Digital Electronic Governor Service Manual

Model E461 Controller with SF Actuator
On Zamboni® Resurfacer
With Speed Ramping Control

IMPORTANT:
READ THESE INSTRUCTIONS COMPLETELY
PRIOR TO MAKING ANY ADJUSTMENTS

Principles of Operation

The function of the electronic governor is to hold the engine speed as closely as possible to a desired speed. It will do this even though loads on the engine, such as driving on ramps or engaging pumps and augers, change. The governor system consists of two components – the actuator and the electronic controller.

The actuator is used to open and close the carburetor throttle plate and operates as an electromagnet. As more electrical power is applied to the actuator, it rotates further against its spring opening the carburetor throttle arm further. With less electrical power applied, the spring inside the unit returns the throttle to a more closed position.

The controller is an electronic device that senses engine speed and provides variable electrical power to the actuator. Engine speed is sensed by detecting the firing pulses sent to the ignition coil. The more pulses, the faster the engine is running. The pulses are counted and then compared with a desired speed number. The desired speed number is adjustable by means of a dash rocker switch that serves to ramp the engine speed up or down. The difference between the actual speed (determined from the ignition pulses) and the set or desired speed is amplified by the controller, modified to improve response, and becomes the electrical power signal that operates the actuator. For example, if the actual speed is less than the desired speed, more power is sent to the actuator to open the throttle further to increase engine speed. This continues until the actual speed and the desired speed are the same.

Service Considerations

The actuator mounting has been engineered by Zamboni®. You should be sure the mounting is secure and unmodified from its original state. Looseness of the actuator mounting will result in poor performance or in extreme cases could cause loss of engine speed control.

The linkage between the actuator and the carburetor is very important. The linkage should appear as shown in Fig. 1. This should be inspected for any wear, looseness of rod ends or drag. Friction in any joint will cause erratic governing. Smooth movement of the linkage should be verified. Also check for any stickiness in the carb throttle shaft. A small amount of preload in the linkage is necessary. Preload is checked or set by disconnecting the linkage at either the carb or actuator and then verifying that the length of the rod is set such that the actuator arm must be lifted off its stop by about a ½ ball diameter to reconnect the linkage.

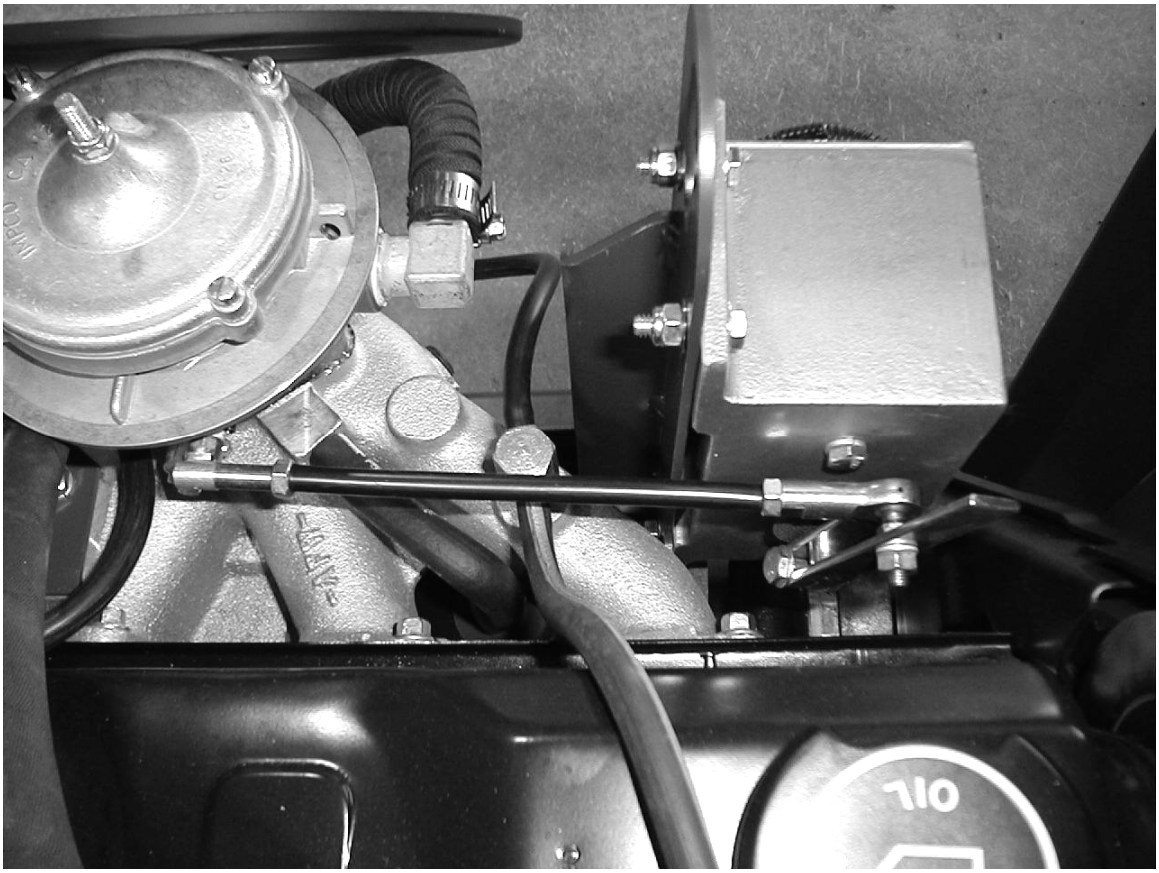


Figure 1 – Typical linkage installation

Good governor performance depends on many things in the engine/vehicle system. This will include the carburetor (for example, fuel mixture, accelerator pump, idle speed), fuel (clean, correct grade), the engine itself (timing, spark plugs, valves, etc.), the vehicle loads (no excessive or rapidly varying loads). **All of these should be checked before any attempt is made to adjust or fix a suspected governor problem.**

Basic checks of the wiring will require the use of a multimeter to measure voltages and continuity. Detailed wiring information will be found elsewhere in your service manual. Before any in depth checking is done for an inoperative governor, be sure to check the governor fuse. Then check the wiring for the governor system, looking first at is the overall condition of the

wiring particularly for any broken or loose connections, bare wires or pinched wires. Once this is done, electrical tests can begin. The pins referred to here are in the connector between the controller and the harness. Wire colors at these pins are shown in Table 1.

- Pin A, measure 12 volts to ground.
- Pin B, check for a ground
- Pin C and D, check for ignition signals (on a multimeter, these will appear to be very erratic readings)
- Pins E and F, check for continuity through the wiring and the actuator – you should get a reading of about 3 ohms; check continuity also to ground – you should see an open circuit
- Pin G, measure 12 volts to ground when the speed select switch is held in the up or increase position
- Pin H, measure 12 volts to ground when the speed select switch is held in the down or decrease position

Packard Connector Plug Pin	Wire Color
A	Red
B	Black
C	Yellow
D	White
E	Brown
F	Blue
G	Orange
H	Green

Table 1

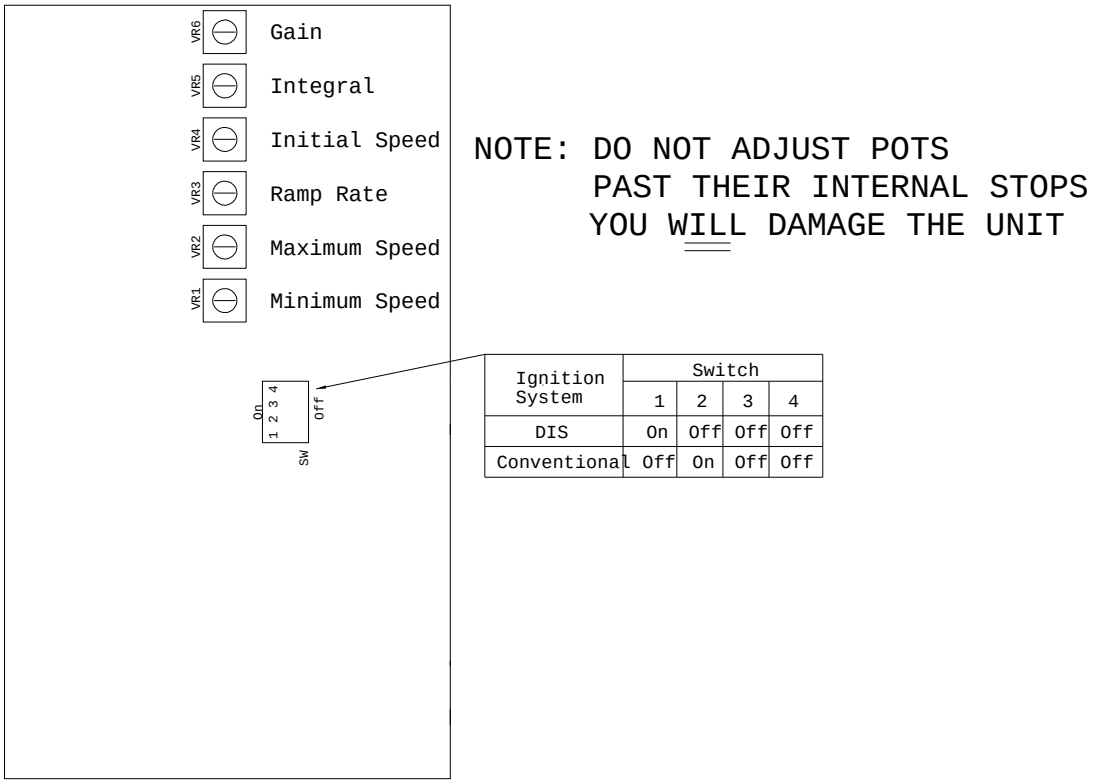
Governor Start Up

There are several adjustments in the controller. Potentiometers included with the E461 controller are 2 speed sets, 1 ramp rate set, 1 initial speed set, 1 gain and 1 integral adjustment **Please read and understand the effect and sequence of adjustment before you attempt any changes.**. The potentiometers used are ¾ turn pots that **will be damaged if they are turned past their stops** – these appear as flat, square components with a round white center which has a small screwdriver slot.

The speed set adjustments are used to set the maximum and minimum speeds. The ramp rate is used to set the rate at which the speed ramps up or down when the dash switch is actuated. The initial speed pot is used to set the speed at which the engine runs immediately after starting and for the first minute or two. The gain adjustment is used to determine the overall sensitivity of the governor system. Too little gain will result in poor response to changes in speed commands and loads. Too much gain will result in an overly aggressive system that may become unstable or hunt (the engine speed bouncing up and down every couple of seconds). The integral adjustment is used to vary the time that the system takes to fully recover to the desired speed from a speed or load change. The integral adjustment differs from the gain adjustment in that the integral controls the rate at which the final correction to speed happens. In other words, the gain affects the response of the

system to a speed close to the desired speed in the first second or two while the integral controls the final recovery to desired speed over the next several seconds. Too little integral results in an engine that takes excessively long to get back to the desired speed. Too much integral results in an unsteady system where the engine speed will slowly wander (over 10-20 seconds) around the desired speed.

The locations of the adjustments are shown in Fig. 2.



Ignition System	Switch			
	1	2	3	4
DIS	On	Off	Off	Off
Conventional	Off	On	Off	Off

Figure 2 – Adjustment Locations

If an adjustment is necessary, the following procedure is to be used:

Remove the governor fuse. Start the engine and allow it to come to operating temperature. Set the carb idle speed as shown in Table 2. Stop the engine.
Note: Be sure the hot carb idle speed is set to the correct speed. **A carb idle speed that is too high will cause long delays when governed operation is called for.**

Now reinstall the fuse. Start the engine with an extra person to watch the throttle and control engine speed manually if necessary to prevent engine over speeds. The engine will start and, as a warm-up

feature, go to its initial speed setting for a short time after which it will gradually slow to the minimum governed speed if the up/down switch is not touched. Operating the up/down switch before the initial speed procedure is complete will cause the unit to begin normal operation. If the engine does not start within 5 seconds the controller will slowly advance the throttle at the actuator providing more fuel until it reaches full throttle. Allow the engine to reach operating temperature. If necessary to adjust the minimum speed, hold the speed up/down switch in the down position and slowly adjust the minimum speed pot to obtain the speed shown in Table 2. If necessary to adjust the maximum speed, press and hold the speed up/down switch in the up position and slowly adjust the maximum speed pot to obtain the speed shown in Table 2. Make the adjustments slowly, allowing the system to stabilize.

Speed	Adjustment Point	Model 440	Model 520
Non-governed carb idle	Carb idle stop	900	900
Minimum governed	Minimum speed	1050	1050
Maximum governed	Maximum speed	2550	2750

Table 2 - Machine Speeds

The rate at which the speed changes between the minimum and maximum governed speeds may be adjusted by means of the Ramp Rate pot shown in Figure 2. Turning the pot clockwise makes the speed change more quickly while turning it counterclockwise slows the rate of speed change.

To adjust the Initial Speed (seen immediately after starting), jumper the outer terminals on the speed up/down dash switch and hold the switch in the up or down position when making the adjustment to the Initial Speed pot shown in Figure 2. Turning the pot clockwise will raise the speed while turning it counterclockwise will lower the initial speed.

When the speed adjustments are completed, change speeds and apply loads to the engine noting its response. Turn the “Gain” adjustment CW to make the system more sensitive to changes and CCW to make it less sensitive. You are trying to get an adjustment where the system responds crisply without excessive bouncing of the throttle or instability. The normal position for this is about 1/3 turn CW from the full CCW position.

Now make any necessary adjustments to the “Integral” pot. Turning it CW will make the system return to the desired speed more quickly following speed or load changes. Turning it CCW will make it return more slowly. **An up or down speed change command is necessary for the controller to use the new setting so bump the switch up or down following each integral adjustment**. Remember, excessive integral will cause the speed to slowly wander around the desired speed. Also, too quick of a return to speed may affect the vehicle driving performance.

Engine Shutdown

Prior to the engine being shut off, it should be returned to low speed and allowed to run at the low speed for 15 to 30 seconds. If the engine is shut off from a higher speed (not recommended), the governor control will reset itself upon restarting to the initial speed described above.

Troubleshooting

Problems requiring troubleshooting can be generally divided into two categories:

1. The system makes no attempt to control speed
    a. It idles all the time
    b. It goes to full throttle all time
2. The system operates but performance is not satisfactory

The first case, where the system makes no attempt to control speed and the engine only idles all the time, can be caused by:

1. No power
2. Incorrect linkage, preventing movement
3. Incorrect electrical hookup
4. No speed signal to governor
5. Damaged controller or actuator

These problems are explained below:

1. No power – use a multimeter to check for 12-15 VDC between pins A and B at the controller connector. Check during engine stopped, but ignition switch on, and again with the engine running. If voltage is absent or low, check for:
    a. Governor fuse blown
    b. Wiring error
    c. Low battery
    d. Failed voltage regulator
    e. Bad ground connection
    f. Corroded terminals
    g. Broken wires

2. Incorrect linkage – turn ignition switch from off to on (engine not running) while observing the linkage. The linkage should kick off of its idle position briefly and then return to the idle position. If it doesn't, disconnect the linkage from the actuator arm, again turn power from off to on, if arm now kicks, look for binding or stickiness in the linkage or carb shaft. Any friction in these areas will create problems.

3. Incorrect electrical hookup – recheck all wiring and connections to the controller and actuator using the vehicle wiring diagram. **Check specifically for reversed polarity as this will damage the controller or blow the fuse. Connecting the battery terminals backwards will result in the same problems.**

4. No speed signal to the controller:
   a. Using the multimeter, measure voltage between pins C and B and then between pins D and B (B being the ground) with the engine running. You should see a rather erratic reading during both measurements. This will typically be in the 5 to 20 VDC area.
   b. The checks above do not guarantee good speed signals but the absence of them proves there is a problem in that area.

5. Damaged controller or actuator – if the above steps have not revealed a problem, the controller or actuator may have been damaged or may have failed. Before replacing the units, make the following test:

Do not start the engine during the following test, as the disconnected carb will go to full throttle by itself.

   a. Disconnect all wiring and linkage from the actuator.
   b. Apply 12 VDC directly from a battery source to the actuator terminals (polarity here is not important). The actuator arm should move to an "open throttle" position and stay there. With power still applied, move the arm back and forth by hand. If no binding or rubbing is felt, the actuator is likely OK.
   c. For ease of testing, remove the controller from the dash and wire it directly to the actuator as follows referring to Table 1 for pin information:
      1. One of the actuator terminals to pin E and the other to pin F on the controller
      2. Battery minus (-) to pin B
   d. **Remembering that reversed polarity will damage the controller, recheck polarity** and then touch a wire from battery plus (+) to pin A. The actuator should kick once towards open throttle and then fall back to the idle position immediately. If this happens here but didn't when wired on the vehicle, the vehicle wiring is suspect. If it doesn't kick, the controller is likely damaged.

Warning – Do not allow the engine to run at wide-open throttle as damage to the engine and pumps will occur.

If the engine attempts to go to full throttle and stay there, the following should be checked:

   a. Wiring to the actuator – one of the wires may be shorted to ground, disconnect the 2 wires at the controller and use the multimeter to check for unwanted continuity to ground
   b. Reconnect the wires to the controller and with vehicle power off again use the multimeter to check for unwanted continuity to ground. Some resistance may be seen but no shorts to ground are permissible.
   c. Check the speed selector switch operation and speed adjustments

If the governor system attempts to work but performance is not satisfactory, check for the following installation and adjustment problems:

   a. Governor unable to move fuel system freely – look for:

1. Linkage binding or misadjusted
2. Low voltage to controller during operation
3. Carb throttle shaft or butterfly sticky or binding (engine vacuum creates large down forces on the butterfly and throttle shaft that are not seen with the engine stopped – check carefully with engine running and carb disconnected from linkage) Maintain **control over the throttle position to prevent excessive engine speed that will cause damage.**

b. Sudden momentary movements may be caused by loose wiring or connections or intermittent shorts in wiring
c. Slow wandering of speed may be caused by an integral pot that is turned too far CW
d. Sluggish performance may be a sign that the gain pot is adjusted too far CCW (less sensitive)
e. Aggressive performance or unstable operation (engine surging or hunting) may be caused by the gain pot being adjusted too far CW (more sensitive)