An Animated Linear Feedback Shift Register (LFSR) as a Pseudo Random Pattern Generator in Excel 2003 – Part#2

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- In the previous section a very sketchy theoretical introduction was given after which the excel implementation of a 14-bit long Fibonacci type LFSR device was started.
- A device was chosen to generate a maximum length sequence ($2^{14}-1$).
- A "table" type implementation is explored in this section whereas the next section will contain a "table & sequential" mixed implementation approach.

Some considerations about the spreadsheet "table implementation" of the LFSR:

- The whole model is supposed to be sequential, which means that the present state of the logic is a function of both the present input and the past inputs (input history). This implies that it has to be an area in the worksheet allocated to storing past inputs as part of the model.
- As far as implementation is concerned, the whole system could be modeled as a table where the number of time steps simulated is equal to the number of rows in the table. In other words for each time step we need to store the information in a table row. This is the easiest way to implement such a system and it has the advantage of speed (the calculations for all time steps are performed simultaneously by the worksheet). The disadvantage of this type of implementation is the fact that the table is limited in size to about 65000 rows in MS Excel 2003. This implies that in the "table" implementation limits the number of simulated time steps to about 65000 due to worksheet size limitation.
- The hardware equivalent of the "table implementation" is not a sequential circuit but a combinatorial circuit containing a large number of gates (non inverting buffers) equal to the number of stages in the shift register times the number of time steps. Of course such a hardware equivalent schematic must contain the XOR feedback gate group multiplied by the number of modeled time steps.

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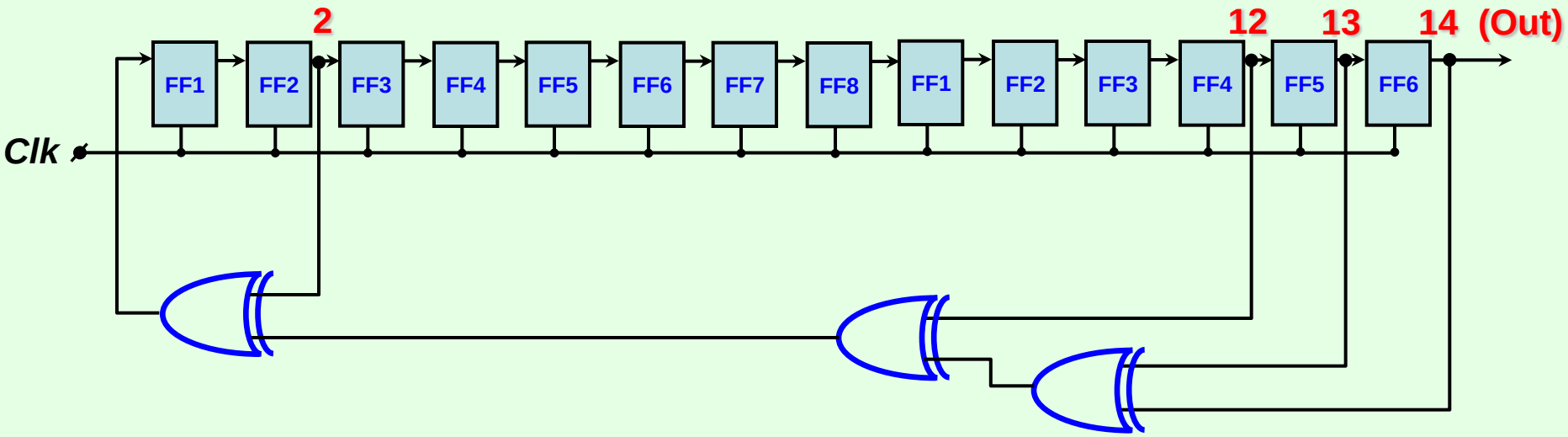
A standard schematic of a LFSR:

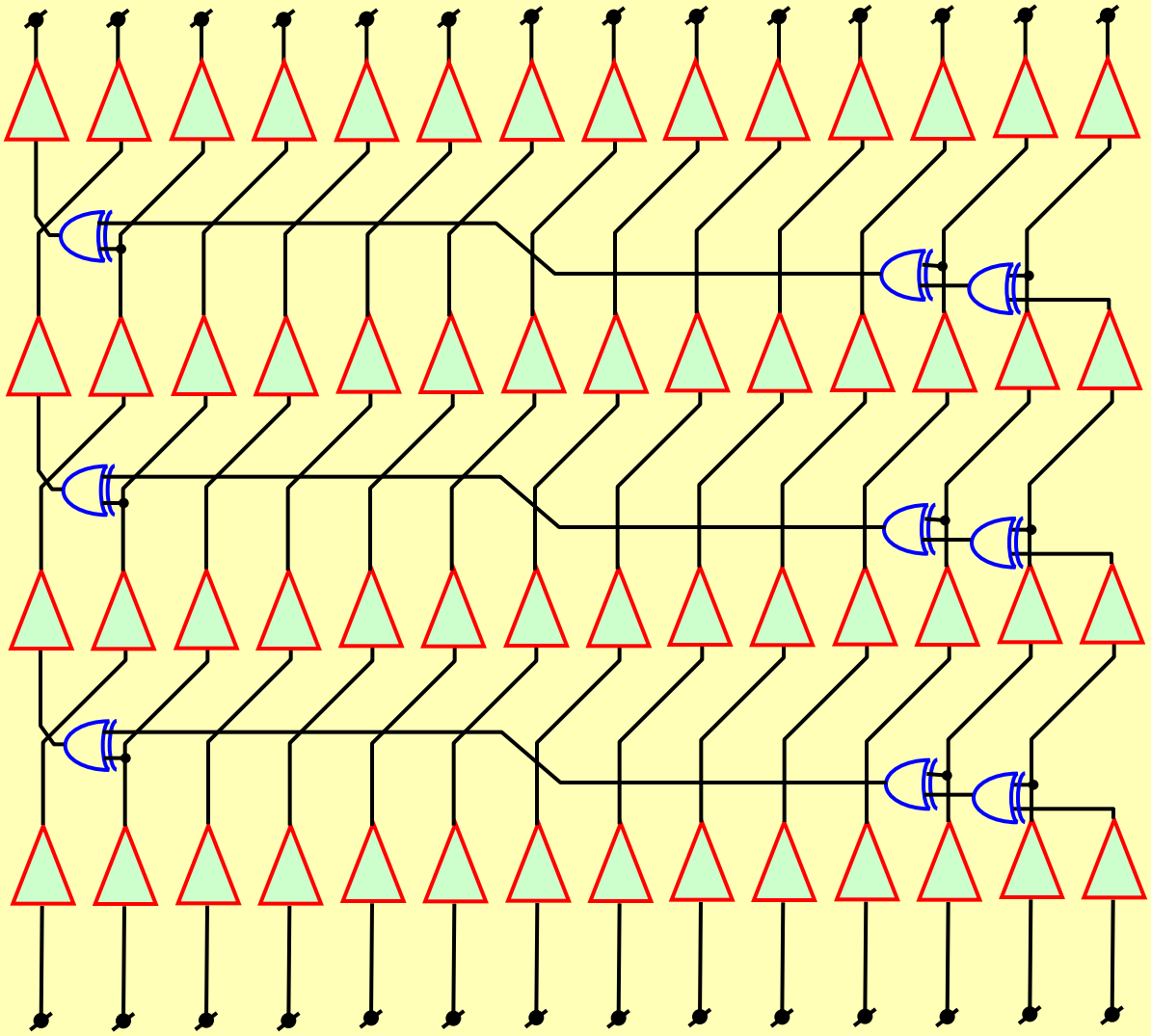
- We are trying to implement the following sequential schematic:



- If we are using a table type implementation, the sequential schematic above becomes fully combinatorial and an example of combinatorial implementation for three (3) time steps is shown in the next page:

A fully combinatorial schematic for the "table implementation" of the LFSR:

- The schematic below represents a "table implementation" of a four time step model built in all combinatorial logic. The triangles represent non-inverting buffers.



This models the third time step

This models the second time step

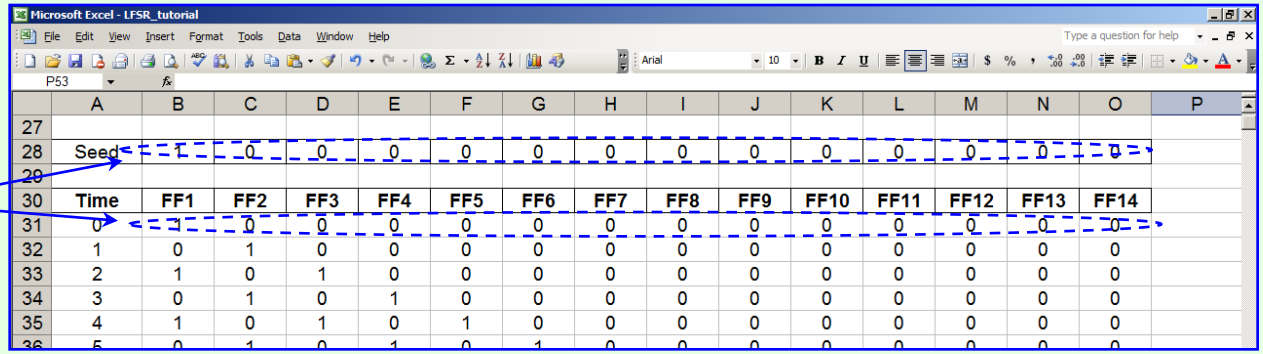
This models the first time step

This represents the initial condition set by the seed value

Input Seed

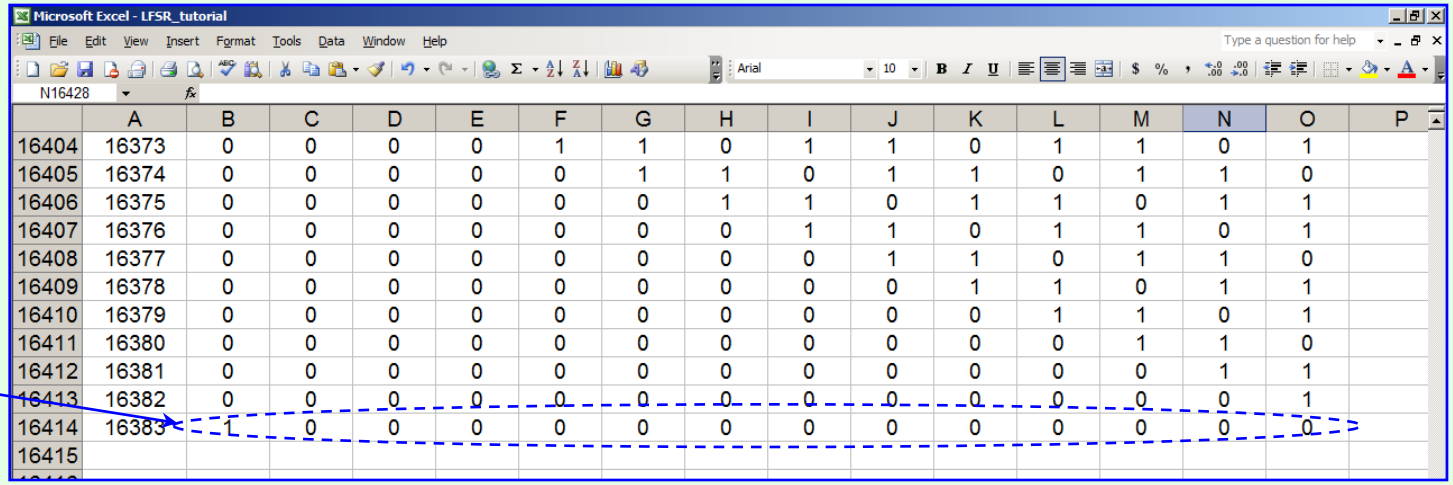
The spreadsheet "table implementation" of the LFSR:

- Rename the first worksheet "Tutorial_1" and copy it, then rename the new worksheet "Tutorial_2"
- A31: "0", A32: "=A31+1", B31: "=B28" then drag-copy B31 to the right up to cell O31



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
27															
28	Seed	1	0	0	0	0	0	0	0	0	0	0	0	0	0
29															
30	Time	FF1	FF2	FF3	FF4	FF5	FF6	FF7	FF8	FF9	FF10	FF11	FF12	FF13	FF14
31	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
32	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
33	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0
34	3	0	1	0	1	0	0	0	0	0	0	0	0	0	0
35	4	1	0	1	0	1	0	0	0	0	0	0	0	0	0

- A31: "=exor(C31,exor(M31,exor(N31,O31)))", C32: "=B31" then drag-copy C32to the right up to cell O32
- Drag-copy range A32:O32 down to row# 14614 (down to range A14614:O14614)
- We can see that range A14614:O14614 contains the starting seed which is what we expect since this particular LFSR is a maximum length LFSR and it is supposed to repeat the output sequence with a periodicity of $2^{14}-1=16383$



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
16404	16373	0	0	0	0	1	1	0	1	1	0	1	1	0	1
16405	16374	0	0	0	0	0	1	1	0	1	1	0	1	1	0
16406	16375	0	0	0	0	0	0	1	1	0	1	1	0	1	1
16407	16376	0	0	0	0	0	0	0	1	1	0	1	1	0	1
16408	16377	0	0	0	0	0	0	0	0	1	1	0	1	1	0
16409	16378	0	0	0	0	0	0	0	0	0	1	1	0	1	1
16410	16379	0	0	0	0	0	0	0	0	0	0	1	1	0	1
16411	16380	0	0	0	0	0	0	0	0	0	0	0	1	1	0
16412	16381	0	0	0	0	0	0	0	0	0	0	0	0	1	1
16413	16382	0	0	0	0	0	0	0	0	0	0	0	0	0	1
16414	16383	1	0	0	0	0	0	0	0	0	0	0	0	0	0
16415															