

# Microwave & RF Device Characterization Solutions

## MT2000 – Mixed-Signal Active Load Pull System (1.0 MHz to 40.0 GHz) And MT2001 System Software

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# Measurement & Modeling Device Characterization Solutions

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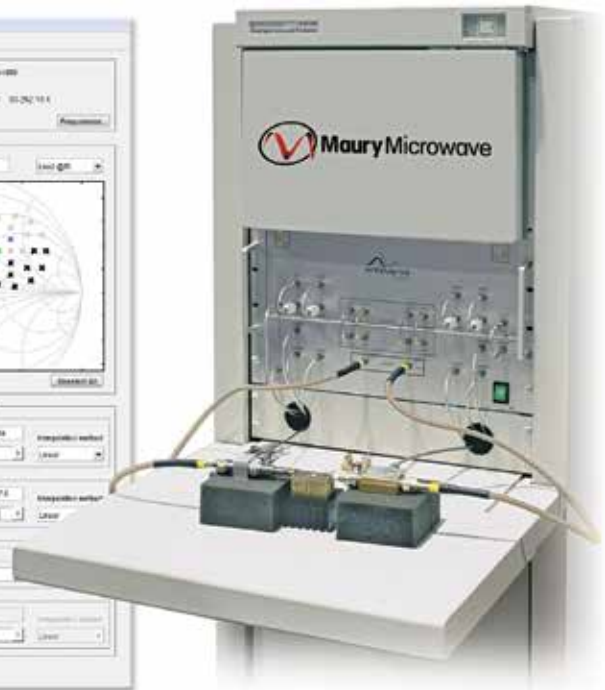
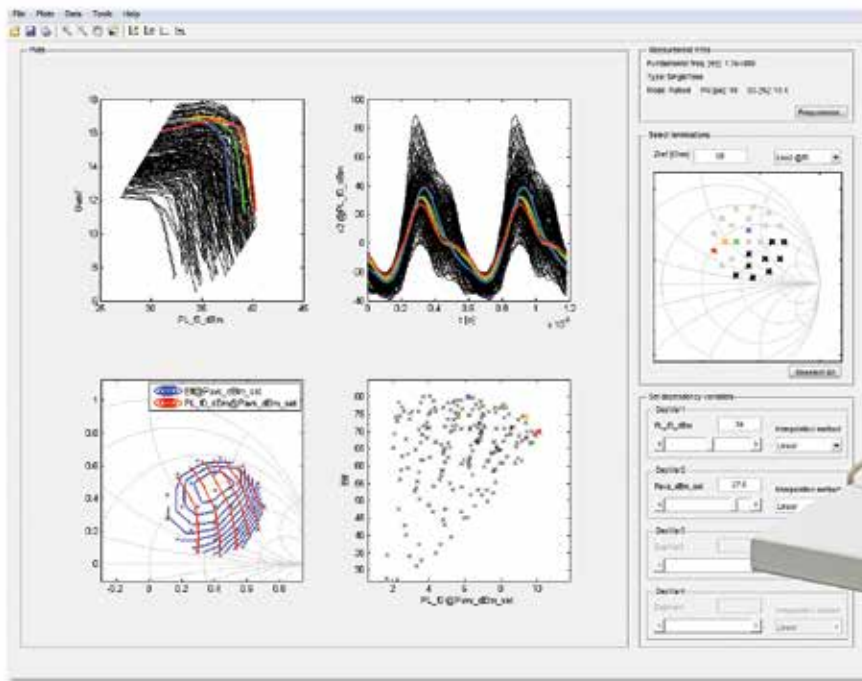
- **RF Device Characterization Methods**
- **Pitfalls To Avoid When Purchasing A Device Characterization System**
- **Device Characterization Software**
  - IVCAD Advanced Measurement & Modeling Software (MT930 Series)
  - ATSV5 Automated Tuner System Software (MT993 Series)
  - AMTSv3 Automated Mobile Test System Software (MT910 Series)
- **Maury Automated Tuners**
  - LXI™-Certified High-Gamma Tuners™
  - LXI™-Certified High-Power Tuners
  - LXI™-Certified 7mm Tuners
  - LXI™-Certified 3.5mm Tuners
  - LXI™-Certified 2.4mm Tuners
  - LXI™-Certified 1.85mm Tuners
  - Millimeter-Wave Tuners
  - LXI™-Certified Multi-Harmonic Tuners
  - LXI™-Certified 7mm Sensor Tuners
- **Automated Sliding Loads**
- **Pre-Matching Probe Mounts**
- **Noise Receiver Modules**



- 50 GHz Noise Receiver Modules
- 50 GHz PNA-X Noise Receiver Modules
- Millimeter-Wave Noise Receiver Modules
- **Precision Low-Loss Coaxial Triplexers & Diplexers**
- **Low-Loss Couplers**
- **Low-Loss Load Pull Test Fixtures**
- **Wide Matching Range Coaxial Slide Screw Tuners**
- **RF Device Characterization System Integration**
- **Turnkey Measurement Systems**
- **Integrated Load Pull and Noise Measurement Systems**
- **Mixed-Signal Active Load Pull Systems**
- **AMCAD Engineering's PIV/PLP Family of Pulsed IV Systems**

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# MT2000 – Mixed-Signal Active Load Pull System (1.0 MHz to 40.0 GHz) And MT2001 System Software



U.S. Patent No. 8,456,175

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## Key Features (Typical Performance)

- Broadband system concept (e.g. 0.7-40.0 GHz)
- Re-configurable hardware; single-ended, differential and number of controlled harmonics
- High speed and dynamic range
- Embedded measurement of (Pulsed/Isothermal) DC parameters

## Single tone

- "Real-time" measurement speed >1,000 power and load states per minute
- Multi-dimensional parameter sweeps
- (Pulsed/Isothermal) High Power testing
- Measurement of calibrated Voltage and Current waveforms
- Device protection included
- Waveform reconstruction

## Modulated signals

- Wideband modulated signals (e.g. multi-carrier WCDMA) up to 240 MHz
- Modulated Signal Library Included
- Losses and delay of cables, probes etc. are eliminated
- Upload the s-parameters of any "virtual matching networks" and get a one-to-one agreement with your board design (also for linearity)
- Device testing with digital predistortion

## General Description

This novel mixed-signal load pull system is designed to handle realistic wideband complex modulated signals with a high dynamic range and provide user defined reflection coefficients vs. frequency at the DUT reference planes.

The system concept is based on:

- IQ signal generation, synthesized with fully synchronized arbitrary waveform generators (AWG)
- Wideband A/D converters to measure the wideband reflection coefficient

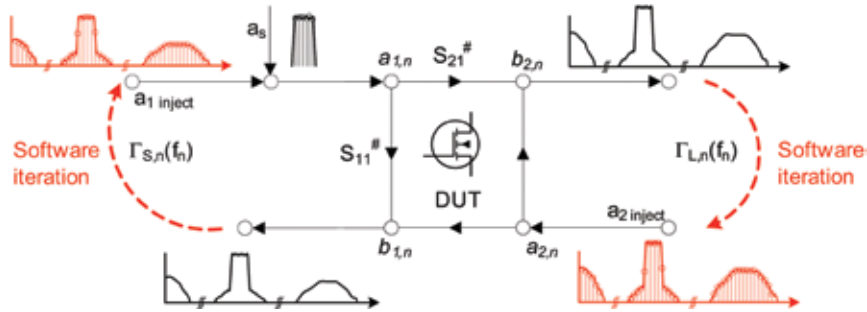


Figure 1. Principle of the Mixed-Signal Load Pull setup as a Signal-Flow diagram

## Wideband Generation/Detection

The maximum modulation bandwidth is set by the bandwidth of the AWG and IQ modulators.

- Currently available with 60, 120 or 240 MHz of controlled bandwidth
- Total number of measurement points in every controlled band is >40,000 points

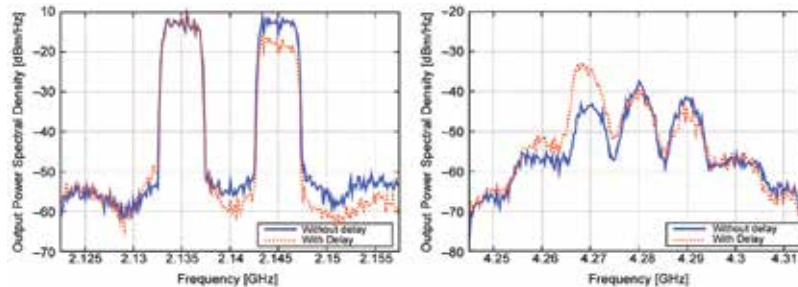


Figure 2. Output spectrum of the DUT at  $f_0$  and  $2f_0$  tested with multi-carrier WCDMA (with and without delay compensation).

## "Real-Time" Load Pull

Synchronization between signal generation and detection facilitates ultra-fast measurements.

- Independently fully controlled multidimensional Load Pull parameters sweep
- 5,760 measurement points in less than 5 minutes: 90 fundamental load states, swept load and source harmonic termination, 16 power levels

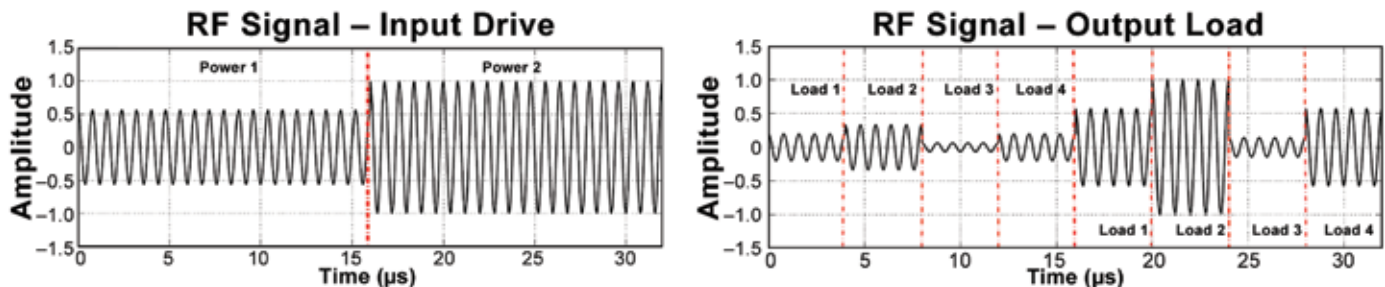
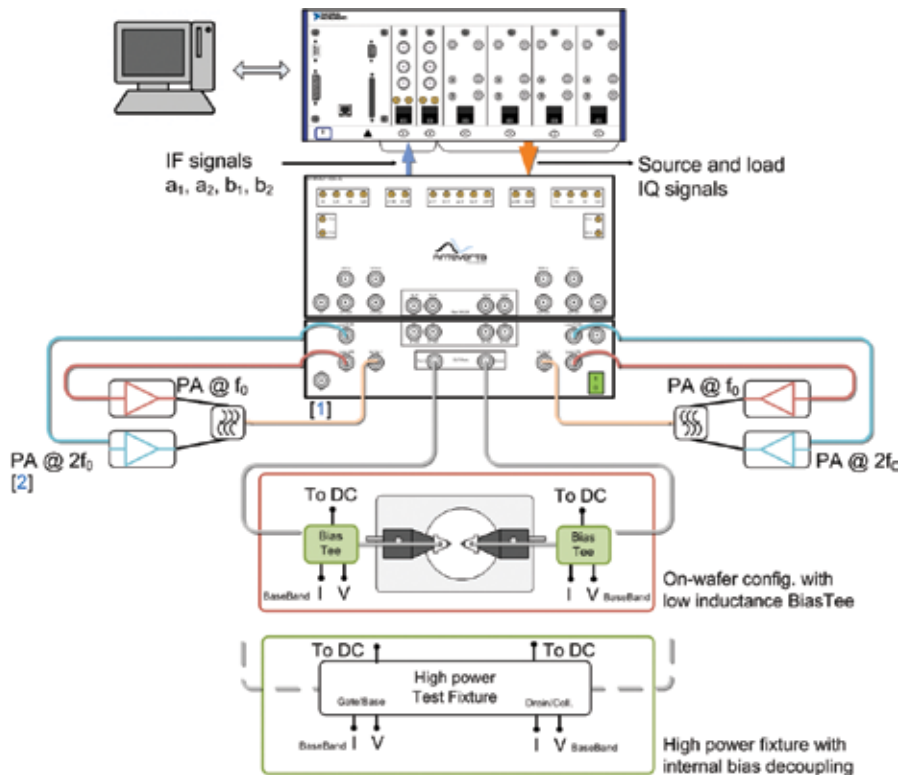


Figure 3. Injection signals as used in the "real-time" multi-dimensional parameter sweeps.

## High Power/On-Wafer Configuration

The active loops are fully re-configurable (e.g., the same hardware would also support source pull at  $f_0$  and load pull at  $f_0$ ,  $2f_0$  and  $3f_0$ , or true differential source and load pull at  $f_0$ ). See [1] in the diagram below.

The proprietary algorithm (patent pending) results in low requirements on the loop amplifiers, so linearity is no longer a problem in this regard, while their  $P_{sat}$  should be just slightly larger than the power generated by the device under test (DUT). See [2] in the diagram at below.



## MT2001 Software Modules

Module	Description
MT2001A	MT2000 POWER MEASUREMENTS (required)
MT2001B	MT2000 MODULATED MEASUREMENTS
MT2001C	MT2000 TWO-TONE MEASUREMENTS
MT2001D	MT2000 NVNA (TIME DOMAIN ANALYSIS)
MT2001E	EXTERNAL CONTROL
MT2001F	VISUALIZATION

## Suggested Reading

- 5A-044 – Active Harmonic Load Pull with Realistic Wideband Communications Signals.
- 5A-045 – Active Harmonic Load Pull for On-Wafer Out-of-Band Device Linearity Optimization.
- 5A-046 – A Mixed-Signal Approach for High-Speed Fully Controlled Multidimensional Load Pull Parameters Sweep.
- 5A-047 – Base-Band Impedance Control and Calibration for On-Wafer Linearity measurements
- 5A-048 – A Mixed-Signal Load Pull System for Base-Station Applications
- 5C-087 – Active Load Pull Surpasses 500 Watts!

**Available Models**

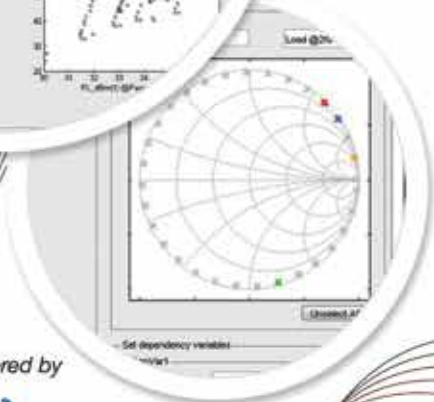
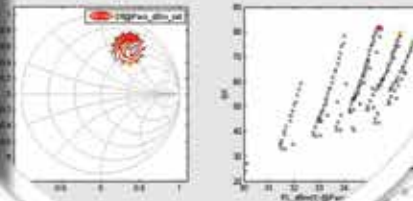
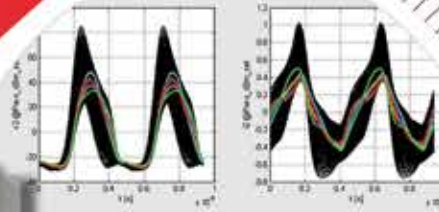
Model	Modulation Bandwidth (MHz)	System RF Bandwidth (GHz)	Number of Active Tuning Loops <sup>2</sup>	Power <sup>1</sup> Handling: CW/Pulsed (W)	Typical Detection Dynamic Range (dB)	Typical Active Load Dynamic Range (dB)	Minimum Pulse Width (nS)
MT2000HF2-60	60	0.001 – 2.0	2	50/500	80	60	200
MT2000HF2-120	120						
MT2000HF2-240	240						
MT2000HF4-60	60	0.001 – 2.0	4				
MT2000HF4-120	120						
MT2000HF4-240	240						
MT2000A2-60	60	0.3 – 6.0	2	100/1000	80	60	200
MT2000A2-120	120						
MT2000A2-240	240						
MT2000A4-60	60	0.3 – 6.0	4				
MT2000A4-120	120						
MT2000A4-240	240						
MT2000B2-60	60	0.4 – 18.0	2				
MT2000B2-120	120						
MT2000B2-240	240						
MT2000B4-60	60	0.4 – 18.0	4				
MT2000B4-120	120						
MT2000B4-240	240						
MT2000D2-60	60	0.5 – 26.0	2	20/200	80	60	200
MT2000D2-120	120						
MT2000D2-240	240						
MT2000D4-60	60	0.5 – 26.0	4				
MT2000D4-120	120						
MT2000D4-240	240						
MT2000E2-60	60	0.7 – 40.0	2				
MT2000E2-120	120						
MT2000E2-240	240						
MT2000E4-60	60	0.7 – 40.0	4				
MT2000E4-120	120						
MT2000E4-240	240						

<sup>1</sup> Higher power options are available.

<sup>2</sup> 5-loop and 6-loop add-ons available.

# REDUCE A DAY OF MEASUREMENTS TO JUST MINUTES? YES WE CAN!

**MT2000 mixed-signal active load pull system**, the only active load pull solution capable of tuning thousands of impedance/power states per minute, with time-domain waveforms, and wideband impedance control over 240 MHz bandwidth for realistic modulated signals.



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