Phase 1 Workshop Home Study Guide

This study guide will take you through the Phase 1 Workshop curriculum in 9 Study Blocks using the same training aids and books taught by Vince Fischelli in the 3-Day “Phase 1 – “Hands-On Vehicle Electrical-Electronics Troubleshooting Workshop.”

There are three Training Materials Used in the Phase 1 Workshop
(1) Text Book “Vehicle Electrical Troubleshooting SHORTCUTS”
This 250 page book is divided into 7 sections and this is explained 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 contains 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. Resistor Bag H-RB01 contains resistors needed for problem insertion.

Two books are included in H-111A.
- The Instructor Guide, H-IG111A, contains 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 YouTube video about the H-111A. In the YouTube search bar print H-111Avince and you will go right to the 44 minute video.

(3) FIRST THINGS FIRST-Pro
A laminated flip-chart that tests 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 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.

A Few Comments Before You Get Started
Set aside a convenient and comfortable Study Station (place to study) where your study materials will easily remain available so you can start and stop studying without the hassle of packing up or unpacking materials each time. Your Study Station should have easy access to line voltage (wall plug) for the Power Supply. The Power Supply has no ON/OFF switch. It is controlled by plugging it 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 all the time. Disconnect from power when not in use. Do not short the red and black wires together while plugged in to power. This will destroy the power supply and that is not covered by warranty.
9 Study Blocks - Study in Numerical Order
(Check Off each item when completed)

<table>
<thead>
<tr>
<th>Block 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Study Section 1 in SHORTCUTS – Essential Electrical Principles</strong></td>
</tr>
<tr>
<td>___ Read Pages 1-1 to 1-23. This section covers essential electrical principles that explain the laws and principles needed to understand electrical circuit operation.</td>
</tr>
<tr>
<td>___ Completed studying Section 1</td>
</tr>
<tr>
<td>___ Review Questions Pages 1-24 to 1-26. (Answers in the back of SHORTCUTS.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Block 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Study Section 2 in SHORTCUTS – Working with Digital Multimeters</strong></td>
</tr>
<tr>
<td>Read Section 2 in SHORTCUTS. Important concepts to focus on are listed below and should be checked off when completed and understood.</td>
</tr>
<tr>
<td>___ 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.</td>
</tr>
<tr>
<td>___ 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.</td>
</tr>
<tr>
<td>___ 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.</td>
</tr>
<tr>
<td>___ 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.</td>
</tr>
<tr>
<td>___ Pages 2-21 to 2-22 explains continuity testing, why it is both a good test and a bad test.</td>
</tr>
<tr>
<td>___ Pages 2-23 to 2-27 explains semiconductor (solid-state) diodes, diode testing using the Diode Test of a DMM.</td>
</tr>
<tr>
<td>___ 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.</td>
</tr>
<tr>
<td>___ Completed Section 2</td>
</tr>
<tr>
<td>___ Section 2 Review Questions Pages 2-33 to 2-34 (Answers in back of the book.)</td>
</tr>
</tbody>
</table>
Block 3


View You Tube video https://www.youtube.com/watch?v=wlWlc4sGvA

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 to be connected to line voltage (wall socket or power strip).

Initial Set-Up Procedure (Explained on You Tube)

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. 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

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 List of 28 H-111A Troubleshooting 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 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 indicate a “short 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 your assistant install “short-to-ground” problems 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” condition.

**DO THIS:**
- Remove Fuse F1
- Remove Lamp from Lamp socket
- Close Switches S1, S3 and S4.
- Insert a zero-ohm resistor in “U-noxx” jumper
- Troubleshoot problem with the ohmmeter and determine between what two points the "short" exists in the circuit.

**Check off 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 “Vehicle Electrical Troubleshooting SHORTCUTS” beginning with Block 4, Study Section 3 in SHORTCUTS – How Electrical Circuits Work
Read Section 3 in SHORTCUTS – How Electrical Circuits Work

Why study electrical circuit principles?

___ 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
**Block 5**

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

Watch YouTube video: "Battery Testing Tips" (41 minutes) [CLICK HERE](https://www.youtube.com/watch?v=7UAVc4Z2ihY)

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 some vehicle batteries and/or batteries in storage.

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>O.C.V.</th>
<th>% State of Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>

___ 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 some vehicles.

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Cranking Voltage</th>
<th>Ambient Temp</th>
<th>°F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

___ Summary of cranking voltage test

___ Understand Battery cranking electron current test

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

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Cranking Amps</th>
<th>Ambient Temp</th>
<th>°F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

___ Understand Battery Recharge Electron Current Test

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

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Recharge Amps</th>
<th>Time running</th>
<th>min.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

___ 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
Block 6

Read Section 5 in SHORTCUTS - Quick Troubleshooting Cranking
Watch You Tube video: "Cranking Circuit Testing Tips" (46 minutes)
CLICK HERE  https://www.youtube.com/watch?v=EDciaypL8Vw

Some of these tests repeat from the previous 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 test the battery under load. The battery is used to test 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 combined
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 testing 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
Read Section 6 in *SHORTCUTS - Quick Troubleshooting Charging Systems*

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

CLICK HERE — https://www.youtube.com/watch?v=4EFzX3SN6ck

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 test 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
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 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.

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.
Block 9

**Study Section 7 in SHORTCUTS – Reading Schematic Diagrams**

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>___</td>
<td>How to read a schematic or “schemation” diagram</td>
</tr>
<tr>
<td>___</td>
<td>Understand What a schematic or “schemation” diagram can do</td>
</tr>
<tr>
<td>___</td>
<td>Understand What a diagram cannot do</td>
</tr>
<tr>
<td>___</td>
<td>Understand “Schemation” of a vehicle’s primary electrical system</td>
</tr>
<tr>
<td>___</td>
<td>Understand Inventory a circuit diagram</td>
</tr>
<tr>
<td>___</td>
<td>Understand Trace the path of electron current</td>
</tr>
<tr>
<td>___</td>
<td>Understand Measure the voltage around the circuit</td>
</tr>
<tr>
<td>___</td>
<td>Understand Physically trace the circuit lines</td>
</tr>
<tr>
<td>___</td>
<td>Completed Exercise 7-3</td>
</tr>
<tr>
<td>___</td>
<td>Understand Reading a relay-controlled cooling fan circuit diagram</td>
</tr>
<tr>
<td>___</td>
<td>Understand How the circuit works</td>
</tr>
<tr>
<td>___</td>
<td>Completed Exercise 7-4</td>
</tr>
<tr>
<td>___</td>
<td>Understand Reading a relay controlled cranking circuit diagram</td>
</tr>
<tr>
<td>___</td>
<td>Understand How the circuit works</td>
</tr>
<tr>
<td>___</td>
<td>Completed Exercise 7-5</td>
</tr>
<tr>
<td>___</td>
<td>Understand Reading a relay controlled horn circuit diagram</td>
</tr>
<tr>
<td>___</td>
<td>Understand How the circuit works</td>
</tr>
<tr>
<td>___</td>
<td>Completed Exercise 7-6</td>
</tr>
<tr>
<td>___</td>
<td>Reading a rear compartment relay-controlled lid release circuit diagram</td>
</tr>
<tr>
<td>___</td>
<td>Understand How the circuit works</td>
</tr>
<tr>
<td>___</td>
<td>Completed Exercise 7-7</td>
</tr>
<tr>
<td>___</td>
<td>Reading a relay-controlled window defogger circuit diagram</td>
</tr>
<tr>
<td>___</td>
<td>Understand How the circuit works</td>
</tr>
<tr>
<td>___</td>
<td>Completed Exercise 7-8</td>
</tr>
<tr>
<td>___</td>
<td>Understand Reading a relay-controlled wiper/washer pump motor circuit diagram</td>
</tr>
<tr>
<td>___</td>
<td>Understand How the circuit works</td>
</tr>
<tr>
<td>___</td>
<td>Completed Exercise 7-9</td>
</tr>
<tr>
<td>___</td>
<td>Understand Troubleshooting the circuit on paper / Conclusion</td>
</tr>
</tbody>
</table>

*Congratulations on completing the “Phase 1 – “Hands-On Vehicle Electrical-Electronics Troubleshooting Workshop.” May you have great success and make more money, Vince Fischelli. Phase 2 Workshop training is explained on the next page.*
Phase 2 *Hands-On* Electrical-Electronic Troubleshooting Training Program

Phase 2 incorporates completing the four remaining circuit board trainers. Each trainer comes with its own circuit board that plugs into the bottom connector (U700) 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. To complete Phase 2 follow the training program of the four remaining circuit boards and complete them in numerical order. 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.

For a description of each circuit board and a link to purchase can be found on our webpage [www.veejer.com/handson](http://www.veejer.com/handson)

**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.

**H-115 Troubleshooting Relay Circuits**
A YouTube video is available for 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.

**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.

**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.

Best wishes for your success. Let us know by email how you liked the training program and what elements benefited you the most.

Vince Fischelli