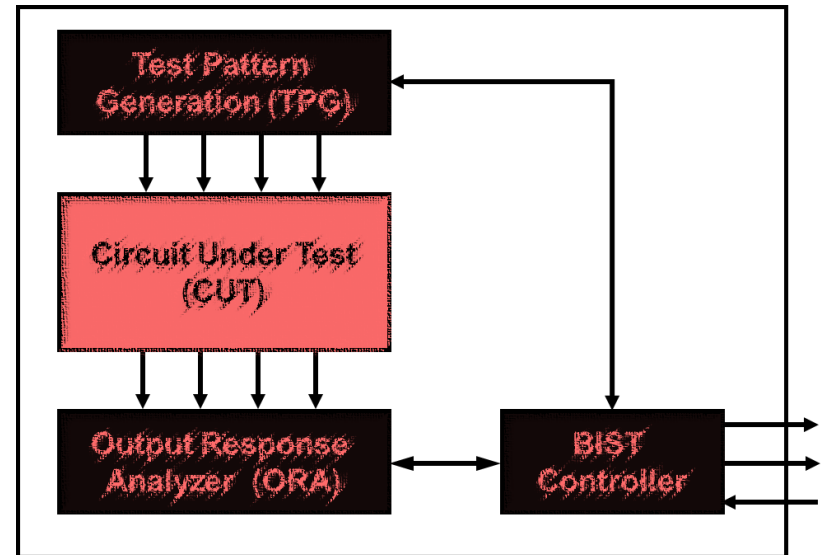


BIST Part 2

- 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

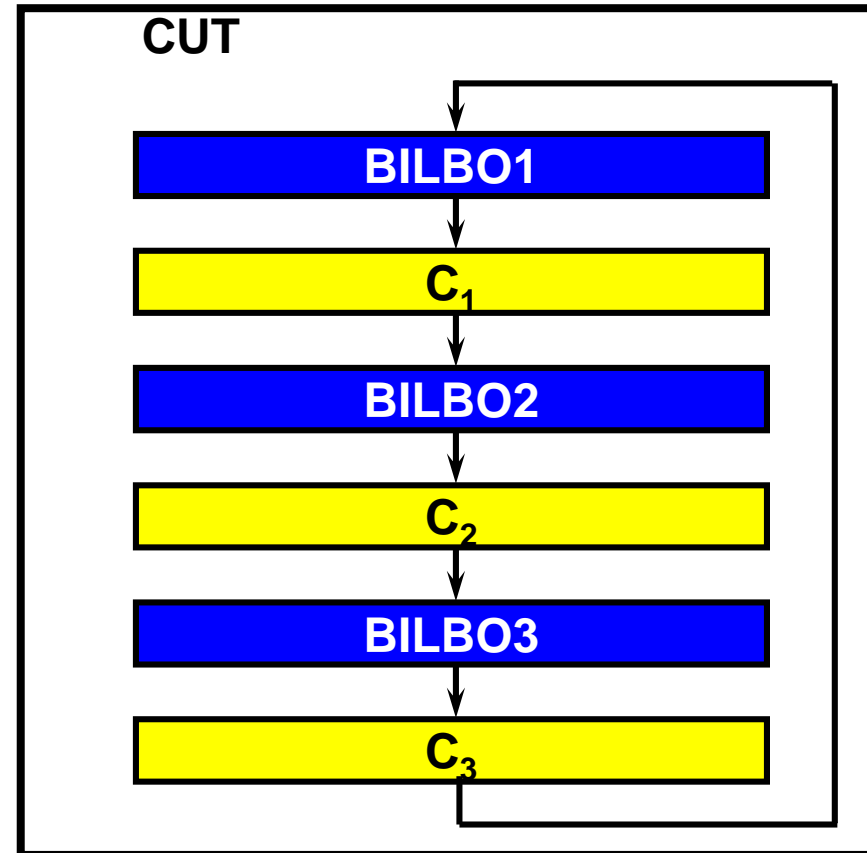
- Separate BIST
- Test per clock
 - ♦ At each clock: apply a test pattern, observe output



How about Sequential CUT?

Test Per Clock – Sequential CUT

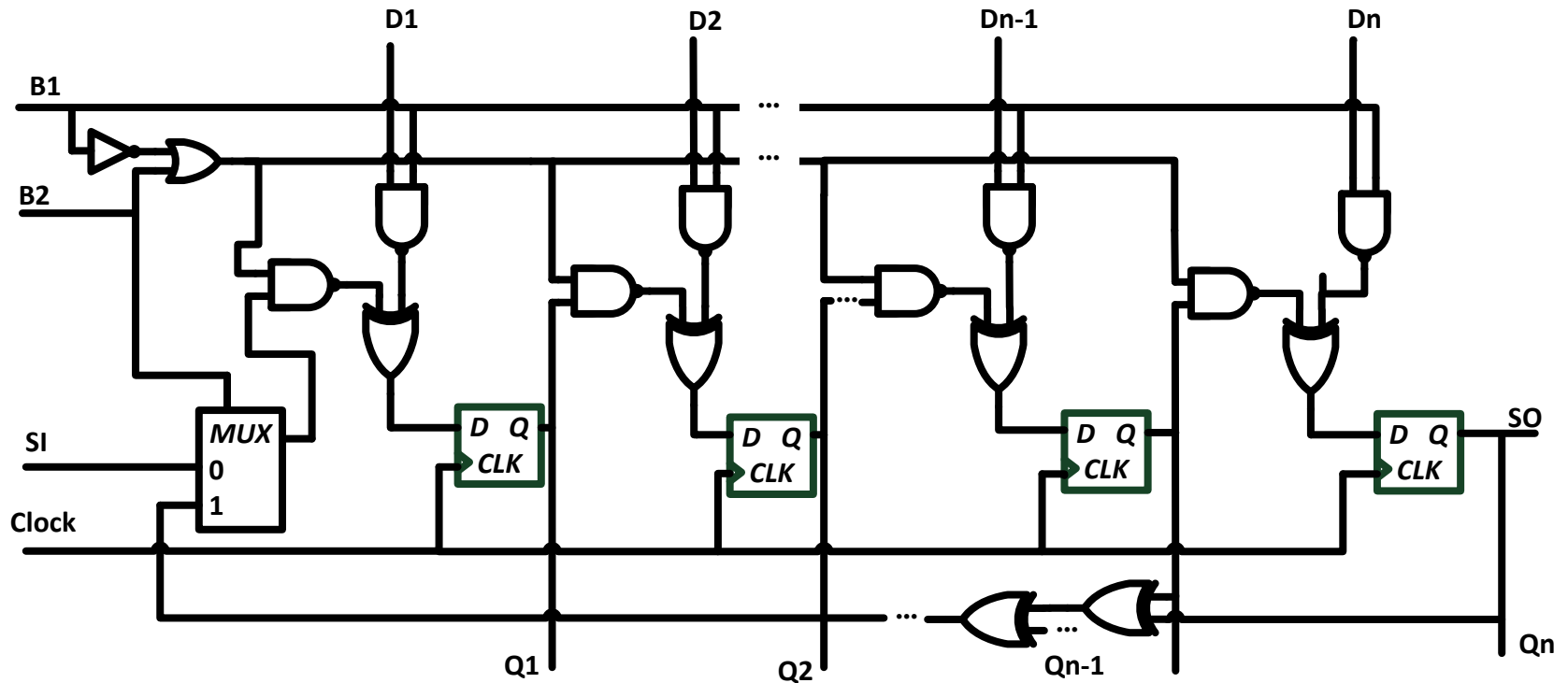
- **BILBO = Built-in Logic Block Observer** [Könemann 79]
 - ♦ Serve as TPG and ORA
- When testing C1
 - ♦ BILBO1 is TPG, BILBO2 is ORA
- When testing C2
 - ♦ BILBO2 is TPG, BILBO3 is ORA
- When testing C3
 - ♦ BILBO3 is TPG; BILBO1 is ORA
- Embedded BIST
 - ♦ Reuse CUT's FF as BILBO



Yellow blocks are comb. logic

Built-in Logic Block Observer, BILBO

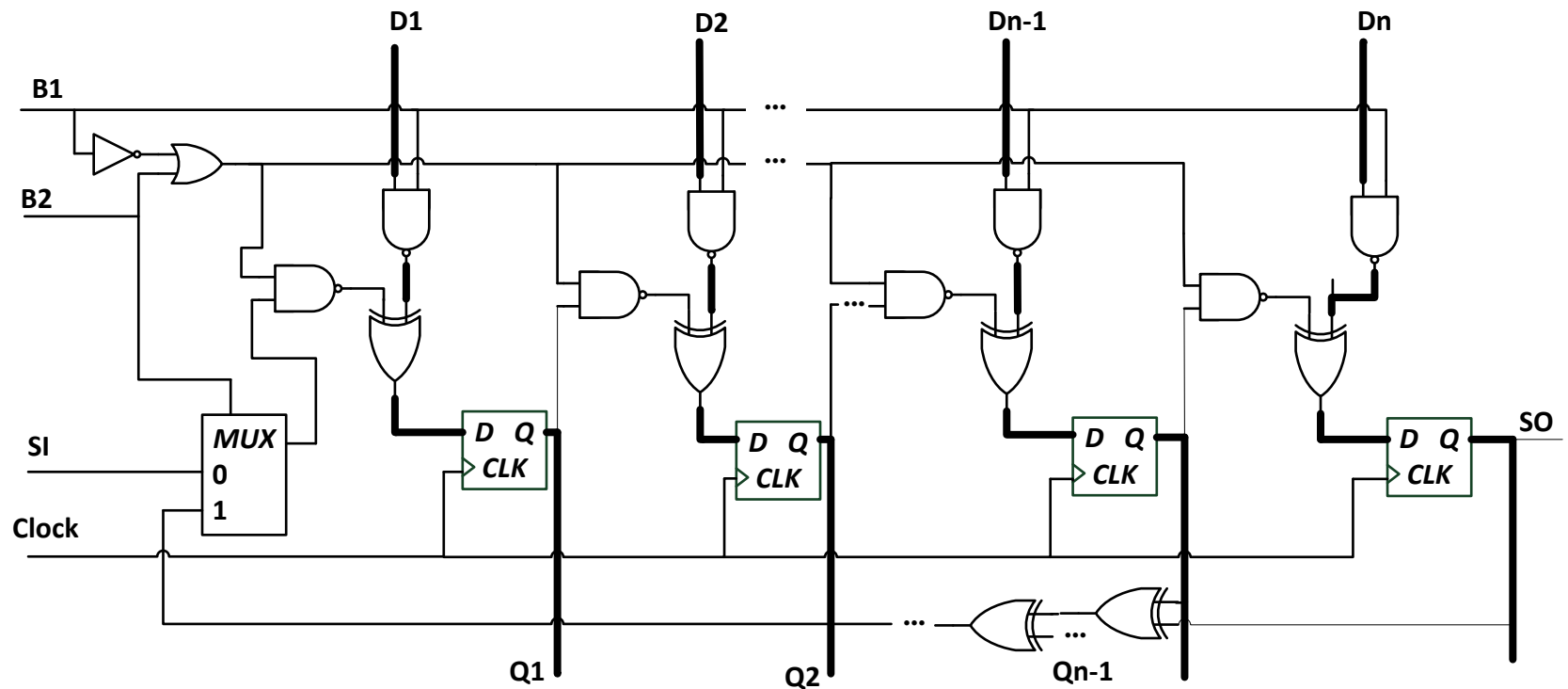
- B_1 B_2 control four modes of operation



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

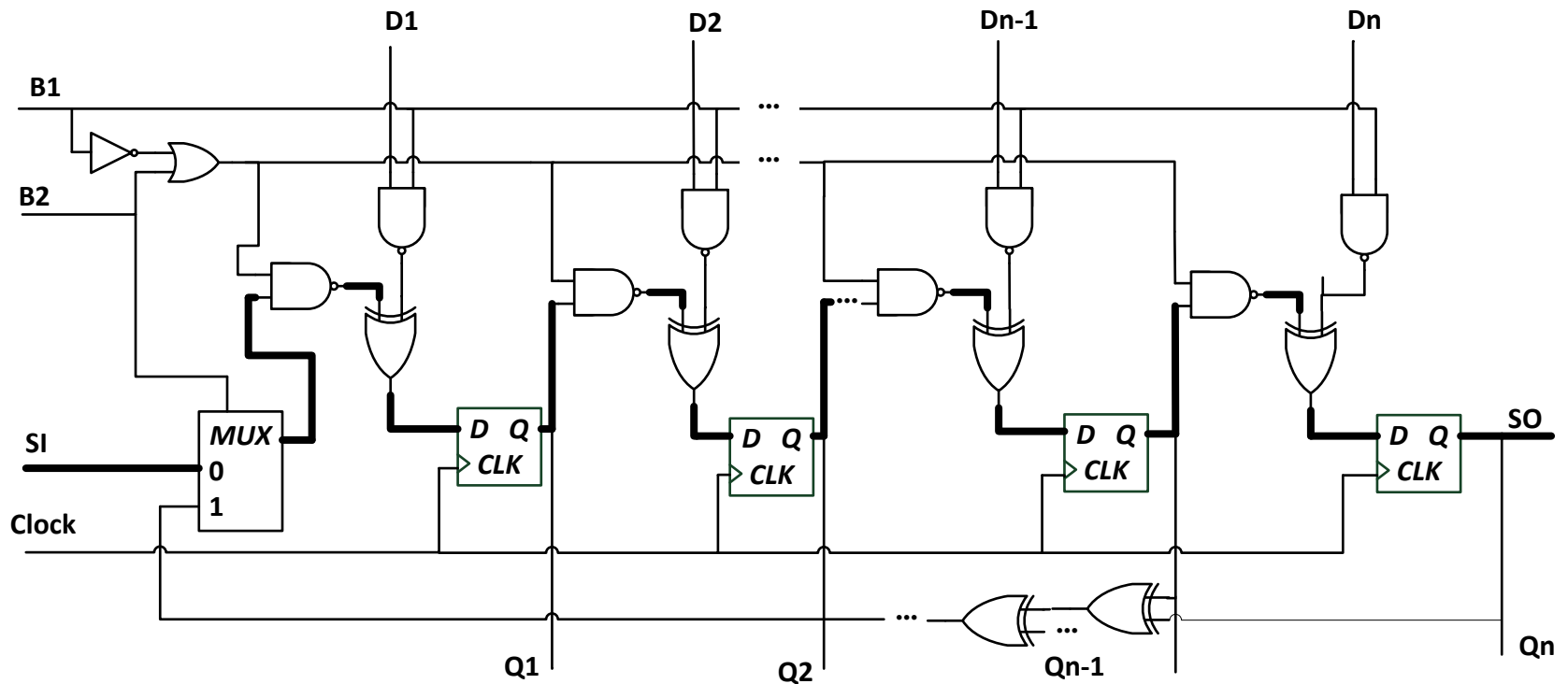
Normal Operation Mode

- $B1=1, B2=0$



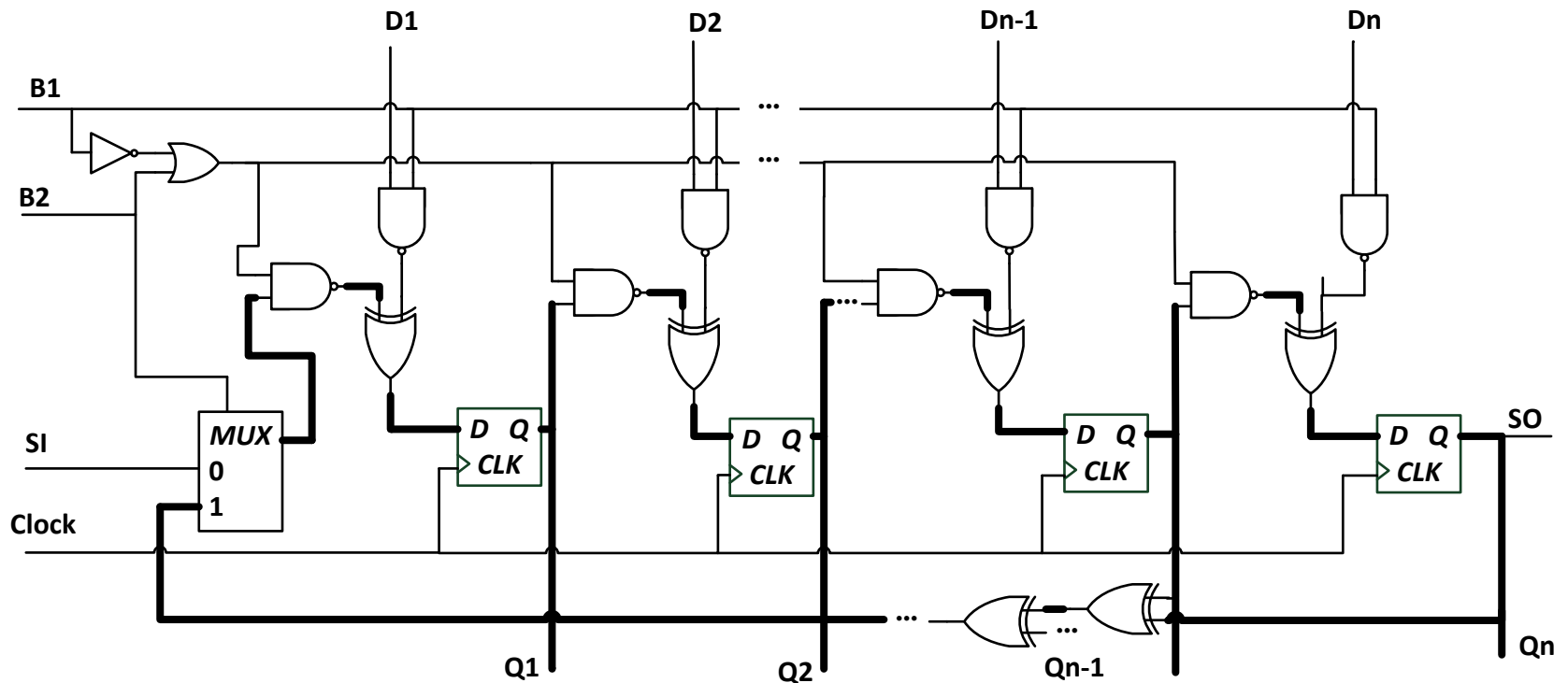
Scan Chain Mode

- $B1=B2=0$



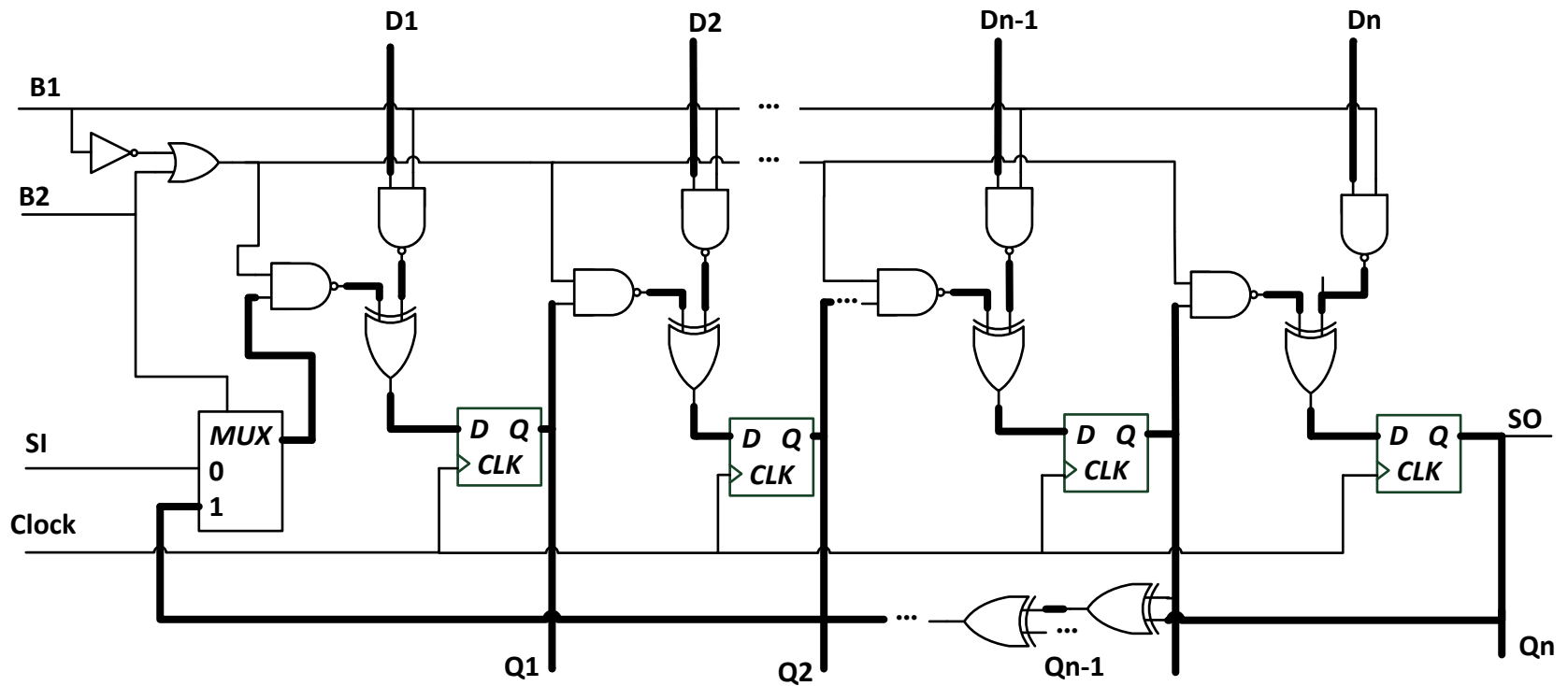
LFSR Mode

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



MISR Mode

- $B1=1, B2=1$



Pros and Cons of BILBO

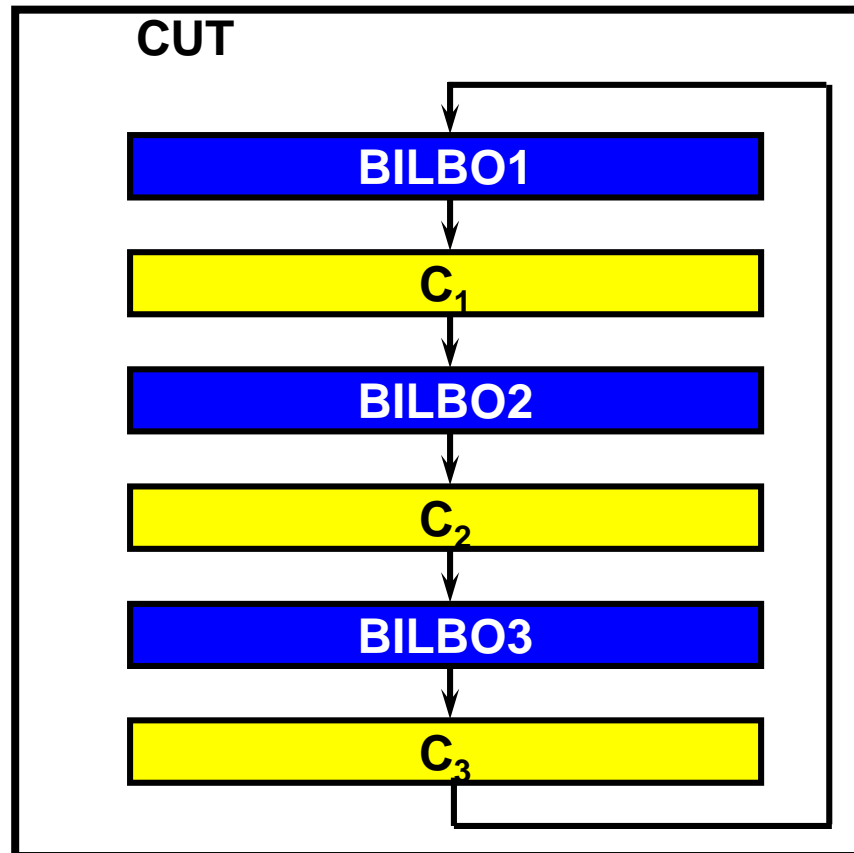
- **Pro**
 - ◆ **At-speed testing**
- **Cons**
 - ◆ **Area too large**
 - ◆ **Performance penalty**

Not Really Useful due to Overhead

Quiz

Q: BILBO belongs to separate BIST or embedded BIST?

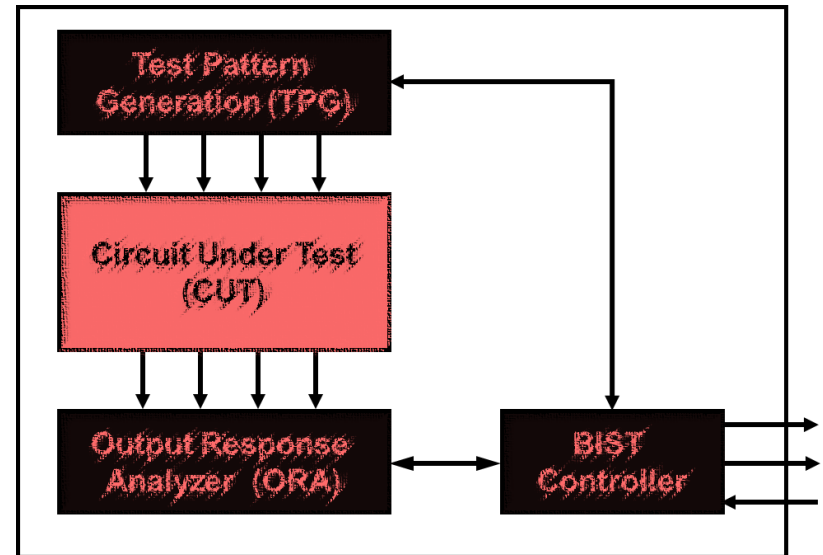
ANS:



Yellow blocks are comb. logic

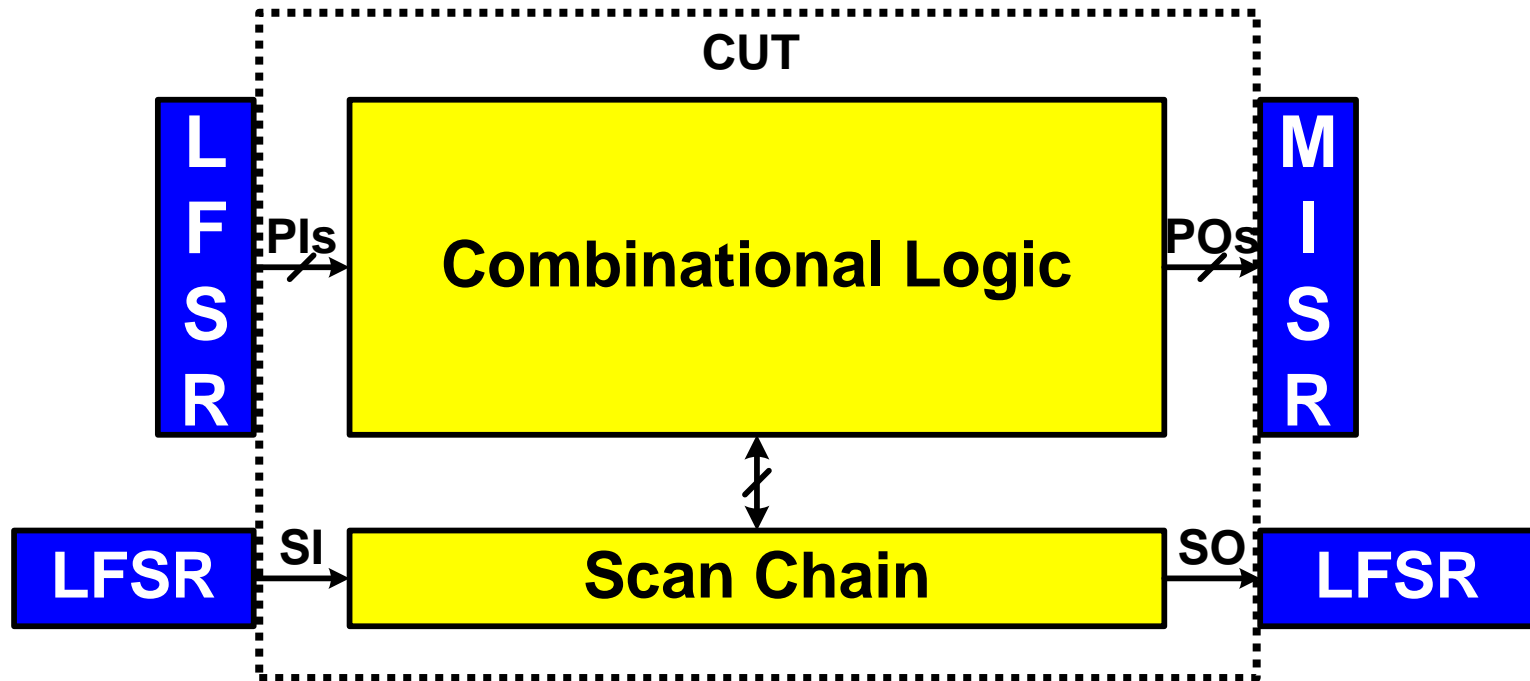
BIST Part 2

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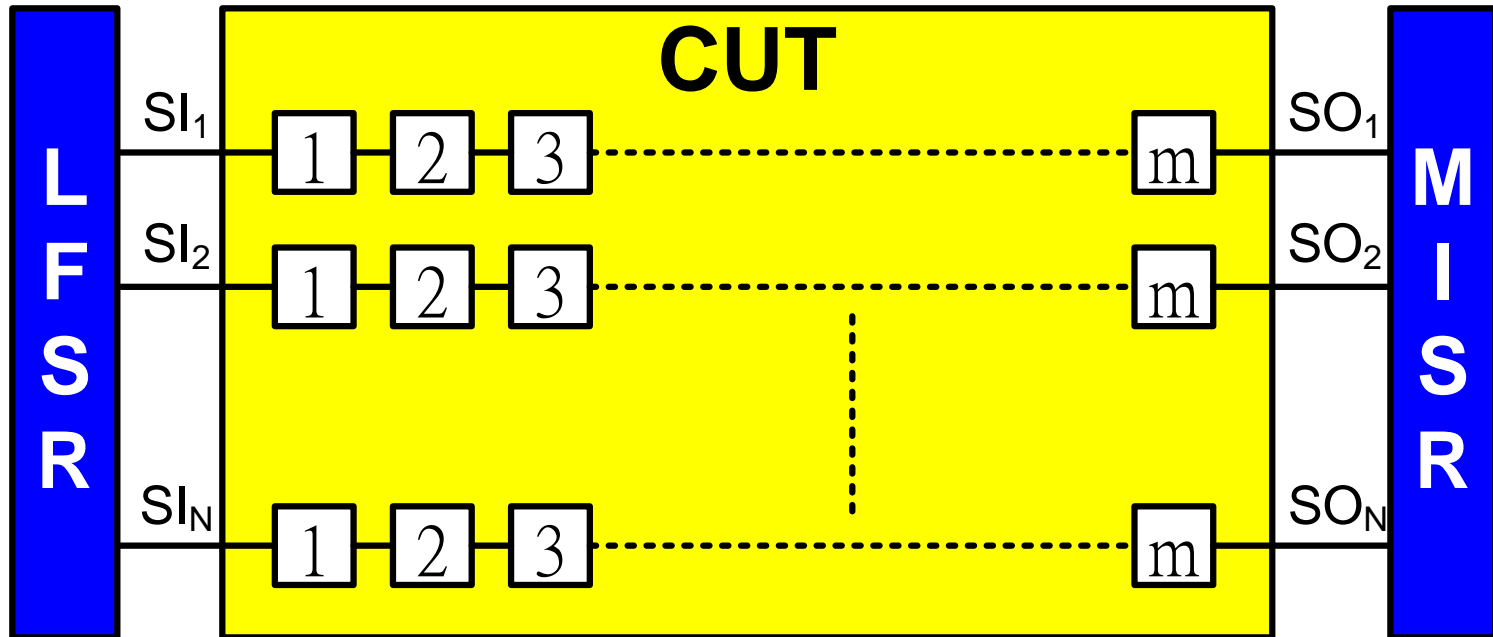
Test Per Scan – Single Chain

- 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

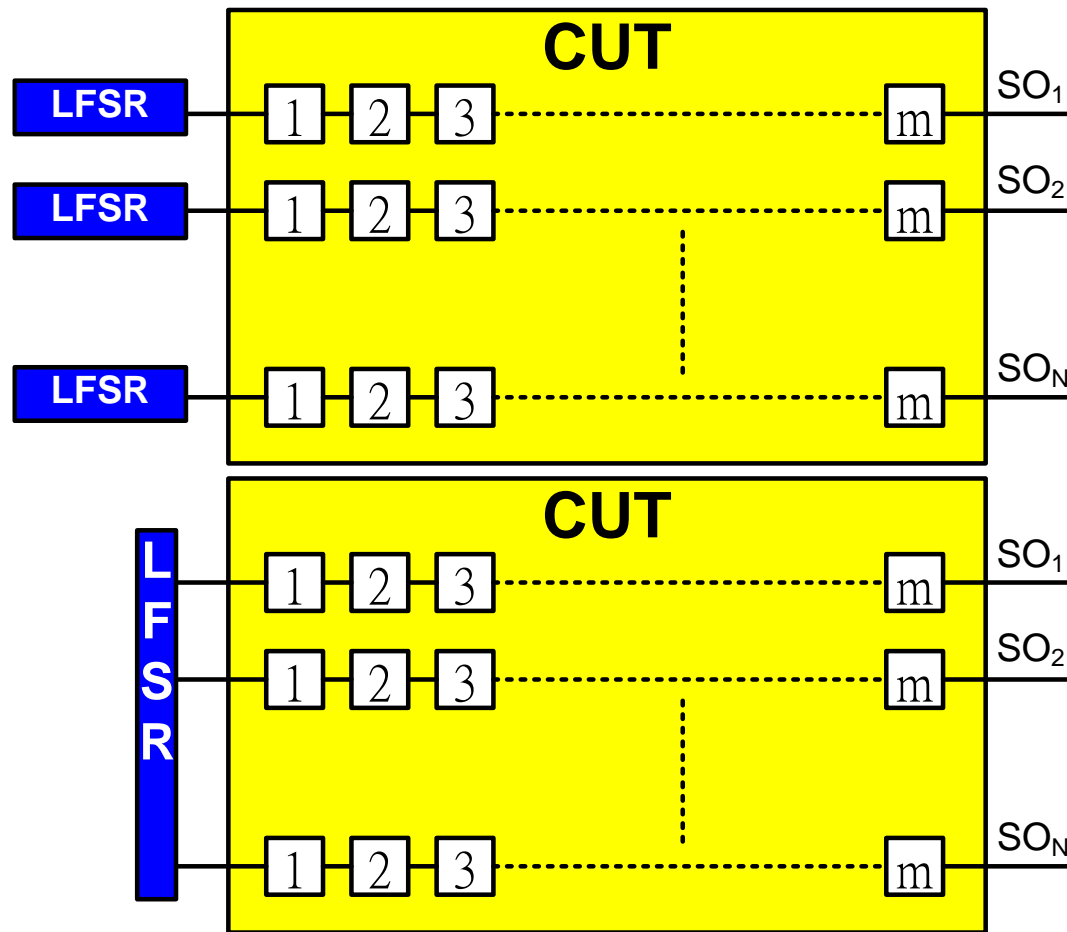
STUMPS is Very Popular Architecture

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

