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Modifying the *Load* to Achieve Matching

When we think of impedance matching, we typically consider the load as fixed impedance, and our matching network as the circuit that transforms the load impedance to our system impedance. There are, however, some techniques that are applied between the load and matching network. They may be easiest to comprehend if we consider them as modifications to the load rather than part of the matching network.

Transistor Prematching

The first example is a reactive circuit placed inside a power transistor package, as is commonly done with LDMOS and other types of MOSFET devices.

The high input capacitance of this transistor structure results in a very low input impedance. Many power devices include an internal L-C network to raise the impedance to a level that is more practical for discrete component or transmission line matching. This network usually consists of a low inductance (multiple bond wires) connected between the transistor gate pad and a MOS capacitor connected in shunt. The junction of the inductor and capacitor becomes the new input connection, with the new impedance determined by the value of the capacitor. All that's necessary is to transform the very low impedance (typically less than one ohm) to the ten-ohm range. Similar prematching circuits may also be included at the device drain, to raise the output impedance. With more complex internal matching, the entire matching network can be placed inside the package. See Figure 1.

By selecting different component values, the transistor can have an easily matched impedance at the desired frequency. The equipment designer can then develop a matching network with practical component values for its inductors, capacitors and/or transmission lines.

Resistive Loading

An older technique, used for many years with MOSFET power devices in the HF-VHF-UHF range, is to place a resistor in series with the gate input of the device, installed externally. While this is actually part of the matching network, it is easiest to understand when included with the load, i.e., the gate input impedance of the device.

Many power amplifier circuits in this frequency range are broadband, using transmission line transformers or conventional primary/secondary transformers with ferrite or iron powder magnetic cores. Transformer matching involves resistive source and load impedances (with some stray reactances).

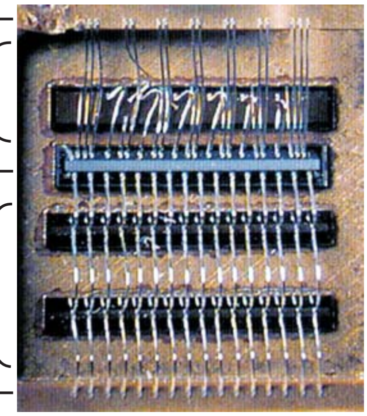

Figure 1 · LDMOS prematching detail. The bond wires provide inductance; the dark horizontal bars are shunt capacitors.

The resistance becomes dominant rather than the capacitive reactance, increasing the impedance. This provides a predictable, mainly resistive load impedance allowing "standard" matching. The cost is reduced gain, but at these lower frequencies, MOSFET devices have ample gain and some loss is acceptable.

Antenna Matching

Antennas are rarely considered to have controllable impedance, but there are two simple ways this can be accomplished: adding a lumped component to provide a type of prematching, and manipulating the antenna dimensions to vary the feedpoint impedance. Like the above MOSFET examples, the intent of such impedance adjustment is to achieve a match with a simpler network, or perhaps to achieve a match with a broader VSWR bandwidth.

Consider a dipole with a length/diameter ratio that results in a feedpoint impedance of 24 +*j*0 ohms at the design frequency. Obtaining a precise match to a 50-ohm system requires two reactive elements or a 1/4-wavelength section of 34.6 ohm transmission line, a non-standard impedance value. However, if the antenna can be lengthened, or an inductance placed at the feedpoint, to present an impedance of 24 +*j*17 ohms, a 35-degree length of 25-ohm line will provide the necessary transformation to 50 ohms. 25-ohm line is not common, but is available. The line section may also be made with two 50-ohm lines connected in parallel.

Other simplified antenna matching schemes will become apparent as you examine the range of impedance adjustment that can be achieved by altering the dimensions.