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APPLICATION NOTE 3393

Frequency Calculator for the DS1094L

By: Hrishikesh Shinde

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Abstract: This application note presents an easy-to-use frequency calculator, for determining the register values to be programmed into the DS1094L Multiphase Spread-Spectrum EconOscillator. The DS1094L is capable of generating 4 multiphase, spread-spectrum, square wave outputs between 31.25kHz and 2MHz, in either 2, 3 or 4 phase modes. The spread-spectrum system function is important when EMI is a concern of the end application, such as switched-mode power supplies.

Need for the Calculator

The data sheet for the [DS1094L](#) shows how to manually calculate the register values for a desired frequency. The user must make a few iterations before arriving at the best set of register values ideally suited for their application. The Frequency Calculator, however, is an intuitive, fast method for the user to reach an optimal solution with minimal effort.

The Calculator

The Frequency Calculator was developed using Microsoft Excel 97 and should function on any platform that has Microsoft Excel 97 (or any newer version) with the Analysis Toolpack (Checking the Analysis Toolpack checkbox under Tools, Add-ins should turn the Analysis Toolpack on). It is available for [download](#) (XLS file). It is a standalone program and only requires a few inputs from the user to get it working! The calculator is shown in **Figure 1**.

User Inputs

The user must input values in the blue, italicized rows.

1. The first input is the Desired Frequency, which is entered in MHz. Allowable frequencies range between 0.03125MHz to 2MHz. The box below the Desired Frequency box will indicate an "Error!" if an incorrect value is entered.
2. To program the number of phases desired, the user then enters a value from Table 3 in the data sheet. The Phase Generator section in the data sheet explains the phase generator and the three options available. The default value of 0 will program the device to have 2 phases. The other options available are 1 and 2. The value 3 is a reserved input.

The Frequency Calculator then calculates solutions based on different options for the internal Master Oscillator Frequency and the Prescaler settings. These solutions are explained in the Master Oscillator and Prescaler sections of the data sheet, and briefly in the Calculations section below. There are four possible solutions for each Phase setting selection, one for each of the four Prescaler settings.

- The user now selects one of the desired solutions. As explained in the Frequency Calculator below, higher values for the master oscillator frequency will consume more power, but may provide a smaller percentage error. Depending on the application, the user decides on one of the four possible solutions.
- The user then selects the desired Dither Amount. This is applicable only if spread-spectrum output is desired. There are four settings, each corresponding to a different dither amount. The default is 0, which corresponds to a dither amount of 0% (no dither). Detailed information can be found in the Triangle Wave Generator section of the data sheet.
- The last input is the Dither Frequency which determines the modulation frequency for the spread-spectrum output. Again, there are four settings corresponding to different dither frequencies. The default is 0, corresponding to a dither frequency of $f_{MOSC}/128$. If dither is desired, the user enters a 1, 2, or 3 which correspond to the different frequencies shown in the calculator.

FREQUENCY CALCULATOR FOR THE DS1094L

- 1. Enter the Desired Frequency (in MHz)**

Note Valid Frequencies are between 0.03125MHz and 2 MHz

CORRECT
- 2. Select Desired Phase Generator Settings (see Notes)**

Note1 Refer to Figure 1 and Table 3 in Datasheet
 Note2: For very Low Frequencies, you might have to put in a higher Phase Value, and vice versa for Higher Frequencies

0 = 2 Phase, 1 = 3 Phase,
 2 = 4 Phase, 3 = Reserved
 (based on Table 3 in the datasheet)

CALCULATIONS

Master Oscillator Frequency (MHz)
 Note : Between 1MHz and 2MHz in 0.1 MHz (100KHz) steps

PreScaler Exponent
 Corresponds to Prescaler Value of

Value to be programmed in the DAC (decimal)

Expected Frequency Out (MHz)

% Error

Solution 1	Solution 2	Solution 3	Solution 4
1.0	1.9	FALSE	FALSE
0	1	2	3
1	2	4	8
0	9	FALSE	FALSE
0.25	0.2375	FALSE	FALSE
4.16666667	1.0416667	FALSE	FALSE

- 3. Select Solution (based on Calculations above)**

Note: Higher Frequencies consume more power

(Select between Solutions 1 - 4)
- 4. Select Desired Dither Amount**

0 = 0%, 1 = 2%, 3 = 4%, 4 = 8%
- 5. Select Desired Dither Frequency**

0 = $f_{MOSC}/128$, 1 = $f_{MOSC}/256$
 2 = $f_{MOSC}/512$, 3 = $f_{MOSC}/1024$

Value (BIN) to be programmed in "DAC" Register	00001001	(Make sure the correct Solution is selected above)
Value (HEX) to be programmed in "DAC" Register	09	
Value (BIN) to be programmed in "PRESCALER" Register	01001000	(Make sure the Analysis Toolpack is on, under Tools, Add-ins)
Value (HEX) to be programmed in "PRESCALER" Register	48	

The Calculations

After the user enters the first two inputs, the Frequency Calculator determines the possible solutions. As an example, **Table 1** shows the different options available for a desired frequency of 240kHz or 0.24MHz.

Table 1

	0 = 2 Phase		1 = 3 Phase		2 = 4 Phase	
Master Frequency (Mhz)	1	1.9	1.4	1	1.9	
Prescaler Value	2	3	1	0	1	
Actual Output Frequency (MHz)	0.25	0.238	0.233	0.25	0.238	
Error (%)	4.17	1.04	2.79	4.17	1.04	

As shown, the user has several options which would have taken a long time to calculate manually, but are easily determined using the Frequency Calculator. Depending on the requirements and tolerable error, the user can determine which option best fits the application. The major tradeoffs are power (due to a higher master frequency) and allowable error.

Interpreting the Results

Once the inputs are correctly entered, the Frequency Calculator gives the values in binary (BIN) and in hexadecimal (HEX), which must be programmed into the device.

However, issues can arise when the user inputs an incorrect value. Some cases are presented below:

- If the user enters an incorrect frequency, the programmed values will not be correct. The CALCULATIONS section will also show "False" values in all the sections.
- The phase settings may not be high enough to enable that particular frequency. (As recommended, the phase value should be higher for a very low frequency, typically less than 120kHz.) In this case, again, all the solutions in the CALCULATIONS section will show a "False" value. The user will have to increase the phase settings value.
- The solutions section might not be programmed correctly. If the calculator shows that Solution 1 is valid and others are not, then the user must input '1' in the Select Solution cell. If other solutions are selected, incorrect values will appear in the "Values to be programmed" cells.

Conclusion

The Frequency Calculator lets the user easily obtain the correct values to be programmed into the DS1094L for a desired frequency.

Depending on the volume, devices can also be custom programmed at our factory to customer-defined frequencies. These requests should be sent to: custom_EconOscillators_Info@dalsemi.com.

Questions, comments, and suggestions concerning this application note can be sent to: MixedSignal.Apps@dalsemi.com.

Related Parts

[DS1094L](#)

Multiphase Spread-Spectrum EconOscillator

[Free Samples](#)

More Information

For Technical Support: <http://www.maximintegrated.com/support>

For Samples: <http://www.maximintegrated.com/samples>

Other Questions and Comments: <http://www.maximintegrated.com/contact>

Application Note 3393: <http://www.maximintegrated.com/an3393>

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