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The Engine & Genset Control Company
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ECC 326

GENERATOR FREQUENCY SENSING SPEED CONTROL UNIT

INSTALLATION

The ECC326 speed control unit is an all electronic device designed to control engine speed with precise response to transient engine loads changes. This closed loop speed control, when connected to a proportional actuator and supplied with a speed signal/ frequency from the main AC generator, will control a wide variety of engines in an isochronous mode. The speed signal input must be in the frequency range of 40 to 80 Hz.

The ECC326 is a hard potted module designed to operate with high reliability in harsh environments. The adjustment procedure is considered to be simple.

Standard features include: protection against reversal of the battery supply, accidental shorts in the actuator wiring, high voltage transient on the DC and AC lines, and the loss of the speed signal or battery supply.

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DESCRIPTION

The generator's frequency, when used as an engine speed signal, can be either 50 or 60 Hz nominally. The minimum and maximum amplitude levels required to operate the ECC326 are 1V AC to 260V AC. The generator's residual voltage must reach 1 V AC so the loss of speed signal will be defeated and allow the actuator to open the fuel valve to start the engine. Other than the Min and Max AC input values, the control is not very sensitive to the wave shape or the voltage levels from the generator.

When the speed signal is received by the controller, the signal is conditioned to operate the GAC proprietary speed sensor circuit. If the speed signal disappears for longer than approximately 0.2 seconds, the actuator output will be shut off (loss of speed signal protection). When cranking the engine, the control unit will sense a very low frequency and operate the actuator to start the engine.

The internal summing circuit receives the speed signal and combines it with the speed setting reference adjustment along with the remote speed trim setting. The output of the summing circuit is the input to the dynamics control circuits of which the gain and stability adjustments are a part. These control functions provide isochronous and stable performance.

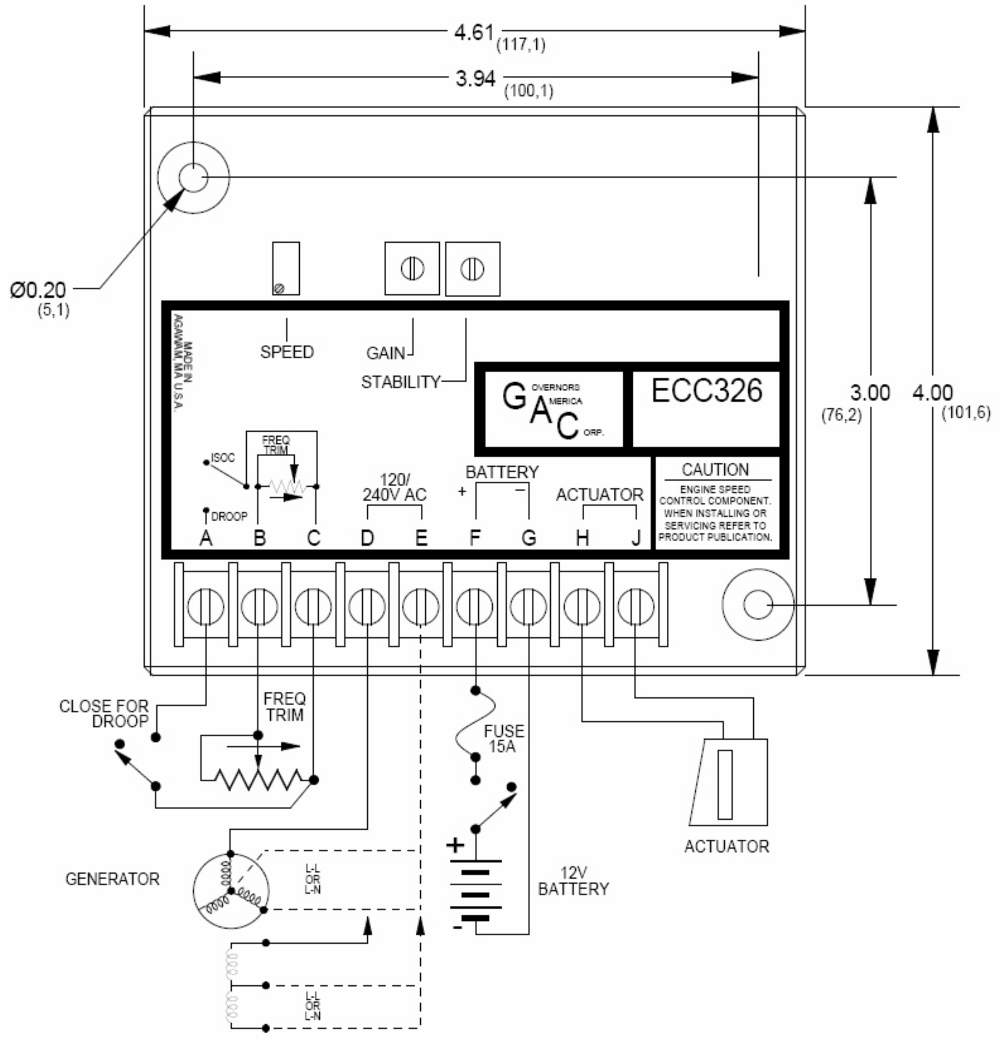
During engine cranking, the actuator should be fully energized and should move to the maximum fuel position. The actuator will remain in that state during engine cranking and acceleration up to the operating speed. With the engine at a steady load, the actuator will be energized with sufficient current to maintain the governed speed set point.

The output circuit to the actuator provides a controlled switching current loop to the proportional actuator at a frequency of about 200 Hz. This switching frequency is well beyond the natural frequency response of the actuator, thus there is no visible motion of the actuator due to this switching circuit. Switching of the output transistor reduces internal power dissipation and provides for efficient power control up to 10 Amps of continuous current at 25°C. A proportional actuator will respond to the average current to position the engine fuel control lever.

The ECC326 is compatible with all proportional GAC actuators except the ACB2000 which has too a high current requirement (15A).

WIRING

Basic electrical connections are shown in the Wiring Diagram, Fig. 1. Battery and actuator connections should be #16AWG (1.3mm2) or larger. Long cables require an increased wire size to minimize voltage drops. The battery positive (+) input, Terminal F, should be fused for 15A.
Connection to the generator: The two input Terminals, D and E, should be connected to the generator's AC windings. These connections can be either line to line or line to neutral. Terminal E should be connected to the neutral if this connection is chosen. See the wiring diagram for various connections to the generator.



ADJUSTMENTS

WARNING
An overspeed shutdown device, independent of the governor system, should be provided to prevent loss of engine control which may cause personal injury or equipment damage.

Before Starting the Engine

Check to insure that the GAIN, STABILITY and external SPEED TRIM controls, are set to their mid positions.

Start the Engine

The ECC326 control is factory set to operate at approximately 60 Hz generator frequency.

Crank the engine with DC power applied to the governor system. The actuator will energize (within 1.5V DC of battery voltage) and force the fuel control to its maximum fuel position until the engine starts. The governor system should then control the engine at near rated speed.

If the engine is unstable after starting, turn the GAIN, and STABILITY, CCW until the engine speed is stable.

Governor Speed Setting

The governed speed set point can be increased by the CW rotation of the SPEED adjustment.

The Remote speed adjustment (optional) can be used as a SPEED TRIM control. See Fig. 1.

Governor Performance

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

A. Rotate the GAIN adjustment CW until instability develops. Gradually move the adjustment CCW until stability returns. Move the adjustment 1/8 of a turn 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 1/8 of a turn further CCW to insure stable performance.

C. Normally, adjustments made at no load result in satisfactory performance across the entire load range. GAIN readjustment might be required after load is applied to the engine if a non linearity exists in the fuel control. A strip chart recorder or storage oscilloscope with appropriate electronics can be used to measure generator frequency to further optimize the governor's performance.

If instability cannot be corrected, or further performance improvements are required, refer to the Instability section under SYSTEM TROUBLESHOOTING.

SPECIFICATIONS	
PERFORMANCE	
Isochronous Operation	±0.25%
Speed Range (unless stated in units specifications)	40 - 80 HZ
Speed drift with temperature	± 1%
Speed Trim (see unit specification)	+/- 2 Hz
ENVIRONMENTAL	
Ambient Temperature	-40 to +185°F (-40 to +85C)
Relative Humidity	Up to 100%
INPUT POWER	
DC Supply	12V DC (8-15 VDC) Nominal (24V DC available as special order)
Polarity	Negative Ground (case isolated)
Power consumption	<50 mA + Actuator Current
Maximum actuator current	10 Amps
Generator frequency sensing	Load on generator, 40K Ohms Minimum sensing 1 VAC RMS Maximum voltage 260 VAC
RELIABILITY	
Vibration	5G 20 - 500 Hz
Shock	20G's
Testing	100% Functional Testing before and after potting
PHYSICAL	
Dimensions	See Wiring Diagram (Fig. 1)
Weight	0.75 lb (0.34 kg)
Mounting	Any Position

SYSTEM TROUBLESHOOTING

System Inoperative

If the governing system does not function, the fault may be determined by performing the voltage tests described in Steps 1 & 2, (+) and (-) refer to meter polarity. Should normal values be indicated, the fault may be with the actuator or the wiring to the actuator. See specific actuator publication for testing details.

STEP	TERMINALS	NORMAL READING	POSSIBLE CAUSE OF ABNORMAL READING
1	F(+) & G(-)	Battery Supply Voltage (12 or 24VDC) (while cranking, 8.0 VDC)	1. DC battery power not connected. 2. Low battery voltage. 3. Check for blown fuse. 4. Wiring error.
2	J(+) & H(-)	Battery Voltage less 1.5 volts (When cranking)	1. No Speed signal (Generator residual too low, see additional troubleshooting) 2. Wrong connection at Terminals D & E
		Voltage present, but actuator does not move	Actuator circuit open, measure actuator resistance

Unsatisfactory Performance

If the governing system functions poorly, perform the following tests.

Symptom	Test	Probable Fault
Engine Over speed	1. **Do Not Crank**. Apply DC power to the governor system	1. If actuator goes to full fuel, then disconnect speed sensing wires at Terminals D & E. If actuator is still at full fuel, speed If actuator is still at full fuel - speed
		If actuator is at minimum fuel position - erroneous speed signal. Check wiring to generator to assure generator voltage is properly connected to the unit.
	2. Manually hold the engine at the desired running speed. Measure the DC voltage between Terminals G (-) & F (+).	1. If the voltage reading is 1.0 to 2.0 VDC, a) SPEED adjustment set above desired speed. Turn CCW. b) Defective speed control unit.
		2. If the voltage reading is above 2.0 VDC, on the speed control unit. Actuator or linkage binding.
		3. If the voltage reading is below 1.0 VDC, Defective speed control unit.
Overspeed during start up	1. Low GAIN setting.	1. Try to increase the Gain setting CW and also turn the Stability CW as much as possible without causing instability. 2. Check the actuator for binding or friction which may be causing a low gain setting issue.
Actuator does not fully energize	1. Measure the DC voltage at the actuator It should be 0.8 to 1.5V DC less then the actual battery voltage but not less than 8V DC	1. Replace the battery if it is weak or undersized. 2. Actuator wiring incorrect or too small a wire gauge.
	2. Momentarily connect Terminals J and F. The actuator should move to the full fuel position.	1. Actuator or battery wiring error. 2. Actuator or linkage binding. 3. Defective actuator.
Engine remains below desired governing speed.	1. Measure the actuator output, Terminals J (+) & H (-) while running under governor control.	1. If voltage is within approximately 2V DC of the battery supply voltage, then fuel control restricted from reaching full fuel position. Possibly due to mechanical governor, carburetor spring, linkage alignment, or interference. 2. If not, increase SPEED setting.

Engine does not start (Minimum AC residual too low)	1. Measure V AC at Terminals D and E while cranking.	1. If too low consider connecting a 7 amp diode between the starter motor battery signal and Terminal J. (Cathode of the diode to "J")

Electromagnetic Compatibility (EMC)

EMI SUSCEPTIBILITY: - Any 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 unit's sensitive circuits from moderate external interfering sources. The ECC326 can tolerate levels of at least 10 V/Meter from 10 MHz to 1 GHz (CE requirements)

Although it is difficult to predict levels of interference, applications 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 is connected to a single point on the grounded metal plate or place the unit in a sealed metal box.

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.

Instability

Instability in a closed loop speed control system can be categorized into 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.

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 a jitter. Slow periodic instability is below 3 Hz., can be very slow, and is sometimes violent.

If a fast instability occurs, this is typically the governor responding to engine firings. Raising the engine speed increases the frequency of instability and vice versa.

Interference from powerful electrical signals can also be the cause. Turn off the battery chargers or other electrical equipment to see if the symptom disappears.

Slow instability can have several causes. Adjustment of the GAIN and STABILITY (if included) usually cures most situations by matching the speed control unit dynamics. The control system can also be optimized for best performance by following procedure.

If slow instability is unaffected by this procedure, evaluate the fuel system and engine performance. **Check the fuel system linkage for binding, high friction, or poor linkage. Be sure to check linkage during engine operation.** Also look at the engine fuel system. Irregularities with carbureted or fuel injection systems can change engine power even with a constant throttle setting. This can result in speed deviations beyond the control of the governor system. Poor mixture adjustment or bad ignition timing can cause speed instability in Gas engine applications.

NON-PERIODIC instability should respond to the GAIN control. If increasing the gain reduces the instability, then 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 voltage regulator.

If unsuccessful in solving instability, contact your local distributor or Huegli Tech AG for technical assistance.