Rex's Speed Shop

Guide: Rotax-1, 348, 504, 560 & 604 Engines

ND CDi Ignition Troubleshooting Guide

Introduction: Rotax Ignition System

The Rotax 348, 504, 560 and 604 are members of a closely related family of air-cooled four-stroke single-cylinder engines used by numerous European motorcycle manufacturers from the 1980s onwards. Applications ranged from Aprilia and KTM trail motorcycles to the Armstrong and Harley-Davidson military machines and later CCM competition and supermoto models.

Many of these engines use the same Nippon Denso electronic ignition system, with an external ignition amplifier identified by numbers 070000-0780 or 070000-0781. The Rotax reference for this unit is 264 740. Rex's replacement unit (P/N: RTX) is designed specifically as a direct replacement for this ignition amplifier. Always check the number printed on the original ignition unit before ordering.

The amplifier unit is not testable without very special equipment, so our focus is on the rest of the system that can be easily assessed and tested by mechanics.This guide supplements the workshop manual and assumes the person carrying out the tests is competent to use a good quality multimeter and interpret the results.

A simple plug-in replacement unit or partial rewind of just one part of the stator may have been all that was required to restore a relatively new ignition system. Systems 30 years or older often require a more holistic approach to restore reliable operation. This often involves an electrical equivalent of a full engine rebuild, from the generator up.

Start with the Basics

Before testing the ignition system, replace the spark plug and plug cap, don't assume they are good. Check the wiring and connections and rule out basic fuel or mechanical problems.

Define the fault:

- No spark?
- Difficult starting or only starts by bump starting?
- Misfire when hot?
- Misfire under load?
- Intermittent spark?
- Did the fault change, or the ignition stopped after fitting another amplifier unit?
- Is the spark yellow or orange rather than whitish-blue?

These symptoms help determine where to test next.

A Rex's Rewind ~ Defining the process

Much of the equipment we deal with is now more than 30 years old and well beyond its intended design life. Age-degraded electrical insulation is one of the most common causes of stator failure.

First the stator is stripped of all copper and insulation material under controlled conditions so that its magnetic properties are not degraded. Replacing insulation before new winding wire is applied is an essential part of the rewinding process, not an optional extra. Careful replacement of the winding to exact OEM specification ensures maximum output and lifespan of the overhauled part.

Poor Starting
Before looking more deeply into the ignition system, it is worth addressing a commonly asked question: is the ignition causing a starting problem? It certainly can be, but experience with big singles suggests that ignition faults are not always the cause of difficult starting. On many occasions we have started a customer's supposedly difficult bike with a single operation of the kick starter, much to the surprise of its owner. This demonstrates that other factors should be checked before investigating the ignition system in detail.

Correct valve clearances and carburettor settings are particularly important. These should be checked and adjusted as suggested in the shop manual before assuming that an ignition fault is responsible. A correctly set up engine should normally start readily. Two particularly common causes of difficult starting are:

Incorrect idle mixture
An idle mixture that has been deliberately set too rich can make the engine considerably more difficult to start, especially when the engine is hot. Set the mixture correctly using the procedure described in the workshop manual before carrying out further ignition tests.

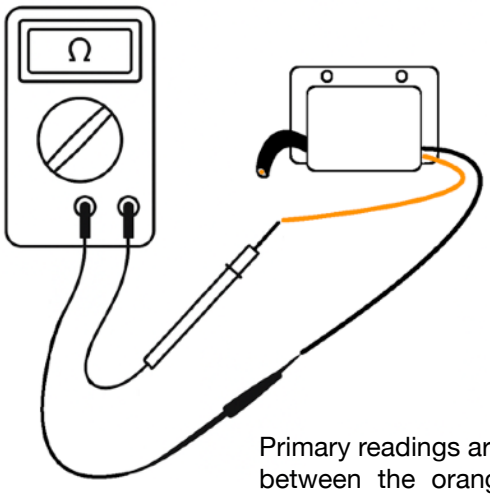
Starting technique
Starting technique can make a surprisingly large difference. If possible, speak to experienced owners whose machines start reliably and compare the procedure they use. Learning and consistently applying the correct technique can transform starting behaviour.

Having addressed these issues, let's now look at common ignition system faults and causes.

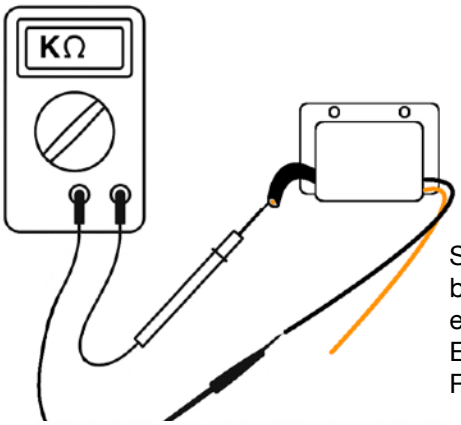
Test 1. No Sparks - HT Coil
The HT coil is located under the fuel tank. The shop manual specifies 0.98 Ω primary and 12 KΩ secondary. Aftermarket coils may differ slightly from these figures, so exact readings are less important than sensible, stable results.

The workshop manual describes the full test procedure if further information is required. The HT coil must be used with a 5 KΩ spark plug cap, which must be removed while testing.

A coil that is open circuit, gives an unstable reading or is drastically out of range should be considered faulty.



Primary readings are made between the orange wire and black earth wire. Budget aftermarket coils may not have an earth wire. Measure between metal frame and primary connection in this case.

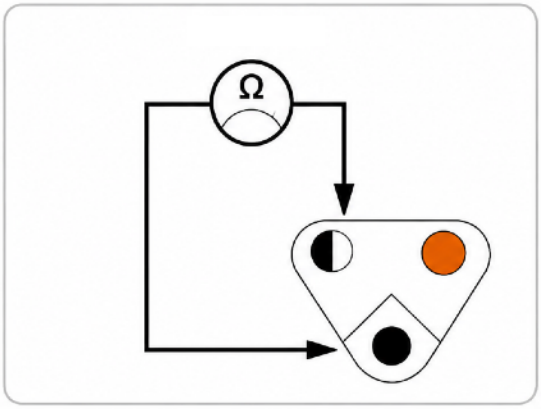


Secondary resistance is taken between HT lead and black earth wire, or the metal frame. Ensure the plug cap is REMOVED from the HT lead.

HTC11: Replacement HT coil designed specifically for the Rotax systems (264735). 70mm mounting centres and correct connector

Test 2. No Sparks - Kill Circuit

Some models may have both an ignition switch and an engine kill switch. Either switch can prevent the amplifier unit from producing a spark. A simple way to test both switches is to locate the amplifier unit (often under the fuel tank) and disconnect the triangular three-pin connector. Carry out the following tests on the motorcycle wiring side of the connector, not the amplifier unit.



Using a multimeter set to continuity, test between the black/white wire and black wire:

- With either the ignition switch OFF or kill switch OFF, there should be a good, solid connection.
- With the ignition switch ON and kill switch set to RUN, there must be no connection.

If continuity remains when both switches are in the running position, there is a fault in the kill circuit which will prevent the amplifier from producing a spark. Check the switches and wiring and clear any faults.

Still No Fix? In-depth Stator Checks

The stator contains dedicated windings that power and trigger the amplifier unit. These are completely separate from the much heavier windings used for lighting and battery charging.

In production since 2008, Rex's replacement ignition units have earned respect with owners worldwide. (Standard model shown.)

Taking the age of the parts into consideration is now important when diagnosing these systems. Most original stators are more than 30 years old - well beyond their expected design life and deterioration of these components is now extremely common and can manifest in a number of ways.

Amplifier units are simple to replace but cannot be tested without specialist equipment. Never connect the amplifier unit, or an HT coil connected to it, to DC power from the bike's battery or charging system. Doing so will cause its immediate failure.

Inspecting the stator

Having completed the initial checks, the next step is a careful visual inspection of the stator. Pay particular attention to the wiring leaving the stator. Electrical stress and temperature in this area are high, so the generator wiring must be in first class condition, with no joins, repairs or hard and brittle insulation. Corroded, loose or unsuitable connectors are unacceptable in this high stress area of the wiring.

Look carefully for mechanical damage to the windings and deterioration of the insulation. Discolouration or flaking of the coating on the windings is a warning sign. If the insulation appears burnt, brittle or readily comes away, the stator has deteriorated and should not be considered serviceable.

If no obvious faults are found, the next step is to measure the resistance of the individual source and trigger windings. These are divided into high and low speed source windings that power the amplifier unit and high and low speed trigger windings that give the timing advance.

The resistance measurements are taken via the connectors on the stator lead using a professional level multimeter. Use the form at the end of this guide to record all your readings.

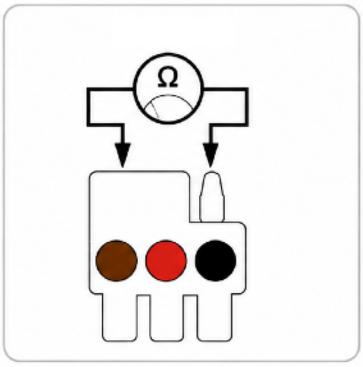
XD05F: Correct plug cap for Rotax engines. This system requires a 5KΩ resistor in the cap

Advice When Taking Winding Resistance Readings

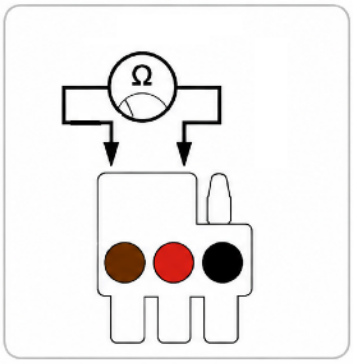
The same stator is used across these Rotax engines. The manual gives a range of winding resistances at 20°C. This is misleading as copper wire changes its resistance predictably with temperature. It is possible to accurately calculate the resistance/temperature variation of copper wire, and remove a grey area from your diagnosis. We give the corrected figures in table form below. Source and trigger windings are precision components, so once ambient temperature has been accounted for, any significant difference between the specification and measured value is a clear warning that the coil has a wire fault. In reality, only a very small tolerance is allowable, but due to copper being highly temperature-sensitive and meters varying slightly in accuracy small variations of up to 2% are normal. Once the discrepancy reaches 5% or more, the winding should be considered faulty, especially if it is more than 20 years old. Additionally, any winding that gives no reading, or one that does not remain steady, has also failed.

Take the following readings via the stator's connectors and write them down. Note the ambient temperature too. The ambient temperature correction chart (given below) indicates a good reading at different temperatures, removing temperature error.

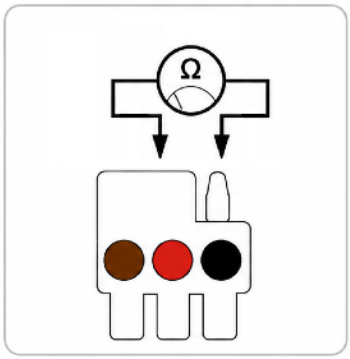
Source Coil Tests



Test 3: Black to Brown



Test 4: Brown to Red



Test 5: Black to Red

Original Specifications at 20ºC

Source Coils
Test 3: Low Speed Source - Black to Brown: 329Ω

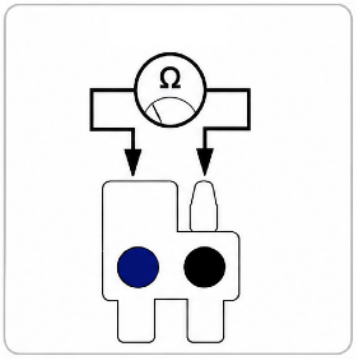
Test 4: High Speed Source - Brown to Red: 5Ω

Test 5: Source Coil Integrity - Black to Red: 334Ω

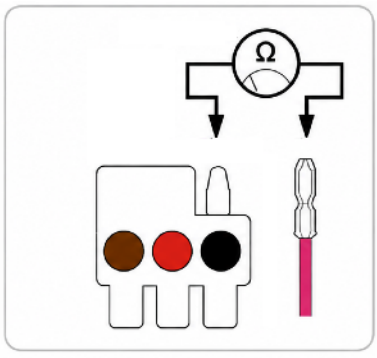
Trigger Coils (Pick-ups)
Test 6: Low Speed - Blue to Black: 145Ω

Test 7: Advance/High Speed Pink to Black 16Ω

Trigger Coil Checks (Pick-ups)



Test 6: Blue to Black



Test 7: Pink to Black

Interpreting your Readings
First, compile your readings so the data is easy to assess and compare to the 'look-up' table which shows the acceptable range at a particular temperature. Tests 3, 4, 6 & 7 are where temperature compensation is important, test 5 is simply a 'back check' to confirm integrity of the internal source winding interconnections, so should always equal the total of tests 3 & 4.

The engine must not have been run for several hours, ensure it has cooled to the ambient temperature, also make an accurate note of the temperature at the motorcycle's location.

Ambient Temperature:		**C or F (please circle)**	
TEST	**ITEM UNDER TEST**	**YOUR RESULTS**	
Test 1	HT Coil - Cap **REMOVED** 0.98Ω/12KΩ	Primary - Ω	
		Secondary - K Ω	
Test 2	Kill Switch - Resistance between Black & Black/white wire at the 3 way plug. **Confirm continuity or if none.**	Ign **ON +** Kill set to **RUN**	
		Either Ign or Kill Set to OFF	
Test 3	Low speed source	Black to Brown	
Test 4	High Speed Source	Brown to Red	
Test 5	Source coil interconnection integrity	Black to Red	
Test 6	Low speed trigger	Black to Blue	
Test 7	Advance/high speed trigger	Black to Pink	

It can get quite complicated at this point, if you'd like us to interpret this data for you please e-mail: tech@rexs-speedshop.com.

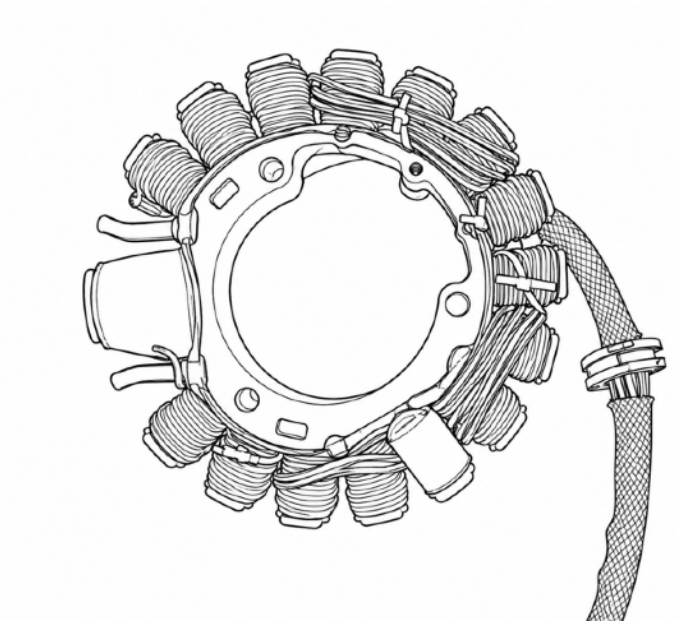
A clear photo of this page, once filled out with your data, is a good way of getting this to us.

If Rotax were publishing these specifications today, we believe the resistance table would look more like this, with copper temperature taken into account for really accurate test results:

Ambient Temp ºC	**Test 3 Pass Range**	**Test 4 Pass Range**	**Test 6 Pass Range**	**Test 7 Pass Range**
-10	284 - 296Ω	4.3 - 4.5Ω	125.3 - 130.5Ω	13.8 - 14.4Ω
-5	291 - 302Ω	4.4 - 4.6Ω	128.1 - 133.4Ω	14.1 - 14.7Ω
0	297 - 309Ω	4.5 - 4.7Ω	131.0 - 136.3Ω	14.5 - 15.0Ω
5	303 - 315Ω	4.6 - 4.8 Ω	133.7 - 139.2Ω	14.8 - 15.4Ω
10	310 - 322Ω	4.7 - 4.9Ω	136.5 - 142.1Ω	15 - 15.7Ω
15	316 - 329Ω	4.8 - 5.0Ω	139.2 - 145Ω	15.4 - 16Ω
20	322 - 336Ω	4.9 - 5.1Ω	142.1 - 147.9Ω	15.7 - 16.3Ω
25	329 - 342Ω	5.0 - 5.2Ω	144.9 - 150.8Ω	16.0 - 16.6Ω
30	335 - 349Ω	5.1 - 5.3Ω	147.7 - 153.7Ω	16.3 - 17Ω
35	341 - 355Ω	5.2 - 5.4Ω	150.5 - 156.7Ω	16.6 - 17.3Ω
40	348 - 362Ω	5.3 - 5.5Ω	153.3 - 159.2Ω	16.9 - 17.6Ω

Conclusion

Resistance measurements show if the wire resistance within a winding is the same as when it was newly made. This can help show whether the tightly packed turns of fine wire are still properly insulated from one another. If that insulation begins to fail, adjacent turns can become shorted together, reducing the effective resistance of the winding.



The seemingly random symptoms of capacitor discharge ignition failure are caused by the random way insulation breaks down. There is a possibility that the winding resistance can be perfect, yet the winding is leaking its power to the stator core. This fault does not show on a multimeter test, however it does show up with the application of heat and load.

Age, heat and high voltage can all cause electrical insulation to deteriorate, much as mechanical parts inside an engine gradually wear as the engine is used. The difference here is electrical components can also deteriorate simply through age, even when they have seen little or no use. In electrical components, this deterioration may show up as shorted turns, leakage to earth, or other changes in resistance.

If your stator gives perfect, stable resistance readings but the bike still does not run properly, look further for other symptoms. Does the fault worsen when the bike is hot? Is there a mysterious misfire or problems only under load? Is the bike difficult to start, perhaps needing bump starting? Has fitting a new amplifier unit caused it to stop working altogether? New amplifier units load the windings to their full design power, charging much faster and to a higher voltage than an old amplifier can achieve, which highlights weaknesses in ageing windings. If heat or load triggers problems, this strongly indicates insulation failure that a multimeter test may not always detect.

Please note that we are not responsible for misdiagnosis of your motorcycle's ignition faults, so where brand new parts are returned for re-testing our standard test fees apply. This guide highlights the problems you are likely to encounter when fitting new parts to aged systems, many are now well beyond their useful life expectancy.

If you find off-specification resistances or suspect failing insulation, the cure is usually to have the generator overhauled back to its 'as new' specification. Our workshops have full facilities to overhaul stators and are happy to advise before you send parts to us for work.

Special Edition Amplifier unit.

Thoroughly tried and tested electronics mounted in a much improved case. Visually similar to the original unit. Made in UK.