

- **EXPLANATION:**

Detailed explanation: All changes related to the new instruction are tagged with comment: *// LWPC* in the soft-core. We must perform the following actions:

- Inhibit "Reserved Instruction Exception":

Comment:

assign maj_ri_e = ... (mpc_ir_e[31:26] == 6'o47) //

- New signal:

- *lwpc_instr*: Set to 1 when lwpc found:

assign lwpc_instr = (mpc_ir_e[31:26] == 6'o47);

- Incorporate new functionality:

- b. We must insert the new operands as an input to the *lw* adder.

aop_e and *dva_offset_e* are the inputs to the adder that calculates the Effective Address:

- c. *aop_e*: Incorporate the PC as an input. The PC is already available at E-Stage in signal *iva_e*.

assign aop_e[31:0] = lwpc_instr ? iva_e : (icc_pcrel_e ? (iva_e & ~{30'b0, {2{icc_pcrel_e}}}) : edp_abus_e); //
LWPC

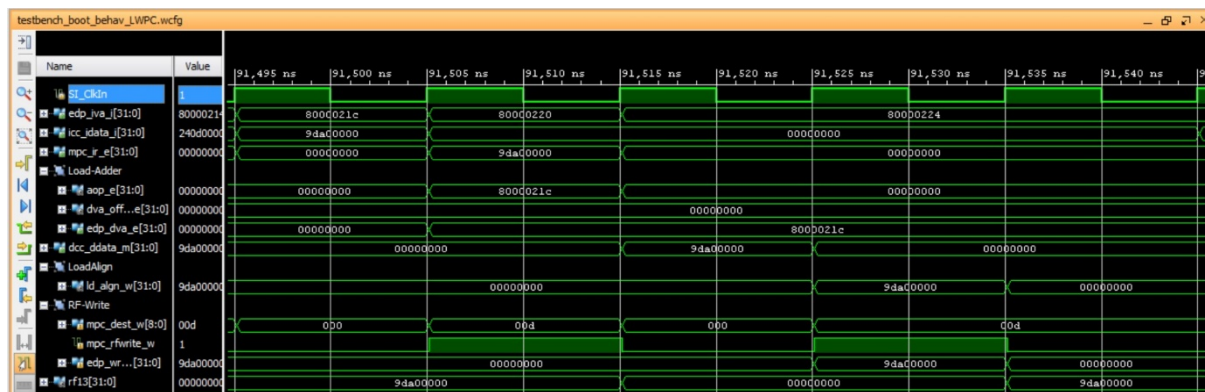
- d. *dva_offset_e*: Incorporate the SignExt(Imm<<2) as an input.

assign dva_offset_e[31:0] = lwpc_instr ? {
{11{mpc_ir_e[18]}}, mpc_ir_e[18:0], 2'b0} :
{32{mpc_subtract_e}} ^ bbus_imm_e; // *LWPC*

- We must select Rs as Destination Register:

assign dest_e[5:0] = lwpc_instr ? { 1'b0, mpc_ir_e[25:21] } :
((special_e | spec2_e | mpc_cnv_e | rwp_gpr_e |
dest_cnv_dsp_e | lx_e) ? { rwp_gpr_e & ~rdpgpr_e, pdest_e } :
((lnk31_e) ? 6'h1f : { 1'b0, src_b_e[4:0] })); // *LWPC*

- **EXAMPLE - SIMULATION:**



Observe that in the fifth cycle rf13 is written to 0x9da00000, which corresponds to the opcode of the instruction stored at PC=0x8000021c.

- **EXECUTION ON THE BOARD:**

When the program is downloaded on the board, you should see on the 7-seg displays:

- 7-seg displays=\$t5, which in our example is 0x9da00000

Then, when you debug the program following the steps stated in the document, you should observe the following:

```
C:\ mips-mti-elf-gdb -q program.elf -x C:\Users\Dan\Desktop\Scripts\Ne...
Reading symbols from program.elf...done.
0x00000000 in ?? ()
The target is assumed to be little endian
semihosting is enabled
JTAG tap: mAU0.cpu tap/device found: 0x00000001 (mfg: 0x000 (<invalid>), part: 0x0000, ver: 0x0)
target halted in MIPS32 mode due to debug-request, pc: 0xbfc00000
Loading section .exception_vector, size 0x200 lma 0x80000000
Loading section .text, size 0x34 lma 0x80000200
Loading section .bootrom, size 0x1b0 lma 0xbfc00000
Start address 0xbfc00000, load size 996
Transfer rate: 30 KB/sec, 332 bytes/write.

Program received signal SIGINT, Interrupt.
0x80000228 in main () at main.c:23
23      MFP 7SEGEN = 0x00;
(gdb) monitor reset halt
JTAG tap: mAU0.cpu tap/device found: 0x00000001 (mfg: 0x000 (<invalid>), part: 0x0000, ver: 0x0)
target halted in MIPS32 mode due to debug-request, pc: 0xbfc00000
(gdb) b *0x8000021c
Breakpoint 1 at 0x8000021c: file main.c, line 8.
(gdb) c
Continuing.

[Remote target] #1 stopped.
0x8000021c in main () at main.c:8
8      asm volatile
(gdb) i r
      zero      at      v0      v1      a0      a1      a2      a3
R0  00000000 00000000 00000000 80000250 00000000 00000002 80001000 00000000
    t0      t1      t2      t3      t4      t5      t6      t7
R8  80000204 00000002 00000000 00000000 00000000 00000000 00000000 00000000
    s0      s1      s2      s3      s4      s5      s6      s7
R16 9fc0013c 00000000 00000000 00000000 00000000 00000000 00000000 00000000
    t8      t9      k0      k1      gp      sp      s8      ra
R24 00000000 00000000 00000000 00000000 80008250 8003ffff 00000000 9fc001a4
    status  lo      hi      badvaddr  cause  pc
      00000000 00000100 00000000 00000000 00000000 8000021c
(gdb) stepi
0x80000220      8      asm volatile
(gdb) i r
      zero      at      v0      v1      a0      a1      a2      a3
R0  00000000 00000000 00000000 80000250 00000000 00000002 80001000 00000000
    t0      t1      t2      t3      t4      t5      t6      t7
R8  80000204 00000002 00000000 00000000 00000000 00000000 00000000 00000000
    s0      s1      s2      s3      s4      s5      s6      s7
R16 9fc0013c 00000000 00000000 00000000 00000000 00000000 00000000 00000000
    t8      t9      k0      k1      gp      sp      s8      ra
R24 00000000 00000000 00000000 00000000 80008250 8003ffff 00000000 9fc001a4
    status  lo      hi      badvaddr  cause  pc
      00000000 00000100 00000000 00000000 00000000 80000220
(gdb)
```