Overdrive SSPA protection circuit

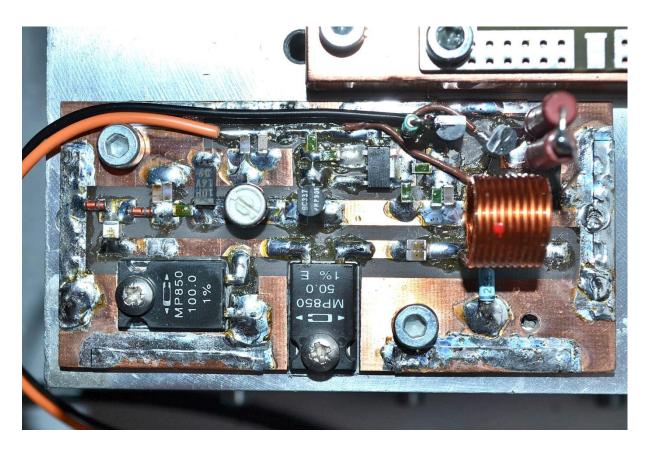
To avoid damages on the (expensive) power transistors embedded in the popular SSPA's nowadays, it is mandatory not to overdrive them.

As I wasn't willing to use the ALC feature of the W6PQL "Ultimate Amplifier Control Board (V6)" (but well using its other numerous features) to limit the input drive power of my SSPA, I have been developing the circuit described here. It ensures that as soon as the RF drive power level exceeds a preset level at its input, it prevents the power to reach the output, so that the subsequent expensive transistor is protected. This circuit can be used together with the W6PQL board.

The circuit is depicted below. The theory of operation and schematic are shown on the following pages.







Refer to the schematic on the next page.

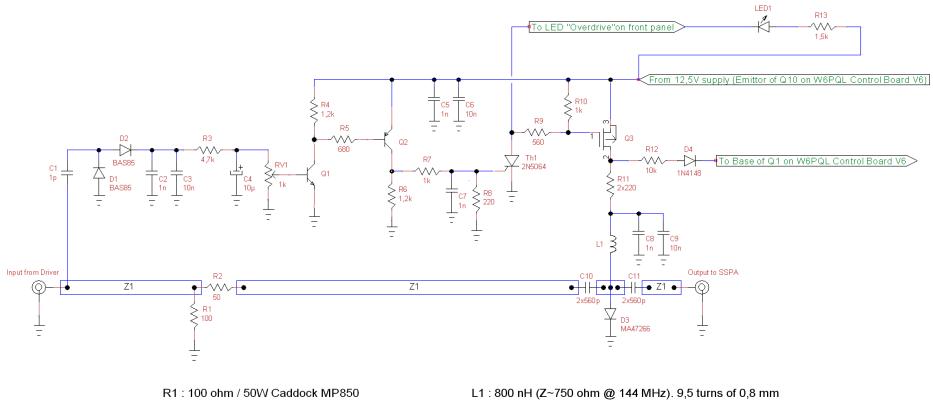
The input RF power is detected by the schottky diodes D1 & D2 (these can be non schottky standard diodes). The RF power threshold as from which the circuit will trip is adjusted thanks to RV1. Once the voltage on the base of the transistor Q1 is sufficient, it starts to conduct, so does Q2 too.

The voltage supply (around 12,5V) is then present on the voltage divider R7/R8 and hence on the gate of the thyristor Th1, which then conducts. The P-channel MOSFET Q3 (on the schematic, the pin 2 is the Drain, the 3 is the Source and the 1, the Gate) conducts in turn, allowing a current of around 100 mA to flow into the PIN diode D3, which then shortcuts the RF path to ground. I have been using a PIN diode out of my junkbox (MA47266 of M/A-Com) ; beside that one, the more common UM9401 can be used too (this can handle 100W). A possible sourcing is RF-Elettronica in Italy (http://www.rf-microwave.com/eng/home.html).

Additionnaly, the Drain of Q3 is connected to the base of the transistor Q1 (MMBT2222) on the W6PQL "Ultimate Amplifier Control Board (V6)", making this last to trip as well. The LED "Overdrive" indicates this state on the front panel of the amplifier.

A 6 dB attenuator in the RF path is made up by the combination of R1 and R2. The purpose of this attenuator is to help at controlling easily the RF power at the input of the SSPA that follows the overdrive protection circuit. Indeed, e.g. the span from 2W to 4W (the usual drive power of the current SSPA's) is 3 dB, while from 8W to 10W it is just 1 dB. Moreover, a higher power level is more compatible with the equipment I'm using.

In the normal working state (the PIN diode non conducting), when the overdrive board is terminated by a 50 ohm load, the VSWR seen from the input is 1,1/1. This is good enough so that no compensation of the parasitic inductors and capacitors of the attenuator is foreseen. When the PIN diode is conducting, R2 is shortcut to ground and in parallel with R1 ; it results in a 33,3 ohm impedance, which corresponds to a VSWR of 1,5/1 (the measurement shew 1,45/1). It is more than adequate in this situation.



R1 : 100 ohm / 50W Caddock MP850 R2 : 50 ohm / 50W Caddock MP850 R3 : 4,7k ohm / 0,25W SMD1206 R4, R6 : 1,2k ohm / 0,25W SMD1206 R5 : 680 ohm / 0,25W SMD1206 R7 : 1k ohm / 0,25W SMD1206 R8 : 220 ohm / 0,25W SMD1206 R9 : 560 ohm / 0,25W SMD1206 R10 : 1k ohm / 0,25W SMD1206 R11 : 2x220 ohm in parallel / 3W PR03 Philips R12 : 10k ohm / 0,25W through hole R13 : 1,5k ohm / 0,5W through hole RV1 : 1k ohm Bourns type 3359

C1 : 1pF Hi-Q Tekelec C2, C5, C7, C8 : 1nF X7R SMD1206 C3, C6, C9 : 10nF X7R SMD1206 C4 : 4,7 μ F / 16V Tantalum C10, C11 : 2x560pF NP0 in parallel SMD1206 L1 : 800 nH (Z~750 ohm @ 144 MHz). 9,5 turns of 0,8 mm diam. Cu wire on 11 mm internal diam. Total length 10mm.

D2 : BAS85 schottky diodes SMD D3 : MA47266 M/A-Com PIN diode D4 : 1N4148 through hole LED1 : red LED diode ("Overdrive")

Q1 : 2N2222, BC549, PZTA42,... (any standard NPN) Q2 : 2N2907, BC559, PZTA92,... (any standard PNP) Q3 : BST100 P-channel MOSFET Th1 : 2N5064 thyristor

Z1 : 50 ohm strip-line (2,7 mm width on 1,6 mm thick FR4 PCB)

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