Универзитет у Нишу
ЕЛЕКТРОНСКИ ФАКУЛТЕТ

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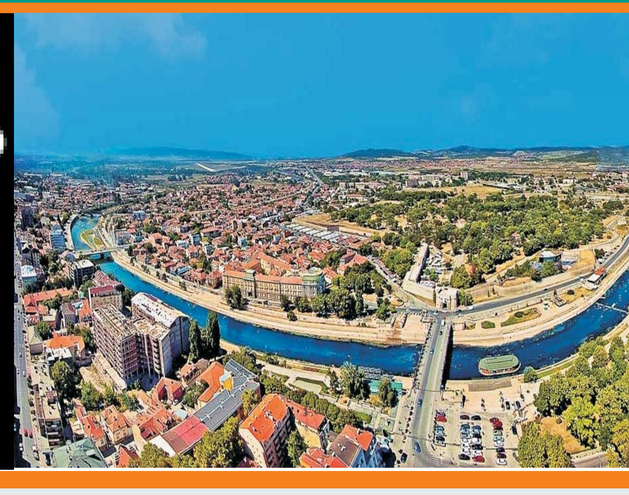
eNergetics 2019



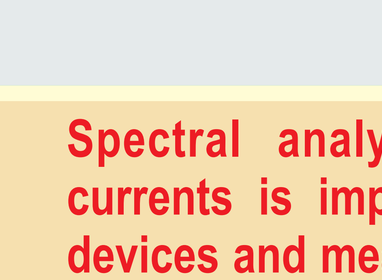
COMPUTATION OF THE LIGHTNING ENERGY SPECTRAL DENSITY

Spectral analysis of the lightning discharges currents is important for the choice of protective devices and measurement equipment in the cases of fast transients in electric power systems. This paper gives results for the frequency spectra of typical lightning currents according to the standard IEC 62305 and measured lightning currents. Their Fourier transforms are determined by using program Origin.

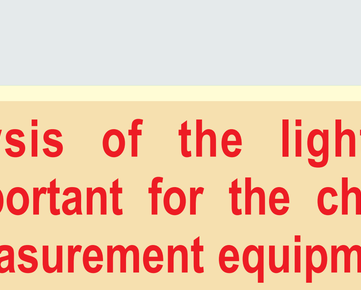
MP-AEF with N peaks may represent lightning currents waveshapes better than other functions from literature.

$$i(t)=\begin{cases} I_{m1}\sum_{i=1}^{k_1} b_{1i}\left[\frac{t}{t_{m1}}\exp\left(1-\frac{t}{t_{m1}}\right)\right]^{a_{1i}}, & 0\le t\le t_{m1},\\ \sum_{j=1}^{n-1} I_{mj}+I_{mn}\sum_{i=1}^{k_n} b_{ni}\left[\frac{t-t_{mn-1}}{t_{mn}-t_{mn-1}}\exp\left(1-\frac{t-t_{mn-1}}{t_{mn}-t_{mn-1}}\right)\right]^{a_{ni}}, & t_{mn-1}\le t\le t_{mn},\\ & n=2,\ldots,N,\\ (\sum_{j=1}^{N} I_{mj})\sum_{i=1}^{k_{N+1}} b_{N+1i}\left[\frac{t}{t_{mN}}\exp\left(1-\frac{t}{t_{mN}}\right)\right]^{a_{N+1i}}, & t_{mN}\le t<\infty. \end{cases}$$

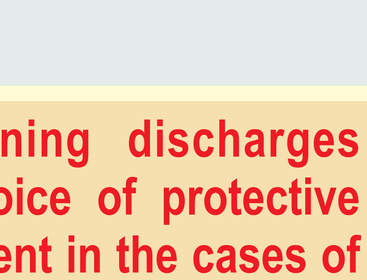
First positive stroke current



Approximation by 2P-AEF(1,4,4)

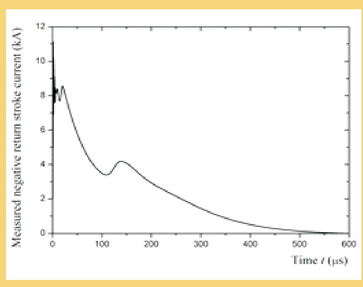


Real and imaginary parts of the FFT

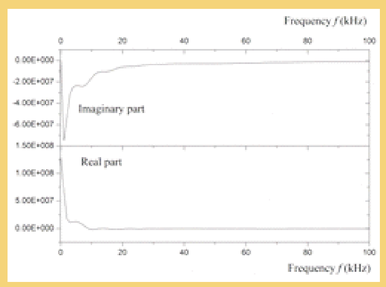


Amplitude spectrum versus frequency

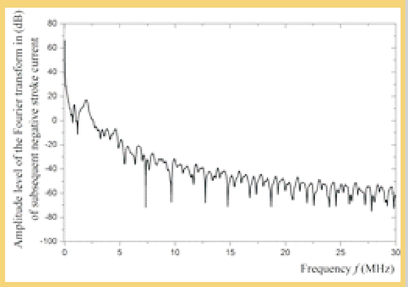
An example of the measured negative stroke current



Approximation by 13P-AEF

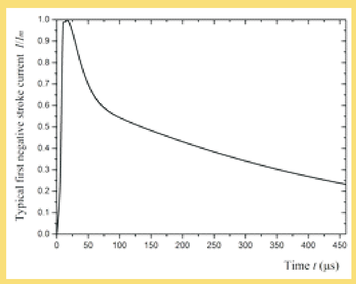


Real and imaginary parts of the FFT

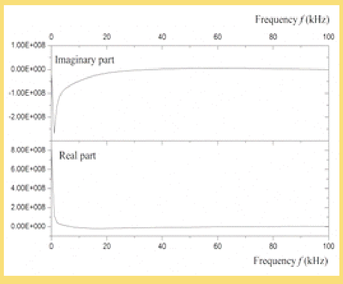


Amplitude spectrum versus frequency

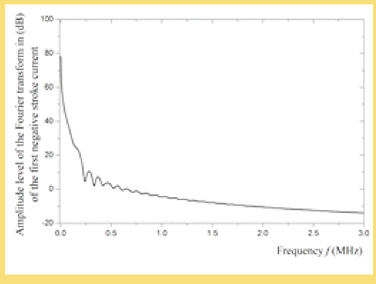
First negative stroke current



Approximation by 2P-AEF(2,1,2)



Real and imaginary parts of the FFT



Amplitude spectrum versus frequency

For lightning negative stroke currents, rising times are shorter than for positive, so that frequencies of interest are higher for negative discharges. In cases of the negative strokes, rising times are shorter for subsequent than for the first strokes. Frequencies important for analysis of such signals are up to tens of MHz for subsequent strokes, whereas up to a few MHz for the first strokes. In that range, attenuation of currents is about 100 dB.

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