DFM100

Dual Fuel Application Module

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1 OVERVIEW

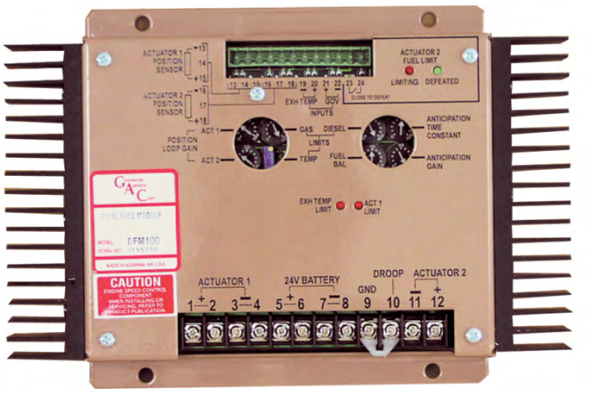
The DFM100 is part of a cost effective, affordable means of turning diesel engines into diesel-gas engines for Bi Fuel applications. A bi-fuel engine is a compression-ignited (diesel) engine that runs on the simultaneous combustion of diesel fuel and natural gas.

The DFM100's function is to drive two GAC independent feedback equipped electric actuators in conjunction with one GAC Electronic Speed Device (ESD) and one GAC Magnetic Pick-Up.

Under normal operating conditions, bi-fuel generators operate on 70% natural gas and 30% diesel fuel or better, while maintaining the same power output.

Bi fuel mode has been shown to create both a reduction of soot and NOx precipitation over a large engine operating area.

DFM100 is equipped with a FUEL BALANCE adjustment. Some mechanical calibration of the actuator linkage and the fuel rack are required to ensure the systems are performing correctly. Each actuator driver circuit has its own actuator [GAS & DIESEL] POSITION LOOP GAIN adjustment to optimize the feedback control loop response. The actuators need to be of similar types with similar position sensors and outputs.



2 SPECIFICATIONS

PERFORMANCE	
DC Input Voltage	18 - 32 V DC (Nominal 24 V DC) Transient protected to +/-250 V DC
Actuator 1 Current	up to 15 A, Short Circuit protected
Actuator 2 Current	up to 15 A, Short Circuit protected
PWM Drive from Governors	550 Hz MIN from 12-32 V DC MAX amplitude
Actuator Position Sensors	5 V DC excitation 1 to 4 V DC output
Thermocouple	Type K (1.0 mV = 25 °C, 22.3 mV= 540 °C (1000 °F)) Cold junction compensated above 0 °C
ENVIRONMENTAL	
Operating Temperature	40° to +85 to°C
Humidity	up to 100 %
Vibration	1 g @ 20 -100 Hz
Shock	10 g (11 ms)
AGENCY COMPLIANCE	
EMC	PER CE EN55011, EN50081-2, and EN50082-2
PHYSICAL	
Dimensions	See Section 4, Wiring Diagram
Weight	2.0 lbf (gf).
Mounting	Any Position, Vertical Preferred

3 CONFIGURATION OVERVIEW

The DFM100's function is to drive two GAC independent feedback equipped electric actuators in conjunction with one GAC Electronic Speed Device (ESD) and one GAC Magnetic Pick-Up.

In most cases while operating in Bi Fuel mode, the diesel function is limited to a specific percentage level of fuel to START combustion in the engine. The lower the percentage is set on the DIESEL FUEL LIMIT adjustment, the higher the amount of gaseous fuel is fed to the engine. Setting the DIESEL FUEL LIMIT adjustment lower than the recommended percentage (10-15%), may result in high exhaust temperatures and poor combustion.

The LEDs on the DFM100 indicate when diesel fuel is being limited and when the gas relay is energized and providing gas to the engine.

RECOMMENDED CONFIGURATION COMPONENTS

ESD Speed Controllers with Droop
- ESD5111 Standard Unit
- ESD5111T Temp Compensated
- ESD5131 Soft Coupling Option
- ESD5221 Single Element Speed Switch / 10 Amp Relay Output
- ESD5335 24 V DC / Speed Ramp / 2 Element Speed Switch w/ Dual Dynamics

Actuators
- ATB T2F Series 45-65mm / 12 or 24 V DC / Throttle Body Actuators
- ATB T3F Series 75-85mm / 12 or 24 V DC / Throttle Body Actuators
- ACE175AF Bosch 'P' Pump / 12 or 24 V DC / Left Hand Rack / Packard Connector / Feedback Sensor
- ADD176AF Bosch 'A' Pump / 12 or 24 V DC / Left Hand Rack / Packard Connector / Feedback Sensor
- ACE275K Bosch 'P' 3000 - 7000 Fuel Injection Pump / 24 V DC / Heavy Duty Bearing Retention / Packard Connector

Feedback Sensor
- ACE295F-24 Bosch 'Z' Pump / 24 VDC / Packard Connector w Mating Connector / Feedback Sensor
- EC1515 Feedback Sensor Mating Connector or CH1515 Feedback Sensor Mating Cable Harness

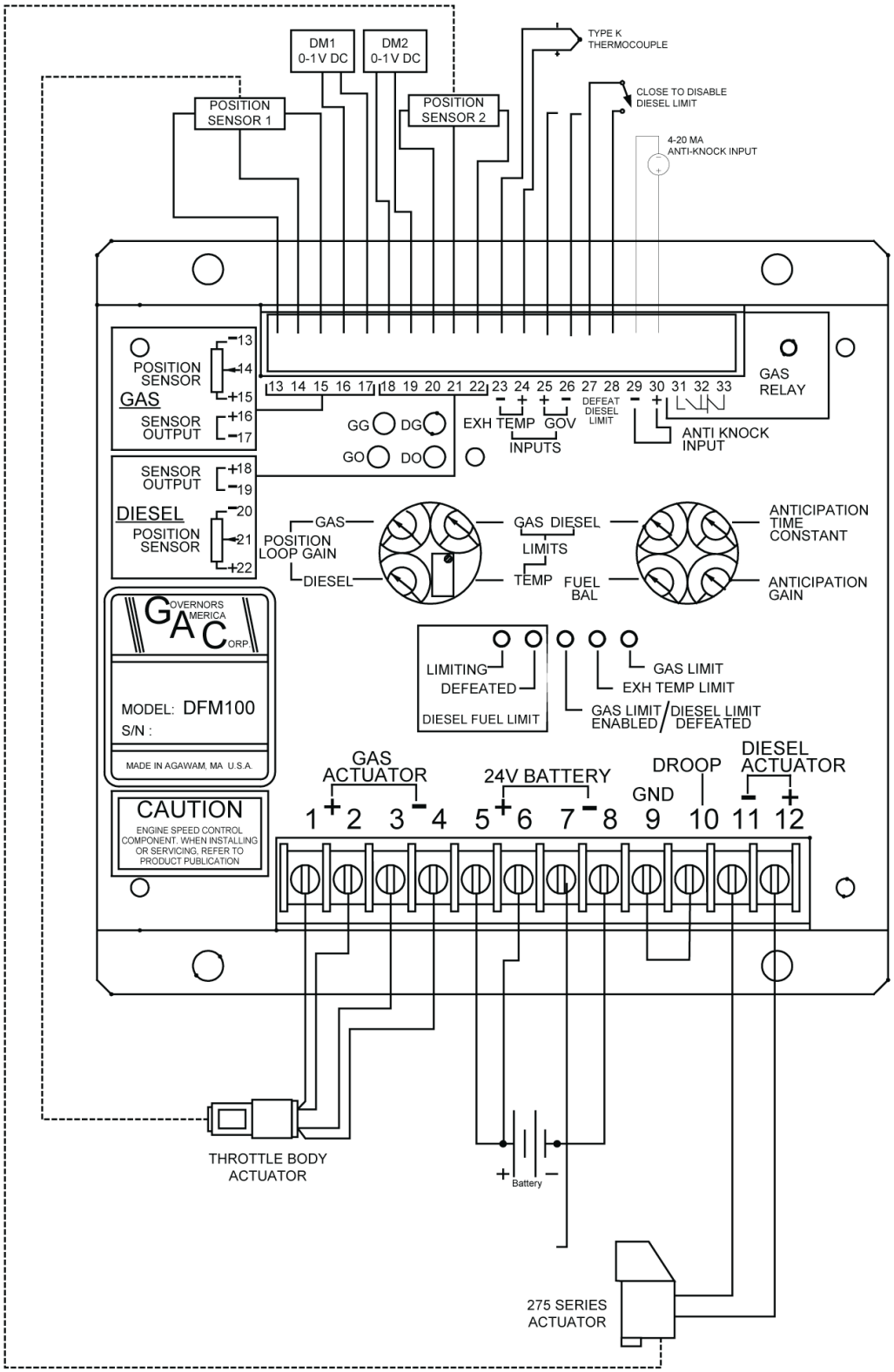
The exhaust temperature can run very hot on some diesel engines. In a bi fuel application this can ruin the engine with excessive heat. Exhaust temperature varies from cylinder to cylinder therefore monitoring the exhaust temperature is mandatory.

- Exhaust Gas Temperature Sensor / Type-K Thermocouple / 1200 ºF [650 ºC] MAX / Includes Mating Connector

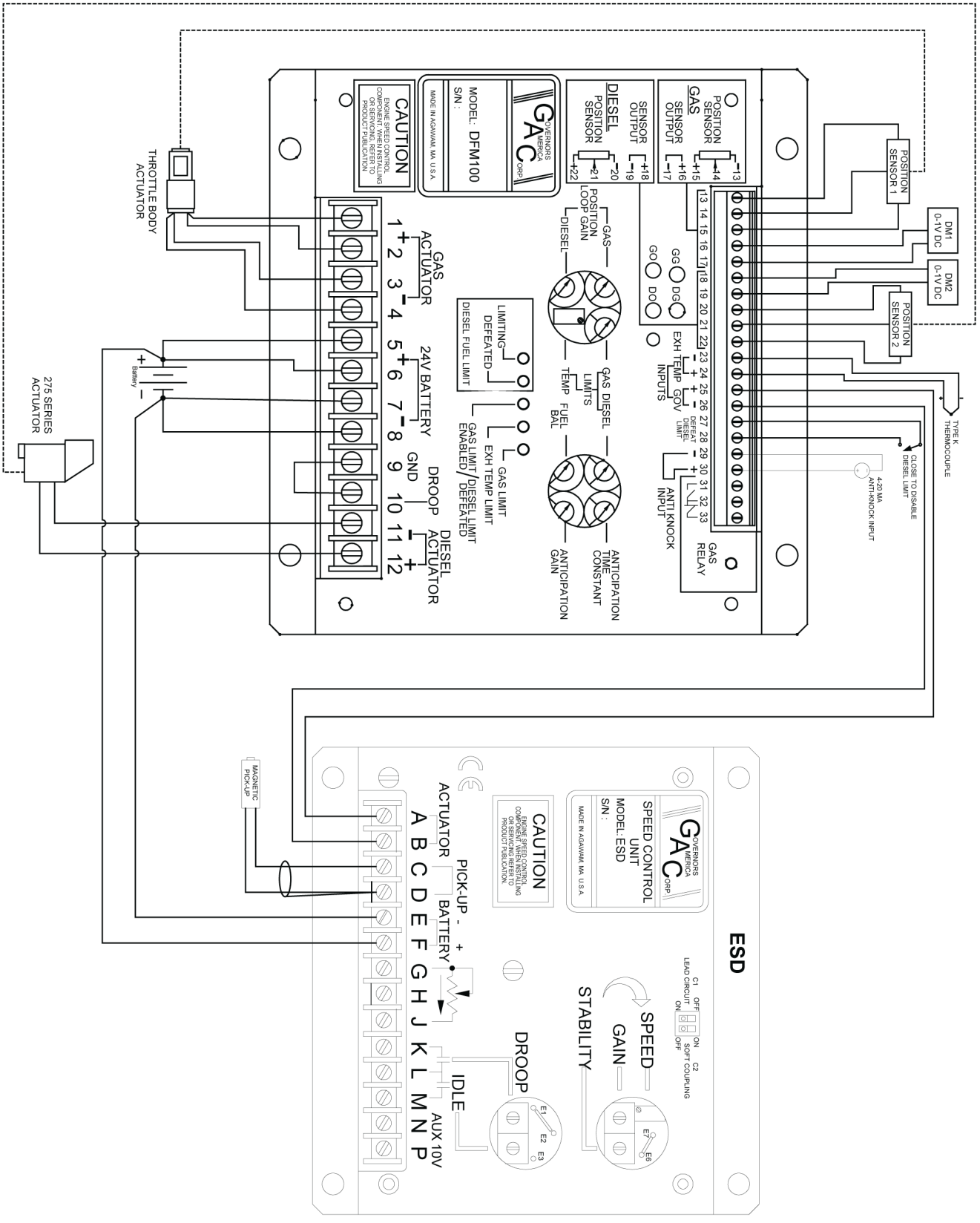
See Section 8 for additional hardware and wiring information.

4 DFM100 WIRING DIAGRAM

The DFM100 is usually mounted along side an ESD Series unit. When mounting the unit, attach it to a vertical surface to prevent any moisture from collecting on the circuit board. The normal installation information as shown in your ESD manual should be followed for the DFM100 as well.



4 ESD TO DFM100 WIRING



5 INSTALLATION

CONNECTING TO THE ESD

The Electronic Speed Device (ESD) used with the DFM100 must be of the actuator voltage driver type with a PWM output and not a current driver type (see Table 1.) In normal actuator usage with a GAC ESD, one side of the actuator is typically at near ground level voltage.

1. Connect Terminal B on the ESD (the low side of the actuator drive), to Terminal 26 on the DFM100.
2. Connect Terminal A on the ESD (the high side output of the actuator), to Terminal 25 on the DDM100.
3. Install jumpers between Terminals 9 and 10 on the DFM100.

EXHAUST TEMPERATURE MEASUREMENTS

When a Type K thermocouple is plugged into Terminals 23 and 24, the DFM100 will detect the exhaust gas temperature. If this feature is not utilized, a jumper should be placed across Terminals 23 and 24. The thermocouple wire must be used for the entire length of the connection.

The exhaust temperature can run very hot on some diesel engines IN a bi fuel application, which can ruin the engine with excessive heat. Exhaust temperature varies from cylinder to cylinder therefore monitoring the exhaust temperature is mandatory.

DIESEL FUEL LIMIT

In most cases while operating in Bi Fuel mode, the diesel function is limited to a specific percentage level of fuel to START combustion in the engine. The lower the percentage is set on the DIESEL FUEL LIMIT adjustment, the higher the amount of gaseous fuel is fed to the engine. Setting the DIESEL FUEL LIMIT adjustment lower than the recommended percentage (10-15%), may result in high exhaust temperatures and poor combustion.

Closing Terminals 27 and 28 will shut off the diesel fuel limiter thus causing the diesel fuel to rise to the level necessary to support the engine load.

CABLING REQUIREMENTS

Position sensor cables must be of a three wire shielded type with the shields connected only to the case on the DFM100. The actuator feedback sensor (AB feedback sensor type) is a three, sensor-terminated wire with an AMP connector (see Section 8, Connectors) for accessory parts.

For proper connection from the feedback sensor or the cable harness to the DFM100 refer to Table 4. Case ground (right or left corner screw) should be connected to battery minus (Terminal 7) with a separate cable for the best EMC ratings. Cables used on the terminals for Actuator 1 or 2 handle fully actuator current, therefore they must be sized properly to handle the current (see Section 8, Connectors for recommended wire size).

ADDING DROOP

Before wiring the actuators to the DFM100 decide whether droop operation is required in the application.

No Droop	If no droop is required, connect the actuators as shown in Wiring Diagram 1 directly to the DFM100.
Droop to Gas Actuator (Actuator 1)	If droop is required, use the Gas Actuator (actuator used for gaseous fuel control) for the droop signal. To utilize this signal: 1. Disconnect Terminal 26 on the DFM100 from Terminal B on the Electronic Speed Device (ESD). 2. Connect the minus (-) of Gas Actuator to Terminal B on the ESD. The connection normally goes to Terminals 3 and 4 on the DFM100. 3. Connect Terminals 3 and 4 on the DFM100 to Terminal E of the ESD. 4. Droop may be adjusted on the ESD and it will be proportional to the current in Actuator 1.
Droop to Diesel Actuator (Actuator 2)	If the application requires droop be proportional to Actuator 2 (the diesel sides): 1. Remove the jumper from Terminals 9 and 10. 2. Disconnect Terminal 26 on the DFM100 from Terminal B on the ESD. 3. Connect Terminal 10 on the DFM100 to Terminal B on the ESD. 4. Connect Terminal 9 on the DFM100 to Terminal E on the ESD.
Dual Connections	The Gas Actuator and 24V Battery terminals on the DFM100 use dual connections to prevent overcurrent conditions. The current rating for the Gas Actuator driver is over 20 A and the total DC current consumption for both actuators could reach 30 A. These values are larger than the rating of a single terminal on the connector. Depending on the choice of actuators, the current consumption will likely be much lower. Refer to your actuators installation manual to determine the total current consumption.

6 STARTUP AND ADJUSTMENT

The DFM100 is part of a cost effective, affordable means of turning diesel engines into diesel-gas engines for Bi Fuel applications*. The DFM100's function is to drive two GAC independent feedback equipped electric actuators in conjunction with one GAC *Electronic Speed Device (ESD) and one GAC Magnetic Pick-Up*.

Preset the adjustments on the DFM100 as follows:

NOTE: For a Bi Fuel application, it's best to first run the system with 100% diesel to preset the speed control system.

1. Start the engine and set the speed and performance adjustments as outlined in your ESD series manual.
2. Record the rack position on an external monitor (via Terminals 18(+) and 19(-)) vs. engine load on the diesel actuator. This will provide information on the quantity of diesel fuel vs. total power produced when in dual fuel operation.
3. Adjust the GAS & DIESEL POSITION LOOP GAIN as high as possible without engine or actuator instability. Each actuator driver circuit has its own actuator POSITION LOOP GAIN adjustment to optimize the feedback control loop response.
4. The SPEED GAIN adjustment on the ESD and the ACTUATOR GAIN adjustment on the DFM100 can interact. It is possible to turn one up and the other down and get similar results. The SPEED LOOP GAIN must not be turned too low or the speed control performance could suffer. A mid-range setting or higher for both GAIN adjustments is preferable.
5. Once the system is proven to run well on diesel, shut down the system, leave the diesel defeat switch open, and restart the engine.
6. Restart the engine with no load or a light load on the engine, the engine should run stable.
7. Apply a greater load to the engine. When the load level is above 40%, adjust the DIESEL LIMIT CCW until the diesel fuel level reaches not less than 15% as determined by the data taken above from the position sensors signal when the engine was run on diesel only.
8. Continue to apply load, noting that the diesel fuel should be holding at a fixed level (DIESEL ACTUATOR FUEL LIMIT LIMITING LED ON). As the load increases, the gas valve will incrementally open. The DIESEL LIMIT adjustment may need to be adjusted if the exhaust temperature rises too high or the engine does not accept higher amounts of gas. Once the EXH TEMP LIMIT is reached, the DIESEL LIMIT will be automatically defeated adding more diesel fuel to the engine.

7 ADJUSTMENTS

LIMIT MAXIMUM GAS

If it is needed to limit the maximum gas supply (the opening of the gas controlling actuator) to the engine, the GAS LIMIT adjustment may be turned CCW until the GAS ACT LIMIT LED comes ON. Once the GAS LIMIT has been reached (GAS ACT LIMIT LED turns ON) the DIESEL LIMIT is then defeated and any further load applied to the engine will be supplied via the diesel fuel system up to the maximum of the engine's capacity.

ANTICIPATION ADJUSTMENTS

Two adjustments are provided which affect the load dynamics on the diesel side of the fuel control making make it possible to provide near optimum transient response with the diesel fuel or operation that approaches diesel fuel performance alone. The purpose of the anticipation feature is to defeat the DIESEL LIMIT when a sudden load change occurs. The magnitude and time constant of the anticipation signal to defeat the limit is adjustable. Apply a step load of at least 50%.

1. Adjust the ANTICIPATION GAIN adjustment CW so that the diesel fuel increases during the transient. The higher setting the greater the ff-speed load transient.
2. Next, adjust the ANTICIPATION TIME CONSTANT so that the offspeed transient has the shortest time off-speed. Adjusting these two controls, will

GAS AND DIESEL RACK POSITION MONITORING CALIBRATION

With power applied to the DFM100 and before starting the engine, the voltage at the Terminals 16(+) and 17(-) should be adjusted to zero Volts by the Gas Offset (GO) for the Gas rack position and at Terminals 18(+) and 19(-) by the Diesel Offset (DO). At maximum Gas and Diesel rack positions the voltage at the above-mentioned terminals should be 1 Volt and can be adjusted by Gas Gain (GG) and Diesel Gain (DG) respectively.

FUEL BALANCE ADJUSTMENT MONITORING CALIBRATION

In order to manipulate both fuel systems the DFM100 is equipped with a FUEL BALANCE adjustment. Some mechanical calibration of the actuator linkage and the fuel rack will be required to assure that the systems are performing correctly. Each actuator driver circuit has its own actuator [GAS & DIESEL] POSITION LOOP GAIN adjustment to optimize the feedback control loop response.

In most cases while operating in Bi Fuel mode, the diesel function will be limited to a specific percentage level of fuel to START combustion in the engine. The lower the percentage is set on the DIESEL FUEL LIMIT adjustment, the higher the amount of gaseous fuel is fed to the engine. Setting the DIESEL FUEL LIMIT adjustment lower than the recommended percentage (10-15%), may result in high exhaust temperatures and poor combustion. The LED indicators on the DFM100 indicate when diesel fuel is being limited as well as when the gas relay is energized and providing gas to the engine.

EXHAUST TEMPERATURE MEASUREMENTS

When a Type K thermocouple is plugged into Terminals 23 and 24, the DFM100 will detect the exhaust gas temperature. If this feature is not utilized, a jumper should be placed across Terminals 23 and 24. An open thermocouple will register as a fault and will automatically remove any fuel limiting from the diesel side. The range of exhaust temperature can be adjusted via the TEMP pot. Normal factory setting is 450°C (18-5 m V). The thermocouple wire must be used for the entire length of the connection.

8 CONNECTORS

ACTUATOR CONNECTORS

Actuator Connectors

ACTUATOR CONNECTOR		CH1515		DFM100	
Number	Color	Number	Color	Gas Actuator	Diesel Actuator
1	Red	1	Red	15 (+)	22 (+)
2	Black	2	Black	13 (-)	20 (-)
4	White	4	White	14 ( )	21 ( )

RECOMMENDED WIRE SIZES

Recommended Wire Size for a GAC Feedback Actuator

ACTUATOR	RECOMMENDED WIRE SIZE FOR TYPICAL APPLICATION*
All ATB T2F Series	14 AWG
All ATB T3F Series	14 AWG
ADD176AF - ACE175AF	16 AWG
ACE275K	16 AWG
ACE295F-24	16 AWG

*Compensation for length and temperature affect wire size.

9 EC DIRECTIVE

DECLARATION OF CONFORMITY TO EC DIRECTIVES

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directives & Standards.

Application to Council Directives	Heavy & Light Industrial Applications
Standard to which Conformity is Declared	EN55011, EN50081-2, and EN50082-2
Manufacturer's Name	GOVERNORS AMERICA CORPORATION
Manufacturer's Address	Agawam, MA 01001 USA
Importer's Name	
Importer's Address	
Type of Equipment	Bi Fuel Module
Model Number	DFM100
Serial Number	Above J7000
Year of Manufacture	2007 and later

Signature:

Place: Agawam, MA USA

Full Name: Mr. William Ferry

Date: 08-28-07

Position: President

In order to be compliance with the above directives, the installer is obligated to install the equipment in strict accordance with the following guidelines.

1. The device must be mounted against a metal ground plate with four bolts which make positive electrical connections between the case and the back plane must be installed.

2. All cable shields on connections to the device must be connected to the case at the screw on the case as shown on **Wiring Diagram 1**.

3. Battery minus connections must be jumper wired to the case as shown in the **Wiring Diagram 1**.

4. The installer must refer to **Wiring Diagram 1** provided in the literature for proper electrical connections.