

### Pipeline Behavior of Various MIPS Instructions

Numbers inside the table indicate the number of cycles spent in each stage.

(Note: This is not a complete list of the MIPS instruction set.)

| instruction | IF   | ID | F-ID | EX | F-EX | MD | FMUL | FDIV | MEM | FMEM | WB | F-WB |
|-------------|--|----|------|----|------|----|------|------|-----|------|----|------|
| typical int | 1  | 1  |      | 1  |      |    |      |      | 1   |      | 1  |      |
| mult        | 1  | 1  |      |    |      | 11 |      |      |     |      |    |      |
| div         | 1  | 1  |      |    |      | 34 |      |      | 1   |      | 1  |      |
| mflo        | 1  | 1  |      |    |      | 2  |      |      | 1*  |      | 1* |      |
|             | * In the mflo instruction (and mfhi too),<br>the MEM and WB occur simultaneously<br>with the 2 cycles in MD. |    |      |    |      |    |      |      |     |      |    |      |
| lwc1        | 1  | 1  |      | 1  |      |    |      |      |     | 1    |    | 2    |
| mov.s       | 1  |    | 1    |    | 1    |    |      |      |     | 1    |    | 2    |
| add.s       | 1  |    | 1    |    | 2    |    |      |      |     | 1    |    | 2    |
| cvt         | 1  |    | 1    |    | 3    |    |      |      |     | 1    |    | 2    |
| mul.s       | 1  |    | 1    |    | 1    |    | 2    |      |     |      |    |      |
|             |  |    |      |    | 1    |    |      |      |     | 1    |    | 2    |
| mul.d       | 1  |    | 1    |    | 1    |    | 3    |      |     |      |    |      |
|             |  |    |      |    | 1    |    |      |      |     | 1    |    | 2    |
| div.s       | 1  |    | 1    |    | 1    |    |      | 8    |     |      |    |      |
|             |  |    |      |    | 3    |    |      |      |     | 1    |    | 2    |
| div.d       | 1  |    | 1    |    | 1    |    |      | 15   |     |      |    |      |
|             |  |    |      |    | 3    |    |      |      |     | 1    |    | 2    |
|             | Note: My MIPS reference shows the F-WB as two<br>separate stages, each taking one cycle.                     |    |      |    |      |    |      |      |     |      |    |      |

### Pipeline Behavior of Various SPARC Instructions

Numbers inside the table indicate the number of cycles spent in each stage.

(Note: This is not a complete list of the SPARC instruction set.)

| instruction | IF | ID | EX | F-EX | MEM | WB | F-WB |
|-------------|----|----|----|------|-----|----|------|
| typical int | 1  | 1  | 1  |      | 1   | 1  |      |
| mul         | 1  | 1  | 19 |      | 1   | 1  |      |
| div         | 1  | 1  | 39 |      | 1   | 1  |      |
| st          | 1  | 1  | 1  |      | 2   |    |      |
| fadd        | 1  | 1  |    | 17   |     |    | 1    |
| fcmpd       | 1  | 1  |    | 15   |     |    | 1    |
| fnegd       | 1  | 1  |    | 2    |     |    | 1    |
| fmovd       | 1  | 1  |    | 2    |     |    | 1    |
| fitod       | 1  | 1  |    | 13   |     |    | 1    |
| ftoid       | 1  | 1  |    | 14   |     |    | 1    |
| fdivs       | 1  | 1  |    | 38   |     |    | 1    |
| fdivd       | 1  | 1  |    | 56   |     |    | 1    |
| fstod       | 1  | 1  |    | 14   |     |    | 1    |
| fdtos       | 1  | 1  |    | 16   |     |    | 1    |
| fmuls       | 1  | 1  |    | 25   |     |    | 1    |
| fmuld       | 1  | 1  |    | 32   |     |    | 1    |
| fsqrts      | 1  | 1  |    | 51   |     |    | 1    |
| fsqrtd      | 1  | 1  |    | 80   |     |    | 1    |
| ba          | 1  | 1  |    |      |     |    |      |
| be          | 1  | 1  |    |      |     |    |      |
| bg          | 1  | 1  |    |      |     |    |      |
| bge         | 1  | 1  |    |      |     |    |      |
| bl          | 1  | 1  |    |      |     |    |      |
| ble         | 1  | 1  |    |      |     |    |      |
| bne         | 1  | 1  |    |      |     |    |      |
| call        | 1  | 1  |    |      |     |    |      |

These are integer instructions.

These floating point instructions execute in the same time if single precision.

These f.p. instructions execute longer if double precision.

These are branches and jumps.