基于VerilogHDL语言以及MIPS32-C3体系结构的

带有异常与中断处理的流水线CPU设计文档

一、数据通路

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | addu | subu | ori | lui | lw | sw | beq | j | jal | jr | MUX | 0 | 1 | MF | 0 | 1 | 2 |
| Fetch | PC | ADD4 | ADD4 | ADD4 | ADD4 | ADD4 | ADD4 | NPC|ADD4 | NPC | NPC | NPC | MUX\_PC | ADD4 | NPC |  |  |  |  |
| Decode | NPC |  |  |  |  |  |  | offset | index | index | V1D |  |  |  |  |  |  |  |
| RF | V1D | 1 | 1 | 1 | 1 | 1 | 1 | 1 |  |  | 1 |  |  |  | MF\_V1D | V1D | DMoutW | AOM |
| V2D | 1 | 1 |  |  |  | 1 | 1 |  |  |  |  |  |  | MF\_V2D | V2D | DMoutW | AOM |
| CMP | RD1 |  |  |  |  |  |  | 1 |  |  |  |  |  |  | MF\_V1D | V1D | DMoutW | AOM |
| RD2 |  |  |  |  |  |  | V2D |  |  |  |  |  |  | MF\_V2D | V2D | DMoutW | AOM |
| CMPsel |  |  |  |  |  |  | EQ |  |  |  |  |  |  |  |  |  |  |
| EXT | EXTOp |  |  | ZERO | UPPER | SIGN | SIGN |  |  |  |  |  |  |  |  |  |  |  |
| NPC | NPCsel |  |  |  |  |  |  | BRANCH | JUMP | JUMP | REGI |  |  |  |  |  |  |  |
| Execute | V1E | 1 | 1 | 1 | 1 | 1 | 1 | FLUSH | FLUSH | FLUSH | FLUSH |  |  |  |  |  |  |  |
| V2E | 1 | 1 |  |  |  | 1 | FLUSH | FLUSH | FLUSH | FLUSH |  |  |  |  |  |  |  |
| ImmOutE |  |  | 1 | 1 | 1 | 1 | FLUSH | FLUSH | FLUSH | FLUSH |  |  |  |  |  |  |  |
| ShiftE |  |  |  |  |  |  | FLUSH | FLUSH | FLUSH | FLUSH |  |  |  |  |  |  |  |
| ALU | SrcAE | 1 | 1 | 1 | 1 | 1 | 1 |  |  |  |  |  |  |  | MF\_V1E | V1E | DMoutW | AOM |
| SrcBE | V2E | V2E | imm | imm | imm | imm |  |  |  |  | MUX\_SrcB | V2E | imm | MF\_V2E | V2E | DMoutW | AOM |
| Shift |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ALUCtrl | ADD | SUB | OR | ADD | ADD | ADD |  |  |  |  |  |  |  |  |  |  |  |
| M | WRM | rd | rd | A2rt | A2rt | A2rt |  |  |  |  |  | MUX\_WR | rd | A2rt |  |  |  |  |
| AOM | value | value | value | value | addr | addr |  |  |  |  |  |  |  |  |  |  |  |
| WDMM |  |  |  |  |  | V2E |  |  |  |  |  |  |  | MF\_WDMM | V2E | DMoutW |  |
| DM | DMWE |  |  |  |  |  | 1 |  |  |  |  |  |  |  |  |  |  |  |
| Load |  |  |  |  | WORD | WORD |  |  |  |  |  |  |  |  |  |  |  |
| DMoutM |  |  |  |  | 1 |  |  |  |  |  |  |  |  |  |  |  |  |
| WriteBack | DMoutW |  |  |  |  | 1 |  |  |  |  |  |  |  |  |  |  |  |  |
| AOW | value | value | value | value |  |  |  |  |  |  |  |  |  |  |  |  |  |
| PC | PC | PC | PC | PC | PC |  |  | PC+8 | PC+8 |  |  |  |  |  |  |  |  |
| WRW | rd | rd | A2rt | A2rt | A2rt |  |  |  | 31 |  |  |  |  |  |  |  |  |

二、各个模块以及控制器设计

|  |  |  |
| --- | --- | --- |
| reg[31:0] PC |  | Fetch 取指令 |
| 指示下一条指令的地址 |  | 初始化：PC置0x00003000 |
| NPC[31:0] | I | 下一次的PC值输入 |
| EN | I | 冲突单元控制PC使能端，暂停用 |
| reset | I | 同步复位，复位值为0x00003000 |
| clk | I | 时钟 |
| PC\_F[31:0] | O | F级PC输出 |
|  |  |  |
| reg[31:0] IM[0:1023] |  |  |
| 指令存储器 | 0x00003000-0x00003ffc |  |
| PC[31:0] | I | PC输入 |
| Instr\_F[31:0] | O | 指令输出 |
|  |  |  |
|  |  |  |
| ADD4 |  |  |
| PC[31:0] | I | PC输入 |
| PCADD4F[31:0] | O | F级PC+4输出 |

|  |  |  |
| --- | --- | --- |
| Decode | 译码 |  |
| PC\_F[31:0] | I | PC输入 |
| PCADD4\_F[31:0] | I | PC+4输入 |
| Instr\_F[31:0] | I | 指令输入 |
| EN | I | 冲突单元控制D级流水使能端，暂停用 |
| clk | I | 时钟 |
| reset | I | 同步复位置0 |
| PC\_D[31:0] | O | D级PC输出 |
| PCADD4\_D[31:0] | O | D级PC+4输出 |
| InstrD[31:0] | O | D级指令输出 |
|  |  |  |
| RF |  |  |
| clk | I | 时钟 |
| reset | I | 同步复位,全部置0 |
| A1rs[25:21] | I | rs |
| A2rt[20:16] | I | rt |
| A3[4:0] | I | 写回寄存器的地址 |
| RegWE | I | 寄存器写使能 |
| WPC[31:0] | I | 写寄存器的指令的PC |
| RWD[31:0] | I | 写寄存器的数据RegWriteData |
| V1D[31:0] | O | D级读出值1 |
| V2D[31:0] | O | D级读出值2 |
|  |  |  |
| CMP |  | 有符号 |
| Instr[31:0] | I | 整个指令做比较器选择信号(统一用A2做func的情况\_ |
| RD1[31:0] | I | 待比较的寄存器值1 |
| RD2[31:0] | I | 待比较的寄存器值2 |
| CMPout | O | 比较结果输出 |
|  |  |  |
| EXT |  |  |
| Immin[15:0] | I | 立即数输入 |
| EXTOp[1:0] | I | 扩展选择信号 |
| ImmOut\_D[15:0] | O | D级扩展立即数输出信号 |
|  |  |  |
| NPC |  |  |
| RegRead | I | 寄存器的地址值，jr,jalr用 |
| Offset[15:0] | I | 偏移量 |
| InstrIndex[25:0] | I | j与jal用的跳转目标 |
| PC+4 | I | PC+4输入 |
| PC[31:0] | I | PC输入 |
| NPCsel[1:0] | I | NPC选择信号 |
| Instr[31:0] | I |  |
| NPCout[31:0] | O | npc输出 |
| PC+8[31:0] | O |  |

|  |  |  |
| --- | --- | --- |
| Execute | 执行 |  |
| PC[31:0] | I | PC输入 |
| V1[31:0] | I | 寄存器读出值1 |
| V2[31:0] | I | 寄存器读出值2 |
| ExtImm[31:0] | I | 扩展后的立即数 |
| Shift[10:6] | I | 移位运算用的数 |
| reset | I | 指令清除(暂停&bgezal等有条件写入) |
|  |  |  |
| clk | I |  |
| PCAdd8[31:0] | I | PC+8输入 |
| PCE[31:0] | O | E级PC输出 |
| V1E[31:0] | O | E级寄存器读出值1 |
| V2E[31:0] | O | E级寄存器读出值2 |
| ImmOutE[31:0] | O | E级扩展后的立即数 |
| ShiftE[4:0] | O | E级移位运算用的数 |
| PCAdd8\_E[31:0] | O | PC+8输出 |
|  |  |  |
| ALU |  |  |
| SrcA\_E[31:0] | I | 运算数A |
| SrcB\_E[31:0] | I | 运算数B |
| Shift\_E[4:0] | I | 移位数 |
| ALUCtrl[3:0] | I | ALU控制信号 |
| AO\_E[31:0] | O | E级ALU运算结果 |

|  |  |  |
| --- | --- | --- |
| Memory | 存储 |  |
| clk | I | 时钟 |
| reset | I | 同步复位,全部置0 |
| PC\_E[31:0] | I |  |
| AO\_E[31:0] | I | E级ALU运算结果 |
| WDM\_E[31:0] | I | E级写内存的数据WriteDataMemoryE |
| PCAdd8\_E[31:0] | I |  |
| AO\_M[31:0] | O | M级ALU运算结果 |
| WDM\_M[31:0] | O | M级写内存的数据 |
| PC\_M[31:0] | O |  |
| PCAdd8\_M[31:0] | O |  |
|  |  |  |
| DM |  |  |
| clk | I | 时钟 |
| reset | I | 同步复位置0 |
| WE | I | 内存写使能 |
| Load[3:0] | I | 读写位控制信号 |
| AO\_M[31:0] | I | 内存写入地址 |
| WDM\_M[31:0] | I | 内存写入数据 |
|  |  |  |
| PCM | I | M级PC |
| DMout\_M | O | M级DM读取数据 |
|  |  |  |
| WriteBack | 写回 |  |
| clk | I | 时钟 |
| reset | I | 同步复位置0 |
| DMout\_M | I | M级DM读取数据 |
| AO\_M[31:0] | I | M级ALU运算结果 |
| PCAdd8\_M[31:0] | I |  |
| PC\_M | I | M级PC |
|  |  |  |
| DMout\_W | O | W级DM读取数据 |
| AO\_W[31:0] | O | W级ALU运算结果 |
| PCAdd8\_W[31:0] | O |  |
| PC\_W | O | W级PC |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Instr[31:0] | I | 指令信息输入 |  |  |
|  |  |  |  |  |
| ControlUnitD |  |  |  |  |
| CMPrst | I | 比较结果输入 |  |  |
| MUX\_PC\_sel | O | MUX\_PC选择信号(+4or跳) |  |  |
| EXTCtrl[1:0] | O | 扩展单元控制信号 |  |  |
|  |  |  |  |  |
| ControlUnitE |  |  |  |  |
| ALUSrcB | O | 选择ALU的SrcB来源 |  |  |
| ALUCtrl[3:0] | O | ALU控制信号 |  |  |
|  |  |  |  |  |
| ControlUnitM |  |  |  |  |
| MemWrite | O | 内存写使能 |  |  |
| Load[2:0] | O | 读写位控制信号 |  |  |
|  |  |  |  |  |
| ControlUnitW |  |  |  |  |
| Mem2Reg[1:0] | O | 寄存器堆写使能， |  |  |
| RegWE |  | 有的还取决于CMPout |  |  |
|  |  |  |  |  |
| HazardUnit |  |  |  |  |
| StallUnit:算出当前指令的rs,rt,A3，用Res寄存器传下去 |  |  |  |  |
| Instr[31:0] | I | 指令信息输入 |  |  |
| Tnew\_E | I |  |  |  |
| Tnew\_M | I |  |  |  |
| Tnew\_W | I |  |  |  |
| Stall | O |  |  |  |
| rs\_D | O |  |  |  |
| rt\_D | O |  |  |  |
| Tnew\_rs\_D | O | ResE | ResM | ResW |
| Tnew\_rt\_D | O | Tnew | Tnew | Tnew |
|  |  | rsE | A3M | A3W(输出到RF |
|  |  | rtE |  |  |
| ForwardUnit |  | A3E |  |  |
| rsD | I | reset(暂停orbgezal失败时，清空rsE,rtE,A3E) |  |  |
| rtD | I |  |  |  |
| rsE | I |  |  |  |
| rtE | I |  |  |  |
| A3E | I |  |  |  |
| A3M | I |  |  |  |
| A3W | I |  |  |  |
| sel\_V1D | O |  |  |  |
| sel\_V2D | O |  |  |  |
| sel\_V1E | O |  |  |  |
| sel\_V2E | O |  |  |  |
| sel\_WDMM | O |  |  |  |

三、测试程序：

暂停系列

0, E1:

lui $t0 0xf65b

ori $t1 $0 0xabfe

ori $t2 $0 0x3000

lui $t3 0x49bf

addu $t5 $t1 $t3

addu $t4 $t1 $t3

beq $t4 $t5 end #cal-beq

subu $t6 $t2 $t3

func:

ori $1 $0 4

subu $31 $31 $1

jr $31 #cal-jr

sw $t4 0($0)

jr $31

end: subu $t6 $t3 $t1

jal func

lui $s0 0x462b

ori $s1 $0 0x336c

subu $s2 $s0 $s1

nop

运行结果：

$ 8 <= f65b0000

$ 9 <= 0000abfe

$10 <= 00003000

$11 <= 49bf0000

$13 <= 49bfabfe

$12 <= 49bfabfe

$14 <= b6413000

$14 <= 49be5402

$31 <= 00003040

$16 <= 462b0000

$ 1 <= 00000004

$31 <= 0000303c

\*00000000 <= 49bfabfe

$16 <= 462b0000

$17 <= 0000336c

$18 <= 462acc94

0,E2:

lui $t0 0xf65b

ori $t1 $0 0xabfe

ori $t2 $0 0x3000

lui $t3 0x49bf

addu $t5 $t1 $t3

sw $t5 0($0)

#rs Tuse=0, Tnew\_E=`DM

lw $t4 0($0) #sw-lw

beq $t4 $t5 end #lw-beq

func:

sw $31 4($0)

subu $31 $31 4

beq $t4 $t5 end

lui $t4 0x83ba

nop

lw $31 4($0) #lw-jr

jr $31

addu $t4 $t0 $t2

end:subu $t4 $t3 $t1

jal func

addu $t6 $t4 $t5

ori $s0 $0 0xfa6b

addu $s1 $t4 $s0

运行结果：

$ 8 <= f65b0000

$ 9 <= 0000abfe

$10 <= 00003000

$11 <= 49bf0000

$13 <= 49bfabfe

\*00000000 <= 49bfabfe

$12 <= 49bfabfe

\*00000004 <= 00000000

$12 <= 49be5402

$31 <= 00003054

$14 <= 937e0000

\*00000004 <= 00003054

$ 1 <= 00000000

$ 1 <= 00000004

$31 <= 00003050

$12 <= 83ba0000

$31 <= 00003054

$12 <= f65b3000

$16 <= 0000fa6b

$17 <= f65c2a6b

0,M1

lui $t0 0xf65b

ori $t1 $0 0xabfe

ori $t2 $0 0x3000

lui $t3 0x49bf

addu $t5 $t1 $t3

sw $t5 0($0)

lw $t4 0($0)

addu $t1 $t1 $t3

beq $t4 $t5 end #lw-cal-beq

func:

sw $31 4($0)

subu $31 $31 4

beq $t4 $t5 end

lui $t4 0x83ba

nop

lw $31 4($0)

addu $t1 $t1 $t2

jr $31 #lw-cal-jr

addu $t4 $t0 $t2

end:subu $t4 $t3 $t1

jal func

addu $t6 $t4 $t5

ori $s0 $0 0xfa6b

addu $s1 $t4 $s0

运行结果：

$ 8 <= f65b0000

$ 9 <= 0000abfe

$10 <= 00003000

$11 <= 49bf0000

$13 <= 49bfabfe

\*00000000 <= 49bfabfe

$12 <= 49bfabfe

$ 9 <= 49bfabfe

\*00000004 <= 00000000

$12 <= ffff5402

$31 <= 0000305c

$14 <= 49bf0000

\*00000004 <= 0000305c

$ 1 <= 00000000

$ 1 <= 00000004

$31 <= 00003058

$12 <= 83ba0000

$31 <= 0000305c

$ 9 <= 49bfdbfe

$12 <= f65b3000

$16 <= 0000fa6b

$17 <= f65c2a6b

1,E2

ori $t2 $0 0x3000

lui $t3 0x49bf

addu $t5 $t1 $t3

sw $t5 0($0)

ori $t1 $0 0xabfe

lw $t4 0($0)

addu $t1 $t1 $t4 #lw-cal

ori $t0 $0 0x0008

sw $t0 4($t0)

lw $t0 4($t0) #lw sw

sw $t1 8($t0)

运行结果：

$10 <= 00003000

$11 <= 49bf0000

$13 <= 49bf0000

\*00000000 <= 49bf0000

$ 9 <= 0000abfe

$12 <= 49bf0000

$ 9 <= 49bfabfe

$ 8 <= 00000008

\*0000000c <= 00000008

$ 8 <= 00000008

\*00000010 <= 49bfabfe

1,E2

ori $t1 $0 0xabfe

lw $t4 0($0)

addu $t1 $t4 $t1 #lw-cal

ori $t0 $0 0x0008

运行结果：

$10 <= 00003000

$11 <= 49bf0000

$13 <= 49bf0000

\*00000000 <= 49bf0000

$ 9 <= 0000abfe

$12 <= 49bf0000

$ 9 <= 49bfabfe

$ 8 <= 00000008

Rs 0,E1,E2,M1

lui $t0 0xf65b

ori $t1 $0 0xabfe

ori $t2 $0 0x3000

lui $t3 0x49bf

addu $t5 $t1 $t3

addu $t4 $t1 $t3

beq $t5 $t4 end #cal-beq

subu $t6 $t2 $t3

ori $1 $0 4

subu $31 $31 $1

end: subu $t6 $t3 $t1

sw $t6 0($0)

lw $s0 0($0)

end1:lw $s1 0($0)

beq $s0 $s1 end1

ori $s0 $s1 0x619f

运行结果：

$ 8 <= f65b0000

$ 9 <= 0000abfe

$10 <= 00003000

$11 <= 49bf0000

$13 <= 49bfabfe

$12 <= 49bfabfe

$14 <= b6413000

$14 <= 49be5402

\*00000000 <= 49be5402

$16 <= 49be5402

$17 <= 49be5402

$16 <= 49be759f

$17 <= 49be5402

$16 <= 49be759f

转发系列

lui $t0 0xf65b

ori $t1 $0 0xabfe

lui $t4 0xaf78

tiao:

ori $t2 $0 0x3018

addu $t5 $t1 $t3

beq $t4 $t5 end

lui $t3 0x49bf

j tiao

addu $t4 $t1 $t3

addu $t4 $t4 $t3

end:

subu $t5 $t1 $t2

#addu $t4 $t4 $t3

ori $t3 $0 0x3044

func:

beq $t3 $31 ha

addu $t4 $t4 $t2

ori $t5 $t3 0x6349

jal func

addu $t5 $t2 $t3

subu $t1 $t2 $t5

ha:

subu $t4 $t4 $0

addu $t5 $0 $t4

beq $t4 $t5 end6

subu $t4 $t5 $t3

addu $t6 $t2 $t3

j ha

end6:

ori $t3 $t4 0x26cb

ori $1 $0 48

addu $ra $ra, $1

lui $2 0x41ba

jr $ra

addu $1 $0 $t3

subu $t4 $t4 $t1

ori $s0 $0 24

addu $ra $ra $s0

stein:jr $ra

addu $t4 $t5 $t1

subu $t2 $t4 $t3

ori $1 $0 4

jal stein

addu $ra $ra $1

lui $s1 0x6249

subu $s1 $s1 $31

jal stein

subu $t0 $t3 $t5

lui $t0 0xf65b

ori $t1 $0 0xabfe

lui $t4 0xaf78

tiao:

ori $t2 $0 0x3018

addu $t5 $t1 $t3

beq $t4 $t5 end

lui $t3 0x49bf

j tiao

addu $t4 $t1 $t3

addu $t4 $t4 $t3

end:

subu $t5 $t1 $t2

#addu $t4 $t4 $t3

ori $t3 $0 0x3044

func:

beq $t3 $31 ha

addu $t4 $t4 $t2

ori $t5 $t3 0x6349

jal func

addu $t5 $t2 $t3

subu $t1 $t2 $t5

ha:

subu $t4 $t4 $0

addu $t5 $0 $t4

beq $t4 $t5 end6

subu $t4 $t5 $t3

addu $t6 $t2 $t3

j ha

end6:

ori $t3 $t4 0x26cb

ori $1 $0 48

addu $ra $ra, $1

lui $2 0x41ba

jr $ra

addu $1 $0 $t3

subu $t4 $t4 $t1

ori $s0 $0 24

addu $ra $ra $s0

stein:jr $ra

addu $t4 $t5 $t1

subu $t2 $t4 $t3

ori $1 $0 4

jal stein

addu $ra $ra $1

lui $s1 0x6249

subu $s1 $s1 $31

jal stein

subu $t0 $t3 $t5

ori $t2 $0 0x3000

lui $t3 0x49bf

addu $t5 $t1 $t3

sw $t5 0($0)

lw $t4 0($0)

addu $t1 $t1 $t3

beq $t4 $t5 end

func:

sw $31 4($0)

subu $31 $31 4

beq $t4 $t5 end

lui $t4 0x83ba

nop

lw $31 4($0)

addu $t1 $t1 $t2

jr $31

addu $t4 $t0 $t2

end:subu $t4 $t3 $t1

jal func

addu $t6 $t4 $t5

ori $s0 $0 0xfa6b

addu $s1 $t4 $s0

ori $t2 $0 0x3000

lui $t3 0x49bf

addu $t5 $t1 $t3

addu $t4 $t1 $t3

beq $t4 $t5 end

subu $t6 $t2 $t3

func:

ori $1 $0 4

subu $31 $31 $1

jr $31

sw $t4 0($0)

jr $31

end: subu $t6 $t3 $t1

jal func

lui $s0 0x462b

ori $s1 $0 0x336c

subu $s2 $s0 $s1

nop

运行结果：

$ 8 <= f65b0000

$ 9 <= 0000abfe

$12 <= af780000

$10 <= 00003018

$13 <= 0000abfe

$11 <= 49bf0000

$12 <= 49bfabfe

$10 <= 00003018

$13 <= 49bfabfe

$11 <= 49bf0000

$13 <= 00007be6

$11 <= 00003044

$12 <= 49bfdc16

$13 <= 0000734d

$31 <= 00003044

$13 <= 0000605c

$12 <= 49c00c2e

$12 <= 49c00c2e

$13 <= 49c00c2e

$12 <= 49bfdbea

$11 <= 49bfffeb

$ 1 <= 00000030

$31 <= 00003074

$ 2 <= 41ba0000

$ 1 <= 49bfffeb

$ 1 <= 49bfffeb

$12 <= 49bf2fec

$16 <= 00000018

$31 <= 0000308c

$12 <= 49c0b82c

$10 <= 0000b841

$ 1 <= 00000004

$31 <= 0000309c

$31 <= 000030a0

$12 <= 49c0b82c

$17 <= ffffcf60

$31 <= 000030ac

$ 8 <= fffff3bd

$12 <= 49c0b82c

$ 8 <= f65b0000

$ 9 <= 0000abfe

$12 <= af780000

$10 <= 00003018

$13 <= 49c0abe9

$11 <= 49bf0000

$12 <= 49bfabfe

$10 <= 00003018

$13 <= 49bfabfe

$11 <= 49bf0000

$13 <= 00007be6

$11 <= 00003044

$12 <= 49bfdc16

$13 <= 0000734d

$31 <= 00003044

$13 <= 0000605c

$12 <= 49c00c2e

$12 <= 49c00c2e

$13 <= 49c00c2e

$12 <= 49bfdbea

$11 <= 49bfffeb

$ 1 <= 00000030

$31 <= 00003074

$ 2 <= 41ba0000

$ 1 <= 49bfffeb

$ 1 <= 49bfffeb

$12 <= 49bf2fec

$16 <= 00000018

$31 <= 0000308c

$12 <= 49c0b82c

$10 <= 0000b841

$ 1 <= 00000004

$31 <= 0000309c

$31 <= 000030a0

$12 <= 49c0b82c

$17 <= ffff9ec0

$31 <= 000030ac

$ 8 <= fffff3bd

$12 <= 49c0b82c

$ 8 <= f65b0000

$ 9 <= 0000abfe

$12 <= af780000

$10 <= 00003018

$13 <= 49c0abe9

$11 <= 49bf0000

$12 <= 49bfabfe

$10 <= 00003018

$13 <= 49bfabfe

$11 <= 49bf0000

$13 <= 00007be6

$11 <= 00003044

$12 <= 49bfdc16

$13 <= 0000734d

$31 <= 00003044

$13 <= 0000605c

$12 <= 49c00c2e

$12 <= 49c00c2e

$13 <= 49c00c2e

$29 <= 3cbccd80

$30 <= 2a790000

$30 <= 2a79845e

$31 <= b8100000

$31 <= 8e8b0000

$ 5 <= 06bab9db

\*00000000 <= 06bab9db

$ 1 <= ab1053c7

\*00000004 <= ab1053c7

$13 <= 2411dc29

\*00000008 <= 2411dc29

$24 <= bca89fef

\*0000000c <= bca89fef

$30 <= f3ffd7e9

\*00000010 <= f3ffd7e9

$ 3 <= d51e6c67

\*00000014 <= d51e6c67

$ 2 <= e71176c6

\*00000018 <= e71176c6

$ 7 <= 56a89ecc

\*0000001c <= 56a89ecc

$26 <= fb1af48f

\*00000020 <= fb1af48f

$29 <= f8091e3a

\*00000024 <= f8091e3a

$23 <= 3bbdf53f

\*00000028 <= 3bbdf53f

$19 <= c1351f3f

\*0000002c <= c1351f3f

$ 2 <= c0befca1

\*00000030 <= c0befca1

$ 8 <= 00000000

\*00000034 <= 00000000

$22 <= 823690a5

\*00000038 <= 823690a5

$19 <= 05dfe452

\*0000003c <= 05dfe452

$ 0 <= 00fad8e1

\*00000040 <= 00000000

$28 <= d3b5c932

\*00000044 <= d3b5c932

$ 6 <= d9ad8fdb

\*00000048 <= d9ad8fdb

$ 1 <= 2c08bdef

\*0000004c <= 2c08bdef

$29 <= c880cd9e

\*00000050 <= c880cd9e

$19 <= 69466d5f

\*00000054 <= 69466d5f

$17 <= cd5b6089

\*00000058 <= cd5b6089

$23 <= b6885c2a

\*0000005c <= b6885c2a

$ 1 <= 132ad16c

\*00000060 <= 132ad16c

$ 6 <= bc51db57

\*00000064 <= bc51db57

$ 0 <= 00007e8e

\*00000068 <= 00000000

$13 <= ccce5db0

\*0000006c <= ccce5db0

$21 <= 28c8a16b

\*00000070 <= 28c8a16b

$13 <= 132ad16c

\*00000074 <= 132ad16c

$28 <= d3b5f97e

\*00000078 <= d3b5f97e

$28 <= d3b5fd7f

\*0000007c <= d3b5fd7f

$ 3 <= 2ea885bd

\*00000080 <= 2ea885bd

$ 2 <= c0beffa3

\*00000084 <= c0beffa3

$14 <= 660bf7cf

\*00000088 <= 660bf7cf

$29 <= c880cd9e

\*0000008c <= c880cd9e

$19 <= 42230a3d

\*00000090 <= 42230a3d

$30 <= f3ffd7ed

\*00000094 <= f3ffd7ed

$31 <= 8e8becde

\*00000098 <= 8e8becde

$10 <= bad6f67b

\*0000009c <= bad6f67b

$15 <= b0a87fdd

\*000000a0 <= b0a87fdd

$26 <= fb1af7ff

\*000000a4 <= fb1af7ff

$23 <= b6887f2a

\*000000a8 <= b6887f2a

$27 <= 2ea885bd

\*000000ac <= 2ea885bd

$31 <= 8e8becdf

\*000000b0 <= 8e8becdf

\*000000b4 <= c880cd9e

\*000000b8 <= 8e8becdf

\*000000bc <= 132ad16c

$29 <= 00000fdc

$ 1 <= 00000020

$31 <= 00003474

\*00000fdc <= 76b2c1bd

\*00000fec <= 00003474

\*00000fe0 <= 06bab9db

\*00000fe4 <= bc51db57

\*00000fe8 <= 56a89ecc

\*00000ff0 <= 00000000

\*00000ff4 <= 91fd296d

\*00000ff8 <= bad6f67b

$17 <= 0000006c

$18 <= 00000064

$ 8 <= 00000000

$ 9 <= 132ad16c

$ 7 <= 132ad16c

$ 4 <= 76b2c1bd

$ 5 <= 19e58b47

$10 <= 90984d04

$ 4 <= 9098ef87

$10 <= 21309a08

$10 <= 42613410

$ 5 <= 42617712

$ 6 <= 426177f2

$31 <= 000037dc

$29 <= 00000fbc

\*00000fcc <= 000037dc

\*00000fbc <= 9098ef87

\*00000fc0 <= 42617712

\*00000fc4 <= 426177f2

\*00000fc8 <= 132ad16c

\*00000fd0 <= 00000000

\*00000fd4 <= 132ad16c

\*00000fd8 <= 42613410

$17 <= 000000bb

$18 <= 00000154

$ 9 <= 2ea885bd

$ 8 <= 132ad16c

$ 7 <= 41d35729

$ 4 <= a3c3c0f3

$ 5 <= 7109fccf

$10 <= 14cdbdc2

$ 4 <= 14cdfdc6

$10 <= 299b7b84

$10 <= 5336f708

$ 5 <= 5336f70d

$ 6 <= 5336f7fd

$31 <= 00003cec

$29 <= 00000f9c

\*00000f9c <= 14cdfdc6

\*00000fa0 <= 5336f70d

\*00000fac <= 00003cec

\*00000fa4 <= 5336f7fd

\*00000fa8 <= 41d35729

\*00000fb0 <= 132ad16c

\*00000fb4 <= 2ea885bd

\*00000fb8 <= 5336f708

$17 <= 000000d6

$18 <= 0000004b

$ 8 <= c0befca1

$ 9 <= bad6f67b

$ 7 <= 7b95f31c

$ 4 <= d58cfa67

$ 5 <= 0e0ded88

$10 <= e39ae7ef

$ 4 <= e39af7ef

$10 <= c735cfde

$10 <= 8e6b9fbc

$ 5 <= 8e6bdfbe

$ 6 <= 8e6bdffe

$31 <= 00003c7c

$29 <= 00000f7c

\*00000f7c <= e39af7ef

\*00000f8c <= 00003c7c

\*00000f80 <= 8e6bdfbe

\*00000f84 <= 8e6bdffe

\*00000f88 <= 7b95f31c

\*00000f90 <= c0befca1

\*00000f94 <= bad6f67b

\*00000f98 <= 8e6b9fbc

$17 <= 000000c6

$18 <= 00000119

$ 9 <= 2ea885bd

$ 8 <= f8091e3a

$ 7 <= 26b1a3f7

$ 4 <= dba41629

$ 5 <= bd14657b

$10 <= 98b87ba4

乘除测试：

li $t0, 0x7fffffff

li $t1, 0xffffffff

li $t2, 0x80000000

mult $t0, $t0

mfhi $s0

mflo $s1

multu $t0, $t0

mfhi $s2

mfhi $s3

mult $t1, $t1

mfhi $s4

mflo $s5

multu $t1, $t1

mfhi $s6

mflo $s7

mult $t2, $t2

mfhi $s0

mflo $s1

multu $t2, $t2

mfhi $s2

mflo $s3

mult $t0, $t1

mfhi $s0

mflo $s1

multu $t0, $t1

mfhi $s2

mflo $s3

mult $t0, $t2

mfhi $s4

mflo $s5

multu $t0, $t2

mfhi $s6

mflo $s7

mult $t1, $t2

mfhi $s0

mflo $s1

multu $t1, $t2

mfhi $s2

mflo $s3

mult $0, $t1

mfhi $s2

mflo $s3

multu $t1, $0

mfhi $s4

mflo $s5

div $t0, $t0

mfhi $s0

mflo $s1

divu $t0, $t0

mfhi $s2

mflo $s3

div $t1, $t1

mfhi $s4

mflo $s5

divu $t1, $t1

mfhi $s6

mflo $s7

div $t2, $t2

mfhi $s0

mflo $s1

divu $t2, $t2

mfhi $s2

mflo $s3

div $t0, $t1

mfhi $s0

mflo $s1

div $t1, $t0

mfhi $s2

mflo $s3

divu $t0, $t1

mfhi $s4

mflo $s5

divu $t1, $t0

mfhi $s6

mflo $s7

div $t0, $t2

mfhi $s0

mflo $s1

div $t2, $t0

mfhi $s2

mfhi $s3

divu $t0, $t2

mfhi $s4

mflo $s5

divu $t2, $t0

mfhi $s6

mflo $s7

div $t1, $t2

mfhi $s0

mflo $s1

div $t2, $t1

mfhi $s2

mflo $s3

divu $t1, $t2

mfhi $s4

mflo $s5

divu $t2, $t1

mfhi $s6

mflo $s7

div $0, $t1

mfhi $s0

mflo $s1

divu $0, $t1

mfhi $s0

mflo $s1

ori $t1, 1234

add $t0, $0, $t1

mthi $t0

mtlo $t0

mfhi $s0

mflo $s1

add $t0, $0, $t1

mtlo $t0

mthi $t0

mfhi $s2

mflo $s3

ori $t0 $0, 423

nop

mthi $t0

mtlo $t1

mfhi $s4

mflo $s5

ori $t0, $0, 8765

nop

nop

mthi $t0

mtlo $t0

mflo $s6

mfhi $s7

ori $t0, $0, 6543

nop

nop

nop

mthi $t0

mtlo $t0

mflo $s0

mfhi $s1

运行结果：

$ 1 <= 7fff0000

$ 8 <= 7fffffff

$ 9 <= ffffffff

$ 1 <= 80000000

$10 <= 80000000

$16 <= 3fffffff

$17 <= 00000001

$18 <= 3fffffff

$19 <= 3fffffff

$20 <= 00000000

$21 <= 00000001

$22 <= fffffffe

$23 <= 00000001

$16 <= 40000000

$17 <= 00000000

$18 <= 40000000

$19 <= 00000000

$16 <= ffffffff

$17 <= 80000001

$18 <= 7ffffffe

$19 <= 80000001

$20 <= c0000000

$21 <= 80000000

$22 <= 3fffffff

$23 <= 80000000

$16 <= 00000000

$17 <= 80000000

$18 <= 7fffffff

$19 <= 80000000

$18 <= 00000000

$19 <= 00000000

$20 <= 00000000

$21 <= 00000000

$16 <= 00000000

$17 <= 00000001

$18 <= 00000000

$19 <= 00000001

$20 <= 00000000

$21 <= 00000001

$22 <= 00000000

$23 <= 00000001

$16 <= 00000000

$17 <= 00000001

$18 <= 00000000

$19 <= 00000001

$16 <= 00000000

$17 <= 80000001

$18 <= ffffffff

$19 <= 00000000

$20 <= 7fffffff

$21 <= 00000000

$22 <= 00000001

$23 <= 00000002

$16 <= 7fffffff

$17 <= 00000000

$18 <= ffffffff

$19 <= ffffffff

$20 <= 7fffffff

$21 <= 00000000

$22 <= 00000001

$23 <= 00000001

$16 <= ffffffff

$17 <= 00000000

$18 <= 00000000

$19 <= 80000000

$20 <= 7fffffff

$21 <= 00000001

$22 <= 80000000

$23 <= 00000000

$16 <= 00000000

$17 <= 00000000

$16 <= 00000000

$17 <= 00000000

$ 9 <= ffffffff

$ 8 <= ffffffff

$16 <= ffffffff

$17 <= ffffffff

$ 8 <= ffffffff

$18 <= ffffffff

$19 <= ffffffff

$ 8 <= 000001a7

$20 <= 000001a7

$21 <= ffffffff

$ 8 <= 0000223d

$22 <= 0000223d

$23 <= 0000223d

$ 8 <= 0000198f

$16 <= 0000198f

$17 <= 0000198f

综合测试：

01ec6821

00157643

3c1bec28

03613827

801f0077

21fcfdcd

029fa82a

01458804

333c3cfa

013a9823

00161b82

027ee023

33cad732

00001812

2d3574ca

3c045f98

03770007

3c04465f

014b001b

03800013

0014b580

901f013a

01193023

02a00013

34c5cac6

900e027c

154a001e

00000000

012a0018

00bf0823

901c0173

900700f6

37448bf3

1ca00027

00000000

00a00011

3c189114

a00c0051

19400002

00000000

01a00013

07200021

00000000

1710000b

00000000

0002e7c2

07200029

00000000

a00f000f

001e6806

3643ee4e

23c28c70

1619003f

00000000

0000d810

039f0018

3c017cc0

160a003e

00000000

03ebc027

1137002d

00000000

03fd001a

00000000

22daca99

03400011

24ddd8cc

033f7823

80000013

900d03f7

a00c00a8

1c000001

00000000

000fb5c2

00cc7823

03c00011

0005f400

1e200012

00000000

00089823

03c00013

02ed0806

00007810

001fe082

29d8b05d

800a0066

00000812

0133001b

000579c2

3c125f82

371034c3

000ae82b

21b56a1b

001eb400

02c9d027

05a0003d

00000000

0000402b

3215ae86

03760019

1b80002c

00000000

000a10c0

033b0018

01ae8823

1d200024

00000000

233540f6

0005802b

03008004

05a10028

00000000

00826021

02eae025

a003000a

10cb0029

00000000

1d400015

00000000

1d000027

00000000

00e8b023

2ade9ac7

02f00019

000323c0

0048001a

00000000

00006010

3c137545

01820019

00e7001b

1940003e

00000000

0344702a

06a0002a

00000000

02725027

06010006

00000000

9001000b

2653ad10

21299350

0002dec2

3c069d43

035a9823

000e402b

106c003d

00000000

19400033

00000000

001ffb02

000e64c2

00007010

0019a82b

2097046a

00c39023

02f5782a

01df0018

3c03cc87

34ba5fa8

00e00823

a0190085

037d001a

00000000

0000f82b

303ef8a6

00009812

02200011

15ff0008

00000000

235b92d5

03759804

03600018

0000d010

227151c6

0007ae03

0244001b

02a12006

00153dc2

0000f010

03b55827

0000c810

3c114967

009f0804

05e1002a

00000000

02000013

1e40002a

00000000

024a0019

3c02b06f

16c40015

00000000

03e00013

02f0e023

009d0019

0290001a

00000000

231d27af

21b87528

03d6b823

347d1375

1b200003

00000000

039d1007

276de11e

04c1001c

00000000

1820000c

00000000

001d382b

01fd001b

05200001

00000000

31575ab0

135f000c

00000000

00000812

01ad001a

00000000

2022efc7

17b20003

00000000

02b76021

0000482b

01800013

00a00013

35feeb2e

00138023

07e0001e

00000000

036e9807

00e00011

018c001b

026b2804

122f0006

00000000

00158600

2ed56ee4

03ac1021

02fa0019

03b37007

2081fee6

00007810

00ecf807

0294802a

01b33023

13e40028

00000000

000c0f00

01a67006

0319001a

00000000

1b800030

00000000

0174482a

015a6027

0017482b

901803d9

2ddf446b

007a0019

2295dfa4

28e87deb

2c80767b

01712823

02bf0019

004bd804

00250018

05c10036

00000000

03c82025

001ac343

0212001a

00000000

003bf825

02524821

03400013

05c1003c

00000000

006b5821

0016e82b

000dee80

19000035

00000000

30c0abd1

009db825

02c00011

01c00011

02600011

00001940

0055d823

8002024b

2811d506

27dbf83b

a00a00d4

00e78004

2808ca07

001b37c0

0052001b

03200011

36faa0dc

0003acc2

1960003e

00000000

3015936c

29f01d72

02e8c025

24f8f1d6

264e5c2c

04010014

00000000

0371f823

05810033

00000000

2b5f0fb7

01c20018

24ad9991

35a14d5d

80190315

19c0002c

00000000

03a00013

03800013

3c0956ce

9004020d

03e01021

00430018

00f4d823

013f1806

03a00011

07210022

00000000

90170040

01070018

02e10019

901a00e5

00056a43

01120823

20488644

000eaf83

008e7025

02c00013

01a72825

800a0398

03d53004

0000f812

338c9689

3121c1e3

025ab004

001fd642

03200011

001d28c0

00084006

0006e82b

03f3f023

037df027

29c8ad77

03d5502a

00e9001b

02000013

00b4b006

03f51806

02ff182a

2a0b9948

00124821

0247e806

15880019

00000000

02054004

17c60036

00000000

16d10013

00000000

00334021

8010021e

04200018

00000000

901203d6

1c200036

00000000

0093001b

00029f40

01c85807

00079040

0148001a

00000000

3c0be3a6

03ef282a

801a0305

03d89806

00064c03

01277806

0005782b

03962807

00006010

16090024

00000000

02cd5023

0016c02b

00008812

90100217

321fe633

1ce00036

00000000

01c4d804

01a00013

1058002e

00000000

02600013

33f3e154

04600029

00000000

06600020

00000000

3c16cb8e

031fc004

00fda827

00645006

016d0018

01221021

018a0019

3c0e2272

800c0381

03e30019

02c5602a

207e4f01

04610035

00000000

0142e027

05a10014

00000000

02060823

801e0103

00db001a

00000000

00015b43

16700013

00000000

01468006

33459737

0014682b

90010362

0126e823

0279c806

037b9804

00cad804

02400011

000b0102

2d7e0ddd

00000010

00000812

039d8023

0191001a

00000000

00f1802a

0680001f

00000000

1aa00017

00000000

03c14827

36acfcc4

02eb0018

1f40002b

00000000

00188b42

10ab0020

00000000

33bafbb0

02539807

024c3807

03279021

0053d806

21d1d776

801303ed

01e92823

1f000017

00000000

21a06895

01f9b806

07210030

00000000

030bf027

037c0025

901c03f6

025e001a

00000000

05e00036

00000000

00600011

00960019

0012a500

02b22823

34cf6789

2a987216

03692807

03ea0019

01ae001b

900202b0

001d7a42

001c0018

3c0c062a

00ca0018

02847827

02646027

03519825

00004012

22d2c317

001eb342

0560001f

00000000

008f3027

03a8182a

0278902a

00800011

212a96b7

365de19b

2b53f397

17e50017

00000000

05210000

00000000

0780000c

00000000

801003ce

a00100ce

20426928

9007009c

00000000

1800000c

00000000

1d600028

00000000

00004810

2835ab7b

017f6807

36e158f8

001b482b

29d43981

107a002e

00000000

00800011

0000a810

00002010

01110019

00008812

03baa006

2da36224

a01900f2

031cf804

0580000c

00000000

03800013

277f8160

07600002

00000000

01ad0827

00a6a806

013e682a

0000e012

03a1e023

03800013

19000001

00000000

12f3002e

00000000

0000b010

03d80018

01000011

0000c010

34eb266b

02bdb807

02000011

000102c3

015f0019

00151343

3c0dc615

00004012

36e65eef

001f95c2

00e98027

0014ae02

03589825

012b001b

031af827

0019882b

80080108

3784da2c

2184f935

03990018

3c0d8e8a

0000b812

029b3007

02e85027

001b65c0

0142001a

00000000

00e1f821

1ec00037

00000000

02e00013

173d0000

00000000

3635ee9f

01757823

007e9007

151c0009

00000000

0126c007

002a5823

218b958c

a01400a2

0006e502

0294f825

04210003

00000000

23853750

02062023

0000d810

3c0fdc0a

3c1413b2

0396a827

31de942f

01837807

000c9023

001a382b

332ab1c6

008be804

02980018

2a2d16c6

1840000f

00000000

02bd8023

00001012

2d0db7d5

01960018

00b6582a

02a06827

014bf006

19c0001a

00000000

331d84a7

003d001b

343011e9

3c0ccdc7

22e02535

001e482b

0048001b

02070019

00008812

036b001a

00000000

0000f812

0055a027

1900000d

00000000

1ca00024

00000000

0006ab82

00c24807

00200011

28ca5a78

034f001a

00000000

02080018

007f001b

0022001b

3c01e36f

00a6202a

34cd9f0c

030c7821

21991046

02200013

330e8e9c

00002812

3c10b16e

03c3001a

00000000

1d00002e

00000000

258002b3

0000d810

000dd5c0

2b675bcf

02c50018

01000013

02be1823

000a7103

00a00013

3c007032

027b9806

2c6e769d

03766825

35f6cad6

05610018

00000000

a0000031

037d3827

0002a400

2145ac8d

900b03ca

0185001b

001b8903

1ce0002a

00000000

01c96023

07e1002a

00000000

0239a825

0025a821

02da1025

1ea00027

00000000

19e00037

00000000

029e001a

00000000

12e2002c

00000000

2c47240f

25ffc673

00920018

1109000f

00000000

14b8000d

00000000

376979a3

00001810

1f000037

00000000

00125821

00f33025

00105883

001e082b

3c1a6a79

03fb0018

027f0018

00007810

a005001e

001fa82b

001ee02b

0007582b

267d618d

06e10011

00000000

01e60019

3c05f5f5

02e87021

0201c004

06a1001b

00000000

20eadee5

02435023

1f200015

00000000

801e03ac

00108702

0104682a

2ac69217

0198d82a

000ea402

00006010

0016282b

2e90c874

801b0101

05200027

00000000

04210027

00000000

00004810

00002010

901000f1

3c061cea

03c9001b

31eb2e75

2e583873

01c5a82a

00800011

03600013

2b3077bf

03a00013

00161100

325d4994

00120a40

225707a9

1a80001e

00000000

300ec88f

11d20022

00000000

02411004

211afd3d

01a4001b

01bcb021

2d198923

0329001b

01b20018

a0030027

00f2001a

00000000

02b1482a

3726df44

2cd4d23a

2f01d988

14c10037

00000000

03a88821

900202fb

900500ce

3c0749b7

00ab0019

16cf0032

00000000

00e47004

021d9025

3c057019

13110032

00000000

03e7001b

02800013

03d8001a

00000000

0017682b

2cfdceb4

9018018f

03d06006

000a9d82

0118d823

10620009

00000000

032a2021

01301006

0142a807

a0160002

00002010

03193006

018b0823

00661804

000473c0

2666ce60

014ec821

80110044

0011082b

33ab4b08

154b002f

00000000

1196000f

00000000

2bf8a464

9010022f

111d0031

00000000

0115b023

18e0000a

00000000

000b3c82

01200013

12850007

00000000

17ff0038

00000000

1ee00009

00000000

运行结果：

$13 <= 00000000

$14 <= 00000000

$27 <= ec280000

$ 7 <= 13d7ffff

$31 <= 00000000

$28 <= fffffdcd

$21 <= 00000000

$17 <= 00000000

$28 <= 00000000

$19 <= 00000000

$ 3 <= 00000000

$28 <= 00000000

$10 <= 00000000

$ 3 <= 00000000

$21 <= 00000001

$ 4 <= 5f980000

$ 0 <= 00000000

$ 4 <= 465f0000

$22 <= 00000000

$31 <= 00000000

$ 6 <= 00000000

$ 5 <= 0000cac6

$14 <= 00000000

$ 1 <= 0000cac6

$28 <= 00000000

$ 7 <= 00000000

$ 4 <= 00008bf3

$22 <= 00000000

$15 <= 00000000

$30 <= cac60000

$19 <= 00000000

$ 1 <= 00000000

$15 <= 00000000

$28 <= 00000000

$24 <= 00000000

$10 <= 00000000

$ 1 <= cac60000

$15 <= 00000195

$18 <= 5f820000

$16 <= 000034c3

$29 <= 00000000

$21 <= 00006a1b

$22 <= 00000000

$26 <= ffffffff

$ 8 <= 00000000

$21 <= 00002482

$ 8 <= 00000000

$30 <= 0000ebbf

$16 <= 00000000

$19 <= 00000000

$ 5 <= 00000000

$16 <= 82000000

$21 <= 00000001

$ 2 <= 00000000

$14 <= 00000000

$ 1 <= 00008ad9

$15 <= 00000000

$31 <= 00000000

$16 <= 00000000

$ 6 <= 00000000

$ 1 <= 00000000

$14 <= 00000000

$29 <= 00000000

$ 8 <= 00000000

$12 <= 00000000

$30 <= 00004f01

$30 <= ffffffff

$ 0 <= ec280000

$28 <= 00000000

$20 <= 00000000

$ 5 <= a07e0001

$15 <= 00006789

$24 <= 00000001

$ 5 <= 00000000

$ 2 <= 00000000

$15 <= 00000000

$12 <= 062a0000

$15 <= ffff740c

$12 <= ffff740c

$19 <= ffffffff

$ 8 <= 00000000

$18 <= ffffc317

$22 <= 0007ffff

$ 6 <= 00000000

$ 3 <= 00000000

$18 <= 00000001

$10 <= ffff96b7

$29 <= 0000e19b

$19 <= 00000000

$16 <= 00000000

\*000000ce <= 00

$ 2 <= 00006928

$ 7 <= 00000000

$21 <= 00008bf3

$ 4 <= 00008bf3

$17 <= 00000000

$20 <= 0000001f

$ 3 <= 00000001

\*000000f2 <= 00

$31 <= 00000000

\*000000a2 <= 1f

$28 <= 00000000

$31 <= 0000001f

$27 <= 00000000

$15 <= dc0a0000

$20 <= 13b20000

$21 <= fff80000

$30 <= 00000000

$15 <= 00000000

$18 <= 00008bf4

$ 7 <= 00000001

$10 <= 00000000

$29 <= 00000000

$13 <= 00000001

$16 <= fff80000

$ 2 <= 13b20000

$13 <= 00000001

$11 <= 00000001

$13 <= 0007ffff

$30 <= 00000001

$ 1 <= e36f0000

$ 4 <= 00000000

$13 <= 00009f0c

$15 <= ffff740d

$25 <= ffff8452

$14 <= 00000000

$ 5 <= 00000000

$16 <= b16e0000

$ 0 <= ffff76bf

$27 <= 00000000

$26 <= 86000000

$ 7 <= 00000001

$ 3 <= fff7ffff

$14 <= 00000000

$ 0 <= 70320000

$19 <= 00000000

$14 <= 00000000

$13 <= 0007ffff

$22 <= fffffedf

$ 7 <= 00000000

$31 <= ffff3a80

\*0000001e <= 00

$21 <= 00000001

$28 <= 00000001

$11 <= 00000000

$29 <= 0000618d

$12 <= 00000000

$ 5 <= 00000001

$16 <= 00000001

$27 <= 00000000

$ 9 <= 00000000

$ 4 <= 00000000

$16 <= 00000000

$ 6 <= 1cea0000

$11 <= 00002405

$24 <= 00000000

$21 <= 00000001

$16 <= 00000001

$ 2 <= ffffedf0

$29 <= 00000994

$ 1 <= 0117e800

$23 <= 0000939d

$14 <= 00000000

$ 2 <= 80000000

$26 <= fffffd3d

$22 <= 00080000

$25 <= 00000001

\*00000027 <= ff

$ 9 <= 00000000

$ 6 <= 0000df45

$20 <= 00000001

$ 1 <= 00000001

中断异常：

li $28, 0

li $29, 0

mtc0 $0, $13

mtc0 $0, $14

li $0, 0x2c89fc15

li $1, 0x50ba346d

li $2, 0xb7306fa

li $3, 0x3efc9d7

li $4, 0x4456d999

li $5, 0x39ffa7f6

mflo $3

sltiu $5, $4, 0x4ebf

li $5, 0x940a8c3f

div $1, $4

add $3, $4, $1

addi $1, $1, 0x7543

multu $5, $3

add $0, $2, $4

sub $0, $1, $3

mthi $0

ori $2, $5, 0x5959

srlv $4, $4, $3

sltu $3, $0, $4

sltu $5, $1, $0

lw $3, 2($0)

lh $0, 2($0)

div $4, $0

sh $0, 32($0)

addiu $3, $1, 0x67f4

sw $5, 2($0)

sub $1, $2, $0

multu $4, $3

xor $4, $2, $1

sllv $4, $0, $5

addi $5, $4, 0x4de6

addi $5, $0, 0x2d22

srlv $3, $3, $1

andi $5, $2, 0x6386

add $5, $3, $0

add $2, $1, $1

sub $2, $1, $5

srav $4, $0, $1

add $0, $4, $5

li $3, 0xf8e051f2

lh $2, 52($0)

srav $2, $2, $1

add $2, $5, $5

mtlo $5

divu $3, $3

multu $2, $3

sw $1, 3($0)

div $1, $3

slti $2, $1, 0x777d

sb $0, 52($0)

sltu $3, $0, $1

sw $2, 46($0)

mflo $2

div $4, $4

lbu $4, 25($0)

addi $4, $4, 0x549e

add $3, $3, $4

slti $0, $3, 0x4a05

sub $2, $1, $1

add $3, $2, $1

lh $4, 7($0)

lbu $4, 42($0)

add $2, $0, $4

lb $0, 5($0)

lbu $4, 8($0)

sb $3, 2($0)

andi $4, $0, 0x2249

xori $1, $2, 0x124

sllv $1, $4, $3

lh $5, 43($0)

lbu $1, 42($0)

ori $5, $2, 0x5e17

ori $1, $3, 0x2081

subu $0, $5, $2

lh $2, 40($0)

lw $1, 5($0)

sw $5, 24($0)

addi $1, $5, 0x1adc

srlv $5, $3, $5

nor $0, $2, $0

mtlo $4

lui $0, 0x40d2

mult $0, $5

ori $1, $1, 0x4221

xori $3, $2, 0x58e7

sw $1, 41($0)

sub $3, $3, $4

srav $0, $4, $3

addi $5, $5, 0x32e1

srav $5, $0, $1

sw $0, 33($0)

ori $5, $0, 0x259e

andi $1, $1, 0x1016

add $3, $4, $2

add $0, $3, $0

slti $1, $5, 0xdac

addi $2, $0, 0x6d03

add $4, $5, $5

li $1, 0x8bc72cdb

addi $4, $0, 0x629c

lui $1, 0x7626

add $3, $4, $3

sh $2, 14($0)

add $0, $4, $2

sltu $4, $0, $2

sub $5, $4, $1

add $1, $3, $1

divu $5, $5

addu $0, $3, $2

lh $5, 1($0)

srav $3, $1, $3

sub $1, $0, $0

sltiu $2, $1, 0x134f

lw $5, 9($0)

ori $0, $3, 0x6fd2

srav $5, $1, $4

lbu $0, 44($0)

slti $0, $1, 0x1f37

sub $3, $5, $2

or $3, $0, $1

sub $2, $2, $4

slt $4, $0, $1

sw $0, 10($0)

addiu $5, $5, 0x73b7

add $4, $0, $3

lb $3, 20($0)

mflo $1

sb $1, 48($0)

addi $3, $5, 0xd91

xori $3, $1, 0x4e54

sltiu $4, $1, 0x7081

sltiu $1, $2, 0x7a3a

sh $3, 16($0)

lhu $1, 52($0)

add $3, $1, $2

andi $4, $2, 0x38bc

lui $0, 0x172a

mult $4, $1

add $3, $5, $4

add $0, $4, $2

sllv $2, $1, $1

sltiu $1, $2, 0x5b41

sw $3, 44($0)

li $4, 0x570d3426

and $4, $0, $5

sub $5, $4, $2

sltiu $5, $0, 0x2d88

addi $5, $1, 0x2cd1

add $2, $0, $1

add $2, $5, $3

add $1, $2, $0

lbu $4, 5($0)

slt $1, $4, $3

and $0, $3, $4

sltiu $2, $4, 0x5caa

sub $3, $5, $5

sh $4, 34($0)

lui $0, 0x7e73

addi $2, $4, 0x6fe

addi $2, $1, 0xa08

sltu $4, $1, $5

add $4, $1, $1

lhu $4, 21($0)

sllv $0, $5, $3

addu $1, $0, $2

or $2, $2, $2

sub $5, $3, $3

sltiu $2, $4, 0x7ba1

divu $2, $0

mflo $2

srav $2, $3, $2

andi $0, $5, 0x60e0

lb $2, 29($0)

mfhi $1

subu $4, $3, $2

addi $0, $2, 0x3d94

addiu $4, $2, 0x46cb

add $5, $3, $5

sub $1, $5, $2

or $2, $0, $3

addiu $0, $2, 0x8a

slt $0, $5, $4

addi $3, $2, 0x33df

subu $0, $2, $2

add $3, $2, $0

srav $5, $1, $0

srav $1, $4, $1

sub $1, $0, $2

addi $4, $3, 0x6d33

addi $3, $5, 0x295c

xor $1, $2, $2

sub $5, $2, $5

mfhi $0

ori $0, $0, 0x581c

or $2, $4, $5

lbu $2, 18($0)

addiu $0, $1, 0x251e

sub $3, $0, $0

and $3, $2, $4

lw $1, 10($0)

sw $5, 51($0)

add $0, $4, $5

divu $1, $2

sltiu $1, $4, 0x73ea

sh $2, 18($0)

addi $1, $1, 0x2483

li $2, 0xb53b5a15

sub $5, $1, $4

div $5, $5

slt $2, $2, $4

sltiu $0, $5, 0x6670

add $4, $5, $3

sub $5, $5, $0

subu $2, $1, $3

and $4, $1, $2

slti $1, $2, 0x5ab8

addi $5, $3, 0x52be

sh $5, 43($0)

add $3, $4, $4

add $5, $0, $0

andi $2, $1, 0x5085

add $0, $4, $1

addu $2, $0, $5

sub $1, $0, $3

subu $1, $3, $3

slt $4, $2, $4

sh $0, 20($0)

slt $5, $1, $5

addi $3, $3, 0x7345

mthi $2

slti $5, $2, 0x6f8e

sub $1, $5, $2

li $5, 0x8271f348

sllv $5, $0, $5

div $0, $5

srav $3, $3, $1

sub $5, $5, $4

xor $2, $3, $4

ori $3, $0, 0x3af2

subu $3, $5, $2

mthi $5

sltu $3, $2, $4

srlv $5, $2, $4

and $5, $3, $1

multu $4, $5

add $4, $5, $3

mult $0, $2

sub $5, $3, $4

slti $5, $4, 0x3a33

addi $1, $3, 0x4add

add $3, $5, $4

sub $0, $4, $1

addi $5, $1, 0x2bb1

lhu $1, 44($0)

xori $1, $4, 0x5e19

add $4, $5, $5

addi $2, $5, 0x2b53

addu $4, $2, $3

add $3, $4, $4

lb $1, 26($0)

addi $1, $3, 0x3c72

sw $4, 24($0)

or $2, $5, $0

addiu $4, $3, 0x5f7c

srav $1, $5, $4

add $4, $4, $1

mult $3, $2

nor $4, $3, $2

add $2, $5, $4

addi $0, $4, 0x21ed

add $4, $1, $0

add $2, $4, $2

add $3, $0, $5

sub $5, $5, $4

or $2, $1, $3

addiu $5, $4, 0x2d85

addi $2, $3, 0x62c6

sub $5, $1, $1

addiu $4, $3, 0x37e1

ori $0, $3, 0x6431

add $3, $2, $2

lbu $3, 8($0)

sub $1, $4, $4

lb $3, 27($0)

sub $1, $1, $0

sw $2, 4($0)

lhu $3, 52($0)

sub $2, $5, $5

lhu $4, 4($0)

lh $4, 34($0)

div $1, $4

addu $4, $4, $3

sub $1, $3, $1

mfhi $5

li $4, 0x750a1c28

sw $0, 17($0)

slti $1, $0, 0x5718

addi $2, $1, 0x6cf7

addi $0, $0, 0x73dd

add $2, $4, $5

xori $0, $5, 0x107c

addi $5, $2, 0x51d1

add $4, $3, $1

lh $2, 43($0)

lhu $4, 50($0)

sub $0, $3, $2

multu $2, $5

mfhi $5

sub $1, $0, $1

add $4, $2, $5

sltiu $5, $0, 0x47e8

li $3, 0x3755a151

srav $3, $4, $0

sub $4, $5, $4

subu $2, $3, $0

sltiu $4, $3, 0x28d9

add $1, $3, $1

addiu $0, $4, 0x7f5f

mtlo $5

add $5, $2, $2

lb $2, 33($0)

div $3, $2

sub $2, $1, $1

sub $3, $2, $5

lw $0, 14($0)

mfhi $5

nor $0, $1, $5

xori $1, $3, 0x3b66

xor $2, $4, $5

addiu $3, $4, 0x4d3b

sllv $0, $4, $0

lhu $1, 31($0)

sub $5, $5, $5

sw $1, 23($0)

slt $5, $4, $2

lbu $3, 49($0)

add $1, $5, $3

sub $2, $1, $4

sub $4, $5, $5

add $2, $1, $4

sub $1, $4, $1

add $5, $0, $3

add $5, $0, $1

addi $0, $1, 0x11a8

sh $1, 23($0)

sub $1, $1, $2

lb $3, 20($0)

lbu $4, 37($0)

addi $3, $5, 0x3e5a

sltu $2, $1, $3

add $5, $4, $1

srlv $2, $4, $0

lh $1, 29($0)

lh $2, 28($0)

sltiu $5, $5, 0x1dde

div $4, $0

nor $2, $4, $5

add $0, $0, $3

addi $3, $1, 0x1628

sub $2, $2, $1

add $5, $1, $4

add $1, $5, $0

lh $1, 10($0)

sw $5, 18($0)

lb $4, 11($0)

andi $1, $0, 0x7119

sub $5, $1, $4

add $4, $4, $5

sb $2, 38($0)

add $2, $5, $3

mflo $2

or $0, $1, $1

div $4, $5

slti $5, $5, 0x12a3

sub $2, $3, $2

sub $2, $1, $5

addi $0, $2, 0x2ac4

addi $0, $4, 0x4780

add $2, $2, $0

addi $5, $4, 0x27c8

sub $1, $1, $0

add $1, $3, $3

addi $4, $1, 0x74d0

addi $1, $0, 0x1e17

sltiu $4, $4, 0x7774

sub $4, $2, $0

mtlo $4

xori $0, $5, 0x43d

multu $3, $0

srav $2, $2, $3

add $3, $4, $3

sub $0, $1, $0

mtlo $5

multu $5, $2

mthi $0

addi $5, $3, 0x29b7

addiu $0, $5, 0x6cec

andi $3, $2, 0x6486

add $0, $5, $4

mtlo $0

lhu $3, 41($0)

li $3, 0x70095d75

mfhi $4

sub $1, $3, $1

mult $5, $2

sw $3, 25($0)

addi $0, $2, 0x3ab2

xor $3, $2, $0

or $2, $0, $1

sllv $3, $5, $2

divu $5, $4

sub $1, $5, $4

slti $2, $2, 0x2c66

mtlo $5

sub $2, $4, $3

subu $0, $4, $3

sub $0, $0, $1

sltiu $3, $5, 0x368b

add $2, $2, $4

addi $1, $2, 0x2fde

add $3, $4, $5

addi $5, $0, 0x214e

sh $0, 48($0)

add $5, $2, $5

lbu $0, 47($0)

mtlo $4

addiu $0, $1, 0x38f5

lb $0, 30($0)

sub $0, $1, $1

slti $0, $4, 0x1520

add $0, $1, $1

mfhi $1

add $1, $3, $3

add $5, $1, $5

add $1, $5, $1

add $5, $4, $1

or $4, $2, $3

sltiu $1, $1, 0x558f

lh $3, 19($0)

slt $3, $4, $1

addi $3, $4, 0x1ef1

sllv $1, $1, $0

lb $1, 18($0)

add $2, $2, $5

addi $1, $0, 0x5ce0

srav $3, $4, $2

srlv $2, $5, $3

add $4, $4, $5

nor $5, $4, $2

addu $1, $4, $0

add $2, $2, $1

addi $5, $4, 0x5756

sub $5, $3, $2

sub $0, $2, $0

addi $4, $1, 0xd5e

add $1, $4, $4

slti $4, $4, 0x26

sb $3, 33($0)

lbu $3, 25($0)

sub $0, $3, $4

addi $5, $0, 0x708b

subu $1, $5, $1

ori $2, $0, 0x225f

slt $3, $5, $0

sw $0, 3($0)

lb $1, 21($0)

lbu $2, 43($0)

lw $2, 50($0)

mfhi $4

mflo $5

divu $1, $1

multu $4, $5

lhu $4, 38($0)

sub $2, $4, $3

addu $5, $4, $3

sub $2, $4, $2

mtlo $4

sb $4, 44($0)

ori $2, $4, 0x338

addu $4, $0, $2

add $2, $3, $4

mflo $3

sb $2, 29($0)

lhu $2, 12($0)

slti $2, $4, 0x21a7

sb $1, 48($0)

addi $2, $2, 0x6782

mflo $1

sllv $5, $5, $1

lh $5, 52($0)

addi $3, $0, 0xccf

xori $3, $1, 0x3e17

sb $2, 37($0)

add $1, $2, $3

mthi $2

xor $4, $1, $2

xor $3, $5, $3

addu $4, $2, $5

xor $2, $4, $2

add $1, $2, $2

subu $5, $4, $4

lhu $3, 19($0)

mfhi $2

add $3, $1, $5

addi $3, $4, 0x684e

lbu $0, 31($0)

sub $2, $3, $5

sub $1, $2, $0

li $0, 0xf6d0f42f

add $4, $5, $3

sub $3, $0, $0

lhu $1, 0($0)

sllv $3, $4, $3

addi $1, $1, 0x408e

lhu $1, 30($0)

addiu $4, $3, 0x72e2

add $5, $0, $1

sub $0, $5, $2

add $5, $5, $5

addi $1, $3, 0x3f40

or $1, $2, $0

addi $4, $0, 0x32e1

sh $2, 19($0)

xor $0, $5, $2

lbu $2, 47($0)

sub $1, $5, $1

divu $1, $0

sub $3, $3, $5

sltu $2, $5, $0

lw $3, 18($0)

add $5, $2, $5

mult $1, $2

lh $2, 9($0)

or $2, $0, $1

sb $5, 5($0)

addi $3, $0, 0x3036

add $0, $5, $3

add $5, $2, $4

or $0, $5, $1

sllv $5, $5, $0

sltiu $3, $3, 0x1ab6

div $4, $0

srav $4, $3, $2

li $5, 0xbb3b898f

sllv $3, $1, $5

sub $4, $2, $5

sh $1, 13($0)

divu $4, $0

addi $4, $2, 0x1fcd

or $3, $5, $1

addi $2, $3, 0x5829

srav $5, $5, $2

addi $4, $3, 0x6812

sltiu $2, $5, 0x1558

addu $0, $1, $0

sub $0, $5, $4

mfhi $4

sh $5, 43($0)

addiu $1, $5, 0x6a97

add $1, $2, $2

or $3, $0, $3

addi $0, $3, 0x5c38

addu $0, $1, $4

and $0, $0, $3

lui $2, 0x38a8

addi $0, $1, 0x4968

sw $5, 14($0)

sub $2, $4, $3

sh $2, 49($0)

lh $4, 10($0)

subu $4, $2, $0

ori $0, $5, 0x7abf

ori $1, $2, 0x3753

sub $5, $1, $5

multu $4, $1

addi $2, $1, 0x5afc

lh $2, 45($0)

sub $4, $3, $4

sub $5, $4, $4

slt $1, $5, $3

addi $3, $0, 0x7f6

sub $0, $2, $4

srav $4, $2, $5

srav $1, $1, $2

addi $0, $5, 0x7683

sltu $2, $1, $2

add $4, $1, $3

divu $1, $0

sltu $0, $2, $5

sub $1, $1, $3

multu $3, $4

srlv $1, $4, $5

addu $5, $3, $5

or $0, $1, $3

add $5, $2, $0

lui $2, 0x6c7

sb $2, 27($0)

ori $5, $0, 0x1baa

subu $2, $2, $5

and $5, $4, $3

add $1, $2, $0

addi $0, $1, 0x2b80

lbu $0, 45($0)

mflo $1

sub $5, $3, $3

sub $3, $3, $4

subu $1, $5, $2

lui $5, 0x3f81

add $4, $5, $2

addi $4, $5, 0xce1

add $0, $4, $1

sltiu $2, $2, 0x4bcf

and $3, $5, $1

add $1, $3, $3

sub $0, $2, $3

addi $2, $2, 0x4ca3

andi $1, $3, 0x78f4

addu $0, $0, $5

andi $1, $4, 0x3aa4

sub $0, $4, $2

ori $4, $4, 0x929

addiu $1, $2, 0x1e8

add $5, $5, $1

divu $4, $0

sltiu $5, $4, 0x129d

add $5, $3, $0

sb $5, 35($0)

addi $2, $1, 0x78cd

add $5, $3, $1

srav $1, $3, $1

addi $0, $0, 0x6878

addi $3, $4, 0xe1d

sllv $3, $0, $5

mthi $2

lui $1, 0x4044

sw $4, 25($0)

srlv $1, $4, $1

srlv $4, $4, $4

div $1, $2

srlv $1, $5, $0

li $2, 0xdb9dbaff

sub $3, $1, $5

add $1, $1, $0

addi $3, $0, 0x6410

divu $4, $0

add $3, $1, $5

sh $3, 9($0)

addi $1, $5, 0x647d

lw $2, 8($0)

addi $0, $3, 0x509f

lbu $0, 11($0)

sub $5, $2, $4

add $5, $3, $4

lh $3, 29($0)

xori $2, $5, 0x2b6d

sltiu $3, $5, 0x2d61

mult $3, $5

xori $0, $4, 0x798f

sltiu $1, $5, 0x4566

sb $2, 7($0)

li $5, 0x74113a6e

subu $0, $2, $3

add $5, $1, $3

addi $3, $2, 0x6ed3

sltu $0, $2, $4

add $0, $1, $5

and $5, $5, $1

sltiu $5, $2, 0x742f

mflo $2

ori $2, $2, 0x38a4

lui $3, 0x4fef

add $5, $3, $1

div $4, $3

sub $1, $2, $4

add $2, $1, $2

lw $0, 1($0)

lbu $2, 2($0)

add $0, $2, $0

addu $5, $5, $4

andi $5, $3, 0x5ff5

mthi $2

sub $4, $1, $2

addi $1, $1, 0xeeb

mult $1, $0

lb $1, 17($0)

div $0, $0

addi $1, $1, 0x44e1

xor $4, $4, $2

add $2, $5, $3

add $1, $2, $1

lw $2, 50($0)

sub $4, $0, $3

add $4, $3, $0

addi $2, $2, 0x147e

and $5, $5, $5

addi $4, $4, 0x62ed

add $0, $4, $5

sh $3, 36($0)

mflo $1

sltu $3, $5, $2

div $4, $0

addi $4, $4, 0x37e3

or $4, $1, $4

addi $1, $0, 0x405b

or $0, $0, $4

nor $4, $1, $2

addu $4, $4, $4

lh $1, 9($0)

lbu $0, 23($0)

lb $5, 12($0)

xori $3, $0, 0xb51

sw $4, 31($0)

mfhi $1

add $2, $5, $2

add $1, $2, $2

srav $2, $3, $4

lui $0, 0x5e3c

mtlo $1

add $5, $1, $3

andi $2, $3, 0x5271

sub $1, $4, $2

add $4, $2, $1

sllv $4, $5, $0

add $5, $0, $5

and $0, $2, $4

addi $2, $4, 0x152c

lhu $4, 38($0)

add $4, $4, $2

slti $5, $4, 0x4770

ori $3, $0, 0x73a1

li $2, 0xb5092761

sltiu $0, $0, 0x291a

srav $0, $5, $4

xor $1, $3, $4

addi $5, $1, 0x66c2

addi $2, $5, 0x2c3b

divu $0, $0

multu $3, $4

lhu $3, 8($0)

mtlo $4

addi $2, $0, 0x2964

multu $1, $4

srlv $1, $5, $0

mtlo $2

addi $4, $1, 0x4b77

addi $3, $2, 0x5d3a

sub $5, $1, $4

sub $4, $0, $1

sub $5, $4, $2

addi $4, $4, 0x674d

mthi $5

addi $1, $3, 0x15ee

add $2, $1, $4

or $1, $0, $3

mult $5, $4

sub $1, $4, $4

add $2, $5, $0

sub $2, $2, $4

sub $4, $4, $3

add $0, $5, $3

ori $4, $2, 0x6196

subu $2, $3, $3

addu $3, $2, $0

add $5, $0, $4

mtlo $4

add $0, $0, $4

sw $2, 42($0)

srav $4, $1, $2

add $2, $4, $4

slt $3, $5, $4

lh $5, 24($0)

add $2, $2, $1

addi $1, $4, 0x6198

mthi $2

mtlo $1

xor $5, $1, $3

sub $4, $0, $1

addi $1, $1, 0x3bbf

addi $3, $4, 0x38c1

sw $2, 27($0)

lhu $5, 2($0)

sllv $5, $2, $4

addi $5, $2, 0x35b4

add $2, $1, $4

mult $1, $5

xor $5, $4, $5

addi $0, $4, 0x49ae

addu $2, $5, $4

addi $3, $1, 0x2531

lh $1, 35($0)

addiu $1, $3, 0x2040

sub $2, $4, $4

lbu $5, 37($0)

sub $2, $3, $5

mflo $4

lw $1, 45($0)

lb $2, 43($0)

addi $1, $3, 0x7a2a

subu $5, $2, $2

sub $5, $1, $0

add $1, $4, $5

sub $3, $4, $0

add $0, $0, $0

andi $5, $5, 0x500

add $4, $3, $0

sw $0, 50($0)

sltu $2, $3, $3

mfhi $2

sw $5, 10($0)

addi $2, $4, 0x9a1

addi $5, $3, 0x5f48

lui $0, 0x44ec

addi $0, $3, 0x48c8

divu $3, $5

addi $1, $3, 0x5900

ori $1, $0, 0x64b0

sllv $2, $2, $5

mthi $5

add $1, $2, $3

lbu $0, 22($0)

and $0, $5, $0

mult $4, $1

mthi $3

lui $3, 0x7cb9

srav $3, $2, $3

addiu $0, $1, 0x3b0f

addu $3, $2, $0

addi $2, $2, 0x451b

div $1, $4

addi $0, $0, 0x10d8

slt $2, $2, $4

add $1, $3, $1

addu $1, $3, $5

add $5, $1, $3

lhu $2, 36($0)

and $5, $5, $5

xori $1, $3, 0x5a75

sub $2, $2, $3

sub $3, $1, $0

slt $1, $0, $3

add $5, $1, $4

sub $1, $3, $4

div $5, $1

andi $0, $2, 0x1f28

lbu $1, 25($0)

or $4, $2, $1

srav $1, $2, $4

sltu $0, $5, $3

sub $1, $1, $3

addi $4, $5, 0xa2a

and $3, $3, $0

addi $5, $3, 0x793e

sb $4, 46($0)

lb $3, 35($0)

mfhi $4

slti $2, $2, 0x6fe1

lh $5, 19($0)

div $0, $5

lui $3, 0x46a5

mfhi $1

slt $4, $0, $4

multu $0, $5

sltiu $0, $1, 0x6854

sub $3, $0, $3

mult $3, $4

sub $4, $3, $2

andi $4, $3, 0x384d

sub $5, $2, $0

add $4, $0, $0

slti $5, $0, 0x98d

ori $0, $1, 0x349e

nor $5, $2, $5

nor $5, $2, $1

add $1, $4, $1

slt $5, $4, $4

addi $3, $3, 0x61e7

lb $3, 17($0)

addi $4, $0, 0x691f

srav $4, $5, $4

subu $3, $5, $1

addi $0, $5, 0x4c91

mtlo $3

add $4, $3, $4

add $5, $5, $4

add $4, $1, $3

sh $3, 16($0)

li $3, 0xc1fdb8be

multu $2, $3

mfhi $1

addi $3, $3, 0x79ea

addi $1, $5, 0x7d95

mfhi $4

add $1, $3, $4

andi $2, $0, 0x37fd

sub $2, $0, $3

or $4, $1, $1

addi $1, $2, 0x2570

sw $1, 50($0)

div $4, $1

lbu $3, 37($0)

sllv $5, $5, $2

sb $3, 42($0)

addi $2, $4, 0x3864

add $4, $3, $0

mthi $5

addi $4, $0, 0x122f

ddf:

j ddf

nop

.ktext 0x4180

mfc0 $t9, $14

addiu $t9, $t9, 4

mtc0 $t9, $14

eret

sh $2, 42($0)

运行结果：

$28 <= 00000000

$29 <= 00000000

$ 1 <= 2c890000

$ 0 <= 2c89fc15

$ 1 <= 50ba0000

$ 1 <= 50ba346d

$ 1 <= 0b730000

$ 2 <= 0b7306fa

$ 1 <= 03ef0000

$ 3 <= 03efc9d7

$ 1 <= 44560000

$ 4 <= 4456d999

$ 1 <= 39ff0000

$ 5 <= 39ffa7f6

$ 3 <= 00000000

$ 5 <= 00000000

$ 1 <= 940a0000

$ 5 <= 940a8c3f

$ 3 <= d860d999

$ 1 <= 940a7543

$ 0 <= 4fc9e093

$ 0 <= bba99baa

$ 2 <= 940add7f

$ 4 <= 00000022

$ 3 <= 00000001

$ 5 <= 00000000

$25 <= 0000307c

$25 <= 00003080

$ 0 <= 00000000

\*00000020 <= 0000

$ 3 <= 940add37

$25 <= 00003090

$25 <= 00003094

$ 1 <= 940add7f

$ 4 <= 00000000

$ 4 <= 00000000

$ 5 <= 00004de6

$ 5 <= 00002d22

$ 3 <= 00000001

$ 5 <= 00004106

$ 5 <= 00000001

$25 <= 000030b8

$25 <= 000030bc

$ 2 <= 940add7e

$ 4 <= 00000000

$ 0 <= 00000001

$ 1 <= f8e00000

$ 3 <= f8e051f2

$ 2 <= 00000000

$ 2 <= 00000000

$ 2 <= 00000002

$25 <= 000030e8

$25 <= 000030ec

$ 2 <= 00000001

\*00000034 <= 00

$ 3 <= 00000001

$25 <= 000030fc

$25 <= 00003100

$ 2 <= 00000001

$ 4 <= 00000000

$ 4 <= 0000549e

$ 3 <= 0000549f

$ 0 <= 00000000

$ 2 <= 00000000

$ 3 <= f8e00000

$25 <= 00003120

$25 <= 00003124

$ 4 <= 00000000

$ 2 <= 00000000

$ 0 <= 00000000

$ 4 <= 00000000

\*00000002 <= 00

$ 4 <= 00000000

$ 1 <= 00000124

$ 1 <= 00000000

$25 <= 00003144

$25 <= 00003148

$ 1 <= 00000000

$ 5 <= 00005e17

$ 1 <= f8e02081

$ 0 <= 00005e17

$ 2 <= 00000000

$25 <= 0000315c

$25 <= 00003160

\*00000018 <= 00005e17

$ 1 <= 000078f3

$ 5 <= 000001f1

$ 0 <= ffffffff

$ 0 <= 40d20000

$ 1 <= 00007af3

$ 3 <= 000058e7

$25 <= 00003184

$25 <= 00003188

$ 3 <= 000058e7

$ 0 <= 00000000

$ 5 <= 000034d2

$ 5 <= 00000000

$25 <= 00003198

$25 <= 0000319c

$ 5 <= 0000259e

$ 1 <= 00001012

$ 3 <= 00000000

$ 0 <= 00000000

$ 1 <= 00000000

$ 2 <= 00006d03

$ 4 <= 00004b3c

$ 1 <= 8bc70000

$ 1 <= 8bc72cdb

$ 4 <= 0000629c

$ 1 <= 76260000

$ 3 <= 0000629c

\*0000000e <= 6d03

$ 0 <= 0000cf9f

$ 4 <= 00000001

$ 5 <= 89da0001

$ 1 <= 7626629c

$ 0 <= 0000cf9f

$25 <= 000031e8

$25 <= 000031ec

$ 3 <= 00000007

$ 1 <= 00000000

$ 2 <= 00000001

$25 <= 000031f8

$25 <= 000031fc

$ 0 <= 00006fd7

$ 5 <= 00000000

$ 0 <= 00000000

$ 0 <= 00000001

$ 3 <= ffffffff

$ 3 <= 00000000

$ 2 <= 00000000

$ 4 <= 00000000

$25 <= 0000321c

$25 <= 00003220

$ 5 <= 000073b7

$ 4 <= 00000000

$ 3 <= 00000000

$ 1 <= 00000001

\*00000030 <= 01

$ 3 <= 00008148

$ 3 <= 00004e55

$ 4 <= 00000001

$ 1 <= 00000001

\*00000010 <= 4e55

$ 1 <= 00000000

$ 3 <= 00000000

$ 4 <= 00000000

$ 0 <= 172a0000

$ 3 <= 000073b7

$ 0 <= 00000000

$ 2 <= 00000000

$ 1 <= 00000001

\*0000002c <= 000073b7

$ 1 <= 570d0000

$ 4 <= 570d3426

$ 4 <= 00000000

$ 5 <= 00000000

$ 5 <= 00000001

$ 5 <= 570d2cd1

$ 2 <= 570d0000

$ 2 <= 570da088

$ 1 <= 570da088

$ 4 <= 00000000

$ 1 <= 00000001

$ 0 <= 00000000

$ 2 <= 00000001

$ 3 <= 00000000

\*00000022 <= 0000

$ 0 <= 7e730000

$ 2 <= 000006fe

$ 2 <= 00000a09

$ 4 <= 00000001

$ 4 <= 00000002

$25 <= 000032c0

$25 <= 000032c4

$ 0 <= 570d2cd1

$ 1 <= 00000a09

$ 2 <= 00000a09

$ 5 <= 00000000

$ 2 <= 00000001

$ 2 <= 00000000

$ 2 <= 00000000

$ 0 <= 00000000

$ 2 <= 00000000

$ 1 <= 00000000

$ 4 <= 00000000

$ 0 <= 00003d94

$ 4 <= 000046cb

$ 5 <= 00000000

$ 1 <= 00000000

$ 2 <= 00000000

$ 0 <= 0000008a

$ 0 <= 00000001

$ 3 <= 000033df

$ 0 <= 00000000

$ 3 <= 00000000

$ 5 <= 00000000

$ 1 <= 000046cb

$ 1 <= 00000000

$ 4 <= 00006d33

$ 3 <= 0000295c

$ 1 <= 00000000

$ 5 <= 00000000

$ 0 <= 00000000

$ 0 <= 0000581c

$ 2 <= 00006d33

$ 2 <= 00000000

$ 0 <= 0000251e

$ 3 <= 00000000

$ 3 <= 00000000

$25 <= 00003354

$25 <= 00003358

$25 <= 00003358

$25 <= 0000335c

$ 0 <= 00006d33

$ 1 <= 00000001

\*00000012 <= 0000

$ 1 <= 00002484

$ 1 <= b53b0000

$ 2 <= b53b5a15

$ 5 <= b53a92cd

$ 2 <= 00000001

$ 0 <= 00000000

$ 4 <= b53a92cd

$ 5 <= b53a92cd

$ 2 <= b53b0000

$ 4 <= b53b0000

$ 1 <= 00000001

$ 5 <= 000052be

$25 <= 000033a0

$25 <= 000033a4

$25 <= 000033a4

$25 <= 000033a8

$ 5 <= 00000000

$ 2 <= 00000001

$ 0 <= b53b0001

$ 2 <= 00000000

$ 1 <= 00000000

$ 1 <= 00000000

$ 4 <= 00000000

\*00000014 <= 0000

$ 5 <= 00000000

$ 3 <= 00007345

$ 5 <= 00000001

$ 1 <= 00000001

$ 1 <= 82710000

$ 5 <= 8271f348

$ 5 <= 00000000

$ 3 <= 00007345

$ 5 <= 00000000

$ 2 <= 00007345

$ 3 <= 00003af2

$ 3 <= ffff8cbb

$ 3 <= 00000000

$ 5 <= 00007345

$ 5 <= 00000000

$ 4 <= 00000000

$ 5 <= 00000000

$ 5 <= 00000001

$ 1 <= 00004add

$ 3 <= 00000001

$ 0 <= ffffb523

$ 5 <= 0000768e

$ 1 <= 000073b7

$ 1 <= 00005e19

$ 4 <= 0000ed1c

$ 2 <= 0000a1e1

$ 4 <= 0000a1e2

$ 3 <= 000143c4

$ 1 <= 00000000

$ 1 <= 00018036

\*00000018 <= 0000a1e2

$ 2 <= 0000768e

$ 4 <= 0001a340

$ 1 <= 0000768e

$ 4 <= 000219ce

$ 4 <= fffe8831

$ 2 <= fffefebf

$ 0 <= fffeaa1e

$ 4 <= 0000768e

$ 2 <= ffff754d

$ 3 <= 0000768e

$ 5 <= 00000000

$ 2 <= 0000768e

$ 5 <= 0000a413

$ 2 <= 0000d954

$ 5 <= 00000000

$ 4 <= 0000ae6f

$ 0 <= 000076bf

$ 3 <= 0001b2a8

$ 3 <= 00000000

$ 1 <= 00000000

$ 3 <= 00000000

$ 1 <= 00000000

\*00000004 <= 0000d954

$ 3 <= 00000000

$ 2 <= 00000000

$ 4 <= 0000d954

$ 4 <= 00000000

$ 4 <= 00000000

$ 1 <= 00000000

$ 5 <= 00000000

$ 1 <= 750a0000

$ 4 <= 750a1c28

$25 <= 000034e0

$25 <= 000034e4

$ 1 <= 00000001

$ 2 <= 00006cf8

$ 0 <= 000073dd

$ 2 <= 750a1c28

$ 0 <= 0000107c

$ 5 <= 750a6df9

$ 4 <= 00000001

$25 <= 00003500

$25 <= 00003504

$ 4 <= 00000000

$ 0 <= 8af5e3d8

$ 5 <= 3582638a

$ 1 <= ffffffff

$25 <= 00003518

$25 <= 0000351c

$ 5 <= 00000001

$ 1 <= 37550000

$ 3 <= 3755a151

$ 3 <= 00000000

$ 4 <= 00000001

$ 2 <= 00000000

$ 4 <= 00000001

$ 1 <= 37550000

$ 0 <= 00007f60

$ 5 <= 00000000

$ 2 <= 00000000

$ 2 <= 00000000

$ 3 <= 00000000

$25 <= 00003558

$25 <= 0000355c

$ 5 <= 3582638a

$ 0 <= c8289c75

$ 1 <= 00003b66

$ 2 <= 3582638b

$ 3 <= 00004d3c

$ 0 <= 00000001

$25 <= 00003574

$25 <= 00003578

$ 5 <= 00000000

$25 <= 0000357c

$25 <= 00003580

$ 5 <= 00000001

$ 3 <= 00000000

$ 1 <= 00000001

$ 2 <= 00000000

$ 4 <= 00000000

$ 2 <= 00000001

$ 1 <= ffffffff

$ 5 <= 00000000

$ 5 <= ffffffff

$ 0 <= 000011a7

$25 <= 000035a8

$25 <= 000035ac

$ 1 <= fffffffe

$ 3 <= 00000000

$ 4 <= 00000000

$ 3 <= 00003e59

$ 2 <= 00000000

$ 5 <= fffffffe

$ 2 <= 00000000

$25 <= 000035c8

$25 <= 000035cc

$ 2 <= 00000000

$ 5 <= 00000000

$ 2 <= ffffffff

$ 0 <= 00003e59

$ 3 <= 00001626

$ 2 <= 00000001

$ 5 <= fffffffe

$ 1 <= fffffffe

$ 1 <= 00000000

$25 <= 000035f4

$25 <= 000035f8

$ 4 <= 00000000

$ 1 <= 00000000

$ 5 <= 00000000

$ 4 <= 00000000

\*00000026 <= 01

$ 2 <= 00001626

$ 2 <= 00000001

$ 0 <= 00000000

$ 5 <= 00000001

$ 2 <= 00001625

$ 2 <= ffffffff

$ 0 <= 00002ac3

$ 0 <= 00004780

$ 2 <= ffffffff

$ 5 <= 000027c8

$ 1 <= 00000000

$ 1 <= 00002c4c

$ 4 <= 0000a11c

$ 1 <= 00001e17

$ 4 <= 00000000

$ 4 <= ffffffff

$ 0 <= 000023f5

$ 2 <= ffffffff

$ 3 <= 00001625

$ 0 <= 00001e17

$ 5 <= 00003fdc

$ 0 <= 0000acc8

$ 3 <= 00006486

$ 0 <= 00003fdb

$25 <= 00003688

$25 <= 0000368c

$ 1 <= 70090000

$ 3 <= 70095d75

$ 4 <= 00000000

$ 1 <= 00005d75

$25 <= 000036a0

$25 <= 000036a4

$ 0 <= 00003ab1

$ 3 <= ffffffff

$ 2 <= 00005d75

$ 3 <= fb800000

$ 1 <= 00003fdc

$ 2 <= 00000000

$ 2 <= 04800000

$ 0 <= 04800000

$ 0 <= ffffc024

$ 3 <= 00000000

$ 2 <= 04800000

$ 1 <= 04802fde

$ 3 <= 00003fdc

$ 5 <= 0000214e

\*00000030 <= 0000

$ 5 <= 0480214e

$ 0 <= 00000000

$ 0 <= 048068d3

$ 0 <= 00000000

$ 0 <= 00000000

$ 0 <= 00000001

$ 0 <= 09005fbc

$ 1 <= ffffffff

$ 1 <= 00007fb8

$ 5 <= 0480a106

$ 1 <= 048120be

$ 5 <= 048120be

$ 4 <= 04803fdc

$ 1 <= 00000000

$25 <= 00003724

$25 <= 00003728

$ 3 <= 00000000

$ 3 <= 04805ecd

$ 1 <= 00000000

$ 1 <= 00000000

$ 2 <= 090120be

$ 1 <= 00005ce0

$ 3 <= 00000000

$ 2 <= 048120be

$ 4 <= 0901609a

$ 5 <= f27e9f41

$ 1 <= 0901609a

$ 2 <= 0d828158

$ 5 <= 0901b7f0

$ 5 <= f27d7ea8

$ 0 <= 0d828158

$ 4 <= 09016df8

$ 1 <= 1202dbf0

$ 4 <= 00000000

\*00000021 <= 00

$ 3 <= 000000a1

$ 0 <= 000000a1

$ 5 <= 0000708b

$ 1 <= edfd949b

$ 2 <= 0000225f

$ 3 <= 00000000

$25 <= 0000378c

$25 <= 00003790

$ 1 <= 00000000

$ 2 <= 00000000

$25 <= 00003798

$25 <= 0000379c

$ 4 <= ffffffff

$ 5 <= 00000000

$ 4 <= 00000001

$ 2 <= 00000001

$ 5 <= 00000001

$ 2 <= 00000000

\*0000002c <= 01

$ 2 <= 00000339

$ 4 <= 00000339

$ 2 <= 00000339

$ 3 <= 00000001

\*0000001d <= 39

$ 2 <= 00000000

$ 2 <= 00000001

\*00000030 <= 00

$ 2 <= 00006783

$ 1 <= 00000001

$ 5 <= 00000002

$ 5 <= 00000000

$ 3 <= 00000ccf

$ 3 <= 00003e16

\*00000025 <= 83

$ 1 <= 0000a599

$ 4 <= 0000c21a

$ 3 <= 00003e16

$ 4 <= 00006783

$ 2 <= 00000000

$ 1 <= 00000000

$ 5 <= 00000000

$25 <= 00003820

$25 <= 00003824

$ 2 <= 00006783

$ 3 <= 00000000

$ 3 <= 0000cfd1

$ 0 <= 00000000

$ 2 <= 0000cfd1

$ 1 <= 0000cfd1

$ 1 <= f6d00000

$ 0 <= f6d0f42f

$ 4 <= 0000cfd1

$ 3 <= 00000000

$ 1 <= 00000000

$ 3 <= 0000cfd1

$ 1 <= 0000408e

$ 1 <= 00000000

$ 4 <= 000142b3

$ 5 <= 00000000

$ 0 <= ffff302f

$ 5 <= 00000000

$ 1 <= 00010f11

$ 1 <= 0000cfd1

$ 4 <= 000032e1

$25 <= 00003878

$25 <= 0000387c

$ 0 <= 0000cfd1

$ 2 <= 00000000

$ 1 <= ffff302f

$ 3 <= 0000cfd1

$ 2 <= 00000000

$25 <= 00003894

$25 <= 00003898

$ 5 <= 00000000

$25 <= 000038a0

$25 <= 000038a4

$ 2 <= ffff302f

\*00000005 <= 00

$ 3 <= 00003036

$ 0 <= 00003036

$ 5 <= ffff6310

$ 0 <= ffff733f

$ 5 <= ffff6310

$ 3 <= 00000000

$ 4 <= 00000000

$ 1 <= bb3b0000

$ 5 <= bb3b898f

$ 3 <= 80000000

$ 4 <= 44c3a6a0

$25 <= 000038dc

$25 <= 000038e0

$ 4 <= ffff4ffc

$ 3 <= bb3b898f

$ 2 <= bb3be1b8

$ 5 <= ffffffbb

$ 4 <= bb3bf1a1

$ 2 <= 00000000

$ 0 <= bb3b0000

$ 0 <= 44c40e1a

$ 4 <= 00000000

$25 <= 00003908

$25 <= 0000390c

$ 1 <= 00006a52

$ 1 <= 00000000

$ 3 <= bb3b898f

$ 0 <= bb3be5c7

$ 0 <= 00000000

$ 0 <= 00000000

$ 2 <= 38a80000

$ 0 <= 00004968

$25 <= 0000392c

$25 <= 00003930

$ 2 <= 44c47671

$25 <= 00003934

$25 <= 00003938

$ 4 <= 00000000

$ 4 <= 44c47671

$ 0 <= ffffffbf

$ 1 <= 44c47773

$ 5 <= 44c477b8

$ 2 <= 44c4d26f

$25 <= 00003954

$25 <= 00003958

$25 <= 00003958

$25 <= 0000395c

$ 5 <= 00000000

$ 1 <= 00000000

$ 3 <= 000007f6

$ 0 <= 00005bfe

$ 4 <= 44c4d26f

$ 1 <= 00000000

$ 0 <= 00007683

$ 2 <= 00000001

$ 4 <= 000007f6

$ 0 <= 00000000

$ 1 <= fffff80a

$ 1 <= 000007f6

$ 5 <= 000007f6

$ 0 <= 000007f6

$ 5 <= 00000001

$ 2 <= 06c70000

\*0000001b <= 00

$ 5 <= 00001baa

$ 2 <= 06c6e456

$ 5 <= 000007f6

$ 1 <= 06c6e456

$ 0 <= 06c70fd6

$ 0 <= 00000073

$ 1 <= 003f6064

$ 5 <= 00000000

$ 3 <= 00000000

$ 1 <= f9391baa

$ 5 <= 3f810000

$ 4 <= 4647e456

$ 4 <= 3f810ce1

$ 0 <= 38ba288b

$ 2 <= 00000000

$ 3 <= 39010000

$ 1 <= 72020000

$ 0 <= c6ff0000

$ 2 <= 00004ca3

$ 1 <= 00000000

$ 0 <= 3f810000

$ 1 <= 000008a0

$ 0 <= 3f80c03e

$ 4 <= 3f810de9

$ 1 <= 00004e8b

$ 5 <= 3f814e8b

$ 5 <= 00000000

$ 5 <= 39010000

\*00000023 <= 00

$ 2 <= 0000c758

$ 5 <= 39014e8b

$ 1 <= 00072020

$ 0 <= 00006878

$ 3 <= 3f811c06

$ 3 <= 00000000

$ 1 <= 40440000

$25 <= 00003a40

$25 <= 00003a44

$ 1 <= 3f810de9

$ 4 <= 001fc086

$ 1 <= 39014e8b

$ 1 <= db9d0000

$ 2 <= db9dbaff

$ 3 <= a29bb175

$ 1 <= db9d0000

$ 3 <= 00006410

$ 3 <= 149e4e8b

$25 <= 00003a70

$25 <= 00003a74

$ 1 <= 3901b308

$ 2 <= 00000000

$ 0 <= 149e9f2a

$ 0 <= 00000000

$ 5 <= ffe03f7a

$ 5 <= 14be0f11

$25 <= 00003a8c

$25 <= 00003a90

$ 2 <= 14be247c

$ 3 <= 00000000

$ 0 <= 001fb909

$ 1 <= 00000000

\*00000007 <= 7c

$ 1 <= 74110000

$ 5 <= 74113a6e

$ 0 <= 14be247c

$ 5 <= 74110000

$ 3 <= 14be934f

$ 0 <= 00000000

$25 <= 00003ac0

$25 <= 00003ac4

$ 5 <= 74110000

$ 5 <= 00000000

$ 2 <= 00000000

$ 2 <= 000038a4

$ 3 <= 4fef0000

$25 <= 00003ad8

$25 <= 00003adc

$ 1 <= ffe0781e

$ 2 <= ffe0b0c2

$25 <= 00003ae8

$25 <= 00003aec

$ 2 <= 00000000

$ 0 <= 00000000

$ 5 <= 001fc086

$ 5 <= 00000000

$ 4 <= ffe0781e

$ 1 <= ffe08709

$ 1 <= 0000004e

$ 1 <= 0000452f

$ 4 <= ffe0781e

$ 2 <= 4fef0000

$ 1 <= 4fef452f

$25 <= 00003b24

$25 <= 00003b28

$ 4 <= b0110000

$ 4 <= 4fef0000

$ 2 <= 4fef147e

$ 5 <= 00000000

$ 4 <= 4fef62ed

$ 0 <= 4fef62ed

\*00000024 <= 0000

$ 1 <= 00000000

$ 3 <= 00000001

$ 4 <= 4fef9ad0

$ 4 <= 4fef9ad0

$ 1 <= 0000405b

$ 0 <= 4fef9ad0

$ 4 <= b010ab80

$ 4 <= 60215700

$25 <= 00003b68

$25 <= 00003b6c

$ 0 <= 00000000

$ 5 <= 00000000

$ 3 <= 00000b51

$25 <= 00003b78

$25 <= 00003b7c

$ 1 <= 00000000

$ 2 <= 4fef147e

$25 <= 00003b84

$25 <= 00003b88

$ 2 <= 00000b51

$ 0 <= 5e3c0000

$ 5 <= 00000b51

$ 2 <= 00000251

$ 1 <= 602154af

$ 4 <= 60215700

$ 4 <= 00000b51

$ 5 <= 00000b51

$ 0 <= 00000251

$ 2 <= 0000207d

$ 4 <= 00000001

$ 4 <= 0000207e

$ 5 <= 00000001

$ 3 <= 000073a1

$ 1 <= b5090000

$ 2 <= b5092761

$ 0 <= 00000001

$ 0 <= 00000000

$ 1 <= 000053df

$ 5 <= 0000baa1

$ 2 <= 0000e6dc

$ 3 <= 00000000

$ 2 <= 00002964

$ 1 <= 0000baa1

$ 4 <= 00010618

$ 3 <= 0000869e

$ 5 <= ffffb489

$ 4 <= ffff455f

$ 5 <= ffff1bfb

$ 4 <= ffffacac

$ 1 <= 00009c8c

$ 2 <= 00004938

$ 1 <= 0000869e

$ 1 <= 00000000

$ 2 <= ffff1bfb

$ 2 <= ffff6f4f

$ 4 <= ffff260e

$ 0 <= ffffa299

$ 4 <= ffff6fdf

$ 2 <= 00000000

$ 3 <= 00000000

$ 5 <= ffff6fdf

$ 0 <= ffff6fdf

$25 <= 00003c58

$25 <= 00003c5c

$ 4 <= 00000000

$ 2 <= 00000000

$ 3 <= 00000001

$ 5 <= ffffa1e2

$ 2 <= 00000000

$ 1 <= 00006198

$ 5 <= 00006199

$ 4 <= ffff9e68

$ 1 <= 00009d57

$ 3 <= ffffd729

$25 <= 00003c8c

$25 <= 00003c90

$ 5 <= 00000000

$ 5 <= 00000000

$ 5 <= 000035b4

$ 2 <= 00003bbf

$ 5 <= ffffabdc

$ 0 <= ffffe816

$ 2 <= ffff4a44

$ 3 <= 0000c288

$25 <= 00003cb4

$25 <= 00003cb8

$ 1 <= 0000e2c8

$ 2 <= 00000000

$ 5 <= 00000000

$ 2 <= 0000c288

$ 4 <= 2101a42c

$25 <= 00003ccc

$25 <= 00003cd0

$ 2 <= 00000000

$ 1 <= 00013cb2

$ 5 <= 00000000

$ 5 <= 00013cb2

$ 1 <= 2102e0de

$ 3 <= 2101a42c

$ 0 <= 00000000

$ 5 <= 00000400

$ 4 <= 2101a42c

$25 <= 00003cf4

$25 <= 00003cf8

$ 2 <= 00000000

$ 2 <= 00000000

$25 <= 00003d00

$25 <= 00003d04

$ 2 <= 2101adcd

$ 5 <= 21020374

$ 0 <= 44ec0000

$ 0 <= 2101ecf4

$ 1 <= 2101fd2c

$ 1 <= 000064b0

$ 2 <= dcd00000

$ 1 <= fdd1a42c

$ 0 <= 00000000

$ 0 <= 00000000

$ 3 <= 7cb90000

$ 3 <= dcd00000

$ 0 <= fdd1df3b

$ 3 <= dcd00000

$ 2 <= dcd0451b

$ 0 <= 000010d8

$ 2 <= 00000001

$ 1 <= daa1a42c

$ 1 <= fdd20374

$ 5 <= daa20374

$ 2 <= 00000000

$ 5 <= daa20374

$ 1 <= dcd05a75

$ 2 <= 23300000

$ 3 <= dcd05a75

$ 1 <= 00000000

$ 5 <= 2101a42c

$ 1 <= bbceb649

$ 0 <= 00000000

$ 1 <= 000000a1

$ 4 <= 233000a1

$ 1 <= 11980000

$ 0 <= 00000001

$ 1 <= 34c7a58b

$ 4 <= 2101ae56

$ 3 <= 00000000

$ 5 <= 0000793e

\*0000002e <= 56

$ 3 <= 00000000

$ 4 <= 2101a42c

$ 2 <= 00000000

$25 <= 00003dc0

$25 <= 00003dc4

$ 3 <= 46a50000

$ 1 <= 00000000

$ 4 <= 00000001

$ 0 <= 00000001

$ 3 <= b95b0000

$ 4 <= b95b0000

$ 4 <= 00000000

$ 5 <= 00000000

$ 4 <= 00000000

$ 5 <= 00000001

$ 0 <= 0000349e

$ 5 <= fffffffe

$ 5 <= ffffffff

$ 1 <= 00000000

$ 5 <= 00000000

$ 3 <= b95b61e7

$ 3 <= 0000004e

$ 4 <= 0000691f

$ 4 <= 00000000

$ 3 <= 00000000

$ 0 <= 00004c91

$ 4 <= 00000000

$ 5 <= 00000000

$ 4 <= 00000000

\*00000010 <= 0000

$ 1 <= c1fd0000

$ 3 <= c1fdb8be

$ 1 <= 00000000

$ 3 <= c1fe32a8

$ 1 <= 00007d95

$ 4 <= 00000000

$ 1 <= c1fe32a8

$ 2 <= 00000000

$ 2 <= 3e01cd58

$ 4 <= c1fe32a8

$ 1 <= 3e01f2c8

$25 <= 00003e68

$25 <= 00003e6c

$ 3 <= 00000000

$ 5 <= 00000000

\*0000002a <= 00

$ 2 <= c1fe6b0c

$ 4 <= 00000000

$ 4 <= 0000122f

主要思路：中断0,1，F\_AdEL, D\_RI, E\_Ov, M\_AdEL,AdES中断冲突同时

1. 冲突处理

|  |  |
| --- | --- |
| rs暂停 |  |
| 0,E1 | calc + beq/jr |
| 0,E2 | lw + beq/jr |
| 0,M1 | lw + x + beq/jr |
| 1,E2 | lw + cal |
|  | lw + sw |
|  |  |
| rt暂停 |  |
| 0,E1 | calc + beq |
| 0,E2 | lw + beq |
| 0,M1 | lw + x + beq |
| 1,E2 | lw + cal |

|  |  |
| --- | --- |
| rs转发 |  |
| 0,E\_PC | 暂无 |
| 0,M\_ALU | cal + x + beq/jr |
| 0,M\_PC | jal + delay + beq |
|  | jal + delay + jr |
| 0,W\_ALU | jal + addu$31,$31,4 + jr |
|  |  |
| 0,W\_DM | lw + x + beq/jr |
| 0,W\_PC | jal + delay + beq/jr |
| 1,E\_ALU | cal/lw + cal/lw |
| 1,E\_PC | jal + cal/lw/sw |
| 1,M\_ALU | cal + cal |
| 1,M\_DM | lw + cal |
| 1,M\_PC | jal + lw/sw/cal |
| 1,W\_ALU | cal + x + x + cal |
| 1,W\_DM | lw + x + x + cal |
| 1,W\_PC | jal + x + x + cal |
|  |  |
| rt转发(仅列出Tuse=2的情况，Tuse=1的情况与rs类似) | |
| 2,E\_ALU | cal + sw |
| 2,E\_DM | lw + sw |
| 2,E\_PC | jal + sw |
| 2,M\_ALU | cal + x + sw |
| 2,M\_DM | lw + x + sw |
| 2,M\_PC | jal + x + sw |
| 2,W\_ALU | cal + x + x + sw |
| 2,W\_DM | lw + x + x + sw |
| 2,W\_PC | jal + x + x + sw |

|  |
| --- |
| 乘除相关 |
| Cal+mul/div |
| Lw+mul/div |
| Jal(r) + mul/div |
| Mul/div \* 2 |

思考题

1. 软件/硬件（RW / HW）接口：在接口之上是中断处理程序和用于不同设备的设备驱动程序，在此之下是各种设备的控制器，如CD-ROM控制器、硬盘控制器、键盘控制器、打印机控制器、网络控制器等，它们都属于硬件。由于设备种类繁多，故该接口相当复杂。

2.cache的下一级。

3.不一定。可能有的设备并不支持任何的非整字操作，那么字节使能对该外设则毫无作用。

4..ktext 0x4180

mfc0 $t9, $14

addiu $t9, $t9, 4

mtc0 $t9, $14

eret

sh $2, 42($0)。

5.通过南桥的控制器向总线发出一个中断请求，总线把请求传递至北桥，北桥来沟通CPU。