

Receiver Front End Protection When Used with Active Antenna AAA-1

AAA-1 active antenna has very high dynamic range and its 1 dB compression point is at +20 dBm. At the output a heavy clipped signal can reach 6 V pp. This voltage is safe for the most of the conventional receivers and transceivers. *This limit is reached only when there is a nearby transmitter or nearby lightning strike.* Normally the total output power from 20 KHz to 30 Mhz is below 0 dBm at the antenna output.

AAA-1 is well protected at the input and does not need any special measures even when legal power TX is used. But the output voltage might be a problem for some receivers (Rx).

Rx input limits

The Rx input can be damaged by excessive voltage. The maximal safe input peak to peak (pp) limit is usually equal to the supply voltage. Most of the IC chips have maximal input ratings from -0.5 V to $V_{supply}+0.5$ V. If the Rx is a 5 volt device, a 4 V peak-to-peak (pp) signal is in the safe zone. If it is 3.6 V device, 3 V pp should be safe.

Recently at the market several type of good SDR receivers are available (SDR Play, Airspy, etc.) Most of them have a limitation of the maximal input signal at +10 dBm from the specification. This level is equal to 2 V pp. The AAA-1 has at the Control board a diode limiter (switched on by J108 jumper) which limits the signal to 4 V pp (16 dBm). This is a safe voltage for my Perseus SDR which is a 5V device but for other radios there is a risk.

We can protect the Rx input with attenuators and limiters with different level of clipping. Each approach has an impact to the dynamic range of the AAA-1 and also at the output level of the signal. Table 1 gives some major parameters of these solutions.

Protection with 6 dB attenuator

In order to protect a 10 dBm SD radio I will suggest to switch on the limiter (J108 on) in the Control board and to insert a 6 dB attenuator (Fig.1) between the Control board and the radio. This will limit the RX input voltage to 2 V pp (10 dBm). With this limiter the dynamic range of AAA-1 is slightly reduced and 1 dB compression point becomes 15 dBm. The reduction of the signal with 6 dB can be compensated by increasing the RF gain of the radio. The lowest output internal noise of AAA-1 is somewhere at -121 dBm at 500 Hz bandwidth. With attenuator of 6 dB it will become -127 dBm which is acceptable if the noise floor of the used RX is above -133dBm. (it is assumed that the RX noise floor must be at least 6 dB below the AAA-1 output noise).

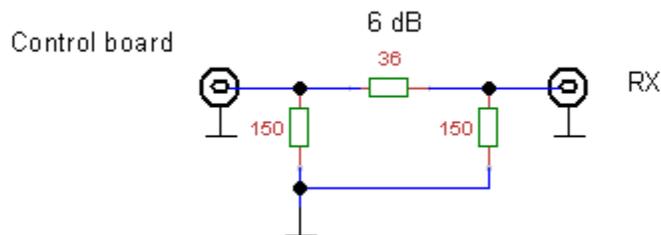


Fig.1 6 dB attenuator with internal limiter in Control board in on position

Protection with 10 dB attenuator without limiter

Another approach is to use 10 dB attenuator without limiter (Fig.2). This will preserve the full dynamic range of the AAA-1 but RX with MDS > -137 dBm will be needed. Both SDRPlay and Airspy have MDS > -140 dBm (@500 Hz BW) .

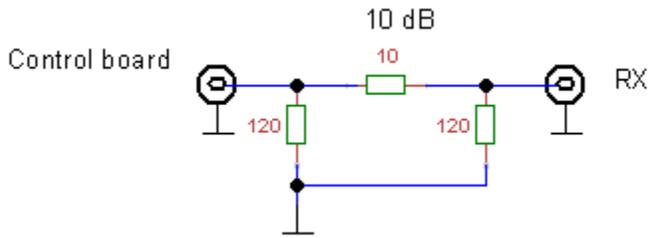


Fig. 2

Protection with external 3 dB attenuator and limiter

Another way is to reduce the clipping level but this will reduce the dynamic range of the active antenna. A compromise approach is shown on Fig. 3 which has lower attenuation and good dynamic range. The limiter is made of two serially connected diodes: one normal and one schottky diodes. The attenuator is T type with 3.5 dB attenuation. The limiter is doubled to limit the output voltage to 2 V even at very high input levels.

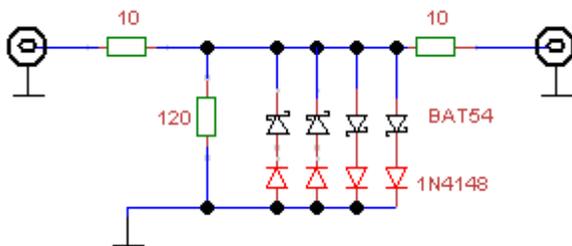


Fig.3

	1 dB compress. Point [dBm]	Additional Attenuation [dB]	Max. output Vpp [V]	Degradation of OIP2 [dBm]	Degradation of OIP3 [dBm]	Required RX MDS [dBm]
AAA-1 no limiter	20	0	6	0	0	-127
AAA-1 no limiter, 10 dB attenuator	20	10	2	0	0	-137
AAA-1 int. limiter + 6dB attenuator	15	6	2	0	2	-133
AAA-1 + ext.limiter + 3 dB attenuator	14	3.5	2	0	3	-130

Table 1 Impact on the dynamic range and signal level of 3 different approaches. The required RX MDS is for 500 Hz bandwidth. The degradation of the output intercept points (OIP) is measured at 0 dBm signal at AAA-1 output. The compression point is measured at the output of the amplifier before any attenuator.

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