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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 "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	56800E
Core Size	16-Bit
Speed	60MHz
Connectivity	I²C, LINbus, SCI, SPI
Peripherals	LVD, POR, PWM, WDT
Number of I/O	35
Program Memory Size	48KB (24K x 16)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	3K x 16
Voltage - Supply (Vcc/Vdd)	3V ~ 3.6V
Data Converters	A/D 8x12b; D/A 1x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 125°C (TA)
Mounting Type	Surface Mount
Package / Case	44-LQFP
Supplier Device Package	44-LQFP (10x10)
Purchase URL	https://www.e-xfl.com/product-detail/nxp-semiconductors/mc56f8245mld

- Up to 54 general-purpose I/O (GPIO) pins
  - 5 V tolerant I/O
  - Individual control for each pin to be in peripheral or GPIO mode
  - Individual input/output direction control for each pin in GPIO mode
  - Individual control for each output pin to be in push-pull mode or open-drain mode
  - Hysteresis and configurable pullup device on all input pins
  - Ability to generate interrupt with programmable rising or falling edge and software interrupt
  - Configurable drive strength: 4 mA / 8 mA sink/source current
- JTAG/EOnCE debug programming interface for real-time debugging
  - IEEE 1149.1 Joint Test Action Group (JTAG) interface
  - EOnCE interface for real-time debugging

2.1.6 Power Saving Features

- Low-speed run, wait, and stop modes: as low as 781 Hz clock provided by OCCS and internal ROSC
- Large regulator standby mode available for reducing power consumption at low-speed mode
- Less than 30 µs typical wakeup time from stop modes
- Each peripheral can be individually disabled to save power

2.2 Award-Winning Development Environment

Processor Expert (PE) provides a Rapid Application Design (RAD) tool that combines easy-to-use component-based software application creation with an expert knowledge system.

The CodeWarrior Integrated Development Environment (IDE) is a sophisticated tool for code navigation, compiling, and debugging. A complete set of evaluation modules (EVMs), demonstration board kit, and development system cards supports concurrent engineering. Together, PE, CodeWarrior, and EVMs create a complete, scalable tools solution for easy, fast, and efficient development.

2.3 Architecture Block Diagram

The MC56F825x/MC56F824x's architecture appears in Figure 1 and Figure 2. Figure 1 illustrates how the 56800E system buses communicate with internal memories and the IP bus interface as well as the internal connections among the units of the 56800E core.

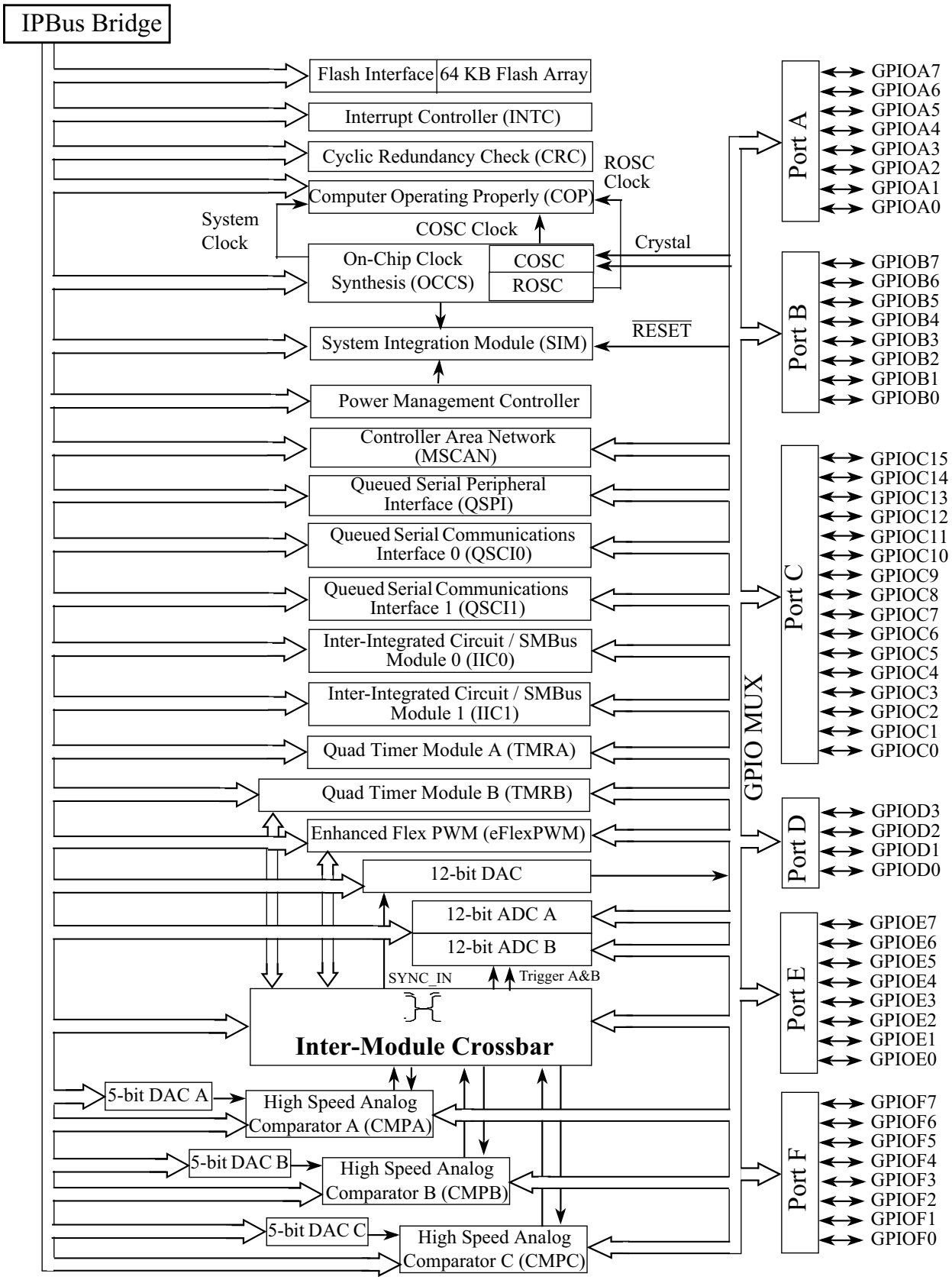

Figure 2. Peripheral Subsystem

Table 4. MC56F825x/MC56F824x Pins (continued)

Pin Number			Pin Name	Peripherals													
44 LQFP	48 LQFP	64 LQFP		GPIO	I^2C	SCI	SPI	MSCAN[1]	ADC	Cross Bar	COMP	Quad Timer	eFlex PWM	Power	JTAG	Misc.
19	21	28	GPIOB3/ *ANB3&VREFLB&CMPC_M0*	**GPIOB3**					*ANB3& VREFLB*		*CMPC_M0*					
		29	V_{DD}											**V_{DD}**		
20	22	30	V_{SS}											**V_{SS}**		
21	23	31	GPIOC6/*TA2/XB_IN3/ CMP_REF*	**GPIOC6**						*XB_IN3*	*CMP_REF*	*TA2*				
22	24	32	GPIOC7/$\overline{SS}$/*TXD0*	**GPIOC7**		*TXD0*	$\overline{SS}$									
23	25	33	GPIOC8/*MISO/RXD0*	**GPIOC8**		*RXD0*	*MISO*									
24	26	34	GPIOC9/*SCLK/XB_IN4*	**GPIOC9**			*SCLK*			*XB_IN4*						
25	27	35	GPIOC10/MOSI/XB_IN5/MISO	**GPIOC10**			MOSI/ MISO			XB_IN5						
	28	36	GPIOF0/*XB_IN6*	**GPIOF0**						*XB_IN6*						
26	29	37	GPIOC11/*CANTX/SCL1/TXD1*	**GPIOC11**	*SCL1*	*TXD1*		*CANTX*								
27	30	38	GPIOC12/*CANRX/SDA1/RXD1*	**GPIOC12**	*SDA1*	*RXD1*		*CANRX*								
		39	GPIOF2/*SCL1/XB_OUT2*	**GPIOF2**	*SCL1*					*XB_OUT2*						
		40	GPIOF3/*SDA1/XB_OUT3*	**GPIOF3**	*SDA1*					*XB_OUT3*						
		41	GPIOF4/*TXD1/XB_OUT4*	**GPIOF4**		*TXD1*				*XB_OUT4*						
		42	GPIOF5/*RXD1/XB_OUT5*	**GPIOF5**		*RXD1*				*XB_OUT5*						
28	31	43	V_{SS}											**V_{SS}**		
29	32	44	V_{DD}											**V_{DD}**		
30	33	45	GPIOE0/*PWM0B*	**GPIOE0**									*PWM0B*			
31	34	46	GPIOE1/*PWM0A*	**GPIOE1**									*PWM0A*			
32	35	47	GPIOE2/*PWM1B*	**GPIOE2**									*PWM1B*			
33	36	48	GPIOE3/*PWM1A*	**GPIOE3**									*PWM1A*			
34	37	49	GPIOC13/*TA3/XB_IN6*	**GPIOC13**						*XB_IN6*		TA3				
	38	50	GPIOF1/*CLKO/XB_IN7*	**GPIOF1**						*XB_IN7*						*CLKO*
35	39	51	GPIOE4/*PWM2B/XB_IN2*	**GPIOE4**						*XB_IN2*			*PWM2B*			
36	40	52	GPIOE5/*PWM2A/XB_IN3*	**GPIOE5**						*XB_IN3*			*PWM2A*			
		53	GPIOE6/*PWM3B/XB_IN4*	**GPIOE6**						*XB_IN4*			*PWM3B*			
		54	GPIOE7/*PWM3A/XB_IN5*	**GPIOE7**						*XB_IN5*			*PWM3A*			
37	41	55	GPIOC14/*SDA0/XB_OUT0*	**GPIOC14**	*SDA0*					*XB_OUT0*						
38	42	56	GPIOC15/*SCL0/XB_OUT1*	**GPIOC15**	*SCL0*					*XB_OUT1*						
39	43	57	V_{CAP}											**V_{CAP}**		
		58	GPIOF6/*TB2/PWM3X*	**GPIOF6**								*TB2*	*PWM3X*			
		59	GPIOF7/*TB3*	**GPIOF7**								*TB3*				
40	44	60	V_{DD}											**V_{DD}**		

3.2 Pin Assignment

Figure 3 shows the pin assignments of the 56F8245 and 56F8255's 44-pin low-profile quad flat pack (44LQFP). Figure 4 shows the pin assignments of the 56F8246 and 56F8256's 48-pin low-profile quad flat pack (48LQFP). Figure 5 shows the pin assignments of the 56F8247 and 56F8257's 64-pin low-profile quad flat pack (64LQFP).

NOTE

The CANRX and CANTX signals of the MSCAN module are not available on the MC56F824x devices.

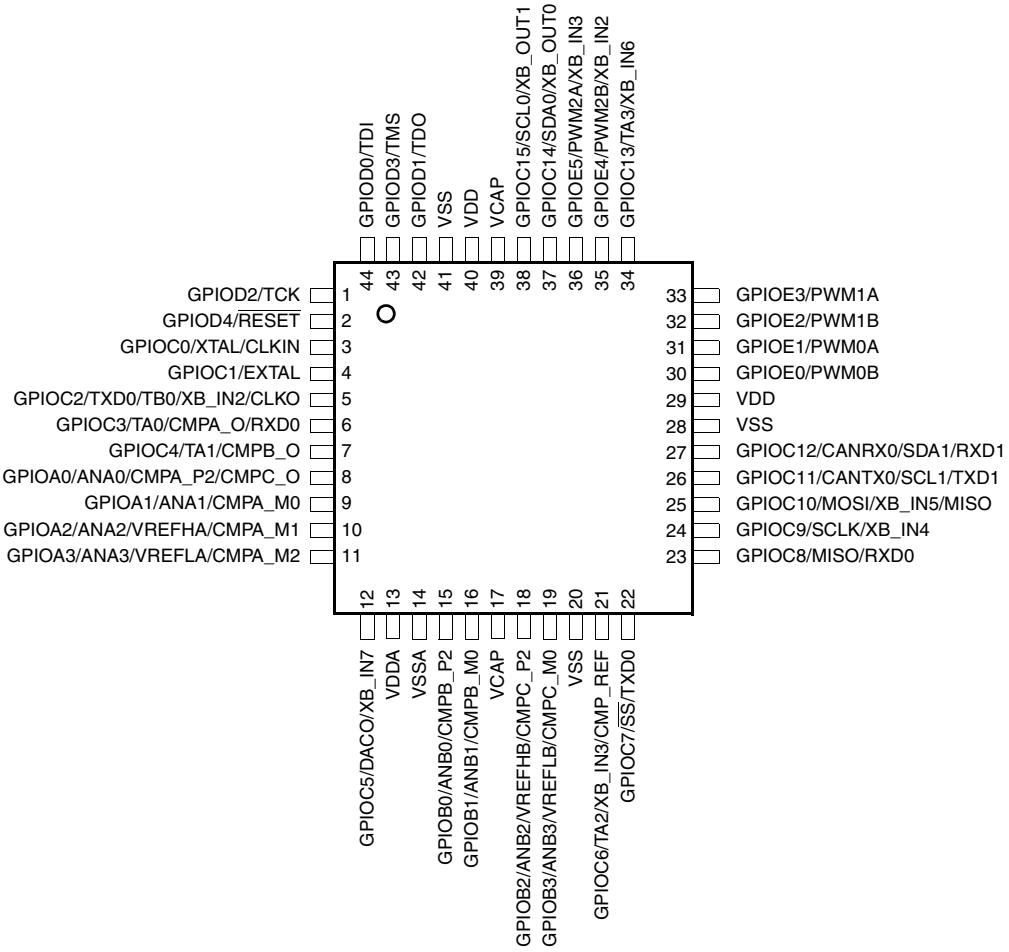

Figure 3. Top View: 56F8245 and 56F8255 44-Pin LQFP Package

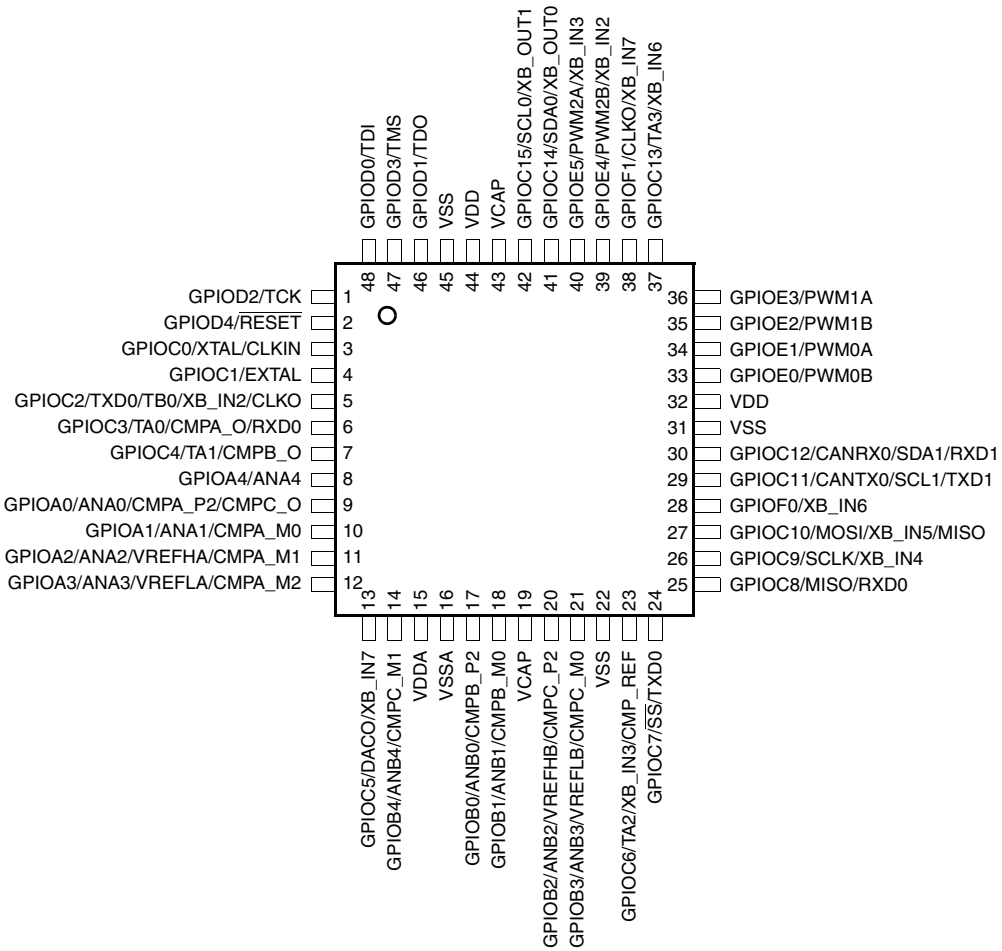

Figure 4. Top View: 56F8246 and 56F8256 48-Pin LQFP Package

Table 5. MC56F825x/MC56F824x Signal and Package Information (continued)

Signal Name	44 LQFP	48 LQFP	64 LQFP	Type	State During Reset	Signal Description
GPIOB0 *(ANB0& CMPB_P2)*	15	17	24	Input/ Output Input	Input, internal pullup enabled	Port B GPIO — This GPIO pin can be individually programmed as an input or output pin. ANB0 and CMPB_P2 — Analog input to channel 0 of ADCB and positive input 2 of analog comparator B. When used as an analog input, the signal goes to ANB0 and CMPB_P2. After reset, the default state is GPIOB0.
GPIOB1 *(ANB1& CMPB_M0)*	16	18	25	Input/ Output Input	Input, internal pullup enabled	Port B GPIO — This GPIO pin can be individually programmed as an input or output pin. ANB1 and CMPB_M0— Analog input to channel 1 of ADCB and negative input 0 of analog comparator B. When used as an analog input, the signal goes to ANB1 and CMPB_M0. After reset, the default state is GPIOB1.
GPIOB2 *(ANB2& VREFHB& CMPC_P2)*	18	20	27	Input/ Output Input	Input, internal pullup enabled	Port B GPIO — This GPIO pin can be individually programmed as an input or output pin. ANB2 and VREFHB and CMPC_P2 — Analog input to channel 2 of ADCB and analog references high of ADCB and positive input 2 of analog comparator C. When used as an analog input, the signal goes to ANB2 and VREFHB and CMPC_P2. ADC control register configures this input as ANB2 or VREFHB. After reset, the default state is GPIOB2.
GPIOB3 *(ANB3& VREFLB& CMPC_M0)*	19	21	28	Input/ Output Input	Input, internal pullup enabled	Port B GPIO — This GPIO pin can be individually programmed as an input or output pin. ANB3 and VREFLB and CMPC_M0 — Analog input to channel 3 of ADCB and analog references low of ADCB and negative input 0 of analog comparator C. When used as an analog input, the signal goes to ANB3 and VREFLB and MPC_M0. ADC control register configures this input as ANB3 or VREFLB. After reset, the default state is GPIOB3.

Table 5. MC56F825x/MC56F824x Signal and Package Information (continued)

Signal Name	44 LQFP	48 LQFP	64 LQFP	Type	State During Reset	Signal Description
GPIOC14 *(SDA0)* *(XB_OUT0)*	37	41	55	Input/ Output Input/ Open-drain Output Input	Input, internal pullup enabled	Port C GPIO — This GPIO pin can be individually programmed as an input or output pin. SDA0 — I^2C0 serial data line XB_OUT0 — Crossbar module output 0 After reset, the default state is GPIOC14.
GPIOC15 *(SCL0)* *(XB_OUT1)*	38	42	56	Input/ Output Input/ Open-drain Output Input	Input, internal pullup enabled	Port C GPIO — This GPIO pin can be individually programmed as an input or output pin. SCL0 — I^2C0 serial clock XB_OUT1 — Crossbar module output 1 After reset, the default state is GPIOC15.
GPIOE0 *PWM0B*	30	33	45	Input/ Output Input	Input, internal pullup enabled	Port E GPIO — This GPIO pin can be individually programmed as an input or output pin. PWM0B — NanoEdge PWM submodule 0 output B After reset, the default state is GPIOE0.
GPIOE1 *(PWM0A)*	31	34	46	Input/ Output Output	Input, internal pullup enabled	Port E GPIO — This GPIO pin can be individually programmed as an input or output pin. PWM0A — NanoEdge PWM submodule 0 output B After reset, the default state is GPIOE1.
GPIOE2 *(PWM1B)*	32	35	47	Input/ Output Output	Input, internal pullup enabled	Port E GPIO — This GPIO pin can be individually programmed as an input or output pin. PWM1B — NanoEdge PWM submodule 1 output A After reset, the default state is GPIOE2.
GPIOE3 *(PWM1A)*	33	36	48	Input/ Output Output	Input, internal pullup enabled	Port E GPIO — This GPIO pin can be individually programmed as an input or output pin. PWM1A — NanoEdge PWM submodule 1 output A After reset, the default state is GPIOE3.

Table 13. EOnCE Memory Map

Address	Register Abbreviation	Register Name
X:0xFF FF91–X:0xFF FF90	OBMSK (32 bits)	Breakpoint Unit Mask Register 2
X:0xFF FF8F		Reserved
X:0xFF FF8E	OBCNTR	EOnCE Breakpoint Unit Counter
X:0xFF FF8D		Reserved
X:0xFF FF8C		Reserved
X:0xFF FF8B		Reserved
X:0xFF FF8A	OESCR	External Signal Control Register
X:0xFF FF89 –X:0xFF FF00		Reserved

5 General System Control Information

5.1 Overview

This section discusses power pins, reset sources, interrupt sources, clock sources, the system integration module (SIM), ADC synchronization, and JTAG/EOnCE interfaces.

5.2 Power Pins

V_{DD}, V_{SS} and V_{DDA}, V_{SSA} are the primary power supply pins for the device. The voltage source supplies power to all on-chip peripherals, I/O buffer circuitry, and internal voltage regulators. The device has multiple internal voltages to provide regulated lower-voltage sources for the peripherals, core, memory, and on-chip relaxation oscillators.

Typically, at least two separate capacitors are across the power pins to bypass the glitches and provide bulk charge storage. In this case, a bulk electrolytic or tantalum capacitor, such as a 10 µF tantalum capacitor, should provide bulk charge storage for the overall system, and a 0.1 µF ceramic bypass capacitor should be located as near to the device power pins as is practical to suppress high-frequency noise. Each pin must have a bypass capacitor for optimal noise suppression.

V_{DDA} and V_{SSA} are the analog power supply pins for the device. This voltage source supplies power to the ADC, PGA, and CMP modules. A 0.1 µF ceramic bypass capacitor should be located as near to the device V_{DDA} and V_{SSA} pins as is practical to suppress high-frequency noise. V_{DDA} and V_{SSA} are also the voltage reference high and voltage reference low inputs, respectively, for the ADC module.

5.3 Reset

Resetting the device provides a way to start processing from a known set of initial conditions. During reset, most control and status registers are forced to initial values, and the program counter is loaded from the reset vector. On-chip peripheral modules are disabled and I/O pins are initially configured at the reset status shown in Table 5 on page 18.

The MC56F825x/MC56F824x has the following sources for reset:

- Power-on reset (POR)
- Partial power-down reset (PPD)
- Low-voltage detect (LVD)
- External pin reset (EXTR)
- Computer operating properly loss of reference reset (COP_LOR)
- Computer operating properly time-out reset (COP_CPU)

when selecting a crystal, because crystal parameters determine the component values required to provide maximum stability and reliable startup. The load capacitance values used in the oscillator circuit design should include all stray layout capacitances. The crystal and associated components should be mounted as near as possible to the EXTAL and XTAL pins to minimize output distortion and startup stabilization time. When using low-frequency, low-power mode, the only external component is the crystal itself. In the other oscillator modes, load capacitors (C_x, C_y) and feedback resistor (R_F) are required. In addition, a series resistor (R_S) may be used in high-gain modes. Recommended component values appear in Table 27.

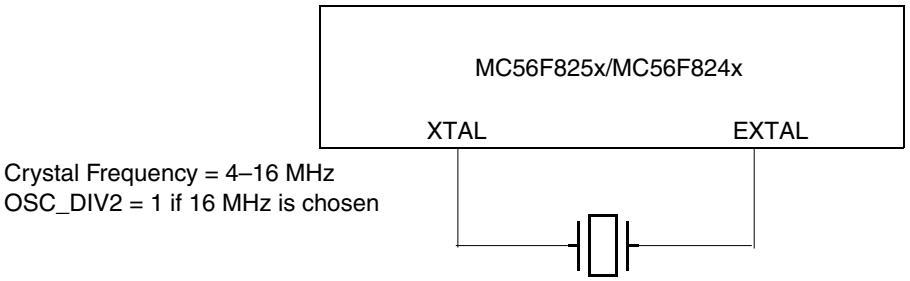

Figure 9. Typical Crystal Oscillator Circuit without Frequency Compensation Capacitor

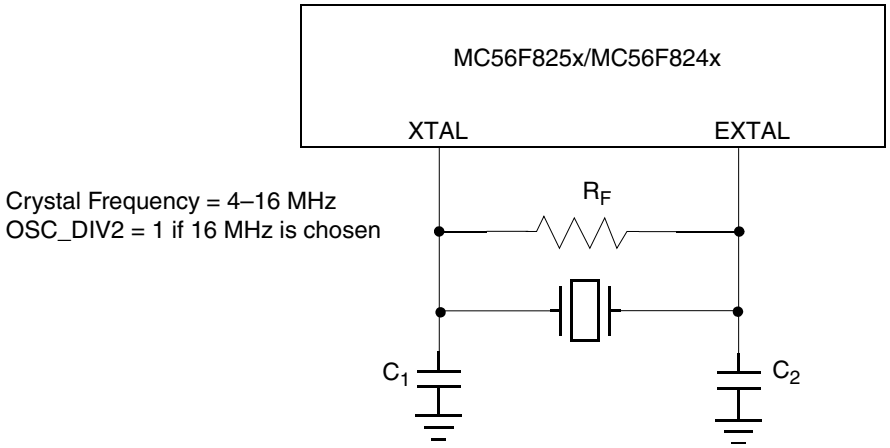

Figure 10. Typical Crystal or Ceramic Resonator Circuit

5.4.3 Alternate External Clock Input

The recommended method of connecting an external clock appears in Figure 11. The external clock source is connected to the CLKIN pin while:

- both the EXT_SEL bit and the CLK_MODE bit in the OSCTL register are set, and
- corresponding bits in the GPIOB_PER register in the GPIO module and the GPS_C0 bit in the GPS0 register in the system integration module (SIM) are set to the correct values.

The external clock input must be generated using a relatively low-impedance driver with a maximum frequency not greater than 120 MHz.

Table 14. Connections by Comparator Inputs (continued)

Comparator Input	Comparator A	Comparator B	Comparator B
M0 (from package pin)	CMPA_M0	CMPB_M0	CMPC_M0
M1 (from package pin)	CMPA_M1	CMPB_M1	CMPC_M1
M2 (from package pin)	CMPA_M2	CMPB_M2	CMPC_M2
M3 (from internal)	12-bit DAC	12-bit DAC	12-bit DAC

5.7.2 Crossbar Switch Connections

The Crossbar Switch module provides a generic mechanism for making connections between on-chip peripherals as well as between peripherals and pins. It provides a purely combinational path from input to output. The module groups 30 identical multiplexes with 22 shared inputs. All Crossbar control registers that are used to select one of the 22 input signals to output are write protected. Control of the write protection setting is in the SIM_PROT register.

In general, the crossbar module connects the Enhanced Flex PWM, ADC, Quad Timers, and comparators together, which allows synchronization between PWM pulse generation and ADC sampling. In addition, several crossbar inputs and outputs are routed to package pins. For example, the user can define an XB_INn pin as a PWM fault protection input that is routed to the PWM module through the crossbar, increasing the flexibility of pin use and reducing the complexity of PCB layout.

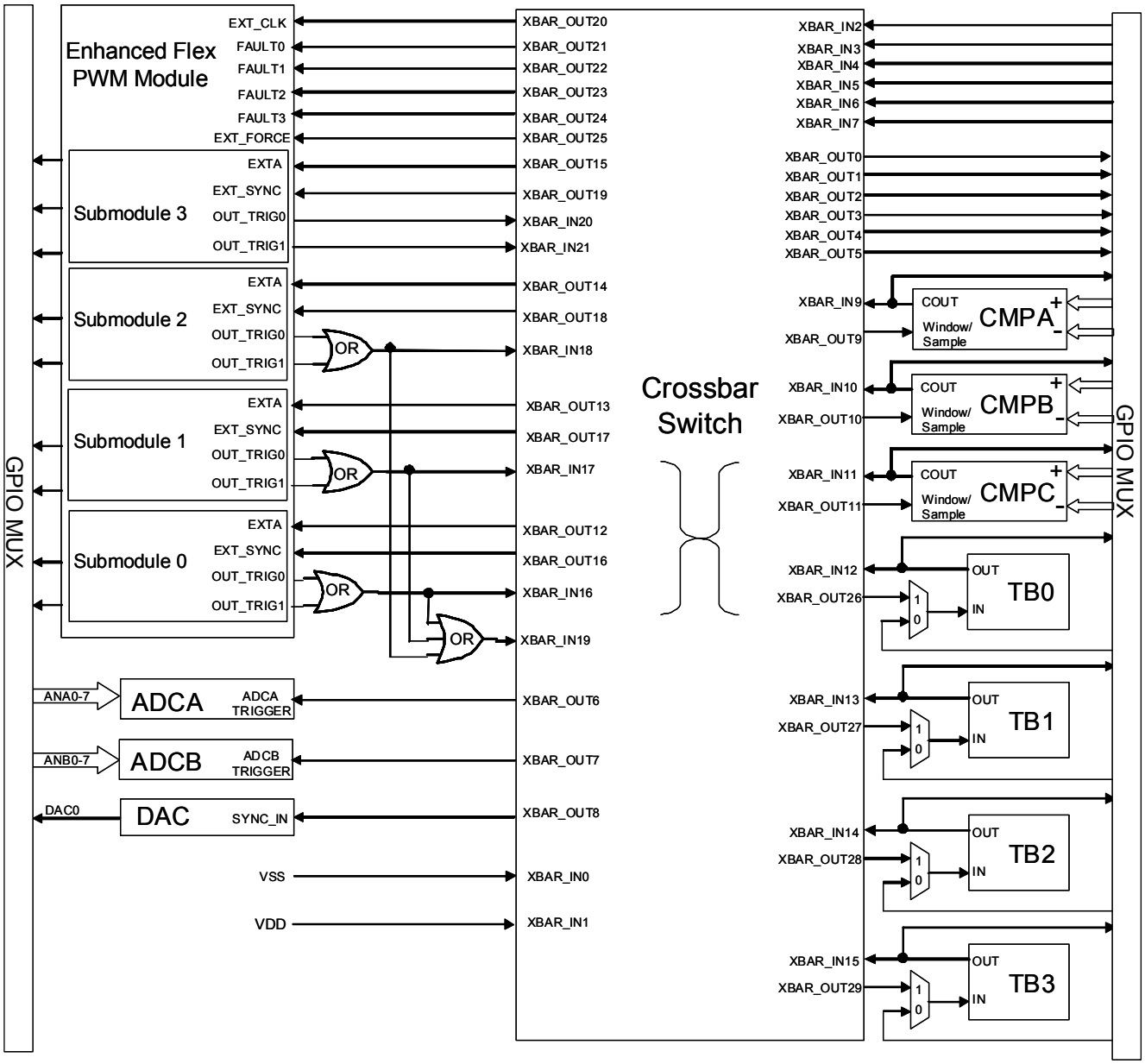

Figure 13. Crossbar Switch Connections

5.7.2.1 Crossbar Switch Inputs

Table 15 lists the signal assignments of Crossbar Switch inputs.

Table 15. Crossbar Input Signal Assignments

XBAR_INn	Input from	Function
XBAR_IN0	Logic Zero	V_{SS}
XBAR_IN1	Logic One	V_{DD}
XBAR_IN2	XB_IN2	Package pin
XBAR_IN3	XB_IN3	Package pin
XBAR_IN4	XB_IN4	Package pin
XBAR_IN5	XB_IN5	Package pin
XBAR_IN6	XB_IN6	Package pin
XBAR_IN7	XB_IN7	Package pin
XBAR_IN8	Unused	
XBAR_IN9	CMPA_OUT	Comparator A Output
XBAR_IN10	CMPB_OUT	Comparator B Output
XBAR_IN11	CMPC_OUT	Comparator C Output
XBAR_IN12	TB0	Quad Timer B0 Output
XBAR_IN13	TB1	Quad Timer B1 Output
XBAR_IN14	TB2	Quad Timer B2 Output
XBAR_IN15	TB3	Quad Timer B3 Output
XBAR_IN16	PWM0_TRIG_COMB	eFlexPWM submodule 0: PWM0_OUT_TRIG0 or PWM0_OUT_TRIG1
XBAR_IN17	PWM1_TRIG_COMB	eFlexPWM submodule 1: PWM1_OUT_TRIG0 or PWM1_OUT_TRIG1
XBAR_IN18	PWM2_TRIG_COMB	eFlexPWM submodule 2: PWM2_OUT_TRIG0 or PWM2_OUT_TRIG1
XBAR_IN19	PWM[012]_TRIG_COMB	eFlexPWM submodule 0, 1, or 2; PWM0_TRIG_COMB or PWM1_TRIG_COMB or PWM2_TRIG_COMB
XBAR_IN20	PWM3_TRIG0	eFlexPWM submodule 3: PWM3_OUT_TRIG0
XBAR_IN21	PWM3_TRIG1	eFlexPWM submodule 3: PWM3_OUT_TRIG1

5.7.2.2 Crossbar Switch Outputs

Table 16 lists the signal assignments of Crossbar Switch outputs.

Table 16. Crossbar Output Signal Assignments

XBAR_OUTn	Output to	Function
XBAR_OUT0	XB_OUT0	Package pin
XBAR_OUT1	XB_OUT1	Package pin
XBAR_OUT2	XB_OUT2	Package pin
XBAR_OUT3	XB_OUT3	Package pin
XBAR_OUT4	XB_OUT4	Package pin
XBAR_OUT5	XB_OUT5	Package pin
XBAR_OUT6	ADCA	ADCA Trigger

7.3 ESD Protection and Latch-up Immunity

Although damage from electrostatic discharge (ESD) is much less common on these devices than on early CMOS circuits, use normal handling precautions to avoid exposure to static discharge. Qualification tests are performed to ensure that these devices can withstand exposure to reasonable levels of static without suffering any permanent damage.

All ESD testing conforms with AEC-Q100 Stress Test Qualification. During device qualification, ESD stresses are performed for the human body model (HBM), the machine model (MM), and the charge device model (CDM).

All latch-up testing conforms with AEC-Q100 Stress Test Qualification.

A device is defined as a failure if, after exposure to ESD pulses, the device no longer meets the device specification. Comprehensive DC parametric and functional testing is performed according to the applicable device specification at room temperature and then at hot temperature, unless specified otherwise in the device specification.

Table 18. MC56F825x/MC56F824x ESD/Latch-up Protection

Characteristic [1]	Min	Typ	Max	Unit
ESD for Human Body Model (HBM)	2000	—	—	V
ESD for Machine Model (MM)	200	—	—	V
ESD for Charge Device Model (CDM)	750	—	—	V
Latch-up current at T_A = 85 °C (I_{LAT})	± 100			mA

[1] Parameter is achieved by design characterization on a small sample size from typical devices under typical conditions, unless otherwise noted

7.4 Thermal Characteristics

This section provides information about operating temperature range, power dissipation, and package thermal resistance. Power dissipation on I/O pins is usually small compared to power dissipation in on-chip logic and voltage regulator circuits, and it is user-determined rather than being controlled by the device design. To account for $P_{I/O}$ in power calculations, determine the difference between actual pin voltage and V_{SS} or V_{DD} and multiply by the pin current for each I/O pin. Except in cases of unusually high pin current (heavy loads), the difference between pin voltage and V_{SS} or V_{DD} is very small.

Table 19. 44LQFP Package Thermal Characteristics

Characteristic	Comments	Symbol	Value (LQFP)	Unit
Junction to ambient Natural convection	Single layer board (1s)	$R_{\theta JA}$	70	°C/W
Junction to ambient Natural convection	Four layer board (2s2p)	$R_{\theta JMA}$	48	°C/W
Junction to ambient (@200 ft/min)	Single layer board (1s)	$R_{\theta JMA}$	57	°C/W
Junction to ambient (@200 ft/min)	Four layer board (2s2p)	$R_{\theta JMA}$	42	°C/W
Junction to board		$R_{\theta JB}$	30	°C/W
Junction to case		$R_{\theta JC}$	13	°C/W
Junction to package top	Natural convection	Ψ_{JT}	2	°C/W

Table 34. SPI Timing[1] (continued)

Characteristic	Symbol	Min	Max	Unit	Refer to
Data set-up time required for inputs Master Slave	t_{DS}	 20 0	 — —	 ns ns	Figure 20, Figure 21, Figure 22, Figure 23
Data hold time required for inputs Master Slave	t_{DH}	 0 2	 — —	 ns ns	Figure 20, Figure 21, Figure 22, Figure 23
Access time (time to data active from high-impedance state) Slave	t_A	 4.8	 15	 ns	Figure 23
Disable time (hold time to high-impedance state) Slave	t_D	 3.7	 15.2	 ns	Figure 23
Data valid for outputs Master Slave (after enable edge)	t_{DV}	 — —	 4.5 20.4	 ns ns	Figure 20, Figure 21, Figure 22, Figure 23
Data invalid Master Slave	t_{DI}	 0 0	 — —	 ns ns	Figure 20, Figure 21, Figure 22, Figure 23
Rise time Master Slave	t_R	 — —	 11.5 10.0	 ns ns	Figure 20, Figure 21, Figure 22, Figure 23
Fall time Master Slave	t_F	 — —	 9.7 9.0	 ns ns	Figure 20, Figure 21, Figure 22, Figure 23

[1] Parameters listed are guaranteed by design.

7.20 Freescale's Scalable Controller Area Network (MSCAN)

Table 36. MSCAN Timing

Characteristic	Symbol	Min	Max	Unit
Baud Rate	BR_{CAN}	—	1	Mbps
Bus Wake-up detection	T_{WAKEUP}	T_{IPBUS}	—	µs

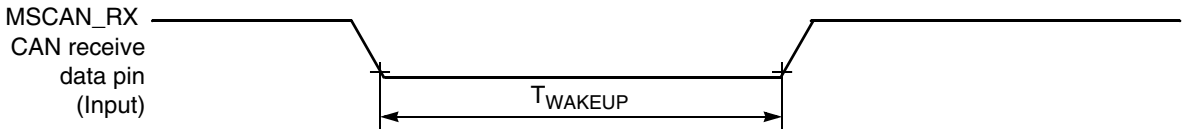

Figure 26. Bus Wake-up Detection

7.21 Inter-Integrated Circuit Interface (I^2C) Timing

Table 37. I^2C Timing

Characteristic	Symbol	Standard Mode		Unit
		Minimum	Maximum	
SCL Clock Frequency	f_{SCL}	0	100	kHz
Hold time (repeated) START condition. After this period, the first clock pulse is generated.	$t_{HD;\ STA}$	4.0	—	µs
LOW period of the SCL clock	t_{LOW}	4.7	—	µs
HIGH period of the SCL clock	t_{HIGH}	4.0	—	µs
Set-up time for a repeated START condition	$t_{SU;\ STA}$	4.7	—	µs
Data hold time for I^2C bus devices	$t_{HD;\ DAT}$	0[1]	3.45[2]	µs
Data set-up time	$t_{SU;\ DAT}$	250[3]	—	ns
Rise time of SDA and SCL signals	t_r	—	1000	ns
Fall time of SDA and SCL signals	t_f	—	300	ns
Set-up time for STOP condition	$t_{SU;\ STO}$	4.0	—	µs
Bus free time between STOP and START condition	t_{BUF}	4.7	—	µs
Pulse width of spikes that must be suppressed by the input filter	t_{SP}	N/A	N/A	ns

1 The master mode I^2C deasserts ACK of an address byte simultaneously with the falling edge of SCL. If no slaves acknowledge this address byte, a negative hold time can result, depending on the edge rates of the SDA and SCL lines.

2 The maximum $t_{HD;\ DAT}$ must be met only if the device does not stretch the LOW period (t_{LOW}) of the SCL signal.

3 A Fast mode I^2C bus device can be used in a Standard mode I^2C bus system, but the requirement $t_{SU;\ DAT}$ > = 250 ns must then be met. This is automatically the case if the device does not stretch the LOW period of the SCL signal. If such a device does stretch the LOW period of the SCL signal, it must output the next data bit to the SDA line $t_{rmax} + t_{SU;\ DAT}$ = 1000 + 250 = 1250 ns (according to the Standard mode I^2C bus specification) before the SCL line is released.

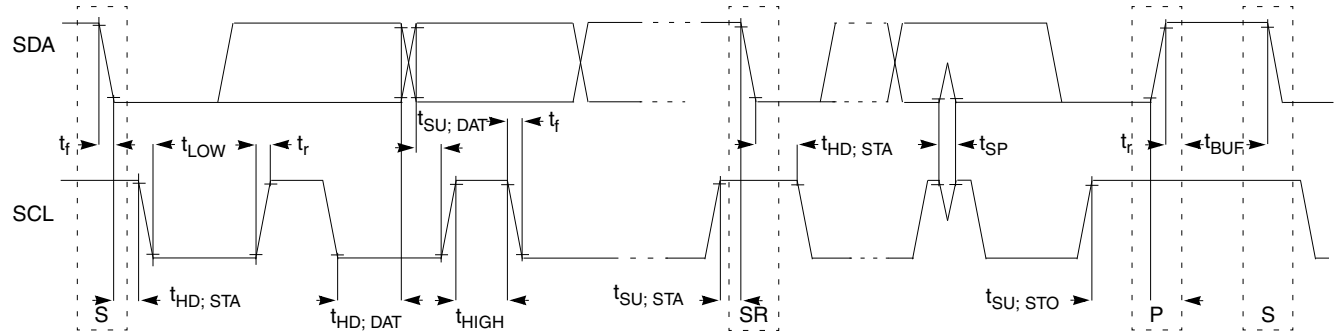

Figure 27. Timing Definition for Standard Mode Devices on the I^2C Bus

7.22 JTAG Timing

Table 38. JTAG Timing

Characteristic	Symbol	Min	Max	Unit	See Figure
TCK frequency of operation[1]	f_{OP}	DC	SYS_CLK/8	MHz	Figure 28
TCK clock pulse width	t_{PW}	50	—	ns	Figure 28
TMS, TDI data set-up time	t_{DS}	5	—	ns	Figure 29
TMS, TDI data hold time	t_{DH}	5	—	ns	Figure 29
TCK low to TDO data valid	t_{DV}	—	30	ns	Figure 29
TCK low to TDO tri-state	t_{TS}	—	30	ns	Figure 29

[1] TCK frequency of operation must be less than 1/8 the processor rate.

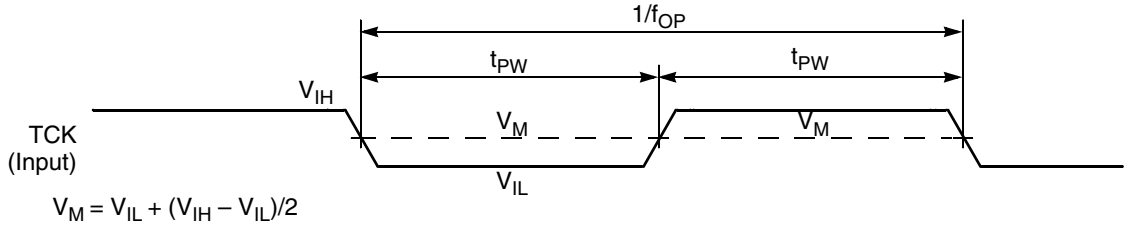

Figure 28. Test Clock Input Timing Diagram

NOTES:

1. DIMENSIONS AND TOLERANCING PER ASME Y14.5M–1994.
2. CONTROLLING DIMENSION: MILLIMETER
3. DATUM PLANE H IS LOCATED AT BOTTOM OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE BOTTOM OF THE PARTING LINE.
4. DATUMS L, M AND N TO BE DETERMINED AT DATUM PLANE H.
5. DIMENSIONS TO BE DETERMINED AT SEATING PLANE T.
6. DIMENSIONS DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.25 PER SIDE. DIMENSIONS DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE H.
7. DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. DAMBAR PROTRUSION SHALL NOT CAUSE THE DIMENSION TO EXCEED 0.53. MINIMUM SPACE BETWEEN PROTRUSION AND ADJACENT LEAD OR PROTRUSION 0.07.

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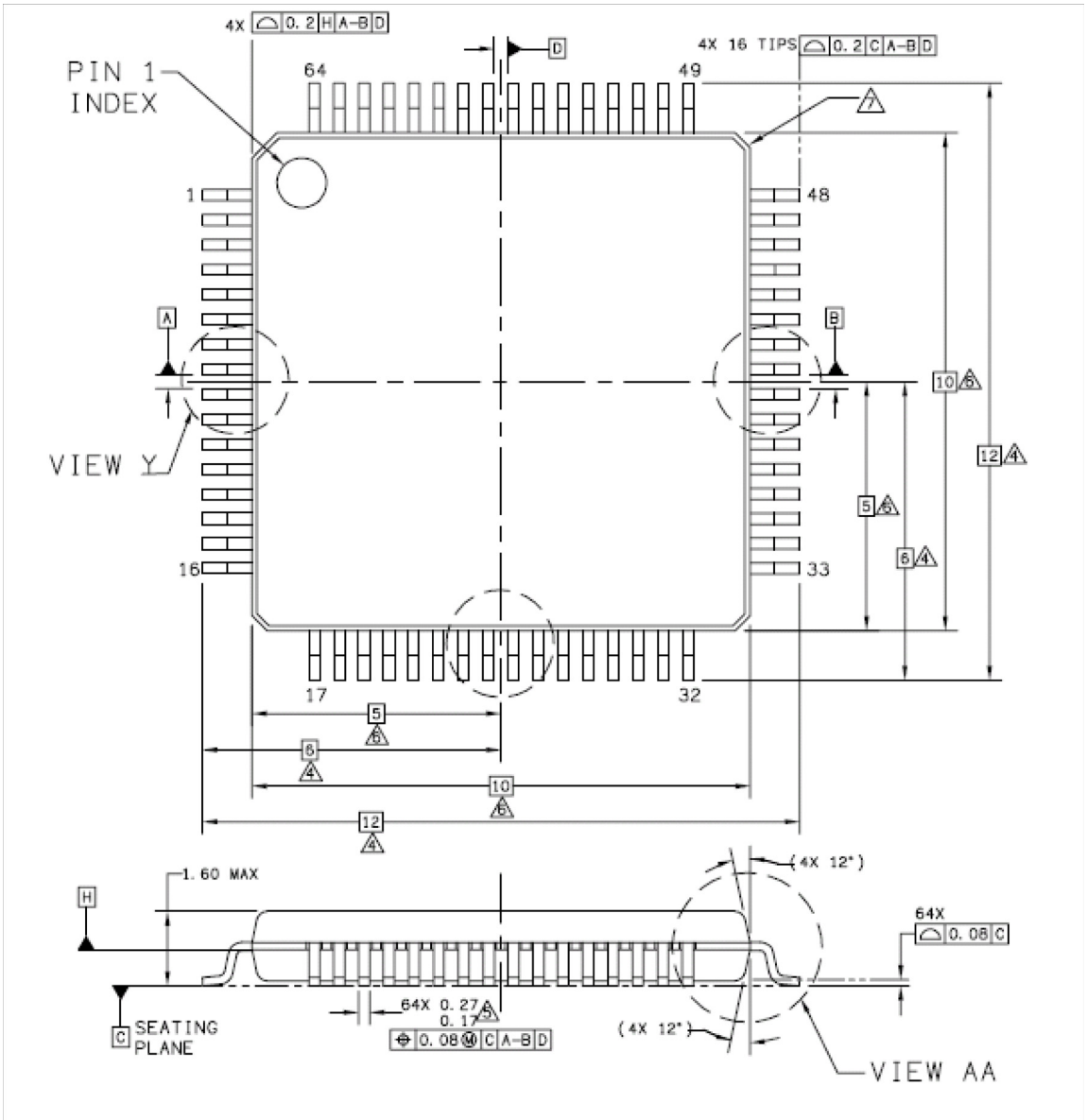
TITLE: 44 LD LQFP, 10 X 10 PKG, 0.8 PITCH, 1.4 THICK	DOCUMENT NO: 98ASS23225W	REV: D
	CASE NUMBER: 824D-02	26 FEB 2007
	STANDARD: JEDEC MS-026 BCB	

Figure 32. 56F8245 and 56F8255 44-Pin LQFP Mechanical Information

10.3 64-pin LQFP



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	CASE NUMBER: 840F-02	11 AUG 2006
	STANDARD: JEDEC MS-026 BCD	

NOTES:

1. DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.
3. DATUMS A, B AND D TO BE DETERMINED AT DATUM PLANE H.
4. DIMENSIONS TO BE DETERMINED AT SEATING PLANE C.
5. THIS DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL NOT CAUSE THE LEAD WIDTH TO EXCEED THE UPPER LIMIT BY MORE THAN 0.08 mm AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSION AND ADJACENT LEAD SHALL NOT BE LESS THAN 0.07 mm.
6. THIS DIMENSION DOES NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.25 mm PER SIDE. THIS DIMENSION IS MAXIMUM PLASTIC BODY SIZE DIMENSION INCLUDING MOLD MISMATCH.
7. EXACT SHAPE OF EACH CORNER IS OPTIONAL.
8. THESE DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN 0.1 mm AND 0.25 mm FROM THE LEAD TIP.

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	CASE NUMBER: 840F-02	11 AUG 2006
	STANDARD: JEDEC MS-026 BCD	

Figure 34. 56F8247 and 56F8257 64-Pin LQFP Mechanical Information

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