

# SMART Sensors for Everyday Life

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# FAA RESEARCH INTO TWA 800 FUEL TANK EXPLOSION

In addition to TWA 800 in 1996, there were several airliner accidents in the 1990's related to fuel tank explosions. The frayed wiring systems of TWA 800 and other aircraft lead to the FAA Aging Aircraft Program and the Aging Aircraft Conference.

**“Development of Technologies to Monitor and Extend the Performance of the Electrical Wire and Interconnect Systems (EWIS) of Aging Aircraft”**

**funded by**

**FAA William J. Hughes Technical Center,  
Aging Aircraft Electrical System Program  
supervisor Mr. Michael Walz**

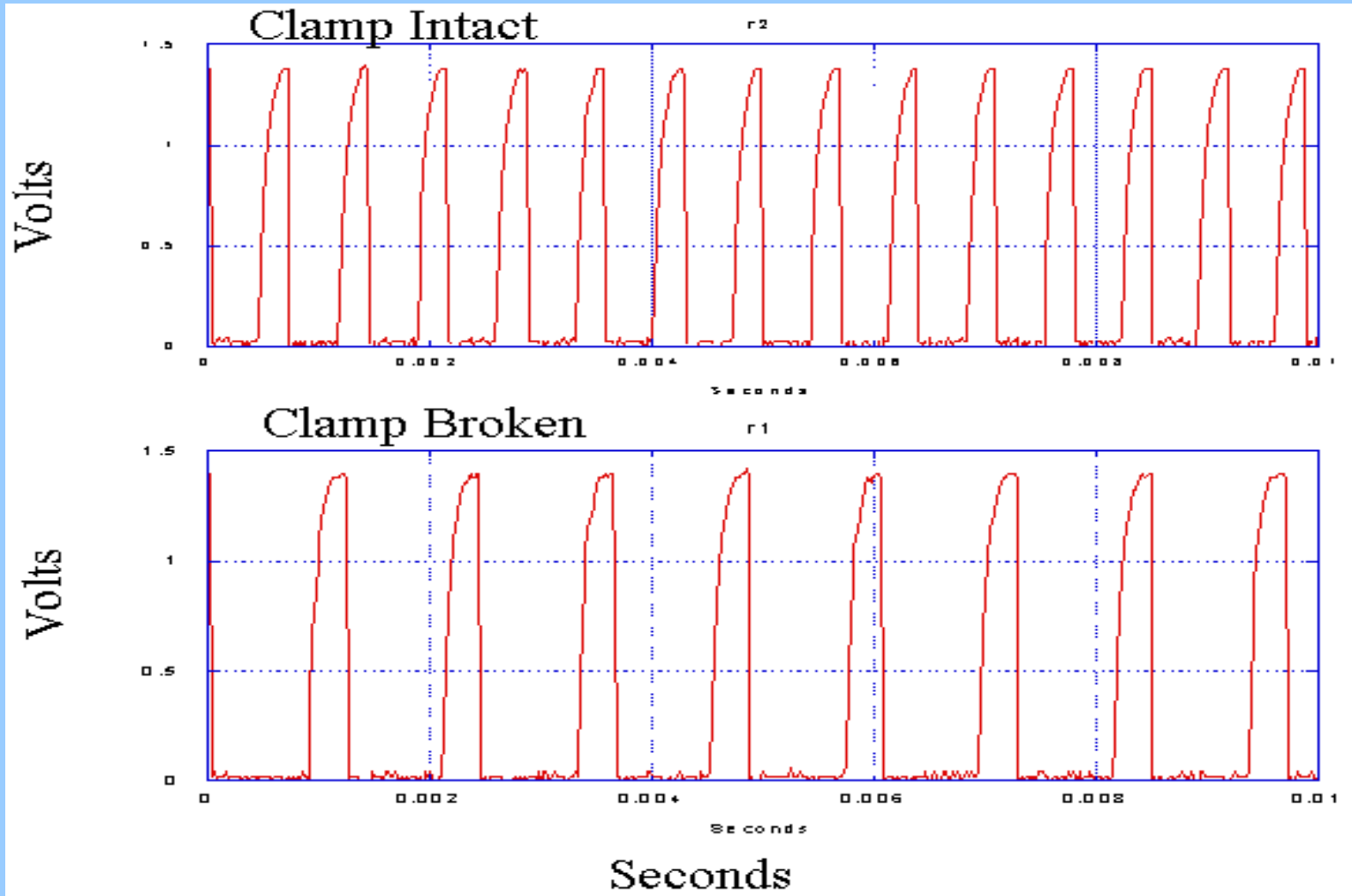
**Three of the research projects performed to develop/improve:**

- Self-repairing wire insulation
- [Self-diagnostic aircraft EWIS bundles and supports](#) **“Smart Clamp”**
- Connector health monitoring procedures

# Initial “Smart” Clamp Concept Used Variable Frequency Transmitter

(Based on “smart pill” swallowed to record digestive temperatures)

## Transmitter Output Changes When Clamp Breaks



## **“SMART CLAMP” WITH FREQUENCY TRANSMITTER UNSUITABLE FOR AIRCRAFT WIRING SYSTEMS DUE TO:**

- **Continuous output – 1000’s of signals to detect**
- **Requires calibration/signal evaluation**
- **Power Requirements**
- **Sensor Size and Cost**
- **Potential Interference with Aircraft Communications**

# **THEREFORE “SMART CLAMP” BASED ON CONCEPT OF CONDITION-BASED OUTPUT**

**Even though there are 1000’s of sensors, only the sensors  
experiencing an abnormal condition (clamp broke)  
will output a signal**

**For long-term aircraft use, the “Smart Clamp” must also:**

- Only output signal when scanned**
- No calibration/signal evaluation**
- No Power Requirements**
- Minimal Sensor Size, Weight and Cost**

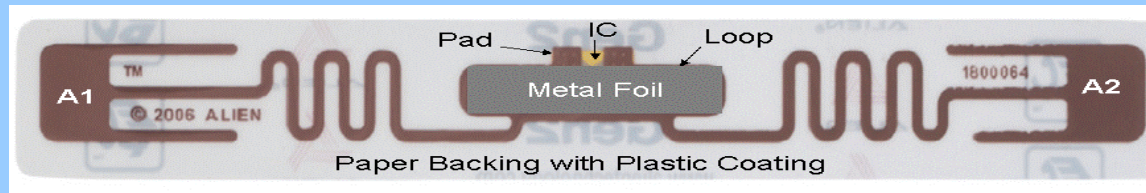
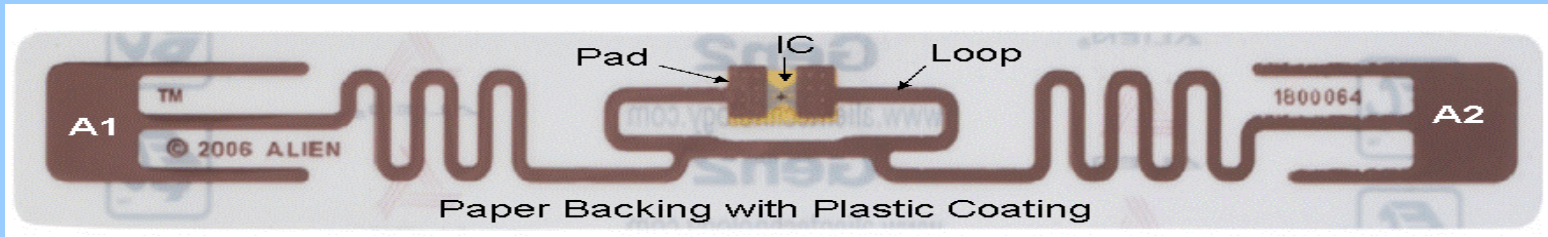
## **Passive Radio Frequency Identification Tag (RFID)**

- No power requirements
- Only outputs signal when scanned by nearby reader
- Can be programmed with sensor location/type
- Needs permanent record of abnormal condition

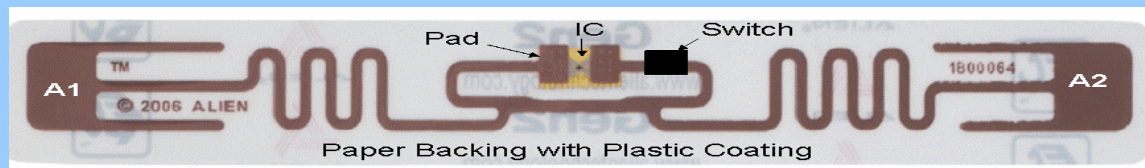
## **Status and Motion Activated Radiofrequency Tag (SMART) Sensors**

Use concept of reversibly deactivated/activated Integrated Circuit (IC)

# ALIEN GEN 2 SQUIGGLE RFID TAG

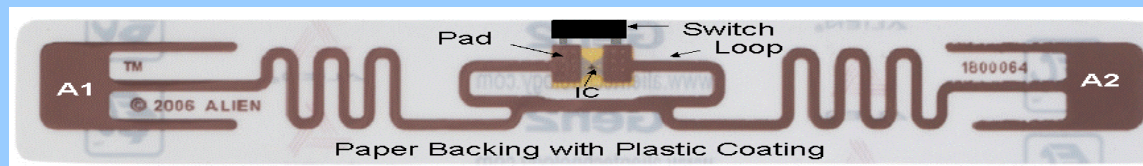


RFID TAG *Reversibly* DEACTIVATED BY PLACING METAL FOIL OVER LOOP



**Not Used:**  
Contacts reliability

RFID TAG *Reversibly* DEACTIVATED BY INSERTING SWITCH INTO LOOP

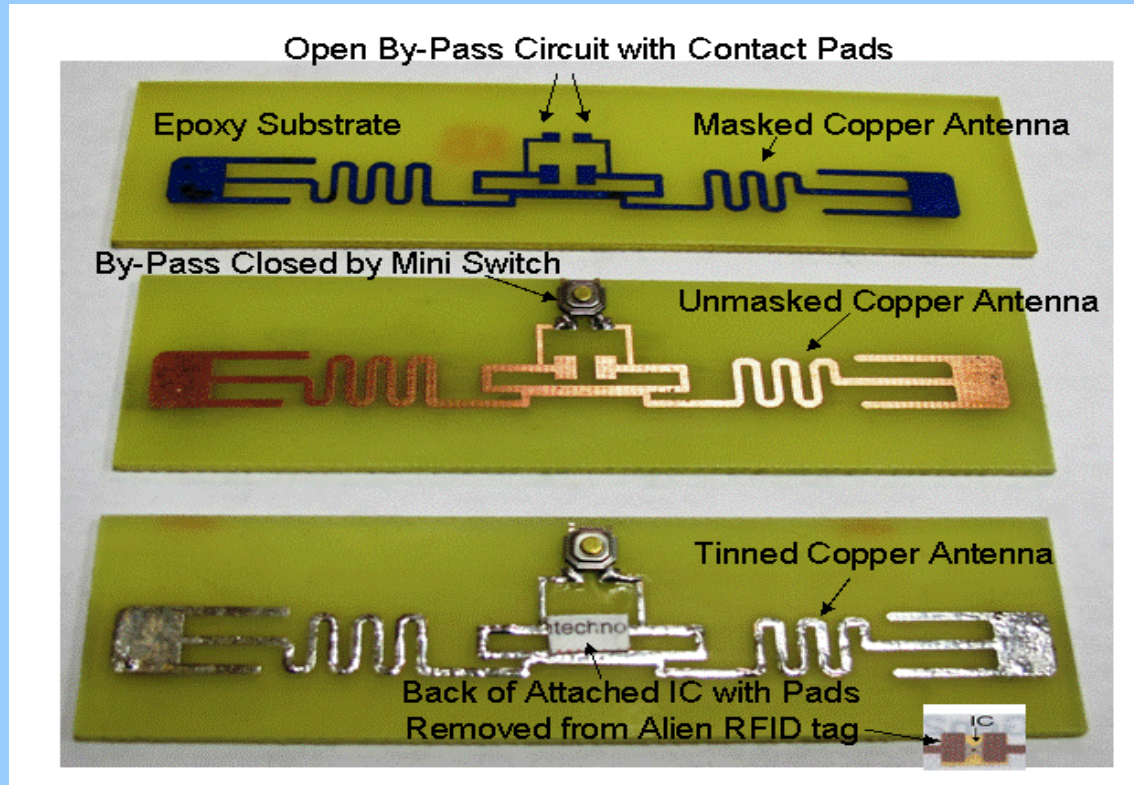
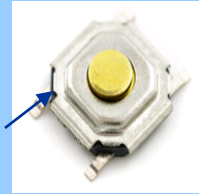


RFID TAG *Reversibly* DEACTIVATED BY ADDING BY-PASS TO IC PADS

# Steps in Producing SMART Clamp Prototype (Etched) With Button Switch

Miniature Push Button Switch

6 mm x 6 mm x 1 mm



When Switch Pressed (Clamp Closed), By-Pass Closed – RFID Tag Undetectable  
When Switch Released (Clamp Failed), By-Pass Open – Tag ID No./Location Read

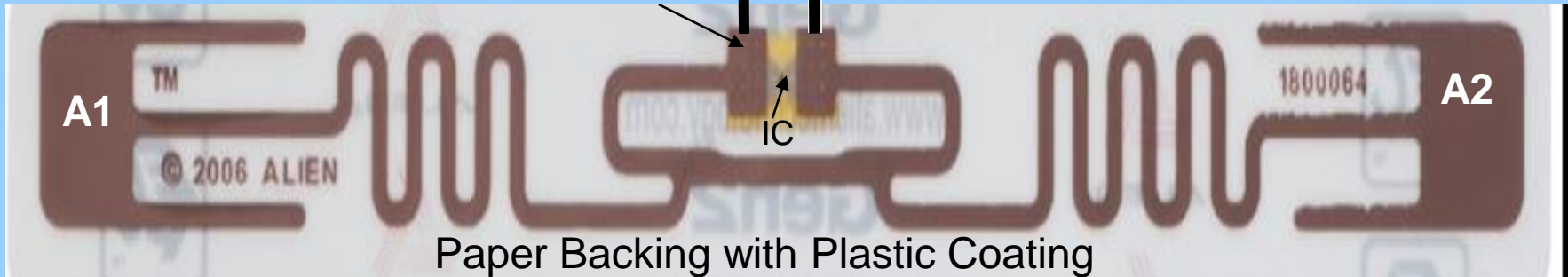
Patent application: January 2010

Licensed to American Thermal Instruments Dayton, OH: July 2011



# SMART Thermal Event Sensors Based on Deactivated RFID Tag

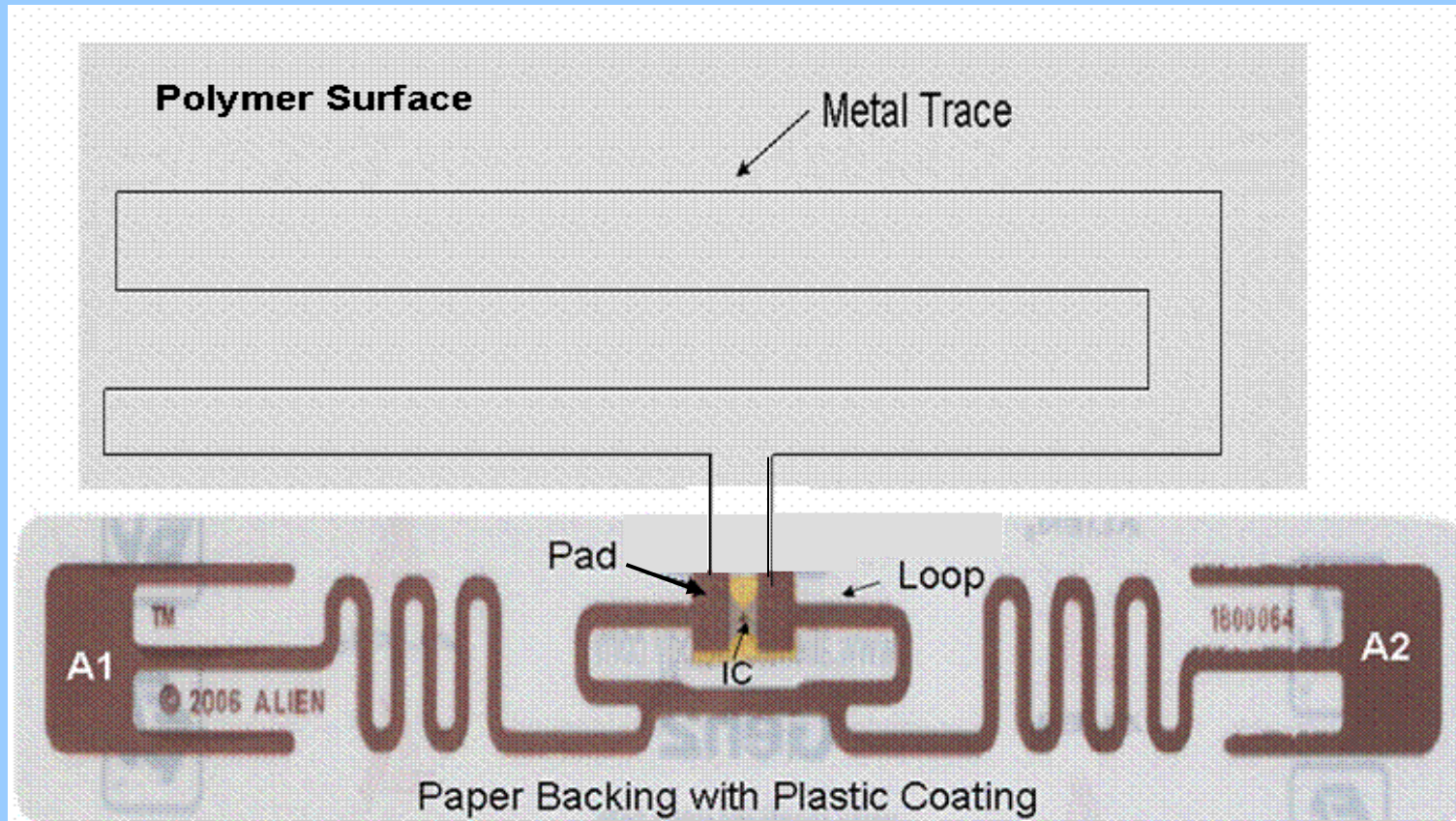
Meltable Substrate  
Pad  
Meltable/Corrodible Trace



- Direct sensor – low temperature metal trace or substrate
- Indirect sensor – combustion products react with trace

# SMART Crack Sensor

By-Pass Closed by Conductive Trace - Crack Opens By-Pass, RFID Read to Locate Crack



# Different Uses for SMART Sensor

Passive Tag (No-Power): Provides permanent record of momentary condition/action

Active Tag (Battery): Provides instant but finite indication of momentary condition/action

- **Push-Button Switch in By-Pass**

- SMART Clamp for wiring bundles: improper wire installation/clamp breakage
- E-Passports instead of shield: can't be read with passport closed
- Tamper detection: release of closed button tears un-repairable circuit

- **Impact Switch in By-pass**

- Unsupported wiring striking against wall during flight: detected at rest on ground
- Dropped during shipping: detection at shipping center vs color when received
- Football helmets: tell if exceeded impact limit with regard to concussion potential
- Composite aircraft/car bumpers: tell if been hit (damage not visible on outside )

- **Conductive Path in By-pass**

- Detect cracks in composite panels such as planes, wind turbine blades, helmets?
- Detect tampering such as electronics, bottle of wine, drug cartons, etc.
- Theft of jewelry (low since can be wrapped with metal foil)
- Tire tread life

- **Meltable/Corrodible/Dissolvable Path in By-Pass**

- Detect intermittent hot spots during flight: detect with electricity off on ground
- Detect frozen food/vaccines that experienced temporary warm-up
- Detect corrosive environment for wide range of structures, equipment, etc.
- Detect fuel leaks on tanks/bladders of aircraft, cars, trucks, etc.