

# Report

## Group 8

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### Control unit

The input of the control unit is the 32-bit instruction. And there are 10 outputs of the control unit, the ports are RegDst, ALUSrc, MemtoReg, RegW, MemR, MemW, Branch, Bne, Bgtz and the 4-bit ALUCtr.

When RegDst outputs 0, the register destination number for the write register comes from the rt field. Otherwise it comes from the rd field.

When ALUSrc outputs 0, the second ALU operand comes from the second register file output. Otherwise, the second operand is the sign-extended.

When MemtoReg outputs 0, the value fed to the register Write data input comes from the ALU. Otherwise, the value comes from the memory.

When RegW outputs 1, the register is written with the value on the Write data input.

When MemR outputs 1, Data memory contents designated by the address input are put on the Read data output.

When MemW outputs 1, Data memory contents designated by the address input are replaced by the value on the Write data input.

When Branch outputs 1, IF unit will check Zero flag to determine branch or not.

When Bne outputs 1, IF unit will check Zero flag to determine branch or not.

When Bgtz outputs 1, IF unit will check Zero flag and R[s]' MSB to determine branch or not.

And the control can be divided into 2 parts. One is the main control and another is the alu control.

### Main control

The input of the main control 26-31 bit instruction. And the outputs are RegDst, ALUSrc, MemtoReg, RegW, MemR, MemW, Branch, Bne, Bgtz and 2-bit ALU\_op which is used to control the alu control.

And table below is the truth table of the main control.

main control truth table												
	OP	RegDst	ALUSrc	MemtoReg	RegW	MemR	MemW	Branch	BN	BGT	ALU_op(1)	ALU_op(0)
R-type	00000	1	0	0	1	0	0	0	0	0	1	0

LW	10001	1	0	1	1	1	1	0	0	0	0	0	0
SW	10101	1	x	1	x	0	0	1	0	0	0	0	0
ADDI	00100	0	0	1	0	1	0	0	0	0	0	0	0
BEQ	00010	0	x	0	x	0	0	0	1	0	0	0	1
BNE	00010	1	x	0	x	0	0	0	0	1	0	0	1
BGTZ	00011	1	x	0	x	0	0	0	0	0	1	0	1

As we can see there are 7 different types of operations.

When the operation is R-type, the register destination number for the write register comes from the rd field. the second ALU operand comes from the second register file output. the value fed to the register Write data input comes from the ALU. And the register is written with the value on the Write data input. And R-type will not use the memory.

When the operation is LW, the register destination number for the write register comes from the rt field. And the second operand comes from the sign-extended. It will read the data from the memory and write into the register.

When the operation is SW, it do not need the register. And the second operand comes from the sign-extended. And write the output of the alu into memory.

When the operation is ADDI, the register destination number for the write register comes from the rt field. The second operand comes from the sign-extended. And need to write the output data of the alu into register.

When the operation is BEQ, only the IF unit and zero flag matter. If zero flag is set then  $pc = pc + 4 + offset * 4$ .

When the operation is BNE, if zero flag is not set then  $pc = pc + 4 + offset * 4$ .

When the operation is BGTZ, if zero flag is not set and [Rs] is greater than zero then  $pc = pc + 4 + offset * 4$ .

#### ALU control

The inputs of the ALU control are instruction of 0 to 5 bit, and the ALU\_op. And the output of the ALU control is the 4 bits ALUCtr.

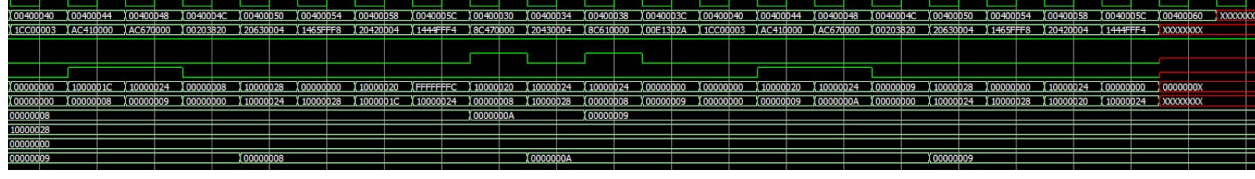
And table below is the truth table of the ALU control.

ALU_op	Func	ALUCtr	operation
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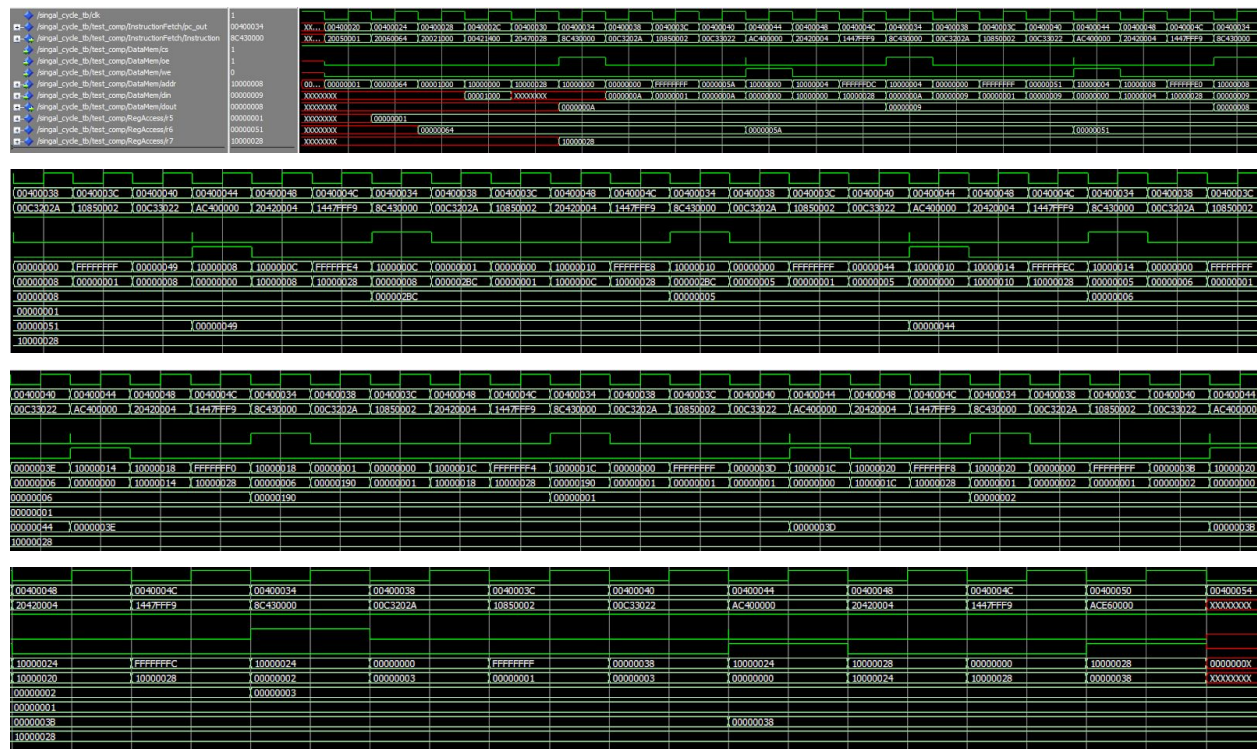


00400038	0040003C	00400040	00400044	00400048	0040004C	00400050	00400054	00400058	0040005C	00400060	00400064	00400068	0040006C	00400070	00400074	00400078	0040007C	00400080	00400084	00400088	0040008C	00400090	00400094	00400098	0040009C	00400100	00400104	00400108	0040010C	00400110	00400114	00400118	0040011C	00400120	00400124	00400128	0040012C	00400130	00400134	00400138	0040013C	00400140	00400144	00400148	0040014C	00400150	00400154	00400158	0040015C	00400160	00400164	00400168	0040016C	00400170	00400174	00400178	0040017C	00400180	00400184	00400188	0040018C	00400190	00400194	00400198	0040019C	00400200	00400204	00400208	0040020C	00400210	00400214	00400218	0040021C	00400220	00400224	00400228	0040022C	00400230	00400234	00400238	0040023C	00400240	00400244	00400248	0040024C	00400250	00400254	00400258	0040025C	00400260	00400264	00400268	0040026C	00400270	00400274	00400278	0040027C	00400280	00400284	00400288	0040028C	00400290	00400294	00400298	0040029C	00400300	00400304	00400308	0040030C	00400310	00400314	00400318	0040031C	00400320	00400324	00400328	0040032C	00400330	00400334	00400338	0040033C	00400340	00400344	00400348	0040034C	00400350	00400354	00400358	0040035C	00400360	00400364	00400368	0040036C	00400370	00400374	00400378	0040037C	00400380	00400384	00400388	0040038C	00400390	00400394	00400398	0040039C	00400400	00400404	00400408	0040040C	00400410	00400414	00400418	0040041C	00400420	00400424	00400428	0040042C	00400430	00400434	00400438	0040043C	00400440	00400444	00400448	0040044C	00400450	00400454	00400458	0040045C	00400460	00400464	00400468	0040046C	00400470	00400474	00400478	0040047C	00400480	00400484	00400488	0040048C	00400490	00400494	00400498	0040049C	00400500	00400504	00400508	0040050C	00400510	00400514	00400518	0040051C	00400520	00400524	00400528	0040052C	00400530	00400534	00400538	0040053C	00400540	00400544	00400548	0040054C	00400550	00400554	00400558	0040055C	00400560	00400564	00400568	0040056C	00400570	00400574	00400578	0040057C	00400580	00400584	00400588	0040058C	00400590	00400594	00400598	0040059C	00400600	00400604	00400608	0040060C	00400610	00400614	00400618	0040061C	00400620	00400624	00400628	0040062C	00400630	00400634	00400638	0040063C	00400640	00400644	00400648	0040064C	00400650	00400654	00400658	0040065C	00400660	00400664	00400668	0040066C	00400670	00400674	00400678	0040067C	00400680	00400684	00400688	0040068C	00400690	00400694	00400698	0040069C	00400700	00400704	00400708	0040070C	00400710	00400714	00400718	0040071C	00400720	00400724	00400728	0040072C	00400730	00400734	00400738	0040073C	00400740	00400744	00400748	0040074C	00400750	00400754	00400758	0040075C	00400760	00400764	00400768	0040076C	00400770	00400774	00400778	0040077C	00400780	00400784	00400788	0040078C	00400790	00400794	00400798	0040079C	00400800	00400804	00400808	0040080C	00400810	00400814	00400818	0040081C	00400820	00400824	00400828	0040082C	00400830	00400834	00400838	0040083C	00400840	00400844	00400848	0040084C	00400850	00400854	00400858	0040085C	00400860	00400864	00400868	0040086C	00400870	00400874	00400878	0040087C	00400880	00400884	00400888	0040088C	00400890	00400894	00400898	0040089C	00400900	00400904	00400908	0040090C	00400910	00400914	00400918	0040091C	00400920	00400924	00400928	0040092C	00400930	00400934	00400938	0040093C	00400940	00400944	00400948	0040094C	00400950	00400954	00400958	0040095C	00400960	00400964	00400968	0040096C	00400970	00400974	00400978	0040097C	00400980	00400984	00400988	0040098C	00400990	00400994	00400998	0040099C	00401000	00401004	00401008	0040100C	00401010	00401014	00401018	0040101C	00401020	00401024	00401028	0040102C	00401030	00401034	00401038	0040103C	00401040	00401044	00401048	0040104C	00401050	00401054	00401058	0040105C	00401060	00401064	00401068	0040106C	00401070	00401074	00401078	0040107C	00401080	00401084	00401088	0040108C	00401090	00401094	00401098	0040109C	00401100	00401104	00401108	0040110C	00401110	00401114	00401118	0040111C	00401120	00401124	00401128	0040112C	00401130	00401134	00401138	0040113C	00401140	00401144	00401148	0040114C	00401150	00401154	00401158	0040115C	00401160	00401164	00401168	0040116C	00401170	00401174	00401178	0040117C	00401180	00401184	00401188	0040118C	00401190	00401194	00401198	0040119C	00401200	00401204	00401208	0040120C	00401210	00401214	00401218	0040121C	00401220	00401224	00401228	0040122C	00401230	00401234	00401238	0040123C	00401240	00401244	00401248	0040124C	00401250	00401254	00401258	0040125C	00401260	00401264	00401268	0040126C	00401270	00401274	00401278	0040127C	00401280	00401284	00401288	0040128C	00401290	00401294	00401298	0040129C	00401300	00401304	00401308	0040130C	00401310	00401314	00401318	0040131C	00401320	00401324	00401328	0040132C	00401330	00401334	00401338	0040133C	00401340	00401344	00401348	0040134C	00401350	00401354	00401358	0040135C	00401360	00401364	00401368	0040136C	00401370	00401374	00401378	0040137C	00401380	00401384	00401388	0040138C	00401390	00401394	00401398	0040139C	00401400	00401404	00401408	0040140C	00401410	00401414	00401418	0040141C	00401420	00401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## 2. Bills\_branch



### 3.unsigned\_sum

