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APPLICATION NOTE 5988

DISTRIBUTION AUTOMATION NEEDS HIGHLY ACCURATE ANALOG DATA CONVERTERS

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Abstract: While well established, the distribution automation segment is an actively growing part of the smart grid market. New applications are driving the need for lower power, higher accuracy data converters and system solutions.

Distribution Automation Advances the Modern Grid

"Distribution automation" is an old industry, finding new and vibrant life with the smart grid. Generally speaking, distribution automation involves sensors, switches, and communication networks spread across the smart grid, working together "to locate and automatically fix faults and to fine-tune voltage levels on the grid."[1] It means using intelligent, automated control over all facets of electrical distribution in the grid,[2] with the goal of improving grid reliability, performance, and acceptance of renewables without drastically modifying the core infrastructure. The term applies upstream of the smart meters themselves, and where utilities need to actively monitor grid activities and efficiently distribute power throughout the grid.

Distribution automation involves detection, diagnosis, location, and isolation of faults, and quick restoration of power (see **Figure 1**). For this, utilities need analog data converters that provide excellent static and dynamic performance to accurately measure power flow and faults. By implementing intelligent distribution automation systems with high-speed, highly accurate, high-resolution data converters, utilities can characterize the nature of a fault. They can reduce average interruption by up to 33% and decrease restoration times from 45 minutes to less than 3 minutes. This fast response time allows utilities to reduce the frequency and duration of interruptions and, therefore, the cost of outages. These outages have an annual estimated economic impact of €62 ($79B) in the US[3] and €150 ($190) in Europe[4] Given these statistics, it is not surprising that utilities are investing heavily in distribution automation. The segment grew from $4.4B in 2012 to $5.4B in 2013, driven principally, "by renewed interest in renewable integration and grid reliability in China, the US and Europe."[5]

Figure 1. Utilities cannot always predict when and where faults will occur. To respond quickly to fault events they must have the infrastructure to accurately measure power flow in real time. Photo is © Diro, Dreamstime.com, power distribution station with lightening strike.

Detecting Faults Requires New Data Conversion Technology

Traditional data converters used in the distribution automation segment provide high resolution, speed, and coherent sampling which, in combination, allow a utility to optimize power factor for ultra-efficient distribution and the characterization of faults. But utilities are now looking to further improve the reliability of their grids by adding more sensors (**Figure 2**). They want, and need, more accurate dynamic data to make decisions and respond in as close to real time as possible.

Figure 2. Utilities are improving system reliability by installing more current fault sensors on their powerlines.

Adding current fault sensors to older utility infrastructure makes that infrastructure smarter. You increase the granularity by which utilities can detect faults, and thus you increase the speed of fault location and correction. Furthermore, these additional sensors communicate on the smart meter communication network if, that is, the utility has installed one. Therefore, these sensors are essentially piggybacking on the automated metering infrastructure (AMI). Again, this combination of smart sensors and smart meters reduces the cost of outages.

While this all makes good logical sense, utilities still face another daunting challenge. Most of today's current sensors do not readily have the necessary power to operate in a substation where 110VAC/220VAC would be prevalent. Therefore, these sensors often need to run off batteries or fiber optic lines. The sensors must also consume very little power.

Semiconductor companies have responded with new low-power, high-speed, single-channel analog-to-digital converters (ADCs) to address this need for a smarter and even more responsive grid. These data converters are uniquely positioned for current fault-sensing solutions, which must run at ultra-low power while maintaining high-speed and high-resolution performance (**Figure 3**).

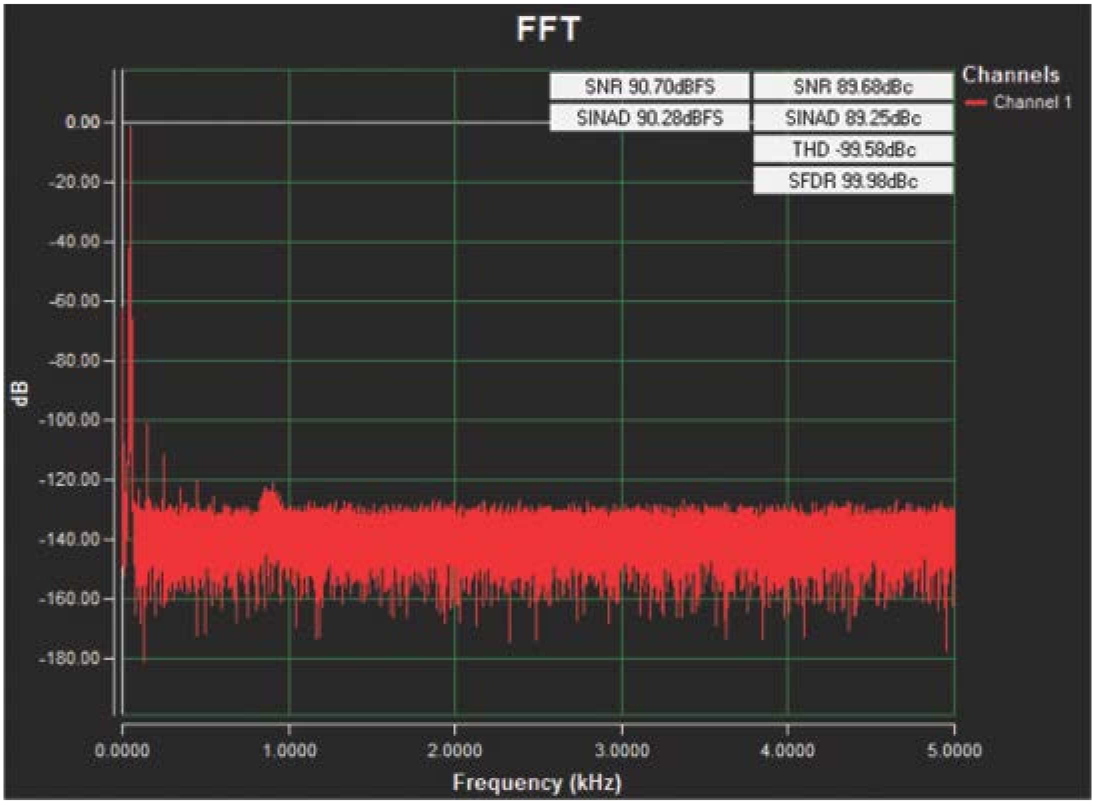

Figure 3. FFT data from the 16-bit MAX11901 ADC on the MAXREFDES38# subsystem reference design.[6] *The input is a ±3V 50Hz sine-wave differential signal, with a 10ksps sample rate and a Blackman-Harris window at room temperature. The signal chain consumes less than 85mW during operation.*

Modern ADCs with these capabilities are ideal for distribution automation in smart utility operation because they offer utilities greater information for a fraction of the typical power consumption. With these data converters, the smart grid gets even smarter and distribution automation thrives.

References

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