

S

2007



BELTRAME
CENTRO SERVIZI ENERGIA

USER'S MANUAL



CONTENTS

IMPORTANT NOTICE.....	4
1. SAFETY INSTRUCTIONS.....	5
1.1 General	
1.2 Safety Instructions	
2. DEVICE DESCRIPTION.....	6
2.1 Introduction	
2.2 Hardware	
2.2.1 Control elements and interfaces.....	7
2.2.2 Device connections CN3.....	10
2.2.3 Device connections CN5	
2.2.4 Device connections CN2.....	11
2.2.5 Device connections CN4.....	12
3. OPERATOR INTERFACE.....	12
3.1 Set or change parameters.....	13
3.2 Navigating the menus	
3.3 Menu.....	14
3.3.1 Menu D (Display)	
3.3.2 Menu P (Parameters)	
4. RUNNING THE ENGINE.....	15
4.1 Running the engine	
4.1.1 Starting the engine	
4.1.2 Governor Performance.....	16
4.2 Description capabilities	
4.2.1 Real-Time Display	
4.2.2 Pick-up detection	
4.2.3 Actuator ramp	
4.2.4 Start Up Ramp.....	17
4.2.5 Speed set control	
4.2.6 Variable Speed Inputs.....	18
4.2.7 Idle	
4.2.8 Droop	
4.3 Description of the Protection.....	19
4.3.1 Overspeed	
4.3.2 Overload	
4.3.3 Loss of Pick-up signal	
4.3.4 Led Signals.....	20

5.	SPECIFICATIONS.....	21
5.1	Performance	
5.2	Enviromental	
5.3	Inputs/Outputs	
5.4	Mechanical Details	
6.	NOTES ON THE OPERATION OF THE REGULATOR.....	22
7.	SOME EXEMPLES OF TEETH NUMBER OF ENGINES FLYWHEEL.....	22

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 it 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 behavior 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.

All rights with respect to this document, including applications for patent and registration of other industrial property rights, are reserved. Unauthorized use, in particular reproduction or making available to third parties, is prohibited.



1. SAFETY INSTRUCTIONS

1.1 General

The safety instructions shall be followed during installation, commissioning, operation and maintenance of the excitation system. 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. Only specially instructed personnel must 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 firefighting.

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 precede any instruction in the context where a potentially dangerous situation may appear. The safety instructions are divided into three categories, and each one is introduced by a symbol with its description:

	<p>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.</p>
	<p>WARNING! This symbol indicates a dangerous situation. A non-observance may lead to bad or life-threatening physical injury or death. It may cause also possible damages to the devices.</p>
	<p>NOTICE! This symbol emphasizes important information. A non-observance may cause damage to the device or to objects close to it.</p>

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.

This voltage regulator manages the following functions:

- 1) Isocron control of the rotation;
- 2) Safety controls (Overspeed and Overload);
- 3) Droop control for use in parallel 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 four 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.

Mounting:

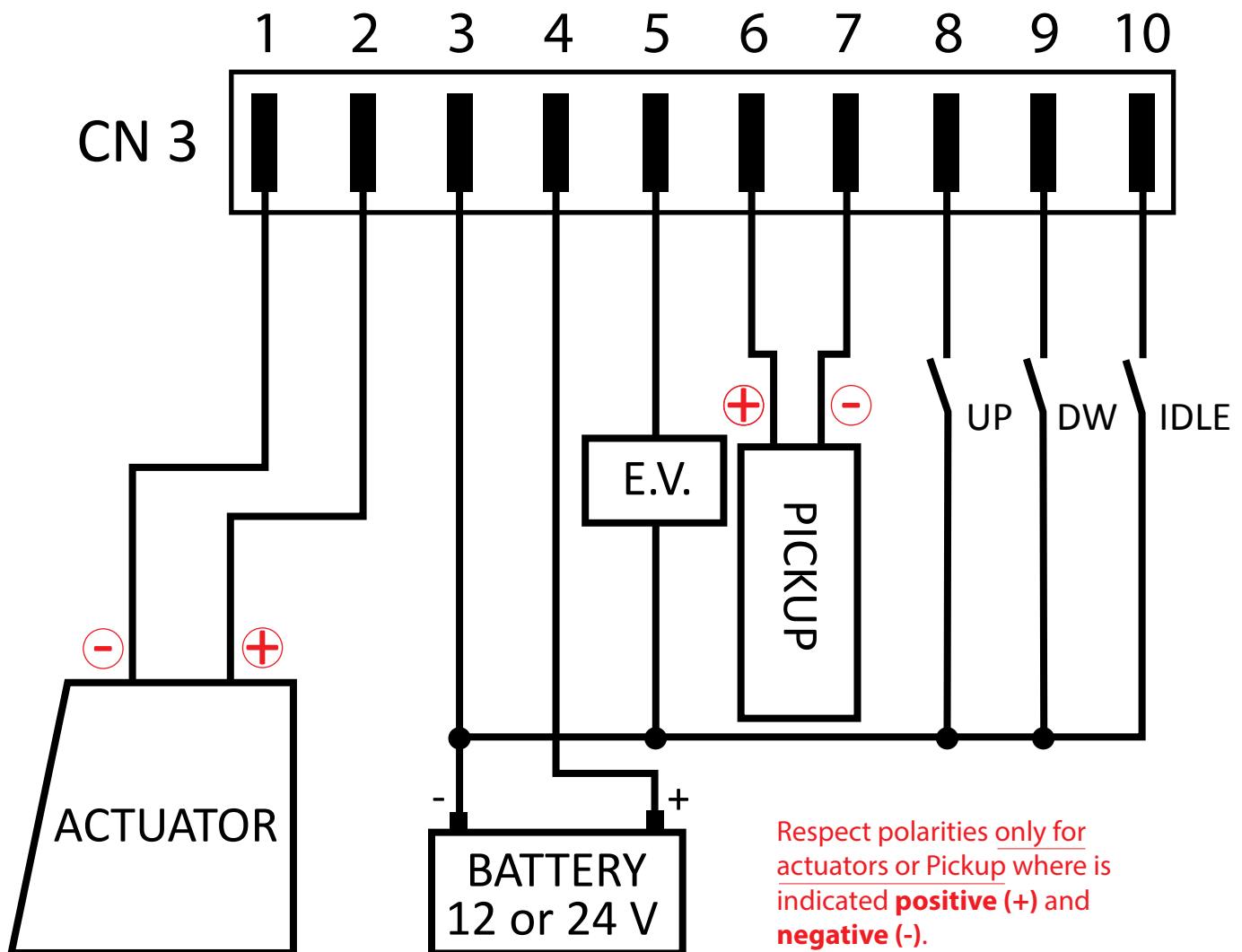
The S2007 is designed for wall mounting on a metal panel.

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 diagram below.

S2007



2.2.1 Control elements and interfaces

Carrying out settings on the unit

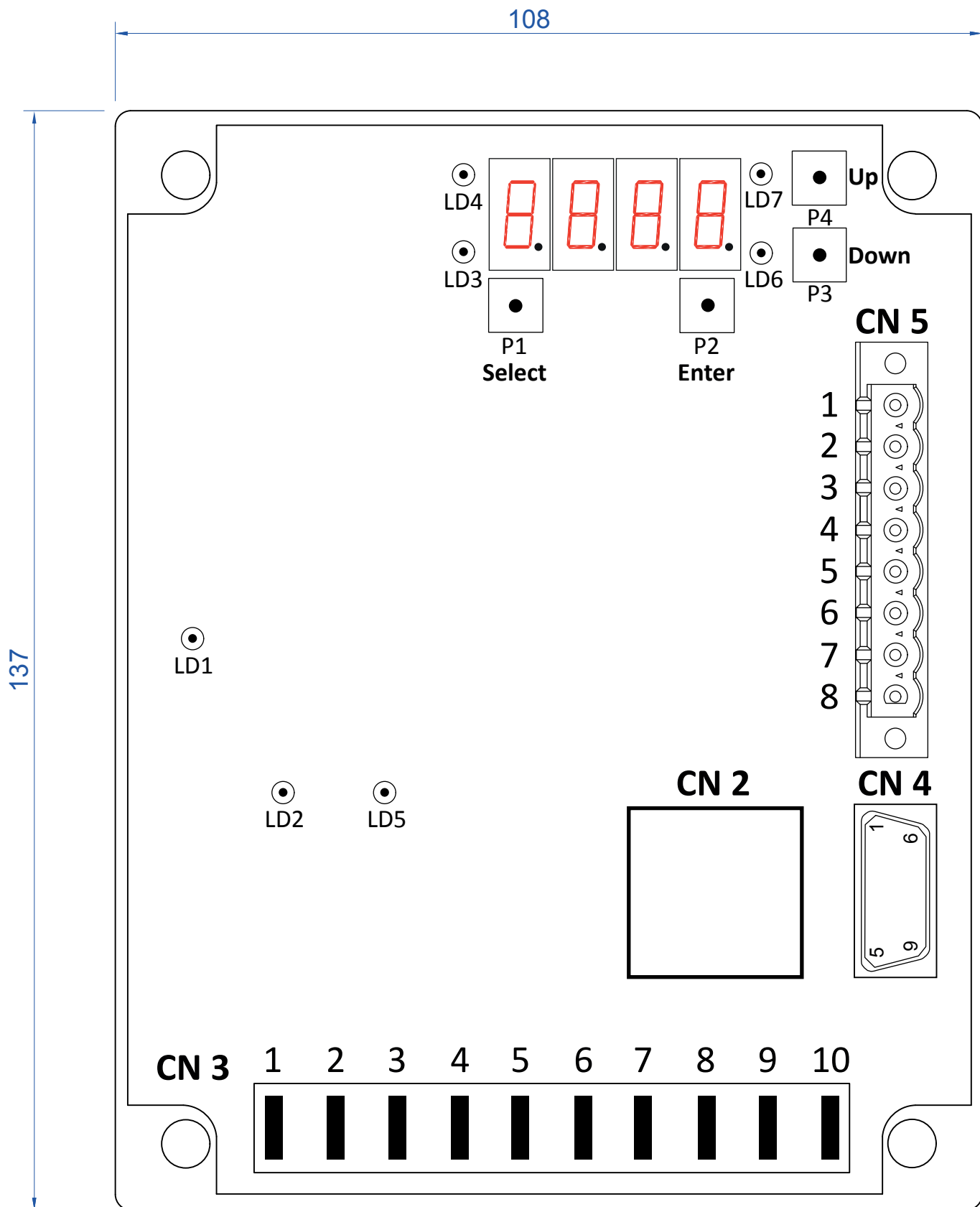
The display and the four keys are sufficient to allow complete operation.

All settings can be carried out directly on the unit without additional equipment:





- Input/Output configuration
- Parameters setting
- Display of main measures.

Terminal Boards:

Overview of the device connectors.


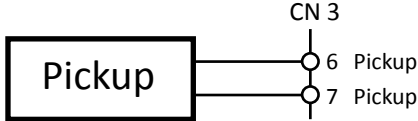
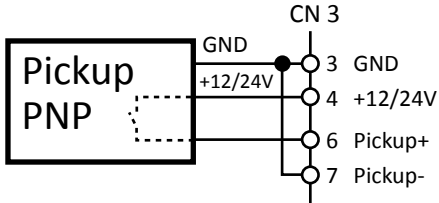
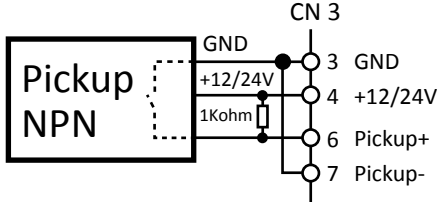
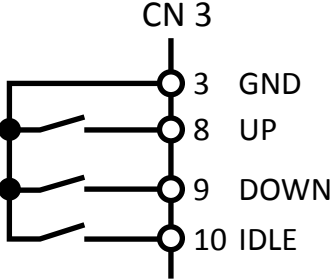


Connectors

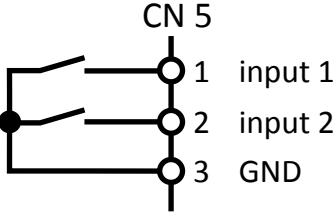
CN2 – CAN BUS Interface		CN4 – RS232 Interface	
1	CAN H	1	Reserved (do NOT use or connect!)
2	CAN L	2	Tx (from regulator to PC)
3	GND CAN	3	Rx (from PC to regulator)
4	n.c.	4	Reserved (do NOT use or connect!)
5	n.c.	5	GND
6	n.c.	6	Reserved (do NOT use or connect!)
7	GND CAN	7	Reserved (do NOT use or connect!)
8	n.c.	8	Reserved (do NOT use or connect!)
		9	Reserved (do NOT use or connect!)
CN3 - Inputs/Outputs		CN5 – Inputs/Outputs	
1	Actuator 	1	Digital input (COM=GND)
2	Actuator 	2	Digital input (COM=GND, enabled droop)
3	Battery – (GND/COM)	3	GND/COM
4	Battery + (12÷24Vdc)	4	Analog input 0÷10V
5	Out aux (Solenoid valve)	5	Supply output +10V (20mA)
6	PickUp 	6	Analog input 4÷20mA
7	PickUp 	7	Analog input -5÷5V
8	UP (COM=GND)	8	GND/COM
9	DOWN (COM=GND)		
10	IDLE (COM=GND)		
<p>NB: Respect polarities <u>only for actuators or PickUp</u> where is indicated positive (+) and negativ (-).</p>			


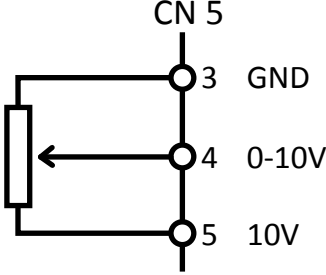
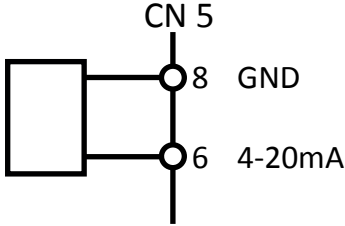
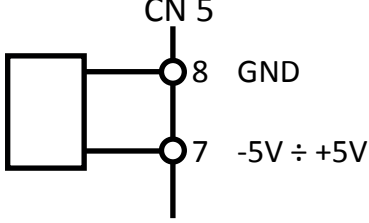
n.c. = not connected

2.2.2 Device connections CN3

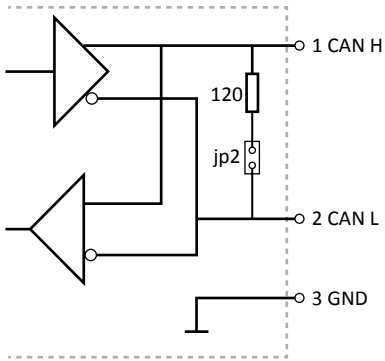
Terminal designation	Signal	Specifications
Actuator	DC output	12÷24Vdc 0÷12 A (15A for 10s)
Solenoid valve	Digital output	12÷24Vdc 2A max
Pickup  RESPECT PICK UP POLARITIES	Passive Pickup	
	Active Pickup N.B. Open jumper J1	 <p>Or</p> 
Up	Digital Input	
Down	Digital Input	
IDLE	Digital Input	

2.2.3 Device connections CN5

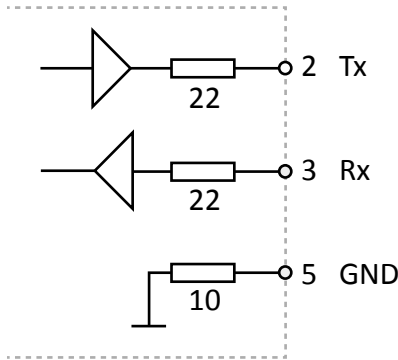
Terminal designation	Signal	Specifications
Digital Input	2 digital Input	 <ul style="list-style-type: none"> • Programmable function • 10V 5mA

Terminal designation	Signal	Specifications
Analog input  N.B.: Inputs 0÷10V and 4÷20mA are to be used one at a time. They can't operate simultaneously.	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 (Optional)	CAN	 <ul style="list-style-type: none"> • Selectable termination • CANopen and proprietary protocols

2.2.5 Device connections CN4

Terminal designation	Signal	Specifications
Communication	RS232	



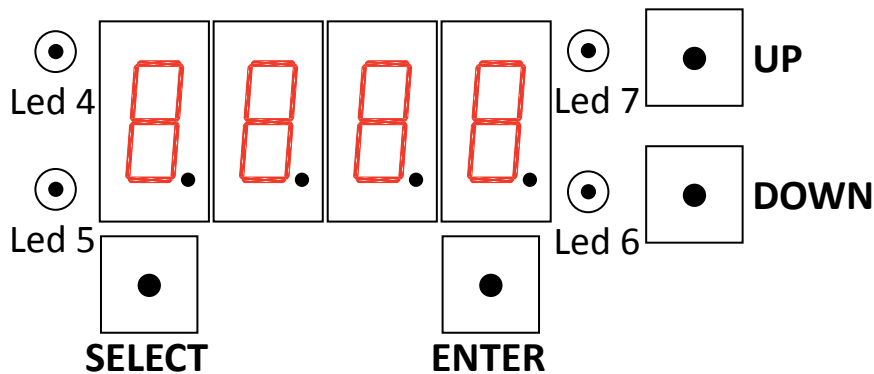
To connect a device such as a notebook or personal computer at the Digital controller revolutions S2007, an USB/RS232 or RS232/RS232 adapter is needed. Please request it directly to BELTRAME CSE.
NEVER CONNECT TRADE CABLES (more than three conductors)!

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 parameters can be accessed using the intergrated display and keys.



- SELECT** Select viewing menu (d.xxx) or parameters menu (P.xxx)
- ENTER** Select or save current displayed parameter
- UP** Increase parameter number or value
- DOWN** Decrease parameter number or value

It is possible to enter the menus through the functions of the configuration push-buttons

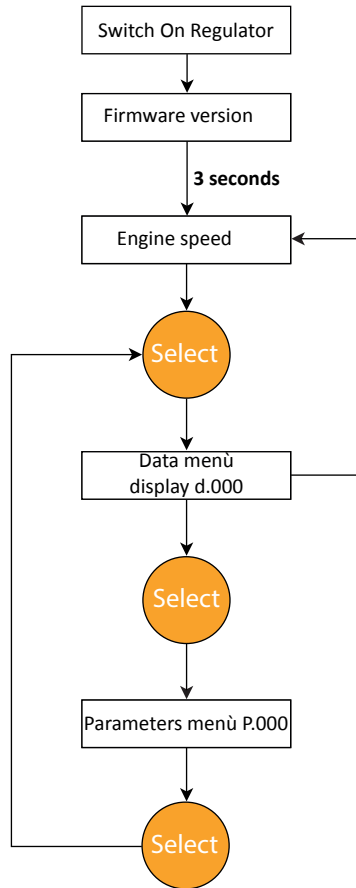
Display of data menu "d"

Display/Modify menu parameters setting "P"

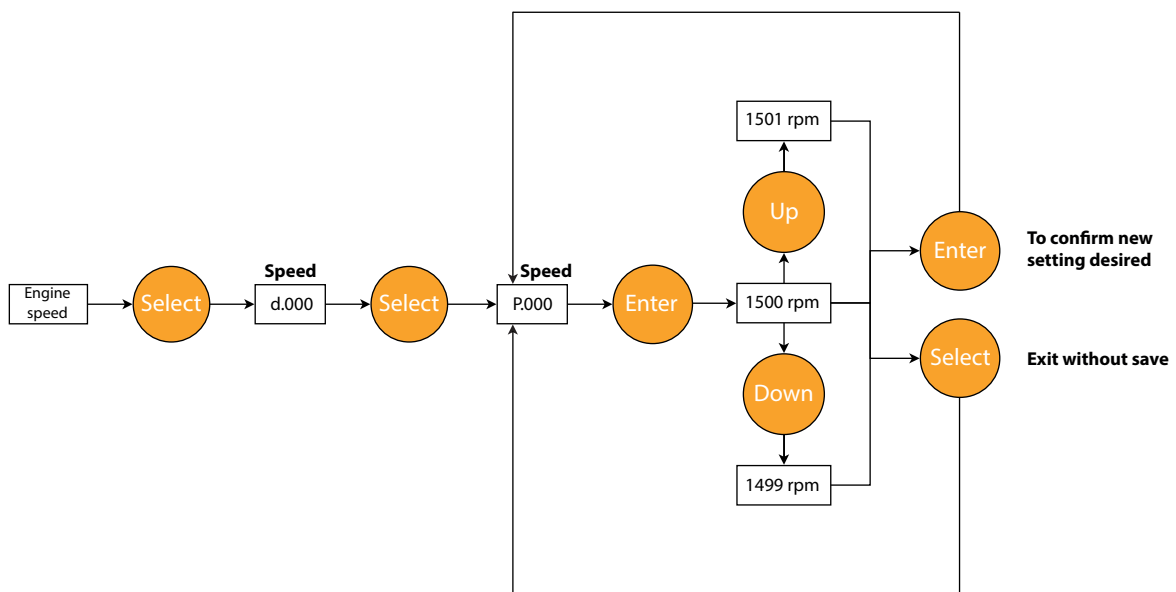
- d.XXX** Data menu, viewing only
- P.XXX** Parameters menù

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 Menù

3.3.1 Menù D (Display)

<i>Display</i>	<i>Parameter</i>	<i>Description</i>	<i>Units</i>	
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 Menù P (Parameters)

<i>Parameter</i>	<i>Parameter</i>	<i>Description</i>	<i>Units</i>	<i>Default</i>	<i>Range</i>
P.000	Rated Speed	Engine speed Set Point	Rpm	1150	600 - 4000
P.001	Kp (GAIN)	Proportional gain for PID control loop. The system becomes more reactive at the value increasing.		150	20 - 5000
P.002	Ki (STABILITY)	Integral gain for PID control loop. The system becomes more reactive at the value increasing.		140	0 - 5000
P.003	Kd (DEADTIME)	Integral gain for PID control loop. The system becomes more reactive at the value increasing.		80	0 - 5000
P.004	IDLE	Sets engine speed when the IDLE input is connected to GND/COM	Rpm	1300	600 - 4000
P.005	Crank speed	Crank termination threshold: RPM when the governor changes from crank mode to control mode	Rpm	1200	600 - 4000
P.006	Over speed	Over speed: RPM when actuator is shut off for safety reason and active an overspeed alarm	Rpm	1700	1350 - 4750
P.007	Start fuel	Max output to actuator while cranking		100%	5% - 100%
P.008	Speed ramp	Time to change speed from crank speed to rated speed	s	5	0,5 - 60
P.009	Droop	Droop at maximum actuator current		1,5%	0,1% - 8%
P.010	Max current	Droop at maximum actuator current	A	10	1 - 15
P.011	Overload time	Time before actuator current is clamped to Max current (P.010)	s	10	5 - 60
P.012	Variable speed control	Maximum speed change from analog inputs		3%	0% - 100%
P.013	Teeth	Number of teeth on flywheel		72	10 - 250
P.014	Rate	Time of the PID action		20	1 - 200

P.015	Reset	PW: 333. Setting P.015 at the value of 333 (pw) and selecting "Enter" is possible to restore all regulator parameters at the default values, except the parameter "P013 flywheel teeth number".			
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The present manual refers to the firmware version 1.3.4 and following updating.



*** NOTICE!**

In case of short circuit at actuator output the S2007 goes in Alarm Mode to prevent from device failure.

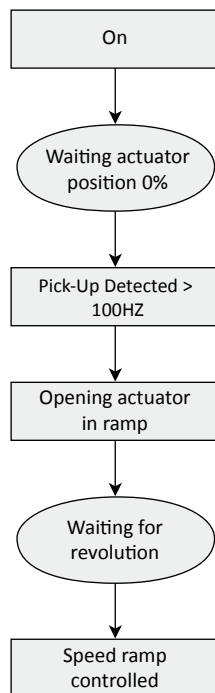
To recover from Alarm Mode shut off the S2007, remove short circuit then switch on again the S2007.

4. RUNNING THE ENGINE

4.1 Running the Engine

4.1.1 Starting the Engine

Power the regulator before starting engine. The actuator remains in rest position until the detection of the minimum starting threshold (100Hz). Once the threshold is exceeded, the speed controller command the opening of the actuator in ramp, and after have completed the engine cranking, ramps up to the set point engine.



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.

Once rated speed is achieved, PID parameters may required further fine adjustment.

4.1.2 Governor Performance

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

- A. Increase **GAIN** parameter until motor speed reaches instability. Gradually decrease the Gain until stability is recovered. Decrease one count further to insure stable performance.
- B. Increase **STABILITY** parameter until motor speed reaches instability. Gradually decrease Stability until stability is recovered. Decrease one count further to insure stable performance. If no instability appears, leave default value.
- C. Increase **DEADTIME** parameter until motor speed reaches instability. Gradually decrease Deadtime until stability is recovered. Decrease one count further to insure stable performance. If no instability appears, leave default value.
- D. This setting made with no load grants normally good performances with load too. However it can happened that an adjustment of the three parameters may be necessary after having applied load to the engine.

4.2 Description capabilities

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.

<i>Display</i>	<i>Parameter</i>	<i>Description</i>	<i>Unit</i>
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 Pickup detection

The speed regulator supplies energy to the actuator only if the pickup signal is higher than 100Hz and remains so stable for at least 100ms time.

4.2.3 Actuator ramp

Once obtained the signal of the pickups, the speed regulator supplies a raising current in ramp allowing the flow of fuel.

A controlled ramp is programmed from 0 (zero) to the percentage value previously set through the parameter P.007 (maximum actuator value) in a time fixed in 1 (one) second.

Example: the parameter P.007 is set at 75% and the ramp time value is 1 second per default, the pwm increases in a linear way from 0 to 75% in one second.

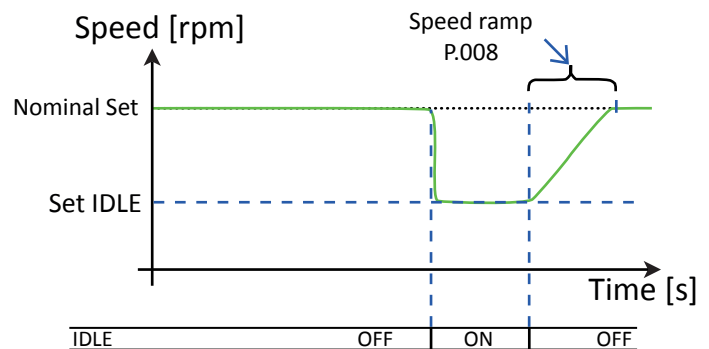
4.2.6 Variable Speed Inputs

If a voltage above/exceeding 0,3V is detected on the 0-10V input (or 4-20mA) during the Rpm Control Set phase, the regulator enable the Analogic Variation of the Set. In this phase the followed Rpm Set is set up through the analog input with continuous variation of the set as a function of the value on the analog input. During this phase the inputs UP/DOWN and DROOP are disabled. The variation limit is always given by the parameter Max. Variation Set (P.012).

Example: The Rpm Nominal Set (P.000) is set up at 1500rpm. The Max. Rpm Variation Set (P.012) is set up at 3%. In this situation a voltage equal to 0,4Vdc on the analog input will bring the rotation set to 1455rpm, while a voltage equal to 10Vdc will bring the rotation to 1545rpm.

The input 4-20mA for the microcontroller looks like the 0-10V input and acts exactly in the same way.

If the value of the analog input decreases below 0,3V following again the RPM Nominal Set, the regulator comes back to the Rpm Set Control (P.000).



4.2.7 Idle

IDLE is a feature that allows to run the motor at reduced speed.

Upon closing the input Idle, the speed governor changes in a step the motor speed from the Set RPM Nominal (P.000) to the Set RPM Idle (P.004).

The rotation speed remains set to this value for all the time that the IDLE input remains closed.

Opening the IDLE input, the regulator performs a controlled ramp from the Set RPM IDLE (P.004) to the Set RPM nominal (P.000) in a time equal to the one set for the Speed Ramp (P.008).

4.2.8 Droop

The Droop function is typically used for parallel between generators.

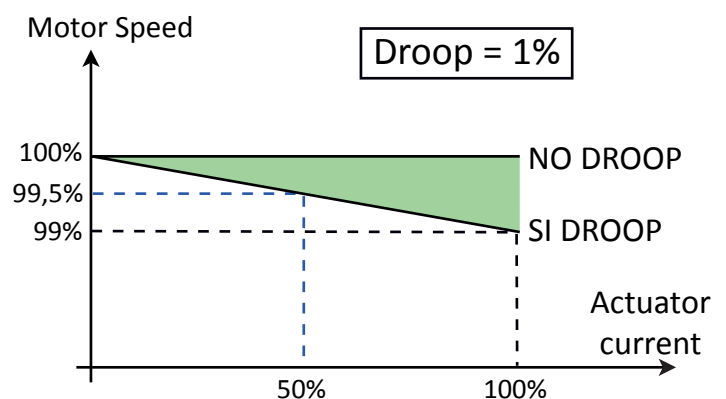
This function makes reduction of the engine speed as a function of the actuator control current.

Until the input 2 is closed, the speed governor makes a downward correction of the Set RPM Nominal (P.000) as a function of current supplied to the actuator.

Increasing the current, the number of revolutions is decreased in an inversely proportional manner. The maximum percentage change the number of revolutions is given by Droop parameter (P.009) and happens at the set of maximum current (P.010).

Example: The Nominal Set Revolutions (P.000) is set to 1500rpm, the Maximum Current (P.010) of 6Adc, the Droop (P.009) to 1%. As the current increases on the actuator of the rotation set is equal to 1485rpm.

If instead the current on the actuator is 3Adc, the rotation set is equal to 1492rpm.



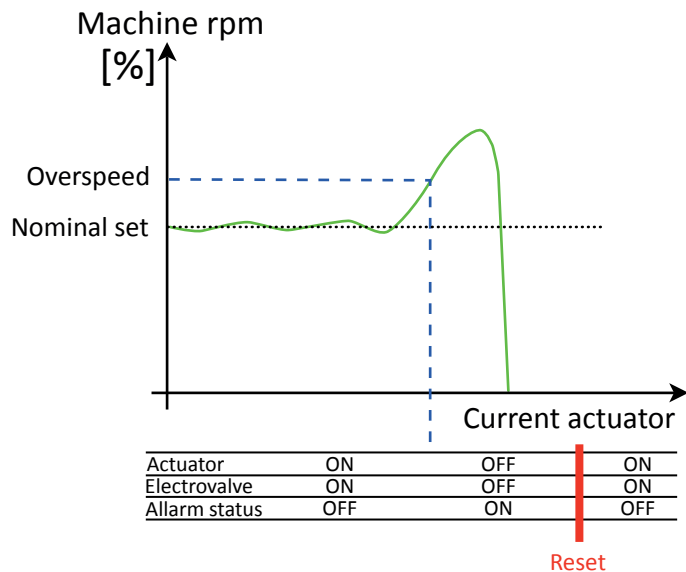
4.3 Description of the Protection

4.3.1 Over speed

If, during the operation, the Rpm value is higher than the value over speed set (P.006) for a time exceeding 1200ms, the rpm regulator switch off the generating set.

The actuator goes immediately (<1ms) in pause position and the aux. output (electrovalve) is disabled.

The rpm regulator remains in this status until the switching off.



**If the number of teeth or the value of the overspeed parameter is not correctly set you may having unwanted interventions or lack of operations.
It's recommended not to rely on this protection if the entered parameters are not correct.**

4.3.2 Overload

The regulator controls the actuator's voltage during the operation. When the requested current is higher than the Max. Current (P.010) the regulator allows an overload for a time to be set up through the parameter Overload Time (P.011). Once the set time finishes, the regulator limits the current at the set up value of Max. Current (P.010) even if the engine speed decrease. When the load condition decreases the regulator follows again the RPM Nominal Set.

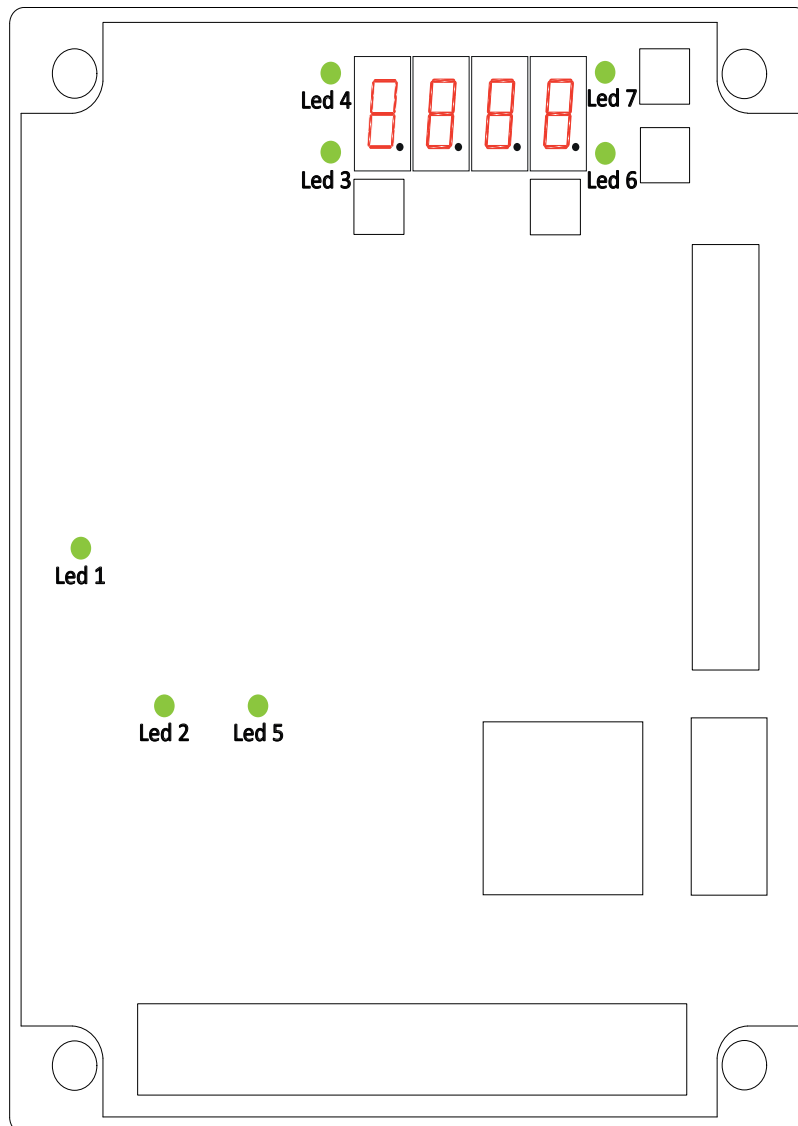
4.3.3 Loss of Pick-Up signal

If the regulator loses the pick-up signal during the running, the actuator goes automatically (<1ms) in pause mode and disables the command/control of the auxiliary output electrovalve (block). The Speed regulator remains indefinitely in this status until the switching off.

4.3.4 Led Signals

The following advice are implemented on the four leds positioned/located at the sides of the display:

- 1) **Led 1:** Mains
- 2) **Led 2:** Actuator
- 3) **Led 3:** Electrovalve
- 4) **Led 4:** Normally off, it flash when IDLE input is enable $T_{on}=T_{off}=500ms$ (slow flash), switch on if input 0-10Vdc (o 4-20mA) is enable (Voltage above 0.3Vdc).
- 5) **Led 5:** Normally off, it flash when overspeed alarm $T_{on}=T_{off}=250ms$ (fast flash). Switch on during the whole time of overload condition.
- 6) **Led 6 and 7:** Normally off; led 7 switch on when a speed increase variation is requested by input UP, led 6 switch on when a speed increase variation is requested by input DW. Both led are switch on when input Droop function is enable.



5. SPECIFICATIONS

5.1 Performance

Speed Range	10Hz - 5 KHz *
Idle Adjust	600÷4000rpm

5.2 Enviromental

Ambient Temperature	da -40° a 85°C
Relative Humidity	Up to 95%

5.3 Inputs / Outputs

Supply	12-24 VDC Battery Systems (8,5 to 30 VDC allowed)
Polarity	Negative Ground (Case Isolated)
Power Consumption	70mA max. plus actuator and solenoid current
Speed Sensor Signal	1-70 VRMS
Actuator Current (25°C)	15 A
Input for loading or synchronoscope variation	0÷10 Vdc, 4÷20mA, -5÷+5V
Reverse Power Protection	Yes
Transient Voltage Protection	Yes
Fuse	FF 12,5A Ultra Fast action, 5x20mm

5.4 Mechanical Details

Dimension	110x140mm
Weight	560g
Mounting	Vertical preferred

*Although the speed is defined in rpm, the operating range is defined at the frequency detected by the sensor on the flywheel.

6. NOTES ON THE OPERATION OF THE REGULATOR

The teeth number of the flywheel teeth-wheel is an important parameter for the functioning of S2007 speed regulator. In fact teeth number links revolutions number of the engine (rpm) to the frequency read by the pickup. Rotation values are set in RPM, but the regulation is done on the frequency value read for which is necessary to set the correct number of teeth.

The formula that links the values is the following one:

$$\text{Frequency read by the pickup [Hz]} = \text{Engine revolutions [rpm]} : 60 \times \text{Flywheel teeth number}$$

If the flywheel teeth number is unknown we can use the following procedure:

- 1) Disable the antismog ramp setting the "minimum rpm set" value (P005) at the "nominal rpm set" (P000).
 - Example: set (P005) at the value of 1500 (rpm).
- 2) On the display select the parameter "flywheel teeth number" (P013), which is set at 72 by default and start the engine.
- 3) If the revolutions number is low after starting, enter the parameter to increase the value. If the revolution number is too high, decrease the value.



ATECTION!

**To increase or decrease the value press softly the push-button.
A long pressure make the increase/decrease faster.**

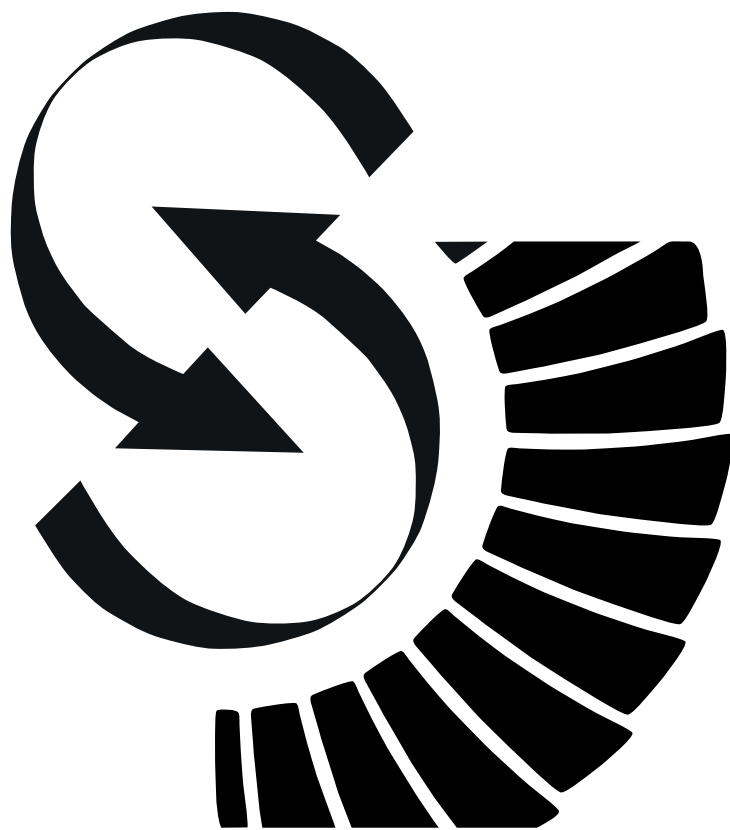
- 4) In case the engine doesn't start at minimum, before to start it again, increase the value (P013) and repeat procedure at point 3.
- 5) Once set the correct value on P013, enable the antismog ramp setting the "minimum rpm set" value (P005) at the desired value, lower than "nominal rpm set" (P000).
 - Example: by default the value of "minimum rpm set" (P005) is 1200rpm and the value of "nominal rpm set" (P000) is 1500 (rpm).

7. SOME EXEMPLES OF THE TEETH NUMBER OF ENGINEES FLYWHEEL

IVECO ENGINES : 8031 – 8041 - 8061 – 8361 = **130 TEETH**
BELL SAE 3 11,5"

IVECO ENGINES : 8210 SRI 25 – 26 – 27 – 28 = **156 TEETH**
BELL SAE 1 14"

IVECO FPT ENGINES : F4GEN45 = **60 TEETH**
CROWH TEETH FROM RADIATOR SIDE



BELTRAME

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