



Combined I-V Table Checking Problem

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Real Data from BUGI40 and Cadence Presentations

- BUGI40: <http://www.eda.org/ibis/bugs/ibischk/bugI40.txt>
- (In all test cases, the [Gnd Clamp] data is 0.0 in the region of interest)
- Presentations
 - “Golden Parser Non-monotonic Warning’s Investigation” by Yingxin Sun and Joy Li, November 9, 2012:
<http://tinyurl.com/byqu7yn> (Presented at the IBIS Quality Committee November 27, 2012)
 - “Combined I-V Table Checks (BUGI40)”, January 31, 2013 IBIS Summit, Bob Ross, Yingxin Sun, and Joy Li
 - “Ibischk5 Specification and Parser”, May 15, 2013 IBIS Summit, Bob Ross and Mike LaBonte (Signal Integrity Software)

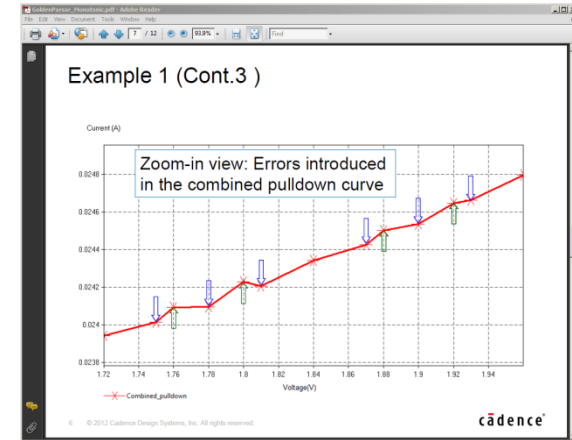


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BUG 40 Issue

- Unexpected Non-Monotonic Warnings for Combined I-V Tables (derived from monotonic data)

- Combined I-V table checks:
 - [Pulldown] + [Gnd Clamp] + [Power Clamp]
 - [Pullup] + [Gnd Clamp] + [Power Clamp]



- Ibischk5 parser is de facto standard for IBIS model correctness (and ibischk5 is embedded in tools)
- Some companies require 0 Errors, 0 Warnings
- IBIS Quality Spec, recommends 0 Errors and 0 Warnings
- Warning messages create support issue for model authors or automatic modeling utilities**



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Facts

- No specification REQUIREMENT that individual or combined I-V tables be monotonic
- No stated method to sum mismatched voltage points (piecewise linear interpolation is allowed and used)
- Non-monotonicity often occurs outside of normal simulation region – in clamping region and not a problem
- Ibischk5 parser is working correctly



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Observations

- Non-monotonic behavior can occur
 - Combined I-V table slope is small
 - I-V table points are misaligned due to
 - Offset V intervals due to Gnd, Vdd and delta V
 - Different reference voltages (min/max)
 - Extraction done with piecewise linear interpolation calculations (if not done right)
 - Combination of above cases
- Example ($y = x^2$) next shows monotonic tables yielding non-monotonic summations



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Example: x Step 2, Offset by 1

(Red: Interpolated Value)

x	y1 = x^2	y2 = x^2	y1-y2 = 0?
0	0		
1	2	1	1
2	4	5	-1
3	10	9	1
4	16	17	-1
5	26	25	1
6	36		

Non-monotonic due to piecewise linear interpolation on both columns

x Step 0.02, Offset by 0.01 (Red: Interpolated Value)

x	y1 = x^2	y2 = x^2	y1-y2
0.00	0.0000		
0.01	0.0002	0.0001	0.0001
0.02	0.0004	0.0005	-0.0001
0.03	0.0010	0.0009	0.0001
0.04	0.0016	0.0017	-0.0001
0.05	0.0026	0.0025	0.0001
0.06	0.0036		

**Still non-monotonic with
higher resolution data**



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x Steps 0.02 and 0.01, 0.00 Offset

(Red: Interpolated Value)

x	y1 = x^2	y2 = x^2	y1-y2
0.00	0.0000	0.0000	0.0000
0.01	0.0002	0.0001	0.0001
0.02	0.0004	0.0004	0.0000
0.03	0.0010	0.0009	0.0001
0.04	0.0016	0.0016	0.0000
0.05	0.0026	0.0025	0.0001
0.06	0.0036	0.0036	0.0000

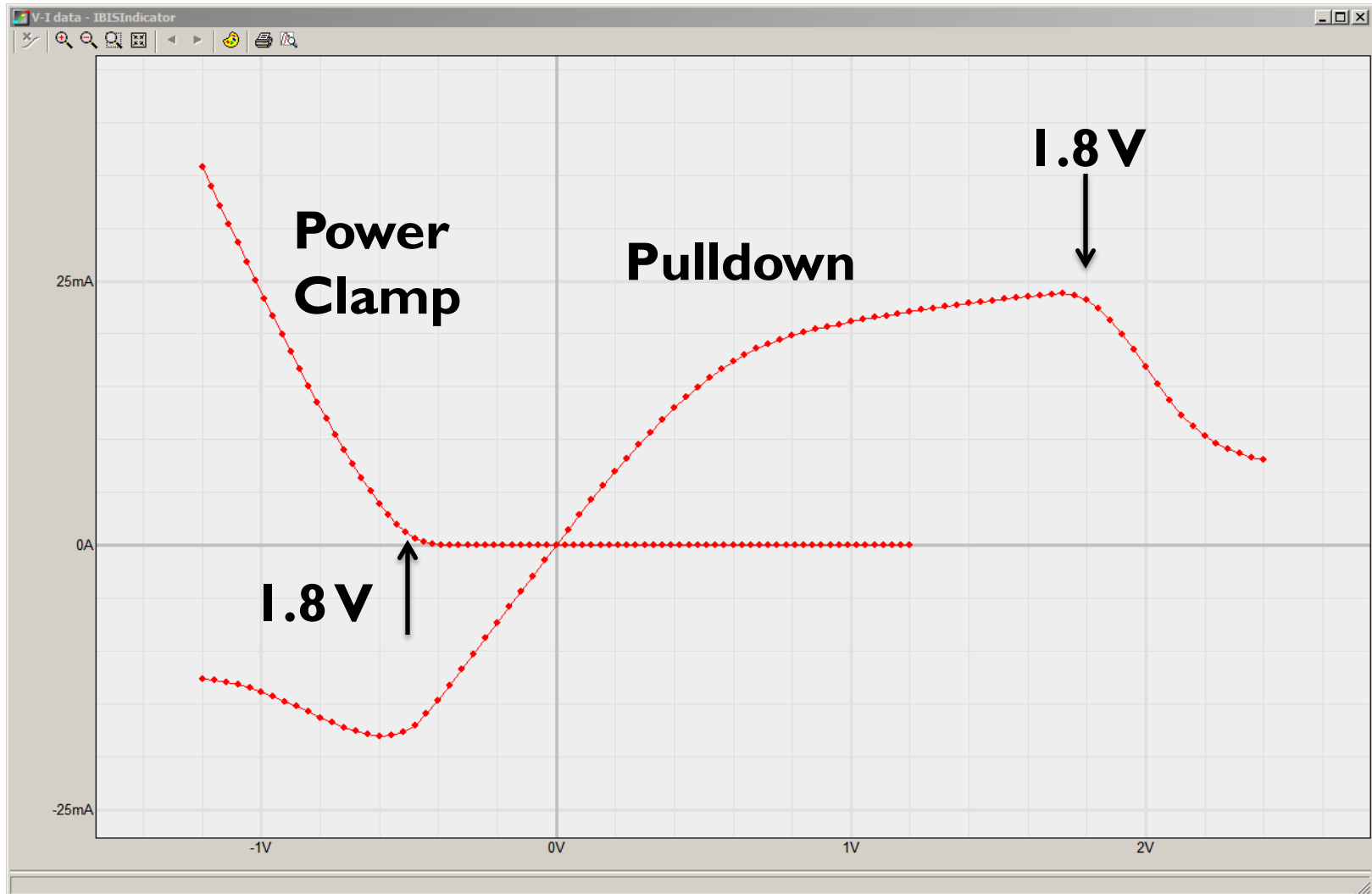
**Different resolution data causes
non-monotonic combination**

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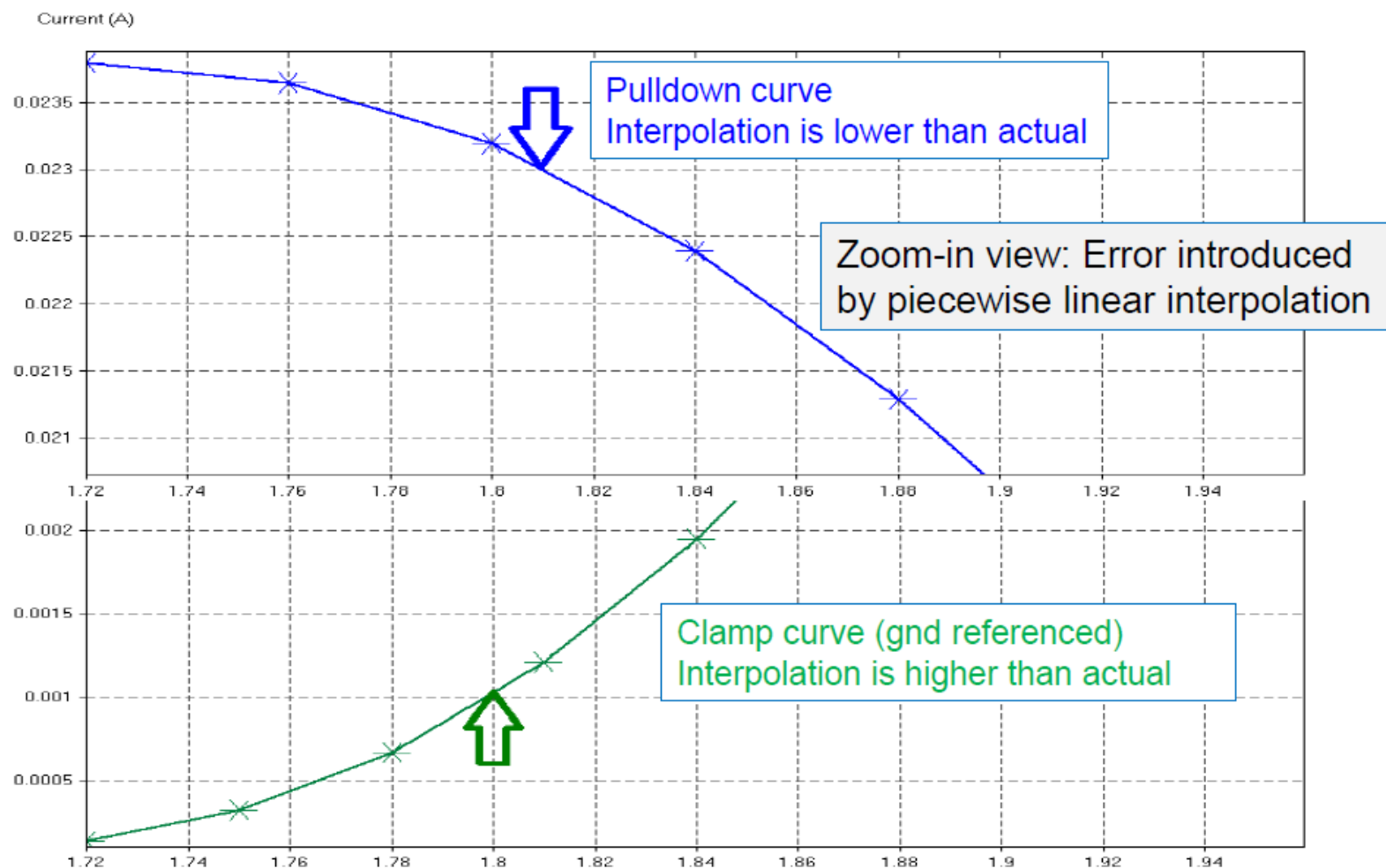


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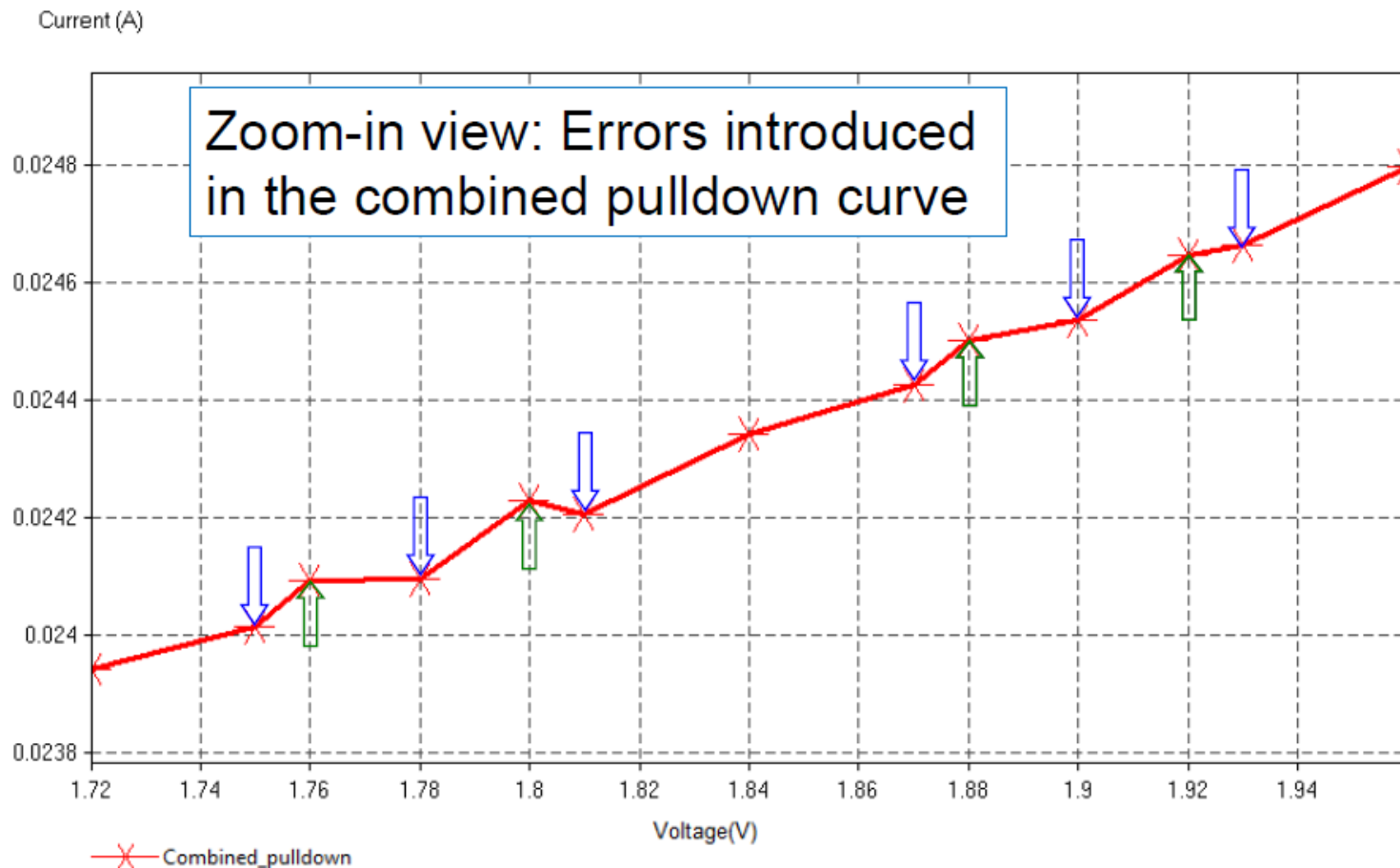
bugl40a.ibs Maximum Data (Vdd = 1.3 V)



Example 1 (Cont.2)



Example 1 (Cont.3)



BUG 40 Resolution

- Change WARNING to NOTE
 - Valid solution for user
 - Avoids tool and model developer support issues
- Add “based on piecewise linear interpolation” to message
- No practical fix
 - Still issues with higher resolution or choosing percentage threshold for non-monotonic warning
 - Piecewise linear interpolation is legal, and spline fitting would just hide information



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Checking bug140a.ibs

IBISCHK5 V5.1.2

Checking bug140a.ibs for IBIS 3.2 Compatibility...

NOTE (line 39) - Pulldown Typical data is non-monotonic

NOTE (line 42) - Pulldown Minimum data is non-monotonic

NOTE (line 42) - Pulldown Maximum data is non-monotonic

NOTE (line 135) - Pullup Typical data is non-monotonic

NOTE (line 137) - Pullup Maximum data is non-monotonic

NOTE (line 138) - Pullup Minimum data is non-monotonic

WARNING - Combined Pulldown for Model: iobuf Maximum data is non-monotonic

Errors : 0

Warnings: 1

File Passed



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Fixed bug140a.ibs in Version 5.1.3

IBISCHK5 V5.1.3

Checking bug140a.ibs for IBIS 3.2 Compatibility...

NOTE (line 39) - Pulldown Typical data is non-monotonic

NOTE (line 42) - Pulldown Minimum data is non-monotonic

NOTE (line 42) - Pulldown Maximum data is non-monotonic

NOTE (line 135) - Pullup Typical data is non-monotonic

NOTE (line 137) - Pullup Maximum data is non-monotonic

NOTE (line 138) - Pullup Minimum data is non-monotonic

NOTE - Combined Pulldown for Model: iobuf Maximum data is non-monotonic based on piece-wise linear interpolation

Errors : 0

File Passed



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Closure

- For best checking results, use the latest version of ibischk5
- Parser being updated as new BUG reports are submitted and processed.



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