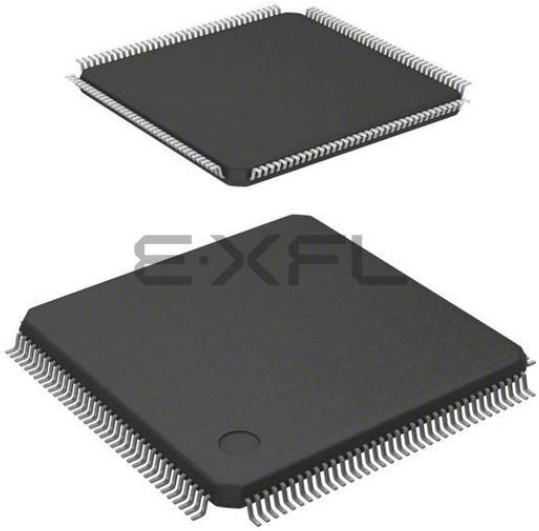

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What is "Embedded - Microcontrollers"?

"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	e200z4d
Core Size	32-Bit Dual-Core
Speed	120MHz
Connectivity	CANbus, LINbus, SCI, SPI, UART/USART
Peripherals	DMA, LVD, POR, PWM, WDT
Number of I/O	96
Program Memory Size	1MB (1M x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	128K x 8
Voltage - Supply (Vcc/Vdd)	3V ~ 3.63V
Data Converters	A/D 32x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 125°C (TA)
Mounting Type	Surface Mount
Package / Case	144-LQFP
Supplier Device Package	144-LQFP (20x20)
Purchase URL	https://www.e-xfl.com/product-detail/stmicroelectronics/spc56el60l5cbosr

1 Introduction

1.1 Document overview

This document describes the features of the family and options available within the family members, and highlights important electrical and physical characteristics of the devices.

This document provides electrical specifications, pin assignments, and package diagrams for the SPC56ELx/SPC564Lx series of microcontroller units (MCUs). For functional characteristics, see the *SPC56ELx/SPC564Lx Microcontroller Reference Manual*. For use of the SPC56ELx/SPC564Lx in a fail-safe system according to safety standard ISO26262, see the *Safety Application Guide for SPCEL60.*

1.2 Description

The SPC56ELx/SPC564Lx series microcontrollers are system-on-chip devices that are built on Power Architecture technology and contain enhancements that improve the architecture's fit in embedded applications, include additional instruction support for digital signal processing (DSP) and integrate technologies such as an enhanced time processor unit, enhanced queued analog-to-digital converter, Controller Area Network, and an enhanced modular input-output system.

The SPC56ELx/SPC564Lx family of 32-bit microcontrollers is the latest achievement in integrated automotive application controllers. It belongs to an expanding range of automotive-focused products designed to address electrical hydraulic power steering (EHPS), electric power steering (EPS) and airbag applications. The advanced and cost-efficient host processor core of the SPC56ELx/SPC564Lx automotive controller family complies with the Power Architecture embedded category. It operates at speeds as high as 120 MHz and offers high-performance processing optimized for low power consumption. It capitalizes on the available development infrastructure of current Power Architecture devices and is supported with software drivers, operating systems and configuration code to assist with users' implementations.

Table 1. SPC56ELx/SPC564Lx device summary (continued)

Feature		SPC56EL60	SPC56EL54
Temperature	Temperature range (junction)	–40 to 150 °C	
	Ambient temperature range using external ballast transistor (LQFP)	–40 to 125 °C	

1. The third eTimer (eTimer_2) is available with external I/O access only in the BGA package, on the LQFP package eTimer_2 is available internally only without any external I/O access.
2. The second FlexPWM module is available only in the BGA package.
3. LBGA257 available only as development package.

1.4 Block diagram

Figure 1 shows a top-level block diagram of the SPC56ELx/SPC564Lx device.

The SRAM module provides the following features:

- System SRAM: 128 KB
- ECC on 32-bit word (syndrome of 7 bits)
  - ECC covers SRAM bus address
- 1-bit error correction, 2-bit error detection
- Wait states:
  - 1 wait state for frequencies =< 120 MHz
  - 0 wait states for frequencies =< 80 MHz

1.5.7 Platform flash memory controller

The following list summarizes the key features of the flash memory controller:

- Single AHB port interface supports a 64-bit data bus. All AHB aligned and unaligned reads within the 32-bit container are supported. Only aligned word writes are supported.
- Array interfaces support a 128-bit read data bus and a 64-bit write data bus for each bank.
- Code flash (bank0) interface provides configurable read buffering and page prefetch support.
  - Four page-read buffers (each 128 bits wide) and a prefetch controller support speculative reading and optimized flash access.
- Single-cycle read responses (0 AHB data-phase wait states) for hits in the buffers. The buffers implement a least-recently-used replacement algorithm to maximize performance.
- Programmable response for read-while-write sequences including support for stall-while-write, optional stall notification interrupt, optional flash operation abort, and optional abort notification interrupt.
- Separate and independent configurable access timing (on a per bank basis) to support use across a wide range of platforms and frequencies.
- Support of address-based read access timing for emulation of other memory types.
- Support for reporting of single- and multi-bit error events.
- Typical operating configuration loaded into programming model by system reset.

The platform flash controller is replicated for each processor.

1.5.8 Platform Static RAM Controller (SRAMC)

The SRAMC module is the platform SRAM array controller, with integrated error detection and correction.

The main features of the SRAMC provide connectivity for the following interfaces:

- XBAR Slave Port (64-bit data path)
- ECSM (ECC Error Reporting, error injection and configuration)
- SRAM array

The following functions are implemented:

- ECC encoding (32-bit boundary for data and complete address bus)
- ECC decoding (32-bit boundary and entire address)
- Address translation from the AHB protocol on the XBAR to the SRAM array

The platform SRAM controller is replicated for each processor.

1.5.9 Memory subsystem access time

Every memory access, that the CPU performs, requires at least one system clock cycle for the data phase of the access. Slower memories or peripherals may require additional data phase wait states. Additional data phase wait states may also occur if the slave being accessed is not parked on the requesting master in the crossbar.

Table 2 shows the number of additional data phase wait states required for a range of memory accesses.

Table 2. Platform memory access time summary

AHB transfer	Data phase wait states	Description
e200z4d instruction fetch	0	Flash memory prefetch buffer hit (page hit)
e200z4d instruction fetch	3	Flash memory prefetch buffer miss (based on 4-cycle random flash array access time)
e200z4d data read	0–1	SRAM read
e200z4d data write	0	SRAM 32-bit write
e200z4d data write	0	SRAM 64-bit write (executed as 2 x 32-bit writes)
e200z4d data write	0–2	SRAM 8-,16-bit write (Read-modify-Write for ECC)
e200z4d flash memory read	0	Flash memory prefetch buffer hit (page hit)
e200z4d flash memory read	3	Flash memory prefetch buffer miss (at 120 MHz; includes 1 cycle of program flash memory controller arbitration)

1.5.10 Error Correction Status Module (ECSM)

The ECSM on this device manages the ECC configuration and reporting for the platform memories (flash memory and SRAM). It does not implement the actual ECC calculation. A detected error (double error for flash memory or SRAM) is also reported to the FCCU. The following errors and indications are reported into the ECSM dedicated registers:

- ECC error status and configuration for flash memory and SRAM
- ECC error reporting for flash memory
- ECC error reporting for SRAM
- ECC error injection for SRAM

1.5.13 System clocks and clock generation

The following list summarizes the system clock and clock generation on this device:

- Lock status continuously monitored by lock detect circuitry
- Loss-of-clock (LOC) detection for reference and feedback clocks
- On-chip loop filter (for improved electromagnetic interference performance and fewer external components required)
- Programmable output clock divider of system clock (÷1, ÷2, ÷4, ÷8)
- FlexPWM module and as many as three eTimer modules running on an auxiliary clock independent from system clock (with max frequency 120 MHz)
- On-chip crystal oscillator with automatic level control
- Dedicated internal 16 MHz internal RC oscillator for rapid start-up
  - Supports automated frequency trimming by hardware during device startup and by user application
- Auxiliary clock domain for motor control periphery (FlexPWM, eTimer, CTU, ADC, and SWG)

The SWT module is replicated for each processor.

1.5.21 Fault Collection and Control Unit (FCCU)

The FCCU module has the following features:

- Redundant collection of hardware checker results
- Redundant collection of error information and latch of faults from critical modules on the device
- Collection of self-test results
- Configurable and graded fault control
  - Internal reactions (no internal reaction, IRQ, Functional Reset, Destructive Reset, or Safe mode entered)
  - External reaction (failure is reported to the external/surrounding system via configurable output pins)

1.5.22 System Integration Unit Lite (SIUL)

The SIUL controls MCU reset configuration, pad configuration, external interrupt, general purpose I/O (GPIO), internal peripheral multiplexing, and system reset operation. The reset configuration block contains the external pin boot configuration logic. The pad configuration block controls the static electrical characteristics of I/O pins. The GPIO block provides uniform and discrete input/output control of the I/O pins of the MCU.

The SIU provides the following features:

- Centralized pad control on a per-pin basis
  - Pin function selection
  - Configurable weak pull-up/down
  - Configurable slew rate control (slow/medium/fast)
  - Hysteresis on GPIO pins
  - Configurable automatic safe mode pad control
- Input filtering for external interrupts

1.5.23 Non-Maskable Interrupt (NMI)

The non-maskable interrupt with de-glitching filter supports high-priority core exceptions.

1.5.24 Boot Assist Module (BAM)

The BAM is a block of read-only memory with hard-coded content. The BAM program is executed only if serial booting mode is selected via boot configuration pins.

The BAM provides the following features:

- Enables booting via serial mode (FlexCAN or LINFlex-UART)
- Supports programmable 64-bit password protection for serial boot mode
- Supports serial bootloading of either Power Architecture code (default) or VLE code
- Automatic switch to serial boot mode if internal flash memory is blank or invalid

1.5.25 System Status and Configuration Module (SSCM)

The SSCM on this device features the following:

- System configuration and status
- Debug port status and debug port enable
- Multiple boot code starting locations out of reset through implementation of search for valid Reset Configuration Half Word
- Sets up the MMU to allow user boot code to execute as either Power Architecture code (default) or as VLE code out of flash memory
- Triggering of device self-tests during reset phase of device boot

1.5.26 FlexCAN

The FlexCAN module is a communication controller implementing the CAN protocol according to Bosch Specification version 2.0B. The CAN protocol was designed to be used primarily as a vehicle serial data bus, meeting the specific requirements of this field: real-time processing, reliable operation in the EMI environment of a vehicle, cost-effectiveness and required bandwidth.

The FlexCAN module provides the following features:

- Full implementation of the CAN protocol specification, version 2.0B
  - Standard data and remote frames
  - Extended data and remote frames
  - 0 to 8 bytes data length
  - Programmable bit rate as fast as 1Mbit/s
- 32 message buffers of 0 to 8 bytes data length
- Each message buffer configurable as receive or transmit buffer, all supporting standard and extended messages
- Programmable loop-back mode supporting self-test operation
- 3 programmable mask registers
- Programmable transmit-first scheme: lowest ID or lowest buffer number
- Time stamp based on 16-bit free-running timer
- Global network time, synchronized by a specific message
- Maskable interrupts
- Independent of the transmission medium (an external transceiver is assumed)
- High immunity to EMI
- Short latency time due to an arbitration scheme for high-priority messages
- Transmit features
  - Supports configuration of multiple mailboxes to form message queues of scalable depth
  - Arbitration scheme according to message ID or message buffer number
  - Internal arbitration to guarantee no inner or outer priority inversion
  - Transmit abort procedure and notification

Table 5. LFBGA257 pin function summary (continued)

Pin #	Port/function	Peripheral	Output function	Input function
C9	I[0]	SIUL	GPIO[128]	GPIO[128]
		eTimer_2	ETC[0]	ETC[0]
		DSPI_0	CS4	—
		FlexPWM_1	—	FAULT[0]
C10	JCOMP	—	—	JCOMP
C11	H[11]	SIUL	GPIO[123]	GPIO[123]
		FlexPWM_1	A[2]	A[2]
C12	I[1]	SIUL	GPIO[129]	GPIO[129]
		eTimer_2	ETC[1]	ETC[1]
		DSPI_0	CS5	—
		FlexPWM_1	—	FAULT[1]
C13	F[14]	SIUL	GPIO[94]	GPIO[94]
		LINFlexD_1	TXD	—
C14	B[1]	SIUL	GPIO[17]	GPIO[17]
		eTimer_1	ETC[3]	ETC[3]
		SSCM	DEBUG[1]	—
		FlexCAN_0	—	RXD
		FlexCAN_1	—	RXD
		SIUL	—	EIRQ[16]
C15	$V_{SS\_HV\_IO\_RING}$	—		
C16	A[4]	SIUL	GPIO[4]	GPIO[4]
		eTimer_1	ETC[0]	ETC[0]
		DSPI_2	CS1	—
		eTimer_0	ETC[4]	ETC[4]
		MC_RGM	—	FAB
		SIUL	—	EIRQ[4]
C17	F[12]	SIUL	GPIO[92]	GPIO[92]
		eTimer_1	ETC[3]	ETC[3]
		SIUL	—	EIRQ[30]
D1	F[5]	SIUL	GPIO[85]	GPIO[85]
		NPC	MDO[2]	—
D2	F[4]	SIUL	GPIO[84]	GPIO[84]
		NPC	MDO[3]	—

Table 5. LFBGA257 pin function summary (continued)

Pin #	Port/function	Peripheral	Output function	Input function
D17	G[3]	SIUL	GPIO[99]	GPIO[99]
		FlexPWM_0	A[2]	A[2]
		eTimer_0	—	ETC[4]
E1	MDO0	—		
E2	F[6]	SIUL	GPIO[86]	GPIO[86]
		NPC	MDO[1]	—
E3	D[1]	SIUL	GPIO[49]	GPIO[49]
		eTimer_1	ETC[2]	ETC[2]
		CTU_0	EXT_TGR	—
		FlexRay	—	CA_RX
E4	NMI	—		
E14	Not connected	—		
E15	C[14]	SIUL	GPIO[46]	GPIO[46]
		eTimer_1	ETC[2]	ETC[2]
		CTU_0	EXT_TGR	—
E16	G[2]	SIUL	GPIO[98]	GPIO[98]
		FlexPWM_0	X[2]	X[2]
		DSPI_1	CS1	—
E17	I[3]	SIUL	GPIO[131]	GPIO[131]
		eTimer_2	ETC[3]	ETC[3]
		DSPI_0	CS7	—
		CTU_0	EXT_TGR	—
		FlexPWM_1	—	FAULT[3]
F1	H[1]	SIUL	GPIO[113]	GPIO[113]
		NPC	MDO[6]	—
F2	G[12]	SIUL	GPIO[108]	GPIO[108]
		NPC	MDO[11]	—
F3	A[7]	SIUL	GPIO[7]	GPIO[7]
		DSPI_1	SOUT	—
		SIUL	—	EIRQ[7]
F4	A[8]	SIUL	GPIO[8]	GPIO[8]
		DSPI_1	—	SIN
		SIUL	—	EIRQ[8]
F6	$V_{DD\_LV\_CORE\_RING}$	—		
F7	$V_{DD\_LV\_CORE\_RING}$	—		

Table 5. LFBGA257 pin function summary (continued)

Pin #	Port/function	Peripheral	Output function	Input function
H17	H[6]	SIUL	GPIO[118]	GPIO[118]
		FlexPWM_1	B[0]	B[0]
		DSPI_0	CS5	—
J1	F[7]	SIUL	GPIO[87]	GPIO[87]
		NPC	MCKO	—
J2	G[15]	SIUL	GPIO[111]	GPIO[111]
		NPC	MDO[8]	—
J3	$V_{DD\_HV\_REG\_0}$	—		
J4	$V_{DD\_HV\_REG\_0}$	—		
J6	V_{DD_LV}	—		
J7	V_{SS_LV}	—		
J8	V_{SS_LV}	—		
J9	V_{SS_LV}	—		
J10	V_{SS_LV}	—		
J11	V_{SS_LV}	—		
J12	V_{DD_LV}	—		
J14	V_{DD_LV}	—		
J15	$V_{DD\_HV\_REG\_1}$	—		
J16	$V_{SS\_HV\_FLA}$	—		
J17	H[15]	SIUL	GPIO[127]	GPIO[127]
		FlexPWM_1	B[3]	B[3]
		eTimer_2	ETC[5]	ETC[5]
K1	F[9]	SIUL	GPIO[89]	GPIO[89]
		NPC	MSEO[0]	—
K2	F[8]	SIUL	GPIO[88]	GPIO[88]
		NPC	MSEO[1]	—
K3	RDY	NPC	RDY	—
		SIUL	GPIO[132]	GPIO[132]
K4	C[7]	SIUL	GPIO[39]	GPIO[39]
		FlexPWM_0	A[1]	A[1]
		SSCM	DEBUG[7]	—
		DSPI_0	—	SIN
K6	V_{DD_LV}	—		
K7	V_{SS_LV}	—		
K8	V_{SS_LV}	—		

Table 8. Pin muxing

Port name	PCR	Peripheral	Alternate output function	Output mux sel	Input functions	Input mux select	Weak pull config during reset	Pad speed(1)		Pin #		
								SRC = 1	SRC = 0	100 pkg	144 pkg	257 pkg
Port A												
A[0]	PCR[0]	SIUL	GPIO[0]	ALT0	GPIO[0]	—	—	M	S	51	73	T14
		eTimer_0	ETC[0]	ALT1	ETC[0]	PSMI[35]; PADSEL=0						
		DSPI_2	SCK	ALT2	SCK	PSMI[1]; PADSEL=0						
		SIUL	—	—	EIRQ[0]	—						
A[1]	PCR[1]	SIUL	GPIO[1]	ALT0	GPIO[1]	—	—	M	S	52	74	R14
		eTimer_0	ETC[1]	ALT1	ETC[1]	PSMI[36]; PADSEL=0						
		DSPI_2	SOUT	ALT2	—	—						
		SIUL	—	—	EIRQ[1]	—						
A[2]	PCR[2]	SIUL	GPIO[2]	ALT0	GPIO[2]	—	Pull down	M	S	57	84	N16
		eTimer_0	ETC[2]	ALT1	ETC[2]	PSMI[37]; PADSEL=0						
		FlexPWM_0	A[3]	ALT3	A[3]	PSMI[23]; PADSEL=0						
		DSPI_2	—	—	SIN	PSMI[2]; PADSEL=0						
		MC_RGM	—	—	ABS[0]	—						
		SIUL	—	—	EIRQ[2]	—						

Table 8. Pin muxing (continued)

Port name	PCR	Peripheral	Alternate output function	Output mux sel	Input functions	Input mux select	Weak pull config during reset	Pad speed(1)		Pin #		
								SRC = 1	SRC = 0	100 pkg	144 pkg	257 pkg
B[6]	PCR[22]	SIUL	GPIO[22]	ALT0	GPIO[22]	—	—	F	S	96	138	B3
		MC_CGM	clk_out	ALT1	—	—						
		DSPI_2	CS2	ALT2	—	—						
		SIUL	—		EIRQ[18]	—						
B[7]	PCR[23]	SIUL	—	ALT0	GPI[23]	—	—	—	—	30	43	R5
		LINFlexD_0	—	—	RXD	PSMI[31]; PADSEL=1						
		ADC_0	—	—	AN[0](3)	—						
B[8]	PCR[24]	SIUL	—	ALT0	GPI[24]	—	—	—	—	31	47	P7
		eTimer_0	—	—	ETC[5]	PSMI[8]; PADSEL=2						
		ADC_0	—	—	AN[1](3)	—						
B[9]	PCR[25]	SIUL	—	ALT0	GPI[25]	—	—	—	—	35	52	U7
		ADC_0 ADC_1	—	—	AN[11](3)	—						
B[10]	PCR[26]	SIUL	—	ALT0	GPI[26]	—	—	—	—	36	53	R8
		ADC_0 ADC_1	—	—	AN[12](3)	—						
B[11]	PCR[27]	SIUL	—	ALT0	GPI[27]	—	—	—	—	37	54	T8
		ADC_0 ADC_1	—	—	AN[13](3)	—						
B[12]	PCR[28]	SIUL	—	ALT0	GPI[28]	—	—	—	—	38	55	U8
		ADC_0 ADC_1	—	—	AN[14](3)	—						

Table 8. Pin muxing (continued)

Port name	PCR	Peripheral	Alternate output function	Output mux sel	Input functions	Input mux select	Weak pull config during reset	Pad speed(1)		Pin #		
								SRC = 1	SRC = 0	100 pkg	144 pkg	257 pkg
H[11]	PCR[123]	SIUL	GPIO[123]	ALT0	GPIO[123]	—	—	M	S	—	—	C11
		FlexPWM_1	A[2]	ALT1	A[2]	—						
H[12]	PCR[124]	SIUL	GPIO[124]	ALT0	GPIO[124]	—	—	M	S	—	—	B10
		FlexPWM_1	B[2]	ALT1	B[2]	—						
H[13]	PCR[125]	SIUL	GPIO[125]	ALT0	GPIO[125]	—	—	M	S	—	—	G15
		FlexPWM_1	X[3]	ALT1	X[3]	—						
		eTimer_2	ETC[3]	ALT2	ETC[3]	PSMI[42]; PADSEL=0						
H[14]	PCR[126]	SIUL	GPIO[126]	ALT0	GPIO[126]	—	—	M	S	—	—	A12
		FlexPWM_1	A[3]	ALT1	A[3]	—						
		eTimer_2	ETC[4]	ALT2	ETC[4]	—						
H[15]	PCR[127]	SIUL	GPIO[127]	ALT0	GPIO[127]	—	—	M	S	—	—	J17
		FlexPWM_1	B[3]	ALT1	B[3]	—						
		eTimer_2	ETC[5]	ALT2	ETC[5]	—						
Port I												
I[0]	PCR[128]	SIUL	GPIO[128]	ALT0	GPIO[128]	—	—	M	S	—	—	C9
		eTimer_2	ETC[0]	ALT1	ETC[0]	PSMI[39]; PADSEL=1						
		DSPI_0	CS4	ALT2	—	—						
		FlexPWM_1	—	—	FAULT[0]	—						

Table 14. Thermal characteristics for LFBGA257 package(1)

Symbol		Parameter	Conditions	Value	Unit
$R_{\theta JA}$	D	Thermal resistance junction-to-ambient natural convection(2)	Single layer board – 1s	46	°C/W
			Four layer board – 2s2p	26	
$R_{\theta JMA}$	D	Thermal resistance, junction-to-ambient forced convection at 200 ft/min	Single layer board – 1s	37	°C/W
			Four layer board – 2s2p	22	
$R_{\theta JB}$	D	Thermal resistance junction-to-board(3)	—	13	°C/W
$R_{\theta JC}$	D	Thermal resistance junction-to-case(4)	—	8	°C/W
Ψ_{JT}	D	Junction-to-package-top natural convection(5)	—	2	°C/W

1. Junction temperature is a function of die size, on-chip power dissipation, package thermal resistance, mounting site (board) temperature, ambient temperature, air flow, power dissipation of other components on the board, and board thermal resistance.
2. Junction-to-Ambient thermal resistance determined per JEDEC JESD51-3 and JESD51-6. Thermal test board meets JEDEC specification for this package.
3. Junction-to-Board thermal resistance determined per JEDEC JESD51-8. Thermal test board meets JEDEC specification for the specified package.
4. Junction-to-Case at the top of the package determined using MIL-STD 883 Method 1012.1. The cold plate temperature is used for the case temperature. Reported value includes the thermal resistance of the interface layer.
5. Thermal characterization parameter indicating the temperature difference between the package top and the junction temperature per JEDEC JESD51-2. When Greek letters are not available, the thermal characterization parameter is written as Psi-JT.

3.5.1 General notes for specifications at maximum junction temperature

An estimation of the chip junction temperature, T_J, can be obtained from *Equation 1*:

Equation 1: $T_J = T_A + (R_{\theta JA} \times P_D)$

where:

T_A= ambient temperature for the package (^oC)

$R_{\theta JA}$= junction to ambient thermal resistance ($^oC/W$)

P_D= power dissipation in the package (W)

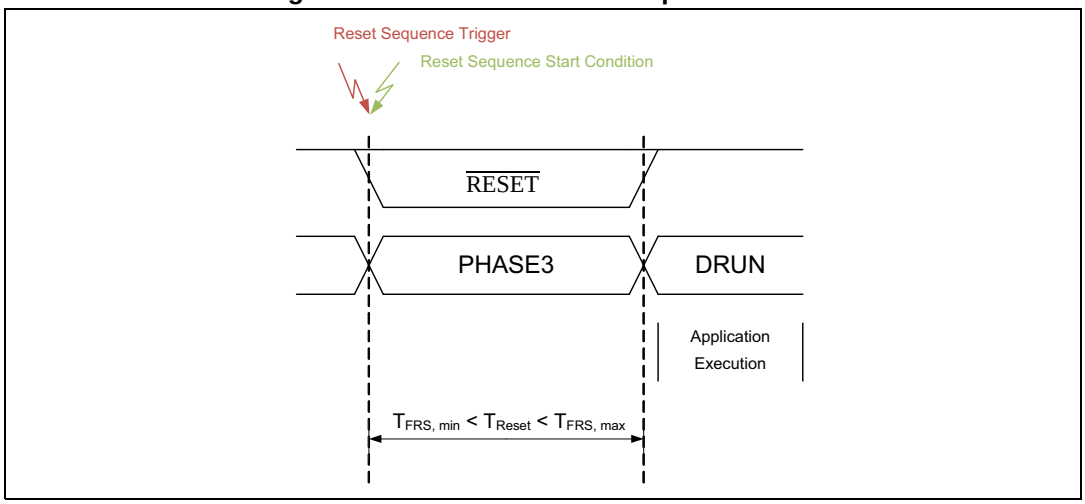
The junction to ambient thermal resistance is an industry standard value that provides a quick and easy estimation of thermal performance. Unfortunately, there are two values in common usage: the value determined on a single layer board and the value obtained on a board with two planes. For packages such as the PBGA, these values can be different by a factor of two. Which value is closer to the application depends on the power dissipated by other components on the board. The value obtained on a single layer board is appropriate for the tightly packed printed circuit board. The value obtained on the board with the internal planes is usually appropriate if the board has low power dissipation and the components are well separated.

When a heat sink is used, the thermal resistance is expressed in *Equation 2* as the sum of a junction to case thermal resistance and a case to ambient thermal resistance:

Table 20. Voltage regulator electrical specifications (continued)

Symbol		Parameter	Conditions	Min	Typ	Max	Unit
—		Main High Voltage Power - Low Voltage Detection, upper threshold	—	—	—	2.93	V
—	D	Main supply low voltage detector, lower threshold	—	2.6	—	—	V
—	D	Digital supply high voltage detector upper threshold	Before a destructive reset initialization phase completion	1.355	—	1.495	V
			After a destructive reset initialization phase completion	1.39	—	1.47	
—	D	Digital supply high voltage detector lower threshold	Before a destructive reset initialization phase completion	1.315	—	1.455	V
			After a destructive reset initialization phase completion	1.35	—	1.38	
—	D	Digital supply low voltage detector lower threshold	After a destructive reset initialization phase completion	1.080	—	1.140	V
—	D	Digital supply low voltage detector upper threshold	After a destructive reset initialization phase completion	1.16	—	1.22	V
—	D	Digital supply low voltage detector lower threshold	Before a destructive reset initialization phase	1.080	—	1.226	V
—	D	Digital supply low voltage detector upper threshold	Before a destructive reset initialization phase	1.160	—	1.306	V
—	D	POR rising/ falling supply threshold voltage	—	1.6	—	2.6	V
—	SR	Supply ramp rate	—	3 V/s	—	0.5 V/µs	—
—	D	LVD_MAIN: Time constant of RC filter at LVD input	3.3V noise rejection at the input of LVD comparator	1.1	—	—	µs
—	D	HVD_DIG: Time constant of RC filter at LVD input	1.2V noise rejection at the input of LVD comparator	0.1	—	—	µs
—	D	LVD_DIG: Time constant of RC filter at LVD input	1.2V noise rejection at the input of LVD comparator	0.1	—	—	µs

Figure 18. Functional Reset Sequence Short



The reset sequences shown in *Figure 17* and *Figure 18* are triggered by functional reset events. RESET is driven low during these two reset sequences ***only if*** the corresponding functional reset source (which triggered the reset sequence) was enabled to drive RESET low for the duration of the internal reset sequence(c).

3.20.3 Reset sequence trigger mapping

The following table shows the possible trigger events for the different reset sequences. It specifies the reset sequence start conditions as well as the reset sequence end indications that are the basis for the timing data provided in *Table 33*.

Table 34. Reset sequence trigger — reset sequence

Reset Sequence Trigger	Reset Sequence Start Condition	Reset Sequence End Indication	Reset Sequence				
			Destructive Reset Sequence, BIST enabled(1)	***Destructive Reset Sequence, BIST disabled***(1)	***External Reset Sequence Long, BIST enabled***	***Functional Reset Sequence Long***	***Functional Reset Sequence Short***
All internal destructive reset sources (LVDs or internal HVD during power-up and during operation)	*Destructive reset*	Release of RESET(2)	triggers		cannot trigger	cannot trigger	cannot trigger
Assertion of RESET(3)	*External reset via RESET*		cannot trigger		triggers(4)	triggers(5)	triggers(6)

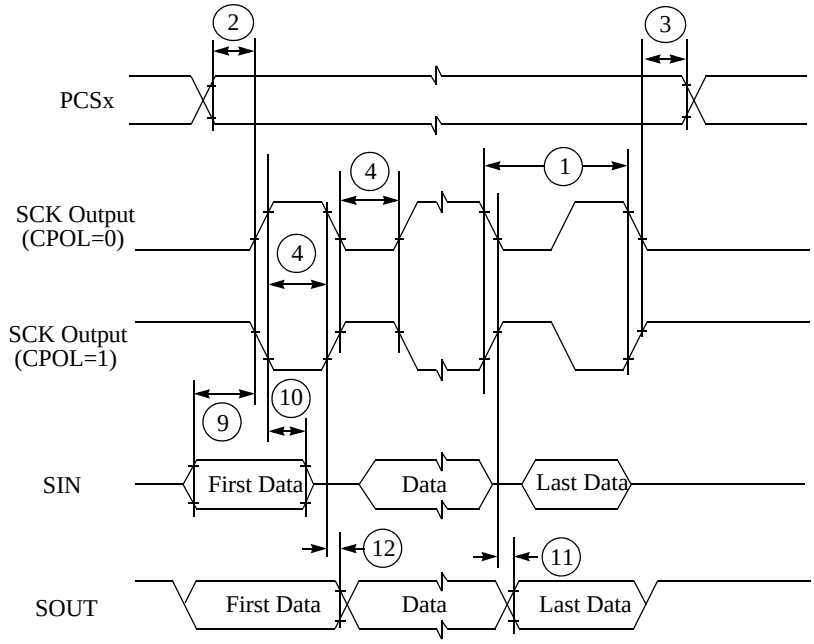
c. See RGM_FBRE register for more details.

Table 41. DSPI timing (continued)

No.	Symbol		Parameter	Conditions	Min	Max	Unit
12	t_{HO}	D	Data hold time for outputs	Master (MTFE = 0)	–2	—	ns
				Slave	6	—	
				Master (MTFE = 1, CPHA = 0)	6	—	
				Master (MTFE = 1, CPHA = 1)	–2	—	

1. Slave Receive Only Mode can operate at a maximum frequency of 60 MHz. In this mode, the DSPI can receive data on SIN, but no valid data is transmitted on SOUT.

Figure 32. DSPI classic SPI timing — master, CPHA = 0



Note: The numbers shown are referenced in *Table 41*.

Table 43. LQFP144 mechanical data (continued)

Symbol	mm			inches[1]		
	Typ	Min	Max	Typ	Min	Max
E3	17.5			0.6890		
e	0.5			0.0197		
L	0.6	0.45	0.75	0.0236	0.0177	0.0295
L1	1			0.0394		
k	3.5°	0.0°	7.0°	3.5°	0.0°	7.0°
Tolerance	mm			inches		
ccc	0.08			0.0031		

1. Values in inches are converted from mm and rounded to four decimal digits.

Figure 43. LFBGA257 package mechanical drawing

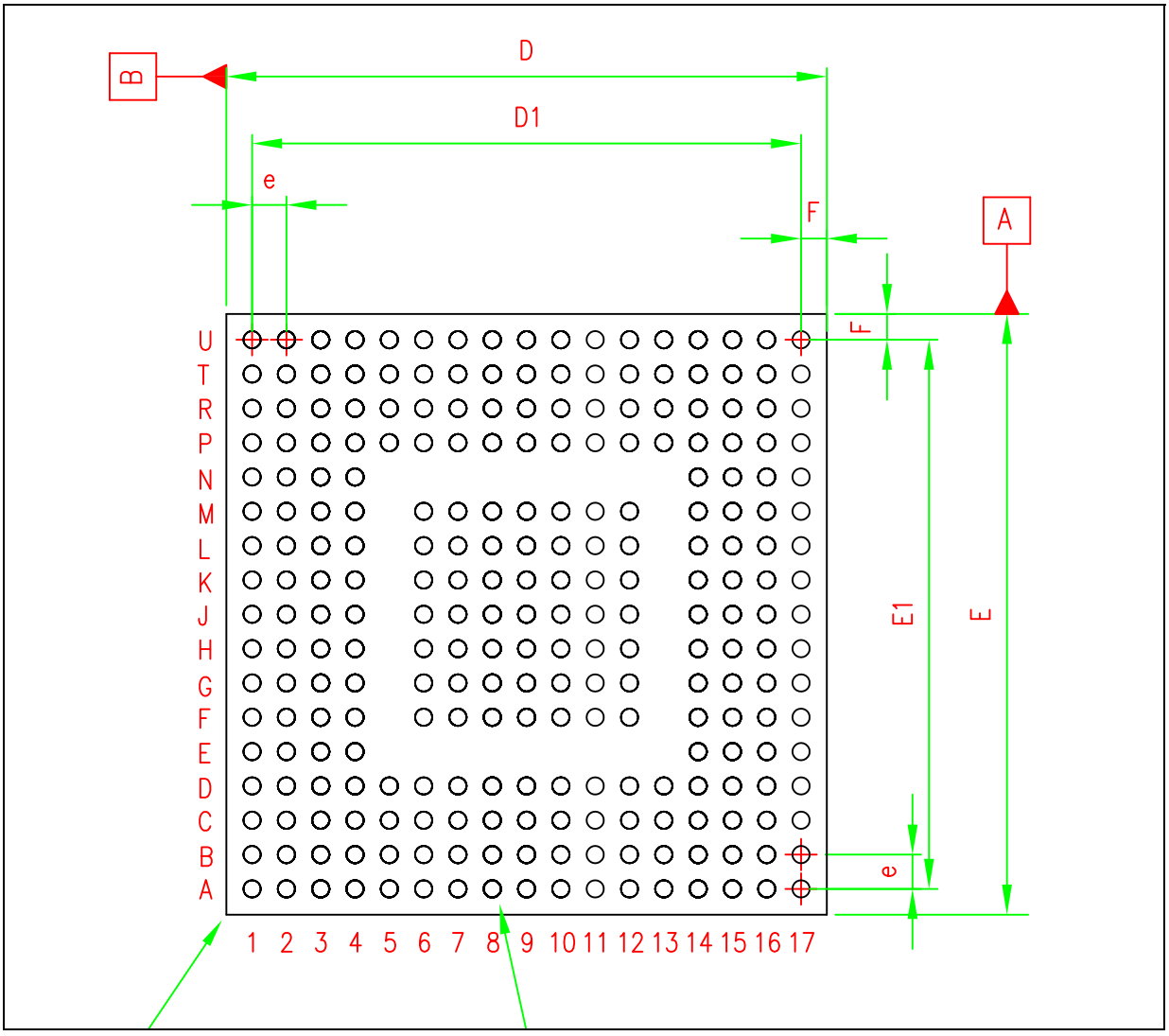


Table 44. LFBGA257 mechanical data

TITLE: LFBGA 14x14x1.7 257 F17x17 PITCH 0.8 BALL 0.4

PACKAGE CODE:

JEDEC/EIAJ REFERENCE NUMBER: JEDEC STANDARD NO.95 SECTION 4.5 (Fine pitch, Square Ball Grid Array Package Design Guide)

	DIMENSIONS						
	DATABOOK (mm)			DRAWING (mm)			
REF.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	NOTES
A			1.70			1.45	(1)
A1	0.21			0.25	0.30	0.35	
A2		1.085		1.03	1.085	1.14	
A3		0.30		0.26	0.30	0.34	
A4			0.80	0.77	0.785	0.80	
b	0.35	0.40	0.45	0.35	0.40	0.45	(2)
D	13.85	14.00	14.15	13.85	14.00	14.15	
D1		12.80			12.80		
E	13.85	14.00	14.15	13.85	14.00	14.15	
E1		12.80			12.80		
e		0.80			0.80		
F		0.6			0.6		
ddd			0.12			0.12	
eee			0.15			0.15	(3)
fff			0.08			0.08	(4)

NOTES:

(1) - LFBGA stands for **L**ow profile **F**ine Pitch **B**all **G**rid **A**rray.
- Low Profile: The total profile height (Dim A) is measured from the seating plane to the top of the component
- The maximum total package height is calculated by the following methodology:
A2 Typ+A1 Typ +√ ($A1^2+A3^2+A4^2$ tolerance values)

- Low profile: 1.20mm < A ≤ 1.70mm / Fine pitch: e < 1.00mm pitch.

(2) – The typical ball diameter before mounting is 0.40mm.

(3) - The tolerance of position that controls the location of the pattern of balls with respect to datums A and B. For each ball there is a cylindrical tolerance zone eee perpendicular to datum C and located on true position with respect to datums A and B as defined by e. The axis perpendicular to datum C of each ball must lie within this tolerance zone.

(4) - The tolerance of position that controls the location of the balls within the matrix with respect to each other. For each ball there is a cylindrical tolerance zone fff perpendicular to datum C and located on true position as defined by e. The axis perpendicular to datum C of each ball must lie within this tolerance zone. Each tolerance zone fff in the array is contained entirely in the respective zone eee above The axis of each ball must lie simultaneously in both tolerance zones.

(5) - The terminal A1 corner must be identified on the top surface by using a corner chamfer, ink or metallized markings, or other feature of package body or integral heatslug.
- A distinguishing feature is allowable on the bottom surface of the package to identify the terminal A1 corner. Exact shape of each corner is optional.

Table 45. Document revision history

Date	Revision	Changes
01-Aug-2012	8 (cont.)	– In *Section 1.5.31: eTimer module*" changed text from "The MPC5643L provides three eTimer modules on the 257 MAPBGA device, and two eTimer modules on the 144 LQFP package" to "The MPC5643L provides three eTimer modules (on the LQFP package eTimer_2 is available internally only without any external I/O access)". – In *Section 3.6: Electromagnetic Interference (EMI) characteristics*",added additional information at the end of this section. – In *Section 3.9: Voltage regulator electrical characteristics*, added text related to external ballast transistor. – In *Table 4: LQFP144 pin function summary* and *Table 5: LFBGA257 pin function summary*, moved EVTI from output function to input function. – In *Table 7: System pins*, changed the direction for EXTAL from "Output Only" to "Input/Output". – In*Table 7: System pins*, added table footnote for symbol "EXTAL". – Changed the row (TVdd) in *Table 9: Absolute maximum ratings*. – In *Table 9: Absolute maximum ratings*, Maximum value for "$V_{DD\_HV\_IOX}$" and "$V_{DD\_HV\_FLA}$" changed from "3.6" to "4.0". – In *Table 22: Current consumption characteristics*, added max value 250 and 290 mA for symbol $I_{DD\_LV\_BIST}$+$I_{DD\_LV\_PLL}$. – Added five additional RunIDD parameters in *Table 22: Current consumption characteristics*. – In *Table 23: Temperature sensor electrical characteristics*, changed condition for parameter "Accuracy" from "-40°C to 25°C" to "-40°C to 150°C" – In *Table 25: FMPLL electrical characteristics*,added '150' to the max value for 'f_{SCM}' In *Table 26: 16 MHz RC oscillator electrical characteristics*,changes done are: f_{RC} symbol- Added min value '15.04' and max value '16.96'.Removed condition "T_J=25°C" Removed row containing Δ_{RCMVAR} symbol. – In *Figure 10: Input Equivalent Circuit*, added the name 'C_S' to the capacitor in the internal circuit scheme. – Removed references to Cut1 and Cut2: Renamed Section "Electromagnetic Interference (EMI) characteristics (cut1)" to "Electromagnetic Interference (EMI) characteristics". In *Table 27: ADC conversion characteristics*, removed reference to cut2 only for symbol 'IS1WINJ' and '$TUE_{IS1WWINJ}$'. In *Section 1.1: Document overview*, modified text to remove references to 'Cut1'. – In *Table 27: ADC conversion characteristics*, for t_{CONV} added '60 MHz' to 'conditions' and '600' to the 'Min' value. Separated SNR into two specifications with conditions Vref 3.3 V and 5.0 V respectively.