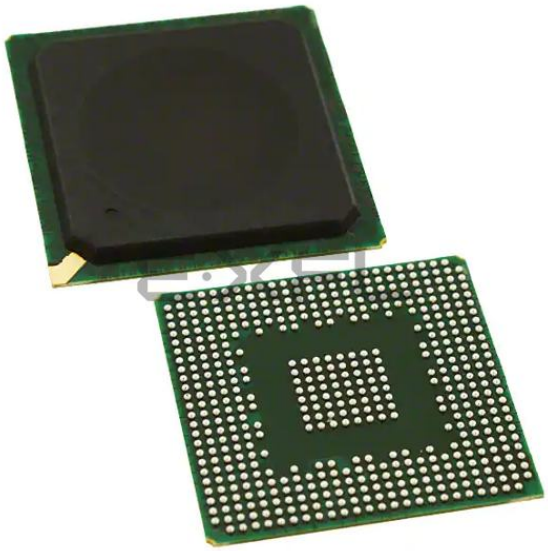

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Understanding Embedded - Microprocessors

Embedded microprocessors are specialized computing chips designed to perform specific tasks within an embedded system. Unlike general-purpose microprocessors found in personal computers, embedded microprocessors are tailored for dedicated functions within larger systems, offering optimized performance, efficiency, and reliability. These microprocessors are integral to the operation of countless electronic devices, providing the computational power necessary for controlling processes, handling data, and managing communications.

Applications of Embedded - Microprocessors

Embedded microprocessors are utilized across a broad spectrum of applications, making them indispensable in

Details	
Product Status	Obsolete
Core Processor	PowerPC e300c3
Number of Cores/Bus Width	1 Core, 32-Bit
Speed	267MHz
Co-Processors/DSP	Security; SEC 2.2
RAM Controllers	DDR, DDR2
Graphics Acceleration	No
Display & Interface Controllers	-
Ethernet	10/100/1000Mbps (2)
SATA	-
USB	USB 2.0 + PHY (1)
Voltage - I/O	1.8V, 2.5V, 3.3V
Operating Temperature	0°C ~ 105°C (TA)
Security Features	Cryptography
Package / Case	516-BBGA Exposed Pad
Supplier Device Package	516-TEPBGA (27x27)
Purchase URL	https://www.e-xfl.com/product-detail/nxp-semiconductors/kmpc8313ezqaddb

1.6 USB Dual-Role Controller

The MPC8313E USB controller includes the following features:

- Supports USB on-the-go mode, which includes both device and host functionality, when using an external ULPI (UTMI + low-pin interface) PHY
- Compatible with *Universal Serial Bus Specification, Rev. 2.0*
- Supports operation as a stand-alone USB device
  - Supports one upstream facing port
  - Supports three programmable USB endpoints
- Supports operation as a stand-alone USB host controller
  - Supports USB root hub with one downstream-facing port
  - Enhanced host controller interface (EHCI) compatible
- Supports high-speed (480 Mbps), full-speed (12 Mbps), and low-speed (1.5 Mbps) operation. Low-speed operation is supported only in host mode.
- Supports UTMI + low pin interface (ULPI) or on-chip USB 2.0 full-speed/high-speed PHY

1.7 Dual Enhanced Three-Speed Ethernet Controllers (eTSECs)

The MPC8313E eTSECs include the following features:

- Two RGMII/SGMII/MII/RMII/RTBI interfaces
- Two controllers designed to comply with IEEE Std 802.3®, 802.3u®, 802.3x®, 802.3z®, 802.3au®, and 802.3ab®
- Support for Wake-on-Magic Packet™, a method to bring the device from standby to full operating mode
- MII management interface for external PHY control and status
- Three-speed support (10/100/1000 Mbps)
- On-chip high-speed serial interface to external SGMII PHY interface
- Support for IEEE Std 1588™
- Support for two full-duplex FIFO interface modes
- Multiple PHY interface configuration
- TCP/IP acceleration and QoS features available
- IP v4 and IP v6 header recognition on receive
- IP v4 header checksum verification and generation
- TCP and UDP checksum verification and generation
- Per-packet configurable acceleration
- Recognition of VLAN, stacked (queue in queue) VLAN, IEEE Std 802.2®, PPPoE session, MPLS stacks, and ESP/AH IP-security headers
- Transmission from up to eight physical queues.
- Reception to up to eight physical queues

Table 2. Recommended Operating Conditions

Characteristic	Symbol	Recommended Value[1]	Unit	Current Requirement
Core supply voltage	V_{DD}	1.0 V ± 50 mV	V	469 mA
Internal core logic constant power	V_{DDC}	1.0 V ± 50 mV	V	377 mA
SerDes internal digital power	$XCOREV_{DD}$	1.0	V	170 mA
SerDes internal digital ground	$XCOREV_{SS}$	0.0	V	—
SerDes I/O digital power	$XPADV_{DD}$	1.0	V	10 mA
SerDes I/O digital ground	$XPADV_{SS}$	0.0	V	—
SerDes analog power for PLL	$SDAV_{DD}$	1.0 V ± 50 mV	V	10 mA
SerDes analog ground for PLL	$SDAV_{SS}$	0.0	V	—
Dedicated 3.3 V analog power for USB PLL	USB_PLL_PWR3	3.3 V ± 300 mV	V	2–3 mA
Dedicated 1.0 V analog power for USB PLL	USB_PLL_PWR1	1.0 V ± 50 mV	V	2–3 mA
Dedicated analog ground for USB PLL	USB_PLL_GND	0.0	V	—
Dedicated USB power for USB bias circuit	USB_VDDA_BIAS	3.3 V ± 300 mV	V	4–5 mA
Dedicated USB ground for USB bias circuit	USB_VSSA_BIAS	0.0	V	—
Dedicated power for USB transceiver	USB_VDDA	3.3 V ± 300 mV	V	75 mA
Dedicated ground for USB transceiver	USB_VSSA	0.0	V	—
Analog power for e300 core APLL	AV_{DD1} [6]	1.0 V ± 50 mV	V	2–3 mA
Analog power for system APLL	AV_{DD2} [6]	1.0 V ± 50 mV	V	2–3 mA
DDR1 DRAM I/O voltage (333 MHz, 32-bit operation)	GV_{DD}	2.5 V ± 125 mV	V	131 mA
DDR2 DRAM I/O voltage (333 MHz, 32-bit operation)	GV_{DD}	1.8 V ± 80 mV	V	140 mA
Differential reference voltage for DDR controller	MV_{REF}	1/2 DDR supply ($0.49 \times GV_{DD}$ to $0.51 \times GV_{DD}$)	V	—
Standard I/O voltage	NV_{DD}	3.3 V ± 300 mV[2]	V	74 mA
eTSEC2 I/O supply	LV_{DDA}	2.5 V ± 125 mV/ 3.3 V ± 300 mV	V	22 mA
eTSEC1/USB DR I/O supply	LV_{DDB}	2.5 V ± 125 mV/ 3.3 V ± 300 mV	V	44 mA
Supply for eLBC IOs	LV_{DD}	3.3 V ± 300 mV	V	16 mA
Analog and digital ground	V_{SS}	0.0	V	—
Junction temperature range	T_A/T_J [3]	0 to 105	°C	

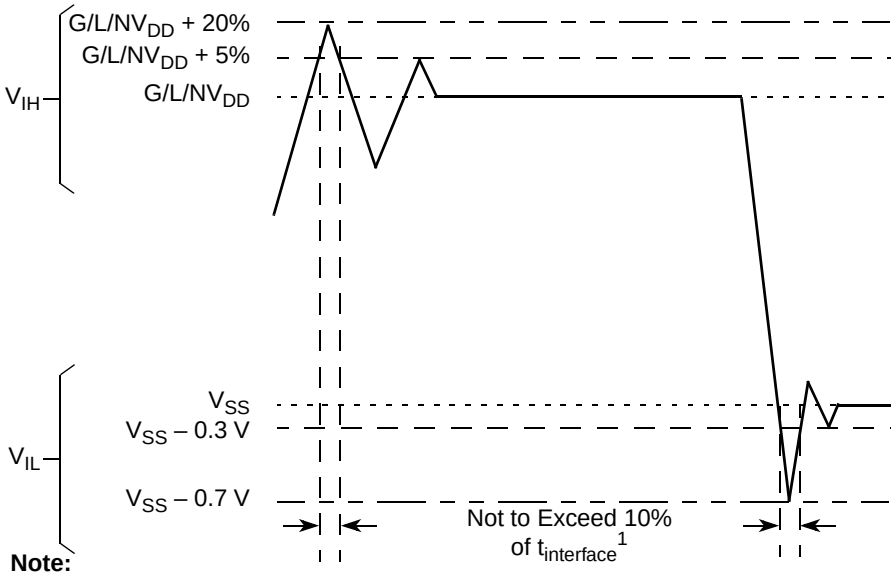
Table 2. Recommended Operating Conditions (continued)

Characteristic	Symbol	Recommended Value[1]	Unit	Current Requirement

Note:

1. GV_{DD}, NV_{DD}, AV_{DD}, and V_{DD} must track each other and must vary in the same direction—either in the positive or negative direction.
2. Some GPIO pins may operate from a 2.5-V supply when configured for other functions.
3. Min temperature is specified with T_A; Max temperature is specified with T_J.
4. All Power rails must be connected and power applied to the MPC8313 even if the IP interfaces are not used.
5. All I/O pins should be interfaced with peripherals operating at same voltage level.
6. This voltage is the input to the filter discussed in Section 22.2, "PLL Power Supply Filtering" and not necessarily the voltage at the AVDD pin, which may be reduced from VDD by the filter.

This figure shows the undershoot and overshoot voltages at the interfaces of the MPC8313E.



Note:

1. Note that $t_{interface}$ refers to the clock period associated with the bus clock interface.

Figure 2. Overshoot/Undershoot Voltage for GV_{DD}/NV_{DD}/LV_{DD}

2.1.3 Output Driver Characteristics

This table provides information on the characteristics of the output driver strengths.

Table 3. Output Drive Capability

Driver Type	Output Impedance (Ω)	Supply Voltage
Local bus interface utilities signals	42	NV_{DD} = 3.3 V
PCI signals	25	
DDR signal	18	GV_{DD} = 2.5 V

Table 5. MPC8313E Typical I/O Power Dissipation (continued)

Interface	Parameter	GV_{DD} (1.8 V)	GV_{DD} (2.5 V)	NV_{DD} (3.3 V)	LV_{DDA}/ LV_{DDB} (3.3 V)	LV_{DDA}/ LV_{DDB} (2.5 V)	LV_{DD} (3.3 V)	Unit	Comments
USBDR controller load = 20 pF	60 MHz	—	—	—	0.078	—	—	W	—
Other I/O	—	—	—	0.015	—	—	—	W	—

This table shows the estimated core power dissipation of the MPC8313E while transitioning into the D3 warm low-power state.

Table 6. MPC8313E Low-Power Modes Power Dissipation[1]

333-MHz Core, 167-MHz CSB[2]	Rev. 1.0[3]	Rev. 2.x or Later[3]	Unit
D3 warm	400	425	mW

Note:

1. All interfaces are enabled. For further power savings, disable the clocks to unused blocks.
2. The interfaces are run at the following frequencies: DDR: 333 MHz, eLBC 83 MHz, PCI 33 MHz, eTSEC1 and TSEC2: 167 MHz, SEC: 167 MHz, USB: 167 MHz. See the SCCR register for more information.
3. This is maximum power in D3 Warm based on a voltage of 1.05 V and a junction temperature of 105°C.

4 Clock Input Timing

This section provides the clock input DC and AC electrical characteristics for the MPC8313E.

4.1 DC Electrical Characteristics

This table provides the system clock input (SYS_CLK_IN/PCI_SYNC_IN) DC timing specifications for the MPC8313E.

Table 7. SYS_CLK_IN DC Electrical Characteristics

Parameter	Condition	Symbol	Min	Max	Unit
Input high voltage	—	V_{IH}	2.4	NV_{DD} + 0.3	V
Input low voltage	—	V_{IL}	–0.3	0.4	V
SYS_CLK_IN input current	$0 V \le V_{IN} \le NV_{DD}$	I_{IN}	—	±10	μA
PCI_SYNC_IN input current	$0 V \le V_{IN} \le 0.5 V$ or $NV_{DD} – 0.5 V \le V_{IN} \le NV_{DD}$	I_{IN}	—	±10	μA
PCI_SYNC_IN input current	$0.5 V \le V_{IN} \le NV_{DD} – 0.5 V$	I_{IN}	—	±50	μA

4.2 AC Electrical Characteristics

The primary clock source for the MPC8313E can be one of two inputs, SYS_CLK_IN or PCI_CLK, depending on whether the device is configured in PCI host or PCI agent mode. This table provides the system clock input (SYS_CLK_IN/PCI_CLK) AC timing specifications for the MPC8313E.

Table 8. SYS_CLK_IN AC Timing Specifications

Parameter/Condition	Symbol	Min	Typ	Max	Unit	Note
SYS_CLK_IN/PCI_CLK frequency	$f_{SYS\_CLK\_IN}$	24	—	66.67	MHz	1
SYS_CLK_IN/PCI_CLK cycle time	$t_{SYS\_CLK\_IN}$	15	—	—	ns	—
SYS_CLK_IN rise and fall time	t_{KH}, t_{KL}	0.6	0.8	4	ns	2
PCI_CLK rise and fall time	t_{PCH}, t_{PCL}	0.6	0.8	1.2	ns	2
SYS_CLK_IN/PCI_CLK duty cycle	$t_{KHK}/t_{SYS\_CLK\_IN}$	40	—	60	%	3
SYS_CLK_IN/PCI_CLK jitter	—	—	—	±150	ps	4, 5

Notes:
1. **Caution:** The system, core, security block must not exceed their respective maximum or minimum operating frequencies.
2. Rise and fall times for SYS_CLK_IN/PCI_CLK are measured at 0.4 and 2.4 V.
3. Timing is guaranteed by design and characterization.
4. This represents the total input jitter—short term and long term—and is guaranteed by design.
5. The SYS_CLK_IN/PCI_CLK driver's closed loop jitter bandwidth should be <500 kHz at –20 dB. The bandwidth must be set low to allow cascade-connected PLL-based devices to track SYS_CLK_IN drivers with the specified jitter.

5 RESET Initialization

This section describes the DC and AC electrical specifications for the reset initialization timing and electrical requirements of the MPC8313E.

5.1 RESET DC Electrical Characteristics

This table provides the DC electrical characteristics for the RESET pins.

Table 9. RESET Pins DC Electrical Characteristics

Characteristic	Symbol	Condition	Min	Max	Unit
Input high voltage	V_{IH}	—	2.1	NV_{DD} + 0.3	V
Input low voltage	V_{IL}	—	–0.3	0.8	V
Input current	I_{IN}	$0 V \le V_{IN} \le NV_{DD}$	—	±5	μA
Output high voltage	V_{OH}	I_{OH} = –8.0 mA	2.4	—	V
Output low voltage	V_{OL}	I_{OL} = 8.0 mA	—	0.5	V
Output low voltage	V_{OL}	I_{OL} = 3.2 mA	—	0.4	V

NOTE

For the ADDR/CMD setup and hold specifications in Table 21, it is assumed that the clock control register is set to adjust the memory clocks by 1/2 applied cycle.

This figure shows the DDR SDRAM output timing for the MCK to MDQS skew measurement (t_{DDKHMH}).

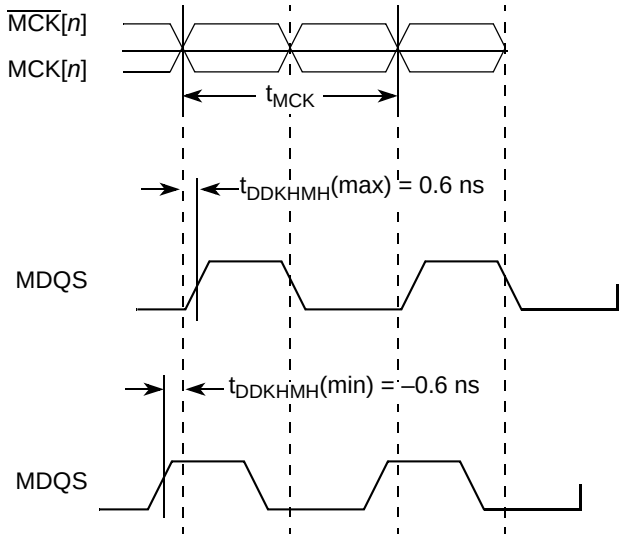


Figure 5. Timing Diagram for t_{DDKHMH}

This figure shows the DDR and DDR2 SDRAM output timing diagram.

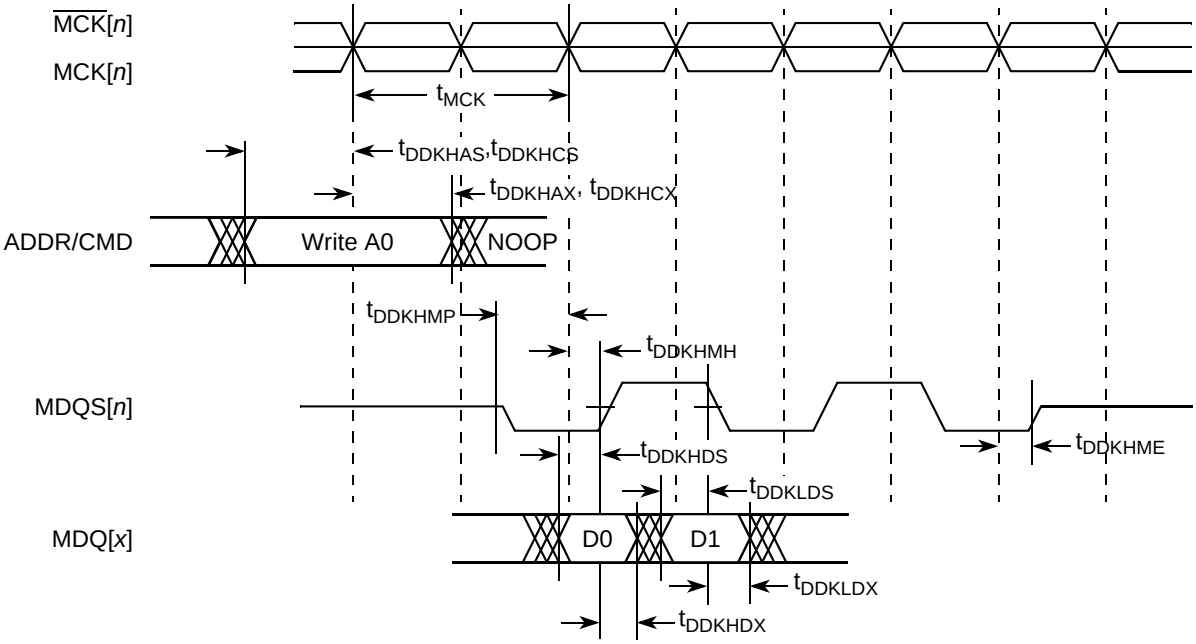


Figure 6. DDR and DDR2 SDRAM Output Timing Diagram

8.1 Enhanced Three-Speed Ethernet Controller (eTSEC) (10/100/1000 Mbps)—MII/RMII/RGMII/SGMII/RTBI Electrical Characteristics

The electrical characteristics specified here apply to all the media independent interface (MII), reduced gigabit media independent interface (RGMII), serial gigabit media independent interface (SGMII), and reduced ten-bit interface (RTBI) signals except management data input/output (MDIO) and management data clock (MDC). The RGMII and RTBI interfaces are defined for 2.5 V, while the MII interface can be operated at 3.3 V. The RMII and SGMII interfaces can be operated at either 3.3 or 2.5 V. The RGMII and RTBI interfaces follow the Hewlett-Packard reduced pin-count interface for *Gigabit Ethernet Physical Layer Device Specification Version 1.2*a (9/22/2000). The electrical characteristics for MDIO and MDC are specified in Section 8.5, "Ethernet Management Interface Electrical Characteristics."

8.1.1 TSEC DC Electrical Characteristics

All RGMII, RMII, and RTBI drivers and receivers comply with the DC parametric attributes specified in Table 24 and Table 25. The RGMII and RTBI signals are based on a 2.5-V CMOS interface voltage as defined by JEDEC EIA/JESD8-5.

NOTE

eTSEC should be interfaced with peripheral operating at same voltage level.

Table 24. MII DC Electrical Characteristics

Parameter	Symbol	Conditions		Min	Max	Unit
Supply voltage 3.3 V	LV_{DDA}/LV_{DDB}	—		2.97	3.63	V
Output high voltage	V_{OH}	I_{OH} = –4.0 mA	LV_{DDA} or LV_{DDB} = Min	2.40	LV_{DDA} + 0.3 or LV_{DDB} + 0.3	V
Output low voltage	V_{OL}	I_{OL} = 4.0 mA	LV_{DDA} or LV_{DDB} = Min	V_{SS}	0.50	V
Input high voltage	V_{IH}	—	—	2.0	LV_{DDA} + 0.3 or LV_{DDB} + 0.3	V
Input low voltage	V_{IL}	—	—	–0.3	0.90	V
Input high current	I_{IH}	V_{IN}[1] = LV_{DDA} or LV_{DDB}		—	40	μA
Input low current	I_{IL}	V_{IN}[1] = VSS		–600	—	μA

Note:
1. The symbol V_{IN}, in this case, represents the LV_{IN} symbol referenced in Table 1 and Table 2.

Table 25. RGMII/RTBI DC Electrical Characteristics

Parameters	Symbol	Conditions	Min	Max	Unit
Supply voltage 2.5 V	LV_{DDA}/LV_{DDB}	—	2.37	2.63	V

This figure shows the MII receive AC timing diagram.

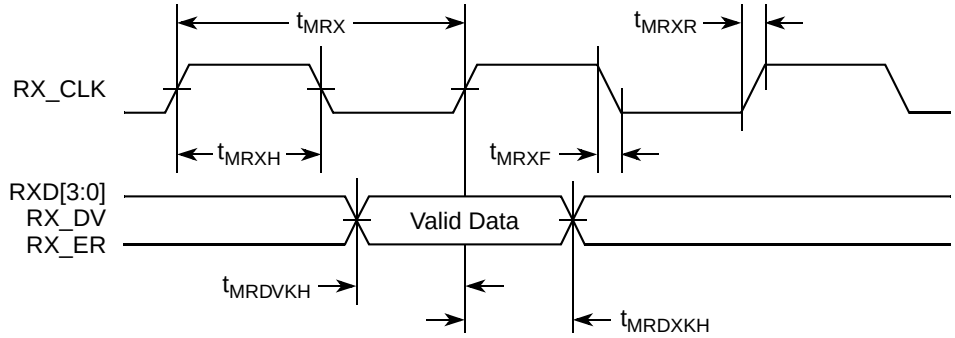


Figure 10. MII Receive AC Timing Diagram RMII AC Timing Specifications

8.2.1.3 RMII Transmit AC Timing Specifications

This table provides the RMII transmit AC timing specifications.

Table 28. RMII Transmit AC Timing Specifications

At recommended operating conditions with NV_{DD} of 3.3 V ± 0.3 V.

Parameter/Condition	Symbol[1]	Min	Typ	Max	Unit
REF_CLK clock	t_{RMX}	—	20	—	ns
REF_CLK duty cycle	t_{RMXH}/t_{RMX}	35	—	65	%
REF_CLK to RMII data TXD[1:0], TX_EN delay	$t_{RMTKHDX}$	2	—	10	ns
REF_CLK data clock rise V_{IL}(min) to V_{IH}(max)	t_{RMXR}	1.0	—	4.0	ns
REF_CLK data clock fall V_{IH}(max) to V_{IL}(min)	t_{RMXF}	1.0	—	4.0	ns

Note:

1. The symbols used for timing specifications follow the pattern of $t_{\text{(first three letters of functional block)(signal)(state)(reference)(state)}}$ for inputs and $t_{\text{(first two letters of functional block)(reference)(state)(signal)(state)}}$ for outputs. For example, $t_{RMTKHDX}$ symbolizes RMII transmit timing (RMT) for the time t_{RMX} clock reference (K) going high (H) until data outputs (D) are invalid (X). Note that, in general, the clock reference symbol representation is based on two to three letters representing the clock of a particular functional. For example, the subscript of t_{RMX} represents the RMII(RM) reference (X) clock. For rise and fall times, the latter convention is used with the appropriate letter: R (rise) or F (fall).

This figure shows the RMII transmit AC timing diagram.

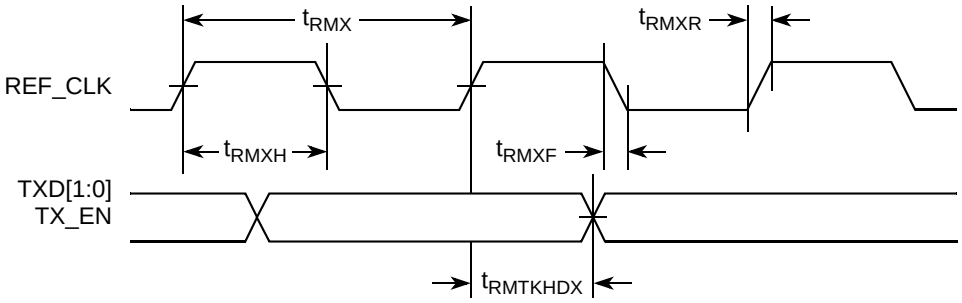


Figure 11. RMII Transmit AC Timing Diagram

8.3.2 AC Requirements for SGMII SD_REF_CLK and $\overline{\text{SD\_REF\_CLK}}$

This table lists the SGMII SerDes reference clock AC requirements. Note that SD_REF_CLK and $\overline{\text{SD\_REF\_CLK}}$ are not intended to be used with, and should not be clocked by, a spread spectrum clock source.

Table 31. SD_REF_CLK and $\overline{\text{SD\_REF\_CLK}}$ AC Requirements

Symbol	Parameter Description	Min	Typ	Max	Unit
t_{REF}	REFCLK cycle time	—	8	—	ns
t_{REFCJ}	REFCLK cycle-to-cycle jitter. Difference in the period of any two adjacent REFCLK cycles	—	—	100	ps
t_{REFPJ}	Phase jitter. Deviation in edge location with respect to mean edge location	–50	—	50	ps

8.3.3 SGMII Transmitter and Receiver DC Electrical Characteristics

Table 32 and Table 33 describe the SGMII SerDes transmitter and receiver AC-coupled DC electrical characteristics. Transmitter DC characteristics are measured at the transmitter outputs (SD_TX[*n*] and $\overline{\text{SD\_TX}}$[*n*]) as depicted in Figure 16.

Table 32. SGMII DC Transmitter Electrical Characteristics

Parameter	Symbol	Min	Typ	Max	Unit	Note
Supply voltage	$XCOREV_{DD}$	0.95	1.0	1.05	V	
Output high voltage	V_{OH}	—	—	$XCOREV_{DD\text{-}Typ}/2 + \lvert V_{OD}\rvert_{\text{-max}}/2$	mV	1
Output low voltage	V_{OL}	$XCOREV_{DD\text{-}Typ}/2 - \lvert V_{OD}\rvert_{\text{-max}}/2$	—	—	mV	1
Output ringing	V_{RING}	—	—	10	%	
Output differential voltage[2, 3]	$\lvert V_{OD}\rvert$	323	500	725	mV	Equalization setting: 1.0x
Output offset voltage	V_{OS}	425	500	575	mV	1, 4
Output impedance (single-ended)	R_O	40	—	60	Ω	
Mismatch in a pair	ΔR_O	—	—	10	%	
Change in V_{OD} between 0 and 1	$\Delta\lvert V_{OD}\rvert$	—	—	25	mV	
Change in V_{OS} between 0 and 1	ΔV_{OS}	—	—	25	mV	
Output current on short to GND	I_{SA}, I_{SB}	—	—	40	mA	

Notes:

1. This will not align to DC-coupled SGMII. $XCOREV_{DD\text{-}Typ}$ = 1.0 V.
2. $\lvert V_{OD}\rvert = \lvert V_{TXn} - V_{\overline{TXn}}\rvert$. $\lvert V_{OD}\rvert$ is also referred as output differential peak voltage. $V_{TX\text{-}DIFFp\text{-}p} = 2*\lvert V_{OD}\rvert$.
3. The $\lvert V_{OD}\rvert$ value shown in the Typ column is based on the condition of $XCOREV_{DD\text{-}Typ}$ = 1.0 V, no common mode offset variation (V_{OS} = 500 mV), SerDes transmitter is terminated with 100-Ω differential load between TX[*n*] and $\overline{\text{TX}}$[*n*].
4. V_{OS} is also referred to as output common mode voltage.

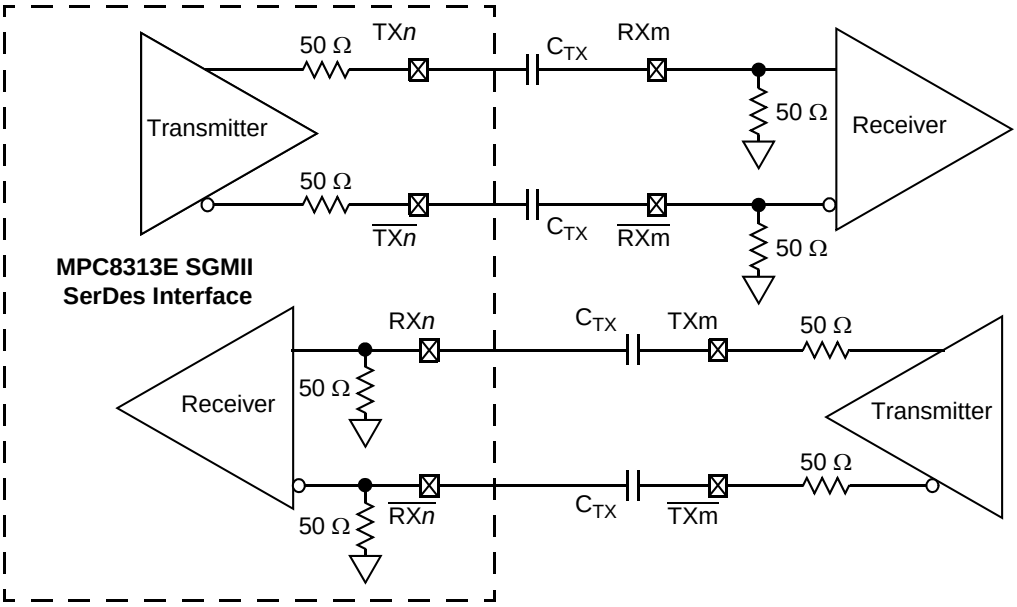


Figure 15. 4-Wire AC-Coupled SGMII Serial Link Connection Example

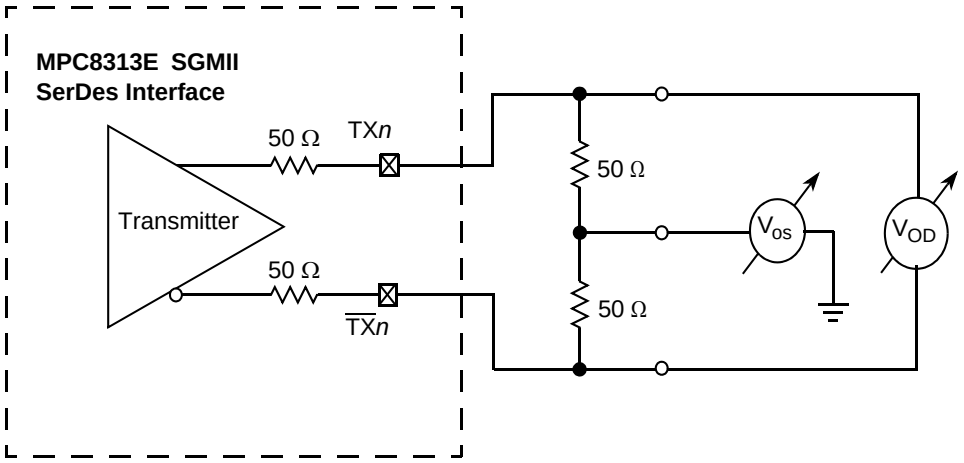


Figure 16. SGMII Transmitter DC Measurement Circuit

Table 33. SGMII DC Receiver Electrical Characteristics

Parameter	Symbol	Min	Typ	Max	Unit	Note
Supply voltage	$XCOREV_{DD}$	0.95	1.0	1.05	V	
DC Input voltage range			N/A			1
Input differential voltage	$V_{RX\_DIFFp\text{-}p}$	100	—	1200	mV	2
Loss of signal threshold	VL_{OS}	30	—	100	mV	
Input AC common mode voltage	$V_{CM\_ACp\text{-}p}$	—	—	100	mV	3
Receiver differential input impedance	Z_{RX_DIFF}	80	100	120	Ω	
Receiver common mode input impedance	Z_{RX_CM}	20	—	35	Ω	

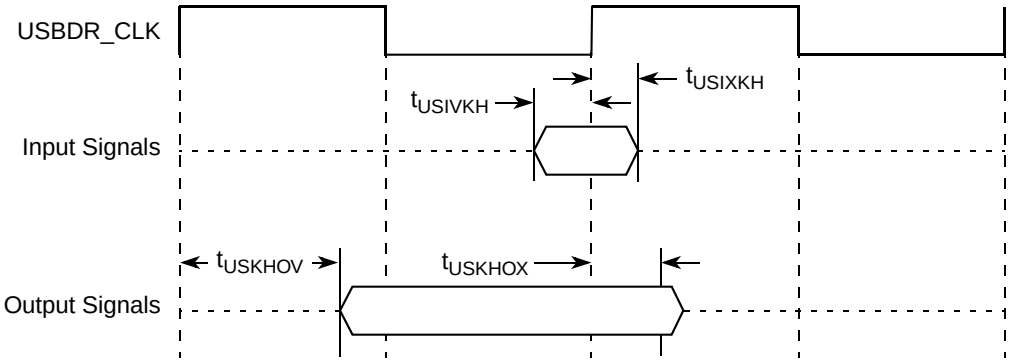


Figure 35. USB Signals

10.2 On-Chip USB PHY

This section describes the DC and AC electrical specifications for the on-chip USB PHY of the MPC8313E. See Chapter 7 in the *USB Specifications Rev. 2*, for more information.

This table provides the USB clock input (USB_CLK_IN) DC timing specifications.

Table 42. USB_CLK_IN DC Electrical Characteristics

Parameter	Symbol	Min	Max	Unit
Input high voltage	V_{IH}	2.7	NV_{DD} + 0.3	V
Input low voltage	V_{IL}	–0.3	0.4	V

This table provides the USB clock input (USB_CLK_IN) AC timing specifications.

Table 43. USB_CLK_IN AC Timing Specifications

Parameter/Condition	Conditions	Symbol	Min	Typ	Max	Unit
Frequency range	—	$f_{USB\_CLK\_IN}$	—	24	48	MHz
Clock frequency tolerance	—	t_{CLK_TOL}	–0.005	0	0.005	%
Reference clock duty cycle	Measured at 1.6 V	t_{CLK_DUTY}	40	50	60	%
Total input jitter/time interval error	Peak-to-peak value measured with a second order high-pass filter of 500 kHz bandwidth	t_{CLK_PJ}	—	—	200	ps

12 JTAG

This section describes the DC and AC electrical specifications for the IEEE Std 1149.1™ (JTAG) interface.

12.1 JTAG DC Electrical Characteristics

This table provides the DC electrical characteristics for the IEEE Std 1149.1 (JTAG) interface.

Table 46. JTAG Interface DC Electrical Characteristics

Characteristic	Symbol	Condition	Min	Max	Unit
Input high voltage	V_{IH}	—	2.1	NV_{DD} + 0.3	V
Input low voltage	V_{IL}	—	–0.3	0.8	V
Input current	I_{IN}	—	—	±5	μA
Output high voltage	V_{OH}	I_{OH} = –8.0 mA	2.4	—	V
Output low voltage	V_{OL}	I_{OL} = 8.0 mA	—	0.5	V
Output low voltage	V_{OL}	I_{OL} = 3.2 mA	—	0.4	V

12.2 JTAG AC Timing Specifications

This section describes the AC electrical specifications for the IEEE Std 1149.1 (JTAG) interface. This table provides the JTAG AC timing specifications as defined in Figure 41 through Figure 45.

Table 47. JTAG AC Timing Specifications (Independent of SYS_CLK_IN)[1]

At recommended operating conditions (see Table 2).

Parameter	Symbol[2]	Min	Max	Unit	Note
JTAG external clock frequency of operation	f_{JTG}	0	33.3	MHz	
JTAG external clock cycle time	t_{JTG}	30	—	ns	
JTAG external clock pulse width measured at 1.4 V	t_{JTKHKL}	15	—	ns	
JTAG external clock rise and fall times	t_{JTGR} & t_{JTGF}	0	2	ns	
$\overline{TRST}$ assert time	t_{TRST}	25	—	ns	3
Input setup times: Boundary-scan data TMS, TDI	 t_{JTDVKH} t_{JTIVKH}	 4 4	 — —	ns	4
Input hold times: Boundary-scan data TMS, TDI	 t_{JTDXKH} t_{JTIXKH}	 10 10	 — —	ns	4
Valid times: Boundary-scan data TDO	 t_{JTKLDV} t_{JTKLOV}	 2 2	 11 11	ns	5
Output hold times: Boundary-scan data TDO	 t_{JTKLDX} t_{JTKLOX}	 2 2	 — —	ns	5

Table 49. I²C AC Electrical Specifications (continued)

All values refer to V_{IH} (min) and V_{IL} (max) levels (see Table 48).

Parameter	Symbol[1]	Min	Max	Unit
Data hold time: CBUS compatible masters I²C bus devices	t_{I2DXKL}	 — 0[2]	 — 0.9[3]	µs
Fall time of both SDA and SCL signals[5]	t_{I2CF}	—	300	ns
Setup time for STOP condition	t_{I2PVKH}	0.6	—	µs
Bus free time between a STOP and START condition	t_{I2KHDX}	1.3	—	µs
Noise margin at the LOW level for each connected device (including hysteresis)	V_{NL}	$0.1 \times NV_{DD}$	—	V
Noise margin at the HIGH level for each connected device (including hysteresis)	V_{NH}	$0.2 \times NV_{DD}$	—	V

Notes:

1. The symbols used for timing specifications follow the pattern of $t_{\text{(first two letters of functional block)(signal)(state)(reference)(state)}}$ for inputs and $t_{\text{(first two letters of functional block)(reference)(state)(signal)(state)}}$ for outputs. For example, t_{I2DVKH} symbolizes I²C timing (I2) with respect to the time data input signals (D) reach the valid state (V) relative to the t_{I2C} clock reference (K) going to the high (H) state or setup time. Also, t_{I2SXKL} symbolizes I²C timing (I2) for the time that the data with respect to the start condition (S) went invalid (X) relative to the t_{I2C} clock reference (K) going to the low (L) state or hold time. Also, t_{I2PVKH} symbolizes I²C timing (I2) for the time that the data with respect to the stop condition (P) reaching the valid state (V) relative to the t_{I2C} clock reference (K) going to the high (H) state or setup time. For rise and fall times, the latter convention is used with the appropriate letter: R (rise) or F (fall).
2. The MPC8313E provides a hold time of at least 300 ns for the SDA signal (referred to the V_{IHmin} of the SCL signal) to bridge the undefined region of the falling edge of SCL.
3. The maximum t_{I2DVKH} has only to be met if the device does not stretch the LOW period (t_{I2CL}) of the SCL signal.
4. C_B = capacitance of one bus line in pF.
5. The MPC8313E does not follow the *I²C-BUS Specifications, Version 2.1,* regarding the t_{I2CF} AC parameter.

This figure provides the AC test load for the I²C.

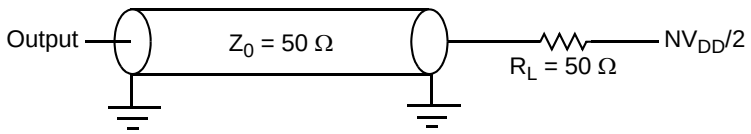


Figure 46. I²C AC Test Load

15.2 Timers AC Timing Specifications

This table provides the Timers input and output AC timing specifications.

Table 54. Timers Input AC Timing Specifications[1]

Characteristic	Symbol[2]	Min	Unit
Timers inputs—minimum pulse width	t_{TIWID}	20	ns

Notes:
1. Input specifications are measured from the 50% level of the signal to the 50% level of the rising edge of SYS_CLK_IN. Timings are measured at the pin.
2. Timers inputs and outputs are asynchronous to any visible clock. Timers outputs should be synchronized before use by any external synchronous logic. Timers inputs are required to be valid for at least t_{TIWID} ns to ensure proper operation

This figure provides the AC test load for the Timers.

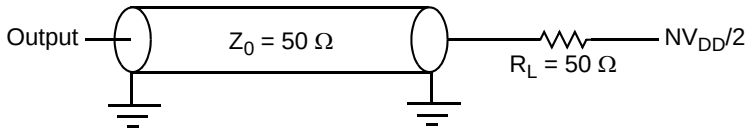


Figure 51. Timers AC Test Load

16 GPIO

This section describes the DC and AC electrical specifications for the GPIO.

16.1 GPIO DC Electrical Characteristics

This table provides the DC electrical characteristics for the GPIO when the GPIO pins are operating from a 3.3-V supply.

Table 55. GPIO (When Operating at 3.3 V) DC Electrical Characteristics

Characteristic	Symbol	Condition	Min	Max	Unit
Output high voltage	V_{OH}	I_{OH} = –8.0 mA	2.4	—	V
Output low voltage	V_{OL}	I_{OL} = 8.0 mA	—	0.5	V
Output low voltage	V_{OL}	I_{OL} = 3.2 mA	—	0.4	V
Input high voltage	V_{IH}	—	2.0	NV_{DD} + 0.3	V
Input low voltage	V_{IL}	—	–0.3	0.8	V
Input current	I_{IN}	$0 V \le V_{IN} \le NV_{DD}$	—	±5	μA

Note:
1. This specification only applies to GPIO pins that are operating from a 3.3-V supply. See Table 62 for the power supply listed for the individual GPIO signal.

Table 62. MPC8313E TEPBGAII Pinout Listing (continued)

Signal	Package Pin Number	Pin Type	Power Supply	Note
TSEC1_TXD1/TSEC_1588_PP2	AD6	O	LV_{DDB}	—
TSEC1_TXD0/USBDR_STP/TSEC_1588_PP3	AD5	O	LV_{DDB}	—
TSEC1_TX_EN/TSEC_1588_ALARM1	AB7	O	LV_{DDB}	—
TSEC1_TX_ER/TSEC_1588_ALARM2	AB8	O	LV_{DDB}	—
TSEC1_GTX_CLK125	AE1	I	LV_{DDB}	—
TSEC1_MDC/LB_POR_CFG_BOOT_ECC_DIS	AF6	O	NV_{DD}	9, 11
TSEC1_MDIO	AB9	I/O	NV_{DD}	—
ETSEC2				
TSEC2_COL/GTM1_TIN4/GTM2_TIN3/GPIO15	AB4	I/O	LV_{DDA}	—
TSEC2_CRS/$\overline{\text{GTM1\_TGATE4}}$/$\overline{\text{GTM2\_TGATE3}}$/GPIO16	AB3	I/O	LV_{DDA}	—
TSEC2_GTX_CLK/$\overline{\text{GTM1\_TOUT4}}$/$\overline{\text{GTM2\_TOUT3}}$/GPIO17	AC1	I/O	LV_{DDA}	12
TSEC2_RX_CLK/GTM1_TIN2/GTM2_TIN1/GPIO18	AC2	I/O	LV_{DDA}	—
TSCE2_RX_DV/$\overline{\text{GTM1\_TGATE2}}$/$\overline{\text{GTM2\_TGATE1}}$/GPIO19	AA3	I/O	LV_{DDA}	—
TSEC2_RXD3/GPIO20	Y5	I/O	LV_{DDA}	—
TSEC2_RXD2/GPIO21	AA4	I/O	LV_{DDA}	—
TSEC2_RXD1/GPIO22	AB2	I/O	LV_{DDA}	—
TSEC2_RXD0/GPIO23	AA5	I/O	LV_{DDA}	—
TSEC2_RX_ER/$\overline{\text{GTM1\_TOUT2}}$/$\overline{\text{GTM2\_TOUT1}}$/GPIO24	AA2	I/O	LV_{DDA}	—
TSEC2_TX_CLK/GPIO25	AB1	I/O	LV_{DDA}	—
TSEC2_TXD3/CFG_RESET_SOURCE0	W3	I/O	LV_{DDA}	—
TSEC2_TXD2/CFG_RESET_SOURCE1	Y1	I/O	LV_{DDA}	—
TSEC2_TXD1/CFG_RESET_SOURCE2	W5	I/O	LV_{DDA}	—
TSEC2_TXD0/CFG_RESET_SOURCE3	Y3	I/O	LV_{DDA}	—
TSEC2_TX_EN/GPIO26	AA1	I/O	LV_{DDA}	—
TSEC2_TX_ER/GPIO27	W1	I/O	LV_{DDA}	—
SGMII PHY				
TXA	U3	O		—
$\overline{\text{TXA}}$	V3	O		—
RXA	U1	I		—
$\overline{\text{RXA}}$	V1	I		—
TXB	P4	O		—
$\overline{\text{TXB}}$	N4	O		—

20.2 Core PLL Configuration

RCWL[COREPLL] selects the ratio between the internal coherent system bus clock (*csb_clk*) and the e300 core clock (*core_clk*). This table shows the encodings for RCWL[COREPLL]. COREPLL values that are not listed in this table should be considered as reserved.

NOTE

Core VCO frequency = core frequency × VCO divider. The VCO divider, which is determined by RCWLR[COREPLL], must be set properly so that the core VCO frequency is in the range of 400–800 MHz.

Table 67. e300 Core PLL Configuration

RCWL[COREPLL]			***core_clk* : *csb_clk* Ratio**[1]	**VCO Divider (VCOD)**[3]
0–1	**2–5**	**6**		
nn	**0000**	0	PLL bypassed (PLL off, *csb_clk* clocks core directly)	PLL bypassed (PLL off, *csb_clk* clocks core directly)
11	***nnnn***	n	n/a	n/a
00	**0001**	0	1:1	2
01	**0001**	0	1:1	4
10	**0001**	0	1:1	8
00	**0001**	1	1.5:1	2
01	**0001**	1	1.5:1	4
10	**0001**	1	1.5:1	8
00	**0010**	0	2:1	2
01	**0010**	0	2:1	4
10	**0010**	0	2:1	8
00	**0010**	1	2.5:1	2
01	**0010**	1	2.5:1	4
10	**0010**	1	2.5:1	8
00	**0011**	0	3:1	2
01	**0011**	0	3:1	4
10	**0011**	0	3:1	8

Note:

1. For *core_clk:csb_clk* ratios of 2.5:1 and 3:1, the *core_clk* must not exceed its maximum operating frequency of 333 MHz.
2. Core VCO frequency = core frequency × VCO divider. Note that VCO divider has to be set properly so that the core VCO frequency is in the range of 400–800 MHz.

Heat sink Vendors include the following list:

Aavid Thermalloy 80 Commercial St. Concord, NH 03301 Internet: www.aavidthermalloy.com	603-224-9988
Alpha Novatech 473 Sapena Ct. #12 Santa Clara, CA 95054 Internet: www.alphanovatech.com	408-749-7601
International Electronic Research Corporation (IERC) 413 North Moss St. Burbank, CA 91502 Internet: www.ctscorp.com	818-842-7277
Millennium Electronics (MEI) Loroco Sites 671 East Brokaw Road San Jose, CA 95112 Internet: www.mei-thermal.com	408-436-8770
Tyco Electronics Chip Coolers™ P.O. Box 3668 Harrisburg, PA 17105 Internet: www.chipcoolers.com	800-522-6752
Wakefield Engineering 33 Bridge St. Pelham, NH 03076 Internet: www.wakefield.com	603-635-2800

Interface material vendors include the following:

Chomerics, Inc. 77 Dragon Ct. Woburn, MA 01801 Internet: www.chomerics.com	781-935-4850
Dow-Corning Corporation Corporate Center PO BOX 994 Midland, MI 48686-0994 Internet: www.dowcorning.com	800-248-2481
Shin-Etsu MicroSi, Inc. 10028 S. 51st St. Phoenix, AZ 85044 Internet: www.microsi.com	888-642-7674
The Bergquist Company 18930 West 78th St. Chanhassen, MN 55317 Internet: www.bergquistcompany.com	800-347-4572

- Output signals on the SerDes interface are fed from the $XPADV_{DD}$ power plane. Input signals and sensitive transceiver analog circuits are on the $XCOREV_{DD}$ supply.
- Power: $XPADV_{DD}$ consumes less than 300 mW; $XCOREV_{DD}$ + $SDAV_{DD}$ consumes less than 750 mW.

22.3 Decoupling Recommendations

Due to large address and data buses, and high operating frequencies, the device can generate transient power surges and high frequency noise in its power supply, especially while driving large capacitive loads. This noise must be prevented from reaching other components in the MPC8313E system, and the MPC8313E itself requires a clean, tightly regulated source of power. Therefore, it is recommended that the system designer place at least one decoupling capacitor at each V_{DD}, NV_{DD}, GV_{DD}, LV_{DD}, LV_{DDA}, and LV_{DDB} pin of the device. These decoupling capacitors should receive their power from separate V_{DD}, NV_{DD}, GV_{DD}, LV_{DD}, LV_{DDA}, LV_{DDB}, and VSS power planes in the PCB, utilizing short traces to minimize inductance. Capacitors may be placed directly under the device using a standard escape pattern. Others may surround the part.

These capacitors should have a value of 0.01 or 0.1 µF. Only ceramic SMT (surface mount technology) capacitors should be used to minimize lead inductance, preferably 0402 or 0603 sizes.

In addition, it is recommended that there be several bulk storage capacitors distributed around the PCB, feeding the V_{DD}, NV_{DD}, GV_{DD}, LV_{DD}, LV_{DDA}, and LV_{DDB} planes, to enable quick recharging of the smaller chip capacitors. These bulk capacitors should have a low ESR (equivalent series resistance) rating to ensure the quick response time necessary. They should also be connected to the power and ground planes through two vias to minimize inductance. Suggested bulk capacitors—100 to 330 µF (AVX TPS tantalum or Sanyo OSCON). However, customers should work directly with their power regulator vendor for best values and types of bulk capacitors.

22.4 SerDes Block Power Supply Decoupling Recommendations

The SerDes block requires a clean, tightly regulated source of power ($XCOREV_{DD}$ and $XPADV_{DD}$) to ensure low jitter on transmit and reliable recovery of data in the receiver. An appropriate decoupling scheme is outlined below.

Only SMT capacitors should be used to minimize inductance. Connections from all capacitors to power and ground should be done with multiple vias to further reduce inductance.

- First, the board should have at least 10 × 10-nF SMT ceramic chip capacitors as close as possible to the supply balls of the device. Where the board has blind vias, these capacitors should be placed directly below the chip supply and ground connections. Where the board does not have blind vias, these capacitors should be placed in a ring around the device as close to the supply and ground connections as possible.
- Second, there should be a 1-µF ceramic chip capacitor from each SerDes supply ($XCOREV_{DD}$ and $XPADV_{DD}$) to the board ground plane on each side of the device. This should be done for all SerDes supplies.

Table 73. Document Revision History (continued)

Rev. Number	Date	Substantive Change(s)
2	10/2008	• Added Note “The information in this document is accurate for revision 1.0, and 2.x and later. See Section 24.1, “Part Numbers Fully Addressed by this Document,” before Section 1, “Overview.” • Added part numbering details for all the silicon revisions in Table 74. • Changed V_{IH} from 2.7 V to 2.4 V in Table 7. • Added a row for V_{IH} level for Rev 2.x or later in Table 45. • Added a column for maximum power dissipation in low power mode for Rev 2.x or later silicon in Table 6. • Added a column for Power Nos for Rev 2.x or later silicon and added a row for 400 MHz in Table 4. • Removed footnote, “These are preliminary estimates.” from Table 4. • Added Table 21 for DDR AC Specs on Rev 2.x or later silicon. • Added Section 9, “High-Speed Serial Interfaces (HSSI).” • Added $\overline{\text{LFWE}}$, LFCLE, LFALE, $\overline{\text{LOE}}$, $\overline{\text{LFRE}}$, $\overline{\text{LFWP}}$, $\overline{\text{LGTA}}$, LUPWAIT, and $\overline{\text{LFRB}}$ in Table 63. • In Table 39, added note 2: “This parameter is dependent on the csb_clk speed. (The MIIMCFG[Mgmt Clock Select] field determines the clock frequency of the Mgmt Clock EC_MDC.)” • Removed mentions of SGMII (SGMII has separate specs) from Section 8.1, “Enhanced Three-Speed Ethernet Controller (eTSEC) (10/100/1000 Mbps)—MII/RMII/RGMII/SGMII/RTBI Electrical Characteristics.” • Corrected Section 8.1, “Enhanced Three-Speed Ethernet Controller (eTSEC) (10/100/1000 Mbps)—MII/RMII/RGMII/SGMII/RTBI Electrical Characteristics,” to state that RGMII/RTBI interfaces only operate at 2.5 V, not 3.3 V. • Added ZQ package to ordering information In Table 74 and Section 19.1, “Package Parameters for the MPC8313E TEPBGAII” (applicable to both silicon rev. 1.0 and 2.1) • Removed footnotes 5 and 6 from Table 1 (left over when the PCI undershoot/overshoot voltages and maximum AC waveforms were removed from Section 2.1.2, “Power Supply Voltage Specification”). • Removed SD_PLL_TPD (T2) and SD_PLL_TPA_ANA (R4) from Table 63. • Added Section 8.3, “SGMII Interface Electrical Characteristics.” Removed Section 8.5.3 SGMII DC Electrical Characteristics. • Removed “HRESET negation to SRESET negation (output)” spec and changed “HRESET/SRESET assertion (output)” spec to “HRESET assertion (output)” in Table 10. • Clarified POR configuration signal specs to “Time for the device to turn off POR configuration signal drivers with respect to the assertion of HRESET” and “Time for the device to turn on POR configuration signal drivers with respect to the negation of HRESET” in Table 10. • Added Section 24.2, “Part Marking,” and Figure 62.

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Document Number: MPC8313EEC
Rev. 4
11/2011