# PRINCIPLES OF CREATING A SIGNAL PROCESSING LANGUAGE

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**The basic principles of construction, set of operators, semantics and syntax of a algorithmic digital signal processing language are presented. The effectiveness of constructing the language on the basis of concepts of a discrete signal as an unlimited sequence of samples, concepts of time scales, current time, etc., is substantiated.**

When realizing problems of digital processing of signals on the basis of universal computer systems, the need to create effective software inevitably arises. In such problem-oriented tasks, the efficiency of software to a considerable degree is determined by the possibility of representing real signals and processing algorithms in a form most corresponding to their physical equivalent with the possibility of realizing the digital signal processing algorithms in real time. Satisfaction of these requirements imposed on software by instrumental means of traditional high-level languages requires, as a rule, considerable expenditures of labor of skilled programmers. The quest to increase the productivity of writing programs and to make the very process of programming problems of digital processing of signals more accessible to specialists led to the idea of creating an algorithmic signal processing language (SPL) [1, 2]. In this aspect the SPL meeting the aforementioned purposes should be a high-level problem-oriented language efficiently realizing typical digital signal processing algorithms and means of debugging and modeling specialized digital devices [3]. Furthermore, the language devices of the SPL should have the capability of expansion by means of an interface matching it with any high-level language.

We will define the main concepts of the SPL. A task is defined as a collection of programs for a computer (a set of programs) and discrete signal input-output hardware which are interconnected in the sense that the SPL means are used for their functioning and interaction. Concepts of discrete time scales - main and additional (decimated) - should be considered important concepts of the SPL. These concepts make it possible to represent within the scope of one algorithm diverse forms of discrete signals with a different sample size mutually decimated and/or delayed relative to one another and uniquely synchronized during mutual operations in the task.

The **main time scale** (MTS) represents a set of times arranged equidistantly with a base period $T_b$ on the time axis ($T_b$ corresponds to the minimum signal sampling period). All times are enumerated by a sequence of integers so that any time is defined as n.

The **additional time scale** (ATS) represents a set of times of the time scale arranged equidistantly with period $T_K = K \cdot T_b$, where K is the decimation factor relative to the MTS. The times of the additional scales are also enumerated by a sequence of integers (i). Here the number of the time is defined as $(i \cdot K + P) \cdot T_b$, where P is the delay of the zero time of the ATS relative to the zero time of the MTS, measured by the number of samples of the MTS. The two time scales are matched if their decimation factors K1 and K2 are multiples, i.e., $K1 = m \cdot K2$ (m is an integer or simple fraction) and the difference of the delay P1 and P2 of the smaller of K in absolute value is equal to: $/P1 - P2/_{\mathrm{mod}\ \min(K1,K2)}$. This condition corresponds to coincidence of the times of the more decimated scale with the times of the less decimated one. This enables performing mutual operations on signals scaled by such scales, taking equal to zero the missing samples of the signal corresponding to the more decimated scale.

A **discrete signal** (DS) - a key concept - is defined as the unlimited sequence of numbers (real, if the signal is real, or complex, if the signal is complex). If the sequence of numbers is one, the signal is one-dimensional or one-channel, if there are N sequences, the signal is N-dimensional or N-channel (X(N)). Each number represents the instantaneous value of the original continuous signal at times determined by the time scale by which the signal is scaled. Thus, the signal samples are always equidistant with period $T_K$ or $T_{b1}$. The sampling period of any DS can be different, but should be a multiple of the base period $T_b$ ($T_K = K \cdot T_b$). The base sampling period $T_b$ is taken as a system parameter of the problem and can be defined as physical time, if the problem of the real time scale related to external real signals is being solved.

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