Wide Band Systems, Inc.®

Technical Product Bulletin No. 105

DIGITAL IFM SYSTEM RECEIVERS

WIDE BAND SYSTEMS' digital IFM system receivers are fully integrated, wide band EW system receivers that provide digital output of RF input frequency, amplitude, pulse width, and Time of Arrival (TOA). In addition, the receivers also provide various intrapulse data such as Frequency Modulation On Pulse (FMOP) and Phase Modulation On Pulse (PMOP). Automatic CW identification and processing is provided, as is recognition and suppression of RF multipath and out of band signals.

Digital IFM receivers offer the system designer or integrator a complete, cost-effective, standalone receiver capability. They include all necessary receiver functions such as external threshold programming capability as well as an internal automatic RF SNR based instantaneous threshold. The critical timing requirements of associating the measured RF frequency data with the measured RF amplified data, for both short duration RF pulses as well as slow rise time RF signals, are satisfied within the receiver. Thresholding is always accomplished with respect to a fixed point on the received RF signal (usually the -3dB point), as opposed to the time of receiver sensitivity threshold crossing. Wide Band IFM receivers are available in either a 3U RETMA rack configuration (including an AC power supply and various preselection or notch filters), or as standalone receiver modules using the host system power supply. For either version, the user need only provide an RF input signal, select the desired threshold source (Internal or External), and provide a destination for the digital data to complete system receiver integration. The two receiver configurations are shown in this Product Bulletin.

The standard video processor

The serial digital data from the Monotonic Digital Amplitude Quantizer is analyzed to locate the start and end of the RF pulse envelope; this data is employed to service the RF Time of Arrival (TOA), Pulse Width, and CW Detection circuits. Although the RF pulse start and end definition is usually the -3dBc points of the RF envelope, the receiver can be set up for any other definition, in 0.5dB increments. The nominal time resolution of the TOA and Pulse Width circuits is 25nS, due to the 40MHz clock employed; an optional Extended TOA Processor is also available, extending the TOA resolution down to 0.3nS, with an absolute accuracy of approximately 1nS.

Amplitude quantization

RF amplitude quantization is accomplished using a Monotonic Digital Amplitude Quantizer; this design samples the RF amplitude every 25nS, producing an 8-bit digital RF amplitude data word with 0.5dB RF amplitude resolution for each sample. Typical RF amplitude absolute accuracies of 1dB are provided. The RF dynamic range exceeds 70dB. The RF amplitude quantizer is time compensated to remove dependence of the timing of a particular point on the RF waveform from the RF amplitude; neither the measured TOA nor the pulse width timing data is RF amplitude dependent.

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The IFM includes a DFD

The IFM Receiver incorporates a WIDE BAND SYSTEMS' Digital Frequency Discriminator (DFD). This DFD employs a parallel array of binary correlators, with both Error Correction and Error Detection logic, to provide measured digital RF frequency data samples once every 25nS, synchronously with the RF Amplitude Quantizer digital amplitude samples. The time synchronization of RF amplitude and RF frequency data samples is closely controlled within the receiver. Typical frequency resolution of the DFD is twelve bits, although DFDs have been produced with as few as six output bits and as many as 16 output bits. The Error Correction capability of the DFD allows the measured phase of any or all correlators to be in error by as much as ±45 electrical degrees, without affecting accuracy of the output data. The Error Detection capability of the DFD allows the flagging of RF frequency measurement errors, particularly those due to two (or more) simultaneous RF inputs which are closely spaced in RF amplitude. The Error Detection process does not rely on the mere detection of the presence of multiple simultaneous inputs, but is dependent on the detection of an error in the frequency measurement process.

Instantaneous SNR estimation

In addition to providing the measured digital RF frequency data, the DFD also supports the Coherent Threshold circuit, which provides a threshold based upon a sample-by-sample estimate of the instantaneous RF input SNR to the receiver. The Coherent Threshold allows the IFM Receiver to be used in a baseband application, without having to program the threshold because of varying noise input RF power levels due to the switching RF front end of the host system. The Coherent Threshold also provides the receiver with some immunity from broadband noise jamming, and does not require blanking the receiver due to high level RF emissions from the host system platforms (other than to protect against RF front end damage). This advantage is achieved because the IFM receiver does not integrate or average over time to establish the RF SNR based Coherent Threshold.

Special flags

The DFD also supports a variety of Out Of Band (OOB) Flag detection circuits, FMOP processing based on either chirp rate or peak to peak excursion (or both), and a wide chip rate range of PMOP processors. In a Multipath environment, the IFM receiver is provided with an Associative Processor (U.S. Patent Pending), which digitally checks all measured RF frequency data against previous data within a fixed time interval; if the new data is similar to (but not necessarily the same as) previous data within the time interval selected, the data report is suppressed as probably RF Multipath in origin. Multiple unrelated RF signals are independently processed within the multipath time interval. Each received signal, in effect, generates it's own independent multipath time interval.

Variable configurations

WIDE BAND IFM receivers are available in standalone configurations, or combined with multiple Digital Amplitude Quantizers for an Amplitude based Angle of Arrival (AOA) system; similarly, multiple phase correlators can be integrated to support a phase AOA system. In any configuration, the IFM Receiver provides parallel digital outputs which are time synchronized to the received RF waveform.

Output data format

In a typical application, the IFM Receiver formats all data in a parallel data word (which may exceed 80 bits, depending on the application), sets a Data Ready Strobe output, then holds the data pending receipt of a Data Acknowledge input. Because the receiver output data rate can exceed four million conversions per second, a FIFO or a Snapshot Buffer is optionally available to reduce the average data rate. The output data is typically single-ended TTL via a buffer; differential line drivers are also available.

A cost-effective solution

To sum up, WIDE BAND SYSTEMS' digital IFM system receivers are integrated packages which, satisfy, in a single device, all of the system requirements for thresholding and complete parametric digital encoding of the received RF waveform. Because this is a single integrated package, the level of performance obtained usually exceeds that which can be obtained by a combination of modules at the system level. Further, this level of performance is obtained at a lower total cost than the sum of module cost plus the integration cost at the system level. A basic design objective is to provide a high performance wide band receiver which requires minimal effort on the part of the user to integrate into the system. The technical staff at WIDE BAND SYSTEMS stands ready to assist the user in the system configuration definition, integration with the system antennas and processor, and will continue to support the system during it's service life.

Reliability through design

Because reliability is substantially dependent of device temperatures, considerable care has been taken to minimize the power requirements of each IFM design and to provide the lowest possible thermal conduction path for each active component. The RF amplifiers are directly attached to the heat transfer surface; each active IC resides on a thermally conductive pad on a copper sheet, attached to the IFM housing. All active ICs are TTL/CMOS; the use of ECL logic is avoided. WIDE BAND SYSTEMS' IFM receiver designs represent the state of the art in wide band receiver technology, providing the culmination of 15 years of incremental design improvements. The Monotonic Digital Amplitude Quantizer, Extended TOA Processor, Coherent Threshold, and Associative Processor circuits are unique to WIDE BAND SYSTEMS, Inc. and are each pending U.S. Patent.

For additional technical information on Wide Band Systems' digital Instantaneous Frequency Measurement system receivers, including performance data on specific models, or to discuss your application in detail, please get in touch with us today. We will respond to your inquiry promptly.

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