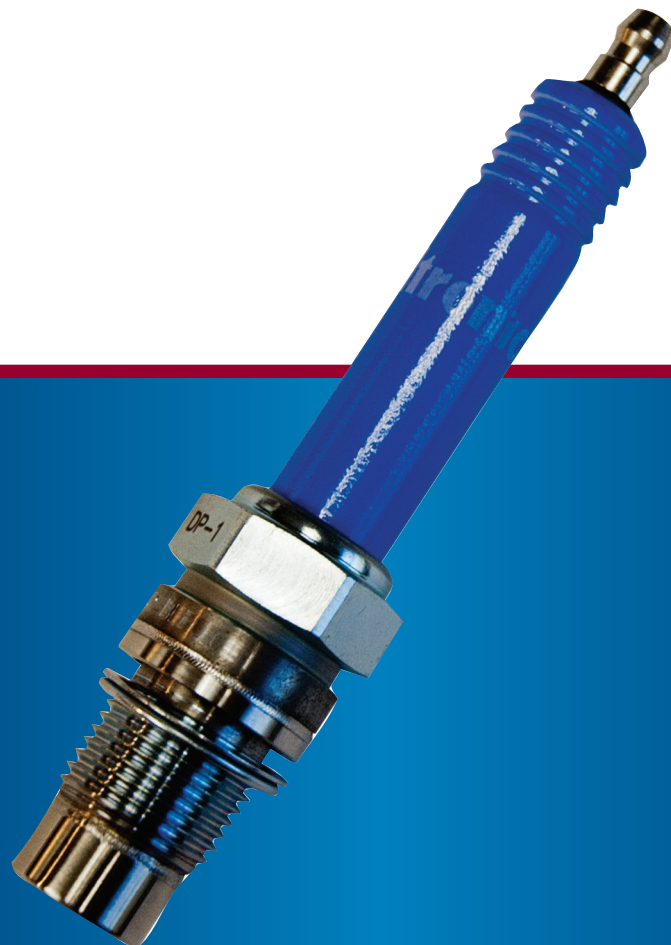


Application & Installation Guide

Passive Pre-Chamber Spark Plug for G3500 Engines

Form PPC AIG 3-13

altronic
HOERBIGER Engine Solutions



1.0 VERIFICATION OF APPLICATION

- 1.1 The engine should be inspected to verify the following information prior to commissioning of PPC sparkplugs.

Engine model and serial number, typically one of the following configurations:

- TALE – SI, EIS, EIS/AFRC, ADEMIII
- ULB – ADEMIII

Engine air fuel ratio control system type, typically one of the following:

- OEM EIS/AFRC
- ADEMIII – NO_x Sensor
- ADEMIII – O₂ Sensor
- Altronic EPC-150

Engine mechanical condition and overall health:

- Engine hours since last major overhaul
- Engine service records, i.e. compression test results, etc
- Engine emission records

Engine load and expected de-rating for environmental conditions, i.e., fan load, altitude, etc.

- Compression applications—typically this can be accomplished through compressor manufacturers performance figures and packager guidelines for other auxiliary loads.
- Generator applications—typically this can be accomplished by observing the electrical output of the generator and applying the appropriate generator and coupling efficiency corrections to arrive at mechanical load.

- 1.2 Engine fuel gas should be evaluated for application suitability prior to commissioning of PPC sparkplugs.

Fuel gas should be analyzed to determine its constituent types and quantities prior to PPC plug installation, care should also be taken to determine the repeatability of the fuel gas over time.

Once fuel gas constituent quantities have been determined and reasonable assurance as to the variability of the fuel has been made, determination of the methane number is helpful—typically this can be done using the Caterpillar GERP software when applying PPC sparkplugs to G3500 engines.

Refer to PPC sparkplug application matrix on page 4 to determine the appropriate sparkplug based on the information obtained above.

2.0 PRE-INSTALLATION

- 2.1 Verify engine and control system operation is consistent with that found in during the application verification.

- Engine load
- Proper air-fuel ratio control operation
- Engine exhaust emissions within OEM specified levels

- 2.2 Record all key operating parameters prior to installation of PPC sparkplugs in the table provided in this document.

- Run unit at full load, allow all temperatures to stabilize and record data in table provided.
- Unload unit and run at 1200rpm, allow all temperatures to stabilize and record data in table provided.

WARNING: This document is intended as a supplement to aid in the application of Altronic's passive pre-combustion chamber (PPC) sparkplug technology, it is not a replacement for OEM, Altronic, or other guidelines and manuals. Always consult all other applicable literature prior to use of this guide.

WARNING: Advanced product applications such as those described herein assume that the installing technician has the requisite experience, knowledge, and equipment to perform the task in a manner which leads to safe operation for both personnel and equipment.

WARNING: The PPC sparkplug applications and procedures described in this guide are intended specifically for mechanical drive Caterpillar™ G3500 gas engines—use of these sparkplugs for any other application is not advised and could result in significant risk to personnel and equipment.

WARNING: PPC sparkplug technology allows open-chamber gas engines to run at leaner air-fuel mixtures and/or other challenging off-design conditions than possible with conventional sparkplugs. The extended operating range previously described can allow for engine operation with improved engine efficiency, engine stability, and reduced exhaust emission rates. These performance improvements can only be realized on engines that are in good mechanical condition, with properly functioning control systems, and operating within manufacturer's design guidelines for all critical parameters. A good measure of an engine's overall health, and thus potential for improvement, is to confirm at a minimum that all manufacturer's predicted levels of performance and exhaust emission can be achieved with standard sparkplugs.

3.0 PPC INSTALLATION

- 3.1 Remove old spark plugs and inspect, any fouling could indicate a condition not diagnosed in the previous sections—repeat checks as required.
- 3.2 Inspect and if necessary clean the spark plug threads in the engine cylinder head using OEM recommended tools and procedures.
- 3.3 Install the PPC spark plugs into the engine cylinder heads
 - Insert the plug into the well and start the threading, this is best performed with the aid of a clean 5/8" rubber hose, do not place any lubrication on the spark plug threads or drop the sparkplugs down the well.
 - Torque all PPC spark plugs to 35lb-ft using a properly functioning torque wrench.
 - Reassemble the engine as normal.

4.0 ENGINE TUNING

- 4.1 Prior to starting the engine after installation of the PPC sparkplugs the following steps should be taken:
 - Retard the engine timing four to six degrees from where previously set.
 - Disable the load timing map.
 - Set the speed timing map for maximum speed.
- 4.2 Prior to loading the engine after installation of the PPC sparkplugs the following steps should be taken:
 - Start the engine and run at 1200rpm with no load and allow the cylinder exhaust temperatures to stabilize – once temperatures have stabilized record in the provided table
 - Compare the cylinder exhaust gas temperatures to those recorded from the unloaded, pre-installation condition.
 - Adjust engine timing to match current cylinder temperatures to previous temperatures.
 - If temperatures are cooler than previously recorded, retard ignition timing one degree at a time until temperatures are equal.
 - If temperatures are hotter than previously recorded, advance ignition timing one degree at a time until temperatures are equal.
- 4.3 In order to complete the engine tuning after installation of the PPC sparkplugs the following steps should be taken:
 - Load the unit as normal
 - Once conditions stabilize, lean the engine air-fuel ratio while observing the following closely:
 - Cylinder exhaust gas temperatures.
 - Air manifold pressure, observing all OEM specified limits, often with a small safety margin.
 - Throttle position. Ideally this should be no more than 60% to 65% open at maximum load, RPM, and intake manifold temperature. It will usually be necessary to adjust the wastegate during the tuning process, often the wastegate will require six revolutions or more as the engine is run at leaner conditions.
 - Fuel actuator position. Ideally this will be 45% or 50% open, it may be necessary to adjust the fuel system pressure regulators and the carburetor load screw. On ADEMIII engines the fuel correction factor should be monitored per OEM guidelines.
 - Observe engine conditions and adjust timing for best HP and exhaust gas

NOTE: While sparkplug installation is often considered a routine task and thus there are certain procedures which are often overlooked leading to compromised performance and life of the sparkplug and associated ignition components. Oil, sweat, and other contaminants on sparkplug insulators and ignition components can dramatically decrease their dielectric limit and lead to premature failure or compromised performance—all components should be kept free of contamination when possible. This can be accomplished by the servicing technician wearing clean, nitrile-based gloves when handling these components. If components have been contaminated they can be cleaned with isopropyl alcohol and lint-free cloth. Also, when working on G3500 engines it is important to verify the proper operation of all oil seals and gaskets around the sparkplug well, this includes those found on the ignition coil and/or the rigid extender. Lastly, sparkplug torque is critical as an under-torque condition can result in improper heat transfer and an over-torque condition can compromise sparkplug seals and insulation.

NOTE: In order to achieve good startability with any PPC plug technology it is often required to retard the ignition timing during starting. The timing during cranking can be retarded to 0° BTDC for this purpose. Also, it may be required to crank for a slightly extended period of time so that the PPC plugs have an opportunity to build a small amount of internal heat. These procedures are considered normal and are often OEM procedures on engines which are factory equipped with PPC sparkplug technology.

temperatures. Once tuning is completed record this information in the table on the next page.

- It may be necessary to repeat this process several times before desired results are achieved, keeping in mind the process described herein aims to optimize exhaust emissions. If other optimizations are required this procedure will need modified with that variable in mind.



G3500 PPC SPARKPLUG APPLICATION MATRIX

	<i>G3500ULB</i>	<i>G3500TALE</i>
<i>LANDFILL/BIO GAS (HIGH METHANE NUMBER & LOW HEATING VALUE)</i>	<i>N/A</i>	<i>P1863DP-1</i>
<i>WELL-HEAD GAS (HIGH METHANE NUMBER)</i>	<i>P1863DP-1</i>	<i>P1863IP-1</i>
<i>WELL-HEAD GAS (MODERATE METHANE NUMBER)</i>	<i>P1863DP-1</i>	<i>P1863IP-2</i>
<i>PIPELINE GAS (HIGH METHANE NUMBER)</i>	<i>P1863DP-1</i>	<i>P1863IP-1</i>

FOR ADDITIONAL APPLICATION INFORMATION PLEASE CONTACT YOUR AUTHORIZED ALTRONIC DISTRIBUTOR

G3500 PPC SPARKPLUG COMMISSIONING DATA TABLE

	PRE-INSTALLATION		POST-INSTALLATION	
	UNLOADED	LOADED	UNLOADED	LOADED
ENGINE SPEED				
SPEED FLUCTUATION (+/- RPM)				
% LOAD (TOTAL)				
BOOST PRESSURE				
INTAKE MANIFOLD PRESSURE				
INTAKE MANIFOLD TEMPERATURE				
AIR INLET TEMPERATURE				
EXHAUST STACK TEMPERATURE				
CYLINDER EXHAUST TEMPERATURES				
-1				
-2				
-3				
-4				
-5				
-6				
-7				
-8				
-9				
-10				
-11				
-12				
-13				
-14				
-15				
-16				
THROTTLE POSITION				
FUEL ACTUATOR POSITION				
WASTEGATE POSITION (FROM START)				
IGNITION SPARK TIMING (BTDC)				
AIR-FUEL RATIO FEEDBACK SETPOINT				
-NO _x				
-O ₂				
ENGINE EXHAUST EMISSION LEVELS				
-NO _x				
-O ₂				
-CO				