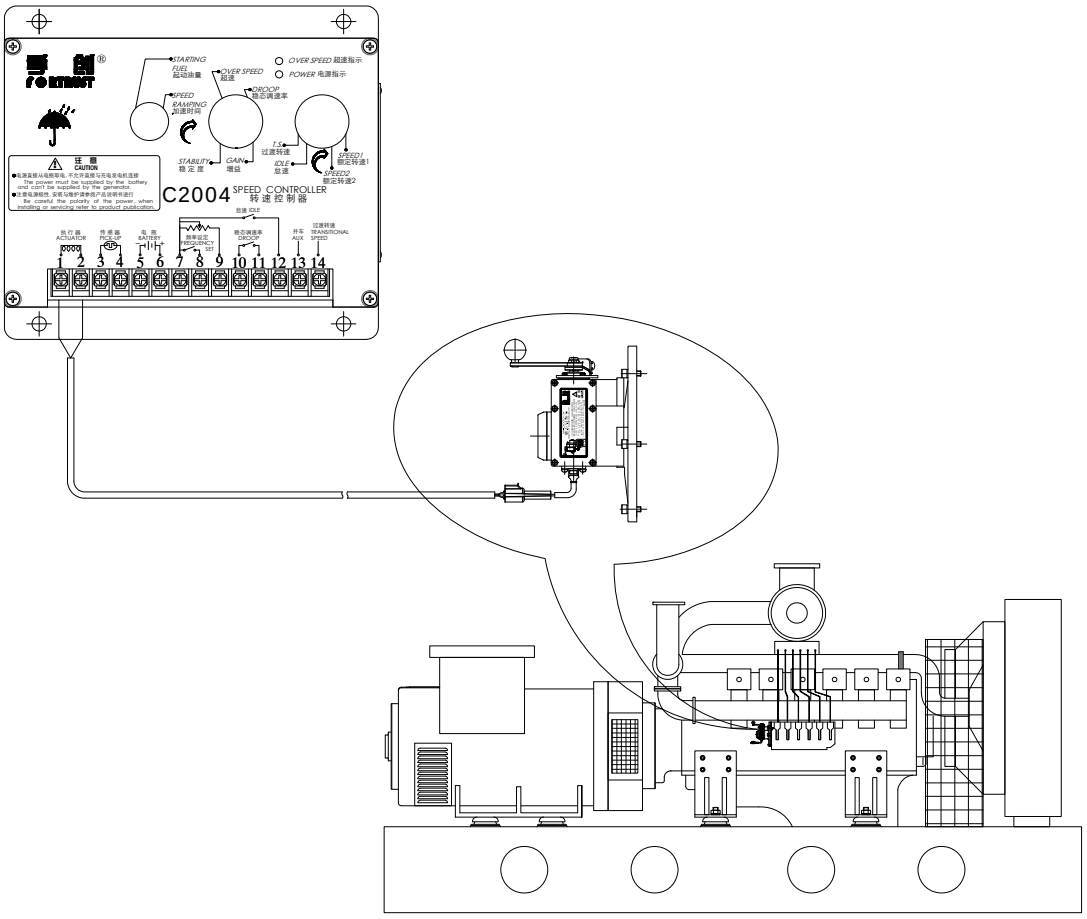
孚创 ESG2004 系列
Fortrust ESG2004 Series

电子调速器使用说明书

Electronic Governor Instruction



上海孚创动力电器有限公司

SHANGHAI FORTRUST POWER ELECTRIC CO., LTD

前 言 Foreword

本使用说明书主要介绍了电子调速系统的工作原理、组成、调节、操作、维护及简易故障的排除方法等，适用于对发动机及电子调速器有一定了解、日常进行安装、接线、使用及维修的工作人员。建议将本说明书置于产品的工作场所，并严格遵循这里所提供的方法去操作。

警 告 CAUTION

- 本电子调速系统中使用到的转速传感器不得与其他系统共用，以防造成干扰。
- 本电子调速系统具有超速保护功能，但该功能是在电子调速系统工作正常、油泵不卡死等的情况下才能工作。因此，您不能完全依靠本电子调速器来防止发动机超速，而应在发动机系统上安装独立、有效的超速保护装置。
- 发动机起动之前应确认喷油泵供油杆处于断油的位置。

目　录

1 电子调速器工作原理

发动机电子调速器是将发动机控制在设定工作转速下稳定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、超速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)：

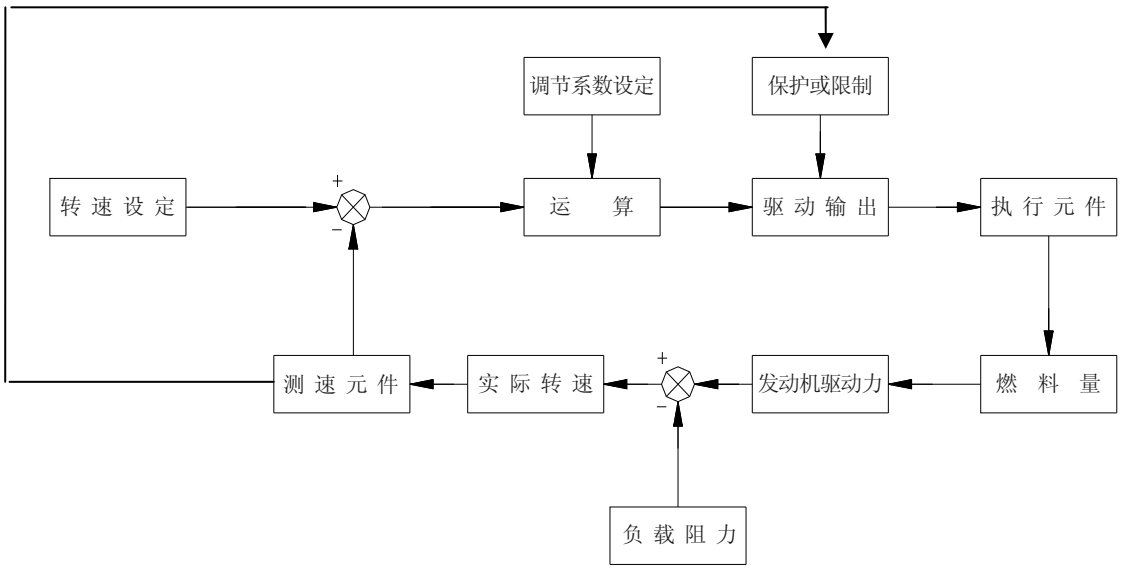


图 1.1 调速器原理示意图

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趋向稳定。通过手动调整控制器增益、稳定性以及稳态调速率电位器等可满足不同发动机对于瞬态调速率、稳定时间和稳态调速率的需求。

2 电子调速系统的组成

2.1 C2004 型转速控制器(SPEED CONTROLLER)

2.1.1 基本电气特性

☑ 电源电压： DC24V（范围 18V～32V）或 DC12V（范围 9V～16V）

☑ 电源消耗： ＜ 0.2A（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 C2004 型转速控制器的基本功能

- 起动油量可调 ：调节发动机起动时的排烟状况；
- 转速控制及转速微调 ：采用单闭环方式控制转速，转速可精确调节、遥控；
- 升速时间可调 ：可调节发动机从怠速至额定工况时的升速时间；
- 超速保护 ：可设定超速限制值，切断执行器电源，使发动机停车；
- 高低速转换 ：可在怠速工况与额定工况之间进行切换；
- 稳态调速率（速降）可调 ：稳态调速率范围可调；
- 并机功能 ：可实现多台机组的并联工作，分手动和自动并机；
- 全程调速 ：可实现在一定范围内的转速之间连续、平滑的调节；
- 自动停车保护 ：当转速信号消失、控制器掉电时，使发动机自动停机；
- 双频切换 ：适用于两种标定额定转速之间的简单切换；
- 过渡转速 ：可在怠速与额定转速之间设置一个过渡转速进行过渡；

以上基本功能的实现可参考后续章节参数设置中的详细说明，其中全程调速功能根据用户对转速调节范围的不同要求，可能需要配置不同的外接配件，如果用户有对该项功能的需要，请联系我们。

2.1.3 C2004 转速控制器外形及安装尺寸

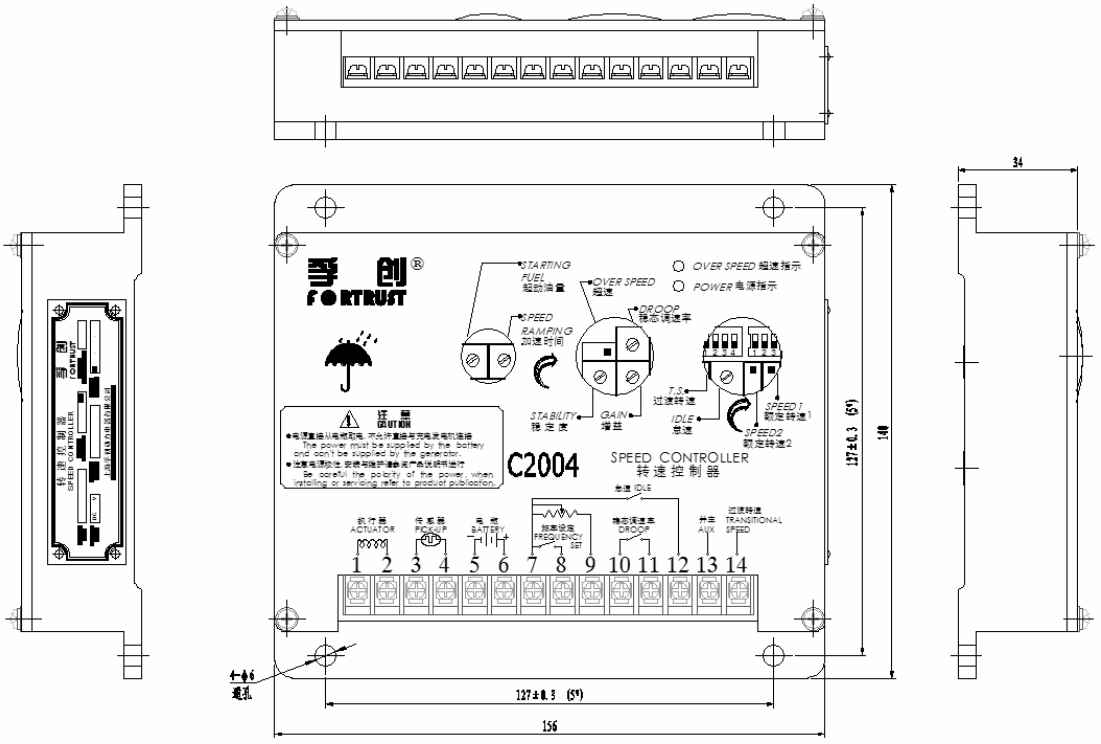


图 2.1 C2004 转速控制器外形及安装尺寸

2.1.4 C2004 转速控制器接线图

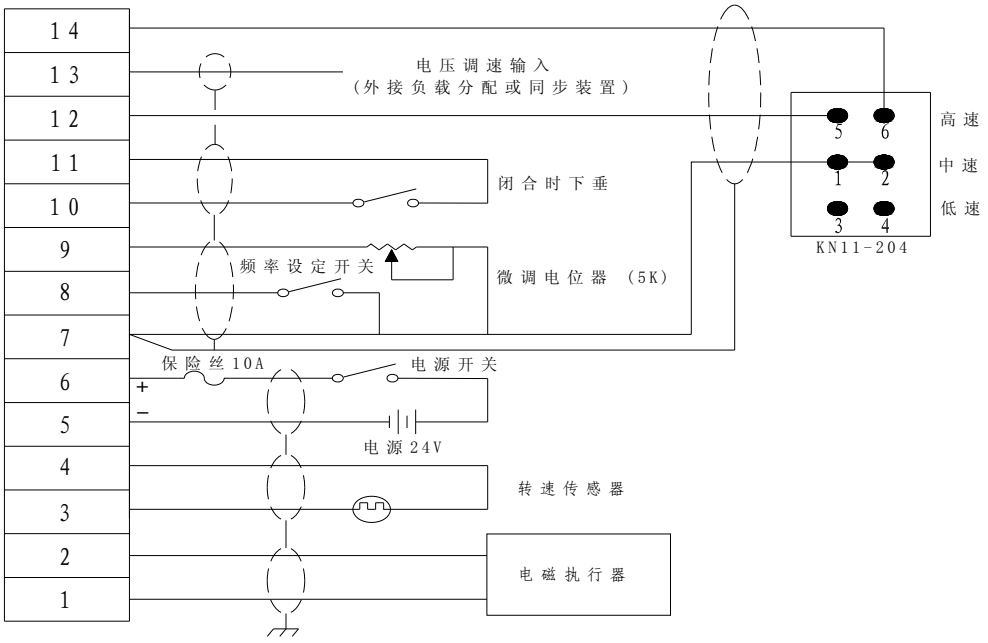


图 2.2.1 C2004 转速控制器接线图（方式 1）

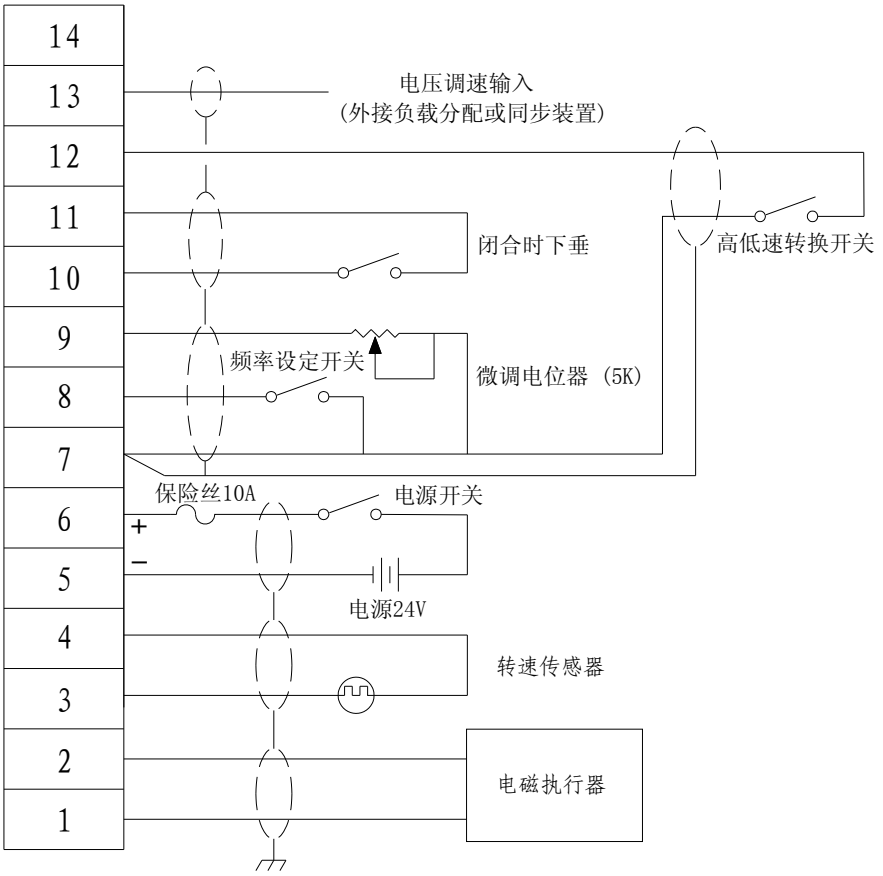
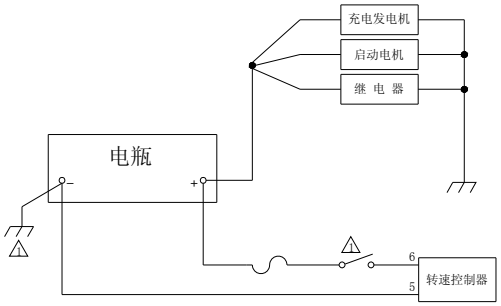


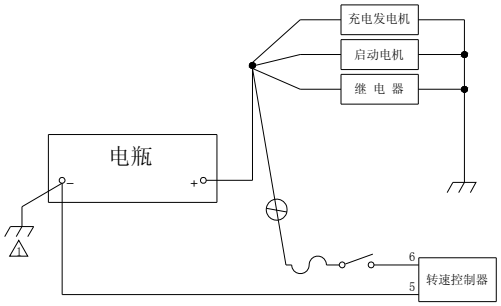
图 2.2.2 C2004 转速控制器接线图（方式 2）

2.1.5 接线端口的定义及要求：

● 1、2 端子接执行器(ACTUATOR)，5、6 端子接电瓶(BATTERY)，要求两组线截面 1.3 mm² 或更粗，线缆越长要求线径越粗，以减小电压降。为防止意外发生，电池组正极到转速控制器电源正极(即端子 6)之间的线缆上串接 10 A 的保险丝(FUSE)是十分必要的；控制器的电源线应单独、直接从电瓶的正负极取出，而不得绕道其他接口，正确接线如下：



☑正确的电源接线图



☒错误的电源接线图

● 3、4 端子接速度传感器(PICK-UP)，速度传感器必须全程使用编织屏蔽网线缆连接，线缆的屏蔽网部分应如图 3.1 的方式 360 度环接到支点上，不可与发动机的其他任何地连接，否则干扰信号可能进入转速控制器，造成难以预测的后果；

● 7、9 端子可接转速微调电位器（FREQ TRIM），并可加长线缆进行遥控（最长线缆可达 5m），如果线缆长度超过所要求的极限值，则必须使用屏蔽网线缆进行连接，屏蔽网应 360 度环接到端子 7 上，所要求的电位器阻值为 5K，调速范围可达到 2400HZ；

● 7、8 端子可接频率设定(FREQ SET)开关，当需要在两种额定工况下频繁切换使用时，可通过该开关进行简单、快速的切换，从而省却对转速重新进行设定的复杂步骤；

● 10、11 端子接稳态调速率（DROOP）开关，断开时稳态调速率为 0，发动机运行在等值调速状态；闭合后通过调整控制器上稳态调速率电位器（DROOP）可使发动机在 0-5%的稳态调速率范围内运行；

● 7、12、14 端子通过专用三档位钮子开关，在怠速、过渡转速、额定转速之间顺序进行切换，当发动机转速跨度较大或惯性力较高时，可从过渡转速过渡一下，来保护发动机；

● 13 端子(AUX)可外接电压调速装置，作为一个敏感的输入端子，建议与附件间的连接使用屏蔽线缆；该端可直接接入孚创公司生产的同步控制器和负载分配器使用；单机运行时可不接；

2.2 电磁执行器(ACTUATOR)

本说明书所述转速控制器可与孚创公司生产的所有单闭环电磁执行器配套使用，用户可根据油泵的型号灵活地选用孚创公司生产的电磁执行器及配套的中间体等，或由孚创公司的专业配试人员进行现场配试，为您的产品提供最佳的配机方案；本说明书所列电磁执行器是根据您产品的配机要求罗列的，若需查询孚创生产的电磁执行器的种类及详细资料可登录孚创公司网站 www.fortrust.cn 或 Email：sales@fortrust.cn、销售热线 021-51961611/12/13 转总机进行查询或与我们联系；配置不同的电磁执行器时，转速控制器的稳态调速率的调节范围会略有不同，这是正常现象，若配置不同的电磁执行器后导致不能满足您的稳态调速率要求，请与我们联系，我们将会为您提供专业的解决方案。

电磁执行器是电调系统的执行机构，ESG2004 系列为单闭环控制方式，可匹配的执行器有 A800C-W、A900C-W、A1000C-W-d1、A2000C-W-d1、A08A-W、A1AWL、A1AWT、A3A-W、A3B、CA2-W，安装方式多样，可根据用户不同的需求进行选配。
以下将根据执行器的安装方式分为内置式和外置式分别进行介绍。

2.2.1 内置式安装

内置式安装是指电磁执行器取代高压油泵机械调速器部分与高压油泵本体直接相连构成一体，内部执行器齿杆与高压油泵齿条联动。执行器的外部有停车手柄，并可通过调整停车手柄的位置实现对最大油量的限定。 ESG2004 系列可匹配的内置式执行器有 A800C-W、A900C-W、A1000C-W-d1、A2000C-W-d1、A08A-W、A3A-W、CA2-W。

2.2.1.1 A800C-W 电磁执行器

☑ 电源电压： DC24V

☑ 工作能力： 0.8N•m

☑ 工作行程： 17mm

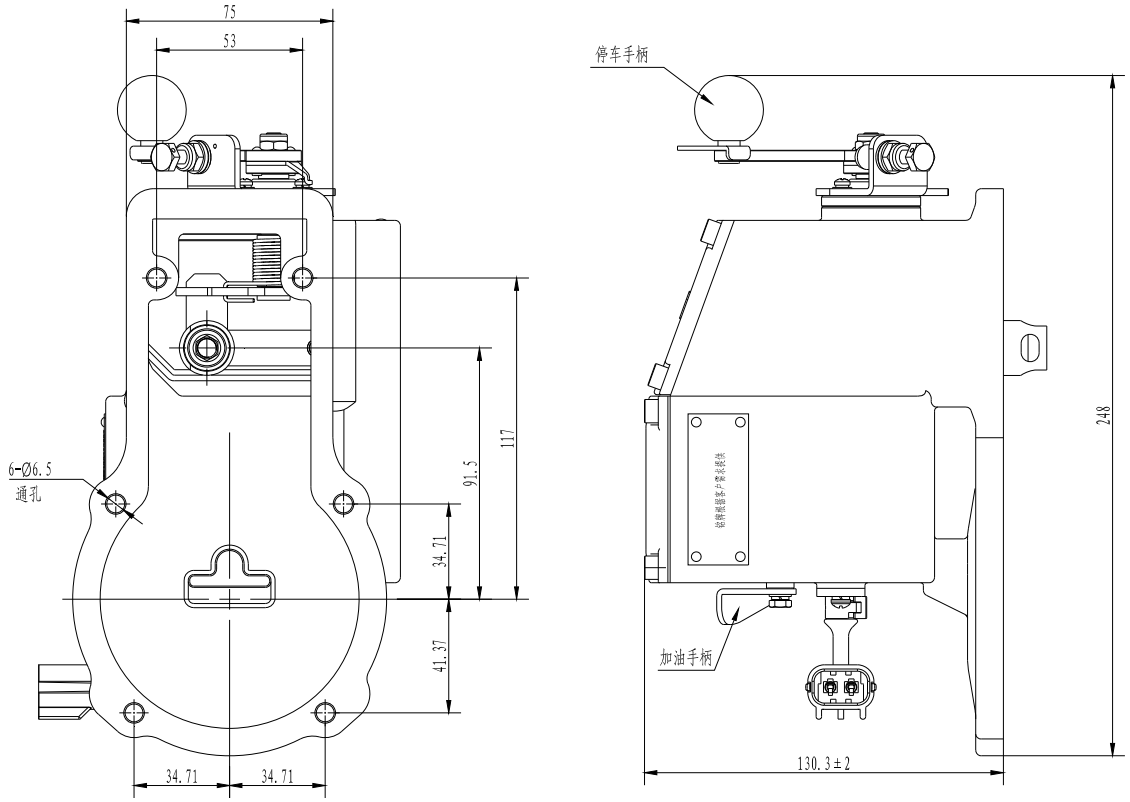


图 2.2.1.1 A800C-W 电磁执行器外形及安装尺寸图

电磁执行器

2.2.1.2 A900C-W 电磁执行器

☑ 电源电压： DC24V

☑ 工作能力： 0.9N•m

☑ 工作行程： 22.5mm

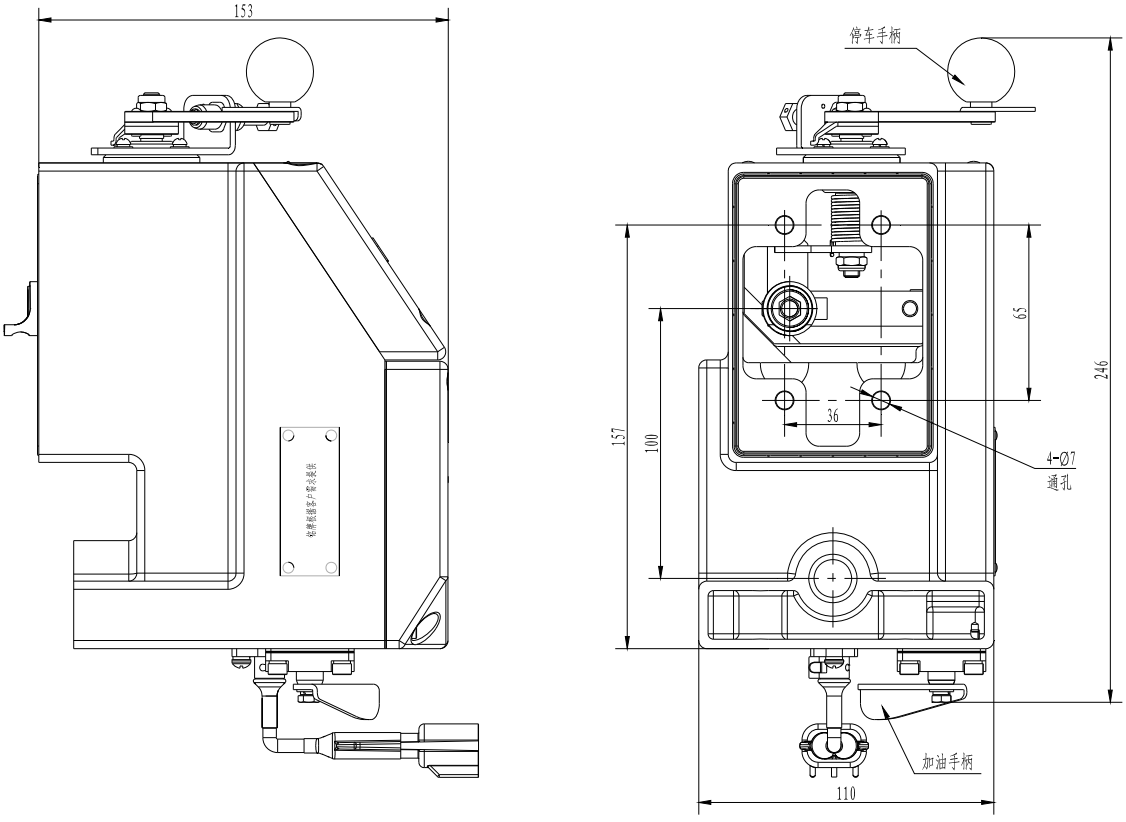


图 2.2.1.2 A900C-W 电磁执行器外形及安装尺寸图

2.2.1.3 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： 1N.m

☑ 工作行程： 22mm

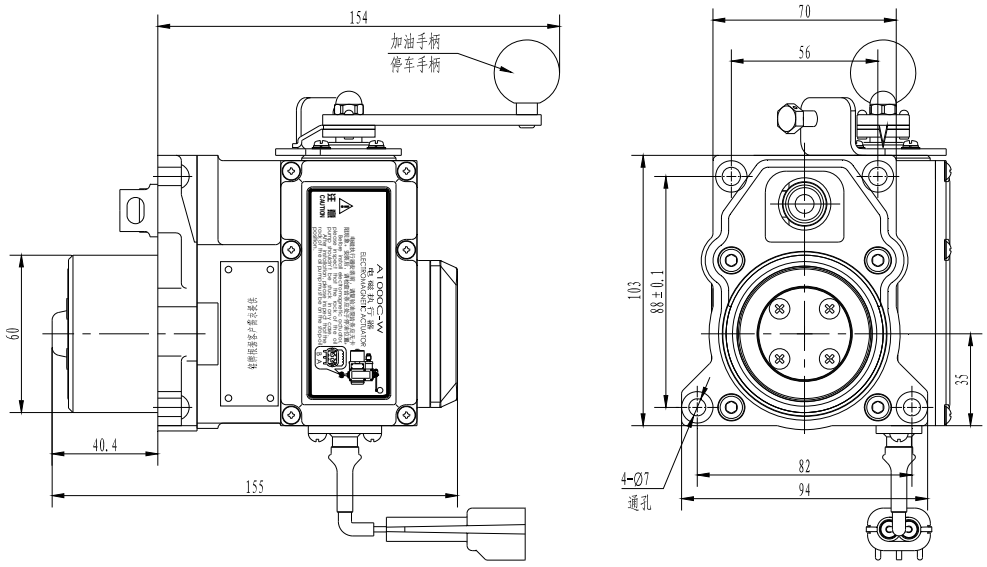


图 2.2.1.3 A1000C-W-d1 电磁执行器外形及安装尺寸图

2.2.1.4 A2000C-W-d1 电磁执行器

☑ 电源电压： DC24V

☑ 工作能力： 2N•m

☑ 工作行程： 22mm

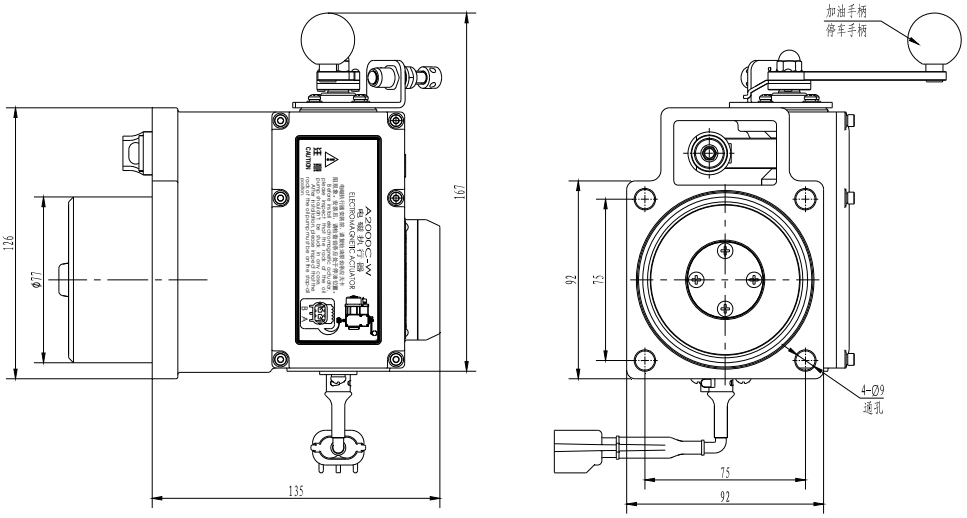


图 2.2.1.4 A2000C-W-d1 电磁执行器外形及安装尺寸图

电磁执行器

2.2.1.5 A08A-W 电磁执行器

☑ 电源电压： DC24V、DC12V 可选（订货时注明）

☑ 工作能力： 0.8 N.m

☑ 工作行程： 18mm

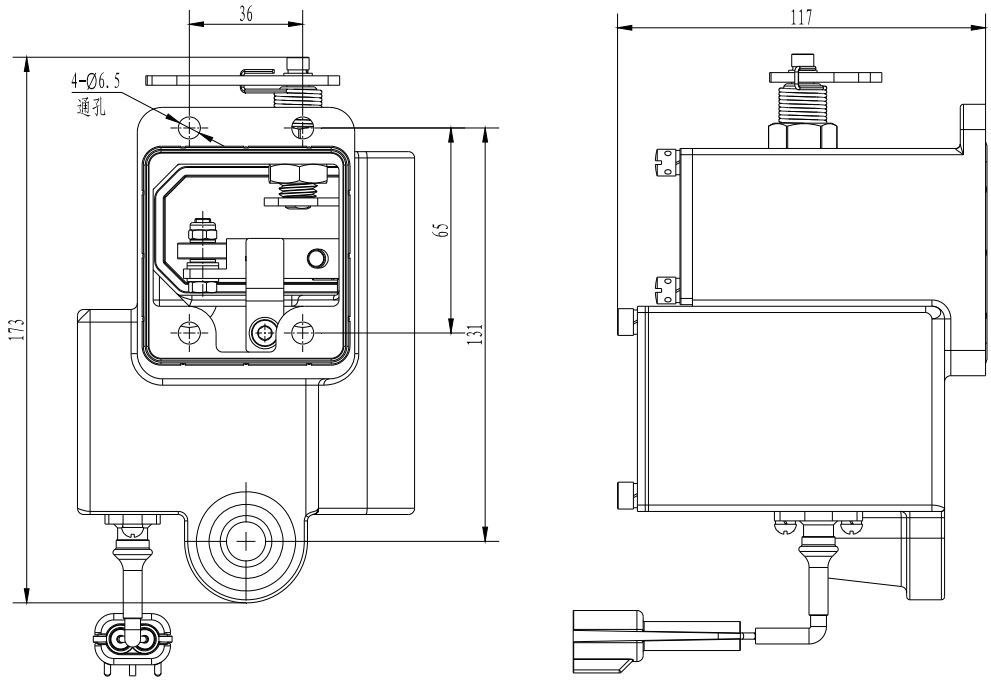


图 2.2.1.5 A08A-W 电磁执行器外形及安装尺寸图

2.2.1.6 A3A-W 电磁执行器

☑ 电源电压： DC24V、DC12V 可选（订货时注明）

☑ 工作能力： 0.9N•m

☑ 工作行程： 19mm

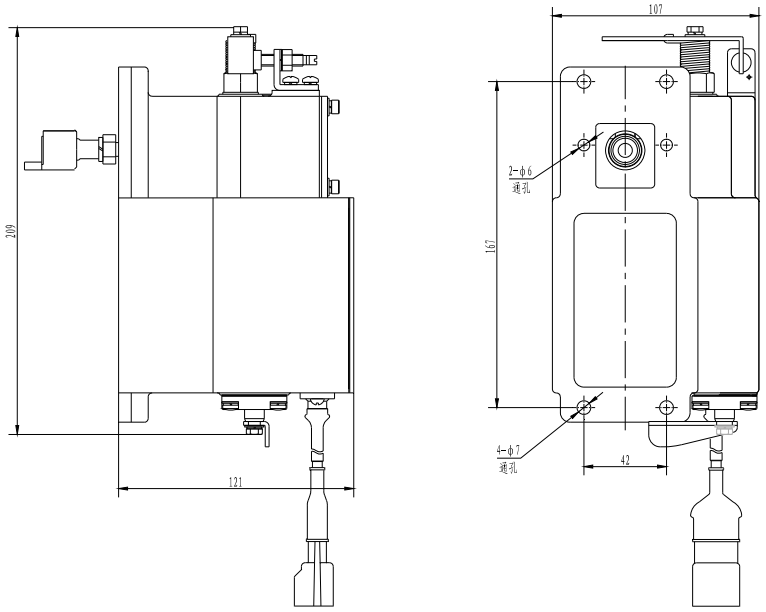


图 2.2.1.6 A3A-W 电磁执行器外形及安装尺寸图

2.2.1.7 CA2-W 电磁执行器

☑ 电源电压： DC24V

☑ 工作能力： 1.2N.m

☑ 工作行程： 20mm

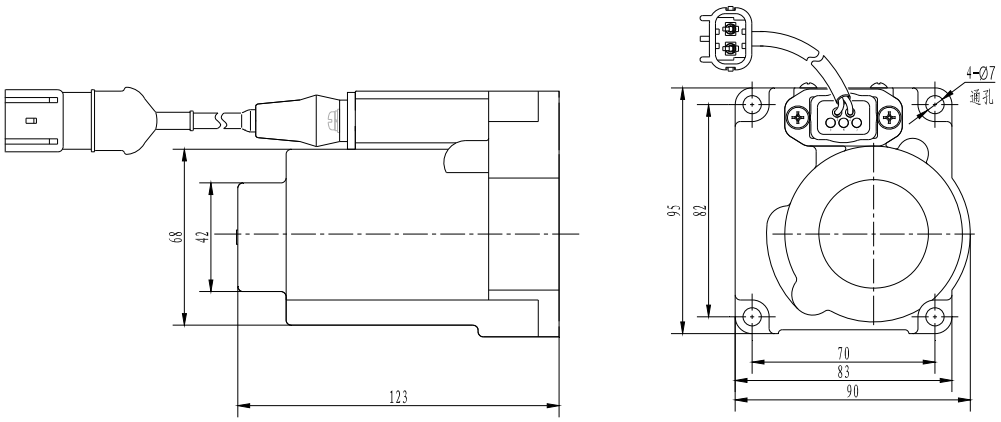


图 2.2.1.7 CA2-W 电磁执行器外形及安装尺寸图

2.2.2 外置式安装

外置式安装是指电磁执行器的供油手柄通过联动装置与油泵机械调速器的停油手柄相连接，在执行器的连接手柄上设置了不同的安装孔，通过调换安装孔的位置可满足油泵不同的行程和扭矩，这种连接方式更适合于对柴油机的成套组装和调速器的改造。ESG2004 系列可匹配的外置式执行器有 A1AWL、A1AWT、A3B。

电磁执行器

2.2.2.1 A1AWL 电磁执行器

☑ 电源电压： DC24V、DC12V 可选（订货时注明）

☑ 工作能力： 1N.m

☑ 工作行程： 21mm

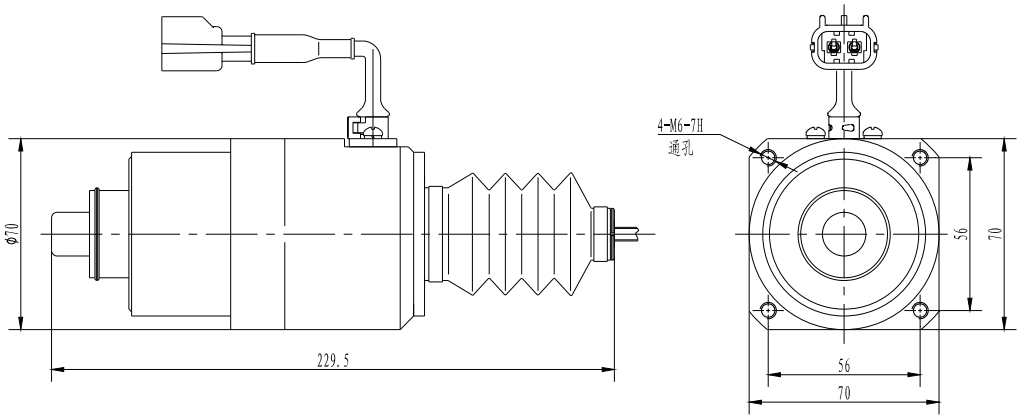


图 2.2.2.1 A1AWL 电磁执行器外形及安装尺寸图

2.2.2.2 A1AWT 电磁执行器

☑ 电源电压： DC24V、DC12V 可选（订货时注明）

☑ 工作能力： 1N.m

☑ 工作行程： 21mm

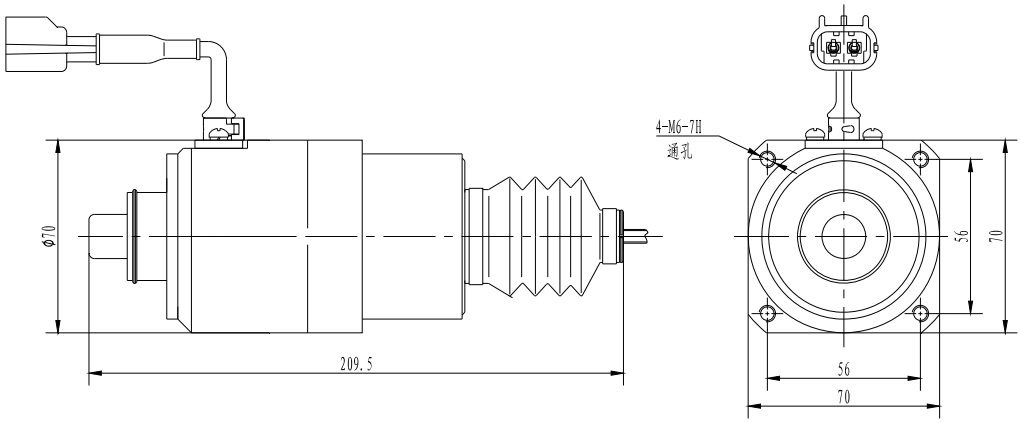


图 2.2.2.2 A1AWT 电磁执行器外形及安装尺寸图

2.3 转速传感器(PICK-UP)

本电子调速系统所采用的转速传感器采用无源磁电式转速传感器，它根据测速齿轮旋转所引起的磁隙变化，在转速传感器的磁头线圈中产生出感应电动势，形成转速信号输出。安装时应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。转速输出信号的频率与转速的对应关系为：f=nz/60，其中 f 为频率（Hz），n 为转速（转/分），z 为飞轮齿数（个）。用户可根据不同发动机的飞轮齿数按上式进行换算来初步设定转速控制器的速度设定值，在发动机起动后再精确调整，来达到所要求的转速值。

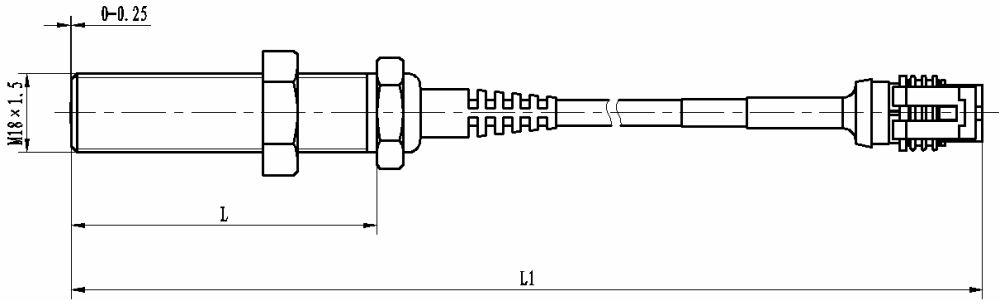


图 2.13 转速传感器外形及安装尺寸图

TM18*1.5-(L)A 系列转速传感器		
产品型号	L(MM)	L1(MM)±0.5MM
TM18*1.5-50A-00	50	315
TM18*1.5-70A-00	70	330
TM18*1.5-90A-00	90	353
TM18*1.5-130A-00	130	392

图 2.3 转速传感器结构图

★孚创公司生产的转速传感器可提供多种安装尺寸，用户可根据实际需要进行选择

警告:本电子调速系统中所使用到的转速传感器不得与其他测速系统共用，否则可能造成非常严重的后果！

3 安装与调试

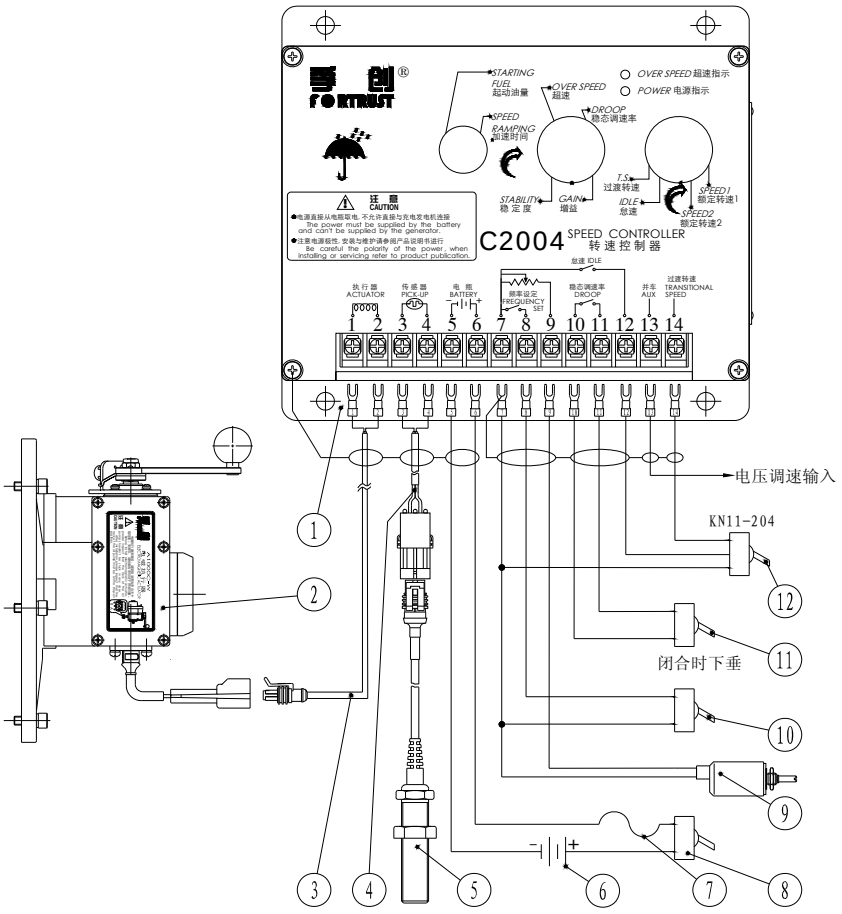
3.1 电子调速器的安装

C2004 转速控制器通常安装于控制柜之中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；转速控制器有防潮处理，但仍须防止水、雾或者凝结物等与控制器接触；安装时应远离高温及热辐射，以防止控制器高温损坏，如果在水和湿气比重较大的地方使用应将控制器垂直安装。

警告： **1．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．**

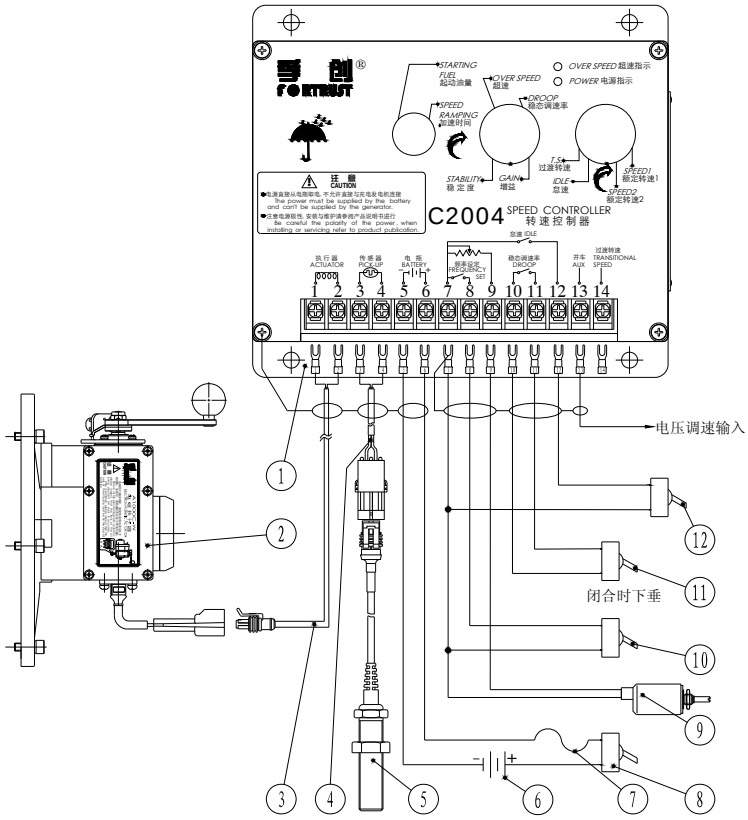
2．外接端口的 7 脚与 9 脚之间必须接配套的微调电位器；若微调电位器损坏则必须将 7 脚与 9 脚之间用导线短接，两引脚不得悬空使用。

3.2 ESG2004 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	10A保险丝
8	电源开关
9	微调电位器
10	频率切换开关
11	下垂切换开关
12	三档转换开关

图 3.1.1　ESG2004 电子调速系统接线图（方式 1）



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6	控制电瓶
7	10A保险丝
8	电源开关
9	微调电位器
10	频率切换开关
11	下垂切换开关
12	高低速转换开关

图 3.1.2　ESG2004 电子调速系统接线图（方式 2）

3.3 发动机起动前调速系统的调整

若是首次起动发动机，安装时应严格检查如下几点：

▲ 检查供油杆的灵活性

要求油泵的整个供油行程无卡滞，供油杆推拉灵活。此项检查非常重要，若供油杆不灵活，意味着可能出现控制系统失灵，造成发动机转速不稳、超速、甚至飞车等严重故障。

▲ 检查执行器的动作是否灵活

要求执行器的连杆与供油杆之间的连接无间隙，执行器的动作灵活，执行器在自然状态下的最小位置应能断油（气），在最大限位位置应能达到最大供油（气）；

▲ 检查相关电气连接

按图 3.1 或配套电子调速系统图的要求，检查电气连接是否正确，电瓶电压应符合使用要求（电瓶空载时略大于 24V（12V），起动瞬间不低于 18V（9V））；

▲ 检查出厂参数设置

孚创公司生产的电调在出厂时一般都已经根据配机单及供货状态协议进行过参数设置，只需按要求核对一下即可，若在特殊情况下您无法了解到这些信息，那么按以下几点进行检查和设置时必要的：

安装与调试

（1）检查起动油量电位器（STARTING FUEL）在较大位置（顺时针为增大方向）；观察增益(GAIN)和稳定度（STABILITY）电位器的位置，在不确定情况下请将它们设置在 12 点位置（即中间位置）；

（2）拨码开关位置若非特别注明，请按如下要求设置：四位的补偿电容调整拨码开关 SW2 置于 1 上 2 上 3 下 4 下的状态（详细设置可参考补偿电容调整表），三位的状态调整拨码开关 SW1 置于 1 下 2 上 3 下的状态（详细设置可参考状态开关调整）；

（3）将三档转速切换开关置于低速的一端（怠速），加速时间电位器（SPEED RAMPING）在升速斜率较慢的一端，不确定时可设置在 12 点（顺时针方向为升速斜率慢的一端）；

（4）控制器的转速设定在出厂时已经根据用户数据进行了预设，在起动柴油机前一般无需对控制器的转速设定电位器进行调整，用户只需在起动发动机后进行更为精准的调整；若不能确定转速设置值，请将额定转速设定电位器逆时针旋转几圈，同时观察一下怠速电位器的位置，在不确定的情况下可将怠速电位器设定在 12 点钟的位置。

3.4 发动机起动后转速控制器的参数调整

注意：在开始进行参数设定之前，以下事项是您需要关注的。

控制器上的所有电位器除额定转速 1（SPEED1）、额定转速 2（SPEED2）、超速（OVER SPEED）电位器可转动 25 圈外（如图 3.2），其余电位器如起动油量（STARTING FUEL）、加速时间（SPEED RAMPING）、稳定度（STABILITY）、增益（GAIN）、稳态调速率（DROOP）、怠速（IDLE）、过渡转速（T.S.）等电位器都是旋转不到一圈的电位器，最大有效调整角度为 270 度，从时钟方向看约为从 7 点顺时针到 4 点的范围，**在进行参数调整时，切记不得超过此范围强行转动，否则将导致电位器损坏，引起发动机停机、不稳定、甚至超速等严重故障。以上电位器均为精密电子器件，调整时应使用专用工具缓慢调节，以防造成人为破坏。**

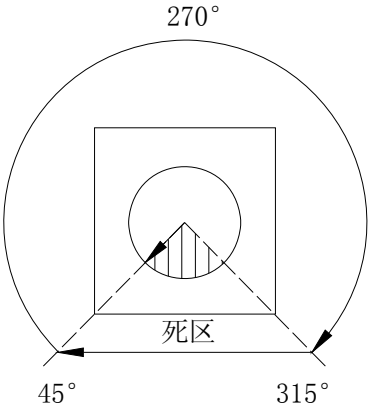

图 3.2 电位器的调节位置

3.4.1 起动油量（烟度）调整

旋转起动油量电位器（STARING FUEL）可对执行器（ACTUATOR）的起动供给油量进行调整，以保证一定的起动油量使发动机能够顺利起动，同时减少起动时燃油供给过多而不充分燃烧给发动机带来的黑烟；发动机起动后，将转速速切换开关拨到怠速位置，调整怠速电位器（IDLE），使发动机在所要求的怠速工况运转，然后逆时针旋转起动油量电位器，直到发动机转速开始下降，再回调到怠速稳定为止，然后停车重新起动。如发动机起动困难，可在该基础上适当增大起动油量（顺时针旋转是起动油量增大的方向）。

发动机的起动油量受环境温度的影响，为了使发动机在各种气候条件下都能顺利起动，应将起动油量电位器设置在偏大的位置。

3.4.2 转速的设定

本控制器的转速设定分为怠速（IDLE）、过渡转速(T.S.)、额定转速 1(SPEED1)、额定转速 2(SPEED2)四种工况，其中怠速、过渡转速均为非负荷工况，额定转速 1 与额定转速 2 为负荷工况，四者之间的标定方式为：额定转速 2>额定转速 1>过渡转速>怠速，四种转速之间是相互影响、互为关联的，设定的顺序应从转速低的速度开始。

发动机起动前应将转速切换开关控制在怠速端（怠速），同时保证频率设定（FREQ SET）开关在（OFF）的位置（对应额定转速 1 的速度），起动后通过调整怠速电位器（IDLE）来设定发动机在怠速工况下的转速值，顺时针方向为转速增加的方向，反之为转速降低的方向；根据开机状态下所显示的转速值，缓慢旋转怠速电位器，直到达到所要求的怠速值为止；

切换转速切换开关至过渡转速端（中速），发动机开始由怠速值根据一定的升速斜率逐渐升速到过渡转速值；通过调整过渡转速电位器（T.S.）来设定发动机在过渡转速下的转速值，顺时针方向为转速增加的方向，逆时针方向为转速降低的方向；根据开机状态下显示的转速值，缓慢旋转过渡转速电位器，直到达到所要求的过渡值为止；

切换转速切换开关至高速端（高速），发动机开始由过渡转速值根据一定的升速斜率逐渐升速到额定

转速 1 的速度值；通过调整额定转速 1 电位器（SPEED1）来设定发动机在额定转速 1 下的转速值，顺时针方向为转速增加的方向，逆时针方向为转速降低的方向；根据开机状态下显示的转速值，缓慢旋转额定转速 1 电位器，直到达到所要求的额定转速 1 值为止；

切换转速切换开关至中速端（中速），稳定后将频率设定（FREQ SET）开关设置在（ON）的位置（对应额定转速 2 的速度），此时对应的中速值会比原设定值偏大一点，这是正常的；然后切换转速切换开关至高速端（高速），发动机开始由过渡转速值根据一定的升速斜率逐渐升速到额定转速 2 的速度值；通过调整额定转速 2 电位器（SPEED2）来设定发动机在额定转速 2 下的转速值，顺时针方向为转速增加的方向，逆时针方向为转速降低的方向；根据开机状态下显示的转速值，缓慢旋转额定转速 2 电位器，直到达到所要求的额定转速 2 值为止；

控制器的外接微调电位器(FREQ TRIM)可以用来遥控转速，以方便对额定转速值进行更为精密的调整，顺时针调整时为转速增加的方向；

需要注意的是，当调整额定转速电位器（包括额定转速 1、额定转速 2）或外接微调电位器来调整发动机的额定转速值时，会同时影响到怠速值及过渡转速值的设定，所以在设定好额定转速值之后，应当对怠速值及过渡转速值进行校正；怠速、过渡转速值在两种额定转速值进行切换后（通过频率设定开关进行切换），会有微小的差异，对应额定转速 2 时的怠速、过渡转速值要比对应额定转速 1 时的值偏高一点，一般情况下以常用额定工况下的额定转速来设置相对应的过渡转速及怠速值，而忽略切换到另一个额定转速时对应过渡转速与怠速值的微小差异，不再做调整（除非有必要）。

3.4.3 升速时间调整

发动机由怠速工况升速到额定转速工况下所需的时间定义为升速时间，可通过调整加速时间电位器（SPEED RAMPING）来调整升速时间的长短。顺时针调整为时间延长的方向，反之为时间缩短的方向。可在 266Hz/秒至 1300Hz/秒的斜率范围内调整，有特殊要求可以定制。

3.4.4 超速保护设定

转速控制器在出厂时，超速保护值已根据用户提供的发动机型号进行过设定，用户尽量不要自行调节。如用户必须进行调节，则务必要由具有相关经验的操作人员按照以下步骤进行设定（因本控制器带双频切换，故应以实际使用的最高速度值为设置参考起点）：

一、顺时针旋转超速设定电位器（OVER SPEED）3～5 圈；

二、起动发动机，使发动机在最高额定转速下运行（如 1500 转/分）；

三、缓慢地顺时针调整对应额定转速调节电位器，使发动机转速逐渐升高，直至所要求的超速保护限

制值（如设置超速限制值为 120%额定转速时，对应的限制值即为 1800 转/分）；

四、缓慢地逆时针调整超速设定电位器，直至红色超速指示 LED 灯（OVER SPEED）亮起，同时发动机实现超速保护停机；

五、断开转速控制器的电源几秒钟（若带自启动控制系统应同时按下停机按钮，以防系统在未防备的情况下马达突然起动），并逆时针旋转额定转速电位器 1 圈后，重新通电，此时超速指示灯应该是灭的,然后起动发动机；

六、调整额定转速电位器或配合调整转速微调电位器，使发动机运行在所要求的额定转速值。至此，超速保护设定完成。

如需对超速保护设定值进行验证，用户可通过顺时针旋转额定转速电位器来逐步升高发动机的额定转速，直至发动机产生超速保护停机，并记录下此时的转速值，即为超速保护设定值。验证完后，再按以上步骤五、六顺序调整即可。若不需使用到额定转速 2 的值，而只
有一个额定转速值，则建议以额定转速 1 作为工作点进行设置，并将频率设定开关去掉。

警告：1、非专业操作人员不得进行操作；

2、超速保护限制设定值不宜设置过低，以免负载突卸时出现熄火等现象；

3、如无特殊要求，请不要对超速保护限制设定电位器（OVER SPEED）进行调整，以免出现发动机不能起动、发动机转速达不到要求、不能实现超速保护等现象。

3.4.5 稳定性调整

如果发动机起动后转速不稳定，则可阅读以下内容按步骤进行调整；稳定性的调整顺序一般为先怠速、后高速、再满载，使发动机在三种状态下都达到稳定。

注意：发动机在怠速、高速及带载情况下的稳定性是相互关联的，调整时要三者兼顾，使系统在三种工况下的稳定性都能达到最佳。在满足以上要求的情况下，增益（GAIN）电位器应尽量调节在偏大的方向，以保证发动机具有最佳的动态指标。

发动机的不稳定性可分为周期性及非周期性的不稳定两种。

周期性的不稳定性又可分为快速不稳定性及慢速不稳定性。快速不稳定性一般是指频率在 3Hz 或更高频的不稳定，而频率小于 3Hz 的不稳定则称为慢速不稳定；慢速不稳定有可能是**非常强烈的不稳定，要特别小心；若出现特别强烈的慢速不稳定，应尽快调节参数将其转变为较为快速的不稳定，再进行精细的调节，以防损坏机器甚至发生事故。**

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发动机的稳定性调整主要是通过对增益(GAIN)和稳定度(STABILITY)电位器并配合状态拨码开关 SW1 及补偿电容拨码开关 SW2 的调整来完成。增益电位器是用来调节调速系统的灵敏度，顺时针调节是增大灵敏度，反之是减少；稳定度电位器是用来调节调速系统的响应时间，顺时针调节是增大响应时间的速率，反之为减少；通过对增益和稳定度的相互配合调节，一般可使发动机达到最佳的状态。

当发动机起动后，在出现不稳定状态时，可按下面方案逐步进行调整：

方案一：

1.调节增益（GAIN）电位器：顺时针旋转增益电位器，若不稳定性有增大的趋势，则逆时针旋转增益电位器直至出现稳定；若没有稳定点，则应旋转增益电位器至相对最稳定处；调节完成后应在此基础上再逆时针回调一点以确保其稳定性能；

2.调节稳定度（STABILITY）电位器：顺时针旋转稳定度电位器，若不稳定性有增大的趋势，则逆时针旋转稳定度电位器直至出现稳定；若没有稳定点，则应旋转稳定度电位器至相对最稳定处；调节完成后应在此基础上再逆时针回调一点以确保其稳定性能。

反复方案一所述的两个步骤，一般可使发动机达到所要求的稳定性；若仍不稳定，则可继续下面的方案。

方案二：调节状态开关：

由前述可知，本转速控制器上的拨码开关 SW1（三位），即为状态开关，是用来更改控制器对信号的处理方式以适应不同发动机的固有特性的，该拨码开关每一位所表达的意思及所适合的机型可参考如下表格：

图表 1.SW1 状态调整（表中所说的“上”与“下”分别对应于 ON 与 OFF）

项目	拨码开关状态	适用
SW1(三位)	1 上 2 上 3 下	适用于阻尼力较大的机型，对大中型柴油机或燃气机可选用此状态
SW1(三位)	1 下 2 上 3 下	适用于 100KW 以下的小型柴油机，有较好的动态指标及稳定指标
SW1(三位)	1 下 2 下 3 上	适用于发动机与发电机之间出现软性连接的机组，对 30KW 以下的微型机型有较好的动态指标及稳定指标

需要注意的是，以上设置及分类是根据大量的配机试验及日常使用经验而得出的结论，对于一些由于在发动机设计、制造或系统集成等方面所形成的系统的固有特性可能并不是明确地按以上分类的，甚至出现状态交叉的现象，因而说以上分类并**不具有明确的对应关系**。

SW1 状态拨码开关 1 号位置，是基于转速控制器对调速系统的响应时间而设计的；

SW1 状态拨码开关 3 号位置，是基于消除在由发动机驱动发电机时所表现出的一种软性摩擦连接而引起的调速系统快速漂移状态而设计的；

由以上分析可知，当发动机出现快速不稳定，且发动机速度越高其不稳定的频率也越高，反之亦然，这时，可尝试将 SW1 的 1 号拨码开关置于 OFF 端（下面），来减少转速控制器对高频信号的敏感度；亦可尝试将 SW1 的 3 号拨码开关置于 ON 端（上面），以消除可能存在的软性摩擦连接而引起的快速不稳定状态；调节好状态后，再重复方案一的方法进行调整，若仍不稳定，可根据图表 2 找出对应此时 SW2 拨码开关的状态，并按图表 2 来调校，拨码开关设置完后应再次重复方案一的方法进行调整，直到发动机稳定。

图表 2.SW2 补偿电容调整

如果是**快速不稳定**，请根据 SW2 的状态在图表中找到对应的位置，并**沿图表往下调整**			
如果是**慢速不稳定**，请根据 SW2 的状态在图表中找到对应的位置，并**沿图表往上调整**			
4	3	2	1
ON	ON	ON	ON
ON	ON	ON	OFF
ON	ON	OFF	ON
ON	ON	OFF	OFF
ON	OFF	ON	ON
ON	OFF	ON	OFF
ON	OFF	OFF	ON
ON	OFF	OFF	OFF
OFF	ON	ON	ON
OFF	ON	ON	OFF
OFF	ON	OFF	ON
OFF	ON	OFF	OFF
OFF	OFF	ON	ON
OFF	OFF	ON	OFF
OFF	OFF	OFF	ON
OFF	OFF	OFF	OFF

当出现慢速不稳定，可尝试将 SW1 的 1 号拨码开关置于 ON 端（上面），或根据图表 2 来进行调校，每调校一次都应重复方案一的方法进行调整，直至达到稳定；

当出现非周期性不稳定时，亦可根据图表 1 及图表 2 的方式来进行调整；若通过以上方案仍不能成功解决，则可能是发动机本身的问题，应检查燃油系统、进气系统、负载的稳定性，并评估发动机的性能，还应检查电源的稳定性、转速信号的幅度是否符合要求（怠速时大于 1.5Vpp，正常转速时大于 4Vpp）、转速信号线和外部调速信号线的屏蔽效果是否良好等。

3.4.6 稳态调速率的调整

3.4.6.1 稳态调速率的调整适用于多台机组并联运行时使用；

3.4.6.2 首先，将每台单机的端子 10、11 短接，打开转速控制器的下垂功能，发动机的下垂特性变软（当将 10、11 端短接后，发动机的转速会有微小的变化，变化幅度的大小取决于您选用的电磁执行器），使得发动机转速会随着发动机负载的增加而减小，当发动机满载时，发动机转速减小的值与额定转速之比，即称之为稳态调速率，，该值可通过调节稳态调速率电位器来改变，顺时针调节为增大稳态调速率的方向，反之减小，用户应根据相关标准或需要进行调节；当您在调整稳态调速率电位器后，发动机的转速会有微小的变动，需要您重新对发动机的转速进行校正。

3.4.6.3 以下举例说明稳态调速率的调整过程：

比如现在有一台 1500 转的机组需要 3%的稳态调速率，即空载时 1545 转，满载时为 1500 转。

a. 调节之前请确认转速控制器所有外接附件都已连接正确，端子 10、11 已短接；

b. 发动机起动后，在空载状态下，将稳态调速率电位器（DROOP）调至大约 12 点钟方向，然后调节额定转速电位器（SPEED）或外接微调电位器(FREQ TRIM)将发动机的转速调整为 1545 转；

c. 调整完成之后，缓慢的增加负载至满载，此时发动机转速会随着负载的增加而缓慢下降；

d. 记录满负载时的转速值，若满负载时转速值超过 1500 转，意味着调速率偏小，需顺时针方向调整稳态调速率电位器一点；反之说明调速率过大，需逆时针方向调整稳态调速率电位器一点；

e. 注意：满负载时不得调节额定转速电位器或外接微调电位器！在经过步骤 d 的调节后，
将发动机缓慢卸载至空载；

f. 空载后，此时发动机的转速将不再是之前设定的 1545 转，可继续通过调节额定转速电位器或外接微调电位器将发动机的转速调整到 1545 转（此过程中不得调节稳态调速率（DROOP）电位器）；

g. 不断重复 C 到 f 的步骤，直至达到发动机的速度在空载时 1545 转、满载时 1500 转便完成了所要求的 3%稳态调速率的调整。

3.6 辅助输入

3.6.1 端子 13 作为辅助输入信号，其信号从负载分配单元、自动同步装置或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。若同步器是单独使用，而不与负载分配器连接，则应该在13、14 端子之间连接一个 3MΩ的电阻来进行电压匹配。

3.6.2 当引入辅助输入信号时，发动机的转速将发生小幅变化，需重新再调整额定电位器或外接的转速微调电位器对发动机的转速进行校正。

4 故障判断与处理

4.1 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；如果调速系统不起作用，且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 DC24V 或 DC12V，并注意电子调速器电源(POWER)指示灯是否亮。
	控制器	超速限制值设置过低，造成超速保护（此种情况时超速指示灯 OVER SPEED 会亮）。
	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是否符合要求。
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 3.4.5。
		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、超速限制值设置过高。
		4、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。当转速信号电压低于 3V 时，应减小速度传感器和发动机的齿间隙，来提高转速信号的振幅。间隙要求小于 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

调速系统会被大的干扰信号通过电缆的传导或直接辐射进入到控制回路，对控制回路产生不利的偏差，给调速系统带来不良影响。为了防止中等的干扰，所有孚创生产的转速控制器都包括过滤装置和屏蔽设置，来保护敏感回路不受外部干扰源的影响。

对干扰值的预测是复杂和困难的，对于空间场的无线电通信、无线对讲机、无线电发报机以及包括使用磁电机、固态点火系统、电压调节器或电池充电机等都应该考虑在可能的干扰源范围内。当您怀疑到空间场或其他系统在使用过程中通过传导或直接辐射的方式影响到了本调速系统的工作时，我们建议您将本控制器的所有外接线缆都使用双屏蔽线缆，并应确保屏蔽线的一端包括速度传感器的屏蔽线 360 度环接到转速控制器外壳的一个支点上，并且将速度控制器的金属板接地或安装在内封密的金属箱内，来防止电子辐射的干扰；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，则其产生的电火花干扰是不能忽略的，所以大的干扰环境应采用特殊的屏蔽措施；若您不能解决此类问题，请与我们的工程师联系，他们将会给您提供更多的建议。

Foreword

This manual mainly introduced the working principle of the electronic governor system,composition,Regulation,operation,maintenance and simple troubleshooting method, it is apply to the working people who know something of the speed controller of to the engine and in charge of some relative things such as installation,connection,usage,and maintain.We suggest to put this manual in the workplace and operate the product according to the mentioned method strictly.

Caution

- Speed sensor to the electronic control system shall not be shared with other systems, or they may cause serious consequences.
- You can't rely on the electronic speed control system to prevent engine overspeed, and overspeed protection device installed independently, effectively in the engine system.
- Before starting the engine should confirm the fuel injection pump rod in oil cut-off position, push and pull the fuel rack should be flexible and no jam.

CATALOGUE

1 The working Principle of the electronic governor

Electronic governor is a precision control device to control the engine works stably under the preset speed. Electronic governor, with its high reliability, full faction, convenient operation & maintenance, high performance of speed control and other special advantages better than other type electronic governor, which have been applied to all kinds of diesel generating sets, vehicles and marine diesel engines more and more widely, this will be a development tendency of the industry application in the future.

The electronic governor is a close loop control system, which compose of the speed setting, speed measurement, comparison, calculation, driven output, actuator, parameter adjusting setting, over speed protection and restrict. (See Figure 1.1)

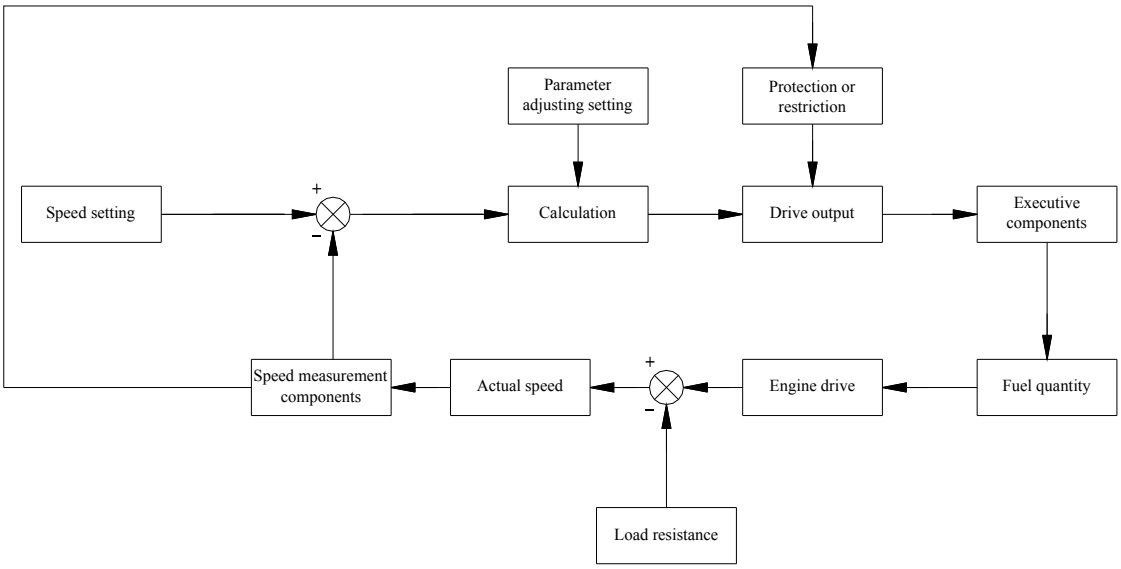


Figure 1.1 Electronic governor system

The closed-loop control mode of the electronic governor can make a quick and accurate response to the instantaneous load change, which can control the engine speed to the stable trend。Manually adjust the potentiometers such as GAIN, STABILITY and DROOP to meet the requirements of different engines on the transient adjustable rate, time stability and steady-state rate.

Speed Control Unit

2 The Structure Of The Electronic Governor System

2.1 C2004 SPEED CONTROLLER

2.1.1 **The basic electronic characteristics**

☑ SUPPLY VOLTAGE: DC24V（Scope 18V～32V）or DC12V（Scope 9V～16V）

☑ SUPPLLY CONSUMPTION： < 0.2A (static state)

☑ SPEED FLUCTUATION RATIO： ≤±0.25 %

☑ STEADY STATE SPEED DROOP： 0～5 % Adjustable

☑ AMBIENT TEMP.： -40℃～ +85℃

☑ RELATIVE HUMIDITY： < 95%

2.1.2 Basic Performance Of C2004 controller

● Adjustable starting fuel: adjusting the status of the smoke exhaust when the engine starts；

● Speed control and fine adjustment: adopting the single closed-loop method to realize accurate speed adjustment and remote control；

● Raising speed time adjustable: can adjust engine from idle to the rated status；

● Overspeed protection：Can set the overspeed limit value, cut off the actuator power supply, stop the engine；

● High and low speed conversion: can convert between idle status and rated status；

● Droop adjustable: can adjust the speed range；

● Parallel machine function: can realize parallel machine function by manual or automatic way；

● The whole speed adjusting: can adjust speed in a continuous and smooth condition within a certain range；

● Automatic shutdown protection: when the speed signal disappears or the controller is power off, the engine will shutdown automatically；

● Dual frequency switching：Suitable for two types of calibration simple switching between the rated speed；

● Transition Rotational speed：Between the idle and the rated speed setting a transition speed transition；

For more information about the basic performance, please see the following chapter about the parameter setting instruction. The function of whole course speed governing may require the different external connection accessories according to user's different requirement of speed governing range. If you need this function please contact us.

2.1.3 The outline overall and installing dimension of controller C2004

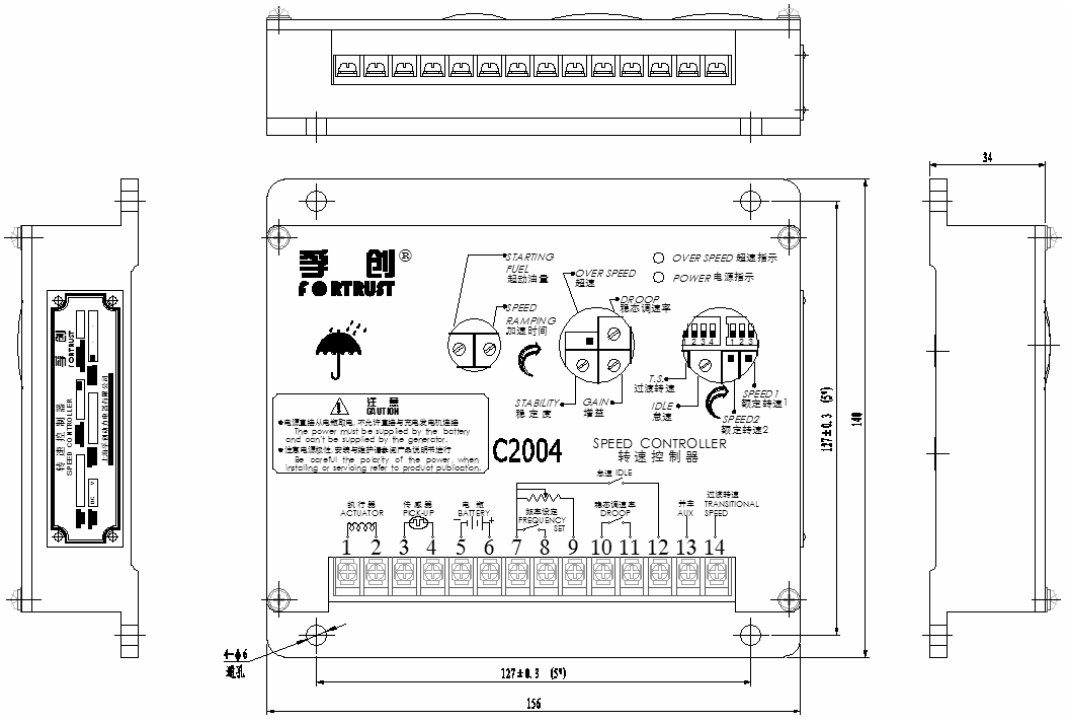


Figure 2.1 The outline overall and installing dimension of controller C2004

2.1.4 The wiring diagram of speed controller C2004

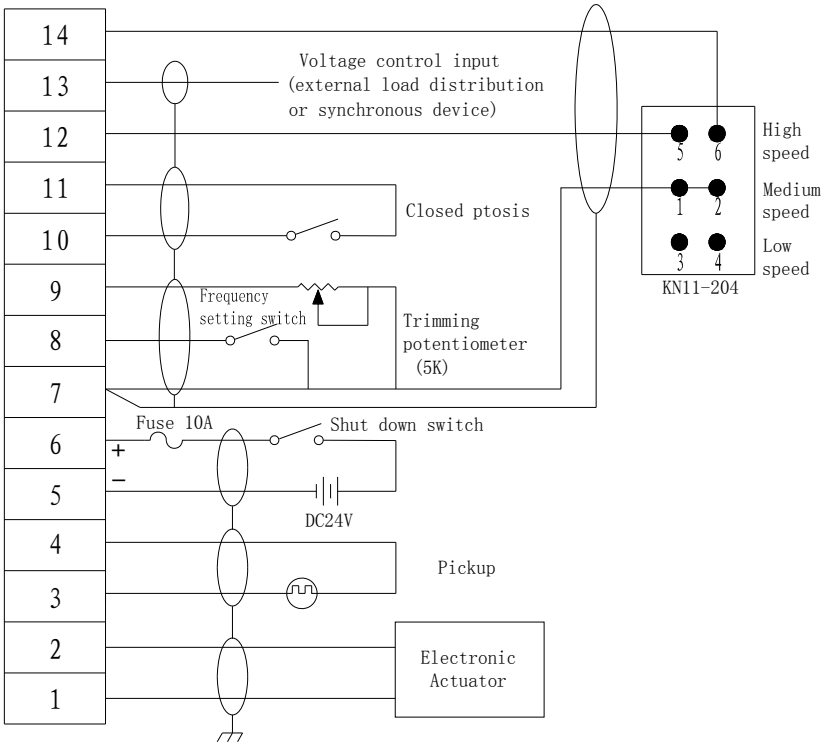


Figure 2.2.1 The wiring diagram of speed controller C2004 (Methods 1)

Speed Control Unit

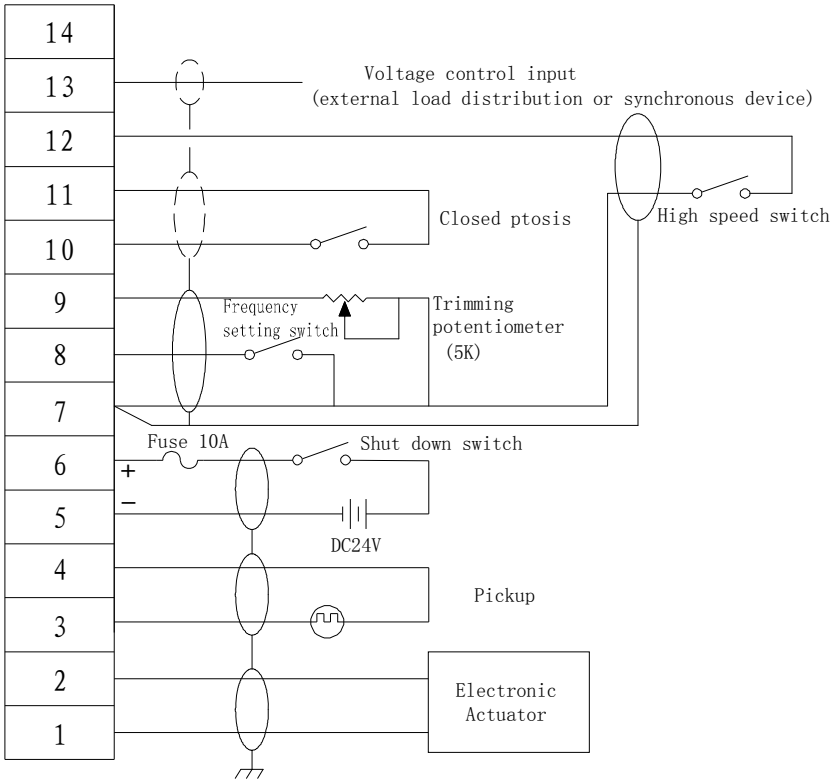
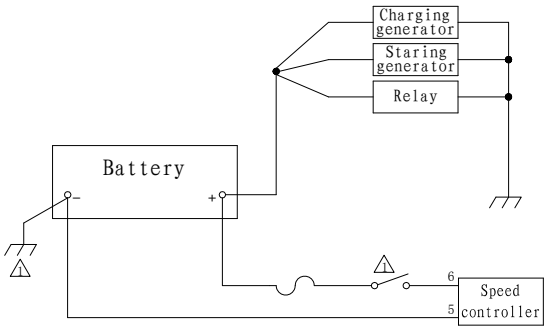


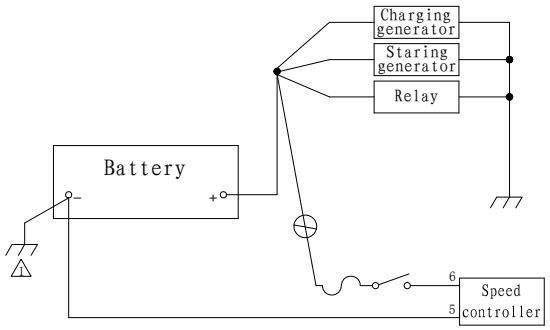
Figure 2.2.2 The wiring diagram of speed controller C2004 (Methods 2)

2.1.5 The definition and requirement of Connection Terminal:

● Terminal 1 and 2 is use for connecting the actuator, terminal 5 and 6 is use for connecting the battery, the cable section should be 1.3 mm² or more to decrease the voltage drop, so more long more bigger. For avoiding the accident, a 15 A fuse is necessary on the cable that is from the battery positive to the power positive of the speed controller (terminal 6);The cable of the speed controller should be connected directly and separately from the battery positive and negative, please don't connect to other terminal, for the correct way see below:



☑ The correct wiring diagram



☒ The wrong wiring diagram

Speed Control Unit

● Terminal 3 and 4 is use for connecting the speed sensor, the cable should be the braided shielded net cable and connect to the point by 360°as figure 3.1 indicated, but it can't be connected to others of the engine ,otherwise it may have the interference signal input to the speed controller and result in the unpredictable consequence；

● The remote potentiometer connects to Terminal 7 and 9.（FREQ TRIM），and can be extended cable remote control (the longest cable up to 5M)，If the length of cable exceeds the required limited value, you must use the braid shielding network cable for connection, the shielding net ring shall be 360-degree ring receiving terminal 7，If it resistance is 5K, speed adjusting range is 2400HZ.；

● Frequency setting (FREQ SET) switch 7 can be connected, the 8 terminal, when required in two under the rated condition of frequent switching when in use, can be switched over simple and fast through the switch, so as to save RE complex steps of speed setting;

● 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%；

● 7, 12, 14 terminal by a special three-way toggle switch, sequential switching between idle or transition speed or rated speed, when the engine speed large span or inertial force is relatively high, but the transition from the speed of transition, to protect the engine；

● Terminal 11 (AUX) can be used as external voltage control device setting，As a sensitive input terminal, it is recommended to use the shielding cables to connect with various parts to prevent the external signal interference; this terminal can be directly connected to the synchronous controller and load distributor produced by Fortrust; There is no need to connect in unit operation；

2.2 Electromagnetic Actuator

The speed controller as this manual mentioned can used with all of the single close-loop actuator that produced by Fortrust, customer choose the actuator and middle plate flexibly according to the model number of the pump, and you also can ask for Fortrust People provide a best solution to you after testing in the site. The actuators as this manual listed according to the requirement of your products, if you need more information of the actuators please log in Fortrust company website as www.fortrust.cn or send mail to sales@fortrust.cn or call us 021-51961611/12/13;

Different actuator with different stability, if you find the problem about that please contact us, we will provide the professional solution to you.

The Electromagnetic Actuator is the executive element of the electronic governor. ESG2004 series speed control unit that is single-loop control mode can matching all kinds of electromagnetic actuator, such as A800C-W、A900C-W、A1000C-W-d1、A2000C-W-d1、A08A-W、A1AWL、A1AWT、A3A-W、A3B、CA2-W.

The following introduction can be divided into external and internal type respectively according to the actuator of the installation.。

2.2.1 **Internal type Actuator**

Internal installation refers to the electromagnetic actuator part instead of the high pressure oil pump mechanical governor attached directly to the high pressure oil pump body as an organic whole, internal actuator rack and the high pressure oil pump rack and linkage. Actuator external parking hand handle, and can be realized by adjusting the handle is the location of the parking of the bulk oil limited. ESG2004 series can match internal actuator such asA800C-W、A900C-W、A1000C-W-d1、A2000C-W-d1、A08A-W、A3A-W、CA2-W.。

2. 2. 1. 1 A800C-W electromagnetic actuator

☑ WORKING VOLTAGE: DC24V

☑ WORKING TORQUE: 0.8N•m

☑ WORKING STROKE: 17mm

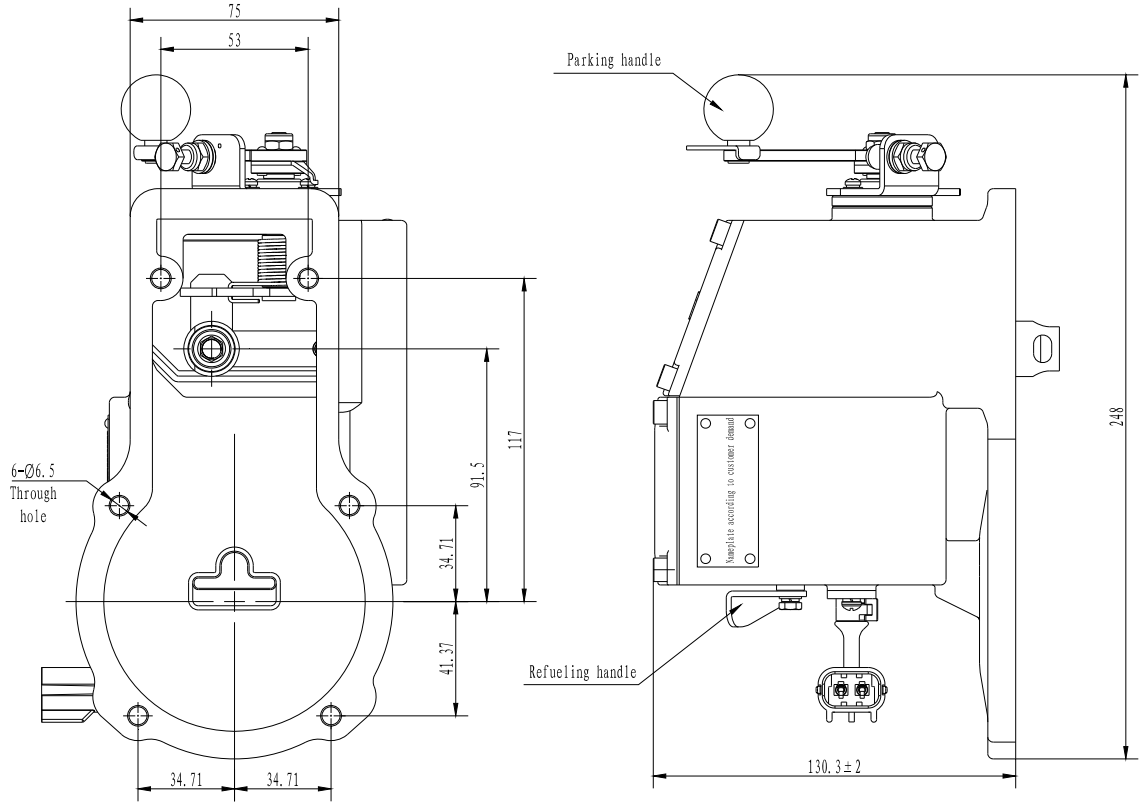


Figure 2.2.1.1 The outline and installing size of the A800C-W electromagnetic actuator

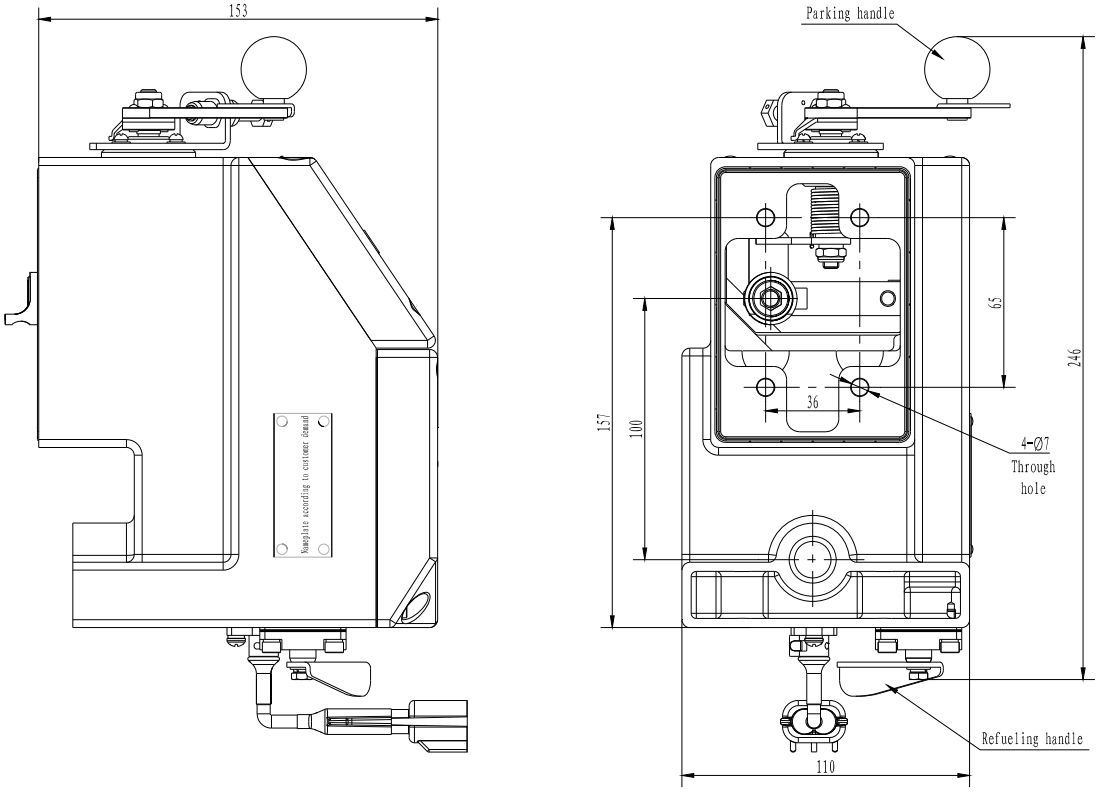
Electromagnetic Actuator

2. 2. 1. 2 **A900C-W electromagnetic actuator**

☑ WORKING VOLTAGE： DC24V

☑ WORKING TORQUE：. 0.9N•m

☑ WORKING STROKE：. 22.5mm



ure 2.2.1.2 The outline and installing size of the A900C-W electromagnetic actuator

2.2.1.3 A1000C-W-d1 electromagnetic actuator

☑ WORKING VOLTAGE： DC24V、DC12V optional (order specify)
☑ WORKING TORQUE： 1N.m
☑ WORKING STROKE： 22mm

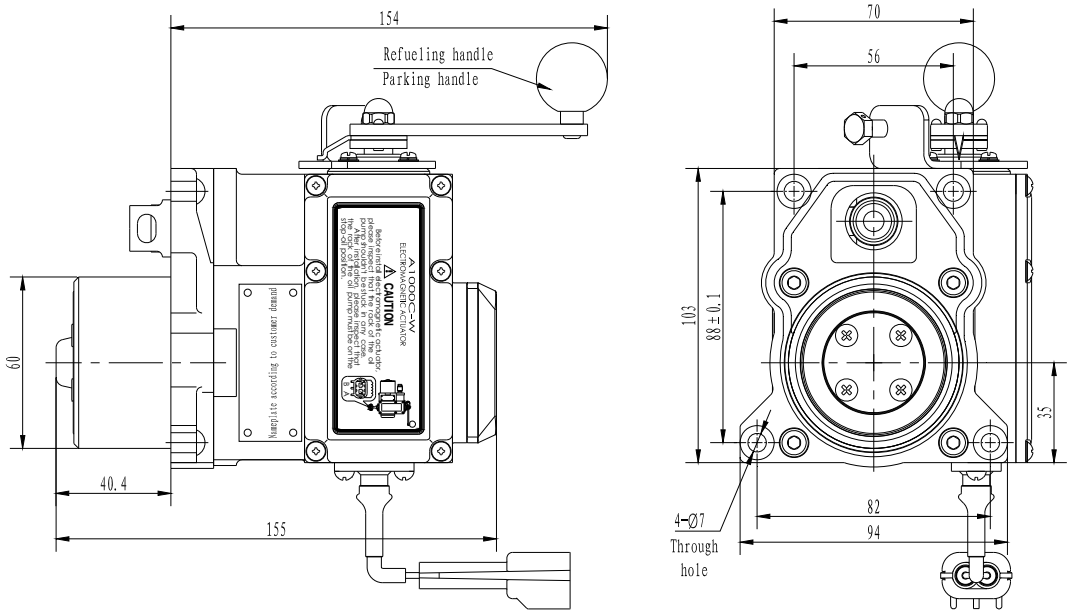


Figure 2.2.1.3 The outline and installing size of the A1000C-W-d1 electromagnetic actuator

2.2.1.4 A2000C-W-d1 electromagnetic actuator

☑ WORKING VOLTAGE： DC24V
☑ WORKING TORQUE： 2N•m
☑ WORKING STROKE： 22mm

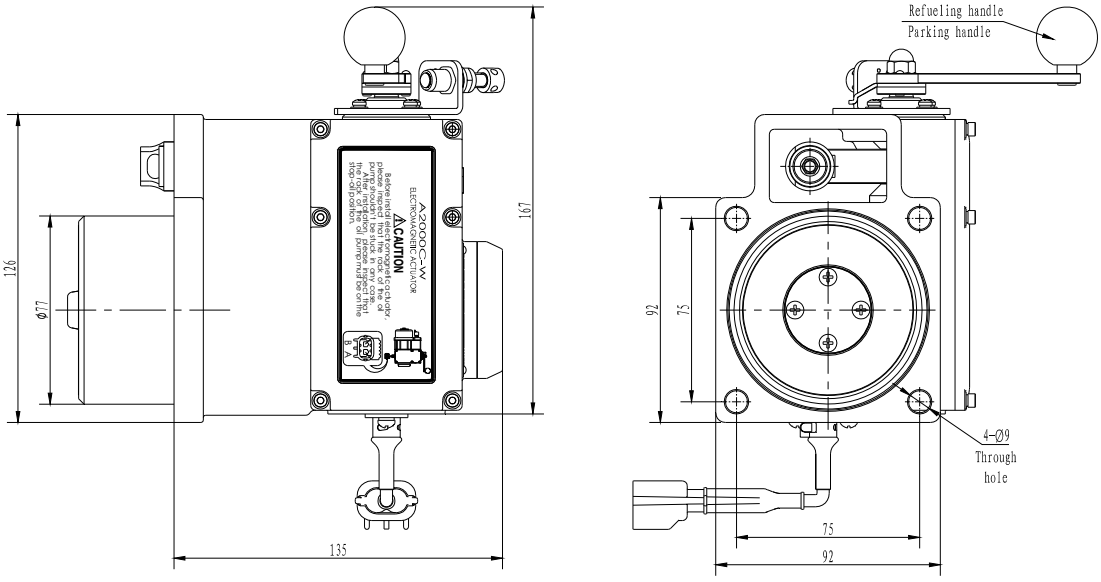


Figure 2.2.1.4 The outline and installing size of the A2000C-W-d1 electromagnetic actuator

Electromagnetic Actuator

2.2.1.5 A08A-W electromagnetic actuator

☑ WORKING VOLTAGE: DC24V、DC12V optional (order specify)
☑ WORKING TORQUE： 0.8 N.m
☑ WORKING STROKE： 18mm

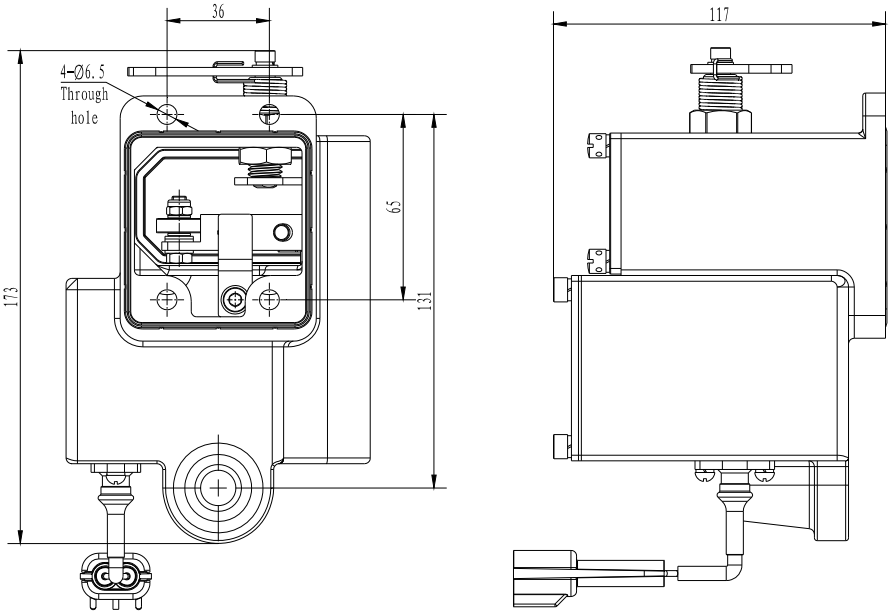


Figure 2.2.1.5 The outline and installing size of the A08A-W electromagnetic actuator

2.2.1.6 A3A-W electromagnetic actuator

☑ WORKING VOLTAGE: DC24V、DC12V optional (order specify)
☑ WORKING TORQUE： 0.9N•m
☑ WORKING STROKE： 19mm

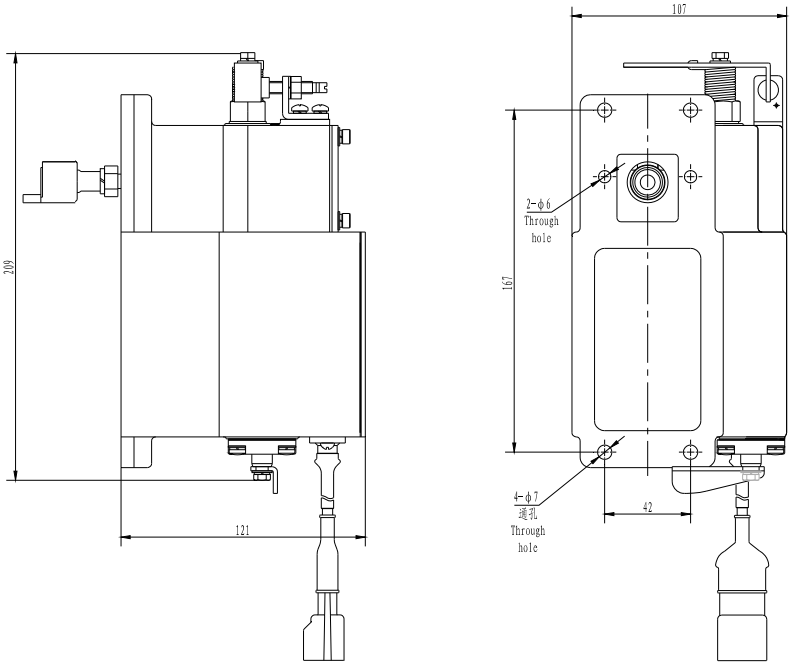


Figure 2.2.1.6 The outline and installing size of the A3A-W electromagnetic actuator

2.2.1.7 CA2-W electromagnetic actuator

☑ WORKING VOLTAGE： DC24V

☑ WORKING TORQUE： 1.2N.m

☑ WORKING STROKE： 20mm

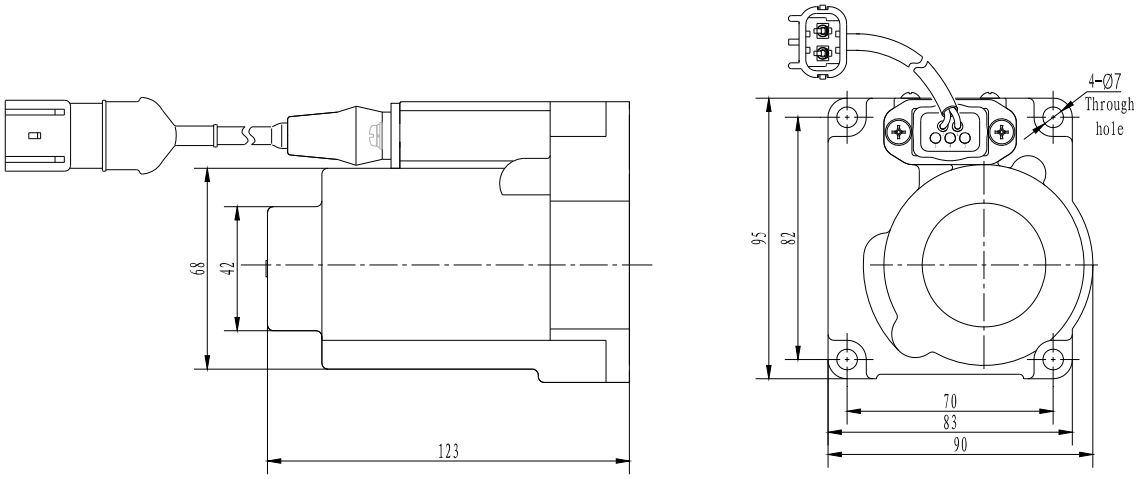


Figure 2.2.1.7 The outline and installing size of the CA2-W electromagnetic actuator

2.2.2 External type installation

External installation refers to the oil supply handle through electromagnetic actuators linkage with mechanical governor cut-out handle connected to the pump in the actuator，on the connection handle to set the different installation hole, by changing the location of the mounting holes can meet different stroke and the pump torque, and this kind of connection mode is more suitable for the complete assembly of diesel engine and governor. ESG2004 series can match the external actuator,such as A3B、A1AW.

Electromagnetic Actuator

2.2.2.1 A1AWL electromagnetic actuator

☑ WORKING VOLTAGE: DC24V、DC12V optional (order specify)

☑ WORKING TORQUE： 1N.m

☑ WORKING STROKE： 21mm

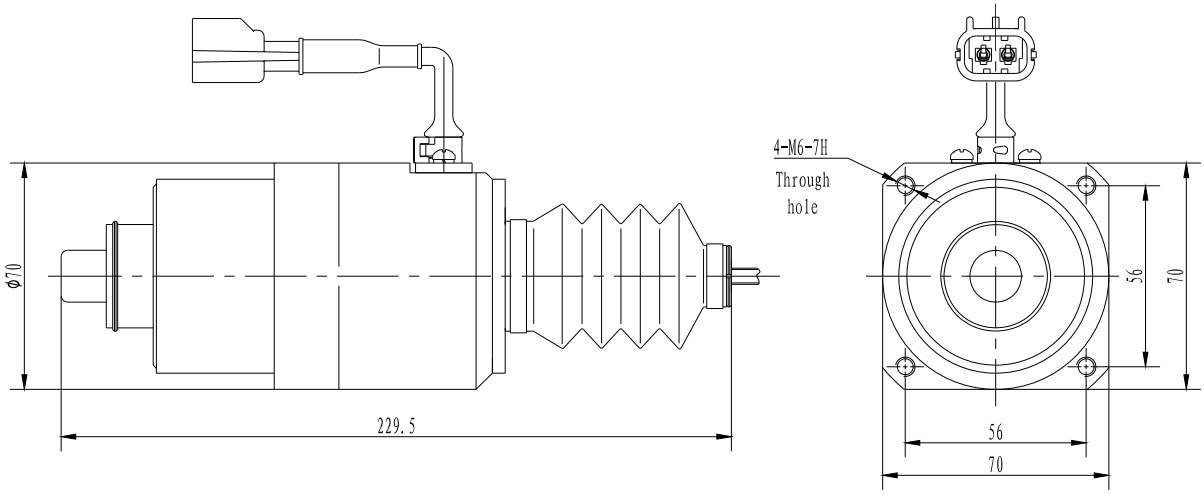


Figure 2.2.2.1 The outline and installing size of the A1AWL electromagnetic actuator

2.2.2.2 A1AWT electromagnetic actuator

☑ WORKING VOLTAGE: DC24V、DC12V optional (order specify)

☑ WORKING TORQUE： 1N.m

☑ WORKING STROKE： 21mm

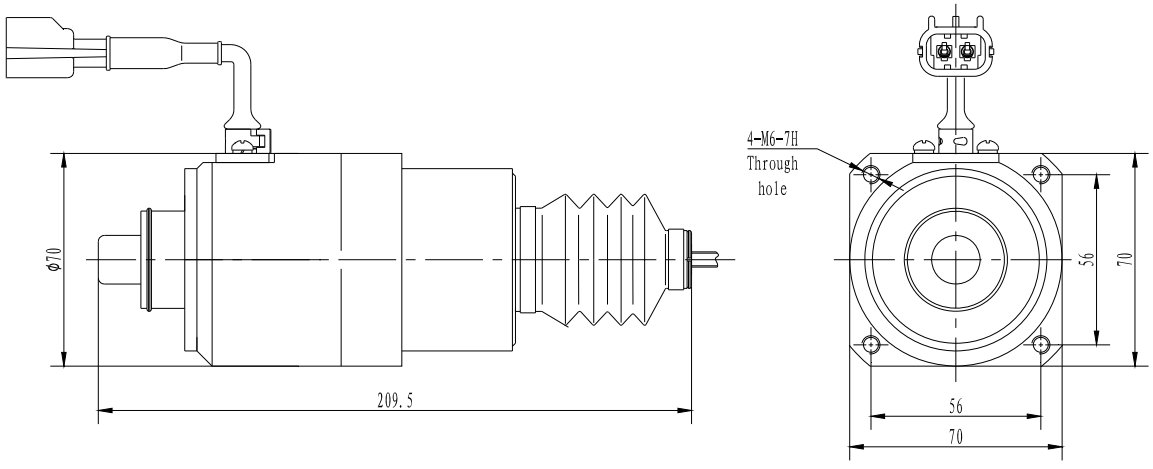


Figure 2.2.2.2 The outline and installing size of the A1AWT electromagnetic actuator

2.2.2.3 A3B electromagnetic actuator

☑ WORKING VOLTAGE: DC24V、DC12V optional (order specify)

☑ WORKING TORQUE: 0.9N.m

☑ WORKING STROKE: 25°

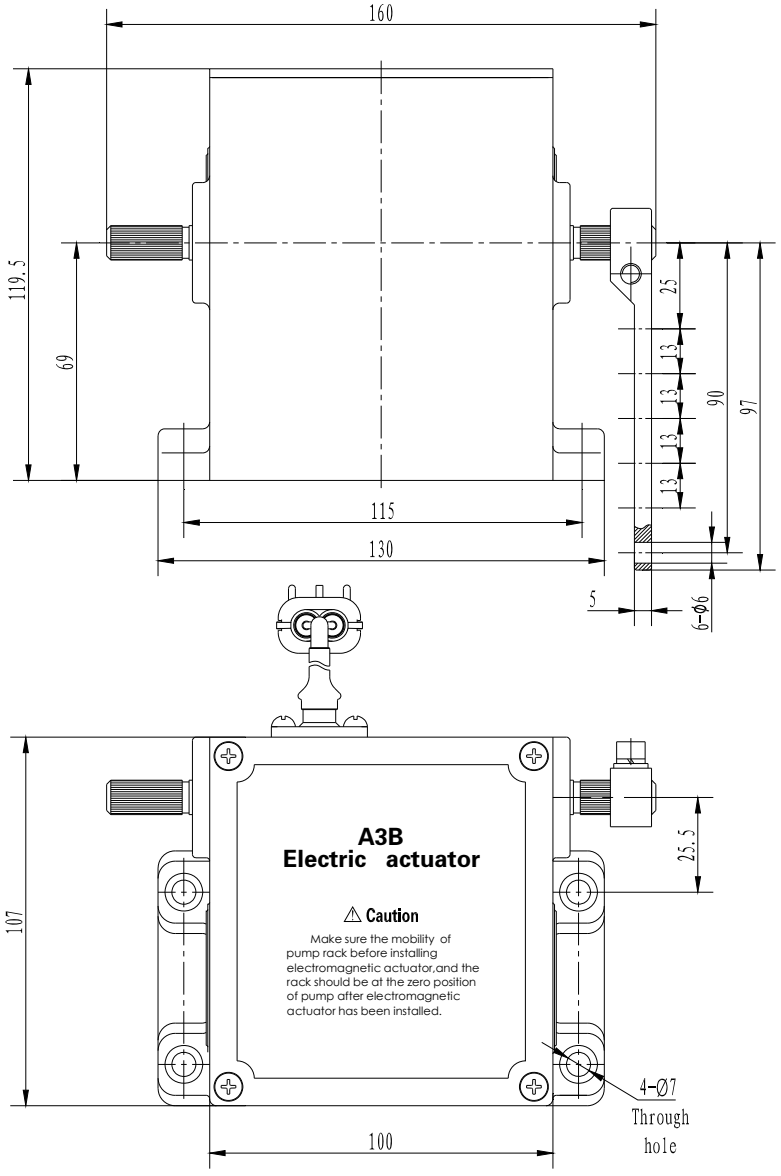


Figure 2.2.2.3 The outline and installing size of the A3B electromagnetic actuator

2.3 Speed Pick-up

The speed sensor of this electronic governor system we used is the passive magnetoelectric speed sensor, it output the speed signal through the magnet gap change that caused by the rotation of the speed measuring gear, and the change will generate the induced electromotive force in the coil of the speed sensor. The speed sensor should be fixed on the engine gear plate when install it, the engine speed will be got through the reaction of flywheel gear numbers; The best gap of installation of the speed sensor is return 1/2 — 3/4 circle(about 0.45mm）after touching the gear teeth. f=nz/60, f is frequency（Hz）, n is speed (speed/minute),z is flywheel gear numbers. Customer could use this formula to calculate and get the initial speed value of speed controller, and adjust the value to the required value after starting the engine.

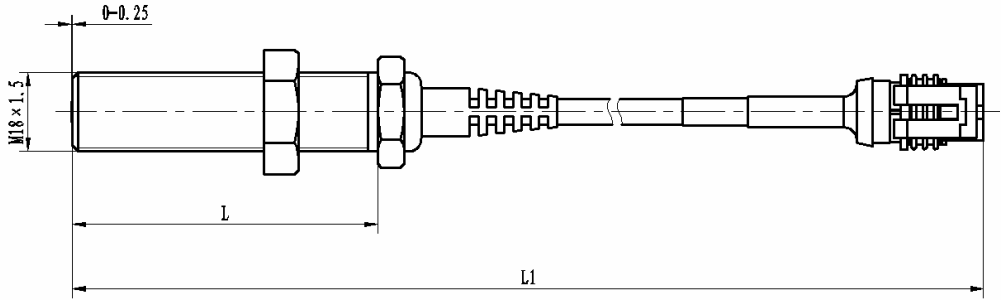


Figure 2.13 The Structure Chart of Speed Senor

TM18*1.5-(L)A Series Speed Sensor		
Product Model No.	L(MM)	L1(MM)±0.5MM
TM18*1.5-50A-00	50	315
TM18*1.5-70A-00	70	330
TM18*1.5-90A-00	90	353
TM18*1.5-130A-00	130	392

★Speed sensor produced by Fortrust have different model with different installing dimension, people choose according to your demand.

Cautions: The speed sensor is only use for this electronic governor, it cannot be used with other speed measuring system, otherwise it may result in very serious consequence!

Installing and Debugging

3 The Installation and Debugging

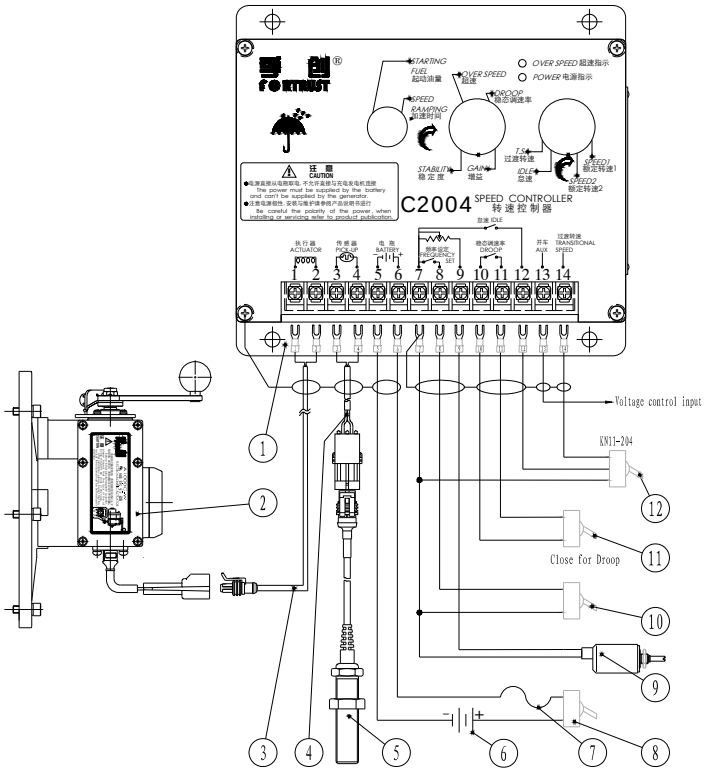
3.1 The installation of the electronic governor

The C2004 speed controller is usually installed in a control cabinet or fixed on other external device of the engine, and please choose the place with dry air and appropriate temperature. The the speed controller should be far away from the water, the mist or the freezing object, even if it has the dampproof surface; the speed controller also should be far away from the high temperature and the thermal radiation to avoid it was damaged. If the place is near the water or with the heavy moisture, please install the controller by vertical direction.

Cautions: 1.The engine should have its own over speed protection device, it cannot only rely on the control system of electronic governor to stop over speed.

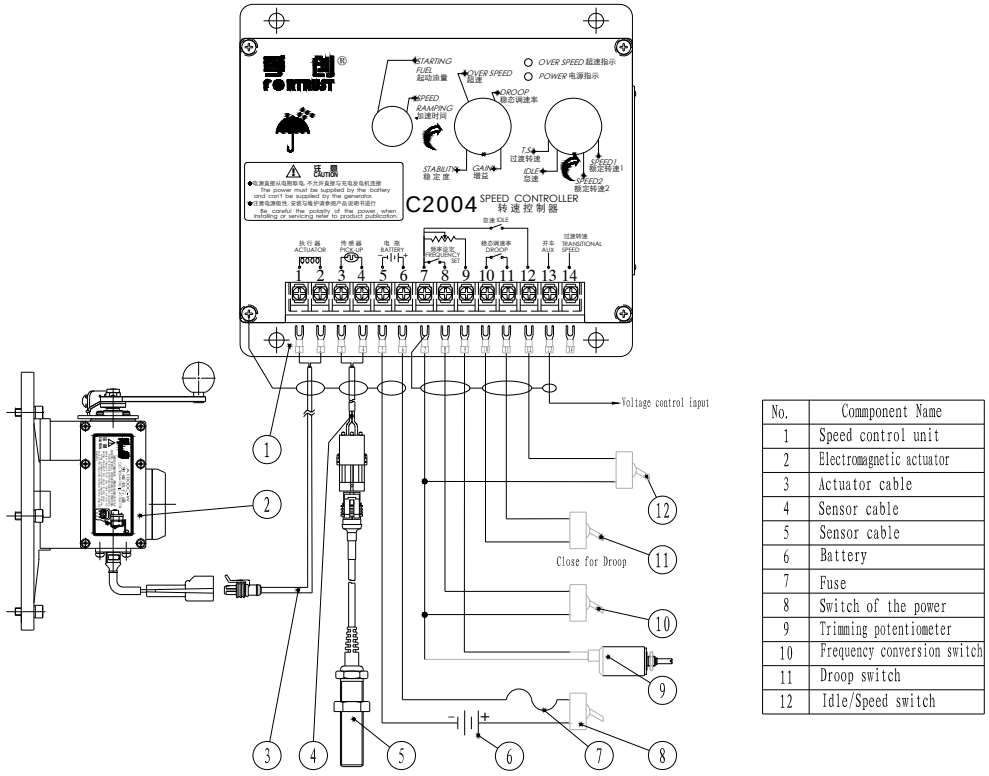
2. Must match with the trimmer potentiometer between terminal 7 and terminal 9 external ports;If trimming potentiometer is damaged, it must be a terminal 7 and terminal 9 conductors are used for short circuit, shall not be suspended between two terminals use.

3.2 The wiring diagram of electronic governor



No.	Commponent 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	Frequency conversion switch
11	Droop switch
12	third gear switch

Figure 3.1 The wiring diagram of electronic governor (Methods 1)



No.	Commponent Name
1	Speed control unit
2	Electromagnetic actuator
3	Actuator cable
4	Sensor cable
5	Sensor cable
6	Battery
7	Fuse
8	Switch of the power
9	Trimming potentiometer
10	Frequency conversion switch
11	Droop switch
12	Idle/Speed switch

Figure 3.1 The wiring diagram of electronic governor (Methods 2)

3.3 Debugging before starting engine

If start the engine in the first time, please strictly check as below:

▲ Check the flexibility of the oil rod

The whole oil supply of the pump should work without jamming and the oil rod works flexibly. If the oil rod worked inflexibly, it means the control system is not work properly and it may cause the major failure of the engine such as speed unsteady, over speed and run away。

▲ Check the flexibility of the actuator

There should have no gap between the shaft of the actuator and oil rod, the actuator is working flexibly, the minimum section is reach to stop oil and the maximum section is reach to supply oil at larges;

▲ Check the relative electrical connection

According to figure 3.1 wiring diagram or the requirement of mating electronic governor system, please check if the electrical connection is correct and battery voltage is accord with the requirement (No-load is slightly larger than 24V,starting moment is not less than 18V);

Installing and Debugging

▲ Check the factory parameter setting

The electronic governor produced by Fortrust have been finished the parameter setting usually according to customer's supply agreement, so you just need to check it, if you cannot get the information under the special situation, please check and set as below：

（1）Check the position of starting Fuel if it is on larger position (Clockwise is for increasing); Check the potentiometer section of GAIN and STABILITY, please set them to 12'clock position if you cannot be sure；

（2）Dial switch position unless specifically stated, please set according to the following requirements: compensation capacitance adjustment four digit dial switch SW2 is arranged in the 1 on 2 on 3 under 4 under state (with setting the reference compensating capacitor adjustment table), to adjust the state of three bit code dialing switch SW1 is arranged in the 1 on 2 under 3 under the state (with set reference state switch adjustment);；

（3）Please set the third gear switch in the low speed (Idle), the SPEED RAMPLING potentiometer at the end of the slower acceleration slope, and in the uncertain case, please set it at 12 o'clock position(the clockwise direction is the end of slower acceleration slope)；

（4）The speed of controller have been preset according to user data, you don't need to adjust the the speed setting potentiometer of the controller before starting the diesel engine, you just need to adjust it accurately after starting the engine. If you cannot sure the speed setting value, please turn the rated speed setting potentiometer by anticlockwise several circles, meanwhile observe the positon of the idle potentiometer, then set it to 12'clock position。

3.4 Parameter adjustment of speed controller after starting engine

Cautions：Before setting the parameter, please pay more attention to the following.

Except the rated speed potentiometer (can turn 25 circles, see figure 3.2),other potentiometer of the controller such as Stability, Gain, Idle cannot be turn more than one circle, their largest adjustable angle is 270°，it is about from 7'clock to 4'clock by clock direction. When you are setting the parameter, please don't turn it over this range, otherwise the potentiometer will be damaged and result in the major failure such as the engine stop, instability and over speed. All of the above potentiometers are the precision electron device, please adjust slowly by the special tools to avoid the man-made sabotage.

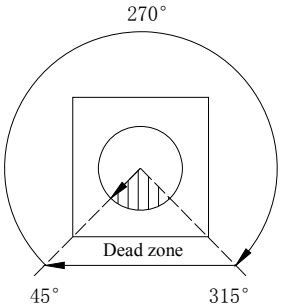


Figure 3.2 The adjusting position of the potentiometer

3. 4. 1 **Adjustment of the starting fuel (smoke)**

You can adjust the fuel supply of the actuator by rotating the STARTING FUEL potentiometer, which can ensure the engine start smoothly with certain starting fuel, and meanwhile, it can reduce the black smoke caused by the excess fuel supply and incomplete combustion；After starting the engine, the speed switching switch to idle position, adjust the idle speed potentiometer (IDLE), make the engine running at idle conditions required, and then counter clockwise rotation starting oil volume potentiometer, until the engine speed begins to drop, then the callback to idle speed stability to stop, and stop restart. If the engine start-up difficulties, can be properly increased based on this starting oil quantity (clockwise rotation is the starting oil amount increasing direction)。

The starting fuel quantity of the engine is influenced by the temperature condition, in order to make the engine start smoothly under any conditions, you shall set the STARTING FUEL potentiometer in the larger position without black smoke.

3. 4. 2 **Speed setting**

The controller is divided into IDLE, T.S., SPEED1,SPEED2 of four kinds of working conditions, IDLE, T.S.are all non load, SPEED1,SPEED2 are all load, between the four is rated speed rated speed:

SPEED2>SPEED1>T.S.>IDLE, between four kinds of speed influence each other, mutual association, set order from low speed to start speed。

Before starting the engine at idle speed will speed switch control end (IDLE), while ensuring the frequency setting (FREQ SET) switch on (OFF) position (speed corresponding to 1 of the rated speed), after starting through the adjustment of idle speed potentiometer (IDLE) to set the speed of the engine in idle conditions value, clockwise as the speed increases direction, contrary to decrease the speed of rotation direction; according to the display start state of idle speed value, slowly rotating potentiometer, until it reaches the desired value until the idle;

Installing and Debugging

Switching speed switch to transition speed end (intermediate), engine idling speed rising from the start of value according to a certain speed rising slope gradually transition to the speed value; by adjusting the transition speed potentiometer (T.S.) to set the engine speed in the transition speed value, clockwise for speed increase direction, counterclockwise rotation speedin the direction of decreasing display; according to the on state value of speed, slowly rotatingtransition speed potentiometer, until you reach the required value transition;

Switching speed switch to high end (high speed), the engine began to transition from the speed value according to certain speed rising slope gradually rise speed to the speed of 1 of the rated speed value; by adjusting the 1 rated speed potentiometer (SPEED1) to set the engine speed rated speed 1 values, a clockwise direction as the speed increases in the direction ofcounter clockwise to decrease the speed of rotation direction; according to the on state value of speed, slowly rotating 1 rated speed potentiometer, until reaching the rated speedrequirement of 1 values so far；

Switching speed switch to medium speed (speed), the stable end after frequency setting(FREQ SET) switch is arranged at the position of (ON) (speed corresponding to 2 of the rated speed), the corresponding speed value would be a bit bigger than the original setting value,this is normal; then switch speed switching switch to high end (high speed), the engine startaccording to certain speed rising slope gradually rise speed to the rated speed of 2 rate valuesby transition speed; 2 by adjusting the rated speed potentiometer (SPEED2) to set the engineat rated speed 2 rpm value, clockwise for speed increase direction, counterclockwise rotation speed in the direction of decreasing display; according to the on state value of speed, slowly rotating 2 rated speed potentiometer, until reaching the rated speed requirement of 2 values so far；

The controller of the external Trimming Potentiometer (FREQ TRIM) can be used to facilitatethe remote control speed, rated speed value is more precise adjustment, clockwise adjustmentas the speed increases in the direction of；

Need to pay attention to is, when adjust the rated speed potentiometer (including 1 rated speed, rated speed 2) or external Trimming Potentiometer to adjust the rated engine speedvalue, will also affect the idle value and the transition speed setting value, so after setting the rated speed value, should be on the idle value and transition speed value correction; idle, the transition speed value in the two rated speed value to switch (switch to switch through thefrequency setting), there will be slight differences, corresponding to the rated speed idling, 2 when the transition speed values than the corresponding 1 rated speed when the value is a little higher, generally

rated speed rated in common conditions to set the transition speed and idle speed corresponding to the value, but ignore the small differences in switching to anotherrated speed when the corresponding transition speed and idle speed value, no longer do adjust (unless necessary)

3.4.3 Adjusting the ACC time

The time when the engine turns from idle status to the rated speed status is called ACC time. You can adjust the SPEED RAMPING potentiometer to adjust the ACC time.

The clockwise adjustment is the extended direction of the ACC time, on the other hand, it is the shorten direction of the ACC time. Under the working condition, you can make adjustment within the scope of 266Hz/S to 1300Hz/S, and it also can be customized according to the special requirements.

3.4.4 Overspeed protection setting

The speed controller in the factory and overspeed protection value has according to users with the engine models had set, users are advised not to adjust. If the user must be adjusted is necessary by the experience of operating personnel in accordance with the following steps to set (for dual band switch, the controller should be at top speed and the actual use of the value set for a reference point)：

Ⅰ、Clockwise rotation overspeed setting potentiometer (OVER SPEED) 3 to 5 ring；

Ⅱ、Start the engine, the engine running at maximum rated speed (1500 rpm)；

Ⅲ、Slowly clockwise adjustment corresponding to the rated speed potentiometer, the engine speed increases gradually, overspeed protection until the required limit values (such as setting the overspeed limit value is 120% of the rated speed, the corresponding limit is 1800 rpm)；

Ⅳ、Slowly adjust potentiometer counterclockwise until the red overspeed overspeed setting, indicating LED lamp (OVER SPEED) lit up, at the same time the engine realizes the overspeed protection shutdown；

Ⅴ、Power off a few seconds (if the speed controller with self starting control system should also press the stop button, in case of a system without the case of preparedness suddenly the motor starting), and the rated speed potentiometer counterclockwise rotation of 1 laps later, re energized, this time overspeed light should be destroyed, and then start the engine；

Ⅵ、Adjust the rated speed potentiometer or with the adjustment speed trimmer potentiometer, make the engine run at the rated speed of the desired value. Thus, overspeed protection settings completed。

The need for overspeed protection setting value is verified, the user can through the clockwise rotation of the

rated speed potentiometer to increase the rated engine speed gradually, until the engine produces overspeed protection shutdown, and record the speed value, namely for overspeed protection setting value. After verification, and then press the above step five or six order adjustment can be. If you don't use up to 2 of the rated speed value, and only a rated speed value, suggest to 1 rated speed as the working point set, and the frequency setting switch remove。

3.4.5 Stability Adjustment

If the engine is starting with instable speed, you can adjust it as the below information. The stability adjustment has three steps and there are idle, high speed and full loading。

Cautions: The engine works under the stability of the idle, high speed and full loading is syntrophic, so adjust the system refer to three steps to the best stability. After reaching to the stability, adjust Gain potentiometer to the larger value to be sure the engine get the best dynamic indicator。

The engine instability has the periodicity and the aperiodicity。

Periodicity instability has the speediness and the low speed. The speediness is usually means the frequency is 3HZ or more, but the frequency is less than 3HZ is low speed instability. Low speed may cause the strong instability and pay more attention to that; If happened, please adjust the parameter to the speediness firstly, then adjust slowly to avoid to damage the machine or the accident happen.。

The stability adjustment of engine finished mainly through the adjustment of GAIN, STABILITY potentiometer and SWI switch. Gain Potentiometer is used for adjusting the sensitivity of the governor system, turn clockwise is for increasing, on the contrary is for decreasing. The stability potentiometer is used for adjusting the respond time of the governor system, turn clockwise is for increasing, on the contrary is for decreasing. The adjustment between Gain and Stability will let the engine works under the best condition。

When start the engine with instable status, please adjust as following：

Solution Ⅰ：

1. Adjust Gain potentiometer: Turn clockwise Gain potentiometer, if instability is tend to increase, please turn anticlockwise until to stable; If the stable point cannot be found, please turn Gain to relative stable position; then turn anticlockwise to a little back to be sure the stability；

2. Stability Potentiometer: Turn clockwise the Stability potentiometer, if the instability is tend to increase, please turn anticlockwise until to stable; If the stable point cannot be found, please turn Stability to relative stable position; then turn anticlockwise to a little back to be sure the stability。

Repeat 2 steps of the solution, usually the engine will reach to the stability, if failed, please see the below solution。

Solution Ⅱ: Adjust SW1:

We know from the above, the dial switch of the controller SW1 is the status switch, it is used for changing the controller signal way to adapt the different engine, for the meaning of each dial please see the below:

Chart 1. SW1 State regulation (said table in the upper and lower correspond to the ON and OFF)

Project	Dial switch state	Application
SW1(Three)	1on 2 on 3 Under	Suitable for large damping force model,for large and medium-sized diesel or gas engine can use this state.
SW1(Three)	1 Under 2 on 3 Under	Small diesel for the following 100KW machine, a dynamic index and stability index better.
SW1(Three)	1 Under 2 Under 3 on	Between the engine and the generator is suitable for soft connection unit, miniature models of 30KW following dynamic index and stability index better.

To be attention, all of the above solution we got from the plenty of matching test and daily service experience, for the problem caused by the engine design, manufacturing or system integration may not be classified as the above, even the phenomenon of state cross, that is why we see the above classify is not specific correspondence。

No.1 positon of SW1 is designed for the respond time of the controller to governor;

No.3 positon of SW1 is based on the elimination of a soft friction reflected in by the engine driven generators connected state when rapid drift caused by the speed control system design;

From the above analysis, when the engine rapid instability, and the engine speed is higher theunstable frequency is higher, and vice versa, then, may try to be SW1 1 dial the switch in theOFF end (below), to reduce the sensitivity of the speed controller of high frequency signal; alsotry to SW1 3 dial the switch in the ON end (above), in order to eliminate the possibleconnection soft friction caused by rapid unstable state; adjust the good state, then the method of repeated scheme is adjusted, if still not stable, according to chart 2 corresponding SW2 thendial switch state, and press chart 2 to adjust, dial switch after setting methods shall be repeated again scheme is adjusted, until the engine stability

Installing and Debugging

Chart 2.SW2 Capacitive compensation adjustment

If fast is not stable, please according to the state of SW2 to find the corresponding position in the chart, and downwards along the chart			
If it is slow and unstable, please according to the state of SW2 to find the corresponding position in the chart, and adjusted upwards along the chart			
4	3	2	1
ON	ON	ON	ON
ON	ON	ON	OFF
ON	ON	OFF	ON
ON	ON	OFF	OFF
ON	OFF	ON	ON
ON	OFF	ON	OFF
ON	OFF	OFF	ON
ON	OFF	OFF	OFF
OFF	ON	ON	ON
OFF	ON	ON	OFF
OFF	ON	OFF	ON
OFF	ON	OFF	OFF
OFF	OFF	ON	ON
OFF	OFF	ON	OFF
OFF	OFF	OFF	ON
OFF	OFF	OFF	OFF

When there is slow and unstable, can try SW1 1 dial the switch in the ON end (above), oraccording to the chart 2 To adjust, each tuned a should be repeated scheme methodto adjust, until it reaches thestable；

When the non periodic instability, can also be according to the chart 1 and chart 2 ways to adjust; if the above scheme is still not resolved successfully, may be the engine itself, shouldcheck the fuel system, intake system, load stability, and evaluate the performance of the engine, also should check the power supply stability,

whether the rotational speed signal amplitude meet the requirements (idle speed is greater than 1.5Vpp, the normal speed of more than 4Vpp), shielding effect of speed signal line and the external control signal line is

good etc.

3.4.6 Adjusting the DROOP

3.4.6.1 The adjustment of the DROOP potentiometer is used in many sets of the parallel operation；

3.4.6.2 First of all, the terminal every single of 10, 11 short circuit, open the speed droop function controller, drooping characteristic of engine become soft (when 10, 11 terminal short circuit, the speed of the engine will have small changes, electromagnetic variation amplitude depends on the size of your choice of actuator), So that the engine speed decreases with the increase of engine load, when the engine at full load, the engine speed to reduce the value and the nominal speed ratio, called the steady state speed rate,, this value can be used by adjusting the rate of the potentiometer to change the steady state speed regulation, clockwise regulation to increase the steady state speed rate direction, whereas decreases, the user should be adjusted according to the related standard or need； When you adjust the DROOP potentiometer, the speed of the engine will have a tiny change and you shall revise the speed of the engine。

3.4.6.3 The following example will explain the process of adjusting the steady-state adjustable rate:

For example, a engine of 1500RMP needs 3% steady-state adjustable rate, this is to say, when in the no-load status, it is 1545 RMP; when in the full-load status, it is 1500 RMP。

a. Please confirm the speed controller of all external attachments have been connected properly before regulating, terminals 10, 11 have been shorted；

b. After the engine starts , in the no-load status, you shall adjust the DROOP potentiometer to about the 12 o'clock direction, then adjust the SPEED potentiometer or the FREQ TRIM potentiometer, adjust the speed of the engine to 1545 RMP；

c. After the adjustment, slowly increase load to full-load status, at this time, the speed of the engine will slowly decrease with the load adding；

d. Record the speed value in the full-load status. When the speed value >1500RMP in the full –load status, the steady-state adjustable rate is smaller, and you shall adjust the SPEED potentiometer in the clockwise direction; on the other hand, the steady-state adjustable rate is larger, and you shall adjust the SPEED potentiometer in the counterclockwise direction；

e. Note: you can't adjust the SPEED potentiometer or the FREQ TRIM potentiometer in the full-load status! After the step d, unload the engine to no-load.；

f. In no-load status, the rotate speed won't be 1545 RMP as set before. You shall continue to adjust the SPEED potentiometer or the FREQ TRIM potentiometer to make the speed to be 1545RMP (You can't adjust the DROOP potentiometer during this period.)；

g. Continuously repeat step c to step f until the speed of the engine achieve 1545 RMP in the no-load status and 1500 RMP in the full-load status. That is to say you finish the adjustment of the required 3% steady-state adjustable rate。

3.6 Auxiliary input

3.6.1 Terminal 13,as the auxiliary input signal introduced from the load allocation unit, automatic synchronization device and other control system which contains ramp generator, is used for automatic synchronization and automatic load distribution。If the synchronizer is used alone, and is not connected with the load balancer,should the resistance between 13 and 14 terminals connected to a 3MΩ To match the voltage。

3.6.2 When introducing the auxiliary input signal, the speed of the engine will change slightly, you shall revise the speed of the engine by adjusting the SPEED potentiometer or the FREQ TRIM potentiometer again。

4 Fault Judgment and Processing

4.1 The fault of the electronic governor will cause the engine performance degradation which may lead the engine to shut down. If the speed regulation system is out of work and you can judge the fault of the electronic governor, you just shall change the electronic governor; Faults of engine and the auxiliary system may be indicated by that the engine speed fails to reach the using requirements, and can't be solved even if you change the electronic governor. Thus, you shall judge the caused through comprehensive analysis on system.

Symptom	Test	Probable Fault
Engine can not start	Battery	Voltage between Terminals 5 and 6 Should be 12V DC or 24V DC, And pay attention to electronic governor power (POWER) light is on。
	Speed Control Unit	Overspeed limit value is set too low, causing the overspeed protection （This situation OVER SPEED indicating lamp will be bright）。
	Pick-up	1、The setting of the speed pick up is not correct and the space is too big。
		2、Speed sensor cable bolt,Measuring the DC resistance should be 830-970Ω.
	Actuator	1、Actuator or linkage binding.
		2、Actuator cable bolt, measuring actuator coil resistance, resistance between 4 ~ 5 ohms.
Actuator does not energize fully	Battery	Starting when measuring the battery voltage, if less than 14V battery undervoltage, need to recharge.
	Actuator	Actuator or linkage binding.
Unsteady engine speed	Speed Control Unit	1、Adjust the stability and the gain of the control unit according to 3.4.5。
		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、speed limit value is set too high。
		4、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.

System Troubleshooting

4.2 Insufficient Magnetic Speed Sensor Signal

When the speed sensor signal is stronger, it can resist the external pulses , the speed sensor can measure the outputted signal which is more than 3volts .When the voltage is less than 3volts, you shall reduce the tooth gap between the speed actuator and engine ,which can improve the amplitude of the signal. The gap shall less than 0.45mm. If the voltage is still less than 3 volts, you shall check the whether the magnetism of the speed actuator is too weak.。

4.3 Electromagnetic interference (EMI)

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. To avoid the medium interference, all the speed controller produced by Our company include the filter unit and shielding designs that can protect the sensitive circuits from the external interference.

It is difficult to predict the value of the interference. You shall consider all the possible range of the interference such as the radio communications of the space field, wireless walkie-talkie, and wireless radio transmitter and also including the use of magneto, solid-state ignition systems, and voltage adjuster or battery chargers.

When you doubt that space field or other systems will affect the speed governor system operation by conduction or direct radiation during the using period, we suggest that you shall use the double shielded cables as the external cables of the controller. Also ensure that one terminal of the shielded cable which includes the 360 degree of the speed actuator shall connect to the shell of the controller. And mount the speed control unit on a grounded metal back plate or place it in a sealed metal box to avoid the electronic interference. There will be a good effect when using the metal cover or the metal container. The most common anti-interference measure is to use the shielding wire. If using the generator with brush, you can’t ignore the electronic spark interference, so you shall use the special shielding measure to the huge interference environment. If you can’t solve this kind of problems, please contact with our engineers. They will give you some more suggestions。

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