WOODWARD

UG40 GOVERNOR WITH DIGITAL INTERFACE (UG40-DI)
Software versions 3.07/3.08/4.01/4.02

INSTALLATION AND COMMISSIONING MANUAL

B03575.C

WARNING

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage.

WARNING

The engine, turbine, or other type of prime mover should be equipped with an overspeed (overtemperature, or overpressure, where applicable) shutdown device(s), that operates totally independently of the prime mover control device(s) to protect against runaway or damage to the engine, turbine, or other type of prime mover with possible personal injury or loss of life should the mechanical-hydraulic governor(s) or electric control(s), the actuator(s), fuel control(s), the driving mechanism(s), the linkage(s), or the controlled device(s) fail.

CAUTION

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

CAUTION

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts.

- Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).
- Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.
- Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.
- When not installed in a control, modules should be kept in a protective antistatic bag.

Revisions in this manual are marked by a vertical line in the margin.

Table of Contents

Table of Figures

1. GENERAL INFORMATION

1.1 Introduction

This manual is applicable to the UG40-DI Governor and describes its mechanical and electrical installation, operation and set-up. It is arranged in ten chapters:

- GENERAL INFORMATION
- ESD PROTECTION AND HANDLING
- DESCRIPTION
- INSTALLATION
- GOVERNOR MECHANICAL OPERATION AND ADJUSTMENTS
- CALIBRATION OF THE DIGITAL INTERFACE
- ADJUSTMENT OF THE DIGITAL INTERFACE
- ALARMS, DIAGNOSTICS AND SERIAL COMMUNICATIONS
- TROUBLESHOOTING AND REPAIRS.

Mechanical operation and adjustment of the UG40-DI is similar to that for the UG40 mechanical governor.

1.2 Description

The UG40-DI is a mechanical-hydraulic governor with a digital interface for controlling diesel engines. The UG40-DI uses a 250 PSI oil supply and is mechanically linked to the fuel racks.

The maximum travel of the output (terminal) shaft is 38°, and the recommended travel of the output shaft is 25° from no load to full load (refer to Section 4.5 for more details).

Normally, the UG40-DI operates isochronously (constant speed) regardless of load on the engine, except during operation as described in Chapter 3. DESCRIPTION.

Speed droop is incorporated in the UG40-DI to divide and balance load between units driving the same shaft or paralleled in an electrical system.

A load limit control is also a standard feature on the UG40-DI. It limits the amount of fuel supplied by restricting the travel of the governor output shaft. An indicator dial shows the governor output shaft limit position.

The load limit control may also be used for manually shutting down the engine.

1.3 System Compliance

This equipment complies with the relevant industry specifications and regulations.

1.4 General Safety Precautions

Obey the following safety precautions when you install the unit:

- Obey all cautions or warnings given in the procedures.
- Never bypass or override machine safety devices.
- Always use sufficient personnel and/or lifting equipment to move the UG40-DI.

1.5 Notes, Warnings and Cautions

The following examples show how notes, warnings and cautions are used in this manual:

Notes are used in the text to provide useful information or hints. This is a note.

WARNING

Warnings are used when a procedure or action is dangerous and injury or death might occur. This is a warning.

CAUTION

Cautions are used when a procedure or action can cause damage to equipment. This is a caution.

1.6 Identification Plate

The identification plate is installed on the front of the governor. It contains the following information:

- Part Number
- Serial number
- Manufacturing date
- Speed range
- Customer part number (if applicable).

Always give the part number and serial number in any correspondence with Woodward.

1.7 Technical Data

Governor pressure	1724 kPa (250 psi)
Weight	Approx. 50 kg (110 lbs)
Work capacity	78 J (57.5 ft-lb)
Drive power requirement	0.37 kW (0.5 hp)
Output	38º
Oil capacity	7 liters
Speed range	350 - 1050 rpm (low speed), 550 - 1300 rpm (high speed)
Start Fuel Limit Duration	Adjustable from 0-20 sec
Operating Temperature Range	-20 to 93°C (-4 to 200°F)
Storage Temperature Range	-40 to 100°C (-40 to 212°F)
Vibration Qualification Test Specification	Woodward RV2 (0.1 G2/Hz Random, 10-2000 Hz, 12.8 Grms, 3 hr per axis).
Shock Qualification Test Specification	40 G, 11 msec saw-tooth pulse
Humidity Qualification Test Specification	Woodward H2 (60°C, 95% RH, 5 days)
IP level	IP54
Steady state speed band	0.25 % of rated speed (under normal operating conditions)
Speed setting linearity	1 % over full range
Speed setting bandwidth	0.5 Hz for full range step (4 to 20mA and 20 to 4mA)
Power supply	24 Vdc nominal (18 - 32 Vdc), 25 watts (fused by 3A, slow)
Shutdown power	18 - 31 Vdc, 12 watts
Alarm signal output	17-31 Vdc, 100 mA, sourcing only
Standard governer drive shaft	1.125” diameter shaft with 48 SAE serrations
Optional governer drive shaft	0.625” diameter shaft with keyway 0.187” wide x 0.094” deep x 1.500” long for gear held by 0.625”-18 castle nut
Terminal (output) shaft	0.750” diameter with 48 SAE serrations

1.8 Software Versions

At power-up for one time, the yellow Mode LED indicates the UG40-DI software version using long flash pulses for the integer digit, and short flash pulses for the decimal digits. The differences between the software versions are as follows:

Software version	Description	Mode LED flash pulse
3.07	Start fuel limit time = fixed 10 seconds.	I….I….I….I.I.I.I.I.I.I
3.08	Start fuel limit time = fixed 20 seconds.	I….I….I….I.I.I.I.I.I.I.I
4.01	Alarm and diagnostics functions.	I….I….I….I….I.I
4.02	Start fuel limit time = adjustable 0 to 20 seconds.	I….I….I….I….I.I.I

I = 1 flash of Mode LED
…. = pause between flash pulses

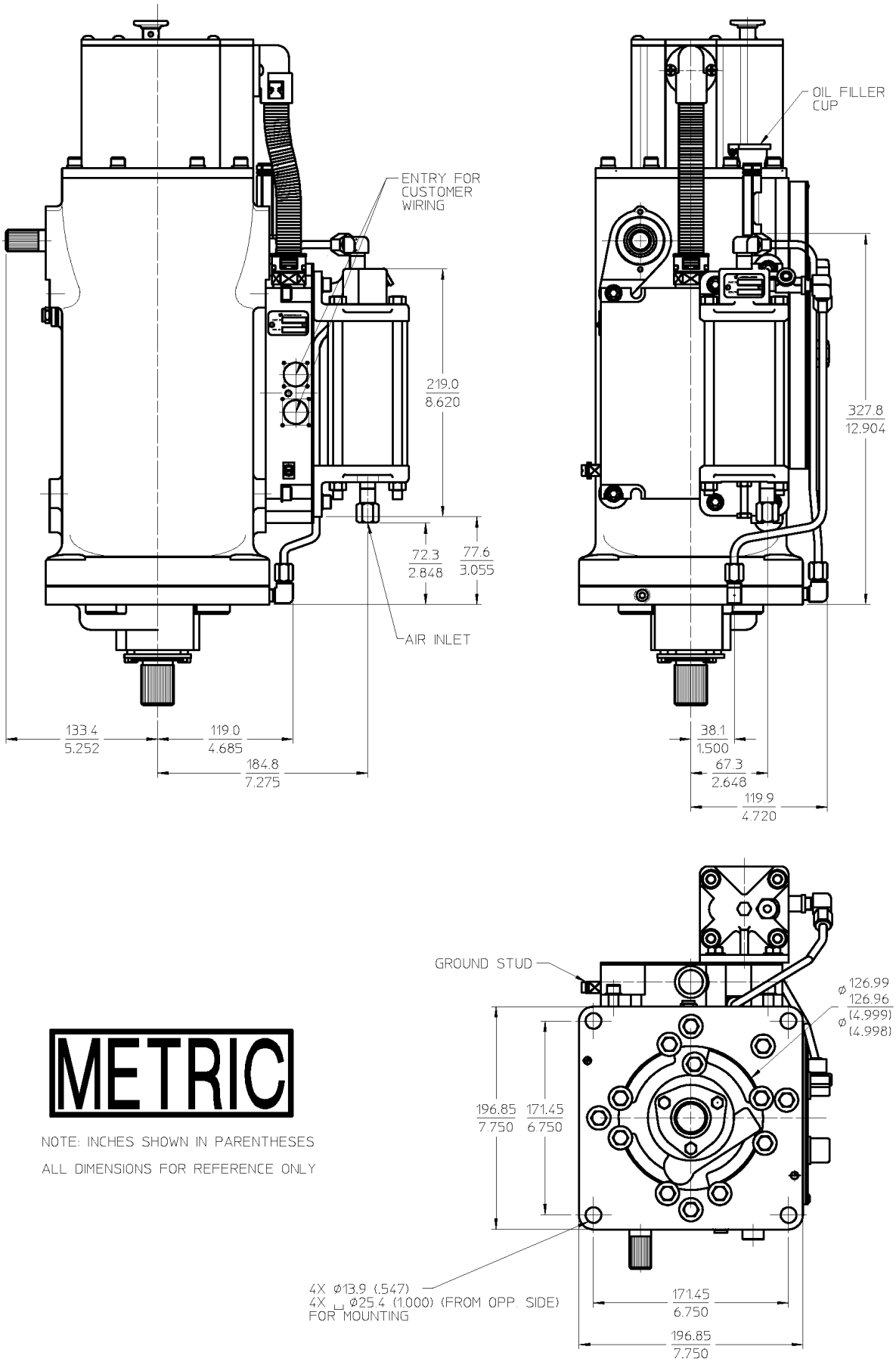


Figure 1.1 Outline Drawing of UG40-DI Governor (sheet 1 of 2)

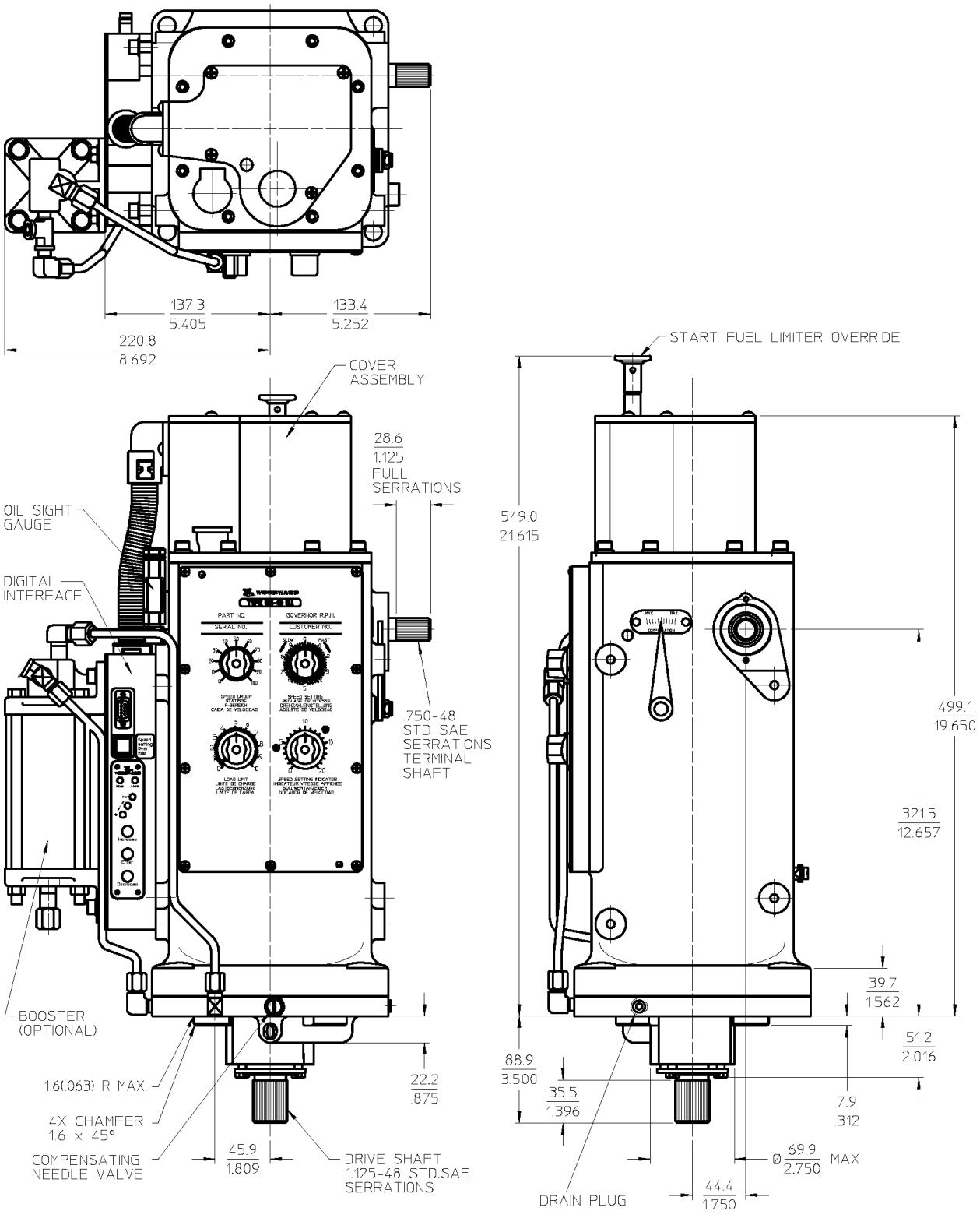


Figure 1.1 Outline Drawing of UG40-DI Governor (sheet 2 of 2)

2. ESD PROTECTION AND HANDLING

CAUTION

All electronic equipment is static-sensitive, some components more than others. To protect these components from static damage, you must take special precautions to minimize or eliminate electrostatic discharges.

Follow these precautions when working with or near the control.

1. Before doing maintenance on the digital interface, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).

2. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.

3. Keep plastic, vinyl, and Styrofoam materials (such as plastic or Styrofoam cups, cup holders, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, and plastic ash trays) away from the control, the modules, and the work area as much as possible.

4. Do not open the digital interface unless absolutely necessary. If you must open the digital interface, follow these precautions:

   - Do not touch any part of the printed circuit board.

   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.

3. DESCRIPTION

3.1 Introduction

This Chapter describes the mechanical and digital interface parts of the UG40-DI governor. The mechanical part is the same as the mechanical part on the UG Dial governor series.

3.2 DI Control Panel and Governor Dial Plate

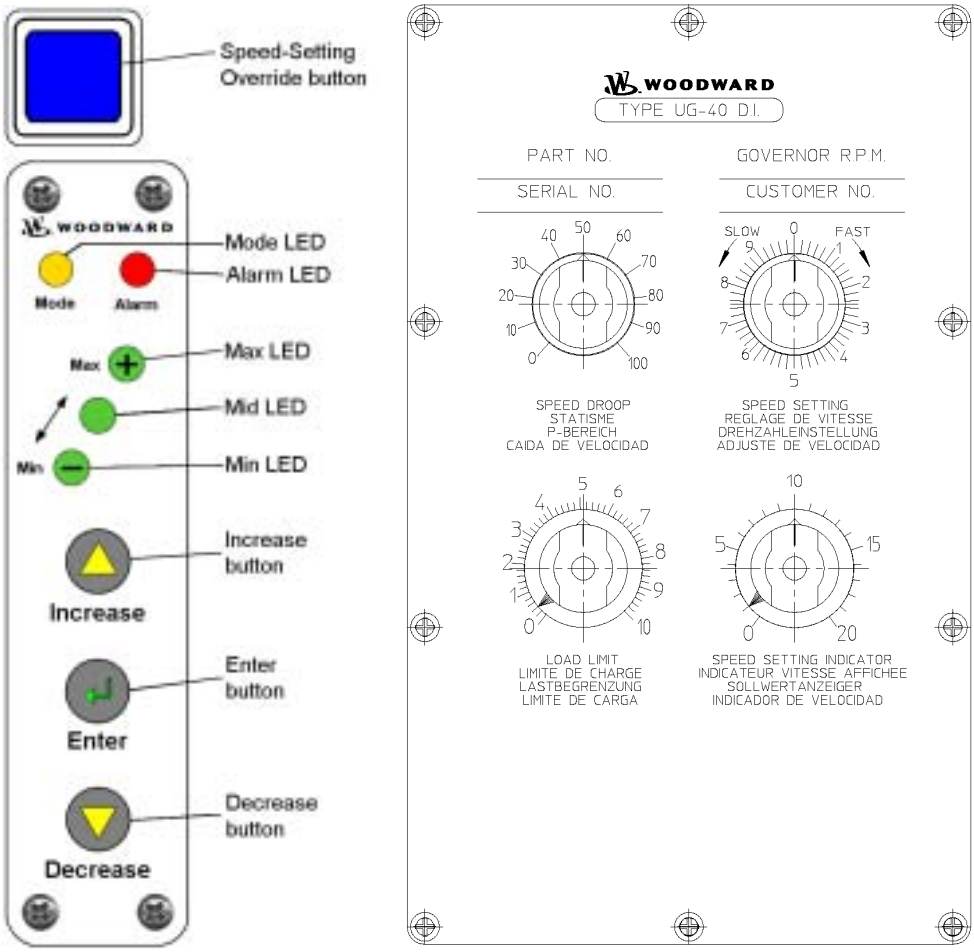


Figure 3.1 DI Control Panel and Governor Dial Plate

3.3 Mechanical Governor

3.3.1 Introduction

Basic mechanical and hydraulic operation is similar for all UG governor types.

Along with the text, a schematic diagram, Figure 3.2, is provided as a visual means of understanding the mechanical operation of the UG40-DI. This schematic shows a basic design and does not include any auxiliary equipment.

3.3.2 Component description

Before describing UG40-DI operation, a brief description of the components will help you understand its operation.

3.3.2.1 Oil pump

The oil pump (14) provides oil pressure for the governor.

The pump gets its oil from the self-contained sump (15). The oil pump is a positive-displacement gear pump with four check valves (13) for either direction of rotation. One pump gear is part of the rotating bushing and the other is part of the laminated drive. The rotating bushing is driven by the governor drive shaft, which is driven by the prime mover. As the bushing rotates, it rotates the laminated drive. The oil pump gears can be driven either clockwise or anticlockwise.

Oil flow is directed through the check valve system into the accumulator system (11).

3.3.2.2 Accumulator

The accumulator (11) stores oil under pressure for the operation of the UG40-DI governor. The accumulator (two cylinders) also acts as a pressure-relief valve if oil pressure increases above a set level.

The accumulator (11) consists of two spring-loaded pistons. Oil is pumped into the cylinders and pressure is increased as the accumulator springs are compressed. When the oil pressure exceeds 250 PSI, oil is released back to the sump through a relief port (12) in each cylinder.

Oil flows from the accumulator through passages to the top of the power piston and to the pilot valve system.

3.3.2.3 Power piston

The power piston (9) rotates the governor output shaft to the increase or decrease fuel position.

The power piston is a differential type with oil pressure on both sides of the piston. The top end of the power piston is connected to the governor output shaft (6) through a power lever and link assembly.

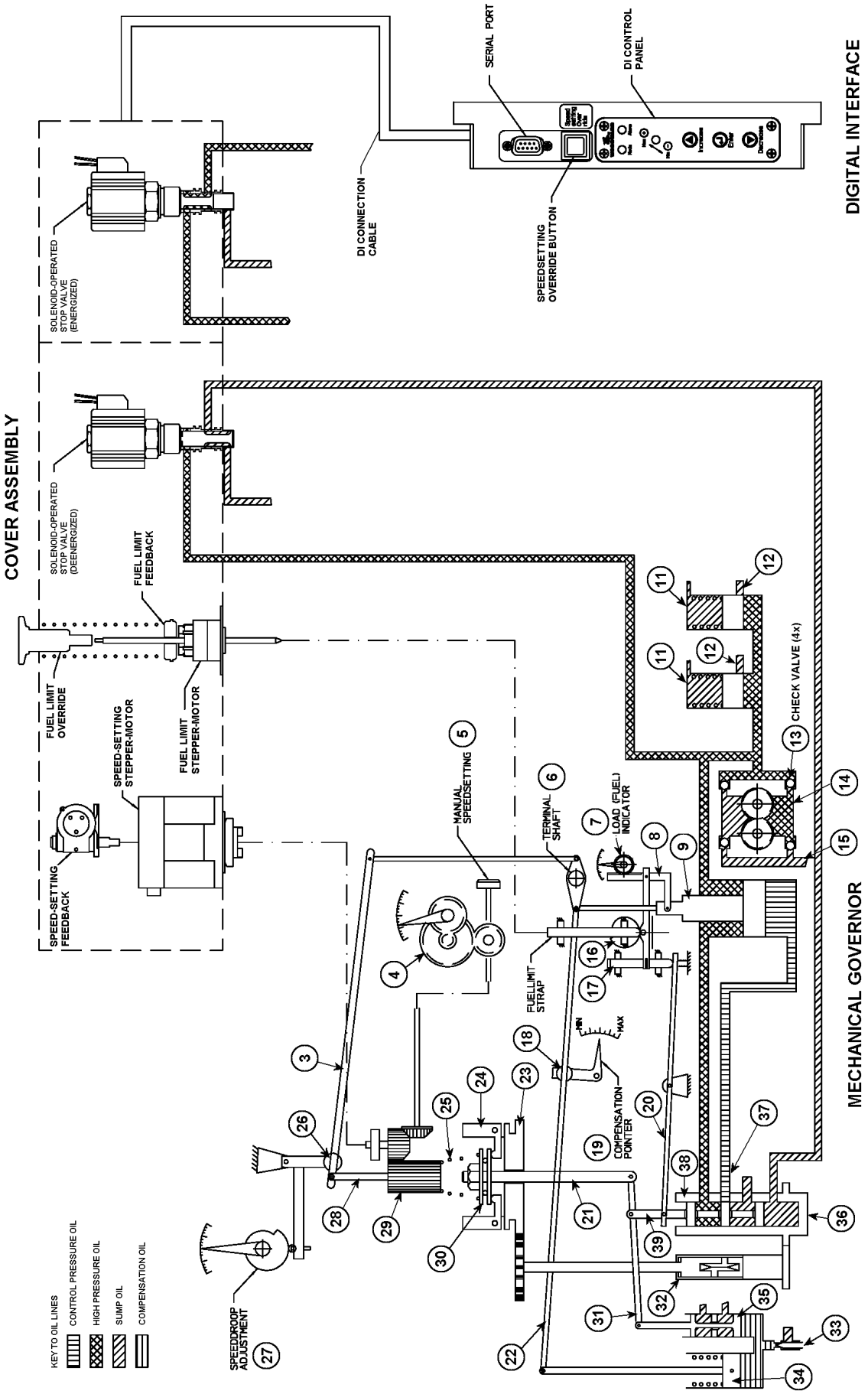


Figure 3.2 Schematic Diagram of the UG40-DI

The bottom of the power piston has a larger area than the top of the piston. Therefore, less oil pressure is needed on the bottom than on the top to maintain the piston stationary. If the oil pressure is the same on both the top and bottom of the piston, the piston moves up to rotate the governor output shaft in the increase fuel direction. The piston moves down only when oil under the piston is released to sump.

Oil to and from the bottom of the power piston is regulated by the pilot valve system.

3.3.2.4 Pilot valve system

The pilot valve plunger and bushing controls the flow of oil to or from the bottom of the power piston.

The pilot valve system includes the rotating bushing (38) and the pilot valve plunger (39). The bushing (38) is rotated by the drive shaft (36) while the pilot valve plunger is held stationary. Because of this rotation the friction between the pilot valve and bushing is reduced. The pilot valve plunger has a control land that regulates oil flow through ports in the bushing.

When the pilot valve plunger (39) is lowered, high-pressure oil flows under the power piston (9), raising it. When the pilot valve plunger is raised, oil is released to sump from under the power piston (9), lowering it. The higher pressure on top of the power piston (9), forces the piston down. When the pilot valve plunger (39) is in its centred position, the control land covers the control port as shown in the schematic, Figure 3.2, and there is no movement of the power piston.

The movement of the pilot valve plunger (39) is controlled by the ballhead system (23) and the dashpot compensation pistons (34) and (35).

3.3.2.5 Ballhead system

The ballhead system (23) senses speed changes of the prime mover compared to the speed setting reference given by the speeder spring (25) and positions the pilot valve plunger (39).

The ballhead system includes a ballhead (23), flyweights (24), a speeder spring (25), a thrust bearing (30), a speeder plug (29) and a speed setting rod (21).

As the governor drive shaft (36) rotates, the gear on the laminated drive (32) turns and rotates the ballhead gears (23). The flyweights (24) are attached to the ballhead with pivot pins, and a thrust bearing (30) rides on the toes of the flyweights (24). The speeder spring (25) is held in position against the thrust bearing (30) by the speeder plug (29). The speeder plug (29) is used to set a pressure on the speeder spring (25).

As the ballhead (23) rotates, the flyweights (24) pivot outward due to the centrifugal force. At the same time the speeder spring (25) is forcing thrust bearing (30) downward on the flyweight toes. This downward force is opposing the centrifugal force of the flyweights. Increasing the drive speed increases the centrifugal force. Compressing the speeder spring (25) with the speeder plug (29) increases the downward force applied to the flyweight toes, and in turn, increases the governor speed setting. The prime mover must run faster to generate a centrifugal force greater than the speeder spring force to balance the system again.

Speeder spring (25) force or speed setting is controlled manually through the synchronizer (speed setting) adjusting knob (5). It can also be controlled from the digital interface (see 3.4 Digital Interface). The speed setting is shown on the speed setting turns indicator (4).

3.3.2.6 Compensation system

The compensation system stabilizes the governor and obtains steady-state speed control. Also, when correctly adjusted, the compensation system effectively regulates the amount of

fuel necessary to bring the engine to the required output to adjust to a decrease or an increase in load.

The compensation system creates a small temporary change of speed setting with governor output shaft movement to produce a stabilizing speed droop characteristic in the governor. The change of speed setting is followed by a slow return of speed setting to its original value. Compensation is simply another word for temporary speed droop characteristic.

The compensation system includes a large dashpot compensation piston (34), a small dashpot compensation piston (35), a floating lever (31), a compensation adjusting lever (22) with a pivotable fulcrum (18), a compensation pointer (19) and a needle valve (33). See Figure 3.2.

The large dashpot compensation piston (34) is connected to the governor output shaft (6) by a compensation adjusting lever (22). A pivotable fulcrum (18) rides on the compensation adjusting lever (22). Changing the fulcrum's (18) position allows the compensation lever (22) to control the amount of stroke available for the large dashpot compensation piston (34).

The small dashpot compensation piston (35) is connected through a floating lever (31) to the pilot valve plunger (39) and the speeder rod (21).

Moving the large dashpot compensation piston (34) down forces oil under the small dashpot compensation piston (35). As the small dashpot compensation piston (35) is forced upward, it lifts the pilot valve plunger (39) to close off the control port, which stops the flow of oil to the bottom of the power piston (9).

The needle valve (33) is a variable orifice, which controls the flow of oil between both the large (34) and the small dashpot compensation (35) pistons, and the oil sump.

Compensation must be properly adjusted to the particular engine and load to provide stable operation (see Section 5.3.2 Compensation Adjustments).

3.3.2.7 Manual load limit control

The load limit control knob on the control plate hydraulically and mechanically limits the load that can be placed on the engine by restricting the travel of the governor output shaft in the increase fuel direction, and consequently the amount of fuel supplied to the engine.

The load limit control is also used for manually shutting down the engine by turning it to zero, and for manual start limiting by moving the knob from 0 – 10 during engine start.

CAUTION

Do not manually force fuel rack linkage to increase fuel without first turning the load limit control knob to 10, its maximum position. Failure to do so may cause damage and/or failure of governor internal parts.

The load limit control consists of an indicator disc (7) geared to a load limit rack (8). The control knob is also attached to the load limit cam (16).

Load is limited mechanically by positioning the load limit knob (cam 16). When the load indicator reaches the preset point, the pilot valve plunger (39) is lifted, stopping any further increase in fuel.

Turning the load limit control to zero to shut down the engine turns the cam (16) forcing the load limit (shutdown) lever (20) and shutdown strap (17) down. As the right end of the load limit (shutdown) lever (20) is forced downward, it pivots about its fulcrum and lifts the pilot valve plunger (39), releasing oil from under the power piston (9). Pressure oil acting on top of the power piston (9) forces it downward, rotating the governor output shaft (6) to minimum fuel and causing the prime mover to shutdown.

3.3.2.8 Manual speed setting knob

The speed setting knob is the speed adjusting control, and is used to change engine speed for a single unit. On engines paralleled with other units, it is used to change engine load.

The lower knob, "SPEED SETTING INDICATOR", has no function of its own but has an indicator disc which shows the number of revolutions of the speed setting knob.

3.3.3 Operation of the UG40-DI Mechanical Part

3.3.3.1 General Information

Refer to Figure 3.2 with the text to better understand the operation of the UG40-DI governor.

The description that follows is based upon speed changes caused by load changes and speed droop.

3.3.3.2 Decrease in load

When the prime mover is running on speed, the flyweights (24) are in a vertical position for normal steady state operation. The pilot valve plunger (39) is centred over the control port of the rotating bushing, and the control land stops the flow of pressure oil through the bushing (38) control port. There is no movement of the power piston (9), and no movement of the governor output shaft (6).

When a decrease in load occurs and the same fuel setting is maintained, a decrease in load creates an increase in speed. This generates the following sequence of governor movements:

1. As speed increases, the centrifugal force of the flyweights (24) increases and becomes stronger than the force of the speeder spring (25).
2. The flyweights (24) tip outward and raise the speeder rod (21) and the right end of the floating lever (31).
3. This raises the pilot valve plunger (39) opening the control port in the rotating bushing (38). Oil is released from the bottom of the power piston (9) to sump.
4. Pressure oil on the top side of the power piston (9) moves it downward rotating the governor output shaft in the decrease fuel direction.
5. Linkage from the governor output shaft (6) lowers the compensation adjusting lever (22), which rotates at the fulcrum (18), raising the large dashpot compensation piston (34).
6. Suction is thus applied to the chamber of the small dashpot compensation piston (35), lowering the left end of the floating lever (31).
7. This towers the pilot valve plunger (39) closing the control port (37).
8. As sump oil flows through the needle valve (33) from the sump into the dashpot compensation piston assembly (34 and 35) the small dashpot compensation piston (35) is returned to its normal centred position by the compensation spring, at the same rate as the speeder rod (21). This keeps the pilot valve plunger (39) in its centred position.
9. The control port in the rotating bushing (38) is kept closed by the land on the pilot valve plunger (39).
10. This stops the governor output shaft and power piston movement in the new decreased fuel position. This is the position needed to run the prime mover at the selected speed setting with the new load.

3.3.3.3 Increase in load

When the prime mover is running on speed, the flyweights (24) are in a vertical position and the pilot valve plunger (39) is in its centred position. There is no movement of the power piston, and no movement of the governor output shaft.

When an increase in load occurs and the same fuel setting is maintained, an increase in load creates a decrease in speed. This generates the following sequence of governor movements:

1. As speed decreases, the centrifugal force of the flyweights (24) decreases and the opposing speeder spring (25) force is now greater than the centrifugal force of the flyweights (24).
2. The flyweights (24) tip inward and lower the speeder rod (21) and the right end of the floating lever (31).
3. This lowers the pilot valve plunger (39) opening the control port in the rotating bushing (38). Pressure oil is released through the control port into the lower cylinder of the power piston (9).
4. The power piston is forced upward by the pressure oil acting on the larger lower surface area of the power piston, and the governor output shaft is rotated in the increase fuel direction.
5. Linkage from the governor output shaft (6) lifts the compensating adjusting lever (22), which rotates at the fulcrum (18), lowering the large dashpot compensation piston (34).
6. Pressure oil is applied to the bottom side of the small dashpot compensation piston (35), raising the left end of the floating lever (31).
7. This raises the pilot valve plunger (39) closing the control port (37).
8. As pressure oil flows through the needle valve (33) from the dashpot compensation piston assembly (34 and 35), the small dashpot compensation piston (35) is returned to its normal centred position by the compensation spring, at the same rate as the speeder rod (21). This keeps the pilot valve plunger (39) in its centred position.
9. The control port in the rotating bushing (38) is kept closed by the land on the pilot valve plunger (39).
10. This stops the governor output shaft and power piston movement in the new increased fuel position. This is the position needed to run the prime mover at the selected speed setting with the new load.

In both cases, a decrease or an increase in load, the compensation system operates in opposite directions.

The compensation or amount of movement of the large dashpot compensation piston (34) is controlled by the compensation adjustment, that is, the position of the fulcrum (18).

The rate at which the small dashpot compensation piston (35) is returned to normal is controlled by the needle valve adjustment, that is, the rate of flow of oil through the needle valve (33).

3.3.3.4 Speed droop

Droop is used to divide and balance load between units driving the same shaft or paralleled in the electrical system.

Droop is the decrease in speed taking place when the governor output shaft moves from the minimum to the maximum fuel position in response to a load increase, expressed as a percentage of rated speed.

If instead of a decrease in speed, an increase takes place, the governor is showing a negative droop. Negative droop will cause instability in a governor. This is caused by incorrect adjustment.

Not enough droop can cause instability in the form of hunting, surging or difficulty in response to a load change. Too much droop can result in slow governor response in picking up or dropping off a load.

Using an example where the governor speed is 1500 RPM at no load and 1450 RPM at full load, droop can be calculated with the formula:

$$\%Droop = \frac{\text{No load speed - Full load speed}}{\text{Full load speed}} \times 100$$

$$\%Droop = \frac{1500 \text{ rpm} - 1450 \text{ rpm}}{1450 \text{ rpm}} \times 100 = 3.5\%$$

If the decrease in speed is greater than 50 RPM when the governor output shaft moves from the minimum to the maximum fuel position, droop greater than 3.5% is shown by the governor. If the decrease in speed is less than 50 RPM, droop less than 3.5% is shown by the governor.

☞ If the governor output shaft does not use the full 30° of available travel from "NO LOAD" to "FULL LOAD, " droop will also be reduced proportionally.

Marks on the droop adjustment scale on the dial panel are reference numbers only, and do not represent droop percentages. Thus the 100 mark does not represent 100% droop. It represents the maximum droop percentage available on that particular UG40-DI governor model.

The speed droop control consists of a control knob, cam, and linkage (27) connected by a sliding fulcrum (26) to the speed droop lever (3). A speeder screw (28) connects the speed droop lever to the speeder plug (29). When speed droop is preset, the compression of the speeder spring (25) changes as the output shaft rotates. Increasing the fuel reduces speeder spring compression and in turn the governor speed setting. The unit gradually reduces its speed as load is applied. This relationship between load and speed acts as a resistance to load changes when the unit is in parallel with other engines.

Reducing droop to zero allows the unit to change load without changing speed. Normally, set zero droop on units running alone. On in-parallel units, set the least amount of droop possible to provide satisfactory load division.

For AC generating units tied in with other units, set droop sufficiently high (reference numbers 30 to 50 on the dial) to prevent interchange of load between units. If one unit in the system has enough capacity, set its governor on zero droop and it will regulate the frequency of the prime mover system. If its capacity is not exceeded this unit will handle all load changes.

Operate the Speed Setting Knob after setting the droop to return to the original RPM. With parallel engines, operate the Speed Setting Knob to distribute load between units.

3.4 Digital Interface

3.4.1 Introduction

The following functions of the UG40-DI are built into the DI part:

1. Speed setting
The following speed settings are available:
- 4 – 20 mA remote speed reference
- Discrete fixed speed input
- Discrete raise/lower speed input.

2. Speed up and down ramp
There are four different ramp-rates in the DI:
- Two adjustable ramp rates for the raise and lower discrete inputs
- One adjustable ramp rate for the 4 – 20 mA raise speed setting
- One fixed ramp rate for the 4 – 20 mA lower speed setting.

3. Fuel limiter
There are three fuel limit setpoints:
- One is fixed and used as an override
- One can be used for the start fuel limit
- One can be used for the clutch fuel limit.

3.4.2 Component Description

3.4.2.1 Digital interface (Di)

The Di is a micro controller-based interface which handles all discrete and analog Input/Output (I/O) signals. These signals are converted into mechanical outputs.

3.4.2.2 Cover assembly

The cover assembly contains the stepper-motor for speed-setting and fuel limiting, and the stop valve. The cover is connected to the Di by a single multi-core cable with a connector on each.

3.4.3 Operation

Refer to Figure 3.1 DI Control Panel and Governor Dial Plate and Figure 3.2 Schematic Diagram of the UG40-DI.

3.4.3.1 Speed setting

Speed setting is controlled by the speed-setting stepper-motor controlled from the Di. The speed-setting assembly contains an absolute feedback potentiometer which provides a feedback signal to the Di.

If a failure occurs it is possible to override the speed-setting by pressing the override button on the Di. This disconnects the supply to the speed-setting stepper motor (but the Di remains active). Reset the override by pressing the button for more than 5 seconds then releasing it.

3.4.3.2 Start fuel limiting

Start fuel limiting is controlled by the start fuel limiter stepper-motor which has a linear feedback. This stepper motor positions its spindle in the start fuel limit position after a stop signal is given to the Di. The stepper motor holds this position for either 10 seconds (software version 3.07), 20 seconds (software version 3.08) or adjustable 0-20 seconds (software version 4.01 and higher) after the stop signal is removed.

If a failure occurs it is possible to override the fuel limiter by lifting the fuel limiter override knob on the top of the cover assembly and turning it counter-clockwise.

3.4.3.3 Solenoid-operated stop valve

The solenoid-operated stop valve is directly hard-wired from the external connector, through the Di. It is independent from the Di control.

4. INSTALLATION

4.1 Introduction

This section provides information necessary for receiving, storage, mounting and start-up adjustments.

4.2 Installation Requirements

Refer to 1.7 Technical Data.

4.3 Unpacking

When you receive your UG40-DI governor it is bolted to a wooden platform in a vertical position. After testing at the factory, the governor is drained of oil which leaves a thin film of oil covering the internal parts, thus preventing rust. No internal cleaning is required before installation.

Some drive shafts are sprayed with a thin film of oil while others (depending on customer requirements) are covered with soft seal. Before installation, remove the soft seal with a rag saturated with mineral spirits.

4.4 Storage

If a governor is being stored for any period of time please refer to Woodward Specification Procedure 25075 "Commercial Preservation Packaging for Storage of Mechanical-Hydraulic Controls".

4.5 Mounting the Governor

Be sure there is adequate space available around the governor to provide easy access for installing the control linkage, filling the governor with oil, and adjusting the speed and compensation system. See Figure 1.1 for governor mounting hole sizes and general dimensions.

The recommended rated speed range for the governor drive is 800 to 1050 RPM. The drive power requirement is 1/2 HP at rated speed and operating temperature. The UG40-DI governor may be driven either clockwise or anticlockwise.

1. Make sure the drive shaft rotates freely.
2. Select the correct length of coupling between the governor and the prime mover drive.
3. Apply liquid heat-conductive gasket or grease to the governor mating surface.
4. Mount the governor squarely on its mounting pad. Make sure the drive shaft fits easily into the governor.
5. Make sure the coupling rotates freely but without backlash. Incorrect alignment of the governor shaft to the coupling, or insufficient clearance between any of the parts, can result in excessive wear and/or seizure of parts. It can also cause an undesirable high frequency vibration or "jiggle" in the governor output shaft (see section 9.3.1 for more information).

WARNING

In the event of a misaligned or broken drive shaft, an overspeed condition or runaway engine can develop. An over-speeding or runaway engine can result in extensive damage to the equipment, personal injury and/or loss of life.

The standard UG40-DI Governor drive gives few installation problems if the alignment of the governor shaft to the drive coupling is correct.

If an optional keyed drive is used when installing the governor, care must be taken to avoid the following undesirable conditions:

a. Rough gear teeth
Rough gear teeth or shaft out-of-round can cause vibrations which can be transmitted to the governor and cause a jiggle in the governor output shaft. The jiggle can be transmitted to the fuel control resulting in an undesirable condition. Replace gears if necessary.

b. Incorrect shimming
Check backlash and re-adjust if necessary to obtain proper mesh without binding or excessive backlash. Refer to the prime mover manufacturer's specifications for the correct amount of backlash.

6. Mount the governor flush with the engine drive pad. If the engine drive pad is at an angle (from 0° to 45° maximum), the UG40-DI must be installed with the front panel facing up.

4.6 Linkage Attachments

This section is only applicable to diesel-powered engines.

Adjustment of the fuel linkage must provide for control of fuel from "OFF" to "FULL FUEL" within the limits of the 38° of governor output shaft travel. It must also provide for approximately 25° output shaft travel between "NO LOAD" and "FULL LOAD".

Attach the fuel rack linkage to the governor output shaft. There must be no lost motion or binding in this linkage. Adequate locking methods must be employed on the linkage connections.

The maximum travel of the output (terminal) shaft is 38°. The recommended travel of the output shaft is 25° from no load to full load, which allows sufficient overtravel at each end so that the governor can shut down the prime mover and also give maximum fuel when required. See Figure 4.1 for recommended output shaft travel adjustment.

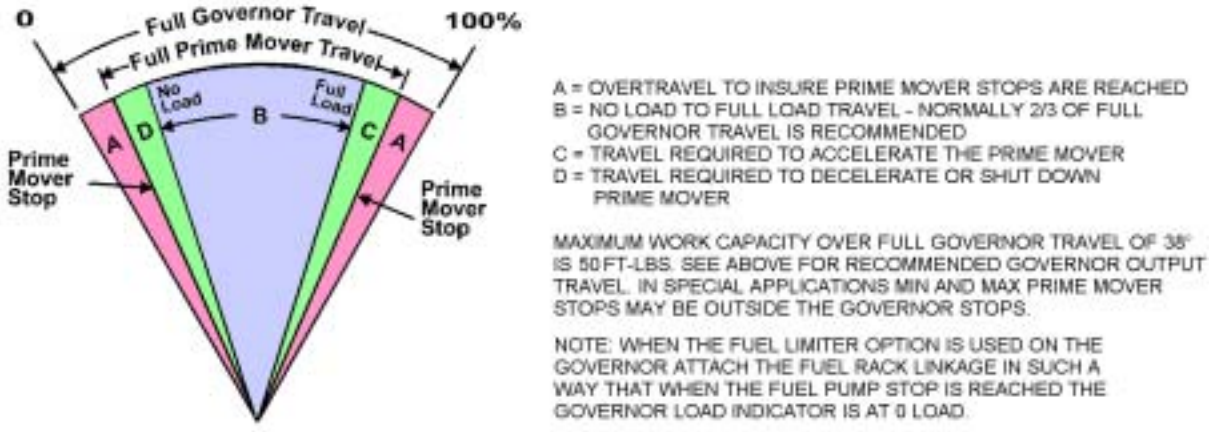


Figure 4.1 Recommended Output Shaft Travel Adjustment

WARNING

Be sure to allow sufficient overtravel at each end of the terminal shaft. Failure to provide sufficient overtravel at maximum fuel position can prevent the prime mover from giving maximum fuel when required. Failure to provide sufficient overtravel at minimum fuel position can prevent the governor from shutting down the prime mover and result In possible damage to equipment and personal injury.

4.7 Oil Supply

Use a high-quality oil suitable for the operating temperature of the governor (see Table 4.2).

Fill the governor with oil to the mark on the oil sight glass (refer to Table 4.1). After the engine is started and the governor is at operating temperature, add oil if necessary. Oil must be visible in the glass under all operating conditions.

Table 4.1 Oil capacity

UG40-DI	7.0 liters

Use the information given in Figure 4.2 and Table 4.2 as a guide in the selection of a suitable lubricating/hydraulic oil. Oil grade selection is based on the operating temperature range of the governor. Also, use this information to aid in recognizing and correcting common problems associated with oil used in Woodward products.

Governor oil is both a lubricating oil and a hydraulic oil. It must have a viscosity index that allows it to perform over the operating temperature range and it must have the correct blending of additives that cause it to remain stable and predictable over this range.

Governor oil must be compatible with seal materials, i.e., nitrile, polyacrylic, and fluorocarbon. Many automotive and gas engine oils, industrial lubricating oils, and other oils of mineral or synthetic origin meet these requirements. Woodward governors are designed to give stable operation with most oils with the viscosity, at the operating temperature, between 50 and 3000 SUS (Saybolt Universal Seconds). At the normal operating temperature, the viscosity should be between 100 to 300 SUS. Poor actuator response or instability may be an indication that the oil viscosity is outside this range.

Excessive component wear or seizure in a governor indicates the possibility of:

1. Insufficient lubrication caused by:
   a. An oil that flows slowly when it is cold, especially during start-up.
   b. No oil in the governor.
2. Contaminated oil caused by:
   a. Dirty oil containers.
   b. A governor exposed to heating up and cooling down cycles, which creates condensation of water in the oil.
3. Oil not suitable for the operating conditions caused by:
   a. Changes in ambient temperature.
   b. An improper oil level which creates foamy, aerated oil.

Operating a governor continuously beyond the high-limit temperature of the oil will result in oil oxidation. This is identified by varnish or sludge deposits on the governor parts. To reduce oil oxidation, lower the actuator operating temperature with a heat exchanger or other means, or change to an oil more oxidation-resistant at the operating temperature.

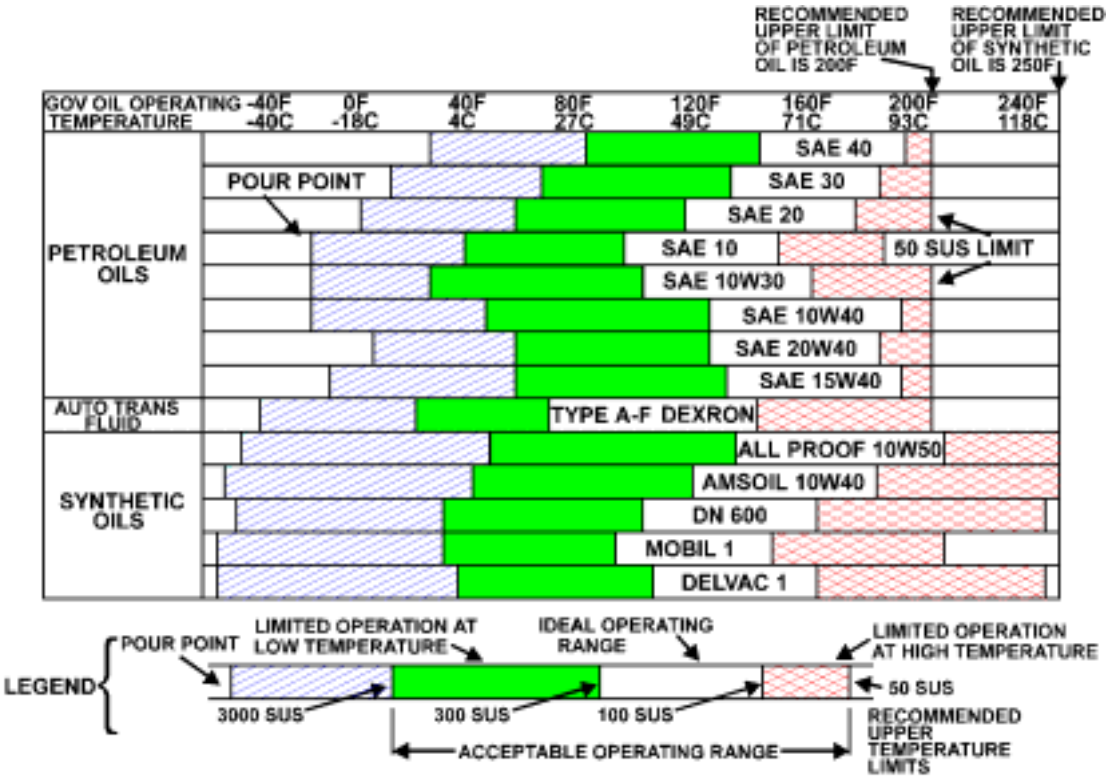


Figure 4.2 Oil Chart

Table 4.2 Viscosity Comparisons

Centistokes (CST, CS or CTS)	Saybolt Universal Seconds (SUS), nominal at 37.7 °C (100 °F)	SAE Motor (approximate)	SAE Gear (approximate)	ISO
15	80	5W		15
22	106	5W		22
32	151	10W	75	32
46	214	10	75	46
68	310	20	80	68
100	463	30	80	100
150	696	40	85	150
220	1020	50	90	220
320	1483	60	115	320
460	2133	70	140	460

WARNING

A loss of stable governor control and possible prime mover overspeed may result If the viscosity exceeds the 50 to 3000 SUS range. An overspeeding and/or runaway prime mover can result in extensive damage to the equipment, personal injury and/or loss of life.

Specific oil viscosity recommendations are given on the Oil Chart (see Figure 4.2). Select a readily available good brand of oil, either mineral or synthetic, and continue using that same brand. Do NOT mix the different classes of oils. Oil that meets the API (American Petroleum Institute) engine service classification in either the "S" group or the "C" group, starting with "SA" or "CA" through "SF" and "CD" is suitable for governor service. Oils meeting performance requirements of the following specifications are also suitable: MIL-L2104A, MIL-L-21041B, MIL-L-2104C, MIL-L-46152, MIL-L-46152A, MIL-L-46152B, MIL-L-45199B.

WARNING

Observe manufacturer's instructions or restrictions regarding the use of solvents. If no instructions are available, handle with care. Use the cleaning solvent in a well-ventilated area away from fires or sparks.

Failure to follow above safety Instructions can result In dangerous fires, extensive damage to equipment, personal injury and/or loss of life.

CAUTION

Do not hold the governor upside down to drain the oil. If the governor is held upside down oil enters the DI stepper motor housing and can enter the DI unit.

Change the governor oil if it is contaminated, and if it is suspected of contributing to the governor instability. Drain the oil while it is still hot and agitated; flush the governor with a clean solvent that has some lubricating quality (such as fuel oil or kerosene) before refilling with new oil. If drain time is insufficient for the solvent to completely drain or evaporate, flush the governor with the same oil it is being refilled with to avoid dilution and possible contamination of the new oil.

Drain the governor by removing the drain plug in the base of the governor housing (see Figure 4.3). The booster mounted on the side of the governor also contains oil. To drain this oil, remove the booster, invert it and blow compressed air through the oil line. Flush the booster using the same method used for the governor.

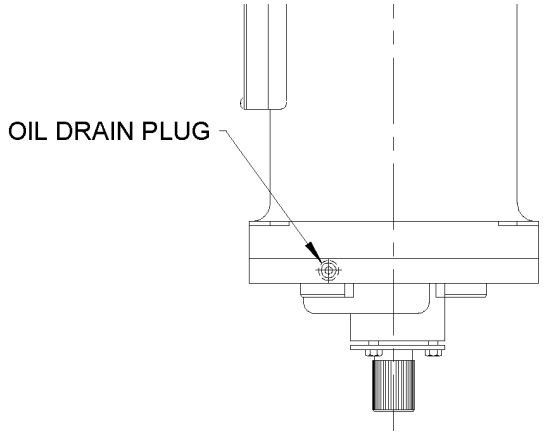


Figure 4.3 Oil Drain Plug

To avoid recontamination, the replacement oil should be free of dirt, water, and other foreign material. Use clean containers to store and transfer oil.

Oil that has been carefully selected to match the operating conditions and is compatible with governor components should give long service between oil changes. For governors operating under ideal conditions, i.e., minimum exposure to dust and water and within the temperature limits of the oil, oil changes can be extended. If available, a regularly scheduled oil analysis is helpful in determining the frequency of oil changes.

Any persistent or recurring oil problems should be referred to a qualified oil specialist for solution.

The recommended continuous operating temperature of the oil is 60 °C (140 °F) to 93 °C (200 °F). The ambient temperature limits are -30 °C (–20 °F) to 85 °C (185 °F). Measure the temperature of the governor on the outside lower part of the case. The actual oil temperature will be warmer by approximately 6 °C (10 °F).

4.8 Electrical Connections

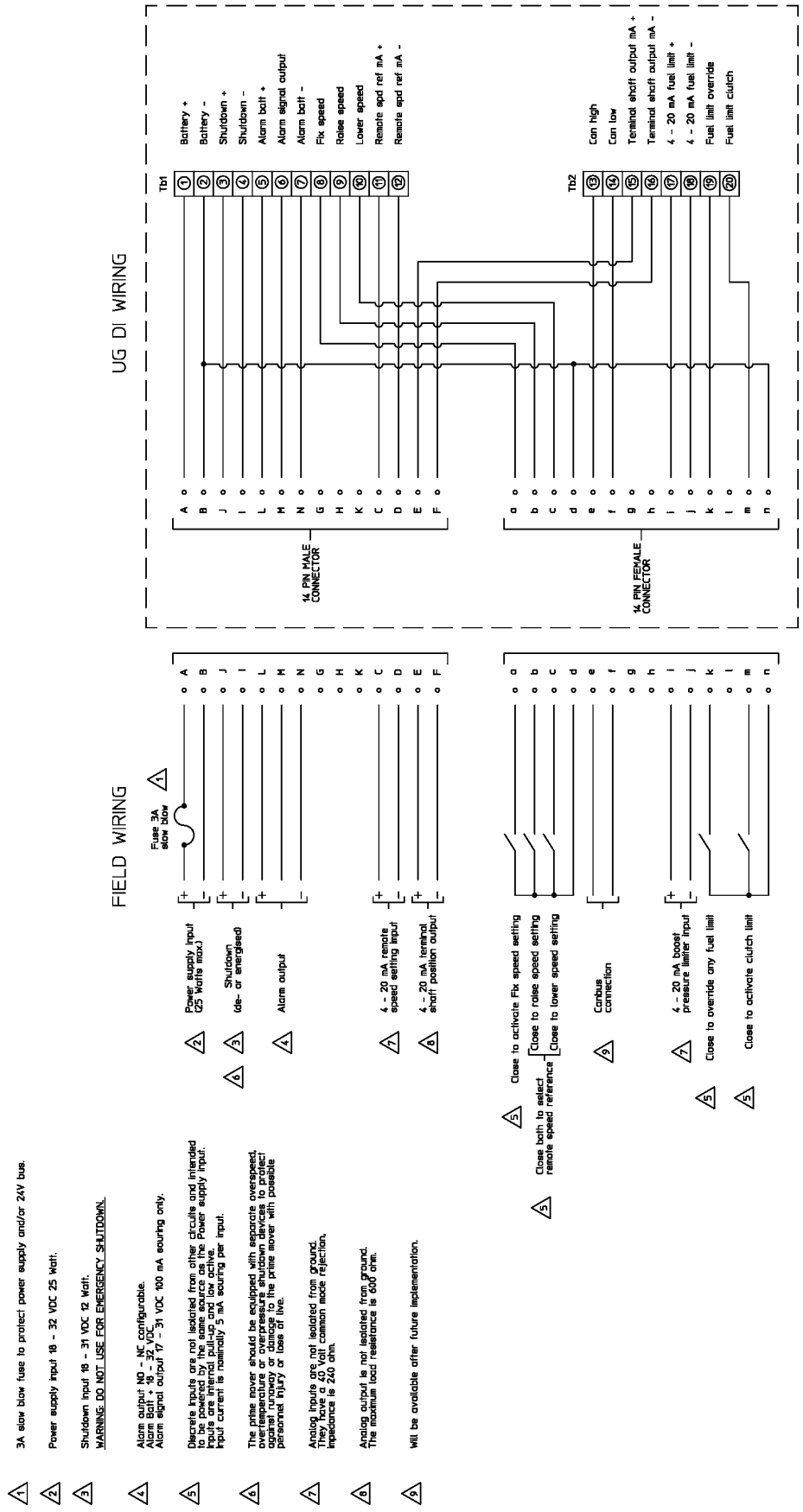


Figure 4.4 UG40-DI Electrical Connections

5. GOVERNOR MECHANICAL OPERATION AND ADJUSTMENTS

5.1 Introduction

This section describes initial mechanical operation and basic mechanical adjustments of the UG40-DI for putting a new or repaired governor into service.

This mechanical adjustment must be completed before the Digital Interface (DI) can be adjusted.

The DI calibration and adjustment procedures are in Chapter 6. CALIBRATION OF THE DIGITAL INTERFACE.

5.2 Check the Maximum Speed Setting

Make sure that the speed range of the new/replacement governor is applicable to the engine.

5.3 Initial Operation for a New Governor – Mechanical

Before initial operation of the UG40-DI, check that all previous installation steps have been correctly accomplished and all linkages are secure and correctly attached. See 4. INSTALLATION. Also, read all of 5. GOVERNOR MECHANICAL OPERATION AND ADJUSTMENTS.

Fill the governor with oil to the top mark on the oil sight glass. Close the needle valve carefully (clockwise) using a Phillips screwdriver and open it (anticlockwise) 1/2 to 3/4 turn. Loosen the nut holding the compensation-adjusting pointer enough to move the pointer and set the pointer in the center of the scale. Tighten the nut.

If replacing a governor, the initial compensation setting can be that of the governor just removed.

Start the engine in accordance with the prime mover manufacturer's instructions.

5.3.1 Adjustments

Normally, the only adjustments for putting a new governor into service are bleeding trapped air and adjusting compensation to obtain satisfactory stability and response. All other operating adjustments were made during factory calibration in accordance with the manufacturer's specifications and should not require further adjustments.

Do not attempt internal adjustment of the governor unless you are thoroughly familiar with the correct procedure.

5.3.2 Compensation Adjustments

The compensation needle valve and pointer are adjustable parts of the compensation system. Their settings directly affect governor stability.

Compensation must be properly adjusted to the particular engine and load to provide stable operation.

When the engine, turbine or other type of prime mover is started for the first time after the governor has been filled with oil, the governor may be stable at constant speed, yet the governor may need adjustment. High overspeeds and underspeeds after load changes and slow return to normal speed indicate the need for compensation adjustment.

☞ Maximum compensation settings generally provide stable steady state operation, but result in greater offspeeds on load changes.

After the oil in the governor has reached its normal operating temperature, make the following compensation adjustments without load on the prime mover to be certain that the governor gives optimum control. See Figure 1.1 for location of the adjustment parts.

1. To bleed trapped air from the governor oil passages, first loosen the nut holding the compensation-adjusting pointer and set the pointer at its extreme upward position for maximum compensation. Tighten nut.

   Next, remove the needle valve access plug and open the needle valve two turns anticlockwise. Use a Phillips screwdriver to avoid damage to the threads inside the bore and to the needle valve.

   Damage to the threads or to the needle valve will cause the governor to change fuel rhythmically. This is called governor hunt. See Section 5 for more information on hunting.

   There are two screwdriver slots in the needle valve, a shallow and a deep slot, located at right angles to each other. The deeper slot is used to expand the head of the needle valve and increase friction to prevent vibrations from changing the needle valve setting. If a plain screwdriver must be used, be sure to use the shallow slot of the needle valve.

   Allow the prime mover to hunt for approximately one-half minute to bleed trapped air from the governor oil passages.

2. Loosen nut holding the compensation pointer and set the pointer as far as it will go towards minimum compensation. Tighten nut.

3. Gradually close the needle valve until hunting just stops. If hunting does not stop, open the needle valve one turn and move the compensation pointer up by one mark on the front panel indicator scale. Again gradually close the needle valve until hunting stops.

   If hunting does not stop, set needle valve 1/4 turn open and repeat setting the compensation pointer up by one mark. Retest governor until hunting stops.

☞ The objective of the compensation adjustment procedure is to find the particular settings for the compensation needle valve and compensation adjustment pointer at which the engine, turbine or other type of prime mover, will return quickly to speed (needle valve adjustment) after a speed disturbance with only a slight over or undershoot (compensation pointer adjustment).

4. From this setting, open the needle valve one turn and momentarily disturb governor stability by turning the load limit knob to increase the load slightly and bringing it back quickly to its original position. Gradually close the needle valve until governor returns to speed with a small overshoot or undershoot and the needle valve is between 3/8 and 3/4 turn open.

   Compensation adjustment determines offspeed and needle valve adjustment determines recovery time.

☞ For most responsive governor control, use as little compensation as possible. Too much compensation causes excessive speed overshoots and undershoots upon load changes.

☞ Closing the needle valve more than 3/8 turn open makes the governor slow to return to normal speed after a load change. Opening the needle valve more than 3/4 open decreases governor stability and can cause hunting.

Once the needle valve adjustment is correct, it is not necessary to change the setting except for large, permanent changes in temperature, which affect governor oil viscosity.

When the compensation adjustment is correct, tighten the compensation pointer nut and install the needle valve access plug with a copper washer. The plug and the washer will seal oil seepage around the needle valve.

5.4 Reading Settings from Mechanical Governor on the Engine

The speed range and the fuel limit can be set with the engine running. These settings should be noted and used in the calibration and adjustment of the Digital Interface (DI).

5.4.1 Procedure

1. Install governor on engine.
2. Remove the 24 VDC supply from the DI (disconnect connectors or push the blue “override remote speed setting” on the DI).
3. Turn the LOAD LIMIT knob to 4 (40% fuel), and the SPEED SETTING INDICATOR to 1 using the SPEED SETTING knob.
4. Start the engine.
5. Set the idle speed to the required setting using the SPEED SETTING knob. Note the values on the SPEED SETTING knob dial and on the SPEED SETTING indicator dial.
6. Repeat the speed setting for the rated speed of the engine. Note the values.
7. Stop the engine and try to find the optimum setting for the start fuel limit (usually between 2.5 and 5 on the Load Limit indicator). With the correct setting the engine starts easily and does not produce excessive smoke. Note the value for the start fuel limit.
8. Stop the engine.

6. CALIBRATION OF THE DIGITAL INTERFACE

6.1 Introduction

This chapter describes the calibration of the Digital Interface (Di) of the UG40-DI governor. Before the Di can be calibrated you must first adjust the mechanical part (refer to 5. GOVERNOR MECHANICAL OPERATION AND ADJUSTMENTS).

The calibration necessary for the governor depends on its condition (See sections 6.1.1 and 6.1.2).

6.1.1 Calibration on test bench

Refer to 6.3 Calibration on Test Bench.

Calibration is necessary when the governor or DI has been replaced. In emergency situations calibration can be done with the governor installed on the engine. The calibration procedure sets the approximate speed reference values for the 4 – 20 mA input and fuel limit settings.

6.1.2 Calibration on engine

Refer to 6.4 Calibration on Engine.

Calibration on engine is done when calibration on the test bench is not possible or a calibrated replacement governor is not available.

6.2 Functions of UG40-DI During Calibration

6.2.1 Introduction

The DI panel and the governor dial plate are used to control the calibration and adjustment procedure, and to enter values. The functions of the DI buttons, DI LEDs, and the Speed Setting knob and indicator depend on the stage of the procedure, and these functions are listed below.

6.2.2 Explanation of the UG40-DI panel during calibration

The DI panel has the following LEDs and buttons (refer to Figure 3.1):

Blue Manual Override button (above DI panel)
This is the remote speed-setting override button which disengages the DI speed-setting and returns the governor to mechanical control (for use only in emergency).

Yellow Mode LED
This LED indicates when the program mode is active (LED is on), and in which menu the program mode is in (see Table 6.1).

Table 6.1 Calibration Mode LED flash codes

	Flash pulse	Program mode
Mode	I….I….I….I….I	Menu 1 : Fuel limit range calibration.
Mode	II….II….II….II….II	Menu 2 : 4 mA and 20 mA current calibration.

I = 1 flash of Mode LED
…. = pause between flash pulses

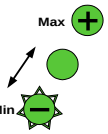
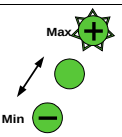
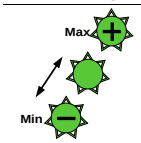
Red LED (refer to Table 6.2)
In program mode this LED indicates a calibration error or program exit without saving. (In normal operation the LED indicates an alarm.)

Table 6.2 Red LED operation

LED on	When active	Description
 Flashes	In menu	Error.
 1 flash	End of menu	Settings not saved.

Green LEDs (refer to Table 6.3)
Green LEDs indicate the step of a menu.

Table 6.3 Calibration program green LED operation

LED on	When active	Menu 1	Menu 2
	Step 1	Set 20% fuel limit.	Set 4.00 mA current.
	Step 3	Set 80% fuel limit.	Set 20.00 mA current.
 2 flashes	End of menu	All changed values in menu are saved.	All changed values in menu are saved.

Enter button (Refer to Table 6.4)
This button is used in two ways:

Short enter: Press the enter key for less than 1 second.

Long enter: Press and hold the enter key for more than 2 seconds.

Table 6.4 Use of Enter button

Action and Duration		Name	When active	Result
	< 1 sec	Short Enter	In menu	Steps to next menu item
	< 1 sec	Short Enter	End of menu.	Settings are not saved and steps to next Menu.
	> 2 sec	Long Enter	End of menu	All LEDs flash two times, and settings are saved.
	1 time	Calibration Pass Code	Start of calibration	Enters menu 1, step 1 (Mode LED code 1, Min LED on)
	3 times			

Increase and Decrease buttons (Refer to Table 6.5)

Increase button
This button is used to increase a value.

Decrease button
This button is used to decrease a value.

Increase and Decrease buttons at the same time
To enter or exit adjustment or calibration program.

Table 6.5 Use of Increase and Decrease buttons

Action and Duration		Name	When active	Result
 **Increase**  **Decrease**	Together > 2 sec	Start calibration	Start of calibration	**Mode** LED flashes then stays on. When released, DI is in program mode.
 **Increase**	1 time	Increase value	In menu	Increases value of setting.
 **Decrease**	1 time	Decrease value	In menu	Decreases value of setting.
 **Increase**  **Decrease**	Together < 1 sec	Exit calibration	End of menu	Calibration is stopped.

6.3 Calibration on Test Bench

CAUTION
The governor must be mechanically adjusted before calibration is started (refer to 5. GOVERNOR MECHANICAL OPERATION AND ADJUSTMENTS).

This procedure is normally done at Woodward.

Calibration is done on the test bench. This procedure sets basic values in the Di so it can be adjusted.

The calibration procedure has the following steps:

Set fuel limit
Sets the fuel limit actuator positions to 20% and 80% fuel limits.

Calibrate 4 and 20 mA speed setting currents
Sets the 4 mA and 20 mA current inputs.

6.3.1 Procedure

1. Install the governor on the test bench.
2. Use the Calibration Flow Chart in section 6.5 to do the calibration procedure.

6.4 Calibration on Engine

CAUTION
The governor must be mechanically adjusted before calibration is started (refer to 5. GOVERNOR MECHANICAL OPERATION AND ADJUSTMENTS).

CAUTION
This procedure must only be done when the use of a test bench is not possible.

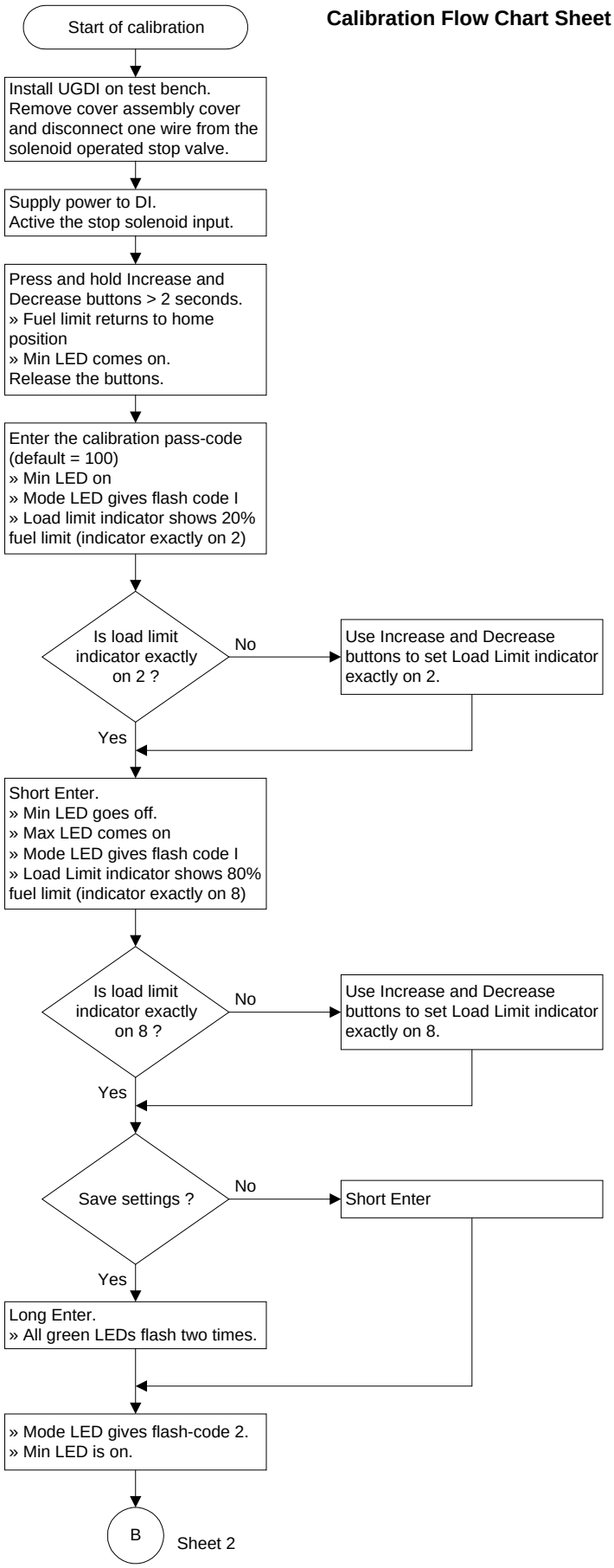
Calibration on engine, for example on a ship when the DI unit or cover assembly is replaced, is done when a test bench is not available. The result is not as accurate as when done on the test bench, and at a convenient time the governor should be removed and calibrated on the test bench.

6.4.1 Procedure

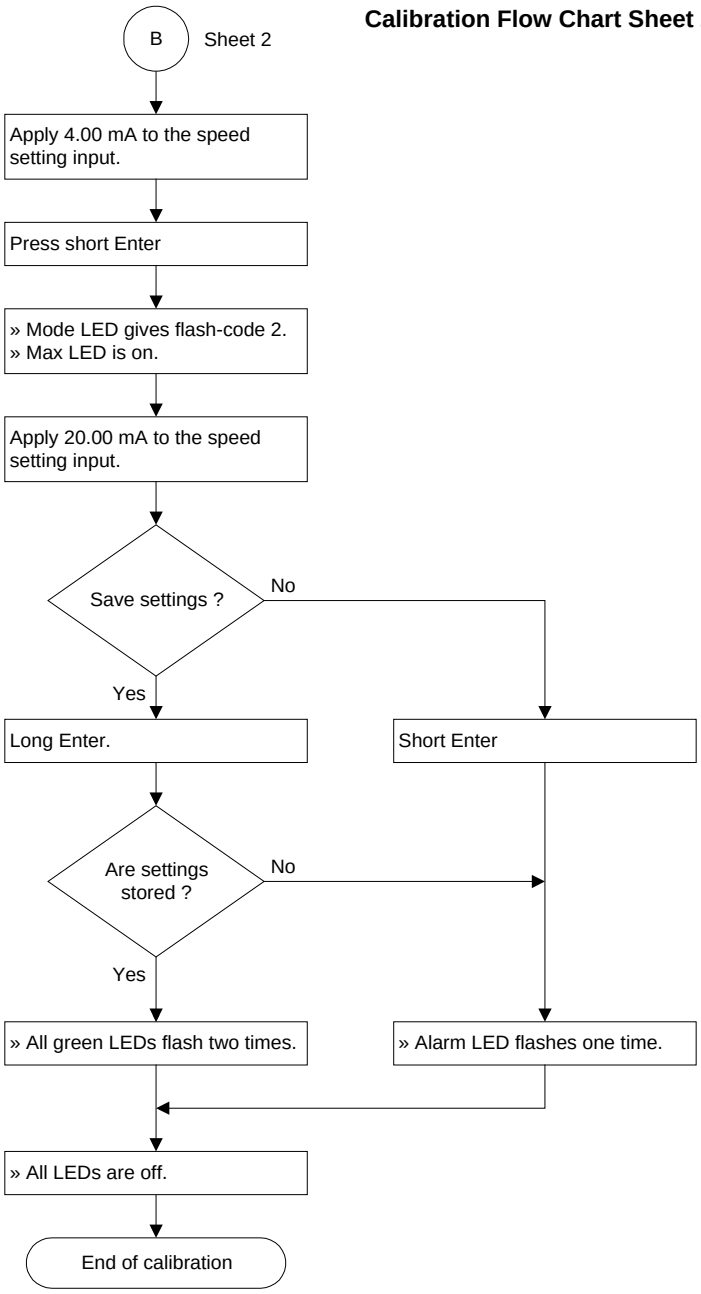
1. Run the engine and read the mechanical settings for idle and rated speeds (refer to section 5.4).
2. Stop the engine.
3. Supply power to the DI.
4. Mark the position of the fuel rack lever on the governor terminal shaft.
5. Disconnect the fuel rack.
6. Pull the terminal shaft by hand and, at the same time, turn the Load Limit knob counterclockwise to 0.
7. Enter calibration mode (refer to 6.5 Calibration Flow Chart and 6.2 Functions of UG40-DI During Calibration), and go to the 20% fuel limit.
8. Turn the Load Limit knob clockwise while slowly pushing the terminal shaft until the Load Limit indicator stops moving. This is the stepper motor position for the 20% fuel limit.
9. If the stepper motor position is not the same as the mechanical reading, change the 20% fuel limit to the mechanical setting using the Increase and Decrease buttons.
10. Check the stepper motor position again. If the stepper motor position is the same as the mechanical position press short Enter.
11. Do steps 8 to 10 for the 80% fuel limit. When the setting is correct press long Enter.
12. Continue with calibration in accordance with the Calibration Flow Chart in section 6.5.
13. Connect the fuel rack lever to the governor terminal shaft in the correct position.
14. Program the idle and rated speed-setting.

6.5 Calibration Flow Chart

Calibration Flow Chart Sheet 1 of 2



Calibration Flow Chart Sheet 2 of 2



7. ADJUSTMENT OF THE DIGITAL INTERFACE

7.1 Introduction

This chapter describes the adjustment of the digital interface of the UG40-DI governor. Before the digital interface can be adjusted you must first adjust the mechanical part (refer to 5. GOVERNOR MECHANICAL OPERATION AND ADJUSTMENTS) and calibrate the digital interface (refer to 6. CALIBRATION OF THE DIGITAL INTERFACE).

The type of adjustment depends on governor condition (See sections 7.1.1 to 7.1.2).

7.1.1 Adjustment

Refer to 7.3 Adjustment.

Adjustment is done on a calibrated governor, either on the engine or on the test bench. This procedure sets the operational settings used during engine operation. Settings from either a previously-installed governor or the settings determined during mechanical operation can be used as a starting point for adjustment.

7.1.2 Fine tuning

Refer to 7.4 Fine-Tuning.

Fine tuning is done with the governor installed and the engine running.

7.2 Functions of UG40-DI During Adjustment

7.2.1 Introduction

The DI panel and the governor dial plate are used to control the calibration and adjustment procedure, and to enter values. The functions of the DI buttons, DI LEDs, and the Speed Setting knob and indicator depend on the stage of the procedure, and these functions are listed below.

7.2.2 Explanation of the UG40-DI panel during calibration and adjustment

The DI panel has the following LEDs and buttons (refer to Figure 3.1):

Blue Manual Override button (above DI panel)
This is the remote speed-setting override button which disengages the DI speed-setting and returns the governor to mechanical control (for use only in emergency).

Yellow Mode LED
This LED indicates when the program mode is active (LED is on), and in which menu the program mode is in (see Table 7.1).

Table 7.1 Adjustment Mode LED flash codes

	Flash pulse	Program mode
	I….I….I….I….I	Menu 1 : Speed setting adjustment.
	Continuously on (with green program LEDs)	Dial adjustment to 0.
	II….II….II….II….II	Menu 2 : Ramp time adjustment.
	III….III….III….III….III	Menu 3 : Fuel limit adjustment.

I = 1 flash of Mode LED
.... = pause between flash pulses

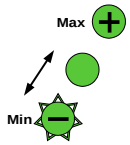
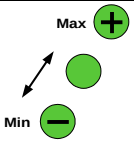
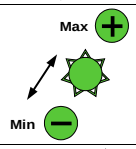
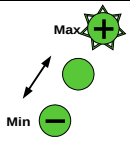
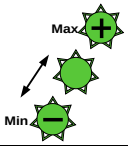
Red LED (refer to Table 7.2)
In program mode this LED indicates a calibration error or program exit without saving. (In normal operation the LED indicates an alarm.)

Table 7.2 Red LED operation

LED on		When active	Description
	Flashes	In menu	Error.
	1 flash	End of menu	Settings not saved.

Green LEDs (refer to Table 7.3)
Green LEDs indicate the step of a menu.

Table 7.3 Adjustment program green LED operation

	When active	Menu 1	Menu 2	Menu 3
	Step 1	Set 4 mA Speed Setting.	Set lower ramp value (discrete).	Set start fuel limit.
	Dial adjustment to 0. Continuously on (with yellow Mode LED)			
	Step 2	Set (20 mA) Speed Setting.	Set raise ramp value (discrete).	Set clutch fuel limit.
	Step 3	Set fixed Speed Setting.	Set raise ramp value (4 - 20 mA).	Software V3.07/3.08: No function. Software V4.01 and higher: Start fuel limit time delay
 2 flashes	End of menu	All changed values in menu are saved.	All changed values in menu are saved.	All changed values in menu are saved.

Enter button (refer to Table 7.4)
This button is used in two ways:

Short enter: Press the enter key for less than 1 second.

Long enter: Press and hold the enter key for more than 2 seconds.

Table 7.4 Use of Enter button

Action and Duration		Name	When active	Result
	< 1 sec	Short Enter	In menu	Steps to next menu item.
	< 1 sec	Short Enter	End of menu.	Settings are not saved.
	> 2 sec	Long Enter	End of menu	All LEDs flash two times, and settings are saved.
	3 times	Default Adjustment Pass Code	Start of adjustment	Enters menu 1, step 1 (Mode LED code 1, Min LED on).

Increase and Decrease buttons (Refer to Table 7.5)

Increase button
This button is used to increase a value.

Decrease button
This button is used to decrease a value.

Increase and Decrease buttons at the same time
To enter or exit adjustment or calibration program.

Table 7.5 Use of Increase and Decrease buttons

Action and Duration		Name	When active	Result
	Together > 2 sec	Start adjustment	Start of adjustment	**Mode** LED flashes then stays on. When released, DI is in program mode.
	1 time	Increase value	In menu	Increases value of setting.
	1 time	Decrease value	In menu	Decreases value of setting.
	Together < 1 sec	Exit adjustment	End of menu	Adjustment is stopped.

7.2.3 Displaying values on the Dial Panel speed setting knob and speed indicator

Refer to Figure 3.1.

The speed setting knob and indicator are used to present the values during the adjustment procedure. One full turn of the speed setting knob moves the speed setting indicator one increment.

Menu	Range during adjustment.	
	Speed Setting knob	Speed Setting indicator
1 - Speed setting	10 turns	10 increments
2 - Ramp time	2 turns	2 increments
3 - Fuel limit	1 turn	1 increment
Fuel limit delay	2 turns	2 increments

7.3 Adjustment

Adjustment is done on a calibrated governor, either on the engine or on the test bench. This procedure sets the operational settings used during engine operation. Settings from either a previously-installed governor or the settings determined during mechanical operation can be used as a starting point for adjustment.

The adjustment procedure has the following steps:

Set speed range
The 4 mA and 20 mA speed settings are set.

Set zero reference
The speed-setting knob is set exactly on 0 to give a reference point for all subsequent settings in adjustment. Note that the UG40-DI temperature can influence the zero position of the speed-setting knob.

Set ramp values
Sets the lower, raise and upper ramp values. The UG40-DI has four different ramp-rates:
- Raise ramp. The ramp-rate for the discrete raise contacts
- Low-ramp. The ramp-rate for the discrete lower contacts
- Up-ramp. The ramp-rate for the speed setting (4-20 mA input)
- Down-ramp. The ramp-rate for the speed setting (4-20 mA input). The down-ramp for the speed setting is fixed and cannot be changed.

Set fuel limit
There are three fuel limit switches in the DI:
- Override is fixed at 100% fuel. This is used for an emergency start.
- The start fuel limit is automatic and not an input contact. When the engine is stopped, the fuel limit is set to the start fuel limit. When the engine is started, the start fuel limit stays on for a set time at the start fuel limit position:

Software version	Start fuel limit time
3.07	10 seconds
3.08	20 seconds
4.01 and higher	0 to 20 seconds

- The clutch fuel limit is a normal contact input that can be programmed to any value between 0 and 100% fuel.

The fuel limit is presented on the Speed Setting knob and indicator. For the limit input (4 - 20 mA) a different set of correction curves can be programmed by PC-link (option available later).

7.3.1 Procedure

CAUTION

For initial adjustment use the safest settings. Test the settings to determine suitability for the engine then do the adjustment again using more applicable settings. Repeat adjustment until the best settings are determined.

Adjustment on engine sets the governor to the settings noted from governor mechanical operation. Adjustment on a test bench sets the governor to the actual test bench speed.

1. Install the governor on the engine or test bench.
2. If the governor is on the engine read the mechanical settings (refer to 5.4 Reading Settings from Mechanical Governor on the Engine).
3. Use the Adjustment Flow Chart in section 7.5 to do the adjustment procedure.

7.4 Fine-Tuning

Fine tuning is done with the calibrated and adjusted governor installed on the engine and the engine running. A maximum of 10% adjustment is allowed for these values in each, but if a greater range of adjustment is required the procedure can be repeated.

Idle speed and rated speed settings
To change the 4 mA speed setting the engine must be running at less than 5% speed setting. To change the 20 mA speed setting the engine must be running at more than 95% speed setting.

Fuel limiter
To change the start fuel limit the engine has to be stopped. Pressing the Increase or Decrease button increases or decreases the start fuel limit by 1%.

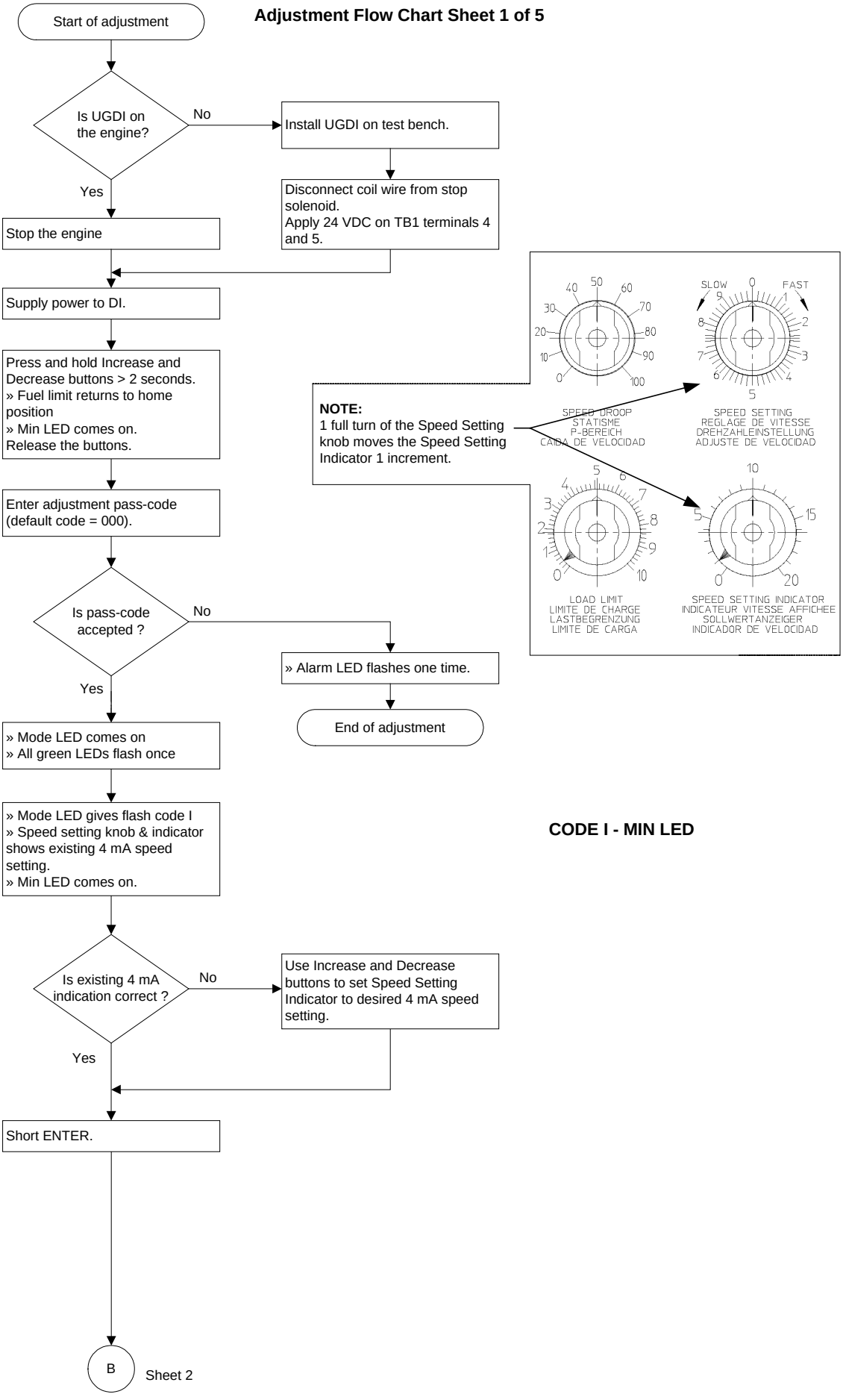
The clutch fuel limit (if active) can be adjusted either when the engine is running or stopped. Pressing the Increase or Decrease button increases or decreases the clutch fuel limit by 1%.

7.4.1 Procedure

1. Start the engine.
2. Use the Fine-Tuning Flow Charts in section 7.6.1 or section 7.6.2 to do the fine-tune procedure.

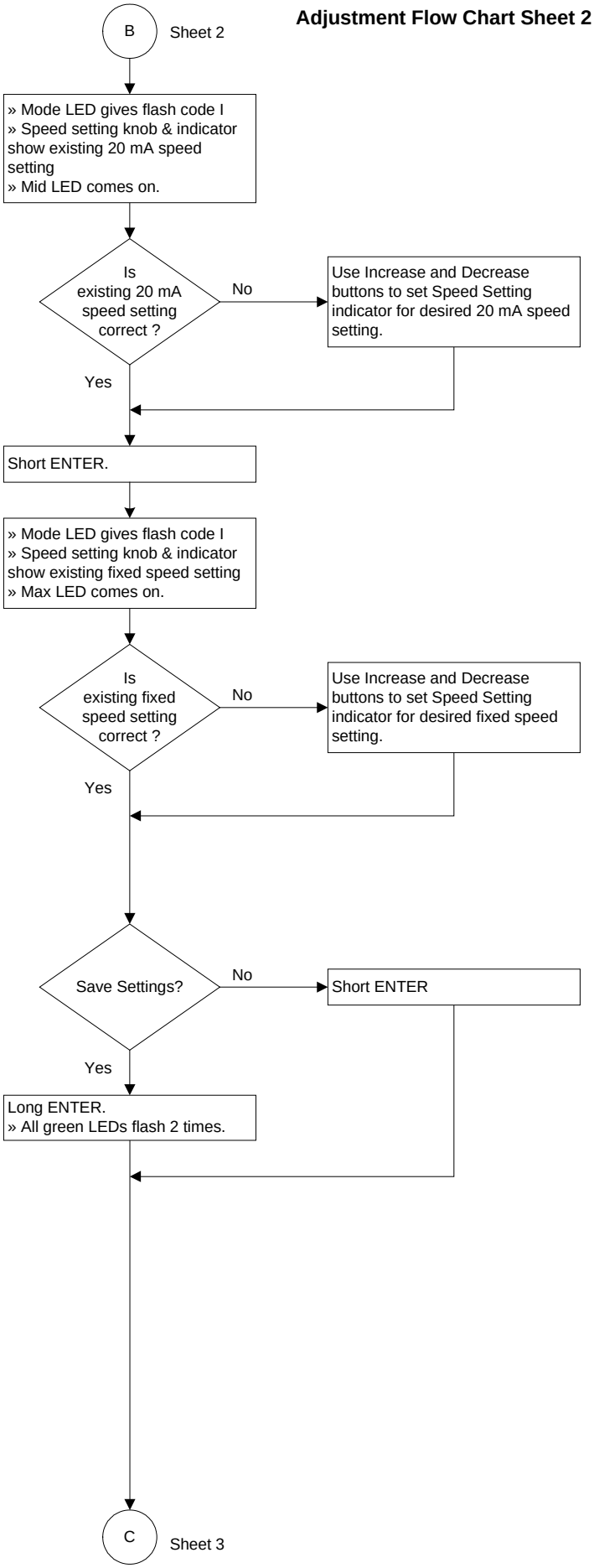
7.5 Adjustment Flow Chart

Adjustment Flow Chart Sheet 1 of 5



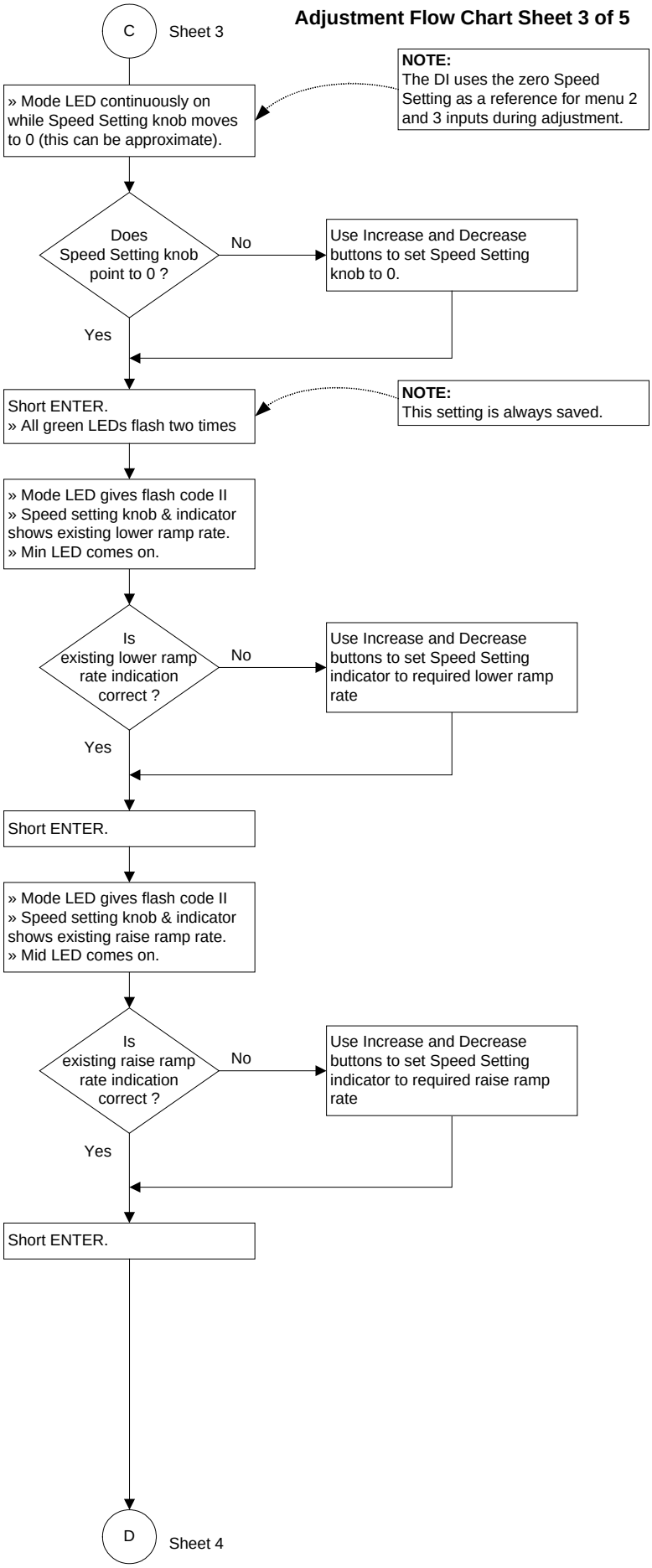
CODE I - MIN LED

Adjustment Flow Chart Sheet 2 of 5

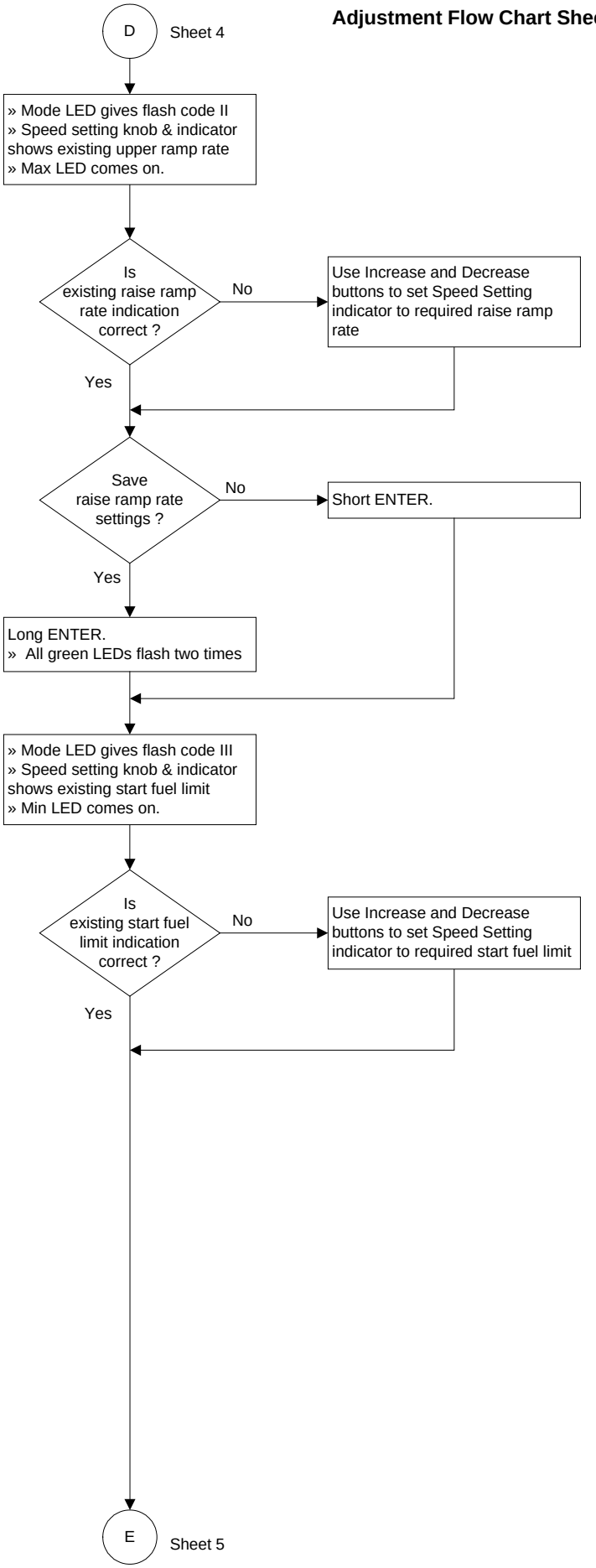


CODE I - MID LED

CODE I - MAX LED


Adjustment Flow Chart Sheet 3 of 5
C
Sheet 3
NOTE:
The DI uses the zero Speed Setting as a reference for menu 2 and 3 inputs during adjustment.
» Mode LED continuously on while Speed Setting knob moves to 0 (this can be approximate).
CODE - Set zero
Does Speed Setting knob point to 0 ?
No
Use Increase and Decrease buttons to set Speed Setting knob to 0.
Yes
Short ENTER.
» All green LEDs flash two times
NOTE:
This setting is always saved.
» Mode LED gives flash code II
» Speed setting knob & indicator shows existing lower ramp rate.
» Min LED comes on.
CODE II - MIN LED
Is existing lower ramp rate indication correct ?
No
Use Increase and Decrease buttons to set Speed Setting indicator to required lower ramp rate
Yes
Short ENTER.
» Mode LED gives flash code II
» Speed setting knob & indicator shows existing raise ramp rate.
» Mid LED comes on.
CODE II - MID LED
Is existing raise ramp rate indication correct ?
No
Use Increase and Decrease buttons to set Speed Setting indicator to required raise ramp rate
Yes
Short ENTER.
D
Sheet 4

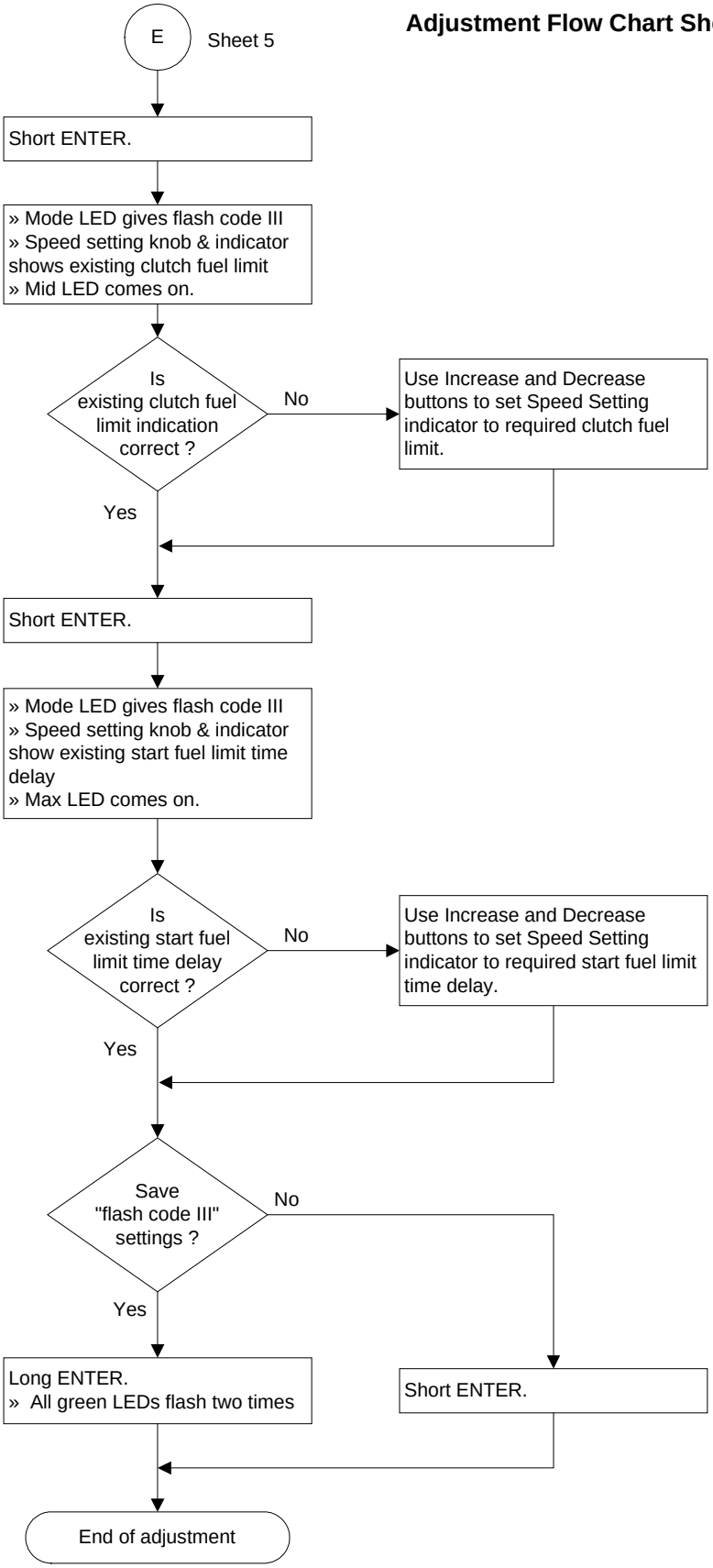
Adjustment Flow Chart Sheet 4 of 5



CODE II - MAX LED

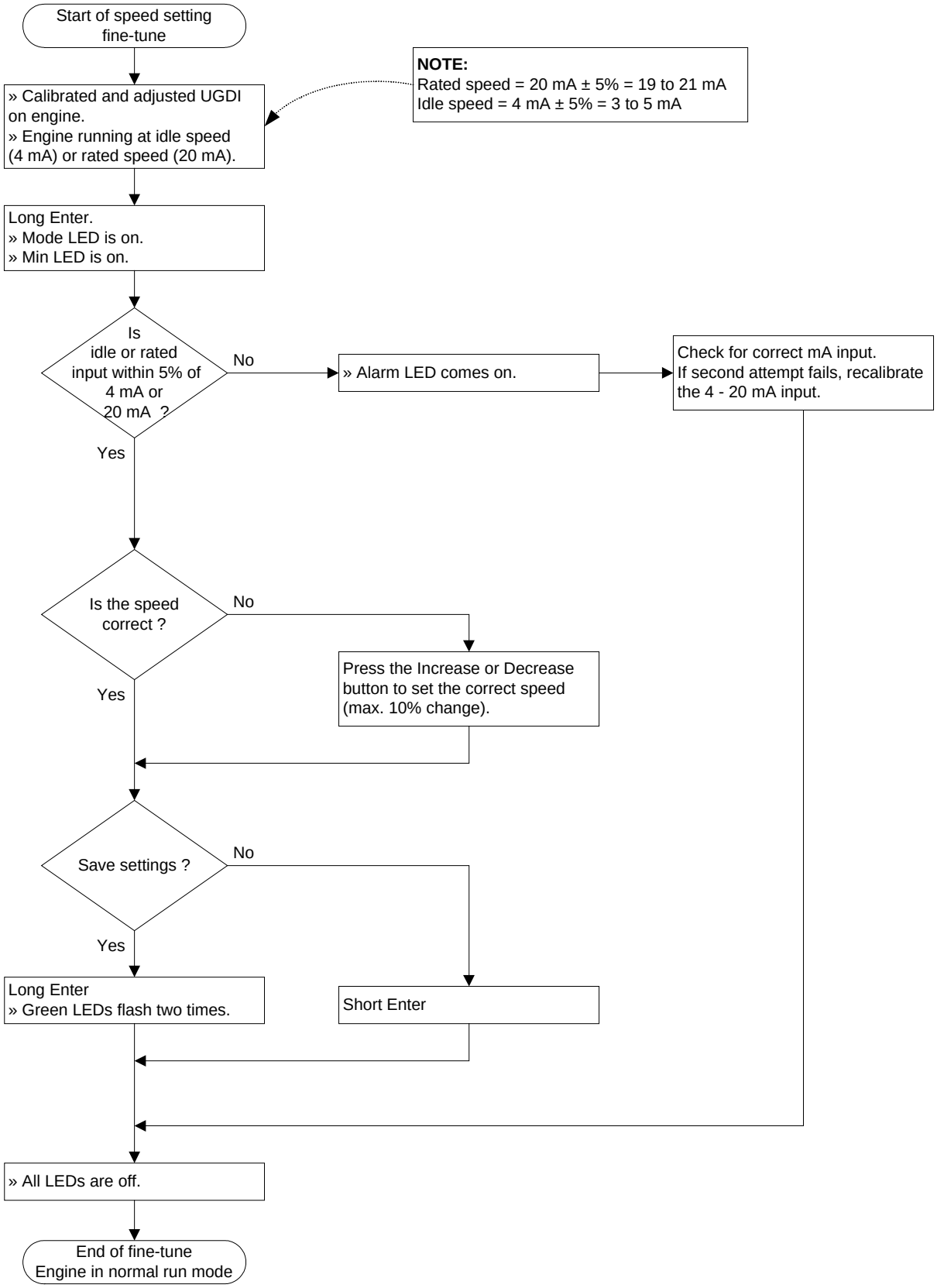
CODE III - MIN LED

Adjustment Flow Chart Sheet 5 of 5

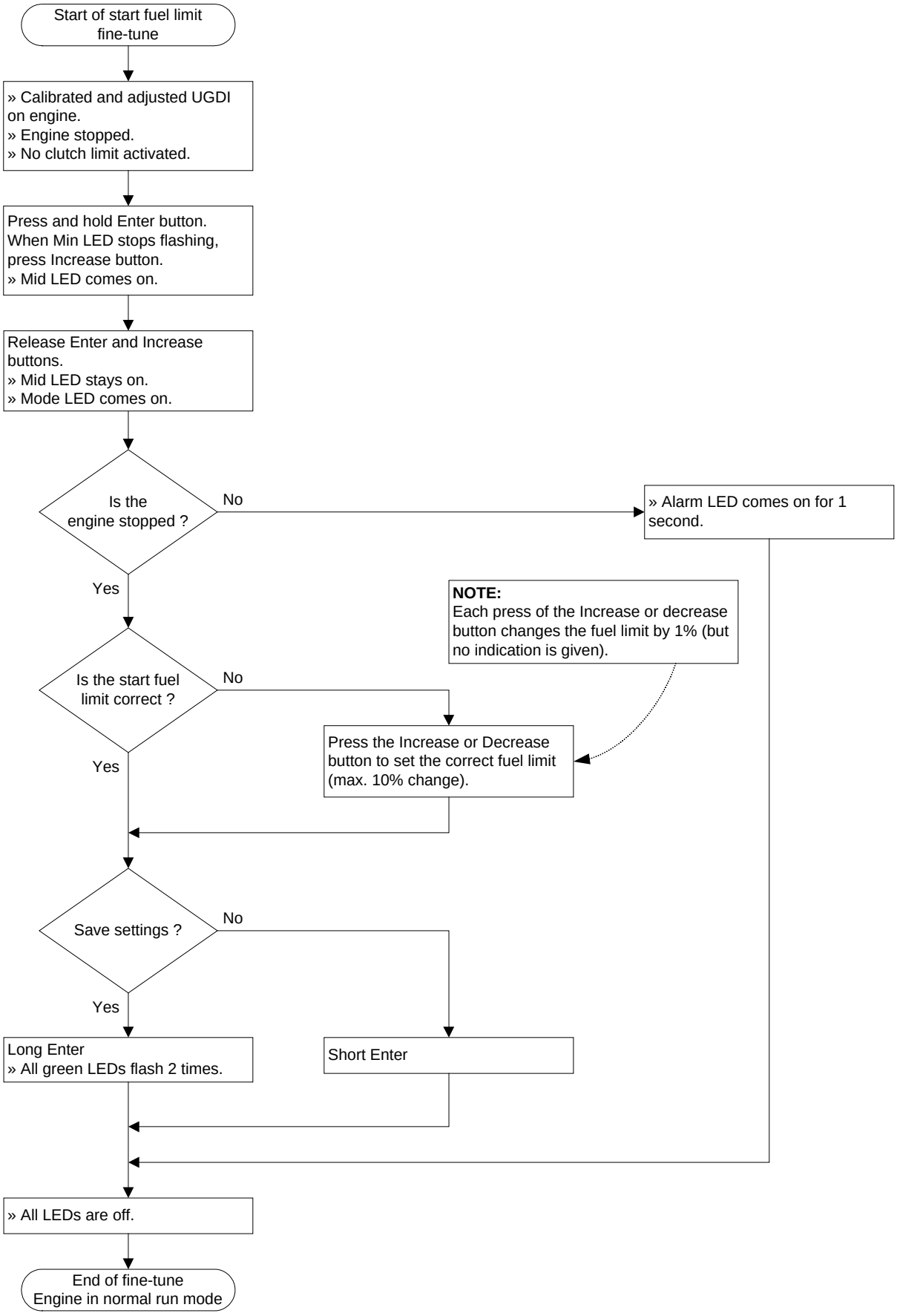


7.6 Fine-Tuning Flow Charts

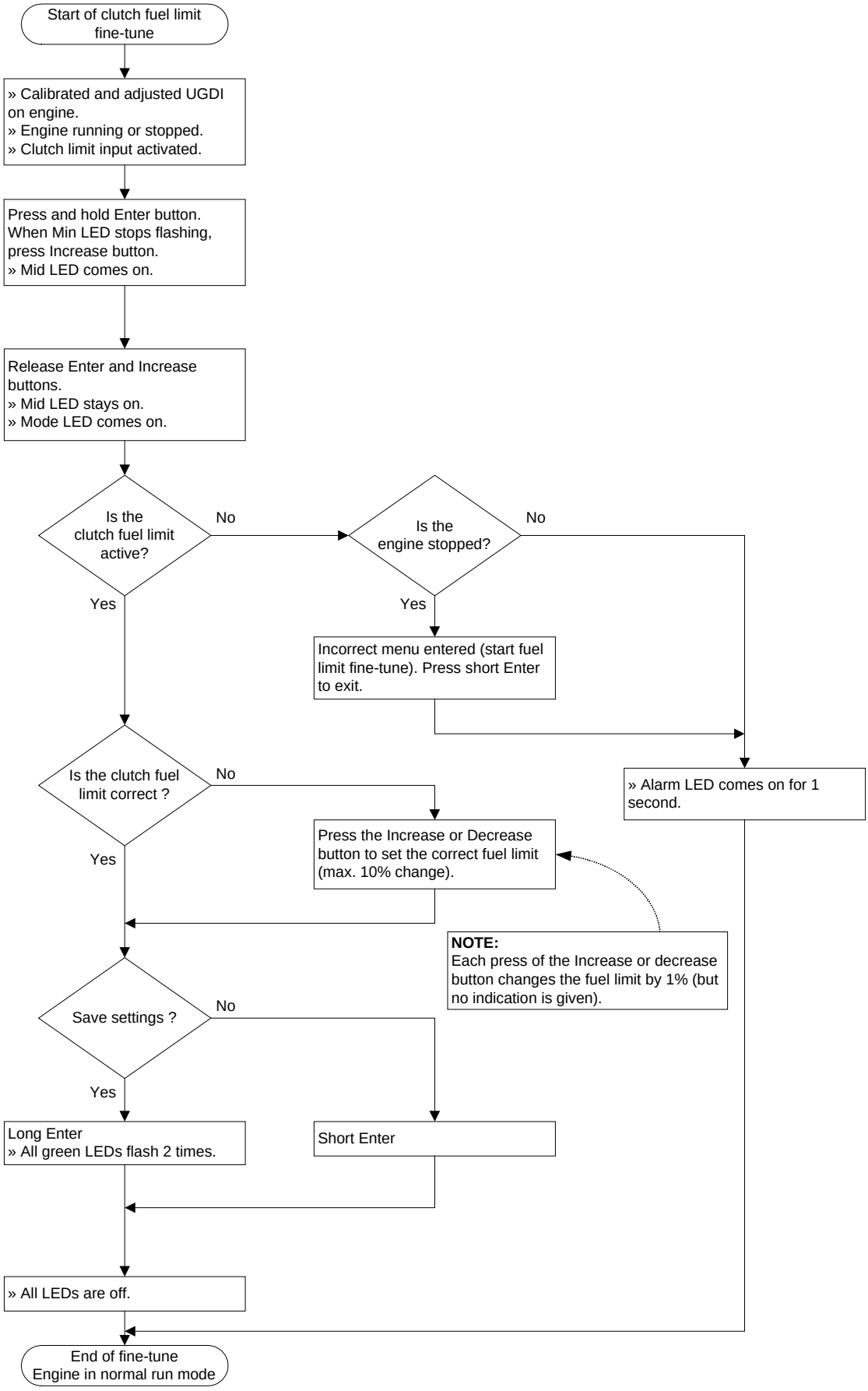
7.6.1 Speed Setting fine-tuning



7.6.2 Fuel limit fine tuning



7.6.3 Clutch fuel limit fine tuning



8. ALARMS, DIAGNOSTICS AND SERIAL COMMUNICATIONS

8.1 Introduction

The UG40-DI has a female 9 pin sub-D connector. This enables the UG40-DI to be connected to a PC enabling some additional features, which will be described in this chapter. From software revision 4.01 and up, alarms and diagnostics features are supported.

This Chapter describes these features and how to interpret and handle these alarms and diagnostics. Before the DI can be operated you must first adjust the mechanical part (refer to 5 GOVERNOR MECHANICAL OPERATION AND ADJUSTMENTS).

8.1.1 Alarm indication and operation

Refer to 8.2 UG40-DI Alarm Indication and Operation.

The red alarm LED is used to indicate an active alarm. It flashes a code consisting of long and short pulses, for example 4 long pulses followed by 3 short pulses. When there is more than one alarm active, the red alarm LED flashes the highest priority code. Flash code 1-1 (that is one long pulse followed by one short pulse) is the highest priority alarm.

When the alarm condition has gone, the highest priority alarm is reset by pressing the Decrease button on the DI. Now the next highest priority alarm, if present, can be reset.

8.1.2 Serial interface

Refer to 8.3 UG40-DI Serial Interface

It is possible to connect a PC to the UG40-DI serial port. The PC must have a terminal program, for example Microsoft Windows HyperTerminal. Using the terminal program you can monitor the alarm and diagnostics, view internal UG40-DI calibration values and upload new software.

The settings for the terminal program are:
- VT100 emulation
- 9600 baud
- 8 data bits
- No parity
- 1 stop bit
- Xon/Xoff flow control.

The serial cable has the following specifications:
- Length up to 3 meters
- Female 9 pin sub-D connector for connecting to PC and male 9 pin sub-D connector for connecting to UG40-DI
- Wires: pin 2 – pin 3, pin 3 – pin 2, pin 5 – pin 5, shielded cable.

8.2 UG40-DI Alarm Indication and Operation

8.2.1 Introduction

The DI panel is used to indicate and handle alarms. The functions of the DI buttons and DI LEDs are listed below.

8.2.2 Explanation of the UG40-DI panel for alarms and diagnostics

The following LEDs and buttons on DI panel are being used for alarms and diagnostics (refer to Figure 3.1):

Blue button (above DI panel)
This is the remote speed-setting override button, which disengages the DI speed-setting and returns the governor to mechanical control (for use only in emergency).

Red LED (refer to Table 8.1)
During normal operation, the red alarm LED indicates active alarms by flashing their corresponding alarm flash codes. Note that this LED has a different function in DI programming mode.

Table 8.1 Red LED operation

LED on	When active	Description
 Alarm I….I….I….I....III	During normal operation	Alarm flash code 4-3.
 Alarm I....II	During normal operation	Alarm flash code 1-2.

I…. = long flash of red alarm LED
I = short flash pulse of red alarm LED

Decrease button (Refer to Table 8.2)
This button resets an alarm if its cause has gone. The red alarm LED will then stop flashing if just a single alarm occurred, or if another (lower priority) alarm is still present, the red alarm LED flashes the corresponding alarm flash code.

Table 8.2 Use of Decrease button

Action and Duration	Name	When active	Result
 Decrease 1 time	Reset Alarm	During alarm flash code	Resets alarm if it's cause has gone

8.2.3 Alarm flash codes

Table 8.3 shows the possible alarm flash codes for the DI.

Table 8.3 Alarms & Diagnostic Flash Codes

Flash Code	Alarm Description	Alarm On delay time (s)	Alarm Off delay time (s)
1-1	DI internal feedback sensor wire cut or shorted to either 5 V or ground	5	5
1-2	Raise or Low active and speed limit has been reached	60	5
1-3	Speed reference input current out of range (<2 mA or >22 mA)	5	5
1-4	DI internal speed setting motor can not reach desired position	60	5
2-1	Booster reference input current out of range (<2 mA or >22 mA)	5	5
2-2	Fuel limiter position not reached	60	5
2-3	Terminal shaft wire cut or shorted to either 5 V or ground	5	5
2-4	Terminal shaft input current out of range (<2 mA or >22 mA)	5	5
3-1	Unknown button(s) pressed during DI power-up	10	10
3-2	DI temperature exceeds 105 °C	300	5
3-3	DI power supply voltage out of range (<18 Vdc or >32 Vdc)	60	5
4-1	DI internal watchdog reset (hardware / software failure)	0	0
4-2	Speed override activated	0	0
4-3	DI internal flatband cable disconnected	0	0

8.3 UG40-DI Serial Interface

8.3.1 Serial link with PC - alarm page

When the Increase and Enter buttons are pressed simultaneously, the alarm page is sent through the serial interface. A page similar to Figure 8.1 is received by the terminal program running on the PC.

Table 8.4 Digital Interface button actions

Action and Duration	Name	When active	Result
 Together < 1 sec	Send Alarm Page	Normal operation	Sends the alarm page through the serial interface; a PC running a terminal program will show an alarm page.

```
SPEED SET:                                DiAct DiLat AlAct AlLat   Code
Fbk wire cut or shorted to 5V/GND:         -     -     -     -      1-1
Speed setting not reached          :       -     -     -     -      1-4
Raise/low active and limit is hit:         -     -     -     -      1-2
Speed input curr. I<2mA or I>22mA:        yes   yes   yes   yes     1-3
Speed 2mA<=I<4mA or 20mA<I<=22 mA:         -     -     -     -      0-0

FUEL LIM & TERMINAL SHAFT:                DiAct DiLat AlAct AlLat   Code
Boost input curr. I<2mA or I>22mA:         -     -     -     -      2-1
Boost 2mA<=I<4mA or 20mA<I<=22 mA:         -     -     -     -      0-0
Limit home position not reached  :         -     -     -     -      2-2
Fuel limit position not reached  :         -     -     -     -      2-2
TS wire cut or shorted to 5V/GND :         -     -     -     -      2-3
Current output I<2mA or I>22mA   :         -     -     -     -      2-4
Output 2mA<I<4mA or 20mA<I<22mA  :         -     -     -     -      0-0

PANEL, TEMP & BATTERY:                    DiAct DiLat AlAct AlLat   Code
At start up: any un-known sw comb:         -     -     -     -      3-1
T>105 deg for more than 5 minutes:         -     -     -     -      3-2
T>100 deg for 60 minutes in total:         -     -     -     -      0-0
18V>U>32V for 1 minute constantly:         -     -     -     -      3-3

SYSTEM:                                   DiAct DiLat AlAct AlLat   Code
Watchdog reset one time or more  :         -     -     -     -      4-1
External reset one time or more  :         -     -     -     -      4-1
Speed override activated         :         -     -     -     -      4-2
Cover connector or cable is open :         -     -     -     -      4-3
General error (=unknown)         :         -     -     -     -      0-0
```

Figure 8.1 Example Alarm and Diagnostics Page

8.3.2 Serial link with PC - parameter page

When the Enter and Decrease buttons are pressed simultaneously, the parameter page is sent through the serial interface. A page similar to Figure 8.2 is received by the terminal program running on the PC.

Table 8.5 Digital Interface Button Actions

Action and Duration		Name	When active	Result
	Together < 1 sec	Send Parameter Page	Normal operation	Sends the parameter page through the serial interface; a PC running a terminal program will show the parameter page

```
UG40-DI   V 4.02  Alarm & diagnostics
Program checksum:0x4BB6
Param. version  :0x1196

0-dial position: 0x0022  (default=0x001E)
Speed at 4mA   : 0x0013  (default=0x001E)
Speed at 20mA  : 0x018E  (default=0x0190)
Fix speed      : 0x00C9  (default=0x00C8)
4mA input (spd): 0x00B6  (default=0x00B6)
20mA inp  (spd): 0x03A6  (default=0x03A6)
Ramp raise-sw  : 0x00C8  (default=0x00C8)
Ramp low-sw    : 0xFE70  (default=0xFE70)
Ramp up 4-20mA : 0x01F4  (default=0x01F4)
Ramp_down      : 0xFCE0  (default=0xFcE0)
4mA output (TS): 0x003C  (default=0x003C)
20mA       (TS): 0x00DB  (default=0x00DB)
TS pos at 4mA  : 0x0064  (default=0x0064)
TS pos at 20mA : 0x0374  (default=0x0374)
FL pos at 80%  : 0x012C  (default=0x012C)
FL pos at 50%  : 0x0276  (default=0x0276)
FL pos at 20%  : 0x03C0  (default=0x03C0)
Startfuel delay: 0x000A  (default=0x000A)
Clutch fuel lim: 0x0320  (default=0x0190)
Start fuel lim : 0x0190  (default=0x0320)
Option settings: 0x0007  (default=0x0007)
PC baud-rate   : 0x00C8  (default=0x00C8)
Diagn.   1-16  : 0x0008
Diagn.   17-32 : 0x0000
Alarm    1-16  : 0x0000
Alarm    17-32 : 0x0000
Time engine off: 0000:30
Time engine run: 0008:55
Time  Temp<60  : 0009:25
Time  60<T<80  : 0000:00
Time  80<T<100 : 0000:00
Time 100<T<120 : 0000:00
Time 120<Temp  : 0000:00
```

Figure 8.2 Example UG40-DI Parameters Page

8.3.3 Serial link with PC - uploading software

CAUTION

Saved hour counter parameters will be reset when the parameter revision of the new software differs from the one currently in the UG40-DI.

Only qualified Woodward personnel may upload new software.

A PC, a serial cable, and terminal emulation software set up as described in 8.1.2 Serial interface are required.

Table 8.6 Digital Interface Button Actions

Action and Duration	Name	When active	Result
 Increase  Enter Together > 2 sec  Decrease	Software upload mode	Normal operation	Forces the UG40-DI in software upload mode. Green Mid LED and yellow Mode LED will flash rapidly for 2 seconds, then the yellow Mode LED will flash slowly indicating ready to receive new software.

Upload mode can be entered by keeping pressed the Increase, Enter and Decrease buttons simultaneously. Both the green Mid LED and the yellow Mode LED will flash rapidly. After two seconds the rapid flashing stops, and the buttons can be released. The yellow Mode LED will flash slowly now, indicating the UG40-DI is ready to receive new software.

When the software is sent to UG40-DI, first the green Mid LED comes on. After about one second it goes off and the green Max and Min LEDs flash rapidly indicating that data is being received by the UG40-DI. When the upload has finished, all green LEDS start flashing.

If the calculated checksum of the new software is correct, press the Enter button on the UG40-DI to perform a reboot.

```
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Please send the hex file now...
Download was successful, congratulations!
The Calculated Checksum(main): 0x4BB6

If this is the correct Checksum, then press the enter key
If wrong then DO NOT press the enter key, but power off

The new main application is booting
```

Figure 8.3 Typical Terminal Program Upload Messages

If the calculated checksum of the new software is NOT correct, disconnect the 24 Vdc power to the UG40-DI to allow rebooting. Because the original software has been erased, upload mode will start automatically. Repeat the upload process.

```
The Stored Checksum(main): 0xFFFF
The Calculated Checksum(main): 0x4BB6*


~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Please send the hex file now...
```

Figure 8.4 Checksum Failed Message

9. TROUBLESHOOTING AND REPAIRS

9.1 Introduction

This section provides instructions for troubleshooting.

It is impossible to anticipate every kind of trouble that is encountered in the field. This manual covers the most common troubles experienced. Poor governing may be due to faulty governor performance, or it may be due to the governor attempting to correct for faulty operation of the prime mover or the equipment driven. The effect of any auxiliary equipment on the overall control required of the governor must also be considered.

9.2 Troubleshooting (Mechanical and Electrical)

9.2.1 Preliminary inspection

WARNING

TO PROTECT AGAINST POSSIBLE PERSONAL INJURY, LOSS OF LIFE AND/OR PROPERTY DAMAGE WHEN STARTING the engine, turbine or other type of prime mover BE PREPARED TO MAKE AN EMERGENCY SHUTDOWN to protect against runaway or over-speeding should the mechanical-hydraulic governor(s) or electric control (s), the actuator(s), fuel control(s), the driving mechanism(s), the linkage(s), or the controlled device(s) fail.

Governor troubles are usually revealed in speed variations of the prime mover, but it does not necessarily follow that such variations are caused by the governor. When improper speed variations appear, the following procedure should be performed:

1. Check the load to be sure the speed changes are not the result of load changes beyond the capacity of the prime mover.

2. Check engine operation to be sure all cylinders are firing properly and that the fuel injectors are in good operating condition and properly calibrated.

3. Check the linkage between the governor and fuel racks or valve. There must be no binding or lost motion.

4. Check the setting of the needle valve and compensation adjustment. (See Section 5.3.2 Compensation Adjustments.)

5. Check that the oil is clean and oil level is correct at operating temperature.

   The source of most troubles in any hydraulic governor stems from dirty oil. Grit and other impurities can be introduced into the governor with the oil, or form when the oil begins to breakdown (oxidize) or becomes sludgy.

   The internal moving parts are continually lubricated by the oil within the unit. Valves, pistons and plungers will stick and even freeze in their bores, due to grit and impurities in the oil.

   If this is the case, erratic operation and poor response can be corrected (if wear is not excessive) by flushing the unit with fuel oil or Kerosene.

   The use of commercial solvents is not recommended as they may damage seals or gaskets.

   Change the oil and flush the governor twice a year if possible.

To change oil, remove the drain plug and drain out the old oil. Flush the governor by filling it with fuel oil, and with the prime mover running at low speed, cycle the governor by opening the needle valve two or three turns.

Let the governor hunt for a minute or two, then stop the engine and drain the governor. Flush the governor once again. Refill the governor with oil (see Section 2, Oil Supply).

Restart the engine and reset the compensation adjustment and needle valve.

6. Check that the drive to the governor is correctly aligned and free of roughness, side loading, and excessive backlash.

9.2.2 Oil

Keep the governor oil level to the mark on the oil sight glass with the unit operating. The correct oil level is 3/4 to 1 1/4 inch (19 to 32 mm) below the top of the governor case.

Dirty oil causes most of all governor troubles. Use clean new or filtered oil. Oil containers used must be perfectly clean. Oil contaminated with water breaks down rapidly, causing foaming and corrodes internal governor parts.

9.2.3 Compensating adjustment and needle valve

The compensating adjustment and needle valve must be correctly adjusted with the governor controlling the engine or turbine, even though the compensation may have been previously adjusted at the factory or on governor test equipment.

Although the governor may appear to be operating satisfactorily because the unit runs at constant speed without load, the governor still may not be correctly adjusted to the load and to the engine it is to control.

High overspeeds and low underspeeds, or slow return to speed, after a load change or speed setting change, are some of the results of an incorrect setting of the compensating adjustment and needle valve.

9.3 Troubleshooting Chart

9.3.1 Definitions

Use the troubleshooting chart (Table 9.1) on the following pages to determine the probable causes of faulty operation and to correct these troubles.

Terms used in the chart are defined as follows:

HUNT
A rhythmic variation of speed which can originate in the governor or in the prime mover. (See Table 9.1, para. 1 A, for troubleshooting information.) A hunt usually has a frequency of less than 50 cycles per minute.

SURGE
A sudden variation of speed occurring at periodic intervals which can also originate in the governor or in the prime mover. (See Table 9.1, para. 1 A, for troubleshooting information.)

JIGGLE
A high frequency vibration of the governor output shaft and fuel linkage. Do not confuse this with normal controlling action of the governor. A jiggle has a frequency of more than 50 cycles per minute.

9.3.2 Trouble-shooting chart

Table 9.1 Troubleshooting Chart

Trouble	Cause	Correction
1. The engine, turbine or other type of prime mover hunts or surges.	A. The trouble may be originating in the governor or the prime mover.	Block the throttle, fuel racks or steam valve in the direction of increase fuel. (Never block the governor output shaft in the direction that would prevent a complete shutdown.) The same blocking action can be performed by using the load limit knob on the governor panel. If hunting and/or surging continues while the governor output shaft is blocked, the problem is in the prime mover. If, after removing the block, hunting and/or surging starts again, the problem can be in the governor or in the prime mover. Go through the compensation adjustment procedure for the governor (see Section 4, Compensation Adjustments). If the problem is still there, replace the governor with a replacement governor. Go through the compensation adjustment procedure for the replacement governor. If the hunting and/or surging continues, the problem is in the prime mover.
	B. Compensation adjustments incorrect.	Adjust needle valve and compensation adjusting pointer.
	C. Dirty oil in governor - sludge.	Drain oil, clean governor and refill.
	D. Low oil level, which permits air to enter and cause foaming. This is evident in the governor as spongy operation.	Add oil to the mark on oil sight glass. If oil level decreases and no external oil leaks can be seen on the governor, check the drive shaft for oil leak. If foaming continues, drain oil and refill using a different type oil.
	E. Oil varnish which causes sticking of parts.	Repair governor.
	F. Lost motion in engine linkage or fuel pumps.	Repair linkage and/or pumps.
	G. Binding in engine-to-governor linkage or fuel pumps.	Repair and realign linkage and/or pumps.
	H. Governor output shaft travel too short to provide full fuel.	Adjust travel until proper travel is obtained.

Trouble	Cause	Correction
	I. Spring on yield linkage to fuel racks too weak	Install heavier spring.
	J. Low oil pressure. Normal operating pressure is 240 to 250 PSI. (See Outline Drawing, Figure 1.1 for pressure test point location.) Pump check valves are not seating or accumulator springs weak.	Return governor to factory for repair.
	K. Power piston is sticking.	Check for side play or binding of output shaft.
	L. Voltage regulator not operating properly.	Check voltage regulator. Operate in voltage droop or manual. Don't disconnect voltage regulator. Adjust, repair or replace voltage regulator.
	M. Fuel linkage incorrectly set. This might occur if the governor has been changed or removed and replaced. Relationship of governor travel to power output of engine should be linear.	Rework or reset the linkage from governor to unit to obtain the linear relationship.
	N. Faulty linkage.	It should be free of binding and lost motion throughout service life of unit. Check yield links, shutdown arrangements, etc., to be sure that prime mover torque changes for very small increments of governor output shaft travel. Stability and good steady-state performance will suffer unless this condition is met.
	P. Incorrect non-linear relationship between governor travel and horsepower output of the prime mover. Engine may hunt with light loads and be stable with a heavy load.	Adjust linkage from governor to gas valve to obtain linear relationship between governor travel and engine output. See also Application Note 50516.
	Q. Engine misfiring (Bad fuel injector. Low pilot fuel on dual fuel engine.)	Check pyrometer readings of each cylinder and make necessary repairs or adjustments.
	R. Load limit indicator binding on nameplate or load limit shaft bent.	Damaged indicator disc or nameplate must be corrected or replaced. Load limit shaft must be replaced if bent.
	S. Negative droop when speed droop knob at zero.	Droop calibration out of adjustment. Reset (see 5 GOVERNOR MECHANICAL OPERATION AND ADJUSTMENTS).
	T. Governor worn.	Return governor to factory for repairs.

Trouble	Cause	Correction
2. Fuel racks do not quickly when open cranking engine, turbine or other type of prime mover.	A. Low oil pressure in governor.	See item 1.J. above.
	B. Cranking speed too low.	May be necessary to use a booster servomotor. See booster servo-motor manuals 01004 and 36684.
	C. Booster servomotor (if used) not functioning properly.	Check action of automatic air starting valve. See Booster Servo-motor Manuals 01004 and 36684.
3. Jiggle at governor output shaft.	A. Rough engine drive or governor drive. **NOTE** If a keyed drive is used, backlash must be checked and the gear shimmed so that there is no binding and the backlash is not too great. This should be done each time a new or replacement governor is installed. If a serrated drive is used, concentricity of shaft to coupling should be maintained. Coupling should be as long as possible to permit greater flexibility.	Inspect drive mechanism. a. Check alignment of gears. b. Inspect for rough gear teeth, eccentric gears, or excessive backlash in gear train. c. Check gear keys and nuts or set screws holding drive gears to shafts. d. Check for bent drive shaft. e. Check serrated or spline coupling for wear and alignment. f. Tighten chain between crankshaft and camshaft (if used). g. Check engine vibration damper (if used).
	B. Governor is not aligned properly.	Loosen governor mounting screws and move the governor slightly on its mounting pad to align the drive shaft with its coupling.
	C. Failure of flexible drive in flyweight head.	Return governor to factory for repairs.
	D. Other possible causes are: - dirty or worn ballhead bearing. - rough or worn gear teeth. - bent speeder spring. - damaged drive shaft seal retainer.	Return governor to factory for repairs. Replace seal retainer.
	E. Air in governor system can cause a jiggle during start ups or transients.	Bleed air. (See 5.3 Initial Operation for a New Governor – Mechanical.)
4. Load does not divide properly on interconnected engines, turbines or other types of prime mover.	A. Speed droop adjustment incorrect.	Readjust droop to divide load properly. Increase droop to resist picking up(or dropping off) load. Decrease droop to increase picking up (or dropping off) load.

Trouble	Cause	Correction
	B. Speed settings of the governors are not the same.	Adjust speed setting so both prime movers run at the same speed.
5. The engine, turbine or other type of prime mover is slow to respond to a speed change or a load change.	A. Needle valve adjustment incorrect.	Readjust compensating needle valve. Open further if possible to do so without causing instability when running without load. Compensation pointer may be too far toward maximum.
	B. Governor is not sensitive in measuring speed change (deadband).	Friction or wear on flyweight toes-sludge in governor, return to factory.
	C. Low oil pressure in governor.	Return governor to factory to inspect pump and check valves if oil pressure is low.
	D. Engine may be overloaded.	Reduce load.
	E. Restricted fuel supply.	Clean fuel supply filters.
	F. Load limit knob set to restrict fuel.	Increase load limit setting.
6. The engine, turbine or other type of prime mover will not pick up rated full load.	A. Fuel racks will not open far enough, or governor at end of its stroke and the load indicator is set at 10.	Adjust engine to governor fuel linkage. Adjust load limiting device or fuel pump stops.
		Check compression of load limit friction spring. Low compression may permit load limit cam to gradually work toward reduced load position.
	B. Restricted fuel supply.	Clean fuel supply filters. Gas pressure low. Gas with different calorific value.
	C. Voltage regulator (if used) not functioning.	Readjust or repair.
	D. Engine misfiring.	Check pyrometer readings of each cylinder and make necessary repairs or adjustments.
	E. Slipping clutch or belts between engine and driven load.	Make adjustments.
	F. Load limit knob set to restrict fuel.	Increase load limit setting.
7. Governor does not respond to synchronizer motor switch.	Slipping clutch. Binding or worn bevel gears.	Increase compression on clutch spring. Repair or return governor to factory.
8. The speed of the prime mover increases with an increase in load.	Droop is negative when adjustment is zero on the panel. Droop calibration out of adjustment.	Reset droop. See 5 GOVERNOR MECHANICAL OPERATION AND ADJUSTMENTS.

9.4 Governor Field Repairs

Seals and bearings of the governor output shaft and drive shaft can be replaced in the field.

Seals and bearing replacement require only a partial disassembly of the governor. See Table 9.2 and Table 9.3 for a list of common bench tools and normal field repair tools.

Seals and bearings can be replaced without these tools, however replacement of parts is made easier if these tools are available.

Order tools from the Woodward Governor Company, Fort Collins, Colorado (see address on the back cover of this manual). Include in order:
- The tool description.
- The tool number or part number of the tool required.
- The manual number (this manual 03575).

9.4.1 Removal of governor from engine

To replace a governor on the engine, or to replace seats or bearings on the governor, remove the governor from the engine as follows:

CAUTION

Use care in handling and resting of the governor on work area. Do not strike or rest governor on end of drive shaft as damage may result to drive shaft, oil seal, bearing, or other internal parts or surfaces. Set governor on wooden block(s) to protect drive shaft when performing maintenance operations.

1. Drain oil from governor and install drain plug again. Some governors are equipped with a drain cock for draining.
2. Clean exterior surfaces using a cloth moistened with cleaning solvent.
3. Disconnect auxiliary device wiring, and pneumatic or hydraulic tubing connections if applicable.
4. Before detaching output shaft and speed setting linkages, mark both shaft and lever so they may be easily reinstalled at their original positions.
5. Remove the four stud nuts holding the governor to the mounting pad and lift the governor off. Remove the gasket between governor and governor mounting pad.
6. Set governor on wooden blocks to protect drive shaft. Be very careful to avoid striking the end of the drive shaft. Damage to internal parts of the governor may result.

Table 9.2 List of Common Bench Tools

Tool description	Reference number	Tool number	Application
T-Handle Hex Wrench 7/16”	1	189440	Various bolts on UG.
"T" Handle Alien Wrench 3/16”	2	8995-047	To install 1/8 in. pipe plugs
Standard Alien Wrench 5/64”	3	8995-048	For No. 8:32 headless set screw
Bench Block	4	011971	To press out small bearings and bushings
No. 2 Phillips Head Screwdriver	5	8995-049	Various screws on UG
Hooked Scribe	6	189792	Removing and installing cotter pins

Table 9.3 List of Normal Field Repair Tools

Tool description	Reference number	Tool number	Application
William Pliers	7	8995-023	Replace retaining ring on drive shaft
Bearing Seater	8	8995-024	Replace drive shaft bearing
Seal Protector (used with 030952)	9	030951	Fit on output shaft to protect seal
Dial Indicator W/Base	10	8995-017	To check droop adjustment
Seal Installing Tool (Micarta Type)	11	030952	Install output shaft seals (for extra long shafts only)
Bushing Driver	12	8995-028	To adjust output shaft bushings
Serration Wrench	13	030943	Turning output shaft or drive shaft
Torque Wrench with 7/16” Socket	14	8995-038	25 lb.-in. torque on drive shaft bearing retainer plate screws

9.5 Returning the UG40-DI to Woodward

If you have to return the UG40-DI governer to Woodward please complete the form on the following page. Make sure the governer is suffciently packaged to prevent it from damage. Include the form in the package with the governor.

The form should also be completed if you contact Woodward for technical assistence.

General

Your Name	
Your Address	
Site Location	
Phone Number	
Fax Number	

Prime Mover Information

Engine/Turbine Model Number	
Manufacturer	
Number of Cylinders (if applicable)	
Type of Fuel (gas, gaseous, steam, etc)	
Rating	
Application	

Governor Information

Woodward Part Number and Revision Letter	
Governor Type	
Serial Number	
Software Version	
Reason for Return	
Special Remarks	

.

We appreciate your comments about the content of our publications.
Please send comments to:

Woodward
Documentation Department
Hoofdweg 601
2131 BA Hoofddorp
The Netherlands

Phone: +31 (0)23 5661111
Fax: +31 (0)23 5636529

Woodward Governor Nederland
Hoofdweg 601
2131 BA Hoofddorp, The Netherlands
Phone +31 (0)23 5661111 • Fax +31 (0)23 5636529

World Wide Web Home Page - www.woodward.com

Registered Firm
ISO 9001:1994/Q9001-1994
Certificate QSR-36

DUTCH COUNCIL
FOR CERTIFICATION

Woodward has company-owned plants, subsidiaries, and branches, as well as authorized distributors and other authorized service and sales facilities throughout the world.

Complete address/phone/fax/e-mail information for all locations is available on our website.