



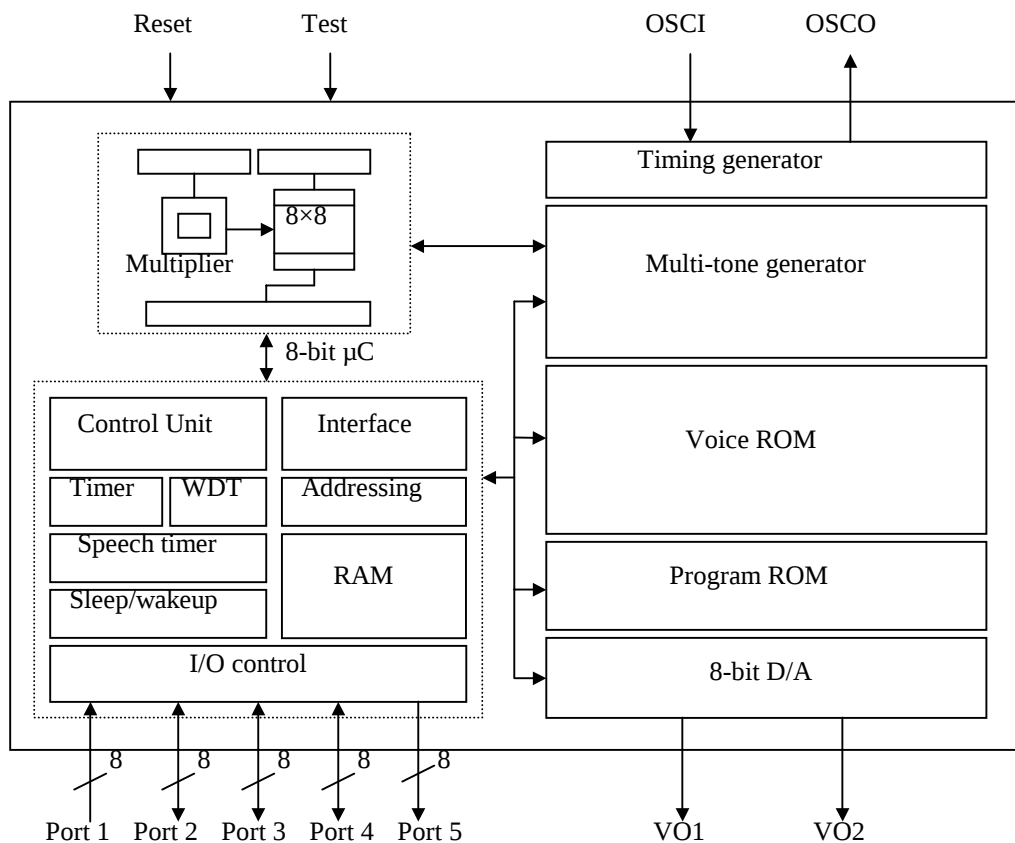
General Description

EM60000 series is an 8-bit micro-controller based sound processor IC with an audio function that delivers multi-channel speech and instrument playback. The micro-controller includes a powerful 8-bit RISC CPU to handle most of the speech/melody functions, an 8K word program ROM, and a voice ROM that extends up to 2M bytes. There are two speech channels and four melody channels that can be played back simultaneously. The speech synthesis is implemented by software with support for a wide range of sampling rates and different volume levels. The micro-controller also provides real instrument waveforms to obtain good quality audio melody. The EM60000 offers one 8-bit input port and one 8-bit I/O port with internal pull-low/wake-up functions for user's applications. In addition, up to three general I/O ports are provided. By programming the micro-controller, applications such as section combination, trigger mode, output control, keyboard matrix, and other logic functions can be easily implemented. Together, all these powerful features will inspire the user to realize a wide variety of ideas.

Features

- Operating voltage: 2.4 ~ 5.5V.
- 8-bit RISC CPU.
- Two general-purpose timers and two speech timers with interrupts.
- 8K word program ROM access.
- Total of six channels—the 2 speech and 4 melody channels can be played simultaneously.
- Wide-range of speech sampling rates—4KHz to 20KHz (program controlled).
- Speech/voice algorithm implemented by software—PCM, ASPCM, ADPCM.
- On chip Voice ROM will extend up to 2M Bytes.
- Uses real instrument waveforms for good quality audio melody.
- Built-in 8-bit by 8-bit hardware multiplier with 16-bit result.
- One 8-bit input port and one 8-bit I/O port with pull-low/wake-up functions.
- Provides additional general-purpose I/O ports (up to 3 ports).
- Provides crystal oscillation or internal oscillator (by connecting a resistor).
- Two 8-bit current DAC outputs.
- Built-in watchdog timer (WDT).

Block Diagram



Parts List

The EM60000 series have 8K $\times$ 13 bit program ROM and 144 bytes RAM.

Part number	Voice ROM	Input pin	I/O pin	Output pin
EM60001	32K $\times$ 8 bits	8 (Port 1)	16 (Port 2, 3)	None
EM60101	64K $\times$ 8 bits	8 (Port 1)	24 (Port 2, 3, 4)	None
EM60201	128K $\times$ 8 bits	8 (Port 1)	24 (Port 2, 3, 4)	None
EM60301	256K $\times$ 8 bits	8 (Port 1)	24 (Port 2, 3, 4)	None
EM60600S	2048K $\times$ 8 bits	8 (Port 1)	24 (Port 2, 3, 4)	8 (Port 5)

Pin Assignments

Symbol	I/O	Function Description
OSCI	I	Crystal in/Resistor.
OSCO	O	Clock output.
P1.0~7	I	Bit 0~7 of port 1.
P2.0~7	I/O	Bit 0~7 of port 2.
P3.0~7	I/O	Bit 0~7 of port 3.
P4.0~7	I/O	Bit 0~7 of port 4 (except EM60001).
P5.0~7	O	Bit 0~7 of port 5 (except EM60001, EM60101, EM60201, EM60301).
VO1	O	Current output of DAC 1.
VO2	O	Current output of DAC 2.
VDD	-	Positive power supply.
VSS	-	Negative power supply.
TEST	I	For test only (normally floating).
RESET	I	Reset pin (active low, internal pull-high)



Specifications

Absolute Maximum Ratings

Parameter	Specification
Supply voltage ($V_{DD} - V_{SS}$)	-0.3V to +7.0V
Input voltage	$V_{SS} - 0.3V$ to $V_{DD} + 0.3V$
Operating Temperature	-20°C to 70°C
Storage Temperature	-55°C to 125°C

Electrical Characteristics

For EM60001/101/201/301 (Temperature: 25°C, $V_{SS}=0V$)

Items	Sym	Min.	Typ.	Max.	Unit	Condition
Operating Voltage	V_{DD}	2.4	-	5.5	V	
Standby Current	I_{SB}	-	-	5	μA	$V_{DD}=4.5V$
	I_{SB}	-	-	1.0	μA	$V_{DD}=3V$
Operating Current	I_{OP}	-	3	5	mA	$V_{DD}=4.5V$, $F_{OSC}=6MHz$, no load
	I_{OP}	-	1.5	3	mA	$V_{DD}=3V$, $F_{OSC}=4MHz$, no load
Drive Current of Port 2, 3, 4, 5	I_{OH}	9	-	-	mA	$V_{DD}=4.5V$, $V_{OH}=2.4V$
	I_{OH}	2	-	-	mA	$V_{DD}=3V$, $V_{OH}=2.4V$
Sink Current of Port 2, 3, 4, 5	I_{OL}	3.5	-	-	mA	$V_{DD}=4.5V$, $V_{OL}=0.4V$
	I_{OL}	-	-	24	mA	$V_{DD}=4.5V$, $V_{OL}=3V$
	I_{OL}	2.5	-	-	mA	$V_{DD}=3V$, $V_{OL}=0.4V$
	I_{OL}	-	-	12	mA	$V_{DD}=3V$, $V_{OL}=1.5V$
Input Voltage of All Input Ports (Without Internal Pull-low)	V_{IH}	1.8	-	-	V	$V_{DD}=4.5V$
	V_{IL}	-	-	0.8	V	$V_{DD}=4.5V$
	V_{IH}	1.4	-	-	V	$V_{DD}=3V$
	V_{IL}	-	-	0.6	V	$V_{DD}=3V$
Input Current (With Internal Pull-low)	I_I	-	8	12	μA	$V_{DD}=4.5V$
	I_I	-	3	5	μA	$V_{DD}=3V$
D/A Output Current (maximum volume)	I_{VO}	2	3	4	mA	$V_{DD}=4.5V$, $V_O=0.7V$
	I_{VO}	2	3	4	mA	$V_{DD}=3V$, $V_O=0.7V$
Operating Frequency Range	F_{OSC}	-	4	6	MHz	$V_{DD}=4.5V$
	F_{OSC}	-	-	4	MHz	$V_{DD}=2.4V$
Warm-up / Wake-up time	T_W	12	18	24	Ms	$V_{DD}=4.5V$



For EM60600S (Temperature: 25°C, VSS=0V)

Items	Sym	Min.	Typ.	Max.	Unit	Condition
Operating Voltage	V _{DD}	2.4	-	3.6	V	
Standby Current	I _{SB}	-	-	1.0	μA	V _{DD} =3V
Operating Current	I _{OP}	-	1.5	3	mA	V _{DD} =3V, F _{OSC} =4MHz, no load
Drive Current of Port 2, 3, 4, 5	I _{OH}	2	-	-	mA	V _{DD} =3V, V _{OH} =2.4V
Sink Current of Port 2, 3, 4, 5	I _{OL}	2.5	-	-	mA	V _{DD} =3V, V _{OL} =0.4V
	I _{OL}	-	-	12	mA	V _{DD} =3V, V _{OL} =1.5V
Input Voltage of All Input Ports	V _{IH}	1.4	-	-	V	V _{DD} =3V
	V _{IL}	-	-	0.6	V	V _{DD} =3V
(Without Internal Pull-low)						
Input Current (With Internal Pull-low)	I _I	-	3	5	μA	V _{DD} =3V
D/A Output Current (maximum volume)	I _{VO}	2	3	4	mA	V _{DD} =3V, V _O =0.7V
Operating Frequency Range	F _{OSC}	-	-	4	MHz	V _{DD} =3V
Warm-up / Wake-up time	T _W	32	36	45	Ms	V _{DD} =3 V

Internal Oscillator Frequency

For EM60001

External Resistor (R _{EXT})	System Frequency (F _{OSC})
470KΩ	500KHz
220KΩ	1MHz
120KΩ	2MHz
56KΩ	4MHz
39KΩ	6MHz

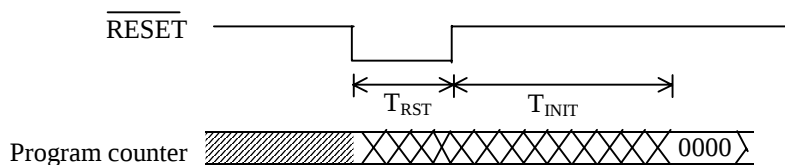
For EM60101, 201, 301

External Resistor (R _{EXT})	System Frequency (F _{OSC})
240KΩ	500KHz
120KΩ	1MHz
60KΩ	2MHz
30KΩ	4MHz
20KΩ	6MHz

For EM60600S

External Resistor (R_{EXT})	System Frequency (F_{OSC})
200K Ω	1MHz
100K Ω	2MHz
50K Ω	4MHz

Warm up Timing

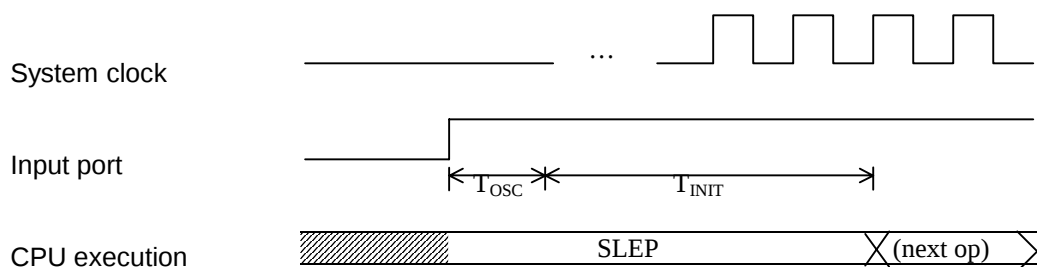


$T_{RST} > 100ns$: RESET pulse width

$T_{INIT} = 18ms$: CPU warm-up time @ $V_{DD}=4.5V$ (for EM60001~EM60301)

$T_{INIT} = 36ms$: CPU warm-up time @ $V_{DD}=3V$ (for EM60600S)

Wake up Timing

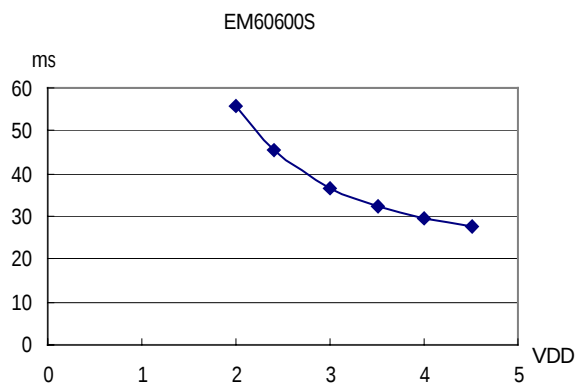
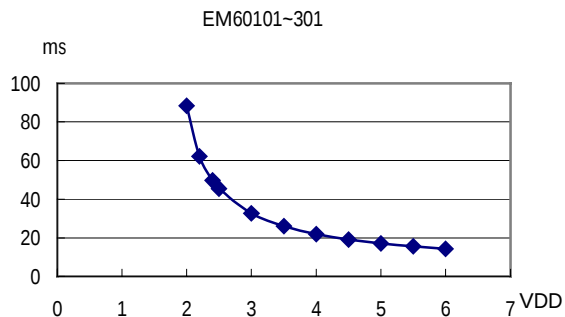
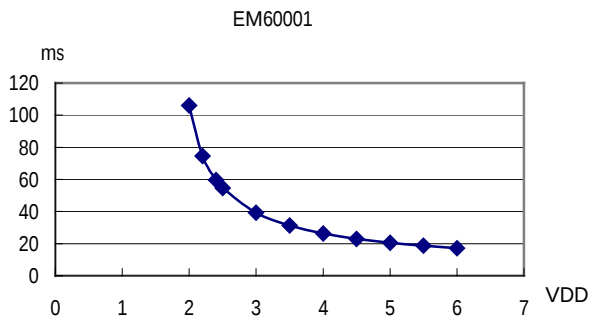


$T_{OSC} = 16$ clock cycles.

$T_{INIT} = 18ms$: CPU warm-up time @ $V_{DD}=4.5V$ (for EM60001~EM60301)

$T_{INIT} = 36ms$: CPU warm-up time @ $V_{DD}=3V$ (for EM60600S)

Warm up Time vs. V_{DD}

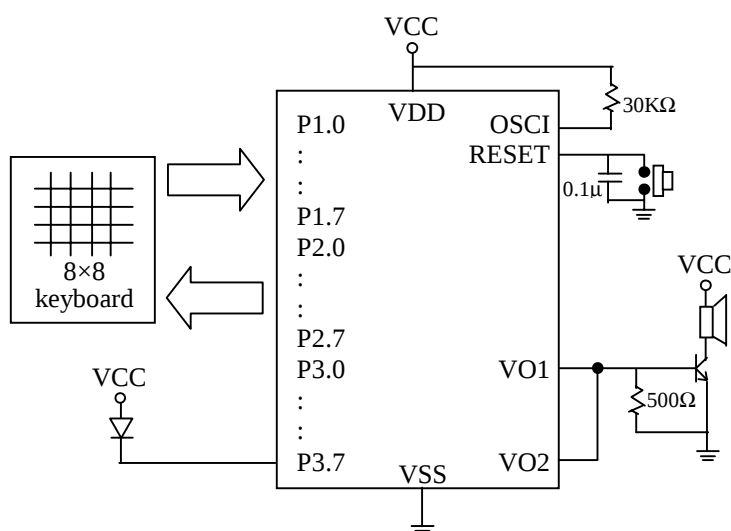


Note: When V_{DD} is greater than 3V, T_{INIT} value will vary at $\pm 10\%$.

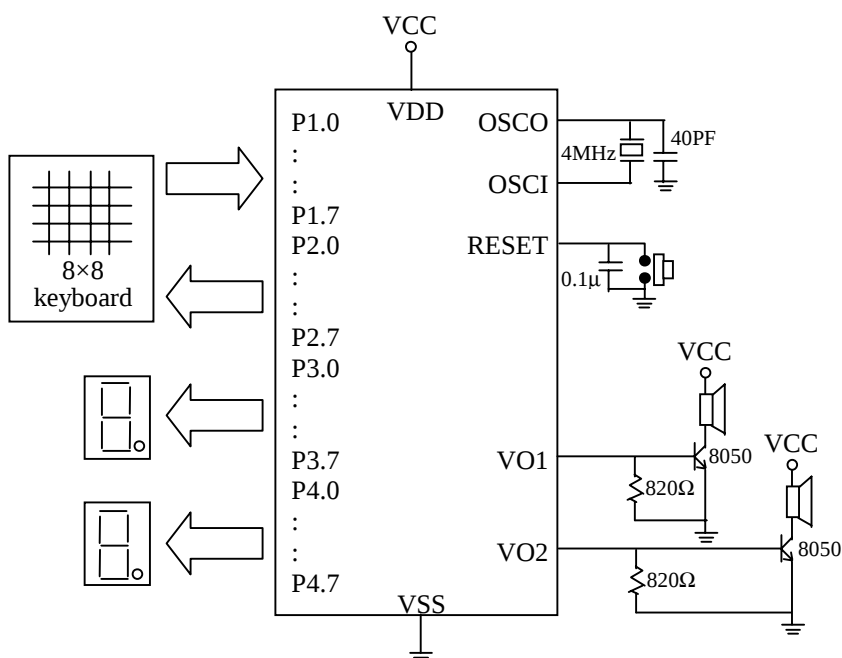
Likewise, when V_{DD} is smaller than 3V, T_{INIT} value will vary at $\pm 30\%$.

Application Circuit

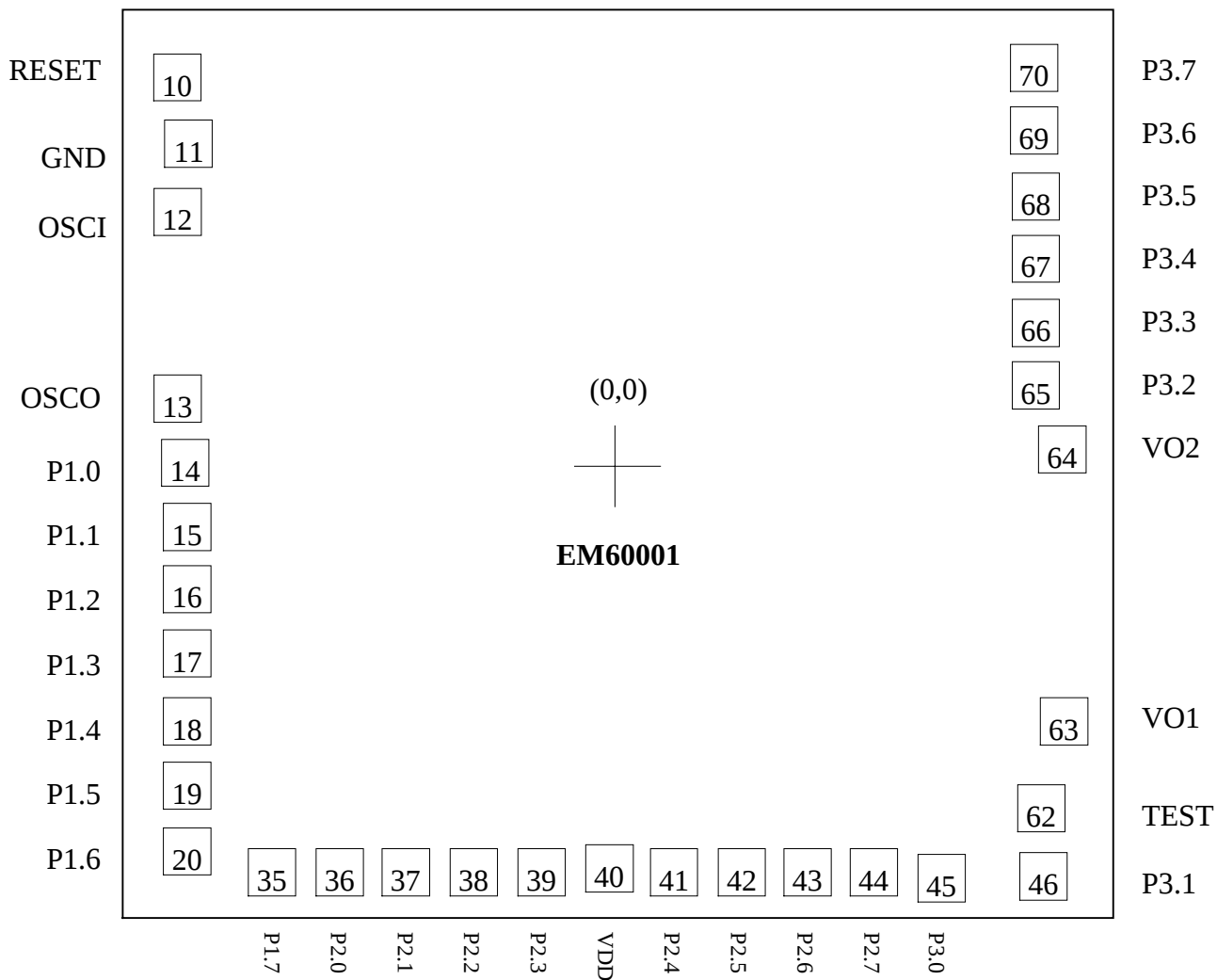
EM60001 application circuit with RC option



EM60301 application circuit with Crystal option



Pad Diagram



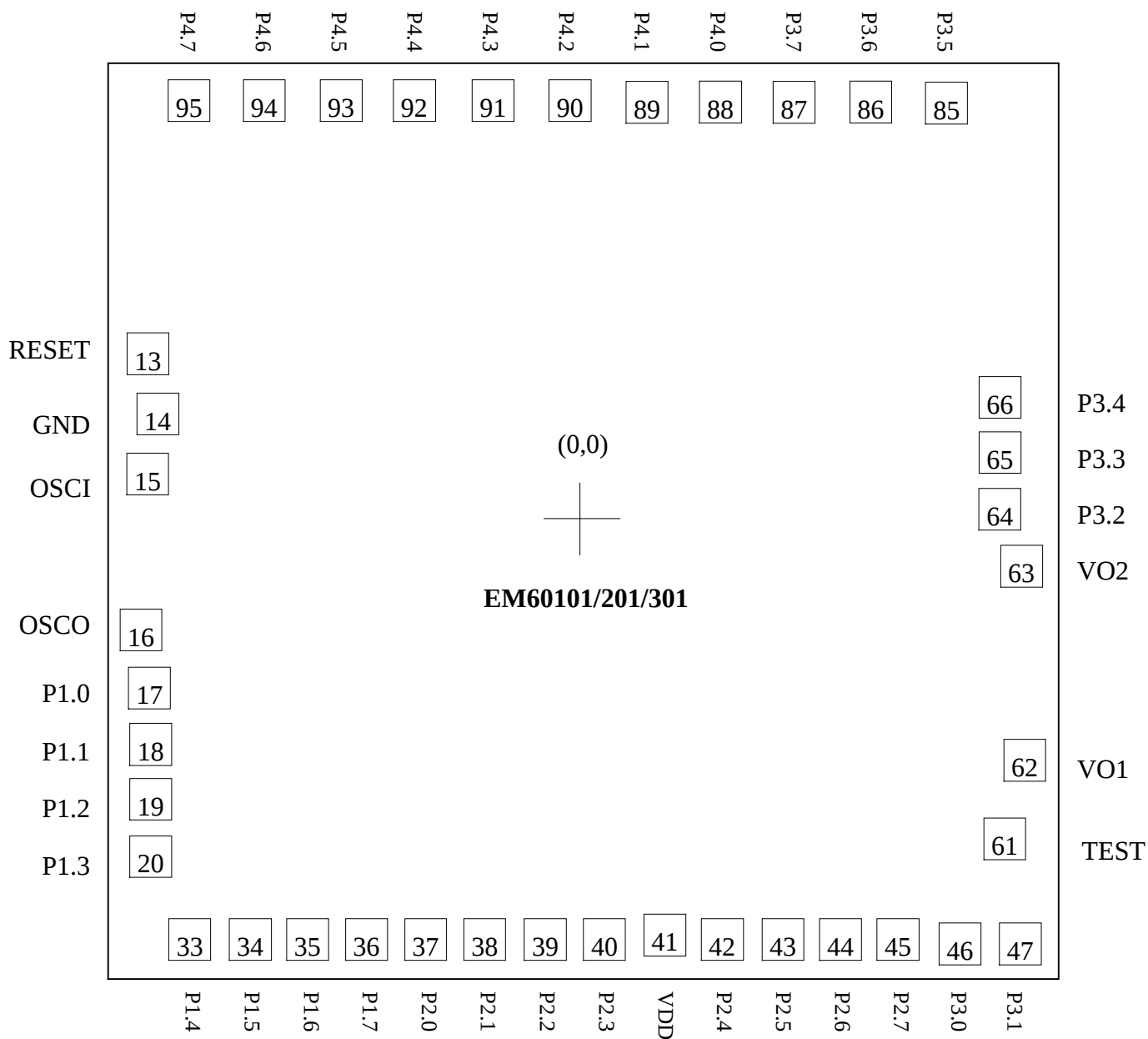
Pin NO.	Symbol	X	Y	Pin NO.	Symbol	X	Y
1	NC			6	NC		
2	NC			7	NC		
3	NC			8	NC		
4	NC			9	NC		
5	NC			10	RESET	-955.9	873.9



Pin NO.	Symbol	X	Y	Pin NO.	Symbol	X	Y
11	GND	-940.1	720.9	56	NC		
12	OSCI	-961.0	570.5	57	NC		
13	OSCO	-964.7	190.5	58	NC		
14	P1.0	-950.9	43.9	59	NC		
15	P1.1	-950.9	-101.5	60	NC		
16	P1.2	-950.9	-246.9	61	NC		
17	P1.3	-950.9	-392.3	62	TEST	945.8	-750.4
18	P1.4	-950.9	-537.7	63	VO1	994.9	-590.1
19	P1.5	-950.9	-683.1	64	VO2	994.9	-11.3
20	P1.6	-950.9	-828.5	65	P3.2	960.8	149.4
21	NC			66	P3.3	960.8	289.7
22	NC			67	P3.4	960.8	429.7
23	NC			68	P3.5	960.8	569.7
24	NC			69	P3.6	960.8	709.7
25	NC			70	P3.7	960.8	849.7
26	NC			71	NC		
27	NC			72	NC		
28	NC			73	NC		
29	NC			74	NC		
30	NC			75	NC		
31	NC			76	NC		
32	NC			77	NC		
33	NC			78	NC		
34	NC			79	NC		
35	P1.7	-729.5	-875.9	80	NC		
36	P2.0	-584.9	-875.9	81	NC		
37	P2.1	-440.3	-875.9	82	NC		
38	P2.2	-295.6	-875.9	83	NC		
39	P2.3	-151.0	-875.9	84	NC		
40	VDD	5.2	-865.1	85	NC		
41	P2.4	150.7	-875.9	86	NC		
42	P2.5	295.3	-875.9	87	NC		
43	P2.6	440.0	-875.9	88	NC		
44	P2.7	584.6	-875.9	89	NC		
45	P3.0	727.8	-885.9	90	NC		
46	P3.1	960.8	-890.4	91	NC		
47	NC			92	NC		
48	NC			93	NC		
49	NC			94	NC		
50	NC			95	NC		
51	NC			96	NC		
52	NC			97	NC		
53	NC			98	NC		
54	NC			99	NC		
55	NC			100	NC		

Chip size : 2400 * 2200 um

For PCB layout, IC substrate must be connected to Vss.



Pin NO.	Symbol	X	Y	Pin NO.	Symbol	X	Y
1	NC			11	NC		
2	NC			12	NC		
3	NC			13	RESET	-1065.9	49.5
4	NC			14	GND	-1050.1	-103.5
5	NC			15	OSCI	-1070.9	-251.5
6	NC			16	OSCO	-1074.7	-631.6
7	NC			17	P1.0	-1060.9	-778.1
8	NC			18	P1.1	-1060.9	-923.5
9	NC			19	P1.2	-1060.9	-1068.9
10	NC			20	P1.3	-1060.9	-1214.3

Pin NO.	Symbol	X	Y	Pin NO.	Symbol	X	Y
21	NC			61	TEST	1056.3	-1177.9
22	NC			62	VO1	1105.4	-1017.6
23	NC			63	VO2	1105.4	-438.8
24	NC			64	P3.2	1071.3	-278.5
25	NC			65	P3.3	1071.3	-138.6
26	NC			66	P3.4	1071.3	1.4
27	NC			67	NC		
28	NC			68	NC		
29	NC			69	NC		
30	NC			70	NC		
31	NC			71	NC		
32	NC			72	NC		
33	P1.4	-957.9	-1455.9	73	NC		
34	P1.5	-812.5	-1455.9	74	NC		
35	P1.6	-667.1	-1455.9	75	NC		
36	P1.7	-512.7	-1455.9	76	NC		
37	P2.0	-377.2	-1455.9	77	NC		
38	P2.1	-232.5	-1455.9	78	NC		
39	P2.2	-87.9	-1455.9	79	NC		
40	P2.3	58.3	-1455.9	80	NC		
41	VDD	214.5	-1445.1	81	NC		
42	P2.4	362.2	-1455.9	82	NC		
43	P2.5	506.9	-1455.9	83	NC		
44	P2.6	651.5	-1455.9	84	NC		
45	P2.7	796.2	-1455.9	85	P3.5	980.8	1502.7
46	P3.0	939.4	-1465.9	86	P3.6	789.8	1502.7
47	P3.1	1079.4	-1465.9	87	P3.7	593.3	1502.7
48	NC			88	P4.0	402.3	1502.7
49	NC			89	P4.1	205.8	1502.7
50	NC			90	P4.2	14.8	1502.7
51	NC			91	P4.3	-181.7	1502.7
52	NC			92	P4.4	-372.7	1502.7
53	NC			93	P4.5	-569.2	1502.7
54	NC			94	P4.6	-760.2	1502.7
55	NC			95	P4.7	-956.7	1502.7
56	NC			96	NC		
57	NC			97	NC		
58	NC			98	NC		
59	NC			99	NC		
60	NC			100	NC		

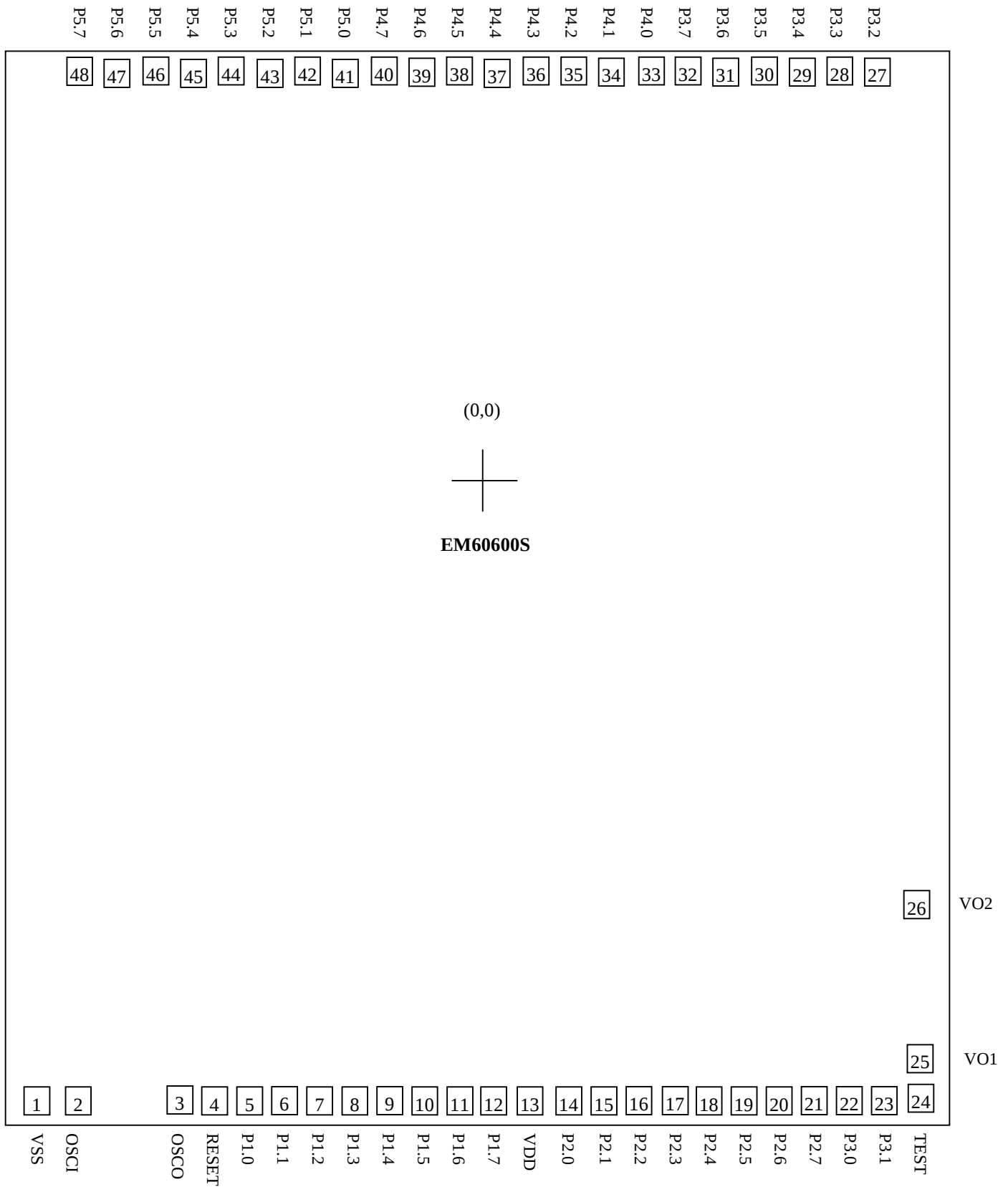
Chip size : 2600 * 3350 um

For PCB layout, IC substrate must be connected to Vss.



EM60000

STEREO FOUR CHANNEL 8-BIT BASED SOUND PROCESSOR



Pin No.	Symbol	X	Y	Pin No.	Symbol	X	Y
1	VSS	-1544.9	-2168.4	25	VO1	1561.6	-1970.6
2	OSCI	-1398.9	-2169.9	26	VO2	1561.6	-1406.4
3	OSCO	-1037.7	-2169.9	27	P3.2	1357.2	2174.0
4	/RESET	-913.9	-2172.7	28	P3.3	1232.9	2174.0
5	P1.0	-791.7	-2169.9	29	P3.4	1103.1	2174.0
6	P1.1	-669.5	-2169.9	30	P3.5	975.0	2174.0
7	P1.2	-547.3	-2169.9	31	P3.6	843.4	2174.0
8	P1.3	-425.1	-2169.9	32	P3.7	716.0	2174.0
9	P1.4	-302.9	-2169.9	33	P4.0	589.3	2174.0
10	P1.5	-180.7	-2169.9	34	P4.1	461.5	2174.0
11	P1.6	-58.5	-2169.9	35	P4.2	336.1	2174.0
12	P1.7	63.7	-2169.9	36	P4.3	208.2	2174.0
13	VDD	186.9	-2168.4	37	P4.4	80.3	2174.0
14	P2.0	335.4	-2169.9	38	P4.5	-44.4	2174.0
15	P2.1	459.0	-2169.9	39	P4.6	-169.2	2174.0
16	P2.2	582.6	-2169.9	40	P4.7	-292.9	2174.0
17	P2.3	706.2	-2169.9	41	P5.0	-416.7	2174.0
18	P2.4	829.8	-2169.9	42	P5.1	-542.0	2174.0
19	P2.5	953.4	-2169.9	43	P5.2	-668.1	2174.0
20	P2.6	1077.0	-2169.9	44	P5.3	-793.2	2174.0
21	P2.7	1200.6	-2169.9	45	P5.4	-917.9	2174.0
22	P3.0	1322.8	-2169.9	46	P5.5	-1044.5	2174.0
23	P3.1	1443.9	-2169.9	47	P5.6	-1170.4	2174.0
24	TEST	1565.0	-2168.4	48	P5.7	-1295.3	2174.0

Chip size : 3430 * 4700 um

For PCB layout, IC substrate must be connected to VSS.