

Creating “Eye” Displays Using Probe in the PSpice Environment

December 2009

In communications work, the “eye” display is frequently used to illustrate the voltage and timing margins present in a system transmitting digital data. In an eye display the signal is shown with a time axis that is a small number of data periods long. The signal “wraps” from the right edge of the display back to the left edge, thereby depicting a large number of overlapping data periods. If a random bit pattern is simulated and then displayed in this way, the required margins can be seen as the opening in the “eye” on the display.

Probe’s macro feature can be used to create a sweep function that implements the wrap feature required. You can then change the time axis variable from time to this sweep function to obtain an eye display. To use the macro feature, select Macros from the Trace menu in Probe. Then enter these three macros:

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pi=4*atan(1)
mod(a, b) = (b)*(atan(tan((a)/(b))*pi-pi/2))+pi/2)/pi
eye_sweep(p, d) = mod(time+(p)/2+(d), p) - ((p)/2+(d))

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The first macro (π) calculates the value of π . The second macro (mod) is a floating-point modulo function, implemented using the tangent and arctangent functions. The third macro (eye_sweep) implements an “eye sweep” function; the display is centered at one half the period ($p/2$), plus a time delay (d). To use the macros, simply change the time axis variable from time to $\text{eye_sweep}(p, d)$. In this function, p is the data period of the system (or a multiple of it), and d is the time interval by which the start of the display is delayed.

As an example, consider a simple system that sends a “random” stream of bits through an Analog Behavioral Model of a bandpass filter. The bit stream is generated by a ten-bit shift register (U1) with feedback provided by an XOR gate (U2). The signal is processed by a tristate buffer (U3) and a filter (E1). This arrangement generates a pseudo-random sequence 1023 bits long. The simulation runs for 1.5 usec, which is 300 bit periods of 5 nsec.

Here is a schematic diagram of the circuit:

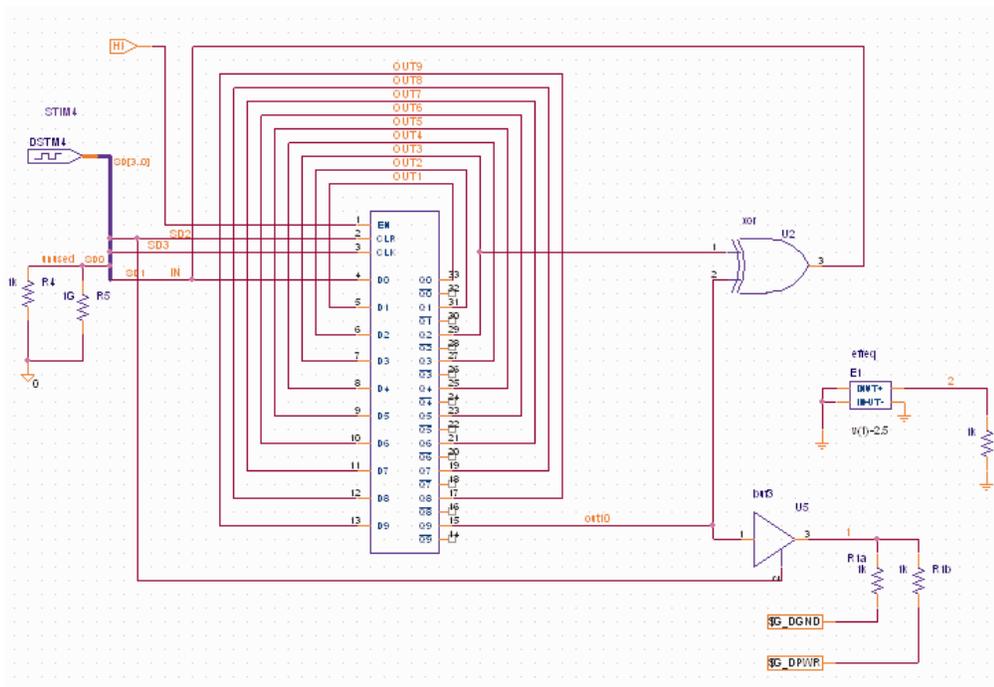


Figure 1: Schematic diagram of random generator

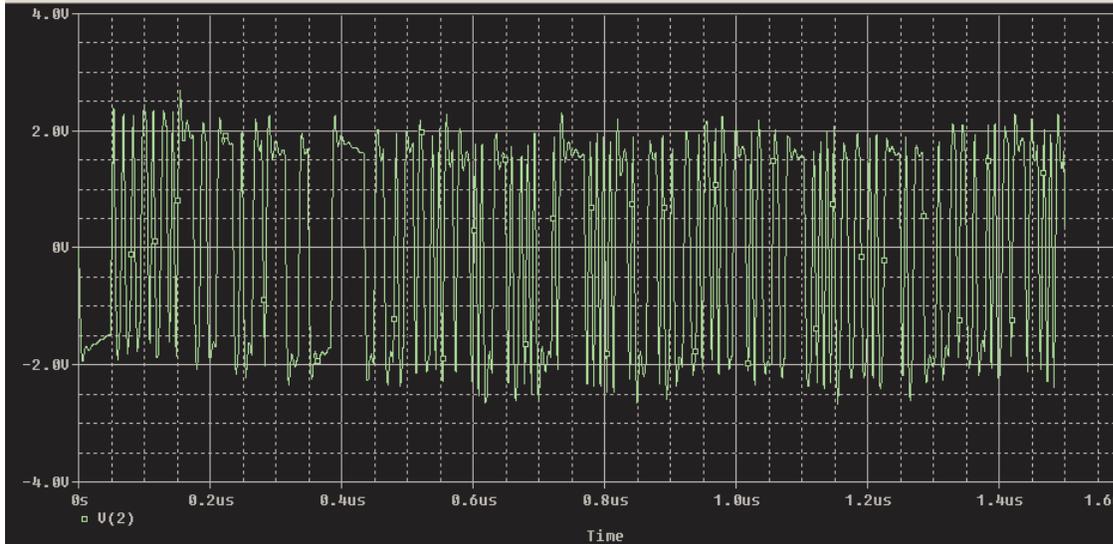


Figure 2: Standard filter output

Figure 2 shows the standard display of the filter's output versus time. It is very difficult to use this display to determine the voltage and timing margins for data recovery from the system. The eye display, on the other hand, superimposes the results for all three hundred data periods on a shortened time axis, enabling both margins to be gauged easily.

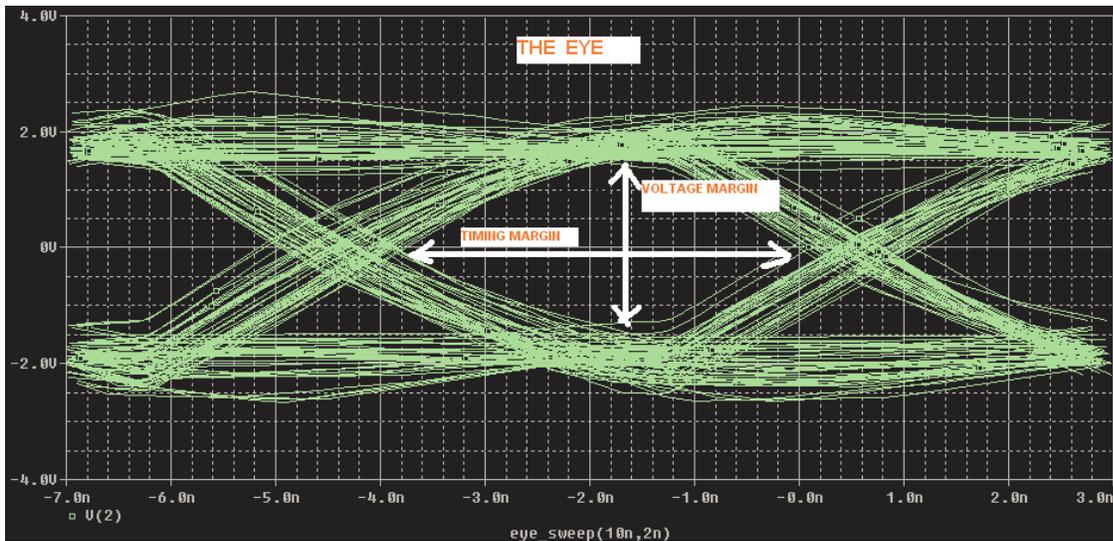


Figure 3: Filter output for two data periods showing classic eye shape

Figure 3 shows the eye display of the filter output with two data periods for the time axis duration, and shows the classic eye shape. The problem is that half of the simulation data is displayed, not in the central eye, but in the two half-eyes on either side.

To include all of the simulation data in one eye, we need to use a single data period for the sweep period. We also need to offset the display slightly to make sure that the eye is centered in the smaller display. The results are shown below.

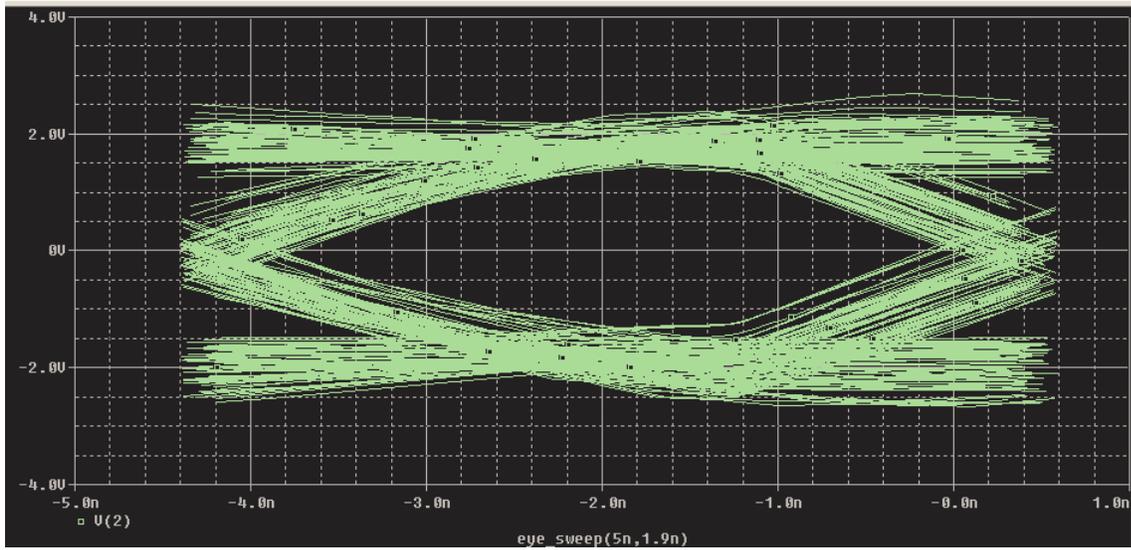


Figure 4: Filter output for one data period showing all simulation data in one eye