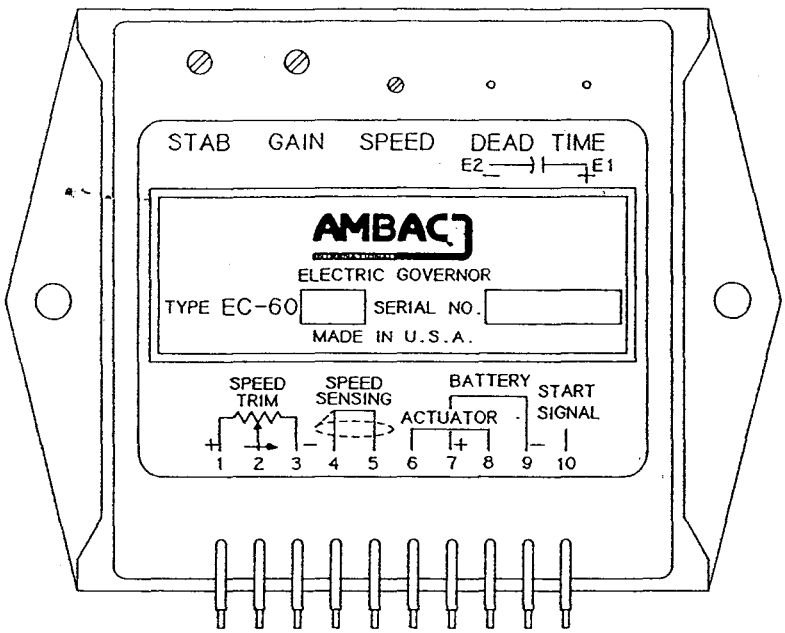
ENGINE GOVERNING SYSTEMS

AMBAC INTERNATIONAL

EC 60

Supersedes Issue
Dated March 1994

SPEED CONTROL UNIT



ACTUAL SIZE

OPTIONAL SPEED SENSING

FEATURES

- Low cost
- Compact size
- Isochronous operation
- Remote speed trim capability
- Transient voltage protected
- Vibration and moisture protected
- Fail safe speed signal

CAN ACCEPT SPEED SIGNAL FROM:

- One phase of generator output
- Tach drive from alternator
- Spark plug wire sensor
- Ignition coil
- Magnetic pickup

ENGINE GOVERNING SYSTEMS

AMBAC INTERNATIONAL

EC 60

INTRODUCTION

The EC 60 speed control unit contains all solid state electronic circuits which sense speed from either a generator or a gasoline engine ignition system and provides a controlled output current to a proportional electric actuator for throttle control.

The performance of the speed control unit is isochronous. The speed is adjustable via a 22-turn speed adjust control. The gain control adjusts the speed of response. The stability control and dead time compensation capacitor are used to match the time constant of the speed controller to the actuator and engine. A speed anticipation circuit is provided to minimize over-shooting on engine start-up. A wide range of speed signal inputs and DC supply voltage amplitudes can be accepted. If the input speed signal is lost, the speed control unit will sense this and shut down the system.

SPECIFICATIONS

VARIATIONS

- EC 60A3 ..... 12V, 50/60 Hz unit
  EC 60A4 ..... 24V, 50/60 Hz unit
- Frequency Range (Speed Sensing) ..... 45 to 130 Hz
- Remote Speed Trim Range ..... 15 Hz
- EC 60B3..... 12V, 400 Hz unit
  EC 60B4 ..... 24V, 400 Hz unit
- Frequency Range (Speed Sensing) ..... 200 to 500 Hz
- Remote Speed Trim Range ..... 250 Hz

OPERATION

- Governing Mode ..... Isochronous
- Steady State Stability ..... ± 0.25% or better
- Speed Drift with Temperature ..... ± 1% maximum

POWER INPUT

- Speed Sensor Signal to Speed Controller ..... 4-30 volts rms, 3mA
- Supply ..... 12-30 VDC (transient voltage protection)
- Polarity ..... Negative ground
- Power Consumption ..... 24mA (continuous) plus actuator current
- Maximum Actuator Controllable Current ..... 4 Amperes continuous

ENVIRONMENTAL

- Temperature Range ..... -40° to + 65C (-40° to +150°F)
- Relative Humidity ..... up to 100%
- Case ..... Fungus proof and corrosion resistant

PHYSICAL

- Dimensions ..... See Figure 1
- Weight ..... 0.2 kgs. (0.5 lbs.)
- Mounting ..... Any position
- Electrical Connections ..... Pigtail barrier strip connector provided

RELIABILITY

- Tested 100%
- Vibration ..... Printed circuit board is encapsulated

ACCESSORIES

- FU 411369 ..... Holder w/electronic fuse for 12 volt systems
- FU 411368 ..... Holder w/electronic fuse for 24 volt systems
- FU 411367 ..... Electronic fuse for 12 volt systems
- FU 411366 ..... Electronic fuse for 24 volt systems
- MP 411446 ..... Spark plug sensor

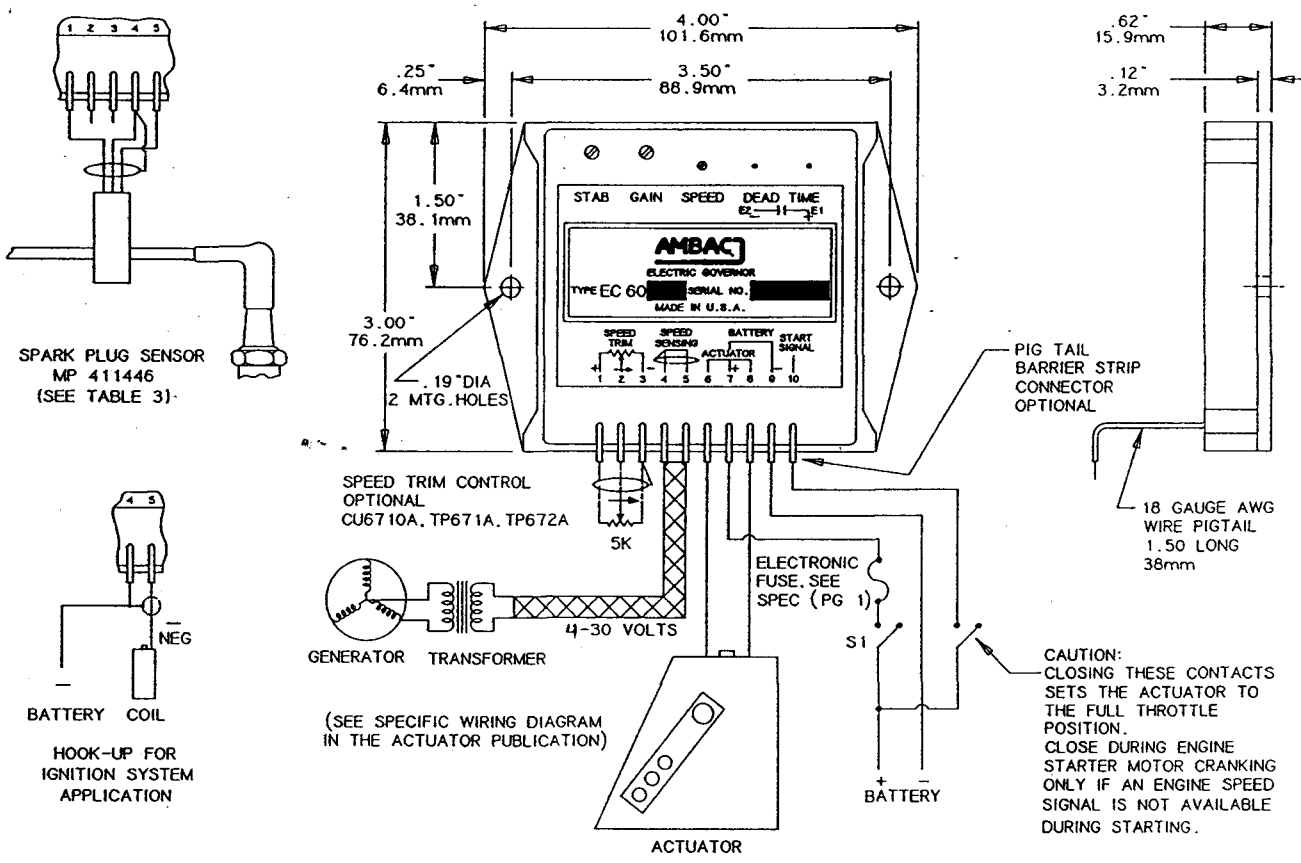


Figure 1 - EC60 Speed Controller Dimensions and Wiring Connections

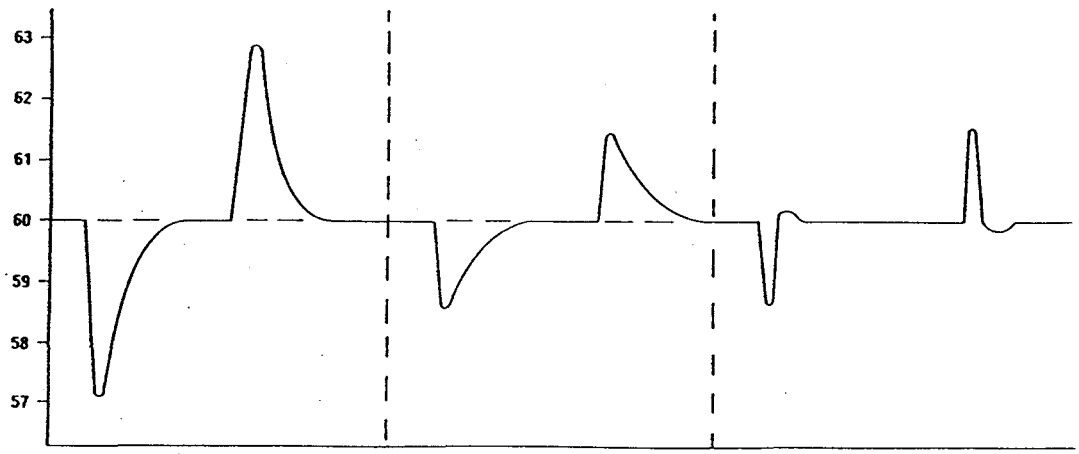


Figure 2 - Typical Performance Chart

ENGINE GOVERNING SYSTEMS

AMBAC INTERNATIONAL

EC 60

DESCRIPTION

The control circuits are designed to operate directly from a 12 or 24 VDC battery system. The engine speed signal is obtained from either the generator or gasoline ignition system. The speed control unit will accept any signal if the frequency is proportional to engine speed and in the frequency range of the speed control unit (above 2 Hz to run, 45 to 130 Hz to govern). The signal strength must also be within the range of the input amplifier (4 to 30 volts RMS).

For an ignition coil sensing system, terminal "5" should be connected to the coil (-) so as to provide a switched battery voltage each time a spark plug is energized or as shown on Figure 1 and Table 3, a spark plug sensor may be used to measure engine speed.

When using one phase of the generator output, a voltage transformer is required for generator voltages above 30 volts, for example, with a 220 volt line to ground generator, a 50:5 transformer should be used as shown in Figure 1.

A speed sensor monitor circuit is used to detect the ignition or generator pulses. If the pulses disappear for longer than 1 second, the speed control unit will turn off the output circuit. Some generators will not provide the 4 volt minimum signal strength during engine starting. For these cases, a start signal input is provided (terminal 10). Once battery voltage is supplied to this signal input, the speed sensor monitoring circuit is disabled, and the actuator will go to full throttle. Once a speed signal is detected, it will immediately regulate the engine speed. To avoid the possibility of excessive engine speeds, should a speed signal not be sensed, a voltage signal should only be supplied to terminal 10 during engine cranking.

A gain control is provided to adjust the speed control unit's sensitivity. A stability control and dead time compensation capacitors match the time constant of the electronic controller to actuator and engine.

The actuator output current switching circuit provides a pulse width modulated current to drive the actuator. The actuator responds to the average current to position the engine throttle. The output of the circuit provides up to 4 amps of continuous current at voltages up to 30 VDC. The output is suitable to drive AMBAC's AGB, AGD, AGS, AGK130, AGK200, and AGK500 actuators, as well as those from other manufacturers.

An overshoot limiter circuit minimizes the overshoot of speed on start-up (typically less than 1.5%).

INSTALLATION

The speed control unit is rugged enough for mounting in the control cabinet or engine mounted enclosure. Care should be taken to ensure that the speed control unit is not subjected to extreme heat. If it is expected that water or mist will come in contact with the speed control unit, mount it vertically so that condensation will not accumulate on the speed control unit.

Leads to the battery and the actuator from the speed control unit should be #16, or #14 if over 10 feet long. These are the leads that are connected to terminals 6, 7, 8, and 9 of the speed control unit. A fast acting external fuse (see ACCESSORIES column on page 1) must be in series with terminal 7, the positive (+) battery input terminal. The speed sensor leads are twisted and/or shielded for their entire length and are connected to terminals 4 and/or 5. Connect the shield to terminal 4 only. Do not connect the shield at the speed sensor end. If a remote speed trim control is used, connect it using shielded wire. Connect the shield to terminal 3. Actuator connections should be made according to the actuator publications.

CAUTION:
THE ENGINE SHOULD BE EQUIPPED WITH AN INDEPENDENT OVERSPEED SHUTDOWN MECHANISM TO PREVENT RUNAWAY WHICH CAN CAUSE DAMAGE OR PERSONNEL INJURY.

INITIAL SETTING

Insert an appropriate dead time compensation capacitor in pins E1 and E2. These are located at the top right hand corner of the speed controller. Typical capacitor values for a 50 KW engine running at 1800 rpm are shown on Table 1 below. Smaller engines at higher speeds will require less and vise versa.

Table 1

Actuator	Approximate Capacitance Range (μF)
AGS 50/AGL 100	0 - 10
AGB 130/AGD 130/AGK 130	10 - 22
AGB 200/AGD 200/AGK 200	10 - 22
AGK 500	22 - 68

Capacitor sizes 4.7, 10, 22 and68 μF are provided. These are tantalum 10 WVDC, 12 VDC, 20% surge. Observe polarity when connecting to pins E1 (+) and E2 (-). Capacitive values can be added by soldering additional capacitors to pins E1 and E2 in parallel. Larger actuators which are fitted to larger engines have slower response time and need more compensation. During performance testing, if low frequency (less than 3Hz) instability or surge is encountered, increase the dead time compensation. If high frequency instability is encountered, decrease the compensation.

The speed control unit has been adjusted at the factory for starting conditions and will control the engine at 45Hz. The following adjustments or checks should be made prior to starting the engine:

A. Pre-set the gain, stability and, if used, the external speed trim control to their mid-points.

B. Apply DC power to the engine governing system thru the wiring system by closing the switch S1. The actuator may momentarily move but should remain in the no fuel position.

C. MOMENTARILY connect terminal 8 to terminal 9. This should cause the actuator to snap into the maximum fuel position. If not, check for wiring defects or consult the "Trouble-shooting" Section (Page 5).

INITIAL ENGINE START

Crank the engine. The actuator will move the fuel control to the maximum fuel position as soon as an engine speed signal above 4-volt and 2Hz is sensed or the start signal control switch is closed (see connection to terminal 10 on Figure 1). Once the 4-volt, 2Hz speed signal is sensed via terminals 4 and 5, the input to terminal 10 will be ignored. The engine will be controlled to a preset 45Hz by the speed controller after start-up.

GOVERNOR SPEED ADJUSTMENTS

Increase the engine speed to the desired governed speed by turning the "speed" adjusting screw in a CW direction. If at any time the engine governing system becomes unstable, turn the gain and stability control CCW until the engine is stable.

PERFORMANCE ADJUSTMENTS

Once the engine is at governed speed, the two performance adjustments, gain and stability, can be made as follows:

A. At no load, turn the gain control CW until instability results. Then back-off slightly CCW (1/8 turn) beyond the point where stability returns.

B. Turn the stability control CW until instability results. Then back-off slightly CCW (1/8 turn) beyond the point where stability returns. Excellent performance should result from these adjustments.

C. Load may now be applied to the engine. If necessary, repeat A and B above until optimum performance is obtained. Normally, the critical condition for gain and stability adjustment is at no load.

NOTE: Optimum adjustment of both controls is in the furthest CW position that will result in the best response and stability under all operating conditions. Backing off slightly from the best position achieved during adjustment will allow for changing conditions that may affect the dynamic response of the engine. If a load bank and a recorder are available, use them to verify the performance using Figure 2 as a guide. If a stable system cannot be obtained, refer to the Troubleshooting Section.

The previous procedures should result in a high performance isochronous governed speed control system.

TABLE 2
TROUBLESHOOTING

Symptom: Governor is inoperative or throttle does not move. (Measurements to be made with standard VOM.)

STEP	TERMINALS	NORMAL MEASUREMENT	POSSIBLE CAUSES OF ABNORMAL MEASUREMENTS
1	4, 5	4 to 30 volt rms (AC measurement)	1. Faulty speed sensing signal (transformer or ignition coil). 2. Shorted or improper speed sensing wiring (to the transformer or ignition coil).
2	7, 9	Battery voltage (DC measurement 7+ and 9-)	1. Improper wiring of battery circuit or fuse blown.
3	1, 3	5 volts ± 0.5V from the internal supply (DC measurement 1+ and 3-)	1. Inadequate battery voltage. 2. Short across trim control circuit. 3. Defective speed control unit.
4	8, 9	2 volts maximum but not less than 0.5V while cranking engine. (Voltage to transistor) DC measurement 8+ and 9-)	1. Speed setting lower than cranking speed. 2. Output transistor defective. 3. Error in actuator wiring. 4. Actuator defective.

Erratic or Unstable Governing or Unwanted Droop

If noisy electrical devices are present, such as magnetos, solid state ignition systems, battery chargers or regulators which emit radio frequency interference (RFI), unstable governing or droop may be noticed. The speed control unit has internal filters which provide some protection from radio frequency interference. Excessive levels of RFI must be treated separately. A metal shield placed around the emitting source will help and/or placing the governor harness and speed control unit as far away as possible from the emitting source. Always twist the leads from the speed sensor transformer or ignition coil all the way back to the speed control unit. Shield the speed sensor leads with the shielding connected to terminal "4" of the speed control unit only. If noise is still present, a 1000 micro-Fd (12V) capacitor may be connected across the speed trim control, terminal 1+ to terminal 3-. This will reduce external interference coming from the power supply. When extreme RFI is encountered, it may be necessary to shield battery leads to the speed control unit. The shield should be grounded at terminal "9" of the speed control unit.

TABLE 3

ENGINE SPEED RANGES WITH SPARK PLUG SENSING

o SPARKS ONCE PER REVOLUTION

i.e., - 2 stroke engines
- some small 4 stroke engines

Number of Cylinders Sensed	EC 60A3 RPM Range		EC 60A4 RPM Range	
	Min. (45Hz)	Max. (130Hz)	Min. (200Hz)	Max. (500Hz)
1	2700	7800		
2	1350	3900		
3	900	2600	4000	10000
4	675	1950	3000	7500

o SPARKS ONCE EVERY TWO REVOLUTIONS

i.e., - 4 stroke engines

Number of Cylinders Sensed	EC 60A3 RPM Range	
	Min. (45Hz)	Max. (130Hz)
2	2700	7800
3	1800	5200
4	1350	3900

Note: The speed controller frequency range is from 45 to 130 Hz. Thus, by sensing more than one spark plug, the engine operating range can be lowered. Care must be taken to ensure that the multiple spark plugs sensed have an even firing order, e.g., for a 4-cylinder, 4 stroke engine with a firing order of 1, 3, 4, 2, where it was desired to use 2 sensors for an engine speed range of 2700 to 7800 rpm, only spark plugs 1 and 4 or 3 and 2 could be paired together. Care is needed with VEE configuration engines to avoid the uneven firing from one bank to the other.