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EVO: Electrical System

ELECTRICAL BASICS

Power Distribution is discussed in the Electrical Charging Section.

The Reference Section also has related information:

Basic Electrical Concepts

Buying & using a multimeter

See also Current Draw with Key Switch OFF

Wire Gauges - By Circuit

Typically, the MoCo does not publish the wire gauges used on their bikes. However, in the 1995-96 Electrical Troubleshooting Guide (99948-96), the wire gauges used on various circuits were listed. The following list should be fairly accurate for other models of this era, as well. I'm certain that some changes would have occured in later years, but in general, this list should guide you in making repairs of existing circuitry.

Battery cables, required to carry high current loads (up to 200amps) for the starter motor, must use heavy duty wire. Custom made battery cables, being relatively short on motorcycles, are typically made with 4 gauge wire, with 2 gauge wire chosen where the reduced flexibility can be accomodated or where required for a longer run from a more distant battery location.

A general discussion of Wire Gauge & Amperage Rating is included in the Reference section titled Electrical Concepts.

Wire Gauges used in the 1996 XL Main Harness are listed below. These are generalized across all models. Check your Electrical Diagnostic Manual for specifics of your model/year.

18ga wire was utilized for these connections:

- One of three Main Chassis Grounds

- Output of 10a/15a CBs (Circuit Breakers) to power circuits
- Starter Relay Coil Control from Starter Button
- Coil connections
- Horn connections
- Neutral Switch
- Oil Pressure Switch
- Ignition Module (except Ground)
- VOES
- Cam Position Sensor
- Rt Switch wiring (all)
- Instrument Cluster
- Turn Signal Module (except Power In)
- Rear Turn Signals
- Rear Taillight
- Front & Rear Stoplight Switch
- Position Lamp wiring (headlight)

16ga wire was utilized for these connections:

- One of three Main Chassis Grounds
- Lt Switch for High or Low Beam to Headlight
- Ignition Module Ground
- Turn Signal Module Power In

14ga wire was utilized for these connections:

- One of three Main Chassis Grounds
- Keyswitch into 10a/15a CB - feeds all
- From Keyswitch to Starter Relay
- Output of Starter Relay to Starter Solenoid
- Output of Voltage Regulator to Main Circuit Breaker [1)]

12ga wire was utilized for these connections:

- Battery Power to Main 50a CB (from starter stud junction)
- Main 50a CB to Keyswitch

In a thread by morvenhouse on the XLForum, he included this picture of the difference between his 6-AWG stock battery cable and the 3-AWG battery cable he made:

[2)]

Wiring Colors - By Function

HD has been quite consistent over the years in selecting wire colors based on the function they perform, although this practice was NOT ABSOLUTE in all models or years.

For example:[3)]

Blue wire was used throughout for regular lighting power
Yellow wire was used for low beam headlight power from the Hi/Lo Switch
White wire was used for high beam headlight power from the Hi/Lo Switch
Brown wire was used for the right turn signal power to the bulbs
Violet wire was used for the left turn signal power to the bulbs
Orange or Orange/White was used throughout for Accessory power

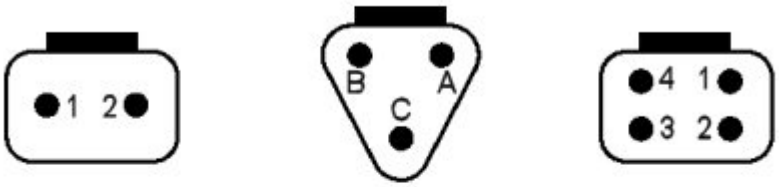
Connector Options

Here is a link to a great listing of connector and connection options. That web page discusses switches, wiring, connectors and tools. Contributed by Oldrump1 from the XLForum.net [4)]

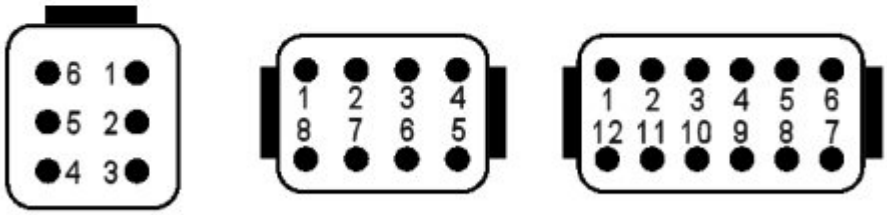
Deutsch Connectors

Example connectors - 6-pin & 12-pin Plug Connectors for Female Socket Contacts

Deutsch DT Connectors - Size 16 Contacts



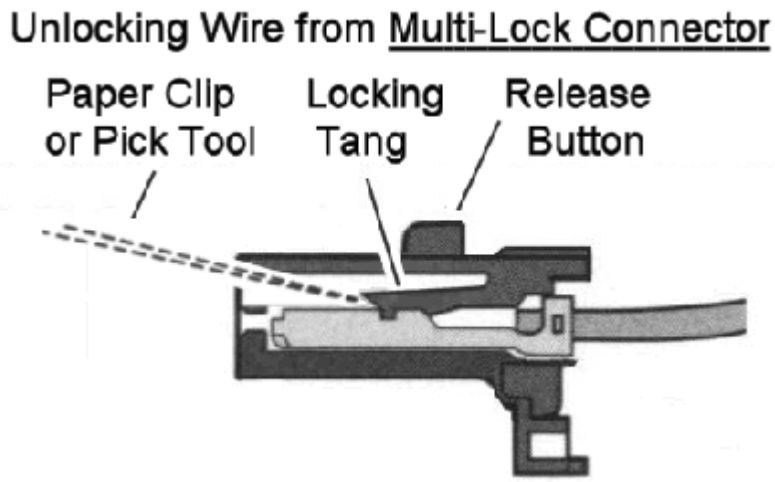
Pin Numbering - Wire insertion side of plug connector for female sockets



Receptacle Connectors use Male Pins
Plug Connectors use Female Sockets [5)]

Here's an XLForum Thread that shows **how to disassemble various connectors**.

For Multi-Lock Connectors, here's an animation of Removing the Wire From the Connector:



Molex Connectors

See TT#291 for a list of Molex Connectors & Pin/Socket Part Numbers.

Battery Cables - The Place to Start

A huge number of issues are caused by battery cable deterioration and/or loose connectors. The negative cable to the frame is especially critical. All Sportster models occasionally have trouble with the battery cables but it seems to be even more prevalent on the rubber-mounted engine models from 2004-up (since the motor moves more in relation to the frame).

(If you're having a No Start issue, after doing everyting mentioned in this section, have a look at the REF section on Troubleshooting a No Start Problem.)

The large Positive Battery Cable goes direct to the Starter Solenoid. There is another wire from the Battery (or from the Starter Solenoid) that feeds the Main Circuit Breaker (or Maxi-Fuse) for the system electrical & electronic devices.

The large Negative Battery Cable on the early models went to rear motor mount. Later, it was moved to the backside of the Primary cavity on the crankcase near the Starter Motor.

“I was checking the voltage at the battery against the voltage at the starter, at first it was the same. I moved the bike to get to the other side and double checked the voltage and it dropped significantly. I nudge the battery once and watched the voltage go to zero! I removed the positive lead and it appeared fine on the outside. One good pull on both ends and the end to the starter and about 2” of copper strands slid out from the insulating jacketing“, said TimC of the XLForum.[6)]

To check the battery cables - PULL HARD on both ends of both the positive and the negative cables where they mount to the battery and to the engine. There should be no looseness to the cable at the connector junction. Corrosion in the connectors and the wire itself can be hidden from your casual

examination yet will still cause severe loss in current capability. Therefore, PULL HARD to be sure they are solid.

If both ends are secure in their connectors, then verify that the bolts at each end of each cable are without corrosion and are firmly tight. Wrench tight.

Then use your voltmeter (multimeter, dvm, etc.) to measure the incoming voltage (from the battery) at the key switch. Then measure the outgoing voltage from each of the keyswitch positions. If you still have no power, continue checking downstream, thru the fuses, until you find the break in the voltage circuit.

[7]


[8]

As you can see in the pictures above, if the connections are not tight even the posts can melt due to high current arcing. The operational vibrations often loosen bolts of all sorts on the bike, including the battery cables. In addition to tightening the bolts, you can physically restrain the connectors with a zip tie around the battery post. With proper placement, even the rubber boots can be put back in place.

Battery Charge Level

Battery condition can be seen as the voltage of the battery after it has been charged. To verify that it is in a 100 percent fully charged condition, charge the battery and disconnect the charger. **Let the battery rest for one to two hours**, then check the voltage level.

AGM-type Batteries

Voltage Reading	12.7	12.6	12.3	12.0	11.8
Percent Charged	100%	75%	50%	25%	0%

Older-style Sealed Lead Acid Batteries

Voltage Reading	13.0	12.8	12.5	12.2	12.0
Percent Charged	100%	75%	50%	25%	0%

9)10)

Be sure your multimeter BLACK Probe is properly grounded to the Battery Negative Post or to the frame.

The above charts reflect the charts in the HD manuals as footnoted. Some other reference sources may indicate that SLA voltages are typically lower than AGM voltages. Check the manufacturer's specifications for your specific battery if you have any questions.

Also see additional information on batteries in the REF Section.

Battery Voltage Readings

From the XLForum.net [11)]

Whenever there is a problem that may even remotely be electrical, it is important to know the quality of power with which you are operating. This is why you should have a volt-ohm meter (DVM/Multimeter) and take voltage readings, as described below, as part of your initial diagnostics.

Be sure to connect your BLACK Probe directly at the Battery Negative Post to take a reference Battery Voltage Reading - or use the frame once you have established that the battery voltage (taken on the Battery Positive Post) is the same with the BLACK Probe on the Battery Negative Post -and/or- on the frame.

When there is “no power” at all, check the main circuit breaker or maxi fuse (usually 30amp) located near the battery - Power is supplied from the battery, thru the MaxiFuse to the key switch. Check to be sure the MaxiFuse is not blown - If that is good, then, check all the remaining fuses. The 1997-earlier models (including ironheads) have thermal circuit breakers which are self-resetting. Although quite resilient, these will fail from time to time.

Corrosion can be a real power killer. It can degrade the quality of your voltage significantly and your geographic location can be a factor in the potential for corrosion. Be sure to check both the front and back of the fuse box/panel for corrosion, especially on the 2007-later models where the fuse box is in a very exposed area and subject to standing water.

If the fuses/circuit breakers are OK, check the keyswitch itself.

Remember - Many suspected fuel issues turn out to be electrical. Some suspected ignition module issues (rigid mount) turn out to be voltage quality related. So do a through check on these systems.

Taking Voltage Readings - You need to know the following voltage readings (and provide them to your tech or when asking questions on the forum):

SUMMARIZED - Basic Battery Voltage Test
Take a voltage reading across the battery POSITIVE and NEGATIVE terminals...

1) With the keyswitch off (should be 12.8v or more)
2) With the keyswitch on - but engine not running (should be 12.5v or more)
3) With the keyswitch on, while cranking the starter (should be 10.5v or more)
4) With the engine running with a slightly elevated rpm above idle (should be 13.5v or more)

Also check the Key Switch for proper function & test for constant current drain. Link to function & testing info.

THE DETAILS

- **1. KEY OFF** battery voltage, at the battery: Normal is 12.8, acceptable is 12.6 to 12.8 for no load. If just taken off a charger, voltage may be 13 point something, but battery should be allowed to 'rest' for 1-hour before taking qualified readings. In the case of a bad cell, the other cells overcharge and give an almost normal reading, until load is applied.
    - If lower, then battery is discharged and needs charging or
    - Battery has a bad cell
- **2. KEY ON** battery voltage (headlight on): Normal is not under about 12.5 initially, but will decline the longer that the headlight is on, without the motor running. Under no load, 12.5 volts indicates 50% discharge, but under load, it is just voltage drop.
    - If lower, then battery is discharged and needs charging or
    - Battery has a bad cell or
    - Battery cable(s) have high resistance
- **3. KEY ON - While Cranking** the starter motor: Normal is not under 10.5 volts
    - If lower, then battery is discharged and needs charging or
    - Battery has a bad cell or
    - Battery cable(s) have high resistance or
    - Starter is drawing too much current
- **4. KEY ON - Bike Running** at 2500 RPMs: Normal battery voltage should be 13.8 to 14.8
    - If not, then check stator internal resistance and whether either end of stator is grounded
    - If the stator resistance is within spec and is not shorted to ground, the regulator or regulator ground is suspect

(Above references are typical of AGM batteries - lead-acid battery readings can be slightly different)

Grounding is Critical

Ground connections on the bike are like a spider web - they should all be interconnected through the various ground bolts, harness connectors and individual components. There should only be a very slight difference in resistance between any two ground points in the entire system. If there is excess resistance between any ground point and the negative battery terminal, there is something loose, frayed, corroded or disconnected.

Over the years, HD has grounded the Sportster electrical systems in a number of ways.

1993-Earlier - For these models, **components were grounded to the frame** at a nearby point. Power was distributed throughout the system on a minimal number of wires in the wiring harness. However, there are two harness-like ground wires that connect to the frame below the battery & brake hose clamp. They include grounds for the **Starter Relay**, **Turn Signal Canceller**, **Ignition Module** and **Horn**. Be sure these ground wires are clean & tight.

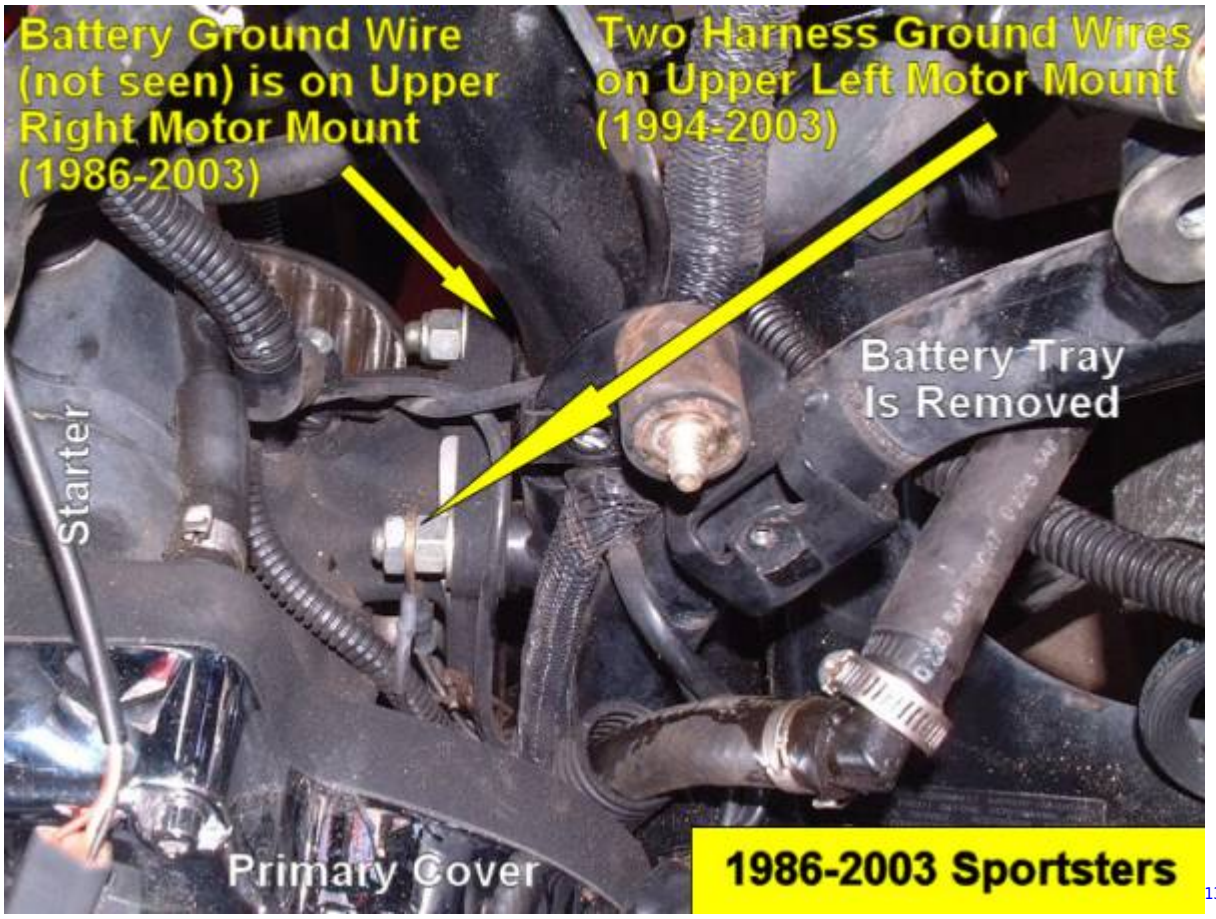
There could be as many as a dozen points on the frame used for grounding other devices. The front turn signals (on the handlebars) were grounded thru a connecting strap between the fork riser bolts & the triple tree.

12)

Beginning in 1994, the wiring harness itself began to carry ground wires to various components. The wiring harness by then consisted of many separate power wires to multiple locations, with a number of circuit breakers protecting the various circuits from overload.

The battery ground cable and the common wiring harness ground wires connect to the engine. Up through 2003, the ground wires connected onto the upper left (or right) rear engine

mounting bolt. After the bolt & nut secured the engine to the frame, the battery & harness cables are placed onto the extended bolt and a lock nut is then used on the same bolt - this secures the cables to the engine & frame. There were still devices that grounded thru the frame (back to the battery), such as the horn, the oil pressure indicator switch and the neutral indicator switch.



13)

Beginning in 2004, the Rubbermount models have the wiring harness grounds collected to a single point on the engine called the **Powertrain Ground Point**. Located near the starter motor, this PGP is a dual-threaded stud mounted horizontally to the engine case with the ground wires from the wiring harness attached by a nut.

Similarly, there is another dual-threaded stud to mount the negative battery cable to the crankcase. This ground point is particularly subject to thread corrosion between the stud and the engine because the stud socket on the engine is a vertical hole. When water gets in the threads, causing corrosion, there are erratic electrical problems created throughout the system.

If a bike of these model years experiences erratic electrical problems, be sure to remove this stud and thoroughly clean the female threads on the engine. Then, clean the stud threads on both ends and apply a copper-based antiseize compound on reassembly to provide the best electical conductivity and minimize future corrosion.

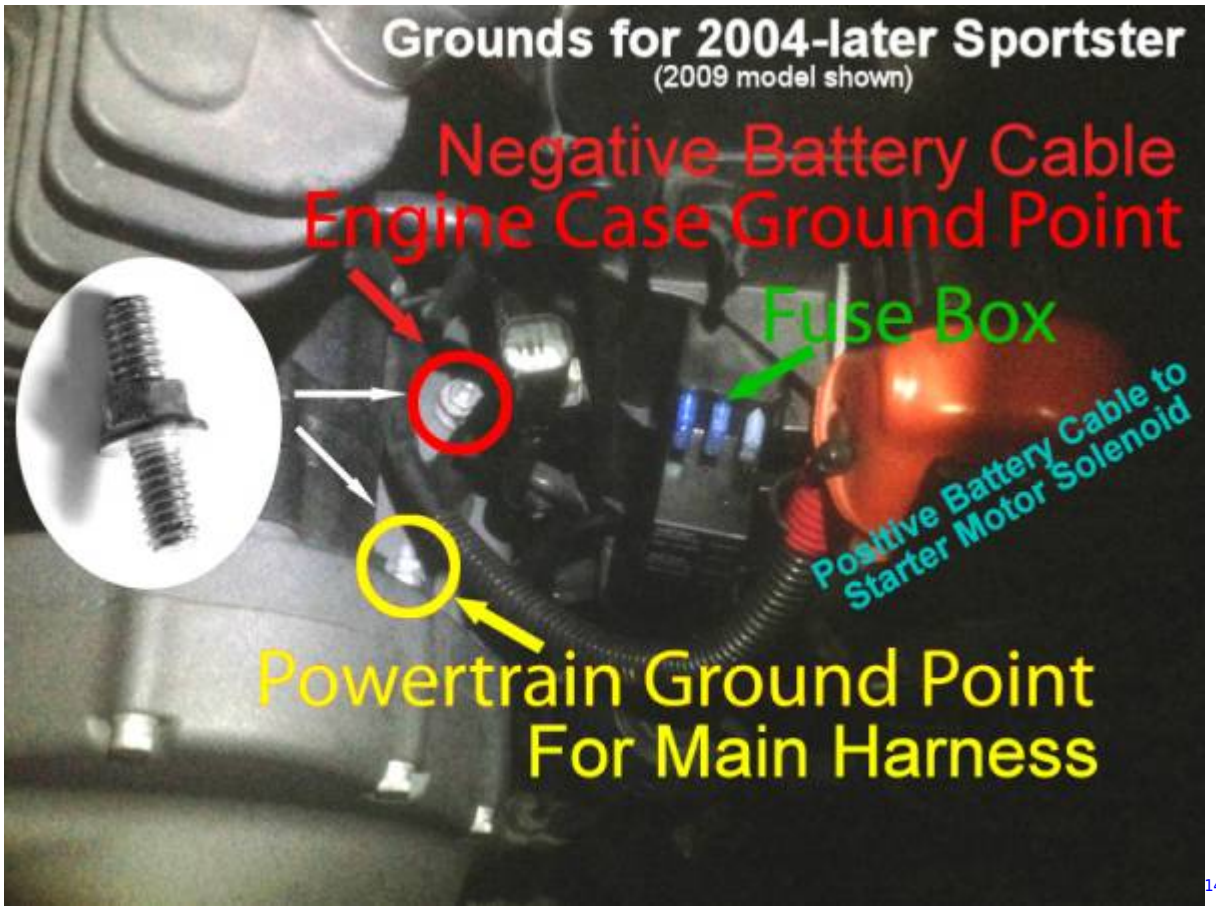
Some folks have moved the Battery Ground Cable off the vertical stud and placed that on the other stud which is located horizontally on the top of the crankcase at the Primary Cover. This stud is less likely to have the corrosion problem. This move can be done as a solution or as a preventative action.

Another point that must not be overlooked is the **grounding strap** that attaches between the engine and the frame. It is located in parallel with the torsion tie bar UNDER THE REAR OF THE ENGINE. Remove the strap and thoroughly clean both connecting points and reassemble with copper-based antiseize compound as suggested above.

A recurring problem has been the **battery ground cable** from the negative battery terminal to the engine/frame ground point. This cable often fails with internally broken wire strands or excessive corrosion. This condition is aggravated by storing the bike outdoors.

Here is a link to a very long XLForum Thread about corrosion in the threads of the Engine Ground bolt (might be used for Powertrain Ground Point or Battery Negative cable depending on year). That corrosion degraded the voltage to the engine significantly. Also, more reading HERE regarding battery cables.

2004-later has two main ground points - Engine Case Battery Ground & Power Train Ground (AKA GND1) (2004-2007 may have these reversed with battery ground on primary cover & harness ground on case stud)



14)

There is an Engine-to-Frame Grounding Strap under the rear of the engine

15)

Testing for Proper Grounds

It's possible to use a volt/ohm meter, or Digital Volt Meter (DVM), to check the resistance from any ground point on the bike back to the negative battery terminal. Such resistance checks can discover problems. To do this type of check, the meter is set on a low resistance scale (less than 100ohms if possible).

BE SURE TO ZERO THE METER - When using the ohms scale on any meter, before taking measurements be sure to Zero The Meter. This means, put both meter probes together & see what the reading indicates. Often, the meter will read a small bit of resistance. When making ground checks, this 'small bit of resistance' must be accounted for in your readings. If the probes together show 0.25 ohms of resistance and you check a ground point as 0.60 ohms, you need to subtract the probe resistance from the reading – 0.60 minus 0.25 equals a true reading of 0.35 ohms at the ground point being checked.

The negative battery cable should be removed from the battery (to disable power on the bike). One lead of the meter is placed on the battery end of the negative cable (now disconnected from the battery) while the other end is placed on the ground point being checked. If properly connected, the meter should read a very low resistenace, nearly ZERO (usually less than one ohm).

Using a test light - A quick and dirty test (although not able to detect borderline issues) can be performed with a powered test light connected between the negative battery cable and the ground point under examination. These test lights sometimes look like pens or screwdrivers with a pointed probe and a small internal battery. If the light illuminates, there is a circuit connection between the two points being tested. This is similar to using the multimeter continuity check. The meter also sends power through the circuit to see if the circuit is completed.

There is another method for testing grounds. You can test ground connections using voltage checks. This uses the voltage setting of the meter and does not require you to remove the negative battery cable. With this method, you will use the battery itself to test for continuity to various ground points on the bike. A digitial multimeter (DVM) is prefered for this method.

First, set your meter to read DC voltage where 12 volts is easily measured (maybe the 20v scale). Place the red lead from the meter on the positive battery terminal. In fact, you should find a way to clamp it on that terminal (maybe using a plastic spring clamp). Be very careful not to short the positive terminal to any part of the bike.

Now measure a **REFERENCE VOLTAGE**. Place the black lead on the negative battery terminal to take an initial voltage reading of the battery itself. This voltage should be close to 12.8 DC volts. Whatever your voltage reading, directly on the battery, will be called the **REFERENCE VOLTAGE**.

When checking the voltage between the positive terminal of the battery and ANY GROUND POINT on the bike, you should have a voltage reading very close to the Reference Voltage (like 12.8v above). Every single ground point on the entire bike should measure within .3v of this reading (~2%).

So, if you take the black lead to the other end of the negative battery cable, on the powertrain ground or engine, it should measure near the Reference Voltage. If you take the black lead to the ground pin on the headlight connector, it should measure near the Reference Voltage. If you take the black lead to the ground pin in the taillight connector, it should measure near the Reference Voltage. If you take the black lead to the cylinder heads (next to the spark plugs), the meter should read near the Reference Voltage.

IN EVERY CASE, the red lead is still on the positive battery terminal and the ground point you are testing should have a good connection back to the negative battery terminal through the ground connections of the wiring harness, the powertrain ground, the frame and the battery engine case ground point. If ANY GROUND POINT does not measure within .3v of the Reference Voltage, there is something loose, frayed, corroded or disconnected which causes the voltage loss. [16)]

P&A Battery Connector (2004-later)

The Parts & Accessory Battery Connector (AKA B+ Connector), which is included on 2004-later Sportsters, allows the connection of electrical accessories directly to constant battery power. Besides the Maxifuse, this connection has no fuses or circuit breakers, so it is important that all accessories connected to this B+ Connector have their own fuses to protect the wiring. Do not exceed the total capacity of the Maxifuse.

A blank P/N 72100-04 mating connector is installed on the B+ Connector from the factory. This will allow you to add your own wire using one of the crimp on contacts as listed below. Most accessory items intended to use this B+ Connector already include a wire terminated with the appropriate contact.

To create your own functioning mating connector, select the contact you need from the list below to crimp on your wire. The HD connector parts below are from the (Aptiv) Delphi Metri-Pack 480 series. Those P/N's are also shown.

Description	HD P/N	Delphi P/N
Connector Shell	72100-04	12015987
Contact (for wire #12 AWG)	72105-04	12052827
Contact (for wire #14-16 AWG)	72101-04	12020120
Contact (for wire #18-20 AWG)	72107-04	12020119
Contact (for wire #20-22 AWG)	72125-04	12066269

P/N 70270-04A is a pre-made splitter cable to allow a total of 3 connections. If your added device does not already have a pre-terminated wire, you will require the above parts for each of the 3 connections.

See this part of TT#57 for information.

5 Volt Sensor Supply

Starting with the 1998 Sport model, the ICM/ECM has provided a +5v power output for various sensors. The MAP sensor seems to have been the first sensor that required such a voltage.

Below is a listing of where the +5v supply is connected for various years and various devices, along with the listing of where the similar Sensor Ground wire is connected. Notice that not all devices that were powered by the +5v supply used the specialized sensor ground connections.

These connections do not have a history of failures, but if you have problem symptoms on multiple sensors, be sure to trace out these lines (both supply & grounds) to eliminate them as a potential source of the issue.

1998-2003 Sport Ignition Control Module ICM GRAY Connector Pin 1 is +5v Output (RED/White Wire) ICM GRAY Connector Pin 8 is Sensor Ground (BLACK/White Wire)	1998-? MAP Sensor Connector 80B - Pin 1 - 5v Sensor Power (R/W Wire) MAP Sensor Connector 80B - Pin 3 - Sensor Ground (B/W Wire) CAM Sensor Connector 14B - Pin A - 5v Sensor Power (R/W Wire) CAM Sensor Connector 14B - Pin C - Sensor Ground (B/W Wire) ?-2003 MAP Sensor Connector 80B - Pin C - 5v Sensor Power (R/W Wire) MAP Sensor Connector 80B - Pin A - Sensor Ground (B/W Wire) CAM Sensor Connector 14B - Pin A - 5v Sensor Power (R/W Wire) CAM Sensor Connector 14B - Pin C - Sensor Ground (B/W Wire)
1998-2003 models other than the Sport model do not produce or utilize 5v power.	

2004-2006 Engine Control Module ICM Connector Pin 3 is +5v Output (RED/White Wire) ICM Connector Pin 4 is Sensor Ground (BLACK/White Wire)	MAP Sensor Connector 80B - Pin C - 5v Sensor Power (R/W Wire) MAP Sensor Connector 80B - Pin A - Sensor Ground (B/W Wire) VSS - Vehicle Speed Sensor Connector 65B - Pin 1 - 5v Sensor Power (R/W to RED Wire) VSS - Vehicle Speed Sensor Connector 65B - Pin 3 - Uses Powertrain Ground (BLACK Wire)
2007-2013 Engine Control Module ECM Connector Pin 14 is +5v Output (RED/White Wire) ECM Connector Pin 26 is Sensor Ground (BLACK/White Wire)	**5v power is fed from ECM Pin 14 to all of these connections:** VSS Connector 65B - Pin A (BLACK/Red Wire) – (VSS uses Powertrain Ground Point (BLACK Wire)- Not 5v Sensor Ground) (2008-later)Jiffy Stand Connector 133B - Pin 1 (R/W Wire) – (JSS uses Powertrain Ground (BLACK Wire)) —- (This connector on all models may have an issue due to its location) Passes Thru Engine Harness Connector 145A/B - Pin 5 (R/W Wire) TMAP Sensor Connector 80B - Pin C (or 3) (R/W Wire) TPS Sensor Connector 88B - Pin B (R/W Wire) **The following devices are grounded thru the ECM on Pin 26:** ETS - Engine Temp Sensor - Pin 2 (B/W Wire) Front O2S - Oxygen Sensor - Pin 2 - (B/W Wire) Rear O2S - Oxygen Sensor - Pin 2 - (B/W Wire) Passes Thru Engine Harness Connector 145A/B - Pin 3 (B/W Wire) TMAP - Temp/Manifold Abs Pressure Sensor - Pin A (or 1) - (B/W Wire) TPS - Throttle Position Sensor - Pin A - (B/W Wire) ECM Connector Pin 10 & 28 are Power Grounds - They go to the Powertrain Ground Point

2014-later CANbus Engine Control Module ECM Connector 2 - Pin 9 is +5v Output (RED/White Wire) ECM Connector 2 - Pin 7 is 5v Sensor Ground (BLACK/White Wire)	**5v power is fed from ECM Connector 2 - Pin 9 to all of these connections:** VSS Connector 65B - Pin A (R/W Wire) – (VSS uses Powertrain Ground Point (BK/GN Wire)- Not 5v Sensor Ground) JSS - Jiffy Stand Sensor Connector 133B - Pin 1 (R/W Wire) – Uses Powertrain Ground (BK/GN Wire) —- (This connector on all models may have an issue due to its location) Passes Thru Engine Harness Connector 145A/B - Pin 8 (R/W Wire) to: TMAP Sensor Connector 80B - Pin 3 (R/W Wire) TPS Sensor Connector 88B - (2014 its on Pin 1 (later years its on Pin B)(R/W Wire)) **The following devices are grounded thru the ECM on Connector 2 - Pin 7:** ETS - Engine Temp Sensor - Pin B (B/W to TAN Wire) Front O2S - Oxygen Sensor - (138A/B)Pin 4 - (B/W to BLACK Wire) Rear O2S - Oxygen Sensor - (137A/B)Pin 4 - (B/W to BLACK Wire) Passes Thru Engine Harness Connector 145A/B - Pin 6 (B/W Wire) TMAP - Temp/Manifold Abs Pressure Sensor - Pin 1 - (B/W Wire) TPS - Throttle Position Sensor - (2014 its on Pin 2 (later years its on Pin A) (B/W Wire)) ECM Connector 1 & Connector 2 - Pin 10 are both listed as Sensor Grounds (BK/GN) —- These are General Grounds - They go to the Powertrain Ground Point

Tip For Hunting Down Short Circuits

If you are attempting to locate a short circuit, rather than continuing to replace fuses while looking for the problem, you can use a test light in place of the fuse at the fuse block. [17)] Start removing one load at a time or wiggle wires. When the light goes out, examine the wiring on the portion of circuit last disconnected for the cause.

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1)

https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-electrical/sportster-motorcycle-electrical-and-ignition/189707-stator-regulator-wire-gauge?t=2022873

2)

https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-era-specific-and-model-specific/rubber-mount-sportster-motorcycle-talk-2004-2006/138767-an-electric-starter-guide?t=1506137 - Pic from morvenhouse - Annotated by IXL2Relax

3)

sportsterdoc of the XLFORUM.net

4)

https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-electrical/sportster-motorcycle-lighting/184283-diy-wiring?threadid=1979596

5)

Illustration created by IXL2Relax at the XLForum

6)

https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-era-specific-and-model-specific/frame-mount-evo-sportster-talk-1986-2003-models/139448-1200s-check-engine-sputter-backfire?t=1513037

7)

https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-electrical/sportster-motorcycle-electrical-and-ignition/195261-why-tight-battery-cables-are-important?t=2071578 - Pic from The Doctor71 - Annotated by IXL2Relax

8)

Pic from SportsterPaul

9)

2016 Sportster Owner's Manual

10)

1998 Sportster Service Manual

11)

from sportsterdoc of the XLFOUM https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-electrical/sportster-motorcycle-electrical-and-ignition/166144-voltage-readings-why-we-need-them?t=1784651 with slight modifications

12)

https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-era-specific-and-model-specific/frame-mount-evo-sportster-talk-1986-2003-models/197175-1991-frame-engine-original-ground-locations?t=2073777 - Pics from John Harper - Annotated by IXL2Relax

13)

https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-electrical/sportster-motorcycle-electrical-and-ignition/180689-looking-for-a-pic?t=1944256 - Pic from decman - Annotated by IXL2Relax

14) , 15)

https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-electrical/sportster-motorcycle-electrical-and-ignition/176231-nightster-electrical-problems-not-sure-where-to-go-from-here?t=1891463 - Pic from Chopsticks - Annotated by IXL2Relax

16)

Contributed by IXL2Relax of the XLFORUM.net

17)

HD Tech Tip #48 dated August 1998