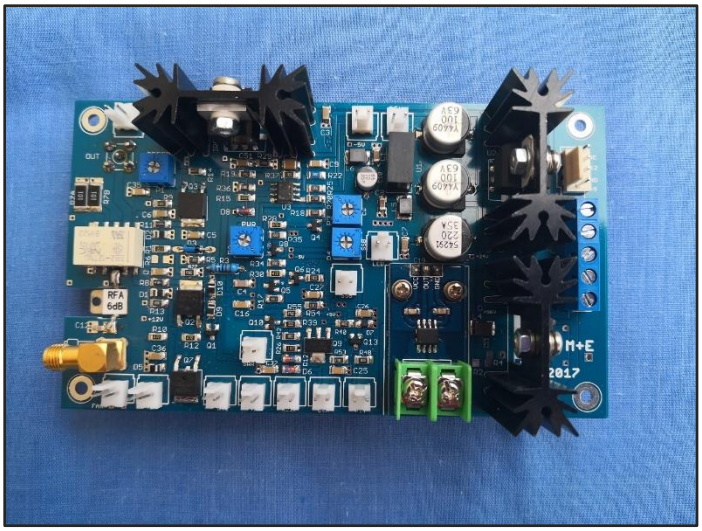
# High performance LDMOS amplifier protection circuit



## 1. Main features:

- Fast input overdrive protection,
- Output VSWR protection,
- Temperature protection,
- Different gate bias settings on CW and SSB mode,
- Very fast gate bias switching from positive to negative bias voltage,
- Switching circuit to RF relays,
- Fan speed control circuit,
- PTT switch circuit,
- Support by the the main Arduino control unit,
- Act together with current meter circuit,
- Usage from different LDMOS voltages, (28 to 65V),
- Small, compact outlet

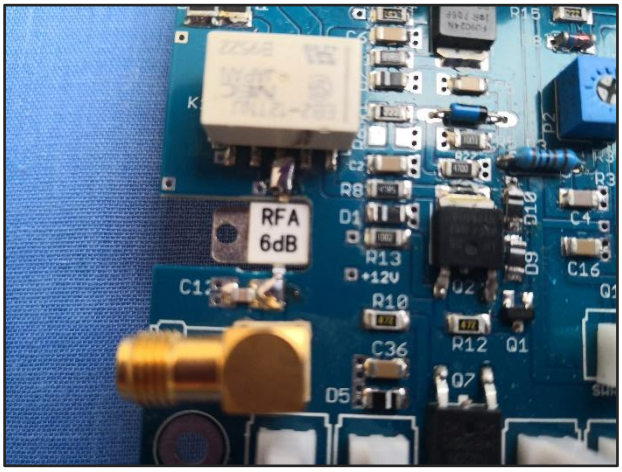
## 2. Input overdrive protection:

RF input overdrive is a very common cause of destruction the LDMOS circuits. On the most case 3-5W drive is enough to full drive of high gain LDMOS amplifiers. In cases lot of a lot drivers it's impossible to set the driving power below 5Watts. To solve this problem we built in a 6dB/20W attenuator. Using ALC circuit to solve the overdrive problem is not a good solution because it is not fast enough and we get linearity problems.

The second problem is when spikes arrive from the most drivers. It was necessary to build a very fast protection circuit to save our LDMOS amplifiers. The RF input part of the circuit consists of an attenuator, a fast RF switch with a small dummy load. The further circuits in

case overdrive will switch the RF relays to „bypass" excess power and will give a negative voltage to LDMOS Gate very fast.

The resistive power divider and the diode creates DC voltage - this level is adjustable - and drives the Schmitt trigger circuit. The driving power value is may be between 2 and 10Watts. The output of the Schmitt trigger controls a thyristor gate. Troubleshooting will be done by the Arduino automatically with some delay. Manual reset is also available.




## 3. Output VSWR protection:

The poor (> 2) output VSWR also will be blocking the amplifier as well. We using a coupler at the end of the amplifier to produce FWD and REV signals for measurement the forward and reflected power. These signals drive the Arduino unit to display the output and reflected power on the color display of the amplifier. The Arduino calculate from these signals the output VSWR and displays it on the screen. The unit makes up L level output in case the output VSWR higher than 2. This signal is connecting to SWR input of the protection circuit. This L level accross switch transistor will be going to open the thyristor and it results a similar action as in case the input overdrive.

## 4. Temperature protection:

Every LDMOS amplifier has high efficiency and relative low power are to dissipated in the heatsink.

We don't want to run the amplifier over 65°C heatsink temperature. To protect the LDMOS unit we built in 65°C temperature switch. The switching component is open on normal temperature. If heatsink temperature exceeds the 65°C is went to short. The circuit connecting to KL/RESET input of the circuit. The sensor placed on the heatsink near of the LDMOS transistor. A NTC resistor also helps to LDMOS to maintain the idle current constant versus temperature. When the heatsink temperature exceeds 65°C the TMP switch going to short and will control the Schmitt trigger input over a schottky diode. The result will be similar as before and the PA stops till the heatsink temperature drops below 65°C. We need to count with little hysteresis.

This input point of the protection circuit is connected parrallel to the Arduino circuit output.

In case of other failures the Arduino gives short time L signal (1sec) to this point, to RESET the failure. If the failure still on continously it's unable to reset the failure. We need to fix the failure. (overdrive, VSWR etc.)

## 5. Different gate bias:

We built in a special bias circuit provided by an fast operational amplifier. The op. amplifier works on +/- 5V voltage, the -voltage is generated from the stabilized +5V voltage by DC/DC converter. The operation amplifier produces + or -voltage it depends on the PTT state is open or short, or the protection is live or not. This voltage connecting directly to LDMOS gate.accross simple RC components.

Its filtered with low value capacitors to minimalize the switching hysteresis and the switch time. The gate voltage is about -3V if the PTT is OFF, or the protection is still ON.

The nominal voltage is different on CW and SSB mode, In both case we can set the gate voltage with trimmers. The operating mode is possible to set by external switch, or possible choose it from Arduino display. Two different gate voltages are valid for class B or AB class operation.

## 6. Very fast gate bias voltage switching:

On case alarm condition we need to save the LDMOS amplifier. (input overdrive, high antenna VSWR, high heatsink temperature) The fast operational amplifier gives on normal state of about +2.4V to LDMOS gate. On case of failure the RF relay switching circuit switches immediately to „bypass" mode. The op. amplifier gives -3V voltage to LDMOS gate and blocks it. The used op. amplifier can switch very fast. The switching time depends from RC circuits. If we using small serial resistor and small parallel capacitor value the switch time will be only 30-40uS. It's well enough time to block the LDMOS. The input circuit works in longer time about in 1- 2mSec. On bypass the input of the amplifier will be loaded with 50 Ohm resistor, placed on the circuit board.

## 7. PTT, RF relay switch, fan speed control circuits:

The PTT switch consist of low voltage, low current input. To transmit we have to put the input to GND. It's possible to control direct from external input connector or direct from the Arduino. It has LED lamp output. If we control it from Arduino the TX-ON mode is visible on the color display unit.

The fan speed control unit is simple, but well-tested circuit in our transverters. To sensor input connecting a NTK 2K resistor. The base fan speed is 50% at room temperature, adjustable by potentiometer. The fan reaches the full 100% speed at 50°C. The circuit drives two (or more) 12V low current silent fans. The unit can drive an Arduino input to display the actual heatsink temperature and the fan speed.

The RF relay FETswitch is controlled by the protection circuit and the PTT input. In case of alarm is going automatically to RX „bypass" mode.

## 8. Acting with the Arduino, current meter, etc.

The unit is usable itself, or acts together with  our Arduino/color display circuit as well.

We can use it with different type LDMOS amplifiers. It works properly from the popular 50 or 28V LDMOS voltages. It has stabilizer circuits and provides +24V, +12V and +5V low current outputs to different auxiliary circuits in the amplifier.

The dimension of the PCB is relative small, 130x75x30mm, equipped with the needed heatsinks, with high performance current meter circuit (up to 35A) SMA type RF input and output connectors, and PCB mounted input and output connectors.The component position are to be seen here.