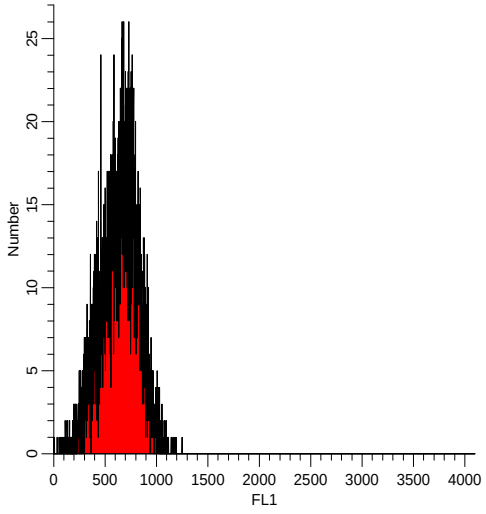
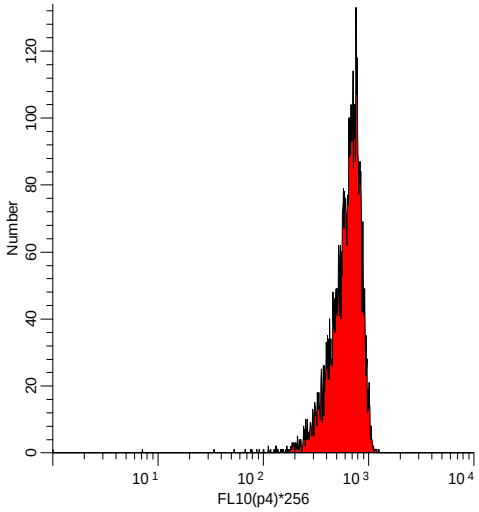
A Discussion of Linear-to-Log Data Conversion in Flow Cytometry

From this



To this



A Discussion of Linear-to-Log Data Conversion in Flow Cytometry

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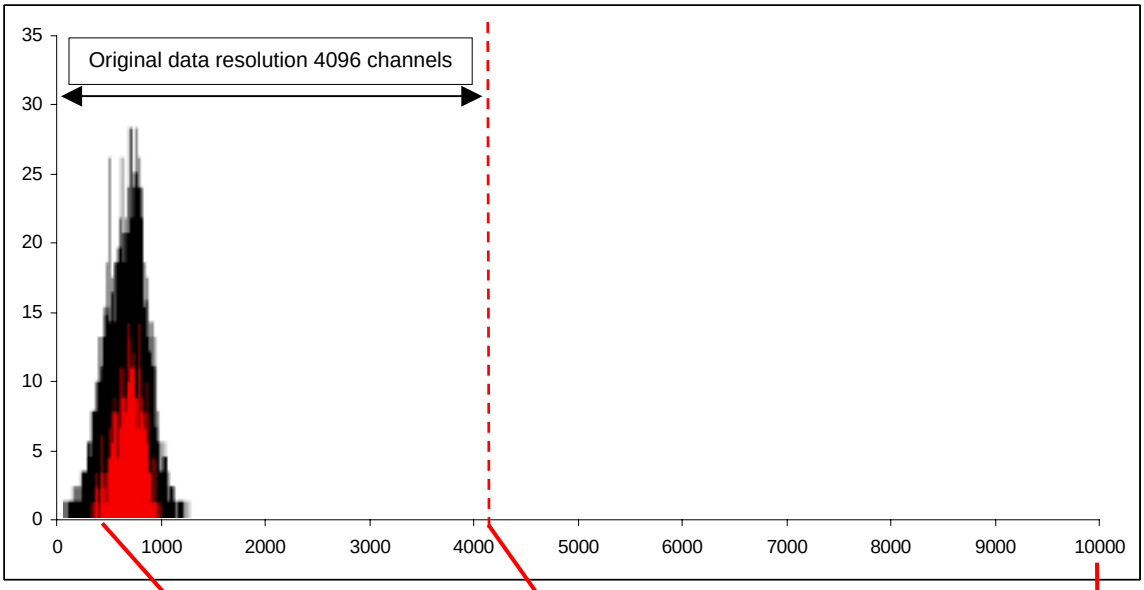
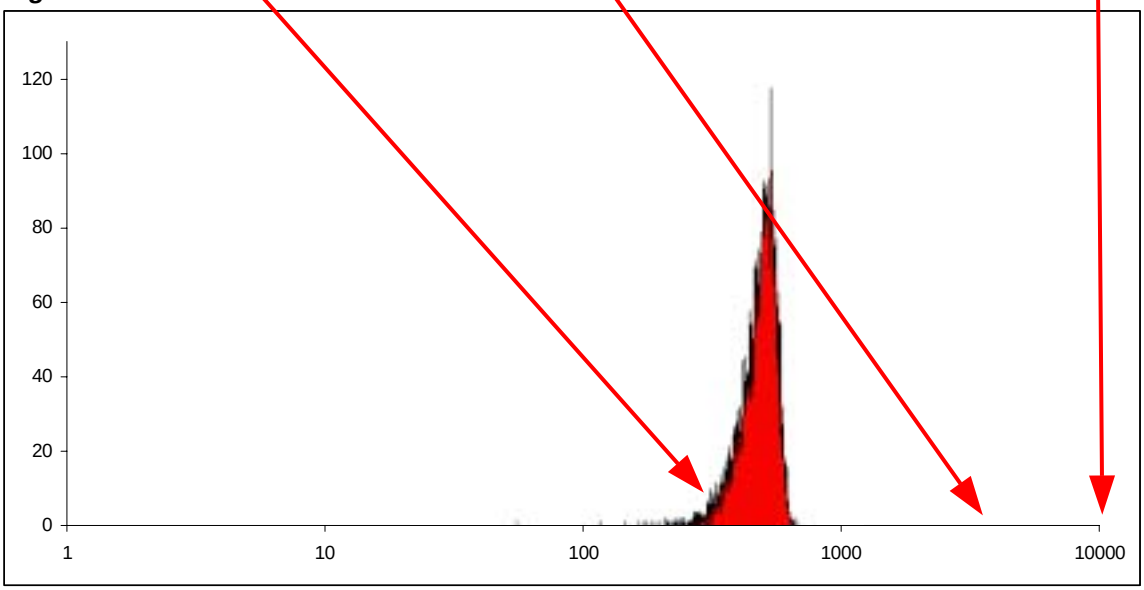
There are different techniques one may employ to convert linear scale data in a flow cytometric listmode data file to an equivalent log scale data distribution. One method displays the data in the number of log decades represented by the resolution of the parameter. The other method displays the data on a four-decade log scale. Each will give equivalent results if done properly, as will be shown in the following examples. For consistency of data presentation in flow cytometry, the four-decade log scale method is preferred.

Below is a general schematic representation of the desired transformation:

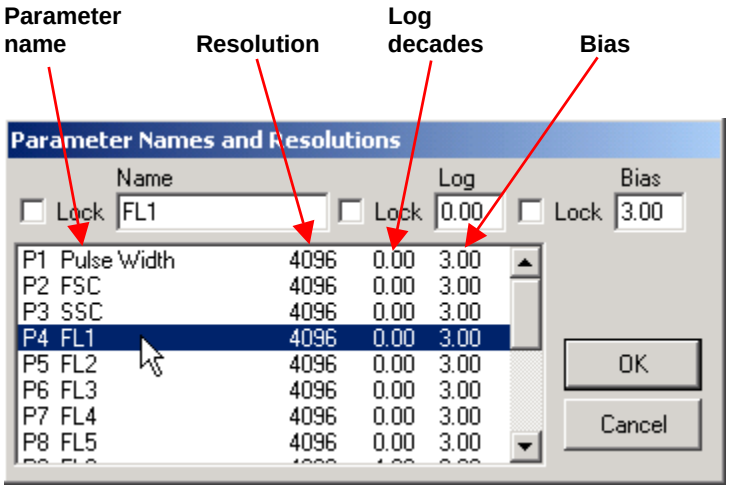
Linear Domain



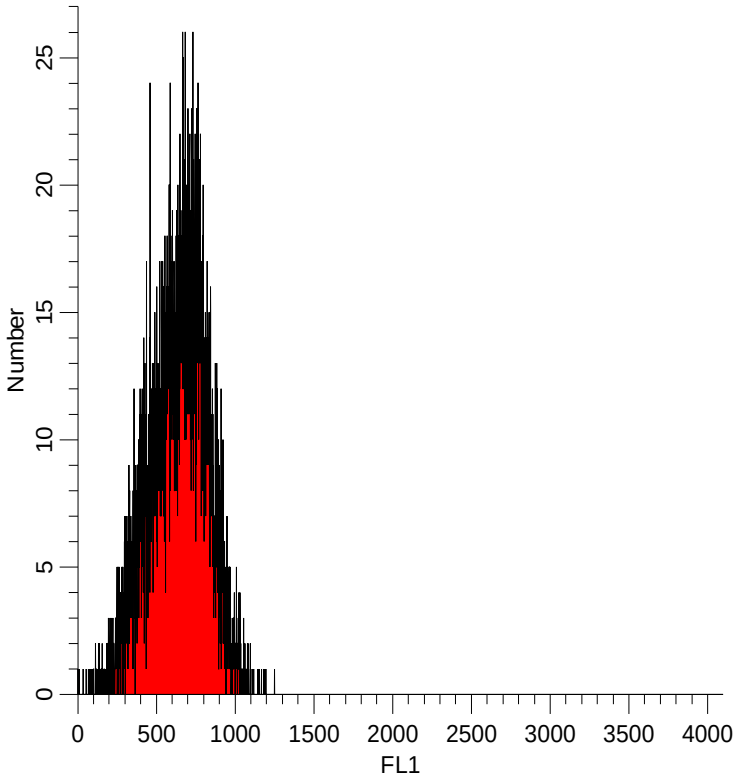
Log Domain



To begin, we examine a listmode file whose parameter of interest, parameter 4 (FL1) is linear with a native resolution of 4096 channels. Note that the log decade scale (Log) is zero in the file keyword, indicating a linear scale acquisition parameter. The parameter's values range from 0 to 4095.



A single-parameter histogram of this parameter, displayed at a resolution of 4096 channels, is shown below. The linear median X is 653.34 (**Example 1**).

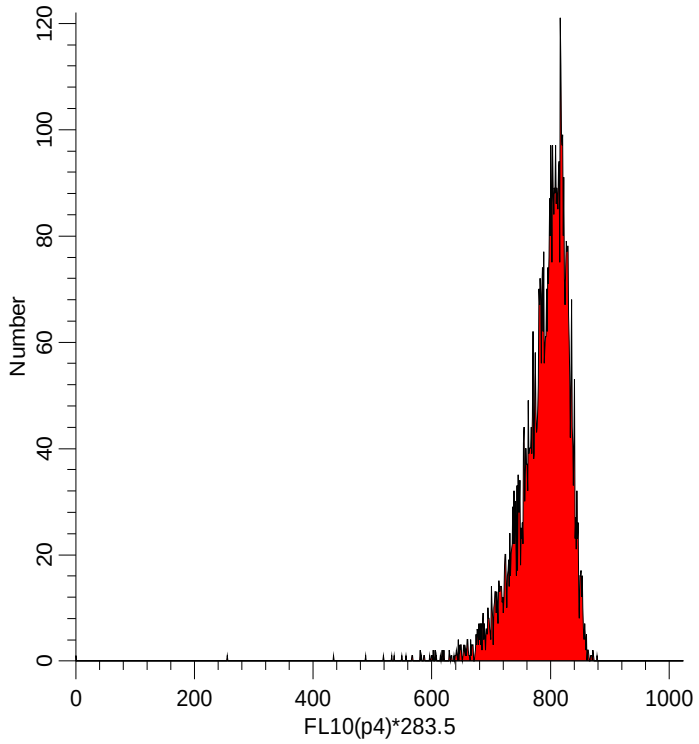


Example 1

In WinList, converting this linear scale value to a log scale is given by the equation Y=log(P4)*1024/log(4096) *(Y=log(parameter)*(calculated parameter resolution)/log(acquisition resolution)*, which can be reduced to Y=log(P4)*1024/3.612, or

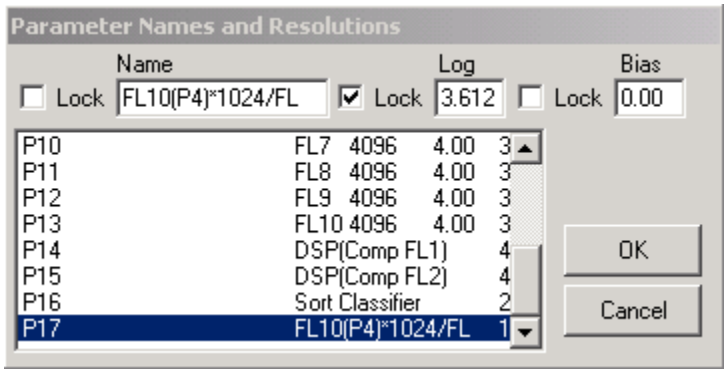
Y=log(P4)*283.5 **(Equation 1).**

A single-parameter histogram of this calculated parameter, displayed at a resolution of 1024 channels, is shown below.

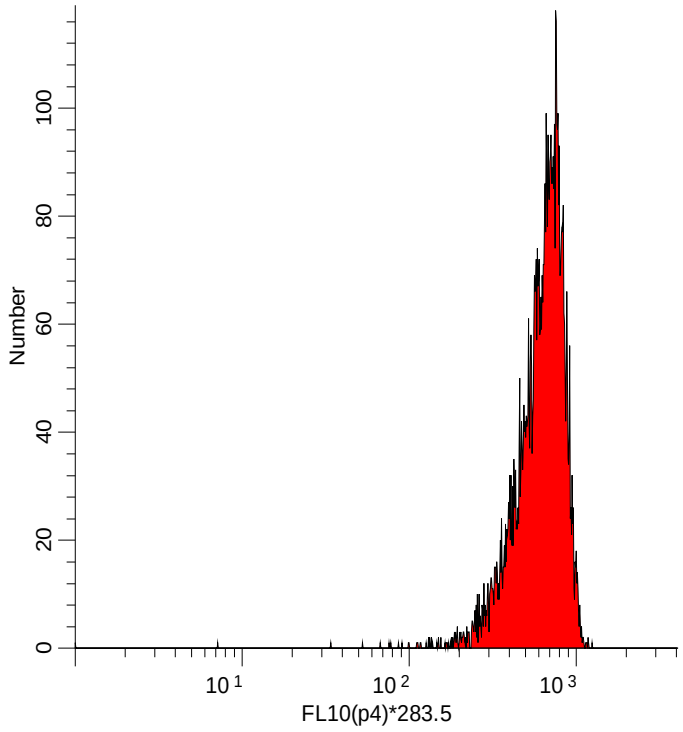


The problem here is that we are displaying a log parameter on linear axis scale. Let's see how to display the data on a log axis. A correct treatment would be to calculate the number of log decades represented by the original data's linear scale. This is represented as log(R), where R is the acquisition resolution. In this example, the number of log decades represented by the original parameter is log(4096), or 3.612 log decades.

Enter the actual value of 3.612 log decades in WinList in the Names and Resolution dialog:



The resulting histogram, now properly scaled, is shown below. Note that the scale is less than 4 decades. The linMedian X is 652.11 (**Example 2**).



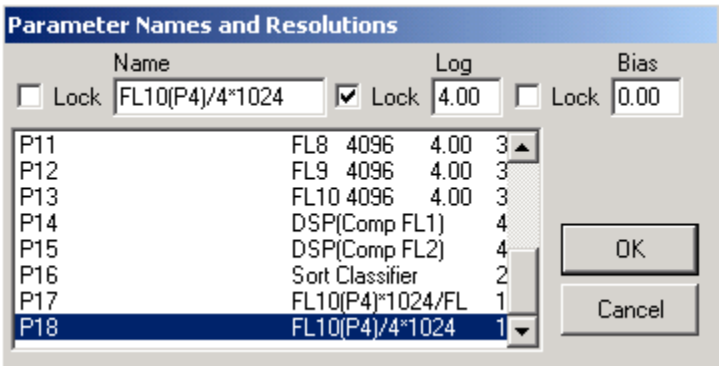
Example 2

We are displaying a linear scale of 4096 units on a log scale. We do not want to change the absolute linear value in the process. The original linear X median (**Example 1**), was 653.34. Using the actual 3.612 log decade range of the original acquisition resolution yields a linear median X (**Example 2**) of 652.11 on the log scale, nearly equivalent to the original linear scale acquisition. Due to rounding effects, transformed values might not exactly match the linear values.

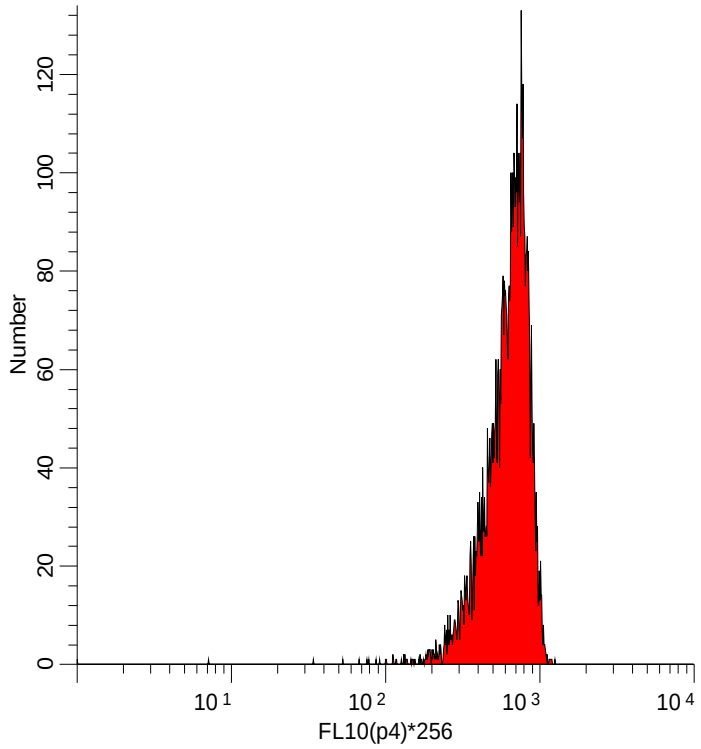
We may also maintain the proper linear scale in a little simpler manner by changing the transformation expression itself: Y=log(P4)*1024/log(10,000), which simplifies to Y=log(P4)*1024/4, or

Y=log(P4)*256 (Equation 2).

This transformed parameter is in 4-decade log scale, and we enter 4.00 in the Names and Resolutions dialog.



The histogram below shows a full four-decade resolution scale with a linMedian X of 653.97 (**Example 3**).



Example 3

Summation

The table below shows the results of these transformations in relation to the original linear scale data. A transformation using the absolute number of log decades for this 4096 channel resolution parameter is shown in Example 2. A proper transformation that displays the data in a full four-decade log scale is shown in Example 3.

	Calculated parameter expression used:	**Log decades in Names and Resolutions**	**Log decades in histogram**	**Linear Median Value**
Example 1	WinList linearization			**653.34**
Example 2	Y=log(P4)*283.5	3.612	3.612	652.11
Example 3	Y=log(P4)*256	4.00	4.00	653.97