
EM60000 Series

**Stereo Four Channels
8-Bit Based
Sound Processor**

Product Specification

Doc. Version 1.5

ELAN MICROELECTRONICS CORP.


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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

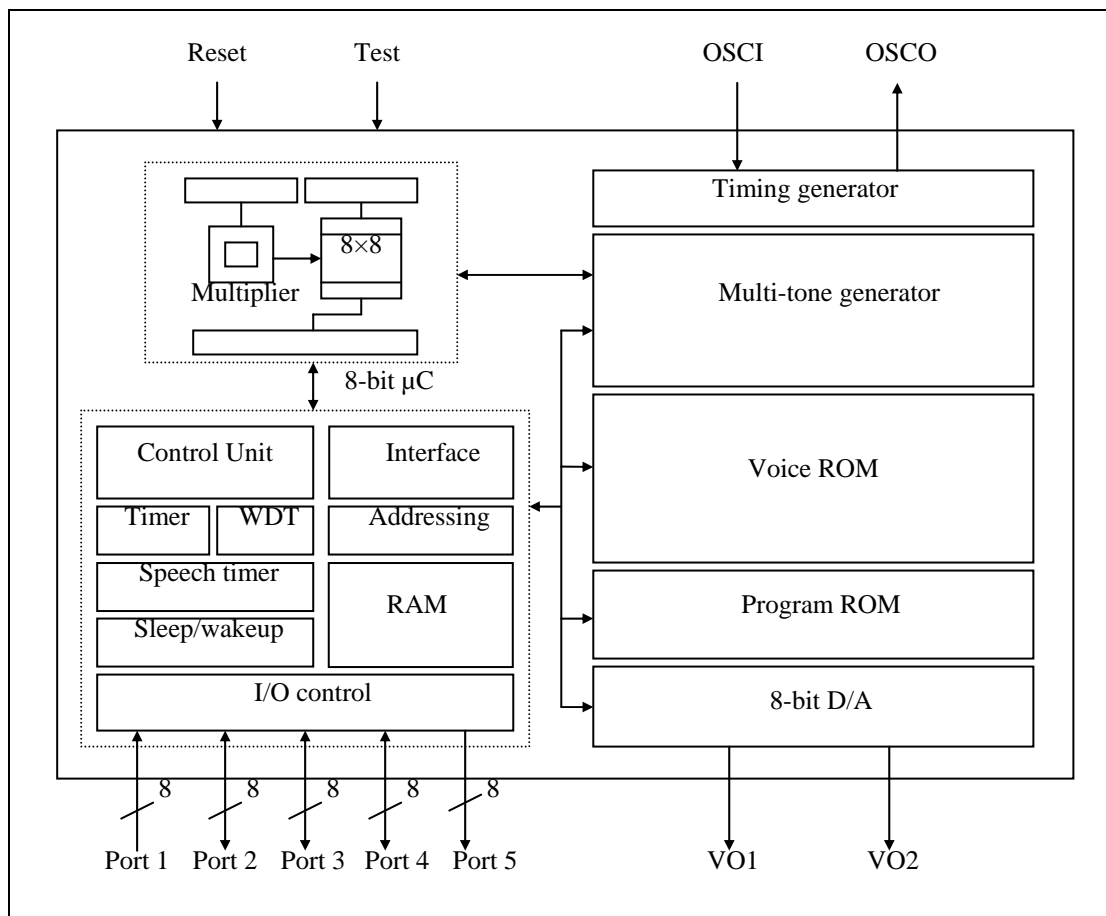


Figure 3-1 EM60000 Block Diagram

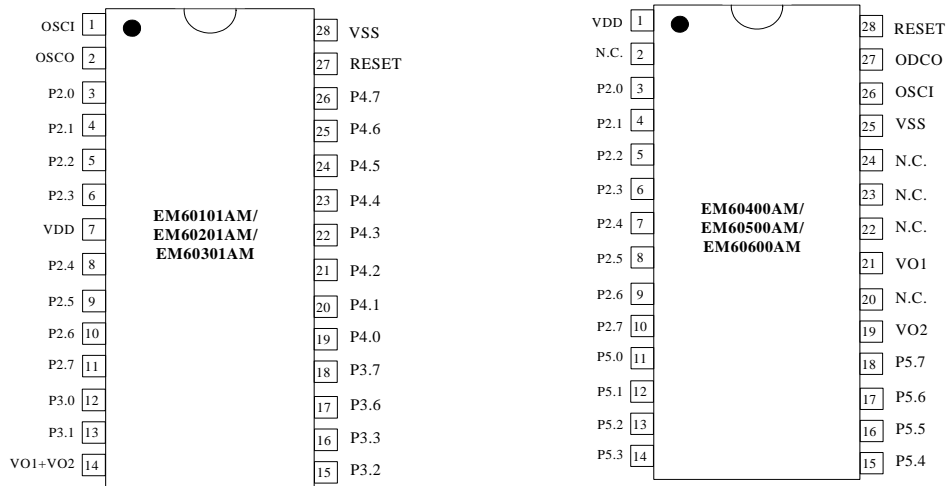
4 Selection Table

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 8Kx13 bit Program ROM and 144 bytes RAM.

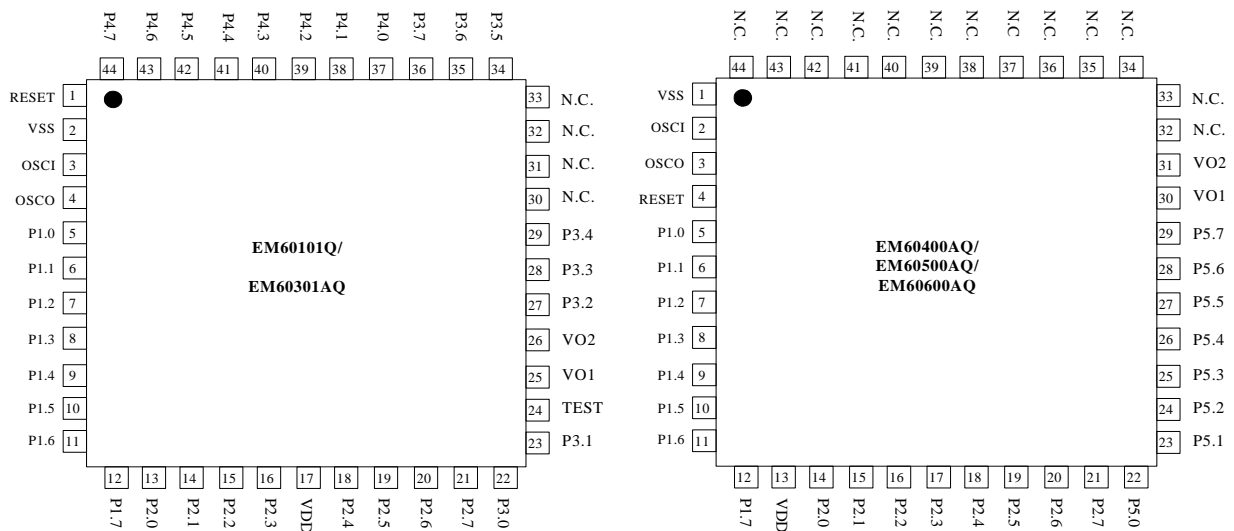
Part Number	Voice ROM	Input Pin	I/O Pin	Output Pin
EM60001	32K × 8 bits	8 (Port 1)	16 (Ports 2, 3)	None
EM60101	64K × 8 bits	8 (Port 1)	24 (Ports 2, 3, 4)	None
EM60201	128K × 8 bits	8 (Port 1)	24 (Ports 2, 3, 4)	None
EM60301	256K × 8 bits	8 (Port 1)	24 (Ports 2, 3, 4)	None
EM60400	512K × 8 bits	8 (Port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

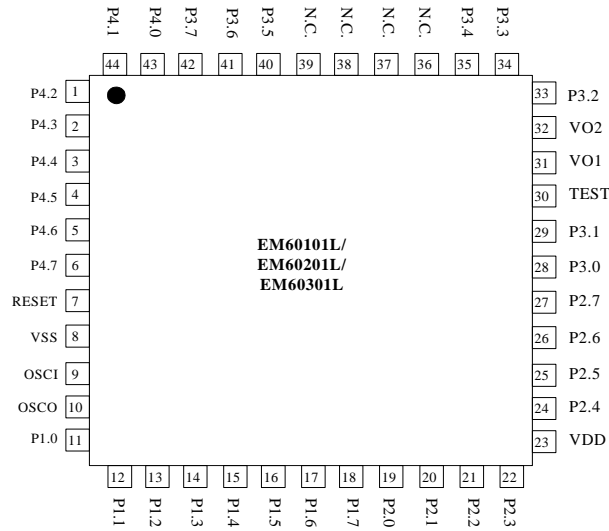


EM60101-Q/ EM60301-AQ/EM60400-AQ/EM60500-AQ/EM60600-AQ – QFP44L

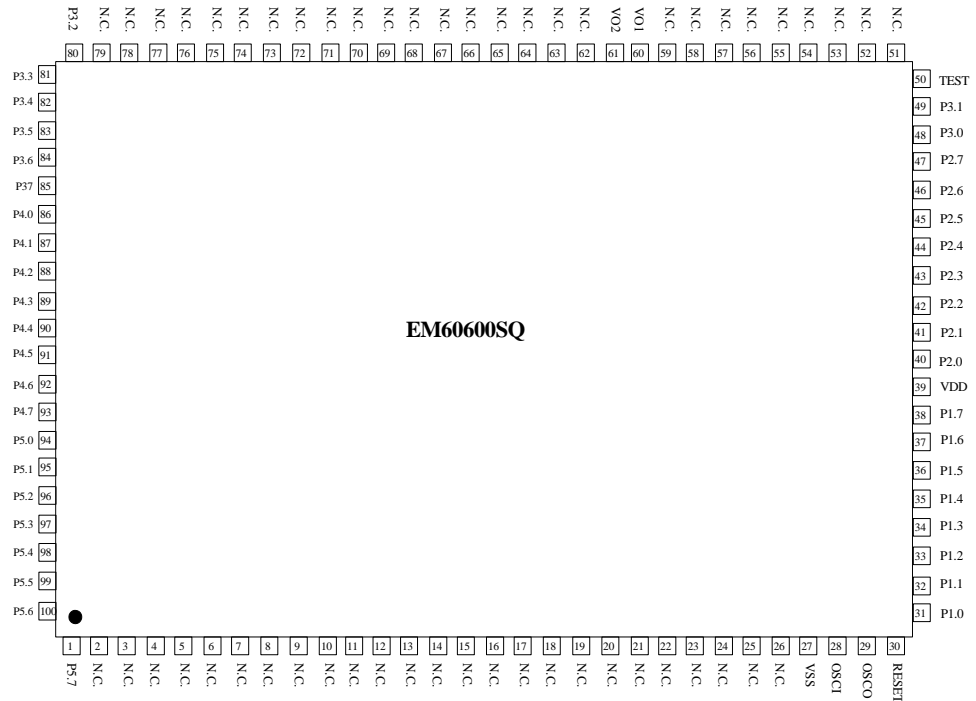




EM60101-L/EM60201-L/EM60301-L – PLCC44L



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	VDD	-	2.4	-	5.5	V
Standby Current	ISB	VDD=3V	-	-	1.0	μA
		VDD=4.5V	-	-	5	
Operating Current	IOP	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	IOH	VDD=3V, VOH=2.4V	2	-	-	mA
		VDD=4.5V, VOH=2.4V	9	-	-	
Sink Current of Ports 2, 3, 4, & 5	IOL	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)	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)	II	VDD=3V	-	3	5	μA
		VDD=4.5V	-	8	12	
D/A Output Current (Maximum volume)	IVO	VDD=3V, VO=0.7V	2	3	4	mA
		VDD=4.5V, VO=0.7V	2	3	4	
Operating Frequency Range	FOSC	VDD=2.4V	-	-	4	MHz
		VDD=4.5V	-	4	6	
Warm-up/Wake-up time	TW	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 (R _{EXT})	System Frequency (F _{osc})
470K Ω	500kHz
220K Ω	1MHz
120K Ω	2MHz
56K Ω	4MHz
39K Ω	6MHz

- For EM60101 & EM60201

External Resistor (R _{EXT})	System Frequency (F _{osc})
240K Ω	500kHz
120K Ω	1MHz
60K Ω	2MHz
30K Ω	4MHz
20K Ω	6MHz

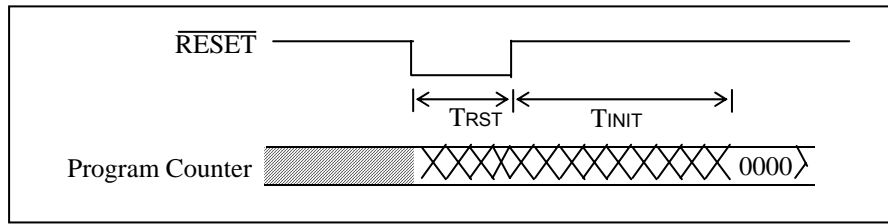
- For EM60301, EM60400 and EM60500

External Resistor (R _{EXT})	System Frequency (F _{osc})
400K Ω	500kHz
200K Ω	1MHz
100K Ω	2MHz
50K Ω	4MHz
33K Ω	6MHz

- For EM60600 & EM60600S

External Resistor (R _{EXT})	System Frequency (F _{osc})
200K Ω	1MHz
100K Ω	2MHz
50K Ω	4MHz

9.2 Warm-up Timing



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

$T_{INIT} = 18ms$: CPU warm-up time @ $V_{DD} = 4.5V$ (for EM60001 ~ EM60600)

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

Figure 6-1 Warm-up Timing Diagram

9.3 Warm-up Time vs. V_{DD}

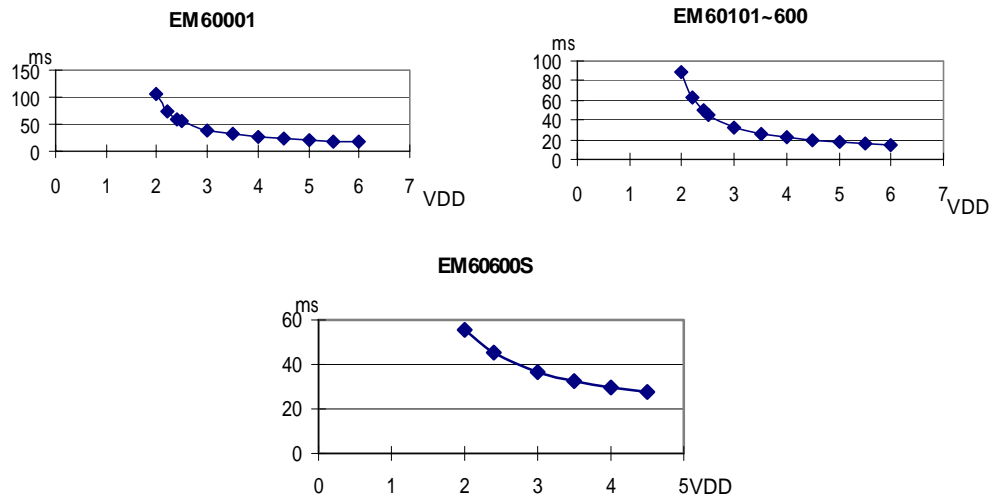


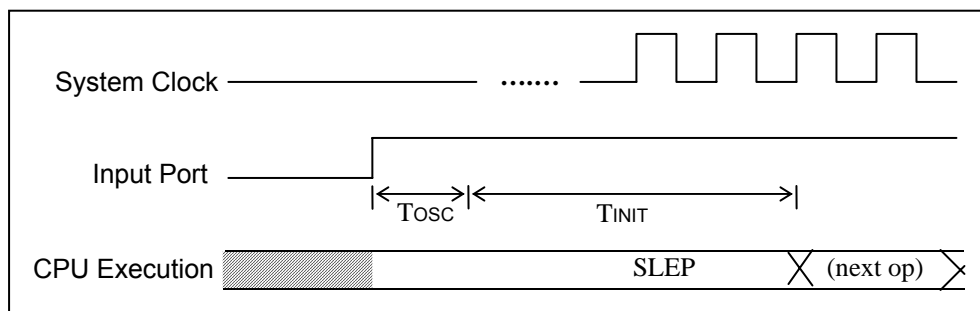
Figure 6-3 Warm-up Time vs. V_{DD} Performance Graphs

NOTE

When V_{DD} is greater than 3V, T_{INIT} value will vary at +10%.

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

9.4 Wake-up Timing



$T_{osc} = 16$ clock cycles.

$T_{INIT} = 18ms$: CPU warm-up time @ $V_{DD}=4.5V$ (for EM60001 ~ EM60600)

$T_{INIT} = 36ms$: CPU warm-up time @ $V_{DD}=3V$ (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 $0.1\mu F$ 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 $10\mu F$.
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 $0.001\sim 0.01\mu F$.

10.1 EM6000 Series with RC Option

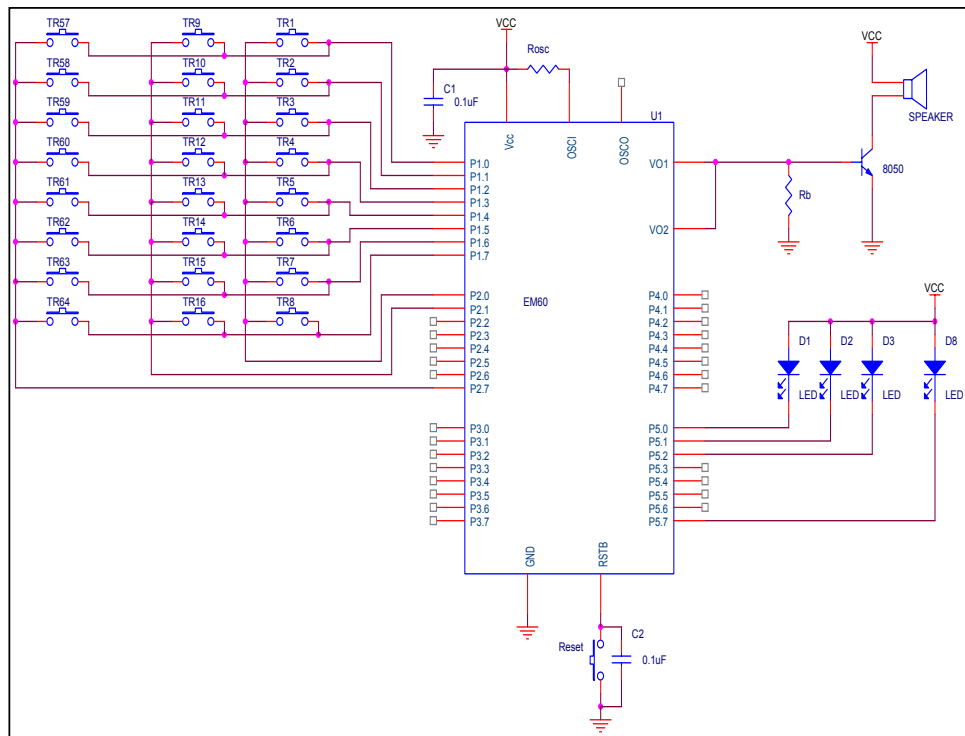


Figure 7-1 EM6000 Series with RC Option Application Circuit

10.2 EM60 Series Heavy Loading with Crystal Option

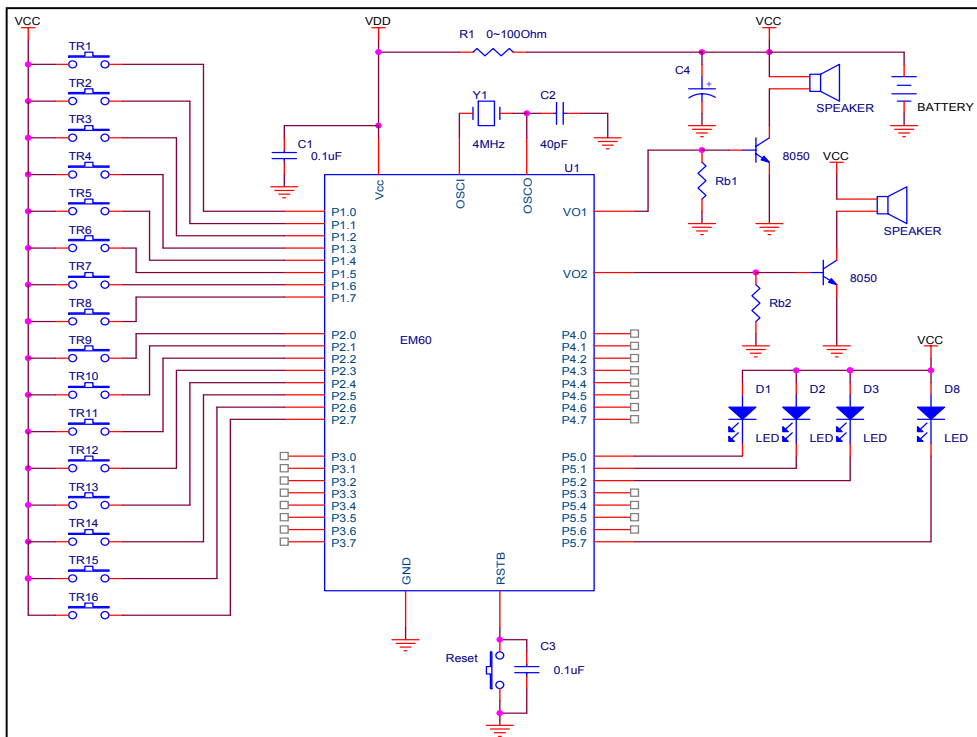


Figure 7-2 EM6000 Series Heavy Loading with Crystal Option Application Circuit

