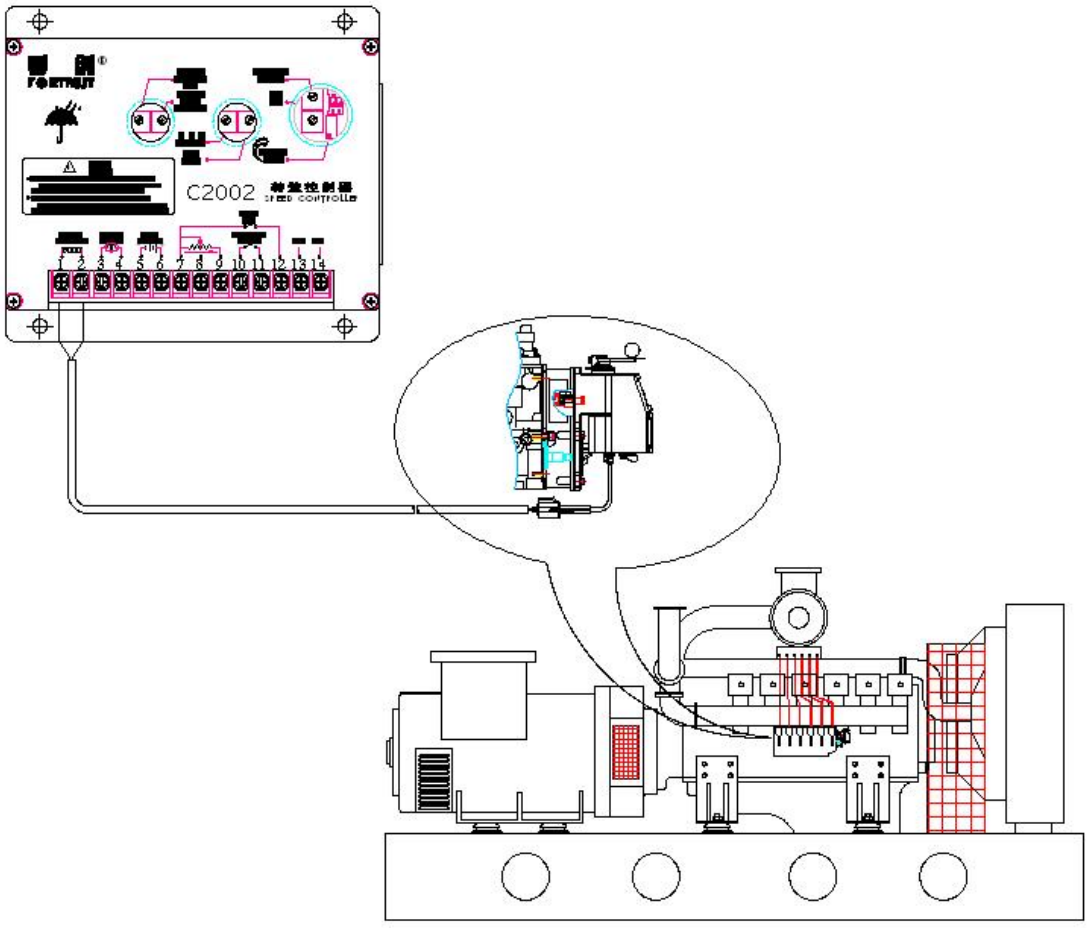
孚创®
FORTRUST

ESG2002 系列

电 子 调 速 器

使 用 说 明 书



上海孚创动力电器有限公司

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1 电子调速器工作原理

发动机调速器是将发动机稳定控制在设定工作转速下运行的精密控制装置。电子调速器因其性能可靠、功能齐全、安装维护方便以及调速性能优异等有别于其它类型调速器的独特优势，正越来越广泛地应用于发动机调速系统、发电机组监控系统之中，成为行业应用的一种发展趋势。

电子调速器具有转速设定、测速、比较、运算、驱动输出、执行元件、调节系数设定、保护或限制等机构或部件，各机构或部件经过有效组合形成一个闭环控制系统(如图 1.1 所示)：

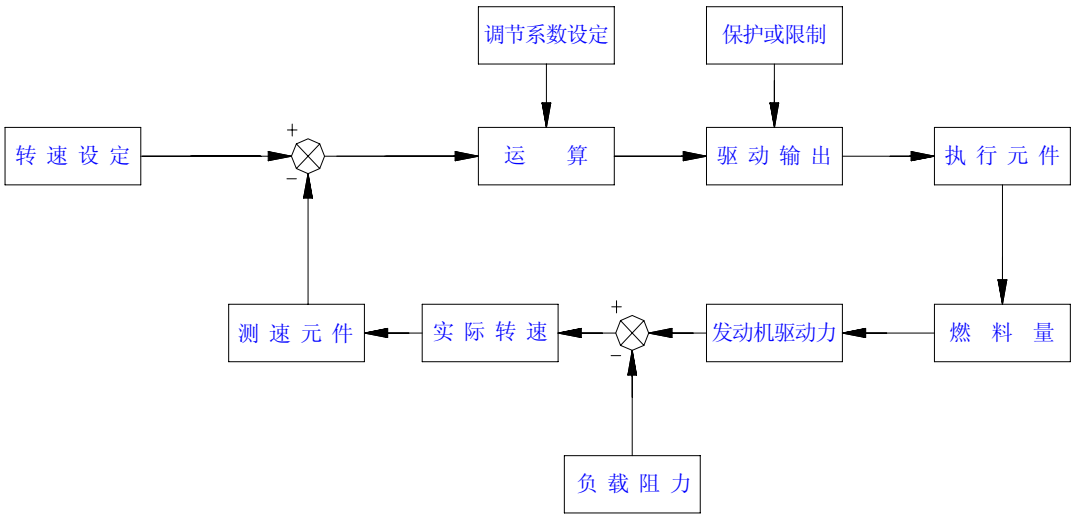


图 1.1 调速器原理示意图

电子调速器的闭环控制方式能够对发动机瞬间负荷变化产生快速和精确的响应，用以控制发动机的转速。通过手动调整控制器增益、稳定性以及稳态调速率电位器可满足不同发动机对于稳态调速率、瞬态调速率和稳定时间的需求。

2 电子调速系统的组成

2.1 转速控制器

2.1.1 基本电气特性

☑ 电源电压： DC12V（范围 9V～16V）

☑ 电源消耗： ＜ 0.1A（不包括执行器）

☑ 转速波动率：≤ ±0.25 %

☑ 稳态调速率：0～5 % 可调

☑ 环境温度： -40℃～ +85℃

☑ 环境湿度： ＜ 95%

2.1.2 C2002 转速控制器外形及安装尺寸

转速控制器安装在控制箱或固定在发动机其它外围设备上，安装时应尽量选择空气干燥，温度适宜的地方安装，如果应用在水和湿气比重较大的地方应将控制器垂直安装。安装尺寸图如图 2.1 所示。

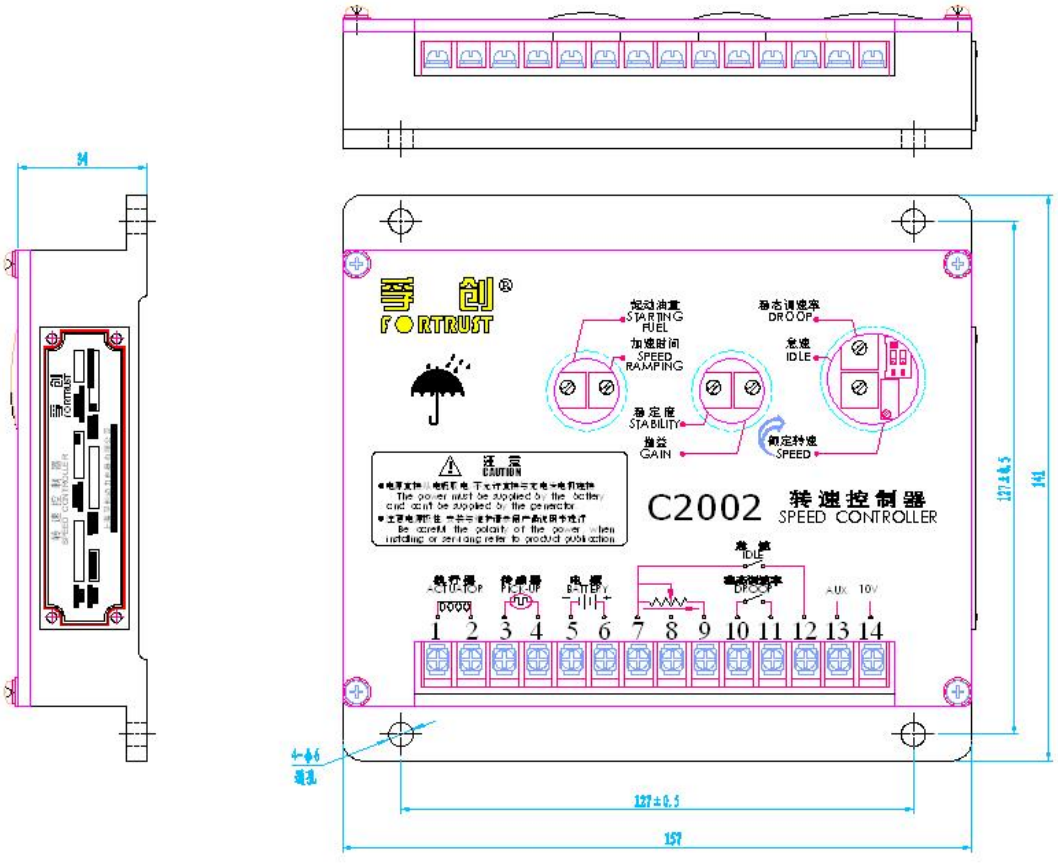


图 2.1 C2002 转速控制器外形及安装尺寸图

2.1.3 C2002 转速控制器接线图

控制器接线请参照图 2.2 转速控制器接线图。

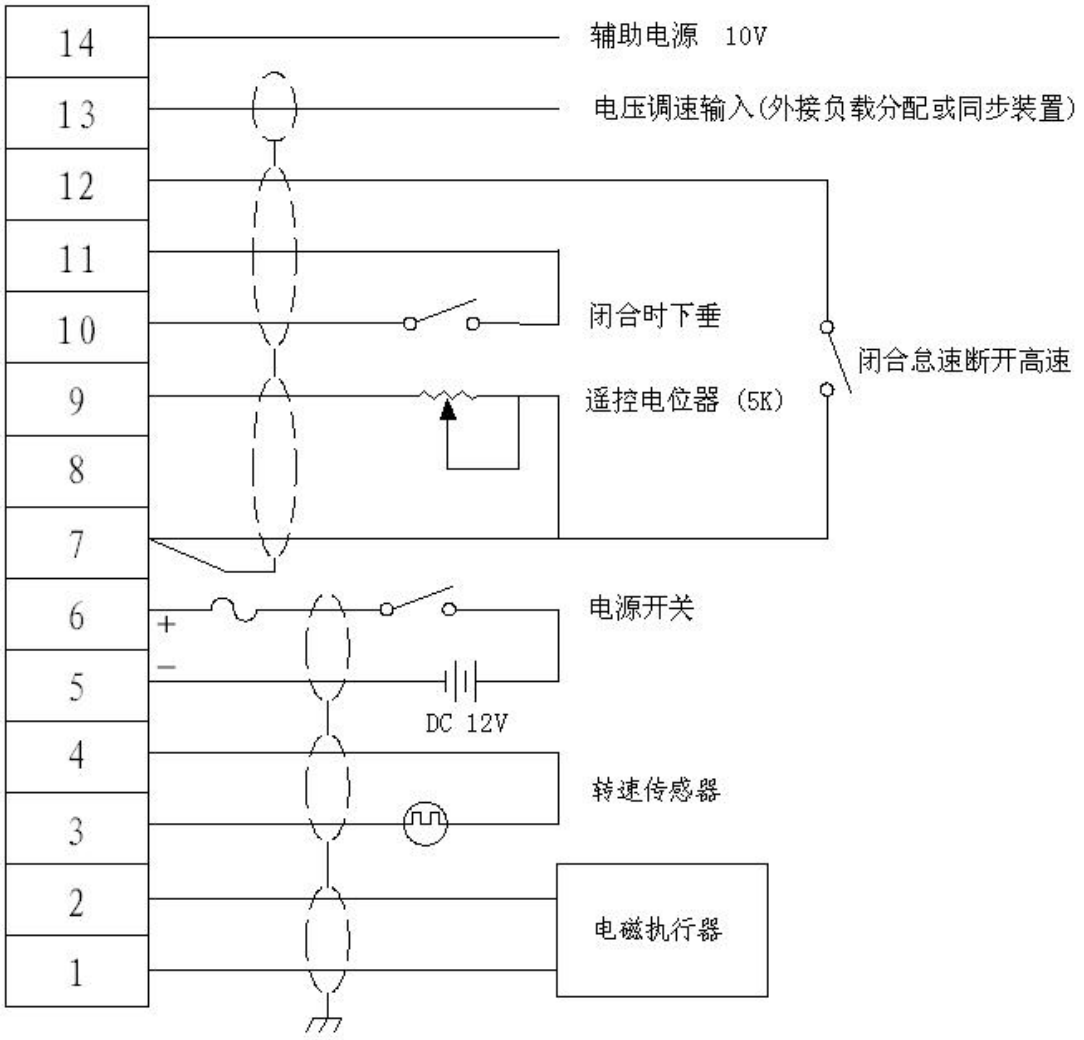


图 2.2 C2002 转速控制器接线图

1 、 2 端子接执行器，5、6 端子接电瓶，这两组线要求截面 1.3 mm² 或更粗的线．线越长要求线径越粗，以减小压降．电池组正极（即端子 6 ）应串接 15A 的保险丝；

3、4 端子接速度传感器，速度传感器必须用屏蔽线缆，线缆的屏蔽部分应接到端子 4 上，但不可与其它部分相连接，否则干扰信号可能进入速度控制器；

7、9 端子接转速微调电位器，电位器阻值为 5K，调速范围可达到 2400HZ；

10、11 端子接稳态调速率开关，断开稳态调速率为 0，闭合后通过调整控制器上稳态调速率电位器可将稳态调速率设定在 0-5%范围内；

7、12 端子接高/低速开关，闭合时为怠速，断开后升至额定转速；

13 端子接电压调速装置，可直接接入同步控制器和负载分配器完成自动并车和自动负载分配功能，单机运行时可不接；

14 端子外供 10V/20mA 电源，但在使用中如发生短路或超负荷使用将损坏控制器。

电磁执行器 Electromagnetic Actuator

2.2 电磁执行器

电磁执行器是电调系统的执行机构，ESG2002 系列为单闭环控制方式，可匹配的执行器 A900C-W、A800C-W、A1000C-W-d1、A2000C-W-d1，安装方式多样，可根据用户不同的需求进行选配。

2.2.1 A900C-W 电磁执行器

☑ 电源电压：DC24V（范围 21V～28V）

☑ 工作能力： 0.9 N.m

☑ 工作行程： 22.5 mm

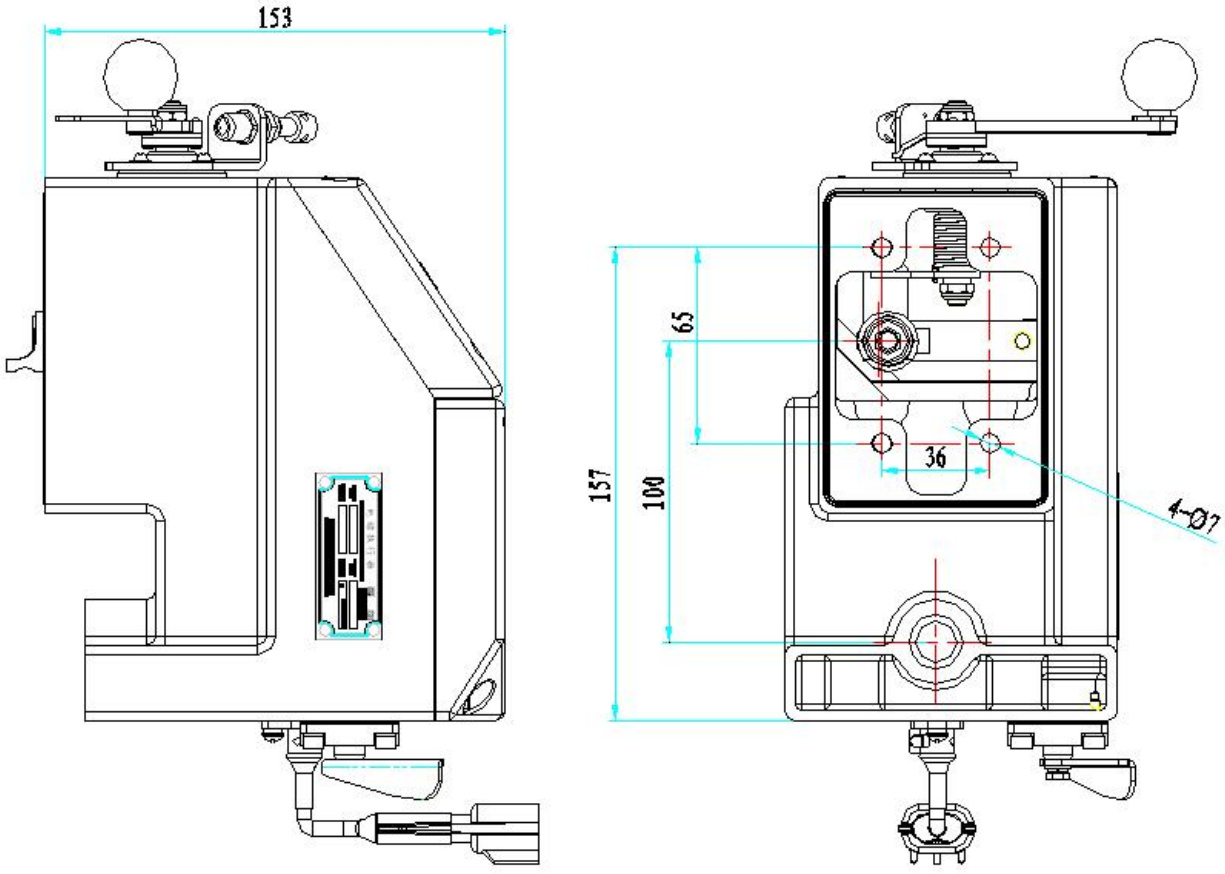


图 2.3 A900C-W 电磁执行器外形及安装尺寸图

2.2.2 A800C-W 电磁执行器

☑ 电源电压：DC24V（范围 21V～28V）

☑ 工作能力： 0.8N.m

☑ 工作行程： 17mm

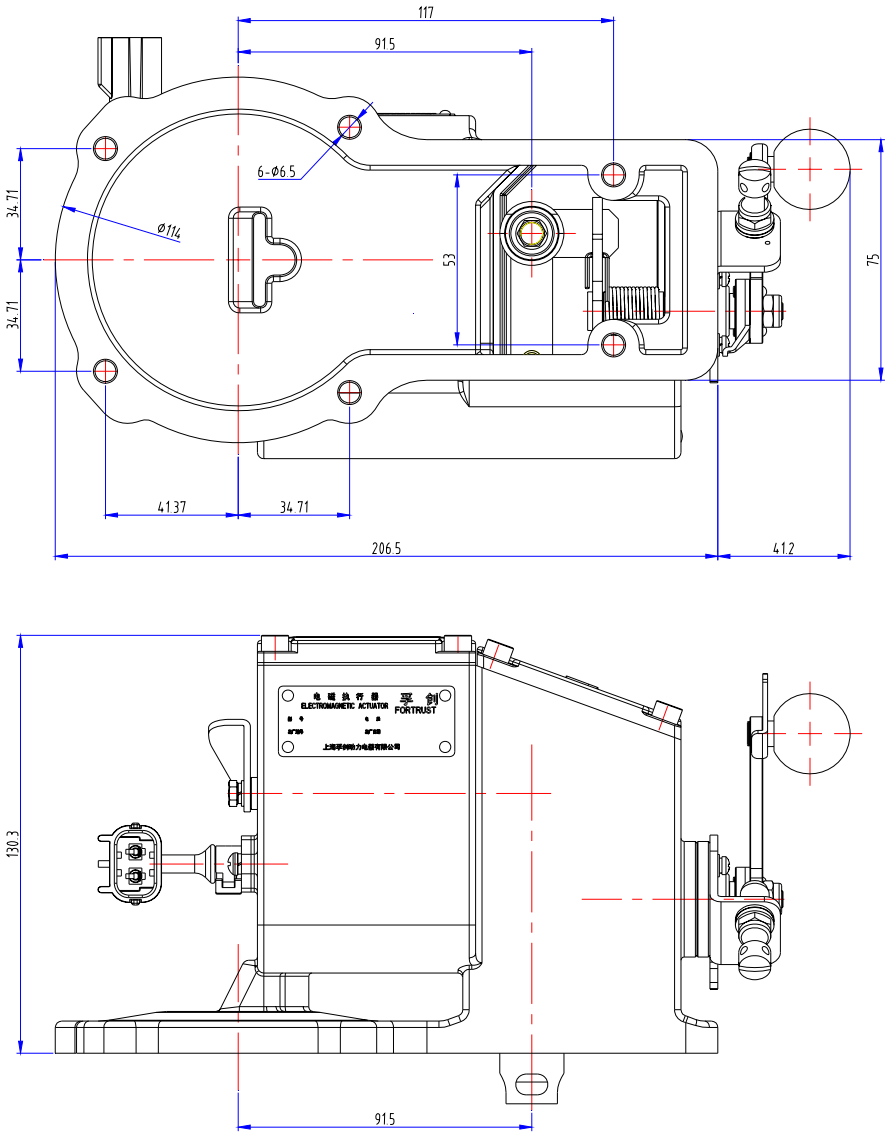


图 2.4 A800C-W 电磁执行器外形及安装尺寸图

2.2.3 A1000C-W-d1 电磁执行器

☑ 电源电压：DC24V、DC12V 可选（订货时注明）

☑ 工作能力： 1 N.m

☑ 工作行程： 18 mm

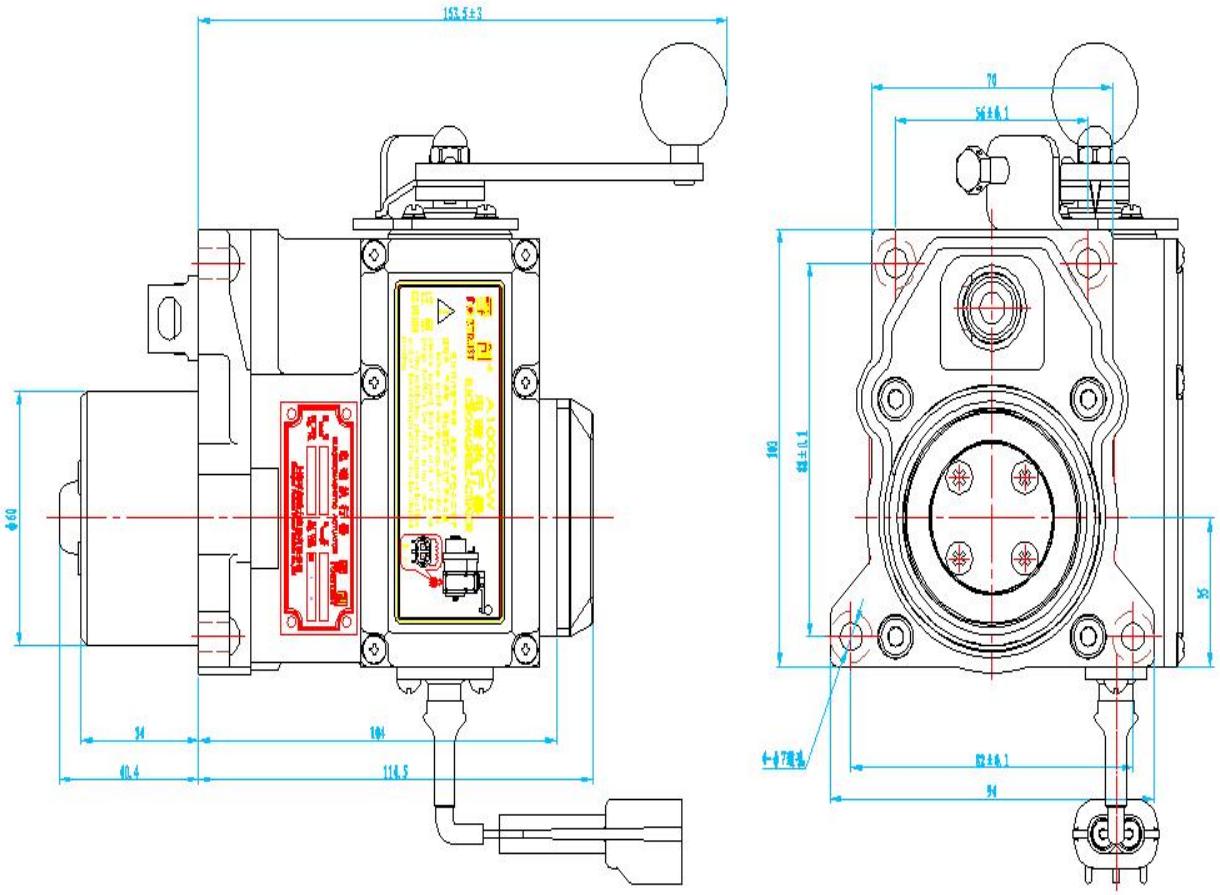


图 2.5 A1000C-W-d1 电磁执行器外形及安装尺寸图

2.2.4 A2000C-W-d1 电磁执行器

☑ 电源电压：DC24V

☑ 工作能力： 2 N.m

☑ 工作行程： 18 mm

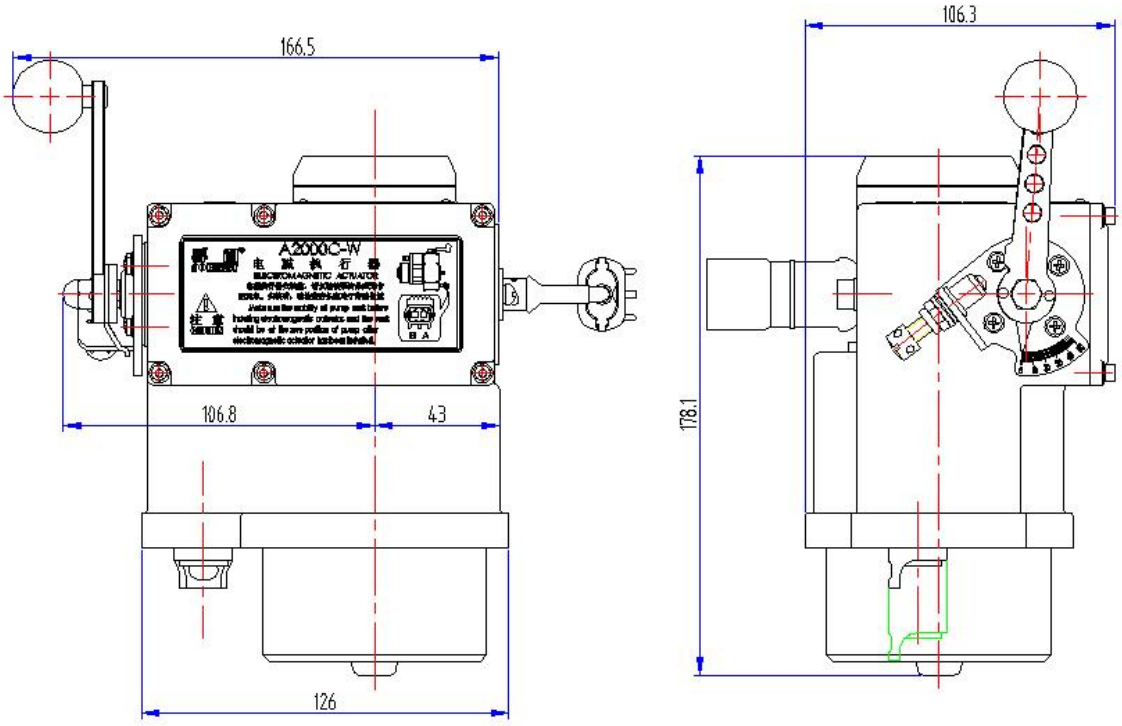


图 2.6 A2000C-W-d1 电磁执行器外形及安装尺寸图

2.3 转速传感器

转速传感器采用无源磁电式转速传感器，测速齿轮旋转引起的磁隙变化，在探头线圈中产生感应电动势，安装时将转速传感器固定在发动机齿轮盘上，通过感应飞轮齿数来判断发动机的转速，传感器的安装应在接触到齿轮的齿顶后退出 1／2 － 3／4 圈（约 0.45mm），这是一个较为理想的间隙。

孚创公司可提供多种安装尺寸，可根据用户实际需要进行选择。

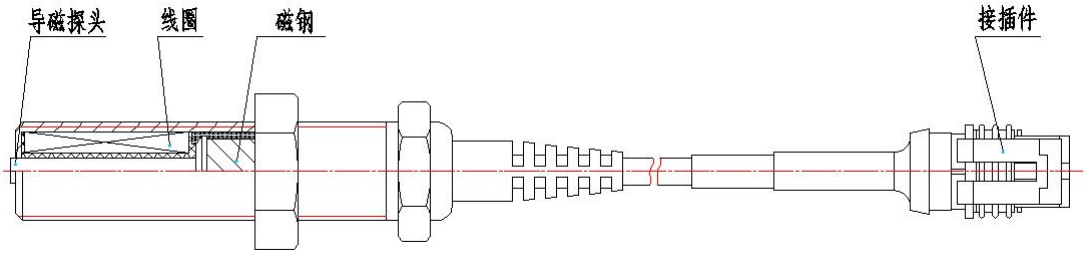


图 2.7 转速传感器结构图

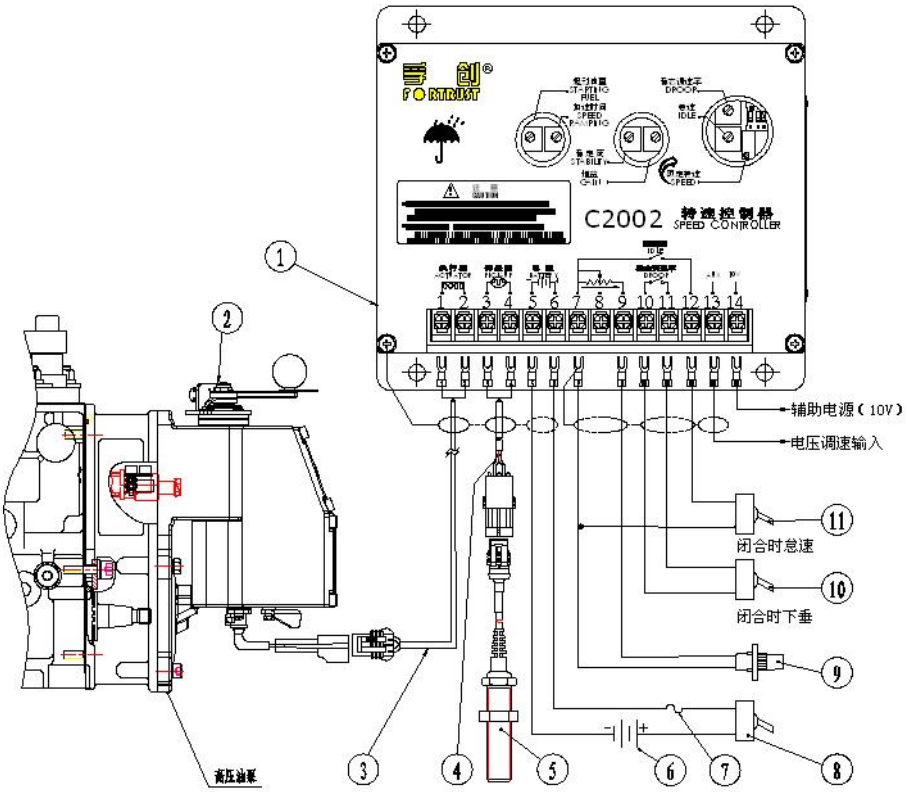
3 安装与调试

3.1 电子调速器的安装

C2002 转速控制器通常安装于控制柜之中或直接固定在发动机上，转速控制器有防潮处理，但仍须防水，雾或者凝结物与控制器接触．并且安装时应远离高温或热辐射以防止控制器高温损坏．

发动机应有独立的超速保护装置，不能依赖调速控制系统来阻止超速．

3.2 ESG2002 电子调速系统接线图



序号	名　　称
1	转速控制器
2	电磁执行器
3	执行器电缆
4	传感器电缆
5	转速传感器
6	控制电瓶
7	保险丝
8	电源开关
9	微调电位器
10	下垂切换开关
11	怠速/额定转换开关

图 3.1 ESG2002 电子调速系统接线图

3.3 起动发动机前的调整

3.3.1 观察调节增益和稳定性的电位器，一般情况下出厂设置在 12 点位置（即中间位置），红色拨码开关置于 1 下 2 上 3 下；

3.3.2 控制器在出厂时都已经进行了设置，所以在起动柴油机前一般无须对控制器进行调整，用户只须起动发动机后进行精细调整.

3.4 起动后控制器的调整

3.4.1 起动时可通过调整起动油量电位器对执行器的起动供给油量进行调整，保证一定的起动油量使发动机能够充分起动，同时减少起动时发动机带来的黑烟；

3.4.2 发动机起动后控制器应控制在怠速位，怠速电位器用于设定发动机起动时的转速；外接的速度开关断开时，发动机由怠速转换到额定转速；额定转速电位器用于对发动机额定转速进行调整. 调整额定转速电位器或外接微调电位器对额定转速进行精密调整，额定转速设置点顺时针旋转频率增加.

3.4.3 如果发动机起动后不稳定，调节增益和稳定性电位器直到发动机稳定.

3.4.4 起动后在发动机空载时进行如下调整

3.4.4.1 顺时针旋转增益电位器直到不稳定状态，然后逆时针微调直到系统稳定，之后再进一步逆时针调整一部分以确保稳定.

3.4.4.2 顺时针旋转稳定度电位器直到出现不稳定状态，然后逆时针调整到稳定，同样再进一步逆时针微调一部分确保发动机稳定旋转.

3.4.4.3 增益和稳定度调整完后，再通过微调电位器对额定转速进行调整以达到转速要求.

3.4.5 如果发动机需要引入怠速运行，高 / 低速开关闭合，然后再调节怠速电位器达到要求转速，调节时顺时针调整为频率增加（通常为额定转速的 50%）.

3.4.6 通过以上调整如发动机仍无法稳定，此时需要对拨码开关进行调整，如图 3.2 四种情形，每拨动一次后再对增益和稳定性电位器进行调整，直到发动机稳定。

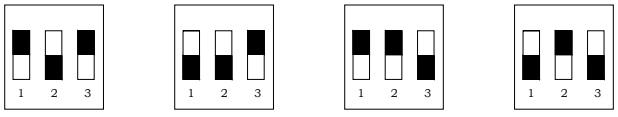


图 3.2 拨码开关调整示意图

3.5 稳态调速率的调整

3.5.1 稳态调速率的调整适用于多台机组并联运行时使用.

3.5.2 将端子 10、11 短接，使发动机下垂特性变软，发动机转速将随着发动机负载增加而减小，顺时针调节增大稳态调速率，反之减小.

3.5.3 调整完毕之后，发动机的转速会有微小的变动，再重新进行速度设置.

3.6 辅助输入

3.6.1 端子 13 做为辅助输入信号，其信号从负载分配单元，自动同步装置和一些其它的控制系统引入，作为系统进行自动同步，自动负载分配时使用。

3.6.2 当引入辅助输入信号时速度将发生小幅变化，需重新再调整额定电位器或外接的转速微调电位器进行设置。

3.7 辅助输出

端子 14 可外供 10V，20mA 的电源，以供外系统动力使用，但在使用中如发生短路将损坏控制器.

4 故障判断与处理

4.1 电子调速器故障判断

电子调速器故障将引起发动机性能下降，以至于发动机不能运行，如果能明确判断为电子调速器故障，更换电子调速器即可；如果是发动机及其辅助系统故障，有可能通过发动机转速达不到使用要求表现出来，更换电子调速器也不能解决问题，因此，故障原因应通过对系统的综合分析,逐项验证排查来判断.

故障现象	检测部位	检测方法
发动机不能起动	电瓶电压	测量 5 、 6 端电瓶电压应为 DC12V
	传感器	1、转速传感器安装不良，间隙过大.
		2、转速传感器电缆断线，测量其直流电阻应为 830－970 欧姆.
	执行器	1、执行器与油泵齿条联动部分有卡阻现象.
		2、执行器电缆断线,测量执行器线圈内阻为 2±0.2 欧姆.
执行器不能将油阀完全打开	电瓶电压	起动时测量电瓶电压，如果电压低于额定工作电压的 75%，则电瓶欠压，需要对电瓶进行充电.
	执行器	执行器与油泵齿条联动部分有卡阻现象.
发动机转速不稳	控制器	1、调节控制器上的稳定度和增益电位器，具体方法详见章节 3.4
		2、测量 14、7 端电压应为 10±0.5V.
	执行器	检查执行器与油泵齿条联动部分是否有间隙及松动现象.
发动机超速	控制器	1、发动机齿数确认有误，额定转速设置过高
		2、增益设置过低，灵敏度差，导致突卸负载时转速瞬间过高
		3、转速控制器故障，应更换
	执行器	1、执行器与油泵齿条联动部分有卡阻现象或连接松脱
		2、执行器与油泵供油零位不匹配，执行器断电后仍不能关断油泵供油
	转速传感器	转速传感器信号出错，接线损坏

4.2 磁性不充足的速度传感器信号

当转速传感器信号较强，则能抵抗外部脉冲干扰，转速控制器能够测量到转速传感器输出 3V 以上的有效值信号. 当电压低于 3V 时，应减小速度传感器和发动机的齿间隙，可以提高信号的振幅. 间隙要小于 0.45mm. 如此时电压仍低于 3V，应检查转速传感器的磁性是否太弱.

4.3 电磁干扰

电缆或者直接辐射的控制电路信号是很大的干涉源，将给调速系统带来不良影响. 转速传感器的连接应使用带屏蔽的电缆. 由于干扰源不一样，推荐使用双屏蔽的电缆线. 并且速度控制器的金属板接地或安装在内封密的金属箱内，防电子辐射. 用金属罩或金属容器效果更好.采用屏蔽线是最普通的抗干扰措施.若配用有刷的发电机其电火花干扰是不能忽略的，所以大干扰环境应采用特殊的屏蔽措施.

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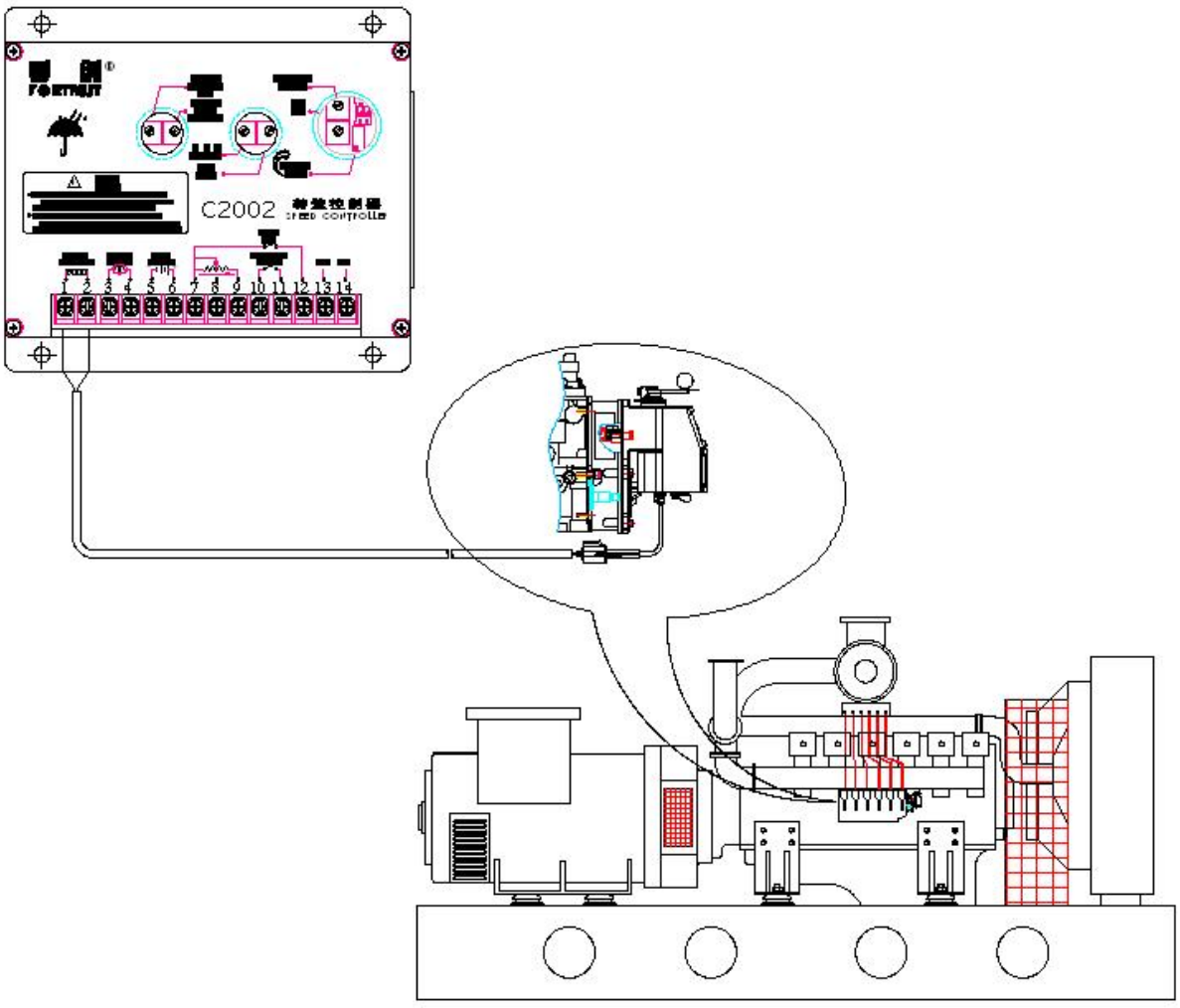
ESG2002 series
ELECTRONIC GOVERNOR
INSTRUCTION



Shanghai Fortrust Power Electric Co., Ltd.

CATALOGUE

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1 The Principle Of The Electronic Governor System

Electronic governor, with its simple structure, high reliability, convenient operation, easy function extension and high cost performance, applies to all kinds of diesel generating sets, vehicles and marine diesel engines.

Its normal type is all-electronic single pulse speed and close loop position structure, provided with functions of non-corresponding or corresponding control, speed and rated speed during running maximum fuel supply control, emergency stop and etc.

It is also capable of adding other control functions according to the customer's particular requirements.

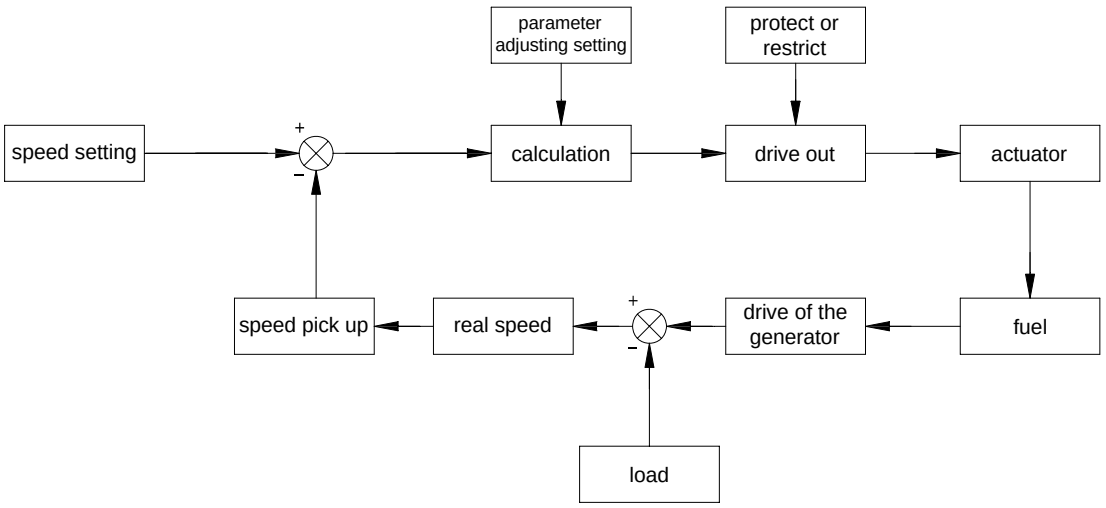


Figure 1.1 Electronic governor system

Speed Control Unit

2 The Structure Of The Electronic Governor System

2.1 Speed Control Unit

2.1.1 The basic electronic characteristics

- SUPPLY VOLTAGE : DC12V（Scope 9V～16V）
- SUPPLLY CONSUMPTION : < 0.1A (static state)
- SPEED FLUCTUATION RATIO : ≤ ±0.25%
- STEADY STATE SPEED DROOP : 0~5% Adjustable
- AMBIENT TEMP. : -40°C ~ +85°C
- RELATIVE HUMIDITY : <95%

2.1.2 The outline and installing size of the C2002 speed control unit

The speed control unit is installed on the control box or fixed other peripheral equipment in the engine. It should be installed in the place of air drying and temperature suitable. If it be installed in the place of more water and humidity, the speed control unit should be mounted vertically. Its outline and installing size refers to figure 2.1.

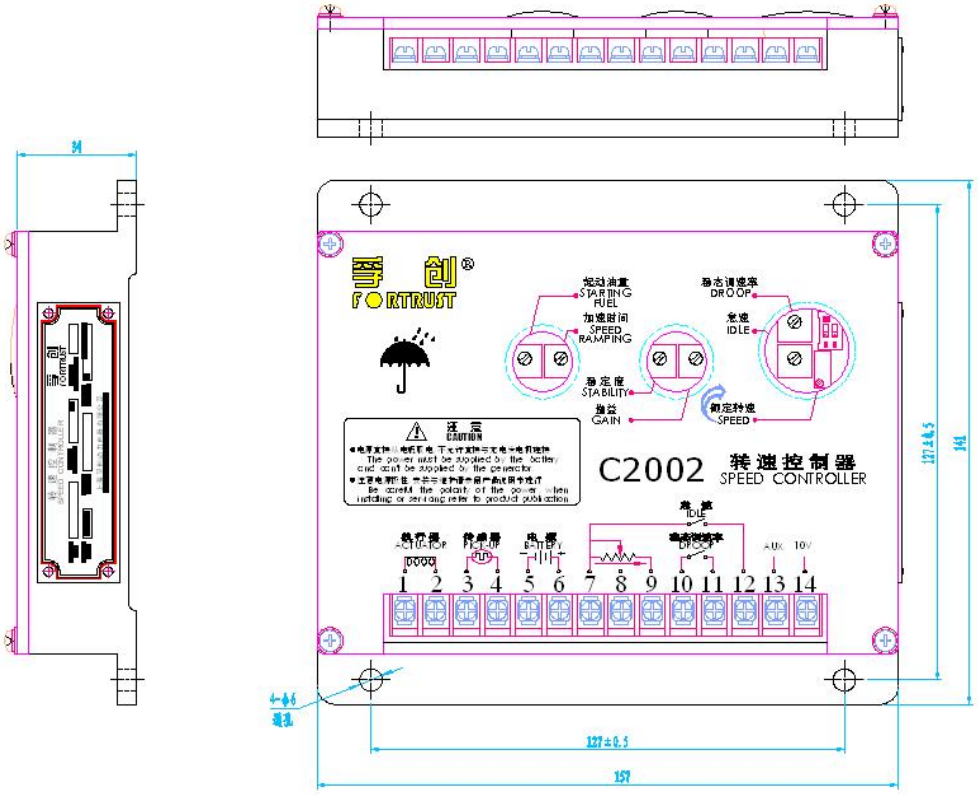


Figure 2.1 : The outline and installing size of the C2002 speed control unit

Speed Control Unit

2.1.3 Connection diagram of the C2002 speed control unit

2. 1. 3. 1 C2002 speed control unit's connection diagram for normal generator set refers to figure 2.2.

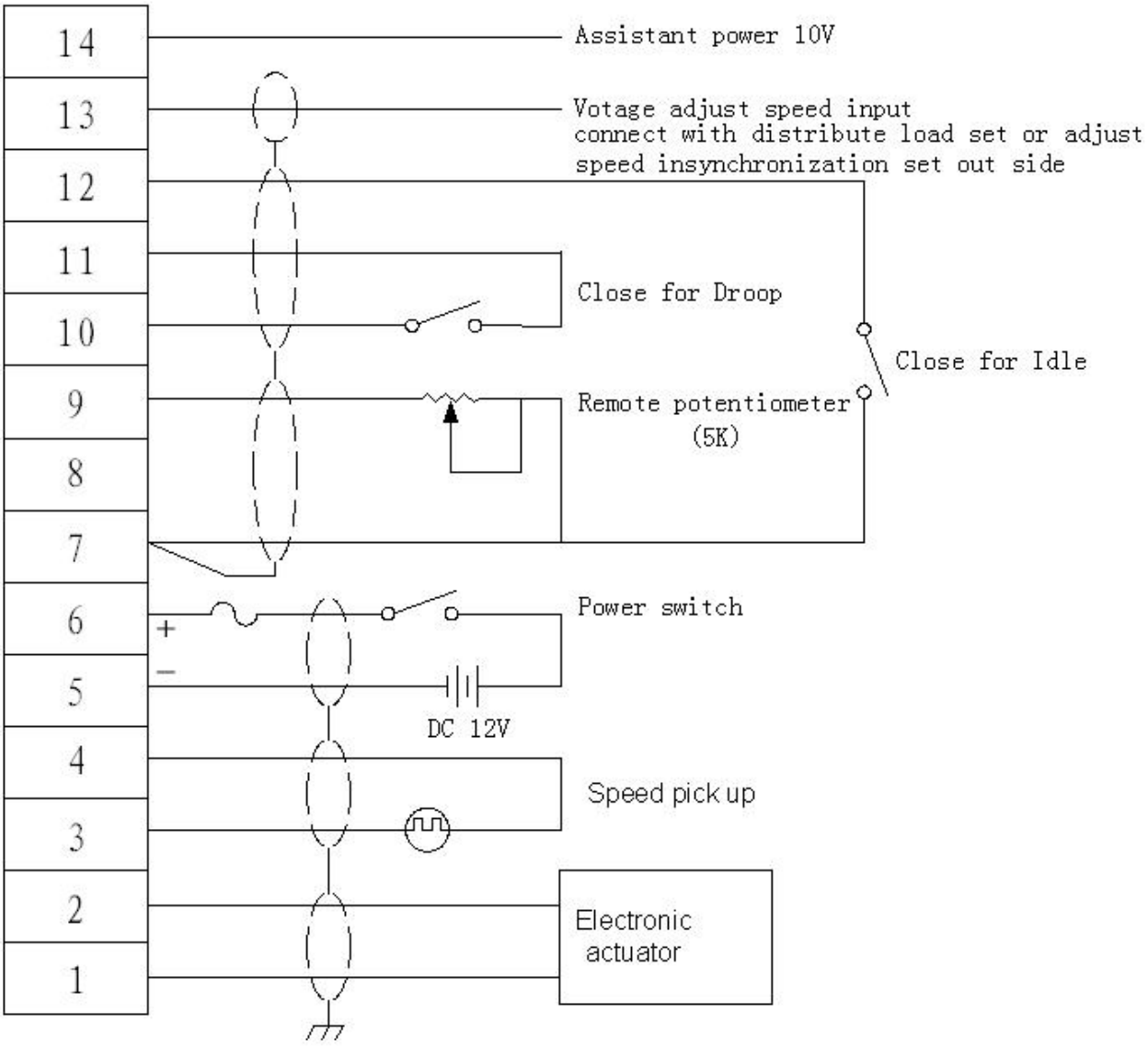


Figure 2.2 Connection diagram of the C2002 speed control unit for normal generator set

- The Electromagnetic Actuator connects to Terminals 1 and 2 and battery connects to Terminals 5 and 6. Terminals 1, 2, 5, and 6 should be #16 AWG (1.3 mm sq) or larger. Long cables require an increased wire size to minimize voltage drops. The battery positive (+) input, Terminal 6, should be fused for 15 amps as illustrated.
- Magnetic speed sensor connects to Terminal 3 and 4 *MUST BE TWISTED AND/OR SHIELDED* for their entire length. The speed sensor cable shield should only be connected to Terminal 4. The shield should be

insulated to insure no other part of the shield comes in connect with engine ground, otherwise stray speed signals may be introduced into the speed control unit to stop the engine.

- The remote potentiometer connects to Terminal 7 and 9. If it resistance is 5KΩ, speed adjusting range is 2400HZ.
- Speed droop connects to Terminal 10 and 11. When the Terminal 10 and 11 is off, speed droop is 0; When the Terminal 10 and 11 is closed, speed droop range is 0-5%.
- Rated and idle speed switch connects to Terminal 7 and 12. The switch close for idle, the switch off for rated speed.
- Terminal 13 receives input signal from load distribution device, automatic synchronizer device and other governor system auxiliary device.
- Terminal 14 output +10 volt regulated supply.

Electromagnetic Actuator

2.2 The Electromagnetic Actuator

The Electromagnetic Actuator is the executive element of the electronic governor. ESG2002 series speed control unit that is single-loop control mode can matching all kinds of electromagnetic actuator, such as A900C-W、A800C-W、A1000C-W-d1、A2000C-W-d1。

2.2.1 A900C-W electromagnetic actuator

- WORKING VOLTAGE: DC24V（Scope 21V～28V）
- WORKING TORQUE: 0.9 N•m
- WORKING STROKE: 22.5 mm

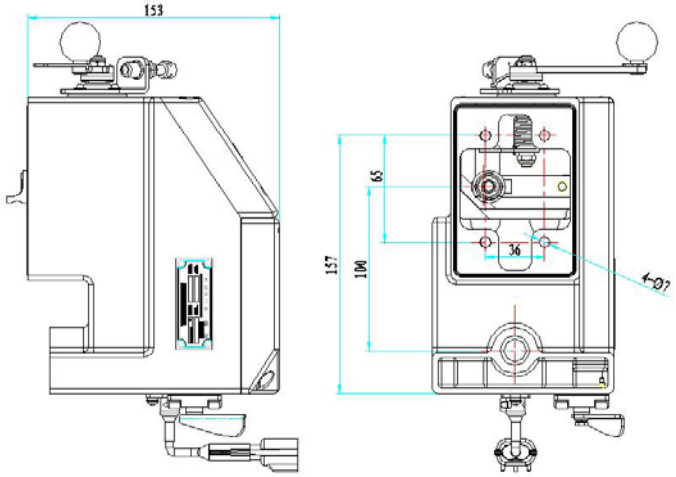


Figure 2.3 The outline and installing size of the A900C-W electromagnetic actuator

Electromagnetic Actuator

2.2.2 A800C-W electromagnetic actuator

- WORKING VOLTAGE: DC24V（Scope 21V～28V）
- WORKING TORQUE: 0.8 N•m
- WORKING STROKE: 17mm

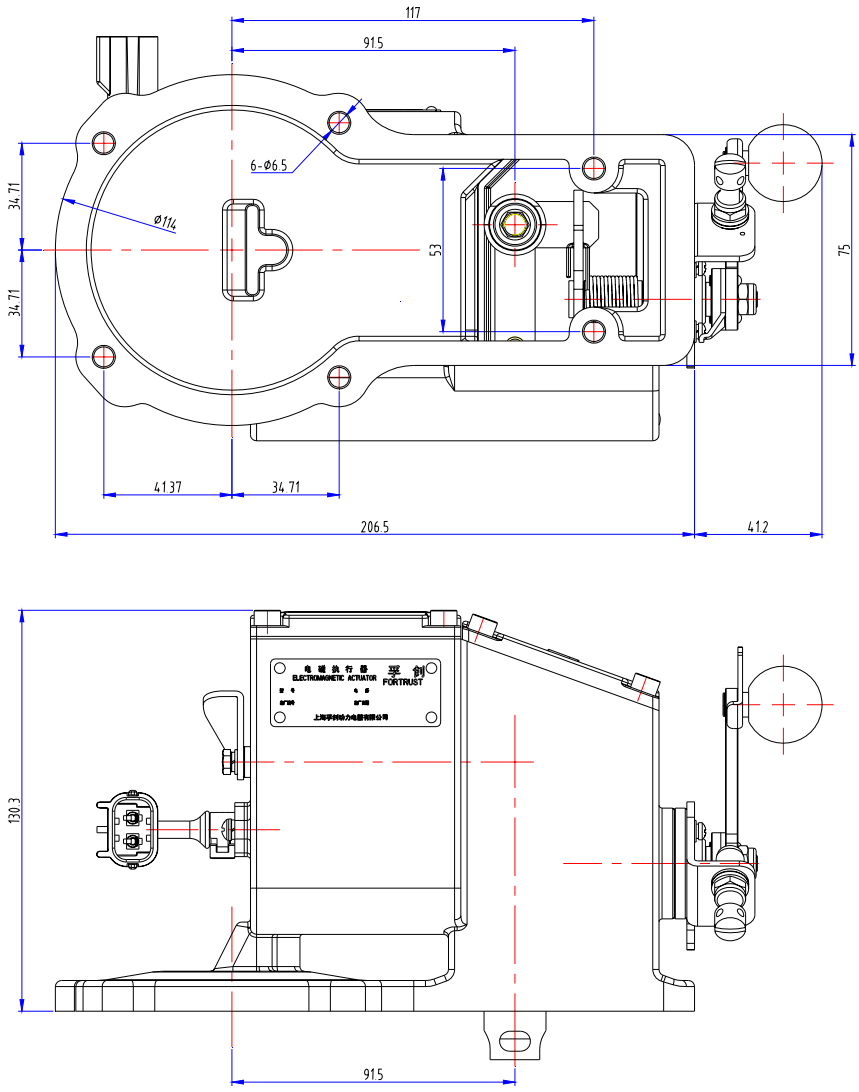


Figure 2.4 The outline and installing size of the A800C-W electromagnetic actuator

Electromagnetic Actuator

2.2.3 A1000C-W-d1 electromagnetic actuator

- WORKING VOLTAGE: DC24V、DC12V optional (order specify)
- WORKING TORQUE: 1 N•m
- WORKING STROKE: 18 mm

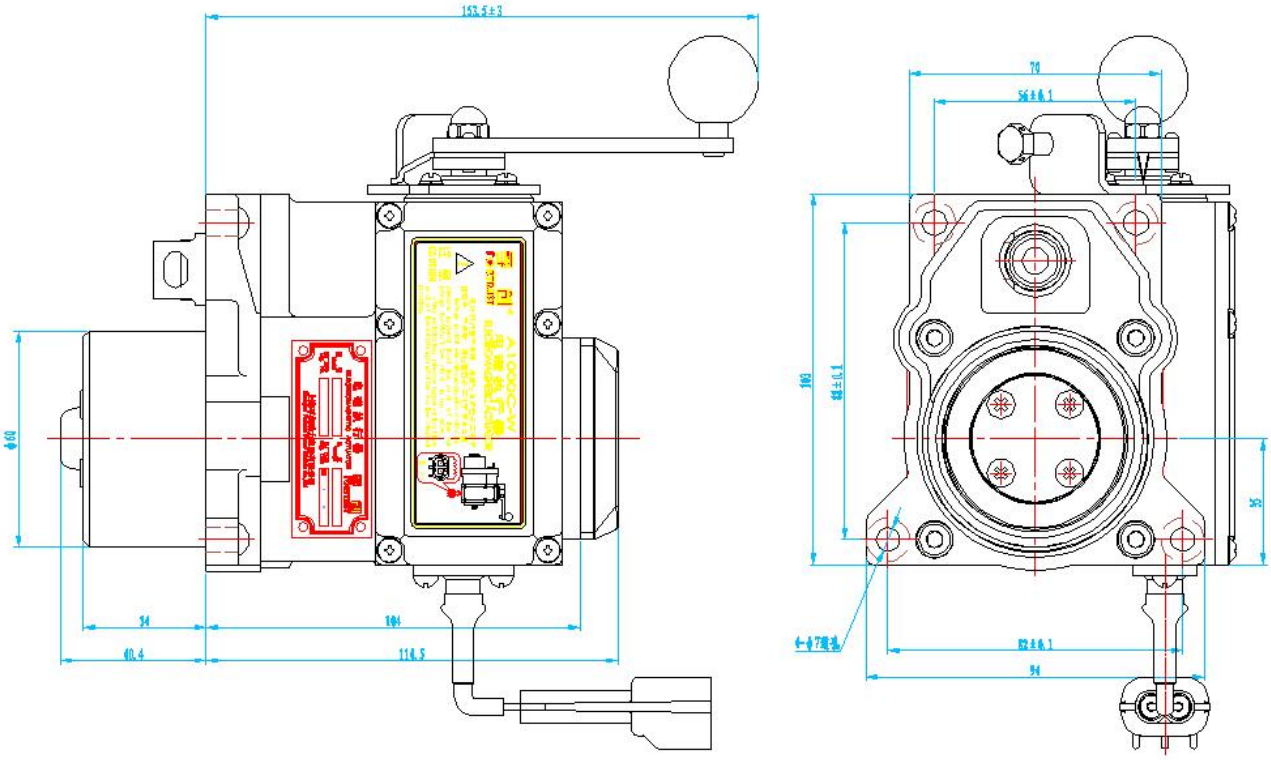


Figure 2.5 The outline and installing size of the A1000C-W-d1 electromagnetic actuator

Electromagnetic Actuator

2.2.4 A2000C-W-d1 electromagnetic actuator

- WORKING VOLTAGE: DC24V
- WORKING TORQUE: 2 N • m
- WORKING STROKE: 18 mm

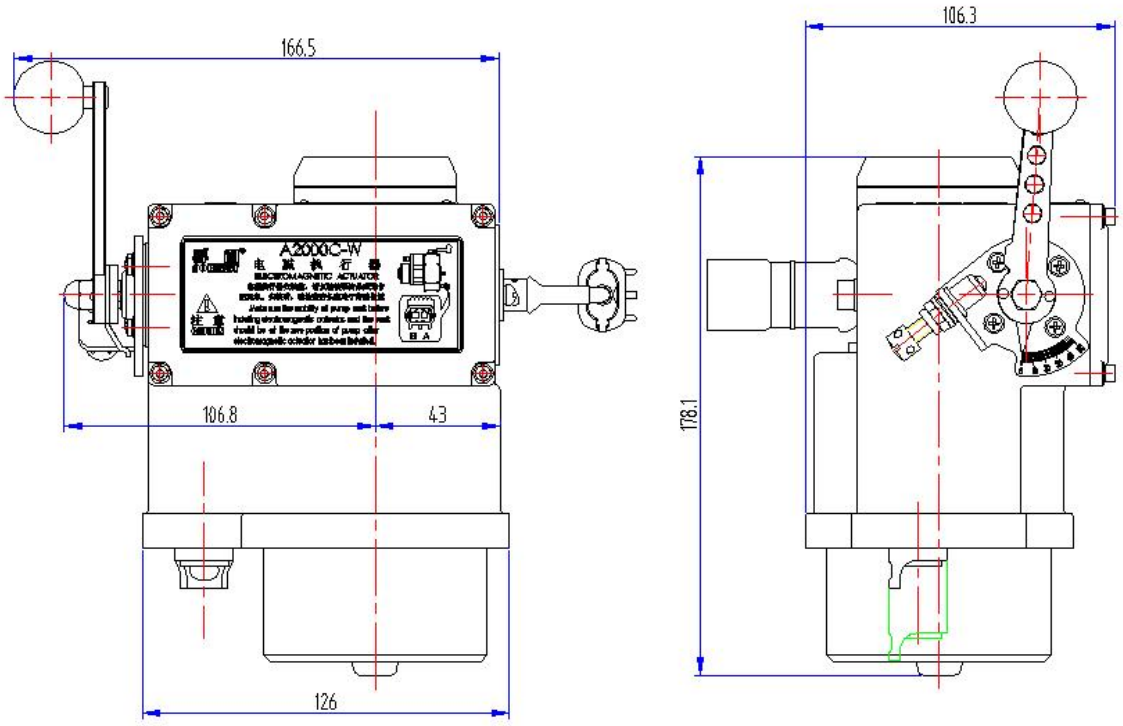


Figure 2.6 The outline and installing size of the A2000C-W-d1electromagnetic actuator

Speed sensor

2.3 Speed Pick-up

The Speed Pick-up of the Electromagnetic Governor is Speed Pick-up of magnetoelectricity, inner structure of which are made of sensor, loop, alnico and plug. Its structure refers to figure 2.4. The gap between the magnetic speed sensor and the ring gear teeth should not be any smaller than 0.02 in. (0.45 mm). Usually, backing out the speed sensor 3/4 turn after touching the ring gear tooth will achieve a satisfactory air gap.

2.3.1 The structure of the speed pick-up

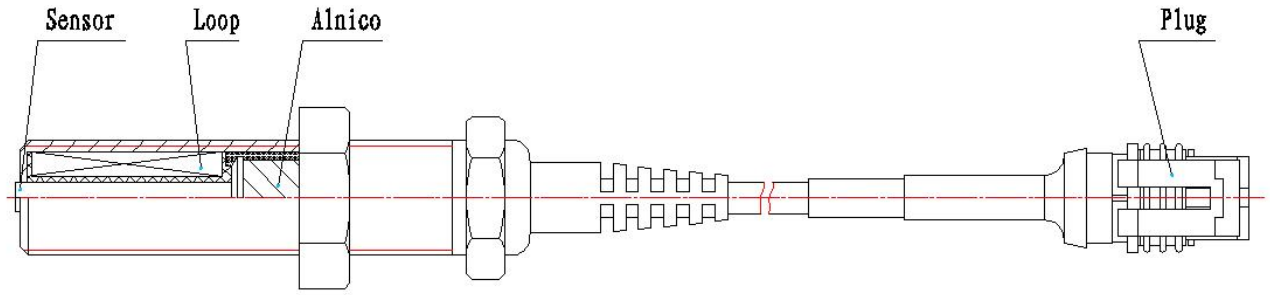


Figure 2.7 The structure picture of the speed pick-up

3 Installing and Debugging

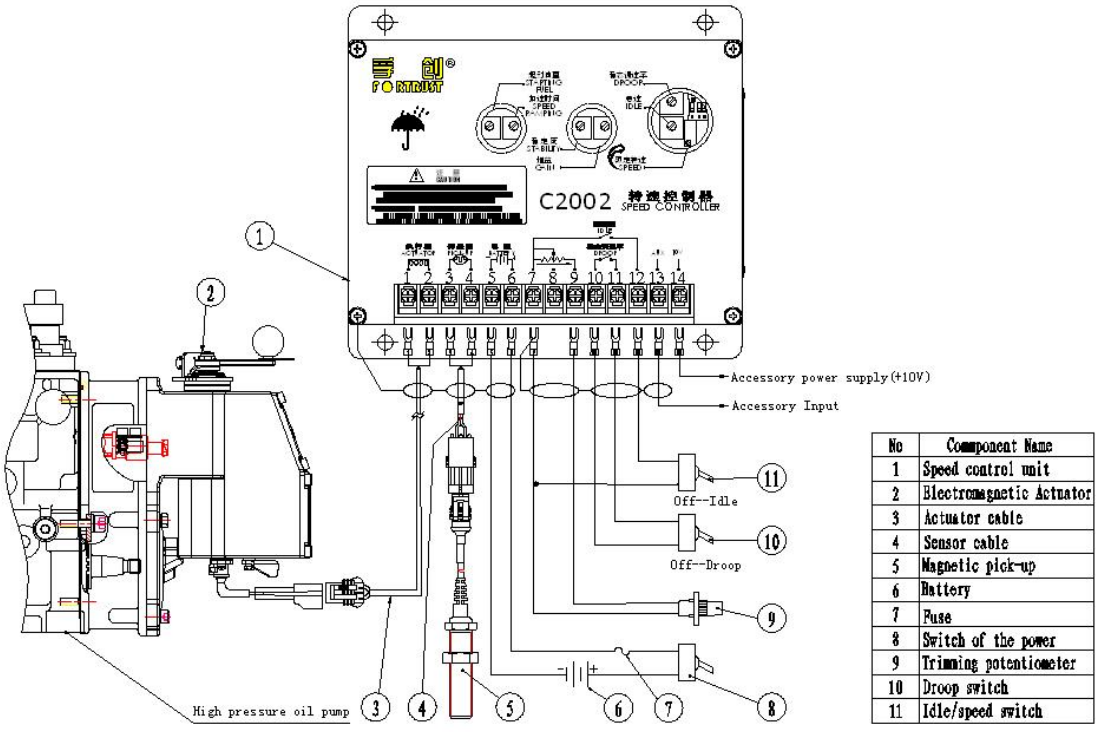
3.1 Installing Of The Electronic Governor

The C2002 speed control unit is rugged enough to be placed in a control cabinet or engine mounted enclosure with other dedicated control equipment. If water, mist, or condensation may be in contact with the controller, it should be mounted vertically. This will allow the fluid to drain away from the speed control unit.

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. Do not rely exclusively on the governor system of electric actuator to prevent overspeed. A secondary shut off device, such as a fuel solenoid, should be used.

3.2 Connection Diagram Of The ESG2002 Series Electronic Governor System



No	Component Name
1	Speed control unit
2	Electromagnetic Actuator
3	Actuator cable
4	Sensor cable
5	Magnetic pick-up
6	Battery
7	Fuse
8	Switch of the power
9	Trimming potentiometer
10	Droop switch
11	Idle/speed switch

Figure 3.1 Connection diagram of the ESG2002 series electronic governor system

Installing and Debugging

3.3 Adjustments before Starting Engine

Check to insure the **GAIN** and **STABILITY** adjustments, normally this value is set mid position by factory. Leave factory conditions of Red State Switch is  , namely RSW-1, RSW-3 = OFF, RSW-2 = ON.

Rated and idle speed of the speed control unit had been set by factory. Normally, this value is near from the user's engine working rotate speed value. In practice, after some adjustments, controller can achieve rated and idle speed, and the stability would be very well.

3.4 Adjustment of the Controller after Starting

3.4.1 Crank the engine with D.C. power applied to the governor system. Start fuel quantity varies with environmental temperature of engine start. Though adjusting start fuel quantity potentiometer; exhaust smoke from the engine can be adjusted to the best state.

3.4.2 The governor system should control the engine at low idle speed. If the engine is unstable after starting, turn the **GAIN** and **STABILITY** adjustments counterclockwise until the engine is stable.

3.4.3 The governed speed set point is increased by clockwise rotation of the **SPEED** adjustment control. Remote speed adjustment can be obtained with an optional Speed Trim Control.

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

3.4.4.1 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.

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

3.4.4.3 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.

3.4.5 After the governor speed setting has been adjusted, place the optional external selector switch in the **IDLE** position. The idle speed set point is increased by clockwise rotation of the **IDLE** adjustment control. When the

engine is at idle speed, the speed control unit applies droop to the governor system to insure stable operation.

3.4.6 Through the above adjustments engine still unable to stability, it needs to be adjusted Red State Switch now, figure 3.2 four cases (a: RSW-1、RSW-3 = ON、RSW-2 = OFF; b: RSW-1、RSW-2 = OFF、RSW-3 = ON; c: RSW-1、RSW-2 = ON、RSW-3 = OFF; d: RSW-1、RSW-3 = OFF、RSW-2 = ON). After every adjusting Red State Switch go on the 3.4.4.1 and 3.4.4.2 adjusting procedure again. If it is still unable to stability, should inspect engine and fuel pump for service condition. And then, contact with manufacturer.

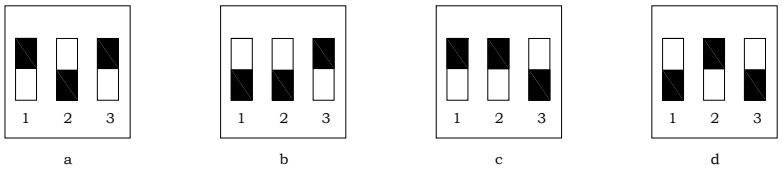


Figure 3.2 Red State Switch

3.5 Speed Droop Operation

3.5.1 Droop is typically used for the paralleling of engine driven generators.
3.5.2 Place the optional external selector switch in the **DROOP** position, that is connected Terminals 10 and 11. Droop is increased by clockwise rotation of the **DROOP** adjustment control. When in droop operation, the engine speed will decrease as engine load increases. The percentage of droop is based on current change from no load to full load of the actuator.
3.5.3 After the droop level has been adjusted, the rated engine speed setting may need to be reset. Check the engine speed and adjust the speed setting accordingly.

3.6 Accessory Input

3.6.1 When the Auxiliary Terminal 13 accepts input signals from load sharing units, auto synchronizers and other governor system accessories are directly connected to this terminal. It is recommended that this connection form accessories should be shielded as it is a sensitive input terminal.
3.6.2 When an accessory is connected to Terminal 13, the speed will decrease and the speed adjustment must be reset.

3.7 Accessory Output

The +10 volt regulated supply, Terminal 14, can be utilized to provide power to FORTRUST governor system accessories. Up to 20 ma of current can be drawn from this supply. Ground reference is Terminal 7. Caution - a short circuit on this terminal can damage the speed control unit.

4 System Troubleshooting

4.1 Check-up the Fault

When any incorrect matter happens during installation testing or using, please clear the problem referring to following diagrams.

Symptom	Test	Probable Fault
Engine can not start	Battery	voltage between Terminals 5 and 6 Should be 12V DC.
	Pick-up	1、the setting of the speed pick up is not correct and the space is too big.
		2、Impedance between Terminals 3 and 4 Should be 830 to 970 ohms.
	Actuator	1、Actuator or linkage binding.
		2、impedance between Terminals 1 and 2 Should be 2±0.2ohms.
Actuator does not energize fully	Battery	If the voltage is less than 14V(9V) for a 24V(12V) system, replace the battery if it is weak or undersized.
	Actuator	Actuator or linkage binding.
Unsteady engine speed	Speed Control Unit	1、adjust the stability and the gain of the control unit according to 3.4.
		2、voltage between Terminals 14 and 7 Should be 10±0.5V.
	Actuator	Check the actuator and the oil pump's rack and make sure their connect is not loose.
Engine Overspeed	Speed Control Unit	1、the number of engine gear is wrong and the rate speed is high
		2、the gain is set too low and sensitive degree is not enough, which bring about too high instant speed
		3、Defective speed control unit.
	Actuator	1、Actuator or linkage binding.
		2、if zero position of the actuator is not according to actuator of the oil pump, actuator cannot cut up the oil to the oil pump after losing power
	Pick-up	If error speed sensor signal happens, please Check wiring.

4.2 Insufficient Magnetic Speed Sensor Signal

A strong magnetic speed sensor signal will eliminate the possibility of external pulses. The speed control unit will govern well 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 3 and 4.

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 be smaller than 0.45mm .When the engine is stopped, back the speed sensor out by 3/4 turn after touching the ring gear tooth to achieve a satisfactory air gap.

4.3 Electromagnetic Compatibility (EMC)

EMI SUSCEPTIBILITY -The electronic governor system can be adversely affected by large interfering signals that are introduced through the cabling or through direct radiation into the control circuits.

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

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 possible interfering sources.

If it is suspected that external fields are either radiated or conducted, they will affect the electronic governor system operation; it is recommended to use shielded cable for all external connections. Make 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 on a grounded metal back plate or place it in a sealed metal box.

What is called radiation is when the interfering signal is radiated directly through space to the electronic governor system. A metal shield or a solid metal container is usually effective to isolate the electronic governor system from this type of interference source.

What is called conduction is when the interfering signal is conducted through the interconnecting wiring to the electronic governor system. Shielded cables and filters are common preventive measures.

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