

DSP-7-PA

Controller for amateur radio power amplifiers with large 7" TFT touch color display

and many measurement functions, sensors and WiFi webinterface

Safety functions

General information about the safety of high power amplifiers (LDMOS, MOSFET): One of the most important tasks of the controller is to detect fault situations and shut down the power stage before the valuable RF transistors are destroyed. Such a shutdown can take some 10 milliseconds because the error must first be detected by appropriate measurements. Therefore, power amplifiers should be designed in such a way that they can withstand faulty operation or other defects for a short moment. When using LDMOS transistors (with appropriate gate protection) this is usually given.

The controller helps to detect faults and reacts accordingly, but it is not a panacea. Therefore, some things should be taken into account already when building the power amplifier:

- **Provide input attenuator.** PAs are usually much more sensitive than necessary. An attenuator made of RF resistors (about 3 watts) is therefore very useful. A TVS diode should be connected in parallel to the middle ground resistor. It limits erroneously high control power until the controller switches off. Example see [HERE](#) in the upper schematic the diodes D10,11,12,13.
- **Gate protection diodes:** especially the otherwise extremely robust LDMOS transistors are real sensitive at the gate connection. Once too much voltage at the gate and 200 Eur are destroyed (please also pay attention to static charges during installation, which can partially damage the transistor and lead to late failures). Therefore the gate must be protected with diodes. Example see [HERE](#) in the upper schematic the diodes D2,3,4,5 etc. It is a complete mystery to me why so many OMs present power amplifiers without any gate protection in YouTube.
- **no negative feedback:** by negative feedback you couple back overvoltage from the output to the sensitive gates and can destroy the transistors if e.g. the antenna is defective. With my power amplifiers I have measured IM3 values of better than 30dB even without negative feedback. The resulting distortion in the AF signal is less than 1%, which is better than all AF amplifiers in our transceivers. Therefore a negative feedback is not necessary. Perhaps with the exception of special RF transistors or circuit designs I have not measured so far.
- **Use three Pwr/Swr measurement bridges:** this controller does not have connections for 3 measurement bridges by accident. The additional bridge at the input and the one between the PA and the filter are mainly for detecting misoperation. If you are still so careful, sometime it happens and you set the transceiver to 100 watts, and already the (hopefully existing) TVS diode smokes (see above: input attenuator). Or you choose the wrong filter. These measuring

bridges have saved my expensive transistors a few times.

- **Install current limiting:** Transistors have a maximum current (LDMOS e.g. 35A). If you exceed this e.g. by mismatching, the transistor is defective very fast. Currently HP server power supplies are very popular because they are cheap. They supply 50 volts and 60A and can therefore easily exceed the allowed current through the transistors. The controller monitors this quite reliably, but a shutdown takes a few milliseconds and might therefore come too late. For this reason I have developed a very simple but effective circuit which prevents an overcurrent from occurring in the first place.
- **Use of the ALC:** this controller has an ALC which monitors the current consumption of the PA, if it rises above an adjustable value (with a potentiometer), an ALC voltage is generated. This voltage is fed back to the ALC input of the transceiver, which then reduces its control power. The whole thing happens so fast that it is the most effective method to protect the input of the PA.

Error detection by the controller:

Too high antenna SWR:

If the SWR is worse than 2 the controller switches to standby, the PA is switched off and the transceiver is switched directly to the antenna, if the SWR is worse than 3, an antenna defect, cable defect or similar is suspected and an emergency shutdown of the complete PA takes place.

wrong adjustment of the low pass filter (is only recognized if a measuring bridge is installed between PA and filter):

there are 2 reasons for this: one is operating error, you have switched on a wrong filter, or a filter is defective. As soon as the SWR to the filter rises strongly, an immediate emergency shutdown of the complete PA occurs.

too high driver power (is only recognized if a measuring bridge is installed at the input):

the cause is practically always incorrect operation. Leave the transceiver at 100W and transmit into the PA. An emergency shutdown of the complete PA occurs.

heat sink temperature above the set limit:

the transmitting operation of the PA is stopped, i.e. the transceiver is switched through directly to the antenna. Thus a QSO can be continued, although with lower power.

set time limit exceeded:

If the PA is on the air for more than xx minutes, the transmit mode is terminated, i.e. the transceiver is switched through directly to the antenna. This is to prevent that a defective PTT or an erroneously permanently switched on transmit mode can overheat the power amplifier.

Current consumption too high:

If the current consumption exceeds a set limit, an emergency shutdown occurs.

Operating voltage too high:

If the voltage supply exceeds a set limit, an emergency shutdown occurs. In most cases HF irradiation into the power supply leads to a disturbance of the voltage regulation, which is detected here.

Function during operation:

the controller continuously monitors the heat sink temperature, even when not transmitting, or even after it has been switched off with the OFF key. If the temperature exceeds 40 degrees, the output FAN is switched through. The fan is connected here and its second connection to +12V. If the temperature drops below 35 degrees, it is switched off again.

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