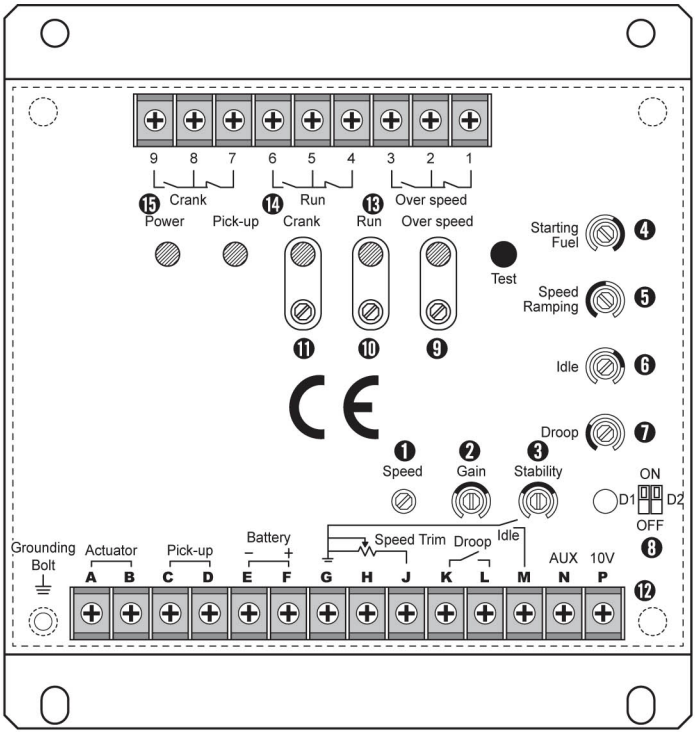
September 2013 Ver. 1.00

DGC-2013

Governor Controller Unit

Owner's Manual



[Fig. 1] Wiring Diagram and Outline

Description

DGC-2013 is a high-performance electronic device designed to control engine speed with fast and precise response based on PID algorithm. In this device, single operation (Isochronous mode) and parallel operation (Droop mode) is possible.

- Mount the controller unit vertically to the surface of a control cabinet to protect from water and high humidity, and do not expose the controller unit to the source of radiant heat. In the case of extended exposure to humidity (for over a month or condensation problem), dry the controller unit thoroughly before using as the number of rated turn could not be reached from fluctuation in the resistance value of internal circuit resulting from humidity.
- Do not rely exclusively on the actuator function of electronic governor to prevent overspeed. A secondary shutoff device such as a fuel solenoid must be used.
- It is recommended to use avg. setup range of each engine for setup section display of front side of each adjustment resistance, and set engine within the setup section.
- **EMC (Electromagnetic Compatability)**

  To satisfy EMC requirements, the controller unit should be mounted on the grounded metal side, and it is required to use shielded wires for all signal lines and ground all the shields to one of the bolts used to mount the controller.
  In addition, EMC related product quality issues that occur as a result of not following the installation method to prevent electromagnetic waves, as described above, cannot be ensured.

<< Adjustment Mode Item Description >>

❶ **Speed** adjustment resistance : Adjust the operating speed of engine.

❷ **Gain** adjustment resistance : Gain adjustment (sensitivity adjustment).

❸ **Stability** adjustment resistance : Stability adjustment (responsiveness adjustment).

❹ **Starting Fuel** adjustment resistance : Adjust fuel amount while staring engine.

❺ **Speed Ramping** adjustment resistance : Adjust the time to reach the rate speed after starting engine

❻ **Idle** adjustment resistance : Adjust the initial speed of engine.

❼ **Droop** adjustment resistance : Adjust droop amount (%) in droop operation.
(Refer to "Droop Amount" - Page 24)

❽ **Dip Switch** : Switch for adjusting differential function selection (Refer to "Instability" - Page 26)

❾ **Over Speed lamp** adjustment resistance : Adjust engine overspeed lamp & relay operation time.

❿ **Run Lamp** adjustment resistance : Adjust engine operation lamp & relay operation time.

⓫ **Crank Lamp** : Adjust the initial speed display lamp & relay operation time.

⓬ **TB1** : Terminal block for input & output.

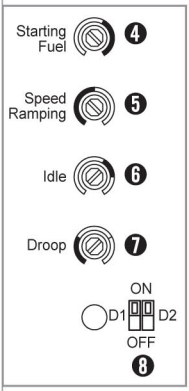
⓭ **TB2** : Engine overspeed relay contact output terminal (capacity - 2A/125VAC).

⓮ **TB3** : Engine operating speed relay contact output terminal (capacity - 2A/125VAC).

⓯ **TB4** : Engine initial speed relay contact output terminal (capacity - 2A/125VAC).

- ▷ The guide range of potentiometer resistance
- ▷ Adjustment range for potentiometer in front of CASE is the adjustment range for application to Doosan Infracore engine.
- ▷ For potentiometer adjustment, use a small size **(-) screw driver**. (beware of potentiometer damage)
- ▷ Make sure that all electrical connections are correctly made before starting engine.

▶Engine Start Adjustment



1. **G-M Terminal Connection** (engine initial speed (Idle) switch ON).
2. ❹ **Starting Fuel**
   - Adjustment objective : Adjustment for the most economical fuel amount according to install engine mode.
   - Recommended direction : 1~5 o'clock direction
   - Adjustment problems : 7~1 o'clock direction could cause start up error due to lack of fuel, and 5 o'clock and above direction could lower fuel efficiency with significant exhaust.
3. ❺ **Speed Ramping** Adjust potentiometer to 9 ~ 12 o'clock direction.
   - The time to reach run speed prolongs upon turning clockwise direction (↷). (max. over 10 sec)
   - Overshoot and hunting could occur at rapid speed if adjustment value is too small.
4. Start cranking the engine : Operate Start motor cranking.

▶Adjustment of Engine Operating Speed & Initial (Idle) Speed

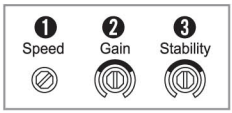
5. **Adjust engine operating speed (frequency).**
   - After engine crank up, remove **G-M** terminal connection. (Idle switch OFF)
   - In no load status, adjust speed (frequency) to ❶ **Speed** potentiometer.
     Clockwise direction (↷) RPM increase / counterclockwise direction (↶): RPM decrease
6. **Idle speed adjustment.**
   - With Idle switch ON again, adjust speed to 800 rpm by using ❻ **Idle** potentiometer.
   - Adjustment objective : Adjust initial fuel amount during cranking and engine warm up after cranking the engine.
   - Recommended direction :12~3 o'clock direction. 800 RPM is recommended for engine RPM even though there is difference in direction depending on engine type and rated RPM.
   - Adjustment problem : Initial start up function is deteriorated with excessive fuel consumption during warm up.

◈ It should not be overlooked that idle speed is one of important factors that determine engine start-up characteristics. Accordingly, it is necessary to adjust the idle speed after adjusting rated speed regardless of the use of "idle mode".

▶Governor Characteristic Adjustment

7. After removing **G-M** terminal connection (with idle switch OFF), adjust after engine reaches the RUN speed.

8. Gain adjustment.



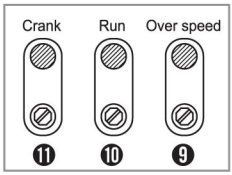
- In no load status, turn clockwise (↷) **❷Gain** potentiometer until the engine becomes unstable.
- Slowly turn **❷Gain** potentiometer counterclockwise (↶) and stop at position where RPM is most stable.
- For stability, further turn **❷Gain** potentiometer counterclockwise (↶) about 20 min (10°) for stability.

9. Stability adjustment.

- In no load status, turn **❸Stability** potentiometer clockwise (↷) until the engine becomes unstable.
- Slowly turn **❸Stability** potentiometer counterclockwise (↶) and stop at position where RPM is most stable.
- For stability, further turn **❸Stability** potentiometer counterclockwise (↶) for about 20 min (10°).

▶Accessory Adjustment

10. Adjust Run Lamp ON time.



- At the rated speed, turn **⓾Run** potentiometer counterclockwise (↺) until the lamp is turned on.
- To prevent the flickering of lamp (on/off phenomenon during load change when set at rated speed), further turn counterclockwise for about 90°.

11. Adjust Crank Lamp ON time.

- At the idle speed, turn **⓫ Crank** potentiometer counterclockwise (↺) until Idle Lamp is turned on.
- To prevent the flickering of lamp (on/off phenomenon during load change when set at rated speed), further turn counterclockwise for about 90°.

12. Adjust Overspeed Lamp ON time.

- At the rate speed, while pressing Test button ( ), slowly turn ❾ **Over Speed** potentiometer counterclockwise ( ) until Overspeed Lamp is turned on and the engine shuts off.
- With the above adjustment, the overspeed function is set at about 15% higher speed.

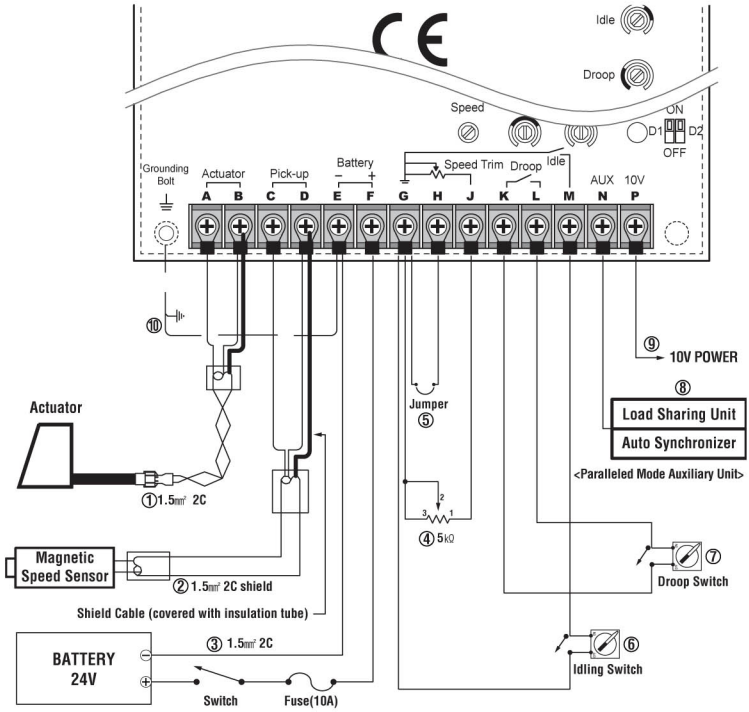
※ After completing every adjustment, start the engine once again to ensure the stable operation at engine start up, at no load and at load.

▶Starting Fuel Adjustment (minimizing exhaust fumes)

- Idle switch ON → Adjust idle speed to 800 RPM → Turn ❹**Starting Fuel** potentiometer counterclockwise ( ) until the speed drops → For stability, turn once again clockwise ( ) for about 15°
- If exhaust fumes are within tolerance level, it is recommended to set ❹**Starting Fuel** higher than 5 o'clock. If it is set too low, it may be difficult to start the engine and could cause speed overshoot after start-up, thereby exceeding the preset overspeed value.

▶When Engine Does Not Start

- If there is no problem with wiring, → revert every adjustment value to "factory set values". (Refer to Table 2. - Page 24) → Start the engine once again
- If the problem is not resolved: replace the controller since the problem may be due to controller hardware error.



[Fig. 2] Wiring Diagram

▷ Refer to [Fig. 2] Wiring Diagram for wiring.

▷ For every wiring, use 1.5㎟ or larger shielded cable.

▷ While using shielded cable, every shielded cable not displayed in [Fig. 2] must be grounded to the frame.

① As for actuator wiring, use twisted cable.
After connection, resistance between **A-B** should be 3.5~4.5Ω.

② As for magnetic speed sensor cable, "shielded" cable must be used, and the shielded area must be connected to terminal **D**.
If this shielded area is grounded to engine or not grounded, it could cause hunting problem through the input of distorted speed signal. Accordingly, it must be grounded.

③ Make sure that the polarity of battery connected to terminal **E** & **F** is not switched, and install 10A fuse between battery (+) and terminal **F.**
After connection, confirm that the voltage between terminals is DC24V(±4V).
Additionally, ground terminal **E** to the frame. (wiring ⑩)

④ As shown in the figure, fine adjustment is possible in the range of "preset speed ±210Hz" for engine speed through external connection of 5kΩ resistance.

⑤ In the case of using 12V battery or actuator with 5A or higher current consumption, connect terminal **G** and **H**.

⑥ Selector switch for switching between "Idle mode" and "Run mode"
ON (connected) : Idle mode **OFF (disconnected) : Run speed mode**

⑦ "DROOP" mode selector switch
ON (connected) : DROOP mode **OFF (disconnected) : Isochronous mode**

⑧ The signal from auxiliary unit used for parallel operation system should be connected to terminal **N**. Shielded cable should be used.

⑨ ACCESSORY POWER SUPPLY: terminal **P** that supplies +10[V] & 20[mA] power can be used as the power for auxiliary unit and applied in various ways.
However, it should be used within the range of rated capacity while paying attention to short circuit, and exceeding the capacity could cause fatal damage to the controller.

<CAUTION> Wrong wiring and battery voltage must be checked before use as they can cause fatal damage to the controller.

▶Magnetic Speed Sensor Installation & Connection

- The optimal distance between magnetic speed sensor and ring gear is about 0.45mm. Accordingly, after tightening sensor until it touches the ring gear, turn this in reverse direction by 3/4 for appropriate distance.
- Speed sensor signal can be checked by measuring the voltage (AC) between terminal **C-D** in operation mode.
- As for the voltage of sensor authorized for controller, AC 3V or higher voltage is required.

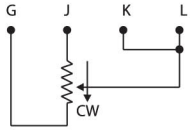
Remote Speed Adjustment

As shown in [Fig. 3], connecting speed adjustment potentiometer remotely allows remote adjustment of engine speed over specific speed range. Set resistance value according to the speed range required by referring to Table 1.

In the case of using minium speed for the engine speed in Remote adjustment mode, speed drops from system instability and load.

Accordingly, setting DROOP amount low (counterclockwise) by using ❼**Droop** adjustment potentiometer in minimum speed set-up mode could maintain engine stability. On the other hand, the governor operates in near **Isochronous** mode regardless of DROOP preset value in maximum speed mode.

▷ Mode of maintaining a certain (rated) speed regardless of load change



[Fig. 3]

Speed Range	Potentiometer Value	Engine RPM Conversion per Ring Gear		
		160	152	146
900 Hz	1K	337rpm	355rpm	370rpm
2,400 Hz	5K	900rpm	947rpm	986rpm
3,000 Hz	10K	1125rpm	1184rpm	1230rpm
3,500 Hz	25K	1315rpm	1381rpm	1438rpm
3,700 Hz	50K	1387rpm	1460rpm	1520rpm

[Table 1] Potentiometer Values on Speed Range

NO.	300611-00683	300611-00684	300611-00685	300611-00686
Overspeed	1725rpm (based on 160 gear teeth)	2070rpm (based on 160 gear teeth)	1725rpm (based on 152 gear teeth)	2070rpm (based on 152 gear teeth)
Run lamp	Maximum *CW	Maximum CW	Maximum CW	Maximum CW
Crank lamp	Maximum CW	Maximum CW	Maximum CW	Maximum CW
Gain	Mid-range (12 o'clock)	Mid-range (12 o'clock)	Mid-range (12 o'clock)	Mid-range (12 o'clock)
Stability	Mid-range (12 o'clock)	Mid-range (12 o'clock)	Mid-range (12 o'clock)	Mid-range (12 o'clock)
Starting Fuel	Full CW (Maximum Fuel)	Full CW (Maximum Fuel)	Full CW (Maximum Fuel)	Full CW (Maximum Fuel)
Speed Ramping	9 o'clock	9 o'clock	9 o'clock	9 o'clock
Droop	Full **CCW (minimum)	Full CCW (minimum)	Full CCW (minimum)	Full CCW (minimum)
Adjustment	(160 gear teeth)	(160 gear teeth)	(152 gear teeth)	(152 gear teeth)
Speed Adjustment	4000Hz (1500rpm)	4800Hz (1800rpm)	3800Hz (1500rpm)	4053Hz (1800rpm)
Idle Adjustment	2133Hz (800rpm)	2133Hz (800rpm)	2026Hz (800rpm)	2026Hz (800rpm)

* CW: clockwise ** CCW: counterclockwise

[Table 2] Factory Set Values

DROOP Parallel Mode (manual paralleling)

• Definition of DROOP : Decrease in speed setting from load increase.

$$\textbf{DROOP}(\%) = \frac{(\textit{No Load Speed-Full Load Rated Speed})*100}{\textit{Full Load Roted Speed}}$$

• Purpose of DROOP : DROOP is used for load sharing in parallel operation system between generators. If dropping function is not available in parallel system, generator could overload or lead to motorizing.

• Application of DROOP : For DROOP operation,

1. Turn ON the Droop selector switch connected to **K-L** terminal.
2. In DROOP mode, speed decreases as load increases, and DROOP amount (%) can be determined by using "❼**Droop**" adjustment potentiometer.
   The range of decrease increases when turned in clockwise direction. (DROOP amount (%) increase)

• The amount of DROOP commonly used is within 10%, and the minimum amount of DROOP required to maintain stability in speed DROOP governor should be at least 2.5%. Since the preset rated speed values could change according to the level of DROOP adjustment, speed should be readjusted when needed after checking the engine speed.

Accessory Input (automatic paralleling)

AUXILIARY terminal **N** is a terminal that receives signal from load sharing unit, auto synchronizer or other governor system auxiliary units. While connecting, used shielded cable. Since engine speed drops when auxiliary unit is connected to terminal **N**, speed adjustment potentiometer must be reset.
While operating in the maximum frequency mode that can be accommodated by control device, jumper cable between terminals **G** and **J** or frequency trim control might be needed. Using this device will increase the acceptable frequency range for speed control to 7,000Hz or higher.

Controller LAMP Display (Diagnosis) Function

• **Power** : When battery power is connected and internal control power (DC 12V) is generator, lamp is turned on to indicate that main controller is being operated.

• **Pick Up** : When the signal of magnetic speed sensor entered into terminal **C-D** is AC 3.0[V] or higher, lamp is turned on.

• **Crank** : Lamp is turned on and RELAY is operated upon reaching preset rated speed (idle speed).

• **Run** : Lamp is turned on and RELAY is operated upon reaching preset rated speed (run speed).

• **Over Speed** : Lamp is turned on and RELAY is operated to cut off actuator output when engine speed reaches the preset overspeed.

Instability

▶Fast Cycle Instability (Hunting)

* Application of SW D1 & D2 (Refer to Fig. 1)

- Placing D1 at **ON** position will operated differential function.
- Quick response to speed change is possible by increasing the responsiveness to speed changes in speed (rpm).
- Fine hunting of fast cycle could occur by responding sensitively also to external high-frequency noise.
  In such case, place D1 at **OFF** position and readjust ❷**Gain** & ❸**Stability.**
- If instability still exists, placing SW D2 of the device at **OFF** position could be helpful in stabilizing the engine.
  After taking these measures, readjust ❷**Gain** & ❸**Stability** one again to optimize the system, which will be helpful in decreasing and eliminating instability.

▶Slow Cycle Instability (Hunting)

There are various causes of slow cycle hunting but it generally occurs due to lack to optimized tuning as mechanical characteristics of engines vary slightly.

Such hunting can be resolved in most cases by readjusting the ❷**Gain** & ❸**Stability** status inside the controller. (Refer to the Adjustment Order on the previous page - Page 18)

▶If Problem Still Exists

- Loss of control function due to controller defect - replace controller.
- External mechanical device defect (actuator, fuel injection device, turbin, etc.) - rectify mechanical devices.

System Inoperative

When the engine governor system does not operated normally, its cause can be estimated by testing based on the contents described below. (+), (-) refer to the polarity of measuring instrument. If the result of test conducted through below methods is normal, the cause might be defective actuator or actuator wiring. In such case, check the actuator.

STEP	TERMINAL	TEST PERIOD	NORMAL READING	ESTIMATED CAUSE of ABNORMAL READING	CORRECTIVE MEASURE
1	F(+) & E(-)	When stopping E/G	DC 24V	1. Battery problem 2. Wrong wiring	1. Inspect battery line 2. Replace battery
2	F(+) & E(-)	When cranking start	DC 15 or higher		
3	C & D	When stopping E/G	Tester ohmmeter 300~1200Ω	1. Speed sensor defect 2. Damage of speed sensor wiring or wrong wiring	1. Inspect sensor line 2. Replace speed sensor
4	C & D	When cranking start	Tester AC voltmeter 1.5V or higher when measured	1. Distance between speed sensor and ring gear is too wide. 2. Speed sensor defect	
5	A & B	When stopping E/G	Tester ohmmeter 3.8~4.5Ω	1. When measurement is below 3.8Ω, check short circuit between lines. 2. When measurement is above 4.8Ω, check disconnection between lines. 3. Actuator problem	1. Check actuator line short circuit & disconnection. 2. Replace actuator
6	P(+) & G(-)	KEY S/W ON	DC 9.5~10.5V	Control device defect	Replace controller
7	F(+) & A(-)	When cranking	DC 9~15V when normal DC 1~3V when abnormal	1. Speed setting is low. 2. Short circuit or disconnection of Actuator wiring 3. Actuator	1. Check speed setting 2. Inspect actuator line 3. Replace actuator when found faulty