NOTES ON THE USE OF HIGH POWER AMPLIFIERS WITH LDMOS TECHNOLOGY DEVICES.

These notes aim to give some useful suggestions to pallet users, who have to do with complete equipments architectures.

Section 1_Shielding

Projects dealing with high gain amplifiers, especially when using more pallets in cascade connection, require a very good shielding between stages and between RF Section and the rest of the module. A scanty effectiveness of shielding can cause a coupling between the RF field, radiated by final stages, and the driving signal of low level stages. Possible consequences are distortions, resonance and self oscillations in case of phase coupling.

This kind of self-oscillations, in particular, is in most cases destructive for final stages. Oscillation being triggered off, it tends to increase its level more and more (Positive Feed-back) because of the high gain of the loop.

For this reason the wisest thing is to use a high retaining quality shielding; possible airflow outlets should have a diameter equivalent to 1/15 wavelength of signal crossing the amplifier. Shielding fixing screws must be located to a max distance of 1/4 wavelength of signal or it is possible to use an EMI gasket in alternative.

In addition, particular attention must be given to supply inputs inside RF box; we suggest to use feed-through capacitors or ferrites mounted around the cable on both internal and external sides of the box.

Bypassing possible RF gathered by conductors with two capacitors, one on the external and the other on the internal side of the box and both as near as possible to the crossing point, is also an effective action.

Section 2_ Supplies

A good supply system is necessary to obtain the best performances of any RF pallet, in particular when treating with an analogue signal where currents are high and absorption depends on modulating signal variations.
It is advisable then to use cables with suitable sections (4A max per 2mm) in order to minimize dynamic voltage falls and, if possible, to connect power supply senses near the supply point of pallets.

Also, we suggest using power supplies with a fast control loop, able to effectively follow the load variations (we can provide complete specifications for each particular case) and, if possible, to separate final stages supplies from driver/pre-driver ones, since the latter could be sensitive to supply variations provoked by final stages.

Section 3_ Protections

Only a very good protection system can protect devices, in particular those with a high power, towards disturbances coming from input or output possible mismatching. Please note that most of Solid State Transmitters failures are due to; Overdrive (in case of amplitude overshoots during exciting systems switching on/off), Reflected power (cables/antenna breakdowns or ice and outsider objects on antenna) or, more rarely, overshoots coming from power supplies.

On the contrary it is very unusual to find failures due to devices, which very often go beyond all MTBF expectations, even working at extreme temperature conditions.

These considerations are even more important if using LDMOS amplifiers. Such devices deliver very good electrical performances and have a good MTBF at high junction temperatures, but are much more sensitive to overshoots and reflected power.

This higher sensitivity is due to high peak power delivered by such devices. In fact, observing the AMJAM curve of an LDMOS device, it is possible to remark that after the compression starting point, an output power increase always corresponds to each input power increase, even if this will be lower and lower.

In other words, output power will meet saturation point as a very high value, where on the contrary with old bipolar devices, saturation was reached at 3/5 dB over 1 dB compression point. For this reason an LDMOS device ensures a higher peak/rms ratio, very useful with digital signal, but at the same time the device power can easily exceed the max current/voltage limit of device itself, especially in case of overdrive, even if of short duration.

Note that incase of digital signal the device must deliver about 11/12 dB more than RMS at any envelope peak. In case of overdrive or reflected power applied with this kind of signal, voltage increase at envelope peak can exceed the breakdown voltage of device, creating a discharge, which will destroy the device itself.
We can illustrate this concept by means of AMP-400UHF example.

AMP-400UHF works with DVB-T signal at an assumed Pout of 90W. In these conditions each MRF377 must deliver about 50W RMS, which correspond to about 630W instantaneous.

At power peak, the voltage peak will be about 50V, close to the drain, considering a collector impedance of about 2 Ohm.

If the instantaneous power doubles because of the overdrive/reflected power, the instantaneous voltage will be 70V about, which corresponds to breakdown voltage stated by the manufacturer (even if our measurements show that the real breakdown occurs at 83/87V about). In this case the device can break if the protection system is not effective.

Note that in the same load/power (90W) conditions and with a CW signal, the amplifier keeps normally working. Moreover, seen that in CW there can be only a thermal damage, in case of CW reflected power the LDMOS device, which has a thermal resistance of only 0.35 deg./W, will be more rugged than a bipolar one. As per our test results and manufacturer’s specifications, we can state that a protection system is effective if it completely cuts the drive signal in less than 1 µsec. from the occurring of overdrive or reflected power.

The supply switching off, even very fast, cannot be effective, since the capacitors load on the pallet is enough to damage the devices.

PROTECTION CIRCUIT