



MIPS Instruction opcodes.

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Instruction	Example	Meaning	Comments
add	add \$1,\$2,\$3	$\$1 = \$2 + \$3$	3 operands;
subtract	sub \$1,\$2,\$3	$\$1 = \$2 - \$3$	3 operands;
add immediate	addi \$1,\$2,100	$\$1 = \$2 + 100$	+ constant;
add unsigned	addu \$1,\$2,\$3	$\$1 = \$2 + \$3$	3 operands;
subtract unsigned	subu \$1,\$2,\$3	$\$1 = \$2 - \$3$	3 operands;
add imm. unsign.	addiu \$1,\$2,100	$\$1 = \$2 + 100$	+ constant;
multiply	mult \$2,\$3	Hi, Lo = $\$2 \times \3	64-bit signed product
multiply unsigned	multu \$2,\$3	Hi, Lo = $\$2 \times \3	64-bit unsigned product
divide	div \$2,\$3	Lo = $\$2 \div \3 , Hi = $\$2 \bmod \3	Lo = quotient, Hi = remainder
divide unsigned	divu \$2,\$3	Lo = $\$2 \div \3 , Hi = $\$2 \bmod \3	Unsigned quotient & remainder
Move from Hi	mfhi \$1	$\$1 = \text{Hi}$	Used to get copy of Hi
Move from Lo	mflo \$1	$\$1 = \text{Lo}$	Used to get copy of Lo
and	and \$1,\$2,\$3	$\$1 = \$2 \& \$3$	3 reg. operands; Logical AND
or	or \$1,\$2,\$3	$\$1 = \$2 \$3$	3 reg. operands; Logical OR
xor	xor \$1,\$2,\$3	$\$1 = \$2 \wedge \$3$	3 reg. operands; Logical XOR
nor	nor \$1,\$2,\$3	$\$1 = \sim(\$2 \$3)$	3 reg. operands; Logical NOR
and immediate	andi \$1,\$2,10	$\$1 = \$2 \& 10$	Logical AND reg, constant
or immediate	ori \$1,\$2,10	$\$1 = \$2 10$	Logical OR reg, constant
xor immediate	xori \$1, \$2,10	$\$1 = \sim\$2 \& \sim 10$	Logical XOR reg, constant
shift left logical	sll \$1,\$2,10	$\$1 = \$2 \ll 10$	Shift left by constant
shift right logical	srl \$1,\$2,10	$\$1 = \$2 \gg 10$	Shift right by constant
shift right arithm.	sra \$1,\$2,10	$\$1 = \$2 \gg 10$	Shift right (sign extend)
shift left logical	sllv \$1,\$2,\$3	$\$1 = \$2 \ll \$3$	Shift left by variable
shift right logical	srlv \$1,\$2, \$3	$\$1 = \$2 \gg \$3$	Shift right by variable
shift right arithm.	srav \$1,\$2, \$3	$\$1 = \$2 \gg \$3$	Shift right arith. by variable

Branch Addressing: PC-relative Example

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Loop:  slt    $t1,$zero,$a1      # t1=9,a1=5    if(0 < $a1) $t1 = 1;
      beq    $t1,$zero,Exit    # no=>Exit    if($t1 >= 0)  return;
      add    $t0,$t0,$a0      # t0=8,a0=4
      subi   $a1,$a1,1        # a1=5
      j      Loop             # goto Loop
Exit:  add    $v0,$t0,$zero    # v0=2,t0=8

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Address						
80000	0	0	5	9	0	42
80004	4	9	0	<u>3</u>		
80008	0	8	4	8	0	32
80012	<u>8</u>	5	5	<u>-1</u>		
80016	2	<u>20000</u>				
80020	0	8	0	2	0	32

80020 = 80004 + 4 + 3*4

MIPS Instructions:

Name	Example	Comments
32 registers	\$s0-\$s7, \$t0-\$t9, \$zero, \$a0-\$a3, \$v0-\$v1, \$gp, \$fp, \$sp, \$ra, \$at	Fast locations for data. In MIPS, data must be in registers to perform arithmetic. MIPS register \$zero always equals 0. Register \$at is reserved for the assembler to handle large constants.
2 ³⁰ memory words	Memory[0], Memory[4], ..., Memory[4294967292]	Accessed only by data transfer instructions. MIPS uses byte addresses, so sequential words differ by 4. Memory holds data structures, such as arrays, and spilled registers, such as those saved on procedure calls.

MIPS assembly language

Category	Instruction	Example	Meaning	Comments
Arithmetic	add	add \$s1, \$s2, \$s3	$\$s1 = \$s2 + \$s3$	Three operands; data in registers
	subtract	sub \$s1, \$s2, \$s3	$\$s1 = \$s2 - \$s3$	Three operands; data in registers
	add immediate	addi \$s1, \$s2, 100	$\$s1 = \$s2 + 100$	Used to add constants
Data transfer	load word	lw \$s1, 100(\$s2)	$\$s1 = \text{Memory}[\$s2 + 100]$	Word from memory to register
	store word	sw \$s1, 100(\$s2)	$\text{Memory}[\$s2 + 100] = \$s1$	Word from register to memory
	load byte	lb \$s1, 100(\$s2)	$\$s1 = \text{Memory}[\$s2 + 100]$	Byte from memory to register
	store byte	sb \$s1, 100(\$s2)	$\text{Memory}[\$s2 + 100] = \$s1$	Byte from register to memory
	load upper immediate	lui \$s1, 100	$\$s1 = 100 * 2^{16}$	Loads constant in upper 16 bits
Conditional branch	branch on equal	beq \$s1, \$s2, 25	if ($\$s1 == \$s2$) go to PC + 4 + 100	Equal test; PC-relative branch
	branch on not equal	bne \$s1, \$s2, 25	if ($\$s1 != \$s2$) go to PC + 4 + 100	Not equal test; PC-relative
	set on less than	slt \$s1, \$s2, \$s3	if ($\$s2 < \$s3$) $\$s1 = 1$; else $\$s1 = 0$	Compare less than; for beq, bne
	set less than immediate	slti \$s1, \$s2, 100	if ($\$s2 < 100$) $\$s1 = 1$; else $\$s1 = 0$	Compare less than constant
Unconditional jump	jump	j 2500	go to 10000	Jump to target address
	jump register	jr \$ra	go to \$ra	For switch, procedure return
	jump and link	jal 2500	$\$ra = PC + 4$; go to 10000	For procedure call