*Radioelectronics and Communications Systems*
*Vol. 48, No. 7, pp. 1–6, 2005*

*Izvestiya VUZ. Radioelektronika*
*Vol. 48, No. 7, pp. 3–11, 2005*
*UDC 621.37*

# CALCULATION OF SCALAR PRODUCT OF SIGNALS BASED ON HARTLEY'S TRANSFORM

V. L. Seletkov

*Kiev, Ukraine*

**The paper considers analytical relationships permitting to calculate the scalar product of signals at various linear transformations of the signal components with the use of Hartley's transform of these signals.**

In the problems of comparative analysis of real-valued radio signals $x(t)$ and $y(t)$, at creation of systems of demodulation and generalized spectral analysis of the signals, we often have to deal with calculation of the scalar product (correlation integral) of these signals [1]

$$[x(t)\nabla y^*(t)] = \int_{-\infty}^{\infty} x(t)y^*(t)\mathrm{d}t \tag{1}$$

where, for unification of all subsequent relationships, in the case of complex-valued signals the operation of complexification of the signal $y(t)$ is used.

For scalar product (1) the major (metric) properties hold:

$$[kx(t)\nabla y^*(t)] = [x(t)\nabla ky^*(t)] = k[x(t)\nabla y^*(t)];$$

$$[(x(t) \pm y(t))\nabla z^*(t)] = [x(t)\nabla z^*(t)] \pm [y(t)\nabla z^*(t)].$$

Scalar product (1) permits to determine the norms $\|x(t)\|$, $\|y(t)\|$ of the signals $x(t)$ and $y(t)$:

$$\|x(t)\|^2 = [x(t)\nabla x^*(t)] = \int_{-\infty}^{\infty} |x(t)|^2\,\mathrm{d}t; \qquad \|y(t)\|^2 = [y(t)\nabla y^*(t)] = \int_{-\infty}^{\infty} |y(t)|^2\,\mathrm{d}t,$$

and also to introduce the concept of "angle" $(x(t)\wedge y(t))$ between these real signals, where the sine and cosine of this angle

$$\cos(x(t)\wedge y(t)) = \frac{[x(t)\nabla y^*(t)]}{\|x(t)\|\|y(t)\|}; \qquad \sin(x(t)\wedge y(t)) = \frac{[\tilde{x}(t)\nabla y^*(t)]}{\|x(t)\|\|y(t)\|},$$

and where $\tilde{x}(t)$ is the signal which is conjugate to $x(t)$ after Hilbert [1].

Thus,

$$[x(t)\nabla y^*(t)] = \|x(t)\|\|y(t)\|\cos(x(t)\wedge y(t));$$

$$[\tilde{x}(t)\nabla y^*(t)] = \|x(t)\|\|y(t)\|\sin(x(t)\wedge y(t)),$$

**REFERENCES**

1. A. A. Korostelev, The Space-Time Theory of Radio Systems — a Textbook for Higher School [in Russian], Radio i Svyaz', Moscow, 1987.
2. R. Bracewell, The Hartley Transform [Russian translation], Mir, Moscow, 1990.
3. V. L. Seletkov, Izv. VUZ. Radioelektronika, Vol. 45, No. 8, pp. 49–55, 2002.

25 March 2004