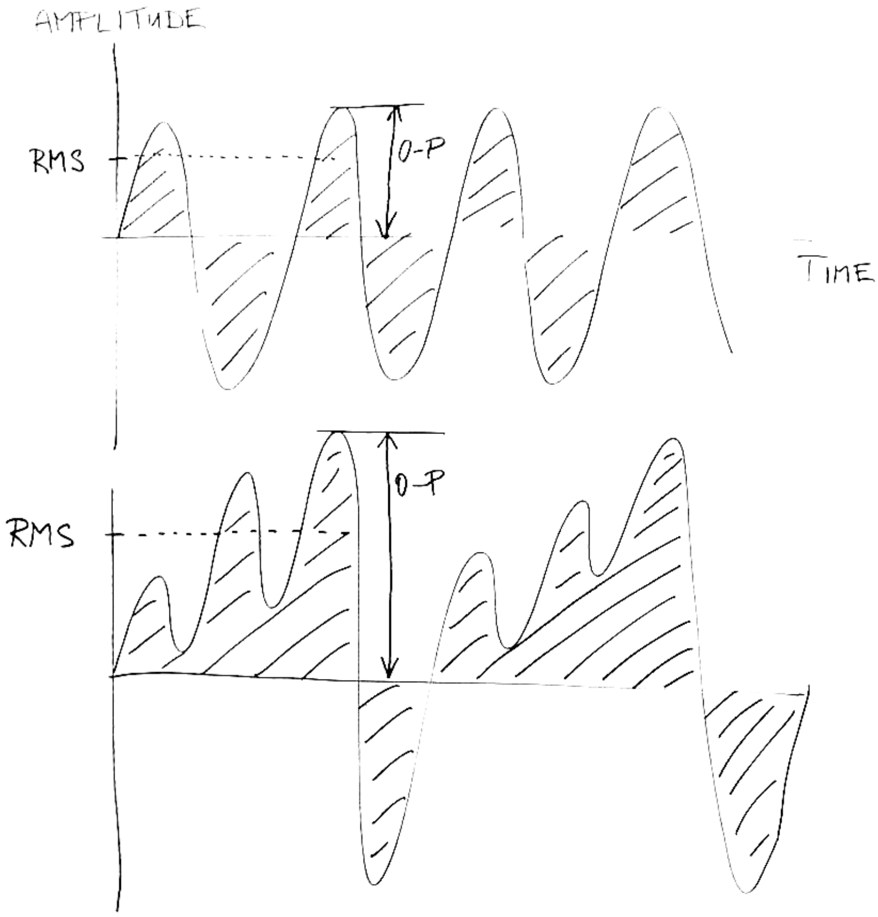
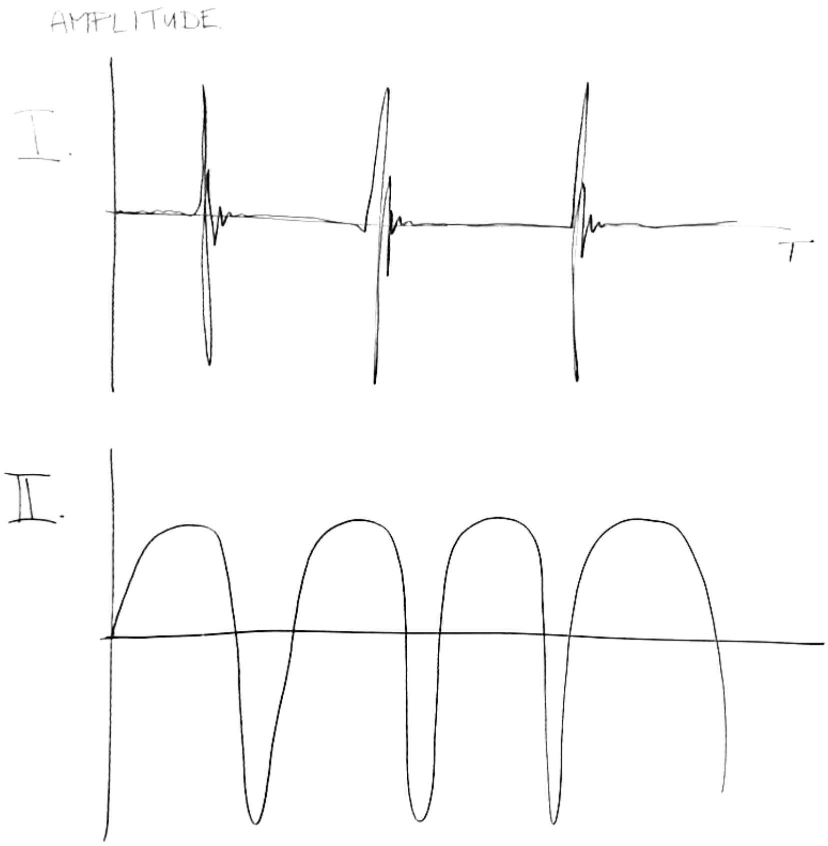
When the 0-PEAK value is equal to 1.414*rms

The answer is not difficult - almost never. But many users (I am afraid, the most of users) believe that this mathematical formula is always valid.



The RMS value is the "energy" parameter, purely mathematically it is the integration of the time signal function. That is, it is the area below the signal (hatched areas above).
The 0-P value is the amplitude value, it is the maximum of amplitude in the signal.

Look at the picture below. There are two signals. Both of them have similar maximum of amplitude, but they have totally different RMS values. The signal I has very low energy and it means very small RMS value. The signal II. by contrast has very large energy and a large RMS value.



When is the RMS equal PEAK/ 1.414 valid ? Only for a pure sine wave !

When my signal contains only one sine wave, then I can use this calculation. In real life such a signal does not exist. Always more then one frequency is super positioned in signal and also some distortion always exists.
Why is this formula such popular? The reason is, that many users are "spectrum" users. The FFT spectrum is the recalculation of time signal to a different form. The way, how it is done, is a statistical process, when we try to express real signal as superposition of sine waves with various frequencies. <u>It is a statistical process, not the exact formula</u>.
That is why for some signals (e.g. sine wave) we receive perfect result (it means, when we recalculate the spectrum back to the time signal, then that signal is almost the same as original signal). For next signal (e.g. with transient events) we receive less perfect results, after inversion back to time we receive less or more different signal, then the original one.

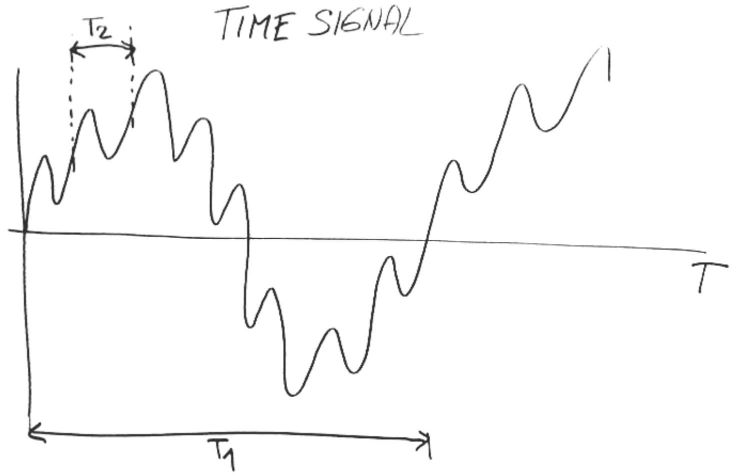
The key-thing is, that for FFT we use sine waves for building of signal (pure mathematics can use whatever different function which has required properties). And for sine wave the formula RMS is equal PEAK/ 1.414 is valid. Each line in the spectrum we can recalculate to RMS or PEAK form.

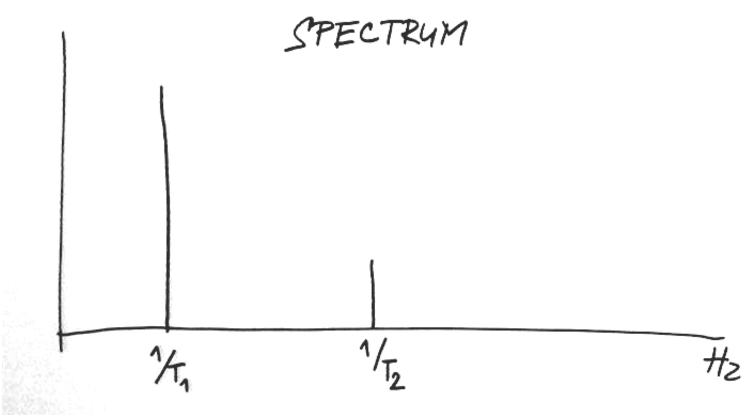
The second type of user is the "wide band - overall values" user. These users organise their diagnostics on the base of overall values. They define frequency bands and in these bands they measure REAL RMS or REAL PEAK or many next REAL parameters of the signal. Of course between REAL RMS and PEAK is not any "1.414" relation.

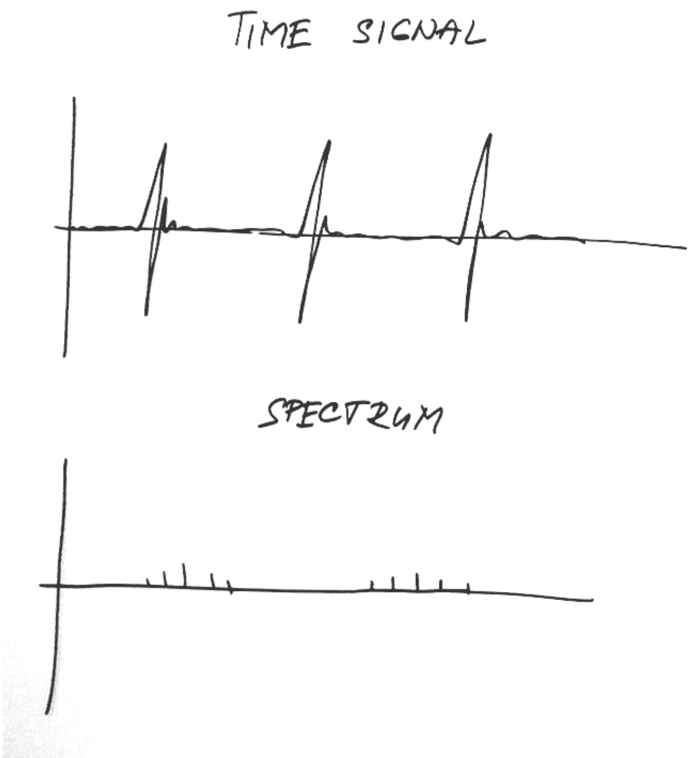
The spectrum measurement is only the additional parameter. Many "spectrum" users use the spectrum as the base and from that base they calculate "spectral-alarm bands". From the spectrum we can receive only RMS band value (and without the knowledge of how correct it is). It is not possible to receive the PEAK value, which was in original time signal. The PEAK value we can get only from time signal.

The confusion between RMS, PEAK and 1.414 is based on "only-spectrum" representation of the signal. <u>We</u> train our customers to measure firstly overall parameters or real band parameters. When we measure firstly spectrum and from this structure we develop next properties, then we forget that the spectrum is statistical parameter, which is less or more flawed. We have no chance to find by how much it is flawed without the original time signal. Some parameters (such as TRUE PEAK value) are definitely lost.

See examples of time signals vs. spectra. The first is relatively pure sinusoidal superposition. Such a signal is a good source for FFT. When we look at time signal and spectrum, in both of them we find all information.
The second one is typical transient signal (e.g. gearbox or ball bearing), which is not suitable for FFT. When we look at time signal, then we know all information and everything is clear. When we have spectrum only, we know nothing.







I can recommend the James I. Taylor "The Vibration Analysis Handbook", where he also explains in very good form the problems we are talking about.