CPU Registers: 8086, 32-bit, and 64-bit Architectures

Overview

Registers are **fast storage units** inside the CPU that allow quick access to data and instructions. We will cover:

- 8086 (16-bit) Registers
- 32-bit General Purpose Registers (x86)
- 64-bit General Purpose Registers (x86-64)
- Segment, Pointer/Index, and Flag Registers

1. 8086 (16-bit) Registers

General Purpose Registers

General Purpose Registers (16-bit)

- AX (Accumulator) – Arithmetic, logic, I/O
- BX (Base) – Base pointer for memory access
- CX (Count) – Loop counter / string operations
- DX (Data) – I/O operations, multiply/divide

Each can be split into high/low bytes:

$$\text{AX} \rightarrow \text{AH} \mid \text{AL}, \quad \text{BX} \rightarrow \text{BH} \mid \text{BL}, \quad \text{CX} \rightarrow \text{CH} \mid \text{CL}, \quad \text{DX} \rightarrow \text{DH} \mid \text{DL}$$

AX = AH | AL
BX = BH | BL
CX = CH | CL
DX = DH | DL

Segment Registers

Segment Registers

- CS – Code Segment
- DS – Data Segment
- SS – Stack Segment
- ES – Extra Segment

Physical Address:

$$\text{Physical Address} = (\text{Segment} \times 16) + \text{Offset}$$

Pointer and Index Registers

Pointer / Index Registers

- SP – Stack Pointer
- BP – Base Pointer
- SI – Source Index
- DI – Destination Index
- IP – Instruction Pointer (points to next instruction)

Flag Register

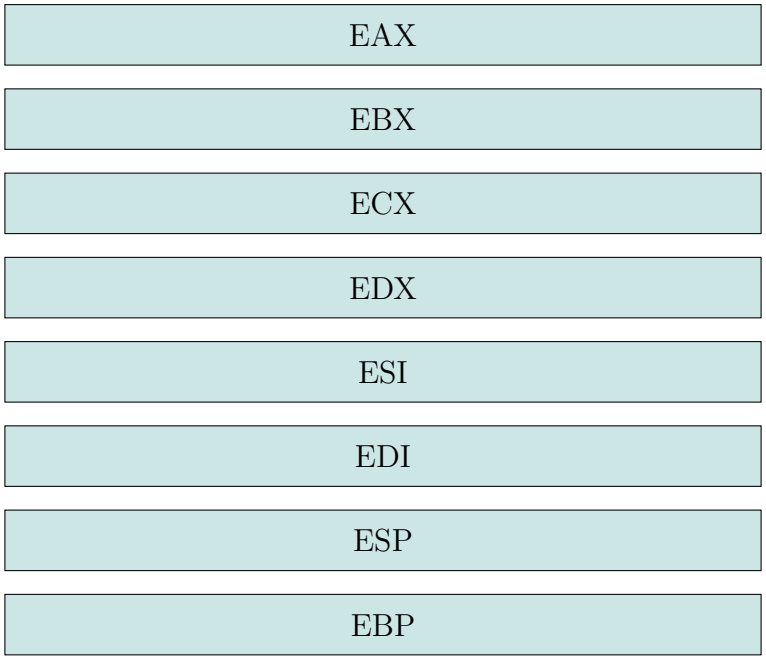
Flag Register

- 16-bit register to indicate CPU status
- Condition Flags: CF, PF, AF, ZF, SF, OF
- Control Flags: TF, IF, DF, etc.

2. 32-bit General Purpose Registers (x86)

32-bit GPRs

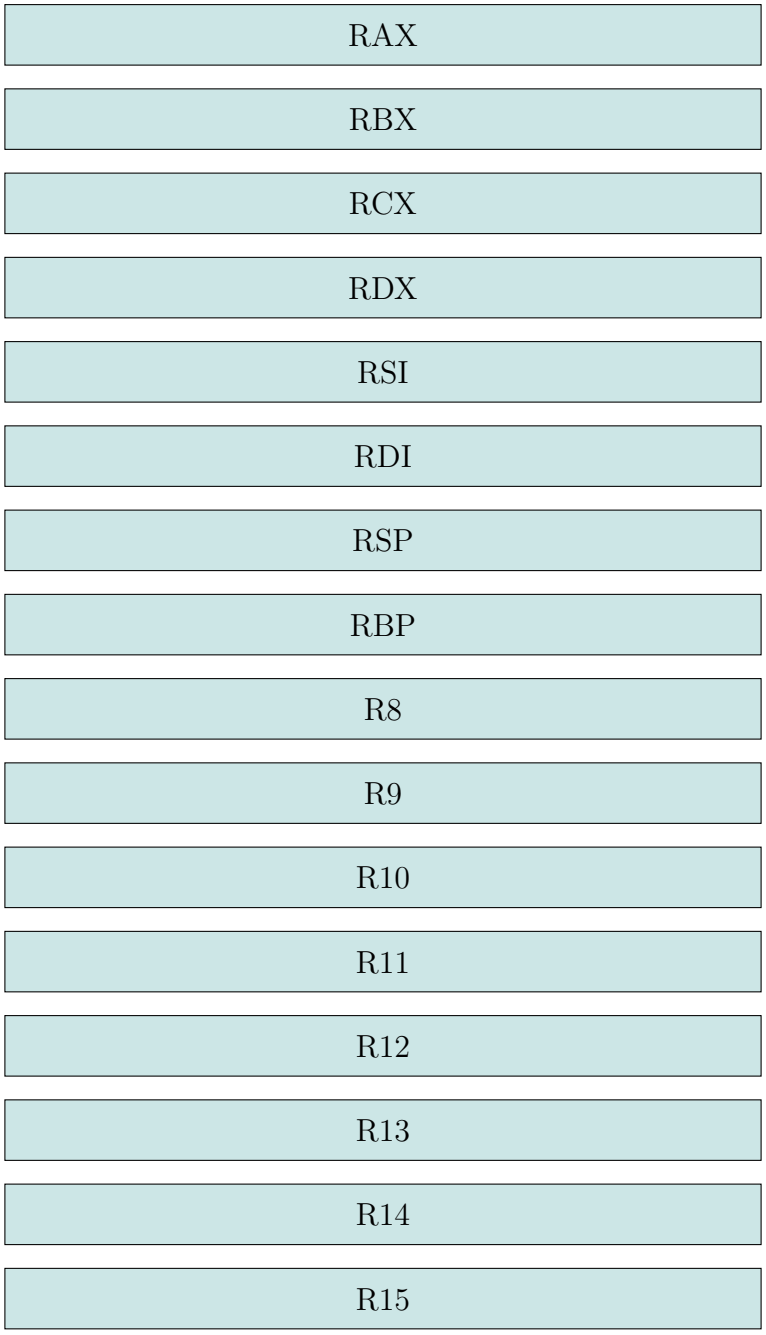
- EAX, EBX, ECX, EDX – extended versions of AX, BX, CX, DX
- ESI, EDI – extended SI and DI
- ESP, EBP – extended stack pointer and base pointer



3. 64-bit General Purpose Registers (x86-64)

64-bit GPRs

- RAX, RBX, RCX, RDX – extended EAX, EBX, ECX, EDX
- RSI, RDI – extended ESI, EDI
- RSP, RBP – extended ESP, EBP
- R8 – R15 – additional 64-bit general-purpose registers



Summary

- 8086 registers – 16-bit, segmented, for memory, stack, and flags
- 32-bit x86 – EAX, EBX, ECX, EDX, ESI, EDI, ESP, EBP
- 64-bit x86-64 – RAX–R15, extended pointers and data registers
- All architectures have dedicated flag registers for status and control