Notes for MTT 2002 Presentation at Seattle
LDMOS and Vdmos
30 - 512 Mhz BroadBand Amps

Slide 2
This presentation will discuss the design of miniature coaxial structures and examine the implementation of improved design techniques to enable the designer to obtain insight in matching the load line of power Mosfet transistor over a decade of bandwidth. The development of a suitable load line using coaxial transmission line transformers in conjunction with embedded lumped structures to enable efficient load line match across a decade of bandwidth will be covered.
The physical structures for generating load impedances at low frequencies and high power are so large as to be impractical to implement for load pull techniques. Additionally, since the band width is multi octave, broadband structures must be used to determine the load line rather than multiple narrow band measurements. A computer with suitable software and good device models is the most practical approach.

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Starting with the device, at low frequencies the output impedance is relatively high compared with the calculated load line required to produce the desired power. As the operating frequency is increased the output capacitance (Coss) and reverse capacitance (Crss) and an increased saturation voltage lowers the optimum load line to achieve satisfactory performance. Over a decade of bandwidth, the optimum impedance can drop by a factor two, eg from 12 to 6 ohms. Of all the coaxial transformer designs, one of the most practical for wide band impedance matching is the 4:1 design with a balun transformer to achieve optimum balance. A conventional design allows the coax transformer to transform the impedance to match the low end of the band and by adding additional low pass matching sections to lower the impedance at the upper band edge. Although this technique performs satisfactorily, using micro strip implementation will occupy considerable space.
A novel approach to this problem is to use the effective inductance of the coaxial transmission lines as the inductive component in a PI matching network. Only small chip capacitors will be needed to complete the transformation ratios at the upper band edge.

Slide 5
Zin Zout of transistor - showing variation in the impedance value against frequency.
The values are measured from drain to drain. The values of Zin and Zout for a single ended transistor can be obtain by dividing these values by two.
Our data sheets provide Zin Zout information for all our products in their respective single ended or push pull configurations. All our push pull data is for drain to drain.

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A novel approach to this problem is to use the effective inductance of the coaxial transmission lines as the inductive component in a PI matching network. Only small chip capacitors will be needed to complete the transformation ratios at the upper band edge. By a selection of the transmission lines impedance and electrical length, a load line may be created that will essentially provide the basic transformation ratios at the lower band edge. As the frequency is increased the combination of the transmission line effective inductance along with the shunt capacitance will lower the load line to effectively match the device at the upper band edge. This can be accomplished by the same physical constraints of just a broad band transformer alone. Using this technique enables one to construct decade bandwidth power amplifiers with physical dimensions no larger than the transformers and the device.

For example, to design a 80 watt broadband amplifier that covers 30-512 Mhz band, one would first calculate the load line for the lower band edge. A 12.5 ohm load line can be easily achieved with a 4:1 transformer and a 1:1 balun. In order to successfully embed the upper edge matching network into the transformer, the electrical length of the transformer should be shorter than 1/8 wavelength at the highest operating frequency. This will keep the transmission line acting as an inductance. Low permeability ferrites may be added to increase the shunt inductance at the lower band edge. This ferrite will have a negligible effect at the upper frequency band edge. Both the length and impedance of the coax may be varied to optimize the performance over the band.