- MT4463 -
A Large-Signal Network Analyzer

A product by MAURY MICROWAVE CORPORATION

Product Description
Outline

- Measurement capabilities, key values and users
- System hardware overview
  - Core components
  - Customizable and optional instruments
- System software overview
  - Screen captures of control GUI
  - Screen captures of display GUI
    - Under CW and modulation(*) excitation
    - In time, frequency and frequency-time(*) domain
    - Dynamic(*) AM/AM, AM/PM and HDA
    - Load impedances
  - Powerful scripting language
  - Connecting to your development tools
MT4463 measures...

Accurately
Completely
In a traceable way

In following domains
- Frequency domain
- Frequency - time domain
- Time domain

Under realistic conditions
- Continuous wave
- Periodic Modulation
- Source and Load Tuning

Compatible with Simulation Tools

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MT4463… Key Values

● Complete(*) and accurate(**) component characterization with ONE connection
  - at the component level
  - in a network analyzer sense
  - under small-signal (linear - S-parameters)
  - under large-signal (nonlinear - voltage/current or waves) conditions
  - optionally in a mismatched environment

● Better understand the behavior of your components
● Understand why certain tests are failing
● Certify models and model libraries adequately under realistic conditions
● Improve models based on complete and accurate characterization
● Test reliability and observe breakdowns in realistic conditions

● Understanding and exploiting this new data, you can create major competitive advantages

(*) IF behavior is presently still missing
(**) absolutely calibrated
MT4463… Some of the users

- Process Engineers
  - Reliability issues

- Device Modeling Engineers
  - Model certification
  - Model improvement / extraction

- Power Amplifier Designers
  - Fast PA characterization in combination with active tuning
  - Characteristics that cannot be measured with loadpull

- Circuit Designers
  - Understanding why design and test do not agree
  - Stability analysis
MT4463

MT4463A - 20 GHz

MT4463B - 50 GHz
Adapting MT4463 to different needs

Active HF Component Characterization

DC IV Characterization

Small-Signal

Adding
... DC Capability

Adding
... Pre-match Tuner
... Second Source

MT4463A/B

Accurate Complete

Large-Signal

Adding
... Modulation Capability

Adding
... Tuners

Modulation Characterization

Passive Tuning

Under different Impedance Conditions

Active Tuning
The Hardware Partitioning

Core part: is always part of MT4463

Required but customizable part: is always necessary but there are different choices available, even using your own equipment

Optional part: the MT446A is an open system and has unlimited possibilities for different stimuli
MT4463A - 20 GHz

- System Source
- Sampling Converter
- Test Set
- Test Board
- Power Meter
- Harmonic Phase Reference Amplifier
- Power Sensor
- Pulse Generator
- PC Acquisition Unit
MT4463B - 50 GHz

- System Source
- Sampling Converter
- Test Set - Calibration Module
- Harmonic Phase Reference Amplifier
- Power Meter
- Power Sensor
- Pulse Generator
- PC
- Acquisition Unit
- Test Set - Reflectometers
- Power Sensor
- Pulse Generator
- PC
- Acquisition Unit
The DUT Interface

Possible DUT interfaces:
- Test port cables
- Fixture
- Wafer probe
The Test Set - 40 GHz(*)

MT4466A001

(*) 20 GHz Test Set available on request
The Test Set - 50 GHz

MT4466B001

Calibration Module
MT4466C001

2x Reflectometer
MT4466D001
The Test Set - 50 GHz - On Wafer
MT4466B001
The Test Set - 50 GHz - Connectorized

MT4466B001

Reflectometer

Calibration Module
The Test Set - 50 GHz

MT4466B001

- To minimize losses, consists of:
  - 2 Reflectometers
  - 1 Calibration Module (simplifying calibration)
- Mountable on probe station
- Configurable as connectorized test set

- 2.4 mm cables delivered with test set
- Calibrated as connectorized test set
- Source
- +20 dBm
- NO DC

- DUT Port
- Port 1
- Port 2
- 40 VDC Max
- 500mA

DUT

20 Watt Max

+20 dBm

NO DC

Source

Calibration Module
MT4466C001

Reflectometer
MT4466D001

Reflectometer
MT4466D001

Sense-Bias

a

b

40 VDC Max

500mA

Input

10 Watt Max

Input

10 Watt Max

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The Sampling Converter - 50 GHz

RF inputs

- $a_1$
- $b_1$
- $a_2$
- $b_2$

Step att

IF outputs

- Ch$_1$ ($a_1$)
- Ch$_2$ ($b_1$)
- Ch$_3$ ($a_2$)
- Ch$_4$ ($b_2$)

Filter

10 MHz input

f$_{LO}$

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The Harmonic Phase Reference - 20 GHz

HPR amplifier unit

Phase Ref In
16 dBm Max
600 MHz - 1.2 GHz

Power Leveling

Phase Ref Out

HPR pulse generator

Output

HPR Amplifier

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The Harmonic Phase Reference - 50 GHz

HPR Drive Module

HPR Source unit

Phase Ref In

Power Leveling

DC

Phase Ref Out

HPR pulse generator

Output
Customizable and Optional Instruments

- Calibration Kits
- Power Meters and Sensors
- Microwave Synthesizers
- Vector Signal Generators
- DC force and sense
- Tuners

- Detailed information: see data sheet
The Software LSNA v1.1.0

- **Small - Signal:** S-parameters
- **Large - Signal:** Provides calibrated measurements of voltages and currents or incident and reflected waves in reference planes at the device under test under periodic stimulus in mismatched conditions
- Graphical User Interface supporting basic functionality
  - Control
  - Data Visualization
- Open system
  - Powerful scripting language to develop own applications
  - API to connect into your tools
    - MATLAB
    - LabVIEW ...
Easy control via GUI

Configure System

De-embedding

Calibrate System

SOLT
LRRM
TRL

Modulation

Ranging

Save data
Calibration using GUI

SOLT Calibration

In this case:
DC is not applied via bias tees but separately via port 3 and 4

DC calibration eliminates the cable losses
From small - signal to large - signal with ONE connection

Commercial available FET in fixture

Absolute Calibration

Bias Control

Deembedding

Test Port 1

Test Port 2

Synthesizer Control

\[ V_{gs} = -0.3 \text{ V} \quad V_{ds} = 1.5 \text{ V} \]
Measuring S-parameters

- Power Control at Port 1
- Power Control at Port 2

S\(_{11}\), S\(_{12}\), S\(_{21}\), S\(_{22}\)

**Frequency Range:** 600 MHz – 20, 40 or 50 GHz (depending on Test Set and Source)

**Supported Calibration techniques:** SOLT, LRRM, TRL
Large-Signal Measurements - CW - Voltage/Current

Time domain
Large-Signal Measurements - CW - Voltage Waves

Time domain
Large-Signal Measurements - CW - Voltage/Current

Frequency domain
DC-IV curve and load line

Small-signal - 50 Ohm Termination

Large-signal - 50 Ohm Termination

Large-signal - non-50 Ohm Termination
Input and Load impedance under CW

Impedance at fundamental non-50 Ohm Termination

Impedance at 2nd harmonic non-50 Ohm Termination
Periodic Modulation - Multi-tone generation

Carrier

Modulation

Tones

Generation of Multi-tone
Large-Signal Measurements - Modulation - Voltage/Current

Frequency domain
Large-Signal Measurements - Modulation - Voltage/Current

Zoom into one of the spectral components

Frequency domain
Large-Signal Measurements - Modulation - Voltage/Current

Frequency - Time domain
Dynamic AM/AM and AM/PM (two-tone 2kHz spacing)
Dynamic HDA (two-tone 2kHz spacing)
Powerful Scripting Language

Fast development of prototypes and new applications, exploiting all MT4463 capabilities, using Mathematica™
Connecting to your development tools

Stimulus

Connection via LabVIEW

Response

Talk to your instruments through your own tools

Connection via C-program

Data export
- Citifile
- Table
- CSV

Connection via others

Connection via DLL

C-callable

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Conclusion

- MT4463 is the ultimate instrument to study nonlinear behavior
- MT4436 measures from small - signal to large -signal with one connection
- MT4436 measures under CW and modulation condition in mismatched environments
- MT4436 returns measurements which are completely compatible with present simulators
- MT4436 is designed to evolve over - time securing your investment
MT4463 …

“Beyond S-parameters”

Do not hesitate to contact us

Technical information

NMDG Engineering
Leading beyond S-parameters

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Sales information

MAURY MICROWAVE CORPORATION

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