How to obtain the steady state values from IBIS model I-V curves to verify with the steady state values from V-T curves?

In the IBIS model, sometimes we encounter a warning of I-V and V-T mismatch when performing IBIS syntax checking. This warning is referring to the steady state voltage values found in the V-T curves such as rising and falling which are different from the steady state voltage values obtained from the I-V curves such as pullup and pulldown. Whenever the differences exceed certain limits as specified by the IBIS syntax checker, it will prompt warning or error. The following steps show how to construct load lines at the I-V curves to obtain the steady state voltage values and verify with the steady state voltage values from the V-T curves. Note that you would need to manually take the screenshots of the I-V curves and use a photo editing program such as Microsoft Paint to draw the load lines.

1. Set Up

The examples in this document use the following:

- HyperLynx Visual IBIS Editor Version 4.1
- The Cyclone IV GX ttl25_rio_r25 IBIS model curves at typical corner
- Microsoft Paint

2. Load line

Load line of 50Ohm is constructed using the following equation:

I = (Vfixture - Vsweep)/50

Note:

i. Vfixture can be found in the IBIS model by looking for the V_fixture, Vfixture_min, and V_fixture_max keywords

ii. Vsweep = x-axis of the I-V curves

3. Steady state of rising with Vfixture = Vccio

To verify the steady state value of the V-T curve rising characteristic type 2 (with Vfixture = Vccio) with the steady state value obtained from the I-V curve, do the following:

a) Construct the load line at the Pullup + Both clamps curves

b) Plot two points with the load line equation by setting Vsweep = 0 and Vsweep = Vfixture
   i) Vsweep = 0; I = (2.5 - 0)/50 = 50mA
   ii) Vsweep = 2.5; I = (2.5 - 2.5)/50 = 0A

c) Draw a straight line connecting the above 2 points to construct the 50Ohm load line

d) Zoom into the waveform to have a proper view if needed

e) As shown in the Figure 3-1, the crossing of the 50Ohm load line with the typical Pullup + Both Clamps curve (blue line) = 2.5V is similar to the steady state of the typical rising characteristic type 2 = 2.5V in Figure 3-2.

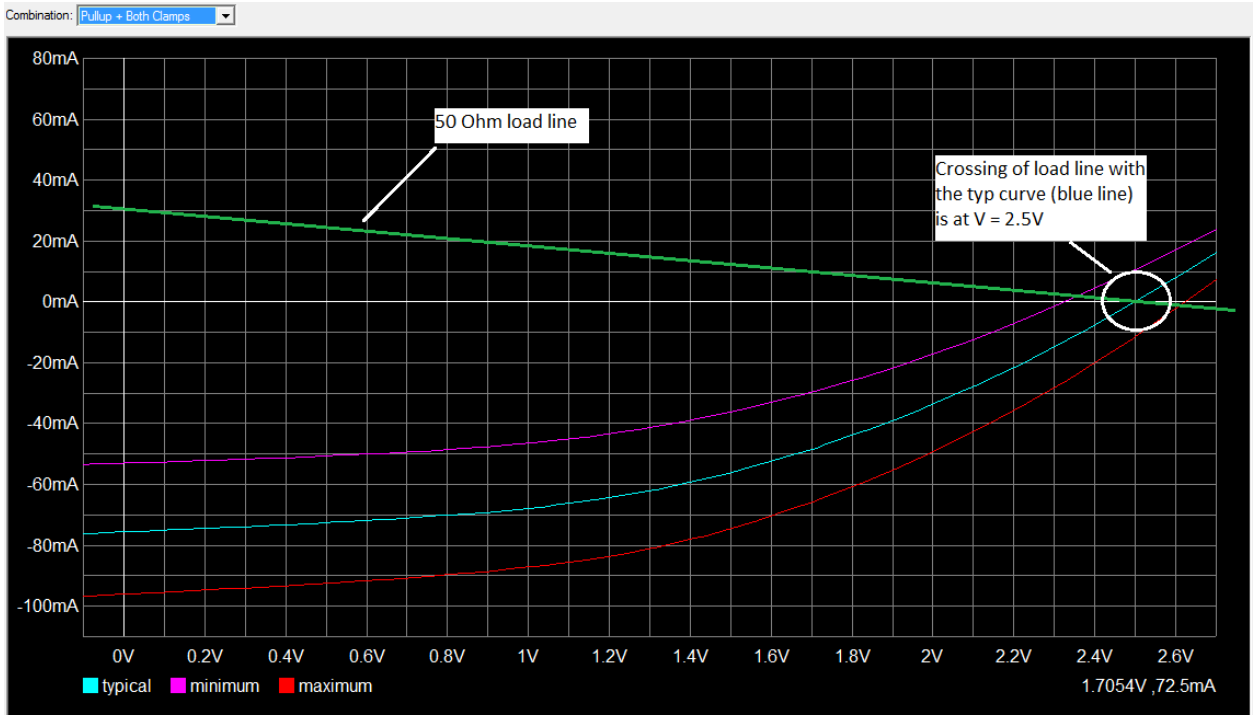

Figure 3-1. Crossing of 50 Ohm load line with the typical Pullup + Both Clamps curve

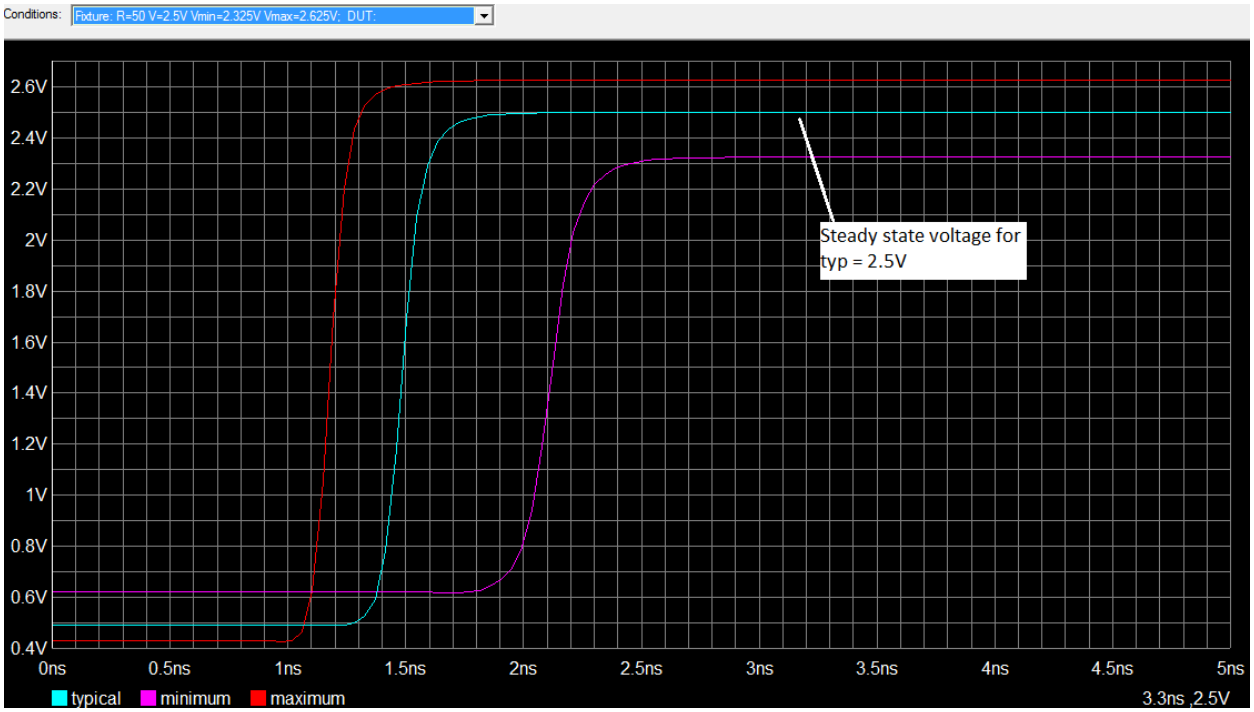

Figure 3-2. Steady state voltage of the typical rising characteristics with Vfixture = Vccio

4. Steady state of rising with Vfixture = 0

To verify the steady state value of the V-T curve rising characteristic type 1 (with Vfixture = 0) with the steady state value obtained from the I-V curve, do the following:

a) Construct the load line at the Pullup + Both clamps curves

b) Plot two points with the load line equation by setting Vsweep = 0 and Vsweep = Vfixture
   i. Vsweep = 0; I = (0 - 0)/50 = 0 mA
   ii. Vsweep = 2.5; I = (0 - 2.5)/50 = -50 mA

c) Draw a straight line connecting the above 2 points to construct the 50 Ohm load line

d) As shown in Figure 4-1, the crossing of the 50 load line with the typical Pullup + Both Clamps curve (blue line) = 1.9111V has no significant difference from the steady state of the rising characteristic type 1 = 1.914V in Figure 4-2

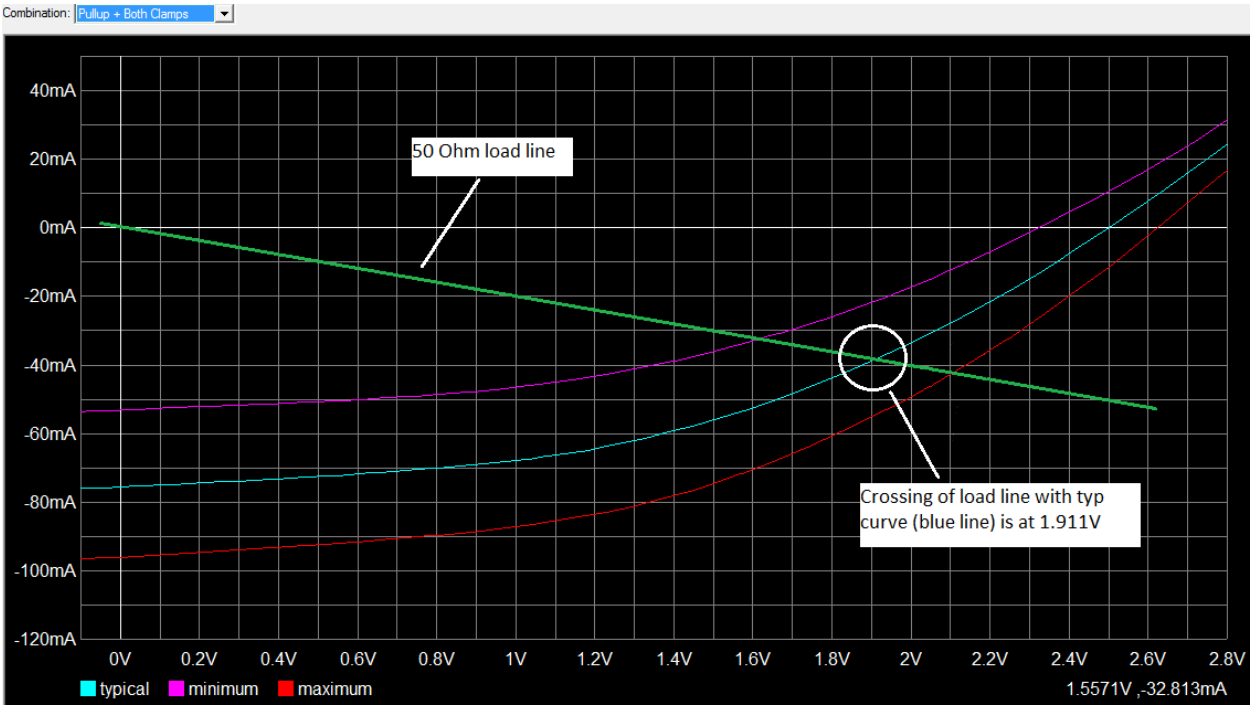

Figure 4-1. Crossing of 50 Ohm load line with the typical Pullup + Both Clamps curve

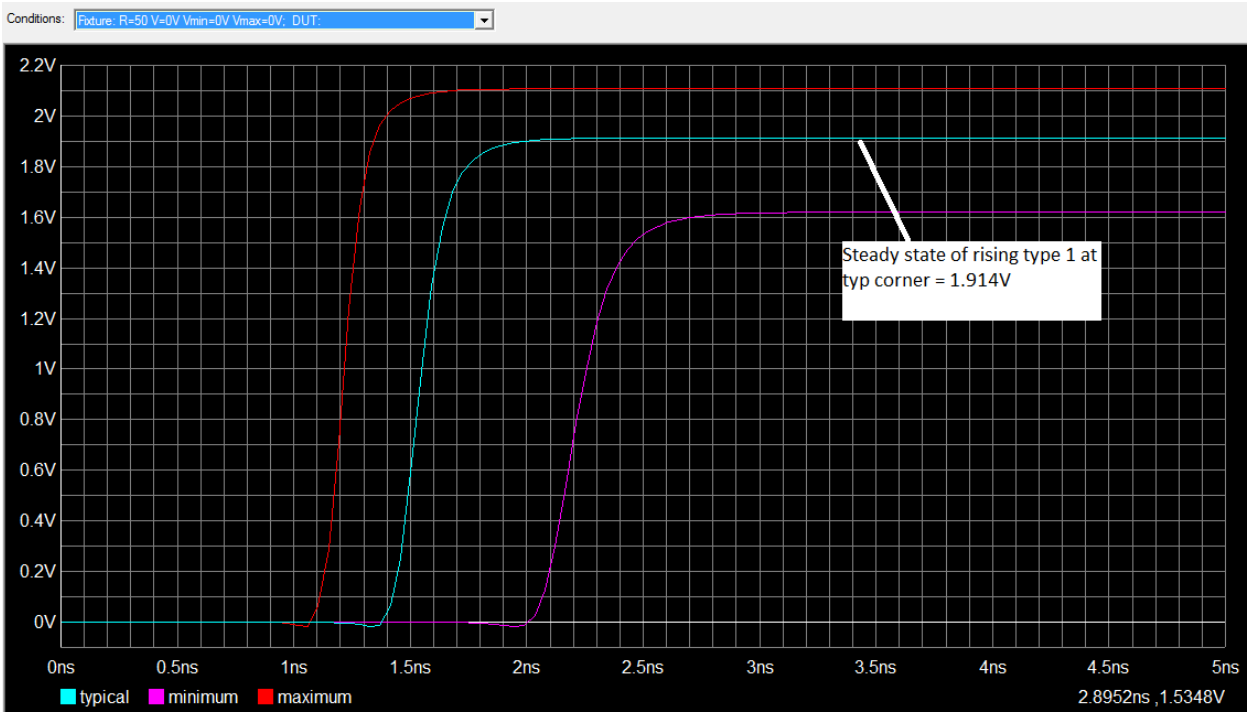

Figure 4-2. Steady state voltage of the typical rising characteristics with Vfixture = 0V

5. Steady state of falling with Vfixture = Vccio

To verify the steady state value of the V-T curve falling characteristic type 2 (with Vfixture = Vccio) with the steady state value obtained from the I-V curve, do the following:

a) Construct the load line at the Pulldown + Both clamps curves
b) Plot two points with the load line equation by setting Vsweep = 0 and Vsweep = Vfixture
    i. Vsweep = 0; I = (2.5 - 0)/50 = 50mA
    ii. Vsweep = 2.5; I = (2.5 - 2.5)/50 = 0A
c) Draw a straight line in connecting the above 2 points to construct the 50 Ohm load line
d) As shown in Figure 5-1, the crossing of the 50 load line with the typical Pulldown + Both Clamps curve (blue line) = 0.494V has no significant difference from the steady state of the falling characteristic type 2 = 0.493V in Figure 5-2

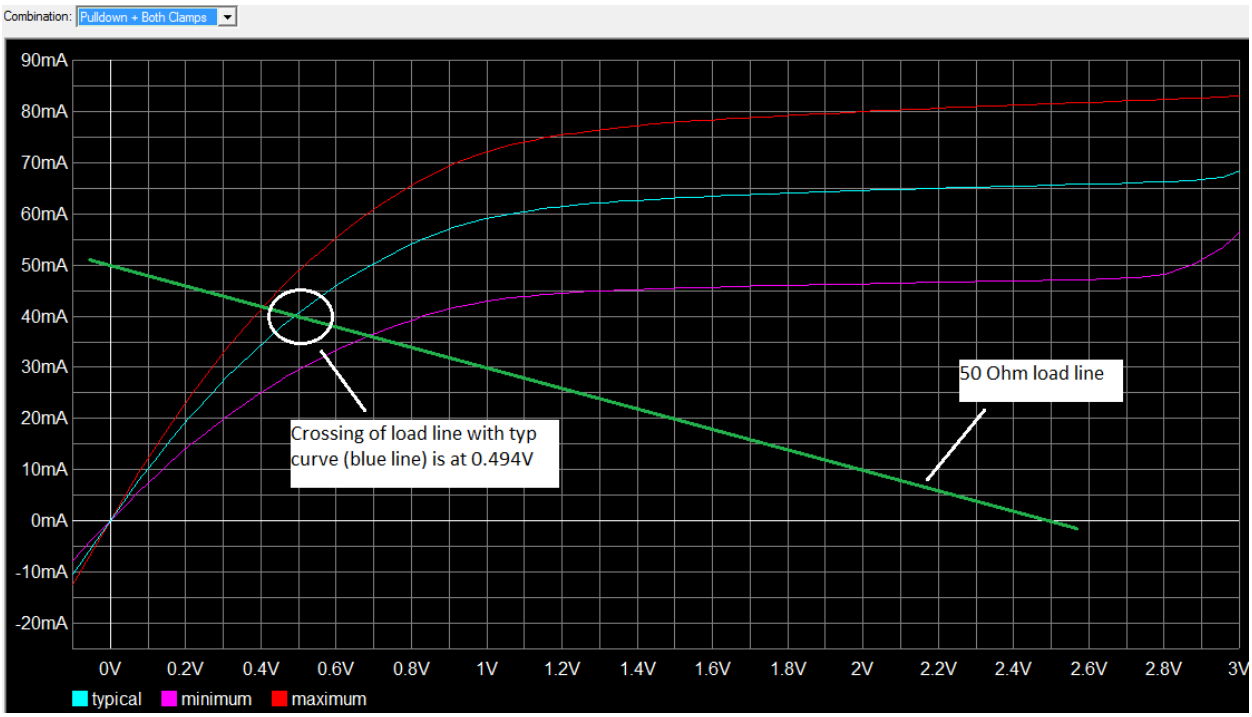

Figure 5-1. Crossing of 50 Ohm load line with the typical Pulldown + Both Clamps curves

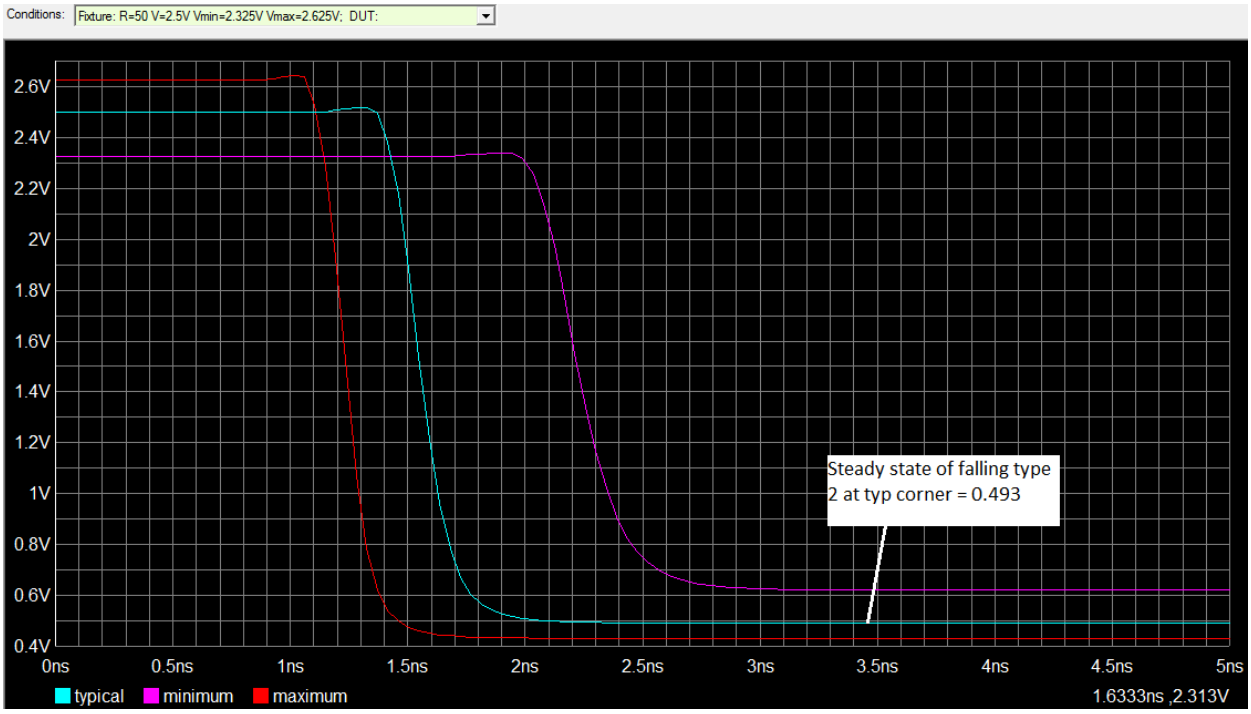

Figure 5-2. Steady state voltage of the typical falling characteristics with Vfixture = Vccio

6. Steady state of falling with Vfixture = 0

To verify the steady state of the V-T curve falling characteristic type 1 (with Vfixture = 0) with the steady state value obtained from the I-V curve, do the following:

a) Construct the load line at the Pulldown + Both clamps curves
b) Plot two points with the load line equation by setting Vsweep = 0 and Vsweep = Vfixture
    i. Vsweep = 0; I = (0 - 0)/50 = 0 mA
    ii. Vsweep = 2.5; I = (0 - 2.5)/50 = -50 mA
c) Draw a straight line in connecting the above 2 points to construct the 50 Ohm load line
d) As shown in Figure 6-1, the crossing of the 50 load line with the typical Pulldown + Both Clamps curve (blue line) = 0V is similar to the steady state of the falling characteristic type 1 = 0V in Figure 6-2

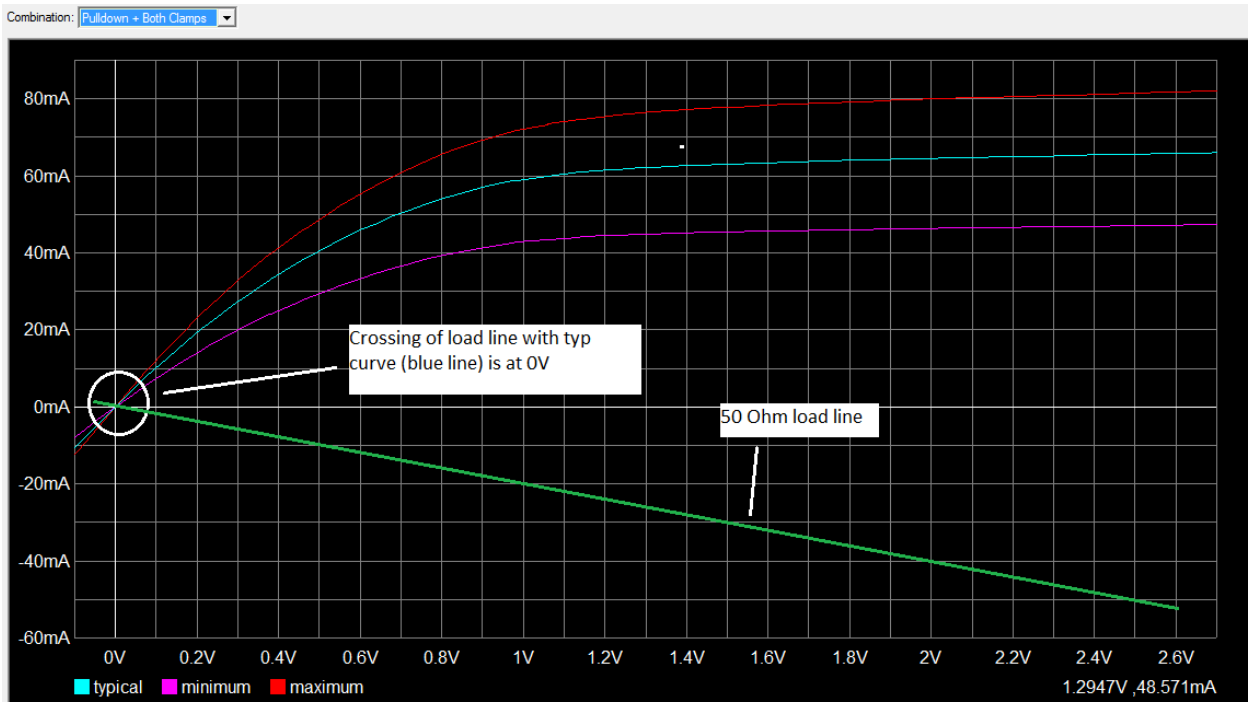

Figure 6-1. Crossing of 50 Ohm load line with the typical Pulldown + Both Clamps curves

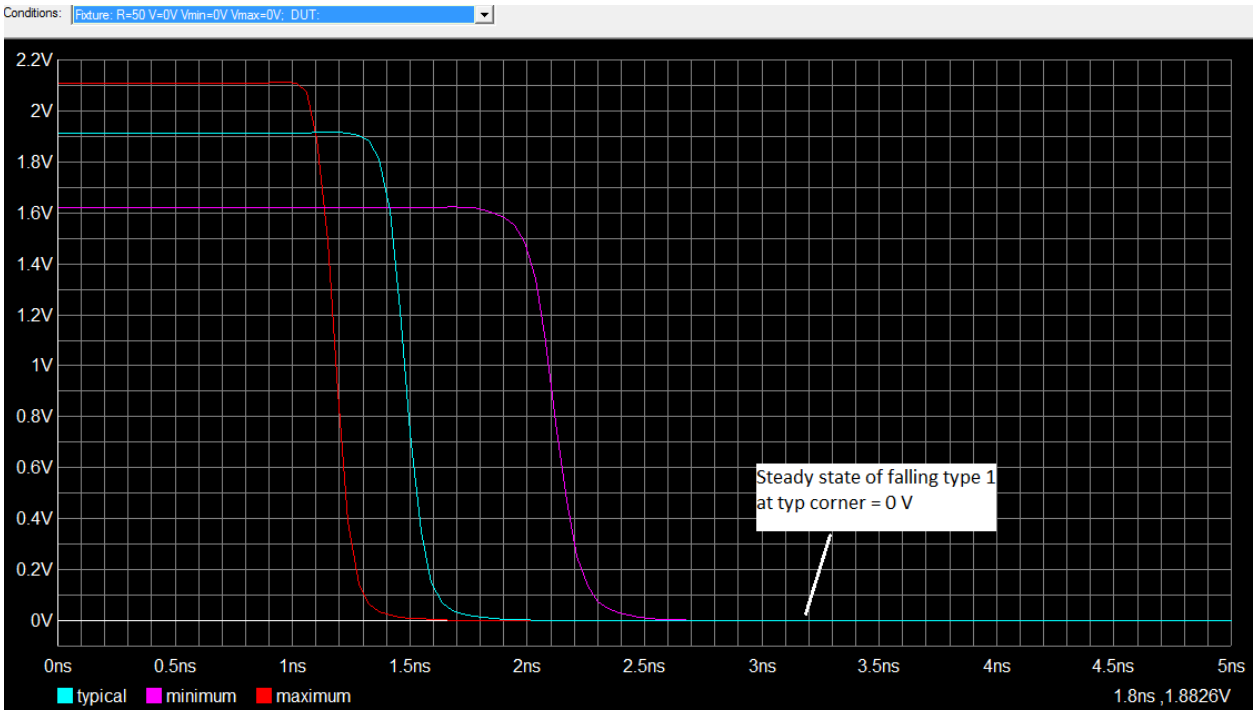

Figure 6-2. Steady state voltage of the typical falling characteristics with Vfixture = 0 V

7. Conclusion

By constructing the load lines at the IBIS I-V curves, we can find the steady state value of the rising and falling characteristics. These steady state values can be used to verify with the steady state values from the V-T curves. By using these instructions, you can verify the if I-V and V-T mismatch warnings issued by the syntax checker are valid or not.

8. Revision History

Revision	Changes Made	Date
V1.0	Initial release.	Nov 2011