

UHF RFID Tag Antenna-Based Sensing for Corrosion Detection and Characterization Using Principal Component Analysis

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ABSTRACT : Recently, structural health monitoring (SHM) using radio frequency identification (RFID) tag antenna-based sensing (TABS) has received increasing attention because of its wireless, passive, and low-cost characteristics. However, a great challenge in the SHM using RFID TABS is multiple influences in the measurement. This paper presents an ultrahigh frequency RFID sensor system for corrosion detection and characterization. In this paper, a 3-D antenna sensor is designed to work on the surface of a protective coated steel sample. Sweep-frequency measurements are applied for analog identifier with principal component analysis (PCA) to overcome the multiple influences from reader-tag orientation, distance, and environment. Feature extraction and selection through PCA can get robust and sensitive defect information by projecting the test data into an orthogonal feature space. The test results demonstrate that the proposed method can be applied to detect and characterize early-stage corrosion in metals.

KEYWORDS: Antenna sensor, corrosion detection, principal component analysis (PCA), radio frequency identification (RFID), structural health monitoring (SHM).

I. INTRODUCTION

Structural health monitoring (SHM) and structural integrity evaluation (SIE) based on radio frequency identification (RFID) in the ultrahigh frequency (UHF) band are receiving more and more attention because of their wireless, passive, and low-cost characteristics. Integrating sensing ability in RFID tags renders the whole system capable of not only tracking, but also providing real-time cognition of aspects of object's status or environmental conditions. Recently, people's readiness to use RFID-based "smart skin" for in situ monitoring of the health state of large-scale infrastructure is increasing, thanks to the low cost and wide availability of RFID technology.

The last several decades have witnessed unprecedented prosperity in railway industry globally. Potential threats behind such a rapid expansion of railway network must be envisaged [4]. The surface of the rail web (cross section connecting the rail head with the foot) and foot (base support of the rail) can be wasted by corrosion, leading to fracture.

II. EXISTING METHOD

Structural health monitoring (SHM) & Structural integrity evaluation (SIE) based on radio frequency identification (RFID) in the ultrahigh frequency (UHF) band are using RFID TABS is multiple influences in the measurement. Detecting and Characterizing corrosion in metals using RFID sensor system in terms of antenna design, system configuration are calculated in existing system.

2.1 Disadvantages

- The design and development of sensing and communications frequency devices are challenging.
- Zigbee communications are short length communication.
- Analysis and Optimization of frequency of RFID devices are difficult.

III. PROPOSED METHOD

In proposed system, 4 different RFID tags are used as different materials (subjected to corrosion).and from that the corrosion can be determined based on the frequency level received from different materials(tags) at the early stages. Wireless transmission evaluated through zigbee communication to PC. In Existing system detection and transmission both done by RFID, cause difficulty in designing of antenna frequency is eliminated by zigbee communication protocol.

A. ADVANTAGES

- Due to the complex and bulky systems Electromagnetic (EM) non destructive testing
- Wireless transmission possible
- The challenges of RFID sensor system for remotely monitoring the defect reduced by zigbee communication.
- Effective calculations can be done by frequency measurements.
- low cost and wide availability of RFID technology.

IV. BLOCK DIAGRAM

A. LCD DISPLAY

A liquid crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements. LCDs are used in a wide range of applications including computer monitors, televisions, instrument panels, aircraft cockpit displays, and signage. They are common in consumer devices such as video players, gaming devices, clocks, watches, calculators, and telephones, and have replaced cathode ray tube (CRT) displays in most applications. They are available in a wider range of screen sizes than CRT and plasma displays, and since they do not use phosphors, they do not suffer image burn-in. LCDs are, however, susceptible to image persistence. An LCD is a small low cost display. it is easy to interface with a micro-controller because of an embedded controller (the black blob ack of the board). This controller is standard across many displays (hd 44780), which means many micro-controllers have libraries that make displaying messages as easy as a single line of code and its cable between them are designed to the end process .the hardware. Software tools used for building large-scale data acquisition systems.

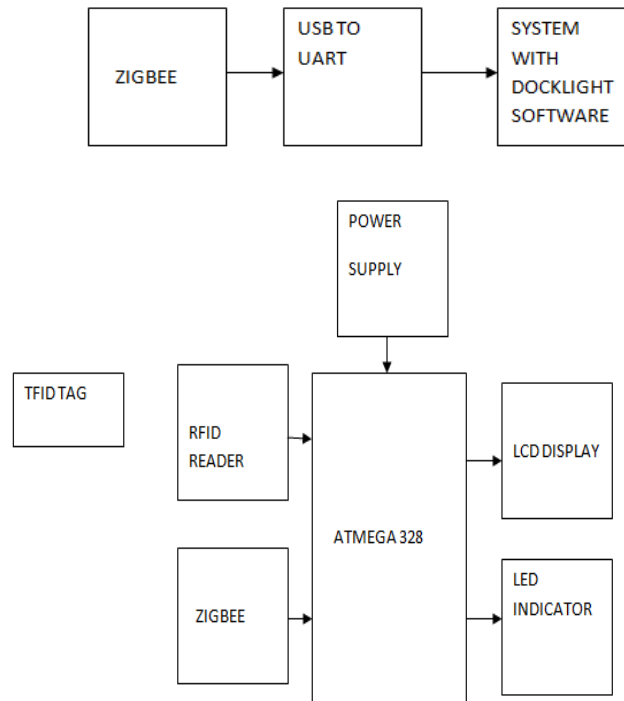


Figure 1 Block diagram

B. POWER SUPPLY

There are many types of power supply. Most are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronics circuits and other devices. A power supply can be broken down into a series of blocks, each of which performs a particular function.

For example a 5V regulated supply:

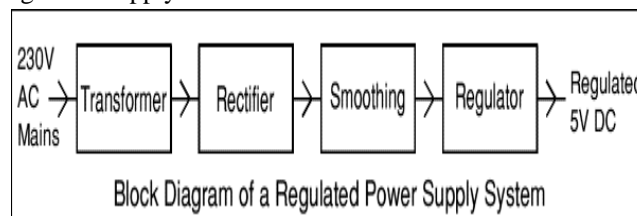


Figure 2 Regulated power supply system

The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils, instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. The two lines in the middle of the circuit symbol represent the core.

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustable set voltage. The

regulators can be selected for operation with load currents from hundreds of Milli amperes to tens of amperes, corresponding to power ratings from milliwatts to tens of watts. A fixed three-terminal voltage regulator has an unregulated DC input voltage, V_i , applied to one input terminal, a regulated DC output voltage, V_o , from a second terminal, with the third terminal connected to ground. The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts.

C. LEVER CONVERTOR

A standard serial interfacing for PC, RS232C, requires negative logic, i.e., logic '1' is -3V to -12V and logic '0' is +3V to +12V. To convert a TTL logic, say, TxD and RxD pins of the Micro controller chips, thus need a converter chip. A MAX232 chip has long been used in many Controller boards. It provides 2-channel RS232C port and requires external 10uF capacitors. The MAX232 from Maxim was the first IC which in one package contains the necessary drivers and receivers to adapt the RS-232 signal voltage levels to TTL logic. It became popular, because it just needs one voltage (+5V or +3.3V) and generates the necessary RS-232 voltage .

It is helpful to understand what occurs to the voltage levels. When a MAX232 IC receives a TTL level to convert, it changes a TTL Logic 0 to between +3 and +15 V, and changes TTL Logic 1 to between -3 to -15 V, and vice versa for converting from RS232 to TTL. This can be confusing when you realize that the RS232 Data Transmission voltages at a certain logic state are opposite from the RS232 Control Line voltages at the same logic state. To clarify the matter, see the table below. For more information see RS-232 Voltage Levels. The MAX232 from Maxim was the first IC which in one package contains the necessary drivers and receivers to adapt the RS-232 signal voltage levels to TTL logic.

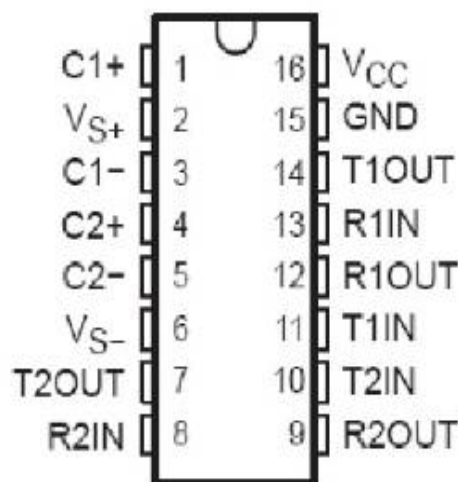


Fig: Max 232

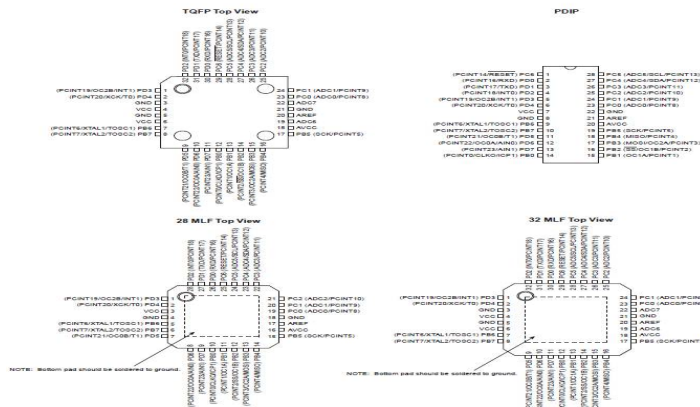
Figure 3 max 232

Organized by

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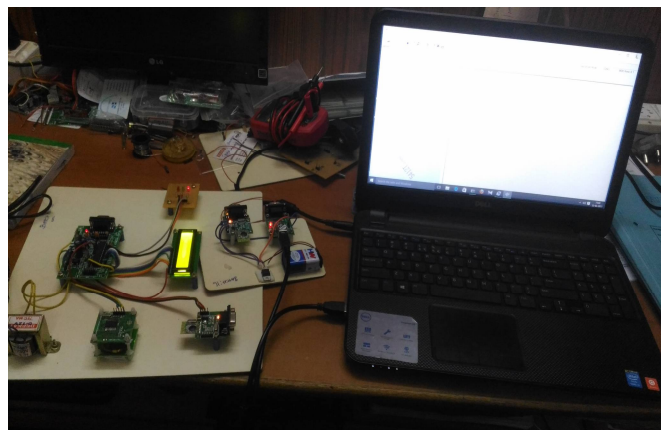
D. ATMEGA 328

In Power-save mode, the asynchronous timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except asynchronous timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low power consumption. The device is manufactured using Atmel's high density non-volatile memory technology. The On-chip ISP Flash allows the program memory to be reprogrammed In-System through an SPI serial interface, by a conventional non-volatile memory programmer, or by an On-chip Boot program running on the AVR core.



Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running. Depending on the clock selection fuse settings, PB6 can be used as input to the inverting Oscillator amplifier and input to the internal clock operating circuit. Depending on the clock selection fuse settings, PB7 can be used as output from the inverting Oscillator amplifier. If the Internal Calibrated RC Oscillator is used as chip clock source, PB7..6 is used as TOSC2..1input for the Asynchronous Timer/Counter2 if the AS2 bit in ASSR is set.

V. OUTPUT



VI. CONCLUSION

A 3-D UHF RFID tag antenna has been designed to sense the corrosion in metals. PCA has been used to extract sensing information by a sweep-frequency measurement of AID, which relieves the challenge in the antenna design, while enhances the sensitivity and robustness. The developed RFID sensor system can successfully detect and characterize the corrosion stages and remotely measure the corrosion's information via a reader and a tag in a stand-off distance. It inherits the advantage of pulsed eddy current for NDT&E and demonstrates cost-effective way to implement distributed monitoring. This approach has potential to bridge the gaps of NDT&E and SHM for industry application. However, there are some limitations. The first is that one dedicated antenna is investigated for a set of dedicated samples. The second is that the RFID grid needs to be studied for distributed monitoring. Future work will focus on how to solve these limitations and improve the RFID sensor system, which includes the design and development of more antennas for different defects and samples. Different measurement strategies from readers will be further investigated as well. This project is developed to automate the battery testing process in industries.

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