Historically, industry CP junction boxes, referred to as “anode junction boxes,” “rectifier junction boxes,” and “bond boxes” are constructed only in one manner. Components, such as shunts, resistors, copper header bars, and measurement terminals, are mounted to an insulated back panel mounted to the bottom of an enclosure on stand-offs. The screw/nut connections to secure these components, and the copper bus commonly used to join shunts in parallel, are normally on the underside of this panel. Field wiring from a rectifier, anodes, reference cells, or the pipeline enter the enclosure and land on the shunts, resistors, or measurement terminals. The industry has significant problems with this type of construction in the case of loose connections that are inaccessible, or if trying to add another component to the panel, as the hardware on the underside of the enclosure generally requires disconnection of all field wired connections and removal of the back panel from the enclosure, installation of new components (or tightening of loose connections) on the panel, followed by the reverse procedure to place the unit back in service. This can take a number of hours to perform, and on occasion field wires can be reversed or placed on the wrong termination, resulting in confusion or in a reversed polarity rectifier connection to the structure and anode bed.

By contrast, in the Dairyland UltraBox all components such as shunts, resistors, isolated terminals, etc., are designed as modules that snap onto one or more DIN rails mounted inside the box on channels. The DIN rails can be adjusted and positioned anywhere on the channels. Further, any module (shunt module, resistor module, etc) can readily be added, removed, or repositioned. For any changes, all field wiring can be left in place, and no disassembly of the unit is required. All hardware is accessible, unlike traditional boxes. Where shunts are involved, adjustable and removable link bars are used to connect one to the next, and form a common header. Adding another shunt involves merely adding another header link to connect it to the rest. The modularity and flexibility of this entire approach addresses each of the disadvantages of traditional junction boxes.

Full Description:

(Please provide complete answers to the questions below. Graphs, charts, and photos can be inserted to support the answers.)

1. **What is the innovation?**

   The Dairyland UltraBox is a modular junction box design that can be configured in many different ways to achieve the desired connection of any combination of shunts, resistors, measurement terminals, etc for measuring and controlling the current to anodes and pipelines in active cathodic protection systems.. These components are mounted on modules with snap-in clips, which attach to DIN rails mounted to channels inside of various sized enclosures. The clips are spring loaded to lock onto the rails. Removal involves depressing a toggle bar on the clip with an object such as a screwdriver. It can then be lifted off of the rail. Likewise, a module can be repositioned anywhere along the rail. The rails themselves can be shifted to any position between the channels that are mounted to the enclosure.

Shunt module (SW shunt shown)

Resistor module

In traditional junction boxes, these components have been mounted to an insulated panel mounted to the bottom of an enclosure on stand-offs. The screw/nut connections to secure these components and the copper bus commonly used to join shunts in parallel were normally on the underside of this panel. In order to make any change after such junction box was installed, most any change could take hours because to access, remove, and work on this panel generally required disconnection of all cable connections and removable of cables from the enclosure, followed by the reverse procedure to place the unit back in service.

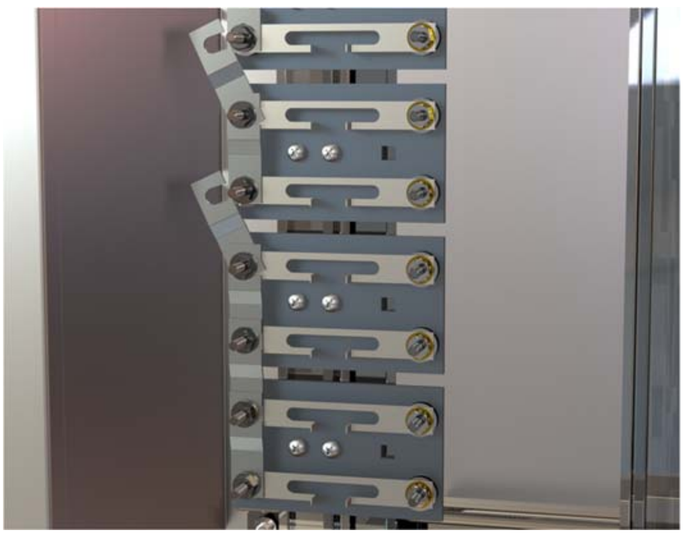
By contrast, all components such as shunts, resistors, isolated terminals, etc., in the Ultra Box are designed as modules that snap on a DIN rail. Therefore, any component can readily be added, removed, or changed to a different version of any component. Any change can be made with the cables left in place. All shunt modules are offered with commonly specified shunts and all resistor modules are offered in commonly specified wattage and resistance values. All modules are offered with one shunt or one resistor per module, but very common shunts types and resistor ratings are also offered with two shunts and two resistors per module, for efficiency. Other modules offered are two isolated terminals modules for potential measurements or to facilitate span tests (where the pipeline itself is used as a shunt); one with four terminals and one with eight terminals. These modules can be mounted to the same DIN rails on which shunts and resistor are mounted or they can be mounted directly to the struts to which DIN rails are attached using a separate kit with a very short section of DIN rail. Another module offered contains a blank resistor core that can be used as a form so that a user can wind their own nichrome wire resistor on site.

Example of terminal module, above

Some users specify junction boxes with shunts only but with “provision for resistors” in the future, but with this modular approach the user can easily add resistor modules on a second rail later when needed. The only “provision for resistors” needed is to assure that the enclosure purchased is large enough for the future resistor modules added later.

Multiple enclosure sizes are offered, and a unique aspect is that all enclosure sizes can ordered with the DIN rails mounted horizontally or vertically. For certain applications one orientation is highly preferably versus the other to facilitate ease of cable entry and connection. For example, where an anode junction box has a large number of shunts and resistors, it is preferable to have two sets of vertical rails, with all resistor output terminals oriented toward the center of the box for field wiring exit out of the bottom center of the enclosure, as shown in an image below. All enclosures are furnished without cable entrance holes so users can add these holes in their preferred locations, which is common practice for junction boxes.

The Ultra Box is a very user friendly alternative to existing junction box designs due to the highly flexible modular design approach. When multiple shunts are to be connected in parallel, a very common requirement, it is done with movable links that join adjacent shunts and are secured with a flange nut on each end. When these nuts are loosened, the link can be pivoted out of the way to remove or change a shunt but the link is always retained in the process. The Ultra Box is expected to meet requirements that are normally specified by users for junction boxes.



Example of moveable links on left, connecting multiple JB shunts

Examples of populated boxes:

2. How does the innovation work?

Traditional junction box use is well understood by the industry, and this approach doesn't fundamentally change the control and measurement of current for CP systems. The above description of the method of construction defines how the product works, by simplifying the assembly of the modules in the box, and allowing the user to manage and alter any arrangement without the difficulties normally encountered by the industry.

3. Describe the corrosion problem or technological gap that sparked the development of the innovation? How does the innovation improve upon existing methods/technologies to address this corrosion problem or provide a new solution to bridge the technology gap?

As discussed above, the flexibility in the modular nature of the product overcomes the frustration that industry personnel have encountered in the field while tightening connections or adding components. Much time can be saved in the field with this approach, along with the freedom to add components if additional circuits are needed. Miswiring incidents are unlikely with this approach, and reversed rectifier field connections likewise are reduced, since complete disassembly is not needed to perform these functions, unlike traditional boxes. One additional improvement not mentioned earlier is that resistor design has been improved over traditional wire-wound slide resistors. In the UltraBox, heavier rib-wound designs allow greater contact with the adjustable resistor band, preventing the hot spots sometimes produced with wire edge-wound designs. This also allows greater power dissipation per resistor for a given physical size as compared to wire-wound construction.

4. Has the innovation been tested in the laboratory or in the field? If so, please describe any tests or field demonstrations and the results that support the capability and feasibility of the innovation.

The fundamental nature of shunt and resistor use in this new arrangement does not require field testing, as these components are familiar to industry. Rather, the unique packaging and arrangement is where benefit has been provided. Laboratory testing was performed, regarding cable forces applied to the modules, as well as power dissipation and related temperature rise for boxes that contained resistors. This resulted in design iterations and improvements in venting to limit temperature rise. Maximum power dissipation was measured and established for each size of vented enclosure that will be used with resistors.

5. How can the innovation be incorporated into existing corrosion prevention and control activities and how does it benefit the industry/industries it serves (i.e., does it provide a cost and/or time savings; improve an inspection, testing, or data collection process; help to

extend the service life of assets or corrosion-control systems, etc.)?

The Ultrabox takes known components (shunts, resistors, measurement terminations) and creates must greater ease of use and field time reduction. Access to all components is improved. Additional circuits can be installed without the challenges of traditional boxes. Consistent orientation and connection of modules provides a uniform appearance less likely to confuse users. Spare modules can be carried by the user that do not require any field work other than to snap in the module and connect the field wiring.

6. Is the innovation commercially available? If yes, how long has it been utilized? If not, what is the next step in making the innovation commercially available? What are the challenges, if any, that may affect further development or use of this innovation and how could they be overcome?

The UltraBox will be available to the market in December 2018, as the design has been finalized and all supporting information completed by then.

7. Are there any patents related to this work? If yes, please provide the patent title, number, and inventor.

Yes. Patented by Accurate Corrosion. Patent number 9,667,048 B2. Inventors Bryan Reed and Justin Duhamell.