



## APPENDIX F MEMORY ACCESS TIMING

### F.1 Introduction

**Table F-1** lists all possible memory access timing to internal and external memory combinations. The clock values show the number of clocks from the moment an address is valid on a specific bus, until data is back on that same bus. The following assumptions were used when compiling the information:

- The arbitration time was ignored. The values assume that the bus (or buses) involved in a transaction was in the IDLE state when the transaction needs that bus.
- The UIMB works in a mode of 1:1. This is relevant for IMB accesses values. In the case of 2:1 mode, the clock latency for a cycle on the IMB should be doubled. (each IMB access takes two clocks.)
- The basic delay of external bus to U-bus is four clocks (external master case).
- All IMB accesses are assumed to be 16-bit accesses only. If 32-bit accesses are used, then each such IMB access is split into two separate 16-bit cycles with normal IMB performance for each.

**Table F-1 Memory Access Times Using Different Buses**

	INTERNAL				EXTERNAL RAM/ FLASH		SHOW CYCLE	
	FLASH	RAM	IMB	SIU	Internal Memory Mapped External	Non- mapped Internal Memory	Write	Read
RCPU Load/Store	3/4 <sup>1</sup>	1	6	5	4+N <sup>2</sup>	4+N	2	2
RCPU Instruction Fetches	2-1-1-1-1...	3 <sup>3</sup>	-	-	2+N	2+N	-	1 <sup>4</sup>
Peripheral Mode (only ext. master is active)	4/5	6	7	6				
Slave Mode (both ext. & int. CPUs are active)	5/6	7	8	7				

**NOTES:**

1. "/" comes for on/off page flash access.
2. N is the number of clocks from external address valid till external data valid in the case of read cycle. In the case of zero wait states, N = 2.
3. Assuming BBC is parked on U-BUS.
4. Until address is valid on external pins

Table F-2 Timing Examples



Access	# Clock													Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	
Load/Store -> Ebus	L	U	E											6 <sup>1</sup>
				E	U	L								
Load/Store -> IMB 16 bits	L	U	IMB											6
				IMB	U	L								
Instruction Fetch-> cmf new page 3 consecutive accesses	C,U													2
		U <sup>2</sup>												
		C,U												1
		U												1
			C,U											1
Instruction Fetch-> cmf new page Load/Store -> IMB	C,U													2
		U												
	L	U	IMB											6
				IMB	U	L								
Instruction Fetch-> cmf new page Load/Store -> IMB		C	U											6
						U								
	L	U	IMB											6
				IMB	U	L								
External Bus-> cmf new page	E		U											5
				U	E									
External Bus-> IMB	E		U	IMB										7
					IMB	U	E							
Instruction Fetch-> cmf 2 consecutive accesses & External Bus-> cmf		C,U												2
			U											
			C	_3	-	-	-	-	-	-	-	U		11
													U	
	E		retry	E <sup>4</sup>		U								8
							U	E						

NOTES:

1. N is the number of clocks from external address valid until external data valid in the case of read cycle. In the case of zero wait states, N = 2.
2. Core instruction fetch data bus is usually the UBUS
3. 8 clocks are dedicated for external access, and internal accesses are denied.
4. Assuming the external master immediately retries

LEGEND

Shaded areas = address phase ; Non-shaded areas = data phase