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Computer Registers

- A register is a very small amount of very fast memory that is built into the CPU (central processing unit). Contents can be accessed at extremely high speeds.
- Registers are used to store data temporarily during the execution of a program.
- Different processors have different register sizes.
- Registers are a type of computer memory used to quickly accept, store, and transfer data and instructions that are being used immediately by the CPU.
- The registers used by the CPU are often termed as Processor registers.
- A processor register may hold an instruction, a storage address, or any data (such as bit sequence or individual characters).
- The computer needs processor registers for manipulating data and a register for holding a memory address.

List of the most common registers used in a basic computer:

Register	Symbol	Number of bits	Function
Data register	DR	16	Holds memory operand

Address register	AR	12	Holds address for the memory
Accumulator	AC	16	Processor register
Instruction register	IR	16	Holds instruction code
Program counter	PC	12	Holds address of the instruction
Temporary register	TR	16	Holds temporary data
Input register	INPR	8	Carries input character
Output register	OUTR	8	Carries output character

ACCUMULATOR (AC): The processor register AC consists of 16-bits. It is used to hold the results or partial results of arithmetic and logical operations. An accumulator is a register in which intermediate arithmetic and logic results are stored.

DATA REGISTER (DR): The register DR consists of 16-bits and it is used to hold memory operands (data). This register contains the data to be written into memory or receives the data read from memory.

TEMPORARY REGISTER (TR): Temporary register have 16-bits and it provides temporary storage of variables or results.

INSTRUCTION REGISTER (IR): The instruction register consists of 16-bits. The purpose of the instruction register is to hold a copy of the instruction which the processor is to execute. In our basic computer, instruction register (IR) holds instruction code which is read from memory.

ADDRESS REGISTER (AR): This register specifies the address in memory for next read or writes operations. The address register consists of 12-bits.

PROGRAM COUNTER (PC): Program counter has 12-bits and it holds the address of the next instruction to be read from memory after the current execution is executed. The instructions are read sequentially because the program counter automatically increments after fetching the current instruction.

INPUT REGISTER (INPR): Input register has 8-bits. INPR register receives a character from an input device and delivers it to the AC.

OUTPUT REGISTER (OUTR): Output register has 8-bits. The output register receives information from AC and transfer it to the output device.

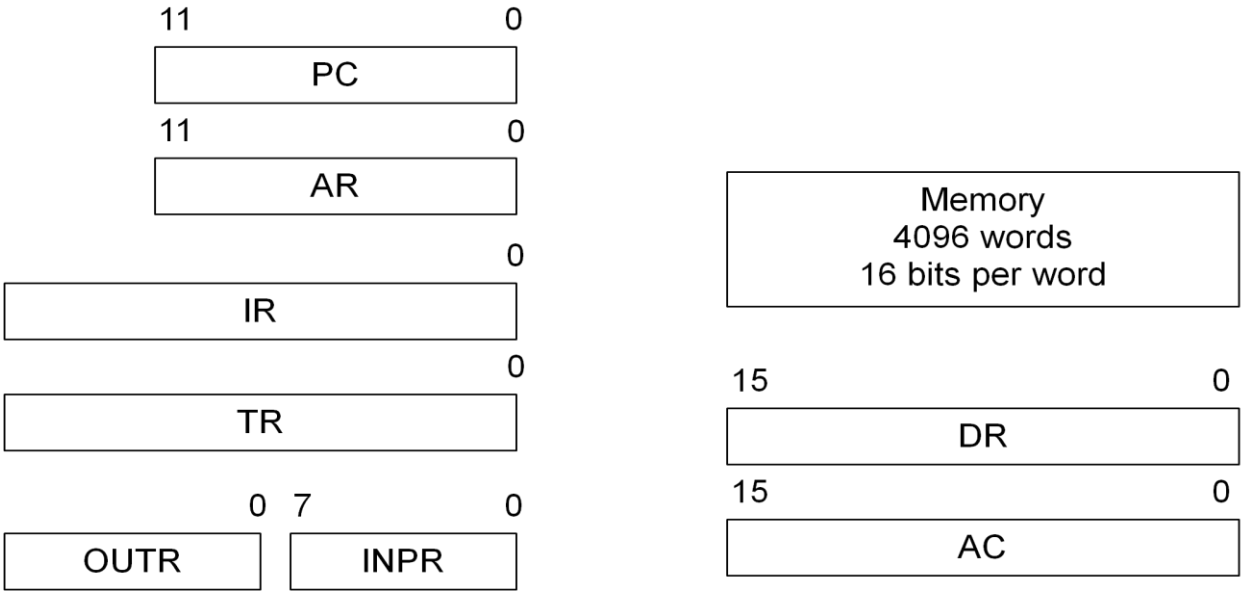

Fig: Basic Processor Registers

BUS SYSTEM

- A wire or a collection of wires that carry some multi-bit information is known as bus. Main purpose of bus is to transfer information form one system to another.
- The basic computer has eight register, memory unit and control unit.
- Path must be provided to transfer information from one register to another and from memory to the register.
- The number of wires will be excessive if the connection is made between the output of each register and input of other.
- A more efficient scheme in transferring information in a system having many register is to use a common bus.

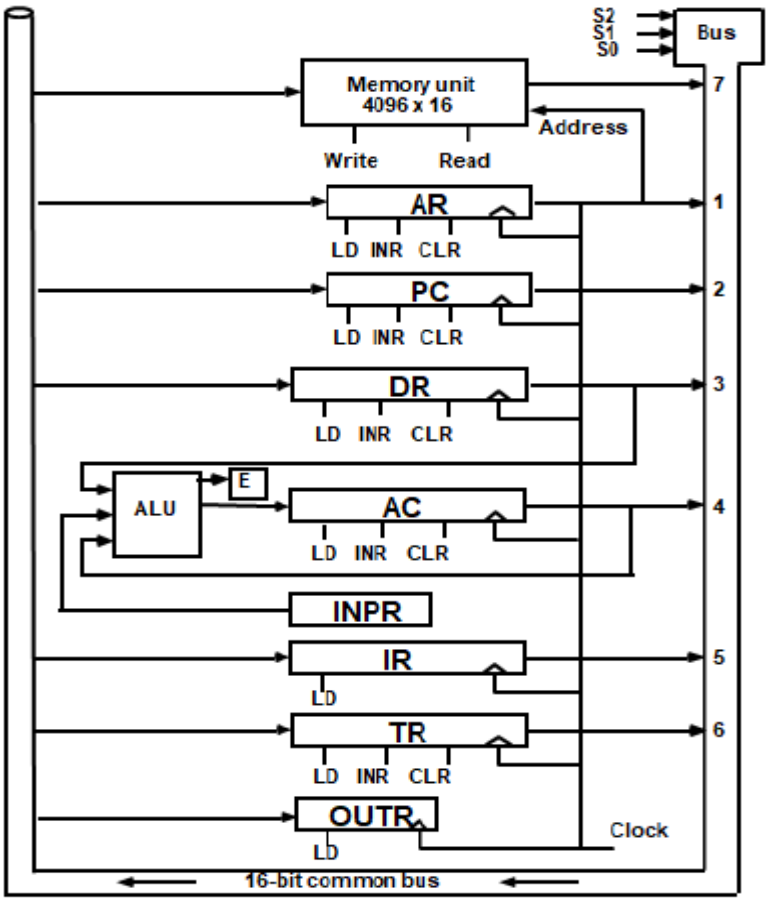

Fig: Registers Connected to Common Bus

- Three control lines, S_2, S_1, and S_0 control which register the bus selects as its input

S_2 S_1 S_0	Register
0 0 0	x
0 0 1	AR
0 1 0	PC
0 1 1	DR
1 0 0	AC
1 0 1	IR
1 1 0	TR
1 1 1	Memory

- Either one of the registers will have its load signal activated, or the memory will have its read signal activated
    - Will determine where the data from the bus gets loaded.
- The 12-bit registers, AR and PC, have 0's loaded onto the bus in the high order 4 bit positions.
- When the 8-bit register OUTR is loaded from the bus, the data comes from the low order 8 bits on the bus.

- Five registers have three control inputs: LD (load), INR (increment) and CLR (clear). Two registers have only a LD input.
- Load (LD): The lines from the common bus are connected to the inputs of each register and the data inputs of the memory. The particular register whose LD input is enabled receives the data from the bus.

- Increment (INR)) and Clear (CLR): The contents of the particular register are incremented when its INR signal is enabled and cleared when its CLR signal is enabled.

- Memory Unit: The memory receives the 16-bit information from the bus when its write input is enabled and the memory places its 16-bit information onto the bus when its read input is activated and $S_2S_1S_0$= 111.

- Address Register (AR): This register specifies the address in memory for next read or writes operations. The address register consists of 12 bits.When selection inputs $S_2S_1S_0$ =001 is applied to the bus, the address register AR receives or transfers address from or to the bus when its LD input is enable. The address is incremented or clear by the inputs INR or CLR.

- Program Counter (PC): Program counter has 12 bits and it holds the address of the next instruction to be read from memory after the current execution is executed. When selection inputs $S_2S_1S_0$= 010 is applied to the bus, the program counter (PC) receives or transfers address from or to the bus when its LD input is enable. The address is incremented or clear by the inputs INR or CLR.

- Data Register (DR): The register DR consists of 16-bits and memory operands (data). This register contains the data to be written into memory or receives the data read from memory. ϒ When selection inputs $S_2S_1S_0$ = 011 is applied to the bus, the data register DR receives or transfers data from or to the bus when its LD input is enable. The data is incremented or clear by the inputs INR or CLR.

- Accumulator (AC): The processor register AC consists of 16 bits. The 16-bit inputs to the Adder / logic circuit come from the outputs of AC. They are used to implement register micro operation such as complement and shift the contents of AC. The results of these micro operations are again transferred to AC. So an accumulator is a register in which intermediate arithmetic and logic results are stored. When selection inputs $S_2S_1S_0$= 100 is applied to the bus, the processor register AC receives or transfers its data to the bus by enabling the LD input of DR, it transfers the contents of DR through the adder / logic circuit into AC when its LD input is enable. The data of AC is incremented or clear by the inputs INR or CLR.

- Instruction Register (IR): The instruction register consists of 16-bits. The purpose of the instruction register is to hold a copy of the instruction which the processor is to execute. The instruction read from memory is placed in the IR. When selection inputs $S_2S_1S_0$ = 101 is applied to the bus, the instruction register IR receives or transfers instruction code from or to the bus when its LD input is enable.

- Temporary Register (TR): Temporary registers have 16 bits. It provides temporary storage of variables or results. When selection inputs $S_2S_1S_0$ = 111 is applied to the bus, the temporary register TR receives or transfers

temporary data from or to the bus when its LD input is enable. The data is incremented or clear by the inputs INR or CLR.

- Input Register (INPR): The Input Register INPR consists of 8-bits and hold alphanumeric input information. The serial information from the input device is shifted into input of 8-bit register INPR. When LD input of AC is enable, the 8-bit information of INPR is transferred to the AC via Adder/logic circuit.

- Output Register (OUTR): The output OUTR receives information from AC and transfers it to the output device.