Conversion of flip flops pdf

In previous chapter, we discussed the four flip-flops, namely SR flip-flop, D flip-flop, JK flip-flop & T flip-flop. We can convert one flip-flop into the remaining three flip-flops by including some additional logic. So, there will be total of twelve flip-flop conversions. Follow these steps for converting one flip-flop to the other. Consider the characteristic table of desired flip-flop. Fill the excitation values (inputs) of given flip-flop for each combination of present state and next state. The excitation table for all flip-flops is shown below. Present State Next State SR flip-flop inputs D flip-flop input JK flip-flop inputs T flip-flop input Q(t) Q(t+1) S R D J K T 0 0 0 x 0 0 x 0 0 1 1 0 1 1 x 1 1 0 0 1 0 x 1 1 1 1 x 0 1 x 0 0 Get the simplified expressions for each excitation input. If necessary, use Kmaps for simplifying. Draw the circuit diagram of desired flip-flop according to the simplified expressions using given flip-flop and necessary logic gates. Now, let us convert few flip-flops into other. Follow the same process for remaining flipflop conversions. SR Flip-Flop to other Flip-Flop Conversions Following are the three possible conversions of SR flip-flop to other flip-flops. SR flip-flop to D flip-flop SR flip-flop to JK flip-flop SR flip-flop to T flip-flop SR flip-flop to D flip-flop conversion Here, the given flip-flop is SR flip-flop and the desired flip-flop is D flip-flop. Therefore, consider the following characteristic table of D flip-flop. D flip-flop input Present State Next State D Q(t) Q(t + 1) 0 0 0 0 1 0 1 0 1 1 1 1 We know that SR flip-flop has two inputs S & R. So, write down the excitation values of SR flip-flop for each combination of present state and next state values. The following table shows the characteristic table of D flip-flop along with the excitation inputs of SR flip-flop. D flip-flop input Present State Next State SR flip-flop inputs D Q(t) Q(t + 1) S R 0 0 0 0 x 0 1 0 0 1 1 0 1 1 0 1 1 1 x 0 From the above table, we can write the Boolean functions for each input as below. $$S=m_{2}+d_{3}$$ $$R=m_{1}+d_{0}$$ We can use 2 variable K-Maps for getting simplified expressions for these inputs. The k-Maps for S & R are shown below. So, we got S = D & R = D' after simplifying. The circuit diagram of D flip-flop is shown in the following figure. This circuit consists of SR flip-flop and an inverter. This inverter produces an output, which is complement of input, D. So, the overall circuit has single input, D and two outputs Q(t) & Q(t)'. Hence, it is a D flip-flop. Similarly, you can do other two conversions. D Flip-Flop to other Flip-Flop Conversions Following are the three possible conversions of D flip-flop to other flip-flops. D flip-flop to T flip-flop D flip-flop to SR flip-flop D flip-flop to JK flip-flop D flip-flop to T flip-flop conversion Here, the given flip-flop is D flip-flop and the desired flip-flop is T flip-flop. Therefore, consider the following characteristic table of T flip-flop. T flip-flop input Present State Next State T Q(t) Q(t + 1) 0 0 0 0 1 1 1 0 1 1 1 0 We know that D flip-flop has single input D. So, write down the excitation values of D flip-flop for each combination of present state and next state values. The following table shows the characteristic table of T flip-flop along with the excitation input of D flip-flop. T flip-flop input Present State Next State D flip-flop input T Q(t) Q(t + 1) D 0 0 0 0 0 1 1 1 1 0 1 1 1 1 0 0 From the above table, we can directly write the Boolean function of D as below. $$D=T\oplus Q\left (t \right)$$ So, we require a two input Exclusive-OR gate along with D flip-flop. The circuit diagram of T flip-flop is shown in the following figure. This circuit consists of D flip-flop and an Exclusive-OR gate. This Exclusive-OR gate produces an output, which is Ex-OR of T and Q(t). So, the overall circuit has single input, T and two outputs Q(t) & Q(t)’. Hence, it is a T flip-flop. Similarly, you can do other two conversions. JK Flip-Flop to other Flip-Flop Conversions Following are the three possible conversions of JK flip-flop to other flip-flops. JK flip-flop to T flip-flop JK flip-flop to D flip-flop JK flip-flop to SR flip-flop JK flip-flop to T flip-flop conversion Here, the given flip-flop is JK flip-flop and the desired flip-flop is T flip-flop. Therefore, consider the following characteristic table of T flip-flop. T flip-flop input Present State Next State T Q(t) Q(t + 1) 0 0 0 0 1 1 1 0 1 1 1 0 We know that JK flip-flop has two inputs J & K. So, write down the excitation values of JK flip-flop for each combination of present state and next state values. The following table shows the characteristic table of T flip-flop along with the excitation inputs of JK flipflop. T flip-flop input Present State Next State JK flip-flop inputs T Q(t) Q(t + 1) J K 0 0 0 0 x 0 1 1 x 0 1 0 1 1 x 1 1 1 0 x 1 From the above table, we can write the Boolean functions for each input as below. $$J=m_{2}+d_{1}+d_{3}$$ $$K=m_{3}+d_{0}+d_{2}$$ We can use 2 variable K-Maps for getting simplified expressions for these two inputs. The k-Maps for J & K are shown below. So, we got, J = T & K = T after simplifying. The circuit diagram of T flip-flop is shown in the following figure. This circuit consists of JK flip-flop only. It doesn’t require any other gates. Just connect the same input T to both J & K. So, the overall circuit has single input, T and two outputs Q(t) & Q(t)’. Hence, it is a T flip-flop. Similarly, you can do other two conversions. T Flip-Flop to other Flip-Flop Conversions Following are the three possible conversions of T flip-flop to other flip-flops. T flip-flop to D flip-flop T flip-flop to SR flip-flop T flip-flop to JK flip-flop T flip-flop to D flip-flop conversion Here, the given flip-flop is T flip-flop and the desired flip-flop is D flip-flop. Therefore, consider the characteristic table of D flip-flop and write down the excitation values of T flip-flop for each combination of present state and next state values. The following table shows the characteristic table of D flip-flop along with the excitation input of T flip-flop. D flip-flop input Present State Next State T flip-flop input D Q(t) Q(t + 1) T 0 0 0 0 0 1 0 1 1 0 1 1 1 1 1 0 From the above table, we can directly write the Boolean function of T as below. $$T=D\oplus Q\left (t \right)$$ So, we require a two input Exclusive-OR gate along with T flip-flop. The circuit diagram of D flip-flop is shown in the following figure. This circuit consists of T flip-flop and an Exclusive-OR gate. This Exclusive-OR gate produces an output, which is Ex-OR of D and Q(t). So, the overall circuit has single input, D and two outputs Q(t) & Q(t)’. Hence, it is a D flip-flop. Similarly, you can do other two conversions. In this article, let’s learn about flip flop conversions, where one type of flip flop is converted to another type. For the conversion of one flip flop to another, a combinational circuit has to be designed first. If a JK Flip Flop is required, the inputs are given to the combinational circuit and the output of the combinational circuit is connected to the inputs of the actual flip flop. Thus, the output of the actual flip flop is the output of the required flip flop. In this post, the following flip flop conversions will be explained. SR Flip Flop to JK Flip Flop As told earlier, J and K will be given as external inputs to S and R. As shown in the logic diagram below, S and R will be the outputs of the combinational circuit. The truth tables for the flip flop conversion are given below. The present state is represented by Qp and Qp+1 is the next state to be obtained when the J and K inputs are applied. For two inputs J and K, there will be eight possible combinations. For each combination of J, K and Qp, the corresponding Qp+1 states are found. Qp+1 simply suggests the future values to be obtained by the JK flip flop after the value of Qp. The table is then completed by writing the values of S and R required to get each Qp+1 from the corresponding Qp. That is, the values of S and R that are required to change the state of the flip flop from Qp to Qp+1 are written. SR Flip Flop to JK Flip Flop JK Flip Flop to SR Flip Flop This will be the reverse process of the above explained conversion. S and R will be the external inputs to J and K. As shown in the logic diagram below, J and K will be the outputs of the combinational circuit. Thus, the values of J and K have to be obtained in terms of S, R and Qp. The logic diagram is shown below. A conversion table is to be written using S, R, Qp, Qp+1, J and K. For two inputs, S and R, eight combinations are made. For each combination, the corresponding Qp+1 outputs are found ut. The outputs for the combinations of S=1 and R=1 are not permitted for an SR flip flop. Thus the outputs are considered invalid and the J and K values are taken as “don’t cares”. JK Flip Flop to SR Flip Flop SR Flip Flop to D Flip Flop As shown in the figure, S and R are the actual inputs of the flip flop and D is the external input of the flip flop. The four combinations, the logic diagram, conversion table, and the K-map for S and R in terms of D and Qp are shown below. SR Flip Flop to D Flip Flop D Flip Flop to SR Flip Flop D is the actual input of the flip flop and S and R are the external inputs. Eight possible combinations are achieved from the external inputs S, R and Qp. But, since the combination of S=1 and R=1 are invalid, the values of Qp+1 and D are considered as “don’t cares”. The logic diagram showing the conversion from D to SR, and the K-map for D in terms of S, R and Qp are shown below. D Flip Flop to SR Flip Flop JK Flip Flop to T Flip Flop J and K are the actual inputs of the flip flop and T is taken as the external input for conversion. Four combinations are produced with T and Qp. J and K are expressed in terms of T and Qp. The conversion table, K-maps, and the logic diagram are given below. JK Flip Flop to T Flip Flop JK Flip Flop to D Flip Flop D is the external input and J and K are the actual inputs of the flip flop. D and Qp make four combinations. J and K are expressed in terms of D and Qp. The four combination conversion table, the K-maps for J and K in terms of D and Qp, and the logic diagram showing the conversion from JK to D are given below. JK Flip Flop to D Flip Flop D Flip Flop to JK Flip Flop In this conversion, D is the actual input to the flip flop and J and K are the external inputs. J, K and Qp make eight possible combinations, as shown in the conversion table below. D is expressed in terms of J, K and Qp. The conversion table, the K-map for D in terms of J, K and Qp and the logic diagram showing the conversion from D to JK are given in the figure below. D Flip Flop to JK Flip Flop

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