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Measurement Based IBIS Models

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Agenda

- What to expect
- What does it take to make measurement based models
- Process
- Question

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What to Expect

- Any component can be modeled
  - No NDA required
  - No SPICE deck required
  - No compatibility issues
- All you need is a sample and a datasheet

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It is easy to get samples of the component that needs to be modeled unless the component is not in production yet. In most cases you do not need to sign a NDA to get samples or a datasheet.

With SPICE you frequently need to get a NDA signed which increases the time and cost of making a model. Lawyers do not do their work for free.

Many semiconductor vendors have proprietary SPICE simulators. Modeling a component which has a proprietary description means you will need a copy of the proprietary SPICE simulator.

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Accuracy

- DC better than 1%
- AC Bandwidth >10 GHz
- AC accuracy limited by:
  - Probing technique
  - Fixturing

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Its easy to measure the DC characteristics to the level of accuracy required. Getting good AC bandwidth requires good fixturing, good probing and high bandwidth samplers.

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IBIS Features Supported

- Anything you can do with SPICE
  - Have not tried
    - Dynamic clamps
    - Bus hold
    - TT
- Doing a fully coupled package model would be costly
- Full min/typ/max if process corner components are available

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Most IBIS features are described with either IV and VT tables or by taking the data right off the spec sheet. Dynamic clamps and Bus Hold require special setups and measurements. TT is easy to measure. We have not seen any demand for these features.

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Required Equipment

- Wide bandwidth scope and specialized probes
  - > 10 GHz
  - 50 Ohms load terminated to an arbitrary voltage
  - TDR capability very useful

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The bandwidth of the scope should be at least 5 times the bandwidth of the signals you model. Most parts these days have 200 to 500 psec transitions. This implies a scope bandwidth of at least 8.75 GHz.

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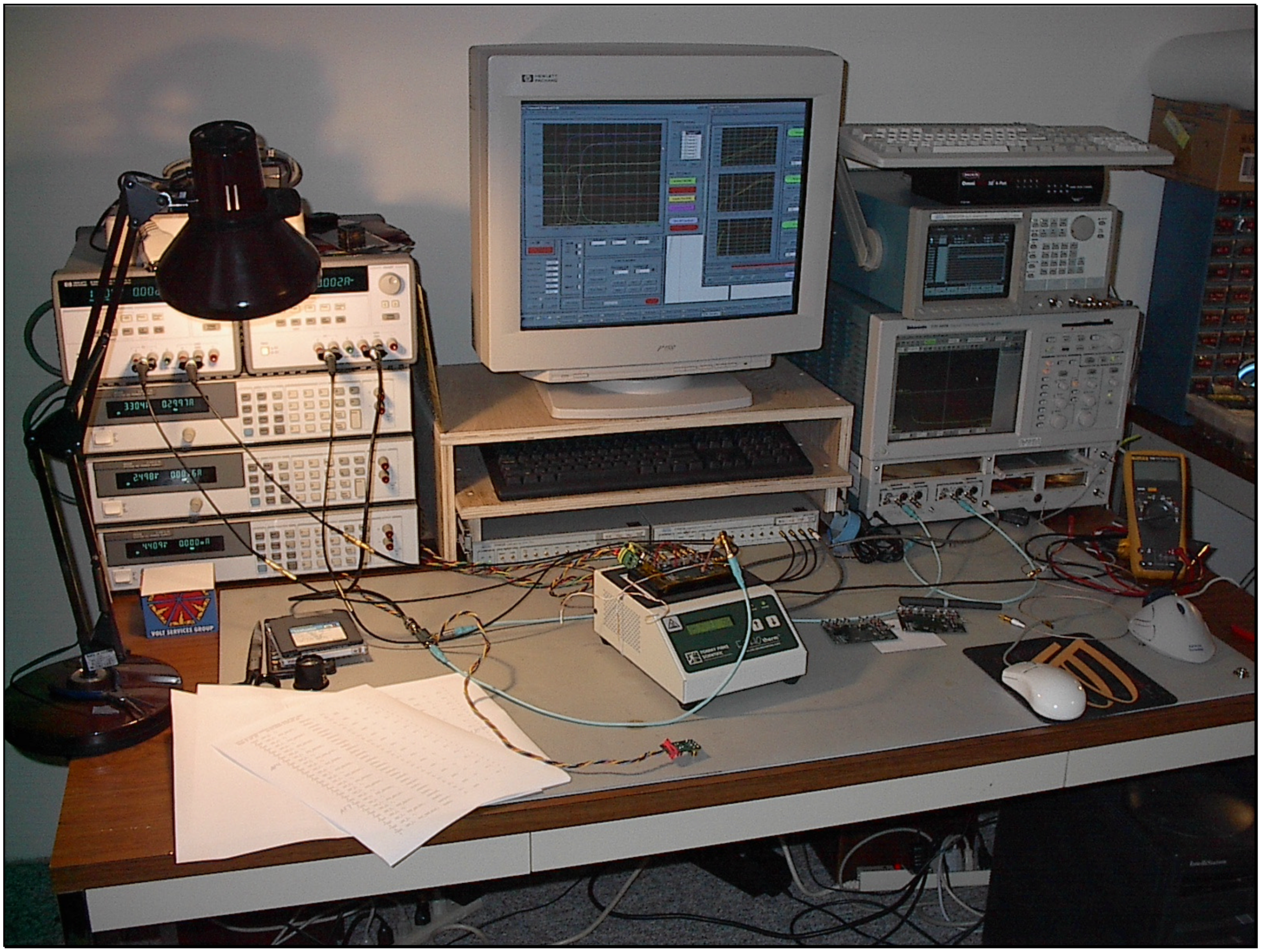

This is one of Teraspeed's test setups. There are 5 power supplies, one scope with 20 GHz sampling heads and a 24 channel word generator. Also pictured is a hot/cold plate to vary the case temperature from 0 to 100C. There are a lot of other tools required such as probes, attenuators, etc.

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Stimulus

- High speed word generator
  - 24 channels at 100 MHz
  - Variable output levels
    - ECL
    - PECL
    - LVDS
    - CML

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Power Supplies

- One supply to do IV sweeps
  - At least +/- 7 volts
  - At least +/- 1 Ampere
- At least 4 additional supplies to power chip
- One supply for termination voltage

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Most outputs will source of sink between 100 and 500 ma. We have seen parts that can sink over 1 Amp. The supplies need to be able to both source or sink current to make these measurements.

Many of today's chips have 3 or more supply connections. A core supple, a I/O supply or two and maybe some bias supplies.

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Misc. Equipment

- Hot/cold plate 0 to 100 C
- DMM
- Device programmers
- Signal generator
- Temperature probe
- Etc.

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Like most things the more automation you can use the more productive you can be. Also properly designed tools will prevent errors form occurring. Many of the problems seen in IBIS models are just syntax issues. Automated tools will prevent those kinds of mistakes.

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Measurement Process

- VT data
  - 50 Ohms to ground and acquire rise and fall
  - 50 Ohms to Vcc and acquire rise and fall
  - Preserve timing relationships between waveforms

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Keeping the time correlation between waveforms is very important. The scope must be triggered off some external event, not the waveforms of interest.

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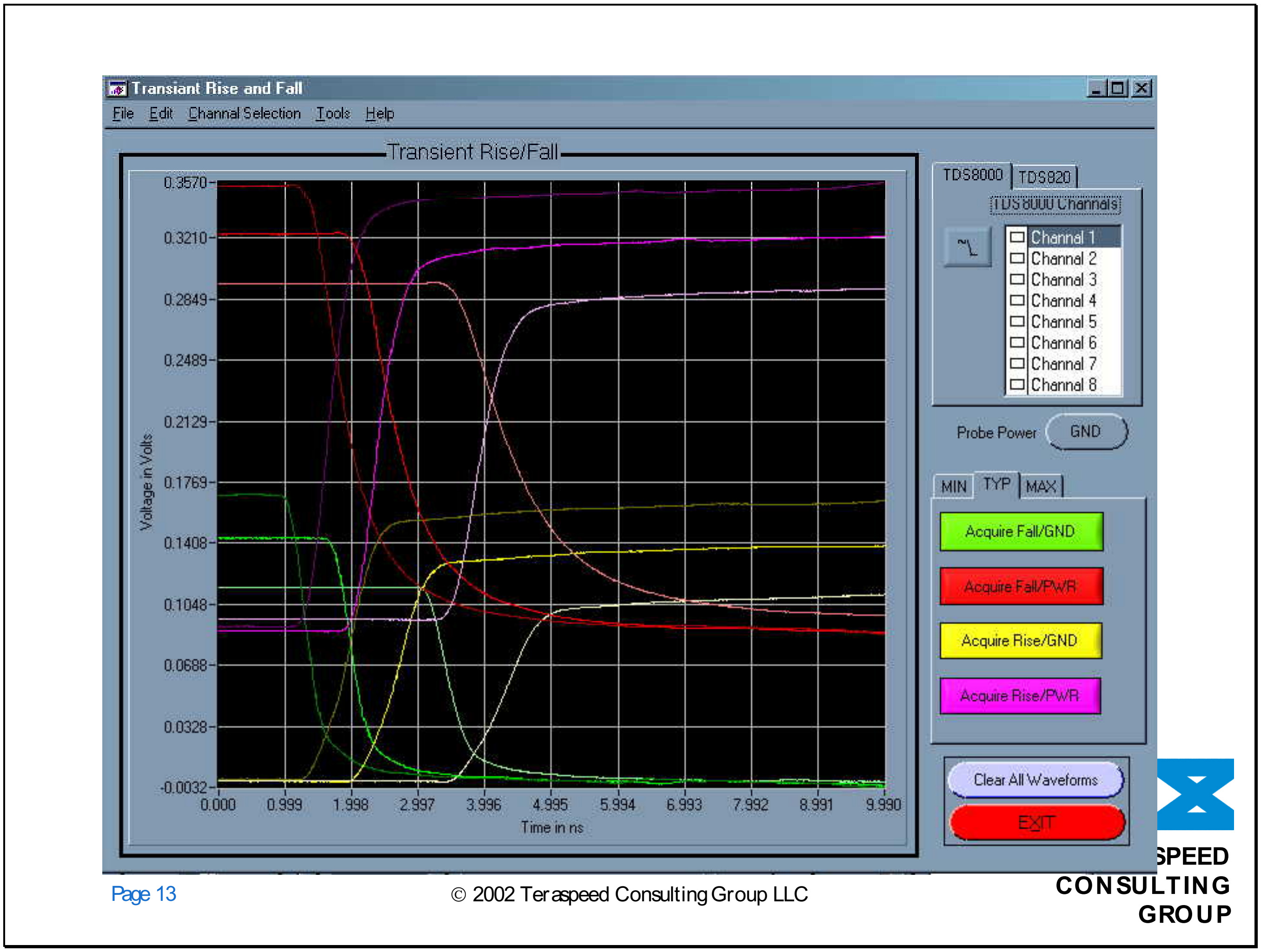

Here is a complete set of VT curves for a part measured over process, temperature and voltage. The upper set of waveforms are with the 50 Ohm termination tied to Vcc and the lower set for the output terminated to ground. It is easy to see the change in prop delay in the component from the max to typ to minimum set of conditions.

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Measurement Process

- IV Data
  - Place output in high state
    - Sweep from 0 to Vcc + 1.2 Volts
  - Place output in low state
    - Sweep from –1.2V to Vcc
  - If appropriate get input or tri-state
    - Sweep from –1.2 to Vcc + 1.2 Volts

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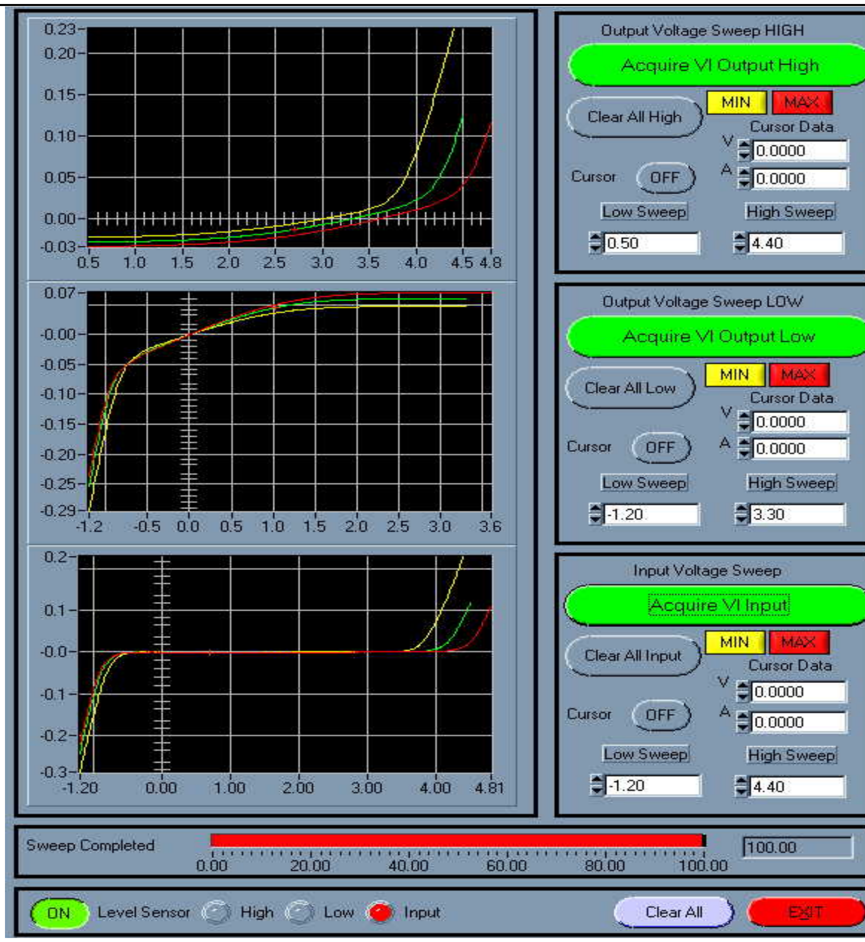

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These are the IV characteristics of the same component over process, temperature and voltage. The upper window shows the pull up characteristics, the middle the pulldown and the lower the input.

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Collect Component Data

- Pin data
  - Number
  - Signal
  - Model
  - Package parasitics
  - Electrical specification
  - Timing test load
  - Diff pin pairs
  - Etc.

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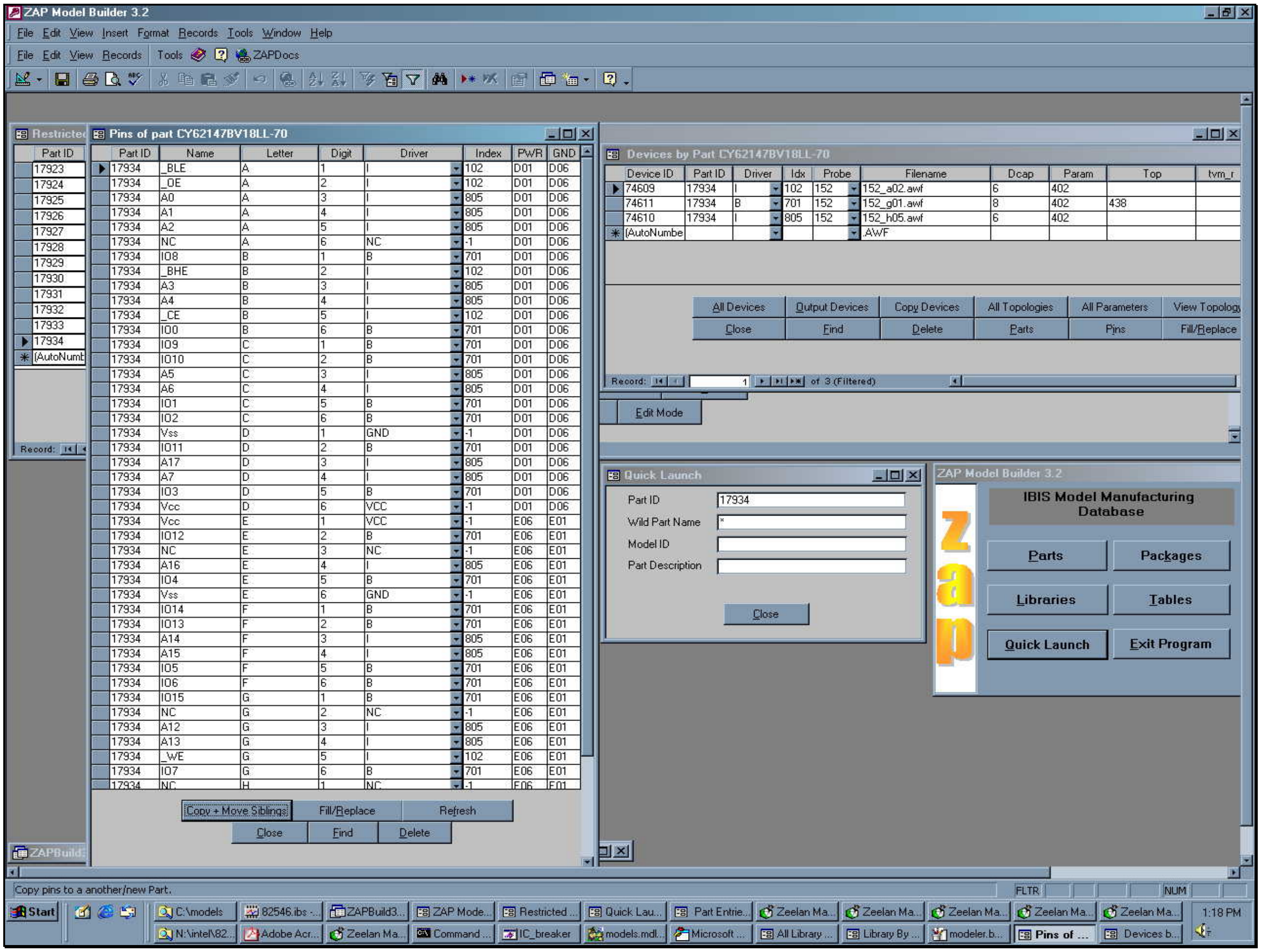

This shows some of the screens in our database. All pin and specification data is stored in the database.

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Build Model

- Build model
- Check with IBIS Golden Parser
- Load and check in a simulator

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Too may model makers neglect step two in the process. There are too many models that will not pass the IBIS parser.

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Skills Needed

- Thorough knowledge of logic
- High frequency measurement techniques
- More than passing knowledge of the IBIS spec.

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Question

- Would a model with temperature and voltage variation be more useful than a typical only model?

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Would a model that has voltage and temperature variation only, no process information give the SI engineer more useful information than a typical only model.