



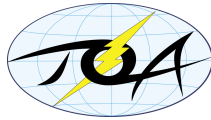
DSP-DF200™

Advanced Lightning Sensor

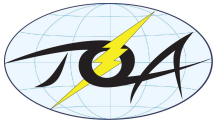
Capabilities

(Lightning Detection Network)

By



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DSP-DF200 Multi-Purpose Advanced Lightning Sensor



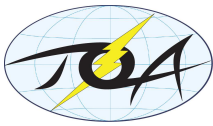
This state-of-the-art sensor was designed by TOA Systems, whose engineers have been global lightning location leaders since the 1980's with their patented Time-of-Arrival systems. Since 2003, these same engineers have installed over 350 operational lightning detection sensors across the globe.

The above sensor was designed with a capability to perform several functions simultaneously with zero dead time, while also allowing for real-time remote waveform monitoring.

The main design requirements were to have a capability of concurrently monitoring lightning events from:

- 1. Cloud to ground lightning within a distance up to 1000 km from the sensor. This provides for accurate ground strike location to approximately 200 to 300 m rms. Nearby intra-cloud lightning events can also be located.**
- 2. The reflection of the lightning radio wave from the ionosphere for a single hop transmission allowing for the location of events occurring at distances from about 1000 km to 2000 km from a sensor.**
- 3. Lightning occurring at distances of 3000 km to 10,000 km from a sensor which can propagate with little attenuation in the earth/ionosphere wave guide. These radiofrequency signatures are known as sferics and are monitored by the sensor in both the time and frequency domain allowing for very long range location at several thousand km distance.**

The DSP-DF200's core processing power is provided by a DSP specific Field Programmable Gate Array (FPGA). Legacy systems have utilized a traditional processor that buffers data over a period of time and analyzes the results offline. The technology breakthrough offered by an FPGA is true parallel processing. FPGA devices differ from traditional processors because processors are only capable of executing a single instruction at a time. Even "dual-core" processors have limitations since they are only processing two instructions at once. However, FPGAs provide **truly parallel processing** and can perform nearly unlimited logic functions **simultaneously**. This provides a tremendous advantage for applications which require zero dead-time because there is no processing lag or offline processing. Due to the FPGA's parallel processing paths, the device is capable of receiving multiple channels of 16-bit data at 50Msps, and processing the data streams real-time using parallel logic paths. Furthermore, each 16-bit A/D input channel can then be fanned out to multiple processing paths with zero loss, zero time delay, and zero dead time. This revolutionary



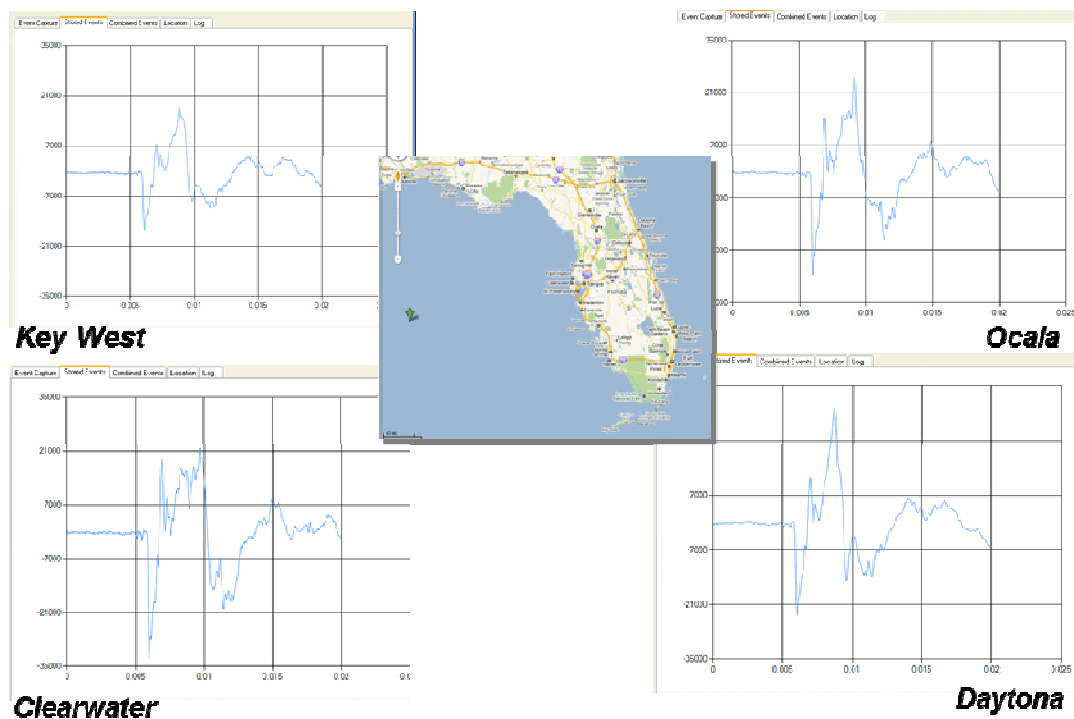
technology is capable of implementing numerous filters, numerous algorithms, and many channels at the same time using true parallel processing.

The sensor then distributes the real time data recorded by the sensor to several IP's in binary or encrypted format.

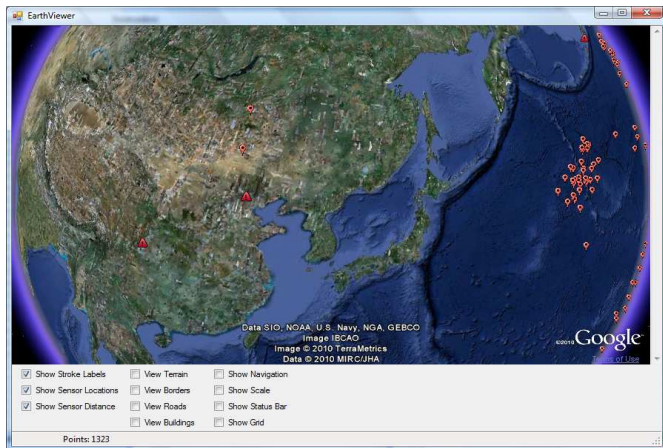
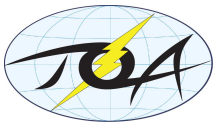
The sensor can receive a string of coefficients from a download stream that allows for the calculation and insertion of narrow or broadband filters. These filters are then automatically calibrated to correct for their group timing delay before the time-tagging of any events. The sensor also uses a proprietary mix of GPS timing as well as an OCXO (oven controlled crystal oscillator) allowing for time tagging to 5 nanosecond accuracy.

The waveforms received from the lightning signature are recorded and forwarded on demand to the central processor.

In summary the sensor utilizes two high sensitivity, low noise wideband receivers, state-of-the-art digital filters and equalizers, along with a precision GPS time reference, allowing the sensor to characterize and categorize the lightning stroke. With state-of-the-art digital signal processing performance, the DSP-DF200 provides unparalleled stroke detection through the use of multistage, adjustable window tuned filters, followed by banks of filter processing.



This figure shows the data received at the central processor from four sensors separated by about 200 km and receiving the signature from a lightning flash over the Gulf of Mexico calculated to be some 500 km distant.



In the sferics mode the sensors detect lightning occurring at considerable distances. This example shows the calculated location of the events off the east coast of Asia and the sensors used in the location of two of the strikes (green) as well as a redundant verification from a fourth sensor (purple).

