

How To Determine if My Electric Golf Cart is Separately Excited or Series

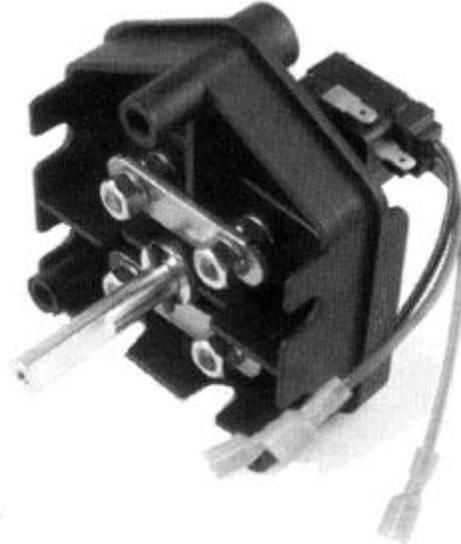
Many electric golf cart owners know little about the specifics of their cart. Some people know the brand or the voltage, but not much else. When discussing the terms, separately excited or series, most folks have no idea what those words mean. However, when it is time to purchase replacement parts or to upgrade anything about the electrical system of the golf cart, much more information must be derived. One of these critical facts to be known is whether or not your cart has a separately excited or series electrical system. Let's first define some terms for discussion.

- **Field Windings or Field Circuit:** The field winding is the conducting wire connected to the armature that energizes the pole pieces. Field windings are connected in series or parallel. If you open a motor, the field windings are the organized coils of generally copper wire which is shaped to fit the inside of the motor casing in such a way that the armature can spin inside it.
- **Armature:** An armature is the rotating portion of a DC motor or generator. This is the part internally to the motor which spins to "chase" a rotating polarity created by the field windings.
- **Series Wound DC Motor:** The field circuit and the armature circuit of a DC series motor are connected in series, thus the name. Series motors have been used in golf carts since the late 40's.
- **Separately Excited DC Motor:** The field winding of a separately excited motor is energized from a source different from that of the armature winding. Small DC motors may have permanent-magnet fields with armature excitation only. However, for golf cart purposes, most separately excited motors are not permanent magnet varieties. Many modern golf carts utilize these motors for unique speed and torque characteristics as well as nice features like regenerative braking, roll away protection, and others.

So, with the terminology defined, let's discuss how to quickly distinguish between the two systems. The specific details of these differences may vary slightly from manufacturer to manufacturer, but the principles remain unchanged.

- **Look at the Direction Selector Switch:** Hereafter, let's refer to this switch as the FNR (Forward-Neutral-Reverse).
 - Golf carts with a series motor and controller will utilize a mechanical FNR switch. This is generally some type of lever next to the driver's leg which is physically moved side to side to change direction. This switch has a series of four stationary contacts and four moving contacts on a rotating cam. Generally, the stationary contacts are wired to the main battery bank (+) lead and one of the motor armature terminals. The motor generally picks up the battery (-) feed via the controller. The moving contacts on the cam are generally wired to the field terminals of the

motor. By moving the lever from side to side, it physically disconnects the field circuit to the motor, and connects it back in opposite polarity, causing the motor to reverse direction. This switch carries the full current load (amperage) of the golf cart at any given time.



- Golf carts with a separately excited motor and controller typically use a low current, toggle or paddle type switch for the FNR. This switch is usually either mounted on the dash or beside the driver's leg as with the series example above. In either event, the switch does not physically reverse the polarity of the motor. It simply sends a low current signal to the controller. The controller then does the polarity switch to the motor internally based on the toggle switch position. One exception is the E-Z-GO DCS (Drive Control System), which utilizes a lever controlled FNR, but is still a separately excited system. In that example, the switch simply activates either a forward or reverse micro switch to send a signal to the controller instead switching the polarity manually at the switch. See the E-Z-GO PDS FNR switch below.



- **Look for a Tow/Run/Maintenance Switch:** Series golf carts do NOT have a Tow/Run/Maintenance switch, while separately excited golf carts DO have this type of switch. This switch is a kill switch of sorts. Series controllers do not draw power when the key is in the OFF position. While separately excited carts have a “logic memory” similar to the way the stereo in your automobile remembers your preset favorite channels. If you leave for an extended time, you need to flip the Tow/Run/Maintenance switch in your separately excited golf cart to the Tow or Maintenance position to kill the logic memory and prevent your batteries from discharging in your absence. Since series controllers do not have this logic memory, there is no need for this type of switch. This switch is also used to release the electronic braking in your separately excited golf cart in the event it dies and needs to be towed home. If you tow these vehicles without flipping the switch to “TOW”, you could permanently damage the motor and/or controller. Again, there is an exception as some early Club Car models with separately excited motors did not have a Tow/Run switch.

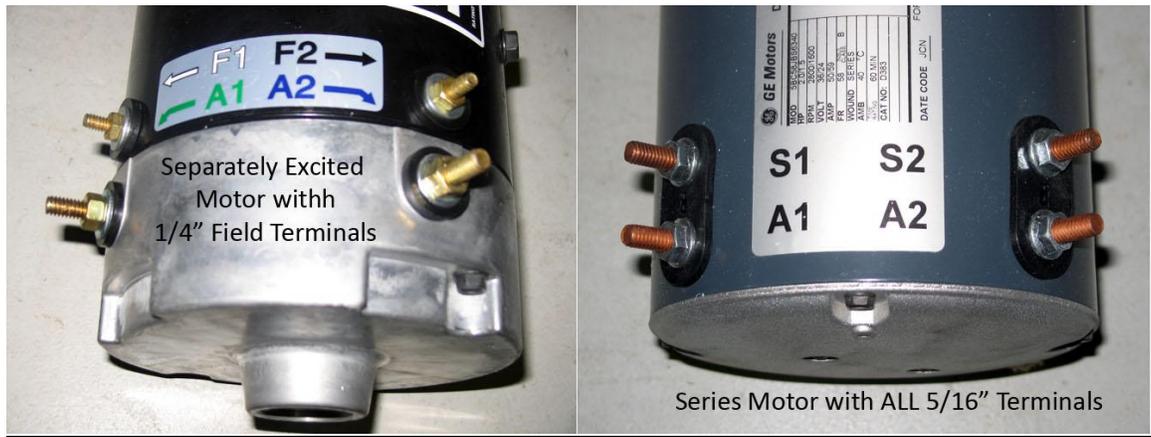


- **Look for a Motor Speed Sensor:** Series wound motors do not utilize a motor speed sensor, while most separately excited motors do. Typically, a motor speed sensor is a magnet based device implanted into the closed end of the motor to transmit the rpms of the motor back to the controller. There are usually three or more small wires from the sensor connected to the controller. The controller then uses this information to regulate the regenerative braking at predetermined levels. Again, there is another exception. The E-Z-GO DCS electrical system did not utilize a motor speed sensor, while most others did. Note the speed sensor wires/connector in the picture below.



- **Examine the Field Terminals & Wiring:** On a series wound motor, all terminals (field & armature) are typically the same size. Most commonly, they are 5/16" bolts. This is not true on most separately excited motors. These motors generally have armature studs in 5/16" size, while the field studs are 1/4". Likewise, the power wires connected to the terminals of a series motor are usually 6 gauge or larger. On a separately excited motor, the wires to the

armature terminals (A1 & A2), are also usually 6 gauge or larger, but the wire to the field terminals (F1 & F2) are typically a much smaller 8-10 gauge wire.



There are four simple ways to determine if your electric golf cart has a separately excited or series electrical system, which can be very important for ordering repair parts or arranging upgrades. The motors and controllers are in no way interchangeable between a series and separately excited system, so be sure to educate yourself prior to ordering.

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