SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

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Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECB231 DIGITAL ELECTRONICS

II YEAR/ III SEMESTER

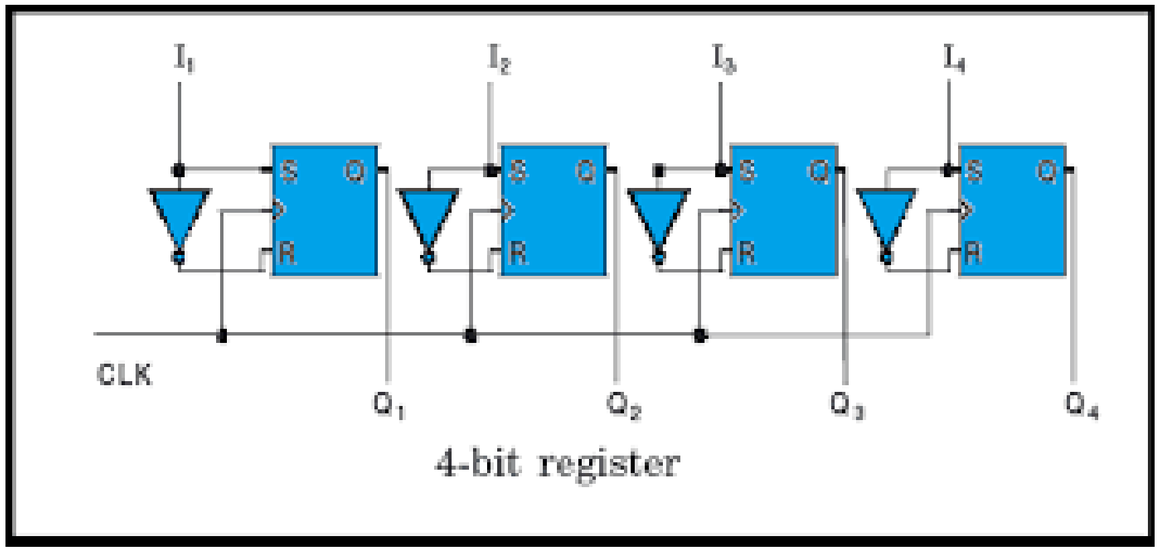
UNIT-IV DESIGN OF SEQUENTIAL CIRCUITS

Topic 1- Registers , Shift Registers, Universal Shift Registers

IDENTIFY THE TOPIC

Registers

- Flip flops can be used to store a single bit of binary data (1or 0).
- However, in order to store multiple bits of data, we need multiple flip flops.
- N flip flops are to be connected in an order to store n bits of data.
- A Register is a device which is used to store such information.
- It is a group of flip flops connected in series used to store multiple bits of data.



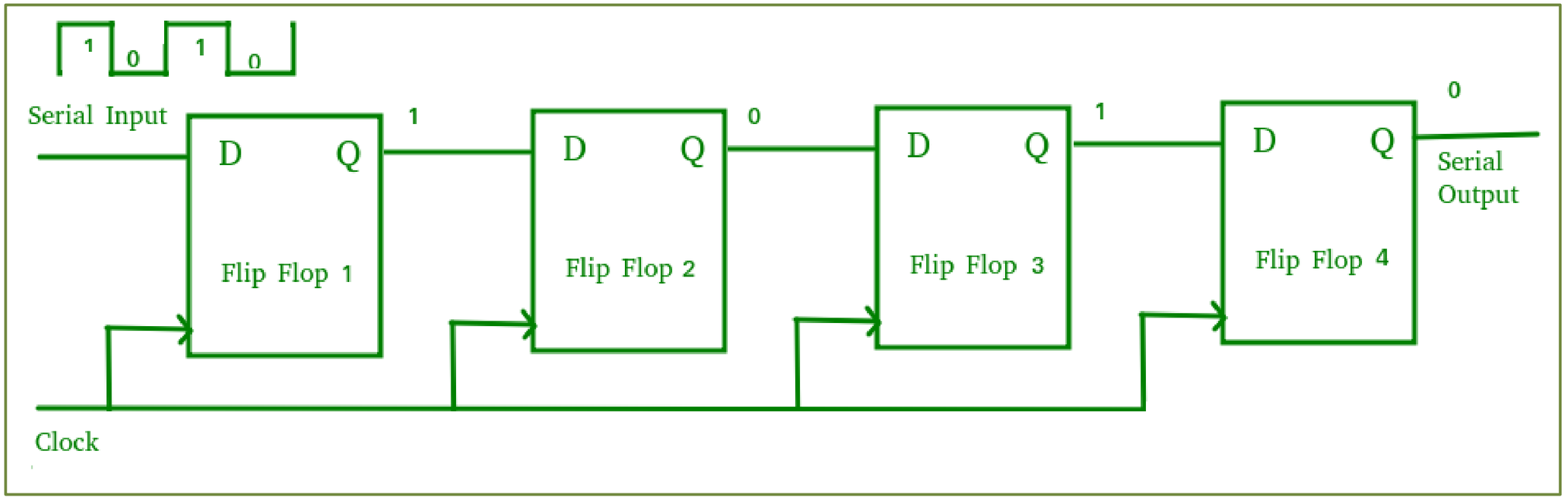
4-bit register

Types of Registers

Shift registers are basically of 4 types. These are:

- Serial In Serial Out shift register
- Serial In parallel Out shift register
- Parallel In Serial Out shift register
- Parallel In parallel Out shift register

Serial In Serial Out shift register

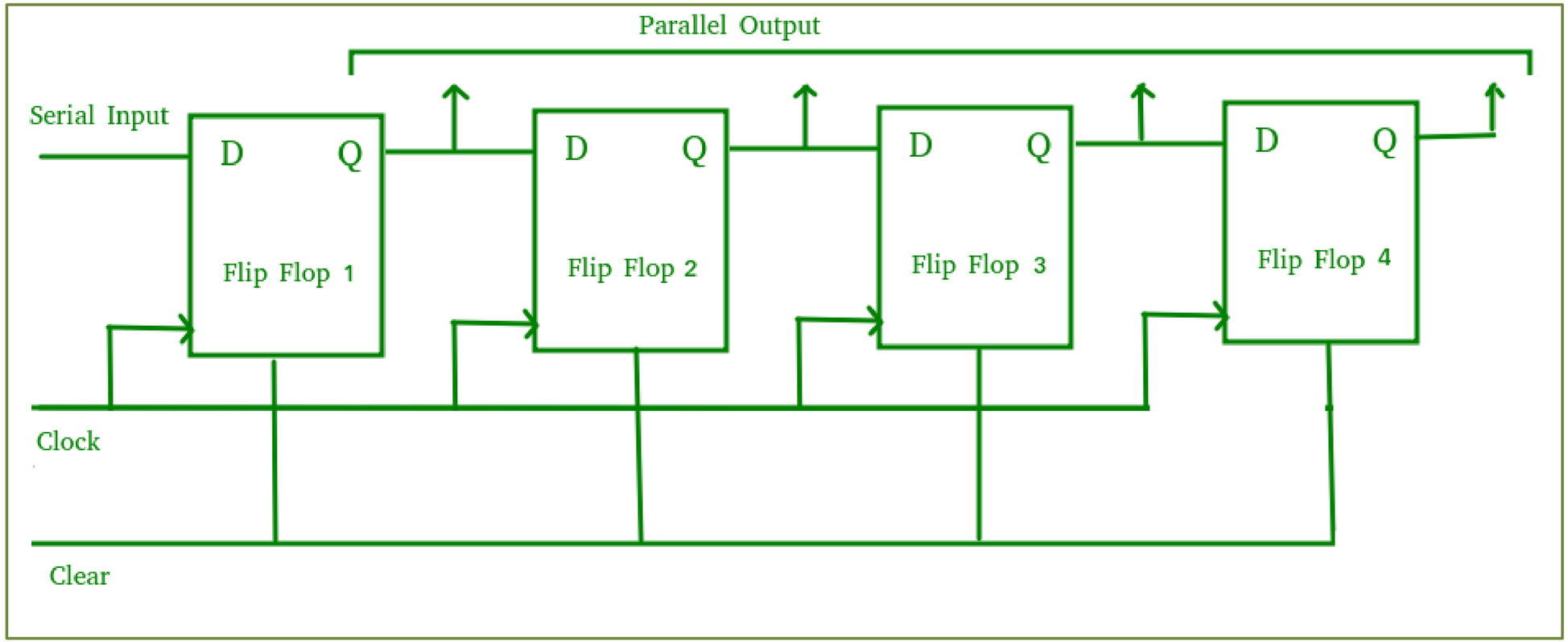


Serial In Serial Out shift register

Operation of the Shift-right Register

Timing pulse	Q_A	Q_B	Q_C	Q_D	*Serial output at* Q_D
Initial value	0	0	0	0	0
After 1st clock pulse	1	0	0	0	0
After 2nd clock pulse	1	1	0	0	0
After 3rd clock pulse	0	1	1	0	0
After 4th clock pulse	1	0	1	1	1

Serial-In Parallel-Out shift Register (SIPO)



Serial-In Parallel-Out shift Register (SIPO)

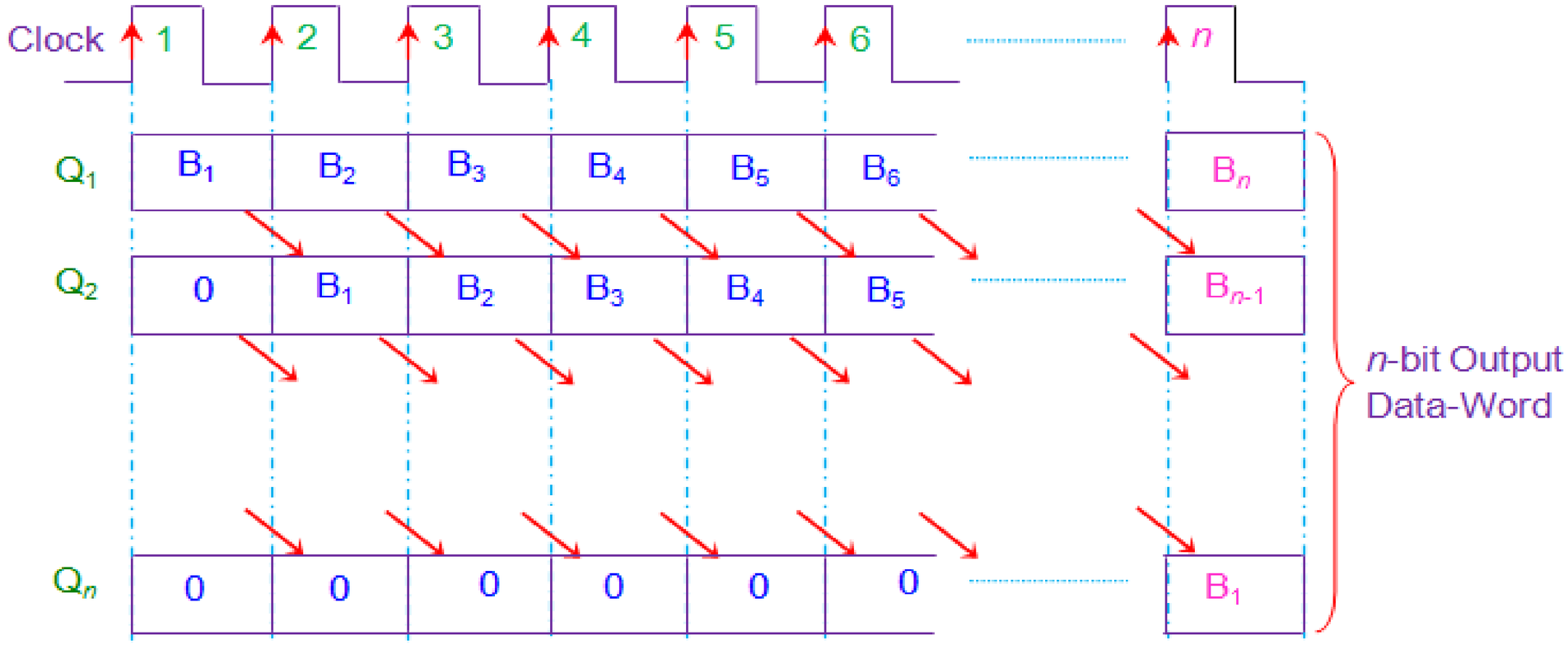
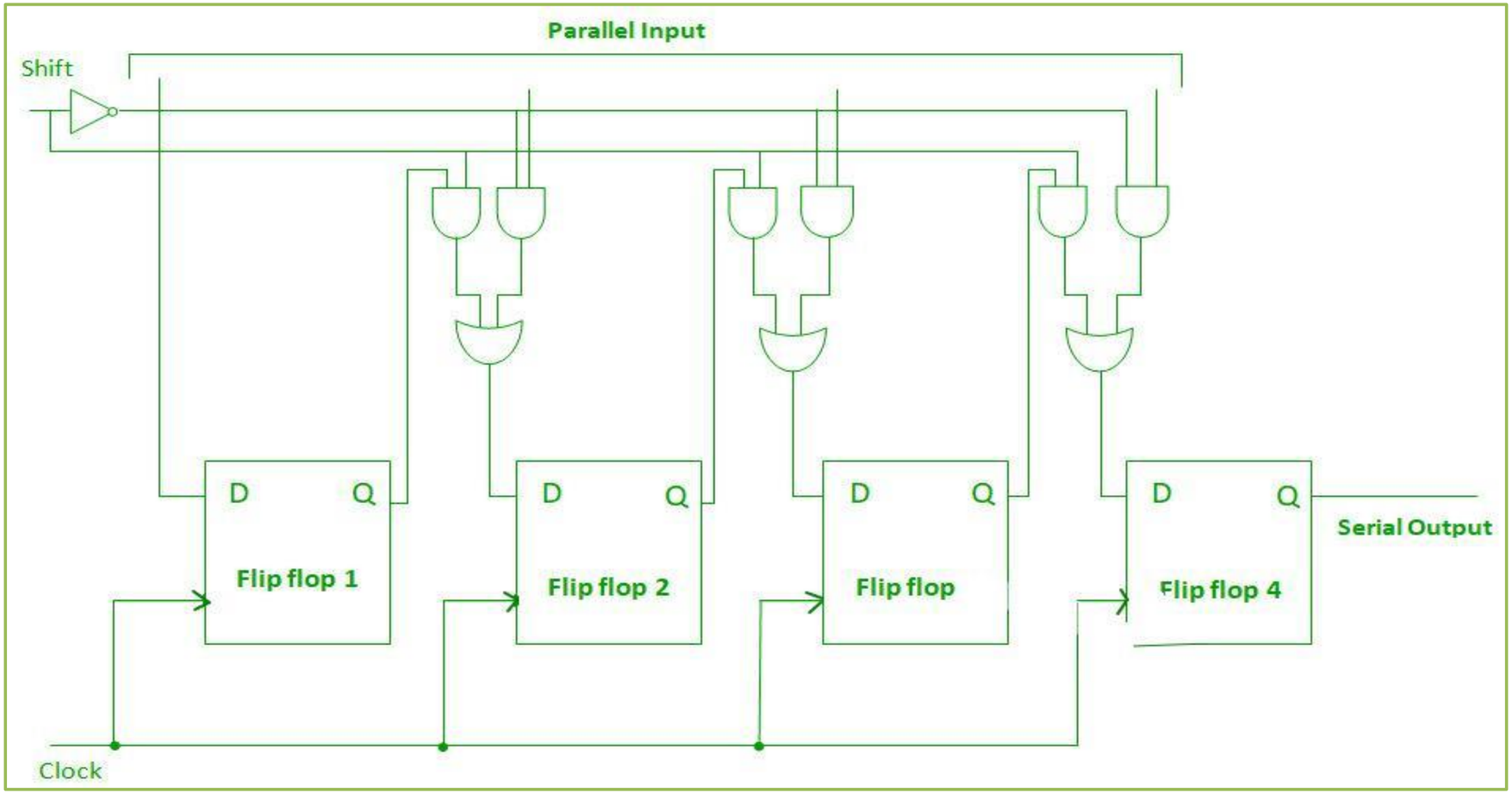


Figure 2 Output Waveform of *n*-bit Right-Shift SIPO Shift Register

Parallel-In Serial-Out Shift Register (PISO)



Parallel-In Serial-Out Shift Register (PISO)

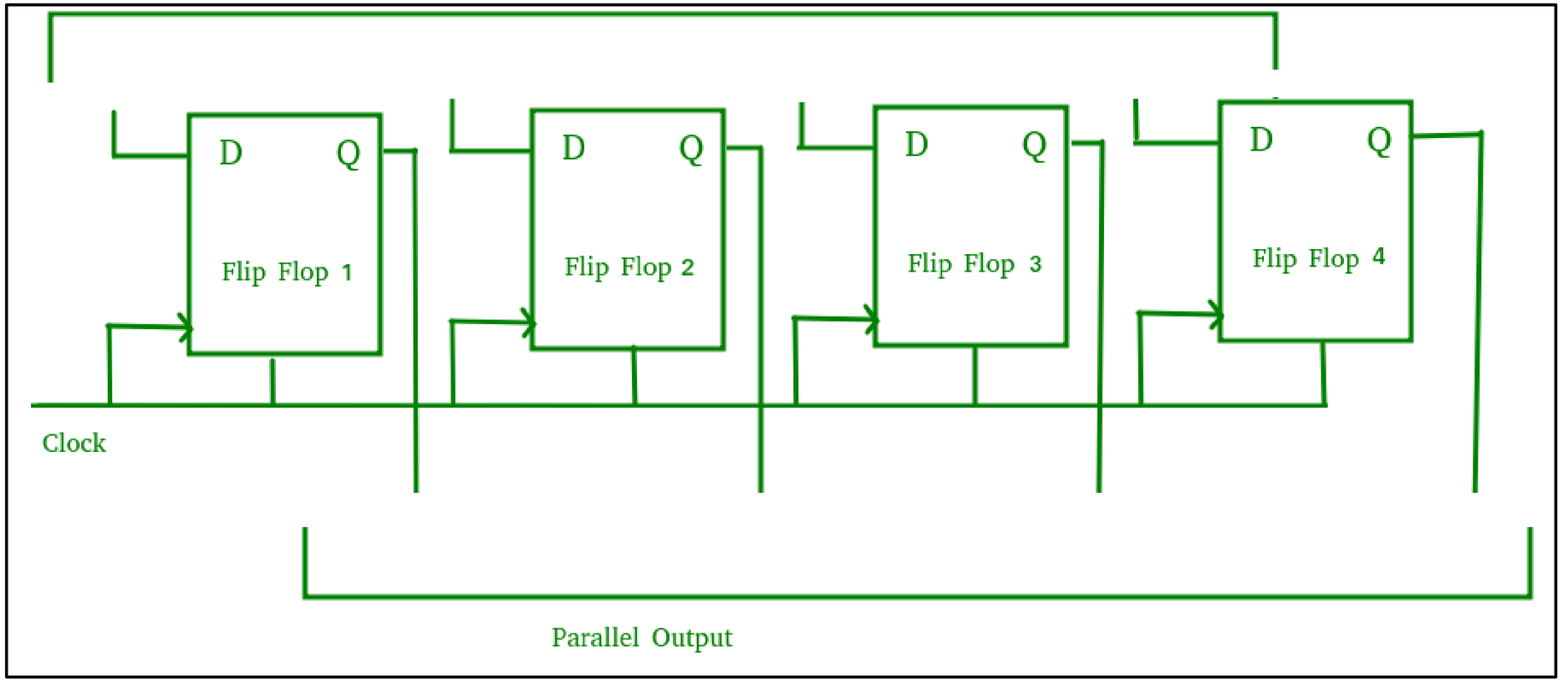
Table I Data Movement in Right-Shift PISO Shift

Clock Cycle	SH / $\overline{LD}$	Q_1	Q_2	Q_3	...	Q_{n-1}	Q_n = Data out
1	0	B_1	B_2	B_3		B_{n-1}	B_n
2	1	0	B_1	B_2	...	B_{n-2}	B_{n-1}
3	1	0	0	B_1	...	B_{n-3}	B_{n-2}
.		.	.	.		.	.
.		.	.	.	...	.	.
.		.	.	.		.	.
n-1	1	0	0	0	...	B_1	B_2
n	1	0	0	0		0	B_1

Parallel data Loading Operation

Serial data retrieval

Parallel-In Parallel-Out Shift Register (PIPO)



Parallel-In Parallel-Out Shift Register (PIPO)

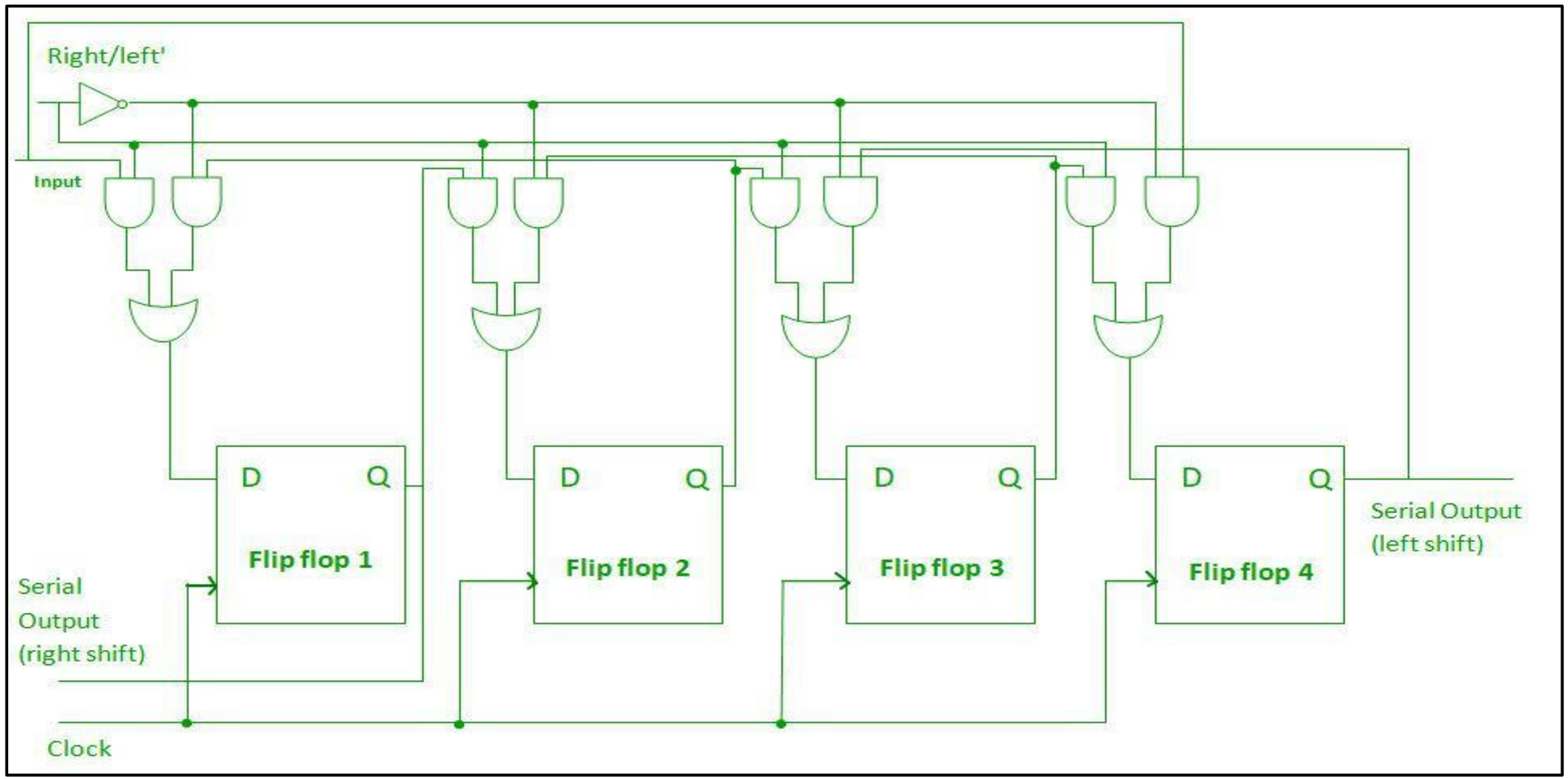
Table I Data Movement in Right-Shift PIPO Shift Register

Clock Cycle	SH / $\overline{LD}$	Q_1	Q_2	Q_3	...	Q_{n-1}	Q_n
1	0	B_1	B_2	B_3		B_{n-1}	B_n
2	1	0	B_1	B_2	...	B_{n-2}	B_{n-1}
3	1	0	0	B_1	...	B_{n-3}	B_{n-2}
.		.	.	.		.	.
.		.	.	.	...	.	.
.		.	.	.		.	.

→ Parallel Data Loading

Parallel Data Retrieval

Bidirectional Shift Register



Bidirectional Shift Register

Clock Cycle	CLR	R / $\overline{L}$	Q_1	Q_2	...	Q_{n-1}	Q_n
1	0	1	B_1	0		0	0
2	0	1	B_2	B_1		0	0
.	.	.	.	.		.	.
.	.	.	.	.	...	.	.
.	.	.	.	.		.	.
n	0	1	B_n	B_{n-1}	...	B_2	B_1
n+1	1	X	0	0	...	0	0
n+2	0	0	0	0	...	0	B_1
n+3	0	0	0	0	...	B_1	B_2
n+4	0	0	0	0	...	B_2	B_3
.	.	.	.	.		.	.
.	.	.	.	.	...	.	.
.	.	.	.	.		.	.

Right-Shift of Data Bits

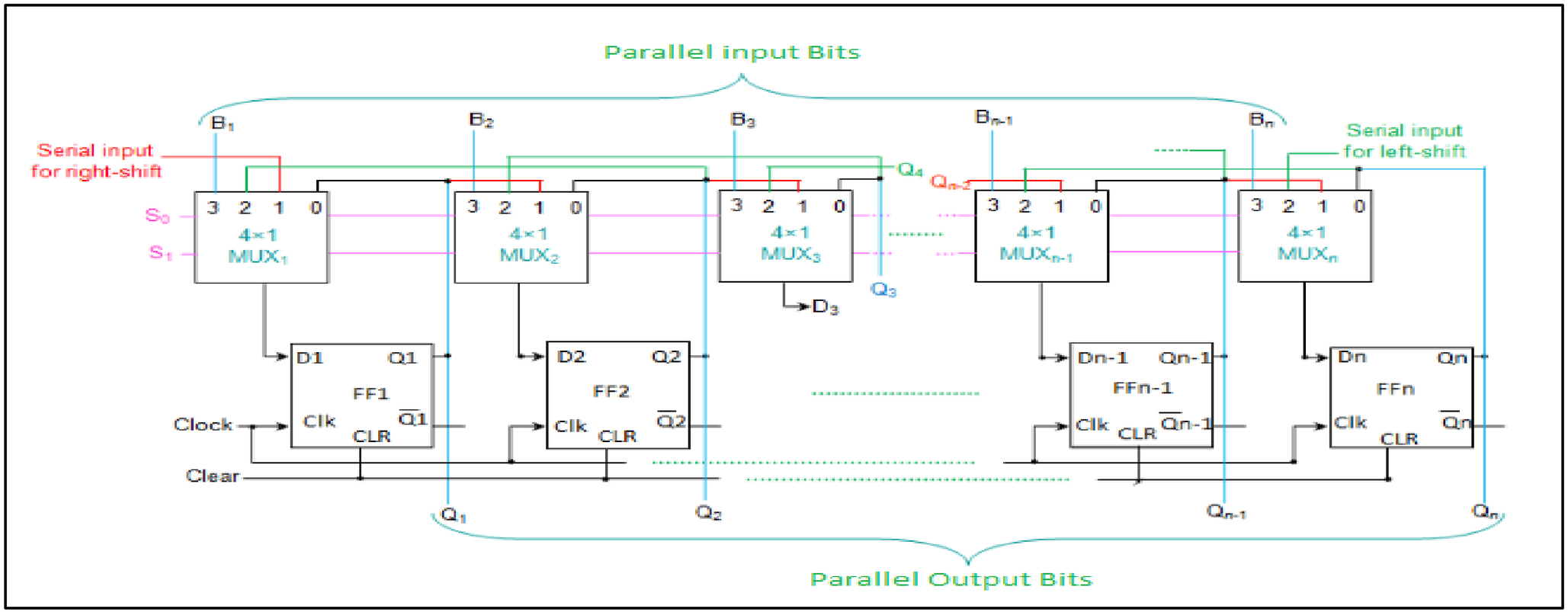
→ Register is Cleared

Left-Shift of Data Bits

Table I Data Movement in Bidirectional Shift Register

Universal Shift Register

A Universal shift register is a register which has both the right shift and left shift with parallel load capabilities. Universal shift registers are used as memory elements in computers. A Unidirectional shift register is capable of shifting in only one direction.



Universal Shift Register

Table II Truth Table for *n*-bit Universal Shift Register

Serial Input for Left Shift	$L_1L_2 \ldots L_n$
Serial Input for Right Shift	$R_1R_2 \ldots R_n$
Parallel Input	$B_1B_2 \ldots B_n$

Clk	CLR	Mux Output	Outputs					
			Q_1	Q_2	---	Q_{n-1}	Q_n	
1	1	X	0	0	---	0	0	Register is Cleared
2	0	1	R_1	0	---	0	0	Right-shift of Data Bits
3	0	1	R_2	R_1	---	0	0	
. . .	. . .	. . .	. . .	. . .	---	. . .	. . .	
n+1	0	1	R_n	R_{n-1}	---	R_2	R_1	
n+2	1	X	0	0	---	0	0	Register is Cleared
n+3	0	2	0	0	---	0	L_1	Left-shift of Data Bits
n+4	0	2	0	0	---	L_1	L_2	
. . .	. . .	. . .	. . .	. . .	---	. . .	. . .	
2*n*+2	0	2	L_1	L_2	---	L_{n-1}	L_n	
2*n*+3	0	0	L_1	L_2	---	L_{n-1}	L_n	No Change
2*n*+4	0	0	L_1	L_2	---	L_{n-1}	L_n	
2*n*+5	0	3	B_1	B_2	---	B_{n-1}	B_n	Parallel Data Loading
. . .	. . .	. . .	. . .	. . .	---	. . .	. . .	

Application of Shift Register

- The shift registers are used for temporary data storage.
- The shift registers are also used for data transfer and data manipulation.
- The serial-in serial-out and parallel-in parallel-out shift registers are used to produce time delay to digital circuits.
- The serial-in parallel-out shift register is used to convert serial data into parallel data thus they are used in communication lines where demultiplexing of a data line into several parallel line is required.
- A Parallel in Serial out shift register us used to convert parallel data to serial data.

THANK YOU