AFR-64R

Rich Burn Air/Fuel Ratio Controller

Installation and Operations Manual

Please read manual for hazard and safety advisement.

00-02-0708
2012-11-23
Section 40

WARNING

Read this entire manual and any other publications relevant to this project prior to installing, modifying or operating the equipment described herein. Follow safe practice standards. Observe all local, state and federal codes. Use this manual for safe, effective operation. Improper installation, operation or other use of this product could result in any combination of poor performance, equipment damage, human injury or possible death.

FW Murphy and Compliance Controls reserves the right to change or alter any and all specifications at anytime without prior notification and without incurring any obligation to such changes. The information included in this publication is believed to be accurate at the time of publication; however, no responsibility is taken by FW Murphy/Compliance Controls unless expressly given.

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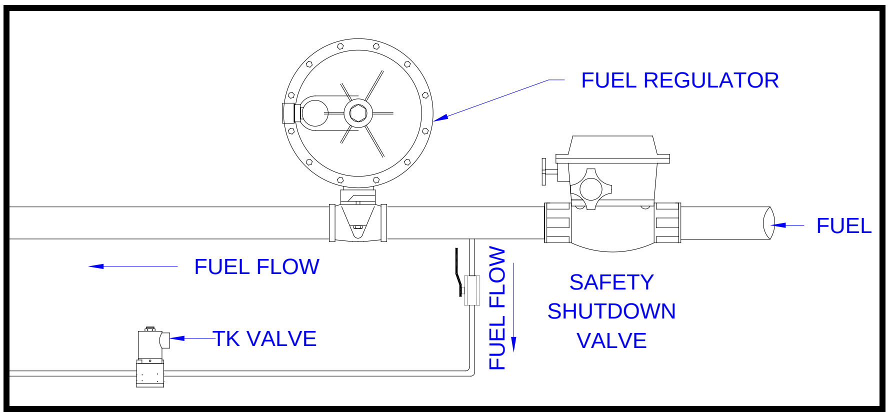
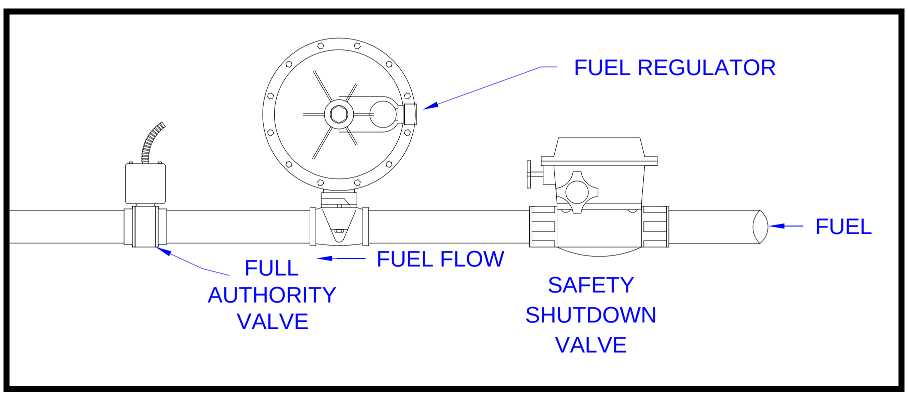
Safety

- **The electrically actuated fuel control valves supplied with this product are designed to control fuel flow only. They are not designed to replace a fuel shut-off valve or a fuel shut-off system. Therefore the product relies on the installation and use of an automatically closing fuel shut-off valve (user supplied) to stop fuel flow during and after engine shutdown and is necessary for safe product use. Such valves are widely available.**



TK Valve shown properly installed downstream of automatic fuel shutoff valve



Butterfly Valve shown properly installed downstream of automatic fuel shutoff valve

- **Automatic and/or semiautomatic fuel shut-off valves are mandated by the National Fire Protection Association's "NFPA 37 – Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines." We recommend reading the National Fire Protection Association's codes and standards, NFPA 37 and NFPA 54 along with any other national, state, and local codes and standards relevant to your application.**

- **Do not open the controller's enclosure when a hazardous atmosphere is present. Wiring connections that could spark are present inside the enclosure.**

- **Do not connect or disconnect end devices or make wiring changes while power is supplied to the product unless the area is known to be non-hazardous. Electrical sparks may occur.**

- **Separate non-incendive and intrinsically safe wiring from any other wiring.**

- **Do not share the speed signal supplied to an electronic governor or ignition system with this product.**

- **Do not operate components beyond their respective safety ratings (maximum/minimum pressure, voltage, current, etc.).**

- **All electrical connections should be performed by qualified personnel and should meet all Federal, State, Local and End User electrical codes.**

- **If the installer is unfamiliar with Federal, State, Local and End User electrical codes or is unable to safely complete any of the installation requirements put forth in this manual, contact your COMPLIANCE CONTROLS distributor for information on qualified installers.**

Failure to follow the safety instructions of this manual could void the product warranty.

This product is often used in retrofit applications. It is the responsibility of the installer(s)/end user(s) to assess the safety and suitability of the product with regard to the end user's or users' specific application. This responsibility is not shared by Compliance Controls.

Introduction

This manual describes the basic installation, setup, operation and maintenance of the Compliance Controls Rich Burn Air/Fuel Ratio Control System; model AFR-64R, used to control rich-burn, four cycle, spark-ignited, gaseous fuel engines.

The system is designed to maximize the efficiency of a 3-way catalyst by maintaining the proper air/fuel ratio over varying engine loads, speeds, fuel quality, ambient temperatures and barometric pressure. This is done without operator intervention after the initial program setup.

The Compliance Controls AFR-64R air/fuel ratio controller represents cutting edge technology in many areas: hardware, microprocessor power, control system software, operator interface options, adaptability to variable engine conditions and control requirements, software upgrade capability, in addition to comprehensive on-board diagnostics system (OBD).

Parts and Supplies

This section identifies installation parts and provides check lists for systems and optional parts

AFR-#D-R-64R-11-TK## – TK Valve (Single Bank – with Post Catalyst Control)

Quantity	Part #	Model #	Description
(1)	**00020708**	**AFR-64R MANUAL**	**AFR-64R I/O Manual**
(1)	**47000470**	**AFR-64R/L-CD**	**AFR-64R/L PC Software**
(1)u	**47700314**	**AFR-ND-R-64RControl Unit**	**Enclosure; ECM; TCB; Hardware & No Display**
(1)u	**47700308**	**AFR-WD-R-64R Control Unit**	**Enclosure; ECM; TCB; Hardware; With Display**
(1)b	**00031003**	**CSBV-1/4**	**1/4" NPT Ball Valve**
(1)b	**00031004**	**CSBV-3/8**	**3/8" NPT Ball Valve**
(1)	**00031015**	**HEGO CABLE -100**	**HEGO Cable - 100' Length**
(1)	**00031016**	**HEGO CABLE -50**	**HEGO Cable - 50' Length**
(2)	**00031017**	**HEGO SENSOR**	**Heated Oxygen Sensor**
(2)	**00031021**	**KTC-12**	**Type "K" thermocouple (12" probe)**
(1)	**00031022**	**MAG PU**	**Magnetic Pick-up 4" Length**
(1)	**00031023**	**MAG PU CABLE-50**	**Magnetic Pick-up Cable 50'**
(1)	**47050819**	**MAP CABLE - 50**	**MAP Sensor Cable 50'**
(1)	**00030997**	**MAP SENSOR**	**Intake Manifold Press Sensor**
(1)	**00031029**	**NM-10**	**Null Modem Cable 10' Length**
(2)	**00031030**	**O2 NUT**	**18mm x 1.5 Threaded, Coupling for O2 Sensor**
(1)v	**47700325**	**TK-10**	**TK-10, Fuel Control Valve - 0.5 - 5 psig**
(1)v	**47700326**	**TK-11B**	**TK-11B, Fuel Control Valve - 5 to 35 psig**
(1)v	**47700322**	**TK-2**	**TK-2, Fuel Control Valve - 5 to 35 psig**
(1)v	**47700323**	**TK-4B**	**TK-4B, Fuel Control Valve - 5 to 35 psig**
(1)v	**47700324**	**TK-6B**	**TK-6B, Fuel Control Valve - 5 to 35 psig**

(1)b	***Indicates only 1 ball valve type is used, depending on the valve type used***
(1)v	***Indicates only 1 of the valve types are used***
(1)u	***Indicates only 1 of the Control Units are used, depending on the display option***

AFR-#D-R-64R-21-TK## – TK Valve *(Dual Bank – with Post Catalyst Control)*

Quantity	Part #	Model #	Description
(1)	00020708	AFR-64R MANUAL	AFR-64R I/O Manual
(1)	47000470	AFR-64R/L-CD	AFR-64R/L PC Software
(1)u	47700314	AFR-ND-R-64RControl Unit	Enclosure; ECM; TCB; Hardware & No Display
(1)u	47700308	AFR-WD-R-64R Control Unit	Enclosure; ECM; TCB; Hardware; With Display
(2)b	00031003	CSBV-1/4	1/4" NPT Ball Valve
(2)b	00031004	CSBV-3/8	3/8" NPT Ball Valve
(1)	00031015	HEGO CABLE -100	HEGO Cable - 100' Length
(2)	00031016	HEGO CABLE -50	HEGO Cable - 50' Length
(3)	00031017	HEGO SENSOR	Heated Oxygen Sensor
(2)	00031021	KTC-12	Type "K" thermocouple (12" probe)
(1)	00031022	MAG PU	Magnetic Pick-up 4" Length
(1)	00031023	MAG PU CABLE-50	Magnetic Pick-up Cable 50'
(1)	47050819	MAP CABLE - 50	MAP Sensor Cable 50'
(1)	00030997	MAP SENSOR	Intake Manifold Press Sensor
(1)	00031029	NM-10	Null Modem Cable 10' Length
(3)	00031030	O2 NUT	18mm x 1.5 Threaded, Coupling for O2 Sensor
(2)v	47700325	TK-10	TK-10, Fuel Control Valve - 0.5 - 5 psig
(2)v	47700326	TK-11B	TK-11B, Fuel Control Valve - 5 to 35 psig
(2)v	47700322	TK-2	TK-2, Fuel Control Valve - 5 to 35 psig
(2)v	47700323	TK-4B	TK-4B, Fuel Control Valve - 5 to 35 psig
(2)v	47700324	TK-6B	TK-6B, Fuel Control Valve - 5 to 35 psig

(2)b	*Indicates only 1 ball valve type is used, depending on the valve type used*
(2)v	*Indicates only 1 of the valve types are used*
(1)u	*Indicates only 1 of the Control Units are used, depending on the display option*

AFR-#D-R-64R-11-FA## – Full Authority Valve *(Single Bank – w/ Post Catalyst Control)*

Quantity	Part #	Model #	Description
(2)a	47050835	ADAPTER,2" FT Flange Assy	One 2" NPT Flange, Gkt & Hdw for FT-33, 60, & 68
(2)a	47050834	ADAPTER,3" FT Flange Assy	One 3" NPT Flange, Gkt & Hardware for FT-75
(1)	00020708	AFR-64R MANUAL	AFR-64R I/O Manual
(1)	47000470	AFR-64R/L-CD	AFR-64R/L PC Software
(1)u	47700314	AFR-ND-R-64R Control Unit	Enclosure; ECM; TCB; Hardware & No Display
(1)u	47700308	AFR-WD-R-64R Control Unit	Enclosure; ECM; TCB; Hardware; With Display
(1)c	47000016	FL Cable 50	FL Valve Cable - 50' Length
(1)v	47700033	FL-25,25MM Butterfly Valve	25 MM Full Authority (FA) Butterfly Valve
(2)a	47000001	FL-25-Flange Assy	One 1" NPT NPT Flange, Gkt & Hdw for FL-25
(1)v	47000017	FL-50,50MM Butterfly Valve	50 MM Full Authority (FA) Butterfly Valve
(2)a	47000003	FL-50-Flange Assy	One 2" NPT NPT Flange, Gkt & Hdw for FL-50
(1)c	47050836	FT CABLE-50	FT Valve Cable - 50' Length
(1)v	00031008	FT-33	33mm Full Authority Fuel Control Valve
(1)v	00031009	FT-60	60mm Full Authority Fuel Control Valve
(1)v	00031010	FT-68	68mm Full Authority Fuel Control Valve
(1)v	00031011	FT-75	75mm Full Authority Fuel Control Valve
(1)	00031015	HEGO CABLE -100	HEGO Cable - 100' Length
(1)	00031016	HEGO CABLE -50	HEGO Cable - 50' Length
(2)	00031017	HEGO SENSOR	Heated Oxygen Sensor
(2)	00031021	KTC-12	Type “K” thermocouple (12” probe)
(1)	00031022	MAG PU	Magnetic Pick-up 4" Length
(1)	00031023	MAG PU CABLE-50	Magnetic Pick-up Cable 50'
(1)	47050819	MAP CABLE - 50	MAP Sensor Cable 50'
(1)	00030997	MAP SENSOR	Intake Manifold Press Sensor
(1)	00031029	NM-10	Null Modem Cable 10' Length
(2)	00031030	O2 NUT	18mm x 1.5 Threaded, Coupling for O2 Sensor

(1)c *Indicates only 1 cable assembly style is used, depending on the valve type used*
(1)v *Indicates only 1 of the valve types are used*
(1)u *Indicates only 1 of the Control Units are used, depending on the display option*
(2)a *Indicates only 1 flange adaptor style is used, depending on the valve type used*

AFR-#D-R-64R-21-FA## – Full Authority Valve *(Dual Bank – w/ Post Catalyst Control)*

Quantity	Part #	Model #	Description
(4)a	47050835	ADAPTER,2" FT Flange Assy	One 2" NPT Flange, Gkt & Hdw for FT-33, 60, & 68
(4)a	47050834	ADAPTER,3" FT Flange Assy	One 3" NPT Flange, Gkt & Hardware for FT-75
(1)	00020708	AFR-64R MANUAL	AFR-64R I/O Manual
(1)	47000470	AFR-64R/L-CD	AFR-64R/L PC Software
(1)u	47700314	AFR-ND-R-64R Control Unit	Enclosure; ECM; TCB; Hardware & No Display
(1)u	47700308	AFR-WD-R-64R Control Unit	Enclosure; ECM; TCB; Hardware; With Display
(2)c	47000016	FL Cable 50	FL Valve Cable - 50' Length
(2)v	47700033	FL-25,25MM Butterfly Valve	25 MM Full Authority (FA) Butterfly Valve
(4)a	47000001	FL-25-Flange Assy	One 1" NPT NPT Flange, Gkt & Hdw FL-25
(2)v	47000017	FL-50,50MM Butterfly Valve	50 MM Full Authority (FA) Butterfly Valve
(4)a	47000003	FL-50-Flange Assy	One 2" NPT NPT Flange, Gkt & Hdw for FL-50
(2)c	47050836	FT CABLE-50	FT Valve Cable - 50' Length
(2)v	00031008	FT-33	33mm Full Authority Fuel Control Valve
(2)v	00031009	FT-60	60mm Full Authority Fuel Control Valve
(2)v	00031010	FT-68	68mm Full Authority Fuel Control Valve
(2)v	00031011	FT-75	75mm Full Authority Fuel Control Valve
(1)	00031015	HEGO CABLE -100	HEGO Cable - 100' Length
(2)	00031016	HEGO CABLE -50	HEGO Cable - 50' Length
(3)	00031017	HEGO SENSOR	Heated Oxygen Sensor
(2)	00031021	KTC-12	Type “K” thermocouple (12” probe)
(1)	00031022	MAG PU	Magnetic Pick-up 4" Length
(1)	00031023	MAG PU CABLE-50	Magnetic Pick-up Cable 50'
(1)	47050819	MAP CABLE - 50	MAP Sensor Cable 50'
(1)	00030997	MAP SENSOR	Intake Manifold Press Sensor
(1)	00031029	NM-10	Null Modem Cable 10' Length
(3)	00031030	O2 NUT	18mm x 1.5 Threaded, Coupling for O2 Sensor
(1)c	*Indicates only 1 cable assembly style is used, depending on the valve type used*		
(1)v	*Indicates only 1 of the valve types are used*		
(1)u	*Indicates only 1 of the Control Units are used, depending on the display option*		
(2)a	*Indicates only 1 flange adaptor style is used, depending on the valve type used*		

AFR-#D-R-64R-11-ICV75 – In-Line Control Valve (Single Bank – w/ Post Catalyst Control)

Quantity	Part #	Model #	Description
(1)	00020708	AFR-64R MANUAL	AFR-64R I/O Manual
(1)	47000470	AFR-64R/L-CD	AFR-64R/L PC Software
(1)u	47700314	AFR-ND-R-64R Control Unit	Enclosure; ECM; TCB; Hardware & No Display
(1)u	47700308	AFR-WD-R-64R Control Unit	Enclosure; ECM; TCB; Hardware; With Display
(1)	00031015	HEGO CABLE -100	HEGO Cable - 100' Length
(1)	00031016	HEGO CABLE -50	HEGO Cable - 50' Length
(2)	00031017	HEGO SENSOR	Heated Oxygen Sensor
(1)	47700327	ICV-75	ICV-75, In-line Control Valve 3/4 NPT
(2)	00031021	KTC-12	Type “K” thermocouple (12” probe)
(1)	00031022	MAG PU	Magnetic Pick-up 4" Length
(1)	00031023	MAG PU CABLE-50	Magnetic Pick-up Cable 50'
(1)	47050819	MAP CABLE - 50	MAP Sensor Cable 50'
(1)	00030997	MAP SENSOR	Intake Manifold Press Sensor
(1)	00031029	NM-10	Null Modem Cable 10' Length
(2)	00031030	O2 NUT	18mm x 1.5 Threaded, Coupling for O2 Sensor

(1)u *Indicates only 1 of the Control Units are used, depending on the display option*

AFR-#D-R-64R-21-ICV75 – In-Line Control Valve (Dual Bank – w/ Post Catalyst Control)

Quantity	Part #	Model #	Description
(1)	00020708	AFR-64R MANUAL	AFR-64R I/O Manual
(1)	47000470	AFR-64R/L-CD	AFR-64R/L PC Software
(1)u	47700314	AFR-ND-R-64R Control Unit	Enclosure; ECM; TCB; Hardware & No Display
(1)u	47700308	AFR-WD-R-64R Control Unit	Enclosure; ECM; TCB; Hardware; With Display
(1)	00031015	HEGO CABLE -100	HEGO Cable - 100' Length
(2)	00031016	HEGO CABLE -50	HEGO Cable - 50' Length
(3)	00031017	HEGO SENSOR	Heated Oxygen Sensor
(2)	47700327	ICV-75	ICV-75, In-line Control Valve 3/4 NPT
(2)	00031021	KTC-12	Type “K” thermocouple (12” probe)
(1)	00031022	MAG PU	Magnetic Pick-up 4" Length
(1)	00031023	MAG PU CABLE-50	Magnetic Pick-up Cable 50'
(1)	47050819	MAP CABLE - 50	MAP Sensor Cable 50'
(1)	00030997	MAP SENSOR	Intake Manifold Press Sensor
(1)	00031029	NM-10	Null Modem Cable 10' Length
(3)	00031030	O2 NUT	18mm x 1.5 Threaded, Coupling for O2 Sensor

(1)u *Indicates only 1 of the Control Units are used, depending on the display option*

Spare/ Loose Parts

Part #	Model #	Description
47050835	ADAPTER,2" FT Flange Assy	One 2" NPT Flange, Gkt & Hdw for FT-33, 60, & 68
47050834	ADAPTER,3" FT Flange Assy	One 3" NPT Flange, Gkt & Hardware for FT-75
00020708	AFR-64R MANUAL	AFR-64R I/O Manual
47000470	AFR-64R/L-CD	AFR-64R/L PC Software
47700314	AFR-ND-R-64R Control Unit	Enclosure; ECM; TCB; Display & Hardware
47700308	AFR-WD-R-64R Control Unit	Enclosure; ECM; TCB; Display & Hardware
47050823	BACK PANEL SCE-12P20	Enclosure Back Plate
47050824	COM KIT AFR	UniOP Display Daughter Board for secondary Modbus
00002138	CONVERTER,CALEX	12 to 24 Volts DC to DC converter
00031003	CSBV-1/4	1/4” NPT Ball Valve
00031004	CSBV-3/8	3/8” NPT Ball Valve
47000006	ECM-R-64R	Engine Control Module for the AFR-64R
47050831	ENCLOSURE-CSA	CSA Approved Enclosure
47000016	FL Cable 50	FL Valve Cable - 50' Length
47700033	FL-25,25MM Butterfly Valve	25 MM Full Authority (FA) Butterfly Valve
47000001	FL-25-Flange Assy	One 1" NPT NPT Flange, Gkt & Hdwfor FL-25
47000017	FL-50,50MM Butterfly Valve	50 MM Full Authority (FA) Butterfly Valve
47000003	FL-50-Flange Assy	One 2" NPT NPT Flange, Gkt & Hdw for FL-50
47050832	FLOTECH 2" GASKET	2" Flange gasket only
47050836	FT CABLE-50	FT Valve Cable - 50' Length
00031007	FT2 SPOOL PIECE	2" NPT Spacer FT Valve removal
00031008	FT-33	33mm Full Authority Fuel Control Valve
00031009	FT-60	60mm Full Authority Fuel Control Valve
00031010	FT-68	68mm Full Authority Fuel Control Valve
00031011	FT-75	75mm Full Authority Fuel Control Valve
47050833	GASKET,3",FT FLANGE	3" Flange gasket only
00031014	HEGO BLOCK	Rich Burn O2 Mounting Block
00031015	HEGO CABLE -100	HEGO Cable - 100' Length
00031016	HEGO CABLE -50	HEGO Cable - 50' Length

Part #	Model #	Description
00031017	HEGO SENSOR	Heated Oxygen Sensor
47700327	ICV-75	ICV-75, In-line Control Valve 3/4 NPT
00031021	KTC-12	Type “K” thermocouple (12” probe)
00031022	MAG PU	Magnetic Pick-up 4" Length
00031023	MAG PU CABLE-50	Magnetic Pick-up Cable 50'
47050819	MAP CABLE - 50	MAP Sensor Cable 50'
00030997	MAP SENSOR	Intake Manifold Press Sensor
00031029	NM-10	Null Modem Cable 10' Length
00031030	O2 NUT	18mm x 1.5 Threaded, Weldable, Coupling for O2 Sensor
00031012	O-RING,FL-25-FLG	FL-25 Flange o-ring
00031019	O-RING,FL-50-FLG	FL-50 Flange o-ring
00031031	PLUG,MALE,18MM,F/Vacant O2	Male Plug (18mm) for a Vacant Oxygen Sensor Hole
47050841	TCB	Terminal Connector Board
47700325	TK-10	TK-10, Fuel Control Valve - 0.5 - 5 psig
47700326	TK-11B	TK-11B, Fuel Control Valve - 5 to 35 psig
47700322	TK-2	TK-2, Fuel Control Valve - 5 to 35 psig
47700323	TK-4B	TK-4B, Fuel Control Valve - 5 to 35 psig
47700324	TK-6B	TK-6B, Fuel Control Valve - 5 to 35 psig
47050859	UNIOP COM CABLE	UniOP Communications Cable – 18"
47050860	UNIOP COM CABLE-PANEL	UniOP Communications Cable – 6'
47050861	UNIOP COM CABLE-REMOTE	UniOP Communications Cable - 50'
47000014	UNIOP DISPLAY AFR-64R	AFR-64R Display Only, Comm Cable & Pwr Cable not Included
47050820	UNIOP GASKET	Gasket seal for mounting UniOP in panel
47050845	UNIOP POWER CABLE	UniOP Pwr Cable – 18" Length
47050846	UNIOP POWER CABLE-REMOTE	UniOP Pwr Cable - 50' Length

Parts Identification

Please remember your specific kit may not include all of these parts. Refer to the Installation section of this manual for a parts listing of each kit.

ECM-AFR-64R CONTROL MODULE

The ECM-AFR-64R control module consists of a molded enclosure designed to protect the Printed Circuit Board (PCB). The PCB includes the microprocessor controller and all associated electronics for signal inputs, filtering, controlled outputs and communications.

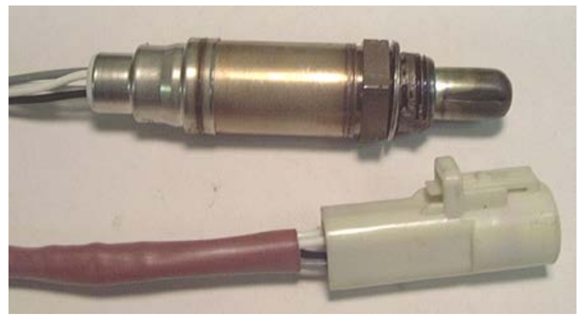
TERMINAL CONNECTOR BOARD

The terminal connector board consists of:

- three (3) tier screw terminal strip where all systems connections are made
- status indicator light (green) located above the fuses on the connector circuit board to indicate the controller has power
- relays
- fuses

HEGO SENSOR

(Heated Exhaust Gas Oxygen)



The heated exhaust gas oxygen sensor is a Zirconia-type sensor used in conjunction with the AFR-64R to calculate the excess exhaust oxygen concentration in gas fired engine applications. The sensor incorporates an integrated electric heating element inside of the thimble of the sensor. The heating of the thimble increases the stability of the sensor's sensitivity to its optimum operating temperature of 990°F (550°C). The sensor has a maximum ambient temperature rating of 250°F (121°C) with a meltdown point of 500°F (260°C). The maximum thimble temperature is rated at 1300°F (704°C).

HEGO Cable

(4 Wire Oxygen Sensor Cable)

A 20 gauge, four (4) conductor, shielded cable (10 turns per foot), with a standard length of 50 feet, terminated on one end with a modular connector for the HEGO sensor. The maximum recommended length of this cable is 100 feet. Harness sheath color is Blue.

UNIOP DISPLAY

The UniOP is a 4 line x 20 character, 24 volt DC, panel mounted, user interface display system.

BUTTERFLY VALVE

Full Authority Fuel Control Valve
Available in 25mm, 33mm, 50mm, 60mm, 68mm & 75mm

Warning: Not a fuel shut-off valve!

An electronically actuated, full authority valve, controls fuel flow to the carburetor or mixer. The valve position responds proportionally to the valve command.

The full authority fuel valve is available with a variety of bore sizes for various applications. One control valve is needed per control bank.

Butterfly Full Authority (FA) Valve Cable Assembly

The fuel valve cable assembly is a 16 gauge, four (4) conductor, shielded (10 turns per foot), with a standard length of 50 feet, terminated on one end with a modular connector for the fuel valve connection. 50 feet is the maximum recommended length for this cable. Harness sheath color is green.

TK VALVE

Supplemental (TK) Fuel Control Valve

Warning: Not a fuel shut-off valve!

The supplemental valve controls the air/fuel ratio by adding a small amount of fuel to the intake air stream that is independent of the carburetor. This supplemental fuel usually represents approximately 15-20% of the total fuel flow to the engine. The system adjusts the fuel with the proportional solenoid valve commanded and powered from the AFR-64R Control Module.

MODEL NUMBER	PRESSURE RANGE	INLET/OUTLET PIPE
TK-2	5 - 35 psig	1/4 - 3/8
TK-4B	5 - 35 psig	1/4 - 3/8
TK-6B	5 - 35 psig	3/8 – 1/2
TK-10	0.5 – 5 psig	3/8 – 1/2
TK-11B	5 - 35 psig	3/8 - 1/2

ICV-75 In-Line Control Fuel Valve

The ICV-75 valve is a flow restricted, bypass control valve. This valve is designed to be installed in the main fuel line between the final cut regulator and the carburetor. The ICV is designed to control 10% to 20% of the fuel flow to the carburetor. The valve is designed around a solenoid actuated orifice along with a manual main stream restrictor screw. The valve has a 3/4” NPT inlet and 3/4” NPT outlet.

TK & ICV VALVE CABLE ASSEMBLY

This cable is a customer provided item. Compliance Controls recommends that the cable used for the TK Valves be two conductor, twisted (10 turns per foot) shielded wire (18AWG minimum, 14AWG maximum). The drain wire from this shielded cable should only be terminated to an earth ground at the controller end of the cable – that is it should **not** be connect to the earth ground of the valve. The earth ground (green wire) of the valve (if equipped) should be connected to the earth ground lug inside the controller enclosure through one of the three conductors of the user supplied cable.

MAP SENSOR

Manifold Absolute Pressure sensor

A pressure transducer that is connected to the intake manifold, used to measure the pressure of air in the intake manifold prior to induction into the engine. The sensor is a 5-volt reference type sensor capable of measuring the intake manifold pressure from 0 to 43 pounds per square inch absolute (0-3 bars absolute). The pressure reading is used for the mapping of the pre and post HEGO sensor targets and is also used in conjunction with other inputs to calculate the airflow rate to the engine, which is used to estimate an engine load for the default valve positions in the event of sensor failure.

MAP CABLE ASSEMBLY

Manifold Absolute Pressure sensor cable assembly

The cable assembly is a 18 gauge, three (3) conductor, shielded cable (10 turns per foot), with a standard length of 50 feet, terminated on one end with a modular connector for the sensor. On applications requiring longer lengths, the cable is also available in 75 feet and 100 feet options. The maximum recommended length of this cable is 100 feet. Harness sheath color is Gray.

MAGNETIC PICKUP (MPU)

5/8" x 18 thread x 4" long

Used to measure the speed of the engine A magnetic pickup (instead of G-Lead) reduces the chances of RF noise interference. Typically installed in the flywheel housing, over the center of the flywheel ring gear, but can be installed on any rotating item on the engine that can produce a minimum of 2 pulses per crankshaft revolution. A 5/8" – 18 UNF thread is tapped into the flywheel housing, perpendicular to the center of the ring gear with a 0.040" air gap. The MPU sends the pulses to the controller, which calculates the engine speed. The engine speed is necessary for the proper operation of the controller.

MAGNETIC PICKUP Cable

Cable assembly is a 20 gauge, two (2) conductor, shielded cable (10 turns per foot), with a standard length of 50 feet, terminated on one end with a military style Cannon Plug type connector for the Magnetic Pickup. The maximum recommended length of this cable is 100 feet. Harness sheath color is Black.

THERMOCOUPLE – Type "K"

This thermocouple with its ungrounded design, is used by the controller to monitor the catalyst inlet, outlet and differential temperatures. The type "K" non-grounded thermocouple readings can be used as a catalyst high temperature shutdown device, but is not required for the operation of the system. The thermocouple has a 12" (standard) probe length. Type "K" thermocouple wire must be used when connecting this device to the controller.

O2 NUT

The 02 Nut is constructed of 304 stainless steel, machined to 18mm x 1.5P threads for the sensor. The face of this coupling has a 125 RMS finish allowing for a proper gasket seal. This fitting can be welded to the exhaust pipe, over a 7/8" hole which will allow the HEGO sensor thimble to be exposed to the exhaust flow at an optimum depth. This nut cannot be welded to cast iron with standard welding procedures.

HEGO SENSOR BLOCK – (Optional)

Used to relocate HEGO sensors away from areas where ambient temperatures exceed the HEGO sensor's ratings – 18mm x ¼" NPT x ½" NPT (1/4" npt inlet; 1/2" npt outlet)

Used when the HEGO sensor is remotely mounted – 18mm x ¼" NPT x ½" NPT (1/4" npt inlet; 1/2" npt outlet)

Installation

Installation Checklist

1. Before installing the AFR-64R, make sure the engine is in good mechanical condition and the ignition and fuel systems are in good shape. By this, all cylinders have good compression, the valves are adjusted to factory specifications, the spark plugs are in good condition, properly gapped and torqued, and have good gaskets, the ignition timing is set at factory specifications, the carburetor/mixer is in good working order and the fuel pressures are set to factory specifications.

2. Inspect kit for installation parts. Ensure the parts, controllers, and harnesses are in the kit for the given application. Make sure enough conduit, conduit fittings, tubing, tubing fittings, and wire are on hand. AWG 16 shielded, twisted wire should be used for any connection not done by a harness piece. Thermocouple wiring can be AWG 20, shielded, twisted (recommended), thermocouple grade extension wire for Type K.

3. If the AFR-64R enclosure is to be used, remove the Engine Control Module (ECM) and Terminal Connector Board (TCB) from the enclosure before mounting or modifying the enclosure for conduit holes. Conduit entries at the top of the enclosure are not recommended, and especially should not be used with enclosures placed outside in the elements.

4. Run conduit and pull wire or harnesses for the HEGO Sensors, MAP Sensor, Fuel Control Valve(s), Magnetic Pick-Up, optional Pre- and Post- Catalyst Thermocouples, DC Power, and Auxiliary, Alarm and Shutdown Relays. Do not terminate any wiring at the Terminal Connecter Board (TCB) until all end devices have been connected or terminated.

5. Determine if the HEGO Sensors should be remote mounted. This would be done if the ambient temperature exceeds 250° F at the sensor location, if the exhaust temperature exceeds 1350°F at the HEGO Sensor tip, or if there is a possibility of cross flow from opposite banks at the sensor installation location. The maximum tubing run length is 24” for all tubing.

6. Install the HEGO Sensors (1-3). Determine single or dual bank operation. Determine mounting, using existing 18 x 1.5 mm connections, using HEGO Sensor Couplings, or using HEGO Sensor Blocks.

7. Install the Manifold Absolute Pressure (MAP) Sensor. Locate a suitable pressure tap in the intake manifold and identify the mounting location for the sensor.

8. Install the Fuel Control Valve(S) (1-2).

    a. TK (supplemental) Valve. Plan tubing installation with the appropriately sized tubing for the model number of the valve. Make sure a valve is installed to shut off the fuel supply pressure to the TK valve, in the supply tubing run downstream of the engine fuel shutdown valve. The TK valve should be mounted as close as possible to the injection point.

    b. Butterfly Full Authority (FA) or ICV (In-Line Control) Valve. Locate piping where the valve will be installed. This should be a place downstream of the engine fuel shutdown valve and the final cut regulator. It should be as close as possible to the carburetor / mixer, and a minimum of 3 pipe diameters downstream of the final cut regulator.

9. Decide whether the speed signal will be shared with other devices (never share with an ignition system or a speed control device), or whether the Magnetic Pick-Up (MPU) provided with the kit will be used.

10. Decide whether the optional Pre-Catalyst and Post-Catalyst Temperature Thermocouple(s) will be used, and if used, where they will be installed. They are recommended for catalyst protection and should be installed as close as possible to the catalyst element(s).

11. After all sheet metal work is finished on the enclosure and the enclosure is mounted, put the ECM and TCB back in. Make sure all metal shavings and cuttings have been removed and the enclosure is clean and free from debris.

12. Terminate the connections from the wiring on the appropriate terminal block points. The battery's positive (+) connection should be the final connection made.

Safeguarding Electronics

All electronic equipment is sensitive to static electricity and magnetic fields, some components more than others. To protect these components from damage, you must take special precautions to minimize or eliminate electrostatic discharges and electromagnetic pulses (EMP).

Follow these precautions when working with or near the control.

1. **Before welding on engine skid**, the AFR-64R Control Module and the Terminal Connector Board (TCB) should be removed from the enclosure and placed in an antistatic protective bag.

2. Before touching electronics, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).

3. 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.

4. 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.

5. Avoid unnecessary removal of the Terminal Connector Board (TCB). If you must remove the TCB from the control cabinet, follow these precautions:

    - Do not touch any part of the printed circuit board (PCB) except the edges.

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

    - When replacing a TCB, keep the new TCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old TCB from the control cabinet, place it in the antistatic protective bag.

    - If shipping the AFR-64R Control Module (ECM) and/or Terminal Connector Board, the Module (ECM) and Terminal Connector Board should be placed in an antistatic protective bag and packed with static free Styrofoam material.

Matching the Kit to the Application and Parts Verification

Often the individual who has ordered this product and the individual faced with installing it are not one and the same. To save the installer potential time and grief, it will prove beneficial to verify the decisions made by the purchaser. Consequently, the installer should take a moment to consider the application and its general requirements.

The vast majority of application requirements will be straightforward. For example, mounting the AFR on a dual bank engine will *usually* call for two fuel control valves and 2 oxygen sensors (3 if using a post catalyst sensor). However, here is a list of deviations:

- Dual Bank Engine, 2 Carburetors, <u>BUT</u> Common Exhaust Manifold: Requires 2 fuel valves but ONE oxygen sensor mounted pre catalyst. Both fuel valves are wired in parallel to the left bank output of the controller only. The pre catalyst sensor is connected to the left bank pre catalyst HEGO input. The controller should be setup for a single bank engine through the display.

- Dual Bank Engine, <u>BUT</u> 1 Carburetor (Exhaust manifold may be separate or common. It does not matter): Requires 1 fuel valve and 1 pre catalyst oxygen sensor. The fuel valve is connected to the left bank valve input. The pre catalyst sensor is wired to the left bank pre catalyst HEGO input. The controller should be setup for a single bank engine through the display.

- Dual Bank Engine, 2 Carburetors, <u>BUT</u> no room for 2 pre catalyst sensors in exhaust: Requires 2 fuel valves and 1 pre catalyst sensor. The fuel valves are wired in parallel to the left bank input of the controller only. The controller should be setup for a single bank engine through the display.

The Appendix contains diagrams of the many dual and single bank applications. Each drawing lists the kit number appropriate for the given application. Locate the diagram that represents your engine configuration and mark the page for future reference.

Verify Package Contents

Having verified the choice of kits purchased for the application, check the kits contents using the kit part listings in 'Parts and Supplies'.

Installation Guidelines for Components

General Guidelines for Mounting the TK Valve

Required tools and hardware:

- Necessary tools for the removal of air and fuel piping and associated supports (pipe wrenches; hand tools, tubing bending and cutting tools)
- Drill and pipe taps to install fuel piping into fuel and air inlet system
- Required pipe nipples, fittings and tubing to modify fuel piping
- Necessary pipe fitting in the high pressure fuel piping to accept connections to the fuel control valve
- Pipe thread sealant
- OEM gaskets and/or o-rings for engine's air and fuel system
- Support bracket (if required) for TK fuel control valve

The connections required for the TK Valve will require tubing fittings, tubing, and possibly a bracket. Fittings may need to be added to the fuel plumbing, and intake air plumbing, or pipes in the fuel plumbing and intake air plumbing will need to be drilled and tapped for pipe threads for the tubing connections for the supply pressure to the TK Valve, and the outlet of the TK Valve into the intake air piping going into the carburetor / mixer.

The TK valve controls the flow of an auxiliary stream of high pressure fuel, obtained by tapping into the fuel line **before** the "final cut" or "ounce" regulator. This auxiliary fuel is injected into the engine **before** the carburetor/mixer on the air-inlet side**. Do not tie injection point into any balance lines. This statement also includes balance lines on naturally aspirated engines when equipped.** (Please Note: Some naturally aspirated engines now use a balance line to compensate for pressure drop across the air intake filter. Do not tie into these.) Such a strategy relies on you to "ballpark" the desired air/fuel ratio by adjusting the carburetor load screw. Thereafter, the controller fine tunes the air/fuel ratio about this point.

> WARNING: Fuel flow into the engine when not running or during shutdown by using the ignition system (thereby allowing the engine to pull fuel though the engine as it spins down) can result in fuel filling the intake manifold where it could be ignited by a backfire or flowing to the exhaust system and catalytic converter (if present). This fuel could be ignited by the high temperatures found in the exhaust and could result in damage to the engine, associated equipment and could cause personal injury or death. It may also escape to atmosphere either through the air intake or through the exhaust thereby creating a hazardous atmosphere in the area.

The electrically actuated fuel control valves supplied with this product are designed to control fuel flow only. They are not designed to replace a fuel shut-off valve or a fuel shut-off system. Therefore the product relies on the installation and use of an automatically closing fuel shut-off valve (user supplied) to stop fuel flow during and after engine shutdown and is necessary for safe product use. Such valves are widely available.

Automatic/semi-automatic fuel shut-off valve(s) are mandated by National Fire Protection Association's "NFPA 37 – Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines."

To prevent catalyst and/or engine damage, most engine manufactures recommend a specific engine shutdown procedure. Consult your engine manufacture for these procedures. If the procedures are not available, a general rule to follow would be to 1st turn off the engine's fuel system and then turn off the ignition system 5 to 10 seconds later. This would allow any remaining air fuel mixture to be consumed in the cylinders rather than in the exhaust stream.

A manually operated ball valve (not a needle valve) should be installed in the auxiliary tubing upstream of the solenoid valve in order to isolate the AFR system from the engine during maintenance or troubleshooting. The diameter of the ball valve should be equal to or greater than the diameter of the tubing recommended for the respective TK valve.

Below are the details of the working pressures and pipe sizes for each of the valves.

MODEL NUMBER	PRESSURE RANGE	INLET/OUTLET PIPE
TK-2	5 - 35 psig	1/4 - 3/8
TK-4B	5 - 35 psig	1/4 - 3/8
TK-6B	5 - 35 psig	3/8 – 1/2
TK-10	0.5 – 5 psig	3/8 – 1/2
TK-11B	5 - 35 psig	3/8 – 1/2

The TK Valve should be mounted by the 3/8" bolt holes of the valve's foot plate indicated in Illustration 2. Mount the TK Valve so that there is easy access to the ½" NPT pipe connections for the tubing fittings. Upstream plumbing can be longer because of the higher pressure. The TK valve should be mounted as close as possible to the injection point.

It is import to remember that the valve's coil should be mounted in an upright position (12 o'clock position) to prevent damage to the coil caused by normal engine vibration.

The outlet tubing (piping) should never be connected to the regulator's balance line. The location of the fuel inlet to the plumbing and the outlet to the intake air stream should not be in the bottom of those pipes, so any incidental liquids will not enter the tubing. The tubing used is typically stainless steel, with the appropriate fittings. The tubing should be properly de-burred, and free of debris. Any debris can damage the TK Valve.

The electrical connection is by a short pigtail of wire coming out of a ½" female conduit fitting. The upper housing with the conduit fitting can be rotated in any orientation.

Prior to the installation of any conduit or piping, remove the coil from the valve by removing the "E" clip from the top of the valve. Do not apply any lateral force to the coil or coil tower during the installation of the piping. Do not disassemble the valve any further than removal of the coil. Any further disassembly of the valve will void the warranty of the valve.

TK Valve Mounting Foot Print

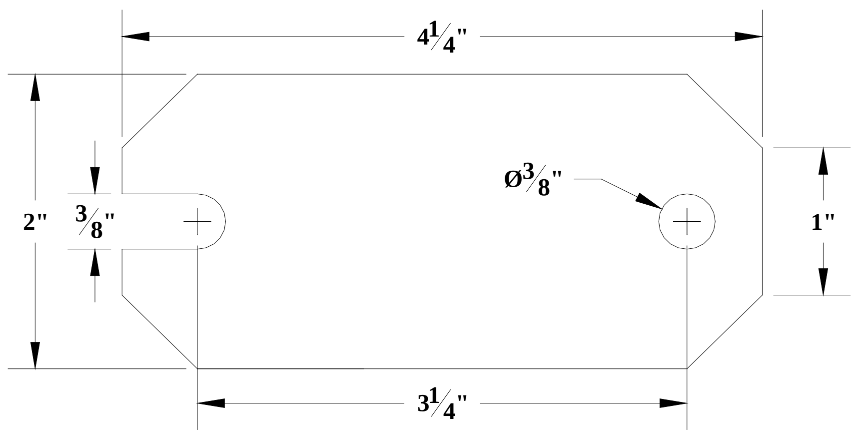


Illustration 2 TK Valve Mount Foot Print

General Guidelines for Mounting the Full Authority (FA) Valve Mounting

Required tools and hardware:

- Necessary tools for the removal of piping and associated supports (pipe wrenches; hand tools)
- Required pipe nipples and fittings to modify fuel piping
- Necessary pipe cutting and threading equipment
- Pipe thread sealant
- OEM gaskets and/or o-rings for engine's fuel system
- Support bracket (if required) for Full Authority fuel control valve

- WARNING: Fuel flow into the engine when not running or during shutdown by using the ignition system (thereby allowing the engine to pull fuel though the engine as it spins down) can result in fuel filling the intake manifold where it could be ignited by a backfire or flowing to the exhaust system and catalytic converter (if present). There it could be ignited by the high temperatures sometimes present. It may also escape to atmosphere either through the air intake or through the exhaust thereby creating a hazardous atmosphere in the area.

- The electrically actuated fuel control valves supplied with this product are designed to control fuel flow only. They are not designed to replace a fuel shut-off valve or a fuel shut-off system. Therefore the product relies on the installation and use of an automatically closing fuel shut-off valve (user supplied) to stop fuel flow during and after engine shutdown and is necessary for safe product use. Such valves are widely available.

- Automatic/semi-automatic fuel shut-off valve(s) are mandated by National Fire Protection Association's "NFPA 37 – Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines."

- To prevent catalyst and/or engine damage, most engine manufactures recommend a specific engine shutdown procedure. Consult your engine manufacture for these procedures. If the procedures are not available, a general rule to follow would be to 1st turn off the engine's fuel system and then turn off the ignition system 5 to 10 seconds later. This would allow any remaining air fuel mixture to be consumed in the cylinders rather than in the exhaust stream.

The Full Authority valve must be installed downstream of the engine's final cut fuel pressure regulator and downstream of the engine fuel shut-off valve. It is a requirement that the spacing between the final cut regulator and the fuel control valve be at least three (3) pipe diameters. This spacing is necessary to prevent surging of the regulator pressure during the valve operation. Ideally, the fuel control valve should be mounted as close as possible to the engine's carburetor.

Here are two examples of Full Authority Valve mounting. Illustration 3 is not an ideal installation due to the spacing of the valve to the fuel pressure regulator. Illustration 4 is a better example because of the increased spacing between the fuel control valve and the fuel pressure regulator. The Full Authority Valve needs to be as close to the carburetor as possible. There is an arrow on the Full Authority Valve body to indicate flow direction.

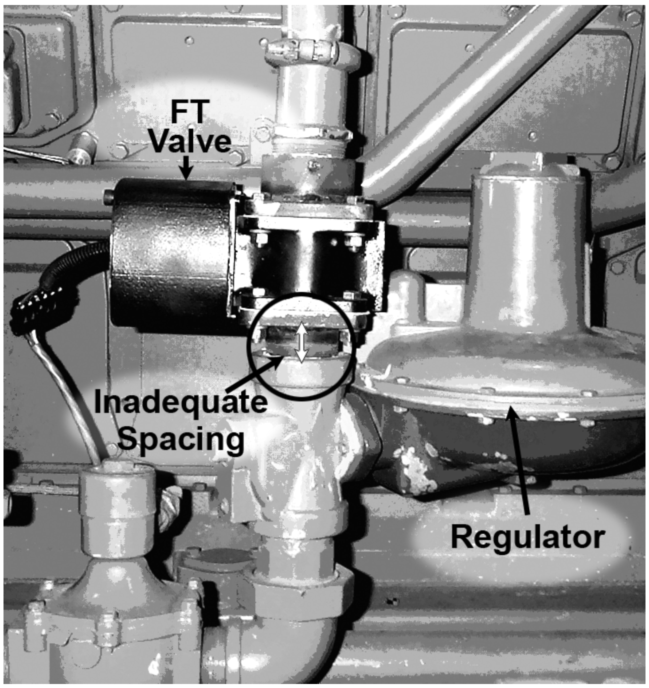


Illustration 3 – Improper Installation

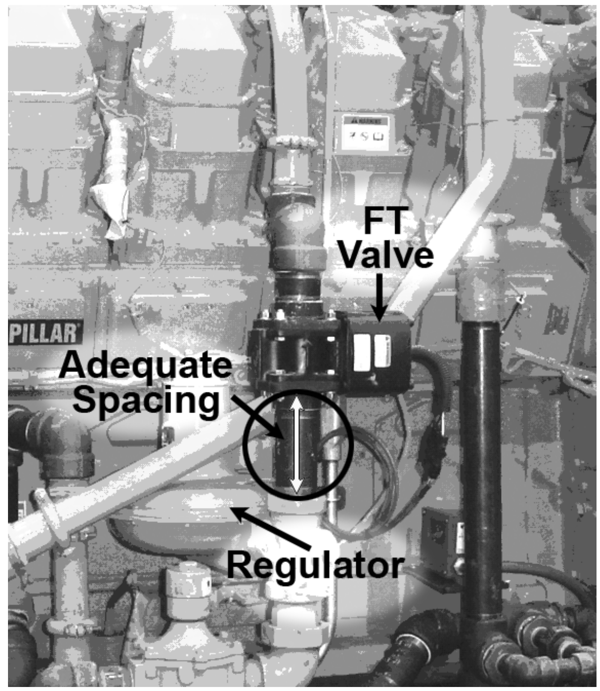


Illustration 4 – Proper Installation

The table below matches a given valve to its flange adapter size. Some applications will require bushings to match the fuel line size to the given flange adapter.

Butterfly Valve Size	Maximum Pipe (NPT Size)
FL 25	1”
FT 33	2"
FL 50	2”
FT 60	2"
FT 68	2"
FT 75	3"

Armored hose for petroleum gas service could be used with the Full Authority Valve mounted by its body. Illustration 5 indicates the basic mounting bracket dimensions for the FT series valves. The bolts used are M8 x 10 mm long. Longer bolts will be needed to compensate for the thickness of the mounting plate. A slot in the bracket needs to be made for the cable as shown by the 1 inch diameter hole shown. Make a 1" slot from the bottom of the bracket to allow the hole as shown.

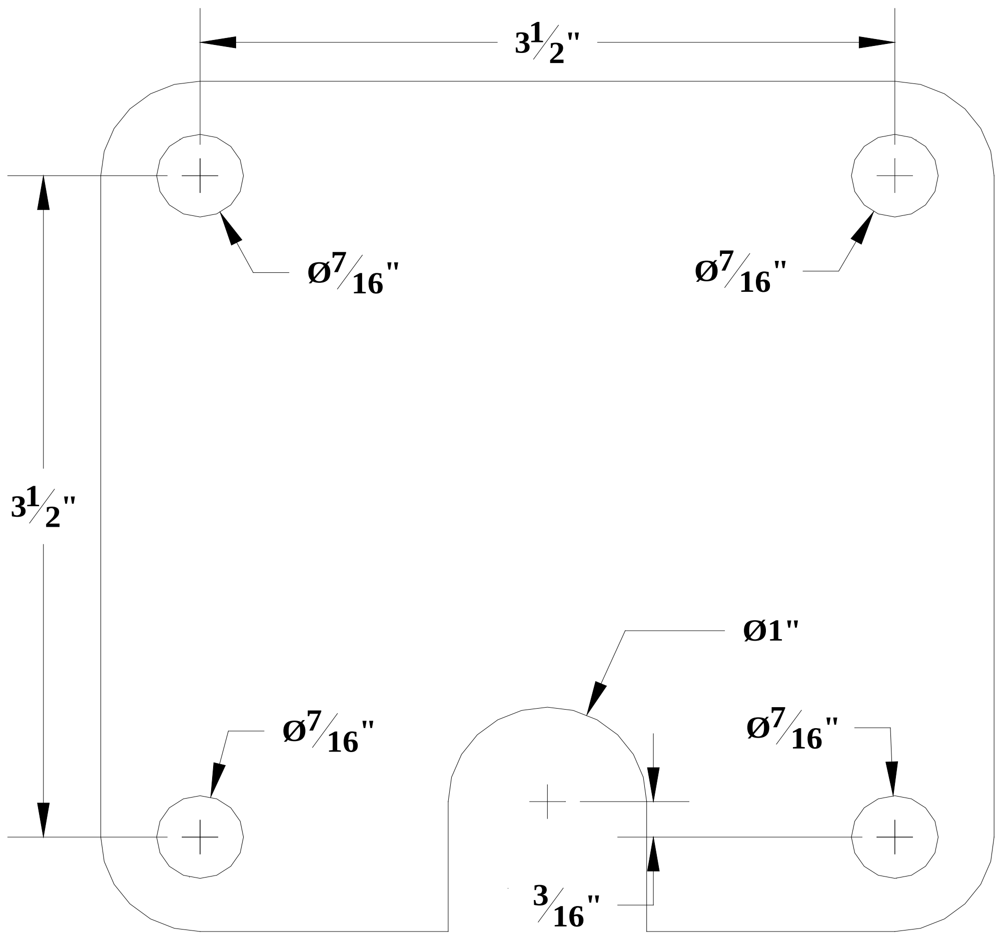


Illustration 5 - Dimensions for Making FT Full Authority Valve Mounting Bracket

General Guidelines for Mounting the In-Line Control (ICV) Valve

Required tools and hardware:

- Necessary tools for the removal of piping and associated supports (pipe wrenches; hand tools)
- Required pipe nipples and fittings to modify fuel piping
- Necessary pipe cutting and threading equipment
- Pipe thread sealant
- OEM gaskets and/or o-rings for engine's fuel system
- Support bracket (if required) for Full Authority fuel control valve

WARNING: Fuel flow into the engine when not running or during shutdown by using the ignition system (thereby allowing the engine to pull fuel though the engine as it spins down) can result in fuel filling the intake manifold where it could be ignited by a backfire or flowing to the exhaust system and catalytic converter (if present). There it could be ignited by the high temperatures sometimes present. It may also escape to atmosphere either through the air intake or through the exhaust thereby creating a hazardous atmosphere in the area.

The electrically actuated fuel control valves supplied with this product are designed to control fuel flow only. They are not designed to replace a fuel shut-off valve or a fuel shut-off system. Therefore the product relies on the installation and use of an automatically closing fuel shut-off valve (user supplied) to stop fuel flow during and after engine shutdown and is necessary for safe product use. Such valves are widely available.

Automatic/semi-automatic fuel shut-off valve(s) are mandated by National Fire Protection Association's "NFPA 37 – Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines."

To prevent catalyst and/or engine damage, most engine manufactures recommend a specific engine shutdown procedure. Consult your engine manufacture for these procedures. If the procedures are not available, a general rule to follow would be to 1st turn off the engine's fuel system and then turn off the ignition system 5 to 10 seconds later. This would allow any remaining air fuel mixture to be consumed in the cylinders rather than in the exhaust stream.

The In-Line Control (ICV) valve must be installed downstream of the engine's final cut fuel pressure regulator and downstream of the engine fuel shut-off valve. It is a requirement that the spacing between the final cut regulator and the fuel control valve be at least three (3) pipe diameters. This spacing is necessary to prevent surging of the regulator pressure during the valve operation. Ideally, the fuel control valve should be mounted as close as possible to the engine's carburetor.

It is import to remember that the valve's coil should be mounted in a downward position (6 o'clock position) to prevent damage to the coil caused by normal engine vibration.

The electrical connection is by a short pigtail of wire coming out of a ½" female conduit fitting. The upper housing with the conduit fitting can be rotated in any orientation.

Prior to the installation of any conduit or piping, remove the coil from the valve by removing the "E" clip from the top of the valve. Do not apply any lateral force to the coil or coil tower during the installation of the piping. Do not disassemble the valve any further than removal of the coil. Any further disassembly of the valve will void the warranty of the valve.

HEGO Sensor Installation General Guidelines

Pre-Catalyst HEGO Sensor

- See ‘Installation Suggestion on Various Engine Types’.
- The pre catalyst HEGO sensor(s) should be mounted as close as practical to the engine exhaust manifold(s), after any turbo charger system.
- On any engine installation where there is a common intake or exhaust manifold, only one pre catalyst HEGO sensor will be needed.
- On applications where only one (1) pre-catalyst HEGO sensor is used, the wiring should be connected to the Left Bank connectors only.
- On engine applications with dual carburetors and dual exhaust manifolds, one pre catalyst HEGO sensor will be used for each control bank.
- The maximum allowable shell temperature (melt down point) on the sensors is 500 °F (260°C). The sensors should never be installed in areas where the ambient air is stagnant and/or where the ambient air conditions exceed 250°F (121°C). The maximum thimble temperature is 1300°F.
- When the exhaust piping is insulated, the insulation should be removed from around the sensors to prevent overheating, a minimum of 3” diameter or 3 times the thickness of the insulation, whichever is greatest.
- When the exhaust pipe is installed horizontally, sensors should only be mounted between the 1:00 and 5:00 positions or the 7:00 to 11:00 positions. If the sensor is mounted vertically at the 12:00 & 6:00 positions, premature sensor failure will occur due to excessive shell temperatures and condensation build up in the exhaust pipe after shutdown. When the exhaust pipe is mounted vertically, orientation of the sensor should be to give the sensor the best chance for the lowest ambient air temperatures.
- Sensors should be installed with a light coat of anti-seize thread lubricant and torque to 30 lb-ft (40 Nm). Care should be taken that no excess anti-seize lubricant will come in contact with the sensor thimble.

Post Catalyst HEGO Sensor

- See the Installation Layout Examples section for suggestion on various engine types
- The HEGO sensor should be mounted after the catalytic converter, as close as practical to the outlet of the converter element.
- The maximum allowable shell temperature (melt down point) on the sensors is 500 °F (260°C). The sensors should never be installed in areas where the ambient air is stagnant and/or where the ambient air conditions exceed 250°F (121°C).
- When the exhaust piping is insulated, the insulation should be removed from around the sensors to prevent overheating, a minimum of 3” diameter or 3 times the thickness of the insulation or whichever is greatest.
- The sensors should only be mounted between the 1:00 and 5:00 positions or the 7:00 to 11:00 positions. If the sensor is mounted vertically at the 12:00 or 6:00 positions, premature sensor failure will occur due to excessive shell temperatures and condensation build up in the exhaust pipe after shutdown.

- Sensors should be installed with a light coat of anti-seize thread lubricant and torque to 30 lb-ft (40 Nm). Care should be taken that no excess anti-seize lubricant will come in contact with the sensor thimble.

HEGO Sensor Mounting

For ambient temperatures less than 250°F.

Illustration 6 indicates the installation procedure used when the O2 Coupling that is optional with the kit is used. The mounting location of the pre catalyst sensor should be as close as practical to engine but should never be mounted pre turbocharger.

> **NOTE:** The O2 Coupling is constructed of 304 stainless steel and cannot be welded to cast iron by normal welding procedures.

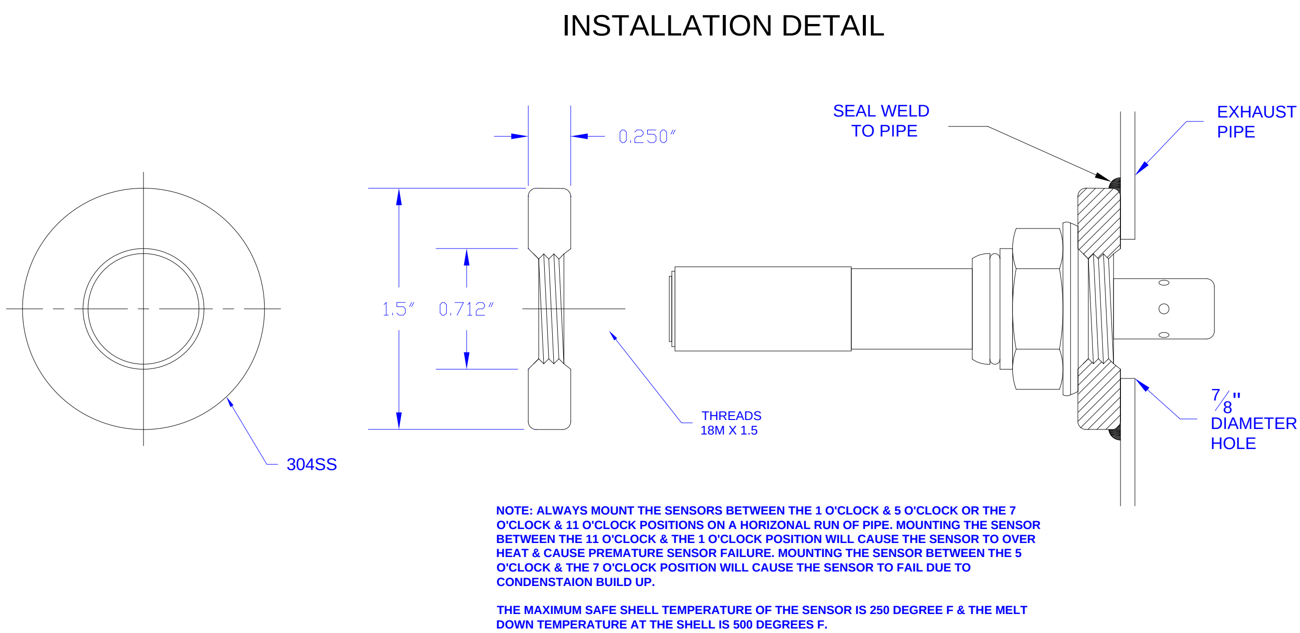


Illustration 6 - HEGO Sensor and O2 NUT

> **NOTE:** The holes in the sensor must be in the exhaust gas flow. On a horizontal pipe, the HEGO Sensor should be mounted between the clock positions of 1 and 5, or 7 and 11. Never mount the sensor between the clock positions of 11 and 1 (too hot), or 5 and 7 (condensation problems). The HEGO Sensor should be torqued to 30-35 foot-pounds. Illustration 7 indicates the horizontal pipe mounting rules.

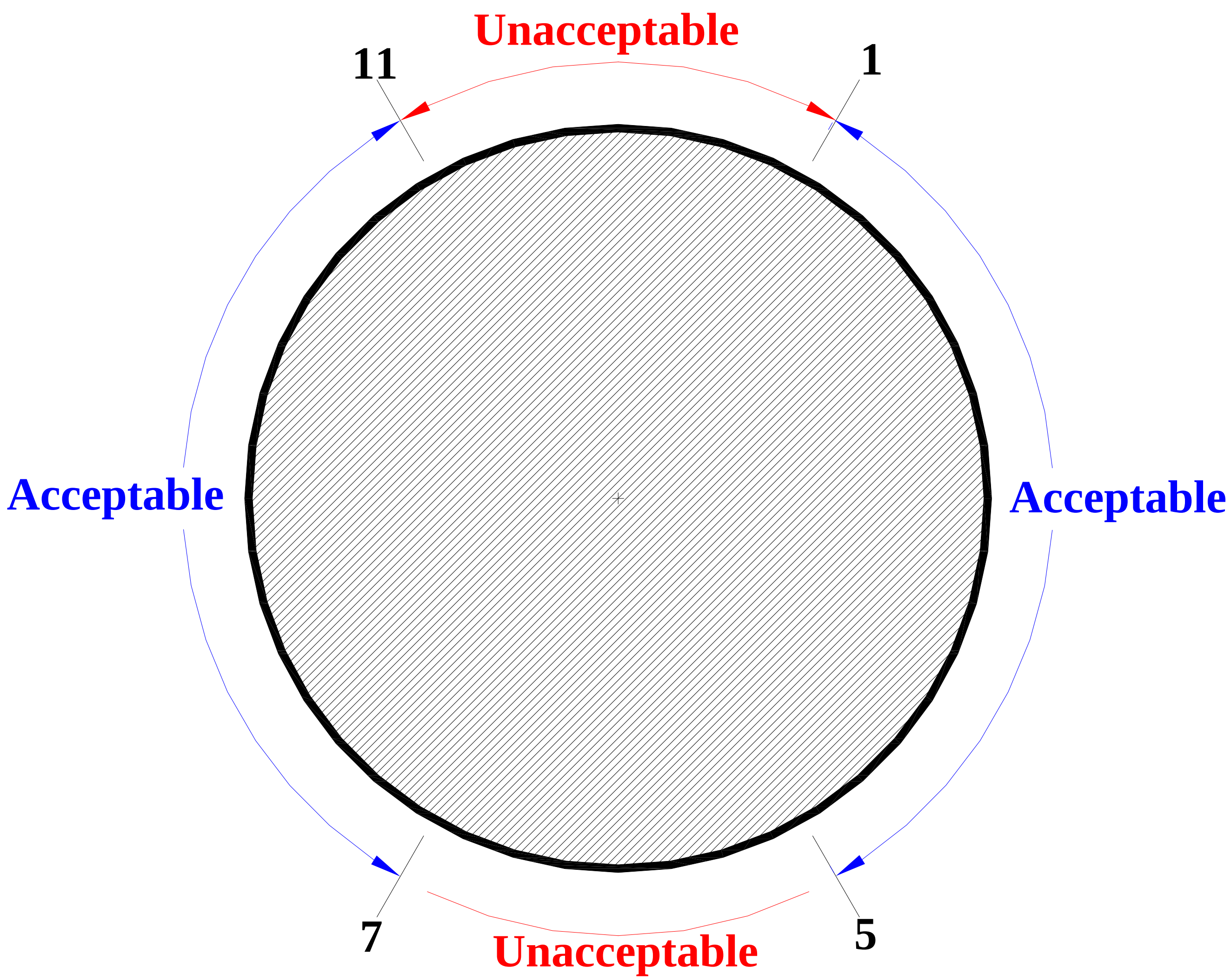


Illustration 7 - Allowed mounting orientations for HEGO Sensor on a horizontal pipe run

HEGO Sensor Mounting Using HEGO Sensor Block

For sensor ambient temperatures greater than 250°F.

When the ambient temperature at the mounting point for the HEGO Sensor is greater than 250°F, or the exhaust back pressure is greater than 18” water column, the HEGO Sensor Block is used.

It is usually mounted by 1-3/4” U-Bolts, as it is 1-5/8” in diameter. It has a 1/2” NPT female outlet and a 1/4” NPT female inlet. Below are pictures showing the stainless steel tubing, fittings, and brackets that may be used.

The HEGO block must not be exposed to a high pressure differential between its inlet and outlet. The inlet must be upstream of the turbocharger. The inlet should come from a location lower than the outlet.

All tubing should run up from the connection to the HEGO Sensor Block, and then down again from the HEGO Sensor block to the exhaust. Make sure there are no traps for moisture to collect when the engine is not running. Also, make sure the wires are routed so they will not get hot.

> **NOTE:** It is crucial for proper operation of the HEGO Block that the inlet connection not exceed 3/8” tubing or pipe and that the outlet connection be no less than 1/2” tubing or pipe.

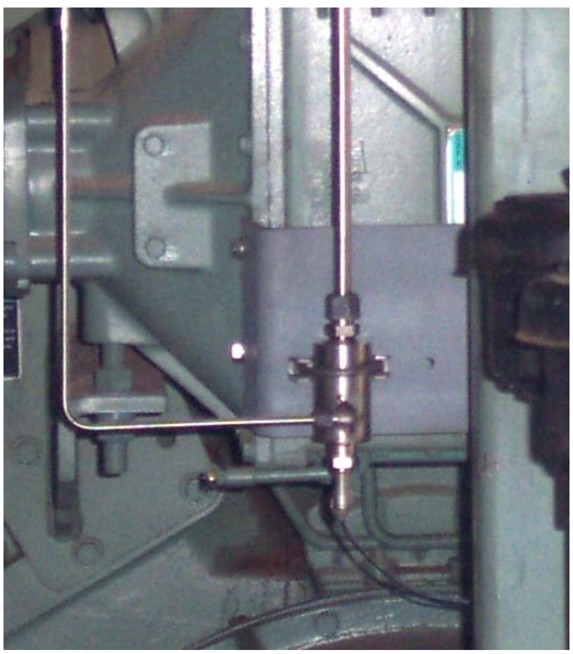


Illustration 8 – Incorrect installation - HEGO is mounted in the 6:00 o’clock position

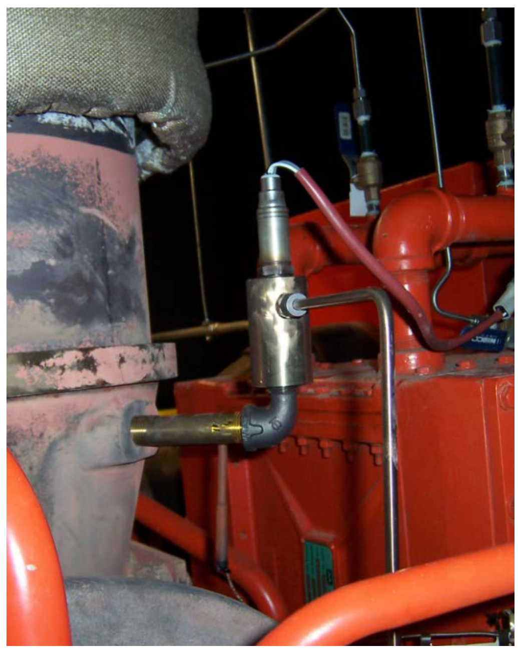


Illustration 9 – Correct installation - HEGO Sensor is mounted in the 12:00 o’clock position

In Illustration 8, this is an example of an incorrect installation due to the orientation of the sensor. The sensor should never be mounted below the horizontal plane. Illustration 9 is an example of a properly installed HEGO Block.

Illustration 10 is an example of the desired inlet and outlet port locations on a turbocharged engine.

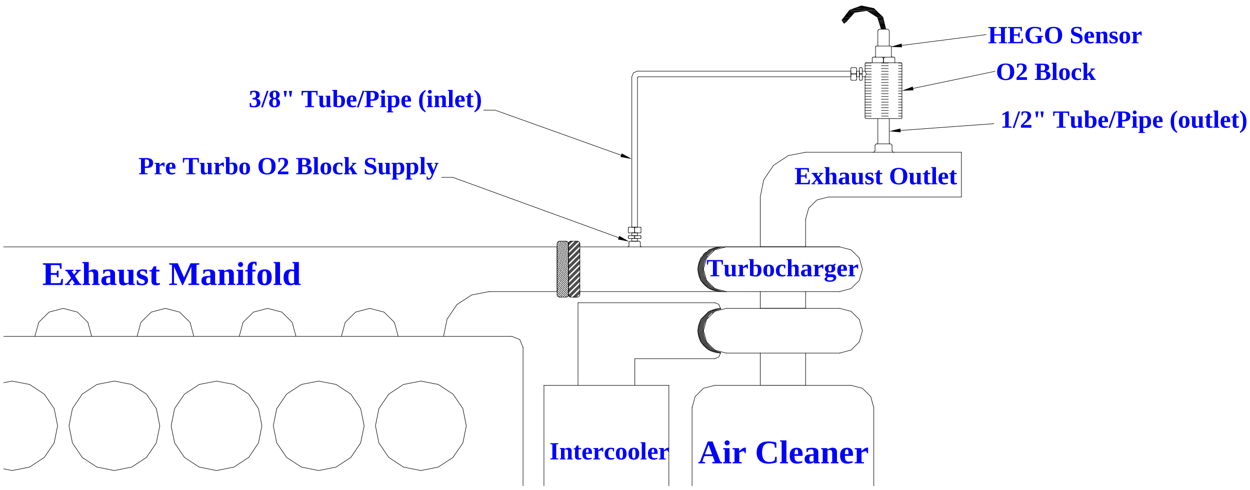


Illustration 10 - Proper HEGO Sensor Block Mounting for HEGO Sensor on a Turbocharged Engine

In the diagram above, looking at the top of a turbocharged engine, the HEGO Sensor Block Inlet is ¼" tubing tapped in before the turbocharger. The outlet from the HEGO Sensor Block is 1/2" tubing going into the exhaust pipe, downstream of the inlet connection. The orientation of the HEGO Sensor is in either the 12 o'clock position (OK for use with the HEGO Sensor Block), or the 3 or 9 o'clock positions.

For Naturally Aspirated engines, pitot tube type mounting is required. Illustration 11 shows a recommended design for the pitot tube type design. Several considerations need to be kept in mind when designing the pitot tube:

- The HEGO block and the pitot tubes should be orientated to avoid low spots where moisture could accumulate.
- The inlet tube/pipe must be 3/8" diameter and must be orientated so as the opening of the tube /pipe is facing into the exhaust flow.
- The outlet tube/pipe must be 1/2" diameter and must be orientated so as the opening of the tube/pipe is facing away from the exhaust flow.

This design will allow the exhaust gas to be forced into the HEGO Block via the 3/8” tube/pipe and sucked out of the HEGO Block via the 1/2” tube/pipe.

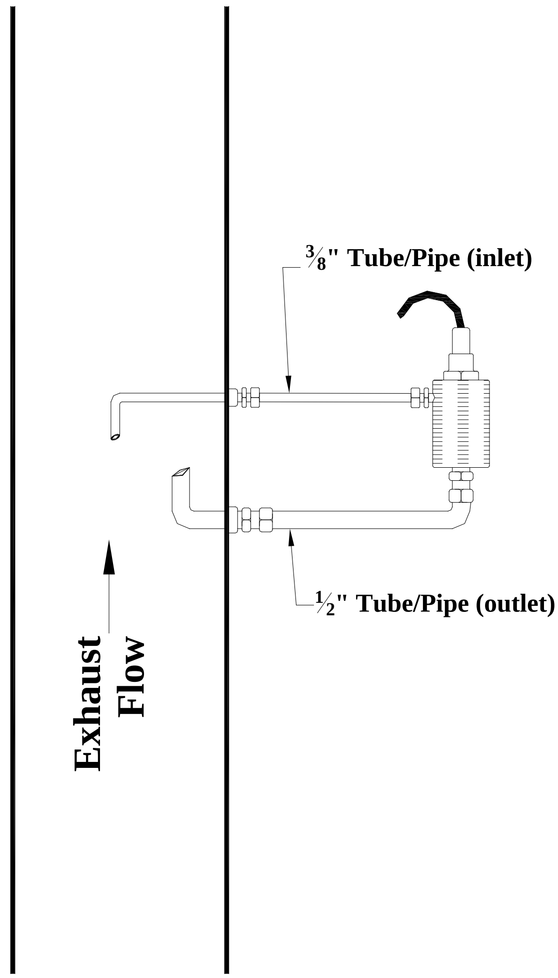
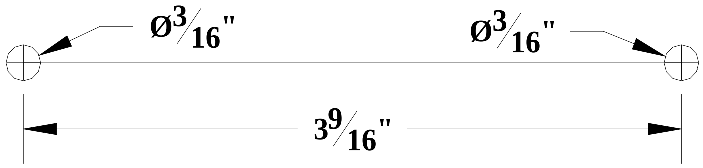


Illustration 11 - HEGO Sensor Block Mounting using Pitot Tube Installation on a Naturally Asperated Engine

MAP Sensor Installation

The MAP Sensor has a barbed nipple for 3/16" ID flexible automotive type petroleum fuel resistive tubing, or hose. It can be secured on that barbed nipple with an automotive style hose clamp. The following illustration shows the MAP Sensor mounting foot print.



MAP Sensor Foot Print

A bracket has been fabricated to mount the MAP sensor between the cylinders on a CAT G3516TA. The pressure connection is from a metal tubing tee in the Manifold Pressure tubing line already in place.

MAP Mounting on Intake Manifold

On engines like the Waukesha L7042G, where there are two Intake Manifolds, only one manifold pressure is monitored. The MAP Sensor must not see ambient temperatures higher than 200°F.

MAP Tap on Waukesha

Mounting Thermocouples

The controller solely uses the optional thermocouples for catalyst over temperature protection. Thermocouples are not required for controller operation; however, jumpers should be installed across the thermocouple contacts on the Terminal Connection Board (TCB) if not used to prevent alarms. (See wiring section).

The controller is meant to interface with Type K, ungrounded thermocouples. The user will need to supply type K thermocouple wire at installation.

One thermocouple should be installed before the catalyst and the other post catalyst. Both should be located as close as possible to the catalyst itself. The thermocouple probes should extend well into the center of the pipe.

Mounting Magnetic Pickup

The controller requires a speed input. This can be from a G-Lead connection on the ignition or from the optionally supplied Magnetic Pickup. In some situations, the speed signal can be from a Magnetic Pick-Up used for a tachometer or controller. **Never share the MPU signal used by an electronic governor or ignition system with the controller!** Different components have different electrical characteristics and the consequences of failure are severe.

Illustration 12 shows typical installation of the optional magnetic pickup (MPU) with the supplied harness. The MPU requires a 5/8-18 threaded hole. It has to be centered on the ring gear, and adjusted close to the teeth. The signal strength of the MPU is proportional to the gap from the tips of the flywheel teeth.

Screw the MPU in until the ring gear is touched. Then back it out 5/8 to 3/4 turn to get a 0.030” to 0.040” gap. Tighten the lock nut to 25 to 30 foot-pounds.

The signal strength is measured with an AC Volt Meter. The voltage must be above 3 VAC, and is preferred to be less than 10 VAC when connected to the controller. When not connected to the controller, the signal will be a higher voltage.

Illustration 12 - MPU, Strain Relief and Sealtite

Enclosure Mounting and Conduit Entries

Before any enclosure modifications are made for conduit entries and anything else to be mounted on the enclosure, the ECM-AFR-64R module and TCB must be removed. They should not be put back in until all enclosure modifications are complete and all metal shavings have been removed.

Conduit entries should typically be from the bottom, but the sides can be used. However, the top should only be used in an indoors application.

With the ECM-R-64R (black case) and TCB out of the enclosure, the TCB can be separated or installed using the violet colored cam latch of the TCB assembly. The ECM-R-64R and the TCB should be separated as little as possible. It is almost impossible to operate the cam latch for the plug connector with the assembly mounted inside the enclosure. Removing the EMC-R and TCB and then separating them is a good way of protecting the ECM-R-64R if any welding is to be done on the equipment.

The enclosure is mounted by 4 ¼" bolts, nuts, flat washers and lock washers. Care should be taken to separate wiring for different purposes using multiple conduit entries. The details of this are shown on the following diagram. One inch conduit is shown with the appropriate hole size. For other sizes use the below as a guide:

Conduit Size	Hole Size
1/2	7/8
3/4	1 1/8
1	1 3/8
1 1/4	1 3/4
1 1/2	2

Conduit Considerations

Conduit size and the choice of flex conduit versus rigid conduit must be made like any other installation. The choice of conduit pull boxes and junction boxes may be affected by the size of the plugs on the harnesses.

Always pull a harness using the free wire end from the location where the plug will be.

Gland fittings, strain reliefs or cord grips will be used in several places at the end of the conduit run.

Minimizing free wire runs, providing mechanical strength by the appropriate use of conduit and fittings, and strain relief of the wiring are the goals.

Make sure to run noise sensitive signals separately from noise creating wire.

Also separate non-incendive and intrinsically safe wiring from any other wiring.

Wire Termination

Refer to the table at the end of this section when making wiring connections to the Terminal Connection Board (TCB). For single bank engine applications all connections should be made to the Left Bank. The rare dual bank applications using only one pre catalyst oxygen sensor (HEGO) should have that sensor connected to the left bank pre catalyst HEGO input and **both** fuel valves wired to the left bank as well. (That is to say the valves should be wired in parallel to the left bank.) The controller is then configured for a single bank engine (one pre-catalyst sensor).

General wiring considerations:

- Always use good cable and wire stripping tools, and crimping tools in good condition.
- Wherever possible, use stranded tinned copper (do not solder). Raw copper wiring will corrode easily. Make any splices inside a weather-proof conduit fitting.
- Always provide extra lengths of wiring at termination points so if there is a need to redo a connection, there will be plenty of wire to work with. It is much better to have a service loop of extra wire than to be short.
- The battery's positive (+) should be the final connection made to the board.

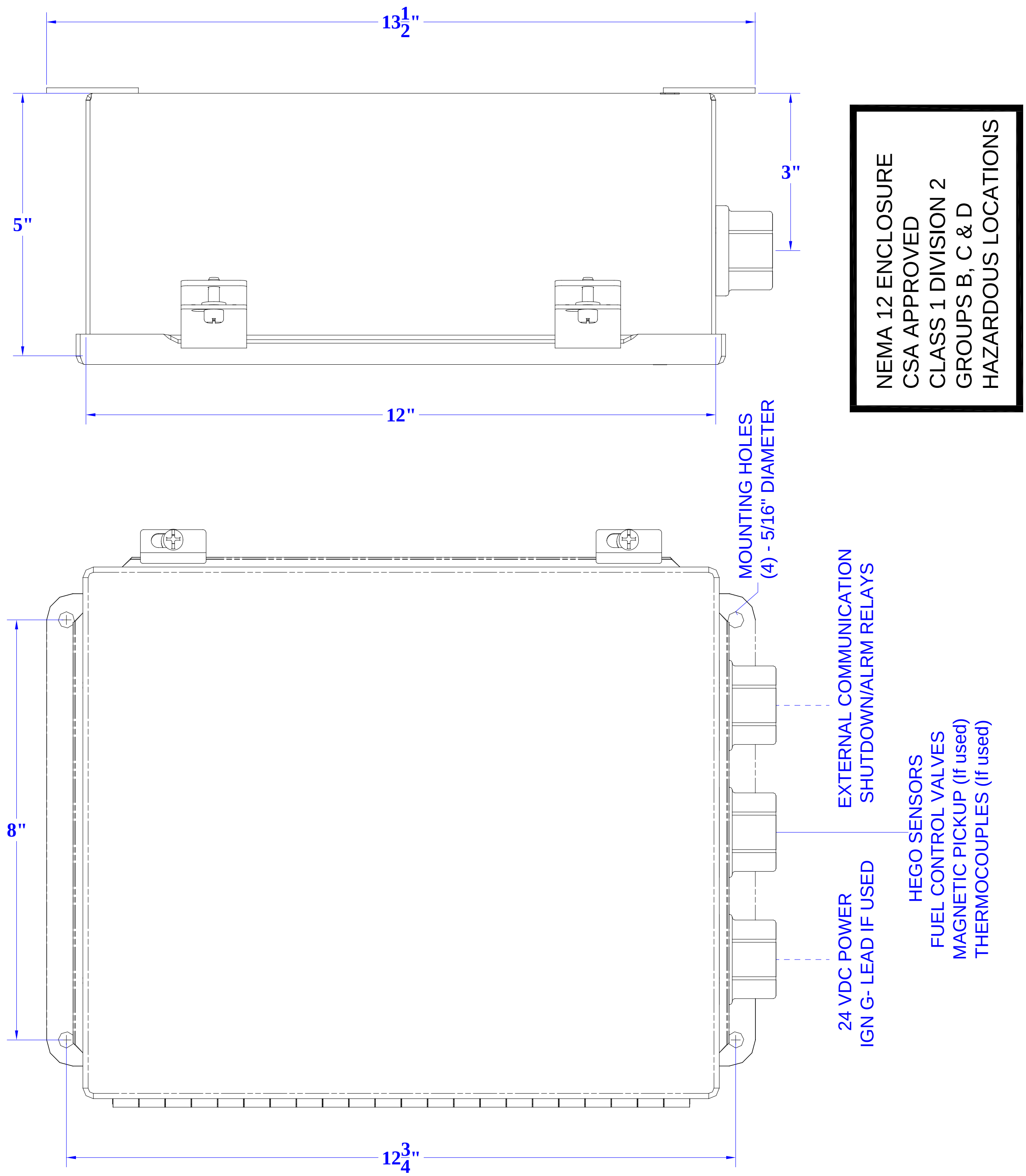


Illustration 13 - Enclosure Mounting Dimensions, Recommended Conduit Locations, and Wire Separation

Wiring Connections

Wherever possible, use stranded tinned copper (do not solder). Raw copper wiring will corrode easily. Make any splices inside a weather-proof conduit fitting. Always provide extra lengths of wiring at termination points so if there is a need to redo a connection, there will be plenty of wire to work with. It is much better to have a service loop of extra wire than to be short. Always use good cable and wire stripping tools, and crimping tools in good condition.

Engine Mounting Requiring Disassembly of Engine

If there are no provisions or available connections to tap, or use for fuel pressure, intake manifold air pressure, HEGO mounting, manifold pressure or temperature, or exhaust temperature, then provisions must be made to have the tools and parts available to disassemble the part of the engine which must be modified by drilling and tapping. If the Intake Manifold has to be drilled and tapped, it should be removed from the engine so any filings can be properly removed prior to reassembly. The gaskets should be replaced when this is done. The same goes for any pipe or casting on the engine.

AFR-64R Wiring Schematic

General Wiring Termination – All Valves

WIRING TERMINATION

UPPER (short) TIER

Terminal	DEVICE	WIRE COLOR
72	NOT USED	X
71	NOT USED	X
70	NOT USED	X
69	NOT USED	X
68	NOT USED	X
67	NOT USED	X
66	NOT USED	X
65	MAP SENSOR (–)	BLACK
64	MAP SENSOR SIGNAL (+)	WHITE
63	MAP SENSOR (+)	RED
62	NOT USED	X
61	BUTTERFLY VALVE(s) POWER (+) (Not for TK valves)	RED
60	NOT USED	X
59	SHUTDOWN RELAY - COMMON	CUSTOMER SUPPLIED
58	SHUTDOWN RELAY - NO	CUSTOMER SUPPLIED
57	SHUTDOWN RELAY - NC	CUSTOMER SUPPLIED
56	ALARM RELAY - COMMON	CUSTOMER SUPPLIED
55	ALARM RELAY - NO	CUSTOMER SUPPLIED
54	ALARM RELAY - NC	CUSTOMER SUPPLIED
53	BUTTERFLY VALVE(s) POWER (–) (Not for TK valves)	BLACK
52	BATTERY INPUT (–) 9-30 VDC	CUSTOMER SUPPLIED
51	NOT USED	X
50	DC VOLTAGE (+) 9-30 VDC NON FUSED	CUSTOMER SUPPLIED
49	BATTERY INPUT (+) 9-30 VDC	CUSTOMER SUPPLIED

MIDDLE TIER

Terminal	DEVICE	WIRE COLOR
48	NOT USED	X
47	AUX RELAY COMMON	CUSTOMER SUPPLIED
46	NOT USED	X
45	NOT USED	X
44	NOT USED	X
43	NOT USED	X
42	RIGHT BANK HEGO HEATER (+)	WHITE
41	RIGHT BANK HEGO HEATER (–)	GREEN
40	G-LEAD (+) (Use with #38)	CUSTOMER SUPPLIED
39	MAG PICKUP (+) (Use with #38)	RED
38	MAG PICKUP or G-LEAD (–)	BLACK
37	RIGHT BANK HEGO SIGNAL (+)	RED
36	RIGHT BANK HEGO SIGNAL (–)	BLACK
35	NOT USED	X
34	NOT USED	X
33	RIGHT BANK VALVE SIGNAL (+) (Butterfly or TK valves)	TK - RED BUTTERFLY - WHITE
32	RIGHT BANK VALVE SIGNAL (–) (Butterfly or TK valves)	TK - BLACK BUTTERFLY - GREEN
31	POST CATALYST THERMOCOUPLE (+)	YELLOW
30	POST CATALYST THERMOCOUPLE (–)	RED
29	NOT USED	X
28	NOT USED	X
27	NOT USED	X
26	NOT USED	X
25	NOT USED	X

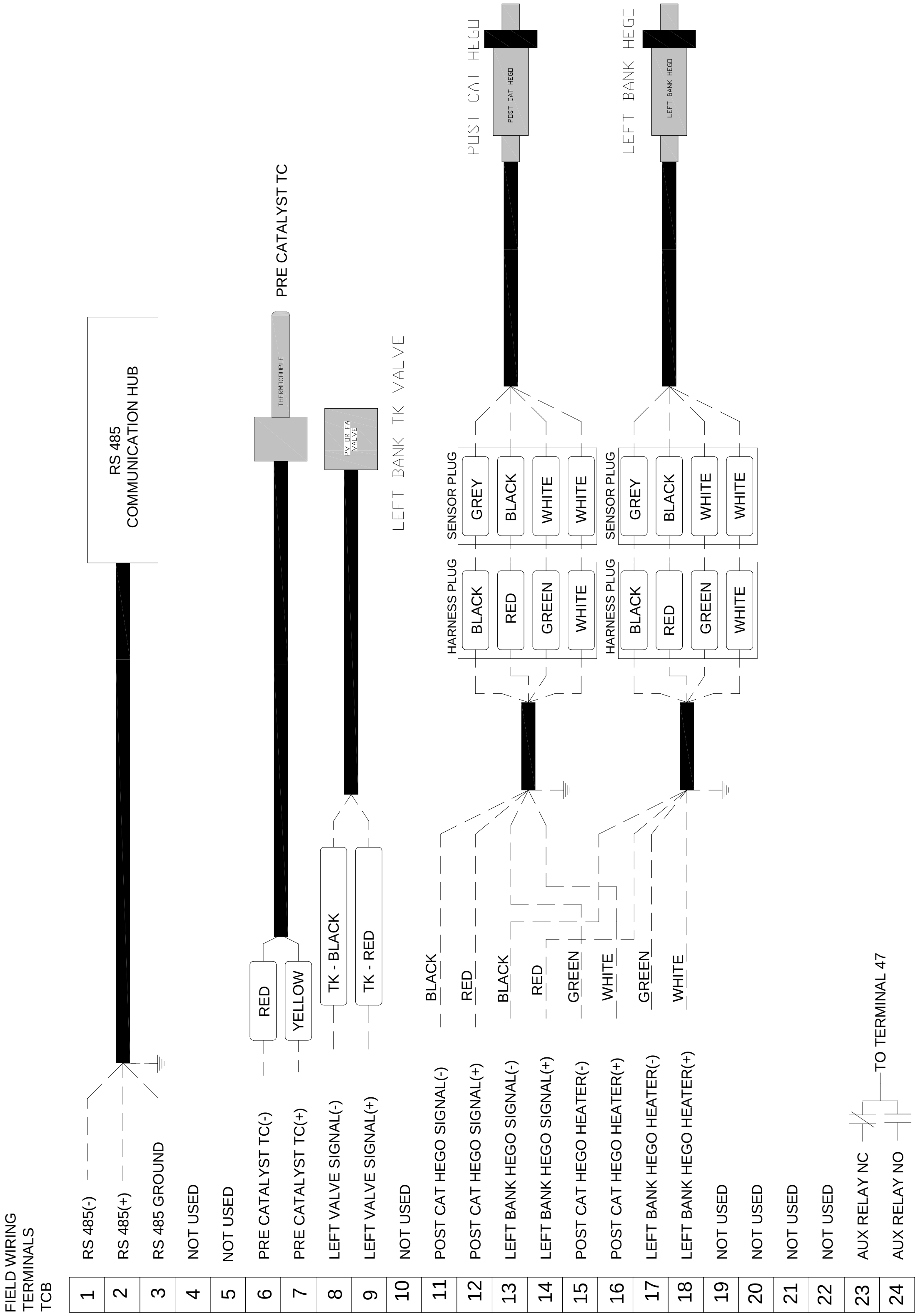
LOWER (tall) TIER

Terminal	DEVICE	WIRE COLOR
24	AUX RELAY NO	CUSTOMER SUPPLIED
23	AUX RELAY NC	CUSTOMER SUPPLIED
22	NOT USED	X
21	NOT USED	X
20	NOT USED	X
19	NOT USED	X
18	LEFT BANK HEGO HEATER (+)	WHITE
17	LEFT BANK HEGO HEATER (–)	GREEN
16	POST CATALYST HEGO HEATER (+)	WHITE
15	POST CATALYST HEGO HEATER (–)	GREEN
14	LEFT BANK HEGO SIGNAL (+)	RED
13	LEFT BANK HEGO SIGNAL (–)	BLACK
12	POST CATALYST HEGO SIGNAL (+)	RED
11	POST CATALYST HEGO SIGNAL (–)	BLACK
10	NOT USED	X
9	LEFT BANK VALVE SIGNAL (+) (Butterfly or TK valves)	TK - RED BUTTERFLY - WHITE
8	LEFT BANK VALVE SIGNAL (–) (Butterfly or TK valves)	TK - BLACK BUTTERFLY - GREEN
7	PRE CATALYST THERMOCOUPLE (+)	YELLOW
6	PRE CATALYST THERMOCOUPLE (–)	RED
5	NOT USED	X
4	NOT USED	X
3	RS485 Ground	CUSTOMER SUPPLIED
2	RS485 (+)	CUSTOMER SUPPLIED
1	RS485 (–)	CUSTOMER SUPPLIED

CONNECT ALL SHIELDS TO EARTH GROUND IN THIS ENCLOSURE
CONNECT GREEN WIRE ON TK VALVE (IF EQUIPPED) TO EARTH GROUND IN THIS ENCLOSURE

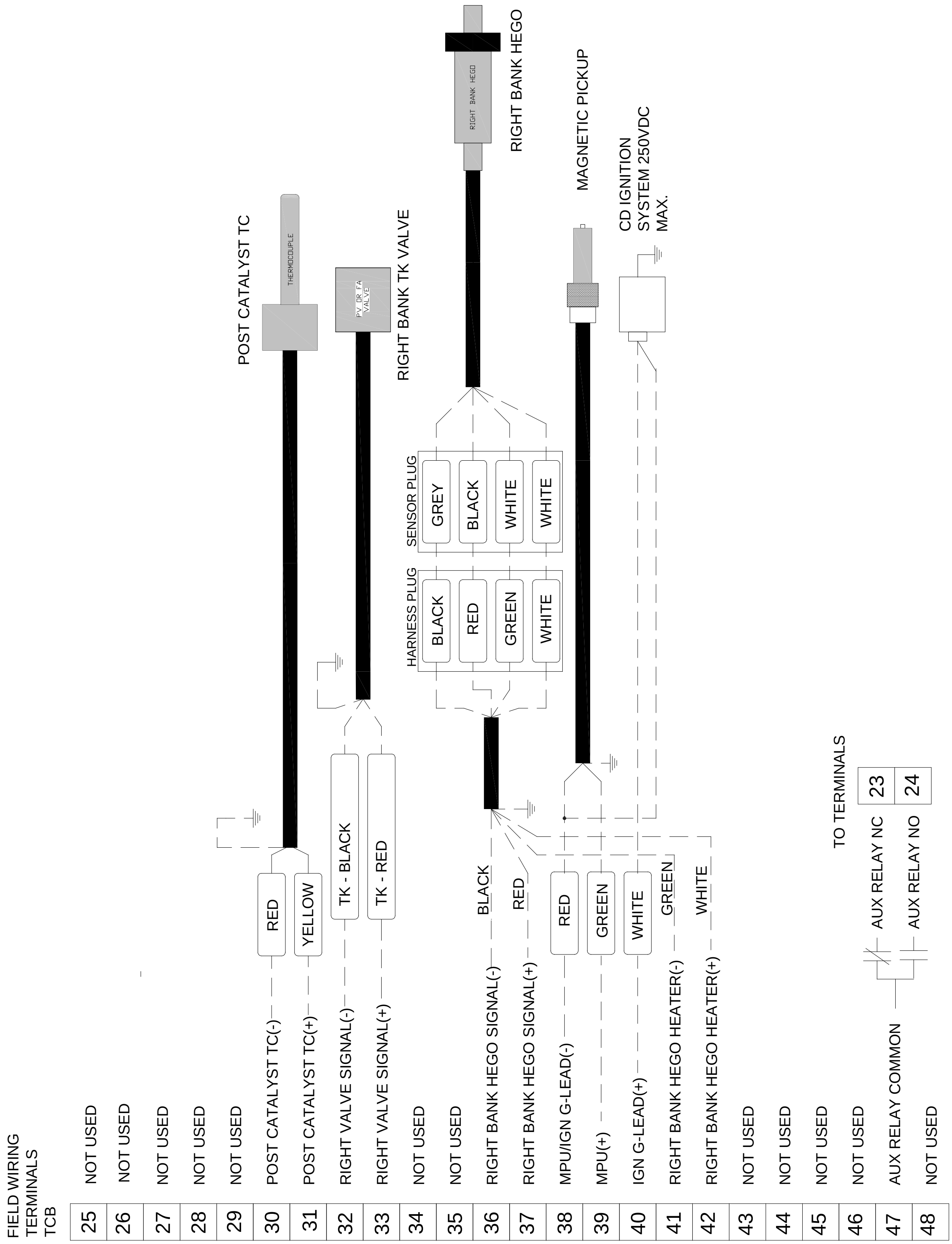
0900058

TK & ICV Valve Field Wiring Schematic – Lower Tier (tall)



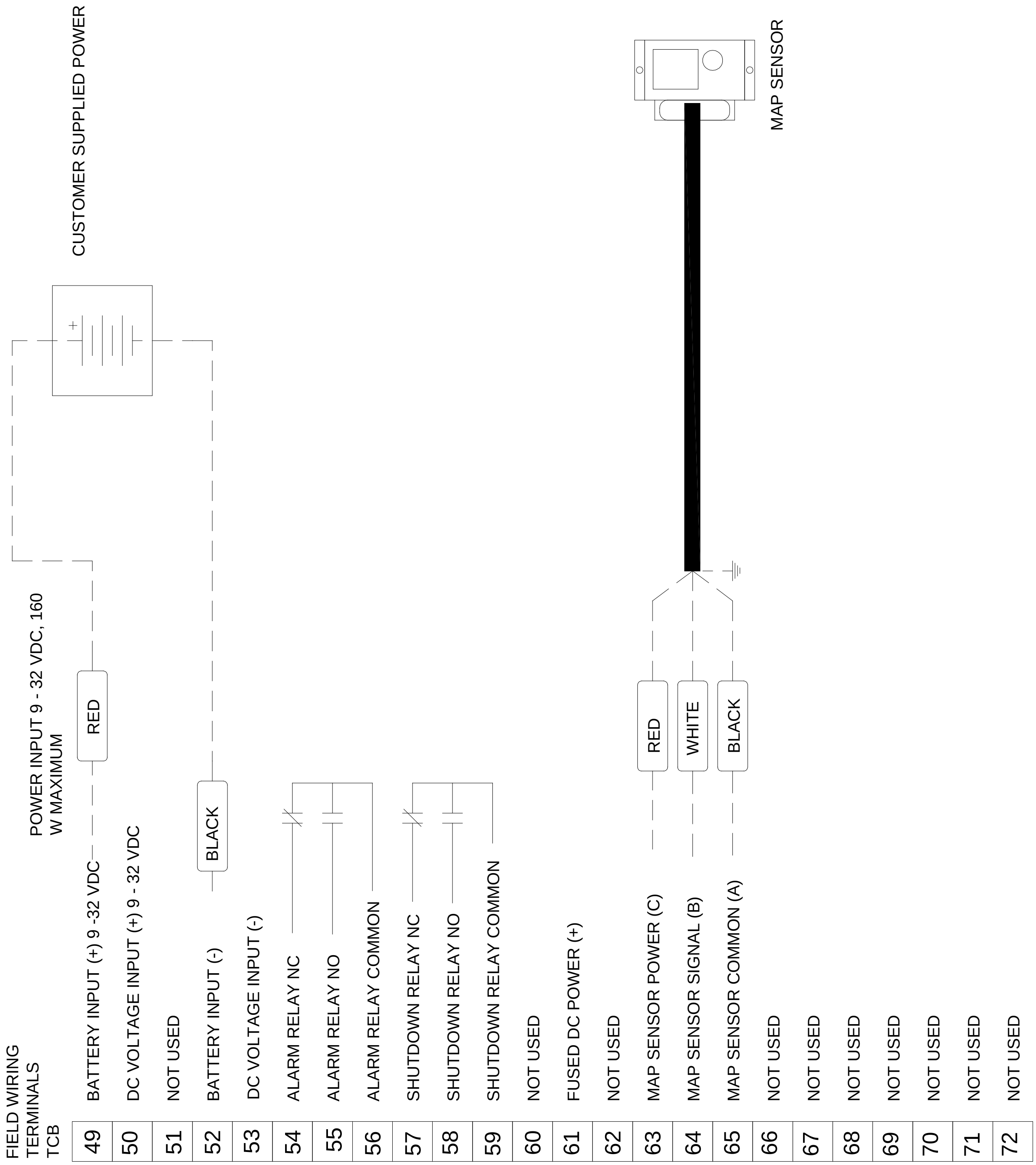
NOTE: If system is setup for "Single Bank" operation, only the Left Bank oxygen sensor and control valve is active.

TK & ICV Valve Field Wiring Schematic – Middle Tier



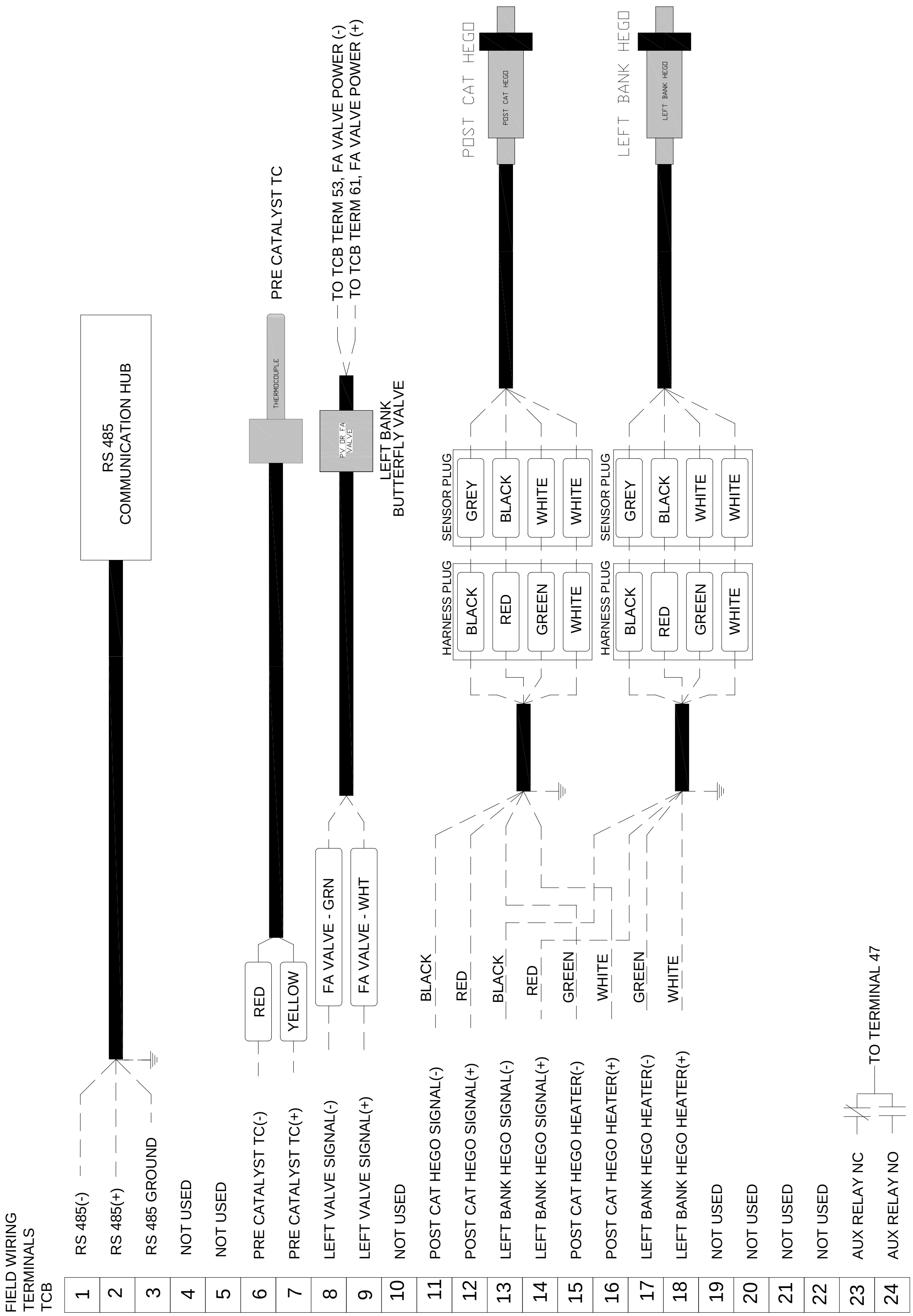
NOTE: Either the Magnetic Pickup or the G-Lead is used, not both
NOTE: If system is setup for "Single Bank" operation, only the Left Bank oxygen sensor and control valve is active.

TK & ICV Valve Field Wiring Schematic – Upper Tier (short)



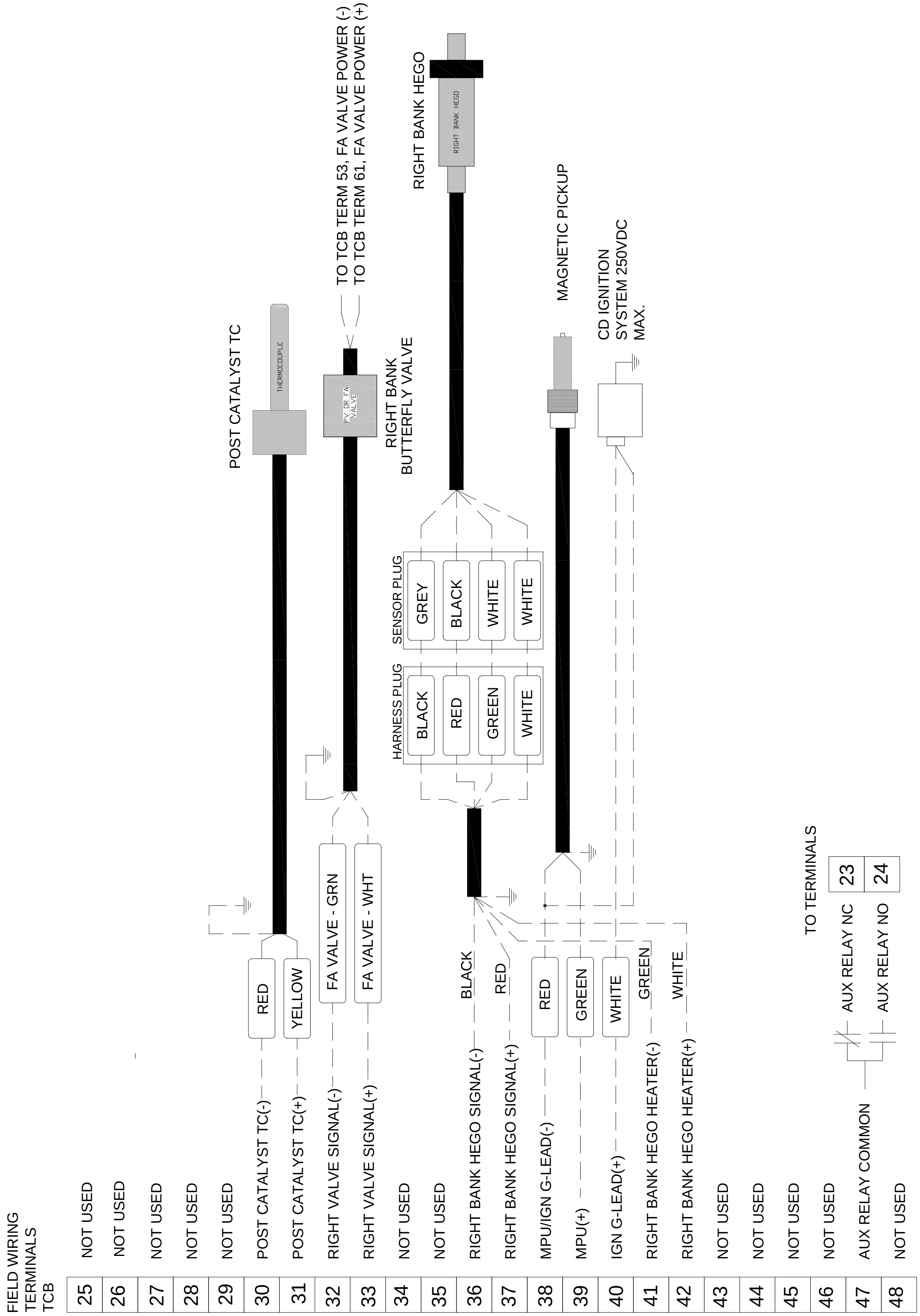
NOTE: If system is setup for "Single Bank" operation, only the Left Bank oxygen sensor and control valve is active.

Butterfly Full Authority (FA) Valve Field Wiring Schematic – Lower Tier (tall)



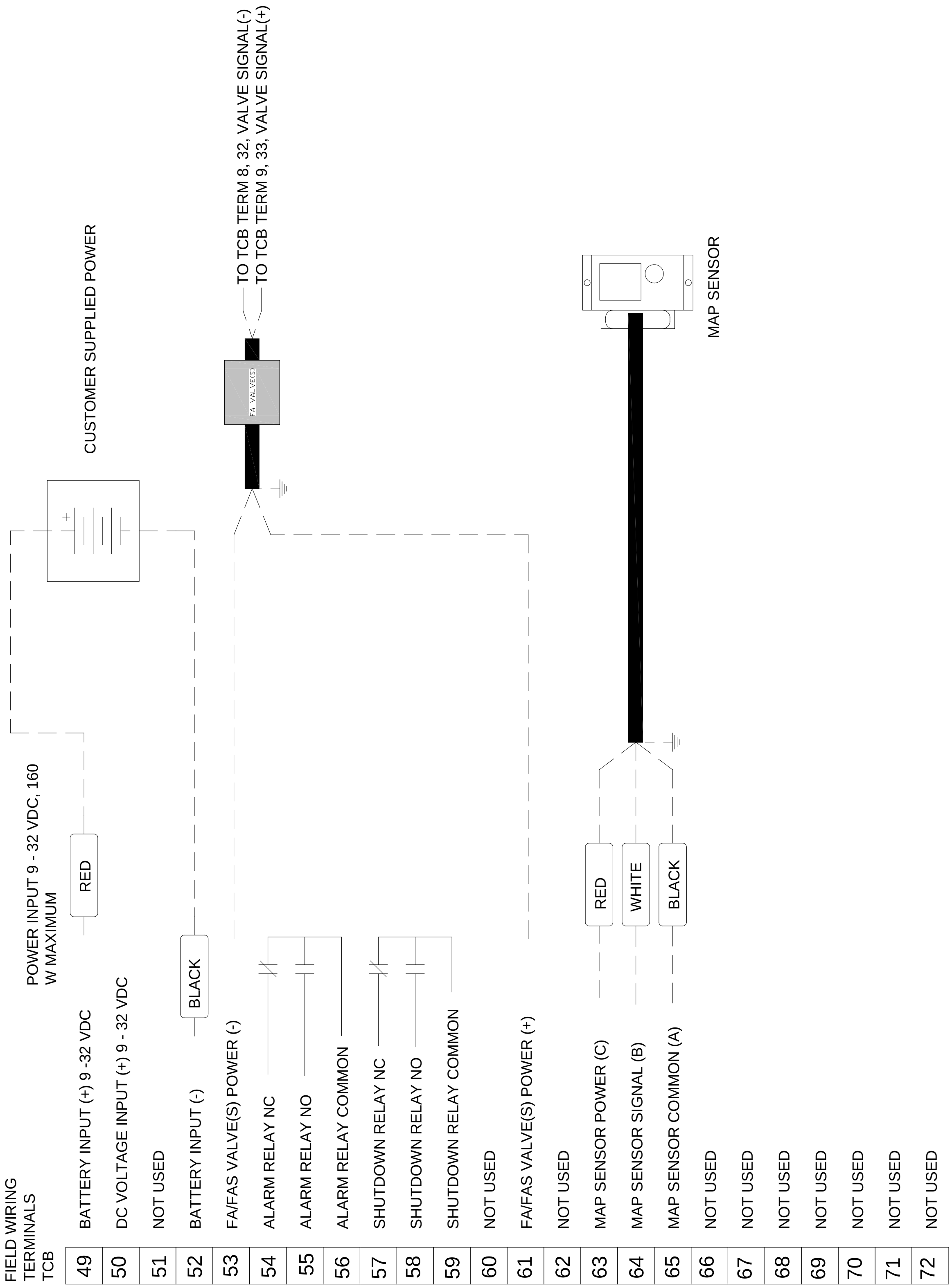
NOTE: If system is setup for "Single Bank" operation, only the Left Bank oxygen sensor and control valve is active.

Butterfly Full Authority (FA) Valve Field Wiring Schematic – Middle Tier



NOTE: Either the Magnetic Pickup or the G-Lead is used, not both
NOTE: If system is setup for "Single Bank" operation, only the Left Bank oxygen sensor and control valve is active.

Butterfly Full Authority (FA) Valve Field Wiring Schematic – Upper Tier (short)



NOTE: If system is setup for “Single Bank” operation, only the Left Bank oxygen sensor and control valve is active.

Start-Up and Commissioning

1. With the AFR-64R installed with all the end devices, prepare for the commissioning by having:
    a. A laptop computer with the Compliance Controls software installed, and a good battery or power adapter. No other software should be running while the Compliance Controls software is running. An open serial COM port (com 1 through 8) of the Laptop PC must be used by the CC software only. If RSLOGIX / RSVIEW, or any other PLC, HMI, or software that uses the serial port is installed, it may have to be uninstalled, they may have to be disabled to free up the available COM port.
    b. A null modem cable (pins 2 and 3 swapped from end to end, both ends DB9 female). This null modem cable (female x female x 10') is supplied with each AFR-64R kit.
    c. The password for full access control. See the password file in the program file menu *(Start > Programs > Compliance Controls> Passwords)*
    d. A multimeter capable of reading DC voltages up to 35 volts.
    e. An emissions analyzer capable of reading NO_x, CO and O_2.
    f. One 36" water manometer or similar type digital electronic manometer with isolation valves, to measure differential fuel pressure in inches water column (in. WC).
    g. Pressure Gauge capable of measuring the fuel line pressure upstream of the final cut regulator.

2. Plan to do the dirty work, like making provisions for the manometer connections, or mounting pressure gauge first, so your hands can be clean while operating the PC.

3. As a reference, the fuel pressure supplied to the regulator(s) and carburetor(s) should be checked prior to the commissioning of the system. In most cases, the fuel pressures should be adjusted to the engine manufacturer's recommendations. There will be instances where the fuel pressure may need to deviate from the OEM settings in order to better meet the desired exhaust emissions control. These pressure readings will be read at different points depending on whether the Butterfly (full authority) or the TK (supplemental) valves are used.
    a. If the Butterfly Full Authority (FA) or In-Line Control (ICV) Valve is used, the fuel pressure will be measured between the final cut regulator and the valve. The fuel pressure will always be measured between the fuel pressure and the air pressure applied to the regulator. On turbocharged engine, the manometer will be connected to the regulator's outlet side and the air side will be connected to the carburetor's inlet air somewhere between the turbocharger and the carburetor air horn, refer to illustration 14. On naturally aspirated engines (non-turbo charged), there are two possible measurement styles depending on whether the regulator is equipped with a balance line between the carburetor's air inlet and the air side of the regulator or whether the engine is equipped with a non-balanced regulator. If a naturally aspirated engine is using a balanced regulator, refer to illustration 15 for the recommended measuring method. For non balanced regulators, refer to illustration 15 for the recommended measuring method.
    b. If the TK Valve is used, several different measurement methods can be used depending on whether the engine is turbocharged, naturally aspirated with

balanced regulator or naturally aspirated without a balanced regulator. On turbocharged engine, the manometer will be connected to the regulator's outlet side and the air side will be connected to the carburetor's inlet air somewhere between the turbocharger and the carburetor air horn, refer to illustration 16. On naturally aspirated engines (non-turbo charged), there are two possible measurement styles depending on whether the regulator is equipped with a balance line between the carburetor's air inlet and the air side of the regulator or whether the engine is equipped with a non-balanced regulator. If a naturally aspirated engine is using a balanced regulator, refer to illustration 17 for the recommended measuring method. For non balanced regulators, refer to illustration 17 for the recommended measuring method.

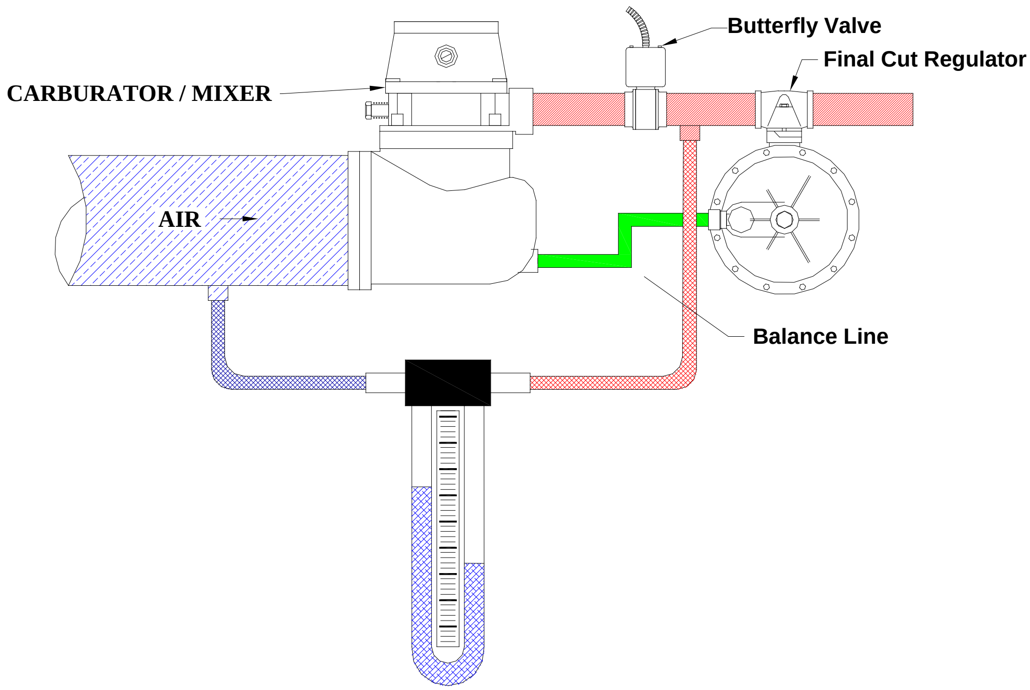


Illustration 14 – Fuel/Air Measurement – Butterfly Valve – Turbo Charged Engine & Naturally Aspirated Engine - Balanced Regulator

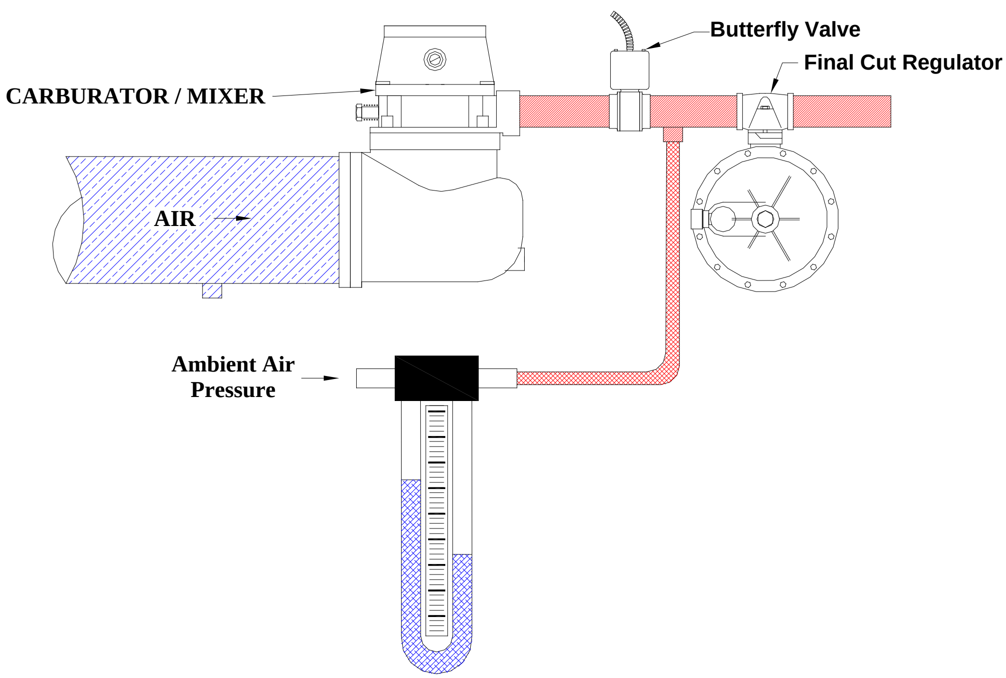


Illustration 15 – Fuel/Air Measurement – Butterfly Valve – Naturally Aspirated Engine - Non Balanced Regulator

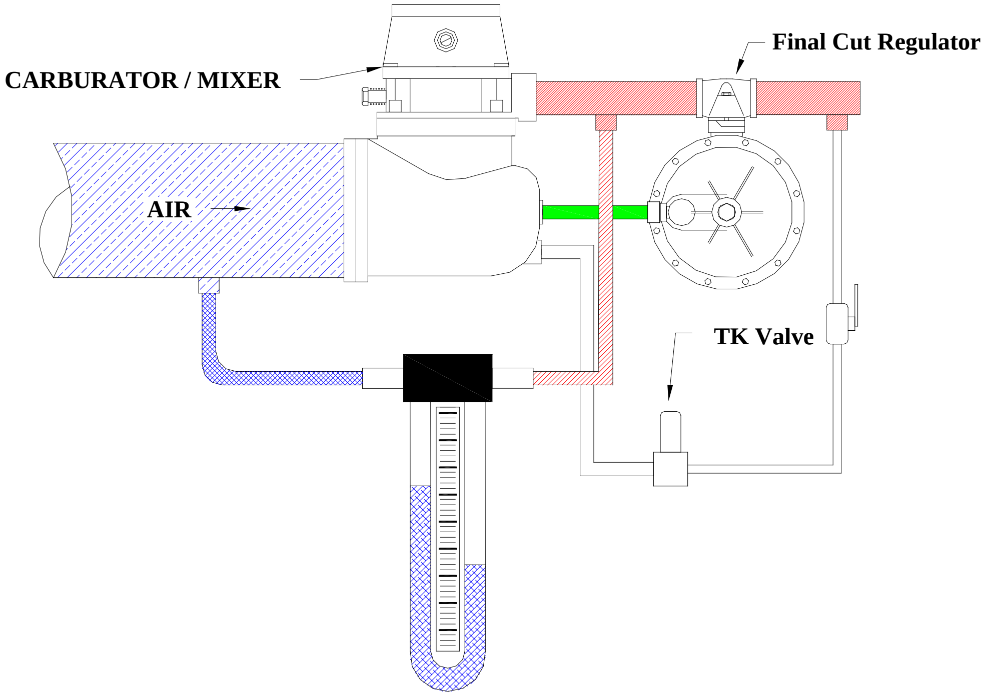


Illustration 16 – Fuel/Air Measurement – TK Valve – Turbo Charged Engine & Naturally Aspirated Engine - Balanced Regulator

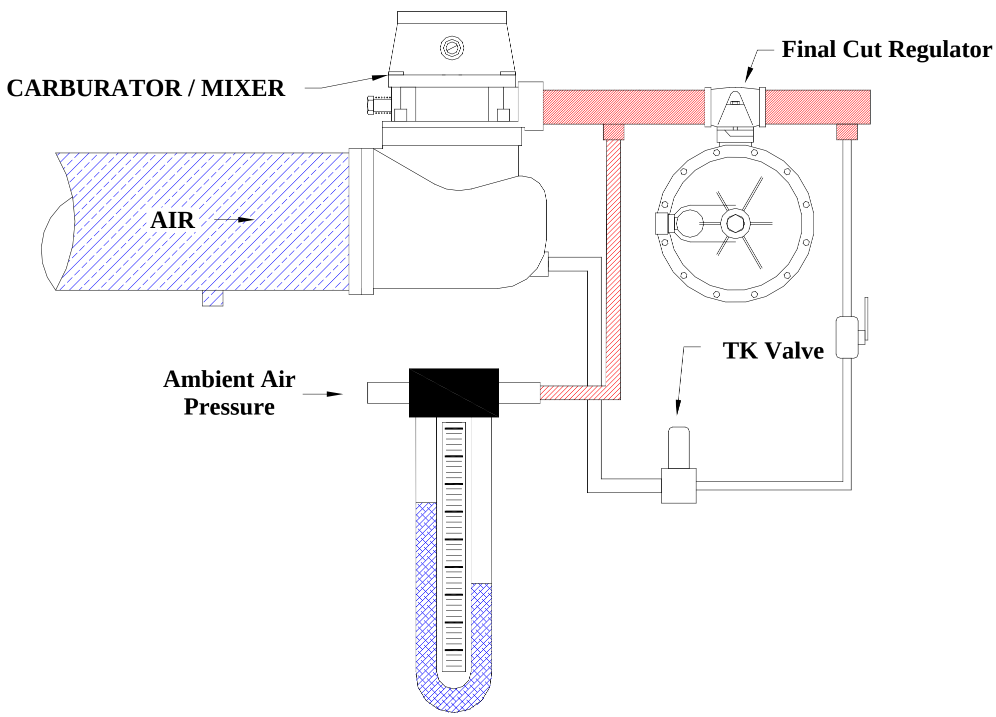
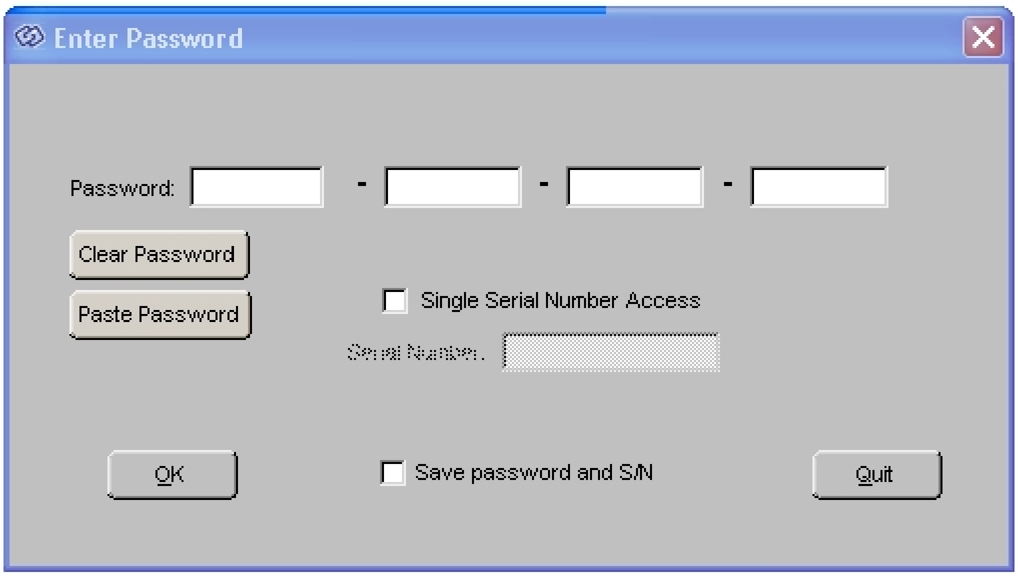


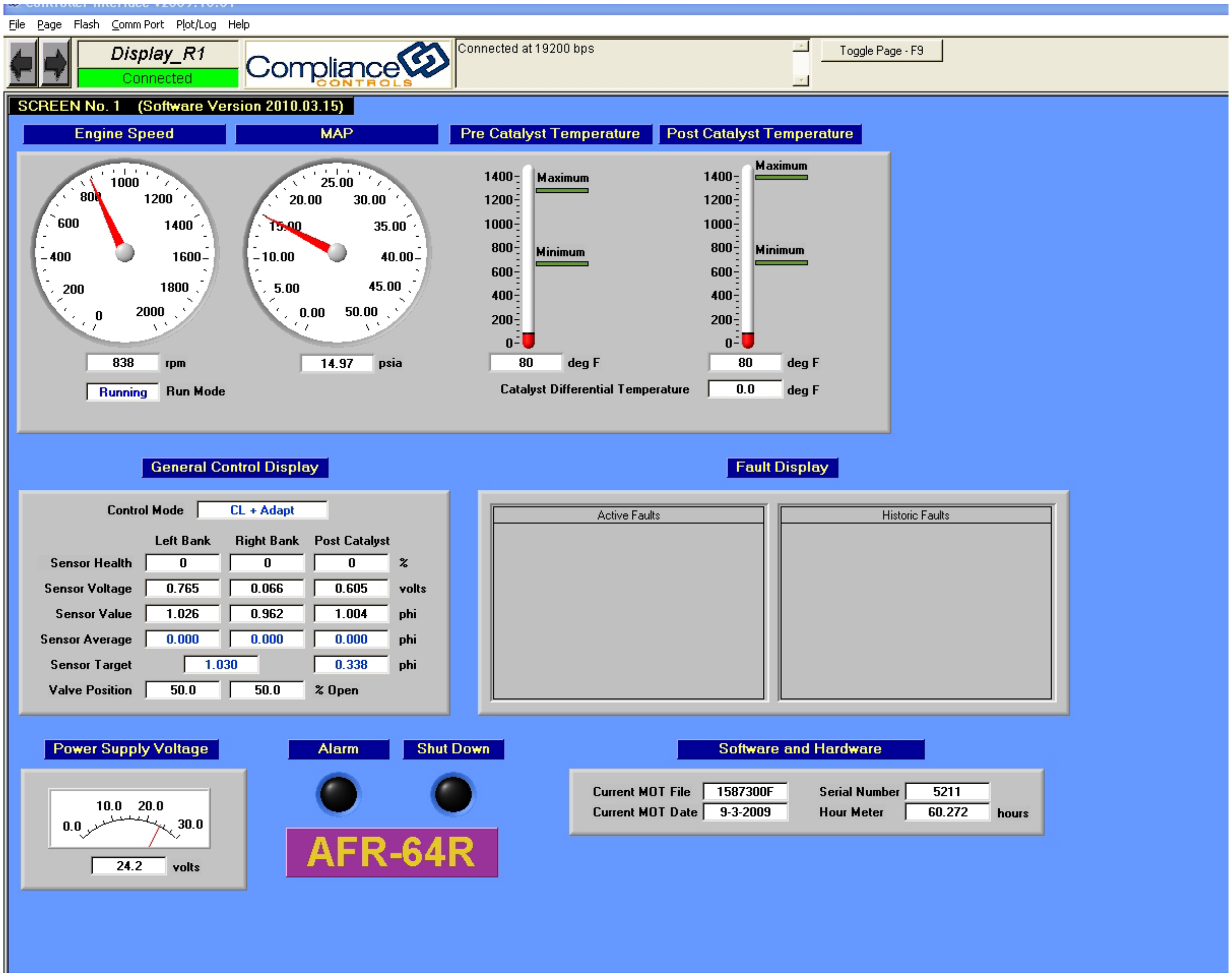
Illustration 17 – Fuel/Air Measurement – TK Valve – Naturally Aspirated Engine - Non Balanced Regulator

4. Turn the power on to the AFR-64R. You can verify the AFR-64R is powered-up by the Power LED on the TCB located below the fuses. Turn on the PC and connect the null modem cable after booting-up from the com port on the PC to the com port on the AFR-64R. After the PC has booted-up, run the Compliance Controls software. You may have a desktop icon you can double click. If not, the executable file can be located in the "Start" menu (Start > Programs > Compliance Controls > Compliance Controls) or it can be located in the main operating drive, typically "C" in the program C:\Program Files\Compliance Controls v2009.10.01\ Controller Interface.exe. Once started, the password screen will come up first. It looks like this:



Enter the password and click OK. It is possible to login to the Lean Burn software for the AFR-64R module. Make sure you use the AFR-64R password. The password can also be copied and pasted from the Windows Excel ® spread sheet or a basic text file that can be found in the Compliance Controls folder on the PC's hard drive. The password can also be saved once it is entered into the password cells by clicking on the "Save password and S/N" check box. Once the password is saved, each time the software is started, the password is automatically entered.

5. On the PC screen, you will see something like this, depending on your screen size and resolution (the image shown if from a resolution of 1280 x 1024).



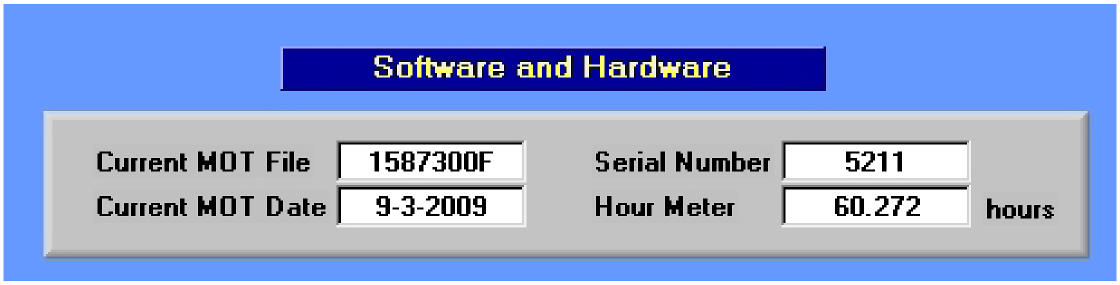
Note the green box under Display_R1 that says "Connected", and the box to the right of the Compliance Controls logo that says "Connected at 19,200 bps. This lets you know you are communicating properly between the PC and the AFR-64R. If you do not see those, you will see the box below Display_R1 the same color as the box above it, and it will say "Not Connected". The box to the right of the Compliance Controls logo will alternate between saying

"Error opening com port 2 in HandleConnect Link error - attempting reconnect..."
and
"Error opening com port 8 in HandleConnect Link error - attempting reconnect..."

If that happens, go to the troubleshooting section of this Manual.

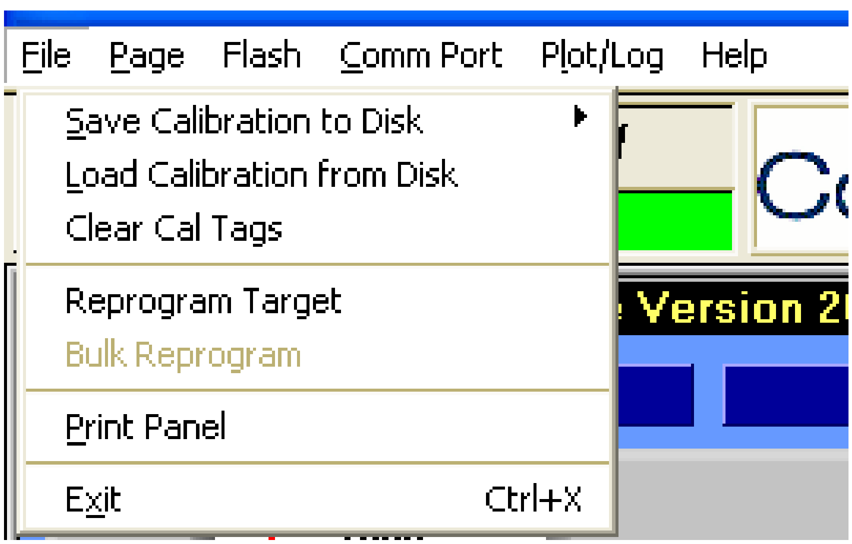
NOTE: Depending on your screen resolution, you may have to use the slider bars for up and down, or side to side to see various parts of each page, or screen.

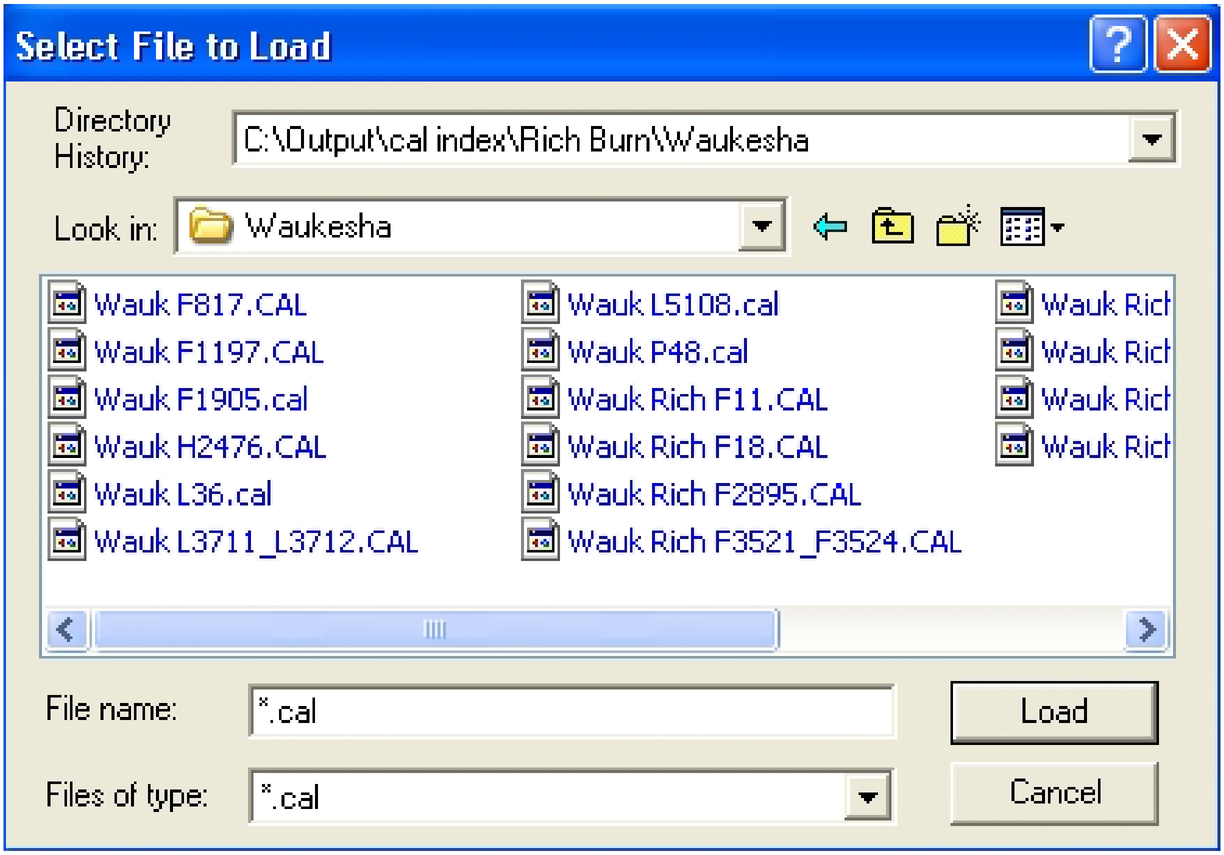
6. Look down and to the right of this screen.



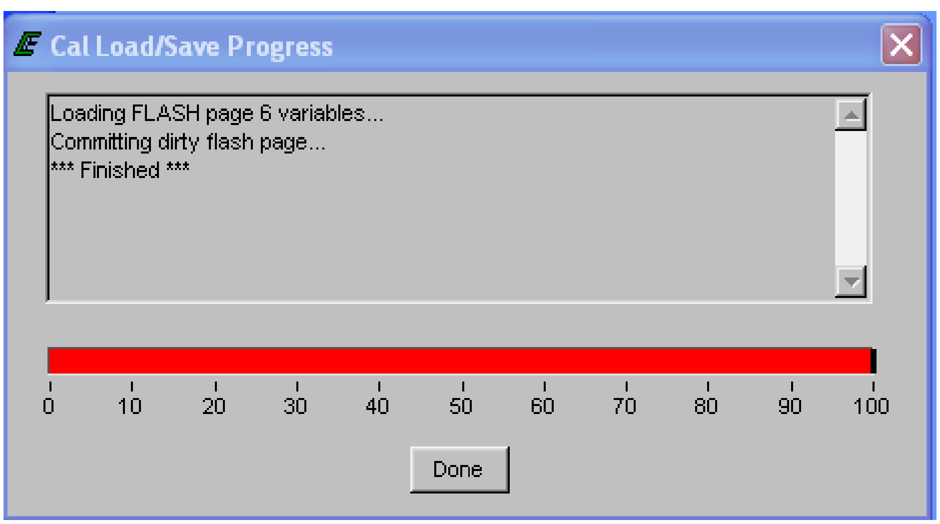
In the cell marked "Current MOT File". This file number should read "F" at the end of the file name. This means you have the current version of firmware. If you have an earlier revision, you will want to go to the instructions for loading the newer version. These instructions are in the Troubleshooting section.

7. The next step would be to choose a calibration (CAL) file for your particular engine. These CAL files are located in the "Compliance Controls" folder on the "C" drive of your PC in a sub-folder named "CAL Index". If you do not have a CAL file for your engine, contact your local Compliance Control's distributor or by logging onto the Extranet portion of the Compliance Controls web site. Go to www.ComplianceControls.com, and click on EXTRANET at the upper left portion of the screen. You must already have a login name and a user password. Loading the CAL file is done by clicking on "*File"* (top left of screen), then "*Load Calibration from Disk*". You will get the window below. Choose the CAL file, and click Load.



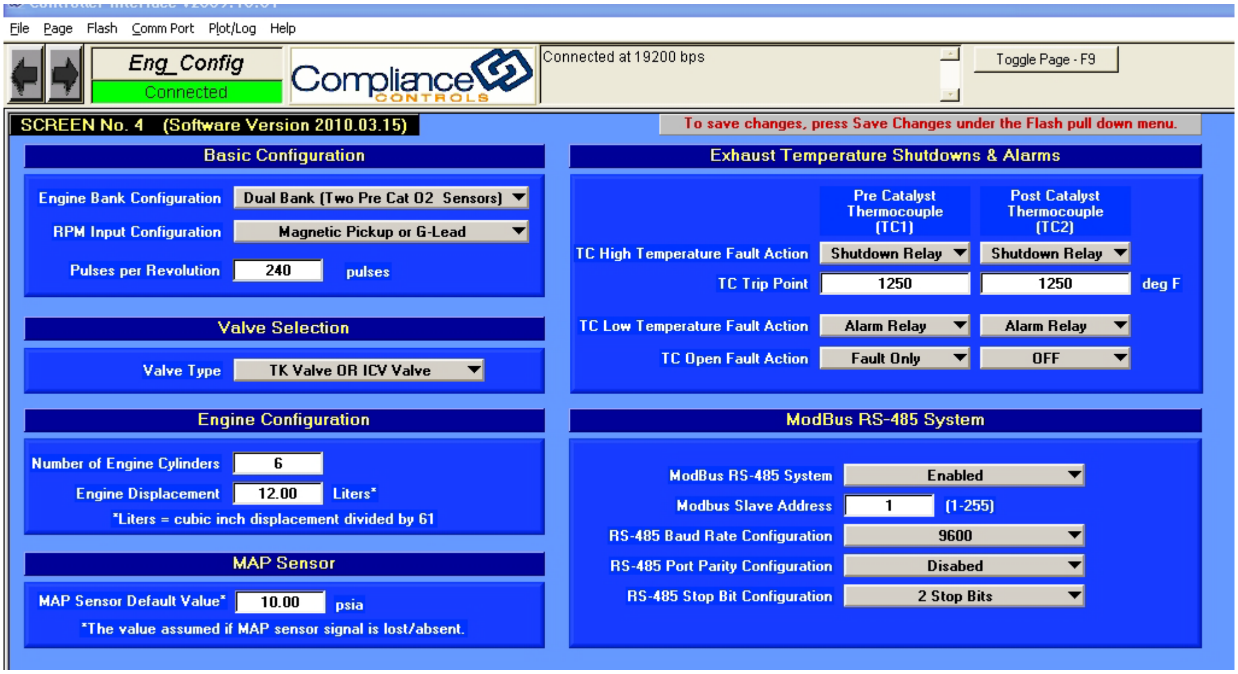


When the file has been loaded, you will get this window:



Click “Done” after you see “*** Finished ***”.

8. Next press the Page Up or Page Down key, or click the left or right arrow keys to go to Screen No. 4, the Eng_Config screen.

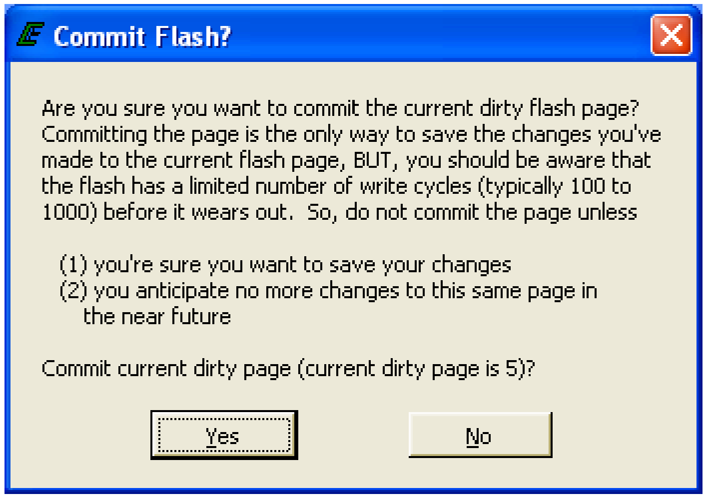


9. Here you will go to the thermocouple setup, labeled in the top right box as “Exhaust Temperature Shutdowns and Alarms”, as shown below.

If you are not using thermocouples, you will want to set all 6 choices for “Off”. Each of the boxes with the Down Arrow at the right has these choices:

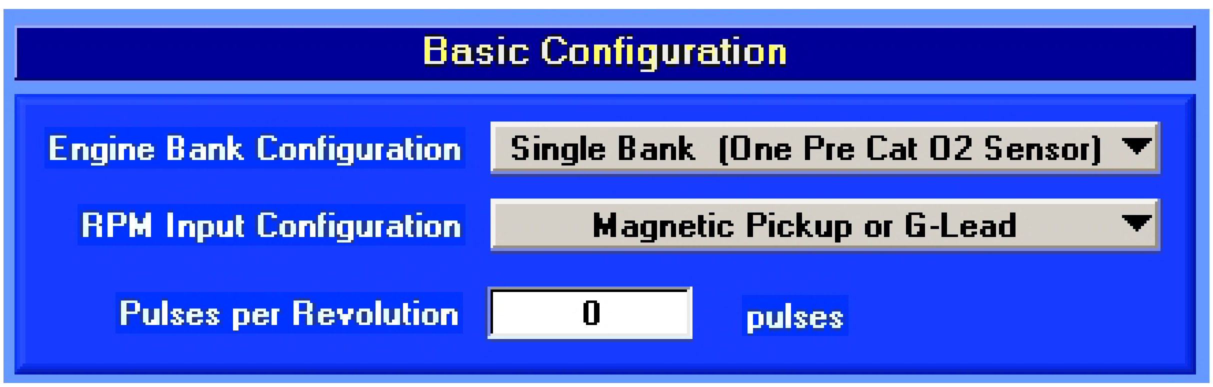
Off **Fault Only** **Alarm Relay** **Shutdown Relay**

Shutdowns can be cleared by cycling the power, or by clicking on the Red Shutdown lamp on the Display, Screen (Screen No. 1). Alarms can also be cleared by the PC by double clicking on the historical alarm. If you are using the high set point for the thermocouples, set that value at this time. Compliance Controls recommends that the high catalyst trip points be set at 150°F above the normal operating temperature of the exhaust system or 1250°F, whichever is lowest. You must save these settings prior to making changes to any other part of the controller. To save the changes, click on Flash, then Save Changes. You will get a warning box like shown on the next page.



If you are done with the thermocouple set-up, click “Yes”. All changes are now saved to the onboard memory of the controller.

10. Even if you used a CAL file, you should review all the parameters to make sure they are in agreement with the engine and the AFR-64R kit equipment. Start with the Window for Basic Configuration shown below.



For the Engine Bank Configuration, you will choose one of the following:

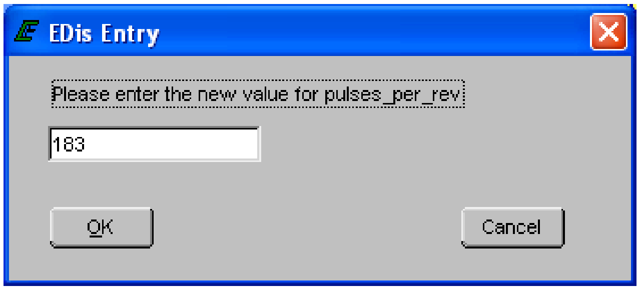
- Single Bank (One Pre Cat O2 Sensor) – *Uses only the Left Bank signals*
- Dual Bank (Two Pre Cat O2 Sensor) – *Uses both the Left and Right Bank signals*

.

RPM Input Configuration gives choices of:

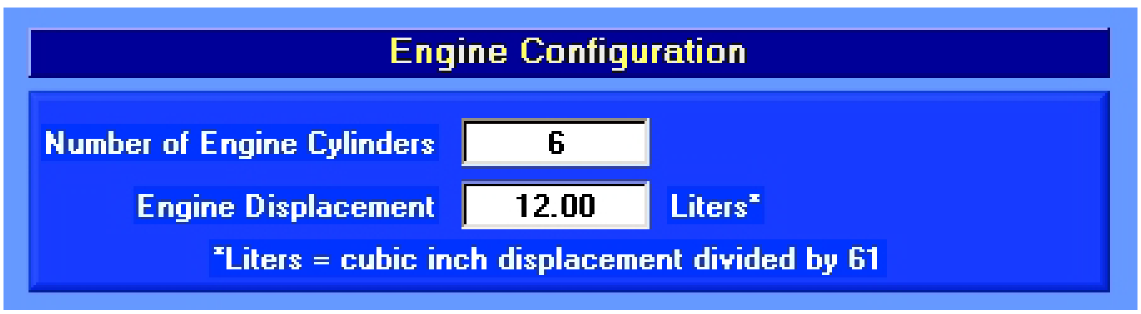
- Disconnected
- Magnetic Pick Up or G-Lead *(factory default setting)*
- Not Used
- Nor Used
- Discrete - Ground=Running
- Discrete – Open=Running
- Discrete - +V=Running

You will always choose Magnetic Pick Up or G-Lead. Magnetic Pick-Ups are highly recommended because they offer greater resolution of speed signal and very much less electrical noise. Next choose the Pulses Per Revolution (If you do not know, there is a list of common engines in the back of the manual). Click on the number. You can then double click, or press Enter to get the edit window shown below.



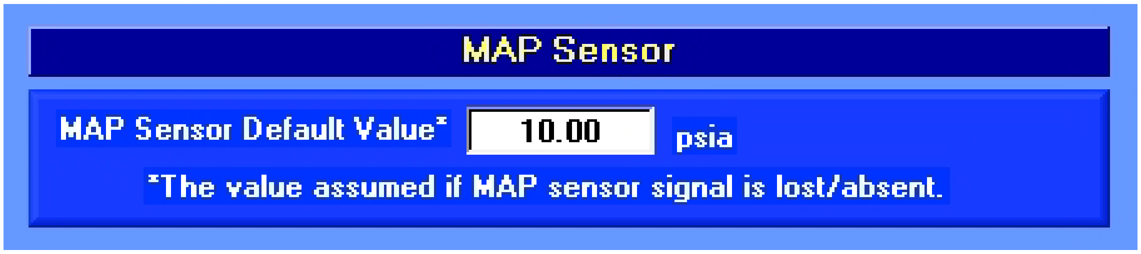
Type the number you want, then click OK, or press Enter. Next, go to the Valve Selection window shown on below.

For the Valve Type, you have a choice of “TK or ICV Valve” or “Butterfly (FA) Valve”. Choose “TK or ICV Valve” or “Butterfly (FA) Valve” for whichever valve is being used. Next go to the window for Engine Configuration shown below.

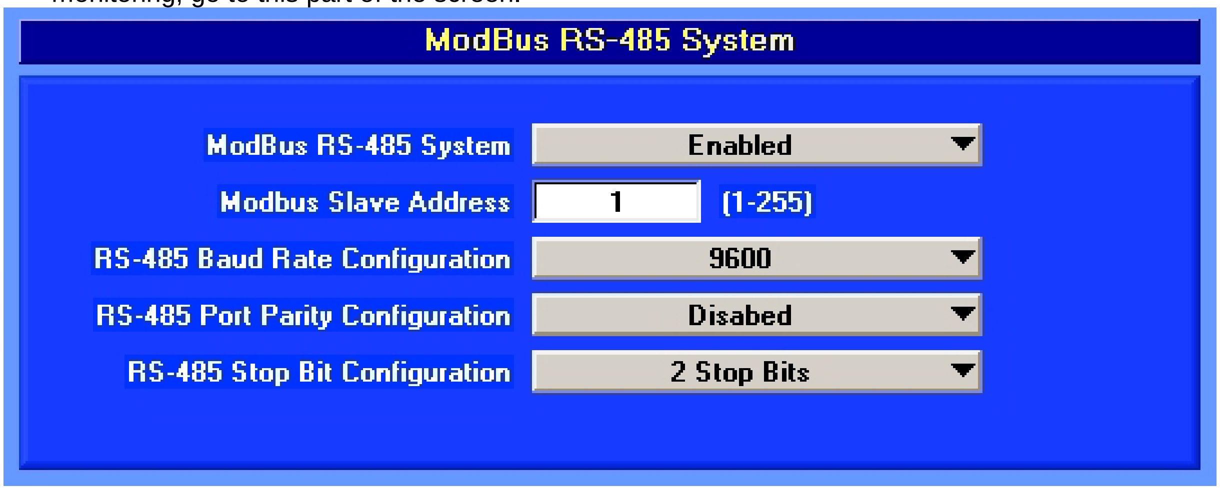


Choose the correct number of cylinders and liters displacement using the number editing window explained before. (If you are not sure of the Engine Displacement, there is a table in the back of the manual showing a list of common engines.) Engine Displacement is typically known as CID (Cubic Inches Displacement), which must be converted into Liters by dividing CID by 61.

You have the option at this time to choose a “Default MAP Setting”. This setting is a manifold absolute pressure reading will go to if the MAP Sensor should fail. Set this default at your typical manifold absolute pressure during normal operation.

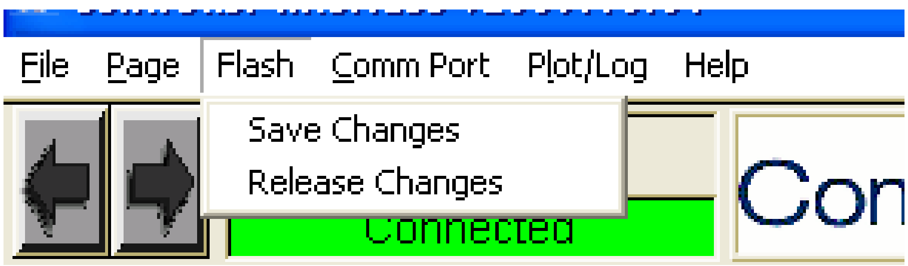


11. Also, while on this page, if Modbus communications is desired, for the UniOP, or remote monitoring, go to this part of the screen.

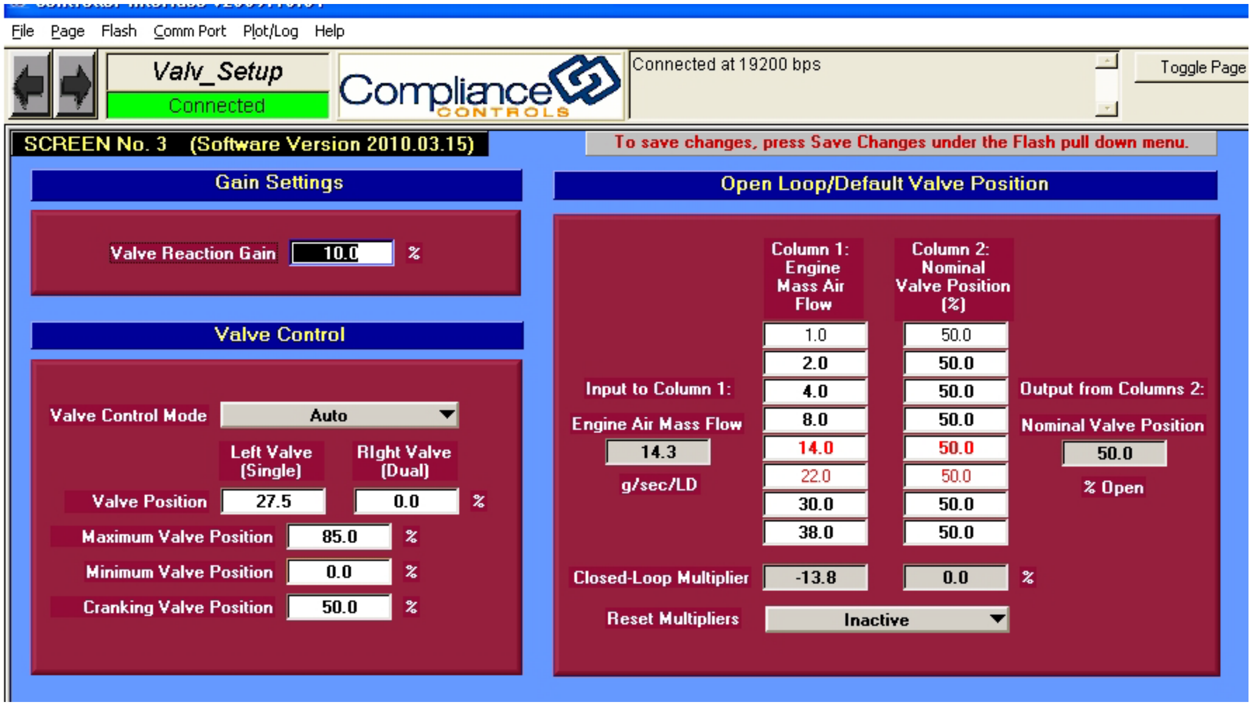


Choose Enabled for the Modbus RS-485 System. Next, choose the Modbus Slave Address. The UniOP requires address 1, unless a special configuration has been specified. The RS-485 Port Configuration has choices of Disabled, Odd, or Even, and the RS-485 Stop Bit Configuration has choices of 1 Stop Bit or 2 Stop Bits. For N,8,1, choose Disabled, and 1 Stop Bit. Some Modbus systems will require 2 Stop Bits.

12. Click on Flash and Save Changes to save these settings as described before.



13. Next, press Page Up, or click the left arrow to go to Screen No. 3, Valv_Setup as shown below.



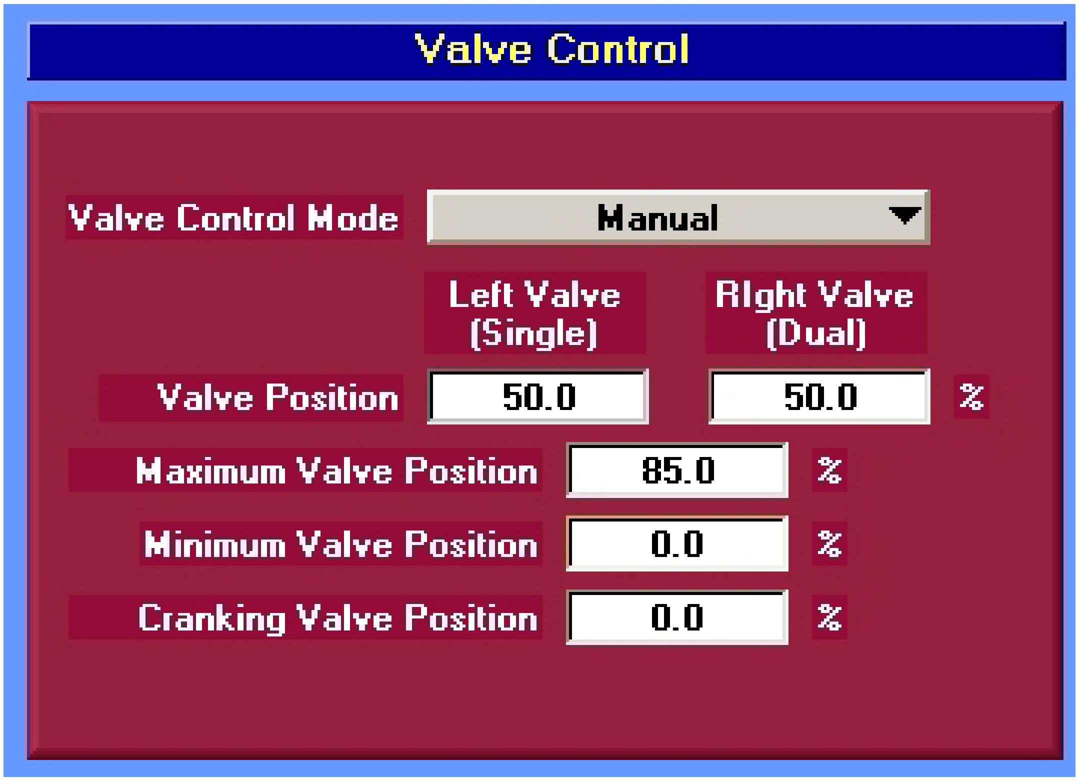
14. Prior to cranking the engine, a safe starting point for the "Valve Cranking Position" is 50%. While cranking the engine, if it seems the engine is starving for fuel and the Butterfly (FA) Valve is being used, raise the Cranking Valve Position 5.0 % at a time until it seems it is not starving for fuel. If the engine seems it is being flooded, lower the Cranking Valve Position 5.0 % at a time until it seems it is not being flooded. The Starting Position for the TK Valve should always be 0%.

15. Once the engine starts, let it warm-up. If the Butterfly (FA) Valve is used, put the "Valve Control Mode" into "Manual" to choose a valve position that allows the engine to warm-up.

    Load the engine as much as possible. Make a good determination of the percentage load the engine is running at, taking into account the Intake Manifold Pressure and where it is related to the maximum manifold pressure, Engine Speed and its relationship to the maximum engine speed, and the Altitude. Another way to estimate the load is if you can get the unit running at the conditions of a performance run from a compressor sizing program. On a generator, you could read the kW generated and compare that to the maximum rating of the generator. Set the Valve Position to a position from the table below based on the load the engine is running at.

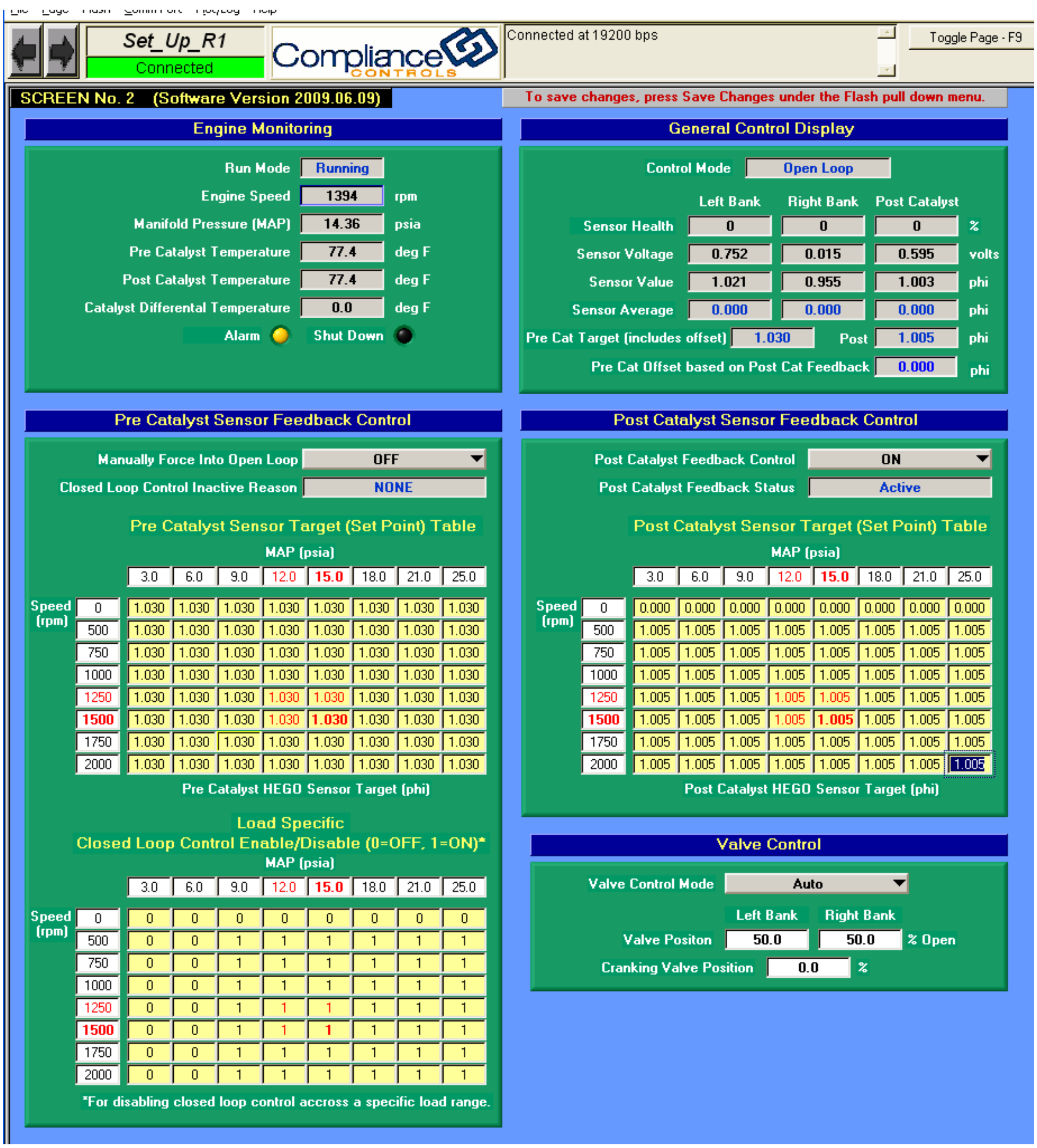
Percent Engine Load	Percent Valve Position
100	70
80	65
60	60
40	55

    If there are two valves, do the same for the second valve. You may have to manually set the valve position in order to get the engine to full load.

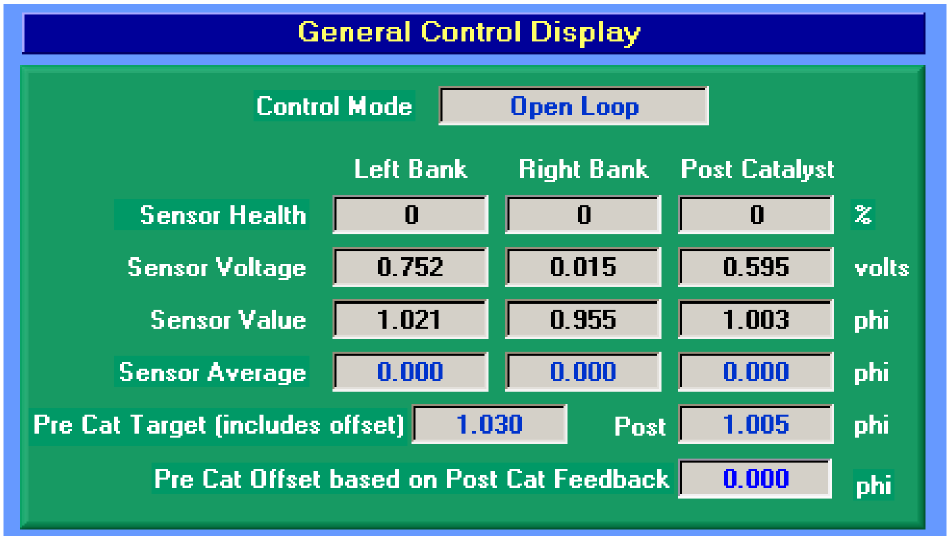


16. Put an Exhaust Gas Analyzer in the exhaust. Adjust the load screw(s) on the carburetor(s) until the desired emissions levels are achieved. If the catalyst is green (new), adjust the load screw(s) to get 0.2 to 0.5% excess O2 pre-catalyst. This is seen by the HEGO Sensor voltage being approximately 0.8 VDC. Let the engine run for approximately 2 hours. Then adjust the load screw(s) to get the desired emissions No more adjustment to the load screws should be done after this.

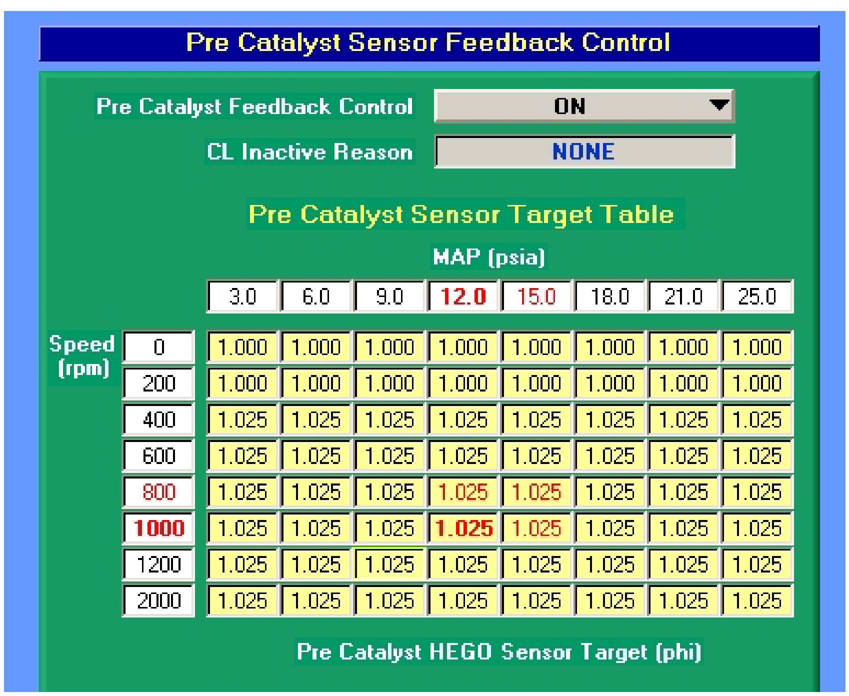
17. Now go to the Set_Up_R1 (Screen No. 2).



18. Note the Sensor Voltages and the Sensor Values as seen in the "General Control Display" window as shown below. The Sensor Voltage should read in the 0.6 to 0.8 range, and the Sensor Value in Phi should read ideally in a range from 1.025 to 1.040, and the averages should be close, also. The Post Catalyst Sensor should read in the range from 1.003 to 1.010 Phi.



19. In the window below, "Pre Catalyst Sensor Feedback Control", first scale the RPM to the useful range for the engine, then scale the MAP in psia to reasonable values for normal engine operation where compliance to emissions regulations are desired, in the Pre Catalyst Sensor Target Table. **NOTE** – The Speed and MAP Tables require a minimum operating point. The minimum RPM point must be set to 0 and the minimum operating point for the MAP setting should be 3 psia. Any values above these points will cause the controller to malfunction at operating points below these minimum settings.



For example, what is shown starts at 3.0 psia, and has increments of every 3 psia. For the engine being controlled, make reasonable assumptions about the reasonable range of MAP. The increments do not have to be even. It is important that the maximum engine RPM and MAP setting in these tables be set above the highest possible operating ranges of the engine. If the engine MAP or RPM exceed the operating range of the table, the controller will no longer control properly.

For example, if you have an engine that will not idle at less than 600 RPM, and has a maximum speed of 1200 RPM, and has a maximum boost pressure of 15 psig, and really does not ever run in a vacuum, then your table increments might be more like this shown below. The first speed data point has to be 0 RPM, and the first pressure data point has to be 3.0 psia.

Original value	New Value	Original Value	New Value
RPM	*RPM*	*MAP psia*	*MAP psia*
0	0	3	3
200	600	8	15
600	700	15	17
800	800	18	20
1000	900	22	23
1200	1000	26	26
1800	1100	31	28
2000	1250	35	32

The values entered will be automatically updated on all three tables, the Pre Catalyst Sensor Target Table, the Post Catalyst Sensor Target Table, and the Load Specific Control Table.

Next, enter the Post Catalyst Sensor Value reading from the General Control Display into the red highlighted cells in the Post Catalyst Sensor Target Table.

Repeat this procedure with the Pre Catalyst Sensor Averages in the Pre Catalyst Sensor Target Table.

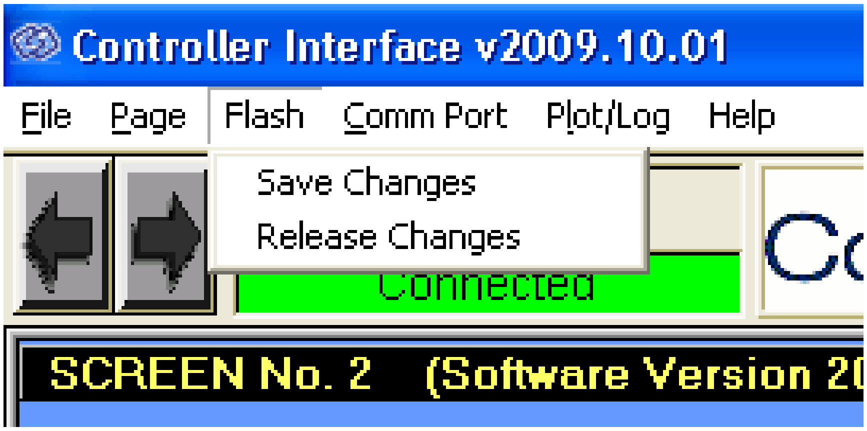
19. While entering the desired values in the working cell, the values can be entered one cell at a time or multiple cells can be tagged for change. To tag more than one cell, click on one cell, hold down the "Shift" key on the PC key board, move the tag from cell to cell with the key board's "Arrow" keys. Type in any number and hit the "Enter" key. All tagged cell will be changed.

20. At this point, the valve control should be returned to automatic operation. No further changes should be made to the load screw setting or the final cut regulator fuel pressure. The load screw position and engine's fuel pressure should be recorded at this time for future reference.

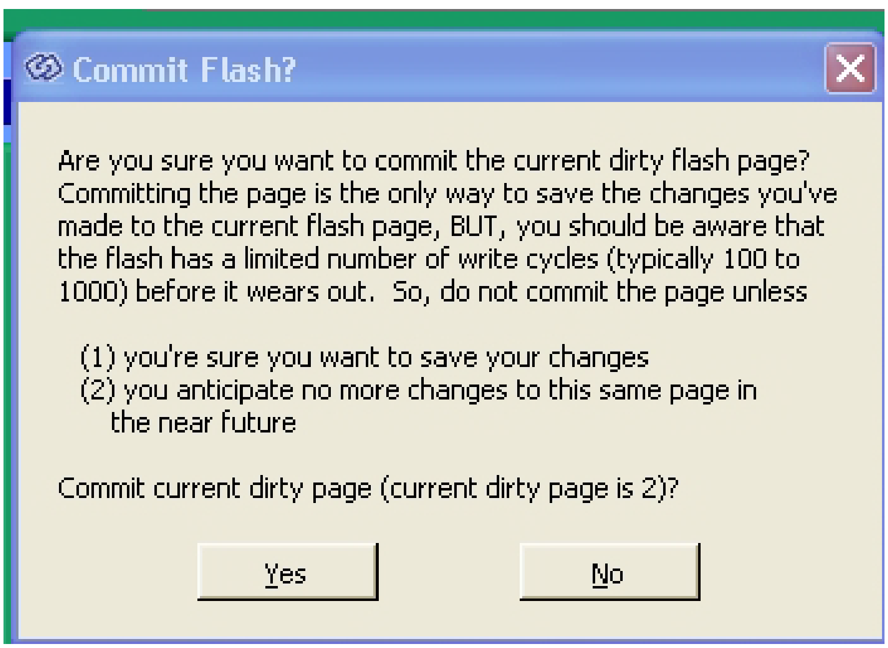
21. If possible, vary the load and/or speed while analyzing the emissions to fill in as many cell ranges as possible. The table to work with initially is the Post Catalyst Table. After those values are filled in, the Pre Catalyst Table can be worked with. These tables are used by interpolating between 4 points. Try to be as close to an RPM value and as close to a MAP pressure value as possible when entering other points in the table. It might be best to make the RPM or MAP values at the top and left edge of the table into your stable data points when doing this. The only rules for the values for the RPM and the MAP are that they start at 0 RPM and 3.0 PSIA, and the RPM increases from top to the bottom,

and the MAP increases from the left to the right. Another way is to enter the average values in all cells highlighted in red, and all cells touching those cells.

22. Next, you will want to save all the settings by having it "Flashed" in the controller. Without doing that, the data will be lost if power is interrupted. Click on Flash and then *"Save Changes"*.

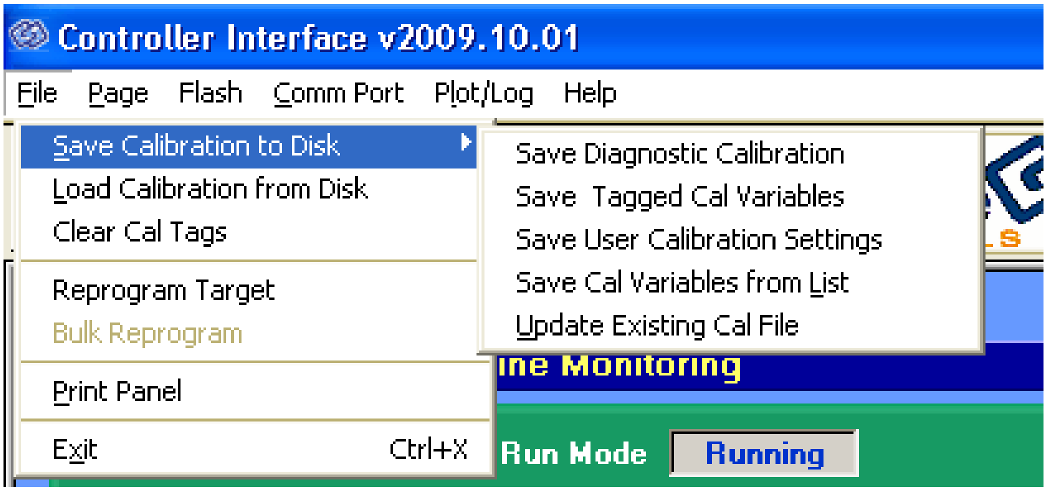


23. Once you choose to save the changes you will get the *"Commit Flash"* message window that cautions about flashing the memory hundreds of times. Click Yes.

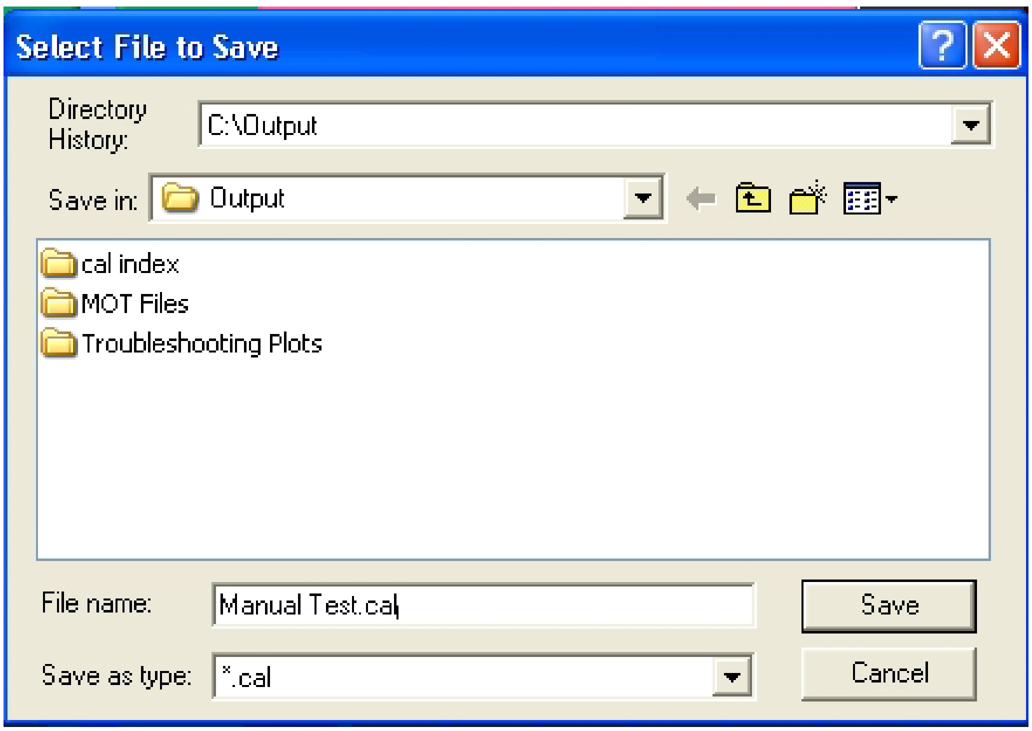


24. It is recommended to save your work by saving the cal file. Click on File, then Save Calibration to Disk > will give the following choices:

Save Diagnostic Calibration
Save Tagged Cal Variables
<u>Save User Calibration Settings</u>
Save Cal Variables from List
Update Existing Cal File



Choose "Save User Calibration Settings". You will get the following window.



Make sure you have the path and folder location you want, and give the file a name. A suggestion for "File name" would be to use the unit number, engine type, and the date. File name cannot exceed 64 characters.

25. You can now remove the Emissions Analyzer, the manometer, shut down the PC software, and unplug your PC. The Start-Up and Commissioning is complete.

Initial Setup and Commissioning Outline

1. Tools and equipment required prior to engine startup and commissioning
    a. PC with the latest Compliance Controls display software, currently Revision 2010.03.15. PC must have 1 open com port
    b. Female x Female null modem communications cable (provided with kit)
    c. Password for full access control - `1V4D-3VS3-PQ5N-MULJ`
    d. Calibration (CAL) file for the engine
    e. A multimeter capable of reading DC voltages up to 35 volts
    f. An emissions analyzer capable of reading NOx, CO and O_2
    g. One 36" Manometer or similar type digital electronic manometer with isolation valves to measure fuel pressure in inches water column (in. WC).
    h. Pressure Gauge capable of measuring the fuel line pressure upstream of the final cut regulator
2. Setup manometer and/or pressure gauge on fuel system as described in *"Start-Up and Commissioning"* section of this manual.
3. Insure that AFR-64R controller has been powered up.
4. Connect the null modem communication cable to the male DB9 connector on the TCB and to the open serial port on the PC.
5. Start PC Display software and enter password `1V4D-3VS3-PQ5N-MULJ` if it has not been previously saved.
6. On "Screen 1 – Display_R1" verify that the latest MOT file software is loaded onto the ECM. At the release of this manual (March 2010) the current MOT file number is 1587300**F**. This version is considered "Revision F".
7. If the MOT file revision is different that Revision F, refer to the *"Troubleshooting Section"* for procedures on updating the MOT file.
8. Install a calibration file for the engine application. Refer to the *"Start-Up and Commissioning"* section of this manual for CAL file installation instructions.
9. Change to "Screen 4 – Eng_Config" to adjust the following areas:
    a. Exhaust Temperature Alarm and Shutdown
        i. TC High Temperature Fault Action
        ii. TC Trip Point
        iii. TC Low Temperature Fault Action
        iv. TC Open Fault Action
    b. After the Exhaust Temperature parameters have been set, the changes must be "Flashed" to the EEPROM prior to continuing the setup of the controller. See *"Start-Up and Commissioning"* section of this manual for details on this action.
    c. If a CAL file was not available for the engine application, set the following parameters; if a CAL file was available for the engine application, skip to Bullet number 10.
        i. Engine Bank Configuration – Single Bank or Dual Bank
        ii. RPM Input Configuration - This setting should always be set to "Magnetic Pickup or G-Lead"
        iii. Pulses per Revolution
        iv. Valve Type – "TK Valve or ICV Valve" or "Butterfly Valve".
        v. Number of Engine Cylinders
        vi. Engine Displacement in Liters – CID divided 61
        vii. If the ModBus RS-485 system is not being used, skip to Bullet 11
        viii. ModBus RS-485 System
        ix. ModBus Slave Address
        x. RS-485 Port Parity Configuration
        xi. RS-485 Stop Bit Configuration
        xii. Flash changes made to this point
10. Change to "Screen 3 – Valv_Setup" and adjust the following area:

   a. If an Engine CAL file was used, skip to Bullet 11
   b. Gain Settings –
      i. Valve Reaction Gain – Set between 10 and 25%
   c. Valve Control –
      i. Minimum Valve Position – Set at 0%
      ii. Maximum Valve Position – TK Valve = 99%; FA Valve = 85%
      iii. Cranking Valve Position – TK Valve = 0%; FA Valve = application specific, typically 50%
11. Change to "Screen 2 – Set_Up_R1"
12. Start the engine.
13. Once the engine has started and the Engine RPM has stabilized, set the valve control to "Manual"
14. Enter a desired valve position for the control banks used. If controller is set up as a "Single Bank" application, only the Left Bank will be used. Use these Parameters for determining the desired valve position:
    a. 100 to 81% engine load = 70% valve
    b. 80 to 61% engine load = 65% valve
    c. 60 to 41% engine load – 60% valve
    d. 40 t0 21% engine load = 55% valve
    e. 20% and lower = 50% valve
15. Load the engine to the desired operating point.
16. Sample the catalyst outlet exhaust emissions levels.
17. Adjust the carburetor load screw(s) until the desired emissions levels are achieved. NOTE – When working with a Dual Bank configuration, insure that both carburetors are adjusted evenly. This is done by monitoring the Sensor Voltages for the Left and Right Banks.
18. Enter the Post Catalyst Sensor Average reading into the red highlighted cells in the Post Catalyst Sensor Target Table.
19. Enter the Pre Catalyst Sensor Average reading into the red highlighted cells in the Pre Catalyst Sensor Target Table.
20. Change the Valve Control to Auto
21. Monitor the emissions levels to insure that the desired emissions levels are maintained. If the desired emissions are not achieved, change the pre catalyst and post catalyst target values until the desired emissions are achieved
    a. An increase in the target value = Richer
    b. A decrease in the target value = Leaner
22. NOTE – No further adjustments should be made to the carburetor's load screw or the engine's fuel pressure after this point.
23. Change the engine's load and/or speed to the next desired operating range
24. Adjust the Post Catalyst and Pre Catalyst Target values to achieve the desired emissions levels at this load.
    a. An increase in the target value = Richer
    b. A decrease in the target value = Leaner
25. Repeat steps 23 and 24 as many times as possible to cover as much of the table's operating range as possible.
26. Return the engine to a standard, stable load.
27. At the top left hand side of any screen, click on the Flash pull down menu and click on "Save Changes".
28. Again at the top left hand corner of any screen, clock on the File pull down menu and choose "Save Calibration to Disk". In this pull down menu, choose "Save all calibration parameters which you have write access"
29. Choose a file name and save the CAL file to a location of your choice.
30. Setup and commissioning of the system is now complete. Monitor the operation of the system. Changes can be made to the system at any time if emissions requirements change. Remember to Flash any further changes to the EEPROM.

Troubleshooting, Maintenance and Replacement

Product Support

The following troubleshooting guidelines are provided for you to use when corrective action is needed. However, if you need technical assistance please contact your distributor.

To find a COMPLIANCE CONTROLS Distributor in your area, please visit our web site at

www.ComplianceControls.com

CORPORATE OFFICE
Tulsa, Oklahoma
5311 So. 122nd East Ave.
Tulsa, OK 74146-6006
Phone – (918) 317-4100
Fax – (918) 317-4266

www.ComplianceControls.com

Email at: **TechnicalService@ComplianceControls.com**

Visual Troubleshooting and Meter Checking

The TCB (Terminal Connector Board) connected to the AFR-64R has indicator LED's (Light Emitting Diodes, or lights). They are Power, Alarm, Shutdown, and Auxiliary. The Alarm, Shutdown, and Auxiliary LED's are connected to relays, which have Form "C" contacts (COM (common), NO (Normally Open), and NC (Normally Closed)). The relays are energized when their associated LED's are lit. The Power LED is lit when power is connected and the fuses are good. There are 2 - 5 Amp fuses. They are:

Buss C520 5 Amps 250 V

Below is a sketch of the TCB as it is mounted in the enclosure so you can see the locations of the terminal blocks, relays, LED's and fuses. The Phillips head screws shown should never be removed.

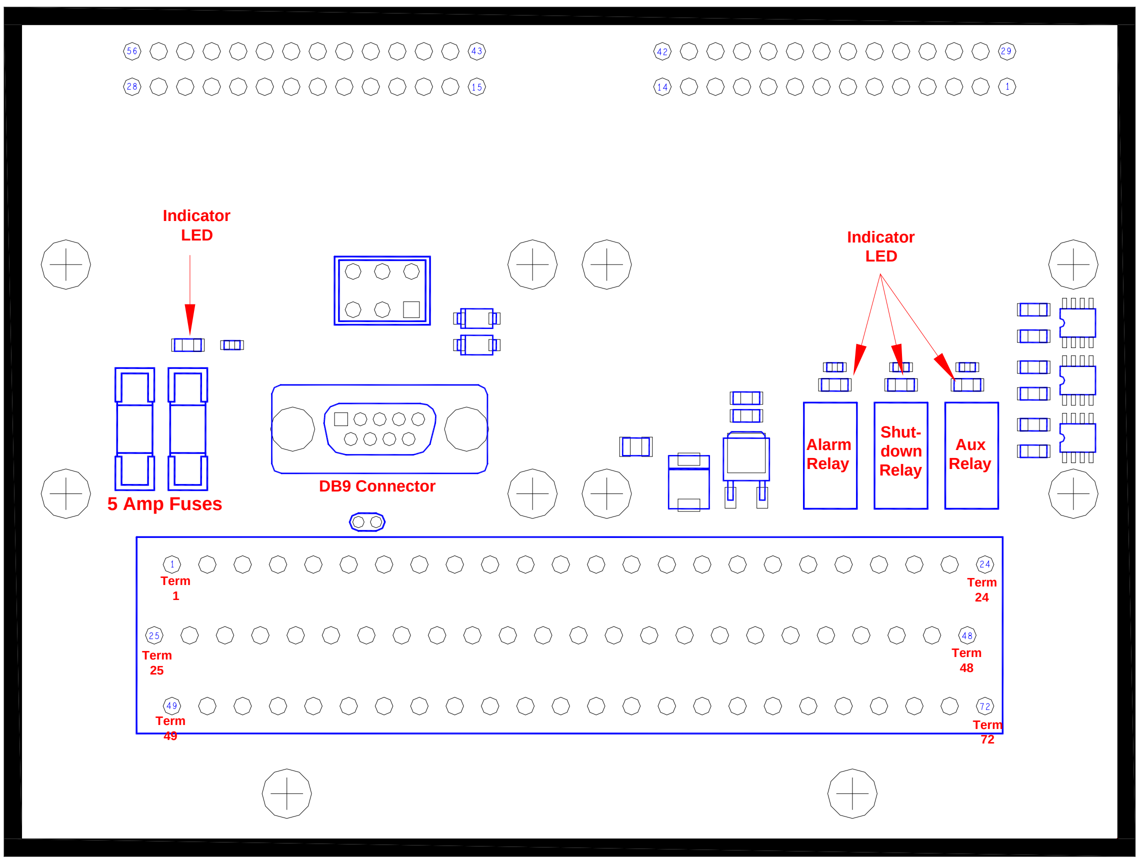


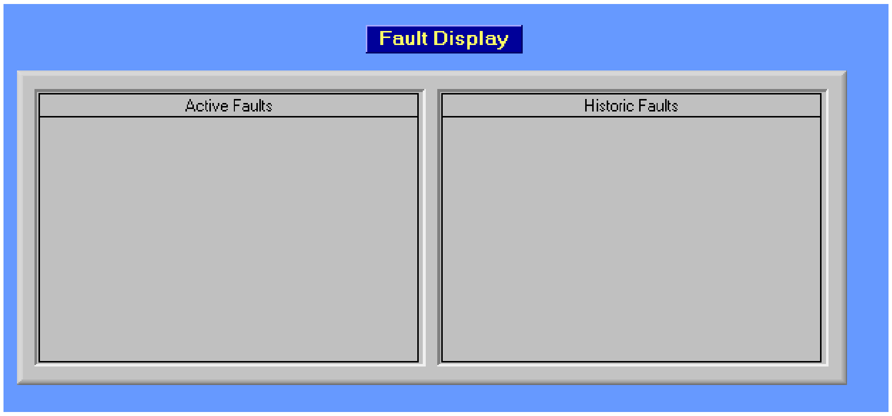
Illustration 18 – TCB Layout

If the Power LED is not lit, and DC power is measured with a meter at terminals 49 (Battery Input +) and 52 (Battery Input -), then check the fuses. Both fuses are used are connected parallel. Try measuring with the red probe of the volt meter at the bottom end of the fuses, the end away from the terminal blocks and the black probe of the meter at terminal 52 or 53.

If the fuses are blown, turn off the power, remove the fuses, remove any wires from terminal 52, and use your meter measuring Ohms between the bottom end of the fuse clips and terminal 52 or 53. You should measure 20 k to 30 k Ohms. If the reading is much lower (less than 10 Ohms), then remove any wires from terminals 16, 18, 42, and 61. If the reading goes up to the 20 k to 30 k region, then check each of the wires that were disconnected from terminals 16, 18, 42, and 61 versus earth ground. The wires that were connected to terminals 16 (Post Cat HEGO Heater +), 18 (Left Bank HEGO Heater +) and 42 (Right Bank HEGO Heater +) should read in the neighborhood of 100 k Ohms when reading back to terminal 52 or 53. The wire connected to terminal 61 (FA Valve Power) should read in the neighborhood of 30 M Ohms when reading back to terminal 52 or 53. If any of these wires reads low, like the reading from the fuses, then that wire, harness, or device is suspect. With those wires disconnected, again measure from the bottom of the fuses to terminal 52. If the reading is in the neighborhood of 20 k to 30 k Ohms, then the problem has been found and replacing the fuses will cure the problem after the wire, harness, or end device has been replaced.

If the low ohms reading are still present, then the ECM-R and TCB should be returned for repair, and a new ECM-R and TCB installed.

If the Power LED is lit, and the Shutdown LED is lit, then there are several steps to go through if a PC is not available to connect to read the problem from the Fault Display as shown below from the Display_R1, Screen No. 1, below.



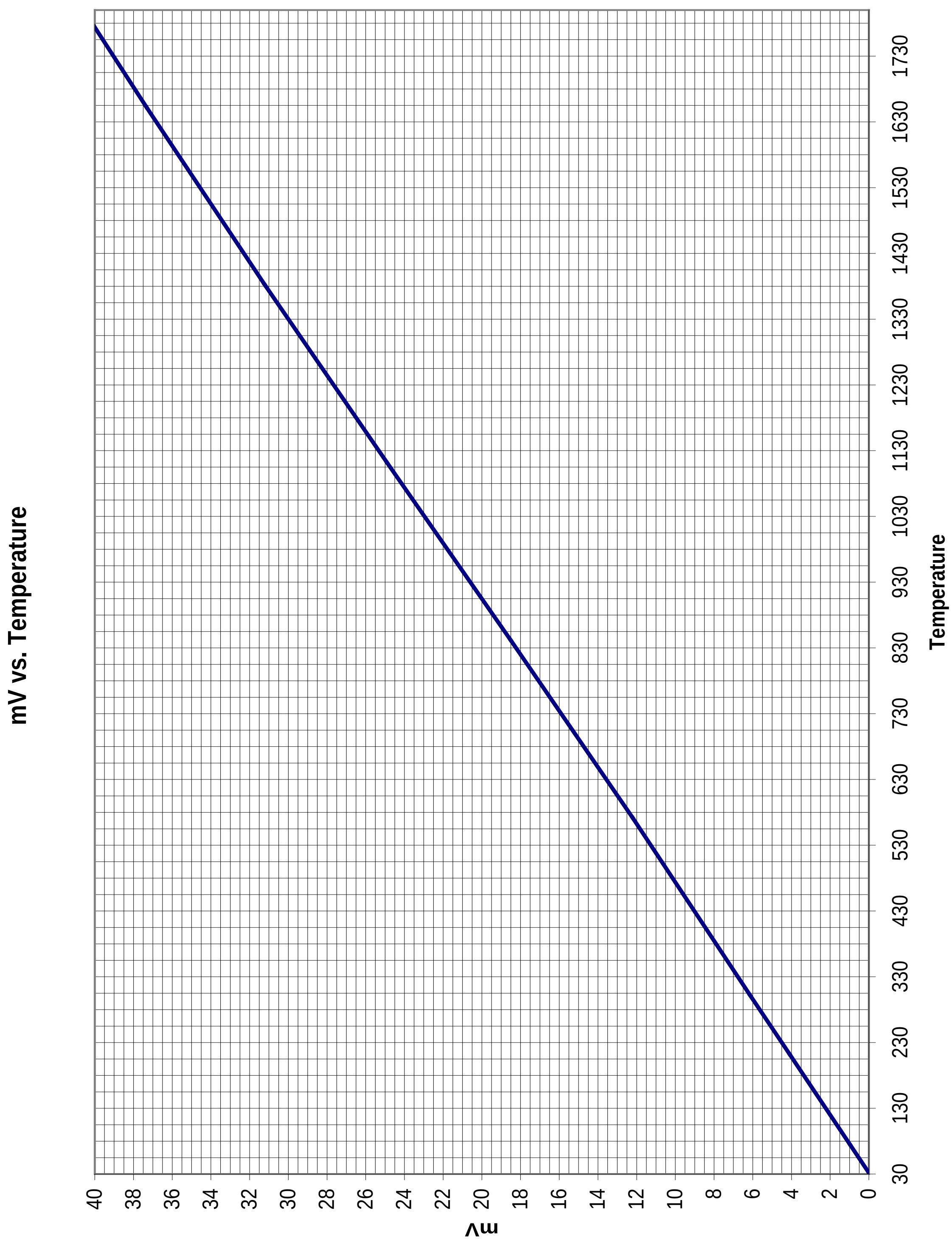
With the unit powered, and running, the following list of voltage ranges are normal for the terminals listed: (NOTE : All Voltages have a tolerance of measurement. These values are given as a guideline, and are not expected to be exact. These are ball park values unless specified otherwise. 0 VDC means Power Supply minus (-). The values were measured with the black probe of the meter on terminal 52.)

1. RS-485 – 0 VDC not connected, 2 to 3 VDC and jumping when connected (polling device dependent)
2. RS-485 + 4 VDC not connected, 2 to 3 VDC and jumping when connected (polling device dependent)
3. 0 VDC
4. -5.6 VDC when not communicating, -3 to -6 and jumping when communicating with a PC RS-232
5. -4.2 VDC when not communicating, -2 to -4 and jumping when communicating with a PC RS-232
6. 0 VDC
7. < 40 mVDC for less than 1800 F, see chart for mV vs. deg. F voltage created by TC – Pre Cat
8. 0 VDC
9. 0.15 VDC when below 25 RPM -- LB TK or FA Valve Signal
   6 VAC, 2 VDC, 312.5 Hz at 0%, running
   7.6 VAC, 23 VDC, 312.5 Hz at 85 % running
11. 0 VDC
12. 0.5 to 0.8 VDC - Post Cat HEGO Signal
13. 0 VDC
14. 0.5 to 0.8 VDC - LB HEGO Signal
15. Pulse Width Modulated 100 Hz, DC reading will vary from Power Supply Plus to near Power Supply Minus depending on duty cycle (90 % will give close to minus, and 10% will give close to plus)

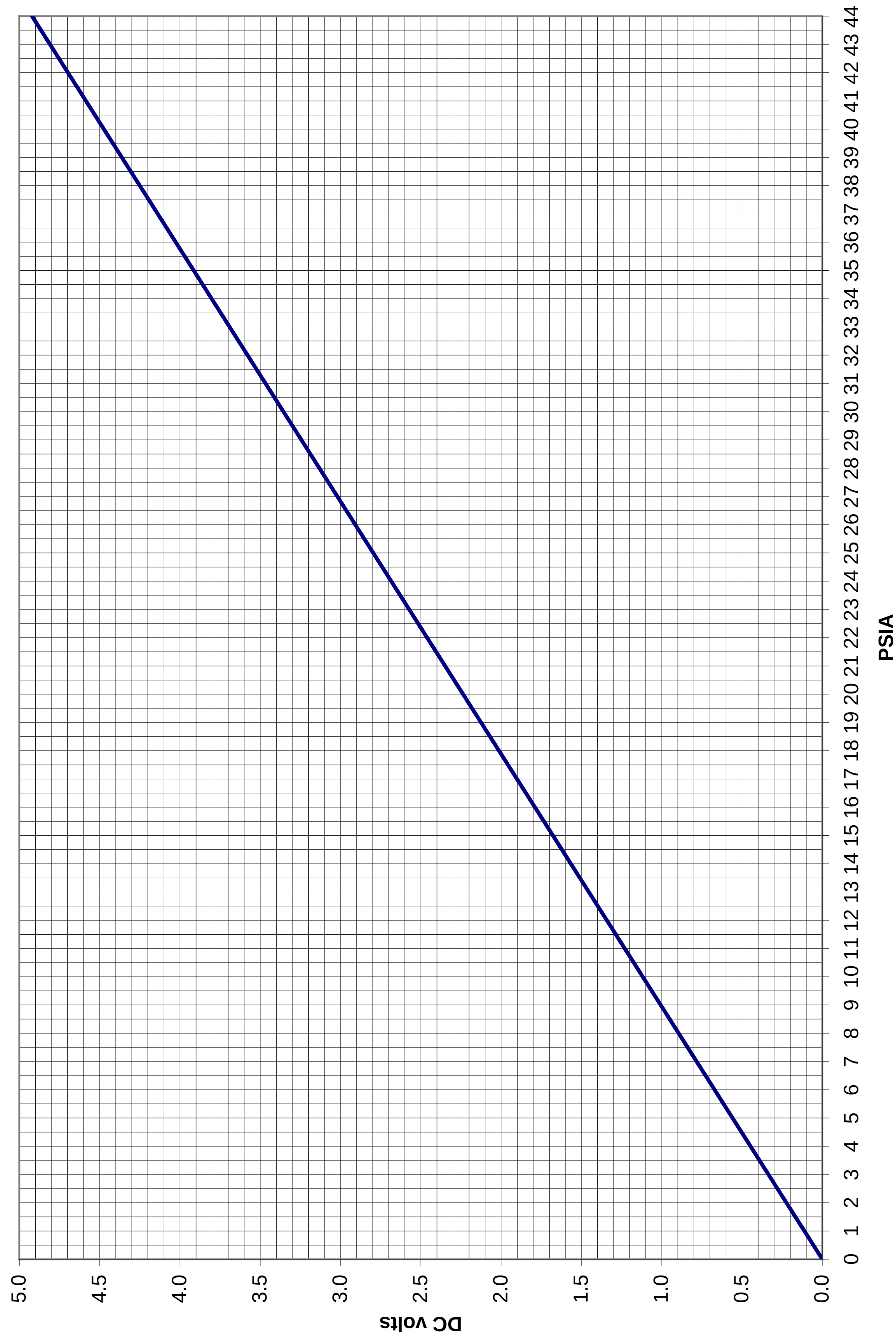
this is the transistor output for the PWM for the HEGO heater. When it turns off, it is Power Supply (+). When it turns on, it is close to Power Supply (-).
16. Power Supply + (9-32 VDC) -- Post Cat HEGO Heater
17. Pulse Width Modulated 100 Hz, DC reading will vary from Power Supply Plus to near Power Supply Minus depending on duty cycle (90 % will give close to minus, and 10% will give close to plus) this is the transistor output for the PWM for the HEGO heater. When it turns off, it is Power Supply (+). When it turns on, it is close to Power Supply (-).
18. Power Supply + (9-32 VDC) -- LB HEGO Heater
23. AUX RELAY NC – when relay not energized COM volts, when relay energized, connected device not connected voltage
24. AUX RELAY NO – when relay not energized, connected device not connected voltage, when relay energized, COM volts
25. CAN Link – 2.4 VDC not connected
26. CAN Link + 2.4 VDC not connected
30. 0 VDC
31. < 40 mVDC for less than 1800 F, see chart for mV vs. deg. F voltage created by TC – Post Cat
32. 0 VDC
33. 0.15 VDC when below 25 RPM – RB TK or FA Valve Signal
    6 VAC, 2 VDC, 312.5 Hz at 0%, running
    7.6 VAC, 23 VDC, 312.5 Hz at 85 % running
38. 0 VDC
39. Mag Pick-Up +, 0.2 1- 100 VAC rms, 8 – 10,000 Hz (10 kHz)
40. 0 – 250 VDC pulsing, G Lead for Ignition Speed Signal
41. Pulse Width Modulated 100 Hz, DC reading will vary from Power Supply Plus to near Power Supply Minus depending on duty cycle (90 % will give close to minus, and 10% will give close to plus) this is the transistor output for the PWM for the HEGO heater. When it turns off, it is Power Supply (+). When it turns on, it is close to Power Supply (-).
42. Power Supply + (9-32 VDC) -- RB HEGO Heater
47. AUX RELAY COM – Power Supply +, Power Supply -, connected device common, connected device voltage
49. Power Supply + 9 – 32 VDC Customer Power Supply Connect
50. Power Supply + 9 – 32 VDC
52. 0 VDC Customer Power Supply Connect
53. 0 VDC -- FA Valve Power
54. ALARM RELAY NC – when relay not energized COM volts, when relay energized, connected device not connected voltage
55. ALARM RELAY NO – when relay not energized, connected device not connected voltage, when relay energized, COM volts
56. ALARM RELAY COM – Power Supply +, Power Supply -, connected device common, connected device voltage
57. SHUTDOWN RELAY NC – when relay not energized COM volts, when relay energized, connected device not connected voltage
58. SHUTDOWN RELAY NO – when relay not energized, connected device not connected voltage, when relay energized, COM volts
59. SHUTDOWN RELAY COM – Power Supply +, Power Supply -, connected device common, connected device voltage
61. Power Supply + FA Valve Power
63. 5 VDC
64. MAP signal 0 -5 DVC, see chart with Volts vs. PSIA for the MAP sensor
65. 0 VDC

See Charts for mV vs. deg. F for Type K thermocouples, VDC vs. PSIA for the MAP Sensor, and VDC vs. % Excess O2 for HEGO Sensor.

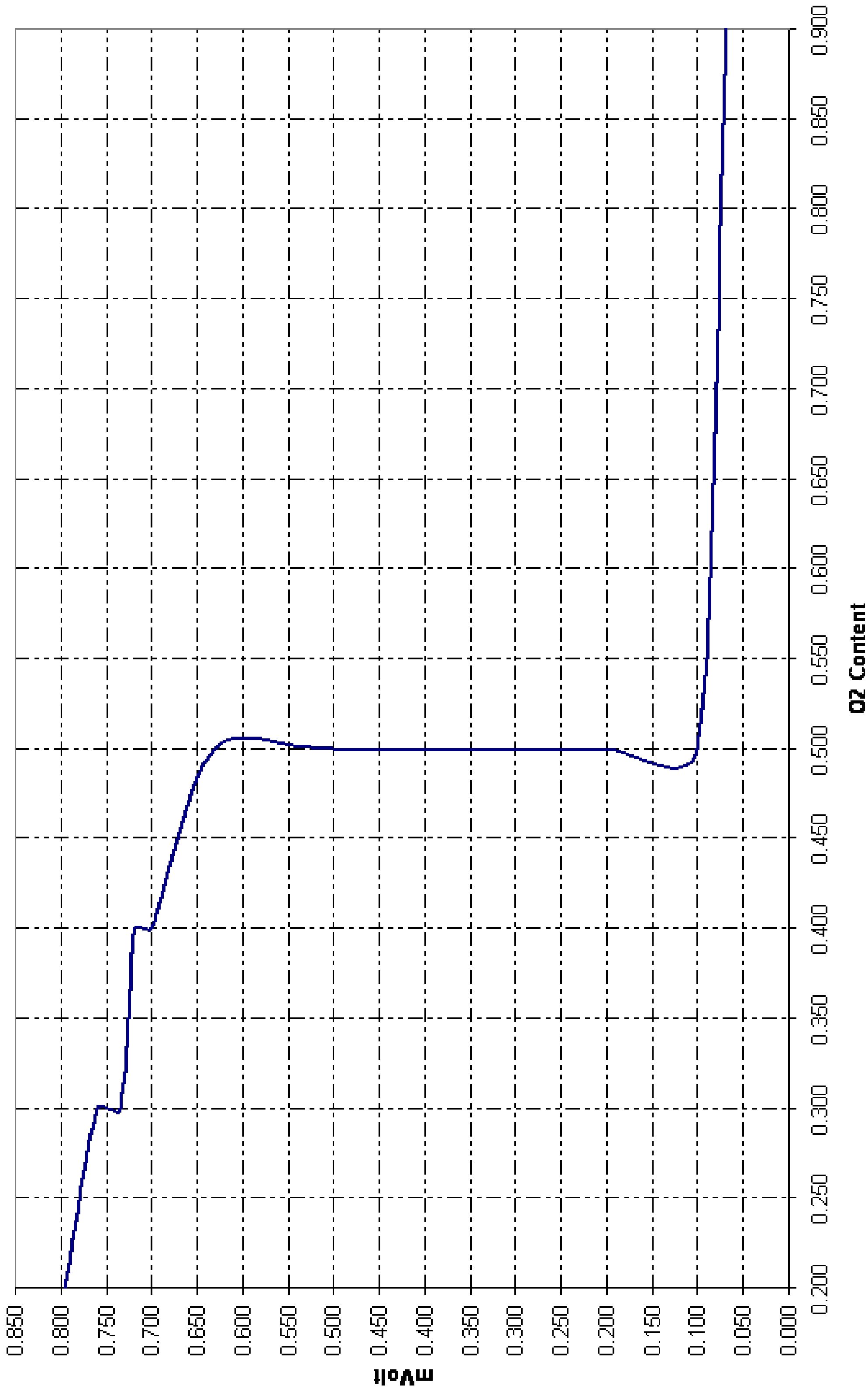
Thermocouple mV vs. Temperature



MAP Sensor VDC vs. PSIA



HEGO Sensor Voltage vs. Estimated O2 Content



FT Valve Position Testing

At the plug connector for the FT valve, on the FT Valve side, voltage can be read to see what the valve position feedback signal is. See the diagram below to see how to connect the Multi-meter to read Volts DC. The readings will be in the range of 0 – 5 VDC. Undo the latch at either side of the plug and remove the rubber plugs from the locations indicated. Place the meter probes in the holes indicated after the rubber sealing plugs have been removed. Three charts are included to show the Feedback Voltage versus the Percentage Driven. There will be some variation between valves.

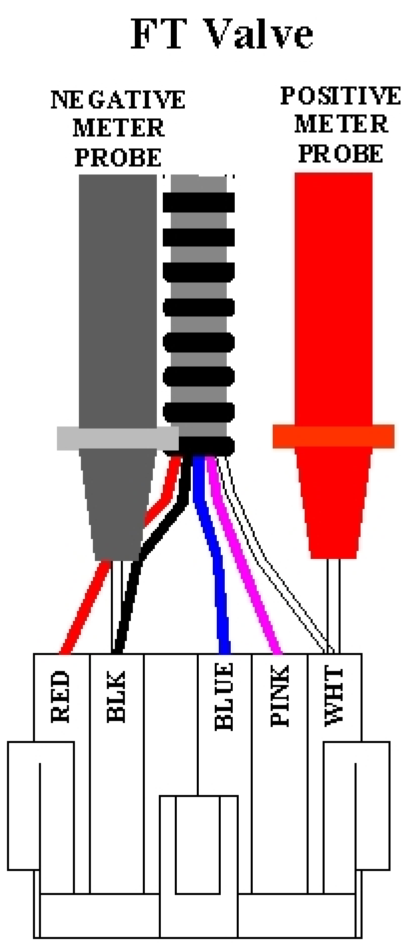
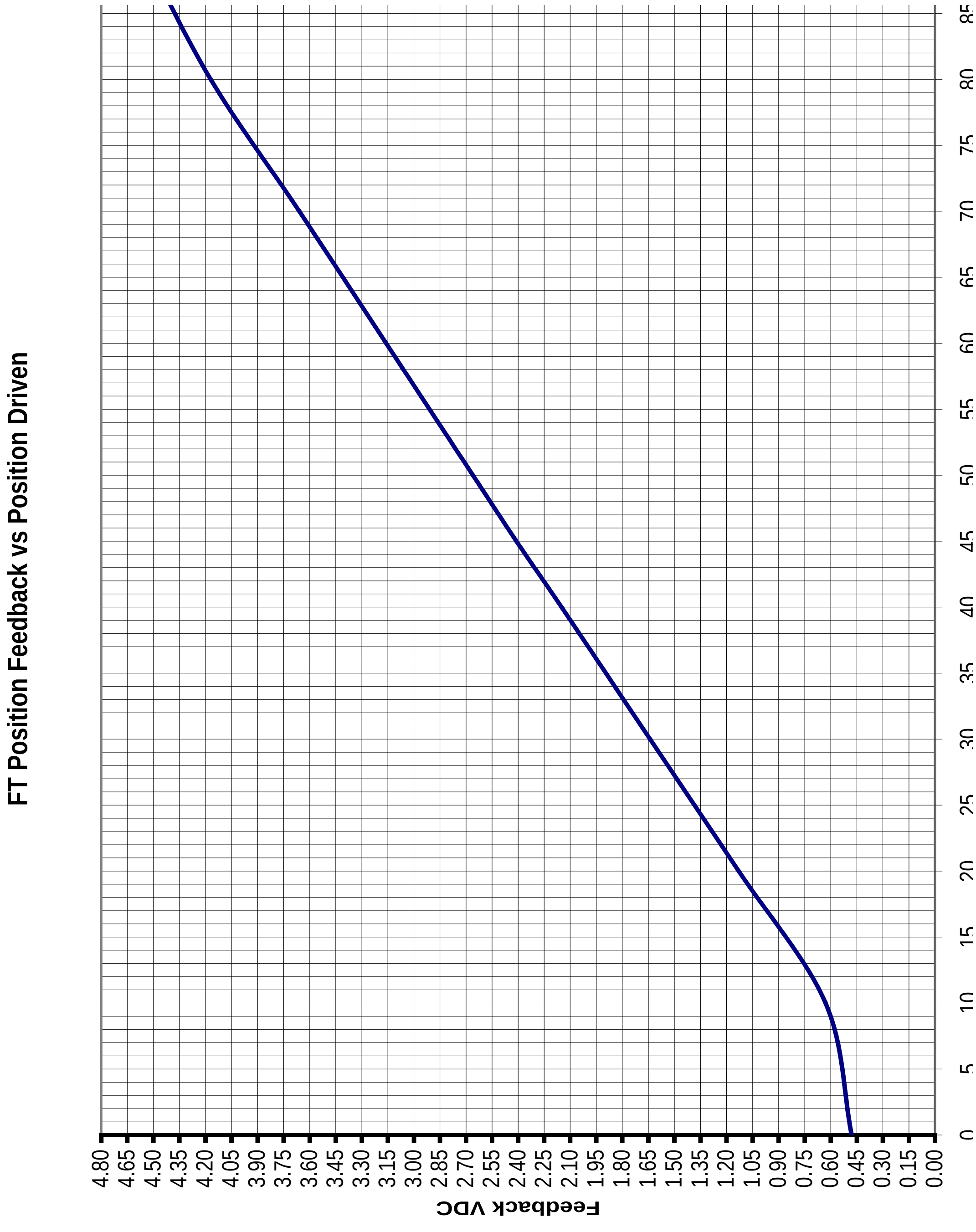


Illustration 19 – FT Valve Position Testing Probe Placement

Push the meter probes in until DC voltage is read. It will be in the range of 0 – 5 VDC. There is some variance from valve to valve. The chart represents those variances.

FT Valve Position Feedback vs. Driven Position



Troubleshooting Action Steps

When values are read at the terminal block different than what was listed, follow these steps:

1. Disconnect the wiring at the TCB for the trouble points.
2. Disconnect the device at the other end of the wires.
3. Measure Ohms between the disconnected wires at the controller end and ground. There should never be any reading except Open Lead, or open circuit. If there are any readings showing Ohms, then that wiring, harness, or cable is shorted to ground and needs to be replaced.
4. Measure Ohms between individual wires of wiring, a harness, or a cable. The readings should always be Open Lead, or open circuit. If there are any readings of Ohms, then that wiring, harness, or cable has shorts between the wires and needs to be replaced.

If the wiring harnesses, or cables pass the tests above, then the devices that were connected to the wiring harness, or cable should be checked with a meter. At this point, the device is the most likely suspect. But there are a few things that can be checked.

1. Thermocouples – Check the thermocouple wire versus the metal of the sheath, or skid ground for Ohms. Ungrounded (the only kind recommended) thermocouples must show open circuit

   Use an independent device to read the thermocouple to get temperature readings from it to check the accuracy of the Thermocouple.

   Use a thermocouple simulator to put a calibrated signal into the unit.

   MilliVolts can be read from the thermocouple, but the reading is subject to Cold Junction Compensation, and can have large errors as compared to a thermocouple table, or the chart already shown.

2. HEGO checking
   The Ohms between Heater + and Heater – should be approximately 7.

3. Magnetic Pick-up 1000 Ohms

4. MAP Sensor with the plug connector at the top, and the red meter probe always on the left,

Left to Center	5.46 k Ohms
Center to Right	9.59 k Ohms
Left to Right	4.14 k Ohms

5. FT Valve
   Red probe to Red wire on far end Black probe on Black wire 35 M Ohms
   Red Probe to Blue wire (harness green) Black probe to Pink wire (harness white) 157-158 k Ohms
   Red Probe to White wire, Black probe to Black wire 0.97 m Ohms

6. TK Valve
   Coil should measure 15 Ohms ± 1 Ohm.

Troubleshooting Communications with the PC

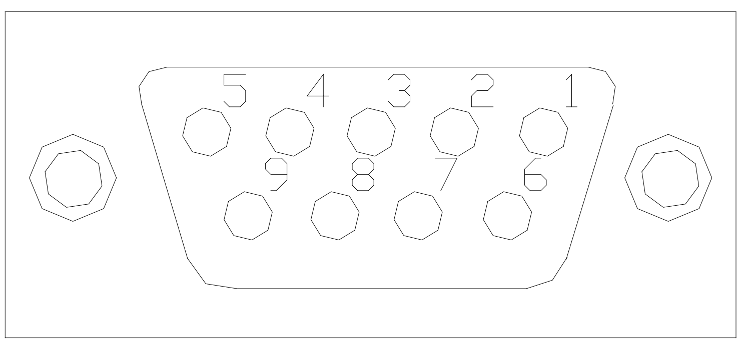
If the PC will not communicate with the AFR-64R, there are several things to check.

1. Check the Com Port settings in the software. The choices are:
   Automatic, COM1, COM2, COM3, COM4, COM5, COM6, COM7, or COM8
   Usually Automatic will work fine. But it may be necessary to force the selection. In the Control Panel for the PC, depending on your OS (Windows whatever) choose the Classic View, then choose System, then in the Hardware tab, choose Device Manager, then expand "Ports (COM & LPT)". Double click on the COM port you are trying to use. You will get a Window titled "Communications Port (COM1) Properties. That window has tabs for General, Port Settings, Driver and Resources. Again depending on your operating system the choices may be different. The main thing is that Windows thinks the port is working, it is enabled, the settings are for a Baud Rate greater than 19,200, 8 Data Bits, Parity – None, Stop bits – 1, Flow Control – None. In the Advanced button, you may want to uncheck the box for the FIFO buffers.

2. Try another device, or a PC to PC connection using Hyperterminal and a null modem cable.

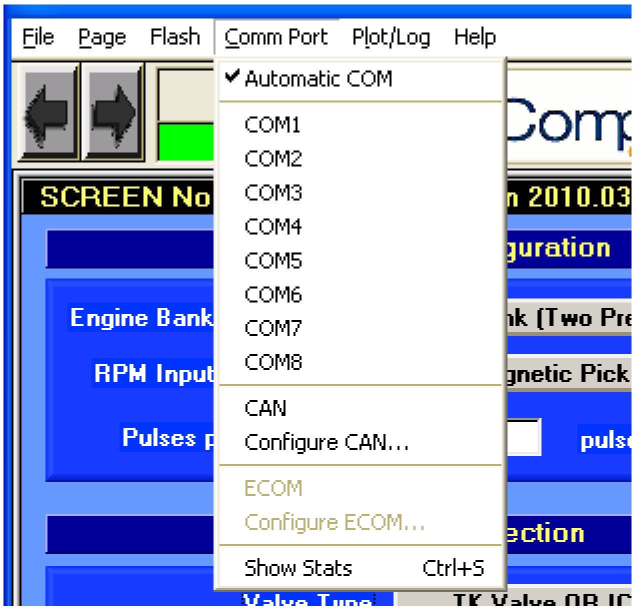
3. Check the null modem cable for continuity end to end. The end to end pin out should be:

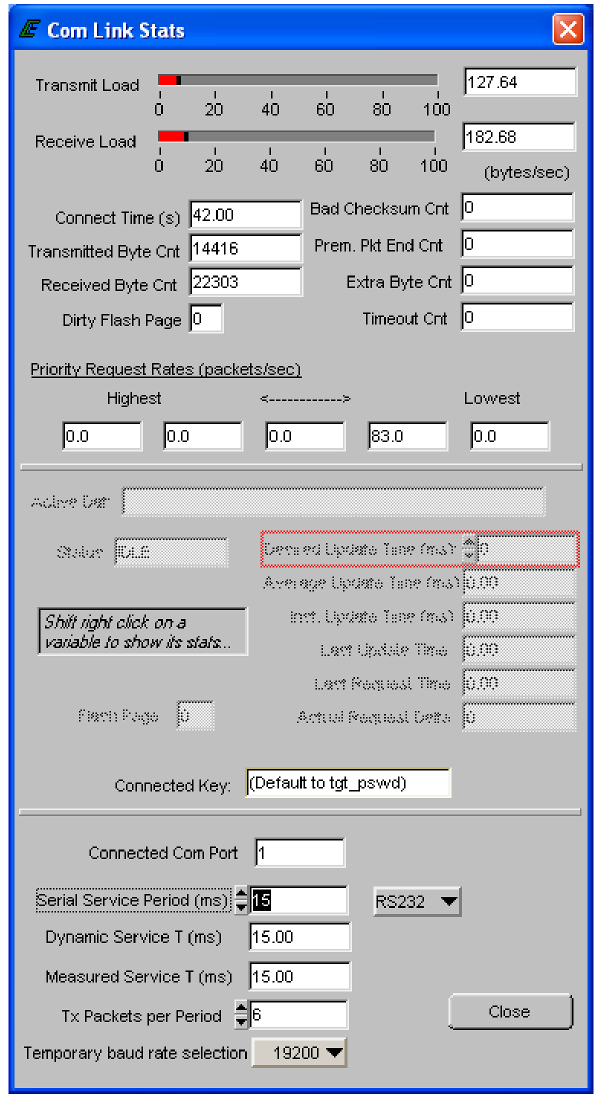
   Pin 1 Pin 4
   Pin 2 Pin 3
   Pin 3 Pin 2
   Pin 4 Pin 1
   Pin 5 Pin 5
   Pin 6 not used either end
   Pin 7 pin 8
   Pin 8 Pin 7
   Pin 9 Pin 9



4. Make sure no other software "owns" the COM port. You may have to disable or uninstall the conflicting software.

5. If you click on "COM Port", then *"Show Stats"*, you will get this window shown below.





Loading a MOT file

To reload the controller's operating software (MOT file), follow these steps:

1) Insure that the engine is shutdown and controller is powered up.
2) Start the "Display Software" on your PC.
3) Click on the "File" pull down menu at the top left hand side of the screen (on any screen)
4) Click on the "Reprogram Target" button.
5) Choose the operating file (MOT file) for the controller in use. At the time of this publication the current operating file (MOT file) is AFR-64R_rev_F. Contact your local Compliance Control's distributor if the operating software that you have is not the most current. Or, if you have previously gotten a user name and password for the extranet part of the Compliance Controls web site, you can check the latest release there.

Plotting Techniques and Diagnostics

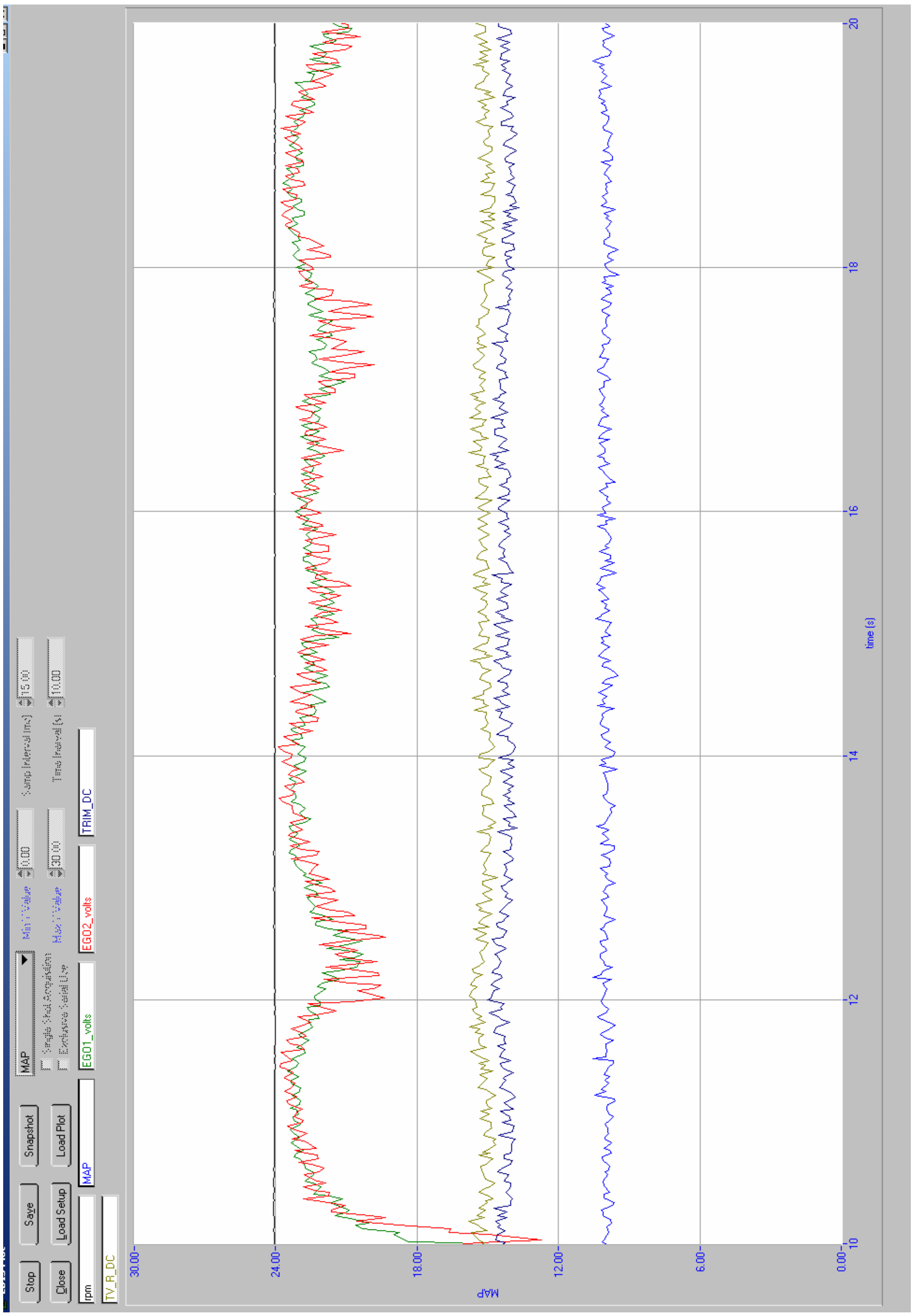
The plotting command is a very useful tool in setting up and monitoring the controller. The "oscilloscope" style plotting allows variables to be plotted for a graphical representation. The following steps are how to plot the data.

1) When looking at a screen, move the mouse cursor to the variable to be plotted.
2) Right click on the variable.
3) The variable cell color will be changed from gray or white to green.
4) A maximum of ten (10) variables may be tagged for a single plot
5) Once all variables are tagged, press the 'p' key to plot.
6) The plotting will be started with a default time of 10 seconds.
7) All variables of the plotting can be changed while in plotting mode.

When saving plots, only the data displayed on the screen at the time when the "Save" button is pressed will be saved. To save the plot, follow these steps:

1) Press the "SAVE" button
2) Choose a file name and a file location.
3) Press the save button at the bottom right hand side of the screen.

Plot Example



Maintenance

The AFR-64R controller and system components were designed to be very reliable in operation. Very few of the components require any maintenance; however the heated exhaust gas oxygen sensors (HEGO), intake manifold pressure (MAP) sensor and the thermocouple sensors have a limited life and will require regular replacement. A regular program for engine maintenance should continue after the AFR-64R system is installed. To provide emissions compliance, the original engine systems need to be in proper working order. Please review the warning statements, and any warnings associated with the exhaust system components. The use of certain gasket sealers (RTV), thread sealers and high temperature thread lubricants can cause poisoning of the oxygen sensors. Contact your COMPLIANCE CONTROLS distributor for a list of possible sensor poisons. The frequent replacement required for the oxygen sensor can cause these contaminants to build up relatively quickly. Excessive engine oil consumption can also cause these effects over longer periods of time. The AFR-64R system will relieve the operator of constant carburetor tuning for emissions compliance, but consistent engine maintenance is still required.

Replacement Information

The replacement of sensors will depend mainly on engine operating hours. Below is an estimated life expectancy of the AFR-64R end devices:

- HEGO Sensors – The “Health” of the HEGO sensors are monitored by the controller and are reported as a percentage. The HEGO sensor should be replaced once the health drops below 50%. The controller considers the sensor(s) faulty once the health drops below 40%. If the engine is not run for a period greater than 12 months the sensor should be replaced due to the possibility of moisture saturation.
- MAP Sensor – 16,000 hours of engine operation or 36 months installed, whichever occurs first.
- Thermocouple – 36,000 hours of engine operation or 48 months installed, whichever occurs first.

Troubleshooting Guide

Problem/Fault	Trigger Point	Possible Cause	Correction
MAP High Pressure	MAP Pressure greater than 42 psia - Disables Adaptive Learn	Faulty MAP sensor	Replace MAP sensor
		Wiring harness shorted	Replace harness
		MAP sensor connected to port other than intake manifold	Move connection to intake manifold
		Shorted connection on TCB	Replace TCB
		Faulty ECM control module	Replace ECM module
		MOT file corrupted	Reload most recent MEC-R MOT file
MAP Low Pressure	MAP voltage less than 0.050 volts DC - Disables Adaptive Learn	Faulty MAP sensor	Replace MAP sensor
		Wiring harness open	Replace harness
		Open connection on TCB	Replace TCB
		Faulty ECM control module	Replace ECM module
		MOT file corrupted	Reload most recent MEC-R MOT file
Thermocouple 1 or 2 Open	Exhaust temperature exceeds 1800 degrees F for more than 1 second	Open or broken thermocouple wiring	Replace or repair wiring
		Open or broken thermocouple probe	Replace themocouple probe
		Open connection on TCB	Replace TCB
		Faulty ECM control module	Replace ECM module
		MOT file corrupted	Reload most recent MEC-R MOT file
Thermocouple 1 or 2 High Temp	Exhaust temperature exceeds user defined set point for greater than 5 seconds	Cylinder misfire	Check ignition system
			Change spark plugs
			Check cylinder compression
		Thermocouple bad	Replace themocouple probe
		Faulty ECM control module	Replace ECM module
		MOT file corrupted	Reload most recent MEC-R MOT file
Thermocouple 1 or 2 Low Temp	Exhaust temperature less than 500 degrees F for greater than 300 seconds	Faulty thermocouple	Replace thermocouple
		Shorted thermocouple wire	Replace thermocouple wire
		Incorrect wire type	Replace wire with type “K” compatible wire
		Shorted TCB connection	Replace TCB
		Faulty ECM control module	Replace controller
		MOT file corrupted	Reload most recent MEC-R MOT file
CJC High Voltage	CJC voltage greater than 4.95 volts DC	Faulty ECM control module	Replace ECM module
		MOT file corrupted	Reload most recent MEC-R MOT file
CJC Low Voltage	CJC voltage less than 0.050 volts DC	Faulty ECM control module	Replace ECM module
		MOT file corrupted	Reload most recent MEC-R MOT file
MAT High Voltage	MAT voltage greater than 4.950 volts DC - Disables Adaptive Learn	Incorrect MEC-R MOT file loaded	Reload most recent MEC-R MOT file
		MOT file corrupted	Reload most recent MEC-R MOT file

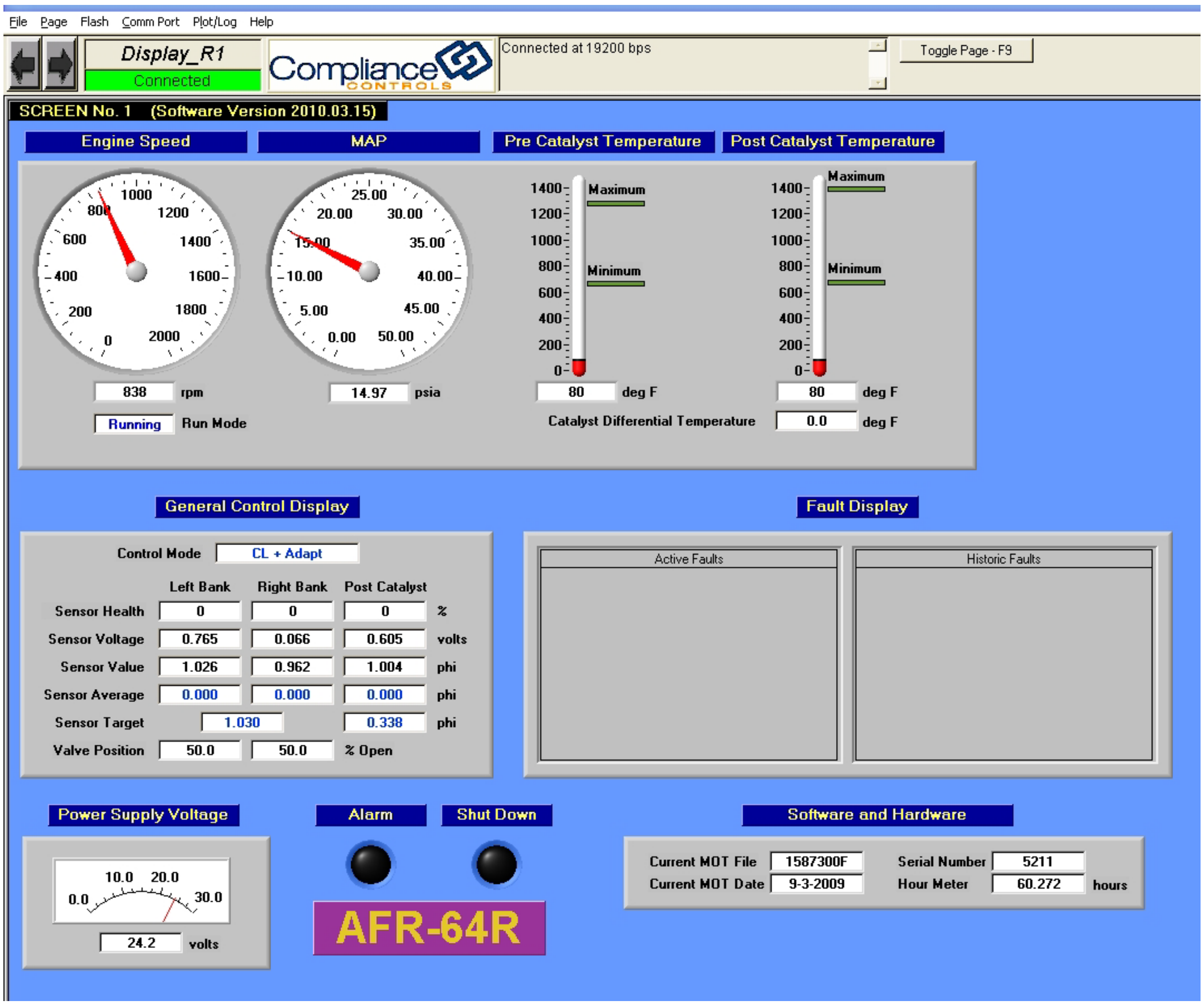
Problem/Fault	Trigger Point	Possible Cause	Correction
MAT Low Voltage	MAT voltage less than 0.050 volts DC - Disables Adaptive Learn	Incorrect MEC-R MOT file loaded	Reload most recent MEC-R MOT file
		MOT file corrupted	Reload most recent MEC-R MOT file
MAT High Temp Pre-Alarm	MAT Temperature exceeds 150 degrees F - Disables Adaptive Learn	Incorrect MEC-R MOT file loaded	Reload most recent MEC-R MOT file
		MOT file corrupted	Reload most recent MEC-R MOT file
MAT High Temp Alarm	MAT Temperature exceeds 160 degrees F - Disables Adaptive Learn	Incorrect MEC-R MOT file loaded	Reload most recent MEC-R MOT file
		Faulty TCB	Replace TCB
		Faulty ECM control module	Replace controller
		MOT file corrupted	Reload most recent MEC-R MOT file
BP High Pressure	Barometric Pressure greater than 16.0 psia	Faulty ECM control module	Replace controller
		MOT file corrupted	Reload most recent MEC-R MOT file
BP Low Pressure	Barometric Pressure less than 8.30 psia	Faulty ECM control module	Replace controller
		MOT file corrupted	Reload most recent MEC-R MOT file
Voltage High	Supply voltage greater than 32.0 volts DC - Disables Adaptive Learn - Cycle power to reset	Power supply	Replace power supply
		Cross connection	Check for cross connection with other power supply
		Faulty ECM control module	Replace controller
		MOT file corrupted	Reload most recent MEC-R MOT file
Voltage Low	Supply voltage less than 9.5 volts DC - Disables Adaptive Learn - Cycle power to reset	Power supply faulty	Replace power supply
		Poor connection	Improve connection
		Faulty TCB	Replace TCB
		Faulty ECM control module	Replace controller
		MOT file corrupted	Reload most recent MEC-R MOT file
Max Govern Speed Override	Observed engine speed greater than 4500 RPM	Pulses per revolution set incorrectly	Adjust pulses per revolution
		Dirty magnetic pickup	Clean magnetic pickup
		Faulty magnetic pickup	Replace Magnetic pickup
		MOT file corrupted	Reload most recent MEC-R MOT file
		Faulty ECM controller	Replace ECM controller
5VE High Voltage	5 volt extermal voltage supply greater than 5.4 volts DC - Disables Adaptive Learn	Faulty ECM control module	Replace controller
		MOT file corrupted	Reload most recent MEC-R MOT file

Problem/Fault	Trigger Point	Possible Cause	Correction
5VE Low Voltage	5 volt extermal voltage supply less than 4.6 volts DC - Disables Adaptive Learn	Faulty ECM control module	Replace controller
		MOT file corrupted	Reload most recent MEC-R MOT file
Fuel Rev Limit	Observed engine speed greater than 4800 RPM	Pulses per revolution set incorrectly	Adjust pulses per revolution
		Dirty magnetic pickup	Clean magnetic pickup
		Faulty magnetic pickup	Replace Magnetic pickup
		MOT file corrupted	Reload most recent MEC-R MOT file
		Faulty ECM controller	Replace ECM controller
Spark Rev Limit	Observed engine speed greater than 4900 RPM	Pulses per revolution set incorrectly	Adjust pulses per revolution
		Dirty magnetic pickup	Clean magnetic pickup
		Faulty magnetic pickup	Replace Magnetic pickup
		MOT file corrupted	Reload most recent MEC-R MOT file
		Faulty ECM controller	Replace ECM controller
AL High Left or Right Bank	Adaptive Learn - Actual fuel control valve position greater than "Nominal" valve position by +30% of range	Carburetor set too lean	Adjust carburetor load screw – rich
		Fuel pressure too low	Increase fuel pressure at final cut regulator
		HEGO sensor failure	Replace faulty HEGO sensor
		Fuel control valve not responding	Check valve wiring; Replace fuel control valve
AL Low Left or Right Bank	Adaptive Learn - Actual fuel control valve position less than "Nominal" valve position by - 30% of range	Carburetor set too rich	Adjust carburetor load screw – lean
		Fuel pressure too high	decrease fuel pressure at final cut regulator
		HEGO sensor failure	Replace faulty HEGO sensor
		Fuel control valve not responding	Check valve wiring; Replace fuel control valve
CL High Left or Right Bank	Closed Loop - Adapted Pre Catalyst target valve greater than Pre Catalyst target by +30% of range	Pre-Catalyst Phi values set too lean	Adjust Phi values richer
		HEGO sensor failure	Replace faulty HEGO sensor
		Fuel control valve not responding	Check valve wiring; Replace fuel control valve
CL Low Left or Right Bank	Closed Loop - Adapted Pre Catalyst target valve less than Pre Catalyst target by -30% of range	Pre-Catalyst Phi values set too rich	Adjust Phi values leaner
		HEGO sensor failure	Replace faulty HEGO sensor
		Fuel control valve not responding	Check valve wiring; Replace fuel control valve
EGO Fault Left, Right or Post Catalyst	HEGO sensor cold or non responsive for greater than 60 seconds - Disables Adaptive Learn	HEGO sensor failure	Replace faulty HEGO sensor
		MOT file corrupted	Reload most recent MEC-R MOT file
		Faulty TCB	Replace TCB
		Faulty ECM controller	Replace ECM controller
COP Failure	Processor failure	Faulty ECM controller	Replace ECM controller
Invalid interrupt	Processor failure	Faulty ECM controller	Replace ECM controller

Problem/Fault	Trigger Point	Possible Cause	Correction
UEGO Heater Supply High Voltage	HEGO sensor heater supply heater voltage persistanty high	HEGO sensor failure	Replace faulty HEGO sensor
		MOT file corrupted	Reload most recent MEC-R MOT file
		Faulty TCB	Replace TCB
		Faulty ECM controller	Replace ECM controller
UEGO Heater Supply Low Voltage	HEGO sensor heater supply heater voltage persistanty low	HEGO sensor failure	Replace faulty HEGO sensor
		MOT file corrupted	Reload most recent MEC-R MOT file
		Faulty TCB	Replace TCB
		Faulty ECM controller	Replace ECM controller
A/D loss	Processor failure	Faulty ECM controller	Replace ECM controller
RT1 Loss	Processor failure	Faulty ECM controller	Replace ECM controller
RT2 Loss	Processor failure	Faulty ECM controller	Replace ECM controller
RT3 Loss	Processor failure	Faulty ECM controller	Replace ECM controller
Flash Checksum Invalid	Processor failure	Faulty ECM controller	Replace ECM controller
RAM Failure	Processor failure	Faulty ECM controller	Replace ECM controller
High HEGO Sensor Voltage	Not a coded fault - General troubleshooting only	Engine running too rich	Adjust carburetor leaner
		Fuel control valve failure	Replace fuel control valve
		Faulty oxygen sensor wiring harness - open	Replace wiring harness
		Faulty oxygen sensor	Replace oxygen sensor
		Oxygen sensor overheating	Cool or relocate oxygen sensor
		Exhaust leak / oxygen intrusion	Correct exhaust leak
		Faulty TCB	Replace TCB
		Faulty ECM controller	Replace ECM controller
		MOT file corrupted	Reload most recent MEC-R MOT file
HEGO Sensor Voltage Low	Not a coded fault - General troubleshooting only	Engine running too lean	Adjust carburetor richer
		Fuel control valve failure	Replace fuel control valve
		Faulty oxygen sensor wiring harness - shorted	Replace wiring harness
		Faulty oxygen sensor	Replace oxygen sensor
		Oxygen sensor overheating	Cool or relocate oxygen sensor
		Exhaust leak / oxygen intrusion	Correct exhaust leak
		Faulty TCB	Replace TCB
		Faulty ECM controller	Replace ECM controller
		MOT file corrupted	Reload most recent MEC-R MOT file

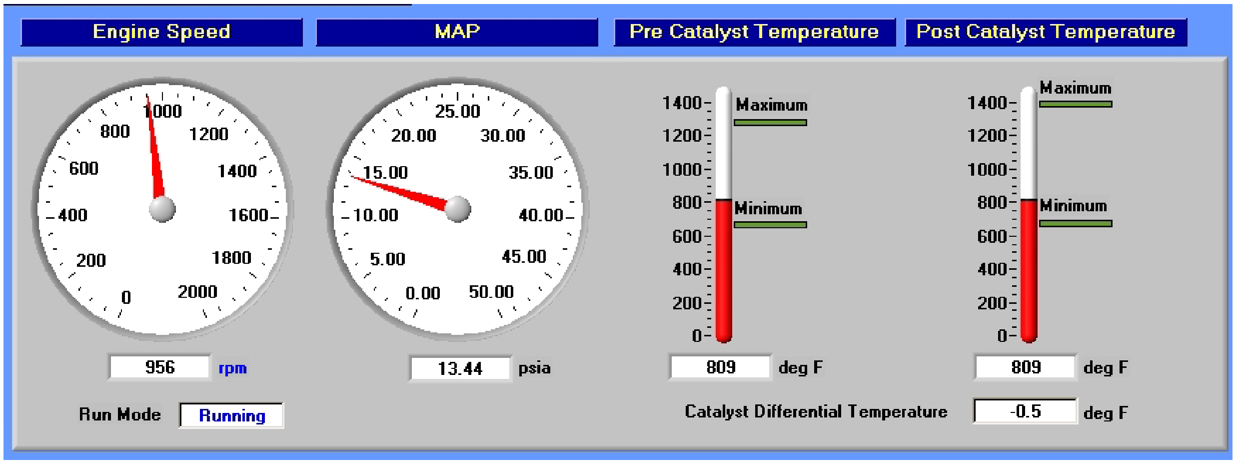
PC Display Screen Description

Display Screen (Screen No. 1)



On the “Display Screen (Screen No. 1)”, all engine operating parameters monitored by the controller and all of the AFR-64R controller’s operational parameters can be seen.

Engine Operating Parameters Group



Engine Speed – Actual engine speed. Expressed in Revolutions Per Minute (RPM).

MAP – Intake Manifold Absolute Pressure. Expressed in Pounds per Square Inch Absolute (PSIA).

Run Mode - Indicates the mode of operation of the engine as determined by the engine speed input. Three operating modes are seen though out the operation of the controller from engine start to engine shutdown:

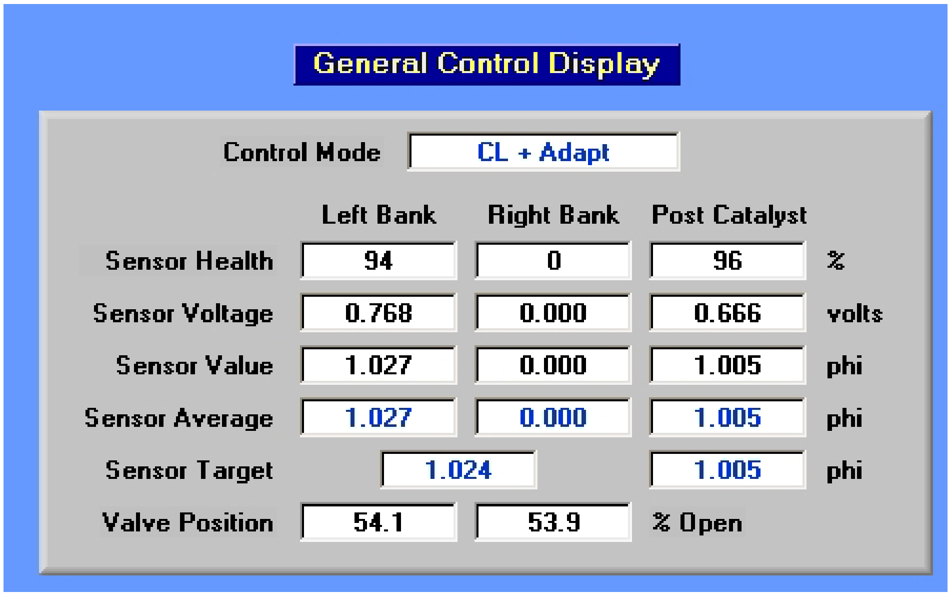
- **STOP** – any engine speed below 25 RPM;
- **CRANKING** – engine speeds greater than 25 RPM and less than 450 RPM;
- **RUNNING** – any engine speed greater than 450 RPM.

Pre Catalyst Temperature – The actual exhaust gas temperature entering the catalytic converter housing. Expressed as Degrees Fahrenheit (°F).

Post Catalyst Temperature – The actual exhaust gas temperature exiting the catalytic converter housing. Expressed as Degrees Fahrenheit (°F).

Catalyst Differential Temperature – The calculated differential temperature across the catalytic converter housing.

General Control Display Group



Control Mode – Indicates the operating mode of the controller. In this cell there are four (4) possible operating modes:

- **Open Loop** – The control system has not yet met all of the requirements to go into Closed Loop. In this mode no input from the HEGO sensors are required for operation. The controller only operates at predetermined valve positions.
- **CL Inactive** – Closed Loop Inactive. In this mode the controller has met all necessary parameters to go into Closed Loop operation but is locked out of Closed Loop by the Sensor Control Table (see the “Setup” screen). The controller operates the same as it would in Open Loop.
- **CL Active** – Closed Loop Active. In this mode the controller has met all necessary parameters for operation and has been cleared to control by the Closed Loop Enable Table. The controller operates on the feedback signal from the Left and/or Right Bank HEGO (pre catalyst) sensors only.
- **CL + Adapt** – Closed Loop + Adaptive, the controller operates with the feedback signal from the Post Catalyst HEGO sensor. With the Post Catalyst HEGO sensor average Phi signal, the controller adapts the Left and/or Right Bank HEGO Phi targets to compensate for the offset needed to correct the emissions into the catalyst, to insure that the emissions exiting the catalyst are maintained at the desired point.

Sensor Health – The reliability of the HEGO sensors are monitored throughout the operation of the controller. The controller reads a resistance through the HEGO sensor and calculates a “Health” percentage. When the sensor “Health” reaches 40%, the sensor is considered failed and is turned off. When the Post Catalyst sensor fails, the controller switches from Closed Loop Adaptive to Closed Loop Active and controls strictly by the Left and/or Right Bank HEGO (pre catalyst) sensor. When the Left and/or Right Bank HEGO (pre catalyst) sensor fail, the controller switches to “Open Loop” and the valves default to the predetermined positions located in the “Open Loop Table” located on the “Advance Setup” screen. When any of the sensor’s health reaches 50%, the sensor should be replaced to prevent the controller from changing control state.

Sensor Voltage – These are the actual voltage readings generated by the HEGO sensors during normal engine operation. These values are used by the controller to calculate a Phi value. The voltage readings are useful during troubleshooting of the engine and controller. These values are expressed as volts DC.

Sensor Value – These are real time Phi values that the controller calculates when it reads the actual HEGO sensor voltage. These values are used by the controller to calculate a Sensor Average.

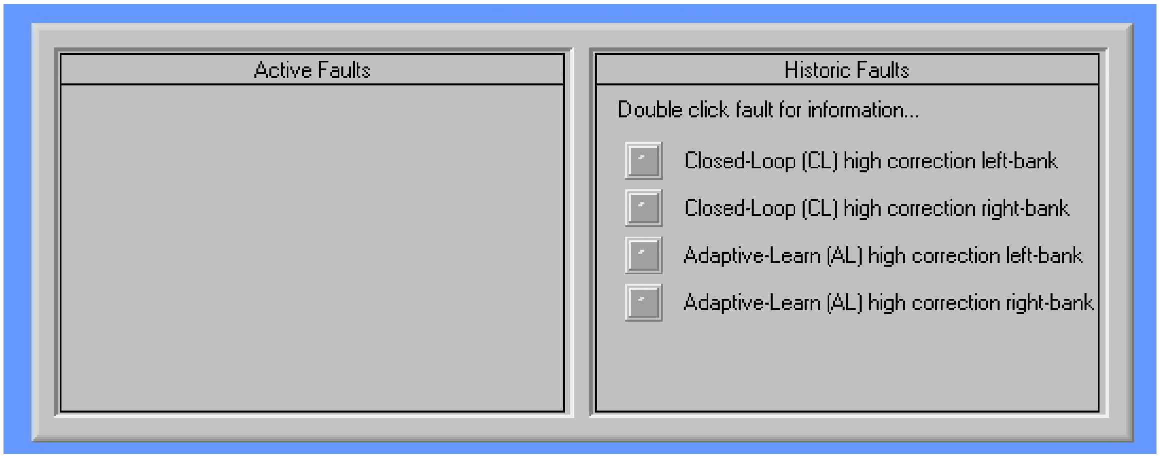
Sensor Average – These values are calculated rolling averages of the Sensor Values and are used by the controller drive the engine to the appropriate air/fuel ratio.

Sensor Target – These are the Phi values used by the controller to drive the engine air/fuel ratio to a desired point.

Valve Position – These are the actual fuel valve position expressed as a percent open: 0% being fully closed and 99% being fully open when the supplemental valve is used and 0% being fully closed and 85% being fully open when the full authority valves are used.

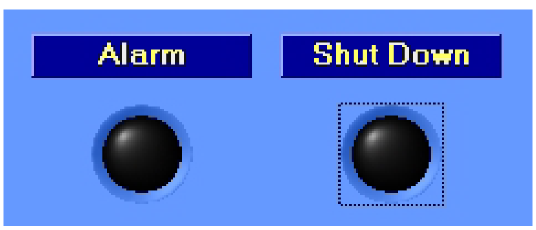
Power Supply Voltage – The actual DC supply voltage to the controller.

Fault Display Group



Active Fault Box – (Left) In this box all current faults are displayed. Once the fault clears itself, the fault is removed from this box. Only Current or Active faults are displayed. A list of Faults and possible causes can be found in Chapter 11 – “Troubleshooting and Maintenance”. When a fault is logged into this box, the Fault Relay is energized and the contacts switch state. The Fault Relay can only be cleared once all of the faults in the Active Fault Box have been cleared.

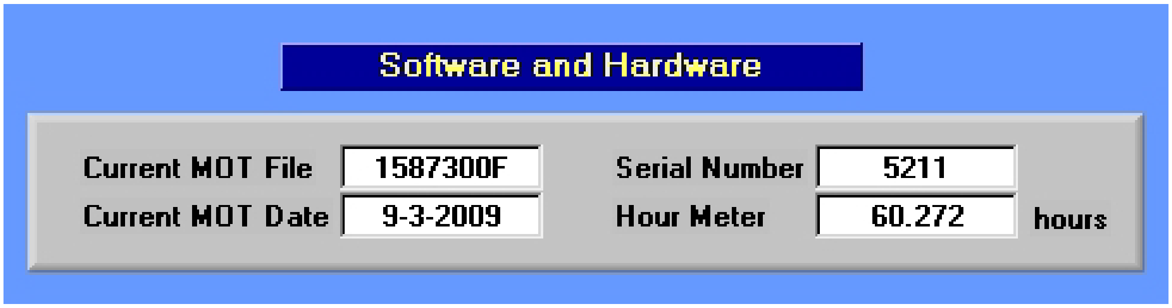
Historic Fault Box – (Right) In this box all current faults and previously cleared faults are stored. Once an Active Fault clears itself, the fault is stored in the Historic Fault Box. These faults can only be cleared manually by double clicking the red box next to the fault, choosing the fault to clear and acknowledging the fault.



Alarm Indicator Lamp – This amber lamp is illuminated anytime a fault is logged into the Active Fault Box. This is an indication that the Fault Relay has been energized. This lamp will stay illuminated until all active faults have been cleared.

Shutdown Indicator Lamp – This red lamp is illuminated anytime the controller has recognized a shutdown indication. At this time only the Exhaust Temperature faults will illuminate this lamp and energize the Shutdown Relay. This lamp will stay illuminated until all shutdown faults have been cleared and acknowledged. Once the shutdown has been cleared, a single click on the Red Lamp will reset the shutdown relay.

Software and Hardware Group



In this group all information about the controller hardware and the installed software appear. The model numbers indicated in this screen are current model numbers and dates

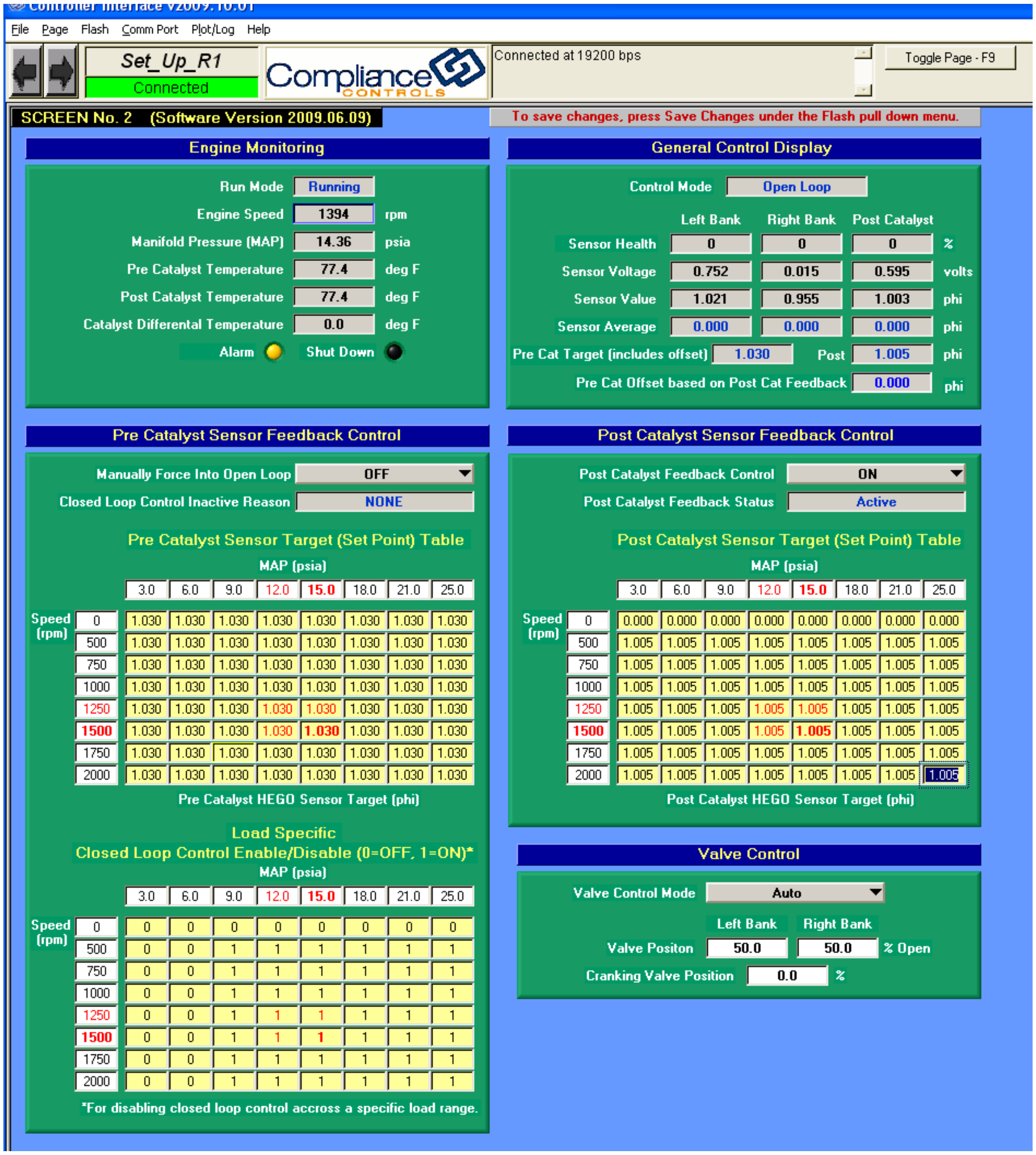
Current MOT File – Indicates which software (MOT file) is currently loaded onto controller. At this time all, current controller are shipped with a MOT file number 1587300 followed by a revision letter such as “F”. This file is located in a folder on your hard drive <C:\Output\MOT Files> and is named AFR-64R_rev_F for ease of identification.

Current MOT Date – Indicates the date in which the current software (MOT file) was created.

Serial Number – Indicates the serial number of the ECM.

Hour Meter – Indicates the life timer of the controller’s ECM . This internal clock only operates when a run signal is present. This clock cannot be zeroed.

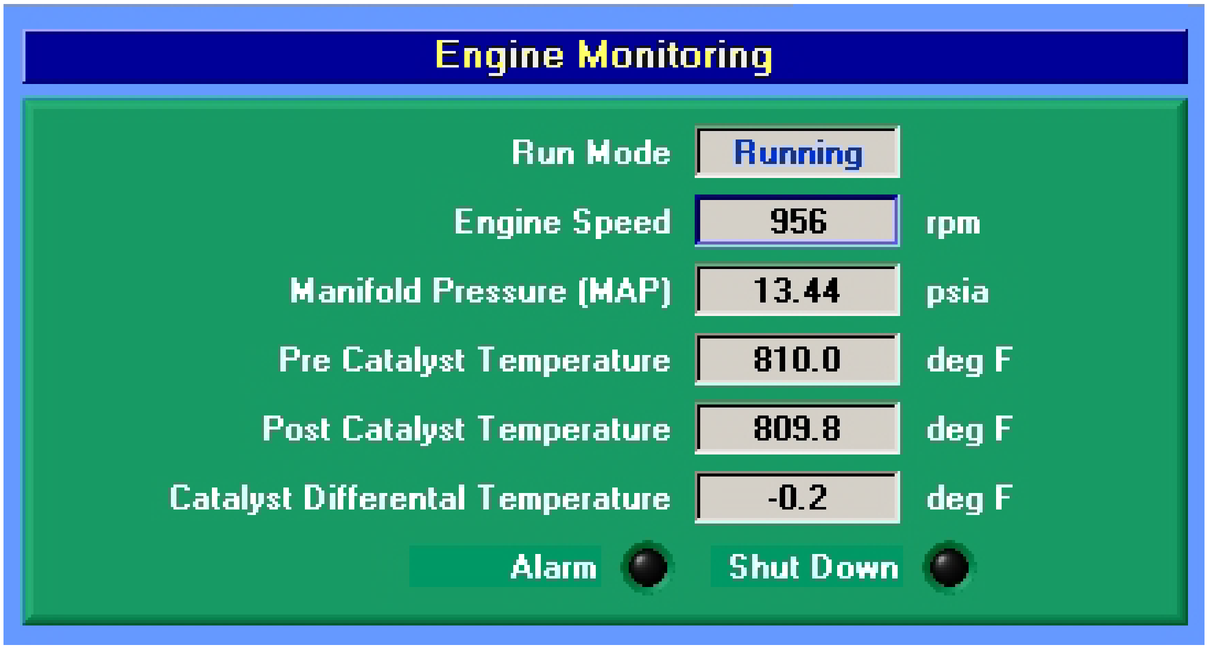
SET-UP SCREEN (Screen No. 2)



From the "SETUP" Screen (Screen No. 2), all of the controller's targeting parameters can be set, as well as monitoring of the engine's real time operating parameters. This screen's main purpose is for the setup and fine adjustment of the controller.

This screen is divided into five main groups: Engine Monitoring, General Control Display, Pre Catalyst Sensor Feedback Control, Post Catalyst Feedback Control and Valve Control.

Engine Monitoring Group



Run Mode – Indicates the mode of operation of the engine as determined by the engine speed input. Three operating modes are seen though out the operation of the controller from engine start to engine shutdown:

- **STOP** – any engine speed below 25 RPM;
- **CRANKING** – engine speeds greater than 25 RPM and below 450 RPM;
- **RUNNING** – any engine speed greater than 450 RPM.

Engine Speed – Actual engine speed, expressed in Revolutions Per Minute (RPM).

Manifold Pressure (MAP) – Intake Manifold Absolute Pressure (MAP). Expressed in Pounds per Square Inch Absolute (PSIA).

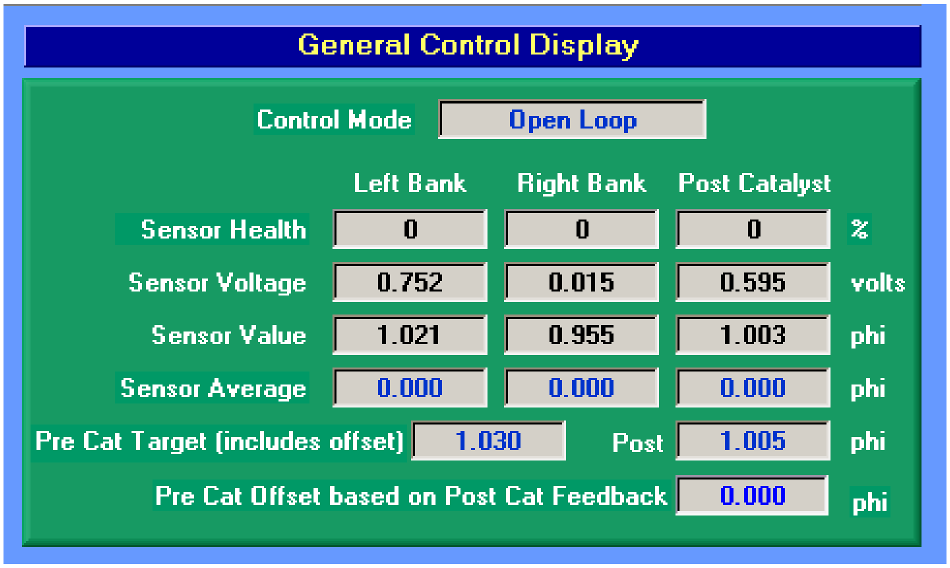
Pre Catalyst Temperature – The actual exhaust gas temperature entering the catalyst housing. Expressed as Degrees Fahrenheit (°F).

Post Catalyst Temperature – The actual exhaust gas temperature exiting the catalyst housing. Expressed as Degrees Fahrenheit (°F).

Catalyst Differential Temperature – The calculated temperature change across the catalyst housing (post catalyst temperature minus pre catalyst temperature). Expressed as Degrees Fahrenheit (°F).

Alarm and Shut Down Indicator Lamps – These lamps, amber for Alarm and red for Shut Down, indicate whether a fault has been detected and recorded. Refer to the "Fault Group" on the Display screen as to what the related fault is. These faults and/or Alarms cannot be cleared from this screen.

General Controls Display Group



Control Mode – Indicates the operating mode of the controller. In this cell there are four (4) possible operating modes:

- **Open Loop** – The control system has not yet met all of the requirements to go into Closed Loop. In this mode no input from the HEGO sensors are required for operation. The controller only operates at predetermined valve positions based on the “Nominal Valve Table” located on Screen 3 “Valve Setup”.
- **CL Inactive** – Closed Loop Inactive. In this mode the controller has met all necessary parameters to go into Closed Loop operation but is locked out of Closed Loop by the Load Specific Table. In this mode, the controller operates the same as it would in Open Loop.
- **CL Active** – Closed Loop Active. In this mode the controller has met all necessary parameters for operation and has been cleared to control by the Closed Loop Enable Table. The controller operates on the feedback signal from the Left Bank and/or Right Bank (pre catalyst) HEGO sensors only.
- **CL + Adapt** – Closed Loop + Adaptive, the controller operates with the feedback signal from the post catalyst HEGO sensor. With the post catalyst HEGO sensor average Phi signal, the controller adapts the Left and/or Right Bank Phi targets to compensate for the offset needed to correct the emissions into the catalyst, to insure that the emissions exiting the catalyst are maintained at the desired point.

Sensor Health – The reliability of the oxygen (HEGO) sensors are monitored throughout the operation of the controller. The controller reads a resistance through the HEGO sensor and calculates a “Health” percentage. When the sensor “Health” reaches 40%, the sensor is considered failed but the controller continues to receive input from this sensor. When the Post Catalyst sensor fails, the controller switches from Closed Loop Adaptive to Closed Loop Active and controls strictly by the Left and/or Right Bank HEGO (pre catalyst) sensor. When the Left and/or Right Bank HEGO (pre catalyst) sensor fail, the controller switches to “Open Loop” and the valves default to the predetermined positions located in the “Open Loop Table” located on the “Advance Setup” screen. When any of the sensor’s health reaches 50%, the sensor should be replaced to prevent the controller from changing control state.

Sensor Voltage – These are the real time voltage readings generated by the oxygen (HEGO) sensors. The controller uses these voltages to calculate the Phi values. These voltage readings are also useful during troubleshooting of the engine and controller. These values are expressed as volts DC.

Sensor Value – These are values that the controller calculates when it reads the actual HEGO sensor voltage. These values are used by the controller to calculate a Sensor Average.

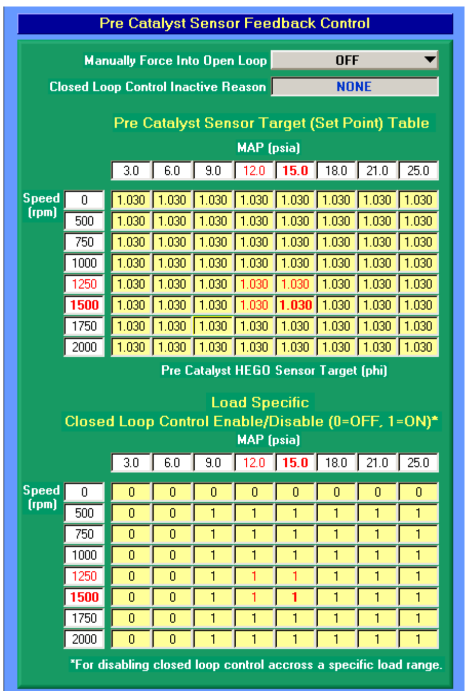
Sensor Average – These values are calculated rolling averages of the Sensor Values. These values are used by the controller drive the engine to the appropriate air/fuel ratio. These values are used by the controller to determine the actual engine air/fuel ratio.

Sensor Target – These are the Phi values used by the controller to drive the engine air/fuel ratio to a desired level.

Post Cat Offset – This reading is a calculation of the total offset of the pre catalyst target value in order for the post catalyst target to be achieved. As the controller works to achieve the desired target value, the controller adjusts the pre catalyst target value either richer or leaner in order to achieve its target. The controller allows for a maximum offset of +0.010 or – 0.010 phi value.

> An example would be: If the Phi value in the Pre Cat Table was 1.025, the controller will only allow an adjustment to this value to 1.015 or 1.035 depending on whether the post cat sensor was richer or leaner of the target.

Pre Catalyst Sensor Feedback Control Group



Pre-Catalyst Feedback Control – In this pull down menu there are two choices for operation.

- **On** – This setting turns on the pre catalyst (Left/Right Bank) sensors, allowing for Closed Loop operation.
- **Off** – This setting turns off the pre catalyst (Left/Right Bank) sensors. When disabled, the controller reverts to Open Loop operation.

CL Inactive Cause – Closed Loop Inactive Cause. In this cell, the controller indicates what is the cause for the closed loop operation being inactive. There are four (4) causes:

- **Manual Force Inactive** – This indicates that the pre-catalyst feedback control has been set to disabled. Enabling the pre-catalyst feedback control to enable will clear this cause.
- **CL Ena Map = 0** – This indicates that the engine speed and/or load has not reached a point where the Closed Loop Enable Table will allow the controller to go active.
- **Phi Command out of Range** – The operation of the engine has exceeded the operation range of the sensor. This condition causes the controller to default into Open Loop operation.
- **None** – Indicates that there is no cause for the Closed Loop to be inactive. At this point **the controller is in automatic operation.**

Load Specific Table – In this group, the user defines the control target for the Left and Right Banks. While the controller is in closed loop, the controller looks at this lookup table to determine a valid target as define by the engine speed and manifold pressure. This table is user defined in all 3 cell groups; MAP Cells, Speed Cells and the Target Cells.

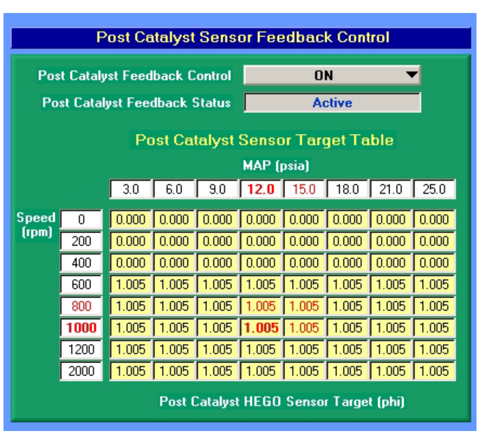
- **MAP Cells** – Located in the upper row. This field comes from the factory with pre set pressure ranges. These cells may have to be adjusted according to the engine application. These cells can range from 3 psia to 45 psia. The adjustments to these cells must be in ascending order and should plot out in a smooth line. Changing values in this table will automatically change the range in the Sensor Control Table and in the Pre and Post Catalyst Target Tables. The lowest low point of these cells must be set at 3 psia. All parameters in this field are user definable. The low setting for the MAP pressure **must** be set at 3 psia. Any setting higher than this low point will cause the controller to operate erratically.

- **Speed Cells** – Located in the left hand column. These cells come from the factory with preset speed ranges. These cells will need to be reset according to the systems application. Changing values in this table will automatically change the range in the Sensor Control Table and in the Pre and Post Catalyst Target Tables. The low setting for the SPEED cell **must** be set at 0 rpm. Any setting higher than this low point will cause the controller to operate erratically.
- **Target Cells** – The remaining cells to the right of the Speed Cells and below the MAP Cells are the Target Cells. These cell ranges will need to be defined by the user during the system setup according to the desired emissions level at varying loads and speeds. All values in these cells are expressed as Phi.

Sensor Control Table – In this table, the user defines when the controller should go into automatic operation and when it should remain operating from the Open Loop Table. This table is user defined in all 3 cell groups; MAP Cells, Speed Cells and the Open Loop Cells. Entering a 1 for closed loop and entering a 0 for open loop define an open loop cell.

- **MAP Cells** – Located in the upper row. This field comes from the factory with pre set pressure ranges. These cells may have to be adjusted according to the engine application. These cells can range from 3 psia to 45 psia. The adjustments to these cells must be in ascending order and should plot out in a smooth line. Changing values in this table will automatically change the range in the Sensor Control Table and in the Pre and Post Catalyst Target Tables. The low setting for the MAP pressure **must** be set at 3 psia. Any setting higher than this low point will cause the controller to operate erratically.
- **Speed Cells** – Located in the left hand column. These cells come from the factory with preset speed ranges. These cells will need to be reset according to the systems application. Changing values in this table will automatically change the range in the Sensor Control Table and in the Pre and Post Catalyst Target Tables. The low setting for the SPEED cell **must** be set at 0 rpm. Any setting higher than this low point will cause the controller to operate erratically.
- **Closed Loop Cells** – The remaining cells to the right of the Speed Cells and below the MAP Cells are the Open Loop Cells. These cell ranges will need to be defined by the user during the system setup according to the desired open loop position at varying loads and speeds.

Post Catalyst Sensor Feedback Control Group



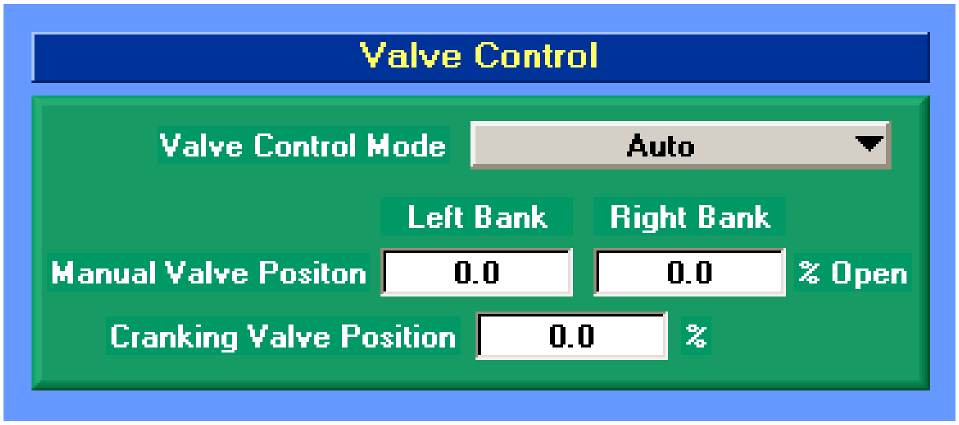
Post-Cat Feedback Control – Post Catalyst Feedback Control. In this pull down menu there are two choices for operation.

- **On** – This setting allows for the Enabling of the Post Catalyst HEGO sensor. Enabling the Post Catalyst sensor allows for Closed Loop + Adaptive operation of the controller. The controller will operate with input from the Post Catalyst HEGO sensor.
- **Off** – This setting turns off the Post Catalyst HEGO sensor and sets the controller into Closed Loop mode. With this setting the controller will never go into Closed Loop + Adaptive. All reading from the Post Catalyst sensor will be zeroed while the sensor is disabled.

Post Catalyst Feedback Status – In this cell, there are two (2) possible statuses:

- **Active** – In this state the system is in Closed Loop + Adaptive. The Pre-Catalyst Phi values are adapted to meet the required Post Catalyst HEGO target.
- **Inactive** – In this state the system is in Closed Loop mode. The Post Catalyst HEGO Phi readings are disregarded and the controller operates from the base Left/Right Bank (pre catalyst) HEGO targets.

Valve Control Group



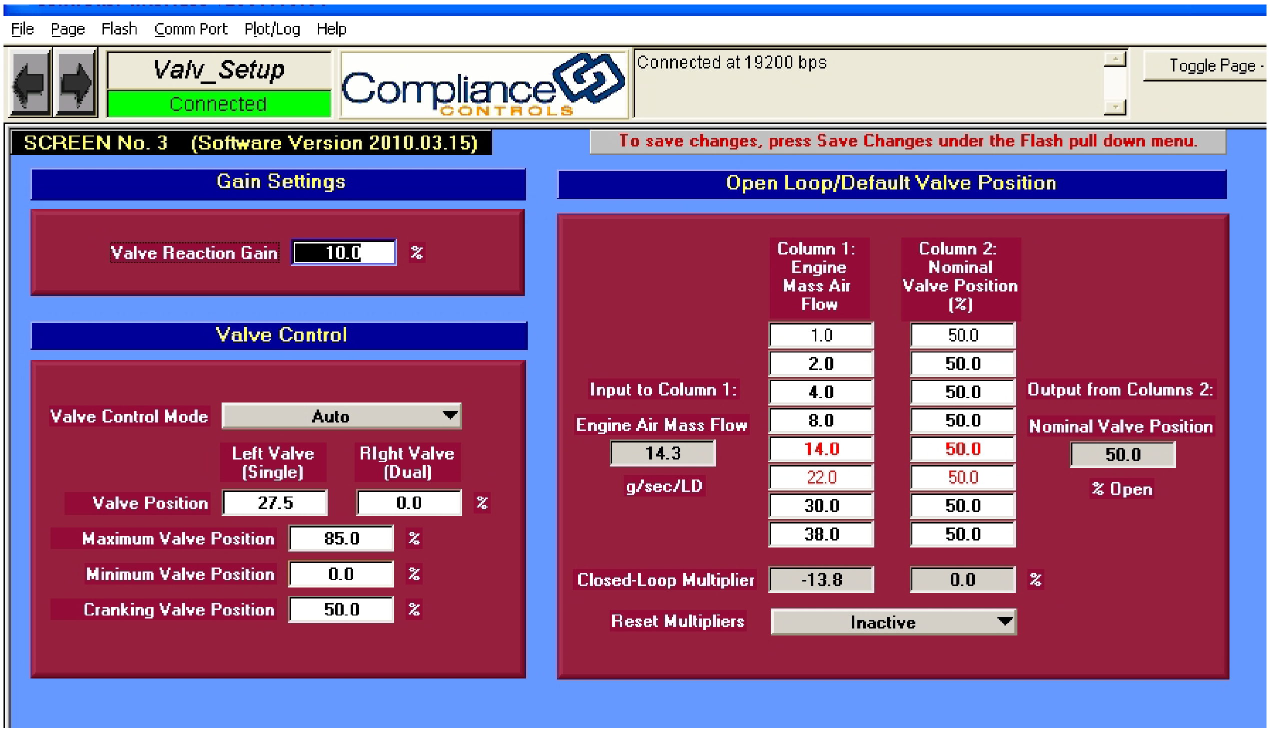
Valve Control Mode – In this pull down menu there are two (2) modes of valve operation:

- **Auto** – In this mode the controller is in control of the operation of the valves and determines their positions according to the desired HEGO sensor target.
- **Manual** – In this mode, the user can determine a valve position for the valves. When this mode is chosen, a desired valve position can be entered into the valve position cell.

Manual Valve Positions – While in Manual Mode, desired valve positions can be entered into these cells and the valves would be forced into the position. While in Auto Mode the actual valve positions are indicated here.

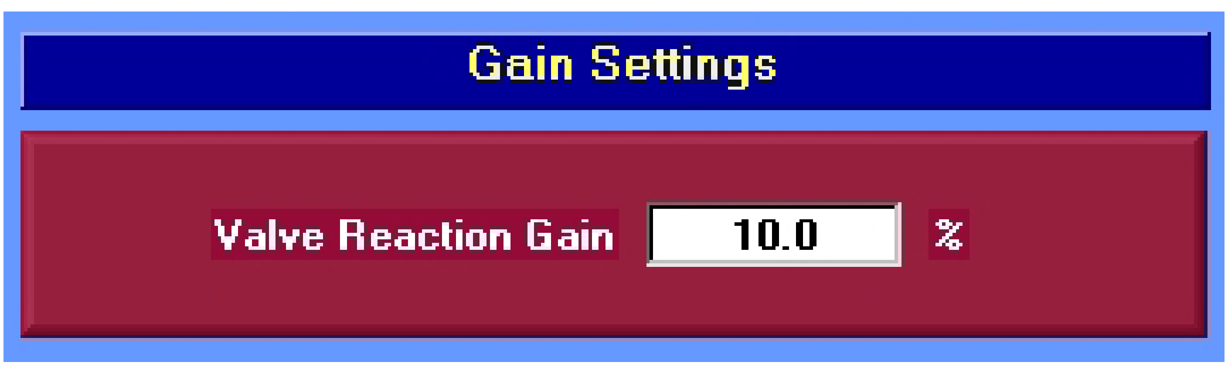
Cranking Valve Position – In this cell, the starting position for the control valves are entered. This is the position of the fuel control valves at speeds greater than 2 RPM and less than 450 RPM. When using a supplemental fuel valve (TK) this position is typically 0%. When a full authority valve is used this position will varies between 30% and 85% depending on the engine application.

Valve Set-Up (Screen No. 3)



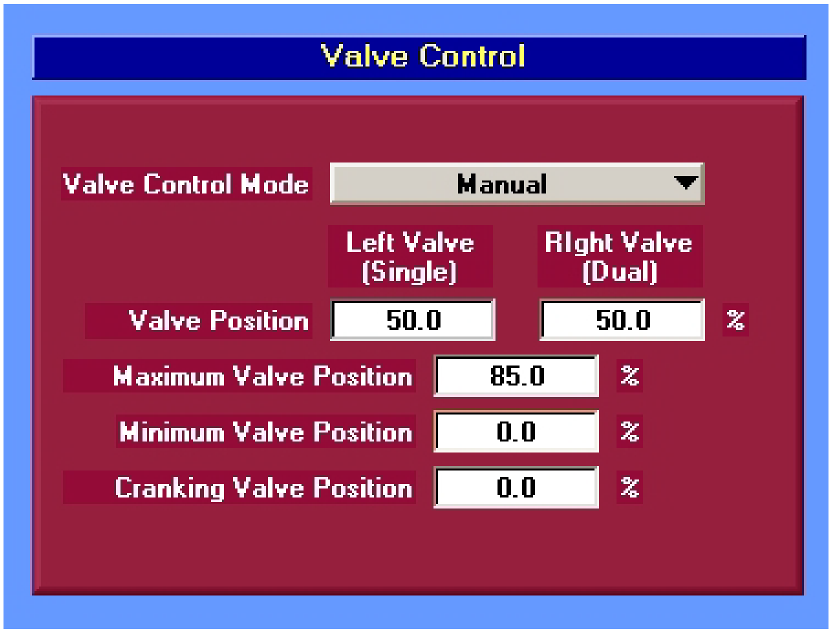
From the “VALVE SET-UP” screen (screen no. 3), the controller gains are adjusted and the fuel control valves are matched to the engine.

Gain Setting Group



Valve Reaction Gain – This gain setting adjusts the time that the valve(s) reacts to the change in the pre-catalyst sensors. This gain setting is typically set in the low ranges (5 to 25%). The gain settings are dependent on the distance between the pre catalyst oxygen sensor and the engine. The greater the distance the between the two, the greater the gain setting should be. If this gain setting is adjusted too high, the reaction time is faster and the controller has a tendency to over compensate or overshoot the target. If the gain is set too low the reaction time is slower and the controller reacts too slowly to the changes and the controller has a tendency to chase it’s self.

Valve Control Group



Valve Control Mode – In this pull down menu there are two (2) modes of valve operation:

- **Auto** – In this mode the controller is in control of the operation of the valves and determines their positions according to the desired HEGO sensor target.
- **Manual** – In this mode, the user can determine a valve position for the valves. When this mode is chosen, a desired valve position can be entered into the valve position cell

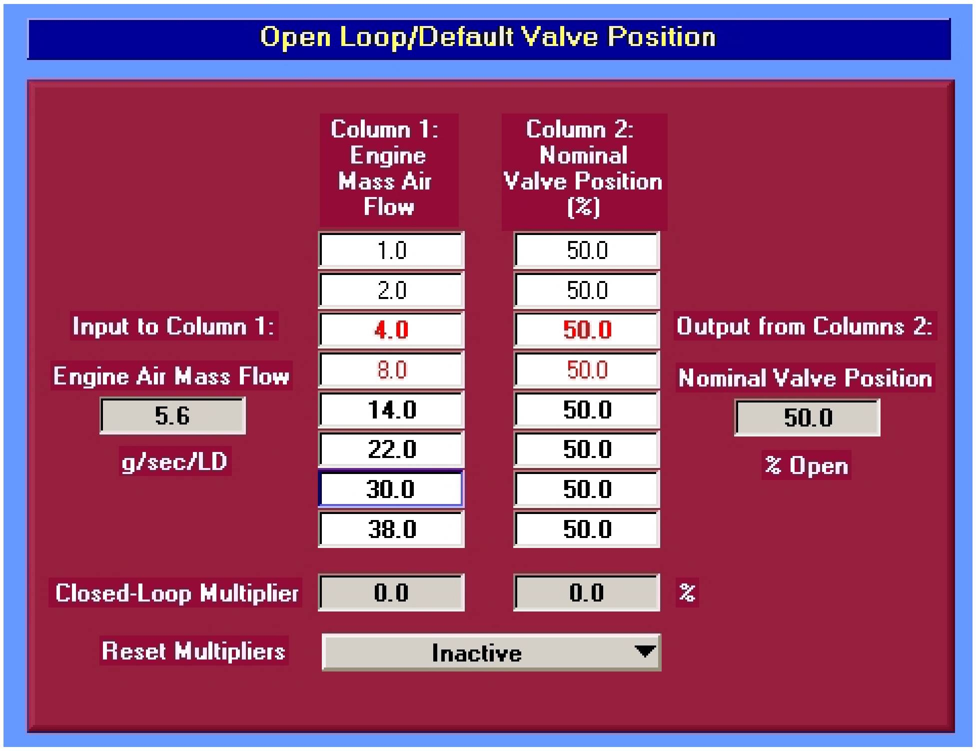
Valve Position – In these cells, the actual valve position is indicated during normal operation. During the setup, the valve positions can be manually entered while in *"MANUAL"* valve mode.

Maximum Valve Position - This is a user defined field. In this cell, the maximum opening of the valve is defined. When using the supplemental valves, the maximum opening cannot exceed 100%. When using the full authority valves, the maximum opening cannot exceed 85%.

Minimum Valve Position - This is a user defined field. In this cell, the minimum closing position of the valve is defined. With all valve types, it is recommended to set this position at 0% to allow the controller have the widest possible control range.

Cranking Position – This is a user defined field. In this cell, the valve position during engine cranking is defined (between 25 RPM and 450 RPM). When the supplemental valves (TK) are used this value is typically 0%. When the full authority valves (FA) are used, this value is typically between 10 to 85%, depending on the amount of fuel needed to start the engine.

Open Loop/Default Valve Position Group



Open Loop/Default Valve Position Table – This section is divided into two (2) columns: Column 1 - Engine Mass Air Flow and Column 2 - Nominal Valve Position (%).

- **Engine Mass Air Flow** – These cells are used as a reference as to the particular load that the engine is currently operating at. These cells are not typically defined by the user, but can be adjusted as needed to fit a particular application. This field is expressed in grams per second per liter (g/sec/LD)
- **Nominal Valve Position** - These cells are used as a reference as to the calculated nominal valve position of the controller during normal operation. This is the valve position that the system would default to in the event of a HEGO sensor failure. During normal operation, this position should be as close as possible to the actual valve position.

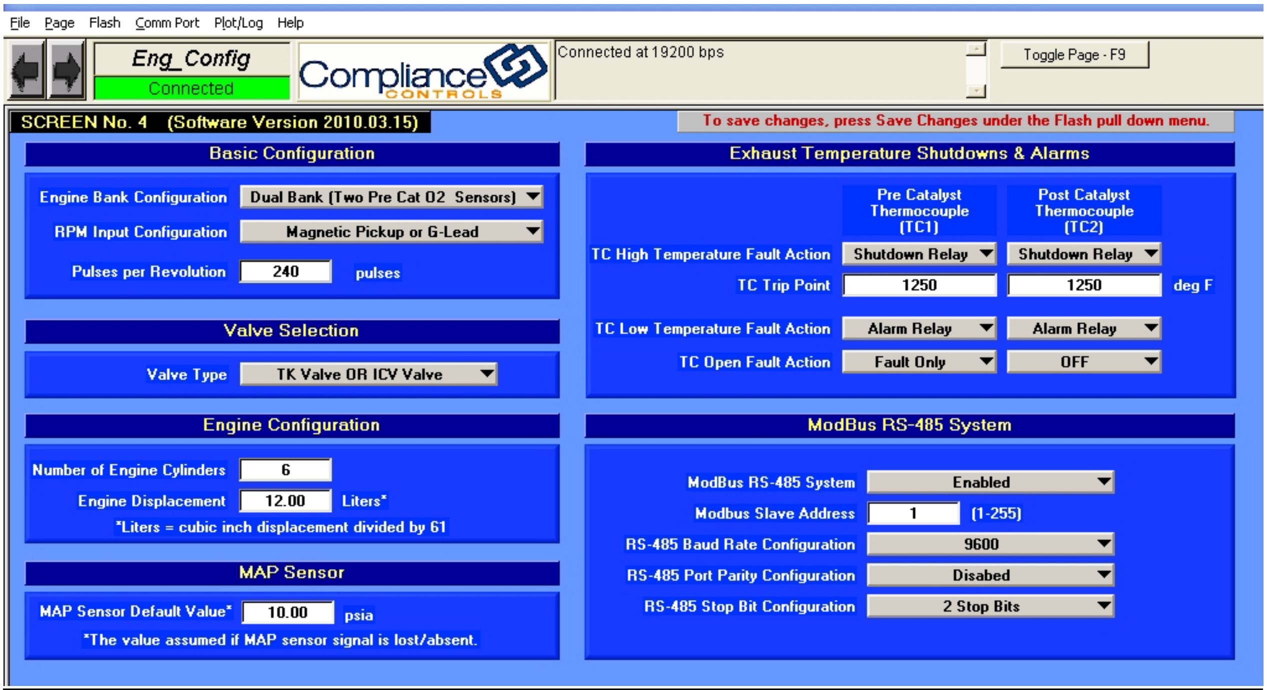
Engine Mass Air Flow – In this cell, the calculated mass air flow rate to the engine is displayed. The controller calculates this value from the user defined engine parameters as well as the engine speed, and intake manifold pressure. This value is used by the controller as a point of reference as to the load of the engine and is expressed in grams per second per liter.

Nominal Valve Position – In this cell, the calculated nominal valve position is displayed.

Closed Loop Multiplier – These two cells indicate the amount of offset applied to the Left Bank and Right Bank Phi targets. These values are expressed as a percentage.

Reset Multipliers - This pull down menu allows the user to reset all of the learned values (multipliers) back to the factory default setting of zero (0). This feature is valuable when readjusting the desired targets and/or calibrating the valves.

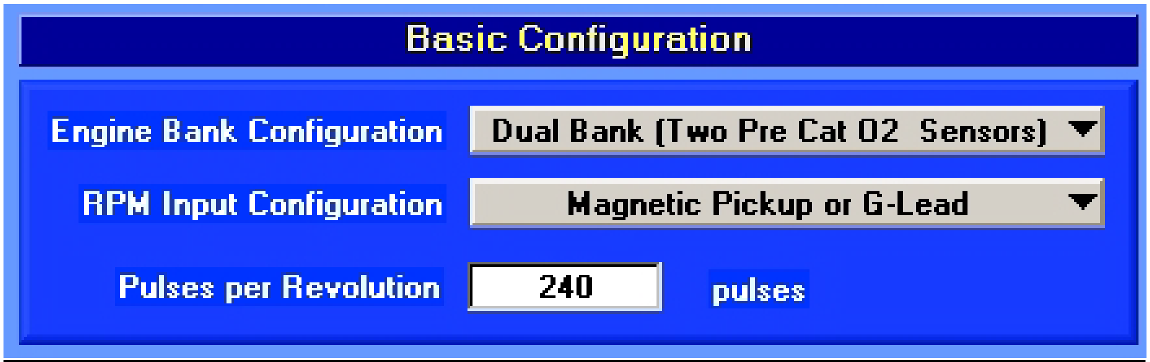
Engine Configuration (Screen No. 4)



From the "ENGINE CONFIGURATION" screen (screen 4), the controller is configured for the particular engine that it has been installed on as well as the exhaust temperature shutdown and alarm functions. This screen's main purpose is for the matching of the controller to the engine.

This screen is divided into six (6) main groups: Basic Configuration, Exhaust Temperature Shutdown and Alarms, Valve Selection, Engine Configuration, MAP Sensor and ModBus RS-485 System.

Basic Configuration Group



Engine Bank Configuration – In this pull down menu, the number of valves and HEGO sensors needed are determined

- **Single Bank (One Pre Cat O2 Sensor)** – Designed for inline engines or "V" Bank design engines using a common exhaust manifold or a common intake manifold. This mode allow for the use of one (1) pre catalyst HEGO sensor and one (1) fuel control valve output. In this operation mode, only the Left Bank oxygen sensor and control valve is used and operational.
- **Dual Bank (Two Pre Cat Sensors)** – Designed for "V" Bank engines using two (2) intake manifolds and two (2) exhaust manifolds. This mode allows for the operation of dual HEGO sensors and Dual control valves. In this operation mode, both of the oxygen sensors and control valves are operational.

NOTE:
When the controller is setup as a single bank system, only the Left Bank oxygen sensor and control valve is used.

RPM Input Configuration – In this pull down menu, the type of speed input device is determined.

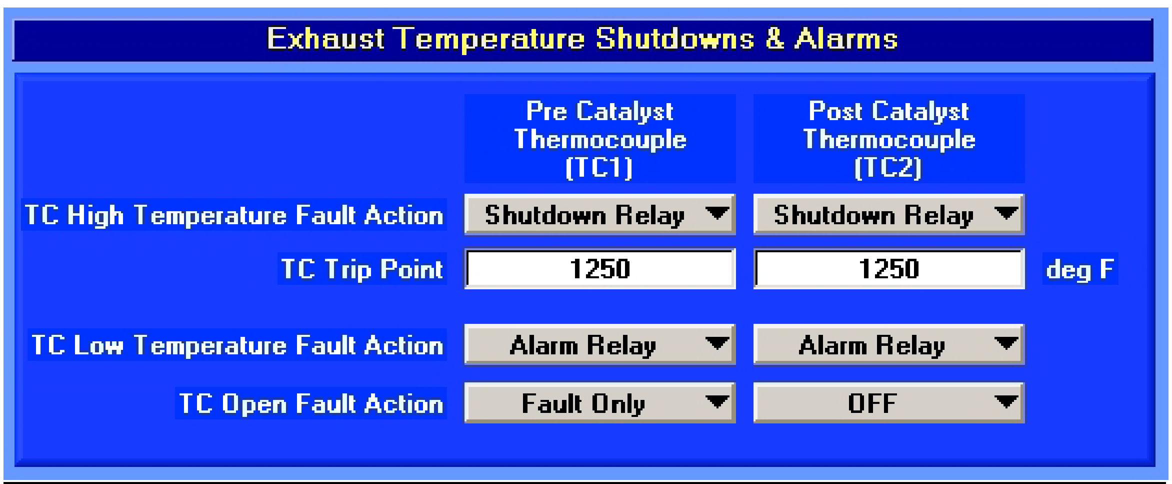
- **Disconnected** – No input device is used. The controller will never see a speed signal. This input mode will not allow the controller to go into operation and is never recommended.
- **Magnetic Pickup or G-Lead** – In this input mode, two types of configuration can be used to determine pulses per revolution and engine speed:
  - **Magnetic Pickup** – A magnetic pickup is the preferred method of pulse measurement due to the low occurrence of RF noise generated. The Magnetic Pickup is typically installed over the flywheel ring gear and counts the pulses generated as the flywheel teeth pass over the magnet in the magnetic pickup.
  - **G-Lead** – The G-Lead is a sensing lead from the ignition system that reads all voltages from all cylinders. Each time a cylinder fires, the G-Lead reads the pulse generated by the firing of that cylinder. The controller senses this firing and determines the engine speed by how many cylinders are fired each crankshaft rotation. Due to the high occurrences of RF noise generated by ignition systems, we do not recommend the use of the G-Lead input.
- **Not Used –** These options are just as they are stated "Not Used". These will be used in future application expansion of the controller.
- **Discrete – Ground = Running** – This feature is designed for troubleshooting of the controller only. By grounding the (+) terminal of the Magnetic Pickup input on the TCB and choosing this option, the controller will generate a false speed signal of 1000 RPM. This option is not recommended for normal operation of the controller. This will cause the controller to stay active at

all times. This option should only be used when advised by a Compliance Controls service technician.

- **Discrete – Open = Running** – This feature is designed for troubleshooting of the controller only. By not connecting any wires to (+) terminal of the Magnetic Pickup input on the TCB and choosing this option, the controller will generate a false speed signal of 1000 RPM. This option is not recommended for normal operation of the controller. This will cause the controller to stay active at all times. This option should only be used when advised by a Compliance Controls service technician.
- **Discrete – +V = Running** – Not currently activated. This feature is designated for future application expansion of the controller.

Pulses Per Revolution – In this cell the number of pulses per revolution are entered. If a Magnetic Pickup is used, this is the number of teeth on the flywheel ring gear. If a G-Lead is used this number is typically ½ of the total number of cylinders of the engine. See the Appendix – "Engine Data" for a list of the most common engine types and the number of flywheel teeth for these engines.

Exhaust Temperature Shutdown & Alarm Group



In this group, the controller can be configured to set an alarm or a shutdown during engine operation according to the exhaust temperature condition. All items are divided into two (2) columns: Pre-Catalyst Thermocouple (TC1) and Post- Catalyst Thermocouple (TC2).

TC high temperature fault action –This feature is used primarily as a catalyst protection device. This field has a pull down menu with four (4) options:

- **Off** – The controller ignores all temperature readings. No alarms/faults or shutdowns will be used.
- **Fault Only** – Only a fault code is generated in the active and historic fault boxes during a high temperature condition. No relays are activated.
- **Alarm Relay** – The controller sets an alarm on the fault screens and the Alarm/Fault relay is activated.
- **Shutdown Relay** - The controller sets an alarm on the fault screens and activates the Shutdown relay.

TC Trip Point - "When the Thermocouple Temperature is greater than" – In these cells the thermocouple high temperature trip points are set. For most catalyst applications, this value should be set to 150°F above the normal operating point of the exhaust system. This value should never exceed 1350°F

TC low temperature fault action – This feature is primarily used as a thermocouple assurance device. If a temperature of less than 500° F is seen for greater than 6 minutes after an engine run signal has been received, the controller will flag this fault and assume that the thermocouple is bad. This field has a pull down menu with four (4) options:

- **Off** – The controller ignores all temperature readings. No alarms/faults or shutdowns will be used.
- **Fault Only** – Only a fault code is generated in the active and historic fault boxes during a low temperature condition. No relays are activated.
- **Alarm Relay** – The controller sets an alarm on the fault screens and the Alarm/Fault relay is activated.
- **Shutdown Relay** - The controller sets an alarm on the fault screens and activates the Shutdown relay.

TC open fault action - This feature is primarily used as a thermocouple assurance device. If a sudden elevation in temperature (greater than 1800° F) is seen in less than 1 second, the controller will flag this fault and assume that the thermocouple device is bad. This field has a pull down menu with four (4) options:

- **Off** – The controller ignores all temperature readings. No alarms/faults or shutdowns will be used.
- **Fault Only** – Only a fault code is generated in the active and historic fault boxes during an open condition. No relays are activated.
- **Alarm Relay** – The controller sets an alarm on the fault screens and the Alarm/Fault relay is activated.
- **Shutdown Relay** - The controller sets an alarm on the fault screens and activates the Shutdown relay.

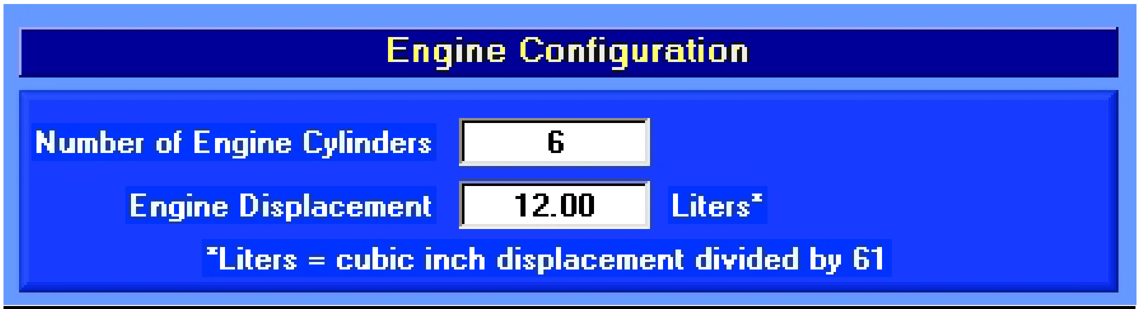
Any changes to this group must be committed (flashed) to the EPROM before continuing.

Valve Selection Group

Valve Type – The AFR-64R controller has the ability to operate with several types of control valve:

- **TK Valve or ICV Valve –** This is a proportional type control valve and is used when a fuel supplemental type of AFR is installed. These valves have an operating range from 0% to 100%.
- **Butterfly Valve –** This is a full authority type control valve and is used when the controller manipulates 100% of the fuel to the engine. These valves have an operating range from 0% to 85%.

Engine Configuration Group

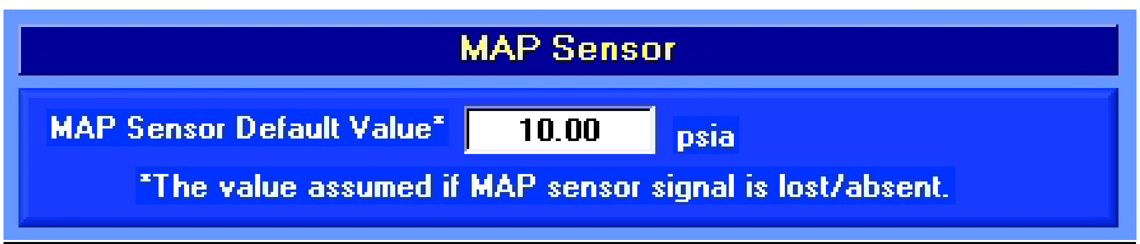


In this group, the controller is matched to the engine. This information is vital to the proper operation of the controller. This data is used by the controller to calculate load points during its operation and should be as accurate as possible.

Number of cylinders – This is the total number of cylinders of the engine.

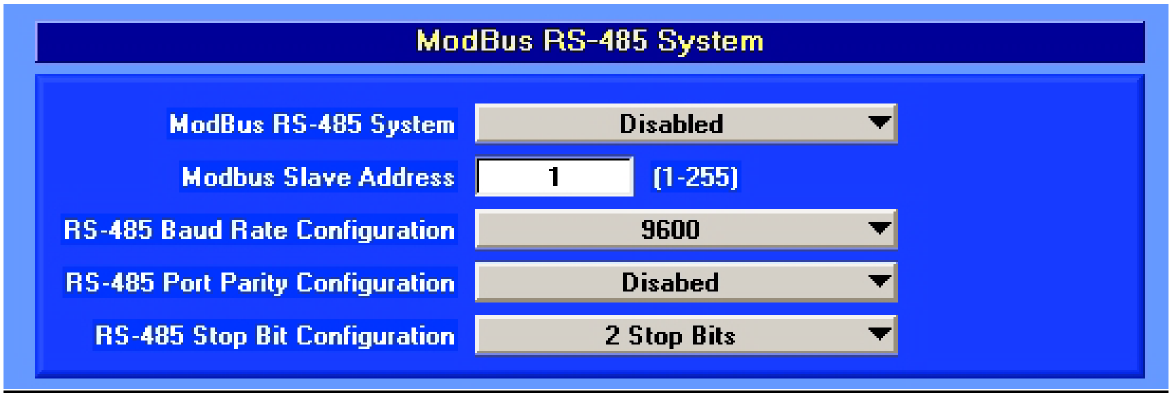
Engine Displacement – The total engine displacement is entered here. The displacement is expressed in Liters. If the cubic inch displacement is known, divide this number by 61 to convert it to liters displacement.

MAP Sensor Default Group



In this group, the user has ability to choose a point where the controller will default the MAP pressure to in the event of a failure of the MAP sensor. This pressure setting will be used to determine the Phi target values as well as the default valve position described on Screen 3.

ModBus RS-485 System Configuration Group



This group is divided into 5 basic sections and is used to define the communication type and control to an outside communication device.

On this screen the communication capabilities of the controller are enabled, disabled and monitored.

ModBus RS-485 System – From this pull down menu, there are two possible choices: Enabled and Disabled.

- **Enabled** - The circuitry needed for communication is engaged and outside communication is possible.
- **Disabled** - The circuitry needed for communication is disengaged and outside communication is not possible.

ModBus Slave Address – Whenever the ModBus system is used to communicate to an outside system, such as a Scada system or even the UniOP display, the outside system is considered the “Master” and the controller is considered the “Slave”. Each “Slave” system that is attached to a “Master” system must have its own unique address. This address allows the master to talk to that system and that system alone. An address that is assigned to the particular slave can range from 1 to 255.

RS-485 Baud Rate Configuration - This setting adjust the rate of communication of the controller to the “Master” device. The higher the baud rate, the faster communication is between the two systems. Caution must be used when setting the baud rate – the faster the baud rate, the more apt the system is to pickup out side interference. There are two (2) options in this pull down menu:

- 9600
- 19200

RS-485 Port Parity Configuration –
- Disabled –
- Odd –
- Even –

RS-485 Stop Bit Configuration –
- 1 Stop Bit –
- 2 Stop Bits –

UniOP Installation and Operation

System Components

Component Overview

The following components are needed to assembly the MEC with UniOP display. Pictures are shown for each component.

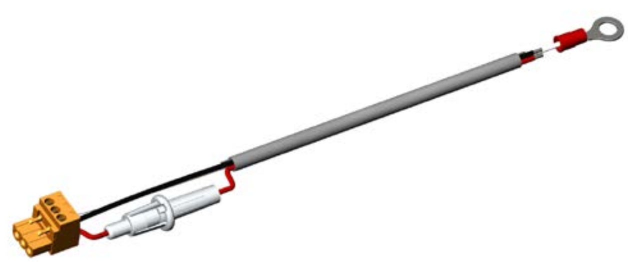
Part	Description	Qty.
UniOP Display	4 Line Display Monitor	1
UniOP Mounting Bracket		4
Communications Cable	Series D Subminiature Type 15P Cable	1
Power Cable	1 Amp Fused Power Cable	1
Resistor	750W, ¼ Watt, Pull-up Resistor	1

UniOP Display

UniOP Mounting Bracket

750 Ohm Resistor

UniOP Communications Cable



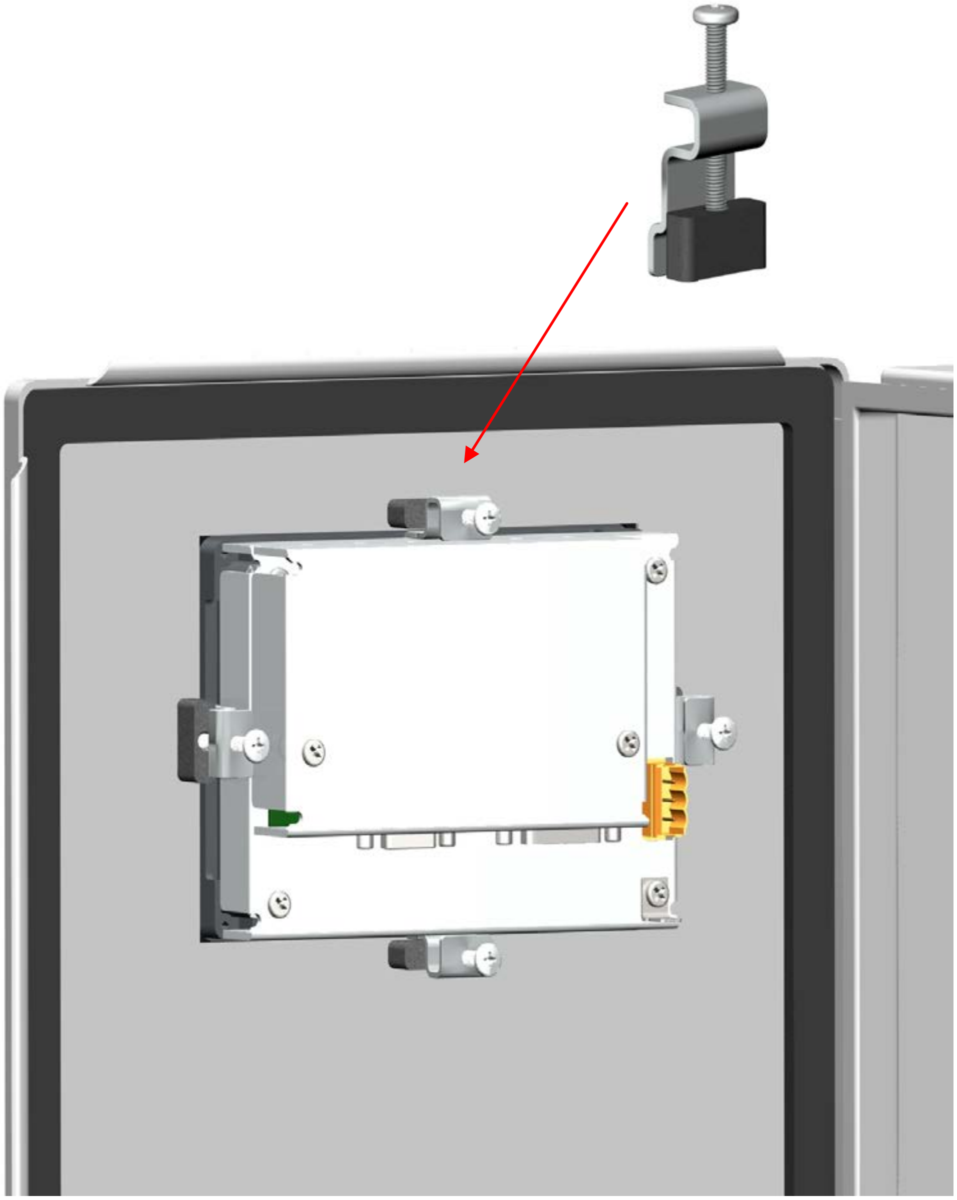
UniOP Power Cable

Assembly Procedure

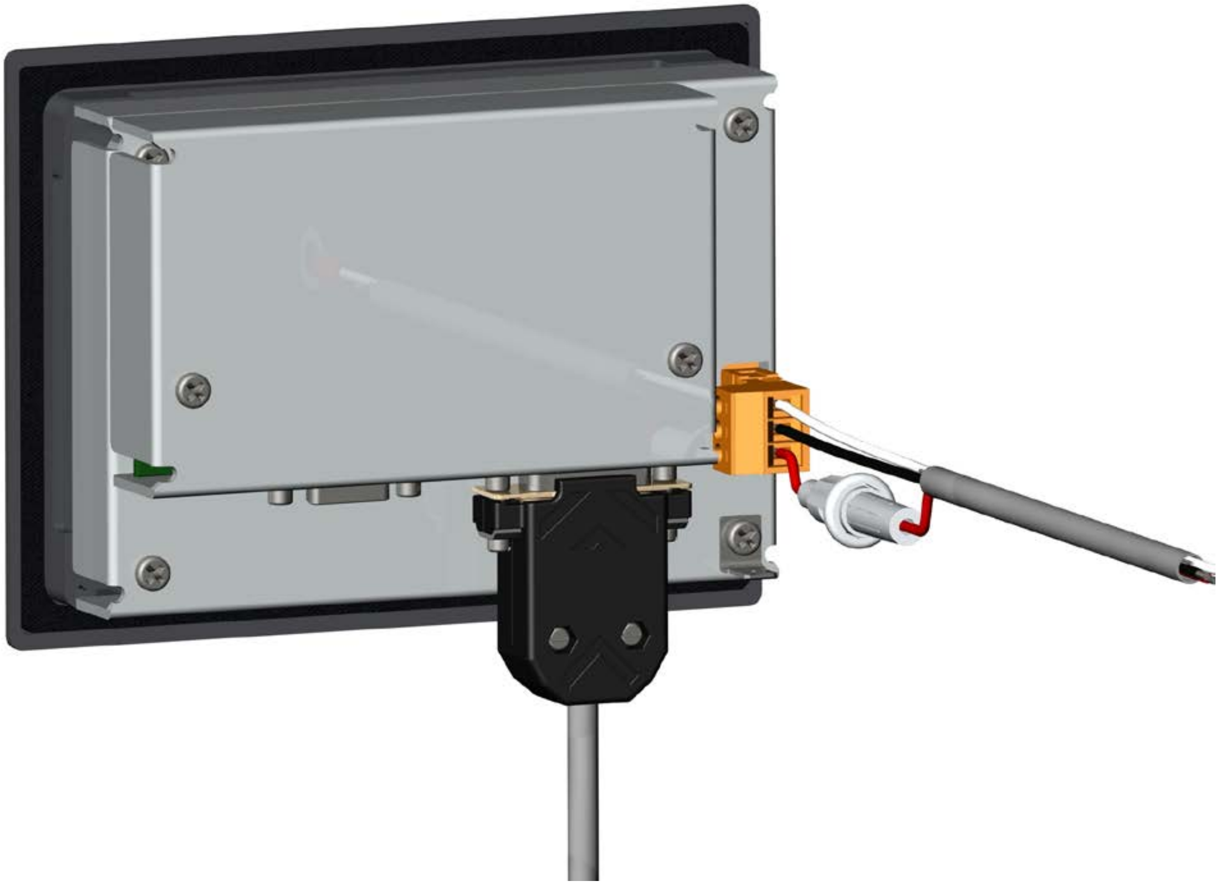
STEP 1: Disconnect or turn off all power to the MEC.

STEP 2: Cut hole in the enclosure. The dimensions are shown in Chapter 4.

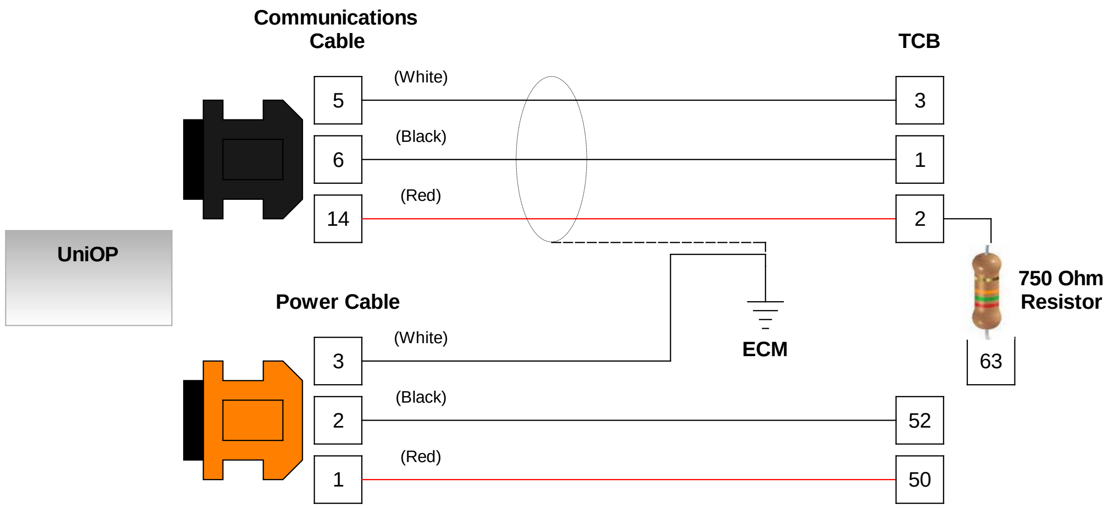
STEP 3: Mount UniOP in Enclosure. Use the four mounting brackets to secure the UniOP as shown below.



STEP 4: Insert the Communications and Power Cable into the UniOP. Place these cables in the UniOP ports as shown below.



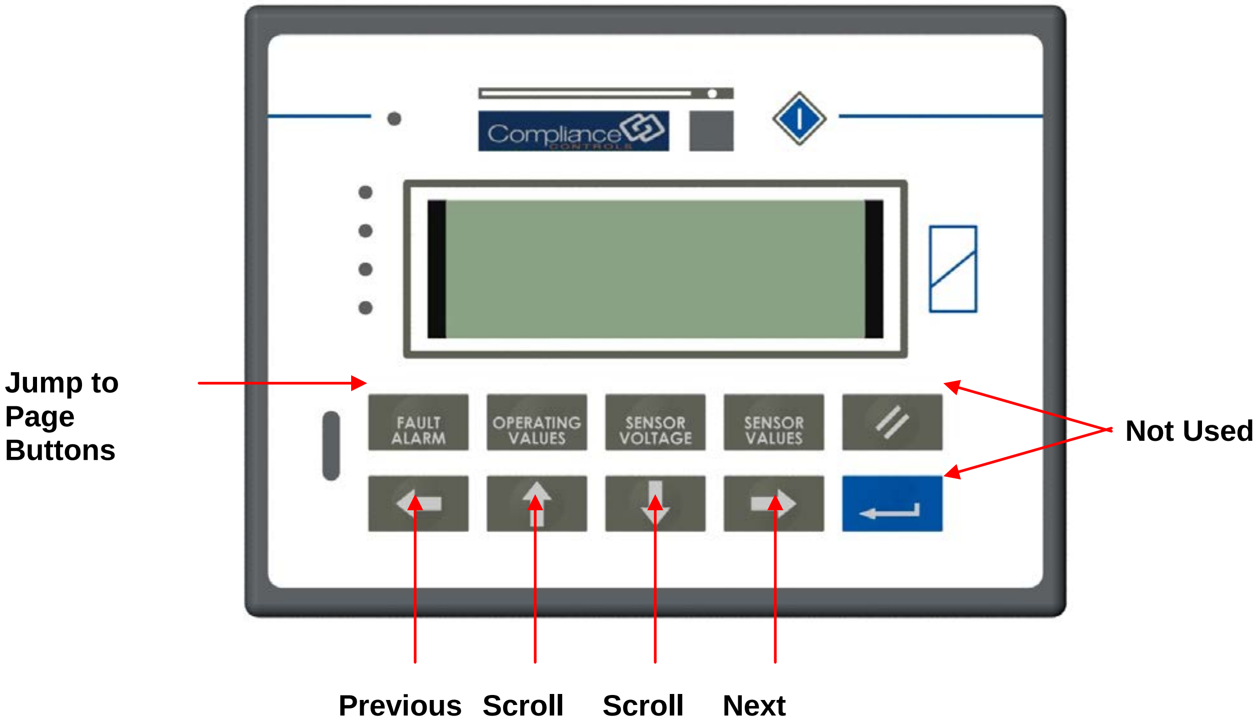
STEP 5: Connect the UniOP cables to the TCB. The correct pin out is located below. Use the ring terminals on the communications and power cable to connect to the ground screw on the ECM. If the UniOP is mounted outside of the enclosure, make sure to add the 750W resistor to the TCB. This will allow the UniOP to be mounted up to 500 feet away. If the UniOP is mounted in the MEC enclosure the 750W resistor is not needed. Once the wiring is completed, the cables should be tie wrapped to the door and inside of the enclosure.



STEP 6: Reconnect or turn power back on to the MEC.

Operation Instructions

The picture below shows the keys used in the UniOP operation. Only eight keys are needed for the display operations. The scroll up and down buttons only work on the operating value pages where there are more than 4 lines of display. The screens for the AFR-64R and MEC-L are shown on pages 79 & 80.



UniOP Screens for MEC-R

Page 1

COMPLIANCE CONTROLS
MEC-R v06.01
Rich Burn
AFR CONTROLLER

Page 2

Run Mode	MMMMM
RPM	9999
MAP	999.9 psia

Page 3

Catalyst Temperatures	
PreCAT	999 deg F
PostCAT	999 deg F
DiffCAT	999 deg F

Page 4 Button 1

Fault Status:
MMMMMMMMMMMM
Shutdown Status:
MMMMMMMMMMMM

Page 5

Hour Meter:	99.999
Power Volts:	99.99 V

Page 6

CL Inactive Reason:
MMMMMMMMMMMMM
PostCAT Feedback Status:
MMMMMMMMMMMMM

Page 7

Sensor Health	
Left Bank	99%
Right Bank	99%
Post Catalyst	99%

Page 8 Button 3

Sensor Voltage	
Left Bank	99.99 V
Right Bank	99.99 V
Post Catalyst	99.99 V

Page 9

Sensor Targets	
Left Bank	99.99 phi
Right Bank	99.99 phi
Post Catalyst	99.99 phi

Page 10

Sensor Averages	
Left Bank	99.99 phi
Right Bank	99.99 phi
Post Catalyst	99.99 phi

Page 11 Button 4

Sensor Value	
Left Bank	99.99 phi
Right Bank	99.99 phi
Post Catalyst	99.99 phi

Page 12

Valve Position:	
Left Bank	999.9%
Right Bank	999.9%

Page 13

Active Faults 0
MMMMMMMMMMMM
MMMMMMMMMMMM
MMMMMMMMMMMM

Page 14

Historic Faults 0
Press F1 to Reset
MMMMMMMMMMMM
MMMMMMMMMMMM

Page 15

Shutdown Relay: Off
Engine Must be Shut -
Down and Press F1 to
Reset

Page 16 Button 2

Control Mode:	
MMMMMMMMMMMMMMMM	
CL Inactive Reason:	
MMMMMMMMMMMMMMMM	
PostCAT Feedback Status:	
MMMMMMMMMMMMMMMM	
Left Bank Sensor:	
Sensor Health	999.9%
Sensor Voltage	99.99 V
Sensor Value	99.99 phi
Sensor Average	99.99 phi
Sensor Target	99.99 phi
Right Bank Sensor:	
Sensor Health	999.9%
Sensor Voltage	99.99 V
Sensor Value	99.99 phi
Sensor Average	99.99 phi
Sensor Target	99.99 phi
PostCAT Sensor:	
Sensor Health	999.9%
Sensor Voltage	99.99 V
Sensor Value	99.99 phi
Sensor Average	99.99 phi
Sensor Target	99.99 phi
Valve Position:	
Left Bank	999.9%
Right Bank	999.9%

Button Names	
Button 1	Fault / Alarm
Button 2	Operating Values
Button 3	Sensor Voltage
Button 4	Sensor Value

Appendix

Terms and Definitions

ATM	Atmospheric (pressure), 14.7 psia at sea level (29.92 inches mercury, 1.01 bar)
°C	Degrees Celsius/Centigrade
Closed Loop (CL)	Control using feedback signals from the controlled parameters
COM Port	A DB9 (RS232) communication port, mounted on the “Interface Module”, used for communication and controller setup via a PC computer.
Duty Cycle	Percent of “on” time per total PWM signal on/off cycle time. For a PWM valve, this will determine how open the valve will be.
ECM	Engine Control Module
EMI	Electro Magnetic Interference
EPR	Electronic Pressure Regulator
Equivalence ratio	Normalized air/fuel ratio used to compare different fuels relative to stoichiometry phi (ϕ) = (A/F)stoich / (A/F)actual
°F	Degrees Fahrenheit
Fault	Indicates a system malfunction. Also known as Alarm. Faults will not shutdown the engine, unless configured to do so.
Gain	A percentage of a predetermined time frame in which the controller sees a change until the time it reacts to the change
G-Lead	Ignition pulse output signal (high voltage) used to measure engine speed
UEGO Sensor	Universal Exhaust Gas Oxygen sensor
kW	Kilowatt (power)
Lambda (λ)	A measurement of excess air in the exhaust stream. A normalized air/fuel ratio used to compare different fuels related to stoichiometry (1(λ) = stoichiometry). Also Know as equivalence ratio. Lambda is the inverse of Phi
LCD	Liquid Crystal Display
LED	Light Emitting Diode

MAP Manifold Absolute Pressure sensor – Used to monitor the intake manifold absolute pressure. Has a range of 0 – 43 psia (0-3 bar absolute). Used as an indicator of engine load.

MAT Manifold Absolute Temperature sensor. Used to monitor the intake manifold temperature over a wide temperature range.

MPU Magnetic Pickup – speed sensor

Open Loop Control without feedback from any controlled parameters

PC Personal Computer

PCB Printed Circuit Board

Phi (ϕ) A measurement of excess fuel in the exhaust stream. Phi is the inverse of Lambda (1/lambda). Also known as equivalence ratio.

Plotting A diagnostic tool used to troubleshoot the engine and controller. Any numerical input or output can be tagged and plotted on a graph at time periods from 1 second to 10,000 seconds

psia Pounds per square inch absolute, pressure

psig Pounds per square inch gauge, pressure (over ambient)

PWM Pulse Width Modulated

RF Radio Frequency noise. An electrical noise that occurs at radio frequency

RPM Revolutions Per Minute (rotation speed)

Status Module A user interface module that only incorporates 3 status lights (power, alarm & shutdown)

Stereo Separate fuel systems for each bank of cylinders including intake manifolds, throttles, and carburetors on a multi-bank engine.

Stoichiometric A chemically balanced mixture (all reactants are mutually consumed) – in the case of an engine air/fuel ratio mixture, just enough air to theoretically burn all of the fuel

TC Thermocouple – Only type “K” is used in this application

TCB Terminal Connector Board

System Specification

System Power Specifications (dependent on number of end devices)

Device	Steady State @ 24V DC (amps)	Steady State @ 12V DC (amps)
UNIOP Display	0.25	0.50 (when used with optional 12 to 24V DC converter for 12 volt operation)
ECM	0.15	0.15
Oxygen Sensor (each)	1.00 (each)	1.00
TK Valve	0.80 (each)	0.80
FA Valve	1.10 (each)	2.20

NOTE FA Valve: Peak current draw during transient conditions of .25 sec is 2.1 amps @ 24V DC and 4.2 amps @ 12V DC

Controller

Power Supply	24 volts DC – optional 12-24 volt DC to DC converter available
Enclosure	NEMA 12

Controller - Environmental

Operating Temperature	-40 to +185°F (-40 to +85°C)
Storage Temperature	-40 to +185°F (-40 to +85°C)

TK & ICV Valve

	Pressure Ranges
1/8” Orifice	5 to 35 psig (TK2)
1/4” Orifice	5 to 35 psig (TK4B)
3/8” Orifice	5 to 35 psig (TK6B)
5/8” Orifice	0.5 to 5 psig (TK10)
11/16” Orifice	5 to 35 psig (TK11B)
Housing Burst Pressure	200 psig
Coil Resistance	15.0 ohms (± 1.5 ohms)
Wire Size	22 AWG
Signal Power	0 - 13 volts DC
Power Consumption	0.8 amps maximum (valve at 100% open)
Signal	Pulse Width Modulated (PWM)

Full Authority (FA) Valve

Valve Sizes	Fuel Piping Sizes
33mm	Up to 1 ¼” npt
60mm	Up to 2 “ npt
75mm	Up to 3” npt
Housing Burst Pressure	200 psig
Max. Working Pressure	40 psig
Wire Size	18 AWG
Supply Power	9-32 volts DC
Signal Power	0 - 32 volts DC (application specific)
Signal	Pulse Width Modulated (PWM)

Valve – Environmental

Operating Temperature	-40 to +158°F (-40 to +70°C) housing temp.

Vibration	Sine Wave 10-2000 Hz at 10 g's peak-peak

INPUTS

HEGO Sensor	(Heated Zirconia Oxygen Sensor)
Voltage	0.0 to 1.0 volts DC (sensor generated)
Ambient Temperature	500 °F (260°C) shell temperature maximum
Operating Temperature	660° to1350 °F (349F to 733°C) sensor tip
Heater Circuit	1 amp maximum
MAP Sensor	
Input Power	0-5 volts DC
Pressure Range	0-3 bar absolute
	0-43.5 pounds per square inch absolute
Temperature Range	-40° to 250 °F (-40° to 121°C)
Magnetic Pickup	0.20-100 Vrms
	100 volts AC (peak to peak)
	8-10,000 Hz
G-Lead	+/- 250 volts DC
Alarm/Shutdown/Aux Relays	
Dry Contact Relays	120 watt maximum (dual contact)
	4 amps at 30 volts
UniOP Display	
Power Supply	option 12 to 24V DC converter for 12 volt operation
Power Consumption	0.25 amps maximum
Text Display	4 Line x 20 Character per line

Environmental

Operating Temperature	-4° to 140°F (-20° to 60°C)

Notes, Warnings & Precautions

NOTES:

- **To avoid damage to the AFR-64R module and circuit board, these items should be removed from the enclosure before mounting or installation of conduit entries. The AFR-64R is attached to a mounting plate for easy removal and re-installation.**
- **If the installer is unfamiliar or unable to complete any of the installation requirements listed above, contact your COMPLIANCE CONTROLS distributor for information on qualified installers. See the Product Support section for contact information.**
- **The engine should be shutdown prior to updating the software.**
- **The 304 stainless steel HEGO coupling cannot be welded to cast iron with standard welding procedures!**

WARNINGS & PRECAUTIONS

- **To avoid damage to the Full Authority valve, the butterfly plate should never be removed.**
- **To avoid damage to the AFR-64R module and circuit board, these items should be removed from the enclosure before any welding is performed on the engine skid or attached equipment. The AFR-64R is attached to a mounting plate for easy removal and re-installation.**
- **The power supply and the G-lead must be run in separate dedicated conduit to isolate other signals from possible EMI and RF interference!**

- **Prior to the installation of any conduit entries, the AFR-64R Module and Circuit board should be removed from the enclosure! See the Installation section – Safeguarding Electrical Circuit Boards prior to removal!**

- **The user interface modules are not weatherproof. If the engine is going to be exposed to the environment, it is highly recommended that the module be remotely mounted in the engine control panel, protected from the elements!**

- **The AFR-64R enclosure should not be opened when a hazardous atmosphere is present. Wiring connections that could cause sparks are present inside cabinet.**

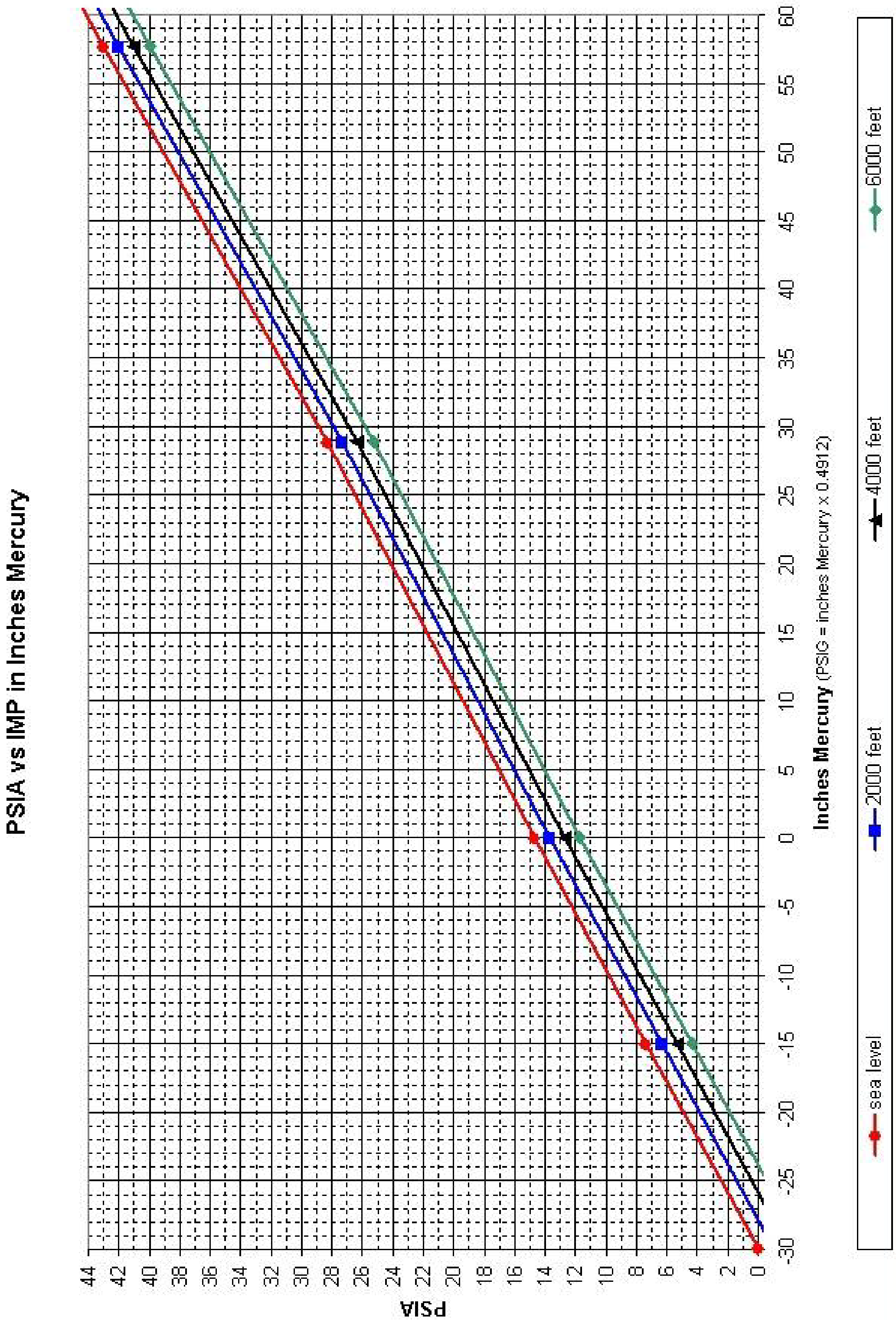
- **Never disconnect while circuits are live unless area is known to be non-hazardous.**

- **The AFR-64R fuel control valves are not designed as a positive sealing valve. These fuel control valves should be installed downstream of a fuel shut off device to prevent fuel gas leaks while the engine is not running!**

- **The HEGO sensor maximum shell temperature (melt down point) is 500°F (260°C). These sensors should never be installed in areas where the ambient air is stagnant and/or where the ambient air conditions exceed 250°F (121°C).**

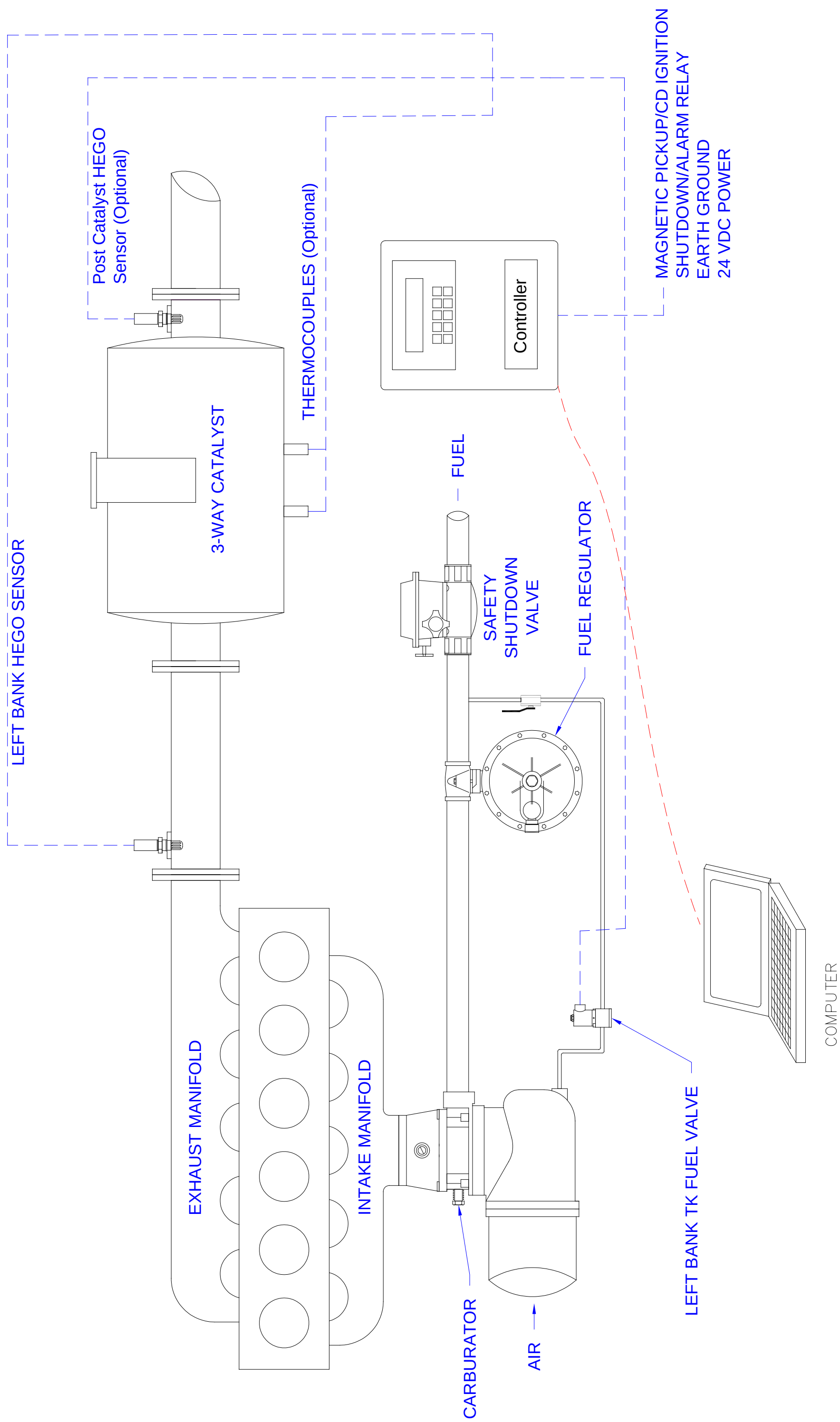
- **All electrical connections should be performed by qualified personnel and should meet all Federal, State, Local and End User electrical codes**

PSIA vs. Intake Manifold Pressure in Inches of Mercury

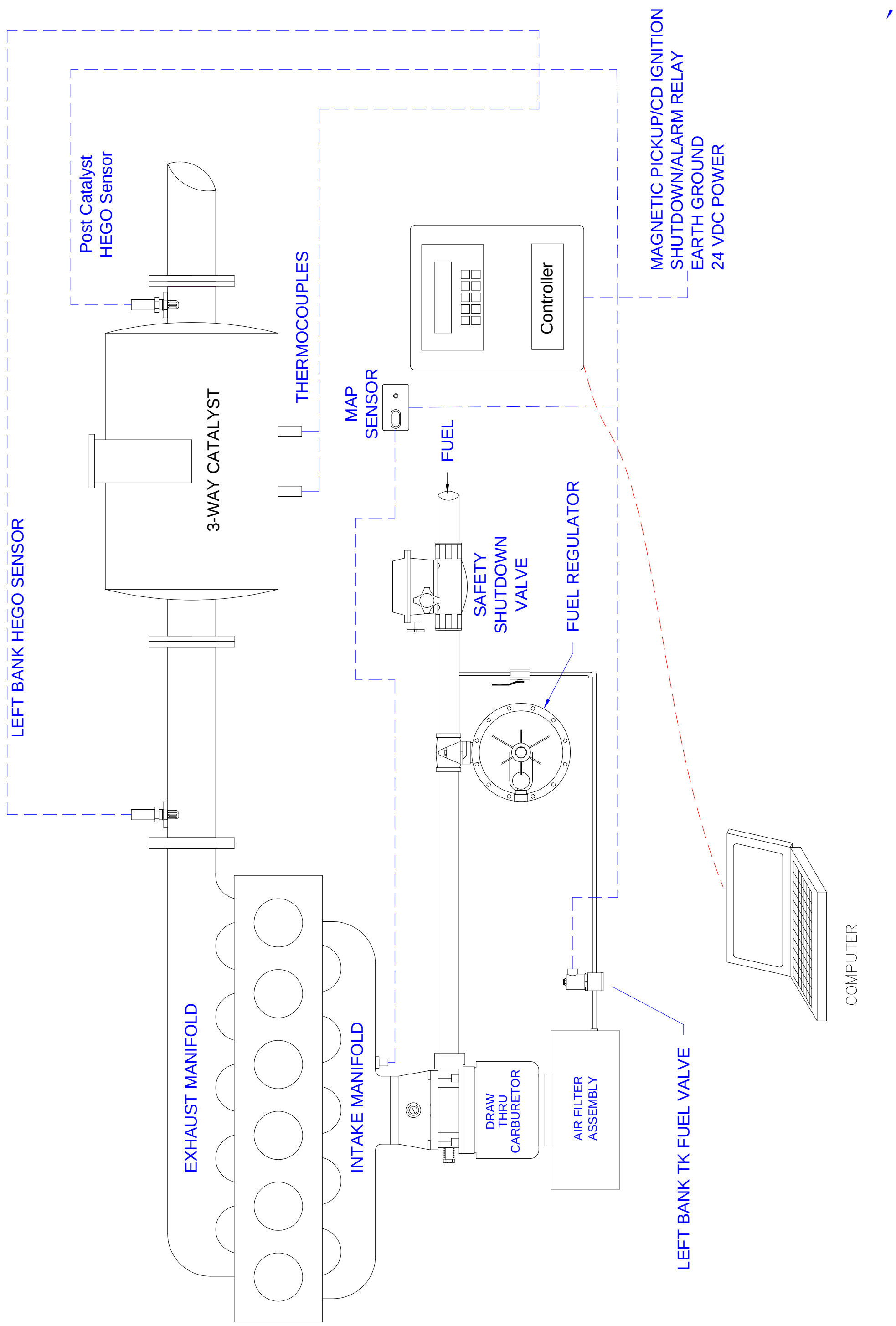


Installation Layouts Examples

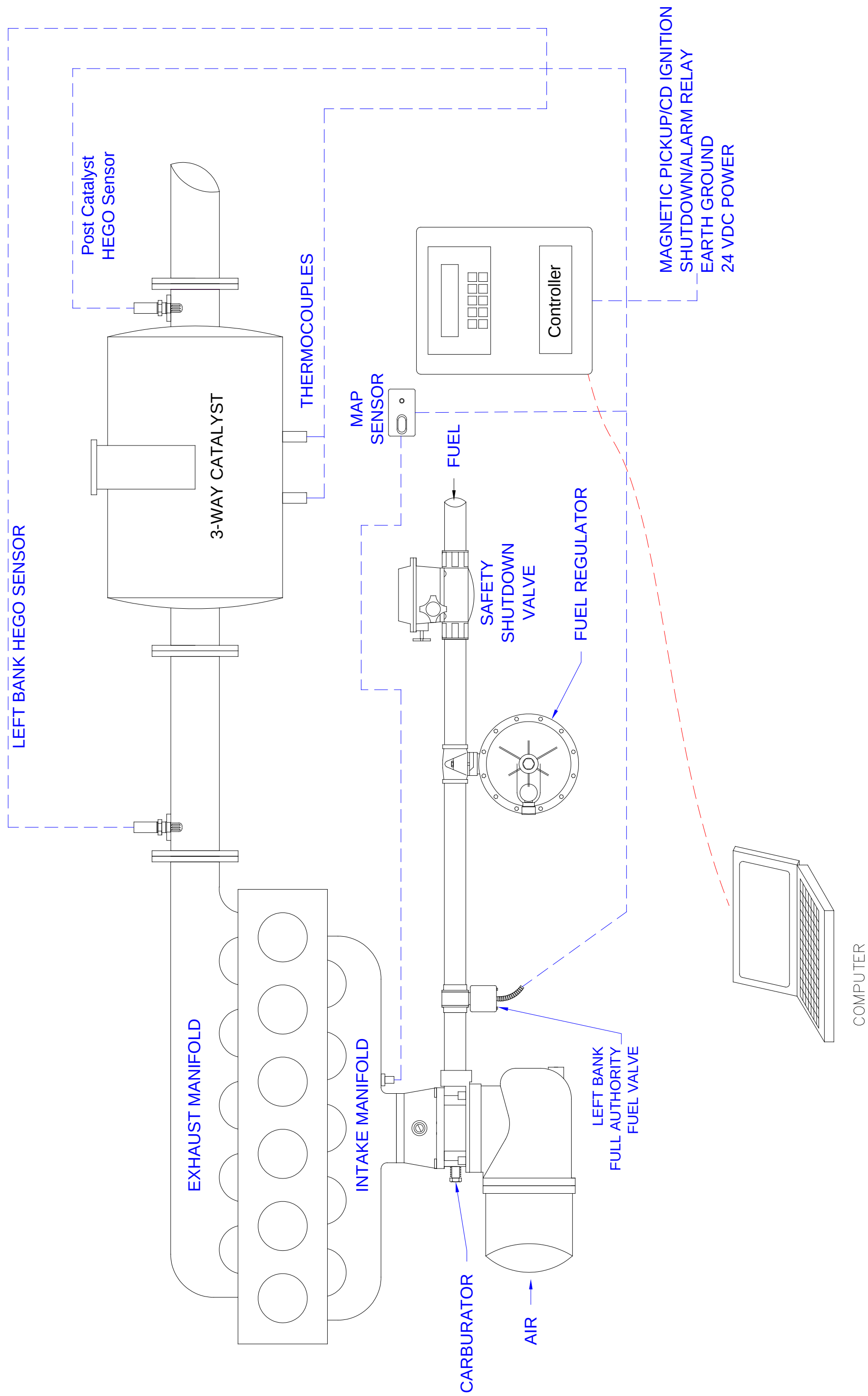
AFR-ND-R-64R-11-TK## *(Single Bank, High Pressure Carburetor, Supplemental TK Valve)*



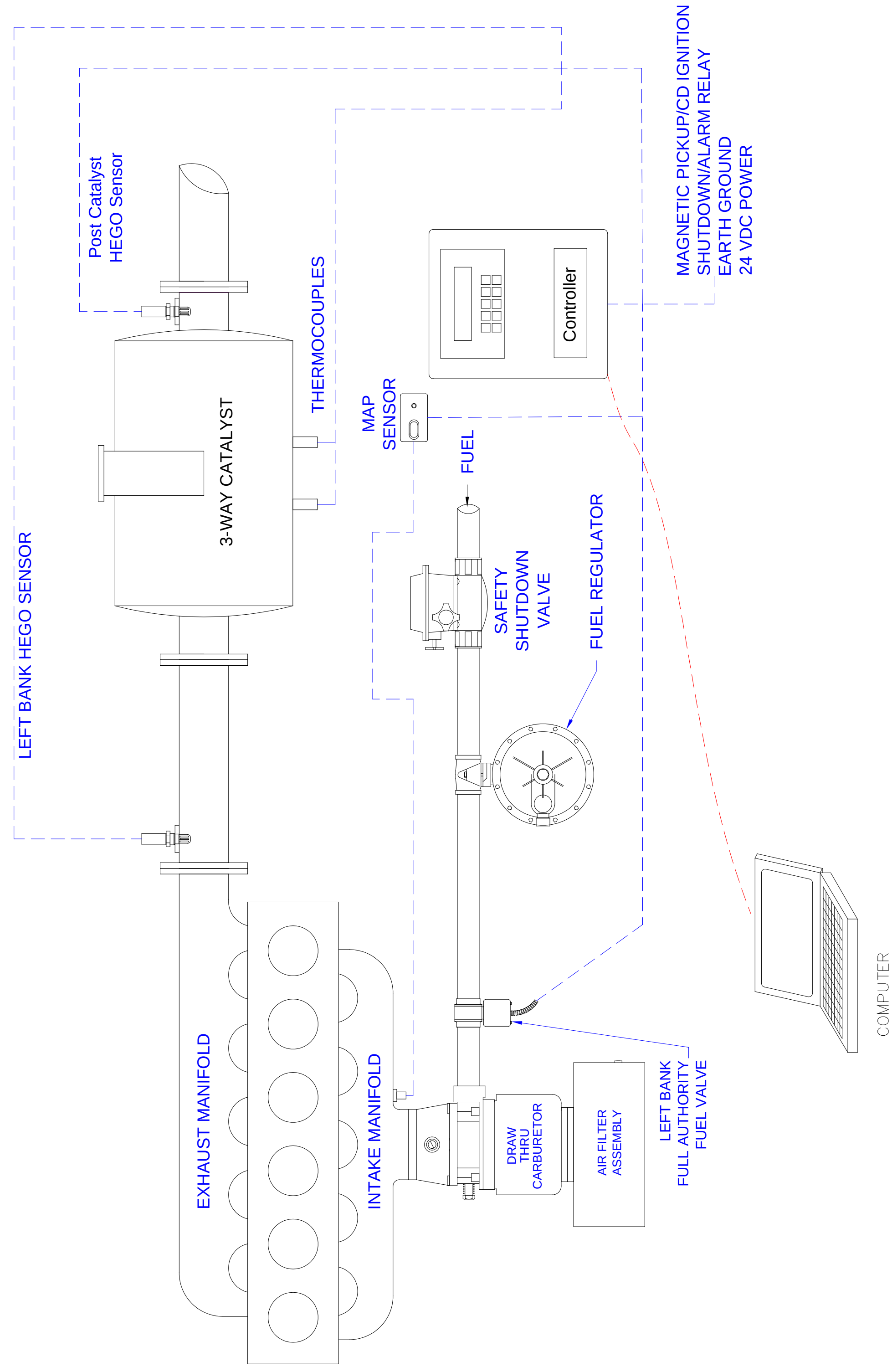
AFR-ND-R-64R-11-TK## *(Single Bank, Low Pressure Carburetor, Supplemental TK Valve)*



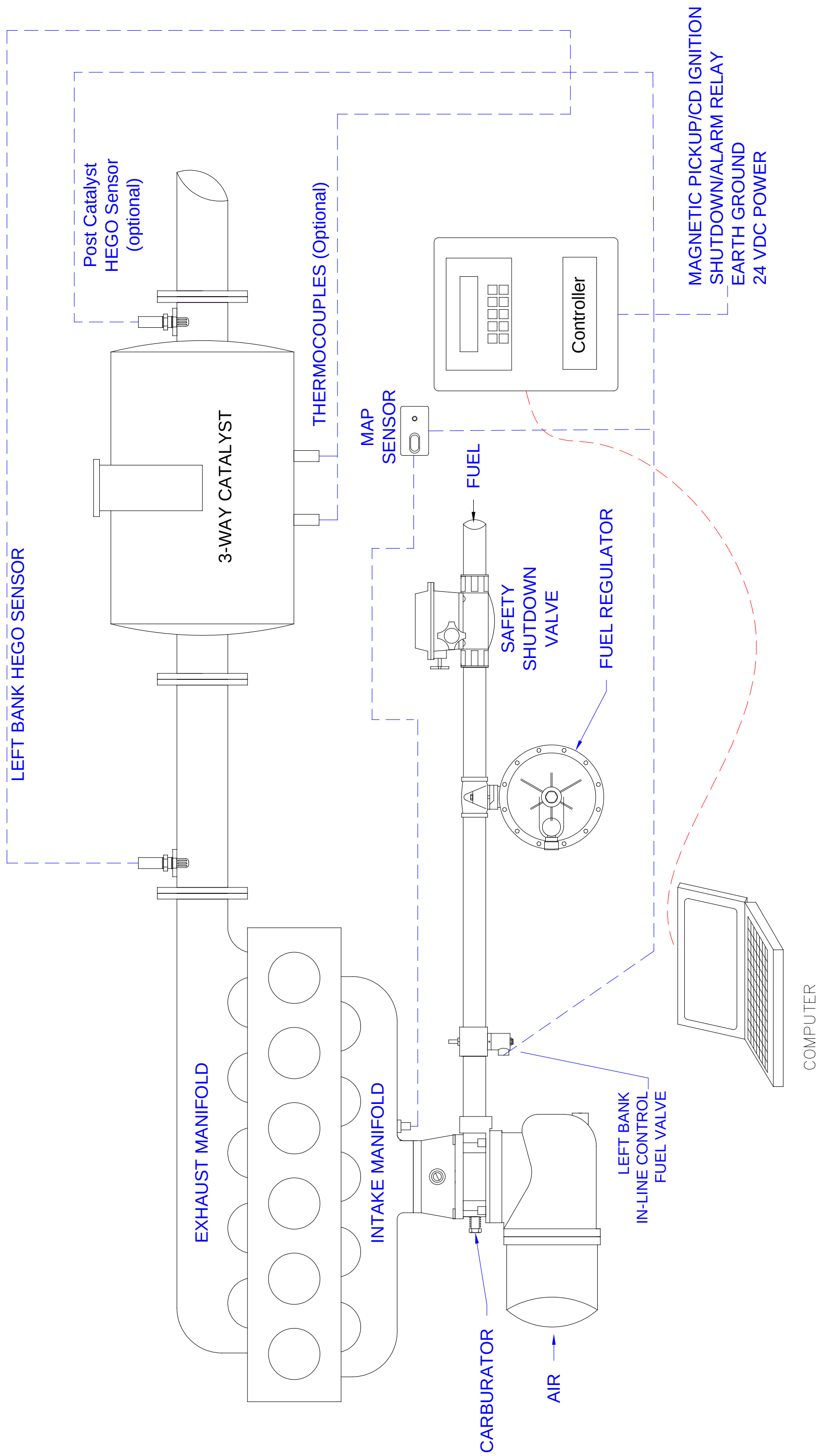
AFR-ND-R-64R-11-FA## *(Single Bank, High Pressure Carburetor, Full Authority Valve)*



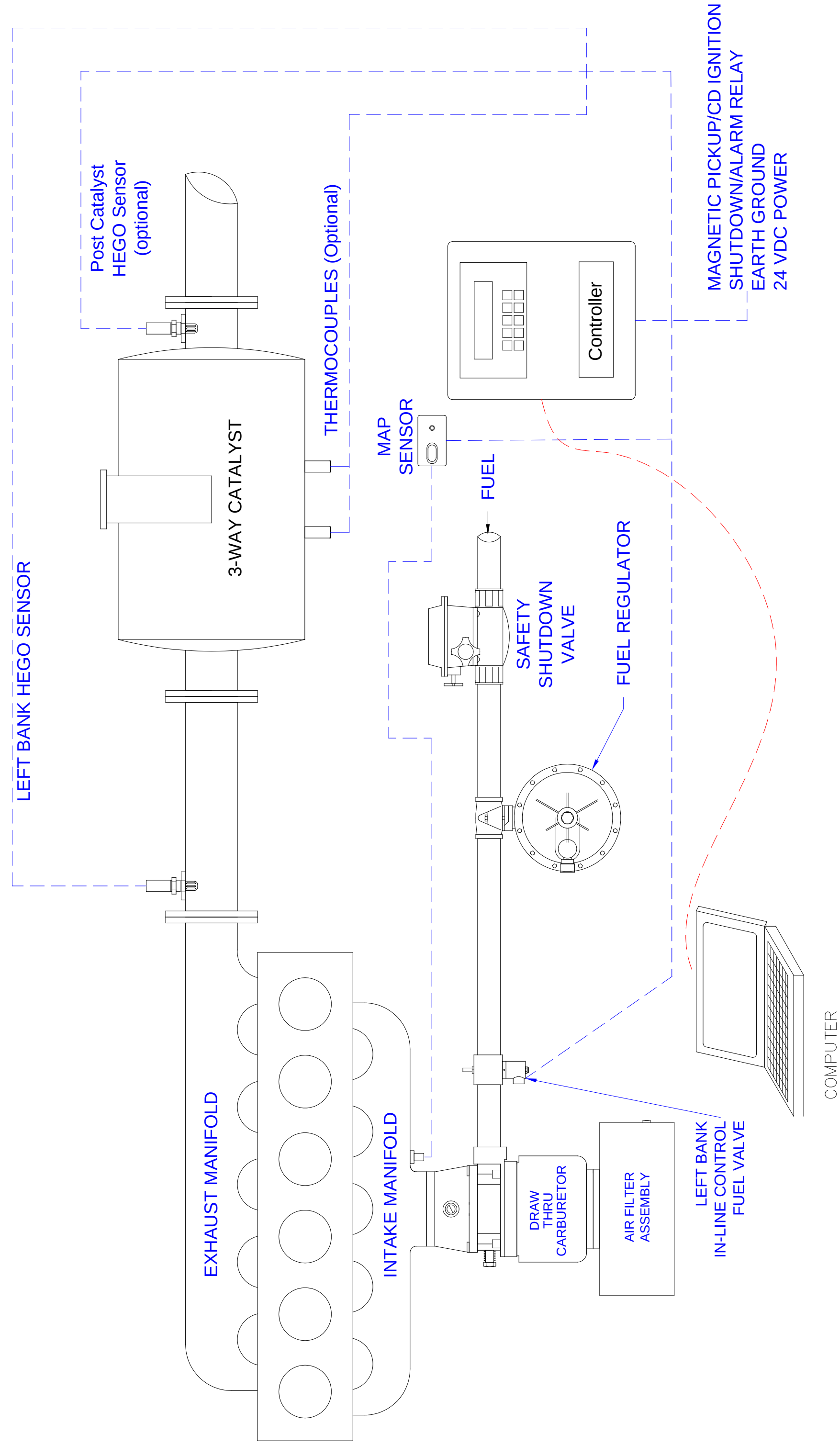
AFR-ND-R-64R-11-FA## *(Single Bank, High Pressure Carburetor, Full Authority Valve)*



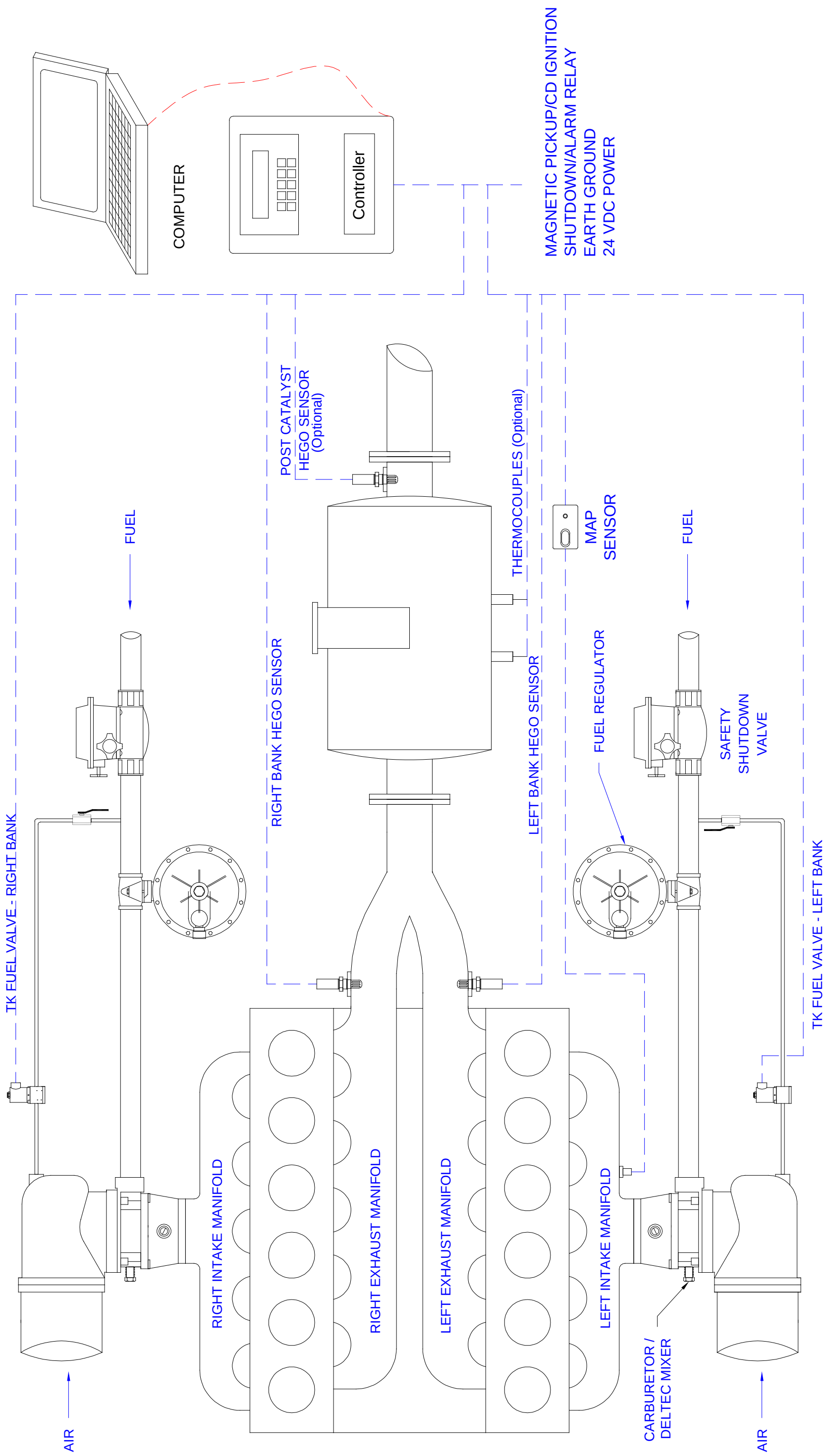
AFR-ND-R-64R-11-ICV75 *(Single Bank, High Pressure Carburetor, In-Line Control Valve)*



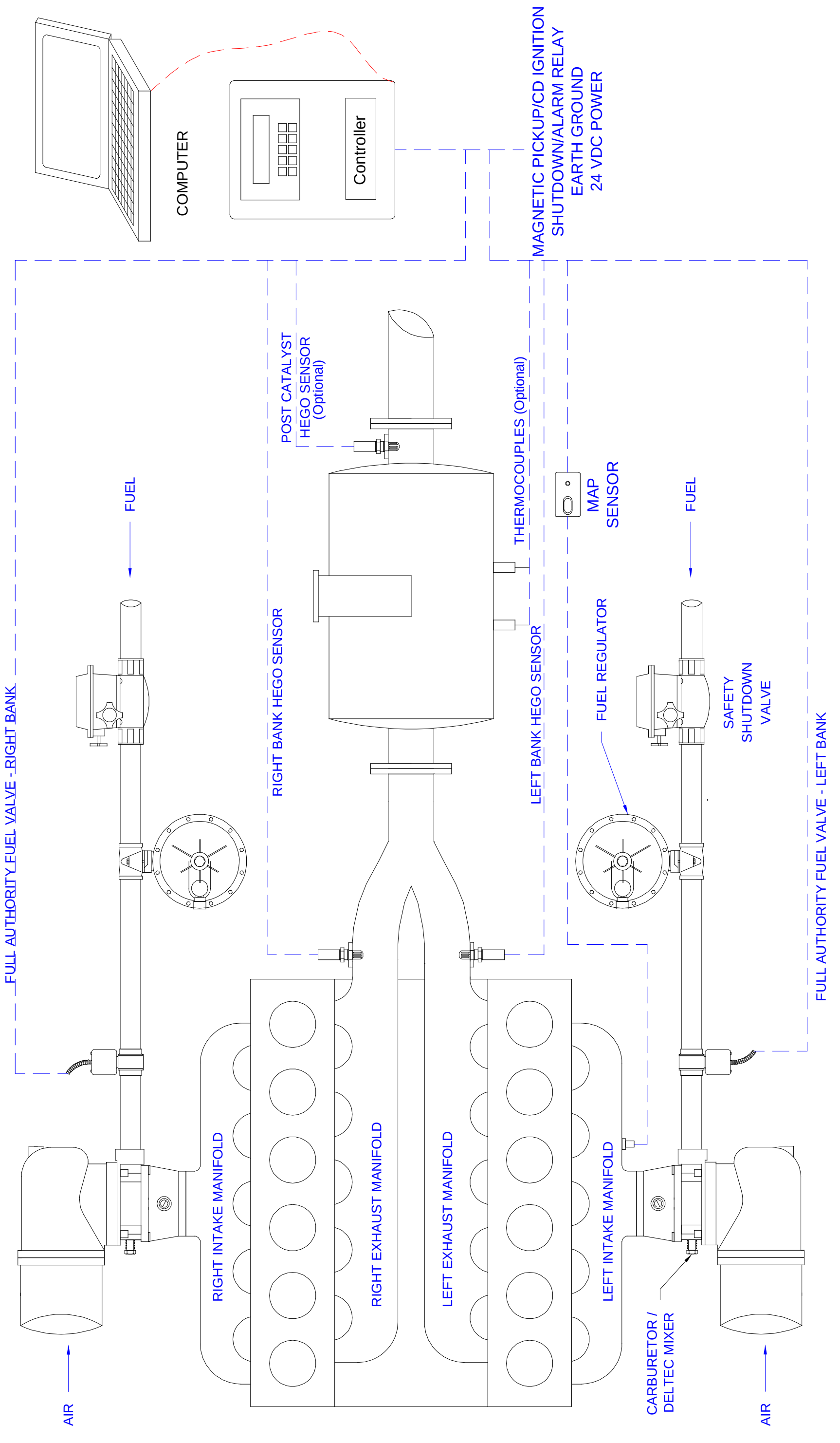
AFR-ND-R-64R-11-ICV75 *(Single Bank, Low Pressure Carburetor, In-Line Control Valve)*



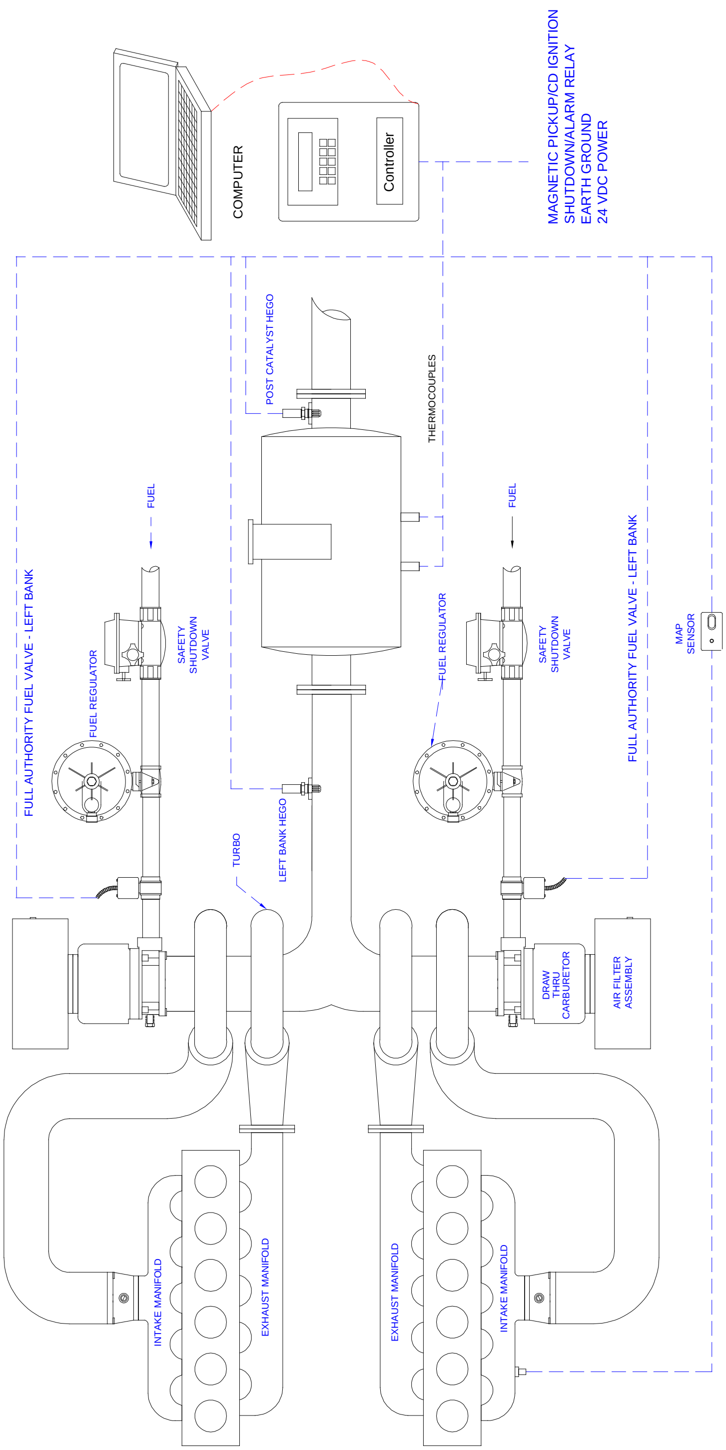
AFR-ND-R-64R-21-TK## *(Dual Bank, High Pressure Carburetor, Supplemental TK Valve)*



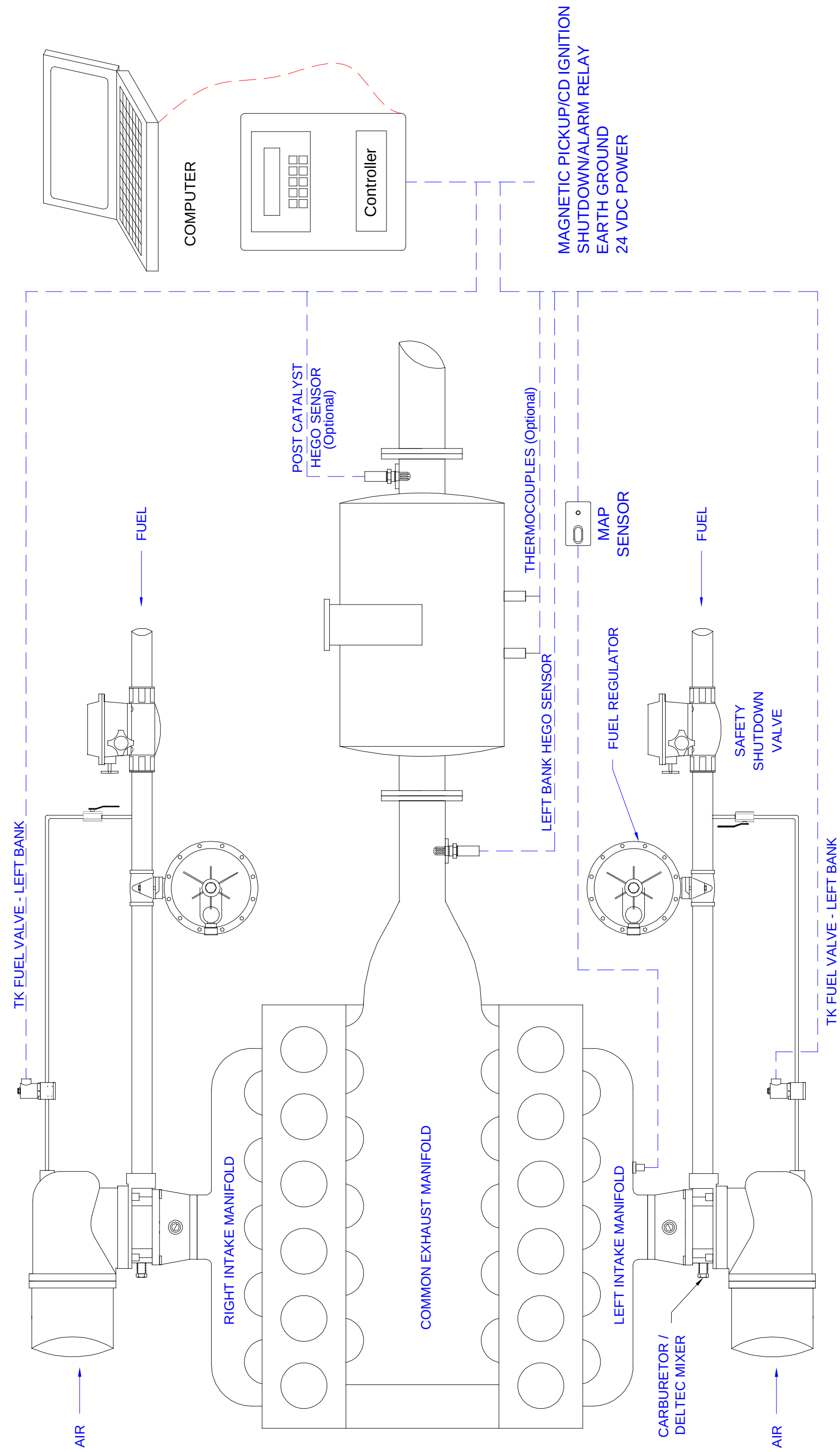
AFR-ND-R-64R-21-FA## *(Dual Bank, High Pressure Carburetor, Full Authority Valve)*



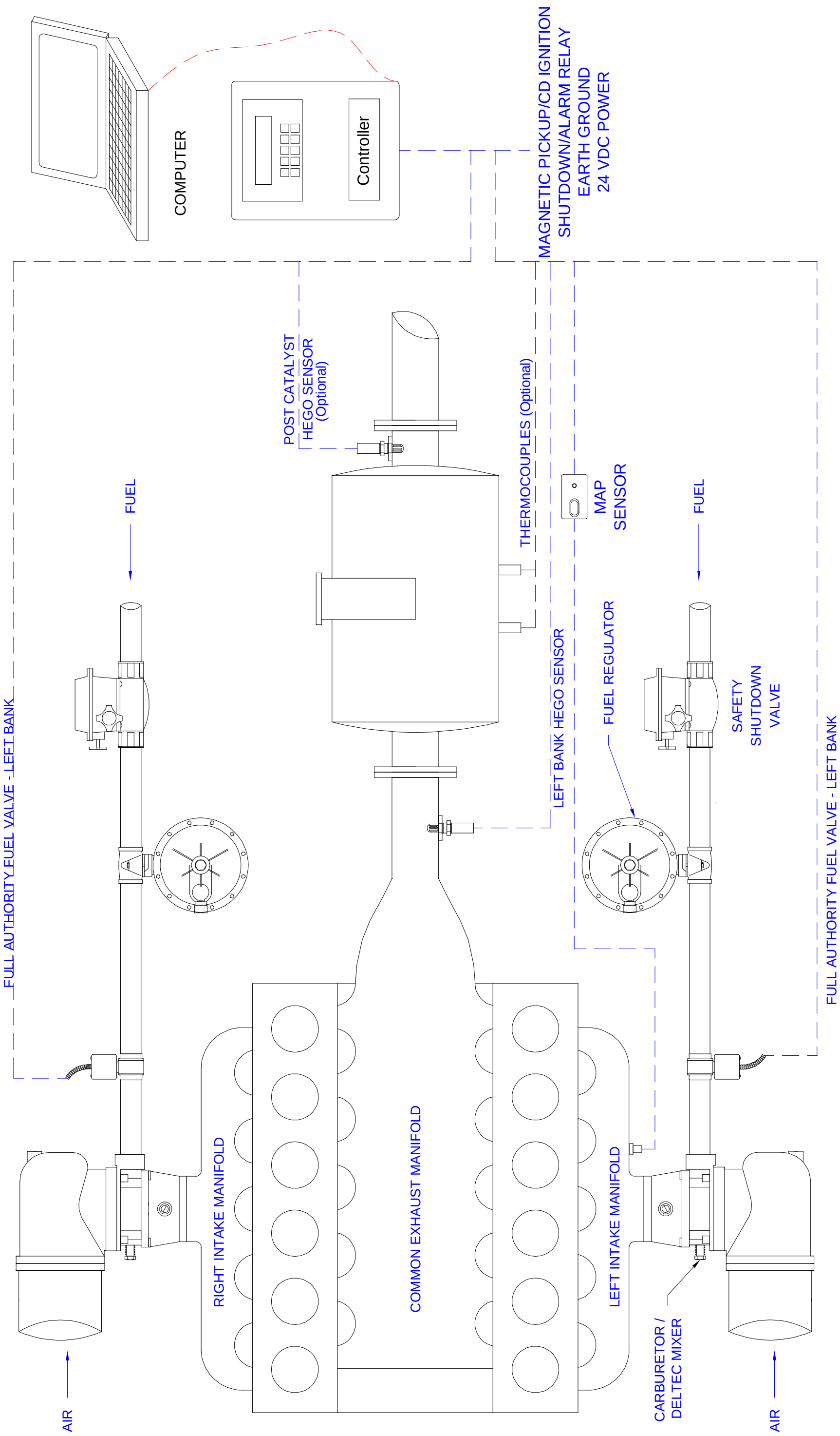
AFR-ND-R-64R-21-FA## *(Dual Bank, Low Pressure Carburetor, Full Authority Valve)*



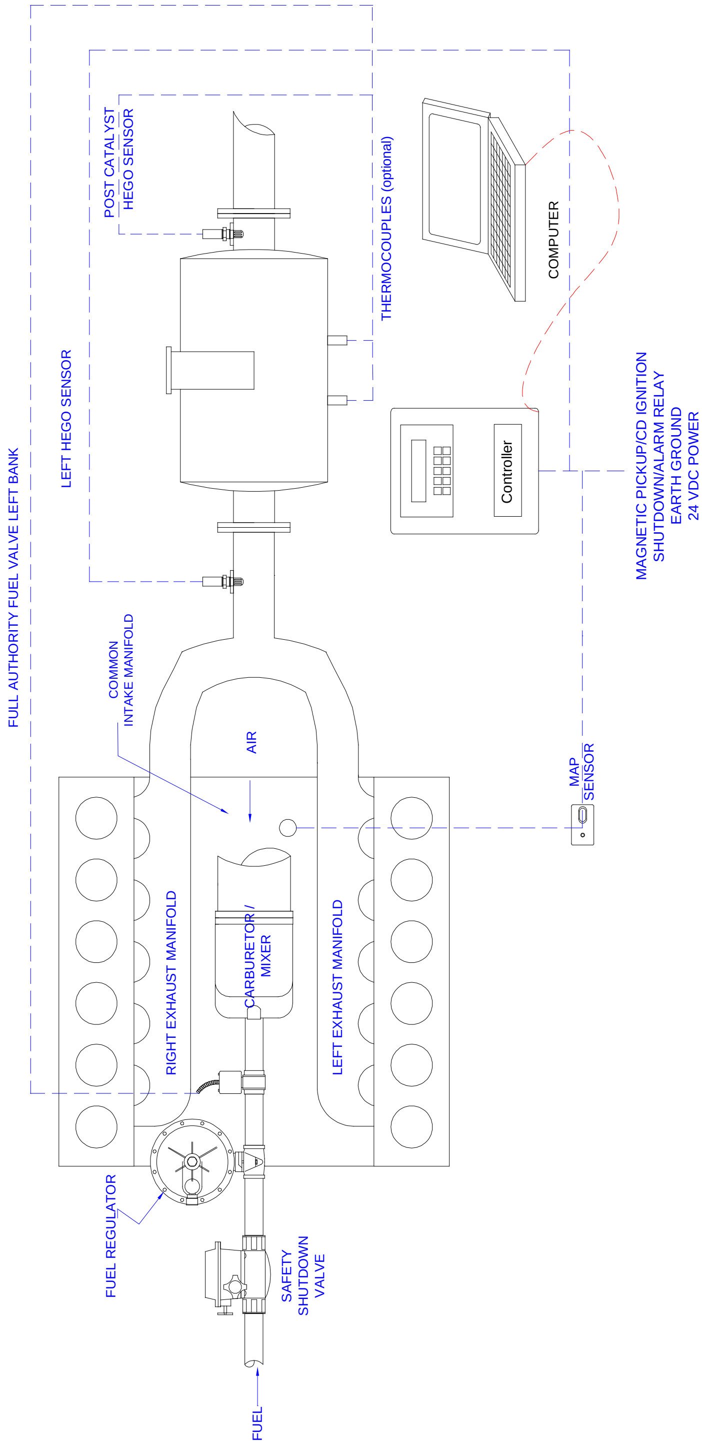
AFR-ND-R-64R-21-FA## *(Dual Bank, High Pressure Carburetor, Common Exhaust Manifold TK Supplemental Valve)*



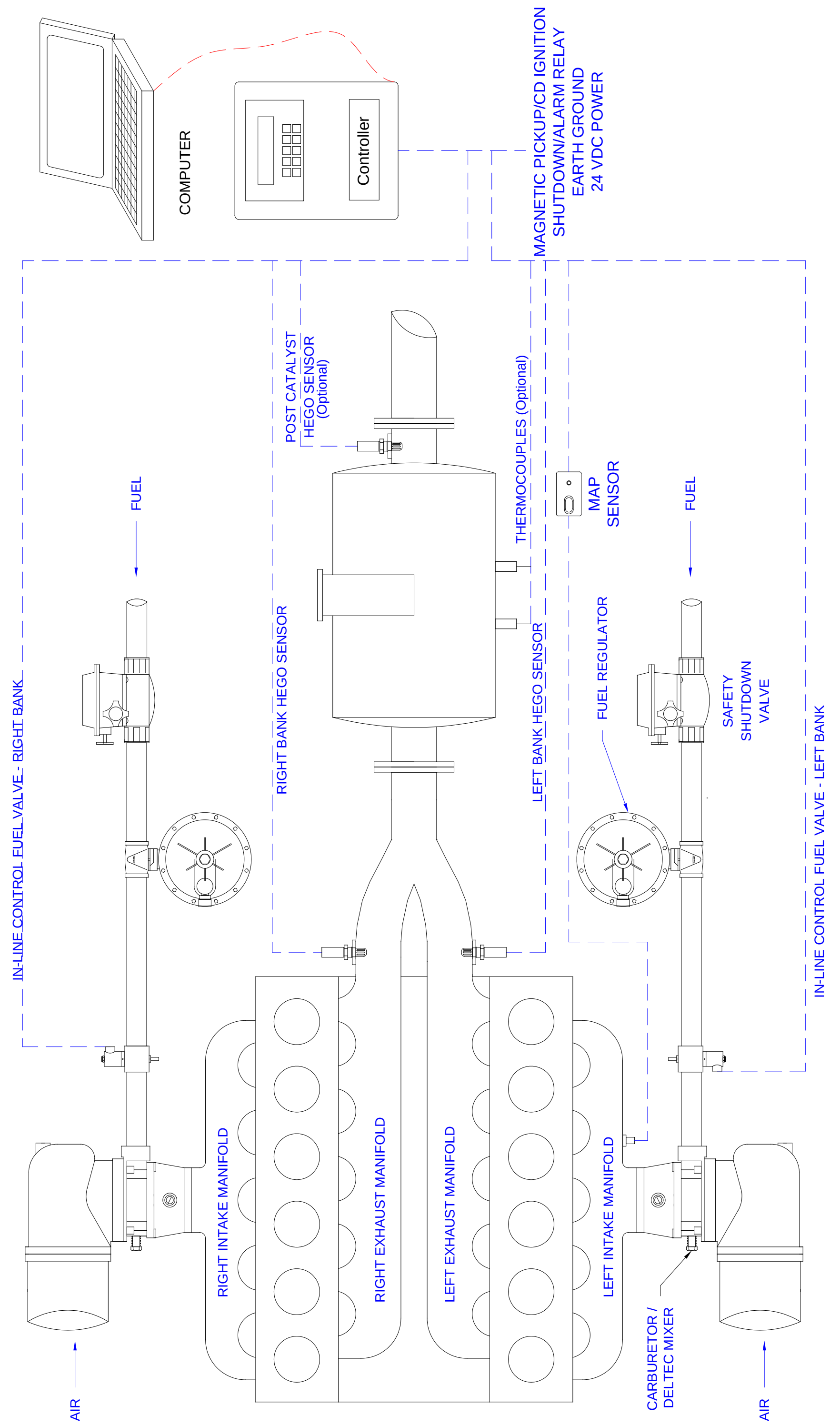
AFR-ND-R-64R-21-FA## *(Dual Bank, High Pressure Carburetor, Common Exhaust Manifold Full Authority Valve)*



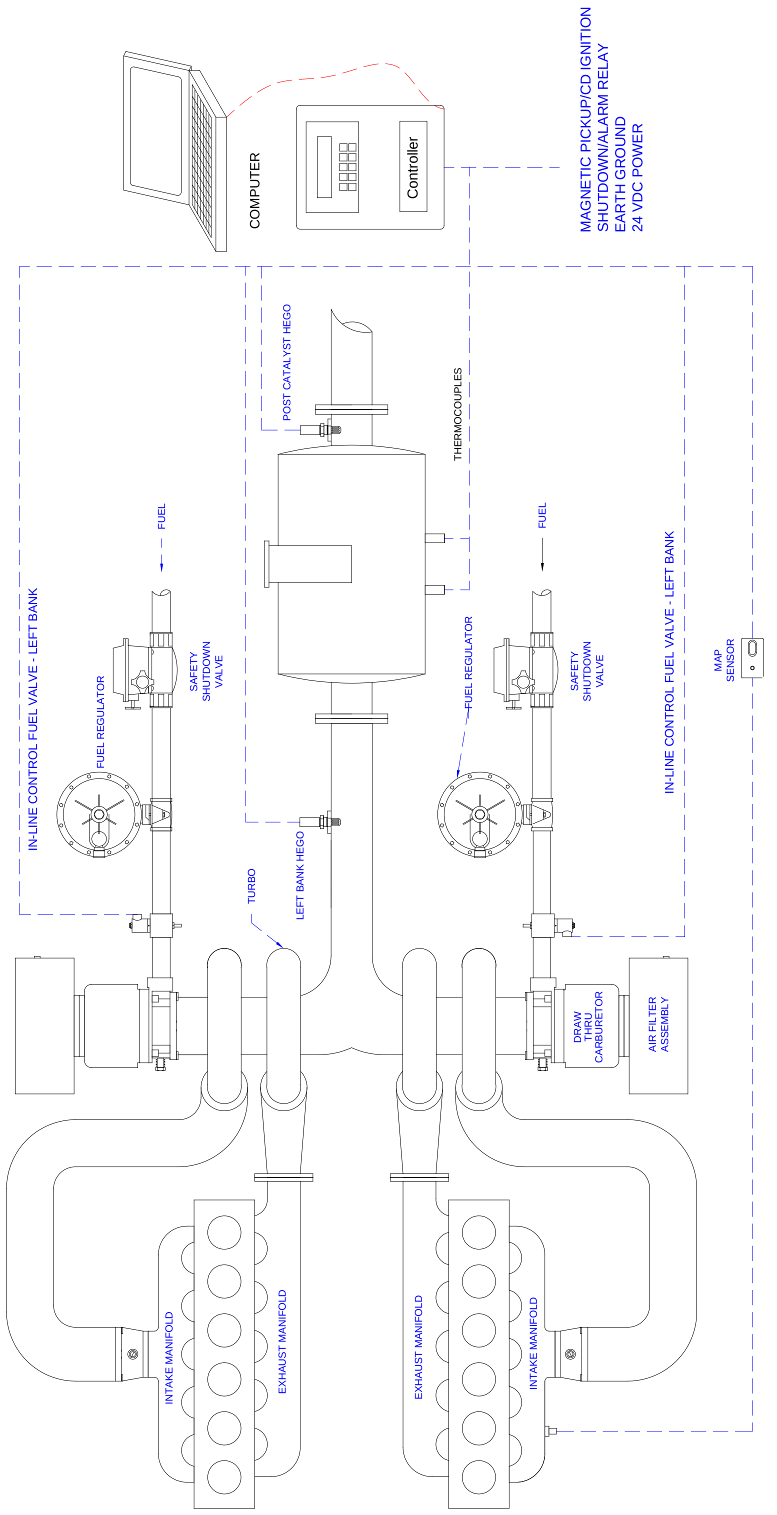
AFR-ND-R-64R-21-FA## *(Dual Bank, High Pressure Carburetor, Common Intake Manifold Full Authority Valve) (Cat 3500 series)*



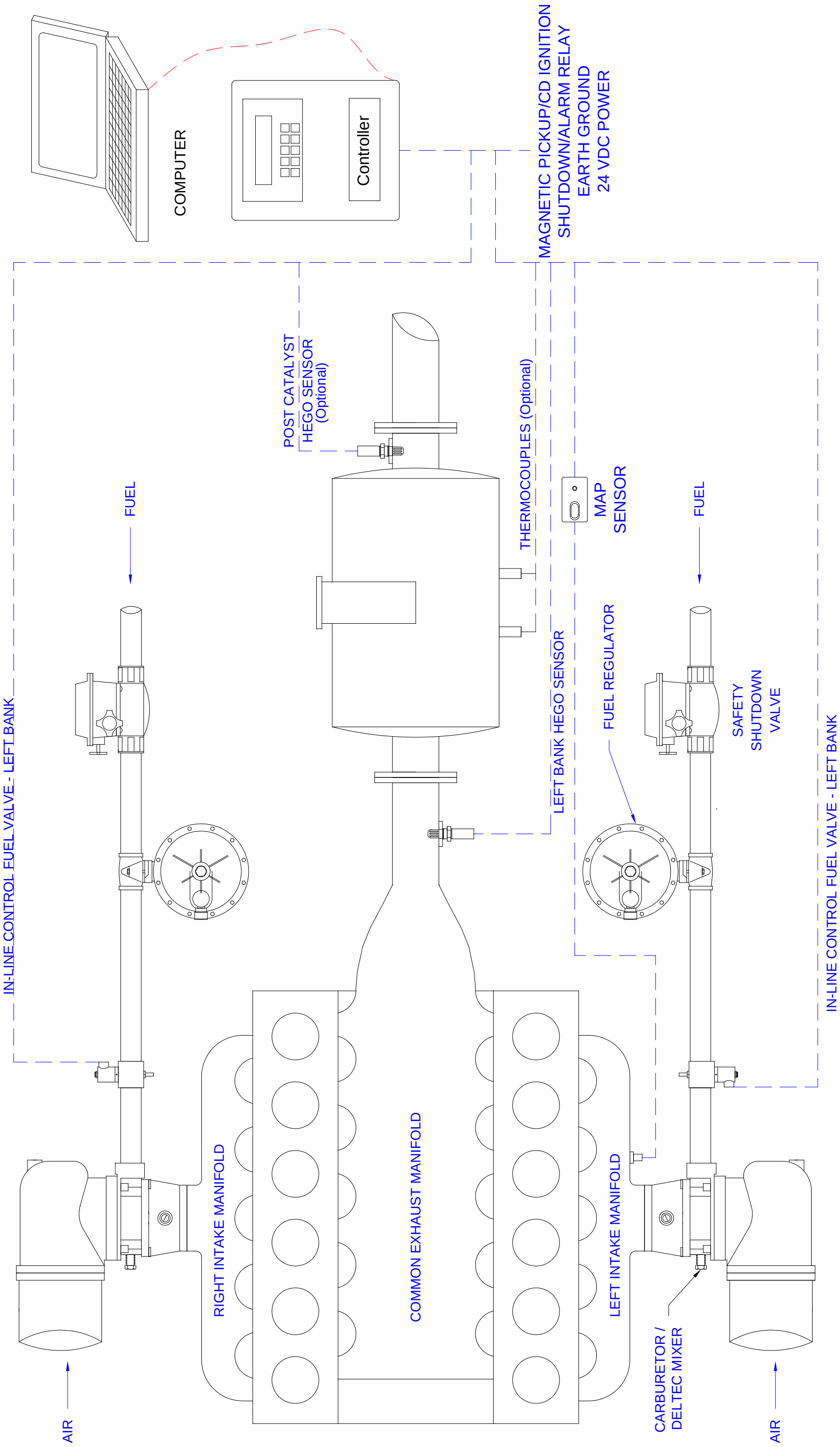
AFR-ND-R-64R-21-ICV75 *(Dual Bank, High Pressure Carburetor, In-Line Control Valve)*



AFR-ND-R-64R-21- ICV75 (Dual Bank, Low Pressure Carburetor, In-Line Control Valve)



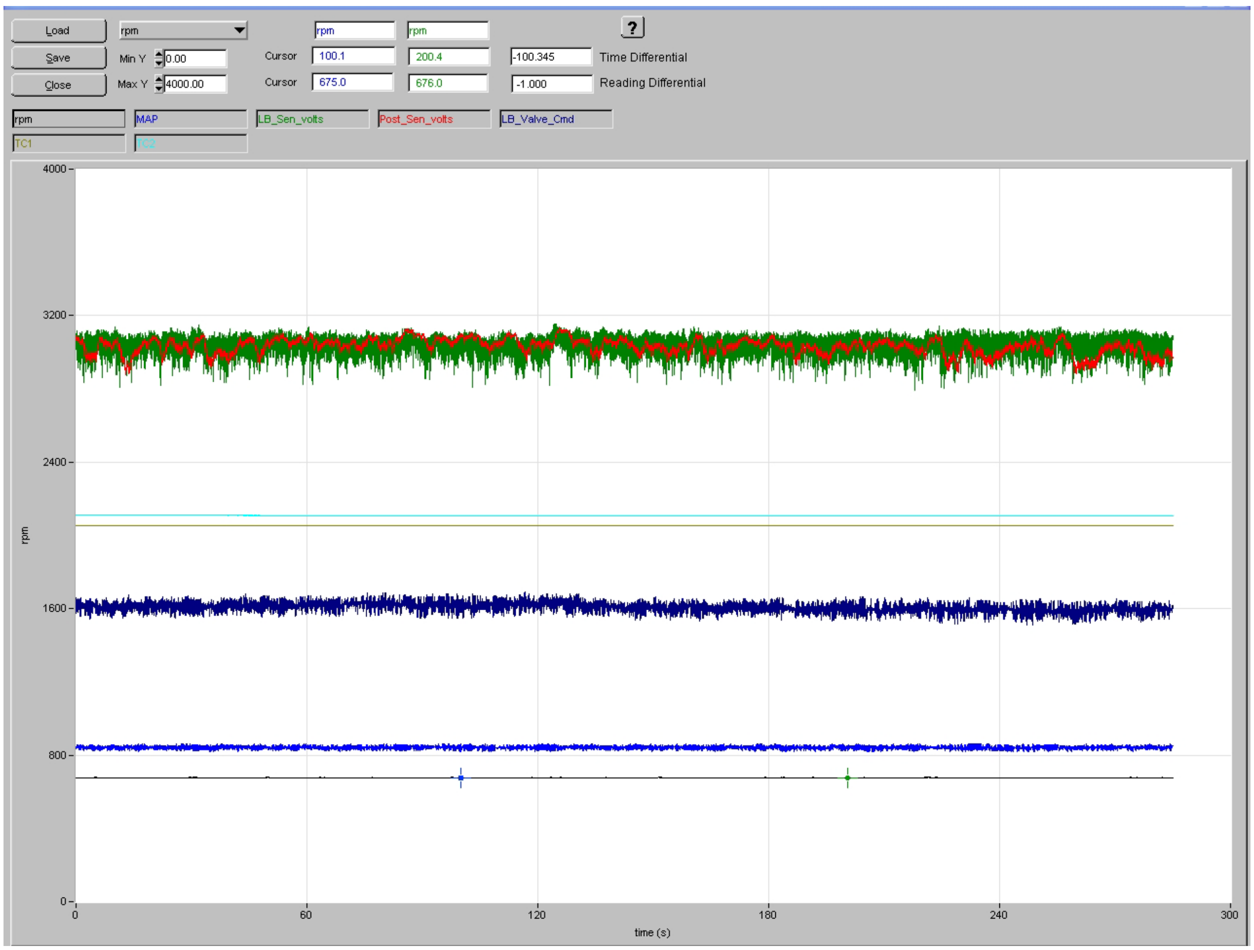
AFR-ND-R-64R-21- ICV75 (Dual Bank, High Pressure Carburetor, Common Exhaust In-Line Control Valve)



Plot Examples

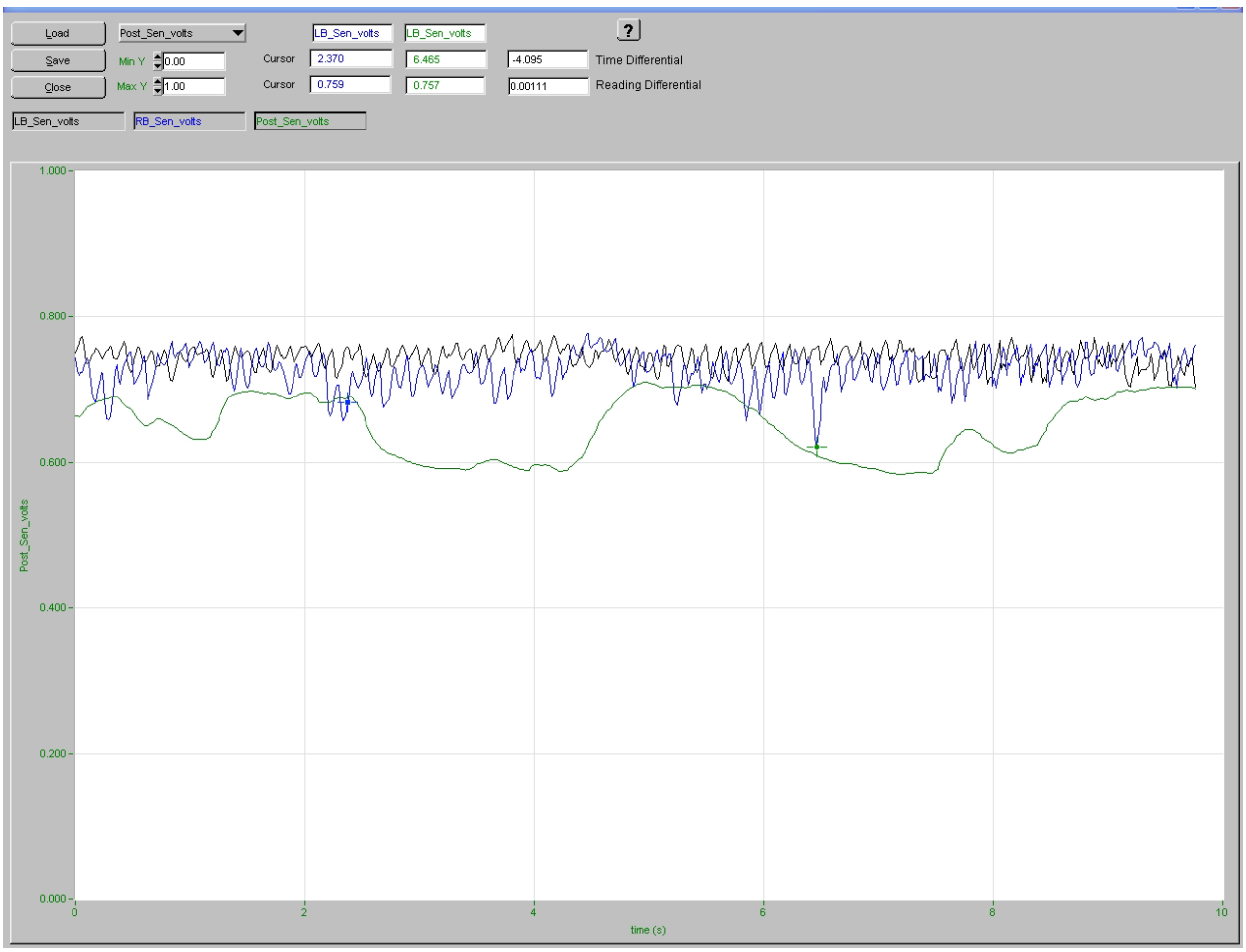
Typical HEGO Plot

This plot represents a typical oxygen sensor on an engine that is running at a standard stable load. No misfires or catalyst related problems are detected. The millivolt signals from the left and post catalyst oxygen sensors are stable within 75 mV (0.075 volts DC) peak to peak. The scratchy or wavy trace seen on the sensor signals is considered to be within normal operating parameters.



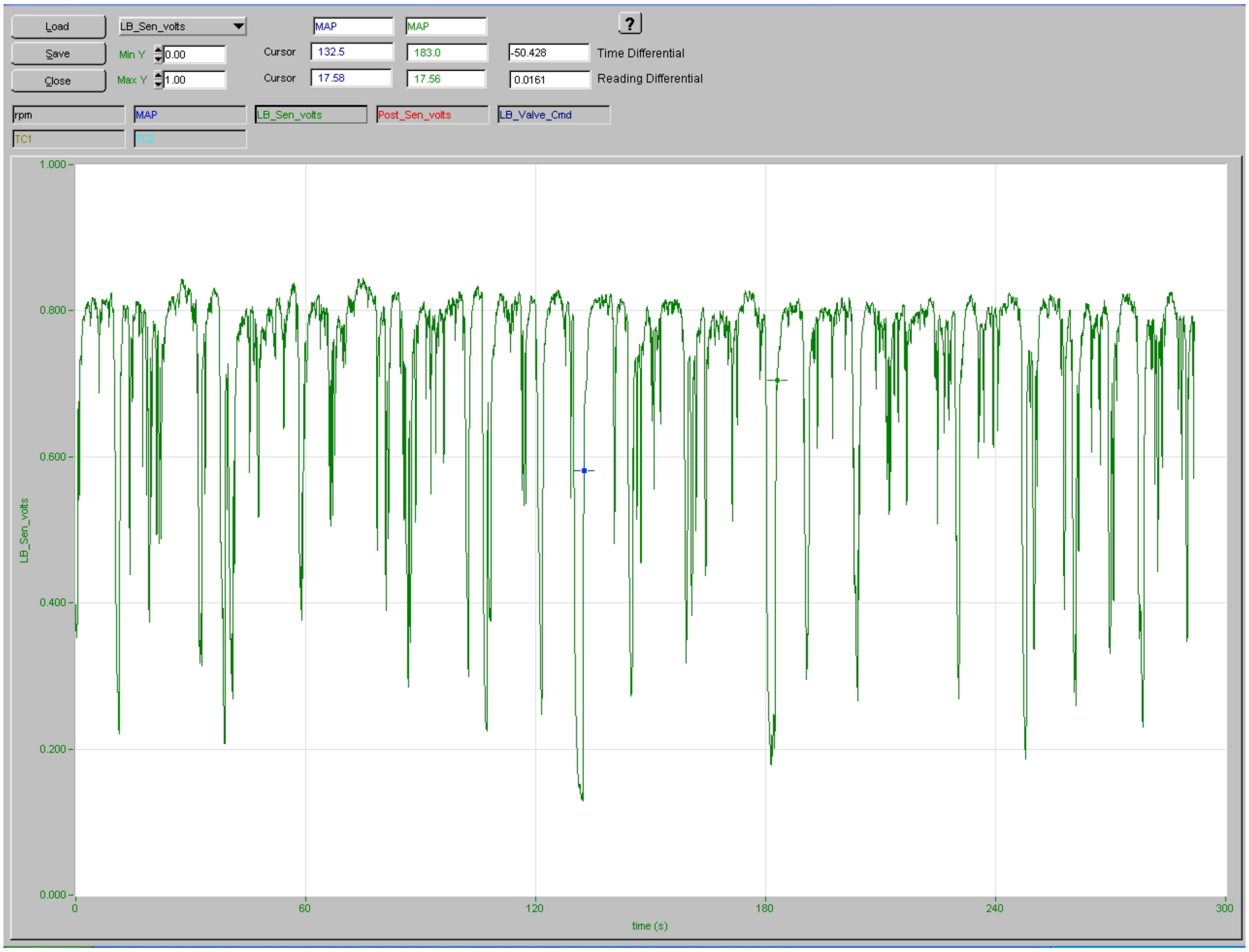
Ashed Catalyst

In this plot, ashing of the catalyst element is detected. This is determined by looking at the stability of the Left Bank O2 Signal and the instability of the Post Catalyst O2 Signal. The presents of elevated levels of ash on the surface of the catalyst causes the catalyst element to store and release oxygen at an abnormal rate. Under normal circumstances, the oxygen storage and release from the catalyst is at a stable steady rate, providing a stable oxygen sensor voltage output. When the catalyst is storing oxygen the sensors voltage output is increased due to the lack of oxygen, but when the catalyst releases the stored oxygen, the voltage output decreases. This causes the swing seen in this plot. Excessive ashing of a catalyst is typically due to one of two things: 1st – An engine motor oil is being used that has a higher ash content than recommended; 2nd – Engine problems such as but not limited to worn valve guides, worn piston rings; etc.



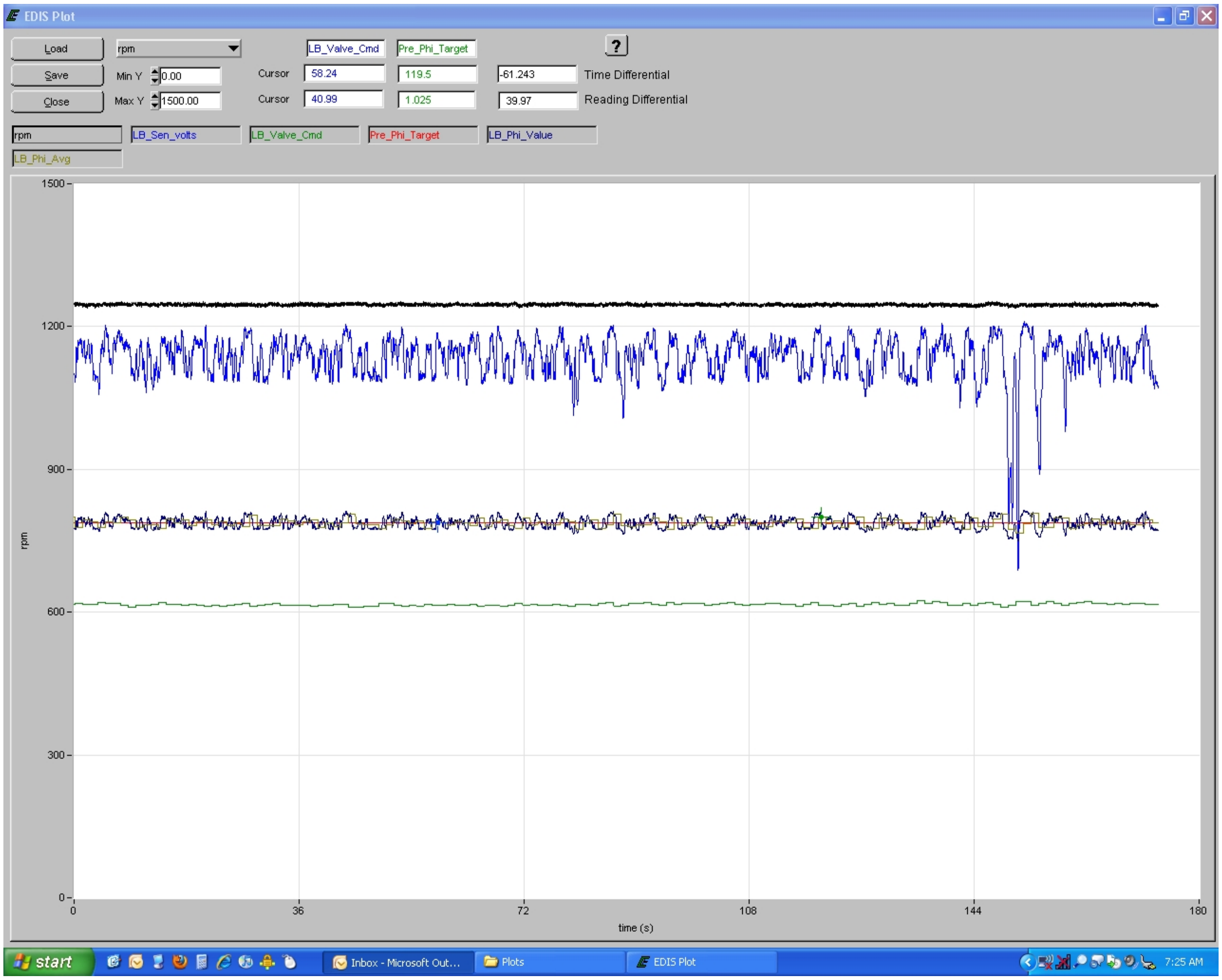
Continuous Misfire

In this plot, a continuous misfire has been detected. Note the multiple, long sharp spikes in the Left Bank HEGO sensor voltage. The sharp spikes in the Left Bank HEGO sensor voltages are caused by the un-burnt oxygen that is expelled from the cylinder during a misfire travels across the LB HEGO sensor. In general, if the HEGO sensor voltage spike is less than 75 mV, this would be considered normal. If the sensor voltage spike is between 75 and 150 mV, this would be considered an incomplete combustion. If the sensor voltage is greater than 150 mV, this would be considered a misfire.



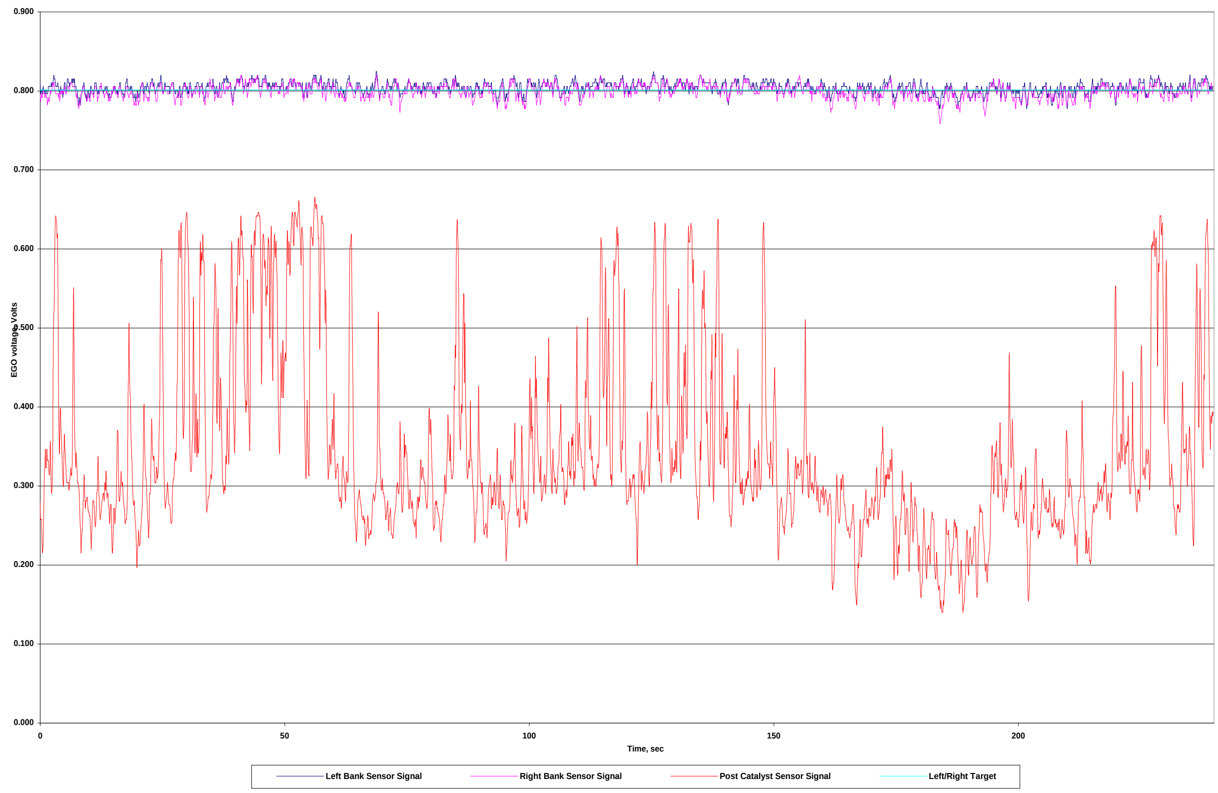
Single Cylinder or Intermittent Misfire

In this plot, an occasional or intermitting misfire has been detected. Note the long sharp spikes in the Left Bank HEGO sensor voltage. The sharp spikes in the Left Bank HEGO sensor voltages are caused by the un-burnt oxygen that is expelled from the cylinder during a misfire travels across the LB HEGO sensor. In general, if the HEGO sensor voltage spike is less than 75 mV, this would be considered normal. If the sensor voltage spike is between 75 and 150 mV, this would be considered an incomplete combustion. If the sensor voltage is greater than 150 mV, this would be considered a misfire.



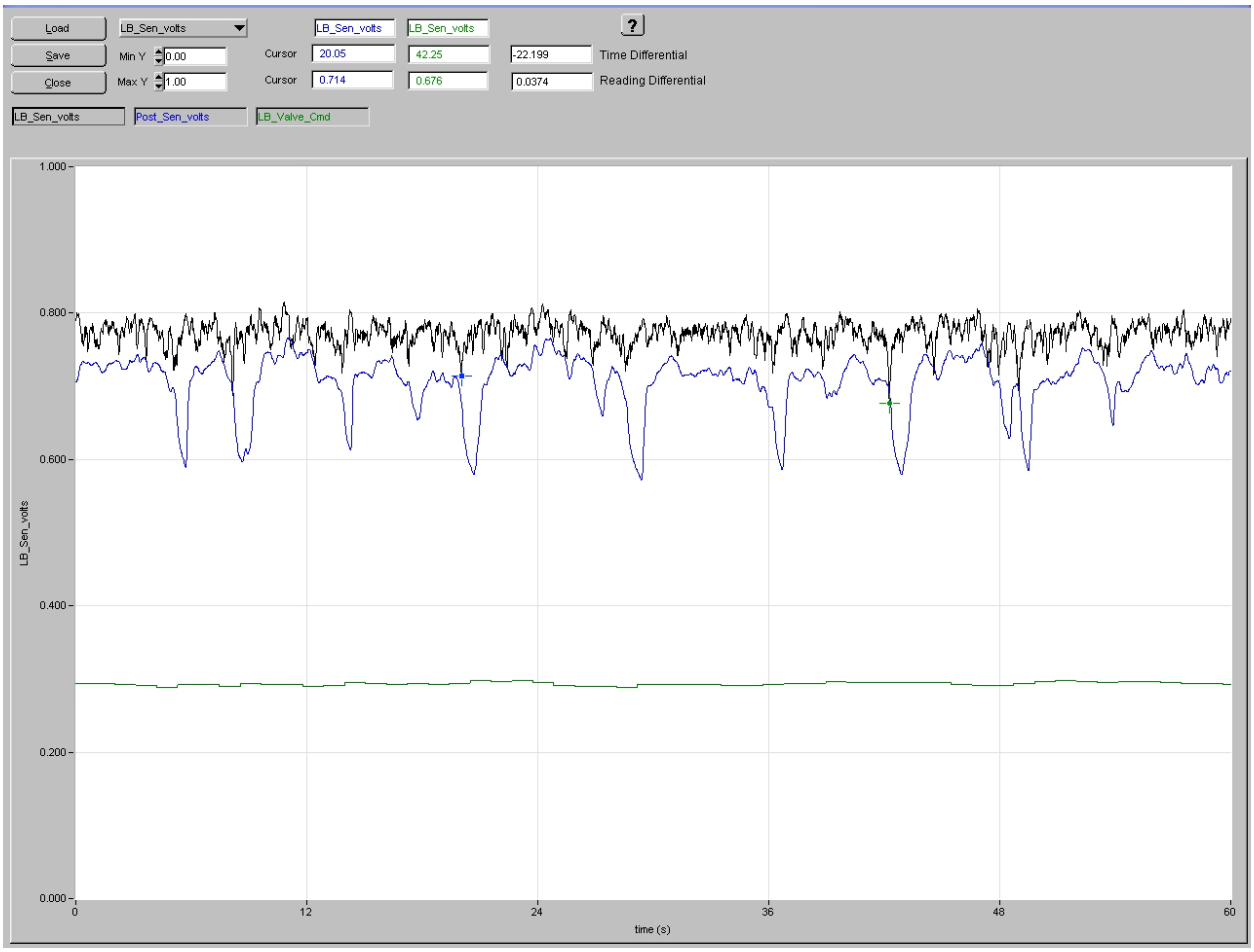
Sticking Exhaust Valve

In this plot, an exhaust valve is stuck in the open position. This is evident by the long slow swing seen in the left bank sensor signal voltage. The swing can also be seen shortly after in the post catalyst sensor signal. This swing is caused by the lack of combustion in this cylinder. The lack of combustion causes excess oxygen to be expelled into the exhaust stream which is detected by the oxygen sensors.



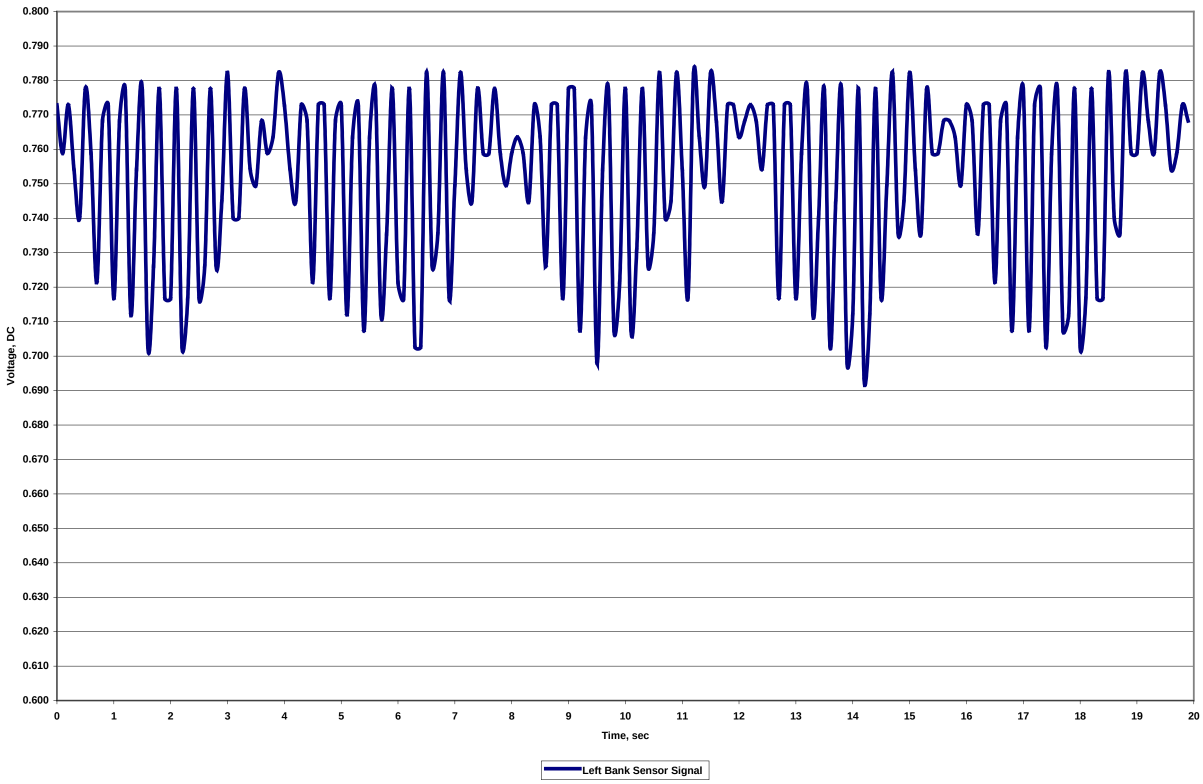
Damaged Catalyst

In this plot, damage to the catalyst element can be detected. The rapid change in the post catalyst sensor signal indicates that there is movement in the catalyst foil material. Note that there is no rapid change in the left bank sensor signal. This indicates that the problem lies between the inlet of the catalyst and the outlet of the catalyst. Some of the possible problems with the catalyst could be but are not limited to: loose catalyst material, catalyst element loose in the housing, severe sagging of catalyst material, torn catalyst material.



Leaking Exhaust Valve

In this plot, a leaking exhaust valve has been detected. This is evident by the slow, spiky swinging pattern seen in the left bank oxygen sensor signal. These spiky patterns are caused when the valve fails to close completely, the un-burnt oxygen and fuel slip past the valve and enters the exhaust stream. As the piston reaches top dead center (TDC) on the combustion stroke, the spikes are at their greatest. This particular plot is from a low speed engine, so the swings are longer. The higher the speed of an engine, the tighter pattern the swings will be.



Engine Data

Engine Manufacture	Engine Model	Number of Cylinders	Displacement Liters	Flywheel Tooth Count
Caterpillar	G3304	4	7.0	157
Caterpillar	G3306	6	10.5	157
Caterpillar	G3406	6	13.4	157
Caterpillar	`G3408	8	17.9	157
Caterpillar	G3412	12	26.9	157
Caterpillar	G3508	8	33.7	183
Caterpillar	G3512	12	50.5	183
Caterpillar	G3516	16	67.4	183
Caterpillar	G342	6	20.4	183
Caterpillar	G379	8	32.2	183
Caterpillar	G398	12	48.3	183
Caterpillar	G399	16	64.4	183
White	6G510	6	50.2	230
White	6G825	6	81.0	230
White	8G825	8	108.0	230
White	12G825	12	162.0	230
White	16G825	16	216.0	230
Arrow	VRG220	4	3.6	121
Arrow	VRG330	6	5.4	121
Waukesha	F817	6	13.4	138
Waukesha	F1197	6	19.6	144
Waukesha	F11	6	11.0	148
Waukesha	F18	6	18.0	150
Waukesha	H24	8	24.0	150
Waukesha	L36	12	36.0	165
Waukesha	P48	16	48.0	165
Waukesha	F1905	6	31.2	158
Waukesha	F2895	6	47.5	208
Waukesha	F3521	6	57.7	208
Waukesha	H2475	8	40.6	204
Waukesha	L3711	12	60.8	204
Waukesha	L5108	12	83.7	208
Waukesha	L5790	12	94.9	208
Waukesha	L7042	12	115.4	208
Waukesha	P9390	12	153.9	208
Waukesha	8L–AT27GL	8	142.5	267
Waukesha	12V-AT27GL	12	213.9	291
Waukesha	16V-AT27GL	16	285.0	291

Liters = Cubic Inch Displacement divided 61

ModBus Addresses

Name	Index	X Size	Y Size	Data Bytes	Type Flag	Mode Flag	Mode Compare	Mode Name	Plot Label	ModBus Index	ModBus Index End	ModBus Write	ModBus Decimals
Rpm	0	1	1	2	0				rpm	40001	40001		0
MAP	1	1	1	2	0				MAP	40002	40002		2
run_mode	16	1	1	1	0	1	0x00	Stopped		40025	40025		
							0x01	Cranking					
							0x02	Underspd					
							0x03	Running					
power_mode	17	1	1	1	0	1	0xfe	Sleep		40024	40024		
							0xff	Key-off					
							0x00	Standby					
							0x01	Active					
mdot_a_ports	36	1	1	2	0				mdot_a_ports	40087	40087		1
FaultSysFlag	40	1	1	1	0	1	0x00	OK		40026	40026		
							0x01	FAULT					
Vbat	42	1	1	2	0				Batt_Volt	40023	40023		1
EGO1_volts	44	1	1	2	0				LB_Sen_volts	40010	40010		3
EGO2_volts	45	1	1	2	0				RB_Sen_volts	40011	40011		3
EGO3_volts	46	1	1	2	0				Post_Sen_volts	40012	40012		3
fuel_ctl_mode	60	1	1	1	0	1	0x00	Open Loop	fuel_ctl_mode	40028	40028		
							0x01	CL Inactive					
							0x03	CL Active					
							0x07	CL + Adapt					
CL_BM1	61	1	1	2	1				CL_multi_LB	40081	40081		
A_BM1	62	1	1	2	1				Adp_multi_LB	40083	40083		
Manual_BM	63	1	1	2	1				Manual_BM				
BM1_crct	64	1	1	2	0				BM1_crct				
CL1_perturb	65	1	1	2	1				CL1_perturb				
CLInactiveFlag	66	1	1	1	0	1	4	Manual force inactive	CLInactiveFlag	40030	40030		
							1	CL Ena Map = 0					
							2	Phi command out-of range					
							0	NONE					
EGO1_DCa	67	1	1	2	0				EGO1_DCa				
EGO1_DCd	68	1	1	2	0				EGO1_DCd				
CLp_E	69	1	1	2	0				CLp_E				
TRIM_DC	84	1	1	2	0				LB_Valve_Cm d	40021	40021		1
CL_BM2	99	1	1	2	1				CL_multi_RB	40082	40082		
A_BM2	100	1	1	2	1				Adp_multi_RB	40084	40084		
BM2_crct	101	1	1	2	0				BM2_crct				
EGO2_DCa	106	1	1	2	0				EGO2_DCa				
EGO1_WR_phi_raw	113	1	1	2	0				EGO1_WR_phi_raw				
rMAP	114	1	1	2	0				rMAP				
Phi_cmd_wtrim	141	1	1	2	0				Pre_Phi_Target	40019	40019		3
TV_R_DC	142	1	1	2	0				RB_Valve_Cmd	40022	40022		1
SD_latch_hot	143	1	1	1	0	1	0x00	OK	Shutdown	40027	40027		
							0x01	SHUTDOWN					
K_adapt	356	1	1	2	1					40075	40075	1	
K_CL_acquire	363	1	1	2	1					40074	40074	1	
TRIM_mode	379	1	1	1	0	1	0x00	Auto		40089	40089	1	
							0x01	Manual					
trim_nom_crkP	509	1	1	2	1					40080	40080		
HM_RAM_seconds	602	1	1	4	0				HM_RAM_seconds				
HM_hours	603	1	1	2	0				HM_hours				
HM_RAM_starts	604	1	1	4	0				HM_RAM_starts	40073	40073		
fault_clear_all	629	1	1	1	0					41001	41001	1	
FT_input_cfg	630	1	1	1	0	1	0x00	Gnd=LP, Open=Gsln, +5V=NG					
							0x01	Gnd=NG, Open=Gsln, +5V=LP					
							0x02	Open=Gsln, +12V=LP					
							0x03	Open=Gsln, +12V=NG					
							0x04	Gasoline Only					
							0x05	LP Only					
							0x06	NG Only					
							0x07	Open=LP, +12V=NG					
							0x08	Open=NG, +12V=LP					
RS485_Rx_packs	982	1	1	4	0	0			RS485_Rx_cnt	40102	40102		
RS485_Tx_packs	983	1	1	4	0	0			RS485_Tx_cnt	40103	40103		
RS485_Rx_csfail	984	1	1	2	0	0			RS485_Rx_csfail	40104	40104		
RS485_Rx_inact	985	1	1	4	0	0							
RS485_Rx_noise	986	1	1	2	0	0							
RS485_bad_fmt	987	1	1	2	0	0							
RS485_SD_rq	988	1	1	2	0	0							
RS485_Rx_inv	989	1	1	2	0	0			RS485_Rx_inv	40105	40105		
TRIM_nom_DC	1203	1	1	2	0				TRIM_nom_DC	40088	40088		1
TRIM_nom_phi	1204	1	1	2	0				TRIM_nom_phi				
TRIM_sens	1205	1	1	2	1				TRIM_sens				
CTM_phi_lim	1206	1	1	2	0				CTM_phi_lim				
CTMA_phi_lim	1207	1	1	2	0				CTMA_phi_lim				
CTM_CL_tgEGO	1208	1	1	2	0				CTM_CL_tgEGO				

Name	Index	X Size	Y Size	Data Bytes	Type Flag	Mode Flag	Mode Compare	Mode Name	Plot Label	ModBus Index	ModBus Index End	ModBus Write	ModBus Decimals
CTM_CL_tgphi	1209	1	1	2	0				CTM_CL_tgphi				
CTM_CL_forcewt	1210	1	1	2	0				CTM_CL_forcewt				
trim_LP_min	1211	1	1	2	0				trim_LP_min	40078	40078		
trim_LP_max	1212	1	1	2	0				trim_LP_max	40079	40079		
EGO1_phiFB	1221	1	1	2	0				LB_Phi_Value	40013	40013		3
EGO2_phiFB	1222	1	1	2	0				RB_Phi_Value	40014	40014		3
EGO3_phiFB	1223	1	1	2	0				Post_Phi_Value	40015	40015		3
EGO1_phiFB_avg	1224	1	1	2	0				LB_Phi_Avg	40016	40016		3
EGO2_phiFB_avg	1225	1	1	2	0				RB_Phi_Avg	40017	40017		3
EGO3_phiFB_avg	1226	1	1	2	0				Post_Phi_Avg	40018	40018		3
Phi_pstFB_d	1227	1	1	2	0				Post_Phi_Target	40020	40020		3
Phi_pstFB_delta	1228	1	1	2	1				Phi_pstFB_delta				
Phi_pstFB_act	1229	1	1	1	0	1	0	Inactive	Phi_pstFB_act	40032	40032		
							1	Active					
CL_postcat_ena	1240	1	1	1	0	1	0	Disabled	CL_postcat_ena	40031	40031	1	
							1	Enabled					
CL_Kp_p_postcat	1255	1	1	2	1				CL_Kp_p_postcat	40076	40076	1	
CLLP_Kp_p_postcat	1256	1	1	2	1				CLLP_Kp_p_postcat				
CLNG_Kp_p_postcat	1257	1	1	2	1				CLNG_Kp_p_postcat				
CL_Kp_n_postcat	1258	1	1	2	1				CL_Kp_n_postcat	40077	40077	1	
GasCarb_trim_mode	1275	1	1	1	0	1	0	PWM Valve	GasCarb_trim_mode	40037	40037	1	
							1	Megajector					
TC1_T	1303	1	1	2	0				TC1	40004	40004		1
TC2_T	1304	1	1	2	0				TC2	40005	40005		1
TC_21_dT	1305	1	1	2	1				TC_Diff	40006	40006		1
CL_control_type	1307	1	1	1	0	1	0	Disabled	CL_control_type	40033	40033	1	
							1	Stoich Dithering					
							2	Stoich Steady-State					
							3	Widerange					
EGO1_config	1308	1	1	1	0	1	0	Heated	EGO1_config				
							1	Un-heated					
EGO2_config	1309	1	1	1	0	1	0	Heated	EGO2_config				
							1	Un-heated					
EGO3_config	1310	1	1	1	0	1	0	Heated	EGO3_config				
							1	Un-heated					
bank_mode	1311	1	1	1	0	1	0	Single Bank	bank_mode	40034	40034	1	
							1	Dual Bank					
rpm_config	1314	1	1	1	0	1	0	Disconnected	rpm_config	40035	40035	1	
							1	Magnetic Pickup					
							2	Hall-Effect - No Pullup					
							3	Hall-Effect – Pullup Enabled					
							4	Discrete - Ground=Running					
							5	Discrete - Open=Running					
							6	Discrete - +V=Running					
pulses_per_rev	1318	1	1	2	0				pulses_per_rev	40036	40036	1	
N_cyl_def	1319	1	1	1	0				cylinders	40039	40039	1	
TC1_open	1320	1	1	2	0				TC1_open				
TC2_open	1321	1	1	2	0				TC2_open				
TC1_highT	1322	1	1	2	0				TC1_highT	40044	40044	1	
TC2_highT	1323	1	1	2	0				TC2_highT	40045	40045	1	
TC1_lowT	1324	1	1	2	0				TC1_lowT				
TC2_lowT	1325	1	1	2	0				TC2_lowT				
TC1_open_FSW	1350	1	1	1	0	1	0x00	Ignore		40048	40048	1	
							0x80	Code Only					
							0x90	Alarm					
							0xD0	Shutdown					
TC1_highT_FSW	1351	1	1	1	0	1	0x00	Ignore		40042	40042	1	
							0x80	Code Only					
							0x90	Alarm					
							0xD0	Shutdown					
TC1_lowT_FSW	1352	1	1	1	0	1	0x00	Ignore		40046	40046	1	
							0x80	Code Only					
							0x90	Alarm					
							0xD0	Shutdown					
TC2_open_FSW	1353	1	1	1	0	1	0x00	Ignore		40049	40049	1	
							0x80	Code Only					
							0x90	Alarm					
							0xD0	Shutdown					
TC2_highT_FSW	1354	1	1	1	0	1	0x00	Ignore		40043	40043	1	
							0x80	Code Only					
							0x90	Alarm					
							0xD0	Shutdown					
TC2_lowT_FSW	1355	1	1	1	0	1	0x00	Ignore		40047	40047	1	
							0x80	Code Only					
							0x90	Alarm					
							0xD0	Shutdown					
EGO1Z_health	1372	1	1	2	0				LB_health	40007	40007		0
EGO2Z_health	1373	1	1	2	0				RB_health	40008	40008		0
EGO3Z_health	1374	1	1	2	0				Post_health	40009	40009		0
CLtrim_tbl_type	1392	1	1	1	0	1	0	1-D Simplified	CL_trim_map_type	40053	40053	1	

Name	Index	X Size	Y Size	Data Bytes	Type Flag	Mode Flag	Mode Compare	Mode Name	Plot Label	ModBus Index	ModBus Index End	ModBus Write	ModBus Decimals
							1	2-D Expanded					
TRIM_valve_type	1393	1	1	1	0	1	0	Proportional Fuel Injector	TRIM_valve_type	40038	40038	1	
							1	Logic In-Line Power Valve					
TRIM_nom_V	1394	1	1	2	0				TRIM_nom_V				
TRIM_Pin	1395	1	1	4	2				TRIM_Pin	40085	40085	1	
TRIM_Cd	1396	1	1	4	2				TRIM_Cd				
TRIM_max_diae	1397	1	1	4	2				TRIM_max_diae	40086	40086	1	
Vd_actual	1398	1	1	4	2				Vd_actual	40040	40040	1	2
eng_stoke_type	1399	1	1	1	0	1	0	4-stroke	eng_stoke_type	40041	40041	1	
							1	2-stroke					
TRIM_recal_unlock	1400	1	1	1	0	1	0	Locked	TRIM_recal_unlock	40050	40050	1	
							1	Use calibration parameters only					
							2	Use current engine state to estimate valve inlet pressure					
							3	Use current engine state to estimate flow correction					
TRIM_recal_go	1401	1	1	1	0	1	0	Idle	TRIM_recal_go	40052	40052	1	
							1	Go					
TRIM_recal_status	1402	1	1	1	0	1	0	Inactive	TRIM_recal_status	40051	40051	1	
							1	Processing					
							2	Success					
							3	Failed - Invalid valve type for auto calibration					
							4	Failed - Engine must be running at nominal condition					
							5	Failed - Valve parameters out of range					
							0	???					
RS485_JLG_ena	1429	1	1	1	0	1	0	Disabled	ModBus_ena	40101	40101	1	
							1	Enabled					
RS485_parity	1430	1	1	1	0	1	0	Disabled	RS485_parity	40107	40107	1	
							1	Odd					
							2	Even					
RS485_stop_bits	1431	1	1	1	0	1	0	1 Stop Bit	RS485_stop_bits	40108	40108	1	
							1	2 Stop Bits					
MB_slave_addr	1432	1	1	1	0				MB_slave_addr				
AuP_RPGprogress	1433	1	1	1	0	1	0	Inactive	AuP_RPGprogress				
							1	Connecting					
							2	Failed Connection					
							3	Getting Device Type					
							4	Incorrect Device Type					
							5	Setting Fuse Defaults					
							6	Failed Reconnect After Fuse Defaults					
							7	Chip Erase					
							8	Failed Reconnect After Erase					
							9	Programming Flash					
							10	Failed Programming Flash					
							11	Programming EEPROM					
							12	Failed Programming EEPROM					
							13	Verifying Flash					
							14	Failed Flash Verification					
							15	Verifying EEPROM					
							16	Failed EEPROM Verification					
							17	Programming Lock Bits					
							18	Failed Reconnect After Lock Bits					
							19	Success					
							20	Power Lost					
							21	Invalid State Detected					
							0	???					
MB_dirty_cal_page	1442	1	1	1	0				MB_dirty_cal_page	41002	41002	1	
RS485_baud	1471	1	1	1	0	1	0	9600	RS485_baud	40106	40106	1	
							1	19200					
MJ_ctl_strat	1472	1	1	1	0	1	0	Internal PID Only	MJ_ctl_strat				
							1	Feedforward Area					
DPA_Kp	1473	1	1	2	1				DPA_Kp				
DPA_Ki	1474	1	1	2	1				DPA_Ki				
DPA_Kd	1475	1	1	2	1				DPA_Kd				
DPA_Kvi	1476	1	1	2	1				DPA_Kvi				
DPA_I_min	1477	1	1	2	1				DPA_I_min				
DPA_I_max	1478	1	1	2	1				DPA_I_max				
DPA_SenseLP	1479	1	1	2	3				DPA_SenseLP				
DPA_AcmdLP	1480	1	1	2	3				DPA_AcmdLP				
DPA_Pref	1481	1	1	2	0				DPA_Pref				
DPA_Pin	1482	1	1	2	1				DPA_Pin				
DPA_sens_min	1483	1	1	2	1				DPA_sens_min				
DPA_sens_max	1484	1	1	2	1				DPA_sens_max				
DPS_Kp	1485	1	1	2	1				DPS_Kp				

Name	Index	X Size	Y Size	Data Bytes	Type Flag	Mode Flag	Mode Compare	Mode Name	Plot Label	ModBus Index	ModBus Index End	ModBus Write	ModBus Decimals
DPS_Ki	1486	1	1	2	1				DPS_Ki				
DPS_Kd	1487	1	1	2	1				DPS_Kd				
DPS_I_min	1488	1	1	2	1				DPS_I_min				
DPS_I_max	1489	1	1	2	1				DPS_I_max				
DPS_AcmdLP	1490	1	1	2	3				DPS_AcmdLP				
DPS_SenseLP	1491	1	1	2	3				DPS_SenseLP				
MJI_Pstart	1492	1	1	2	1				MJI_Pstart				
MJI_flash_wr_left	1493	1	1	1	1				MJI_flash_wr_left				
MJI_flash_wr_force	1494	1	1	1	0	1	0	Idle	MJI_flash_wr_force				
							1	Write Flash					
MJI_cur_cal_mod	1495	1	1	4	0								
MJ_eng_cal_mod	1496	1	1	4	0								
MJ_param_comm	1497	1	1	1	0	1	0	Disabled	MJ_param_comm				
							1	Enabled					
MJ_soft_support	1498	1	1	1	0	1	0	Standard DP Mode Only	MJ_soft_support				
							1	Standard or Area DP Mode					
MJ_param_differ	1499	1	1	1	0	1	0	Params Match	MJ_param_differ				
							1	Params Do Not Match					
MJ_param_upload	1500	1	1	1	0	1	0	Idle	MJ_param_upload				
							1	Upload Params From MJ					
MJ_intF_bits	1501	1	1	4	0				MJ_intF_bits				
MJ_cal_state	1502	1	1	1	0				MJ_cal_state				
MB_NVFaults	1503	1	1	2	0				MB_NVFaults	43001	43001		
MB_ActFaults	1504	1	1	2	0				MB_ActFaults	42001	42001		
MB_TRIM_DC	1505	1	1	2	0				LB_Valve_Cm d	40090	40090		
MB_TV_R_DC	1506	1	1	2	0				RB_Valve_Cmd	40091	40091		1
MB_trim_nom_crkP	1507	1	1	2	1					40092	40092		
MB_dirty_pg_exists	1508	1	1	1	0				MB_dirty_pg_exists	40093	40093		
debug_u16	0	1	8	2	0								
raw_table	1	1	37	2	0								
Tspka_base_CAD	2	16	16	2	0								
Tspka_base_MAP	3	16	1	2	0								
Tspka_base_rpm	4	1	16	2	0								
TVE_VE	5	16	16	2	1								
TVE_MAP	6	16	1	2	0								
TVE_rpm	7	1	16	2	0								
TPhi_base_MAP	8	8	1	2	0					40501	40508	1	1
TPhi_base_rpm	9	1	8	2	0					40509	40516	1	0
TPhi_base_Phi	10	8	8	2	1					40517	40580	1	3
TCL_ena	17	8	8	2	0					40617	40680	1	0
Ttrim_mdotaP	58	1	8	2	1					40201	40208	1	1
Ttrim_nom_MAPP	90	8	1	2	0					40301	40308	1	1
Ttrim_nom_rpmP	91	1	8	2	0					40309	40316	1	0
Ttrim_nom_DCP	92	8	8	2	0					40317	40380	1	1
TCL_postcat_phigsln	116	8	8	2	1					40717	40780	1	3
TMJ_nom_PP	118	8	8	2	1					40417	40480	1	2
Ttrim1D_nom_DC	123	1	8	2	0					40209	40216	1	1
TMJ1D_nom_P	124	1	8	2	1					40217	40224	1	2
MB_NVFaultCode	146	1	8	2	0					43002	43009	1	
MB_ActFaultCode	147	1	8	2	0					42002	42009	1	
MB_sw_model	148	1	3	2	1					40054	40056		
MB_cal_model	149	1	3	2	1					40057	40059		
MB_cal_date	150	1	3	2	1					40060	40062		
MB_hw_model	151	1	3	2	1					40063	40065		
MB_hw_date	152	1	3	2	1					40066	40068		
MB_serial_num	153	1	2	2	1					40069	40070		
MB_HM_RAM_hr	154	1	2	2	1					40071	40072		
MB_Ttrim_nom_MAPP	155	8	1	2	0					40401	40408	1	1
MB_Ttrim_nom_rpmP	156	1	8	2	0					40409	40416	1	0
MB_TPhi_base_MAP	157	8	1	2	0					40601	40608	1	1
MB_TPhi_base_rpm	158	1	8	2	0					40609	40616	1	0
MB_TPhi_base_MAP2	159	8	1	2	0					40701	40708	1	1
MB_TPhi_base_rpm2	160	1	8	2	0					40709	40716	1	0

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