Ibischk5 Specification and Parser

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Outline

- Ibischk5 specification
  - Document update
  - Work in progress
- Ibischk5 Version 5.1.3 release
  - BUG140 discussion

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Outline of ibischk5 Parser Spec

Contents

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Command Line for ibischk5

```
Usage: ibischk5        <IBS filename>
     : ibischk5  -ebd <EBD filename>
     : ibischk5  -pkg <PKG filename>
     : ibischk5  -ami <AMI filename>
Usage: ibischk5  -caution -numbered        <IBS filename>
     : ibischk5  -caution -numbered -ebd <EBD filename>
     : ibischk5  -caution -numbered -pkg <PKG filename>
     : ibischk5  -caution -numbered -ami <AMI filename>
The flags prior to the file name can be in any order,
and the -caution and/or -numbered flags are optional.
```

- **–ami** for <file_name>.ami (algorithmic model interface control file)
- **–numbered** for numbered **E**rror, **W**arning, **N**otes, **C**aution, and **B**ug messages

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ibischk5 {–numbered} –ami file4.ami

```
Checking file4.ami for IBIS 5.0 Compatibility...

ERROR - Illegal Usage value A specified for Param1
ERROR - Illegal Type value B specified for Param1
ERROR - Illegal Format value C specified for Param1
ERROR - No Reserved_Parameters found

Errors   : 4

File Failed
```

```
Checking file4.ami for IBIS 5.0 Compatibility...

E4627 - Illegal Usage value A specified for Param1
E4627 - Illegal Type value B specified for Param1
E4627 - Illegal Format value C specified for Param1
E4622 - No Reserved_Parameters found

Errors   : 4

File Failed
```

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Parser Classifications –numbered to get message no.

- E – Error (violation of a specification rule or serious modeling convention violation)

- W – Warning (out of range data or other unexpected model data)

- C – Caution (requires caution flag, legal but probably wrong entry)

- N – Note (so far, used for non-monotonic tables)

- B – Program Bug (an Internal Error that may be related to operating system, memory allocation or ambiguous code branches

- U – Unused (message that is no longer available)

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1200+ Unique Message Strings

http://www.eda.org/ibis/ibischk5/ibischk5_messages_draft2.xlsx

Number	Symbol in Code	Message string	Parameters	Comment	Category	Clasification
100	MDL_ERR_0	Unable to Allocate Memory: %s %d	filename, line number	The code failed to allocate memory in <filename> at <linenumber>	Internal Error	E
101	MDL_ERR_1	Unable to get IBIS structure		Program data structures are corrupt	Internal Error	E
102	MDL_ERR_2	Orphan Model keyword.		Model keyword found but not within a Model declaration	Error with IBIS file Line number	E
103	MDL_ERR_3	Illegal Digital Port <%s> (not allowed in SPICE Ports section)	portname	Improper use of Digital port <portname>	Error with IBIS file Line number	E
104	MDL_ERR_4	D_switch not allowed with (D_drive,D_receive,or D_enable) in		Improper use of D_switch	Error with IBIS file Line number	E
105	MDL_ERR_5	%s not allowed with D_switch in Ports/A2D/D2A Section			Error with IBIS file Line number	E
106	MDL_ERR_6	Reserved Digital Port <%s> used as	portname	Improper use of Reserved Digital port <portname>	Error with IBIS file Line number	E
107	MDL_ERR_7	Orphan data line keyword.		A Model related data line was found where none was expected	Error with IBIS file Line number	E
108	MDL_ERR_8	TTgnd Typical value should be >0		Improper TTgnd typical value	Error with IBIS file Line number	E
109	MDL_ERR_9	TTgnd Min value should be >0		Improper TTgnd minimum value	Error with IBIS file Line number	E
110	MDL_ERR_10	TTgnd Max value should be >0		Improper TTgnd maximum value	Error with IBIS file Line number	E
111	MDL_ERR_11	TTgnd typ value is not in between		Improper range for TTgnd	Warning	W
112	MDL_ERR_12	TTpower Typical value should be >0		Improper TTpower typical value	Error with IBIS file Line number	E
113	MDL_ERR_13	TTpower Min value should be >0		Improper TTpower minimum value	Error with IBIS file Line number	E
114	MDL_ERR_14	TTpower Max value should be >0		Improper TTPower maximum value	Error with IBIS file Line number	E
115	MDL_ERR_15	TTpower typ value is not in between		Improper range for TTPower	Warning	W
116	MDL_ERR_16	[Model Spec] should be specified immediately after all the subparameters of a model and		Improper positioning of [Model Spec]	Error with IBIS file Line number	
117	MDL_ERR_17	[Receiver Thresholds] should not be specified for model type %s	modeltype	Receiver thresholds are not allowed for a <modeltype> which is not an Input or I/O model type	Warning with IBIS file Line number	W
118	MDL_ERR_18	[Add Submodel] should be specified before other keywords for a model		Improper positioning of [Ad Submodel]	Error with IBIS file Line number	E
119	MDL_ERR_19	%s Already Defined For Model '%s'	sub parameter/keyword, modelname	A model <sub-parameter or keyword> was already defined for <modelname>	Error with IBIS file Line number	E
120	MDL_ERR_20	[Receiver Thresholds] should be specified immediately after all the subparameters of a model and before the other keywords of a		Improper positioning of [Receiver Thresholds] keyword	Error with IBIS file Line number	E
121	MDL_ERR_21	Expecting Keyword. Invalid Line		An invalid line was found where a keyword was expected	Error with IBIS file Line number	E

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Revised Spread Sheet (based on script conversion from source spread sheet)

	ErrNum	Type	Symbol	Message	Comments
1	ErrNum	Type	Symbol	Message	Comments
2	100	B	MDL_ERR_0	Unable to Allocate Memory: %filename% %linenum%	The code failed to allocate memory
3	101	B	MDL_ERR_1	Unable to get IBIS structure: %filename% %linenum%	Program data structures are corrupt
4	102	E	MDL_ERR_2	Orphan Model keyword.: %filename% %linenum%	Model keyword found but not within a Model declaration
5	103	E	MDL_ERR_3	Illegal Digital Port <%portname%> (not allowed in SPICE Ports section): %filename% %linenum%	Improper use of Digital port <portname>
6	104	E	MDL_ERR_4	D_switch not allowed with (D_drive;D_receive;or D_enable) in Ports/A2D/D2A Section: %filename% %linenum%	Improper use of D_switch
7	105	E	MDL_ERR_5	%portname% not allowed with D_switch in Ports/A2D/D2A Section: %filename% %linenum%	<portname> (D_receive; D_enable; D_drive) are not allowed with D_switch
8	106	E	MDL_ERR_6	Reserved Digital Port <%portname%> used as analog port: %filename% %linenum%	Improper use of Reserved Digital port <portname>
9	107	E	MDL_ERR_7	Orphan data line keyword.: %filename% %linenum%	A Model related data line was found where none was expected
10	108	E	MDL_ERR_8	TTgnd Typical value should be > 0: %filename% %linenum%	Improper TTgnd typical value
11	109	E	MDL_ERR_9	TTgnd Min value should be > 0: %filename% %linenum%	Improper TTgnd minimum value
12	110	E	MDL_ERR_10	TTgnd Max value should be > 0: %filename% %linenum%	Improper TTgnd maximum value
13	111	W	MDL_ERR_11	TTgnd typ value is not in between Min and Max : %filename% %linenum%	Improper range for TTgnd
14	112	E	MDL_ERR_12	TTpower Typical value should be > 0: %filename% %linenum%	Improper TTpower typical value
15	113	E	MDL_ERR_13	TTpower Min value should be > 0: %filename% %linenum%	Improper TTpower minimum value
	114	E	MDL_ERR_14	TTpower Max value should be > 0: %filename%	Improper TTpower maximum value

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Semi-automated Documentation Steps

Initial spread sheet from parser developer

Modify spread sheet by script

Sort by Symbol (source code modules)
and move entries into sections

Final editing of comments and indexing of
message numbers to sections

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Example – Error 102

```
IBISCHK5 V5.1.3

Checking error_number_example.ibs for IBIS 3.2
Compatibility...

E0102 (line  133) - Orphan Model keyword.

Errors  : 1

File Failed
```

MDL Section Message (see spread sheet)

...

0102 E Orphan Model keyword %filename% %linenum% Model keyword found but not within
a Model declaration

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Ongoing Project by Iteration

- Process used to correct source spread sheet

- Comments expanded (for example, the percent thresholds for Errors and Warnings for V-T matching)

- Some related messages will be described (such as different non-monotonic messages)

- Some messages will remain incomplete or TBD

- Indexing of message numbers to message section and pages planned

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Ibischk5 V5.1.3 release (6 Bugs)

- Released March, 2013 (source code and several executables)

- Mostly trivial Bugs based on feedback from developers using parser source code

- BUG140 dealt with changing non-monotonic Warning to Note shown later

- BUG144 dealt with an Internal Error (B) message moved to an Error (E) message (B0122 moved to E0174)

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Real Data from BUG140 and Cadence Presentation

- "Golden Parser Non-monotonic Warning's Investigation" by Yingxin Sun and Joy Li, Cadence Design Systems, November 9, 2012:   http://tinyurl.com/byqu7yn

- Presented at IBIS Quality Committee November 27, 2012

- BUG140:   http://www.eda.org/ibis/bugs/ibischk/bug140.txt

- (In all test cases, the [Gnd Clamp] data is 0.0 in the region of interest)

- Material taken from "Combined I-V Table Checks (BUG140)", January 31, 2013 IBIS Summit Bob Ross, Yingxin Sun and Joy Li
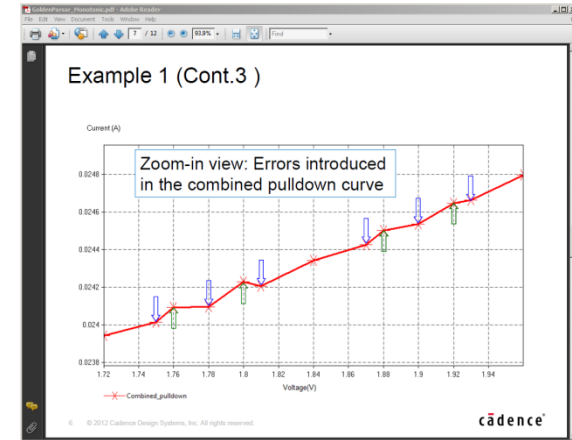
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BUG140 Issue

- 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 utility**

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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)

- Specification recommends individual I-V table parser checking

- Combined checks added with BUG94 (BUG92 dealt with submodels): http://www.eda.org/ibis/bugs/ibischk/

- Non-monotonicity often occurs outside of normal simulation region – in clamping region and not a problem

- Ibischk5 parser is operating 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 with piecewise linear interpolation calculations (if not done right)
    - I-V tables have different V resolution
  - Combination of above cases

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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

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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
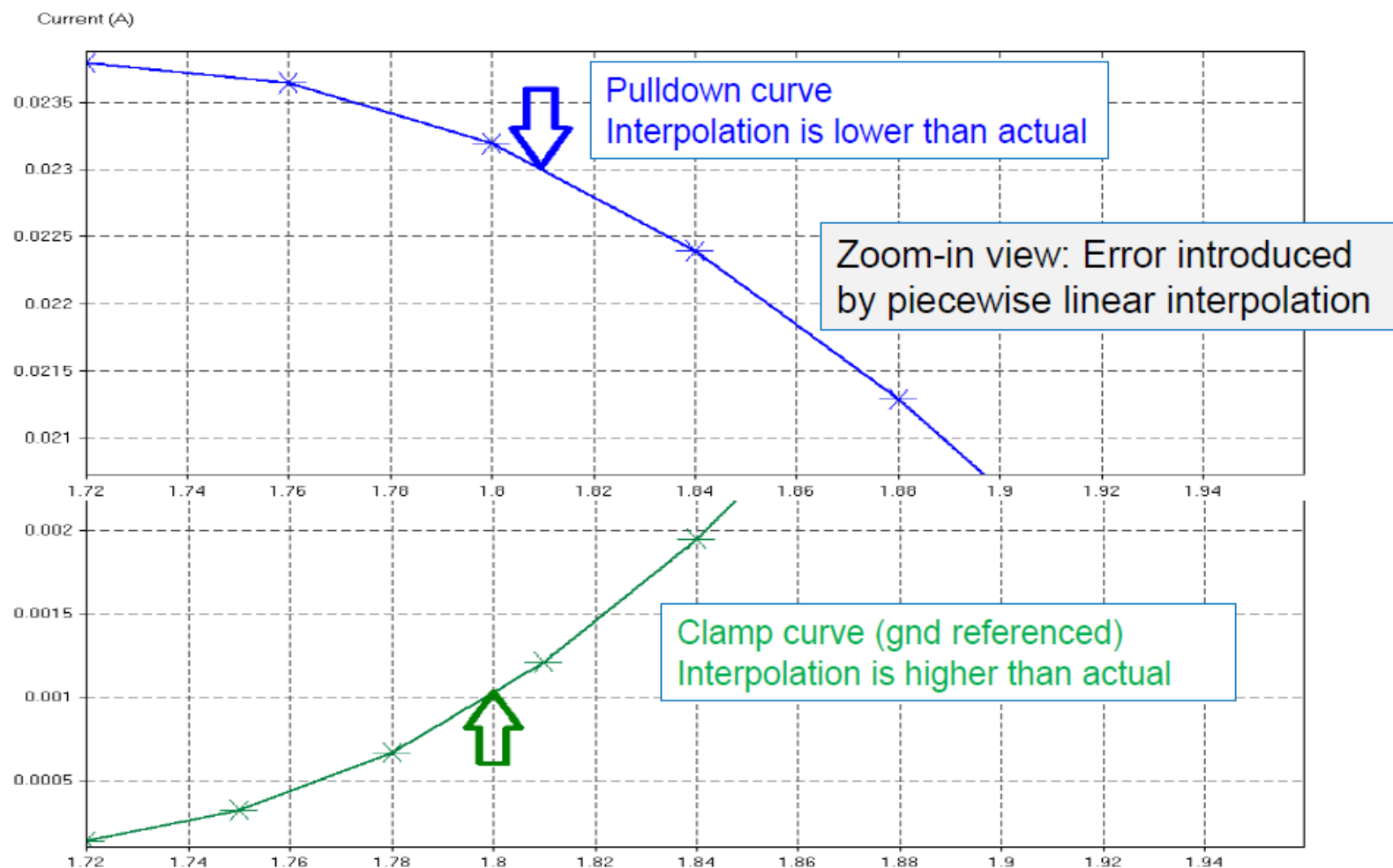
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bug140a.ibs Maximum Data
(Vdd = 1.3 V)

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Example 1 (Cont.2)

Current (A)

Pulldown curve
Interpolation is lower than actual

Zoom-in view: Error introduced
by piecewise linear interpolation

Clamp curve (gnd referenced)
Interpolation is higher than actual

cādence

Example 1 (Cont.3)

Zoom-in view: Errors introduced in the combined pulldown curve
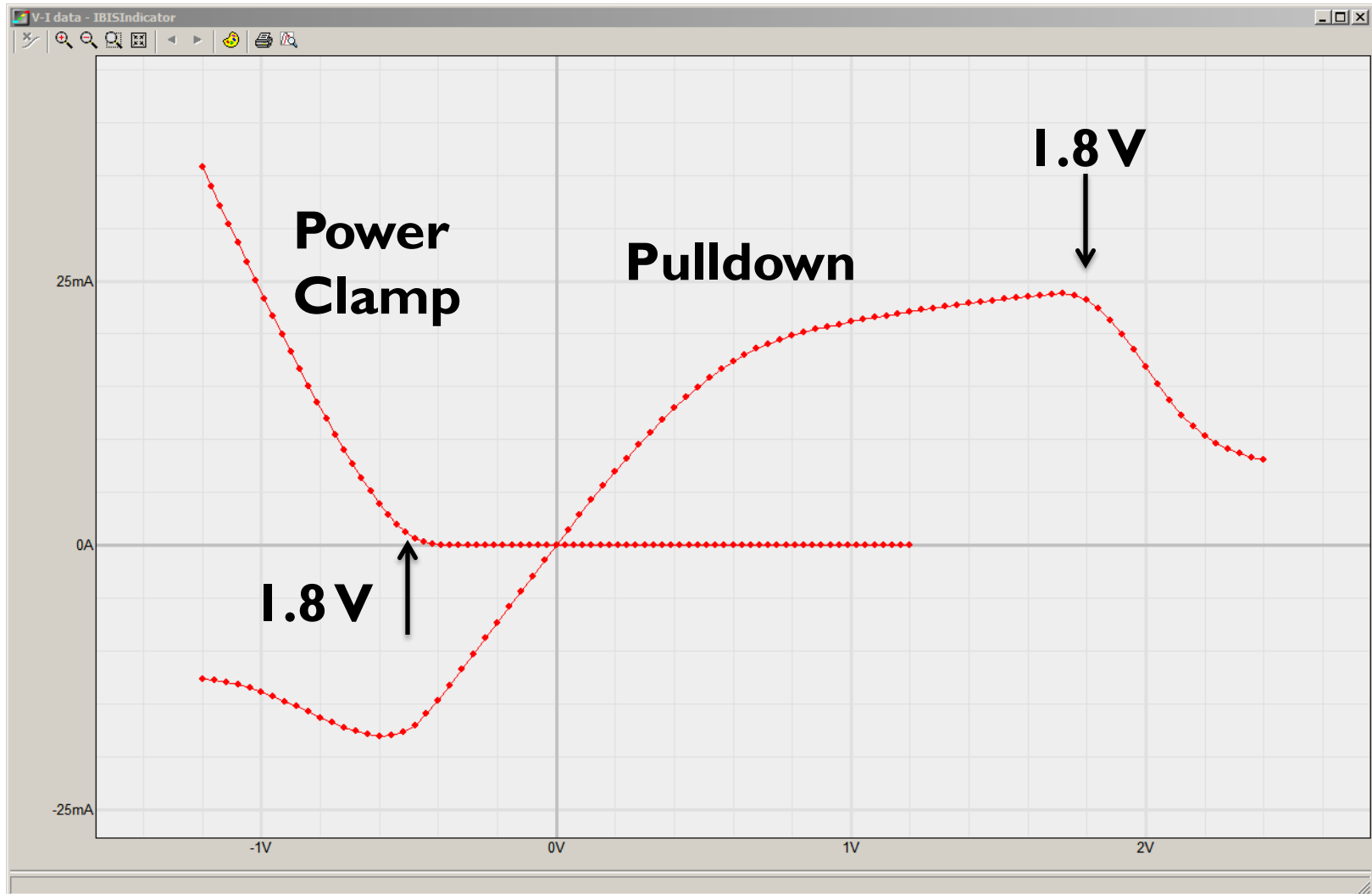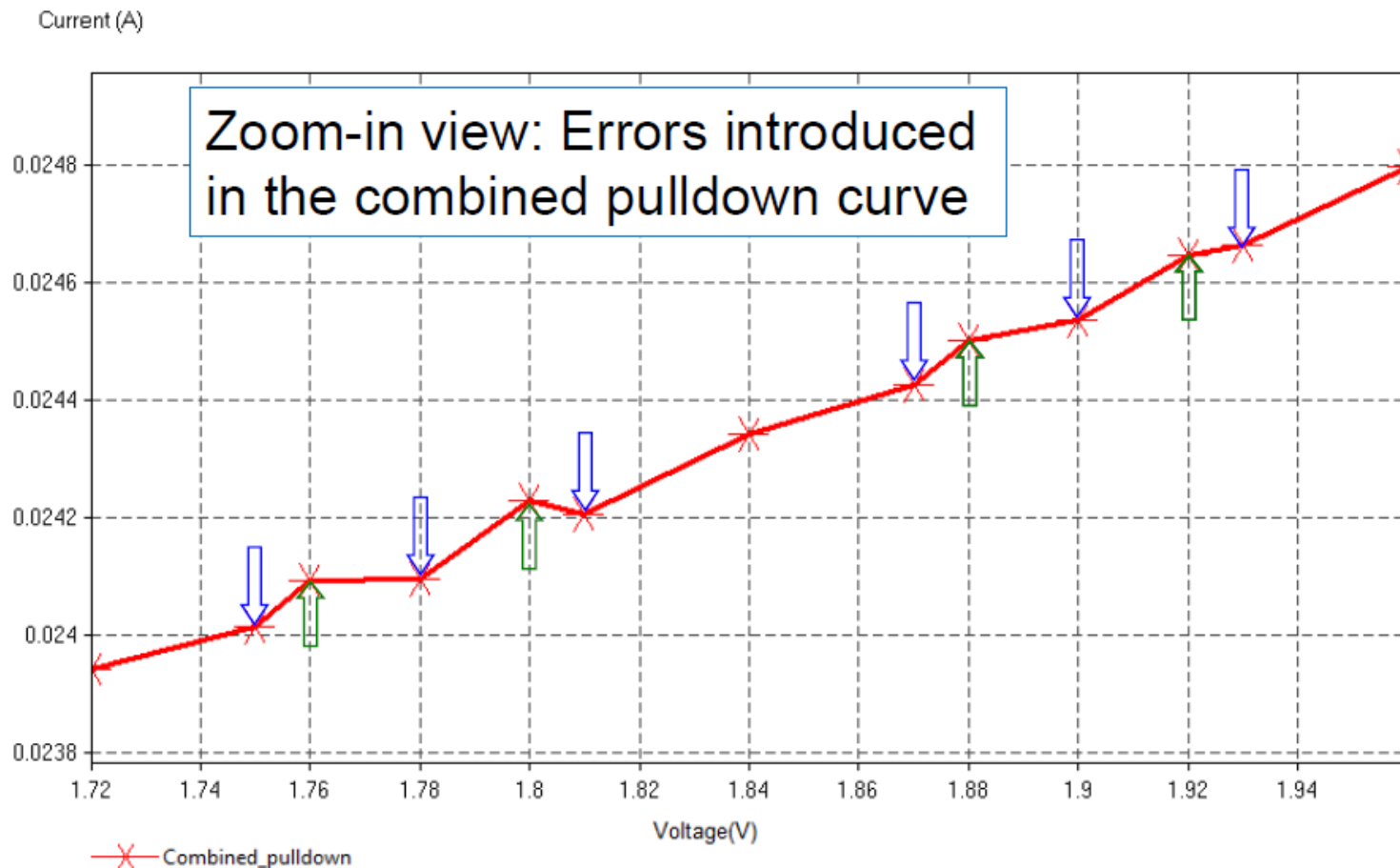
BUG140 Resolution

- 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

- Parser specification for ibischk5 being produced

- 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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