COMMANDER Oz AIR/FUEL CONTROL UNIT
IMPCO PART EK-CDP-1/EK-CDP-1H Kit INSTALLATION INSTRUCTIONS

INTRODUCTION

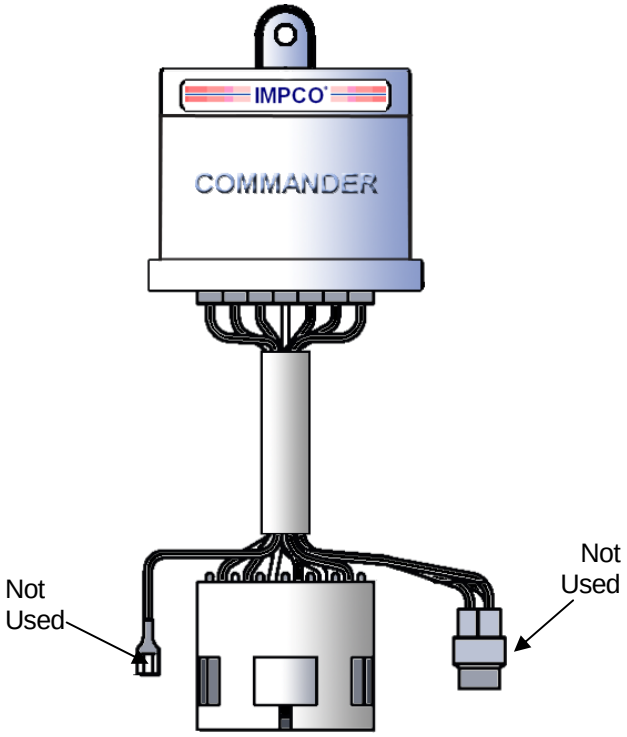
This document will show you how to install the IMPCO Commander "Oz" fuel control processor for industrial engines. The EK-CDP-1 and the EK-CDP-1H Kit contain all of the electrical components required to convert your IMPCO open-loop fuel system to a state-of-the-art closed loop fuel control technology.

SYSTEM DESCRIPTION

The Commander is an advanced digital closed-loop fuel control processor for alternate fuels. These Kits supply the required electrical parts to convert IMPCO open-loop fuel systems to closed-loop feedback control. The Commander controller is designed to reduce overall exhaust emissions without the use of catalytic converters. The compact construction provides a sealed enclosure for operation in harsh industrial engine environments. The small electronic module controls fuel pressure based on engine speed and rich/lean status from the oxygen sensor. The Commander's microprocessor reads and calculates this data to provide a precise stoichiometric air/fuel ratio. The IMPCO Commander delivers good exhaust emissions, driveability and fuel economy at a reasonable cost. The controller is compatible with all IMPCO feedback mixers.

BEFORE YOU BEGIN

This entire manual should be carefully read and understood BEFORE you convert your forklift. Some installations may require additional parts. Also you must be qualified to operate, and have access to automotive test equipment. Check the components parts list on page 8 to ensure your Kit is complete.



IMPCO ECM Commander

Although the Commander is easy to install some special tools are required to properly adjust the air fuel mixtures and verify proper system operating pressures. The IMPCO FSA-1000 Fuel System Analyzer is used to set the fuel mixture and duty cycle. This is a required tool for the Commander installation and is also used on other IMPCO closed-loop fuel systems. The ITK-1 pressure test kit is used to verify system fuel pressures and is a required tool for all IMPCO fuel system diagnostic testing. When converting an open-loop system to closed-loop you will also need to change out the standard air gas valve, or complete mixer with a (FB) feed back air gas valve, or complete FB carburetor. The FB valves are not included in the Commander Kit (See Table 1 for specific air gas valve recommendations). The Commander processor is intended to be used with volatile gaseous fuels and if improperly installed may create a hazardous condition. Engine emissions

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and performance may also be affected by improper installation. Accordingly, the system and associated equipment should be installed only by trained and qualified personnel in accordance with the instructions in this manual.

Model/Series Carburetor	Description
55 Series	AV1-14925 with "O" Series type converter.
100/125 Series	AV1-1447
25M-10 Series, Dual Fuel	AVI-1447-4
75 Series	*Special factory only procedures. Recommend order complete FB175A-1 Series only.
200/225 Series	AV1-1245
300A 20 Series	AV2-49
300A 50/70 Series	AV2-50

Table 1

IMPORTANT:
The Commander processor is a stand alone unit. It has no interface capabilities to a factory on board computer.

CAUTION

During the installation of the Commander, if you come across an unfamiliar or potentially hazardous conditions, call your local IMPCO distributor for clarification before proceeding.

CAUTION

To prevent ignition of leaking gaseous fuels which may cause a fire and/or explosion, avoid open sparks, flames, and operation of electrical devices in or about the engine compartment.

CAUTION

Always follow installation regulations that apply to you. These requirements are found in NFPA-52 for natural gas, and NFPA58 for LPG. These are U.S. standards. For Canadian codes see National Standards CANADA. Additionally, some states or provinces may also have certain requirements of which you must be aware.

MECHANICAL INSTALLATION

CAUTION

Disconnect the battery negative cable before you begin. This will prevent the possibility of accidental wiring shorts.

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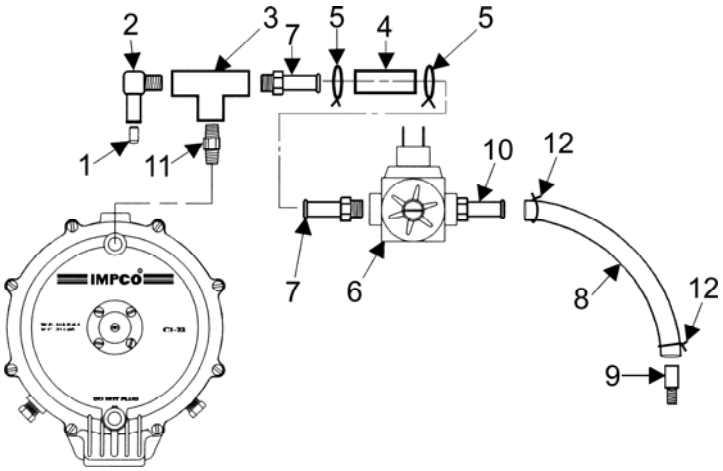

Item	P/N	Description	Qty
1	J1-21	Jet, Feed Back Bleed	1
2	F4-12	Fitting, 1/8" NPT 3/8" Hose 90El Nyl	1
3	F4-32	Fitting, 1/8" NPT Female Tee Brass	1
4	H1-15189	Hose, 3/8" ID 2"L Fuel/Oil	1
5	C2-16664-1	Clamp, Hose, .69" OD	2
6	AV1-15115-4	FCV Solenoid Assy, IMPCO	1
7	2H-103B	Fitting, 1/8" NPT 3/8" Hose Brass	2
8	H1-5-001	Hose, Vacuum 1/4" ID 4' Length	1
9	F4-2	Fitting, 1/4" Unf 1/4" Hose Vac Nip	1
10	F4-15840	Fitting, 1/8" NPT 1/4" Hose Nip Brass	1
11	F4-33	Fitting, 1/8" NPT Hex Nip Brass	1
12	C2-30	Clamp, Pinch 1/4" ID Hose	2

Figure 1

1. The Commander can not be installed near high temperature sources such as exhaust manifolds or high tension spark plug wires. Determine a suitable location for the Commander module where temperature will not exceed 160 degrees F. Mount the Commander securely on a flat surface using the mounting tab provided on the top case. **Do not** distort the base of the unit.
2. Install the recommended IMPCO fuel system components for your specific application **(the Commander requires an FB series carburetor/mixer)**. Preset the fuel power adjustment to the middle of the rich/lean scale. Install the IMPCO fuel control valve (FCV) on the regulator/converter assembly, as shown in Figure 1.

IMPORTANT
The FCV valve is directional. Install the fitting item #10 to the FCV port marked “VAC.” Install the fitting item #7 to the port marked “IN.”

IMPORTANT
If the mixer and/or regulator is a tamper resistant design, special tools and training are required to alter any fuel controls. Contact your distributor for details.

The FCV must have an independent air valve source from the IMPCO mixer/adapter. Keep these vacuum lines as short as possible.

3. Route the Commander wire harness leads to approximate terminations using the wiring system schematics. Secure the harness leads away from high heat sources and moving parts.
4. The Kits supply a mounting boss for the sensor. This boss can be welded to a convenient location on the manifold or on a section of the exhaust pipe header at no more than 12" from the last exhaust valve. The reason for this is the oxygen sensor has no output signal below 600° F. A symptom of an oxygen sensor mounted too far down the exhaust stream would be falling out of closed-loop operation during extended idle times due to the sensor cooling off. This is not acceptable and may also impair higher speed running conditions.
5. If it is not possible to locate the supplied sensor within the 12" specified, the EK-CDP-1H Kit must be used. The sensor included in this Kit has a built in heater coil that heats the sensor

with +12 volts. It is not dependent on exhaust temperature for output. Additional benefits can be faster closed-loop control during warm-ups further reducing exhaust emissions. See Figure 2. Remove the exhaust piece from the engine that you will modify for the sensor installation. The welding of the sensor boss while mounted to the lift truck is not recommended.

6. Drill or punch a 7/8" hole to the area you wish to mount the sensor. Thoroughly clean and deburr this hole to prepare for welding.
7. Locate the oxygen sensor boss shoulder ridge down and clamp in place. We recommend lightly installing an old spark plug to the boss to protect the threads from damage during the welding process. Place a generous weld bead around the entire boss. Let cool, remove the spark plug and check the thread integrity by installing the oxygen sensor. It should screw down flush easily finger tight without the use of a wrench to the contact gasket. If not, re-tap these threads until this can be achieved.
8. Torque the sensor to 41 N•m (30 ft. lb), unless another torque spec is otherwise noted in instructions included in the sensor package.
9. Mount the FCV (Fuel Control Valve) to the IMPCO regulator as shown in Figure 1.

IMPORTANT
BE SURE TO TURN THE 0.10" ORIFICE AWAY FROM THE ENGINE FAN FLOW. This will prevent the possibility of mixture fluctuations and help to keep this orifice clear of dirt and debris.

If a balance line must be used, refer to the "Optional Balanced System Diagram" section at the end of this manual. Trim and connect a suitable length of supplied vacuum line to the fitting and connect to the FCV port as shown. It is important to follow this recommendation as the valve is directional. Remove one of the ¼" x 28 air valve vacuum screw plugs from the IMPCO mixer. Install the supplied F4-2 vacuum fitting. Cut a suitable length of supplied vacuum line to reach between this vacuum fitting and connect to the remaining port on the FCV and the newly installed F4-2. Keep these lines as short as possible.

ELECTRICAL INSTALLATION

The Commander blue wire is not normally used for most lift truck applications. This wire, when grounded puts the Commander in the "open-loop" mode. Open loop duty cycle is pre-programmed to run a fixed duty cycle. This blue wire should only be used for systems with air injection. If the engine you are converting does not have air injection do not connect the blue wire.

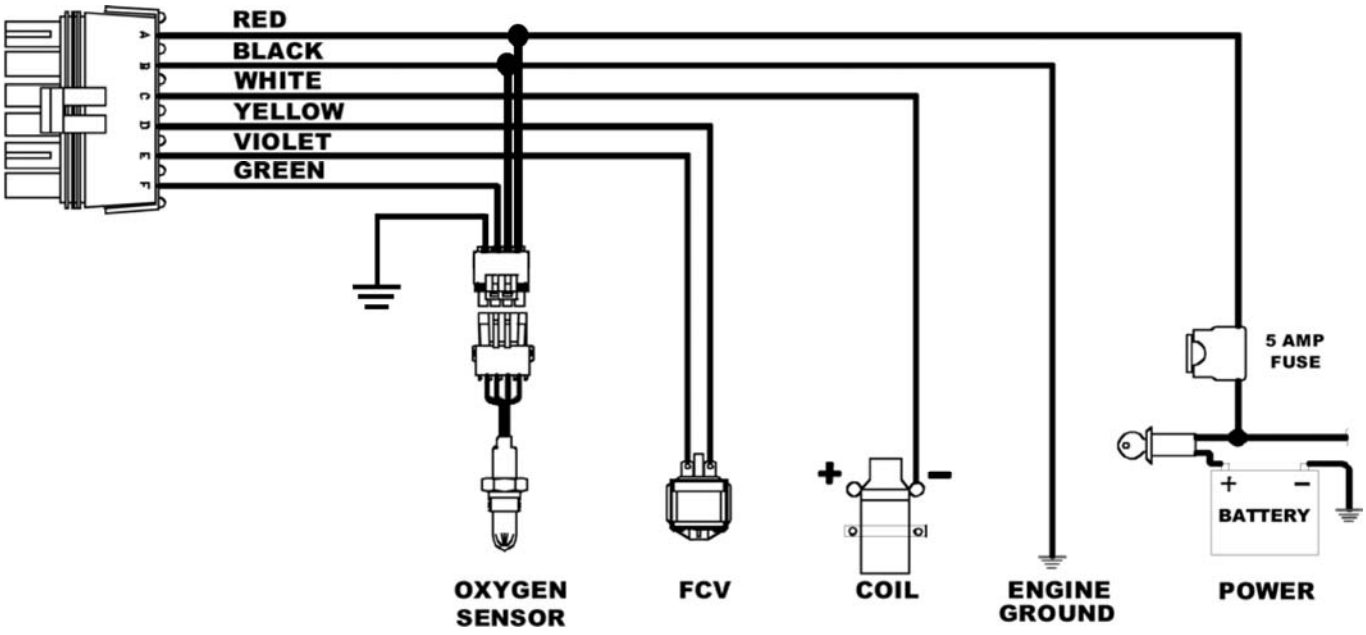

Figure 2: The electrical diagram for Kit EK-CDP-1H. Note that Kit EK-CDP-1 is identical except for the heated Oxygen Sensor.

1. Prepare to cut the harness leads to required length for final termination. Solder all terminal connections whenever possible, **(except the oxygen sensor wires)**, and use shrink tubing.
2. Connect the Commander red wire to a switched +12 volt source protected with a 5 amp fuse. This source must provide power with the key in the "START" and "ON" positions. This source should not supply power with the ignition key in the "OFF" or "ACCESSORY" position and must be fused for protection. For dual fuel installations the switched +12 volt source must be wired through a fuel selection switch and protected using a 5 amp fuse. This is to cut power to the Commander during gasoline operation. Direct power is applied through the key switch only on dedicated, single fuel systems.
3. Connect the black wire securely to engine ground. Terminate the wire with suitable connector and attach to an engine ground using a #8 or larger bolt.
4. Connect the white wire to the vehicle tachometer signal or the "reference high" signal. This can be verified by connecting a shop tachometer to this lead. Verify a tachometer reading when engine is running. Consult your factory service manuals ignition diagram for this connection if you are not sure.
5. Connect the violet and yellow wires to the fuel control valve. The FCV has no polarity, so either wire can be connected to either terminal.
6. EK-CDP-1H Kit: Connect the Oxygen Sensor Electrical Connection and the black wire to ground. EK-CDP-1 Kit: connect the green wires together.

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FEEDBACK SYSTEM ADJUSTMENTS

IMPCO Fuel System Analyzer, FSA-1000

The Commander is designed as an independent fuel control processor. However, it is very important that all existing on board controls and sensors work properly. Many engine operating problems are due to malfunctions of the existing engine systems equipment. Make sure the following engine systems are to specifications: ignition, timing, valve adjustment, exhaust and cooling. Also ensure that the IMPCO fuel control system components have been installed properly and the fuel pressures have been tested before adjustment.

The Fuel System Analyzer (FSA-1000) must be used to adjust the IMPCO fuel management system. Always verify emissions with a CO meter after FSA adjustment.

Connect the FSA-1000:

Black wire lead to battery ground.
Red to battery positive
Green to the oxygen sensor
Yellow to the yellow wire of the FCV.

Idle Mixture Adjustment

IMPORTANT
Ensure that the vehicle's engine, transmission and hydraulic system are at **operating temperature** before taking fuel system readings or making adjustments.

1. Determine if the vehicle has feedback control during idle by observing the "COMPUTER COMMAND" display on the FSA-1000. A fixed duty cycle is normal during the warm-up time of the oxygen sensor (open-loop).
2. If the number displayed is constant (does not change), there is no feedback control during idle. The system is operating in "open-loop." The Commander will stay at a fixed duty cycle when the engine is cold and there is no activity from the oxygen sensor, or the air diverter is on, grounding the Commander blue wire.

IMPORTANT
Some engines may revert to open-loop operation if the idle is prolonged and the oxygen sensor cools below its operating temperature. This indicates that a heated sensor may be needed.

3. Accelerate the engine several times to activate the oxygen sensor. When the vehicle has feedback control at idle, adjust the IMPCO carburetor idle mixture adjustment screw until the "COMPUTER COMMAND" reading on the FSA is approximately 50. By setting the reading as close to 50 as possible, the controller has full range to go rich or lean. The "50" is the ideal number. You may see occasional swings between 20-80. This is an acceptable range. The LED lamps should transition from rich to lean in a fairly regular manner.

IMPORTANT
A vehicle with feedback control at idle should show significant change in the "COMPUTER COMMAND" number when turning the idle mixture adjustment screw.

Power Mixture Adjustment

IMPORTANT
Ensure that the vehicle's engine, transmission and hydraulic system are at **operating temperature** before taking fuel system readings or making adjustments. A transmission temperature of at least 150° F is recommended.

1. To adjust the wide open throttle (WOT) power mixture using a dynamometer, set the power valve adjustment to a 20-80 duty cycle reading on the FSA at full governed speed, WOT.
2. WOT power mixture can be adjusted without a dynamometer by holding the unit at tilt relief and setting the power mixture control to 20-80 duty cycle reading on the FSA at WOT.
3. Tilt relief is full throttle, continued hydraulic loading at maximum travel of mast tilt. The transmission must be in neutral.
4. Adjust the power valve slowly and allow at least 15 seconds for the reading to stabilize.

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Final Load Check

1. During the load test the “COMPUTER COMMAND” should remain between 20 and 80 under normal “closed-loop” operation. This verifies that the computer has the amount of control necessary to keep the fuel mixture correct.
2. There is a problem if either the “RICH” or “LEAN” indicator lamp stays on continuously with no flashing between them when operating at a steady speed during closed-loop control.

If you are unable to achieve this, verify that the OEM system is functioning properly, determine that the alternate fuel system is also operating correctly. Test the operating fuel pressures with the ITK-1 pressure test kit. Check both primary and secondary pressures. Always disconnect and plug the vacuum line from the carburetor to the fuel control valve when checking pressures. A fluctuation will occur with the line connected. Compare these steady pressures with the specifications of the regulator you are using.

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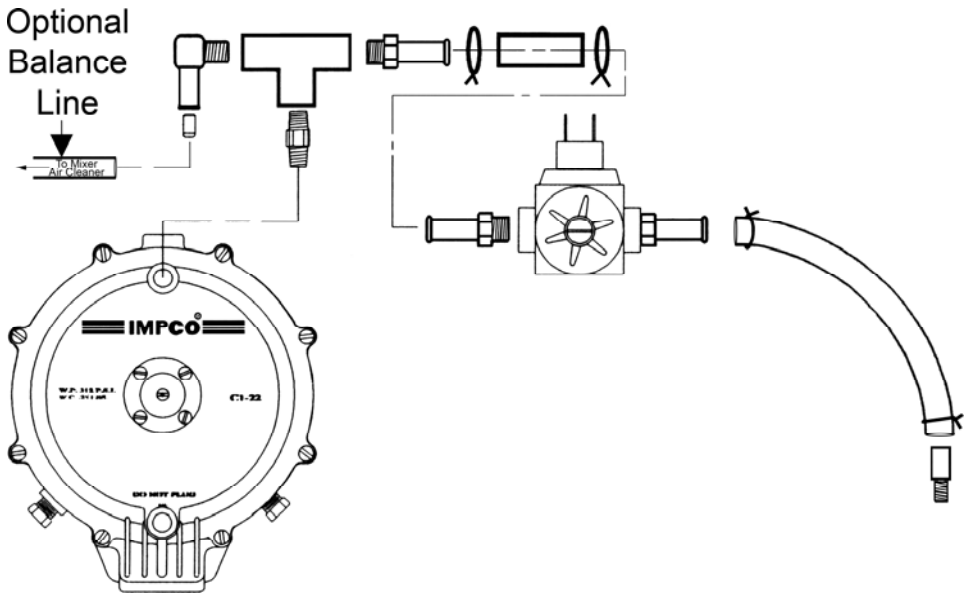
OPTIONAL BALANCED SYSTEM DIAGRAM

Both Kits are supplied with an open orifice vent. It is designed to provide fuel control without a balance line. The intention of this design is to provide proper fuel control on a wide range of industrial engine applications with no user engineering or complicated adjustment procedures. The Commander processor is able to provide for minor changes in fuel, temperature and air inlet restrictions. It is, however, possible to increase the overall range and flexibility of this control system by using the air cleaner balance system. This will also provide greater resistance to dust, dirt and debris that may clog the open orifice in severe applications.



COMPONENT PART LIST				KIT	
Item	P/N	Description	Qty	EK-CDP-1	EK-CDP-1H
1	AE3-31273-001	Controller, CDPOZ Electronic	1	•	•
2	AW-15994	Wire Harness, Cmdr	1	•	
	AW-52904-001	Wire Harness, Cmdr W/Heated O2 Snsr	1		•
3	FL-5026-10	Oxygen Sensor Boss 1018	1	•	•
4	S8-52292-001	Oxygen Sensor, Single Wire	1	•	
	S8-50234-001	Oxygen Sensor, Heated Three Wire	1		•
5	J1-21*	Jet, Feed Back Bleed	1	•	•
6	F4-12*	Fitting, 1/8" NPT 3/8" Hose 90El Nyl	1	•	•
7	F4-32*	Fitting, 1/8" NPT Female Tee Brass	1	•	•
8	H1-15189*	Hose, 3/8" ID 2"L Fuel/Oil	1	•	•
9	C2-16664-1*	Clamp, Hose, .69" OD	2	•	•
10	AV1-15115-4*	FCV Solenoid Assy, IMPCO	1	•	•
11	2H-103B*	Fitting, 1/8" NPT 3/8" Hose Brass	2	•	•
12	H1-5-001*	Hose, Vacuum 1/4" ID 4' Length	1	•	•
13	F4-2*	Fitting, 1/4" Unf 1/4" Hose Vac Nip	1	•	•
14	F4-15840*	Fitting, 1/8" NPT 1/4" Hose Nip Brass	1	•	•
15	F4-33*	Fitting, 1/8" NPT Hex Nip Brass	1	•	•
16	C2-30*	Clamp, Pinch 1/4" ID Hose	2	•	•

**Also included in the parts list shown in Figure 1 on page 3*

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