Freescale Semiconductor
Product Brief

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56F8037 Digital Signal Controller Product Brief

1 56F8037 Description

The 56F8037 is a member of the 56800E core-based family of Digital Signal Controllers (DSCs). It combines, on a single chip, the processing power of a DSP and the functionality of a microcontroller with a flexible set of peripherals to create an extremely cost-effective solution. Because of its low cost, configuration flexibility, and compact program code, the 56F8037 is well-suited for many applications. The 56F8037 includes many peripherals that are especially useful for industrial control, motion control, home appliances, general purpose inverters, smart sensors, fire and security systems, power management, and medical monitoring applications.

The 56800E core is based on a dual Harvard-style architecture consisting of three execution units operating in parallel, allowing as many as six operations per instruction cycle. The MCU-style programming model and optimized instruction set allow straightforward generation of efficient, compact DSP and control code. The instruction set is also highly efficient for C compilers to enable rapid development of optimized control applications.

Contents

The 56F8037 supports program execution from internal memories. Two data operands can be accessed from the on-chip data RAM per instruction cycle. The 56F8037 also offers up to 53 General Purpose Input/Output (GPIO) lines, depending on peripheral configuration.

The 56F8037 Digital Signal Controller includes 64KB of Program Flash and 8KB of Unified Data/Program RAM. Program Flash memory can be independently bulk erased or erased in pages. Program Flash page erase size is 512 Bytes (256 Words).

A full set of programmable peripherals—PWM, ADCs, QSCIs, QSPIs, I2C, PITs, Quad Timers, DACs, and analog comparators—supports various applications. Each peripheral can be independently shut down to save power. Any pin in these peripherals can also be used as General Purpose Input/Outputs (GPIOs).

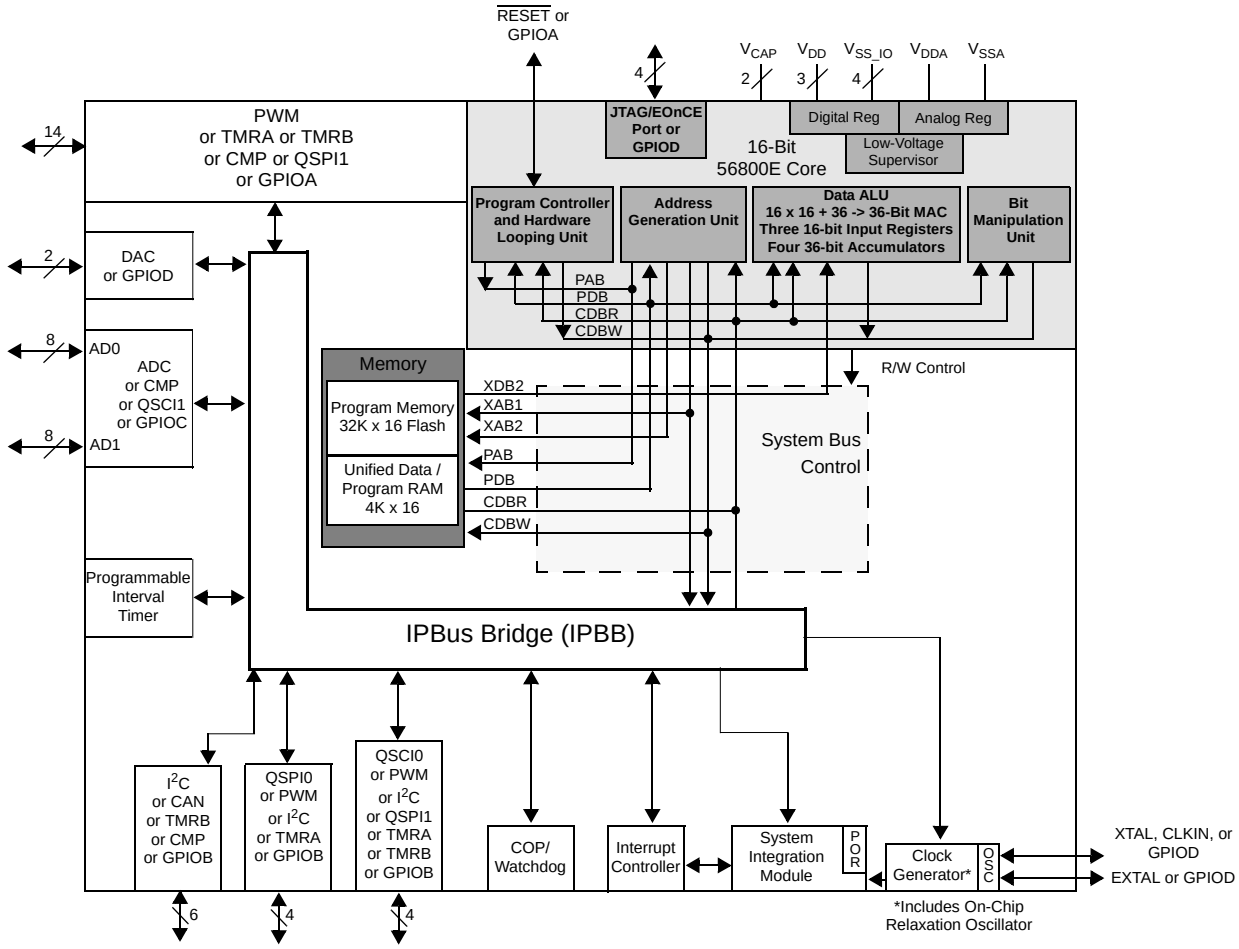


Figure 1. 56F8037 Block Diagram

2 Digital Signal Controller Core

- Efficient 16-bit 56800E family Digital Signal Controller (DSC) engine with dual Harvard architecture
- As many as 32 Million Instructions Per Second (MIPS) at 32MHz core frequency
- Single-cycle 16 × 16-bit parallel Multiplier-Accumulator (MAC)
- Four 36-bit accumulators, including extension bits
- 32-bit arithmetic and logic multi-bit shifter
- Parallel instruction set with unique DSP addressing modes
- Hardware DO and REP loops
- Three internal address buses
- Four internal data buses
- Instruction set supports both DSP and controller functions
- Controller-style addressing modes and instructions for compact code
- Efficient C compiler and local variable support
- Software subroutine and interrupt stack with depth limited only by memory
- JTAG/Enhanced On-Chip Emulation (OnCE) for unobtrusive, processor speed-independent, real-time debugging

3 Memory

- Dual Harvard architecture permits as many as three simultaneous accesses to program and data memory
- Flash security and protection that prevent unauthorized users from gaining access to the internal Flash
- On-chip memory:
  - 64KB of Program Flash
  - 8KB of Unified Data/Program RAM
- EEPROM emulation capability using Flash

4 Peripheral Circuits for 56F8037

- One multi-function six-output Pulse Width Modulator (PWM) module
  - Up to 96MHz PWM operating clock
  - 15 bits of resolution
  - Center-aligned and Edge-aligned PWM signal mode
  - Four programmable fault inputs with programmable digital filter
  - Double-buffered PWM registers

  - Each complementary PWM signal pair allows selection of a PWM supply source from:
    - PWM generator
    - External GPIO
    - Internal timers
    - Analog comparator outputs
    - ADC conversion result which compares with values of ADC high- and low-limit registers to set PWM output
- Two independent 12-bit Analog-to-Digital Converters (ADCs)
  - 2 x 8 channel inputs
  - Supports both simultaneous and sequential conversions
  - ADC conversions can be synchronized by both PWM and timer modules
  - Sampling rate up to 2.67MSPS
  - 16-word result buffer registers
  - ADC Smart Power Management (Auto-standby, auto-powerdown)
- Two 12-bit Digital-to-Analog Converters (DACs)
  - 2 microsecond settling time when output swing from rail to rail
  - Automatic waveform generation generates square, triangle and sawtooth waveforms with programmable period, update rate, and range
- Two 16-bit multi-purpose Quad Timer modules (TMRs)
  - Up to 96MHz operating clock
  - Eight independent 16-bit counter/timers with cascading capability
  - Each timer has capture and compare capability
  - Up to 12 operating modes
- Two Queued Serial Communication Interfaces (QSCIs) with LIN Slave functionality
  - Full-duplex or single-wire operation
  - Two receiver wake-up methods:
    - Idle line
    - Address mark
  - Four-bytes-deep FIFOs are available on both transmitter and receiver
- Two Queued Serial Peripheral Interfaces (QSPIs)
  - Full-duplex operation
  - Master and slave modes
  - Four-words-deep FIFOs available on both transmitter and receiver
  - Programmable Length Transactions (2 to 16 bits)
- One Inter-Integrated Circuit (I^2C) port
  - Operates up to 400kbps
  - Supports both master and slave operation
  - Supports both 10-bit address mode and broadcasting mode

- One Freescale scalable controller area network (MSCAN) module
  - Fully compliant with CAN protocol - Version 2.0 A/B
  - Supports standard and extended data frames
  - Supports data rate up to 1Mbps
  - Five receive buffers and three transmit buffers
- Three 16-bit Programmable Interval Timers (PITs)
- Two analog Comparators (CMPs)
  - Selectable input source includes external pins, DACs
  - Programmable output polarity
  - Output can drive Timer input, PWM fault input, PWM source, external pin output and trigger ADCs
  - Output falling and rising edge detection able to generate interrupts
- Computer Operating Properly (COP)/Watchdog timer capable of selecting different clock sources
- Up to 53 General-Purpose I/O (GPIO) pins with 5V tolerance
- Integrated Power-On Reset and Low-Voltage Interrupt Module
- Phase Lock Loop (PLL) provides a high-speed clock to the core and peripherals
- Clock Sources:
  - On-chip relaxation oscillator
  - External clock:
    - Crystal oscillator
    - Ceramic resonator
    - External clock source
- On-chip regulators for digital and analog circuitry to lower cost and reduce noise
- JTAG/EOnCE debug programming interface for real-time debugging

5 Recommended Operating Conditions

Table 1. Recommended Operating Conditions
($V_{REFL\ x}$= 0V, V_{SSA} = 0V, V_{SS} = 0V)

Characteristic	Symbol	Notes	Min	Typ	Max	Unit
Supply voltage	V_{DD}, V_{DDA}		3	3.3	3.6	V
ADC Reference Voltage High	V_{REFHx}		3.0		V_{DDA}	V
Voltage difference V_{DD_IO} to V_{DDA}	ΔV_{DD}		-0.1	0	0.1	V
Voltage difference V_{SS_IO} to V_{SSA}	ΔV_{SS}		-0.3	0	0.3	V
Device Clock Frequency Using relaxation oscillator Using external clock source	FSYSCLK		 1 0		 32 32	MHz
Input Voltage High (digital inputs)	V_{IH}	Pin Groups 1, 2	2.0		5.5	V
Input Voltage Low (digital inputs)	V_{IL}	Pin Groups 1, 2	-0.3		0.8	V
Oscillator Input Voltage High XTAL not driven by an external clock XTAL driven by an external clock source	V_{IHOSC}	Pin Group 5	 V_{DDA} - 0.8 2.0		 V_{DDA} + 0.3 V_{DDA} + 0.3	V
Oscillator Input Voltage Low	V_{ILOSC}	Pin Group 5	-0.3		0.8	V
Analog Input Voltage	V_{IA}	Pin Group 3	0.0		V_{DDA}	V
DAC Output Load Resistance	RLD		3K		—	ohms
DAC Output Load Capacitance	CLD		—		400	pF
Output Source Current High at V_{OH} min.)[1] When programmed for low drive strength When programmed for high drive strength	I_{OH}	 Pin Group 1 Pin Group 1	 — —		 -4 -8	mA
Output Source Current Low (at V_{OL} max.)[1] When programmed for low drive strength When programmed for high drive strength	I_{OL}	 Pin Groups 1, 2 Pin Groups 1, 2	 — —		 4 8	mA
Ambient Operating Temperature (Automotive)	T_A		-40		125	°C
Ambient Operating Temperature (Extended Industrial)	T_A		-40		105	°C
Flash Endurance (Program Erase Cycles)	N_F	T_A = -40°C to 125°C	10,000		—	cycles
Flash Data Retention	T_R	T_J <= 70°C average	15		—	years

1 Total chip source or sink current cannot exceed 75mA

6 Product Documentation

The documents listed in **Table 2** are required for a complete description and proper design with the 56F8037. Documentation is available from local Freescale distributors, Freescale Semiconductor sales offices, Freescale Literature Distribution Centers, or online at:
http://www.freescale.com

Table 2. 56F8037 Chip Documentation

Topic	Description	Order Number
DSP56800E Reference Manual	Detailed description of the 56800E family architecture, 16-bit Digital Signal Controller core processor, and the instruction set	DSP56800ERM
56F802X and 56F803X Peripheral Reference Manual	Detailed description of peripherals of the 56F802x and 56F803x family of devices	MC56F80XXRM
56F802X and 56F803X Serial Bootloader User Guide	Detailed description of the Serial Bootloader in the 56F802x and 56F803x family of devices	56F80XXBLUG
56F8037 Technical Data Sheet	Electrical and timing specifications, pin descriptions, and package descriptions (this document)	MC56F8037
56F8037 Errata	Details any chip issues that might be present	MC56F8037E

7 56F8037 Package and Pin-Out

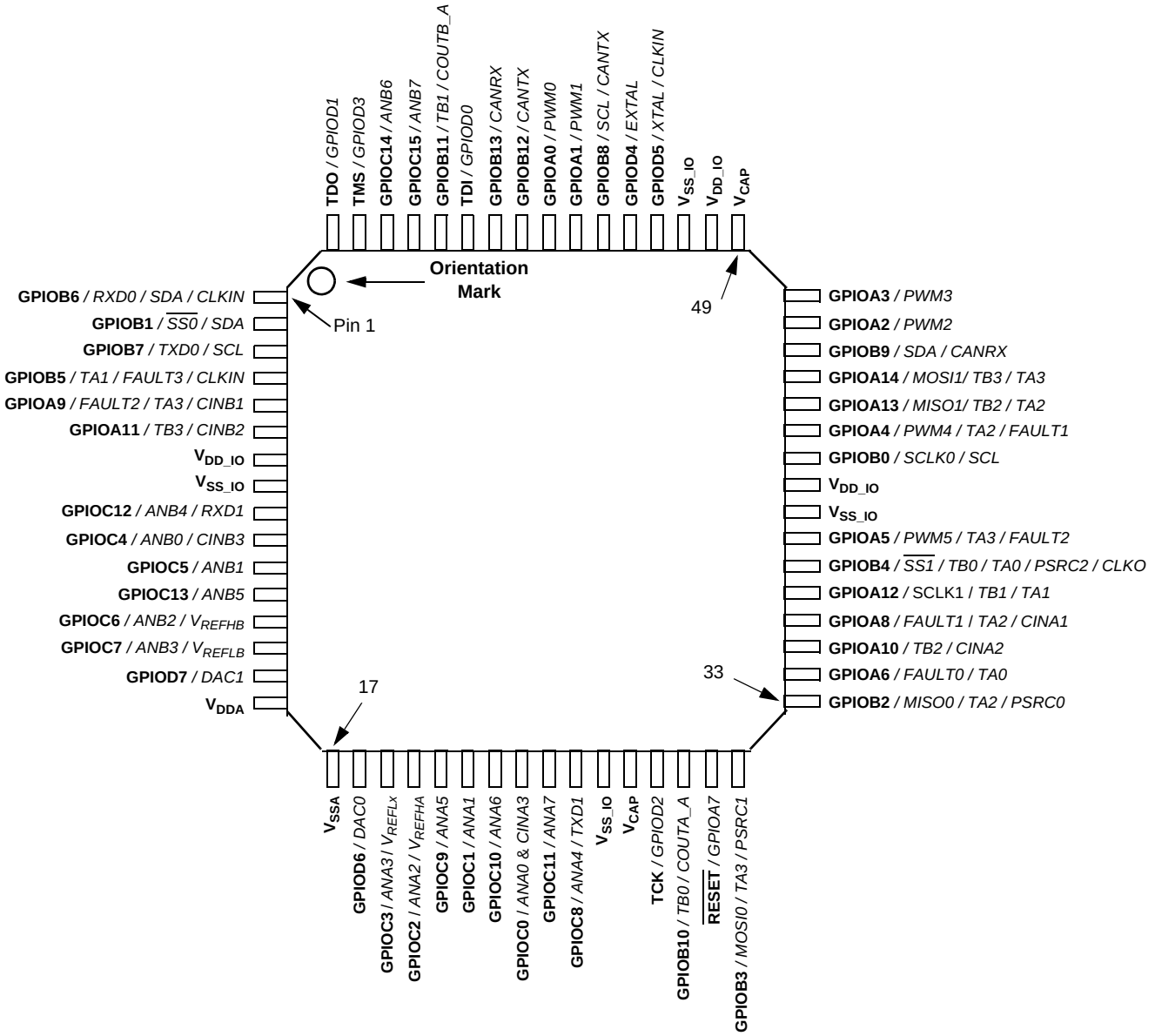


Figure 2. Top View, 56F8037 64-Pin LQFP Package

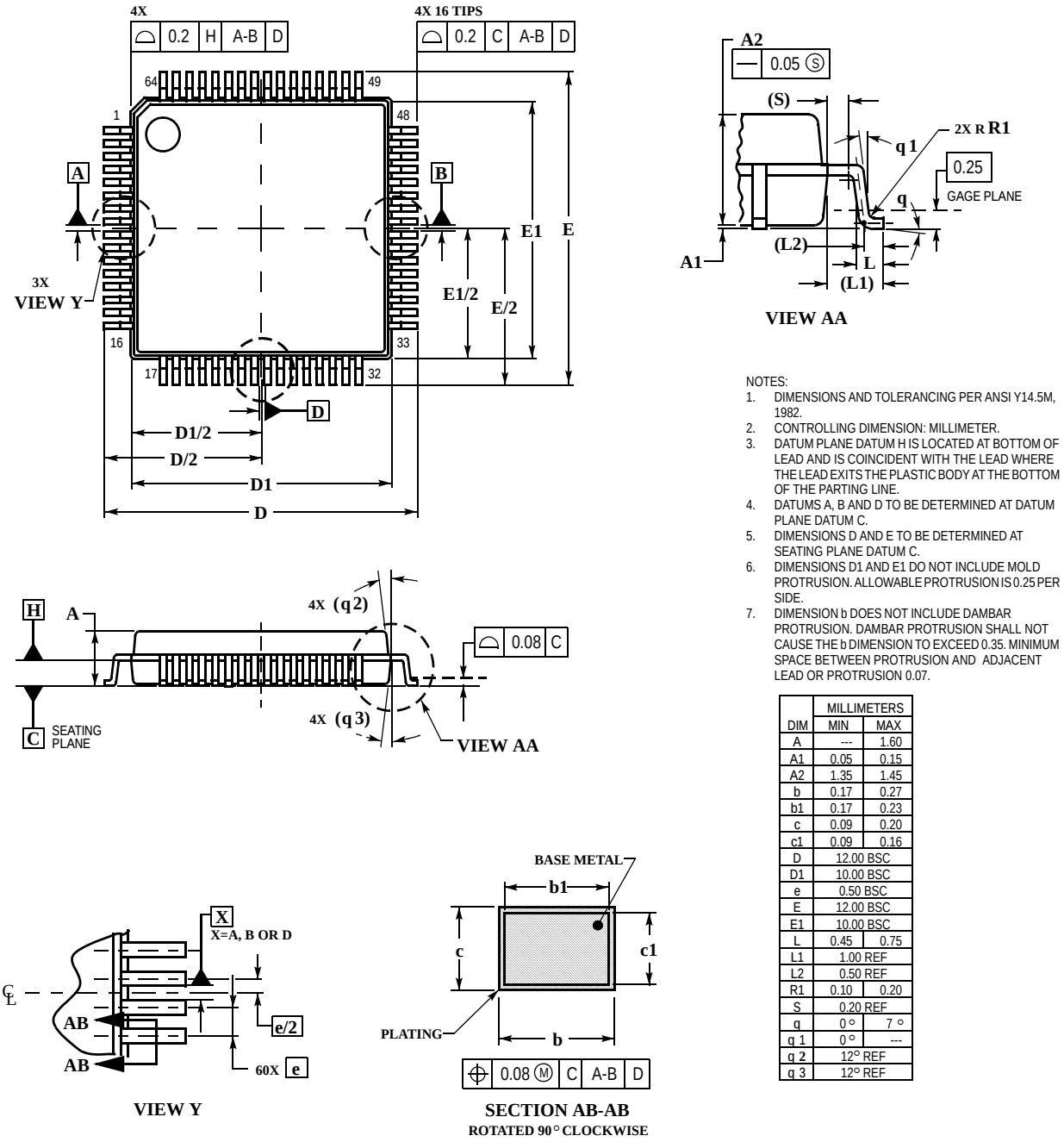
Peripheral pins in bold identify the reset state in **Table 3**.

Table 3. 56F8037 64-Pin LQFP Package Identification by Pin Number[1]

Pin #	Signal Name	Pin #	Signal Name	Pin #	Signal Name	Pin #	Signal Name
1	**GPIOB6** *RXD0 / SDA / CLKIN*	17	**V_{SSA}**	33	**GPIOB2** *MISO0 / TA2 / PSRC0*	49	**V_{CAP}**
2	**$\overline{GPIOB1}$** *$\overline{SS0}$ / SDA*	18	**GPIOD6** *DAC0*	34	**GPIOA6** *FAULT0 / TA0*	50	**V_{DD_IO}**
3	**GPIOB7** *TXD0 / SCL*	19	**GPIOC3** *ANA3 / V_{REFLA}*	35	**GPIOA10** *TB2 / CINA2*	51	**V_{SS_IO}**
4	**GPIOB5** *TA1 / FAULT3 / CLKIN*	20	**GPIOC2** *ANA2 / V_{REFHA}*	36	**GPIOA8** *FAULT1 / TA2 / CINA1*	52	**GPIOD5** *XTAL / CLKIN*
5	**GPIOA9** *FAULT2 / TA3 / CINB1*	21	**GPIOC9** *ANA5*	37	**GPIOA12** *SCLK1 / TB1 / TA1*	53	**GPIOD4** *EXTAL*
6	**GPIOA11** *TB3 / CINB2*	22	**GPIOC1** *ANA1*	38	**$\overline{GPIOB4}$** *$\overline{SS1}$ / TB0 / TA0 / PSRC2 / CLKO*	54	**GPIOB8** *SCL / CANTX*
7	**VDD_IO**	23	**GPIOC10** *ANA6*	39	**GPIOA5** *PWM5 / TA3 / FAULT2*	55	**GPIOA1** *PWM1*
8	**VSS_IO**	24	**GPIOC0** *ANA0 & CINA3*	40	**V_{SS_IO}**	56	**GPIOA0** *PWM0*
9	**GPIOC12** *ANB4 / RXD1*	25	**GPIOC11** *ANA7*	41	**V_{DD_IO}**	57	**GPIOB12** *CANTX*
10	**GPIOC4** *ANB0 & CINB3*	26	**GPIOC8** *ANA4 / TXD1*	42	**GPIOB0** *SCLK0 / SCL*	58	**GPIOB13** *CANRX*
11	**GPIOC5** *ANB1*	27	**V_{SS_IO}**	43	**GPIOA4** *PWM4 / TA2 / FAULT1*	59	**TDI** *GPIOD0*
12	**GPIOC13** *ANB5*	28	**V_{CAP}**	44	**GPIOA13** *MISO1 / TB2 / TA2*	60	**GPIOB11** *TB1 / COUTB_A*
13	**GPIOC6** *ANB2 / V_{REFHB}*	29	**TCK** *GPIOD2*	45	**GPIOA14** *MOSI1 / TB3 / TA3*	61	**GPIOC15** *ANB7*
14	**GPIOC7** *ANB3 / V_{REFLB}*	30	**GPIOB10** *TB0 / COUTA_A*	46	**GPIOB9** *SDA / CANRX*	62	**GPIOC14** *ANB6*
15	**GPIOD7** *DAC1*	31	**$\overline{RESET}$** *GPIOA7*	47	**GPIOA2** *PWM2*	63	**TMS** *GPIOD3*
16	**V_{DDA}**	32	**GPIOB3** *MOSI0 / TA3 / PSRC1*	48	**GPIOA3** *PWM3*	64	**TDO** *GPIOD1*

1 Alternate signals are in italic

8 56F8037 Mechanical Outline



NOTES:
1. DIMENSIONS AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DATUM PLANE DATUM 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 A, B AND D TO BE DETERMINED AT DATUM PLANE DATUM C.
5. DIMENSIONS D AND E TO BE DETERMINED AT SEATING PLANE DATUM C.
6. DIMENSIONS D1 AND E1 DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.25 PER SIDE.
7. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. DAMBAR PROTRUSION SHALL NOT CAUSE THE b DIMENSION TO EXCEED 0.35. MINIMUM SPACE BETWEEN PROTRUSION AND ADJACENT LEAD OR PROTRUSION 0.07.

	MILLIMETERS	
DIM	MIN	MAX
A	---	1.60
A1	0.05	0.15
A2	1.35	1.45
b	0.17	0.27
b1	0.17	0.23
c	0.09	0.20
c1	0.09	0.16
D	12.00 BSC	
D1	10.00 BSC	
e	0.50 BSC	
E	12.00 BSC	
E1	10.00 BSC	
L	0.45	0.75
L1	1.00 REF	
L2	0.50 REF	
R1	0.10	0.20
S	0.20 REF	
q	0°	7°
q 1	0°	---
q 2	12° REF	
q 3	12° REF	

Figure 3. 56F8037 64-Pin LQFP Mechanical Information

Please see **www.freescale.com** for the most current case outline.

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