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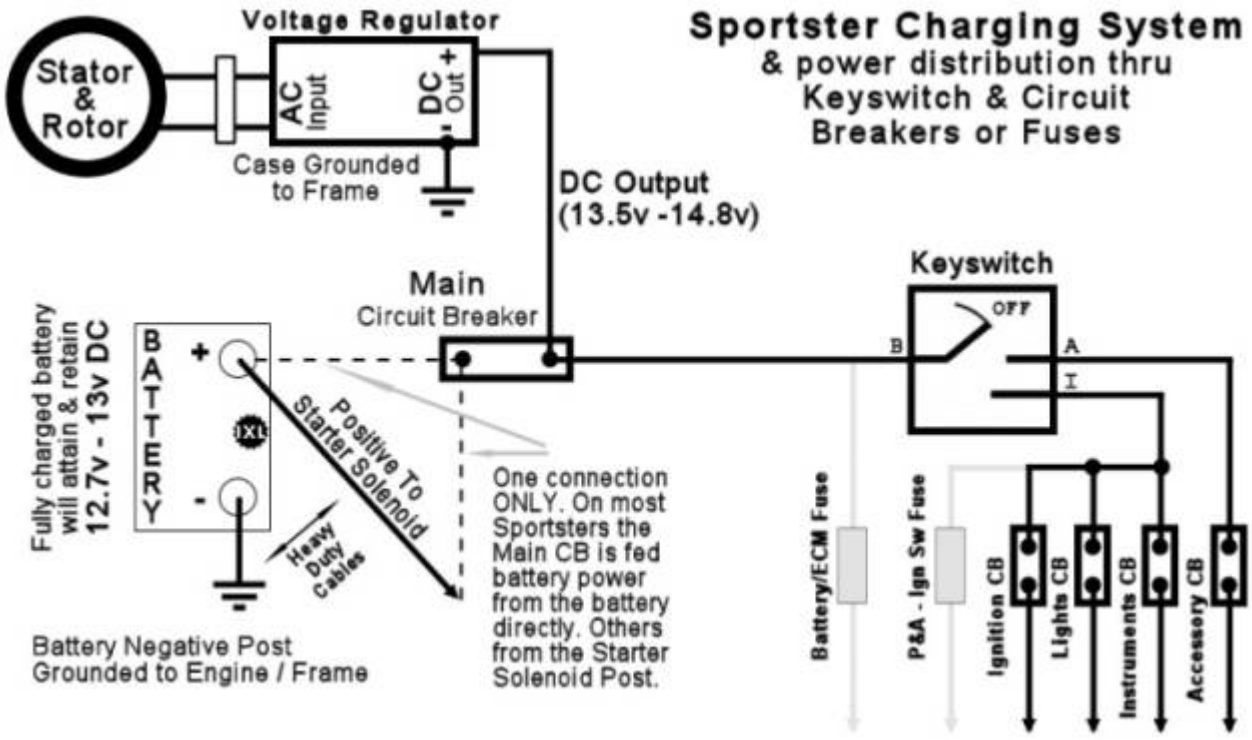
EVO: Electrical System

FUSES, RELAYS, CHARGING SYSTEM

Be sure to review the basic Electrical Concepts in the Reference Section, especially wire gauging.

See also Current Draw with Key Switch OFF

OVERVIEW: Charging System and Power Distribution



Note: Most people think of electricity in regards to voltage (as power), with power flowing from positive to negative to complete the circuit. For that reason, this explanation ignores the scientific facts of actual electron flow when conceptualizing the charging process, relationships and power distribution. This description includes the concept that power flows from the most positive source to the lesser positive connection (sometimes thru various devices) and eventually to the negative, ground, point. Voltages are typical (such as 12v) with exact values varying under differing circumstances.

The overview diagram is representative of a typical system and not exact for a specific Sportster model. Although later models have a more complicated distribution scheme, the charging components and operation are functionally the same for all models with alternators (Stator/Rotor). Some model wiring diagrams are in the Sportsterpedia. Refer to your FSM for detailed wiring diagrams, procedures & tests for your specific model.

The Basics

A fully charged, good battery, with no load, will show 12.7v - 13v DC when measured on a multimeter. Under light load the battery will read 12.5v and under heavy load (starting the engine) it will read 10.5v or more. The achieved voltage output of the Battery and/or Regulator, under load, will vary according to the existing charge level of the battery, load of the bike circuitry and the Stator output from engine RPMs.

When the engine is running, the Rotor magnets rotate around the coils of the Stator, producing an alternating current (AC) output. This AC output is fed to the Voltage Regulator (VR) which converts the AC to Direct Current (DC) and limits (regulates) the voltage level of it's DC output. Typical, regulated, charging voltage is 14.5v (+/-.2v) to the battery & system when the battery is fully charged.

Distribution

On most Sportster models, power from the battery positive terminal is sent to the high current terminal of the Starter/Solenoid using heavy gauge wire (for maximum power during starting) and another, lighter gauge, wire from the battery positive terminal is sent to the Main Circuit Breaker. However, for some models the wiring was slightly different. There was still a heavy gauge wire to the Starter/Solenoid terminal, but then the lighter gauge wire ran from the Starter/Solenoid terminal to feed power to the Main CB. In either case, the Main CB is (essentially) getting power directly from the battery with no other devices interrupting that flow.

The function of the Main Circuit Breaker is to protect most of the electrical wiring. The high current wire from the battery to the Starter/Solenoid cannot be protected from ground shorts. For this reason, **the battery should be disconnected when working on the electrical system of the bike to prevent accidental shorts.** Obviously, you need the battery connected when doing voltage tests. In that case, be EXTREMELY CAREFUL not to create any shorts.

The Main Circuit Breaker prevents shorts (from connected devices and in the electrical wiring) from drawing more than 30 Amps of power from the battery (which is capable of supplying more than 200 Amps). Under a dead short condition, the Main CB will break the connection, automatically reset (after a brief period) and break the connection again if the short remains. This will continuously repeat making a clicking sound as the CB breaks and remakes connections. If using a fuse, it will simply melt, then remelt the replacement fuse if the short remains.

Many circuit breakers have Copper & Silver colored terminals to identify the typical connection for power

input (Copper for incoming Battery power) and the load (Silver for outgoing to the electrical circuits). When a CB has color identified terminals, the Copper Terminal is internally designed to be safer than the Silver Terminal in case of an internal failure of the CB.

Whether using autoreset Circuit Breakers or Fuses, the function and purpose is the same - to protect the wiring from overloads. As far as conductivity, **Fuses & Circuit Breakers function just as if they were a simple piece of wire.** The only difference is that they are rated for a certain current load and then disconnect if too much current runs thru them. There are no internal parts to keep voltage from flowing either direction.

The number of separate circuits that are created and protected by individual fuses varies by model. The four main circuits are: Accessory, Ignition, Lights & Instruments. In later models, Battery & ECM fuses were added to supply constant power to computerized modules even when the keyswitch is OFF.

The Keyswitch has two active positions - Accessory & Ignition (see diagram). The accessory position (A) provides power for a small subset of electrical devices that may need to operate without the engine running, like the brake light & flashers, in an emergency breakdown. The ignition position (I) operates the remaining operational electrical circuits to power all other devices. The incoming power connection is identified as (B) for battery. When the keyswitch is in the Ignition position, the accessory connection is still active and still feeding power thru the accessory circuit breaker. Remember, when the battery & main CB (or Main Fuse) is connected, the Keyswitch is getting power from the battery, even when the Keyswitch is in the OFF position (not sending power to the rest of the circuitry). An internal short in the Keyswitch may still occur, popping the CB. Sometimes too many things hanging on the key ring, blowing in the wind, will overstress the keyswitch and cause internal failures.

Functioning

The Main CB has the battery positive voltage connected on the input side (Copper Terminal) and the Voltage Regulator (VR) positive output voltage connected on the output side (Silver Terminal). The output side of the Main Circuit Breaker (where the VR is connected) also is wired to the input connection of the Keyswitch. This allows either the battery or VR to supply the operatonal power for the bike.

Starting the Engine: Since the charging system (Stator & VR) does not produce any power until the engine is running, we need the battery to get the engine running. With the keyswitch on, power flows out of the battery, into the Copper terminal of the Main CB, out of the Silver terminal of the Main CB, thru the keyswitch, then thru the Ignition CB to the RUN switch. Power, thru the Ignition CB, is also sent to the controlled terminals of the Starter Relay. With the RUN switch ON, pressing the starter button will activate the Starter Relay to send battery power to activate the starter/solenoid.

ReCharging the Battery: Once the engine fires and is running, now the Voltage Regulator (VR) is producing power (voltage) that is more than the battery voltage (especially since the battery just used power to operate the starter motor). So, power will flow out of the VR, into the Silver terminal of the CB, out of the Copper terminal of the CB, to the battery. This is how the Stator & VR now recharges the battery back to full power. The power flows from the higher VR voltage back into the lower powered battery.

At the same time, when the engine is running and the VR is charging the battery, the VR also provides enough power to operate the rest of the electrical needs of the motorcycle. This VR power now takes over from the battery (which was used when the bike wasn't running) and is sent thru the keyswitch to

be distributed thru the individualized CBs to the ignition circuit, lights circuit, accessories circuit, etc.

You should notice that in starting the engine, power flows one way thru the Main CB (Copper to Silver) and in recharging the battery the power will flow the opposite direction thru the CB (Silver to Copper). The circuit breaker, when not overloaded, functions as a simple piece of wire, allowing power flow either direction. Power will flow in the direction needed to equalize the voltage or feed the load, from high to low.

The charging function operates just like when you put an external charger on the battery. The positive wire on the charger is connected to the positive post on the battery (and negative to negative, grounded). Then power will flow from the charger to the battery to raise the voltage of the stored power in the battery.

Be sure that the battery wire is connected on one side of the Main CB while the VR & Keyswitch are connected on the other side. This arrangement prevents destructively high current flow (and potential fire) on the wiring in case the VR or Keyswitch develops an internal failure, like a short circuit to ground. Note that a few HD wiring diagrams incorrectly showed the VR connected to the battery side of the CB. If the bike you have is actualy wired that way from the factory, it should, for safety, be changed to the proper connection location.[1)]

After starting the bike, the charging system will take time to re-charge the battery. If you have had difficulty starting the bike or the battery has not been used or charged for quite some time, it may not be fully charged until the bike has been ridden several hours.

When the battery is fully charged (externally or ridden), it may have a voltage higher than expected just afterward. It is important to rest the battery for one hour after the charging is complete. This one hour 'rest period' allows the battery voltage to stabilize in the battery cells. After the one hour rest period, if the battery is capable of holding a full charge, measuring the battery voltage should still show it at 12.7v - 13v DC. This is a full charge condition.

Circuit Breakers & Fuses

The Circuit Breakers (CB) used on Sportsters are of the self-resetting type. Once they break contact, they will automatically reset after a period of time. These breakers function based on a bi-metallic strip that is heated by current flowing through the strip. More current will cause more heat.

If the rated amperage for the CB is exceeded, the strip will be overheated, causing it to bend away from the internal contact, thereby opening the circuit and removing the current flow. Once the bi-metallic strip has cooled sufficiently, it will return from its heated position and once again make contact. This will allow the current to begin flowing again. If the circuit is still drawing excessive current, the CB will repeat the open & close cycling until the current level is reduced below the current rating and no longer causing the bi-metallic strip to overheat.

The circuit breakers have copper (incoming power) and silver (outgoing power) colored terminals. The copper terminal of the Main Circuit Breaker is the input side for the battery. [2)] The keyswitch is attached

to the output side, the silver terminal. Also, the wire from the Voltage Regulator (VR) attaches on the (silver) output terminal, then passes current thru the circuit breaker in reverse direction to charge the battery. CAUTION: You should NOT run the output wire from the Voltage Regulator on the copper terminal of the circuit breaker, nor directly to the battery positive terminal, even if the original wiring was connected that way. Connecting in that way would allow a failing VR to short the battery to ground, pulling hundreds of amps of current from the battery and potentially causing a fire.

Although very reliable, over time & usage, the CB may no longer function at the rated current, requiring replacement of the Circuit Breaker.

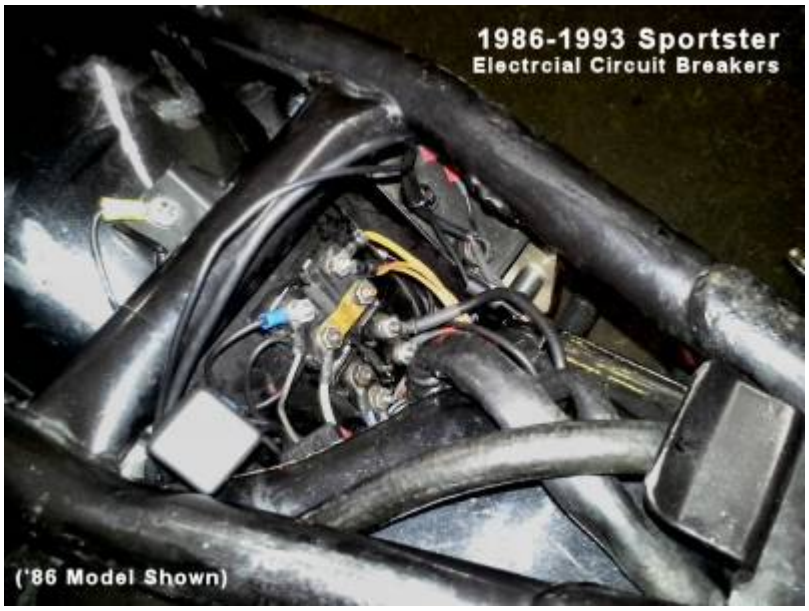
Starting in 1998, the individual circuits were protected with fuses (rather than circuit breakers), while the overall system was still protected with a self-resetting circuit breaker. In 2004, the overall system protection was implemented with a Maxi-Fuse.

The following quotation makes the point that fuses are often slow to react to overcurrent situations. It is critical to replace rated fuses with the same rating in order to properly protect the circuits.

> First, fuse ratings can be a bit misleading. A 10A ATO (automotive) fuse will conduct 11 amps for 100 hours minimum. At 13.5 Amps a 10A ATO fuse can take as long as 10 minutes to blow. It is not like once you draw 10 amps “poof” the fuse is gone. (From FUSE SIZING PRIMER located at http://www.powerlet.com/learningCenter/fuseSizing)

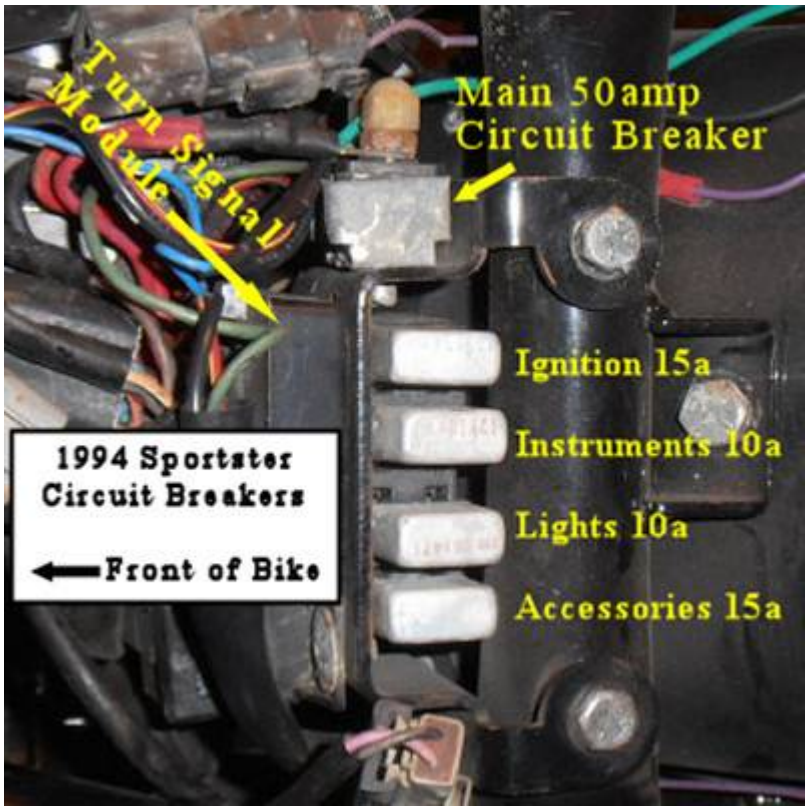
(1984L-1990)

- All 1986 to 1990 models have 4 circuit breakers mounted on the front side of the rear fender under the seat. [3)]
- Circuit Breakers (CB) - Under Seat - Automatically Resettable - Ring Lugs for wiring
  - 30A - Main Circuit Breaker - Bolt Stud Type
- Keyswitch
  - 'Ignition' position (White Wire) runs to Ignition & Accessories CBs
  - 'Lights' position (Green Wire) runs to Lights CB
  - Both Keyswitch positions feed all CBs because of jumper between Ig & L at Keyswitch
- Circuit Breaker Ratings - Bolt Stud Type
  - 15A - Lights CB
  - 15A - Ignition CB
  - 15A - Accessories CB



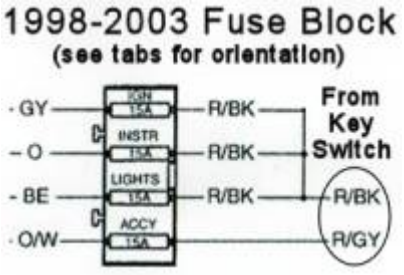
(1991-1993) [4)]

- All 1991 to 1993 models have 4 circuit breakers mounted on the front side of the rear fender under the seat. [5)]
- Circuit Breakers (CB) - Under Seat - Automatically Resettable - Ring Lugs for wiring
  - 30A - Main Circuit Breaker - Bolt Stud Type
- Keyswitch
  - 'Ignition' position (White Wire) runs to Ignition & Accessories CBs
  - 'Lights' position (Green Wire) runs to Lights CB
  - Both Keyswitch positions power all CBs because of a buss bar at the CBs (or a jumper between Ig & L at Keyswitch)
  - The 4-way Flashers are activated from either key position by pressing both turn signal switches at the same time - Flashers will operate this way until the battery is dead or the keyswitch is turned off - Key cannot be removed
- Circuit Breaker Ratings - Bolt Stud Type
  - 15A - Lights CB
  - 15A - Ignition CB
  - 15A - Accessories CB



(1994-1997)

- All 1994 to 1997 models have 5 circuit breakers mounted under the seat. Ignition, instruments, lights and accessories are mounted on the circuit breaker block installed in the electrical bracket under the seat. The main circuit breaker is mounted on the electrical bracket on the right side of the circuit breaker block.[6)]
- Circuit Breakers (CB) - Automatically Resettable
  - 50A - Main Circuit Breaker (1994-1996) - Bolt Stud Type
  - 30A - Main Circuit Breaker (1997) - Bolt Stud Type
- Keyswitch
  - 'Accessory' position allows 4-way Flasher without other Lights active
  - 'Accessory' position (Green Wire) runs to Accessories CB (also active with Ignition position)
  - 'Ignition' position (White Wire) runs to Ignition, Instruments and Lights CBs
  - The 4-way Flashers are activated from the 'Accessory' position by pressing both turn signal switches at the same time - Flashers will operate this way until the battery is dead or the keyswitch is turned off - Key can be removed in Acc position
- Circuit Breaker Ratings - Socket Blade Type
  - 15A - Ignition CB
  - 10A - Instruments CB
  - 10A - Lights CB
  - 15A - AccessoriesCB



(1998-2003) [7)]

- These models have a Main Circuit Breaker, 4 Fuses, the Starter Relay and the Data Link Connector (1200S Only) located under left-side triangle cover to rear of battery.
- Fuses - Socketed and individually insertable
  - 30A - Main Circuit Breaker - Bolt Stud Type
- Keyswitch
  - 'Accessory' position allows 4-way Flasher without other Lights active (also active with Ignition position)

  - 'Accessory' position (Red/Green Wire) runs to Accessories Fuse
  - 'Ignition' position (Red/Black Wire) runs to Ignition, Instruments and Lights Fuses
  - The 4-way Flashers are activated from the 'Accessory' position by pressing both turn signal switches at the same time - Flashers will operate this way until the battery is dead or the keyswitch is turned off - Key can be removed in Acc position
- Fuse Ratings (72330-95)
  - 15A - Ignition Fuse
  - 15A - Instruments Fuse
  - 15A - Lights Fuse
  - 15A - Accessories Fuse

(2004-2006)

- Fuses - Socketed and individually insertable - Fuse Panel under left side panel behind battery
  - 30A - MaxiFuse - Socketed and insertable - By Battery
- Keyswitch
  - 'Accessory' position (Red/Green Wire) also active in Ignition position
  - 'Ignition' position (Red/Black Wire)
  - The 4-way Flashers are activated from the 'Ignition' position (with the RUN switch on) by pressing both turn signal switches at the same time - The key can then be turned off & removed - Flashers will operate for up to 2 hours, then automatically shutdown
- Fuse Ratings (72330-95)
  - 15A - Accessories Fuse (KeySw-Red/Green)

    - 15A - Battery Fuse (Red wire from MaxiFuse direct)
    - 15A - Lights Fuse (KeySw-Red/Black)
    - 15A - Ignition Fuse (KeySw-Red/Black)
    - 15A - Instruments Fuse (KeySw-Red/Black)
    - 15A - Spare Socket (Unconnected)

(2007-2009)

- Fuses - Socketed and individually insertable - Fuse Panel
    - 30A - MaxiFuse - Socketed and insertable - By Battery
- Keyswitch
    - 'Accessory' position (Red/Gray Wire) also active in Ignition position
    - 'Ignition' position (Black/Red Wire)
    - The 4-way Flashers are activated from the 'Ignition' position (with the RUN switch on) by pressing both turn signal switches at the same time - The key can then be turned off & removed - Flashers will operate for up to 2 hours, then automatically shutdown
- Fuse Ratings (72330-95)
    - 15A - ECM Fuse (Red wire from MaxiFuse direct)
    - 15A - Fuel Pump Fuse (Yellow/Green wire from System Relay)
    - 15A - Spare Socket - Unconnected
    - 15A - Ignition Fuse (KeySw-Black/Red)
    - 15A - Instruments Fuse (KeySw-Black/Red)
    - 15A - Spare Socket - Unconnected
    - 15A - Accessories Fuse (KeySw-Red/Gray)
    - 15A - Battery Fuse (Red wire from MaxiFuse direct)
    - 15A - Lights Fuse (KeySw-Black/Red)
    - 15A – P&A Ignition Fuse (KeySw-Black/Red)
    - 15A - Spare Socket (Unconnected)
    - … - Open Socket
- **NOTE:** The 2007-2009 model years have a significant history of corrosion and gunk collecting in the fuse/relay tray causing low-grade shorts and erratic electrical operation - This is especially problematic if the bike is left outside or operated in the rain. It's a good idea to check & thoroughly clean this tray at least every year (or 4 to 6 months if parked outside).

(2010-2013)

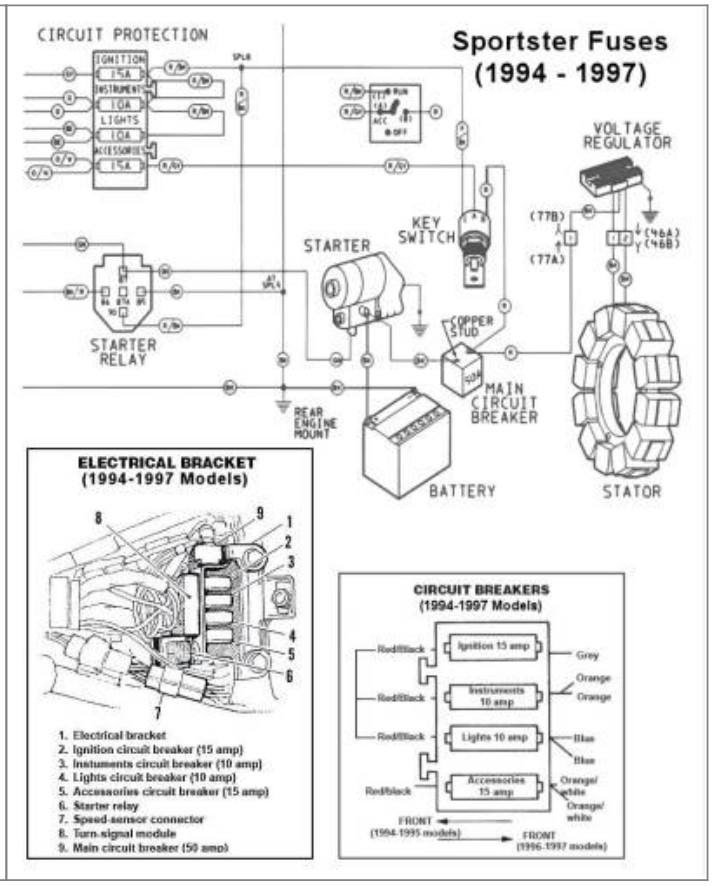
- Fuses - Socketed and individually insertable - Fuse Panel
    - 30A - MaxiFuse - Socketed and insertable - By Battery
- Keyswitch
    - 'Accessory' position (Red/Gray Wire) also active in Ignition position
    - 'Ignition' position (Red/Black Wire)
    - The 4-way Flashers are activated from the 'Ignition' position (with the RUN switch on) by pressing both turn signal switches at the same time - The key can then be turned off & removed - Flashers will operate for up to 2 hours, then automatically shutdown
- Fuse Ratings (72330-95)
    - 15A - Ignition Fuse (KeySw-Red/Black)
    - 15A - Lights Fuse (KeySw-Red/Black)
    - 15A - Accessories Fuse (KeySw-Red/Gray)

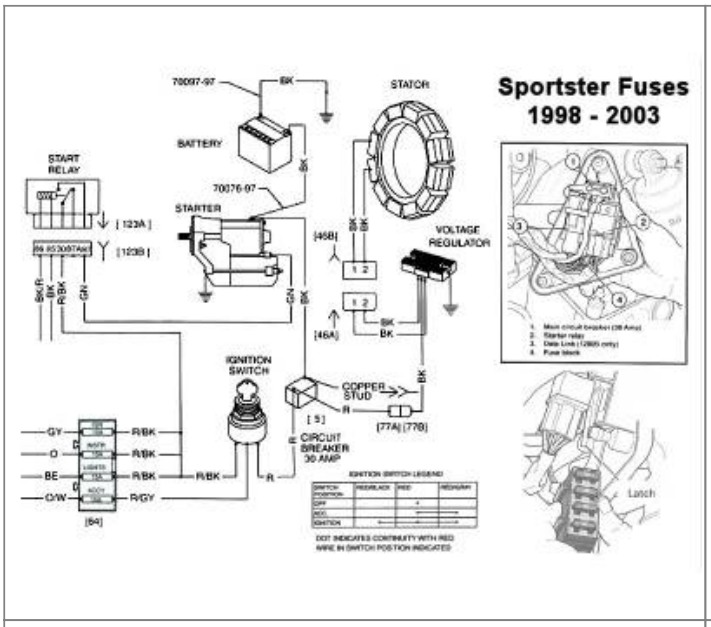
- 15A - ECM Fuse (Red wire from MaxiFuse direct)
- 15A - Battery Fuse (Red wire from MaxiFuse direct)
- 15A - Spare Socket (Unconnected)

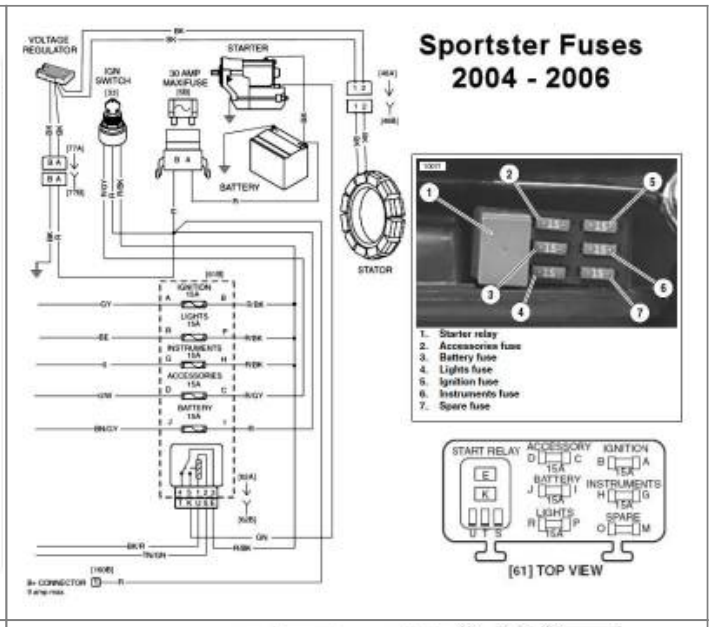
(2014-2022)

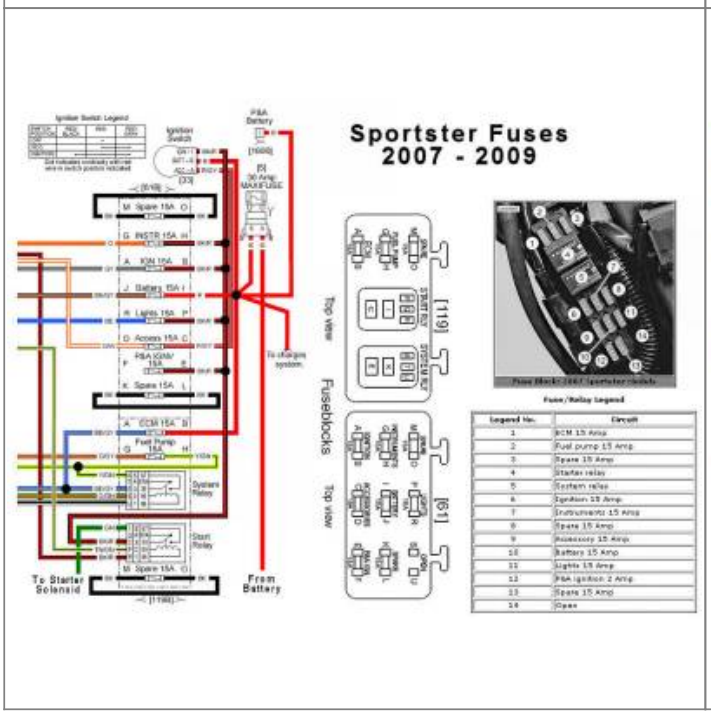
- 2014 - First Year of BCM (Body Control Module) for direct electrical control (minimizes fuses & eliminates relays)
- Fuses - Socketed and individually insertable - All fuses on Fuse Panel Cable (Near Battery)
  - 40A - MaxiFuse - Socketed and insertable
- Keyswitch - Multilevel voltages using only two wires - Black/Green is Ground - Blue/White is signal to BCM
  - 'Accessory' position provides a 'semi-Hi' signal on the Blue/White wire (using 800 ohms to ground)
  - 'Ignition' position provides a 'Lo' signal on the Blue/White wire (using 200 ohms to ground)
  - 'Off' position provides 'no load Hi' signal on the Blue/White wire (using no connection to ground)
  - The 4-way Flashers are activated from the 'Ignition' position (with the RUN switch on) by pressing the triangle switch above the starter switch - The key can then be turned off & removed - Flashers will operate for up to 2 hours, then automatically shutdown
- Fuse Ratings
  - 10A - Battery Fuse - ATO-type (72340-94) - See Footnote for document conflicts [8)]
  - 15A - P&A Fuse - ATO-type (72347-94)

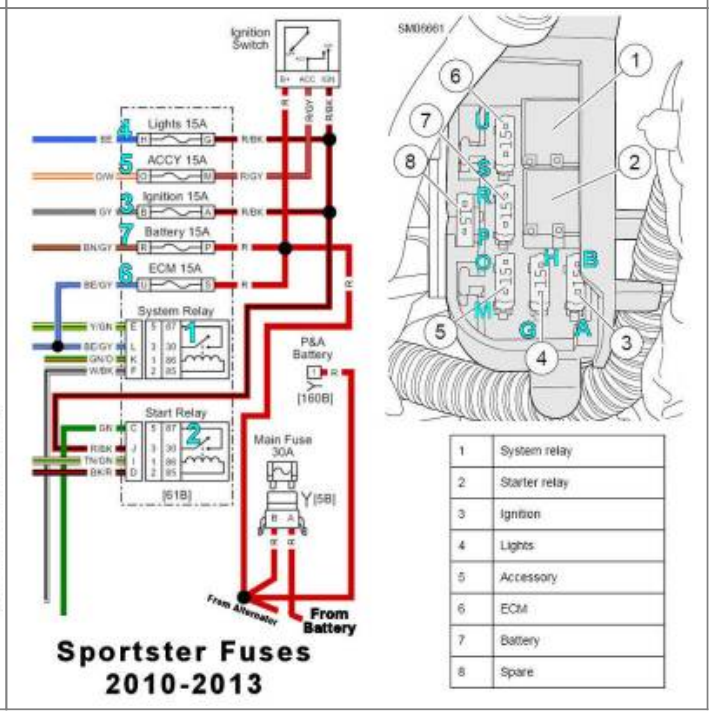
CLICK ON ANY OF THESE IMAGES TO VIEW A LARGER VERSION.





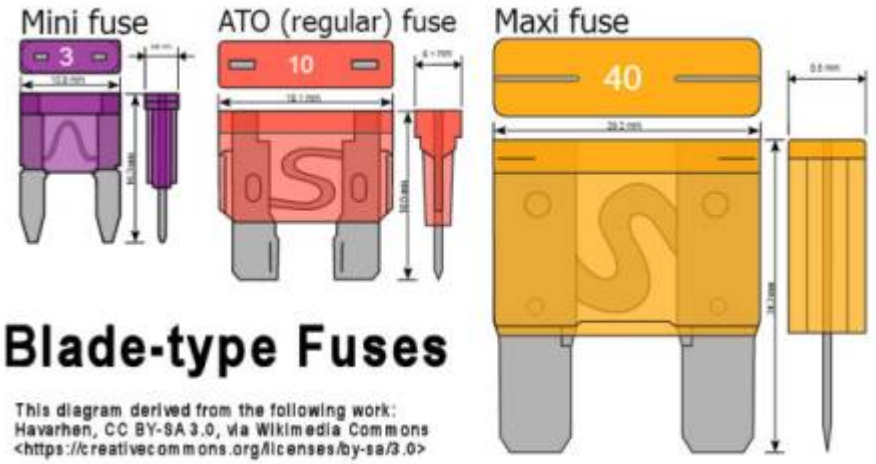






Circuit Breaker / Fuse Part Number Quick Reference Guide

Circuit Breakers			Mini Type Fuse		ATO Type Fuse	
10 Amp	Socket Blade	74588-94	Red	72462-00	Red	72340-94
15 Amp	Socket Blade	74587-94	Blue	72330-95	LtBlue	72347-94
15 Amp	Bolt Stud	74589-73		Maxi Type Fuse		
30 Amp	Bolt Stud	74599-77B		30 Amp	Green	72318-04
50 Amp	Bolt Stud	74600-94		40 Amp	Orange	72314-01



Relays

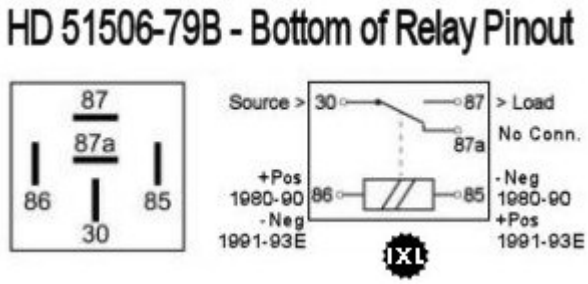
NOTE - all diagrams are of the bottom of the relay. If you are checking for connections at the socket, the pin locations are the mirror reverse of the view here (of the bottom of the relay!) Left is right & right is left!

(In the diagrams, S=Source & is B+ from the Battery or thru Keyswitch. L=Load & goes to the Starter Solenoid.)
(Be sure to see the note at the end of this section regarding diodes in relays)

For Starter Relay function SEE HERE. For System Relay function see below.

(1980-1992 & Early 1993)

- Starter Relay is single-bolt lug mount, connectorized
- Under the seat, on frame by the circuit breakers



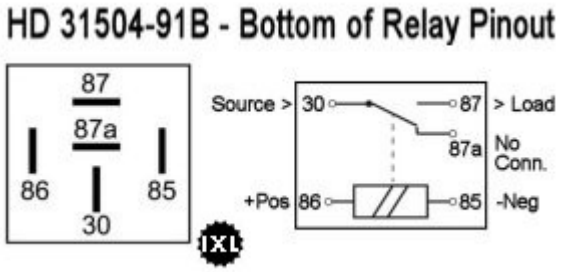
9)

  - HD 31506-79B
  - NAPA ECH MC23010
  - Standard MC-RLY2
  - Tyco V23234C1001X008
  - Bosch 0332019151

(1994-2003 & Late 1993)

- Starter Relay is single-bolt lug mount, connectorized

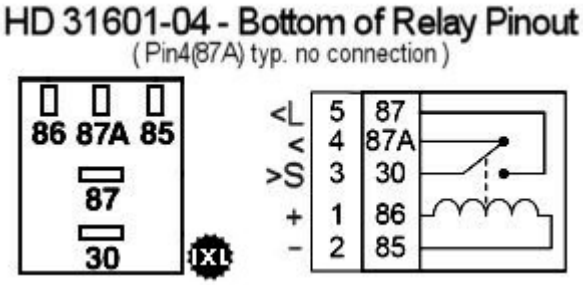
- L93-97 - under the seat, on the circuit breakers mounting frame
- 98-03 - under left-side triangle cover to rear of battery



  - HD 31504-91B [10)]
  - NAPA ECH MC23013
  - Standard MC-RLY4

(2004-2009)

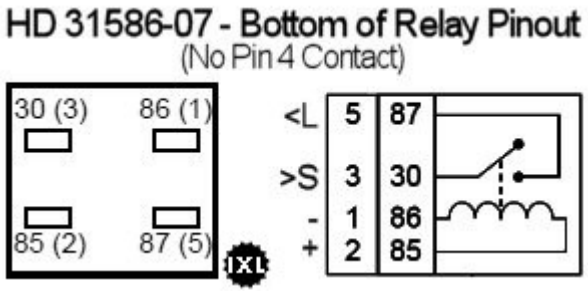
- Starter Relay in 2004 became plug-in on Fuse Panel
- System Relay was added in 2007 as plug-in on Fuse Panel
- These Relays are interchangeable (helpful for diagnostics)



  - HD 31601-04 [11)]
  - Possible Alternatives:
  - NAPA ECH AR614
  - Standard MC-RLY8
  - Borg Warner R3154
  - Niehoff RL 35381
  - Gp Sorenson 41-5154
  - OMRON G8H-UA-007401
- **NOTE:** The 2007-2009 model years have a significant history of corrosion and gunk collecting in the fuse/relay tray causing low-grade shorts and erratic electrical operation - This is especially problematic if the bike is left outside or operated in the rain. It's a good idea to check & thoroughly clean this tray at least every year (or 4 to 6 months if parked outside).
- **NOTE2:** In the UK, check for part number Durite 0-727-13.

(2010-2013)

- The Starter & System Relays are interchangeable (helpful for diagnostics)



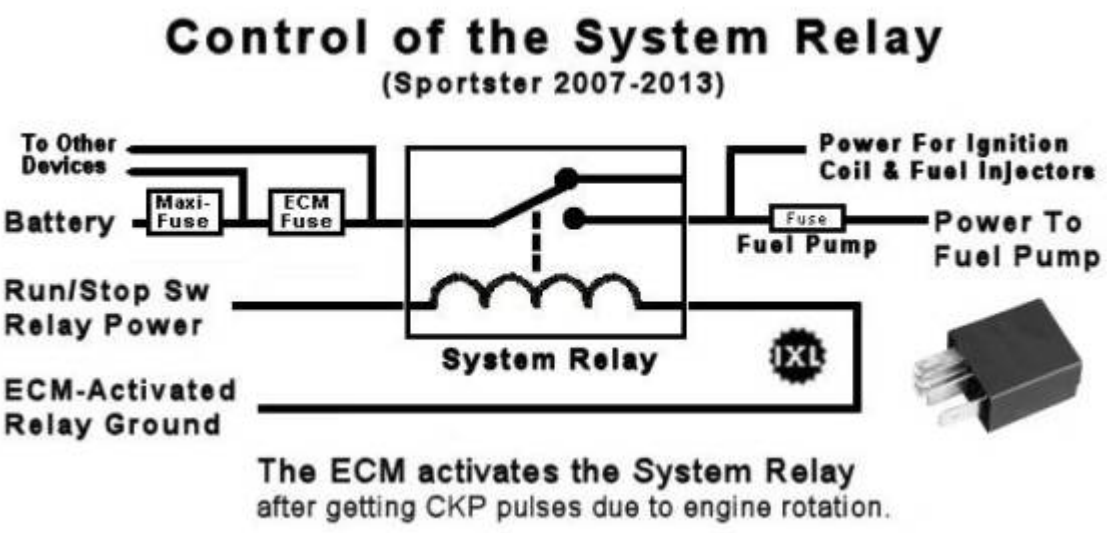
- HD 31586-07
- Possible Alternatives:
- Standard MC-RLY9
- (Superceded from: 31579-04)

(2014-on)

- Body Control Module (BCM) expanded capability - Eliminated relays (minimized fuses)
  - 69992-12B BCM w/o Security
  - 69994-12B BCM w/Security

NOTES:

System Relay Function (2007-2013)



Polarity & Diodes

> - If the originally specified relay did not have a diode, the polarity of the connections to the relay coil made no difference - the relay functioned with either connection orientation. However, when a diode is present across the coil, for reverse EMF bleed off, it is important that the polarity of the normal connection provides reverse bias on the diode and not forward bias. The positive connection must be at the bar end of the diode (the silver band) which is opposite of the way diodes are used in many other applications.

> - If replacing a non-diode relay (original design) with a diode-version, it would be worthwhile double-checking the polarity of the connection to the relay coil to be sure it is compatible with the diode orientation. Where a diode is used, the positive power should reverse bias the diode when normally activated - this allows the bleed off of EMF energy in the reverse direction when the power is removed.
> - In the diagrams above I have included the standard HD connections polarity, as identified in the HD manuals & wiring diagrams, to allow comparison of that wiring to any proposed alternative relay. It appears to me, that many of the relays that include a diode provide positive power on the (86) contact while HD has wired some of their relays (1991-1993 & 2010-2013) with positive power on the (85) contact. Beware: I have not checked every alternative relay listed in the Sportsterpedia for this issue.

(This document may be of interest: Understanding Relays)

Cleaning Corrosion

Be sure you remove the Main Circuit Breaker or MaxiFuse before working on any electrical items. Some work requires removing the battery to assure no power is associated with the items on which you are working. Be Careful.

There are a number of readily available commercial products designed specifically as Contact Cleaners, such as from CRC, WD-40, etc. Look for the Contact Cleaner versions of these product brands, not their generic spray cleaners. These contact clearners are designed to reach in difficult places with a blast of chemical spray to clean the contact surfaces. Be sure to read the precautions & directions on the can as most make notice about their affects on plastics. You don't want to do more harm trying to clean your contacts. As with all chemicals, protect your face and eyes and hands whenever using any spray cleaner.

A home remedy is to use vinegar, which is a mild acid. It can be diluted in equal parts vinegar & water. You can use a toothbrush to apply on fuse/relay sockets, contacts, etc. Once clean, wash with water & dry (compressed air for crevices). Stubborn corrosion may require applying a paste of baking soda (and water). Let it soak into the corrosion and dry. Then brush & flush with water & dry with compressed air.

When the sockets or contacts are thoroughly clean & dry, apply a thin coating of dielectric grease (see here) to the contact surfaces, both the socket & the fuse/relay. The coating should be sufficient to protect the sufaces from air & moisture, but not oozing off onto other components.

CHARGING SYSTEM

The Sportster Charging System consists of the Alternator (Stator & Rotor), Regulator & Battery. The Alternator is of the Permanent Magnet type, the Regulator is a combination rectifier, shunt voltage regulator & the battery is typically of the Absorbent Glass Mat type.

Alternator Design

The Sportster Alternator utilizes a stator & rotor. The stator is a series of electrical coils arranged in a radial pattern and the rotor has a sequence of permanent magnets mounted to a steel shell. The Alternator produces a single-phased AC output.

On 1986-1990 (4-speed) models, the Alternator is implemented in the primary drive cavity as part of the Clutch Assembly. In 1991 (5-speed models), the Alternator was moved to the Engine Sprocket Shaft in the primary drive cavity. As a small benefit in this later design, the weight of the rotating mass of the rotor/magnets supplements the centrifugal force of the crankshaft's flywheel. The functional operation of the Alternator remained the same.

The rotor, with permanent magnets, rotates around the stator which has the stationary electrical coils. As the rotor magnets spin past the coils, they induce a current in the stator's coils, called electromagnetic induction. Because the poles of the magnet are oriented north-south, the current reverses itself each time a magnet sweeps through its field, creating an alternating current.

The picture shown is similar to the 2000 models. There are a number of variations in specific part numbers over the years & models, although the basic design is the same for all 1991-later models.

The two-wire connector used for the Stator output needs to be compatible with the Regulator input connector. See the pictures of the input connectors for various model years in the Regulator section below. The stator output connectors will be similarly designed.

	Stator	Regulator	Rotor	Notes	Stator Specs		Regulator Specs	
4-Speed					**Output Voltage**	**Coil Resistance**	**Output Voltage @75°**	**Current @3600rpm**
1986-1990	29967-84C	74523-84A	36791-84	Rotor+ClutchShell	12v-18v AC/1000rpm	0.2-0.4 Ohms	13.8v-15.0v DC	19 Amps
5-Speed								
1991-only	29967-89C	74523-91	32413-89C	Rotor Only	19v-26v AC/1000rpm	0.2-0.4 Ohms	14.3v-14.7v DC	22 Amps
1992-1993	29967-89C	74523-92A	32413-89C	Rotor Only				
1994-2003	29967-89C	74523-94A	32413-92C	Rotor Only				
2004-2006	29967-89C	74523-04	32494-04B	Rotor+EngSprocket				
2007-2008	29900067	74546-07A	32494-04B	Rotor+EngSprocket	20v-28v AC/1000rpm	0.1-0.3 Ohms	14.3v-14.7v DC	32 Amps

	Stator	Regulator	Rotor	Notes	Stator Specs		Regulator Specs	
4-Speed					Output Voltage	Coil Resistance	Output Voltage @75°	Current @3600rpm
2009-2013	29900067	74711-08	32494-04B	Rotor+EngSprocket				
2014-2018	29900068	74700012	32494-04B	Rotor+EngSprocket				

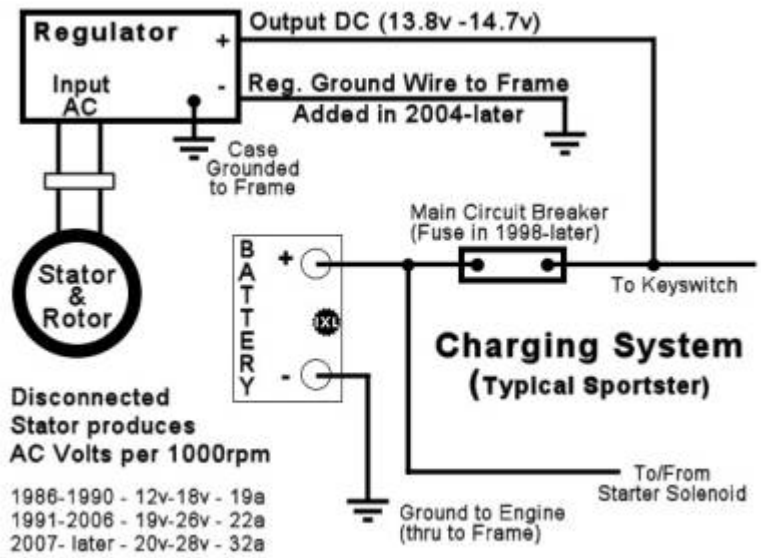
Take Note: The charging system is designed to keep the battery charged and supply power to run the bike. However, even if you disconnect the regulator from the system (and/or the stator from the regulator), the bike will run just fine on the battery alone. Without being recharged, the battery will slowly discharge (over time, depending on the actual current being drawn) to the point where the voltage will be too low to operate the igntion system and the bike will fail to run.

The run-time on the battery alone is surprising. If your stator or regulator fails while on a long-distance ride, you can recharge the battery (wherever possible) and then run the bike on it alone. To do so, you should minimize the current draw from unnecessary components by removing the fuses to those component circuits (such as lights) or disconnecting the devices, temporarily. Of course, running in daylight with other riders would be a safe decision in this emergency.[13)]

Basic Stator (Alternator) Test

Checking for Shorts

Pull the connector between the Stator & Regulator, 2-pin connector near the regulator. Use a multimeter set to the Ohms Scale to measure resistance for these tests. (Before checking resistance, ZERO the meter. Always check that the meter reads '0' ohms when the meter leads are securely pressed together. If the meter reads any value above zero, subtract this base resistance value from any resistance readings you take.)



1) Measure Resistance from each Stator Pin to Ground (should be infinite Ohms)

- If this test shows anywhere below infinity ohms, the stator is grounded. The windings are shorting to the frame and will not properly produce current under normal operaton. The stator needs to be replace.

2) Measure Resistance between the two Stator Pins (should be 0.2 - 0.4 Ohms)

- If the resistance reading is 0 ohms, there is a short in the stator wiring. If greater than specs, there may be damage in the wiring connections. Remove the stator & check for wiring problems.
- Since you are trying to read very a very small resistance value, be sure to use your lowest meter scale & ZERO the meter (to be able to subtract the base resistance value).

Checking for Sufficient Voltage Production

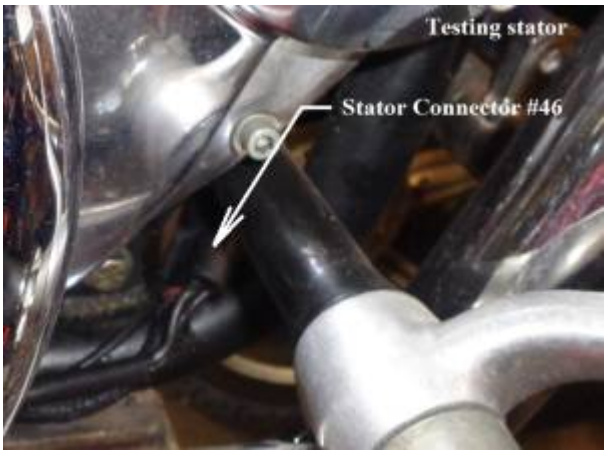
With the Regulator still unplugged from the Stator:
Start the engine & run at approximately 2000 RPMs (Set your multimeter on AC Volts - 100v Scale)

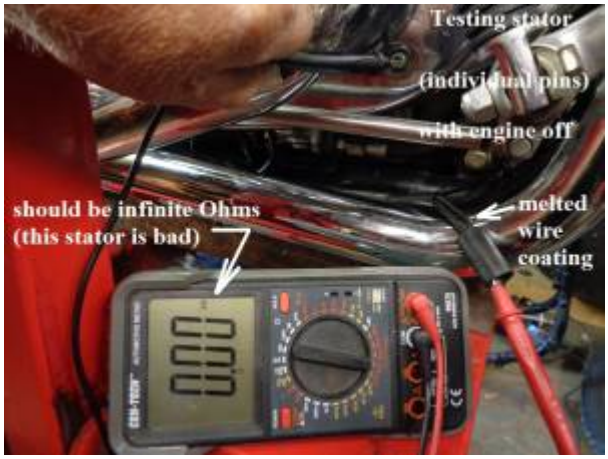
3) Measure AC Volts produced between the two Stator Pins (see the chart above for the expected voltages) [14)]

- If this test shows the voltage too low or does not rise properly when raising the RPMs, some of the windings on the stator may be shorted together, reducing the effective current production. Remove the stator & examine for burned or shorted spots.

Shut down the engine - Reconnect the Regulator - (Be sure to do voltage & ground checks - Click Here)

Example of testing a BAD Stator:[15)]





Replacing The Stator

Sub-Documents

- 1986 - 1990 Stator Replacement
- 1991-2003 Stator Replacement
- 2004-later

Voltage Regulator

The Voltage Regulator is a series regulator with shunt control. The circuit combines the functions of rectifying AC voltage from the Stator into usable DC voltage and regulating that DC voltage to charge the battery & operate the electrical components on the bike.

Checking Regulator Case For Good Grounding

With the engine off and the regulator still mounted on the bike, pull both connections of the regulator to isolate it from the stator & the Main CB/Fuse. Use a multimeter set to the Ohms Scale to measure resistance to ground. (Before checking resistance, always check that the meter reads '0' ohms when the meter leads are securely pressed together. If the meter reads any value above zero, subtract this value from any resistance readings you take.)

Connect the BLACK meter probe to the battery negative or other definite frame ground point. Using the RED meter probe, measure the resistance from the case of the regulator to the ground point. It should read very close to '0' ohms.

If the regulator is on a 2004-later model with a dedicated ground wire on the output connector, check the case of regulator to ground, check the negative contact in the regulator output connector to ground and

check the resistance from the harness negative contact to ground (the Battery negative post). These should all read '0' ohms (or very close).

Now Check That You Have No Rectifier Grounding - Using the RED meter probe, measure the resistance to ground on each contact of the regulator incoming connector. It should read as an open - NO ground connection (infinite ohms). If either of these regulator contacts are showing at, or near, '0' ohms, the regulator is likely defective.

Check the Wire Routing

It is possible for the voltage regulator output wire and the ignition sensor wires to contact the transmission cover screws and transmission case if the wires are not routed properly. Powertrain movement can cause the insulation to be rubbed through resulting in intermittent ignition, charging problems or generating of a fault code on EFI models. [16)]

CAUTION: As shown in the Charging System diagram, BE SURE the output of the voltage regulator is connected to the Keyswitch-Side of the Main Circuit Breaker or Fuse! This is a SAFETY ISSUE. Some models from the factory were wired incorrectly on the battery-side of the main circuit breaker. [17)]

Checking the Running Voltage Output

With the engine off and all connections in place, using a multimeter on the 20v DC scale, take a voltage reading directly across the two battery terminals - This is the Reference Voltage (RV). Now start the bike & raise the idle to approximately 2000rpms. Measure the voltage across the two battery terminals again. If the regulator is working properly, it should be supplying a voltage between 13.8v & 14.8v to the battery when the engine is running. The regulator is not working properly if the voltage remains at the Reference Voltage or is greater than 15 volts.

When operating properly, the voltage supplied to the battery from the charging system (stator/regulator), should be higher than the Reference Voltage. If there is no greater voltage across the battery terminals when measured at 2000rpm vs measured when the bike is turned off, then regulated DC voltage is not getting to the battery from the charging system. Check all wiring for breaks, check the output of the stator for AC voltage (as above) and check for DC output voltage on the regulator output connector.

When the regulator is charging a highly discharged battery, it will supply a charging voltage at the higher part of the range. As the battery capacity is restored, the charging voltage will decrease toward the lower level of the normal charging range.

From 1986-2003, the output connector was a single wire supplying positive DC voltage to the Main Circuit Breaker. The regulator relied on its case to be properly grounded to the frame. Starting in 2004, the regulator used a two wire output connector, implementing both a specific ground wire in addition to the positive voltage wire to the main CB. The case of the regulator should still be well & properly grounded.

18)

Additional XLForum Links related to the charging system:
Testing Charging System -
https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-electrical/sportster-motorcycle-electrical-and-ignition/84152-no-charging-what-next#post1736398
Discussion of aftermarket regulator -
https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-electrical/sportster-motorcycle-electrical-and-ignition/153118-shunt-vs-series-voltage-regulators

BATTERIES

Sub Documents

- Pics and Information on stock EVO Battery Trays and Parts

Stock battery P/N is listed in the table below.

Years	OEM Battery P/N	CCA	Ah	Type	.....	One Generic P/N	L/W/H	Wt
79-96	65991-82B	280	20	AGM		Deka EXT16 - 325CCA - 19Ah	6-7/8 x 4 x 6-1/8	17-lbs
97-03	65989-97A	275	19	AGM		Deka EXT20L - 310CCA - 17.5Ah	6-7/8 x 3-7/16 x 6-1/8	15-lbs

Years	OEM Battery P/N	CCA	Ah	Type	.....	One Generic P/N	L/W/H	Wt
04-??	65958-04	200	12	AGM		Deka EXT14L - 220CCA - 12Ah	5-7/8 x 3-7/16 x 5-3/4	11.5-lbs
2010+	65958-04B	225	12	AGM		Retrofits back to 2004 & forward to at least 2020		

The 'L' designation for the generic battery P/N is indicative of the grounding post of the battery - meaning that L version batteries (with the terminal side closest to you) have the grounding post on the left. Non-L versions have the grounding post on the right.

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%

19)20)

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.

And see the Reference Section for additional battery information.

Go To Technical Menu

1)
HD mentions this in a Service Bulletin
2)
Ironmick of the XLFORUM
https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-era-specific-and-model-specific/ironhead-sportster-motorcycle-talk-1957-1985/130580-the-dreadful-electrical/page3?t=1378363&page=3
3), 5), 6)
Clymer 1986-2003 HD Xl/XLH Sportster Service Manual pg 457
4)
Pic from juzyHD at
https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-styles/sportster-motorcycle-project/195941-made-some-changes-to-my-bike?t=2072379
7)
Pics by Shu of the XLForum -
https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-electrical/sportster-motorcycle-electrical-and-ignition/96048-bike-not-starting?t=805221 - annotated by IXL2Relax

8)

Conflicting Battery Fuse Info - 2014-2017 Schematics show as 15A fuse, but Operation Manuals & Parts Manuals specify 10A - All documents for 2018-2022 show the Battery Fuse as 10A

9) , 10) , 11) , 12) , 14) , 18)

Illustration created by IXL2Relax at the XLForum

13)

Sportsterpaul rode 500 miles on the battery alone - https://www.xlforum.net/forum/general-area/organize-a-ride-out-or-find-a-riding-buddy/195543-2019-east-coast-meet-and-greet/page30?postcount=437#post4315866

15)

photos by Hippysmack

16)

HD Tech Tip #43 dated September 1995

17)

see https://www.xlforum.net/forum/sportster-motorcycle-forum/sportster-motorcycle-electrical/sportster-motorcycle-electrical-and-ignition/203144-is-this-battery-failure?t=2080336 - Post#24 & #32

19)

2014 & 2016 Sportster Owner's Manual

20)

1998 Sportster Service Manual