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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	e200z0h
Core Size	32-Bit Single-Core
Speed	64MHz
Connectivity	CANbus, LINbus, SPI, UART/USART
Peripherals	DMA, POR, PWM, WDT
Number of I/O	49
Program Memory Size	1MB (1M x 8)
Program Memory Type	FLASH
EEPROM Size	64K x 8
RAM Size	80K x 8
Voltage - Supply (Vcc/Vdd)	4.5V ~ 5.5V
Data Converters	A/D 16x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 105°C (TA)
Mounting Type	Surface Mount
Package / Case	100-LQFP
Supplier Device Package	100-LQFP (14x14)
Purchase URL	https://www.e-xfl.com/product-detail/stmicroelectronics/spc56ap60l3beaay

List of figures

The DSPI modules provide these features:

- Full duplex, synchronous transfers
- Master or slave operation
- Programmable master bit rates
- Programmable clock polarity and phase
- End-of-transmission interrupt flag
- Programmable transfer baud rate
- Programmable data frames from 4 to 16 bits
- Up to 28 chip select lines available
  - 8 each on DSPI_0 and DSPI_1
  - 4 each on DSPI_2, DSPI_3, and DSPI_4
- 8 clock and transfer attributes registers
- Chip select strobe available as alternate function on one of the chip select pins for deglitching
- FIFOs for buffering up to 5 transfers on the transmit and receive side
- Queueing operation possible through use of the eDMA
- General purpose I/O functionality on pins when not used for SPI

1.5.23 eTimer

Two eTimer modules are provided, each with six 16-bit general purpose up/down timer/counter per module. The following features are implemented:

- Individual channel capability
  - Input capture trigger
  - Output compare
  - Double buffer (to capture rising edge and falling edge)
  - Separate prescaler for each counter
  - Selectable clock source
  - 0 % to 100% pulse measurement
  - Rotation direction flag (Quad decoder mode)
- Maximum count rate
  - Equals peripheral clock/2 — for external event counting
  - Equals peripheral clock — for internal clock counting
- Cascadeable counters
- Programmable count modulo
- Quadrature decode capabilities
- Counters can share available input pins
- Count once or repeatedly
- Preloadable counters
- Pins available as GPIO when timer functionality not in use

  - Watchpoint triggering, watchpoint triggers program tracing
  - DDR
- Auxiliary Output Port
  - 4 MDO (Message Data Out) pins
  - MCKO (Message Clock Out) pin
  - 2 $\overline{\text{MSEO}}$ (Message Start/End Out) pins
  - $\overline{\text{EVTO}}$ (Event Out) pin
- Auxiliary Input Port
  - $\overline{\text{EVTI}}$ (Event In) pin[a]

1.5.28 IEEE 1149.1 (JTAG) controller

The JTAG controller (JTAGC) block provides the means to test chip functionality and connectivity while remaining transparent to system logic when not in test mode. All data input to and output from the JTAGC block is communicated in serial format. The JTAGC block is compliant with the IEEE standard.

The JTAG controller provides the following features:

- IEEE Test Access Port (TAP) interface with four pins (TDI, TMS, TCK, TDO)
- Selectable modes of operation include JTAGC/debug or normal system operation.
- A 5-bit instruction register that supports the following IEEE 1149.1-2001 defined instructions:
  - BYPASS, IDCODE, EXTEST, SAMPLE, SAMPLE/PRELOAD
- A 5-bit instruction register that supports the additional following public instructions:
  - ACCESS_AUX_TAP_NPC, ACCESS_AUX_TAP_CORE0, ACCESS_AUX_TAP_CORE1, ACCESS_AUX_TAP_NASPS_0, ACCESS_AUX_TAP_NASPS_1
- Three test data registers: a bypass register, a boundary scan register, and a device identification register.
- A TAP controller state machine that controls the operation of the data registers, instruction register and associated circuitry.

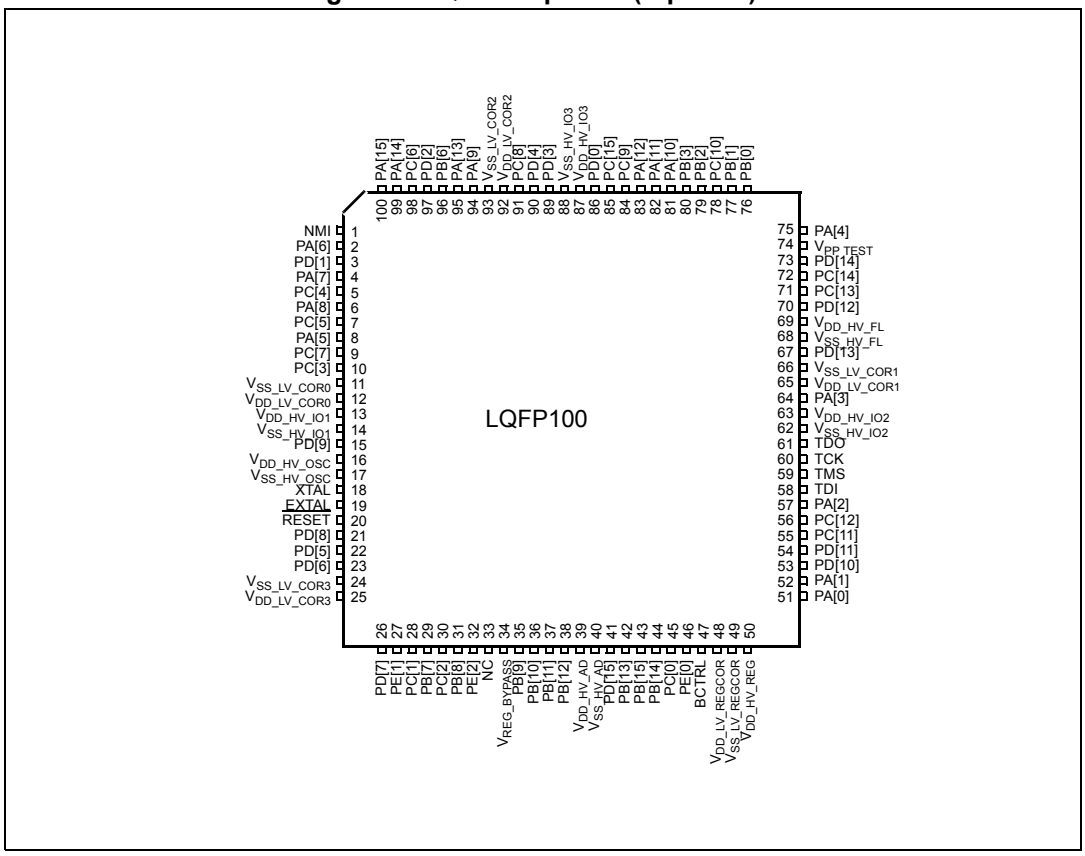
1.5.29 On-chip voltage regulator (VREG)

The on-chip voltage regulator module provides the following features:

- Uses external NPN transistor
- Regulates external 3.3 V to 5.0 V down to 1.2 V for the core logic
- Low voltage detection on the internal 1.2 V and I/O voltage 3.3 V

a. At least one TCK clock is necessary for the EVTI signal to be recognized by the MCU.

Figure 4. LQFP100 pinout (top view)[d]



2.2 Pin descriptions

The following sections provide signal descriptions and related information about the functionality and configuration of the SPC56xP54x/SPC56xP60x devices.

2.2.1 Power supply and reference voltage pins

Table 5 lists the power supply and reference voltage for the SPC56xP54x/SPC56xP60x devices.

Table 5. Supply pins

Supply		Pin		
Symbol	**Description**	**LQFP 100**	**LQFP 144**	**LQFP 176[1]**
VREG control and power supply pins				
BCTRL	Voltage regulator external NPN Ballast base control pin	47	69	81

d. Availability of port pin alternate functions depends on product selection.

Table 7. Pin muxing[1] (continued)

Port pin	PCR No.	Alternate function[2], [3]	Functions	Peripheral [4]	I/O direction [5]	Pad speed[6]		Pin		
						SRC = 0	SRC = 1	LQFP 100	LQFP 144	LQFP 176[7]
A[2] [8]	PCR[2]	ALT0 ALT1 ALT2 ALT3 — — —	GPIO[2] ETC[2] CS3_4 — SIN_2 ABS[0] EIRQ[2]	SIUL eTimer_0 DSPI_4 — DSPI_2 MC_RGM SIUL	I/O I/O O — I I I	Slow	Medium	57	84	102
A[3] [8]	PCR[3]	ALT0 ALT1 ALT2 ALT3 — —	GPIO[3] ETC[3] CS0_2 — ABS[1] EIRQ[3]	SIUL eTimer_0 DSPI_2 — MC_RGM SIUL	I/O I/O I/O — I I	Slow	Medium	64	92	116
A[4] [8]	PCR[4]	ALT0 ALT1 ALT2 ALT3 — —	GPIO[4] ETC[0] CS1_2 ETC[4] FAB EIRQ[4]	SIUL eTimer_1 DSPI_2 eTimer_0 MC_RGM SIUL	I/O I/O O I/O I I	Slow	Medium	75	108	132
A[5]	PCR[5]	ALT0 ALT1 ALT2 ALT3 —	GPIO[5] CS0_1 ETC[5] CS7_0 EIRQ[5]	SIUL DSPI_1 eTimer_1 DSPI_0 SIUL	I/O I/O I/O O I	Slow	Medium	8	14	22
A[6]	PCR[6]	ALT0 ALT1 ALT2 ALT3 —	GPIO[6] SCK_1 CS2_4 — EIRQ[6]	SIUL DSPI_1 DSPI_4 — SIUL	I/O I/O I/O — I	Slow	Medium	2	2	2
A[7]	PCR[7]	ALT0 ALT1 ALT2 ALT3 —	GPIO[7] SOUT_1 CS1_4 — EIRQ[7]	SIUL DSPI_1 DSPI_4 — SIUL	I/O O I/O — I	Slow	Medium	4	10	18
A[8]	PCR[8]	ALT0 ALT1 ALT2 ALT3 — —	GPIO[8] — CS0_4 — SIN_1 EIRQ[8]	SIUL — DSPI_4 — DSPI_1 SIUL	I/O — I/O — I I	Slow	Medium	6	12	20

Table 7. Pin muxing[1] (continued)

Port pin	PCR No.	Alternate function[2], [3]	Functions	Peripheral [4]	I/O direction [5]	Pad speed[6]		Pin		
						SRC = 0	SRC = 1	LQFP 100	LQFP 144	LQFP 176[7]
Port C										
C[0]	PCR[32]	ALT0 ALT1 ALT2 ALT3 —	GPIO[32] — — — AN[19]	SIUL — — — ADC_0	Input Only	—	—	45	66	78
C[1]	PCR[33]	ALT0 ALT1 ALT2 ALT3 —	GPIO[33] — — — AN[2]	SIUL — — — ADC_0	Input Only	—	—	28	41	49
C[2]	PCR[34]	ALT0 ALT1 ALT2 ALT3 —	GPIO[34] — — — AN[3]	SIUL — — — ADC_0	Input Only	—	—	30	45	53
C[3]	PCR[35]	ALT0 ALT1 ALT2 ALT3 —	GPIO[35] CS1_0 ETC[4] TXD EIRQ[21]	SIUL DSPI_0 eTimer_1 LINFlex_1 SIUL	I/O O I/O O I	Slow	Medium	10	16	24
C[4]	PCR[36]	ALT0 ALT1 ALT2 ALT3 —	GPIO[36] CS0_0 — DEBUG[4] EIRQ[22]	SIUL DSPI_0 — SSCM SIUL	I/O I/O — — I	Slow	Medium	5	11	19
C[5]	PCR[37]	ALT0 ALT1 ALT2 ALT3 —	GPIO[37] SCK_0 SCK_4 DEBUG[5] EIRQ[23]	SIUL DSPI_0 DSPI_4 SSCM SIUL	I/O I/O I/O — I	Slow	Medium	7	13	21
C[6]	PCR[38]	ALT0 ALT1 ALT2 ALT3 —	GPIO[38] SOUT_0 — DEBUG[6] EIRQ[24]	SIUL DSPI_0 — SSCM SIUL	I/O O — — I	Slow	Medium	98	142	174

Table 7. Pin muxing[1] (continued)

Port pin	PCR No.	Alternate function[2], [3]	Functions	Peripheral [4]	I/O direction [5]	Pad speed[6]		Pin		
						SRC = 0	SRC = 1	LQFP 100	LQFP 144	LQFP 176[7]
D[7]	PCR[55]	ALT0 ALT1 ALT2 ALT3 —	GPIO[55] CS3_1 — CS4_0 SIN_3	SIUL DSPI_1 — DSPI_0 DSPI_3	I/O O — O I	Slow	Medium	26	37	45
D[8]	PCR[56]	ALT0 ALT1 ALT2 ALT3	GPIO[56] CS2_1 RDY CS5_0	SIUL DSPI_1 nexus_0 DSPI_0	I/O O O O	Slow	Medium	21	32	40
D[9]	PCR[57]	ALT0 ALT1 ALT2 ALT3	GPIO[57] — TXD CS6_1	SIUL — LINFlex_1 DSPI_1	I/O — O O	Slow	Medium	15	26	34
D[10]	PCR[58]	ALT0 ALT1 ALT2 ALT3	GPIO[58] — CS0_3 —	SIUL — DSPI_3 —	I/O — I/O —	Slow	Medium	53	76	92
D[11]	PCR[59]	ALT0 ALT1 ALT2 ALT3	GPIO[59] — CS1_3 SCK_3	SIUL — DSPI_3 DSPI_3	I/O — O I/O	Slow	Medium	54	78	94
D[12]	PCR[60]	ALT0 ALT1 ALT2 ALT3 —	GPIO[60] — — CS7_1 RXD	SIUL — — DSPI_1 LINFlex_1	I/O — — O I	Slow	Medium	70	99	123
D[13]	PCR[61]	ALT0 ALT1 ALT2 ALT3	GPIO[61] — CS2_3 SOUT_3	SIUL — DSPI_3 DSPI_3	I/O — O O	Slow	Medium	67	95	119
D[14]	PCR[62]	ALT0 ALT1 ALT2 ALT3 —	GPIO[62] — CS3_3 — SIN_3	SIUL — DSPI_3 — DSPI_3	I/O — O — I	Slow	Medium	73	105	129
D[15]	PCR[63]	ALT0 ALT1 ALT2 ALT3 —	GPIO[63] — — — AN[20]	SIUL — — — ADC_0	Input Only	—	—	41	58	66

3 Electrical characteristics

3.1 Introduction

This section contains electrical characteristics of the device as well as temperature and power considerations.

This product contains devices to protect the inputs against damage due to high static voltages. However, it is advisable to take precautions to avoid application of any voltage higher than the specified maximum rated voltages.

To enhance reliability, unused inputs can be driven to an appropriate logic voltage level (V_{DD} or V_{SS}). This can be done by the internal pull-up or pull-down, which is provided by the product for most general purpose pins.

The parameters listed in the following tables represent the characteristics of the device and its demands on the system.

In the tables where the device logic provides signals with their respective timing characteristics, the symbol “CC” for Controller Characteristics is included in the Symbol column.

In the tables where the external system must provide signals with their respective timing characteristics to the device, the symbol “SR” for System Requirement is included in the Symbol column.

Caution: All of the following parameter values can vary depending on the application and must be confirmed during silicon validation, silicon characterization or silicon reliability trial.

3.2 Parameter classification

The electrical parameters shown in this supplement are guaranteed by various methods. To give the customer a better understanding, the classifications listed in *Table 8* are used and the parameters are tagged accordingly in the tables where appropriate.

Table 8. Parameter classifications

Classification tag	Tag description
P	Those parameters are guaranteed during production testing on each individual device.
C	Those parameters are achieved by the design characterization by measuring a statistically relevant sample size across process variations.
T	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.

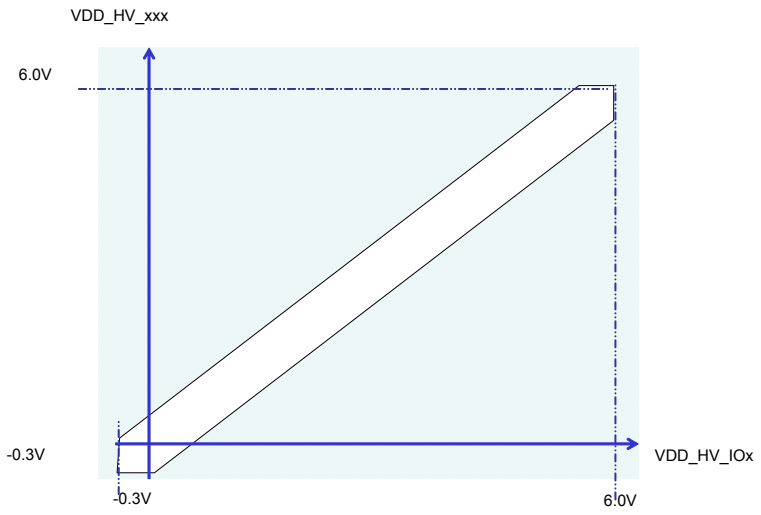
Table 9. Absolute maximum ratings(1) (continued)

Symbol		Parameter	Conditions	Min	Max(2)	Unit
I_{INJSUM}	SR	Absolute sum of all injected input currents during overload condition	—	–50	50	mA
I_{VDD_LV}	SR	Low voltage static current sink through V_{DD_LV}	—	—	155	mA
T_{STG}	SR	Storage temperature	—	–55	150	°C
T_J	SR	Junction temperature under bias	—	–40	150	°C

1. Functional operating conditions are given in the DC electrical characteristics. Absolute maximum ratings are stress ratings only, and functional operation at the maxima is not guaranteed. Stress beyond the listed maxima may affect device reliability or cause permanent damage to the device.
2. Absolute maximum voltages are currently maximum burn-in voltages. Absolute maximum specifications for device stress have not yet been determined.
3. The difference between each couple of voltage supplies must be less than 300 mV, $|V_{DD\_HV\_IOy} - V_{DD\_HV\_IOx}| < 300$ mV.
4. Guaranteed by device validation.
5. Minimum value of TV_{DD} must be guaranteed until $V_{DD\_HV\_REG}$ reaches 2.6 V (maximum value of V_{PORH}).

Figure 5 shows the constraints of the different power supplies.

Figure 5. Power supplies constraints



The SPC56xP54x/SPC56xP60x supply architecture provides an ADC supply that is managed independently of standard V_{DD_HV} supply. *Figure 6* shows the constraints of the ADC power supply.

In particular two different transient periods can be distinguished:

- A first and quick charge transfer from the internal capacitance C_{P1} and C_{P2} to the sampling capacitance C_S occurs (C_S is supposed initially completely discharged): considering a worst case (since the time constant in reality would be faster) in which C_{P2} is reported in parallel to C_{P1} (call $C_P = C_{P1} + C_{P2}$), the two capacitances C_P and C_S are in series, and the time constant is

Equation 5

$$\tau_1 = (R_{SW} + R_{AD}) \times \frac{C_P \times C_S}{C_P + C_S}$$

Equation 5 can again be simplified considering only C_S as an additional worst condition. In reality, the transient is faster, but the A/D converter circuitry has been designed to be robust also in the very worst case: the sampling time T_S is always much longer than the internal time constant:

Equation 6

$$\tau_1 < (R_{SW} + R_{AD}) \times C_S \ll T_S$$

The charge of C_{P1} and C_{P2} is redistributed also on C_S, determining a new value of the voltage V_{A1} on the capacitance according to *Equation 7*:

Equation 7

$$V_{A1} \times (C_S + C_{P1} + C_{P2}) = V_A \times (C_{P1} + C_{P2})$$

- A second charge transfer involves also C_F (that is typically bigger than the on-chip capacitance) through the resistance R_L: again considering the worst case in which C_{P2} and C_S were in parallel to C_{P1} (since the time constant in reality would be faster), the time constant is:

Equation 8

$$\tau_2 < R_L \times (C_S + C_{P1} + C_{P2})$$

In this case, the time constant depends on the external circuit: in particular imposing that the transient is completed well before the end of sampling time T_S, a constraint on R_L sizing is obtained:

Equation 9

$$8.5 \times \tau_2 = 8.5 \times R_L \times (C_S + C_{P1} + C_{P2}) < T_S$$

Of course, R_L shall be sized also according to the current limitation constraints, in combination with R_S (source impedance) and R_F (filter resistance). Being C_F definitively bigger than C_{P1}, C_{P2} and C_S, then the final voltage V_{A2} (at the end of the charge transfer transient) will be much higher than V_{A1}. *Equation 10* must be respected (charge balance assuming now C_S already charged at V_{A1}):

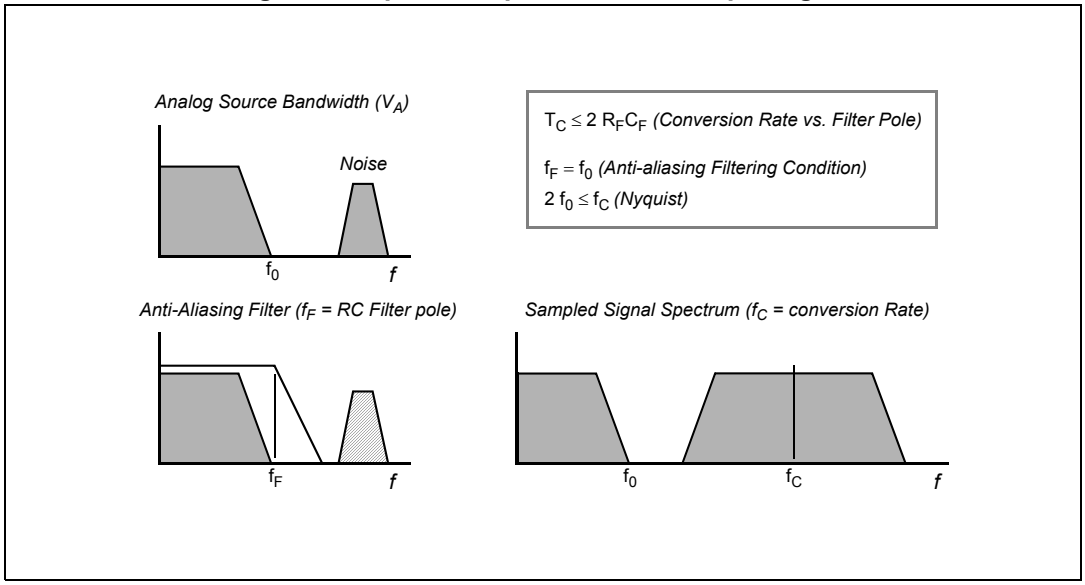
Equation 10

$$V_{A2} \times (C_S + C_{P1} + C_{P2} + C_F) = V_A \times C_F + V_{A1} \times (C_{P1} + C_{P2} + C_S)$$

The two transients above are not influenced by the voltage source that, due to the presence of the $R_F C_F$ filter, is not able to provide the extra charge to compensate the voltage drop on

C_S with respect to the ideal source V_A; the time constant R_FC_F of the filter is very high with respect to the sampling time (T_S). The filter is typically designed to act as anti-aliasing.

Figure 19. Spectral representation of input signal



Calling f_0 the bandwidth of the source signal (and as a consequence the cut-off frequency of the anti-aliasing filter, f_F), according to the Nyquist theorem the conversion rate f_C must be at least $2f_0$; it means that the constant time of the filter is greater than or at least equal to twice the conversion period (T_C). Again the conversion period T_C is longer than the sampling time T_S, which is just a portion of it, even when fixed channel continuous conversion mode is selected (fastest conversion rate at a specific channel): in conclusion it is evident that the time constant of the filter R_FC_F is definitively much higher than the sampling time T_S, so the charge level on C_S cannot be modified by the analog signal source during the time in which the sampling switch is closed.

The considerations above lead to impose new constraints on the external circuit, to reduce the accuracy error due to the voltage drop on C_S; from the two charge balance equations above, it is simple to derive *Equation 11* between the ideal and real sampled voltage on C_S:

Equation 11

$$\frac{V_A}{V_{A2}} = \frac{C_{P1} + C_{P2} + C_F}{C_{P1} + C_{P2} + C_F + C_S}$$

From this formula, in the worst case (when V_A is maximum, that is for instance 5 V), assuming to accept a maximum error of half a count, a constraint is evident on C_F value:

Equation 12

$$C_F > 2048 \times C_S$$

3.15.2 ADC conversion characteristics

Table 32. ADC conversion characteristics

Symbol		Parameter	Conditions[1]	Value			Unit
				Min	Typ	Max	
V_{INAN}	SR	Analog input voltage[2]	—	$V_{SS\_HV\_AD}$ – 0.3	—	$V_{SS\_HV\_AD}$ + 0.3	V
f_{CK}	SR	ADC Clock frequency (depends on ADC configuration) (The duty cycle depends on AD_clk[3] frequency)	—	3[4]	—	60	MHz
f_s	SR	Sampling frequency	—	—	—	1.53	MHz
t_{ADC_S}	D	Sample time[5]	f_{ADC} = 20 MHz, INPSAMP = 3	125	—	—	ns
			f_{ADC} = 9 MHz, INPSAMP = 255	—	—	28.2	µs
t_{ADC_C}	P	Conversion time[6]	f_{ADC} = 20 MHz[7], INPCMP = 1	0.650	—	—	µs
C_S[8]	D	ADC input sampling capacitance	—	—	—	2.5	pF
C_{P1}[8]	D	ADC input pin capacitance 1	—	—	—	3	pF
C_{P2}[8]	D	ADC input pin capacitance 2	—	—	—	1	pF
C_{P3}[8]	D	ADC input pin capacitance 3	—	—	—	1	pF
R_{SW1}[8]	D	Internal resistance of analog source	$V_{DD\_HV\_AD}$ = 5 V ±10%	—	—	0.6	kΩ
			$V_{DD\_HV\_AD}$ = 3.3 V ±10%	—	—	3	kΩ
R_{SW2}[8]	D	Internal resistance of analog source	$V_{DD\_HV\_AD}$ = 5 V ±10%	—	—	2.15	kΩ
			$V_{DD\_HV\_AD}$ = 3.3 V ±10%	—	—	3.6	kΩ
R_{AD}[8]	D	Internal resistance of analog source	—	—	—	2	kΩ
I_{INJ}	T	Input current injection	Current injection on one ADC input, different from the converted one. Remains within TUE spec.	–5	—	5	mA
INL	P	Integral Non Linearity	No overload	—	±1.5	—	LSB
DNL	P	Differential Non Linearity	No overload	–1.0	—	1.0	LSB
OFS	T	Offset error	—	—	±1	—	LSB
GNE	T	Gain error	—	—	±1	—	LSB
TUE	P	Total unadjusted error without current injection	16 precision channels	–2.5	—	2.5	LSB

Table 32. ADC conversion characteristics (continued)

Symbol		Parameter	Conditions[1]	Value			Unit
				Min	Typ	Max	
TUE	T	Total unadjusted error with current injection	16 precision channels	–3	—	3	LSB
TUE	T	Total unadjusted error with current injection	10 standard channels	–4	—	4	LSB

1. V_{DD} = 3.3 V to 3.6 V / 4.5 V to 5.5 V, T_A = –40 °C to $T_{A\ MAX}$, unless otherwise specified and analog input voltage from $V_{SS\_HV\_AD}$ to $V_{DD\_HV\_AD}$.
2. V_{INAN} may exceed V_{SS_ADC} and V_{DD_ADC} limits, remaining on absolute maximum ratings, but the results of the conversion will be clamped respectively to 0x000 or 0x3FF.
3. AD_clk clock is always half of the ADC module input clock defined via the auxiliary clock divider for the ADC.
4. When configured to allow 60 MHz ADC, the minimum ADC clock speed is 9 MHz, below which precision is lost.
5. During the sample time the input capacitance CS can be charged/discharged by the external source. The internal resistance of the analog source must allow the capacitance to reach its final voltage level within t_{ADC_S}. After the end of the sample time t_{ADC_S}, changes of the analog input voltage have no effect on the conversion result. Values for the sample clock t_{ADC_S} depend on programming.
6. This parameter includes the sample time t_{ADC_S}.
7. 20 MHz ADC clock. Specific prescaler is programmed on MC_PLL_CLK to provide 20 MHz clock to the ADC.
8. See *Figure 16*.

3.16 Flash memory electrical characteristics

Table 33. Program and erase specifications

Symbol		Parameter	Conditions	Value				Unit
				Min	Typ[1]	Initial max[2]	Max[3]	
$T_{wprogram}$	P	Word Program (32 bits) Time[4]	Data Flash	—	30	70	500	µs
$T_{dwprogram}$	P	Double Word (64 bits) Program Time[4]	Code Flash	—	18	50	500	µs
T_{BKPRG}	P	Bank Program (64 KB)[4, 5]	Data Flash	—	0.49	1.2	4.1	s
	P	Bank Program (1056 KB)[4, 5]	Code Flash	—	2.6	6.6	66	s
T_{MDPRG}	P	Module Program (512 KB)[4]	Code Flash	—	1.3	1.65	33	s
$T_{16kpperase}$	P	16 KB Block Pre-program and Erase Time	Code Flash	—	200	500	5000	ms
			Data Flash		700	800		
$T_{32kpperase}$	P	32 KB Block Pre-program and Erase Time	Code Flash	—	300	600	5000	ms
$T_{64kpperase}$	P	64 KB Block Pre-program and Erase Time	Code Flash	—	400	900	5000	ms
$T_{128kpperase}$	P	128 KB Block Pre-program and Erase Time	Code Flash	—	600	1300	5000	ms
t_{ESRT}	P	Erase Suspend Request Rate[6]	Code Flash	20	—	—	—	ms
			Data Flash	10				

1. Typical program and erase times assume nominal supply values and operation at 25 °C. All times are subject to change pending device characterization.
2. Initial factory condition: < 100 program/erase cycles, 25 °C, typical supply voltage.

Table 39. Nexus debug port timing(1) (continued)

No.	Symbol		C	Parameter	Value			Unit
					Min	Typ	Max	
6	t_{NTDIS}	CC	D	TDI data setup time	6	—	—	ns
	t_{NTMSS}	CC	D	TMS data setup time	6	—	—	ns
7	t_{NTDIH}	CC	D	TDI data hold time	10	—	—	ns
	t_{NTMSH}	CC	D	TMS data hold time	10	—	—	ns
8	t_{TDOV}	CC	D	TCK low to TDO data valid	—	—	35	ns
9	t_{TDOI}	CC	D	TCK low to TDO data invalid	6	—	—	ns

1. All values need to be confirmed during device validation.
2. Lower frequency is required to be fully compliant to standard.

Figure 25. Nexus output timing

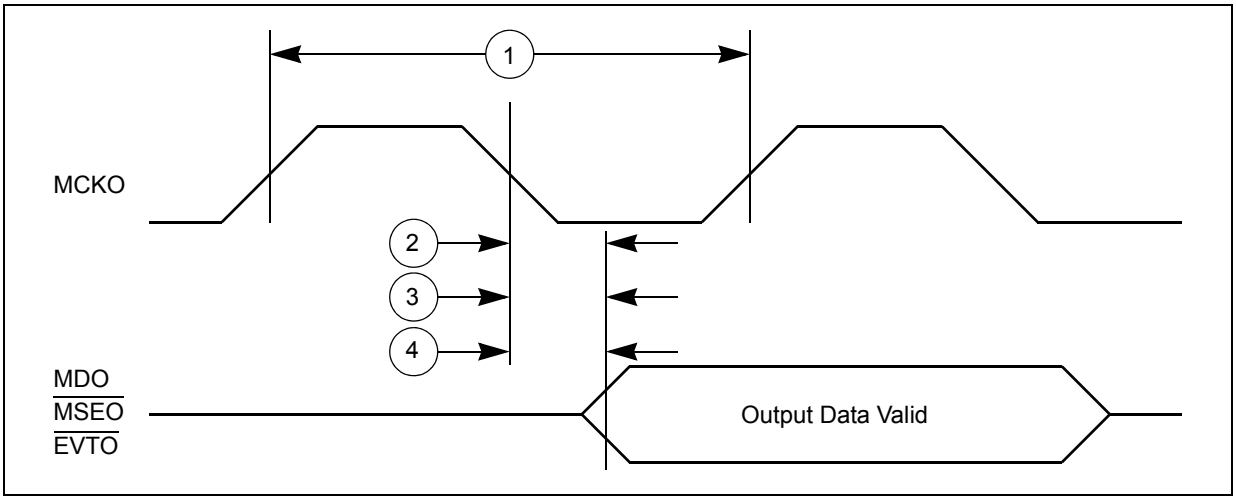


Figure 26. Nexus event trigger and test clock timings

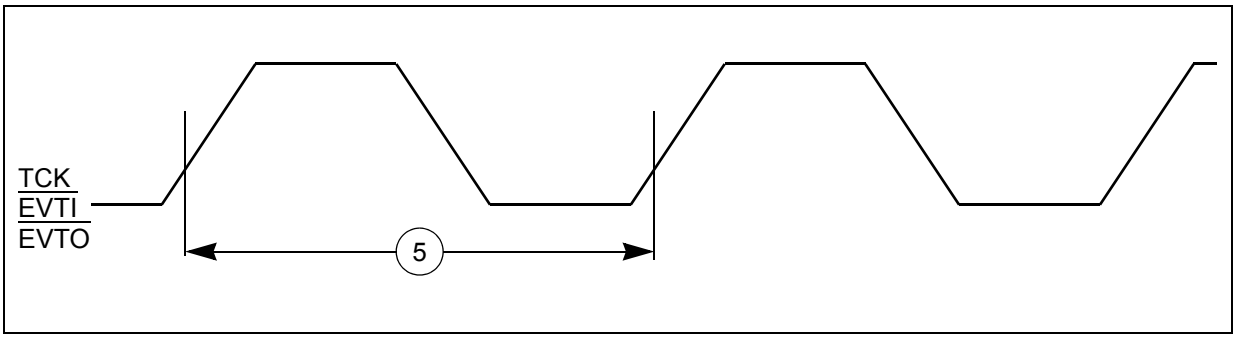
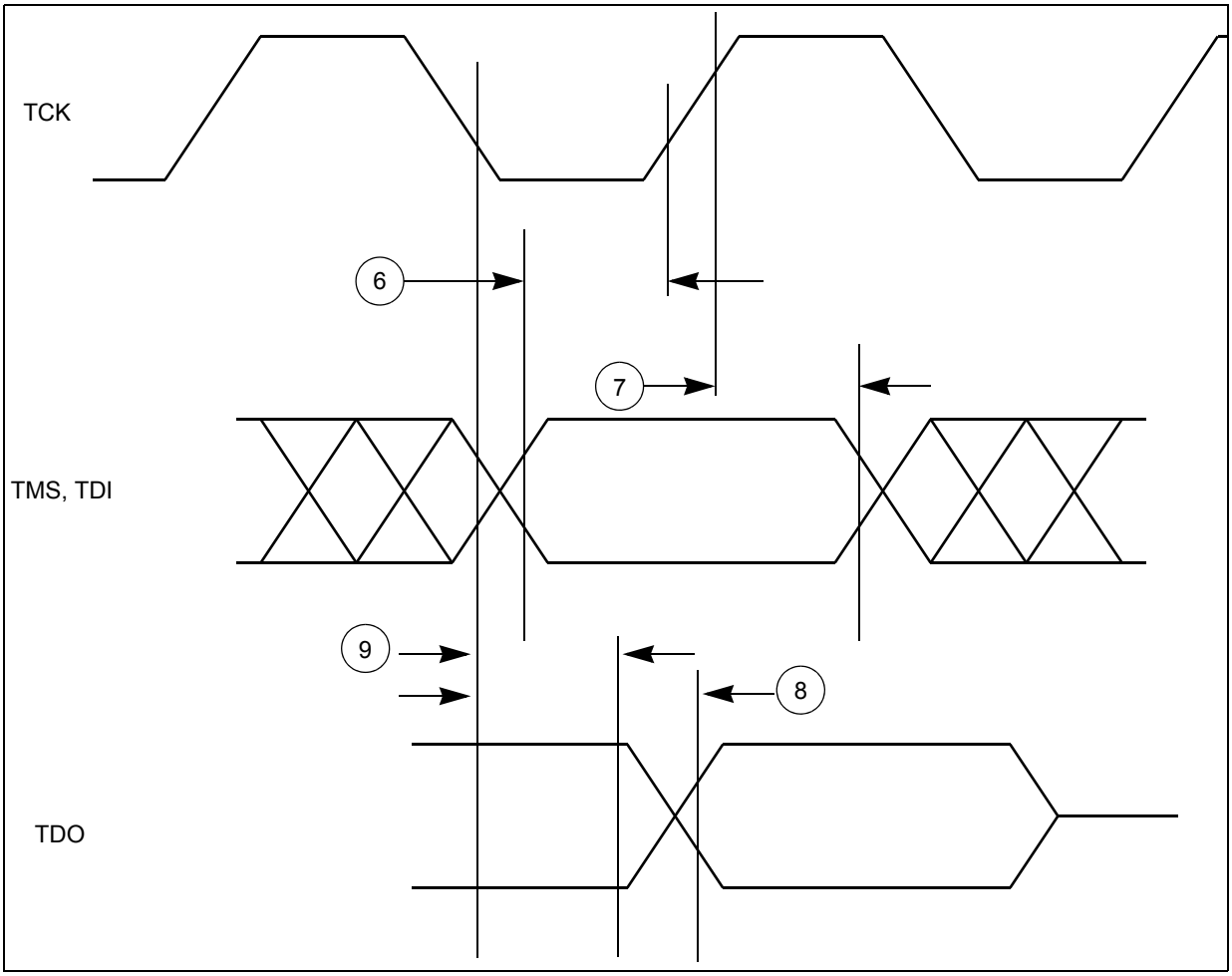


Figure 27. Nexus TDI, TMS, TDO timing



3.18.4 External interrupt timing (IRQ pin)

Table 40. External interrupt timing[1]

No.	Symbol		C	Parameter	Conditions	Min	Max	Unit
1	t_{IPWL}	CC	D	IRQ pulse width low	—	4	—	t_{CYC}
2	t_{IPWH}	CC	D	IRQ pulse width high	—	4	—	t_{CYC}
3	t_{ICYC}	CC	D	IRQ edge to edge time[2]	—	4 + N [3]	—	t_{CYC}

1. IRQ timing specified at f_{SYS} = 64 MHz and $V_{DD\_HV\_IOx}$ = 3.0 V to 5.5 V, $T_A = T_L$ to T_H, and CL = 200pF with SRC = 0b00.
2. Applies when IRQ pins are configured for rising edge or falling edge events, but not both.
3. N= ISR time to clear the flag.

Figure 36. DSPI modified transfer format timing — slave, CPHA = 1

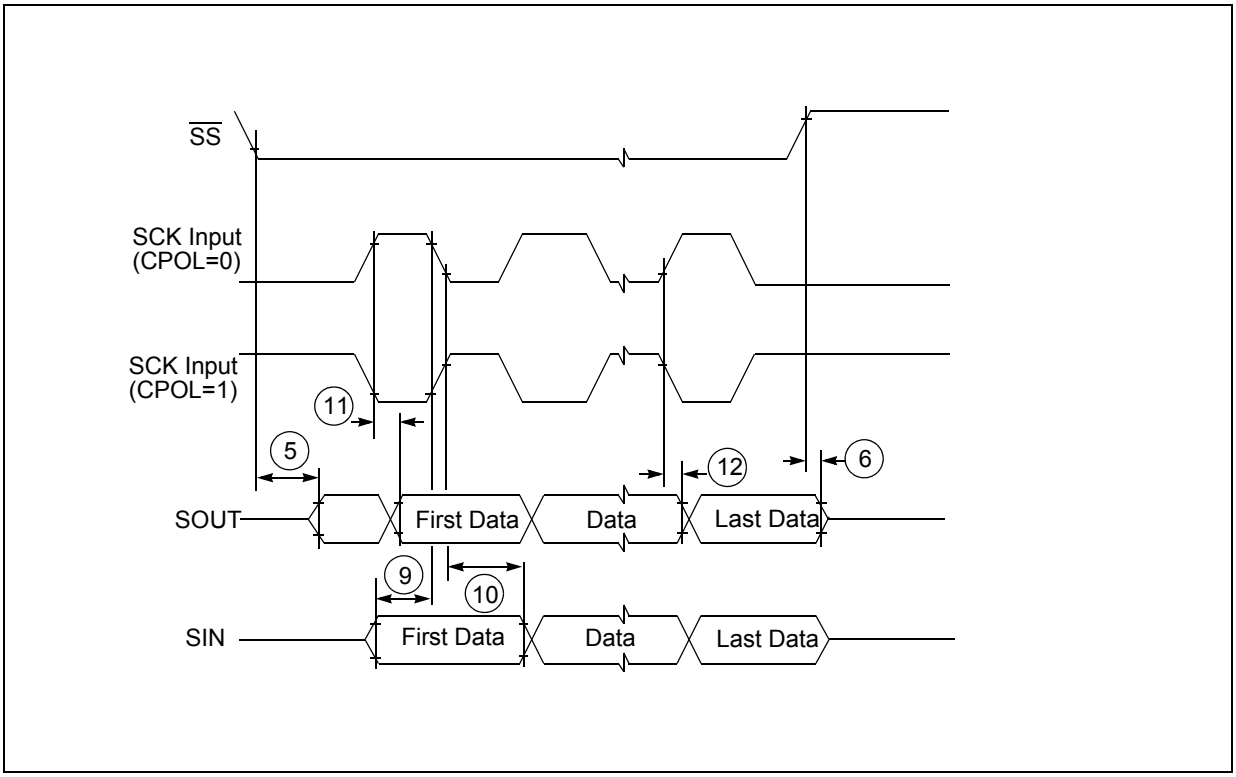
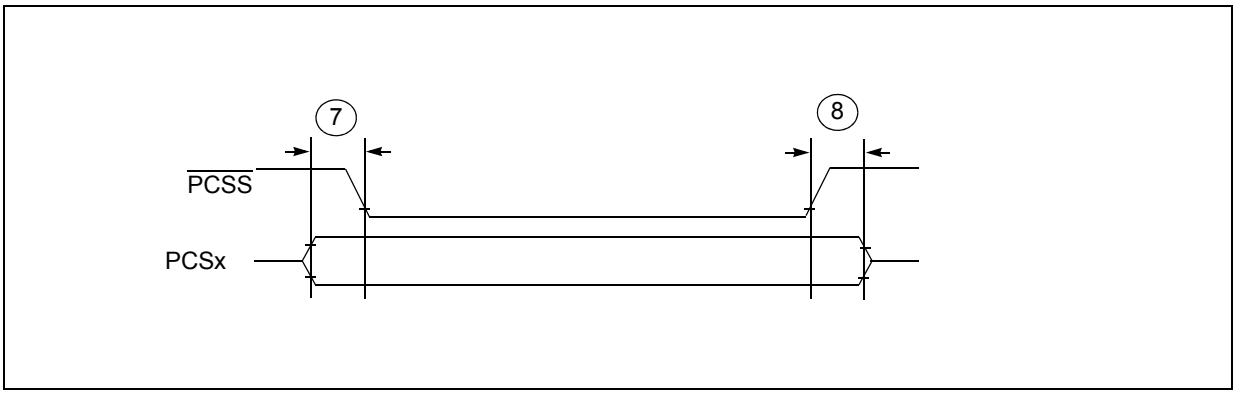


Figure 37. DSPI PCS strobe (PCSS) timing



4 Package characteristics

4.1 ECOPACK®

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: *www.st.com*. ECOPACK® is an ST trademark.

4.2 Package mechanical data

4.2.1 LQFP144 mechanical outline drawing

Figure 38. LQFP144 package mechanical drawing

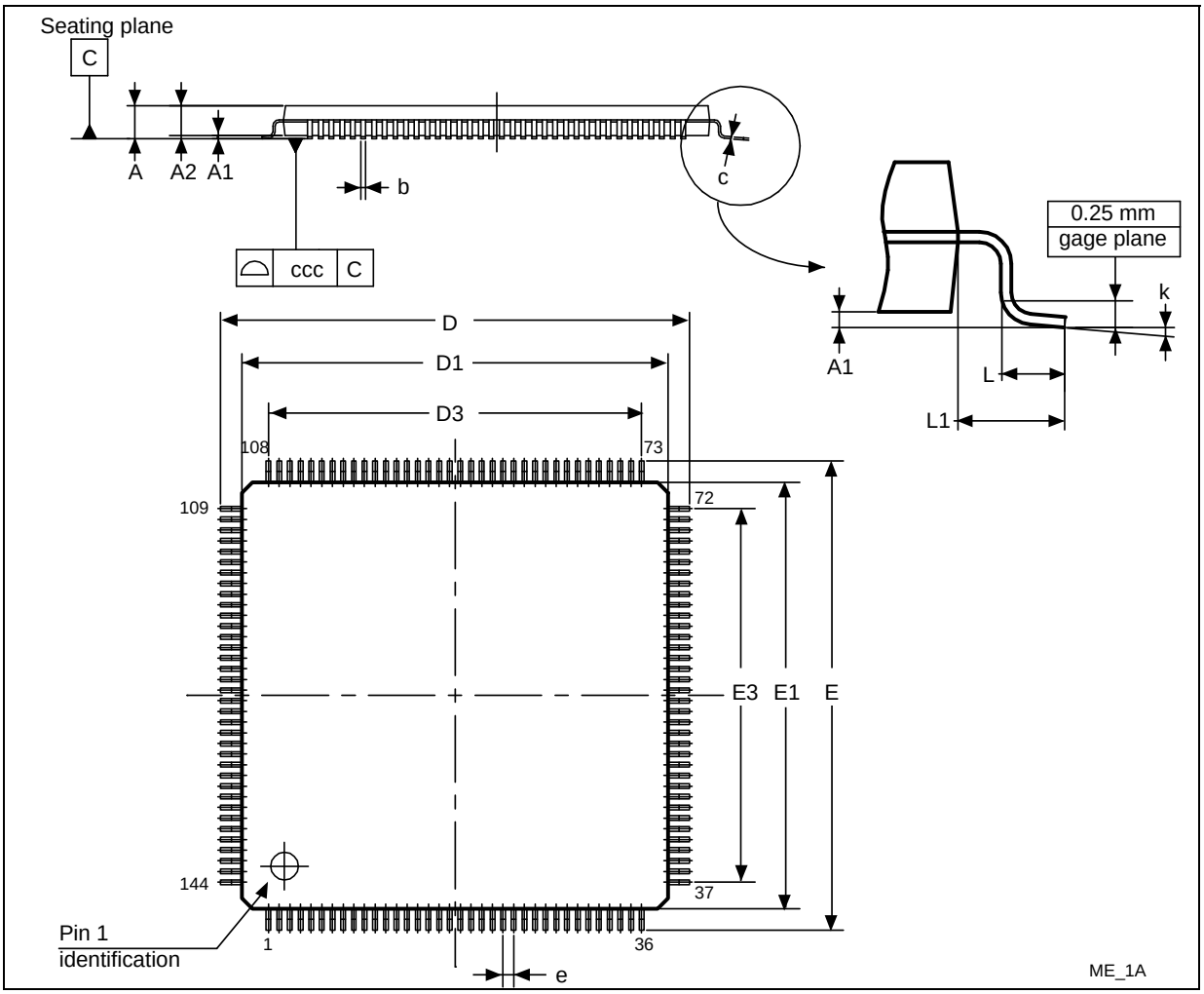


Table 42. LQFP144 mechanical data

Symbol	mm			inches[1]		
	Min	Typ	Max	Min	Typ	Max
A	—	—	1.600	—	—	0.0630
A1	0.050	—	0.150	0.0020	—	0.0059
A2	1.350	1.400	1.450	0.0531	0.0551	0.0571
b	0.170	0.220	0.270	0.0067	0.0087	0.0106
c	0.090	—	0.200	0.0035	—	0.0079
D	21.800	22.000	22.200	0.8583	0.8661	0.8740
D1	19.800	20.000	20.200	0.7795	0.7874	0.7953
D3	—	17.500	—	—	0.6890	—
E	21.800	22.000	22.200	0.8583	0.8661	0.8740
E1	19.800	20.000	20.200	0.7795	0.7874	0.7953
E3	—	17.500	—	—	0.6890	—
e	—	0.500	—	—	0.0197	—
L	0.450	0.600	0.750	0.0177	0.0236	0.0295
L1	—	1.000	—	—	0.0394	—
k	0.0 °	3.5 °	7.0°	3.5 °	0.0 °	7.0 °
ccc[2]	0.080			0.0031		

1. Values in inches are converted from mm and rounded to 4 decimal digits.
2. Tolerance.

Table 43. LQFP100 mechanical data (continued)

Symbol	mm			inches[1]		
	Min	Typ	Max	Min	Typ	Max
b	0.170	0.220	0.270	0.0067	0.0087	0.0106
c	0.090	—	0.200	0.0035	—	0.0079
D	15.800	16.000	16.200	0.6220	0.6299	0.6378
D1	13.800	14.000	14.200	0.5433	0.5512	0.5591
D3	—	12.000	—	—	0.4724	—
E	15.800	16.000	16.200	0.6220	0.6299	0.6378
E1	13.800	14.000	14.200	0.5433	0.5512	0.5591
E3	—	12.000	—	—	0.4724	—
e	—	0.500	—	—	0.0197	—
L	0.450	0.600	0.750	0.0177	0.0236	0.0295
L1	—	1.000	—	—	0.0394	—
k	0.0 °	3.5 °	7.0 °	0.0 °	3.5 °	7.0 °
ccc[2]	0.080			0.0031		

1. Values in inches are converted from mm and rounded to 4 decimal digits.
2. Tolerance.

6 Revision history

Table 44 summarizes revisions to this document.

Table 44. Document revision history

Date	Revision	Substantive changes
21-Dec-2010	1	Initial release
18-Oct-2011	2	In the Feature list: Revised the first bullet. Changed “Up to 82 GPIO” to “Up to 80 GPIO” Changed “and 82 GPIO” to “and 49 GPIO” Changed “FlexRay module“ to “1 FlexRay™ module”. Added *Section 1.5: Feature details* *Table 4: SPC56xP54x/SPC56xP60x series block summary*, added FlexRay entry. In the “LQFP176 pinout (top view)” figure: – Pin 104 now is TDI, was PB[5] – Pin 107 now is TDO, was PB[4] – Pin 71 now is NC, was OKOUT – Pin 72 now is NC, was OKOUT_B – Pin 87 now is NC, was NBYPASS_HV – Pin 88 now is NC, was IPP_LIVI_B_VDDIO *Table 7: Pin muxing*: PB[6] was clk_out_div5, is now clk_out_div256 Removed PB[4] and PB[5] rows In the A[3] row, changed ABS[2] to ABS[1] *Section 3.11: DC electrical characteristics*, added “Peripherals supply current (5 V and 3.3 V)” table *Table 14: EMI testing specifications*, removed all references to SAE Replaced both *Table 12: Thermal characteristics for 144-pin LQFP* and *Table 13: Thermal characteristics for 100-pin LQFP* *Table 30: PLLMRFM electrical specifications (V_{DDPLL} = 1.08 V to 1.32 V, V_{SS} = V_{SSPLL} = 0 V, TA = TL to TH)*, changed the max value of f_{SYS} from 120 to 64 *Table 33: Program and erase specifications*: Removed all TBC changed the initial max value of T_{BKPRG} (Code Flash) from 3.3 to 6.6 s changed the max value of T_{BKPRG} (Data Flash) from 1.9 to 4.1 s changed the max value of $T_{wprogram}$ (Data Flash) from 300 to 500 µs Added t_{ESRT} row *Table 17: Voltage regulator electrical characteristics*, updated $V_{DD\_LV\_REGCOR}$ values Updated *Table 18: Low voltage monitor electrical characteristics* Updated *Table 21: Supply current (5.0 V, NVUSRO[PAD3V5V]=0)* and *Table 23: Supply current (3.3 V, NVUSRO[PAD3V5V]=1)* Removed “NVUSRO[OSCILLATOR_MARGIN] field description” section. Removed orderable parts tables.