ME300 2,4, and 6m LDMOS Power Amplifiers

1. Introduction

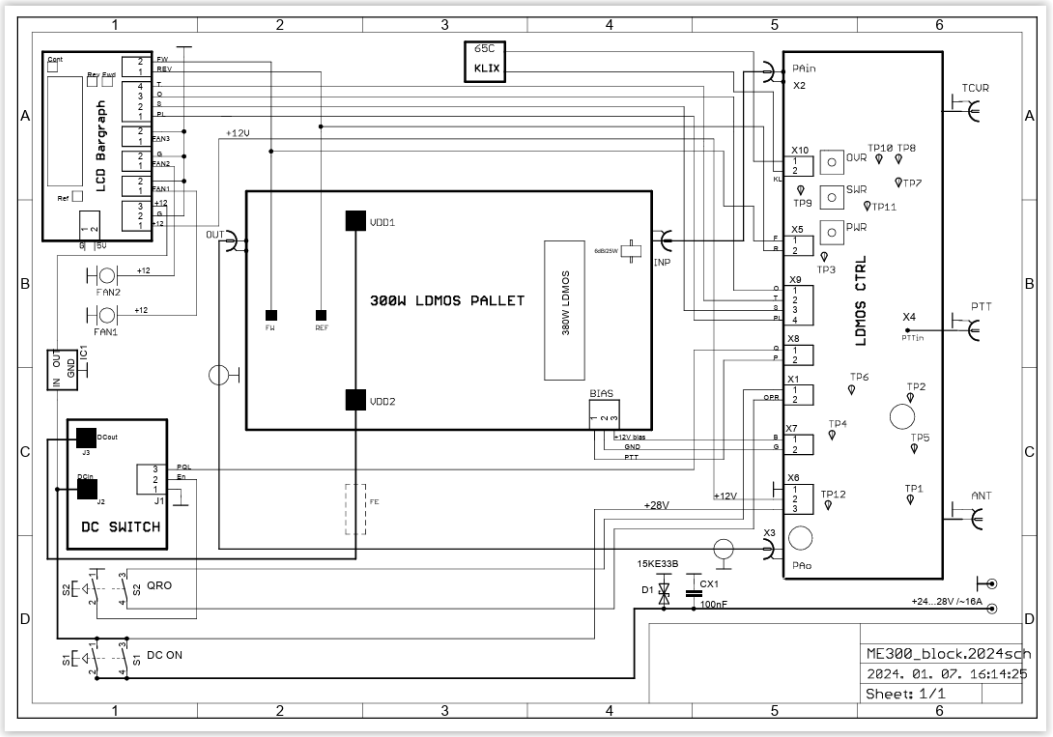
This 300W output power amplifier was originally we designed for 4m. During the design and implementation phase, we decided to design both a 6m and 2m version, as only minor modifications were needed to achieve this.

We aimed for a simple implementation, but taking into account that FT8 operation requires increased cooling requirements, we equipped the amplifier with 4 silent fans and a robust heatsink.

We haven't forgotten to include a relatively simple control unit for quick protection.

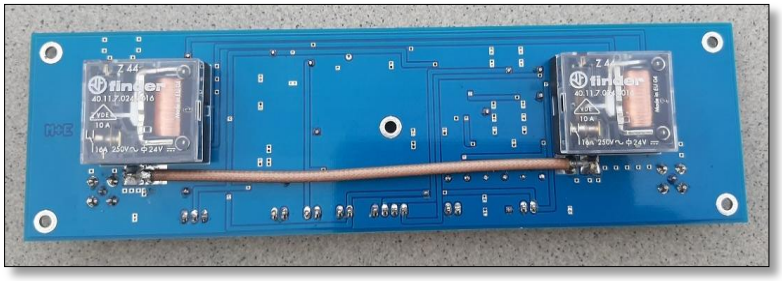
The amplifier has 4 circuit boards: An LDMOS RF amplifier, a control, a DC switch, and an LCD display unit.

See the block diagram of the power amplifier:



2. Control & Protection circuit

The control and protection circuit is located on the rear panel of the amplifier with the rear UHF or N terminals are soldered directly to the panel.



The RF relays are high-performance Finder PCB signal relays mounted on the back of the panel. The input and output cables to the power amplifier module are each connected to an SMA socket. The protection circuit is solved with a fast operational amplifier and thyristors. The protection circuit performs 4 functions.

A Klix switching at 65C will prevent the heat sink temperature from rising above 65C.

The signal from the SWR measuring unit activates the protection if the SWR is above 1:3. The SWR potmeter is used to set the maximum VSWR value.

Use the OVR potmeter we can set the maximum drive power of the power amplifier.

The PWR potmeter is used to set the maximum peak power (300W)

The various faults are indicated by an SMD LED on the control unit.

Fault signals are also displayed on the front panel of the PA, where a red flashing LED indicates the fault status.

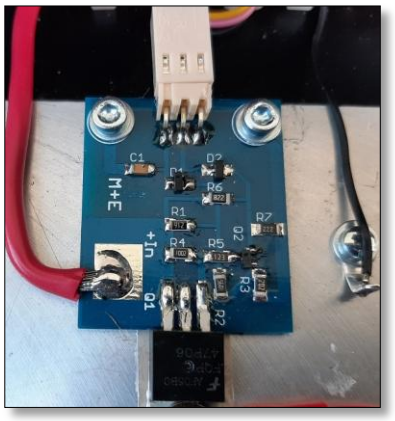
The fault signal can be reset by switching the device on and off.In the case of high temperatures, wait until the heat sink temperature falls below 65C, only then will the control unit allow the power amplifier to operate.

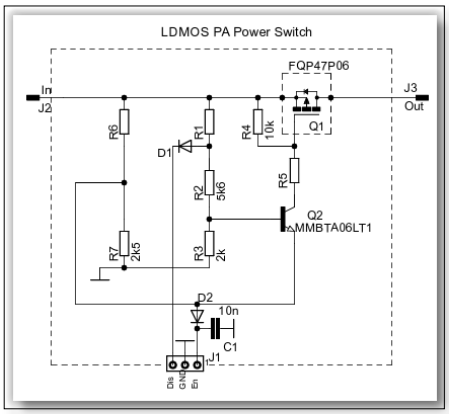
The control unit is also equipped with various switching units.

3. DC switch

The DC switch is a well-proven W6PQL type modified FET switching unit, which is used to connect the DC voltage to the RF unit.

The unit is connected to the control unit, which disconnects the DC voltage from the pallet in case of an error signal.

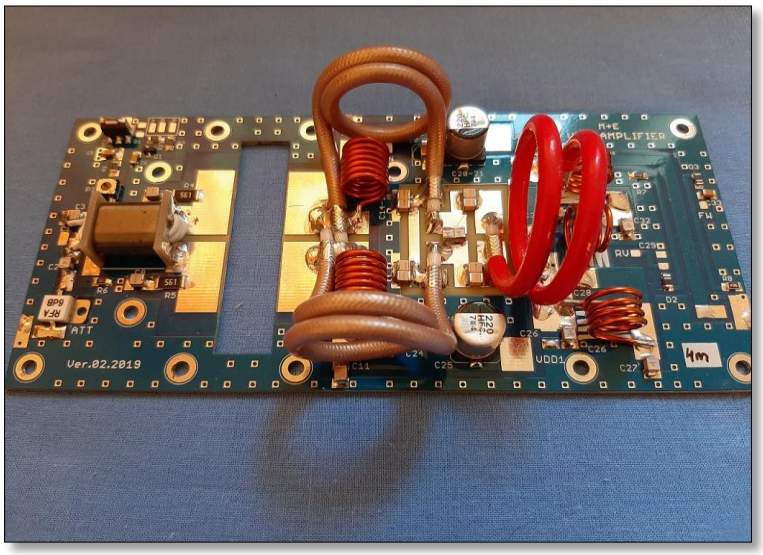




When the amplifier is on and the STBY/OPR switch is on OPR, the FET switches the DC voltage to the pallet.

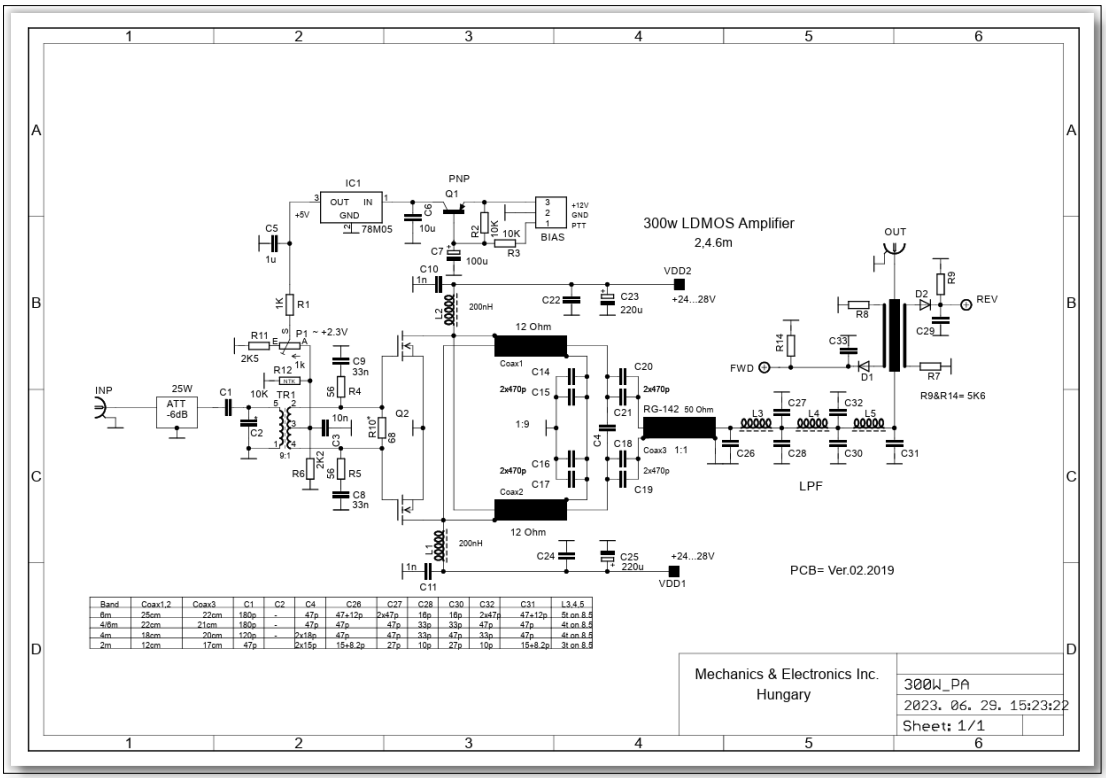
4. The RF pallet

The "soul" of the amplifier is the RF board. The picture shows the 4m amplifier panel without the LDMOS. For 2 and 6m, we have installed pallets of similar design, the coaxial transformers are sized for the given band.



The 6dB/50W attenuator we placed at the input of the amplifier. This attenuator provides a constant load to the driver unit.

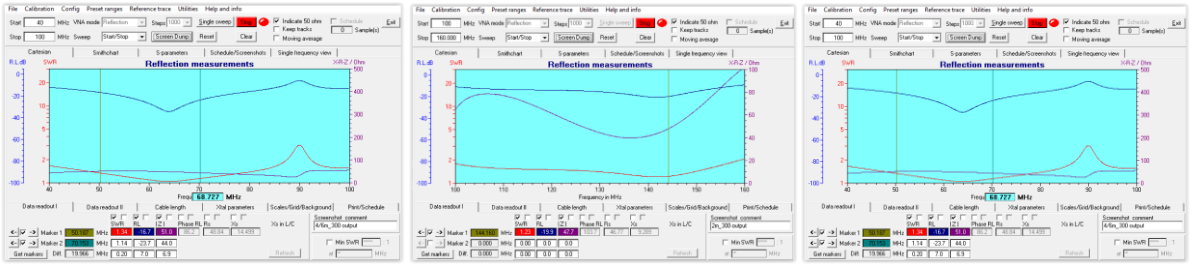
The 6dB attenuation allows the drive amplifier to be used at higher levels. Most radios can be regulated down to a minimum of 3-5W, which would be a lot to drive the power amplifier.
The amplifier uses a 380W Ptot 28 Volt LDMOS from various manufacturers.
The amplifier is a standard broadband amplifier, with coaxial cables of the right impedance and length to tune to the desired frequency.
Every LDMOS amplifiers produce a lot of harmonics, so a harmonic filter must be placed at the output.
After the harmonic filter, we also added a directional coupler. The PCB is made of TC350 material, the filter tuning capacitors and the couplers are of ATC type.
The setting of the LDMOS working point (AB1) is done with the potentiometer P1, after a 5V stabilizer from a 12V signal from the switching unit.
The bias is temperature compensated.
The pallet unit was mounted on a panel-sized ALU-CU cooling plate, which we fixed to the heat sink with additional screws.
The circuit diagram of the RF amplifier can be found at the following picture:



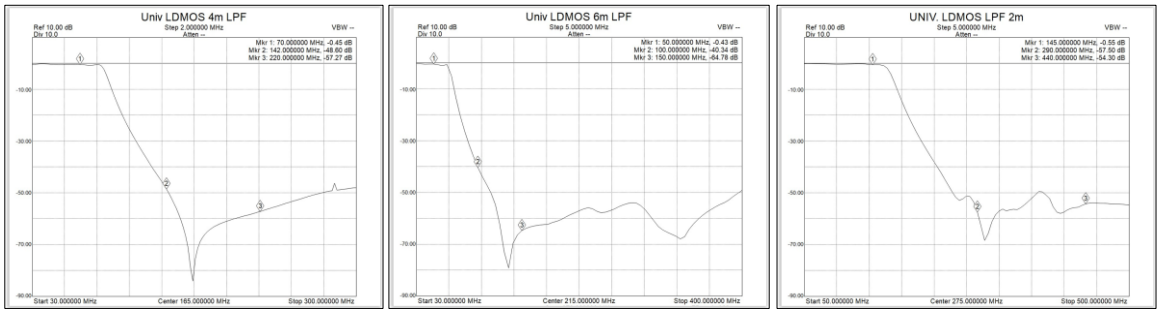
Band	Coax1,2	Coax3	C1	C2	C4	C26	C27	C28	C30	C32	C31	L3,4,5
6m	25cm	22cm	180p	-	47p	47+12p	2x47p	16p	16p	2x47p	47+12p	5t on 8.5
4/6m	22cm	21cm	180p	-	47p	47p	47p	33p	33p	47p	47p	4t on 8.5
4m	18cm	20cm	120p	-	2x18p	47p	47p	33p	47p	33p	47p	4t on 8.5
2m	12cm	17cm	47p		2x15p	15+8.2p	27p	10p	27p	10p	15+8.2p	3t on 8.5

The input stage has a 6dB attenuator, followed by a 4:1 broadband transformer.
The idle current of the LDMOS is set by potmeter P1.

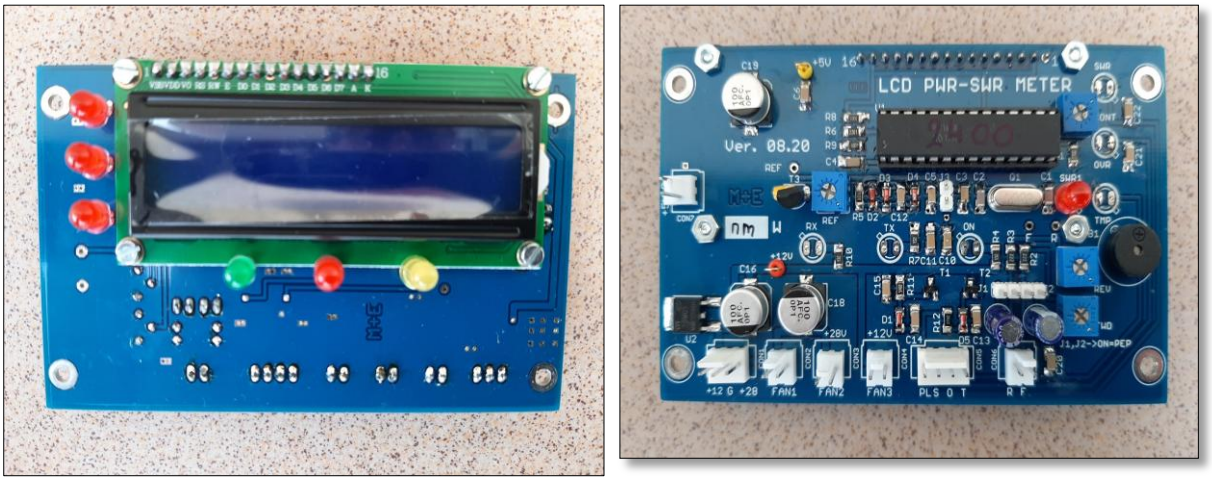
The input VSWR is close to 50 Ohms over a wide bandwidth, providing a good match to the drive transceiver:
Output VSWR measurements by band. Measurements without LPF filters:



The LPF has similar characteristics on every bands, with at least -50dB suppression on the 2nd harmonic.

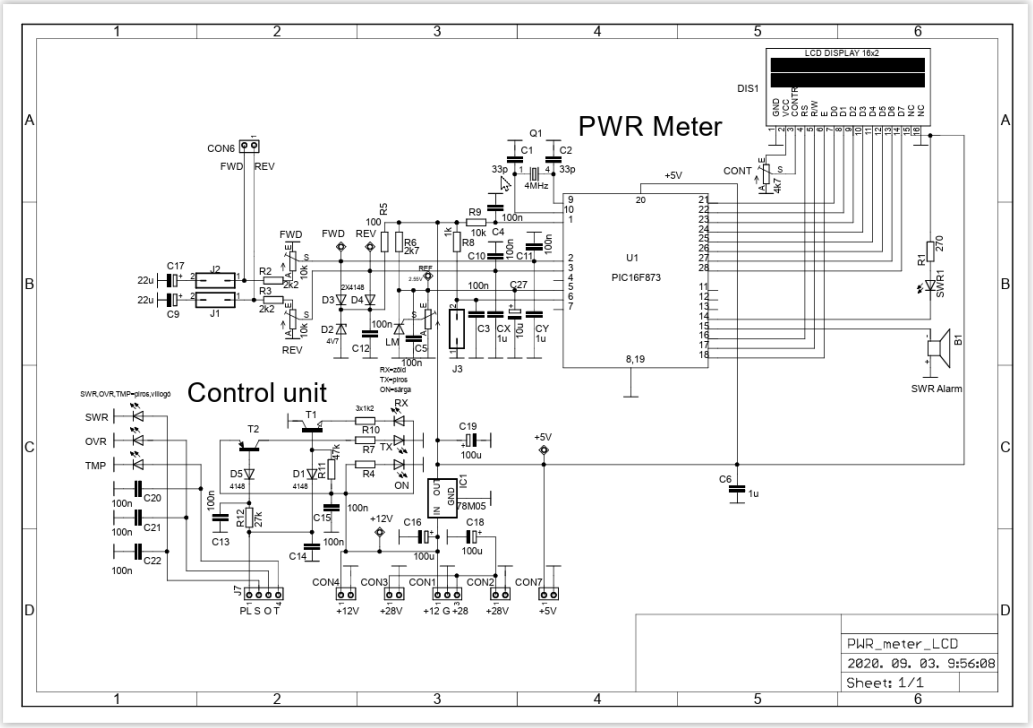


5.The LCD display unit



The display PCB contains a 2-line LCD display with associated circuitry, and the FWD and REV potentiometers for PWR scale calibration.

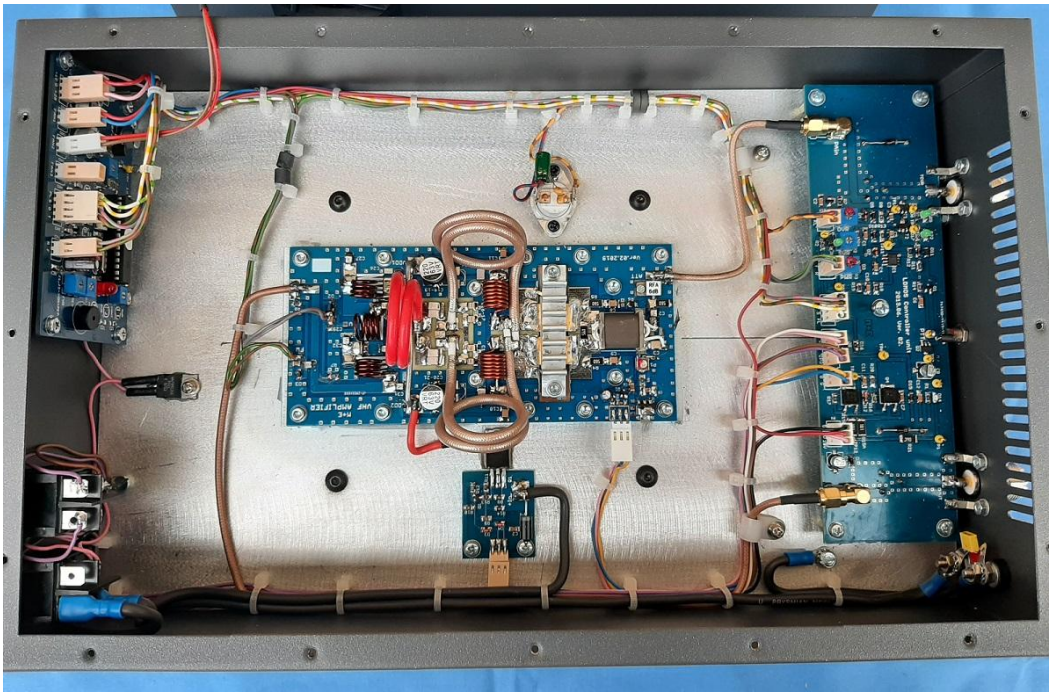
The 5V stabilizer needed supply the display is located here, as well as the function and error LEDs located on the front panel.The display shows the current output power, the SWR, and a bar-graph with the forward power.
The display unit schematics:



6. The Construction

For proper cooling, the amplifier is mounted on a 360x220x40 mm heat sink.
On top of the heatsink, 2pcs 80x80mm fans are mounted on a U-shaped plate.
On the front of the unit you will find an ON-OFF switch, a similar design OPR/STBY switch and a 2-line LCD display with error and status LEDs.
The TCVR and ANT RF connectors are located on the back of the amplifier. The 2m version has "N" type connectors, the 4 and 6m amplifiers have UHF type connectors. On request these versions can also be fitted with "N" type connectors.
On the rear panel is the PTT RCA socket, which must be connected to GND in order to switch the PA to transmit.(0.7V/<1mA)
Inside the PA, the control unit is mounted on 5pcs spacers, the centre of the TCVR and ANT connectors are soldered directly to the panel.
The drive and output of the pallet are connected to a SMA sockets.

Inside photo of ME300:



The complete pallet is located in the middle of the heat sink. The pallet is directly cooled by 2pcs 60x60mm fans attached to the bottom cover.
The display unit is mounted on the front panel.
PCB connectors were used to connect the units.
The device operates from an optional external power supply of 24...28 volts with a minimum load of 16A.(Low noise switching power supply)

Front and rear panel of the amplifier:

7. Using of linear amplifier

Connect the power supply, the drive radio and the antenna. Set the output power of the radio to the minimum (3..5W) Connect the PTT cable to the SND (GND on TX) output of the radio. Switch the radio on in CW or FM mode. Turn on the amplifier, set the STBY switch to OPR.
When the radio is keyed, the output power is shown on the display.
Check the VSWR of the antenna on the display. If the value is correct, increase the output power of the radio to the desired value (max. 300W)
If the power is increased further the built-in protection will start to operate, the OVR LED will start to flash.
Reduce the drive power, reset the fault by turning the ON/OFF switch on and off.
In FT8 mode you can use the amplifier with a maximum output power of about 280W in continuous operation.
If you want to work with the radio power only, set the STBY/OPR switch to STBY.
In this case, the display does not indicate output power but the TX LED indicates when you are in transmit mode.
When the STBY/OPR switch is in the STBY position, the drive power is delivered directly to the antenna. If either of the fault LEDs is flashing, the protection will shut down the amplifier and the drive power will also be sent directly to the antenna output.
The fault can be reset by momentarily turning the ON/OFF switch to the OFF position and back to the ON position.
If you get a TMP error, you cannot reset the error until the heat sink temperature goes below 65C.
In case of an OVR fault signal, reduce the drive. In case of SWR error, check the antenna, cable or the RF connectors.
In continuous FT8 operation, the heat sink temperature does not rise above +35C if 280W output power is set.

FEATURES & SPECIFICATIONS

- **Low harmonic content (below -60dBc on VHF bands) thanks to an efficient Chebyshev filter.**
- **Fast and effective protection systems maintain the amplifier's safety from operational damage.**
- **Compact linear amplifier with 300 watts SSB/CW & 280 watts continously DIGI-MODE of output power on amateur bands 50MHz,70MHzand 144MHz bands.**
- **Compatible with all transceiver models available on the market - ground on transmit (PTT) and 10W of RF drive power is sufficient.**
- **Intermodulation distortions (IMD3): better than 30dB below the rated PEP output.**

- **Input circuit: broadband, SWR below 1.2:1 (1.1:1 typically); on each bands continuous range without retuning or switching.**
- **Power Supply: 28v/16A external optional supply.**
- **Temperature range: -10 C to +65 C, (14 F to 149 F)**
- **Dimensions: (W x H x D) 220 x 160 x 390 mm; 5.7kg**