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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 e500
Number of Cores/Bus Width	1 Core, 32-Bit
Speed	1.0GHz
Co-Processors/DSP	Signal Processing; SPE, Security; SEC
RAM Controllers	DDR, DDR2, SDRAM
Graphics Acceleration	No
Display & Interface Controllers	-
Ethernet	10/100/1000Mbps (2)
SATA	-
USB	-
Voltage - I/O	1.8V, 2.5V, 3.3V
Operating Temperature	-40°C ~ 105°C (TA)
Security Features	Cryptography, Random Number Generator
Package / Case	783-BBGA, FCBGA
Supplier Device Package	783-FCPBGA (29x29)
Purchase URL	https://www.e-xfl.com/product-detail/nxp-semiconductors/mpc8544ecvtaqga

- Double-precision floating-point APU. Provides an instruction set for double-precision (64-bit) floating-point instructions that use the 64-bit GPRs.
- 36-bit real addressing
- Embedded vector and scalar single-precision floating-point APUs. Provide an instruction set for single-precision (32-bit) floating-point instructions.
- Memory management unit (MMU). Especially designed for embedded applications. Supports 4-Kbyte–4-Gbyte page sizes.
- Enhanced hardware and software debug support
- Performance monitor facility that is similar to, but separate from, the device performance monitor

The e500 defines features that are not implemented on this device. It also generally defines some features that this device implements more specifically. An understanding of these differences can be critical to ensure proper operations.

- 256-Kbyte L2 cache/SRAM
  - Flexible configuration
  - Full ECC support on 64-bit boundary in both cache and SRAM modes
  - Cache mode supports instruction caching, data caching, or both.
  - External masters can force data to be allocated into the cache through programmed memory ranges or special transaction types (stashing).
    - 1, 2, or 4 ways can be configured for stashing only.
  - Eight-way set-associative cache organization (32-byte cache lines)
  - Supports locking entire cache or selected lines. Individual line locks are set and cleared through Book E instructions or by externally mastered transactions.
  - Global locking and flash clearing done through writes to L2 configuration registers
  - Instruction and data locks can be flash cleared separately.
  - SRAM features include the following:
    - I/O devices access SRAM regions by marking transactions as snoopable (global).
    - Regions can reside at any aligned location in the memory map.
    - Byte-accessible ECC is protected using read-modify-write transaction accesses for smaller-than-cache-line accesses.
- Address translation and mapping unit (ATMU)
  - Eight local access windows define mapping within local 36-bit address space.
  - Inbound and outbound ATMUs map to larger external address spaces.
    - Three inbound windows plus a configuration window on PCI and PCI Express
    - Four outbound windows plus default translation for PCI and PCI Express
- DDR/DDR2 memory controller
  - Programmable timing supporting DDR and DDR2 SDRAM
  - 64-bit data interface

Figure 1 shows the MPC8544E block diagram.

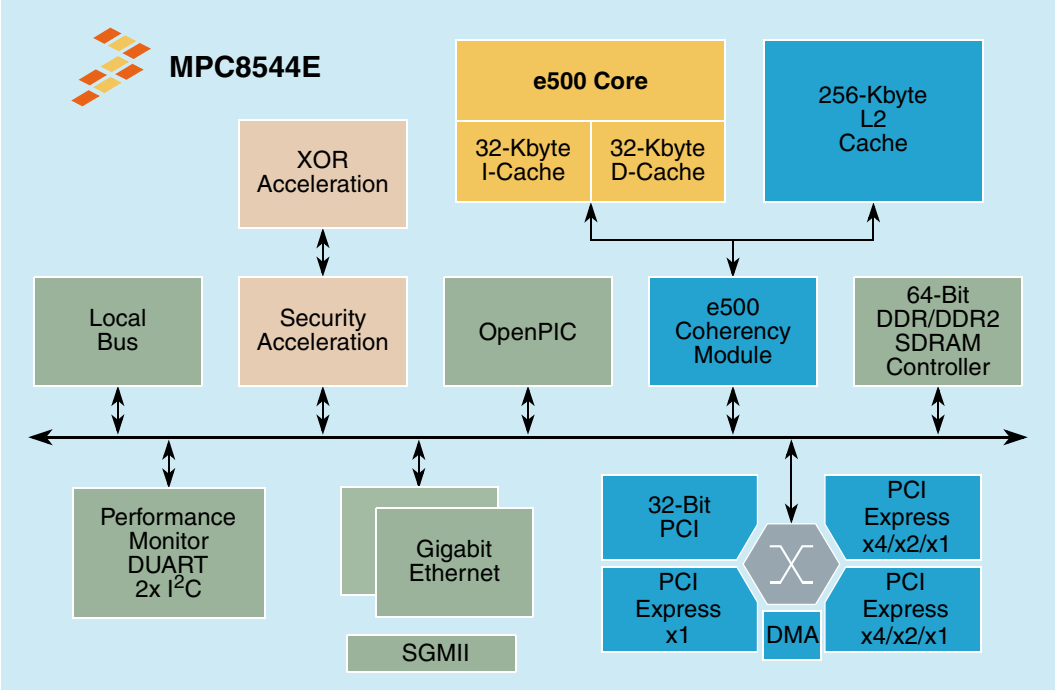

Figure 1. MPC8544E Block Diagram

2 Electrical Characteristics

This section provides the AC and DC electrical specifications and thermal characteristics for the MPC8544E. This device is currently targeted to these specifications. Some of these specifications are independent of the I/O cell, but are included for a more complete reference. These are not purely I/O buffer design specifications.

2.1 Overall DC Electrical Characteristics

This section covers the ratings, conditions, and other characteristics.

2.1.1 Absolute Maximum Ratings

Table 1 provides the absolute maximum ratings.

Table 1. Absolute Maximum Ratings[1]

Characteristic	Symbol	Max Value	Unit	Notes
Core supply voltage	V_{DD}	–0.3 to 1.1	V	—
PLL supply voltage	AV_{DD}	–0.3 to 1.1	V	—
Core power supply for SerDes transceivers	SV_{DD}	–0.3 to 1.1	V	—
Pad power supply for SerDes transceivers	XV_{DD}	–0.3 to 1.1	V	—

Table 1. Absolute Maximum Ratings[1] (continued)

Characteristic		Symbol	Max Value	Unit	Notes
DDR and DDR2 DRAM I/O voltage		GV_{DD}	–0.3 to 2.75 –0.3 to 1.98	V	—
Three-speed Ethernet I/O, MII management voltage		LV_{DD} (eTSEC1)	–0.3 to 3.63 –0.3 to 2.75	V	—
		TV_{DD} (eTSEC3)	–0.3 to 3.63 –0.3 to 2.75	V	—
PCI, DUART, system control and power management, I^2C, and JTAG I/O voltage		OV_{DD}	–0.3 to 3.63	V	—
Local bus I/O voltage		BV_{DD}	–0.3 to 3.63 –0.3 to 2.75 –0.3 to 1.98	V	—
Input voltage	DDR/DDR2 DRAM signals	MV_{IN}	–0.3 to (GV_{DD} + 0.3)	V	2
	DDR/DDR2 DRAM reference	MV_{REF}	–0.3 to (GV_{DD} + 0.3)	V	2
	Three-speed Ethernet signals	LV_{IN} TV_{IN}	–0.3 to (LV_{DD} + 0.3) –0.3 to (TV_{DD} + 0.3)	V	2
	Local bus signals	BV_{IN}	–0.3 to (BV_{DD} + 0.3)	V	—
	DUART, SYSCLK, system control and power management, I^2C, and JTAG signals	OV_{IN}	–0.3 to (OV_{DD} + 0.3)	V	2
	PCI	OV_{IN}	–0.3 to (OV_{DD} + 0.3)	V	2
Storage temperature range		T_{STG}	–55 to 150	°C	—

Notes:
1. Functional and tested operating conditions are given in Table 2. Absolute maximum ratings are stress ratings only, and functional operation at the maximums is not guaranteed. Stresses beyond those listed may affect device reliability or cause.
2. (M,L,O)V_{IN}, and MV_{REF} may overshoot/undershoot to a voltage and for a maximum duration as shown in Figure 2.

2.1.2 Recommended Operating Conditions

Table 2 provides the recommended operating conditions for this device. Note that the values in Table 2 are the recommended and tested operating conditions. Proper device operation outside these conditions is not guaranteed.

Table 2. Recommended Operating Conditions

Characteristic	Symbol	Recommended Value	Unit	Notes
Core supply voltage	V_{DD}	1.0 ± 50 mV	V	—
PLL supply voltage	AV_{DD}	1.0 ± 50 mV	V	1
Core power supply for SerDes transceivers	SV_{DD}	1.0 ± 50 mV	V	—
Pad power supply for SerDes transceivers	XV_{DD}	1.0 ± 50 mV	V	—
DDR and DDR2 DRAM I/O voltage	GV_{DD}	2.5 V ± 125 mV 1.8 V ± 90 mV	V	2

Table 2. Recommended Operating Conditions (continued)

Characteristic		Symbol	Recommended Value	Unit	Notes
Three-speed Ethernet I/O voltage		LV_{DD} (eTSEC1)	3.3 V ± 165 mV 2.5 V ± 125 mV	V	4
		TV_{DD} (eTSEC3)	3.3 V ± 165 mV 2.5 V ± 125 mV		
PCI, DUART, PCI Express, system control and power management, I^2C, and JTAG I/O voltage		OV_{DD}	3.3 V ± 165 mV	V	3
Local bus I/O voltage		BV_{DD}	3.3 V ± 165 mV 2.5 V ± 125 mV 1.8 V ± 90 mV	V	5
Input voltage	DDR and DDR2 DRAM signals	MV_{IN}	GND to GV_{DD}	V	2
	DDR and DDR2 DRAM reference	MV_{REF}	GND to $GV_{DD}/2$	V	2
	Three-speed Ethernet signals	LV_{IN} TV_{IN}	GND to LV_{DD} GND to TV_{DD}	V	4
	Local bus signals	BV_{IN}	GND to BV_{DD}	V	5
	PCI, Local bus, DUART, SYSCLK, system control and power management, I^2C, and JTAG signals	OV_{IN}	GND to OV_{DD}	V	3
Junction temperature range		T_j	0 to 105	°C	—

Notes:

1. This voltage is the input to the filter discussed in Section 21.2, "PLL Power Supply Filtering," and not necessarily the voltage at the AV_{DD} pin, which may be reduced from V_{DD} by the filter.
2. **Caution:** MV_{IN} must not exceed GV_{DD} by more than 0.3 V. This limit may be exceeded for a maximum of 20 ms during power-on reset and power-down sequences.
3. **Caution:** OV_{IN} must not exceed OV_{DD} by more than 0.3 V. This limit may be exceeded for a maximum of 20 ms during power-on reset and power-down sequences.
4. **Caution:** T/LV_{IN} must not exceed T/ LV_{DD} by more than 0.3 V. This limit may be exceeded for a maximum of 20 ms during power-on reset and power-down sequences.
5. **Caution:** BV_{IN} must not exceed BV_{DD} by more than 0.3 V. This limit may be exceeded for a maximum of 20 ms during power-on reset and power-down sequences.

3 Power Characteristics

The estimated typical core power dissipation for the core complex bus (CCB) versus the core frequency for this family of PowerQUICC III devices is shown in Table 4.

Table 4. MPC8544ECore Power Dissipation

Power Mode	Core Frequency (MHz)	Platform Frequency (MHz)	V_{DD} (V)	Junction Temperature (°C)	Power (W)	Notes
Typical	667	333	1.0	65	2.6	1, 2
Thermal				105	4.5	1, 3
Maximum					7.15	1, 4
Typical	800	400	1.0	65	2.9	1, 2
Thermal				105	4.8	1, 3
Maximum					7.35	1, 4
Typical	1000	400	1.0	65	3.6	1, 2
Thermal				105	5.3	1, 3
Maximum					7.5	1, 4
Typical	1067	533	1.0	65	3.9	1, 2
Thermal				105	6.0	1, 3
Maximum					7.7	1, 4

Notes:

1. These values specify the power consumption at nominal voltage and apply to all valid processor bus frequencies and configurations. The values do not include power dissipation for I/O supplies.
2. Typical power is an average value measured at the nominal recommended core voltage (V_{DD}) and 65°C junction temperature (see Table 2) while running the Dhrystone 2.1 benchmark.
3. Thermal power is the average power measured at nominal core voltage (V_{DD}) and maximum operating junction temperature (see Table 2) while running the Dhrystone 2.1 benchmark.
4. Maximum power is the maximum power measured at nominal core voltage (V_{DD}) and maximum operating junction temperature (see Table 2) while running a smoke test which includes an entirely L1-cache-resident, contrived sequence of instructions which keep the execution unit maximally busy.

4 Input Clocks

This section contains the following subsections:

6.1 DDR SDRAM DC Electrical Characteristics

Table 10 provides the recommended operating conditions for the DDR SDRAM component(s) of the MPC8544E when GV_{DD}(typ) = 1.8 V.

Table 10. DDR2 SDRAM DC Electrical Characteristics for GV_{DD}(typ) = 1.8 V

Parameter/Condition	Symbol	Min	Max	Unit	Notes
I/O supply voltage	GV_{DD}	1.71	1.89	V	1
I/O reference voltage	MV_{REF}	0.49 × GV_{DD}	0.51 × GV_{DD}	V	2
I/O termination voltage	V_{TT}	MV_{REF} – 0.04	MV_{REF} + 0.04	V	3
Input high voltage	V_{IH}	MV_{REF} + 0.26	GV_{DD} + 0.3	V	—
Input low voltage	V_{IL}	–0.3	MV_{REF} – 0.24	V	—
Output high current (V_{OUT} = 1.26 V)	I_{OH}	–13.4	—	mA	—
Output low current (V_{OUT} = 0.33 V)	I_{OL}	13.4	—	mA	—

Notes:
1. GV_{DD} is expected to be within 50 mV of the DRAM GV_{DD} at all times.
2. MV_{REF} is expected to be equal to 0.5 × GV_{DD}, and to track GV_{DD} DC variations as measured at the receiver. Peak-to-peak noise on MV_{REF} may not exceed ±2% of the DC value.
3. V_{TT} is not applied directly to the device. It is the supply to which far end signal termination is made and is expected to be equal to MV_{REF}. This rail should track variations in the DC level of MV_{REF}.

Table 11 provides the DDR2 I/O capacitance when GV_{DD}(typ) = 1.8 V.

Table 11. DDR2 SDRAM Capacitance for GV_{DD}(typ) = 1.8 V

Parameter/Condition	Symbol	Min	Max	Unit	Notes
Input/output capacitance: DQ, DQS, $\overline{\text{DQS}}$	C_{IO}	6	8	pF	1
Delta input/output capacitance: DQ, DQS, $\overline{\text{DQS}}$	C_{DIO}	—	0.5	pF	1

Note:
1. This parameter is sampled. GV_{DD} = 1.8 V ± 0.090 V, f = 1 MHz, T_A = 25°C, V_{OUT} = GV_{DD}/2, V_{OUT} (peak-to-peak) = 0.2 V.

Table 12 provides the recommended operating conditions for the DDR SDRAM component(s) when GV_{DD}(typ) = 2.5 V.

Table 12. DDR SDRAM DC Electrical Characteristics for GV_{DD}(typ) = 2.5 V

Parameter/Condition	Symbol	Min	Max	Unit	Notes
I/O supply voltage	GV_{DD}	2.375	2.625	V	1
I/O reference voltage	MV_{REF}	0.49 × GV_{DD}	0.51 × GV_{DD}	V	2
I/O termination voltage	V_{TT}	MV_{REF} – 0.04	MV_{REF} + 0.04	V	3
Input high voltage	V_{IH}	MV_{REF} + 0.31	GV_{DD} + 0.3	V	—
Input low voltage	V_{IL}	–0.3	MV_{REF} – 0.3	V	—
Output high current (V_{OUT} = 1.8 V)	I_{OH}	–16.2	—	mA	—

Table 37. RGMII and RTBI AC Timing Specifications (continued)

At recommended operating conditions with L/TV_{DD} of 2.5 V ± 5%.

Parameter/Condition	Symbol[1]	Min	Typ	Max	Unit	Notes
Fall time (20%–80%)	t_{RGTF}	—	—	0.75	ns	—

Notes:

1. In general, the clock reference symbol representation for this section is based on the symbols RGT to represent RGMII and RTBI timing. For example, the subscript of t_{RGT} represents the TBI (T) receive (RX) clock. Note also that the notation for rise (R) and fall (F) times follows the clock symbol that is being represented. For symbols representing skews, the subscript is skew (SK) followed by the clock that is being skewed (RGT).
2. This implies that PC board design will require clocks to be routed such that an additional trace delay of greater than 1.5 ns will be added to the associated clock signal.
3. For 10 and 100 Mbps, t_{RGT} scales to 400 ns ± 40 ns and 40 ns ± 4 ns, respectively.
4. Duty cycle may be stretched/shrunk during speed changes or while transitioning to a received packet's clock domains as long as the minimum duty cycle is not violated and stretching occurs for no more than three t_{RGT} of the lowest speed transitioned between.
5. Guaranteed by design.

Figure 22 shows the RGMII and RTBI AC timing and multiplexing diagrams.

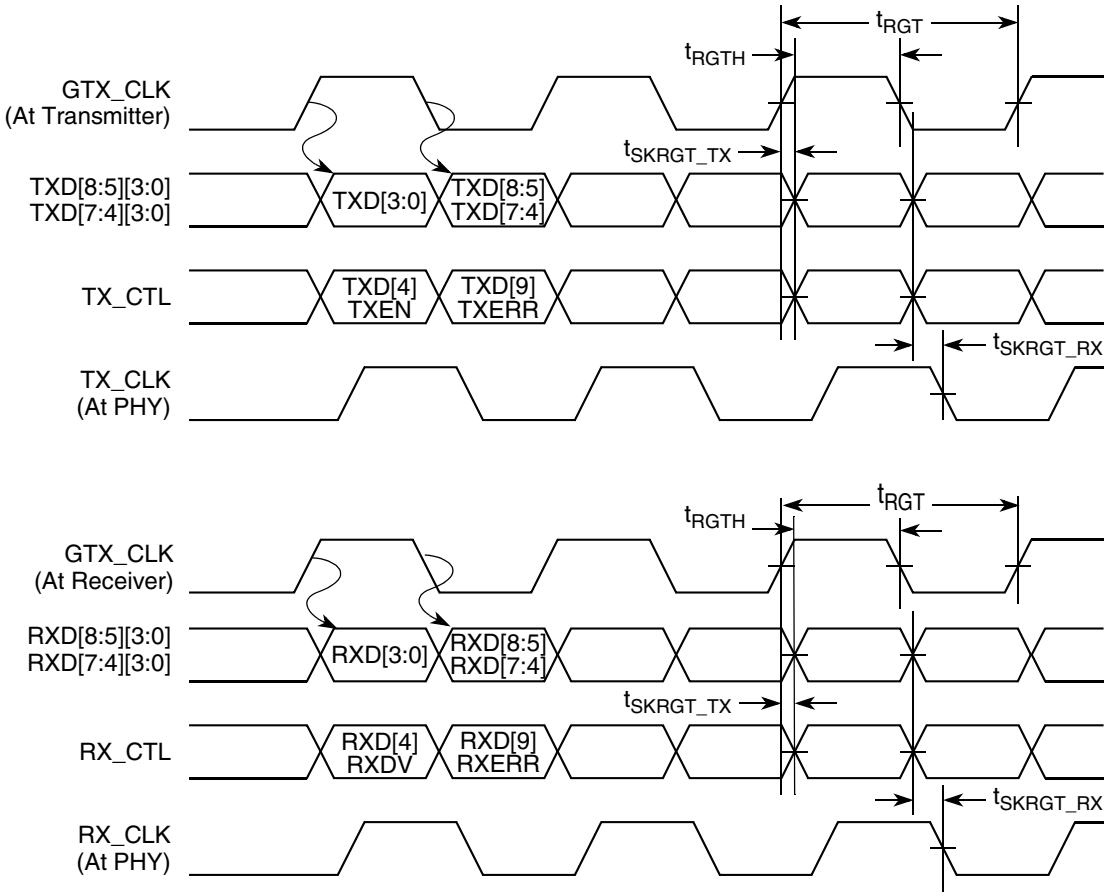

Figure 22. RGMII and RTBI AC Timing and Multiplexing Diagrams

Table 44. Local Bus DC Electrical Characteristics (1.8 V DC) (continued)

Parameter	Symbol	Min	Max	Unit	Notes
High-level output voltage (BV_{DD} = min, I_{OH} = –2 mA)	V_{OH}	1.35	—	V	—
Low-level output voltage (BV_{DD} = min, I_{OL} = 2 mA)	V_{OL}	—	0.45	V	—

10.2 Local Bus AC Electrical Specifications

Table 45 describes the general timing parameters of the local bus interface at BV_{DD} = 3.3 V. For information about the frequency range of local bus see Section 19.1, "Clock Ranges."

Table 45. Local Bus General Timing Parameters (BV_{DD} = 3.3 V)—PLL Enabled

Parameter	Symbol[1]	Min	Max	Unit	Notes
Local bus cycle time	t_{LBK}	7.5	12	ns	2
Local bus duty cycle	t_{LBKH}/t_{LBK}	43	57	%	—
LCLK[n] skew to LCLK[m] or LSYNC_OUT	$t_{LBKSKEW}$	—	150	ps	7, 8
Input setup to local bus clock (except LUPWAIT)	$t_{LBIVKH1}$	2.5	—	ns	3, 4
LUPWAIT input setup to local bus clock	$t_{LBIVKH2}$	1.85	—	ns	3, 4
Input hold from local bus clock (except LUPWAIT)	$t_{LBIXKH1}$	1.0	—	ns	3, 4
LUPWAIT input hold from local bus clock	$t_{LBIXKH2}$	1.0	—	ns	3, 4
LALE output transition to LAD/LDP output transition (LATCH setup and hold time)	t_{LBOTOT}	1.5	—	ns	6
Local bus clock to output valid (except LAD/LDP and LALE)	$t_{LBKHOV1}$	—	2.9	ns	—
Local bus clock to data valid for LAD/LDP	$t_{LBKHOV2}$	—	2.8	ns	—
Local bus clock to address valid for LAD	$t_{LBKHOV3}$	—	2.7	ns	3
Local bus clock to LALE assertion	$t_{LBKHOV4}$	—	2.7	ns	3
Output hold from local bus clock (except LAD/LDP and LALE)	$t_{LBKHOX1}$	0.7	—	ns	3
Output hold from local bus clock for LAD/LDP	$t_{LBKHOX2}$	0.7	—	ns	3
Local bus clock to output high Impedance (except LAD/LDP and LALE)	$t_{LBKHOZ1}$	—	2.5	ns	5

Figure 28 through Figure 33 show the local bus signals.

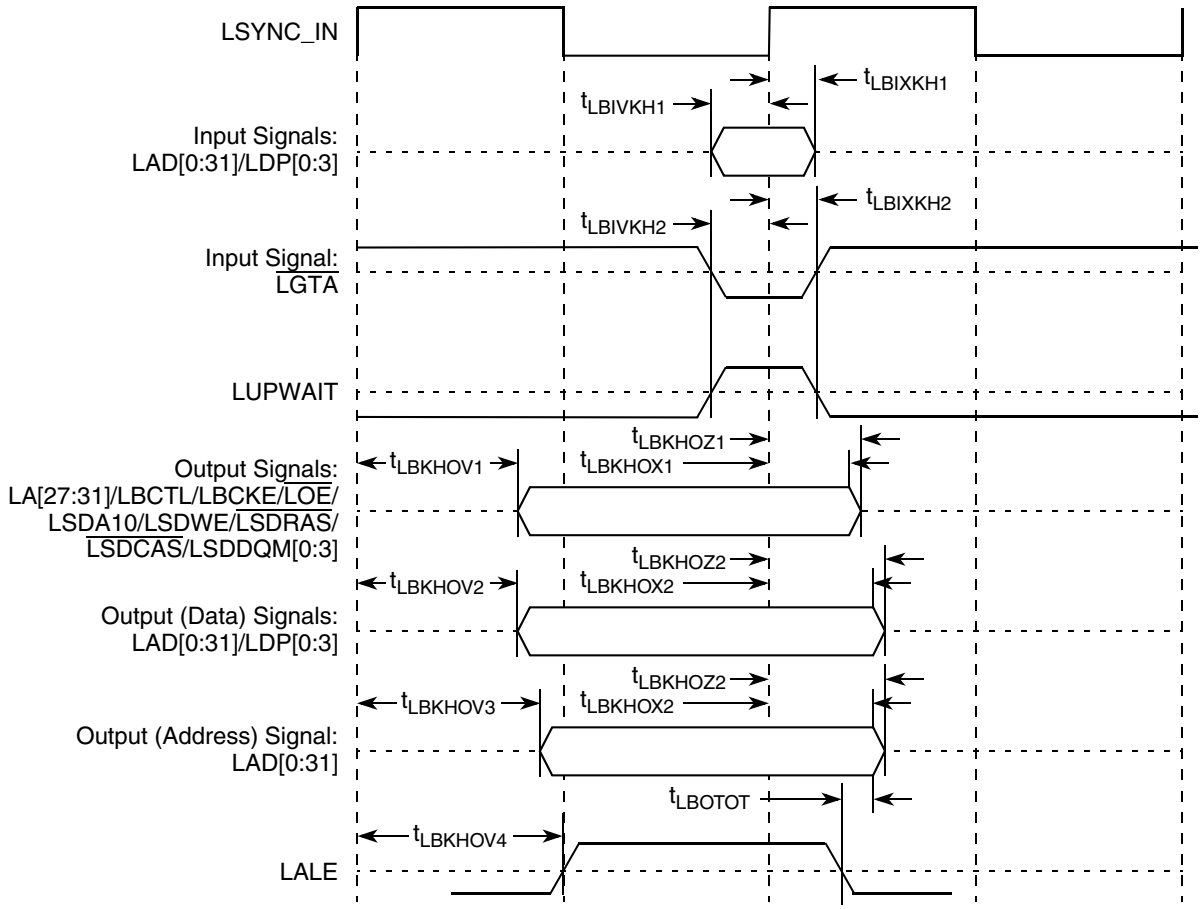

Figure 28. Local Bus Signals (PLL Enabled)

Table 48 describes the general timing parameters of the local bus interface at V_{DD} = 3.3 V DC with PLL disabled.

Table 48. Local Bus General Timing Parameters—PLL Bypassed

Parameter	Symbol[1]	Min	Max	Unit	Notes
Local bus cycle time	t_{LBK}	12	—	ns	2
Local bus duty cycle	t_{LBKH}/t_{LBK}	43	57	%	—
Internal launch/capture clock to LCLK delay	t_{LBKHKT}	1.2	4.9	ns	—
Input setup to local bus clock (except LUPWAIT)	$t_{LBIVKH1}$	7.4	—	ns	4, 5
LUPWAIT input setup to local bus clock	$t_{LBIVKL2}$	6.75	—	ns	4, 5
Input hold from local bus clock (except LUPWAIT)	$t_{LBIXKH1}$	–0.2	—	ns	4, 5
LUPWAIT input hold from local bus clock	$t_{LBIXKL2}$	–0.2	—	ns	4, 5
LALE output transition to LAD/LDP output transition (LATCH hold time)	t_{LBOTOT}	1.5	—	ns	6
Local bus clock to output valid (except LAD/LDP and LALE)	$t_{LBKLOV1}$	—	1.6	ns	—

Table 48. Local Bus General Timing Parameters—PLL Bypassed (continued)

Parameter	Symbol[1]	Min	Max	Unit	Notes
Local bus clock to data valid for LAD/LDP	$t_{LBKLOV2}$	—	1.6	ns	4
Local bus clock to address valid for LAD, and LALE	$t_{LBKLOV3}$	—	1.6	ns	4
Output hold from local bus clock (except LAD/LDP and LALE)	$t_{LBKLOX1}$	–4.1	—	ns	4
Output hold from local bus clock for LAD/LDP	$t_{LBKLOX2}$	–4.1	—	ns	4
Local bus clock to output high Impedance (except LAD/LDP and LALE)	$t_{LBKLOZ1}$	—	1.4	ns	7
Local bus clock to output high impedance for LAD/LDP	$t_{LBKLOZ2}$	—	1.4	ns	7

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, $t_{LBIXKH1}$ symbolizes local bus timing (LB) for the input (I) to go invalid (X) with respect to the time the t_{LBK} clock reference (K) goes high (H), in this case for clock one (1). Also, t_{LBKHOX} symbolizes local bus timing (LB) for the t_{LBK} clock reference (K) to go high (H), with respect to the output (O) going invalid (X) or output hold time.
2. All timings are in reference to local bus clock for PLL bypass mode. Timings may be negative with respect to the local bus clock because the actual launch and capture of signals is done with the internal launch/capture clock, which proceeds LCLK by t_{LBKHKT}.
3. Maximum possible clock skew between a clock LCLK[m] and a relative clock LCLK[n]. Skew measured between complementary signals at $BV_{DD}/2$.
4. All signals are measured from $BV_{DD}/2$ of the rising edge of local bus clock for PLL bypass mode to $0.4 \times BV_{DD}$ of the signal in question for 3.3-V signaling levels.
5. Input timings are measured at the pin.
6. The value of t_{LBOTOT} is the measurement of the minimum time between the negation of LALE and any change in LAD.
7. For purposes of active/float timing measurements, the Hi-Z or off state is defined to be when the total current delivered through the component pin is less than or equal to the leakage current specification.

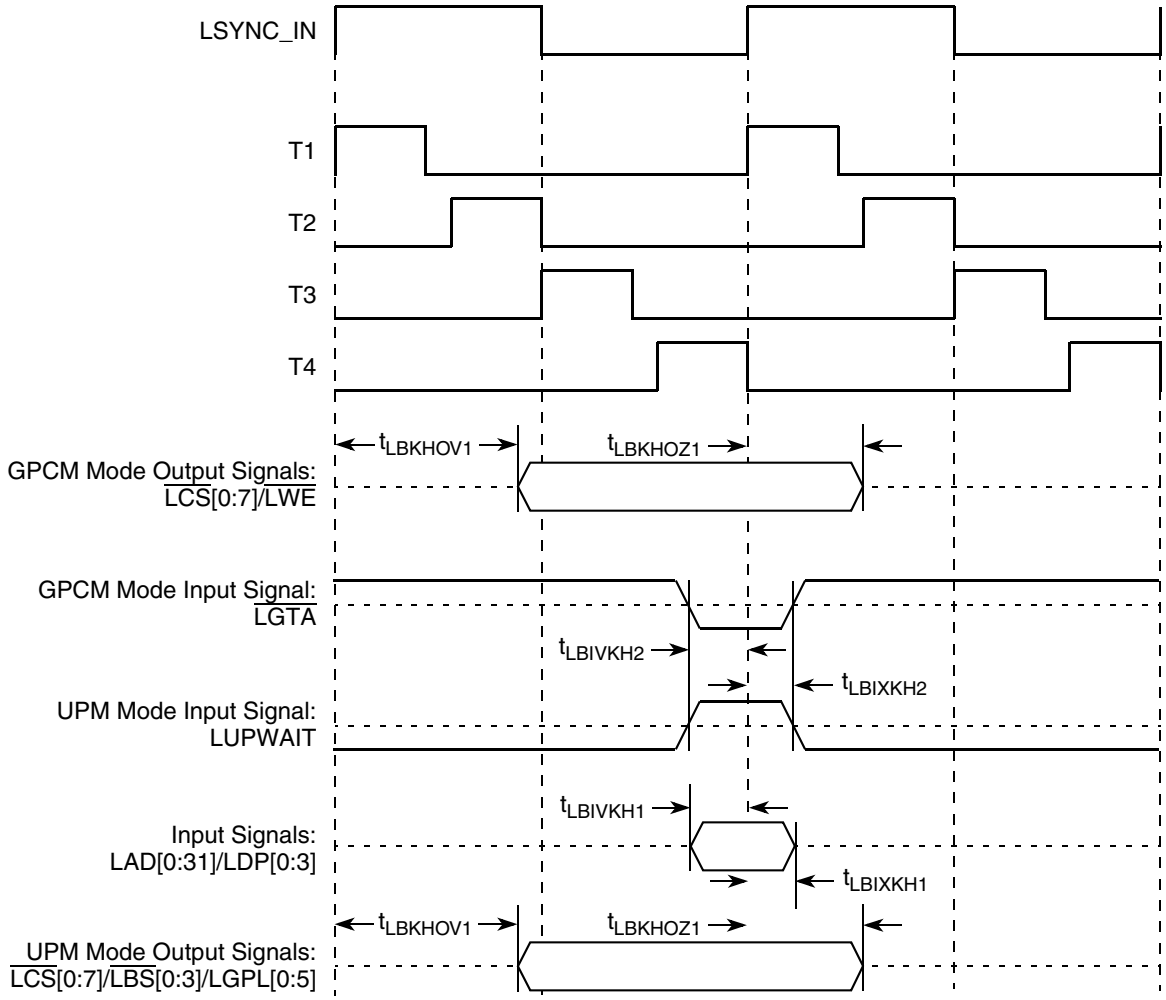

Figure 32. Local Bus Signals, GPCM/UPM Signals for LCCR[CLKDIV] = 8 or 16 (PLL Enabled)

Table 50. JTAG AC Timing Specifications (Independent of SYSCLK)[1] (continued)

At recommended operating conditions (see Table 3).

Parameter	Symbol[2]	Min	Max	Unit	Notes
JTAG external clock to output high impedance: Boundary-scan data TDO	 t_{JTKLDZ} t_{JTKLOZ}	 3 3	 19 9	ns	5

Notes:

1. All outputs are measured from the midpoint voltage of the falling/rising edge of t_{TCLK} to the midpoint of the signal in question. The output timings are measured at the pins. All output timings assume a purely resistive 50-Ω load (see Figure 34). Time-of-flight delays must be added for trace lengths, vias, and connectors in the system.
2. 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_{JTDVKH} symbolizes JTAG device timing (JT) with respect to the time data input signals (D) reaching the valid state (V) relative to the t_{JTG} clock reference (K) going to the high (H) state or setup time. Also, t_{JTDXKH} symbolizes JTAG timing (JT) with respect to the time data input signals (D) went invalid (X) relative to the t_{JTG} clock reference (K) going to the high (H) state. Note that, in general, the clock reference symbol representation is based on three letters representing the clock of a particular functional. For rise and fall times, the latter convention is used with the appropriate letter: R (rise) or F (fall).
3. $\overline{\text{TRST}}$ is an asynchronous level sensitive signal. The setup time is for test purposes only.
4. Non-JTAG signal input timing with respect to t_{TCLK}.
5. Non-JTAG signal output timing with respect to t_{TCLK}.

Figure 34 provides the AC test load for TDO and the boundary-scan outputs.

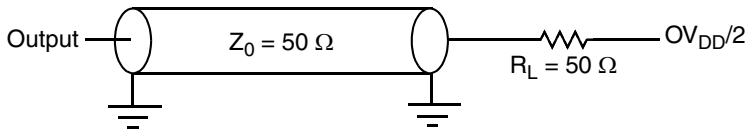

Figure 34. AC Test Load for the JTAG Interface

Figure 35 provides the JTAG clock input timing diagram.

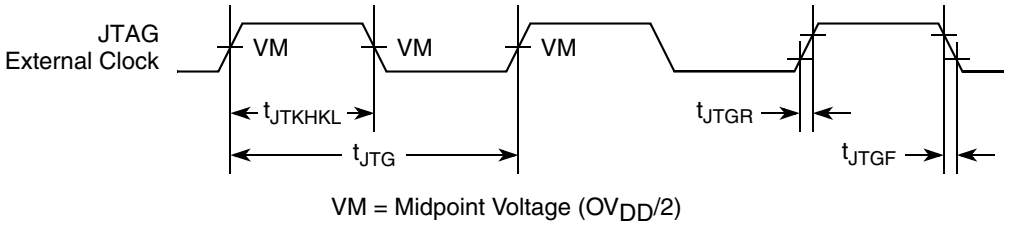

Figure 35. JTAG Clock Input Timing Diagram

Figure 36 provides the $\overline{\text{TRST}}$ timing diagram.

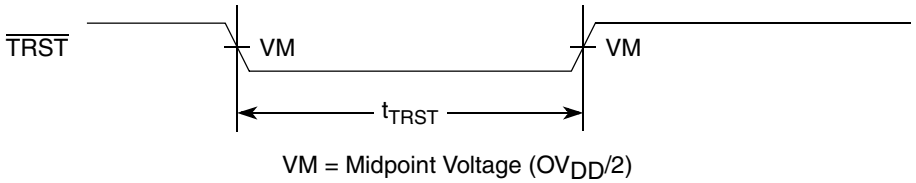

Figure 36. $\overline{\text{TRST}}$ Timing Diagram

Figure 38 provides the AC test load for the I^2C.

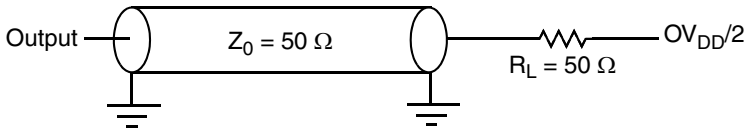

Figure 38. I^2C AC Test Load

Figure 39 shows the AC timing diagram for the I^2C bus.

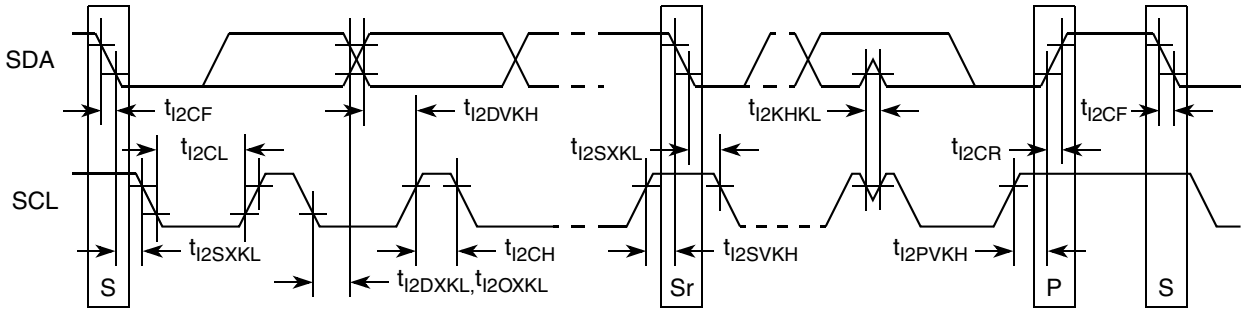

Figure 39. I^2C Bus AC Timing Diagram

14 GPIO

This section describes the DC and AC electrical specifications for the GPIO interface of the MPC8544E.

14.1 GPIO DC Electrical Characteristics

Table 53 provides the DC electrical characteristics for the GPIO interface.

Table 53. GPIO DC Electrical Characteristics

Parameter	Symbol	Min	Max	Unit	Notes
High-level input voltage	V_{IH}	2	OV_{DD} + 0.3	V	—
Low-level input voltage	V_{IL}	–0.3	0.8	V	—
Input current (V_{IN} = 0 V or V_{IN} = V_{DD})	I_{IN}	—	±5	μA	1
High-level output voltage (OV_{DD} = mn, I_{OH} = –2 mA)	V_{OH}	2.4	—	V	—
Low-level output voltage (OV_{DD} = min, I_{OL} = 2 mA)	V_{OL}	—	0.4	V	—

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

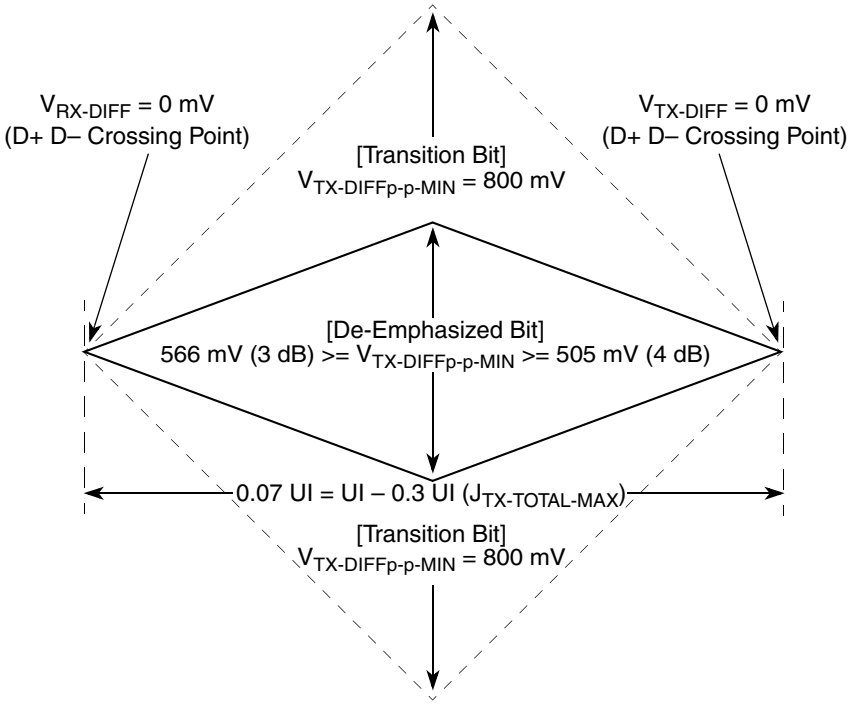

Figure 56. Minimum Transmitter Timing and Voltage Output Compliance Specifications

17.4.3 Differential Receiver (RX) Input Specifications

Table 60 defines the specifications for the differential input at all receivers. The parameters are specified at the component pins.

Table 60. Differential Receiver (RX) Input Specifications

Symbol	Parameter	Min	Nom	Max	Units	Comments
UI	Unit interval	399.88	400	400.12	ps	Each UI is 400 ps ± 300 ppm. UI does not account for spread spectrum clock dictated variations. See Note 1.
$V_{RX-DIFFp-p}$	Differential peak-to-peak input voltage	0.175	—	1.200	V	$V_{RX-DIFFp-p} = 2 \times \lvert V_{RX-D+} - V_{RX-D-} \rvert$ See Note 2.
T_{RX-EYE}	Minimum receiver eye width	0.4	—	—	UI	The maximum interconnect media and transmitter jitter that can be tolerated by the receiver can be derived as $T_{RX-MAX-JITTER} = 1 - T_{RX-EYE} = 0.6$ UI. See Notes 2 and 3.

Table 60. Differential Receiver (RX) Input Specifications (continued)

Symbol	Parameter	Min	Nom	Max	Units	Comments
$T_{RX-EYE-MEDIAN-to-MAX-JITTER}$	Maximum time between the jitter median and maximum deviation from the median	—	—	0.3	UI	Jitter is defined as the measurement variation of the crossing points ($V_{RX-DIFFp-p}$ = 0 V) in relation to a recovered TX UI. A recovered TX UI is calculated over 3500 consecutive unit intervals of sample data. Jitter is measured using all edges of the 250 consecutive UI in the center of the 3500 UI used for calculating the TX UI. See Notes 2, 3, and 7.
$V_{RX-CM-ACp}$	AC peak common mode input voltage	—	—	150	mV	$V_{RX-CM-ACp} = \lvert V_{RXD+} - V_{RXD-}\rvert \div 2 - V_{RX-CM-DC}$ $V_{RX-CM-DC} = DC_{(avg)}$ of $\lvert V_{RX-D+} - V_{RX-D-}\rvert/2$ See Note 2.
$RL_{RX-DIFF}$	Differential return loss	15	—	—	dB	Measured over 50 MHz to 1.25 GHz with the D+ and D– lines biased at +300 and –300 mV, respectively. See Note 4.
RL_{RX-CM}	Common mode return loss	6	—	—	dB	Measured over 50 MHz to 1.25 GHz with the D+ and D– lines biased at 0 V. See Note 4.
$Z_{RX-DIFF-DC}$	DC differential input impedance	80	100	120	Ω	RX DC differential mode impedance. See Note 5.
Z_{RX-DC}	DC input impedance	40	50	60	Ω	Required RX D+ as well as D– DC impedance (50 ± 20% tolerance). See Notes 2 and 5.
$Z_{RX-HIGH-IMP-DC}$	Powered down DC input impedance	200 k	—	—	Ω	Required RX D+ as well as D– DC impedance when the receiver terminations do not have power. See Note 6.
$V_{RX-IDLE-DET-DIFFp-p}$	Electrical idle detect threshold	65	—	175	mV	$V_{RX-IDLE-DET-DIFFp-p} = 2 \times \lvert V_{RX-D+} - V_{RX-D-}\rvert$ Measured at the package pins of the receiver.
$T_{RX-IDLE-DET-DIFF-ENTERTIME}$	Unexpected electrical idle enter detect threshold integration time	—	—	10	ms	An unexpected electrical idle ($V_{RX-DIFFp-p} < V_{RX-IDLE-DET-DIFFp-p}$) must be recognized no longer than $T_{RX-IDLE-DET-DIFF-ENTERING}$ to signal an unexpected idle condition.

Table 62. MPC8544E Pinout Listing (continued)

Signal	Package Pin Number	Pin Type	Power Supply	Notes
V_{DD}	L16, L14, M13, M15, M17, N12, N14, N16, N18, P13, P15, P17, R12, R14, R16, R18, T13, T15, T17, U12, U14, U16, U18,	Power for core (1.0 V)	V_{DD}	—
SVDD_SRDS	M27, N25, P28, R24, R26, T24, T27, U25, W24, W26, Y24, Y27, AA25, AB28, AD27	Core power for SerDes 1 transceivers (1.0 V)	SV_{DD}	—
SVDD_SRDS2	AB1, AC26, AD2, AE26, AG2	Core power for SerDes 2 transceivers (1.0 V)	SV_{DD}	—
XVDD_SRDS	M21, N23, P20, R22, T20, U23, V21, W22, Y20	Pad power for SerDes 1 transceivers (1.0 V)	XV_{DD}	—
XVDD_SRDS2	Y6, AA6, AA23, AF5, AG5	Pad power for SerDes 2 transceivers (1.0 V)	XV_{DD}	—
XGND_SRDS	M20, M24, N22, P21, R23, T21, U22, V20, W23, Y21	—	—	—
XGND_SRDS2	Y4, AA4, AA22, AD4, AE4, AH4	—	—	—
SGND_SRDS	M28, N26, P24, P27, R25, T28, U24, U26, V24, W25, Y28, AA24, AA26, AB24, AB27, AC24, AD28	—	—	—
AGND_SRDS	V27	SerDes PLL GND	—	—
SGND_SRDS2	Y2, AA1, AB3, AC2, AC3, AC25, AD3, AD24, AE3, AE1, AE25, AF3, AH2	—	—	—
AGND_SRDS2	AF1	SerDes PLL GND	—	—
AVDD_LBIU	C28	Power for local bus PLL (1.0 V)	—	19
AVDD_PCI1	AH20	Power for PCI PLL (1.0 V)	—	19
AVDD_CORE	AH14	Power for e500 PLL (1.0 V)	—	19
AVDD_PLAT	AH18	Power for CCB PLL (1.0 V)	—	19

Table 72. MPC8544EThermal Model (continued)

Conductivity	Value	Units
Solder and Air (29 × 29 × 0.58 mm)		
Kx	0.034	W/m•K
Ky	0.034	
Kz	12.1	

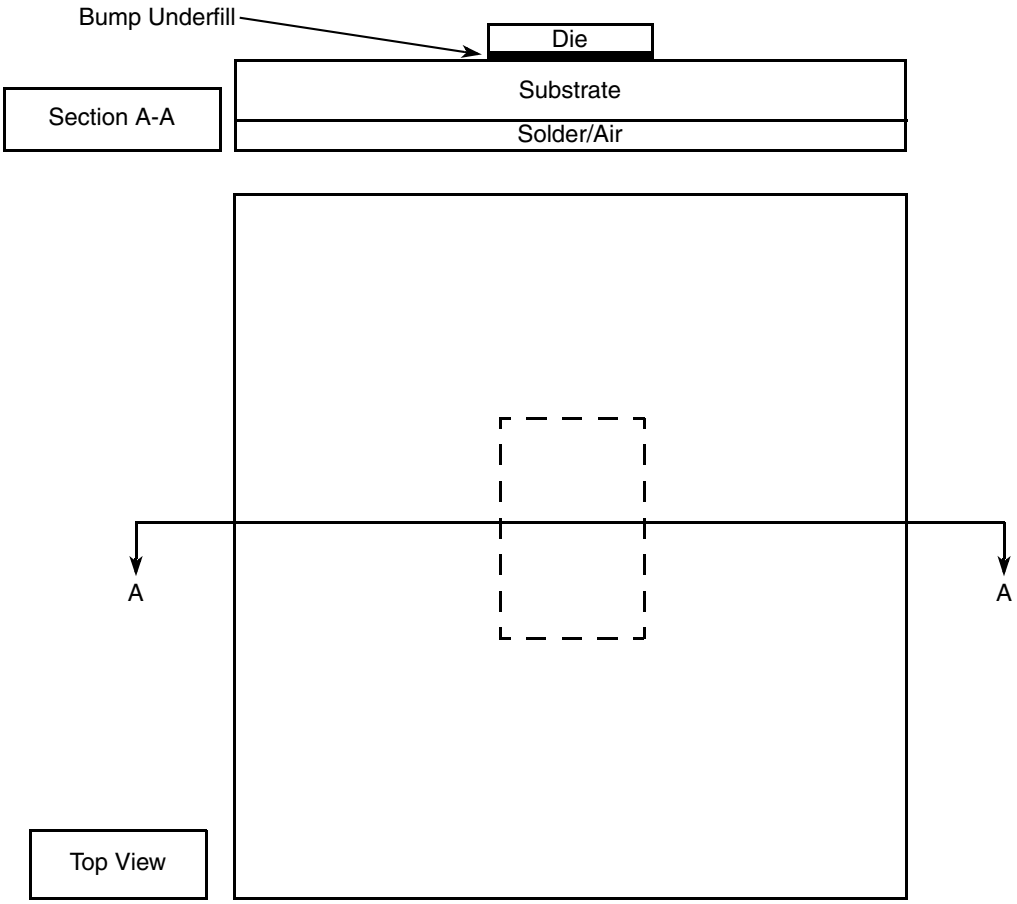

Figure 60. System Level Thermal Model for MPC8544E (Not to Scale)

The Flotherm library files of the parts have a dense grid to accurately capture the laminar boundary layer for flow over the part in standard JEDEC environments, as well as the heat spreading in the board under the package. In a real system, however, the part will require a heat sink to be mounted on it. In this case, the predominant heat flow path will be from the die to the heat sink. Grid density lower than currently in the package library file will suffice for these simulations. The user will need to determine the optimal grid for their specific case.

21.9.1 Termination of Unused Signals

If the JTAG interface and COP header will not be used, Freescale recommends the following connections:

- $\overline{\text{TRST}}$ should be tied to $\overline{\text{HRESET}}$ through a 0-kΩ isolation resistor so that it is asserted when the system reset signal ($\overline{\text{HRESET}}$) is asserted, ensuring that the JTAG scan chain is initialized during the power-on reset flow. Freescale recommends that the COP header be designed into the system as shown in Figure 69. If this is not possible, the isolation resistor will allow future access to $\overline{\text{TRST}}$ in case a JTAG interface may need to be wired onto the system in future debug situations.
- No pull-up/pull-down is required for TDI, TMS, or TDO.

Figure 68 shows the COP connector physical pinout.

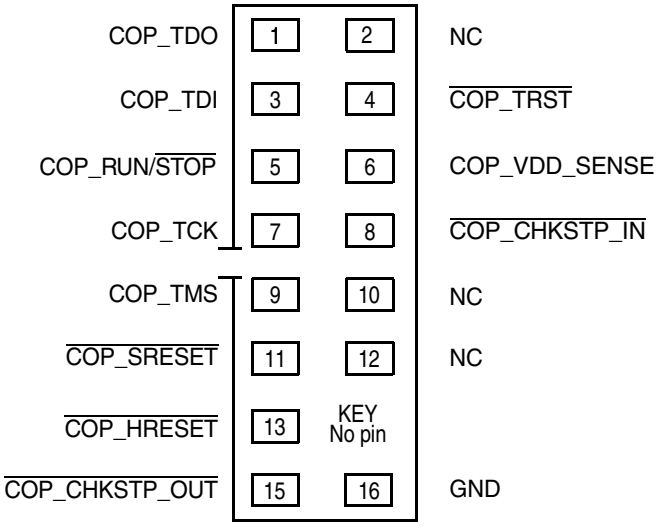

Figure 68. COP Connector Physical Pinout

23 Document Revision History

This table provides a revision history for the MPC8544E hardware specification.

Table 76. MPC8544E Document Revision History

Revision	Date	Substantive Change(s)
8	09/2015	• In Table 10 and Table 12, removed the output leakage current rows and removed table note 4.
7	06/2014	• In Table 75, “Device Nomenclature,” added full Pb-free part code. • In Table 75, “Device Nomenclature,” added footnotes 3 and 4.
6	05/2011	• Updated the value of t_{JTKLDX} to 2.5 ns from 4ns in Table 50.
5	01/2011	• Updated Table 75.
4	09/2010	• Modified local bus information in Section 1.1, “Key Features,” to show max local bus frequency as 133 MHz. • Added footnote 28 to Table 62. • Updated solder-ball parameter in Table 61.
3	11/2009	• Update Section 20.3.4, “Temperature Diode,” • Update Table 61 Package Parameters from 95.5%sn to 96.5%sn
2	01/2009	• Update power number table to include 1067 MHz/533 MHz power numbers. • Remove Part number tables from Hardware spec. The part numbers are available on Freescale web site product page. • Removed I/O power numbers from the Hardware spec. and added the table to bring-up guide application note. • Update t_{DDKHMP}, t_{DDKHME} in Table 18. • Updated RX_CLK duty cycle min, and max value to meet the industry standard GMII duty cycle. • Update paragraph Section 21.3, “Decoupling Recommendations.” • Update Figure 5 DDR Output Timing Diagram. • In Table 40, removed note 1 and renumbered remaining note. • Update Section 22, “Device Nomenclature,” with regards to Commercial Tier.
1	06/2008	Update in Table 18 DDR SDRAM Output AC Timing Specifications tMCK Max value Improvement to Section 16, “High-Speed Serial Interfaces (HSSI) Update Figure 59 Mechanical Dimensions Update in Table 48 Local Bus General Timing Parameters—PLL Bypassed
0	04/2008	Initial release.

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