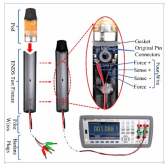

Oct 23, 2020

Coil Resistance Testing Apparatus for VUSE ALTO

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1 Works for me dx.doi.org/10.17504/protocols.io.bibnkame

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ABSTRACT

Measuring coil resistance of Electronic Nicotine Delivery Systems (ENDS) accurately is critical in any research studying the characteristics of electronic cigarettes and their effects on the performance of these devices. It has been shown in several papers that changing coil resistance has the potential to change the Hazardous and Potentially Hazardous Constituents (HPHC) of emissions and consequently health effects on users. This protocol describes how to build a test apparatus for coil resistance measurement for ENDS. This apparatus mimics the geometrical and electrical characteristics of the ENDS and thus provides accurate measurements of the effective coil resistance. The steps shown in this protocol are illustrated for creating a VUSE ALTO test apparatus, but the general idea can be applied to other devices.

DOI

dx.doi.org/10.17504/protocols.io.bibnkame

PROTOCOL CITATION

Qutaiba Saleh, Edward C Hensel, Risa Robinson 2020. Coil Resistance Testing Apparatus for VUSE ALTO. **protocols.io** https://dx.doi.org/10.17504/protocols.io.bibnkame

KEYWORDS

e-cig, ALTO, Pot-style, Coil resistance, emissions, ENDS, product characteristics

CREATED

Jul 08, 2020

LAST MODIFIED

Oct 23, 2020

PROTOCOL INTEGER ID

38990

GUIDELINES

General capabilities:

- Comfortable with using hand tools such as screwdrivers, pliers, file, and tweezer.
- Familiar with using Digital multi-meter (DMM) to make voltage, current, and resistance reading. It is important that the DMM used provides the option for four-wire resistance measurement. The DMM used in this protocol is a Keysight Model 34465A. This link is for the operating and service guide for 34465A.
- Familiar with using power tools such as a small drill.

- General experience with electric circuits and uses of tools such as soldering iron.

MATERIALS TEXT

1. Vuse ALTO Electronic cigarette, to be disassembled and converted into a test fxiture.
2. Digital Multimeter with four-wire resistance measurement option such as Keysight 34465A
3. Copper wire +2 Meters. High conductance thin wire is preffered.
4. Soldering iron
5. Hot glue gun
6. Hand tools such as small screwdirvers, pliers, file, and tweezer
7. Table vise

SAFETY WARNINGS

The next is a short list of safety advices. For comprehensive guidelines, please, follow the standard safety procedures when working on electronic circuits or using the various tools in this protocol.

Use caution when dealing with:

- Lithium battery. It is important to use caution when working on the battery even if the battery is discharged. Short circuit connection between the battery terminals could cause fire.
- Electronic kit could contain capacitors which could cause electric shock or fire when they discharge.
- Soldering iron could lead to burn of the operator and material damage.
- Using power tools such as drills.

ABSTRACT

Measuring coil resistance of Electronic Nicotine Delivery Systems (ENDS) accurately is critical in any research studying the characteristics of electronic cigarettes and their effects on the performance of these devices. It has been shown in several papers that changing coil resistance has the potential to change the Hazardous and Potentially Hazardous Constituents (HPHC) of emissions and consequently health effects on users. This protocol describes how to build a test apparatus for coil resistance measurement for ENDS. This apparatus mimics the geometrical and electrical characteristics of the ENDS and thus provides accurate measurements of the effective coil resistance. The steps shown in this protocol are illustrated for creating a VUSE ALTO test apparatus, but the general idea can be applied to other devices.

BEFORE STARTING

Assemble all the materals listed in the material page.

This protocol is for pod-style ENDS which typically consist of two user sub-assemblies.
The ENDS Pod is the removable pod which contains the heating coil, wick, e-liquid and mouthpiece.
The ENDS Power Control Unit (PCU) contains the battery, electronic circuitry and user interface.

Preparation 2h

1 **Discharge ENDS battery**
This step is critical for the safety of the operator and the lab facility. The battery can be discharged by using the ENDS until the battery is out of energy. The LED on the device flashes 10 times when the battery needs to be charged. This is a good indication that the battery is discharged.

It is **important** to use caution when working on the battery even if the battery is discharged. Short circuit connection between the battery terminals could cause fire.

Open the ENDS PCU to access the internal component 10m

2 **Remove the pod from the PCU**, if it is not already removed.

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3 **Hold the device using a vice or any similar tool**.
The device should be in an upside-down position as shown in the picture.

Table top vise holding and inverted ENDS PCU.

4 Using a small screwdriver, **poke the two small metal retainer-clips** as shown in the picture in step 3.
These two clips can be totally pushed inside the device. The picture shows as if the two clips are pushed together at the same time just to help locate the location of the clips, however, they can be pushed one at a time.

5 **Pull the plastic end of the device with a pliers.**
It could require some strength and shake to pull the end. In some devices, this step can be performed with hands.
The plastic end of the device is part of an internal plastic case which contains all the internal components of the device and it can be pulled out off of the external metal case as one unit as shown in picture.

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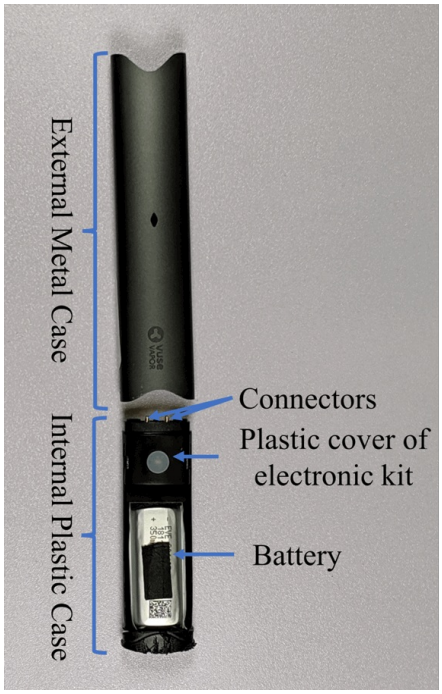
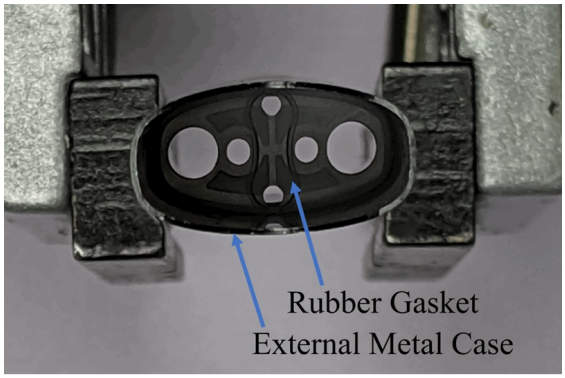


Partially disassembled ENDS PCU.

6 **Remove the white rubber gasket from the external case.**
This piece works as a separator between the internal case and the housing for the pod. It can be easily removed by pushing it out of the case with a screwdriver, a pen, or any other similar tool.
After removing the rubber gasket, the external metal case will look like an empty tube.



Axial view of the ENDS external metal case.

7 **Remove the plastic cover of the electronic kit** (labeled in the picture shown in step 5).
It is a small black piece of plastic with white clear circle in the center. It can be easily removed by hand. The white clear circle in the center is covering the LED. At the end of this step, the internal case will look as shown in the picture.

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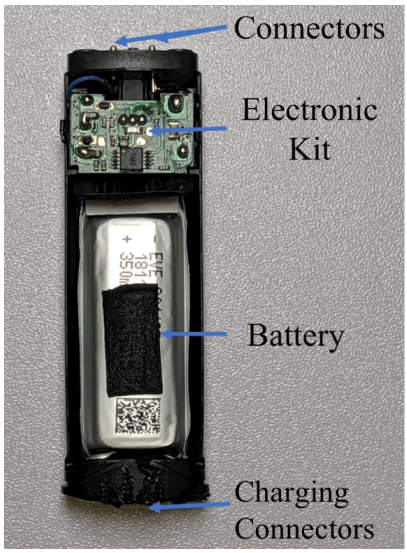

Top view of the ENDS PCU internal plastic case.

Remove the battery and electronic kit from the internal case 30m

8 **Dislocate the battery and electronic kit from internal case.**

This step can be performed by hand. A tool like a plastic tweezer can be also used to dislocate the battery. Metal tools are not recommended to be used with the battery. It is also important to be careful when handling the battery even if no metal tools are used.

This step will expose the wires which connected the components together as shown in the picture below.

Three sets of wires are used in this device:

1. Long red and long white wires which connect the charging flat connectors to the electronic kit.
2. Red and black wires which connect the battery to the electronic kit.
3. Short blue and black wires which connect the spring-loaded connectors to the electronic kit.

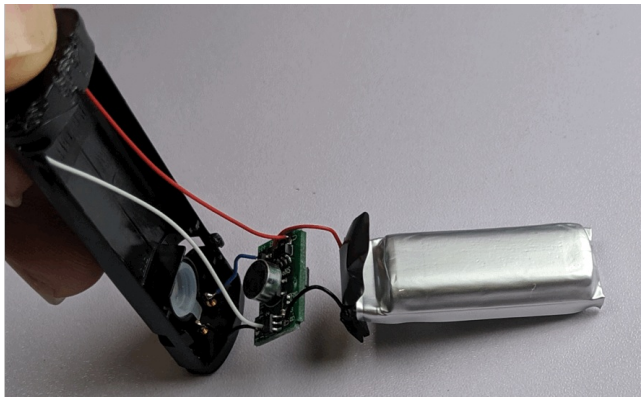

Illustration of ENDS PCU electronic kit disassembly.

The next picture shows the soldering locaitons of the wires on the electronic kit.

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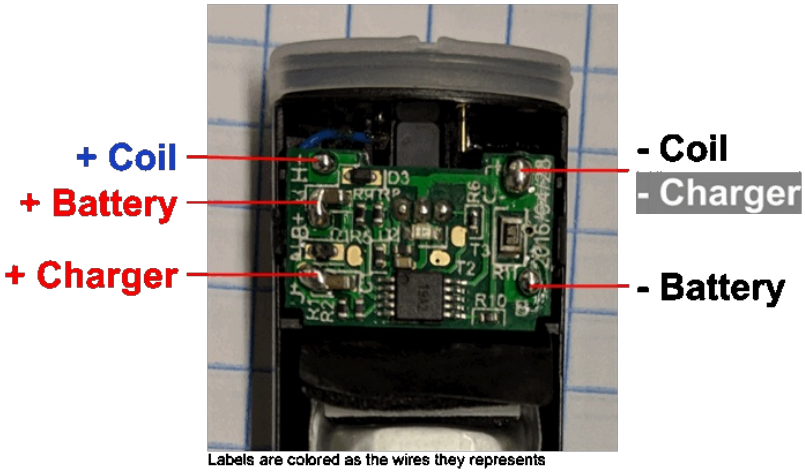


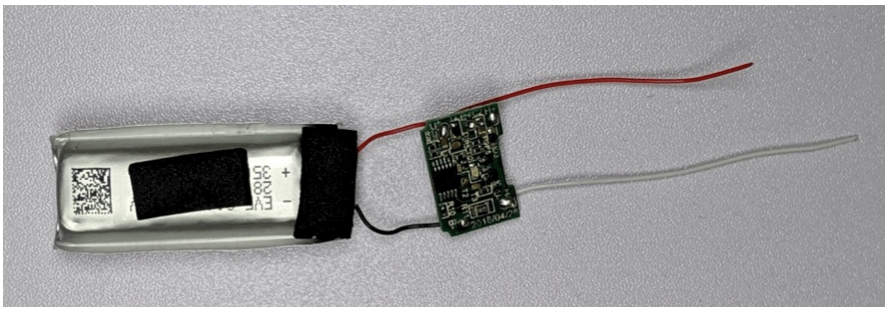
Identification of key electrical connections on the ENDS PCU control board.

9 Remove the battery and electronic kit from the internal case

9.1 **Cut the long red and the long white wires** running from the electronic kit to the charging connectors side leaving the wires attached to the electronic kit. As shown in the picture in next step.

9.2 Using soldering iron, **disconnect the short blue and short black wires** running from the electronic kit to the spring-loaded connectors from the kit side leaving the wires connected to the spring-loaded connectors.
Using the soldering iron to disconnect the wires keeps the metal core of the wire exposed which will be used in the following steps.
At the end of this step, the battery and electronic kit should be completely separated and look like the picture below.

> The battery and the electronic kit should be properly stored to prevent any short circuit or damage to the battery. Wrap electrical tape on the lose terminals of the red and white wires.



Illustratin of the battery and control board removed from the ENDS PCU

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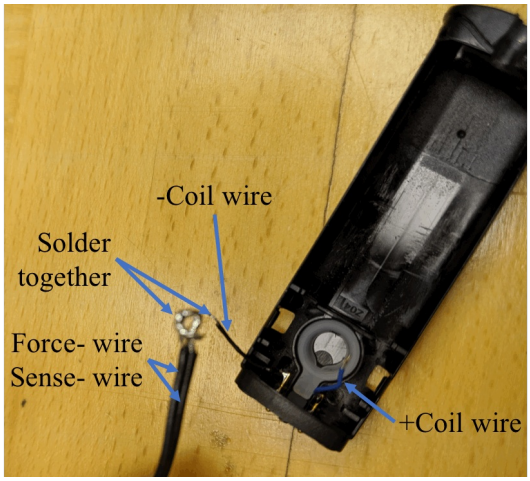
Connect four wires leads 30m

10 Cut four wires with the same length. The length of the wire is preferred to be 50-70cm for easier handling. Longer or shorter wires can be used as preffered.
The wires are grouped into groups of two wires. The first group is positive group while the second group is the negative group.

11 Using soldering iron, **connect one side of the wires in each group together.**

12 Using soldering iron, **connect the positive and negative wires to the blue and the balck wires in the PCU**.
The picture below shows the process for the negative wires (Forse- and Sense-). The same process is applied to the positive wires.



Soldering negative leads to black wire connected to the spring loaded connector

13 Using soldering iron, **connect the other terminal of each wire to a banana plug**.
These plugs are used to connect the tesing apparatus to the DMM.

Four-wire leads for connecting the digital multi meter to the test apparatus.

14 **Make a groove in the far end of the plastic case** (charder connector side) of the PCU to make room for the four wires.
See picture in the next step.

15 **Fix the wires in the plastic case of the PCU** using hot glue and plastic clips.

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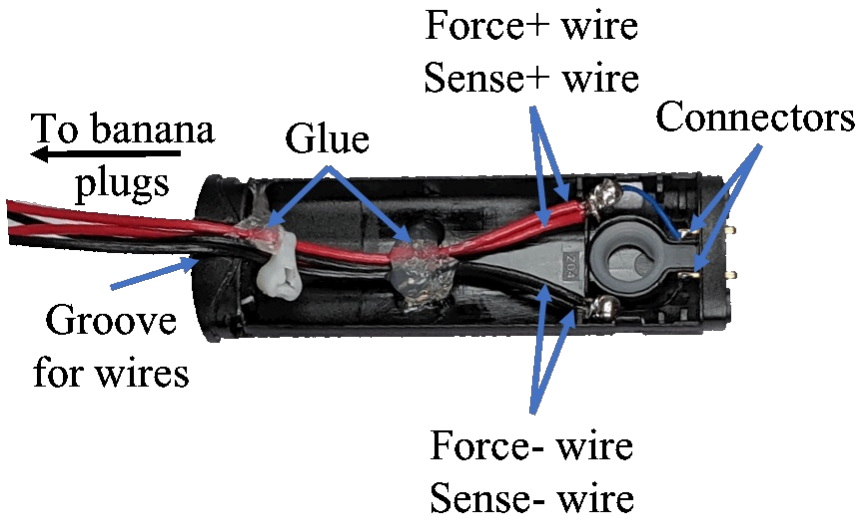
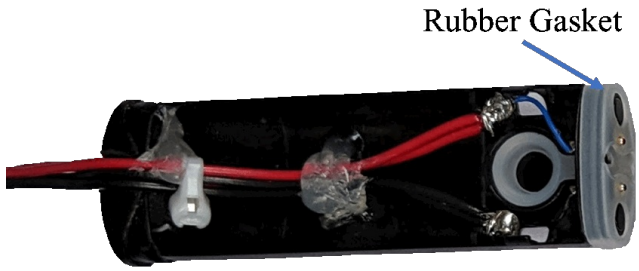
See the picture.



Gasket reinstalled on the ENDS PCU inner plastic carrier.

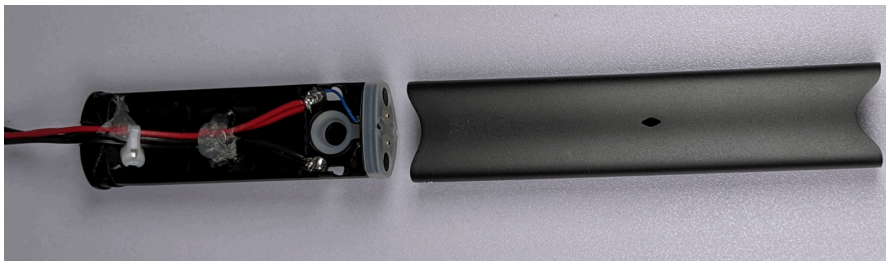
Final assembly 10m

16 **Put the white rubber gasket back on the connector side of the plastic case.**



Gasket reinstalled on the ENDS PCU inner plastic carrier.

17 **Insert the plastic case back in the external metal case of the ENDS.**
Slide the plastic case in the metal case slowly to avoid casuign any damage to the rubber gasket.



ENDS PCU inner plastic carrier about to be inserted into the ENDS PCU outer metal case.

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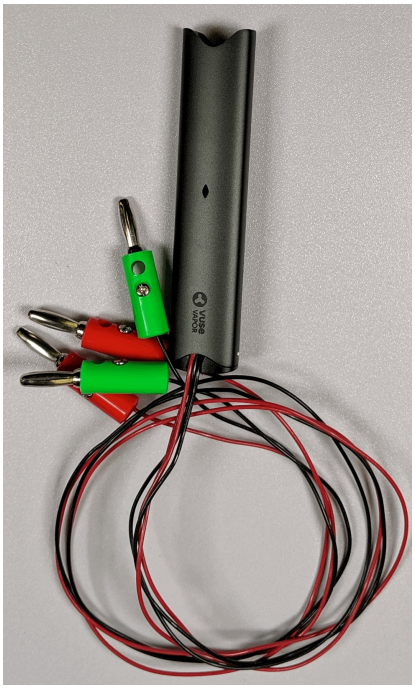
ENDS PCU inner plastic carrier sliding into the ENDS PCU outer metal case.

After this step the test fixture is completed and ready to use.

When the case is fully inserted, it is stable enough so that no retainers are necessary to hold it in place. Not using the retainers makes it easier to reopen the device for future maintenance.



Test apparatus finished and ready for use.

First reading verification 10m

18 **Set the ENDS test fixture** vertically using a table tope vise or any similar handler as shown in picture (A) below. This step is to make sure the fixture is not moving to ensure steady reading. If a vise is not available, the ENDS test fixture can be fixed horizontally on a tabletop as shown in picture (B) below. The orientation should not make difference in the readings, but one orientation is preferred for comparable results.

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(A) ENDS test fixture held vertically using table top vise.

(B) ENDS test fixture held horizontally on a table.

19 **Connect the four-wire leads to the DMM** (Digital Multimeter) using the four banana plugs. Connect the Force+ and Sense+ leads to the inputs denoted HI in the DMM and connect the Force- and Sense- to the input denoted LO in DMM. The arrangement and labels of the inputs on the DMM might vary from one brand to another. Picture (A) below shows the configuration for the Keysight Truevolt Series Digital Multimeters.
Picture (B) and picture (C) show the ENDS test fixture leads connected to DMM Keysight 34465A and Keysight 34401A respectively.

For detailed information about connecting the leads and taking resistance measurement look at page 66 of the Operating and Service Guide of Keysight Truevolt Series Digital Multimeters here.

. Keysight Truevolt Series Operating and Service Guide. https://literature.cdn.keysight.com/litweb/pdf/34460-90901.pdf

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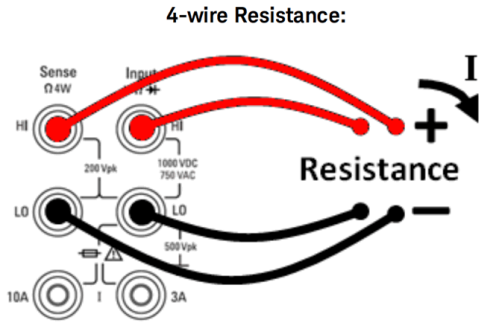
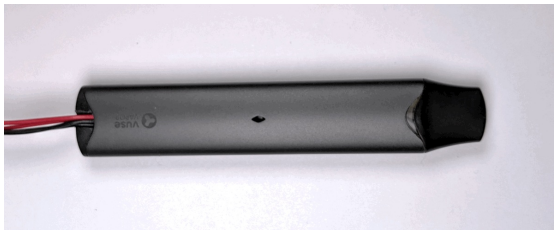


(A) Four-wire leads setup.
The picture is taken from the operating and service guide for Keysight 34465A DMM.

(B) ENDS test fixture leads pluged to Keysight 34465A DMM.

(C) ENDS test fixture leads pluged to Keysight 34401A DMM.

20 **Insert the ALTO pod into the ENDS test fixture.**



ENDS test fixture with pod inserted in it.

21 **Turn the DMM on.**

22 **Press [Ω4W] on the front panel of the DMM.** The DMM will start to make readings of the resistance value using the four-wire technique. As shown in picture (B) and (C) of step 19.

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Based on our analysis of 35 Vuse ALTO pods, the expected coil resistance value is within the range of 0.8960-1.2141 [Ω].

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