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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	Obsolete
Core Processor	e200z4d
Core Size	32-Bit Single-Core
Speed	120MHz
Connectivity	CANbus, I²C, LINbus, SCI, SPI
Peripherals	DMA, POR, PWM, WDT
Number of I/O	147
Program Memory Size	3MB (3M x 8)
Program Memory Type	FLASH
EEPROM Size	64K x 8
RAM Size	192K x 8
Voltage - Supply (Vcc/Vdd)	3V ~ 5.5V
Data Converters	A/D 27x10b, 5x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 105°C (TA)
Mounting Type	Surface Mount
Package / Case	176-LQFP
Supplier Device Package	176-LQFP (24x24)
Purchase URL	https://www.e-xfl.com/product-detail/nxp-semiconductors/spc5646bf0vlu1

F = Fast[1, 2]

I = Input only with analog feature[1]

A = Analog

3.2 System pins

The system pins are listed in Table 3.

Table 3. System pin descriptions

Port pin	Function	I/O direction	Pad type	RESET config.	Pin number		
					176 LQFP	208 LQFP	256 MAPBGA
$\overline{\text{RESET}}$	Bidirectional reset with Schmitt-Trigger characteristics and noise filter.	I/O	M	Input, weak pull-up only after PHASE2	29	29	K1
EXTAL	Analog input of the oscillator amplifier circuit. Needs to be grounded if oscillator bypass mode is used.	I	A[1]	—	58	74	T8
XTAL	Analog output of the oscillator amplifier circuit, when the oscillator is not in bypass mode. Analog input for the clock generator when the oscillator is in bypass mode.	I/O	A[1]	—	56	72	T7

NOTES:
1 For analog pads, it is not recommended to enable IBE if APC is enabled to avoid extra current in middle range voltage.

3.3 Functional ports

The functional port pins are listed in Table 4.

Table 4. Functional port pin descriptions (continued)

Port pin	PCR	Alternate function[1]	Function	Peripheral	I/O direction[2]	Pad type	RESET config.	Pin number		
								176 LQFP	208 LQFP	256 MAPBGA
PB[5]	PCR[21]	AF0 AF1 AF2 AF3 — —	GPI[21] — — — ADC0_P[1] ADC1_P[1]	SIUL — — — ADC_0 ADC_1	I — — — I I	I	Tristate	91	107	N13
PB[6]	PCR[22]	AF0 AF1 AF2 AF3 — —	GPI[22] — — — ADC0_P[2] ADC1_P[2]	SIUL — — — ADC_0 ADC_1	I — — — I I	I	Tristate	92	108	N14
PB[7]	PCR[23]	AF0 AF1 AF2 AF3 — —	GPI[23] — — — ADC0_P[3] ADC1_P[3]	SIUL — — — ADC_0 ADC_1	I — — — I I	I	Tristate	93	109	R16
PB[8]	PCR[24]	AF0 AF1 AF2 AF3 — — — —	GPI[24] — — — ADC0_S[0] ADC1_S[4] WKPU[25] OSC32k_XTAL[4]	SIUL — — — ADC_0 ADC_1 WKPU SXOSC	I — — — I I I I	I	—	61	77	T11
PB[9][5]	PCR[25]	AF0 AF1 AF2 AF3 — — — —	GPI[25] — — — ADC0_S[1] ADC1_S[5] WKPU[26] OSC32k_EXTAL[4]	SIUL — — — ADC_0 ADC_1 WKPU SXOSC	I — — — I I I I	I	—	60	76	T10
PB[10]	PCR[26]	AF0 AF1 AF2 AF3 — — —	GPIO[26] SOUT_1 CAN3TX — ADC0_S[2] ADC1_S[6] WKPU[8]	SIUL DSPI_1 FlexCAN_3 — ADC_0 ADC_1 WKPU	I/O O — — I I I	S	Tristate	62	78	N7

Table 4. Functional port pin descriptions (continued)

Port pin	PCR	Alternate function[1]	Function	Peripheral	I/O direction[2]	Pad type	RESET config.	Pin number		
								176 LQFP	208 LQFP	256 MAPBGA
PC[10]	PCR[42]	AF0 AF1 AF2 AF3	GPIO[42] CAN1TX CAN4TX MA[1]	SIUL FlexCAN_1 FlexCAN_4 ADC_0	I/O O O O	M/S	Tristate	36	36	L1
PC[11]	PCR[43]	AF0 AF1 AF2 AF3 — — —	GPIO[43] — — MA[2] CAN1RX CAN4RX WKPU[5]	SIUL — — ADC_0 FlexCAN_1 FlexCAN_4 WKPU	I/O — — O I I I	S	Tristate	35	35	K4
PC[12]	PCR[44]	AF0 AF1 AF2 AF3 ALT4 — —	GPIO[44] E0UC[12] — — FR_DBG[0] SIN_2 EIRQ[19]	SIUL eMIOS_0 — — Flexray DSPI_2 SIUL	I/O I/O — — O I I	M/S	Tristate	173	205	B4
PC[13]	PCR[45]	AF0 AF1 AF2 AF3 ALT4	GPIO[45] E0UC[13] SOUT_2 — FR_DBG[1]	SIUL eMIOS_0 DSPI_2 — Flexray	I/O I/O O — O	M/S	Tristate	174	206	A3
PC[14]	PCR[46]	AF0 AF1 AF2 AF3 ALT4 —	GPIO[46] E0UC[14] SCK_2 — FR_DBG[2] EIRQ[8]	SIUL eMIOS_0 DSPI_2 — Flexray SIUL	I/O I/O I/O — O I	M/S	Tristate	3	3	B2
PC[15]	PCR[47]	AF0 AF1 AF2 AF3 ALT4	GPIO[47] E0UC[15] CS0_2 — FR_DBG[3] EIRQ[20]	SIUL eMIOS_0 DSPI_2 — Flexray SIUL	I/O I/O I/O — O I	M/S	Tristate	4	4	A1
PD[0]	PCR[48]	AF0 AF1 AF2 AF3 — — —	GPI[48] — — — ADC0_P[4] ADC1_P[4] WKPU[27]	SIUL — — — ADC_0 ADC_1 WKPU	I — — — I I I	I	Tristate	77	93	R12

Table 4. Functional port pin descriptions (continued)

Port pin	PCR	Alternate function[1]	Function	Peripheral	I/O direction[2]	Pad type	RESET config.	Pin number		
								176 LQFP	208 LQFP	256 MAPBGA
PE[6]	PCR[70]	AF0 AF1 AF2 AF3 —	GPIO[70] E0UC[22] CS3_0 MA[1] EIRQ[22]	SIUL eMIOS_0 DSPI_0 ADC_0 SIUL	I/O I/O O O I	M/S	Tristate	167	191	B6
PE[7]	PCR[71]	AF0 AF1 AF2 AF3 —	GPIO[71] E0UC[23] CS2_0 MA[0] EIRQ[23]	SIUL eMIOS_0 DSPI_0 ADC_0 SIUL	I/O I/O O O I	M/S	Tristate	168	192	A5
PE[8]	PCR[72]	AF0 AF1 AF2 AF3	GPIO[72] CAN2TX E0UC[22] CAN3TX	SIUL FlexCAN_2 eMIOS_0 FlexCAN_3	I/O O I/O O	M/S	Tristate	21	21	G1
PE[9]	PCR[73]	AF0 AF1 AF2 AF3 — — —	GPIO[73] — E0UC[23] — WKPU[7] CAN2RX CAN3RX	SIUL — eMIOS_0 — WKPU FlexCAN_2 FlexCAN_3	I/O — I/O — I I I	S	Tristate	22	22	H1
PE[10]	PCR[74]	AF0 AF1 AF2 AF3 —	GPIO[74] LIN3TX CS3_1 E1UC[30] EIRQ[10]	SIUL LINFlexD_3 DSPI_1 eMIOS_1 SIUL	I/O O O I/O I	S	Tristate	23	23	G3
PE[11]	PCR[75]	AF0 AF1 AF2 AF3 — —	GPIO[75] E0UC[24] CS4_1 — LIN3RX WKPU[14]	SIUL eMIOS_0 DSPI_1 — LINFlexD_3 WKPU	I/O I/O O — I I	S	Tristate	25	25	H3
PE[12]	PCR[76]	AF0 AF1 AF2 AF3 — — — —	GPIO[76] — E1UC[19] — CRS SIN_2 EIRQ[11] ADC1_S[7]	SIUL — eMIOS_1 — FEC DSPI_2 SIUL ADC_1	I/O — I/O — I I I I	M/S	Tristate	133	157	C14

Table 4. Functional port pin descriptions (continued)

Port pin	PCR	Alternate function[1]	Function	Peripheral	I/O direction[2]	Pad type	RESET config.	Pin number		
								176 LQFP	208 LQFP	256 MAPBGA
PE[13]	PCR[77]	AF0 AF1 AF2 AF3 —	GPIO[77] SOUT_2 E1UC[20] — RXD[3]	SIUL DSPI_2 eMIOS_1 — FEC	I/O O I/O — I	M/S	Tristate	127	151	C16
PE[14]	PCR[78]	AF0 AF1 AF2 AF3 —	GPIO[78] SCK_2 E1UC[21] — EIRQ[12]	SIUL DSPI_2 eMIOS_1 — SIUL	I/O I/O I/O — I	M/S	Tristate	136	160	A14
PE[15]	PCR[79]	AF0 AF1 AF2 AF3	GPIO[79] CS0_2 E1UC[22] SCK_6	SIUL DSPI_2 eMIOS_1 DSPI_6	I/O I/O I/O I/O	M/S	Tristate	137	161	C12
PF[0]	PCR[80]	AF0 AF1 AF2 AF3 —	GPIO[80] E0UC[10] CS3_1 — ADC0_S[8]	SIUL eMIOS_0 DSPI_1 — ADC_0	I/O I/O O — I	S	Tristate	63	79	P7
PF[1]	PCR[81]	AF0 AF1 AF2 AF3 —	GPIO[81] E0UC[11] CS4_1 — ADC0_S[9]	SIUL eMIOS_0 DSPI_1 — ADC_0	I/O I/O O — I	S	Tristate	64	80	T6
PF[2]	PCR[82]	AF0 AF1 AF2 AF3 —	GPIO[82] E0UC[12] CS0_2 — ADC0_S[10]	SIUL eMIOS_0 DSPI_2 — ADC_0	I/O I/O I/O — I	S	Tristate	65	81	R6
PF[3]	PCR[83]	AF0 AF1 AF2 AF3 —	GPIO[83] E0UC[13] CS1_2 — ADC0_S[11]	SIUL eMIOS_0 DSPI_2 — ADC_0	I/O I/O O — I	S	Tristate	66	82	R7
PF[4]	PCR[84]	AF0 AF1 AF2 AF3 —	GPIO[84] E0UC[14] CS2_2 — ADC0_S[12]	SIUL eMIOS_0 DSPI_2 — ADC_0	I/O I/O O — I	S	Tristate	67	83	R8

Table 4. Functional port pin descriptions (continued)

Port pin	PCR	Alternate function[1]	Function	Peripheral	I/O direction[2]	Pad type	RESET config.	Pin number		
								176 LQFP	208 LQFP	256 MAPBGA
PI[7]	PCR[135]	AF0 AF1 AF2 AF3 ALT4	GPIO[135] E1UC[31] CS1_4 CS1_5 CS1_6	SIUL eMIOS_1 DSPI_4 DSPI_5 DSPI_6	I/O I/O O O O	S	Tristate	12	12	E2
PI[8]	PCR[136]	AF0 AF1 AF2 AF3 —	GPIO[136] — — — ADC0_S[16]	SIUL — — — ADC_0	I/O — — — I	S	Tristate	108	130	J14
PI[9]	PCR[137]	AF0 AF1 AF2 AF3 —	GPIO[137] — — — ADC0_S[17]	SIUL — — — ADC_0	I/O — — — I	S	Tristate	—	131	J15
PI[10]	PCR[138]	AF0 AF1 AF2 AF3 —	GPIO[138] — — — ADC0_S[18]	SIUL — — — ADC_0	I/O — — — I	S	Tristate	—	134	J16
PI[11]	PCR[139]	AF0 AF1 AF2 AF3 — —	GPIO[139] — — — ADC0_S[19] SIN_3	SIUL — — — ADC_0 DSPI_3	I/O — — — I I	S	Tristate	111	135	H16
PI[12]	PCR[140]	AF0 AF1 AF2 AF3 —	GPIO[140] CS0_3 CS0_2 — ADC0_S[20]	SIUL DSPI_3 DSPI_2 — ADC_0	I/O I/O I/O — I	S	Tristate	112	136	G15
PI[13]	PCR[141]	AF0 AF1 AF2 AF3 —	GPIO[141] CS1_3 CS1_2 — ADC0_S[21]	SIUL DSPI_3 DSPI_2 — ADC_0	I/O O O — I	S	Tristate	113	137	G14
PI[14]	PCR[142]	AF0 AF1 AF2 AF3 — —	GPIO[142] — — — ADC0_S[22] SIN_4	SIUL — — — ADC_0 DSPI_4	I/O — — — I I	S	Tristate	76	92	T12

Table 4. Functional port pin descriptions (continued)

Port pin	PCR	Alternate function[1]	Function	Peripheral	I/O direction[2]	Pad type	RESET config.	Pin number		
								176 LQFP	208 LQFP	256 MAPBGA
PM[4]	PCR[196]	AF0 AF1 AF2 AF3	GPIO[196] — — —	SIUL — — —	I/O — — —	M/S	Tristate	—	—	L12
PM[5]	PCR[197]	AF0 AF1 AF2 AF3	GPIO[197] — — —	SIUL — — —	I/O — — —	M/S	Tristate	—	—	F9
PM[6]	PCR[198]	AF0 AF1 AF2 AF3	GPIO[198] — — —	SIUL — — —	I/O — — —	M/S	Tristate	—	—	F6

NOTES:

1 Alternate functions are chosen by setting the values of the PCR.PA bitfields inside the SIUL module. PCR.PA = 000 → AF0; PCR.PA = 001 → AF1; PCR.PA = 010 → AF2; PCR.PA = 011 → AF3; PCR.PA = 100 → ALT4. This is intended to select the output functions; to use one of the input functions, the PCR.IBE bit must be written to ‘1’, regardless of the values selected in the PCR.PA bitfields. For this reason, the value corresponding to an input only function is reported as “—”.

2 Multiple inputs are routed to all respective modules internally. The input of some modules must be configured by setting the values of the PSMIO.PADSELx bitfields inside the SIUL module.

3 NMI[0] and NMI[1] have a higher priority than alternate functions. When NMI is selected, the PCR.PA field is ignored.

4 SXOSC’s OSC32k_XTAL and OSC32k_EXTAL pins are shared with GPIO functionality. When used as crystal pins, other functionality of the pin cannot be used and it should be ensured that application never programs OBE and PUE bit of the corresponding PCR to "1".

5 If you want to use OSC32K functionality through PB[8] and PB[9], you must ensure that PB[10] is static in nature as PB[10] can induce coupling on PB[9] and disturb oscillator frequency.

6 Out of reset all the functional pins except PC[0:1] and PH[9:10] are available to the user as GPIO.
PC[0:1] are available as JTAG pins (TDI and TDO respectively).
PH[9:10] are available as JTAG pins (TCK and TMS respectively).
It is up to the user to configure these pins as GPIO when needed.

7 When MBIST is enabled to run (STCU Enable = 1), the application must not drive or tie PAD[178) (MDO[0]) to 0 V before the device exits reset (external reset is removed) as the pad is internally driven to 1 to indicate MBIST operation. When MBIST is not enabled (STCU Enable = 0), there are no restriction as the device does not internally drive the pad.

8 These pins can be configured as Nexus pins during reset by the debugger writing to the Nexus Development Interface "Port Control Register" rather than the SIUL. Specifically, the debugger can enable the MDO[7:0], MSEO, and MCKO ports by programming NDI (PCR[MCKO_EN] or PCR[PSTAT_EN]). MDO[8:11] ports can be enabled by programming NDI ((PCR[MCKO_EN] and PCR[FPM]) or PCR[PSTAT_EN]).

NOTE

Stresses exceeding the recommended absolute maximum ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. During overload conditions ($V_{IN} > V_{DD\_HV\_A/HV\_B}$ or $V_{IN} < V_{SS\_HV}$), the voltage on pins with respect to ground (V_{SS_HV}) must not exceed the recommended values.

4.4 Recommended operating conditions

Table 9. Recommended operating conditions (3.3 V)

Symbol		Parameter	Conditions	Value		Unit
				Min	Max	
V_{SS_HV}	SR	Digital ground on VSS_HV pins	—	0	0	V
$V_{DD\_HV\_A}$[1]	SR	Voltage on $V_{DD\_HV\_A}$ pins with respect to ground (V_{SS_HV})	—	3.0	3.6	V
$V_{DD\_HV\_B}$[1]	SR	Voltage on $V_{DD\_HV\_B}$ pins with respect to ground (V_{SS_HV})	—	3.0	3.6	V
V_{SS_LV}[2]	SR	Voltage on VSS_LV (low voltage digital supply) pins with respect to ground (V_{SS_HV})	—	V_{SS_HV} – 0.1	V_{SS_HV} + 0.1	V
V_{RC_CTRL}[3]		Base control voltage for external BCP68 NPN device	Relative to V_{DD_LV}	0	V_{DD_LV} + 1	V
V_{SS_ADC}	SR	Voltage on VSS_HV_ADC0, VSS_HV_ADC1 (ADC reference) pin with respect to ground (V_{SS_HV})	—	V_{SS_HV} – 0.1	V_{SS_HV} + 0.1	V
$V_{DD\_HV\_ADC0}$[4]	SR	Voltage on VDD_HV_ADC0 with respect to ground (V_{SS_HV})	—	3.0[5]	3.6	V
			Relative to $V_{DD\_HV\_A}$[6]	$V_{DD\_HV\_A}$ – 0.1	$V_{DD\_HV\_A}$ + 0.1	
$V_{DD\_HV\_ADC1}$[7]	SR	Voltage on VDD_HV_ADC1 with respect to ground (V_{SS_HV})	—	3.0	3.6	V
			Relative to $V_{DD\_HV\_A}$[6]	$V_{DD\_HV\_A}$ – 0.1	$V_{DD\_HV\_A}$ + 0.1	
V_{IN}	SR	Voltage on any GPIO pin with respect to ground (V_{SS_HV})	—	V_{SS_HV} – 0.1	—	V
			Relative to $V_{DD\_HV\_A/HV\_B}$	—	$V_{DD\_HV\_A/HV\_B}$ + 0.1	

4 This voltage is internally generated by the device and no external voltage should be supplied.

5 100 nF capacitance needs to be provided between $V_{DD\_HV\_(ADC0/ADC1)}$/$V_{SS\_HV\_(ADC0/ADC1)}$ pair.

6 Both the relative and the fixed conditions must be met. For instance: If $V_{DD\_HV\_A}$ is 5.9 V, $V_{DD\_HV\_ADC0}$ maximum value is 6.0 V then, despite the relative condition, the max value is $V_{DD\_HV\_A}$ + 0.3 = 6.2 V.

7 PA3, PA7, PA10, PA11 and PE12 ADC_1 channels are coming from $V_{DD\_HV\_B}$ domain hence VDD_HV_ADC1 should be within ±100 mV of $V_{DD\_HV\_B}$ when these channels are used for ADC_1.

8 Guaranteed by device validation.

NOTE

SRAM retention guaranteed to LVD levels.

4.5 Thermal characteristics

4.5.1 Package thermal characteristics

Table 11. LQFP thermal characteristics[1]

Symbol		C	Parameter	Conditions[2]	Pin count	Value[3]			Unit
						Min	Typ	Max	
$R_{\theta JA}$	CC	D	Thermal resistance, junction-to-ambient natural convection[4]	Single-layer board—1s	176	—	—	38[5]	°C/W
					208	—	—	41[6]	°C/W
$R_{\theta JA}$	CC	D	Thermal resistance, junction-to-ambient natural convection[7]	Four-layer board—2s2p[7]	176	—	—	31	°C/W
					208	—	—	34	°C/W

NOTES:

1 Thermal characteristics are targets based on simulation that are subject to change per device characterization.

2 V_{DD} = 3.3 V ± 10% / 5.0 V ± 10%, T_A = –40 to 125 °C.

3 All values need to be confirmed during device validation.

4 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.

5 Junction-to-Ambient thermal resistance determined per JEDEC JESD51-3 and JESD51-6.

6 Junction-to-Ambient thermal resistance determined per JEDEC JESD51-2 and JESD51-6

7 Junction-to-Board thermal resistance determined per JEDEC JESD51-8.

Table 12. 256 MAPBGA thermal characteristics[1]

Symbol		C	Parameter	Conditions	Value	Unit
$R_{\theta JA}$	CC	—	Thermal resistance, junction-to-ambient natural convection	Single-layer board—1s	43[2]	°C/W
				Four-layer board—2s2p	26[3]	

NOTES:

1 Thermal characteristics are targets based on simulation that are subject to change per device characterization.

2 Junction-to-ambient thermal resistance determined per JEDEC JESD51-2 with the single layer board horizontal. Board meets JESD51-9 specification.

3 Junction-to-ambient thermal resistance determined per JEDEC JESD51-6 with the board horizontal.

Table 20. I/O consumption (continued)

Symbol		C	Parameter	Conditions[1,2]	Value[3]			Unit
					Min	Typ	Max	
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[4]	

NOTES:
1. V_{DD} = 3.3 V ± 10% / 5.0 V ± 10%, T_A = –40 to 125 °C, unless otherwise specified.
2. V_{DD} as mentioned in the table is $V_{DD\_HV\_A}$/$V_{DD\_HV\_B}$.
3. All values need to be confirmed during device validation.
4. Stated maximum values represent peak consumption that lasts only a few ns during I/O transition.

4.7 RESET electrical characteristics

The device implements a dedicated bidirectional $\overline{\text{RESET}}$ pin.

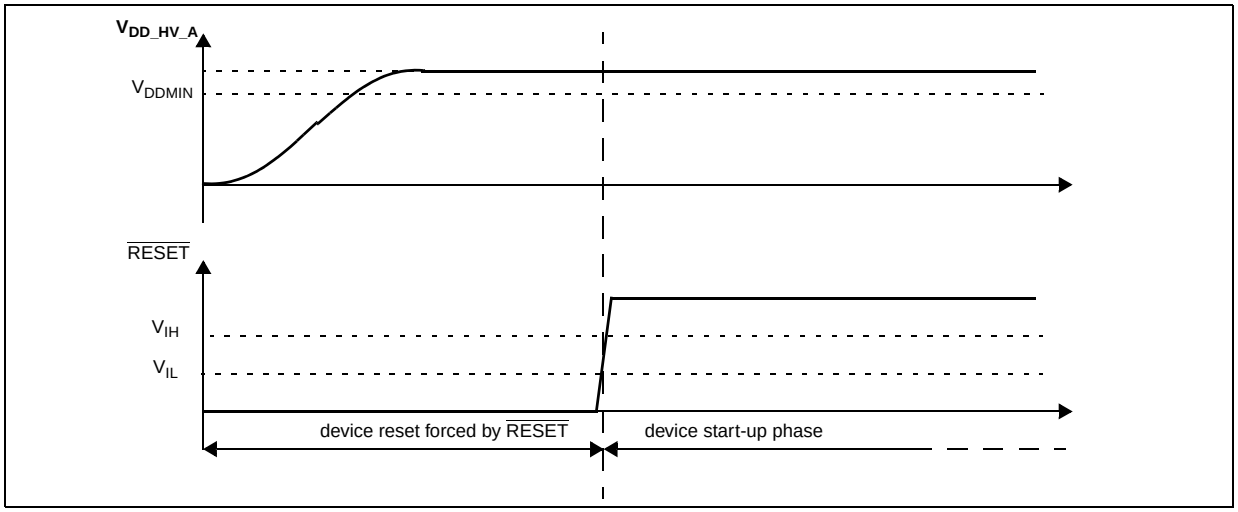

Figure 6. Start-up reset requirements

ECC circuitry provides correction of single bit faults and is used to improve further automotive reliability results. Some units will experience single bit corrections throughout the life of the product with no impact to product reliability.

Table 28. Flash memory read access timing[1]

Symbol		C	Parameter	Conditions[2]		Frequency range	Unit
				Code flash memory	Data flash memory		
f_{READ}	CC	P	Maximum frequency for Flash reading	5 wait states	13 wait states	120 —100	MHz
		C		4 wait states	11 wait states	100—80	
		D		3 wait states	9 wait states	80—64	
		C		2 wait states	7 wait states	64—40	
		C		1 wait states	4 wait states	40—20	
		C		0 wait states	2 wait states	20—0	

NOTES:
1 Max speed is the maximum speed allowed including PLL frequency modulation (FM).
2 V_{DD} = 3.3 V ± 10% / 5.0 V ± 10%, T_A = –40 to 125 °C, unless otherwise specified.

4.10.2 Flash memory power supply DC characteristics

Table 29 shows the flash memory power supply DC characteristics on external supply.

Table 29. Flash memory power supply DC electrical characteristics

Symbol		Parameter	Conditions[1]		Value[2]			Unit
					Min	Typ	Max	
I_{CFREAD}[3]	CC	Sum of the current consumption on $V_{DD\_HV\_A}$ on read access	Flash memory module read f_{CPU} = 120 MHz + 2%[4]	Code flash memory			33	mA
I_{DFREAD}(3)				Data flash memory			13	
I_{CFMOD}(3)	CC	Sum of the current consumption on $V_{DD\_HV\_A}$ (program/erase)	Program/Erase on-going while reading flash memory registers f_{CPU} = 120 MHz + 2% (4)	Code flash memory			52	mA
I_{DFMOD}(3)				Data flash memory			13	
I_{CFLPW}(3)	CC	Sum of the current consumption on $V_{DD\_HV\_A}$ during flash memory low power mode		Code flash memory			1.1	mA
I_{CFPWD}(3)	CC	Sum of the current consumption on $V_{DD\_HV\_A}$ during flash memory power down mode		Code flash memory			150	µA
I_{DFPWD}(3)				Data flash memory			150	

NOTES:
1 V_{DD} = 3.3 V ± 10% / 5.0 V ± 10%, T_A = –40 to 125 °C, unless otherwise specified.
2 All values need to be confirmed during device validation.

NOTES:
1. All ESD testing is in conformity with CDF-AEC-Q100 Stress Test Qualification for Automotive Grade Integrated Circuits.
2. A device will be defined as a failure if after exposure to ESD pulses the device no longer meets the device specification requirements. Complete DC parametric and functional testing shall be performed per applicable device specification at room temperature followed by hot temperature, unless specified otherwise in the device specification.
3. Data based on characterization results, not tested in production.

4.11.3.2 Static latch-up (LU)

Two complementary static tests are required on six parts to assess the latch-up performance:

- A supply over-voltage is applied to each power supply pin.
- A current injection is applied to each input, output and configurable I/O pin.

These tests are compliant with the EIA/JESD 78 IC latch-up standard.

Table 33. Latch-up results

Symbol	Parameter	Conditions	Class
LU	Static latch-up class	T_A = 125 °C conforming to JESD 78	II level A

4.12 Fast external crystal oscillator (4–40 MHz) electrical characteristics

The device provides an oscillator/resonator driver. Figure 10 describes a simple model of the internal oscillator driver and provides an example of a connection for an oscillator or a resonator.

Table 34 provides the parameter description of 4 MHz to 40 MHz crystals used for the design simulations.

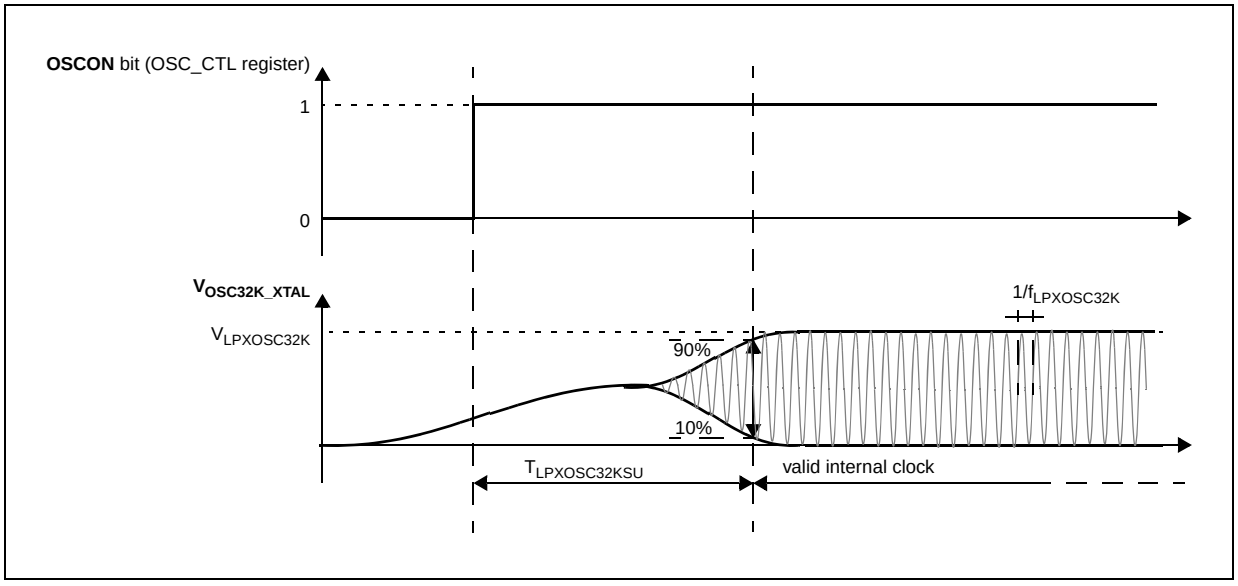

Figure 14. Slow external crystal oscillator (32 kHz) electrical characteristics

Table 37. Slow external crystal oscillator (32 kHz) electrical characteristics

Symbol		C	Parameter	Conditions[1]	Value[2]			Unit
					Min	Typ	Max	
f_{SXOSC}	SR	—	Slow external crystal oscillator frequency	—	32	32.768	40	kHz
g_{mSXOSC}	CC	—	Slow external crystal oscillator transconductance	V_{DD} = 3.3 V ± 10%,	13[3]	—	33[3]	µA/V
				V_{DD} = 5.0 V ± 10%	15[3]	—	35[3]	
V_{SXOSC}	CC	T	Oscillation amplitude	—	1.2	1.4	1.7	V
$I_{SXOSCBIAS}$	CC	T	Oscillation bias current	—	1.2	—	4.4	µA
I_{SXOSC}	CC	T	Slow external crystal oscillator consumption	—	—	—	7	µA
$T_{SXOSCSU}$	CC	T	Slow external crystal oscillator start-up time	—	—	—	2[4]	s

NOTES:
1 V_{DD} = 3.3 V ± 10% / 5.0 V ± 10%, T_A = –40 to 125 °C, unless otherwise specified.
2 All values need to be confirmed during device validation.
3 Based on ATE CZ
4 Start-up time has been measured with EPSON TOYOCOM MC306 crystal. Variation may be seen with other crystal.

4.14 FMPLL electrical characteristics

The device provides a frequency-modulated phase-locked loop (FMPLL) module to generate a fast system clock from the main oscillator driver.

Table 38. FMPLL electrical characteristics

Symbol		C	Parameter	Conditions[1]	Value[2]			Unit
					Min	Typ	Max	
f_{PLLIN}	SR	—	FMPLL reference clock[3]	—	4	—	64	MHz
Δ_{PLLIN}	SR	—	FMPLL reference clock duty cycle(3)	—	40	—	60	%
f_{PLLOUT}	CC	P	FMPLL output clock frequency	—	16	—	120	MHz
f_{CPU}	SR	—	System clock frequency	—	—	—	120 + 2%[4]	MHz
f_{FREE}	CC	P	Free-running frequency	—	20	—	150	MHz
t_{LOCK}	CC	P	FMPLL lock time	Stable oscillator (f_{PLLIN} = 16 MHz)		40	100	µs
Δt_{LTJIT}	CC	—	FMPLL long term jitter	f_{PLLIN} = 40 MHz (resonator), f_{PLLCLK} @ 120 MHz, 4000 cycles	—	—	6 (for < 1ppm)	ns
I_{PLL}	CC	C	FMPLL consumption	T_A = 25 °C	—	—	3	mA

NOTES:
1 V_{DD} = 3.3 V ± 10% / 5.0 V ± 10%, T_A = –40 to 125 °C, unless otherwise specified.
2 All values need to be confirmed during device validation.
3 PLLIN clock retrieved directly from 4-40 MHz XOSC or 16 MIRC. Input characteristics are granted when oscillator is used in functional mode. When bypass mode is used, oscillator input clock should verify f_{PLLIN} and Δ_{PLLIN}.
4 f_{CPU} 120 + 2% MHz can be achieved at 125 °C.

4.15 Fast internal RC oscillator (16 MHz) electrical characteristics

The device provides a 16 MHz main internal RC oscillator. This is used as the default clock at the power-up of the device and can also be used as input to PLL.

Table 39. Fast internal RC oscillator (16 MHz) electrical characteristics

Symbol		C	Parameter	Conditions[1]	Value[2]			Unit
					Min	Typ	Max	
f_{FIRC}	CC	P	Fast internal RC oscillator high frequency	T_A = 25 °C, trimmed	—	16	—	MHz
	SR	—		—	12		20	
$I_{FIRCRUN}$[3],	CC	T	Fast internal RC oscillator high frequency current in running mode	T_A = 25 °C, trimmed	—	—	200	µA
$I_{FIRCPWD}$	CC	D	Fast internal RC oscillator high frequency current in power down mode	T_A = 25 °C	—	—	100	nA
		D		T_A = 55 °C	—	—	200	nA
		D		T_A = 125 °C	—	—	1	µA

Table 39. Fast internal RC oscillator (16 MHz) electrical characteristics

Symbol		C	Parameter	Conditions[1]		Value[2]			Unit
						Min	Typ	Max	
$I_{FIRCSTOP}$	CC	T	Fast internal RC oscillator high frequency and system clock current in stop mode	T_A = 25 °C	sysclk = off	—	500	—	µA
					sysclk = 2 MHz	—	600	—	
					sysclk = 4 MHz	—	700	—	
					sysclk = 8 MHz	—	900	—	
					sysclk = 16 MHz	—	1250	—	
T_{FIRCSU}	CC	C	Fast internal RC oscillator start-up time	T_A = 55 °C	V_{DD} = 5.0 V ± 10%	—	—	2.0	µs
		—			V_{DD} = 3.3 V ± 10%	—	—	5	
		—		T_A = 125 °C	V_{DD} = 5.0 V ± 10%	—	—	2.0	
		—			V_{DD} = 3.3 V ± 10%	—	—	5	
$\Delta_{FIRCPRE}$	CC	C	Fast internal RC oscillator precision after software trimming of f_{FIRC}	T_A = 25 °C		–1	—	+1	%
$\Delta_{FIRCTRIM}$	CC	C	Fast internal RC oscillator trimming step	T_A = 25 °C		—	1.6		%
$\Delta_{FIRCVAR}$	CC	C	Fast internal RC oscillator variation over temperature and supply with respect to f_{FIRC} at T_A = 25 °C in high-frequency configuration	—		–5	—	+5	%

NOTES:
1. V_{DD} = 3.3 V ± 10% / 5.0 V ± 10%, T_A = –40 to 125 °C, unless otherwise specified.
2. All values need to be confirmed during device validation.
3. This does not include consumption linked to clock tree toggling and peripherals consumption when RC oscillator is ON.

4.16 Slow internal RC oscillator (128 kHz) electrical characteristics

The device provides a 128 kHz low power internal RC oscillator. This can be used as the reference clock for the RTC module.

Table 40. Slow internal RC oscillator (128 kHz) electrical characteristics

Symbol		C	Parameter	Conditions[1]	Value[2]			Unit
					Min	Typ	Max	
f_{SIRC}	CC	P	Slow internal RC oscillator low frequency	T_A = 25 °C, trimmed	—	128	—	kHz
	SR	—		untrimmed, across temperatures	84	—	205	
I_{SIRC}[3],	CC	C	Slow internal RC oscillator low frequency current	T_A = 25 °C, trimmed	—	—	5	µA

Table 48. On-chip peripherals current consumption[1]

Symbol		C	Parameter	Conditions		Value[2]	Unit
						Typ	
IDD_HV_ADC1	CC	D	ADC_1 supply current on $V_{DD\_HV\_ADC1}$	V_{DD} = 5.5 V	Analog static consumption (no conversion)	300 × f_{periph}	µA
				V_{DD} = 5.5 V	Analog dynamic consumption (continuous conversion)	6	mA
$I_{DD\_HV(FLASH)}$	CC	D	CFlash + DFlash supply current on $V_{DD\_HV\_ADC}$	V_{DD} = 5.5 V	—	13.25	mA
$I_{DD\_HV(PLL)}$	CC	D	PLL supply current on V_{DD_HV}	V_{DD} = 5.5 V	—	0.0031 × f_{periph}	

NOTES:
1 Operating conditions: T_A = 25 °C, f_{periph} = 8 MHz to 120 MHz.
2 f_{periph} is in absolute value.

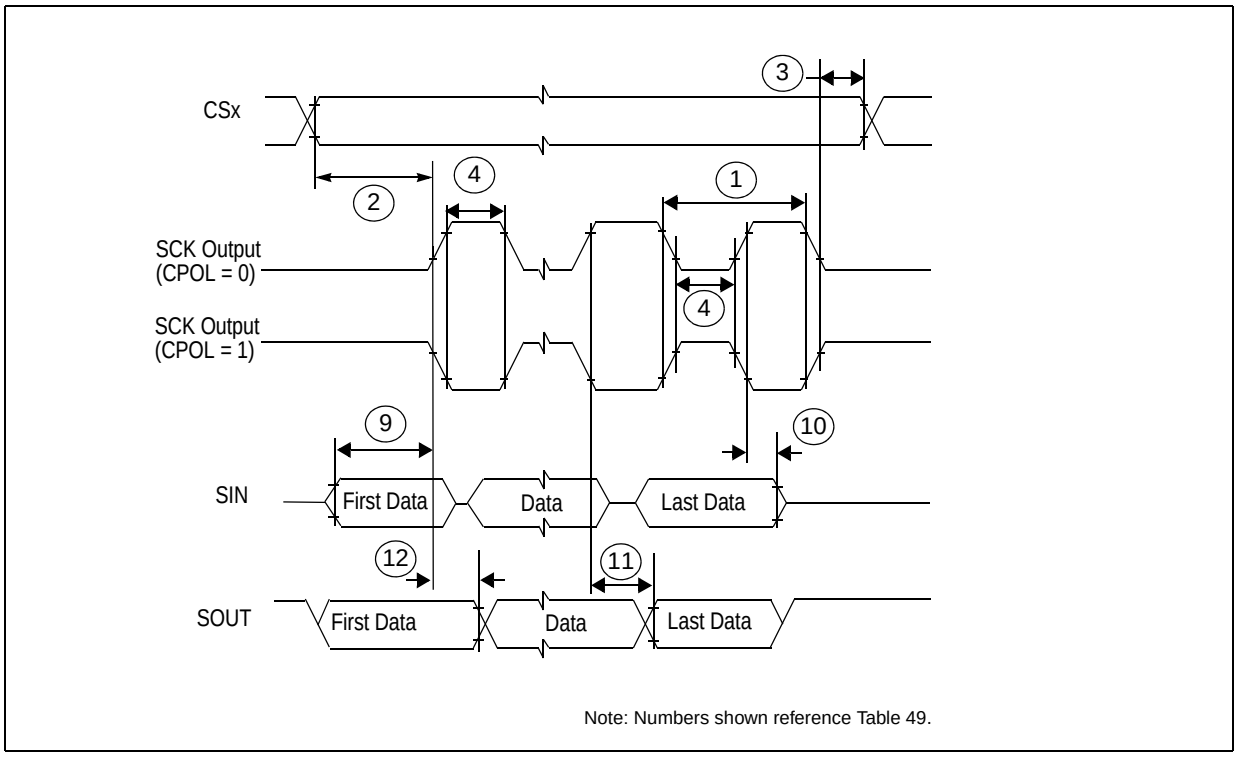

Figure 29. DSPI modified transfer format timing–master, CPHA = 0

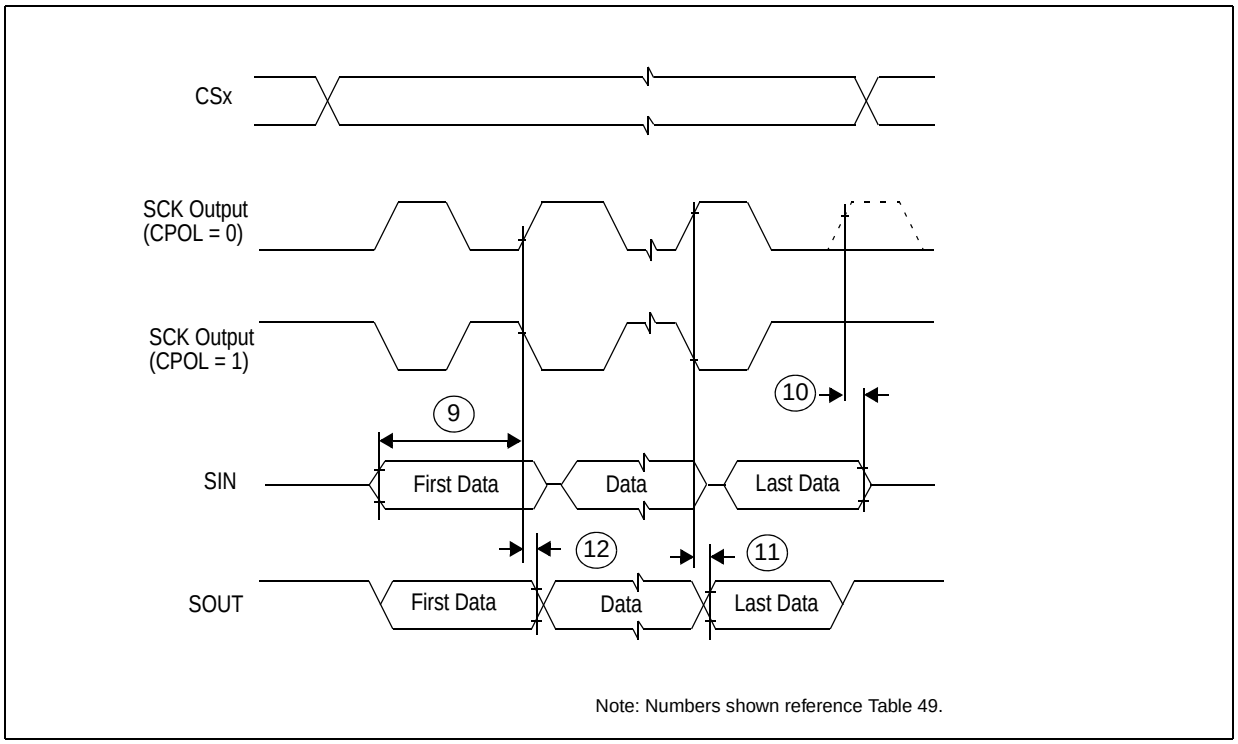

Figure 30. DSPI modified transfer format timing–master, CPHA = 1

5.1.3 256 MAPBGA package mechanical drawing

Figure 43. 256 MAPBGA mechanical drawing (Part 1 of 2)

Appendix A
Abbreviations

Table 53 lists abbreviations used but not defined elsewhere in this document.

Table 53. Abbreviations

Abbreviation	Meaning
CS	Chip select
EVTO	Event out
MCKO	Message clock out
MDO	Message data out
MSEO	Message start/end out
MTFE	Modified timing format enable
SCK	Serial communications clock
SOUT	Serial data out
TBD	To be defined
TCK	Test clock input
TDI	Test data input
TDO	Test data output
TMS	Test mode select