Chapter 05: Basic Processing Units … Control Unit Design Organization

Lesson 07:

Microoperations for Shifts or rotate

Objective

- Learn how an arithmetic shift right or logic-shift right or left logic operation performed by the sequences of microoperations
- Learn how an rotate right or left bit operation performed by the sequences of microoperations

An Arithmetic or logic shift or a rotate operation

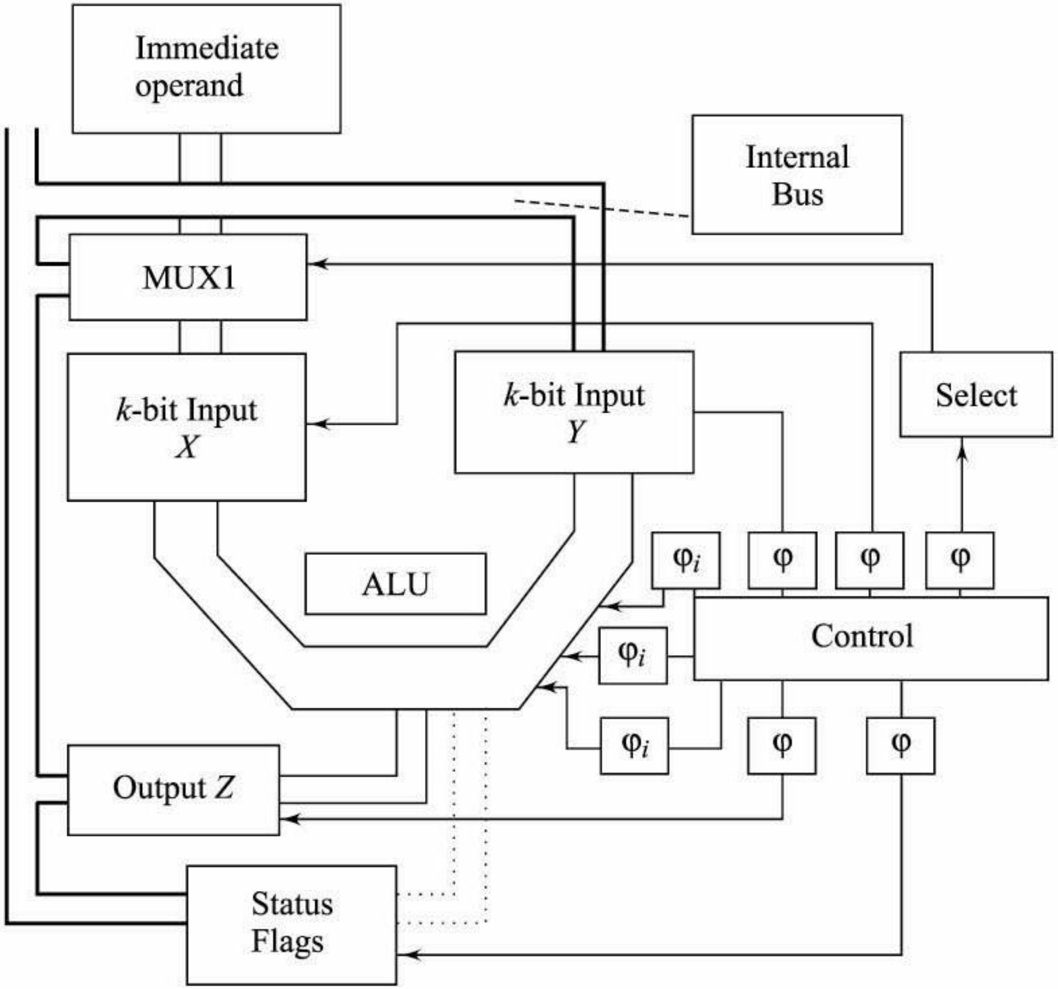
Execution of a shift or rotate Instruction by Data Path Implementation

- Execution of an ALU instruction can be considered as the implementation of a specific data path flow, as per the specific instruction for shift or rotate and left or right operations on the bits
- Control of the data-path unit and control unit (controlling and sequencing unit)
- Control unit generates control signals to implement each step using signals ϕs

Sequence of actions to define the controlled transfers of data between processing subunits

- Processing subunits— registers, *X*, ALU circuits, *Z*, and status register along a required data path
- MUX unit to select one data path among several

ALU design as data path with a control unit for arithmetic or logic operation



Microoperations after receiving the instruction at IR

- Decoded by decoding logic
- Then the logic results at register instruction decoder (ID) initiate control actions
- Each control signal selects an action through a gate input ϕ at each step

Operations by ALU

- Arithmetic shift left ASL— ri ← ASL ri
- logical shift left LSL— ri ← LSL ri
- Arithmetic shift Right— ASR ri ← ASR ri
- logical shift Right LSR— ri ← LSR
- Rotate Left (circular shift left)— RL ri ← RL ri
- Rotate Right (circular shift right)— RR ri ← RL ri

Microoperations for executing the instruction using ALU

1. Step i: Transfers a k-bit input source operand through the bus fro ri to X

ri→ (Bus), → (Bus) → MUX

MUX— a multiplexer to select one among several channels at inputs as per the select subunit signal

Microoperations for executing the instruction using ALU

2. Step i + 1: Transfers a k-bit input source operand through the bus using MUX to X
   Input operand through a MUX → X

Microoperations for executing the instruction using ALU

3. *Step* $i + 2$: Transfer X to ALU— $X \rightarrow \text{ALU}$

Microoperations for executing the instruction using ALU

4. *Step* i + 3: ALU processing unit select through one of the gates ϕ_i an operation as per the shift or rotate instruction, which was received at the IR

Microoperations for executing the instruction using ALU

5. *Step i* + 4: Transfers a *k*-bit output *Z* from ALU—

$Z \leftarrow \text{ALU}$

Microoperations for executing the instruction using ALU

6. *Step i* + 5: Transfers status flags generated, for example, carry or overflow to status register —

Status Register ← ALU

Microoperations for executing the instruction using ALU

7. *Step* $i + 6$: Transfers from Z the result to destination operand through bus—

   (Bus) $\leftarrow Z$

Microoperations for executing the instruction using ALU

8. *Step* $i + 6$: Transfers from *bus* the result to destination operand through bus—

   $ri \leftarrow (\text{Bus})$

ALU instruction for shift or rotate

- Eight steps in ri ← shift or rotate (X operand), Flags ← status of operation and Bus → ri

Control Signal for selecting an ALU shift or rotate operation

ALU control input during an interval T step 3 for a bit Operation for shift or rotate

- One active C_{alu} among six ϕs for six bit operations
- ϕ_{ASL} : ALU $\leftarrow$ ASL (X)
- ϕ_{LSL} : ALU $\leftarrow$ LSL (X)

1. ϕ_{ASR} : ALU $\leftarrow$ ASR (X)
2. ϕ_{LSR} : ALU $\leftarrow$ LSR (X)

ALU control input during an interval T step 5 for a Logic Operation

5. ϕ_{RL}: ALU $\leftarrow$ LSR (X)
6. ϕ_{RL} : ALU $\leftarrow$ LSR (X)

Summary

We learnt

- An arithmetic shift right or logic-shift right or left logic operation performed by the sequences of microoperations
- Operation as per control signal activated in step 3 among 8 steps
- A rotate right or left logic operation performed by the sequences of microoperations
- Eight steps for an ALU operation among 4 shift and 2 rotate operations

End of Lesson 07 on

Microoperations for Shifts