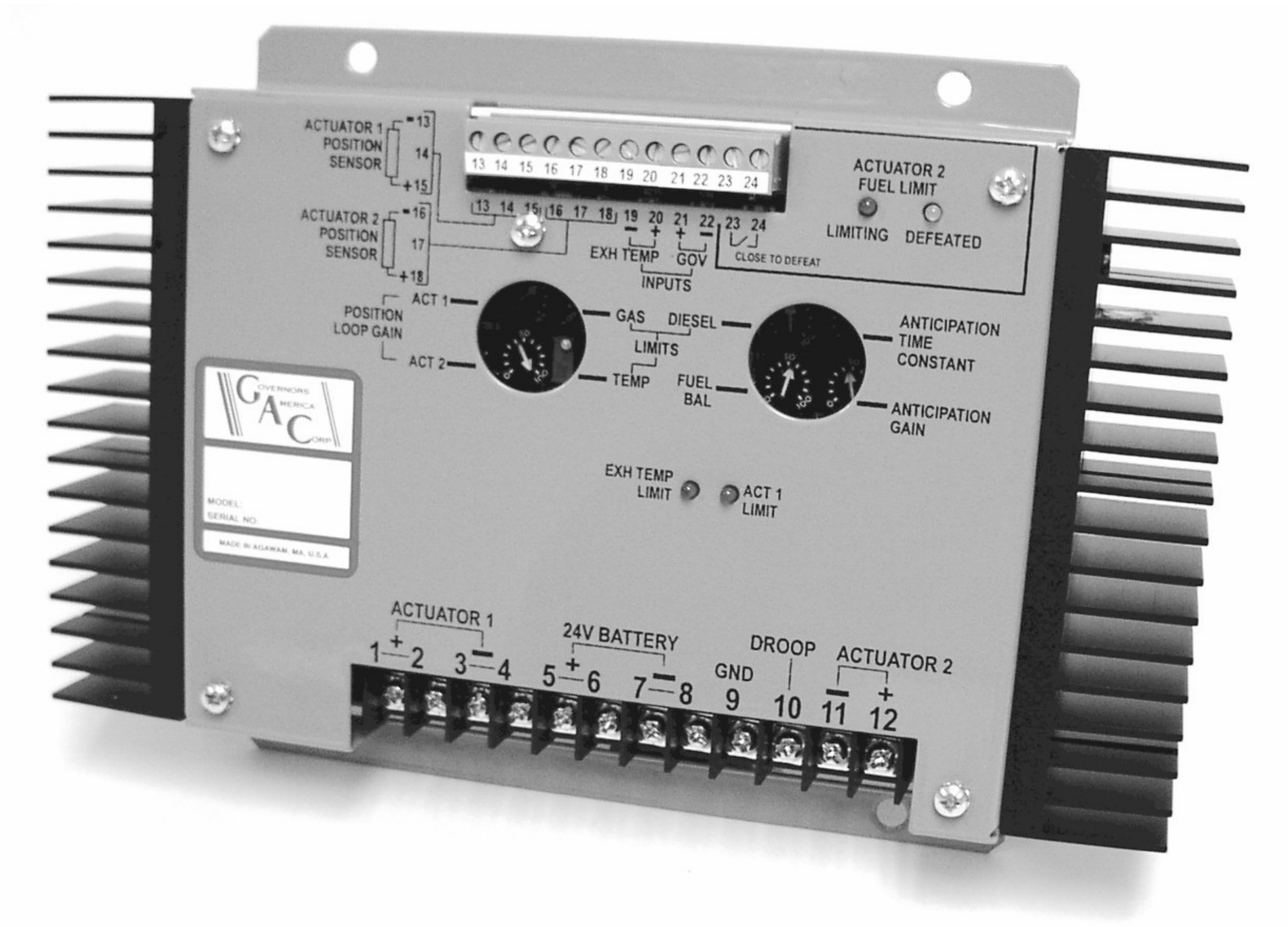
Governors America Corp. Engine Governing Systems	**Document:** Product Information **Version:** 1 **Status:** actual **Author:** bs **Date:** 03-03-19 **Approved:** ro **Date:** 03-03-19 **File:** *PC*	**DFM 100** **Product Information Bulletin** GAC PIB 1114, Rev.XA	HUEGLI TECH LTD SWITZERLAND Tel.: +41-62-916 50 30 Fax. +41-62-916 50 35 www.huegli-tech.com

DFM100
DUAL ACTUATOR MODULE



INTRODUCTION

The DFM 100 module is an accessory module who's function is to drive two independent feedback equipped electric actuators from one GAC speed control. This module is primarily installed where two fuel systems are used on a single engine. This may be two independent fuel pumps or a diesel fuel pump and a gaseous supply to the engine (Dual Fuel application).

DESCRIPTION

In a Dual Fuel Pump application, the desire is to drive the two fuel pump racks equally so that all cylinders receive equal fuel levels. The actuators should be similar types with similar position sensors and equal outputs. To equalize both fuel systems, a FUEL BALANCE adjustment in the DFM100 is provided to correct for any unbalance in the fuel systems and equalize the fuel from both pumps. Any difference noted by these accurate actuator position sensors will be cancelled out by the electronics so that the position sensors will track equally throughout the range, unless the balance adjustment is used to compensate otherwise. Some mechanical calibration of the actuator linkage and the fuel rack will be required to assure that the systems are nearly alike at one fuel delivery point. This can be idle fuel or any mid point of load control. The FUEL BALANCE adjustment is then used to set equal engine cylinder power at near 100% engine load.

Each actuator driver circuit has its own actuator POSITION LOOP GAIN adjustment to optimize the feedback control loop response.

In the Dual Fuel Mode, two different actuator systems are typically used. One can be a standard diesel fuel pump actuator with feedback, and the other a gaseous fuel control valve with feedback. When in Dual Fuel operation, the diesel function is usually limited to a specific level of fuel to start combustion in the engine. The lower the diesel fuel level limit, the more gaseous fuel that can be put into the engine. Too low a fuel level on the diesel side can cause serious engine problems such as high exhaust temperatures and poor combustion, so the diesel percentage is usually set above the 10-15% level. To set the diesel fuel limit, a DIESEL LIMIT adjustment is provided which holds the diesel fuel constant even though the governor may be requesting more fuel. Any additional fuel must then come from the gaseous side. An LED on the unit indicates when the diesel fuel is being limited.

CONTROL FUNCTION DESCRIPTION

DEFEAT DIESEL LIMIT
If for any reason it is desired to remove the diesel fuel limit, closing Terminals 23 and 24 will defeat this function and the diesel fuel will then rise to the level necessary to support the engine load.

EXHAUST TEMPERATURE
The DFM100 has provisions to sense exhaust gas temperature when a Type K thermocouple is connected at Terminals 19 and 20. It is mandatory that a thermocouple be connected to the unit or these two terminals must be shorted together. An open thermocouple is considered a fault and will shut off the Gas control loop. When the gas loop is shut off, it also automatically removes any fuel limiting to the diesel side so that the system will not be starved for fuel.

The range of exhaust temperature limit is adjustable from about 625°C to 790°C (26mV to 33mV) with the TEMP LIMIT adjustment. CW adjustment raises the temperature limit. The thermocouple is cold junction compensated inside the DFM100 so the thermocouple wire must be used all the way from the exhaust end of the thermocouple to the DFM100 terminals. An internal calibration adjustment for the thermocouple is also provided for factory setting of the Max Temperature setting, 700° (29 mV).

SPECIFICATIONS

DC Input voltage	18 - 32 Volts DC (Nominal 24V DC) Transient protected to +/-250V DC
Actuator 1 Current	up to 25 Amps, Short Circuit protected
Actuator 2 Current	up to 15 Amps, Short Circuit protected
PWM Drive from Governors	550 Hz from 12-32 VDC, Max amplitude
Actuator Position Sensors	5V DC excitation, 1 to 4V DC outputs
Thermocouple	Type K, i.e. 1.0 mV = 25°C, 22.3 mV= 540°C (1000°F) Cold junction compensated above 0°C
Operating Temperature	- 40°C to +85°C
Humidity	up to 100%
Vibration	TBD
Shock	TBD
EMC	Meets GAC specifications

INSTALLATION

Refer to the Wiring Diagram for proper connections. It is suggested that the DFM100 be mounted along side the speed control. When mounting the unit, attach it to a vertical surface to prevent any moisture from collecting on the circuit board. The normal precautions outlined in the speed control literature should be followed for the DFM100 as well.

Governor Connections

The governor used with the DFM100 must be of the voltage driver type and not a current driver type. The types that can be used with the DFM 100 are: ESD5111, 5131, or 5221. An ESD2210, 2100, or 1000 could also be used, but since these units do not have droop functions, they would not be able to provide that feature. In normal actuator usage with a GAC speed control, one side of the actuator is typically at near ground level voltage. Connect Terminal B of the 5000 SERIES speed control unit, which is the low side of the actuator drive, to Terminal 22 of the DFM100. Connect Terminal A of the speed control unit, which is the high side output of the actuator, to Terminal 21 of the DFM100.

Actuator Connections

Before wiring the actuators to the DFM100 the customer must decide whether droop operation is required in the application. If no droop is required then connect the actuators as shown in the Wiring Diagram directly to the DFM100. Also, a jumper must be added between Terminals 9 and 10.

If Droop is required, then the actuator used for gaseous fuel control, Actuator 1, is best used as a droop signal. To utilize this signal, connect the minus of Actuator 1 (connection that would go to Terminals 3 and 4 of the DFM100) to Terminal B of the speed control unit. Also connect Terminal 3 and 4 of the DFM100 to Terminal E of the speed control unit. Since these two cables are both handling full actuator current to the gaseous side, they must be a large wire size to handle that current. Droop may be adjusted at the speed control and it will be proportional to the current in Actuator 1.

If the application requires that droop be proportional to Actuator 2, the diesel side, then ignore above paragraph and connect Terminal 10 of the DFM100 to Terminal B of the 5000 SERIES speed control unit. Also connect Terminal 9 of the DFM100 to Terminal E of the speed control unit. Since these two cables are both handling full actuator current for the diesel side they must be of a large enough wire size for that current.

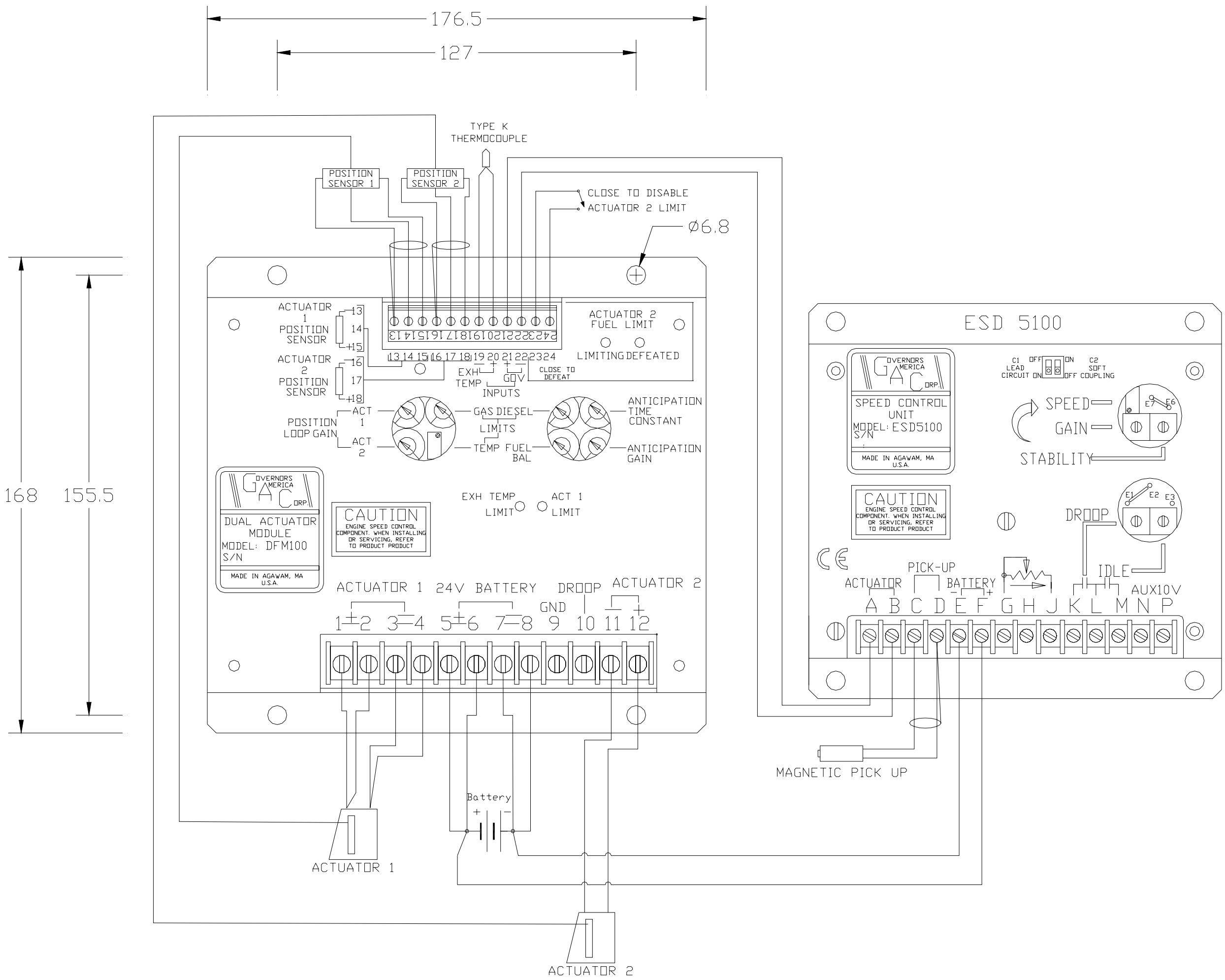
Other wiring issues

It is suggested that each position sensor cable be of a three wire shielded type with the shields connected to the case of the DFM100. Case ground (right corner screw) should be connected to battery minus (Terminal 8) with a separate cable for best EMC ratings.

ACTUATOR 1 and the 24V BATTERY terminals on the DFM100 both have dual connections.

Dual connections are needed because the current rating for the Actuator #1 driver is over 20 Amps and the total DC current consumption for both actuators could reach as high as 30 amps. 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 actuator publications to determine the total current consumption and appropriate wire size for the battery and actuators.

WIRING DIAGRAM



ADJUSTMENTS

Preset the adjustments as follows:
Anticipation Gain 0
Anticipation Time constant 100
Act 1 Position Loop Gain .... 40% CW
Act 2 Position Loop Gain .... 40% CW
Diesel Limit 100
Gas Limit 100
Temp Limit ...700°C (29 mV) {Factory setting}
Fuel Balance 50

For a Dual Fuel application, it best to first run the system with 100% diesel to preset the speed control system. The easiest way to defeat the gas side is to open the thermocouple at Terminals 19 and 20. The gas will then be automatically shut off (EXH TEMP LIMIT and ACT 1 LIMIT LEDs will both be ON) and the diesel side will be unrestricted.

Start the engine and set the speed and performance adjustments per the literature for the specific speed control used. It's helpful to record the position sensors voltage output (Terminals 17(+) and 16 (-)) 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.

Each actuator driver circuit has its own actuator POSITION LOOP GAIN adjustment to optimize the feedback control loop response. Adjust the Actuator Gain as high as possible without engine or actuator instability. Note: the Speed Gain adjustment in the governing module and the Actuator Gain adjustment can interact some. 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. Mid range or higher for both adjustments is preferable.

Once the system is proven to run well on diesel, shut down the system, reconnect the thermocouple, leave open the diesel defeat switch, and restart the engine. With no load or a light load on the engine, the engine should run stable. If necessary, adjust the governor's Gain and Stability for stable speed performance. The gas valve should be slightly open and should be consuming gas, but at low levels. If the proportion of gaseous fuel at this light load is too much or too little, then adjust the FUEL BAL control for the desired proportion of Gas vs Diesel.

Apply greater load to the system. When the load level is above 40%, adjust the DIESEL LIMIT CCW until the diesel fuel level reaches 15% as determined by the data taken above from the position sensors signal when the engine was run on diesel only.

Caution: The exhaust temperature can run very hot on some diesel engines and can ruin the engine with excessive heat. Monitoring the exhaust temperature is mandatory. Also note that the exhaust temperature may vary from cylinder to cylinder and where the temperature is taken in the exhaust steam could be a cooler than normal spot and provide false security.

Continue to apply load noting that the diesel fuel should be holding at a fixed level (ACTUATOR 2 FUEL LIMIT LIMITING LED ON). As the load increases, the gas valve will be opening more and more. If the exhaust temperature rises too high, or the engine does not accept higher amounts of gas, adjust the diesel limit higher to stay out of the high exhaust temperature operating area. If the EXH TEMP LIMIT is reached, the Gas system will be shut OFF and the Diesel limit defeated.

If it is desirable to limit the maximum gas supply (opening of the gas controlling actuator) to the engine, the GAS LIMIT adjustment may be turned CCW until the ACT 1 LIMIT LED comes ON. No other action is taken so the maximum power from the engine may be limited with this adjustment.

Anticipation Adjustments

Two adjustments are provided which affect the load dynamics on the diesel side of the fuel control. 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%. Adjust the ANTICIPATION GAIN adjustment CW so that the diesel fuel increases during the transient. A higher setting will reduce the off speed load transient. Then adjust the ANTICIPATION TIME CONSTANT so that the off speed transient has the shortest time off-speed. Between these two controls, it should be possible to provide a near optimum transient response with the diesel fuel or operation that approaches Diesel fuel performance alone.