Contents

Important Notice

Our experience has shown that, if the information and recommendations contained in this Operating Instructions are observed, the best possible reliability of our products is assured.

The data contained herein purports solely to describe the product and is not a warranty of performance or characteristics. It is with the best interests of our customers in mind that we constantly strive to improve our products and keep them abreast of advances in technology. This may, however, lead to discrepancies between a product and its "Technical Description" or " Operating Instructions".

This document has been carefully prepared and reviewed, however should in spite of this the reader find an error, he is requested to inform us at his earliest convenience.

It is scarcely possible for the operating instructions for technical equipment to cover every eventuality, which can occur in practice. We would therefore request you to notify us or our agent in the case of all unusual behaviour that does not appear to be covered by these operating instructions.

It is pointed out that all local regulations must be observed when connecting and commissioning this equipment in addition to these operating instructions.

We cannot accept any responsibility for damage incurred as a result of mishandling the equipment regardless of whether particular reference is made in these operating instructions or not.

We lay particular stress on the fact that only genuine spare parts should be used for replacements.

1. SAFETY INSTRUCTIONS

1.1 General

The safety instructions shall be followed during installation, commissioning, operation and maintenance. Read all instructions carefully before operating the device and keep this manual for future reference.

Required Qualification

Personnel involved in installation work and commissioning of the S2007 must be familiar, specially instructed and informed about the residual danger areas according to the regulations currently in force.

Operating personnel is not permitted to work at the control system.

Specially instructed personnel must only carry out maintenance and repair work.
The maintenance personnel must be informed about the emergency shutdown measures and must be capable of turning off the system in case of emergency.
The maintenance personnel must be familiar with the accident prevention measures at their workplace and must be instructed in first aid and fire fighting.

It is the owner's responsibility to ensure that each person involved in the installation and commissioning of the S2007 has received the appropriate training or instructions and has thoroughly read and clearly understood the safety instructions in this chapter.

1.2 Safety Instructions

The safety instructions always appear at the beginning of each chapter and/or precede any instruction in the context where a potentially dangerous situation may appear. The safety instructions are divided into five categories and emphasized by the use of the following layout and safety signs:

	**DANGER!** This symbol indicates an imminent danger resulting from mechanical forces or high voltage. A non-observance leads to life-threatening physical injury or death.
	**WARNING!** This symbol indicates a dangerous situation. A non-observance may lead to bad or life-threatening physical injury or death.
	**CAUTION!** This symbol indicates a dangerous situation. A non-observance may lead to physical injury or cause damage to the device.
	**NOTICE!** This symbol emphasizes important information. A non-observance may cause damage to the device or to objects close to it.
	**IMPORTANT!** This symbol indicates useful information. Not to be used to indicate dangerous situations.

2. DEVICE DESCRIPTION

2.1 Introduction

The S2007 is an electronic device designed to control engine speed with fast and precise response to transient load changes.

This closed loop control, when connected to a proportional electric actuator and supplied with a magnetic speed sensor signal, will control a wide variety of engines in an isochronous or droop mode.

It is designed for high reliability and built ruggedly to withstand the engine environment.

A practical and simple-to-operate panel on the unit is used for all control operations. In addition, user-friendly software facilitates commissioning and allows optimization of operation.

The mechanical construction is compact and robust.

2.2 Hardware

Structure:

The device, placed inside a plastic box, is submerged in resin allowing so the maximum resistance against engine vibrations and a reliability with time.

Control elements:

A 4 digit 7-segment display is located on it in order to allow an easy visualization of parameters. The use of push buttons placed at the side and below the display allows to scroll the menu of all parameters and to set those of interest.

Installation:

Mounting:

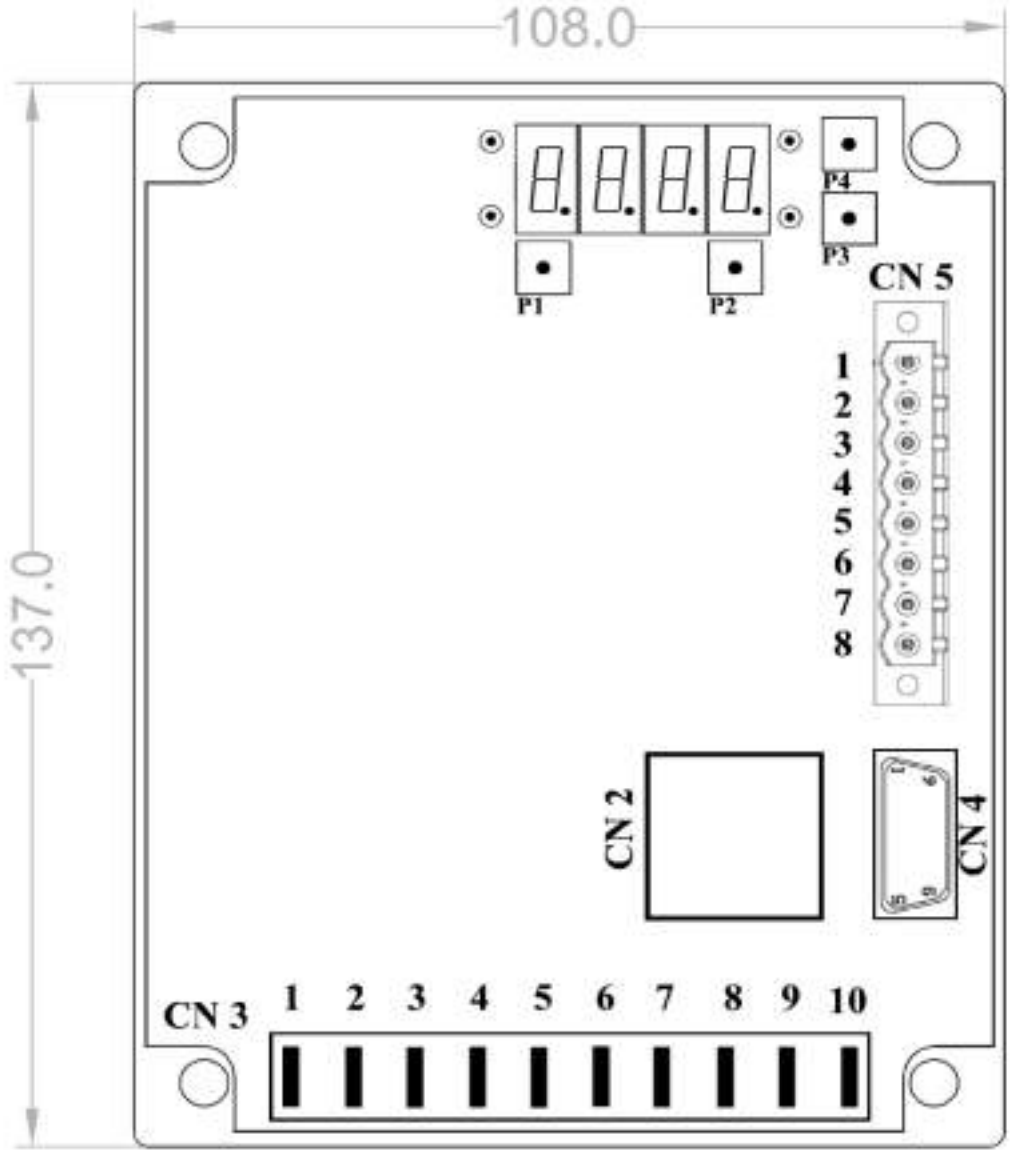
The S2007 is designed for wall mounting on a metal panel.
Mounting on a non-dissipative surface such as a plastic panel may lead to device overheating and is to be avoided.
For optimal cooling is to keep free a minimum distance of 100 mm all around the unit.

Connection diagram:

Basic electrical connections are illustrated in the figure below.

Terminal blocks

Overview of full device connections



CN2 – CAN BUS interface

1. CAN H
2. CAN L
3. GND CAN
4. n.c.
5. n.c.
6. n.c.
7. GND CAN
8. n.c.

CN3 – Inputs/Outputs

1. Actuator -
2. Actuator +
3. Battery – (GND/COM)

CN4 – RS232 interface

1. Reserved (do NOT use!)
2. Tx
3. Rx
4. Reserved (do NOT use!)
5. GND
6. Reserved (do NOT use!)
7. Reserved (do NOT use!)
8. Reserved (do NOT use!)
9. Reserved (do NOT use!)

CN5 – Inputs/Outputs

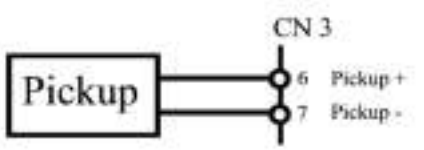
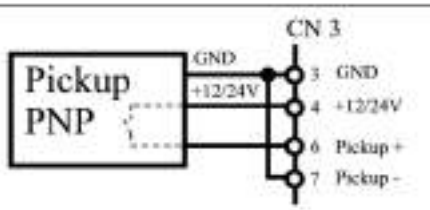
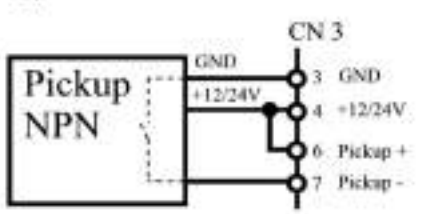
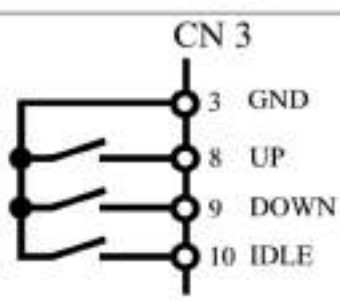
1. Digital Input (COM=GND)
2. Digital input (COM=GND)

4. Battery + (12÷24Vdc)
5. Out aux (Solenoid valve)
6. Pickup +
7. Pickup –
8. UP (COM=GND)
9. DOWN (COM=GND)
10. IDLE (COM=GND)

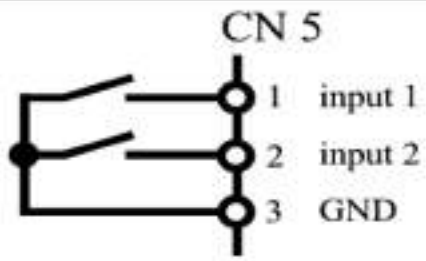
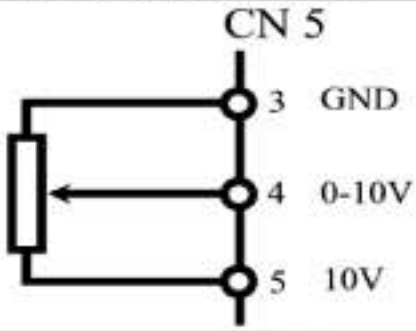
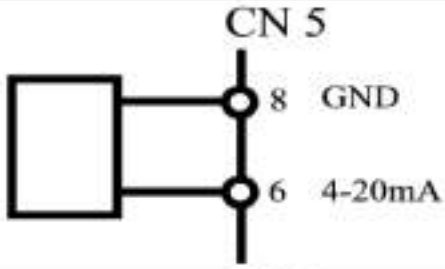
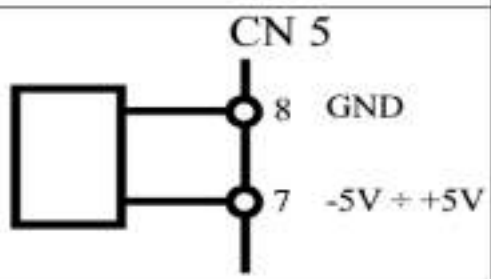
3. GND/COM
4. Analog input 0÷10V
5. Supply output +10V (max 20mA)
6. Analog input 4÷20mA
7. Analog input -5÷5V
8. GND/COM

n.c. = not connected

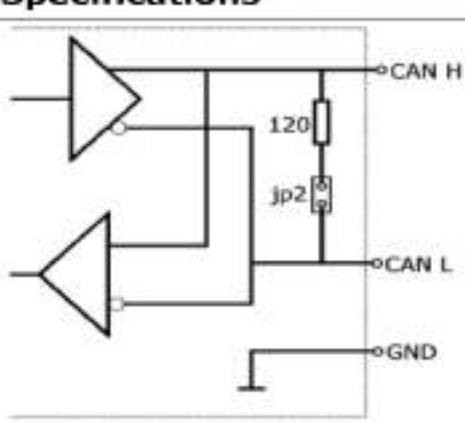
2.2.2 Device connections CN3

Terminal designation	Signal	Specifications
Actuator	DC output	12÷24Vdc 0÷12 A (15A for 10s)
Solenoid valve	Digital output	12÷24Vdc 2Amax
Pickup	Passive pickup	
	Active pickup	 or 
Up	Digital Input	
Down	Digital Input	
IDLE	Digital Input	

2.2.3 Device connections CN5

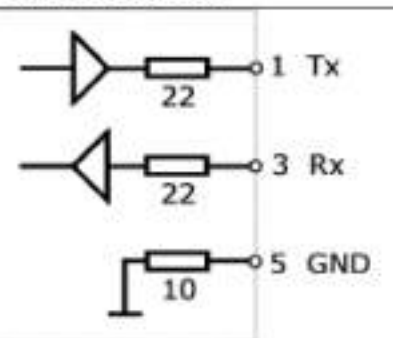
Terminal designation	Signal	Specifications
Digital inputs	2 digital inputs	 • programmable function
Analog inputs	analog input 0÷10Vdc (Potentiometer =2kΩ ÷ 5kΩ 0,25W)	
	analog input 4÷20mA	
	analog input -5V ÷ +5V	

2.2.4 Device connections CN2

Terminal designation	Signal	Specifications
Communication	CAN	 • selectable termination

		• CANopen and proprietary protocols

2.2.5 Device connections CN4

Terminal designation	Signal	Specifications
Communication	RS232	

NOTICE!

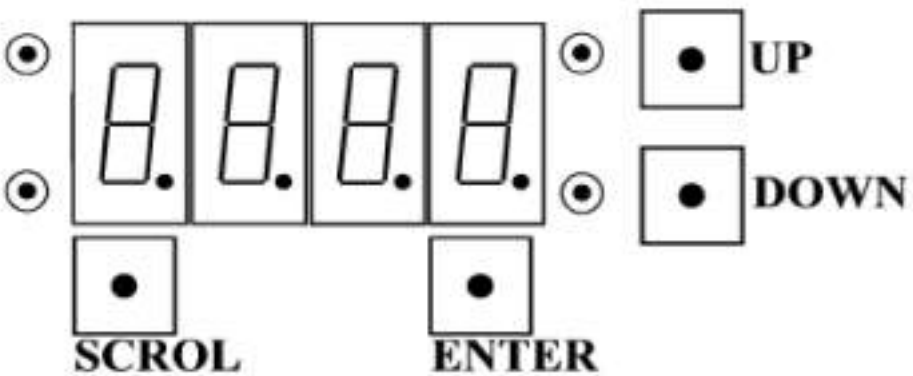
To connect a device such as a notebook or a personal computer to ***S2007 Speed Digital Governor***, proprietary USB/RS232 adapter or proprietary RS232/RS232 adapter shall be

3. OPERATOR INTERFACE

In this following charter are described the operations of management parameter using the integrated display.

3.1 Set or change parameters

Many parameter can be accessed using the integrated display and keys.



SCROL Change menu parameter set (d.xxx and P.xxx)

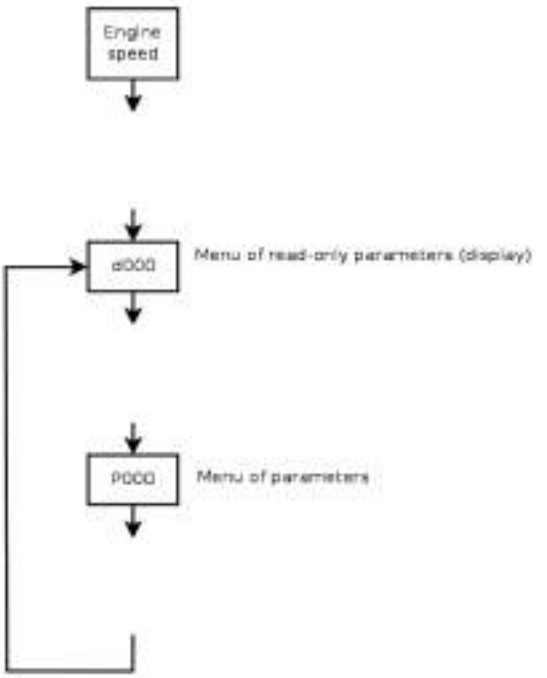
ENTER Select or save current displayed parameter

UP Increase parameter number or value

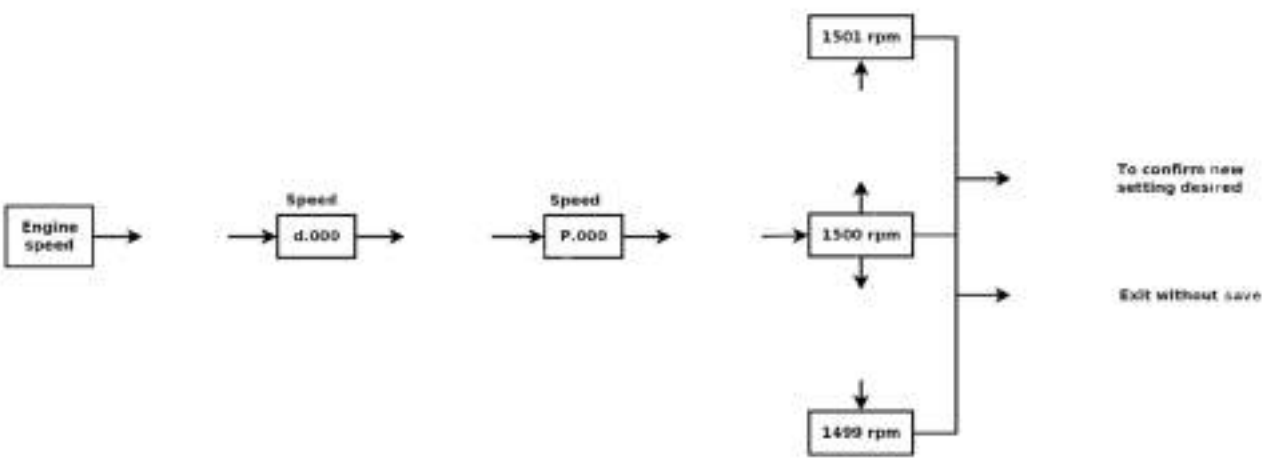
DOWN Decrease parameter number or value

3.2 Navigating the menus

When the S2007 is power on, the display automatically shows parameter d.000 (Engine speed) in the Display menu.



Example: how to change a SPEED reference



3.3 Menu

3.3.1 Menu d - Display

Display	Name	Description	[Units]	
D.000	Engine speed	Actual engine speed	rpm	
D.001	Speed set	Speed set point	rpm	
D.002	Actuator current	Current supplied to actuator	A	
D.003	Actuator voltage	Voltage supplied to actuator	V	
D.004	Input 0-10V	0-10V analog input voltage	V	
D.005	Input 4-20mA	4-20mA analog input current	mA	
D.006	V Batt	Battery voltage	V	
D.007		Firmware version		

3.3.2 Menu P - Parameters

Parameter	Name	Description	[Units]	Default	Range
P.000	Speed	Engine speed Set Point	Rpm	1500	1200 - 4000
P.001	Kp (GAIN)	Proportional (P) gain for PID control loop			20 - 5000
P.002	Ki (STABILITY)	Integral (I) gain for PID control loop			0 - 5000
P.003	Kd (DEADTIME)	Derivative (D)gain for PID control loop			0 - 5000
P.004	IDLE	Engine speed in Idle mode	Rpm	1300	1000 - 4000
P.005	Crank	Crank termination threshold: RPM when the governor changes from crank mode to control mode	Rpm	1200	1000 - 4000
P.006	Over speed	Over speed: RPM when actuator is shut off for safety reason	Rpm	1700	1350 - 4750
P.007	Start fuel	Starting fuel: preset utput voltage to actuator when crank begins		100%	0,5% - 100%
P.008	Speed ramp	Rate throttle at which is ramped open during start		10%	0-100%
P.009	Droop	Droop at maximun load current (based on duty cycle of the actuator)		1,5 %	0,1% - 8%
P.010	Max current	Max actuator current	A	10	1 - 15
P.011	Overload time	Time before current is clamped to Max value (P.010)		10s	0,5s – 60s
P.012	Variable speed control	Maximum speed change from analog inputs		3%	0% - 100%
P.013	Teeth	Number of teeth on flywheel		60	10 - 1000

P.014	Rate	Time between calls to PID control loop		20	1 - 200
P.015	Reset	To reset the device, enter the number "333" in parameter P.015			

4. RUNNING THE ENGINE

4.1 Running the engine

4.1.1 Starting the engine

Before cranking engine, supply DC power to governor system, then actuator will be pre-set as defined by **START FUEL** parameter (P.007, default value is maximum fuel rate).
Starting Ramp (P.007), will then control the rate at which fuel is increased during engine cranking.

NOTICE!

if engine speed is unstable after start up, adjust **GAIN** (P.001), **STABILITY** (P.002), and **DEADTIME COMPENSATION** (P.003) until engine speed is stabilized.
Poor PID settings can affect this response so tune the system at normal operating speeds before setting the starting parameters (see below).

4.1.2 Governor Performance

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

A. Increase **GAIN** parameter until motor speed reachs instability. Gradually decrease the Gain until stability is recovered. Decrease one count further to insure stable performance.

B. Increase **STABILITY** parameter until motor speed reachs instability. Gradually decrease Stability until stability is recovered. Decrease one count further to insure stable performance.

C. Increase **DEADTIME** parameter until motor speed reachs instability. Gradually decrease Deadtime until stability is recovered. Decrease one count further to insure stable performance.

D. **GAIN**, **STABILITY** and **DEADTIME** small adjustments may be required after load is applied to engine. Normally, adjustments made in no load conditions achieve satisfactory performance.

4.2 Additional features

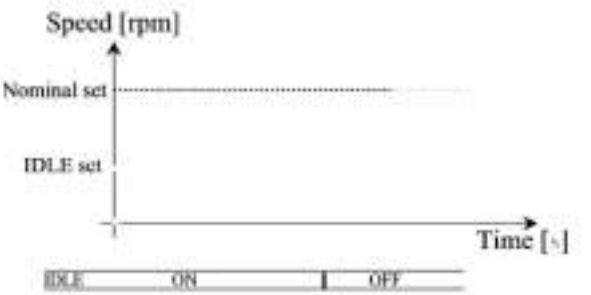
4.2.1 Real-Time Display

While engine runs, S2007 Digital Speed Governor can display real time measures and other useful information (see table below). Cycle through the table with UP / DOWN keys.

Display	Parametet	Description	Units
D.000	Engine speed	Actual engine speed	rpm
D.001	Speed set	Speed set point	rpm
D.002	Actuator current	Actual actuator current	A
D.003	Actuator voltage	Actual actuator voltage	V
D.004	Input 0-10V	0-10V input voltage	V
D.005	Input 4-20mA	4-20mA input current	mA
D.006	V Batt	Battery voltage	V
D.007		Firmware version	

4.2.2 Idle Speed

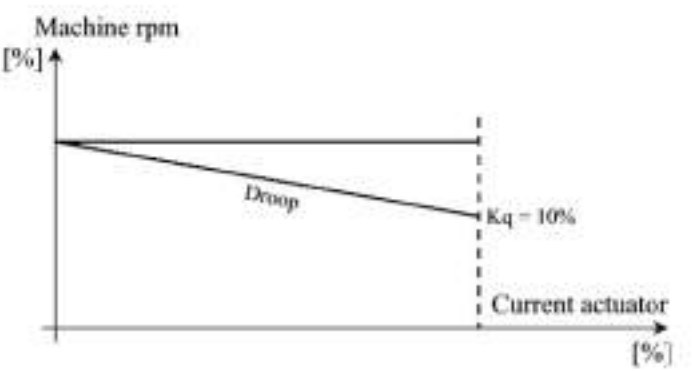
To adjust **IDLE** speed, shut down engine, place optional external switch in IDLE position then restart engine. Once started, IDLE speed set point can be calibrated through IDLE parameter (P.004).



4.2.3 Speed Droop Operation

Droop is typically used with parallel of several engine driven generators.

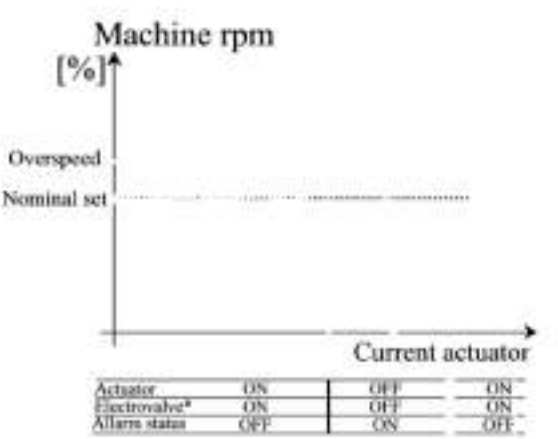
With S2007 governor powered off, place optional external selector switch in **DROOP** position, then start engine. While engine is running, **DROOP** can be adjusted by **DROOP** parameter (P.007). In DROOP MODE engine speed will decrease as engine load increases. The percentage of droop is based on the change in current in the actuator from no load to full load (DRNG in the Special Menu).



4.2.4 Overspeed

When the S2007 detects engine has reached the speed specified by the **OVERSPEED** parameter (P.006), the S2007 will force the speed to 0 RPM, will set the actuator output to 0V and, if enabled, open the solenoid valve. **OVERSPEED** is a Menu parameter, and is expressed in RPM.

	Notice! If incorrect tooth count is entered the OverSpeed setting may not be what is desired so never rely on this function as the ultimate equipment protection.



If the running speed of the engine reaches the **OVERSPEED** set point, while the system is in a running state, the S2007 will stop outputting a signal to the actuator for a zero fuel command and will no longer attempt to control the engine.

After the S2007 has detected an overspeed, the display will flash the RPM along with the warning and OVERSPEED indicators. No parameters will be allowed to be changed.
To re-activate the S2007, DC power must be turned off then back on to reset the control.

4.2.5 Loss of Magnetic Pickup Sensing

If the S2007 is commanding the actuator to move and detects no input from the magnetic pickup, the S2007 will set the actuator to 0V and command the speed to 0 RPM.

After the S2007 has detected loss of magnetic pickup, the display will flash the RPM along with the warning indicator.
No parameters will be allowed to be changed.

4.2.6 Variable Speed Inputs

The S2007 is equipped with four inputs for variable speed.

1. analog input 0÷10V. This input accepts a 2÷5K potentiometer connected between terminals 3,4 and 5 of CN5.
2. analog input 4÷20mA. The terminals used are 6 and 8 of CN5.
3. analog input -5V ÷ +5V. The terminals used are 7 and 8 of CN5.
4. digital inputs: terminal 8 for UP and terminal 9 for DOWN of CN3 (closed to ground).

Generally, these inputs are used to perform fine tuning of generator frequency or in conjunction with other governor system accessories such as load sharing units, synchronizers, etc. Variable speed function is used to operate over a larger RPM range.

5. SYSTEM TROUBLESHOOTING

5.1 System inoperative

If the engine governing system does not function, the fault may be determined by performing the voltage tests described in Steps 1 through 3. Positive (+) and negative (-) refer to meter polarity. Should normal values be indicated during troubleshooting steps, then the fault may be with the actuator or the wiring to the actuator. Tests are performed with battery power on and the engine off, except where noted. See actuator publication for testing procedure on the actuator.

Step	Wires	Normal reading	Probable cause of abnormal reading
1	CN3-3 Battery – (GND) CN3-4 Battery +	Battery supply voltage (12 or 24V dc)	1. DC battery power not connected. Check for blown fuse 2. Low battery voltage 3. Wiring error
2	CN3-6 CN3-7	1Vac RMS minimum while cranking	1. Gap between speed sensor and gear teeth too great Check gap 2. Improper or defective wiring to the speed sensor 3. Resistance between 6 and 7 (CN3) should be 30 to 1200 ohms. See specific magnetic pickup data for resistance 4. Defective speed sensor.

5.2 Insufficient Magnetic Speed Signal

A strong magnetic speed sensor signal will eliminate the possibility of missed or extra pulses. A speed sensor signal of 1VAC RMS or greater at cranking speed is required. Measure the signal at Terminals 6 and 7 (CN3). Shielding of the pickup wires is recommended.
The amplitude of the speed sensor signal can be raised by reducing the gap between the speed sensor tip and the engine ring gear. The gap should not be any smaller than 0,45 mm. 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.

5.3 Electromagnetic Compatibility (EMC)

EMI SUSCEPTIBILITY - The governor system is rated for CE levels per EN50082-1 and EN50082-2. However, it can be adversely affected by large interfering signals that are conducted through the cabling or through direct radiation into the control circuits.

Although regulation of emitting devices is better controlled today it is still difficult to predict levels of interference, applications that include magnetos, solid sate ignition systems, radio transmitters, voltage regulators or battery chargers and they should be considered as suspect as possible interfering sources. If it is suspected that external fields, either those that are radiated or conducted, are or will affect the governor systems operation, it is recommended to use shielded cable for all external connections to the control Terminals. Be 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 to a grounded metal back plate or place it in a sealed metal box.

Radiation is when the interfering signal is radiated directly through space to the governing system. A metal shield or a solid metal container is usually effective for this interference.

Conduction is when the interfering signal is conducted through the interconnecting wiring. Shielded cables and installing filters are common remedies.

5.4 Instability

Instability in a closed loop speed control system can be categorized into two general types. **PERIODIC** appears to be sinusoidal and at a regular rate. **NON-PERIODIC** is a random wandering or an occasional deviation from a steady state band for no apparent reason.

The **PERIODIC** type can be further classified as fast or slow instability. Fast instability is a 3 Hz. or faster irregularity of the speed and is usually a jitter. Slow periodic instability is below 3 Hz., can be very slow, and is sometimes violent.

If fast instability occurs, this is typically the governor responding to engine firings. Raising the engine speed increases the frequency of instability and vice versa. In this case, readjust the **GAIN** and **STABILITY** for optimum control. In extreme cases, this may not take all the jitter out of the system. In this case, decrease the **DEADTIME** parameter.

Slow instability can have many causes. If slow instability exists, verify the SOFT Special Menu parameter is disabled. If this is unsuccessful, it is possible to decrease the update rate of the controller. This is done by decreasing the RATE Advanced parameter. **This should be done with extreme caution and in single increments. Each time RATE is changed, the GAIN, STABILITY, and DEADTIME must be re-adjusted.**

If slow instability is unaffected by this procedure, evaluate the fuel system and engine performance. Check the fuel system linkage for binding, high friction, or poor linkage is the moist likely cause. Be sure to check linkage during engine operation. Also look at the engine fuel system. Irregularities with carburetion or fuel injection systems can change engine power with a constant throttle setting. This can result in speed deviations beyond the control of the governor system. Adding a small amount of droop can help stabilize the system for troubleshooting purposes.

NON-PERIODIC instability should respond to the **GAIN** control. If increasing the Gain reduces the instability, then the problem is probably with the engine. Higher gain allows the governor to respond faster and try to correct for disturbance. Look for engine mis-firings, an erratic fuel system, or load changes on the engine generator set voltage regulator.

6. SPECIFICATIONS

6.1 Performance

Isochronous Operation	±0.25%
Speed Range / Governor	10Hz - 5 KHz *
Idle Adjust	Full Range
Droop Range	1 - 5% regulation**

6.2 Enviromental

Ambient Temperature	-40° to 85°C (-40 to +180°F)
Relative Humidity	up to 95%
All Surface Finishes	Fungus Proof and Corrosion Resistant
CE Rated	EN55011, EN50081-2, EN50082-2

6.3 Compliance/ standards

Agency	CE and RoHS Requirements

6.4 Input/output

Supply	12-24 VDC Battery Systems (8.5 to 30 VDC)***
Polarity	Negative Ground (Case Isolated)
Power Consumption	70mA max. continuous plus actuator current
Speed Sensor Signal	1-70 VRMS
Actuator Current (25°C)	12 Amps Continuous
Load Share / Synchronizer Input	0-10 VDC (5V nominal, reversed, 100Hz/V)
Reverse Power Protection	Yes
Transient Voltage Protection	36V

6.5 Reliability

Vibration	7G, 20-100 Hz
Shock	20G Peak
Testing	100% Functional Testing

6.6 Physical

Dimension	137x108mm
Weight	
Mounting	Any position, Vertical Preferred

*Though governing speeds are entered into the EDG in RPM, it is operating range is specified in flywheel frequency. This is because RPM is dependent on the number of teeth specified on the flywheel (# TEETH parameter). For example, isochronous governing at 1,800 RPM with # TEETH set to 150, the EDG will govern at 4,500 Hz. If variable speed operation is used and the desired operating range is 1,000 to 2,000 RPM, and # TEETH is set to 150, the EDG will govern between 2,500-5,000 Hz.

**Droop is based on a speed sensor frequency of 4000 Hz. and an actuator current change no load to full load. Applications with more actuator current change will experience higher percentages of droop. See droop description for specific details on operation of droop ranges. Actual droop percentage can depend on actuators current consumption.

***Protected against reverse voltage by a series diode. A 15 amp fuse must be installed in the positive battery lead.