At-A-Glance Alarm Unit Evaluation

"Intrinsically Safe Apparatus"

By

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I. Intrinsically Safe - What is it? Where?

A. What does intrinsically safe mean?

1. Intrinsic safety is a protection method employed in potentially explosive atmospheres. Devices that are certified as "intrinsically safe" are designed to be unable to release sufficient energy, by either thermal or electrical means, to cause ignition of flammable material (gas or dust/particulates).

2. Intrinsically safe standards apply to all equipment that can create one or more of a range of defined potential explosion sources:

a) Electrical sparks

b) Electrical arcs

c) Flames

d) Hot surfaces

e) Static electricity

f) Electromagnetic radiation

g) Chemical reactions

h) Mechanical impact

i) Mechanical friction

j) Compression ignition

k) Acoustic energy

l) Ionizing radiation

3. **The three key elements of combustion are:**

   a) Inflammable Material (gases, particles/dust)

   b) Oxygen/Air

   c) Ignition Source

B. Where is it used?

1. **Typical industries and applications included:**

   a) Petrochemical

   b) Oil platforms and refineries

   c) Pharmaceutical

   d) Pipelines

   e) Gas supply utilities

   f) Gas-fired power generation

   g) Any environment where explosive gases are present.

2. **In these industries, classified areas include:**

   a) Areas in and around storage tanks of flammable materials.

   b) Gas compression pumps for moving gases through a pipeline or into a tank.

   c) Reaction vessels with the potential of a leak through a seal or access cover.

   d) Storage and handling areas for drums of susceptible materials.

   e) Processes with an explosive by-product (i.e. methane).

II. Krueger Sentry's At-A-Glance Alarm – IS Concerns

A. Primary concerns with the unit relating to IS:

1. **Electrical sparks**
2. **Electrical arcs**
3. **Static electricity**
4. **Mechanical impact**
5. **Mechanical friction**

B. Unrelated concerns regarding the At-A-Glance Alarm

1. **Flames**
2. **Hot surfaces**
3. **Electromagnetic radiation**
4. **Chemical reactions**
5. **Compression ignition**
6. **Acoustic energy**
7. **Ionizing radiation**

Note: When factoring in the design of the At-A-Glance alarm, I felt that it was safe to assume that *only* the primary concerns needed to be addressed for this test. Since this design utilizes low voltage CMOS technology and a piezoelectric audible transducer, the current draw remains below a level that could potentially create a hot surface.

The only way to otherwise get a potentially hot surface or chemical reaction from this device would be to connect the battery in reverse or short the battery terminals together. But since there appears to be no adverse affect by reversing the battery terminals on this unit, and there is already a resistance internal to the battery (4.5Ω) that would help to prevent a hazardous condition in the event of a short, so heat or chemical reaction should not be an issue.

The current draw on the unit in normal state is in the micro amp range, and is only about 80mA while in the alarmed state. This equates to about 720mW, which is on the piezoelectric alarm and not dissipated across any heat-generating devices.

III. Evaluation of Primary Concerns

A. Electrical Sparks and Arcs

1. Both of these issues could be treated as one concern. Since the only mechanical switch on the device is a concealed reed switch that switches only low-current logic, my focus for this concern was primarily based on battery replacement – in short, could a spark be created during battery installation?

a) My primary goal here was to monitor the capacitance of the circuit prior to battery installation. The results of my examination showed that the capacitance of the device has a peak potential over a period of time when the alarm may become active. See Figure 1 below.

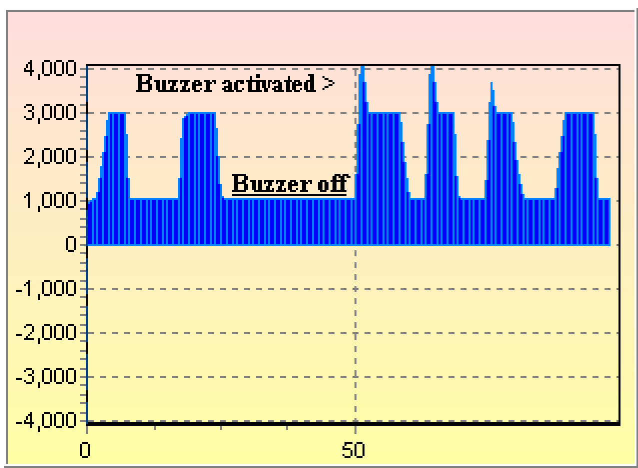


Figure 1. Capacitance averages to about 10uF, but peaks to over 40uF if buzzer has not been activated for a period of time. This shows that the buzzer itself adds to the total capacitance. The potential concern here was spark generation when the battery is first connected.

NOTE: I was unable to create a noticeable spark during this test, and this maintenance task does not directly relate to the device being intrinsically safe, but should be carefully considered for safety.

B. Static Electricity

1. Static Electricity was a primary concern when evaluating the installation of the device. The unit and battery both ship in static safe packaging, but my concern here was if the unit could collect static electricity during the installation. The enclosure of the unit appears to have carbon composition within the polymer used to create the enclosure, but the exact level is unknown. I have tried to generate static electricity on and around the

enclosure but was unable to notice the presence of any stored energy, and since the actual apparel of the installer would be likely to change in or near an actual hazardous (confined) location, this concern is likely covered.

C. Mechanical Impact and friction

1. The primary concern with mechanical impact and friction are both drop test concerns (enclosure fracture) and potential spark issues if the any steel objects on the unit were to scratch against concrete or metal while dropped to create a spark upon impact. Both showed little cause for concern during actual drop test.

IV. Dust Tight Enclosures

A. Clause 3.2.3 of the Approval Standards states that "Circuits of intrinsically safe apparatus shall be enclosed in a dust-tight enclosure meeting the requirements of Clause 3.3.

1. The enclosure should be dust-tight to avoid the potential for dust particles to gather on or near a heat source and potentially ignite. This was the final portion of the testing. It consisted of taking a box that could be made air tight, and placing the device inside of it. It needed to have talcum powder (for this test I used baby powder) placed at the bottom of the box, sealed, then needed to maintain a pressure that is below atmospheric pressure by the use of a vacuum pump. I simply used a reinforced cardboard box and sealed it with tape on all sides. The vacuum pump lowered the pressure and allowed the powder to evenly move around through the air within the box. See Figures 2 and 3 below.

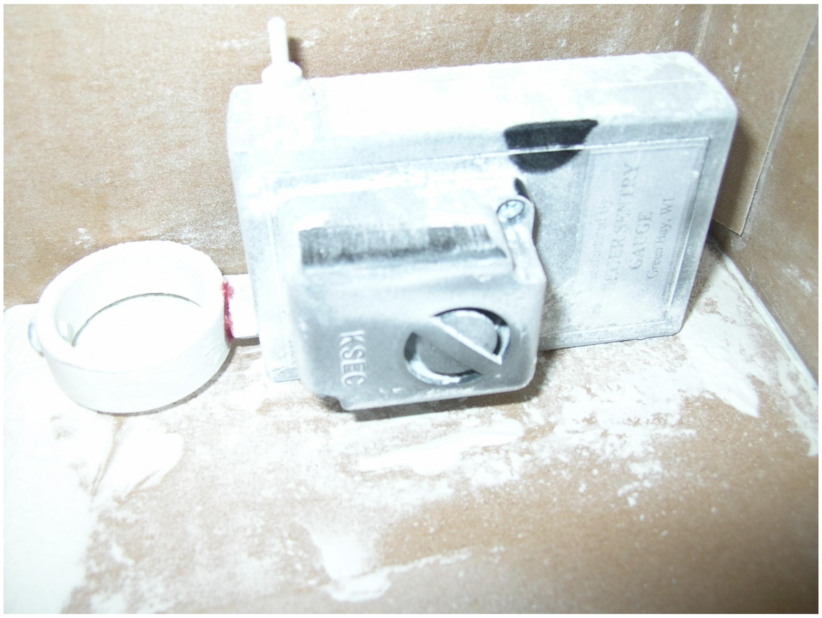


Figure 2. This is the unit after dust-proof testing. Test consisted of about 2 table spoons of Baby Powder in a vacuum tight box. The box was shaken several times while being held at a pressure lower than atmospheric pressure with a vacuum pump.

Figure 3. As seen in the picture, the unit was well covered with powder, and the surrounding box is still in tact.

This test was defined by section 4.2 of the test procedures listed on the Approval Standard for Intrinsically Safe Apparatus and Associated Apparatus for use in Class I, II, and III, Division 1, Hazardous (Classified) Locations. This approval standard is from FM Approvals LLC, and can be viewed or downloaded at the following web URL: http://fmglobal.com/approvals/resources/approvalstandards/3610.pdf.

2. **Figure 4 below shows that only a small amount of powder managed to get inside of the enclosure, however this powder became trapped in the groove of the 9-volt battery lid and fell in when the lid was removed prior to splitting the case.**

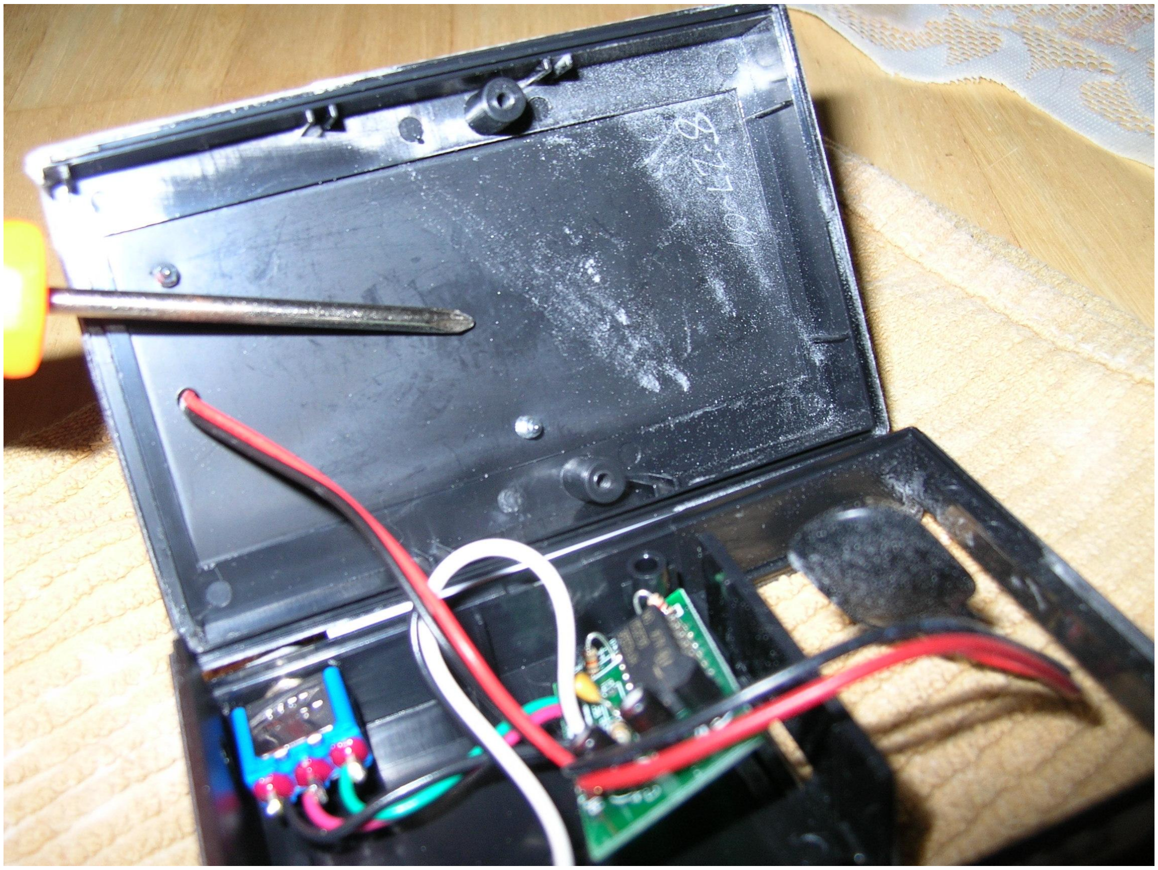


Figure 4. Shown here is the only sign of powder inside of the unit, which fell in by way of opening the 9-volt battery lid prior to completely cleaning off the outside of the unit and splitting open the case.

3. Figures 5-7show that the enclosure actually was not contaminated with powder so it does qualify as a dust-tight enclosure.

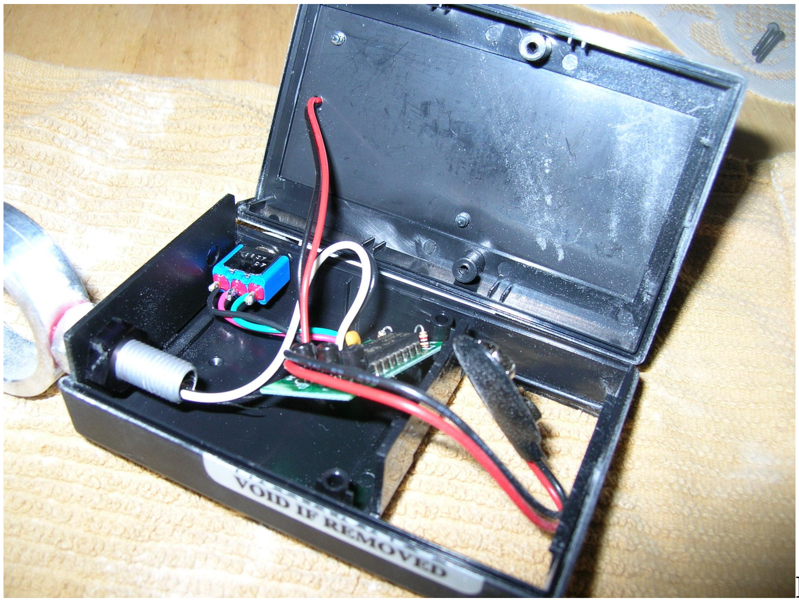
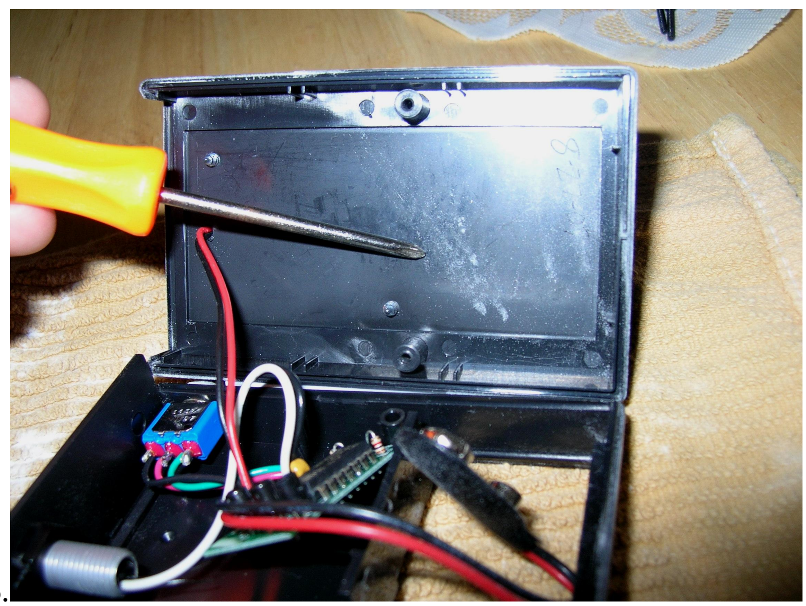


Figure 5.

Figure 6.



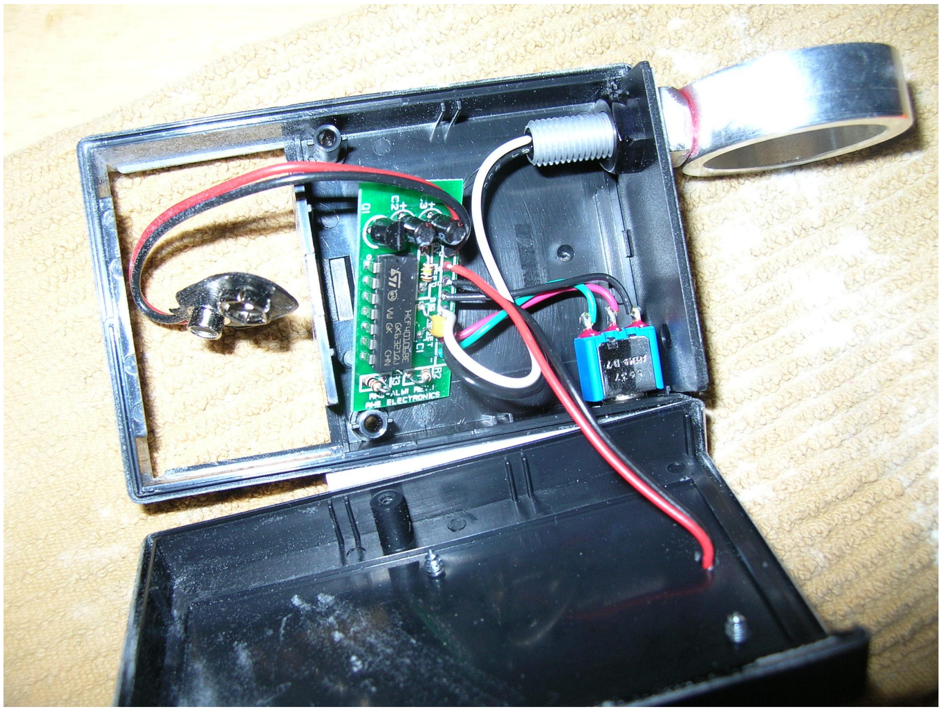


Figure 7. The remainder of the enclosure is without powder and the board itself also remains without any sign of powder. One of the requirements to having Intrinsically Safe Device is that it is dust-proof.

V. Conclusion

A. It is the professional opinion of Miller Engineering that this device does meet the suggested requirements of an Intrinsically Safe Apparatus based upon the described evaluation results.

VI. Recommendations and/or Suggestions

A. Add clause to instruction sheet.

1. "Install battery at a safe location or at a safe distance from tank to prevent potential for hazards," or "Remove unit from equipment prior to battery change when used in Class I, II, and III, Division 1, Hazardous Locations."

B. Conformal coating on PC board or potting the device may also help to reduce the potential for unpredictable problems with units that are placed in hazardous locations or where there is a potential for corrosion.

C. For further evaluation or certification, the unit could be tested by an OSHA approved testing facility and Classified for Hazardous Locations.