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What is "Embedded - Microcontrollers"?

"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "<u>Embedded - Microcontrollers</u>"

Details	
Product Status	Active
Core Processor	S08
Core Size	8-Bit
Speed	20MHz
Connectivity	LINbus, SCI
Peripherals	LVD, PWM, WDT
Number of I/O	12
Program Memory Size	8KB (8K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	512 x 8
Voltage - Supply (Vcc/Vdd)	1.8V ~ 3.6V
Data Converters	A/D 8x12b
Oscillator Type	External
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	16-TSSOP (0.173", 4.40mm Width)
Supplier Device Package	16-TSSOP
Purchase URL	https://www.e-xfl.com/product-detail/nxp-semiconductors/mc9s08qb8ctgr

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Revision History

To provide the most up-to-date information, the revision of our documents on the World Wide Web will be the most current. Your printed copy may be an earlier revision. To verify you have the latest information available, refer to:

http://freescale.com/

The following revision history table summarizes changes contained in this document.

Rev	Date	Description of Changes
1	10/22/2008	Initial public released.
2	12/17/2008	Completed all the TBDs in Table 8.
3	3/6/2009	Corrected the 24-pin QFN package information. Changed V_{DDAD} and V_{SSAD} to V_{DDA} and V_{SSA} separatedly. In Table 7, updated the $II_{In}I$, $II_{OZ}I$ and added $II_{OZTOT}I$. In Table 11, updated the DCO output frequency range-trimmed, and updated some of the symbols.

Related Documentation

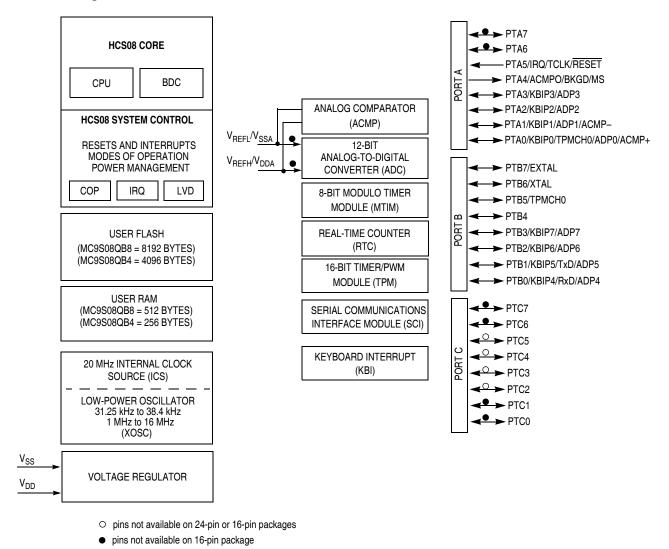
Find the most current versions of all documents at: http://www.freescale.com

Reference Manual (MC9S08QB8RM)

Contains extensive product information including modes of operation, memory, resets and interrupts, register definition, port pins, CPU, and all module information.

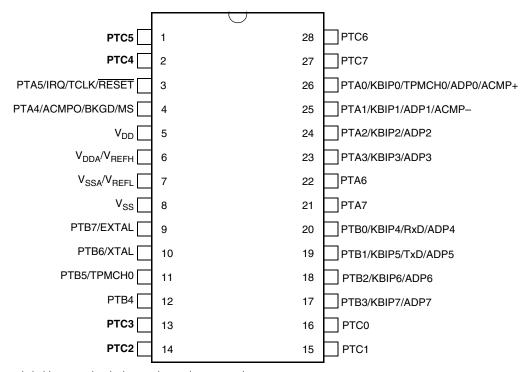
1 MCU Block Diagram

The block diagram shows the structure of the MC9S08QB8 MCU.



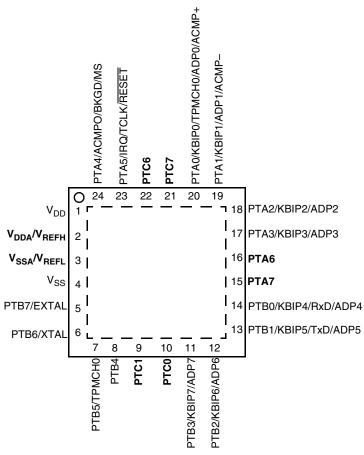
 1 $\,$ V $_{\rm DDA}$ /V $_{\rm REFH}$ and V $_{\rm SSA}$ /V $_{\rm REFL}$ are double bonded to V $_{\rm DD}$ and V $_{\rm SS}$ respectively in 16-pin package.

Figure 1. MC9S08QB8 Series Block Diagram



Pins shown in bold type are lost in the next lower pin count package.

Figure 2. MC9S08QB8 Series in 28-Pin SOIC Package



Pins shown in bold type are lost in the next lower pin count package.

Figure 3. MC9S08QB8 Series in 24-Pin QFN Packages

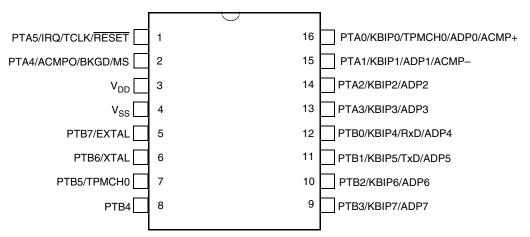


Figure 4. MC9S08QB8 Series in 16-Pin TSSOP Package

3.1 Introduction

This chapter contains electrical and timing specifications for the MC9S08QB8 series of microcontrollers available at the time of publication.

3.2 Parameter Classification

The electrical parameters shown in this supplement are guaranteed by various methods. To give the customer a better understanding the following classification is used and the parameters are tagged accordingly in the tables where appropriate:

Table 2. Parameter Classifications

Р	Those parameters are guaranteed during production testing on each individual device.
С	Those parameters are achieved by the design characterization by measuring a statistically relevant sample size across process variations.
Т	Those parameters are achieved by design characterization on a small sample size from typical devices under typical conditions unless otherwise noted. All values shown in the typical column are within this category.
D	Those parameters are derived mainly from simulations.

NOTE

The classification is shown in the column labeled "C" in the parameter tables where appropriate.

3.3 Absolute Maximum Ratings

Absolute maximum ratings are stress ratings only, and functional operation at the maxima is not guaranteed. Stress beyond the limits specified in Table 3 may affect device reliability or cause permanent damage to the device. For functional operating conditions, refer to the remaining tables in this section.

This device contains circuitry protecting against damage due to high static voltage or electrical fields; however, it is advised that normal precautions be taken to avoid application of any voltages higher than maximum-rated voltages to this high-impedance circuit. Reliability of operation is enhanced if unused inputs are tied to an appropriate logic voltage level (for instance, either V_{SS} or V_{DD}) or the programmable pull-up resistor associated with the pin is enabled.

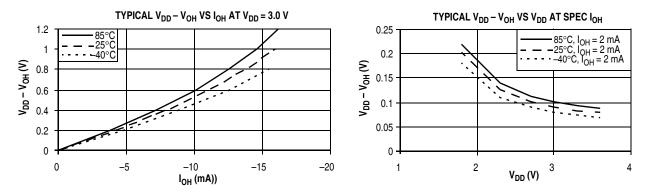


Figure 8. Typical High-Side (Source) Characteristics — Low Drive (PTxDSn = 0)

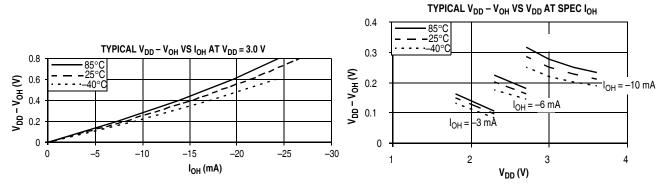


Figure 9. Typical High-Side (Source) Characteristics — High Drive (PTxDSn = 1)

3.7 Supply Current Characteristics

This section includes information about power supply current in various operating modes.

Table 8. Supply Current Characteristics

Num	С	Parameter	Symbol	Bus Freq	V _{DD} (V)	Typical ¹	Max	Unit	Temp (°C)
1	Р	Run supply current	RI _{DD}	10 MHz	_	5.60	6	mA	–40 to 85°C
'	Т	FEI mode, all modules on	LIDD	1 MHz	3	0.80	_	IIIA	-40 to 65 C
2	Т	Run supply current	RI _{DD}	10 MHz		3.60	_	mA	–40 to 85°C
	Т	FEI mode, all modules off	טטיי י	1 MHz	3	0.75	1	ША	- 4 0 to 05 O
3	Т	Run supply current LPRS=0, all modules off	RI _{DD}	16 kHz FBILP	3	165		μΑ	–40 to 85°C
3	Т		i iiDD	16 kHz FBELP	J	105	_	μΑ	-40 to 65 C
4	Т	Run supply current LPRS=1, all modules off	RI _{DD}	16 kHz FBELP	3	7.3	_	μА	–40 to 85°C
5	Т	Wait mode supply current	WI _{DD}	10 MHz	3	570	_	μА	–40 to 85°C
	Т	FEI mode, all modules off	VVIDD	1 MHz		290	_	μΑ	-40 to 65 C
6	Т	Wait mode supply current LPRS = 1, all mods off	WI _{DD}	16 kHz FBELP	3	1	_	μА	−40 to 85°C
	Р			_	3	0.25	0.65	μΑ	−40 to 25°C
	С			1		0.5	0.8		70°C
7	Р	Stop2 mode supply current	S2I _{DD}	_		1	2		85°C
'	С	Clop2 mede cappiy carrent	OZ.DD			0.2	0.5	μπ	–40 to 25°C
	С				2	0.3	0.6		70°C
	С					0.7	1.6		85°C
	Р			_		0.45	0.80		-40 to 25°C
	С			_	3	1	1.8		70°C
8	Р	Stop3 mode supply current	S3I _{DD}	_		3	5.8	μΑ	85°C
	С	no clocks active	DD	_		0.3	0.6	μιν	–40 to 25°C
	С			_	2	0.8	1.5		70°C
	С			_		2.5	5.0	1	85°C

Data in Typical column was characterized at 3.0 V, 25 °C or is typical recommended value.

Table 9. Stop Mode Adders

Num	С	C Parameter	Condition			Units		
Italii		i arameter	Condition	-40 °C	25 °C	70 °C	85 °C	Omis
1	T	LPO	_	50	75	100	150	nA
2	T	ERREFSTEN	RANGE = HGO = 0	1000	1000	1100	1500	nA
3	Т	IREFSTEN ¹	_	63	70	77	81	μА

Table 9. Stop Mode Adders (continued)

Num	С	Parameter	Condition			Units		
Nulli	O	Farameter	Condition	-40 °C	25 °C	70 °C	85 °C	Omis
4	Т	RTC	Does not include clock source current	50	75	100	150	nA
5	T	LVD ¹	LVDSE = 1	90	100	110	115	μΑ
6	T	ACMP ¹	Not using the bandgap (BGBE = 0)	18	20	22	23	μΑ
7	Т	ADC ¹	ADLPC = ADLSMP = 1 Not using the bandgap (BGBE = 0)	95	106	114	120	μΑ

¹ Not available in stop2 mode.

3.8 External Oscillator (XOSC) Characteristics

Reference Figure 10 and Figure 11 for crystal or resonator circuits.

Table 10. XOSCVLP and ICS Specifications (Temperature Range = −40 to 85°C Ambient)

Num	С	Characteristic	Symbol	Min	Typ ¹	Max	Unit
1	С	Oscillator crystal or resonator (EREFS = 1, ERCLKEN = 1) Low range (RANGE = 0) High range (RANGE = 1), high gain (HGO = 1) High range (RANGE = 1), low power (HGO = 0)	f _{lo} f _{hi} f _{hi}	32 1 1	_ _ _	38.4 16 8	kHz MHz MHz
2	D	Load capacitors Low range (RANGE=0), low power (HGO=0) Other oscillator settings	C _{1,} C ₂		ote ² ote ³		
3	D	Feedback resistor Low range, low power (RANGE = 0, HGO = 0) ² Low range, high gain (RANGE = 0, HGO = 1) High range (RANGE = 1, HGO = X)	R _F		— 10 1		МΩ
4	D	Series resistor — Low range, low power (RANGE = 0, HGO = 0) ² Low range, high gain (RANGE = 0, HGO = 1) High range, low power (RANGE = 1, HGO = 0) High range, high gain (RANGE = 1, HGO = 1) ≥ 8 MHz 4 MHz 1 MHz	R _S	111 111		 0 10 20	kΩ
5	С	Crystal start-up time ⁴ Low range, low power Low range, high gain High range, low power High range, high gain	t CSTL t CSTH	_ _ _ _	600 400 5 15	_ _ _ _	ms
6	D	Square wave input clock frequency (EREFS = 0, ERCLKEN = 1) FEE mode FBE or FBELP mode	f _{extal}	0.03125 0	_ _	20 20	MHz

- ¹ Data in Typical column was characterized at 3.0 V, 25 °C or is typical recommended value.
- ² Load capacitors (C_1, C_2) , feedback resistor (R_F) and series resistor (R_S) are incorporated internally when RANGE = HGO = 0.
- ³ See crystal or resonator manufacturer's recommendation.
- ⁴ Proper PC board layout procedures must be followed to achieve specifications.

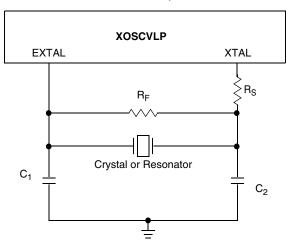


Figure 10. Typical Crystal or Resonator Circuit: High Range and Low Range/High Gain

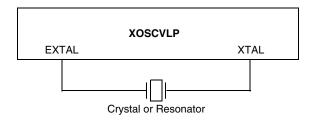


Figure 11. Typical Crystal or Resonator Circuit: Low Range/Low Power

3.9 Internal Clock Source (ICS) Characteristics

Table 11. ICS Frequency Specifications (Temperature Range = -40 to 85°C Ambient)

Num	С	Charac	Characteristic				Max.	Unit
1	Р	Average internal reference freq at V _{DD} = 3.6 V and temperature	verage internal reference frequency — factory trimmed V _{DD} = 3.6 V and temperature = 25 °C					kHz
2	Р	Internal reference frequency —	ernal reference frequency — user trimmed				39.06	kHz
3	Т	Internal reference start-up time	t _{IRST}	_	60	100	μS	
4		DCO output frequency range — trimmed ²	output frequency range — Low range (DRS = 00) ed ²		16	_	20	MHz
5	Р	DCO output frequency ² Reference = 32768 Hz and DM	DCO output frequency ² Reference = 32768 Hz and DMX32 = 1					MHz
6		Resolution of trimmed DCO out and temperature (using FTRIM)	$\Delta f_{dco_res_t}$		±0.1	±0.2	%f _{dco}	

3.11 Analog Comparator (ACMP) Electricals

Table 14. Analog Comparator Electrical Specifications

С	Characteristic	Symbol	Min	Typical	Max	Unit
D	Supply voltage	V _{PWR}	1.8	_	3.6	V
D	Supply current (active)	I _{DDAC}	_	20	35	μА
D	Analog input voltage	V _{AIN}	$V_{SS} - 0.3$	_	V_{DD}	V
Р	Analog input offset voltage	V _{AIO}	_	20	40	mV
С	Analog comparator hysteresis	V _H	3.0	9.0	15.0	mV
Р	Analog input leakage current	I _{ALKG}	_	_	1.0	μΑ
С	Analog comparator initialization delay	t _{AINIT}	_	_	1.0	μS

3.12 ADC Characteristics

Table 15. 12-Bit ADC Operating Conditions

Characteristic	Conditions	Symbol	Min	Typical ¹	Max	Unit	Comment
	Absolute	V_{DDA}	1.8	_	3.6	V	
Supply voltage	Delta to V _{DD} (V _{DD} – V _{DDA}) ²	ΔV _{DDA}	-100	0	100	mV	
Ground voltage	Delta to V _{SS} (V _{SS} – V _{SSA}) ²	ΔV _{SSA}	-100	0	100	mV	
Supply Current	Stop, Reset, Module Off	I _{DDAD}	_	0.007	0.8	μΑ	
Input Voltage		V _{ADIN}	V _{REFL}	_	V _{REFH}	V	
Input Capacitance		C _{ADIN}	_	4.5	5.5	pF	
Input Resistance		R _{ADIN}	_	5	7	kΩ	
	12 bit mode $f_{ADCK} > 4 MHz$ $f_{ADCK} < 4 MHz$			_	2 5		
Analog Source Resistance	10 bit mode $f_{ADCK} > 4MHz$ $f_{ADCK} < 4MHz$	R _{AS}	_ _	_ _	5 10	kΩ	External to MCU
	8 bit mode (all valid f _{ADCK})		_	_	10		
ADC	High Speed (ADLPC = 0)		0.4	_	8.0		
Conversion Clock Freq.	Low Power (ADLPC = 1)	f _{ADCK}	0.4	_	4.0	MHz	

Typical values assume $V_{DDA} = 3.0 \text{ V}$, Temp = 25 °C, $f_{ADCK} = 1.0 \text{ MHz}$ unless otherwise stated. Typical values are for reference only and are not tested in production.

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² DC potential difference.

Table 16. 12-Bit ADC Characteristics ($V_{REFH} = V_{DDA}, V_{REFL} = V_{SSA}$)

Characteristic	Conditions	С	Symbol	Min	Typical ¹	Max	Unit	Comment
Supply Current ADLPC=1 ADLSMP=1 ADCO=1		Т	I _{DDAD}	_	120	_	μА	
Supply Current ADLPC=1 ADLSMP=0 ADCO=1		Т	I _{DDAD}	_	202	_	μА	
Supply Current ADLPC=0 ADLSMP=1 ADCO=1		Т	I _{DDAD}	1	288	l	μА	
Supply Current ADLPC=0 ADLSMP=0 ADCO=1		Т	I _{DDAD}		0.532	1	mA	
Supply Current	Stop, Reset, Module Off	Т	I _{DDAD}	_	0.007	0.8	μА	
ADC	High Speed (ADLPC = 0)	0	£	2	3.3	5	MHz	t _{ADACK} =
Asynchronous Clock Source	Low Power (ADLPC = 1)	Р	f _{ADACK}	1.25	2	3.3	IVITZ	1/f _{ADACK}
Conversion Time (Including	Short Sample (ADLSMP = 0)	Т	t _{ADC}	ı	20	ı	ADCK	See reference manual for conversion time variances
sample time)	Long Sample (ADLSMP = 1)			ı	40	I	cycles	
Sample Time	Short Sample (ADLSMP = 0)	T	t _{ADS}	_	3.5	_	ADCK	
Cample Time	Long Sample (ADLSMP = 1)	•		-	23.5	ı	cycles	
Total	12-bit mode	Т		_	±3.0	_		For 28-pin and 24-pin
Unadjusted	10-bit mode	Р	E _{TUE}	_	±1	_	LSB ²	packages only.
Error	8-bit mode	Т		_	±0.5	_		Includes quantization
Total	10-bit mode	Р		_	±1.5	_		For 16-pin
Unadjusted Error	8-bit mode	Т	E _{TUE}	_	±0.7	_	LSB ²	package only. Includes quantization
	12-bit mode	Т		_	±1.75	_		
Differential	10-bit mode	Р	DNL	_	±0.5	_	LSB ²	
Non-Linearity	8-bit mode	Т		_	±0.3	_		
	Monotonicity and No-Missing	g-Code:	s guarantee	d				•

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Program and erase operations do not require any special power sources other than the normal V_{DD} supply. For more detailed information about program/erase operations, see the memory section.

Table 17. Flash Characteristics

С	Characteristic	Symbol	Min	Typical	Max	Unit
D	Supply voltage for program/erase -40°C to 85°C	V _{prog/erase}	1.8		3.6	V
D	Supply voltage for read operation	V _{Read}	1.8		3.6	V
D	Internal FCLK frequency ¹	f _{FCLK}	150		200	kHz
D	Internal FCLK period (1/FCLK)	t _{Fcyc}	5		6.67	μS
D	Byte program time (random location) ⁽²⁾	t _{prog}	9		t _{Fcyc}	
D	Byte program time (burst mode) ⁽²⁾	t _{Burst}	4		t _{Fcyc}	
D	Page erase time ²	t _{Page}	4000		t _{Fcyc}	
D	Mass erase time ⁽²⁾	t _{Mass}	20,000		t _{Fcyc}	
D	Byte program current ³	RI _{DDBP}	_	4	_	mA
D	Page erase current ³	RI _{DDPE}	_	6	_	mA
С	Program/erase endurance ⁴ T_L to $T_H = -40$ °C to + 85°C $T = 25$ °C	_	10,000	 100,000	_ _	cycles
С	Data retention ⁵	t _{D_ret}	15	100	_	years

The frequency of this clock is controlled by a software setting.

3.14 EMC Performance

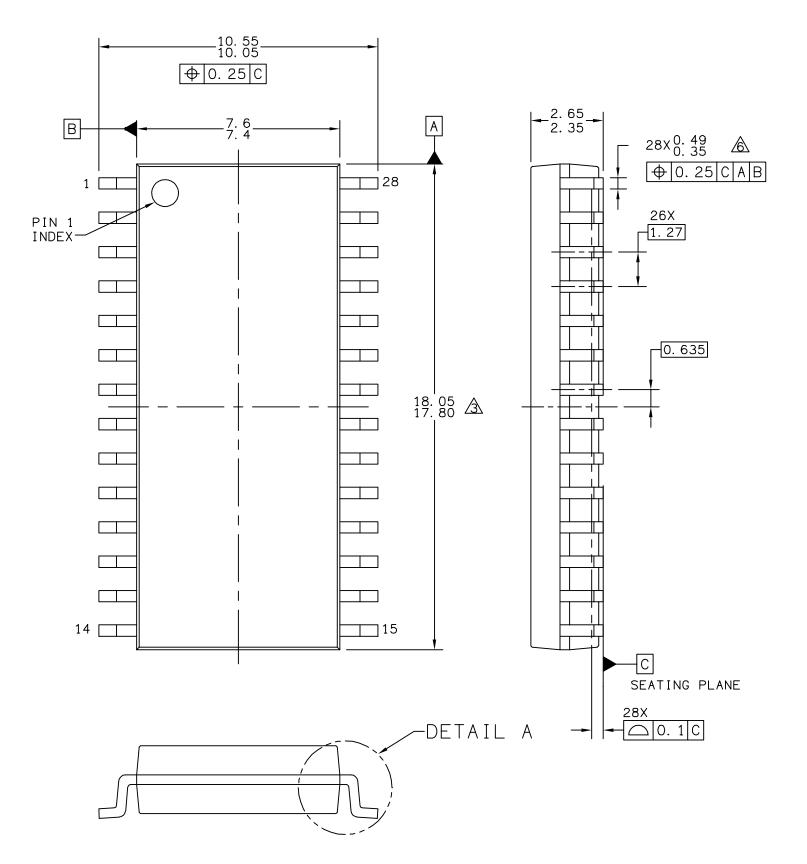
Electromagnetic compatibility (EMC) performance is highly dependant on the environment in which the MCU resides. Board design and layout, circuit topology choices, location and characteristics of external components as well as MCU software operation all play a significant role in EMC performance. The system designer should consult Freescale applications notes such as AN2321, AN1050, AN1263, AN2764, and AN1259 for advice and guidance specifically targeted at optimizing EMC performance.

² These values are hardware state machine controlled. User code does not need to count cycles. This information supplied for calculating approximate time to program and erase.

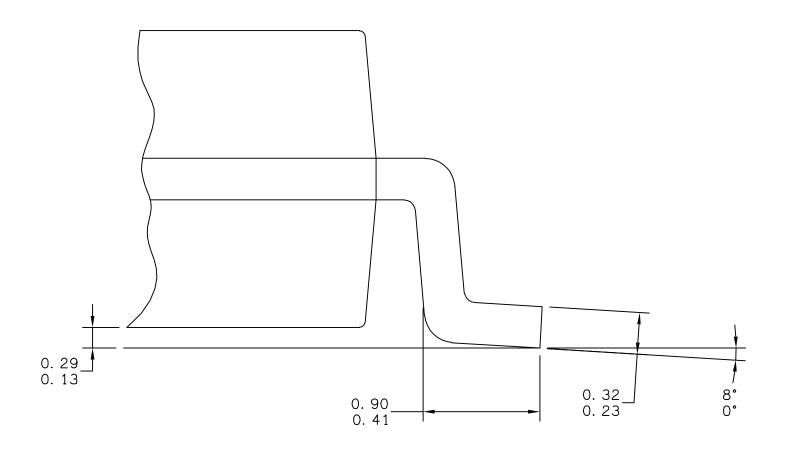
³ The program and erase currents are additional to the standard run I_{DD} . These values are measured at room temperatures with $V_{DD} = 3.0 \text{ V}$, bus frequency = 4.0 MHz.

Typical endurance for flash was evaluated for this product family on the 9S12Dx64. For additional information on how Freescale defines typical endurance, please refer to Engineering Bulletin EB619, Typical Endurance for Nonvolatile Memory.

⁵ **Typical data retention** values are based on intrinsic capability of the technology measured at high temperature and de-rated to 25°C using the Arrhenius equation. For additional information on how Freescale defines typical data retention, please refer to Engineering Bulletin EB618, *Typical Data Retention for Nonvolatile Memory.*



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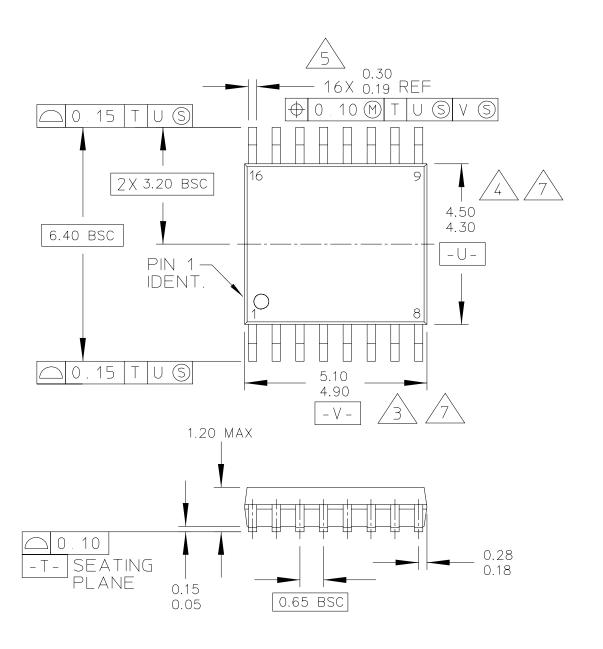
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