EM60000 Series

Stereo Four Channels
8-Bit Based
Sound Processor

Product Specification

Doc. Version 1.5

ELAN MICROELECTRONICS CORP.

April 2006

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Contents

Specification Revision History

Doc. Version	Revision Description	Date
1.3	Deleted Pad Diagrams	2005/03/09
1.4	Added new Products to the Series; EM60400, EM60500, and EM60600	2006/01/23
1.5	Added Package diagram in the Pin Assignment section	2006/04/28

1   General Description

The EM60000 series is an 8-bit microcontroller based sound processor IC with an audio function that delivers multi-channel speech and instrument playback. The microcontroller includes a powerful 8-bit RISC CPU that handles most of the speech/ melody functions; an 8K word program ROM and a voice ROM with a capacity of up to 2M bytes. It has 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 microcontroller also provides real instrument waveforms to ensure good quality audio melody.

The EM60000 provides one 8-bit input port and one 8-bit I/O port with internal pull-low/wake-up functions, and up to three general I/O ports. By software programming, applications such as section combination, trigger mode, output control, keyboard matrix, and other logic functions; can be easily implemented. All these powerful features combined to ensure device versatility to suit a wide range of application possibilities and implementation of user audio concepts.

2   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 audio channels: 2 speech and 4 melody channels which 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 that extends up to 2M bytes

- Uses real instrument waveforms for high quality audio melody production

- 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)

- Optional crystal oscillator or RC oscillator

- Two 8-bit current DAC outputs

- Built-in watchdog timer (WDT)

3   Block Diagram
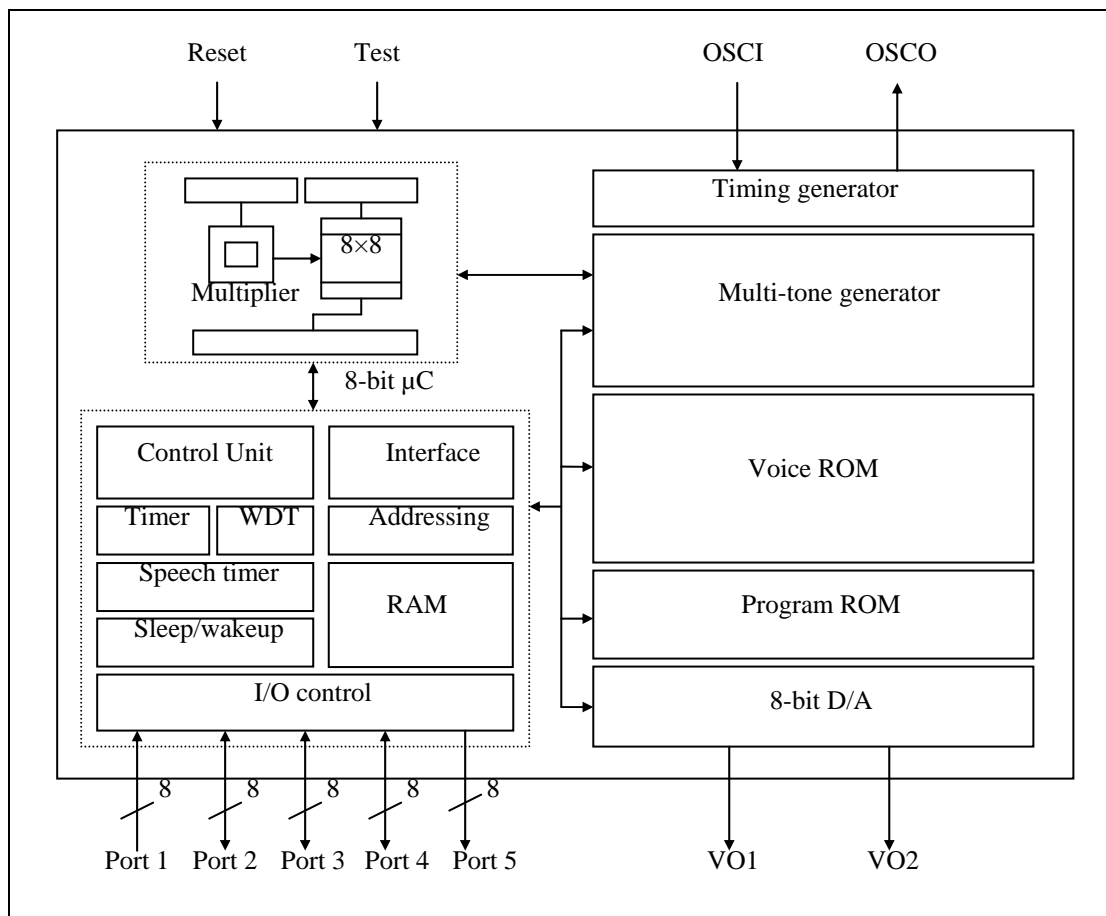
Figure 3-1 EM60000 Block Diagram

4   Selection Table

The EM60000 Series integrates an extensive range of features, most of which are common to all devices, except for some distinctive features like Program ROM and Data RAM. For user convenience in the choice of the most suitable product for their application, the following table is provided, which enumerates the main features of each device. All devices in the series have 8K×13 bit Program ROM and 144 bytes RAM.

Part Number	Voice ROM	Input Pin	I/O Pin	Output Pin
EM60001	32K × 8 bits	8 (Port 1)	16 (Ports 2, 3)	None
EM60101	64K × 8 bits	8 (Port 1)	24 (Ports 2, 3, 4)	None
EM60201	128K × 8 bits	8 (Port 1)	24 (Ports 2, 3, 4)	None
EM60301	256K × 8 bits	8 (Port 1)	24 (Ports 2, 3, 4)	None
EM60400	512K × 8 bits	8 (Port 1)	24 (Ports 2, 3, 4)	8 (Port 5)
EM60500	1024K × 8 bits	8 (Port 1)	24 (Ports 2, 3, 4)	8 (Port 5)
EM60600	2048K × 8 bits	8 (Port 1)	24 (Ports 2, 3, 4)	8 (Port 5)
EM60600S	2048K × 8 bits	8 (Port 1)	24 (Ports 2, 3, 4)	8 (Port 5)

5 Pin Assignment

EM60101-AM/EM60201-AM/EM60301-AM/EM60400-AM/EM60500-AM/ EM60600-AM
– SSOP28L

OSCI	1	28 VSS
OSCO	2	27 RESET
P2.0	3	26 P4.7
P2.1	4	25 P4.6
P2.2	5	24 P4.5
P2.3	6	23 P4.4
VDD	7	**EM60101AM/** 22 P4.3
P2.4	8	**EM60201AM/** 21 P4.2
P2.5	9	**EM60301AM** 20 P4.1
P2.6	10	19 P4.0
P2.7	11	18 P3.7
P3.0	12	17 P3.6
P3.1	13	16 P3.3
VO1+VO2	14	15 P3.2

VDD	1	28 RESET
N.C.	2	27 ODCO
P2.0	3	26 OSCI
P2.1	4	25 VSS
P2.2	5	24 N.C.
P2.3	6	23 N.C.
P2.4	7	**EM60400AM/** 22 N.C.
P2.5	8	**EM60500AM/** 21 VO1
P2.6	9	**EM60600AM** 20 N.C.
P2.7	10	19 VO2
P5.0	11	18 P5.7
P5.1	12	17 P5.6
P5.2	13	16 P5.5
P5.3	14	15 P5.4

EM60101-Q/ EM60301-AQ/EM60400-AQ/EM60500-AQ/EM60600-AQ – QFP44L
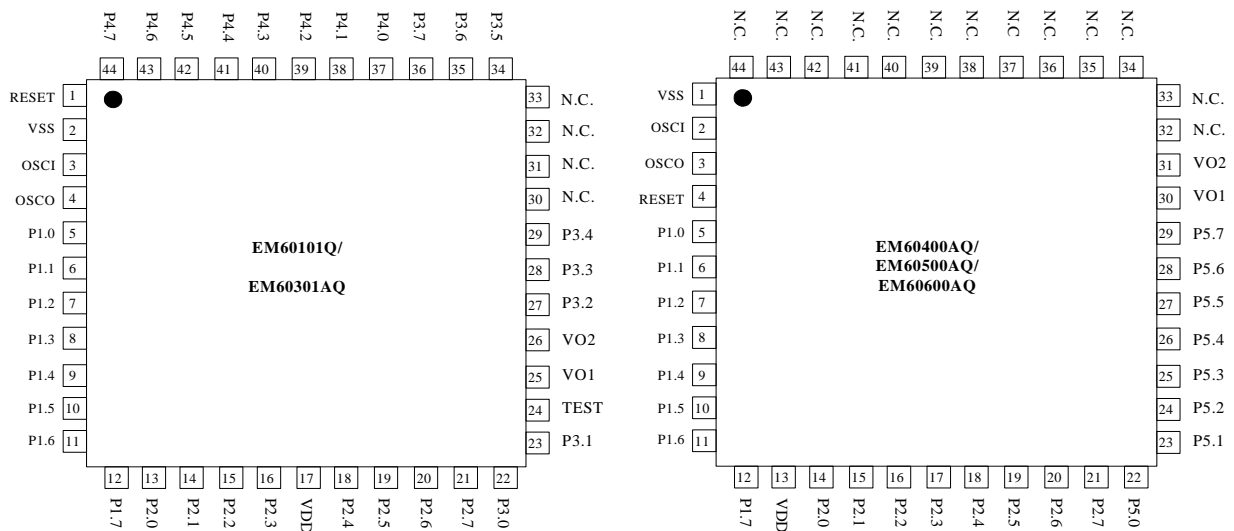
EM60101-L/EM60201-L/EM60301-L − PLCC44L

EM60600S-Q − QFP100L
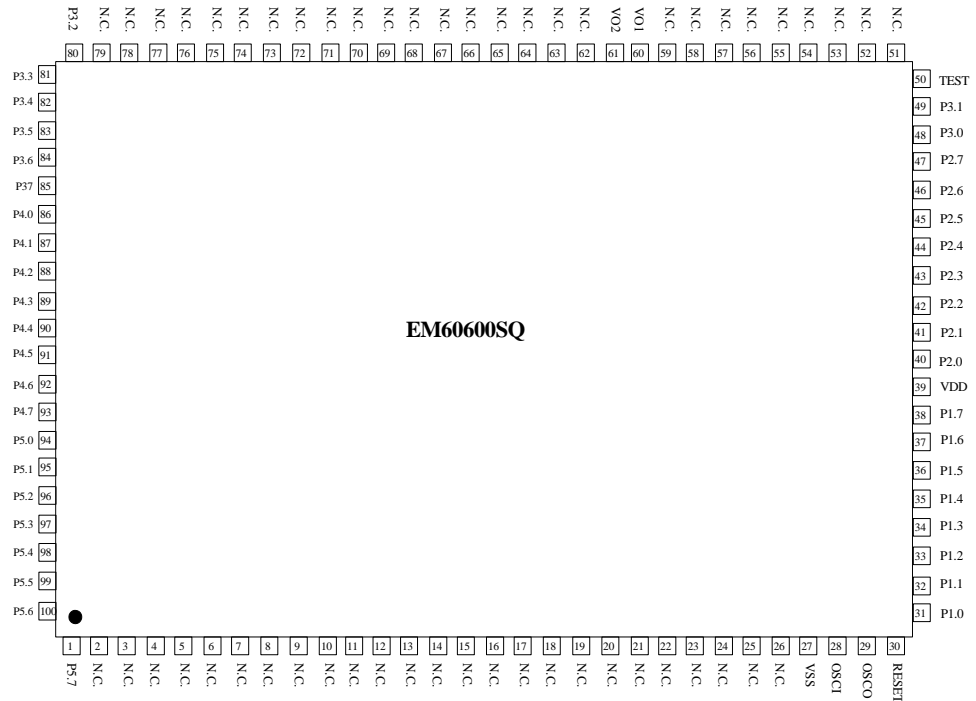
6 Pin Description

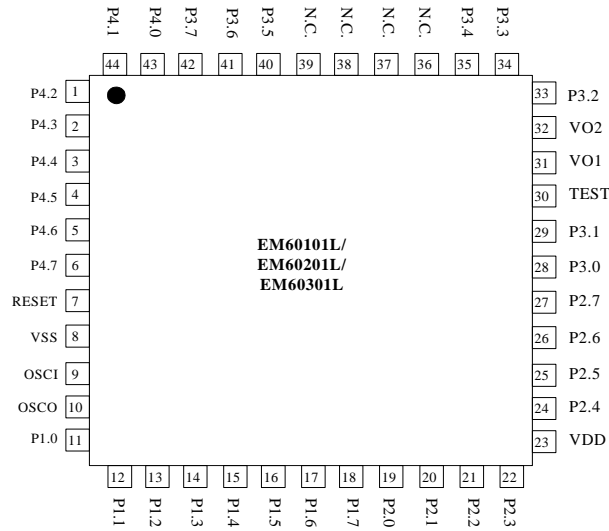| Symbol	I/O	Function Description
OSCI	I	Crystal in/Resistor
OSCO	O	Clock output
P1.0 ~7	I	Bits 0 ~7 of Port 1
P2.0 ~7	I/O	Bits 0 ~7 of Port 2
P3.0 ~7	I/O	Bits 0 ~7 of Port 3
P4.0 ~7	I/O	Bits 0 ~7 of Port 4 (except EM60001)
P5.0 ~7	O	Bits 0 ~7 of Port 5 (except EM60001, EM60101, EM60201, EM60301)
VO1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

7 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

8   Electrical Characteristics

■   For EM60001/101/201/301/400/500/600 (Temperature: 25°C, VSS=0V)

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

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

Items	Symbol	Condition	Min.	Typ.	Max.	Unit
Operating Voltage	VDD	-	2.4	-	3.6	V
Standby Current	ISB	VDD=3V	-	-	1.0	µA
Operating Current	IOP	VDD=3V, FOSC=4MHz, No load	-	1.5	3	mA
Drive Current of Ports 2, 3, 4, & 5	IOH	VDD=3V, VOH=2.4V	2	-	-	mA
Sink Current of Ports 2, 3, 4, & 5	IOL	VDD=3V, VOL=0.4V	2.5	-	-	mA
	IoL	VDD=3V, VOL=1.5V	-	-	12	mA
Input Voltage of All Input Ports (Without Internal Pull-low)	VIH	VDD=3V	1.4	-	-	V
	VIL	VDD=3V	-	-	0.6	V
Input Current (With Internal Pull-low)	II	VDD=3V	-	3	5	µA
D/A Output Current (Maximum volume)	IVO	VDD=3V, VO=0.7V	2	3	4	mA
Operating Frequency Range	FOSC	VDD=3V	-	-	4	MHz
Warm-up/Wake-up time	TW	VDD=3 V	32	36	45	Ms

9   Other Specifications

9.1 Internal Oscillator Frequency

■   For EM60001

External Resistor (REXT)	System Frequency (FOSC)
470KΩ	500kHz
220KΩ	1MHz
120KΩ	2MHz
56KΩ	4MHz
39KΩ	6MHz

■   For EM60101 & EM60201

External Resistor (REXT)	System Frequency (FOSC)
240KΩ	500kHz
120KΩ	1MHz
60KΩ	2MHz
30KΩ	4MHz
20KΩ	6MHz

■   For EM60301, EM60400 and EM60500

External Resistor (REXT)	System Frequency (FOSC)
400KΩ	500kHz
200KΩ	1MHz
100KΩ	2MHz
50KΩ	4MHz
33KΩ	6MHz

■   For EM60600 & EM60600S

External Resistor (REXT)	System Frequency (FOSC)
200KΩ	1MHz
100KΩ	2MHz
50KΩ	4MHz

9.2 Warm-up Timing
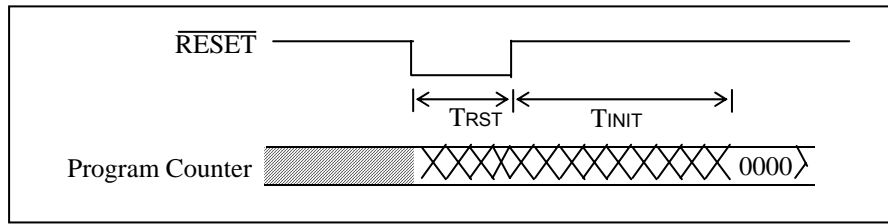
TRST > 100ns: RESET pulse width
TINIT = 18ms: CPU warm-up time @ VDD =4.5V (for EM60001 ~ EM60600)
TINIT = 36ms: CPU warm-up time @ VDD =3V (for EM60600S)

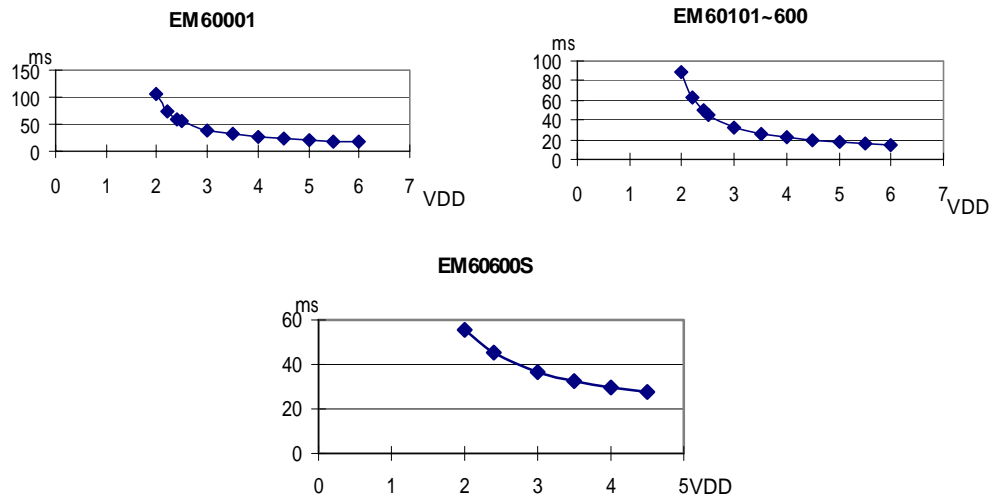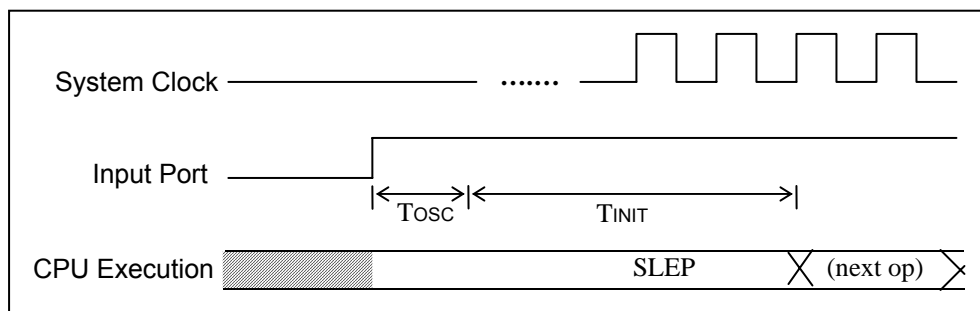*Figure 6-1 Warm-up Timing Diagram*

9.3 Warm-up Time vs. V$_{DD}$

Figure 6-3 Warm-up Time vs. Vdd Performance Graphs

NOTE
When VDD is greater than 3V, TINIT value will vary at +10%.
Likewise, when VDD is smaller than 3V, TINIT value will vary at +30%.

9.4 Wake-up Timing

Tosc = 16 clock cycles.

TINIT = 18ms: CPU warm-up time @ VDD=4.5V (for EM60001 ~ EM60600)

TINIT = 36ms: CPU warm-up time @ VDD=3V (for EM60600S)

Figure 6-2 Wake -up Timing Diagram

10 Application Circuit

Important notes for the following application circuits**:**

1. For noisy power supply application, suppress the noise by adding a 0.1µF ceramic capacitor between:
    *   Ground and power VCC & IC's VDD pad

2. For the LED direct drive application, it is recommended that Sink drive is used to reduce possible noise contamination.

3. For heavy loading application, it is recommended that an electrolytic capacitor is added between VCC and ground. The recommended capacitor value for button cell applications is 10µF.

4. The recommended value of the bypass resistor for button cell application is 750Ω or less.

5. The use of spring direct trigger is not recommended. If you must use such trigger, you need to add a ceramic capacitor between trigger pin and ground to debounce the spring noise. The recommended capacitor value is 0.001~0.01 µF.

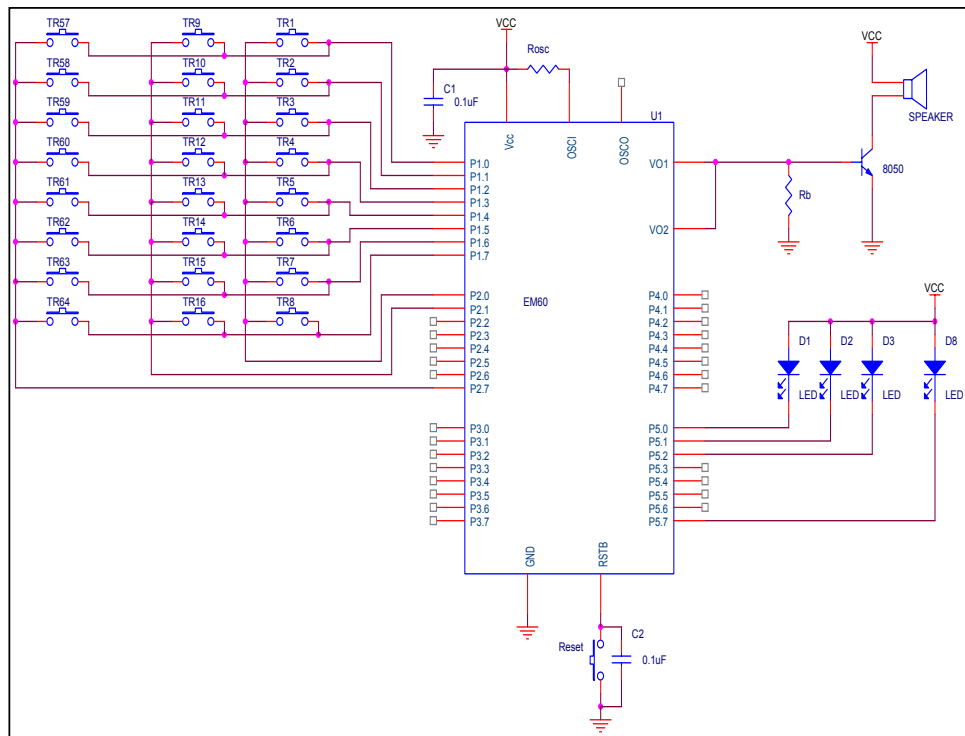## 10.1 EM60000 Series with RC Option

Figure 7-1 EM60000 Series with RC Option Application Circuit

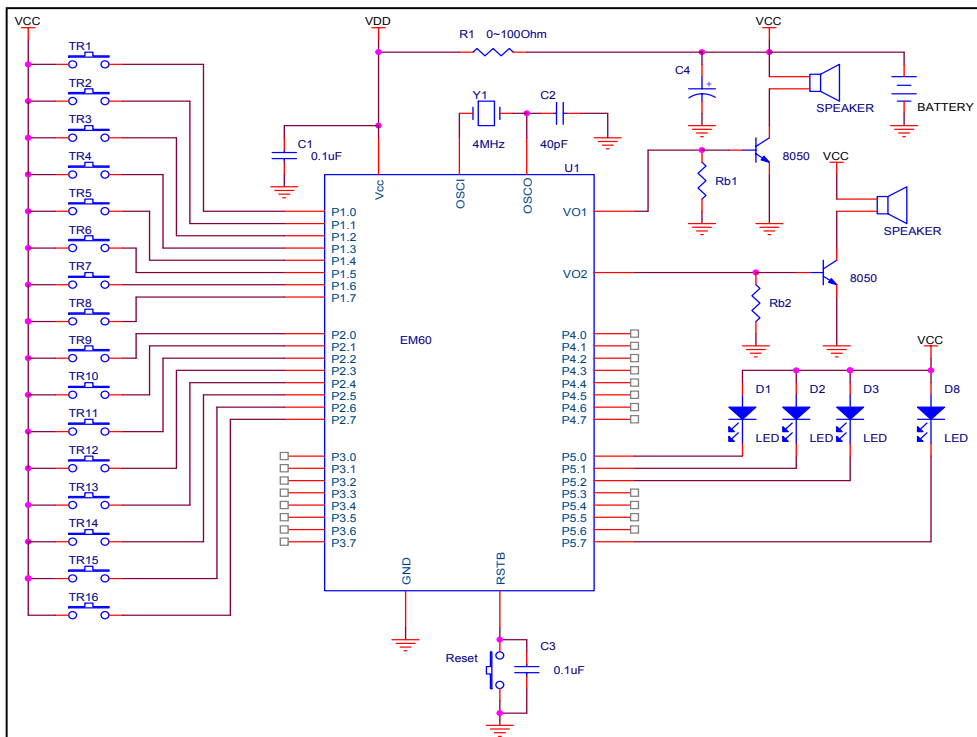## 10.2 EM60 Series Heavy Loading with Crystal Option

Figure 7-2 EM60000 Series Heavy Loading with Crystal Option Application Circuit