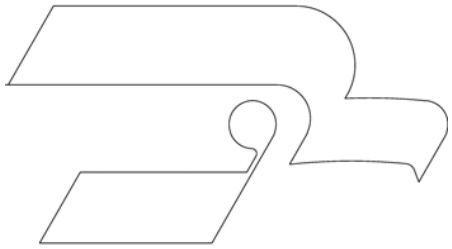
PRECISION AIRMOTIVE LLC



EAGLE EMS

POST-INSTALLATION TROUBLESHOOTING GUIDE

ENGINE TYPE _____
SERIAL NO _____
DATE OF PURCHASE _____
INSTALLATION DATE _____

GEN5025 I0109

PRECISION AIRMOTIVE LLC
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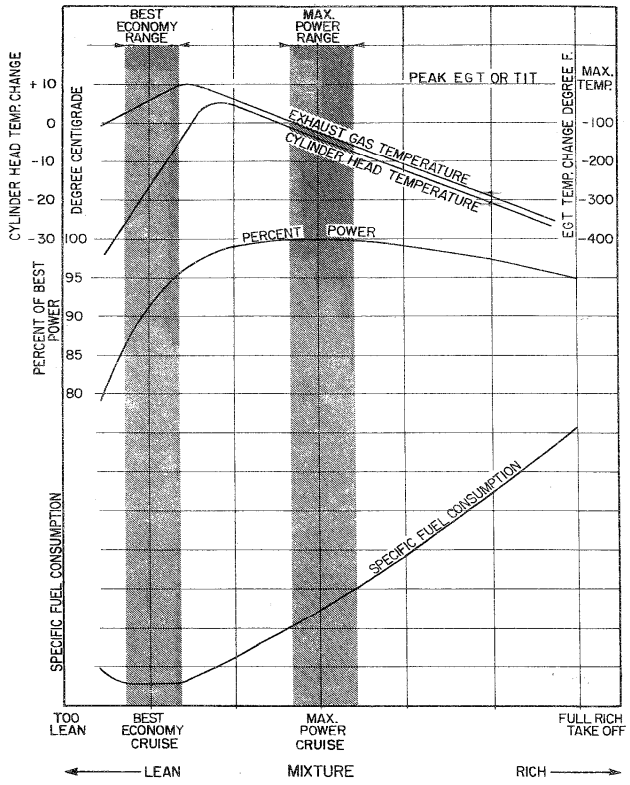

POST-INSTALLATION
TROUBLESHOOTING GUIDE

1.0 Description:

The purpose of this document is to aid in the installation process by allowing the assembler to verify that the EAGLE EMS is working correctly. If it is not working correctly, this guide can be used to troubleshoot the situation.

The Troubleshooting Guide has two sections. The first section assumes the system troubleshooting will occur using only the Annunciator Lights. The second section assumes the system troubleshooting will occur using the Annunciator Lights and a laptop computer.

It should be noted that the Eagle EMS System can improve all aspects of engine performance, but it cannot compensate for mismatched cylinder compression, engine wear or other out-of-tolerance engine conditions.

2.0 Pre-Test Recommendation

This Pre-Test Procedure assumes that the "EAGLE EMS Installation Manual" has been read and followed during the assembly and installation of the EAGLE EMS. Reading and understanding the "EAGLE EMS Owner's Manual" is also beneficial.

We recommend that the engine be pre-tested for EAGLE EMS battery voltage, compression, fuel and spark before you attempt to start the engine for the first time. Follow the starting procedure in the "EAGLE EMS Owner's Manual," making sure that the boost pump is turned on and the selector valve is turned to the correct fuel tank. If you find problems while performing the pre-test procedure, there are potential remedies in the following paragraphs.

2.1 Caution

2.1.1 Propeller

Extreme care must be taken when working around the engine and propeller. Residual fuel left in the cylinders can accidentally ignite and turn the propeller over during troubleshooting. We recommend that fuel not be introduced into the system until spark and compression are verified.

2.1.2 Fuel Leaks

Ensure that all the fittings, fuel lines, distribution block and pumps have been checked for fuel leaks before attempting to start the engine.

2.1.3 Bleeding Air from the System

Removing air from the fuel system will make the first start with the Eagle EMS go much more quickly. This can be accomplished by turning the boost pump on, cracking loose a fuel injector fitting and running the pump until fuel sprays/spurts from the fitting.

3.0 Pre-Test Procedure with Annunciator Panel and <u>NO</u> Laptop

3.1 Prior to First Engine Run with EAGLE EMS

Three things are required for an engine to run: spark, fuel and compression. The quality and timing of each are important. This is true for any internal combustion engine whether it has a carburetor, servo or electronic injection.

3.2 Compression

If the engine was running well before the EAGLE EMS installation, the compression can be assumed to be adequate. If not, you can confirm that compression is adequate by referring to the wet and dry cylinder pressures in the manufacturer's engine manual.

3.3 Checking Spark

3.3.1 Ensure that the Main Buss and Eagle Battery are fully charged. If they are not fully charged or are of questionable reliability, the current draw by the starter and other loads will make it difficult to troubleshoot starting issues.

3.3.2 After the engine is running, the EAGLE EMS will run off the Buss or the Eagle EMS Battery, depending on which one has the higher voltage.

3.3.3 Wet spark plugs are indicative of no spark, weak spark or excessive fuel. If you want to make a quick functional check for spark and timing, turn the propeller over at hand crank speed (with spark plugs removed and no fuel in the system or cylinders) and verify that the spark plug fires at top dead center on the compression stroke. Even though the plugs are grounded through the shielding, it is strongly advisable to ground the plugs to the engine case to reduce the possibility of an electrical shock. The EAGLE EMS ignition system is a wasted spark design, which means that the opposite engine cylinders fire together. In this case, the #3 cylinder fires at the same time as #1. Compression and timing can be verified by holding your finger over the #1 spark plug hole and turning the engine over by hand. The cylinder's compression will lift your finger off the spark plug hole when the cylinder is at or near top dead center during the compression stroke. Don't forget to check left and right ECU timing.

3.3.4 The EAGLE EMS speed sensors are roughly timed using the alignment pin from the Slick Magnetos or a similarly sized pin. For final timing, an automotive timing light, automotive spark plug and ignition wire can be used.

3.3.5 Replace the #1 shielded ignition wire and spark plug with a high energy automotive ignition wire and spark plug. With the automotive spark plug grounded to the block, slip a timing light over the automotive spark plug wire and turn the engine over by hand. The light should flash when the flywheel passes through 0°. If the flywheel 0° is not visible, a Dummy Dome or Prop Spinner can used. If an engine shop installs and times the Speed Sensors, the Speed Sensor timing should not need to be checked. If a laptop is not available, a specialized timing tool can be borrowed to fine-tune the engine. Contact Precision Airmotive and request service tool ST5000.

3.4 Engine Speed (RPM) Output Wire

The output from this wire can be used to verify that the speed sensors are working. If RPM can be read on an external meter, the speed sensors and ECU are functioning on at least a basic level. By contrast, if RPM is not displaying and the engine is running, either the signal is not present or the RPM meter is not working. Details on how to use this output wire can be found on our website.

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Appendix C

Lean Out Rise

Lean out rise is a term used to explain the technique of using the Manual Mixture Control Knob to indicate the air/fuel ratio. If an engine is running rich (AFR greater than 12.5:1), then leaning out the mixture with fixed throttle will result in increased RPM. If the knob is gradually rotated counter-clockwise, RPM will eventually drop and the engine will run rough. Typically, RPM increases by 25 to 50 RPM at idle before dropping. As RPM increases from the lean out rise, the manifold pressure should decrease. The lean out rise will change the exhaust temperature, cylinder head temperature and fuel consumption. For a specific example, see the following graph which shows the changes in a Lycoming 360. There is a 125°F increase in exhaust temperature between best power and peak EGT. The 125°F swing would be a good indicator that the mixture was correct at this throttle position. For different applications, see the manufacturer's recommended lean out rise parameters.

If there isn't a lean out rise, the engine could be running lean of best power. You can determine how lean by looking at the exhaust temperature difference between best power and economy cruise. If the mixture knob adjustment creates the manufacturer's recommended range in EGT from best power to economy cruise, the engine is exactly at best power (12.5:1) without the lean mixture control. If the temperature swing is less than the manufacturer's recommended range for EGT from best power to economy cruise, then the engine is lean of best power. The degree of leanness is more than likely proportional to the difference between the actual EGT swing and the manufacturer's recommended range, and to the difference between best power and the current AFR reading. For example, if the EGT swing was only half of the manufacturer's recommended range, the AFR would be 13.6. If the change in EGT was only 75% of the recommended range the AFR would be 13.1:1. These rules work at idle, taxi and in-flight conditions.

You can make temporary AFR changes with the mixture control knob. Permanent changes are made by altering the calibration file in the computer. Unwanted changes can be caused by air leaks, restricted air flow or other similar changes.

See the next page for the chart.

Appendix B
Troubleshooting Chart (continued)

PROBLEM	POSSIBLE CAUSE	REMEDY
Mixture Control Does Not Function	Mixture Control Wiring	Check For 5 Kohms Of Resistance Between The Associated ECU Connector Pin, With The Control Set To Full Rich.
Exhaust Gas Temperatures Are Too High, When Mixture Is Full Rich	Mixture Is Too Lean	See "Calibration Manual" For Instructions

The intent of the troubleshooting section is to address those issues that may arise when installing the EAGLE EMS in an airframe and does not address troubleshooting associated with individual components. As you troubleshoot, keep in mind that a rebuilt engine, with most of the EAGLE EMS System installed, has already been run at an authorized dealer and that the individual components are tested before leaving the Precision Airmotive facility.

The values loaded into the system software vary with different engines and airframes. In time, we expect to have optimized software programs for popular combinations of engines and airframes. If your system has been sitting around for several years and is a popular configuration, you may want to contact your dealer regarding availability of optimized software.

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3.5 Fuel Flow (GPH) Output Wire
The GPH meter will not be helpful for troubleshooting unless the engine is running. When the engine is running, knowing the fuel flow for the engine operating condition is helpful in determining mixture. Too high a fuel flow indicates a rich mixture and too low a fuel flow indicates a lean mixture. The GPH signal can be programmed to give a very accurate fuel flow over a wide operating range. Details on how to use this output wire can be found on our website.

3.6 Annunciator Lights
The Annunciator Panel indicates the status of the system. See Appendix A for specific details.

4.0 After Starting Engine with <u>NO</u> Laptop Access

4.1 Once Engine Starts
If the Cylinder Head Temperatures are greater than 200°F and the Annunciator Panel has the correct display of lights (See Owner's Manual), the engine should have a smooth idle. If it is not running smoothly, review section 3.1 and verify fuel, spark compression quality and timing. If the engine still doesn't idle smoothly, the following information should be helpful.

4.2 Checking Fuel
The presence of fuel can be verified by smell. If you smell fuel, you more than likely have fuel falling out of the throttle body or the exhaust. If no fuel is getting to the cylinders, the spark plugs will be dry when removed and you should suspect a problem with fuel flow to the system. You can verify there is fuel pressure by measuring fuel pressure at the distribution block. If you remove all the injectors from the engine and turn over the engine with the starter, the injectors should have a pulsed spray pattern. The higher the pressure, the more pronounced the spray pattern. Turning the key switch completely off for 1 second and then on again will add an additional shot of fuel to the engine.

4.3 Engine Runs Rough, Fuel Delivery Suspected
If the lower plugs are not fouled but dry, then lack of pulse width and fuel pressure should be suspected as possible problems. The fuel pump pressure can be verified by looking at the instrument panel's fuel pressure gauge. The reading should match the rated output for the fuel pump. If there is no fuel pressure gauge in the instrument panel, fuel pressure can be measured with a "T" fitting at the distribution block or directly at the fuel injector, which is an AN #4 fitting. There are two 1/8" NPT unused fuel injector outlets at the distribution block which can also be used as measurement points. However, because they are located after the fuel filter, be extremely careful not to introduce any dirt, metal shavings, pipe sealant, or other foreign objects into the system. If this happens, a likely outcome is a plugged injector, which would have to be cleaned at Precision Airmotive. If the ignition coils fire at the right time (See Section 3.3) and the fuel is suspect, you should first check for dry plugs or for fuel fouling of the plugs. Fuel-fouled plugs occur when fuel flow is excessive. Typically the lower plugs foul before the upper plugs.

4.4 Engine Runs Rough, Fuel Mixture Suspected

Some means for determining the source of problems are reading the spark plugs, reading the air/fuel mixture via sensor/meter and checking for the following: RPM changes while adjusting the mixture control knob, differences in the cylinders' EGT readings and changes in EGT readings while adjusting the mixture control knob.

Perform a mixture lean out rise test prior to performing plug readings. (See Appendix C for instructions.) The color of the spark plugs can also be checked to determine whether a rich or lean condition exists. Spark plug manufacturers have color charts that use shades of gray to indicate fuel mixture. In general, leaving the mixture control in the lean position will cause the plugs to turn a light gray in color. However, reading plug color is not as accurate as using an Oxygen Sensor or EGTs. With individual injectors in each cylinder, the color from plug to plug should be the same. If one of the plugs is a different shade of gray, that cylinder should be investigated for the cause of the rough idle.

An Oxygen Sensor will read noisy or erratic at idle due to the exhaust pulses coming through the engine. Also, EGTs don't start to read until well above idle, due to the lack of heat buildup. Even though the readings are erratic, we recommend that an average O2 Sensor reading be used to verify and calibrate in order to obtain optimum performance from the system. When verification and calibration are completed, the O2 Sensor can be removed. To correct a lean rough idle, with "out of range" oxygen values, a calibration change is required. A rich rough idle from "out of range" oxygen values can be compensated for by adjusting the mixture control knob. Procedures for changing calibration and other engine operating parameters are documented in the "EAGLE EMS Calibration Manual." Before attempting to recalibrate, keep in mind that initial calibration is made with the exhaust system, intake system and cowling available at the engine shop, which may differ from your application.

If your application is different from the engine shop test stand setup or plane-specific VE table, then recalibrating makes sense. As the engine shop performs more Eagle EMS installations, it will accumulate data for VE tables for different airframe and engine combinations.

4.5 Engine Runs Rough at Idle

Intake air leaks can cause rough idle. Air leaks can be detected by the traditional troubleshooting practice of using propane at the leak site to increase idle speed. An incorrect advance can also cause a rough idle, and that can be verified by reviewing the idle speed and advance recommended by the engine OEM. Crossed spark plug wires can also cause a rough idle. Verify the routing per the following:

POST-INSTALLATION TROUBLESHOOTING GUIDE

Appendix B

Troubleshooting Chart (continued)

PROBLEM	POSSIBLE CAUSE	REMEDY
Engine Will Not Start Left And Right ECU Lights Are Flashing	Eagle Battery Requires Charging	Charge Eagle Battery
Engine Will Not Start Or Stay Running Left And Right ECU Lights Are Flashing, Fuel Pressure Error Code	No Fuel To Distribution Block	Check Boost Pump Pressure And Selector Valve Position
Engine Will Not Start Fuses Are Good Charge Light Flashing	Eagle Battery Is Discharged	Charge Eagle Battery
Engine Will Not Idle	Throttle Stop Not Adjusted	Adjust Throttle Stop For 650 Rpm
Engine Will Not Idle Fuel Pressure Error Code	Not Enough Fuel To Distribution Block	Check Boost Pump Pressure And Selector Valve Position
Engine Idles Rough ECU Lights Off	Individual Coil Or Injector Is Not Working	Monitor Exhaust Temperatures To Determine Suspect Cylinder, Swap Components To See Which Components Causes Colder Cylinder
Engine Idles Rough ECU Lights Off (Continued)	Engine Is Running To Lean Or To Rich	Install Oxygen Sensor Into Exhaust And Monitor Air Fuel Ratio, Adjust "VE" Table For Correct Values Or Use Mixture Control To Adjust Rich Mixture
Engine Idles Rough Lost Sync, Retrigger And/Or Crank Position Error Code	Speed Sensors Are Likely Cause	Swapping Speed Sensor Connections Should Move The Flashing Light From One Side To The Other. Look For Bent Pins, Pinched Harness, Disconnects, Open Wires, MAG Spacer, Missing Gears And Poor Grounds.
Engine Stumbles When Throttle Is Increased	Enrichment Circuit Not Calibrated To Application	See "Calibration Manual" For Instructions
Engine Backfires When Throttle Is Decreased	Enrichment Circuit Not Calibrated To Application	See "Calibration Manual" For Instructions

Appendix B

Troubleshooting Chart

This chart assumes that the pre-testing was successful and that no laptop or O2 sensor is connected. The chart is divided into sequential sections: initial power up, starting and idle. Taxiing, take off, ascent, lean cruise, descent and landing are covered in the "EAGLE EMS Owner's Manual."

CAUTION: Always test the ignition system with the plug wires connected and spark plug case grounded or damaged electronics could result. Also, the insulation of the high-tension wires can be damaged if the spark plugs are not installed.

NOTE: When you rotate the key switch, the ECU and Charge lights will blink for 4 seconds as the ECU powers up.

PROBLEM	POSSIBLE CAUSE	REMEDY
Key Switch On "Both" Left Or Right ECU Flashing	Sensors Outside Limits	If Flashing Changes When Swapping Left And Right Side Harnesses, Check Error Code For Sensor Out Of Limits. Look For Bent Pins, Pinched Harness, Disconnects, Open Wires And Poor Ground Connections.
Key Switch On "Both" Left And Right ECU Flashing And CHG Light Is On	Battery Is Below 11.3 Volts	Charge Eagle Battery
Key Switch On "Both" Chg Light Is On	Battery Is Above 11.3 Volts And Less Than The Main Battery	Charge Eagle Battery
Engine Will Not Start No Lights Flashing	Speed Sensors Not Functioning	Verify That Speed Sensors Are Rotating And Harnesses Are Connected. Replace Sensors If Rotating
	PMU Not Powering Up ECU	Replace PMU After Checking For 11.3 Volts
Engine Will Not Start Right Or Left ECU Flashing, Lost Sync, Retrigger And/Or Crank Position Error Code	Speed Sensor Not Functioning	Swapping Speed Sensor Connections Should Move The Flashing Light From One Side To The Other. Look For Bent Pins, Pinched Harness, Disconnects, Open Wires, MAG Spacer, Missing Gears And Poor Grounds.

Ignition Coils to Spark Plug

Right Coil

From:	To:
From Coil Position #1	Cylinder #1 Top
From Coil Position #3	Cylinder #3 Top
From Coil Position #2	Cylinder #2 Bottom
From Coil Position #4	Cylinder #4 Bottom

Left Coil

From Coil Position #1	Cylinder #1 Bottom
From Coil Position #3	Cylinder #3 Bottom
From Coil Position #2	Cylinder #2 Top
From Coil Position #4	Cylinder #4 Top

4.6 Engine Runs Rough, Spark Suspected

If the spark is suspected, there are two possible causes: the timing is off, or the spark is weak or non-existent. The easiest way to confirm either condition is to disconnect the spark plugs from the head (leaving spark plug wires in place) and look for a spark. Take care that all the plugs are removed and no fuel is present in the combustion chambers. Spark should be visible at the spark plug during each rotation of the engine or propeller. See Section 3.3 for timing information. The spark should also occur at Top Dead Center (TDC) for cylinder #1. The timing can be confirmed by placing your finger over the spark plug hole and turning the engine over by hand (bringing the #1 cylinder up on compression). Watch the #1 plug and note when the spark fires: It should fire as the cylinder passes through TDC and at the same time you should feel the cylinder's compression lifting your finger off of the hole. The firing order should be verified by the same technique: Cylinder at TDC co-incident with 0º at the flywheel. 0º at the flywheel occurs when the 0º on the flywheel lines up with the center line of the engine case.

4.7 Engine Stumbles

An engine can stumble because there is too much or not enough fuel for a specific engine condition. However, a rich mixture is more likely to cause a stumble than a lean mixture. Engine conditions that bring on a stumble are typically warm-up, extreme temperatures (hot OR cold) and rapid throttle changes. To isolate the cause of the stumble, consider the following: Does the engine run better on the "p" or "s" side of the ECU? At what RPM does the stumble occur? Does the stumble occur when the engine is cold or hot or somewhere in between? Does stumble occur during changes in throttle position? Does altitude affect the stumble? Have the factory-set "cfg" and "cal" values in the software been changed?

The software has factory settings for these conditions, but individual engines and configurations may require different settings and can be adjusted per the Calibration Manual. If the rich or lean condition is determined to be a function of a software setting, a computer is needed to change the setting. It is recommended that the CHTPE% values not be adjusted for warm-up and that other parameters be adjusted instead to correct for a stumble.

4.8 Engine Backfire

Under some operating conditions the engine could backfire. Although backfires do not directly affect engine performance, they can damage the exhaust system components. Backfiring can occur when there is too much or too little fuel for the air flow through the engine. If a rich or lean condition is determined to be a function of a software setting, a computer is needed to change the setting. Assuming the factory settings have been verified, the fuel mixture and ignition advance changes can be made to improve the combustion cycle during low MAP. If the minimum fuel injector pulse width of 6 milliseconds does not correct the backfire for a MAP less than 5", the pulse width compensation (PWCOMP) can be increased or decreased to change the mixture during rapid throttle changes. The ignition timing ADV function can also be used to adjust the spark during rapid throttle changes and low MAP. Contact the factory representative before making these changes.

4.9 Frequently Asked Questions

It is our hope and plan that the troubleshooting section is rarely needed and that after getting this far through this document the engine is running well. However, if the EAGLE EMS is not meeting expectations, Precision Airmotive or the engine shop that installed the system can be contacted for technical support. Precision Airmotive's website, www.precisionairmotive.com, has a "Most Frequently Asked Questions" page in the Eagle EMS section that might address your concerns.

4.10 Troubleshooting Chart

There is a troubleshooting chart located in Appendix B. The chart assumes that the system has been installed and that the system is being turned on for the first time.

5.0 Pre-Test Procedure With Annunciator Panel and LAPTOP

5.1 Prior to First Engine Run with EAGLE EMS

Three things are required for an engine to run: spark, fuel and compression. The quality and timing of each are important. This is true for any internal combustion engine whether it has a carburetor, servo or electronic injection. Follow the starting procedure in the "EAGLE EMS Owner's Manual," making sure that the boost pump is turned on and the selector valve is turned to the correct fuel tank. After you start the engine, additional troubleshooting tips (if needed) can be found in Section 4.0, ***"After Starting Engine with NO Laptop Access."***

5.2 Compression

If the engine was running well before the EAGLE EMS installation, the compression can be assumed to be adequate. If not, you can confirm that compression is adequate by referring to the wet and dry cylinder pressures in the manufacturer's engine manual.

5.3 Checking Fuel

The presence of fuel can be verified by smell. If you smell fuel, you more than likely have fuel falling out of the throttle body or the exhaust. If no fuel is getting to the cylinders, the spark plugs will be dry when removed and you should suspect a problem with fuel flow to the system. You can verify there is fuel pressure by measuring fuel pressure at the distribution block. If you remove all the injectors from the engine and

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Appendix A

Annunciator Lights

The Annunciator Panel indicates the status of the system. To interpret the EAGLE EMS Annunciator Lights in relation to starting and the recommended starting sequence, refer to the "EAGLE EMS Owner's Manual." One aspect of the Annunciator Lights, not discussed in the Owner's Manual, is decoding the light pulse sequences (on-and-off flashes) to identify specific errors. The Error Code Table below can be used to interpret the flashing ECU lights on the Annunciator Panel. If you place the key switch on the non-functional side (that is, the side reporting an error), then the codes would apply to the non-functional side.

In the table, an S indicates a short pulse (½ second long) of the ECU light and an L indicates a long pulse (¾ second). S indicates no failure; L indicates that a failure exists. The position where the L occurs in the sequence indicates the specific failure mode. If there is more than one long pulse, then there is more than one failure mode. After the sequence finishes, there is a 5 second pause before it repeats itself.

ERROR CODE TABLE

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
No Errors	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S=Short, 1/2 sec
Battery	L	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	L=Long, 3/4 sec
Fuel Pressure	S	L	S	S	S	S	S	S	S	S	S	S	S	S	S	S	
IAT Limit	S	S	L	S	S	S	S	S	S	S	S	S	S	S	S	S	
CHT Limit	S	S	S	L	S	S	S	S	S	S	S	S	S	S	S	S	
MAP Limit	S	S	S	S	L	S	S	S	S	S	S	S	S	S	S	S	
TPS Limit	S	S	S	S	S	L	S	S	S	S	S	S	S	S	S	S	
BAP Limit	S	S	S	S	S	S	L	S	S	S	S	S	S	S	S	S	
Over Speed	S	S	S	S	S	S	S	L	S	S	S	S	S	S	S	S	
Lost Sync	S	S	S	S	S	S	S	S	L	S	S	S	S	S	S	S	
Unassigned	S	S	S	S	S	S	S	S	S	L	S	S	S	S	S	S	
Injector Drive	S	S	S	S	S	S	S	S	S	S	L	S	S	S	S	S	
Unassigned	S	S	S	S	S	S	S	S	S	S	S	L	S	S	S	S	
Pulse Width	S	S	S	S	S	S	S	S	S	S	S	S	L	S	S	S	
Voltage Spike	S	S	S	S	S	S	S	S	S	S	S	S	S	L	S	S	
Re-trigger	S	S	S	S	S	S	S	S	S	S	S	S	S	S	L	S	
Crank Position	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	L	
5 SECOND PAUSE	TIME (16 seconds)																5 SECOND PAUSE

NOTE: If there is no error, there will be no long pulse -- only 16 short 1/2 second pulses. If there is a single error there will be one long pulse in the sequence; if there are two errors, two pulses; and so on. The positions where the long pulses occur indicate the specific failure modes.

spark during rapid throttle changes and low MAP. Contact the factory representative before making these changes

10.0 Troubleshooting Chart

There is a Troubleshooting Chart located in Appendix B. The chart assumes that the system has been installed and that the system is being turned on for the first time. This chart also assumes that the pre-testing was successful and no laptop or O2 sensor is connected. The chart is divided into sequential sections: initial power up, starting and idle. Taxing, take off, ascent, lean cruise, descent and landing are covered in the "Eagle Owner's Manual."

NOTE: When rotating the key switch, the ECU and Charge lights will blink for 4 seconds as the ECU powers up.

CAUTION: Always test the ignition system with the plug wires connected and spark plug case grounded, or damaged electronics could result. Also, the insulation of the high-tension wires can be damaged if the spark plugs are not installed.

10.1 The intent of the troubleshooting section is to address those issues that may arise when installing the EAGLE EMS in an airframe and does not address troubleshooting associated with individual components. As you troubleshoot, keep in mind that a rebuilt engine, with most of the EAGLE EMS System installed, has already been run at an authorized dealer and that the individual components are tested before leaving the Precision Airmotive facility.

10.2 The values loaded into the system software vary with different engines and airframes. In time, we expect to have optimized software programs for popular combinations of engines and airframes. If your system has been sitting around for several years and is a popular configuration, you may want to contact your dealer regarding availability of optimized software.

11.0 Frequently Asked Questions

It is our hope and plan that the troubleshooting section of this document is rarely needed and that after getting this far through this document that the engine is running well. However, if the EAGLE EMS is not meeting your expectations, Precision Airmotive or the engine shop that installed the system can be contacted for technical support. Precision Airmotive's website, www.precisionairmotive.com, has a "Most Frequently Asked Questions" page in the Eagle EMS Section that might address your concerns.

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turn over the engine with the starter, the injectors should have a pulsed spray pattern. The higher the pressure, the more pronounced the spray pattern. Turning the key switch completely off for 1 second and then on again will add an additional shot of fuel to the engine.

5.4 Checking Spark

5.4.1 Ensure that the Main Buss and Eagle Battery are fully charged. If they are not fully charged or are of questionable reliability, the current draw by the starter and other loads will make it difficult to troubleshoot starting issues.

5.4.2 After the engine is running, the EAGLE EMS will run off the Buss or the Eagle EMS Battery, depending on which one has the higher voltage.

5.4.3 Wet spark plugs are indicative of no spark, weak spark or excessive fuel. If you want to make a quick functional check for spark and timing, turn the propeller over at hand crank speed (with spark plugs removed and no fuel in the system or cylinders) and verify that the spark plug fires at top dead center on the compression stroke. Even though the plugs are grounded through the shielding, it is strongly advisable to ground the plugs to the engine case to reduce the possibility of an electrical shock. The EAGLE EMS ignition system is a wasted spark design, which means that the opposite engine cylinders fire together. In this case, the #3 cylinder fires at the same time as #1. Compression and timing can be verified by holding your finger over the #1 spark plug hole and turning the engine over by hand. The cylinder's compression will lift your finger off the spark plug hole when the cylinder is at or near top dead center during the compression stroke. Don't forget to check left and right ECU timing.

5.4.4 The EAGLE EMS speed sensors are roughly timed using the alignment pin from the Slick Magnetos or a similarly sized pin. For final timing, an automotive timing light, automotive spark plug and ignition wire can be used.

5.5 Checking Spark Timing with Laptop

The engine timing can be verified by checking whether the value programmed into the ADV table of the ECU matches the actual timing. See "EAGLE EMS Calibration Procedure" for how to connect a laptop to the ECU and read system settings. Keep in mind that both sides of the ECU should be tested for spark. The spark is set at the factory for 0° at starting. If the following timing technique is unsatisfactory, you can borrow a specialized timing tool. Contact Precision Airmotive and request service tool ST5000.

Engine timing and left and right side speed sensor alignment are built into the ECU software and the Annunciator Panel. To fine-tune the timing after using the Slick Alignment Pins for coarse adjustment, connect the laptop per the "EAGLE EMS Calibration Manual." To prevent the engine from unwanted movement, make sure there is no fuel in the cylinders and the spark plugs are removed from the engine.

Type "cfg=01 15 100" and then hit "ENTER." An asterisk (*) will appear on the screen if the command is accepted. A question mark indicates that the command was not accepted. When the asterisk appears, rotate the engine in its normal operating direction, through Top Dead Center on #1 cylinder. This will cause the laptop display to transition from "1" to "0." Also, the laptop will beep and the Left and Right ECU Function Lights will light up. Repeat the same timing adjustment for the right side speed sensor. Make sure that both ECU Function Lights come on together at TDC, as you rotate the engine in its normal operating direction. An "ERR" on the laptop display indicates the engine is out of time by more than 10 degrees.

Restore normal software function by typing "cfg=01 15 2" on the left and right side. Torque the speed sensor hold-down nuts to the vendor's recommended value. This completes sensor alignment.

If you will not be using a laptop to time the engine, a timing light, an automotive spark plug wire and a spark plug can be used to conventionally time the engine, similar to conventional automotive methods. When the cylinder comes up on compression for #1, the timing light should flash as the stationary mark (crank case seam) and flywheel 0° mark pass each other. Aiming the light at the stationary mark makes the check easier to visualize. If the flywheel 0° is not visible, a Dummy Dome or Prop Spinner can used. If an engine shop installs and times the Speed Sensors, the Speed Sensor timing should not need to be checked.

5.6 Timing Advance Table

The advance table will display on the laptop similar to Figure 1 below.

```
adv  Enter adv=row,sp,col,sp,val (CR)
        01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
01 RPM  05 08 10 13 16 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19  500-3200
02 MAP  04 04 04 04 04 03 03 03 02 02 02 01 01 01 00 00 00 00 00 00 00  5-31"
03 CHT  00 00 01 02 03 04 05 06 05 04 04 04 04 04 04 03 02 01 00  0-250c in 10c steps
04 BAP  00 00 00 00 00 00 00 00 00 00 00 00 00 00 01 01 02 02 02 02 02 02 02 02 02 02 02  5-31”
```

Figure 1

5.7 OPS Printout

The EAGLE EMS printout lists input values, programmed values and output values. Input values are CHT, IAT, MAP, BAP, RPM and FPSIa. ADV is a programmed value. Output values are PWusec, VE%, CHTPE%, GPH, PPH, MOD, TIME and OXY. The ECU combines the programmed and input values to control the spark and fuel.

Initial Laptop Printout for a Typical EAGLE EMS

Pwusec	VE%	CHTPE%	CHT	IAT	MAP”	BAP”	FPSIa	PSID	ADV	GPH	PPH	MOD	RPM	TIME	AFR	OXY
p 00000	100	138	+032	+028	29.6	29.6	20.8	06.2	00	00.0	000.0	00	0000	00:00:01	10.5	17.79
p 00000	100	138	+032	+028	29.6	29.6	20.8	06.2	00	00.0	000.0	00	0000	00:00:02	10.5	17.79
p 00000	100	138	+032	+028	29.6	29.6	20.8	06.2	00	00.0	000.0	00	0000	00:00:03	10.5	17.78
p 18000	100	138	+032	+032	16.5	29.6	20.8	12.7	00	00.0	000.0	00	0080	00:00:04	10.5	17.81

Figure 2

9.3 Engine Runs Rough, Spark Suspected

If the spark is suspected, there are two possible causes: the timing is offor the spark is weak or non-existent. The easiest way to confirm either condition is to disconnect the spark plugs from the head (leaving spark plug wires in place) and look for a spark. Take care that all the plugs are removed and no fuel is present in the combustion chambers. Spark should be visible at the spark plug during each rotation of the engine or propeller. See Section 3.3 for timing information. The spark should also occur at Top Dead Center (TDC) for cylinder #1. The timing can be confirmed by placing your finger over the spark plug hole and turning the engine over by hand (bringing the #1 cylinder up on compression). Watch the #1 plug and note when the spark fires: It should fire as the cylinder passes through TDC, and at the same time you should feel the cylinder's compression lifting your finger off of the hole. The firing order should be verified by the same technique: Cylinder at TDC co-incident with 0º at the flywheel. 0º at the flywheel occurs when the 0º on the flywheel lines up with the center line of the engine case.

9.4 Engine Stumbles

An engine can stumble because there is too much or not enough fuel for a specific engine condition. However, a rich mixture is more likely to cause a stumble than a lean mixture. Engine conditions that bring on a stumble are typically warm-up, extreme temperatures (hot OR cold) and rapid throttle changes. To isolate the cause of the stumble, consider the following: Does the engine run better on the "p" or "s" side of the ECU? At what RPM does the stumble occur? Does the stumble occur when the engine is cold or hot or somewhere in between? Does stumble occur during changes in throttle position? Does altitude affect the stumble? Have the factory-set "cfg" and "cal" values in the software been changed? The OPS screen can tell the operator if the conditions seen by the EAGLE EMS match the realities of the situation. Does the CHT look correct for the amount of time the engine has been running? Does the MAP value follow the changes in throttle position? Does the IAT reflect the outside air temperature? Does the BAP value reflect the actual altitude of the airplane? Are the factory-set "cfg" and "cal" values correct for the engine?

The software has factory settings for these conditions, but individual engines may require different settings and can be adjusted per the rapid throttle response section of the Calibration Manual. It is recommended that the CHTPE% values not be adjusted for warm-up and that other parameters be adjusted instead to correct for a stumble.

9.5 Engine Backfires

Under some operating conditions the engine could backfire. Backfiring can occur when there is too much or too little fuel for the air flow through the engine. Although backfires do not directly affect engine performance, they can damage the exhaust system components. Assuming that the VE Table and rapid throttle change have been verified to be correct, there are ignition advance changes that can be made to improve the combustion cycle. If the minimum fuel injector pulse width of 6 milliseconds does not correct the backfire for a MAP less than 5", the pulse width compensation (PWCOMP) can be increased or decreased to change the mixture during rapid throttle changes. The ignition timing ADV function can also be used to adjust the

Laptop Printout for Idle on EAGLE EMS

PWusec	VE%	CHTPE%	CHT	IAT	MAP"	BAP"	FPSIa	PSIDA	DVGPH	PPH	MOD	RPM	TIME	AFR	OXY
p 13519	080	117	+179	+039	18.0	29.3	40.8	31.9	27 02.0	012.3	00	0650	00:03:53	12.5	12.62
p 13651	080	117	+179	+039	18.1	29.2	40.6	31.7	27 02.0	012.3	00	0645	00:03:54	12.5	12.15
p 13519	080	117	+179	+039	18.0	29.2	40.6	31.7	27 02.0	012.2	00	0650	00:03:55	12.5	12.32
p 13814	080	117	+176	+039	18.2	29.3	40.5	31.5	27 02.1	012.5	00	0650	00:03:56	12.5	12.70
p 13584	080	117	+179	+039	18.1	29.2	40.8	32.0	27 02.1	012.4	00	0645	00:03:57	12.5	12.57
p 13475	080	117	+179	+039	17.9	29.2	40.6	31.9	27 02.0	012.3	00	0650	00:03:58	12.5	11.95
p 13606	080	117	+179	+039	18.0	29.3	40.8	31.6	27 02.0	012.3	00	0650	00:03:59	12.5	12.40
p 13492	080	117	+179	+039	17.9	29.2	40.9	32.1	27 02.0	012.2	00	0645	00:04:00	12.5	11.67
p 14287	080	117	+179	+039	19.0	29.3	40.8	31.4	27 02.2	013.0	00	0680	00:04:01	12.5	12.45
p 14251	080	117	+179	+039	18.9	29.3	41.1	31.8	27 02.4	014.3	00	0720	00:04:02	12.5	12.49

Figure 4

9.1 Engine Runs Rough At Idle

Incorrect fuel, spark or air can cause rough idle. Intake air leaks increase the amount of air, leaning out the mixture and causing rough idle. An average fuel mixture reading of greater than 12.5 may indicate an air leak. This condition can be corrected by using traditional troubleshooting practices.

An incorrect advance can also cause a rough idle. The advance can be verified by reviewing the idle speed and engine timing and comparing them to the engine manufacturer's recommended values. A rough idle can occur if either the left or right side speed sensor is not working. The computer compensates for fuel pump pressure, but if the fuel pressure sensors are not working correctly, the mixture can be can be rich or lean. Fuel pressure can be verified by looking at the FPSIa value on the OPS screen. If the actual fuel pressure is lower than system-measured fuel pressure, the AFR will be leaner than 12.5. If the actual fuel pressure is higher than the system measured fuel pressure, the AFR will be richer than 12.5. If an O2 reading is not available, you can check the color of the spark plugs to find whether a rich or lean condition exists. Spark plug manufacturers have color charts that use shades of gray to indicate fuel mixture.

9.2 Fuel Mixture

For conditions related to fuel, the computer readout can be very helpful, especially if an O2 Sensor is installed. An average reading in the OXY Column between 12 and 13 indicates a fuel mixture that would yield a smooth idle after warmup. In order to correct a rough idle with out-of-range oxygen values, changing the VE table is required. The procedure for changing the VE table is documented in the "EAGLE EMS Calibration Manual." Before attempting to recalibrate, keep in mind that initial calibration is made with the exhaust system, intake system and cowling available at the engine shop, which may differ from your application. If your application is different from the engine shop test stand setup or plane-specific VE table, then recalibrating makes sense. As the engine shop performs more Eagle EMS installations, it will accumulate data for VE tables for different airframe and engine combinations.

You can interpret the preceding data as follows

5.7.1 First Column

- This column will have a "p" (left) or an "s" (right).
- A "p" means the engine is running on the primary side.
- An "s" means the engine is running on the secondary side.
- If the key switch is in the "L" position, the column will have a "p."
- If the key switch is in the "R" position, the column will have an "s."
- If the key switch is in the "Both" position, there should be a "p" in the first column.
- If the letter in the first column doesn't match the switch position, there is likely to be a miswire.

NOTE: If there is a "sync" error or an input failure with MAP or FLP (fuel pressure) on the left side, the Annunciator Light will flash and the right side will take over running the engine.

5.7.2 PWusec Column

The number in this column represents microseconds, and it will range from 00000 to 45000 µsec. If the engine is not turning, this number should be 00000.

On row 5 of the printout, the EAGLE EMS is attempting to inject 18000 µsec worth of fuel into the engine when it first starts on a cold day. The CHT column has +032, which means the engine is at the freezing point of water and will need a wide pulse width to start.

NOTE: PWusec is an output value. If the calculated value is greater than 65535 µsec, the display will read 8888, indicating an out-of-range value.

5.7.3 VE% Column

The number in this column indicates the volumetric efficiency of the engine. It should range between 75 and 105 depending on operating conditions. If VE% is outside this range, the ECU may have issues.

5.7.4 CHTPE% Column

CHTPE% (Cylinder Head Temperature Power Enrichment) will be between 93 and 138 during normal engine operation. 138 is the highest and richest value you should ever see. CHTPE% should be 138 at cold start; 117 is the typical value for best power. If CHTPE% is outside the 93-138 range, the ECU may have issues.

NOTE: There may be a flashing Annunciator Light associated with VE% and/or CHTPE% being out of range. They are output values and would not directly cause an Annunciator Light to flash.

5.7.5 CHT Column

This number should reflect the engine head temperature. During a cold start, the head temperature should be the same as the outside air temperature. If the number doesn’t seem accurate, switch to the secondary side and verify the value.

The "p" and "s" values should match each other and the engine temperature. If they match each other, but not the engine temperature, there is a problem with the EMS System. If one of them matches the engine temperature and the other doesn't, there is an issue with the side that doesn't match.

NOTE: There may be a flashing Annunciator Light if the CHT is out of range and the engine is running. The CHT is out of range if it is less than 0ºF (cold day) or greater than 489ºF (overheating). An open electrical connection to the sensor would produce a 0ºF reading.

5.7.6 IAT Column

The number in this column should reflect the outside air temperature, if the engine hasn't been running. However, if the engine has been run recently, the number should be higher than the ambient air temperature. The range for this measured value is -40ºF to 215ºF.

If the number doesn't seem accurate, switch to the secondary side and verify the value. The "p" and "s" values should match each other and the air temperature. If they match each other, but not the air temperature, there is a problem with the EMS System. If one of them matches the air temperature and the other doesn't, there is an issue with the side that doesn't match.

NOTE: There won't be a flashing Annunciator Light associated with IAT unless the sensor reads less than -40ºF or greater than 215ºF.

5.7.7 MAP" Column

The reading for Manifold Air Pressure should range from 7 to 30 inches. When the engine is not running, the values in MAP and BAP (Barometric Air Pressure) should be the same -- approximately 30" at sea level. If the number doesn't seem accurate, switch to the secondary side and verify the value. The "p" and "s" values can also be checked against the local weather report for accuracy.

NOTE: There won't be a flashing Annunciator Light associated with MAP unless BAP or MAP is greater than 34.9 or less than 3.7.

5.7.8 BAP" Column

The number in this column reflects the elevation (Barometric Air Pressure) in inches of mercury. When the engine is not running, the values in MAP and BAP should be the same -- approximately 30" at sea level. If the number doesn't seem accurate, switch to the secondary side and verify the value. The "p" and "s" values can also be checked against the local weather report for accuracy.

NOTE: There won't be a flashing Annunciator Light associated with BAP unless BAP or MAP is greater than 34.9 or less than 3.7.

8.1 System Status Codes

0001 = System Ready
0002 = TDC Found (Position Sync)
0004 = Fuel Injector Enable
0008 = Input Data Ready
0010 = Cranking (< 500 RPM)
0020 = Idle (> 400 RPM Idle Speed)
0040 = Run (> 1000 RPM)
0080 = Over Speed (> 3200 RPM)
0100 = Analog to Digital Sample Flag when Stopped
0200 = Transient Flow Active
0400 = Cruise Range
0800 = Start Pulse Width Available
1000 = End Of Message Found
2000 = Address Message For Us
4000 = Process Message
8000 = Serial Busy

8.2 Multiple System Status Codes

For multiple system conditions, the system code values are added together.

8.2.1 A 0003 SYS code is 0001 plus 0002, meaning that the system is ready and we have sync. (Sync indicates that both speed sensors are working.) 0030 is the sum of 0010 and 0020, meaning that the engine is cranking at less than 500 RPM and idle is greater than 400 RPM. If all four of these conditions occurred at the same time, the SYS code would be 0033.

8.2.2 If the thousands digit of the SYS code adds up to more than 9, letters replace numbers in the thousands digit of the code: 10 = A, B = 11, C=12, D=13, E=14 and F=15. For example, if we have Serial Busy (8000) and Process Message (4000), then the SYS code is C000 (8000 + 4000 = 12000).

8.2.3 If all six of the error codes mentioned in the previous two paragraphs occurred at one time, the SYS code would be C033.

8.2.4 0237 under the SYS column in Figure 3 indicates Transient Flow Active, Idle > 400 RPM, Cranking <500 RPM, Fuel Injector Enable, TDC Found, and System Ready (0200 + 0020 + 0010 + 0004 + 0002 + 0001 = 0237).

9.0 After Starting Engine with Laptop

Once the engine starts, the OPS printout is similar to Figure 4 below, and the Annunciator Panel has the correct lights, the engine should have a smooth idle. If it doesn't idle smoothly, the following information should be helpful.

6.3 Single Error Code

0000 = No Error Code (Normal)
0001 = Battery Limits
0002 = Fuel Pressure Limits
0004 = IAT Limits
0008 = CHT Limits
0010 = MAP Limits
0020 = TPS Limits
0040 = BAP Limits
0080 = Over Speed
0100 = Lost Sync
0200 = Unassigned
0400 = Injector On Too Long
0800 = Unassigned
1000 = Pulse Width Error (calc)
2000 = Voltage Spike
4000 = Re-Trigger
8000 = Crank Position Error

6.4 Multiple Error Codes

For multiple errors, the error code values are added together.

6.4.1 0003 is 0002 plus 0001, meaning that the fuel pressure and battery voltage are out of limits. 0030 is 0020 plus 0010, meaning that the TPS and MAP are out of limits. If all four of these errors occurred, the error code would be 0033.

6.4.2 If the thousands digit of the error code adds up to more than 9, letters replace numbers in the thousands digit of the code: 10 = A, B = 11, C=12, D=13, E=14 and F=15. For example, suppose a crank position error (8000) and re-trigger error (4000) occur. 8000 + 4000 = 12000, and C000 would show up below the ERR header.

6.4.3 If all six of the error codes mentioned in the previous two paragraphs occurred at one time, the ERR code would be C033.

7.0 EAGLE EMS Battery Voltage

The VOLTS heading in the OPS2 output (Figure 3) indicates the Eagle EMS battery voltage. The output shows 12.7 volts. If this reading drops below 11.3, an error code is generated.

8.0 ECU System Status

Built into the ECU software are self-diagnostics which can be used to aid in troubleshooting. The results of the self diagnostics are shown in a four-digit status code under the SYS column in Figure 3. The status code can be translated into a specific operating condition.

- 0001 means the ECU is System Ready and the software has not identified an out-of-limits condition.
- 0002 means the ECU engine is turning over and the speed sensors are putting out a signal.
- Both of these conditions could exist at the same time, and in that case, the 4 digit code under the SYS header would be 0003 (0001 + 0002).
-

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5.7.9 FPSIa Column

Fuel Pressure in Absolute psi will range from 00.0, when the boost pump is off and the engine isn't running, to a maximum of 60 psi when the engine and boost pump are running or have been run recently. The value of FPSIa should be the rated boost pump pressure when the engine isn't running. The value should be lower when the engine is running and the boost pump is off. After engine start, the boost pump is typically turned off and the mechanical pump creates a lower system pressure. If the boost pump pressure was greater than the mechanical pump pressure, the system will see boost pump pressure, not mechanical pump pressure. The FPSIa reading is typically 27 psi when the engine is operating normally and the boost pump is off.

NOTE: If the fuel pressure drops below 24 psi and the engine is less than 250 RPM, the Annunciator Light will NOT come on. If the left side fuel pressure goes out of limits high (75) or low (0), the ECU switches from the left side to the right side.

5.7.10 PSID Column

This value is calculated from FPSIa and MAP. You should use FPSIa and MAP to determine system condition rather than the PSID value.

NOTE: The left and right Annunciator Light will only come on with low fuel pressure across the injectors AND if the engine RPM is greater than 250.

5.7.11 Timing ADV Column

The number in this column will range from 00 to 30. The starting ADV should be 0° advance. At idle and above, the advance should be 25° or the manufacturer's recommended value. If timing is suspected as a possible issue, check the timing per section 5.5.

NOTE: Timing is a programmed value and would not directly cause an Annunciator Light to flash.

5.7.12 GPH Column

The number in this column should range from 00.0 at start to a greater value based on fuel consumption. GPH is calculated from PPH using 5.87 lbs/gal for Avgas.

NOTE: There will not be a flashing Annunciator Light associated directly with GPH. It is a calculated value based on sensor and programmed values.

5.7.13 PPH Column

The number in this column should range from 000.0 at start to a greater value based on fuel consumption.

NOTE: There will not be a flashing Annunciator Light associated directly with PPH. It is a calculated value based on sensor and programmed values.

5.7.14 MOD Column

The number in this column ranges from 00 to 24. In the starting mode with the mixture knob in the richest position (fully clockwise), MOD should read 00. If it does not, the mixture knob may not be properly wired.

NOTE: If the mixture control knob is left in the lean position, the Annunciator Light will flash when the engine speed is zero. MOD is a calculated value based on sensor and programmed values.

5.7.15 RPM Column

The number in this column will range from 0000 to 3000. The 0000 in rows 1 through 3 in Figure 2 reflect an engine that is not turning over. The 0080 in row 4 reflects an 80 RPM cranking speed. If the engine is turning over and the RPM is not reading above 0000 the left speed sensor is not functioning. The right side can be checked in a similar manner. If one side is working but not the other, the associated speed sensor should be checked. Possible causes would be a defective speed sensor, leaving the magneto spacer in place, forgetting the drive gear on the engine, forgetting the drive gear on the speed sensor or forgetting to plug in the speed sensor harness. Interchanging the left and right side speed sensor harnesses will help isolate the issue.

NOTE: There will not be a flashing Annunciator Light associated with RPM unless the readings differ between the "p" (left) and "s" (right) sides. The Annunciator Light associated with the non-functional side will flash; the light associated with the functional side will not.

5.7.16 TIME Column

The number in this column reflects the elapsed time (hours:minutes:seconds) between when the key switch was turned on and the row of data is being generated. If this is not functioning properly, the ECU is the most likely source of error.

NOTE: There will not be a flashing Annunciator Light associated with TIME. The increments in this value are set by the OPS command.

5.7.17 AFR Column

AFR (Air/Fuel Ratio)is a calculated value based on settings in the ECU. In a sense this is a theoretical value. An AFR of 12.5 is the best power value and the goal of the factory settings. During warmup, overheating and lean mixture adjustments, this value will change. During warmup and overheating the 12.5 value should decrease and the value should also change when you rotate the lean mixture knob.

NOTE: There will not be a flashing Annunciator Light associated with AFR. It is an output value that should be 12.5 for best power.

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5.7.18 OXY Column

This is the actual air/fuel ratio, as measured by the Wide Band Oxygen Sensor. The number in this column should range from 10.5 to 20.03, if a wide band oxygen sensor is installed in the exhaust header and connected to the ECU. If you have not installed a Wide Band Oxygen Sensor, you may ignore the 20.03 value in this column. During engine startup, the number in this column should be greater than 12.5 and less than 20.03. When the engine is running normally, the value in this column should be between 11.9 and 13.1. The ECU does not use the OXY value to make any adjustments or decisions about system function. You should not suspect any issues with the OXY value until after the engine has been running for a few minutes. See the "EAGLE EMS Calibration Manual" for the procedure for setting up the OXY value for the EAGLE EMS.

NOTE: There will not be a flashing Annunciator Light associated with the OXY value. Using an O2 sensor for measuring fuel mixture provides accurate data for adjusting fuel mixture. When a laptop is attached to the system, it can record flight data which is useful in troubleshooting.

5.8 RPM Meter

When the instrument panel RPM gauge is reading cranking RPM from the ECU, we know that the speed sensors and ECU are functional. By contrast, if RPM is not displaying and the engine is running, either the signal is not present or the RPM meter is broken.

5.9 GPH Meter

The GPH meter will not be helpful for troubleshooting unless the engine is running. When the engine is running, knowing the fuel flow for the engine operating condition is helpful in determining mixture. Too high a fuel flow indicates a rich mixture and too low a fuel flow indicates a lean mixture. The GPH signal can be programmed to give a very accurate fuel flow over a wide operating range. Details on how to use this output wire can be found on our website.

6.0 Laptop Error Codes

6.1 OPS2 Command

The same Error Codes that are read from the Annunciator Lights can also be read by using the Laptop OPS2 command. The output from the OPS2 command looks like Figure 3 below. See the "Calibration Manual" for more detailed fault printout.

OPS2 Command Output

ACRV%	REF5%	TDM	VOLTS	DWELL	SQ	ERR	SYS	SUS%	PEAK	MAPr	IATr	CHTr	TPSr	BAPr	BATr	AD6r	FLPr	TIME
100	085	04271	12.7	1972	02	0000	0237	027	0928	0300	0543	0273	0000	0850	0414	0270	0508	02:26:11

Figure 3

6.2 ERR Column

Under the ERR column is the Error Code. It functions similarly to how the flashing Annunciator Lights indicate failure codes (See Appendix A). The 0000 indicates that no errors exist. If a code other than 0000 is present, check the "Calibration Manual" for more detail.