ESC61C Series
Speed Control Unit

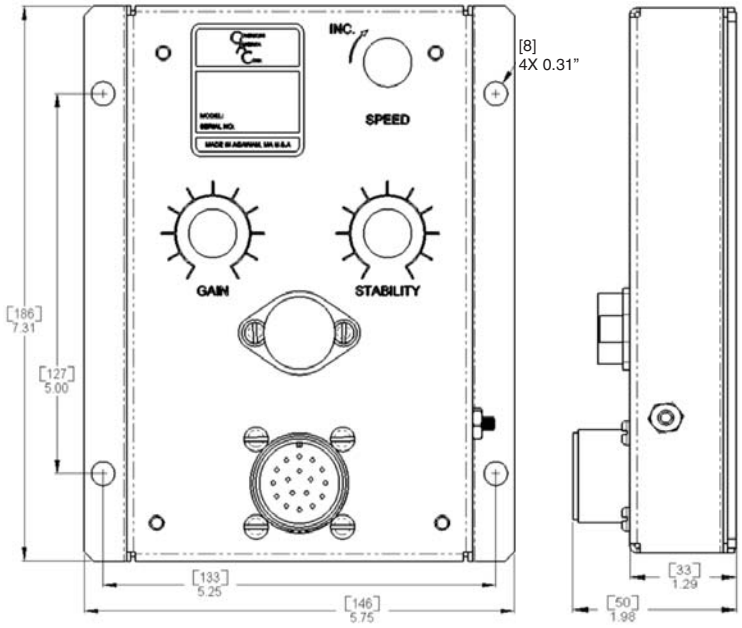
1 INTRODUCTION

The speed control unit is a rugged assembly that can be mounted in a control cabinet or engine mounted enclosure with other dedicated control equipment. If water, mist, or condensation can come in contact with the controller, it should be mounted vertically to allow fluids to drain from the speed control unit.

2 INSTALLATION

DIAGRAM 1:

DIM: [mm]
inches

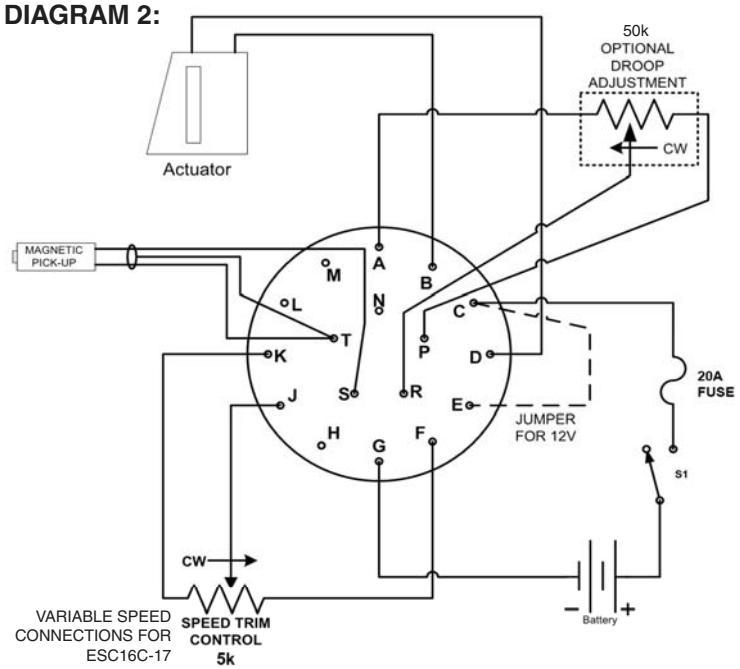


NOTE An overspeed shut device, independent of the governor system, should be provided to prevent loss of engine control, which may cause equipment damage or personal injury.

3 WIRING

Basic electrical connections are illustrated in Diagram 2. Actuator and battery connections to terminals B, C, D, and G should be #16 AWG (1.3 mm^2) or larger. Long cables require an increased wire size to minimize voltage drops.

DIAGRAM 2:



4 SPECIFICATIONS

PERFORMANCE	
Isochronous Operation / Steady State	+/- 0.25% or better
Speed Range	300 - 10k Hz continuous
Droop Range	0 - 5% regulation
Speed Drift with Temperature	< +/- 1%
Speed Trim Range	+/- 200 Hz
Terminal Sensitivity R J (Without Jumper) J With Jumper Between Posts E1 and E2	 104 Hz / Volt 40 Hz / Volt 1100 Hz / Volt
ELECTRICAL POWER INPUT	
Operating Voltage	11 - 40 VDC (Transient and reverse voltage protected)
Polarity	Negative ground, case isolated
Power Consumption	60 mA continuous plus actuator current
Max. Actuator Current at 25°C (77°F)	20 Amps.
Speed Sensor Signal	0.5 to 30 VRMS

ENVIRONMENTAL	
Ambient Temperature	-65 to 180°F (-55 to 82°C)
Relative Humidity	Up to 95%
All Surface Finishes	Fungus Proof and Corrosion Resistant
RoHS Regulations	Compliant
PHYSICAL	
Dimensions	See Diagram 1
Weight	3.2 Lbs. (1.45 kg)
RELIABILITY	
Vibration	5G @ 20 - 500 Hz
Testing	100% Functionally Tested

SELECTION CHART	
PART NUMBER	**DESCRIPTION**
ESC61C-7	Standard Unit (Replaces AMBAC / UTC CU671C-7, CU671C-10 and CU673-10)
ESC61C-17	Variable Speed Operation Version (Replaces AMBAC / UTC CU671-17 and CU673C-17)
EC1200	Mating Connector for ESC61C Series

Connecting the Magnetic Speed Sensor:

Magnetic speed sensor wires connected to Terminals S and T **MUST BE TWISTED AND/OR SHIELDED** for their entire length. The speed sensor cable shield should ideally be connected to Terminal T as shown in Diagram 1. The shield should be insulated to insure no other part of the shield comes in contact with engine ground, otherwise stray speed signals may be introduced into the speed control unit. 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 turn after touching the ring gear teeth will achieve a satisfactory air gap. The magnetic speed sensor voltage should be at least 1 VAC RMS during cranking.

Anything other than a very short connection to Terminal R must be shielded also. Connect the shield to Terminal H.

5 ADJUSTMENTS

Before Starting the Engine

Check to insure the **GAIN** and **STABILITY** adjustments, and if applied, the external **SPEED TRIM CONTROL** are set to mid position.

Check the fail-safe features of the controller and part of the actuator wiring by applying D.C. battery current to the governor system by closing S1, shown in Diagram 2. The actuator should momentarily move, but must return to minimum fuel position.

Start Engine

The speed control unit is factory set at approximately engine idle speed. (1000 Hz. speed sensor signal)

Crank the engine with D.C. power applied to the governor system. The actuator will energize to the maximum fuel position until the engine starts. 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 counterclockwise until the engine is stable.

Governor Speed Setting

The governed speed set point is increased by clockwise rotation of the **SPEED** adjustment pot. Remote speed adjustment can be obtained with an optional Speed Trim Control. (See Diagram 2)

Governor Performance

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

Rotate the **GAIN** adjustment clockwise until instability develops. Gradually move the adjustment counterclockwise until stability returns. Move the adjustment one division further counterclockwise to insure stable performance.

Rotate the **STABILITY** adjustment clockwise until instability develops. Gradually move the adjustment counterclockwise until stability returns. Move the adjustment one division further to insure stable performance.

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

Speed Droop Operation

Adjustable droop can be obtained by connecting a 50K potentiometer to Terminals A, P, and R as illustrated in Diagram 2. The range of droop is dependent on the change of actuator current and the frequency of the speed sensor signal.

With the engine at rated speed and full load, turn the droop control 1/2 turn clockwise. Re-adjust the engine speed to the rated speed setting. Remove the engine load and note the engine speed for the percentage of droop obtained. To increase the percent of droop, rotate the droop control clockwise. Decreases in the percent of droop will require counterclockwise rotation of the droop control.

Droop is typically used for the paralleling of engine driven generators. Usually 3% droop is adequate for engine paralleling or for non-generator set applications.

Speed Trim

A remote panel mounted speed trim may be required to perform engine speed trimming and for synchronizing. Speed trim control is achieved by connecting a 5K potentiometer as illustrated in Diagram 2. The range of the speed trim is ± 200 Hz. when connected as shown.

Accessory Input

The accessory Terminal R accepts input signals from load sharing units, auto synchronizers, and other governor system accessories. GAC accessories are directly connected to this terminal. It is recommended that this connection from accessories be shielded, as it is a sensitive input terminal.

Accessory Supply

The +10 volt regulated supply, Terminal K, can be utilized to provide power to GAC governor system accessories. Up to 20 mA of current can be drawn from this supply. Ground reference is Terminal H.

Wide Range Remote Variable Speed Operation

Simple and effective remote variable speed can be obtained with the ESC61C Series control unit.

In order to use the speed control unit in variable speed operation, a simple modification is required. The modification is as follows:

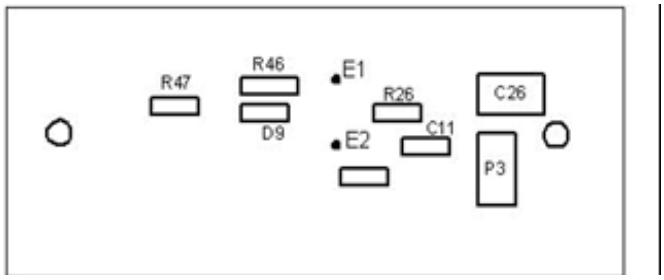
1. Remove the five (5) screws, which hold the circuit board and base plate to the case.

2. Remove the four (4) screws, which hold the connector to the case.

3. Lift the case to one side in order to gain access to the topside of the circuit board. (See Diagram 3)

4. At the top and middle of the circuit board, locate two posts E1 and E2. Solder a solid wire link between these two posts. This modification changes the sensitivity of Terminal J from 40 Hz/Volt to 1100 Hz/Volt. The ESC61C-17 speed control unit is factory set with this modification.

Diagram 3



Insufficient Magnetic Speed Signal

A strong magnetic speed sensor signal will eliminate the possibility of missed or extra pulses. The speed control unit will govern 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 S and T.

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). When the engine is stopped, back the speed sensor out by 1/4 turn after touching the ring gear tooth to achieve a satisfactory air gap.

6 SYSTEM TROUBLESHOOTING

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, 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 actuator publication for testing procedure on the actuator.

Step	Wires	Normal Reading	Probable Cause of Abnormal Reading
1	C(+) & F(-)	Battery Supply Voltage (12, 24 or 32 VDC)	1. DC battery power not connected. Check for blown fuse. 2. Low battery voltage 3. Wiring error.
2	K(+) & H(-)	10 VDC, Internal Supply	1. Short on Terminal K or defective accessory 2. Defective speed control unit
3	S(+) & T(-)	1.0 VAC RMS min. while cranking	1. Gap between speed sensor and gear teeth too great. Check / reset gap. 2. Improper or defective wiring to the speed sensor. Resistance should be between 30 to 1200 Ohms. 3. Defective speed sensor
4	B(+) & H(-)	2.0 VDC while cranking	1. Speed adjustment set too low 2. Wiring error to actuator 3. Defective speed control unit 4. Defective actuator

Unsatisfactory Performance

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

Symptom	Test	Probable Fault
Engine overspeed	1. Do Not Crank. Apply power to the governor system	1. Actuator goes to full fuel. Then disconnect the speed sensor wires. If the actuator is still at full fuel the speed control unit may be defective. If the actuator goes to its minimum fuel position, there is an erroneous speed signal. Check the speed sensor and cable wiring.
	2. Manually hold the engine at the desired running speed. Measure the DC voltage between terminal B and F on the speed control unit.	1. If the voltage reading is 1.0 to 1.5 VDC, a) SPEED adjustment set above desired speed b) Defective speed control unit 2. If the voltage reading is above 1.5 VDC, actuator or linkage binding. 3. Set point of the overspeed shutdown device set too low. 4. If the voltage reading is below 0.8 VDC, defective speed control unit.
Actuator does not energize fully while cranking.	1. Measure the battery voltage while cranking. It must not be less than 8 VDC.	1. Replace the battery if weak or undersized.
	2. Momentarily connect B to F. The actuator should move to the full fuel position.	1. Actuator or battery wiring in error. 2. Actuator or linkage binding. 3. Defective actuator.
Engine remains below desired governed speed	1. Measure the actuator output, B and D, while running under governor control.	1. If voltage measurement is within 2 volts or less of the battery supply voltage level, then fuel control restricted from reaching full fuel position. Possibly due to mechanical governor, carburetor spring, or linkage interference. 2. If not, increase speed setting.

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 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 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, adding a jumper from N to M will reduce this tendency. Interference from powerful electrical signals can also be the cause. Turn off the battery chargers or other electrical equipment to see if the system instability disappears.

Slow instability can have many causes. **GAIN** and **STABILITY** adjustment and placement of a jumper connection from H to M usually cures most situations by matching the speed control unit to the engine dynamics.

If more dead time compensation is need, an additional 10MFD capacitor can be placed between posts E10(+) and E11(-). These posts are located near the circular connection at the edge of the circuit board.

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 carburetion or fuel injection systems can change engine power with a constant throttle setting. 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.

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 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 GAC for assistance.