# Capacitor Discharge Ignition
# Fault Finding Made Easy

## Introduction

Capacitor discharge, or 'CDi ignition' is perhaps the most common ignition used on small engines today. Its popularity is due in part as its a very simple and reliable system that in most cases generates its own power allowing an engine to run with no external power source. CDi ignition is in fact an electronically controlled magneto, unless the engine is turning the ignition does not work. However while CDi can be a low cost utilitarian system it also possesses features that with clever design and electronics will give an impressive performance boost compared to a standard system.

Power for sparks is generated by magnets mounted on the engine's crankshaft that when rotating excite a set of 'source' windings in the generator. These windings charge a large capacitor which is electronically triggered, sending a short, sharp burst of power to a step-up type HT coil. Great care is needed when working on CDi ignition as the source windings produce very high voltages and the capacitor can deliver a nasty electric shock even when the engine is not running. Some systems will charge the capacitor to 200 volts. There are some exceptions to this method of operation, the early Kawasaki triples and some modern scooters use a device called an inverter (you can hear it whistling when you switch on the ignition on the old triples) which takes 12 volts DC and converts it to the very high voltage needed for CDi, however these systems are extremely rare and are not covered in this guide.

Troubleshooting CDi is very poorly explained most shop manuals, they all seem to give misleading or incomplete advice and often fail to mention the most common faults suffered. We've created this publication based on years of in-depth experience in both repairing and designing ignition systems to clear up some myths and help you get straight to the problem without having to buy a lot of unnecessary parts. If you are not comfortable working on electrical systems or have exhausted your knowledge you can send the parts for expert assessment and repair. Our trade counter open to the public in Robertsbridge East Sussex and where all enquiries and items for repair should be sent. If you are local to us you are welcome to stop by and talk to us.

## First Identity the Ignition System Fitted

CDi is often confused with other types of electronic ignition, the most common mistake is wrongly labelling DC powered TCi or transistor ignition as CDi ignition. The manual should identify which type of ignition is fitted. If you are still not sure locate the ignition unit and see what is written on it, phrases like '12 volt transistor ignition' should be taken to mean TCi and not CDi. The wiring diagram will also confirm which system it is. TCi ignition needs a battery to produce the spark so will have a live feed from the ignition switch to the HT coils. Be wary of parts vendors and mechanics who use terms such as '12 volt CDi" as unless they are referring to inverter systems they clearly not sure what they are dealing with. Remember the majority of CDi systems do not use 12 volts and must never be connected to the 12 volt supply!

## Caution!

It's important to understand that this guide does not override any safety cautions or warnings given in a shop manual, its only purpose is to make troubleshooting CDi ignition more accurate through improved knowledge of the system. You will require the shop manual as it will (or should) contain information you will need when fault finding.

The ignition system develops very high voltages on both its primary and secondary sides. Great care must be exercised to avoid electric shocks.

Always use strobe lamps that have an inductive clamp that fits around the HT lead. Avoid the sort that interrupt the ignition as these cause the HT voltage to climb to extremely dangerous levels.

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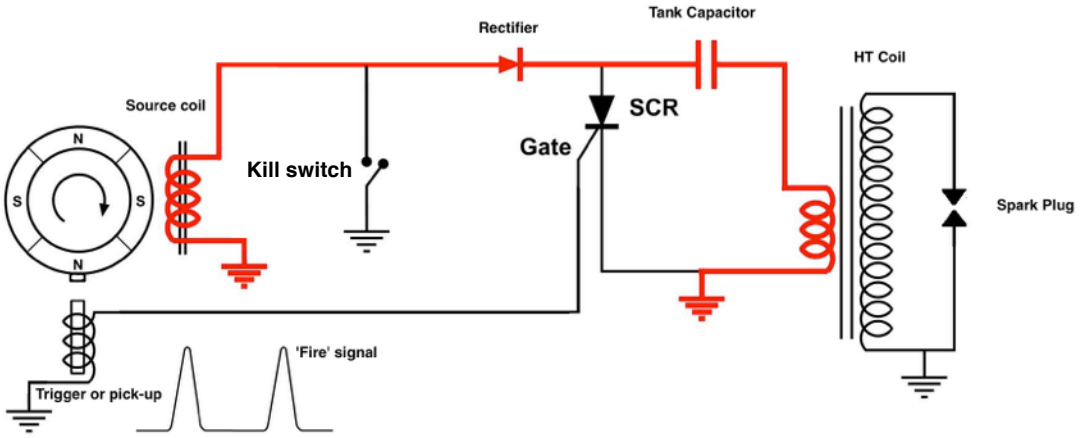


Above is a schematic of a basic CDi ignition system, it can be broken down in to the following components: Source coil, trigger or pulsar coil, kill switch, HT coil and ignition unit which contains the capacitor and triggering circuit. There are more complicated systems but these are simply variations of the above system. Only the ignition unit requires very specialised equipment in order to test it, everything else is testable with a good multimeter.

## Trouble shooting

Our first question to the customer is “what is the bike doing?” Sometimes there’s no spark and the machine will not run at all. When trouble shooting CDi ignitions you should first focus on what the bike is doing (or isn’t doing). Running faults that come on at certain RPMs, starting cold but not hot or problems that get worse when the engine is hot are often traced to a failed or failing winding in the generator. The source coils are aptly named, they are the source of the ignition’s power but when they get old they are also the source of most of the ignition’s problems too. Of course you should follow the trouble shooting in the shop manual to rule out other problems and we assume basic checks have been carried out before digging deeper in to the system. We accept that it may be easier to look at parts that can be un-plugged quickly rather than delving in to the generator, however ignition units can’t be tested at home and you find out later on that replacing them can cause even more problems.

***“If a source winding is 40 years old it’s been on borrowed time for the last 20!”***

Its a fact that the older electronic parts get the more likely they are to fail. Quite simply, as the insulation ages it dries out and degrades, a process that is speeded up by thermal cycling and stress from electrical current. In any machine the parts that work the hardest or have the most stress on them fail first, so it makes sense to start by looking at the copper source windings as these do most of the work in an ignition system. Its common for faults caused by aged generator windings come on or worsen as they are heated by the engine, these symptoms include:

- Starts normally when the engine is cold but is hard to start hot or won’t start when hot.
- Runs for a few miles but then starts to misfire or won’t rev fully or cuts out completely.
- Will start and rev in neutral, but when the engine is loaded it won’t rev.
- No, weak, intermittent,  yellow or thin white spark
- Mis-fires at higher RPMs.
- Not running on all cylinders.
- Runs with an old CDi unit but not a new one.
- Won’t kick start, but will bump start.

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Checking windings can be subjective and requires a good quality multimeter (our TM-2 meter is ideal). If you do find a definite fault straight away, IE a resistance that is out of tolerance or gives no reading, all is well and good. However results aren't always that clear cut and the manuals often don't help you as much as they could. Most allow a 10% tolerance, some are more unhelpful as they specify a large resistance range as being acceptable. In short its not, the source winding will have a specific resistance when new and if its changed even by a small margin it shows the winding is faulty. All generators are made to very exacting standards on machines that put on an exact number of turns every time. Winding industry standards typically state that each winding will have a DC resistance within 2% of the last. If this changes by as little as 5% the winding is considered to have failed. If you use the lower 5% tolerance you will be far more likely to trace the problem quickly.

Measuring the resistance is the best way to spot a fault, its not infallible however. Firstly windings change their resistance with temperature. The figures in the manual are taken at the ISO standard day temperature of 20 degrees centigrade, you should try and take your readings at 20 degrees too. However this isn't always practical so note the ambient temperature then we can apply a correction factor to your results. The important detail is that the engine must be completely cold when you take the readings, if its been run recently it must be left until its settled back to the ambient temperature.

More often than not your tests will produce a number of readings, low speed source, high speed source, and various pick-ups for example. Our recommendation is to write them down in a list (there is a handy table included at the end of this publication). Its much easier to spot one thats drifted away from spec if its surrounded by those that are where they are supposed to be. Another benefit of making a list is that it makes no difference what the temperature is, a reading off tolerance will be still be spotted when surround by readings taken at the same temperature.

Confusingly some failed windings may give perfect resistance readings, this is because most multimeters only use 1.5 volts to test the item, this is not enough to properly test insulation and even failed insulation can pass this test. However if you have a running problem that gets worse with heat or a weak spark, the windings that power the ignition are the prime suspect. Our technicians can often help you if you e-mail your test results to the the tech team (tech@rexs-speedshop.com).

*Faults that manifest as;- refusing to start unless bump started, not running on all cylinders and not running on a new CDi unit but will run on an old one are due to the fact that the source winding is 'weak' and no longer able to supply its full output. In this case the insulation has started to fail but has not failed completely. The winding can still produce power but at a much reduced level.*

*Electricity will always go via the easiest route, just like water will. On multi-cylinder machines a weak source winding will result in the capacitor(s) in the CDi unit not being fully charged. The result is that there is not enough power to fire the engine fully. The power will take the easiest route so you may notice that the one cylinder not running swaps around, suddenly coming to life for a while. Its worth remembering that very often spark plugs soaked in fuel often stop working for good and replacing it may bring the cylinder back to life for a short time. This is a sure sign of a failing source coil.*

*Weak windings are often unable to run new CDi units. This is why swapping ignition boxes can add to the problems. As capacitors age they loose the ability to store a charge, weak windings are able to charge old capacitors. When a brand new unit is fitted the capacitor will charge up fully, loading the winding fully, often to the point where it stops producing power completely. When the old unit is refitted the ignition works again leading to owner to think the new unit is faulty. Its extremely rare for a new unit not to work, ones purchased from us will have been test run first making a "DOA" unit virtually unheard of.*

*If you can get the engine to run by spinning it faster IE bump starting this too is a sure sign the source coil is weak.*

*Windings fail slowly in a number of different ways. Faults that get worse with heat, load or need the engine to be spun faster than normal to start indicate a CDi source winding in the early stage of failure.*

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## Timing pick-ups/pulsar coils

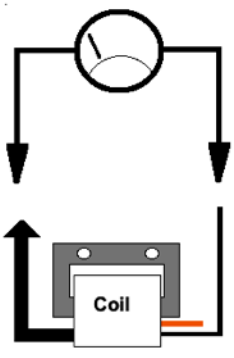
The trigger pick-ups are wound components which also fail in the same manner as source windings and the same procedure is used to test them. However the pick-ups are normally mounted on the periphery of the generator, rather than buried inside it and so are subjected to much less heat. Also they operate at vey low voltages, both factors mean that pick-up failures are not as common as source coil failures. That said some machines suffer more than others. The Suzuki GT250/500, GN/SP400, RG250, Honda 400 Superdream, Kawasaki KH400 and early Yamaha RD250 are models that spring to mind as being regular visitors to our workshops due to failed pick-ups. Very specialist knowledge and equipment is needed to get them right. The wire size is critical as is the number of turns. Using a heavy duty alternative wire will throw the timing off, as will getting the number of turns wrong. Often a special winding pattern is used so the output is a sharp, accurate spike rather than a sine wave.

Some four-stroke engines will have two pick-ups to give the timing information, one that is for starting, often called the low speed pick-up and one for the upper end of the RPM range. Honda made an over complicated system by adding more trigger windings than are strictly needed in the CB400N, they went on to create an even more complex system for the CX500. A failure of a pick-up will therefore cause a problem with starting or at the point in the rev range where that particular winding gives the timing signal. You must check each of the trigger windings despite a pick-up failure being far less common. Apply the same 5% tolerance rule to the figures in the manual.

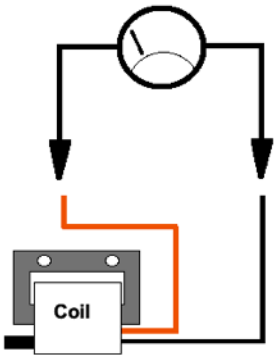
## HT coils

Although these are well covered in the shop manual there are a few points worthy of note. Very often you'll find that the resistance is different to what the manual says. Provided the correct type of coil is used it resistances are not something to worry about. CDi ignition coils have a primary of between 0.4 and 1.8 ohms and a secondary anywhere between 5-15K ohms. CDi needs a step up HT coil rather than an inductive type. This goes back to the point discussed earlier regarding the identification of the ignition system. Avoid buying coils as described as "6 or 12V CDi", invariably these will be for TCi ignition and will cause poor starting and place extra load on the source coils when used on a CDi system.

When testing HT coils, first remove the HT cap. The primary is tested between the two primary connections, if there is only one then the metal frame is the earth. The secondary between the HT lead without ant HT cap and earth connection. On dual HT lead coils the secondary is measured between the two HT leads. The primary is measured between the two primary wires as before. Primaries are constructed of thick wire and rarely give problems, secondary windings are typically 10,000-15,000 turns of very fine wire and do break down due to the high voltage and delicate nature of the wire used.




**Secondary**
(Kilo Ohms)




**Primary**
(Ohms)

*The metal frame is the earth if there is only one primary wire*

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Our workshops are able to test analogue CDi units (except where an immobiliser is fitted) and we offer either new parts or a rewind service for most stators, magneto coils and some pick-up windings. We have a range of regulator rectifiers, CDi units, HT coils and AGM sealed Batteries in stock and we have the expertise to ensure you get the correct parts. On the “Rex’s Tech Support” page of our website there are a number of model specific help sheets that are free to down load. For technical help you can e-mail you results to tech@rexs-speedshop.com, either take a good clear photo of your results or if you are able, e-mail a scanned copy. We are happy to work with motorcycle repair shops and public alike.

## Test Results

**Never take stator resistance readings from an engine that is not at ambient temperature**

**Ambient temperature when readings taken:…….. C / F**

**Make & Model……Year……**

| **Record both the figures given in the manual and your own readings** | | | | |
|---|---|---|---|---|
| Test | Item | Units | Manual figures | Readings observed |
| 2 | HT Coil Primary | Ohms | | |
| | HT Coil Secondary | Kilo Ohms | | |
| 3 | Low speed source | Ohms | | |
| 4 | High speed source | Ohms | | |
| 5 | Low speed pick-up | Ohms | | |
| 6 | Intermediate pick-up (where fitted) | Ohms | | |
| 7 | High speed pick-up | Ohms | | |

*Please do not bother attempting to measure voltages while kick starting or using the electric starter. Some systems produce very high voltages which can give a nasty electric shock.*

*Generator output is extremely dependant on the speed the generator is being turned at. You have no way of accurately measuring the speed while kick starting, even electric starters will vary depending on the battery state. There is no data to compare your voltage readings to so there is no way of knowing what a good reading is nor when its out of limits.*

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