IGNITION SYSTEM

GENERAL

NOTE: For DI and 4-TEC models, refer to ENGINE MANAGEMENT section.

MAGNETO OUTPUT	
ENGINE TYPE	WATT
717	160 @ 6000 RPM
787 RFI	270 @ 6000 RPM

717 Engines

Unregulated AC current is produced in the magneto by the battery charging coil. This AC current is rectified and regulated by the charging system. The resulting regulated DC current is used to charge the battery.

Unregulated AC current is produced in the magneto by the ignition generator coil for the ignition system. This current is sent to the MPEM where it is processed to then be sent to the ignition coil.

The ignition generator coil, MPEM and the ignition coil work together in this Digital CDI ignition system.

787 RFI Engines

Unregulated AC current is produced by the magneto. This AC current is rectified and regulated by the charging system. The resulting regulated DC is used to charge the battery.

The CPS, MPEM, ECU and the ignition coil work together in this Digital Inductive ignition system.

All Engines

A 12 volts battery supplies the Multi-Purpose Electronic Module (MPEM) with DC current.

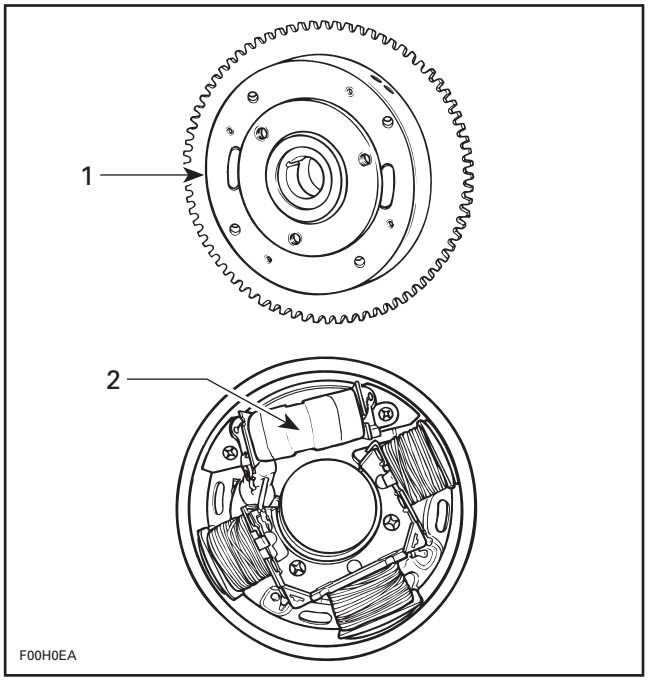
Refer to CHARGING SYSTEM.

Magneto System

The magneto is the primary source of electrical energy. It transforms magnetic field into electric current (AC).

717 Engines

The flywheel contains 4 permanent magnets and spins around the generating coil. This electric current flows to the multi-purpose electronic module (MPEM).



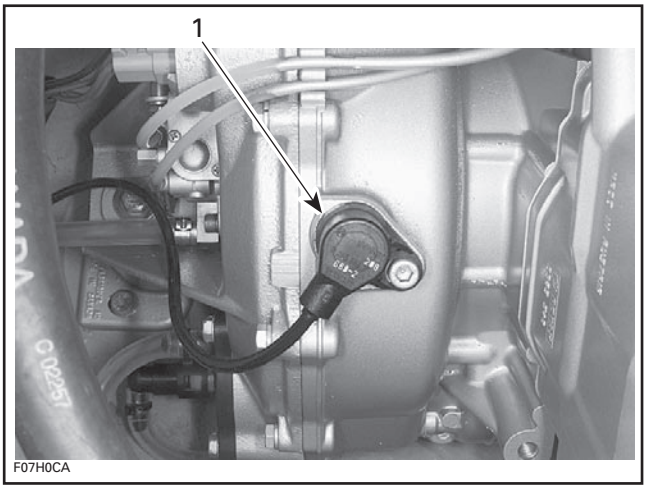
1. Flywheel
2. Generating coil

787 RFI Engines

Crankshaft Position Sensor (CPS)

The CPS is an inductive speed sensor located on the magneto housing and is working in conjunction with a 60 teeth ring gear which has 2 teeth missing on the gear. The inductive sensor registers the 58-tooth sequence.

An AC voltage is generated by the sensor and is sent to the ECU to calculate the crankshaft position and the engine speed.



1. Crankshaft position sensor (CPS)

Ignition Coil

Ignition coil induces voltage to a high level in secondary windings to produce a spark at spark plug.

717 Engines

The ignition coil steps up the voltage input from the multi-purpose electronic module to high voltage current for both spark plugs.

The ignition coil is located in the rear electrical box located under air intake.

787 RFI Engines

The digital inductive ignition system on the RFI models allows the spark plugs to spark independently on each piston stroke.

CAUTION: Do not interchange spark plug cables. Reversed spark plug cables will not allow the RFI to run and will cause backfires.

MULTI-PURPOSE ELECTRONIC MODULE (MPEM)

717 and 787 RFI Engines

The MPEM is responsible of the following electrical functions related to the ignition system:

– ignition timing curve
– engine rev limiter.

For the other functions of the MPEM, refer to INSTRUMENTS AND ACCESSORIES section.

787 RFI Engines

The MPEM is also used with the Rotax fuel injection system.

The RFI models use a digital inductive ignition system. The Bosch ECU controls the ignition timing and dwell time. It receives input from the CPS and signals the ignition coil when to fire.

IGNITION TIMING

Before checking ignition timing with a stroboscopic timing light (dynamic test), it is mandatory to scribe a timing mark on the PTO flywheel (static test) corresponding to the specific engine.

Also, the timing mark scribed on the PTO flywheel can be used to troubleshoot a broken magneto woodruff key.

CAUTION: The relation between the PTO flywheel mark position and crankshaft position may change as the PTO flywheel might move/tighten/loosen on the crankshaft. As an example on threaded flywheels, when the engine is accelerated out of water, PTO flywheel may tighten then loosen when the engine is decelerated. This will result in a false ignition timing reading. Always verify PTO flywheel mark position before checking ignition timing with an appropriate timing light. If mark does not align with tool, repeat static test to ensure flywheel has not loosen or moved before changing the ignition timing.

NOTE: Do not use the factory mark found on the PTO flywheel to check ignition timing or troubleshoot any problems.

787 RFI Engines

Normally ignition timing adjustment should not be required. It has been set at factory and it should remain correctly adjusted since every part is fixed and not adjustable. The only time the ignition timing might have to be changed would be when replacing the crankshaft, the magneto rotor the CPS and the MPEM or the ECU. If the ignition timing is found incorrect, you should first check for proper crankshaft alignment. This might be the indication of a twisted crankshaft.

RFI Models

The fixed timing mode must be activated before checking ignition timing. See FIXED TIMING FUNCTION paragraph.

Static Test

All Engines

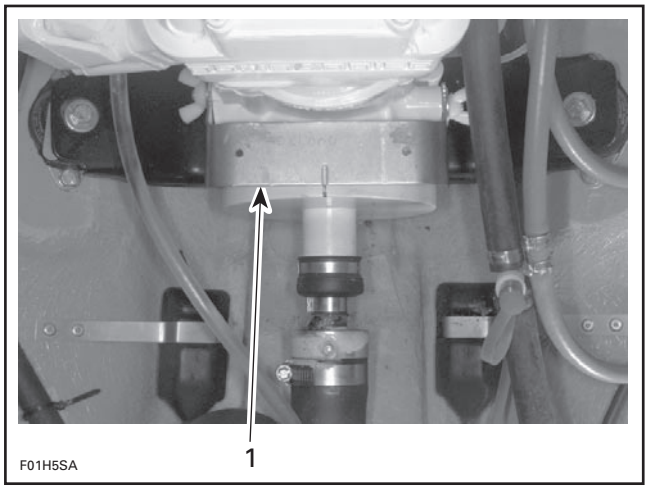
– Disconnect MAG side spark plug wire and connect wire to grounding device then remove spark plug.

CAUTION: Never crank engine with spark plugs removed unless spark plug cables are connected to the grounding device.

– Remove PTO flywheel guard.

717 Engines

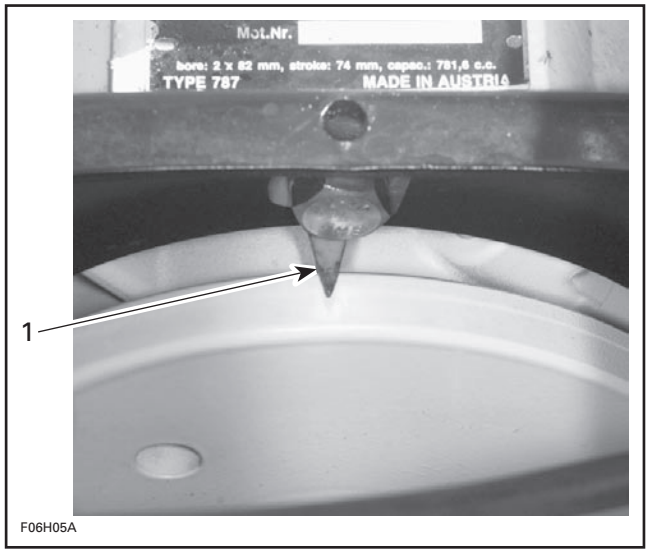
– Install timing mark pointer tool on engine using wing nuts previously removed.



TYPICAL
1. Timing mark pointer tool (P/N 295 000 130)

787 RFI Engines

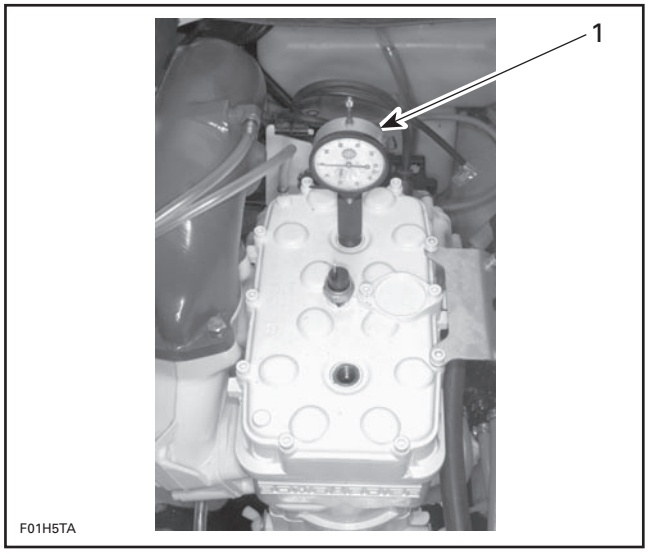
– Remove middle screw securing the engine to the rear engine mount. Reinstall screw with timing mark pointer tool.



1. Timing mark pointer tool (P/N 295 000 135)

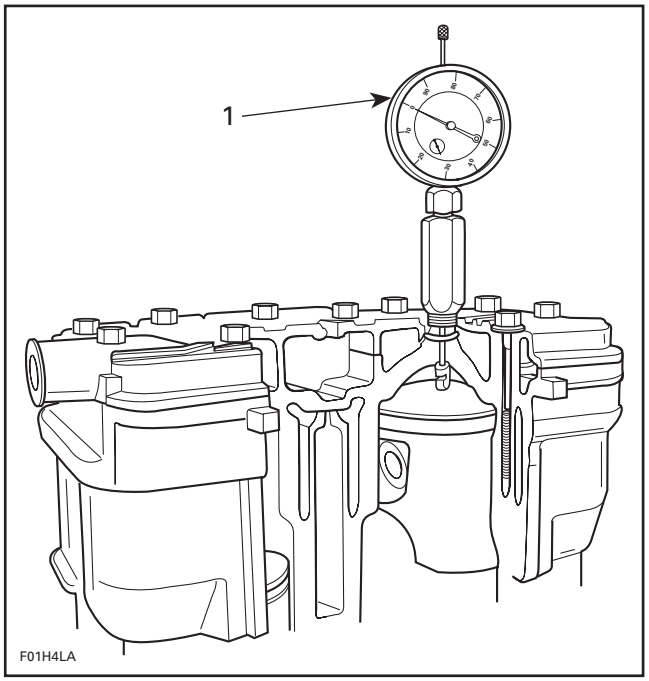
All Engines

– Install and adjust a TDC gauge (P/N 295 000 143) in MAG side spark plug hole.



TYPICAL
1. TDC gauge on MAG side

– Rotate PTO flywheel counterclockwise (when facing it) until piston is at top dead center.

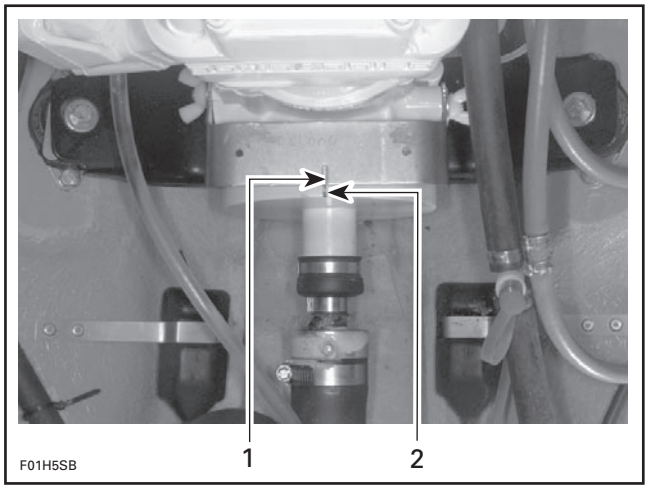


TYPICAL
1. Adjust gauge dial at zero

– From this point, rotate flywheel clockwise to reach proper specification according to engine. Refer to the following chart.

ENGINE	IGNITION TIMING (BTDC)
717	2.59 mm (.102 in)
787 RFI	1.02 mm (.040 in)

– Scribe a thin mark on PTO flywheel in the middle of tool slot (717 engines) or aligned with timing mark pointer tool (787 RFI engines).



TYPICAL
1. Tool slot
2. Flywheel mark

NOTE: This mark becomes the reference when using the stroboscopic timing light.

CAUTION: The static test cannot be used as a timing procedure, therefore, always check the timing with a stroboscopic timing light.

– Remove TDC gauge.
– Reinstall spark plug and connect wire.

Dynamic Test

To check ignition timing, use a timing light (available at local facilities).

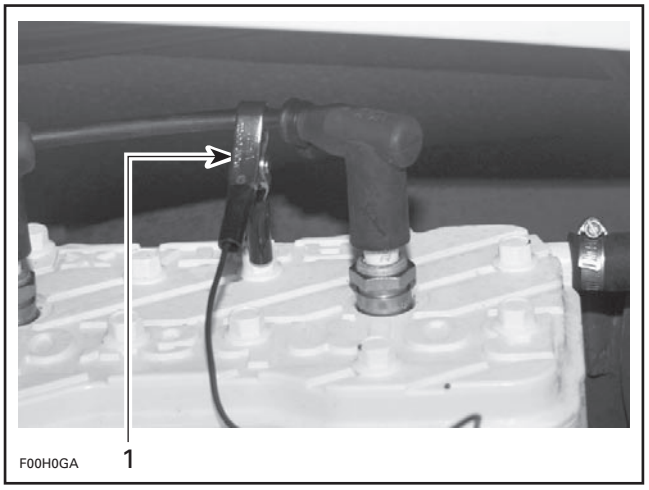
NOTE: Ensure to use a timing light capable to work with 2-stroke engines.

717 Engines

NOTE: To perform this procedure, make sure to use a stroboscopic timing light rated up to 6000 RPM. Otherwise, an inaccurate reading will be obtained.

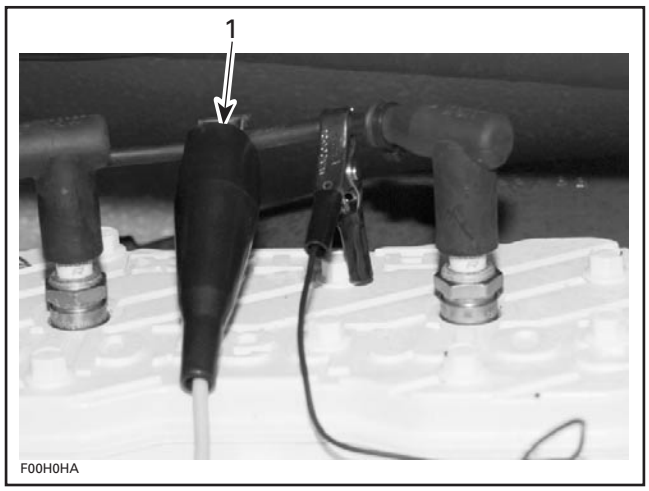
The ignition components are affected by temperature variation, therefore, timing must be checked when engine is cold, after idling for a MAXIMUM of 20 seconds.

– Connect an induction-type tachometer (P/N 529 014 500) to spark plug wire.



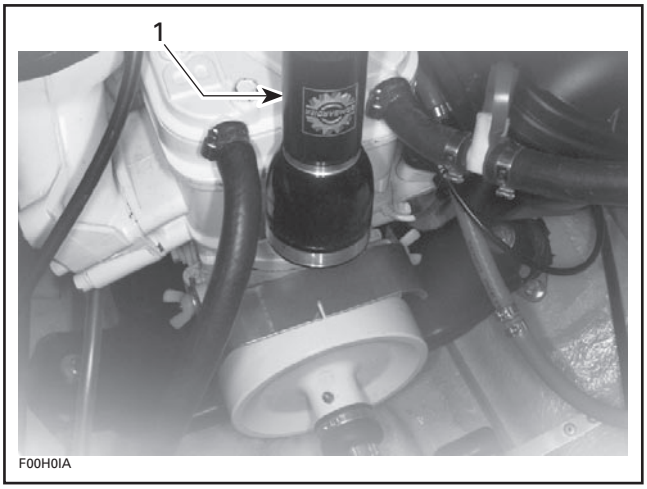
1. Tachometer pick-up

– Connect timing light pick-up to MAG side spark plug wire.



1. Timing light pick-up

– Start engine and point timing light straight in line with timing tool slot. Bring engine to 6000 RPM.



1. Timing light straight in line with tool slot

CAUTION: If engine is to be run more than a few seconds, engine must be cooled using the flush kit.

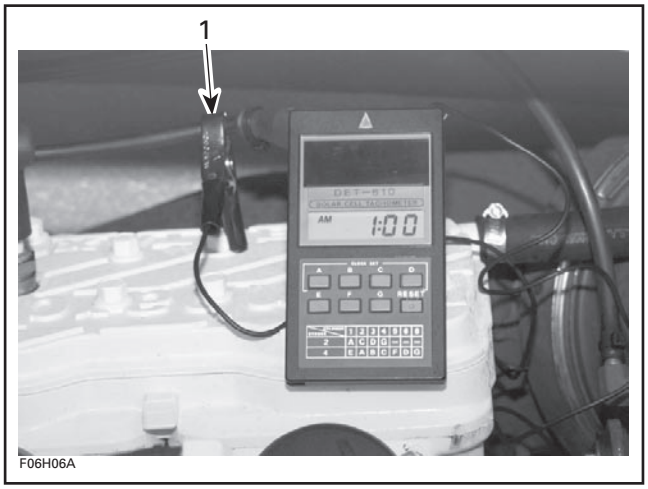
– Check if PTO flywheel mark aligns with timing tool slot.

NOTE: On this system, timing advance decreases as engine speed increases.

If timing mark aligns with tool slot, timing is properly set. If mark does not align with tool slot, recheck PTO flywheel mark before adjusting ignition timing to ensure PTO flywheel has not loosen.

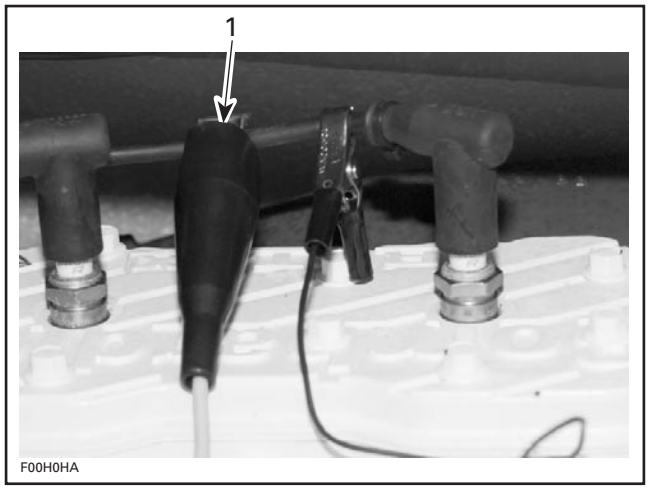
787 RFI Engines

– Connect an induction-type tachometer (P/N 529 014 500) to spark plug wire.



1. Tachometer pick-up

– Connect timing light pick-up to MAG side spark plug wire.

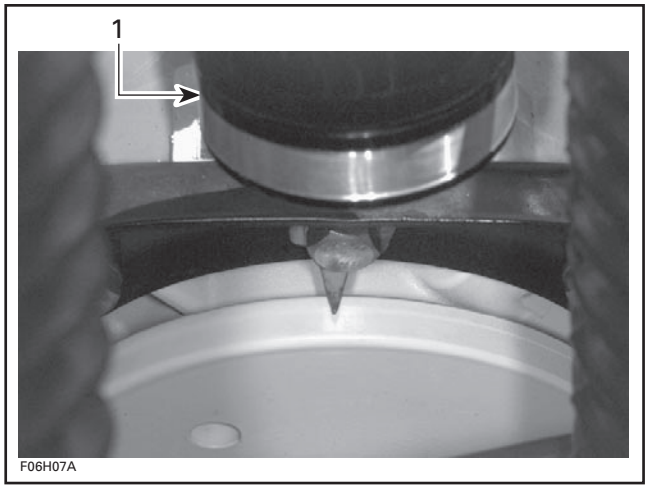


1. Timing light pick-up

IMPORTANT: To check the ignition timing, the timing advance curve must be locked first. This allows to perform ignition timing at **any RPM** by keeping the timing "frozen" so that it does not vary with engine RPM. See FIXED TIMING FUNCTION for more information.

NOTE: **Fixed Timing** function must be activated before starting engine when using the MPEM programmer. When using B.U.D.S., it must be activated **after** starting the engine.

– Start engine and point the beam of a timing light on mark.



1. Timing light straight in line with tool slot

CAUTION: If engine is to be run more than a few seconds, engine must be cooled using the flush kit.

NOTE: If mark on PTO flywheel is perfectly aligned with timing mark pointer, no adjustment is required. If mark does not align with pointer, recheck PTO flywheel mark before adjusting ignition timing to ensure PTO flywheel has not loosen or moved.

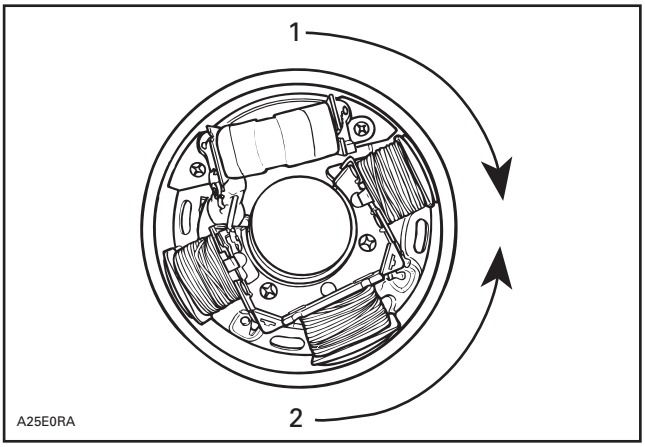
Ignition Timing Adjustment

717 Engines

Remove magneto housing cover and wire support.

For removal of magneto, refer to MAGNETO SYSTEM.

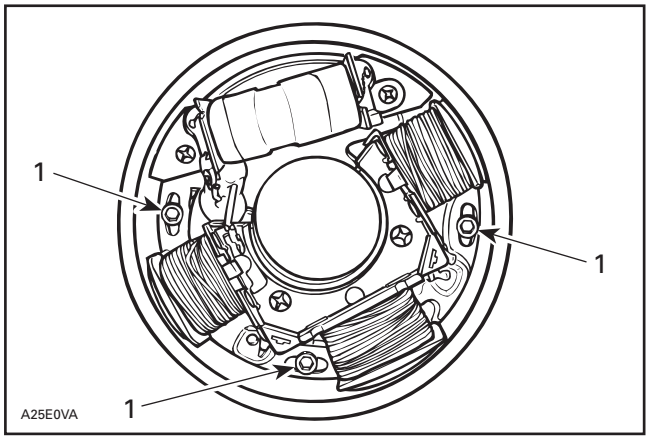
Timing is performed by moving armature plate; clockwise to retard spark occurrence or counterclockwise to advance.



TYPICAL
1. To retard
2. To advance

To adjust, loosen 3 armature plate retaining screws and slightly rotate armature plate in proper direction.

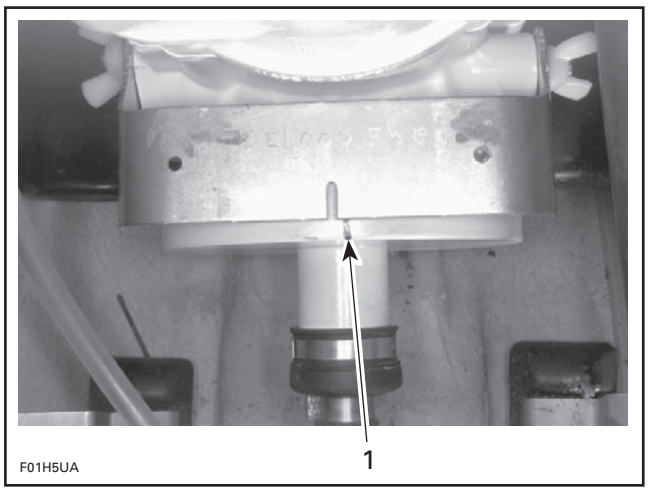
NOTE: As a guideline, turn the armature plate the same amount needed to align mark on PTO flywheel.



TYPICAL
1. Retaining screw

Example 1

When PTO flywheel mark is on right side of timing tool slot, it indicates advanced timing.

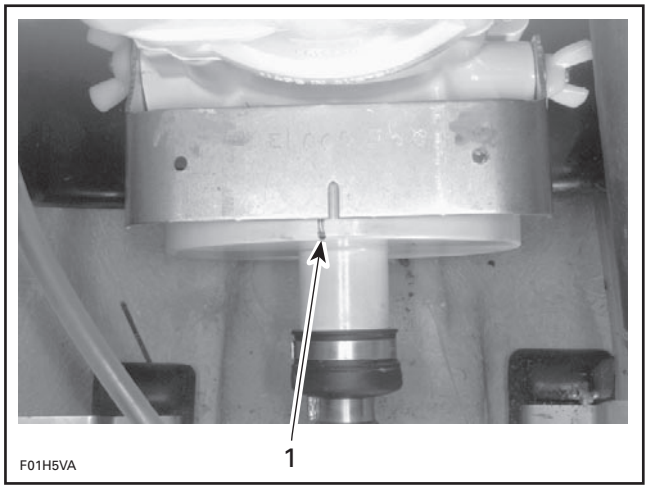


1. Too advanced timing

In this case, turn armature plate clockwise when facing it.

Example 2

When PTO flywheel mark is on left side of timing tool slot, it indicates retarded timing.



1. Retarded timing

In this case, turn armature plate counterclockwise when facing it.

After adjustment, tighten armature plate retaining screws.

CAUTION: Armature plate screws must have Loctite 243 (blue) applied before tightening. Make sure armature plate screws are well secured.

Reinstall removed parts. Refer to MAGNETO SYSTEM.

Recheck ignition timing (make sure engine is cold).

Repeat armature plate positioning procedure if timing mark position is not adequate.

787 RFI Engines

CAUTION: If the ignition timing is adjusted too advanced, this will cause serious damage to the engine.

VCK (Vehicle Communication Kit)

For the 787 RFI engines, use the VCK (Vehicle Communication Kit) (P/N 295 035 981).

NOTE: For more information on the VCK, refer to its online help.

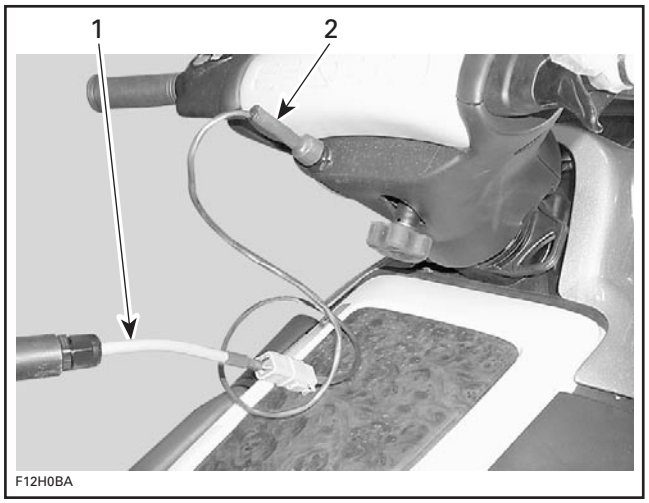
B.U.D.S. (Bombardier Utility Diagnostic Software) is designed, among other things, to allow adjusting the ignition timing.

CAUTION: If the computer you are using is connected to the 110 Vac power outlet, there is a potential risk of electrocution when working in contact with water. Be careful not to touch water while working with the VCK.

Electrical Connections

DESS Post Connection

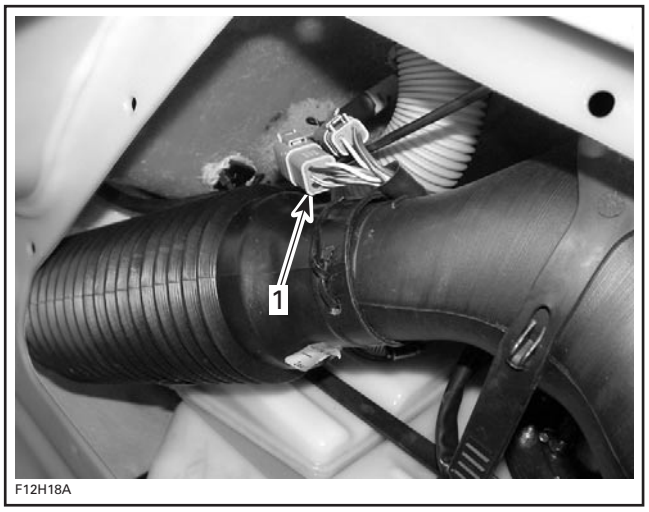
Use adapters of the VCK and connect cable to the vehicle DESS post. Open the software B.U.D.S.



1. 6-pin adapter (P/N 529 035 679)
2. DESS adapter (P/N 529 035 684)

DESS Post Connection Through the 6-Pin Connector

Disconnect the connector shown in the following picture and install RFI DESS adapter (P/N 278 001 978).



1. Connector to be disconnected

After all connections are done, connect the safety lanyard to the DESS post to activate the communication.

All Connections

IMPORTANT: When using the software B.U.D.S., ensure that the protocol matching the connection used is properly selected in "**MPI**" under "**Choose protocol**" as per the following chart.

TYPE OF CONNECTION	ADAPTER TO USE	PROTOCOL TO CHOOSE
Through DESS post	DESS adapter (P/N 529 035 684)	DESS
Through 6-pin DESS connector	RFI DESS (P/N 278 001 978)	

MPEM Programmer

As an alternate method to correct the ignition timing, the data of the MPEM can be changed using the MPEM programmer (P/N 529 035 878).

NOTE: For more information on the MPEM programmer, refer to the *MPEM programmer guide* (P/N 219 700 138).

Refer to the TIMING CORRECTION CHARTS, used per MPEM programmer, to find the number corresponding to the timing correction needed.

The **Fixed Timing** function must be activated first. This function allows to check ignition timing at any RPM because it locks ignition timing at 12 degrees BTDC.

NOTE: Fixed Timing function must be activated before starting engine when using the MPEM programmer.

Fixed Timing Function

1) Connect the communication cable to the MPEM programmer and the other end to the safety lanyard switch on the craft.
2) Press the **ON/C** button on programmer and enter your password.
3) Press **3** to choose **Vehicle info** in programmer.
4) Press **8** to choose **Bosch system**.
5) Press **1** to choose **Diagnosis**.
6) Press **4** to choose **Adjustment**.
7) Press **4** to choose **Fixed timing**.
8) The programmer display **Timing = 12.00 deg.**

9) Press any key to continue. Programmer will go back one level to **Adjustment**.
10) Press **Menu** to go back one level to **Diagnosis**.
11) Press **Menu** to go back one level to **Bosch system**.
12) Programmer now ask **Quit Bosch Diagnosis?** Choose **yes** to quit.

Press **2** to choose **Start Vehicle, the programmer will then ask Modify Max RPM, press menu** then start engine with start/stop button.

NOTE: If engine fail to start and as soon engine stops revving (start/stop button has been released), **Fixed Timing** function is disabled. To reactivate function, repeat complete procedure.

Timing Verification

With engine running, check timing.

CAUTION: If engine is to be run more than a few seconds, engine must be cooled using the flush kit.

If timing is correct stop engine. This will automatically disable **Fixed Timing** function.

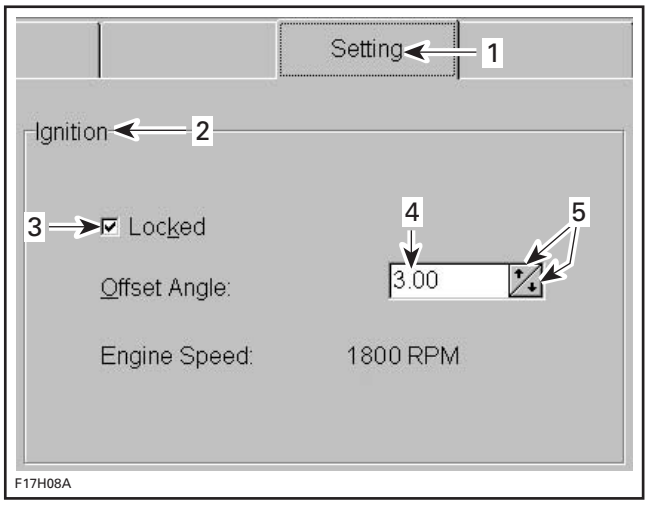
If further adjustment is required refer to following procedure.

Timing Adjustment

Unlike the other models, the ignition timing correction can be made from 4.5° (advanced) to - 2.25° (retarded).

VCK (Vehicle Communication Kit)

The VCK will display directly the timing correction under "Offset angle". See illustration below.



1. *"Setting" tab*
2. *Ignition offset section*
3. *"Locked" box*
4. *Current angle in MPEM*
5. *Arrows to change the angle*

MPEM Programmer

The MPEM programmer will display correction numbers from 1 to 8. Refer to the next TIMING CORRECTION CHART.

Access the **BOSCH SYSTEM** in the MPEM programmer, then select **ADJUSTMENT** in the submenu.

Choose **IGNITION** in the **ADJUSTMENT** menu.

The screen will display the actual ignition timing correction in degrees and it will also offer to adjust it.

Refer to the following chart to find the number corresponding to the timing correction needed.

Choose the **Fixed Timing** function, start the engine and verify the timing again. Repeat the above procedure if the timing is still incorrect.

TIMING CORRECTION CHART 787 RFI	
MPEM PROGRAMMER NUMBER	IGNITION TIMING CORRECTION
1	4.50°
2	3.75°
3	3°
4	2.25°
5	.75°
6	0°
7	- 0.75°
8	- 2.25°

Ignition timing is set at 12° BTDC at any RPM, when the **Fixed Timing** function is active.

PROCEDURE

All Engines

When dealing with ignition problems, the following items should be verified in this order:

1) Spark occurrence/spark plug condition.
2) Battery condition.
3) Electrical connections.
4) Engine start/stop switch.
5) Safety lanyard switch.
6) Power supply cut-off relay.
7) Multi-Purpose Electronic Module (MPEM).
8) Magneto output (**717 engines**).
9) Ignition coil output.

CAUTION: Whenever replacing a component in ignition system, check ignition timing.

NOTE: To perform verification, a good quality multimeter such as Fluke 111 (P/N 529 035 868) should be used.

Engine Start/Stop Switch Verification

Disconnect the YELLOW/RED wire of the start/stop switch. Using an ohmmeter, connect test probes to YELLOW/RED wire and to ground.

Measure resistance, it must be an open circuit (switch is normally open). Depress and hold switch, the ohmmeter should read close to 0 ohm.

Safety Lanyard Switch Verification

NOTE: The safety lanyard also controls the power supply cut-off relay. Refer to INSTRUMENTS ACCESSORIES for its testing procedure.

If 2 short beeps are not heard when installing the safety lanyard, refer to DIGITALLY ENCODED SECURITY SYSTEM.

The following continuity tests can also be performed using an ohmmeter:

Disconnect switch wires.

Safety Lanyard Removed

Connect test probes to switch BLACK and BLACK/YELLOW wires. Measure resistance, there should be no continuity (open circuit).

Connect one test probe to the WHITE/GRAY wire and the other test probe to the switch terminal. Measure resistance, it must be close to 0 ohm.

Connect one test probe to the BLACK wire and the other test probe to the switch ring. Measure resistance, it must be close to 0 ohm.

Safety Lanyard on Switch

Connect test probes to switch BLACK and BLACK/YELLOW wires. Measure resistance, it must be close to 0 ohm.

Rev Limiter Verification

To check engine rev limiter, connect an induction tachometer (P/N 529 014 500), start engine and check its maximum speed.

MODEL	RPM LIMITER SETTING
717	7100 ± 50
787 RFI	7200 ± 50

Multi-Purpose Electronic Module (MPEM) Verification

It is not possible to accurately check the MPEM condition without specialized tools. Therefore, replace MPEM with a good known unit to conduct testing.

NOTE: Before replacing the MPEM, make sure all connectors are properly secured and there is no water in connectors. Check also the signal and power contacts in the AMP plug connectors. See WIRING DIAGRAMS.

Generating Coil Verification

717 Engines

STATIC TEST

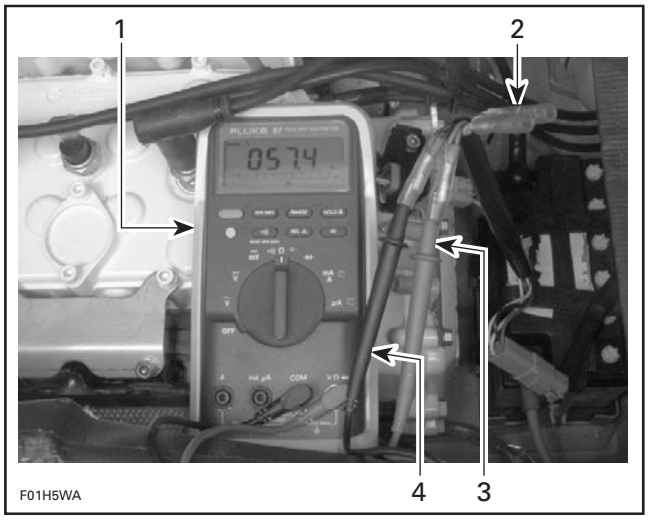
Disconnect magneto wiring harness connector.

Install the 4-pin magneto harness adapter (P/N 295 000 131).

TYPICAL

Check resistance with a multimeter. Refer to the following table for values and wire colors.

PART NAME	ADAPTER WIRE	RESISTANCE
Generating coil	BLACK with RED/BLACK	40 - 76 Ω



1. *Multimeter*
2. *4-pin magneto harness adapter*
3. *RED/BLACK wire*
4. *BLACK wire*

DYNAMIC TEST

1) Connect spark plug cables to grounding device.
2) Disconnect magneto wiring harness connector.
3) Install the 4-pin magneto harness adapter (P/N 295 000 131).
4) Connect positive test probe of the multimeter to the RED/BLACK wire of the 4-pin magneto harness adapter.
5) Connect negative test probe of the multimeter to BLACK wire of the 4-pin magneto harness adapter.
6) Set multimeter to Vac scale.
7) Crank engine and note result. The obtained value should be between 18 and 25 Vac.
8) If the generating coil is out of specification, replace it.

NOTE: If the generating coil tests good, disconnect the primary wires of the ignition coil. Crank engine and check voltage at primary wires. It should be at least 20 Vac. If there is insufficient or no voltage, either the MPEM or wiring harness is defective.

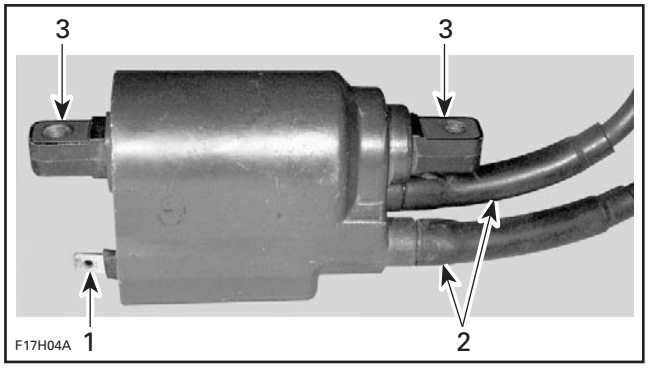
Ignition Coil Verification

STATIC TEST

NOTE: An ignition coil with good resistance measurement can still be faulty. Voltage leak can occur at high voltage level which is not detectable with an ohmmeter.

717 Engines

Primary Winding



1. *Primary side*
2. *Secondary side*
3. *Ground plate*

Disconnect the wire connectors on primary side of the ignition coil.

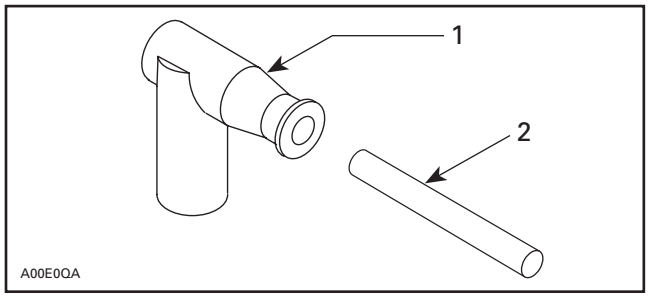
Using a multimeter, check the resistance between the primary side connectors of the coil.

The resistance should be 0.34 to 0.62 Ω at 20°C.

If not within specification, replace the ignition coil.

Secondary Winding

The spark plug caps must be removed from high tension cables, because they are resistor caps. The cap resistance is 4.48 kΩ.



1. Resistor cap
2. High-tension cable

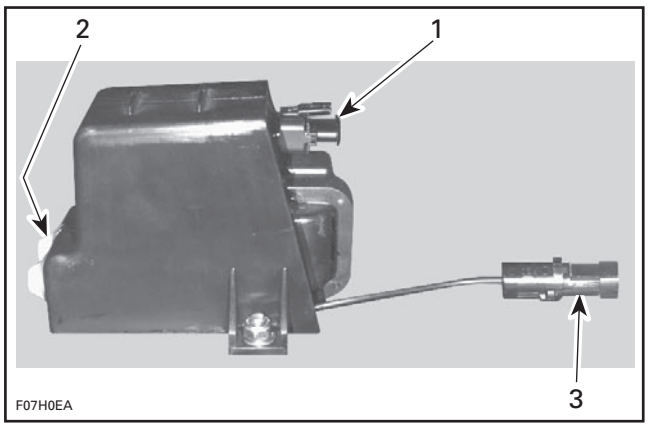
Using a multimeter, check the resistance between the two high tension leads with the spark plug caps removed.

The resistance should be 12 ± 3 kΩ at 20°C.

NOTE: A short circuit will read 0 ohm (or close to) on ohmmeter.

787 RFI Engines

Primary Winding



IGNITION COIL
1. Primary side
2. Secondary side
3. Ground wire

Disconnect the wire connector on the primary side of the ignition coil.

Using a multimeter, check the resistance between the terminals 1 and 2. Repeat a resistance test between terminals 2 and 3.

The resistance should be 0.3 to 0.6 Ω at 20°C.

If not within specification, replace the ignition coil.

If the ignition coil test good, check the power supply on the primary side.

Disconnect the ignition coil 3-pin connector. Check to see if there is approximately 6 Vdc between the red wire and engine ground.

If there is no voltage, either the MPEM or the wiring harness is defective.

Secondary Winding

Due to the integrated diode, it is not possible to take any resistance measurement of the secondary winding on the 787 RFI models.

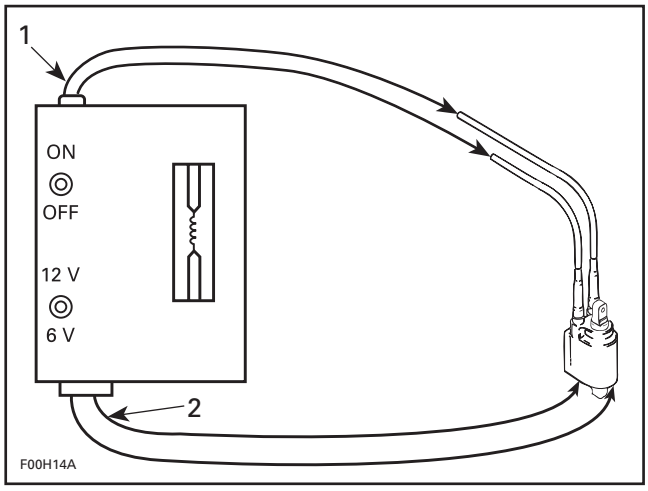
DYNAMIC TEST

All Models

Use an ignition coil tester, available from after-market tool/equipment suppliers.

CAUTION: Do NOT use coil tester on metal work bench. Follow manufacturer instructions.

– With ignition coil removed from craft, disconnect spark plug caps from high tension cables.
– Hook high tension leads from tester to ignition coil high tension cables.
– Connect 2 smaller tester leads to primary of ignition coil.



TYPICAL
1. Leads to secondary
2. Leads to primary

– Turn power switch to 12 volts and you should observe spark jumping at a predetermined gap of 7 to 8 mm (.276 to .311 in).

If there is no spark, if it is weak or intermittent, the coil is defective and should be replaced.

SPARK PLUGS

Disassembly

First unscrew the spark plug one turn.

Clean the spark plug and cylinder head with pressurize air then completely unscrew.

Heat Range

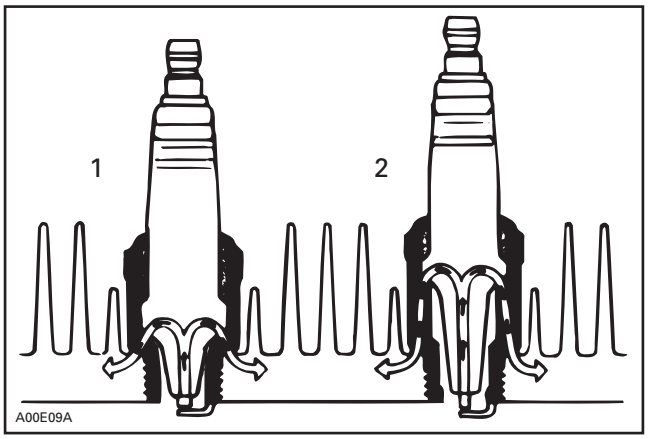
The proper heat range of the spark plugs is determined by the spark plugs ability to dissipate the heat generated by combustion.

The longer the heat path between the electrode tip to the plug shell, the hotter the spark plug operating temperature will be and inversely, the shorter the heat path, the colder the operating temperature will be.

A "cold" type plug has a relatively short insulator nose and transfers heat very rapidly into the cylinder head.

Such a plug is used in heavy duty or continuous high speed operation to avoid overheating.

The "hot" type plug has a longer insulator nose and transfers heat more slowly away from its firing end. It runs hotter and burns off combustion deposits which might tend to foul the plug during prolonged idle or low speed operation.



1. Cold
2. Hot

CAUTION: Severe engine damage might occur if a wrong heat range plug is used.

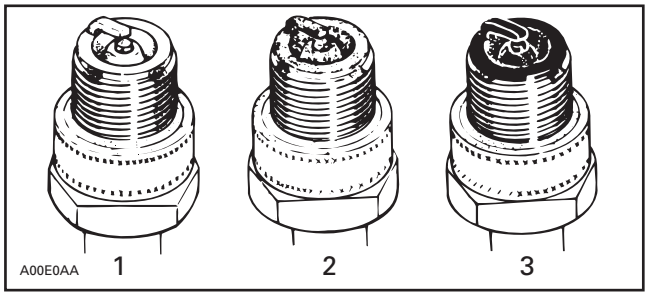
A too "hot" plug will result in overheating and pre-ignition, etc.

A too "cold' plug will result in fouling or may create carbon build up which can heat up red-hot and cause pre-ignition or detonation.

Fouling

Fouling of the spark plug is indicated by irregular running of the engine, decreased engine speed due to misfiring, reduced performance, and increased fuel consumption. This is due to a loss of compression. Other possible causes are: prolonged idling, or running on a too rich mixture due to a faulty carburetor adjustment or incorrect fuel. The plug face of a fouled spark plug has either a dry coating of soot or an oily, glossy coating given by an excess either of oil or of oil with soot. Such coatings form a conductive connection between the center electrode and ground.

Spark Plug Analysis



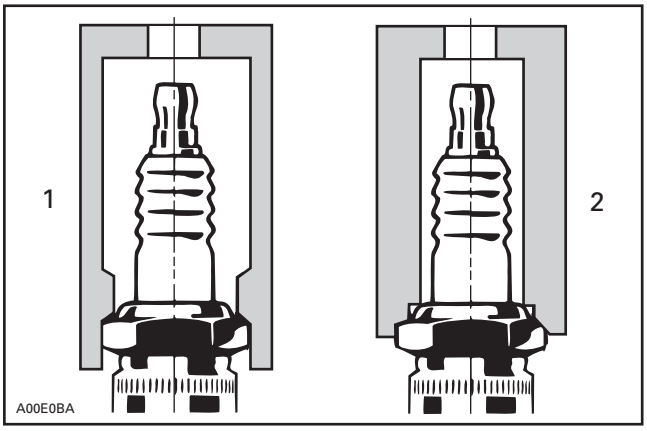
1. Overheated (light grey)
2. Normal (brownish)
3. Fouled (black)

The plug face (and piston dome) reveals the condition of the engine, operating condition, method of driving and fuel mixture. For this reason it is advisable to inspect the spark plug at regular intervals, examining the plug face (i.e. the part of the plug projecting into the combustion chamber) and the piston dome.

Spark Plug Installation

Prior to installation make sure that contact surfaces of the cylinder head and spark plug are free of grime.

1) Using a wire feeler gauge, set electrode gap according to the following chart.
2) Apply anti-seize lubricant over the spark plug threads to prevent possible seizure.
3) Hand screw spark plug into cylinder head and tighten with a torque wrench and a proper socket.



1. Proper socket
2. Improper socket

Spark Plug Chart

ENGINE	SPARK PLUG	TORQUE	GAP
717 and 787 RFI engines	BR8ES	24 N•m (17 lbf•ft)	0.4 - 0.5 mm (.016 - .020 po)

NOTE: Refer to next page for NGK SPARK PLUG SYMBOL EXPLANATION.

NGK Spark Plug Symbol Explanation