DSL variants, such as ADSL, SDSL, and VDSL because of the improved control over the spectrum due to the limited extent of TFB functions.

[**0048**] While various preferred embodiments of TFB encoding and decoding techniques have been disclosed herein, it is to be understood that many changes may be made therein without departing from the spirit of the invention.

[**0049**] Thus, the aforementioned techniques can be applied not only to the communication of digital information, but also e.g. to its storage in which one or more digital information streams are stored on a storage medium based on analog techniques.

BRIEF DESCRIPTION OF THE DRAWINGS

[**0050**] For a better understanding of the invention, as well as other objects and features thereof, reference is made to the accompanying drawings wherein:

[**0051**] **FIG. 1A** is a block diagram setting forth an illustrative implementation of a transmitter of a system according to the present invention equipped to convert incoming binary data into a TFB packet stream for transmission over a communications link.

[**0052**] **FIG. 1B** is a block diagram representing an illustrative implementation of an encoder of the transmitter shown in **FIG. 1A**.

[**0053**] **FIG. 1C** is a block diagram representing an illustrative implementation of a waveform generator of the transmitter shown in **FIG. 1A**.

[**0054**] **FIG. 2A** is a block diagram setting forth an illustrative implementation of a receiver of the system according to the present invention equipped to decode an incoming TFB packet into one or more streams of binary data.

[**0055**] **FIG. 2B** is a block diagram representing an illustrative implementation of a front end of the receiver shown in **FIG. 2A**.

[**0056**] **FIG. 2C** is a block diagram representing an illustrative implementation of a decoder of the receiver shown in **FIG. 2A**.

[**0057**] **FIG. 2D** is a block diagram representing an illustrative implementation of a bit stream generator of the receiver shown in **FIG. 2A**.

[**0058**] **FIG. 3A** is an example of a non-TFB function in the time domain.

[**0059**] **FIG. 3B** is an example of a non-TFB function in the frequency domain.

[**0060**] **FIG. 4A** is an example of a TFB function in the time domain.

[**0061**] **FIG. 4B** is an example of a TFB function in the frequency domain.

[**0062**] **FIGS. 5A and 5B** enlarge the pulse shapes presented in **FIG. 4A** and **FIG. 3A** respectively for comparison.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[**0063**] The systems and methods of the present invention enhance effective capacity of communications links or storage media by transmitting a plurality of TFB waveform components each characterized by a unique TFB function. A combination of TFB functions is used to construct a TFB packet, and a plurality of TFB packets is used to generate a TFB stream.

[**0064**] Pursuant to a first embodiment of the invention that increases effective data throughput of the communications link, incoming information is received as a bit stream of binary coded information ("0"s and "1"s),and then transformed to an equivalent coding in which the binary "0" and "1" of the bit stream, are translated into equivalent weighing factors to be applied to a TFB function selected from a set of predetermined TFB functions as described below. Note that the mapping of a single bit to a TFB function is by way of illustration only, and by no means a constraint. It is possible to map a number of bits onto a single TFB function.

[**0065**] Conceptually, the TFB packet is constructed from a set of TFB functions. These functions are utilized, potentially in a modified form, to encode a sequence of bits as a continuous-time signal, and to decode this signal into the sequence of bits that it represents. Encoding occurs by computing a weighted sum, also called a linear combination, of the TFB functions. The weight for a given TFB function is given by the weighing factor for a bit or group of bits mapped onto that function.

[**0066**] Fundamentally, TFB functions have the advantageous property of being substantially confined in both of the frequency and the time domain. A preferred sub-class of TFB functions are orthogonal TFB functions. Each TFB waveform component in the predetermined set of orthogonal TFB waveform components is unique and mutually orthogonal with respect to all other TFB waveform components in this set. A more preferred sub-class of the orthogonal TFB functions are Hermite-Gaussian functions. A Hermite-Gaussian function is a function that has the same shape (modulo a constant) in both the frequency domain and the time domain. The invention comprises the use of both Hermite-Gaussian functions and other TFB functions. An example of a TFB function is

$$\mathrm{sec}h(z)=1/\cos h(z)=2/(e\hat{\ }z+e\hat{\ }-z).$$

[**0067**] The TFB functions are summed, after the weighting process described above, thereby providing TFB blocks and, thence, a stream of TFB blocks.

[**0068**] Methods and systems in accordance with the invention may be used in conjunction with any transmission medium capable of conveying or transmitting a stream of information. Such transmission media may include wire, satellite transmission, wireless communications, radio frequency transmission over the air, radio frequency transmission through a coaxial cable, fiber optics, etc. and such protocols as T-1, ATM, Frame Relay, etc. Systems and methods developed in accordance with the invention will function with virtually any digital information capable of being transmitted or stored using analog technology, such as data, image, video or voice applications.

[**0069**] **FIG. 1A** is a block diagram setting forth an illustrative implementation of a transmitter **100** of a system according to the present invention equipped to convert incoming binary data into a TFB stream for transmission over a transmission medium to a receiver. An incoming binary data bit stream **110** includes a sequence of logical