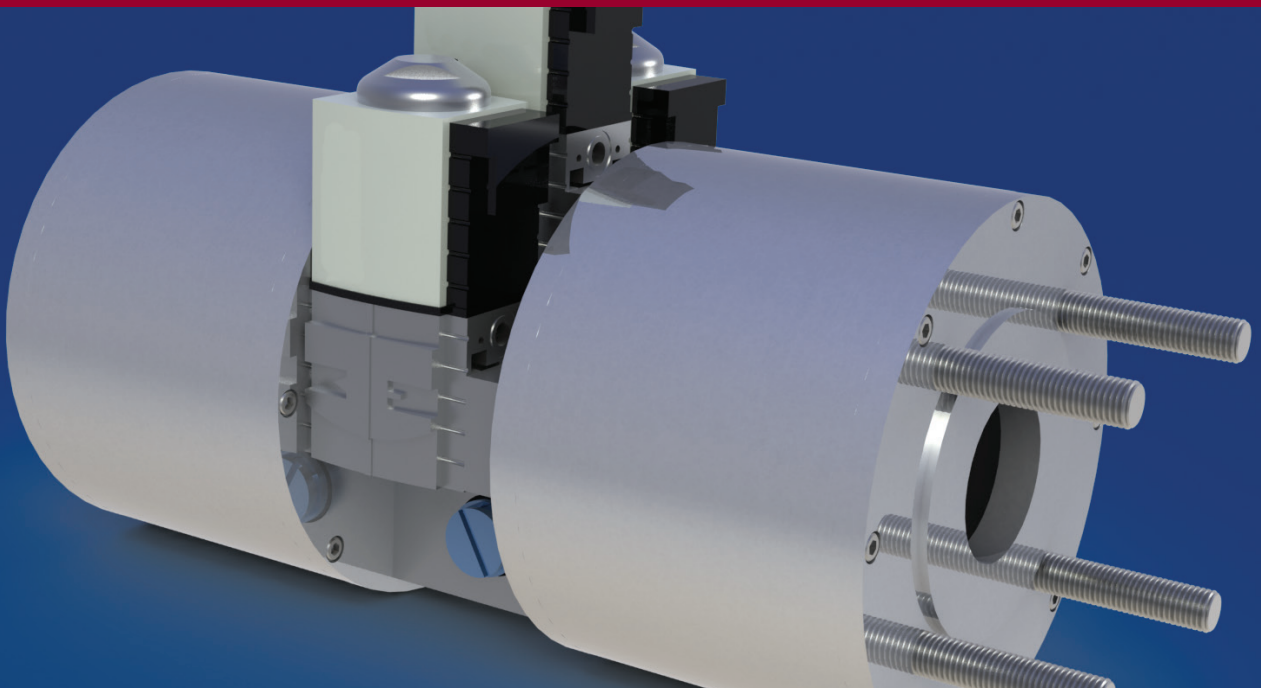


Installation & Operating Manual

GTI Step Control System (STEPCON®)

STEPCON 9-14

altronic
HOERBIGER Engine Solutions



1.0 SAFETY PRECAUTIONS

- 1.1 Follow all local codes when installing the STEPCON system. All gas manifold components should be installed and/or inspected by a licensed plumbing contractor.
- Ensure adequate ventilation in work area in order to prevent accumulation of gas caused by undetected leaks. Accumulations of natural gas or other hydrocarbon vapors can result in high energy explosions that can damage or destroy structures and cause injury or death to nearby personnel.
 - An appropriately rated fire extinguisher must be kept in a readily accessible location during all phases of installation.
 - Observe all warnings found on the equipment. Ensure that warning labels are legible and not obstructed by dirt, grease or other equipment.
 - Do not install any component that appears to have been tampered with, subjected to high temperatures or damaged in any way. Installation of a damaged component may result in gas leaks and/or improper operation of the Bi-Fuel System.
 - Do not attempt to operate engine until a thorough leak check has been completed. Use of an industry standard leak detection fluid (such as “Snoop”) is required on all gas connections, joints and flanges. ALL LEAKS MUST BE FIXED PRIOR TO OPERATING ENGINE IN ANY MODE.
 - All Bi-Fuel system components must be used within the temperature and pressure ranges specified in this manual or as otherwise dictated by component labeling. Operation of components outside of design temperature and pressure limits can result in fire, explosion and/or harm to personnel.
 - Installation, commissioning and operation should only be performed by authorized personnel who have been properly and thoroughly trained with the GTI Bi-Fuel® and STEPCON® equipment.

WARNING: Deviation from these instructions may lead to improper engine operation which could cause personal injury to operators or other nearby personnel.

2.0 DESCRIPTION AND THEORY OF OPERATION

- 2.1 The STEPCON is designed as an optional enhancement of the basic GTI Bi-Fuel fumigation system. The general theory of operation of the basic GTI Bi-Fuel system can be found in section 2.1 of the Altronic GTI Bi-Fuel Installation and Operating Manual, FORM GTI IOM. The STEPCON system retains all of the components of the basic fumigation system with the addition of a Gas Control Manifold (GCM), kW sensor, and a panel upgrade with customized firmware and outputs.
- 2.2 The STEPCON is designed to enhance the basic GTI Bi-Fuel system, allowing its application over a wider load range, adjusting the optimal substitution rate based on load with the capability to make substitution-level adjustments in response to rapid load changes.
- 2.3 Figure I is a basic diagram illustrating the major components of the GTI Bi-Fuel and STEPCON system. The design retains the basic philosophy of the GTI Bi-Fuel system, requiring no modifications to the diesel engine, controls, or sensors, and utilizing all of the same basic safety systems to protect the engine. The STEPCON system incorporates a kW sensor to enhance its ability to sense engine load, and a gas control manifold (GCM) assembly, installed directly on the outlet side of the gas train. The GCM incorporates a standard manual power valve in parallel with three single-solenoid fuel control valves, each of which has a fully adjustable orifice that is manually set by the commissioning technician.
- 2.4 A standard GTI Bi-Fuel commissioning procedure is performed for the load window where the lowest level of substitution will take place. Only the manual power valve is used to set this initial (lowest) level of substitution; all three

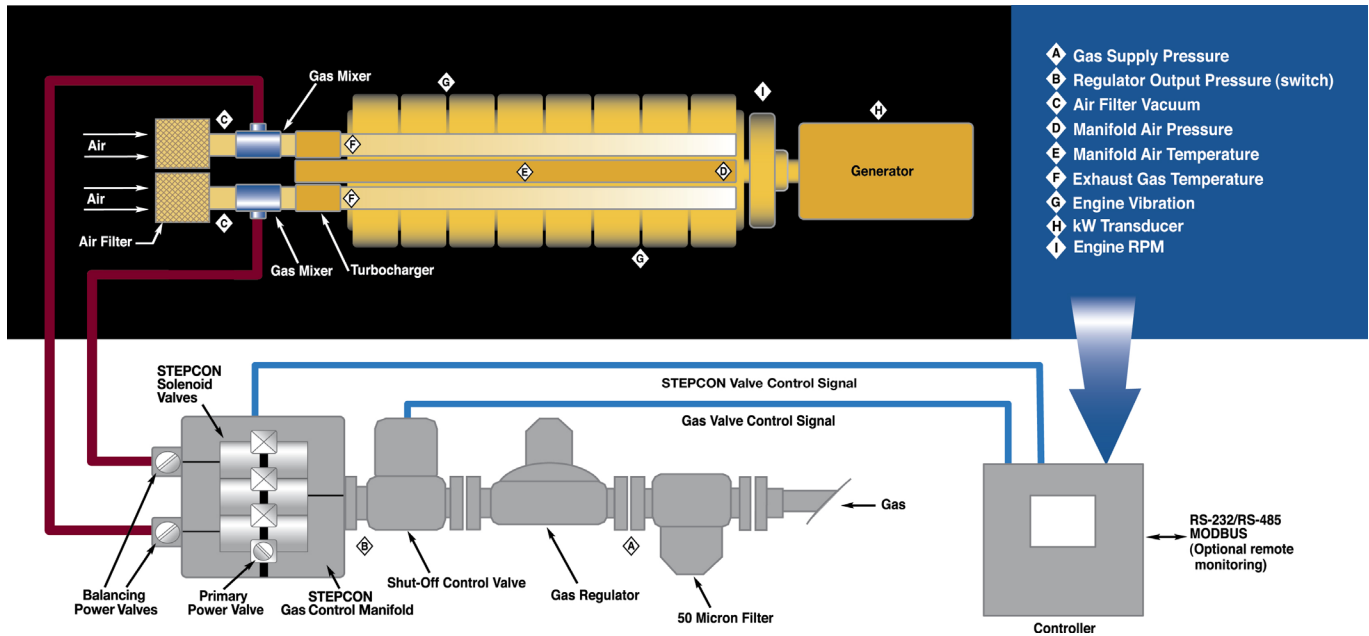


Figure 1: Schematic Representation of GTI Bi-Fuel System with STEP CON

solenoid valves are electrically closed. The commissioning procedure is repeated for the second, third, and fourth stepped levels of substitution, each time setting the percent of substitution for its corresponding load window by adjusting the variable orifice of each solenoid valve. Customized software is used to create ON/OFF combinations of the three solenoid valves in the gas control manifold to “shape” the gas substitution curve to follow the engines tolerance to gas as engine load is varied across a wide range, providing optimized substitution over a wide load band. The result is a load map that allows the GTI control panel to rapidly transition to the selected valve combinations based on engine load, thus maximizing the benefits of the bi-fuel application.

3.0 APPLICATIONS

3.1 The STEPCON system is designed for use in GTI Bi-Fuel applications where there is a need to accommodate adjustments in the optimal substitution rate as a result of changes in conditions that would normally require a limitation to the maximum possible substitution over a given load window; or a limitation to the maximum possible load window with a given rate of substitution. One example of this would be installations where high operating temperatures (either time of day or load related) limit the substitution at elevated loads. Another example would be a genset that spends a large percentage of its time at light load, below the point where a standard bi-fuel system, optimized to operate in the engine's moderate-to-heavy load region, would be in the bi-fuel OFF condition (such as on a drill rig).

4.0 STEPCON SIZING

4.1 The STEPCON system is available in a number of models to accommodate various engine configurations. The inlet side of the GCM is equipped with an integrated DN65 or DN80 flange pattern with incorporated studs that are designed to mate to the DN outlet flange of the associated DMV of the GTI gas train. The outlet side of the GCM is equipped with male JIC connection(s) in size

and number combinations to accommodate all engine configurations for which the standard GTI Bi-Fuel systems are available. The GCM is designed so as not to impose any restriction on the gas flow.

STEPCON Gas Control Manifold	Inlet Flange	Outlet Size	Outlets
STEP65115	DN65	1.5" JIC	1
STEP65215	DN65	1.5" JIC	2
STEP65415	DN65	1.5" JIC	4
STEP80120	DN80	2.0" JIC	1
STEP80220	DN80	2.0" JIC	2
STEP80420	DN80	2.0" JIC	4
STEP80620	DN80	2.0" JIC	6

TABLE I: STEPCON Fuel Control Manifold Size Chart

5.0 STEPCON COMPONENTS

- 5.1 In addition to the standard GTI Bi-Fuel system components described in detail in the GTI Installation and Operating Manual (FORM GTI IOM), the additional STEPCON components are described as follows:
- 5.2 **STEPCON GAS CONTROL MANIFOLD (GCM)** – A proprietary flow-metering device that allows for precise multiple adjustment of gas flow to the engine. The GCM works in conjunction with the Zero Governor Regulator and Air-Gas Mixer to control the amount of gas supplied to the engine for a given engine load. The GCM consists of three main parts: inlet plenum, power valves, and outlet plenum. The GCM inlet and outlet plenums are constructed of CNC-machined aerospace quality materials. The finished GCM inlet and outlet plenums are mil-spec anodized for surface hardness and corrosion protection. Constructed of aluminum, the STEPCON Gas Control Manifold (GCM) bolts to the outlet of the Dual Modular Valve (DMV) at the outlet end of the gas train. Sandwiched in the center of the assembly, the manifold incorporates three (3) manually set, fully adjustable orifice, electrically operated fuel control solenoid valves and one (1) manual gas power valve (GPV). Gas flows in parallel through the gas power valve and any combination of the solenoid valves that are powered in the OPEN condition. The assembly works as an electronically-controlled variable restriction that switches in mapped steps, resulting in multiple optimized stacked substitution rates based on real-time engine load.

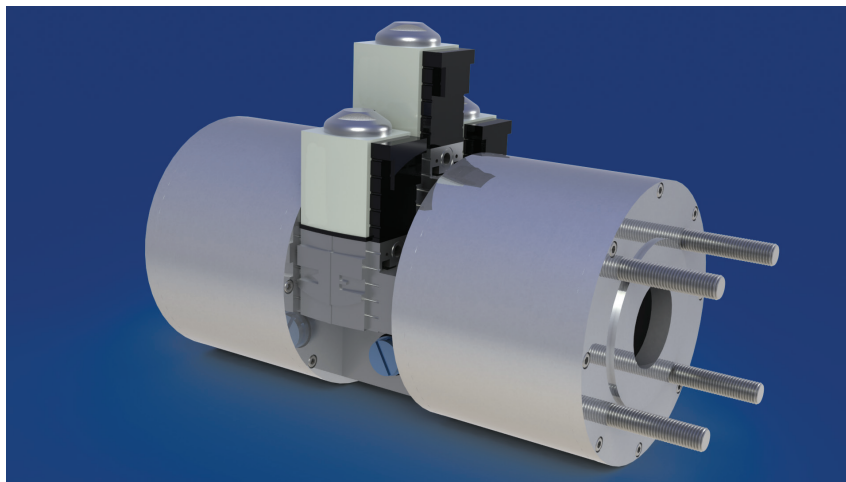


Figure II: STEPCON gas control manifold

- 5.3 **CONTROL PANEL** – The STEPCON system can only be used in conjunction with the GPN2015 monitoring and control panel. In addition to the standard functions associated with the GTI Bi-Fuel system, the GPN 2015 panel contains specialized firmware and outputs designed to control the STEPCON Gas Control Manifold valves. The controls are housed in a stainless steel panel.



FIGURE III: GPN2015 Panel

NOTE: Refer to GTI V-Engine Control System Operating Manual for complete details of the operation of the GPN 2015 panel.

NOTE: Regardless of the engine size or configuration, the STEPCON option is only available with the GPN2015 panel. There is no option to use the GPN1000 or GPN0100 panels, and GPN2020 panels cannot be upgraded to accommodate the STEPCON operation.

6.0 CONTROLS AND MONITORING

- 6.1 **CONTROL LOGIC** – For a complete overview of the control logic of the standard GTI Bi-Fuel system, refer to GTI Bi-Fuel Installation and Operating Manual (FORM GTI IOM).
- 6.2 The STEPCON system operates by referencing a user-defined map of engine load versus solenoid valve activation that is created at the time of commissioning using terminal software provided with each GTI system. A kilowatt or RPM sensor provides a reference of the engine load as an analog input to the controls. There can be up to ten (10) load reference switch points that result in a selected combination of activation of the three solenoid valves in the Gas Control Manifold (GCM). As the control sees the engine load cross these switch points, it transitions the valve activation combination accordingly, resulting in a change in the substitution rate.

NOTE: The solenoid valves contained in the STEPCON Gas Control Manifold do not serve as safety shutoff valves for the GTI system. This function is retained by the dual modular solenoid valve installed as part of the standard gas train.

7.0 STEPCON INSTALLATION

- 7.1 **GAS CONTROL MANIFOLD** – The STEPCON GCM is equipped with either a DN65 or DN80 stud pattern on its inlet side that mates directly to the outlet flange of the Dual Modular Valve (DMV) that is part of the standard gas train. The kit includes all required hardware and a gasket. Flanges should be tightened using an alternating pattern to assure even tightening across the flange face. If the STEPCON GCM is being added to an existing gas train, make sure that the support of the gas train is adjusted as necessary to ensure the horizontal center line of the gas train matches the horizontal center line of the GCM and adequate support is provided to the entire gas train assembly, including the GCM.

NOTE: DO NOT OVER-TIGHTEN FLANGE BOLTS! Maximum torque for flange bolts is 37 ft-lb (50 N-m).

- 7.2 The GCM arrives as a complete assembly, equipped with a small U-channel mounting carrier attached to the underside of the body. The assembly weighs approximately 100 pounds, so best practice steps should be taken to ensure it is adequately supported and secured in place in addition to the securing of the gas train as outlined in section 4.2.4 of the GTI Bi-Fuel Installation and Operating Manual (FORM GTI IOM).
- 7.3 After installation of the gas train and Gas Control Manifold is complete, the entire assembly must be leak tested using an industry-standard leak detection fluid ("Snoop" or equivalent); ALL LEAKS MUST BE FIXED AND RETESTED PRIOR TO OPERATING ENGINE IN ANY MODE.
- 7.4 **CONTROL PANEL INSTALLATION** – Reference section 4.3 of GTI Bi-Fuel Installation and Operating Manual (FORM GTI IOM) for installation details.
- 7.5 **3 PHASE 3 WIRE GENERATOR SET and 3 PHASE 4 WIRE GENERATOR SET** – The kilowatt sensor is comprised of three ct's and a watt transducer module powered by 230 VAC $\pm 15\%$. See 3Phase 3Wire and 3Phase 4Wire diagram (Figure XII).
- 230VAC instrument power may require addition of step-down transformer, see appropriate wiring diagram for installation
- 7.6 **KILOWATT SENSOR CALIBRATION** – The kilowatt sensors must be calibrated at the time of installation. Figure V shows the calibration screen with channel 27 (used for the sensor input) selected. In the "Calibration SetPoints" area of the screen, the "Current Data" box shows the actual reading of the KW sensor based on the current calibration, any time that this screen is viewed. It is important to note that when the screen is opened, the "Sensor Range" and "Sensor Voltage" windows contain the DEFAULT CALIBRATION settings, regardless of where the sensor is actually calibrated. **THEY ARE "WRITE ONLY".**
- 7.7 The simple calibration procedure is as follows:
- Select channel 27
 - Set the generator set to the rated speed and a no-load condition
 - Adjust the Sensor Voltage Low value and select "accept" until the KW sensor Current Data reading shows 0kW
 - Take the engine to the 100% load point and adjust the Sensor Voltage High value and select "accept" until the kW sensor Current Data reading shows desired kW (or to the maximum site load condition, while modifying Sensor Range High value to equal this high engine load percentage)
 - Adjust the High Sensor Voltage value and select "accept" until the KW sensor reading matches the actual kW of generator set load

NOTE: The Gas Power Valve adjusting screw can be threaded from either the left or right sides of the assembly. This accommodates access to the power valve adjustment from the most convenient side once the assembly is installed. The supplied threaded plug must be installed on the side of the power valve opposite to where the adjustment screw was installed.

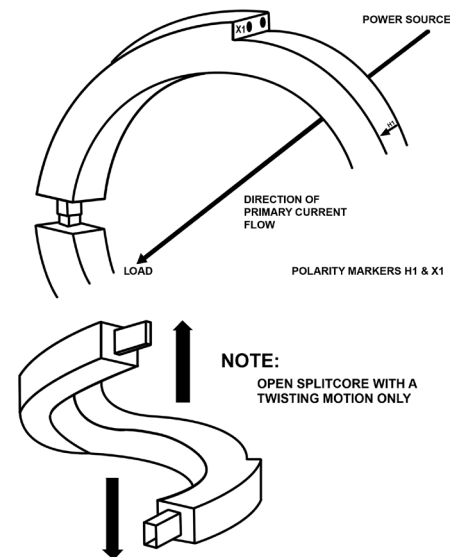


Figure IV: Kilowatt Sensor Installation

NOTE: The controller does not accept any changes unless the ACCEPT button is activated.

NOTE: Take care when installing current transformers as they are directional. The arrow printed should point away from the power source. Open split core with a twisting motion only.

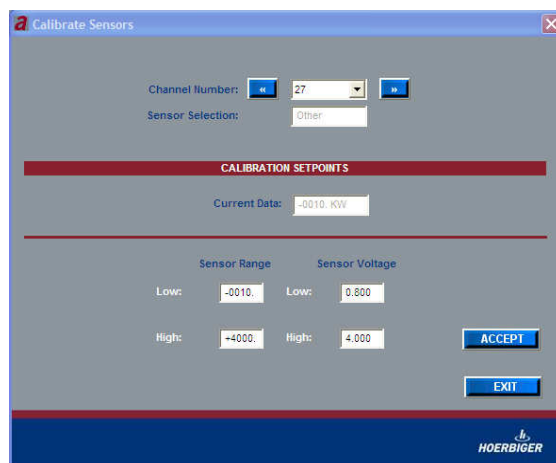


Figure V: Kilowatt Sensor Calibration

7.8 STEPCON WIRING – The GPN2015 panel is delivered with the STEPCON Gas Control Manifold wiring harness included (693153). This harness runs from the terminations in the control panel to the individual solenoids in the GCM, and also contains the conductors required for the kilowatt sensors.

The harness should be installed in the proper control panel entrance and properly terminated within the control panel. It should be routed to the GCM using best wiring practices, avoiding excessively hot surfaces, or surfaces which will vibrate and chafe the harness. Reference the wiring schematic provided in Figure IX at the end of this document.

Each of the three solenoid valves are provided with a DIN connector for termination of the harness end of the STEPCON connection. It is recommended that the DIN plugs be oriented with the conductor opening facing inward as shown in Figure VI.

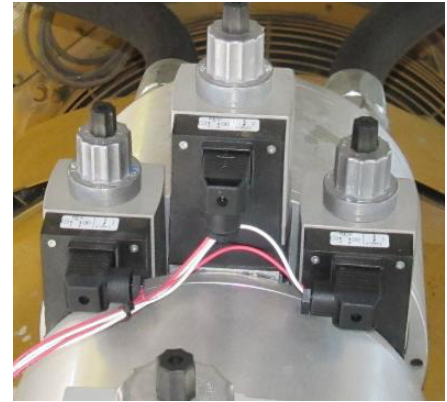


Figure VI: STEPCON Connection

8.0 STEPCON SETUP AND OPERATION

- 8.1 Before proceeding with setup and commissioning of the STEPCON system, **it is required that the installation technician be fully familiar with section 5.0 of the Altronic GTI Bi-Fuel Installation and Operating Manual (FORM GTI IOM)**. For the sake of brevity, this section is not repeated in this manual.
- 8.2 All engine baseline data across the full operating range of the engine and with sufficient resolutions (at least 10% load steps are recommended), with the engine operating on 100% diesel, must be collected prior to beginning the setup procedure as described in Altronic GTI Bi-Fuel Installation and Operating Manual (FORM GTI IOM).

NOTE: It is critically important that the means to vary the genset load is available during the commissioning process. Failure to have this ability will result in the inability to verify correct substitution and protection settings.

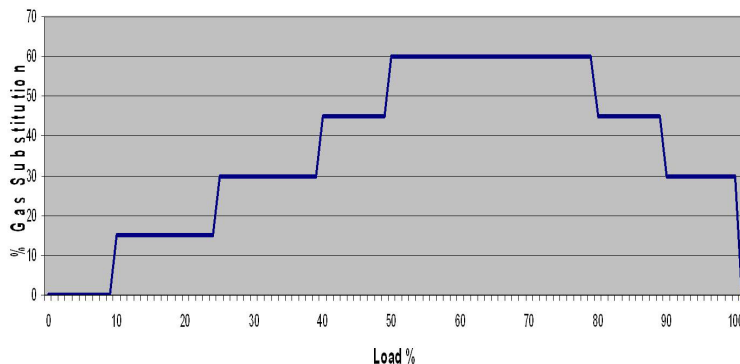


FIGURE VII: Stepped Load vs. Substitution Example

- 8.3 In basic terms, the STEPCON is a system that allows for genset commissioning at multiple substitution levels for various load points. At each of these load points, the basic commissioning procedure for the standard GTI Bi-Fuel system is the basis of the procedure. It is important that the commissioning technician be familiar with the specific application load profile, along with the practical operating range desired by the customer.
- 8.4 The goal is to create a “step-like” substitution vs. load map as shown in Figure VII. In the example shown, the highest substitution will take place between 50 and 80% of rated load, with reduced substitution at heavier and lighter loads to maintain desired stable engine operating conditions. These steps are accomplished with ON/OFF combinations of the three solenoid valves in the STEPCON GCM assembly to create a map of load vs. substitution.
- 8.5 Figure VIII shows the STEPCON terminal software screen used to build the load vs. substitution map. The number of switch-points is selected in the top drop-down box, “Setpoint to use,” with the selection ranging from 1 to 10. For each switch-point, the technician enters the kW and uses the check boxes to dictate



Figure VIII: STEPCON Terminal Software

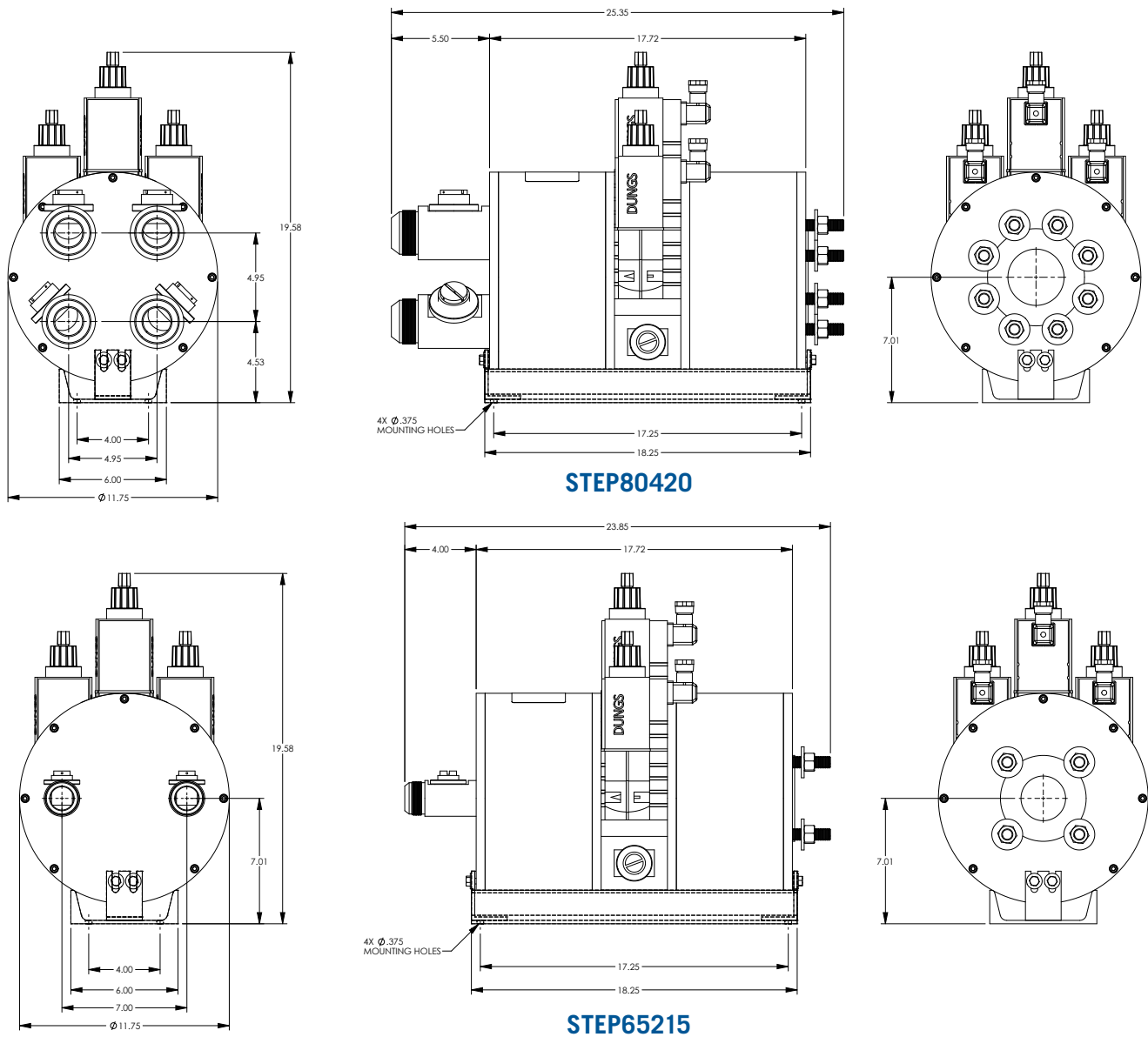
the desired combination of STEPCON valves that will be powered ON at the given setpoint. The bottom window of this box allows the technician to specify a dead band to avoid rapid toggling between setpoints in operation.

It is important that the commissioning technician is familiar with the load profile of the application and the desired practical operating range in order to help visualize this step map.

- 8.6 The STEPCON valves are either full ON or OFF. They cannot be powered to partially-open positions. However, it is possible to manually limit the travel of the valve poppet using the main flow adjustment cap on the top of each valve, adding another degree of freedom in creating an optimal load vs. substitution map. The travel is adjusted by removing the black plastic cap that provides access to the hydraulic break adjustment, and backing off the two set screws at the base of the aluminum main flow adjustment cap.
- 8.7 To start the commissioning process, the technician should have conferred with the customer to establish a rough idea of the desired load range. Based on this, he will be able to roughly determine how many steps in control will need to be initiated. In the example, the customer expects bi-fuel application between 10% and 90% load.
- 8.8 The first step following the diesel base line work is to perform a system commissioning at the lowest targeted load. In this example, this is between 10 and 25% load. All three of the STEPCON valves should be adjusted to the full closed position in the OFF state. The substitution rate is set using the power valve in the STEPCON manifold. Once this is complete, the adjustment screw should be locked down. No further adjustment of this valve should be made at any other load points.
- 8.9 The next range in the example is about 25% to 40% and 90% to 100% load. This stage of work should be performed with one of the valves powered in the ON condition. The substitution rate is set using the main flow adjustment on this powered solenoid valve. Once the substitution that provides stable operation with acceptable exhaust gas and vibration levels is determined, no further adjustment of this power valve can take place.
- This step is repeated for the 40% to 50% and 80% to 90% load ranges, powering the second valve open along with the first, with adjustments made to main flow adjustment of the second valve. The procedure is repeated again at the highest tolerated gas substitution load range with the third valve powered open.
- 8.10 For V-engine configurations, the Air Gas Mixer-Power Valve (AGM-PV) are used to balance the gas distribution for each bank as described in the Altronic GTI Bi-Fuel Installation and Operating Manual (FORM GTI IOM).
- 8.11 Upon completion of the map, the technician should run the engine across the full load range to ensure proper bi-fuel operation at all switch-points. The commissioning report must be completed, signed and submitted to Altronic (with a copy provided to the customer), and an acknowledgment must be received for the job to be considered complete.

NOTE: The main flow adjustment is only about eight turns from full open to closed. Although there is a mechanical stop at the full open end of the travel, there is no such stop at the closed end, and forcing the adjustment beyond eight turns can damage the valve. It is recommended to establish the full open position (make any desired index markings while in this position) then close the valve exactly (8) eight turns: This is considered Full Closed.

FIGURE IX – STEPCON DIMENSIONS



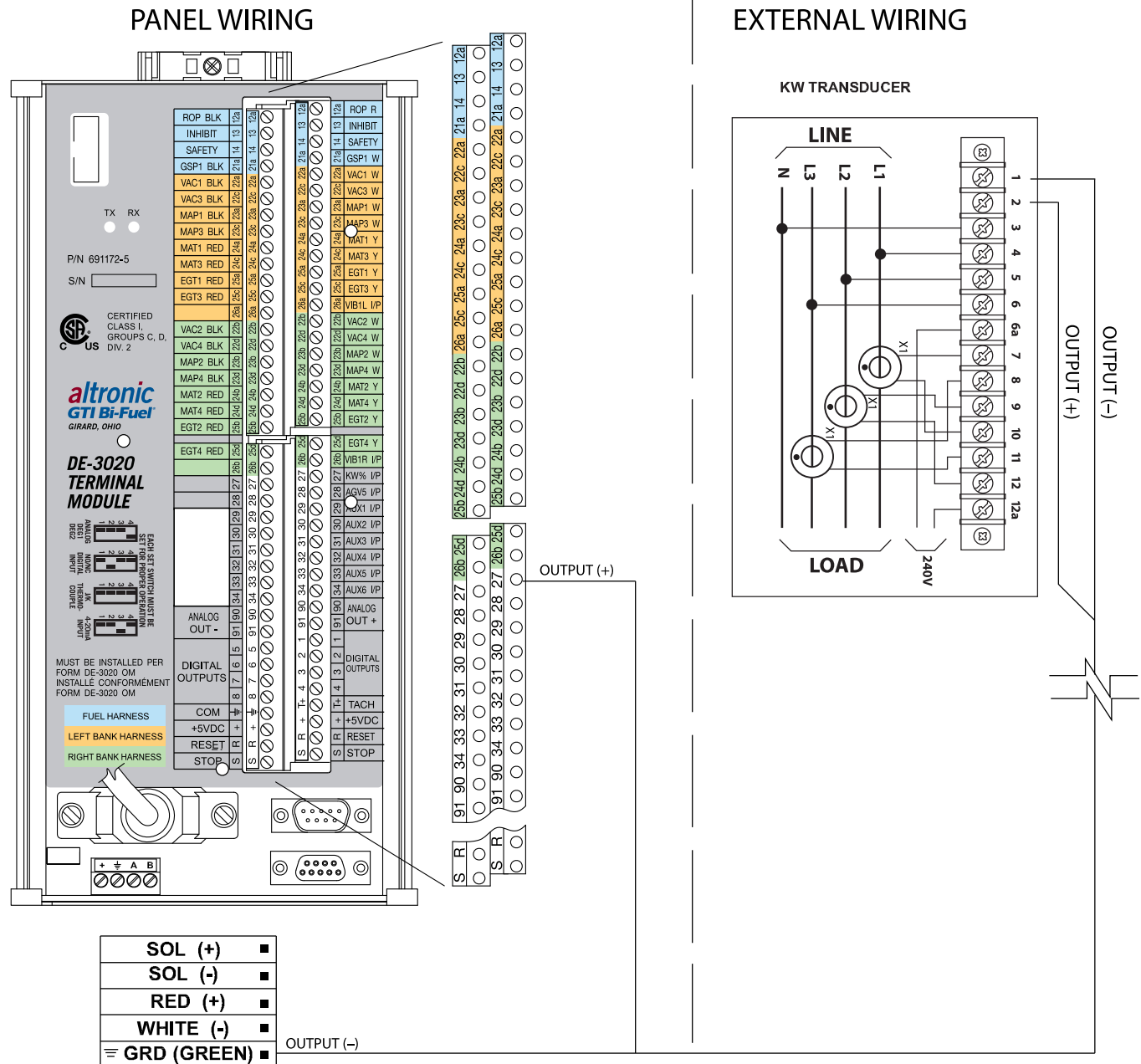
GCM Part Number	Description	Order with
STEP65115	DN65 – 1x1.5" JIC	G11064-10 hose (1) G11063 fittings (2)
STEP65215	DN65 – 2x1.5" JIC	G11064-10 hose (2) G11063 fittings (4)
STEP65415	DN65 – 4x1.5" JIC	G11064-10 hose (4) G11063 fittings (8)
STEP80120	DN80 – 1x2.0" JIC	G11073-10 hose (1) G11072 fittings (2)
STEP80220	DN80 – 2x2.0" JIC	G11073-10 hose (2) G11072 fittings (4)
STEP80420	DN80 – 4x2.0" JIC	G11073-10 hose (4) G11072 fittings (8)
STEP80620	DN80 – 6x2.0" JIC	G11073-10 hose (6) G11072 fittings (12)

NOTE:

If ordering as part of complete kit, do not order separate power valves.

Does not require use of gas train outlet adapter flange G11007 or G11008

FIGURE X – 3 PHASE 3 WIRE AND 3 PHASE 4 WIRE WIRING SCHEMATIC



NOTE: KW Terminal Strip Specs.
Wire Strip Length: .38" [9.652]
Recommended Torque: 8 in-lbs.

NOTE: All furnished drawings and instructions assume (-) ground DC system. In the case of a floating ground, or (+) ground DC system, please contact Altronic Factory for support.