

IBIS Summit 2002

A Critique of IBIS Models Available for Download on the Web – Part I

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IBIS Model Review Project

- Project Goals
 - Scope the severity of the problems with IBIS models available on the Web.
 - Identify typical errors and warnings that will likely be found in IBIS models found on the Web.
 - Identify the probable cause(s) for each class of errors.
 - Identify what models can be repaired, or "fixed" in a reduced capacity by removing the offending section (i.e. - waveform tables).
 - Develop internal tools to diagnose model problems, identify their source, and fix the issue when possible.

Why Are IBIS Models So Popular?

- Reduces the amount of time needed for simulation.
- Proprietary data remains proprietary.
- Well suited for rapid simulation of large-scale systems.
- Simulators: IBIS models can be plugged directly into the routed board for post-route analysis.
- Most IBIS models can be downloaded from vendors' web sites.



How Good Are the IBIS Models Available From Vendor Web Sites?

- “Why not do an analysis?”
 - To scope the severity of the problems with IBIS models on the Web.
 - Part 1: Identify the IBISCHK3 error and warning reports that will most likely find in these models.
 - Part 2: Identify IBISCHK3-undetected errors that will most likely find in these models.

Process

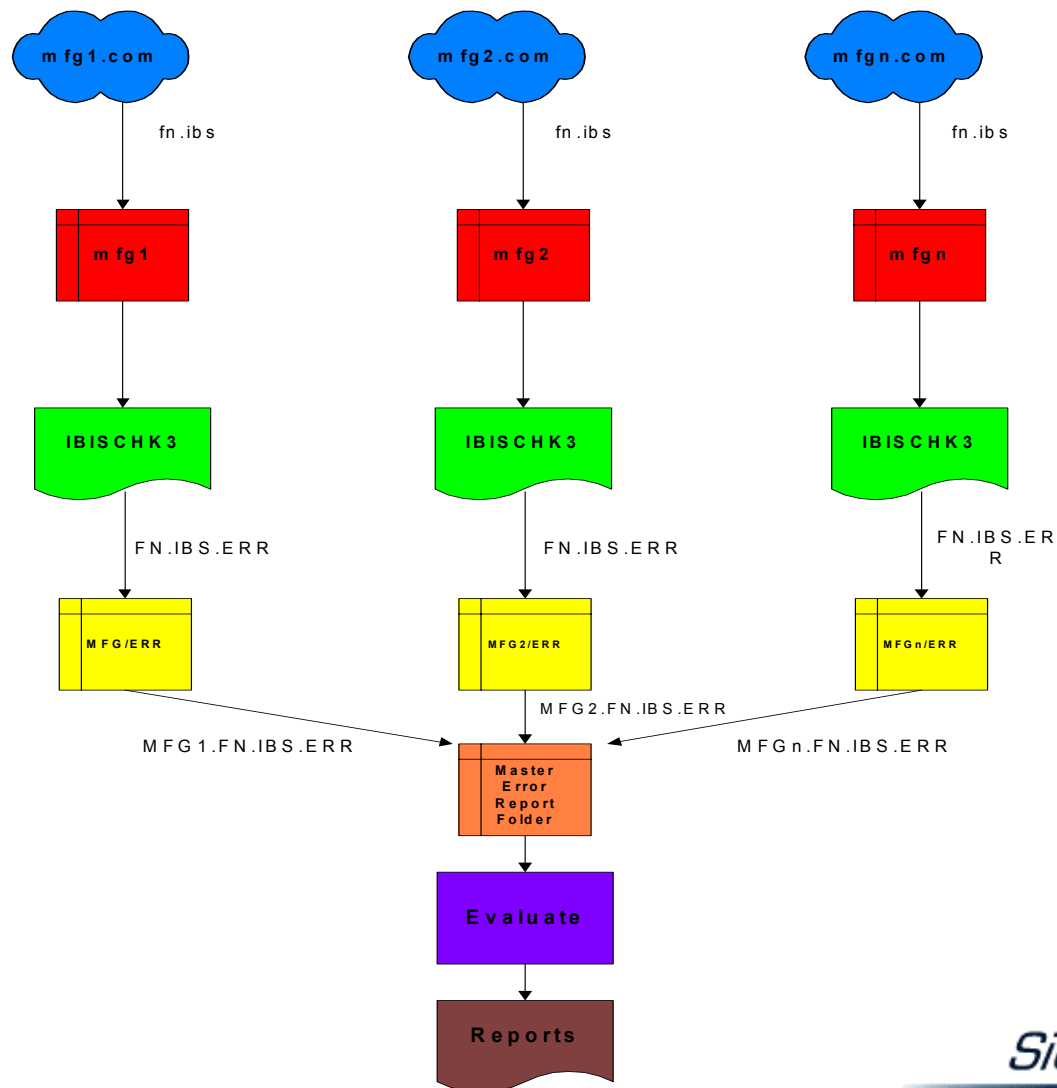
- Downloaded every readily available IBIS model off of the vendor web sites.
- Ran them through the IBISCHK3 Golden Parser.
- Parsed and Categorized into Excel spreadsheet reports.
- Gathered statistical data.
- Pinpointed the root causes of the most common IBISCHK3 errors and warnings.



Rules

- Any IBIS file was valid as long as it could be turned into an ASCII text file.
- No IBIS file content modifications were allowed.
- EBD files were not evaluated.
- Reports were categorized by the error or warning reported, not by the underlying cause.
- Multiple errors or warnings of the same type within a file were be counted as one report.

The Process From Web to Report



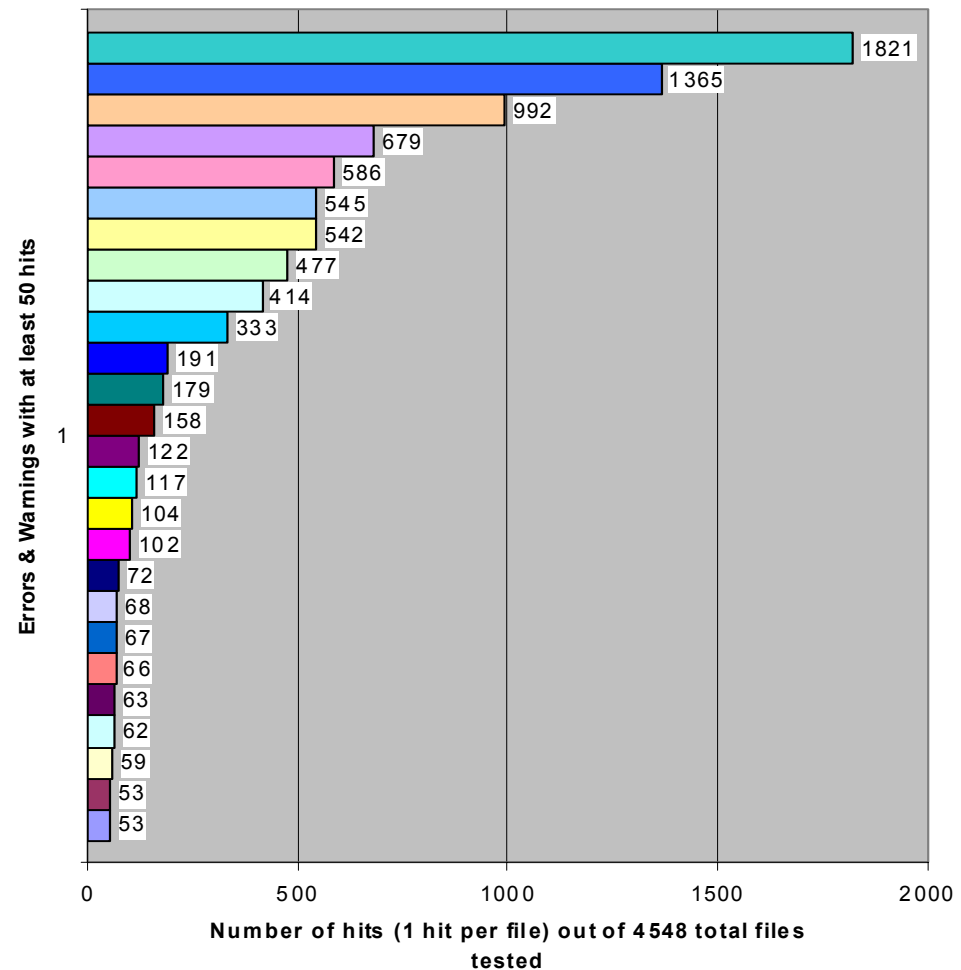
I. Test For Individual IBISCHK3 Errors and Warnings

- Broke down Errors and Warnings by frequency of occurrence.
 - Created a Perl script to detect unique text string segments of IBISCHK3's Error and Warning messages.
 - Accumulated number of 'hits' for each error or warning.
 - Checked results by comparing the number of errors and warnings detected to the IBISCHK3-generated summation whenever possible.

Results

Errors and Warnings with 50 or more hits.

- Non-monotonic Data
- Ext file name not the same as internal file name
- 'param' should not be specified for model
- Minimum value never reaches zero
- Found illegal character
- VI/VT table mismatch under equivalent load warning
- VI/VT table mismatch under equivalent load error
- Tab characters should not be used
- Text string too long
- Text line greater than 80 characters
- Model not referenced
- File_name must contain one period
- Extreme currents present in clamp VI curve
- Unknown IBIS version
- Required keyword not found
- Typ value not in between Min and Max
- Value repeated in first column
- VI curves cannot drive thru Vmeas
- Vinl not set
- Min value is not the smallest value listed
- Vinh not set

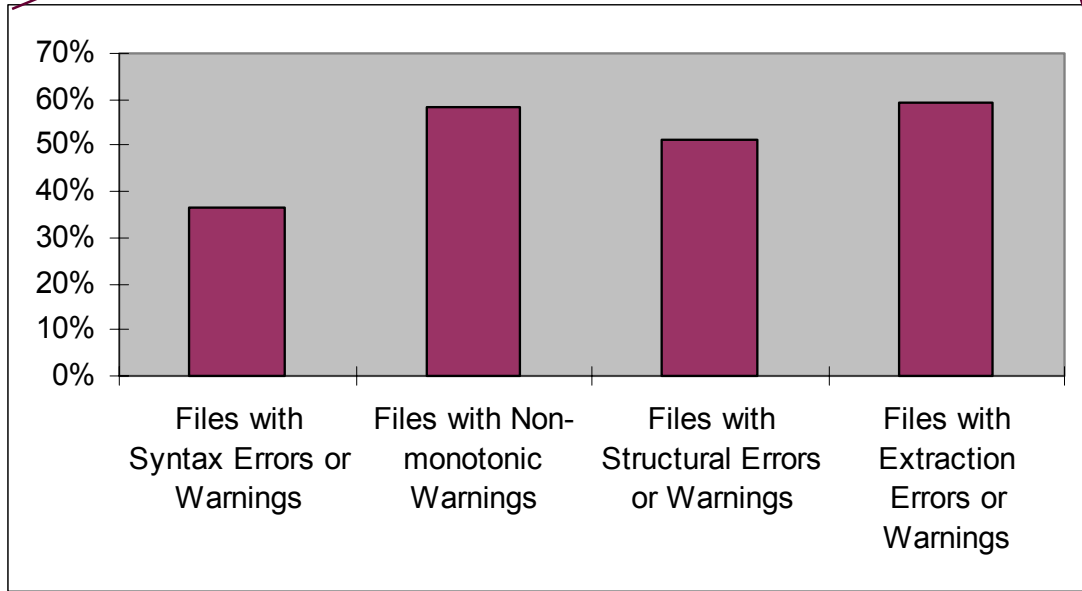
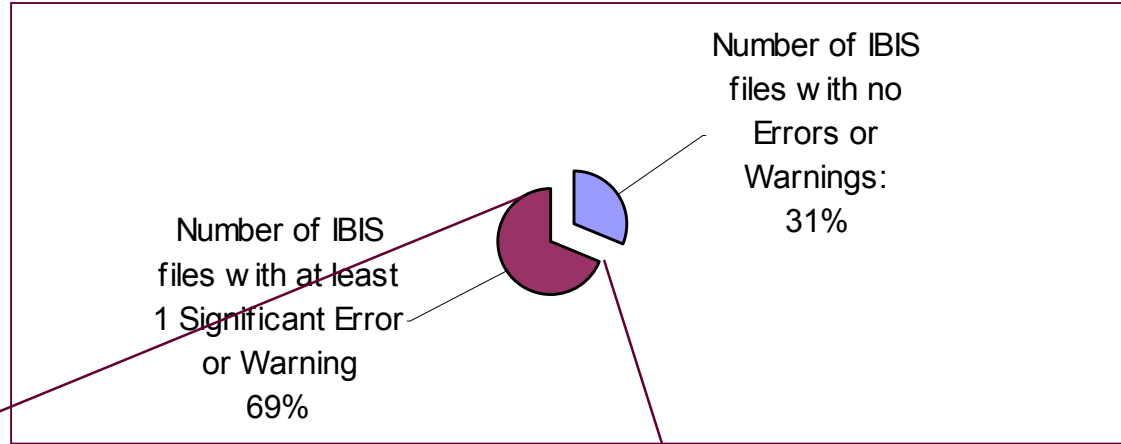


II. Categorized IBISCHK3 Errors and Warnings

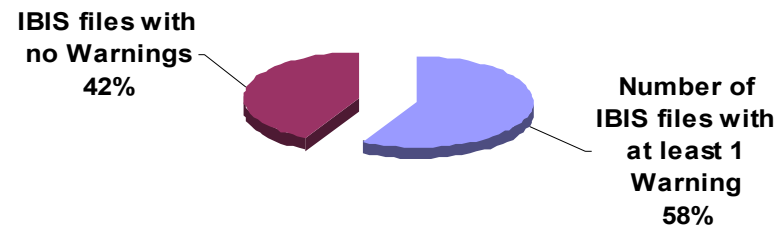
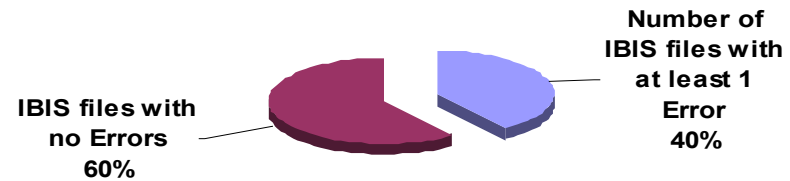
- Categories used
 - Data Extraction Errors and Warnings.
 - Structural Errors and Warnings.
 - Non-monotonicity Warnings.
 - Syntax Errors and Warnings.
 - Don't care.

II. Categorized IBISCHK3 Errors and Warnings (Cont.)

- Don't Care = Removed from analysis
 - Tab characters used.
 - Space(s) in a name.
 - File name must end in .ibs.
 - Caused mostly by “File name too long” truncation to 12 characters.
 - File name opened '*external_file_name.ibs*' not the same as File_name '*keyword_file_name.ibs*'.



Results (Continued)



IBISCHK3 Anomalies Discovered

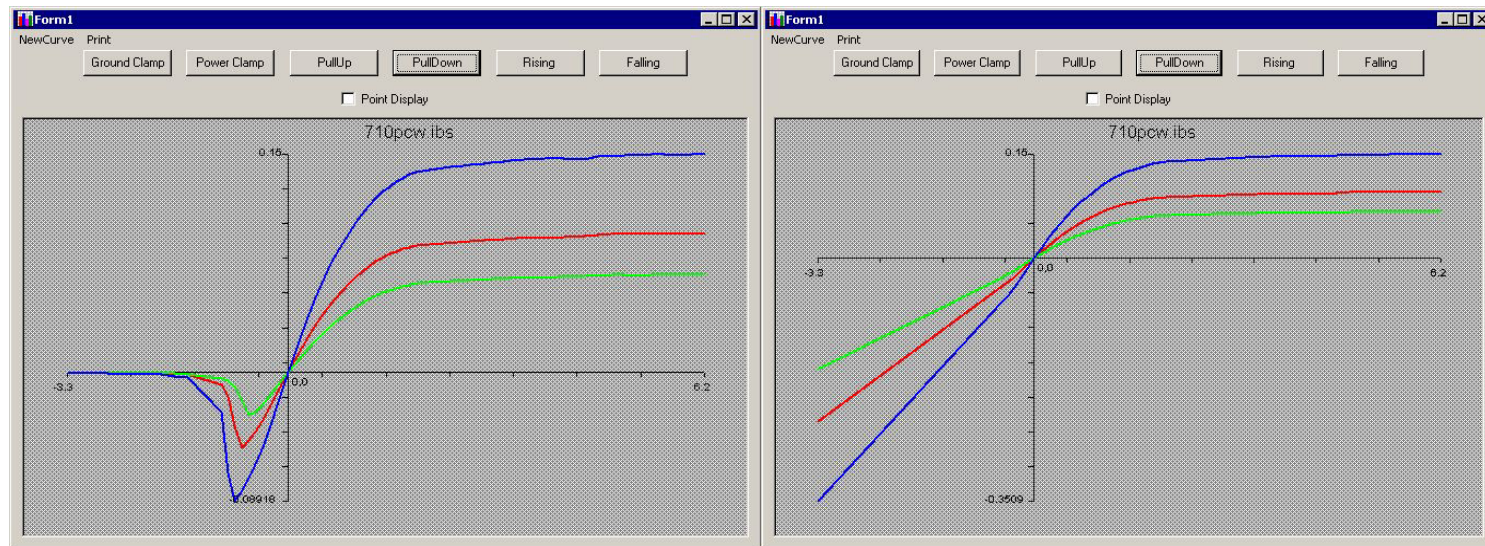
- “File_name Too Long” truncation to the legal number of characters creates new errors “File Name Opened Not The Same As File_name” and “File_name Must Contain a Period”.
- Orphaned Carriage Return Character (control-d) Error In Line 0 Not Always Counted In Total Errors.
- Conversion to space of orphaned Carriage Return Character (control-d) error in Line 0 sometimes creates new error “IBIS Version Cannot Be Determined. Exiting.”

Repairing the Top Five IBIS Model VI / VT Data Problems

- Non-monotonic Data.
- Minimum value never reaches zero.
- VI / VT table mismatch under equivalent loading conditions.
- Extreme currents present in VI table.
- VI curve cannot drive through V_{meas} .

Non-monotonic Table Data

- 3 possible causes of non-monotonic behavior
 - **Case 1: Clamps are saturated.**
 - Repair by
 - Removing the offending points.
 - Cleaning up the curve.



Before

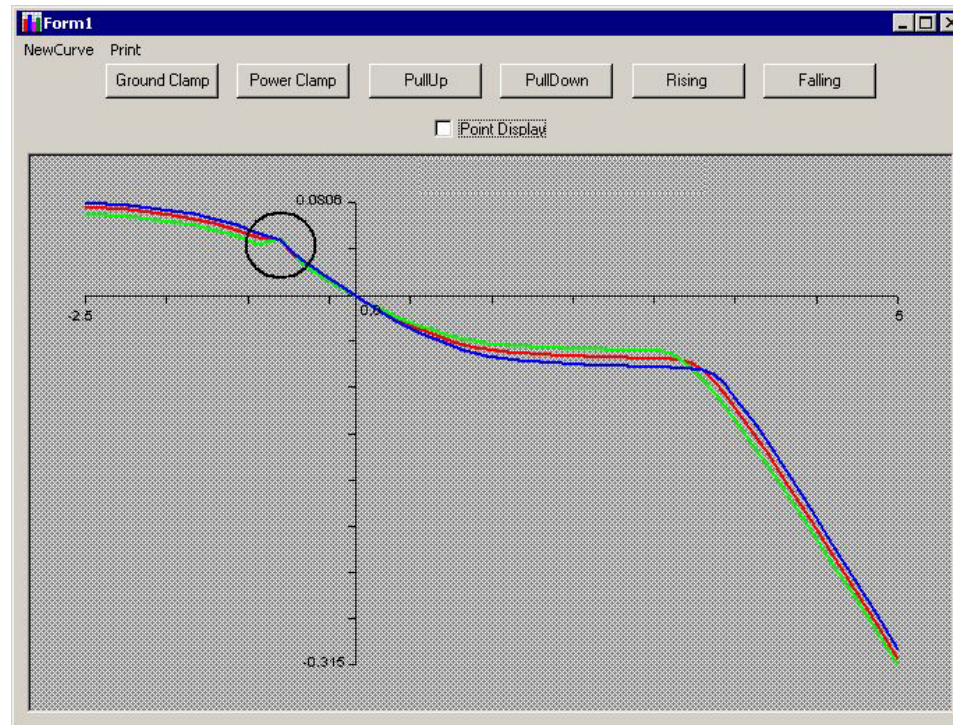
After

Non-monotonic Table Data (Cont)

- **Case 2: Older versions of SP2IBIS only allowed 2 digits after the decimal point.**
 - **Repair by**
 - Removing the duplicate points if curve integrity can be maintained, or
 - Re-converting the SPICE model using latest version of SP2IBIS.

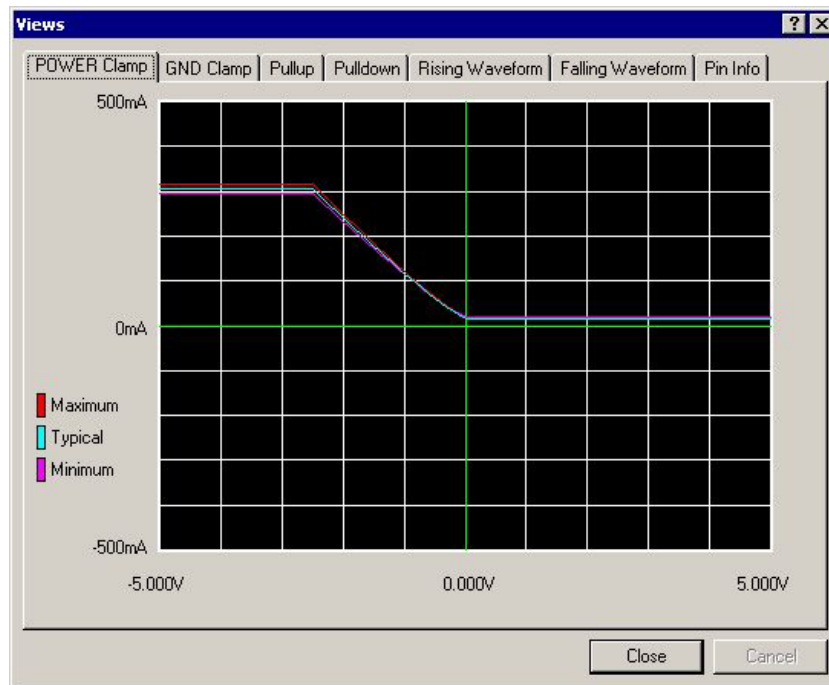
Non-monotonic Table Data (Cont)

- Case 3: The device really is non-monotonic.
 - Repair by using a waveform viewer and ASCII text editor to smooth out the curve, but BE CAREFUL!

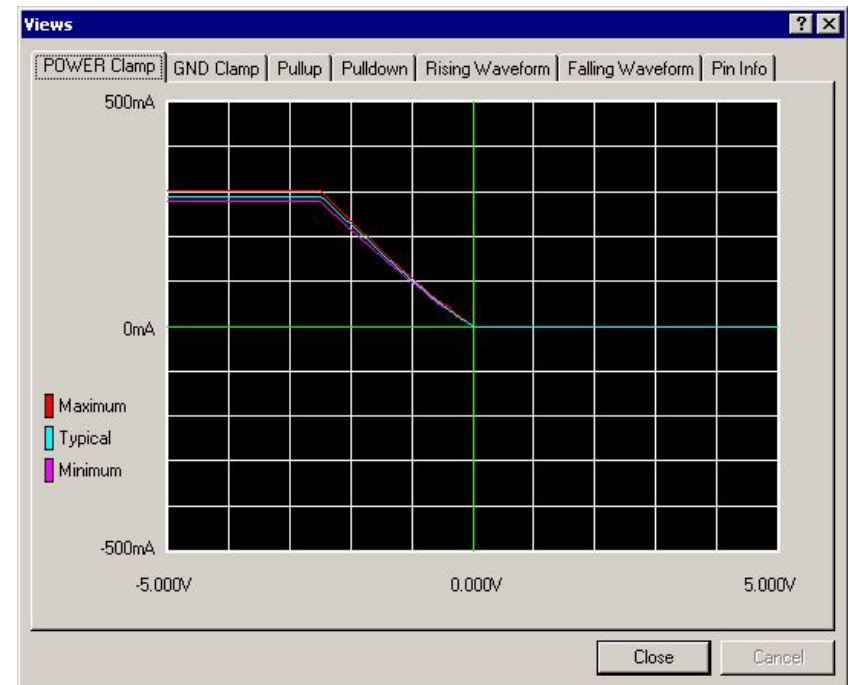


Minimum Value Never Reaches Zero

- Caused by clamp leakage current.
- Repair by subtracting out the leakage current from all table values.



Before



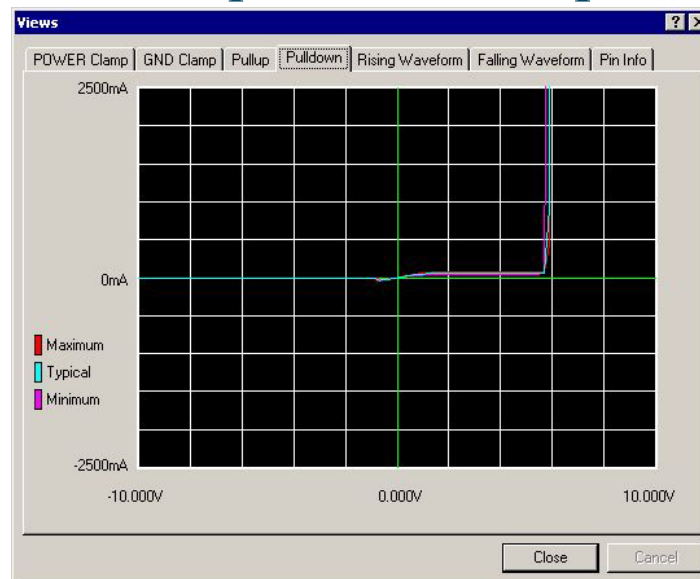
After

VI / VT Table Mismatch Under Equivalent Loading Conditions.

- Several possibilities for Error:
 - Case 1: Incorrect test load used during data extraction.
 - Case 2: Waveform simulation time wasn't long enough.
 - Case 3: Not all current sources accounted for.
 - Case 4: Bad SPICE simulation setup conditions (Temp, Voltage, Process deck incomplete, Wrong process deck, etc.)
- No repair possible By End User. Use dV/dT .

Extreme Currents Present

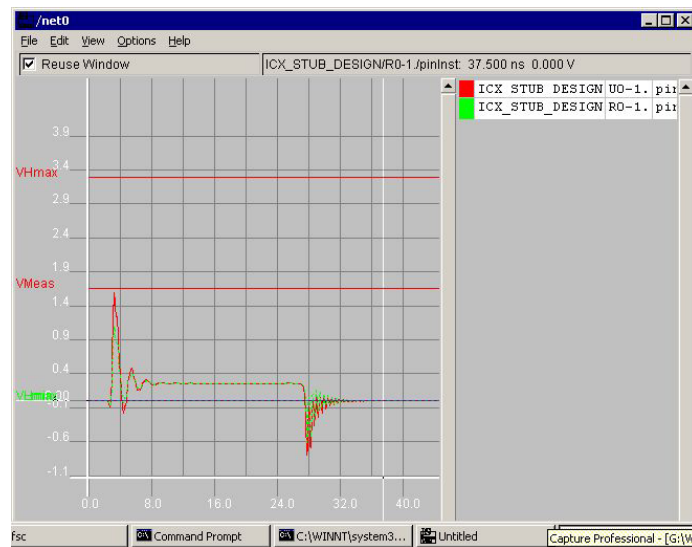
- 3 possible causes:
 - Case 1: Device is simulated in SPICE outside its normal operating range
 - Case 2: Error during V/I table extraction, such as an incorrect test load.
 - Case 3: The table voltage range went well beyond what is required for the part .



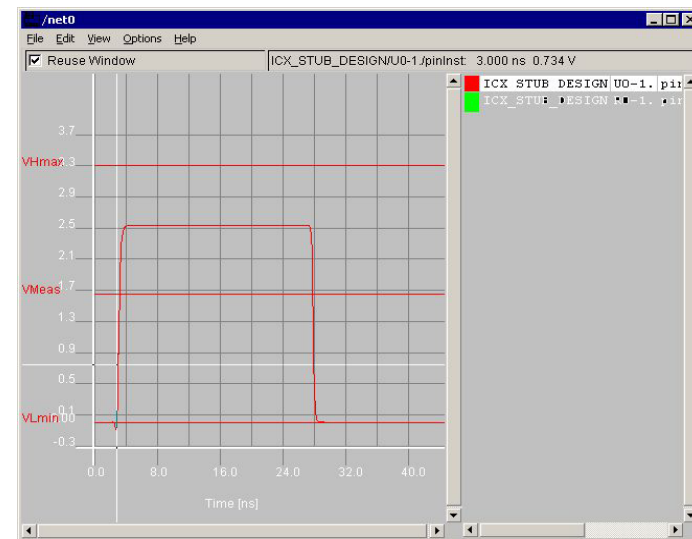
VI Curve Cannot Drive Through Vmeas

- Look for bad test load values (V_{ref} , R_{ref} , C_{ref}).
- Possible extraction error.
 - Cannot be repaired.
 - Re-extraction of table data will be necessary.

VI Curve Cannot Drive Through Vmeas (Cont.)



Before



After

Summary

- What this analysis discovered:
 - At least 74% of the IBIS files on the Web need some sort of correction by the end user before use.
 - At least 40% of the IBIS files on the Web are in serious condition.
 - Many of the most common errors and warnings detected by IBISCHK3 can be repaired, or made usable but with reduced accuracy.

Future Work

- Next presentation
 - Determine how many IBIS files available on the Web are likely to have an error not detectable by the IBISCHK3 Golden Parser
 - Review a statistical sample of IBIS files for IBISCHK3-undetected model errors.
 - Predict the total number of model files which may be effected.
 - Discuss most common errors discovered, whether they are repairable by the end user and, if so, how to repair them.