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Product Note 58

Manual Prematching Modules, MPM for Frequencies between 0.8 and 50 GHz

Manual Prematching Modules operate like manual slide screw tuners and are designed to be inserted between the Test Fixture or Wafer Probes and the input or output Tuners in a load pull setup.
MPM's contribute twofold to a state of the art load pull setup:

1. **MPM's improve the impedance tuning range (or maximum VSWR) up to tenfold (10:1 -> 100:1).**
2. **MPM's are used to adapt the 30° or 45° probes to the horizontal airline of the tuners without using lossy flexible or semirigid cables.**

Background and Operation

Load Pull testing of high power transistors require accurate tuning capability around 1Ω output impedance or less. RF Power handling capability of the tuners around 50 Watts at very high VSWR is meanwhile a "must".
The traditional solution to these requirements is to use low characteristic impedance (like 10 Ω or 20 Ω) λ/4 long microstrip transformers on the test fixture, which allow to effectively tune around the 1Ω or less impedance range. There are though three major inconveniences of this type of solution:

1. Limited bandwidth of less than 10%
2. Fixed tuning direction (typically, but not always 180°), to be re-designed for each particular DUT.
3. Fixed transforming ratio.

MPM's do not suffer from any of those shortcomings. They cover as much bandwidth as any FOCUS tuner, such as 0.8-18, 6-40 or 10-50 GHz; they can be adjusted to target any specific area (angle) on the Smith Chart; and they can generate any prematching transforming ratio between 1:1 and 20:1. Once set the MPM's are calibrated and handled as part of the load pull setup, described by their S2P files.

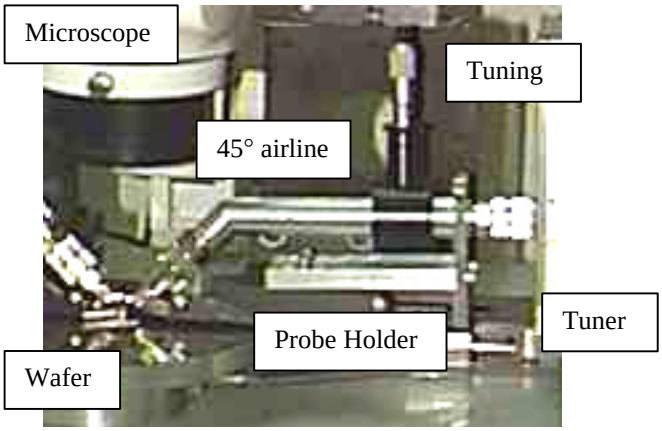

Figure 1: 45° prematching module MPM-1808 (0.8-18 GHz) mounted on a wafer setup.

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Further advantages, such as higher power handling due to the splitting of VSWR in more than one steps or calibration accuracy for the same reasons are common to MPM's and transformer sections. The only shortcoming of MPM's is the fact that it can only be connected at the outside connector of the test fixture or the wafer probe, in which case the insertion loss of one probe or half the test fixture will limit the maximum VSWR available at the transistor leads. Table I shows both the effect of the insertion loss on the maximum VSWR at DUT reference plane, when a single tuner without MPM (columns four and five) and a tuner with MPM (columns two and three) is used.

S21[dB]	$R_{min}[\Omega]$	Γ_{max} @1.0	$R_{min}[\Omega]$	Γ_{max} @0.85
0.00	0.00	1.000	4.05	0.850
-0.025	0.14	0.994	4.20	0.845
-0.05	0.29	0.989	4.30	0.842
-0.075	0.43	0.983	4.50	0.835
-0.10	0.58	0.977	4.61	0.831
-0.15	0.86	0.966	4.91	0.821
-0.20	1.15	0.954	5.19	0.812
-0.50	2.87	0.891	6.82	0.760

Table I: Effect of Test Fixture (wafer probe) insertion loss (S21) on maximum VSWR at DUT, when a single tuner (@0.85) and a tuner with MPM (@1.0) is used.

Further Reading..

1. Product Note 52: "Prematching Tuners for Very High VSWR and Power Load Pull Measurements", Focus Microwaves, February 1999
2. Product Note 54: "MLTF, a Minimum Loss Transistor Test Fixture for Sub 1Ω Load Pull Measurements", Focus Microwaves, June 1999.

The results of table I show the requirement for extremely low loss wafer probes and test fixtures. Focus Microwaves offers such a test fixture, model MLTF (Minimum Loss Test Fixture [2]) for packaged power transistors.
When an MPM is used in combination with MLTF, tuning to impedances far below 1Ω are possible up to 6 GHz. At higher frequencies this limit decreases to the extend of the losses of the fixtures and wafer probes as shown in table I.

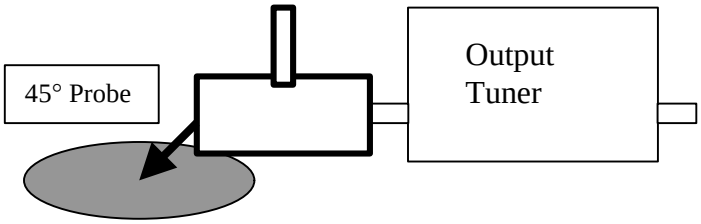

Figure 2: Connection of an Output Prematching Module

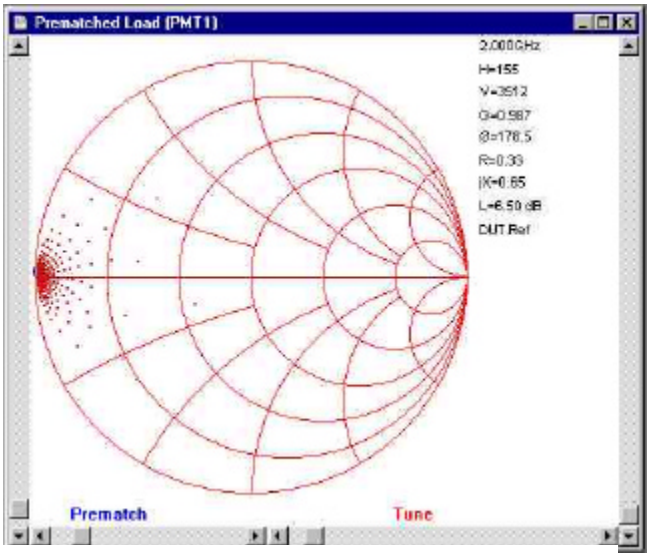

Figure 3: Maximum Tuning using a Prematching Module and a Minimum Loss Test Fixture