Problem statement:

*A=A1 A0*is a 2-bit multiplicand and *B = B1 B0*is a 2-bit multiplier.*R=R3 R2 R1 R0*is the 4-bit product. That means *R=A×B.*

Design Details:

To design a circuit for the 2-bit multiplier at first we need to generate the required truth table, which is:

|  |  |
| --- | --- |
| Input | Output |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| A1 | A0 | B1 | B0 | R3 | R2 | R1 | R0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 |
| 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 |
| 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |

***Figure: Truth Table for 2-bit Multiplier.***

Then,we have to determine the required equations of *R3,R2,R1,R0*by using the K-Map method and the whole process is given below:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *B1 B0* |  |  |  |  |
| *A1 A0* |  | 00 | 01 | 11 | 10 |
|  | 00 | 0 | 0 | 0 | 0 |
|  | 01 | 0 | 0 | 0 | 0 |
|  | 11 | 0 | 0 | 1 | 0 |
|  | 10 | 0 | 0 | 0 | 0 |

So, *R3= A1A0B1 B0*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *B1 B0* |  |  |  |  |
| *A1 A0* |  | 00 | 01 | 11 | 10 |
|  | 00 | 0 | 0 | 0 | 0 |
|  | 01 | 0 | 0 | 0 | 0 |
|  | 11 | 0 | 0 | 0 | 1 |
|  | 10 | 0 | 0 | 1 | 1 |

So, *R2= A1A’0B1 + A1B1 B’0*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *B1 B0* |  |  |  |  |
| *A1 A0* |  | 00 | 01 | 11 | 10 |
|  | 00 | 0 | 0 | 0 | 0 |
|  | 01 | 0 | 0 | 1 | 1 |
|  | 11 | 0 | 1 | 0 | 1 |
|  | 10 | 0 | 1 | 1 | 0 |

So, *R1 = A1B’1 B0+ A1A’0B0+ A’1 A0B1+ A0B1 B’0*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *B1 B0* |  |  |  |  |
| *A1 A0* |  | 00 | 01 | 11 | 10 |
|  | 00 | 0 | 0 | 0 | 0 |
|  | 01 | 0 | 1 | 1 | 0 |
|  | 11 | 0 | 1 | 1 | 0 |
|  | 10 | 0 | 0 | 0 | 0 |

So, *R0= A0B0*

Circuit Diagram:

And, finally we have to draw the required logic diagram with the help of these equations and it is: