

PIN DIODES: switches, attenuators, limiters, multipliers

An “**ideal**” PIN diode acts as a current controlled variable resistor, the attenuation is independent from power and frequency of use. The performances of a “**real**” PIN diode are limited both by the power level and the frequency, due to a more evident rectification effect at low frequencies. The effect of rectification is simply the normal behaviour of a traditional diode in presence of alternate current (RF), but in pin diodes it is a defect that prevents its use at low frequencies.

The choice of a pin diode for low frequencies (short to medium wave < 15 MHz) can be very difficult especially when it has to be used on HF receivers front-ends with good dynamic, in fact the diode itself is the cause of unwanted mixing, in this case is wasted the precious and expensive “**high dynamic**” for the use of a wrong or with poor performances diode, another typical example is in AGC circuits for IF at 70 MHz with TV or digital signals or in instrumentation attenuators and also for AM signals.

PIN diodes suitable for low distortion and usable below 15 MHz are specified with very long lifetime ($\tau > 1\mu s$) so we can say empirically those for low distortion RF attenuators and switches where the rectification effect at low frequencies are more limited.

See Ham Radio back issues, QST 12-94, Ulrich Rohde's various articles and application notes reported on old catalogues of the manufacturers of PIN diodes such as HP, Ma-Com, Alpha, Unitrode, etc... to know more about this topic. Below it is reported a table that helps in choosing the PIN diodes with a practical-empirical rather than scientific approach.

application	frequency	τ or C_j	(τ = lifetime)
Attenuator + AGC low distortion low intermodulation	HF	high lifetime $\tau > 1000$ nS	Linear variation of the R_s vs. bias (typical $3\Omega - 10k\Omega$)
	VHF - UHF	τ med. lifetime	
Limiter fast switch shunt configuration	HF	$C_j < 4$ pF	very short lifetime < 10nS
	VHF	$C_j < 2$ pF	
	UHF + μW	very low C_j	
medium power switch	HF	high lifetime $\tau > 1000$ nS	medium-low R_s , small dissipable power
	VHF-UHF	τ med. lifetime	
high power switch	as above	as above	very low R_s , medium-high dissipable power > 1 W , with glass pin diodes it is easier to obtain good dissipable power just keeping leads a little longer (they act like a heat sink)
phase shifter and modulators	they have to be used as low distortion attenuators		
band switching	they are among the most common low cost diodes used for commercial devices for band switch or antenna switch. If they are used at low frequencies see the above description.		
Cases with suffix 03W or 02W are better for high frequency (> 2,5 GHz) applications			