Table A. Part Numbers Addressed in this Data Sheet

Freescale Part No.[1]	Operating Conditions			Significant Differences from Hardware Specification	Processor Version Register Value
	CPU Frequency (MHz)	V_{DD}	T_J (°C)		
MPC8245ARZU400D	400	2.1 ± 100 mV	0 to 85	Modified voltage and temperature specifications to achieve 400 MHz	0x80811014
MPC8245ARVV400D					

Note:
The 'A' in the part number represents parts that are manufactured under a 29-angstrom process instead of the original 35-angstrom process. Package Options: ZU - TBGA, V V- Lead Free TBGA

4 Electrical and Thermal Characteristics

This section provides the AC and DC electrical specifications and thermal characteristics for the MPC8245.

4.1.1 Absolute Maximum Ratings

The tables in this section describe the MPC8245 DC electrical characteristics. Table 1 provides the absolute maximum ratings.

Table 1. Absolute Maximum Ratings

Characteristic [1]	Symbol	Range	Unit
Supply voltage—CPU core and peripheral logic	V_{DD}	–0.3 to 2.2	V
Supply voltage—memory bus drivers	GV_{DD}	–0.3 to 3.6	V
Supply voltage—PCI and standard I/O buffers	OV_{DD}	–0.3 to 3.6	V
Supply voltage—PLLs	$AV_{DD}/AV_{DD}2$	–0.3 to 2.2	V
Supply voltage—PCI reference	LV_{DD}	–0.3 to 5.4	V
Input voltage [2]	V_{in}	–0.3 to 3.6	V
Operational die-junction temperature range	T_j	0 to 85	°C
Storage temperature range	T_{stg}	–55 to 150	°C

Notes:
1. Table 2 shows functional and tested operating conditions. 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 permanent damage to the device.
2. PCI inputs with LV_{DD} = 5 V ± 5% V DC may undergo corresponding stress at voltages exceeding LV_{DD} + 0.5 V DC.

4.1.2 Recommended Operating Conditions

Table 2 provides the recommended operating conditions for the MPC8245 part numbers described herein.

Table 2. Recommended Operating Conditions (1)

Characteristic	Symbol	Recommended Value for 400 MHz CPU	Unit
Supply voltage	V_{DD}	2.1 V ± 100 mV	V
CPU PLL supply voltage	AV_{DD}	2.1 V ± 100 mV	V
PLL supply voltage—peripheral logic	$AV_{DD}2$	2.1 V ± 100 mV	V
Die-junction temperature(2)	T_j	0 to 85	°C

Notes:
1. Freescale tested these operating conditions and recommends them. Proper device operation outside of these conditions is not guaranteed.
2. For information about the thermal characteristics of this part, refer to the *MPC8245 Integrated Processor Hardware Specifications*. Note that the lower die-junction temperature creates a greater need to use a heat sink with this part.

4.1.5 Power Characteristics

The AC electrical characteristics and AC timing for the parts described in this document are unaffected, and comply with the *MPC8245 Integrated Processor Hardware Specifications*. Table 5 provides the power consumption for the MPC8245 part numbers described herein.

Table 5. Power Consumption

Mode	PCI Bus Clock/Memory Bus Clock CPU Clock Frequency (MHz)	Unit	Notes
	66/133/399		
Typical	2.8	W	1, 5
Max—CFP	3.3	W	1, 2
Max—INT	2.8	W	1, 3
Doze	1.9	W	1, 4, 6
Nap	0.7	W	1, 4, 6
Sleep	0.4	W	1, 4, 6

Table 5. Power Consumption (continued)

Mode	PCI Bus Clock/Memory Bus Clock CPU Clock Frequency (MHz)	Unit	Notes
	66/133/399		
I/O Power Supplies[10]			
Mode	**Range**	**Unit**	**Notes**
Typ—OV_{DD}	140–360	mW	7, 8
Typ—GV_{DD}	340–920	mW	7, 9

Notes:

1. The values include V_{DD}, AV_{DD}, and $AV_{DD}2$, but do not include I/O supply power.
2. Maximum—FP power is measured at V_{DD} = 2.1 V with dynamic power management enabled while running an entirely cache-resident, looping, floating point multiplication instruction.
3. Maximum—INT power is measured at V_{DD} = 2.1 V with dynamic power management enabled while running entirely cache-resident, looping, integer instructions.
4. Power saving mode maximums are measured at V_{DD} = 2.1 V while the device is in doze, nap, or sleep mode.
5. Typical power is measured at V_{DD} = AV_{DD} = 2.1 V, OV_{DD} = 3.3 V where a nominal FP value, a nominal INT value, and a value where there is a continuous flush of cache lines with alternating ones and zeros on 64-bit boundaries to local memory are averaged.
6. Power saving mode data measured with only two PCI_CLKs and two SDRAM_CLKs enabled.
7. The typical minimum I/O power values was the result of the MPC8245 performing cache resident integer operations at the slowest frequency combination of 33:66:200 (PCI:Mem:CPU) MHz.
8. The typical maximum OV_{DD} value resulted from the MPC8245 operating at the fastest frequency combination of 66:133:399 (PCI:Mem:CPU) MHz for the 400-MHz part, and performing continuous flushes of cache lines with alternating ones and zeros to PCI memory.
9. The typical maximum GV_{DD} value resulted from the MPC8245 operating at the fastest frequency combination of 66:133:399 (PCI:Mem:CPU) MHz for the 400-MHz part, and performing continuous flushes of cache lines with alternating ones and zeros on 64-bit boundaries to local memory.
10. Power consumption of PLL supply pins (AV_{DD} and $AV_{DD}2$) < 15 mW that the design guarantees but were not tested.

4.3.1 Clock AC Specifications

Figure 7 through Figure 10 show the DLL locking range loop delay vs. frequency of operation for 29 angstrom parts. These graphs define the areas of DLL locking for various modes. The gray areas show where the DLL will lock.

Register settings that define each DLL mode are shown in Table 9.

Table 9. DLL Mode Definition

DLL Mode	Value of Bit 2 of Config Register at 0x76	Value of Bit 7 of Config Register at 0x72
Normal tap delay, No DLL extend	0	0
Normal tap delay, DLL extend	0	1
Max tap delay, No DLL extend	1	0
Max tap delay, DLL extend	1	1

The DLL_MAX_DELAY bit can lengthen the amount of time through the delay line. This is accomplished by increasing the time between each of the 128 tap points in the delay line. Although this increased time makes it easier to guarantee that the reference clock will be within the DLL lock range, it also means there may be slightly more jitter in the output clock of the DLL, should the phase comparator shift the clock between adjacent tap points. Refer to Freescale application note AN2164, *MPC8245/MPC8241 Memory Clock Design Guidelines*:*Part 1*, for details about DLL modes and memory design.

The value of the current tap point once the DLL has locked can be determined by reading bits 6–0 (DLL_TAP_COUNT) of the DLL tap count register (DTCR, located at offset 0xE3). These bits store the value (binary 0 through 127) of the current tap point and can indicate whether the DLL advances or decrements as it maintains the DLL lock. Therefore, for evaluation purposes, DTCR can be read for all DLL modes that support the T_{loop} value that is used for the trace length of SDRAM_SYNC_OUT to SDRAM_SYNC_IN. The DLL mode that provides the smallest tap point value seen in DTCR should be used. This is because the bigger the tap point value, the more jitter that can be expected for clock signals. Note that keeping a DLL mode that is locked below tap point 12 is not recommended.

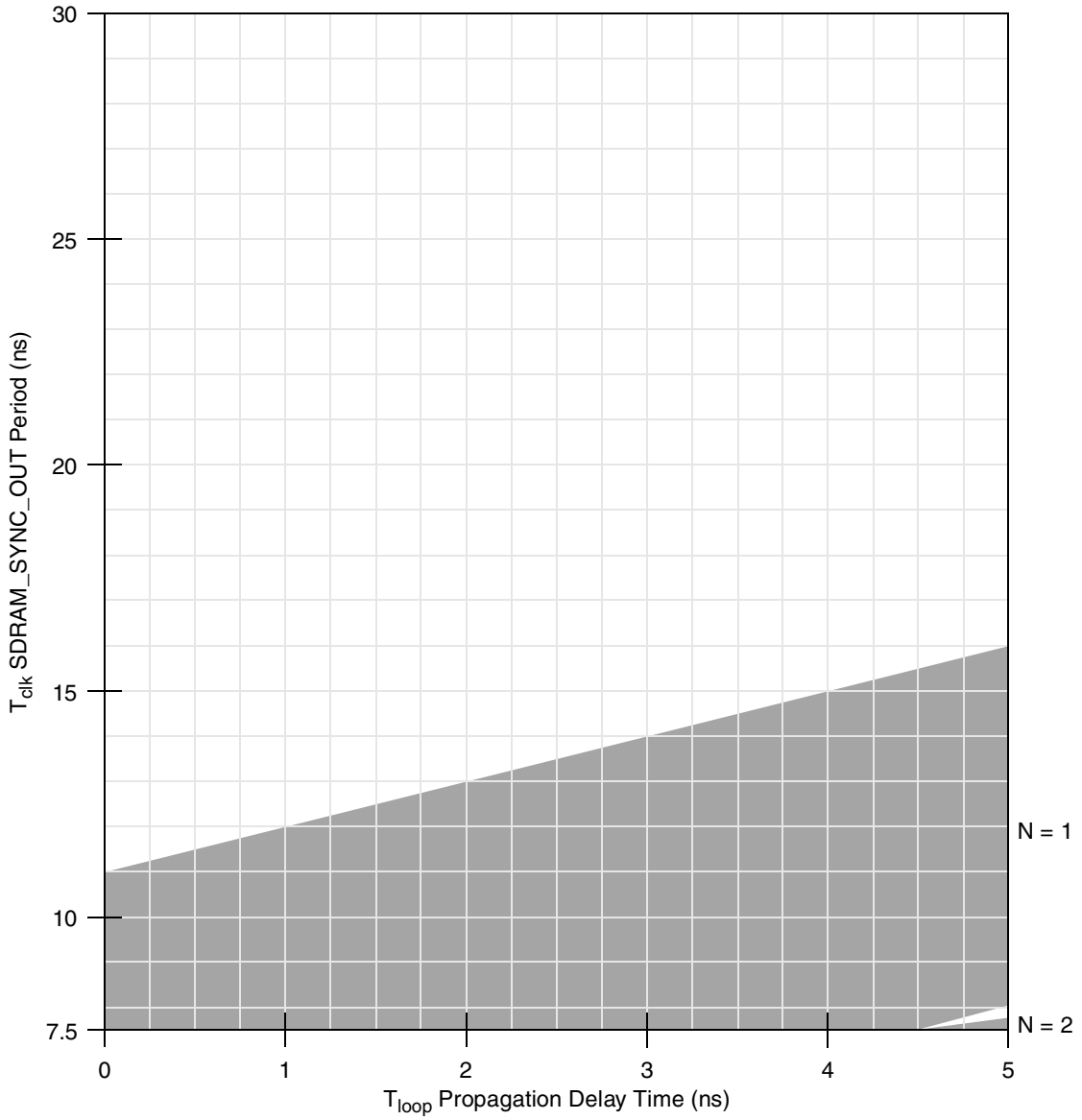

Figure 7. DLL Locking Range Loop Delay vs. Frequency of Operation for DLL_Extend = 0 and Normal Tap Delay

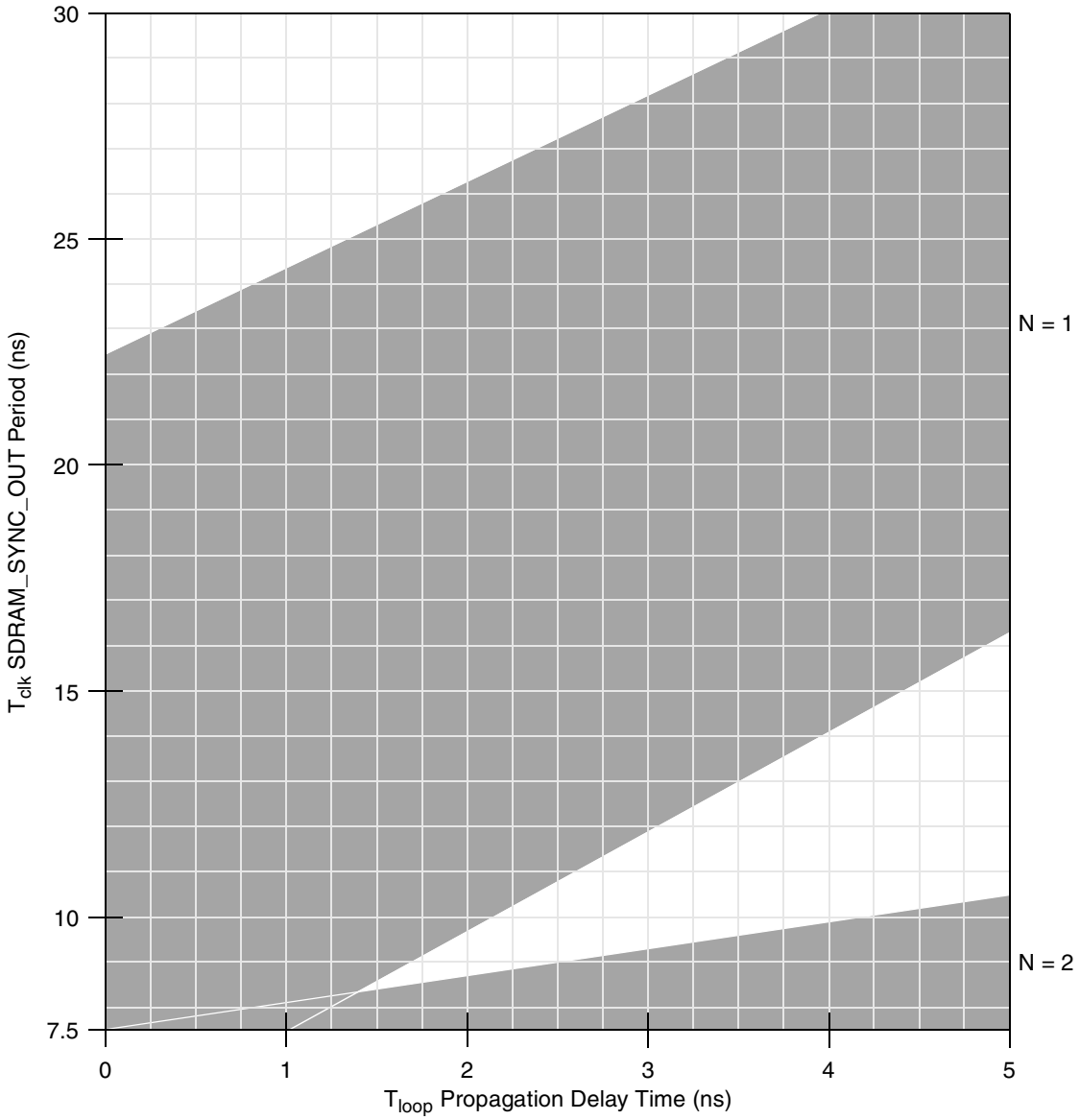

Figure 8. DLL Locking Range Loop Delay vs. Frequency of Operation for DLL_Extend = 1 and Normal Tap Delay

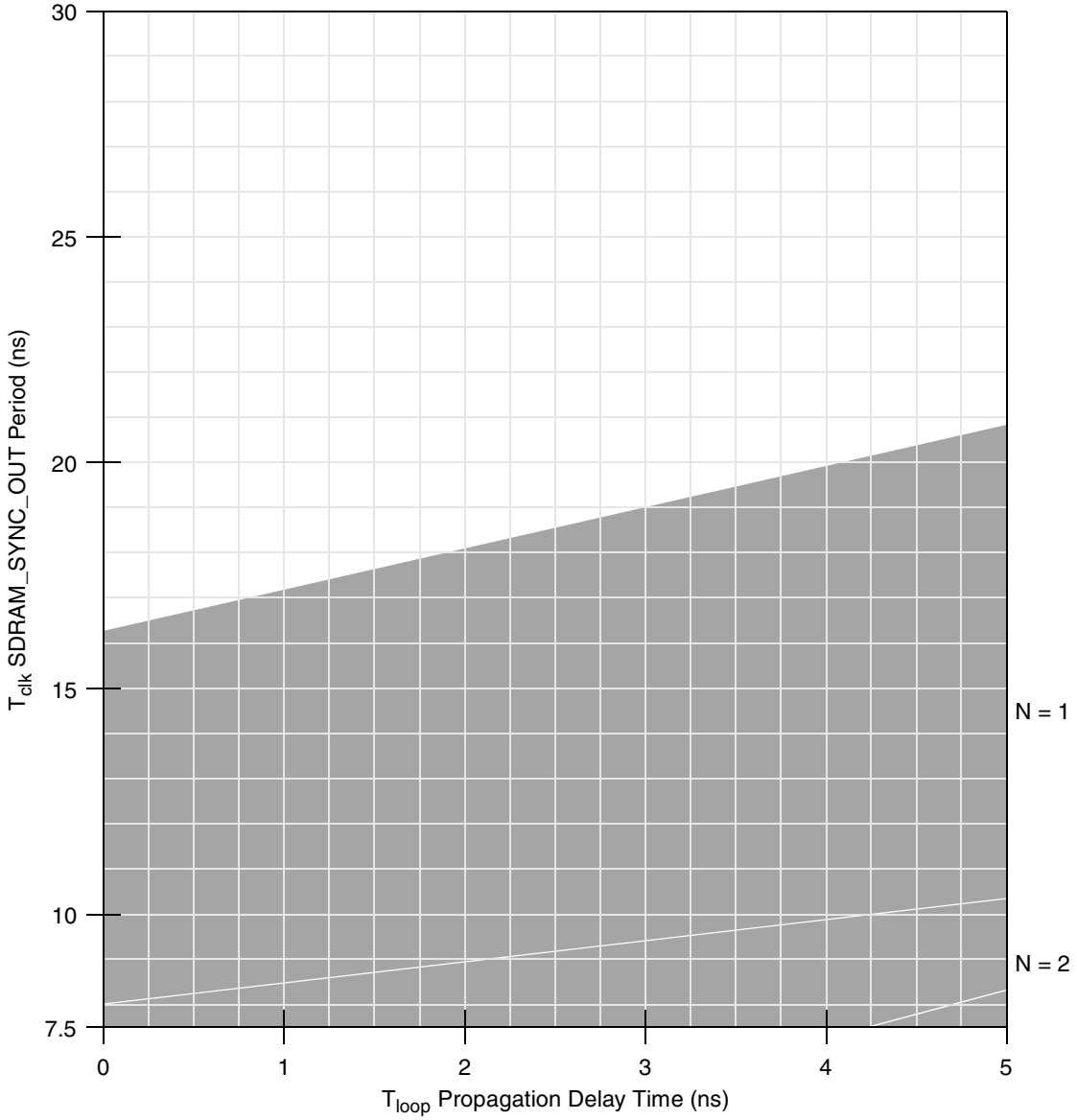

Figure 9. DLL Locking Range Loop Delay vs. Frequency of Operation for DLL_Extend = 0 and Max Tap Delay

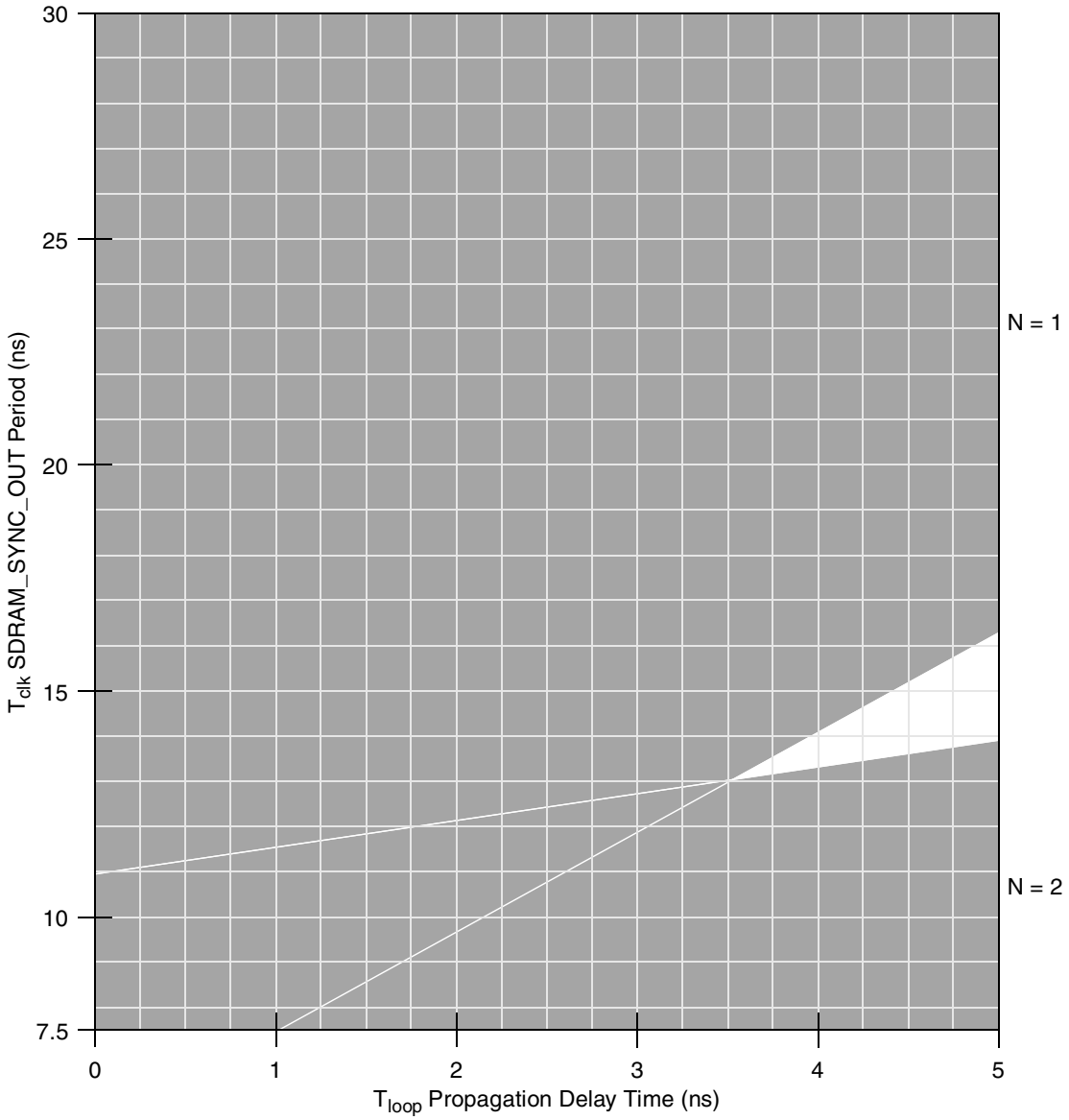

Figure 10. DLL Locking Range Loop Delay vs. Frequency of Operation for DLL_Extend = 1 and Max Tap Delay

6 PLL Configuration

The MPC8245 internal PLLs are configured by the PLL_CFG[0:4] signals. For a given PCI_SYNC_IN (PCI bus) frequency, the PLL configuration signals set both the peripheral logic/memory bus PLL (VCO) frequency of operation for the PCI-to-memory frequency multiplying and the MPC603e CPU PLL (VCO) frequency of operation for memory-to-CPU frequency multiplying. The PLL configurations for the 400-MHz parts are shown in Table 18.

Table 18. PLL Configurations for the 400-MHz Part Offering

Ref	PLL_CFG [0:4][11,14,15]	400-MHz Part [9]			Multipliers	
		PCI Clock Input (PCI_SYNC_IN) Range [1] (MHz)	Periph Logic/Mem Bus Clock Range (MHz)	CPU Clock Range (MHz)	PCI-to-Mem (Mem VCO)	Mem-to-CPU (CPU VCO)
0	00000	25–44[2]	75–132	188–330	3 (2)	2.5 (2)
1	00001	25–44[5]	75–132	225–396	3 (2)	3 (2)
2	00010[13]	50[9]–66[1]	50–66	225–297	1 (4)	4.5 (2)
3	00011[16]	50[8]–66[1]	50–66	100–133	1 (Bypass)	2 (4)
4	00100	25–46[4]	50–92	100–184	2 (4)	2 (4)
6	00110[17]	Bypass			Bypass	Bypass
7 (Rev. B)	00111	60[6]–66[1]	60–66	180–198	1 (Bypass)	3 (2)
7 (Rev. D)	00111[13]	25–28[5]	100–112	350–392	4 (2)	3.5 (2)
8	01000	60[6]–66[1]	60–66	180–198	1 (4)	3 (2)
9	01001	45[6]–66[1]	90–132	180–264	2 (2)	2 (2)
A	01010	25–44[5]	50–88	225–396	2 (4)	4.5 (2)
B	01011	45[3]–66[1]	68–99	204–297	1.5 (2)	3 (2)
C	01100	36[6]–46[4]	72–92	180–230	2 (4)	2.5 (2)
D	01101	45[3]–66[1]	68–99	238–347	1.5 (2)	3.5 (2)
E	01110	30[6]–46[4]	60–92	180–276	2 (4)	3 (2)
F	01111	25–38[5]	75–114	263–399	3 (2)	3.5 (2)
10	10000	30–44[2]	60–132	180–264	3 (2)	2 (2)
11	10001	25–33[2]	100–132	250–330	4 (2)	2.5 (2)
12	10010	60[6]–66[1]	90–99	180–198	1.5 (2)	2 (2)
13	10011	25–33[5]	100–132	300–396	4 (2)	3 (2)
14	10100	26[6]–47[4]	52–94	182–329	2 (4)	3.5 (2)
15	10101	27[3]–40[5]	68–100	272–400	2.5 (2)	4 (2)
16	10110	25–46[4]	50–92	200–368	2 (4)	4 (2)

Table 18. PLL Configurations for the 400-MHz Part Offering (continued)

Ref	PLL_CFG [0:4][11,14,15]	400-MHz Part [9]			Multipliers	
		PCI Clock Input (PCI_SYNC_IN) Range [1] (MHz)	Periph Logic/Mem Bus Clock Range (MHz)	CPU Clock Range (MHz)	PCI-to-Mem (Mem VCO)	Mem-to-CPU (CPU VCO)
17	10111	25–33[2]	100–132	200–264	4 (2)	2 (2)
18	11000	27[3]–53[5]	68–132	204–396	2.5 (2)	3 (2)
19	11001	36[6]–66[1]	72–132	180–330	2 (2)	2.5 (2)
1A	11010	50[9]–66[1]	50–66	200–264	1 (4)	4 (2)
1B	11011[13]	34[3]–66[1]	68–132	204–396	2 (2)	3 (2)
1C	11100	44[6]–66[1]	66–99	198–297	1.5 (2)	3 (2)
1D	11101	48[6]–66[1]	72–99	180–248	1.5 (2)	2.5 (2)
1E (Rev. B)	11110[10]	Not usable			Off	Off
1E (Rev. D)	11110	33[3]–57[5]	66–114	231–399	2 (2)	3.5 (2)
1F	11111[10]	Not usable			Off	Off

Notes:

1. Limited by maximum PCI input frequency (66 MHz).
2. Limited by maximum system memory interface operating frequency (133 MHz).
3. Limited by minimum memory VCO frequency (132 MHz).
4. Limited due to maximum memory VCO frequency (372 MHz).
5. Limited by maximum CPU operating frequency (400 MHz).
6. Limited by minimum CPU VCO frequency (360 MHz).
7. Limited by maximum CPU VCO frequency (800 MHz).
8. Limited by minimum CPU operating frequency (100 MHz).
9. Limited by minimum memory bus frequency (50 MHz).
10. In clock off mode, no clocking occurs inside the MPC8245, regardless of the PCI_SYNC_IN input.
11. Range values are shown rounded down to the nearest whole number (decimal place accuracy removed) for clarity.
12. PLL_CFG[0:4] settings that are not listed are reserved.
13. Multiplier ratios for this PLL_CFG[0:4] setting are different from the MPC8240 and are not backwards-compatible.
14. PCI_SYNC_IN range for this PLL_CFG[0:4] setting is different from the MPC8240 and may not be fully backwards-compatible.
15. Bits 7–4 of register offset <0xE2> contain the PLL_CFG[0:4] setting value.
16. In PLL bypass mode, the PCI_SYNC_IN input signal clocks the internal processor directly, the peripheral logic PLL is disabled, and the bus mode is set for 1:1 (PCI:Mem) mode operation. This mode is intended for hardware modeling support. The AC timing specifications given in this document do not apply in the PLL bypass mode.
17. In dual PLL bypass mode, the PCI_SYNC_IN input signal clocks the internal peripheral logic directly, the peripheral logic PLL is disabled, and the bus mode is set for 1:1 (PCI_SYNC_IN:Mem) mode operation. In this mode, the OSC_IN input signal clocks the internal processor directly in 1:1 (OSC_IN:CPU) mode operation, and the processor PLL is disabled. The PCI_SYNC_IN and OSC_IN input clocks must be externally synchronized. This mode is intended for hardware modeling support. The AC timing specifications given in this document do not apply in the dual PLL bypass mode.

9 Ordering Information

Ordering information for the parts covered in this document is provided in Section 9.1, “Part Numbers Fully Addressed by This Document.” Section 9.3, “Part Marking,” addresses the marking specifications.

9.1 Part Numbers Fully Addressed by This Document

Table 21 provides the ordering information for the MPC8245 parts described herein. Note that the individual part numbers correspond to a maximum processor core frequency.

Table 23. Part Numbers Addressed by This Document.

MPC	*nnnn*	*X*	X	*xx*	*nnn*	*x*

Product Code	Part Identifier	Process [3] Identifier	Process Descriptor	Package [1]	Processor Frequency [2]	Revision Level	Processor Version Register Value
MPC	8245	A	R: 0° to 85°C	ZU = TBGA V V= Lead-free TBGA	400 MHz 2.1 V ± 100 mV	D:1.4 Rev ID:0x14	0x80811014

Notes:

1. See Section 5, “Package Description,” for more information on available package types.
2. Processor core frequencies supported by parts addressed by this specification only. Not all parts described in this specification support all core frequencies. Additionally, parts addressed by part number specifications may support other maximum core frequencies.
3. Process identifier ‘A’ represents parts that are manufactured under a 29-angstrom process verses the original 35-angstrom process.

9.3 Part Marking

Parts are marked as in the example shown in Figure 33.

Notes:

MMMMMM is the 6-digit mask number.
ATWLYYWW is Test traceability code.
YWWLAZ is the Assembly traceability code.
CCCCC is the country code.

Figure 33. Freescale Part Marking for TBGA Device

2 Document Revision History

Table B provides a revision history for this part number specification.

Table B Document Revision History

Rev. No.	Date	Substantive Change(s)
3	12/05	• Changed Document ID from MPC8245ARUPNS to MPC8245ECS02AD. • Changed title of document from *MPC8245 Part Number Specification for the MPC8245ARZUnnnX Series*" to the "*MPC8245 Hardware Specification Addendum for the MPC8245ARXXnnnx Series*." • Table A and Table 23 were updated to reflect current part offerings for the part. • Removed Section 2, "Features" and Section 3, ".General Parameters." • Added Section 4, "Electrical and Thermal Characteristics." heading and introduction. • Remove all 466 MHz specific information as this part is not available for new orders. Section 4.3.3 was removed because it was specific to the 466 MHz part. • Figure 33 was updated to reflect current part marking format.
2	07/12/04	• Updated to Freescale template. • Updated section numbers to accurately reflect hardware specifications sections. • Changed junction temperature range in Table 1 to reflect range depicted in Table A (0° to 85°C). • Added Section 4.3.1 to illustrate DLL locking graphs for 29 angstrom parts (400- and 466-MHz parts).
1.0		• Added to list of parts covered by this document, including the non-A process identifier parts. Updated Table A and Table 20. • Nontechnical reformatting.
0.1		Minor edit to part number.
0		Original release.

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