Radio Navigation and Radar

4. Exercise

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1. Problem

Determine the spectrum

$$\underline{S}(\omega) = \int_{-\infty}^{+\infty} \underline{s}(t)\, \mathrm{e}^{-\mathrm{j}\omega t}\, \mathrm{d}t$$

of the linearly frequency modulated pulse

$$\underline{s}(t) = \operatorname{rect}\left(\frac{t}{T}\right) \mathrm{e}^{\mathrm{j}\frac{1}{2}kt^2}\,.$$

You may use the Fresnel integrals

$$C(z) = \int_0^z \cos\left(\frac{\pi x^2}{2}\right) \mathrm{d}x$$

$$S(z) = \int_0^z \sin\left(\frac{\pi x^2}{2}\right) \mathrm{d}x$$

to represent your result.

2. Problem

In the following an unmodulated train of pulses

$$\underline{s}(t) = \sum_{k=-\infty}^{+\infty} \underline{s}_\mathrm{P}(t - kT)$$

is considered.

a) Discuss the range ambiguity based on typical properties of pulse trains.

b) Determine the spectrum

$$\underline{S}(\omega) = \int_{-\infty}^{+\infty} \underline{s}(t)\,\mathrm{e}^{-\mathrm{j}\omega t}\,\mathrm{d}t$$

of the unmodulated pulse train as a function of the spectrum

$$\underline{S}_\mathrm{P}(\omega) = \int_{-\infty}^{+\infty} \underline{s}_\mathrm{P}(t)\,\mathrm{e}^{\mathrm{j}\omega t}\,\mathrm{d}t$$

of the basis pulse $\underline{s}_\mathrm{P}(t)$ and the period T.

c) Discuss the velocity ambiguity based on typical properties of spectra of pulse trains.