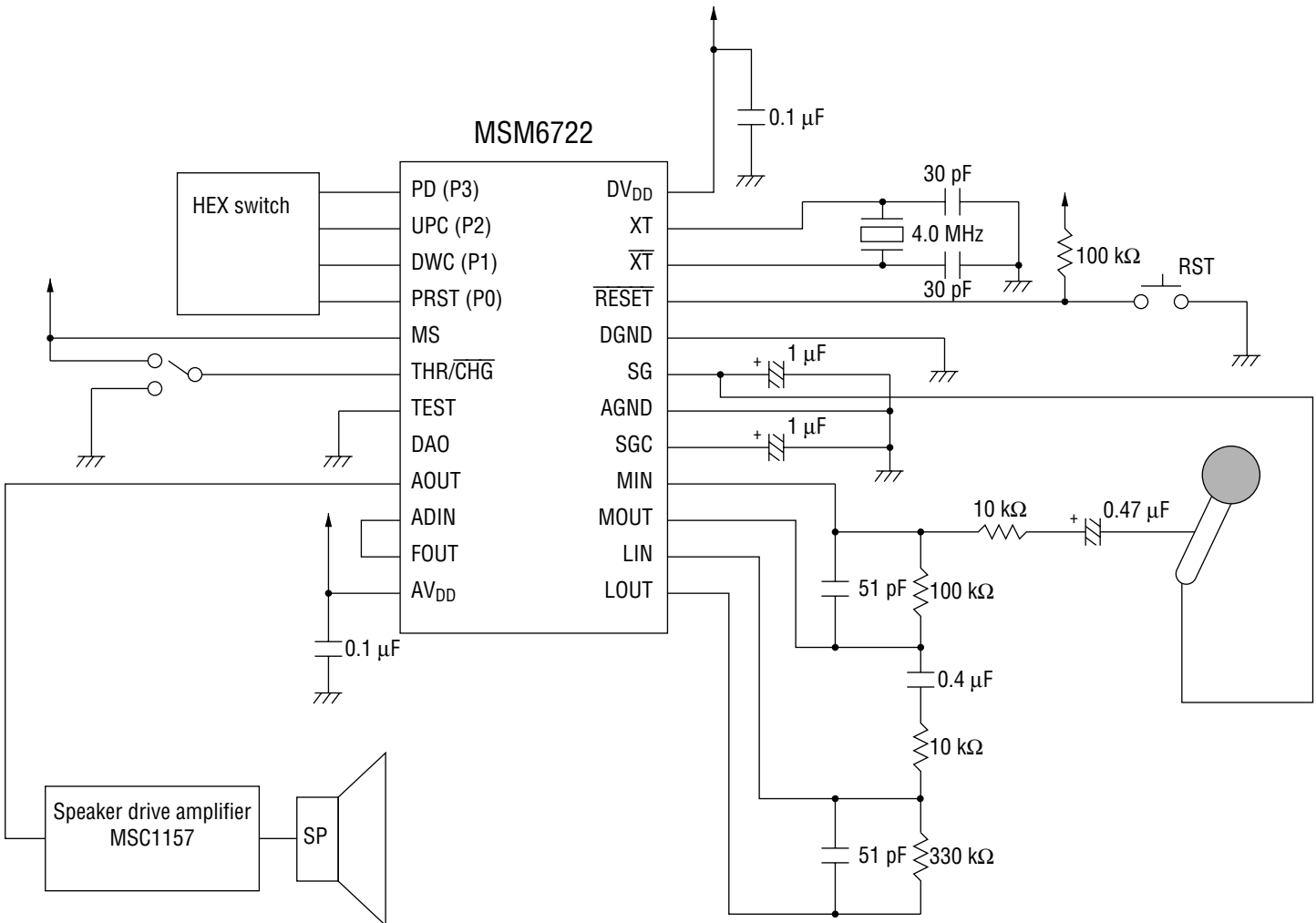
Pitch Conversion Diagram



Pitch Conversion Table

Pitch step	DA sampling cycle (μ s)/ frequency (kHz)
16	60/16.6
15	71/14.0
14	76/13.1
13	80/12.5
12	90/11.1
11	90/10.5
10	101/9.90
9	113/8.84
8	120/8.33
7	127/7.87
6	143/6.99
5	151/6.62
4	160/6.25
3	180/5.55
2	190/5.26
1	202/4.95
0	227/4.40

BINARY Mode

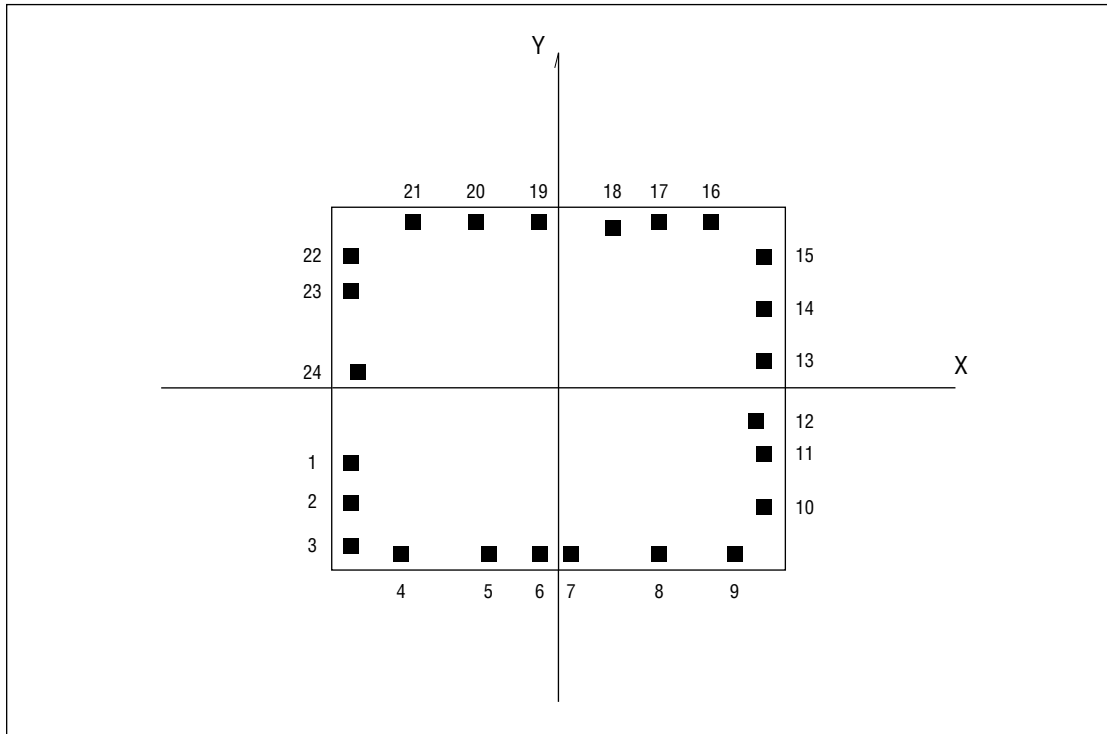


PAD CONFIGURATION

Pad Layout (Top View)

View from the side cofiguring the pads

Chip Size : 3.99 mm × 3.08 mm
 Chip Thickness : 350 μm ±30 μm
 Pad Size : 110 μm × 110 μm
 Chip Substrate Voltage : V_{DD}



Pad Coordinates

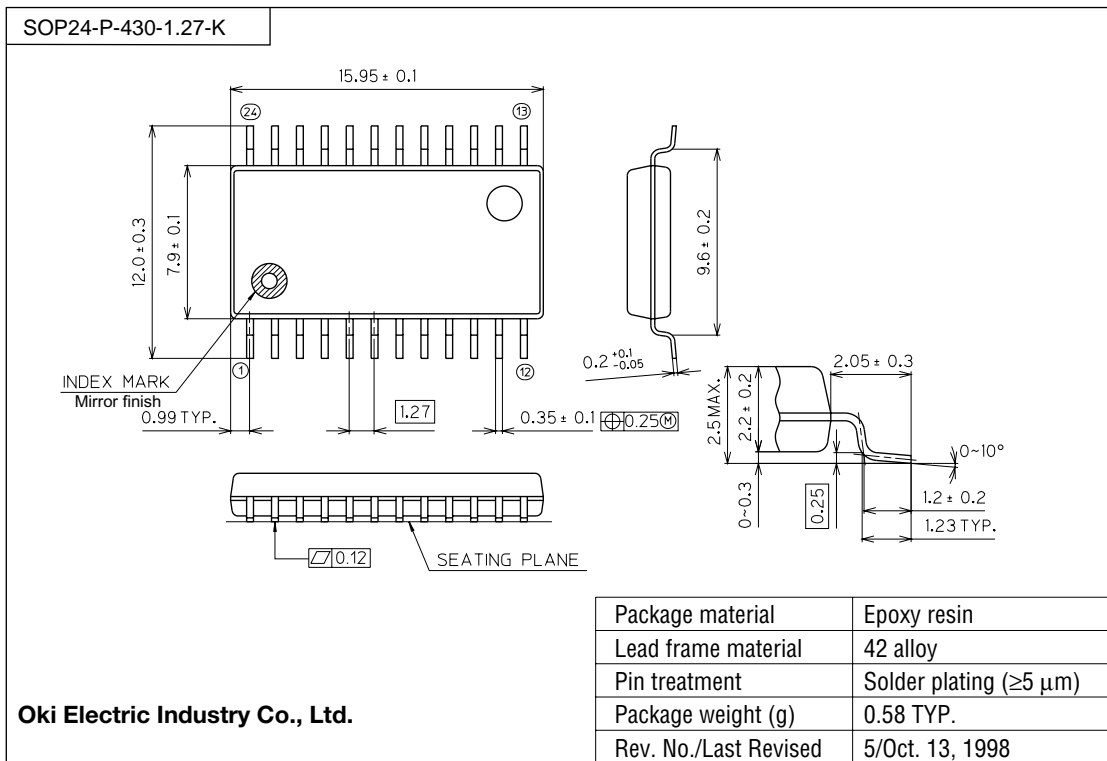
(Chip center is located at X=0 and Y=0.)

Pad No	PAD name	X (μm)	Y (μm)
1	PD	-1784	-602
2	UPC	-1784	-955
3	DWC	-1784	-1310
4	PRST	-1314	-1391
5	MS	-736	-1397
6	THR/CHG	-275	-1397
7	TEST	53	-1397
8	DAO	912	-1396
9	AOUT	1447	-1396
10	ADIN	1783	-974
11	FOUT	1783	-561
12	AV _{DD}	1733	-238

Pad No	PAD Name	X (μm)	Y (μm)
13	LOUT	1782	356
14	LIN	1782	780
15	MOUT	1782	1193
16	MIN	1351	1359
17	SGC	938	1359
18	AGND	598	1295
19	SG	-127	1359
20	DGND	-650	1359
21	RESET	-1198	1359
22	X _T	-1787	1053
23	XT	-1786	703
24	DV _{DD}	-1736	84

PACKAGE DIMENSIONS

(Unit : mm)



Notes for Mounting the Surface Mount Type Package

The surface mount type packages are very susceptible to heat in reflow mounting and humidity absorbed in storage.

Therefore, before you perform reflow mounting, contact Oki's responsible sales person for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

REVISION HISTORY

Document No.	Date	Page		Description
		Previous Edition	Current Edition	
FEDL6722-04	Jul. 2001	—	—	Fourth edition
FEDL6722-05	Feb. 27, 2002	9	10	Changed contents of the table for ceramic oscillators
		—	20	Addition of Revision History

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