NATEF Task Area A-6
Electrical & Electronic Systems

• A. General Electrical System Diagnosis
• B. Battery Diagnosis & Service
• C. Starting System Diagnosis & Repair
• D. Charging System Diagnosis & Repair
• E. Lighting System Diagnosis & Repair
• F. Gauges, Warning Devices, Instrument Cluster D & R
• G. Horn, Wiper and Washer Diagnosis & Repair
• H. Accessory Diagnosis & Repair
NATEF Task Area A-6 Electrical & Electronic Systems

A. General Electrical System Diagnosis

A6.A.1 Complete work order to include customer information, vehicle identifying information, verify customer concern, related service history, cause, & correction.
A6.A.2 Identify & interpret electrical/electronic system concern; determine necessary action.

Verify Complaint → Determine Cause → Make Correction
NATEF Task Area A-6 Electrical & Electronic Systems

A. General Electrical System Diagnosis

Research applicable vehicle and service information, such as brake system operation, vehicle service history, service precautions, and technical service bulletins.

Quick Fixes
- Repair-Tracs
- Hotline Archives
- Posted Fixes
- NHTSA Recalls
- TSBs
- Fast Fixes
- OBD-II Code Data
- Identifix Articles

Repair Info
- Wiring Diagram Groups
- Component Locations
- Specifications

Estimating Info
- MOTOR Parts & Labor
- CHILTON Labor
- Factory Scheduled Maintenance
- Maintenance Schedules
- Reliability Report

Hotline
- Hotline Available

TSBs: Technical Service Bulletins

<table>
<thead>
<tr>
<th>OEM Number</th>
<th>Issue Date</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>06-068</td>
<td>No Date Available</td>
<td>Vehicle Pulls or Drifts, and/or Steering Wheel Is Off-Center</td>
</tr>
<tr>
<td>07-006</td>
<td>No Date Available</td>
<td>MIL Is On With DTC P1172 or P2A00</td>
</tr>
<tr>
<td>07V549000</td>
<td>No Date Available</td>
<td>RECALL - AIR BAGS:FRONTAL</td>
</tr>
<tr>
<td>98-051</td>
<td>No Date Available</td>
<td>Special Tool Loan Program</td>
</tr>
<tr>
<td>06-019</td>
<td>04/20/2006</td>
<td>WIND NOISE AT THE TOP OF THE WINDSHIELD</td>
</tr>
<tr>
<td>06-017R</td>
<td>05/18/2006</td>
<td>PDI AND NEW MODEL INFORMATION - REVISED</td>
</tr>
<tr>
<td>06-038</td>
<td>06/24/2006</td>
<td>PASSENGER SEAT DOES NOT SLIDE</td>
</tr>
<tr>
<td>06-068</td>
<td>10/03/2006</td>
<td>VEHICLE PULLING OR DRIFTING</td>
</tr>
<tr>
<td>06-068</td>
<td>10/03/2006</td>
<td>VEHICLE PULLING OR DRIFTING</td>
</tr>
<tr>
<td>00-088</td>
<td>10/06/2006</td>
<td>BRAKE REFINISHING GUIDELINES - REVISED</td>
</tr>
</tbody>
</table>

http://www.rsandas.com/

Amazing Automotive Electrical Site
Locate and interpret vehicle and major component identification numbers (VIN, vehicle certification labels, calibration decals)

1st character - Identifies the country in which the vehicle was manufactured. For example: U.S.A.(1 or 4), Canada(2), Mexico(3), Japan(J), Korea(K), England(S), Germany(W), Italy(Z)

2nd character - Identifies the manufacturer. For example; Audi(A), BMW(B), Buick(4), Cadillac(6), Chevrolet(1), Chrysler(C), Dodge(B), Ford(F), GM Canada(7), General Motors(G), Honda(H), Jaguar(A), Lincoln(L), Mercedes Benz(2 or 5), Plymouth(P), Saturn(S), Toyota(T), VW(V), Volvo(V).

3rd character - Identifies vehicle type or manufacturing division.

4th to 8th characters - VDS - Vehicle Descriptor Section. These 5 characters occupy positions 4 through 8. The manufacturer uses these characters to identify attributes of the vehicle. Identifies vehicle features such as body style, engine size, transmission type.

9th Character - The check digit "character or digit 9" in the sequence of a vehicle identification number (when the 17 character digit format was established) can best be described as identifying the VIN number.


11th character - Identifies the assembly plant for the vehicle.

12th to 17th characters - VIS - Vehicle Identifier Section. The last 8 characters of the VIN are used for the identification of specific vehicle. The last four characters shall always be numeric. Identifies the sequence of the vehicle for production as it rolled off the manufacturers assembly line.

How to Find Your VIN Number:

1. Dashboard on the driver side of the vehicle.
2. Driver side door where it latches when it's closed.
Diagnose electrical/electronic integrity of series, parallel, and series-parallel circuits using principles of electricity (Ohm's law).
Use wiring diagrams during diagnosis of electrical circuit problems.
A. General Electrical System Diagnosis


Open Circuit Voltage
Voltage Available
Voltage Drop
DC Amps - In Series
DC Amps - Inductive
Resistance Ω
Capacitance
Continuity
Diode Tests
Relay Tests
A6.A.8 Check electrical circuits with a test light; determine necessary action.
A. General Electrical System Diagnosis

Check electrical/electronic circuit waveforms; compare to waveform library known-good images, interpret readings and determine needed repairs.

Library of Automotive Waveforms

The automotive waveform library contains over 130 waveforms. The waveforms are from a variety of vehicles and show both good (working) and bad (faulty) circuits. Waveforms were captured using the Automotive Diagnostics Kit.

If you have captured any automotive waveforms, please send us the .PSD files together with a brief description.

Please select a type of waveform to see all available waveforms.

Charging and starting
Sensors
Actuators
Ignition
CAN Bus
FirstLook
Check electrical circuits using fused jumper wires; determine necessary action.
UNDERSTANDING RELAYS

CONDUCTOR

SPRING-PULL

MAGNETIC-PULL

CONTACT

POINTS

#30 #86 #85 #87 #87A

ALWAYS GOES TO ELECTRICAL DEVICE (LIGHTS, FAN, AC, ETC.)

ALWAYS GOES TO POSITIVE FEED FROM FUSE BOX

ALWAYS GOES TO GROUND SOURCE

ALWAYS GOES TO MAIN POWER SOURCE

TO POWER A SECOND ELECTRICAL DEVICE ... WHEN #87 IS OFF, #87A IS ON WHEN #87 IS ON, #87A IS OFF

TURNING A RELAY ON & SENDING POSITIVE POWER ... USING A GROUND FEED

POSITIVE OUTPUT TO ANY ELECTRIC UNIT (LIGHTS, FAN, AC, ETC.)

CONNECT 2ND CIRCUIT

2ND SWITCH

CONNECT TO 2ND CIRCUIT

IRON ARMATURE

ELECTROMAGNET

1ST CIRCUIT

1ST SWITCH
Simple Relay Circuit.

On

Switch Fuse

Battery

Device Fuse

85 M
30 H
86 S
87 B

Lights, horn or other device.

To Ground
A short circuit is simply a low resistance connection between the two conductors supplying electrical power to any circuit. This results in excessive current flow in the power source through the 'short,' and may even cause the power source to be destroyed. If a fuse is in the supply circuit, it will do its job and blow out, opening the circuit and stopping the current flow.
Measure and diagnose the cause(s) of excessive (key-off battery drain) parasitic draw; determine necessary action.

**PARASITIC DRAIN**
Check for excessive battery drain or parasitic loads using an ammeter. Make sure all electrical loads are off in the car, doors closed, and the key is out of the ignition switch. Disconnect one of the battery cables from the battery, placing an ammeter in series between the battery post and cable clamp. The current draw reading should be less than 35 milliamps. A reading higher than this (or manufacturer specifications) would indicate excessive battery drain. Something is "on", allowing current to flow running down the battery. Vehicles today typically will draw less than .020 amps (20 milliamps) of current to maintain electronic memories and circuits.
A6.A.14 Inspect and test switches, connectors, relays, solenoid solid state devices, and wires of electrical/electronic circuits; perform necessary action.

If the control coil is energized, then the motor feed contacts close.
Remove and replace terminal end from connector; replace connectors and terminal ends.
NATEF Task Area A-6 Electrical & Electronic Systems

A. General Electrical System Diagnosis


Twisted-pair cable
- Insulated copper wires

Coax cable
- Protective sheath
- Wire mesh shield
- Copper wire
- Insulation

Fiber optic cable
- Protective sheath
- Glass core
- Glass cladding

Cable types
Perform (rosin core) solder repair of electrical wiring. (including heat shrink)
A6.A.18 Identify location of hybrid vehicle high voltage circuit disconnect (service plug) location and safety procedures.
Perform battery state-of-charge test; determine needed service
Perform battery capacity test (or conductance test); confirm proper battery capacity for vehicle application; determine necessary action.

<table>
<thead>
<tr>
<th>Hydrometer Indicator</th>
<th>State of Charge</th>
<th>Required Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Dot</td>
<td>Above 65%</td>
<td>Load Test</td>
</tr>
<tr>
<td>Black Dot</td>
<td>Below 65%</td>
<td>Charge Battery</td>
</tr>
<tr>
<td>Clear Dot</td>
<td>Low Electrolyte</td>
<td>Replace Battery (if Cranking Complaint)</td>
</tr>
</tbody>
</table>

2 CCA per Cubic Inch
2 CCA per 16 cc’s
NATEF Task Area A-6 Electrical & Electronic Systems

B. Battery Diagnosis & Service

A6.B.3 Maintain or restore electronic memory functions
NATEF Task Area A-6 Electrical & Electronic Systems

B. Battery Diagnosis & Service

A6.B.4 Inspect, clean, fill, and replace battery
NATEF Task Area A-6 Electrical & Electronic Systems

B. Battery Diagnosis & Service

A6.B.5 Perform slow/fast battery charge.
A6.B.6 Inspect & clean battery cables, connectors, clamps, and hold-downs-repair/replace as needed

Voltage Drop of Negative Cable End
A6.B.7 Start a vehicle using jumper cables and a battery or auxiliary power supply to mfr. procedures.
Identify high voltage circuits of electric or hybrid vehicles and related safety precautions.
NATEF Task Area A-6 Electrical & Electronic Systems

B. Battery Diagnosis & Service

A6.B.9 Identify electronic modules, security systems and/or radios that require re-initialization or code entry following battery disconnect.
Identify hybrid vehicle auxiliary (12v) battery service, repair and test procedures.
Perform starter current draw tests; determine necessary action.
A6.C.2 Perform starter circuit voltage drop tests; determine necessary action
NATEF Task Area A-6 Electrical & Electronic Systems

C. Starting System Diagnosis & Repair

A6.C.3 Inspect and test starter relays and solenoids; determine necessary action.
**TERMINAL 85: GROUND**
This terminal can be interchanged with TERMINAL 86 or trigger as the switching means.

**TERMINAL 86: TRIGGER**
When fed voltage, this terminal causes the relay to switch "on" and feed current from the INPUT 30/51 to OUTPUT 87. This terminal is interchangeable with TERMINAL 85 (ground) as the switching means.

**TERMINAL 87: OUTPUT**
This terminal outputs 12v from 30/51 when the relay is switched "on." Used to feed accessory.

**TERMINAL 87a: OUTPUT**
In some relays, this terminal mimics output with TERMINAL 87. In other relays, this terminal will output power when the relay is "untriggered" meaning it is hot when the relay is "off" and goes cold when the relay is "triggered" or "on."

**NOTES:** terminals 30/51 & 87 are "normally open" and carry nothing thru when 85 & 86 have no current. When 85 & 86 have current supplied to them (are "triggered"), 30/51 & 87 close completing the circuit. 30/51 & 87 can carry +12v thru or they can also complete a ground circuit.
Remove and install starter in a vehicle.
A6.C.5 Inspect and test switches, connectors, and wires of starter control circuits

Diagram showing the electrical connections for starting system.
Differentiate between electrical and engine mechanical problems that cause a slow-crank or a no-crank condition.
A6.D.1 Perform charging system output test; determine necessary action
Diagnose charging system for the cause of undercharge, no-charge & overcharge conditions
Inspect and adjust generator (alternator) drive belts, pulleys and tensioners; check pulley and belt alignment.
Remove, inspect, and install generator (alternator).
Perform charging circuit voltage drop tests; determine necessary action.
Diagnose the cause of brighter than normal, intermittent, dim, or no light operation; determine necessary action
Inspect, replace, and aim headlights and bulbs.
Inspect and diagnose incorrect turn signal, brake, park or hazard light operation; perform necessary action.
A6.E.4 Identify system voltage and safety precautions associated with high intensity discharge headlights.

The color of light can be measured in “degrees Kelvin,” which refers to the “temperature” (shade) of light. Natural sunlight at noon is 4870 degrees K. Light produced by a HID xenon bulb is 4100 degrees K. Light from a standard halogen bulb is 3200 degrees K, and that from an ordinary incandescent bulb is 2800 degrees K. The lower the temperature rating, the more yellowish the light appears.

Blue-white light is better for visual perception, but yellow light is actually somewhat better for reducing glare in fog, rain and snow (that’s why fog lights are yellow).

The xenon bulbs that are used in HID lighting systems also produce three times the light output of standard halogen headlamps (3000 lumens versus 1000 lumens), and require less energy (35 to 42 watts versus 55 watts). This is possible because HID lighting systems work like a vapor-filled street light or metal halide lamp. HID bulbs typically produce 71 lumens of light per watt compared to 18 lumens of light per watt for standard halogen bulbs.
Inspect and test gauges and gauge sending units for cause of intermittent, high, low, or no gauge readings; determine necessary action.
A6.F.2

Inspect and test connectors, wires, and printed circuit boards of gauge circuits; determine necessary action.
Diagnose the cause of incorrect operation of warning devices and other driver information systems; determine necessary action.
Inspect and test sensors, connectors, and wires of electronic (digital) instrument circuits; determine necessary action.
Diagnose incorrect horn operation; perform necessary action.
Diagnose incorrect wiper operation; diagnose wiper speed control and park problems; perform necessary action.
Diagnose incorrect windshield washer operation; perform necessary action
Diagnose incorrect operation of motor-driven accessory circuits; determine necessary action
Diagnose incorrect heated glass, mirror or seat operation; determine necessary action.
Diagnose incorrect electric lock operation; determine necessary action.

This actuator can move the metal hook shown in this photo to the left or right. When mounted in the car, it is vertical, so the hook can move up or down. It mimics your motions when you pull the knob up or push it down.
Diagnose incorrect operation of cruise control systems; repair as needed.
Diagnose supplemental restraint system (SRS) concerns; determine necessary action. (Note: follow manufacturer's safety procedures to prevent accidental deployment)
Disarm and enable the airbag system for vehicle service.
Diagnose radio static and weak, intermittent, or no radio reception; determine action.
A6.H.8 Remove & reinstall door panel.
Diagnose body electronic system circuits using a scan tool; determine necessary action.
A6.H.10 Check for module communication (including CAN/BUS systems) errors using a scan tool.
Diagnose the cause of false, intermittent, or no operation of anti-theft systems.