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Product Note No 12A

Measurement Software for the Computer Controlled Microwave Tuner System (CCMT)

This Note describes the measurement software packages and routines of the Computer Controlled Microwave Tuner system (CCMT Version5.2) .

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 core of the system is electro-mechanical slide screw tuners. The CCMT tuners are available from 0.2 to 110 GHz in coaxial (up to 50 GHz) and waveguide (26.5 to 110 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® operation and Graphics environment.

The CCMT system uses the GPIB to communicate with instruments. Focus Microwaves has developed specific DLLs (Dynamic Link Libraries) and DDEs (Dynamic Data Exchange) drivers that can be called within Labview® or HP-VEE® or standard GPIB interface in DOS or even from MATLAB®. These software packages permit the use of Focus' microwave tuners as fully calibrated and programmable modules in user-defined, programmed and operated ATE setups, for various Load Pull and Noise measurements.

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In the following pages the different operations 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 [1]	95,181,361	SYSOFT
Number of Calsets	99	SYSOFT
Number of Calibration Frequencies	no limit	"
Equidistant Frequencies		"
Frequency List		"
Choice of Γ-max		"

Supported Network Analyzers

Wiltron 360 A,B
Wiltron 37000
Hewlett Packard 8510 A,B,C
Hewlett Packard 8720/8753 A-D [1]
Hewlett Packard 8553D [2]
Hewlett Packard 85108 pulsed

2. Setup Calibration

Feature	Software Package
Max Number of frequencies = 51	SYSOFT
Passive Block Calibration	"
Read-in pre-measured ASCII (.S2P) files	"
TRL test fixture characterization [3]	"
TDL test fixture characterization [4]	"
Include transforming sections	"
Keyboard entry of test jig data	"
Active device S-parameter measurement	"
Read-in S-parameter of Test Jig models	"
Harmonic Set-up of Fixture Calibration	HSOFT

[1] The mechanical tuners of Focus Microwaves have a tuning capability between 500,000 and 10,000,000 impedance states depending on frequency and tuner type. For all these states all four S-parameter of the tuners (and the setup) are interpolated among the nine closest calibrated points using 2nd order Lagrange polynoms, as will be described in this note, with an overall tuning accuracy better than 40 and 50 dB (0.3 to 1%).

[2] The use of the HP-8753 is not recommended for calibrating low loss - high reflection devices, such as tuners. The quality of the calibration data can be inadequate.

[3] An attenuator of 10dB may be used at each port of the HP-8753D to reduce errors due to the fact that it has only 3 detectors.

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

[5]: TDL = Through - Delay - Line calibration method. Only TDL should be used with the HP-8753, not TRL.

3. **Load Pull Measurement Routines and related software**

MEASUREMENT ROUTINE	SOFTWARE PACKAGE
1) System Software (SYSOFT):	SYSOFT
System Configuration	"
Tuner Manual Control	"
Data Conversion to ASCII	"
GPIB direct Communication	"
Tuner Calibration	"
Setup Calibration	"
Test Fixture TRL Calibration	"
2) Basic Routines (ASOFT):	ASOFT
Deembedding to Fixture or DUT reference plane	"
Automatic Load / Source Pull at Psource=Constant	"
Mouse Tune and Measure	"
Automatic Peak Search (Power, Gain, Efficiency)	"
Cursor Tune and Measure	"
Saturation Measurements /Plots	"
Contour and 3D plots	"
Automatic DUT Biasing	"
Measure on Pattern / Section of Smith Chart	"
User Defined Instrument Control (GPIB drivers)	"
Measurement Quantities:	"
Output Power	
Gain	
Two Tone Intermod	
Intercept	
Efficiency	
DC Power	
DC Bias	
Gain Compression	
3) XLP-1 Routines	XLP-1
Measure DUT Large Signal Impedance	"
Macro File	"
Fine Peak Search	"
Pattern Peak Search	"
Source Pull under Pin(DUT)=Constant	"
Display Harmonic Impedances	"
4) XLP-2 Routines	XLP-2

Load / Source Pull at Pout=Constant (Regulated Psource)	“
Saturation Plots for Intermod	“
High Order Intermod	“
Adjacent Channel Power (ACPR)	“

5) XLP-3 Routines XLP-3

AM/PM Load Pull	“
Design Window & Compression Load Pull	“
Compression Peak Search	“
Optimize DC Bias for Max Pout/Gain/Eff	“
Oscillator Load Pull	“
RF pulse measurements	“

6) Power Data Manager, PDM (DOS) [6]

7) Design Verification Measurements, DVP (DOS) [7]

8) Microwave Power Amplifier Design Software, (μW-PADS) [8]

9) Load / Source Pull *<u>for Constant</u>*:
Gain
Efficiency
Intermod
ACPR
Output Current

10) Harmonic Load Pull, PHT (Calibration, Measurement), additional hardware required

11) Test Fixture Characterization (TRL), S-parameter measurement and Adapter Removal Software, S2PMEAS

12) DC IV Curves measurement and plot software (DOS and Windows), DCPAR

13) HP-VEE driver for tuner calibration, control and tuning (DDE and DLL, Windows)

14) MATLAB driver for tuner calibration, control and tuning (DOS and Windows)

15) GPTC (General Purpose Tuner Controller) software for tuner calibration, control and tuning (DOS)

16) LABVIEW driver for tuner calibration, control and tuning (DDE and DLL, Windows).

4. Data Processing

Feature	Software Package
Combine data from Load Pull files	SYSOFT
Move reference plane after the measurement	ASOFT
Tuner Calfile conversion to ASCII	SYSOFT
Calibration File Conversion to ASCII	"
Datafile conversion to ASCII	"
Convert ASCII file to Data file	"
Generate Contours for μwPADS [8] from L/P files	μwPADS
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	"

[6]: Power Data Manager , PDM, measures Load Pull Data of a selection of variables as a function of Input Power Sweep and uses a dedicated Graphics package to plot any combination of those data and their mathematical derivatives. It also includes a "Mapping" feature which identifies Impedances on the Smith Chart which fulfill a combination of user defined target conditions. (PN-21)

[7]: Design Verification Software, DVP, is an application that permits you to verify, by measurements, the performance of an MIC or MMIC amplifier using the same chip or package transistor according to the transistor's original design. (PN-18)

[8]: High Power Amplifier Design Software, μW-PADS, permits the design of amplifier stages practically up to saturation level using only measured power contour data. (TN 1-92 & TN 1-93)

5. Noise Measurements

Measurement routine	Software Package

1) Noise Measurement Software:

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 using Cold Noise Source	“
Noise measurement using tuner 2	“

2) Windows Noise Measurements Software (TWIN-NOISE):

On Wafer noise measurements	WIN-NOISE
Automatic Search for Fmin	“
Automatic measure of 4 noise parameters	“
Mouse impedance pattern (any tunable point)	“
Repeat measurement on Pattern	“
Cold Source Noise Measurements	“
Noise, Gain, Stability Circles	“
Stability factor K	“
Iso Contours, 3D Surface generation, Mouse pointing & reading in contours, Contour Zoom	“

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	"
Saturation plots	"
Power Data Manager [6] Graphics program	PDM
Iso Contours and 3D Surface generation for windows [9]	WinGRAPH

7. Other Features

Manual tuner control	SYSOFT
Mechanical tuner test	"
Tuning accuracy test (automatic)	"
Select different operation paths (Cal, Data, Setup)	"
GPIB keyboard communication	"
Power Amplifier Design Software	μwPADS
Generate Contours for μwPADS from L/P files	μwPADS
Control the tuners via GPIB [10]	CCMT-GPIB

[9]: This package includes:

- Wingraph for Contours & 3D Surfacing Plots
- Winplot for X-Y plots, S-parameters, Saturation Pi/Pout plots & DC-curves
- 'Surfer' Software for user scalable, colored contours & 3D Plots
- 'PSP' Software for saving graphic files in .TIF format

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

List of Supported GPIB Instruments

Network Analyzers	Power Meters	Spectrum Analyzers	Signal Sources
HP-8510 A	HP-436 A, B	HP-8569	HP-83xx
HP-8510 B	HP-437 B	HP-70000	HP-86xx
HP-8510 C	HP-438	HP-8562	HP-89400
HP-8720 A-C	HP-441	HP-8594	Anritsu MG3633
HP-8753 A-C	HP-442	HP-8566	Anritsu MG3670
HP-8753 D	HP-70100	TEK-2782	Anritsu MN3650C
HP-85108 pulsed	HP-8991 pulsed	TEK-2755	Marconi 2031
Wiltron 360 A-B	Boonton 4200	Advt. R3271	Marconi 204
Wiltron 37000	Boonton 4220	Anritsu MS2602	GigaTr. 905
	Boonton 4300	Anritsu MS2601	Wiltron 66xx
	Boonton 4400	Anritsu MS2613	Fluke 6062A
	Hughes 4770	R&S FSE (Noise)	Boonton 2100
	Wavetek 8502		R&S SMG/SMH
	Marconi 6960		
	Giga Tr. 8542		
	Anritsu ML 4803		

Power Supplies	Multimeters	Noise Analyzers
HP-4142	HP-3478	HP-8970A / B
HP-662x	HP-3458	HP-8566 Spectrum
HP-663x	HP-3458 pulsed	R&S FSE Spectrum
HP-6643	HP-34401	Eaton 2075
HP-6653	Advt. TR6846	**Frequency Counters**
HP-6038	Keithley 236	HP-5342
HP-4145		HP-5351
HP-3631		EIP-575
Thander 3510		SD-6530
Advt. TR6246		
Advt. TR6143		
PPS-1200		
XT-15-4		