Welcome to E-XFL.COM

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	768KB (768K x 8)
Program Memory Type	FLASH
EEPROM Size	64K x 8
RAM Size	64K x 8
Voltage - Supply (Vcc/Vdd)	3V ~ 3.6V
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/spc56ap54l3befby

Contents

Table 4. SPC56xP54x/SPC56xP60x series block summary (continued)

Block	Function
Peripheral bridge (PBRIDGE)	Is the interface between the system bus and on-chip peripherals
Periodic interrupt timer (PIT)	Produces periodic interrupts and triggers
Power control unit (MC_PCU)	Reduces the overall power consumption by disconnecting parts of the device from the power supply via a power switching device; device components are grouped into sections called “power domains” which are controlled by the PCU
Reset generation module (MC_RGM)	Centralizes reset sources and manages the device reset sequence of the device
Semaphore unit (SEMA4)	Provides the hardware support needed in multi-core systems for implementing semaphores and provide a simple mechanism to achieve lock/unlock operations via a single write access
Static random-access memory (SRAM)	Provides storage for program code, constants, and variables
System integration unit lite (SIUL)	Provides control over all the electrical pad controls and up 32 ports with 16 bits of bidirectional, general-purpose input and output signals and supports up to 32 external interrupts with trigger event configuration
System status and configuration module (SSCM)	Provides system configuration and status data (such as memory size and status, device mode and security status), device identification data, debug status port enable and selection, and bus and peripheral abort enable/disable
System timer module (STM)	Provides a set of output compare events to support AUTOSAR(1) and operating system tasks
System watchdog timer (SWT)	Provides protection from runaway code
Wakeup unit (WKPU)	Supports up to 18 external sources that can generate interrupts or wakeup events, of which 1 can cause non-maskable interrupt requests or wakeup events.

1. AUTOSAR: AUTomotive Open System ARchitecture (see autosar.org web site).

- 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
- Receive features
  - Individual programmable filters for each mailbox
  - 8 mailboxes configurable as a six-entry receive FIFO
  - 8 programmable acceptance filters for receive FIFO
- Programmable clock source
  - System clock
  - Direct oscillator clock to avoid PLL jitter

1.5.19 Safety port (FlexCAN)

The SPC56xP54x/SPC56xP60x MCU has a second CAN controller synthesized to run at high bit rates to be used as a safety port. The CAN module of the safety port provides the following features:

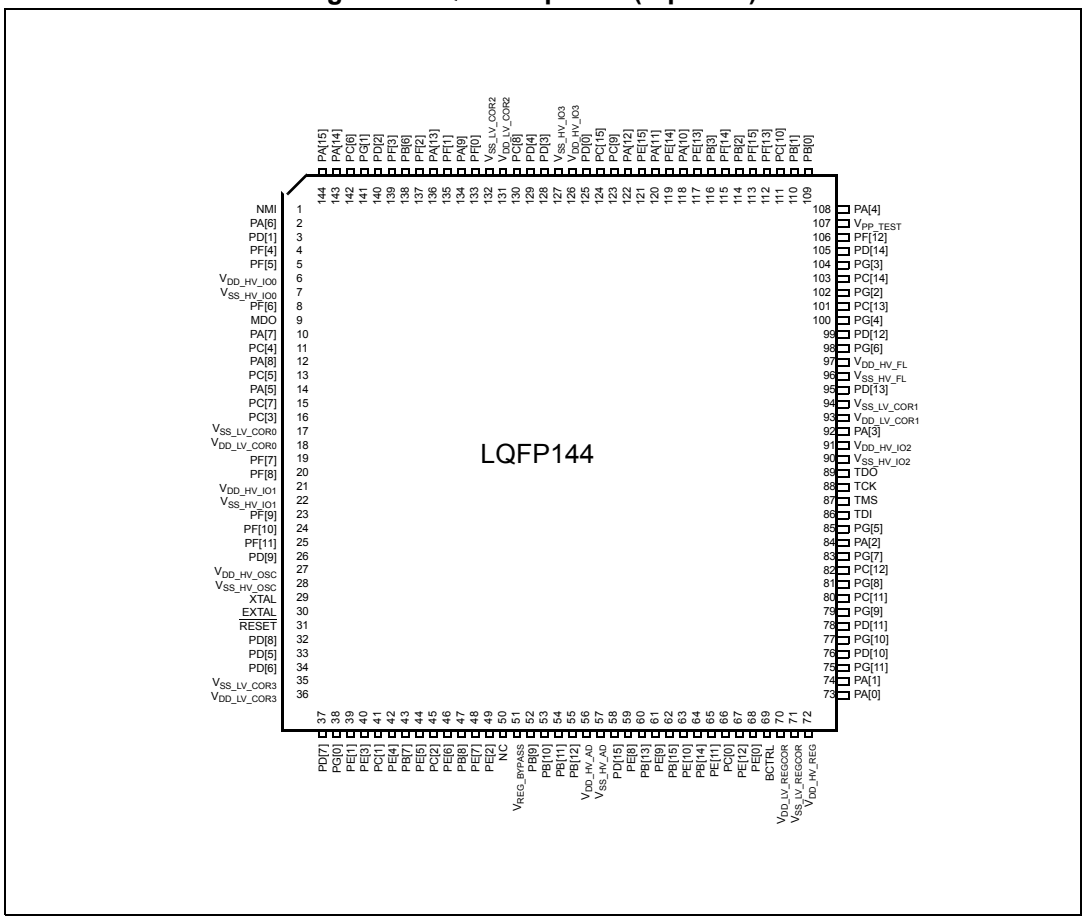
- Identical to the FlexCAN module
- Bit rate as fast as 7.5 Mb at 60 MHz CPU clock using direct connection between CAN modules (no physical transceiver required)
- 32 Message buffers of 0 to 8 bytes data length
- Can be used as a third independent CAN module

1.5.20 FlexRay

The FlexRay module provides the following features:

- Full implementation of FlexRay Protocol Specification 2.1
- 64 configurable message buffers can be handled
- Dual channel or single channel mode of operation, each as fast as 10 Mbit/s data rate
- Message buffers configurable as Tx, Rx or RxFIFO
- Message buffer size configurable
- Message filtering for all message buffers based on FrameID, cycle count and message ID
- Programmable acceptance filters for RxFIFO message buffers

Figure 3. LQFP144 pinout (top view)(c)



c. 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]
E[7]	PCR[71]	ALT0 ALT1 ALT2 ALT3 —	GPIO[71] — — — AN[10]	SIUL — — — ADC_0	Input Only	—	—	—	48	56
E[8]	PCR[72]	ALT0 ALT1 ALT2 ALT3 —	GPIO[72] — — — AN[22]	SIUL — — — ADC_0	Input Only	—	—	—	59	67
E[9]	PCR[73]	ALT0 ALT1 ALT2 ALT3 —	GPIO[73] — — — AN[23]	SIUL — — — ADC_0	Input Only	—	—	—	61	69
E[10]	PCR[74]	ALT0 ALT1 ALT2 ALT3 —	GPIO[74] — — — AN[24]	SIUL — — — ADC_0	Input Only	—	—	—	63	75
E[11]	PCR[75]	ALT0 ALT1 ALT2 ALT3 —	GPIO[75] — — — AN[25]	SIUL — — — ADC_0	Input Only	—	—	—	65	77
E[12]	PCR[76]	ALT0 ALT1 ALT2 ALT3 —	GPIO[76] — — — AN[26]	SIUL — — — ADC_0	Input Only	—	—	—	67	79
E[13]	PCR[77]	ALT0 ALT1 ALT2 ALT3 —	GPIO[77] SCK_3 — — EIRQ[25]	SIUL DSPI_3 — — SIUL	I/O I/O — — I	Slow	Medium	—	117	141
E[14]	PCR[78]	ALT0 ALT1 ALT2 ALT3 —	GPIO[78] SOUT_3 — — EIRQ[26]	SIUL DSPI_3 — — SIUL	I/O O — — I	Slow	Medium	—	119	143

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

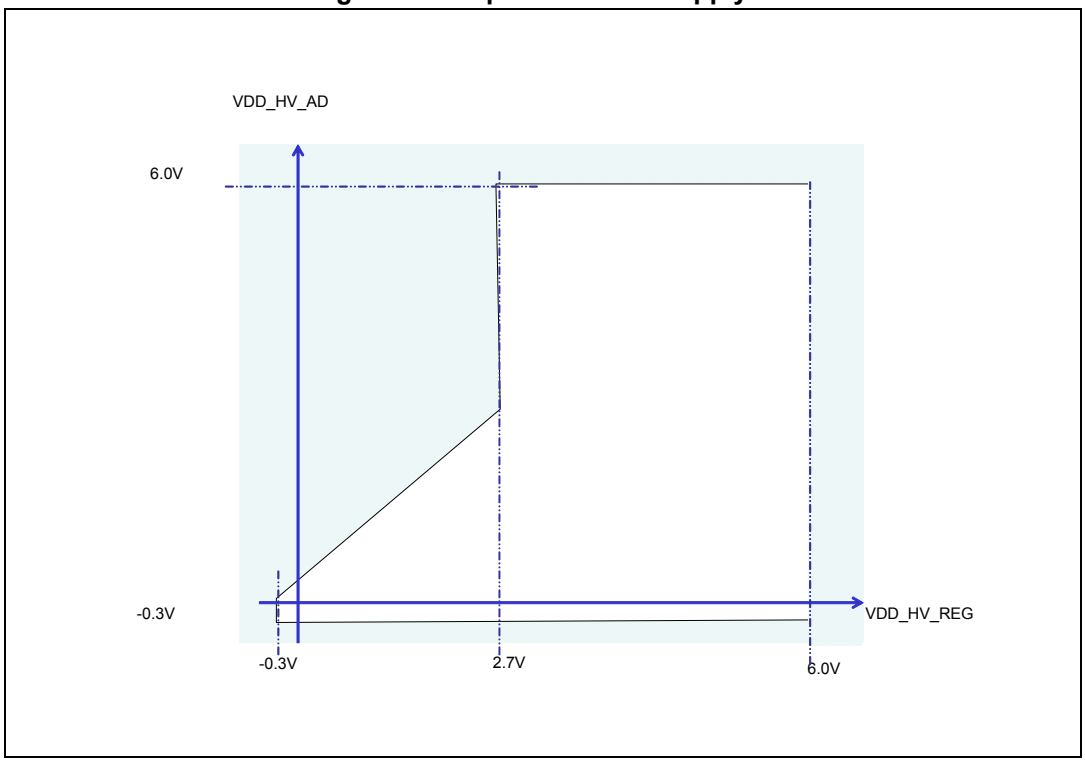
The electrical parameters shown in this supplement are guaranteed by various methods. To give the customer a better understanding, the classifications listed in *Table 8* are used and the parameters are tagged accordingly in the tables where appropriate.

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.

Figure 6. Independent ADC supply[e]



3.4 Recommended operating conditions

Table 10. Recommended operating conditions (5.0 V)

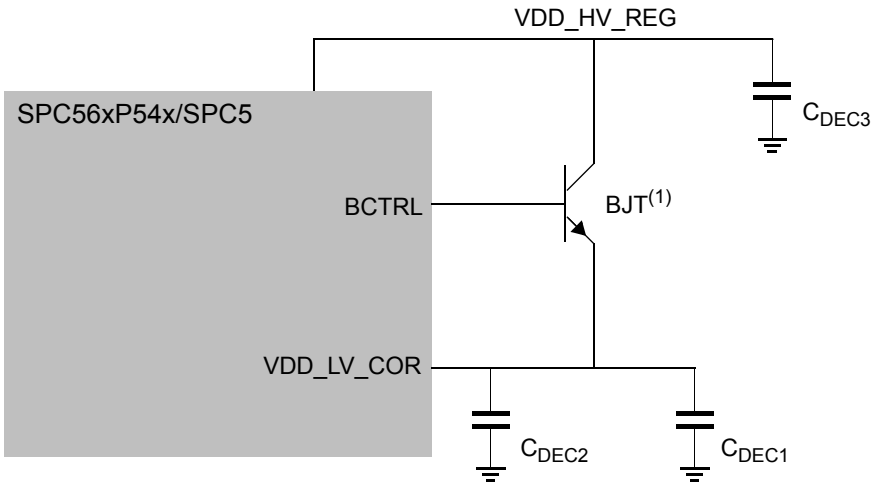
Symbol		Parameter	Conditions	Min	Max[1]	Unit
V_{SS_HV}	SR	Digital ground	—	0	0	V
$V_{DD\_HV\_IOx}$[2]	SR	5.0 V input/output supply voltage	—	4.5	5.5	V
$V_{SS\_HV\_IOx}$	SR	Input/output ground voltage	—	0	0	V
$V_{DD\_HV\_FL}$	SR	5.0 V code and data flash memory supply voltage	—	4.5	5.5	V
			Relative to $V_{DD\_HV\_IOx}$	$V_{DD\_HV\_IOx}$ – 0.1	$V_{DD\_HV\_IOx}$ + 0.1	
$V_{SS\_HV\_FL}$	SR	Code and data flash memory ground	—	0	0	V
$V_{DD\_HV\_OSC}$	SR	5.0 V crystal oscillator amplifier supply voltage	—	4.5	5.5	V
			Relative to $V_{DD\_HV\_IOx}$	$V_{DD\_HV\_IOx}$ – 0.1	$V_{DD\_HV\_IOx}$ + 0.1	
$V_{SS\_HV\_OSC}$	SR	5.0 V crystal oscillator amplifier reference voltage	—	0	0	V

e. Device design targets the removal of this conditions. To be confirmed by design during device validation.

$V_{DD\_LV\_REGCOR}/V_{SS\_LV\_REGCOR}$ pair. Additionally, capacitors with total values not below C_{DEC3}, should be placed between the $V_{DD\_HV\_REG}/V_{SS\_HV\_REG}$ pins close to ballast collector. Capacitors values have to take into account capacitor accuracy, aging and variation versus temperature.

All reported information are valid for voltage and temperature ranges described in recommended operating condition, *Table 10* and *Table 11*.

Figure 9. Voltage regulator configuration



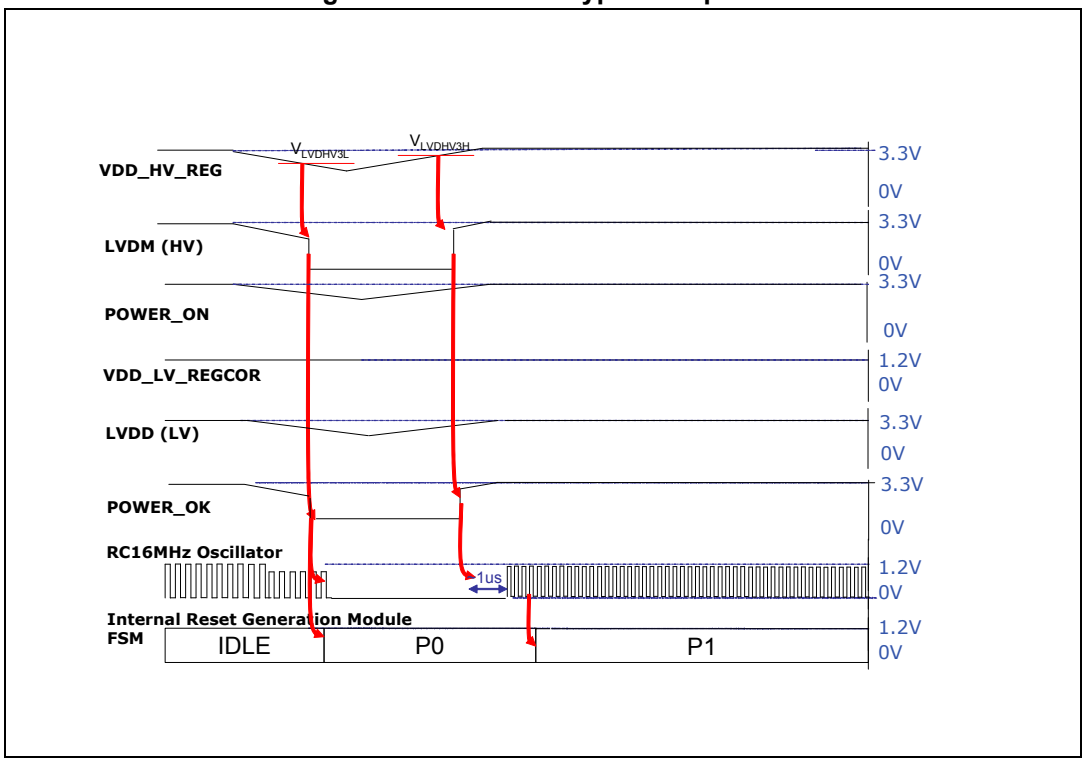
1. Refer to *Table 16*.

Table 16. Approved NPN ballast components

Part	Manufacturer	Approved derivatives(1)
BCP68	ON Semi	BCP68
	NXP	BCP68-25
	Infineon	BCP68-25
BCX68	Infineon	BCX68-10;BCX68-16;BCX68-25
BC868	NXP	BC868
BC817	Infineon	BC817-16;BC817-25;BC817SU;
	NXP	BC817-16;BC817-25
BCP56	ST	BCP56-16
	Infineon	BCP56-10;BCP56-16
	ON Semi	BCP56-10
	NXP	BCP56-10;BCP56-16

1. For automotive applications please check with the appropriate transistor vendor for automotive grade certification.

Figure 12. Brown-out typical sequence



3.10 NVUSRO register

Portions of the device configuration, such as high voltage supply, and watchdog enable/disable after reset are controlled via bit values in the non-volatile user options register (NVUSRO) register.

For a detailed description of the NVUSRO register, please refer to the device reference manual.

3.10.1 NVUSRO[PAD3V5V] field description

Table 19 shows how NVUSRO[PAD3V5V] controls the device configuration.

Table 19. PAD3V5V field description(1)

Value(2)	Description
0	High voltage supply is 5.0 V
1	High voltage supply is 3.3 V

1. See the device reference manual for more information on the NVUSRO register.
2. '1' is delivery value. It is part of shadow Flash, thus programmable by customer.

The DC electrical characteristics are dependent on the PAD3V5V bit value.

3.11.3 I/O pad current specification

The I/O pads are distributed across the I/O supply segment. Each I/O supply segment is associated to a V_{DD}/V_{SS} supply pair as described in *Table 25*.

Table 25. I/O supply segment

Package	Supply segment						
	1	2	3	4	5	6	7
LQFP144	pin8 – pin20	pin23 – pin38	pin39 – pin55	pin58 – pin68	pin73 – pin89	pin92 – pin125	pin128 – pin5
LQFP100	pin15 – pin26	pin27 – pin38	pin41 – pin46	pin51 – pin61	pin64 – pin86	pin89 – pin10	—

Table 26. I/O consumption

Symbol		C	Parameter	Conditions[1]		Value			Unit
						Min	Typ	Max	
I_{SWTSLW}[2]	CC	D	Dynamic I/O current for SLOW configuration	C_L = 25 pF	V_{DD} = 5.0 V ± 10%, PAD3V5V = 0	—	—	20	mA
					V_{DD} = 3.3 V ± 10%, PAD3V5V = 1	—	—	16	
I_{SWTMED}[2]	CC	D	Dynamic I/O current for MEDIUM configuration	C_L = 25 pF	V_{DD} = 5.0 V ± 10%, PAD3V5V = 0	—	—	29	mA
					V_{DD} = 3.3 V ± 10%, PAD3V5V = 1	—	—	17	
I_{SWTFST}[2]	CC	D	Dynamic I/O current for FAST configuration	C_L = 25 pF	V_{DD} = 5.0 V ± 10%, PAD3V5V = 0	—	—	110	mA
					V_{DD} = 3.3 V ± 10%, PAD3V5V = 1	—	—	50	
I_{RMSSLW}	CC	D	Root medium square I/O current for SLOW configuration	C_L = 25 pF, 2 MHz	V_{DD} = 5.0 V ± 10%, PAD3V5V = 0	—	—	2.3	mA
				C_L = 25 pF, 4 MHz		—	—	3.2	
				C_L = 100 pF, 2 MHz		—	—	6.6	
				C_L = 25 pF, 2 MHz	V_{DD} = 3.3 V ± 10%, PAD3V5V = 1	—	—	1.6	
				C_L = 25 pF, 4 MHz		—	—	2.3	
				C_L = 100 pF, 2 MHz		—	—	4.7	
I_{RMSMED}	CC	D	Root medium square I/O current for MEDIUM configuration	C_L = 25 pF, 13 MHz	V_{DD} = 5.0 V ± 10%, PAD3V5V = 0	—	—	6.6	mA
				C_L = 25 pF, 40 MHz		—	—	13.4	
				C_L = 100 pF, 13 MHz		—	—	18.3	
				C_L = 25 pF, 13 MHz	V_{DD} = 3.3 V ± 10%, PAD3V5V = 1	—	—	5	
				C_L = 25 pF, 40 MHz		—	—	8.5	
				C_L = 100 pF, 13 MHz		—	—	11	

Table 26. I/O consumption (continued)

Symbol		C	Parameter	Conditions[1]		Value			Unit
						Min	Typ	Max	
I_{RMSFST}	CC	D	Root medium square I/O current for FAST configuration	C_L = 25 pF, 40 MHz	V_{DD} = 5.0 V ± 10%, PAD3V5V = 0	—	—	22	mA
				C_L = 25 pF, 64 MHz		—	—	33	
				C_L = 100 pF, 40 MHz		—	—	56	
				C_L = 25 pF, 40 MHz	V_{DD} = 3.3 V ± 10%, PAD3V5V = 1	—	—	14	
				C_L = 25 pF, 64 MHz		—	—	20	
				C_L = 100 pF, 40 MHz		—	—	35	
I_{AVGSEG}	SR	D	Sum of all the static I/O current within a supply segment	V_{DD} = 5.0 V ± 10%, PAD3V5V = 0		—	—	70	mA
				V_{DD} = 3.3 V ± 10%, PAD3V5V = 1		—	—	65	

1. V_{DD} = 3.3 V ± 10% / 5.0 V ± 10%, T_A = –40 to 125 °C, unless otherwise specified.
2. Stated maximum values represent peak consumption that lasts only a few ns during I/O transition.

3.12 Main oscillator electrical characteristics

The SPC56xP54x/SPC56xP60x provides an oscillator/resonator driver.

Table 27. Main oscillator electrical characteristics (5.0 V, NVUSRO[PAD3V5V]=0)

Symbol		Parameter	Min	Max	Unit
f_{OSC}	SR	Oscillator frequency	4	40	MHz
g_m	P	Transconductance	6.5	25	mA/V
V_{OSC}	T	Oscillation amplitude on EXTAL pin	1	—	V
t_{OSCSU}	T	Start-up time[1],[2]	8	—	ms

1. The start-up time is dependent upon crystal characteristics, board leakage, etc., high ESR and excessive capacitive loads can cause long start-up time.
2. Value captured when amplitude reaches 90% of EXTAL.

Table 28. Main oscillator electrical characteristics (3.3 V, NVUSRO[PAD3V5V]=1)

Symbol		Parameter	Min	Max	Unit
f_{OSC}	SR	Oscillator frequency	4	40	MHz
g_m	P	Transconductance	4	20	mA/V
V_{OSC}	T	Oscillation amplitude on EXTAL pin	1	—	V
t_{OSCSU}	T	Start-up time[1],[2]	8	—	ms

1. The start-up time is dependent upon crystal characteristics, board leakage, etc., high ESR and excessive capacitive loads can cause long start-up time.
2. Value captured when amplitude reaches 90% of EXTAL.

Table 29. Input clock characteristics

Symbol		Parameter	Min	Typ	Max	Unit
f_{OSC}	SR	Oscillator frequency	4	—	40	MHz
f_{CLK}	SR	Frequency in bypass	—	—	64	MHz
t_{rCLK}	SR	Rise/fall time in bypass	—	—	1	ns
t_{DC}	SR	Duty cycle	47.5	50	52.5	%

3.13 FMPLL electrical characteristics

Table 30. PLLMRFM electrical specifications (V_{DDPLL} = 1.08 V to 1.32 V, V_{SS} = V_{SSPLL} = 0 V, T_A = T_L to T_H)

Symbol		Parameter		Conditions	Value		Unit
					min	max	
$f_{ref\_crystal}$ f_{ref_ext}	D	PLL reference frequency range(1)		Crystal reference	4	40	MHz
f_{pll_in}	D	Phase detector input frequency range (after pre-divider)		—	4	16	MHz
$f_{FMPLLOUT}$	D	Clock frequency range in normal mode		—	4	120	MHz
f_{FREE}	P	Free running frequency		Measured using clock division — typically /16	20	150	MHz
f_{sys}	D	On-chip PLL frequency		—	16	64	MHz
t_{CYC}	D	System clock period		—	—	1 / f_{sys}	ns
f_{LORL} f_{LORH}	D	Loss of reference frequency window(2)		Lower limit	1.6	3.7	MHz
				Upper limit	24	56	
f_{SCM}	D	Self-clocked mode frequency(3),(4)		—	20	150	MHz
C_{JITTER}	T	CLKOUT period jitter(5),(6),(7),(8)	Short-term jitter(9)	f_{SYS} maximum	–4	4	% f_{CLKOUT}
			Long-term jitter (avg. over 2 ms interval)	f_{PLLIN} = 16 MHz (resonator), f_{PLLCLK} at 64 MHz, 4000 cycles	—	10	ns
t_{lpll}	D	PLL lock time (10), (11)		—	—	200	µs
t_{dc}	D	Duty cycle of reference		—	40	60	%
f_{LCK}	D	Frequency LOCK range		—	–6	6	% f_{sys}
f_{UL}	D	Frequency un-LOCK range		—	–18	18	% f_{sys}
f_{CS} f_{DS}	D	Modulation Depth		Center spread	±0.25	±4.0(12)	%f_{sys}
				Down Spread	–0.5	–8.0	
f_{MOD}	D	Modulation frequency(13)		—	—	70	kHz

1. Considering operation with PLL not bypassed.

2. “Loss of Reference Frequency” window is the reference frequency range outside of which the PLL is in self clocked mode.
3. Self clocked mode frequency is the frequency that the PLL operates at when the reference frequency falls outside the f_{LOR} window.
4. f_{VCO} self clock range is 20–150 MHz. f_{SCM} represents f_{SYS} after PLL output divider (ERFD) of 2 through 16 in enhanced mode.
5. This value is determined by the crystal manufacturer and board design.
6. Jitter is the average deviation from the programmed frequency measured over the specified interval at maximum f_{SYS}. Measurements are made with the device powered by filtered supplies and clocked by a stable external clock signal. Noise injected into the PLL circuitry via V_{DDPLL} and V_{SSPLL} and variation in crystal oscillator frequency increase the C_{JITTER} percentage for a given interval.
7. Proper PC board layout procedures must be followed to achieve specifications.
8. Values are obtained with frequency modulation disabled. If frequency modulation is enabled, jitter is the sum of C_{JITTER} and either f_{CS} or f_{DS} (depending on whether center spread or down spread modulation is enabled).
9. Short term jitter is measured on the clock rising edge at cycle n and cycle n+4.
10. This value is determined by the crystal manufacturer and board design. For 4 MHz to 20 MHz crystals specified for this PLL, load capacitors should not exceed these limits.
11. This specification applies to the period required for the PLL to relock after changing the MFD frequency control bits in the synthesizer control register (SYNCR).
12. This value is true when operating at frequencies above 60 MHz, otherwise f_{CS} is 2% (above 64 MHz).
13. Modulation depth will be attenuated from depth setting when operating at modulation frequencies above 50 kHz.

3.14 16 MHz RC oscillator electrical characteristics

Table 31. 16 MHz RC oscillator electrical characteristics

Symbol		Parameter	Conditions	Min	Typ	Max	Unit
f_{RC}	P	RC oscillator frequency	T_A = 25 °C	—	16	—	MHz
Δ_{RCMVAR}	P	Fast internal RC oscillator variation over temperature and supply with respect to f_{RC} at T_A = 25 °C in high-frequency configuration	—	–6	—	6	%
$\Delta_{RCMTRIM}$	T	Post Trim Accuracy: The variation of the PTF(1) from the 16 MHz	T_A = 25 °C	–1	—	1	%
$\Delta_{RCMSTEP}$	T	Fast internal RC oscillator trimming step	T_A = 25 °C	—	1.6	—	%

1. PTF = Post Trimming Frequency: The frequency of the output clock after trimming at typical supply voltage and temperature

3.15 Analog-to-Digital converter (ADC) electrical characteristics

The device provides a 10-bit Successive Approximation Register (SAR) Analog-to-Digital Converter.

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

Table 41. DSPI timing[1] (continued)

No.	Symbol		C	Parameter	Conditions	Min	Max	Unit
12	t_{HO}	CC	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. All timing are provided with 50pF capacitance on output, 1ns transition time on input signal

Figure 29. DSPI classic SPI timing — master, CPHA = 0

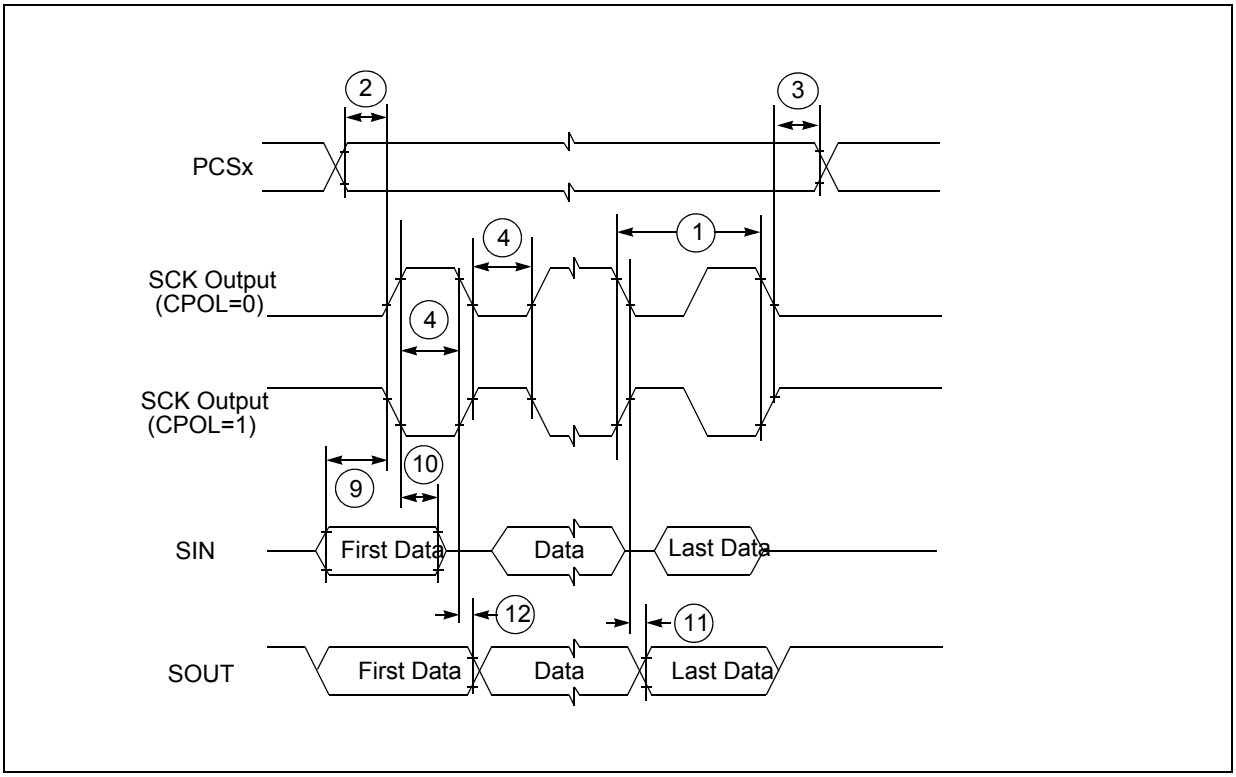


Table 42. LQFP144 mechanical data

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.

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.