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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/spc5646bf0vlu1r

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Other Features

- System clocks sources
  - 4–40 MHz external crystal oscillator
  - 16 MHz internal RC oscillator
  - FMPLL
  - Additionally, there are two low power oscillators: 128 kHz internal RC oscillator, 32 kHz external crystal oscillator
- Real Time Counter (RTC) with clock source from internal 128 kHz or 16 MHz oscillators or external 4–40 MHz crystal
  - Supports autonomous wake-up with 1 ms resolution with max timeout of 2 seconds
  - Optional support from external 32 kHz crystal oscillator, supporting wake-up with 1 second resolution and max timeout of 1 hour
- 1 Real Time Interrupt (RTI) with 32-bit counter resolution
- 1 Safety Enhanced Software Watchdog Timer (SWT) that supports keyed functionality
- 1 dual-channel FlexRay Controller with 128 message buffers
- 1 Fast Ethernet Controller (FEC)
- On-chip voltage regulator (VREG)
- Cryptographic Services Engine (CSE)
- Offered in the following standard package types:
  - 176-pin LQFP, 24 × 24 mm, 0.5 mm Lead Pitch
  - 208-pin LQFP, 28 × 28 mm, 0.5 mm Lead Pitch
  - 256-ball MAPBGA, 17 × 17mm, 1.0 mm Lead Pitch

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
A	PC[15]	PB[2]	PC[13]	PI[1]	PE[7]	PH[8]	PE[2]	PE[4]	PC[4]	PE[3]	PH[9]	PI[4]	PH[11]	PE[14]	PA[10]	PG[11]	A
B	PH[13]	PC[14]	PC[8]	PC[12]	PI[3]	PE[6]	PH[5]	PE[5]	PC[5]	PC[0]	PC[2]	PH[12]	PG[10]	PA[11]	PA[9]	PA[8]	B
C	PH[14]	VDD_HV_A	PC[9]	PL[0]	PI[0]	PH[7]	PH[6]	VSS_LV	VDD_HV_A	PA[5]	PC[3]	PE[15]	PG[14]	PE[12]	PA[7]	PE[13]	C
D	PG[5]	PI[6]	PJ[4]	PB[3]	PK[15]	PI[2]	PH[4]	VDD_LV	PC[1]	PH[10]	PA[6]	PI[5]	PG[15]	PF[14]	PF[15]	PH[2]	D
E	PG[3]	PI[7]	PH[15]	PG[2]									PG[0]	PG[1]	PH[0]	VDD_HV_A	E
F	PA[2]	PG[4]	PA[1]	PE[1]									PH[1]	PH[3]	PG[12]	PG[13]	F
G	PE[8]	PE[0]	PE[10]	PA[0]			VSS_HV	VSS_HV	VSS_HV	VSS_HV			VDD_HV_B	PI[13]	PI[12]	PA[3]	G
H	PE[9]	VDD_HV_A	PE[11]	PK[1]			VSS_LV	VSS_HV	VSS_HV	VSS_HV			VDD_HV_A	VDD_LV	VSS_LV	PI[11]	H
J	VSS_HV	VRC_CTRL	VDD_LV	PG[9]			VSS_LV	VSS_LV	VSS_HV	VSS_HV			PD[15]	PI[8]	PI[9]	PI[10]	J
K	RESET	VSS_LV	PG[8]	PC[11]			VSS_LV	VSS_LV	VSS_LV	VDD_LV			PD[14]	PD[13]	PB[14]	PB[15]	K
L	PC[10]	PG[7]	PB[0]	PK[2]									PD[12]	PB[12]	PB[13]	VDD_HV_ADC1	L
M	PG[6]	PB[1]	PK[4]	PF[9]									PB[11]	PD[10]	PD[11]	VSS_HV_ADC1	M
N	PK[3]	PF[8]	PC[6]	PC[7]	PJ[13]	VDD_HV_A	PB[10]	PF[6]	VDD_HV_A	PJ[1]	PD[2]	PJ[5]	PB[5]	PB[6]	PJ[6]	PD[9]	N
P	PF[12]	PF[10]	PF[13]	PA[14]	PJ[9]	PA[12]	PF[0]	PF[5]	PF[7]	PJ[3]	PI[15]	PD[4]	PD[7]	PD[8]	PJ[8]	PJ[7]	P
R	PF[11]	PA[15]	PJ[11]	PJ[15]	PA[13]	PF[2]	PF[3]	PF[4]	VDD_LV	PJ[2]	PJ[0]	PD[0]	PD[3]	PD[6]	VDD_HV_ADC0	PB[7]	R
T	PJ[12]	PA[4]	PK[0]	PJ[14]	PJ[10]	PF[1]	XTAL	EXTAL	VSS_LV	PB[9]	PB[8]	PI[14]	PD[1]	PD[5]	VSS_HV_ADC0	PB[4]	T
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	

Notes:
1) VDD_HV_B supplies the IO voltage domain for the pins PE[12], PA[11], PA[10], PA[9], PA[8], PA[7], PE[13], PF[14], PF[15], PG[0], PG[1], PH[3], PH[2], PH[1], PH[0], PG[12], PG[13], and PA[3].
2) Availability of port pin alternate functions depends on product selection.

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
PA[7]	PCR[7]	AF0 AF1 AF2 AF3 — — —	GPIO[7] E0UC[7] LIN3TX — RXD[2] EIRQ[2] ADC1_S[1]	SIUL eMIOS_0 LINFlexD_3 — FEC SIUL ADC_1	I/O I/O O — I I I	M/S	Tristate	128	152	C15
PA[8]	PCR[8]	AF0 AF1 AF2 AF3 — — —	GPIO[8] E0UC[8] E0UC[14] — RXD[1] EIRQ[3] ABS[0] LIN3RX	SIUL eMIOS_0 eMIOS_0 — FEC SIUL MC_RGM LINFlexD_3	I/O I/O I/O — I I I I	M/S	Input, weak pull-up	129	153	B16
PA[9]	PCR[9]	AF0 AF1 AF2 AF3 — —	GPIO[9] E0UC[9] — CS2_1 RXD[0] FAB	SIUL eMIOS_0 — DSPI1 FEC MC_RGM	I/O I/O — O I I	M/S	Pull-down	130	154	B15
PA[10]	PCR[10]	AF0 AF1 AF2 AF3 — — —	GPIO[10] E0UC[10] SDA LIN2TX COL ADC1_S[2] SIN_1	SIUL eMIOS_0 I^2C LINFlexD_2 FEC ADC_1 DSPI_1	I/O I/O I/O O I I I	M/S	Tristate	131	155	A15
PA[11]	PCR[11]	AF0 AF1 AF2 AF3 — — — —	GPIO[11] E0UC[11] SCL — RX_ER EIRQ[16] LIN2RX ADC1_S[3]	SIUL eMIOS_0 I^2C — FEC SIUL LINFlexD_2 ADC_1	I/O I/O I/O — I I I I	M/S	Tristate	132	156	B14
PA[12]	PCR[12]	AF0 AF1 AF2 AF3 — —	GPIO[12] — E0UC[28] CS3_1 EIRQ[17] SIN_0	SIUL — eMIOS_0 DSPI1 SIUL DSPI_0	I/O — I/O O I I	S	Tristate	53	69	P6

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
PD[8]	PCR[56]	AF0 AF1 AF2 AF3 — —	GPI[56] — — — ADC0_P[12] ADC1_P[12]	SIUL — — — ADC_0 ADC_1	I — — — I I	I	Tristate	87	103	P14
PD[9]	PCR[57]	AF0 AF1 AF2 AF3 — —	GPI[57] — — — ADC0_P[13] ADC1_P[13]	SIUL — — — ADC_0 ADC_1	I — — — I I	I	Tristate	94	114	N16
PD[10]	PCR[58]	AF0 AF1 AF2 AF3 — —	GPI[58] — — — ADC0_P[14] ADC1_P[14]	SIUL — — — ADC_0 ADC_1	I — — — I I	I	Tristate	95	115	M14
PD[11]	PCR[59]	AF0 AF1 AF2 AF3 — —	GPI[59] — — — ADC0_P[15] ADC1_P[15]	SIUL — — — ADC_0 ADC_1	I — — — I I	I	Tristate	96	116	M15
PD[12]	PCR[60]	AF0 AF1 AF2 AF3 —	GPIO[60] CS5_0 E0UC[24] — ADC0_S[4]	SIUL DSPI_0 eMIOS_0 — ADC_0	I/O O I/O — I	S	Tristate	100	120	L13
PD[13]	PCR[61]	AF0 AF1 AF2 AF3 —	GPIO[61] CS0_1 E0UC[25] — ADC0_S[5]	SIUL DSPI_1 eMIOS_0 — ADC_0	I/O I/O I/O — I	S	Tristate	102	124	K14
PD[14]	PCR[62]	AF0 AF1 AF2 AF3 ALT4 —	GPIO[62] CS1_1 E0UC[26] — FR_DBG[0] ADC0_S[6]	SIUL DSPI_1 eMIOS_0 — Flexray ADC_0	I/O O I/O — O I	S	Tristate	104	126	K13

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
PH[14]	PCR[126]	AF0 AF1 AF2 AF3	GPIO[126] SCK_4 CS1_3 E1UC[27]	SIUL DSPI_4 DSPI_3 eMIOS_1	I/O I/O O I/O	M/S	Tristate	10	10	C1
PH[15]	PCR[127]	AF0 AF1 AF2 AF3	GPIO[127] SOUT_5 — E1UC[17]	SIUL DSPI_5 — eMIOS_1	I/O O — I/O	M/S	Tristate	8	8	E3
PI[0]	PCR[128]	AF0 AF1 AF2 AF3	GPIO[128] E0UC[28] LIN8TX —	SIUL eMIOS_0 LINFlexD_8 —	I/O I/O O —	S	Tristate	172	196	C5
PI[1]	PCR[129]	AF0 AF1 AF2 AF3 — —	GPIO[129] E0UC[29] — — WKPU[24] LIN8RX	SIUL eMIOS_0 — — WKPU LINFlexD_8	I/O I/O — — I I	S	Tristate	171	195	A4
PI[2]	PCR[130]	AF0 AF1 AF2 AF3	GPIO[130] E0UC[30] LIN9TX —	SIUL eMIOS_0 LINFlexD_9 —	I/O I/O O —	S	Tristate	170	194	D6
PI[3]	PCR[131]	AF0 AF1 AF2 AF3 — —	GPIO[131] E0UC[31] — — WKPU[23] LIN9RX	SIUL eMIOS_0 — — WKPU LINFlexD_9	I/O I/O — — I I	S	Tristate	169	193	B5
PI[4]	PCR[132]	AF0 AF1 AF2 AF3	GPIO[132] E1UC[28] SOUT_4 —	SIUL eMIOS_1 DSPI_4 —	I/O I/O O —	M/S	Tristate	143	167	A12
PI[5]	PCR[133]	AF0 AF1 AF2 AF3 ALT4	GPIO[133] E1UC[29] SCK_4 CS2_5 CS2_6	SIUL eMIOS_1 DSPI_4 DSPI_5 DSPI_6	I/O I/O I/O O O	M/S	Tristate	142	166	D12
PI[6]	PCR[134]	AF0 AF1 AF2 AF3 ALT4	GPIO[134] E1UC[30] CS0_4 CS0_5 CS0_6	SIUL eMIOS_1 DSPI_4 DSPI_5 DSPI_6	I/O I/O I/O I/O I/O	S	Tristate	11	11	D2

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 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.

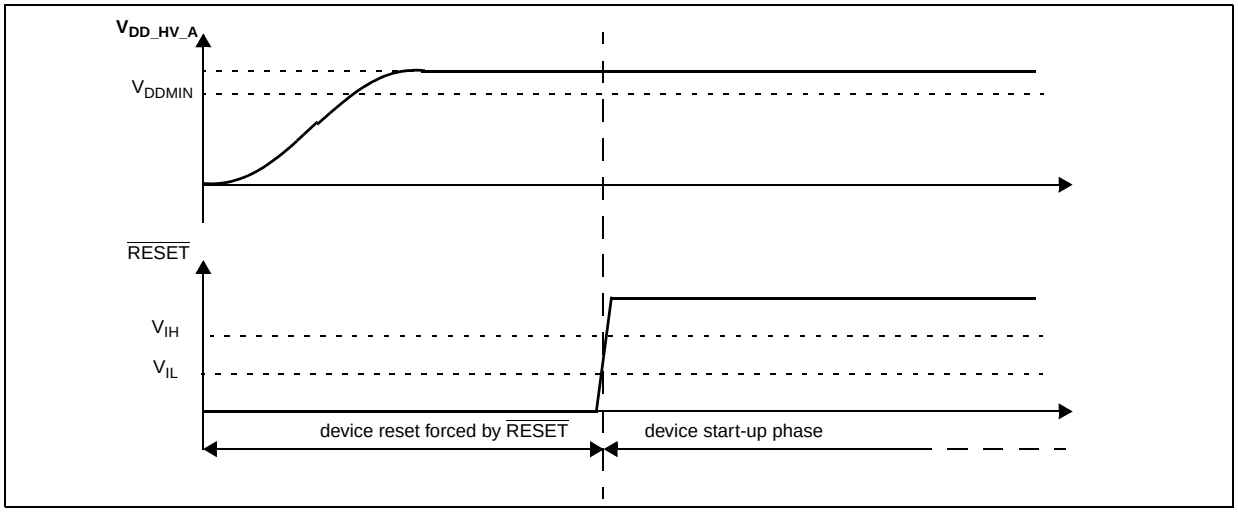
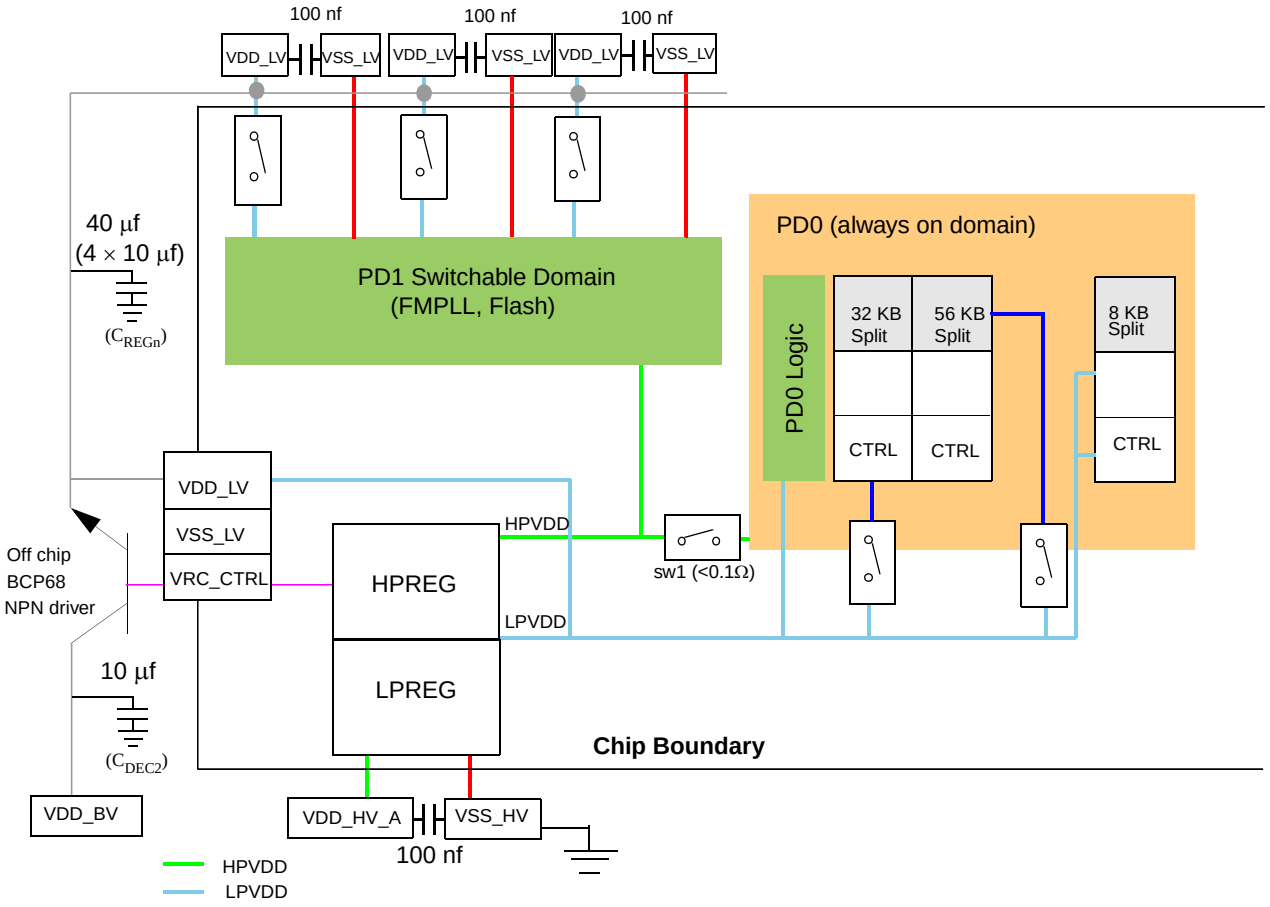


Figure 6. Start-up reset requirements

— LV_CFLA0/CFLA1: Low voltage supply for the two code Flash modules. It is shorted with LV_COR through double bonding.

— LV_DFLA: Low voltage supply for data Flash module. It is shorted with LV_COR through double bonding.

— LV_PLL: Low voltage supply for FMPLL. It is shorted to LV_COR through double bonding.



1) All VSS_LV pins must be grounded, as shown for VSS_HV pin.

Figure 8. Voltage regulator capacitance connection

The internal voltage regulator requires external bulk capacitance (C_{REGn}) to be connected to the device to provide a stable low voltage digital supply to the device. Also required for stability is the C_{DEC2} capacitor at ballast collector. This is needed to minimize sharp injection current when ballast is turning ON. Apart from the bulk capacitance, user should connect EMI/decoupling cap (C_{REGP}) at each V_{DD_LV}/V_{SS_LV} pin pair.

4.8.1.1 Recommendations

- The external NPN driver must be BCP68 type.
- V_{DD_LV} should be implemented as a power plane from the emitter of the ballast transistor.

Table 35. Fast external crystal oscillator (4 to 40 MHz) electrical characteristics

Symbol		C	Parameter	Conditions[1]	Value[2]			Unit
					Min	Typ	Max	
V_{IH}	SR	P	Input high level CMOS (Schmitt Trigger)	Oscillator bypass mode	$0.65V_{DD\_HV\_A}$	—	$V_{DD\_HV\_A}$ + 0.4	V
V_{IL}	SR	P	Input low level CMOS (Schmitt Trigger)	Oscillator bypass mode	–0.3	—	$0.35V_{DD\_HV\_A}$	V

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. Stated values take into account only analog module consumption but not the digital contributor (clock tree and enabled peripherals).

4.13 Slow external crystal oscillator (32 kHz) electrical characteristics

The device provides a low power oscillator/resonator driver.

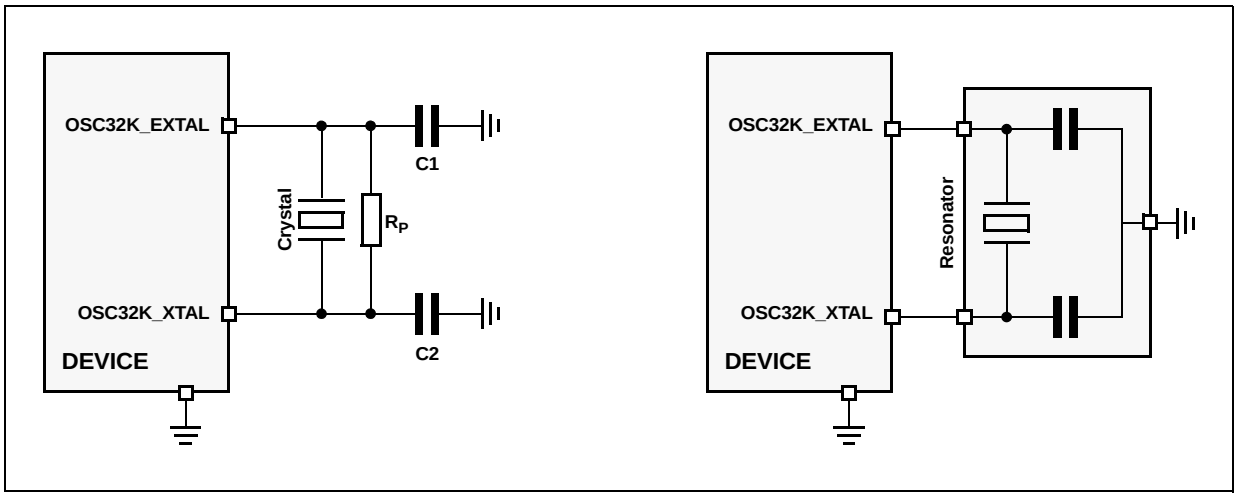


Figure 12. Crystal oscillator and resonator connection scheme

NOTE

OSC32K_XTAL/OSC32K_EXTAL must not be directly used to drive external circuits.

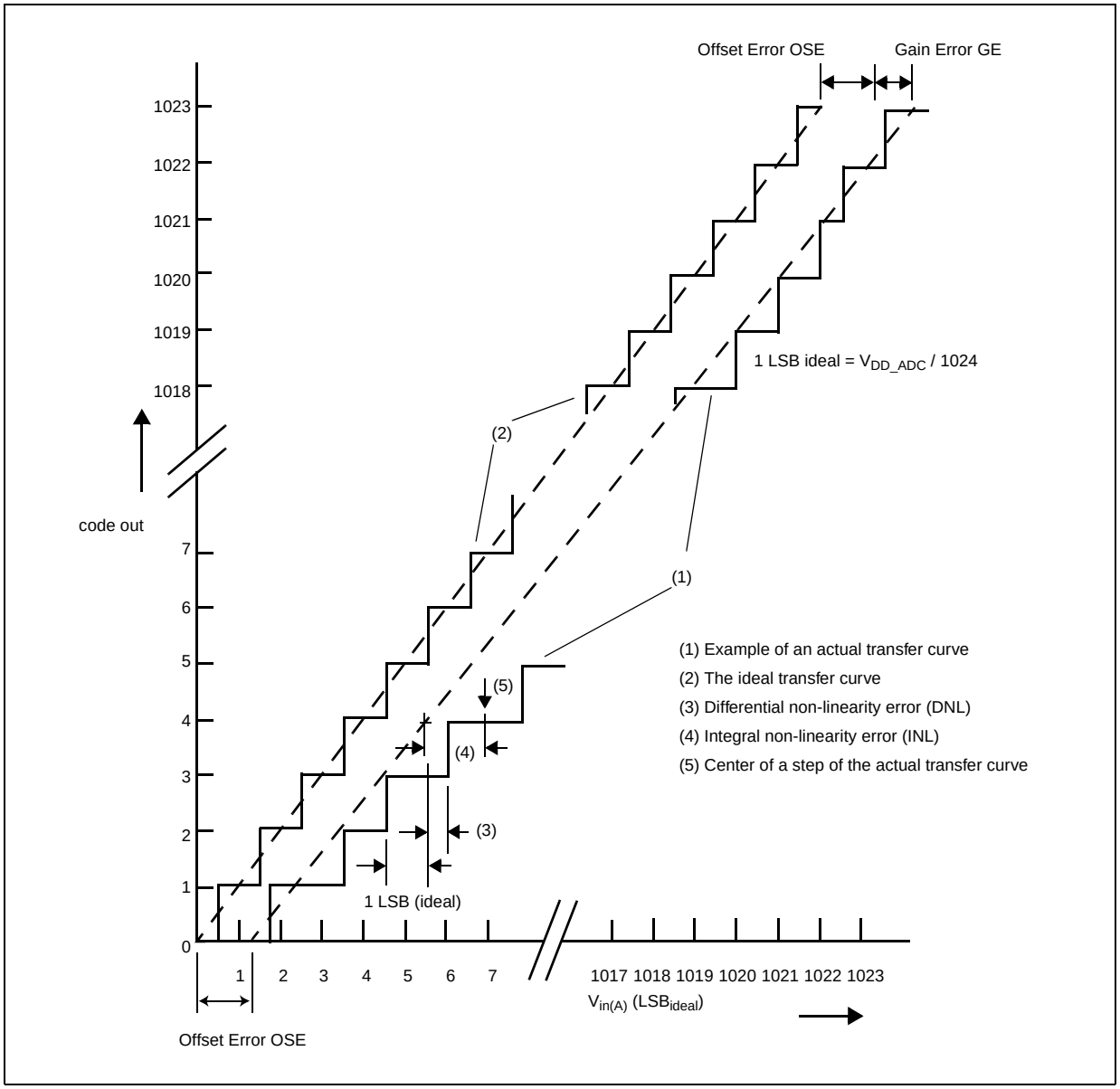


Figure 15. ADC_0 characteristic and error definitions

4.17.1.1 Input impedance and ADC accuracy

To preserve the accuracy of the A/D converter, it is necessary that analog input pins have low AC impedance. Placing a capacitor with good high frequency characteristics at the input pin of the device, can be effective: the capacitor should be as large as possible, ideally infinite. This capacitor contributes to attenuating the noise present on the input pin; furthermore, it sources charge during the sampling phase, when the analog signal source is a high-impedance source. A real filter, can typically be obtained by using a series resistance with a capacitor on the input pin (simple RC Filter). The RC filtering may be limited according to the value of source impedance of the transducer or circuit supplying the analog signal to be measured. The filter at the input pins must be designed taking into account the dynamic characteristics of the input signal (bandwidth) and the equivalent input impedance of the ADC itself.

Table 42. ADC conversion characteristics (10-bit ADC_0) (continued)

Symbol		C	Parameter	Conditions[1]		Value			Unit
						Min	Typ	Max	
R_{SW2}	CC	D	Internal resistance of analog source	—		—	—	2	kΩ
R_{AD}	CC	D	Internal resistance of analog source	—		—	—	2	kΩ
I_{INJ}[7]	SR	—	Input current Injection	Current injection on one ADC_0 input, different from the converted one	V_{DD} = 3.3 V ± 10%	–5	—	5	mA
					V_{DD} = 5.0 V ± 10%	–5	—	5	
| INL |	CC	T	Absolute value for integral non-linearity	No overload		—	0.5	1.5	LSB
| DNL |	CC	T	Absolute differential non-linearity	No overload		—	0.5	1.0	LSB
| OFS |	CC	T	Absolute offset error	—		—	0.5	—	LSB
| GNE |	CC	T	Absolute gain error	—		—	0.6	—	LSB
TUEP	CC	P	Total unadjusted error[8] for precise channels, input only pins	Without current injection		–2	0.6	2	LSB
		T		With current injection		–3		3	
TUEX	CC	T	Total unadjusted error[(8)] for extended channel	Without current injection		–3	1	3	LSB
		T		With current injection		–4		4	

NOTES:

1. V_{DD} = 3.3 V ± 10% / 5.0 V ± 10%, T_A = –40 to 125 °C, unless otherwise specified.
2. Analog and digital V_{SS_HV} must be common (to be tied together externally).
3. V_{AINx} may exceed V_{SS_ADC0} and V_{DD_ADC0} limits, remaining on absolute maximum ratings, but the results of the conversion will be clamped respectively to 0x000 or 0x3FF.
4. During the sample time the input capacitance C_S 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_{ADC0_S}. After the end of the sample time t_{ADC0_S}, changes of the analog input voltage have no effect on the conversion result. Values for the sample clock t_{ADC0_S} depend on programming.
5. This parameter does not include the sample time $t_{ADC0\_S,}$ but only the time for determining the digital result and the time to load the result's register with the conversion result
6. Refer to ADC conversion table for detailed calculations.
7. PB10 should not have any current injected. It can disturb accuracy on other ADC_0 pins.
8. Total Unadjusted Error: The maximum error that occurs without adjusting Offset and Gain errors. This error is a combination of Offset, Gain and Integral Linearity errors.

Table 43. Conversion characteristics (12-bit ADC_1) (continued)

Symbol		C	Parameter	Conditions[1]		Value			Unit
						Min	Typ	Max	
R_{SW2}	CC	D	Internal resistance of analog source	—				2	kΩ
R_{AD}	CC	D	Internal resistance of analog source	—				0.3	kΩ
I_{INJ}	SR	—	Input current Injection	Current injection on one ADC_1 input, different from the converted one	V_{DD} = 3.3 V ± 10%	−5	—	5	mA
					V_{DD} = 5.0 V ± 10%	−5	—	5	
INLP	CC	T	Absolute Integral non-linearity-Precise channels	No overload			1	3	LSB
INLS	CC	T	Absolute Integral non-linearity-Standard channels	No overload			1.5	5	LSB
DNL	CC	T	Absolute Differential non-linearity	No overload			0.5	1	LSB
OFS	CC	T	Absolute Offset error	—			2		LSB
GNE	CC	T	Absolute Gain error	—			2		LSB
TUEP[9]	CC	P	Total Unadjusted Error for precise channels, input only pins	Without current injection		−6		6	LSB
		T		With current injection		−8		8	LSB
TUES[(9)]	CC	T	Total Unadjusted Error for standard channel	Without current injection		−10		10	LSB
		T		With current injection		−12		12	LSB

NOTES:
1. V_{DD} = 3.3 V ± 10% / 5.0 V ± 10%, T_A = −40 to 125 °C, unless otherwise specified.
2. Analog and digital V_{SS_HV} **must** be common (to be tied together externally).
3. 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 VDD_HV_B when these channels are used for ADC_1.
4. VDD_HV_ADC1 can operate at 5V condition while $V_{DD\_HV\_B}$ can operate at 3.3V provided that ADC_1 channels coming from $V_{DD\_HV\_B}$ domain are limited in max swing as $V_{DD\_HV\_B}$.
5. V_{AINx} may exceed V_{SS_ADC1} and V_{DD_ADC1} limits, remaining on absolute maximum ratings, but the results of the conversion will be clamped respectively to 0x000 or 0xFFF.
6. During the sample time the input capacitance C_S 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_{ADC1_S}. After the end of the sample time t_{ADC1_S}, changes of the analog input voltage have no effect on the conversion result. Values for the sample clock t_{ADC1_S} depend on programming.

7 Conversion time = Bit evaluation time + Sampling time + 1 Clock cycle delay.

8 Refer to ADC conversion table for detailed calculations.

9 Total Unadjusted Error: The maximum error that occurs without adjusting Offset and Gain errors. This error is a combination of Offset, Gain and Integral Linearity errors.

4.18 Fast Ethernet Controller

MII signals use CMOS signal levels compatible with devices operating at 3.3 V. Signals are not TTL compatible. They follow the CMOS electrical characteristics.

4.18.1 MII Receive Signal Timing (RXD[3:0], RX_DV, RX_ER, and RX_CLK)

The receiver functions correctly up to a RX_CLK maximum frequency of 25 MHz +1%. There is no minimum frequency requirement. In addition, the system clock frequency must exceed four times the RX_CLK frequency in 2:1 mode and two times the RX_CLK frequency in 1:1 mode.

Table 44. MII Receive Signal Timing

Spec	Characteristic	Min	Max	Unit
M1	RXD[3:0], RX_DV, RX_ER to RX_CLK setup	5	—	ns
M2	RX_CLK to RXD[3:0], RX_DV, RX_ER hold	5	—	ns
M3	RX_CLK pulse width high	35%	65%	RX_CLK period
M4	RX_CLK pulse width low	35%	65%	RX_CLK period

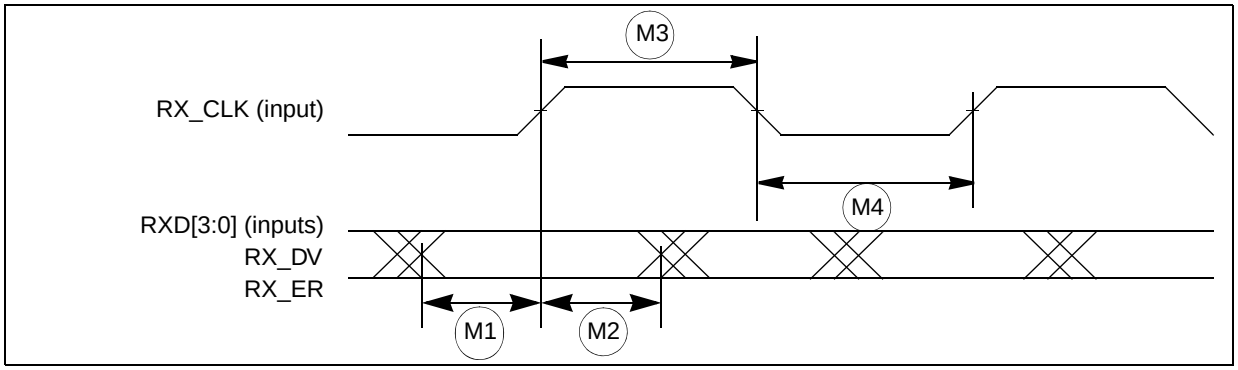


Figure 21. MII receive signal timing diagram

4.18.2 MII Transmit Signal Timing (TXD[3:0], TX_EN, TX_ER, TX_CLK)

The transmitter functions correctly up to a TX_CLK maximum frequency of 25 MHz +1%. There is no minimum frequency requirement. In addition, the system clock frequency must exceed four times the TX_CLK frequency in 2:1 mode and two times the TX_CLK frequency in 1:1 mode.

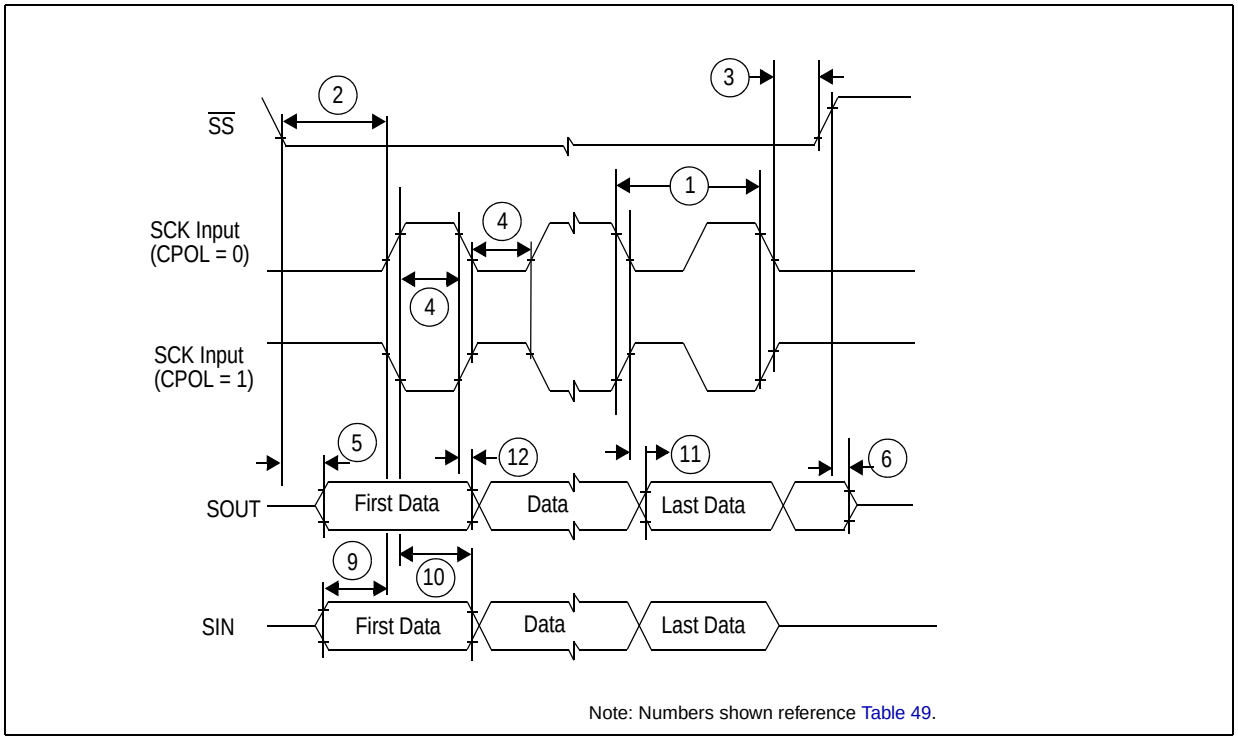


Figure 27. DSPI classic SPI timing–slave, CPHA = 0

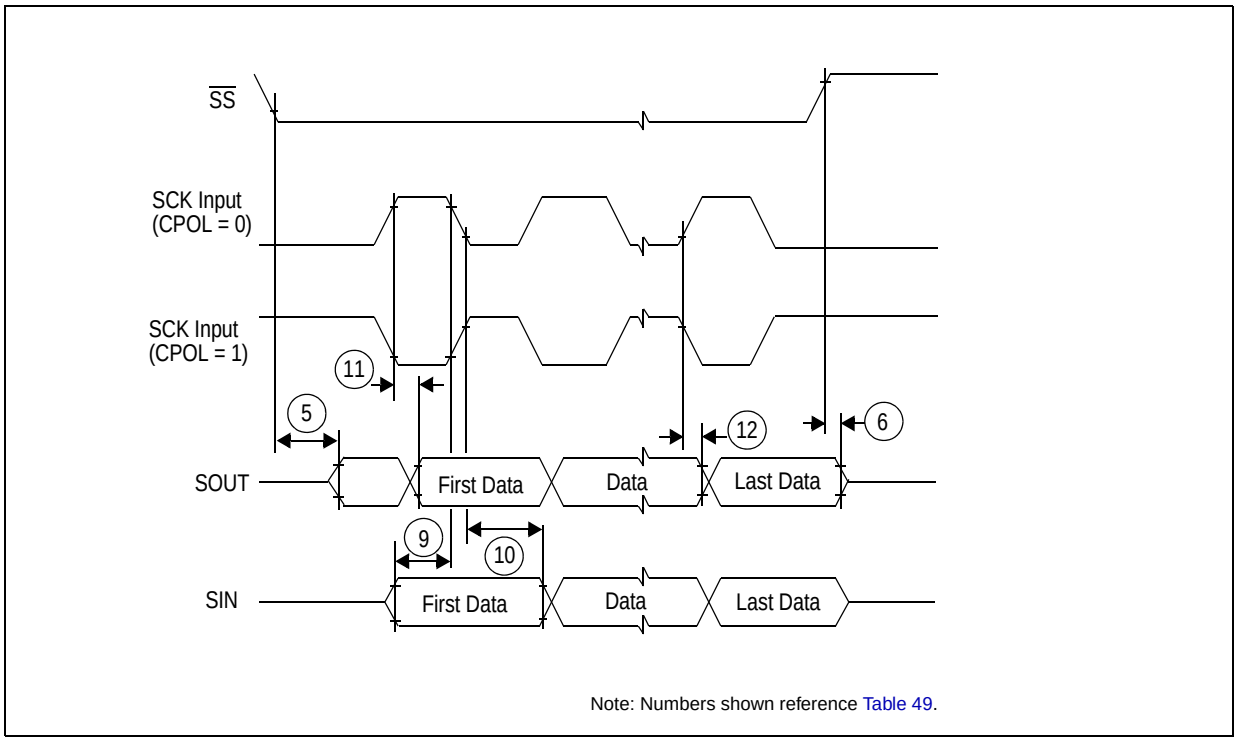


Figure 28. DSPI classic SPI timing–slave, CPHA = 1

5 Package characteristics

5.1 Package mechanical data

5.1.1 176 LQFP package mechanical drawing

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