

RISC-V Instruction Set Summary

31:25		24:20		19:15		14:12		11:7		6:0		<div>R-Type</div> <div>I-Type</div> <div>S-Type</div> <div>B-Type</div> <div>U-Type</div> <div>J-Type</div> <div>R4-Type</div>
funct7		rs2	rs1	funct3		rd		op				
imm _{11:0}				rs1	funct3		rd		op			
imm _{11:5}		rs2	rs1	funct3		imm _{4:0}		op				
imm _{12,10:5}		rs2	rs1	funct3		imm _{4:1,11}		op				
imm _{31:12}							rd		op			
imm _{20,10:1,11,19:12}							rd		op			
fs3	funct2	fs2	fs1	funct3		fd		op				
5 bits		2 bits		5 bits		5 bits		5 bits		7 bits		

Figure B.1 RISC-V 32-bit instruction formats

• imm:

signed immediate in $\text{imm}_{11:0}$

• uimm:

5-bit unsigned immediate in $\text{imm}_{4:0}$

• upimm:

20 upper bits of a 32-bit immediate, in $\text{imm}_{31:12}$

• Address:

memory address: $\text{rs1} + \text{SignExt}(\text{imm}_{11:0})$

• [Address]:

data at memory location Address

• BTA:

branch target address: $\text{PC} + \text{SignExt}(\{\text{imm}_{12:1}, 1'b0\})$

• JTA:

jump target address: $\text{PC} + \text{SignExt}(\{\text{imm}_{20:1}, 1'b0\})$

• label:

text indicating instruction address

• SignExt:

value sign-extended to 32 bits

• ZeroExt:

value zero-extended to 32 bits

• csr:

control and status register

Table B.1 RV32I: RISC-V integer instructions

op	funct3	funct7	Type	Instruction	Description	Operation
0000011 (3)	000	–	I	lb rd, imm(rs1)	load byte	rd = SignExt([Address] _{7:0})
0000011 (3)	001	–	I	lh rd, imm(rs1)	load half	rd = SignExt([Address] _{15:0})
0000011 (3)	010	–	I	lw rd, imm(rs1)	load word	rd = [Address] _{31:0}
0000011 (3)	100	–	I	lbu rd, imm(rs1)	load byte unsigned	rd = ZeroExt([Address] _{7:0})
0000011 (3)	101	–	I	lhu rd, imm(rs1)	load half unsigned	rd = ZeroExt([Address] _{15:0})
0010011 (19)	000	–	I	addi rd, rs1, imm	add immediate	rd = rs1 + SignExt(imm)
0010011 (19)	001	0000000*	I	slli rd, rs1, uimm	shift left logical immediate	rd = rs1 << uimm
0010011 (19)	010	–	I	slti rd, rs1, imm	set less than immediate	rd = (rs1 < SignExt(imm))
0010011 (19)	011	–	I	sltiu rd, rs1, imm	set less than imm. unsigned	rd = (rs1 < SignExt(imm))
0010011 (19)	100	–	I	xori rd, rs1, imm	xor immediate	rd = rs1 ^ SignExt(imm)
0010011 (19)	101	0000000*	I	srlr rd, rs1, uimm	shift right logical immediate	rd = rs1 >> uimm
0010011 (19)	101	0100000*	I	srair rd, rs1, uimm	shift right arithmetic imm.	rd = rs1 >>> uimm
0010011 (19)	110	–	I	ori rd, rs1, imm	or immediate	rd = rs1 SignExt(imm)
0010011 (19)	111	–	I	andi rd, rs1, imm	and immediate	rd = rs1 & SignExt(imm)
0010111 (23)	–	–	U	auipc rd, upimm	add upper immediate to PC	rd = {upimm, 12'b0} + PC
0100011 (35)	000	–	S	sb rs2, imm(rs1)	store byte	[Address] _{7:0} = rs2 _{7:0}
0100011 (35)	001	–	S	sh rs2, imm(rs1)	store half	[Address] _{15:0} = rs2 _{15:0}
0100011 (35)	010	–	S	sw rs2, imm(rs1)	store word	[Address] _{31:0} = rs2
0110011 (51)	000	0000000	R	add rd, rs1, rs2	add	rd = rs1 + rs2
0110011 (51)	000	0100000	R	sub rd, rs1, rs2	sub	rd = rs1 – rs2
0110011 (51)	001	0000000	R	sll rd, rs1, rs2	shift left logical	rd = rs1 << rs2 _{4:0}
0110011 (51)	010	0000000	R	slt rd, rs1, rs2	set less than	rd = (rs1 < rs2)
0110011 (51)	011	0000000	R	sltu rd, rs1, rs2	set less than unsigned	rd = (rs1 < rs2)
0110011 (51)	100	0000000	R	xor rd, rs1, rs2	xor	rd = rs1 ^ rs2
0110011 (51)	101	0000000	R	srl rd, rs1, rs2	shift right logical	rd = rs1 >> rs2 _{4:0}
0110011 (51)	101	0100000	R	sra rd, rs1, rs2	shift right arithmetic	rd = rs1 >>> rs2 _{4:0}
0110011 (51)	110	0000000	R	or rd, rs1, rs2	or	rd = rs1 rs2
0110011 (51)	111	0000000	R	and rd, rs1, rs2	and	rd = rs1 & rs2
0110111 (55)	–	–	U	lui rd, upimm	load upper immediate	rd = {upimm, 12'b0}
1100011 (99)	000	–	B	beq rs1, rs2, label	branch if =	if (rs1 == rs2) PC = BTA
1100011 (99)	001	–	B	bne rs1, rs2, label	branch if ≠	if (rs1 ≠ rs2) PC = BTA
1100011 (99)	100	–	B	blt rs1, rs2, label	branch if <	if (rs1 < rs2) PC = BTA
1100011 (99)	101	–	B	bge rs1, rs2, label	branch if ≥	if (rs1 ≥ rs2) PC = BTA
1100011 (99)	110	–	B	bltu rs1, rs2, label	branch if < unsigned	if (rs1 < rs2) PC = BTA
1100011 (99)	111	–	B	bgeu rs1, rs2, label	branch if ≥ unsigned	if (rs1 ≥ rs2) PC = BTA
1100111 (103)	000	–	I	jalr rd, rs1, imm	jump and link register	PC = rs1 + SignExt(imm), rd = PC + 4
1101111 (111)	–	–	J	jal rd, label	jump and link	PC = JTA, rd = PC + 4

* Encoded in instr_{31:25}, the upper seven bits of the immediate field