Binary Multiplication Simulator User Manual

This user manual details the four interactive aspects of the binary multiplication simulator: providing the input, selecting the multiplication algorithm to be displayed, selecting the display mode of the solution, and exporting the solution to a text file.

A. Providing User Input

To provide the input, i.e., the multiplicand and multiplier, the user enters the numbers in the **Multiplicand** and **Multiplier** fields on the left-hand side of the display.

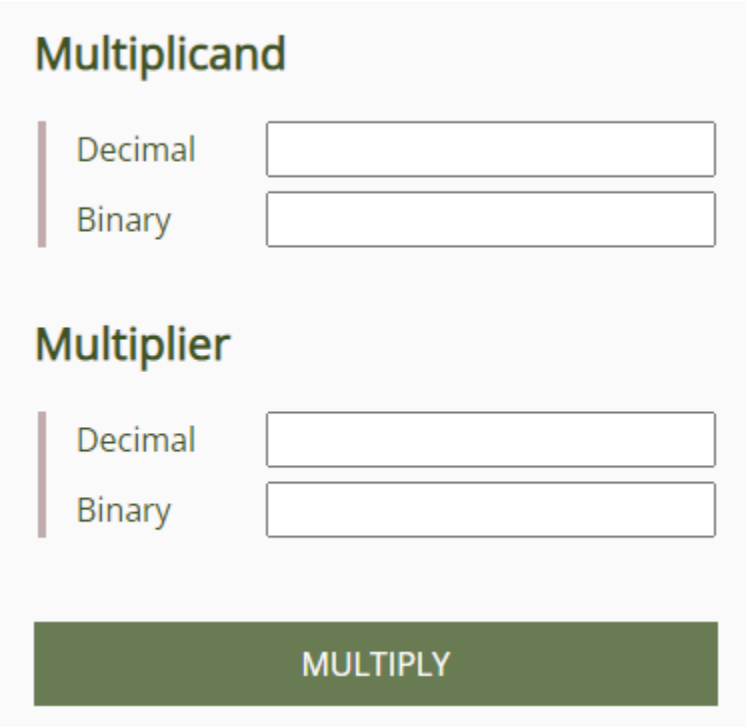

Figure 1. The Multiplicand and Multiplier fields for the user input

After entering the multiplicand and multiplier, the user clicks the **Multiply** button below the input fields to simulate the multiplication procedure for all three algorithms. Though the initial display is for the pencil-and-paper method, the user can view the simulations for all algorithms after clicking the Multiply button by changing the multiplication algorithm displayed, which is covered in Section B of this manual.

1. Supported Input Types

The simulator supports both decimal and binary input. Upon entering the input, the simulator automatically converts the input to the other input type (i.e., two's complement binary for a decimal input and vice versa) and displays it in the appropriate input field in real-time. **Note that binary inputs are interpreted by the simulator as given in two's complement**.

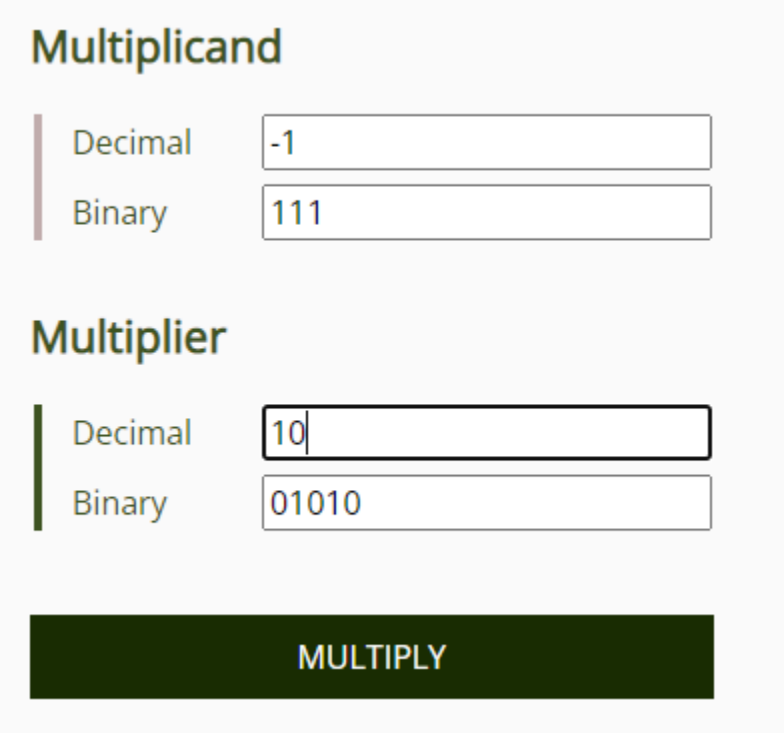

Figure 2. Automatic conversion of the user input

2. Input Error Checking

In the case of ambiguous input, after clicking the Multiply button, the simulator displays an error message detailing the error encountered and prompts the user to enter their input again. For example, the error message for an ambiguous binary input is presented in Figure 3.

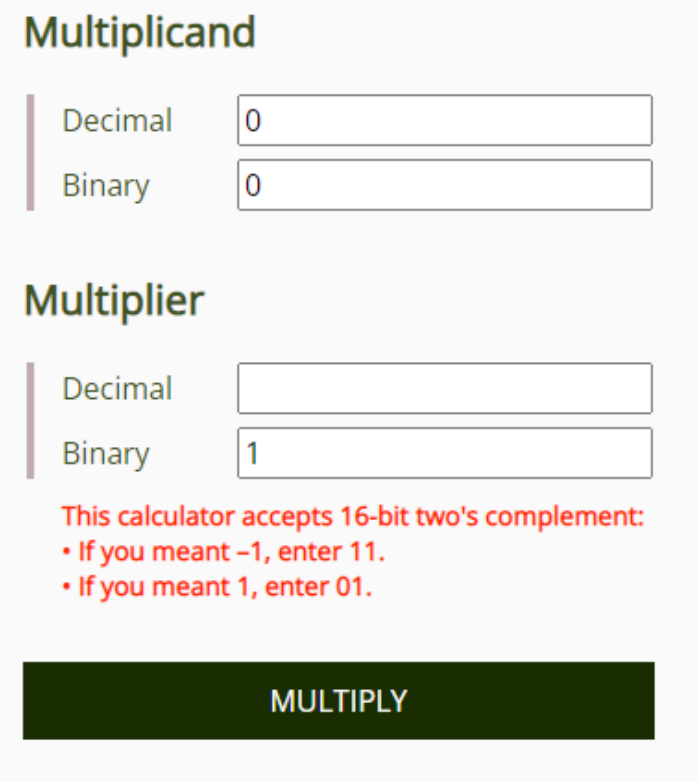

Figure 3. Error message for an ambiguous two's complement input

The full list of cases rejected by the simulation and their corresponding simulation responses is provided in Table 1.

Table 1. List of cases rejected by the simulation and the corresponding simulation responses

Case	Simulation Response
General Input (both decimal and binary)	
At least one factor (i.e., the multiplicand or multiplier) is blank	The Multiply button cannot be clicked
Letter inputs	The letter is not reflected in the text field
Decimal Input	
Special character inputs other than the positive (+) and negative (–) signs	The special character is not reflected in the text field

Inputs greater than $2^{15} - 1$	Error message stating that the input should not exceed 32767
Inputs less than -2^{15}	Error message stating that the input should not exceed –32768
Binary Input	
Special character inputs	The special character is not reflected in the text field
Numerical inputs other than 0 and 1	The number is not reflected in the text field
Inputs greater than $2^{15} - 1$ (Binary: 0111111111111111)	Error message stating that the input should not exceed 16 bits
Inputs less than -2^{15} (Binary: 1000000000000000)	Error message stating that the input should not exceed 16 bits
The ambiguous input 10…0 with 0 to 14 zeroes	Error message clarifying the input

B. Selecting the Multiplication Algorithm

Upon opening the simulator, it is set to display the pencil-and-paper method. To select a different multiplication algorithm, select **one of the three options** in the header section of the simulator. The currently selected multiplication algorithm is highlighted in yellow.

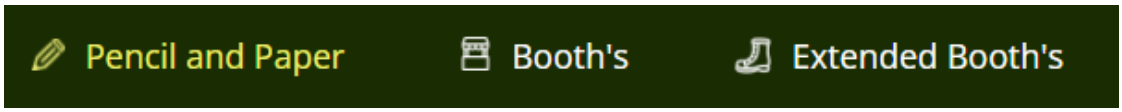

Figure 4. Options corresponding to the three multiplication algorithms, with the pencil-and-paper method currently selected

Note that, as mentioned in Section A of this document, clicking the Multiply button after supplying valid user input produces the simulations of the multiplication process using all three algorithms. Thus, the user can switch among the three algorithms without having to resubmit their input.

C. Selecting the Display Mode

Upon opening the simulator, it is set to display the simulations step by step. To select a different display mode, click the dropdown menu in the right-hand side of the header section of the simulator and select one of the two options: **Step by Step** or **Show All Steps**.

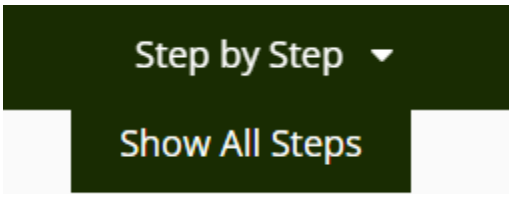

Figure 5. Dropdown menu for the two display modes, with the Step by Step mode currently selected

Note that the selected display mode remains the same for all three algorithms; for instance, if the user selects the Show All Steps option while displaying the pencil-and-paper method, then switches to the Booth's algorithm, the simulation will also be displayed all at once rather than step by step.

Moreover, in the Step by Step display mode, the user can perform three actions:

1. View the **next step** by clicking the button to the right of the step number
2. View the **previous step** by clicking the button to the left of the step number
3. Skip to a **particular step** by entering the chosen step number in the step number text field. Note the following special inputs:

    a. Inputs **greater than the maximum number of steps** will be capped to the **last step**;
    b. Inputs **less than 0** will display the **first step**; and
    c. An input of **0** will display the **description** of the algorithm.

Figure 6. Playback controls on the footer for the Step by Step mode

D. Exporting to a Text File

Upon generating the multiplication simulations, the user can export the solution using the currently selected algorithm to a text file by selecting **Export Steps to Text File**, located on the right-hand side of the footer section of the simulator.

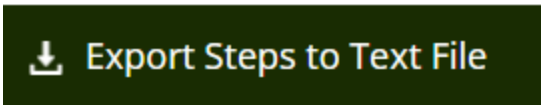

Figure 7. Export Steps to Text File option

Upon selecting this, a text file with the filename **`binaryMultiplication.txt`** is downloaded onto the user's machine.