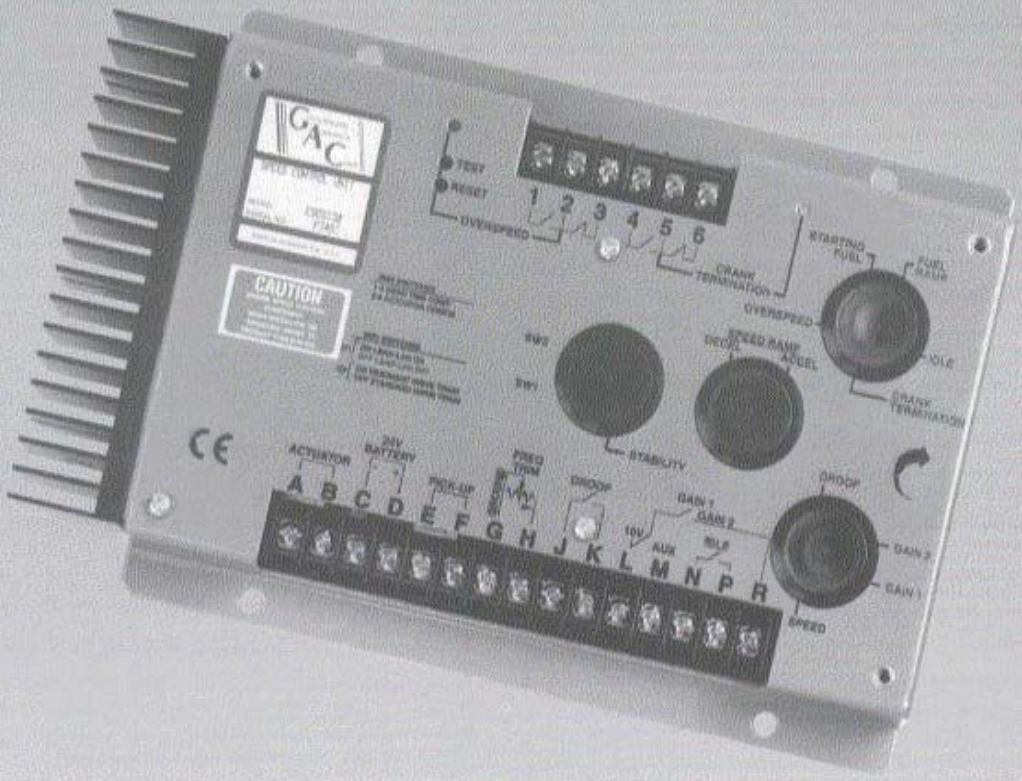
GOVERNORS AMERICA CORP.

ENGINE GOVERNING SYSTEMS

ESD5330 SERIES



SPEED CONTROL UNIT

MEMBER

EGSA Electrical Generating Systems Association

GOVERNORS AMERICA CORP. • 720 Silver Street • Agawam, MA 01001-2907, USA

ESD5330 SERIES SPEED CONTROL UNIT

PRODUCT TECHNICAL INFORMATION

PTI 1041

October 1999

MPC

INTRODUCTION

The ESD5330 Series speed control unit is designed to precisely control engine speed and provide fast precise response to transient engine loads. This speed control is intended to be used with all GAC Actuators including the ACB2000. A complete closed loop control system is formed with the addition of a magnetic pickup signal sensing engine speed and 24 Volt DC power.

The ESD5330 Series has several special built in features:

- **A Two Element Speed Switch (overspeed sensing and crank termination)**
- **Speed Ramping from Idle to Operating Speed**
- **Starting Fuel Control for lower engine exhaust emissions**
- **A unique actuator power drive circuit**

Other standard features include: adjustable Droop, Accessory inputs for Load Sharing, Variable Speed Governing, protection against reverse battery voltage and transient voltages, and a fail safe design in the event of loss of speed signal or battery supply.

DESCRIPTION

Engine speed information for the speed control unit is usually received from a magnetic speed sensor which is mounted in close proximity to the engine driven flywheel ring gear. As teeth pass the pickup, a signal is generated which is proportional to engine speed. The strength of this signal must be in the range of 0.5 - 50 VRMS. When the speed signal is low or absent, the output from the controller will be shut off.

Speed Setting is via the 25 turn SPEED potentiometer in the controller. The setting of this adjustment determines the operating speed of the engine.

Performance Adjustments are provided to match and optimize the controller to specific engine characteristics. The basic control is a PID type with continuous adjustments for the Gain (P) and Stability (I), and DIP switches to adjust the Dead Time Compensation (D). In addition, a special circuit is included for applications with resonant drive trains. Switch SW1, C2 compensates for this situation.

The Unique Power Drive Circuit controls the current to the actuator. The ACB2000 actuator's performance is enhanced by the ability of the ESD5330 to supply high current at appropriate times without any danger of overheating the actuator coils. Maximum response from the governor system is then obtained.

A Two Element Speed Switch is incorporated in the unit for overspeed sensing and crank termination. These independent monitors have set points with limited adjustable ranges. Relay outputs (6 AMP) are available to operate crank termination circuits and fuel or air shutoff devices.

Droop Operation is available by adding a switch across Terminals J and K. Droop is proportional to actuator current changes, from zero to maximum engine power.

Idle Operation can be obtained by adding a switch across Terminals N and P. The idle speed is adjustable over a wide range.

Smooth Speed Ramping is provided automatically during each engine startup. Once the engine speed has reached the crank termination setting, ramping automatically takes place unless the idle switch is closed. The speed ramping will raise the engine speed to the operating speed set point. The ramp time acceleration rate is adjustable.

Start Fuel Limiting results in lower emissions from the engine during the starting and the run up cycle by reducing excess fuel to the engine. The STARTING FUEL adjustment will allow the actuator current to set the starting fuel. Once the engine has started and passed the cranking termination point, it is controlled by the fuel ramping circuit until the speed ramping takes over and smooth acceleration results.

For generator set applications, the ESD5330 Series is compatible with GAC's Load Sharing and Auto Synchronizing modules. With the use of other interfaces and control devices, the ESD5330 Series can be used in a wide variety of industrial engine applications.

APPLICATION and INSTALLATION INFORMATION

The ESD5330 Series speed control unit is rugged enough to be placed in a control cabinet or engine mounted enclosure with other dedicated control equipment. The circuit board is conformally coated to seal out moisture and resist vibration. If water, mist or condensation can come in contact with the controller, it should be mounted vertically. This will allow any accumulated fluids to drain away from the speed control unit.

WIRING

The electrical connections are illustrated in FIGURE 1. on page 3.

Actuator and Battery connections to Terminals A, B, C and D should be appropriately sized with respect to maximum current consumption of the actuator that is being used. Long cable runs require an increased wire size to minimize voltage drops.

Battery positive (+) input, Terminal D, should be fused for 20 Amps as illustrated to protect system wiring.

The Magnetic Speed Sensor connections to Terminals E and F **MUST BE SHIELDED** for their entire length. The speed sensor cable shield should only be connected to the case as shown.

The shield should be insulated to insure that no other part of it comes in contact with engine ground, otherwise, stray signals may be introduced into the ESD5330 causing erratic operation.

ACCESSORY WIRING

FREQuency Trim. The cables to the frequency trim potentiometer can be of any reasonable length up to 15 ft (5 m). If over this length, a shielded cable is required. Connect the shield to Terminal G, signal ground.

Load Sharing or Synchronizing system accessories must use Terminal G as the signal ground.

ESD5330 SERIES SPEED CONTROL UNIT

ESD5330 ..... Standard Unit, 24 Volt operation
ESD5330-12 ..... 12 Volt operation
ESD5331 ..... use w/EFC Actuator
ESD5331-12 ..... use w/EFC Actuator

SPECIFICATIONS

PERFORMANCE

- Isochronous ..... ± 0.25% or better
- Operating Speed Range ..... 1K - 7.5 Hz continuous
- Speed Drift with Temperature ..... ±1% maximum
- Idle Speed Adjust Range ..... 25 - 85% of rated speed
- Droop Range ..... Adjustable from 0 - 5% for a 1.5 A actuator current change
- Speed Trim Range ..... ± 200 Hz
- Remote Variable Speed Range ..... 25 to 100% of rated speed
- Speed Ramp Time ..... Acceleration adjustment range 266 Hz/Sec to 1300 Hz/Sec
  Deceleration adjustment range 250 Hz/Sec to 1000 Hz/Sec
- Starting Fuel Adjustment
  - 0-1.5A ..... 120, 175, 225, 275 Actuators/SW2-7 "OFF"
  - 0.3-4A ..... 2000 Actuator/SW2-7 "ON"
- Overspeed Set Point ..... 2400 Hz to 8300 Hz
- Crank Termination Set Point ..... 200 Hz to 2050 Hz
- Terminal Sensitivity
  - H ..... -105 Hz, ±15 Hz/Volt @ 5 K Impedance
  - M ..... -130 Hz, ±15 Hz/Volt @ 1 M Impedance
  - K ..... -685 Hz, ±40 Hz/Volt @ 225 K Impedance
  - N ..... +1000 Hz, ±50 Hz/Volt @ 8 K Impedance

ENVIRONMENTAL

- Ambient Operating Temperature Range ..... -40° to +85°C (-40° to +185°F)
- Relative Humidity (Noncondensing) ..... up to 95%
- All Surface Finishes ..... Fungus proof and corrosion resistant

INPUT POWER - Nominal Ratings

- DC Supply ..... 24 ±20% VDC battery systems (transient and reverse voltage protected)
- Maximum Continuous DC Supply Voltage ..... 32 Volts
- Polarity ..... Negative ground (case isolated)
- Power Consumption (Engine Stopped) ..... 100 MA (No actuator current)
- Speed Signal Range ..... 0.5-50 VAC
- Maximum Actuator Current ..... Internally limited to 9 A continuous
- Maximum Current, Speed Switch Contact (Terminals 1-6) ..... 6 Amps

RELIABILITY

- Vibration ..... 1 G @ 20-100 Hz
- Shock ..... 10 G (11 ms)
- Testing ..... 100% Functionally tested

PHYSICAL

- Dimensions ..... See FIGURE 1. Wiring Diagram and Outline (page 3)
- Weight ..... 2.0 lbs (0.91 grams)
- Mounting ..... Any position, vertical preferred

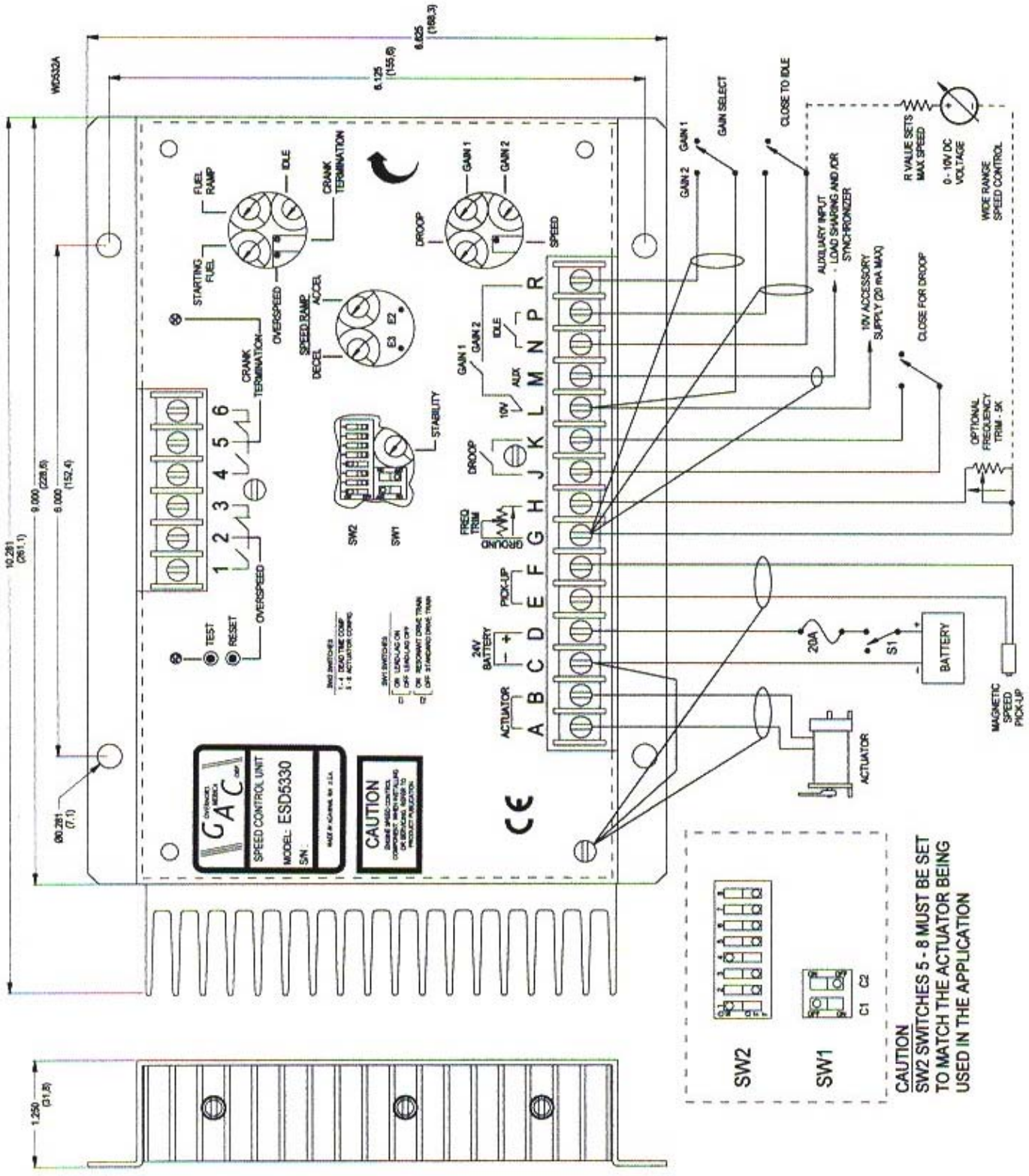
EMC

Conforms to CE directive for light and heavy industrial usage when installed in accordance with special instructions and as per the wiring diagram which is found in PIB 1041.

WARNING

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

FIGURE 1. WIRING DIAGRAM and OUTLINE



MAGNETIC PICKUP INSTALLATION

With the engine stopped, adjust the gap between the magnetic speed pick-up and the ring gear tooth. The gap should not be any smaller than 0.020 in. (0.45 mm). Usually, backing out the speed pick-up 3/4 turn after touching the ring gear tooth will provide a satisfactory air gap. Verify proper installation by measuring the AC voltage output of the pick-up while cranking the engine. The output should be a minimum of 0.5 VAC.

ADJUSTMENTS

Before starting the engine, preset the adjustments.

Check to see that the GAIN, STABILITY, and External FREQuency TRIM (if used) are set to their mid positions. Also check to see that the STARTING FUEL adjustment is set to "100" initially.

CAUTION

Dip Switches SW2-5, SW2-6 and SW2-7 must be set in their proper position before starting the engine. See normal switch position setting below.

SW1 C1 OFF – Lead Lag Circuit
C2 OFF – Soft Coupling Filter

SW2 Actuator Selection/Dead Time Compensation (DTC)

Position	Switch Function		
1	DTC 8X = OFF		
2	DTC 4X = OFF		
3	DTC 2X = OFF		
4	DTC 1X = OFF		
5	Speed Loop Gain 4X	120, 225, 275	= ON
		2000	= OFF
6	Act Loop Gain (7A Max)	120, 225, 275	= ON
	(15A Max)	2000	= OFF
7	Act Loop Gain (7A Max)	120, 225, 275	= OFF
	(15A Max)	2000	= ON
8	Added DTC 11mSec	120, 225, 275	= OFF
	65mSec	2000	= ON

For the 120, 175, 225 and 275 Series actuator applications, it is required that SW2 position be as follows:

SW2-5 *Typically* is in the ON position
SW2-6 Must be in the ON position
SW2-7 Must be in the OFF position
SW2-8 *Typically* is in the OFF position

Switch SW2-5 only with engine stopped, as a major speed transient will occur.

For the 2000 Series actuator application, it is required that SW2 position be as follows:

SW2-5 *Typically* is in the OFF position
SW2-6 Must be in the OFF position
SW2-7 Must be in the ON position
SW2-8 *Typically* is in the ON position

Switch SW2-5 only with engine stopped, as a major speed transient will occur.

All other Dip SW2 switches (1-4) should be set for optimum engine performance as per instructions provided.

The factory speed setting for the controller is 1000 Hz or approximately at idle speed. The crank termination is set very low initially.

START ENGINE

If the cranking termination occurs too quickly, preventing the engine from starting, turn the crank termination adjustment CW. The actuator should snap to full fuel until the engine starts and runs at a low idle setting. Adjust the SPEED setting CW for the desired operating speed.

Should the engine be unstable, turn the GAIN and STABILITY adjustments CCW until the engine is stable. If the system remains unstable or not operating properly, refer to the TROUBLESHOOTING section.

GOVERNOR SPEED SETTING

The governor SPEED adjustment should be set to the operating speed of the Prime Mover.

GOVERNOR PERFORMANCE

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

A. Rotate the GAIN adjustments CW until instability develops. Gradually move the adjustment CCW until stability returns. Move the adjustment one division further CCW to insure stable performance.

B. Rotate the STABILITY adjustment CW until instability develops. Gradually move the adjustment CCW until stability returns. Move the adjustment one division further CCW to insure stable performance.

C. GAIN and STABILITY adjustments may require minor changes after engine load is applied. Normally, adjustments made at no load achieve satisfactory performance.

A strip chart recorder can be used to further optimize the adjustments.

If the GAIN is set below 20 or above 80, or instability cannot be eliminated, or if further performance improvements are required, refer to the section on TROUBLESHOOTING at the end of this publication. Changes in the DIP switch settings are required.

RESONANT DRIVE TRAINS

Many applications require a flexible coupling between the engine and its load. This can take the form of a soft rubber segmented coupling or a drive shaft which behaves as a natural spring. The reasons such couplings are used is for alignment purposes, torsional considerations, or because of the excess length of the drive shaft has a natural spring effect. In any case, the drive train can act as a resonant device causing variable loads at a cyclical rate to be impressed on the engine and its flywheel. Such variations sometimes occur at a frequency that the governor responds to very well. This can cause excessive throttle movement at the same frequency as the resonance. The ESD5330 Series speed control unit has a special circuit that minimizes the effect of the resonances on the governor.

If the system exhibits these characteristics, turn ON SW1, C2 to institute this feature. Readjust the control system per the above procedure and the result should be a significant reduction in throttle dither.

Because the governor does not respond to the resonance any longer does not mean the resonance is not still present in the drive train.

IDLE and RAMP SETTINGS

Close the IDLE switch connecting Terminals N and P. This will cause the engine to slow to an idle speed. Adjust the IDLE setting for the desired idle speed.

Open the IDLE switch between Terminals N and P. The engine will start accelerating toward rated speed. Adjustment of the ACCEL control will allow the engine to accelerate with just enough fuel to bring the system to operating speed with lowest emissions. The desired acceleration and deceleration rates can be achieved by manipulating the ACCEL and DECEL adjustments. Cycle the IDLE switch after each ACCEL or DECEL adjustment change until the desired results are achieved. It is suggested to use an oil pressure

switch to operate these contacts. Open N and P and the engine speed will decelerate at a rate set by the DECEL control. CW is faster for both accel and decel functions.

CAUTION: If the IDLE speed adjustment is set too low, the engine may never exceed the crank termination point, possibly causing starter damage.

SPEED DROOP OPERATION

If droop operation is desired (speed setting reduces with increased engine load), close the switch contact across Terminals J and K. Rotate the DROOP adjustment CW to increase the droop percentage. "0" setting (Full CCW) = Zero droop. 100 = maximum droop.

STARTING FUEL ADJUSTMENT

Turn the STARTING FUEL RAMPING to minimum CCW position (0). Crank the engine and quickly rotate the starting fuel adjustment to CW until the engine starts without excess smoke. Repeat several times to find the best setting. Some engines require large amounts of fuel to start but most modern engines respond to limiting fuel during cranking. Once the engine starts repeatedly in a satisfactory manner, adjust the Fuel Ramping adjustment CW so the engine accelerates to rated speed quickly, without excess smoke.

The acceleration adjustment may be set to the fastest positions, if start fuel ramping is not desired.

INTERNAL SPEED RAMPING FUNCTION

Each time the ESD5330 Series is started the speed ramping function operates by taking control of the engine at near idle position and automatically raises the engine speed until the speed set point is reached. The acceleration time is controlled by the acceleration control. If the idle switch is then closed, the speed will decelerate at the rate set by the deceleration adjustment control. During these ramping periods, the speed control has a small amount of droop added to attain stability at low engine speeds. The droop is eliminated once rated speed is reached unless droop is added by closing the switch at J and K terminals.

The internal ramp generator can also be used for wide range variable speed applications. Connecting a 0-10 VDC variable voltage to terminal "N" with respect to terminal "G" will provide a means to achieve variable speed governing. To calibrate the speed range, either limit the voltage to a level which provides the desired range with an external potentiometer or add resistance in series with terminal N as shown in the diagram.

DUAL GAIN FEATURE

The ESD5330 Series can operate with two distinct gain settings. The two gain adjustments, Gain 1 and Gain 2 are independent adjustments. With the connection from R and L "Open," the Gain 1 adjustment is in operation. With a connection from R to L, Gain 2 is in operation. Switching between the two gain settings should have an imperceptible difference in speed change. The dual gain function is especially useful for engines which exhibit different characteristics under different situations. An engine may run very stable at high speeds and less stable at lower speeds. Setting a single gain control for the lower speeds then yields less than an optimum setting at the higher speeds. A simple switch can be toggled for low or high speed operation. Additionally in gaseous fuel engine applications where the quality or type of gas is changed the two gain settings can be used to idealize the governor for each type of fuel.

For cold engine instability, a temperature sensing switch can reset the governors gain once the engine has reached a normal operating temperature.

These are some examples which the ESD5330 Series can be used to provide more optimum control of dynamic engine characteristics while providing the best of governing control.

OVER SPEED MONITOR

The overspeed monitor circuit trip point is set by the multi-turn potentiometer. This is normally set by raising the engine speed to the specific trip point speed and turning the adjustment CCW until the O.S. circuit turns ON (Red LED). This will also turn off the actuator output circuit and change the state of the internal relay contacts at terminals 1, 2, 3. To reset the O.S. circuit, push "Reset" switch through the hole provided or recycle the DC power to the unit. The "Test" switch will reduce the O.S. setting about 20%. If the engine is running at rated speed and the test button is pushed the O.S. monitor circuit should trip.

The relay contacts at terminals 1, 2, 3 should be used to turn OFF the engine, either fuel or air. Do not rely on the control to turn "OFF" the actuator as a means of shutting off the engine. A fault could have occurred in the actuator, linkage, cables, etc. which the ESD5330 has control over.

CRANKING TERMINATION

When no power is applied to the ESD5330 Series, the crank relay contacts Terminals 5 and 6 are normally closed. As the speed increases, the internal relay will change state and the green LED will light. The speed setting at which this occurs is determined by the multi turn speed setting potentiometer. CW adjustment will increase the speed at which this transition takes place.

Once the circuit had tripped, the crank termination circuit will remain tripped until DC power is removed from the unit. This will reset the function.

ACCESSORY INPUT

The AUXiliary input, Terminal M, directly accepts output signals from GAC Load Sharing units, Auto Synchronizers and other governor system accessories. Consult the applicable GAC publications for details. It is recommended that this connection from accessories be a shielded cable as it is a sensitive input terminal.

NOTE: If the GAC Auto Synchronizer is used alone, not in conjunction with a Load Sharing Module, a resistor must be installed between Terminals M and L. If a frequency trim potentiometer is also used, the resistor should be 910K ohms. If no frequency trim is used, the resistor should be 1.2M ohms. This is required to match the voltage levels between the ESD5300 and the synchronizer.

ACCESSORY SUPPLY

The +10 Volt regulated supply, Terminal L, can be utilized to provide power to GAC governor system accessories. Up to 40 ma of current can be drawn from this supply. The ground reference for this supply is Terminal G.

FINAL SPEED SETTING

After the Droop, Frequency Trim, and/or accessory inputs have been connected, readjust the operating SPEED and IDLE.

SYSTEM TROUBLESHOOTING

INSTABILITY

Instability in a closed loop governor control system can be categorized as two general types. PERIODIC appears to be sinusoidal and at a regular rate. NON-PERIODIC is a random wandering or an occasional deviation from a steady state band for no apparent reason.

PERIODIC INSTABILITY

The PERIODIC type can be further classified as a FAST or SLOW instability. FAST instability is a 3 Hz or faster irregularity of the speed and is usually perceived as a jitter. SLOW periodic instability is at a frequency below 3 Hz, can be very slow, and is sometimes violent.

If **FAST instability** occurs, this is typically the governor responding to engine firings. Raising the engine speed increases the frequency of instability and vice versa. If this is the case SW1 C1 OFF (Lead/Lag) and/or setting SW2 switches 1, 2, and 3 to ON (DTC), as shown in TABLE 1., will reduce this tendency. In extreme cases, this may not take all the jitter out of the system.

A second switch, SW1 (Soft Coupling Filter), C2 may be set to ON to further stabilize the system. Switch locations are shown in FIGURE 1. on page 3. Interference from powerful electrical signals can also cause jitter. Turn off battery chargers or other electrical equipment to see if the symptom disappears.

SLOW instability can have many causes. Adjustment of the GAIN and STABILITY usually cures most situations by matching the ESD5330 Series to the engine dynamics. Turn ON SW1 C1 (Lead/Lag). If this is unsuccessful, the dead time compensation can be modified. Turn SW2 switches (DTC) OFF in this order.

TABLE 1. SW2 DTC Switch Settings

	1	2	3	4	
	ON	ON	ON	ON	
	ON	ON	ON	OFF	
	ON	ON	OFF	ON	
	ON	ON	OFF	OFF	
	ON	OFF	ON	ON	
	ON	OFF	ON	OFF	
If you have **SLOW** Instability	ON	OFF	OFF	ON	If you have **FAST** Instability
	ON	OFF	OFF	OFF	
	OFF	ON	ON	ON	
	OFF	ON	ON	OFF	
	OFF	ON	OFF	ON	
	OFF	ON	OFF	OFF	
	OFF	OFF	ON	ON	
	OFF	OFF	ON	OFF	
	OFF	OFF	OFF	ON	
	OFF	OFF	OFF	OFF	

If SLOW instability is unaffected by this procedure, evaluate the fuel system and engine performance. Irregularities with fuel injection systems can change engine power even when the throttle setting is constant. This can result in speed deviations beyond the control of the governor system. Adding a small amount of droop can help stabilize the system for troubleshooting. Additional DTC can be added by connecting a capacitor across the two posts below the ACCEL/DECEL adjustments. The (+) of the cap is to be connected to E3. 20MFD and above should be used.

NON-PERIODIC INSTABILITY or IRREGULARITY

NON-PERIODIC instability may respond to adjustments made to the GAIN control. If increasing the gain reduces the irregularity, the problem is probably with the engine. Higher gain allows the governor to respond faster and correct for the disturbance. Look for engine misfirings, an erratic fuel system, or load changes on the engine generator set or voltage regulator irregularities.

If unsuccessful in solving the instability, contact GAC or one of their distributors for application assistance.

SYSTEM INOPERATIVE

If the engine governing system does not function, the fault may be determined by performing the voltage tests described below in Steps 1, 2, 3, and 4. (+) and (-) refer to meter polarity. Should normal values be indicated as a result of following the trouble shooting steps, the fault may be with the actuator or the wiring to the actuator. See the actuator publication for testing details.

STEP	TERMINAL	NORMAL READING	PROBABLE CAUSE OF ABNORMAL READING
1	D (+) & C (-)	Battery supply voltage (24 V DC)	1. DC battery power not connected. 2. Low battery voltage. 3. Wiring error or fuse open.
2	E & F	1.0 V AC RMS minimum while cranking	1. Gap between speed sensor and gear teeth too large. 2. Improper or defective wiring to the speed sensor. Resistance between Terminals E & F should be 30 to 300 ohms. 3. Defective speed sensor.
3	L (+) & G (-)	10 V DC, internal supply	1. Short on Terminal L. 2. Defective speed control.
4	A (+) & C (-)	2 V DC less than battery voltage while cranking Battery voltage (-) 2 V while cranking	1. Starting FUEL LIMIT set too low. 2. IDLE set too low. 3. SPEED adjustment set too low. 4. Wiring error to actuator. 5. Defective speed control. 6. Defective actuator.

INSUFFICIENT MAGNETIC SPEED SENSOR SIGNAL

The ESD5330 Series will govern well with a 0.5 volts RMS speed sensor signal. A speed sensor signal of 3 volts RMS or greater at governed speed is recommended. A strong magnetic speed sensor signal will eliminate the possibility of missed or extra pulses. Measure the signal at Terminals E and F. 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 0.020 in. (0.45 mm). With the engine stopped, back the speed sensor out by 3/4 of a turn after touching the ring gear. This will usually achieve a satisfactory air gap.

ELECTROMAGNETIC COMPATIBILITY (EMC)

EMI SUSCEPTIBILITY

The governor system can be adversely affected by large interfering signals that are conducted through the cabling or through direct radiation into the control circuits.

All GAC speed control units contain filters and shielding designed to protect the units sensitive circuits from moderate external interfering sources.

Although it is difficult to predict levels of interference, application that include magnetos, solid state ignition systems, radio transmitters, voltage regulators or battery chargers should be considered suspect as possible interfering sources.

If it is suspected that external fields, either those that are radiated or conducted, are or will affect the governor systems operation, it is recommended to use shielded cable for all external connections. Be sure that only one end of the shields, including the speed sensor shield, is connected to a single point on the case of the speed control unit. Mount the speed control unit to a grounded metal backplate or place it in a sealed metal box.

Radiation is when the interfering signal is radiated directly through space to the governing system. To isolate the governor system electronics from this type of interference source, a metal shield or a solid metal container is usually effective.

Conduction is when the interfering signal is conducted through the interconnecting wiring to the governor system electronics. Shielded cables and installing filters are common remedies.

As an aid to help reduce the levels of EMI of a conductive nature, a battery line filter and shielded cables are conveniently supplied by GAC in KT130. To reduce the levels of EMI of a radiated nature, a shielded containers P/N CA114 can be sourced from GAC and its distributors.

In severe high energy interference locations such as when the governor system is directly in the field of a powerful transmitting source, the shielding may require to be a special EMI class shielding. For these conditions, contact GAC application engineering for specific recommendations.

HUEGLI TECH AG 4900 LANGENTHAL SWITZERLAND
TEL. + 41 62 916 50 30 FAX. + 41 62 916 50 35
E - M a i l : sales@huegli-tech.com www.huegli-tech.com