



دانشگاه صنعتی شریف

دانشکده مهندسی برق

ساختار کامپیوتر

آزمایش 5:

پیاده سازی MULTI_CYCLE پردازنده MIPS

(تکمیل تمامی دستورات)

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ما در طول این ترم سعی کردیم تا آنجایی که می توانیم بخش های اضافه و امتیازی را پیاده سازی کنیم که به شرح زیر هستند:

- ✓ پیاده سازی ضرب کننده به روش **Booth** (آزمایش اول)
- ✓ پیاده سازی تقسیم کننده با علامت و بدون علامت (آزمایش اول)
- ✓ پیاده سازی ضرب و تقسیم ممیز شناور و تهیه تست بنچ های مربوطه (آزمایش دوم)
- ✓ پیاده سازی تمام دستورات به جز **pseudocode**
- ✓ پیاده سازی دستورات **coprocessor1** (بخشی از دستورات این قسمت)

- توجه: این گزارش پیرو گزارش قبلی آمده است و تکمیل کننده ی آن است.

R-format: add, addu, sub, subu, and, or, xor, nor, slt, sltu, sll, srl, sra, sllv, srlv, srav, jr, jalr, mult, multu, mfhi, mflo, div, divu

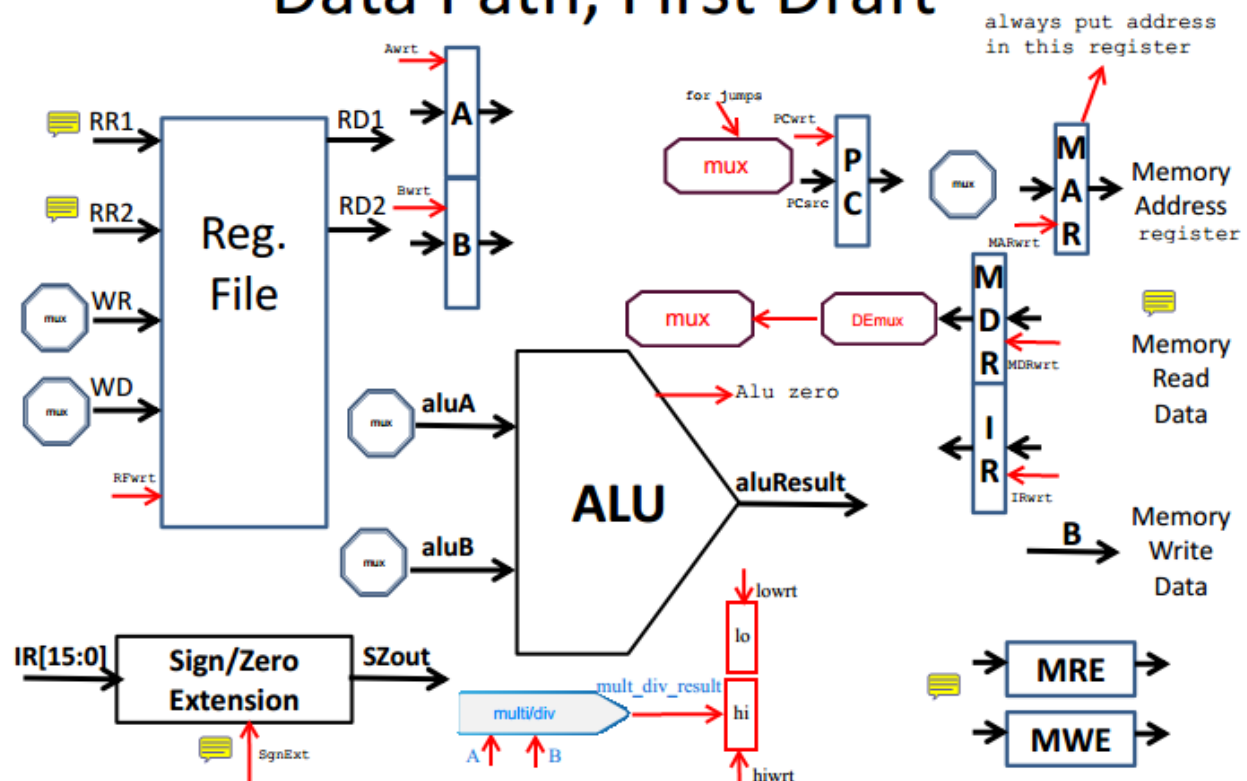
I-format: addi, addiu, slti, sltiu, andi, ori, xori, lui, lw, lh, lhu, lb, lbu, sw, sb, sh, beq, bne

J-format: j, jal

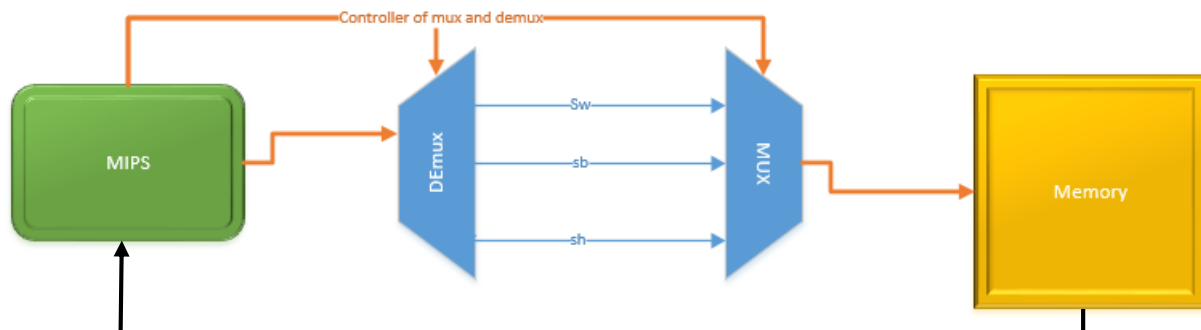
Floating point Coproc1: add.s, sub.s, mul.s, div.s, neg.s, abs.s, lwc1, swc1

که منجر به تغییراتی در datapath شد که در ادامه نشان خواهیم داد:

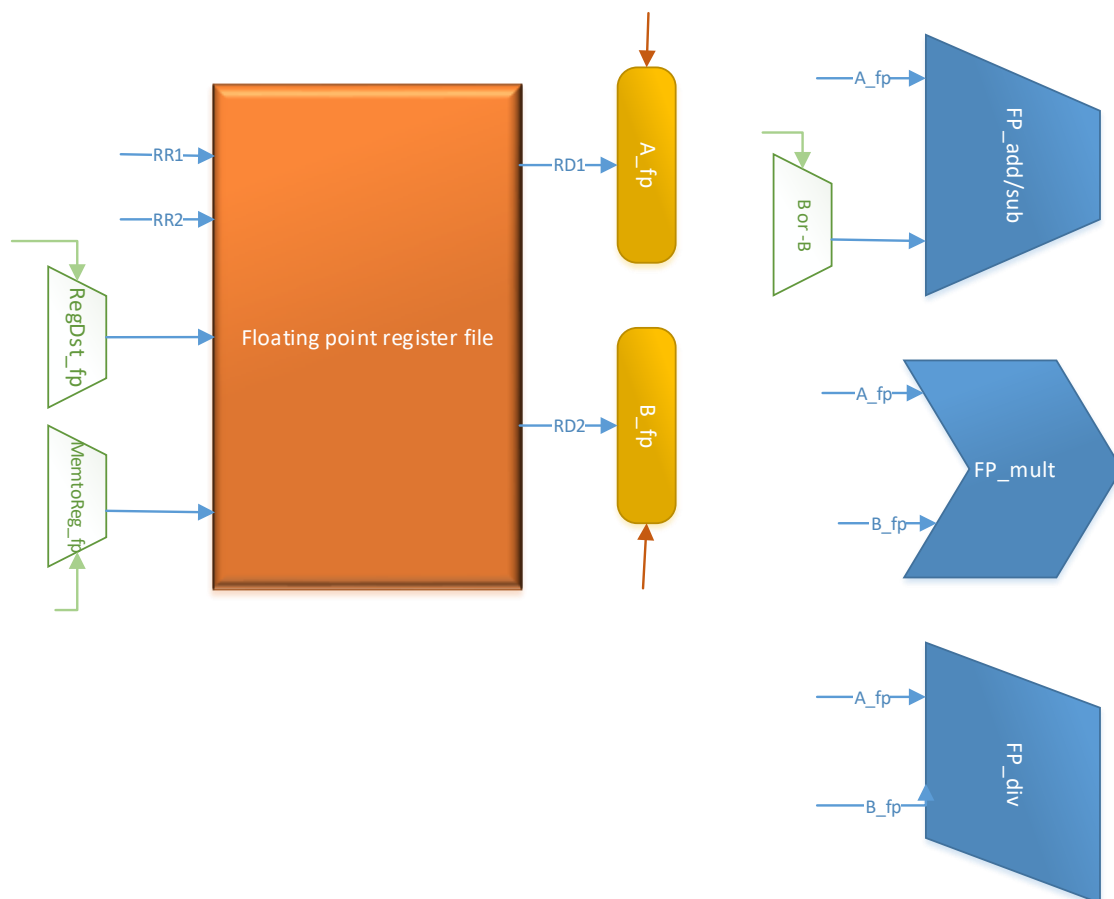
Data Path, First Draft



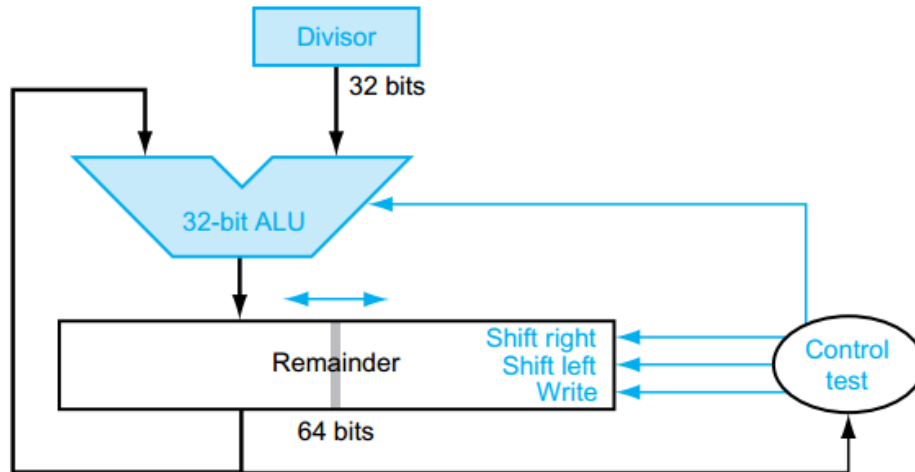
هم چنین تغییراتی در ورودی مموری نیز ایجاد شده است. در واقع برای اجرای دستورات sw, sb, sh یک مالتی پلکسر و یک دیمالتی پلکسر در ورودی مموری قرار داده ایم.



حال یک datapath اولیه برای coprocessor1 رسم می کنیم:



همچنین برای پیاده سازی مدار تقسیم کننده از مدار کتاب COD که بصورت شکل زیر است کمک گرفتیم:



مثال زیر نشان دهنده ی نحوه ی کار این مدار است:

Step	Action	Divisor	Remainder/Quotient
0	Initial Vals	010 001	000 000 111 100
1	R<<	010 001	000 001 111 000
	Rem = Rem - Div	010 001	111 000 111 000
	Rem < 0, R + D	010 001	000 001 111 000
2	R<<	010 001	000 011 110 000
	Rem = Rem - Div	010 001	110 010 110 000
	Rem < 0, R + D	010 001	000 011 110 000
3	R<<	010 001	000 111 100 000
	Rem = Rem - Div	010 001	110 110 110 000
	Rem < 0, R + D	010 001	000 111 100 000
4	R<<	010 001	001 111 000 000
	Rem = Rem - Div	010 001	111 110 000 000
	Rem < 0, R + D	010 001	001 111 000 000
5	R<<	010 001	011 110 000 000
	Rem = Rem - Div	010 001	111 110 000 000
	Rem > 0, R0 = 1	010 001	001 101 000 001
6	R<<	010 001	011 010 000 010
	Rem = Rem - Div	010 001	001 001 000 010
	Rem > 0, R0 = 1	010 001	001 001 000 011

حال یک تست بنچ با تمرکز بر دستورات `div,divu,sw,sb,sh,lw,lh,lhu,lb,lbu` ارائه می کنیم:

منطق تست بنچ به این صورت است که هربار طی چند عملیات باید مقدار دورجیستر برابر شود تا دستورات `branch` همه `taken` شوند.

\$s0 is first set to 0. After any instruction, a "beq" is provided to check the result with the desired #result. If for an instruction, the result is not what we expect, then \$0 is set to another nnumber.

#

these two are reserved for changing %sp and \$ra

`addi $sp, $0, 256`

`addi $ra, $0, 512`

`add $s0, $0, $0 # This should never change`

`#addiu $t1, $0, 456789`

`lui $t1, 0x6`

`ori $t1, 0xf855`

`sh $t1, 0($sp)`

`lhu $t1, 0($sp)`

`#addi $t2, $0, 63573`

`lui $t2, 0`

`ori $t2, 0xf855`

`beq $t2, $t1, plzgo0`

`addi $s0, $0, 1`

`plzgo0:`

`lh $t1, 0($sp)`

`addi $t2, $0, -1963`

`beq $t1, $t2, plzgo1`

`addi $s0, $0, 2`

`plzgo1:`

`#addi $t1, $0, 74751`

`lui $t1, 1`

```
ori $t1, 0x23ff
sb $t1, 0($sp)
lbu $t1, 0($sp)
addi $t2, $0, 255
beq $t1, $t2, plzgo2
addi $s0, $0, 3
plzgo2:
lb $t1, 0($sp)
addi $t2, $0, -1
beq $t1, $t2, plzgo3
addi $s0, $0, 4
plzgo3:
addi $t1, $0, 28
addi $t2, $0, 7
divu $t1, $t2
mflo $t2
addi $t3, $0, 4
beq $t2, $t3, plzgo4
addi $s0, $0, 5
plzgo4:
addi $t1, $0, 28
addi $t2, $0, -7
div $t1, $t2
mflo $t2
addi $t3, $0, -4
beq $t2, $t3, plzgo5
addi $s0, $0, 6
plzgo5:
jr $ra
```

تحلیل تست پنج:

از آنجاییکه در گزارش قبل به اندازه ی کافی درباره ی کد ماشین و waveform بحث شد از آوردن آنها در این گزارش صرف نظر کرده و تنها تغییرات رجیستر و مموری را بررسی میکنیم.

addi \$sp, \$0, 256

Memory Data - /mips_last_tb/mem/mem_data			
00000000	00100000000111010000000100000000	00100000000111110000001000000000	00000000000000001000000000100000
00000004	00110101001010011111100001010101	10100111101010010000000000000000	10010111101010010000000000000000
00000008	00110101010010101111100001010101	00010001010010010000000000000001	00100000000100000000000000000001
0000000c	00100000000010101111100001010101	00010001010101010000000000000001	00100000000100000000000000000010
00000010	00110101010100100100011111111111	10100011101010010000000000000000	10010011101010010000000000000000
00000014	00010001001010100000000000000001	00100000000100000000000000000011	10000011101010010000000000000000
00000018	00010001001010100000000000000001	00100000000100000000000000000010	00100000000100100000000000011100
0000001c	00000001001010100000000000011011	00000000000000000101000000010010	0010000000010110000000000000100
00000020	00100000000100000000000000000101	00100000000100100000000000011100	0010000000010111111111111001
00000024	00000000000000000101000000010010	001000000001011111111111111100	00010001010010110000000000000001
00000028	0000001111100000000000000001000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000002c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000030	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000034	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000038	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000003c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000040	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000044	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000048	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000004c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000050	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000054	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Memory Data - /mips_last_tb/cpu/rf/rf_data - Default			
00000000	00000000000000000000000000000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000004	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000008	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000000c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000010	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000014	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000018	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000001c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	00000000000000000000000100000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

addi \$ra, \$0, 512

Memory Data - /mips_last_tb/cpu/rf/rf_data - Default			
00000000	00000000000000000000000000000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000004	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000008	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000000c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000010	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000014	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000018	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000001c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	00000000000000000000000100000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

add \$s0, \$0, \$0 # This should never change

Memory Data - /mips_last_tb/cpu/rf/rf_data - Default			
00000000	00000000000000000000000000000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000004	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000008	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000000c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000010	00000000000000000000000000000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000014	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000018	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000001c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	00000000000000000000000100000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

#addiu \$t1, \$0, 456789

lui \$t1, 0x6

Memory Data - /mips_last_tb/cpu/rf/rf_data - Default			
00000000	00000000000000000000000000000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000004	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000008	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	00000000000001100000000000000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000000c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000010	00000000000000000000000000000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000014	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000018	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000001c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	00000000000000000000000100000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

ori \$t1, 0xf855

Memory Data - /mips_last_tb/cpu/rf/rf_data - Default			
00000000	00000000000000000000000000000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000004	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000008	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	0000000000000101111100001010101	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000000c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000010	00000000000000000000000000000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000014	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000018	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000001c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	00000000000000000000000100000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

sh \$t1, 0(\$sp)

در این قسمت 16 بیت پایین در مموری save می‌شود.

Memory Data - /mips_last_tb/mem/mem_data - Default			
00000000	00100000000111010000000100000000	00100000000111110000001000000000	00000000000000001000000000100000
00000004	00110101001010011111100001010101	10100111101010010000000000000000	10010111101010010000000000000000
00000008	00110101010010101111100001010101	00010001010010010000000000000001	00100000000100000000000000000001
0000000c	00100000000010101111100001010101	00010001001010100000000000000001	00100000000100000000000000000001
00000010	00110101001010010010001111111111	10100011101010010000000000000000	10010011101010010000000000000000
00000014	00010001001010100000000000000001	00100000000100000000000000000011	10000011101010010000000000000000
00000018	00010001001010100000000000000001	00100000000100000000000000000010	00100000000100100000000000011100
0000001c	00000001001010100000000000011011	00000000000000000101000000010010	0010000000010110000000000000100
00000020	00100000000100000000000000000101	00100000000100100000000000011100	00100000000101011111111111001
00000024	00000000000000000101000000010010	00100000000101111111111111100	0001000101001011000000000000001
00000028	0000001111100000000000000001000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000002c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000030	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000034	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000038	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000003c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000040	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000044	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000048	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000004c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000050	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000054	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

lhu \$t1, 0(\$sp)

در این قسمت 16 بیت پایین یکی از داده‌های حافظه بصورت بدون علامت در t1 لود می‌شود.

Memory Data - /mips_last_tb/cpu/rf/rf_data - Default			
00000000	00000000000000000000000000000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000004	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000008	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	00000000000000000111100001010101	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000000c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000010	00000000000000000000000000000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000014	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000018	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000001c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	00000000000000000000000100000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

#addi \$t2, \$0, 63573

lui \$t2, 0

```
Memory Data - /mips_last_tb/cpu/rf/rf_data - Default
```

00000000	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000004	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000008	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	00000000000000000000000000000000	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000000c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000010	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000014	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000018	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000001c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	00000000000000000000000000000000

```
ori $t2, 0xf855
```

```
Memory Data - /mips_last_tlb/cpu/jffif_data - Default
```

00000000	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000004	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000008	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	00000000000000000000000000000000	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000000c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000010	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000014	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000018	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000001c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	00000000000000000000000000000000

```
beq $t2, $t1, plzgo0
```

چون مقادیر t_1, t_2 با هم برابرند بنابراین branch taken خواهیم داشت دستور بعدی اجرا نمی‌شود.

```
addi $s0, $0, 1
```

plzgo0:

```
lh $t1, 0($sp)
```

Memory Data - /mips_last_tb/cpu/iff/ff_data - Default			
00000000	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000004	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000008	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000000c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000010	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000014	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000018	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000001c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

همانطور که انتظار می‌رفت این دستور بصورت `sign extend` عمل می‌کند.

```
addi $t2, $0, -1963
```

Memory Data - /mips_last_tb/cpu/fff_data - Default			
00000000	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000004	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000008	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	11111111111111111100001010101	11111111111111111100001010101
0000000c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000010	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000014	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000018	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000001c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	00000000000000000000000010000000	00000000000000000000000010000000

```
beq $t1, $t2, plzgo1
```

این دستور نیز taken خواهد شد و دستور بعدی اجرا نمی‌شود.

```
addi $s0, $0, 2
```

plzgo1:

```
#addi $t1, $0, 74751
```

lui \$t1, 1

Memory Data - /mips_last_ib/cpu/ff/ff_data - Default			
00000000	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000004	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000008	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	0000000000000000000000000000	11111111111111111111000010101
0000000c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000010	0000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000014	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000018	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000001c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	0000000000000000000000000000	0000000000000000000000000000

```
ori $t1, 0x23ff
```

Memory Data - /mips_last_tb/cpu/rf/ff_data - Default			
00000000	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000004	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000008	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	0000000000000000001001000111111111	1111111111111111111100001010101
0000000c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000010	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000014	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000018	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000001c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	00000000000000000000000010000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000020	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	0000000000000000000010000000

```
sb $t1, 0($sp)
```

همانطور که مشاهده می‌شود دستورات sb,sh تنها بیت های مقدر شده را تغییر میدهند و به بقیه بیت ها کاری ندارند.

Memory Data - /mips_last_tb/mem/mem_data			
00000000	00100000000011101000000010000000	00100000000011111000000100000000	00000000000000000010000000010000
00000004	00110101001010011111100001010101	00100111101010010000000000000000	00111100000010010000000000000010
00000008	001010101001010111100001010101	00100011010100100000000000000001	00111100000010000000000000000000
0000000c	0010000000001010111100001010101	00010001001010100000000000000001	00111100000010010000000000000001
00000010	00101010010100100101000111111111	10100011101010100000000000000000	00100000000010100000000011111111
00000014	00010001001010100000000000000001	00100000000100000000000000000011	001000000000101111111111111111
00000018	00010001001010100000000000000001	00100000000100000000000000000100	001000000000101000000000000011
0000001c	00000001001010100000000000001011	00000000000000000010100000010010	000100010100101000000000000001
00000020	001000000010000000000000000101	00100000000010010000000000011100	001000000010010101111111111001
00000024	00000000000000000101000000010010	00100000000010111111111111100	001000001001010000000000000001
00000028	00000001111100000000000000001000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000002c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000030	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000034	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000038	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000003c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000040	xxxxxxxxxxxxxxxxxxxx1111100011111111	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000044	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000048	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000004c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000050	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000054	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

```
lbu $t1, 0($sp)
```

Memory Data - /mips_last_tb/cpu/rf/rf_data			
00000000	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000004	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000008	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	00000000000000000000000011111111	111111111111111111110001010101
0000000c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000010	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000014	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000018	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000001c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	00000000000000000000000010000000	00000000000000000000000100000000

```
addi $t2, $0, 255
```

[illegible]


```
beq $t1, $t2, plzgo2
```

این دستور نیز taken خواهد شد و دستور بعدی اجرا نمی‌شود.

```
addi $s0, $0, 3
```

plzgo2:

```
lb $t1, 0($sp)
```

```
Memory Data - /mips_last_tb/cpu/fff_data - Default
```

00000000	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000004	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000008	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	11111111111111111111111111111111	0000000000000000000000000011111111	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000000c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000010	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000014	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000018	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000001c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	0000000000000000000000000100000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	00000000000000000000000100000000

```
addi $t2, $0, -1
```

```
Memory Data - /mips_last_tb/cpu/ifu/ifu_data - Default
```

00000000	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000004	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000008	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	11111111111111111111111111111111	11111111111111111111111111111111	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000000c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000010	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000014	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000018	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000001c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	00000000000000000000000010000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	0000000000000000000010000000

```
beq $t1, $t2, plzgo3
```

این دستور نیز taken خواهد شد و دستور بعدی اجرا نمی‌شود.

```
addi $s0, $0, 4
```

plzgo3:

```
addi $t1, $0, 28
```

Memory Data - /mips_last_tb/cpu/ff/ff_data - Default			
00000000	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000004	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000008	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	00000000000000000000000000000000	11111111111111111111111111111111
0000000c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000010	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000014	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000018	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000001c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	00000000000000000000000000000000	00000000000000000000000000000000

```
addi $t2, $0, 7
```

```
Memory Data - /mips_last_tb/cpu/rf/rf_data - Default
```

00000000	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000004	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000008	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	000000000000000000000000000001100	0000000000000000000000000000011	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000000c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000010	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000014	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000018	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000001c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	000000000000000000000000010000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	000000000000000000000100000000

divu \$t1, \$t2

همانطور که انتظار می‌رفت به خارج قسمت 4 و باقیمانده صفر رسیدیم

```
/mips_last_tb/cpu/hi  
00000000000000000000000000000000  
/mips_last_tb/cpu/lo  
0000000000000000000000000000000100
```

```
mflo $t2
```

```
Memory Data - /mips_last_tb/cpu/fff_data - Default
```

00000000	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000004	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000008	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	0000000000000000000000000000011100	00000000000000000000000000000100	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000000c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000010	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000014	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000018	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000001c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	0000000000000000000000000100000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	0000000000000000000000000100000000

```
addi $t3, $0, 4
```

Memory Data - /mips_last_tb/cpu/rf/rf_data - Default			
00000000	00000000000000000000000000000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000004	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000008	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	00000000000000000000000000001100	00000000000000000000000000000100
0000000c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000010	00000000000000000000000000000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000014	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000018	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000001c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	0000000000000000000000000100000000	0000000000000000000000000100000000

```
beq $t2, $t3, plzgo4
```

این دستور نیز taken خواهد شد و دستور بعدی اجرا نمی‌شود.

```
addi $s0, $0, 5
```

plzgo4:

```
addi $t1, $0, 28
```

Memory Data - /mips_last_tb/cpu/rfft_data - Default			
00000000	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000004	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000008	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	00000000000000000000000000001100	00000000000000000000000000000100
0000000c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000010	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000014	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000018	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000001c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	00000000000000000000000010000000	0000000000000000000000000100000000

```
addi $t2, $0, -7
```

[illegible]

div \$t1, \$t2

```
/mips last tb/cpu/hi
```

000

```
/mips_last_tb/cpu/lo
```

```
111111111111111111111111111111111100
```

mflo \$t2

Memory Data - /mips_last_tb/cpu/rf/rf_data - Default			
00000000	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000004	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000008	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	000000000000000000000000000001100	11111111111111111111111111111100
0000000c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000010	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000014	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000018	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000001c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	0000000000000000000000000100000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000020	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	00000000000000000000000100000000

```
addi $t3, $0, -4
```

Memory Data - /mips_last_tb/cpu/rf/f_data - Default			
00000000	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000004	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000008	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	00000000000000000000000000001100	111111111111111111111111111100
0000000c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000010	00000000000000000000000000000000	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000014	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
00000018	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
0000001c	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	00000000000000000000000010000000	0000000000000000000000000100000000

```
beq $t2, $t3, plzgo5
```

این دستور نیز taken خواهد شد و دستور بعدی اجرا نمی‌شود.

```
addi $s0, $0, 6
```

plzgo5:

jr \$ra

تصویر نهایی مموری و رجیستر به صورت زیر است:

Memory Data - /mips_last_tb/cpu/rf/rf_data - Default				
00000000	00000000000000000000000000000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000004	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000008	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	000000000000000000000000011100	111111111111111111111111111100	111111111111111111111111111100
0000000c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000010	00000000000000000000000000000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000014	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000018	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000001c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	00000000000000000000000100000000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	000000000000000000000100000000

Memory Data - /mips_last_tb/mem/mem_data				
00000000	00100000000111010000000100000000	001000000001111000000100000000	00000000000000000100000000100000	00111100000010010000000000000110
00000004	0011010100101001111100001010101	10100111101010010000000000000000	10010111101010010000000000000000	00111100000010100000000000000000
00000008	0011010101001010111100001010101	00010001010010010000000000000001	00100000000100000000000000000001	10000111010100100000000000000000
0000000c	0010000000001010111100001010101	00010001001010100000000000000001	00100000000100000000000000000010	00111100000010010000000000000001
00000010	00110101001010010010001111111111	10100011101010010000000000000000	10010011101010010000000000000000	00100000000101000000000111111111
00000014	00010001001010100000000000000001	00100000000100000000000000000011	10000011101010010000000000000000	00100000000101011111111111111111
00000018	00010001001010100000000000000001	00100000000100000000000000000100	00100000000010010000000000011100	00100000000101000000000000001111
0000001c	00000001001010100000000000011011	000000000000000000101000000010010	0010000000010110000000000000100	00010001010010110000000000000001
00000020	00100000000100000000000000000101	00100000000010010000000000001100	0010000000001010111111111111001	0000000100101010000000000011010
00000024	00000000000000000101000000010010	001000000000101111111111111100	00010001010010110000000000000001	0010000000010000000000000000110
00000028	0000001111100000000000000001000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000002c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000030	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000034	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000038	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000003c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000040	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000044	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000048	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0000004c	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000050	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
00000054	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

یک تست بنچ مختصر نیز برای دستورات فلوپتینگ پوینت ارائه می کنیم:

```

addi $ra, $0, 512
addi $sp, $0, 256
lwc1 $f0, 0($sp)
lwc1 $f1, -4($sp)
lwc1 $f2, -8($sp)
add.s $f3, $f1, $f0
sub.s $f4, $f3, $f2
neg.s $f5, $f4
abs.s $f6, $f5
div.s $f7, $f6, $f0
mul.s $f8, $f7, $f1
swc1 $f8, -12($sp)

```


jr \$ra

تحليل تست بنچ:(برای جلوگیری از طولانی تر شدن تحلیل مموری را بطور دستی مقدار دهی کردیم(ردیف سوم در حالیمه میتوانستیم با مقدار دهی کردن regfile و سپس با استفاده از دستور sw این کار را انجام دهیم که از آن صرف نظر کردیم)

addi \$ra, \$0, 512

```
Memory Data - /mips_test_bin/mem/mem_data - Default
00000000 201f0200 201d0100 c7a00000 c7a1fffc c7a2ffff 460008c0 46021901 46002147 46002985 460031c3 46013a02 e7a8ffff 03e00008 XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
00000016 XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
0000002c XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
00000040 XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
00000058 XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
0000006e XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
00000084 XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
0000009a XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
000000b0 XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
000000c6 XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
```

```
Memory Data - /mips_test_bin/cpu/ff_data
00000000 00000000 XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
00000016 XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
```

addi \$sp, \$0, 256

```
Memory Data - /mips_test_bin/cpu/ff_data
00000000 00000000 XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
00000016 XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
```

lwc1 \$f0,0(\$sp)

```
Memory Data - /mips_test_bin/cpu/ff_data
00000000 cd9fc536 XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
00000016 XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
```

lwc1 \$f1, -4(\$sp)

```
Memory Data - /mips_test_bin/cpu/ff_data
00000000 cd9fc536 4e579246 bebd8be5 XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
00000016 XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
```

lwc1 \$f2, -8(\$sp)

```
Memory Data - /mips_test_bin/cpu/ff_data - Default
00000000 cd9fc536 4e579246 bebd8be5 XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
00000016 XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
```

add.s \$f3, \$f1, \$f0

```
Memory Data - /mips_test_bin/cpu/ff_data
00000000 cd9fc536 4e579246 bebd8be5 4e07afab XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
00000016 XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
```

sub.s \$f4, \$f3, \$f2

```
Memory Data - /mips_test_bin/cpu/ff_data
00000000 cd9fc536 4e579246 bebd8be5 4e07afab XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
00000016 XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
```

neg.s \$f5, \$f4

```
Memory Data - /mips_test_bin/cpu/ff_data
00000000 cd9fc536 4e579246 bebd8be5 4e07afab 4e07afab XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
00000016 XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
```

abs.s \$f6, \$f5

[illegible]

div.s \$f7, \$f6, \$f0

[illegible]

```
mul.s $f8, $f7, $f1
```

```
Memory Data - /mpe_test_b/cpufiff_b/fdata - Default -
```

```
swc1 $f8, -12($sp)
```

[illegible]

jr \$ra

مقادیر نهایی رجیسترها و مموری بصورت زیر است:

[illegible][illegible][illegible]

محکم کاری:

باید از کارایی ماژول هایی که در کنار ماژول اصلی `multi_cycle_mips.v` برای انجام عملیات هایی مانند: ضرب و تقسیم (صحیح و فلوئینگ پوینت) و همچنین جمع و تفریق فلوئینگ پوینت استفاده شده اند مطمئن شد.

ماژول جمع و تفریق فلوتینگ پوینت (fp_adder.v) همان ماژول آزمایش دوم است و به اندازه ی کافی تست روی آن انجام گرفته است. همچنین ماژول ضرب کننده نیز به مقدار لازم در آزمایش اول تست شده است.

سه ماژول، تست نشده باقی می ماند: fp_mult, fp_div, divider

که البته ماژول divider دو ورژن signed/unsigned دارد.

تصمیم گرفتیم تست بنچ هایی نیز برای این ماژول ها تهیه کنیم که بتوان از عملکرد صحیح آن ها مطمئن شد.

تهیه ی تست بنچ برای signed/unsigned divider کار ساده ای است و دقیقاً مشابه با تست بنچ signed/unsigned multiplier است که در آزمایش اول نیز استفاده شد.

اما تهیه تست بنچ برای ضرب و تقسیم فلوتینگ پوینت اندکی دشوار تر است.

برای این کار، ما تصمیم گرفتیم با استفاده از کد "test.cpp" که به زبان C++ نوشته شده است، به تعداد مشخص شده ضرب و تقسیم فلوتینگ انجام دهیم و نتیجه را به صورت 3 عدد در هر سطر در یک فایل ذخیره کنیم. این سه عدد به این صورت هستند که حاصل ضرب عدد اول در عدد دوم برابر عدد سوم است. برای تقسیم هم دقیقاً به همین صورت است و حاصل تقسیم عدد اول بر عدد دوم برابر عدد سوم است.

نتیجه ی کد C++ به عنوان دو فایل "testdiv.hex", "testmult.hex" ذخیره می شوند.

با استفاده از دو تست بنچ "fp_div__tb", "fp_mult__tb" با دادن 2000 تست سلامت این دو ماژول چک شد.

برای signed/unsigned divider هم مشابه با همان تست بنچ های signed/unsigned multiplier تست انجام شد و نتیجه ی تست موفقیت آمیز بود.

تمامی فایل های ذکر شده در بالا، در پوشه "tests" موجود می باشند.