

GPR image of concrete wall with steel reinforcing bars.

Earth Science Systems, LLC (ESS) is developing an advanced array of electromagnetic pipeline inspection sensors designed for inspection robots. These devices make a variety of NDT measurements including magnetic flux leakage, electromagnetic eddy currents, and ground penetrating radar. Our sensor technology incorporates the latest in electronic miniaturization so that multiple sensor devices can be deployed on sensor skid pads. The small size of these devices allows them to be deployed in robots with a few arms or many arms.

Magnetic Flux Leakage (FL)

This method concentrates a magnetic flux in iron and steel walls, and sensors detect how much flux leaks from the pipe. This leakage can occur as a result of wall thinning due to corrosion and pitting, cracks, dents, wrinkles, and buckles. Thinning and breaks in rebar can be measured. The detectors measure all three components of the magnetic field (a coil only measures one component) to provide more diagnostic information.

Eddy Current (EC)

This technique uses a large transmitting coil in the pig to generate eddy currents in the pipe. In a uniform symmetrical pipe with no defects, the induced eddy currents will flow circumferentially around the pipe. When a defect is present such as an indentation or wall thinning, the eddy currents in

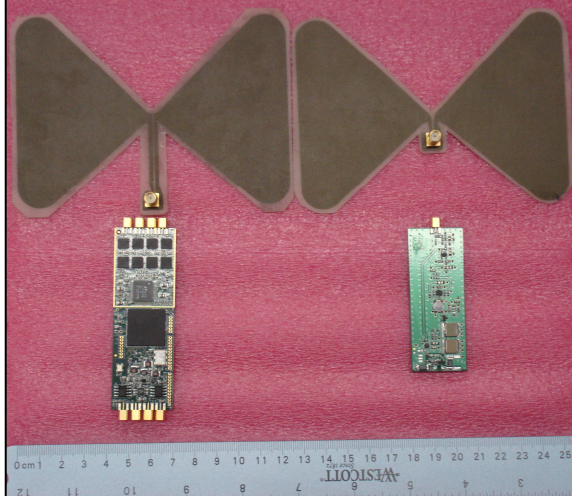
the vicinity of the defect will deviate from the symmetrical circumferential flow. In an alternate configuration, eddy currents are created by both pad-mounted transmitters and a powerful robot mounted transmitter. In addition to detecting defects in steel and iron pipe walls, the eddy current technique can map rebar and rebar defects in non-ferrous pipes. ESS's eddy current detectors also measure all three components of the magnetic field.

Ground Penetrating Radar (GPR)

This method uses electromagnetic waves to provide high-resolution 3D images of non-metallic pipe structures and their supporting materials. These electromagnetic waves reflect off of interfaces between dissimilar materials to produce images of reinforcing rebar, rust, and pipe thickness. GPR can look through non-metallic pipes to detect voids, moisture, or the thickness and condition of annulus fill. GPR maps rebar location, concrete thickness, and can measure concrete condition.

Some defects are only detectable with a single sensor technology, while others can be detected with several different sensors. We are developing expert modeling and interpretation software that analyzes measurements based on multiple physical techniques and simplifies interpretation. This leads to a better overall assessment of tunnel or pipeline integrity.

Photo of GPR electronics and antennas. The circuit boards for eddy current and flux leakage are similar in size.



Specifications

Flux Leakage

- 3 component magnetometer
- Flux transmitter: 100 μ T
- Sensitivity: 100 pT
- ADC resolution: 24 bits, 115 dB, 128 kSPS

Eddy Current

- 3 component receiver
- Transmitter moment: 5 A-m²
- Frequency range: 100 Hz to 50 kHz
- Sensitivity: 10 pT/rt(Hz)
- ADC resolution: 24 bits, 115 dB, 128 kSPS

Ground Penetrating Radar

- Radar type: impulse
- Frequency: 2.5 GHz
- Polarization: dual, linear
- Samples per waveform: 512
- Pulse repetition frequency: 100 MHz

Large moment transmitter

- Transmitter moment: 30 A-m²

Dimensions (each pad)

- Length: 16"
- Width: 4"
- Height: 4"

CPU Requirements

- Pentium I, 800 MHz
- Data storage: (up to 4 GB)
- Program storage: 32 kB
- Peripheral interface: USB (2 ports per sensor pad)

Power (each sensor pad)

- 5 VDC
- 10 W

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