

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:

$$I = (V_{\text{fixture}} - V_{\text{sweep}})/50$$

Note:

- i. V_{fixture} can be found in the IBIS model by looking for the V_{fixture} , $V_{\text{fixture_min}}$, and $V_{\text{fixture_max}}$ keywords
- ii. V_{sweep} = x-axis of the I-V curves

3. Steady state of rising with $V_{\text{fixture}} = V_{\text{ccio}}$

To verify the steady state value of the V-T curve rising characteristic type 2 (with $V_{\text{fixture}} = V_{\text{ccio}}$) 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 $V_{\text{sweep}} = 0$ and $V_{\text{sweep}} = V_{\text{fixture}}$
 - i) $V_{\text{sweep}} = 0$; $I = (2.5 - 0)/50 = 50\text{mA}$
 - ii) $V_{\text{sweep}} = 2.5$; $I = (2.5 - 2.5)/50 = 0\text{A}$
- 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.

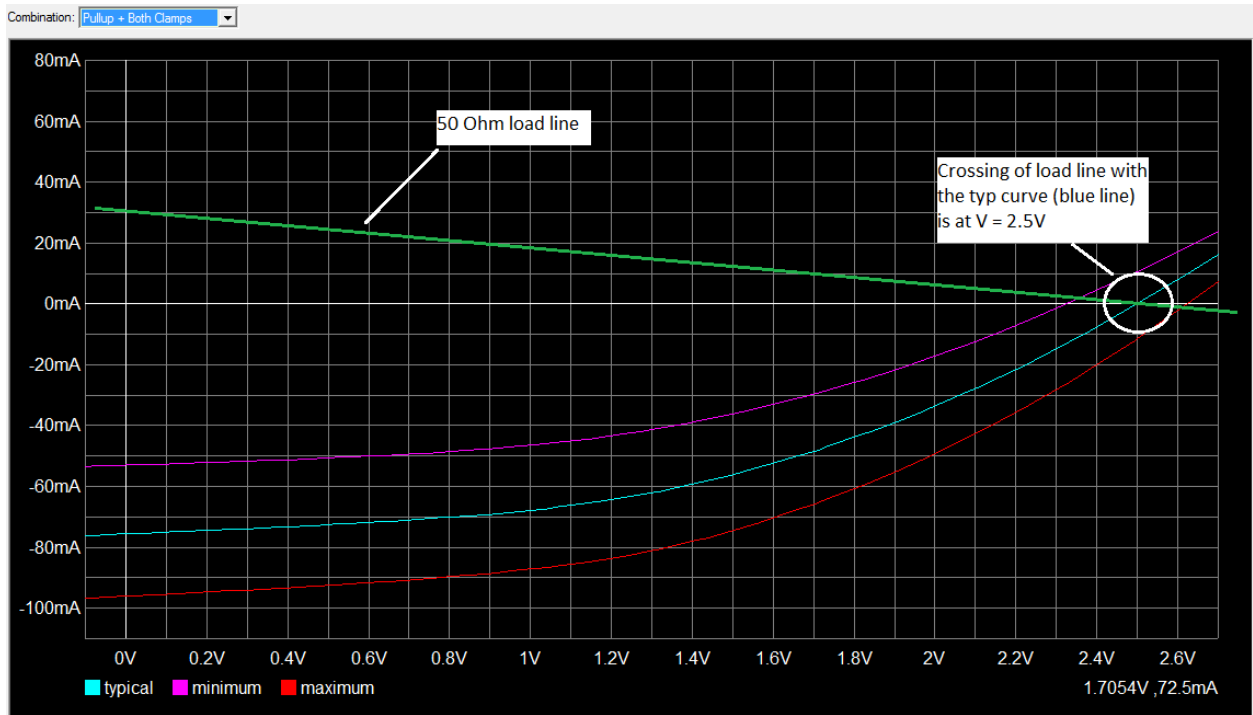


Figure 3-1. Crossing of 50 Ohm load line with the typical Pullup + Both Clamps curve

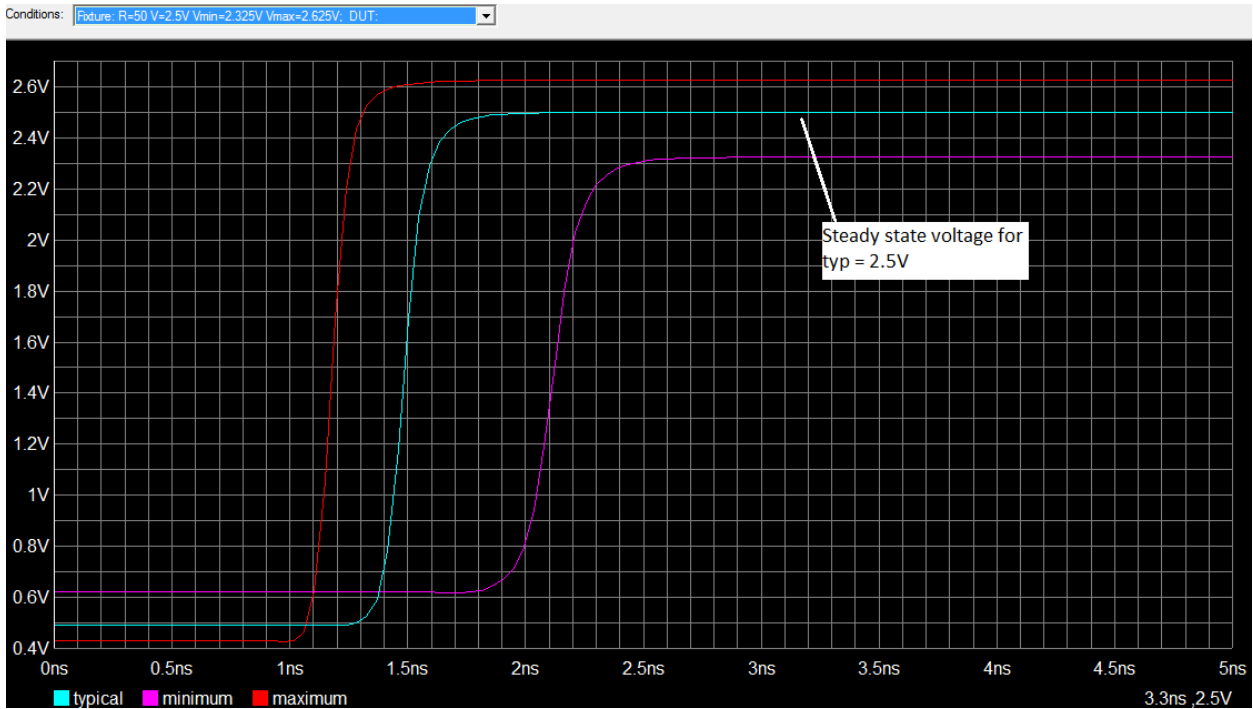


Figure 3-2. Steady state voltage of the typical rising characteristics with $V_{\text{fixture}} = V_{\text{ccio}}$

4. Steady state of rising with $V_{\text{fixture}} = 0$

To verify the steady state value of the V-T curve rising characteristic type 1 (with $V_{\text{fixture}} = 0$) with the steady state value obtained from the I-V curve, do the following:

- Construct the load line at the Pullup + Both clamps curves
- Plot two points with the load line equation by setting $V_{\text{sweep}} = 0$ and $V_{\text{sweep}} = V_{\text{fixture}}$
 - $V_{\text{sweep}} = 0$; $I = (0 - 0)/50 = 0 \text{ mA}$
 - $V_{\text{sweep}} = 2.5$; $I = (0 - 2.5)/50 = -50 \text{ mA}$
- Draw a straight line connecting the above 2 points to construct the 50 Ohm load line
- 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

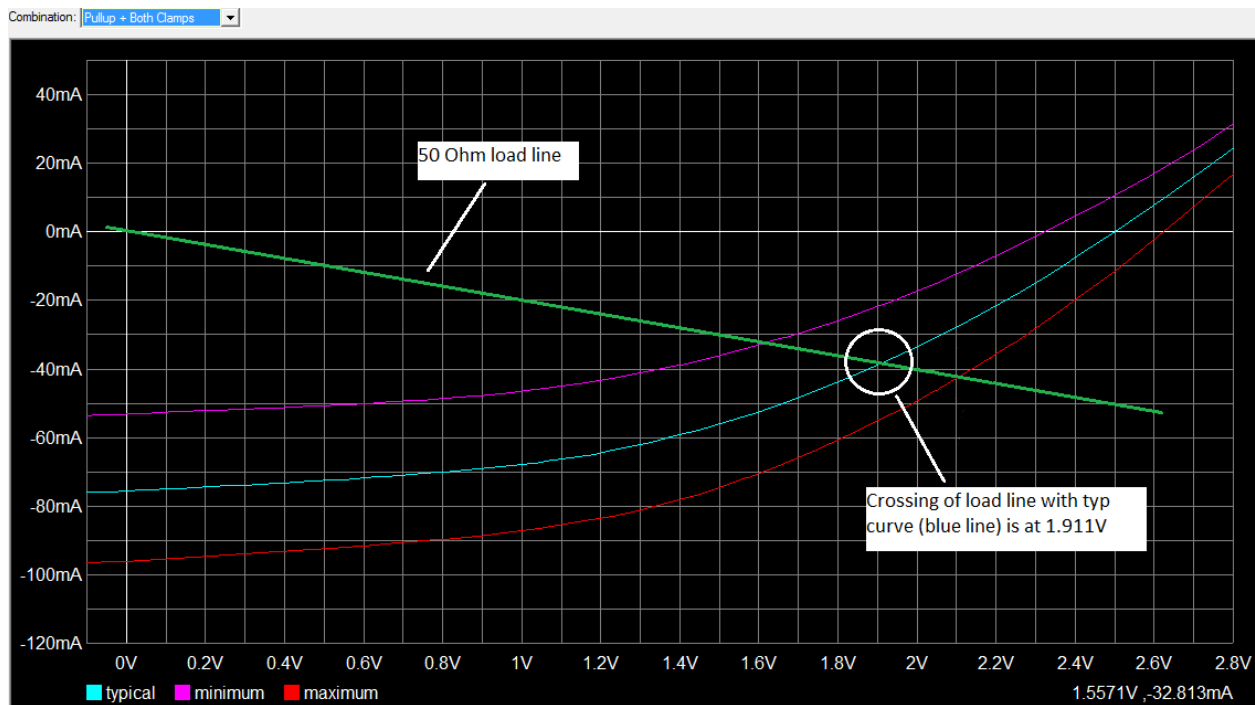


Figure 4-1. Crossing of 50 Ohm load line with the typical Pullup + Both Clamps curve

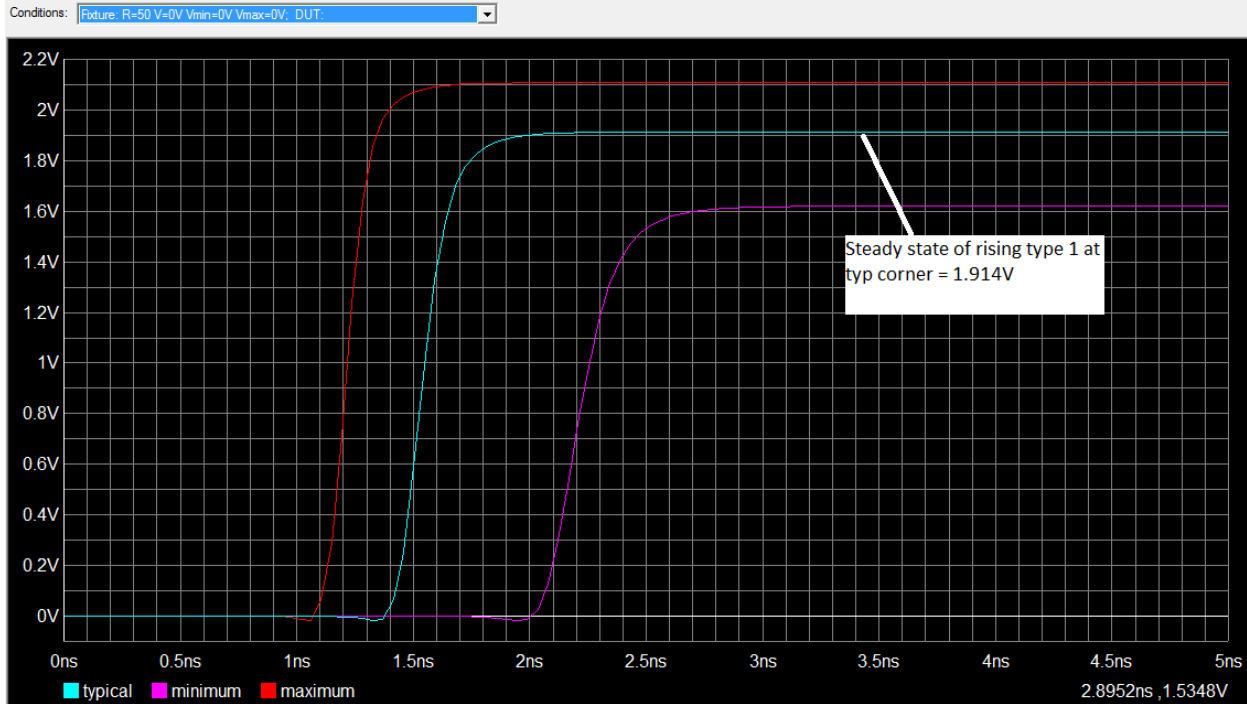


Figure 4-2. Steady state voltage of the typical rising characteristics with $V_{\text{fixture}} = 0V$

5. Steady state of falling with $V_{\text{fixture}} = V_{\text{ccio}}$

To verify the steady state value of the V-T curve falling characteristic type 2 (with $V_{\text{fixture}} = V_{\text{ccio}}$) with the steady state value obtained from the I-V curve, do the following:

- Construct the load line at the Pulldown + Both clamps curves
- Plot two points with the load line equation by setting $V_{\text{sweep}} = 0$ and $V_{\text{sweep}} = V_{\text{fixture}}$
 - $V_{\text{sweep}} = 0$; $I = (2.5 - 0)/50 = 50\text{mA}$
 - $V_{\text{sweep}} = 2.5$; $I = (2.5 - 2.5)/50 = 0A$
- Draw a straight line in connecting the above 2 points to construct the 50 Ohm load line
- 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

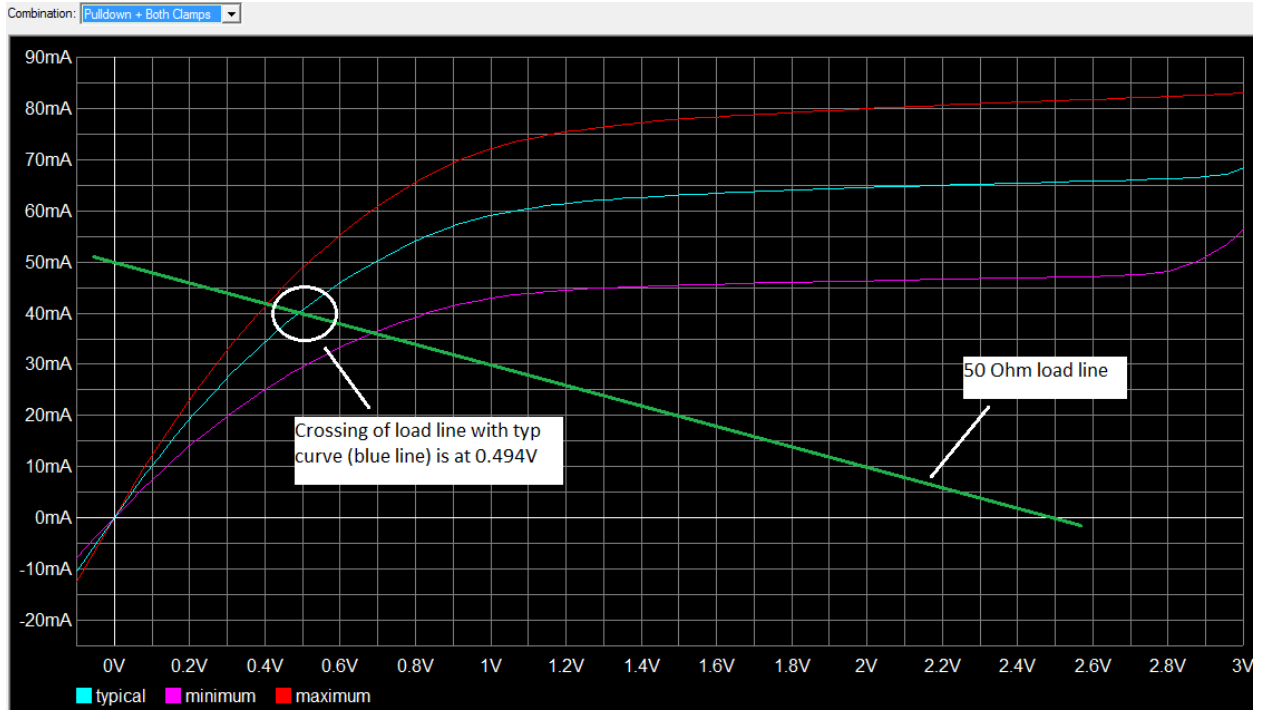


Figure 5-1. Crossing of 50 Ohm load line with the typical Pulldown + Both Clamps curves

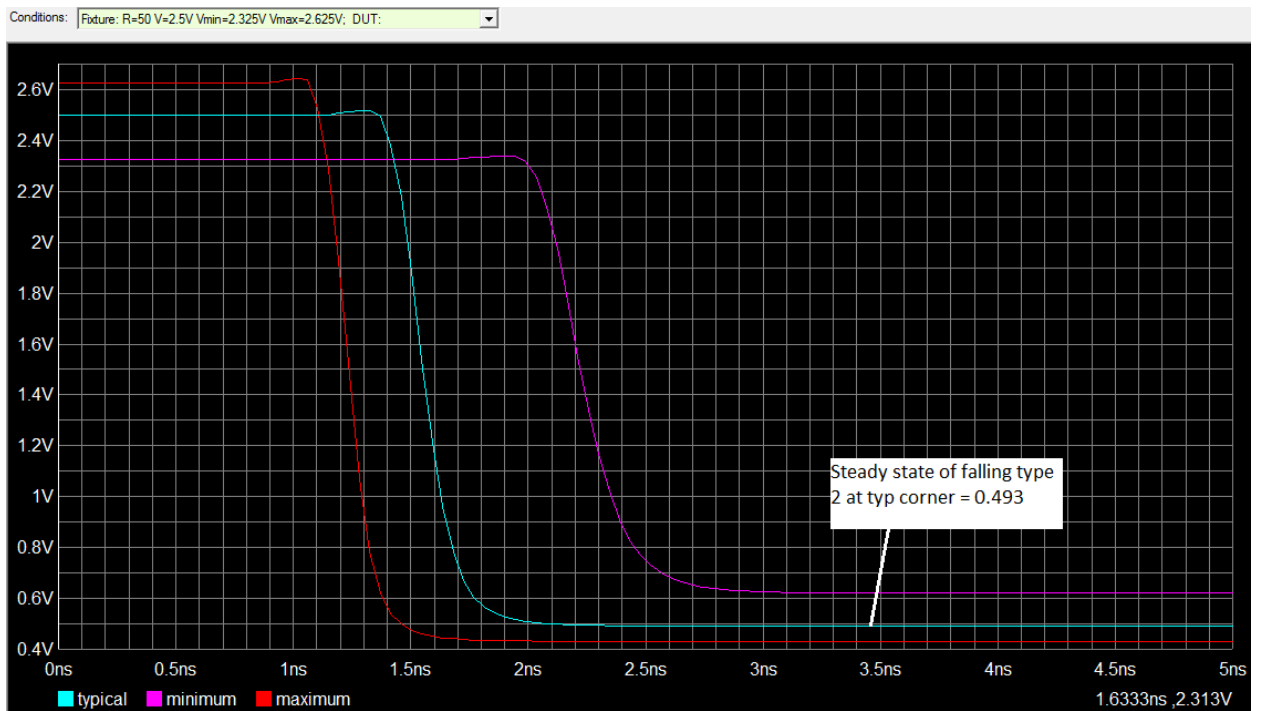


Figure 5-2. Steady state voltage of the typical falling characteristics with $V_{\text{fixture}} = V_{\text{ccio}}$

6. Steady state of falling with $V_{\text{fixture}} = 0$

To verify the steady state of the V-T curve falling characteristic type 1 (with $V_{\text{fixture}} = 0$) with the steady state value obtained from the I-V curve, do the following:

- Construct the load line at the Pulldown + Both clamps curves
- Plot two points with the load line equation by setting $V_{\text{sweep}} = 0$ and $V_{\text{sweep}} = V_{\text{fixture}}$
 - $V_{\text{sweep}} = 0$; $I = (0 - 0)/50 = 0 \text{ mA}$
 - $V_{\text{sweep}} = 2.5$; $I = (0 - 2.5)/50 = -50 \text{ mA}$
- Draw a straight line in connecting the above 2 points to construct the 50 Ohm load line
- 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

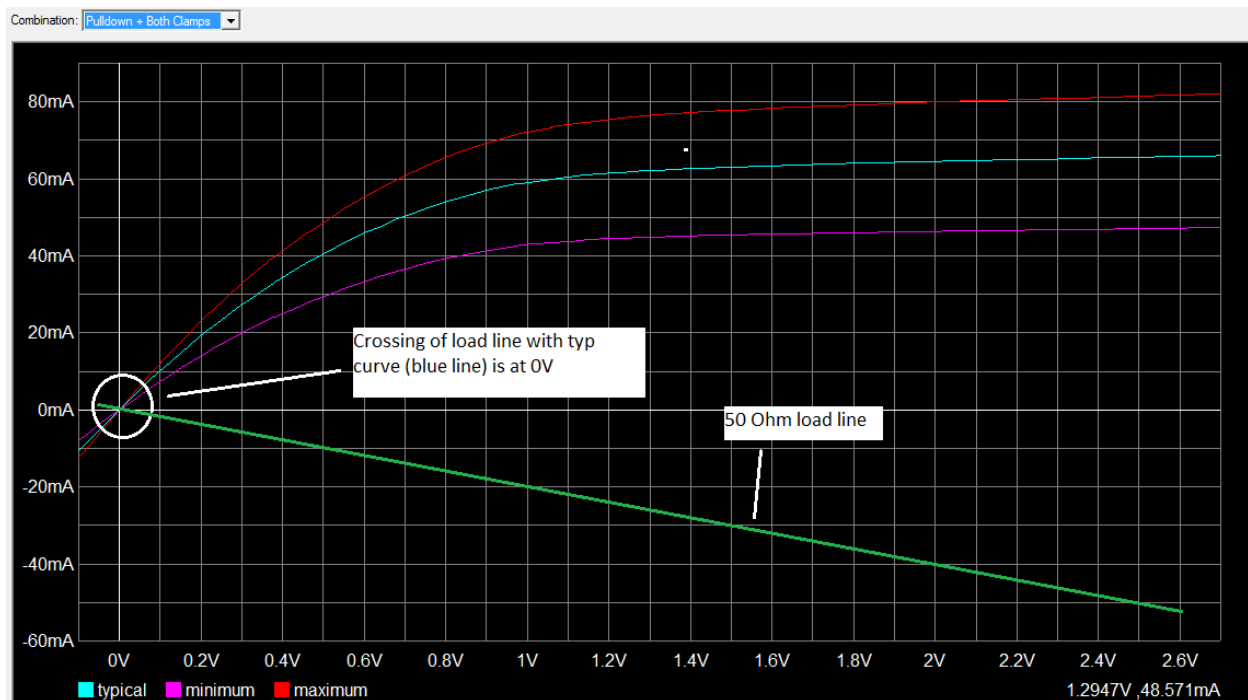


Figure 6-1. Crossing of 50 Ohm load line with the typical Pulldown + Both Clamps curves

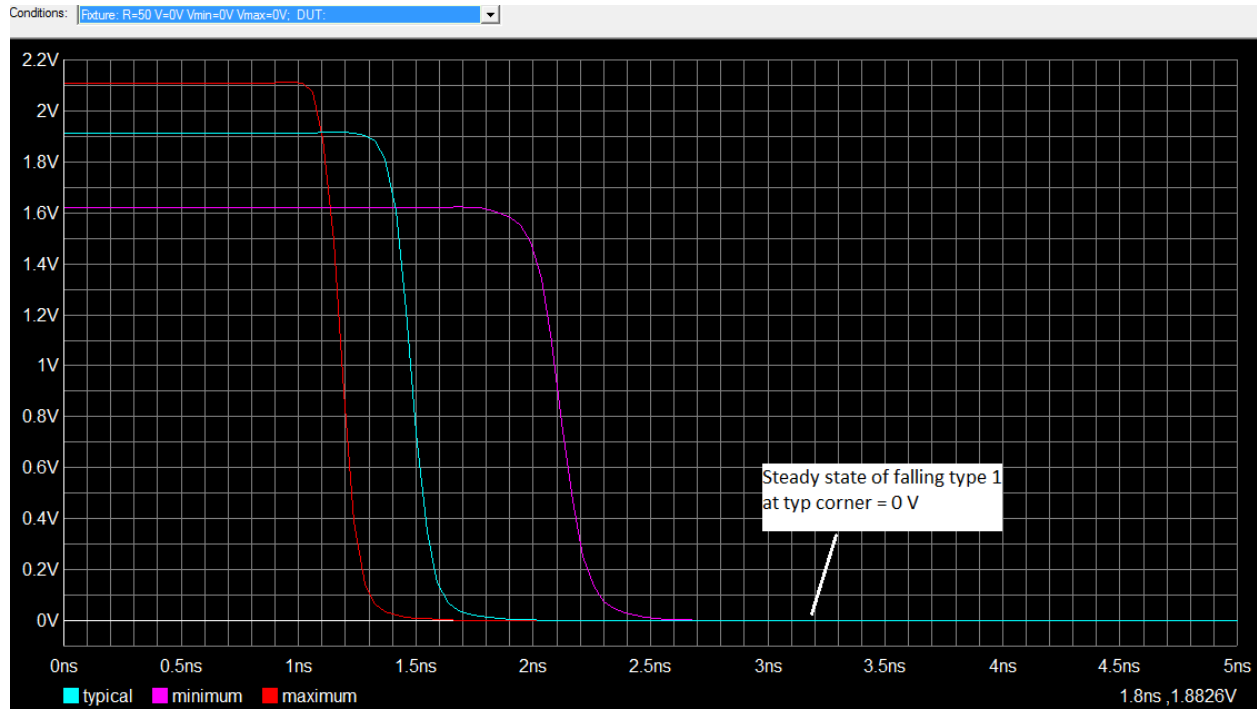


Figure 6-2. Steady state voltage of the typical falling characteristics with $V_{\text{fixture}} = 0 \text{ V}$

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

© 2011 Altera Corporation. All rights reserved. Altera, The Programmable Solutions Company, the stylized Altera logo, specific device designations, and all other words and logos that are identified as trademarks and/or service marks are, unless noted otherwise, the trademarks and service marks of Altera Corporation in the U.S. and other countries. All other product or service names are the property of their respective holders. Altera products are protected under numerous U.S. and foreign patents and pending applications, maskwork rights, and copyrights. Altera warrants performance of its semiconductor products to current specifications in accordance with Altera's standard warranty, but reserves the right to make changes to any products and services at any time without notice. Altera assumes no responsibility or liability arising out of the application or use of any information, product, or service described herein except as expressly agreed to in writing by Altera. Altera customers are advised to obtain the latest version of device specifications before relying on any published information and before placing orders for products or services.