[0006] Embodiments of t~~T~~he present invention provide~~s~~ a monitoring system that employs the first method described above, of timing an interval between successive signal features, and then applying a time domain filter to a period or frequency value derived from that interval. As the frequency of the signal to be measured rises, loss in resolution is manifest as a high frequency error component to the measurement and this error component may be~~is~~ removed by the filter. The effectiveness of the filter in removing the error component may increase~~s~~ as the frequency of the signal to be measured increases, providing a higher sampling rate that is increasingly filtered, in effect, compensating for the decreased resolution that would normally be associated with higher frequencies.

[0007] ~~Specifically then, the present invention, in one embodiment, provides a frequency monitor having an input for receiving a signal to be measured and a signal feature extractor identifying a regular feature of the signal related to the signal's period. A timer system communicates with the signal feature extractor to provide an output being a function of period of the signal, and a low pass filter receives the output to reduce high frequency fluctuations in the output value to provide a measurement output for monitoring frequency of the signal.~~According to an aspect of the present invention, there is provided a frequency monitor comprising: an input for receiving a signal to be measured; a signal feature extractor identifying a regular feature of the signal related to the signal's period; a timer system including a clock providing a periodic clock signal communicating with a counter counting the periodic clock signal between detection signals from the signal feature extractor identifying a regular feature of the signal, the timer system communicating with the signal feature extractor to provide an output being a function of the period of the signal; an inverter receiving the output and converting the period of the signal to a frequency to provide a measured frequency output; and a low pass filter receiving the measured frequency output to reduce high frequency fluctuations in the measured frequency output to provide a corrected frequency output for monitoring frequency of the signal, wherein the low pass filter is in communication with the clock to sample the measured frequency output at the same rate as the clock, and wherein the low pass filter includes an input for adjusting a corner frequency of the low pass filter.

[0007a] According to another aspect of the present invention, there is provided a method of monitoring frequency comprising the steps of: (a) receiving at an input of an electrical circuit an electrical signal to be measured; (b) extracting from the electrical signal, by a signal feature

extractor circuit of the electrical circuit, regular features of the signal related to the signal's period; (c) measuring the period of the electrical signal, by a timer system communicating with the signal feature extractor circuit and including a clock providing a periodic clock signal communicating with a counter counting the periodic clock signal between detection signals from the signal feature extractor circuit extracting regular features of the signal, as demarcated by the regular features and outputting an output being a function of the period of the signal; (d) inverting the output and converting the period of the signal to a frequency to provide a measured frequency output; (e) filtering the measured frequency output with a low pass filter to reduce high frequency fluctuations in the measured frequency output to provide a corrected frequency output representing a frequency of the signal, wherein the low pass filter communicates with the clock to sample the measured frequency output at the same rate as the clock; and (f) adjusting a corner frequency of the low pass filter.

[0007b] According to another aspect of the present invention, there is provided an input module for an industrial control system providing a housing with a backplane providing power to and data communication between multiple modules fitting within the housing; the input module comprising: an input for receiving a signal to be measured; a signal feature extractor circuit identifying a regular feature of the signal related to the signal's period; a timer system circuit including a clock providing a periodic clock signal communicating with a counter counting the periodic clock signal between detection signals from the signal feature extractor identifying a regular feature of the signal, the timer system circuit communicating with the signal feature extractor to provide an output being a function of the period of the signal; an inverter receiving the output and converting the period of the signal to a frequency to provide a measured frequency output; a low pass filter circuit receiving the measured frequency output to reduce high frequency fluctuations in the measured frequency output to provide a corrected frequency output for monitoring frequency of the signal, wherein the low pass filter is in communication with the clock to sample the measured frequency output at the same rate as the clock, and wherein the low pass filter includes an input for adjusting a corner frequency of the low pass filter; and an output terminal communicating with the backplane of the housing of the industrial controller for transmitting the corrected frequency output thereon.

[0008] It is thus a feature of at least one embodiment of the invention to provide a frequency-measuring device that may automatically accommodate a wide range of input signal frequencies without the need for manual or semiautomatic adjustment. The filter smoothly compensates for quantization error that would otherwise decrease the resolution of frequency measurement using the period monitoring technique for high frequency input signals.

[0009] The signal may be a square wave and the feature extractor may be an edge detector.

[0010] It is thus a feature of at least one embodiment of the invention to provide a system working with common square wave inputs using a robust feature extractor.

[0011] The timer system may include a timer measuring the period of the signal and an inverter converting the period to frequency.

[0012] It is thus a feature of at least one embodiment of the invention to apply the filter directly to a frequency signal for more intuitive filtered output when frequency is desired. More generally, the filtering can occur before the inversion process to act directly on the deduced signal period.

[0013] The timer may be a clock providing a periodic clock signal communicating with a counter counting the periodic clock signal between detection signals from the signal feature