IRS SYSTEMENTWICKLUNG GMBH

Material condition monitoring via SDR in Real-time

High speed characterization using resonance effects of antennas with software defined radio.

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Description

Software Defined Radio (SDR) is commonly used in various applications for communications, radar, navigation, broadcast and much more. But it is also possible to characterize material conditions by means of resonance effects at high frequencies. SDR using an RF transmitter, antenna, RF coupler and receiver may be used to stimulate components and depending on the reflected signal the condition of specific materials can be determined.

If the material is not at a stillstand but moving fast, it may be necessary to process the received RF data very fast to determine the condition within milliseconds.

IRS designed and developed a software to determine the status of materials with a fast realtime network analyzer, based on NI USRP platform. NI USRP may be used for powerful applications in small quantities, or as rapid prototyping platform where the programmer may focus on the application rather than struggling with limitations due to hardware.

Key Facts

- Frequency range 10MHz…6GHz (typical 100Mhz)
- Baseband bandwidth up to 160MHz (typical 20MHz)
- Characteristic values calculation in real-time within milliseconds (Resonance and quality factor)
- Continuous streaming of characteristic values to Host-PC
- Online evaluation pass/fail possible within milliseconds.
- Optional use of hardware-trigger to synchronize measurements with external signal.

Use Cases

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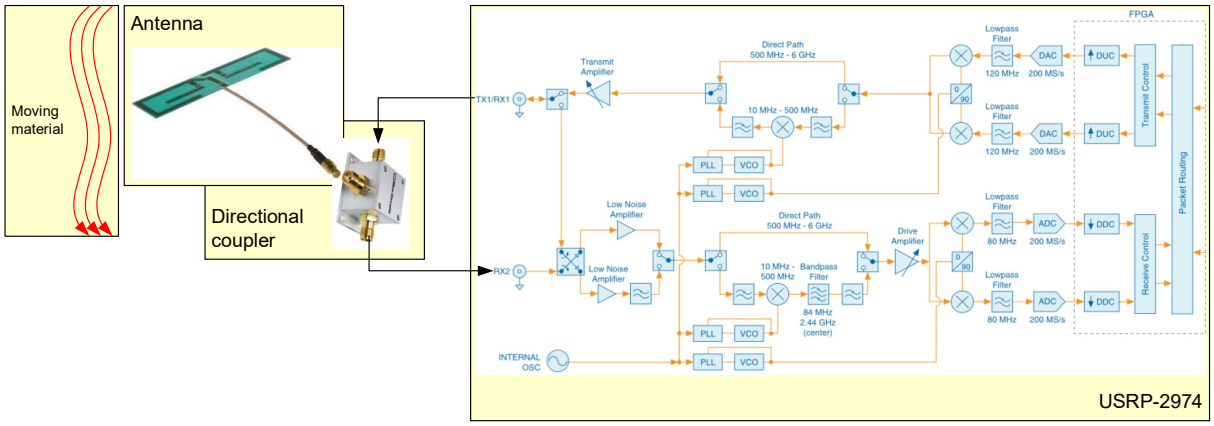
Technical Description

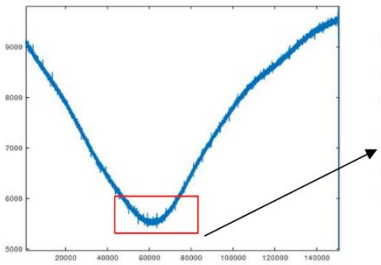
Following picture shows the basic setup of the SDR based sensor for material characterization:



An electrical antenna is positioned close to the material under test. The SDR-device transmitter sends a stimulation signal to the antenna via the directional coupler. Depending on the frequency, the RF energy is partially reflected, back to the SDR-device. The directional coupler makes sure that the reflected energy is fed back only to the SDR-device receiver.

Characteristic parameters

The reflected energy varies with the condition of the material and the applied frequency. I.e. the condition can be determined by the reflected energy, or deviations from this energy at different frequencies. Thus, from the electrical point of view, the resonance frequency and quality factor of the antenna represent the characteristic parameters to be determined.



Real-time operation

To make sure that the characterization can also be performed at a fast-moving component, the calculation of the parameters resonance frequency and quality factor must be done very fast within milliseconds. To achieve this, USRP-2974 provides a powerful FPGA and processor running a real-time operating system. The stimulation and received signal are completely processed within 1ms for the complete signal bandwidth of typically 20MHz.

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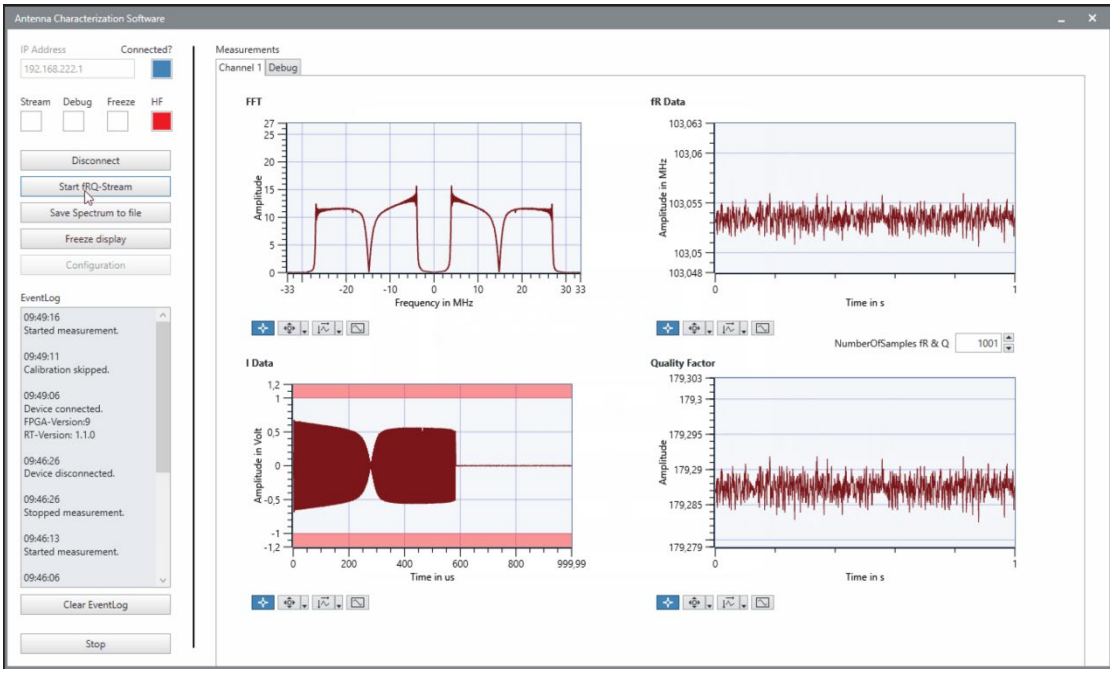
User interface software

The system is controlled by a user interface software which also visualizes both current system status and measurement data.



Characteristic parameters may be streamed continuously to Host-PC to get reports over long-term tests. Complete received spectrum may be stored in intervals of typical one second for informational or debugging purposes. Data is reduced effectively by down-sampling mechanisms.

Technical Data

	Min	Type	Max	Unit
Center frequency range	10	100	6000	MHz
Baseband bandwidth		20	160	Mhz
Evaluation interval	1		50	ms