

Auto/Truck **ELECTRICAL-ELECTRONICS** **TROUBLESHOOTING** **STUDY GUIDE** **2022**

Written and Developed by
Vince Fischelli
Director of Training

Veejer Enterprises Inc.
Garland, Texas U.S.A.





Study Guide 2022

“Auto/Truck Electrical-Electronics Troubleshooting Training”

This study guide will take you through a training program in XX Study Blocks using the same training aids and books taught by Vince Fischelli in his hands-on troubleshooting workshops, lectures, seminars and trade show presentations. This training is developed from over 40 years of teaching electrical-electronics in the military and in the civilian vehicle service industry. Manuals and circuit board modules contained in this training program are listed below.

(1) Textbook: “Vehicle Electrical Troubleshooting *SHORTCUTS*”

This 250+ page book is divided into 7 sections and the contents of each section is described before Page 1-1. When reference is made to this book in the Study Guide it will simply be referred to as **SHORTCUTS**.

(2) Module H-111A: “The Starter Kit”

This module has a Power Board, H-PCB01A and a Lamp Board, H-PCB02A, a 12-volt power supply, H-PS01 (USA) or a UK or Euro Power supply for countries using 220V main line voltage. Two books are included in H-111A. The Student Workbook, **H-WB111A** has detailed directions, circuit explanations, exercises and step-by-step instructions using H-111A. **Instructor Guide, H-IG111A**, has the answers to exercises and troubleshooting problems as well as easy to follow instructions to insert electrical problems on the bottom of the circuit boards. Make plans for someone to insert problems for you. It's easy.

Watch the YouTube video about the H-111A. Go to YouTube and in the search bar type “**h-111a vince**” and you will be directed to the 44-minute video.

(3) Module H-113: “Troubleshooting DC Motor Circuits”

This module contains circuit board H-PCB03, Student Workbook H-WB113 and Instructor Guide H-IG113 with all the answers and instructions for inserting 42 DC Motor troubleshooting problems.

Watch the YouTube video about the DC Motor circuit board. In the YouTube search bar type “**vince H-113**” and it will take you directly to the video. Watch this video before you begin the training program.

(4) Module H-115: “Troubleshooting Relay Circuits”

This module contains circuit board H-PCB05, Student Workbook H-WB115 and Instructor Guide H-IG115 with all the answers and instructions for inserting 75 relay troubleshooting problems.

Watch the YouTube video about the relay circuit board trainer. Go to YouTube and in the search bar type “**vince H-115**” and it will take you directly to the video. Watch this 35 minute video before you begin the training program.

(5) H-116: Wire Harness Troubleshooting

This module contains circuit board H-PCB06, Student Workbook H-WB116 and Instructor Guide H-IG116 with all the answers and instructions for inserting 114 wire harness troubleshooting problems.

Watch the YouTube video about the wire harness circuit board. Go to YouTube and in the search bar type “**vince H-116**” and it will take you directly to the video. Watch this 8 minute video before you begin the training program.



(6) H-200: Troubleshooting CAN Bus Circuits

This module contains circuit board H-PCB200, Student Workbook H-WB200 and Instructor Guide H-IG200 with all the answers and instructions for inserting 18 problems with the 60 ohm CAN network and 24 problems with node voltage supply and ground circuit problems.

Watch the YouTube video about the CAN Bus circuit board trainer. In the search bar type “**vince H-200**” and it will take you directly to the video. Watch this 18 minute video before you begin the training program.

(7) *FIRST THINGS FIRST-Pro* (Single battery 14V System)

A laminated flip-chart to evaluate a vehicle’s primary electrical system consisting of the battery, primary ground circuits (engine ground and accessory ground) and the charging system. The first series of tests are performed with a cold engine then a quick re-test after the engine warms up. Entire test sequence consisting of 14 voltage measurement steps can be accomplished in less than 5 minutes with a little practice.

Additional Technical Publications

(Optional Purchase) *FIRST THINGS FIRST-2* (Dual battery 14V System)

A laminated flip-chart to evaluate a vehicle’s primary electrical system consisting of 2 batteries found on diesel pickups and SUVs. The first series of tests are performed with a cold engine then a quick retest after the engine warms up. Entire test sequence consisting of 14 voltage measurements can be accomplished in less than 5 minutes with a little practice.

(Optional Purchase)

MULTIPLE BATTERY TROUBLESHOOTING in 12V-24V SYSTEMS is available for purchase in print or PDF. Explains battery circuits connected in parallel (12V) and series arrangements (24V). Also covered are the best ways to evaluate and troubleshoot multiple battery circuits.

A Few Comments Before Getting Started

Set aside a convenient, comfortable, and well-lit place to study so your circuit boards are easily accessible. This makes hands-on use easy to start and stop without the hassle of packing up or unpacking materials each time. Some shops set aside a space to set up the circuit boards to practice during the day when a little time permits. This allows more than one technician to study and share the circuit boards if each tech has his own student workbook. As new techs join the workforce, they will have easy access to the training program, and all will benefit.

Your Study Station should have easy access to line voltage (wall plug) for the Power Supply. The Power Supply does not have an ON/OFF switch. It is controlled by **plugging in** to turn it **ON** and **unplugging** it to turn it **OFF**. You can also use the ON/OFF switch on a power strip to control the Power Supply. Do not leave the power supply plugged in and powered up all the time. Disconnect the power supply from AC when not in use.

Do not allow the red and black wires to make contact while plugged in to AC power. This will destroy the power supply and such damage is not covered by warranty.

Begin



13 Study Blocks - Follow in Numerical Order

(Check Off each item when completed)

Study Block 1, Building the Electrical Foundation

Read/Study Section 1 in **SHORTCUTS** – “Essential Electrical Principles”

___ Read Pages 1-1 to 1-23. Section 1 covers essential electrical principles that explain the electrical laws and principles needed to understand electrical-electronic circuit operation, testing and troubleshooting **E-E** (*short for Electrical – Electronic*) circuit problems.

___ Completed studying Section 1

___ Review Questions Pages 1-24 to 1-26. (Answers in the back of *SHORTCUTS*.)

Highly Recommended: (Got to www.veejer.com/webinars)

Listen to Webinar W001: “Clarifying A Major Electrical Misunderstanding.” Find at www.veejer.com/webinars. It's **FREE** and will help to avoid a common mistake many technicians make that causes considerable confusion trying to understand electrical principles when the concepts of voltage and electron current are not clearly understood.

Study Block 2, About DMMs and Current Clamps

Study Section 2 in **SHORTCUTS** – Working with Digital Multimeters

Read Section 2 in *SHORTCUTS*. Important concepts to focus on are listed below and should be checked off when completed and understood.

___ Page 2-4 covers conversions between volts, (V) and millivolts (mV). This is very important to understand the readings on your DMM and technical explanations throughout this training program.

___ Pages 2-5 to 2-11 explains DMM voltage ranges and important concepts using your DMM to measure voltage. Have your DMM in front of you to see how your DMM compares with the examples given.

___ Pages 2-12 to 2-15 explains concepts of measuring electron current. This will be important for hands-on vehicle testing of electron current with a Current Clamp in Section 4.

___ Pages 2-15 to 2-20 explains ohmmeter principles, ohmmeter ranges and measuring resistance of circuit components. Ohmmeters are an important tool to test solid-state components like diodes, transistors, solid-state relays and vehicle circuits such as the CAN Bus network.

___ Pages 2-21 to 2-22 explains continuity testing, why it is both a good test and a bad test.

___ Pages 2-23 to 2-27 explains semiconductor (solid-state) diodes, diode testing using the Diode Test of a DMM.

___ Pages 2-28 to 2-30 explains using a Current Clamp which will be used extensively in Sections 4, 5 and 6 while studying **SHORTCUTS**. There will be a reminder in the Study Guide to review the Current Clamp when it is needed.

___ Completed Section 2

___ Section 2 Review Questions Pages 2-33 to 2-34 (Answers in back of the book.)



Electrical Training Webinars (On-line Seminar) by Vince

Before you begin the hands-on work with the first circuit board trainer, H-111A "The Starter Kit" you have the possibility to purchase 3 webinars presented by Vince. Webinars are a Power Point presentation with audio that explain many of the concepts you will study in the circuit board trainers. Each webinar is under 60 minutes long and supplies explanations about circuit principles that complement the circuit board workbooks. Some technical points presented have been developed after the circuit boards were developed and therefore add additional technical insight.

Webinars are simply a choice to include in your electrical education. This option is available at any time during your studies either before you begin working with the circuit boards or at any time later. A Webinar Handout is provided by email attachment with the purchase of a webinar. You will have the choice to view each webinar as many times as you wish during the first 7 days after purchase. Expect to find information in a webinar that enhances information in a workbook as Vince expresses technical points verbally and you make notes in your handout.

Highly Recommended: (Got to www.veejer.com/webinars)

Order Webinar W002: "The Anatomy of an Electrical Circuit"

The term Anatomy is the science concerned with the bodily structure of humans. Organs are the same internally and perform the same functions in everyone. Doctors study these body parts and how they work together then treat people when organs do not function. Technicians study electrical circuits in vehicles and follow principles like anatomy. Electrical circuits are composed of similar electrical components arranged into complete circuits to perform predetermined functions. It really doesn't matter in what type of vehicle the circuit operates. It will work the same way in any vehicle.

Highly Recommended: (Got to www.veejer.com/webinars)

Order Webinar W003: "How to Troubleshoot Any Electrical Circuit on Any Vehicle"

Part 1 of 2 - There are 8 ways a vehicle electrical circuit can fail. An electrical circuit on any vehicle will experience 8 possible circuit problems. In this Webinar, W003 Part 1, we explain and illustrate the first 5 ways an electrical circuit can fail and the troubleshooting procedure that reveals the problem is in about one minute or less.

Highly Recommended: (Got to www.veejer.com/webinars)

Order Webinar W004: "How to Troubleshoot Any Electrical Circuit on Any Vehicle"

Part 2 of 2 - Webinar Part 2 of 2 parts covers the last three common electrical problems that could occur in any vehicle electrical-electronic circuit. How to use the "TTS" when the load is controlled by an on-board computer. How ohmmeters work and how to use them to find "shorts" in vehicle circuits.

A Webinar Handout is provided with the purchase of each webinar. You have the choice to view each webinar as many times as you wish during the first 7 days after purchase. Expect to find information in a webinar that enhances information in a workbook as Vince expresses technical points verbally as in a seminar.

Technical points provided in the webinars address advances in technology that have developed since these workbooks were originally written and updated.



Study Block 3, Begin Hands-On Testing

Begin H-111A, The Starter Kit, Hands-On Training Program

View You Tube video (Cut and Paste into search bar) “[vine h-111a](#)” to view this explanation of the circuit board concepts. The Starter Kit, **H-111A**, comes in a white flip-top box with two circuit boards, a power supply and two books, Student Workbook **H-WB111A** has all the hands-on curriculum. The Instructor Guide **H-IG111A** has all the answers. Set up the two circuit boards and prepare the Power Supply before connecting to the line voltage (wall socket or power strip).

Initial Set-Up Procedure (Explained on You Tube as well)

Connect the red and black wires to the red and black posts on the Power Board BEFORE plugging in (turning “ON”) the Power Supply. The Power Supply does not have an ON/OFF Switch. Plug-in to turn “**ON.**” Unplug to turn “**OFF**” the Power Supply.

___ Two Wires connected. PLEASE READ CAUTION STATEMENT BELOW.

THE POWER SUPPLY, H-PS01 (USA) or UK or EURO style) SHOULD BE PLUGGED IN ONLY WHEN THE RED AND BLACK WIRES ARE CONNECTED TO THE RED AND BLACK POSTS ON THE POWER BOARD. **DO NOT ALLOW THE RED AND BLACK WIRES TO MAKE CONTACT IF THE POWER SUPPLY IS “ON.” THIS WILL DESTROY THE POWER SUPPLY.** BEFORE DISCONNECTING THE RED AND BLACK WIRES FROM THE RED AND BLACK POSTS VERIFY THAT THE POWER SUPPLY IS TURNED “OFF” (UNPLUGGED). Adding a fuse to the red or black wire will NOT protect the Power Supply. There is a solid-state rectifier circuit inside the Power Supply. The rectifier will instantly fail if the red and black wire tips short together while the Power Supply is “ON” because the rectifier fails BEFORE the fuse can blow. That is why many electronic components are not fused for protection. A fuse will fail before the fuse can blow. That is basic electronics “101.”

___ I HAVE READ AND UNDERSTAND CAUTION STATEMENT

[**NOTE:** Since this training program was released, new technology has been developed called a “FET-Fuse” which acts fast enough to shut down a computer circuit when electron current gets too high to protect the computer circuit from burn-out.” The term “FET” stands for “field-effect transistor.” **Webinar W-005 explains FET fuses.**]

Begin reading Workbook H-WB111A at Page 1. Follow pages in numerical order. Check answers to exercises in the Instructor Guide, H-IG111A.

___ Read and study all exercises Pages 1 to 31. Answers to exercises in H-IG111A.

___ Read Pages 38 to 40 to prepare to troubleshoot 28 electrical problems.

___ In Instructor Guide, H-IG111A read Pages 1 to 3.

___ In Instructor Guide, H-IG111A read Page 6 to verify no problems are inserted on the bottom of the PCBs (No zero-ohm resistors missing in any “Uxx” jumper.

___ In Instructor Guide, H-IG111A read Pages 7-8 for directions inserting problems.

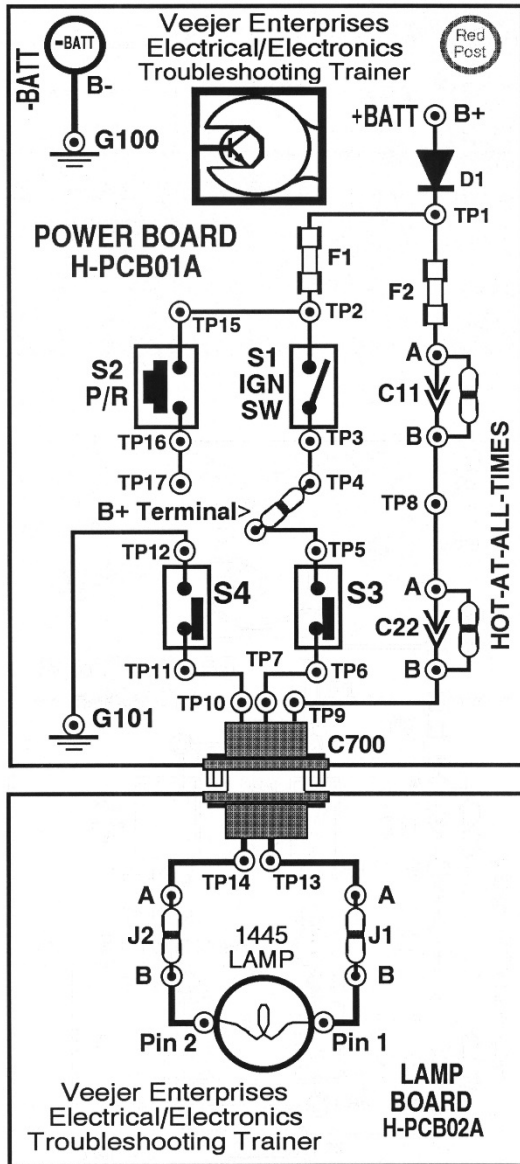
___ Designate someone to insert problems for you so you won’t have any hint what is wrong with each problem before you start troubleshooting.

___ Explain to your assistant how to insert problems in numerical order starting on Page 9 of H-IG111A.



Check Off List: 28 H-111A Troubleshooting Electrical Circuit Problems

Check off when each problem is completed on this page or on Page 71 of Student Workbook H-WB111A. Keep track of which problems have been completed. These 28 problems are either an OPEN circuit or a Vd [voltage drop]. Problems may appear on the voltage side or the ground side of the circuit. Remove the previous problem before inserting a new problem.



- ___ Completed Problem #1.
- ___ Completed Problem #2.
- ___ Completed Problem #3.
- ___ Completed Problem #4.
- ___ Completed Problem #5.
- ___ Completed Problem #6.
- ___ Completed Problem #7.
- ___ Completed Problem #8.
- ___ Completed Problem #9.
- ___ Completed Problem #10.
- ___ Completed Problem #11.
- ___ Completed Problem #12.
- ___ Completed Problem #13.
- ___ Completed Problem #14.
- ___ Completed Problem #15.
- ___ Completed Problem #16.
- ___ Completed Problem #17.
- ___ Completed Problem #18.
- ___ Skip #19 (Short-to-Ground Problem)
- ___ Skip #20 (Short-to-Ground Problem)
- ___ Completed Problem #21.
- ___ Completed Problem #22.
- ___ Completed Problem #23.
- ___ Completed Problem #24.
- ___ Skip #25 (Short-to-Ground Problem)
- ___ Completed Problem #26.
- ___ Skip #27 (Short-to-Ground Problem)
- ___ Completed Problem #28.
- ___ Completed Problem #29.
- ___ Completed Problem #30.
- ___ Completed Problem #31.
- ___ Completed Problem #32.



After completing the 28 problems in H-111A consisting of OPEN connections and Vds (voltage drops) you are ready to tackle short-to-ground problems. You are still working in the Student Workbook H-WB111A.

___ Workbook H-WB111A read Pages 32 to 36 explaining short-to-ground problems.

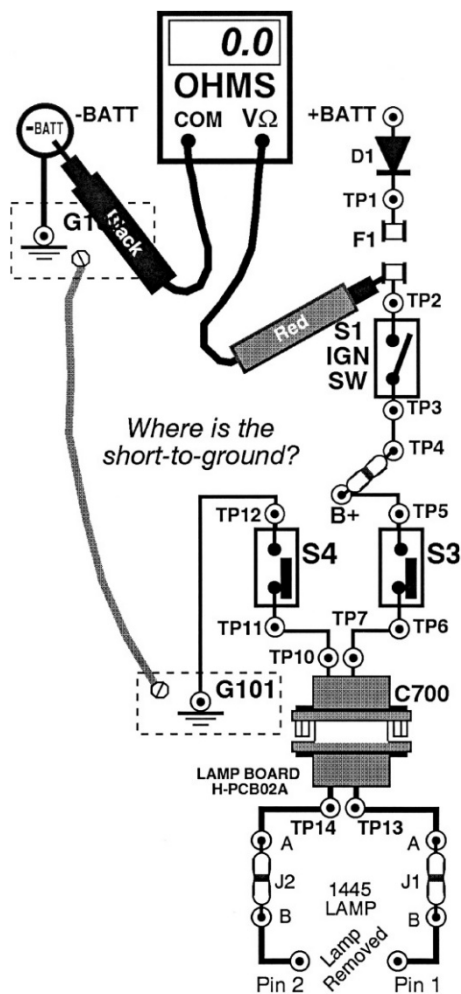
___ Workbook H-WB111A read Pages 63 to 66 explaining ohmmeter readings that show a “short-to-ground is present.”

You are now ready to practice troubleshooting short-to-ground problems.

___ UNPLUG THE POWER SUPPLY.

___ DISCONNECT THE RED AND BLACK WIRES FROM THE RED/BLACK POSTS.

Short-to-Ground Problems



Have someone install “short-to-ground” problems for you from H-IG111A, Page 12. A zero-ohm resistor is placed in a U-NOx jumper location listed on Page 12 to create the “short-to-ground” condition.

DO THIS:

- ___ Remove Fuse F1
- ___ Remove Lamp from Lamp socket
- ___ Close Switches S1, S3 and S4.

Insert a zero-ohm resistor in a “U-noxx” jumper as shown in the Instructor Guide page 12.

Troubleshoot problem with the ohmmeter and decide between what two points the “short-to-ground” exists in the circuit.

Check off each problem when completed.

___ Page 66 Problem 19

___ Page 67 Problem 20

___ Page 68 Problem 25

___ Page 69 Problem 27

Final exercise in Workbook H-WB111A.

___ Read Page 37 explains measuring circuit electron current at a fuse location.

Continue reading in “**Vehicle Electrical Troubleshooting SHORTCUTS,**” Read Section 3 in **SHORTCUTS** – “How Electrical Circuits Work”



Study Block 4, Deeper Understanding of Circuits

Read Section 3 in **SHORTCUTS** – “How Electrical Circuits Work”

Why study electrical circuit principles? It is the best way to understand circuits!

___ Understand Water hoses in a series connection / Hose water current / Electrical series circuit / The law of electron current in a series circuit

___ Understand Impact of resistance R1

___ Understand Current takes the path of least resistance

___ Understand Measuring electron current in a series circuit

___ Understand Voltage in a series circuit

___ Understand How much should a Vd (Voltage Drop) be?

___ Understand Vd of components in a circuit

___ Understand Law of voltage in a series circuit

___ Understand The voltage drop of the voltage side

___ Understand The voltage drop of the ground side

___ Understand Law of resistance in a series circuit

___ Understand Load resistance

___ Understand Starter Kit H-111 troubleshooting training

___ Understand Two water hoses in parallel

___ Understand Electrical parallel circuit

___ Understand Law of current in parallel circuits

___ Understand Current takes the path of least resistance / Measuring total electron current in a parallel circuit / Measuring individual parallel branch electron current / Law of voltage in parallel circuits / Measuring voltage inside a branch / Law of resistance in parallel circuits / Example of resistors in parallel / Compound circuit Voltage measurement techniques / Measuring B+ / Measuring Vd of the voltage side Measuring voltage drop of the ground side / Putting it all together /

H-113 Troubleshooting DC Motor Circuits Troubleshooting Trainer (Studied in Phase 2 Curriculum.)

___ Completed Section 3

___ Answered Review Questions



Study Block 5, All about Auto/Truck Batteries.

Read Section 4 in **SHORTCUTS - Quick Troubleshooting Batteries**

FREE Option: To watch on You Tube type in search bar type "7UAVc4Z2lhY".
"Battery Testing Tips" (41 minutes)

Introduction to batteries / Battery voltage / What happens in a battery / Battery during discharge / Battery discharge circuit / Battery changes during discharge / Battery recharge circuit / The battery during recharge / Testing batteries / Cycle testing electrical circuits

___ Read about battery voltage test called Open Circuit Voltage (O.C.V.)

Perform this test on vehicle batteries and/or batteries in storage.

Vehicle _____ O.C.V. _____ V %State of Charge _____

Vehicle _____ O.C.V. _____ V %State of Charge _____

Vehicle _____ O.C.V. _____ V %State of Charge _____

___ Understand when battery O.C.V. is 12.66V

___ Understand when battery O.C.V. suddenly drops down to 10.55V

___ Understand when battery O.C.V. is suddenly drops to almost zero volt

___ Understand when battery O.C.V. is over 13.00V

___ Understand Battery Cranking Voltage Test

Perform the **Cranking Voltage Test** on vehicles.

Vehicle _____ Cranking Voltage _____ V Ambient Temp _____ °F

Vehicle _____ Cranking Voltage _____ V Ambient Temp _____ °F

Vehicle _____ Cranking Voltage _____ V Ambient Temp _____ °F

___ Summary of cranking voltage test

___ Understand Battery cranking electron current test

Perform the **Cranking Amps Test** on vehicles.

Vehicle _____ Cranking Amps _____ Ambient Temp _____ °F

Vehicle _____ Cranking Amps _____ Ambient Temp _____ °F

Vehicle _____ Cranking Amps _____ Ambient Temp _____ °F

___ Understand Battery Recharge Electron Current Test

Perform **Battery Recharge Electron Current Test** (Single battery negative cable)

Vehicle _____ Recharge Amps _____ A Time running _____ min.

Vehicle _____ Recharge Amps _____ A Time running _____ min.

Vehicle _____ Recharge Amps _____ A Time running _____ min.

___ Understand Carbon pile battery load test not suitable for service bay diagnostics

___ Battery bounce-back test (used only in conjunction with carbon pile test)

___ Determine remaining battery life (compare cranking voltage with ambient temp.)

Overview of 5-Step Battery test procedure / Practice on vehicles and record readings.

___ Completed Section 4

___ Answered Review Questions

MULTIPLE BATTERY TROUBLESHOOTING - 12V-24V SYSTEMS

Available for purchase for work with 24V electrical systems and multiple battery circuits. A purchase link is on our web site at www.veejer.com or call (972) 276-9642



Study Block 6, Cranking Circuit Troubleshooting

Read Section 5 in **SHORTCUTS** - **“Quick Troubleshooting Cranking Circuits”**

FREE Option: Watch You Tube video: "Cranking Circuit Testing Tips" (46 minutes) In You Tube search bar type **“EDciaypL8Vw”** to view.

Some of these tests repeat from the earlier Block 5 on Batteries. That is due to the close interrelationship of the battery and the cranking motor working together. The starter motor is used to evaluate the battery under load. The battery is used to evaluate the performance of the starter motor circuit cranking the engine. Once the individual concepts of battery performance and starter operation are understood separately, they can easily combine for an overall test of starter circuit performance as each component does its job.

Introduction to cranking circuits / Basic cranking circuit /

- Understand starter motor current
- Overview of troubleshooting cranking circuit problems
- Measure cranking current or starter motor draw
- Measure battery cranking voltage
- Understand 3-Step cranking circuit test procedure
- Understand when starter draw is too high
- Understand when starter draw is too low
- Understand if there is a bad connection in the wiring?
- Understand a resistance problem in the starter motor?
- Understand how to pinpoint a bad connection or cable on voltage side.
- Understand how to perform 3 Step QUICK cranking circuit test on a vehicle
- Vehicle _____ Cranking Volts _____ V Cranking Current Test _____ A
- Vehicle _____ Cranking Volts _____ V Cranking Current Test _____ A
- Vehicle _____ Cranking Volts _____ V Cranking Current Test _____ A

- Understand cranking circuit control
- Understand evaluating the solenoid control circuit
- Understand simple cranking circuit
- Understand failure to crank
- Understand cranking control circuit.

Troubleshooting starter relay circuit / A true story.

- Completed Section 5
- Answered Review Questions



Study Block 7, Vehicle Generator (Alternator) Troubleshooting

Read Section 6 in **SHORTCUTS** **“Quick Troubleshooting Charging Systems”**

Watch You Tube video: "Charging System Testing Tips" (52 minutes)

In You Tube search bar type “4EFzX3SN6ck” to view.

Introduction to generator/charging systems / Overview of the charging system / Inside a generator
/ What a generator does / Interpreting the charging voltage /

- Understand Three factors that affect the charging voltage
- Understand Generator voltage tests
- Understand Generator electron current tests
- Understand The charging voltage test
- Understand When charging voltage is too high or too low
- Understand generator/battery current test
- Understand Measuring battery recharge electron current
- Understand Factors that determine battery recharge current
- Understand How to measure battery recharge current
- Understand what's good - what's bad
- Understand Read the DMM correctly
- Understand Determining if a battery is defective when recharging
- Try this simple experiment
- Understand The conclusion of measuring battery recharge current
- Understand Generator ripple voltage test
- Understand Lab scope test of generator output
- Understand Overview of testing vehicle charging system
- Understand Evaluating charging voltage test results
- Understand The wrong way to evaluate a generator
- Understand Two major problems with the generator load test
- Understand Computer controlled generator
- Understand How an onboard computer controls the generator
- Here's the problem
- Understand Testing resistance of rotor/field winding
- Understand Hot and cold resistance
- Understand Evaluating/calculating rotor/field winding condition
- Understand rotor/field windings may be internally grounded
- Understand Introduction to PWM (pulse-width-modulation)
- Understand PWM duty cycle
- Understand PWM rotor/field winding control
- Completed Section 6
- Answered Review Questions



Study Block 8, Putting it all together with quick electrical tests.

FIRST THINGS FIRST-Pro

This is a laminated flip-chart that evaluates a vehicle's primary electrical system consisting of the battery, primary grounds circuits (engine ground and accessory ground) and the charging system. The first series of voltage tests are performed with a cold engine; then running and then a quick retest after the engine warms up. Entire test sequence consisting of 14 voltage measurements can be accomplished in less than 5 minutes with a little practice. Each test step is explained and illustrated on its own laminated page.



Technicians are going through **FIRST THINGS FIRST** for the first time. Each test step is fully explained on the left side of the page and an illustration of the DMM test leads connected to the vehicle is shown on the right side of the page for added clarity. These tests will reveal a weak or undercharged battery, a faulty engine or accessory (sheet metal) ground circuit, and a poor performing charging system.

Simply follow instructions to proceed through the test sequence. Make paper copies of The Test Results Form printed on the back cover of the flip-chart and record your readings.

Vehicle Electrical System Analysis

FIRST THINGS FIRST™ TEST RESULTS			Expected Normal	Problem Noted	Corrected Reading
Step	Test	Volts			
1	Battery Open Circuit Voltage (OCV)		Range of 12.5-12.8V	_____	_____
2	Evaluate O.C.V. Reading			_____	_____
3	Accessory Ground Voltage Drop		0.10V Range of	_____	_____
4	Battery Terminal Cranking Voltage		10.0-11.5V Range of	_____	_____
5	Engine Ground Voltage Drop, Cranking		0.1-0.5V Range of	_____	_____
6	Charging Volts at Battery Terminals		13.8-15.1V Range of	_____	_____
7	Charging (+) Side Voltage Drop		0.2V or less	_____	_____
8	Charging (-) Side Voltage Drop		0.1V or less	_____	_____
9	Engine Ground Voltage Drop, Warm		0.1V or less	_____	_____
10	Accessory Ground Volt Drop, Warm		0.1V or less	_____	_____
11	Charging (+) Side Volt Drop, Warm		0.2V or less	_____	_____
12	Charging (-) Side Volt Drop, Warm		0.1V or less	_____	_____
13	Charging Volts At Batt. Term., Warm		13.8-15.1V Range of	_____	_____
14	Final Chrg. Voltage for Undercharge		Above 13.5V	_____	_____
15	Final Chrg. Voltage for Overcharge		Below 15.1V	_____	_____
16	Trouble Codes No ___ Yes ___			_____	_____

Customer Name _____	Date _____	Mileage _____
Make _____	Model/Color _____	Year _____
Lic. Plate # _____	Phone _____	
VIN _____		

The Test Results Form may be copied on any copy machine and used to record test results. A copy can be given to the customer. There is a place to paste your business card at the bottom, so the customer knows who did the electrical system analysis. The readings obtained show how well the electrical system is performing.

Date Tested: _____
Service Technician _____

Paste a business card in this box and make copies of this page to record test results. Give the customer a copy of this report to build good public relations and customer loyalty. Repair shops can charge the customer 0.5-1.0 hour to perform these tests. If a bad connection is found add from 0.5-1.0 hour to repair the bad connection and note the repair and the corrected DMM reading on this form.



Study Block 9, Practice Exercises Reading Schematic Diagrams

Study Section 7 in *SHORTCUTS* – Reading Schematic Diagrams

- How to read a schematic or “schemation” diagram
- Understand What a schematic or “schemation” diagram can do
- Understand What a diagram cannot do
- Understand “Schemation” of a vehicle's primary electrical system
- Understand Inventory a circuit diagram
- Understand Trace the path of electron current
- Understand Measure the voltage around the circuit
- Understand Physically trace the circuit lines
- Completed Exercise 7-3
- Understand Reading a relay-controlled cooling fan circuit diagram
- Understand How the circuit works
- Understand Troubleshooting the circuit on paper
- Completed Exercise 7-4
- Understand Reading a relay controlled cranking circuit diagram
- Understand How the circuit works
- Understand Troubleshooting the circuit on paper
- Completed Exercise 7-5
- Understand Reading a relay controlled horn circuit diagram
- Understand How the circuit works
- Understand Troubleshooting the circuit on paper
- Completed Exercise 7-6
- Reading a rear compartment relay-controlled lid release circuit diagram
- Understand How the circuit works
- Understand Troubleshooting the circuit on paper
- Completed Exercise 7-7
- Reading a relay-controlled window defogger circuit diagram
- Understand How the circuit works
- Understand Troubleshooting the circuit on paper
- Completed Exercise 7-8
- Understand Reading a relay-controlled wiper/washer pump motor circuit diagram
- Understand How the circuit works
- Understand Troubleshooting the circuit on paper / Conclusion

Continue your electrical education by studying each of the following circuit board trainers in numerical order.



Each electrical trainer comes with its own circuit board that plugs into the bottom of the power board, H-PCB01, from the Starter Kit H-111A.

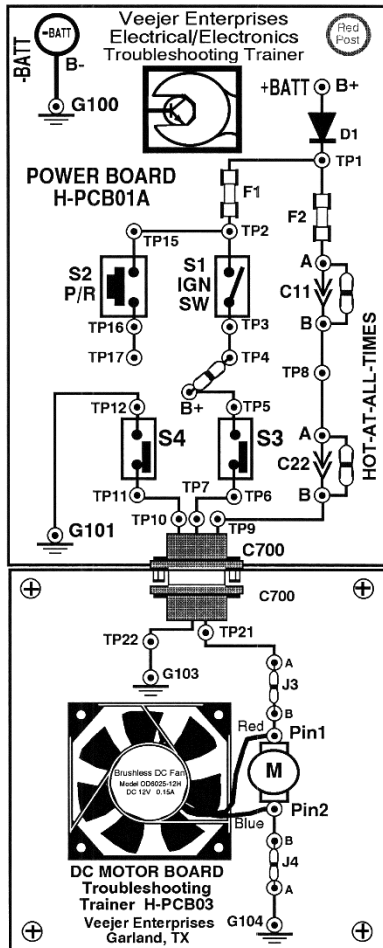
Each circuit board trainer comes with a fully explained and illustrated workbook, instructor guide and resistor bag for that circuit board. Each workbook provides an introduction to the new circuit board and guides the student through the training program which is completed by troubleshooting all the dedicated electrical problems for each circuit board.

Instructions for inserting problems and correct answers are included in the instructor guide for each circuit board. Continue with additional hands-on training exercises using each circuit board trainer. Start with H-113.

Study Block 10, H-113, Troubleshooting DC Motor Circuits

H-113 Troubleshooting DC Motor Circuits

A YouTube video is available for this circuit board trainer. Go to YouTube and in the search bar type “vince H-113” and it will take you directly to the video. Watch this video before you begin the training program. (This You Tube video has been hacked and shortened but we are working to correct this.)



This is the DC Motor Board, H-PCB03, connected to the Power Board, H-PCB01 or H-PCB01A to study this module.

Use Student Workbook, H-WB113.

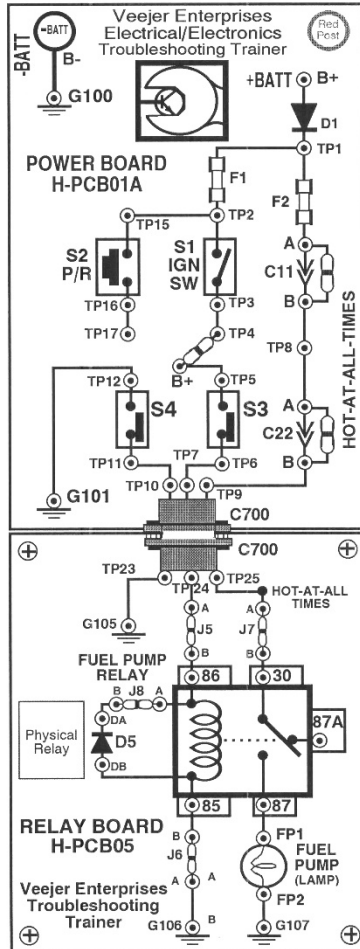
Answers to exercises and instructions for inserting problems is found in Instructor Guide, H-IG113



Study Block 11, H-115, Troubleshooting Relay Circuits

H-115 Troubleshooting Relay Circuits

A YouTube video is available to introduce this circuit board trainer. Go to YouTube and in the search bar type **vince H-115** and it will take you directly to the video. Watch this video before you begin the training program.



This is the Relay Circuit Board, H-PCB05, connected to the Power Board, H-PCB01 or H-PCB01A to study this module.

Use Student Workbook, H-WB115.

Answers to exercises and instructions for inserting problems is found in Instructor Guide, H-IG115.



OPTIONAL TRAINING

Webinars with substantial additional technical training on Solenoids and Relays are available. **W005** and **W006** go beyond what was available in technology when H-113 and H-115 were originally developed and focuses more on computer control of solenoids and relays. Actual voltage readings are included in these webinars that illustrates when a computer circuit is working properly and what voltages indicate a problem and the problem's location in the circuit.

In **W007** and **W008** you will learn about solid-state relays, new technology replacing mechanical relays in high amperage circuits relating to power control circuitry.

Highly Recommended: (Got to www.veejer.com/webinars)

**Order Webinar W005: "Understanding & Troubleshooting Solenoid Circuits"
Part 1 – "ON/Off Solenoids in DC Circuits"**

Solenoids control electrical circuits, mechanical devices and to direct the path of hydraulic fluid in vehicle systems. This online webinar covers ON/OFF solenoid operation in DC circuits and troubleshooting solenoids in circuits. The material is essential to understand solenoids controlled by computers presented in Part 2.

Highly Recommended: (Got to www.veejer.com/webinars)

**Order Webinar W006: " "Solenoid Circuits",
Part 2, "Computer Control of Solenoids"**

Picking up the story of solenoids from Webinar W005 we now discuss on-board computer control of solenoid circuits. Find out why two computers are used to control a solenoid circuit.

Highly Recommended: (Got to www.veejer.com/webinars)

**Order Webinar W007:
Part 1, "What They Never Told You About Mechanical and Solid-State Relays You
Need to Know."**

In this online webinar learn about relay parameters printed on the case of a mechanical relay. An introduction to solid-state relay explains the principle of operation and the purposes of the Input and Output circuits of a solid-state relay. Important to note that solid-state relays were not used in auto/truck electronic circuits when H-WB115 was written. This webinar will serve as an introduction to solid-state relays.

Highly Recommended: (Got to www.veejer.com/webinars)

**Order Webinar W008:
Part 2, "How to Troubleshoot Mechanical and Solid-State Relay Circuits""**

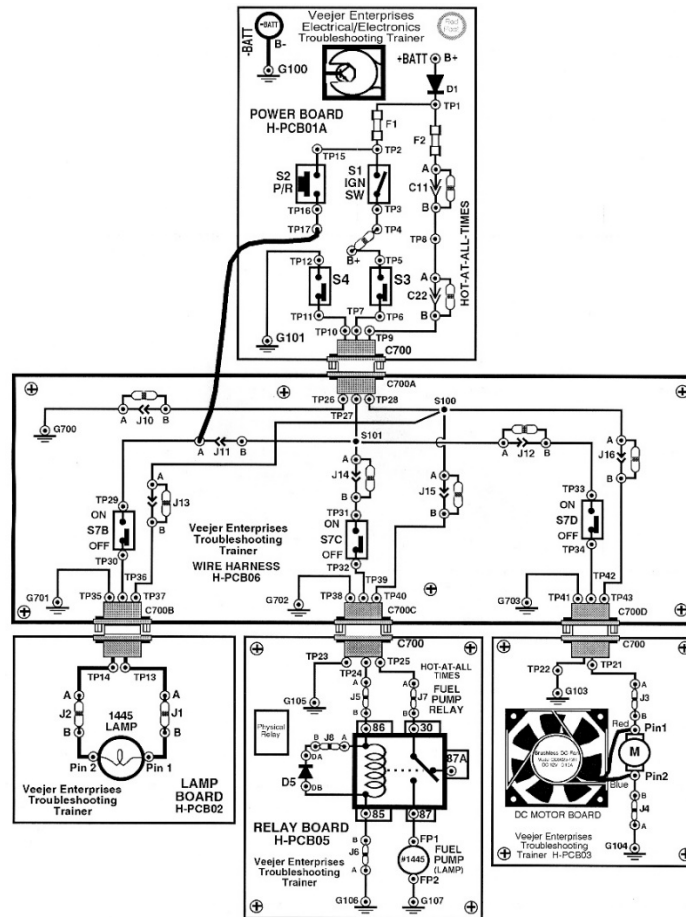
In this online webinar learn what to check first if a mechanical relay CLICKS or DOES NOT CLICK. Then using a DMM and following the fool-proof step-by-step troubleshooting procedures outlined in this webinar to quickly identify the relay circuit problem.



Study Block 12, H-116, Wire Harness Troubleshooting

H-116 Wire Harness Troubleshooting

A YouTube video is available for this circuit board trainer. Go to YouTube and in the search bar type **vince H-116** and it will take you directly to the video. Watch this video before you begin the training program.



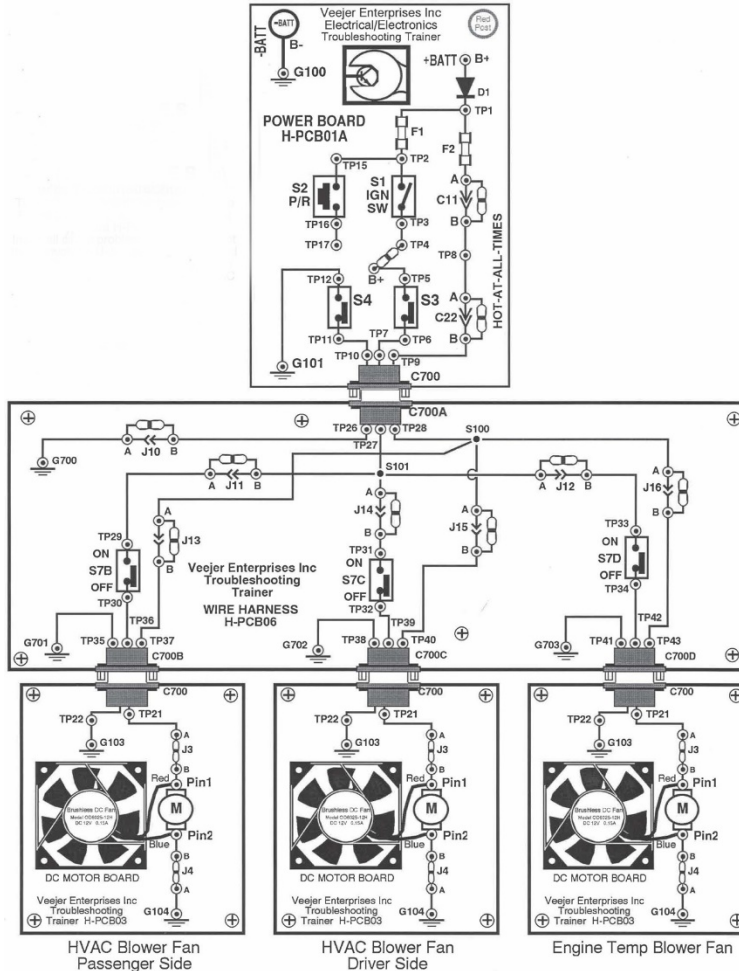
This is the assembled Mini-Electrical System., called "The M.E.S."

Use Student Workbook, H-WB116.

Answers to exercises and instructions for inserting problems is found in Instructor Guide, H-IG116.



Optional Troubleshooting Circuit: Modify the Mini-Electrical System as shown below.



Replace the Lamp Module, H-PCB01, and Relay Module, H-PCB-5, with two additional DC Motor Modules, H-PCB03. This adds some interesting options to the troubleshooting problems. When a problem number is inserted it will affect the associated blower motor performance and overall M.E.S. operation the same way as it did for the original Lamp or Relay Modules. This can be beneficial to understanding how common electrical circuit problems create the same symptoms regardless of the type of electrical load. This can be very helpful to tech schools using the M.E.S. circuit board trainer in the classroom to provide additional circuit troubleshooting to students. Insert electrical problems as you would do with the other circuit board trainers.

To purchase two additional DC Motor Modules (H-113(S) call us at (972) 276-9642 for a special offer. We have additional inventory of H-PCB03 DC Motor Modules and can offer 2 additional modules at a substantial discount with free shipping to US Zip codes. This offer expires without notice when the supply of H-113(S) are sold out.

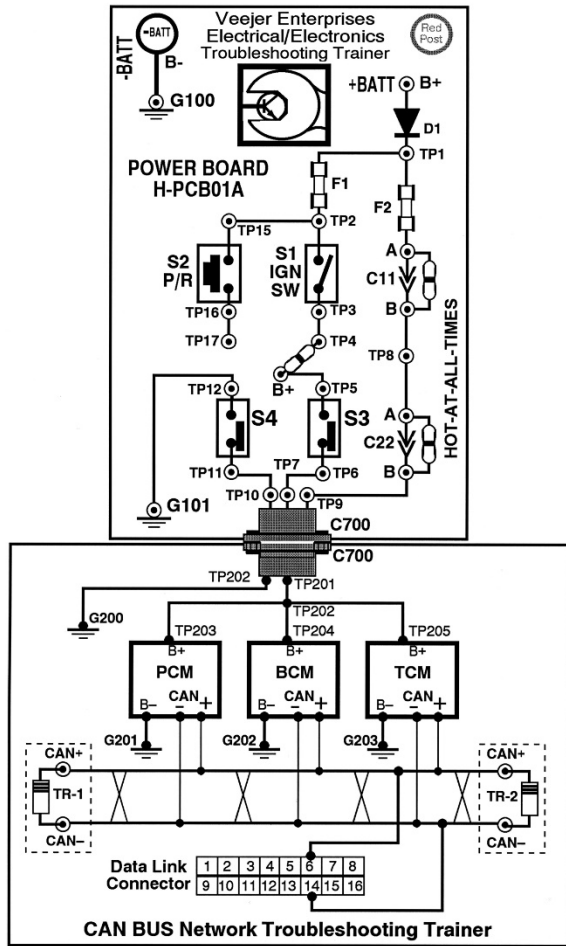
Caution: The voltage regulator on the Power Board, H-PCB01 will get warm when 3 DC Motor modules are connected and running at the same time. Limit “on-time” to not more than 5 minutes. Then power down for 5 minutes and allow the regulator to cool down.



Study Block 13, CAN Bus Circuit Troubleshooting

H-200 Troubleshooting CAN Bus Circuits

A YouTube video is available for this circuit board trainer. Go to YouTube and in the search bar type “vince h-200” and it will take you directly to the video. Watch this video before you begin the training program.



Use Student Workbook, H-WB200.

Answers to exercises and instructions for inserting problems is found in Instructor Guide, H-IG200.

[Option for tech schools:
We have additional CAN Bus circuit boards, H-PCB200, available for purchase at a discount till all inventory is gone. Call us at (972) 276-9642 if you are interested in extra CAN Bus circuit boards available in the classroom.]



FIRST THINGS FIRST™

This is a laminated flip-chart that tests a vehicle's primary electrical system consisting of the battery, primary grounds circuits (engine ground and accessory ground) and the charging system. The first series of voltage tests are performed with a cold engine; then engine running and then a quick retest after the engine warms up. Entire test sequence consisting of 14 voltage measurements is accomplished in less than 5 minutes with a little practice. Each test step is explained and illustrated on its own laminated page.



Technicians are going through **FIRST THINGS FIRST** for the first time. Each test step is fully explained on the left side of the page and an illustration of the DMM test leads connected to the vehicle is shown on the right side of the page for added clarity. These tests will reveal a weak or undercharged battery, a faulty engine or accessory (sheet metal) ground circuit, and a poor performing charging system.

Simply follow instructions to proceed through the test sequence. Make paper copies of The Test Results Form printed on the back cover of the flip-chart and record your readings.

Vehicle Electrical System Analysis

FIRST THINGS FIRST™ TEST RESULTS			Expected Normal	Problem Noted	Corrected Reading
1	Battery Open Circuit Voltage (OCV)		Range of 12.5-12.8V	_____	_____
2	Evaluate O.C.V. Reading			_____	_____
3	Accessory Ground Voltage Drop		0.10V	_____	_____
4	Battery Terminal Cranking Voltage		Range of 10.0-11.5V	_____	_____
5	Engine Ground Voltage Drop, Cranking		Range of 0.1-0.5V	_____	_____
6	Charging Volts at Battery Terminals		Range of 13.8-15.1V	_____	_____
7	Charging (+) Side Voltage Drop		0.2V or less	_____	_____
8	Charging (-) Side Voltage Drop		0.1V or less	_____	_____
9	Engine Ground Voltage Drop, Warm		0.1V or less	_____	_____
10	Accessory Ground Volt Drop, Warm		0.1V or less	_____	_____
11	Charging (+) Side Volt Drop, Warm		0.2V or less	_____	_____
12	Charging (-) Side Volt Drop, Warm		0.1V or less	_____	_____
13	Charging Volts At Batt. Term., Warm		Range of 13.8-15.1V	_____	_____
14	Final Chrg. Voltage for Undercharge		Above 13.5V	_____	_____
15	Final Chrg. Voltage for Overcharge		Below 15.1V	_____	_____
16	Trouble Codes No <input type="checkbox"/> Yes <input type="checkbox"/>				
Customer Name		Date	Mileage		
Make	Model/Color	Year			
Lic. Plate #	Phone				
VIN					
Paste a business card in this box and make copies of this page to record test results. Give the customer a copy of this report to build good public relations and customer loyalty. Repair shops can charge the customer 0.5-1.0 hour to perform these tests. If a bad connection is found add from 0.5-1.0 hour to repair the bad connection and note the repair and the corrected DMM reading on this form.			Date Tested: _____		
			Service Technician _____		

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You have permission to copy The Test Results Form on any copy machine and use it to record test results. Give a copy to the customer. There is a place to paste your business card at the bottom so the customer knows who did the electrical system analysis.

Best wishes for your success in electrical-electronics troubleshooting. I believe if you complete this ultimate electrical training program you will be the outstanding "go-to-electrical guy" in your shop. Others will bring you vehicles they cannot fix and you will make it look easy. Let us know by email how you liked the training program and what elements benefited you the most. Any suggestions or successes you have fixing electrical problems you have are welcome.

Stay tuned to our web site and make sure you are connected to our newsletter email list for future announcements. Sign up www.veejer.com Link at bottom of the page.

At your service,
Vince Fischelli