ESD5550 & ESD5570 Series
Speed Control Unit

+1 413 233 1888
www.governors-america.com

1 INTRODUCTION

The ESD5550/5570 series speed control unit is an all electronic device designed to control engine speed with fast and precise response to transient load changes. This closed loop control, when connected to a proportional electric actuator and supplied with a magnetic speed sensor signal, can control a wide variety of engines in an isochronous or droop mode. Designed for high reliability and built ruggedly to withstand the engine environment. ESD5550/5570 Series speed control unit features include:

- Simple installation
- Starting Fuel and Speed Ramping adjustments to minimize engine exhaust smoke prior to attaining engine operating speed
- Adjustable droop and idle operation
- Inputs for accessories used in multi-engine or special applications
- Protection against reverse battery voltage, transient voltages, accidental short circuit of the actuator and fail safe design in the event of loss of speed sensor signal or battery supply.
- Light Force Actuation (ESD5570 only)

The ESD5550/5570 Series speed control unit is compatible with all GAC proportional actuators (except ACB2001). When paired with a GAC ADC100 Series electric actuator, DROOP adjustment range is less due to the ADC100's low current demand.

2 SPECIFICATIONS

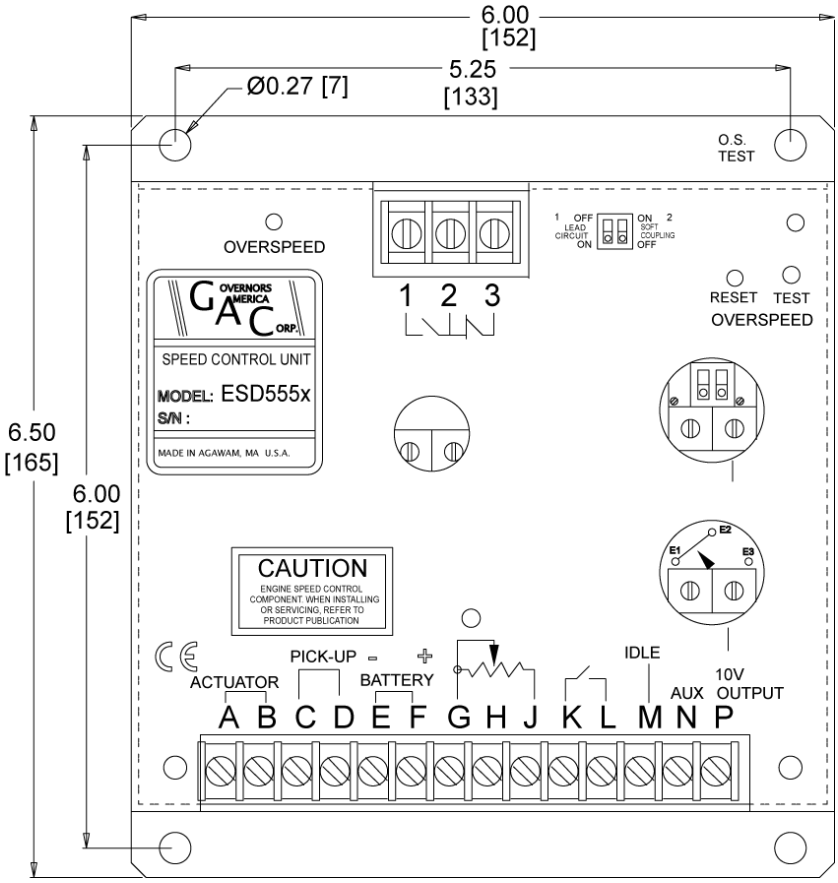
PERFORMANCE		
Isochronous / Steady State Stability		± 0.25 % or better
Speed Range / Governor		1 K - 7.5 K Hz continuous
Speed Drift with Temperature		±1 % MAX
Idle Adjust CW		60 % of set speed
Idle Adjust CCW		Less than 1200 Hz
Droop Range		1 - 5 % regulation
Droop Adjustment MAX (K-L Jumpered)		400 Hz, ±75 Hz per 1 A change
Droop Adjustment MIN (K-L Jumpered)		415 Hz, ±75 Hz per 1 A change
Remote Variable Speed Range		500 - 7.5 Hz or any part thereof
Speed Trim Range		± 200 Hz
Terminal Sensitivity	J L N P	100 Hz ±15 Hz/V @ 5.0 kΩ Impedance 735 Hz ±60 Hz/V @ 65 kΩ Impedance 148 Hz ±10 Hz/V @1 MΩ Impedance 10 V DC Supply @ 20 mA MAX
INPUT / OUTPUT		
Operating Voltage		12 VDC or 24 VDC (Transient and Reverse Voltage Protected)*
Polarity		Negative Ground (Case Isolated)
Power Consumption		50 mA continuous plus actuator current
Actuator Current Range at 77 °F (25 °C) - Inductive Load		Minimum 2.5 A 10 A Peak**
Speed Sensor Signal		0.5 to 120 V RMS
Speed Switch Relay Contacts (N.O. and N.C.)		10 A

RELIABILITY	
Vibration	5 g @ 20 - 500 Hz
Testing	100% Functional Testing
ENVIRONMENTAL	
Ambient Temperature Range	-40° to 85 °C [-40° to 180 °F]
Relative Humidity	up to 95 %
Shock	20 g @ 11 ms
All Surface Finishes	Fungus Proof, Corrosion Resistant
COMPLIANCE / STANDARDS	
Agency	CE, RoHS, Lloyds Register, DNV/GL, Bureau Vertas
PHYSICAL	
Dimension	See Section 3, Installation
Weight	1.8 lbf [0.82 kgf]
Mounting	Any position, vertical preferred

* Protected against reverse voltage by a series diode. A 15 amp fuse must be installed in the positive battery lead.
** Protected against short circuit to actuator (shuts off current to actuator), unit automatically turns back on when short is removed.

3 INSTALLATION

Take into account the following preferences when mounting the speed controller:



Vertical orientation allows fluids to drain in moist environments.

Avoid extreme heat

Mount in a cabinet, engine enclosure, or sealed metal box.

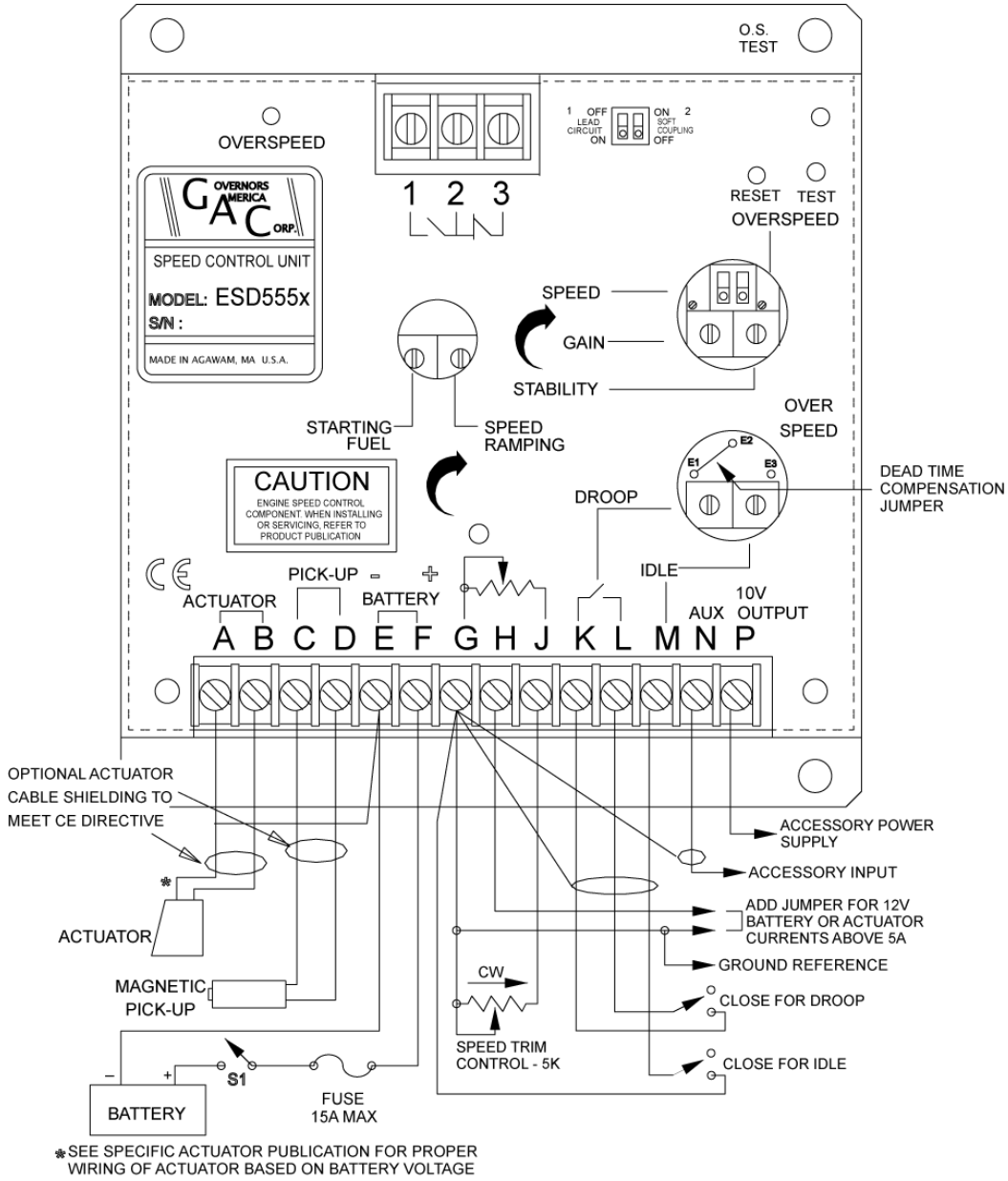
Dimensions in [mm]

4 WIRING

TERMINAL	DEFINITION	NOTES
A & B	ACTUATOR (+/-)	Use #16 [1.3 mm^2] or larger wire. Long cables require an increased wire size to minimize voltage drops.
C & D	PICK-UP * (D is ground)	• Wires must be twisted and/or shielded for their entire length • Gap between speed sensor and gear teeth should not be smaller than 0.02 in. [.5mm] • Speed sensor voltage should be at least 1 V AC RMS during crank
E & F	BATTERY (-/+)	• #16 [1.3 mm^2] or larger wire • A 15 amp fuse must be installed in the positive battery lead to protect against reverse voltage • Battery positive (+) input is Terminal F must be fused for 15 amps as shown in the Wiring diagram in this section to protect against reverse voltage.
G	GROUND	
H & G	Droop Range	Add jumper to decrease droop range
J	Variable Speed Input	0 - 5 V DC
K & L	DROOP Select	Droop active when closed
M	Idle Select	Close for Idle
N	Accessory Input	Load Sharing / Synchronizing,
P	Accessory Power Supply	Supplies +10 V regulated supply to accessories. No more than 20 mA of current can be drawn from this supply. Ground reference is Terminal G. A short circuit in this terminal can damage the speed control unit.

4 WIRING (CONTINUED)

An overspeed shutdown device, independent of the governor system, must be provided to prevent loss of engine control which may cause personal injury or equipment damage. Do not rely exclusively on the governor system to prevent over-speed. A secondary shutoff device such as a fuel solenoid must be used.



When wiring ESD55XX Series controllers:

1. Magnetic speed sensor wires connected to Terminals C and D MUST BE TWISTED AND/OR SHIELDED for their entire length. The speed sensor cable shield should ideally be connected as shown. The shield should be insulated to ensure no other part of the shield comes in contact with engine ground, otherwise stray speed signals may be introduced into the speed control unit.
2. With the engine stopped, adjust the gap between the magnetic speed sensor and the ring gear teeth. The gap should not be any smaller than 0.020 in. (0.45 mm). Usually, backing out the speed sensor 1/4 to 1/2 turn after touching the ring gear teeth will achieve a satisfactory air gap. The magnetic speed sensor voltage should be at least 1.0 V AC RMS during cranking.
3. **Use shielded cable for all external connections to the ESD controller**.
4. One end of each shield, including the speed sensor shield, should be grounded to a single point on the ESD case.
5. **Do not over-tighten terminals**. Torque to no greater than 9.0 in-lb ±2.5 [1.01 ±0.28 N·m].

4 WIRING (CONTINUED)

ACCESSORY INPUT

Auxiliary Terminal N accepts input signals from load sharing units, auto synchronizers, and other governor system accessories.

GAC accessories are directly connected to this terminal. Terminal N connections must be shielded.

NOTE If the auto synchronizer is used alone, not in conjunction with a load sharing module, a 3 Ω resister should be connected between Terminals N and P. This is required to match the voltage levels between the speed control unit and the synchronizer.

ACCESSORY SUPPLY

Terminal P supplies +10 volt regulated supply to provide power to GAC governor system accessories. Up to 20 mA of current can be drawn from this supply. Ground reference is Terminal G.

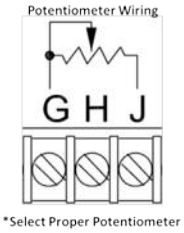
A short circuit on Terminal P can damage the speed control unit.

ADDING A POTENTIOMETER

Use a single remote speed adjustment potentiometer to adjust engine speed. Select the desired speed range and the corresponding potentiometer value.

If the exact range is not found select the next higher range potentiometer. Connect the potentiometer as shown in the WIRING diagram.

SPEED RANGE	POTENTIOMETER
900 Hz	1K
2,400 Hz	5K
3,000 Hz	10K
3,500 Hz	25K
3,700 Hz	50K



5 ADJUSTMENTS

BEFORE STARTING THE ENGINE

Before starting the engine, check and/or adjust the potentiometer and following settings as desired.

ADJUSTMENT / SWITCH	POTENTIOMETER / SWITCH	FACTORY SETTING	NOTES
SPEED	25 turn	1470 Hz ± 50 Hz w/ min. trim	
GAIN	270° turn	50%	Middle position
STABILITY	270° turn	50%	Middle position
DROOP	270° turn	0% (CCW)	
IDLE	270° turn	1075± 75 Hz	
STARTING FUEL RAMP	270° turn	100% (CW) Maximum Fuel	
SPEED RAMP	270° turn	0% (CCW) Fastest	
OVERSPEED	25 turn	100% (CW) Highest	
SW1 Lead Circuit	switch	ON	
SW2 Soft Coupling	switch	OFF	

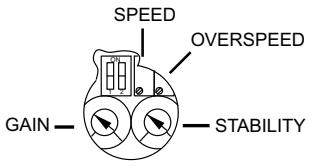
STARTING THE ENGINE

The speed control unit governed speed setting is factory set at approximately engine idle speed 1000 Hz., speed sensor signal). Crank the engine with DC power applied to the governor system. The governor system should control the engine at a low idle speed. If the engine is unstable after starting, turn the GAIN and STABILITY adjustments CCW until the engine is stable.

ADJUSTING OVERSPEED

The overspeed relay output terminals offer both normally open and normally closed contacts.

1. When the engine is running at the desired speed, push and hold the TEST button.
2. Rotate the OVERSPEED adjustment CCW until the red OVERSPEED LED lights and the relay energizes. Current to the actuator will be removed and the engine will shut off.
3. Release the TEST button.
4. After the engine stops, press the RESET button or remove battery power.
5. Restart the engine and it will return to the original speed setting.



The overspeed function is now set to approximately 10% above the requested speed.

STARTING FUEL ADJUSTMENT

The engine's exhaust smoke at start-up can be minimized by completing the following adjustments:

1. Place the engine in idle by connecting Terminals M & G.
2. Adjust the IDLE speed for as low a speed setting as the application allows.
3. Adjust the STARTING FUEL CCW until the engine speed begins to fall. Increase the STARTING FUEL slightly so that the idle speed is returned to the desired level.
4. Stop the engine.

IDLE SPEED SETTING

If the IDLE speed setting was not adjusted as detailed in Starting Fuel Adjustment section, then complete the following:

1. Place the optional external selector switch in the IDLE position.
2. Adjust the IDLE CW yo increase the idle speed set point.
3. When the engine is at idle speed, the speed control unit applies droop to the governor system to ensure stable operation.

ADJUSTING STABILITY

The governed speed set point is increased by a CW rotation of the SPEED adjustment control (25 turn pot.). Remote speed adjustment can be obtained with an optional 5K Speed Trim Control. See section 4, Wiring diagram.

Once the engine is at operating speed and at no load, the following governor performance adjustment can be made.

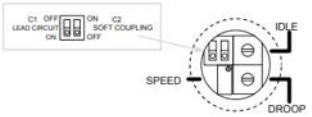
PARAMETER	PROCEDURE
GAIN	1. Rotate the GAIN adjustment clockwise until instability develops. 2. Gradually move the adjustment counterclockwise until stability returns. 3. Move the adjustment one division further counterclockwise to ensure stable performance (270° potentiometer). 4. If instability persists, adjust the next parameter.
STABILITY	1. Rotate the STABILITY adjustment clockwise until instability develops. 2. Gradually move the adjustment counterclockwise until stability returns. 3. Move the adjustment one division further counterclockwise to ensure stable performance (270° potentiometer).

NOTE Normally, adjustments made at no load achieve satisfactory performance. If further performance improvements are required, refer to section 7, SYSTEM TROUBLESHOOTING.

5 ADJUSTMENTS (CONTINUED)

LEAD CIRCUIT AND SOFT COUPLING

The engine's exhaust smoke at start-up can be minimized by completing the following adjustments:



1. Switch 1 (SW1) controls the Lead Circuit. The normal position is ON. Move the switch to the OFF position if there is fast instability in the system.
2. Switch 2 (SW2) controls a circuit designed to eliminate fast erratic governor behavior, caused by very soft or worn couplings in the drive train between the engine and generator. The normal position is OFF.
3. Move to the ON position if fast erratic engine behavior due to a soft coupling is experienced

DROOP OPERATION

Droop is typically used for the paralleling engine driven generators. When in droop operation, the engine speed will decrease as engine load increases. The percentage of droop is based on the actuator current change from no engine load to full load.

1. Place the optional external selector switch in the DROOP position. DROOP is increased by clockwise rotation of the DROOP adjustment control.

2. After the droop level has been adjusted, the rated engine speed setting may need to be reset. Check the engines speed and adjust that speed setting accordingly.

Though a wide range of droop is available with the internal control, droop level requirements of 10% are unusual. If droop levels experienced are higher or lower than those required, contact GAC for assistance.

WIDE RANGE REMOTE VARIABLE SPEED OPERATION

Remote variable speed can be obtained with the an external potentiometer. A single remote speed adjustment potentiometer can be used to adjust the engine speed continuously over a specific speed range.

1. Select the desired speed range and corresponding potentiometer value as detailed in section 4, ADDING A POTENTIOMETER. If the exact range cannot be found, select the next higher range potentiometer.
2. Connect the speed range potentiometer as shown in WIRING Diagram.
3. An additional fixed resistor may be placed across the potentiometer to obtain the exact desired range.
4. To maintain engine stability at the minimum speed setting, a small amount of droop can be added by turning DROOP adjustment CW.
5. At the maximum speed setting the governor performance will be near isochronous, regardless of the droop adjustment setting.

6 METHODS OF OPERATION

One of two methods of operation for the ESD5550/5570 may now selected; starting at operating speed, or starting at idle.

STARTING AT OPERATING SPEED

1. Remove the connection between Terminals M & G.
2. Start the engine and accelerate directly to the operating speed (Gen Sets, etc.).
3. Adjust the SPEED RAMPING for the least smoke on acceleration from idle to rated speed.
4. If the starting smoke is excessive, the STARTING FUEL may need to be adjusted slightly CCW.
5. If the starting time is too long, the STARTING FUEL may need to be adjusted slightly CW.

STARTING AT IDLE SPEED

This method separates the starting process so that each may be optimized for the lowest smoke emissions.

1. Replace the connection between Terminals M & G with a switch, usually an oil pressure switch.
2. Start the engine and control at an idle speed for a period of time prior to accelerating to the operating speed.
3. If the starting smoke is excessive, the STARTING FUEL may need to be adjusted slightly CCW.
4. If the starting time is too long, the STARTING FUEL may need to be adjusted slightly CW.
5. When the switch opens, adjust the SPEED RAMPING for the least amount of smoke when accelerating from idle speed to rated speed.

7 SYSTEM TROUBLESHOOTING

INSUFFICIENT MAGNETIC SPEED SIGNAL

A strong magnetic speed sensor signal eliminates the possibility of missed or extra pulses. The speed control unit governs well with 0.5 volts RMS speed sensor signal.

A speed sensor signal of 3 volts RMS or greater at governed speed is recommended. Measurement of the signal is made at Terminals C and D.

The amplitude of the speed sensor signal can be raised by reducing the gap between the speed sensor tip and the engine ring gear. The gap should not be any smaller than 0.02 in [0.5 mm]. When the engine is stopped, back the speed sensor out by 3/4 turn after touching the ring gear tooth to achieve a satisfactory air gap.

SYSTEM INOPERATIVE

If the engine governing system does not function, the fault may be determined by performing the voltage tests described in Steps 1 through 4. Positive (+) and negative (-) refer to meter polarity. Should normal values be indicated during troubleshooting steps, and then the fault may be with the actuator or the wiring to the actuator. Tests are performed with battery power on and the engine off, except where noted. See your actuator publication for troubleshooting testing.

STEP	WIRES	CHECK	PROBABLE CAUSE
1	F(+) & E(-)	Battery Supply Voltage (12 or 24 V DC)	1. DC battery power not connected. Check for blown fuse. 2. Low battery voltage 3. Wiring error
2	C(+) & D(-)	1.0 V AC RMS minimum while cranking	1. Gap between speed sensor and gear teeth too great. Check Gap. 2. Improper or defective wiring to the speed sensor. Resistance between D and C should be 160 to 1200 Ω. See specific mag pickup data for resistance. 3. Defective speed sensor.
3	P(+) & G(-)	10 V DC, Internal Supply	1. Short on Terminal P. 2. Defective speed control unit.
4	F(+) & A(-)	1.0 - 2.0 V DC while cranking	1. SPEED parameter set too low 2. Short/open in actuator wiring 3. Defective speed control 4. Defective actuator, see your actuator's Troubleshooting guide.

INSTABILITY

INSTABILITY	SYMPTOM	PROBABLE SOLUTION
Fast Periodic	The engine seems to jitter with a 3Hz or faster irregularity of speed.	1. Readjust the GAIN and STABILITY for optimum control. 2. Turn off any local electrical equipment that may be causing EMI interference. 3. Set the Lead Circuit DIP switch SW1 to OFF 4. If system is still unstable, set Soft Coupling SW2 to ON. This may indicate soft or worn couplings in drive train. 5. Remove E1 to E2 jumper. See section 4, Wiring diagram.
Slow Periodic	An irregularity of speed below 3Hz. (Sometimes severe)	1. Readjust GAIN and STABILITY 2. Set Lead Circuit and Soft Coupling DIP switches SW1 and SW2 to ON in the following order: First SW1, Second SW2, and Third SW1 & SW2. 3. Check fuel system linkage during engine operation for: • binding • high friction • poor linkage 4. Adjust DEAD TIME COMPENSATION by adding a capacitor from posts E1 to E2. See section 4, Wiring diagram. Start with 10 mF and increase until instability is eliminated. 5. Add small amount of droop (jumper K and L). See section 4, Wiring diagram.
Non-Periodic	Erratic Engine Behavior	1. If increasing GAIN does not reduce the instability but not totally correct it issue may be with engine. 2. If this is the case, there is most likely a problem with the engine itself. Check for: • engine mis-firings • an erratic fuel system • load changes on the generator set voltage regulator. 3. If throttle is slightly erratic, but performance is fast, move SW1 to the OFF position.

UNSATISFACTORY PERFORMANCE

SYMPTOM		NORMAL READING	PROBABLE CAUSE
Engine Overspeeds	1.	Do Not Crank. Apply DC power to the governor system.	After the actuator goes to full fuel, disconnect the speed sensor at Terminal C & D. If the actuator is still at full fuel-speed then the speed control unit is defective.
	2.	Manually hold the engine at the desired running speed. Measure the DC voltage between Terminals A(-) & F(+) on the speed control unit.	1. If the voltage reading is 1.0 to 2.0 V DC: • SPEED adjustment is set above desired speed • Defective speed control unit 2. If voltage reading is above 2.0 V DC then check for: • actuator binding • linkage binding 3. If the voltage reading is below 1.0 V DC it may be a defective speed control unit 4. Check if Gain is set too low.
Overspeed Shuts Down Engine After Running Speed is Reached			• Speed adjustment set too high. • OVERSPEED set to close to running speed. • Actuator or linkage binding. • Speed control unit defective.
Overspeed Shuts Down Engine Before Running Speed is Reached		Check impedance between Terminals C & D. Should be 160 to 1200 Ω	OVERSPEED set too low. Adjust 5-6 turns CW. Erroneous speed sensor signal. Check wiring.
Actuator does not energize fully	1.	Measure the voltage at the battery while cranking.	If voltage for a 12 V DC system is less than 7 V DC, or for a 24 V DC system is less than 14 V DC, replace the battery if weak or undersized
	2.	Momentarily connect Terminals A and F. The actuator should move to the full fuel position.	• Actuator or battery wiring in error • Actuator or linkage binding • Defective actuator • Fuse opens. Check for short in actuator or harness.
Engine remains below desired governed speed	1.	Measure the actuator output, Terminals A & B, while running under governor control.	If voltage measurement is within 2 V DC of the battery supply voltage level, then fuel control is restricted from reaching full fuel position, possibly due to mechanical governor, carburetor spring, or linkage interference. SPEED parameter set too low