

Teraspeed Modeling

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Visit our web page www.teraspeed.com for more information our capabilities and services

Agenda

- Working with Teraspeed
- Capabilities
- Model Features
- Tools & Specifications

Commitment

- Teraspeed has invested significant time, resources and reputation on the formation of this company. We are well-known and respected in the high-speed engineering community. Teraspeed stands by the quality of the products which we produce and are committed to servicing our customers.



Working with Teraspeed

- **Quality**
 - **Built into the process**
 - QC waveforms as they are measured
 - Process implements correct-by-construction
 - Fully automated process for most aspects of the model generation process – very repeatable
 - **The most experienced team**
 - Building SI models since 1994
 - Over 15,000 models built



Quality is very important to us. We have automated many of the processes we have to ensure a quality product is produced. We have the experience to back this up.

Working with Teraspeed

- Delivery
 - Parts that do not need a new fixture will be completed on average in 2 weeks
 - New fixture designs add about 4 weeks
 - You can buy quicker turn around times

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We can quickly respond to customer requests for models. Our standard lead-times for fixtures can be shortened by paying our suppliers extra for quicker service.

Working with Teraspeed

- Customer Support
 - More than willing to support Teraspeed models
 - Make sure they satisfy users
 - Work with customers on model issues – not just models Teraspeed has made
 - Direct access to modeling engineers
- Model upgrades
 - Will upgrade/fix existing models per quote



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We stand behind our service. We want satisfied customers.

We work with end users to solve modeling issues even if the models are not originally supplied by Teraspeed.

If there are questions the person who made the model is available for discussion.

If you have models that do not work we may be able to fix them for you.

Standard Model Features

- Standard process includes
 - All models pass IBIS check 3 and will load into ICX
 - VT curves
 - Pullup and pulldown curves
 - Differential tables where appropriate
 - Full pinout of the device
 - Individual pin parasitics
 - Timing test loads for all drivers
 - Input thresholds



Optional Model Features

- Optional process is to model over ***NEW***
 - Temperature
 - -10 to 100 C
 - Voltage
 - Per request
 - Process
 - Per available corners
- Model selectors where appropriate
- Model Spec.
- Etc.

We can model just about any feature in the IBIS standard.

Model Features

- Package/EBD models based on
 - TDR analysis
 - Field solving



Package models are as important as the silicon model.

Design Capability

- 0-20 GHz PCB and system design and modeling.
- Package design to 10 GHz clock, 10 Gbps data.
- Test structure and launch design for > 10 GHz measurement bandwidth.
- Custom fixture design for parts to be modeled.
- Simulator correlation to measured data.



Teraspeed also can consult on and/or develop high speed design solutions

Future Planned Capability

- High-bandwidth VNA modeling of passive structures (backplanes, connectors, vias, traces).
- Measurement and software to de-embed package characteristics from measured V/T model data.
- Custom library generation for mixed-mode s-parameter simulation.
- Conversion of broadband measurements into accurate Spice “black-box” circuits.
- Conversion of passive spice circuits into broadband touchstone s-parameter files.
- Full support for IBIS Interconnect Specification for connector and system models.



Teraspeed is continually enhancing the capabilities in-house to meet customer requirements.

Commercial EDA Tools

- Mentor ICX Toolset
- Hyperlynx Visual IBIS Editor
- Hyperlynx LineSim and BoardSim
- Ansoft 2D/3D
- Hspice
- Broadband Spice (s-param to spice conversion)
- CST Microwave (s-param extraction)
- Flomerics Microstrips (3D structure extraction and simulation.)



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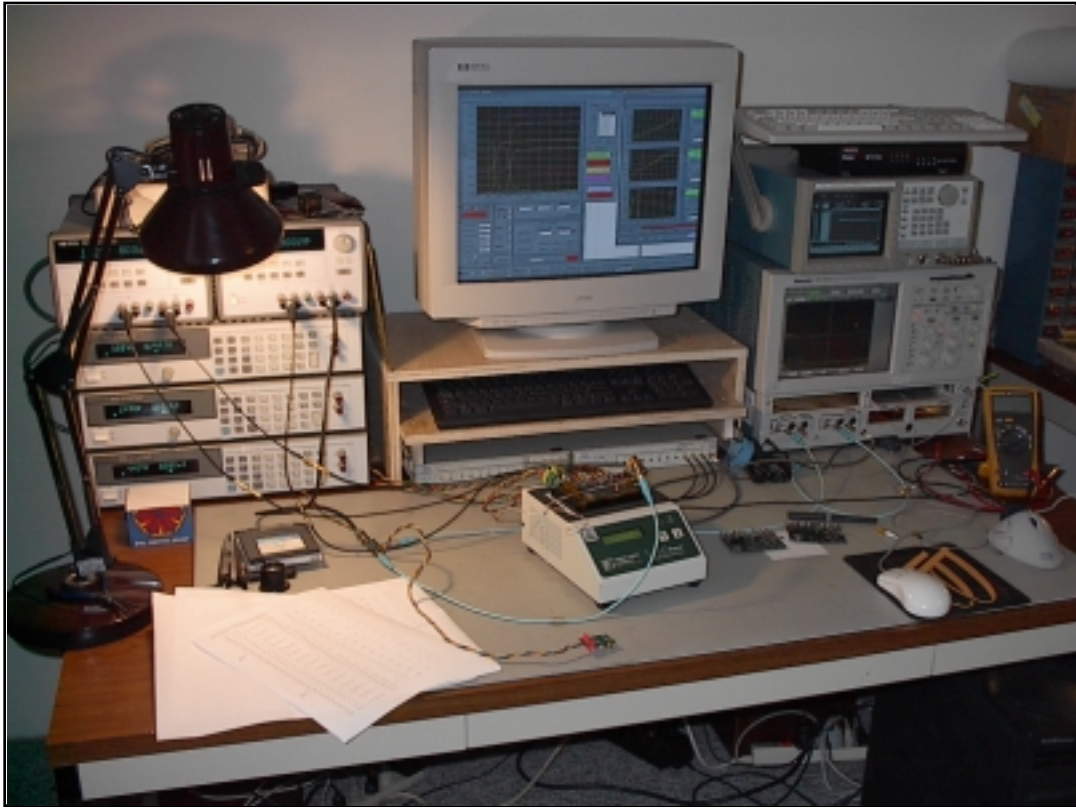
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Teraspeed has a variety of commercial tools beside the internally developed tools to fully develop models, do pre-layout design guides, characterize structures, etc.

Equipment

- Two complete automated test systems
 - One shown on next slide
 - GPIB controlled systems
 - Expandable
- One TDR workstation



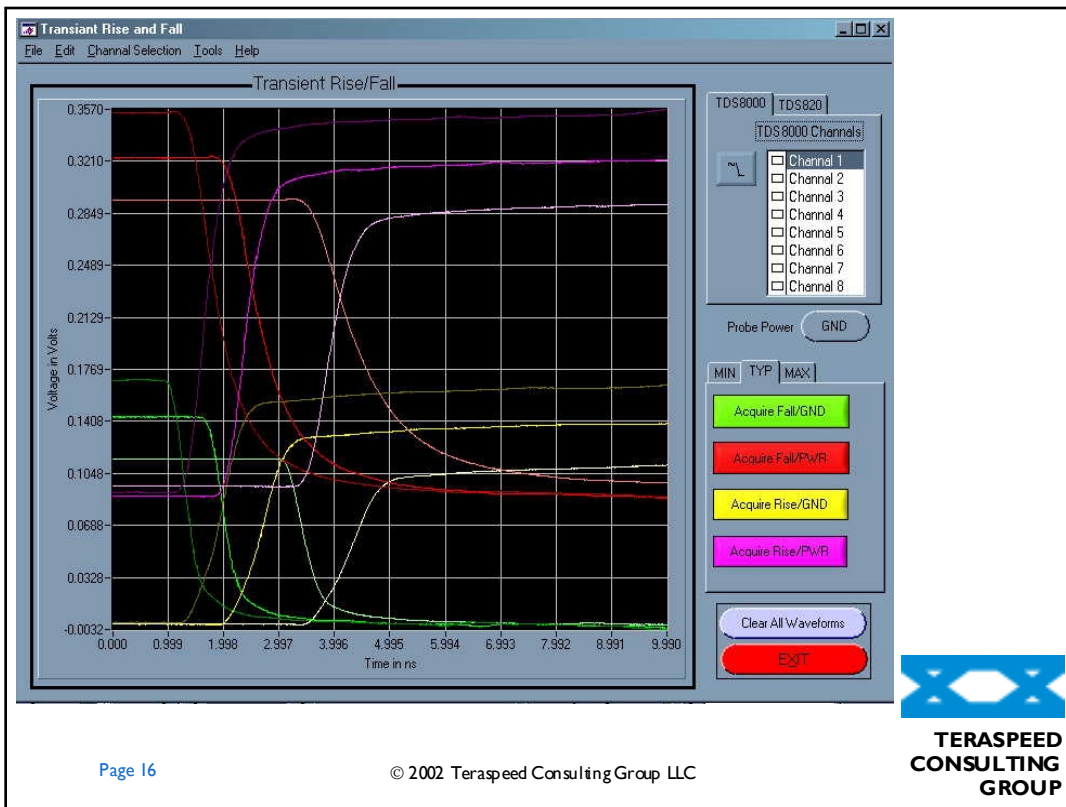


This is one of Teraspeed's test setups. There are 5 power supplies, one scope with 20 GHz sampling heads and a 24 channel word generator. Also pictured is a hot/cold plate to vary the case temperature from -10 to 100C. There are a lot of other tools required such as probes, attenuators, etc.

System #1 Equipment Scope

- Tek TDS8000 with 80E03 and 80E04
 - 4 channels of 20 GHz acquisition
 - 50 Ohms load terminated to an arbitrary voltage
 - Differential TDR/TDT capability

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.



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.

Stimulus

- High speed word generator
- DG2020A
 - 24 channels at 100 MHz
 - Variable output levels
 - ECL
 - PECL
 - LVDS
 - CML
 - CMOS

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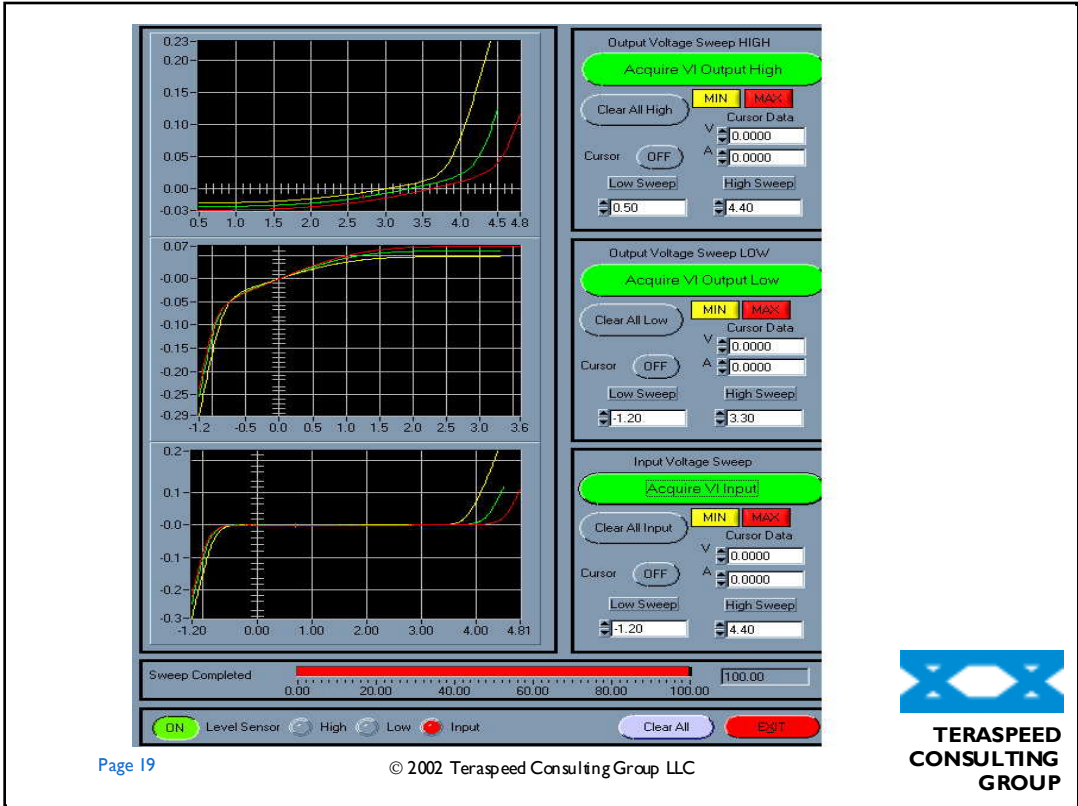
Many of today's chips require complex stimulation. We have the tools to model most any component on the market.

Power Supplies

- Three Agilent 6632B supplies
 - 0 to 20Volts
- Two Agilent E3631A
 - 0 to 6 volts
 - 0 to +20 Volts
 - 0 to – 20 Volts

Most outputs will source or 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 supply, a I/O supply or two and maybe some bias supplies.



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.

Misc. Equipment

- Hot/cold plate -10 to 100 C
- DMMs
- Device programmers
- Signal generator
- Temperature probe
- FET Probes
- Zo Probes
- Real time scope
- Etc.



System #2

- Tek TDS820
 - 2 channels by 6GHz
- Tek DG2020A
- Power supplies
 - E363 1A
 - 6632B
- -hp- Signal Generator

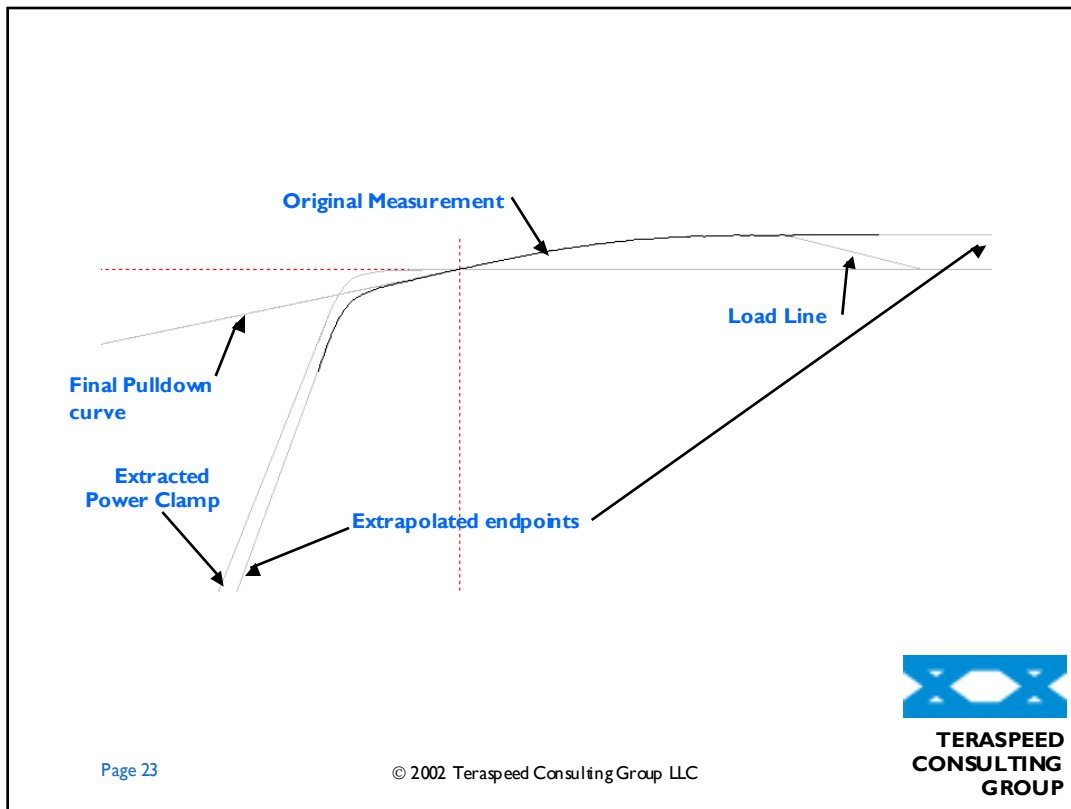


SW Tools

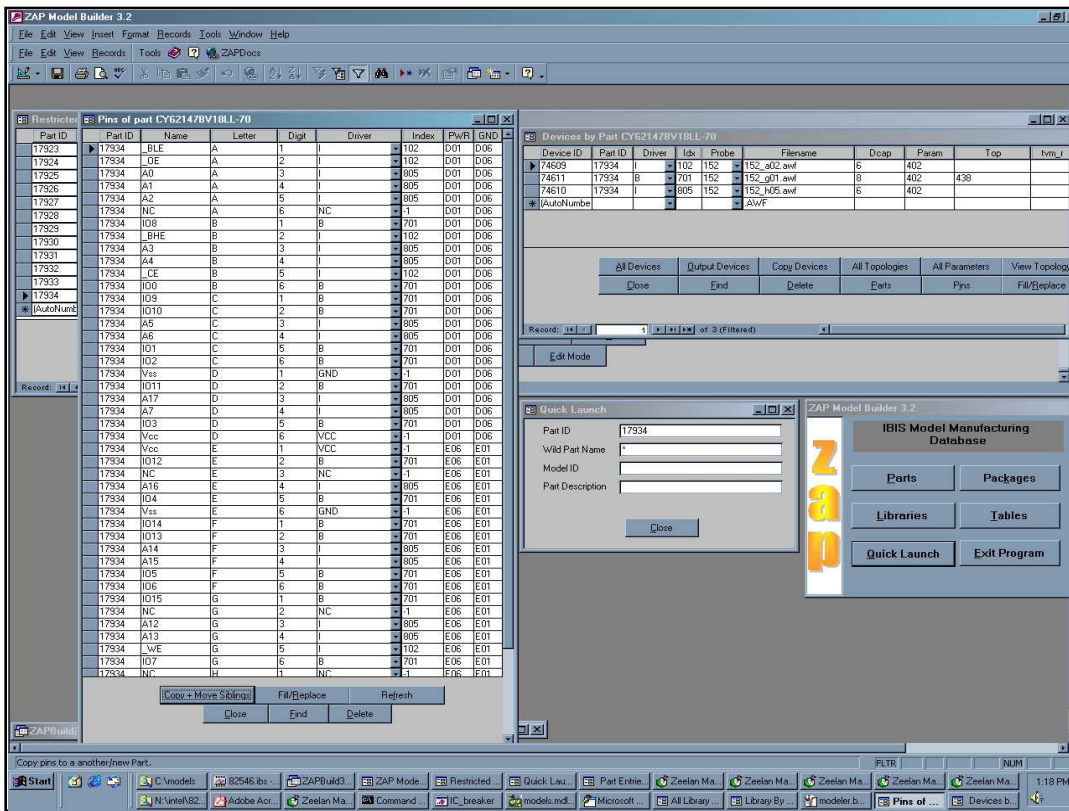
- SW to run the T&M equipment
 - Takes all measurements and saves data
 - Allows inspection, QC, measurements, etc.
- SW to reduce the raw data to IBIS tables
 - Extract clamps where needed
 - Extrapolate endpoints
- SW to write the IBIS model
 - Automates the conversion of component data to IBIS files
 - QC's data and writes a correct-by-construction model
- Data on over 15,000 ICs
 - Including measurements



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



This shows the processing that goes on in one of our tools that extract the ground clamp from the pull down characteristic of a output only driver. First the original waveform is extended to the full IBIS $-V_{cc}$ to $2xV_{cc}$ range (not fully shown here). Then the pulldown characteristic is generated by extending the slow of the resistive region of the curve to $-V_{cc}$. The new pulldown is then subtracted from the extended measurement curve to yield the extracted ground clamp curve.



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

Dedicated TDR System

- Tek 11801C
 - SD24
 - 20 GHz sampling
 - Differential TDR/TDT
- SW to extract LCR and T-line models from packages and boards.

We use this system to model packages, board traces, connectors, etc.

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