

Charging System Troubleshooting Guide

By: Kiwi

A number of owners have reported that their Regulator/Rectifier (R/R) have failed, often this was preceded by a headlight failure and a flat battery leading to starting issues. Troubleshooting found that not only had the R/R failed but in some cases the R/R electrical connector had melted with some pins showing signs of corrosion. The headlight issue was later traced to the headlight relay.

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Tools Required

- Digital Multimeter and test leads with a male & female spade fittings
- Tools required for access (spanners, allen keys, sockets and screwdrivers)

Charging System Overview

In simplified terms the Ninja 650R (ER-6F) and ER-6N uses a stationary Stator Coil mounted to the left hand crankcase cover, it sits inside the flywheel Rotor. The Rotor has magnets so that when the engine is running these rotate around the Stator producing alternating current (AC). The Stator is wired in such a way that there are actually 3 circuits which produce a 3 phase AC output voltage.

This Alternator (Rotor/Stator) setup is connected to a Regulator/Rectifier (R/R) by 3 wires. The R/R rectifies the AC current by using 6 diodes (2 per phase) and converting it to a useable direct current (DC). The more complex part of the R/R is the regulator section, it regulates the higher DC current down to provide a steady 12-14 volts DC. The process in simplest terms monitors the output voltage and "shunts" (partially diverts) the excess portion to ground through a "load".

The R/R has a lot of current constantly flowing through it and the excess voltage is being diverted to ground through the "load" so the R/R gets very hot in the process. The construction of the R/R is all about dissipating this heat through the heat fins on its exterior.

Components and Locations



Stator – removed

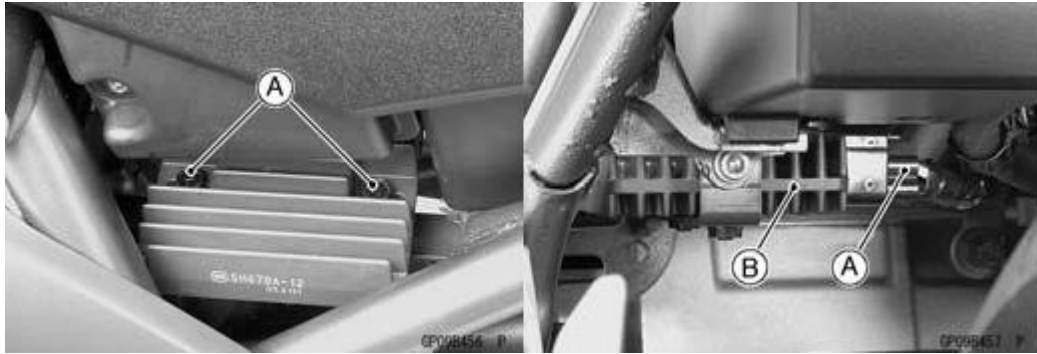


Stator – mounted in left hand crankcase cover



Rotor – left hand crankcase cover removed

Kawasaki Ninja 650R (ER-6F) & ER-6N Resource



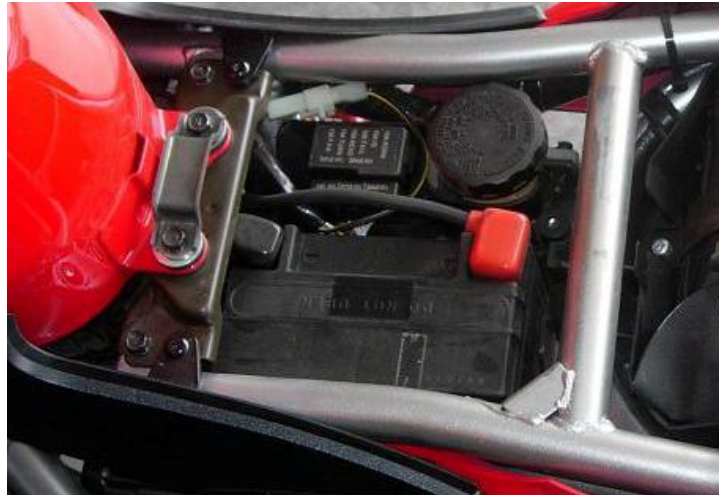
Regulator/Rectifier – below seat left hand side



Relay Box – under fuel tank

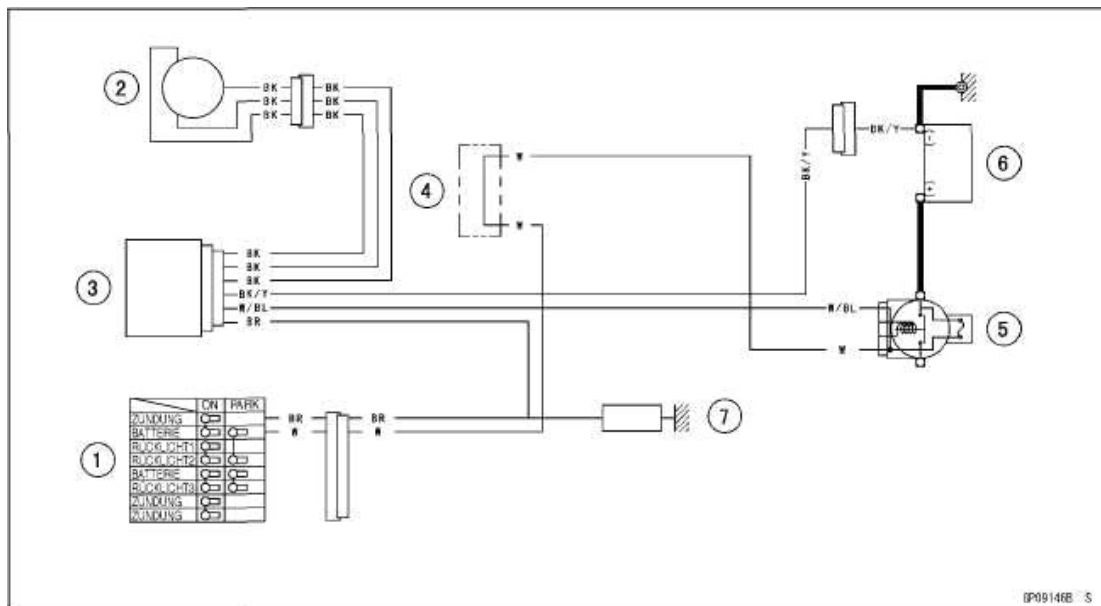


Relay Box



Battery – underseat (black terminal –ve) (red terminal +ve)

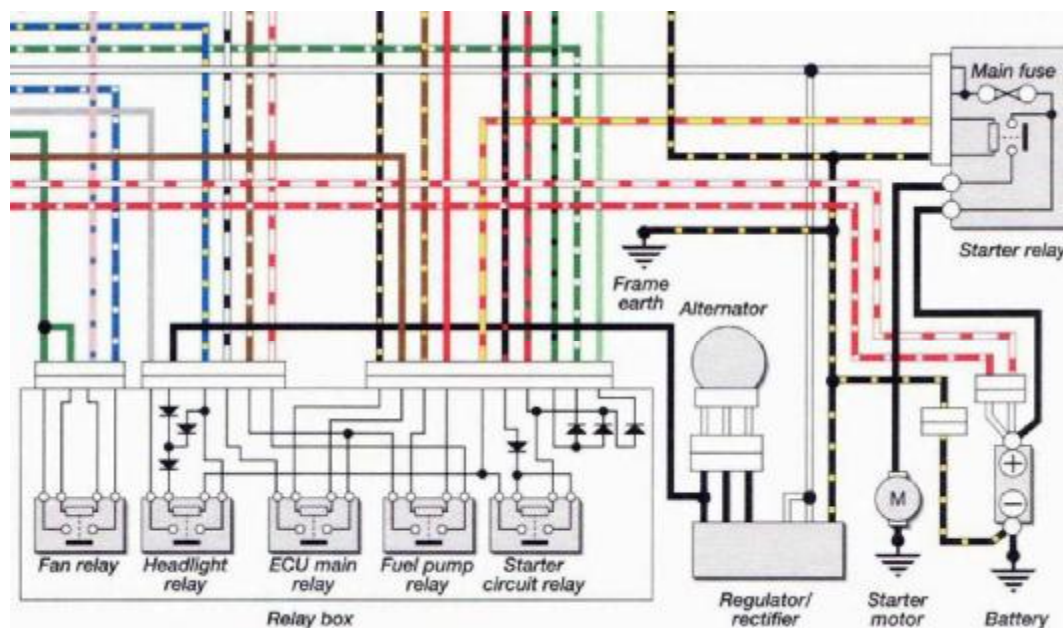
Circuit Diagrams



1. Ignition Switch
2. Alternator
3. Rectifier / Regulator
4. Water-proof Joint
5. Main Fuse 30 A
6. Battery 12 V 10 Ah
7. Load

Wiring Colour Code

BK	Black	BR	Brown	GY	Gray
BL	Blue	G	Green	LB	Light Blue
LG	Light Green	O	Orange	P	Pink
PU	Purple	R	Red	W	White
Y	Yellow				



Worth noting is that all the wiring diagrams available for all models of the Ninja 650R, ER-6F and ER-6N refer to the three AC wires coming out of the Stator to the R/R as black when in fact they are white.

Common Problems and Remedies

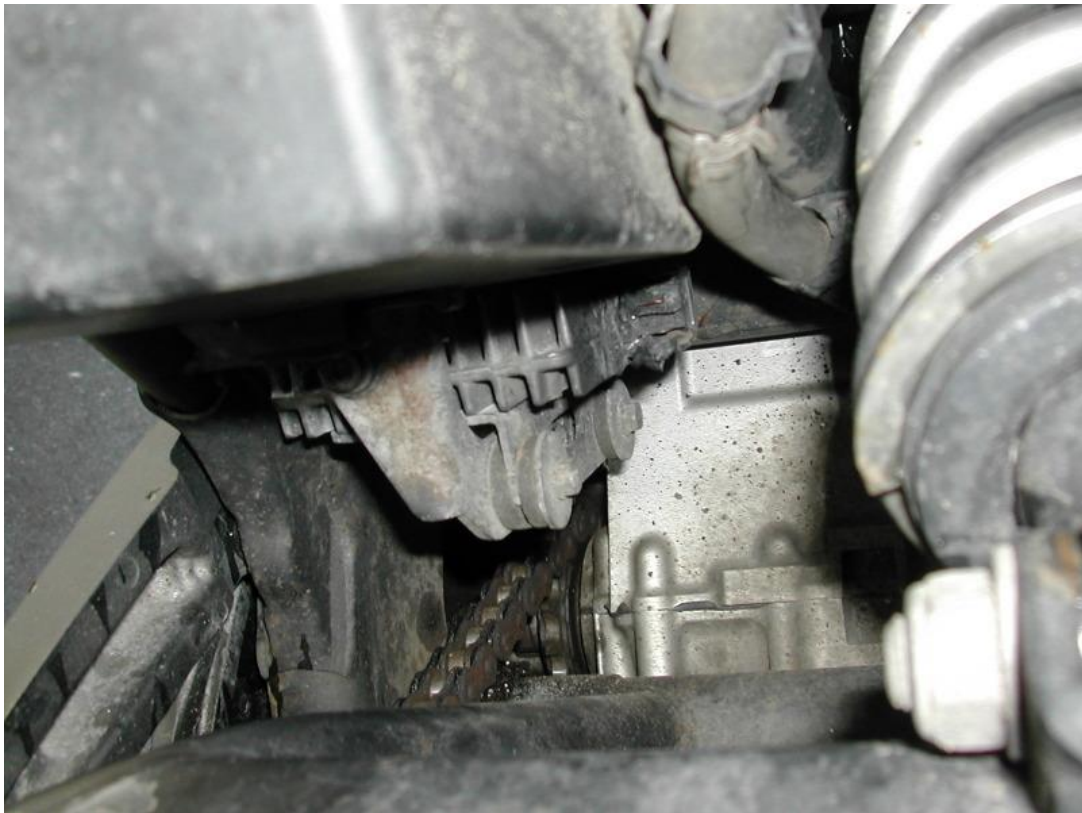
Failure of the Regulator/Rectifier (R/R) is often first evidenced by a flat battery and starting issues. Troubleshooting should always start with the battery.

Make sure you have a good battery. A bad, old or dead battery will load down the charging circuit until it overheats and dies. You know when you put a dead battery on charge and it pegs the battery charger ammeter? Well that is what a bad battery is doing to charging components on your bike.

Having said that. Numerous posts on internet forums with this fault have indicated that more often than not a failed R/R is the culprit. This is often found in association with corroded or damaged pins on R/R electrical connector or loom plug pins. It may be that these are just the weakest link in the chain.



Damaged Regulator/Rectifier Loom Plug



Damaged Regulator/Rectifier connector pins

Those who have experienced headlight issues also find that the headlight relay is at fault. The headlight relay is part of the Relay Box and also contains 3 diodes. Posts to date do not indicate whether it is the diodes or the actual headlight relay

at fault. Unfortunately the individual relays and diodes cannot be replaced and the relay box is sold as a complete unit.

The Service Manual has a complete series of tests for both the headlight relay and diodes, as the Relay Box is not a cheap item it would be advisable to confirm serviceability before making an expensive purchase.

The Battery

The following is taken from the Ninja 650R (ER-6F) & ER-6N Battery FAQ.

Is it the battery, or the charging system, or something in-between? The best way to know for sure is to use a Multimeter selected to DC Volts (20 volt range) attached directly to the battery positive and negative terminals, and observe the following:

1. With the engine and all electrical accessories switched off, the battery should read a minimum of 12.7 volts DC. If not, the battery is either not fully charged, or it is bad (it is incapable of holding a full charge).

Charge the battery fully with a battery charger and check again. Remember however that you must wait at least one hour after charging the battery to conduct this test. Then if the reading is less than 12.7 volts DC, the battery is bad and should be replaced.

State of Charge	Digital Voltmeter
100%	12.7 volts DC
75%	12.4 volts DC
50%	12.1 volts DC
25%	11.9 volts DC
0%	11.8 volts DC

2. If the first test above passes, leave the Multimeter hooked up to the battery terminals, and press the starter button. While the starter is engaged (but before the bike starts) the battery voltage should be 9.5 volts DC or greater. If not, then this signals either a bad battery, very dirty or weak electrical connections, or it could be a problematic starter motor (not likely it's probably the battery).

3. The charging system output voltage should be checked, again with the multimeter at the battery terminals and this time with the engine is running.

Start the engine and operate at various RPM with the headlight on and off (to turn off the headlight, disconnect the headlight connector).

The readings may show nearly battery voltage when the engine speed is low, and, as the engine speed rises, the readings should also rise. But they must be kept under the specified voltage.

According to the Kawasaki Service Manual the measured voltage should be 14.2 - 15.2 volts DC at about 2000-3000 rpm. In reality it is more likely to be in the range of 13.5 – 15.0 volts DC.

NOTE: If the alternator is outputting more than 15.2 volts DC to the battery, the Regulator/Rectifier (R/R) unit is bad and should be replaced. Over-charging a

battery will quickly ruin it and may cause severe damage or failure of other electrical components such as the ECU.

If the charging voltages are too low and do not rise as engine speed increases, suspect the alternator or R/R.

If the charging voltages are too high, suspect the R/R unit firstly, then perhaps dirty or corroded electrical terminals. The procedure for checking all of these is too detailed to describe here so consult the Service Manual for additional details.

4. Although is not related to charging system, another issue such as wiring or an accessory may be causing battery discharge. To check this carry out a current leakage check as follows:

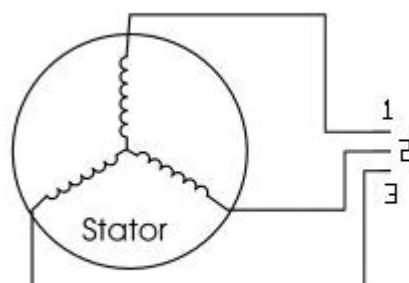
Ensure the battery is fully charged and check that the battery voltage measures above 12.7 volts DC (test 1 above). Disconnect the negative (black -ve) lead from the battery terminal (stud). Measure the Leakage Current of the bike by setting the multimeter to DC Amps, connect one multimeter probe to the battery negative terminal and connect the other multimeter probe to the negative lead. The current should be no higher than about 5.0 mA (milliamps) with the ignition switched OFF. In reality you should expect to see around 1.0 to 2.0 mA.

If Current Leakage exceeds 5.0 mA, there is a fault with wiring harness an accessory such as an alarm or the R/R draining the battery. Try pulling fuses or disconnect the R/R to locate the problem.

The Rotor/Stator

To check the integrity of the stator there are a number of tests that can be carried out. The integrity of the Rotor is more difficult to test and in reality can only be confirmed serviceable by swapping with a known good part. As the only thing likely to go wrong with a Rotor is a loss of magnetism (and that is very unlikely) then this should only be considered when there is no alternator output voltage and all the other tests have checked out OK.

1. To carry out a resistance check of the Stator windings use a Multimeter selected to Ohms (Ω range). Connect the multimeter leads and measure the resistance between each "pair" of windings. Black wire to black wire pins, 1-2, 2-3 & 1-3.



There are two points where this can be done easily, the connector at the Regulator/Rectifier R/R) or you can follow the 3 wires out of the left hand crankcase cover up to an Alternator Lead connector.



Alternator Lead connector

The resistance between each pair of wires should be in the 0.18 - 0.27 ohms range.

A very low winding resistance could be a shorted winding although that is not that common, what normally happens is they burn through and go open circuit with infinite resistance (multimeter displays dashed lines or the abbreviation "OL" which stands for "open loop"). In either case the Stator will require replacement.

A "cooked" Stator is usually obviously when removed with a burnt look to the windings and insulation.

2. The next test is a check of the stator windings to ensure that there is not a short circuit to earth (the engine casing). For this test again use the multimeter selected to Ohms (Ω range), connect one of the multimeter leads to the engine casing and the other lead to each of the black wires pins 1, 2 & 3 separately.

There should be an open circuit with infinite resistance (multimeter displays dashed lines or the abbreviation "OL" which stands for "open loop").

If the multimeter displays a low resistance then it is likely that the windings insulation has burnt through and is shorting to earth through the Stator mountings. In this case the Stator will require replacement.

3. The final check is the Alternator output. Again either unplug the connector to the R/R or the Alternator Lead connector from the Stator windings LHS. Run the engine and with the multimeter selected to AC Volts (250 volt range) measure the AC voltage across each 3 pairs of Stator wires. Black wire to black wire pins, 1-2, 2-3 & 1-3.

Caution – All the Alternator wires are live, use test leads with appropriate male or female spade connectors to avoid an electrical short circuit and damage.

The output voltage should be about 42 volts AC or more at 4000 RPM. A faulty winding will show as a much lower reading than a good one and the Stator will require replacement.

Should you require a replacement, then the Stator fitted to the Ninja 650R (ER-6F) and ER-6N is a Kawasaki Part Number: 21003-0041 however Kawasaki advise that from 2007 this was superseded by Part Number: 21003-0042. There is no information regarding the reasons for this change.

Kawasaki Ninja 650R (ER-6F) & ER-6N Resource

The Stator fitted is unique to the Ninja 650R (ER-6F), ER-6N and Versys models.

From the Kawasaki website P/N 21003-0041 & -0042 are fitted to the following Kawasaki models:

Ninja 650R /ER-6F (EX650) – 2006-2010

ER-6N (ER650) – 2006-2010

Versys (KLE650) – 2007-2010

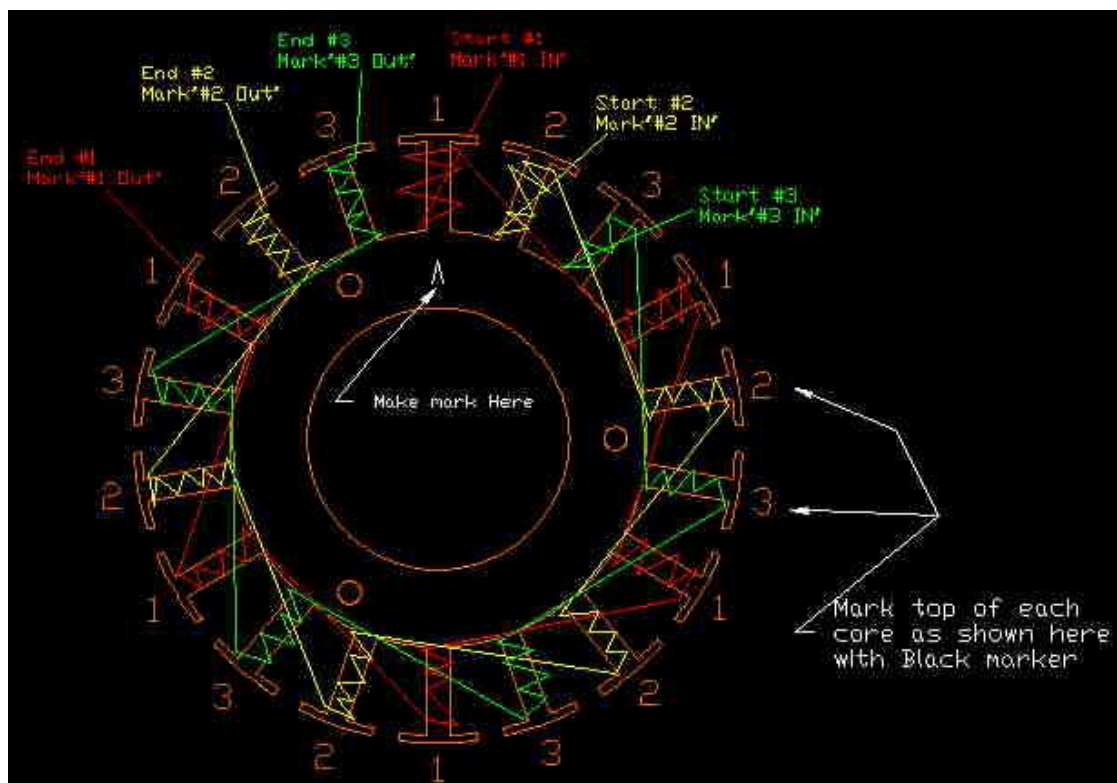
Aftermarket Stators are manufactured and supplied by very few vendors, links to these are located on the website in the Electrical links section.

Another option is to rewind your existing stator, this has been accomplished by a number of owners using this article from "The GS Resources" website:

http://www.thegsresources.com/garage/gs_statorrewind.htm

It appears to be a reprint of the original article from the Suzuki Cavalcade website here:

<http://www.suzukicavalcade.com/Maintenance/stator.htm>



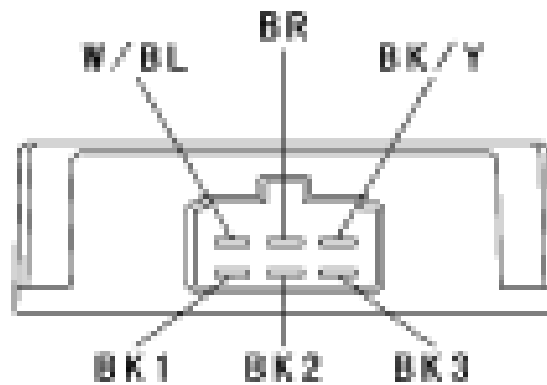
The Regulator/Rectifier

As mentioned previously the Regulator/Rectifier (R/R) performs two functions, firstly the Rectifier section uses diodes to rectify AC voltage from the Alternator converting it to a useable DC voltage. Then the Regulator section regulates the high DC voltage down to provide a steady 12-14 volts DC for system services and charging the battery.

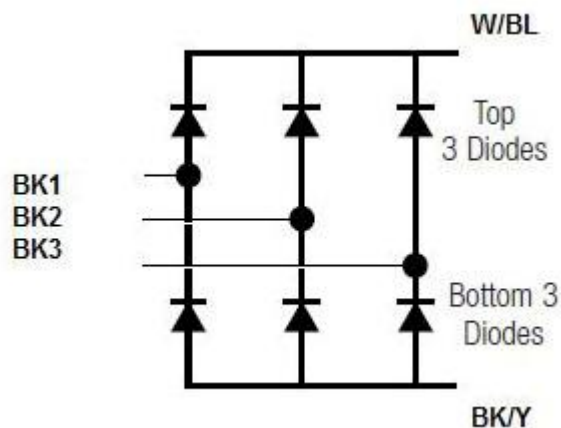


1. To check the diodes in the R/R use the multimeter selected to Ohms (Ω range) and measure the resistance of pins W/BL to BK1 then swap the leads of the multimeter over and repeat the test. If the R/R is OK then there will be a low resistance in one direction and high resistance in the other.

Repeat the test for pins W/BL to BK2 & BK3 and then for pins BK/Y to BK1, BK2 & BK3. Again if the R/R is OK then there will be a low resistance in one direction and high resistance in the other.



Regulator/Rectifier electrical connector



Rectifier Circuit Diagram

The resistance should be low in one direction and more than ten times as much in the other direction. If any two leads are low or high in both directions, the diode is defective and the R/R should be replaced.



Regulator/Rectifier



Regulator/Rectifier

Other information that may assist:

Multimeters: Analog versus digital, the service manuals forgot one important detail

They were written in the era of the analog multimeter. Unfortunately, the manufacturer's have never updated this testing information and it is not accurate for today's digital testing multimeters.



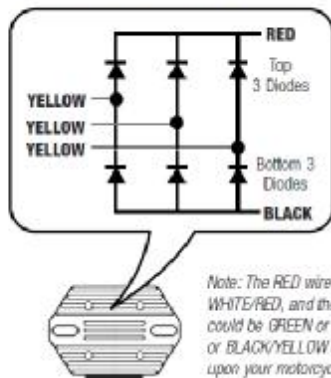
Older Analog Multimeter Newer Digital Multimeter

Why is this so important?

Following the service manual testing procedure for the regulator/rectifier using a modern digital multimeter will result in results that are incorrect. Most rectifiers will test bad, while they're still fine!

What's inside an ElectroSport RR?

You will find three YELLOW wires on the outside going into the part. Each YELLOW wire connects to 2 diodes, for a total of 6 diodes. To understand this more clearly, see the illustration below. Note: A diode is defined with an arrow with a bar over the top. There is also a regulator circuit for controlling the output voltage. This circuit is not easy to test without special equipment, so we do not cover it here. If a regulator/rectifier fails, what usually fails is one of the diodes, not the regulator circuit.



Top Diode Tests

Getting Started

We suggest using a FLUKE™ model 110 digital multimeter. It's one of the best in the business and is very affordable. To begin the test, switch the knob on the multimeter to the "DIODE" selection as shown in figure A.

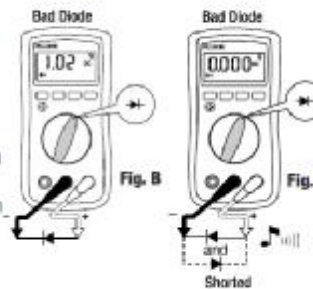
Forward Bias: Top 3 Diodes - Test 1.

From the multimeter connect the BLACK test connector to the RED wire coming from the regulator rectifier. Then from the multimeter connect the RED test connector to ONE of the YELLOW wires coming from the regulator rectifier. The readout should show between 0.400-0.600 along with a single audible beep as shown in (Figure A). Continue by testing the remaining YELLOW wires following the same test procedure.



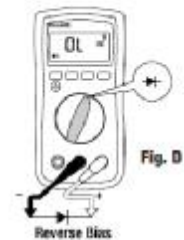
When a diode is bad:

You'll hear a continuous tone with a readout of 0.000 as shown in (Figure C) or the readout will indicate any number value other than 0.400-0.600 shown in (Figure B) or the readout will indicate "OL" as shown in (Figure D).



Reverse Bias: Top 3 Diodes - Test 2.

From the multimeter connect the RED test connector to the RED wire coming from the regulator rectifier. Then from the multimeter connect the BLACK test connector to ONE of the YELLOW wires coming from the regulator rectifier. The display should show "OL" as shown in (Figure D). Continue by testing the remaining YELLOW wires following the same test procedure.



When a diode is bad: You'll hear a continuous tone with a readout value of 0.000 shown in (Figure C) or the readout will indicate ANY number value (Figure B).

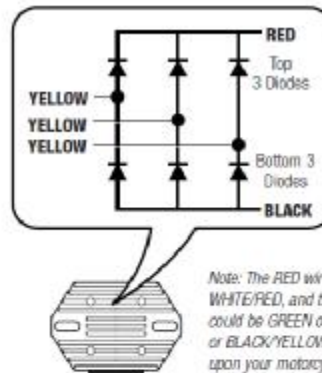
Bottom Diode Tests

Getting Started

To begin the test, switch the knob on the multimeter to the "DIODE" selection as shown in figure A.

Forward Bias: Bottom 3 Diodes - Test 1.

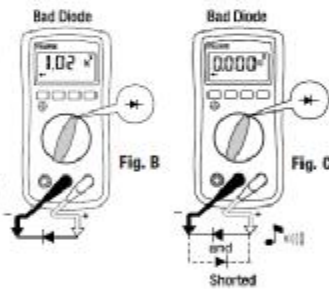
From the multimeter connect the RED test connector to the BLACK wire coming from the regulator rectifier. Then from the multimeter connect the BLACK test connector to ONE of the YELLOW wires coming from the regulator rectifier. The readout should show between 0.400-0.600 along with a single audible beep as shown in (Figure A). Continue by testing the other YELLOW wires following the same testing procedure.



Note: The RED wire could be WHITE/PED, and the BLACK wire could be GREEN or BLACK/WHITE or BLACK/YELLOW depending upon your motorcycle brand.

When a diode is bad:

You'll hear a continuous tone with a readout of 0.000 as shown in (Figure C) or the readout will indicate any number value other than 0.400-0.600 shown in (Figure B) or the readout will indicate "OL" as shown in (Figure D).



Looking for more information

Go to the ElectroSport website: www.electrosport.com

You can download the fault finding chart which will provide you an in-depth understanding and testing procedures for your entire electrical and charging system.

Also, be sure to check out the technical archive for specific ElectroSport product information and installation instructions. If your looking for information regarding your bike model and an ElectroSport product please see the application listing for products. You can then double click on your bike model and year and see specific information regarding your bike and the ElectroSport part which works with it.

Reverse Bias: Bottom 3 Diodes - Test 2.

From the multimeter connect the BLACK test connector to the BLACK wire coming from the regulator rectifier. Then from the multimeter connect the RED test connector to ONE of the YELLOW wires coming from the regulator rectifier. The display should show "OL" as shown in (Figure C). Continue by testing the other YELLOW wires following the same testing procedure.



When a diode is bad: You'll hear a continuous tone with a readout value of 0.000 shown in (Figure C) or the readout will indicate ANY number value (Figure B).

2. The Service Manual also details another series of tests that can be carried out on the R/R to confirm serviceability. These tests confirm the serviceability of the Regulator section using three 12 volt batteries and a test lamp. Due to the complexity of these tests and the equipment requirements it is often quicker and easier to swap with a known serviceable R/R if the Regulator section is suspect.

The Service Manual procedure is repeated below for completeness.

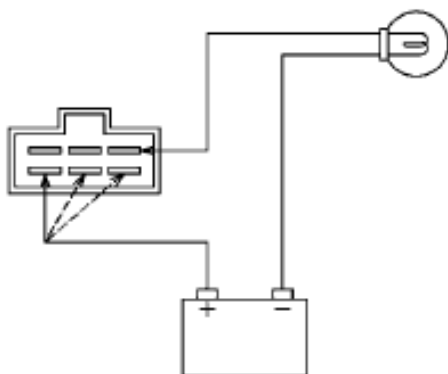
To test the regulator out of circuit, use three 12 Volt batteries and a test light (12 Volt, 3~6 Watt bulb in a socket with leads).

CAUTION - The test light works as an indicator and also a current limiter to protect the regulator/rectifier from excessive current. Do not use an ammeter instead of a test light.

Check to be sure the rectifier circuit is normal before continuing. See test (1.), above.

- Do the 1st step regulator circuit test.

Connect the test light and the 12 Volt battery to the R/R as shown.

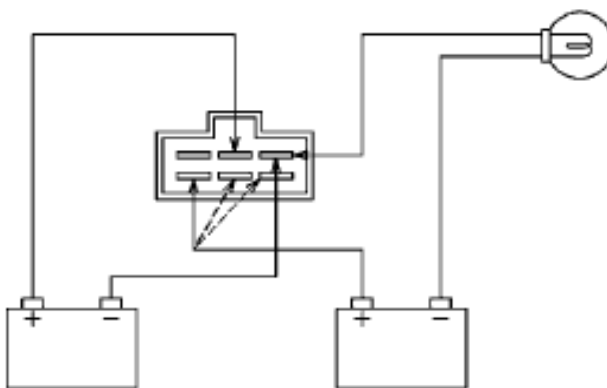


Check the BK1, BK2 and BK3 terminal respectively.

If the test light turns on, the R/R is defective. Replace it. If the test light does not turn on, continue the test.

- Do the 2nd step regulator circuit test.

Connect the test light and the 12 Volt battery in the same manner as specified in the "Regulator Circuit Test-1st Step".

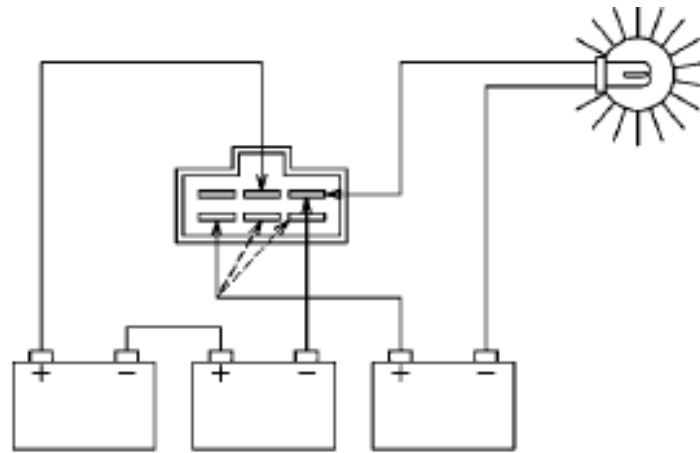


Apply 12 Volt to the voltage BR terminal. Check the BK1, BK2 and BK3 terminal respectively.

If the test light turns on, the R/R is defective. Replace it. If the test light does not turn on, continue the test.

- Do the 3rd step regulator circuit test.

Connect the test light and the 12 Volt battery in the same manner as specified in the "Regulator Circuit Test-1st Step".



Momentarily apply 24 Volt to the voltage BR terminal by adding a 12 Volt battery. Check the BK1, BK2 and BK3 terminals respectively.

CAUTION - Do not apply more than 24 Volts. If more than 24 Volts is applied, the Regulator/Rectifier may be damaged. Do not apply 24 Volts more than a few seconds. If 24 Volts is applied for more than a few seconds, the Regulator/Rectifier may be damaged.

If the test light did not light when the 24 Volt was applied momentarily to the voltage monitoring terminal, the R/R is defective. Replace it.

If the R/R passes all of the tests described, it may still be defective. If the charging system still does not work properly after checking all of the components and the battery, test the R/R by replacing it with a known good unit.

Should you require a replacement, then the R/R fitted to all years of the Ninja 650R (ER-6F) and ER-6N is a Kawasaki Part Number: 21066-1127 but other part numbers (SH678A-12) on the R/R identify it as being manufactured by the Shindengen Electric Mfg Co.

From the Kawasaki website: P/N 21066-1127 is fitted to the following Kawasaki models:

Ninja 650R /ER-6F (EX650) – 2006-2010
ER-6N (ER650) – 2006-2010
Versys (KLE650) – 2007-2010
Z750 (ZR750) – 2005-2010
Z1000 (ZR1000) – 2003-2010
Vulcan 900 (VN900) – 2006-2010
Brute Force 750 4x4 (KVF750) – 2005-2007
Brute Force 650 4x4 (KVF650) – 2007-2008
Mule 4x4 (KAF620) – All years

Searches on the Internet indicate that the Shindengen P/N SH678A-12 is fitted to a variety of makes including the Suzuki V-Strom and some Yamaha models. A search on Google with this P/N reveals the full extent of its use.

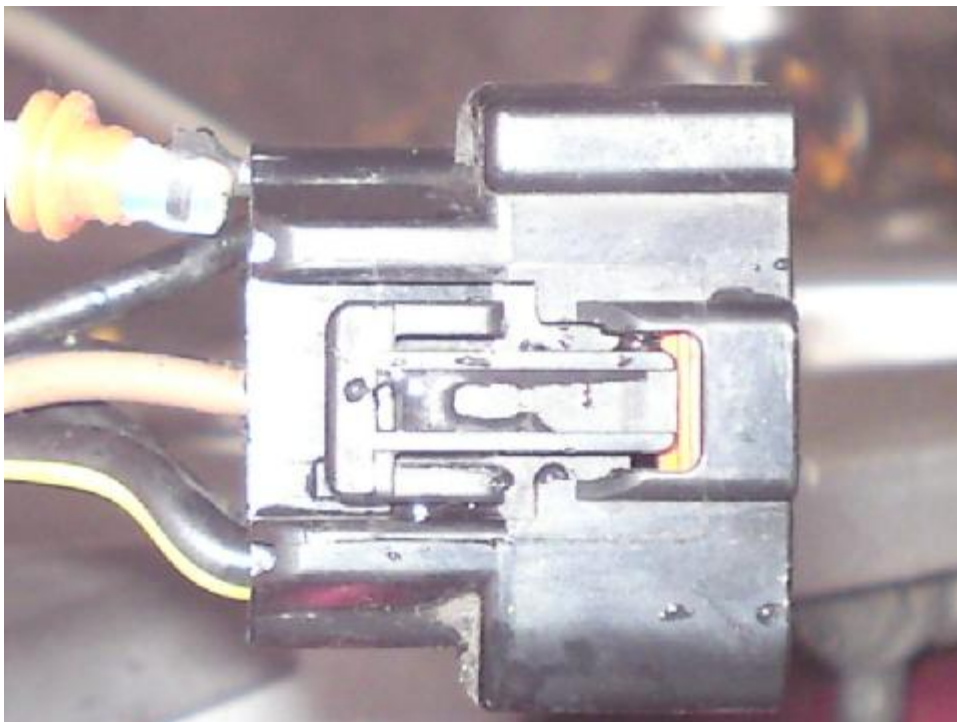
Aftermarket R/R's are manufactured and supplied by a number of vendors, links to these are located on the website in the Electrical links section.

The Regulator/Rectifier Connector

A number of posts on internet forums suggest that the fault with this connector is due to water ingress. Certainly its location is not ideal due to its proximity to the rear wheel. Supposedly Kawasaki made improvements from 2007 and later models as the harness was re-routed to prevent water pooling in the connector. Given that a number of owners with post 07 models who have suffered the same fault I wouldn't bet on this being the complete solution.



Regulator/Rectifier Connector



Regulator/Rectifier Connector

The electrical connector website Eastern Beaver has advised that the logo on the Regulator/Rectifier connector is a Japanese company called Furukawa Electric Co.

Eastern Beaver stock a range of Furukawa connectors and should be able to supply a complete replacement connector or an individual pin.

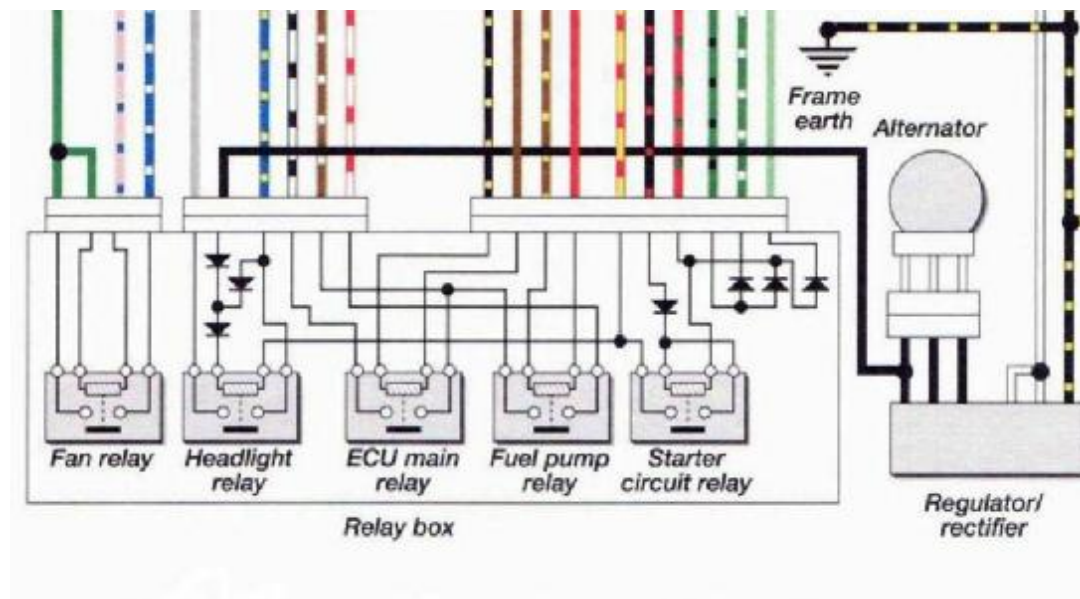
http://www.easternbeaver.com/Main/Elec_Products/Connectors/Sealed/FKWH/fkwh.html



Replacement parts - Furukawa Electric Co.

The Headlight Relay

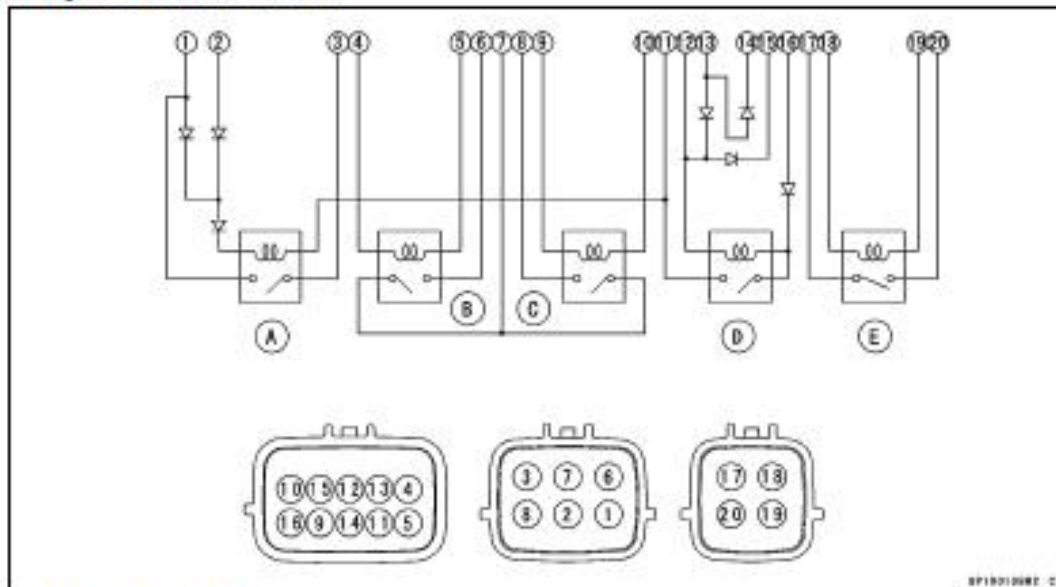
As previously mentioned many owners who have experienced charging system issues have also experienced headlight issues. After replacing the headlight bulbs, the fault still exists. Further trouble-shooting identifies that the headlight relay is at fault. The headlight relay is part of the Relay Box and it also contains 3 diodes. Unfortunately the headlight relay and diodes cannot be replaced individually and the relay box is sold as a complete unit.



The diode arrangement is used as an “electrical latch” to operate the “daylight” headlight system. This system is where the headlight does not operate when the ignition switch is turned on, but operates when the engine is started and the

starter button is released. The headlight remains on (latched) until the ignition is switch is turned off.

Relay Box Internal Circuit



- A: Headlight Relay
- B: ECU Main Relay
- C: Fuel Pump Relay
- D: Starter Circuit Relay
- E: Fan Relay

You can test the circuit of the headlight relay and the diodes which in my opinion is the most likely cause of any headlight relay malfunction.

1. Remove the relay box from the bike.
2. Check the headlight relay circuit portion of the relay box by connecting a multimeter (set to Ω range) between terminals 1 and 3 (see the diagram above). The multimeter should read open circuit (There should be an open circuit with infinite resistance (multimeter displays dashed lines or the abbreviation "OL" which stands for "open loop" or infinity - ∞). If the multimeter does not read as specified, replace the relay box.
3. Check the headlight diode portion of the relay box by connecting a multimeter (set to Ω range) between terminals 1 and 11, then swap the multimeter leads over. Repeat for terminals 2 and 11 (see the diagram above). The resistance should be low in one direction and more than ten times as much in the other direction. If any diode shows low or high in both directions, the diode is defective and the relay box must be replaced.

Should you require a replacement, then the Relay Box initially fitted to the Ninja 650R (ER-6F) and ER-6N was a Kawasaki Part Number: 27002-0001 however Kawasaki advise that this part has been superseded by Part Number: 27002-0007. Again there is no information regarding the reasons for this change.

From the Kawasaki website: P/N 27002-0007 is fitted to the following Kawasaki models:

Ninja 650R /ER-6F (EX650) – 2006-2010

Kawasaki Ninja 650R (ER-6F) & ER-6N Resource

ER-6N (ER650) – 2006-2010
Versys (KLE650) – 2007-2010
Vulcan 900 (VN900) – 2006-2010
Vulcan 1700 (VN1700) – 2009-2010
Vulcan 2000 (VN2000) – 2006-2010
Concours 1400 (ZG1400) – 2008-2010
Z750 (ZR750) – 2007-2010
Z1000 (ZR1000) – 2007-2010
Ninja ZX-6R (ZX600) – 2006-2010
Ninja ZX-6R (ZX636) – 2006
Ninja ZX-10R (ZX1000) – 2006-2010
Ninja ZX-14 (ZX1400) – 2006-2010

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