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Focus microwaves

Application Note 12A

Measurement and Software Capability of the CCMT Load Pull System

This Note lists the calibration, load pull and noise parameter measurement, data processing and graphics software routines of the Computer Controlled Microwave Tuner system (CCMT Version 5.0).

Short Description of the CCMT

The CCMT is an automatic measurement system (ATE) for microwave, DC and other quantities of FETs, bipolar transistors and modules as a function of impedance. Both Noise and Power measurements can be made using the system.

The complete measurement system includes the tuners, tuner controller, GPIB and software from Focus Microwaves and a number of programmable instruments and passive components, such as test fixtures, bias tees, probe stations, cables, couplers, RF switches, isolators and attenuators supplied by the customer.

The core of the system are electro-mechanical slide screw tuners. The CCMT tuners are available from 0.4 to 100 GHz in coaxial (up to 50 GHz) and waveguide (26.5 to 100 GHz) and special frequency bands for high power applications.

The system is controlled by IBM®-PC compatible computers via a proprietary insertable tuner controller and uses MS-DOS® and Windows® graphics environment.

The CCMT system uses the GPIB to communicate with instruments and a proprietary Analog Interface for DC readings and electro-mechanical relay (RF switching) control for fully automated setups. The CCMT software supports actually over 90 most popular GPIB instruments of HP, Wiltron, Anritsu, Rohde&Schwarz, Boonton, EIP, Hughes, Eaton (Maury), Keithley, Advantest and more.

Notice: Numbers in brace brackets such as {PN 3} or {AN 22} refer to Product, Technical or Application Notes published by Focus Microwaves. These notes can be obtained, free of charge, by notifying our office or one of our local representatives.

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In the following pages the different software functions of the CCMT system are listed together with the associated options, features and measurement routines and their classification in distinct Software Packages.

1. Tuner Calibration

Feature		Software Package
Number of Calibration Points	95,181,361	SYSOFT
Number of Calsets	9	SYSOFT
Number of Calibration Frequencies	no limit	"
Equidistant Frequencies	Yes	"
Frequency List	Yes	"
Choice of Γ-max	(0.4 to 0.96)	"
Interpolation between calibration points	Yes	"
Calibration Frequency Resolution	1 MHz	"

Supported Network Analyzers

Wiltron 360 A,B		"
Hewlett Packard 8510 A,B,C		"
Hewlett Packard 8720/8753 [1]		"
Hewlett Packard 8753 A,B,C,D		"
Wiltron 37000		"

2. Setup Calibration

Feature		Software Package
Max Number of frequencies	51	SYSOFT
Passive Block Calibration	Yes	"
Read-in pre-measured ASCII (.S2P) files	Yes	"
TRL test fixture characterization [2]	Yes	"
TDL test fixture characterization [3]	Yes	"
LRM test fixture characterization [5]	option	"
TRL with microstrip transformers	Yes	"
Transformers from model data	Yes	"
Keyboard entry of test jig data	Yes	"
Transistor .S2P measurement	option	"
Use S-par of Test Jig models	Yes	"

[2]: TRL = Through - Reflect - Line calibration method (see AN-6, FMI)

[3]: TDL = Through - Delay - Line calibration method

[4]: Only TDL should be used with the HP-8753, not TRL.

[5]: LRM = Line - Reflect - Match calibration method

3. **Load (Source) Pull Measurements**

Feature	Software Package
Load (Source) pull of all calibrated points	ASOFT
Load (Source) pull of a fraction of cal points	"
Load Pull on a defined Smith Chart Area	"
Load Pull on a User defined Pattern (inter-polated points)	
Fast Peak Search algorithm of - Power, Efficiency, Gai. - Choice of starting point. - Fine Search on rectangular grid around Max. - Search on User defined Pattern	
Intermod/Intercept measurement	"
Adjacent Channel Power Ratio - using AUTO function of Spectrum Analyzers - using CCMT own CUSTOM routine	
Power, Gain, Efficiency Load Pull	"
Choice of Total, Power added and Collector Efficiency	
DC bias load (source) pull (Vd,Id,Ig)	"
Fine PC-Cursor tuning and measurement	"
Saturation measurements (Pout,Eff,IMD)	"
P-xdB compression load pull (x = User defined)	"
Load Pull of Pin,Pout,Loss,Vd,Id,Ig,Eff in ASCII file	"
Tune to any Impedance using the Mouse	"
Tune to any Γ or Z using keyboard entry	"
Measure using the Mouse	"
Normalize Characteristic Impedance to best cover the Smith Chart	"
Insert a Twoport between Tuner and Test Jig	"
Measure DUT Large Signal Impedance	EXT-LP

Define and use MACRO file in Mouse & L/P	
Regulate P-source to keep Pin=constant at DUT ref plane during Source Pull or Source Peak Search	
User defined GPIB drivers [5]	ASOFT
Pout, Gain, Efficiency, IMD etc.. Load Pull at regulated Input Power for: - Pout=constant or - IMD=constant or - ACPR=constant or - Efficicency=constant or - Id=constant	
Load Pull of AM/PM Distortion (φ21 over Pin)	
Saturation Measurement of AM/PM (φ21)	
Oscillator Load Pull	EXT-LP
Oscillator Power & Frequency (Rieke Diagram)	EXT-LP
High order Intermod load pull	EXT-LP
Display and Save Impedances at Harmonic Frequencies	
Design Verification measurements	DVP
IV-Curve measurement	
Power Data Manager [6]	PDM
Measure Contours for PADS [7]	PADS
User defined Limit Action (GPIB) [8]	EXT-LP & AB08
Limit Gate Current	AB08
Limit Input Power to avoid transsitor Gate-Drain breakdown	
Measure using Non-Programmable Power Meters	AB08
Measure Efficiency without programmable DMM's	AB08
Control RF path using Relays	AB08R

4. Data Processing

Combine data from Load Pull files	SYSOFT
Move reference plane after the measurement	ASOFT
Tuner Calfile conversion to ASCII	SYSOFT
Datafile conversion to ASCII	SYSOFT
Generate Contours for PADS [7] from L/P files	PADS
Search a set of L/P files for Max and Γmax	ASOFT
Project a Network's S-parameter in a set of L/P files	EXT-LP
PDM [6] data conversion to L/P (Contour file)	PDM
Generate Contour files from Data in ASCII file	ASOFT
Eliminate "bad" measured points in ASCII file	"

[5]: Programm new non supported instruments (see AN-5)

[6]: Power Data Manager = Load Pull of Power Sweeps, measure Pin,Pout,Pdc,IMD,Id,Ig

[7]: Power Amplifier Design Software

[8]: Can be used to shut down the bias if the device is oscillating or over-driven.

5. Noise Measurements

Measurement routine	Software Package
Automatic search for Fmin	NSOFT
Automatic measure of 4 noise parameters	"
Mouse impedance pattern (any tunable point)	"
Repeat measurement on pattern	"
Adjust the weight factors of measured points	"

Noise Figure Source Pull		"
Noise, Gain, Stability Circles	"	
Stability factor K		"
Mismatch factor limit (oscillations)	"	
Noise parameter De-Embedding	"	
Cold Source Noise measurement		
On Wafer Noise Measurements, TWIN (Windows)		
On wafer noise measurements using Cold Noise Source		
Noise measurement using tuner 2		
Noise Measurements using tuners 1 and 2		
Detect Gate Current for Instable points	AB08	

6. Graphics

Feature	Software Package
Iso Contours generation	GRAPH
3D Surface generation	"
Mouse pointing and reading in contours	"
Generating mouse pointed contour file	"
Contour Zoom	"
Graphical elimination of points in contour	"
Data Filter for eliminating wrong measured points or oscillations	
De-Normalize Characteristic Impedances	
Contour Graphics for MACRO files permits combination and overlap of any two of the measured data (Pin,Pout,Gain,IMD,ACP,Eff,AM/PM,I1,I2, V1,V2,P-DC).	
Saturation plots	"
Power Data Manager [6] Graphics programm	PDM
IV - Curve Plots	

7. Other Features

Manual tuner control	SYSOFT
Mechanical tuner test	"
Tuning accuracy test (automatic)	"
Select different operation paths (Cal, Data, Setup)	"
Direct GPIB keyboard control	"
Power Amplifier Design Software	µW-PADS
Generate Contours for PADS from L/P files	µW-PADS
Control the tuners via GPIB [10] with Learn and Repeat Function	GPTC

Drivers for Tuners and GPIB in MATLAB (DOS & Windows)
Drivers for Tuners for VEE-TEST (Windows)

[10]: Use external Computer (PC, HP-9000 or other) to control via GPIB commands the tuner position, initialization etc. and also write user's own programmes.