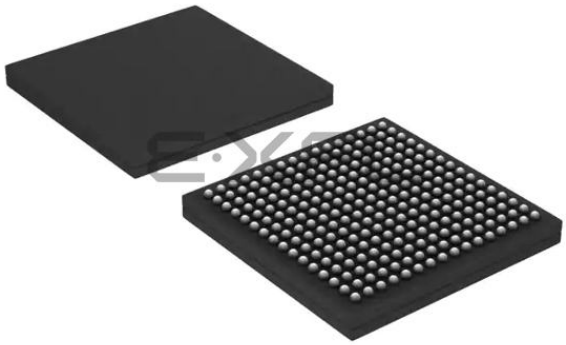

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Details	
Product Status	Active
Core Processor	e200z4d, e200z0h
Core Size	32-Bit Dual-Core
Speed	80MHz/120MHz
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Peripherals	DMA, POR, PWM, WDT
Number of I/O	199
Program Memory Size	3MB (3M x 8)
Program Memory Type	FLASH
EEPROM Size	64K x 8
RAM Size	256K x 8
Voltage - Supply (Vcc/Vdd)	3V ~ 5.5V
Data Converters	A/D 33x10b, 10x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 105°C (TA)
Mounting Type	Surface Mount
Package / Case	256-LBGA
Supplier Device Package	256-MAPBGA (17x17)
Purchase URL	https://www.e-xfl.com/product-detail/nxp-semiconductors/spc5646ccf0vmj1r

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
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
PD[15]	PCR[63]	AF0 AF1 AF2 AF3 ALT4 —	GPIO[63] CS2_1 E0UC[27] — FR_DBG[1] ADC0_S[7]	SIUL DSPI_1 eMIOS_0 — Flexray ADC_0	I/O O I/O — O I	S	Tristate	106	128	J13
PE[0]	PCR[64]	AF0 AF1 AF2 AF3 — —	GPIO[64] E0UC[16] — — CAN5RX WKPU[6]	SIUL eMIOS_0 — — FlexCAN_5 WKPU	I/O I/O — — I I	S	Tristate	18	18	G2
PE[1]	PCR[65]	AF0 AF1 AF2 AF3	GPIO[65] E0UC[17] CAN5TX —	SIUL eMIOS_0 FlexCAN_5 —	I/O I/O O —	M/S	Tristate	20	20	F4
PE[2]	PCR[66]	AF0 AF1 AF2 AF3 ALT4 — —	GPIO[66] E0UC[18] — — FR_A_TX_EN SIN_1 EIRQ[21]	SIUL eMIOS_0 — — Flexray DSPI_1 SIUL	I/O I/O — — O I I	M/S	Tristate	156	180	A7
PE[3]	PCR[67]	AF0 AF1 AF2 AF3 — —	GPIO[67] E0UC[19] SOUT_1 — FR_A_RX WKPU[29]	SIUL eMIOS_0 DSPI_1 — Flexray WKPU	I/O I/O O — I I	M/S	Tristate	157	181	A10
PE[4]	PCR[68]	AF0 AF1 AF2 AF3 ALT4 —	GPIO[68] E0UC[20] SCK_1 — FR_B_TX EIRQ[9]	SIUL eMIOS_0 DSPI_1 — Flexray SIUL	I/O I/O I/O — O I	M/S	Tristate	160	184	A8
PE[5]	PCR[69]	AF0 AF1 AF2 AF3 — —	GPIO[69] E0UC[21] CS0_1 MA[2] FR_B_RX WKPU[30]	SIUL eMIOS_0 DSPI_1 ADC_0 Flexray WKPU	I/O I/O I/O O I I	M/S	Tristate	161	185	B8

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
PG[5]	PCR[101]	AF0 AF1 AF2 AF3 — —	GPIO[101] E1UC[14] — — WKPU[18] SIN_3	SIUL eMIOS_1 — — WKPU DSPI_3	I/O I/O — — I I	S	Tristate	13	13	D1
PG[6]	PCR[102]	AF0 AF1 AF2 AF3	GPIO[102] E1UC[15] LIN6TX —	SIUL eMIOS_1 LINFlexD_6 —	I/O I/O O —	M/S	Tristate	38	38	M1
PG[7]	PCR[103]	AF0 AF1 AF2 AF3 — —	GPIO[103] E1UC[16] E1UC[30] — LIN6RX WKPU[20]	SIUL eMIOS_1 eMIOS_1 — LINFlexD_6 WKPU	I/O I/O I/O — I I	S	Tristate	37	37	L2
PG[8]	PCR[104]	AF0 AF1 AF2 AF3 —	GPIO[104] E1UC[17] LIN7TX CS0_2 EIRQ[15]	SIUL eMIOS_1 LINFlexD_7 DSPI_2 SIUL	I/O I/O O I/O I	S	Tristate	34	34	K3
PG[9]	PCR[105]	AF0 AF1 AF2 AF3 — —	GPIO[105] E1UC[18] — SCK_2 LIN7RX WKPU[21]	SIUL eMIOS_1 — DSPI_2 LINFlexD_7 WKPU	I/O I/O — I/O I I	S	Tristate	33	33	J4
PG[10]	PCR[106]	AF0 AF1 AF2 AF3 —	GPIO[106] E0UC[24] E1UC[31] — SIN_4	SIUL eMIOS_0 eMIOS_1 — DSPI_4	I/O I/O I/O — I	S	Tristate	138	162	B13
PG[11]	PCR[107]	AF0 AF1 AF2 AF3	GPIO[107] E0UC[25] CS0_4 CS0_6	SIUL eMIOS_0 DSPI_4 DSPI_6	I/O I/O I/O I/O	M/S	Tristate	139	163	A16
PG[12]	PCR[108]	AF0 AF1 AF2 AF3 ALT4	GPIO[108] E0UC[26] SOUT_4 — TXD[2]	SIUL eMIOS_0 DSPI_4 — FEC	I/O I/O O — O	M/S	Tristate	116	140	F15

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

4.2.1 NVUSRO [PAD3V5V(0)] field description

Table 6 shows how NVUSRO [PAD3V5V(0)] controls the device configuration for $V_{DD\_HV\_A}$ domain.

Table 6. PAD3V5V(0) field description

Value[1]	Description
0	High voltage supply is 5.0 V
1	High voltage supply is 3.3 V

NOTES:
1 '1' is delivery value. It is part of shadow flash memory, thus programmable by customer.

The DC electrical characteristics are dependent on the PAD3V5V(0,1) bit value.

4.2.2 NVUSRO [PAD3V5V(1)] field description

Table 7 shows how NVUSRO [PAD3V5V(1)] controls the device configuration the device configuration for $V_{DD\_HV\_B}$ domain.

Table 7. PAD3V5V(1) field description

Value[1]	Description
0	High voltage supply is 5.0 V
1	High voltage supply is 3.3 V

NOTES:
1 '1' is delivery value. It is part of shadow flash memory, thus programmable by customer.

The DC electrical characteristics are dependent on the PAD3V5V(0,1) bit value.

4.3 Absolute maximum ratings

Table 8. Absolute maximum ratings

Symbol		Parameter	Conditions	Value		Unit
				Min	Max	
V_{SS_HV}	SR	Digital ground on VSS_HV pins	—	0	0	V
$V_{DD\_HV\_A}$	SR	Voltage on VDD_HV_A pins with respect to ground (V_{SS_HV})	—	–0.3	6.0	V
$V_{DD\_HV\_B}$[1]	SR	Voltage on VDD_HV_B pins with respect to common ground (V_{SS_HV})	—	–0.3	6.0	V
V_{SS_LV}	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

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.

2 V_{DD} as mentioned in the table is $V_{DD\_HV\_A}/V_{DD\_HV\_B}$. All values need to be confirmed during device validation.
3 Analog filters are available on all wakeup lines.
4 The width of input pulse in between 40 ns to 1000 ns is indeterminate. It may pass the noise or may not depending on silicon sample to sample variation.

4.6.3 I/O output DC characteristics

The following tables provide DC characteristics for bidirectional pads:

- Table 14 provides weak pull figures. Both pull-up and pull-down resistances are supported.
- Table 15 provides output driver characteristics for I/O pads when in SLOW configuration.
- Table 16 provides output driver characteristics for I/O pads when in MEDIUM configuration.
- Table 17 provides output driver characteristics for I/O pads when in FAST configuration.

Table 14. I/O pull-up/pull-down DC electrical characteristics

Symbol		C	Parameter	Conditions[1,2]		Value			Unit
						Min	Typ	Max	
$\lvert I_{WPU}\rvert$	CC	P	Weak pull-up current absolute value	$V_{IN} = V_{IL}$, V_{DD} = 5.0 V ± 10%	PAD3V5V = 0	10	—	150	µA
		C			PAD3V5V = 1[3]	10	—	250	
		P		$V_{IN} = V_{IL}$, V_{DD} = 3.3 V ± 10%	PAD3V5V = 1	10	—	150	
$\lvert I_{WPD}\rvert$	CC	P	Weak pull-down current absolute value	$V_{IN} = V_{IH}$, V_{DD} = 5.0 V ± 10%	PAD3V5V = 0	10	—	150	µA
		C			PAD3V5V = 1	10	—	250	
		P		$V_{IN} = V_{IH}$, V_{DD} = 3.3 V ± 10%	PAD3V5V = 1	10	—	150	

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 The configuration PAD3V5 = 1 when V_{DD} = 5 V is only a transient configuration during power-up. All pads but RESET and Nexus output (MDOx, EVTO, MCKO) are configured in input or in high impedance state.

Table 15. SLOW configuration output buffer electrical characteristics

Symbol		C	Parameter	Conditions[1,2]		Value			Unit
						Min	Typ	Max	
V_{OH}	CC	P	Output high level SLOW configuration	Push Pull	I_{OH} = –3 mA, V_{DD} = 5.0 V ± 10%, PAD3V5V = 0	0.8V_{DD}	—	—	V
		C			I_{OH} = –3 mA, V_{DD} = 5.0 V ± 10%, PAD3V5V = 1[3]	0.8V_{DD}	—	—	
		P			I_{OH} = –1.5 mA, V_{DD} = 3.3 V ± 10%, PAD3V5V = 1	V_{DD} – 0.8	—	—	

Table 24. Low voltage power domain electrical characteristics[1]

Symbol		C	Parameter	Conditions[2]		Value			Unit
						Min	Typ[3]	Max[4]	
I_{DDMAX}[5]	CC	D	RUN mode maximum average current	—		—	210	300[6,7]	mA
I_{DDRUN}	CC	P	RUN mode typical average current[8]	at 120 MHz	T_A = 25 °C	—	150	200[9]	mA
		D		at 80 MHz	T_A = 25 °C	—	110[8]	150[10]	mA
		C		at 120 MHz	T_A = 125 °C	—	180	270	mA
I_{DDHALT}	CC	P	HALT mode current[11]	at 120 MHz	T_A = 25 °C	—	20	27	mA
		C		at 120 MHz	T_A = 125 °C	—	35	113	mA
I_{DDSTOP}	CC	P	STOP mode current[12]	No clocks active	T_A = 25 °C	—	0.4	3	mA
		C			T_A = 125 °C	—	16	95	mA
$I_{DDSTDBY3}$ (96 KB RAM retained)	CC	P	STANDBY3 mode current[13]	No clocks active	T_A = 25 °C	—	50	99	µA
		C			T_A = 125 °C	—	630	3200	µA
$I_{DDSTDBY2}$ (64 KB RAM retained)	CC	C	STANDBY2 mode current[14]	No clocks active	T_A = 25 °C	—	40	94	µA
		C			T_A = 125 °C	—	500	2500	µA
$I_{DDSTDBY1}$ (8 KB RAM retained)	CC	C	STANDBY1 mode current[15]	No clocks active	T_A = 25 °C	—	25	87	µA
		C			T_A = 125 °C	—	230	1250	µA
Adders in LP mode	CC	T	32 KHz OSC	—	T_A = 25 °C	—	—	5	µA
			4–40 MHz OSC	—	T_A = 25 °C	—	—	3	mA
			16 MHz IRC	—	T_A = 25 °C	—	—	500	µA
			128 KHz IRC	—	T_A = 25 °C	—	—	5	µA

NOTES:

1. Except for I_{DDMAX}, all the current values are total current drawn from $V_{DD\_HV\_A}$.
2. V_{DD} = 3.3 V ± 10% / 5.0 V ± 10%, T_A = –40 to 125 °C, unless otherwise specified All temperatures are based on an ambient temperature.
3. Target typical current consumption for the following typical operating conditions and configuration. Process = typical, Voltage = 1.2 V.
4. Target maximum current consumption for mode observed under typical operating conditions. Process = Fast, Voltage = 1.32 V.
5. Running consumption is given on voltage regulator supply (V_{DDREG}). It does not include consumption linked to I/Os toggling. This value is highly dependent on the application. The given value is thought to be a worst case value with all cores and peripherals running, and code fetched from code flash while modify operation on-going on data flash. It is to be noticed that this value can be significantly reduced by application: switch-off not used peripherals (default), reduce peripheral frequency through internal prescaler, fetch from RAM most used functions, use low power mode when possible.
6. Higher current may sunk by device during power-up and standby exit. Please refer to in rush current in Table 22.
7. Maximum “allowed” current is package dependent.
8. Only for the “P” classification: Code fetched from RAM: Serial IPs CAN and LIN in loop back mode, DSPI as Master, PLL as system Clock (4 x Multiplier) peripherals on (eMIOS/CTU/ADC) and running at max frequency, periodic SW/WDG timer reset enabled. RUN current measured with typical application with accesses on both code flash and RAM.

To complete these trials, ESD stress can be applied directly on the device. When unexpected behavior is detected, the software can be hardened to prevent unrecoverable errors occurring.

4.11.2 Electromagnetic interference (EMI)

The product is monitored in terms of emission based on a typical application. This emission test conforms to the IEC61967-1 standard, which specifies the general conditions for EMI measurements.

Table 31. EMI radiated emission measurement[1,2]

Symbol		C	Parameter	Conditions		Value			Unit
						Min	Typ	Max	
—	SR	—	Scan range	—		0.150		1000	MHz
f_{CPU}	SR	—	Operating frequency	—		—	120	—	MHz
V_{DD_LV}	SR	—	LV operating voltages	—		—	1.28	—	V
S_{EMI}	CC	T	Peak level	V_{DD} = 5 V, T_A = 25 °C, LQFP176 package Test conforming to IEC 61967-2, f_{OSC} = 40 MHz/f_{CPU} = 120 MHz	No PLL frequency modulation	—	—	18	dBµV
					± 2% PLL frequency modulation	—	—	14[3]	dBµV

NOTES:
1. EMI testing and I/O port waveforms per IEC 61967-1, -2, -4.
2. For information on conducted emission and susceptibility measurement (norm IEC 61967-4), please contact your local marketing representative.
3. All values need to be confirmed during device validation.

4.11.3 Absolute maximum ratings (electrical sensitivity)

Based on two different tests (ESD and LU) using specific measurement methods, the product is stressed in order to determine its performance in terms of electrical sensitivity.

4.11.3.1 Electrostatic discharge (ESD)

Electrostatic discharges (a positive then a negative pulse separated by 1 second) are applied to the pins of each sample according to each pin combination. The sample size depends on the number of supply pins in the device (3 parts × (n+1) supply pin). This test conforms to the AEC-Q100-002/-003/-011 standard.

Table 32. ESD absolute maximum ratings[1,2]

Symbol	Ratings	Conditions	Class	Max value[3]	Unit
$V_{ESD(HBM)}$	Electrostatic discharge voltage (Human Body Model)	T_A = 25 °C conforming to AEC-Q100-002	H1C	2000	V
$V_{ESD(MM)}$	Electrostatic discharge voltage (Machine Model)	T_A = 25 °C conforming to AEC-Q100-003	M2	200	
$V_{ESD(CDM)}$	Electrostatic discharge voltage (Charged Device Model)	T_A = 25 °C conforming to AEC-Q100-011	C3A	500	
				750 (corners)	

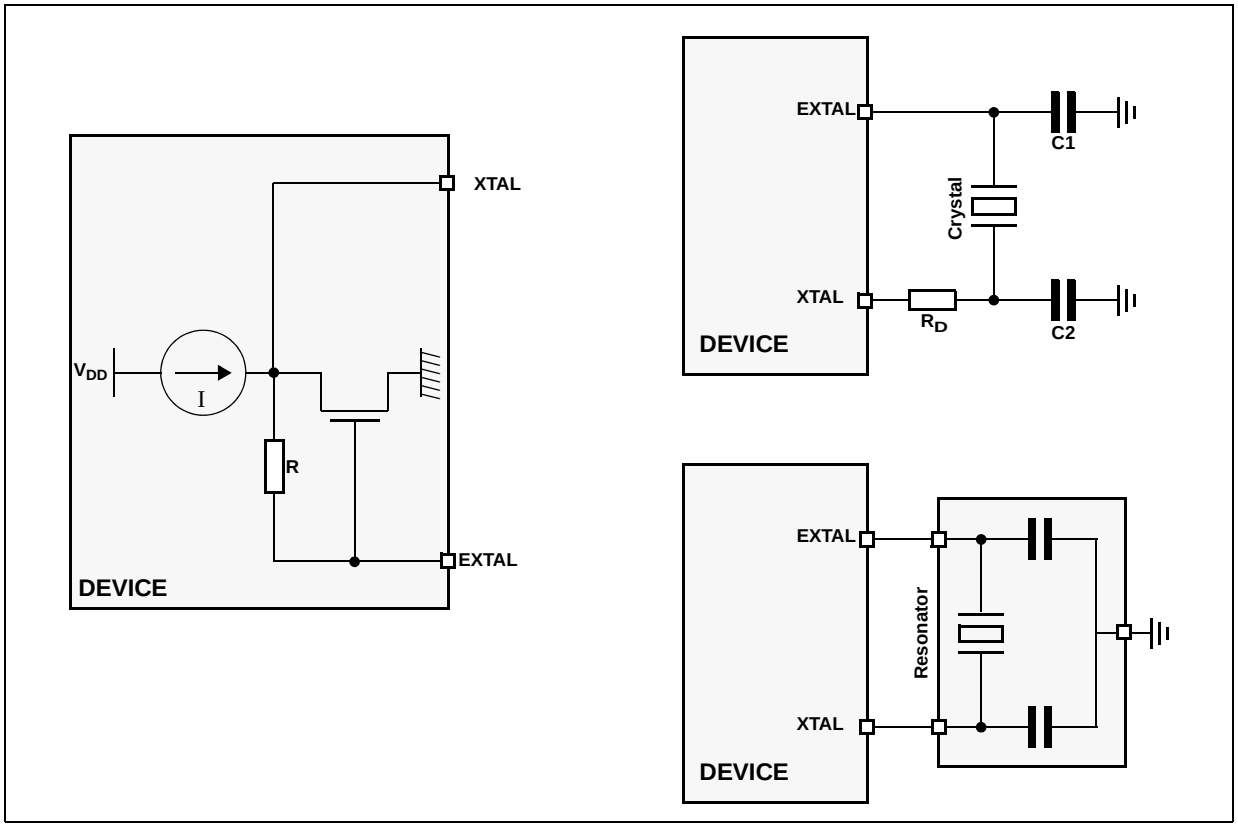

Figure 10. Crystal oscillator and resonator connection scheme

NOTE

XTAL/EXTAL must not be directly used to drive external circuits.

Table 34. Crystal description

Nominal frequency (MHz)	NDK crystal reference	Crystal equivalent series resistance ESR Ω	Crystal motional capacitance (C_m) fF	Crystal motional inductance (L_m) mH	Load on xtalin/xtalout C1 = C2 (pF)[1]	Shunt capacitance between xtalout and xtalin C0[2] (pF)
4	NX8045GB	300	2.68	591.0	21	2.93
8	NX5032GA	300	2.46	160.7	17	3.01
10		150	2.93	86.6	15	2.91
12		120	3.11	56.5	15	2.93
16		120	3.90	25.3	10	3.00
40	NX5032GA	50	6.18	2.56	8	3.49

NOTES:
1 The values specified for C1 and C2 are the same as used in simulations. It should be ensured that the testing includes all the parasitics (from the board, probe, crystal, etc.) as the AC / transient behavior depends upon them.
2 The value of C0 specified here includes 2 pF additional capacitance for parasitics (to be seen with bond-pads, package, etc.).

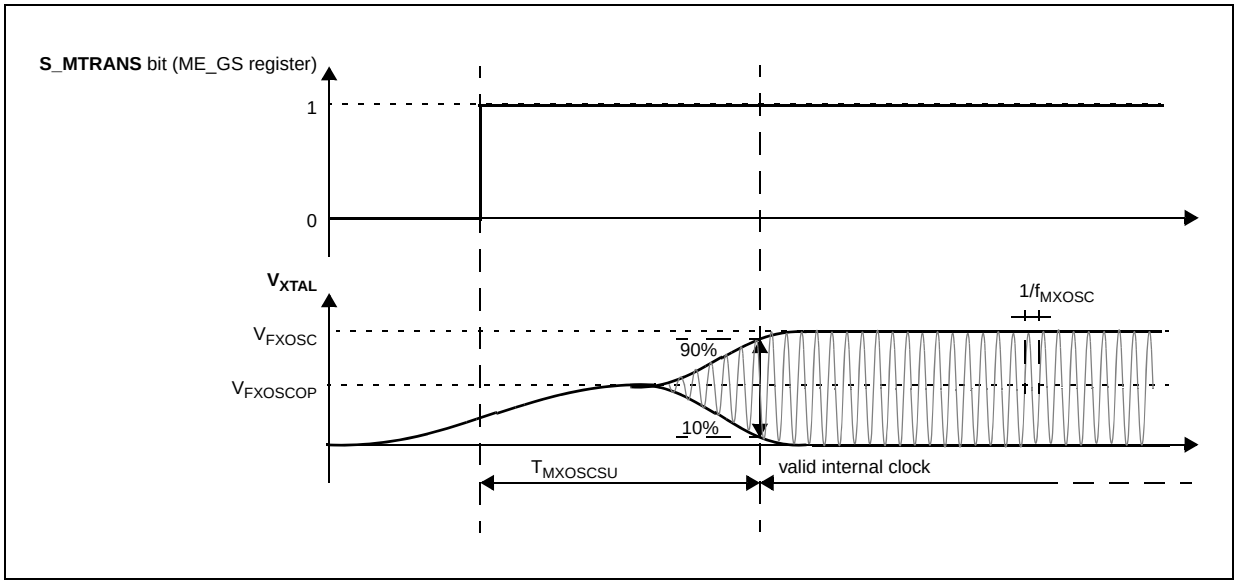

Figure 11. Fast external crystal oscillator (4 to 40 MHz) electrical characteristics

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

Symbol		C	Parameter	Conditions[1]	Value[2]			Unit
					Min	Typ	Max	
f_{FXOSC}	SR	—	Fast external crystal oscillator frequency	—	4.0	—	40.0	MHz
g_{mFXOSC}	CC	C	Fast external crystal oscillator transconductance	V_{DD} = 3.3 V ± 10%	4[3]	—	20[3]	mA/V
				V_{DD} = 5.0 V ± 10%	4[3]	—	20[3]	
V_{FXOSC}	CC	T	Oscillation amplitude at EXTAL	f_{OSC} = 40 MHz For both V_{DD} = 3.3 V ± 10%, V_{DD} = 5.0 V ± 10%	—	0.95	—	V
$V_{FXOSCOP}$	CC	P	Oscillation operating point	—	—	1.8		V
I_{FXOSC},[4]	CC	T	Fast external crystal oscillator consumption	V_{DD} = 3.3 V ± 10%, f_{OSC} = 40 MHz	—	2	2.2	mA
				V_{DD} = 5.0 V ± 10%, f_{OSC} = 40 MHz	—	2.3	2.5	
				V_{DD} = 3.3 V ± 10%, f_{OSC} = 16 MHz	—	1.3	1.5	
				V_{DD} = 5.0 V ± 10%, f_{OSC} = 16 MHz	—	1.6	1.8	
$T_{FXOSCSU}$	CC	T	Fast external crystal oscillator start-up time	f_{OSC} = 40 MHz For both V_{DD} = 3.3 V ± 10%, V_{DD} = 5.0 V ± 10%	—	—	5	ms

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 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.

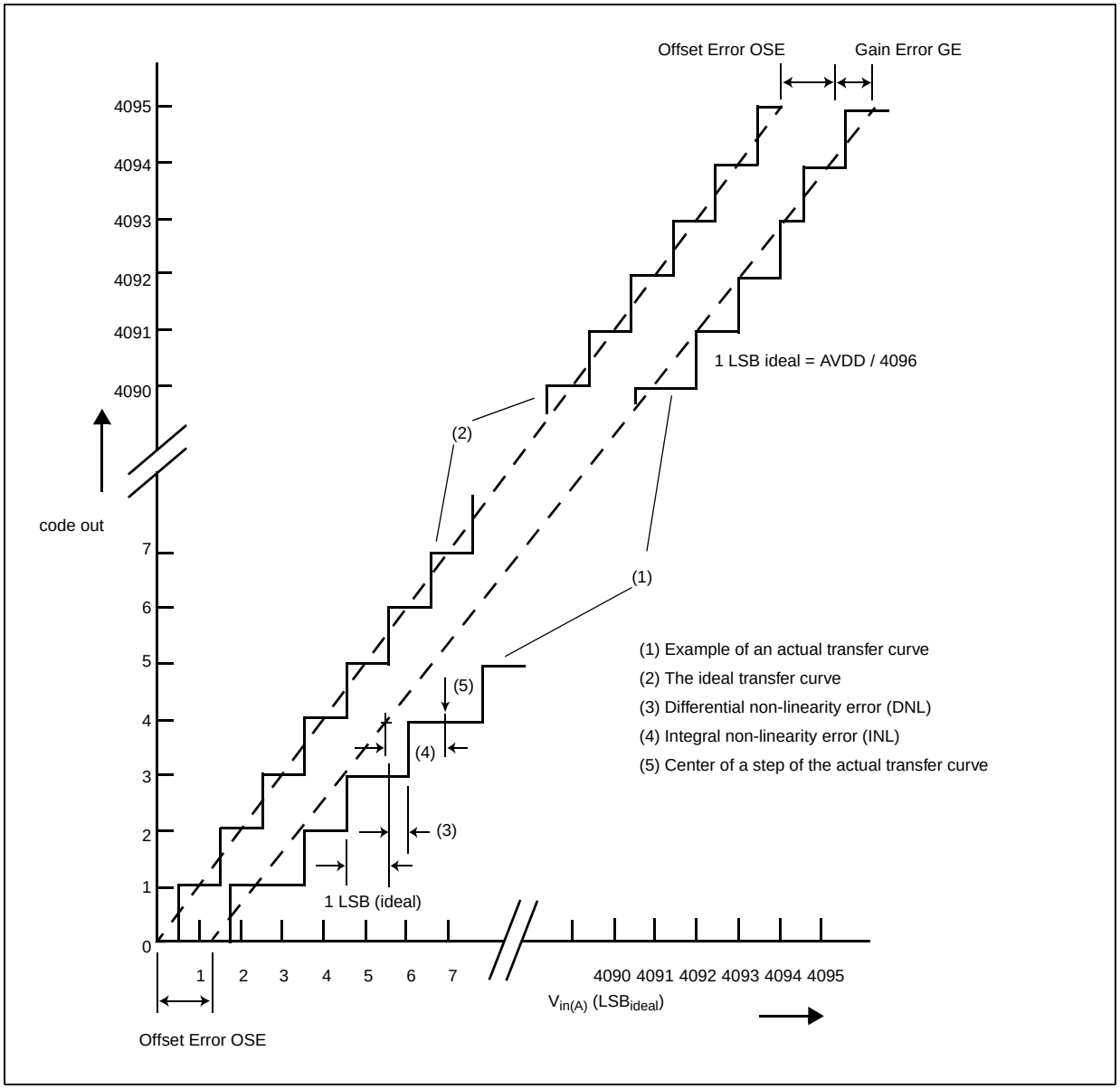

Figure 20. ADC_1 characteristic and error definitions

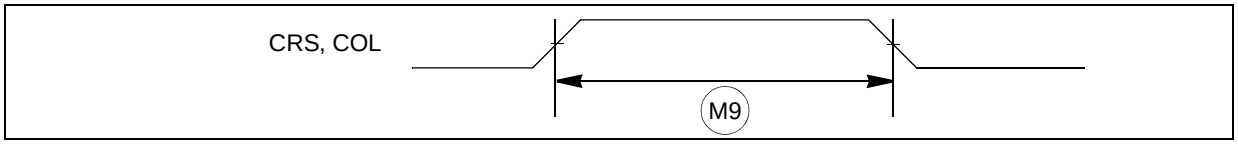

Figure 23. MII async inputs timing diagram

4.18.4 MII Serial Management Channel Timing (MDIO and MDC)

The FEC functions correctly with a maximum MDC frequency of 2.5 MHz.

Table 47. MII serial management channel timing[1]

Spec	Characteristic	Min	Max	Unit
M10	MDC falling edge to MDIO output invalid (minimum propagation delay)	0	—	ns
M11	MDC falling edge to MDIO output valid (max prop delay)	—	25	ns
M12	MDIO (input) to MDC rising edge setup	28	—	ns
M13	MDIO (input) to MDC rising edge hold	0	—	ns
M14	MDC pulse width high	40%	60%	MDC period
M15	MDC pulse width low	40%	60%	MDC period

NOTES:
1 Output pads configured with SRE = 0b11.

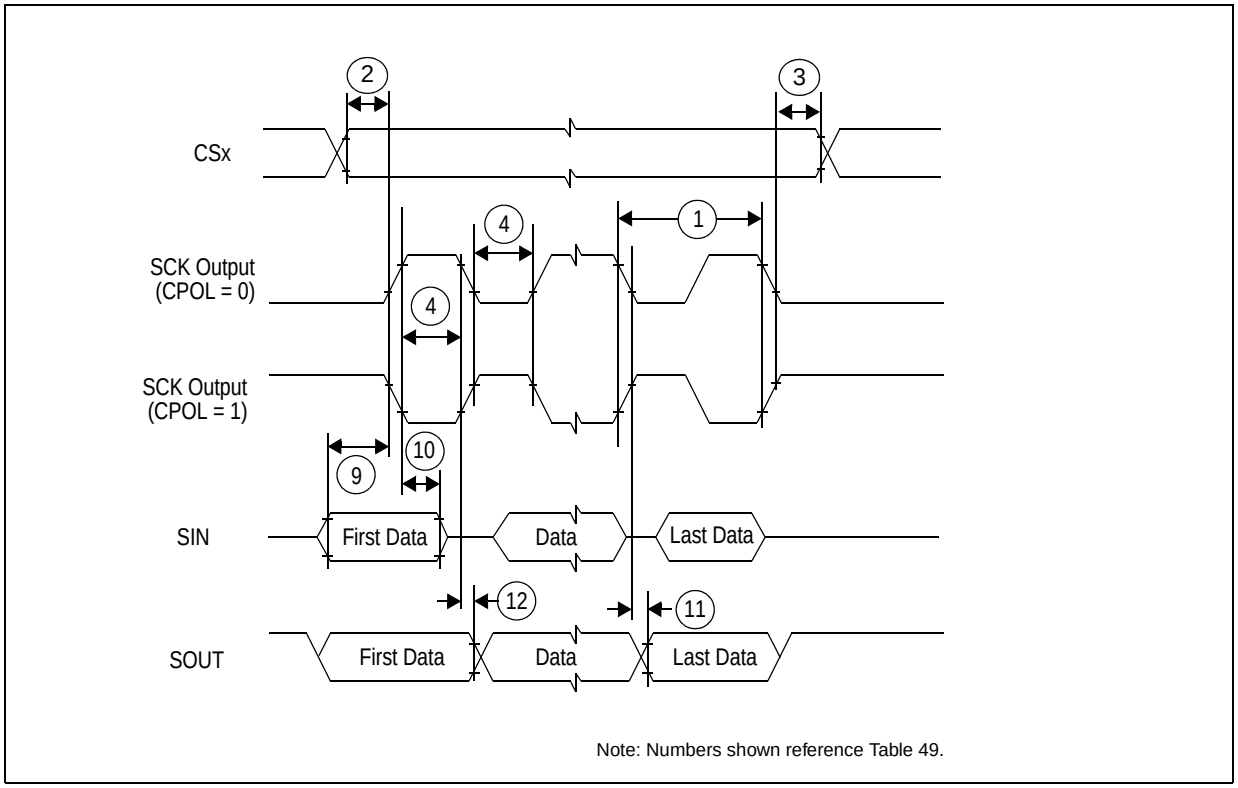

Figure 25. DSPI classic SPI timing–master, CPHA = 0

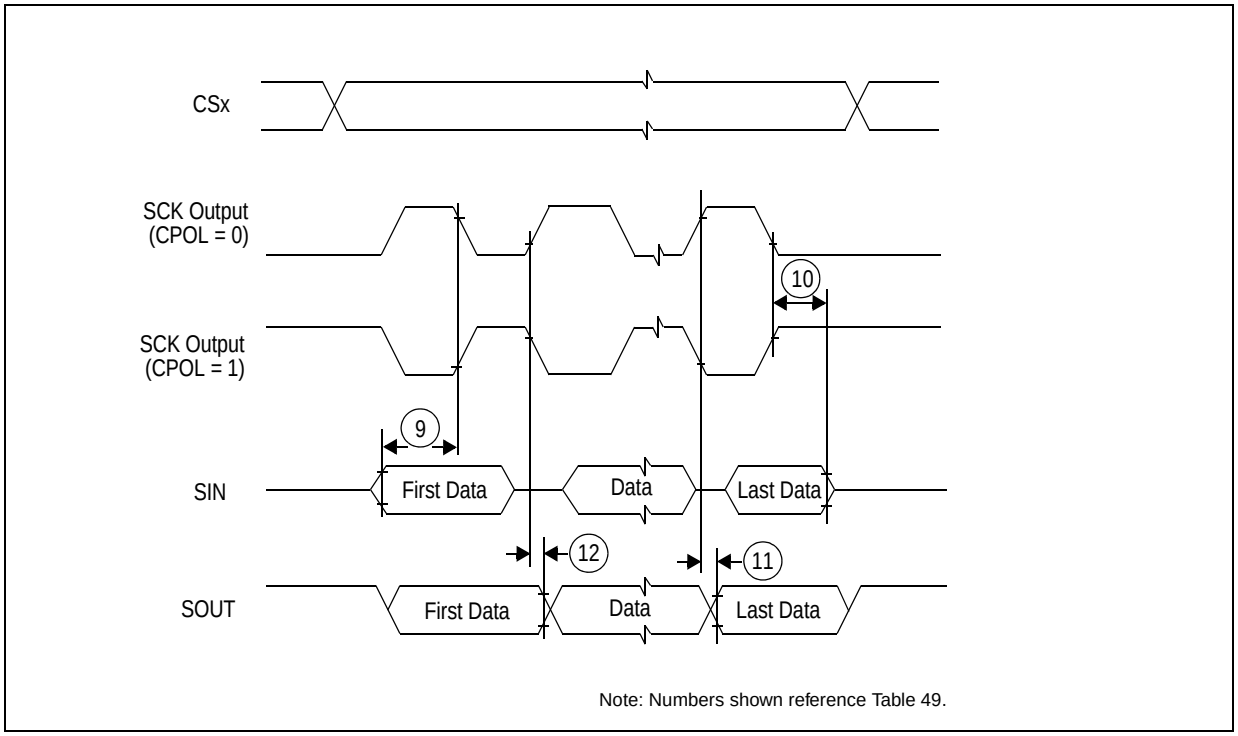

Figure 26. DSPI classic SPI timing–master, CPHA = 1

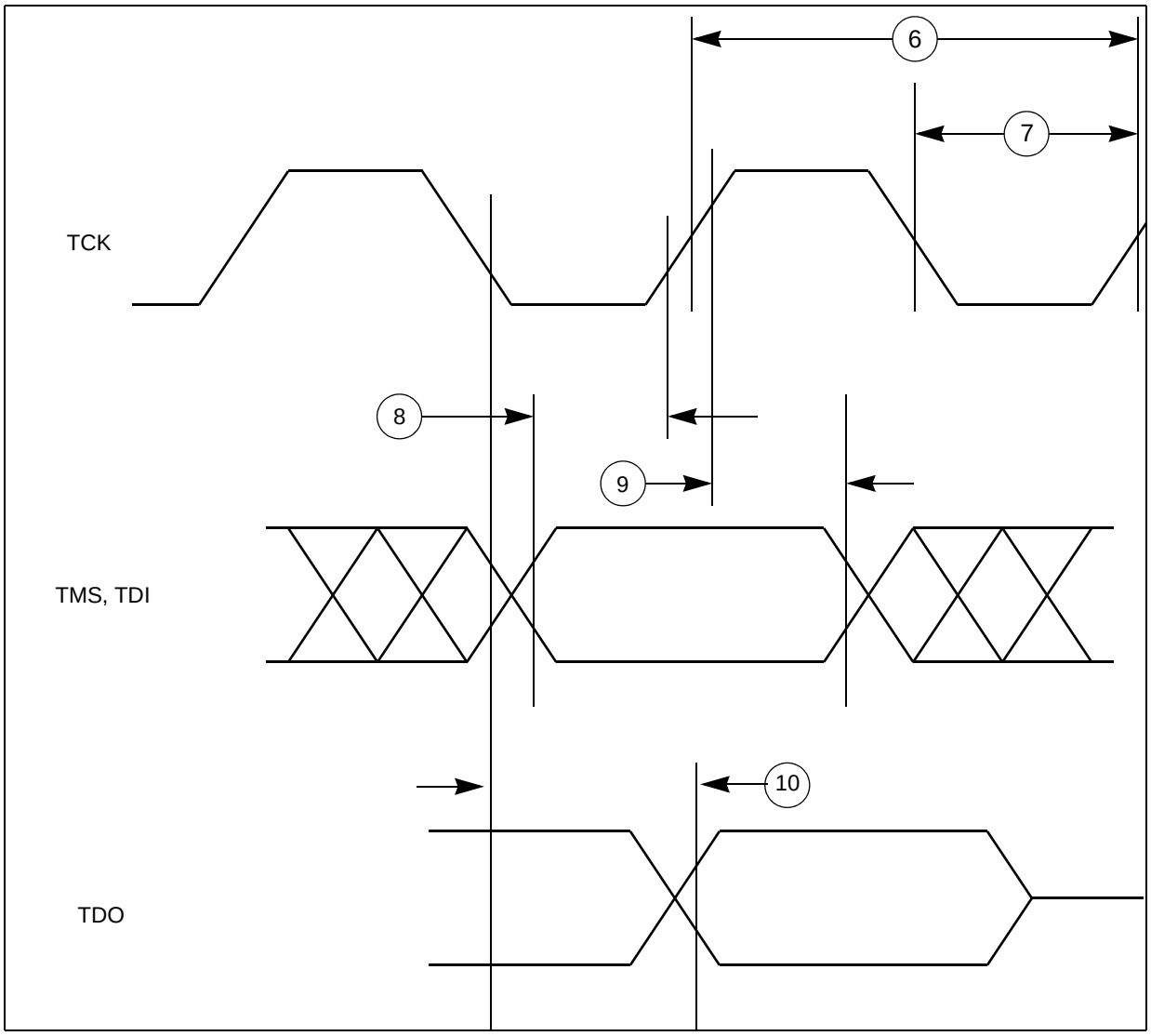

Figure 35. Nexus TDI, TMS, TDO timing

4.19.4 JTAG characteristics

Table 51. JTAG characteristics

No.	Symbol		C	Parameter	Value			Unit
					Min	Typ	Max	
1	t_{JCYC}	CC	D	TCK cycle time	64	—	—	ns
2	t_{TDIS}	CC	D	TDI setup time	10	—	—	ns
3	t_{TDIH}	CC	D	TDI hold time	5	—	—	ns
4	t_{TMSS}	CC	D	TMS setup time	10	—	—	ns
5	t_{TMSH}	CC	D	TMS hold time	5	—	—	ns

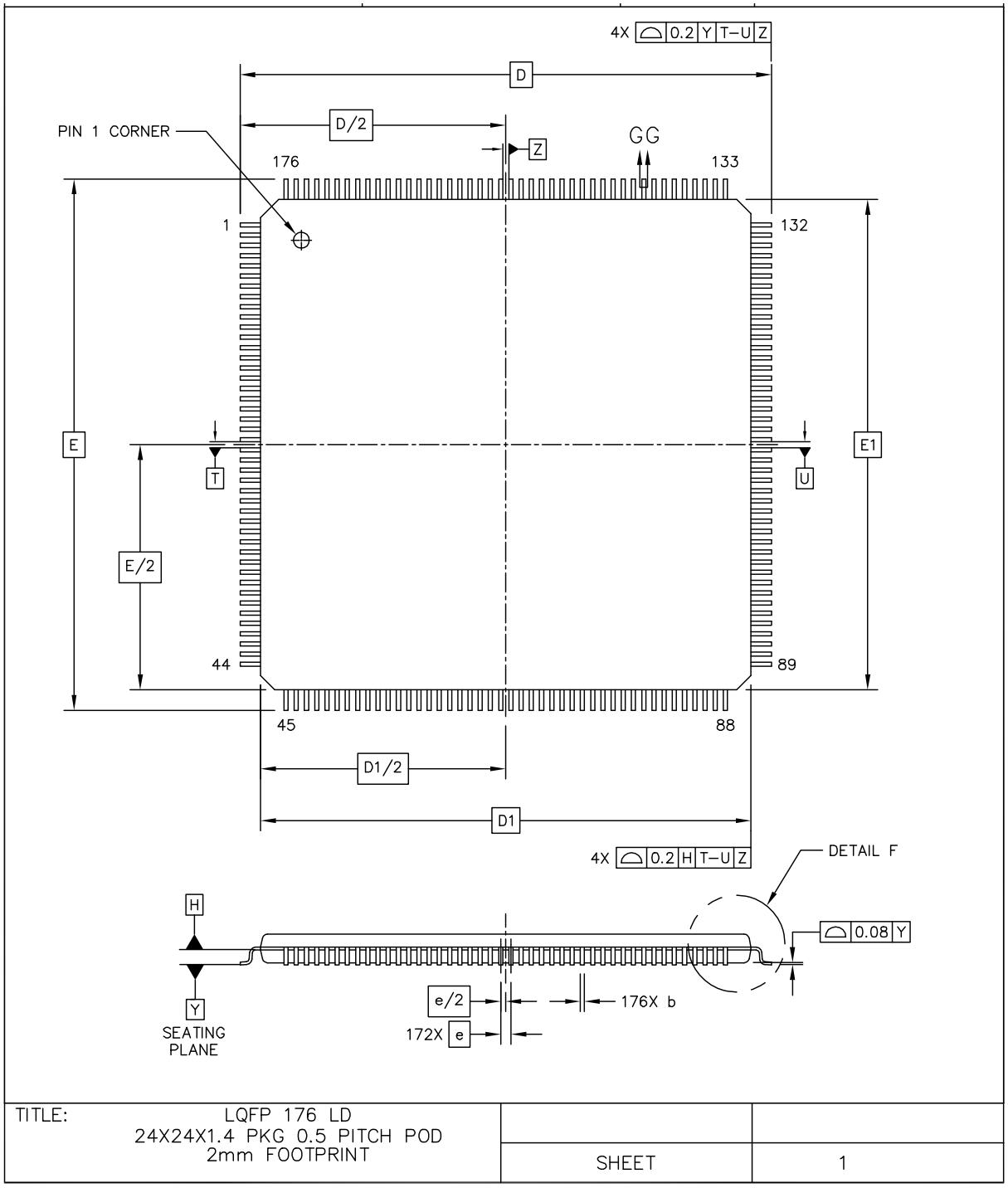

Figure 37. 176 LQFP mechanical drawing (Part 1 of 3)

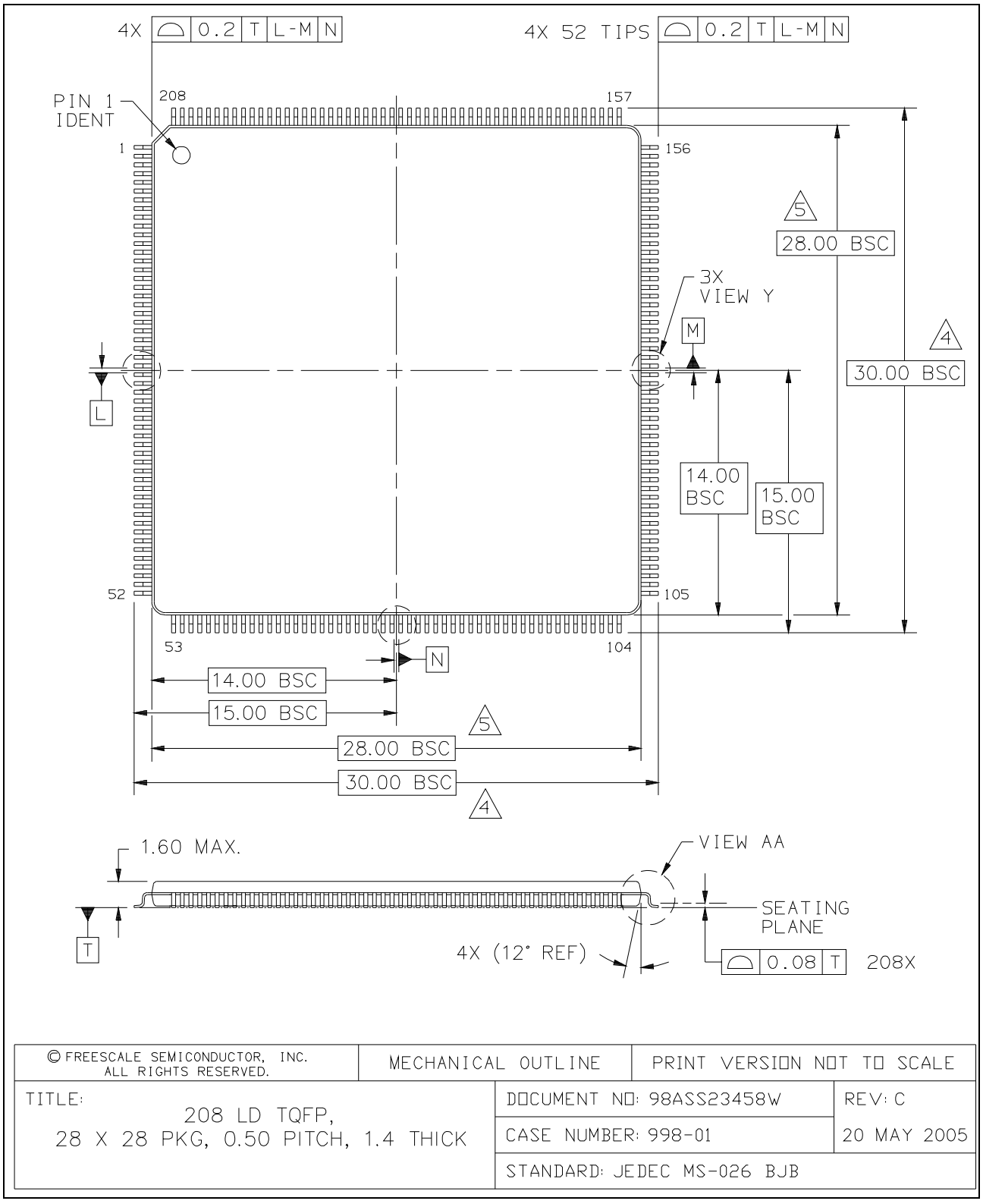

Figure 40. 208 LQFP mechanical drawing (Part 1 of 3)