

1 Sensor transponder module.

2 Sensor transponder mounted at the machine.



OPERATION HOUR METER FOR CONSTRUCTION MACHINES

Application

Construction machines are exposed to heavy stress and must be maintained in regular intervals. During these maintenance tasks for example a technician changes oil and replaces sealing gaskets. Maintenance intervals are normally related to the operating hours and dependent upon the load during operation. But if a machine has been rented to an unknown user, the owner does not really know, how long the machine has been running and under what kind of conditions it has been running. There is no objective indication about these data and conditions. The owner can only make a rough estimation in order to realize appropriate maintenance intervals. A wrong estimation can either lead to unnecessary costs in case of too much maintenance or to unnecessary wearing in case of too little maintenance.

This is the reason why researchers of the Fraunhofer IMS have developed a wireless system for the measurement of operation hours and operation conditions such as temperature and vibration frequency.

The system has been optimized for the use with vibrators that drive steel pilings into the ground. Temperature and vibration frequency are significant indicators for the stress of this kind of machine during operation.

Minor modifications of the system can lead to a different solution that may fit to another kind of device.

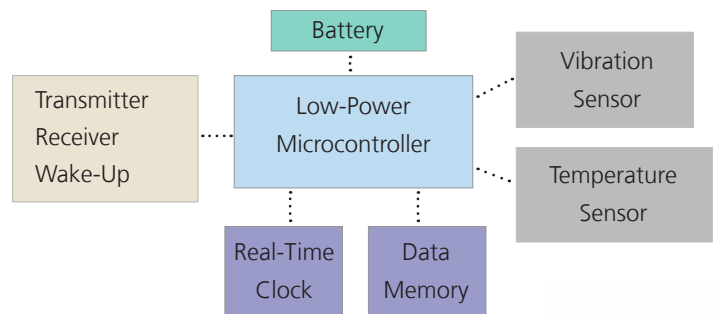
The »Operation Hour Meter« is mounted in a small and very robust housing that can be fixed to the machine using four screws, so that it has direct contact to the machine's temperature and vibration. There is no additional connection needed. In regular time intervals the electronic system wakes up, measures temperature and vibration frequency and stores these data combined with a related time-stamp in its memory. A technician can read-out this memory using a special wireless reader unit. The reader unit processes this data and presents it to the user, who gets objective information about operation hours and operating conditions by this, so that he can decide about maintenance. He gets also information about wrong and dangerous operating conditions

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such as over-temperature which leads to strong wearing of the machine.

Functionality

The »Operation Hour Meter for Construction Machines« is an application specific semi-passive sensor transponder. It consists of a wireless communication frontend, acceleration sensor, temperature sensor, a low-power microcontroller, a non-volatile memory (for example EEPROM), real-time clock and a lithium battery. The transponder is normally running in an ultra-low-power stand-by mode and will be periodically activated by the real-time clock, for example once a minute. The transponder measures the data of its sensors, stores them in memory and returns to the stand-by mode. In stand-by mode only the real-time clock and a wireless receiver that waits for a possible connection to the reader unit are working. This leads to a very low power consumption of the transponder, which results in a battery lifetime of several years.

For the measurement of the operating hours of the construction machine the transponder calculates the vibration frequency by the means of a Fourier transformation (FFT) based on the data of the acceleration sensor. An intelligent algorithm calculates the operating hours from the FFT results and the related time-stamps. Using the additional information of the temperature sensor three operation modes can be detected: no operation, normal operation and fault operation. The mechanical construction of the sensor transponder is very robust so that it can withstand the harsh environmental conditions on a construction site: temperature,

vibration / acceleration, humidity. The PCB including the battery is completely back-filled.

A special reader unit has been developed to read-out data from the memory of the transponder. The logged information about the operation of the machine is displayed to the user. Using an USB connection data can be transferred to a standard PC.

Sensor Transponder

In general sensor transponder systems can be classified according to their frequency range and to their kind of power supply. There are »active« and »passive« and so-called »semi-passive« systems for any usual frequency range: low frequency (LF)/ 130 kHz, high frequency (HF)/13.56 MHz, ultra-high frequency (UHF)/868 MHz. Semi-passive transponders work like data-loggers; they collect data powered by a local energy source (Battery, thermo-generator, solar cell) and can be read-out in a passive way, only powered by the carrier field of the reader unit. The »Operation Hour Meter for Construction Machines« is an example for a semi-passive system.

Fraunhofer IMS has more than 20 years of experience in the development and prototype manufacturing of sensor transponder systems of all kinds and working in any frequency range. The IMS' expertise comprises ASIC design, antenna design, RF field simulation, embedded hardware and software development, system integration including preparation, execution and evaluation of field trials.

Technical Data

Transponder

Dimensions	5 cm × 7 cm × 1.5 cm
Power supply	Lithium battery
Battery life-time	5 years
EEPROM capacity	16 kByte
Acceleration sensor	18 g (1 dimension)
Temperature sensor	-20 °C – +85 °C
Optional sensors	Humidity, light, 3D-acceleration
Operation temp.	-20 °C – +85 °C

Reader Unit

Dimensions (without antenna)	10 cm × 20 cm × 4 cm
Power supply	4 AA-size batteries
EEPROM capacity	16 kByte
Display	2 × 16 characters
Keyboard	4 membrane keys
Antenna	LF antenna, removable
Interfaces	USB, transponder
Operation temp.	+10 °C – +40 °C

Transponder Interface

Frequency range	130 kHz (LF)
Data rate uplink	8 kByte/s
Data rate downlink	1 kByte/s
Readout distance	3 cm

- 3 Construction machine in operation.
- 4 Hand-held reader unit.
- 5 Block diagram of the sensor transponder module.