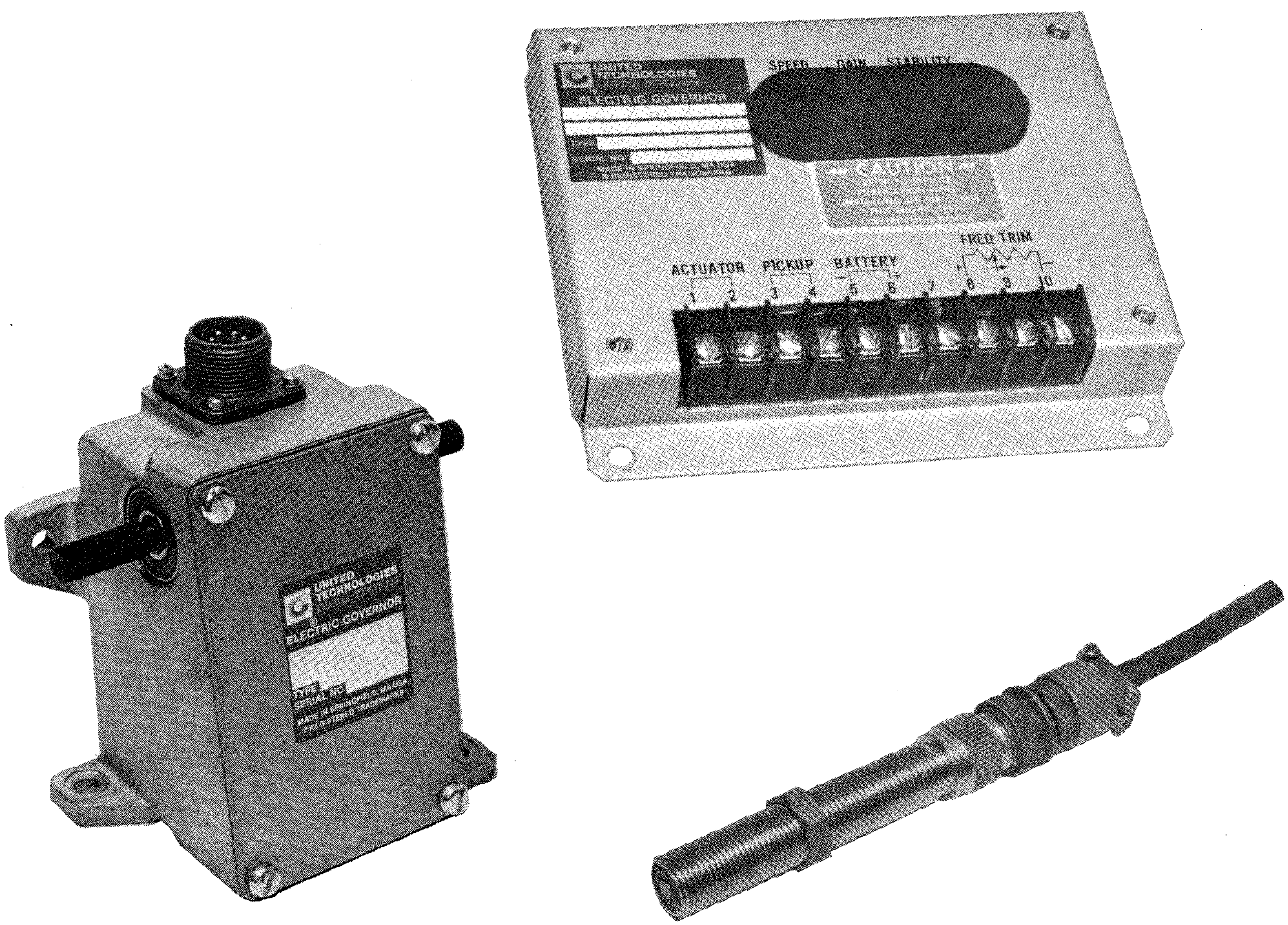
ECD 67-2110 SINGLE ENGINE OPERATION FOR CUMMINS "B" SERIES ENGINES



SYSTEM INTRODUCTION

This publication is provided for applications of the United Technologies Engine Governing Systems to Cummins "B" series engines.

The basic system consists of 3 components: speed control unit, actuator and a magnetic speed sensor.

ECD 67-2110 SPEED CONTROL UNIT

The ECD 67-2000 series speed control unit contains all solid state electronic circuits which sense speed from a magnetic speed sensor or other suitable signal source and, in turn, provides a controlled output current to a proportional electric actuator for throttle control.

The performance of the speed control unit is isochronous. A 6:1 speed range is adjustable via a 22-turn speed adjust control. A gain control to adjust its reponse and a stability control to match the time constant of the engine governing system to the engine are adjustable through the top cover. A speed anticipation circuit is provided to minimize overshooting of speed on engine start-up or from lug-down. Output transistor protection is added to protect against accidental shorts to the terminals of the speed control unit or actuator. Reverse voltage polarity protection is provided by a diode network addressing the battery input terminals. There is a selectable engine idle feature, which may be utilized for engine warm-up or maintenance (optional). Wide tolerances of input signals and DC supply voltages are also featured. If the input signal from the magnetic speed sensor is lost for any reason, the speed control unit will sense this and shutdown the system.

AGB 130 ACTUATOR

The AGB 130 actuator can be used with 12 VDC, 24 VDC, or 32 VDC power supplies. See Page 8 for proper wiring diagrams.

The actuator is a linear electro-magnetic throttle positioning device. It positions the engine throttle, or fuel pump control, according to the amount of current flowing from the speed control unit through the actuator coils. The AGB 130 series Actuator is an ideal choice to govern engines with distributor type pumps (i.e. Roosa Master and CAV).

MAGNETIC SPEED SENSOR

The magnetic speed sensor reponds to the number of ring gear teeth, or other types of ferrous projections, which pass the tip of the speed sensor, by inducing an electrical pulse within the coil. The pulses are then sent into the speed control unit. In effect, the magnetic speed sensor signals the number of teeth per second which pass the tip. This signal is directly proportional to engine speed.

SPECIFICATIONS

ECD 67-2000 SERIES PERFORMANCE OPERATION

- Governing Mode .... Isochronous or Droop, 5% maximum (optional
- Steady-state Stability .... ± 0.25% or better
- Frequency Range .... 1K to 6K Hz continuous
- Speed Drift with Temperature .... ± 1% maximum
- Speed Trim Range .... ± 200 Hz.

POWER INPUT

- Magnetic Speed Sensor Signal .... 0.25-120 VAC volts rms
- Supply .... 10 - 30 VDC (transient and reverse voltage protected)
- Polarity .... Negative Ground (Case isolated)
- Power Consumption .... 60mA (continuous) plus actuator current
- Maximum Controllable Actuator Current at 25 °C (77 °F) .... 10 Amperes

ENVIRONMENTAL

- Temperature Range .... −40° to + 85 °C (−40° to + 180 °F)
- Relative Humidity .... up to 100%
- Case .... Fungus proof and corrosion resistant

PHYSICAL

- Dimensions .... See Figure 1
- Weight .... 0.82 kgs (1.8 lbs)
- Mounting .... Any position (See Installation Page 7)

RELIABILITY

- Tested 100%
- Vibration .... All printed circuit boards are conformally coated

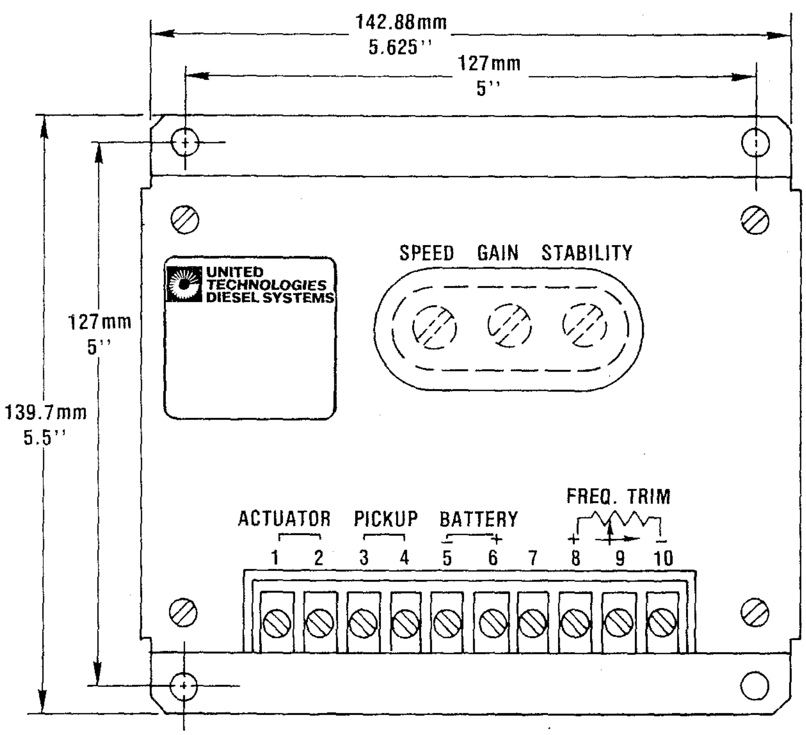


Figure 1.ECD 67-2000 series dimensions

SPECIFICATIONS

AGB-130 ACTUATOR PERFORMANCE

- Work .... 0.35 Joule (0.26 ft - lb)
- Available Torque .... 1.356 Nm (1.0 lbF - ft)
- Maximum Operating Shaft Angular Travel .... 15° CW or CCW

POWER INPUT

- Operating Voltage .... 12, 24 or32 VDC
- Normal Operating Current .... 2A at 12 VDC
  1.5A at 24 or 32 VDC
- Maximum Current (Instantaneous) .... 6A at 12 VDC
  3A at 24 or 32 VDC

ENVIRONMENTAL

- Temperature Range .... −54° to + 95°C (−65° to + 200°F)
- Relative Humidity .... up to 100%
- Case .... Fungus proof and corrosion resistant

PHYSICAL

- Dimensions .... See Figure 2
- Weight .... 1.47 kgs (3.25 lbs)
- Mounting .... Any position (See Installation Page7)

RELIABILITY

- Tested 100%

MATING CONNECTOR

- Use .... EC1249-2 (6 pins)/MS3106R14S-6S
- Wiring harness .... 12 V - CB 679A, 6711A
  24V - CB 6712A, 6714A, 6716A

BALL BEARING ROD ENDS AND LEVERS

- For a ¼-28 linkage rod and the hole to attach it to the lever is for a ¼" bolt BG671
- For ¼" holes .... LE 673-2A
- For a 10-32 linkage rod and the hole to attach it to the lever is for a #10 bolt BG672
- For #10 holes .... LE 673-1A

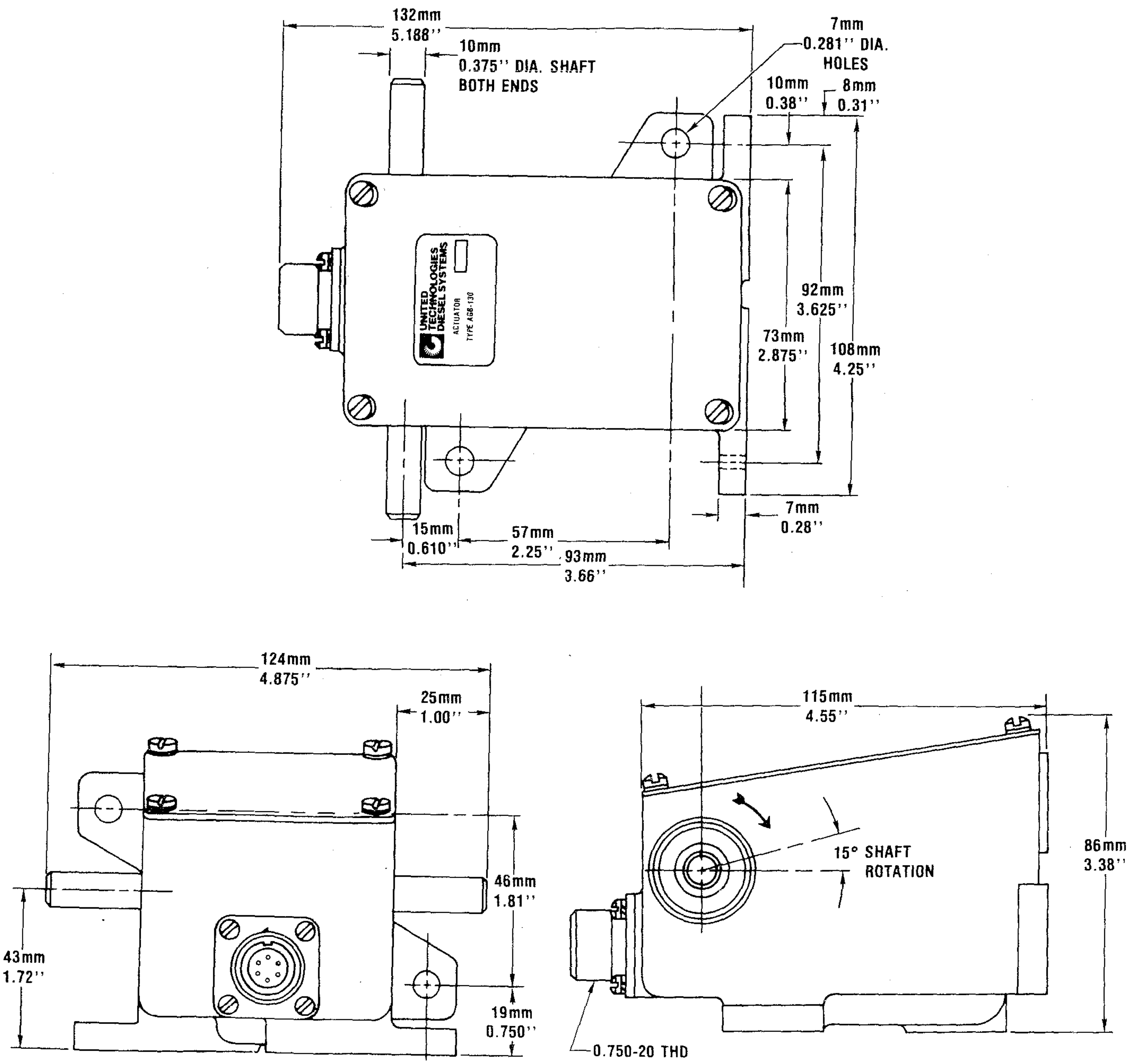


Figure 2. AGB 130 actuator dimensions

SPECIFICATIONS

MAGNETIC SPEED SENSOR

- Dimensions (Unshielded) .... See Figure 3 and Table A
- Thread Size .... 5/8 - 18 UNF-2A
- Tap Drill Size .... 37/64"
- Proximity to Gear Teeth .... 0.75mm (0.030 in.)
- Temperature Range .... −55° to + 105°C (− 65° to + 225°F)
- Output .... 0.50 to 30 volts RMS is recommended to input to the speed control unit
- Resistance .... 50 to 500 ohms

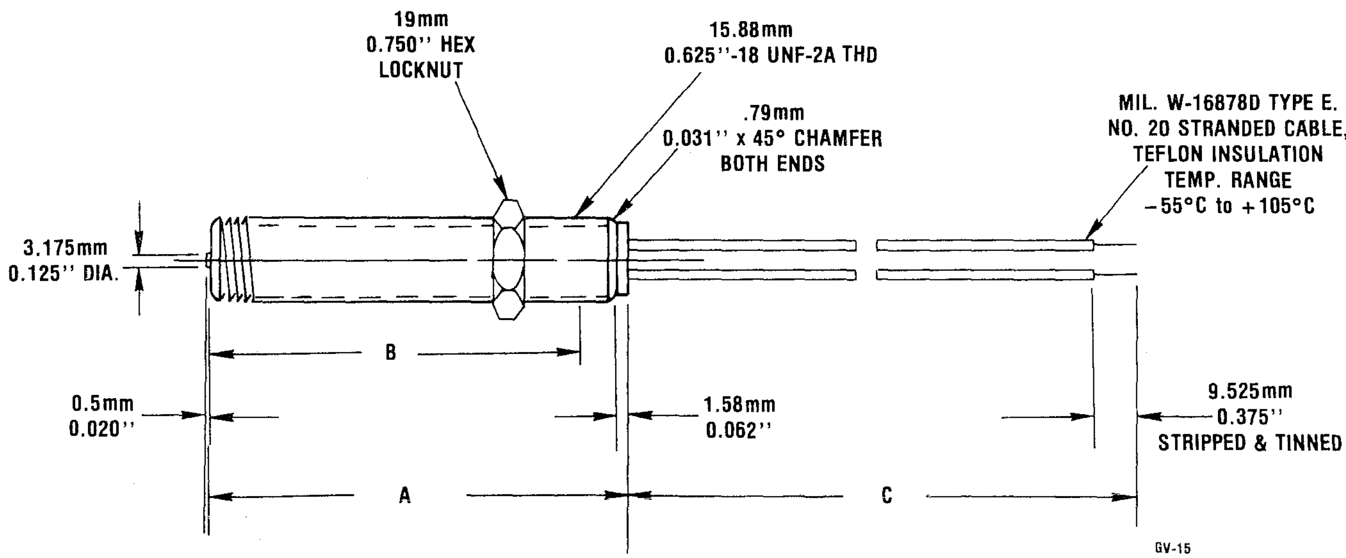


Figure 3. Unshielded magnetic speed sensor dimensions

CAT NO.	DIMENSION A	DIMENSION B MAX. USABLE THREAD LENGTH	DIMENSION C WIRE LEAD LENGTH
MP 675	76mm 3 inches	67mm 2-5/8 inches	305mm 12 inches

Table A
Unshielded magnetic speed sensor dimensions

SYSTEM DESCRIPTION

SPEED CONTROL UNIT

The speed control unit circuits are designed to operate directly from a 12 or 24 VDC battery system. An internal 10 volt regulator supplies all DC power to the speed control circuits.

The engine speed signal is usually obtained from a magnetic speed sensor mounted in close proximity to the teeth of a ferrous gear that is driven by the engine. The frequency of the speed sensor signal is proportional to the engine speed. The flywheel ring gear is normally used because of the high frequency pick up signal. The speed control unit will accept any signal if the frequency is proportional to the engine speed, and in the frequency range of the speed control unit (1K to 6K Hz). The signal strength must also be within the range of the input amplifier (0.25 volts rms to 120 volts rms for approximately sinusoidal signals). When a magnetic speed sensor is used, it is connnected to terminals "3" and "4". The speed control unit has an input impedance of 10,000 ohms between terminal "3" and terminal "4". Terminal "4" is connected internally to the battery negative.

The speed sensor signal is amplified and shaped by the circuits. The signal from the speed sensor amplifier section of the control unit are then fed to a summing circuit (see Figure 4). A speed sensor monitor circuit detects the pulses and, if the pulses disappear for longer than 0.1 second, the speed control unit will turn off the output circuit (current to actuator). This feature can be voided by connecting a jumper across posts A and B as shown in Figure 4. In this way the governor will call for full fuel as soon as battery power is applied. During cranking, the actuator will move to full fuel position and remain there during starting and acceleration of the engine. The summing point of the speed sensor and the speed adjust control is the input to the dynamic control section of the speed control unit. A gain control is provided to adjust the speed control unit sensitivity. The gain is usually advanced (CW) as far as possible for best performance without instability. (See adjustment procedure Page11). The gain control has a non-linear range of 33:1. The dynamic control circuit has a control function that will provide isochronous and stable performance from almost all types of engine systems. The stability control will match the constants of engines with a wide variety of characteristics.

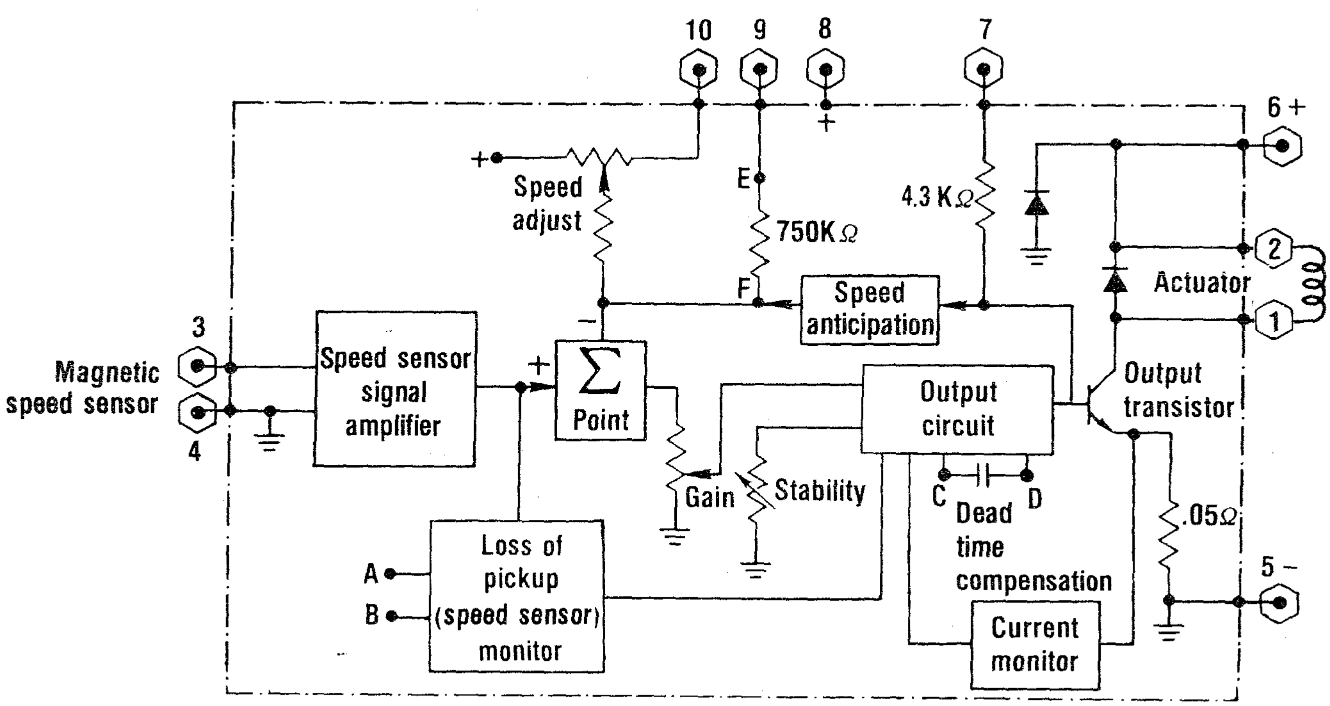


Figure 4. Functional schematic

The output actuator current switching circuit provides current to drive the actuator. The output transistor is alternately switched off and on at a frequency of 400 Hz. which is well beyond the natural frequency of the actuator, hence no visible motion from the switching results. The actuator responds to the average current to position the engine throttle. The output transistor is switched to reduce its internal power dissipation. The output of the circuit provides up to 12 amps instantaneously at voltages up to 30 VDC. The output is suitable to drive either the AGB actuator or a similar proportional electric actuator. An internal current monitor circuit is designed to turn off the output circuit (latches) if actuator currents exceed 15 amps.

Excellent start-up performance is assured via a speed anticipation circuit which minimizes the overshoot of speed on start-up (typically less than 1.5%).

ACTUATOR

The AC frequency signal (proportional to speed) generated by a magnetic speed sensor is constantly fed into the speed control unit and compared with a preset frequency. If the frequencies do not remain identical, a change in current from the speed control unit changes the magnetic force in the actuator which, in turn, causes angular rotation of the actuator shaft. Shaft rotation is proportional to the amount of current flowing through the actuator and is counterbalanced by the internal springs. The actuator housing is sealed against engine environment with gaskets at all openings so steam or other water based cleaning will not affect the system's operation. **No maintenance is necessary.**

SYSTEM INSTALLATION

SPEED CONTROL UNIT

The speed control unit is rugged enough for mounting in the control cabinet or engine mounted enclosure. Care should be taken to insure that the speed control unit is not subjected to extreme heat, as the life of electronic devices is always related to heat. If it is expected that water or mist will come in contact with the speed control unit, mount it vertically so the condensation will not accumulate in the speed control unit. Wiring to the speed control unit should as shown in Figure 5.

Leads to the battery and the actuator from the speed control unit should be #16 or larger. These are the leads that are connected to terminals 1, 2, 5, and 6 of the speed control unit. An external fuse or circuit breaker is recommended in series with terminal 5, the positive (+) battery input terminal. The magnetic speed sensor leads are twisted and/or shielded for their entire length. Connect leads to terminals 3 and 4. Connect the shield to terminal 4 **only.** Do not connect the shield at the magnetic speed sensor end.

MAGNETIC SPEED SENSOR

The speed sensor is mounted in the gear case or flywheel bell housing. The speed sensor can be screwed in (with the engine stopped) until the tip strikes the top of the gear tooth, then backed out ¾ of a turn and secure it by the locknut. The threaded hole should be relatively perpendicular to the centerline of the crankshaft and a spot face should be provided for a flat surface to anchor the locknut securely. Any ferrous gear may be used as long as the frequency and amplitude meet the speed control unit specification.

The wire leads from the speed sensor should be twisted for their entire length up to the speed control unit. The speed sensor leads may need to be shielded if they are exceptionally long 3 meters (10 ft.) or if external interference from spark ignited engines or external equipment is encountered.

Do not ground either of the speed sensor leads. Only the shielded wire is to be grounded, fused, to one specific terminal on the speed control unit. One of the speed sensor input terminals on the speed control unit is commonly connected to ground and should be utilized for the shield connection. The shield should not be connected at the speed sensor end.

ACTUATOR

The actuator should be mounted as closely as possible to the throttle lever on the engine. The lever on the actuator should be as nearly parallel to the throttle lever as possible at mid throttle position. The ball joints will accomodate a maximum of 10° misalignment. Low friction is mandatory and light weight linkage should be used to provide optimum control.

The proper setup of linkage is one of the most important adjustments of a total engine governing system. The speed control unit increases actuator current to control the engine in the full fuel direction and spring force acts to control the engine in the fuel shutoff direction. A proper linkage arrangement will allow the actuator to control the throttle at zero throttle and full throttle with some excess travel beyond these positions for shutoff and full fuel respectively.

The leads from the speed control unit to the actuator should be at least #18 wire for 24 volt and 32 volt operation and #16 wire for 12 volt operation.

12 VOLT OPERATION

Connect the following actuator terminals together with jumpers at the mating half of the connector (see Figure 6).
1. A to C
2. B to D
3. A & D to their respective terminals at the speed control unit (SEE TABLE B).

24 VOLT OPERATION

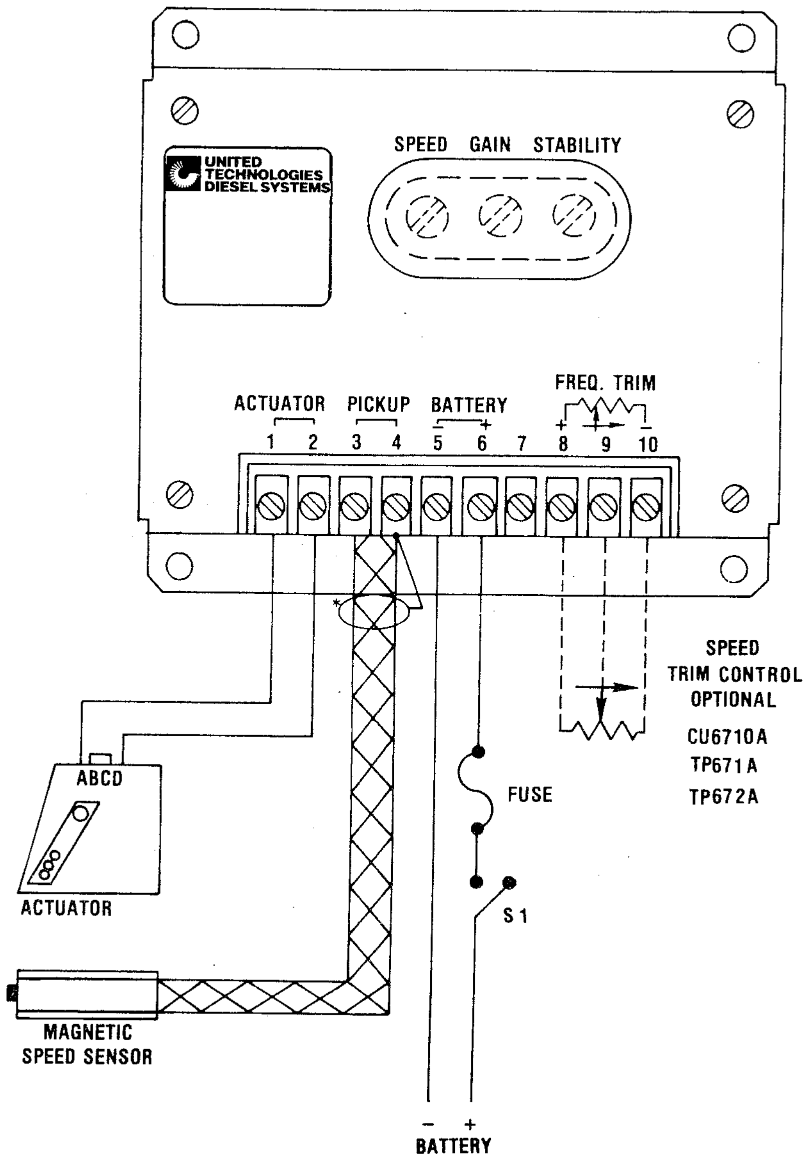
Connect the following actuator terminals together with jumpers at the mating half of the connector (see Figure 7).
1. B to C
2. A & D to their respective terminals at the speed control unit (SEE TABLE B).

SPEED CONTROL UNIT	ACTUATOR TERMINALS		
	A	D	
CU 671C SERIES	B	D	"C" SERIES SPEED CONTROLS
CU 673C SERIES	B	D	
ECQ 1000 SERIES	1	2	ULTRA PRECISE
ECD 67-2000 SERIES	1	2	STANDARD CONTROL
ECD 67-5111 ABOVE SN 23000	A	B	STANDARD CONTROL WITH DROOP CAPABILITY
ECD 67-5221	A	B	STANDARD CONTROL WITH DROOP AND OVER SPEED CAPABILITY

NOTE: See Speed control unit literature specifications for proper operating voltage.

Table B

Wiring chart for AGB 130 actuators



*NOTE: A SHIELDED CABLE SHOULD BE USED IF LEADS ARE LONGER THAN 3 METERS (10 FT.). GROUND SHIELD AT ONE END ONLY.

Figure 5. Wiring to ECD 67-Series speed control unit

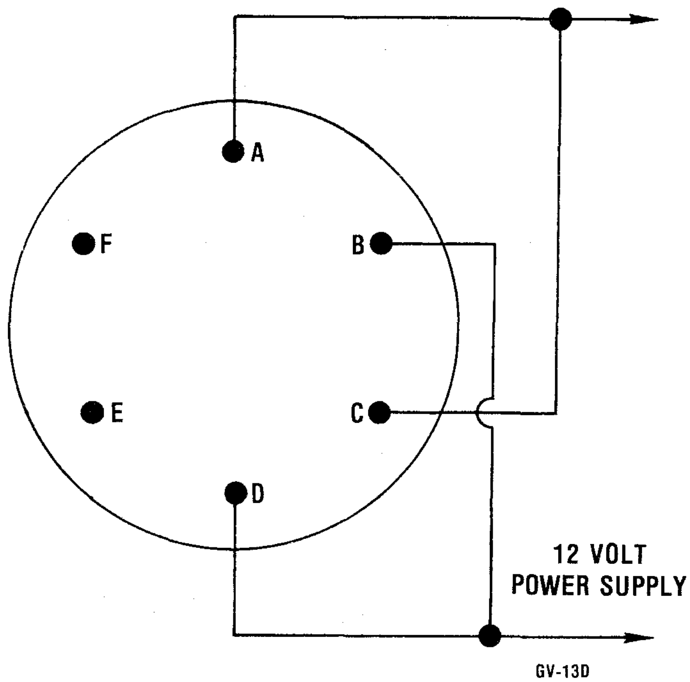


Figure 6. Wiring to AGB 130 actuator for 12 volt operation

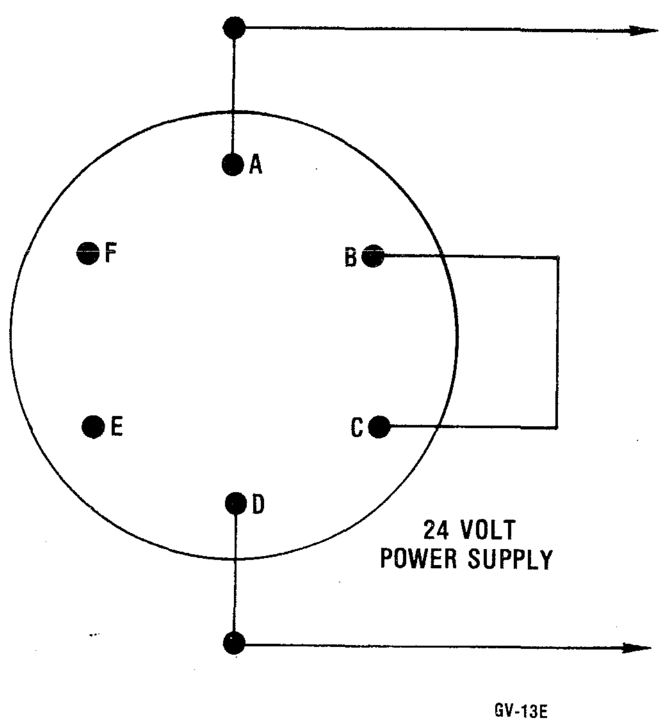


Figure 7. Wiring to AGB 130 actuator for 24 volt operation

SYSTEM ADJUSTMENTS

SPEED CONTROL UNIT

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

STARTING THE ENGINE INITIALLY

The speed control unit has been adjusted at the factory for starting conditions and will control the engine at approximately idle speed (1000 Hz. speed sensor signal). 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 1 to terminal 5. This should cause the actuator to snap into the maximum fuel position. If not, check for wiring defects or consult the "Trouble-shooting" Section.

Crank the engine. During cranking, the actuator will move the fuel control to the maximum fuel position. Once started, the engine will be controlled at a low speed by the pump governing system.

GOVERNOR SPEED ADJUSTMENTS

Increase the engine speed to the desired governed speed by turning the "speed adjust" control in a CW direction. If used, final precise speed adjustment may be made with the external Speed Trim control. If at any time the engine governing system becomes unstable, turn the gain and stability controls 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:

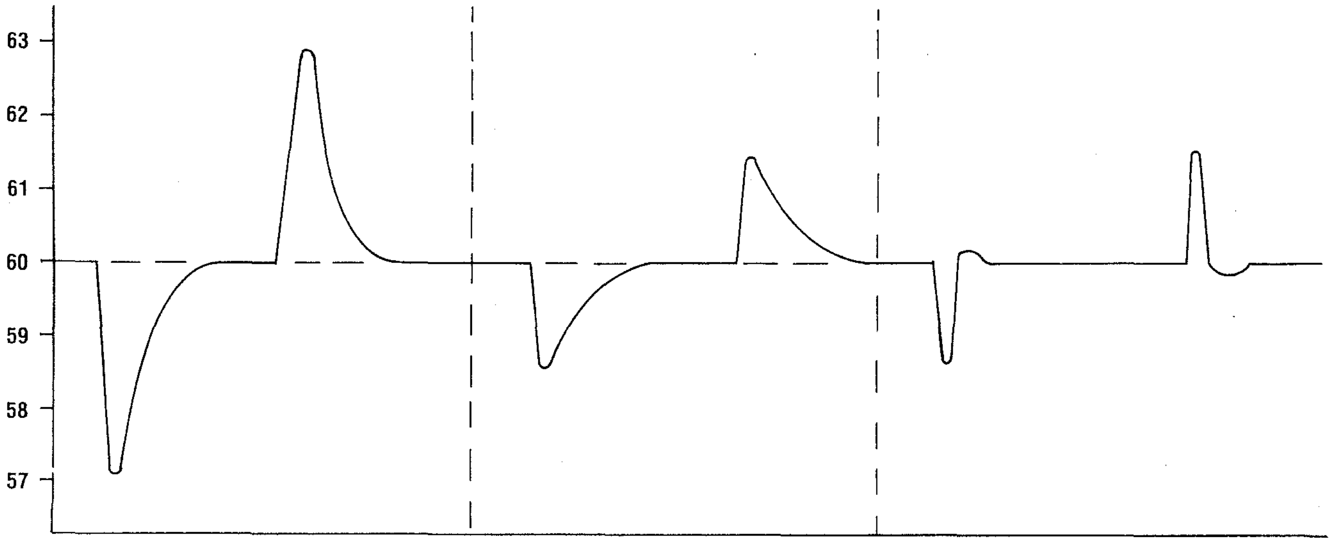
A. At no load, turn the gain control CW until instability results. Then back-off slightly CCW (1/8 turn) beyond the point where stability returns.

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, without causing instability and will result in the best response and stability under all operating conditions. Backing off slightly from this position 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 8 as a guide. If a stable system cannot be obtained, refer to the "Trouble-shooting Section".

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



INITIAL GAIN AND STABILITY CONTROL ADJUSTMENTS GIVE A TRACE INDICATING, FROM THE EXCURSION OF THE TRANSIENT, THE GAIN SHOULD BE INCREASED BY TURNING THE GAIN CONTROL CW. NOTE: TIME IS CONSTANT FOR ALL CONDITIONS.

INCREASED GAIN RESULTED IN A NEW TRANSIENT WITH REDUCED EXCURSION. IT IS APPARENT FROM THE LONG TAIL ON THE TRANSIENT THAT THE STABILITY CONTROL MUST BE TURNED CW.

READJUSTING BOTH GAIN AND STABILITY CONTROLS GIVES A TRACE, INDICATING GOOD TRANSIENT AT FULL LOAD AND GOOD STABILITY. THE SPEED CONTROL UNIT IS NOW PROPERLY ADJUSTED.

EG-10

Figure 8. Typical performance chart

ACTUATOR

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

The DTA fuel pump has 2 levers the one closest to the pump drive is the mechanical governor operating lever and the rear lever is a shut down lever. The electric actuator is intended to be used on the mechanical governor operating lever so the electric governor will be trimming the mechanical governor of the pump. An isochronous system with improved transient reponse will result. The shut off lever is not intended to be used for governing as its design is not rated for continuous duty. (Improved pump covers are available from CAV distributors.)

The linkage from the AGB 130 actuator is connected to the fuel pump operating lever so that with the electric actuator lever at min fuel the engine will run at about 1700 rpm and when the actuator is pushed to full fuel the engine speed will be about 1900 rpm's. This will correspond to allowing the actuator to run in the middle of its range and to obtain the actuator currents shown below.

Exact readings of speed are unimportant only a range of control which is centered so that at half load the actuator is in the middle of its stroke and some margin exists at each end (no load and full load).

AGB 130 ACTUATOR		
	12 VOLT	24 VOLT
No Load	2 amps, 5 volts	1 amp, 10 volts
Full Load	4 amps, 11 volts	2 amps, 20 volts

TROUBLESHOOTING

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	3-4	0.5 volts rms minimum while cranking engine (AC measurement)	1. Gap too large between magnetic speed sensor and gear teeth. 2. Shorted or improper wiring to magnetic speed sensor 3. Defective magnetic speed sensor
2	5-6	Battery voltage (DC measurement 5 – and 6 +)	1. Improper wiring of battery circuit or fuse blown.
3	8-10	10 volts ± 0.5 V. from the internal supply (DC measurement 8 + and 10 –)	1. Inadequate battery voltage. 2. Short across trim control circuit. 3. Defective speed control unit.
4	5-7	4.5V., ± 1V (control energized only(12.5V., ± 1V (while cranking engine DC measurement) (5 – and 7 +)	1. Magnetic speed sensor fail safe feature defective. 2. Defective speed control unit.
5	1-5	2 volts maximum but not less than 0.5V while cranking engine - voltage to transistor (DC measurement 1 + and 5 –)	1. Speed setting lower than cranking speed. 2. Output transistor defective. 3. Error in actuator wiring. 4. Actuator defective.

NOTE: If no measurements can be made as indicated in Steps 3, 4 and 5, the possible cause may be a damaged circuit board. Check continuity of terminals 2 and 6. If open, CORRECT BATTERY SUPPLY POLARITY CONNECTIONS and add an external jumper connection between terminals 2 and 6.

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 magnetic speed sensor 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.** Raise the magnetic speed sensor voltage by reducing the gap between the speed sensor and the ring gear. A gap of 0.020" will provide a strong signal. If noise is still present, a capacitor (1,000 mfd, 12-20 volts) may be connected across the speed trim control, terminal 8 + to terminal 10 –. 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 "5" of the speed control unit.

Periodic Instability (Extra Dead Time Compensation)

Each engine has certain response characteristics to which the engine governing system must be adjusted to match. The increase or decrease of speed, as load on the engine changes, can be reduced to a minimum by proper adjustment of the gain control See performance adjustments, Page 11.

A capacitor, 10 mfd, 10 volt (polarized), may be connected from post C (–) to post D (+) to increase the dead time compensation. (See Figure 4.) Dead time is the time between power strokes plus fuel system delays which can cause slow periodic oscillations or instability when the dead time becomes excessive.