

Part #49 Utilizing the Ducati Generator Output

By Mike Stratman

It has been a practice of mine over the years to keep an informal tally of the nature or type of requests for tech assistance. Judging from the number of bizarre experiments being conducted with the generator output including blown radios and hourmeters, it is time to address the subject of what can be expected of the Ducati Generator circuit. This month we'll look at exactly how the Generator functions, what a Ducati Generator puts out, what you can and cannot expect to power from it, what type of regulator is best for your situation, and some of the common pitfalls people get into when wiring an aircraft electrical systems. We'll also discuss why your Tach goes nuts during a Mag check plus why some day you may have an unexpectedly hard starting engine even with an electric starter.

Why does my Tach go Crazy During a Mag Check?: Before we get started I have to answer one of the most common questions about a Ducati System. Many operators panic when their electronic Tach does not respond as expected during a Mag check. Knowing how the circuit works one can actually expect to get strange Tach readings. The gray wire is connected to a common pair in the ignition poles with the circuit being completed to thru a ground wire. This produces the 6 pulses per revolution the Tach is reading. During a Mag check the ignition voltage is dumped to ground thru a shorting cable (wire #8 in figure #2) killing one side of the dual ignition. The pulse or wave can come up the ground wire confusing the Tach as to the actual pulses being received. Moving the ground wire around will likely produce mixed results. Obviously a Mag check will not produce the standard GA rpm drop many pilots come to expect and there is little you can do to change that. It is best to just listen for the rpm drop and ignore the tach.

How it works: Buried behind the flywheel is a 12-pole stator winding that performs a number of jobs. 2 pair or 4 of the 12 pole windings are dedicated to each of the ignition sides. These windings are independent which accounts for the redundant nature of the dual ignition systems. The only item each side has in common is the flywheel magnets, making for a very hard to defeat this ignition system. The other 8 pole windings are really one continuous winding. See figure #1.

Figure #1 – The heart of the Ducati Magneto Generator. Note the four windings dedicated to the ignition and the 8 poles dedicated to the alternator.

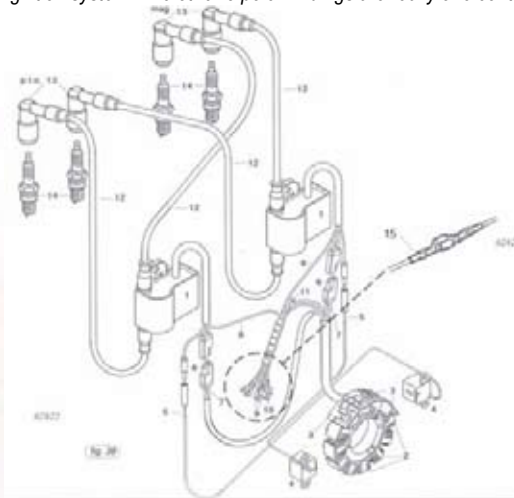


Figure #2 – The schematic for a Dual Ducati as found in the Installation Manual #899-482. Note how the shorting or kill wires #8 actually come from the transducer boxes back into the wiring harness. Not to be confused with the alternator output #9 coming from the magneto.

How Do I Locate The Output Wires: Some confusion has happened due to the production changes and the way the wiring harness is constructed. The yellow wires from the alternator are easily identified as the only two yellow wires coming from the stator. The other yellow yellow/black wires are coming from the transducer boxes mounted on the side of the engine. These are the shorting wires for each ignition side. The confusion comes when these shorting wires are routed into the same harness with the generator wires. If confused about which is which, simply follow the wire back to its source. See figure #2.

Generator Output: The Ducati Generator output is rated at 170 watts AC at 6000 rpm. Of course this will vary by RPM. Chart #1 shows the current output by rpm of a typical Rotax Generator. This alternating current can be used directly to feed AC consumers or via a rectifier-regulator for loading a battery and then feed direct current DC consumers. By AC consumers we are talking about the most basic AC lights or strobes accepting AC voltage. The voltage can be as high as 90-100 volts. Depending on the type of regulator we use, the resulting voltage can vary greatly. If you have no interest in using this circuit for any other device, you might want to use an AC Hourmeter to keep track of engine hours for maintenance purposes.

RPM	AC Voltage
1325	16.3 volts
2300	28.5 volts
4260	52.5 volts
6400.....	77.3 volts

Chart #1 – AC voltage varies by rpm. Here is a cross section of what you can expect as raw AC from a Rotax Generator. See footnote #1.

Regulators: Some regulators are not designed to power devices directly. Some are designed to charge a 12-volt battery. The battery is then the reservoir that holds and steadies the voltage so DC consumers can receive a consistent 12 volts. Yes, I know, batteries are like bricks that make your plane fly like a pig, but it's time to make some compromises. If you want to power DC consumers like strobes, gauges, and starter motors it's time to consider if you can deal with a 15 lbs. lead-acid battery. Regulated voltage is 13.5 to 14.5 volts. Using the formula 170 watts divided by 14 volts = 12.14 or about 12 amps usable load. But in actual operation you should not exceed 80% of the maximum amps or about 9.7 amps continuous load. This gives you a little safety margin when powering devices that are in continuous use. With this in mind let's look at what's available in Regulators.

If you just can't help the urge to run devices without first charging a battery, make sure the device can survive voltage spikes and under volt situations. You are truly running your own experiment when proceeding without a battery.

Single Phase Regulator: This #9103 or Rotax #866-080 regulator is the simplest and cheapest regulator on the market. It does require a minimum 1 amp continuous load to flip the wave from AC to DC. Without a 1 amp load the output will still be AC. This is equal to a 12-volt lamp drawing 15 watts. A minimum 17-amp hour

battery will provide this load as well. Under no circumstances should this regulator be used without a battery. This will likely result in destruction of all but the simplest of devices. See figure #3.



Figure #3 - This #9103 or Rotax #866-080 regulator is the simplest and cheapest regulator on the market. Sells for around \$30.



Figure #5 - The 3 phase or #9251 regulator has a built-in load compensator as well as an extra regulating circuit that could be used as a back up.

This is a "shunt" regulator. In short that means is that the excess voltage is shunted to ground to get down to the 13-14 volts required by the system. This causes heat and may cause RF or radio interference static. This also places an extra load on the engine to produce the voltage being shunted. This regulator was originally designed for snowmobiles and motorcycles but has been used widely in the early Ultralight world. It has gradually been replaced by more sophisticated regulators that are designed especially for our industry. More about these units in a minute. Wiring the single phase is simple when using a 1-amp load. Note how the circuit is completed thru ground. Also identified by Rotax #866-080. See Figure #4.

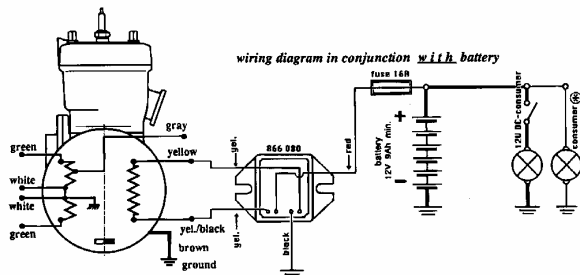


Figure #4 - Wiring Schematic for use with Single phase Regulator #9103

Three phase Regulator: This more advance regulator is easily identified by a set of cooling fins on the entire topside. This helps dissipate the heat created by the shunting. See Figure #5. This unit has a built-in load compensator so as not to require a battery to rectify. It is still a shunt regulator so all excess voltage is dumped to ground as with the single phase #9103. This unit has an extra wiring that connects to another rectifying circuit that can be used as a back up, therefore one of the yellow is not connected. Also identified by Rotax Part #264-870. See Figure #6 for wiring schematic with electric starter in circuit.

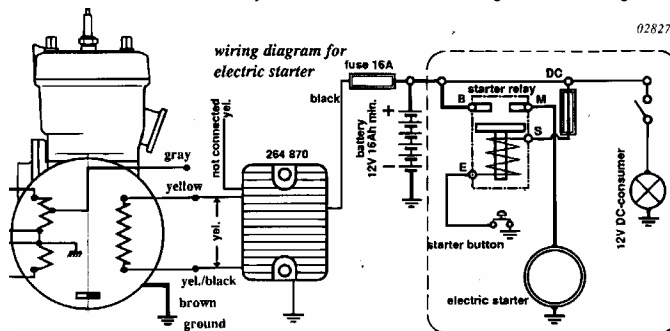


Figure #6 - The 9251 regulator schematic as shown with an electric starter.

KW Regulator: Several years ago a new unit arrived on the market, specially designed for the Rotax Aircraft engine. Its claim to fame was "no battery required". This voltage regulator provides up to 15 amps of pure 12 volts D/C. No voltage spikes and other "dirty" output properties. Can be used to power strobes, instruments, radios, and more. Can also be used to charge a battery system. Unlike other regulators (single phase #9103), no minimum load is required. Super easy hook up includes labeled and Color-coded screw terminals with crimp connectors. Unlike 9103 & 9251, no dangle wires or splicing required. See Figure #7. For a more complete look on what you can expect from this unit refer to Chart #2 for output voltages. As you can see this unit is a big improvement in shunt type regulators.

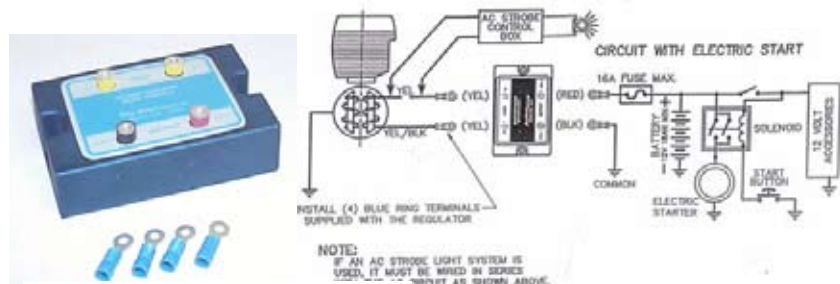


Figure #7 - The KW or "Blue Box" Regulator is a little easier to deal with because of the threaded posts ready to accept wiring.

Figure # 7A - The KW Regulator uses color coded well marked screw terminals for the input and output connections. Saves all the splicing mess of other regulators. When installing a KE Strobe wire in series rather than across as shown at left.

RPM	DC Volts <i>(across Red & Black output terminals)</i>	Conditions
1325	15.1	No load
1325	13.6	2 amp Load
2300	15.4	No Load
2300	13.8	2 amp Load
4260	15.1	No Load
4260	13.7	2 amp Load
6400	15.1	No Load
6400	13.7	2 amp Load

Chart #2 – The output that can be expected from a KW Regulator under no load and 2 amp load conditions*

Precision Power Supply: Another custom device built especially for the light aircraft business is the KE Precision Power Supply. When connected to the lighting coil of the engine it will provide 12 volts of pure noise free safe DC power @ 3 Amps. This power is used to operate radios, including CB, navigation equipment such as GPS, DC powered gauges, etc. The PPS is a pass type-switching regulator, so it will not interfere with Tach, strobes or any other AC equipment. It can be used with or without a battery in the system. When used with a small to medium sized battery it will safely keep that battery charged. It also features a watchdog circuit to carefully monitor its DC output. If the monitor sees anything that isn't okay (higher than safe voltage levels, even spikes) it shuts down the system (crowbar) within microseconds. Thus eliminating the danger of voltage surges and noise spikes damaging your expensive equipment. The 4 1/2 x 3 1/2 inch unit weighs 10 oz. See Figure #8.



Figure #8 – The KE Precision Power Supply is great for powering devices without a battery up to 3-amp load.

Wave Output Comparisons: As you can see we have a lot of different options to consider. For comparison purposes here are some oscilloscope photos that show a multitude for output waves. See Figure #9-thru #13. All measurements were taken at 2300 rpm. Scope time/Div@1ms per. Scope volt/Div with 10x probe@*. Material supplied courtesy by Kuntzleman Electronics.

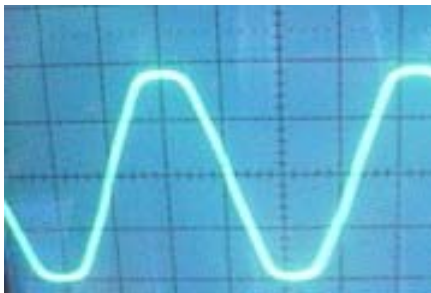


Figure #9 – Shows the AC output from a Rotax Generator with nothing attached. 20 volts per Div.*



Figure #10 – KW Blue Box Regulator with no load on DC side. 20 volts per Div. *



Figure #11 – KW Blue Box Regulator with 2-amp load on DC side. 2 volts per Div. *

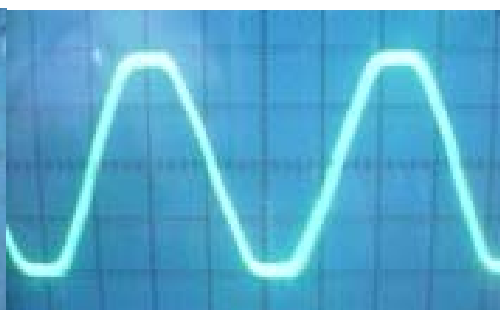


Figure #12 – KE Precision Power Supply with no load attached. 20 volts per Div*



Figure #13 – KE Precision Power Supply with a 2 amp load on its DC side. 20 volts per Div*

Battery Options: Most any electric starter will require a minimum 18-amp hour battery. It is important to note that the Ducati Ignition has an Achilles heel, below 250-225 crankshaft rpm this system will produce absolutely no spark. **That's right !!, not just a weak spark but no spark at all !!** It is common for batteries to have an operational life of maybe two to four years. Of course over time a battery loses some of its amp output. Cold weather will also greatly affect the amp output. At a certain point the battery's ability to turn the engine over will reach a point (225-250 rpm) where the engine will not spark. At this point the operator continues to grind the battery down further decreasing the rpm and likely just flooding the engine with fuel. Often times the diagnosis becomes completely misleading thinking the ignition system has failed or worse, setting the operator off in the wrong direction trying to figure out why what worked perfectly yesterday won't even pop today. While a 25-amp battery weights in at around 21 lbs. it can really save your bacon especially if you do not have a recoil starter back up. See figure #14 for typical battery options.

Another point to consider when setting up an electric starter is cable wire size. The desire save weight is often times compromises the proper AWG size of the cables versus the length of the run of the battery cables. A #6 AWG wire is highly recommended. On extremely long runs an even larger size might be advisable.



Figure #14 – There is no way around it, batteries are major ballast!
The 18-amp hour unit on the left is 15lbs. The 25-amp hour on the right is 21 lbs. Makes sure to recalcuate your weight balance when installing one of these bricks.

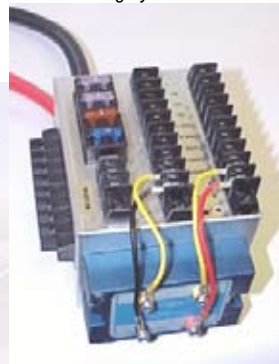


Figure #15 – The KE Hot Box allows you to skip a lot of wiring decisions by making most of the connections and conversions internally. Output terminals are labeled nicely for easy hook-up.

The KE Hot Box: If you want to by pass all the custom fabrication associated with wiring your aircraft, then the KE Hot box is a great time saver. Bought as a custom unit only the Hot Box connects right to the engine wire harness and internally performs all the stuff needed to break the circuit into nicely labeled hook-up terminals for most everything you need on the entire aircraft. The Hot Box is a self-contained primary wiring system. It has everything needed to connect your starter and lighting coil equipped engine electrically with the rest of your aircraft. Also includes a number of easy to change fuses built-in to protect your system in the event of an overload or short circuit.

Here is a list of features that are built in to the Hot Box

1. Fused KE rectifier / regulator to charge the aircraft battery.
2. Four-position auto blade type fuse block supplying three, noise filtered 12-volt taps.
3. Heavy-duty solenoid for the electric start circuit.
4. A special Hobbs hour meter circuit that will only work while the engine is running. Never will false time be run up because you forgot to turn off a switch.
4. A color matching wiring harness, ready to plug into the engine. Colored cables, ready to connect to the starter and battery.
5. Nine pairs of labeled screw down terminals for connecting external instruments, switches, and electrical equipment. A breakdown of these terminals is as follows:
 - MASTER - Connect a switch across these two terminals and you will turn the power on and off to the three 12 volt terminals and the electric start circuit.
 - 12 V - Three individually fused and noise filtered 12-volt DC accessory terminals for powering radios, navigation equipment, etc.
 - TACH - Connect two wires from your tachometer here.
 - L & R MAG - Connect your magneto kill switches across these terminals.
 - START - Connect a push button, spring loaded toggle, or keyed switch here to energize the starter. As a safety feature, when the engine is not running the starter can only be engaged after first turning on the master switch.
 - HOBBS - Connect a (4 -40 Volt) Hobbs hour meter here and it will only operate while the engine is running.
 - Four additional pairs of terminals for temperature sensing and low level warning circuits included on units being used with engines in the pusher configuration.
 - The HOT BOX is completely compatible with the aircraft style keyed dual ignition switch that many builders are using.
 - Models are now available for use with the Engine Instrument System from Grand Rapids Technologies.
 - OVERALL DIMENSIONS including regulator and terminal strips: 4.75" X 4" X 6.5"
 - WEIGHT: 4 lbs. including cables.

One of the drawbacks is the Hot Box is not sold in a generic form. You do need to order the unit custom for your application because the placement of the battery, battery cable lengths, etc. need to be predetermined and the ends installed so as to allow for the minimum cable lengths considering the battery may need to be located somewhere else for ballast purposes. See Figure # 15. So there you have it, you can run a multitude of devices off this Generator circuit or you can just run an Hourmeter or nothing at all. There is a limit of about 10 amps draw you can run off this system. This should cover most reasonable equipment with the exclusion of high wattage landing lights, etc. If your not sure, use an ammeter to see what kind of draw you have with everything operating.

END

* Data provided courtesy of Kuntzleman Electronics

source: part 49a – 4 page