Wireless Electric Power Transmission Using Ultrasonic Guided Waves

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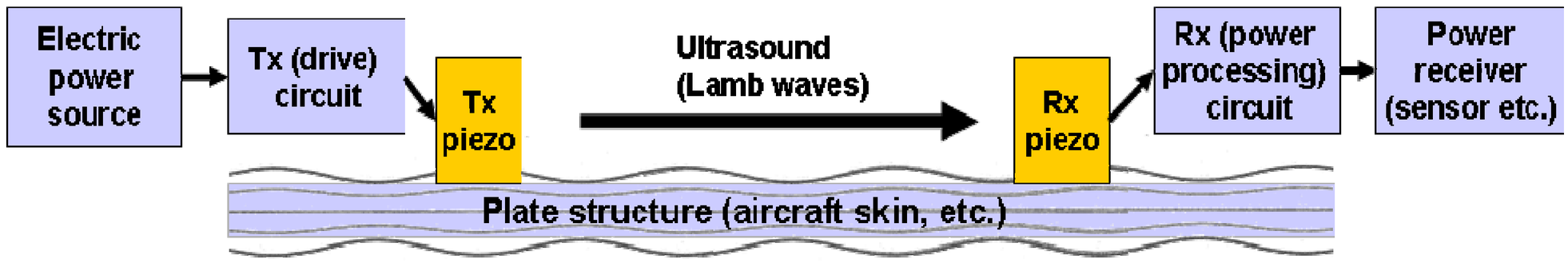


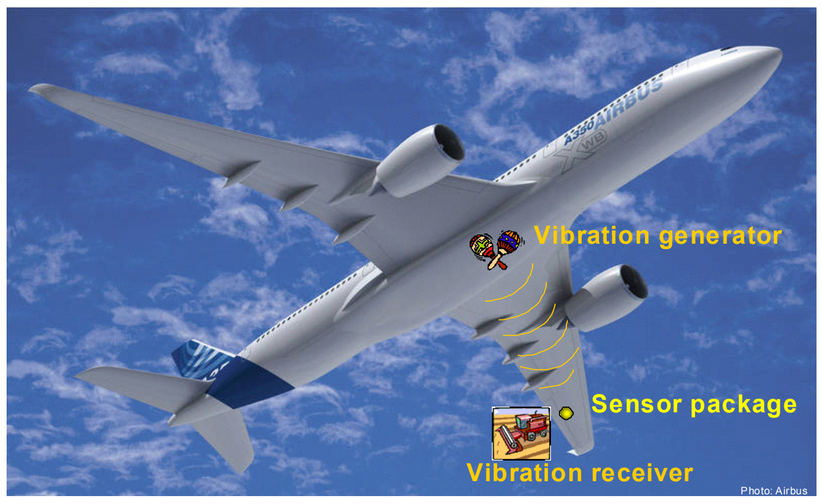
Performance of the current prototype

Measured power throughput: 12.7 mW
Drive voltage: 20 V p-p at 65 kHz or 35 kHz
Distance of transmission: 0.54 m
Transmission in 1.5mm aluminium plate

Transducers: low-profile Quick Pack piezoelectric patch, 0.5 mm-thick

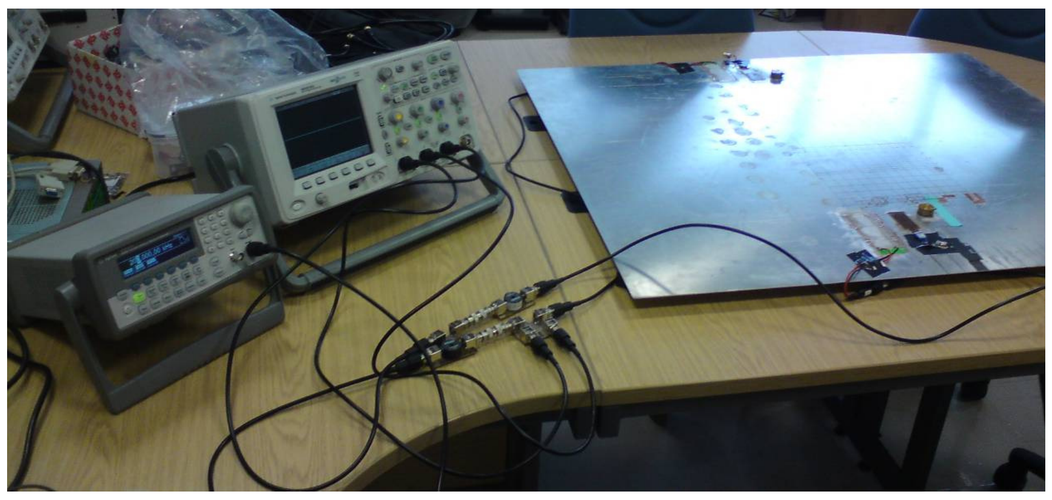
The same setup is expected to transmit 320 mW when driven by a 100 V p-p signal

Summary



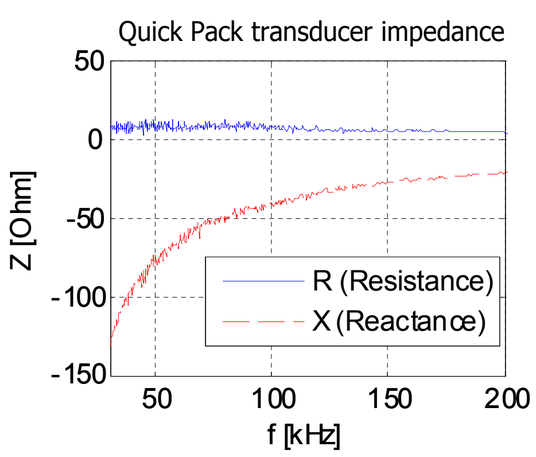
- Application: to **supply electricity to the wireless sensor nodes** of an aircraft structural health monitoring system
- Ultrasound **generato**r positioned near an existing power line
- Ultrasound in the form of **Lamb waves** propagates through the structure of the aircraft
- Ultrasound **receivers** integrated with sensor nodes pick up the incoming ultrasound and convert it back to electricity used to power the sensor node

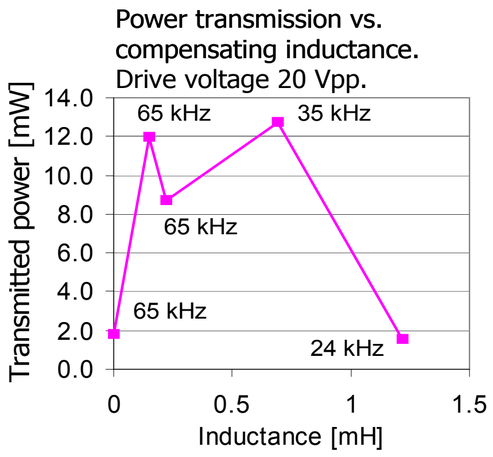
Laboratory prototype



- **Piezoelectric patch transducers** used as both transmitters and receivers of ultrasound
- Patch transducers are **0.5 mm thick**, up to 90 × 30 mm
- Patch transducers at a given input voltage **transmit 1000 times more power** than crystal-type transducers traditionally used in ultrasonic damage detection systems
- Off-the-shelf **Quick Pack** and **MFC** transducers are used
- The laboratory system is built on a 1.5 mm thick aluminium plate to model an aircraft structural element

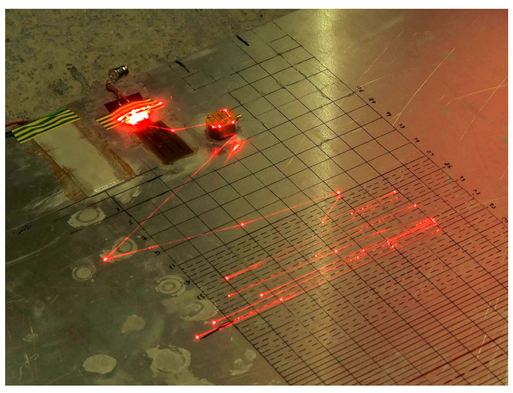
Electric optimisation

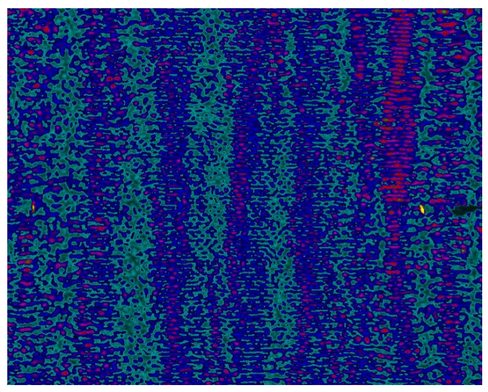




- **Electric characteristics** of patch type transducers are **similar to those of capacitors.** The resistance is small and the reactance is large and negative
- **Inductors can be used to compensate** for the transducers' reactance
- Experiments showed that using an optimally chosen inductor **increases the power throughput** by a factor of seven
- Inductors can also be used to **tune the system** for a desired operating frequency

Laser vibrometry





- **Scanning laser vibrometer** is used to measure the ultrasonic vibration present in the plate
- Distribution of vibration amplitude over the plate area is mapped, allowing to compare various transducers' directional characteristics
- Measured vibration **amplitudes** of the aluminium plate surface are **between 1 and 40 nanometres**
- Generation and reception efficiency of transducers can be quantified
- Measurements will be used to **validate results** from simulations carried out using the **computer software LISA** and to optimise the transducers

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