# Tuner Power Handling Limitations

The two factors limiting the handling power of slide-screw tuners are:

1. The RF tuner connectors and

2. Corona discharge between the tuner probe and the central conductor

The Tuner Connectors limit the RF power due to thermal breakdown: Small dc resistances heat up at high current densities and create a runoff thermal phenomenon at the point of contact between the tuner port facing the DUT output and the test fixture. This is the most critical point in the setup. Using APC-7 connectors, or worn our SMA connectors worsen the situation, because the galvanic contact between the central pins is not good enough. Using N or 7/16 connectors increases power handling by a factor of 3 to 5. We found APC-7 connectors able to handle 50 Watts at VSWR=10:1 safely, N-connectors around 90 Watts and 7/16 connectors beyond 250 Watts. For those "high power" connectors both the central pin contact is far better and their metallic mass big enough to distribute heat.

- APC-7 connectors can be improved if we insert a tight fitting copper pin between the central conductors at the point of contact. However good fitting may be a delicate matter to adjust.
- 3.5mm/2.9mm connectors can handle up to 40 Watts average power. Under pulsed RF power conditions this power is increased by the inverse of the duty cycle. For instance: for 10% duty cycle the maximum power is 400 Watts pulsed.

Corona Discharge in the Tuner Transmission Linesbetween the central conductor and the RF probe at very high VSWR and power. This happens in general when edge effects are predominant on the probes or inhomogenities in the central conductor. This phenomenon is observed in older tuner models more than newer ones, probably because of worn out probe isolation, marks or scratches. At the beginning this effect is not destructive and the tuner remains operational. If repeated the probe isolation may be damaged as well as the central conductors. To avoid this effect the tuners have to be operated at lower VSWR (which is recommended also for measurement accuracy reasons). The final high VSWR can be obtained using Transformers.

In on-wafer tests transformers are not possible, but then the RF power is not very high either. Because the reflection in a slide screw tuner is created by the physical proximity of the RF probe and

the central conductor of the airline (capacitive effect) high electric fields can be generated. As an example: for 50 W CW power reflected in a tuner at S11=0.95 (SWR=39:1) the peak electric field under the probe, which is about 0.1mm away from the central conductor, reaches over 44kV/cm. At S11=0.92 (SWR=24:1) the maximum field is around 35kV/cm. These values are very close to the electrical breakdown field in air (vacuum). A dielectric coating under the probes may prevent a corona discharge for some time but minor surface imperfections and scratches will deteriorate the performance of the tuner with regard to high field corona discharge.

For the above two reasons it is practically impossible to accurately specify the maximum power handling capability of slide screw tuners, since a most important operation condition, << the actual distance of the RF probe to the central conductor >> , is practically impossible to control and report accurately in real operation.