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Product Note No 21

Power Data Manager - PDM

Power Data Manager is a software package with three major utilities:
- The **Display** utility processes and plots Transfer Characteristics of RF and DC quantities measured using the CCMT Load Pull System at all Source or Load impedances. The data includes Input and Output Power, Intermod, DC Power, Drain and Gate Current. Gain, Efficiency and Intercept can be generated using numerical manipulations of measured data [1].
- The **Mapping** utility identifies all Impedances on the Smith Chart, for which up to five User defined conditions are simultaneously met, such as Pout>30dBm, Eff>35%, Gain>10dB, IMD<-35dBc etc...
- The **Contouring** utility can be used to generate ISO Contours of the measured data for any input power.

Introduction

Load pull measurements on transistors are generally restricted into taking RF data for different load or source impedances and graphically process them to ISO contours, so that the Designer can graphically identify the areas of interest on the Smith Chart for the specifications he is aiming. This method bears the problem that some test conditions, especially the power injected into the transistor, may be found insufficient at the design stage and therefore the test would have to be repeated. Also it is difficult to overlap more than two contours on the same Smith Chart in order to identify the areas where certain minimum conditions are simultaneously met.

Power Data Manager works with Load Pull data, measured in a batch process for all input power and impedance conditions, and solves all these problems of the classical load pull system at once.
This note describes the three utilities of PDM [1]:
1- Display (data processing and generation of Transfer Plots)
2- Mapping (identify impedances for combined User defined conditions)
3- Contouring (convert PDM data to ISO contours or 3D surface plots).

October 1994

Measurement of PDM data files [2]

The PDM data files are Load Pull files for which the input or output tuner are set to all or a fraction of calibrated points (95 to 361 impedances) and the input power is swept between User defined minimum and maximum values.

A load pull measurement setup (figure 1) must be available and include programmable sources (two needed for Intermod), power supply, two power meters and a spectrum analyzer, in addition to the two programable tuners, system controller and measurement software.

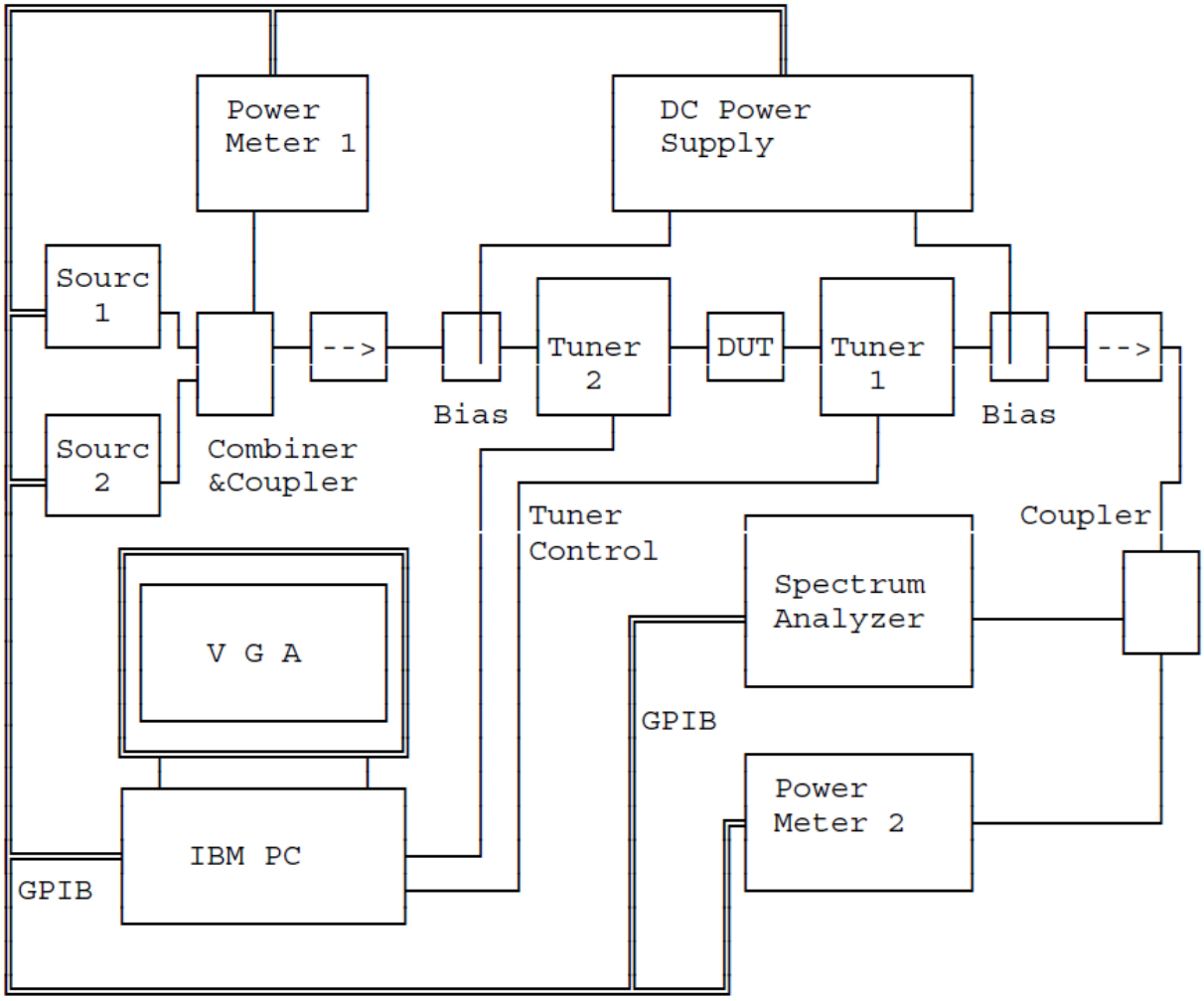


Figure 1: PDM Load Pull measurement setup

The software sets the tuner to the required impedances, sweeps the input power automatically between the required limits and measures a number of pre-selected parameters.
The PDM parameter selection is made between a minimum of two and a maximum of six using the following menu:

Obviously the User should not select parameters to measure for which corresponding instruments are not available.

In case of Intermod, the software controls two sources in frequency and power and is capable of sweeping both together at -3dB of the single signal source level. This way the common horizontal axis both for single carrier and dual carrier is preserved.

An additional feature permits to measure and include automatically the two tone output power, which is slightly different than the single tone power, even for the same total input power, because of Intermod products.
This parameter is shown as P2C in figure 3.

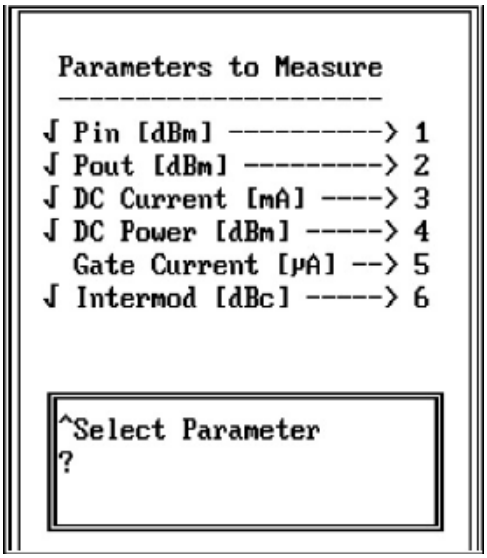


Figure 2: PDM Parameter Selection menu

The PDM files are of type ASCII and include information parameters and number of power and impedance settings tested. A typical PDM file includes about 20,000 measured data points and begins with the following format:

```
Device #3
---------------------------------
4.000 ! FREQUENCY [GHz]
! TUNER CAL = tuner1/F
! 8V,360 mA
 181  ! TUNER POSITIONS
  16  ! POWER POINTS
   6  ! PARAMETERS
Pin  100
Pout  100
ID  10
PDC 100
IMD 100
P2C 100
1 0.005 -0.078     / /  First measured point
 9.10 15.85 356.0 34.57 52.2 15.37
10.09 16.83 356.0 34.57 50.9 16.36
11.08 17.83 356.0 34.57 50.0 17.38
12.06 18.83 354.0 34.55 48.6 18.39 ....
```

Figure 3: PDM data file format (ASCII)

The PDM files in ASCII format are used as a data bank and are never modified by PDM. Through conversion to binary data format new files, distinguished by using the extension .PDF instead of .PDM, are created, which can be loaded into the Power Data Manager programm. These new files can also hold up to 20 Display and 10 Mapping Configurations, created by the User, so he does not need to generate them again each time the programm starts.

Display Utility [1]

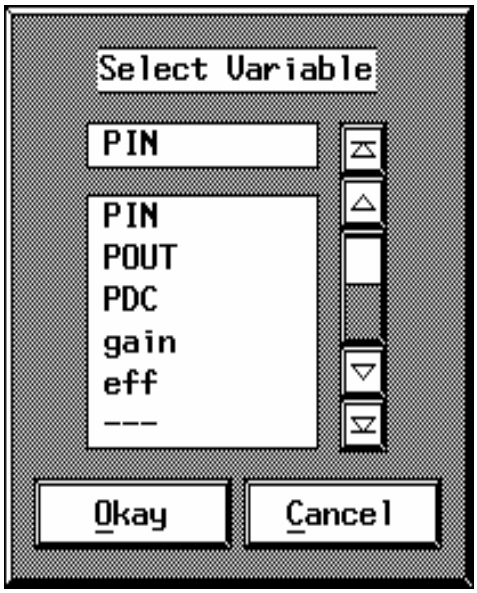


Figure 4: Display Parameter Selection menu

Based on the data measured a screen configuration is created by picking three of the parameters from a menu like the one shown on figure 4.

These parameters can be directly measured data, like PIN, POUT or PDC (=DC Power in dBm), or indirectly computed values, such as Gain=Pout-Pin or Efficiency=100*(lin(Pout)-lin(Pin))/lin(Pdc).

PDM recognizes most practical mathematical manipulations of data, such as **+, - , * , / , SQRT , LOG , LIN** and up to 3 levels of parenthesis.

Based on this technique the Users can define for themselves new combined parameters, critical for their designs, such as a **Pout*Efficiency** product, or a **Gain*Intermod** product, which they can then plot as a function of any other parameter at any load impedance. All measured or computed parameters can also be used in the Mapping utility, in order to identify areas of impedances where this criteria is valid or not.

Figures 5 and 6 show display plots of measured and computed parameters as a function of input power. Figure 5 is the plot of Output Power and Efficiency over Input Power and Figure 6 the plot of Gain and Intermod as a function of Input Power.

Other parameters like Intercept can also be defined and plotted or used in the Mapping process:

ICPT = 0.5 * IMD + POUT

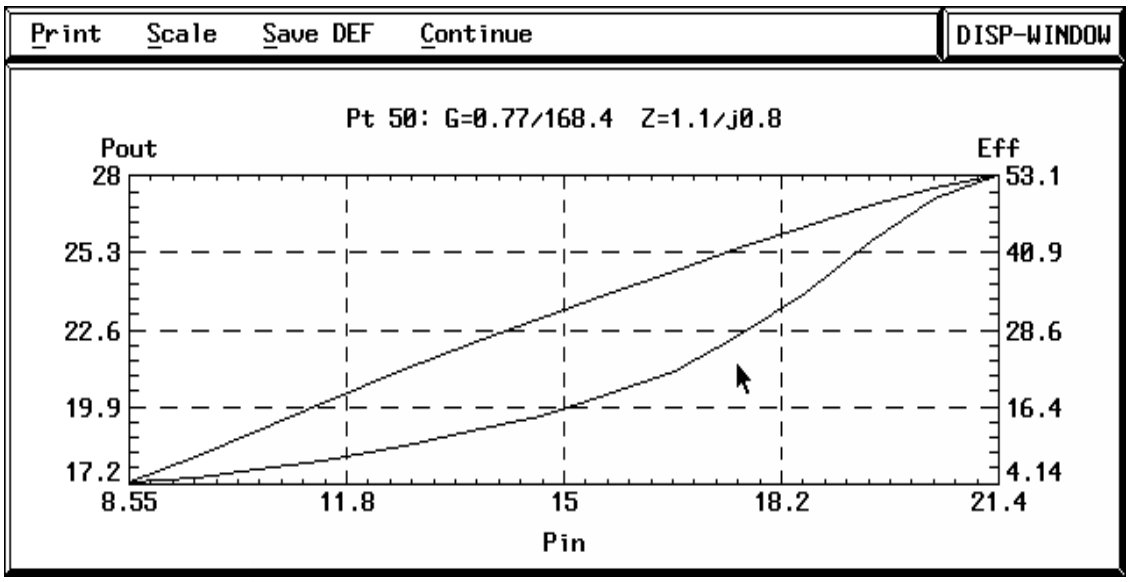


Figure 5: Plot of Efficiency (computed by PDM from Pout, Pin and Pdc measured data) and Output Power as a function of Input Power. The arrow points on the Efficiency curve.

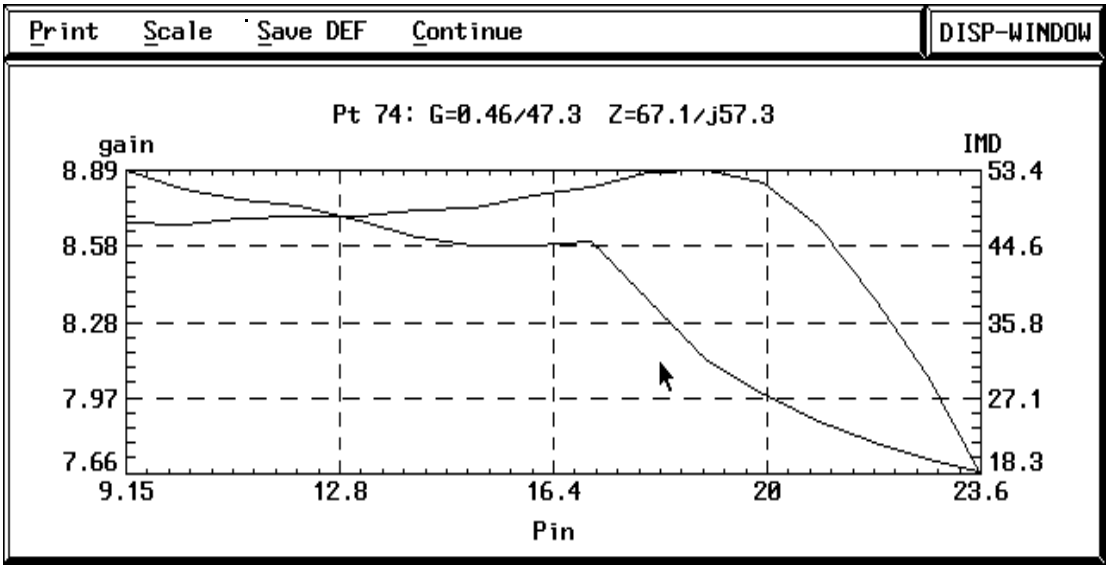


Figure 6: Gain (computed from Pout and Pin) and Intermod (directly measured) plotted as a function of Input Power (the arrow points on the IMD curve).

Mapping Utility [1]

Mapping, in the context of PDM, is the capability to define a number of (up to 5) conditions that need to be met simultaneously by the device at certain load impedances, so the corresponding points are marked on the Smith Chart.

The following Mapping plot shows the load impedances for which the combined conditions **Pout > 30dBm, Gain > 6dB and Efficiency > 10%** are met.

It is very useful to be able to determine rapidly out of a data bank (the PDM file) if the combination of certain requirements to the transistor can be met or not.
If the data are available for more frequencies then PDM's Mapping capability becomes a useful tool to be able to respond rapidly on the chances to use specific devices for designing to required specs.

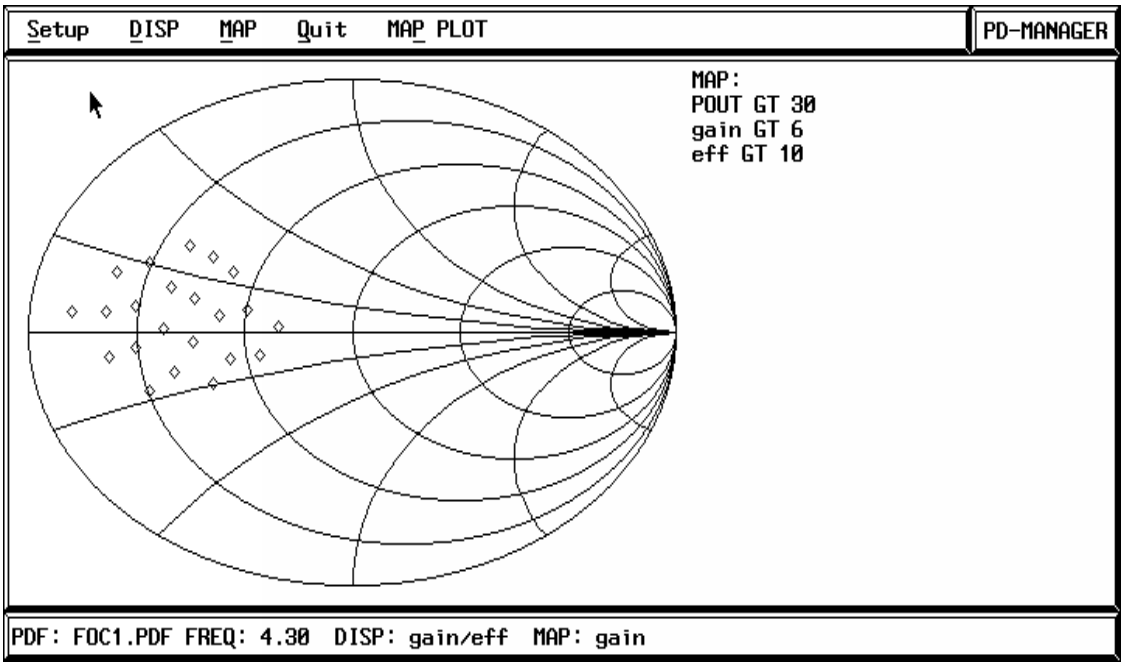


Figure 7: PDM Mapping plot for all Load Impedances satisfying the condition Pout>30dBm,Eff>10% and Gain>6dB simultaneously.

Contouring Utility [4]

The CCMT software permits to use PDM data files to generate ISO contours for any of the measured parameters. This is possible using the programm PDM_DAT.EXE. This programm permits to access any of the measured PDM files and then

a) select any combination of two measured parameters

b) scroll all and select one measured input power value

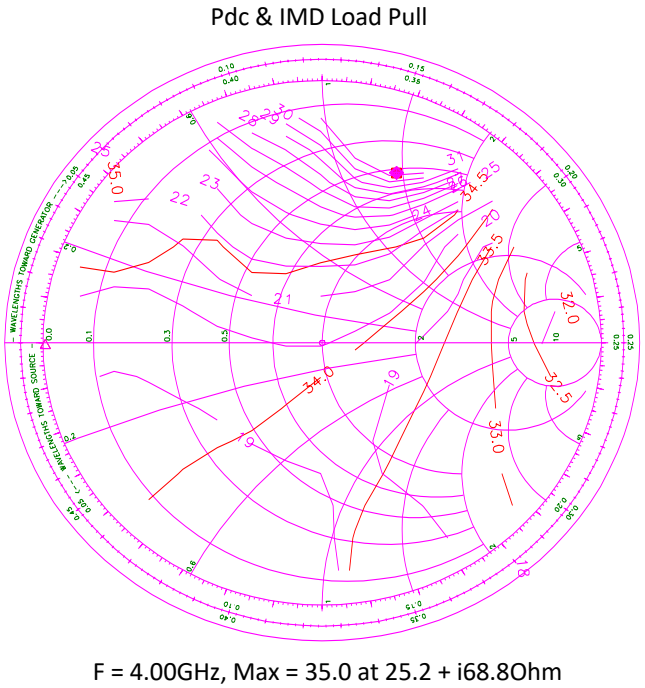
and include the collected data in a Load Pull file, which can then be processed to 2D ISO con-tour or 3D surface plots by the graphics utility of the CCMT system, as shown in figure 8.

```
Conversion of Power Data Manager File to CONTOUR File
-----------------------------------------------------
You want to Edit .PDM file first (y/n)

File  C:\PDM\FLC161.PDM  contains 181 Impedance Points
16 Power Points and 5 Parameters

1 --> Pout
2 --> ID
3 --> PDC
4 --> IMD
5 --> P2C


Select Parameter 1 : PDC
Select Parameter 2 : IMD

Use Cursors ↑ ↓ to Scroll Input Power

Input Power =  22.71 dBm

Press <Enter> to Select...
```

The Contour plot of figure 8 shows the DC power and Intermod contours of the measured FET at 22.7 dBm input power, generated from the PDM file and converted to a load pull file.

The contours show a clear similarity in the load pull behaviour of DC power (or DC current, since Vds= const) and Intermod.

Figure 8: Load Pull of DC Power and Intermod, measured using PDM.



Further reading

[1] Power Data Manager, Operation Manual, Focus Microwaves Inc., January 1992

[2] Computer Controlled Microwave Tuner, Operation Manual, section 4, Load Pull Measurements.

[3] Computer Controlled Microwave Tuner (system), Data Sheet.

[4] Computer Controlled Microwave Tuner, Operation Manual, section 6, Graphics.