AM5BA OTP Series

DATASHEET v1.02

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Revision History

Rev	Date	Description	Page
1.02	2018/05/30	Modify: Electrical Characteristics.	14
1.01	2016/10/25	Add: Package Information. Modify: Electrical Characteristics.	- -
1.00	2016/07/26	New Release.	-

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Table of Contents

1. General Description

AM5BA Series is a 4-bit microprocessor with the advantages of low cost and high performance, containing 4-bit ALU, ROM, RAM, I/O ports, timers, interrupt, clock generator, audio synthesizer, PWM outputs, etc. The audio synthesizer contains two-voice channel. Features such as Watchdog Timer (WDT), Low Voltage Reset (LVR), and Infrared Ray Transmitter (IR) can reduce system costs and enhance reliability. Furthermore, with CMOS technology, SLEEP and SLOW functions can minimize power dissipation.

RISC MCU architecture is very easy to program and control. There are 44 instructions, most of which are executed only in a single cycle. The hardware audio decoder of AM5BA Series supports an ADPCM algorithm at a wide range of selectable bit rates, which can be used to select various modes of the audio filter to meet user's needs. In audio output stage, user can select direct-drive (PWM). Besides, AM5BA Series supports External Audio Data Playback (EADP), which can be more effective allocate ROM usage

2. Features

(1) Single power supply can operate from 2.2 V to 5.5 V at 8 MHz for AM5BA Series.

(2) Program ROM can be up to 64K x 10-bit (0000H ~ FFFFH).

(3) There are three bodies in AM5BA Series:

Product	Voice Duration (sec)	ROM Size (10-bit)	Clock Source	Audio Output	Volume Control	PRA[0] as OSC Share Pin	SPI	PWMIO	IR	Reset
AM5BA340x	340	896K	RM	PWM	v	v	v	v	PRA[2]	PRA[3]
AM5BA170x	170	448K	RM	PWM	v	v	v	v	PRA[2]	PRA[3]
AM5BA084x	84	224K	RM	PWM	v	v	v	v	PRA[2]	PRA[3]

(4) I/O Ports:

Product	I/O Pins	Port Name
AM5BA340x	24	PRA, PRB, PRC, PRD, PRE and PRF
AM5BA170x	24	PRA, PRB, PRC, PRD, PRE and PRF
AM5BA084x	24	PRA, PRB, PRC, PRD, PRE and PRF

(5) Each pin of all I/O ports can be a wake-up pin when configured as input.

(6) Support at most 4-level stack, which can be used as data SRAM for additional 16 x 4-bit space.

Product	Data SRAM	4-Level Stack or Used As Additional Data SRAM
AM5BA340x	200x4 (28H ~ EFH)	16x4 (F0H ~ FFH)
AM5BA170x	200x4 (28H ~ EFH)	16x4 (F0H ~ FFH)
AM5BA084x	200x4 (28H ~ EFH)	16x4 (F0H ~ FFH)

(7) SLEEP and SLOW Mode

System clock is totally stopped when entering SLEEP Mode; meanwhile, all functions will stop to save power. The concept of SLOW Mode is similar to SLEEP Mode, except the Slow clock will not stop. To enter the SLOW Mode, you have to execute SLOW instruction. Once AM5BA IC enters the SLOW Mode and runs for a period of time, the “wakeup” signal, which is generated by internal interrupt or external input change, can lead AM5BA IC into the normal operating mode. For a slower clock, which means in the SLOW Mode, the power consumption is around 8.3uA@3V and 19.4uA@4.5V under the condition of slow wake-up time (512 ms). User can wake up the device from SLEEP Mode by changing data of input port.

(8) Each I/O pin can be controlled by three I/O registers: **(Register Control)**

a) I/O direction register

b) I/O data register

c) I/O pull-low register

(9) All six ports with large current output: **(Code Option)**

(10)Each I/O pin can be set as one of the following states via mask option: ***(*Code *Option)***

a) Floating input

b) Input with pull low

c) Output

d) Software I/O (Register Control)

(11)Low-cost OSC: **(Code Option)**

PRA[0] can be either a general I/O or an OSC pin.

(12)Built-in Infrared Ray (IR) carrier output: **(Code Option)**

There are built-in IR carrier output pins in AM5BA Series, which can be used as transmission pins for wireless transmission. User can set PRA[2] as the IR carrier pin. Through code option, the built-in IR carrier output can be switched to high or low.

(13)Audio synthesizer:

The audio synthesizer has two voice channels . For the voice channel, AM5BA Series supports a selectable bit rate ADPCM algorithm with high-quality voice compression.

(14)Audio Filter: **(Register Control)**

AM5BA Series has two hardware audio filters that can work together or separately to minimize unwanted audio noise.

(15)Audio output method: **(Register Control)**

10-bit direct-drive output (PWM) is supported to provide best audio output quality.

(16)16-level channel volume control: **(Register Control)**

There is a 16-level channel control for both two voice channel.

(17)16-level global volume control: **(Register Control)**

There is a 16-level global volume control for direct-drive output (PWM).

(18)External Reset: User can set PRA[3] as a reset pin. **(Code Option)**

(19)4-level Low voltage detector (LVDT): **(Register Control)**

AM5BA Series supports 4-level low voltage detect that can detect 4 specify voltage : 2.4v, 2.8v, 3.2v, 3.6v.

(20)4-channel hardware PWMIO control: **(Register Control)**

(21)There is a 512 levels resolution and the PWM carry frequency is 125Hz. SPI control (Master/Salve mode):A Serial Peripheral Interface (SPI) controller is built-in AM5B to facilitate communicating with other device and components. There are four control signals on SPI, including MOSI, MISO, SCK and NSS; the four signals are shared with PRB0, PRB1, PRB2, and PRB3. For application efficiency, master mode is the only decision.

SPI Pin	Port Pin
MOSI	PRB0
MISO	PRB1
SCK	PRB2
NSS	PRB3

Master mode is up to 2Mbps and Slave is up to 1Mbps.

(22)Number of instructions: 44.

3. Memory Organization

3.1 ROM

ROM memory is divided into six portions. The first portion 0x0 ~ 0xF is addressed for Reset Vector in normal mode. The second portion 0x10 ~ 0x1F is addressed for Interrupt Vector in normal mode. The third portion 0x20 ~ 0x3FF is reserved and not available for storing programs. The fourth portion 0x400 ~ 0x7FF is reserved for the system information. The fifth portion 0x800 ~ 0xFFFF is addressed for user's main program and voice data. The last portion 0x10000 ~ 0xXXFFF can be used to store voice data. Because JMP and CALL instructions can only reach an immediate address within a 16-bit wide page, the main program and ISR therefore can only be located in the 0x800 ~ 0xFFFF address range. In addition, except for Program Counter (PC), all pointers such as voice pointer (VPTR) and temporary register (TREG) can reach up to 0xXFFFF. FIGURE 3.1 shows the ROM map.

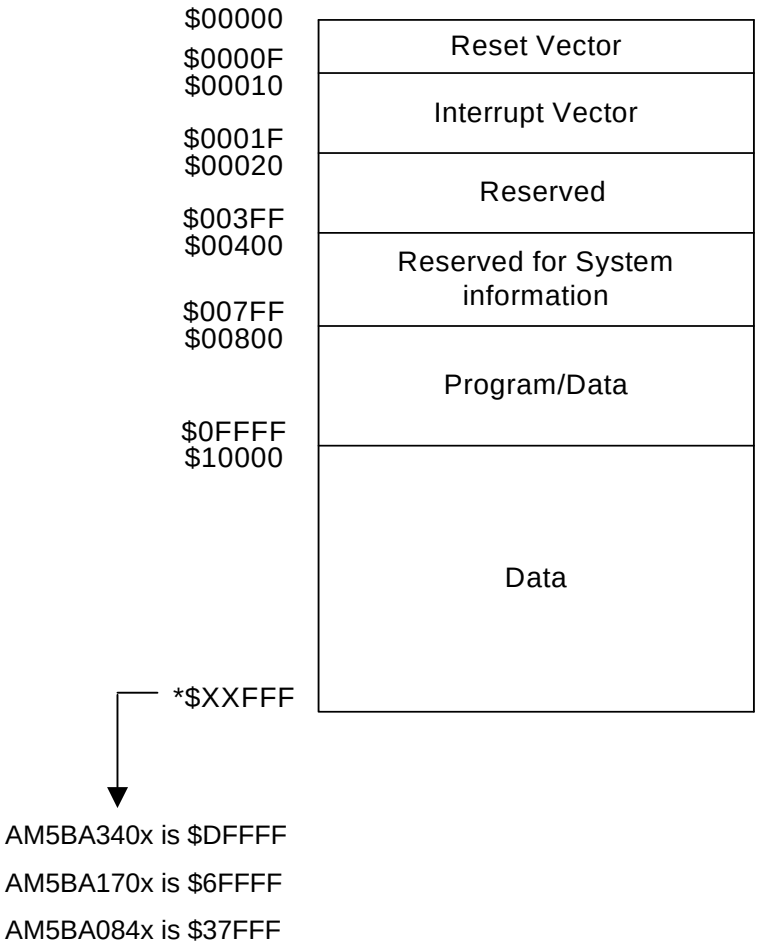


FIGURE 3.1 ROM Map of AM5BA Series

3.2 SRAM

SRAM is composed of Special Function Register (SFR), working SRAM, general SRAM and stack SRAM. Address 0x00 ~ 0x27 is reserved for SFR and address 0x28 ~ 0x3F is for the working SRAM that can be executed with logic or arithmetic instructions. Address 0x40~0x4F is the TREG backup and re-load SRAM which can be executed with the POP and RDPC instruction. Address 0x50~0xEF is the general SRAM and address 0xF0~0xFF is the stack SRAM, as shown in FIGURE 3.3. The stack SRAM is reserved for storing the current PC value when a CALL instruction or interrupt occurs. Furthermore, the SRAM of AM5BA Series also supports indirect addressing mode.

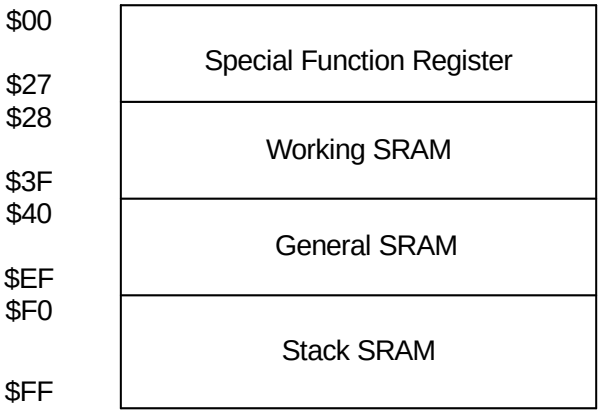
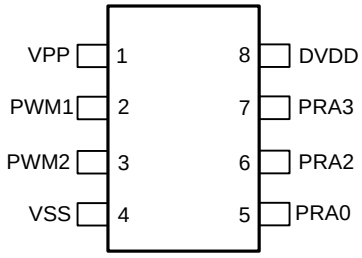


FIGURE 3.3 SRAM Map of AM5BA Series

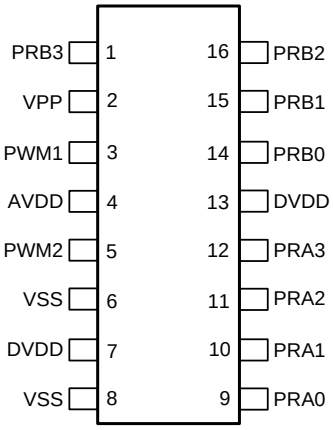
4. Pin Configuration and Pin Description

4.1 Pin Configuration

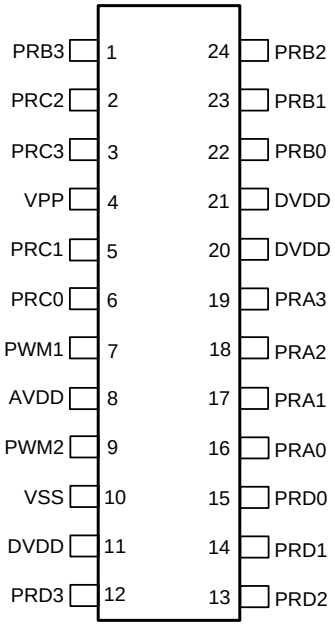
4.1.1 8 Pin – AM5BA340x/AM5BA170x/AM5BA084x SOP



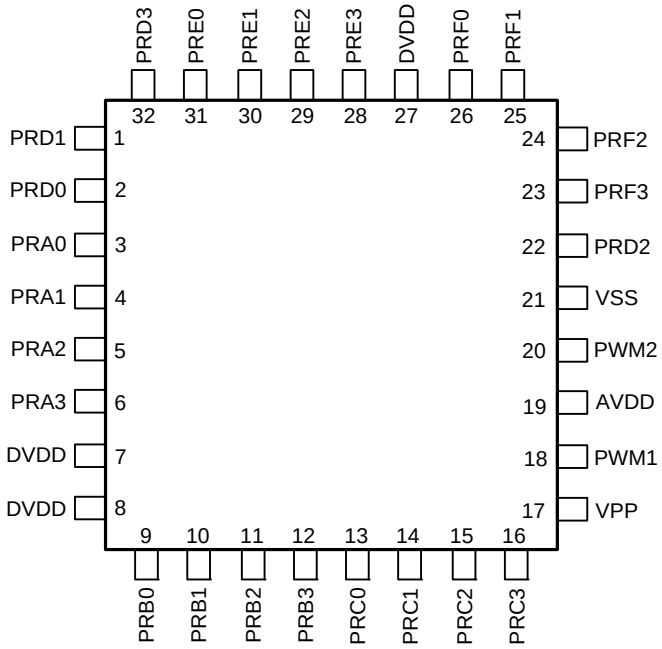
4.1.2 16 Pin – AM5BA340x/AM5BA170x/AM5BA084x SOP



4.1.3 24 Pin – AM5BA340x/AM5BA170x/AM5BA084x SSOP



4.1.4 32 Pin – AM5BA340x/AM5BA170x/AM5BA084x LQFP



4.2 Pin Description

Pin Name	Attr.	Description
IO PORT		
PRA[0] / OSC1	I/O	Four I/O modes can be set via code option for each I/O pin: (1) Floating input mode, (2) Pull-low input mode, (3) Output mode, (4) Software IO mode. Buffer Output type. Or 2 kinds of output current: (1) Normal current, (2) Large current. **(Code Option)** Or selected as an OSC pin: An oscillator input pin for RM Mode. **(Code Option)**
PRA[1]	I/O	Four I/O modes can be set via code option for each I/O pin: (1) Floating input mode, (2) Pull-low input mode, (3) Output mode, (4) Software IO mode. Buffer Output type. Or 2 kinds of output current: (1) Normal current, (2) Large current. **(Code Option)**
PRA[2] / IR	I/O	Four I/O modes can be set via code option for each I/O pin: (1) Floating input mode, (2) Pull-low input mode, (3) Output mode, (4) Software IO mode. Buffer Output type. Or 2 kinds of output current: (1) Normal current, (2) Large current. **(Code Option)** Or selected as an IR Carrier Output pin with programmable 38 KHz or 56KHz. **(Code Option)**
PRA[3] / Reset	I/O	Four I/O modes can be set via code option for each I/O pin: (1) Floating input mode, (2) Pull-low input mode, (3) Output mode, (4) Software IO mode. Buffer Output type. Or 2 kinds of output current: (1) Normal current, (2) Large current. **(Code Option)** Or selected as an external RESET pin with weak pull-low capability. **(Code Option)**
PRB0 ~ 3	I/O	Four I/O modes can be set via code option for each I/O pin: (1) Floating input mode, (2) Pull-low input mode, (3) Output mode, (4) Software IO mode. Buffer Output type. Or 2 kinds of output current: (1) Normal current, (2) Large current. **(Code Option)** Or selected as an SPI Input/Output pin. **(Code Option)**
PRC0 ~ 3	I/O	Four I/O modes can be set via code option for each I/O pin: (1) Floating input mode, (2) Pull-low input mode, (3) Output mode, (4) Software IO mode. Buffer Output type. Or 2 kinds of output current: (1) Normal current, (2) Large current. **(Code Option)** Or selected as an PWMIO Output pin. **(Code Option)**
PRD0 ~ 3 **PRE0 ~ 3** **PRF0 ~ 3**	I/O	Four I/O modes can be set via code option for each I/O pin: (1) Floating input mode, (2) Pull-low input mode, (3) Output mode, (4) Software IO mode. Buffer Output type. Or 2 kinds of output current: (1) Normal current, (2) Large current. **(Code Option)**

Pin Name	Attr.	Description
Audio PAD		
PWM1	O	PWM1 output.
PWM2	O	PWM2 output.
POWER PAD		
AVDD	Power	Positive power supply for analog portion
DVDD	Power	Positive power supply for digital portion
VSS	Power	Ground Potential.
VPP	Power	Connect to VSS or floating during normal operation. Connect to 8.5V as programming EPROM.

5. Electrical Characteristics

The electrical characteristics of AM5BA Series are given in the following tables in which all the data are measured at room temperature. Various production processes among lots or different testing conditions may influence the data result.

5.1 Absolute Maximum Rating

SYMBOL	RATING	UNIT
V_{SS} ~ V_{DD}	-0.5 ~ +5.5	V
V_{in} (For all input)	V_{SS}-0.3 < V_{in} < V_{DD}+0.3	V
V_{out} (For all output)	V_{SS} < V_{out} < V_{DD}	V
T_{op} (Operating)	-25 ~ +85	℃
T_{st} (Storage)	-25 ~ +85	℃

5.2 DC Characteristics

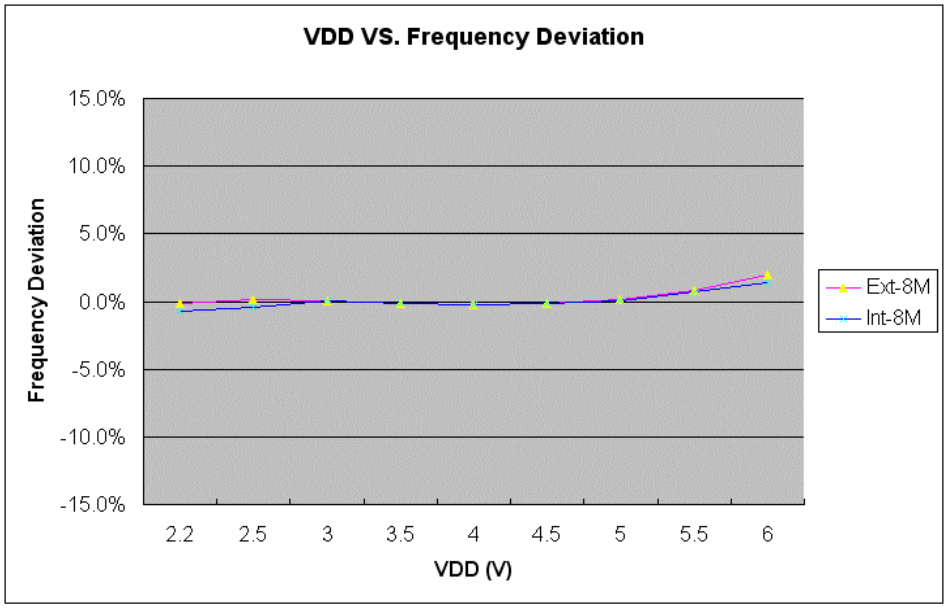
SYMBOL	PARAMETER		VDD	MIN.	TYP.	MAX.	UNIT	CONDITION
V_{DD}	Operating Voltage			2.2	3	5.5	V	8 MHz
I_{SB}	Supply Current	Halt	3			1	uA	SLEEP Mode
			4.5			2		
I_{SLOW}		Slow	3		8.3		uA	SLOW Mode (32 KHz)
			4.5		19.4			
I_{op}		Operating	3		4.4		mA	8 MHz, RM, PWM on, No Loading
			4.5		5.4			
$V_{W\ IH}$	Weak Input High Voltage			$0.4V_{DD}$		V_{DD}	V	
V_{IH}	Input High Voltage			$0.7V_{DD}$		V_{DD}	V	
V_{IL}	Input Low Voltage			V_{SS}		$0.3V_{DD}$	V	
I_{IH}	Input Current (Internal weak pull-low)		3		2.7		uA	V_{il} = 0 V
			4.5		5.6			
I_{OH}	Output High Current (Normal Current)		3		5.6		mA	V_{oh} = 2.6 V
			4.5		14.2			V_{oh} = 3.7 V
I_{OH}	Output High Current (Large Current)		3		8.6			V_{oh} = 2.6 V
			4.5		22			V_{oh} = 3.7 V
I_{ol}	Output Low Current		3		8.3			V_{ol} = 0.4 V

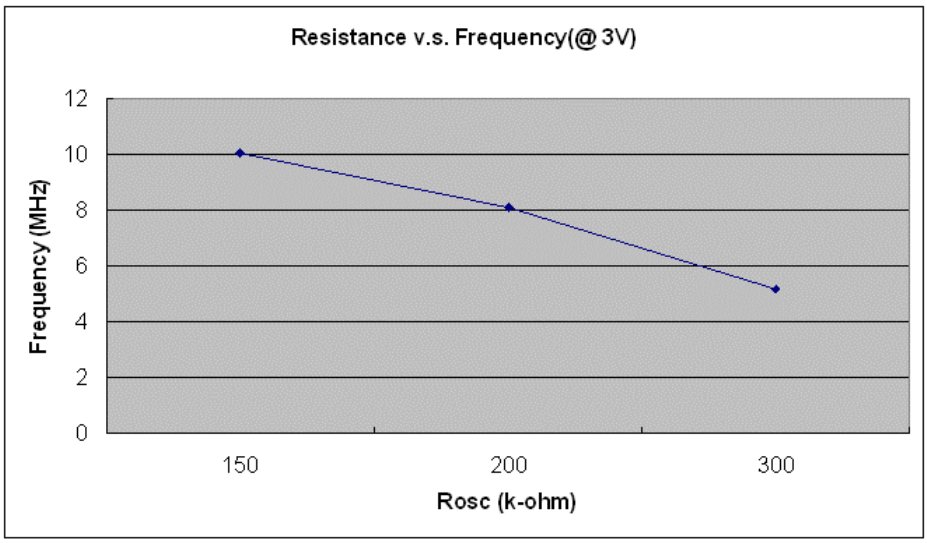
SYMBOL	PARAMETER	VDD	MIN.	TYP.	MAX.	UNIT	CONDITION
		4.5		17.5			V_{ol} = 0.8 V
I_{ol}	Output Low Current (Large Current)	3		19.1			V_{ol} = 0.4 V
		4.5		39.9			V_{ol} = 0.8 V
dF/F	Frequency Stability	3.4		±3%		%	$\frac{F(V)}{F(3)}$, 2.2<V<3.4
dF/F		5.1		±3%		%	$\frac{F(V)}{F(4.5)}$, 2.7<V<5.1
dF/F	F_{osc} Variation	3	7.88	8	8.12	MHz	8M ± 1.5%
		4.5					
dF/F	F_{SLOW} Variation	3		± 5		%	Slow mode, 32 KHz

Note：Ambient temperature is 25℃. Alpha will keep user updated when the temperature setting is changed.

5.3 Typical Rosc vs. V_{DD} for RM Mode Oscillator

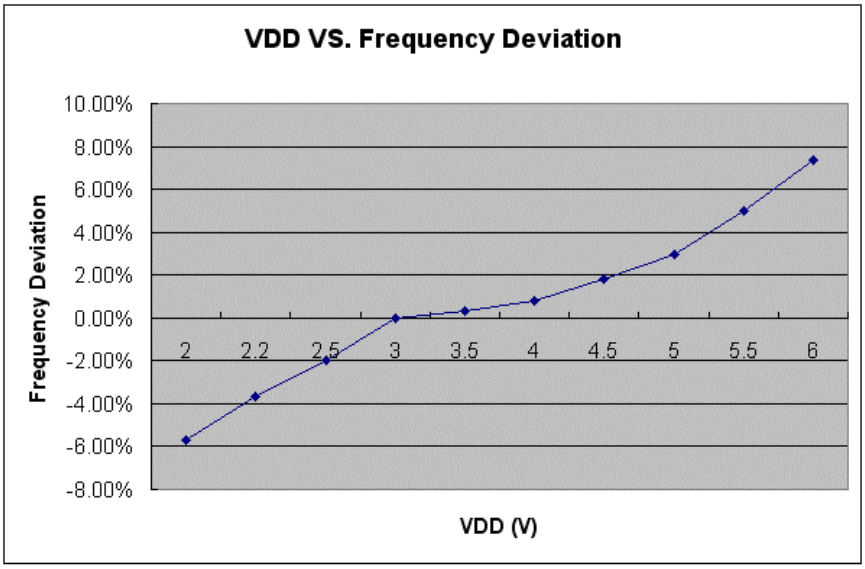
VDD	Oscillator Frequency (MHz)			
	Rosc = 150K	Rosc = 200K	Rosc = 300K	Rin
2.0	9.80	7.93	5.23	7.93
2.2	9.92	8.00	5.23	8.01
2.5	9.98	8.03	5.21	8.02
3.0	10.06	8.09	5.18	8.06
3.5	10.06	8.09	5.17	8.05
4.0	10.11	8.09	5.16	8.09
4.5	10.10	8.09	5.16	8.06
5.0	10.16	8.14	5.19	8.07
5.5	10.18	8.18	5.23	8.13
6.0	10.37	8.29	5.31	8.19


VDD VS. Frequency Deviation
15.0%
10.0%
5.0%
0.0%
-5.0%
-10.0%
-15.0%
Frequency Deviation
2.2
2.5
3
3.5
4
4.5
5
5.5
6
VDD (V)
Ext-8M
Int-8M


Resistance v.s. Frequency(@ 3V)
12
10
8
6
4
2
0
Frequency (MHz)
150
200
300
Rosc (k-ohm)

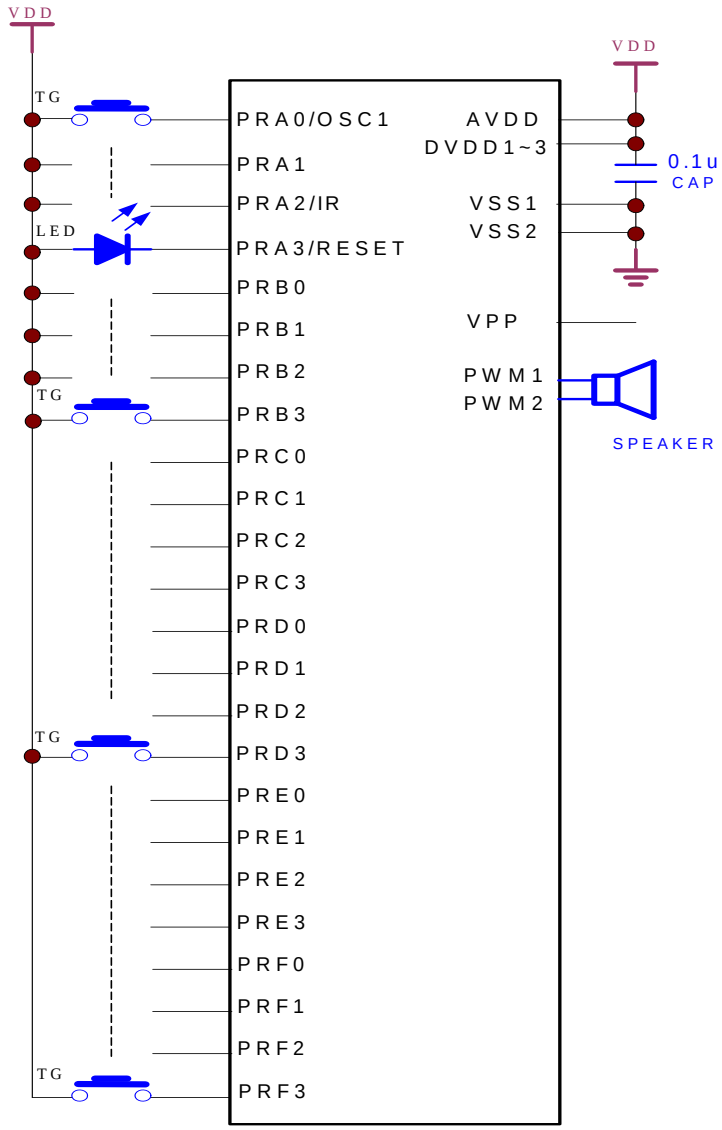
5.4 32 KHz vs. VDD for SLOW Clock Oscillator of AM5BA Series

VDD	Oscillator Frequency(KHz)
2.0	30.03
2.2	30.67
2.5	31.20
3.0	31.84
3.5	31.94
4.0	32.10
4.5	32.41
5.0	32.78
5.5	33.44
6.0	34.18

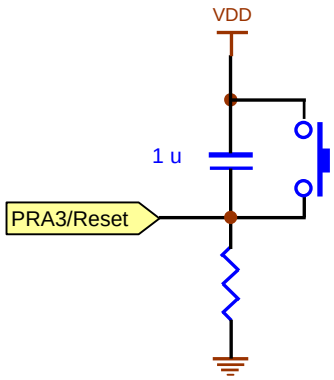


6. Application Circuit

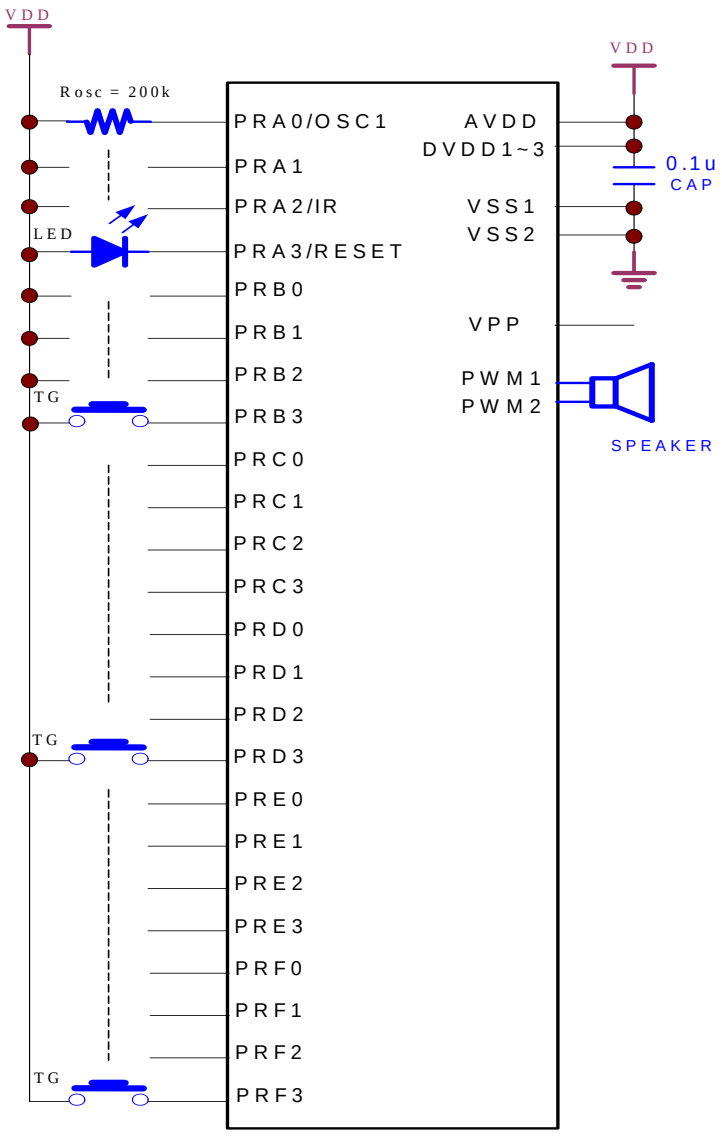
6.1 OSC Mode: Internal RC

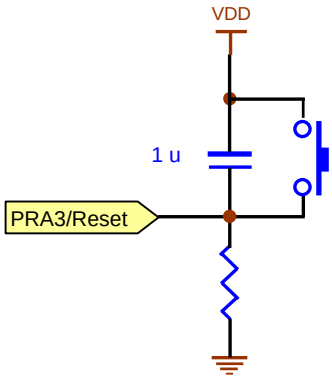


AM5BA340x/AM5BA170x/AM5BA084x



6.2 OSC Mode: External RC

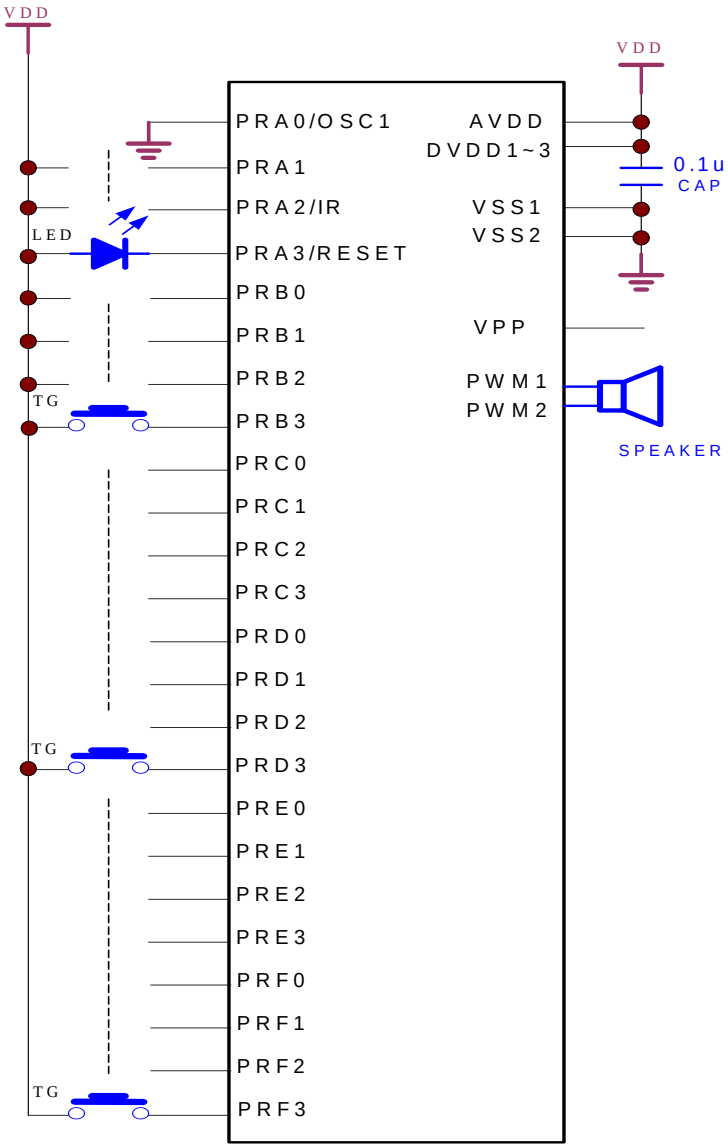


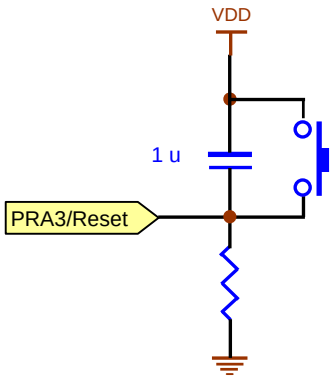


AM5BA340xAM5BA170x/AM5BA084x

6.3 OSC Mode: IRC + OSC

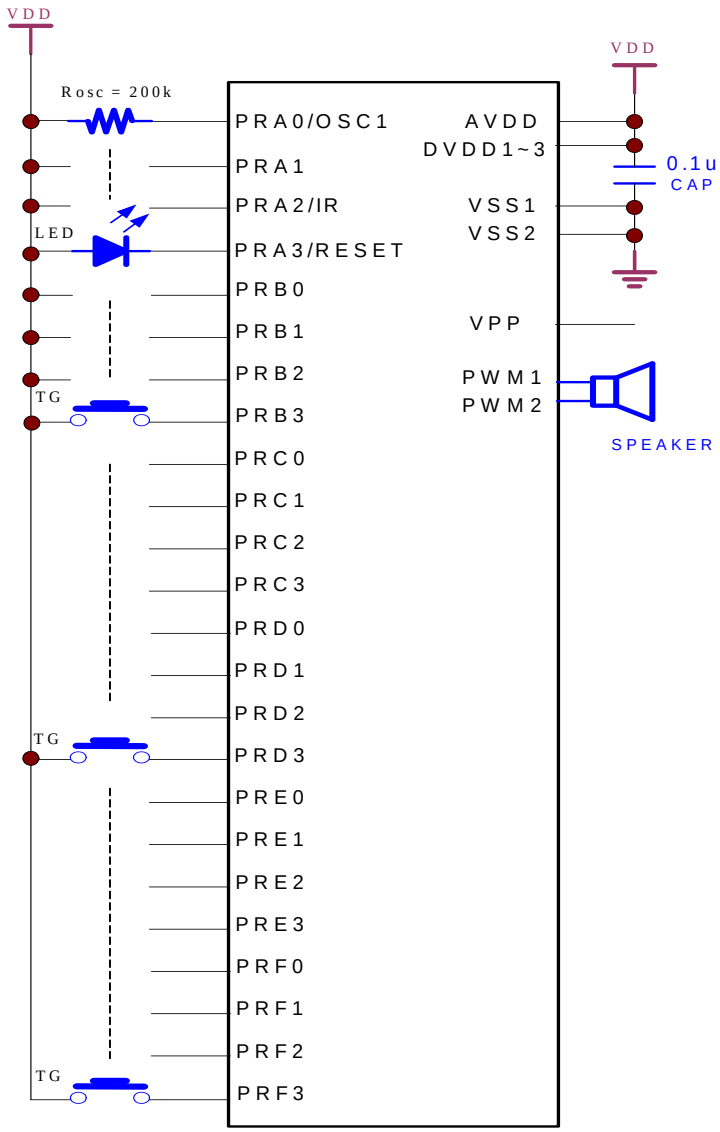
6.3.1 Internal RC

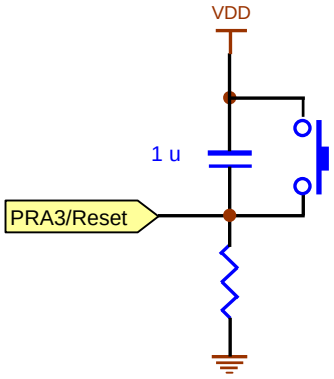




AM5BA340x/AM5BA170x/AM5BA084x

6.3.2 External RC



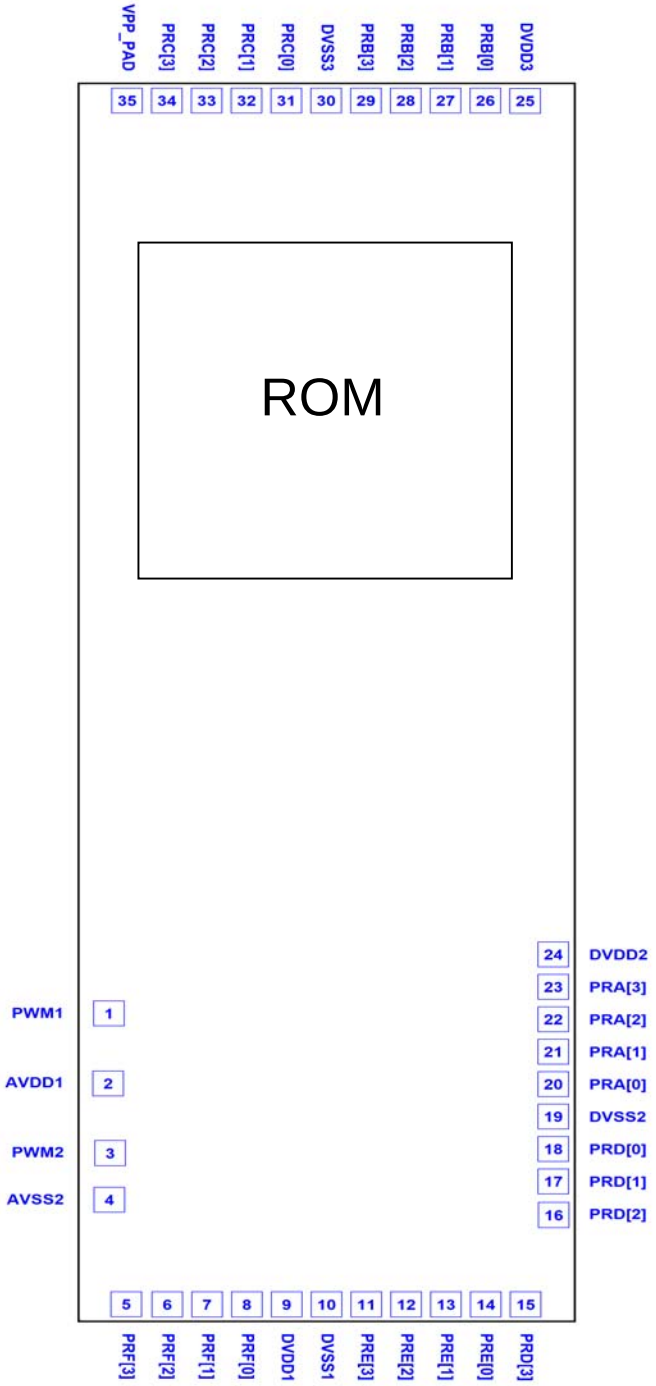


AM5BA340x/AM5BA170x/AM5BA084x

Note：VPP should be directly connected to VSS or floating as shown in the above figures.

7. Pad Location

7.1 AM5BA340x/AM5BA170x/AM5BA084x



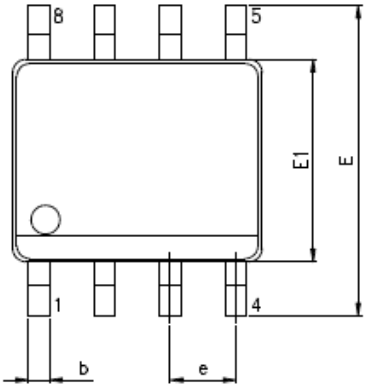
Note：PRA[3] has a 25pF capacitance load in the IC internal.

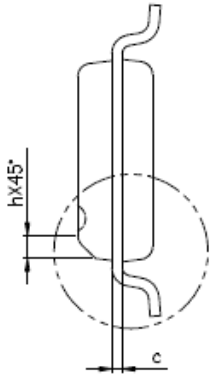
8. Package Dimension

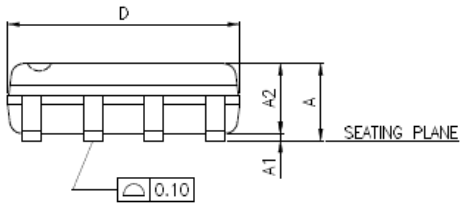
Package Type	Package Body Size (mm)
SOP8L	4.90 x 3.90 x 1.75
SOP16L	9.90 x 3.90 x 1.75
SSOP24L	8.20 x 5.30 x 2.00
LQFP32L	7.00 x 7.00 x 1.40

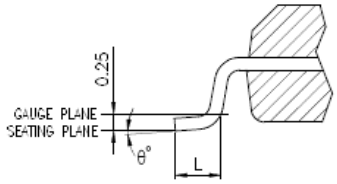
8.1 SOP8L

VARIATIONS (ALL DIMENSIONS SHOWN IN MM)					
SYMBOLS	MIN.	MAX.	SYMBOLS	MIN.	MAX.
A	—	1.75	E	6.00 BSC	
A1	0.10	0.25	E1	3.90 BSC	
A2	1.25	—	e	1.27 BSC	
b	0.31	0.51	L	0.40	1.27
c	0.10	0.25	h	0.25	0.50
D	4.90 BSC		θ°	0	8



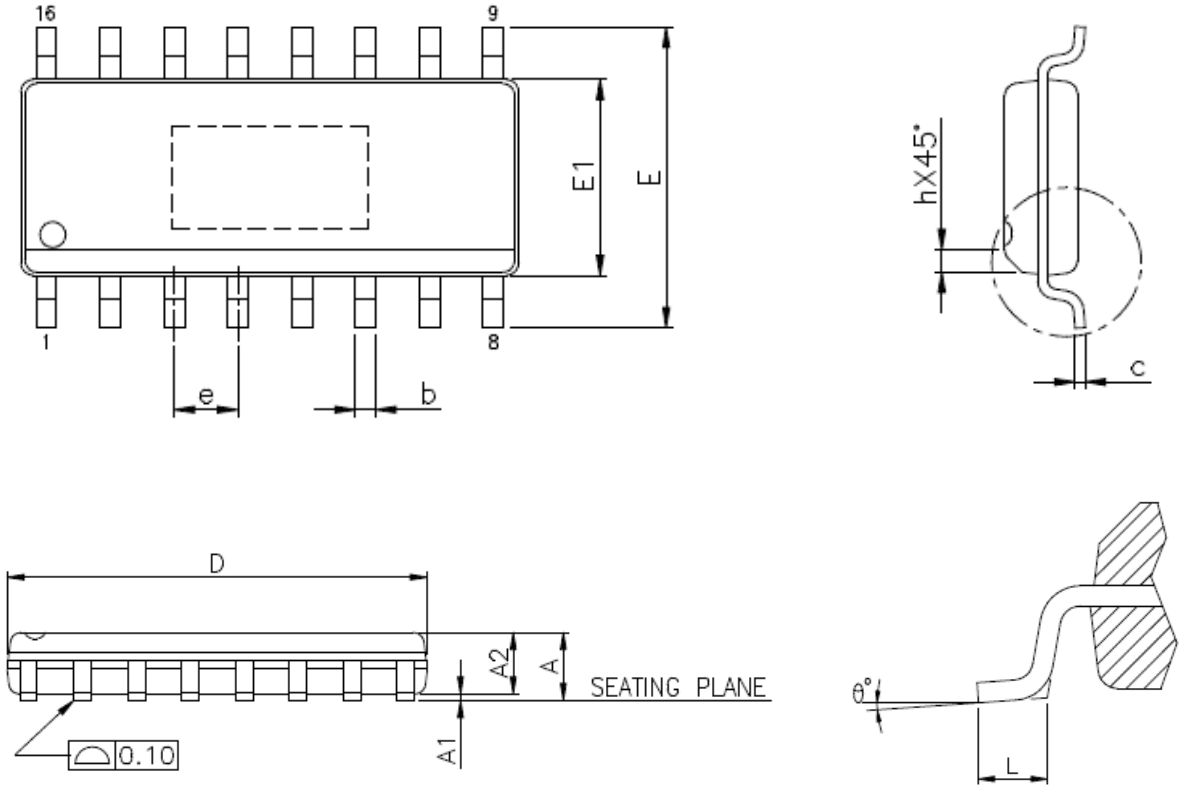






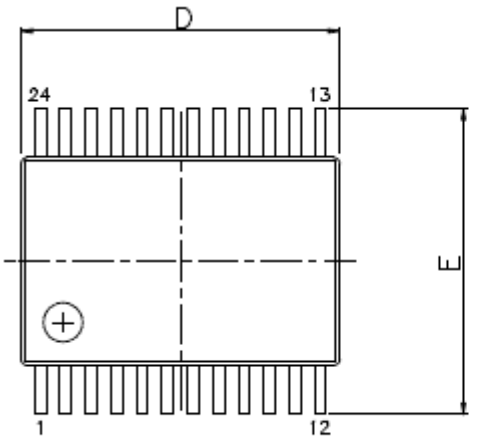
8.2 SOP16L

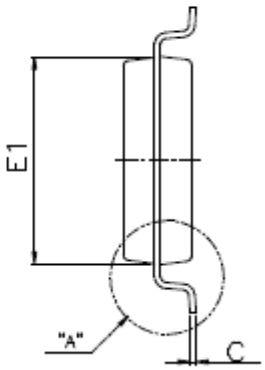
VARIATIONS (ALL DIMENSIONS SHOWN IN MM)					
SYMBOLS	MIN.	MAX.	SYMBOLS	MIN.	MAX.
A	—	1.75	E	6.00 BSC	
A1	0.10	0.25	E1	3.90 BSC	
A2	1.25	—	e	1.27 BSC	
b	0.31	0.51	L	0.40	1.27
c	0.10	0.25	h	0.25	0.50
D	9.90 BSC		θ°	0	8

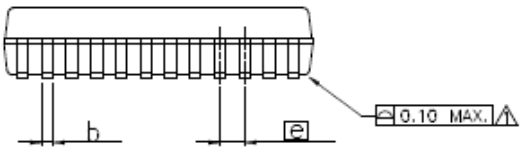


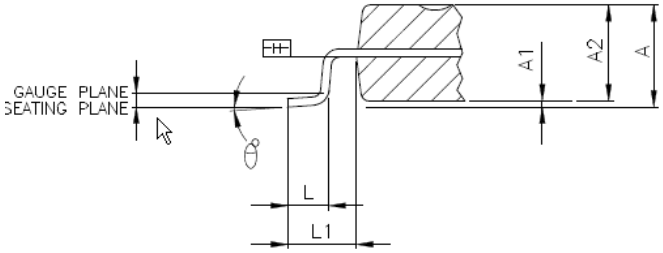
8.3 SSOP24L

VARIATIONS (ALL DIMENSIONS SHOWN IN MM)							
SYMBOLS	MIN.	NOM.	MAX.	SYMBOLS	MIN.	NOM.	MAX.
A	—	—	2.00	E	7.40	7.80	8.20
A1	0.05	—	—	E1	5.00	5.30	5.60
A2	1.65	1.75	1.85	e	—	0.65	—
b	0.22	—	0.38	L	0.55	0.75	0.95
c	0.09	—	0.21	L1	—	1.25	—
D	7.90	8.20	8.50	θ°	0	4	8



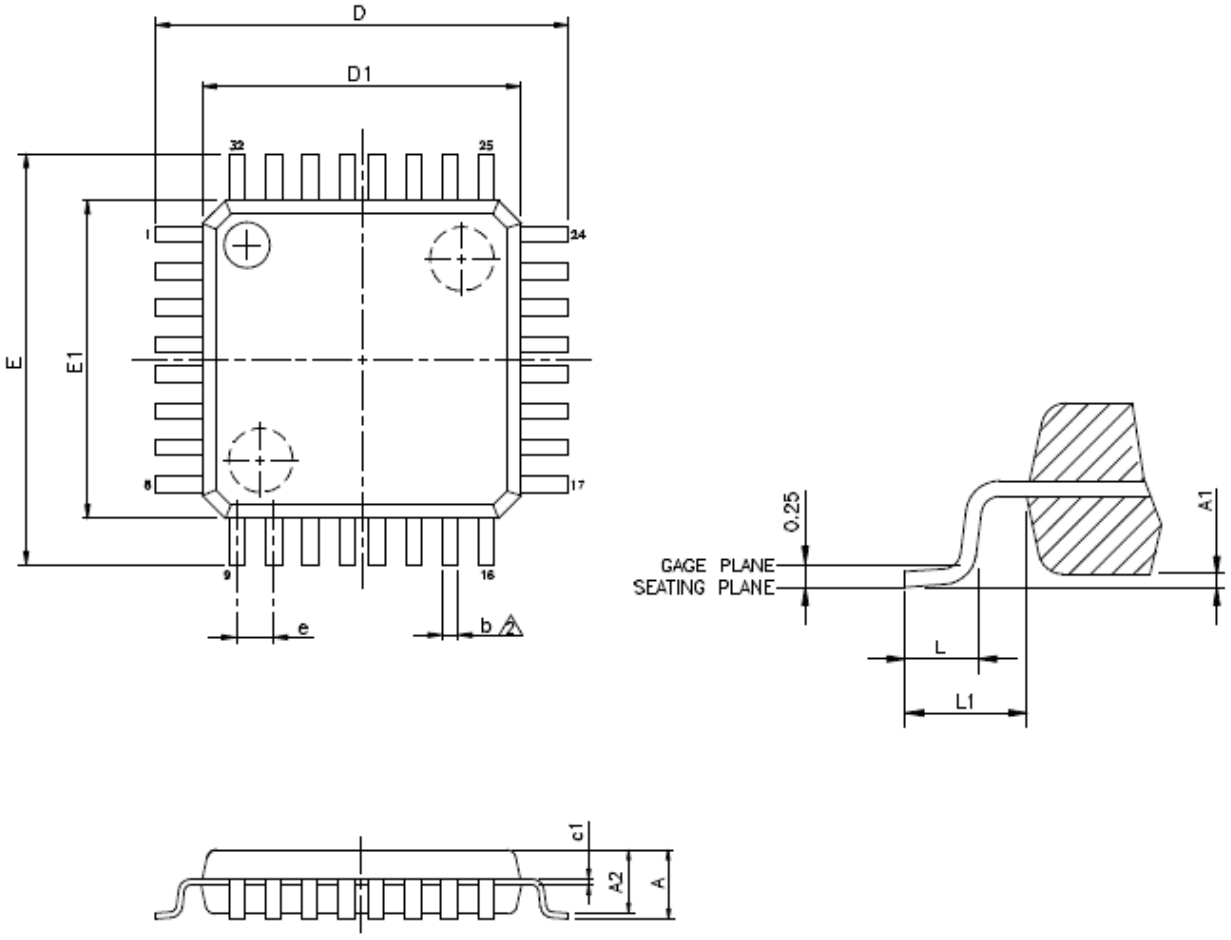






8.4 LQFP32L

VARIATIONS (ALL DIMENSIONS SHOWN IN MM)					
SYMBOLS	**MIN.**	**MAX.**	**SYMBOLS**	**MIN.**	**MAX.**
A	—	1.6	E	9.00 BSC	
A1	0.05	0.15	E1	7.00 BSC	
A2	1.35	1.45	e	0.8 BSC	
c1	0.09	0.16	b	0.30	0.45
D	9.00 BSC		L	0.45	0.75
D1	7.00 BSC		L1	1 REF	



9. Ordering Information

P/N*	Package Type	Pin Count	Package Size
AM5BA340A	Die	35	—
AM5BA340AX	SOP	8	150 mil
AM5BA340AS	SOP	16	150 mil
AM5BA340AD	SSOP	24	209 mil
AM5BA340AQ	LQFP	32	7x7x1.4 mm
AM5BA170A	Die	35	—
AM5BA170AX	SOP	8	150 mil
AM5BA170AS	SOP	16	150 mil
AM5BA170AD	SSOP	24	209 mil
AM5BA170AQ	LQFP	32	7x7x1.4 mm
AM5BA084A	Die	35	—
AM5BA084AX	SOP	8	150 mil
AM5BA084AS	SOP	16	150 mil
AM5BA084AD	SSOP	24	209 mil
AM5BA084AQ	LQFP	32	7x7x1.4 mm

***Indication of Part Number (P/N):**