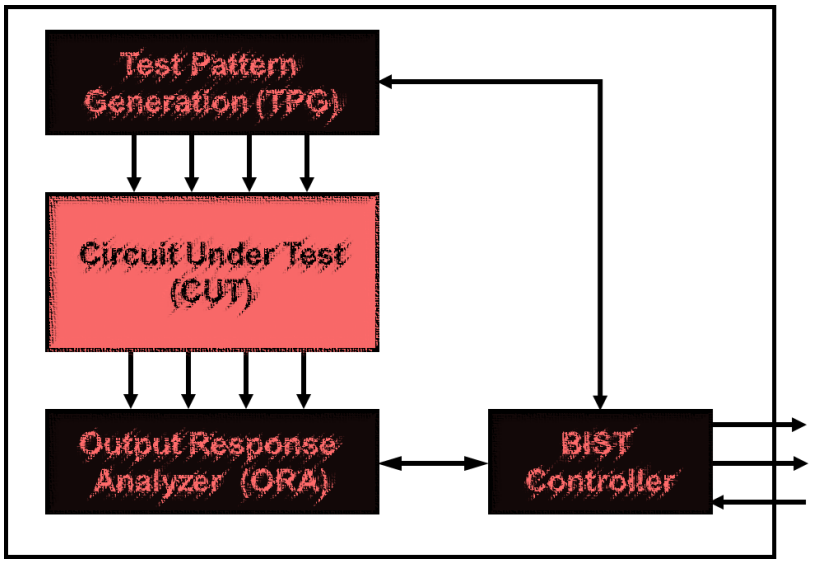
BIST Part 2

- Output Response Analysis
- **BIST Architecture**
  - **Test Per Clock**
    - **BILBO (1979)**
  - **Test Per Scan**
    - **STUMPS (IBM, 1982)**
- Issues with BIST
- Conclusions



BIST Architectures [McCluskey 85]

- Classified by hardware
  - *Separate BIST*
    - TPG/ORA outside of CUT
  - *Embedded BIST*
    - Reuse CUT's FF/latches as TPG/ORA

- Classified by clocking scheme
  - *Test-per-Clock*
    - Apply a test every clock cycle
  - *Test-per-Scan*
    - Apply a test in between scan in/out

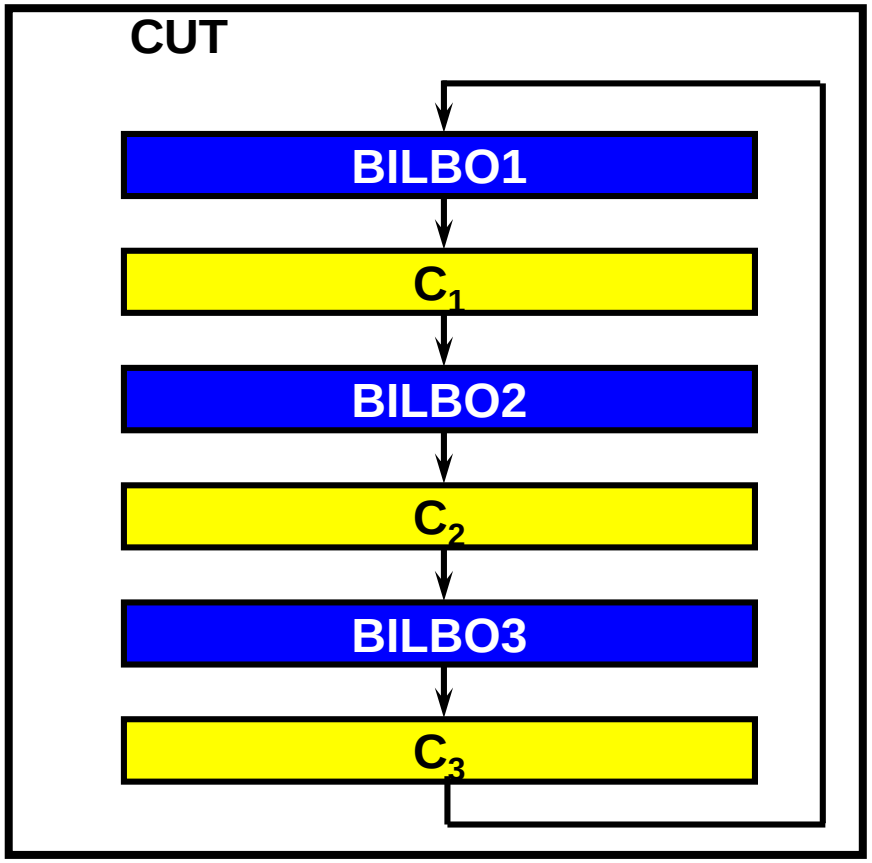
Test Per Clock – Combinational CUT

- **Separate BIST**
- **Test per clock**
  - **At each clock: apply a test pattern, observe output**

How about Sequential CUT?

Test Per Clock – Sequential CUT

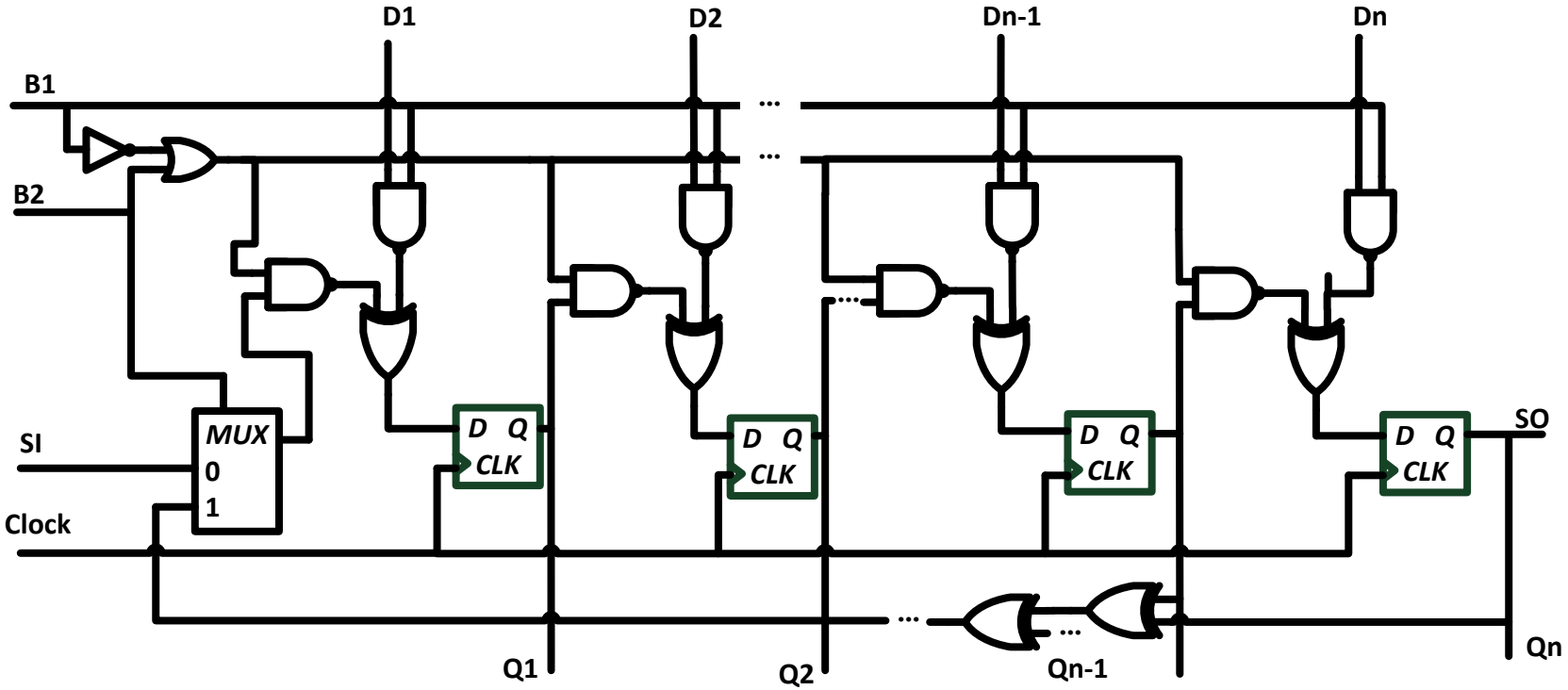
- *BILBO = Built-in Logic Block Observer* [Könemann 79]
  - Serve as TPG and ORA
- When testing C1
  - BILBO1 is TPG, BILBO2 is ORA
- When testing C2
  - BILBO2 is TPG, BILBO3 is ORA
- When testing C3
  - BILBO3 is TPG; BILBO1 is ORA
- Embedded BIST
  - Reuse CUT's FF as BILBO



Yellow blocks are comb. logic

Built-in Logic Block Observer, BILBO

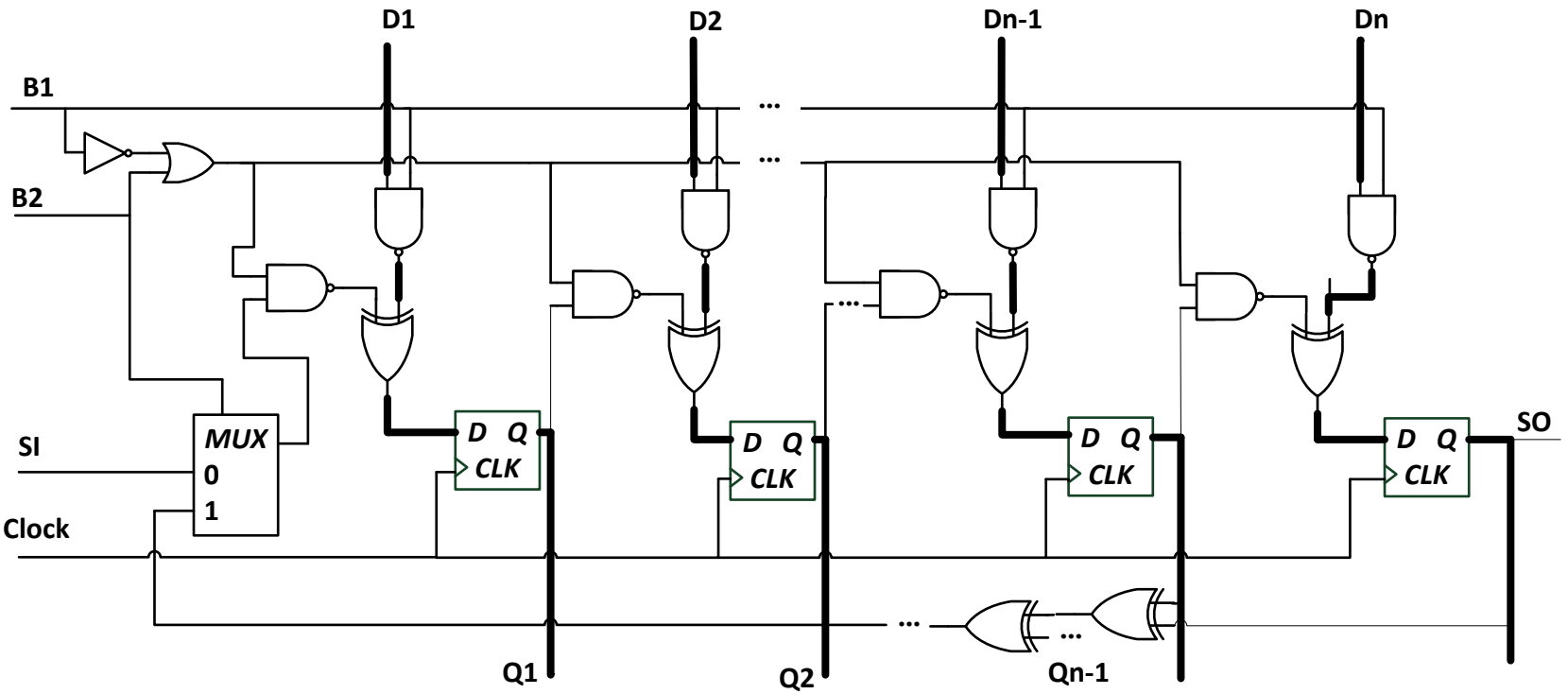
- B_1 B_2 control four modes of operation



B_1	B_2	operation mode
0	0	shift register (scan chain)
1	0	normal operation
1	1	MISR (ORA)
0	1	LFSR (TPG)

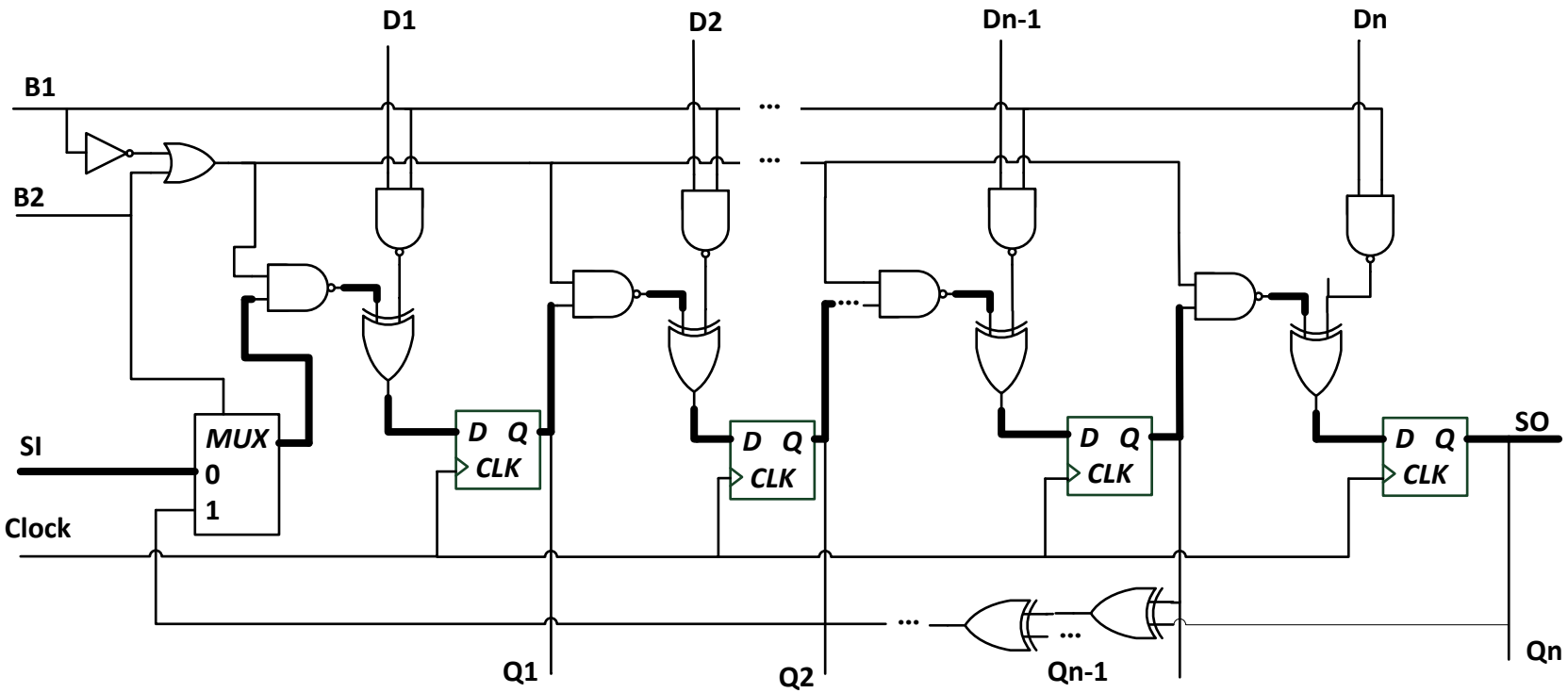
Normal Operation Mode

- **B1=1, B2=0**



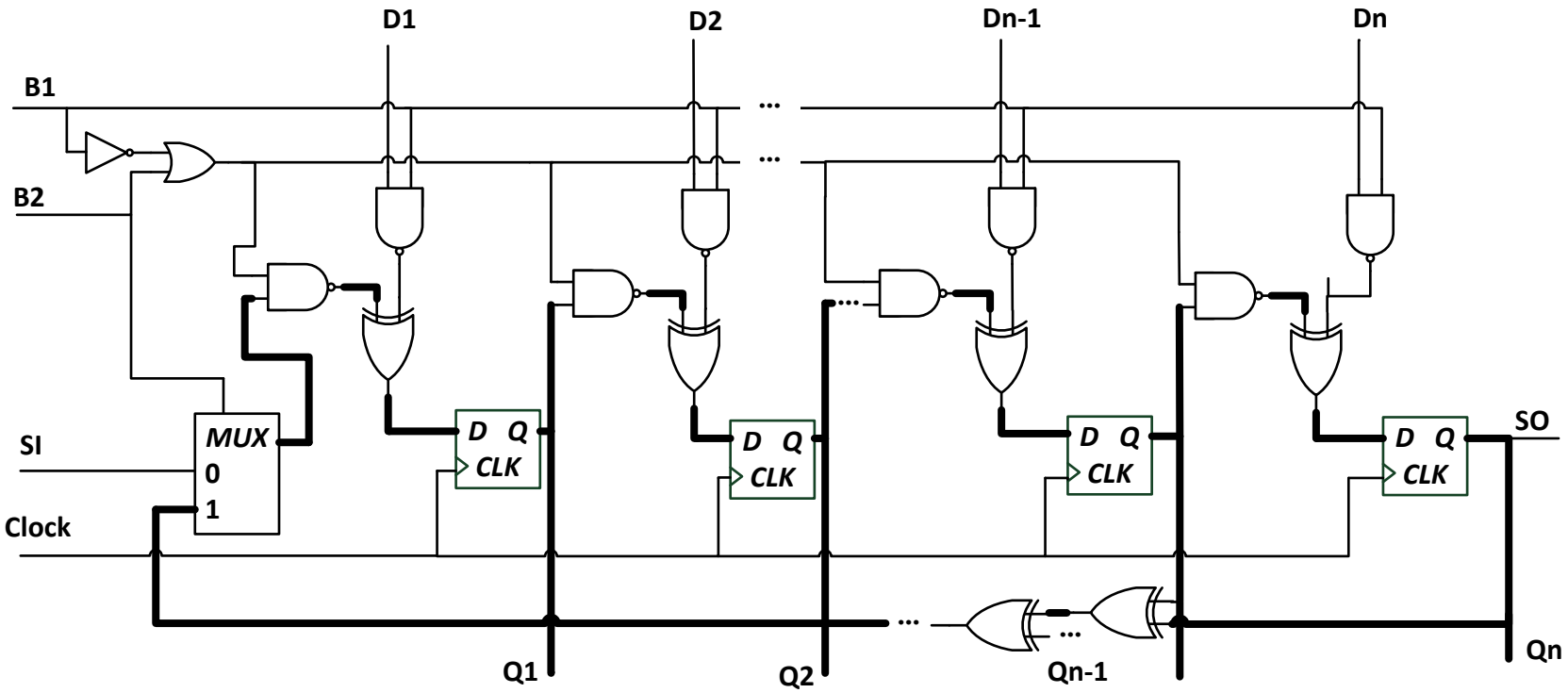
Scan Chain Mode

- **B1=B2=0**



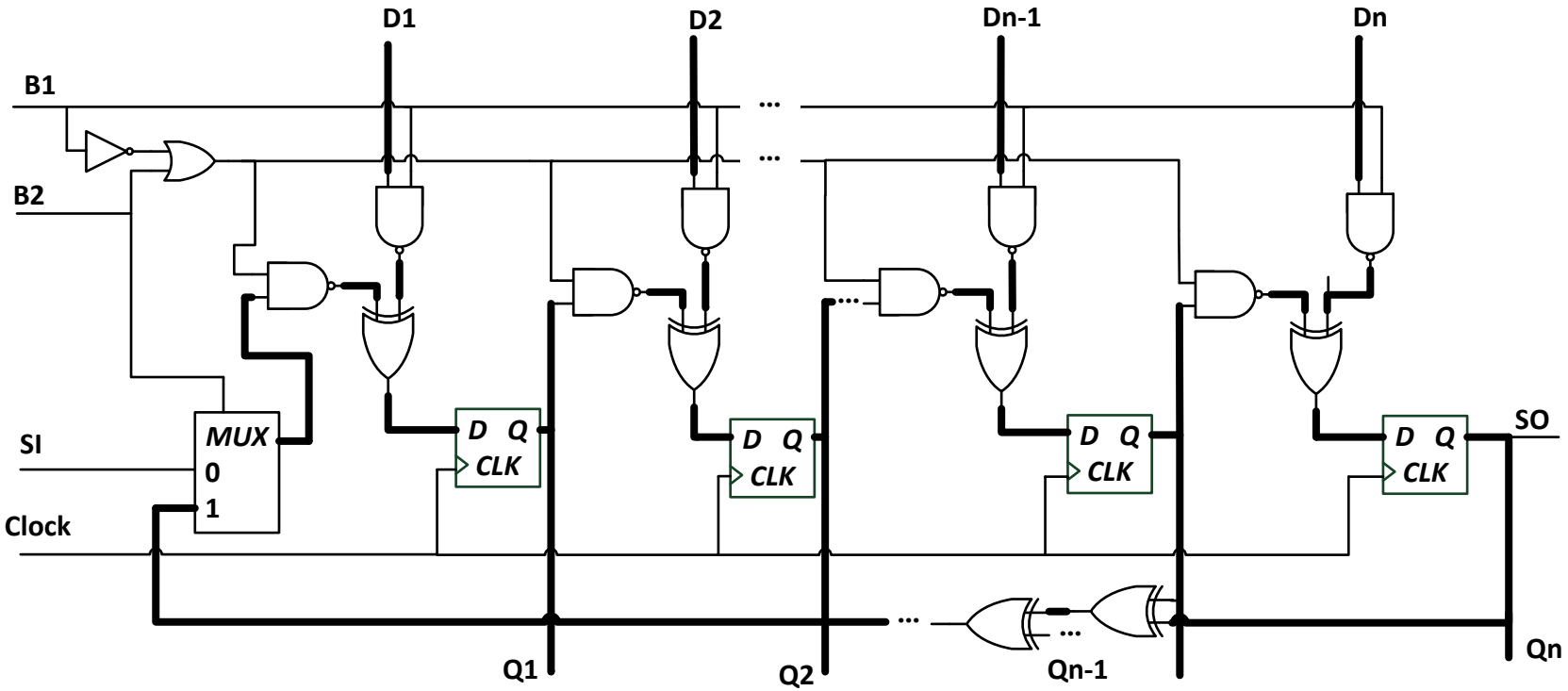
LFSR Mode

- B1=0, B2=1
- Type 1 LFSR



MISR Mode

- **B1=1, B2=1**



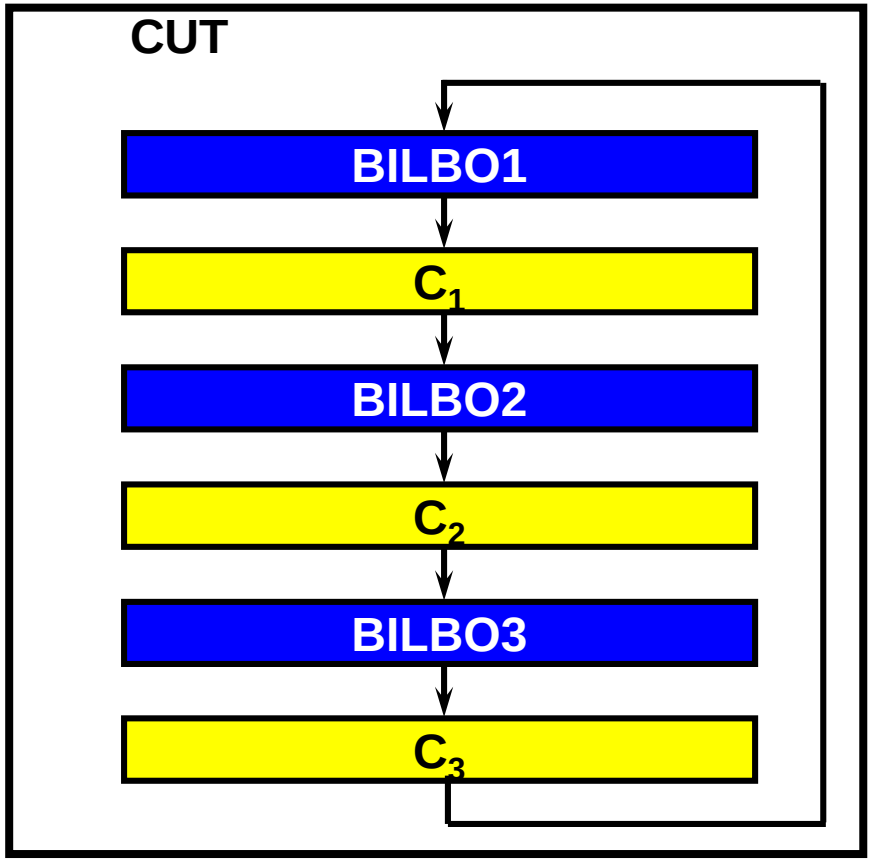
Pros and Cons of BILBO

- Pro
  - At-speed testing
- Cons
  - Area too large
  - Performance penalty

Not Really Useful due to Overhead

Quiz

Q: BILBO belongs to separate BIST or embedded BIST?
ANS:



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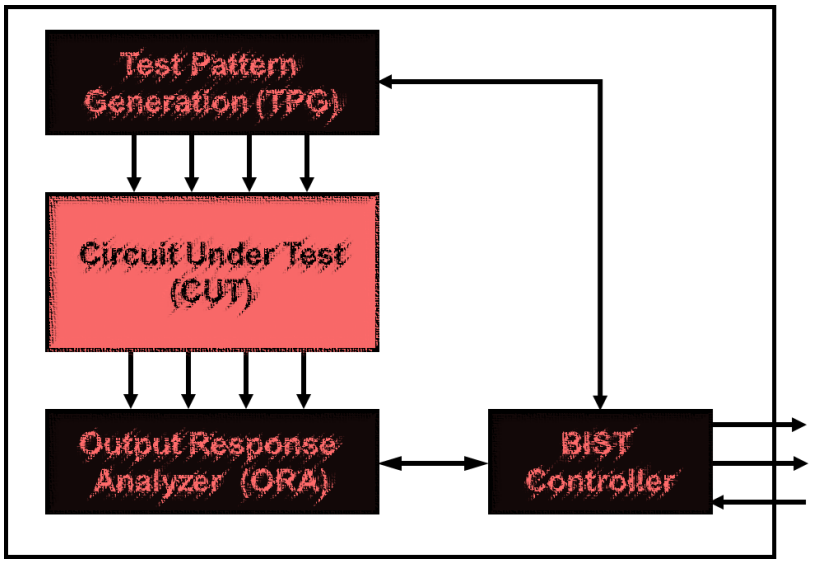
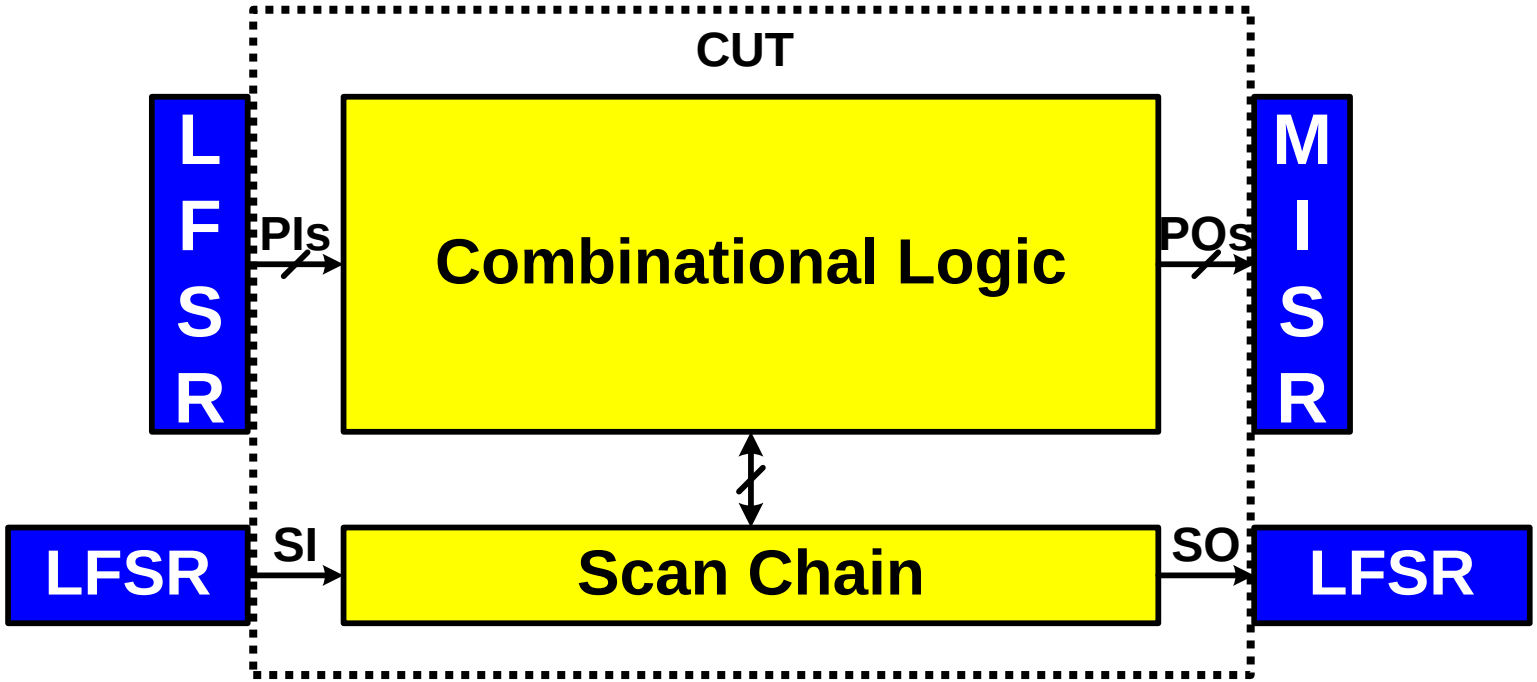


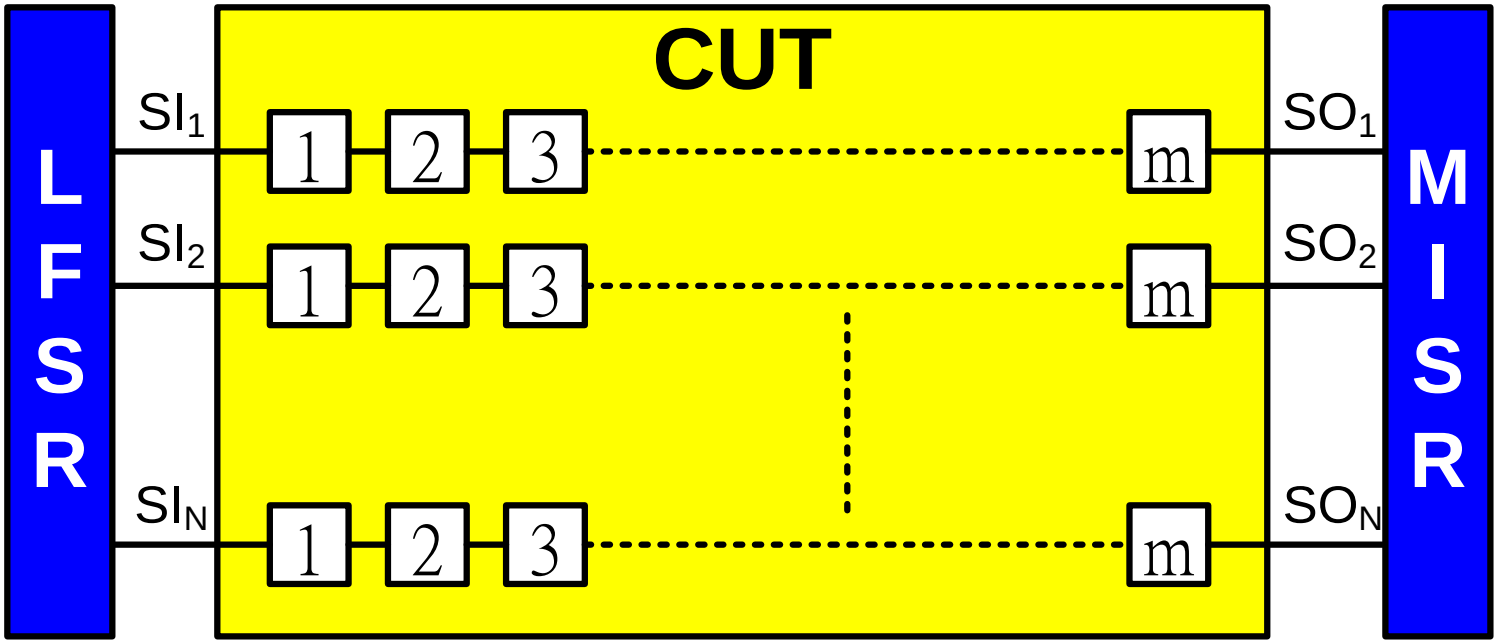
Test Per Scan – Single Chain

- **Test per Scan; Separate BIST**
- **Problem: not scalable.**



How about Multiple Chains?

STUMPS [Bardell McAnney 82]

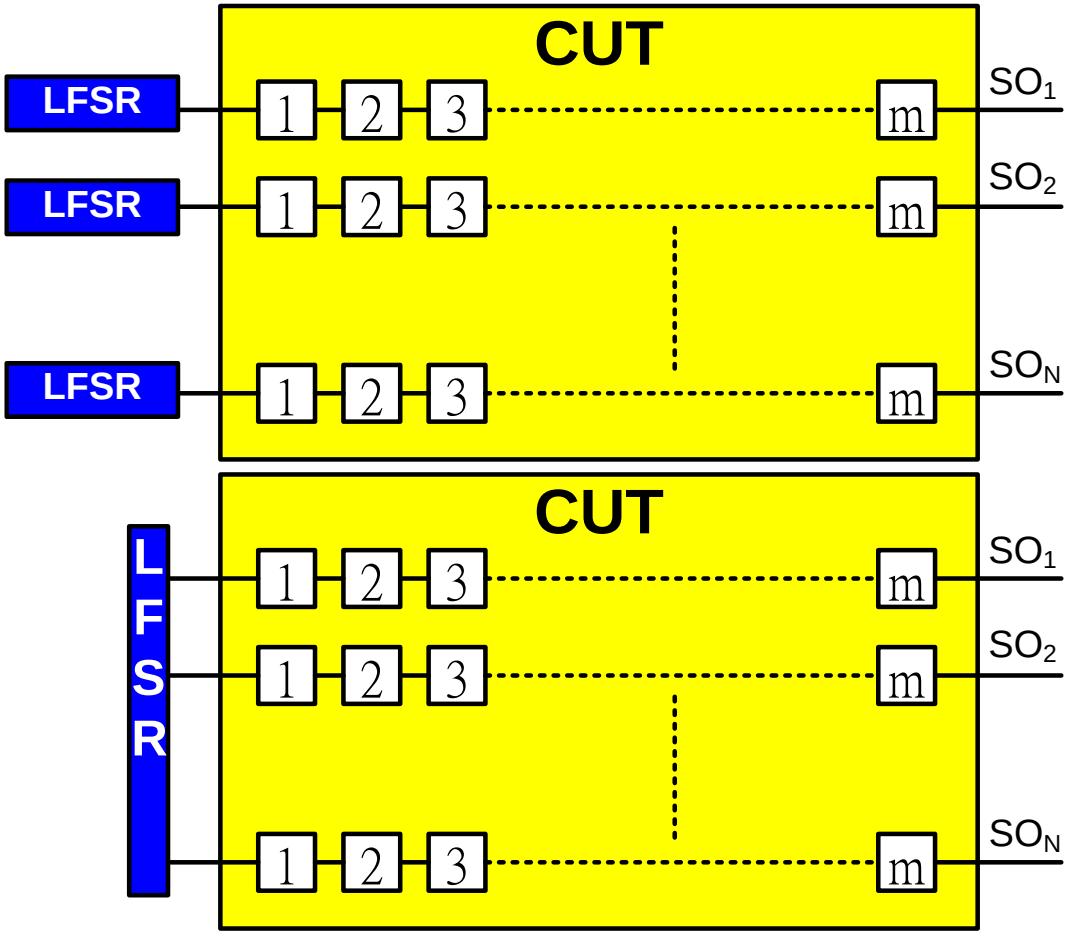


- *STUMPS = Self-Test Using a MISR and Parallel Shift register*
- **Test per scan; separate BIST**
- **Small area, good for multiple chains**

STUMPS is Very Popular Architecture

Quiz

Suppose CUT has 50 scan chains. Each chains is 100 bit long. How many total bits of LFSR do we need?
Q1: if we use one LFSR for each scan chain? Each LFSR 25 bits.
Q2: if we use STUMPS?



Pros and Cons of STUMPS

- Advantages
  - Low area overhead
  - Simple control
- Disadvantages
  - Longer test time (than test per clock)
  - Structure dependency
    - Need phase shifter (see next video)

Summary

- Output Response Analysis
- **BIST Architecture**
  - **Test Per Clock: BILBO (1979)**
    - **Large overhead**
  - **Test Per Scan: STUMPS (IBM, 1982)**
    - **Very useful**
- Issues with BIST
- Conclusions